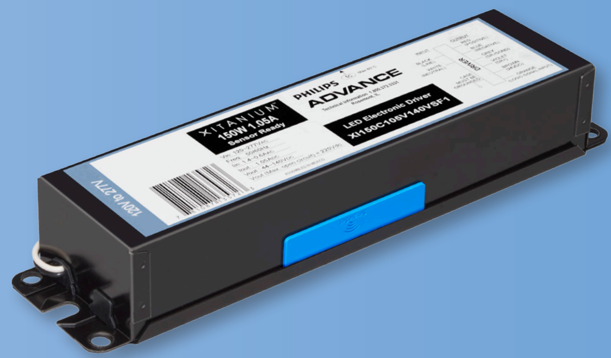
PHILIPS
ADVANCE

LED Drivers

Design-in Guide

Xitanium SR



Wireless, connected, **streamlined**

Xitanium SR LED drivers for outdoor lighting applications

Contents

Introduction to this guide

Figure 1. Philips Advance Xitanium SR 150W outdoor LED driver.

Thank you for choosing Philips Advance Xitanium SR outdoor LED 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.

Information or support

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

- Xitanium SR drivers www.philips.com/xitaniumsr/na
- OEM general info www.philips.com/oemna

Applications

Philips Advance Xitanium SR outdoor LED drivers are designed to operate LED solutions for outdoor lighting, such as area, roadways, parking garages and floodlights.

Safety precautions

Warning

- Avoid touching live parts!
- Do not use drivers with damaged housing and/or connectors!
- Do not use drivers with damaged wiring!

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 must comply with all relevant safety standards.
- The Xitanium SR LED driver is intended for outdoor built-in use only and should not be exposed to water, moisture and chemical agents. Exposure will lead to premature driver failure and should be avoided. It is the luminaire manufacturer's responsibility to prevent exposure.
- Driver must be installed in accordance with national and local electrical codes.
- Design-in support is available; please contact your local Philips sales representative.

Introduction to the Philips Advance Xitanium SR outdoor LED drivers

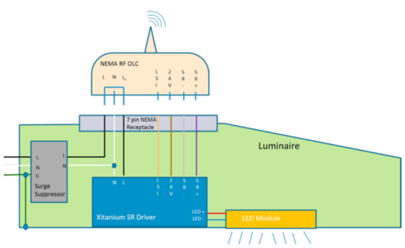


Figure 2. Block diagram of an intelligent lighting luminaire with Xitanium SR driver and (RF) OLC.

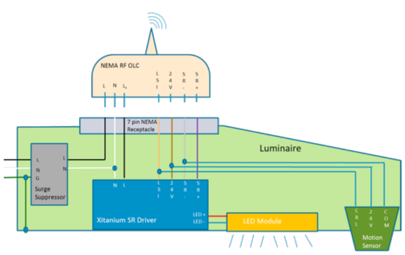


Figure 3. Block diagram of an intelligent lighting luminaire with Xitanium SR driver and added motion sensor.

Application note

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

Philips Advance Xitanium SR LED drivers reduce complexity and cost of luminaires used in wireless connected lighting systems. Please refer to the SR interface section for detailed information on using its features.

Xitanium SR outdoor LED drivers provide different methods to program output current: SR interface and SimpleSet (using Philips 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. A block diagram of an intelligent lighting luminaire with a Xitanium SR driver can be seen in Figure 2. Figure 3 shows a block diagram when a motion sensor is added.

Part number description

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

XI150C105V157VSF1

X : Xitanium LED driver

I : Input voltage (I = 120-277V, R = 120V, V = 277V, G = 347V, H = 347-480V)

15 : Maximum output power (025 = 25W, 060 = 60W, 150 = 150W)

C10 : Maximum output current (C035 = 350mA, C070 = 700mA, C105 = 1050mA)

V157 : Maximum output voltage (V012 = 12V, V054 = 54V, V157 = 157V)

V : Fixed or dimming (C= 0-10V, F = Fixed, V = Sensor Ready)

S : Features (P = Programming, S = SimpleSet)

F : Enclosure designation

1 : Version control

Driver connection and wiring

Driver wiring and corresponding functions are shown in Figure 4. The driver housing must be grounded (earth connection) via the metallic mounting tabs of the housing.

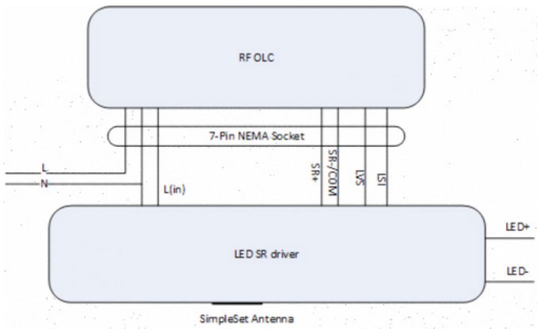


Figure 4. Xitanium SR driver wiring.

Important

Keep wiring between the driver and the LED module as short as possible. However, “remote LED load connection” is acceptable, and Table 1 gives an indication of remote mounting distance vs. driver current in A and cross wire section in AWG size. The table is based on the assumption that 1V drop is acceptable (e.g., the max driver output voltage must be at least 1V higher than the maximum LED load 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 for EMC compliance if remote mounting is used (for example, adding a ferrite clamp around output wires would reduce radiated EMI). In general, lead length should be kept as short as possible to avoid EMC issues.

Please refer to the SR (Sensor Ready) interface section for the wiring requirements for the SR interface.

Output Current (A)	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
2	150	94.4	59.6	37.6	23.7	15
3	100	62.9	39.7	25.1	15.8	10
4	75	47.2	29.8	18.8	11.9	7.5
5	59.9	37.8	23.8	15	9.5	6

Table 1. Maximum allowed distance between driver and LED module in meters as function of output current (based on 1V drop).

Operating parameters of Xitanium SR LED drivers

Figure 5. SimpleSet antenna on outdoor driver.

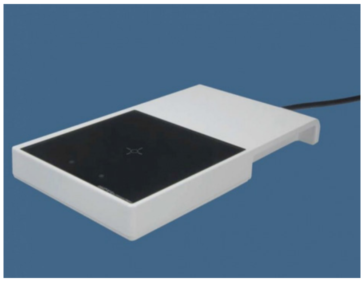


Figure 6. Programming tool.

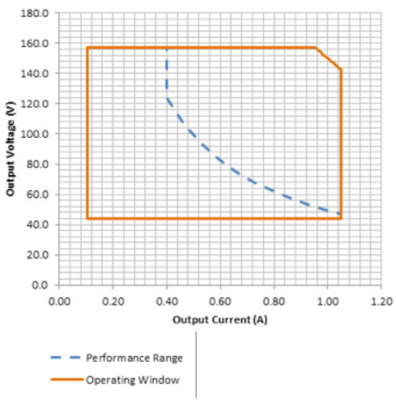


Figure 7. Operating window 150W 0.4-1.05A 157V outdoor SR driver.

