



# ENERGY STAR® Program Requirements for Downlights

## Partner Commitments

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Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR certified products. The ENERGY STAR Partner must adhere to the following partner commitments:

### Certifying Products

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1. **Comply with current ENERGY STAR Eligibility Criteria**, which define performance requirements and test procedures for Downlights. A list of eligible products and their corresponding Eligibility Criteria can be found at [www.energystar.gov/specifications](http://www.energystar.gov/specifications).
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR certification from a Certification Body recognized by EPA for Downlights. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Lamp testing. A list of EPA-recognized laboratories and certification bodies can be found at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification).

### Using the ENERGY STAR Name and Marks

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3. Comply with current ENERGY STAR Brand Book, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Brand Book are available at [www.energystar.gov/logouse](http://www.energystar.gov/logouse).
4. Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S. and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR certified Downlights. The ENERGY STAR mark must be clearly displayed on the front or primary display panel of the product packaging, in product literature (i.e., user manuals, spec sheets, etc.) and on the manufacturer's Internet site where information about ENERGY STAR certified models is displayed.

### Verifying Ongoing Product Certification

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6. Participate in third-party verification testing through a Certification Body recognized by EPA for Downlights, providing full cooperation and timely responses. EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR certified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

### Providing Information to EPA

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7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
  - 7.1. Partner must submit the total number of ENERGY STAR certified Downlights shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).

7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.

7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner.

8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.

9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at [www.energystar.gov/mesa](http://www.energystar.gov/mesa).

### **Performance for Special Distinction**

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In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR certified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR certified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR certified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR certified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR certified products.
- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR certified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR certified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.

- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit [www.epa.gov/smartway](http://www.epa.gov/smartway).
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit [www.epa.gov/greenpower](http://www.epa.gov/greenpower).



# ENERGY STAR® Program Requirements Product Specification for Downlights

## Eligibility Criteria Version 1.0

Following is the Version 1.0 product specification for ENERGY STAR certified downlights. A product must meet all of the identified criteria if it is to earn the ENERGY STAR.

### 1 SCOPE

Certification is limited to downlights and recessed downlight retrofit kits below a total input power of 150 watts intended to be connected directly to the electric power grid. See [Appendix A](#) for illustrations and more details on the scope of this specification.

#### 1.1 Included Products

- Downlights\* with built-in or integral LED module(s) and apertures  $\leq$  ten (10) inches that:
  - Are intended by the manufacturer to be:
    - Fully or partly recessed into the ceiling, or
    - Surface-mounted to the ceiling, or
    - Mounted to a wall lighting downward, or
  - Are provided with a cord, chain, tube, etc., which permits it to be suspended from a ceiling or wall support.
- Recessed downlight retrofit kits\* with built-in or integral LED module(s) and aperture  $\leq$  ten (10) inches.

\*Integral battery packs intended solely for emergency operation of the light source(s) in the event of loss of normal power are considered a feature related to the control of illumination, and as such, products incorporating them may be eligible for ENERGY STAR certification. Additionally, models including mesh Wi-Fi extenders are eligible for certification so long as standby power requirements ([Section 10.4](#)) are met.

#### 1.2 Excluded Products:

- Recessed downlights without an integrated light source.
- Recessed downlights and recessed downlight retrofit kits with aperture greater than ten (10) inches.
- Track-mounted accent lights
- Single- and multi-head monopoint accent lights
- Recessed, semi-recessed, surface mounted, or suspended luminaires with a linear form factor including 1x4, 2x2, or 2x4 troffers.
- Luminaire types typically employed for general office illumination such as linear pendants and panel lighting.
- Bath Vanity luminaires
- Ceiling Fan Light Kits
- Ceiling-mount luminaires that do not meet the Section 4 definition of a downlight.
- Close-to-ceiling mount luminaires that do not meet the Section 4 definition of a downlight.
- Chandeliers
- Cove Mount luminaires and Undercabinet lighting
- Decorative Pendants
- Flush-mount luminaires that do not meet the Section 4 definition of a downlight.
- Integrated LED Lamps
- Linear Strips
- Outdoor Ceiling-, Pendant-, Post-, and Wall-mounted luminaires
- Outdoor Security luminaires
- Portable desk and floor task lights
- Table Lamps
- Ventilating fans with lighting
- Torchieres and Floor Lamps
- Wall Sconces
- Wrapped Lens luminaires and work lights.
- LED Surface Mount Ceiling Retrofit kits.
- LED Surface Mount Wall Sconce Retrofit kits.
- High or low bay luminaires
- HID sources or their SSL replacements
- Socket adapters or converters
- LED lamps intended to replace linear fluorescent, pin-based compact fluorescent, or high-intensity discharge lamps.
- Products incorporating power-consuming features (e.g., luminaires with voice assistance, audio speakers, UV disinfection, or security cameras) in the active mode or off state that are not related to the control of illumination.

### 2 EFFECTIVE DATE

The ENERGY STAR Downlights Version 1 specification takes effect on November 16, 2023. To qualify for ENERGY STAR certification, the model must meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the exact date on which a unit is considered to be completely assembled.

### 3 FUTURE SPECIFICATION REVISIONS

Despite current federal standards excluding downlights and retrofit kits the ongoing general service lamp (GSL) rulemaking and the anticipated 2028 effective date of a new GSL standard does impact the baseline for this program and EPA will need to reevaluate the downlight market before 2028. Stakeholders are encouraged to share reliable sources of downlight market data to help inform continuation of this program beyond 2028. EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are informed through a transparent, inclusive stakeholder process. In the event of a specification revision, please note that ENERGY STAR certification is not automatically granted for the life of a product model.

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### **List of Acronyms and Abbreviations**

<b>ALA</b>	American Lighting Association
<b>ANSI</b>	American National Standards Institute
<b>ASTM</b>	ASTM International
<b>CIE</b>	Commission Internationale de l'Eclairage (International Commission on Illumination)
<b>CSA</b>	CSA International
<b>DOE</b>	U.S. Department of Energy
<b>EPA</b>	U.S. Environmental Protection Agency
<b>IEC</b>	International Electrotechnical Commission
<b>IES</b>	Illuminating Engineering Society
<b>LED</b>	Light Emitting Diode
<b>lm/W</b>	Lumens per watt
<b>NEMA</b>	National Electrical Manufacturers Association
<b>NRTL</b>	Nationally Recognized Testing Laboratory as recognized by OSHA's NRTL Program, which is a part of OSHA's Directorate of Technical Support
<b>OSHA</b>	Occupational Safety & Health Administration
<b>TMP<sub>c</sub></b>	LED Driver Case Temperature Measurement Point
<b>TMP<sub>LED</sub></b>	LED Temperature Measurement Point
<b>UL</b>	Underwriters Laboratories
<b>UUT</b>	Unit Under Test

## 4 DEFINITIONS

**Active Mode:** The state where the energy using product is connected to a mains power source and the primary light-producing function is activated. (Adapted from IEC 62301 Edition 2.0 2011-01)

**Aperture:** The planar opening through which light passes out of the downlight into the lighted space.

**Aperture Size:** The maximum distance between two points on the aperture.

**Beam Angle:** The angle in degrees, between the two opposite directions in which the average intensity is 50% of the center beam intensity as measured in at least two rotational planes, 90° from each other, around and through the beam axis. (ANSI C78.379-2006)

**Built-in LED Module:** LED module, designed to form a replaceable part built into a luminaire, a box, an enclosure or the like and not intended to be mounted outside a luminaire. (CIE S 017:2020 ILV: "built-in LED module")

**Color Rendering Index (CRI):** A measure of the degree of color shift objects undergo when illuminated by the light source, as compared with the color of those same objects when illuminated by a reference source of comparable color temperature. (ANSI/IES LS-1-22)

**Color Tunable Downlight:** For the purpose of this specification, a color tunable downlight has functionality that allows the end user to alter the color appearance of the light generated by the downlight, including any of the following features:

**Color Shifting Dimmable (aka Dim-to-Warm):** dimming capability designed to simulate the behavior of incandescent lamps where the chromaticity gradually shifts to a lower value as the product is dimmed.

**Full-Color-Tunable:** A feature allowing the end user to adjust the light output to create white or colored light. This tuning must include white light that is capable of meeting the specification's color requirements and can alter the color appearance along the black body curve, and also extend to colors beyond the ANSI defined correlated color temperature ranges (e.g., 2700K and 6500K) outside of the ANSI quadrangles.

**White-Tunable:** A feature allowing the end user to adjust the light output over a range of CCTs. This tuning must include white light that is capable of meeting the specification's color requirements along the black body curve.

