

Start time requirements for LED luminaires – an overview

Introduction

As the LED lighting industry continues to mature various industry organizations and government agencies are creating guidelines and/or standards to (1) ensure that LED luminaires meet a minimum set of performance requirements and (2) enforce consistency between LED luminaires. These guidelines predominantly focus on metrics such as efficacy, lumen maintenance, and light distribution. However, several have recently adopted specific language on the start time performance of LED luminaires.

The objective of this paper is to clarify the start time requirements that have been adopted by ENERGY STAR® and CA Title 24 and to discuss how LED luminaires can comply with both.

ENERGY STAR®

The ENERGY STAR program is a voluntary program that is administered by the U.S. Environmental Protection Agency (EPA). It encourages the use of energy efficient products and buildings to protect our climate and save businesses and individuals money. Among other things, the ENERGY STAR program maintains a list of ENERGY STAR certified residential type lighting products (e.g. downlights) that reduce energy consumption but still deliver on a minimum set of features and/or performance.

On June 1, 2016, the ENERGY STAR Luminaires Specification Version 2.0 [1] took effect. All lighting products, even those that already met ENERGY STAR Luminaires Specification Version 1.2 [2], had to be re-certified by an accredited Certification Body to prevent them from being removed from the list of ENERGY STAR certified products.

Previous versions of this specification included a rather general start time requirement for luminaires: “Light source shall remain continuously illuminated within one second of application of electrical power”. However, no specific method of measurement was referenced. In Version 2.0 of this specification, the start time requirement for Solid State luminaires (section 11.1) was reduced to 750ms. Also, the ENERGY STAR Program Requirements for Lamps – Start Time Test Method [3] was referenced as the method of measurement. This Test Method defines start time as “the time between the application of power to the device and the point where light output reaches 98% of the lamp’s initial plateau”.

Certification Bodies typically interpret this start time requirement as the need for the luminaire to reach 98% of its nominal light output within 750ms. Figure 1 shows a graphical representation of this requirement.

CA Title 24, Part 6

The California Energy Commission is the primary planning and policy agency in that state with the objective to “reduc[e] energy costs and environmental impact of energy use - such as greenhouse gas emissions - while ensuring a safe, resilient, and reliable supply of energy” [4]. Standards from this agency only apply to California. Nevertheless, given the market potential in this state, lighting manufacturers cannot ignore the requirements in this standard, even though they may be inconsistent with other (federal) guidelines, such as ENERGY STAR.

In June, 2015, the Commission released an update to its Building Energy Efficiency Standards, CA Title 24, Part 6 [5], which took effect January 1, 2017. This standard focuses on several areas to improve the energy efficiency of newly constructed buildings and additions/alterations to existing buildings. Residential lighting is one of the important efficiency improvements areas in this revised standard. The term “residential” in this standard applies to the following spaces:

- Single-family homes
- Low-rise multi-family building, indoor and outdoor (attached)
- High-rise multi-family residential units
- Fire station dwelling accommodations
- Hotel and motel guest rooms
- Dormitory and senior housing dwelling accommodations
- Buildings such as sheds or garages on residential property
- Common area in low-rise multifamily buildings (interior hallways, lobbies, entertainment rooms, pool houses, club houses, and laundry facilities) assuming it equals 20 percent or less of the total building floor area

Section 150.0 (k) states that all lighting in these spaces shall be “high efficacy”. TABLE 150.0-A in the same document further clarifies which light sources classify as high efficacy. Per this table, certain luminaires are considered high efficacy by design. Others, however, are only considered high efficacy if they are certified in accordance with Joint Appendix JA8 in the 2016 Reference Appendices to CA Title 24, Part 6 [6], including:

- All recessed downlights
- All LED indoor luminaires

JA8 contains two concrete requirements related to start time:

1. JA 8.3.3 Start Time Test
Start time shall be measured in accordance with the ENERGY STAR Program Requirements Product Specifications for Lamps 1.1: Start Time Test Method [3], notwithstanding the scope of the test. For lamps the reported value shall be the average start time of the tested units rounded to the nearest millisecond. For all other sources the reported value shall be the maximum start time of the tested units rounded to the nearest millisecond.
2. JA8.4.3 Start Time
The light source shall meet the following requirements when measured in accordance with the test method of Section JA8.3.3: The light source shall have a start time no greater than 0.5 seconds.