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

Philips Advance Xitanium SR outdoor LED drivers also provide two methods to program output current: SimpleSet and SR interface.

SimpleSet utilizes an antenna (a blue block) as shown in Figure 5, an example programming tool as shown in Figure 6 and Philips 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 detailed programming instructions, please see SimpleSet getting started instruction at www.philips.com/simpleset. The driver output current can also be programmed via the digital SR (DALI-based) interface utilizing the MultiOne software tool.

For more details about SR interface programming, please refer to section SR interface later in the document.

Operating window

Drivers can deliver different levels of output power, depending on driver types. 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 SR outdoor 150W LED 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 1.05A and the LED load voltage at 1.05A would be 157V (see Figure 7), then the driver will limit the voltage and current to a lower level. The resulting operating point will be less than 157V and less than 1.05A. If the upper voltage limit is reached at -40°C (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).

Warning:

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

SR (Sensor Ready) interface

Philips Advance Xitanium SR LED drivers reduce complexity and cost of light luminaires 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 otherwise required. The result is a simpler, less expensive luminaire that enables turning every luminaire into a wireless node. A choice of devices are available on the market from third parties that have been developed via the SR certified program.

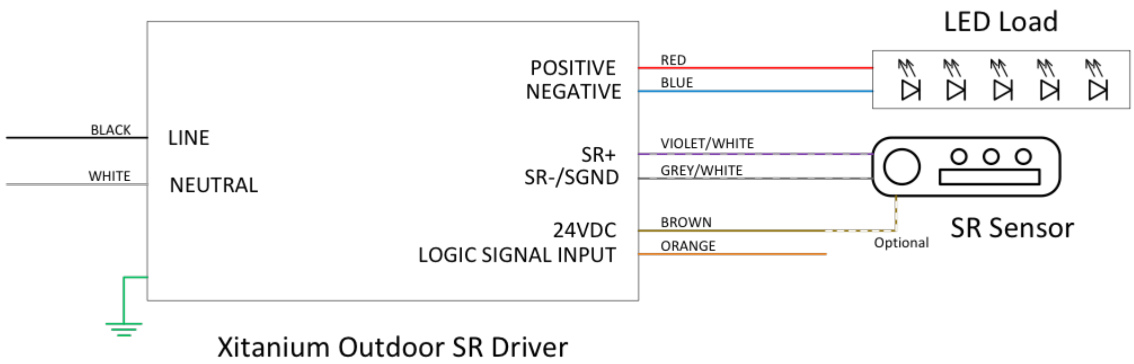


Figure 8. Driver input-side showing SR connector and two-wire connection to a radio sensor.

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

- 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-based 2.0 protocol:
  - > Standard DALI-based 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 on the following pages.

SR bus power 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 (e.g., RF sensor).
- The internal power supply can be turned ON/OFF with the MultiOne configuration software using the SimpleSet tool or the SR interface (DALI-based) tool.
- The built-in SR supply is capable of delivering a minimum current of 52mA (ISR) to the SR bus and the connected device(s). On overload conditions, the SR supply shuts off automatically and auto restarts when the overload condition disappears.
- 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 (Figure 9) for the typical VI curve for one SR supply. See datasheet for details.
- When the internal SR supply is switched OFF, the SR driver will extract a maximum of 2mA from the SR bus (like standard DALI-based gear).

Typical SR supply characteristics

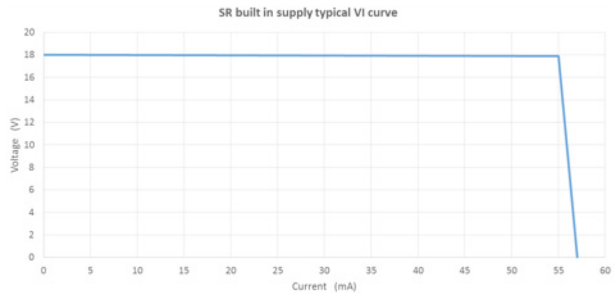


Figure 9. Typical VI curve for SR interface.

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 by 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. SR leads are polarized.
- The total maximum SR bus sourcing current (ISR_MAX_TOTAL) must be ≤ 250mA.
- 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-based 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: ISR_EXTRACTED + ISR_MARGIN ≤ ISR_DELIVERED.

Warning:

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.
- ISR_MAX_TOTAL = 60mA. This is ≤ 250mA [OK].
- ISR_DELIVERED = 52mA
- ISR_EXTRACTED = 40mA
- ISR_MARGIN = 8mA
- 40+8mA ≤ 52mA [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.
- ISR_EXTRACTED = 40+2=42mA.
- 42+8mA ≤ 52mA [OK]

Can this SR supply also be switched on?

- Yes, but you should check the polarity of both SR supplies.
- ISR_TOTAL = 2*60=120mA. This is ≤ 250mA.

Digital communication

- Dimming is possible through the standard digital interface based on DALI 2.0 (IEC 62386 101, 102 Ed2.0). 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 SR driver has built-in energy measurement capability and can report energy and actual power consumption. Accuracy of power measurement is +/-2 % measured input power. Refer to the datasheet for applicable power range. This feature stores parameters in the memory bank. Apparent energy and load side power are also available (see datasheet for details).
- The driver also supports many diagnostic features/parameters which can be accessed via the SR interface and made available to SR Certified partners.

Other considerations for SR interface

- Length of wiring; using 18AWG standard solid wire, the maximum length of the dim wiring, when used for DALI communication, should not exceed 15m.
- The SR control interface terminals are double-insulated from mains and output terminals per IEC61347-1.

LSI (logical signal input) interface

The logic signal input (LSI) is used in the SR outdoor drivers as an additional input signal that can be used to connect simple sensors (e.g., occupancy or photo sensors) to an SR driver without the need for a sophisticated OLC (outdoor lighting controller) and still avoid the need for an external relay that would turn the power to the SR driver on or off (see Figure 10). Typical input would be 0V (open circuit) or 24V (connected to the supply voltage via the external sensor).

