



ENERGY STAR® Program Requirements Product Specification for Recessed Downlights

Eligibility Criteria Version 1.0 DRAFT 1

Following is the Version 1.0 Draft 1 product specification for ENERGY STAR certified Recessed Downlights. A product must meet all of the identified criteria if it is to earn the ENERGY STAR.

1 SCOPE

Certification is limited to recessed downlights and retrofit kits below a total input power of 150 watts intended to be connected directly to the electric power grid. Refer to [Section 4](#) for definitions related to the scope of this specification. Questions about scope may be directed to an EPA recognized Certification Body or lighting@energystar.gov.

NOTE: EPA has capped the total input power at 150 Watts based on an evaluation of qualified products as of January 2023.

1.1 Included Products

- Recessed downlights with integrated light source(s)* and aperture ≤ 10 inches.
- Recessed downlight retrofit kits with integrated light source(s)* and aperture ≤ 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.

NOTE: EPA is including an aperture cut off to clarify the narrow scope of this specification and seeks comment on whether a 10-inch diameter is an appropriate cut off for residential type recessed downlights. Our current data set does not give us visibility of product apertures beyond 9 inches. See below for the updated list of excluded products. The inclusion of models with integral battery packs is unchanged but EPA is proposing that models incorporating mesh W-Fi extenders that meet the existing standby power requirement may also be certified. While not related to the control of illumination, EPA understands that this functionality is growing in prevalence and has the potential to be a big energy adder if not kept in check.

1.2 Excluded Products:

- Recessed downlights without an integrated light source.
- Recessed downlights and recessed downlight retrofit kits with apertures > 10 inches
- Surface-, pendant-mounted downlights and track-mounted 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 and close-to-ceiling mount luminaires
- Chandeliers
- Cove Mount luminaires and Undercabinet lighting
- Decorative Pendants
- 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 Recessed Downlights Version 1.0 specification takes effect upon finalization. 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.

NOTE: EPA anticipates completing the development of this specification in 2023 to allow certifications and product planning to take place more than a year in advance of the sunset of Luminaires.

3 FUTURE SPECIFICATION REVISIONS

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 arrived at through industry discussions. 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

ANSI	American National Standards Institute.
ASTM	American Society for Testing of Materials.
CIE	Commission Internationale de l'Eclairage (International Commission on Illumination).
CSA	Canadian Standards Association.
IEC	International Electrotechnical Commission.
IES	Illuminating Engineering Society.
LED	Light Emitting Diode.
NEMA	National Electrical Manufacturers Association.
NRTL	Nationally Recognized Testing Laboratory as recognized by OSHA's NRTL Program, which is a part of OSHA's Directorate of Technical Support.
OSHA	Occupational Safety & Health Administration.
TMP_c	LED Driver Case Temperature Measurement Point.
TMP_{LED}	LED Temperature Measurement Point.
UL	Underwriters Laboratories.

4 DEFINITIONS

Accent Light (Downlight): A recessed directional downlight employed 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").

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 Size: The maximum distance between the points inside the downlight where light escapes the downlight.

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)

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 seven step MacAdam ellipse or 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.

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.

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).

Direct Lighting: Lighting involving luminaires that distribute 90% to 100% of the emitted light in the general direction of the surface to be illuminated. This term usually refers to light emitted in a downward direction. (ANSI/IES LS-1-22)

Down Light or Downlight (Downlight): A small direct-lighting unit that directs the light downward and can be recessed, surface mounted, or suspended (ANSI/IES LS-1-22). See definition of Direct Lighting for additional information. For purposes of this specification, this definition includes downlight retrofit kits and excludes surface-mounted and suspended downlights.

Downlight Retrofit: A type of luminaire intended to install into an existing downlight, 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 self-ballasted lamps, or products that utilize an existing ballast or transformer.

Input Power: The power consumption in watts of a ballast or driver and a light source system operating in a normal or active mode, as determined in accordance with the test procedure. (ANSI Standard 82.2-2002)

Inseparable SSL Downlight: A downlight featuring solid state lighting components (i.e., LEDs and driver components) which cannot be easily removed or replaced by the end user, thus requiring replacement of the entire downlight. Removal of solid-state lighting components would require (for instance) the cutting of wires, use of a soldering iron, or damage to or destruction of the downlight. This definition does not encompass downlights which feature LED light engines which are user replaceable / upgradeable without the cutting of wires or the use of solder.

