



Testing and Reporting Requirements for Direct-Current (DC) and Power over Ethernet (PoE) Lamps, Luminaires, and Retrofit Kits

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DC and PoE systems have the potential to reduce electrical losses from AC to DC conversions, integrate directly with DC generation sources such as solar and batteries, reduce installation costs, and connect more readily to IT infrastructure for advanced lighting control. These Requirements for DC and PoE Products enable high quality DC and PoE lighting products to be qualified and listed on the DLC SSL QPL.

Products powered by Direct Current (DC) and Power over Ethernet (PoE) must comply with the provisions of this document to be eligible for listing on the DLC Solid-State Lighting Qualified Products List (SSL QPL). DC/PoE products are defined as SSL lamps, luminaires, and retrofit kits that are powered by a DC voltage. PoE products are a specific subset of DC products that comply with the IEEE 802.3 Standards for carrying both power and communication signals on Ethernet cables. Qualified products will be listed as DC or PoE products on the DLC SSL QPL. If DC/PoE lamps, luminaires, and retrofit kits are also capable of being powered by Alternating Current (AC) voltage and the manufacturer desires to have them listed as suitable for both AC and DC, then the AC listing of the product must have a distinct model number that is different from the DC listed product, and it must be separately qualified.

The DLC lists DC/PoE lamps, luminaires, and retrofit kits on the SSL QPL based only on the luminous efficacy of these products as measured at their DC power input. The overall energy consumption of the DC/PoE systems also depends on DC line losses and DC power source efficiency, in addition to luminaire or lamp efficacy. However, given the variation in system architectures and power losses, the DLC does not publish system-level efficacies for DC/PoE SSL products.

Definitions

The following are definitions associated with DC/PoE products:

1. **DC Power Source:** In this policy, the term “DC Power Source” is used to indicate the device(s) that connect AC mains to the lines directly providing DC input power to the DC/PoE product. Though DC/PoE products may be used entirely disconnected from the AC power grid, the

primary focus of this policy is grid-connected SSL lighting. A DC Power Source may be more typically known as any of the following:

- a. **AC-to-DC Power Converter**
 - b. **Power over Ethernet Power Sourcing Equipment (PoE PSE)**, also known as a PoE Switch
 - c. **AC/DC Multi-Directional Inverter**
2. **DC-to-DC Driver:** An LED driver that is typically integrated into the luminaire that converts the DC voltage received at the DC luminaire into the DC voltage required to operate the LEDs in the lamp, luminaire, or retrofit kit. Not all DC/PoE lamps, luminaires or retrofit kits require a DC-to-DC driver.
 3. **Nominal Input Voltage Range:** The input voltage range described on the product specification sheet and other product documentation.
 4. **Operating Input Voltage Range:** The voltage range at which the product functions at full light output as defined in the testing section below. This may be narrower than the Nominal input voltage range in the product documentation: for example, a product described in literature as operating between 25V and 29V may, more precisely, operate between 26.1V and 28.4V.

Eligibility

The following are eligibility rules for DC/PoE products:

- DC/PoE products are only eligible to be submitted as “Family Grouping” DLC application types and must be tested in accordance with the requirements of [the family grouping policy](#). This applies to both single DC/PoE products and DC/PoE product families.
- DC/PoE products must meet all DLC Technical Requirements for the General Application(s) and Primary Use(s) they are submitted for, including minimum lumen output, efficacy, correlated color temperature (CCT), color rendering index (CRI), lumen maintenance, and zonal distribution/spacing, with the exception of total harmonic distortion (THD) and power factor.
- Products marketed or intended for use disconnected from the AC power grid are eligible for listing on the SSL QPL. However, if applicable, eligibility of these products for efficiency program incentives/rebates is at the discretion of efficiency program administrators and should not be assumed based only on QPL listing.
- Linear replacement lamps, mogul screw-base replacement lamps, and 2G11-based replacement lamps for CFLs are only eligible for listing as DC/PoE products if they are UL Type C products. A Type C DC/PoE replacement lamp must utilize DC voltage as the *input* to the remote driver; replacement lamps utilizing DC voltage only between driver and lamp are eligible as AC products, not DC/PoE products.
- Refrigerated Case and Display Case Luminaires are considered modular products with external power supplies. They are sold as systems with multiple units attached to a power supply and

have their own [Technical Requirements](#) for the SSL QPL. Case Lighting products must utilize DC voltage as the *input* to the remote power supply to be eligible under this DC/PoE policy; case lighting utilizing DC voltage only between driver and lamp are eligible as AC products, not DC/PoE products.

