Design-in guide

Philips Lexel LED downlight module system (DLM)

PHILIPS

Contents

1. Introduction

Thank you for choosing the Philips Lexel LED DLM system.
This guide tells you all about this system. If you require any further information or support please consult your local Philips office or visit: www.philips.com/support or www.philips.com/lexel

The advantages of LEDs have been known for 40 years:

- Long life – low maintenance cost
- Robustness – high reliability
- Saturated colors – maximum visual effect
- Cool beam – no heating of illuminated products
- No UV or IR – wide application possibilities
- Low-voltage operation – more safety, ease of use
- Mercury-free – care for the environment

Rapid improvements in high-power LED technology mean that LEDs can now be used for the first time in 'real' lighting applications, providing improvements over traditional lighting systems. Philips Lexel LED DLM system is a flexible LED lighting solution creating thousands of shades of white light and colors from a single slight source.

The use of LEDs has implications for lighting manufacturers in terms of differences in solid-state lighting usage compared with traditional lamps: for example, how to design given the constant improvements in specifications; how to provide the necessary heat sinking and how to deal with variations in flux and/or color. The Philips Lexel LED DLM system addresses these differences and facilitates easy adoption of LED technology for high lumen packages (2000 lm+). The system is designed for integration in luminaires (build-in system). This technical application guide addresses the relevant issues to support and facilitate the work of specifiers and lighting system designers.

The Philips Lexel LED DLM system is, as the name suggests, designed and intended for recessed downlight luminaires. Other applications can be explored by OEMs as long as this creates no design conflicts with the Lexel DLM system and local luminaire standards are respected (for Europe: EN 60598). Please consult us if you wish to deviate from the design rules described in this application guide.

1.1 Features and benefits

Features	Benefits
Superior quality white LED light	An enabler for entry into general lighting
2700 - 6500 K	Creates various lighting atmospheres and tones with a single light source
CRI > 80	Meets the norm for general lighting
Optimized light mixing chamber	Perfectly mixed light, consistent color quality and lumen output
Dimming capability 100 - 0%	Ability to easily create ambiance
Instant 100% light	No delay between power on and light output
Future-proofed, convenient modules	Designed specifically for ease of use by Luminaire Manufacturers
Fixed form factor	Easy for luminaire manufacturers to work with
Easy-to-mount heat sink / optics	Faster time to market
No heat or UV	Comfortable, pleasant light; no damage to materials
Support for standard controls	Easy connection to DALI, DMX / RDM
Long lifetime of 50,000 hrs	Low maintenance, sealed for life
Integrated lifetime-preserving systems	More reliable, longer life

1.2 Applications

The Lexel family of products produces perfectly controllable light to create unique and dynamic environments with flexible scene setting capabilities. Lexel products consistently deliver high quality tunable white and color illumination that creates new value for OEM luminaire manufacturers, such as:

- Creating dramatic effects with the addition of colored lights
- Enabling scene and mood setting flexibility
- Creating inspiring and meaningful shopping experiences

The Lexel LED DLM system is designed for general lighting applications in the professional market for retail, hospitality and offices, enabling the creation of various atmospheres with changing tones of white light and different colors from a single light source. Applications for the Lexel LED DLM include:

- Offices (representative areas such as receptions, boardrooms and restaurants)
- Hospitality (lobbies, receptions, restaurants, bars, elevator halls to create various themes and brand experience)
- Shops (shop windows, wall-washers, leisure areas, focus islands, shop-in-shop concepts: where emphasizing drama effect, calling attention, and creating various themes and brand experience are important)
- Entertainment (wallwashers, backlit walls)

2. Philips Lexel LED DLM system

The Lexel LED DLM system contains two products:

- Lexel LED downlight module
- Lexel LED driver

The Lexel LED DLM cables can be ordered separately.

2.1 Starting characteristics

The system can be switched on in milliseconds, which is a general characteristic of LEDs.

2.2 Luminous flux during start period

In contrast to other light sources, LEDs can be switched on at full power (or at any other dimmed level) instantaneously.

2.3 Lumen maintenance

When used within specification, lumen maintenance of 70% at 50,000 hours is expected for Lexel LED DLM.

2.4 Dimming

The Lexel LED DLM can dim from 100% - 0%. Above 10% dimming the color consistency can be guaranteed.

2.5 Nomenclature

The name of the products are:
Lexel LED DLM 1100 2700-6500
Lexel LED DLM Driver DALI/DMX
Lexel LED DLM 2000 2700-6500
Lexel LED DLM cable 25 cm
LED DLM cable 60 cm

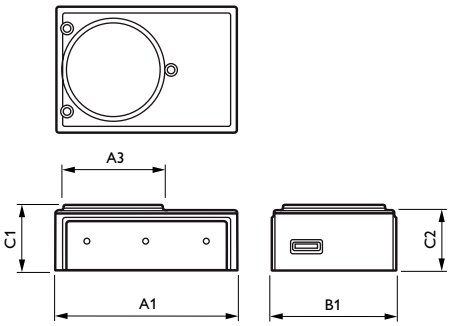
2.6 Weight

Lexel LED DLM module = 465 g
Lexel LED DLM driver = 314 g

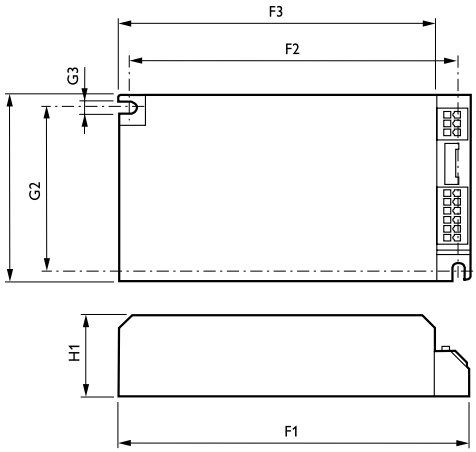
Lexel LED DLM system - module on left, driver on right

2.7 Dimensions of LED module and driver

(typical data; ± 0.2 mm)



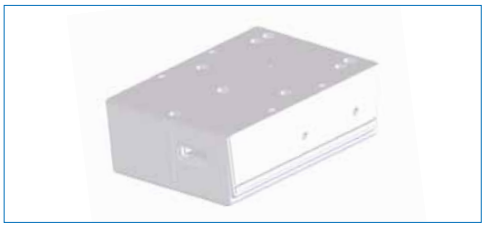
Lexel LED DLM module - dimensions



Lexel LED DLM driver - dimensions

A1	A3	B1	C1	C2	F1	F2	F3	G1	G2	G3	H1
121.6	66.8	82.8	43.7	40.2	138	128.5	124.5	74	63.6	4.5	32

Lexel LED DLM module



Lexel LED DLM module, fixing holes and grooves

Lexel LED DLM driver

2.8 About the Lexel LED downlight module

The LED module consists of four main components:

- PCB with LEDs
- Mixing chamber
- Heat spreader
- Diffuser (emitting aperture)

High-quality tuneable white light and color with high efficiencies is achieved with a plain PCB with LEDs and the Lexel technology. The mixing chamber ensures perfectly mixed light, resulting in uniform colors and good color consistency. The heat spreader facilitates optical heat transfer in three directions and helps luminaire manufacturers to design their own heat sink system. The heat spreader is equipped with screw holes for fixing the heat sink. The function of the diffuser is to shape the light distribution, resulting in a Lambertian beam. The luminaire manufacture has the freedom to design its own secondary optics. The LED module has mechanical provisions which allow for ease of mounting.

2.9 About the Lexel LED DLM driver

The Lexel LED driver is especially designed to operate the Lexel LED module. Together with the dedicated electronics inside the LED module, the driver is designed to operate RGBW high power LEDs. The driver is equipped with universal mains input (120-277 V) and additional 12 V output connector, enabling the easy use of an active cooling system.

Special features of the driver include:

- unique intelligent feedback system enabling color selection, control and consistency over life and between units
- control interface for DALI (color) and DMX/RDM
- option to choose RGB, CCT or xy modes
- Tcase = 65° C
- Safety Class 1 system (protective ground required, no SELV)
- Universal mains input (120-277 V)
- Additional 12 V output connector

3. Lighting Performance characteristics

3.1 UV and other hazards

PET value	>100 hrs./Klux (zero UV)
Damage factor	0.08 @ 4000 K
IR (infrared) radiation	As well as being free of UV radiation, the LED modules are also free of infrared radiation in the beam.

3.2 Photobiological safety aspects

EN/IEC 62471 "Photobiological safety of lamps and lamp systems", covering incoherent light sources applies. This international standard gives guidance for evaluating the photobiological safety of lamps and lamp systems including luminaires. This standard specifies the exposure limits, reference measurement technique and classification scheme for the evaluation and control of photobiological hazards from all electrically powered incoherent broadband sources of optical radiation, including LEDs but excluding lasers, in the wavelength range from 200 nm through 3000 nm.