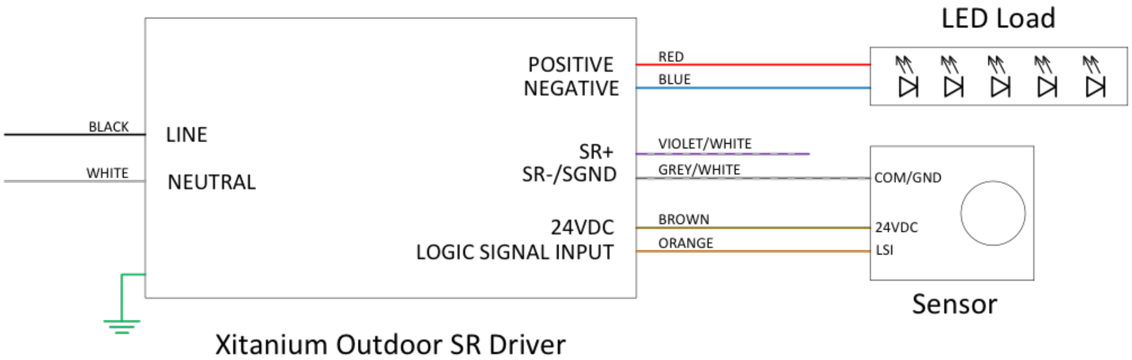


Figure 10. Connection between LSI and sensor.

- Input level "Low": 0-3V. The LSI input is sinking, so it will ensure that an "open" LSI input will be considered as a low.
- Input level "High": 7-27V. In this voltage range, the LSI input will be considered high. Sinking current in this range will be limited to 2mA max. See Figure 11 for the V-I characteristics of the LSI input.
- LSI interface must be protected against 40Vdc (negative or positive with respect to GND [Grey]).

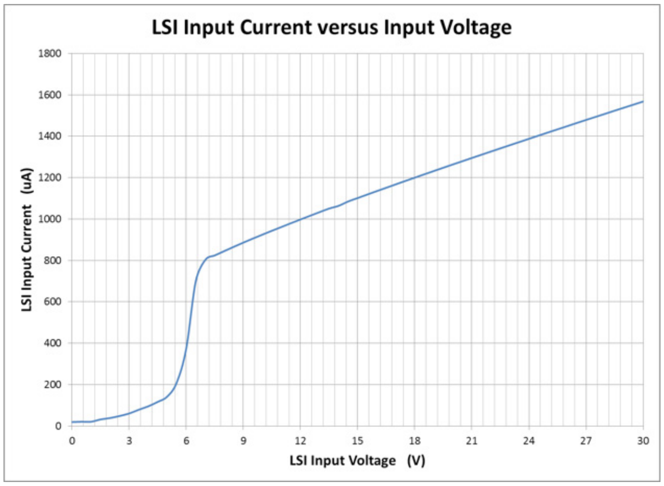
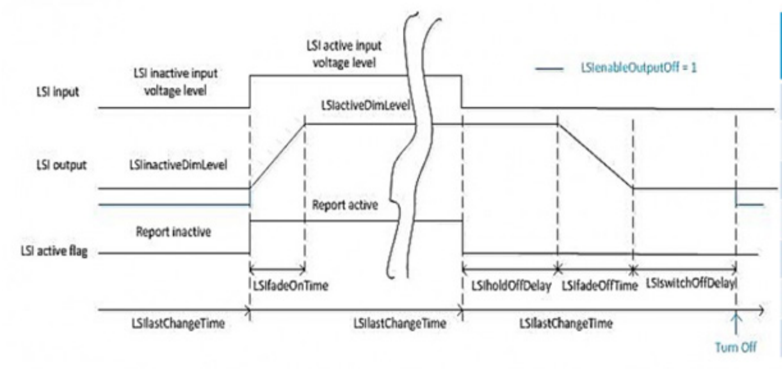


Figure 11. LSI input V-I characteristics.

The LSI “active” and “inactive” dim levels as well as the various time delays can be configured on the driver using SimpleSet and MultiOne (see Figure 12).

These can also be configured by the OLC using SR/DALI interface.



Configurable Parameter*	Range
Active Dim Level	0%-100%
Inactive Dim Level	0%-100%
FadeOnTime	0 - 90 secs
FadeOffTime	0 - 90 secs
HoldOffDelay	0 – 18 hrs
SwitchOffDelay	0 – 18 hrs
EnableOutputOff	0 or 1

Figure 12. LSI state transitions (this example assumes active input voltage level is high).

Auxiliary 24V supply

The auxiliary supply in the SR driver is designed to provide a 24Vdc supply that can power an outdoor lighting controller (OLC), occupancy sensor, photo sensor or other device. It eliminates the need of an AC/DC supply in the connected device and also eliminates the associated need of a surge suppression device and EMI filter in the connected device.

The auxiliary supply can deliver an average power of 3W. It shares the ground connection with the SR- terminal/wire (See Figure 13). In addition, the auxiliary supply will continue to supply energy a short time after mains is switched off (last gasp).

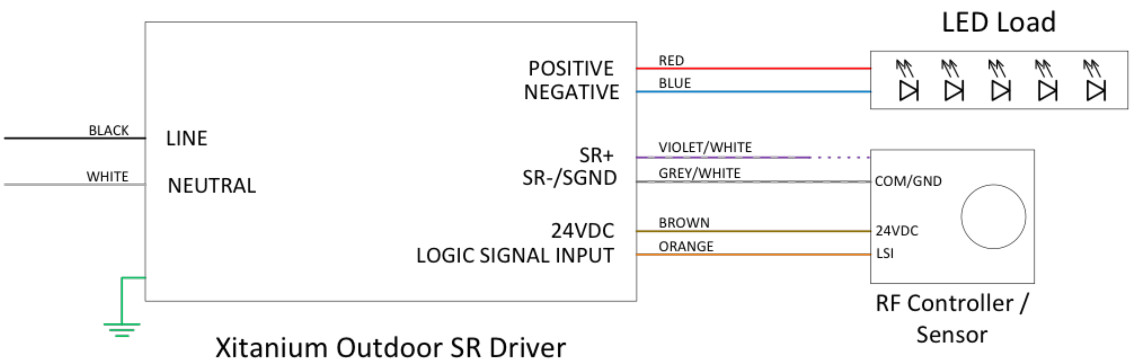


Figure 13. Connection between auxiliary supply interface and sensor.

Auxiliary supply – key functions

- The auxiliary supply can provide an average power of 3W. In case multiple devices on 24V are connected, the SR driver will provide 3W average power; all devices together may not consume more than 3W average.
- Average voltage: The level of 24V +/- 10% will be held for loads between 50mW and 10.5W.
- Maximum voltage does not exceed 30V under any load condition including open circuit.
- Dynamic response: <= 10% overshoot or undershoot for 10.5W to 50mW and 50mW to 10.5W load step.
- Start-up time: The auxiliary supply will reach 90% of the final specified voltage level within 400ms of applying mains power.
- The auxiliary supply will continue to supply energy after mains is switched off (last gasp energy). Some energy may be supplied while the auxiliary supply remains at 24V, but the total energy can be harnessed by allowing the 24V to deplete to near 5V. The energy available for last gasp may be larger when the driver is operational as

compared to when it is in standby. However, the minimum last gasp energy specified is guaranteed also in standby state. This energy can be used by the OLC to send a “last gasp” message to the network to report the power outage or to save parameters into non-volatile memory.

