Outdoor 900W/1800W LED Driver – Design-in Guide

Contents

1. Warnings and Instructions

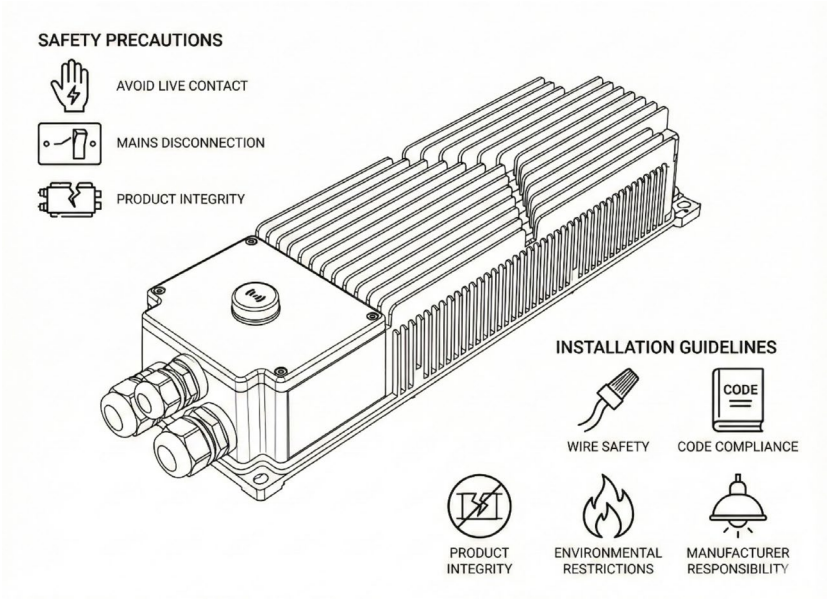
To ensure safe operation and product reliability, strictly adhere to the following safety guidelines and installation instructions.

1.1 Safety Precautions

- **Avoid Live Contact:** Never touch live parts during operation.
- **Mains Disconnection:** Do not service the driver while the mains voltage is connected. This prohibition includes connecting or disconnecting the LED load while the driver is powered.
- **Product Integrity:** Do not use drivers that show damaged wiring, defective contacts, or compromised housing.

1.2 Installation Guidelines

- **Wire Safety:** All unused wires must be capped off to prevent accidental contact with the luminaire chassis or the driver housing.
- **Code Compliance:** The driver must be installed in strict accordance with national and local electrical codes.
- **Environmental Restrictions:** Do not install the driver in flammable or explosive environments.
- **Manufacturer Responsibility:** The luminaire manufacturer is responsible for the final luminaire design and must ensure it complies with all relevant safety standards.

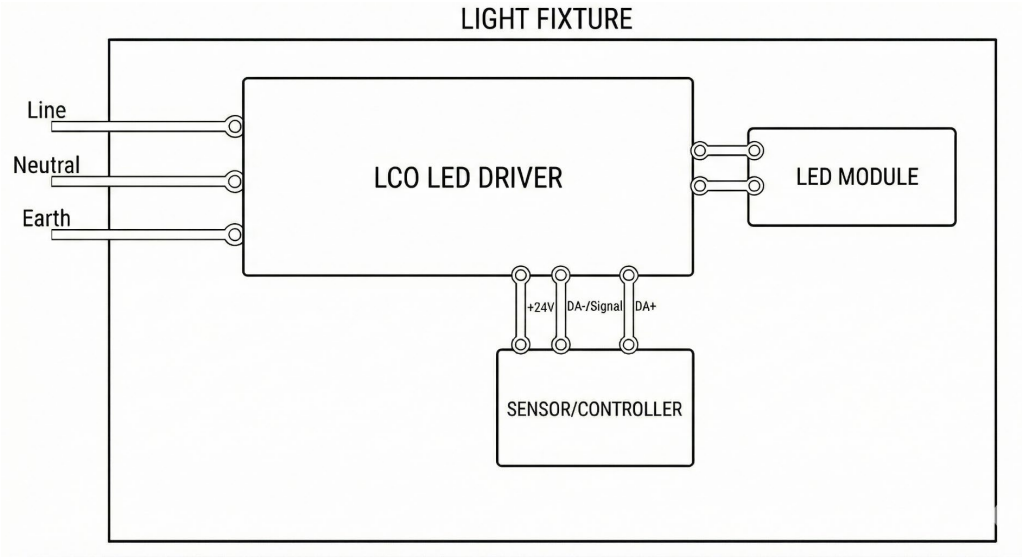


2. Control Interface DALI/D4i

2.1. Aux Introduction and Instructions

The outdoor 900W/1800W drivers feature an integrated auxiliary power output, providing a standard **24V DC** output capable of delivering up to **125 mA**.

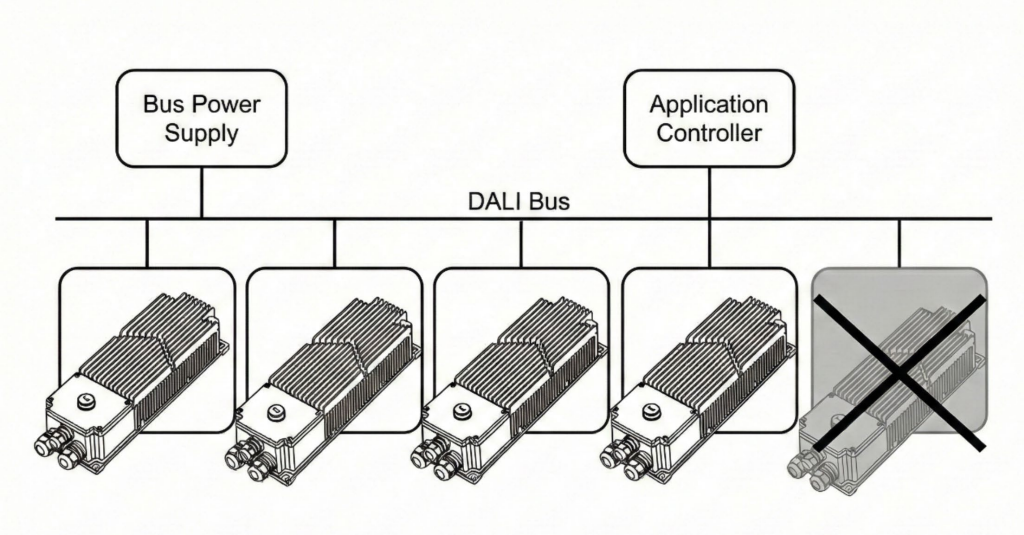
- **Application Scope:** This output is ideal for powering Zhaga/D4i sensors, wireless communication modules, or occupancy/daylight detectors directly within the same luminaire housing.
- **Usage Restrictions:** The Aux output is strictly reserved for Zhaga controllers and sensors only. Any alternative applications are strictly prohibited.
- **Protection Mechanisms:**
    - **Overload Protection:** The output is designed with an overload protection function; "hiccup mode" will be triggered automatically if the load exceeds the limit.
    - **Short Circuit Protection:** There is also built-in short circuit protection for the auxiliary power. The system will auto-recover once the short circuit condition is removed.



2.2. DALI PSU Introduction and Instruction

The outdoor 900W/1800W drivers include a fully compliant **DALI-2 bus power supply (Part 250)**, capable of providing up to **60 mA** to the DALI network by default.

- **Intra-Luminaire Bus:** This feature enables a true intra-luminaire DALI bus, where sensors, controls, and the driver share the same two-wire interface seamlessly.
- **Configuration & D4i Compliance:** The default enabled bus PSU simplifies installation and ensures compliance with **Part 250** requirements for D4i certification.
- **System Management:** In systems utilizing multiple drivers or bus supplies, the DALI bus supply may be disabled on selected devices via standardized DALI commands or NFC programming. This allows for the management of total bus current to avoid exceeding the maximum limit.
- **Multi-Master Limits:** If the bus PSU is not disabled, a maximum of **4 power supplies** can be connected to the same DALI bus, ensuring that the total current remains less than **250 mA**.



2.3. ZHAGA D4i

Zhaga is a global industry consortium dedicated to standardizing interfaces for LED luminaire components to ensure interoperability across ecosystems.

- **Book 18 & Book 20: Book 18** defines the connector, power, and communication pinouts for outdoor luminaires, aiming to enable interchangeable plug-and-play modules equipped with sensors or communication logic. In parallel, **Book 20** provides an equivalent standard for indoor fixtures, ensuring the same level of interoperability across D4i control nodes and drivers.

DALI-2 vs. DALI-1

DALI-2 represents a significant enhancement to the original DALI protocol, standardized under IEC 62386 and managed by the DALI Alliance (DiiA). Unlike the older DALI version-1—which was limited to control gear—DALI-2 introduces certified control devices (including sensors, switches, and controllers), application controllers, and standardized bus power supplies. These additions enable advanced features such as improved interoperability, flexible wiring, precise dimming, and enhanced asset and energy monitoring.

D4i Certification Profile

D4i refers to a specific DALI-2 certification profile developed jointly by the Zhaga Consortium and the DALI Alliance (DiiA). D4i ensures that certified LED drivers include an integrated **24V auxiliary PSU** (per DALI Part 150) and support **Smart Data** capabilities (Parts 251 – 253) for energy usage tracking, fault reporting, and asset management—all communicated via the DALI bus.