**Communication Link:** The product shall include a communication link that is capable of bidirectional data transfer between the product and one or more external applications, devices, or systems. This link shall use open standards, as defined in this specification, for all communication layers.

**Connected Downlight:** A downlight or retrofit which includes elements or instructions (hardware and software or firmware) required to enable communication in response to consumer-authorized energy or performance related commands and complies with all requirements for connected in the specification. These elements may be resident inside or outside of the base downlight or retrofit.

**Consumer Authorized Third Party:** Any entity for which the consumer has provided explicit permission to access the product connected functionality, in whole or in part, via a Communication Link.

**Correlated Color Temperature (CCT):** The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source. (ANSI/IES LS-1-22)

**Down Light or Downlight:** A small luminaire that concentrates light downward towards the working plane and can be recessed (with only the trim and aperture showing) or surface mounted or suspended. (Adapted from CIE S 017:2020 ILV: "downlight"; ANSI/IES LS-1-22: "downlight"; and the ALA description of recessed lighting) For purposes of this specification, this definition includes downlight retrofit kits, recessed adjustable accent lights, and recessed models offering wallwash distribution that are under 150W, with aperture less than or equal to ten inches, and deliver a minimum of 75% of total lumens within the zone 0-60° from nadir.

**Downlight Retrofit:** A small luminaire intended to install into an existing downlight (with only the trim and aperture showing), replacing the existing light source and related electrical components, typically employing an ANSI standard lamp base, either integral or connected to the downlight retrofit by wire leads, and is a retrofit kit classified or certified to UL 1598C. This category does not include integrated LED lamps, or products that utilize an existing fluorescent ballast or transformer.

**Input Power:** The power consumption in watts of the unit under test operating in a normal or active mode, as determined in accordance with the relevant test procedure.

**Integral LED Module:** LED module designed to form a non-replaceable part of a luminaire. (CIE S 017:2020 ILV: "integral LED module")

**Interface Specification:** A document or collection of documents that contains detailed technical information to facilitate access to relevant data and product capabilities over a communications interface.

**LED Array or Module:** An assembly of LED packages (components), or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (ANSI/IES LS-1-22)

**LED Control Circuitry:** Electronic components designed to control a power source by adjusting output voltage, current, or duty cycle to switch or otherwise control the amount and characteristics of the electrical energy delivered to an LED package (component) or an LED array (module). LED control circuitry does include a power source. (ANSI/IES LS-1-22)

**LED Driver:** A device composed of a power source and LED control circuitry designed to operate an LED package (component), an LED array (module), or an LED lamp. (ANSI/IES LS-1-22)

**LED Driver Case Temperature Measurement Point (TMP<sub>c</sub>):** A location on an LED driver case, designated by its manufacturer, which will have the highest temperature of any point on the driver case during normal operation.

**LED Luminaire:** A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit. The LED-based light emitting elements may take the form of LED packages (components), LED arrays (modules), an LED Light Engine, or LED lamps. The LED luminaire is intended to connect directly to a branch circuit. (ANSI/IES LS-1-22)

**LED Package:** An assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (ANSI/IES LS-1-22)

**LED Temperature Measurement Point (TMP<sub>LED</sub>):** A location on an LED package/module/array, designated by its manufacturer, which provides a surrogate temperature measurement location for the actual LED junction. The TMP<sub>LED</sub> may be a solder joint at the board attachment site, a point on the LED package case, or a location on the board of an LED module or array.

**Light Emitting Diode (LED):** A p-n junction semiconductor device that emits incoherent optical radiation when forward biased. The optical emission may be in the ultraviolet, visible, or infrared wavelength regions. (ANSI/IES LS-1-22)

**Luminous Flux Maintenance (sometimes referred to as “lumen maintenance”):** The remaining luminous flux output (typically expressed as a percentage of the initial luminous flux output) at any selected elapsed operating time. Luminous flux maintenance (or “lumen maintenance”) is the converse of luminous flux depreciation (or “lumen depreciation”). (ANSI/IES LM-80-15).

**Luminous Efficacy:** The total emitted luminous flux divided by the total source electrical input power; expressed in lumens per watt (lm/W). (ANSI/IES LS-1-22: “Luminous Efficacy of a Source”)

**Luminaire:** A complete lighting unit consisting of a light source(s) and LED driver(s) together with the parts designed to distribute the light, to position and protect the light source(s), and to connect the light source(s) to the power supply. Also known as a light fixture. (Adapted from ANSI/IES LS-1-22).

**Measured value:** The directly measured value from testing equipment for a given unit under test.

**Nadir:** The angle pointing directly downward from the downlight, or zero degrees.

**Off Mode (Off State):** The state where the energy using product is connected to a mains power source and is not providing any standby mode, network mode, or active mode function. (IEC 62301 Edition 2.0 2011-01)

**Open Standards:** Standards that are: 1) Included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards, 6 and/or 2) Included in the National Institute of Standards and Technology (NIST) Smart Grid framework Tables 4.1 and 4.2, 7 and/or 3) Adopted by the American National Standards Institute (ANSI) or another well-established international standards organization such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), or Internet Engineering Task Force (IETF).

**Photocontrol or Light-Activated Switch:** A photoelectric switch that controls lighting by the level of daylight luminance (ANSI/IES LS-1-22), also referred to as a photosensor.

**Power Factor:** The power input in watts divided by the product of input voltage and input current, as measured under test conditions. (Adapted from ANSI Standard C82.2–2002 (R2016))

**Power Source:** A transformer, power supply, battery, or other device capable of providing current, voltage, or power within its design limits. This device contains no additional control capabilities. (ANSI/IES LS-1-22: “LED Power Source”)

**Rated Luminous Flux Maintenance Life (L<sub>p</sub>; sometimes referred to as Rated Lumen Maintenance Life):** The elapsed operating time over which the LED light source will maintain the percentage, *p*, of its initial light output, e.g., L<sub>70</sub> (hours): Time to 70% luminous flux maintenance. (Adapted from ANSI/IES TM-21-21)

**Recessed Accent Light (Recessed Adjustable Accent Light):** A recessed downlight with internal adjustable/aimable secondary optics designed to emphasize a particular object or surface feature, or to draw attention to a part of the field of view. (Adapted from ANSI/IES LS-1-22: “Accent Lighting”)

**Reported Value:** The value reported for purposes of compliance with Department of Energy regulations and/or ENERGY STAR requirements according to the criteria in each applicable section.

**Secondary Optics (“Optics”):** Materials modifying the distribution or amount of light from, but not integral to a light source, including but not limited to diffusers, reflectors, baffles, lenses, and total internal reflection optics.

**Standby Mode:** The condition in which the energy-using product is connected to a main power source; and offers one or more of the following user-oriented or protective functions: to facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer; or continuous functions, including information or status displays (including clocks) or sensor-based functions. (IEC 62301 ED.2.0 B-2011)

**Trim:** The part of a recessed downlight—most often a flat rim—that covers the ragged edge of the ceiling cut-out and creates an aperture through which light passes out of the downlight into the lighted space. The trim may be a separate ring, or trim ring, or it may be integrated with secondary optics (i.e., a self-flanged reflector). A trim can be airtight or non-airtight. For the purposes of ENERGY STAR certification, decorative trims and recessed adjustable accent lights with secondary optics that extend below the ceiling without fully concealing the aperture are included.

**Wallwash Distribution:** Luminous intensity distribution designed to deliver uniform illumination on an adjacent wall or vertical surface. (Adapted from ANSI/IES LS-1-22: “Wash”)



## 5 TEST CRITERIA

When testing downlights, the methods of measurement identified for each performance requirement in the “Methods of Measurement and/or Reference Documents” column of the performance requirements tables presented within this specification determine ENERGY STAR certification.

All tests must be conducted with the product connected to a supply circuit of rated frequency. For products with multiple operating voltages, the product must be operated at 120 volts throughout testing. If the product is not rated for 120 volts, it must be operated at the highest rated voltage. For dimmable or multi-power products, measurements must be taken at the highest input power setting listed for the model, unless otherwise specified in manufacturer-provided instructions.

### 5.1 Testing Color Tunable and Multi-Output Downlights

For the purpose of this specification, a color tunable downlight has functionality that allows the end user to alter the color appearance of the light generated by the downlight. This tuning must include white light that is capable of meeting the specification’s CCT requirements and can include the ability to alter the color appearance along the black body curve or may also extend to colors beyond the ANSI defined correlated color temperature ranges.

For the purpose of this specification, a multi-output downlight offers multiple discrete light output settings that allow the end user to select a discrete output during or after installation.