In the photobiological safety standard, hazard catagories are defined as follows:

Radiance-based		
Blue Light	LB	300 – 700 nm
Retinal Thermal	LR	380 – 1400 nm
Retinal Thermal Weak Stimulus	LIR	780 – 1400 nm

Irradiance-based		
Actinic UV Skin & Eye	ES	200 – 400 nm
Eye UVA	EUVA	315 – 400 nm
Blue Light Small Sources	EB	300 – 700 nm
Eye IR	EIR	780 – 3000 nm

Measurements on the Lexel LED DLM gave the following results:

Hazard Catagory	Emission Limit
LB	Low (Risk Group 1)
LR	Exempt*
LIR	Exempt
ES	Exempt
EUVA	Exempt
EB	Exempt
EIR	Exempt

* Exempt means no risk

The following should be taken into account:

- The effective radiance measurement for Blue Light (LB) modules is 'Low', meaning that the LED modules are categorized in Risk Group 1. The permitted exposure time for Blue Light radiance (relevant when looking into the source) is limited to 3 hours. Because of the Law of Conservation of Radiance, integrating the LED module into a luminaire results in either the same radiance or a reduced radiance. Final assessment of the luminaire is recommended.
- The measured irradiance-based values (E) for the categorized hazards are all within the exempt group.
- In general, the permitted exposure time for irradiance is limited when in the 'low', 'moderate' or 'high' risk group. Limiting the exposure time and/or the distance to the source can reduce the hazard level. However, for the measured LED modules there are no special precautions necessary since they are ranked in the exempt group. Final assessment of the luminaire (including, for example, secondary optics) is recommended.

Photobiological safety is not assured if the Lexel LED module is lit up without the diffuser. Direct exposure to the LED light is dangerous for the eyes.

4. Designing a luminaire

In this chapter recommendations and values are given to enable optimal luminaire design.

4.1 IEC/UL recommendations

The general recommendations for luminaire design given by the IEC (IEC598) or UL (UL1598) and the national safety regulations are also applicable to LED-based luminaires. Please consult us if you wish to deviate from the design rules described in this application guide.

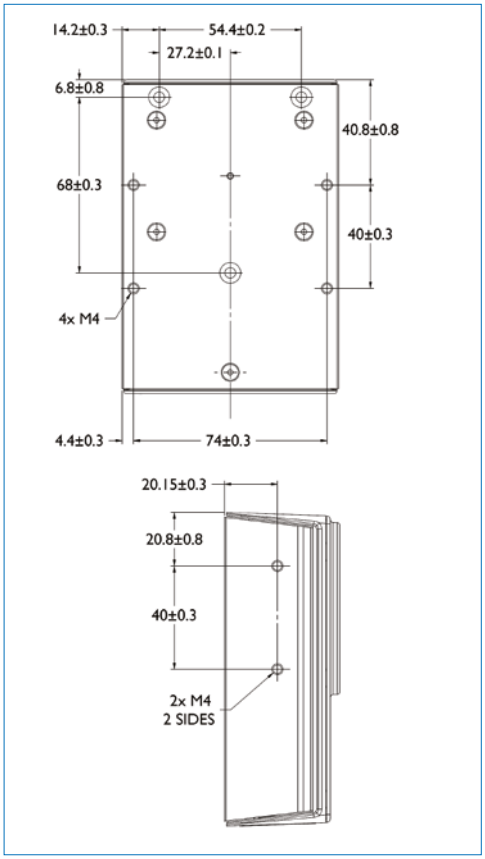
4.2 Conditions for Use

Components (LED Module and LED Driver):

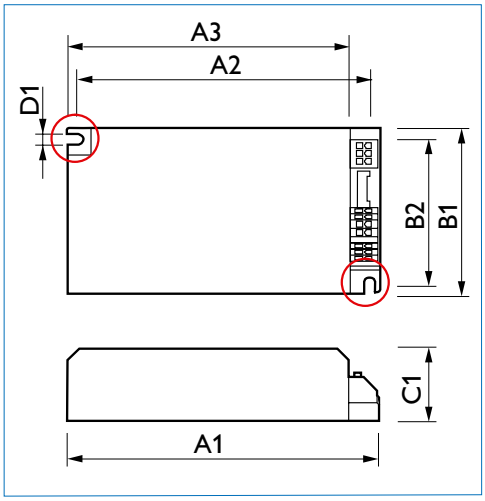
- DMX control inputs to the Luminaire must be isolated from the AC mains by an insulation at least equal to "double" or "reinforced" insulation.
- These components are designed to be mounted inside a Lighting fixture.
- These components do NOT have an IP rating.
- These components are designed for indoor use.
- These components are designed for dry location only.
- These components are not serviceable by the end user.
- The pins of the connectors found on the LED driver support single wire connection. If additional connections are required, a single crimp pin in the OEM's cable assembly must be used.
- These components are to be installed according to international and local safety standards. The suitability of the mounting means shall be determined during the end product evaluation.
- Proper heat sinking of these components must be provided, by the OEM, for correct functioning of the system.
- Temperature tests shall be considered in the end product evaluation, and the specified maximum case temperature (Tc) points shall not be exceeded.
- These components are rated Class 1; both the LED module and the LED driver heat sink must be connected to protective earth according to the applicable safety standards.
- The interface connectors have not been investigated for Safety Extra Low Voltage (SELV) or Limited Current Circuit (LCC).

Luminaire:

- A suitable Electrical and Fire enclosure shall be provided in the end-system.
- In the end-use equipment the LED Driver leads and/or connectors shall be routed, supported, clamped or secured in a manner that it is:
  - Relieved from any strain on wire and connections, and
  - Prevented from loosening of wire connections and damage of conductor isolation.
  - If wiring is outside the fixture, proper strain-relief should be applied.



Location of mounting holes for Lexel LED DLM module



Location of mounting holes for Lexel LED DLM driver

4.3 Warnings

The Lexel LED DLM product is a high power LED product with high optical output. Operators of the LED modules should not look directly into the beam of the light source (especially not with magnifiers or similar optical instruments) as this may cause damage to the eyes.

To avoid the chance of product damage or malfunction, disconnect power before connecting wires, and do not to connect or disconnect cables (supply, data, lamps and interface cables) when voltage is supplied to the LED driver or LED module.

The light emitting region on the front of the LED module should be kept free from dirt, grease and other contaminants in order maintain optimal performance. Use only a soft, dry, lint-free cloth to clean the optics. Never use cleaning solvents as these may damage the optics. To guarantee product lifetime, the luminaire design and specification for use should ensure that the case temperature remains below the recommended temperature.

The Lexel LED DLM product is classified as ESD sensitive. Please take appropriate actions for safe handling of the LED module and LED driver in production environments.

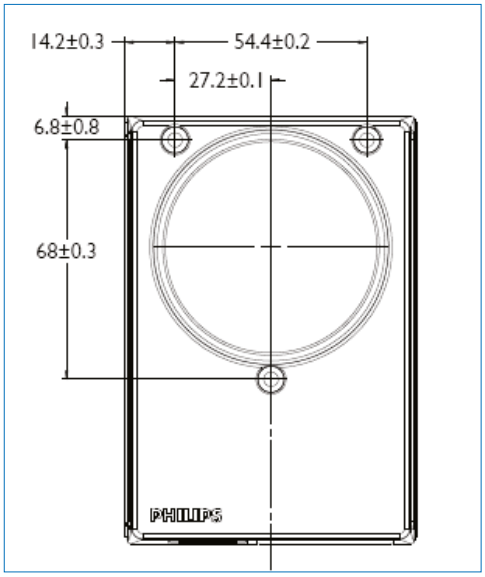
To avoid electrical shock, ensure that LED driver module is properly grounded by connecting the ground terminal to protective earth (as shown in the Schematic Wiring diagram.) This procedure is essential for safe operation of the LED Driver. Ensure that the AC power is switched off before attempting to make any wiring connections to the LED Driver. This is a requirement for the KEMA certification of the luminaire.

4.4 Mounting the LED module

The LED Module should be mounted onto the luminaire heat sink using the 4 threaded holes (M5) located on the bottom surface of the LED Module. There are 2 additional holes located on each side of the LED Module that can be used. Please refer to diagram on the left for the precise location of mounting holes.

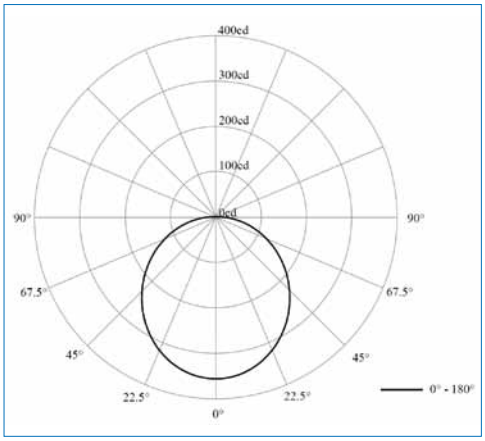
4.5 Mounting the LED driver

The LED Driver should be mounted into the luminaire using the 2 slots provided on opposite corners of the driver. It is recommended that M4 size screws be used to mount the LED Driver into an enclosure. The enclosure should be thermally conductive to aid in the heat dissipation, drawing heat away from the LED Driver.



Location of mounting holes for secondary optics


Example of secondary optic (Alux Luxar and Jordan)



Polar intensity diagram for Lexel LED module

4.6 Mounting secondary optics

The LED Module generates a lambertian beam shape, which is a pragmatic starting point for secondary optic design by luminaire manufacturers. IES files, LTI optical models.