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_c): 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 Light Engine: An integrated assembly composed of LED packages (components) or LED arrays (modules), as well as an LED driver and other optical, thermal, mechanical, and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed. It does not use an ANSI standard base (ANSI/IES LS-1-22). For purposes of this specification, light engines that rely on the downlight for optical control, and/or thermal management, and/or assemblies featuring remote-mounted ("non-integrated") drivers shall also be considered LED light engines.

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_{LED}): 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_{LED} 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)

Lumen Maintenance: Luminous flux maintenance (often referred to as “lumen maintenance”) is 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 ballast(s) or driver(s) (when applicable) 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. (ANSI/IES LS-1-22).

MacAdam Color Ellipses: A series of ellipses around the chromaticity coordinates of a number of different colors. Each ellipse sets the boundary at which a given percentage of people are able to determine that two colors, one with the chromaticity coordinates at the center of the ellipse, and one with chromaticity coordinates on the ellipse, are just noticeably different. (IES Handbook 9th Edition)

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: 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)

Optics: Include reflectors, baffles, lenses and/or diffusers, all of which control the light distribution and the appearance of the lighted downlight.

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 Lumen Maintenance Life (L_p): The elapsed operating time over which the LED light source will maintain the percentage, p, of its initial light output, e.g., L₇₀ (hours): Time to 70% lumen maintenance. (IES TM-21-11)

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

Residential Downlight: A downlight marketed and intended to be used in a residential environment notwithstanding use in commercial, business, and industrial environments. (Adapted from FCC 47 CFR parts 15 and 18)

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

Solid State Lighting (SSL): The term “solid state” refers to the fact that the light is emitted from a solid object—a block of semiconductor—rather than from a vacuum or gas tube, as in the case of an incandescent and fluorescent lighting. There are two types of solid-state light emitters: inorganic light-emitting diodes (LEDs) or organic light-emitting diodes (OLEDs). (Sandia National Laboratories)

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. (US DOE)

Standardized Color Ellipse: A MacAdam color ellipse defined by center chromaticity coordinates (CIE x, y) and a measure of certainty for detecting a color difference specified in standard deviation units called steps. (ANSI C78.376-2014 (R2021))

Trim: The part of a downlight that covers the ragged edge of the ceiling cut-out. The trim may be a separate ring, or trim ring, or it may be integrated with the optics (i.e., a self-flanged reflector). A trim can be airtight or non-airtight.

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 wattage 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 testing 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 9.3). Additionally, watts, lumens, chromaticity, and CRI must be measured and reported for the default “out of the box” white light setting preset by the manufacturer. Partner shall provide detailed instructions to test labs for the control settings or control signals (as applicable) for reaching the most consumptive white light setting.

NOTE: EPA has clarified that color tunable and multi-output models are to be evaluated at the most consumptive setting. Existing certified models that were evaluated at the least efficient setting must be re-evaluated at the most consumptive setting, but new testing should not be required, since performance at this setting has been a reporting requirement in Luminaires V2.2.

5.2 Testing LED Light Engines without Integrated Heat Sinks

When performing LM-82 testing of LED light engines that will rely on the downlight for heat dissipation, it is permissible to use a representative heat sink that provides similar heat dissipation to the downlight that the LED light engine is going to be installed in.

6 PRODUCT CERTIFICATION

6.1 Product Families

Grouped product submissions for ENERGY STAR certification shall 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 the table below. The representative model must be the variation expected to have the greatest difficulty meeting the performance requirements outlined in this specification (e.g., smallest aperture size, darkest or least efficient reflector variation). **Any configuration included in a family grouping that shares a family certification file is representative of the performance of all configurations; any sampled configuration (e.g., downlight with black reflector/trim finish) that fails to meet the requirements during verification testing will result in a failed determination for all product configurations sharing the same family grouping.**

