

ADVANCE

by  Signify

Wireless, connected, streamlined

LED Drivers

Design-in Guide



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Introduction to this guide

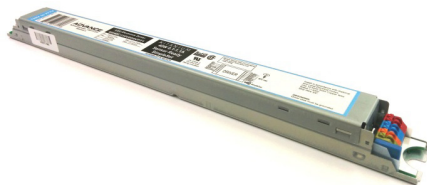


Figure 1. Xitanium SR Indoor LED Driver 40W

Thank you for choosing Advance Xitanium SR Drivers. In this guide you will find the information you need to design Xitanium SR LED Drivers into a luminaire. We advise you to consult our websites for the latest up-to-date information.

Xitanium SR Indoor Drivers are designed to operate LED solutions for indoor lighting such as offices, public buildings, industrial applications and retail environments.

Information and support

If you require any further information or support please consult your local Advance office or visit:

- Xitanium SR Drivers www.philips.com/xitaniumsr
- Xitanium Drivers www.philips.com/xitanium
- OEM general info www.philips.com/oem

Safety precautions



Warnings

- Avoid touching live parts!
- Do not use drivers with damaged wiring!
- Turn off DALI power supply when using driver as standard DALI driver!

Safety warnings and instructions to be taken into account during design-in and manufacturing.

- Do not use damaged or defective contacts or housings.
- Do not service the driver when the mains voltage is connected; this includes connecting or disconnecting the LED load.
- Do not use damaged products.
- Cap off all unused wires to prevent accidental contact with the luminaire or driver housing.
- The luminaire manufacturer is responsible for its own luminaire design and has to comply with all relevant safety standards.
- The Xitanium SR LED Driver is intended for built-in use and should not be exposed to the elements such as snow, water and ice. Exposure will lead to corrosion of the driver housing and should be avoided. It is the luminaire manufacturer's responsibility to prevent exposure. Xitanium SR Indoor Drivers are specified for UL damp and dry locations.
- Driver must be installed in accordance with national and local electrical codes.
- Design-in support is available; please contact your Advance sales representative.

Introduction to Advance Advance Xitanium SR Indoor LED Drivers

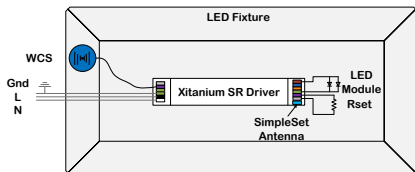


Figure 2. Block representation of an intelligent lighting luminaire with Xitanium SR Driver

Application note

Energy saving, flexible in design, long lasting and low maintenance, LED-based light sources are an excellent solution for indoor environments. For optimal performance, these lighting applications require reliable drivers matching the long lifetime of the LEDs.

Advance Xitanium SR LED Drivers reduce complexity and cost of light fixtures used in wireless connected lighting systems. Please refer to section 6 (SR Interface) for detailed information on using its features.

Xitanium SR Indoor LED Drivers provide different methods to program output current: Rset, SR interface and SimpleSet (using Advance MultiOne software). SimpleSet is especially useful as it provides a way to program the output current without drivers connected to power, significantly reducing luminaire assembly time.

Explanation of the commercial naming of the Xitanium LED Drivers

The names of the drivers are defined as shown in the example below:

Xitanium 40W 0.1-1.1A 54V 120-277V -T

Xitanium	:	Concept name for highly efficient and reliable drivers
40W	:	Maximum output power
0.1-1.1A	:	Adjustable output current range to meet specified max output current and dimming range
54V	:	Maximum output voltage
120-277V	:	Input voltage range
-T	:	Housing type

Driver connection and wiring

Driver connectors and corresponding functions are shown in Figure 3. The driver housing must be grounded (earth connection) via the metallic mounting tabs of the housing. Mains connections are accomplished via the Black and White connections. In cases where both connections are "hot," as may be the case in 208V or 240V applications, the neutral may be connected to the other hot lead provided it is done in accordance with NEC. Maximum ground offset voltage on the neutral lead is equal to the maximum rated driver voltage.

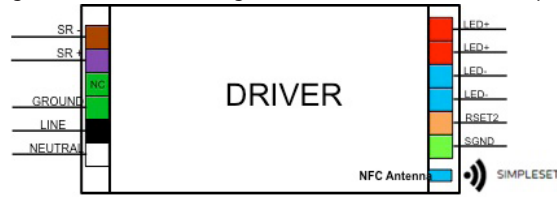


Figure 3. Driver connector color code definition

Important

- Keep wiring between the driver and the LED module as short as possible. However, "remote LED load connection" is acceptable, and Table A gives an indication of remote mounting distance vs. driver current and AWG wire size. The table is based on the assumption that 1V drop is acceptable (e.g., the max driver output voltage rating must be at least 1V higher than the maximum LED voltage). Keep in mind that remote mounting also impacts efficiency of the system (as an example, a 1V drop on a 4A driver results in 4W losses in the wiring, so if less losses are desired, a correspondingly large wire size should be chosen). Also, the remote mounting impacts EMC behavior and additional measures may be necessary to reduce EMC if remote mounting is used (for example adding a ferrite clamp around output wires would reduce radiated EMC). In general, lead length should be kept as short as possible to avoid EMC issues.
- Please refer to section 6 for SR interface wiring requirements.