- DC/PoE luminaires will only be classified as DLC Premium if they meet all DLC Premium classification requirements. An LED Driver ISTMT is required for DLC Premium submissions of luminaires with an integrated DC-to-DC driver. Additional documentation is required for the driver per the [requirements for Premium luminaires](#).
- DC/PoE products may also have other eligible adjustable product features for AC products, such as [Color-Tuning](#) and [Dimming](#), in which case they are also subject to the relevant DLC Testing and Reporting Requirements for those types of products. If products exhibit multiple performance features, they must comply with all applicable Testing and Reporting Requirements.

Testing Methods and Requirements

Testing for DC/PoE products must be provided to cover all areas of investigation as is required for AC family groups. Per the eligibility criteria above, **all DC/PoE products must be submitted as a Family Group**, regardless of the number of products submitted. The below requirements apply to the DC/PoE luminaire, lamp, or retrofit kit under consideration, as test reports will not be required on the DC Power Source.

1. The DC/PoE product or group of products shall be tested according to the guidelines for electrical instrumentation of DC devices in the Illuminating Engineering Society's (IES) LM-79 publication.
 - a. The intent of the LM-79 test reports required for DLC submission is measurement of the luminaire efficacy as well as other photometric characteristics under DC power without including DC Power Source conversion losses or line losses.
 - b. Many DC/PoE products, for example PoE, utilize cables with multiple conductors. LM-79 test reports shall be based on the sum of all power delivered to the product across all connected conductors. The test report shall document the number of powered conductors, and pair-wise grouping if applicable.
 - c. Voltage and current measurements shall be made at the point of entry to the luminaire or retrofit kit, or at the input terminals to the driver in the case of UL Type C replacement lamps. For luminaires and retrofit kits, these measurements shall include any DC-to-DC driver circuitry that is included and shipped under the same model number as the luminaire or retrofit kit, but exclude drivers that need to be ordered separately under a different model number. For UL Type C replacement lamps, these measurements shall include the remote DC-to-DC driver circuitry. If the test laboratory is in doubt about the proper interconnection or placement of voltage sensing leads for power measurement, they should consult the manufacturer.

- d. Test laboratories should connect measurement equipment in such a manner that creates minimal disruptions to data communication if the DC power connection carries both data and power. Manufacturers should, if necessary, provide testing labs with instructions for achieving a state of full light output without the consumption of unnecessary communication power.
 - e. Any removable accessories not required to achieve full light output, such as removable photosensors or occupancy sensors, shall be removed during LM-79 testing. Any accessories with controllable power states that are not required to achieve full light output, such as cameras, microphones or external luminaire power connections, shall be disabled/powered down during LM-79 testing.
2. The luminous efficacy according to the LM-79 Test Method shall be provided at the DC input voltage that results in the worst-case luminous efficacy. The tested voltage must result in the worst luminous efficacy across the product's operating input voltage range and, if applicable, within the input voltage range of the established system protocol (e.g. IEEE 802.3at or IEEE 802.3bt).

For any application where the LM-79 test voltage submitted as worst-case is not the lowest voltage in the operating input voltage range, the manufacturer must submit a written justification explaining why their product performs at lower luminous efficacy at the higher input voltage. A tolerance of the greater of 1% or 1 Volt will apply to the test voltage reported on the LM-79 test report. For example, a manufacturer submitting a product listed with an input voltage operating range of 24 – 30VDC must either submit a test between 23 and 25V, or test at another voltage between 23V and 31V and include a justification of why 24V is not the worst-case luminous efficacy for that product. Justifications should explicitly reference any component or design features that affect performance across voltage range, such as constant-current drivers. For products with a minimum operating input voltage greater than the minimum of the nominal range, the operating input voltage range should be included in the written justification.

Input voltage ranges for PoE products are specified in the IEEE 802.3 standards for each Powered Device Type and Class. However, because minimum input voltages across Type and Class vary by only a few volts and products may operate across multiple Classes, PoE products shall be tested at 45V or the minimum input voltage for their Type and Class as listed in Table 1 below if greater than 45V. PoE products must either be submitted with a test within 1V of 45 or their minimum input voltage from Table 1, or be submitted with a test at another voltage within the IEEE 802.3 input voltage range and a justification of why that voltage produces the worst-case luminous efficacy for that product.