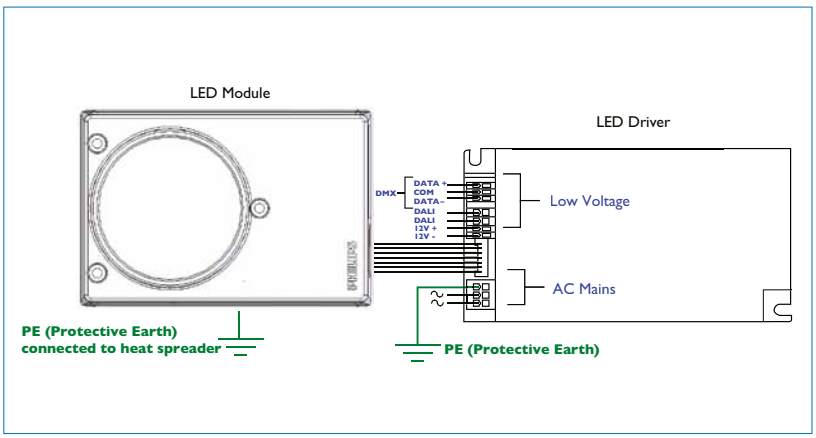
There are 3 mounting holes provided on the LED module for mounting secondary optics if desired by the luminaire manufacturer.

4.7 Wiring

The LED module is connected to the LED driver using a 7-wire interface cable. Please refer to the Schematic Wiring Diagram. Warning: never connect or disconnect the LED module cable when the driver is powered. This might result in LED driver or LED module failure.

Connecting to protective ground

Both the Lexel LED downlight module and Lexel LED driver need to be connected to protective earth in order to comply with safety and EMI regulations. The PE symbol is shown on the product label to ensure that OEMs take proper measures in their luminaire design. The arrow on the label points to the metal heat spreader where the grounding connection is required.



Schematic wiring diagram

Wiring safety requirements:

- DALI is considered an Extra Low Voltage (ELV) circuit as defined in the standards IEC62386-101 Clause 4.2 and IEC61347-2-3 Cause 15.5. The appropriate insulation depends on the final luminaire design.
- DALI control inputs to the luminaire must be isolated from the AC mains by insulation at least equal to basic insulation.
- DALI control inputs in the luminaire must be isolated from SELV circuits by at least equal to double or reinforced insulation.
- DMX should be considered to be a SELV circuit (equivalent to Class 2 circuits) and the appropriate insulation will depend on the final luminaire design.

Description of wiring connections

The connectors in the LED Driver housing provide data connections to the LED module and connection to AC power. Please refer to Wiring Connections for LED Driver table and Schematic Wiring diagram, for the description of each wire and the required wiring connections.

Wiring connections for LED driver

Pin No.	Connection	Type	Wire Recommendations		
			Area (mm^2)	Length of exposed wire (mm)	Color
1	PHASE (LINE) or NEUTRAL	Solid Core or Stranded[1]	Dependent upon luminaire design[2]	8 to 9	Black or brown
2	PHASE (LINE) or NEUTRAL	Solid Core or Stranded[1]	Dependent upon luminaire design[2]	8 to 9	White or blue
3	GROUND3	Solid Core or Stranded[1]	≥ 1.5	8 to 9	Green or Green/Yellow
4	LED Module	7-Wire Interface cable[4]	n/a	n/a	n/a
5	12V output +	Solid Core or Stranded[1]	0.2 to 0.5	8 to 9	Red
6	12V output -	Solid Core or Stranded[1]	0.2 to 0.5	8 to 9	Black
7	DALI	Solid Core or Stranded[1]	0.5 to 1.5	8 to 9	Customer defined
8	DALI	Solid Core or Stranded[1]	0.5 to 1.5	8 to 9	Customer definted
9	DMX > DATA -	EIA485 Shielded or CAT 5 Shielded[5]	0.2 to 0.5	8 to 9	Black or orange
10	DMX > COM	EIA485 Shielded or CAT 5 Shielded[5]	0.2 to 0.5	8 to 9	Shield
11	DMX > DATA+	EIA485 Shielded or CAT 5 Shielded[5]	0.2 to 0.5	8 to 9	White or White/Orange

[1] Recommended wire type is solid-core. Stranded wire may be used if tip bonding or crimp pins are used.

[2] Please refer to IEC60598 or UL1598 luminaire standard for minimum required cross-sectional area for wiring.

[3] The LED driver is class 1, and therefore **protective ground needs to be connected**.

[4] If a Philips 7-Wire Interface cable is not used, please refer to the Wiring section for the connector and wire description.

[5] Cable is suitable for EIA485 use. As outlined in references i and ii, lengths <500 m or <1100 m are recommended. If using CAT5 cable, it is recommended that the cable is shielded with a maximum length of 300 m (see reference iv).

4.8 Interface Cable Connector

The OEM may choose to provide their own interface cable between the LED Module and the LED Driver (if, for instance, a longer interface is required). In such a case, please refer to the Connector Specifications table and the Description of Wires table.

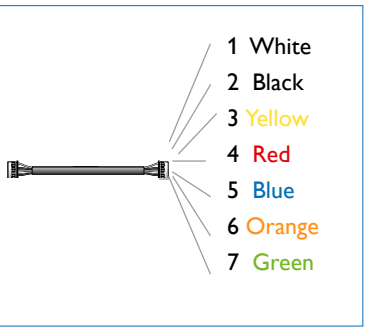
The standard Lexel LED DLM cable is 250 mm and 600 mm. An extended cable length of over 600 mm is feasible providing that the luminaire complies with both safety (EN60598) and EMC standards. These requirements are the responsibility of the luminaire manufacturer.

Connector Specifications

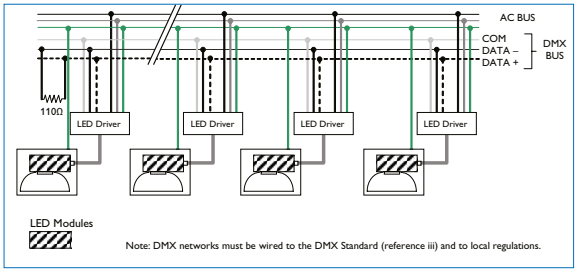
Connector Name	Connector Brand & Type	Connector Supplier Part No.	Counterpart Brand & Type	Counterpart Supplier Part No.
X1 (LED Module)	JST - PH type	S7B-PH-SM4-TB	JST - PH type	Housing: PHR-7 Contacts: SPH-002T-P0.5S
X2 (LED Driver)	JST- PA type	JST B07B-PASK-1	JST – PA type	Housing: PAP-7-V-S Contacts: SPHD-001T-P0.5

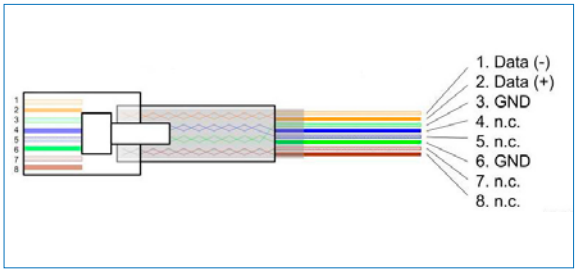
Description of Wires

X1 Connector (7-wire connector)	Description	Notes
1	VDC	
2	-	Not used
3	PGND	
4	VCC	
5	TBUS A	RS-485 A
6	TBUS B	RS-485 B
7	SGND	



4.9 DMX installation wiring





DMX networks must be wired according to the DMX standard (references i - iv) and must adhere to any local regulations. Furthermore, the DMX network must be SELV compliant.

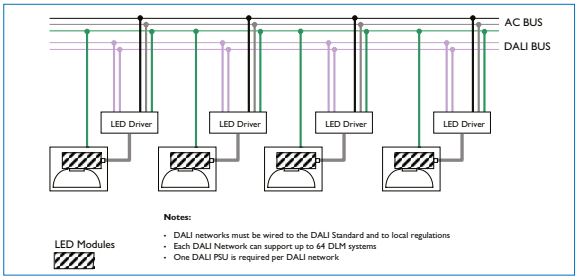
DMX is based on the RS485 communication protocol, but although RS485 is two way communication, this is not implemented in DMX, as DMX is one way communication only.
The recommended DMX connectors in a DMX network are an RJ45 connector or Neutrik XLR 5-pin connector. See DMX pin connections for wiring details of those connectors.
The required control cables are a shielded CAT.5 (or higher) cable or a RJ485 "Shielded Twisted Pair" cable. The DATA + and DATA - signal create the actual DMX signal, where the GND/COM must be connected for reference and to prevent interference and signal disturbance.

