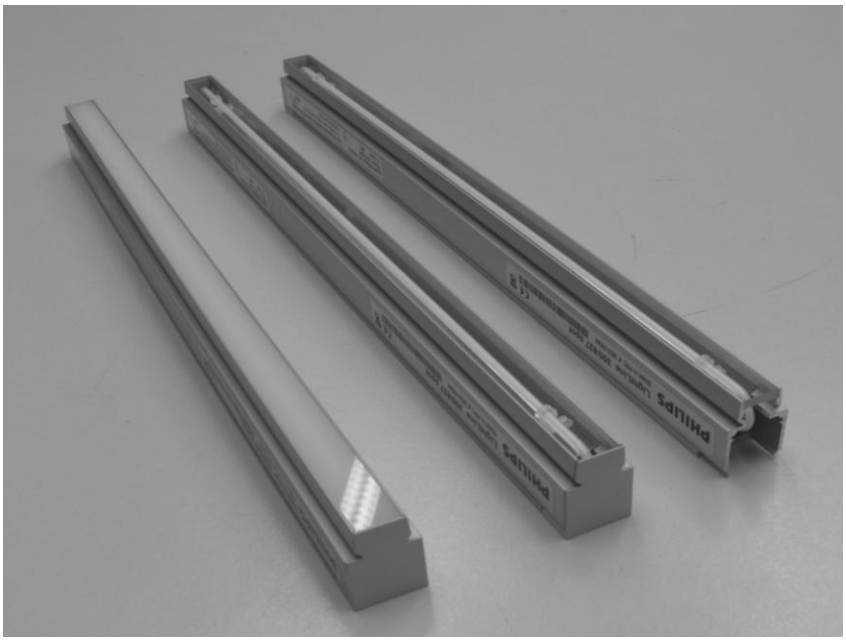
Philips LightLines

Technical Application Guide



To the reader

This publication is based on the available product range and is intended for support to all parties in the lighting industry (e.g. architects, creative designers, specifiers, original equipment makers of luminaires (OEM), installers and wholesalers) with information about applications with LightLines and how to install those.

Please give your feedback, questions and remarks to:

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Philips LightLines

Technical Application Guide

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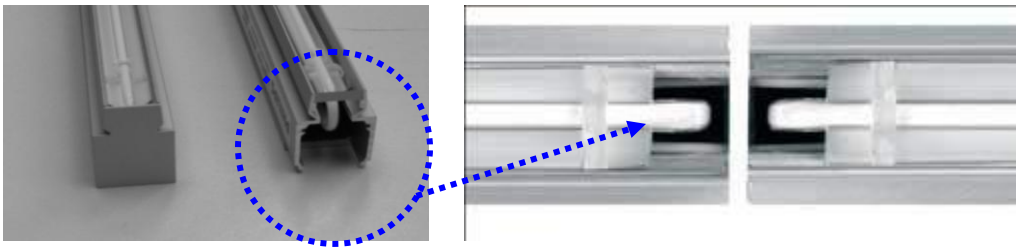
1 : General information on Philips LightLines

1.1 Introduction

The LightLine consists of a slim aluminum profile containing a cold cathode fluorescent lamp (CCFL) is mounted, together with a ballast (inverter). The lamp, electronics and profile are preset (balanced) by the manufacturer.
The lamp has two bent ends for a uniform light output over the length of the LightLine, to enable a continuous line of light when one or more of LightLines are linked in a straight line.

1.2 Features of LightLines

- Uniform light output and luminance over the total length of the LightLine.
  As a result of the bent lamp inside the profile.



- Small dimensions, low built-in depth.
  The very small 2.8 mm diameter of the lamp and the compact design of the inverter result in very slim dimensions of the LightLine. The width of the LightLine is 17 mm, whereas the built-in depth is not more than 25 mm.
- Warm and cool light colors with fluorescent lamps.
  A choice of 2700 K incandescent and 4000 K cool white light.
- A Flood version (wide beam, frosted cover) with a luminance of 2.0 cd/cm^2 and a Spot version (narrow beam, clear cover) with a beam width of 50 degrees.
- Ultra-long lifetime.
  The lifetime of the cold cathode lamp is independent of emitter coatings as with TL-D and TL5 lamps, which makes long lifetimes over 50.000 hours possible.
- Low heat emission.
  As a result of the high efficient fluorescent lamp and inverter the heat emission is very low.
- Low-voltage power supply.

