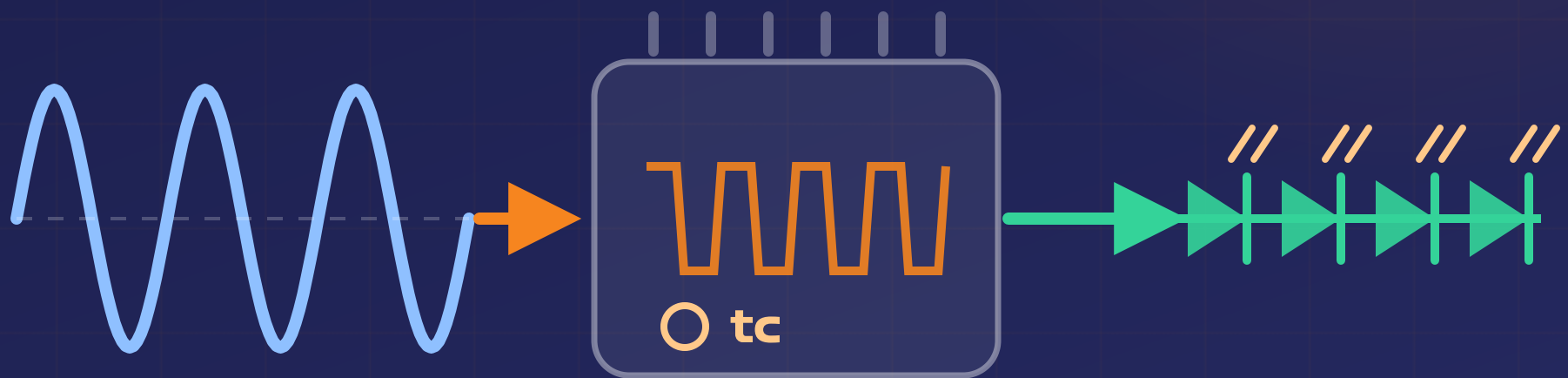




⚡ 230 V AC in ⚙️ the driver 💡 steady mA out

NLC Academy | Episode 19

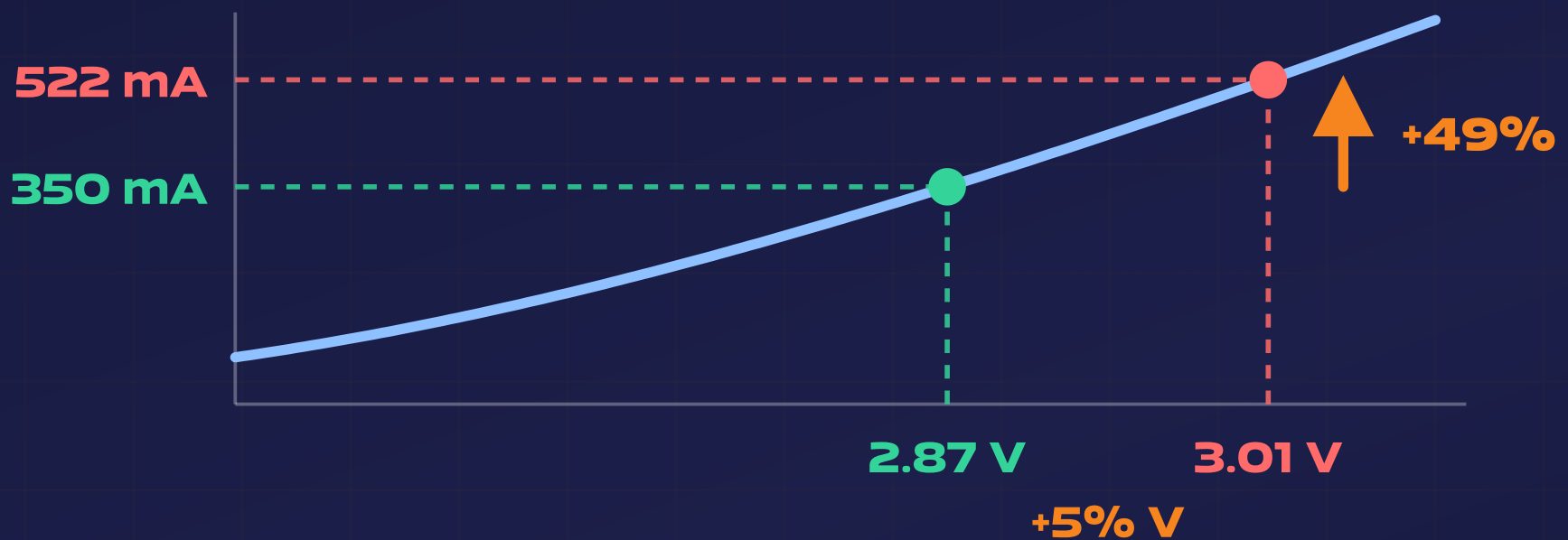
In that test, the LEDs held. The driver circuit did not.