Allowable Variations Within Product Families

Downlight Attribute	Allowable Variation	Additional Test Data Required for Each Variant ¹
Driver (No change in nominal wattage or current)	Allowed, provided that variations will not negatively impact the downlight's compliance with any performance criteria in this specification.	Thermal measurements of each variation may be required (e.g., ballast case temperature or TMP _C).
Correlated Color Temperature (CCT) (Also review Light Source variation below)	Allowed, provided that the lamp series or LED package/module/array series (and associated drive current), ballast or 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. The representative model must be the version within the product family with the lowest CCT for SSL products and the highest CCT for discharge products. Partner must use different downlight model numbers to distinguish between models shipped with light sources of varying CCTs.	None
Electrical Connection (Downlight Retrofit Kits)	Allowed (e.g., E26 and GU24).	None
Heat Sink / Thermal Management Components	Not allowed.	None
Housing/Chassis	Allowed, provided that the light source, driver, and heat sink (as applicable) are integrated into the housing/chassis variations in such a way that the thermal performance of the downlight is not degraded by changes to the housing/chassis.	Engineering rationale or thermal measurements of each variation may be required (e.g., TMP _{LED} , or TMP _C).
Light Source² (Refers to the make and/or model of the source; also review CCT below)	Allowed, provided that variations will not negatively impact the downlight's compliance with any performance criteria in this specification.	<ul style="list-style-type: none"> • Certified performance data from additional light source if separable • Integrating sphere test for inseparable product
Product Wattage³	<p><u>For SSL products:</u></p> <ul style="list-style-type: none"> • The LED package, array, or module model must not change, although CCT remains an allowable variation. • The only permissible performance change to the downlight is to a driver that provides a different drive current to the LED package, array, or module. • The model tested must be the highest wattage, and lowest CCT variant. 	<ul style="list-style-type: none"> • LED drive current measurement • Integrating sphere scan to represent performance of variants including: <ul style="list-style-type: none"> ○ CCT ○ Lumen Output ○ CRI ○ Power Consumption ○ Chromaticity
Reflector / Trim	Allowed, provided that downlight light output exceeds that of the darkest or least efficient reflector variation.	Luminous flux for each basic trim or for the reflector variation with the darkest or least efficient finish must be reviewed.
Diffuser	Allowed, provided that neither luminaire light output nor air flow are reduced.	None

¹ Testing required to document the additional test data listed in this table must be performed by an EPA-recognized laboratory. However, testing to support a partner's engineering rationale for the worst-case variant does not.

² Partners may not retroactively add variations to a product family unless requirements in Table 1 are still met. For example, if the representative model tested has a 3000 Kelvin nominal CCT, partner may not retroactively add a 2700 Kelvin model without additional testing, as this was not the lowest CCT initially tested.

³ When wattage 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 wattage 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 Lumen 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	C62.41.1-2002	IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
ANSI/IEEE	C62.41.2-2002	IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
ANSI	C78.377-2017 (R2022)	Specifications for the Chromaticity of Solid State Lighting (SSL) Products
ANSI/ANSLG	C82.16-2020	Light Emitting Diode Drivers—Methods of Measurement
ANSI	C82.77-10-2021	Harmonic Emission Limits—Related Power Quality Requirements
ANSI/UL	1310-2018	Standard for Safety for Class 2 Power Units
ANSI/UL	1598-2021	Standard for Safety of Luminaires
ANSI/UL	1598B-2010	Standard for Supplemental Requirements for Downlight Reflector Kits for Installation on Previously Installed Fluorescent Luminaires
ANSI/UL	1598C	Light-Emitting Diode (LED) Retrofit Downlight Conversion Kits
ANSI/UL	2108-2015	Standard for Low-Voltage Lighting Systems
ANSI/UL	8750-2015	Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products
ASTM	E283-04(2012)	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	Pub. No. 13.3-1995	Method of Measuring and Specifying Color Rendering of Light Sources
CIE	Pub. No. 015:2004	Colorimetry
EU	Directive 2002/95/EC	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	CFR Title 47 Part 15	Radio Frequency Devices
FCC	CFR Title 47 Part 18	Industrial, Scientific, and Medical Equipment
IEC	62301 ED.2.0 B:2011	Household electrical appliances – Measurement of standby power
IEC	62321 Ed. 1.0	Electrotechnical Products – Determination of Levels of Six Regulated Substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)
IEEE	1789-2015	Recommending Practices for Modulating Current in High Brightness LEDs for Mitigating Health Risks to Viewers
ANSI/IES	LM-58-20	Approved Method: Spectroradiometric Measurement Methods for Light Sources
ANSI/IES	LM-79-19	Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products
ANSI/IES	LM-80-21	Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources
ANSI/IES	LM-84-20	Approved Method: Measuring Optical Radiation Maintenance of LED Lamps, Light Engines, and Luminaires
ANSI/IES	LS-1-22	Nomenclature and Definitions for Illuminating Engineering
ANSI/IES	TM-21-21	Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources
ANSI/IES	TM-28-20	Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaire
NEMA	LSD 45-2009	Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires
NEMA	77-2017	Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA	SSL 7A-2015 (R2021)	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.