	AWG Wire Size					
	12	14	16	18	20	22
0.35	855	540	340	215	136	85.5
0.53	565	356	225	142	89.5	56.5
0.7	428	270	170	107	67.8	42.8
1.05	285	180	113	71.6	45.2	28.5
1.5	200	126	79.4	50.1	31.6	20.0
2	150	94.4	59.6	37.6	23.7	15.0
3	100	62.9	39.7	25.1	15.8	10.0
4	75	47.2	29.8	18.8	11.9	7.5
5	59.9	37.8	23.8	15.0	9.5	6.0

Table A. Max Allowed Distance between Driver and LED Module in Feet (based on 1V drop)

Features of Xtitanium SR LED Drivers

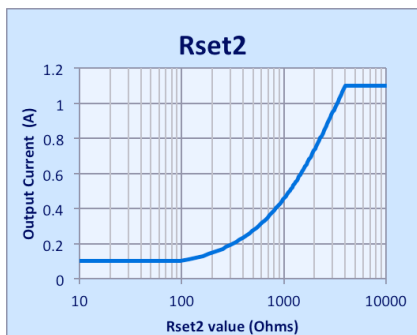


Figure 4. Rset value vs output current setting

Driver output current setting (AOC) via Rset, SimpleSet or SR interface

Output current can be set via a resistor connected between Rset and SGND. Figure 4 shows the Rset value vs output current for drivers with Rset2 function. When Rset is not connected, the output current of the drivers is max specified output current. When output current needs to be set at less than max output current, a correct Rset is required. Rset less than 100 Ohm or higher than resistance corresponding to max output current are not recommended.

Xtitanium SR Indoor LED Drivers also provide two others methods to program output current: SimpleSet and SR interface.

SimpleSet utilizes an antenna (a Blue Block) as shown Figure 5, a programming tool as shown in Figure 6, and Advance MultiOne software.

The output current of LED driver can be programmed when the driver is not powered (i.e., offline programming). Or the driver can be programmed when the driver is powered on (i.e., online programming).

For reliable error-free programming, the drivers need to be grounded when online programming is performed.

For detail programming instruction, please see SimpleSet getting started instruction at www.philips.com/simpleset.

The driver output current can also be programmed via the digital SR (DALI) interface utilizing the MultiOne software tool.

Notes:

1. The AOC setting configured through SimpleSet or SR interface can be reset to Rset (if required) via the MultiOne software using the “Enable” flag under the AOC tab for MultiOne GUI. This flag is “checked” when the driver is programmed via SimpleSet or SR interface. To return to the default Rset mode, this flag can be “unchecked” and the driver will be reprogrammed to return to Rset.
2. The AOC value configured through software (either SimpleSet or SR interface) will have higher priority over Rset. Between SR interface and SimpleSet, the driver will follow the last programmed value. So there is no specific priority assigned to SR interface and SimpleSet. The same logic applies for the auxiliary power supply (refer to the next section).

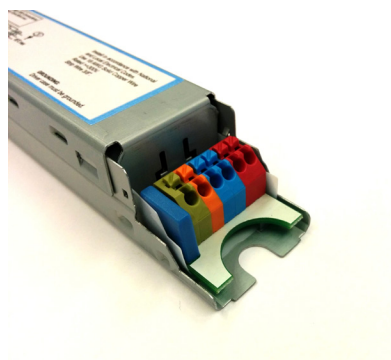


Figure 5. SimpleSet antenna



Figure 6. SimpleSet Driver and programming tool

Operating window

Drivers can deliver different levels of output power, depending on driver type. For each driver there is specified output current/output voltage window. The connected LED load current and voltage characteristics must be within the driver window (under steady state, full output or dim). Driver performance cannot be guaranteed outside the window. See Figure 7 for the operating window for the 40W Indoor SR Driver. The LED load voltage is typically influenced by a number of factors such as temperature, binning (tolerance), drive current and aging. It is important to consider these factors when determining the required voltage range for a certain LED load to ensure that the LED voltage stays within the operating window of the driver. The driver will limit the voltage available for the LEDs based on the window shown. For example, if the LED driver is set to 1.1A and the LED load voltage at 1.1A would be 54V, then the driver would limit the voltage to 36V as shown in Fig. 7. The resulting current at 54V could be less than 800mA. If the upper voltage limit is reached at -40C (when the LED voltage is highest), care must be taken to ensure that sufficient current flows through the LED load to allow the LEDs to warm up and eventually operate within the window area (otherwise, desired drive current will not be achieved).