In accelerated life testing of commercial LED luminaires, the failures showed up in the driver circuit, while 611 LEDs ran nearly a million LED-hours with four failures [13]. This episode: what the driver actually does, the spec lines that decide its life, and what SASO already requires of it in Saudi Arabia.

The physics

An LED is a **current device**.

⚠ Illustrative, not measured product data



1 Forward current sets flux and heat. Forward voltage is what the diode happens to need to pass that current, and it moves with temperature, drive level and binning.

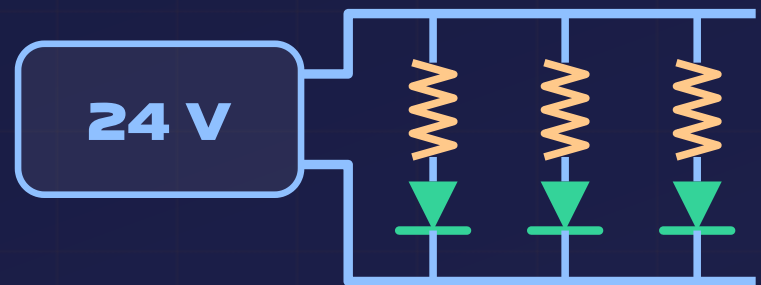
2 So the curve is steep: on the illustrative model above, +5% on the terminal voltage carries across to about +49% current. Feed an LED a fixed voltage and the current is whatever is left over.

Horizontal: forward voltage. Vertical: forward current. Illustrative single-emitter characteristic from a stated model,
 $V = nV_t \cdot \ln(I/I_s) + I \cdot R_s$ with $nV_t = 0.10 \text{ V}$, $I_s = 1e-12 \text{ A}$, $R_s = 0.6 \Omega$. Not measured; real parts differ by type, bin and temperature (Episode 01).

That steepness is the job: **the driver stands between a stiff voltage source and a current-driven device.**

The two families

Constant current or **constant voltage**.



Constant current (CC)

The driver holds the output current and lets the output voltage settle wherever the string needs it, inside a declared voltage window. This is what a spot, a downlight or a floodlight module wants. Check that the string voltage sits inside the driver window at both temperature extremes. [1][2]

Constant voltage (CV)