DALI Data type	Part	DiiA Specification title	DALI-2	D4i
Luminaire Data	251	DALI Part 251 – Memory Bank 1 Extension	Optional	**Mandatory**
Energy Data	252	DALI Part 252 – Energy Reporting	Optional	**Mandatory**
Diagnostics Data	253	DALI Part 253 – Diagnostics & Maintenance	Optional	**Mandatory**

Plug-and-Play Interoperability

Standardizing the physical socket and DALI-based communications ensures that any Zhaga-D4i control component can be plugged into any compatible luminaire and immediately communicate with any compliant D4i driver—without pre-programming. This creates a modular, scalable platform where upgrades to sensors, controllers, or firmware can be performed post-installation, future-proofing the lighting asset and simplifying maintenance.

2.4. DALI Device Type

The outdoor 900W/1800W LED drivers are fully compliant with the DALI Device Type 6 (DT6) standard (IEC 62386-207), which specifically defines the control gear for LED modules.

As a standard DT6 device, the driver occupies one DALI short address for each channel (total 3 addresses) on the network and is designed to provide precise, reliable control over the brightness intensity of a single output channel. This ensures seamless integration, plug-and-play interoperability, and smooth dimming performance when connected to any certified DALI or DALI-2 master control system.

3. Control Interface DMX/RDM

3.1 Protocol Overview

The outdoor 900W/1800W driver supports the industry-standard **DMX512 protocol**, providing reliable one-way control at **250 kbps** with output dimming capabilities ranging from **0.1% to 100%**. This wide dimming range is ideal for both single- and multi-channel lighting configurations, such as RGB architectural installations.

For enhanced configurability and system management, the drivers also support **RDM (Remote Device Management, ANSI E1.20)**, enabling bi-directional communication between controllers and fixtures.

3.2 Channel Modes

- **Single-Channel Mode:** In this configuration, the driver occupies one DMX address and controls all output channels in common. This mode is perfect for monochromatic or white-light fixtures where uniform output is required across the luminaire.
- **Multi-Channel Mode:** Supporting up to 3 independent channels (e.g., for RGB configurations), the driver listens toconsecutive addresses. This allows lighting designers to control each color channel independently to create dynamic color mixing effects.

3.3 Remote Management Capabilities

From a protocol standpoint, RDM support enables the remote management of the device, which is critical for large-scale installations.

- **Configuration:** Typical RDM GET and SET commands include parameters like DMX_START_ADDRESS, DEVICE_LABEL, DEVICE_INFO, and DMX_FAIL_MODE. The driver specifically supports SET_DMX_START_ADDRESS, allowing users to remotely change the DMX address. This is highly useful in scenarios where the luminaires are recessed or difficult to access physically.
- **Real-Time Monitoring:** Crucially, the driver continuously monitors internal sensors and makes real-time values available via RDM. Reported metrics include:
    - Input voltage
    - Input power
    - Case temperature
    - Output current
    - Output voltage

- **Preventive Maintenance:** These metrics feed into the RDM sensor registry, enabling remote diagnostic reading and status monitoring without physical access—ideal for maintaining system health and energy reporting.

3.4 Installation Best Practices

- **Signal Integrity:** The DMX/RDM interface is physically **opto-isolated** to maintain signal integrity and protect the control network from electrical noise.
- **Cabling:** To ensure reliable data transmission, use twisted, shielded cable for all control wiring.
- **Termination:** The last fixture in the DMX chain must be terminated with a **120 Ω resistor** to prevent signal reflection.
- **Cable Length:** Observe maximum cable length limits, generally recommended between **100m to 300m** depending on cable quality and environment.
- **Addressing Limits:** When deploying multiple fixtures per DMX universe, ensure that the total address count does not exceed **512**. If the system requires more addresses, segment the lighting into multiple universes or use splitters.

3.5 Supported RDM PID List

The following table outlines the supported Parameter ID (PID) functions for the outdoor 900W/1800W driver:

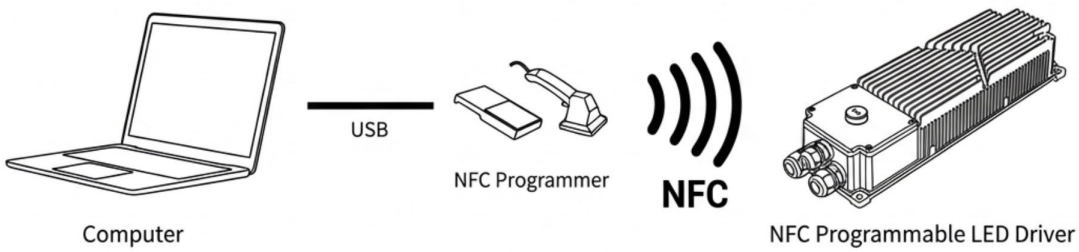
PID （Function List）	GET	SET	Meaning
DEVICE_MODEL_DESCRIPTION	✓		Retrieve device model description
MANUFACTURER_LABEL	✓		Retrieve manufacturer text description
DEVICE_LABEL	✓	✓	Retrieve and set device text description
DMX_PERSONALITY	✓	✓	Retrieve and set device mode
DMX_PERSONALITY_DESCRIPTION	✓		Retrieve device mode description
DEVICE_HOURS	✓	✓	Retrieve and set device operating hours
LAMP_HOURS	✓	✓	Retrieve and set lamp on hours
DEVICE_POWER_CYCLES	✓	✓	Retrieve and set device power cycles
RESET_DEVICE	✓	✓	Retrieve and set device reset
LAMP_STRIKES	✓	✓	Retrieve and set lamp strike count
LAMP_STATE	✓	✓	Retrieve and set lamp state
LAMP_ON_MODE	✓	✓	Retrieve and set lamp on mode
SLOT_DESCRIPTION	✓		Retrieve channel description
SLOT_INFO	✓		Retrieve channel information
FACTORY_DEFAULTS	✓	✓	Retrieve and set factory default channel values

DEFAULT_SLOT_VALUE	✓		Retrieve default settings
SENSOR_DEFINITION	✓		Retrieve sensor definition (partial support)
SENSOR_VALUE	✓		Retrieve sensor value (partial support)
DMX_FAIL_MODE	✓	✓	Retrieve and set DMX signal loss mode
DIMMER_INFO	✓		Retrieve dimmer information
CURVE	✓	✓	Retrieve and set dimming curve
CURVE_DESCRIPTION	✓		Retrieve dimming curve description
PRESET_INFO	✓		Retrieve preset information
SUPPORTED_PARAMETERS	✓		Retrieve supported command definitions
SOFTWARE_VERSION_LABEL	✓		Retrieve software version text description
IDENTIFY_DEVICE	✓	✓	Retrieve and set device identification
DMX_START_ADDRESS	✓	✓	Retrieve and set DMX address
DEVICE_INFO	✓		Retrieve device information

4. Configuration & Programming

4.1. NFC Interface Overview

The outdoor 900W/1800W driver is equipped with a contactless NFC (Near Field Communication) interface, compliant with the ISO 15693 standard. This technology enables rapid, wireless configuration of the driver's operating parameters without the need to apply mains power or connect control wires.



4.1.1. Key Benefits

- **Zero-Power Programming:** Drivers can be read or configured while completely unpowered, ensuring safety and energy efficiency on the production line.
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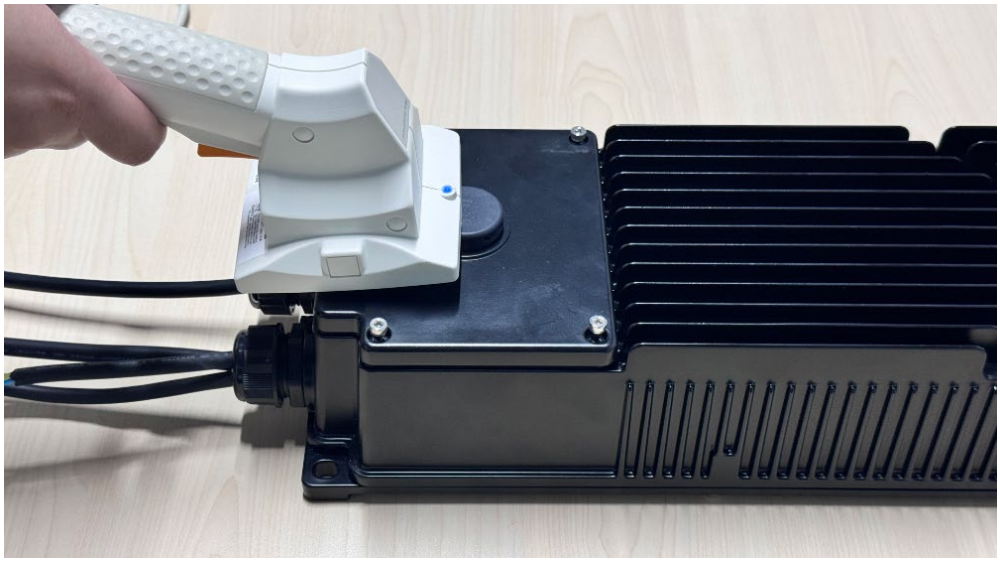
- **Efficiency:** Configuration takes only a few seconds per unit, significantly reducing production cycle time compared to traditional wired interfaces.