In order to ensure stable network communications, the DMX cable should be terminated with a 110 Ohm resistor between the "Data+" and "Data-" wires at the end of the cable run. This prevents DMX signal reflections back to the DMX controller. Please refer to the diagram below for a typical DMX wiring configuration. Some remarks about DMX network topology:

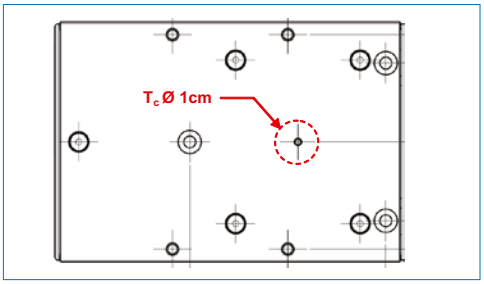
- It is possible to split a DMX-line with the use of an additional piece of hardware: a DMX-splitter.
- Every DMX luminaire consumes "DMX energy" As a result, only maximum 30 DMX luminaires can be connected to one DMX line. More than 30 DMX devices are needed in a DMX network, the signal needs to bee boosted with a DMX-Booster after the first 30 DMX luminaires.
- There are 4 ways DMX optosplitters available on the market both split and boost the DMX signal.

4.10 DALI installation wiring

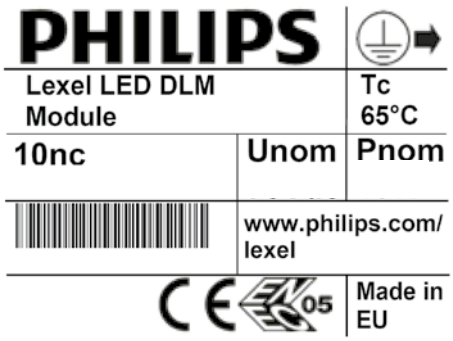
Please refer to the diagram below for a typical DALI wiring configuration:



5. Heat sink design and temperature measurements



Location of Tc on back of Lexel module



Label for Lexel LED DLM module

5.1 Thermal operation

The components in both the LED module and LED driver dissipate a significant amount of heat during operation. In order to ensure that the LED module and LED driver can operate reliably within their recommended temperature ranges, the luminaires in which they are placed must provide adequate heat sinking to ensure that the Tc (Case Temperature) of each LED module is not exceeded. For optimum performance, the Lexel LED DLM system must operate within specified temperature limits.

5.2 Ambient conditions

The Lexel LED DLM system's minimum limit for ambient temperature is determined by the LED Driver's limit, which is -20° C. The maximum ambient temperature for the Lexel LED DLM is +45° C, providing that Tc does not exceed 65° C (please refer to the Critical Measurement Points – LED Module section below).

5.3 Test requirements

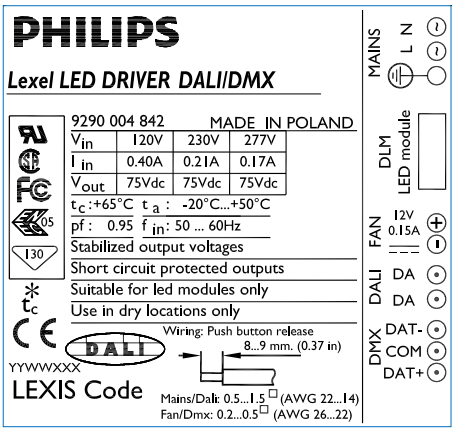
Temperature measurements should only be made when the luminaire is thermally stable, which may take up to 2 hours depending on the thermal capacity of the luminaire (see also the relevant clauses in IEC 60598).

For all measurements such as temperature, luminous flux and power, a stabilization period of at least half an hour must be allowed before any reliable data can be obtained. Measurements must be made by thermocouples, which should be firmly glued to the surface (for example, using an appropriate thermal epoxy, and not secured with adhesive tape).

5.4 Critical measurement point – LED Module

The junction temperature is a critical factor for the operation of LEDs. The temperature of the LED Module's aluminium casing, Tc, is directly related to the LED junction temperature. This critical point, Tc, is on the back surface of the LED Module (as shown in the Location of Tc diagram). Tc should be kept below 65° C/149° F to keep the LED junction temperature at a safe operating temperature and to maintain performance. If Tc exceeds 65° C/149° F, power reduction will be engaged to dim the LED Module's light output in order to prevent the LEDs from damage due to overheating.

To achieve the performance and lifetime specifications, Tc should not exceed 65° C/149° F.



Label for Lexel LED driver (Tc point marked)

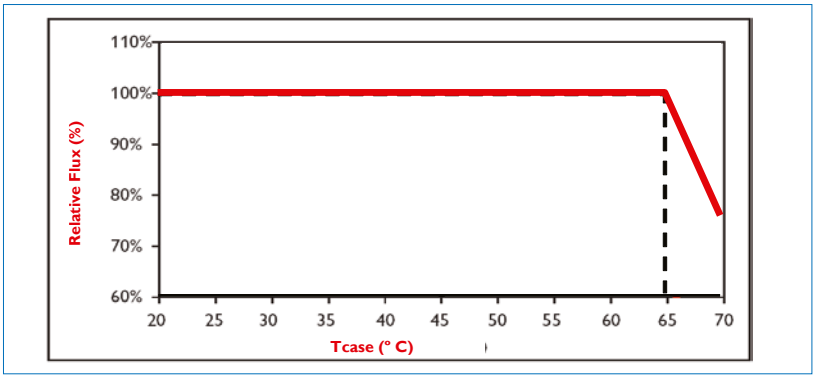
5.5 Critical measurement point – LED driver

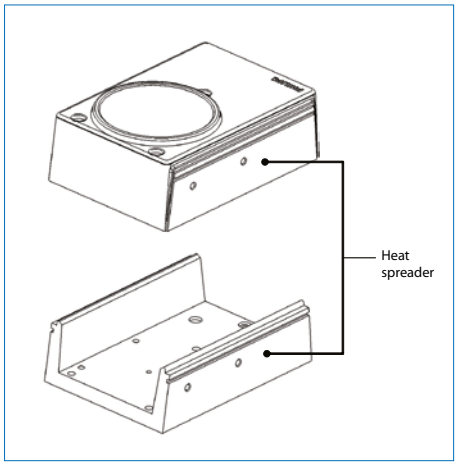
It is recommended that the LED Driver be installed in such a manner that the measured surface temperature at Tc does not exceed 65° C/149° F to ensure protection of the internal components and rated lifetime. The location of Tc is marked on the LED driver label.

5.6 Light output / Tc relationship

The LED module is designed to meet its performance and reliability specifications up to a maximum case temperature of 65° C/149° F. The Relative Flux vs Tc diagram shows the relative flux as a function of case temperature. If the LED Module exceeds a Tc of 65° C/149° F, it will begin to derate its light output in order to provide thermal protection for its internal components.

The Tc vs TAMBIENT and Relative Flux vs TAMBIENT diagrams show the typical relationships between Tc and relative flux versus ambient temperature with the LED module integrated into a luminaire.





Lexel LED DLM heat spreader

5.7 Operation in free air

The Lexel LED DLM system is not designed for operation in free air without additional heat sinking. The Lexel LED DLM is a built-in concept for integration into luminaires.

5.8 Heat sink design

The LED Module contains a heat spreader which serves as an efficient mechanism to transfer the heat generated by the LEDs to the outside surface of the LED module. To ensure that housing temperatures do not exceed the specified maximum values, the heat generated needs to be transported away from the module and the driver. This can be done with an additional heat sink design or the luminaire itself can act as an additional heat sink. The applicable heat transport mechanisms are conduction via the heat sink, convection and thermal radiation to the surroundings.

In general, a luminaire constructed of low thermal resistance would be more effective at transferring the heat from the LED module heat spreader to the environment.

Although a heat sink can have many (complex) shapes, the following is based on a disk type of heat sink. The results for square plates, etc., are more or less the same provided the surface areas are equal. The type of material used has a relatively large influence on the final result. For example, a comparison of the thermal conductivity (k) of copper with that of corrosion resistant steel (see table left) shows that a substantially smaller heat sink can be made with copper. In practice the best material for heat sinks is (soft) aluminum.

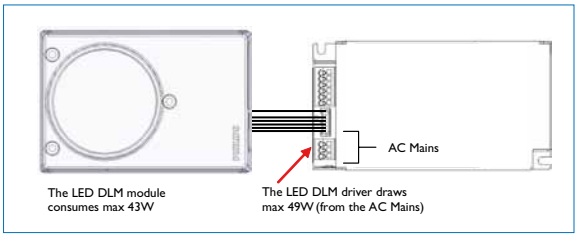
The thickness (d) of the heat sink disk is also of major importance. Assuming the use of different heat sinks of the same diameter but made from different materials, the same effect in terms of temperature difference will be achieved if the product of thermal conductivity (k) and disk thickness (d) is constant. This means more or less the same result is obtained with a disk of 1 mm copper, 2 mm aluminum, 4 mm brass, 8 mm steel or 26 mm corrosion-resistant steel. Increasing the diameter, and thereby also the surface area, of the heat sink disk also leads to an improvement, but the effect is smaller for larger diameters and depends on the thermal conductivity (k) of the material and the thickness (d). Thermal radiation can also form a substantial part of the total heat transfer, and is of the same order as for convection. This depends strongly on the emission coefficient (see table) of the surface, which lies between 0 and 1. For example, a polished aluminum surface has a very low emission coefficient, while that of a painted surface is very high.