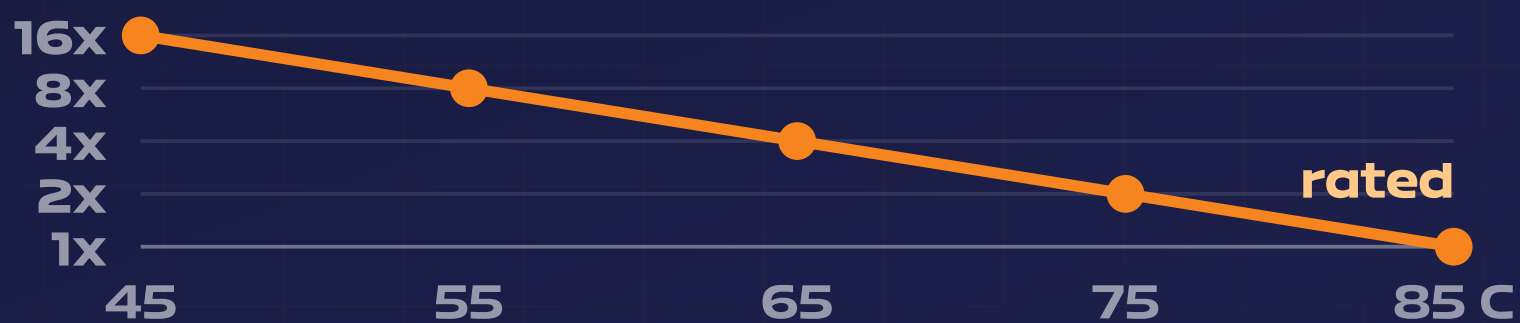
The driver holds a fixed DC bus, typically 12 V or 24 V, and each cuttable segment carries its own current limiting. This is what tape and neon flex want; NLC's SOLID strip publishes DC24V and electrical Class III. [16]

**Wire a CV load to a CC driver and nothing works as specified:
name the family in the spec, not just the wattage.**

The life-limiting part

Heat is the clock: about twice the life per 10 °C cooler.

⚠ Illustrative, not measured product data



- 1 Driver life is derived from the electrolytic capacitor, the part most likely to fail. Its temperature follows the case temperature and the ripple current through it. [12]
- 2 Hence the marked tc point: datasheets state life at a CASE temperature, so an hour count with no tc beside it is not a specification. [12]



Temperature and humidity chamber in the NLC lab: the environment a life figure has to name.

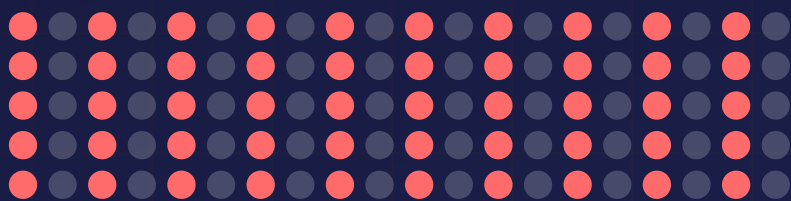
Horizontal: the CAPACITOR's temperature, not the case tc a datasheet quotes. DRAWN from the 10 °C rule, life doubling per 10 °C below a rated 85 °C: an approximate rule of thumb, not measured and not any particular product. Real parts follow their own curve. [12]

Ask for the pair: hours AND the tc they were measured at.

The lifetime notation

Hours are half a number. **The other half is B.**

B50



B20



Shaded dots are the B share, below the stated output threshold; the rest are above it.

L70B50 > 100,000 h

L is the retained-output threshold, B the share below it. At 100,000 h at least half still gives at least 70% of initial output; the > puts the hours higher.

