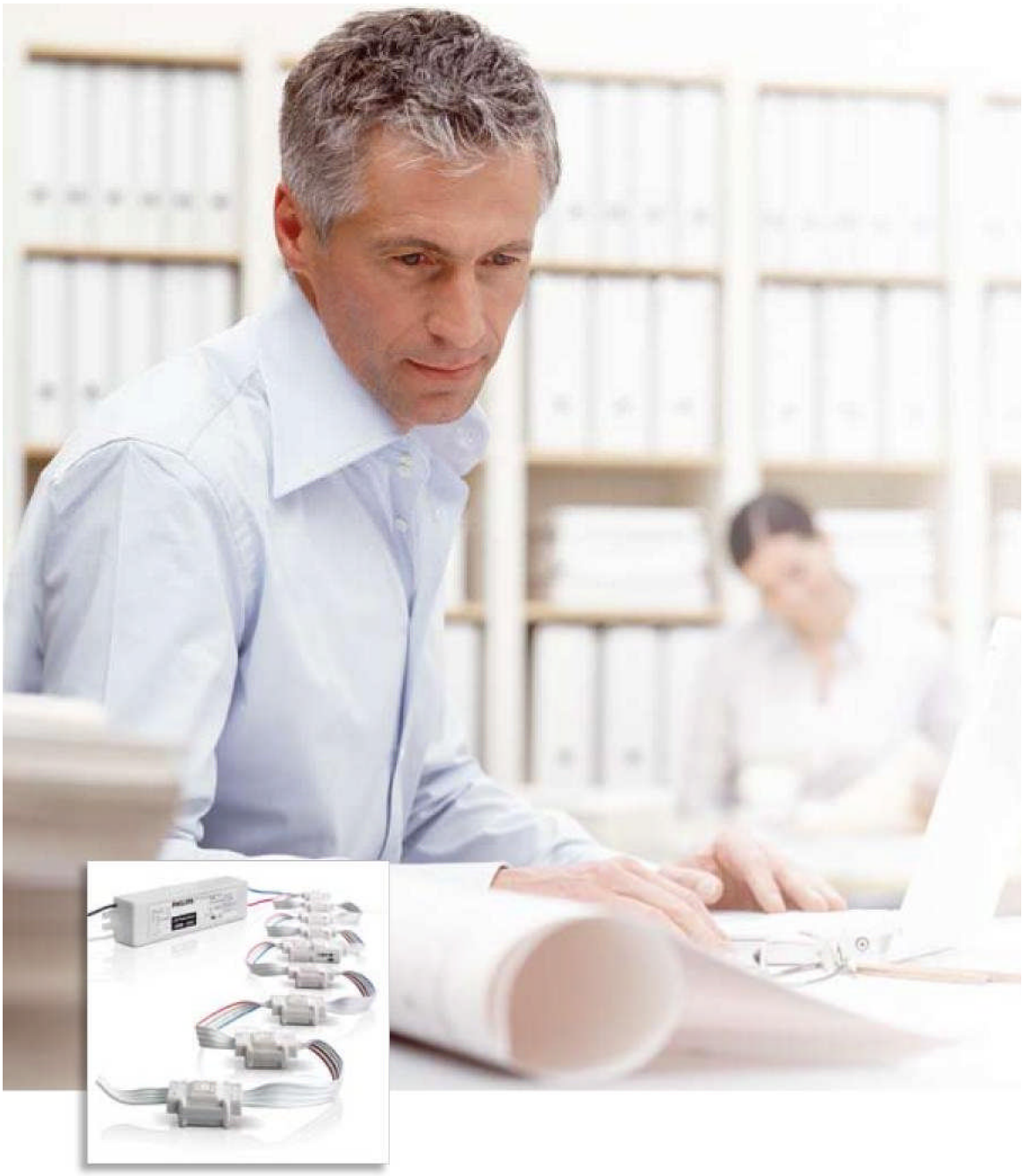

Application guide

Koledo Affinium LED string system low and medium power

KOLEDO
LED SYSTEMS

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1 Introduction

The Koledo Affinium LED string system is a lead-free, RoHS* compliant solid state alternative to neon and fluorescent lighting for signage and band lighting. You can connect any number of channel letters to create any length of band lighting. It is suitable for new constructions as well as retrofit installations and gives you wonderful new possibilities for designing decorative architectural applications.

1.1 Description

The LED string is a flexible chain of solid-state lighting devices. It is made up of two different LED devices, connected by band cable, and is designed to be directly mounted on a sign back-plate or other substrate. The range contains the following colors: red, amber, blue, green, cool white and warm white – with a lambertian radiation pattern. A bluish white version is available on special order. The LED Power Driver is a one-piece device that converts the mains voltage to a safe low DC voltage required for directly operating the LED string. Drivers, accessories and tools complement the total system, ensuring that you can easily connect and install the system.

Fig.1 Koledo Affinium LED string system

* RoHS : Restriction of Hazardous Substances directive

Koledo LED string enables you to protect your customers' brands and offers reliable long life sign lighting at low cost of ownership. Its exceptionally easy-to-install, including both LED string and driver, and the system can be used in virtually every situation, thanks to its fully outdoor-proof IP66 rating.

Excellent light quality and uniformity are ensured by the broad viewing angle. Plus, the flexible string wiring, which allows accurate positioning of the individual LEDs.

The system operates at a safe low voltage. LED strings are robust and breakage during shipping and handling is eliminated.

Retrofit actions can also take place on the spot, as no additional measures have to be taken for outdoor applications.

1.2 Principle of operation

1.2.1 The LED string

Fig. 2 Detailed LED string system

Depending on the color version, the strings consist of parallel series of four or five connected LEDs.

Figures 3 and 4 show the principal electrical diagrams for the LED string system (low and medium power)

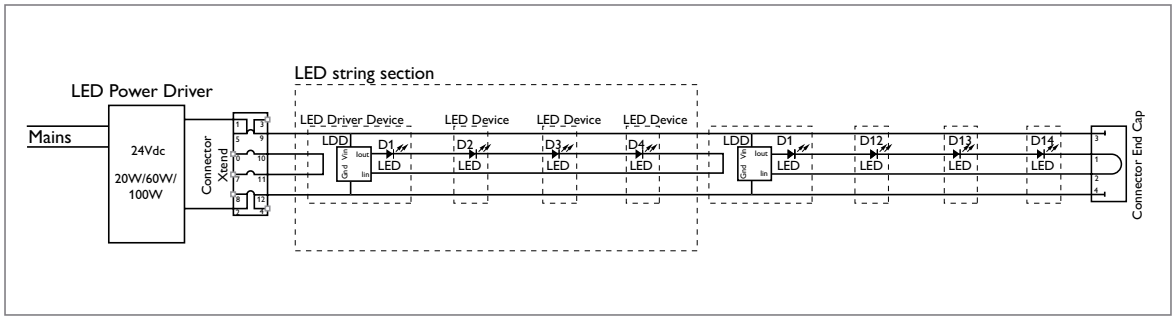


Fig. 3 Principle electrical diagram with sections of four connected LEDs

(1 LED driver device and 3 LED devices)

Affinium low power: green, warm white, cool white, and bluish white

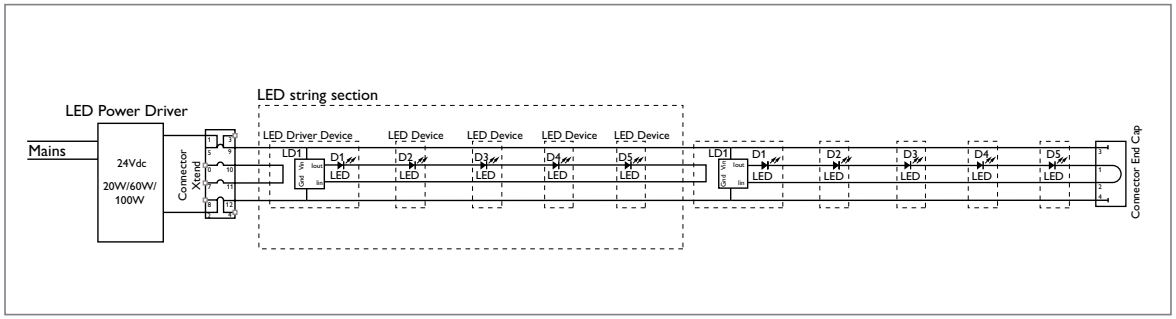


Fig. 4 Principle electrical diagram with sections of five connected LEDs

(1 LED driver device and 4 LED devices)

Affinium low power: red, blue and amber

Affinium medium power: blue, amber, warm white, cool white, and bluish white (on request)

Each LED string section consists of one LED Driver Device (LDD) and three or four LED Devices (LD) depending on the LED color. The LDD consists of a small printed circuit board holding a voltage to a current converter circuit that drives all the LED devices for that section with a current, typical for that type of LED. Plus, a single LED and two conductors for passing the supply voltage to the next LDD. The LDD pcb also holds a short circuit connection for the last LED Device of the previous LED string section.

Each LED device consists of a small printed circuit board with an LED, two separate print tracks for passing through the 24 Vdc supply voltage from the LED Power Driver to the next LDD and a third print track that provides a return path for the LED current to the current source. The whole assembly (LDD as well as LD), except for the optical part, is encapsulated in a cast copolymer. Figures 5 and 6 show the LED Driver Device and the LED Device.

Three different types of voltage to current converter circuits are used. One for the red and amber colored LEDs, one for the blue and green colored LEDs and one for the white LEDs. The main difference is that the three groups need a different constant current for driving the LEDs. The red and amber colored LEDs are driven at 70 mA, the blue and green LEDs at 50 mA and the white LEDs at 30 mA. The maximum number of LEDs connected to one LDD is determined largely by the forward voltage (V_f) of the LEDs. Although the LDD serves as a current source the maximum voltage that can be supplied is not unlimited.

Fig. 5 LED Driver Device (LDD)

Fig. 6 LED Device (LD)

All LED string devices, both LDD and LD are inter-connected by means of a 4 pole flat band cable (AWG 26). As can be seen in figure 3 and 4 the last device in the LED string needs a dedicated end termination connector for providing a return path for the LED current. The schematics show that this end termination connector can be positioned after every device, LED Driver Device and LED Device. Because the LDD provides a constant current it can only be used for the LED incorporated in the LDD.

1.2.2 LEDs

Our system is based on SuperFlux LEDs.

1.2.2.1 LED Colors

Below the wavelength or color temperature for the available LED colors is listed.

Table 1 LED colors Affinium low and medium power

LED color	Wavelength (nm)	Color temperature (K)
Red	624 ±10	
Amber	594 ±5	
Green	526 ±7	
Blue	476 ±7	
Cool White		6300 ±700
Warm White		3000 ±175
Bluish White		8000 ±1000

1.2.2.2 LED types

To enhance lighting uniformity of your signs, the LEDs in the string have a lambertian radiation pattern and a wide viewing angle. This ensures good light distribution.

Table 2 Light radiation pattern

LED color	Lambertian	Low power Viewing angle	Medium power Viewing angle
Red	•	130°	–
Amber	•	130°	110°
Green	•	110°	–
Blue	•	110°	110°
Cool White	•	110°	110°
Warm White	•	110°	110°
Bluish White	•	110°	110°

1.2.2.3 Matching of electrical specifications

In order to produce LEDs with different light colors (wavelengths), different semiconductor materials are used. InGaAlP for red and amber colored LEDs. InGaN for blue and green colored LEDs and also for medium power amber LEDs. And a third material is used for the White LEDs.

All three materials have different electrical characteristics. For example, forward voltage (table 8), reverse breakdown voltage and capacitance. The maximum forward current through the LEDs is also different for the three materials; 70 mA for the red and amber colored LEDs, 50 mA for the blue and green colored LEDs and 30 mA for the white LEDs.

Within each color group differences exist in wavelength (colored LEDs) or color temperature (white LEDs), and luminous flux. All LED string devices supplied within one standard packing unit (SPU = 20m on reel in 1 box) are matched for their forward voltage Vf, wavelength or color temperature and luminous flux.

1.2.3 LED string types

The pitch of the individual LED devices in a LED string is currently set for all three types at 100mm. Special lengths can me made available to you on request. Table 3 lists the available LED strings by their light color and the pitch between individual LED Devices.

Table 3 LED string device pitch for low and medium power

LED color	Pitch (mm)
Red	100
Amber	100
Green	100
Blue	100
Cool White	100
Warm White	100
Bluish White	100

1.2.4 The LED Power Drivers

Philips LED Power Drivers are used with the LED string system. These drivers are specially designed for Solid State Lighting, general lighting- and signage applications, so they will work more efficiently and last longer.

The drivers have a universal mains input (100-240V) and generate a 24DC voltage. The range consists of a slim 20W version with a plastic housing and 60W and 100W versions with a metal housing. All three types have been tested according IP66. Figures 7 and 8 show the three types of LED Power Driver. Figure 9 shows the wiring diagram for all three types of LED Power Drivers.

Fig 7. 20W LED Power Driver

Fig 8. 60W and 100W LED Power Driver

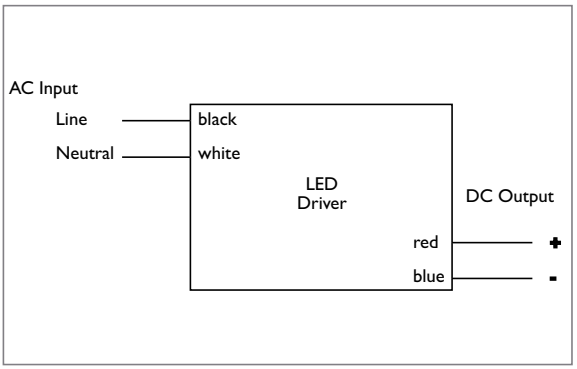


Fig 9. The wiring diagram

1.2.5 Maximum LED string length

The maximum length of LED string that can be connected to a LED Power Driver is determined by a number of electrical parameters. For instance. the output voltage V_{out} and output power P_{out} of the LED Power Driver.
If only a part of the available electric power is consumed because the maximum allowed voltage drop is reached, it is possible to apply LED strings in parallel to the same LED Power Driver as is indicated in figure 10.