When testing color tunable or multi-output downlights, all tests and evaluations must be performed at the most consumptive white light setting (i.e., the white light setting that results in the highest measured input power) covered by this specification ([Section 8.2](#)). Partner must provide detailed instructions to test labs for the control settings or control signals (as applicable) for reaching the most consumptive white light setting.

## 6 PRODUCT CERTIFICATION

**Note:** Partners must ensure that all configurations certified as ENERGY STAR continue to meet the certification criteria through subsequent firmware, software, or other changes to the certified product.

### 6.1 Product Families

Grouped product submissions for ENERGY STAR certification must meet the following requirements: certified products within a product family must be identical to the tested, representative model with the exception of allowed variations listed in Table 1 below.

**The representative tested model must be the variation reported to have the highest input power.** As noted in [Section 12.1](#), laboratory test results must also be produced using the downlight variation expected to have the highest operating temperature among all variations in a product family being certified. Recessed downlight retrofit kits must be tested in the worst-case thermal environment that the product is rated for.

Allowable Product Family Example:

8” aperture Downlight	CCT Setting	Watts	Reflector	Lumens	Efficacy (lm/W)	Notes
Color tunable model offered with reflector options and available with non-IC and Type IC airtight housings	3000K	20.2	White	1,636	81	Default setting
	4000K	20.4	White	1,693	83	
	5000K	20.5	Black	1,435	70	Least efficient
	5000K	20.5	Silver	1,599	78	
	5000K	20.5	White	1,722	84	Representative tested model (Type IC, airtight housing)

During verification testing, any sampled configuration from a product family that (1) has measured input power greater than the reported input power for the representative model, or (2) fails to meet another verification testing criteria will result in a failed determination for all models whose certification is tied to the representative tested model. Note, units that undergo verification testing will not be evaluated for luminous efficacy.

**Table 1: Allowable Variations Within Product Families**

Downlight Attribute	Allowable Variation	Additional Test Data Required for Each Variant
<p><b>The representative tested model must be the variation reported to have the highest input power.</b>                      Testing required to document the additional required test data listed in this table must be performed by an EPA-recognized laboratory. However, testing to support a partner's engineering rationale for each variant does not.</p>		
<p><b>Light Source<sup>1</sup></b>                      (Refers to the make and/or model of the source; also review CCT below)</p>	<p>Allowed so long as the input power of the variant does not exceed the representative tested model and provided that the variant meets the minimum efficacy requirement when used at highest input power and with at least one optics/reflector/trim set and does not negatively impact the downlight's compliance with any other performance criteria in this specification.</p>	<p>Certified performance data for each additional light source:</p> <ul style="list-style-type: none"> <li>• In situ TMP<sub>LED</sub> temperature</li> <li>• LM-79 and LM-80 test reports.</li> <li>• TM-21 luminous flux maintenance life projection</li> </ul>
<p><b>LED Driver</b>                      (No change in nominal input power or current)</p>	<p>Allowed, provided that the variant meets the minimum efficacy requirement when used at highest input power and with at least one optics/reflector/trim set and does not negatively impact the downlight's compliance with any other performance criteria in this specification.</p>	<ul style="list-style-type: none"> <li>• LM-79 test report.</li> </ul> <p>Provide engineering rationale or thermal measurements (e.g., LED driver case temperature or TMP<sub>C</sub>) for each variation.</p>
<p><b>Product Input Power<sup>2</sup></b></p>	<p>The representative tested model must be the variation reported to have the highest input power.</p> <p>The LED package, array, or module model must not change, although CCT remains an allowable variation.</p> <p>The only permissible performance change to the downlight is to a LED driver that provides a different drive current to the LED package, array, or module.</p>	<ul style="list-style-type: none"> <li>• LED drive current measurement</li> <li>• Integrating sphere measurements per ANSI/IES LM-79-19 Section 7 or IES LM-79-08 Section 9 as required to represent performance of each variant including:                             <ul style="list-style-type: none"> <li>○ CCT</li> <li>○ Light Output</li> <li>○ CRI</li> <li>○ Power Consumption</li> <li>○ Chromaticity</li> </ul> </li> </ul>
<p><b>Housing/Chassis/Mounting</b></p>	<p>Allowed, provided that the light source, LED driver, and heat sink (as applicable) are integrated into the housing/chassis/mounting variation(s) in such a way that the thermal performance of the downlight is not degraded.</p>	<p>Provide engineering rationale or thermal measurements (e.g., TMP<sub>LED</sub>, or TMP<sub>C</sub>) for each variation.</p>
<p><b>Reflector/Trim</b></p>	<p>Allowed, provided that the applicable minimum light output requirement is met, and input power is not increased.</p>	<p>Provide engineering rationale or luminous flux measurements for the reflector variation with the smallest aperture and darkest or least efficient finish (as applicable) showing that it meets the applicable minimum light output requirement.</p>
<p><b>Correlated Color Temperature (CCT)</b>                      (Also review Light Source variation above)</p>	<p>Allowed, provided that the LED package/module/array series (and associated drive current), LED driver, and thermal management components are identical, and the variations will not negatively impact the downlight's compliance with any performance criteria in this specification. Partner must use different downlight model numbers to distinguish between models shipped with light sources of varying CCTs.</p>	<p>None</p>
<p><b>Electrical Connection</b></p>	<p>Allowed for recessed downlight retrofit kits (e.g., E26 and GU24).</p>	<p>None</p>
<p><b>Diffuser</b></p>	<p>Allowed, provided that minimum light output requirement is met, and thermal management is not compromised.</p>	<p>None</p>
<p><b>Exterior Housing Color/Pigment</b></p>	<p>Allowed for the exposed surfaces of housings required for alternate cable-, pendant-, semi-recessed, surface, and wall mounting configurations.</p>	<p>None</p>

<sup>1</sup> Partners may not retroactively add variations to a product family unless requirements in Table 1 are still met.

<sup>2</sup> When input power as a variation is used, changes to optics and LED package, array, or module (where applicable) are not permitted, as these changes would result in a change in distribution which must be re-evaluated against the downlight specific requirements. The additional models would still require an integrating sphere LM-79 test to verify other photometric and electrical performance requirements. Each input power variation should be listed individually.

## 6.2 Significant Digits and Rounding

- a. Measurements must be recorded at the resolution of the test instrumentation for each unit in the sample set.
- b. All calculations must be carried out on a per unit basis with directly measured (unrounded) values.
- c. Compliance with the specification limits must be evaluated against the reported value for each model.
- d. Rounding is defined as follows:
  - i. A fractional number at or above the midpoint between two consecutive decimal places or whole numbers must be rounded up to the higher of the two decimal places or whole numbers: or
  - ii. A fractional number below the midpoint between two consecutive decimal places or whole numbers must be rounded down to the lower of the two decimal places or whole number.

## 6.3 Solid State Luminous flux maintenance Performance Data

Content and application of IES LM-80 reports for LED downlights must comply with the [ENERGY STAR Requirements for the Use of LM-80 Data](#).