Thermal Conductivity

Material	W/mk
Copper	400
Aluminum	200
Brass	100
Steel	50
Corrosion-resistant steel	15

Emission Coefficients

Material	W/mk	Emission Coefficient
Aluminum	new/polish	0.04 - 0.06
	oxidized	0.2 - 0.3
	anodized	0.8
Steel	painted	0.8 - 0.95
	new/polished	0.03 - 0.07
	heavily oxidized	0.7 - 0.8



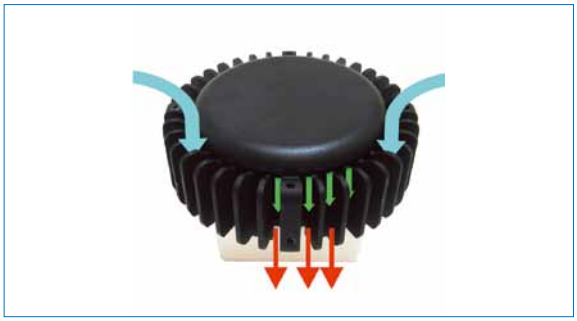
5.9 Lifetime predictions

In order to maximize the light output, the power required by the LED DLM module will increase over the lifetime of the product to compensate for the natural lumen depreciation of LEDs. There are three factors that will cause the light output to diminish over time:

1. Normal LED degradation - the natural depreciation of the LEDs light output over time.
2. Power limiting - the maximum power allowed to be consumed by the LED module.

   In anticipation of the increase in power required during the product's lifetime, the heat sink needs to be designed to dissipate 28 W of power from the LED module. This translates to the LED driver drawing 49 W of power from the AC mains as shown below.
3. Thermal derating - this occurs when the critical temperature point (Tc) exceeds 65° C.

All of these factors need to be accounted for when predicting the lifetime characteristics of lumen depreciation.



5.11 SynJet cooling from Nuventix

Nuventix has developed a cooling solution utilizing SynJet technology that offers silent operation, long life and robust cooling for Fortimo LED DLM systems. Its small size allows it to be used in tight spaces. SynJet cooling allows for universal mounting, permitting great flexibility in installation. The unit is designed for use with 1100 and 2000 lumen Fortimo LED DLMs, providing long-term thermal solutions for LED lighting.

Nuventix has introduced 2 standard version:
- SynJet DLM Cooler with heat sink (round)
- SynJet Universal DLM Cooler with heat sink (square)

For both products design guides and assembly guides are available upon request.

5.12 Nuventix contact information

A specific Synjet cooling version is being introduced for Fortimo Food DLM.
For a full specification and application assistance please refer to their website: www.nuventix.com

Next to Nuventix there are other active cooling suppliers. Below some references for other fan suppliers:

Sunon, website: http://www.sunon.com/index.htm Sunon is a large Taiwan based fan supplier, mainly active in electronics cooling. They have a very interesting technology: Maglev.
They use a magnetic field to stabelize the fan. This results in long lifetime and low noise.

Further we would like to mention 2 other heatsink suppliers
AVC: website http://www.avc.com.tw/
Frigo Dynamics: website http://www.frigodynamics.com/index.php?lang=en

6. Control methods

6.1 DMX addressing

DMX, formally referred to as "DMX512", is a standard that describes a method of digital data transmission between controllers and lighting equipment and accessories. The name DMX512 derives from Digital Multiplex with 512 bytes of information. It covers electrical characteristics (based on the EIA/TIA–485 standard), data format, data protocol, and connector type. This standard is intended to provide for interoperability at both communication and mechanical levels, with controllers made by different manufacturers. The 1986 and 1990 versions also addressed cable requirements and premises wiring. A series of ANSI standards are being developed to address these cable issues not appearing in the ANSI version.

Each Lexel LED DLM requires between 2 to 10 DMX addresses, depending on the DMX personality. The **DMX Personalities** table summarizes the DMX data assignment for each DMX personality. The default address for the Lexel LED DLM is "1".

The DMX address can be set by using:

1. SmartJack Pro
2. An RDM controller (parameter ID "DMX_START_ADDRESS" (see the Supported RDM Parameters section),

DMX personalities

There are two categories of DMX operation – Static and Dynamic. Within these two categories, there is a subset of DMX personalities of operation, described in detail in reference v. The default DMX personality for the Lexel LED DLM is RGB, described in the Static DMX Personalities section.

The DMX personality can be set by using:

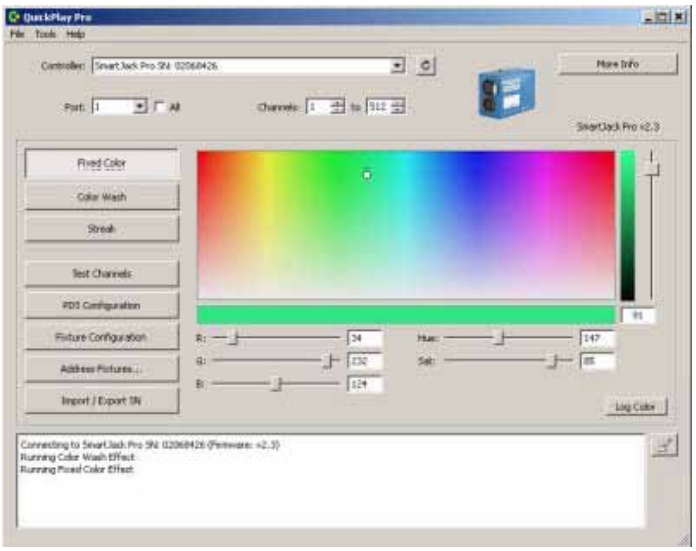
1. SmartJack Pro
2 An RDM controller (described in the DMX-RDM Personality section)

Please refer to the **DMX Personalities** table for the description of the DMX personalities.

6.2 How to configure with SmartJack Pro

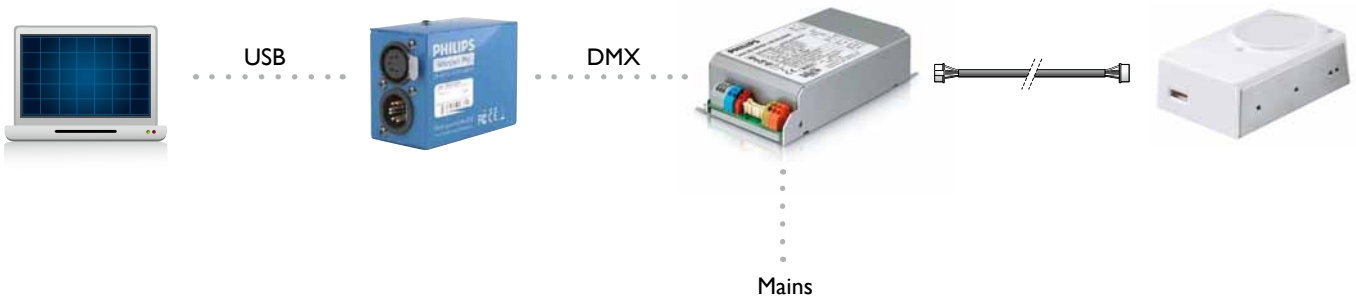
6.2.1 Benefits Philips SmartJack Pro and QuickPlay Pro software:

- Intuitive and easy software (really!)
- Just USB ➔ DMX, no additional power supply
- Also acts as basic DMX controller ➔ demonstrate Lexel!
- Compatible with whole Philips range (CK and Philips Luminaires)
- Cheap compared to competition (Enttec)

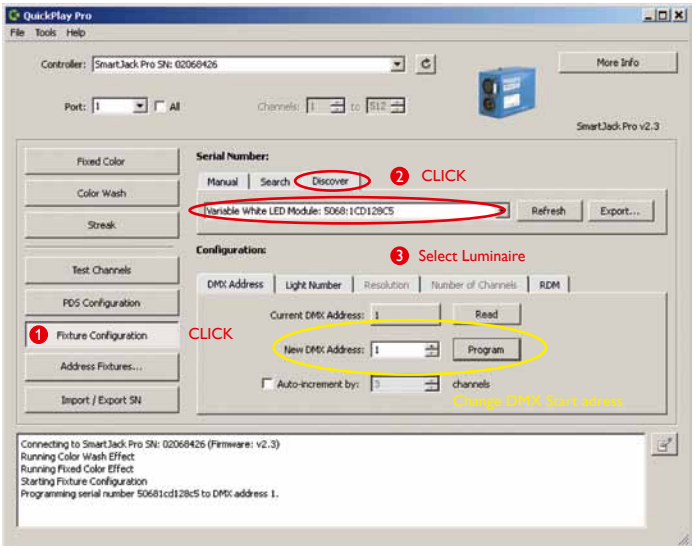


6.2.2 How to configure with SmartJack Pro I

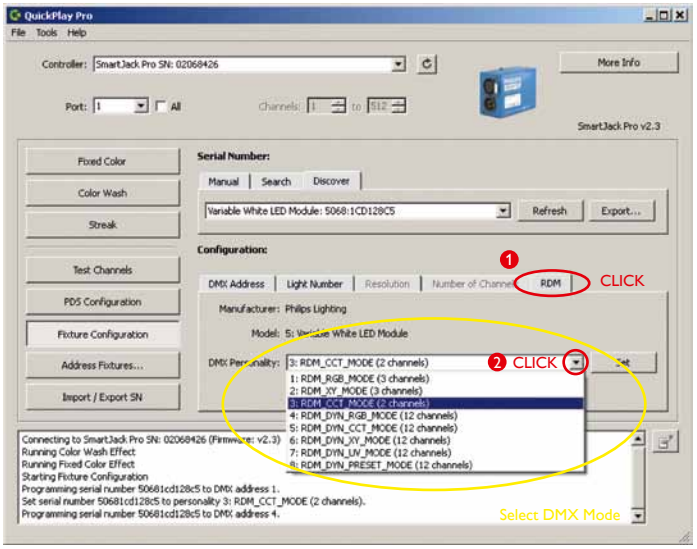
- Install QuickPlay Pro Software download from http://www.colorkinetics.com/support/addressing/
- Connect SmartJack Pro to PC via USB
- Connect SmartJack Pro to Lexel LED DLM driver via DMX
- Connect Lexel LED DLM Module and driver
- Power driver
- Start QuickPlay Pro Software