Some LED luminaires rely on LED drivers that are designed with an “aesthetic fade-in” feature, i.e. the LED driver gradually ramps up the output current per a continuously increasing fade-in curve to ensure a smooth and pleasing increase in the light output of the luminaire. Example 6-7: Fade-in lighting on page 6-10 of the 2016 Residential Compliance Manual [7] clarifies that the start time for luminaires with an aesthetic fade-in is “the point in time at which there is perceived light output and the perceived light increase begins to follow the programmed fade-in curve”. In other words, the start time for an LED driver with an aesthetic fade-in feature corresponds to the time-to-first-light, assuming the light output increases continuously thereafter to the desired light output. Figure 1 shows a graphical representation of the start time requirements for CA Title 24. Note that there is no explicit time window in which a LED luminaire with an aesthetic fade-in reaches its final light output.

How to comply with ENERGY STAR and CA Title 24?

To limit their design, certification, and marketing efforts, it is preferable for luminaire manufacturers to develop, whenever feasible, a single luminaire that can comply will all relevant standards. In practical terms this means that the standard with the most stringent requirement must be met. In the case of start time performance, this means that as of January, 2017, there are two different start time profile requirements, depending on the LED driver that is used. The graphs on the bottom row of Figure 1 summarize the combined “No-Go” zones for ENERGY STAR and CA Title 24, i.e. the luminaire light output over time cannot cross into the green shaded regions. Luminaires that rely on LED drivers without an aesthetic fade-in feature must reach their nominal light output within 500ms. Luminaires that rely on LED drivers with an aesthetic fade-in feature must have a time-to-first-light less than 500ms and must reach their nominal light output within 750ms.

