



DRAFT Testing and Reporting Requirements for Color Tunable Products

Color Tunable Products must comply with the provisions of this document to be eligible for listing on the DLC Solid State Lighting Qualified Products List (SSL QPL). Color Tunable Products are defined as products whose Correlated Color Temperature (CCT) can be adjusted via an input control of any type and whose light output approximately follows the blackbody locus, providing white light at all input configurations. For this purpose, white light is defined as points within Duv magnitudes of 0.012 of the blackbody locus in the CIE 1976 color space. Products supplying colored light (i.e., those capable of generating color points with Duv magnitudes greater than 0.012 in the CIE 1976 color space)—also known as Full Color Tunable—are outside the scope of these proposed requirements and ineligible for listing at this time. Color Tunable products must utilize a control interface or multiple interface options clearly described in the product literature that allow for at least two CCT settings. These may be continuously-variable inputs such as a 0-10V DC signal, an established protocol such as DALI or DMX, a proprietary control signal, setting options described in terms of CCT such as 3000K or 5000K, or simple descriptive terms such as 'Night' or 'Day'.

Type Definitions of Color Tunable Products

Two types of Products are eligible for listing as Color Tunable:

1. White-Tunable products, which have a control signal specifically for adjusting CCT while maintaining nominally constant light output. These products may include a second, independent dimming control. White-Tunable products include both “white-white” products that combine the output of 2 LED primaries, and products with 3 or more white and/or RGB LED primaries, so long as they only produce white light as characterized above in response to their control signal.
2. Dim-to-Warm products do not have color temperature adjustment independent of light output dimming; a single control adjusts both light output and color, typically shifting to lower CCT at lower light intensity.



To be eligible for QPL listing, Color Tunable products must meet either White-Tunable or Dim-to-Warm requirements, and other applicable DLC policies.

White-Tunable Eligibility

The following are eligibility rules for White-Tunable products:

- Applications for white-tuning products will be considered Family Grouping Applications only, including situations where a single product is being submitted.
- White-Tunable products must meet all DLC Technical Requirements at all values of the color control signal, for the General Application(s) and Primary Use(s) for which they are submitted, except CCT. This includes minimum light output, efficacy, CRI, lumen maintenance, THD, Power Factor, and zonal distribution/spacing criteria requirements.
- White-Tunable products must be capable of producing light at CCTs that meet the DLC Technical Requirement—CCTs \leq 5700K for Outdoor or High-Bay products, CCTs \leq 5000K for other Interior products—but products that adjust to CCTs above the applicable maximum or below the lowest nominal ANSI bins are explicitly eligible for listing.
- White-Tunable products will only be classified as DLC Premium if they meet all DLC Premium classification (again, except CCT) requirements at all values of the color control settings.
- White-Tunable products may also have field-adjustable lumen output characteristics, in which case they are also subject to the proposed Field-Adjustable Products Testing and Reporting Requirements. If products exhibit both performance features, they must comply with both Color Tuning and Field-Adjustable Products Testing and Reporting Requirements.

White-Tunable Testing

The testing for white-tunable products must be provided to cover all areas of investigation as with non-Color Tuning family groups, plus additional testing across the color-tunable range for the least efficacious product.

White-Tunable product family submittals must include the reports below. For white-tunable products that also have an independent dimming control, testing must be conducted at the highest light output setting available for that CCT. For cases where provided test results do not appear to reflect the worst-case or setting



required by this document, the DLC will require manufacturers to submit additional information and provide technical rationale to the DLC reviewer to support their case. If LM-79 testing results in any one of the above CCT settings fails to meet the Technical Requirements for the Category, General Application, and Primary Use the product is applying for, the product will not qualify.

The following LM-79 reports shall be provided, based on consideration of the entire color input signal range for all members of the product family:

For the family member with the lowest efficacy of any product-and-color-control-setting combination in the group, complete LM-79 testing, with all metrics other than distribution (IES files) shall be provided at:

1. The **minimum CCT input control** setting
2. The **maximum CCT input control** setting
3. One **intermediate point**:
 - a. For products with continuously variable input signals and those with input signals offering an odd number of discrete settings, the mid-point between the minimum and maximum CCT input signals or the middle setting
 - b. For input signals with an even number of discrete settings, the lower of the two middle CCT input settings
4. Where none of the above tests result in the lowest efficacy condition, the **least efficacious** setting

Additional LM-79 reports shall be performed for whichever product-and-color-control setting combination within the group performs at the worst-case or extreme value family-wide for:

5. Photometric distribution testing (goniophotometric testing) for a representative product for each optical variation within the group. This data must be submitted in IES file format and may be represented additionally in a PDF test report.
6. Where none of the above tests result in the minimum light output product-color-control-setting combination, a test of the product at the color control setting that produces the lowest light output within the group
 - a. For clarity, dimmable products shall NOT be tested in dimmed states. This is a required test of the product that produces the lowest light output of any product at any color control setting, at the maximum output dimming control setting
7. Where none of the above tests result in the minimum nominal CCT output, a representative test of a product at this nominal **minimum CCT**
8. Where none of the above tests result in the maximum nominal CCT output, a representative test of a product at this nominal **maximum CCT**

9. Where none of the above tests result in the minimum nominal CRI output, a representative test of a product at this nominal **minimum CRI**
10. Where none of the above tests result in the highest power consumption condition of any product at any setting, a test of that product at that **highest power consumption** setting
11. Where none of the above tests result in the worst-case Power Quality, the setting(s) with the **worst Power Quality** (Power Factor and THDi)

In-Situ Temperature Measurement Tests (ISTMTs) must be provided on the following:

- Each LED package/module/array (i.e. each component for which LM-80 testing must be provided) at the worst-case thermal condition (worst-case product-setting combination) for that LED
 - It is expected that the worst-case condition for each LED type within a color tunable product will necessarily be under different conditions. If LEDs are employed that have different LM-80s, multiple LED ISTMTs will be required.
- Each driver present in the product, at the worst-case thermal condition for that driver. (For products seeking premium qualification only.)
 - Again, if multiple drivers are used, this may result in the need for multiple driver ISTMTs, under different conditions.