1.3 Benefits of LightLines

- LightLines can be linked to make a **continuous line of light without dark patches.**
- Can be used in **narrow and low spaces**, due to the compact dimensions, low built-in depth and low heat emission.
- Always the same **white light: consistent impression over profile length**, between individual profiles and over lifetime.
- **Stable and good color rendering** over lifetime.
- Easy ‘click and go’ installation.
- Low-voltage power supply allows operation on emergency batteries.

1.4 Applications with LightLines

1.4.1 Architectural lighting (historical buildings, museums)

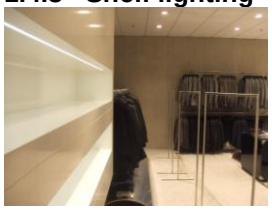


1.4.2 Accentuate shapes and details, e.g. of coves and cabinets (without dark patches)





1.4.3 Shelf lighting




1.4.4 Escape route indication of emergency lighting

1.5 Working principle

The lamp inside the LightLine is a cold cathode fluorescent lamp (CCFL). The tubular lamp works on the low mercury discharge principle (just like TL-D and TL5).
The discharge tube has an electrode sealed into each end and is filled with an inert gas and a low amount of mercury, the latter being present in both liquid and vapor states.
The inner wall of the tube is coated with a mixture of fluorescent powders. These convert the ultraviolet radiation of the mercury discharge into visible radiation (light).
Two different fluorescent powders are available which produce either a warm or cool color temperature with a high efficacy compared with other light sources producing white light. Just like all low pressure mercury lamps the T1 lamp inside the LightLine need a current limiter or inverter which is built-in in the housing made of aluminum.

1.6 Nomenclature

The name of the lamp family is:

TL fluorescent lamps

The technical name of the product is:

LightLine

Example:

LightLine 300/827 Spot	*300*	LightLine with length of 300 mm
	827	$R_a > 80$, T_c of 2700 K
	Spot	clear cover, narrow beam
LightLine 500/840 Flood	*500*	LightLine with length of 500 mm
	840	$R_a > 80$, T_c of 4000 K
	Flood	frosted cover, wide beam
LightLine 700/840 Flood	*700*	LightLine with length of 700 mm
	840	$R_a > 80$, T_c of 4000 K
	Flood	frosted cover, wide beam

1.7 System

The LightLine system consists of

- one or more LightLines
- connecting cables
- mechanical connectors to link the profiles in case of a continuous line
- mounting brackets
- one or more low-voltage power supplies

1.8 Logistics and packaging

The LightLine packaging consists of

- 5 LightLines
- 5 length specific cable harnesses
- 5 mechanical connectors to link the profiles in case of a continuous line
- 10 mounting brackets

1.9 Environmental aspects

LightLines are RoHS compliant and are covered by WEEE.

2. Installation design with LightLines

2.1 Systems with LightLines

A LightLine system consists of one or more LightLine profiles, cable harnesses for electrical connection, linking devices for mechanical connection of the profiles in case of a continuous line, mounting brackets to fix the LightLines on a surface, and one or more low-voltage power supplies. The LightLines are supplied complete with cable harnesses, mechanical connectors and mounting brackets.

2.1.1 Power supplies

For proper operation of the LightLines custom made power supplies are available.
In order to assure that installations with LightLines are in line with regulations regarding system conformity, safety, harmonic distortion and EMC (EN 61000, EN55015, EN60950, EN55022/55024, CISPR22, CNS13438 (C6357), EN 61347, EN 61558 and EN 61547 respectively), it is strongly recommended to use dedicated power supplies for LightLines as supplied by Philips (see table 1 and Chapter 4: *Technical specifications of Philips Power Units for LightLines*).

In order to avoid overload of the power supplies and to secure correct operation, please find in table 1 the minimum and maximum number of LightLines that can be connected to the power supplies as supplied by Philips

	minimum load	maximum load 80% x Pnom
Slim Size Power Supply 24 V DC 35 W Type nr: SSLL 24 DC / 35 , SSLL 25 DC / 35	1*300mm 1*500mm 1*700mm	5 * 300mm. 3 * 500mm. 2 * 700mm.
Normal Size Power supply 24 V DC 90 W Type nr: NSLL 24 DC / 90	1*300mm 1*500mm 1*700mm	14 * 300mm 9 * 500mm 7 * 700mm

Table1: Number of LightLines that can be connected Philips power supplies for LightLines