Note: If LED current and/or voltage characteristic falls outside the driver window, please consult with Advance for application guidance and driver selection.

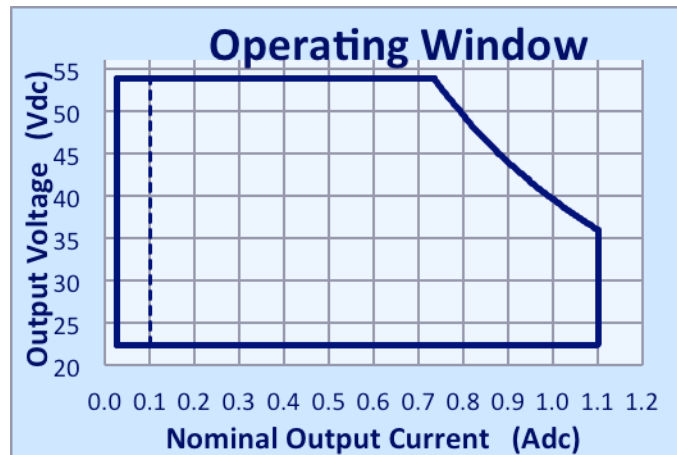


Figure 7. Operating window 40W Indoor SR Driver

Depending on the type of LED load, they can be of constant voltage (CV) or constant current (CC) type. CV loads include a means of on-board current regulation, while CC loads require the driver to provide a constant current output. Therefore it is important to match the correct type of load with the correct type of driver. Most of our LED drivers are CC type, unless specifically identified as CV/CC in driver's datasheet or label.

SR (Sensor Ready) interface

Xtitanium SR LED Drivers reduce complexity and cost of light fixtures used in (wireless) connected lighting systems. It features a digital interface (SR: Sensor Ready) to enable direct connection to any suitable RF sensor (see Figure 8). Functionality integrated into the SR driver eliminates auxiliary components such as power supplies and relay boxes used today in many typical applications. The result is a simpler, less expensive light fixture that enables turning every fixture into a wireless node.

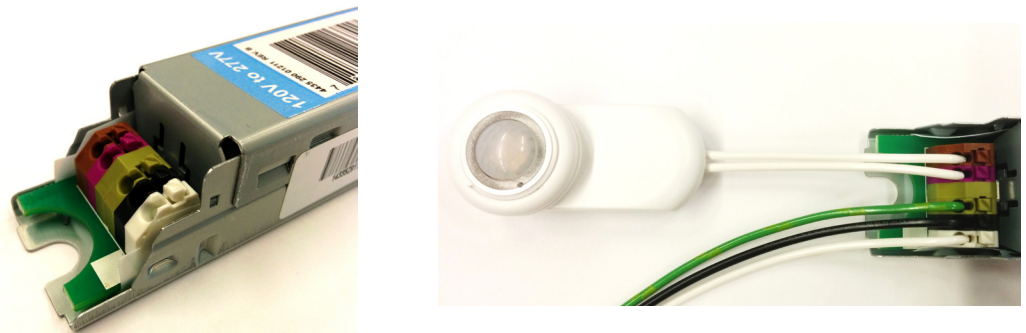


Figure 8. Driver input-side showing SR connector (left) and two-wire connection to a radio sensor (right)

The simple two-wire SR interface supports these key functions:

- Switchable built-in SR bus power supply to provide power to the connected control device (e.g., an RF sensor)
- Two-way digital communication between the SR driver and control device using standard DALI 2.0 protocol
 - > Standard DALI dimming, ON/OFF and control functions
 - > Power and energy reporting utilizing the power monitoring integrated in the driver
 - > Diagnostic information

These functions are described in detail below:

- **Built-in SR bus power supply**

SR supply:

- > The SR driver has the ability to supply the SR bus with a built-in power supply that can be turned ON/OFF. By default the power supply is turned on and ready to be used with an external control device (eg., RF sensor).
- > The built-in SR supply is capable of delivering a minimum current of 52mA (ISR) to the SR bus and the connected device(s).
- > The built-in SR supply will never supply more than 60mA (ISR_MAX).
- > The SR bus voltage will be between 12V and 20V depending on the connected device load and the amount of SR supplies put in parallel. See the graph below for the typical VI curve for one SR supply.
- > When the internal SR supply is switched OFF, the SR driver will extract a maximum of 2mA from the SR bus (like standard DALI gear).
- > If the driver is used in a wired DALI network, the internal power supply can be turned OFF using MultiOne configuration software and the SimpleSet/NFC tool or the MultiOne Interface USB2DALI/LCN8600 tool.
- > The internal power supply can be turned ON/OFF with the MultiOne Engineering using the SimpleSet/NFC tool or the LCN8600 tool. Following DALI command sets can be used with the LCN8600 tool. If more detailed instruction is needed, please contact your Signify sales representative.