## 7 METHODS OF MEASUREMENT AND REFERENCE DOCUMENTS

Organization	Identifier	Description
ANSI/IEEE	<a href="#">C62.41.1-2002</a>	IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
ANSI/IEEE	<a href="#">C62.41.2-2002</a>	IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
ANSI	<a href="#">C78.377-2017 (R2022)</a>	Specifications for the Chromaticity of Solid State Lighting (SSL) Products
ANSI/ANSLG	<a href="#">C82.16-2022</a>	Light Emitting Diode Drivers—Methods of Measurement
ANSI	<a href="#">C82.18-2022</a>	Light Emitting Diode Drivers—Performance Characteristics
ANSI	<a href="#">C82.77-5-2017</a>	Lighting Equipment—Voltage Surge Requirements
ANSI	<a href="#">C82.77-10-2020</a> or -2014	Lighting Equipment—Harmonic Emission Limits—Related Power Quality Requirements
ANSI/UL	<a href="#">1310-2018</a>	Standard for Safety for Class 2 Power Units
ANSI/UL	<a href="#">1598-2021</a>	Standard for Safety of Luminaires
ANSI/UL	<a href="#">1598B-2010</a>	Standard for Supplemental Requirements for Downlight Reflector Kits for Installation on Previously Installed Fluorescent Luminaires
ANSI/UL	<a href="#">1598C</a>	Light-Emitting Diode (LED) Retrofit Downlight Conversion Kits
ANSI/UL	<a href="#">2108-2015</a>	Standard for Low-Voltage Lighting Systems
ANSI/UL	<a href="#">8750-2015</a>	Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products
ASTM	<a href="#">E283-04(2012)</a> or <a href="#">E283/E283M-19</a>	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen (Reapproved 2012)
CIE	<a href="#">Pub. No. 13.3-1995</a>	Method of Measuring and Specifying Color Rendering of Light Sources
CIE	<a href="#">Pub. No. 015:2004</a>	Colorimetry
EU	<a href="#">Directive 2002/95/EC</a>	Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
FCC	<a href="#">CFR Title 47 Part 15</a>	Radio Frequency Devices
FCC	<a href="#">CFR Title 47 Part 18</a>	Industrial, Scientific, and Medical Equipment
IEC	<a href="#">62301 ED.2.0 B:2011</a>	Household electrical appliances – Measurement of standby power
IEC	<a href="#">62321 Ed. 1.0</a>	Electrotechnical Products – Determination of Levels of Six Regulated Substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)
IEEE	<a href="#">1789-2015</a>	Recommending Practices for Modulating Current in High Brightness LEDs for Mitigating Health Risks to Viewers
IES	LM-58-13	Method for Spectroradiometric Measurement Methods for Light Sources
ANSI/IES	<a href="#">LM-58-20</a>	Approved Method: Spectroradiometric Measurement Methods for Light Sources
ANSI/IES	<a href="#">LM-79-19</a>	Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products
IES	LM-79-08	Electrical and Photometric Measurements of Solid-State Lighting Products
ANSI/IES	<a href="#">LM-80-21</a>	Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources
ANSI/IES	LM-80-15	Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
IES	LM-80-08 and its Addendum A	Measuring Lumen Maintenance of LED Light Sources
ANSI/IES	<a href="#">LS-1-22</a>	Nomenclature and Definitions for Illuminating Engineering
ANSI/IES	<a href="#">TM-21-21</a>	Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources
NEMA	<a href="#">LSD 45-2009</a>	Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires
NEMA	<a href="#">77-2017</a>	Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA	<a href="#">SSL 7A-2015 (R2021)</a>	Phase Cut Dimming for Solid State Lighting: Basic Compatibility

## 8 PHOTOMETRIC PERFORMANCE REQUIREMENTS

### 8.1 Luminous Efficacy, Output and Zonal Lumen Density

The performance values in this section pertain to the performance of the entire downlight, including optical losses.

ENERGY STAR Requirements			Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Luminous Efficacy (initial)	Minimum Light Output (initial)	Zonal Lumen Density		
Reported light output divided by reported input power must be $\geq$ 82 lumens per watt (lm/W).	$\leq$ 4.5" aperture: 345 lumens  > 4.5" aperture: 575 lumens	Downlights and recessed adjustable accent lights aimed at nadir must deliver a minimum of 75% of total lumens within the zone 0-60° from nadir.	<b>Methods of Measurement:</b> ANSI/IES LM-79-19 or IES LM-79-08  <b>Reference Document:</b> ANSI/UL 1598C	Laboratory test results must be produced using the complete downlight and the specific LED package, LED module or LED array and LED driver that will be used in production.  The representative tested model must be the variation reported to have the highest input power.  For downlight retrofits: the retrofit product must be installed in a can size within the dimensions and limitations prescribed in the ANSI/UL1598C safety listing. The test report must note the can model tested.  <b>Sample Size:</b> one complete luminaire.

### 8.2 Correlated Color Temperature (CCT)

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
The downlight or recessed downlight retrofit kit must be capable of providing at least one of the nominal correlated color temperatures (CCTs) below and must also fall within the corresponding 7-step chromaticity quadrangle as defined in ANSI C78.377-2017 (R2022).  <ul style="list-style-type: none"> <li>• 2200 Kelvin</li> <li>• 2500 Kelvin</li> <li>• 2700 Kelvin</li> <li>• 3000 Kelvin</li> <li>• 3500 Kelvin</li> <li>• 4000 Kelvin</li> <li>• 5000 Kelvin</li> </ul>	<b>Methods of Measurement:</b> ANSI/IES LM-79-19 or IES LM-79-08  <b>Calculation:</b> CIE 15.2004  <b>Reference Document:</b> ANSI C78.377-2017 (R2022)	One trim ring and one reflector may be used.  <b>Sample Size:</b> one complete luminaire.  <b>Passing Test:</b> The downlight, retrofit kit, or source (when installed in the downlight) must pass.

### 8.3 Color Rendering Index

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
The downlight or recessed downlight retrofit kit must be capable of meeting or exceeding $R_a \geq 80$ and $R_9 > 0$ .	<b>Methods of Measurement:</b> ANSI/IES LM-79-19 or IES LM-79-08  CIE 13.3-1995  <b>Reference Documents:</b> In situ temperature measurements: ANSI/UL 1598:2008 (Sections 19.7, 19.10-16)	<b>Sample Size:</b> one complete downlight or downlight retrofit kit. One trim ring and one reflector may be used.  <b>Passing Test:</b> The downlight, retrofit kit, or source (when installed in the downlight) must pass.

## 8.4 Color Angular Uniformity

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Throughout the beam angle, the variation of chromaticity must be within a total linear distance of 0.006 from the weighted average point on the CIE 1976 (u',v') diagram.</p>	<p><b>Methods of Measurement:</b> ANSI/IES LM-79-19 or IES LM-79-08  IES LM-58-13 or ANSI/IES LM-58-20  CIE 15: 2004</p>	<p>Vertical angular scanning resolution must be 1 degree on the 0- and 90-degree vertical planes, and <math>\Delta u', v'</math> distance must be reported for each vertical angle measured.</p> <p>Only the measurements within the beam angle must be evaluated for color angular uniformity.</p> <p>Downlights that utilize interchangeable trims may be tested without a trim to demonstrate compliance with the color angular uniformity requirement. This applies to the color angular uniformity requirement only and does not extend to other photometric requirements.</p> <p><b>Sample Size:</b> one complete Downlight.</p> <p><b>Passing Test:</b> The Downlight must pass.</p>

## 9 LUMINOUS FLUX MAINTENANCE AND RATED LIFE REQUIREMENTS

### 9.1 Luminous Flux Maintenance

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>The LED package(s)/ module(s)/array(s), including those incorporated into the downlight or recessed downlight retrofit kit must meet the following <math>L_{70}</math> rated luminous flux maintenance life value, in situ:</p> <p><math>L_{70}(6k) \geq 25,000</math> hours</p>	<p><b>Method of Measurement:</b></p> <p>Luminous flux maintenance: ANSI/IES LM-80-21 or ANSI/IES LM-80-15 or LM-80-08 and its Addendum A</p> <p>Luminous flux maintenance Projection Method: ANSI/IES TM-21-21</p> <p>CCT Calculation: CIE 15.2004</p> <p>ANSI/UL 1598:2008 (Sections 19.7, 19.10-16)</p> <p><b>Reference Documents:</b> Chromaticity Specifications: ANSI C78.377-2017 (R2022)</p> <p>Luminous flux maintenance: <a href="#">ANSI/IES TM-21 Calculator</a></p>	<p><b>Sample Size:</b> one complete downlight or recessed downlight retrofit kit.</p> <p>Minimum sample size of twenty units for LED packages, or ten units for LED arrays or LED modules, for each <math>T_S</math> and drive current combination (refer to IES TM-21). Each sample set may be composed entirely of one nominal CCT or may be split between no more than two adjacent nominal CCT values as outlined in ANSI C78.377 (e.g., 2700K and 3000K, or 3000K and 3500K).</p> <p><b>Passing Test:</b> The following conditions must be met:</p> <ol style="list-style-type: none"> <li>1. In the sample downlight, the in situ <math>TMP_{LED}</math> temperature is less than or equal to the temperature specified in the LM-80 test report for the corresponding or higher drive current, within the manufacturer's specified operating current range.</li> <li>2. The drive current measured in the downlight is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher.</li> <li>3. The TM-21 luminous flux maintenance life projection report projects an <math>L_{70}</math> meeting or exceeding requirements.</li> </ol> <p>Luminous flux maintenance projections must support all LED colors used.</p> <p>Demonstration of performance must be documented with a luminous flux maintenance life projection report as detailed in TM-21. The report must be generated using data from the LM-80 test report for the employed LED package/module/array model ("device"), the forward drive current applied to each device, and the in situ <math>TMP_{LED}</math> temperature of the hottest device in the downlight. In addition to LM-80 reporting requirements, the following information must be reported:</p> <ul style="list-style-type: none"> <li>• sampling method and sample size (per LM-80)</li> <li>• test results for each <math>T_S</math> and drive current combination.</li> <li>• description of device including model number and whether device is an LED package, module, or array (see Definitions)</li> <li>• ANSI target, and calculated CCT value(s) for each device in sample set</li> <li>• <math>\Delta u'v'</math> chromaticity shift value on the CIE 1976 diagram for each device in sample set</li> <li>• a detailed rationale, with supporting data, for application of results to other devices (e.g., LED packages with other CCTs)</li> </ul> <p>Access to the <math>TMP_{LED}</math> for the hottest LED may be accomplished via a minimally sized hole in the downlight housing, tightly resealed with a suitable sealant if created for purposes of testing.</p> <p>All thermocouple attachments and intrusions to the downlight housing must be photographed and documented for later reference if required.</p> <p>Important information regarding LM-80 test reports, their application, and provisions for successor subcomponents are detailed in the <a href="#">ENERGY STAR Requirements for the Use of LM-80 Data</a>.</p>