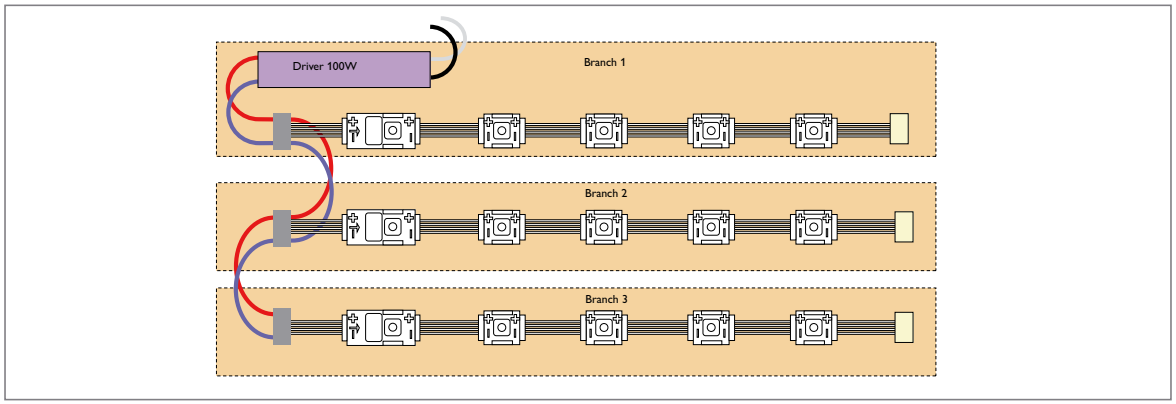


Fig. 10 LED strings connected in parallel to a LED Power Driver

1.2.6 Quantities of LEDs per driver

In table 5 the minimum and maximum number of LED devices per LED Power Driver are listed together with the allowed number of parallel LED string branches.

Table 5 Quantities of LEDs per driver

No extra wire

Affinium LED string		LED Power Driver		
low power	max nr. of LEDs	20W	60W	100W
whites (cool, warm and bluish)	per driver [1]	120	344	536
	per branch [2]	112	180	180
green	per driver [1]	120	344	536
	per branch [2]	112	180	180
blue	per driver [1]	100	290	450
	per branch [2]	95	140	140
amber	per driver [1]	75	235	370
	per branch [2]	75	130	130
red	per driver [1]	80	240	380
	per branch [2]	80	130	130
Affinium LED string		**LED Power Driver**		
medium power	**max nr. of LEDs**	**20W**	**60W**	**100W**
all Affinium LED string	per driver [1]	55	160	260
medium power types	per branch [2]	50	100	100

Quantities of LEDs per driver (figures valid to max. three branches in parallel*)

Wiring AWG 26 (0.405mm, 0.129 mm²)

Affinium LED string low power	Max nr. of LED's	Cable between LED power driver and first LED (LED driver device) of the string								
		10 meter			20 meter			30 meter		
		Driver			Driver			Driver		
		20W	60W	100W	20W	60W	100W	20W	60W	100W
whites	per driver [1]	108	200	200	92	108	108	72	72	72
	per branch [2]	100	116	116	68	68	68	48	48	48
green	per driver [1]	102	196	196	90	116	116	80	80	80
	per branch [2]	84	90	90	64	64	64	42	42	42
blue	per driver [1]	85	165	165	75	85	85	55	55	55
	per branch [2]	70	70	70	45	45	45	30	30	30
amber	per driver [1]	70	145	145	60	75	75	50	50	50
	per branch [2]	65	65	65	35	35	35	25	25	25
red	per driver [1]	70	155	155	65	80	80	55	55	55
	per branch [2]	65	65	65	35	35	35	25	25	25
Affinium LED string medium power	**Max nr. of LED's**	**Cable between LED power driver and first LED (LED driver device) of the string**								
		10 meter			**20 meter**			**30 meter**		
		Driver			**Driver**			**Driver**		
		20W	**60W**	**100W**	**20W**	**60W**	**100W**	**20W**	**60W**	**100W**
all Affinium LED string medium power types	per driver [1]	45	80	80	40	40	40	25	25	25
	per branch [2]	45	45	45	25	25	25	15	15	15

Note:

per driver [1] *per driver the nr. of LEDs divided over the branches may not be exceeded and*

per branch [2] *if more branches (upto 3) are used the nr. of leds per branch may not be exceeded*

If you want to apply more than 3 branches, please contact your local Philips office.

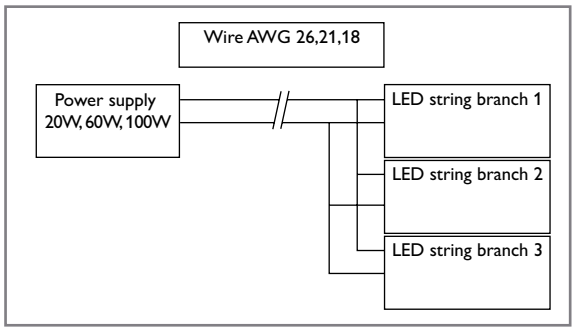
Example 1. **Affinium LED string low power red on AWG 26 (0.405mm, 0.129 mm²)**
10 meter wiring

Can I apply three branches of 60 red LEDs on a 20W LED Power Driver?
No, this is not possible! With 180 LEDs you will exceed the nr. of 70 LEDs allowed per driver.
You can apply for example:
three branches of 2x 30 and 1x 10 LEDs
three branches of 1x 10, 1x 40 and 1x 20 LEDs
three branches of 1x 5, 1x 30 and 1x 35 LEDs
as long as 70 LEDs per driver are not exceeded.

Example 2. **Affinium LED string low power white on AWG 26 (0.405mm, 0.129 mm²)**
10 meter wiring

Can I apply two branches of 108 LEDs on a 100W LED Power Driver?
No, this is not possible! With 216 LEDs in total you will exceed the nr. of allowed 200 LEDs per driver.
You can apply for example:
two branches of 2x 100 LEDs
two branches of 1x 108, 1x 76, 1x 16
as long as 200 LEDs per driver are not exceeded.

Example 3. **Affinium LED string low power blue on AWG 26 (0.405mm, 0.129 mm²)**
10 meter wiring
Can I apply one branch of 100 LEDs on a 100W LED Power Driver?
No, this is not possible! With 100 LEDs you will exceed the nr. of allowed 70 LEDs per branch.
You can apply for example:
one branch of 1x 70 LEDs
three branches of 1x 70, 1x 70 and 1x 25 LEDs
three branches of 1x 70 and 2x 15 LEDs
as long as 165 LEDs per driver are not exceeded.



Note:

In case a design needs more length of LED strings than can be handled by one LED Power Driver (see table 5) a more powerful or a second LED Power Driver is necessary. If two or more LED Power Drivers are selected balance the total length of LED string over the required number of LED Power Drivers for the best optical performance of the design.

1.3 Building a sign

With the introduction of the LED Driver Device the minimum configuration for using an LED string in a channel letter or bandlight application can now be one LED Power Driver together with a single LED Driver Device and two connectors. There is no maximum configuration within a design as it can be extended using extra LED Power Drivers and LED string length. The maximum LED string length per LED Power Driver type is listed in tables 4 and 5.

The LED string can be terminated at any position. This means that a design can always be optimized to the exact number of LED Devices needed for the required light intensity.

The required number of LED devices can be separated from the rest of the LED string by cutting the band cable in the middle between the last LED Device required and the next (fig. 3 and 4).

The LED Driver Device is always the first LED Device in a LED string to be connected to a LED Power Driver. The connection to the LED Power Driver is made by using the dedicated LS Connector Xtend. The LS Connector Xtend is applied to the side of the LDD marked by an arrow (fig. 11).

The position of the red(+) AWG 18 wire coming from the LED Power Driver is aligned with the + sign on the top of the LDD and with the wire in the LED string's band cable (AWG 26 wire) marked with a red line (as seen from the bottom). The blue (ground) wire coming from the LED Power Driver is aligned with the - sign on top of the LDD and with the LED string's band cable wire marked with a blue line(as seen from the bottom. Figure 12 shows a top view of the LDD together with the loop through connecter. The band cables top side shows no markings in order to prevent reflections of the marked band cable wires when mounted in a design.

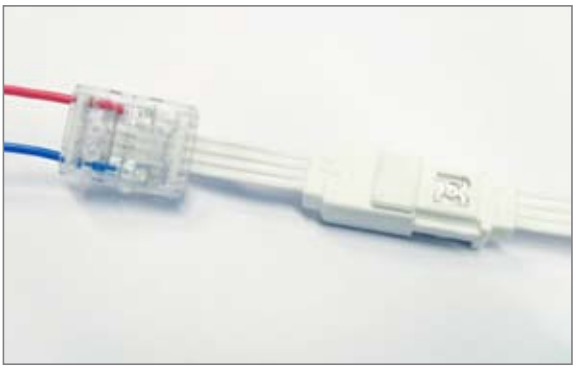


Fig. 11 LED string with LS Connector Xtend

Figure 12 shows a picture of a LED string connected to a LED Power Driver in a design for a box letter.

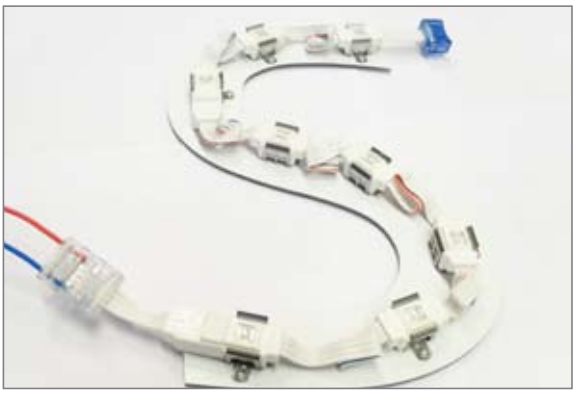


Fig. 12 LED string connected to LED Power Driver

Table 6 lists the individual band cable wires with their color marking and their electrical signal.

Table 6 Band cable markings

Signal	Marking
24 Vdc	
LED forward current	
LED current return line	
Ground	

Figure 13 shows the LS Connector End Cap necessary for closing the electrical loop for the last LED device in the string. Both the LS Connector Xtend as well as the LS end cap connector are developed especially for the LED string system. It are dedicated, easy to apply (no stripping pliers necessary), insulation displacement connectors (IDC) filled with gel, that provide outdoor proof connections.

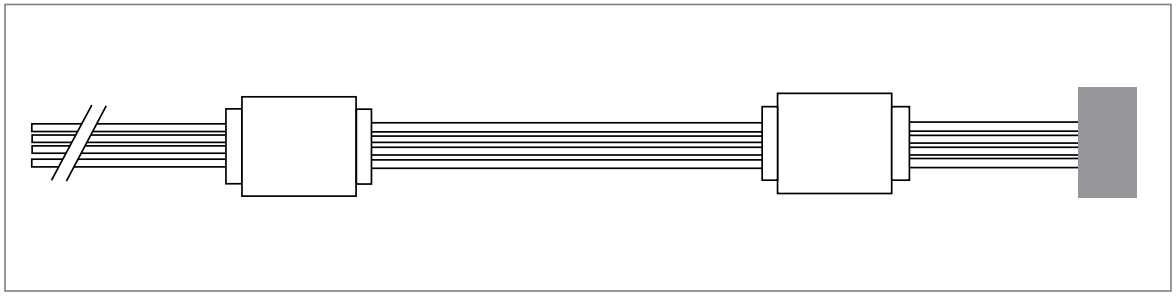


Fig. 13 LED string with LS Connector End Cap, viewed from the bottom side

Figure 14 shows the LS Connector Xtend as it is applied for connecting two Lengths of LED string in parallel to one LED Power Driver. In this situation one of the LED string band cable ends has to be twisted for 180° before being entered into the LS Connector Xtend.

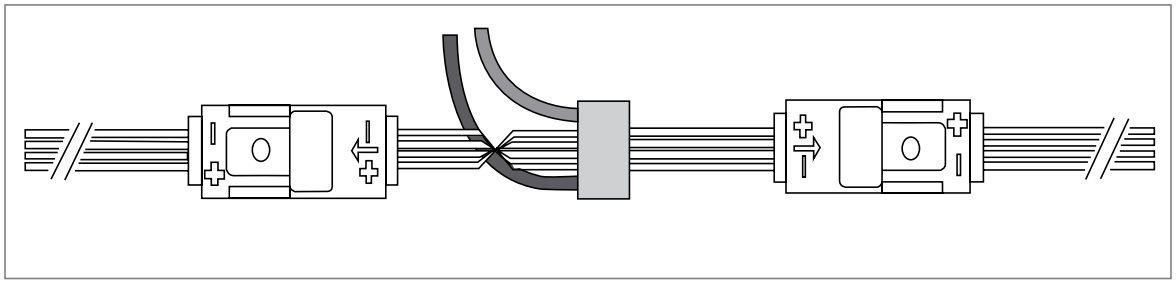


Fig. 14 Connecting two LED strings in parallel to one LED Power Driver

1.3.1 Mounting clip

For ease of installation Philips provides dedicated mounting clips for the LED string system (figure 15). Figure 16 shows a LED Driver Device mounted in a clip.

Fig. 15 LS Mounting Clip

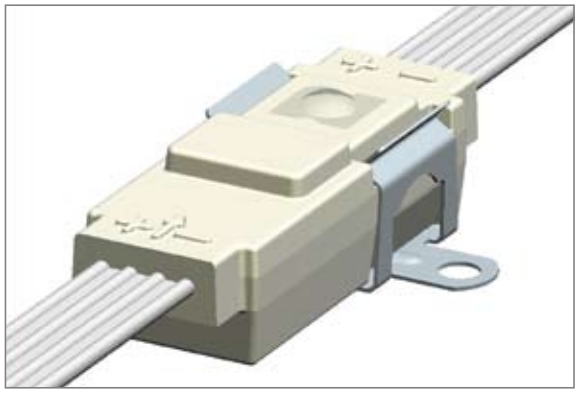


Fig. 16 LDD mounted in a clip

The mounting clips can be fixed to the design (box letter or bandlight) prior to installing the LED string into the design. The clip makes the LED string system extremely easy to install especially in retrofit installations in the field.