L80B20 > 50,000 h

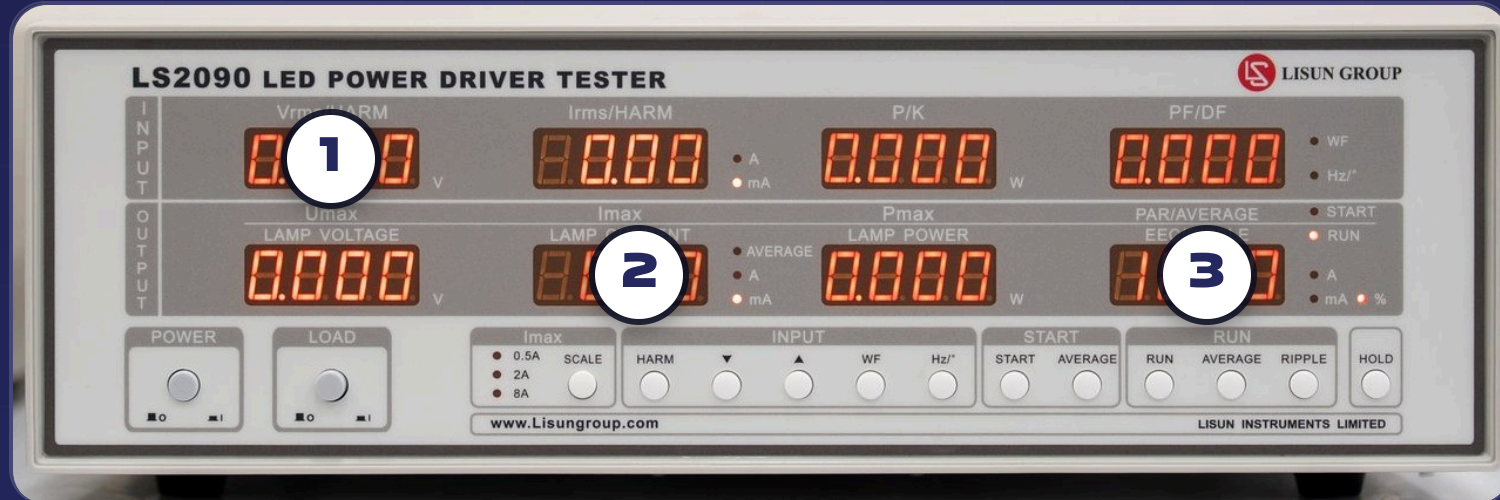
At 50,000 h at least 80% still gives at least 80% of initial output. Different threshold, share and hours: not a ranking against its neighbour. [20]

- 1** B is light-output DEPRECIATION. Whether the driver still runs is a separate promise: hours to a stated survival rate. [12]
- 2** None of it is the driver's number: LM-80/TM-21 cover the LED source, LM-84/TM-28 the luminaire. [15]

Specify lumen maintenance separately from driver lifetime: state driver hours, survival rate and case temperature.

The grid side

What the driver **does to your supply.**



Driver tester in the NLC lab: 1 input volts, 2 output current, 3 output ripple.

Power factor

SASO 2927 requires it of the driver and of the integrated luminaire, for products in its scope. [7]

≥ 0.9

Total harmonic distortion

Same standard, same scope; the test is run per IEC 61000-3-2. [7][4]