### 9.2 Light Source Life

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>The LED package(s) / LED module(s) / LED array(s), including those incorporated into retrofit kits, must meet the following <math>L_{70}</math> luminous flux maintenance life values (refer to Luminous Flux Maintenance Requirements in the preceding section):</p> <ul style="list-style-type: none"> <li>• <math>\geq 25,000</math> hours</li> </ul> <p>Claims in excess of the above requirement must be substantiated with an <a href="#">ANSI/IES TM-21 Calculator</a> luminous flux maintenance life projection report.</p>		

## 9.3 Color Maintenance

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Downlight change in chromaticity coordinates from 0-hour measurement, at any measurement point during operation, must be <math>\leq</math> a total linear distance of 0.007 on the CIE 1976 u'v' diagram. All units must meet this requirement.</p> <p>The change of chromaticity at each measurement point over the tested hours of operation must be <math>\leq</math> 0.007 on the CIE 1976 (u',v') diagram, as demonstrated by the IES LM-80 test report for the employed LED package, array, or module model.</p>	<p><b>Methods of Measurement:</b> ANSI/IES LM-80-21 or IES LM-80-15 or LM-80-08 and its Addendum A</p> <p><b>Reference Documents:</b> Interim operation: ANSI/UL 1598-2021 ANSI/UL 1598C-2014</p>	<p>Laboratory test results must be produced using the specific models of lamp or LED package, LED module or LED array and LED driver that will be used in production.</p> <p><b>Sample Size:</b> same as Luminous Flux Maintenance.</p> <p><b>Passing Test:</b> for all LM-80 samples, at any measurement point, the distance of the chromaticity coordinates from the initial (zero hour) chromaticity coordinates must not exceed 0.007 at the temperature(s) adjacent to the measured in situ <math>TMP_{LED}</math> temperature, and at the corresponding drive current.</p> <p><i>Example 1: an LM-80 test report provides data at <math>T_s = 55^\circ\text{C}</math>, <math>85^\circ\text{C}</math> and <math>105^\circ\text{C}</math>, and the measured in situ <math>TMP_{LED}</math> temperature value is <math>89^\circ\text{C}</math>. Neither the <math>85^\circ\text{C}</math> nor the <math>105^\circ\text{C}</math> LM-80 data may show chromaticity shift exceeding 0.007 at any measurement point from zero through 6,000 hours, for the corresponding drive current. The LM-80 chromaticity data at <math>55^\circ\text{C}</math> is disregarded.</i></p> <p><i>Example 2: an LM-80 test report provides data at <math>T_s = 58^\circ\text{C}</math>, <math>87^\circ\text{C}</math> and <math>106^\circ\text{C}</math>, and the measured in situ <math>TMP_{LED}</math> temperature value is <math>53^\circ\text{C}</math>. The LM-80 data at <math>58^\circ\text{C}</math> may not show chromaticity shift exceeding 0.007 at any measurement point from zero through 6,000 hours, for the corresponding drive current. The LM-80 chromaticity data at <math>87^\circ\text{C}</math> and <math>106^\circ\text{C}</math> is disregarded.</i></p>

## 10 ELECTRICAL PERFORMANCE REQUIREMENTS

### 10.1 Source Start Time

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Light source must remain continuously illuminated within:</p> <ul style="list-style-type: none"> <li>One second of application of electrical power for connected products.</li> <li>750 milliseconds of application of electrical power for all other products.</li> </ul>	<p><b>Method of Measurement:</b> <a href="#">ENERGY STAR Start Time Test Method</a> or ANSI C82.16-2022, sections 3.7 and 13</p>	<p>Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver that will be used in production.</p> <p><b>Sample Size:</b> one sample of each LED package/LED module/LED array and LED driver model combination must be tested.</p> <p><b>Passing Test:</b> sample must pass.</p>

### 10.2 Power Factor

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Power Factor must be <math>\geq 0.7</math></p>	<p><b>Method of Measurement:</b> ANSI C82.77-10:2014 or ANSI C82.77-10-2021</p>	<p>Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver that will be used in production.</p> <p><b>Sample Size:</b> <math>\geq 1</math> samples of each model combination must be tested.</p> <p><b>Passing Test:</b> all samples must pass.</p>

### 10.3 Transient Protection

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>LED driver must comply with ANSI/IEEE C62.41.1-2002 and ANSI/IEEE C62.41.2-2002, Category A operation.</p> <p>The line transient must consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.</p>	<p><b>Method of Measurement:</b> None referenced.</p> <p><b>Reference Documents:</b> ANSI C82.77-5-2017 or ANSI/IEEE C62.41.1-2002 ANSI/IEEE C62.41.2-2002 Category A Location.</p>	<p>Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver combination that will be used in production.</p> <p><b>Sample Size:</b> ≥ 1 samples of each LED package, LED module or LED array and LED driver model combination must be tested.</p> <p><b>Passing Test:</b> all samples must pass.</p> <p>Unit power may be cycled as necessary to determine if UUT is still operational.</p>

### 10.4 Standby Power Consumption

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Products must not draw power in the off mode.</p> <p><u>Exceptions:</u></p> <ul style="list-style-type: none"> <li>• Products with integral motion sensors, occupancy sensors or photosensors, <u>or</u> connected functionality (including mesh Wi-Fi extenders) may draw up to 0.5 watts in standby mode.</li> <li>• Products with energy saving features i.e., integral motion sensors, occupancy sensors or photosensors <u>and</u> connected functionality (including mesh Wi-Fi extenders) may draw up to one watt in standby mode.</li> </ul>	<p><b>Method of Measurement:</b> IEC 62301 ED.2.0 B-2011 or ANSI C82.16-2022, section 15</p> <p><b>Reference document:</b> International Efficiency Marking Protocol <a href="https://downloads.regulations.gov/EERE-2008-BT-STD-0005-0218/content.pdf">https://downloads.regulations.gov/EERE-2008-BT-STD-0005-0218/content.pdf</a></p>	<p>Laboratory test results must detail standby power consumption to the tenth of a watt.</p>

### 10.5 Operating Frequency:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Frequency ≥ 120 Hz</p> <p>Note: This performance characteristic addresses problems with visible flicker due to low frequency operation and applies to steady state as well as dimmed operation. Dimming operation must meet the requirement at all light output levels.</p>	<p><b>Method of Measurement:</b> ANSI C82.18</p> <p><b>Reference Document:</b> IEEE PAR1789</p>	<p>Laboratory test results must be produced using the specific downlight or recessed downlight retrofit kit. Light output waveform must be measured with a photodetector with a rise time of ten microseconds or less, transimpedance amplifier and oscilloscope. Employed equipment models and method of measurement must be documented in the test report. Temporal response, amplification, and filtering characteristics of the system must be suitably designed to capture the photometric waveform. Digitized photometric waveform data and an image of the relative photometric amplitude waveform must be recorded in the test report. Measured data must be recorded to a digital file with an interval between each measurement no greater than 0.00005 sec (50 microseconds) corresponding to an equipment measurement rate of no less than 20 kHz and capture at least one second of data.</p> <p><b>Sample Size:</b> one downlight or recessed downlight retrofit kit must be tested.</p>