The bottom plate of the clip features two holes. The outer hole is for mounting the clip with a screw or blind rivet to the back plane of the design. The inner hole can be used during installation of the clip to pinpoint the exact location of the LED within the design. But this inner hole cannot be used for screws or blind rivets.

In case screw or rivet fixing of the mounting clips is unwanted or impossible the LED strings can also be mounted to a back plane using double-sided adhesive tape (applying Philips LS Mounting Tape pads), or using "LS Adhesive Mounting Clips".

1.3.2 Length of wiring from the power supply

If installation of the driver close to the LED string is unwanted or impossible, you should take into account the length of the wires connecting the driver and the LED string.

Table 7: Practical LED string low power lengths at given supply cable lengths of AWG 26 on a 60W LED power driver

	LED string length (m)	
Supply cable length	10m	30m
Red	15.5	5.5
Amber	14.5	5.0
Green	19.6	8.0
Blue	16.5	5.5
Whites	20.0	7.2

Table 7a: Practical LED string medium power lengths at given supply cable lengths of AWG 26 on a 60W LED power driver

	LED string length (m)	
Supply cable length	10m	30m
Coolwhite	8.0	2.5

1.3.3 Examples of signs

In figure 17, a principal example of using LED strings for constructing a more complicated channel letter (the letter 'K') is shown. A detailed description on how to install the LED string system can be found in Chapter 5 "Installation guide". Figures 18 and 19 both show examples of how interconnections from one box letter to the next can be made.

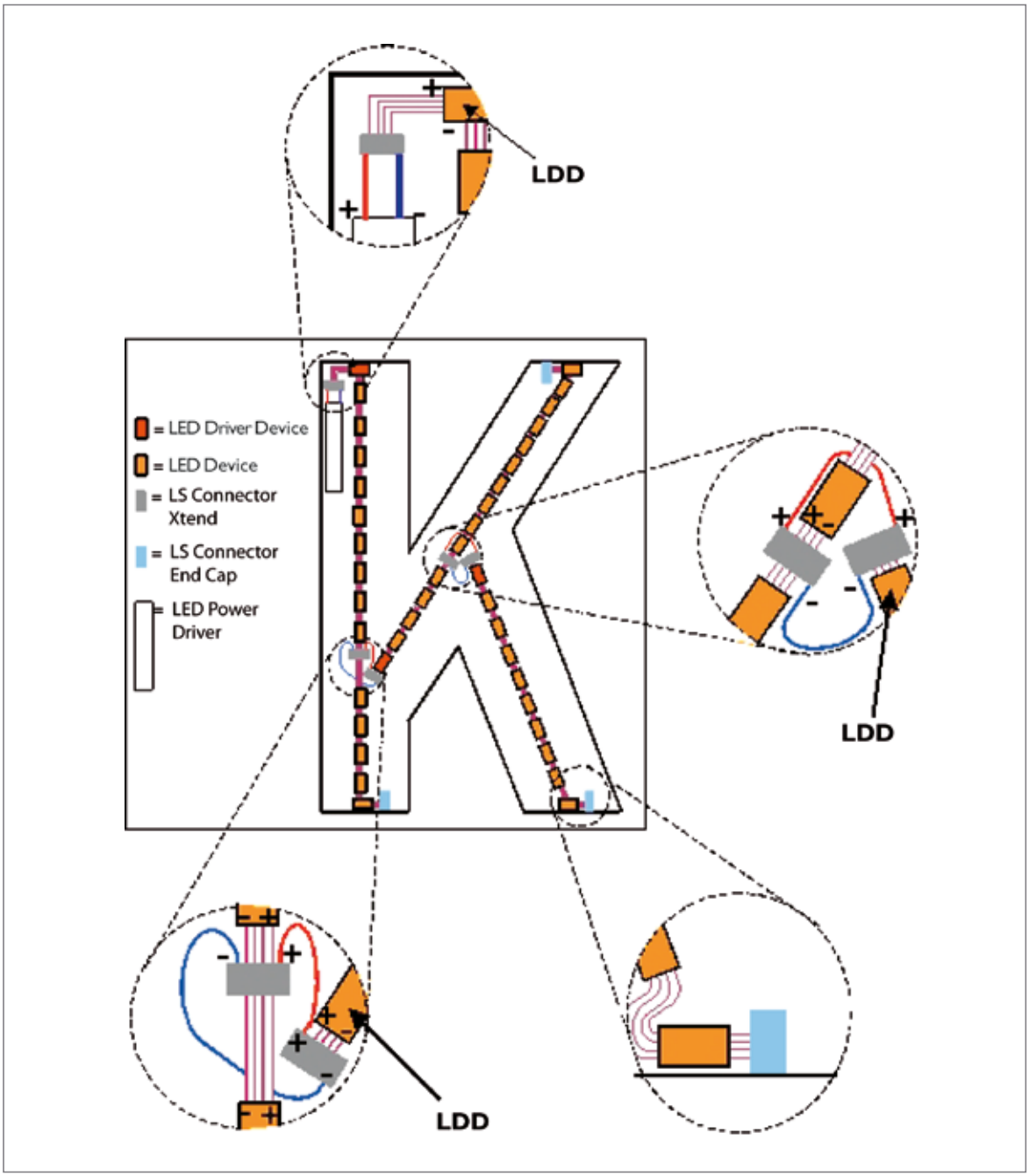


Fig. 17 Constructing a channel letter using LED strings

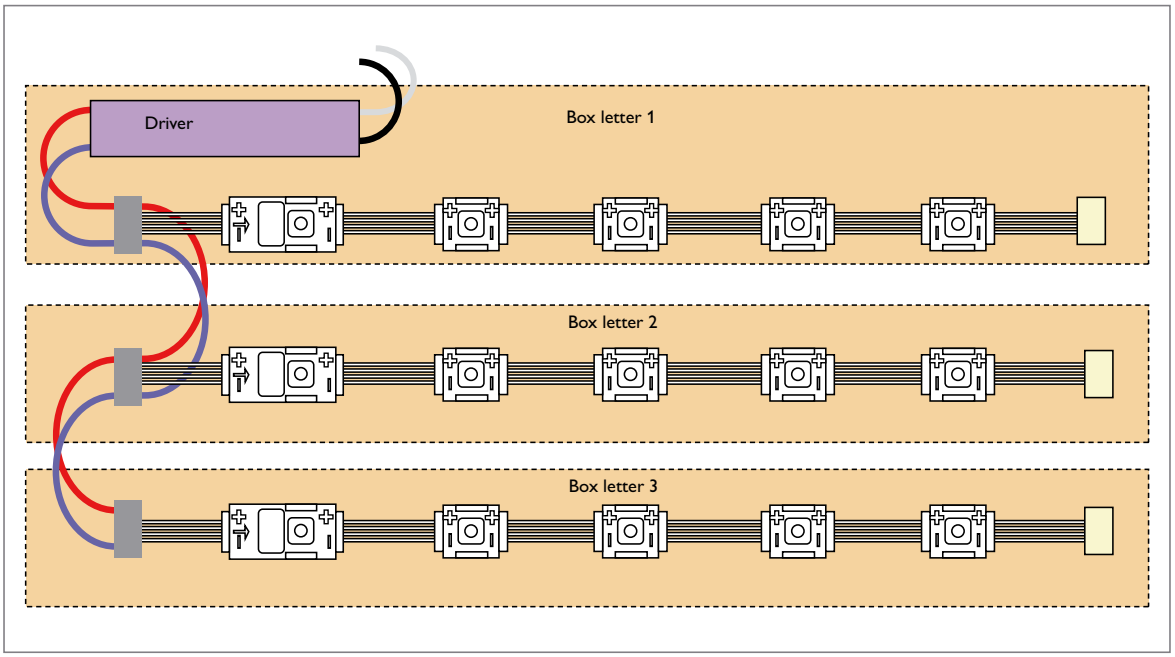


Fig. 18 Connecting box letters in parallel

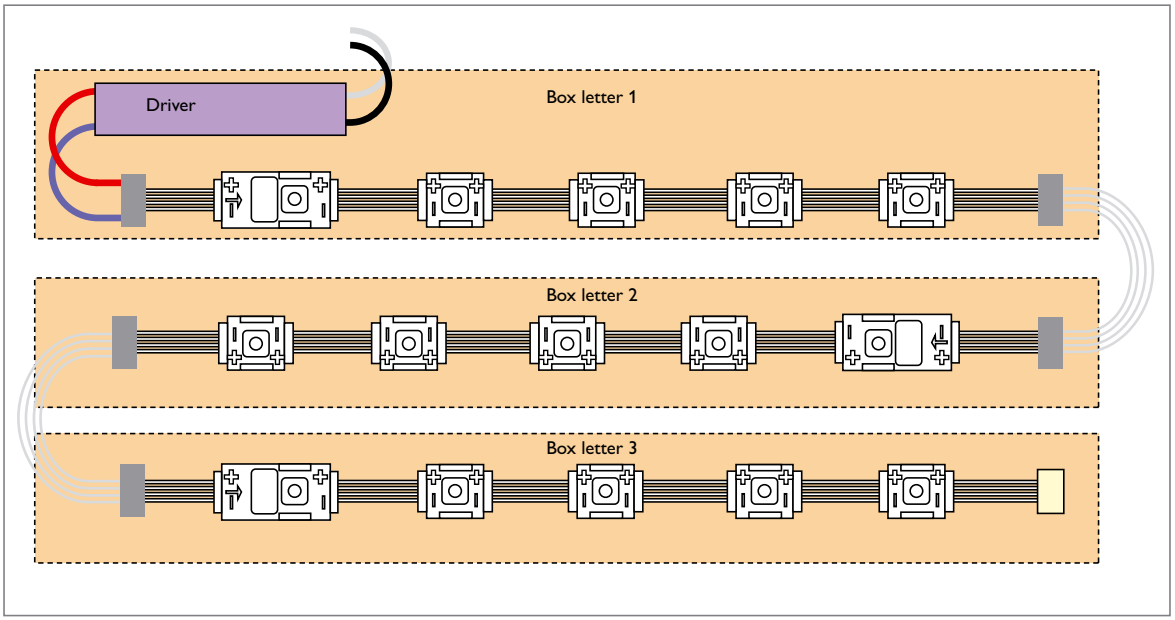


Fig. 19 Connecting box letters in series

2 Specifications

2.1 The LED string

2.1.1 Mechanical dimensions

In figure 20 the mechanical dimensions for the individual LED Driver Device are given. Figure 21 shows the mechanical dimensions for the LED device.

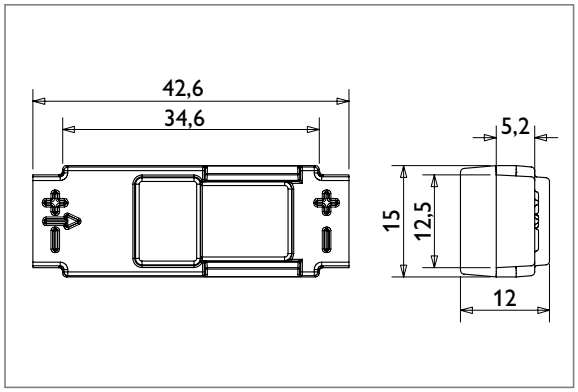


Fig. 20 Dimensions of the LED Driver Device

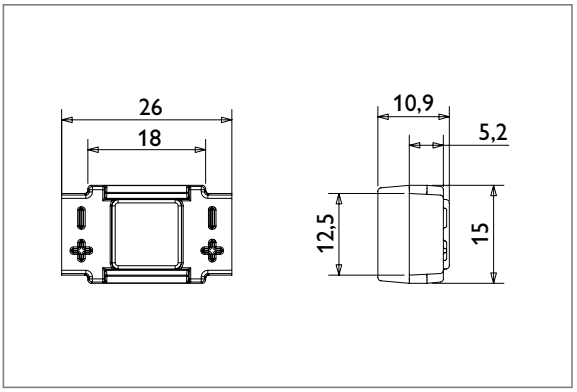


Fig. 21 Dimensions of the LED device

Figure 22 shows the mechanical dimensions within a LED string.