NOTE: EPA is proposing a single minimum efficacy requirement of 90 lumens per watt for all covered products.

Product Type	ENERGY STAR Requirements			Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
	Luminous Efficacy (initial)	Minimum Light Output (initial)	Zonal Lumen Density		
Recessed Downlights and Recessed Downlight Retrofit Kits	90 lm/W	<p>≤ 4.5" aperture: 345 lumens</p> <p>> 4.5" aperture: 575 lumens</p>	Products must deliver a minimum of 75% of total lumens within the 0-60° zone (axially symmetric about the nadir)	<p>Methods of Measurement: ANSI/IES LM-79-19</p> <p>Reference Document: ANSI/UL 1598C</p>	<p>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.</p> <p>Products offered with multiple reflector finish options must be tested with the darkest or least efficient reflector variation.</p> <p>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.</p> <p>Sample Size: 1 complete luminaire.</p>

8.2 Correlated Color Temperature (CCT):

NOTE: EPA is proposing to include 2200K and 2500K nominal CCTs to reflect market developments and insights gained with color tunable products.

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>The recessed downlight, recessed downlight retrofit kit, or replaceable LED light engine must be capable of providing at least one of the following nominal correlated color temperatures (CCTs):</p> <ul style="list-style-type: none"> • 2200 Kelvin • 2500 Kelvin • 2700 Kelvin • 3000 Kelvin • 3500 Kelvin • 4000 Kelvin • 5000 Kelvin <p>The downlight or retrofit kit, or replaceable LED light engine or module chromaticity must also fall within the corresponding 7-step chromaticity quadrangle as defined in ANSI C78.377-2017 (R2022).</p>	<p>Methods of Measurement: ANSI/IES LM-79-19</p> <p>Calculation: CIE 15.2004</p> <p>Reference Document: ANSI C78.377-2017 (R2022)</p>	<p>For downlights, one trim ring and one reflector may be used.</p> <p>Sample Size: 1 complete luminaire. Passing Test: The downlight, retrofit kit, or source (when installed in the downlight) must pass.</p>

8.3 Color Rendering Index:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>The downlight, retrofit kit, or LED light engine must be capable of meeting or exceeding $R_a \geq 80$ and $R_9 > 0$.</p>	<p>Methods of Measurement: ANSI/IES LM-79-19</p> <p>CIE 13.3-1995</p> <p>Reference Documents: In situ temperature measurements: ANSI/UL 1598:2008 (Sections 19.7, 19.10-16)</p>	<p>For downlights, one trim ring and one reflector may be used.</p> <p>Sample Size: 1 complete downlight, retrofit kit, or 1 source and 1 downlight (non-directional).</p> <p>Passing Test: The downlight, retrofit kit, or source (when installed in the downlight) must pass.</p>

8.4 Color Angular Uniformity:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
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>Methods of Measurement: ANSI/IES LM-79-19</p> <p>ANSI/IES LM-58-20</p> <p>CIE 15: 2004</p>	<p>Vertical angular scanning resolution must be 1 degree on the 0- and 90-degree vertical planes, and $\Delta u', v'$ 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>Sample Size: 1 complete Downlight.</p> <p>Passing Test: The Downlight must pass.</p>