DALI Command for PSU Turn-on	Decimal Value
DATA_TRANSFER REGISTER_1	35
DATA_TRANSFER REGISTER	2
ENABLE_WRITE_MEMORY	0
ENABLE_WRITE_MEMORY	0
WRITE_MEMORY_LOCATION_No Reply	85
DATA_TRANSFER REGISTER_1	35
DATA_TRANSFER REGISTER	4
ENABLE_WRITE_MEMORY	0
ENABLE_WRITE_MEMORY	0
WRITE_MEMORY_LOCATION_No Reply	1

DALI Command for PSU Turn-off	Decimal Value
DATA_TRANSFER REGISTER_1	35
DATA_TRANSFER REGISTER	2
ENABLE_WRITE_MEMORY	0
ENABLE_WRITE_MEMORY	0
WRITE_MEMORY_LOCATION_No Reply	85
DATA_TRANSFER REGISTER_1	35
DATA_TRANSFER REGISTER	4
ENABLE_WRITE_MEMORY	0
ENABLE_WRITE_MEMORY	0
WRITE_MEMORY_LOCATION_No Reply	0

Control device(s):

- > Most control devices intended to be used in an SR system will be powered from the SR bus.
- > When communication is present on the SR bus, the bus gets pulled down by the data packages. This reduces the average current available for the power consuming control device. When communicating the average available current can drop with 50%. This should be taken into account when designing the control device.
- > The extracted peak current (ISR_EXTRACTED) should be limited by the control device.

Rules for building an SR system:

- > Respect SR bus polarity when more than one SR supply is connected in parallel.
- > The total maximum SR bus current (ISR_MAX_TOTAL) must be $\leq 250\text{mA}$. This current can be determined by adding ISR_MAX of all SR supplies. As a consequence maximum 4 SR supplies can be connected in parallel.
- > The total current delivered to the SR bus (ISR_DELIVERED) can be determined by adding ISR of all SR supplies.
- > The total current extracted from the SR bus (ISR_EXTRACTED) can be determined by adding consuming devices like SR drivers with switched OFF SR supply, other DALI gear and control devices.
- > To guarantee good communication, a margin of 8mA is needed to drive the SR bus itself (ISR_MARGIN).
- > The following rule should be respected: $\text{ISR_EXTRACTED} + \text{ISR_MARGIN} \leq \text{ISR_DELIVERED}$.

Caution: When the above rules are not taken into account, communication cannot be guaranteed and damage to components may occur.

Typical examples:

One SR driver is connected to a control device. The internal SR supply of this driver is switched ON. The specification of the control device states that the extracted peak current is 40mA. Will this SR system have good communication?

- > One SR supply is involved, so BUS polarity is not an issue.
- > $\text{ISR_MAX_TOTAL} = 60\text{mA}$. This is $\leq 250\text{mA}$ [OK]
- > $\text{ISR_DELIVERED} = 52\text{mA}$
- > $\text{ISR_EXTRACTED} = 40\text{mA}$
- > $\text{ISR_MARGIN} = 8\text{mA}$
- > $40+8\text{mA} \leq 52\text{mA}$ [OK]

Is it allowed to add an SR driver with switched OFF SR supply to this SR system?

- > Yes, an SR driver with switched OFF SR supply extracts 2mA from the SR bus.
- > $\text{ISR_EXTRACTED} = 40+2=42\text{mA}$.
- > $42+8\text{mA} \leq 52\text{mA}$ [OK]

Can this SR supply also be switched on?

- > Yes, but you should check the polarity of both SR supplies.
- > $\text{ISR_TOTAL} = 2*60=120\text{mA}$. This is $\leq 250\text{mA}$.