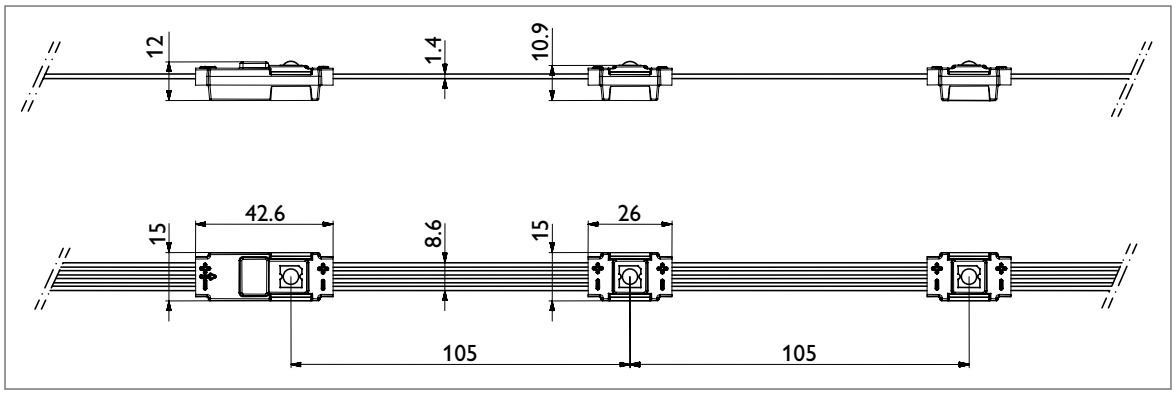


Fig. 22 Mechanical dimensions within a LED string

Table 8 Flat band cable: Philips LS Extension cable, stranded wire AWG 26/7

Item	Value	Unit
Connection cross section	26/7	AWG
Contact pitch	1.50	mm
Outer diameter insulation	1.40	mm

2.1.2 Electrical characteristics

Table 9 LED device

Item	Parameter	LED string low power					medium power			Unit
		Red	Amber	Green	Blue	Whites	Amber	Blue	Whites	
Forward current		70	70	30	50	30	50	50	90	mA
Max. Forward Voltage @ I_f = 70 mA	V_f	3.1	3.5							V
Max. Forward Voltage @ I_f = 50 mA	V_f				3.6					V
Max. Forward Voltage @ I_f = 30 mA	V_f			3.7		4.2				V
Max. Forward Voltage @ I_f = 90 mA							3.6	3.6	3.5	V
Typical power dissipation (excl. cable losses)	P	239	248	165	199	165	357	357	357	mW

2.1.3 Optical characteristics

Table 10 Optical characteristics at Ta = 25°C and at indicated forward currents for the colored LEDs

Item	Para-meter	LED string low power							medium power					Unit
		Red	Amber	Green	Blue	Cool White	Warm White	Bluish White	Amber	Blue	Warm White	Cool White	Bluish White	
Dominant Wavelength	λ	624±10	594±5	526±7	476±7									nm
Correlated Color Temperature	CCT					6300±700	3000±175	8000±1000	594±5	476±7	3000±175	6300±700	8000±1000	K
Viewing angle	Θ	130	130	110	110	110	110	110	110	110	110	110	110	°
Total lumen Typical[1] @I_f = 70mA	Φ_v	7	4.5											lm
Total lumen Typical[1] @I_f = 50mA	Φ_v				2.8									lm
Total lumen Typical[1] @I_f = 30mA	Φ_v			6.3		5.8	5	5.8						lm
Total lumen Typical[1] @I_f = 90mA	Φ_v								8.5	4.5	13	16	16	lm
Total lumen Typical[1] per LED string section	Φ_v	35	22.5	25.2	14	23.2	20	23.2	42.5	22.5	65	80	80	lm
Total lumen Typical[1] per meter	Φ_v	70	45	63	28	58	50	58	85	45	130	160	160	lm

Note:

1. *Luminous flux*

   One of the important factors influencing the performance of the LED string system and Solid State Lighting in general is temperature. With increasing ambient temperature the luminous flux will drop.

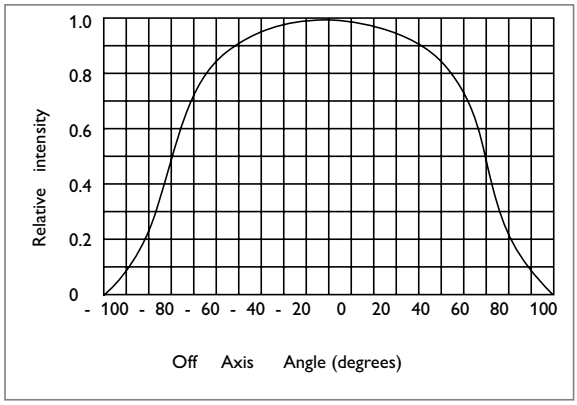


Fig. 23 Relative intensity VS Off axis angle for the colored LEDs (example red and amber)

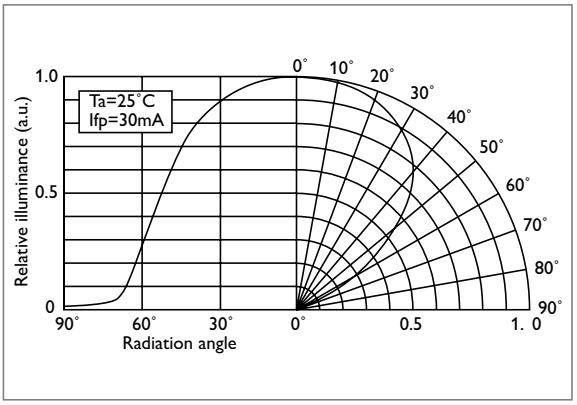


Fig. 24 Relative illuminance VS radiation angle for the white, green and blue LEDs (low power and medium power) and medium power amber.

2.1.4 Environmental ratings

Table 11 Environmental ratings

Item	Parameter	Minimum	Maximum	Unit
Storage Ambient Temperature	$T_{storage}$	-40/-40	+85/+185	°C/°F
Operating Ambient Temperature	$T_{operating}$	-20/-4	+70/+158	°C/°F
Case Temperature at Ta = 20°C	T_c	-	+45/+113	°C/°F
Relative Humidity, storage (no dewing)[1]	RH	5	95	%
Expected lifetime[2]		50000	50000	hrs
Failure rate after 50.000hrs at T_{case}		0.5	0.5	%

Note:

1. The LED string device's encapsulation protects against the ingress of dust and heavy seas or water jets, according to the IP66 classification for luminaries by the IEC 60529.

2. Aging. As is common with solid state lighting the LEDs, luminous flux will decrease with aging. The expected lifetime value for the LED string as listed in table 11, is the operating time after which the luminous flux will be reduced to 50% of its initial value. It is not based on a statistical approach of the number of failures over a specific time period, but based on calculations and extrapolated test data.

2.2 The Driver

2.2.1 Mechanical dimensions

Figure 25 and 26 show the mechanical drawings for the three driver types.

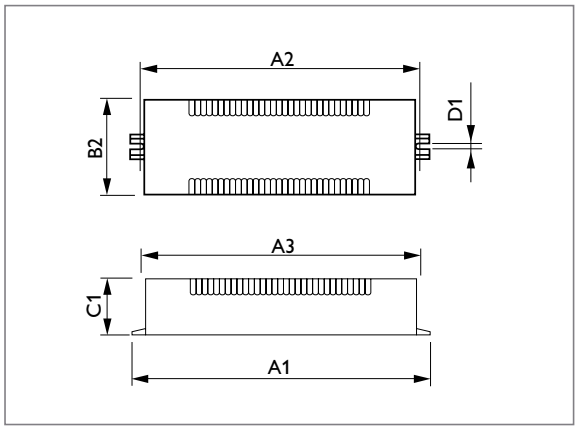


Fig. 25 20W LED Power Driver

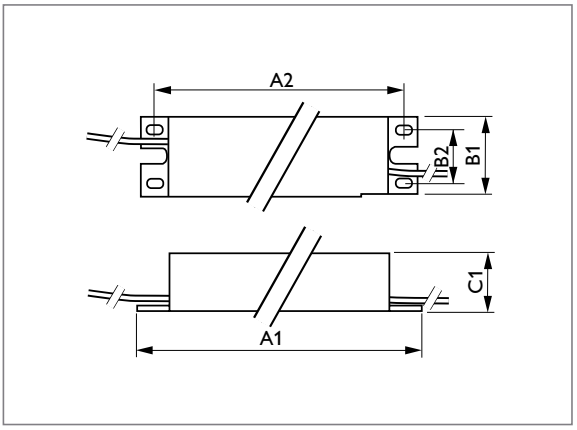


Fig. 26 60W and 100W LED Power Driver

Table 12 lists the dimensions for the 3 driver types

Driver type	A1	A2	B1	B2	C1	D1
20W	130	140	37	18.5	25	4.4
60W	241	229	43.1	26.2	30.0	4.4
100W	241	229	43.1	26.2	30.0	4.4

Notes:

1. All dimensions are in millimeters.

2. Drawing not to scale.

3. Feature two (20W) or four (60W and 100W) slots for mounting with M4 or M6 size screws.

4. Lead wires: 300mm length, 0.825 mm^2 solid core copper.

2.2.2 Electrical characteristics

Table 13 Input

Parameter	Symbol	20W Driver	60W Driver	100W Driver	Units
Input voltage range	V_{in}	100 - 240	100 - 240	100 - 240	V
Frequency	$_{f}$	47 - 63	47 - 63	47 - 63	Hz
Power consumption range max.	$P_{in\ max}$	25	75	120	W
Power factor	P_f	0.9 min	0.9 min	0.9 min	-
Total harmonic distortion	THD	20	20	20	%
Efficiency	-	80% typical	80% typical	80% typical	%

Table 14 Output

Parameter	Symbol	20W Driver	60W Driver	100W Driver	Units
Output voltage range	V_o	23 – 25.6	23 – 25.6	23 – 25.6	V
Output current	I_o	0.85	2.5	4.1	A
Output voltage rippel	-	1.0	1.0	1.0	%
Short circuit protection	-	yes	yes	yes	-

Notes:

1. Electrical characteristics at 25°C ambient temperature.

2. Output insulation 3.25KV 60 Hz.

3. The Affinium LED string products are only suitable for connection to a circuit from a Class 2 power source (Philips LED power driver)

4. Class 2 source-energy limited supply

2.2.3 Environmental ratings

Table 15 Environmental ratings

Parameter	Symbol	Minimum	Maximum	Units
Storage Ambient Temperature	$T_{storage}$	-40/-40	+85/+185	°C/°F
Operating Ambient Temperature	$T_{operating}$	-30/-22	+60/+140	°C/°F
Case Temperature[1]	T_c	-	+90/+194	°C/°F
Lifetime (failures after 50,000 hrs)	L_{50K}	-	5	%

Notes:

1. Case temperature should be measured at test point Tc, as marked on driver label.

2. The housing provides protection against the ingress of dust and heavy seas, according to IP 66 classification for luminaries by the IEC 60529.

2.3 Applicable standards

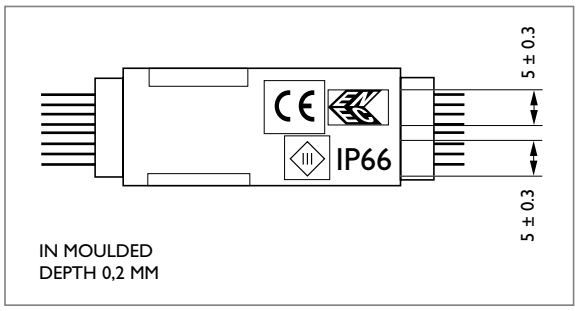
The LED string system has been tested for and complies to the following international standards:

Table 16 Applicable standards

	Test #	Stress type	Abbreviation	Standard
Mechanical integrity	1	Static cable pull	SCP	Philips / KEMA
	2	Dynamic cable pull	DCP	Philips / KEMA
	3	Bump test	BT	IEC 68-2-29 Eb
	4	Vibration variable test	VVT	MIL-STD 883
				METHODE 2007 cond.A
Endurance	5	Cold temperature storage	LTS	IEC 68-2-1 Ab
	6	High temperature storage	HTS	IEC 68-2-2 Bb
	7	Damp heat (temp. humidity)	DH	IEC 68-2-30 Db
	8	Temperature shock	TC	IEC 68-2-14 Nb
	9	Ingress protection	IP	IEC 60529 IP66
Electrical Integrity	10	Electrical Safety	ES	IEC 60598-1 ed 6.0
		LED string		IEC 60598-1 (2004)
				IEC 60598-2-20
				UL 2108
				Class II SELV
				Listed in the UL sign component manual
	11	Electrical Safety	ES	IEC 61347-1:2000
		LED Power Driver		IEC 61347-2-13
				UL1310 ed 5 class 2 power supplies
				UL48 / UL879 electrical signs
				Cass II SELV
				Listed in UL sign component manual (SAM)
	12	Performance		IEC 62384 ed 1.0 (draft)
		LED Power Driver		
	12	Approval Marks		CE CSA
		LED string		UL FCC
				ENEC
	13	Approval Marks		CE CSA
		LED Power Driver		UL FCC
				VDE
	14	Quality standard	QS	ISO 9001-2000
Quality / Environment	15	Environmental standard	EnS	ISO 4001
	16	Toxic materials		RoHS
EMC	17	Generated disturbances to the environment		EN 55015
				CISPR 55015
				IEC 61000-3-2
				IEC 61000-3-2
	18	Immunity		IEC 61547
Safety documents	19	Test reports		KEMA
				UL
	20	CB certificate		yes

2.4 Markings, logos and ID-code on the LED string

2.4.1 Coding of the LED string



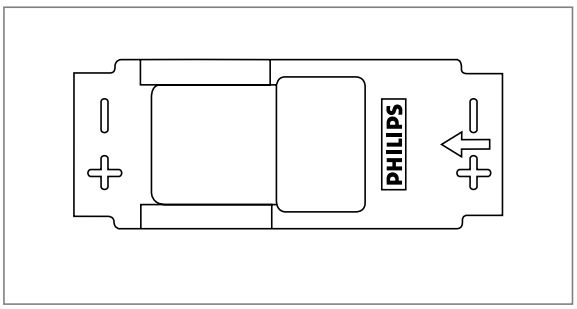
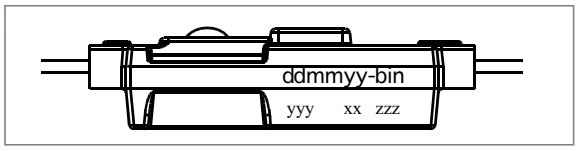


Fig. 27 Markings on a LED string Driver Device

2.4.2 Affinium LED string low power red, amber and green date and origin code

The LED Driver Device is provided with an identification number.