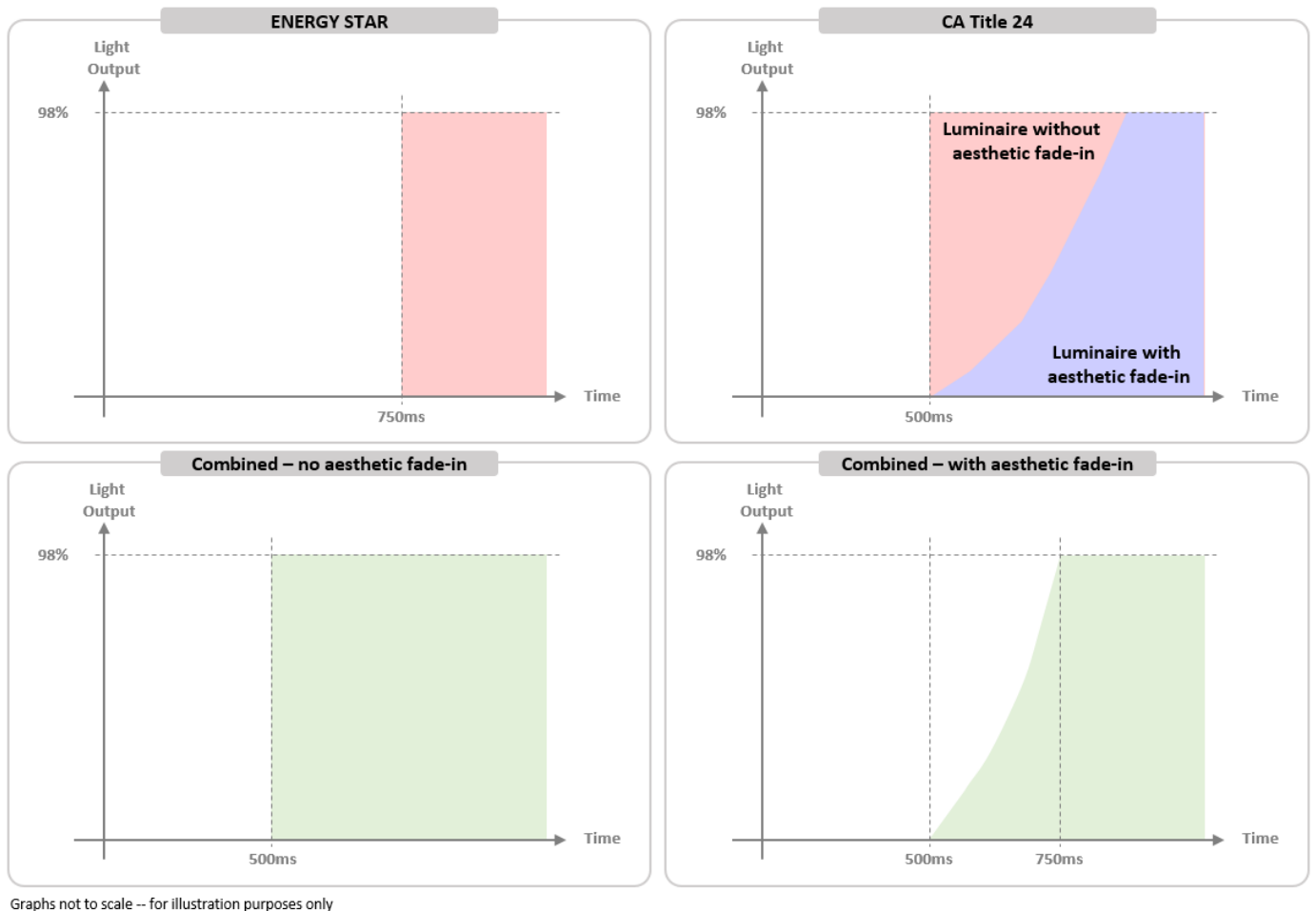


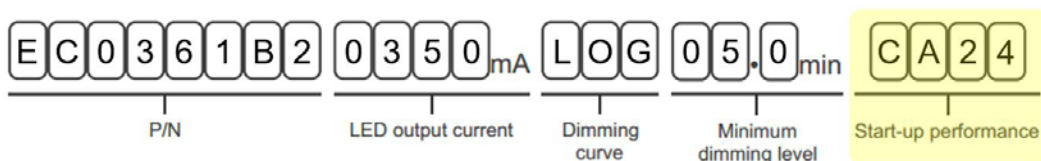
Figure 1 – Graphical representation of the start time requirements in the ENERGY STAR Luminaires Specification Version 2.0 (top-left) and CA Title 24, which goes into effect in January 2017 (top right). Shaded regions represent the "No-Go" zone, i.e. the luminaire light output over time cannot cross into the shaded regions. Note that the "no-go" zone for CA Title 24 is dependent on the driver design. The two graphs on the bottom row represent the combined "no-go" zone if the start time requirements in ENERGY STAR and CA Title 24 are merged.

Start time performance of eldoLED drivers

Since its inception more than 10 years ago, eldoLED has focused on the development of intelligent and fully programmable LED drivers that can mimic what humans perceive as Natural Dimming. Features such as smooth changes in brightness, gradual start-up performance, no flicker, and adaptable dimming curves are, by design, included in all drivers.

eldoLED recently rolled out an update to its portfolio of single-channel 0-10V downlight LED drivers ¹ to allow these drivers to be programmed to meet the more stringent start time requirements imposed by the latest ENERGY STAR and CA Title 24 standards. The LED drivers listed in Table 1 now offer a special ordering option to be programmed with a fast start-up sequence; customers who prefer the original start-up performance characteristics can continue to order LED drivers with the normal start-up sequence.

To order your LED driver with ENERGY STAR and CA Title 24 compliant start-up performance, order your LED driver with ordering option "CA24" (see Order Number Configuration in the LED driver's datasheet):



¹ The first release of downlight products with improved start time performance does not include any DALI LED drivers because DALI LED drivers are typically used in combination with a DALI control network, which, per the DALI standard, defines the maximum allowable response time to go-to-power commands.