If different 24 V DC power supplies are used, the installer must take care that

- the total system (LightLines + power unit) are in line with regulations for system conformity, harmonic distortion and EMC (EN61000, EN55015, EN 61347, EN 61558 and EN 61547 respectively).
- the input voltage of the LightLine(s) is in line with specifications as written in chapter 3: *Technical specifications of Philips LightLines*

2.1.2 Wiring diagram and cable harnesses

For a wiring diagram of a LightLine system, see figure 1

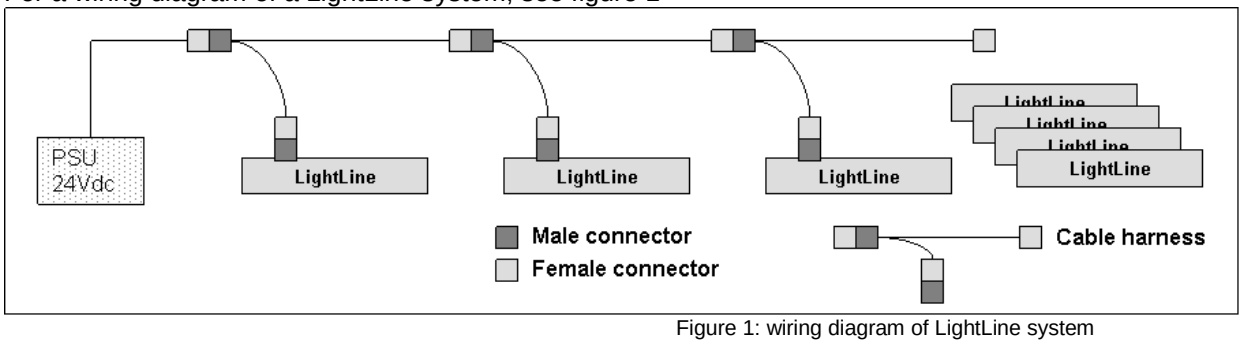


Figure 1: wiring diagram of LightLine system

For correct electrical connection the cable harnesses, LightLines and power supplies are equipped with so-called Fast-Fit connectors.
The cable harnesses are designed to enable looping the LightLines to numbers up till the maximum (recommended) load of the power supplies as supplied by Philips (see above) while keeping the input voltages of the individual LightLines within the tolerance of 24 V DC +/- 1.0 V. Connecting more LightLines to one power supply will result in a high voltage drop and consequently will result in poor functioning of the LightLines (see also 2.1.5: P*ower supply on distance).*

2.1.3 Linking devices for mechanical connection.

For making a continuous line with the LightLines, coupling devices are added to the packaging.

Figure 2: linking devices for LightLines

2.1.4 Mounting brackets for fixing the LightLines on a surface.

For fixing the LightLines on a surface, mounting brackets are added to the packaging. For creating a straight continuous line and to avoid unwanted curves and bends, it is important to mount the LightLines on a flat surface.

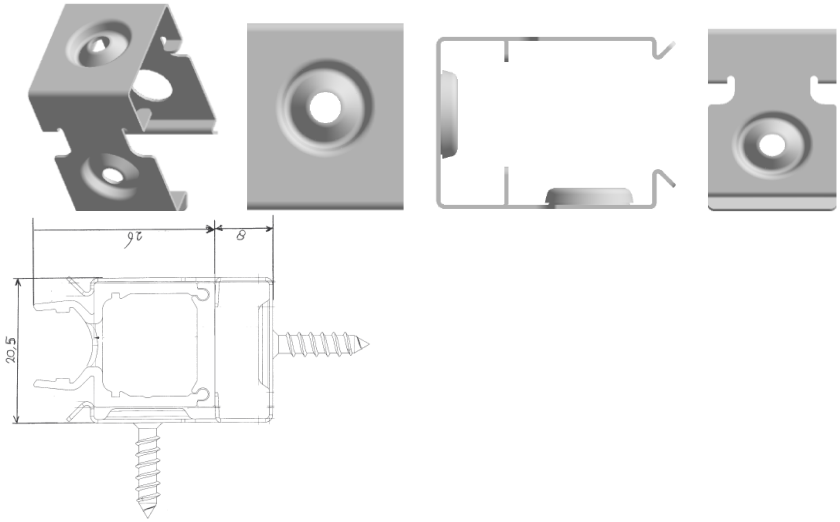


Figure 3: mounting brackets for LightLines

2.1.5 Power supply on distance.

If the power supply is not situated near the LightLines and a connecting power cable is installed between the power unit and the LightLines, the output voltage of the power supply must be adjusted so that the input voltage of the LightLines is within the tolerance of 24V DC +/- 1.0 V. (See also chapter 3: *Technical specifications of Philips LightLines*
Please find in following table 2 an indication of the voltage drop of connecting cables with different diameter, depending on the supply current.
Please keep in mind that values as given in the table are for indication only. No rights can be reserved from the contents of table 2