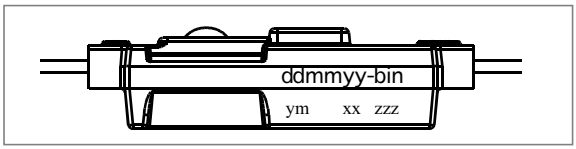


The identification number holds the following information:

Symbols at device	Meaning	Example	Explanation	Additional information
ddmmyy	Production date of the LED string	**230306**	23 march 2006	
bin	Binning information of the LED	**32**	• First digit **(3)** = Luminous flux bin code • Second digit **(2)** = color bin code	• Always a 2 digits code • Code according datasheet of the applied LED
yyy	Manufacturing year and week code of the LED	**631**	• First digit (6) = Year code (200**6**) • Second and third digit = weeknr. (week **31**)	• Code according datasheet of the applied LED
xx	Type of the LED string	**LP** **MP**	• **L**ow **P**ower • **M**edium **P**ower	• Always a 2-letter-code
zzz	Color indicator	**B** **G**	• **B**lue • **G**reen	• Color dependent • Maximally 3 positions (alpha numeric)

2.4.3 Affinium LED string low power blue & whites, and Affinium medium power Amber, blue & whites

The LED Driver Device is provided with an identification number.



The identification number holds the following information:

Symbols at device	Meaning	Example	Explanation	Additional information
ddmmyy	Production date of the LED string	**230306**	23 march 2006	
bin	Binning information of the LED	**b6Rc**	• First letter-digit combination **(b6)** = color bin code • Second letter-letter **(Rc)** or letter-digit combination = Luminous flux bin code	• Always a "letter-digit-letter-letter" code. • Code according datasheet of the applied LED
YM	Manufacturing year and month code of the LED	**61**	• First digit **(6)** = Year code (200**6**) • Second digit **(1)** = mont nr.: 1 for Jan. 9 for Sep. A for Oct. B for Nov.	• Code according datasheet of the applied LED
xx	Type of the LED string	**LP** **MP**	• **L**ow **P**ower • **M**edium **P**ower	• Always a 2-letter code
zzz	Color indicator	**B** **W33**	• **B**lue • **W**hite 3300 K	• Color dependent • Maximally 3 positions (letter/digit)

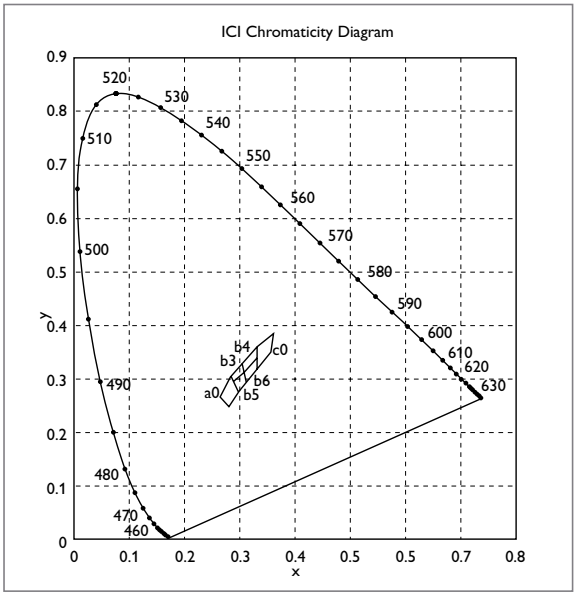


Fig. 29 Distribution of white LEDs over bins in respect to x and y color point

2.5 Driver label information

The label for the LED Power Driver contains the following information:

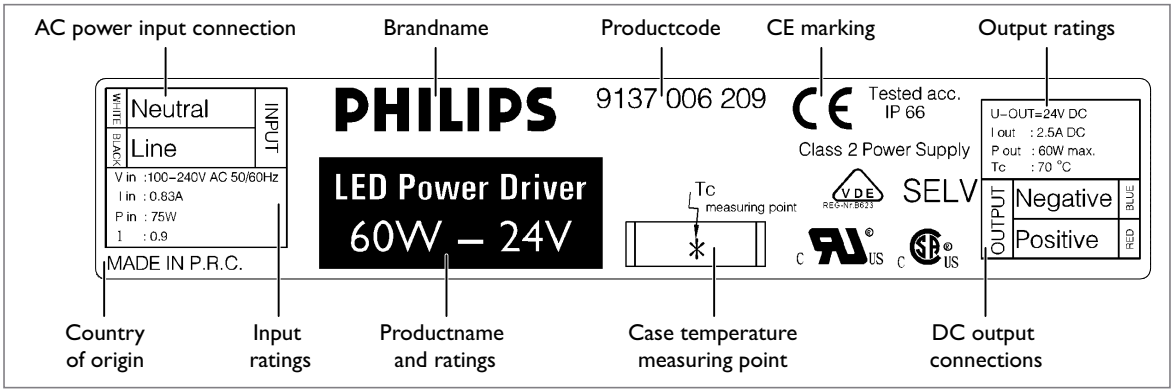
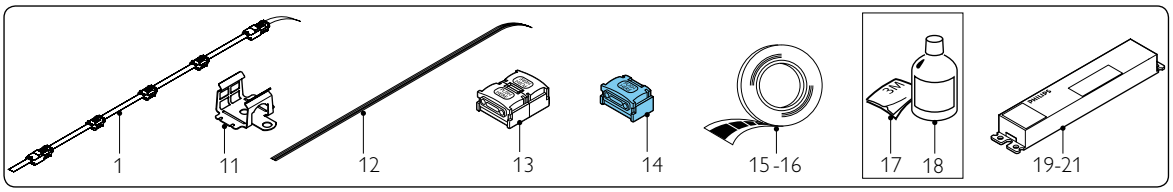


Fig. 30 The LED Power Driver label

Figure 30 is an example of the 60W driver. The labels of the 20 and 100W hold similar information.

For further information see Product Data Sheet Philips LED Power Drivers 100-240V 20, 60 and 100W.

3 Ordering information



	Philips Affinium LED string		Box packaging Qty	Dimensions (cm) L	W	H	Weight (kg)	EOC 8711559
1	Affinium LED string lp red P10		1x20mtr	55	55	3.5	2	763675 00
1	Affinium LED string lp amber P10		1x20mtr	55	55	3.5	2	763699 00
1	Affinium LED string lp blue P10		1x20mtr	55	55	3.5	2	763712 00
1	Affinium LED string lp green P10		1x20mtr	55	55	3.5	2	763736 00
1	Affinium LED string lp W6300 P10 (cool white)		1x20mtr	55	55	3.5	2	763750 00
1	Affinium LED string lp W3000 P10 (warm white)		1x20mtr	55	55	3.5	2	764429 00
1	Affinium LED string lp W8000 P10 (bluish white)		1x20mtr	55	55	3.5	2	764986 00
1	Affinium LED string mp amber P10		1x20mtr	55	55	3.5	2	766102 00
1	Affinium LED string mp blue P10		1x20mtr	55	55	3.5	2	766089 00
1	Affinium LED string mp W6300 P10 (cool white)		1x20mtr	55	55	3,5	2	764481 00
1	Affinium LED string mp W3000 P10 (warm white)		1x20mtr	55	55	3.5	2	766041 00
1	Affinium LED string mp W8000 P10 (bluish white)		1x20mtr	55	55	3.5	2	766065 00

Bluish white on request

	Accessories	Box packaging Qty	Dimensions (cm) L	W	H	Weight (kg)	EOC 8727900	EOC 8711559
11	LS Mounting Clip	200 pcs	10	10	10	0.3		763910 30
12	LS Extension Cable 4W	50 mtr	18	18	1.5	0.75	880885 00	763934 00
13	LS Connector Xtend	10 pcs	7.7	4.8	4.2	0.05	880892 00	
14	LS Connector End Cap	10 pcs	7.7	4.8	4.2	0.05		
15	LS Mounting Tape 210 pads[1]	1 reel of 210 pads	11	11	2.5	0.085		764016 00
16	LS Mounting Tape 1700 pads[1]	1 reel of 1680 pads	25	25	2.5	0.68		764030 00
17	3M Tissues	available from supplier 3M at www.3m.com						
18	VHB™ Cleaner	available from supplier 3M at www.3m.com						

	LED Power Driver (IP66)		Box packaging	EOC 8711500
19	100-240V	20W-24V	10	911940 30
20	100-240V	60W-24V	10	911469 30
21	100-240V	100W-24V	10	911964 30

4 Design rules and hints

4.1 General

When calculating the number of LED string sections necessary, a few basic considerations have to be taken into account;

1. The smallest applicable unit is a LED Driver Device.
2. Always start a design with an LED Driver Device.
3. The number of LED devices per LED string section depend on the LED color:
   - Affinium low power (green, warm white, cool white, and bluish white): four LEDs (1 LED driver device and 3 LED devices)
   - Affinium low power (red, blue and amber): five LEDs (1 LED driver device and 4 LED devices)
   - Affinium medium power (blue, amber, warm white, cool white, and bluish white on request): five LEDs (1 LED driver device and 4 LED devices)
4. The total number of LED strings devices applied in a design can exactly be matched with the luminous flux requirements for the design. The LED string can be cut at any position.
5. The maximum spacing between individual LED string devices is determined by the pitch (100mm see table 3) between the individual LED devices. Because of its flexibility the minimum spacing is only limited by the dimensions of the LED string device.

4.2 Uniformity

Technically the main difference between LED strings and neon or fluorescent lamps is that the LED string consists of individual light spots. Because of this, care has to be taken that individual LED beams overlap one another in order to provide a uniform illumination pattern. A minimum depth for the channel letter is required to prevent the visibility of individual LEDs within the channel letter. Figure 33 shows the cross-section of a channel letter featuring a colored LED string device and an acrylic diffuser.

As can be seen in table 10, the luminous flux is different for the various LED light colors. Table 17 lists some practical values for minimum height and maximum width of a channel letter when applying LED strings as light source.

Table 17 Practical design values for one Affinium LED string low and medium power

Color	Typical letter width (mm)	Letter depth (distance LED to acrylic in mm)	Pitch (distance LED device to LED device in mm)
Red	150	80	65
		100	80
		120	90
		140	100
Amber	150	80	65
		100	80
		120	90
		140	100
Blue	150	80	60
		100	70
		120	85
		140	90
Green	150	80	60
		100	70
		120	85
		140	90
Whites	150	80	60
		100	70
		120	85
		140	90

To cover channel letters with a greater width apply 2 or more LED strings in parallel.

In table 5 you can find more information on how many LED devices you can apply with different wiring and length.

One item that has great influence on the uniformity of the channel letter is the match between the light spectrum (color) transmitted by the LED and the transmission window (color) of the acrylic diffuser. A good match between both can result in a reduced minimum value for the channel letter's depth.

In case it is impossible within the design of a channel letter to apply the minimum depth values from table 17, applying a second diffuser within the channel letter (as illustrated in figure 32) can help to achieve uniformity. As all diffusers absorb part of the light (typical transmission value 35%), applying a second diffuser would mean that a higher initial luminous flux (more LEDs) has to be installed in order to get the same luminous intensity from the channel letter. When applying white LEDs, a second diffuser is a very practical solution for reducing the depth of the design.

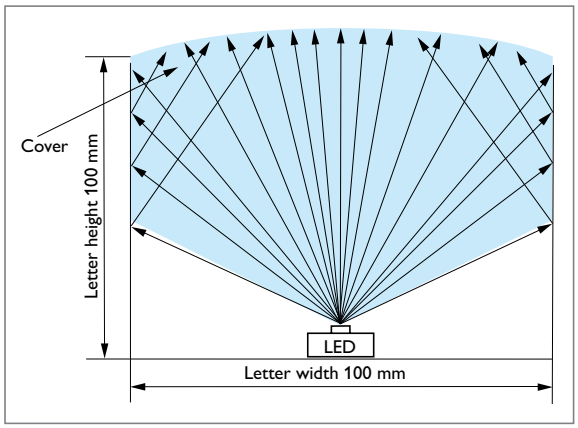


Fig.31 Beam effect of a LED string

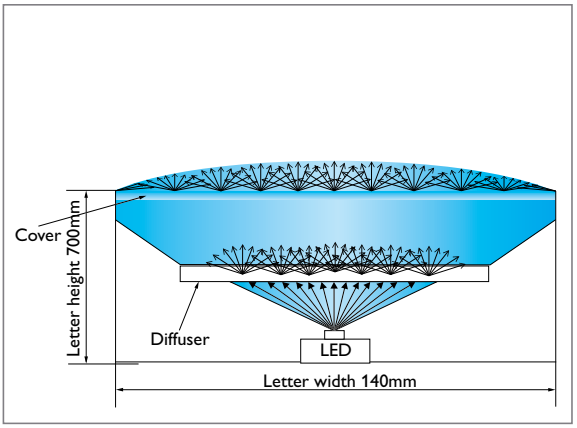


Fig. 32 Letter with additional diffuser

4.3 Colors and whites

The matching of LED color and acrylic diffuser color is especially important in order to achieve a compatible "Day" and "Night" color value for the application. When using colored LEDs a theoretical approach of the match between the light spectrum (dominant wavelength) transmitted by the LED string and the transmission characteristics of the acrylic diffuser can be checked. For specific information concerning the acrylic diffuser, check the product data sheets of the acrylic diffuser material applied for the design.

An opal diffuser with a typical transmission value of 45% will provide sufficient transmission of light from the white LED string, and having good light uniformity.

4.4 Spacing

The spacing of the individual LEDs in a design mainly depends on the uniformity needed. When applying the values from table 17 in designing a channel letter or band-light application, some practical guidelines have to be followed when mounting the LED strings into the channel letter or band-light in order to get the best uniform luminous intensity. The channel letter "L" as shown in figure 33 will be used as an example.

1. Always apply the LED strings as much as possible in straight lines.
2. Start mounting the first LED string device driver as close to the side of the channel letter as possible (fig. 35). In this way, dark corners are prevented.
3. Spread the rest of the LEDs over the channel letter in a balanced way. Figure 36 illustrates the coverage of the complete channel letter area by the luminous flux from the LED string and reflections against the side of the channel letter.
4. When a channel letter design requires two parallel LED strings for instance, apply the same 0.5*S – S – 0.5*S distribution in respect to spacing the LED strings as is common with fluorescent lamps. Refer to figure 37.
5. Figure 38 shows an example of a band-light featuring blue LED string sections. For the best uniform result, always balance the LED strings over the necessary drivers.