9 LUMEN MAINTENANCE AND RATED LIFE REQUIREMENTS

9.1 Lumen Maintenance:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Option 1:</p> <p>The LED package(s) /module(s)/array(s), including those incorporated into downlights, retrofit kits, and LED light engines, must meet the following L_{70} rated lumen maintenance life values, in situ:</p> <ul style="list-style-type: none"> $L_{70}(6k) \geq 25,000$ hours for products with separable light source(s) $L_{70} \geq 50,000$ hours for inseparable products 	<p>Method of Measurement:</p> <p>Lumen Maintenance: ANSI/IES LM-80-21</p> <p>Lumen 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>Reference Documents: Chromaticity Specifications: ANSI C78.377-2017 (R2022)</p> <p>Lumen Maintenance: ANSI/IES TM-21 Calculator</p> <p>NOTE: EPA is proposing to reference the ANSI/IES TM-21 Calculator for new certifications, and to retire the ENERGY STAR TM-21 Calculator on December 31, 2023, after which no new models may be certified to the Luminaires V2.2 specification.</p>	<p>Downlight Sample Size: 1 complete downlight, retrofit kit or LED light engine.</p> <p>LM-80 Sample Size: Minimum sample size of 20 units for LED packages, or 10 units for LED arrays or LED modules, for each T_S and drive current combination (refer to IES TM-21-21). 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>Passing Test: The following conditions must be met. If any of the conditions are not met, Option 1 (component performance) may not be used and the applicant must use Option 2, below, to demonstrate product performance.</p> <ol style="list-style-type: none"> In the sample downlight, the in situ TMP_{LED} 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. 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. The TM-21 lumen maintenance life projection report projects an L_{70} meeting or exceeding requirements. <p>Lumen maintenance projections must support all LED colors used.</p> <p>Demonstration of performance must be documented with a lumen 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 TMP_{LED} 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"> sampling method and sample size (per LM-80) test results for each T_S and drive current combination. description of device including model number and whether device is an LED package, module, or array (see Definitions) ANSI target, and calculated CCT value(s) for each device in sample set $\Delta u'v'$ chromaticity shift value on the CIE 1976 diagram for each device in sample set a detailed rationale, with supporting data, for application of results to other devices (e.g., LED packages with other CCTs) <p>Access to the TMP_{LED} 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 ENERGY STAR Requirements for the Use of LM-80 Data.</p>

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Option 2:</p> <p>The recessed downlight or downlight retrofit must meet the following L₇₀ rated lumen maintenance life values, in situ:</p> <ul style="list-style-type: none"> L70 ≥ 25,000 hours for products with separable light source(s) L70 ≥ 50,000 hours for inseparable products 	<p>Methods of Measurement:</p> <p>Lumen Maintenance: ANSI/IES LM-84-20</p> <p>Lumen Maintenance Projection Method: ANSI/IES TM-28-20 –Projection Method 1, Direct Extrapolation</p> <p>CCT Calculation: CIE 15.2004</p> <p>ANSI/UL 1598:2021 ANSI/UL 1598C-2014</p> <p>Reference Document: Chromaticity Specifications: ANSI C78.377-2017 (R2022)</p>	<p>Downlight or retrofit kit must be operated continuously in accordance with ANSI/UL 1598-2021 or ANSI/UL 1598C-2014 during the testing; any deviations from this must be reported by the lab and included with certification materials.</p> <p>Test reports must detail efficacy, luminous flux, chromaticity coordinates, CCT, and CRI values at all test intervals. Test intervals must be conducted according to IES TM-28-20 with a maximum interval length of 1,000 hours.</p> <p>Lumen maintenance projections must support all LED colors used.</p> <p>Sample Size: According to IES TM-28-20</p> <p>Directional: 3 or more complete downlights or retrofit kits. For downlights, one trim ring and one reflector may be used with the 3 downlight samples.</p> <p>Passing Test: All downlights must pass.</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 L₇₀ lumen maintenance life values (refer to Lumen Maintenance Requirements in the preceding section):</p> <ul style="list-style-type: none"> ≥ 25,000 hours for products with separable light source(s) ≥ 50,000 hours for inseparable products <p>Lumen maintenance life projection claims in excess of the above requirements must be substantiated with a TM-21 or TM-28 lumen 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 ≤ 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 ≤ 0.007 on the CIE 1976 (u',v') diagram, as demonstrated by either:</p> <ul style="list-style-type: none"> The IES LM-80 test report for the employed LED package, array, or module model, or A comparison of chromaticity data in LM-84 reports 	<p>Methods of Measurement: ANSI/IES LM-80-21 or ANSI/IES LM-84-20</p> <p>Reference Documents: 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>For the LM-84 option, downlight or retrofit kit must be operated continuously in accordance with ANSI/UL 1598-2021 or ANSI/UL 1598C during the testing period; any deviations from this must be reported by the lab and included with certification materials. See section 10.1 for testing intervals when using IES LM-84-20.</p> <p>Sample Size (LM-80 option): same as Lumen Maintenance, Option 1.</p> <p>Sample Size (LM-84 option): same as Lumen Maintenance, Option 2.</p> <p>Passing Test (LM-80 option): 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 TMP_{LED} temperature, and at the corresponding drive current.</p> <p><i>Example 1: an LM-80 test report provides data at T_s = 55 °C, 85 °C and 105 °C, and the measured in situ TMP_{LED} temperature value is 89 °C. Neither the 85 °C nor the 105 °C 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 55 °C is disregarded.</i></p> <p><i>Example 2: an LM-80 test report provides data at T_s = 58 °C, 87 °C and 106 °C, and the measured in situ TMP_{LED} temperature value is 53 °C. The LM-80 data at 58 °C 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 87 °C and 106 °C is disregarded.</i></p> <p>Passing Test (LM-84 option): the distance of the chromaticity coordinates from the initial chromaticity coordinates must not exceed 0.007 at any measurement point.</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"> • 1 second of application of electrical power for connected downlights. • 750 milliseconds of application of electrical power for all other products. 	<p>Method of Measurement: ENERGY STAR Start Time Test Method</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>Sample Size: 1 sample of each ED package/LED module/LED array and LED driver model combination must be tested.</p> <p>Passing Test: Sample must pass.</p>