- Voltage ripple at full load (average): <= 300mVpp for any resistive load condition from 50mW to 10.5W.
- The auxiliary supply is overload protected, and driver output may shut down. Light flickering could be observed during 24V overloading. The supply will recover after the overload condition is removed. Note that the only available protections are ensuring that the driver and the auxiliary supply will not be damaged during overload conditions.
- Isolation: All output terminals are isolated Class 2 according to U.S. norms.
- Mains protection: The 24V supply is not protected against connection to mains voltage. The only isolation is from primary mains and LED output. The 24V, SR and LSI connections are not isolated from each other. According to the norms, this 24V auxiliary supply is a Class 2 power supply.
- Pulse power capabilities: To cover the energy consumption needs of various controller types, the auxiliary supply is specified with the pulse power charts shown in Figure 14 that indicate how much power draw is allowed for certain duration pulses.

Time [sec]	**Power [W]**	**Power [W]** **with 2mA max on SR terminals**
<0.0013	10.5	11.1
0.0023	6.2	6.8
60	6.2	6.8
1000	3	3.6

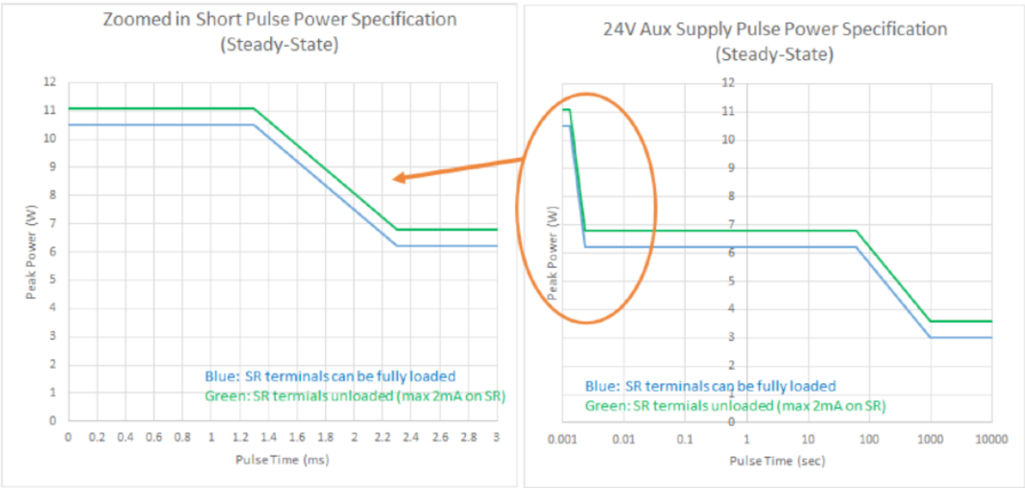


Figure 14. Driver pulse power specification. Any connected device should have a consumption profile that fits within these limits. Two curves are shown; one for the case where the SR terminals can be independently fully loaded to 52mApk (blue) and a second one (green) that allows additional loading on the 24V auxiliary supply as long as the SR terminal is only loaded with a max current of 2mA.

Auxiliary supply – controller requirements

- Start-up: At power-on, the controller must limit the combined power consumption of the SR and 24V terminals to less than 1Wpk while the 24V supply builds up from 0V to 24V. A k kHz bandwidth limit may be used to average this peak power measurement, but absolute peak power must not exceed the profile given in the pulse power limit specification chart in Figure 14. This limitation is placed to avoid start-up delays of the AUX as the auxiliary supply ramps up from 0V to 24V. With the controller being typically a constant power load, this avoids excessive current draw on the auxiliary supply during ramp-up of the supply. There are three options for the controller to know when the 24V is ready for full loading beyond the 1Wpk:

    1. Wait until 24V supply reaches a minimum of 20V.
    2. Wait 100ms after the 24V supply reaches 3V. By design, the 24V will reach the final value within this time.
    3. Wait 100ms after the DALI SR supply voltage is a logic high. The DALI SR supply will come up at the same time as the 24V (assuming SR supply is enabled).

- Input capacitance: The 24V supply functions according to the specification up to an input capacitance of the controller of max 1μF.

Use cases

Basic LSI use case

A basic use case for LSI includes a standard motion/occupancy sensor connected to the LSI input and 24V auxiliary supply as shown in Figure 15. MultiOne or SimpleSet can be used to program the LSI settings, as shown in Figure 16. Once the LSI option is enabled, default values for the different settings that can be programmed are shown.

Mode can be set to either occupancy sensor or photo cell. The active dim level is the level when either occupancy/no light is present. The inactive dim level is the level when no occupancy/light is present.

Many of the different settings like fade time, hold time, switch off delay, etc., can either be programmed by using the sensor (usually by means of rotary buttons or dip switches) or by using the LSI settings. The default LSI settings are set to use the sensor programmed settings. In case the LSI programming settings are going to be used, the sensor settings need to be either de-activated or set to zero so the SR driver uses the programmed LSI settings.

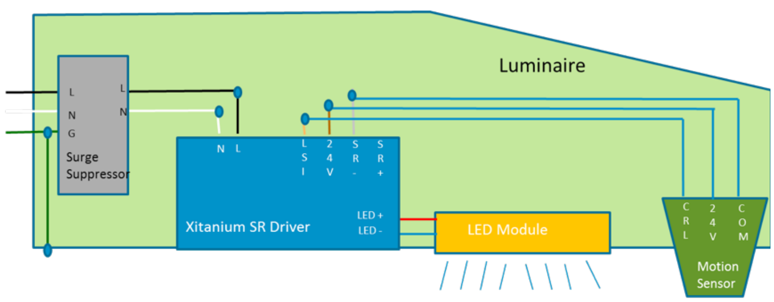


Figure 15. Basic LSI use case using standard motion sensor.

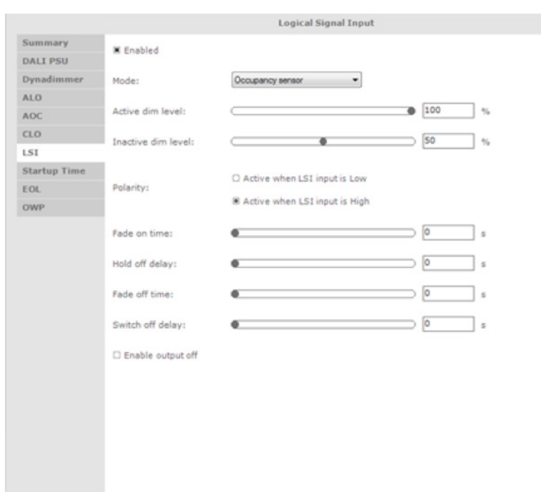


Figure 16. Logical signal input (LSI) settings programmable through MultiOne/SimpleSet.