Note: This Design-in Guide covers the functions available for configuration. For detailed step-by-step instructions on software installation, wiring, and reading/writing operations, please strictly refer to the separate Programming Guide.



4.2. Required Tools

To successfully configure the LCO drivers, the following equipment is required. Please refer to the Programming Guide for detailed software installation instructions and driver setup.

4.2.1. Hardware (NFC Programmer)

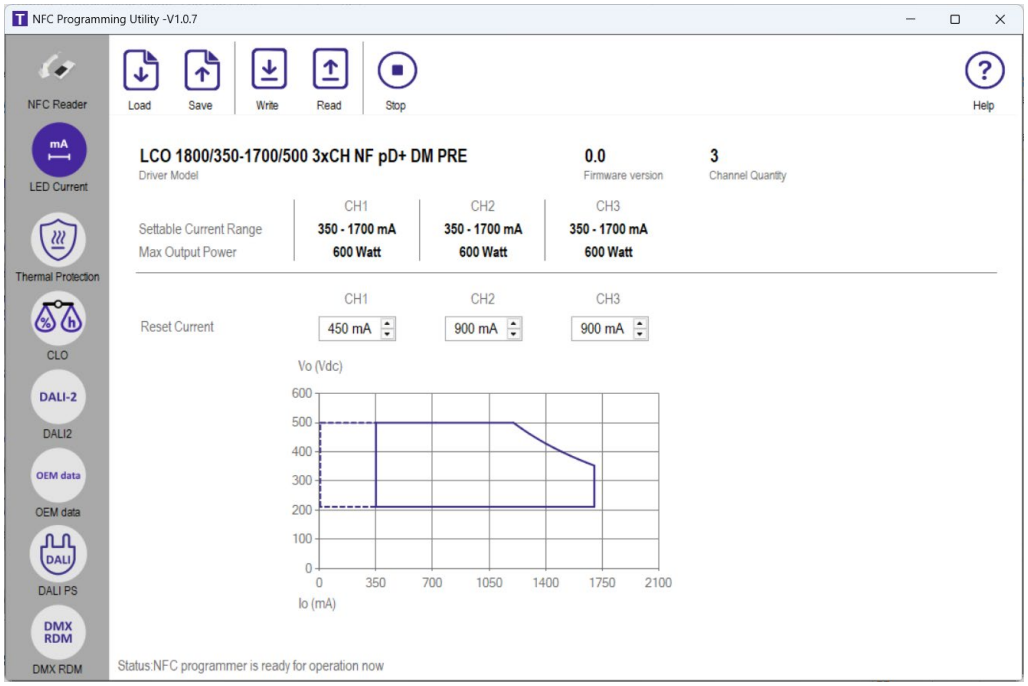
A compatible NFC reader is required to communicate with the driver. The following models are recommended and fully supported:

- **Feig ID CPR30/30+:** Standard desktop reader for production environments.
- **Feig ID ISC.PRH101:** Handheld reader suitable for flexible use.

Note: Ensure the NFC programmer is connected to the computer via USB.

4.2.2. Software

- **NFC Programming Utility:** The dedicated configuration software required to define and write parameters.
- **System Requirements:** The software is compatible with Windows 7, 8, 10, and 11 (supporting both 32-bit and 64-bit architectures).



4.3. Settable Parameters Overview

Using the configuration software, manufacturers can customize specific behaviors of the driver to suit the luminaire's application. The available parameters include:

4.3.1. Output & DMX Configuration

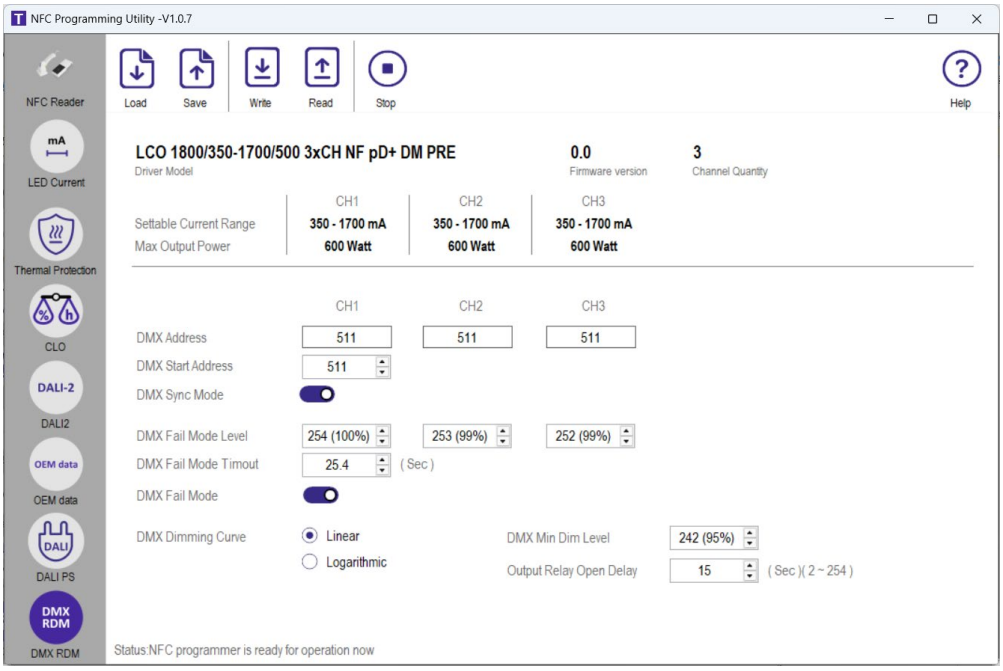
- **Reset Current:** Precise adjustment of the driving current to match the connected LED module's power requirements.

- **Max. Output Power:** Defines the maximum output power limit for a single channel.
- **DMX Address:** Configures the driver’ s starting DMX address.
- **Dimming Curve:** Selection of the dimming behavior:
    - **Linear:** Output scales linearly with the control signal.
    - **Logarithmic:** Output scales logarithmically to match human eye perception.
- **DMX Min Dim Level:** Sets the minimum dimming floor in DMX control(e.g., 0.1%).
- **DMX Sync Mode:** Consolidates operation so all three channels respond to a single DMX address while retaining separate current settings.
- **DMX Fail Mode:** Defines behavior upon signal loss (e.g., setting a specific **Fail Level** or **Timeout**).

  When Fail Mode is enabled, the driver continuously monitors the DMX control interface. If the driver does not receive any valid DMX commands within a user-defined timeframe (FailModeTimeout), it determines that the DMX signal link has been interrupted or is abnormal. Upon detecting this loss of signal, the driver will automatically transition its output to a predefined safety or emergency state (FailModeLevel).

  FailModeLevel: Defines the target output brightness that the driver will maintain during a signal failure. This is set using a standard DMX value ranging from 0 to 255, which corresponds to an output of 0% to 100%.

  FailModeTimeout: Sets the exact duration the driver will wait without receiving a signal before triggering the Fail Mode. This threshold can be adjusted between 1.2 and 25.5 seconds.



4.3.2. Thermal Protection (NTC)

- **NTC Thermal Protection:** Enables real-time monitoring of the LED module temperature.
- **Curve Configuration:** Allows the definition of a linear derating curve (Resistor Value vs. Derating %) to smoothly reduce output current when temperatures rise, protecting the LED module.

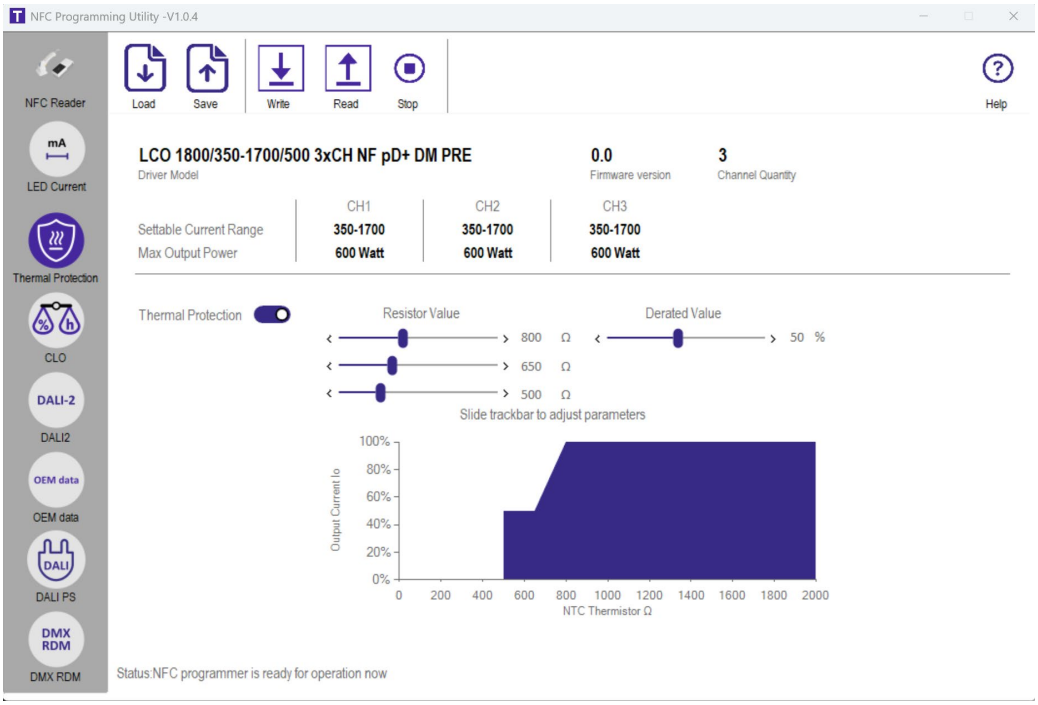
  Based on the provided software interface, the Thermal Protection is enabled with a Derated Value set to 50%. The trackbars define three key resistance milestones: 800 Ω, 650 Ω, and 500 Ω. Here is how the driver behaves across these stages:

  Normal Operation (> 800 Ω): While the LED module is operating within a safe temperature range, the NTC thermistor resistance remains above 800 Ω. During this stage, the driver delivers 100% of the configured output current.