	Voltage drop per meter (V)					
	cable characteristics					
current (A)	0.5 mm² 40 Ω/km	0.75 mm² 25 Ω/km	1.0 mm² 20 Ω/km	1.5 mm² 14 Ω/km	2.5 mm² 8 Ω/km	4.0 mm² 5 Ω/km
0.2	0.016	0.010	0.008	0.006	0.003	0.002
0.5	0.040	0.025	0.020	0.014	0.008	0.005
1.0	0.080	0.050	0.040	0.028	0.016	0.010
2.0	0.160	0.100	0.080	0.056	0.032	0.020
3.0	0.240	0.150	0.120	0.084	0.048	0.030
4.0	0.320	0.200	0.160	0.112	0.064	0.040
5.0	0.400	0.250	0.200	0.140	0.080	0.050

Nominal input currents and voltages		
300mm LightLine	0.210 A	24 V DC +/- 1.0 V
500mm LightLine	0.310 A	24 V DC +/- 1.0 V
700mm LightLine	0.420 A	24 V DC +/- 1.0 V

Table 2: indication of the voltage drop with cables of different diameter

It is also possible to use a power unit which is provided with a so-called SENSE-output, which is able to compensate the voltage drop due to the cable length, to ensure the correct nominal value at the end of the cable.

2.2 Operation conditions

2.2.1 Humidity

The LightLine is only suitable for use according to IP40 conditions (or lower). For operation in humid conditions it is recommended to enclose the LightLines to meet required IP protection.

2.2.2 Ambient temperatures

The light output of LightLines is dependent on the ambient temperature and reaches maximum value at $T_{ambient}$ = 25 ^{0}C. LightLines are specified for operation between 10 ^{0}C and 55 ^{0}C.

2.2.3 Effect of low ambient temperatures on lifetime.

For proper operation of the LightLines and reaching the specified lifetime, the ambient temperature during stable operation should be higher than 10 ^{0}C. A cold air flow around the profiles should be avoided.
When operating the LightLines in ambient conditions below 10 ^{0}C it is recommended to enclose them to enable it to heat up to a temperature higher than 10 ^{0}C during stable operation. In those conditions the period when heating up the ambient from cold ignition to above 10 ^{0}C will influence the lifetime of the LightLines negatively. For an indication see table 3.

Example:
If the LightLine is operated with a 10-hours switching frequency in an ambient of 0 ^{0}C, and enclosed to heat up itself after ignition to above 10 ^{0}C during stable operation, the expected lifetime will be 50% of the rated value (for lifetime performance, see 3.5).

Notes:

- This negative influence is only valid for the periods or seasons that the LightLine is operated in these cold conditions.
- If the LightLine is operated continuously in this ambient condition, there is no negative influence, as long as the ambient temperature during operation is above 10 ^{0}C.