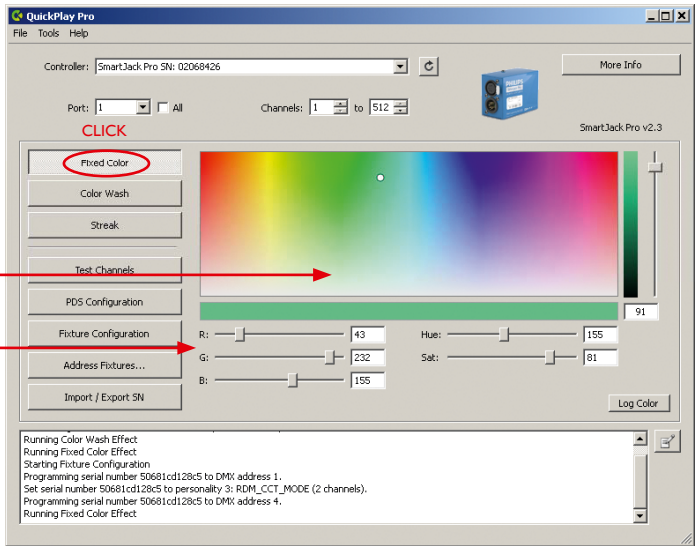
6.2.3 How to configure with SmartJack Pro II



6.2.4 How to configure with SmartJack Pro III



6.2.5 Lexel and SmartJack Pro, how to demonstrate



When Lexel LED DLM is in DMX RGB Mode:

- Just select color on your screen! CLICK
- Or change RGB, or Hue and Saturation

6.3 DMX Personalities

DMX Personalities															
DMX Address	Static			Dynamic											
	RGB	XY	CCT	RGB		CCT		XY		u'v'		Preset			
1	Red Output[1]	"x" Value Output2	CCT[4]	"0" to activate DMX personality		"1" to activate DMX personality		"2 to activate DMX personality		"3" to activate DMX personality		"4" to activate DMX personality			
2	Green Output[1]	"y" Value Output3	Relative Intensity1	Red Output[1]		CCT2 High Byte		x High Byte		u' High Byte		Preset ID (0-31)			
3	Blue Output[1]	Relative Intensity1	Not used	Green Output[1]		CCT2 High Byte		x Low Byte		u' Low Byte		Sync Counter			
4	Not used	Not used	Not used	Blue Output[1]		Not used		y High Byte		v' High Byte		Not used			
5	Not used	Not used	Not used	Not used		Not used		y Low Byte		v' High Byte		Not used			
6	Not used	Not used	Not used	Master Intensity[1]		Relative Intensity1		Relative Intensity[1]		Relative Intensity		Master Intensity			
7	Not used	Not used	Not used	Relative Intensity	Low Byte	Relative Intensity	Low Byte	Relative Intensity	Low Byte	Relative Intensity	Low Byte	Not used			
8	Not used	Not used	Not used	Fade Time	High Byte	Fade Time	High Byte	Fade Time	High Byte	Fade Time	High Byte	Not used			
9	Not used	Not used	Not used	Chroma-ticity	Low Byte	CCT Fade	Low Byte	Chroma-ticity	Low Byte	Chro-maticity	Low Byte	Not used			
10	Not used	Not used	Not used	Fade Time	High Byte	Time	High Byte	Fade Time	High Byte	Fade Time	High Byte	Not used			

[1] Please refer to the (DMX) Relative Intensity section for details on the relationship between Relative Intensity and the byte value

[2] x in the range from 0 to 0.8 in 255 steps, each step increases the value by 0.0032

[3] y in the range from 0 to 0.8 in 255 steps, each step increases the value by 0.0032

[4] Please refer to the (DMX) CCT section for details on the relationship between CCT and the byte value

6.4 Static DMX personalities

Refer to the DMX personalities table for the specific DMX byte assignment for each DMX personality.

a. RGB (3 DMX channels)

This DMX personality utilizes the most widely understood method of specifying chromaticity with LED-based luminaires, and is recommended for applications where both color and white chromaticity points (e.g., 2700K-6500K white, red, green, blue, cyan, magenta, yellow) are specified.

There are 3 channels of output created by the control device, one for each of R, G & B. The output is a value from 0-255 that represents the relative intensity of each color, with 0 being 'off' and 255 being 100% intensity.

In the example below, outputs A & B have the same chromaticity, but output B has twice the intensity compared to output A:

Dimming curve	RDM set value	Description
Philips_dimming_log	0	Logarithmic curve
Philips_dimming_linear	1	Linear curve
Philips_dimming_square	254	Square law curve (Factory Default) > Recommended Setting

Channel	Output A	Output B
R	50	100
G	50	100
B	100	200

TIP: If the RGB DMX personality is used to generate white points (i.e., specific CCT values), the RGB to CCT conversion values are required (refer to the RGB/CCT Conversion table). Please note, however that the accuracy of achieving the white point on the black body locus will be less accurate compared to using the CCT DMX personality.

b. XY (3 DMX channels)

This DMX personality enables the user to specify the (x,y) color coordinates color and intensity.

TIP: To ensure that color consistency is achieved from multiple Lexel LED DLM units, the specified xy points must be contained inside the color gamut as defined in the Color Gamut section.

There are 3 channels of output available for the DMX controller, one for the x coordinate, one for the y coordinate and one for intensity from 0% - 100%

c. CCT (2 DMX channels)

This DMX personality is recommended for applications where only white chromaticity points are specified.
There are 2 channels of output available for the DMX controller, one for CCT value within the range of 2700 K – 6500 K and the other for intensity from 0% - 100%.
The output is a value from 0-255 that represents a step along the blackbody locus within the range noted above plus a value from 0-255 that represents a relative intensity level between 0% and 100%.

6.5 Dynamic DMX personalities

The following dynamic DMX personalities are available.

a.	Dynamic RGB
b.	Dynamic CCT
c.	Dynamic xy
d.	Dynamic u'v'
e.	Dynamic Preset

(Refer to the DMX Personalities table for the specific DMX byte assignment for each DMX personality.)

6.6 There are 3 main benefits for the dynamic DMX personalities

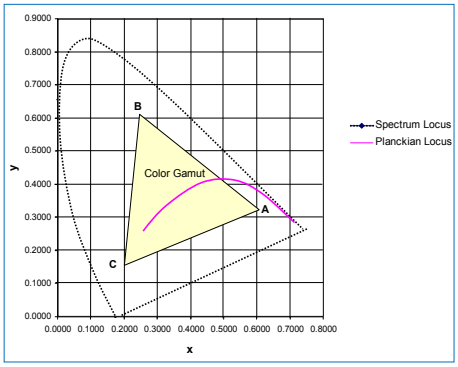
1. Flexibility – The user can program a DMX "scene" with different DMX inputs with minimal effort. (For example, one can achieve a rainbow wash comprising both saturated (RGB) colors and CCT white points along the blackbody curve by using the dynamic RGB and dynamic CCT DMX personality, by adjusting the 7 DMX offset bytes.)

2. Controllability – The user can control the "master" intensity level and the fade times without the use of sophisticated 3rd party DMX control software/hardware. (For example, one easily adjusts the master intensity level for multiple Lexel LED DLM units connected to the DMX network by adjusting the appropriate DMX byte values.)

3. Accuracy / Resolution – For the dynamic CCT, xy and u'v' DMX personalities, 2 bytes are used to control the desired color/white points compared to just 1 byte in the static DMX personalities.
Relative intensity

CCT (Kelvin)	Byte Value (0-255)	CCT (Kelvin)	Byte Value (0-255)
2700	217-255	4600	63
2700	216	4700	59
2800	203	4800	54
2900	191	4900	50
3000	179	5000	46
3100	169	5100	42
3200	159	5200	38
3300	149	5300	35
3400	140	5400	31
3500	132	5500	28
3600	124	5600	25
3700	116	5700	21
3800	109	5800	18
3900	102	5900	15
4000	96	6000	13
4100	90	6100	10
4200	84	6200	7
4300	79	6300	5
4400	73	6400	2
4500	68	6500	0

CCT table (and corresponding byte values)



Lexel LED DLM color gamut

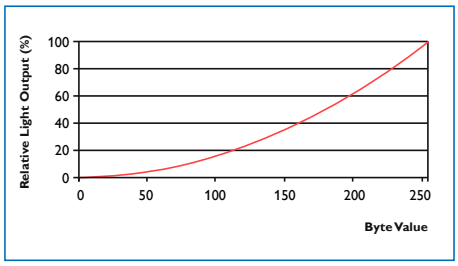
6.7 Relative intensity

The relative intensity produced by the Lexel LED DLM unit ranges from 0-100% in 255 steps, according to the "square law" dimming relationship; this is the factory default setting.