  Derating Phase (800 Ω to 650 Ω): As the module heats up, the resistance drops. Once it crosses the 800 Ω threshold, the driver initiates thermal protection. The output current is linearly reduced from 100% down to the target derated value of 50% as the resistance approaches 650 Ω.

  Maximum Derated Phase (650 Ω to 500 Ω): If the temperature continues to rise, causing the resistance to fall between 650 Ω and 500 Ω, the driver maintains the output at the configured derated level of 50%. This ensures the area remains illuminated while significantly reducing heat generation.

  Critical Shut-off (< 500 Ω): If the temperature reaches a critical extreme and the NTC resistance drops below 500 Ω, the driver will completely shut off the output (0%) to prevent thermal damage to the LED module.



4.3.3. DALI / D4i Configuration

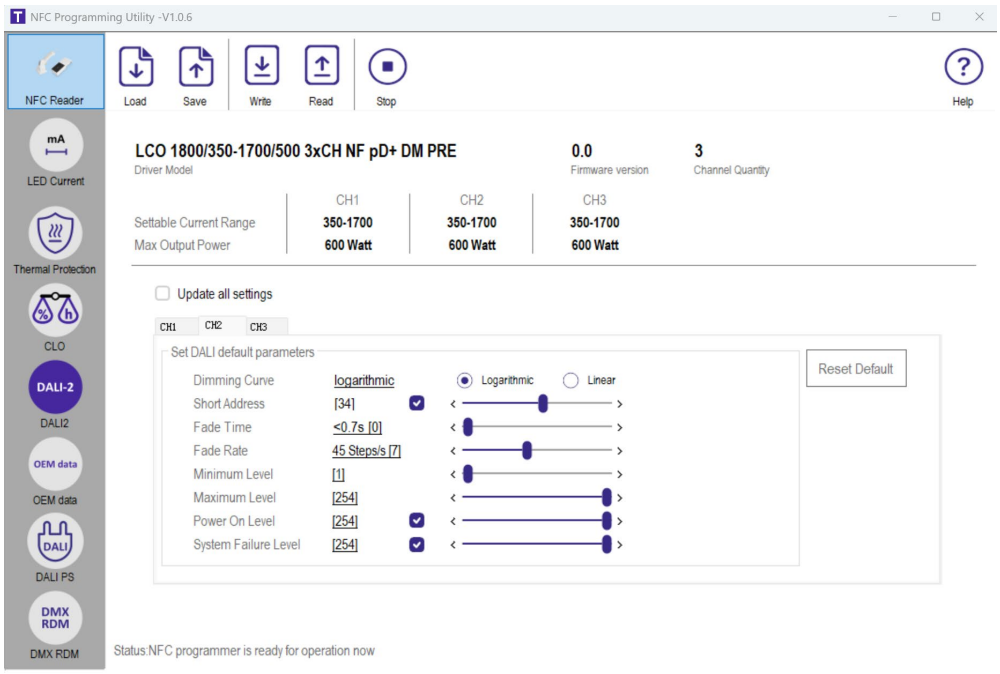
- **DALI Parameters:** Configuration of standard DALI settings via NFC.

o Short Address: Assigning a unique ID (0-63).

o Fade Time / Fade Rate : Defining the transition speed between dimming levels. Fade time setting range 0-15, Fade rate setting range 1-15.

o Power On Level: Setting the brightness level when AC power is applied.

- o System Failure Level: Defining the light output in case of DALI bus failure .



- **D4i Parameters:** Configuration of D4i standard settings (data reporting). **Note:** The Bus Power Supply function must be managed here (disabled/enabled) based on the system architecture (see Section 2.2). Functional Overview: This section allows the luminaire manufacturer to program specific product information into the driver's memory. This data is useful for asset management and system identification in DALI networks.
- Setting Parameters You can input various types of luminaire data. Use the checkboxes to select which information you want to program:
- Identification Info: Enter text strings for the Global Trade Item Number (OEM GTIN), Luminaire Colour, and Luminaire Identification strings.
- Manufacturing Date: Record the production timing by setting the Year and Week of manufacture.
- Technical Specifications: Input electrical and optical parameters such as Input Power, AC Voltage range, Light Output (lm), CRI, and Colour Temperature.
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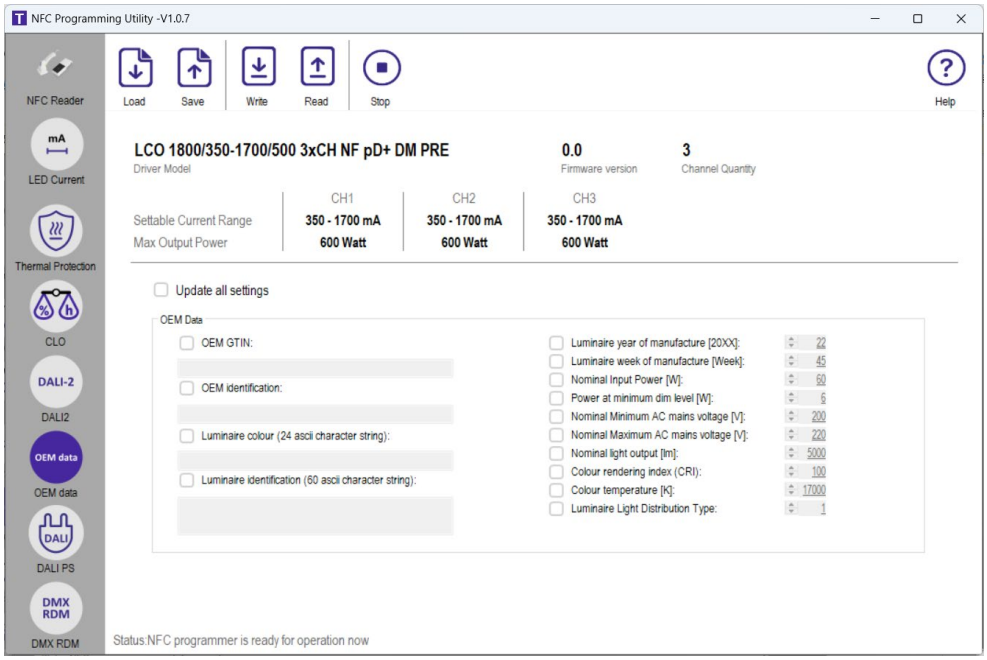


5. Thermal Design in

5.1. Module Temperature Protection (NTC)

The outdoor 900W/1800W drivers include an external NTC (Negative Temperature Coefficient) thermistor interface on the LED board, which enables real-time monitoring of the module’s temperature.

- **Customizable Protection:** By programming the driver via NFC, OEMs can set custom OTP (Over Temperature Protection) thresholds and corresponding current derate curves.
- **Automatic Response:** If the module temperature exceeds the configured setpoint, the driver will automatically reduce currentor shut down entirelyto prevent overheating.
- **Longevity:** This functionality ensures both driver and LED longevity, offering a protection for enclosed or thermally challenging luminaire designs.