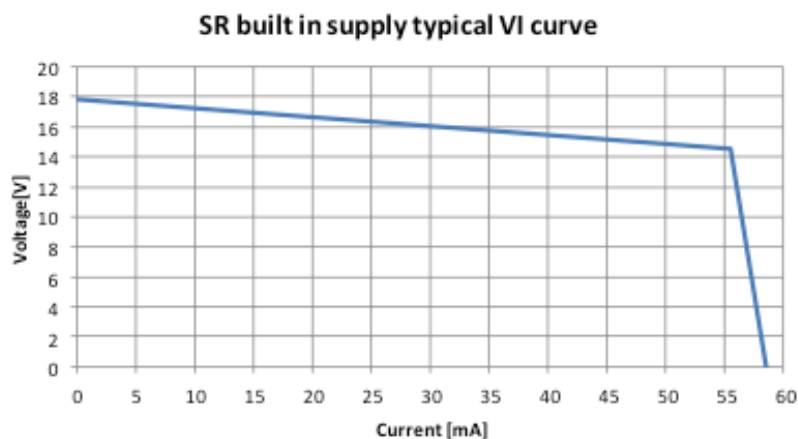


Figure 9. Typical VI curve for SR interface

Digital communication:

- > Dimming is possible through the standard digital interface based on DALI 2.0 (IEC 62386 101, 102 Ed2.0). Dimming range is 1% - 100%. Dimming curves are shown in Figure 10. Logarithmic and linear dimming curve options are available. The curve can be configured via the SR (DALI) interface (see table below for various configuration options).
- > Note that the output current at 100% level is determined by the driver. The minimum current that can be supplied by the driver is specified in the datasheet. The lowest dim level is defined by the higher of the two values: Minimum output current or 1% dim level.
- > The SR driver has built-in energy measurement capability and can report energy and actual power consumption. Accuracy of power measurement is higher of following 2 values: 0.5W or +/-4 % measured input power. This feature stores parameters in the memory bank provision specified in the DALI 2.0 standard. The driver also supports many diagnostic features/parameters which can be accessed via the SR interface.

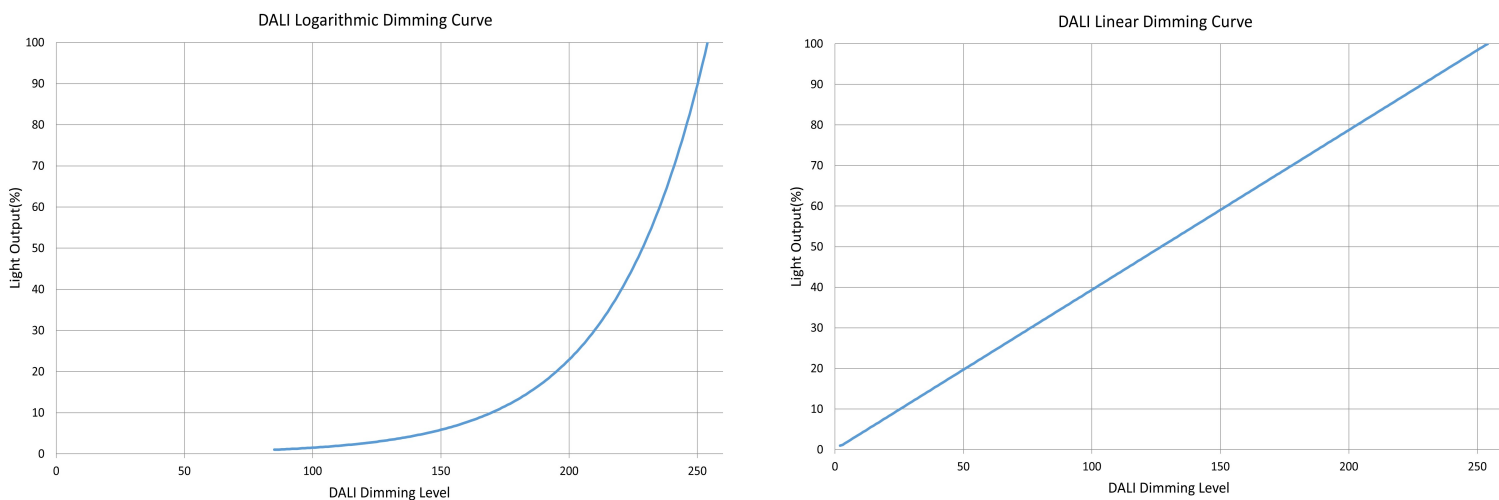


Figure 10. Dimming Curves for DALI Logarithmic (left) and Linear (right)

- > To change the dimming curves from log to linear or linear to log, one needs to use the LCN8600 tool and following DALI command sets. If more detailed instruction is needed, please contact your Signify sales representative.