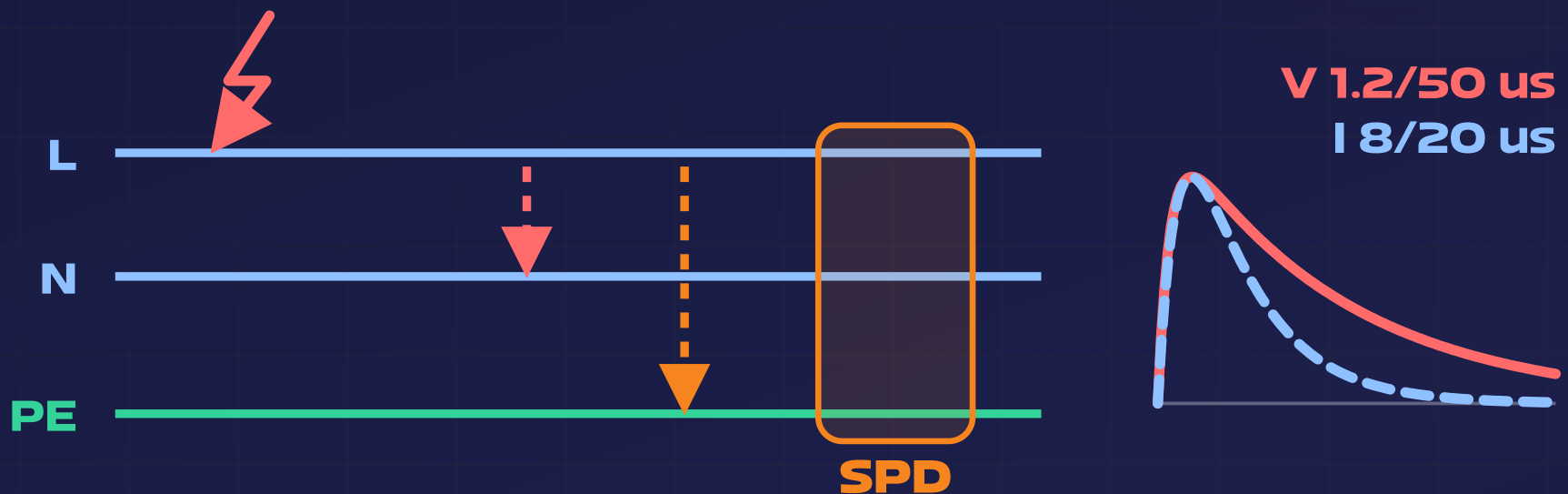
$< 15\%$

Read it precisely: IEC 61000-3-2 Class C limits individual harmonic ORDERS as a percentage of the fundamental current, and AMD1:2020 retired the power-factor form of the third-harmonic limit. It sets no universal 15% THD limit and no 0.9 PF minimum, so the two numbers above are the Saudi requirement. [4][7]

Ask for the numbers **at the dim levels you will actually run,** not only at full output.

The surge

Two paths in, one device across both.



- 1 A surge arrives differentially between line and neutral, and in common mode between the live conductors and earth. Protection answers both, which is why datasheets quote two numbers. The test is the IEC 61000-4-5 combination wave. [5][6]
- 2 For road lighting in its scope, SASO 2927 asks for installation overvoltage protection of 10 kV, internal protection to withstand 4 kV, and an SPD that still works at 80 °C inside the fixture. [7]

Inset: the generator is specified twice over, an open-circuit VOLTAGE of 1.2/50 μs and a short-circuit CURRENT of 8/20 μs . The NLC catalogue spans 1 kV / 2 kV indoors to internal DM 6 kV / CM 10 kV plus external 10 kV / 20 kV outdoors. [5][16]

One surviving surge is not a rating. **Put the kV pair, the mode and the test standard in the spec.**

The safety class

Class I and Class II are not grades.



1 Class I is basic insulation plus a protective-earth connection to accessible conductive parts, so a fault trips the protective device. Class II uses double or reinforced insulation instead. Neither is "better". [3]

2 The class is declared for the COMPLETE luminaire, not for the driver alone: the finished product is designed, tested and marked to one class, whatever its parts are built to. It is regulated too: SASO 2927 specifies Class I in its scope. [3][7]

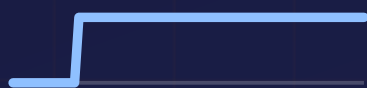
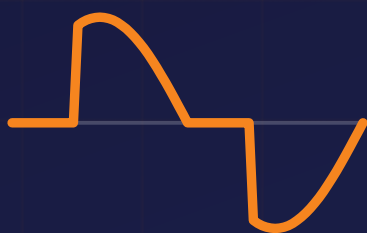


The safety test decides it, not the catalogue: earth bond, dielectric strength, insulation resistance, leakage.

Ask which class the **finished luminaire is marked and tested to.**

The control interface

Three control interfaces, and PWM on both sides.



Phase-cut

Chops the mains

Retrofit wiring.
NEMA SSL 7A-2015 covers FORWARD phase-cut only.
[10]

1-10 V

Two related interfaces

1-10 V is IEC 60929 Annex E; 0-10 V is ANSI C137.1, which adds an electronic off below about 0.5 V. Name standard, range and off.
[9][18]

DALI

A digital, addressable bus

IEC 62386. DT6 (Part 207) is the LED driver, DT8 (Part 209) colour. [8]