Time-based schedule using build-in Dynadimmer use case

The build-in Dynadimmer feature can be used to create a dynamic dimming schedule over a period of time. Figure 17 shows a typical Dynadimmer use case. MultiOne/SimpleSet can be used to program the Dynadimmer settings, as shown in Figure 18. Once the Dynadimmer option is enabled, the Dynadimmer schedule and midnight shift depending on geographical location can be programmed.

For detailed information on how to program all the Dynadimmer settings, please refer to the MultiOne/SimpleSet User Manual that can be found in the Help menu of the MultiOne software.

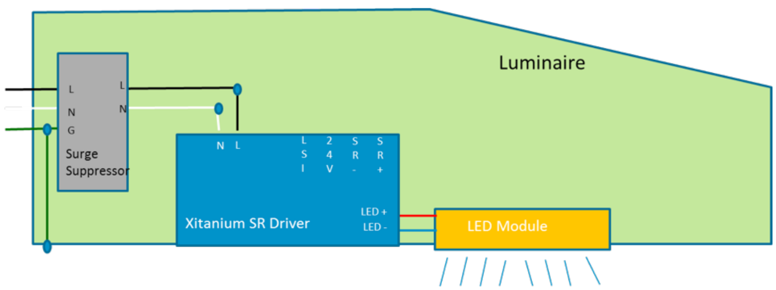


Figure 17. Time-based schedule with Dynadimmer use case.

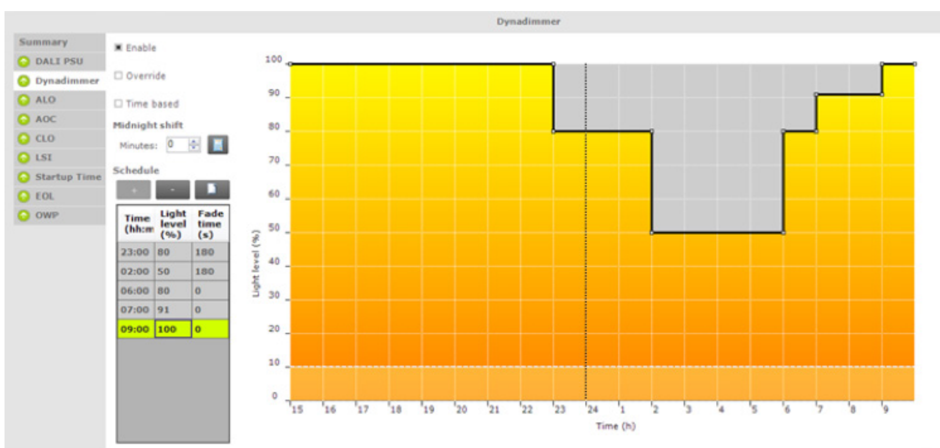


Figure 18. Dynadimmer settings programmable through MultiOne/SimpleSet.

Time-based schedule using build-in Dynadimmer and override control use case

The build-in Dynadimmer feature can be used to create a dynamic dimming schedule over a period of time. In addition to the (automated) schedule, a motion sensor can be added for override capability using the LSI input. Figure 19 shows a typical use case. MultiOne/SimpleSet can be used to program the Dynadimmer settings, as shown in Figure 20. In addition, the LSI feature needs to be enabled and programmed as described in the LSI/Basic LSI use case sections.

For detailed information on how to program all the Dynadimmer settings, please refer to the MultiOne/SimpleSet User Manual that can be found in the Help menu of the MultiOne software.

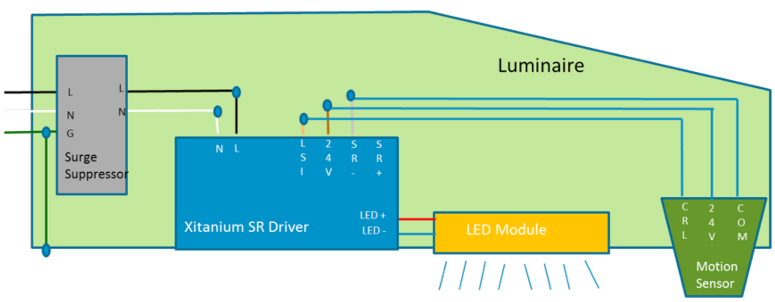


Figure 19. Time-based schedule with Dynadimmer and additional motion sensor use case.

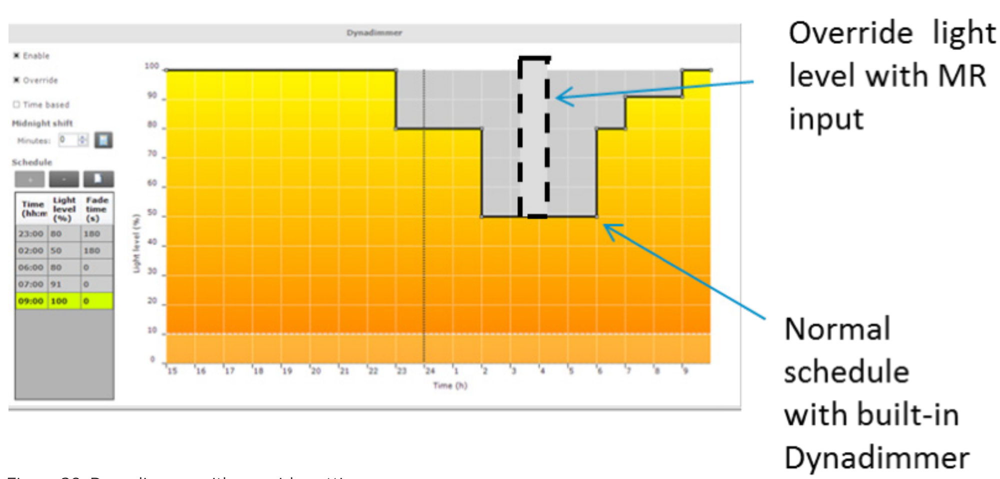


Figure 20. Dynadimmer with override settings.

Fully networked luminaire use case

To use the full functionality of the Philips Advance Xitanium SR LED driver, a luminaire can be fitted with a NEMA RF OLC and motion sensor/photocell to create a fully networked luminaire that can have flexible scheduling, local MR control, central energy monitoring and asset management. Figure 21 shows a typical networked luminaire use case. MultiOne/SimpleSet can be used to program the settings.

For the ultimate reassurance of connectivity Philips has introduced the SR certified program, which lists all companies, components and sensors that are certified to work with the Xitanium SR LED drivers.