## 10.6 Flicker:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance																																
<p>The following flicker-related metrics must be reported:</p> <ul style="list-style-type: none"> <li>Short Term Flicker Indicator (<math>P_{st}</math>)</li> <li>Stroboscopic Visibility Measure (SVM)</li> </ul> <p>Optional: meet NEMA 77-2017 for temporal light modulation limits.</p> <p>These requirements address problems with visible flicker due to low frequency operation and applies to steady state as well as dimmed operation.</p>	<p><b>Method of Measurement:</b> NEMA 77-2017 or ANSI C82.18</p> <p><b>Reference Document:</b> IEEE PAR1789</p>	<p><b>Sample Size:</b> one downlight or recessed downlight retrofit kit must be tested.</p> <p>Laboratory test results must be produced using the specific downlight or recessed downlight retrofit kit .</p> <p>For downlights not marketed as dimmable, measurements must be taken at full light output.</p> <p>For downlights marketed as dimmable, measurements must be taken at the dimmed levels recommended in NEMA 77.</p> <p>The reported values of <math>P_{st}</math> and SVM must be the highest value measured.</p> <p>For the purposes of ENERGY STAR, the waveform digitizer (e.g., oscilloscope) used to capture the waveform data used for the calculation of the reported metrics must have:</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th></th> <th>Units</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Dynamic range of waveform amplitude</td> <td><math>P_{st}</math></td> <td></td> <td><math>\geq 1000:1</math> (60 dB)</td> </tr> <tr> <td>SVM</td> <td></td> <td><math>\geq 100:1</math> (40 dB)</td> </tr> <tr> <td rowspan="2">Sampling Time</td> <td><math>P_{st}</math></td> <td>Seconds</td> <td><math>\geq 180</math></td> </tr> <tr> <td>SVM</td> <td>Seconds</td> <td><math>\geq 1</math></td> </tr> <tr> <td rowspan="2">Sampling Rate</td> <td><math>P_{st}</math></td> <td>kHz</td> <td><math>\geq 10</math></td> </tr> <tr> <td>SVM</td> <td>kHz</td> <td><math>\geq 20</math></td> </tr> <tr> <td rowspan="2">Temporal bandwidth (-3 dB cutoff frequency)</td> <td><math>P_{st}</math></td> <td>kHz</td> <td><math>\geq 0.5</math></td> </tr> <tr> <td>SVM</td> <td>kHz</td> <td><math>\geq 5</math></td> </tr> </tbody> </table> <p>Waveform data must be submitted in CSV format to support the reported values of <math>P_{st}</math> and SVM</p>	Parameter		Units	Value	Dynamic range of waveform amplitude	$P_{st}$		$\geq 1000:1$ (60 dB)	SVM		$\geq 100:1$ (40 dB)	Sampling Time	$P_{st}$	Seconds	$\geq 180$	SVM	Seconds	$\geq 1$	Sampling Rate	$P_{st}$	kHz	$\geq 10$	SVM	kHz	$\geq 20$	Temporal bandwidth (-3 dB cutoff frequency)	$P_{st}$	kHz	$\geq 0.5$	SVM	kHz	$\geq 5$
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Sampling Time	$P_{st}$	Seconds	$\geq 180$																															
	SVM	Seconds	$\geq 1$																															
Sampling Rate	$P_{st}$	kHz	$\geq 10$																															
	SVM	kHz	$\geq 20$																															
Temporal bandwidth (-3 dB cutoff frequency)	$P_{st}$	kHz	$\geq 0.5$																															
	SVM	kHz	$\geq 5$																															

## 11 SERVICEABILITY RECOMMENDATIONS

### 11.1 Light Source Serviceability:

ENERGY STAR Recommendations
When possible, make use of electrical interconnects that allow for consumer replacement of the engine or kit without the cutting of wires or the use of solder, including wire nuts and other reusable connectors.

### 11.2 LED Driver Replaceability:

ENERGY STAR Recommendations
When possible, enable LED drivers to be accessible and removable by an electrician without the cutting of wires and without damage to the downlight housing, trim, or the carpentry (e.g., ceiling drywall) in which the downlight is recessed. Instructions must be provided with the downlight, detailing guidance on LED driver replacement by a “qualified electrician.”

## 12 THERMAL PERFORMANCE REQUIREMENTS

### 12.1 Maximum Measured LED Driver Case Temperature:

This performance characteristic is separate and distinct from safety requirements and may be measured by an EPA recognized laboratory. Revisions to the maximum recommended LED driver case temperature must be made prior to verification testing.

Product Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<b>Downlight</b>	At thermal equilibrium, the measured LED driver case temperature at $TMP_c$ must not exceed the LED driver manufacturer's maximum recommended temperature during in situ (installed in the downlight) operation.	<b>Reference Documents:</b> ANSI/UL 1598:2008 (Sections 19.7, 19.10-16)	Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver that will be used in production.  Laboratory test results must be produced using the downlight with the highest operating temperature among all Downlights in a product family being certified (as applicable).  <b>Sample Size:</b> one downlight must be tested must be tested in situ.  <b>Passing Test:</b> Measured temperature at $TMP_c$ must be less than or equal to the manufacturer recommended maximum.
<b>Recessed Downlight Retrofit Kit</b>	At thermal equilibrium, the measured LED driver case temperature at $TMP_c$ must not exceed the LED driver manufacturer's maximum recommended temperature during in situ (installed in the downlight) operation.	<b>Reference Document:</b> ANSI/UL 1598C	Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver that will be used in production.  Downlight retrofit kit must be tested in the worst-case thermal condition for which it is rated per ANSI/UL1598C-2014.  Recessed downlight retrofit kits must be tested in the worst-case thermal environment that the product is rated for per ANSI/UL1598C-2014.  <b>Sample Size:</b> one sample must be tested in situ per the included manufacturer provided installation instructions in a representative downlight per UL1598C-2014.  <b>Passing Test:</b> Measured temperature at $TMP_c$ must be less than or equal to the manufacturer recommended maximum.

### 12.2 Thermal Performance

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<b>Insulation contact (Type IC):</b> Recessed downlights marketed as Type IC must be approved for zero clearance insulation cover by an OSHA NRTL laboratory.  <b>Airtight construction:</b> Recessed downlight housings or certified/listed accessories marketed as airtight must exhibit leakage less than 2.0 cubic feet per minute (CFM) at 75 Pascals (or 1.57 lbs/ft <sup>2</sup> ) when tested in accordance with ASTM E283-04(2012) or ASTM E283/E283M-19 and must be sealed with a gasket or caulk.	<b>Reference Documents:</b> ANSI/UL 1598-2021  ASTM E283-04(2012) or ASTM E283_E283M-19	For models not rated for insulation contact, packaging and installation instructions must comply with all existing safety standards.

## 13 SAFETY REQUIREMENTS

### 13.1 Luminaire Safety:

Product Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<b>Downlight</b>	Demonstrate compliance with ANSI/UL 1598-2021, ANSI/UL 1598C-2014, ANSI/UL 2108-2015, ANSI/UL 8750-2015, as applicable.	<b>Reference Documents:</b> ANSI/UL 1598-2021 ANSI/UL 1598C-2014 ANSI/UL 2108-2015 ANSI/UL 8750-2015	An OSHA <a href="#">NRTL laboratory</a> must produce this documentation.  Connected products must continue to comply with the applicable product safety standards; the addition of the functionality must not override existing safety protections and functions.
<b>Recessed Downlight Retrofit Kit</b>	Demonstrate compliance with ANSI/UL 8750-2015 – LED Component ANSI/UL 1598C-2014 – LED Retrofit	<b>Reference Documents:</b> ANSI/UL 8750-2015 – LED Component ANSI/UL 1598C-2014 – LED Retrofit	

## 13.2 LED Driver Safety:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Demonstrate compliance with ANSI/UL 1310-2018, ANSI/UL 2108-2015, or ANSI/UL 8750-2015, as applicable.	<b>Reference Documents:</b> ANSI/UL 1310-2018 ANSI/UL 2108-2015 ANSI/UL 8750-2015	An OSHA <a href="#">NRTL laboratory</a> must produce this documentation.  Connected products must continue to comply with the applicable product safety standards – the addition of the functionality must not override existing safety protections and functions.

## 14 CONTROL REQUIREMENTS: Downlights Employing any Control Mechanism

### 14.1 Dimming: All Products Marketed as Dimmable

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
The product and its components must provide continuous dimming from 100% to 20% of light output.  At minimum light output, the downlight must not emit noise above 24 dBA when measured within one meter of the Downlight.	<b>Method of Measurement:</b> None  <b>Reference Document:</b> NEMA SSL 7A-2015 (R2021)	Laboratory test results must be produced using the models of LED package, LED module or LED array and LED driver combination that will be used in production. The test must be performed at the lowest dimming level claimed by partner.  <b>Sample Size:</b> 1 sample of the complete downlight or retrofit kit.  <b>Passing Test:</b> the sample must pass.

### 14.2 Products with Connected Functionality – Optional

To be recognized as connected, on the ENERGY STAR certified product list, a “connected downlight” (or retrofit kit) must include the base downlight or retrofit kit plus elements (hardware and software or firmware) or instructions required to enable communication in response to consumer-authorized energy or performance related commands (e.g., instructions for downloading a mobile application, Bluetooth syncing guidance) and must meet the requirements in sections 14.2.1-14.2.5. These elements may be resident inside or outside of the base downlight. Connected downlights typically communicate with controls via a radio frequency system, although some versions use other methods (such as DMX or DALI). The specific design and implementation of the connected downlight is at the partner’s discretion provided it is interoperable with other devices and enables economical, consumer-authorized third-party access to the functions provided for in sections 14.2.2, 14.2.3, and 14.2.4.