Relative Intensity (%) = (Byte value / 255)2

TIP: The dimming curve can be changed to logarithmic or linear via RDM. Please refer to the Remote Management Device (RDM) section.

The Dimming Curve diagram displays the dimming curve as a function of DMX byte value.



Dimming Curve

6.8 CCT

The CCT is defined in units of Kelvin and is calculated based on the following relationship: Byte Value = (1x106 / CCT) – 154

TIP: The minimum CCT that can be achieved is 2700 Kelvin. Therefore, for byte values of 217-255, the corresponding CCT will still be 2700 Kelvin.
The CCT table summarizes the relationship between CCT (from 2700 to 6500 Kelvin, in increments of 100) and the corresponding byte values.

6.9 Color gamut

The Color Gamut figure displays the unit gamut for the Lexel LED DLM, where unit gamut is defined as the area in the CIE Chromaticity diagram where we can guarantee colour consistency from unit to unit as per the product specifications.

It is important to note that chromaticities outside of the unit gamut can be achieved (e.g., in "RGB", "xy" and "u'v'" DMX personalities), but color consistency will not be guaranteed.

The region defined by the corner points (A, B, C) represents the boundaries of the Lexel LED DLM color gamut. The gamut corners for the Lexel LED DLM are:

A	A	B	B	C	C
X	Y	X	Y	X	Y
0.610	0.320	0.250	0.610	0.200	0.160

6.10 RGB / CCT conversion table

CCT	DMX Value (0-100%)			CCT	DMX Value (0-255)		
(Kelvin)	R	G	B	(Kelvin)	R	G	B
2700	100%	64%	22%	2700	255	164	55
2800	100%	66%	24%	2800	255	168	61
2900	100%	68%	26%	2900	255	173	66
3000	100%	69%	28%	3000	255	177	72
3100	100%	71%	30%	3100	255	182	77
3200	100%	73%	33%	3200	255	186	83
3300	100%	74%	35%	3300	255	189	89
3400	100%	76%	37%	3400	255	193	95
3500	100%	77%	39%	3500	255	197	100
3600	100%	78%	42%	3600	255	200	106
3700	100%	80%	44%	3700	255	203	112
3800	100%	81%	46%	3800	255	206	118
3900	100%	82%	49%	3900	255	209	124
4000	100%	83%	51%	4000	255	212	130
4100	100%	84%	53%	4100	255	214	135
4200	100%	85%	55%	4200	255	217	141
4300	100%	86%	58%	4300	255	219	147
4400	100%	87%	60%	4400	255	222	152
4500	100%	88%	62%	4500	255	224	158
4600	100%	89%	64%	4600	255	226	163
4700	100%	89%	66%	4700	255	228	169
4800	100%	90%	68%	4800	255	230	174
4900	100%	91%	71%	4900	255	232	180
5000	100%	92%	73%	5000	255	234	185
5100	100%	93%	75%	5100	255	236	190
5200	100%	93%	76%	5200	255	238	195
5300	100%	94%	78%	5300	255	239	200
5400	100%	95%	80%	5400	255	241	205
5500	100%	95%	82%	5500	255	242	210
5600	100%	96%	84%	5600	255	244	215
5700	100%	96%	86%	5700	255	245	220
5800	100%	97%	88%	5800	255	247	224
5900	100%	97%	90%	5900	255	248	229
6000	100%	98%	92%	6000	255	249	234
6100	100%	98%	93%	6100	255	250	238
6200	100%	99%	95%	6200	255	252	242
6300	100%	99%	97%	6300	255	253	247
6400	100%	100%	98%	6400	255	254	251
6500	100%	100%	100%	6500	255	255	255

6.11 Remote Device Management (RDM)

RDM is currently an open standard in development. This is an enhancement to USITT DMX512 for configuration, status monitoring, and the management of DMX512–based systems. This standard was developed by the ESTA Technical Standards Program and is designed for interoperability between a number of manufacturers. The Lexel LED DLM system is RDM Compliant. Please see reference ii for further details. RDM is mainly used in commissioning and service operations, whereas DMX512 is mainly used as the controlling protocol.

The RDM Utility of the Lexel OEM Tool Kit software can be used to retrieve and modify properties for a single Lexel LED DLM system.

You must have administrator rights on your PC, in order to connect to Lexel LED DLM devices while using this software.

6.12 Supported RDM parameters

RDM Parameter IDs	Value	Description
Category – Network Management		
DISC_UNIQUE_BRANCH	0x0001	Discover Unique Branch - used for the device discovery process
DISC_MUTE	0x0002	SET parameter > a responder port shall set its Mute flag when it receives this message containing its UID1, or a broadcast address
DISC_UN_MUTE	0x0003	SET parameter > a responder port shall clear its Mute flag when it receives this message containing its UID1, or a broadcast address
COMMS_STATUS	0x0015	GET parameter > Network Management Process - used to collect information that may be useful in analyzing the integrity of the communication system
Category – Status Collection		
QUEUED_MESSAGE	0x0020	GET parameter used to retrieve a message from the responder's message queue
STATUS_MESSAGES	0x0030	GET parameter used to collect Status or Error information from a device
STATUS_ID_DESCRIPTION	0x0031	GET parameter used to request an ASCII text description of a given Status ID, the description may be up to 32 characters
CLEAR_STATUS_ID	0x0032	SET parameter used to clear the status message queue
Category – RDM Information		
SUPPORTED_PARAMETERS	0x0050	GET parameter used to retrieve a packed list of supported PIDs2
PARAMETER_DESCRIPTION	0x0051	GET parameter used to retrieve the definition of some manufacturer-specific PIDs2
Category – Product Information		
DEVICE_INFO	0x0060	GET parameter used to retrieve a variety of information about the device that is normally required by a controller
PRODUCT_DETAIL_ID_LIST	0x0070	GET parameter used for requesting technology details for a device, the response is a packed message containing up to six product detail identifications
DEVICE_MODEL_DESCRIPTION	0x0080	GET parameter provides a text description of up to 32 characters for the device model type
MANUFACTURER_LABEL	0x0081	GET parameter provides an ASCII text response with the manufacturer name for the device of up to 32 characters
DEVICE_LABEL	0x0082	GET/SET parameter provides a means of setting a descriptive label for each device
FACTORY_DEFAULTS (Not currently available)	0x0090	GET/SET parameter used to instruct a device to revert to its Factory Default user settings or configuration as determined by the manufacturer
SOFTWARE_VERSION_LABEL	0x00C0	GET parameter used to get a descriptive ASCII text label for the device's operating software version
BOOT_SOFTWARE_VERSION_ID	0x00C1	GET parameter used to retrieve the unique Boot Software Version ID for the device, the Boot Software Version ID is a 32-bit value determined by the manufacturer
BOOT_SOFTWARE_VERSION_ LABEL	0x00C2	GET parameter used to get a descriptive ASCII text label for the Boot Version of the software for devices that support this functionality
LAMP_FW_VERSION_ID	0xAF04	GET parameter used to retrieve the unique Boot Software Version ID for the device, the Boot Software Version ID is a 32-bit value determined by the manufacturer
LAMP_FW_LABEL	0XAF05	GET parameter used to get a descriptive ASCII text label for the Boot Version of the software for devices that support this functionality
LAMP_BOOT_FW_VERSION_ID	0xAF06	GET parameter used to retrieve the unique Boot Software Version ID for the device, the Boot Software Version ID is a 32-bit value determined by the manufacturer
LAMP_BOOT_FW_LABEL	0xAF07	GET parameter used to get a descriptive ASCII text label for the Boot Version of the software for devices that support this functionality

RDM Parameter IDs	Value	Description
Category – DMX512 Setup		
DMX_PERSONALITY	0x00E0	GET/SET parameter used to set the responder's DMX512 Personality (please refer to the DMX-RDM Personality section for further details)
DMX_PERSONALITY_DESCRIPTION	0x00E1	GET parameter used to get a descriptive ASCII text label for a given DMX512 Personality
DMX_START_ADDRESS	0x00F0	GET/SET parameter used to set or get the DMX512 start address
SLOT_INFO	0x0120	GET parameter used to retrieve basic information about the functionality of the DMX512 slots used to control the device
SLOT_DESCRIPTION	0x0121	GET parameter used for requesting an ASCII text description for DMX512 slot offsets
DEFAULT_SLOT_VALUE	0x0122	GET parameter used for requesting the default values for the given DMX512 slot offsets for a device
Category Sensors		
SENSOR_DEFINITION	0x0200	GET parameter used to retrieve the definition of a specific sensor
SENSOR_VALUE	0x0201	GET/SET parameter used to retrieve or reset sensor data
RECORD_SENSORS	0x0202	SET parameter instructs devices such as dimming racks that monitor load changes to store the current value for monitoring sensor changes
Category – Power/Lamp Settings		
DEVICE_HOURS	0x0400	GET/SET parameter used to retrieve or set the number of hours of operation the device has been in use
LAMP_HOURS	0x0401	GET/SET parameter used to retrieve the number of lamp hours or to set the counter in the device to a specific starting value
LAMP_STATE	0x0403	GET/SET parameter used to retrieve or change the current operating state of the lamp
DEVICE_POWER_CYCLES	0x0405	GET/SET parameter used to retrieve or set the number of Power-up cycles for the device
Category – Control		
IDENTIFY_DEVICE	0x1000	GET/SET parameter used for the user to physically identify the device represented by the UID1
RESET_DEVICE	0x1001	SET parameter used to instruct the responder to reset itself
POWER_STATE	0x1010	GET/SET parameter used to retrieve or change the current device Power State

The following Parameter IDs are specific to the Lexel architecture and shall be implemented in the profiles as specified in below.