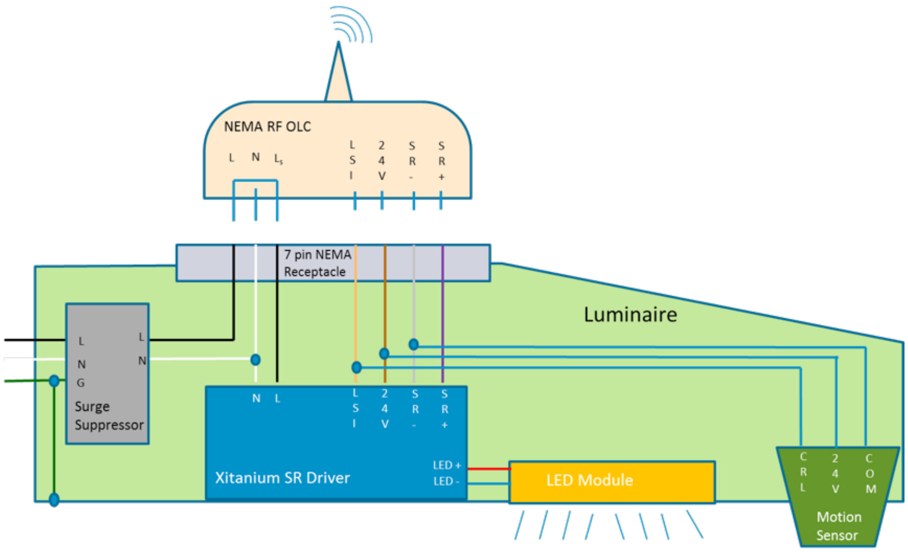


Figure 21. Fully networked luminaire use case.

OEM traceability/asset management use case

The Philips Advance Xitanium SR LED driver can be used to store additional OEM information. An OEM could use this to offer traceability or asset management to end users. The additional information can be luminaire-related data like ID/version numbers, optical data and electrical input data. The data can be stored in the SR driver in either the implemented DALI memory bank 1 or using codes stored as scene settings. MultiOne software using either the DALI interface or SimpleSet (NFC) can be used to program the information in the SR driver.

Memory bank 1 is implemented according to the DALI standard. Mandatory information are the OEM GTIN (6 bytes address 3-8) and OEM ID (8 bytes address 9-16). The information can be read/written using the "OEM Traceability" section in Device features of MultiOne (see Figure 22). The additional info can be any information up to 42 characters long.

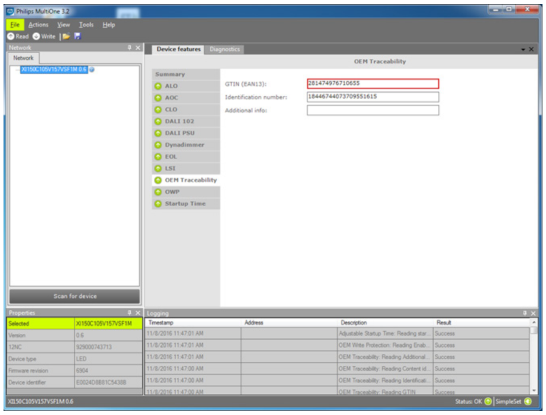


Figure 22. OEM traceability information in MultiOne.

Philips proposes to assign dedicated addresses to parameters like electrical input/output and optical data as shown in Table 2.

Address	Size (Bytes)	Functionality
0	1	Last accessible location
1	1	Memory bank version control
2	1	Lock byte
3 – 8	6	OEM GTIN
9 – 16	8	OEM ID
17 – 18	2	Content format ID
19 – 20	2	Input power (W)
21 – 22	2	Minimum AC mains voltage (V)
23 – 24	2	Maximum AC mains voltage (V)
25 – 26	2	Minimum DC mains voltage (V)
27 – 28	2	Maximum DC mains voltage (V)
29 – 30	2	Minimum AC input current (mA)
31 – 32	2	Maximum AC input current (mA)
33 – 34	2	Nominal light output (Lm)
35 – 36	2	CCT (K)
37	1	Distribution type
38 - 59		Available for additional information

Table 2. Proposed memory bank 1.

The data can also be stored as codes using DALI scenes. To program the scenes use the "DALI 102" section in Device features in MultiOne. Figure 23 shows an example programming scenes 11, 12 and 13 to store codes 10, 20 and 30. Be aware that it is possible to overwrite these values in the field.

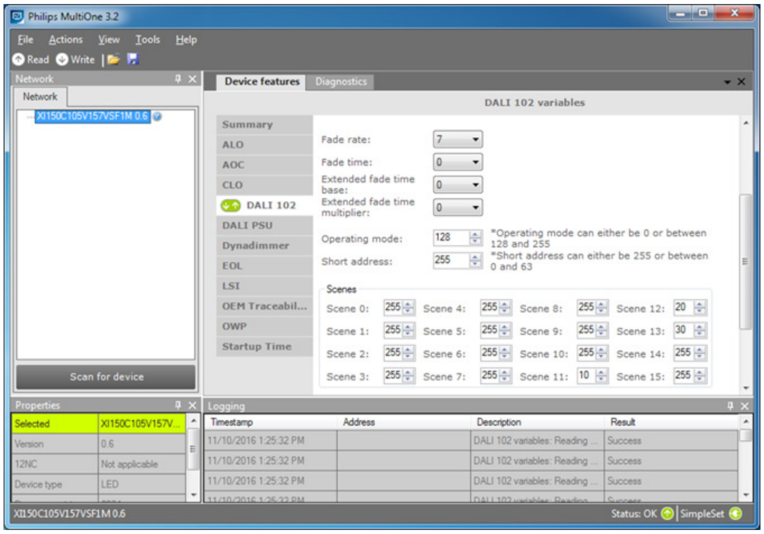


Figure 23. Programming scenes 11, 12 and 13 using DALI 102 variables in MultiOne.

Programming short addresses using SimpleSet

In cases where more than one Philips Advance Xitanium SR driver is connected to one sensor, it is useful for each SR driver to be assigned an individual short address so each individual SR driver can be addressed separately. Using SimpleSet, short addresses can now be programmed into the SR driver. Using the DALI 102 section under Device features the short address can be easily programmed by changing the value in the short address field (see Figure 24 where short address 15 gets assigned).