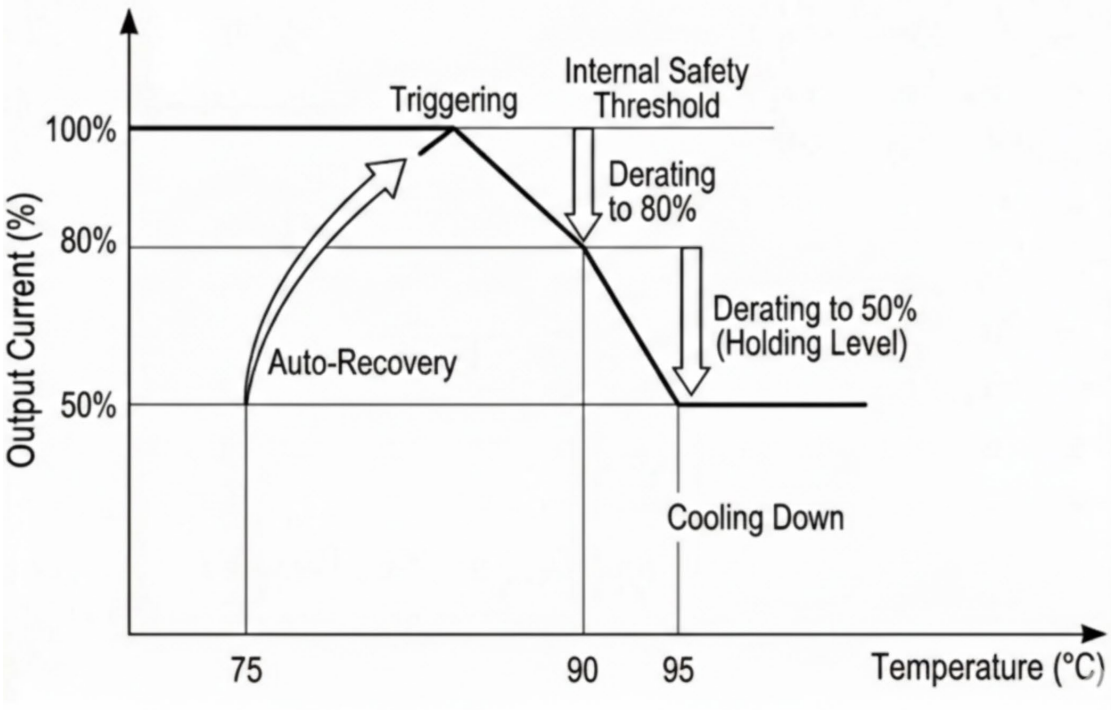
5.2. Driver High Temperature Protection

In addition to module-level protection, LCO drivers utilize an internal thermal monitoring mechanism that tracks the case temperature (Tc). The driver is programmed to reduce output current when Tc approaches critical levels, ensuring thermal stability.

- **Fold-back Mechanism:** This protection prevents internal thermal damage under high ambient or high-load conditions.
- **Auto-Recovery:** After the temperature falls within acceptable limits, the driver will automatically recover its full output, maintaining continuous operation.

Protection Stages:

1. **Stage 1:** The output current drops to **80%** within 60 seconds if the casing temperature reaches approximately **90°C**.
2. **Stage 2:** If the temperature continues to rise and reaches approximately **95°C**, the output current drops to **50%** to strictly protect the LED driver.

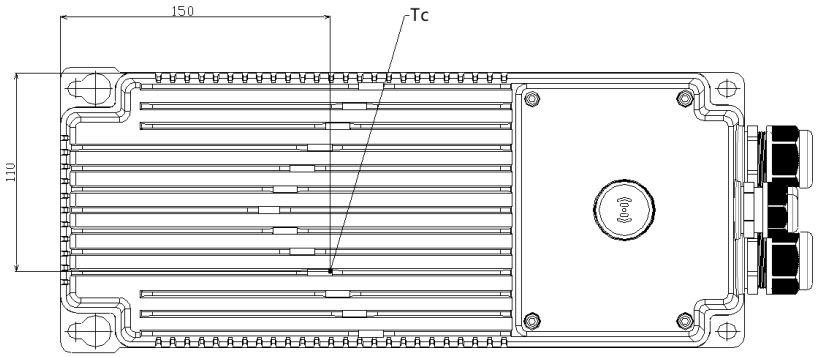


5.3. Preferred Thermal Design for Applications

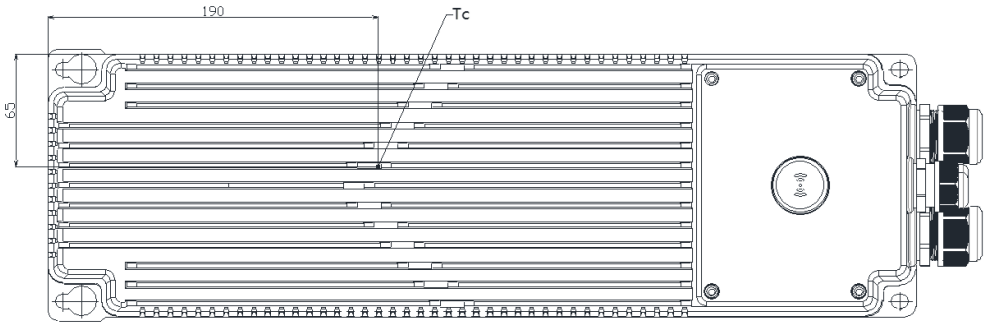
To guarantee the reliability of the thermal performance, thermal testing should be carried out in conditions that replicate the actual installation and application environment.

- **Objective:** This testing is critical to confirm that the temperature of the unit's casing does not exceed the warranted threshold case temperature (Tc).
- **Tc Location:** The specific Tc point is located on the driver casing and must be monitored during testing.

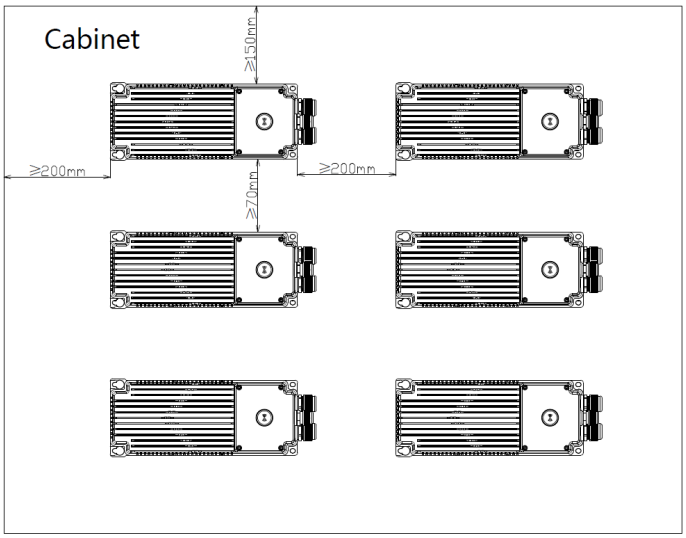
LCO 900/200-1050/500 3CH NF pD+ DM PRE

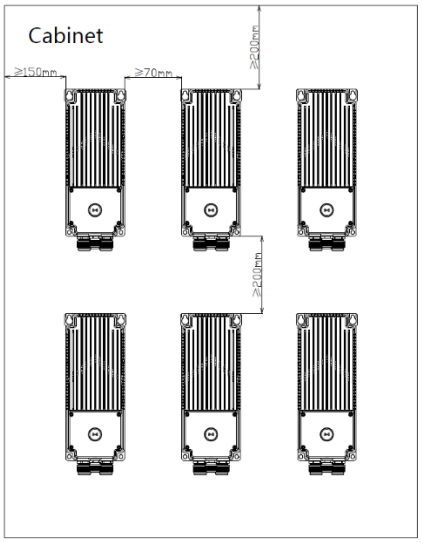


LCO 1800/350-1700/500 3CH NF pD+ DM PRE



- **Installation Spacing:** For optimal setup, it is advised to follow the recommended driver-to-side wall distances to ensure adequate airflow and heat dissipation.





6. Electrical Design in

6.1. Driver Selection Guide

To choose the correct The outdoor 900W/1800W driver model for your installation, follow these practical steps:

1. **Determine Requirements:** Identify your LED design’ s required output by defining both the drive current (I_drive) and the forward string voltage (V_f).
2. **Calculate Power:** Use these values to calculate the required drive power: P_drive = V_f xI_drive.
3. **Review Specifications:** Check the driver specifications, specifically the output current, voltage range, power rating, and dimming/control interfaces.
4. **Verify Compatibility:** Narrow down candidates by confirming:
    - Whether the required drive current falls inside the driver’ s adjustable current range.
    - Whether the LED string voltage falls within the driver’ s voltage window.
    - Whether Pdrive is within the driver’ s maximum output power.
5. **Confirm Features:** Finally, confirm that the driver supports your desired control interface (0-10V, DALI/D4i, DMX/RDM, PWM) and that programmable features like output current adjustment, time dimming, or CLO are available.

6.2. Open Circuit Protection

LCO LED drivers are equipped with a sophisticated no-load protection mechanism designed to protect the driver and the connected LEDs in the absence of a load.

- **Activation:** This protection engages when the output is open-circuited.
- **Response:** The driver will automatically shut down output when detecting an open circuit to prevent damage.

6.3. Short Circuit Protection

LCO LED drivers feature output short-circuit protection as a standard safety measure.

- **Response:** In the event of an output short circuit, the driver automatically limits its output current and voltage to protect itself from damage.
- **Recovery:** Once the short-circuit condition is removed, the driver is designed for **automatic recovery**, meaning it will resume normal operation without requiring a power cycle or manual intervention.

6.4. Over Load Protection

LCO LED Drivers are equipped with robust output overload protection mechanisms designed to protect the driver and connected LEDs from excessive power demands. The protection behavior varies slightly depending on the driver's power rating:

- **For 1800W Drivers:**
    - **Trigger:** Protection activates when the output power exceeds approximately **3%** beyond its rated maximum.
    - **Action:** The driver initiates an intelligent current reduction, limiting the total output power to 1800W.
    - **Recovery:** If the output voltage is subsequently reduced, the output current will gradually recover to its normal level once the output voltage falls back to the full-load rated voltage.
- **For 900W Drivers:**
    - **Trigger:** Protection typically triggers when the output power exceeds its rated maximum by approximately **15%**.
    - **Action:** The driver automatically reduces the output current, limiting the total output power to 900W.
    - **Recovery:** Similar to the 1800W models, the output current will recover to its normal state as the output voltage approaches the rated full-load voltage.