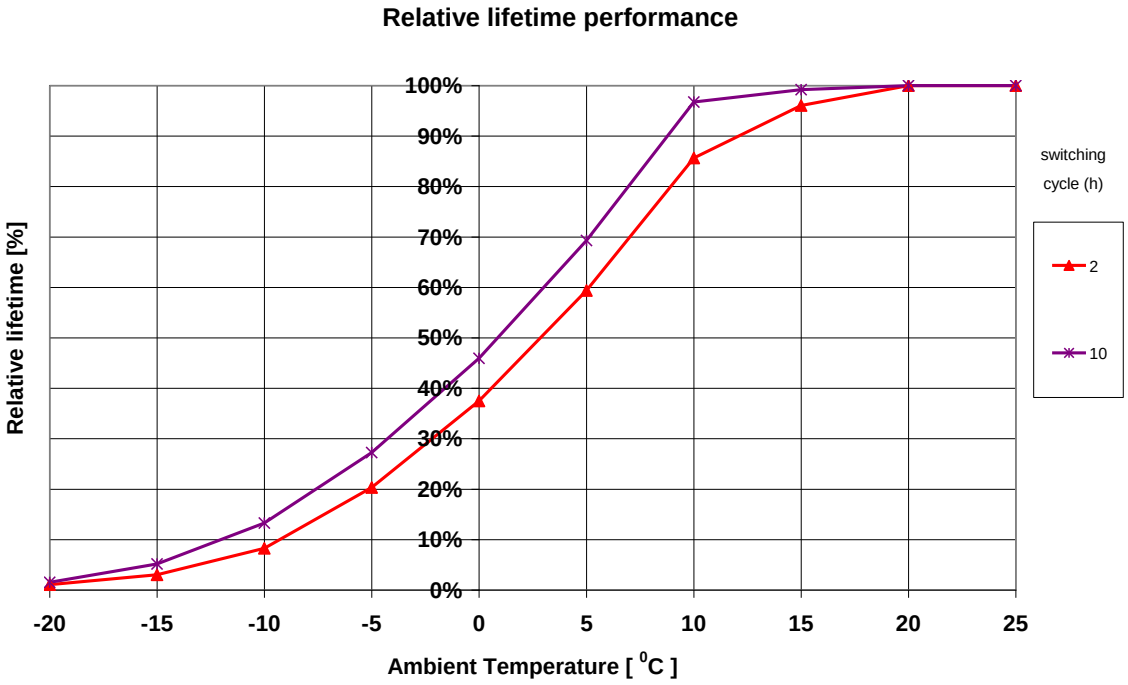


Table 3: dependency of lifetime on ambient temperature

2.2.4 High ambient temperatures.

The electronic components of the inverter inside the LightLine do not allow operating at high temperatures. For proper functioning of the LightLine and secure the rated lifetime, the maximum ambient temperature is T_{max}= 55 ^{0}C. In relation with this, the maximum case temperature T_{Cmax} of 65 ^{0}C should not be exceeded.

2.3 UV radiation.

Fluorescent lamps radiate a very low amount of UV radiation. So this is no issue regarding effects on human eyes and skin.
Another effect of UV radiation is the risk of color fading of the illuminated goods or objects. This fading is dependent on the emitted UV by the source, the illumination level and the materials used in the illuminated object. For LightLines with CCFL lamps the UV damage is generally no issue, due to very low UV radiation. See table 4 for specific values regarding UV radiation and 'D_{fc}'

Color	UV-A µW/lm	UV-B µW/lm	UV-C µW/lm	UV total µW/lm	D_{fc}	PET* klux·h
827	58,1	15,5	0	73,6	0,20	30
840	38,1	6,0	0	44,1	0,19	72

Table 4: specific values for LightLines regarding UV radiation and D_{fc}

Notes:

- The characteristic permissible exposure time (PET*) for a light source is defined as the PET value at an illumination level of 1000 lx.
  PET*= PET x E_{vis}
  E_{vis}= illuminance level
- D_{fc}: damage factor of the light source

2.4 Electrical Interference.

To avoid electrical interference between LightLines and ambient equipment, keep the LightLines away as far as possible from power cables and electrical equipment.

2.5 Safety

When designing an installation with LightLines, the designer should take care that the total system (LightLines + power unit + cables) are in line with regulations for system conformity, harmonic distortion and EMC (EN 61347, EN 61558 and EN 61547 respectively).

3 : Technical specifications of Philips LightLines

3.1 Range

The LightLine range consist of

Commercial name	EOC		Commercial name	EOC
LightLine 300/827 spot	871150026819801		LightLine 300/827 flood	871150026835801
LightLine 300/840 spot	871150026829701		LightLine 300/840 flood	871150026841901
LightLine 500/827 spot	871150026823501		LightLine 500/827 flood	871150026843301
LightLine 500/840 spot	871150026831001		LightLine 500/840 flood	871150026845701
LightLine 700/827 spot	871150026825901		LightLine 700/827 flood	871150026847101
LightLine 700/840 spot	871150026833401		LightLine 700/840 flood	871150026849501