The default maximum pitch between two LED string devices is 100mm. If this poses a problem in your design, LED strings with dedicated spacing between the individual LED string devices are available on request.

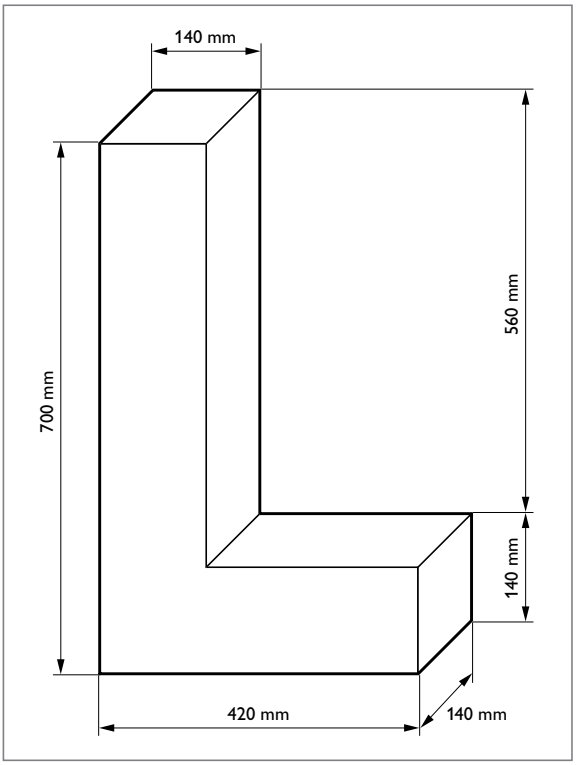


Fig. 33 Letter "L"

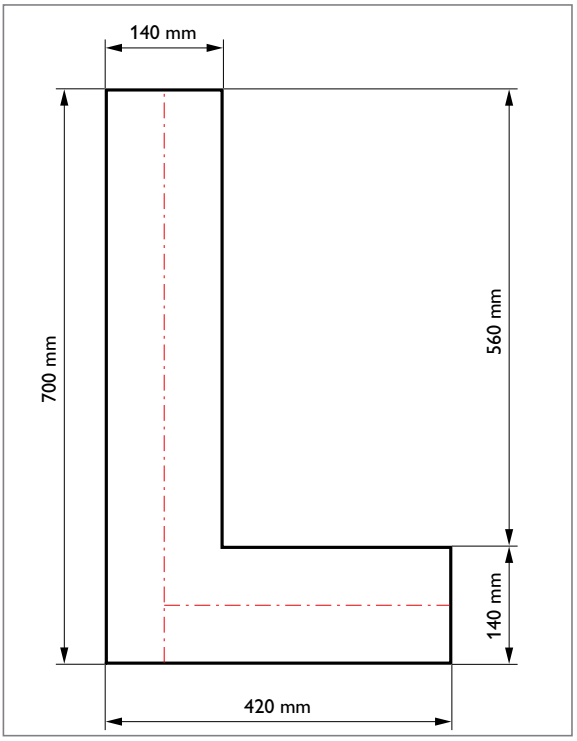


Fig. 34 Lines of application

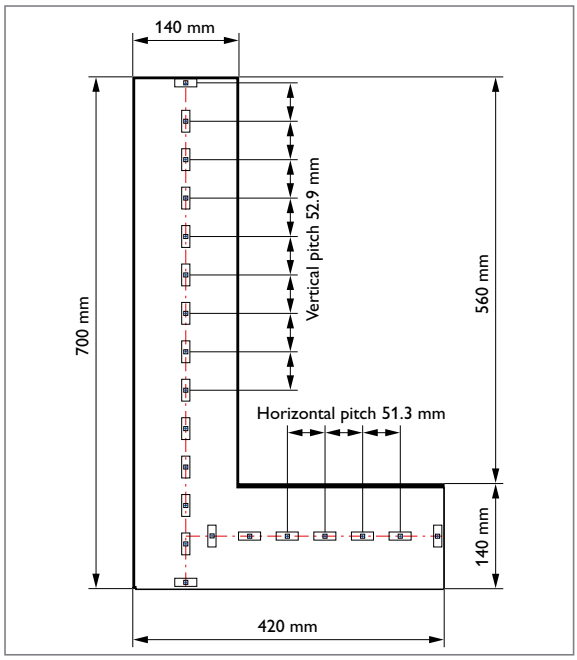


Fig. 35 LED mounting positions

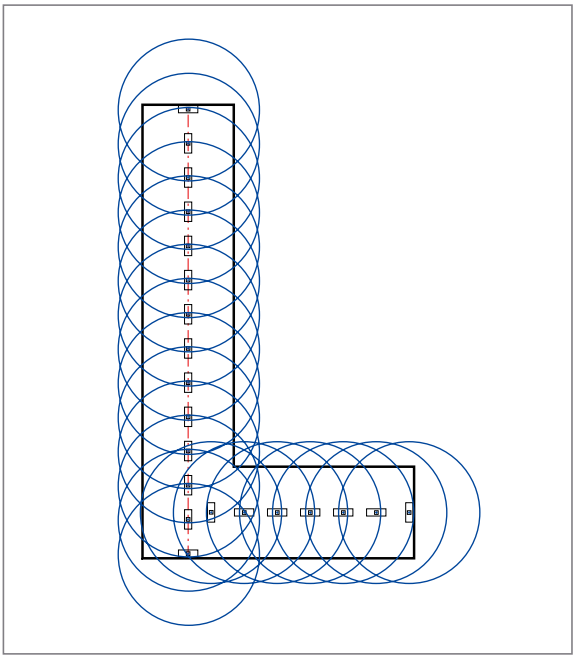


Fig. 36 Light all, incl. corners

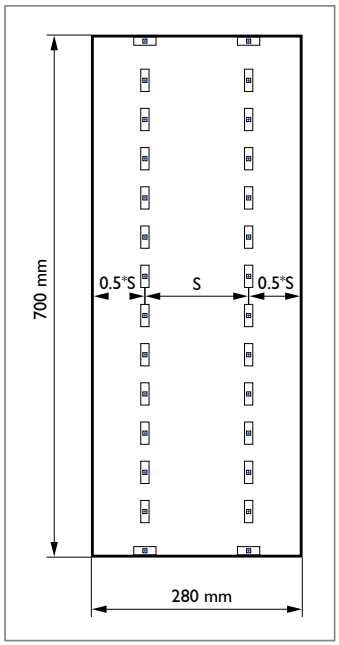


Fig. 37 LED String distribution

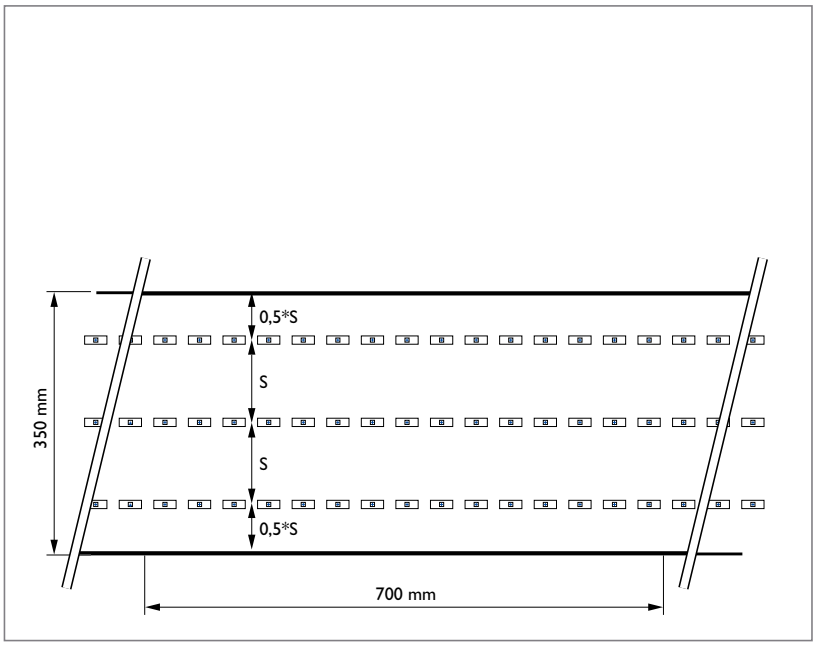


Fig. 38 Lines of application

Note:

As LEDs produce a light beam instead of light in all directions, as with neon, and because channel letters can show all kind of shapes, it is advised to always perform a visual check before fixing the LED string in the sign.

4.5 Special applications

In case of special applications that require special colors or dedicated wire lengths, contact your local Philips sales office.

5 Installation guide

5.1 Recommended materials

5.1.1 Recommended interconnection connector

LS Connector Xtend - interconnects a driver and a string
- interconnects a string and a string

LS Connector End Cap- makes the return connection for the LED current

Fig. 39 Connectors - LS Connector Xtend

LS Connector End Cap

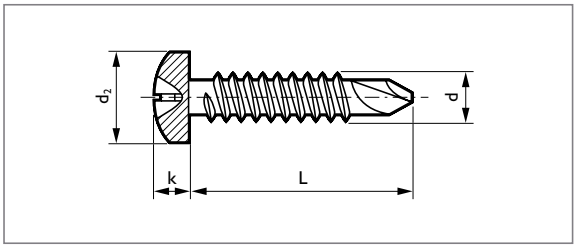
Note:

The insulation must remain on the wires to allow for a maximum insertion of the wires into the connector.

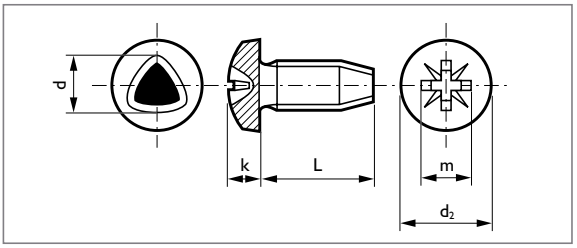
5.1.2 Recommended fixing materials for the LED string

The LED string devices are designed to be mounted to a sign back-plate or other substrate using the dedicated mounting clips or by means of double-sided adhesive tape, using the Philips LS Mounting Tape pads. In case mounting clips are used Philips Lighting advises the use of the following types of screws for fastening the mounting clips:

5.1.2.1 Fasteners for the LED string mounting clips



Stainless steel self-drilling tapping screw
ST2.9 x 13mm according to DIN 7504 M
Screw head according to DIN 7981 type H



Stainless steel tread forming screw
M3 x 12mm according to DIN 7500C
Screw head according to DIN 7985 type Z (Pozidriv).

Fig. 40 and 41 Recommended fasteners for colored LED strings.

Note:

1. *The fasteners are not included with the LED string system and must be ordered locally.*
2. *DO NOT use counter sunk screws.*

5.1.2.2 LS Mounting tape; double-sided adhesive taps

An alternative for the use of fasteners is the use of adhesive pads.
When applying the LED string to a backplate using double-sided adhesive pads, we advice using pre-shaped (rectangle 19mm x 12mm, 0.6mm thick) double Phillips LS Mounting Tape pads. It is also recommended to use the dedicated mounting clips at curve positions.

Note:

1. *The use of the Philips LS Mounting tape together with the LED string has been tested for stainless steel, aluminum and PMMA. If other materials or coatings are used, please ensure that these are compatible with the adhesive pads. If there is any doubt use the dedicated mounting clips instead.*

Applying double-sided self adhesive tape and adhesive mounting clips

Below you will find the suggested surface preparation techniques to be used before applying the recommended LS Mounting tape and LS Adhesive Mounting Clips. The basic cleaning method is the same for many adhesives and coatings on a broad variety of substrates. There are only a limited number of situations where more specialized procedures are required.

Most substrates common to Philips Mounting Tape pads applications are best prepared by cleaning with isopropyl alcohol (IPA). Where heavy oils or greases are present, there may be a need to use degreasing solvent which should always be followed by an IPA cleaning procedure to ensure that any residue or film is removed. Some plastic or paints may have additives that are low surface energy materials and can impede adhesion. These may require removal by abrading (Scotch brite A very fine), priming or using a scotch-tape suitable for that specific surface.

Procedure

Spray or wipe the solution onto the surface and then wipe with a clean cloth or paper towel until dry. Be sure to use clean cloths to avoid smearing around the substrate and recontaminating already clean surfaces.
After cleaning, the tape can be applied, pressed into place and the surfaces can be mated and rolled down.

Effect of pressure on bond performance
The greatest effect on ultimate bond performance is the surface preparation technique employed and the extra pressure applied using mechanical equipment does not impact a greater bond strength than pressure being carefully applied using hand pressure.

5.2 Mounting instructions

The construction of channel letters using LED strings is shown in figure 17. The same paragraph (1.3) briefly explains LED string system configurations with the various driver. More detailed information is provided in the following paragraphs.

5.2.1 Building the sign

In a few easy steps the LED string is connected and mounted into the sign.
Where applicable, the differences between screwing mounting clips and applying adhesive for mounting LED string devices in a design will be highlighted. See Quick installation guide, page 34.

General recommendation for the installation of the LED Power Driver:

Even though the LED Power Driver is an outdoor type driver, it needs to be installed inside an enclosure (channel letter, band light or dedicated installation-box), especially since the mains wiring connections need to be protected from direct human contact. Although channel letters and band light applications normally have provisions to avoid the collection of water inside the enclosure, the driver must be installed at least 2.5 cm above the bottom of the enclosure (see figure 43). When mounting the driver inside a channel letter enclosure, make sure the driver does not block the light from the LED devices, as this will cause dark spots on the letter surface. A distance of 38mm away from any LED device is enough as can be seen in figure 44.