7. EMC Design in

The outdoor 900W/1800W LED drivers are designed to comply with relevant EMC standards, ensuring reliable operation in various electromagnetic environments

without causing or being affected by excessive interference. The drivers meet the requirements of **CISPR15** and related standards, having been tested in controlled environments using reference luminaire setups.

To achieve optimal EMI performance in real-world installations, the following practical recommendations should be followed during system design and assembly:

7.1. Wiring & Layout Optimization

- **Minimize Differential Mode Loops:** Keep the wiring between the driver output and LEDs bundled tightly together to drastically reduce the loop area. This minimizes generated magnetic fields, thereby reducing radiated EMI—a step that is especially important in long linear lighting designs.
- **Reduce Common Mode Coupling:**
    - Keep output wiring short and well-separated from earth-grounded metal parts to minimize parasitic capacitance.
    - Maintain short incoming mains wires inside the luminaire to limit coupling paths.
    - Ensure that the casing of both the driver and the lighting fixture is connected to the ground firmly.
- **Maintain Separation of Circuit Types:** Do not bundle mains and control lines (DMX, DALI, AUX) with output wires. Physical separation reduces cross-coupling and potential noise issues.

7.2. Proper Grounding Practices

- **Class I Luminaires:** Ensure that the chassis and other internal metal parts are properly bonded to the protective earth.
- **Floating Metal:** Avoid leaving large metal parts floating electrically, as this can lead to EMI issues.
- **Connections:** Use short, low-impedance earth wires and maximize the use of metal chassis surfaces for grounding.

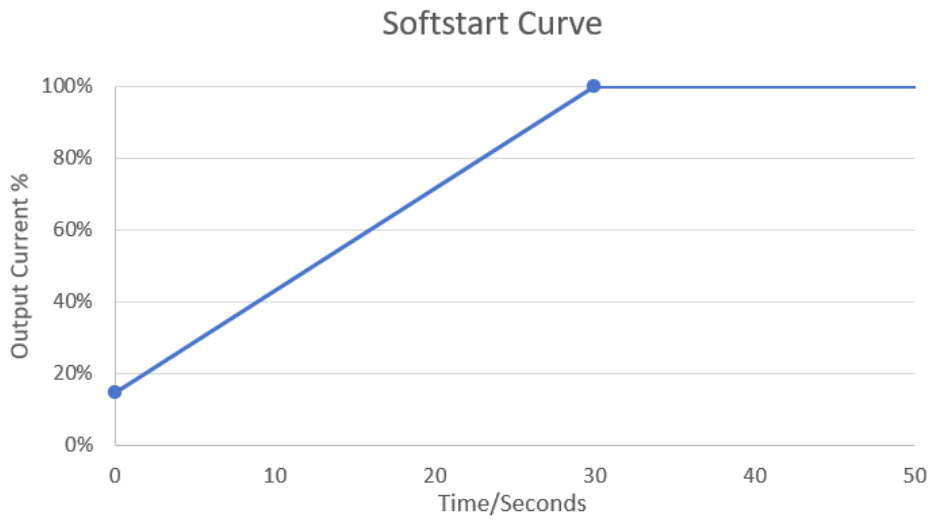
7.3. Additional EMC Measures

In cases where radiated EMC performance is difficult to achieve (often due to complex luminaire geometries), consider using **100 – 300 Ω ferrite beads** on mains or LED wiring. These are effective at suppressing high-frequency interference, particularly between **30 MHz and 300 MHz**.

8. Soft start under cold environment

The outdoor 900W/1800W drivers include an intelligent soft-start feature designed to enhance reliability in low ambient temperature conditions.

- **Activation Threshold:** The feature activates automatically when the ambient or internal temperature drops below **-25°C**.
- **Operation Sequence:** Instead of jumping immediately to full power, the driver initiates operation at **15% output current**. It then gradually ramps up to **100%** over a **30-second** interval.
- **Benefits:**
    - **Component Protection:** This gentle power-up sequence allows internal components and the driver’ s thermal mass to warm evenly.
    - **Reduced Stress:** It significantly reduces electrical stress on capacitors and switching circuitry during the critical startup phase.
- **Applications:** This feature ensures the power supply can confidently start and operate in ultra-cold environments, such as outdoor winter applications or refrigerated installations, providing a smoother warm-up sequence and improved operational stability.

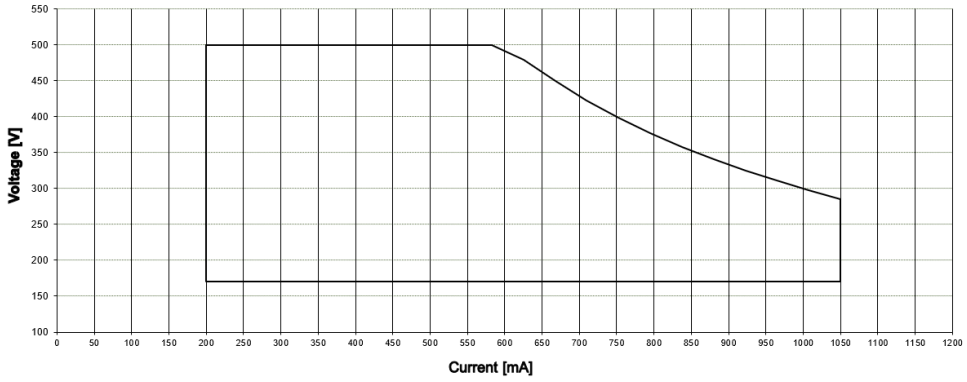


9. Operation Window Instruction

9.1. Adaptable Output Current (AOC)

LED technology advances at a rapid pace, with next-generation LEDs often producing the same luminous output at much lower drive currents. Consequently, lighting designers frequently need to adjust current levels to meet evolving application needs, whether swapping out LEDs for higher efficiency models or modifying PCB configurations.

- **Flexibility:** Unlike traditional drivers with fixed current settings (e.g., 350 mA or 700 mA) that require replacement when updates occur, the outdoor 900W/1800W driver addresses this challenge through its Adaptable Output Current (AOC) capability. Designers can configure the drive current via NFC without changing the driver hardware.
- **Operating Envelope:** Each driver defines a specific "operating window" a combination of allowable voltage and current mapped in the datasheet. Designers must select the appropriate current based on the LED string’s forward voltage (sum of V_f) to ensure the combination remains within this operating envelope.
- **Future-Proofing:** This feature offers future-proof flexibility. As more efficient LEDs enter the market or lumen output requirements change, the same LCO driver can be reprogrammed to fit the new configuration, eliminating the need for different driver models while maintaining certified performance.

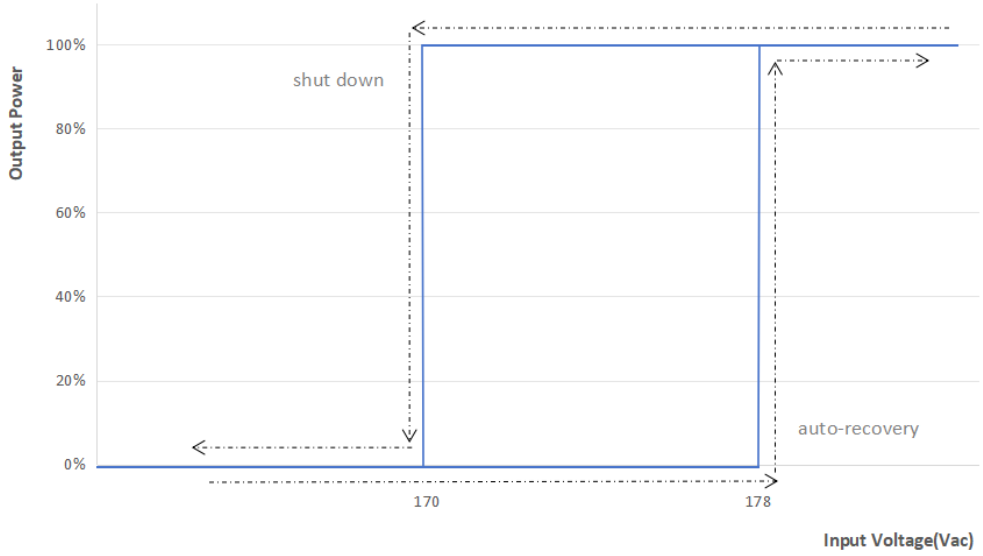


(900W Example)