3.2 Dimensions

For dimensions and tolerances of the LightLines, see below figure 4

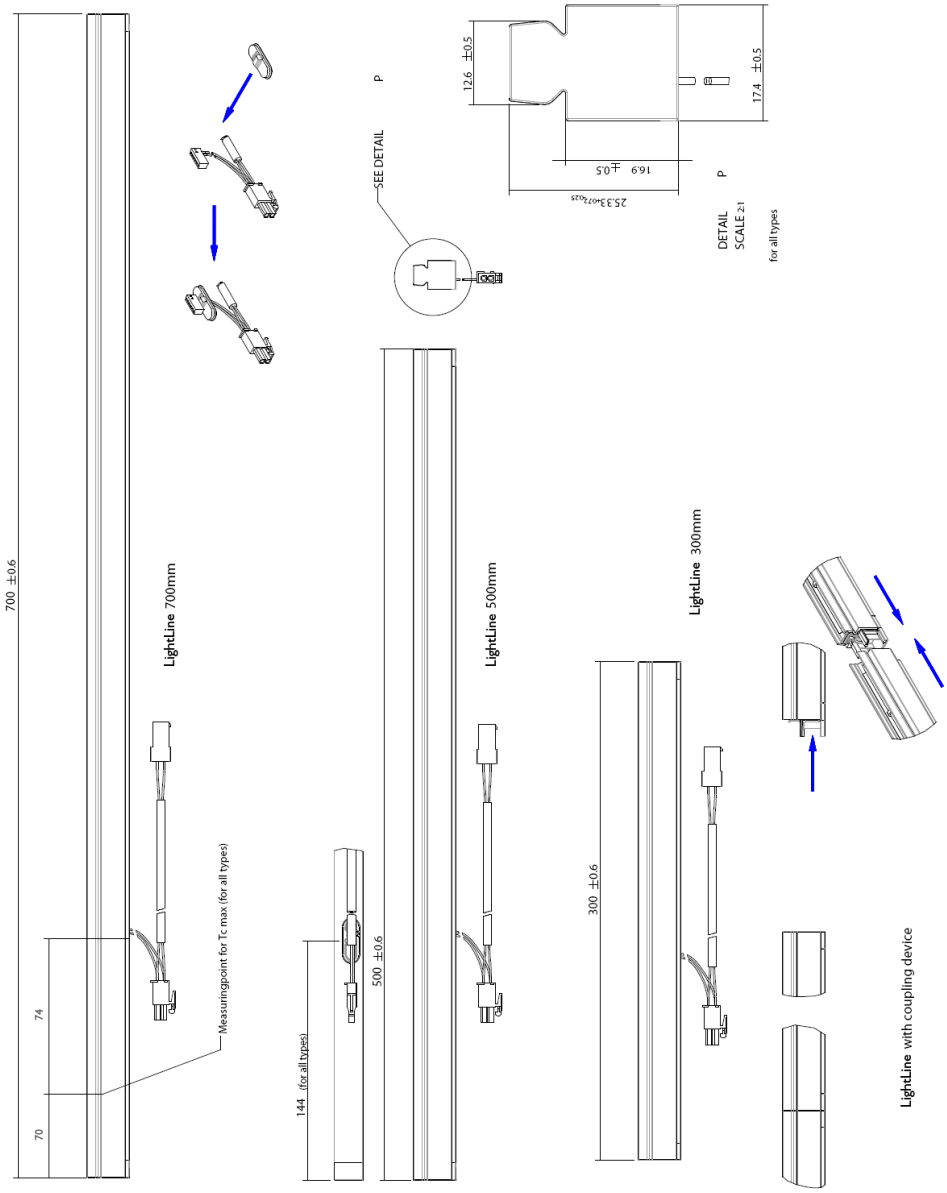


Figure 4: dimensions of LightLines

3.3 Light technical characteristics

3.3.1 Luminous flux, luminance and beam width

naming	length (mm)	Luminous flux (lm)	average luminance (cd/cm ^{2})	beam width (degrees)
LightLine 300/827 Spot LightLine 300/840 Spot	300	160	2.5	50
LightLine 500/827 Spot LightLine 500/840 Spot	500	280	2.5	50
LightLine 700/827 Spot LightLine 700/840 Spot	700	410	2.5	50
LightLine 300/827 Flood LightLine 300/840 Flood	300	160	2.0	100
LightLine 500/827 Flood LightLine 500/840 Flood	500	280	2.0	100
LightLine 700/827 Flood LightLine 700/840 Flood	700	410	2.0	100

Table 5: light technical characteristics of LightLines

3.3.2 Color characteristics

	Color Rendering Index ($R_{a)}$	Correlated color temperature	Chromaticity coordinates
/827	83	2700 K incandescent white	x: 0.466 y: 0.416
/840	87	4000 K cool white	x: 0.380 y: 0.380

Table 6: color characteristics of LightLines

3.3.3 Spectral power distributions

The normalized spectral power distribution of LightLines is given in following diagrams. For an indication on the UV radiation, see chapter 2.