Table 1: eldoLED drivers that can be ordered with a fast start-up sequence to meet the current ENERGY STAR and CA Title 24 start-time requirements.

Power	/B can		/S can	
	EC0drive	SOLOdrive	EC0drive	SOLOdrive
10W	EC0161B	SL0161B	EC0161S	SL0161S
20W	EC0261B	SL0261B	EC0261S	SL0261S
30W	EC0361B	SL0361B	EC0361S	SL0361S
50W	EC0561B	SL0564B	EC0561S	SL0564S

Figure 2 shows a representative oscilloscope trace for the start-up performance of the single-channel 0-10V LED drivers with the fast start-up sequence. The combined “No-Go” zone for LED drivers with an aesthetic fade-in is overlaid on this oscilloscope trace as well.

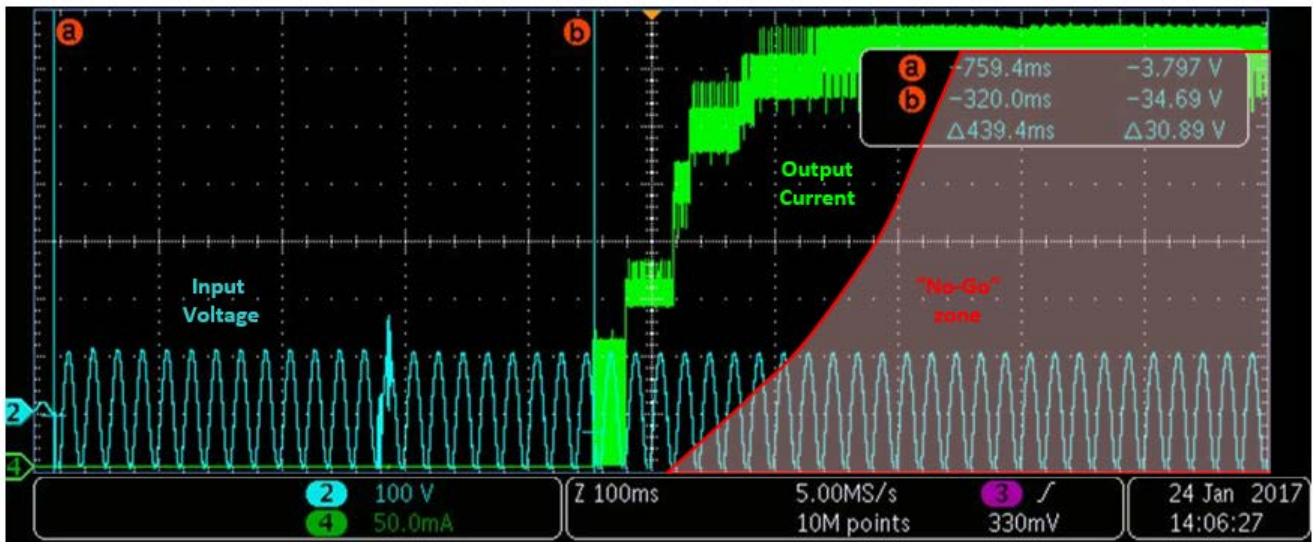


Figure 2: Typical start-up performance for a single-channel 0-10V downlight LED driver from eldoLED with the fast startup sequence. Time-to-first-light is below 500ms; time-to-full-on is below 750ms

Conclusions

Recent updates to the ENERGY STAR and CA Title 24 standards have resulted in stricter requirements on the start-up performance of LED luminaires. LED luminaires that need to comply with both standards may have to meet different start-up profiles, depending on the type of LED driver that is used:

- LED drivers with aesthetic fade-in: time-to-first-light < 500ms; time to nominal light output < 750ms.
- LED drivers without aesthetic fade: time to nominal light output < 500ms.

Single channel 0-10V downlight LED drivers from eldoLED, which, by design, include an aesthetic fade-in feature, do comply with the combined start-up requirements imposed by ENERGY STAR and CA Title 24

References

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