DALI Command for Logarithmic Dimming Curve	Decimal Value
DATA_TRANSFER REGISTER	0
ENABLE_DEVICE_TYPE_X	6
DEVICE_TYPE_6_SELECT_DIMMING_CURVE	1

DALI Command for Linear Dimming Curve	Decimal Value
DATA_TRANSFER REGISTER	1
DEVICE_TYPE_6_ENABLE_DEVICE_TYPE_6	0
DEVICE_TYPE_6_SELECT_DIMMING_CURVE	0

Other considerations for SR interface:

- > Length of wiring; using 18 AWG, the maximum length of the dim wiring, when used for DALI communication, should not exceed 1000 ft. (300 m).
- > The SR control interface terminals are isolated from mains and LED output terminals, and qualified as UL Class 2 circuit.

Configuration options:

Configurable Parameter within the Driver	Configuration Interface		
	Rset (Factory Default)	SimpleSet	SR (DALI) Interface using MultiOne Tool
Adjustable Output Current (AOC)			
Auxiliary Power Supply (ON/OFF)			
Standard DALI 2.0 Configurable Parameters			
Dimming Selection (Log Vs Linear)			

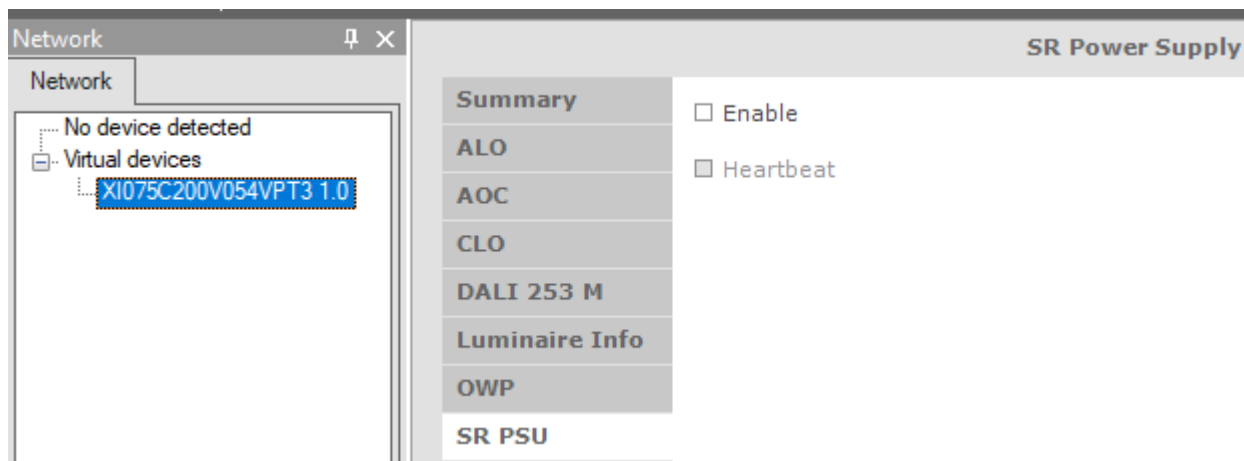
Table B. Configuration Options

Precautions for DALI network applications:

- > Length of wiring; using 18 AWG, the maximum length of the dim wiring, when used for DALI communication, should not exceed 1000 ft. (300 m).
- > The SR control interface terminals are isolated from mains and LED output terminals, and qualified as UL Class 2 circuit.

Configuration options:

- > Disable SR/DALI power supply on each driver.



- > Maintain SR/DALI wiring polarity for the entire installation. Connect SR+ or DA+ to DALI +, and SR- or DA- to DALI -.
- > No mis-wiring of SR /DALI terminals to AC mains. Such miswiring will damage the driver and void warranty.
- > The DALI controller manufacturer must verify interoperability. Normally the network size is limited to 64 drivers per single DALI bus.
- > Staying below 64 drivers would also meet UL 8750 control circuit leakage current limit.

Thermal management

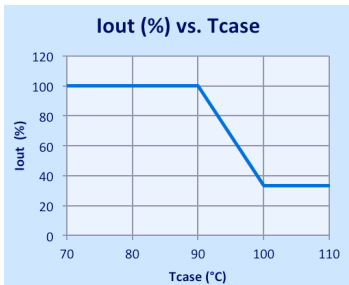


Figure 11. Typical Thermal Fold Back (TFB)

This section covers the critical thermal management points to facilitate design-in. Taking thermal considerations into account will ensure the optimum performance and lifetime of the LED system. It is mandatory to keep driver T_c max within specification to meet driver lifetime and failure rate specifications. Please refer to individual product datasheets for specific values. Advance Xitanium SR LED drivers are designed to provide a lifetime of up to 50,000 hours at the specified T_c max. of 75°C.

Thermal Fold Back (TFB) of driver

The driver will reduce the current to the LED module if the driver itself is overheating. The driver will start limiting the current when the driver case temperature exceeds the maximum specified temperature by minimum 5°C. Refer to the individual driver datasheet for the specified fold back value (Figure 11).