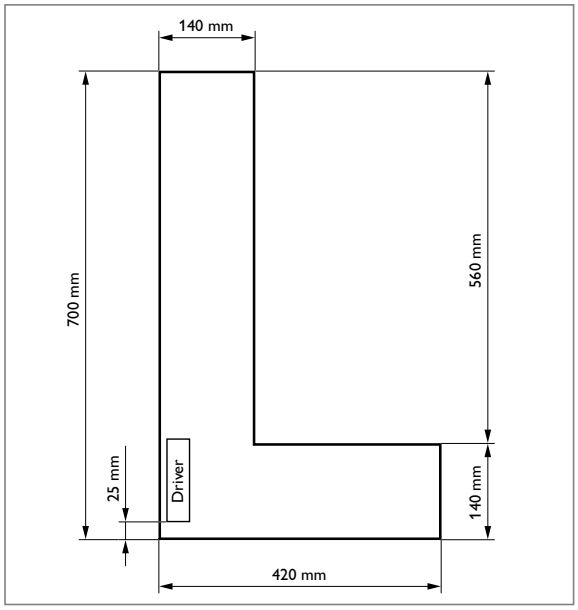


Fig. 43 Driver in channel letter

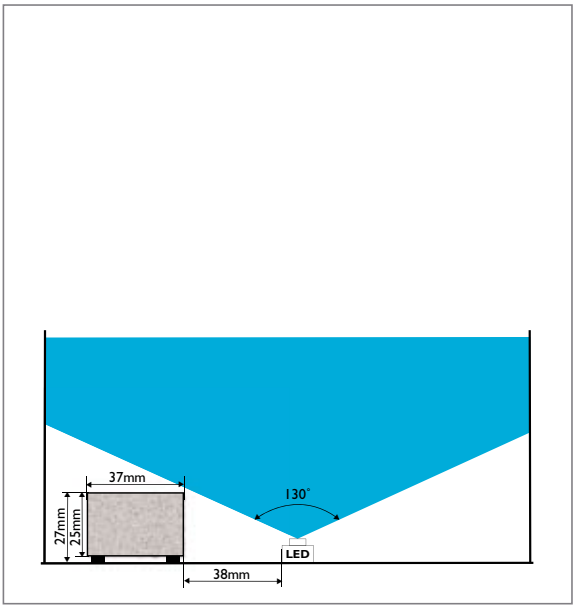


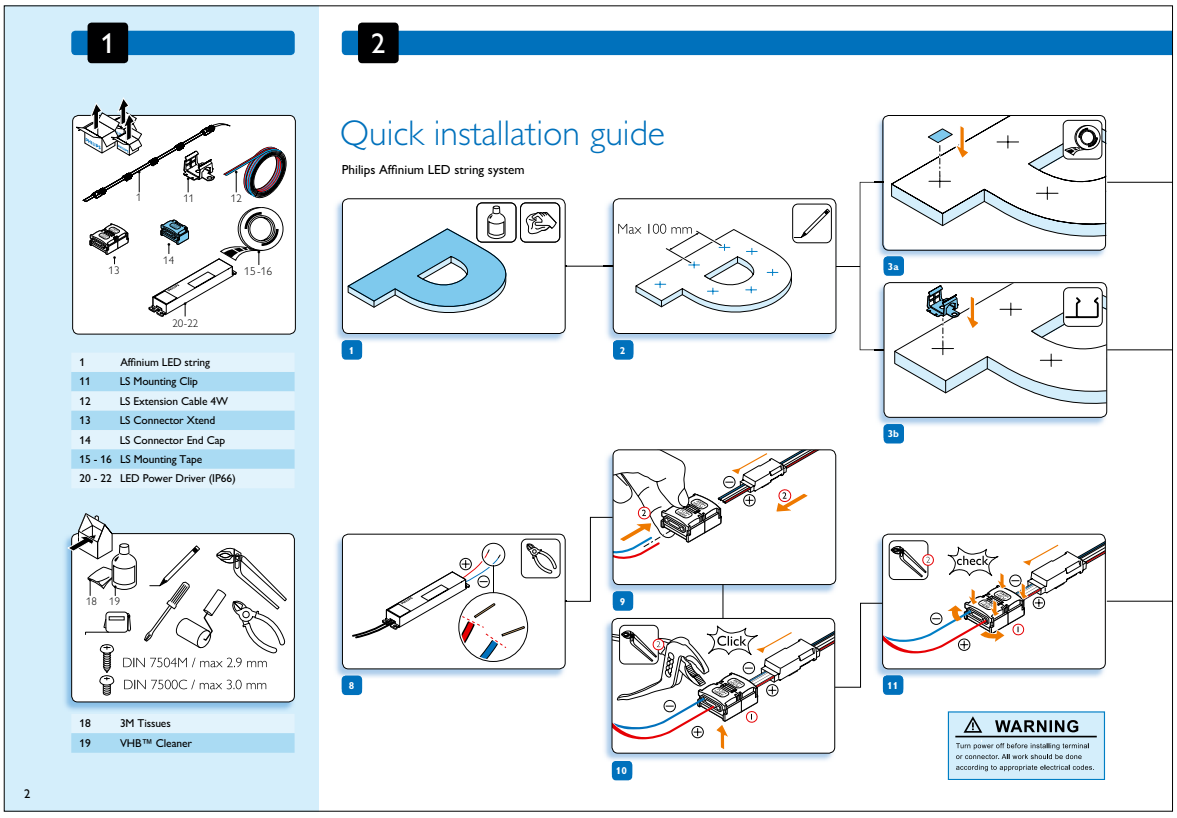
Fig. 44 Position of a LED Power Driver of 20W vs a LED string device

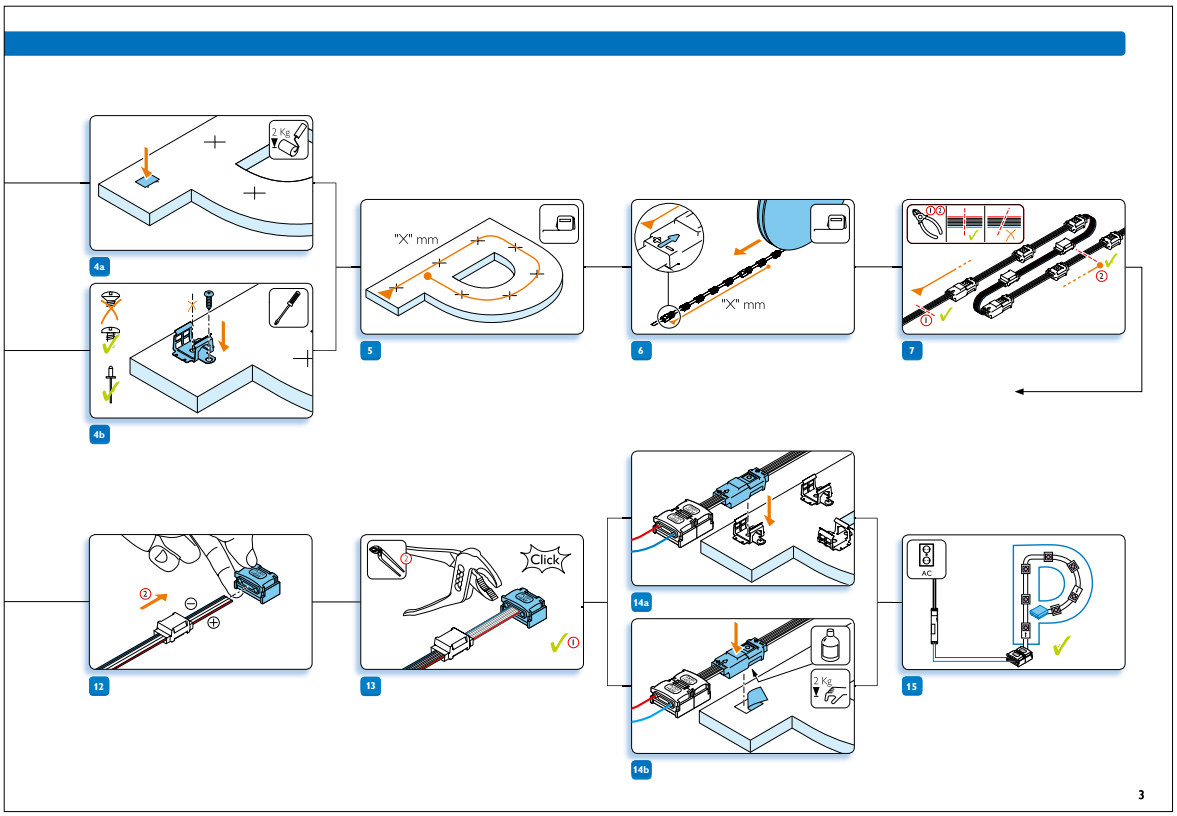
Note:

1. The use of the recommended adhesive tape and adhesive mounting clips, together with the LED string have been tested for stainless steel, aluminum and PMMA. If other materials or coatings are used, please ensure that these are compatible with the adhesive tape. In there is any doubt, use the dedicated screws for fastening the mounting clips instead. See chapter 5.1.2.2 for information on how to apply the recommended double-sided adhesive tape.

Quick installation guide

In every packing of the LED string we have added a quick installation guide, equal to the information on the next pages.





6 Fault-finding

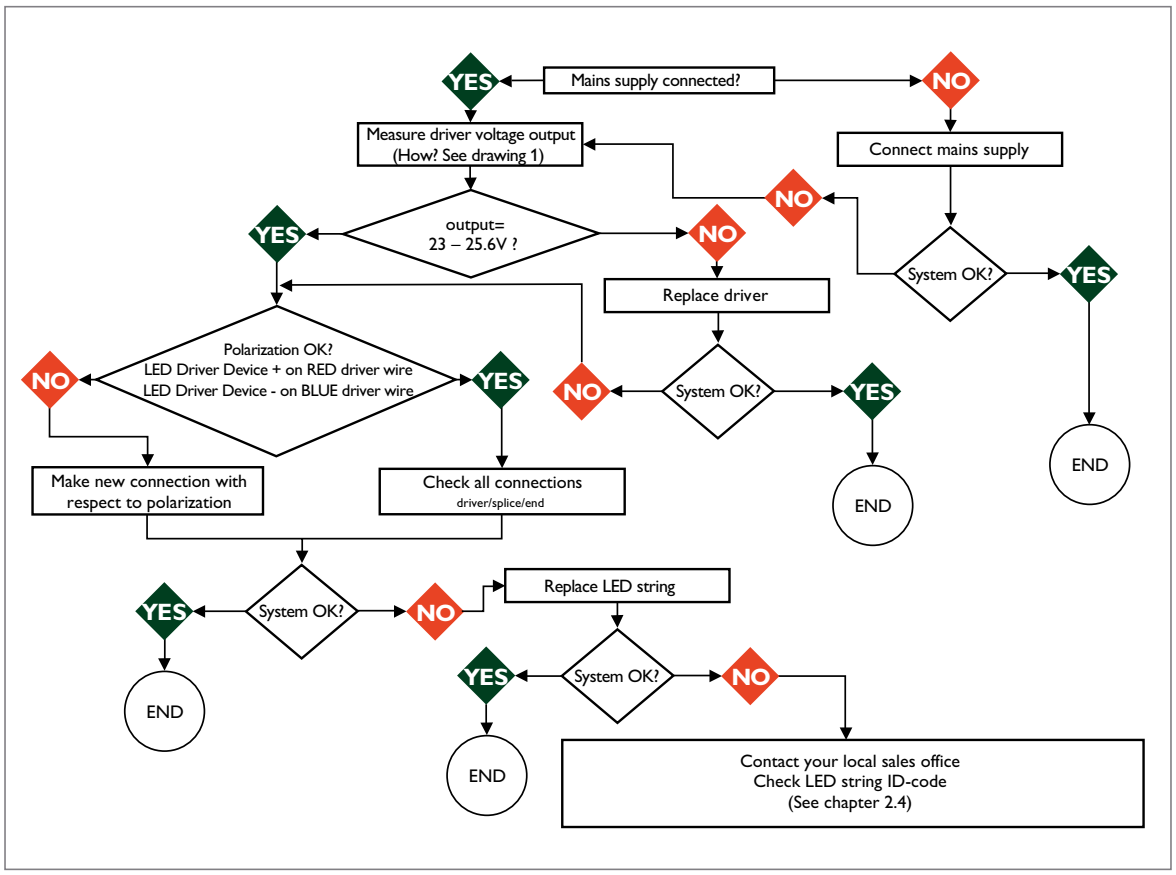
For service aspects regarding the LED string system, please refer to the Appendix with fault-finding plans at the next pages. These may help to solve the most common system and application issues.

Please contact your local sales office if you have any further questions or problems.