LEXEL Parameter IDs	Value	Description
Category – Dynamic Parameters		
DIMMING_CURVE	0xAF00	GET/SET parameter used to define the Dimming Curve to be used by the LED Module
MINIMUM_TRANSITION_TIME	0xAF01	GET/SET parameter used to define the minimum time that the LED Module will take to perform a chromaticity or intensity transition between two consecutive Null mode frames

1) Responders and Controllers identify themselves with a 48-bit Unique ID (UID). The Unique ID (UID) consists of a 16-bit ESTA assigned Manufacturer ID with a 32-bit Device ID
2) The Parameter ID is a 16-bit number that identifies a specific type of Parameter Data

6.13 DMX-RDM personality

The factory default DMX personality for the Lexel LED DLM is CCT. The table below summarizes the available DMX personalities and the corresponding RDM Set Values:

DMX Personality	RDM Set Value
RGB	1
xy	2
CCT (Factory Default)	3
Dynamic RGB	4
Dynamic CCT	5
Dynamic xy	6
Dynamic u'v'	7
Dynamic Preset	8

6.14 RDM dimming curve

The factory default setting is the square law dimming curve.

It is strongly recommended that the dimming curve be kept at the default factory setting, because the "square law" matches very closely with the human response.

The following table summarizes the available options:

Dimming curve	RDM set value	Description
PHILIPS_DIMMING_LOG	0	Logarithmic curve
PHILIPS_DIMMING_LINEAR	1	Linear curve
PHILIPS_DIMMING_SQUARE	254	Square law curve (Factory Default) > Recommended Setting

6.15 DALI

The DALI option is only available for the European version of the LED Driver. It is not available for the North American version.

The Digital Addressable Lighting Interface (DALI) is a digital protocol for controlling of lighting components, such as electronic ballasts and dimmers, in buildings. This allows DALI-compatible devices to communicate with other DALI-compatible devices, such as controllers, sensors and ballasts.

DALI was established as a successor for the still market dominating 1-10 v, and an open standard rival to Digital Signal Interface (DSI) on which it is based. DALI is standardized in accordance with IEC 60929 standard for fluorescent lamp ballasts.

Fundamental system aspects are:

- 64 addresses for 'Load Interface Units' (i.e., dimmers, switches, ballasts)
- Maximum 16 groups
- Maximum 16 scenes; scene levels are programmed in the Load Interface Unit (LIU)
- 256 lamp output levels (8 bit) with logarithmic level regulation
- Light level range 0.1% to 100%
- A range of user interfaces are possible, such as buttons, rotary knobs, switches and sensors including IR sensors and daylight sensors

Standard DALI data can mainly be divided into three types:

- Configuration commands (e.g., address, min/max. level, fade rate, scene levels)
- Control commands (e.g., up/down light level, on/off, store/recall scene, query lamp failure)
- Device response to query commands (e.g., device responds with yes/no, device type)

The advantages of a DALI system are:

- Scene levels can be stored
- Light control configurations can be changed without rewiring
- Bidirectional data transfer allows devices to respond to query commands
- Advanced control possibilities include maintenance and energy-savings
- User-friendly operation
- Reliable compatibility through use of standard commands (standardization of commands IEC929)

Data protocol:

- Frame 11 bits
- Data frame starts with one 0 bits
- Data 8 bits
- Data frame stops with two 1 bits
- 416.67 µs/bit 2400 baud/s
- Manchester Bi-Phase coding

DALI Version:

The DALI interface is compliant to the Draft IEC62386 (COMEX TC 34C). The following parts have been implemented. Please refer to reference vi for further details.

a. Part 102: General requirements

b. Part 207: Particular requirements for control gears; LED modules (device type 6)

c. Part 209: Particular requirements for control gears; colour control (device type 8)

7. Lighting installations and the environment

7.1 Electromagnetic compatibility

Electromagnetic compatibility, EMC, is the ability of a device or system to operate satisfactorily in its electromagnetic environment without causing unacceptable interference in practical situations. Philips Lexel LED DLM systems fulfill the requirements with regard to electromagnetic compatibility as laid down in European Norms EN 55015, EN 61000-3-2 and EN 61547. The Philips Lexel LED DLM system enables the OEM to build a FFC Part 15 Class A Luminaire.

7.2 Ingress protection

Lexel LED DLM modules and LED drivers have no IP classification. The luminaire manufacturer is responsible for proper IP classification and approbation of the luminaire.

7.3 Exposure to direct sunlight

Exposure to direct sunlight during operation may have severe temperature or UV effects. Where this situation is likely, extensive temperature testing is recommended. The Lexel LED DLM system is a build-in system, so this is expected to be negligible.

7.4 Vibration and shocks

Shock: 20 g, 6 ms, sinusoidal, +/- 3 pulses in each orthogonal direction.
Vibration: 5-2000 Hz, 5grams, 1 hour each orthogonal direction without failure.

7.5 Standards and approvals

Philips Lexel LED DLM systems comply with the following international rules and regulations, including:

Safety	EN/IEC 60598-1 & 2-2, EN 61347-1, 2-13, EN/IEC 62031
EMC	EN 61547, EN 61000-3-2, EN 55015
Approvals	ENEC 05, CE, UL 8750, CSA C22.2 No. 250.0

7.6 Glow-wire test

Philips Lexel LED DLM systems conform to the 960 degree glow-wire test. Reference test: according to additional national deviations for clause 13.3 (Annex 2c of EN 60598-1). An exception is made for France, where local regulations are stricter.

7.7 End-of-life behavior

Unlike typical conventional light sources, LEDs are not subject to sudden failure or burnout. There is no time at which the light source will cease to function. Instead, the performance of LEDs shows gradual degradation over time. When used according to specification, Lexel LED DLM modules are predicted to deliver an average of 70% of their initial intensity after 50,000 hours' operation. The life of the system is therefore more dependent on the other electronic system components and soldering methods.

The LED's in the Lexel LED DLM module are arranged in multiple strings where each string is connected in series. If one LED fails, this may be due to an internal short-circuit (a character of blue LEDs). In this case it will still conduct current, so that the other LEDs will still operate.

7.8 Lexel LED DLM system disposal

At the end of their (economic) lifetime, appropriate disposal of the Lexel LED DLM and its components is recommended. The modules are basically normal pieces of electronic equipment containing components that at present are not considered to be harmful to the environment and that can be disposed of with normal care. It is therefore recommended to dispose of these parts as normal electronic waste, according to local regulations.

8. Appendix

8.1 References

i) Document: ANSI E1.11-2004 USITT DMX512-A (A synchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories)

ii) Document: ANSI E1.20-2006 ((RDM) Remote Device Management over DMX512 networks)

iii) Document: DMX512 (Recommended Practice for DMX512 – A Guide for Users and Installers, by Adam Bennette)

iv) Document: ESTA CP/2000-1024 (DMX512 Over Category 5 Cable -Task Group Report –Summary)

v) Document: Philips Lighting 910-0114 (Software Requirements Specification for DMX512 Protocol Conversion)

vi) Document: Philips Lighting 910-0115 (Software Requirements Specification for DALI Protocol Conversion (MIB))

vii) Document: Philips Lighting 910-0171 (SRS for Remote Device Management (RDM) Over DMX512 Networks)

viii) Document: Philips Lighting 910-0172 (Lexel OEM Tool Kit Software User Manual)

8.2 Acronyms

CCT	Correlated Color Temperature	LCC	Limited Current Circuit
DALI	Digital Addressable Lighting Interface	LED	Light Emitting Diode
DLM	Downlight Module	MIB	Multi-Interface Board
DMX	Digital Multiplexing	OEM	Original Equipment Manufacturer
ESD	Electrostatic Discharge	PSU	Power Supply Unit
ESTA	Entertainment Services & Technology Assoc	RDM	Remote Device Management
iMIB	Integrated Multi-Interface Board	RP	Reflash in Place
IEC	International Electrotechnical Commission	SELV	Safety Extra Low Voltage
IES	Illuminating Engineering Society	USITT	United States Institute for Theatre Technology

8.3 Index of Visuals

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