Case Temperature (T_c) point

To achieve optimal lifetime and reliability, it is critical that the temperature of the components in the driver remains within its rating. In the driver design, all precautions are taken to ensure that the internal components are at the lowest possible temperatures.

Initial thermal analysis is performed via IR scans at room temperature to identify the hottest components of the driver. Subsequently, detailed temperature measurements of the critical components are performed under various input/output conditions at worst case operating temperatures.

These temperature measurements are related to a T_{case} (T_c) point on the driver as shown in Figure 12. T_c temperature is a proxy for the temperatures of the critical internal driver components.

The location of the T_c point is identified on the product label (Figure 13).

The specified T_c max of the driver must NEVER be exceeded.

Note:

In order to ensure accurate T_c test results, the case temperature should not vary by more than 1°C for a period of at least 30 minutes after a stable temperature has been achieved. T_c point should not be obstructed when mounted in the luminaire/enclosure.

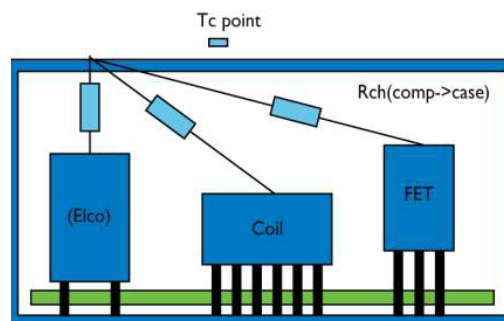


Figure 12. Internal resistance to the driver T_c point

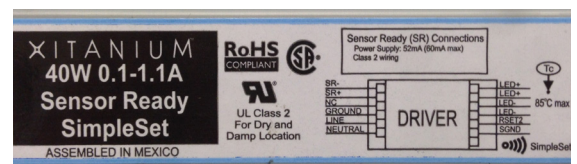


Figure 13. Product label indicating T_c point of driver in T-can

Inrush current

Inrush current refers to the brief high input current which flows into the driver during the initial start-up to charge input-side capacitors. Typically, the amplitude is much greater than the operating or steady-state current, as illustrated in Figure 14.

Xtitanium Drivers meet the inrush specification per NEMA 410 values which are given by 175uF/A for 120V mains and 125uF/A for 277V mains. Usually, with Intellivolt products (120-277V mains), the most critical point is 277V mains. For example, a 150W driver typically has a capacitance value of 41uF which corresponds to approximately 75uF/A at 277V, well below the 125uF/A NEMA 410 requirement at 150W output power.

The values for I_{peak} and T are shown in the datasheet for each driver. The experimental setup used for measuring the inrush current of the Xtitanium SR LED Drivers is shown in Figure 15. For the test setup, a line impedance of 450m/100uH is used. These values are the specified line impedance according to NEMA 410 for inrush current measurement. A DC voltage equal to the peak of the corresponding line voltage is applied (via a capacitor bank) at the input of the network. It should be noted that the inrush current measurement given in the datasheet is the absolute worst case value and many factors can reduce this in a real application. These factors include actual line impedance and phase-angle at turn-on. The inrush data for a given driver (mentioned in driver data sheet) is useful as a criteria for fuse selection. Other factors such as surge, steady state rating, etc., must also be considered for fuse selection.

The best way to reduce inrush is to turn-on relays or switches at the zero crossing of the mains. Many controllers do this to reduce the large inrush currents.

What does inrush current do? High inrush currents can cause circuit breakers or fuses to open if not designed to handle this current. It can limit how many drivers can be connected to a circuit breaker (CB) or fuse.

Please consult the fuse and circuit breaker manufacturer recommendations when selecting appropriate fuse and/or circuit breakers in conjunction with LED luminaires.

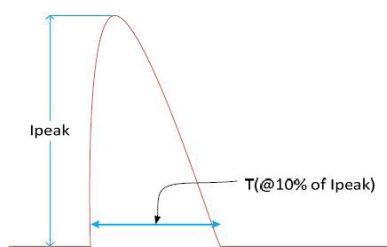
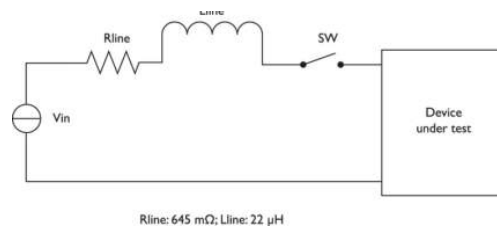


Figure 14. Inrush current



Rline: 645 mΩ; Lline: 22 μH

Figure 15. Inrush current measurement setup

Surge protection

Xitanium SR LED Drivers have limited built-in surge protection. The driver data sheet specifies the surge protection level of the driver. A driver specification of 2.5kV means that the driver is tested to withstand 2.5kV line transient for 100kHz Ring wave with 30 Ohms source impedance. The drivers are tested with the above waveform for all line coupling modes (L to N, L to PE, N to PE and L&N to PE).