PWM

PWM output dimming

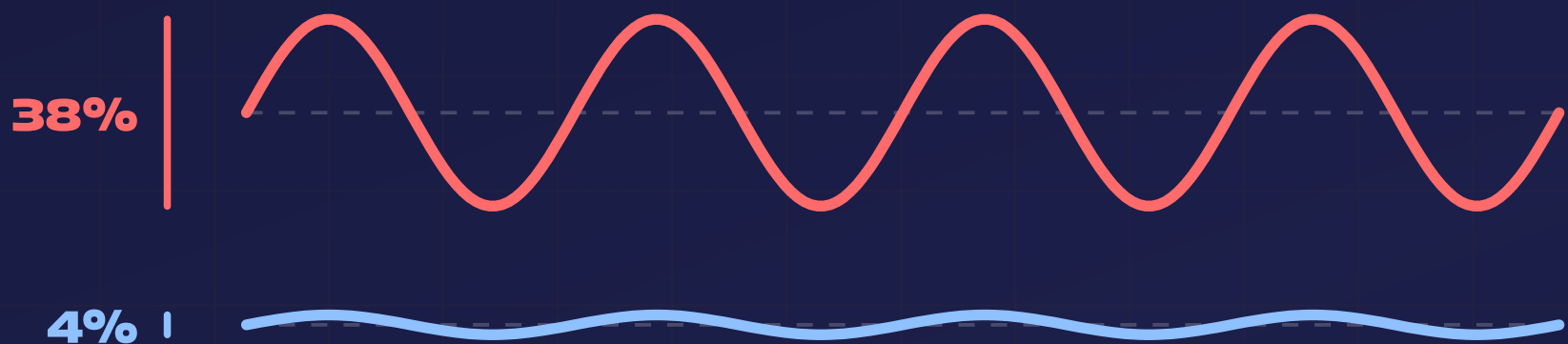
One name, two things: PWM can be the dimming INPUT signal, and also how the driver modulates its OUTPUT. [19] Its frequency is then a flicker question. [11]

SASO 2927 already picks, in its scope: **DALI preferable, or 0-10 V, on a 7-pin ANSI C136.41.** [7][17]

The flicker

Ripple you cannot see until the camera does.

⚠ Illustrative, not measured product data



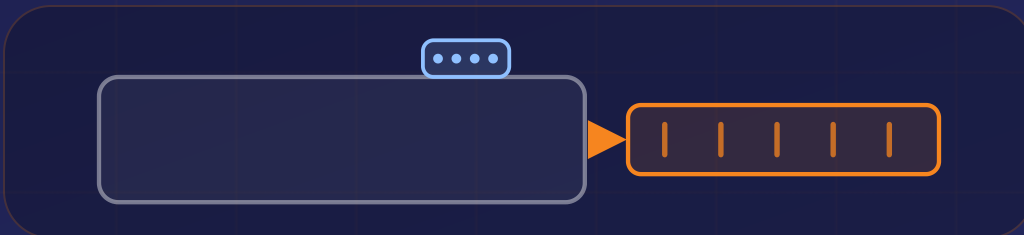
- 1 Output ripple modulates the LED current, and the eye and the sensor read that as flicker. The two things that matter are the modulation frequency and the modulation depth, $(\text{max} - \text{min}) / (\text{max} + \text{min})$. On the Saudi 60 Hz grid, classic rectifier ripple lands at twice mains, 120 Hz.
- 2 IEEE 1789-2015, a recommended practice, grades risk from BOTH axes together, so a single "ripple < 5%" line means nothing without the frequency beside it. Measure it dimmed too. [11]

Horizontal: time. Vertical: LED current about its average. Drawn from stated depths to show the mechanism, not measured; neither colour is a verdict, and no risk threshold is drawn.

If a spec says "flicker-free", **ask which metric (PstLM? SVM?), at which frequency, at which dim level.** [21]

The last spec line

Often the first part to go. Plan the swap.



Blue on the roof: the standard socket for a node. Orange: the gear tray, withdrawing as one part.



COMET: the roof receptacle, and the seam of the gear lid it sits on.

Serviceability is a spec line

A gear tray that withdraws, a connector rather than a potted loom, and a spare still orderable in year eight. The alternative is replacing a whole luminaire because one component reached the end of its life.