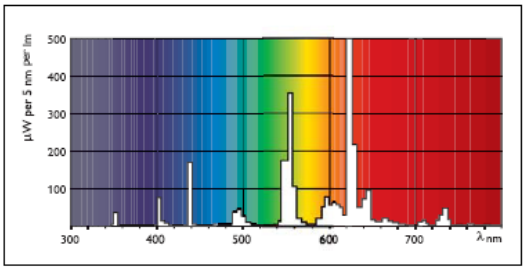


Figure 5: Spectral power distribution color /827

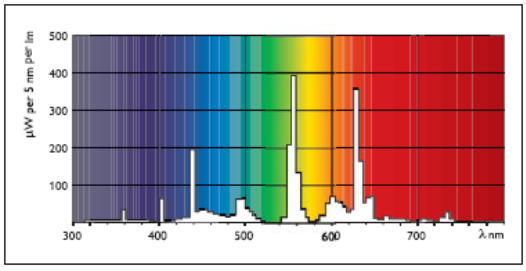


Figure 6: Spectral power distribution color /840

3.4 Electrical characteristics

For proper operation of the LightLines, see table 6 for electrical input requirements.

	Specifications
input Transient Response (%).	± 4%
Input voltage (V DC)	24±1
load voltage ripple (mVpp)	< 300
ripple and noise requirement (mV)	< 150
line regulation (%)	< ± 2
load regulation (%)	< ± 5
turn on delay time (ms)	< 3000
rise time (ms)	< 50
hold-up time (ms)	5
rise time @ full load (ms)	<50

Table 6: input requirements for LightLines

3.5 Lifetime performance

The lifetime of LightLines is defined as the point at which the lumen output falls below 70% of its initial value. Technically the lifetime will be longer and will reach values above 100.000 hours, but with lumen output slowly decreasing to values below 70% of initial.

lifetime (h)	Survivals (%)	Lumen maintenance (%)
50.000	99	70
75.000	90	-
100.000	80	-

Table 7: lifetime performance of LightLines

3.6 Certification.

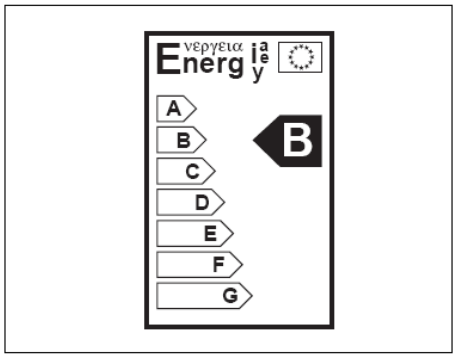
LightLines are CE marked in relation to the Low Voltage Directive *2006/95/*EC + 93/68/EEC and conform to EMC Directive 89/336/EEC. The units comply with IEC 60598.

3.7 Classifications

LightLines are classified as Class II luminaire and all parts of it meet a glow wire test of 960 ^{0}C.
The IP classification is IP40.

3.8 Energy Efficiency Label (European Union)

LightLines are rated energy efficiency class B, described in Annex IV of Council Directive 98/11/EC with regard to energy labeling of household lamps.



4. Technical specifications of Power Units for LightLines.

4.1 Range

The range of 24 V DC power supply units for LightLines consist of a Normal Size Power Unit 90W and a Slim Size Power Unit 35W

Commercial name	**EOC**
Slim size Power Supply 24V DC 35W	871150089772501
Normal size Power Supply 24V DC 90W	871150026896901

Nomenclature for the power supplies:

SSLL 24 / 35	*SSLL*	Slim Size power unit for LightLines
	24	24 V DC
	35	35 W
NSLL 24 / 90	*NSLL*	Normal Size power unit for LightLines
	24	24 V DC
	90	90 W