LM-80 testing must be provided for each LED type present in the product. TM-21 projections must be provided for all LEDs at their measured ISTMTs.

- LM-80 applicability will be determined per the ENERGY STAR guidance, as per normal policies.

As part of the application submittal, manufacturers must report the power consumption for each ANSI C78.377-2015 CCT quadrangle from the minimum CCT to the maximum CCT, for one reported CCT that falls between the quadrangle upper and lower limits. If discrete input control settings do not allow the product to provide light within the CCT range of a particular bin, manufacturers must provide the CCT and power consumption of the closest CCT to that range. If input control settings allow for more than one setting within an ANSI quadrangle, only the data for the setting that produces the actual CCT closest to the nominal CCT center point for the bin per the ANSI standard shall be provided. The data should be provided in a table with this format:

Table 1: Data reporting format for white-tunable product submissions

ANSI CCT Quadrangle (omit any outside product range) / Worst-Case Value	Actual CCT (K)	Power Consumption (W)	Light Output (lm)	Input Control Signal Applied
2200K				
2500K				
2700K				
3000K				
3500K				
4000K				
4500K				
5000K				
5700K				
6500K				
Lowest Efficacy				
Maximum Power				

The DLC will accept the following sources for self-reported/rated performance data in Table 1:

1. In-house laboratory test: In-house test reports from tests conducted in accordance with IESNA LM-79
2. Calculated Scaling: Provide mathematical characterization of luminaire performance based on manufacturer-developed scaling methodology. The manufacturer must provide a description of the scaling methodology employed and the technical basis for its validity. The DLC reserves the right to accept or reject the methodology for use in qualifying products.

Manufacturers can provide in-house testing on driver characteristics and zonal lumen output or other testing that might be necessary to support the designation of a least-efficacious or highest-power-consumption control setting. As per normal, in-house testing informs selection of worst-case. Actual worst-case testing must be conducted per the appropriate test standard at an accredited lab.

Dim-to-Warm Eligibility

The following are eligibility rules for Dim-to-Warm products:

- Dim-to-Warm products must meet all DLC technical requirements, including CCT, for the General Application(s) and Primary Use(s) for which they are submitted, as measured at the maximum output for the product. The requirements include minimum light output, efficacy, CRI, CCT, lumen maintenance, THD, Power Factor, and zonal distribution/spacing criteria requirements.

- Dim-to-Warm products do not need to meet DLC technical requirements at other input control settings, i.e. when they are dimmed below full output.
- Dim-to-Warm products will only be classified as DLC Premium if they meet all DLC Premium classification requirements at the maximum input setting.
- Dim-to-Warm products may also have field-adjustable light output under the Field-Adjustable Products Testing and Reporting Requirements, and thus be listed under both. If products exhibit both performance features, they must comply with both sets of requirements.

Dim-to-Warm Testing

Dim-to-Warm product submittals must include a single LM-79 report performed at the **maximum setting of the dimming input control**. If the LM-79 results fail to meet the Technical Requirements, the product will not qualify.

Other testing reports are required as per existing DLC policies for lumen maintenance and in-situ temperature measurement.

Manufacturers can provide in-house testing on driver characteristics and zonal lumen output or other testing that might be necessary to support the designation of a least-eficacious or highest-power-consumption control setting.

The Family Grouping Testing Requirements apply to Dim-to-Warm products in the same manner as with non-Color Tuning products.

Supporting Documentation

Control Interface Documentation:

Applicants shall provide the following supporting documentation with the application submittal. If any of the following information is not clearly documented in the product specification sheet or other supporting technical or marketing materials, the application will be considered incomplete.

- Description of the method of the input control, show photos of control input location and control input mechanism.
- Reference to any control standards or protocols utilized.
- Clear instructions for how to achieve the settings required in the testing section. Identical instructions must be provided to the test laboratory for testing and to the DLC during the application review.

Listing on the QPL

Products will be listed on the QPL with either “White-Tunable” or “Dim-to-Warm” values under a new “Color Tunable” field.

White-Tunable products will be listed on the QPL at the least efficacious setting, with the product performance characteristics from that LM-79 test: Light Output, Power Consumption, Efficacy, THD, Power Factor, CRI, CCT, Zonal Lumens, Spacing Criteria. The maximum energy consumption in Watts will also be reported in a new field.

Dim-to-Warm products will be listed on the QPL at the full output setting, with the product performance characteristics from that LM-79 test: Light Output, Power Consumption, Efficacy, THD, Power Factor, CRI, CCT, Zonal Lumens, Spacing Criteria.

White-Tunable products will be listed with two new fields displaying the minimum and maximum CCT values.

Dim-to-Warm products will be listed with only the CCT value corresponding to the full output setting.