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Product must continue to comply with the applicable product safety standards – the addition of the functionality must not override existing safety protections and functions.  Must comply with <a href="#">Section 10.4</a> Standby Power	<b>Method of Measurement:</b> None	Connected products without color tuning capabilities must be tested at full power for all applicable requirements. Connected products with color tuning capabilities must be tested under the conditions specified under <a href="#">Section 5.1</a> .  Compliance with connected functionality requirements must be demonstrated through examination of product and/or product documentation.

#### 14.2.1 Open Access

EPA recommends that products use open standards for all communication layers as applicable, including remote management, energy consumption reporting, and operational status reporting. To enable interconnection with the product; an interface specification, Application Programming Interface (API) or similar documentation must be made available to interested parties that enables section 14.2.3, 14.2.4 and 14.2.5 connected functionality, and includes accuracy, units, and measurement intervals for Energy Consumption Reporting.

#### 14.2.2 Energy Consumption Reporting

The product must be capable of interconnecting with consumer authorized entities to communicate data representative of its interval energy consumption. It is recommended that data be reported in watt-hours for intervals of 15 minutes, however, representative data may also be reported in alternate units and intervals as specified in the partner’s interface specification or API.

#### 14.2.3 Operational Status Reporting

At a minimum, the product must be capable of providing the on/off status to energy management systems and other consumer authorized devices, services, or applications via a communication link.

#### 14.2.4 Remote Management

The product must be capable of receiving and responding to energy management system or other consumer authorized remote requests, via devices, services, or applications, similar to hard-wired consumer controllable functions. The product is not required to respond to remote requests that would compromise performance and/or product safety as determined by the product manufacturer.

#### 14.2.5 Information to Consumers

If additional devices, services, and/or infrastructure are required to activate the product's connected capabilities, prominent labels or other forms of consumer notifications must be displayed at the point of purchase and in the product literature. (e.g., "This product has Z-wave control capability and requires interconnection with a Z-wave controller to enable local lighting control.")

### 15 PRODUCT LABELING & PACKAGING REQUIREMENTS:

#### 15.1 Labeling & Packaging:

For units of certified models not intended for retail shelf stocking, these requirements may be fulfilled by providing a supplemental performance summary that includes all of the applicable requirements below. This performance summary must be provided for certification and to any online reseller to help ensure online marketing is consistent with ENERGY STAR certification.

ENERGY STAR Requirements
<ul style="list-style-type: none"> <li>• Packaging or performance summary, and marketing claims must represent the product consistent with its certification.</li> <li>• Packaging or supplemental performance summary must clearly describe the nominal color designation of the lamp in units of Kelvin (e.g., 2700K, 3000K).</li> <li>• Demonstrate the light distribution of the downlight on a cut sheet, marketing materials or packaging, or performance summary.</li> <li>• Comply with current ENERGY STAR Brand Book, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Brand Book is available at <a href="https://www.energystar.gov/partner_resources/energy-star-brand-book">https://www.energystar.gov/partner_resources/energy-star-brand-book</a>.</li> <li>• Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S. and/or ENERGY STAR partner countries.</li> <li>• Provide clear and consistent labeling of ENERGY STAR certified downlights and recessed downlight retrofit kits. The ENERGY STAR mark must be clearly displayed on the front or primary display panel of the product packaging, in product literature (i.e., user manuals, spec sheets, etc.) and on the manufacturer's Internet site where information about ENERGY STAR certified models is displayed.</li> </ul> <p><b>For products marketed as dimmable:</b></p> <p>Packaging or performance summary must:</p> <ul style="list-style-type: none"> <li>• Indicate dimming range (as applicable).</li> <li>• Include a list of compatible dimmers and/or other controls, or web address (e.g., via QR code) to find out more specific information.               <ul style="list-style-type: none"> <li>○ Partner must periodically review this packaging or performance summary language to determine if updates are needed. Partner is encouraged to also maintain an up-to-date web address where additional compatibility information is detailed.</li> </ul> </li> <li>• Include a list of known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or other external lighting controls, or a message noting limitations and web site address to find out more specific information.               <ul style="list-style-type: none"> <li>○ Partner must periodically review this packaging or performance summary language to determine if updates are needed. Partner is encouraged to also maintain an up-to-date web address where additional compatibility information is detailed.</li> </ul> </li> </ul>

#### 15.2 Light Source Shipment:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents
<p>Complete light source components must be provided with the downlight or retrofit kit.</p> <p>Optional: The downlight certification may indicate compliance with a Zhaga book if the light engine utilized is on the Zhaga Consortium's Certified Products Database.</p>	<p><b>Reference Document:</b> Zhaga Consortium's Certified Products Database <a href="https://www.zhagastandard.org/products.html">https://www.zhagastandard.org/products.html</a></p>

## 16 WARRANTY REQUIREMENTS:

**Note:** Partners must provide a copy of the actual warranty that is included with the downlight or recessed downlight retrofit kit packaging. Partner is solely responsible for honoring warranty; intermediate parties (e.g., showrooms, electrical distributors, retailers) are not responsible for honoring warranty claims.

ENERGY STAR Requirements
<p>For downlights and recessed downlight retrofit kits incorporating replaceable LED drivers, a written warranty must be included within product packaging at the time of shipment that covers repair or replacement of defective parts of the housing, mounting hardware, optics, LED driver, and trim for a minimum of 3 years from the date of purchase.</p> <p>For downlights and recessed downlight retrofit kits incorporating non-replaceable LED drivers, the above warranty requirement is extended to 5 years.</p> <p>Warranty language must not place limitations on coverage based on duration of operation (e.g., hours per day).</p>

## 17 Lighting Toxics Reduction Requirements:

ENERGY STAR Requirements	Method of Compliance
<p>Downlights and recessed downlight retrofit kits must not exceed hazardous substance concentrations set for in the European Union's (EU) Restriction of the Use of Certain Hazardous Substances (RoHS) Directive, 2003.</p> <p>Downlights and recessed downlight retrofit kits must not exceed:</p> <ul style="list-style-type: none"> <li>• 0.1% by weight in homogenous material (1000 ppm): Mercury, Lead, Hexavalent Chromium, PBB (polybrominated biphenyls), and PBDE (polybrominated diphenyl ethers)</li> <li>• 0.01% by weight in homogenous material (100 ppm): Cadmium</li> </ul> <p>A list of RoHS exemptions that will be accepted by the ENERGY STAR program that may be relevant to downlights is detailed below:</p> <p><u>Exemptions:</u></p> <ol style="list-style-type: none"> <li>1. Lead in high melting temperature type solders (i.e., lead-based alloys containing 85% by weight or more lead).</li> <li>2. Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g., piezoelectronic devices, or in a glass or ceramic matrix compound.</li> <li>3. Cadmium and its compounds in electrical contacts.</li> <li>4. Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages.</li> <li>5. Lead with PbBiSn-Hg and PbInSn-Hg in specific compositions as main amalgam and with PbSn-Hg as auxiliary amalgam in very compact energy saving lamps.</li> <li>6. Cadmium in color-converting II-IV LEDs (&lt; 10 µg Cd per mm<sup>2</sup> of light-emitting area) for use in solid state illumination or display systems.</li> </ol>	<p>Partner must maintain documentation on file to demonstrate that certified products meet these requirements. EPA reserves the right to request this documentation at any time.</p> <p>Partner may rely on component suppliers to provide certification or declaration documents to show that homogenous materials used in lamps comply with the requirement. Alternatively, partner may have components tested in accordance with IEC 62321 or other appropriate analytical technique to verify that homogenous materials do not exceed the concentration limits of the six regulated substances. Handheld XRF analyzers/scanners may also be used to verify compliance.</p>

## APPENDIX A: Scope Details & Examples

Following is a summary of the definitions and criteria defining scope accompanied by illustrations and images for Examples of excluded luminaires that EPA considers outside the scope of this specification are also provided.

### Included Products

- Downlights with built-in or integral LED module(s) and apertures  $\leq$  ten (10) inches that:
  - Are intended by the manufacturer to be:
    - Fully or partly recessed into the ceiling, or
    - Surface-mounted to the ceiling, or
    - Mounted to a wall lighting downward, or
  - Are provided with a cord, chain, tube, etc., which permits it to be suspended from a ceiling or wall support.
- Recessed downlight retrofit kits with built-in or integral LED module(s) and aperture  $\leq$  ten (10) inches.