4.2 Electrical specification

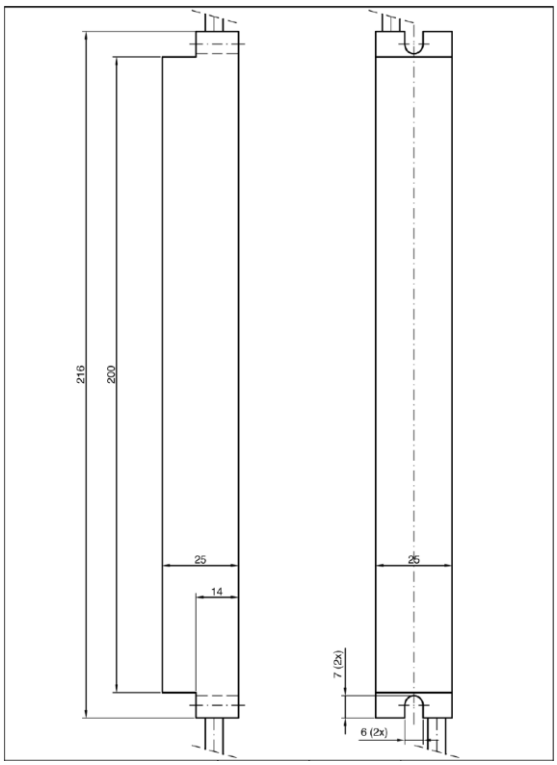
	NSLL 24 / 90	**SSLL 24 / 35**
	switching mode power supply	switching mode power supply
		
	housed, desktop	housed, desktop
Weight (g)	450	250
Dimensions L X W X H (mm)	132,5 X 58 X 30	216 X 25 X 25
	cable, Fast-Fit connector	cable, Fast-Fit connector
Operating temperature (^{0}C)	< 55	< 55
Input voltage (V AC)	90 ~ 264, 47-63 Hz	90 - 264 47-63Hz
Input current (A)	1.5 -> 1.0 (90 -> 264 V AC)	*tbd*
Input wattage no-load (W)	0.7	*tbd*
Efficiency (%)	83	85
Output Voltage (V DC)	24±1	24±1
Pmax (W) *	90	35

Table 7: electrical specs of power units

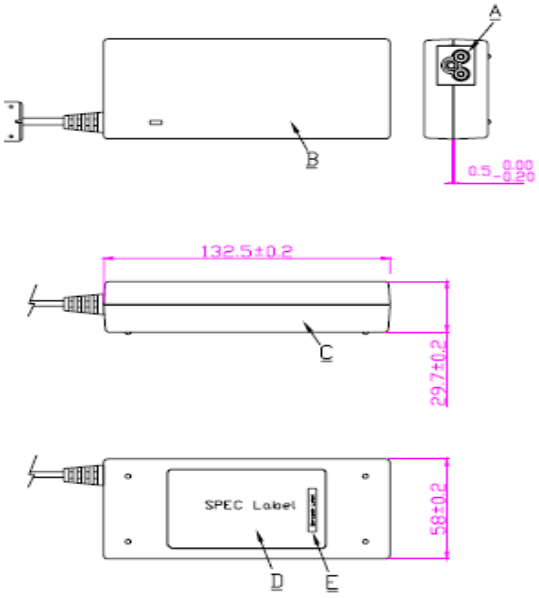
* Always check if the power will not exceed 80% of maximum

4.3 Dimensions

See below figures for dimensions and shapes of the power units for LightLines



SSLL 24 / 35



NSLL 24 / 90

4.4 Certification.

Philips power units are CE marked in relation to the Low Voltage Directive 73/23/EEC + 93/68/EEC and conform to EMC Directive 89/336/EEC.

4.5 Safety

All parts of Philips power units meet a glow wire test of 650 ^{0}C.

5. Definitions.

Lighting Definitions

Color rendering
Effect of an illuminant on the color appearance of objects by conscious or subconscious comparison with their color appearance under a reference illuminant.

Color rendering index (R)
Measure of the degree to which the psychophysical color of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the status of chromatic adaptation.

Color rendering index, CIE 1974 general (R_a)
Mean of the CIE 1974 special color rendering indices for a special set of eight test color samples.

Color temperature
The temperature of a Planckian radiator whose radiation has the same chromaticy as that of a given stimulus.
It is expressed in *Kelvin* (K)

Color temperature, correlated
The temperature of the Planckian radiator whose perceived color most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions.
It is expressed in *Kelvin* (K)

Illuminance
(at a point of a surface). Quotient of the luminous flux incident on an element of the surface containing the point, by the area of that element.
It is expressed in *lux* (lx) = lumen per square meter (lm/m^2).

Luminance
(in a given direction, at a given point of a real or imaginary surface). Quantity defined by the formula, where the luminous flux is transmitted by an elementary beam passing through the given point and propagating in the solid angle containing the given direction; the area of the section of that beam containing the given point; the angle between the normal to that section and the direction of the beam.
It is expressed in *candela per square meter* (cd/m^2 or $cd/cm^{2)}$.

Luminous flux
Quantity derived from radiant flux by evaluating the radiation according to its action upon the CIE standard photometric observer.
It is expressed in *lumen* (lm).