What the standard sockets actually cover

Not the driver socket. Zhaga Book 18 (Ed. 4.0, 2025) standardises the socket between an outdoor luminaire and a sensing or communication node; D4i standardises DALI inside it. Neither makes the driver plug-replaceable. In SASO 2927 scope it is the 7-pin ANSI C136.41. [14][17][7]

The roof socket is for the node. The driver's access panel is a separate tender line.

From the NLC range

Four driver stories, straight from the catalogue.

SOLID

Flexibles

DC24V

Class III

L70B50 > 50,000h

Constant voltage: a fixed 24 V bus, cut to length, each segment limiting itself.



AGILE

COB recessed downlight

Class II

PF >0.95

THD <10%

Double-insulated, with power-quality rows to match. Surge 1 kV (L-N) / 2 kV (L/N-PE)



BUBBLE

Canopy

DM 6 kV / CM10 kV

ext 10 kV / 20 kV

Class I

Outdoor exposure, so the surge rows carry internal and external figures.



AMMONIA

Linear, IP69

0-10V

DALI

L80B20 > 50,000h

Named protocols, not the word "dimmable", plus a microwave sensor option.



None of these rows identifies the driver manufacturer or model. [16]

Before you sign

Five lines that decide **who replaces what, and when.**

- ☐ Name the **family and the window**: CC or CV, the output current or bus voltage, and the string-voltage range at both temperature extremes. [1][2]
- ☐ Demand **lifetime as a triple**: hours, the survival fraction behind them, and the case temperature t_c they were measured at. [12]
- ☐ Write the **power-quality and surge lines** to the standard governing the site: in SASO 2927 scope, power factor at least 0.9, THD below 15%, 10 kV at the installation, 4 kV internal, and an SPD rated for 80 °C inside the fixture. [7]
- ☐ Name the **control interface and the device**, never the word “dimmable”: protocol, minimum dim level, curve, and for phase-cut the tested dimmer models. [8][9][10]
- ☐ Specify **serviceability**: a field-replaceable driver, the access method, and a spares commitment with a date on it. [14]

The sources

Every number on these slides, sourced.

- [1] IEC 62384:2020 · [2] IEC 61347-2-13:2024 · [3] IEC 61140:2016
- [4] IEC 61000-3-2:2018+AMD1:2020+AMD2:2024, Class C
- [5] IEC 61000-4-5:2014+AMD1:2017 · [6] IEC 61547:2020
- [7] SASO 2927:2019, Lighting Products Part 3, road lighting
- [8] IEC 62386 parts 102 / 207 / 209 / 218 (DALI)
- [9] IEC 60929:2011+AMD1:2015, Annex E · [10] NEMA SSL 7A-2015
- [11] IEEE 1789-2015, modulating current in high-brightness LEDs
- [12] Signify, LED Driver Lifetime and Reliability, white paper
- [13] US DOE / RTI, Hammer Testing Findings for SSL, Jan 2014
- [14] DALI Alliance, D4i · Zhaga Book 18 Ed. 4.0 (2025)
- [15] ANSI/IES LM-80, TM-21, LM-84, TM-28
- [16] NLC catalogue, 4 product pages
- [17] ANSI C136.41 receptacle · [18] ANSI C137.1, 0-10 V
- [19] Mean Well PWM-40 datasheet · [20] Signify Fortimo SLM guide
- [21] EU 2019/2020 Annex II, PstLM and SVM · IEC TR 63158

Two you should know about: IEEE 1789-2015 went Inactive-Reserved in March 2026, and SASO 2927:2019 has been amended since publication (Decision 40, February 2023, which deleted the 3000-6000 K rule in clause 10.2), so read the consolidated text before quoting it in a submittal. Full citations ship in the episode reference document.

PRACTICAL LIGHTING ENGINEERING

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<https://nlc.com.sa/academy/why-a-driver.html>



Next episode

Metal & Thermal Conductivity