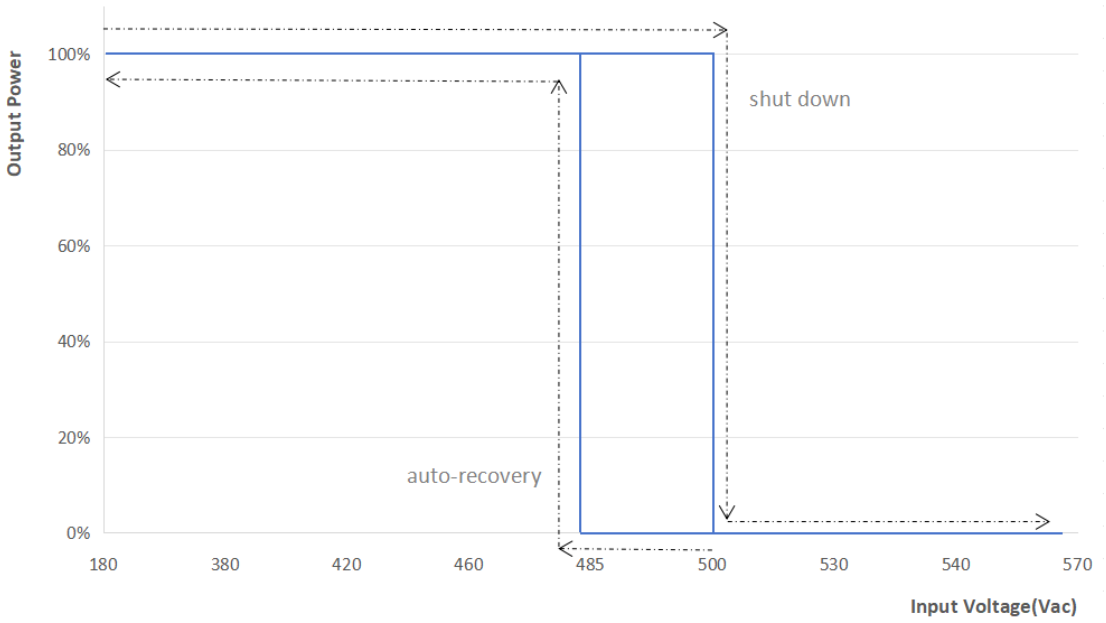
9.2. Mains Operation Conditions

To maximize lifetime reliability, maintaining operation within the **200 – 415 Vac** window is strongly advised.

- **Low Mains:** Operating the outdoor 900W/1800W driver under continuous low AC input, below approximately **180 Vac**, may negatively affect the driver's longevity and performance. While the unit may continue to deliver power, it is designed to turn off if the input voltage drops below **170 Vac**.



- **High Mains:** Conversely, sustained exposure to high AC input voltages above approximately **480 Vac** places undue stress on internal components. The driver is designed to shut down if the voltage exceeds **500 Vac** to prevent catastrophic failure.



9.3. Mains Guard (Protection)

Internally, LCO drivers are equipped with both undervoltage and overvoltage detection circuits to protect the power stage from extreme mains conditions.

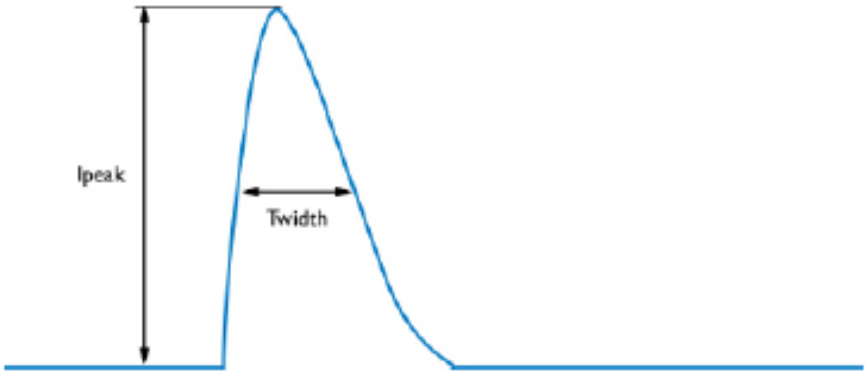
- **Protective Shutdown:** The drivers continue normal operation down to the lower voltage limit, but upon sensing input problem beyond the threshold, protective shutdown or restart protocols are activated to protect internal components.
- **Surge Immunity:** During transient surges, the driver’ s ability to endure up to **20 kV common-mode** and **20 kV differential-mode** surges ensures robust immunity to real-world disturbances.

10. MCB Calculation and Selection Introductions

10.1. Inrush Current Overview

Inrush current refers to the high, short surge of input current drawn by an LED driver at power-on, primarily due to input-side capacitors charging. This spike can be up to tens or hundreds of times greater than the steady-state running current.

LCO drivers are engineered to deliver exceptionally low inrush peaks—often **5 – 10 A** lasting under **6 ms**—allowing far more units per MCB compared to standard drivers. In many cases, the limiting factor becomes the steady-state current, not the peak inrush.



10.2. Calculation Formula

To determine how many LCO drivers can be connected behind a single MCB without nuisance tripping, use the following formula:

Max drivers = min(I_hold / I_inrush, I_trip / I_avg_driving)

Where:

- I_hold is the MCB’s instantaneous withstand current for the inrush pulse duration
- I_trip is the standard MCB rated current (derated by ~70% for Type C)
- I_inrush is the peak inrush current from one driver
- I_avg_driving is the nominal steady-state input current per driver

10.3. Recommended MCB Types

- **Type C:** Use Type C MCBs, which accommodate 5 – 10× rated current. These are ideal for typical LCO driver inrush durations.
- **Type D:** In more aggressive installations, Type D MCBs may offer higher headroom (10 – 14×) but must comply with applicable safety regulations.

LCO drivers feature significantly reduced inrush current characteristics (up to ten times lower than many competitors), making them MCB-friendly and reducing nuisance trips during power-up sequences.

	Automatic circuit breaker type	B10	B13	B16	B20	B25	B32	C10	C13	C16	C20	C25	C32	D10	D16	D25	D32
TYKT, 900W	220V input	1	1	2	2	3	4	1	2	2	3	4	5	1	2	4	5
	277V input	1	2	2	3	4	5	2	2	3	4	5	6	2	3	5	7
	400V input	1(x3)	1(x3)	2(x3)	2(x3)	3(x3)	4(x3)	1(x3)	2(x3)	2(x3)	3(x3)	4(x3)	5(x3)	1(x3)	2(x3)	4(x3)	5(x3)
	480V input	1(x3)	2(x3)	2(x3)	3(x3)	4(x3)	5(x3)	2(x3)	2(x3)	3(x3)	4(x3)	5(x3)	6(x3)	2(x3)	3(x3)	5(x3)	7(x3)
TYKT, 1K8W	220V input	0	0	1	1	1	2	0	1	1	1	2	2	0	1	2	2
	277V input	0	1	1	1	2	2	1	1	1	2	2	3	1	1	2	3
	400V input	0(x3)	0(x3)	1(x3)	1(x3)	1(x3)	2(x3)	0(x3)	1(x3)	1(x3)	1(x3)	2(x3)	2(x3)	0(x3)	1(x3)	2(x3)	2(x3)
	480V input	0(x3)	1(x3)	1(x3)	1(x3)	2(x3)	2(x3)	1(x3)	1(x3)	1(x3)	2(x3)	2(x3)	3(x3)	1(x3)	1(x3)	2(x3)	3(x3)

11. RCD (RCB/RCCB) Calculation and Selection

Introductions

To ensure personnel safety and minimize the risk of electric shock, LCO driver circuits should be protected by a suitable residual-current protective device (RCD/RCCB) in accordance with IEC standards and local regulations.

Key Considerations

- **Cumulative Leakage:** For installations utilizing multiple drivers, cumulative leakage currents must be taken into account. Designers must calculate the total leakage to ensure it remains below the trip threshold of the protective device to prevent nuisance tripping.
- **Integrated Protection (RCBO):** An integrated RCBO (Residual Current Breaker with Overcurrent protection) is highly recommended as it offers combined protection against both leakage currents and overcurrent faults.

Selection Guide

When selecting an RCBO for LCO drivers, follow these criteria:

- **Leakage Threshold:** Select a device whose rated leakage threshold matches the specific driver specifications and the total number of units on the circuit.
- **Overcurrent Rating:** Ensure the overcurrent rating aligns with the maximum operating current and the expected inrush profiles (as calculated in Section 10).
- **Benefits:** This configuration simplifies wiring and enhances both shock and overload protection in a single device.

12. Multi-Channel Features

The outdoor 900W/1800W drivers are purpose-built to support up to three independently controlled output channels. This architecture makes them an ideal solution for applications requiring high accuracy color and brightness control, such as RGB architectural lighting and dynamic outdoor sports lighting.

Key Capabilities

- **Independent Control:** Each channel allows for separate management, enabling complex lighting scenes and dynamic effects.
- **Precision Output:** Each channel delivers a constant current output with tight accuracy (± 2%), ensuring color consistency and smooth dimming transitions even under challenging environmental conditions.
- **Interface Versatility:** The drivers offer full support for multiple control interfaces including DALI-2 / D4i, DMX512, and RDM, enabling integrators to tailor the control system based on specific installation requirements.

Synchronization

Thanks to the synchronized daisy-chain architecture, all three channels remain in lockstep. This provides seamless color blending and eliminates timing mismatches, which is critical in video and stage lighting applications.

Configuration

The output current of each channel can be set separately in the programming software, allowing for precise load balancing and customization for RGB or RGBW LED modules.