### Definitions

**Down Light or Downlight:** A small luminaire that concentrates light downward towards the working plane and can be recessed (with only the trim and aperture showing) or surface mounted or suspended. (Adapted from CIE S 017:2020 ILV: "downlight"; ANSI/IES LS-1-22: "downlight"; and the ALA description of recessed lighting) For purposes of this specification, this definition includes downlight retrofit kits, recessed adjustable accent lights, and recessed models offering wallwash distribution that are under 150W, with aperture less than or equal to ten inches, and deliver a minimum of 75% of total lumens within the zone 0-60° from nadir.

**Downlight Retrofit:** A small luminaire intended to install into an existing downlight (with only the trim and aperture showing), replacing the existing light source and related electrical components, typically employing an ANSI standard lamp base, either integral or connected to the downlight retrofit by wire leads, and is a retrofit kit classified or certified to UL 1598C. This category does not include integrated LED lamps, or products that utilize an existing fluorescent ballast or transformer.

Other related definitions:

**Aperture:** The planar opening through which light passes out of the downlight into the lighted space.

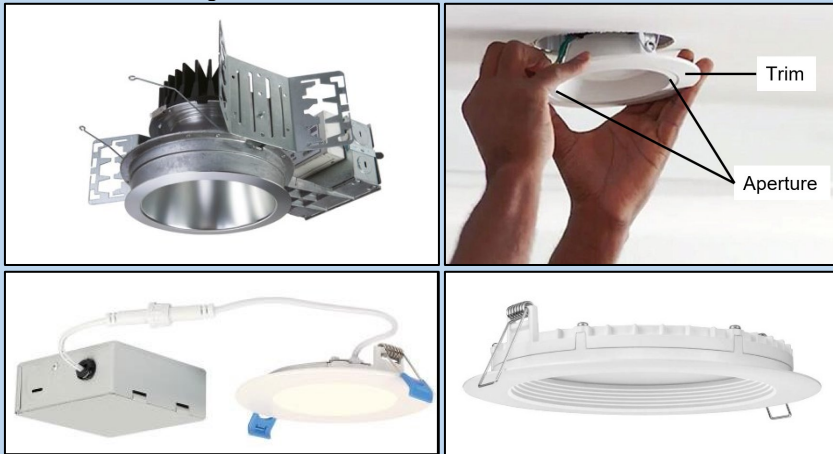
**Aperture Size:** The maximum distance between two points on the aperture.

**Trim:** The part of a recessed downlight—most often a flat rim—that covers the ragged edge of the ceiling cut-out and creates an aperture through which light passes out of the downlight into the lighted space. The trim may be a separate ring, or trim ring, or it may be integrated with secondary optics (i.e., a self-flanged reflector). A trim can be airtight or non-airtight. For the purposes of ENERGY STAR certification, decorative trims and recessed adjustable accent lights with secondary optics that extend below the ceiling without fully concealing the aperture are included.

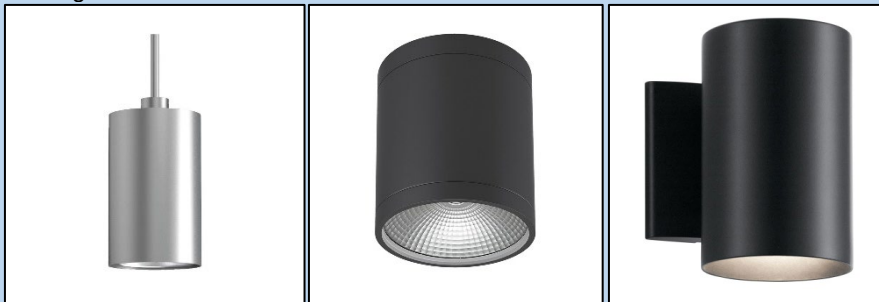
The following examples are meant to help clarify scope and are not an exhaustive list of what is included and excluded. When in doubt, partners should always ask their Certification Body.

## Included Product examples

**Figure 1:** Examples of included downlights and downlight retrofit kits intended to be recessed in a ceiling.



**Figure 3:** Examples of included suspended, surface-, and wall-mounted downlights. Note: the aperture of these products is most often defined by an opening in the outer housing rather than a trim.



## Excluded Product examples

**Figure 2:** Examples of excluded downlights without a built-in or integral LED module or with aperture > 10 inches.



**Figure 4:** Excluded Ceiling- and Flush-Mount Luminaires and Retrofit Kits.



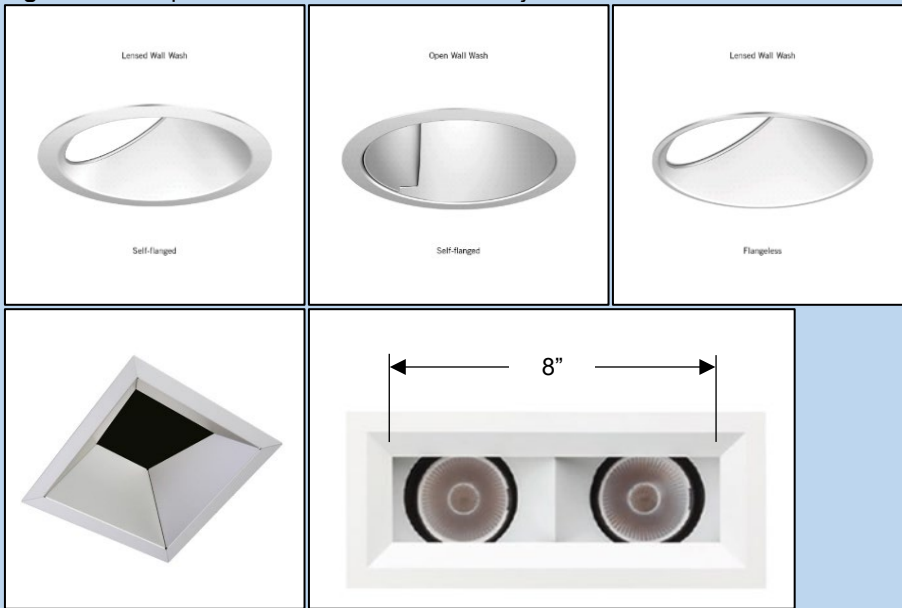
Surface-mounted luminaires and retrofit kits such as these that could be mounted beneath an existing recessed downlight housing but that have diffusers that extend below the ceiling and that do not have a trim and aperture as defined in [Section 4](#) are excluded from the scope of this specification.



Suspended and surface-mounted decorative luminaires such as these with transparent or translucent outer housing are excluded from the scope of this specification.

## Included Product examples

**Figure 5:** Examples of included wallwash and adjustable accent trims.

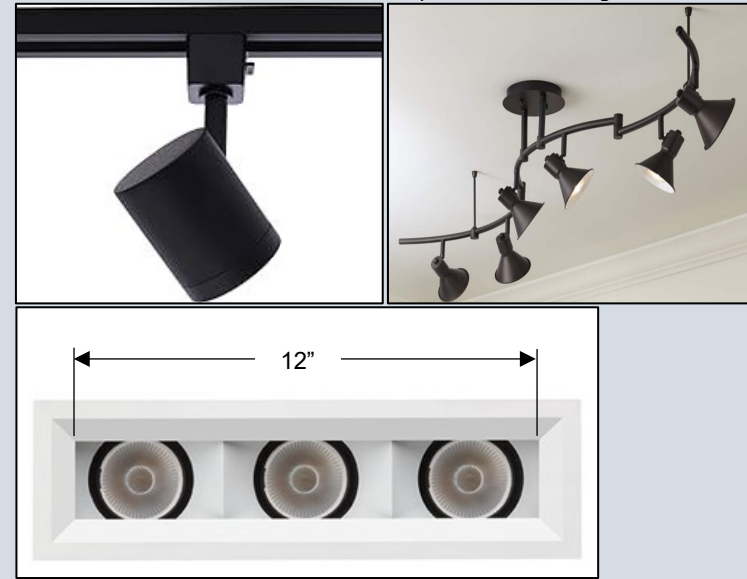


**Figure 7:** Examples of included trims (decorative and functional) that extend below the ceiling without concealing the aperture.



## Excluded Product examples

**Figure 6:** Examples of other excluded track- or monopoint-mounted accent fixtures, and recessed accent luminaires with aperture exceeding ten inches.



**Figure 8:** Examples of other excluded undercabinet, pendant, surface mount ceiling retrofit kits, strip, and panel/troffer luminaires.



**END OF SPECIFICATION**