10.2 Power Factor:

NOTE: EPA is proposing that the power factor requirement be greater than or equal to 0.7 because there are currently no ENERGY STAR certified recessed downlights or recessed downlight retrofit kits with efficacy ≥ 90 lumens per watt that have power factor less

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Power Factor must be ≥ 0.7</p>	<p>Method of Measurement: 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>Sample Size: ≥ 1 samples of each model combination must be tested.</p> <p>Passing Test: all samples must pass.</p>

10.3 Transient Protection:

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>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>Method of Measurement: None referenced.</p> <p>Reference Documents: 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>Sample Size: ≥ 1 samples of each LED package, LED module or LED array and LED driver model combination, or LED light engine must be tested.</p> <p>Passing Test: 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:

NOTE: EPA has included mesh Wi-Fi extenders to explicitly call out how this feature could be evaluated. We request feedback on this approach. This is one energy-consuming feature unrelated to the control of illumination that EPA understands is growing in prevalence and has the potential to be a big energy adder if not kept in check.

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Recessed downlights and recessed downlight retrofit kits must not draw power in the off mode.</p> <p>Exceptions:</p> <ul style="list-style-type: none"> • 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. • 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 1 watt in standby mode. 	<p>Method of Measurement: IEC 62301 ED.2.0 B-2011</p> <p>Reference document: International Efficiency Marking Protocol http://www.regulations.gov/#!documentDetail:D=EERE-2008-BT-STD-0005-0218</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>Method of Measurement: None referenced.</p> <p>Reference Document: IEEE PAR1789</p>	<p>Laboratory test results must be produced using the specific downlight, or LED light engine used in the downlight. Light output waveform must be measured with a photodetector with a rise time of 10 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 1 second of data.</p> <p>Sample Size: 1 downlight, LED light engine, or 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"> Short Term Flicker Indicator (P_{st}) Stroboscopic Visibility Measure (SVM) <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>Method of Measurement: NEMA 77-2017</p> <p>Reference Document: IEEE PAR1789</p>	<p>Sample Size: 1 downlight, LED light engine, or retrofit kit must be tested.</p> <p>Laboratory test results must be produced using the specific downlight, or LED light engine used in the Downlight.</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 P_{st} 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>P_{st}</td> <td></td> <td>$\geq 1000:1$ (60 dB)</td> </tr> <tr> <td>SVM</td> <td></td> <td>$\geq 100:1$ (40 dB)</td> </tr> <tr> <td rowspan="2">Sampling Time</td> <td>P_{st}</td> <td>Seconds</td> <td>≥ 180</td> </tr> <tr> <td>SVM</td> <td>Seconds</td> <td>≥ 1</td> </tr> <tr> <td rowspan="2">Sampling Rate</td> <td>P_{st}</td> <td>kHz</td> <td>≥ 10</td> </tr> <tr> <td>SVM</td> <td>kHz</td> <td>≥ 20</td> </tr> <tr> <td rowspan="2">Temporal bandwidth (-3 dB cutoff frequency)</td> <td>P_{st}</td> <td>kHz</td> <td>≥ 0.5</td> </tr> <tr> <td>SVM</td> <td>kHz</td> <td>≥ 5</td> </tr> </tbody> </table> <p>Waveform data must be submitted in CSV format to support the reported values of P_{st} 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	≥ 180	SVM	Seconds	≥ 1	Sampling Rate	P_{st}	kHz	≥ 10	SVM	kHz	≥ 20	Temporal bandwidth (-3 dB cutoff frequency)	P_{st}	kHz	≥ 0.5	SVM	kHz	≥ 5
Parameter		Units	Value																															
Dynamic range of waveform amplitude	P_{st}		$\geq 1000:1$ (60 dB)																															
	SVM		$\geq 100:1$ (40 dB)																															
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	SVM	kHz	≥ 5																															