13. Strobe Mode Introduction and Application Attention

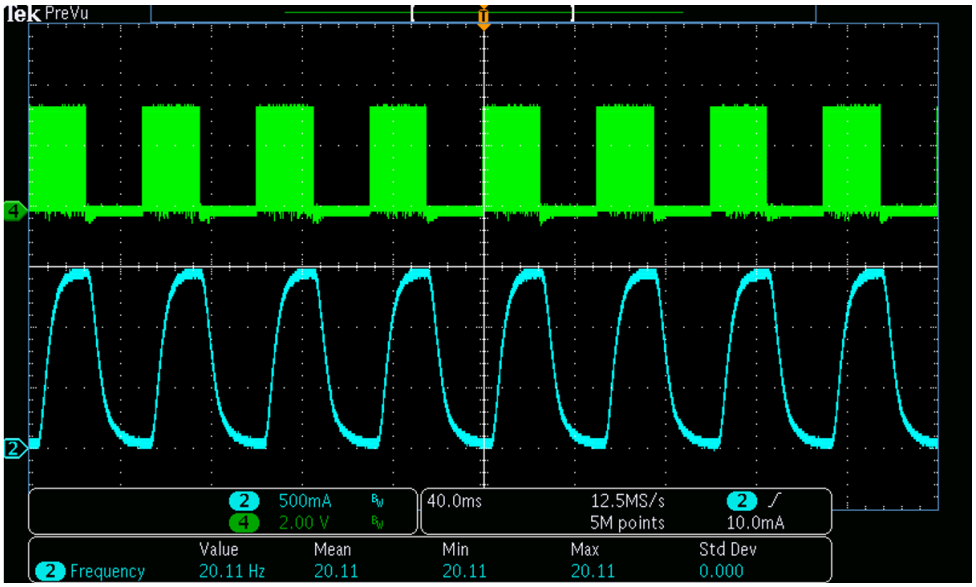
13.1. Overview

The outdoor 900W/1800W LED drivers include a dedicated **Quick-Flashing (strobe) mode** designed specifically to produce fast, attention-grabbing flash sequences with safe and controllable characteristics. This functionality enables designers to achieve the classic strobe effect—ideal for applications in theme parks, entertainment venues, emergency signaling, and architectural highlights where a pulsating light presence enhances visual impact.

13.2. Frequency and Control

- **Optimal Visuals:** Strobe frequencies around **4 – 6 Hz** often produce optimal visual results by creating distinctive flashes without blending into continuous light.

- **Maximum Frequency:** For safety and operational stability, LCO drivers support a maximum strobe frequency of **44 Hz**, enabling more intense flashing patterns without exceeding device limits.
- **Modulation:** When Quick-Flashing mode is activated, the driver modulates the light output using precisely timed **PWM bursts** aligned to the DMX or DALI dimming signal. This preserves peak LED brightness while avoiding excess thermal or electrical stress.



13.3. Thermal Considerations

Even at high flash rates, designers must prioritize thermal durability. Each flash involves brief but intensive current pulses. Therefore, it is critical to ensure:

- **Proper Cable Gauge:** Wiring must be sufficient to handle the pulsed current load.
- **Heat Dissipation:** The luminaire design must allow for adequate heat dissipation to prevent overheating during prolonged strobe operation.

13.4. Safety and Health Warnings

While the driver supports frequencies up to 44 Hz for specialized warning or energy visualization scenarios, such intensities must be evaluated carefully.

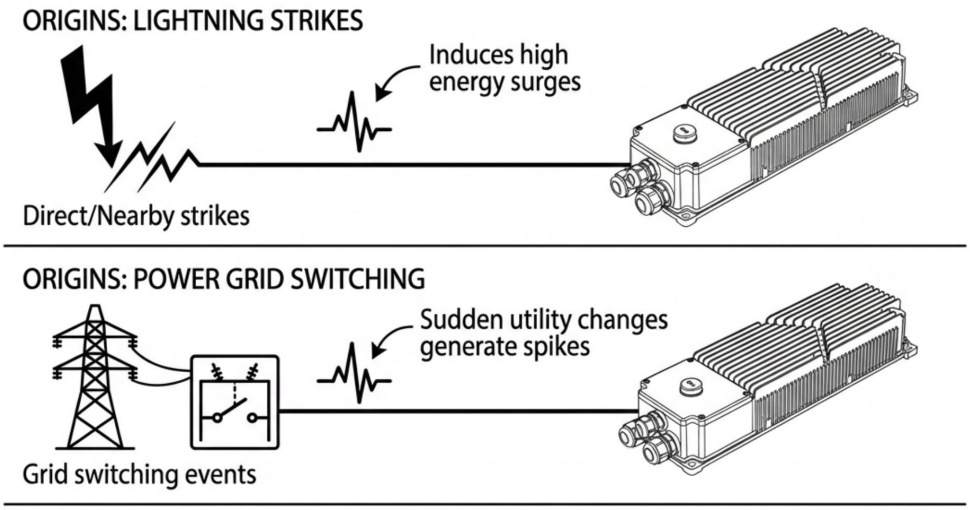
- **Seizure Risk:** Prolonged flashing above approximately **15 Hz** can approach the human headache or seizure threshold (photosensitive epilepsy).
- **Requirement:** Any installations utilizing frequencies exceeding **15 Hz** require clear safety warnings or restricted access to protect the public.

14. Surge Protection Guidelines

14.1. Overview

Surges, also known as transient overvoltages or voltage spikes, are short-duration bursts of excess energy in an electrical circuit.

- **Origins:** These surges can come from various sources, including direct or nearby **Lightning Strikes** (which induce significant surges in power and data lines) and **Power Grid Switching** (where sudden changes in utility power flow generate spikes).
- **Impact:** Surges can cause significant damage to electronic equipment, including LED drivers, leading to premature failure, reduced lifespan, and costly repairs. Implementing effective surge protection is crucial for the reliability of outdoor lighting systems.



14.2. Driver Immunity (Input/Output)

The outdoor 900W/1800W LED drivers offer robust surge immunity on their power input and output terminals.

- **Ratings:** They are rated to withstand up to **20 kV differential mode** surges (Line-to-Neutral, 2 Ω) and **20 kV common mode** surges (Line/Neutral-to-Ground, 12 Ω), conforming to **IEC 61000-4-5**.
- **Output Safety:** Furthermore, surge voltage at the output side(against PE) below 2 kV for 900W and 3kV for 1800W, assuring safe interfacing with LED strings even during significant power disturbances. This parameter shall be considered when selecting outdoor LED modules in the design; meanwhile,

the impact of the harsh operating conditions on dielectric strength shall be taken into account to prevent field failure.

14.3. Wiring and Protection Best Practices

To improve the overall surge protection of the lighting system beyond the driver's internal capabilities, the following practices are highly recommended:

- **Proper Grounding:** Ensure proper grounding of the luminaires and electrical enclosures. A low-impedance ground path is essential for safely diverting surge currents to the earth.
- **Shielded Cables:** Use shielded cables for power and control lines, particularly in areas prone to electromagnetic interference (EMI) or potential surge exposure. Connect the shield to the ground at both ends, following local regulations.
- **Separation of Conductors:** Separate high-voltage power lines from low-voltage control and data cables to minimize inductive coupling of surges. Route cables away from each other to minimize influence.
- **External SPDs:** Install external Surge Protective Devices (SPDs) at the service entrance, distribution panels, and critical points in the lighting circuit. These devices provide an additional layer of protection by diverting surge currents away from sensitive equipment. They can be installed in series or parallel based on design requirements.
- **Lightning Arrestors:** In areas with a high risk of lightning strikes, consider installing lightning arrestors to protect against direct strikes to power lines or luminaires.
- **Maintenance:** Regularly inspect SPDs and other protection components to ensure they are in good working condition and replace any damaged or expired units promptly.
- **Standards Compliance:** Always follow relevant national and international standards for surge protection design and installation, such as **IEC 61643-11** and **IEEE Std C62.41.2**.

15. Hi-Pot Instructions

15.1. Test Overview

A **Hi-Pot test**—also known as a dielectric withstand or insulation test—is essential to verify that the insulation between input/output circuits and the enclosure (case) of the LCO driver can safely withstand overvoltage stress without breakdown.

15.2. Testing Procedure

- **Duration & Monitor:** The test applies a high AC voltage between the input/output terminals and the case for **60 seconds**, while monitoring leakage current to ensure it stays under safe thresholds.
- **Preparation:** Before testing, **disconnect all external components** (e.g., sensors or surge protectors) to avoid false failures.
- **Connection:** One lead is applied to the shorted input/output circuits and the other to the grounded case.
- **Pass/Fail Criteria:** The DUT (Device Under Test) passes if no arcing occurs and leakage remains below specified limits. Failure indicates potential insulation defects or assembly issues.

15.3. Isolation Levels

The outdoor 900W/1800W drivers are designed for dielectric strength testing to verify proper insulation between circuits and casing. The isolation levels are as follows:

Insulation per IEC61347-1	Input	Output	Dimming	Case
Input	-	-	Reinforced	Basic
Output	-	-	Reinforced	Basic
DMX Dimming	Reinforced	Reinforced	-	Basic
DALI Dimming	Reinforced	Reinforced	-	Basic
NTC	-	-	Reinforced	Basic
Case	Basic	Basic	Basic	-

Important Note: The **HPT wire** on the terminal block must ONLY be removed during Hi-pot testing. It MUST be re-inserted immediately afterwards to ensure proper operation.