Appropriate surge protection should be designed into the luminaire to meet the specific category for meeting the Energy Star/ANSI requirement.

Leakage current

Xitanium SR LED Drivers are designed to meet leakage current requirements per UL 8750 standards. The specified maximum value is 0.75 mA RMS at 277V.

Electromagnetic compatibility (EMC)

Xitanium SR LED Drivers meet EMC requirements per FCC Title 47 Part 15 Class A. These tests are conducted with a reference setup that includes a driver and an LED load/heat sink combination mounted on a metal plate (grounded). To maintain good EMC performance at the luminaire level, the input, output and dim wires should be routed separately. The addition of ferrite beads in series with the wires, or coupling the wires through ferrite cores within the luminaire, may improve the overall EMC performance. However, selection of the type and characteristics of the additional filter depends on what frequency components have to be damped and by how much.

Consumer Information for Class A Compliance: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Electrical isolation

The Xitanium SR LED Drivers output is isolated from the primary for isolated Non Class 2 drivers or Class 2 drivers – see datasheet for particular isolation type. Isolation is also provided between all electronic circuits and the chassis. Figure 16 illustrates the isolation scheme for isolated class 2 drivers.

Xitanium SR LED Drivers meet the UL 8750 safety standard. Xitanium Class 2 drivers also meet UL1310 Class 2 safety standard.

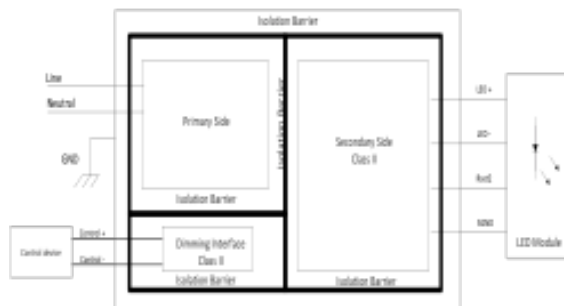


Figure 16. Xitanium Class 2 LED driver isolation

All wiring included on Xitanium SR LED Drivers meet UL1452 safety standard.

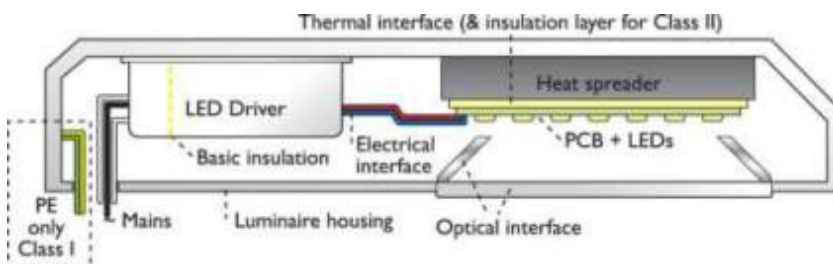


Figure 17. Luminaire design example

Mechanical mounting

Mounting of the driver must address three critical issues:

1. **Solid fastening of the driver in order to avoid movement of the driver relative to luminaire.**

Size of mounting screws/bolts needs to be maximum allowed by the size of driver mounting holes/slots. The tightening torque has to be per screw/bolt manufacturer recommendations.

2. **Electrical grounding of the driver.**

The driver enclosure is painted. It is recommended to use a star washer under the head of the mounting screw: the teeth of the star washer bite into the surface to ensure good electrical connection to the grounded fixture.

3. **Maximize interface area between driver enclosure surface and luminaire mounting surface (heat dissipator) for best (lowest) possible driver T_{case} temperature.**

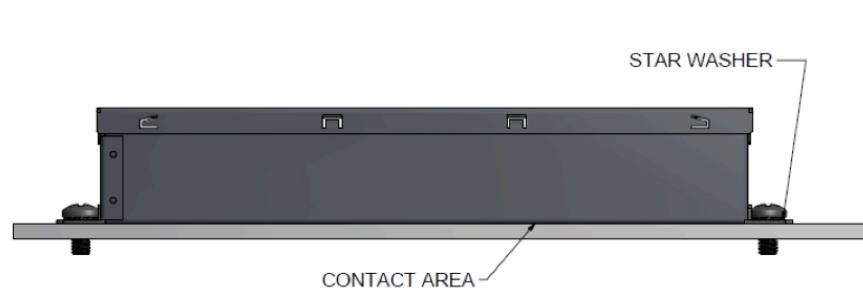


Figure 18. Recommended mounting of the driver

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