11 SERVICEABILITY REQUIREMENTS

11.1 Light Source Replaceability: (Exempt: Inseparable Downlights and Downlight Retrofits)

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents
<p>LED light engines or retrofit kits must 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. Wire nuts and other reusable connectors are allowed.</p> <p>Downlights that cannot meet this requirement are to be evaluated as inseparable (see inseparable requirements below and throughout this specification).</p>	<p>Reference Document: NEMA LSD 45-2009</p>

11.2 Driver Replaceability: (Exempt: All Downlight Retrofit Kits and Inseparable Downlights)

ENERGY STAR Requirements

Drivers must 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 driver replacement by a “qualified electrician”.

12 THERMAL PERFORMANCE REQUIREMENTS

12.1 Maximum Measured 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 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
Recessed Downlight	At thermal equilibrium, the measured driver case temperature at TMP_C must not exceed the driver manufacturer’s maximum recommended temperature during in situ (installed in the downlight) operation.	Reference Documents: 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). Sample Size: 1 downlight must be tested, or 1 source sample shall be tested in situ (installed in the downlight). Passing Test: Measured temperature at TMP_C must be less than or equal to the manufacturer recommended maximum.
Recessed Downlight Retrofit Kit	At thermal equilibrium, the measured driver case temperature at TMP_C must not exceed the driver manufacturer’s maximum recommended temperature during in situ (installed in the downlight) operation.	Reference Document: ANSI/UL 1598C	Laboratory test results must be produced using the specific models of LED package, LED module or LED array and LED driver (i.e., LED light engine) (“source”) 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. Sample Size: 1 sample must be tested in situ per the included manufacturer provided installation instructions in a representative downlight per UL1598C-2014. Passing Test: 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
Insulation contact (Type IC): Recessed downlights marketed as Type IC must be approved for zero clearance insulation cover by an OSHA NRTL laboratory. Airtight construction: 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 ²) when tested in accordance with ASTM E283-04(2012) and shall be sealed with a gasket or caulk.	Reference Documents: ANSI/UL 1598-2021 ASTM E283-19	See packaging section for packaging requirements related to IC and airtight products.

13 SAFETY REQUIREMENTS

13.1 Luminaire Safety:

Product Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Recessed Downlights	Demonstrate compliance with ANSI/UL 1598-2021, ANSI/UL 1598C-2014, ANSI/UL 2108-2015, ANSI/UL 8750-2015, as applicable.	Reference Documents: ANSI/UL 1598-2021 ANSI/UL 1598C-2014 ANSI/UL 2108-2015 ANSI/UL 8750-2015	Documentation must be produced by an OSHA NRTL laboratory . 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.
Downlight Retrofits	Demonstrate compliance with ANSI/UL 8750-2015 – LED Component ANSI/UL 1598C-2014 – LED Retrofit	Reference Documents: ANSI/UL 8750-2015 – LED Component ANSI/UL 1598C-2014 – LED Retrofit	

13.2 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.	Reference Documents: ANSI/UL 1310-2018 ANSI/UL 2108-2015 ANSI/UL 8750-2015	Documentation must be produced by an OSHA NRTL laboratory . 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
<p>The downlight and its components must provide continuous dimming from 100% to 20% of light output.</p> <p>At minimum light output, the downlight must not emit noise above 24 dBA when measured within one meter of the Downlight.</p>	<p>Method of Measurement: None</p> <p>Reference Document: NEMA SSL 7A-2015 (R2021)</p>	<p>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.</p> <p>Sample Size: 1 sample of the complete downlight, retrofit kit, or LED light engine must be tested.</p> <p>Passing Test: the sample must pass.</p>

14.2 Products with Connected Functionality – Optional

ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Product must continue to comply with the applicable product safety standards – the addition of the functionality must not override existing safety protections and functions.</p> <p>Must comply with Section 11.5 Standby Power</p>	<p>Method of Measurement: None</p>	<p>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 Section 5.1.</p> <p>Compliance with connected functionality requirements must be demonstrated through examination of product and/or product documentation.</p>

14.2.1 Connected Product Criteria:

To be recognized as connected, a “connected downlight” (or retrofit) 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 15.2.2-15.2.6. 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 15.2.3, 15.2.4, and 15.2.5.