Table 1: Minimum Powered Device Input Voltage

Powered Device Assigned Class	Power Sourcing Equipment Type			
	Type 1	Type 2	Type 3	Type 4
Class 1	42.9	49.0	49.0	51.1
Class 2	42.1	48.3	48.3	50.4
Class 3	39.9	46.5	46.5	48.7
Class 4	—	42.5	42.5	44.9
Class 5	—	—	44.4	46.6
Class 6	—	—	42.5	44.9
Class 7	—	—	—	44.9
Class 8	—	—	—	43.0

Manufacturers submitting a product without either an LM-79 test at the lowest voltage or a written justification will be required to submit a new test.

- Manufacturers must provide instructions to the testing laboratory for how to achieve the full light output state for LM-79 testing. Full light output state is defined as the light output state where the product is delivering its maximum lumen output, with any dimming input control signal set to the maximum setting. The identical instructions as were provided to the test laboratory must be provided to the DLC as part of the application review, and will be provided to the surveillance testing laboratory if the product is selected for surveillance testing.
- In-Situ Temperature Measurement Tests (ISTMTs) must be conducted in the most appropriate application as defined by its appropriate safety standard, per applicable safety certifications. TM-21 projections will use this thermal measurement in conjunction with the provided LM-80 data and rated drive current to evaluate lumen maintenance and compliance with L₇₀ requirements. Alternatively, LM-84 testing and TM-28 projections will be acceptable. Please contact info@designlights.org if you intend to use this alternative LM-84 approach.

Supporting Documentation

Applicants shall provide the following supporting documentation for DC/PoE products. If any of the following information is not clearly documented in the installation guide, product specification sheet, or other supporting technical or marketing materials, the application will be considered incomplete and the DLC reviewer will not proceed in reviewing the application until the necessary information is provided.

- **Product Installation, Power Source, and Wiring documentation** covering the following:
 - Nominal input voltage to luminaire, lamp or retrofit kit
 - List of compatible DC Power Source models and/or parameters for choosing compatible DC Power Sources
 - List of compatible cable models, and/or parameters for choosing wiring gauge and type

- Where applicable, reference to standard compliance and relevant product subcategories/classifications
 - For PoE products, reference to IEEE 802.3af/at/bt standard compliance, PoE PSE Type, and PD Class
- **Safety Certification**
 - The requirements for safety certification of DC/PoE products are the same as the [safety provisions listed for AC products](#).

Listing on the QPL

The DLC intends to list DC/PoE lamps, luminaires, and retrofit kits on the SSL QPL based only on the luminous efficacy of these products as measured at their DC power input. DC/PoE products are listed on the SSL QPL according to their worst-case efficacy as documented in the LM-79 report(s) specified in Section 2a of the Testing Requirements above. All existing QPL fields apply to DC/PoE products except for total harmonic distortion (THD) and power factor (PF). These two fields are either left blank or “N/A”. DC/PoE products are distinguished from AC products on the SSL QPL as follows:

- DC/PoE listings on the QPL will prominently feature and point to a supplemental guide or pop-up window that provides important information for how to use the DC/PoE listing data, which is different from non-DC/PoE listing data.
- Five new fields have been created for DC/PoE listings, two of which are exclusively applicable to PoE, and one existing field has been modified:
 - **“System Type”**. This new field applies to all products on the QPL and is populated with text as “AC”, “DC”, or “PoE”.
 - **“Test Voltage”**. This new field is required for DC and PoE products and may also be applied to existing AC products. It is a numerical value that lists the voltage from the LM-79 test report (e.g. 24 Volts, 380 Volts, etc.) that corresponds to the worst-case luminous efficacy listed for that product.
 - **“Voltage Range”**. This new field applies to both AC and DC products, and lists the nominal input voltage range for the product (e.g. 120-277VAC, 44-57VDC).
 - **“DC Efficacy”**. This new field lists the worst-case efficacy of DC/PoE products, which is different from the current “Efficacy” field for existing products. The existing “Efficacy” field on DLC QPL has been changed to “AC Efficacy” to clearly differentiate from the “DC Efficacy” of DC/PoE products.
 - **“PoE Type/Class”**. This new field is only applicable to PoE products and lists the Type and Class of PoE utilized.
 - **“PoE Connection”**. This new field is exclusively for PoE products to indicate whether the product connects directly or indirectly to the PoE network; for example, whether a

luminaire connects directly to the PoE network, or indirectly through another luminaire or driver that is connected to the PoE network.