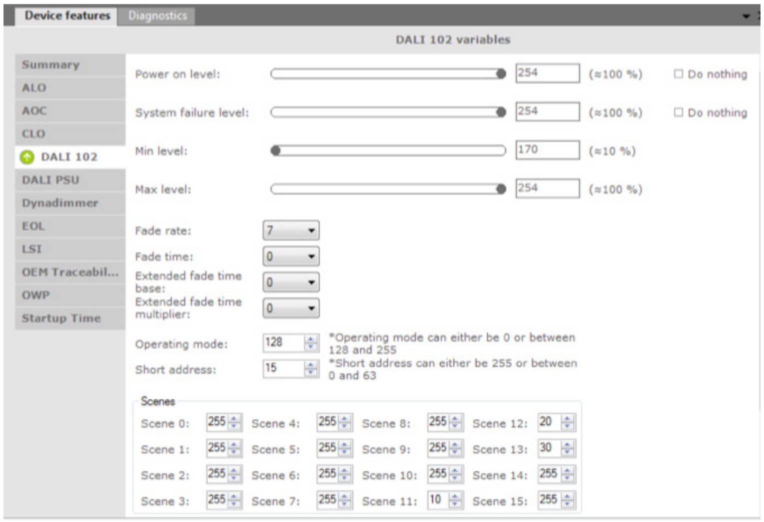


Figure 24. Programming short address (15) using DALI 102 (variables) section.

Thermal design-in

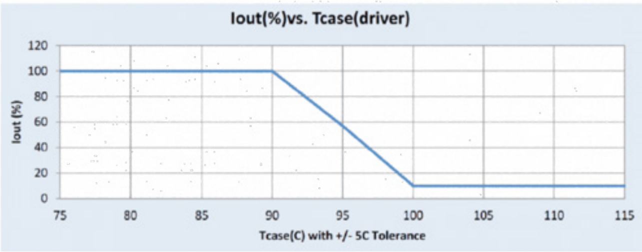


Figure 25. Thermal fold back (TFB) example.

The following section covers the critical thermal management points to facilitate design-in. Taking thermal considerations into account will ensure optimal performance and lifetime of the system. The maximum case temperature (Tc max) of the driver should not be exceeded. It is mandatory to keep driver Tc max within specification to meet driver lifetime and failure rate specifications. Please refer to individual product datasheets for specific values.

Thermal foldback (TFB) of driver

The driver will reduce the current to the LED module if the driver itself is overheating. The driver will limit 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 25).

Case temperature (Tc) point

To achieve optimal lifetime and reliability, it is critical that the temperature of the components in the driver remains within their ratings. During 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 then correlated to a Tcase (Tc) point on the driver as shown in Figure 26. Tc temperature is a proxy for the temperatures of the critical internal driver components.

The location of the Tc point is identified on the product label (Figure 27).

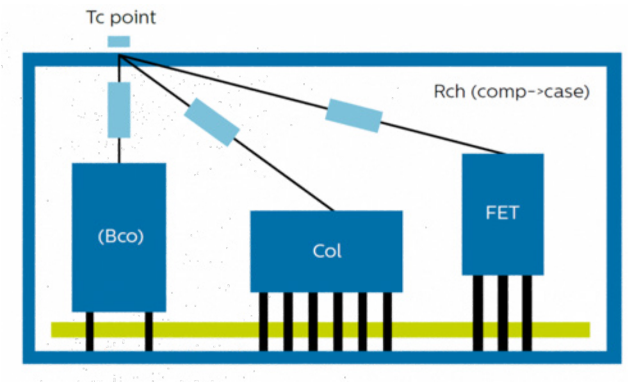


Figure 26. Schematic representation of internal thermal paths to the driver Tc point.

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

Note:

In order to ensure accurate Tc 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. Tc point should not be obstructed when mounted in the luminaire/enclosure.

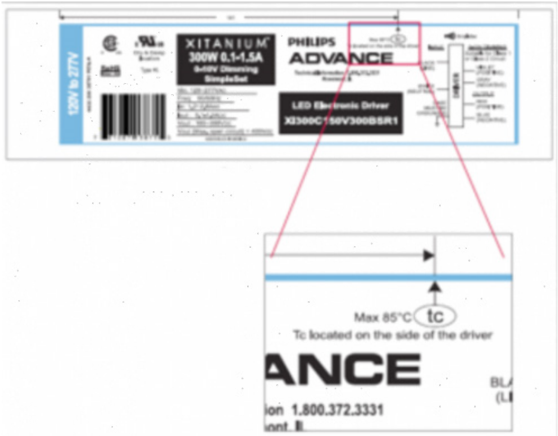


Figure 27. Product label indicating Tc point of an R-can driver.

Electrical design-in

Inrush current

Inrush current refers to the brief high input current that flows into the driver during the moment of connection to mains; see Figure 28. Typically, the amplitude is much greater than the steady-state input current.

Philips Advance Xitanium LED drivers meet the inrush specification values per NEMA 410, which are 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 Ipeak and T are shown in the datasheets for each driver. The experimental setup used for measuring the inrush current of Philips Advance Xitanium LED drivers is shown in Figure 29. For the test setup, a line impedance of 450mohm/100uH is used. These values represent a worst case line impedance (lowest). For the measurements, an input DC voltage equal to the peak of the corresponding line voltage is applied (via a capacitor bank). 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 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.

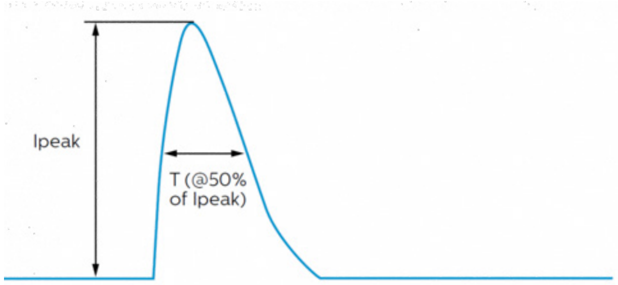


Figure 28. Graphical representation of inrush current.

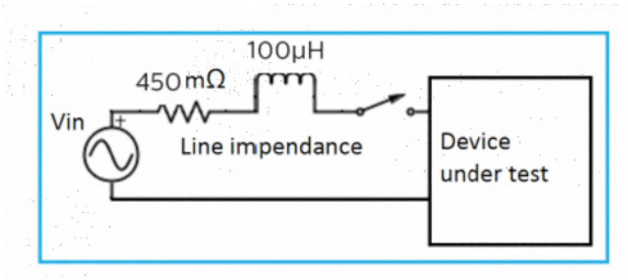


Figure 29. Inrush current measurement setup.

Surge protection

Philips Advance Xitanium LED drivers have limited built-in surge protection (in accordance with IEEE / ANSIC62.41.2 Transient Surge Requirements). The driver datasheet gives the protection level of the driver. A driver specification of 6kV means that the driver is tested to withstand 6kV line transient (2Ω source impedance) based on the 2Ω combination wave setup (1.2uSec/50sec open circuit voltage, 8/20uSec short circuit current). Drivers are typically rated with 6kV, and this rating means that 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). Depending on the geographical location, additional protection against excessive high surge voltages is recommended.

Note: It is highly recommended to test the external surge protection device (SPD) in combination with driver and LED module for worst case line transients.