14.2.2 Open Access

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 15.2.3, 15.2.4 and 15.2.5 connected functionality, and includes accuracy, units, and measurement intervals for Energy Consumption Reporting.

14.2.3 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.

14.2.4 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.

14.2.5 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.

14.2.6 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:

ENERGY STAR Requirements
<ul style="list-style-type: none"> • Packaging and marketing claims must represent the product consistent with its certification. • Packaging must clearly describe the nominal color designation of the lamp in units of Kelvin (e.g., 2700K, 3000K) and may display recommended corresponding nomenclature as outlined below. This may also be met through use of a summary label (as applicable). <ul style="list-style-type: none"> • 2200K – Amber Light • 2500K – Sunset Light • 2700K – Soft White • 3000K – Warm White • 3500K – Neutral White • 4000K – Cool White • 5000K – Daylight • Demonstrate the light distribution of the downlight on a cut sheet, marketing materials or packaging. <p>For products marketed as dimmable: Packaging must :</p> <ul style="list-style-type: none"> • Indicate dimming range (as applicable). • Include a list of compatible dimmers and/or other controls, or web address to find out more specific information. <ul style="list-style-type: none"> ○ Partner must periodically review this packaging 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. • 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"> ○ Partner must periodically review this packaging 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. • Clearly indicate step dimming capability, if employed. <p>For recessed downlights that are insulation-contact (Type IC) rated: Packaging must clearly state this rating. Sample language: "IC-rated for direct contact with insulation."</p> <p>For recessed downlights that are airtight (AT) certified: Packaging must clearly indicate that the downlight permits air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-04(2012). Sample language: "Certified airtight per ASTM E283-19."</p> <p>If marked as airtight, the downlight itself must include a label certifying "airtight", or similar designation, to show air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-19. The label must be clearly visible to a building inspector.</p> <p>Installation instructions must be included listing all components of the assembly that will be necessary to ensure an airtight installation and how the components should be properly installed. For example, depending on the method used to achieve airtight installation, the instructions should alternatively show how a gasket is to be attached, what type of caulk to use and how it should be applied, or which certified airtight trim kits are designed to be installed with the downlight housing.</p> <p>Optional certification marking: While not a requirement for certification, EPA recommends partners provide a conspicuous ENERGY STAR certification mark (e.g., sticker, hangtag) on certified downlights themselves:</p> <ul style="list-style-type: none"> • to facilitate building inspectors confirming certification status of installed downlights • to provide out-of-the-box marketing of a downlight's ENERGY STAR certification • to demonstrate to consumers a partner's commitment to advancing energy efficiency in lighting

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>Reference Document: Zhaga Consortium's Certified Products Database http://www.zhagastandard.org/products/certified/</p>

16 WARRANTY REQUIREMENTS:

Note: Partners must provide a copy of the actual warranty that is included with the recessed downlight or 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 recessed downlights and retrofit kits incorporating replaceable 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, driver, and trim for a minimum of 3 years from the date of purchase.</p> <p>For recessed downlights and retrofit kits incorporating non-replaceable drivers, the above warranty requirement is extended to 5 years.</p> <p>Warranty language must not place limitations on coverage based on duration of Downlight operation (e.g., hours per day).</p>

17 Lighting Toxics Reduction Requirements:

ENERGY STAR Requirements	Method of Compliance
<p>Recessed downlights and 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>Recessed downlights and retrofit kits must not exceed:</p> <ul style="list-style-type: none"> • 0.1% by weight in homogenous material (1000 ppm): Mercury, Lead, Hexavalent Chromium, PBB (polybrominated biphenyls), and PBDE (polybrominated diphenyl ethers) • 0.01% by weight in homogenous material (100 ppm): Cadmium <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"> 1. Lead in high melting temperature type solders (i.e., lead-based alloys containing 85% by weight or more lead). 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. 3. Cadmium and its compounds in electrical contacts. 4. Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages. 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. 6. Cadmium in color-converting II-IV LEDs (< 10 µg Cd per mm² of light-emitting area) for use in solid state illumination or display systems. 	<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>

END OF SPECIFICATION