ANSI C62.41.2 gives some guidance as to what surges can be expected in different exposure locations. For outdoor, low exposure is given at the 6kV/3kA level and high exposure applications at 10kV/10kA. Both of these exposure levels would require an external SPD to protect the system.

Considerations for external SPD selection differential mode surge

Figure 30 shows the test setup for a differential mode surge. For a driver rated at 6kV, Vsurge is 6kV and complies with the standard combi-wave shape (1.2/50uSec open circuit voltage and 8/20uSec short circuit current). The series impedance of the tester is 2ohms as indicated. The voltage at the driver terminals for a surge applied between line and neutral is approximately 1.2kV for drivers rated for 120-277V mains and approximately 1.8kV for drivers rated for 347- 480V mains.

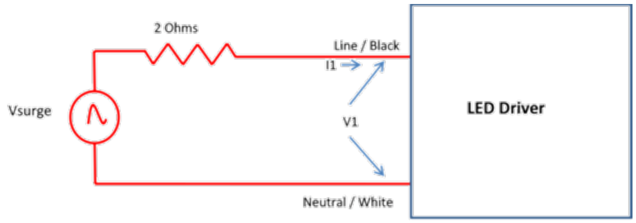


Figure 30. Differential mode surge.

When selecting an external MOV to increase the surge rating of the system, care must be taken to ensure that the external MOV clamping voltage is lower than the clamping voltage of the driver so that the current flowing into the driver during surge is always less than that flowing into the driver in the above setup. The current clamped into the driver in the above setup can be calculated by

I1 = (Vsurge-V1)/2ohm. For 120-277V rated driver with a 4kV surge rating, this becomes I1 = (4kV-1.2kV)/2ohm, I1 = 1.4kA When adding an external SPD, the system setup appears as shown in Figure 31.

Figure 29 shows that the system surge current between I2 (the current into the external SPD) and I1 (the current into the driver). In order for the LED driver to survive the surge, I1 must be kept below the values calculated with the rated surge voltage WITHOUT the SPD as was done above.

To select the external SPD, the following steps must be followed:

1. Determine the desired surge level of the system. IEEE C62.41 can be used as guidance. For example, 10kV/10kA, according to DOE for highly exposed systems.

2. Once Isurge is known (10kA in this example), it must be ensured that the clamping voltage of the external SPD is sufficiently low such that I1 is within the driver capability.

An external SPD must be selected that can handle 10 surges at 10kA for all coupling modes.

For a 120-277V, 4kV surge rated driver, the maximum value for I1 was calculated to be 1.4kA at a V1 of around 1.2kV. This means the external SPD must be selected such that it has a clamping voltage of 1.2kV or less at 8.6kA (10kA - 1.4kA = 8.6kA).

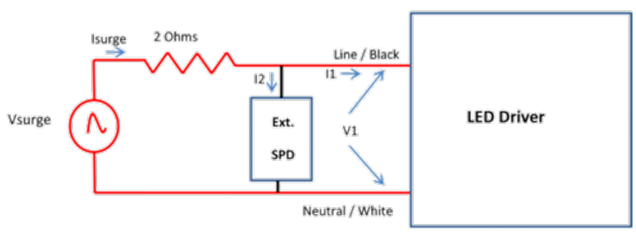


Figure 31. External SPD and driver setup.

SPD requirement

Energy rating: 10 pulses of 10kA for each coupling mode (L-N, L-G, N-G, LN-G) clamping voltage.

Note: Care must be taken to also include any voltage drops on the wires leading to the SPD. A 10kA surge has a di/dt of 1.3A/nSec. Consider that 1 inch of wire can have an inductance of around 20nH. This means an external SPD with wire length of 4 inches (round trip wire length of 8 inches) results in 8 *2 0nH * 1.3A / nSec = 208V. That means if the SPD has a 4-inch wire length, it must clamp at 1.0kV at 9kA in order to keep V1 below 1.2kV. An SPD with an input and output terminal or wires can eliminate this wire voltage drop.

Common mode surge

The external SPD common mode surge clamp level should be less than the LED driver common mode surge withstand specification.

Leakage current

Philips Advance Xitanium LED drivers are designed to meet leakage current requirements per UL 8750 standards. The specified maximum value is 0.75 mA RMS at 277V. The test is done with the driver alone. In a luminaire, leakage current may be higher since the LED load introduces additional leakage capacitance. As such, precautions should be taken on the luminaire level and if multiple drivers are used in the luminaire.

Electromagnetic compatibility (EMC)

Xitanium 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 grounded metal plate. To maintain good EMC performance at the luminaire level, the input, output and dim wires should be kept as far apart as possible. 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.

Electrical isolation

Philips Advance Xitanium LED drivers' output is isolated from the primary for isolated non-Class 2 drivers and Class 2 drivers – see the appropriate datasheet for particular isolation type. Isolation is also provided between all the electronic circuits and the chassis.

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

All of the wires in the Philips Advance Xitanium LED drivers meet the UL1452 safety standards.

Mechanical design-in

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. It is recommended to use a star washer under the head of the mounting screw. The teeth of the star washer will “bite” into the surface to ensure good electrical connection to the grounded luminaire.
3. Maximize interface area between driver enclosure surface and luminaire mounting surface (heat dissipater) for best (lowest) possible driver Tcase temperature.

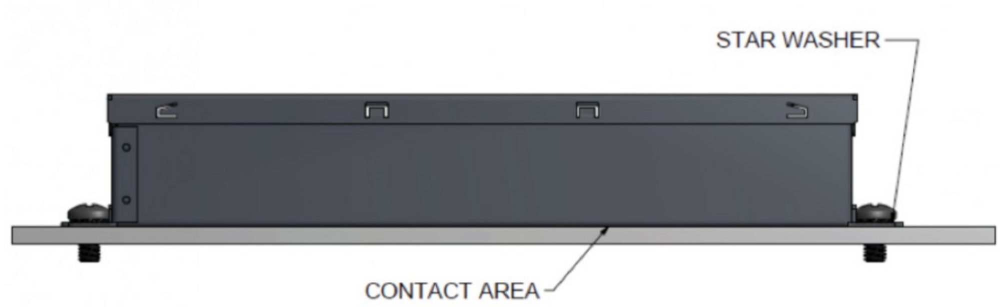


Figure 32. Mechanical design-in.

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Notes

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Philips Lighting
North America Corporation
10275 W. Higgins Road
Rosemont IL 60018
Tel: 800-322-2086
Fax: 888-423-1882
Customer/Technical Service:
800-372-3331
OEM Support: 866-915-5886

Philips Lighting Canada Ltd.
281 Hillmount Rd,
Markham, ON,
Canada L6C 2S3
Tel. 800-668-9008