Fault-finding plans

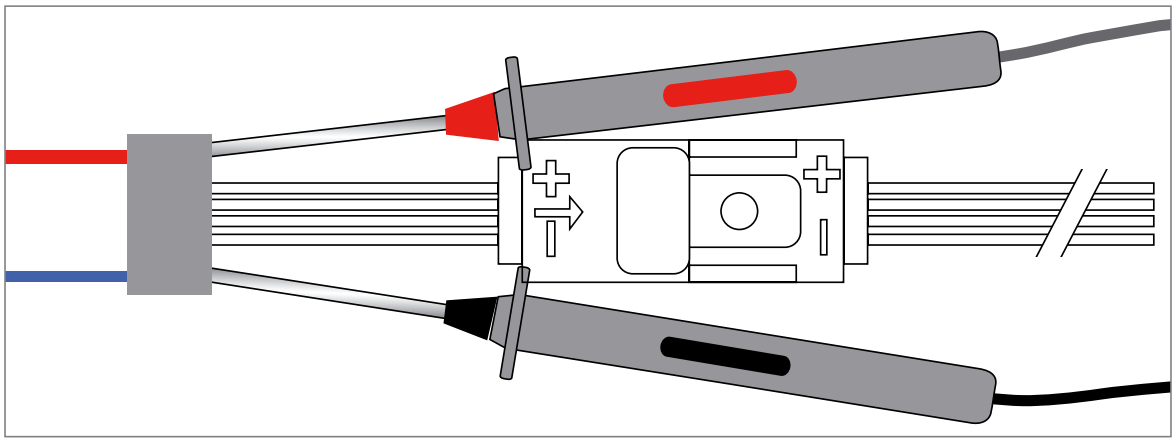
6.1 No light output
6.2 Poor uniformity new system, part 1
6.3 Poor uniformity new system, part 2
6.4 Poor uniformity existing in field system
6.5 Fluctuation in light output
6.6 Partial light output

6.1 No light output



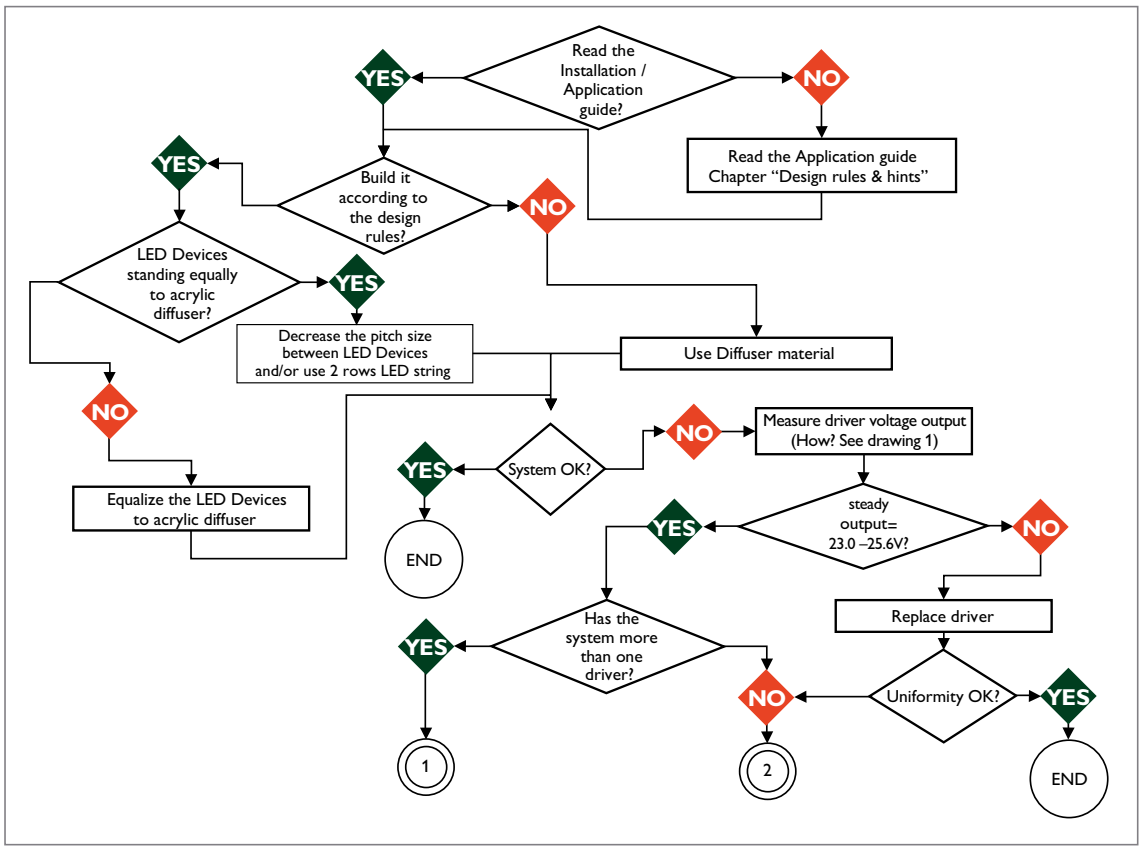
6.2 Measuring the driver output without damaging the system

Materials needed: multimeter with needle probes (tip diameter max 2 mm). The unused LS Connector Xtend terminals can be used for taking voltage measurements.

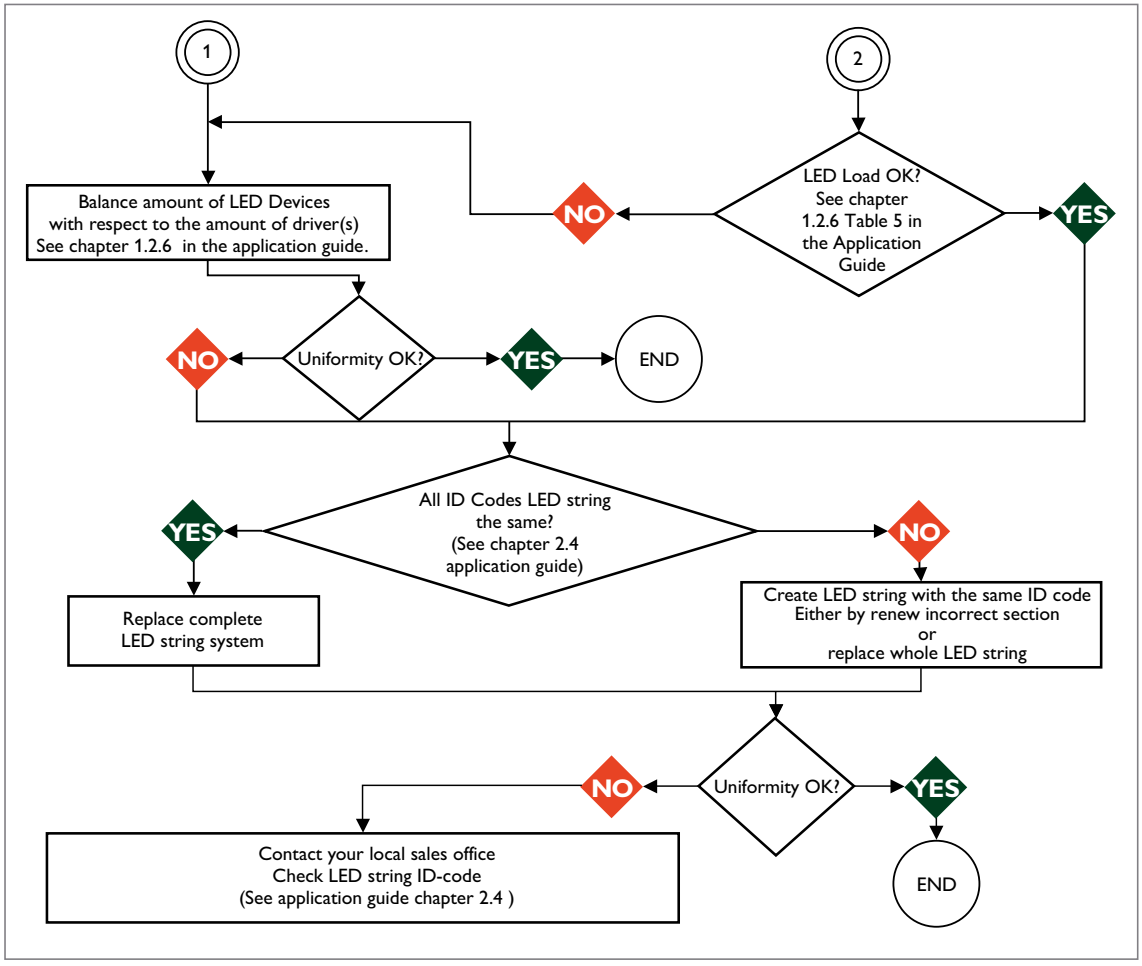


Drawing 1. Measure the driver output

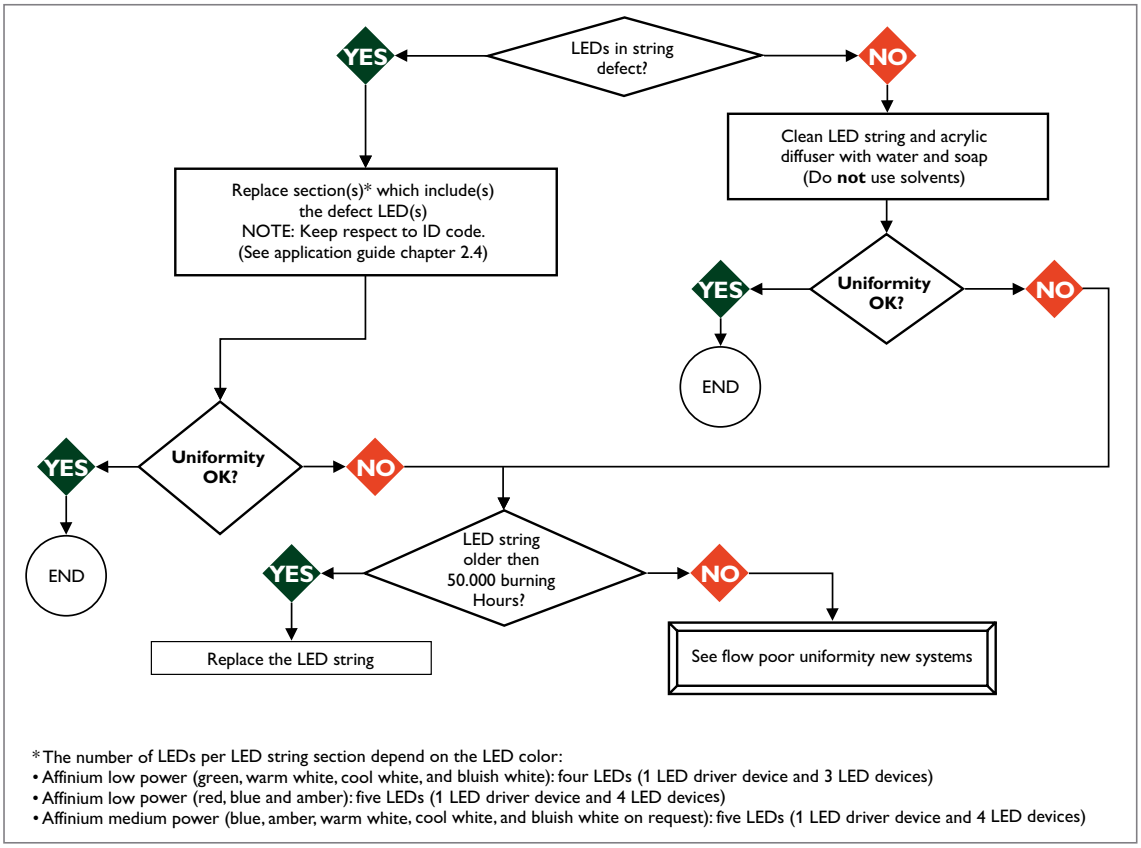
6.3 Poor uniformity new system, part 1



6.4 Poor uniformity new system, part 2

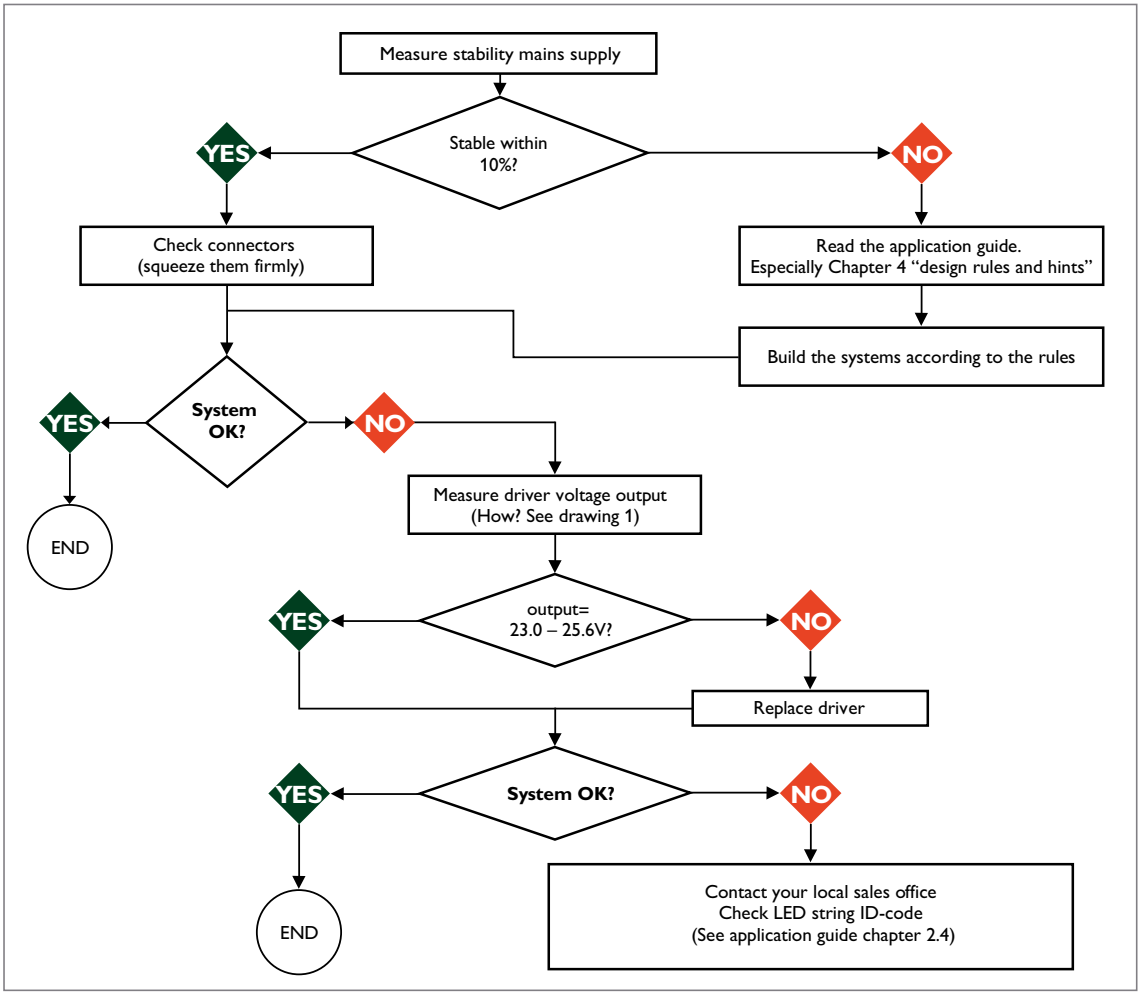


6.5 Poor uniformity existing in field system

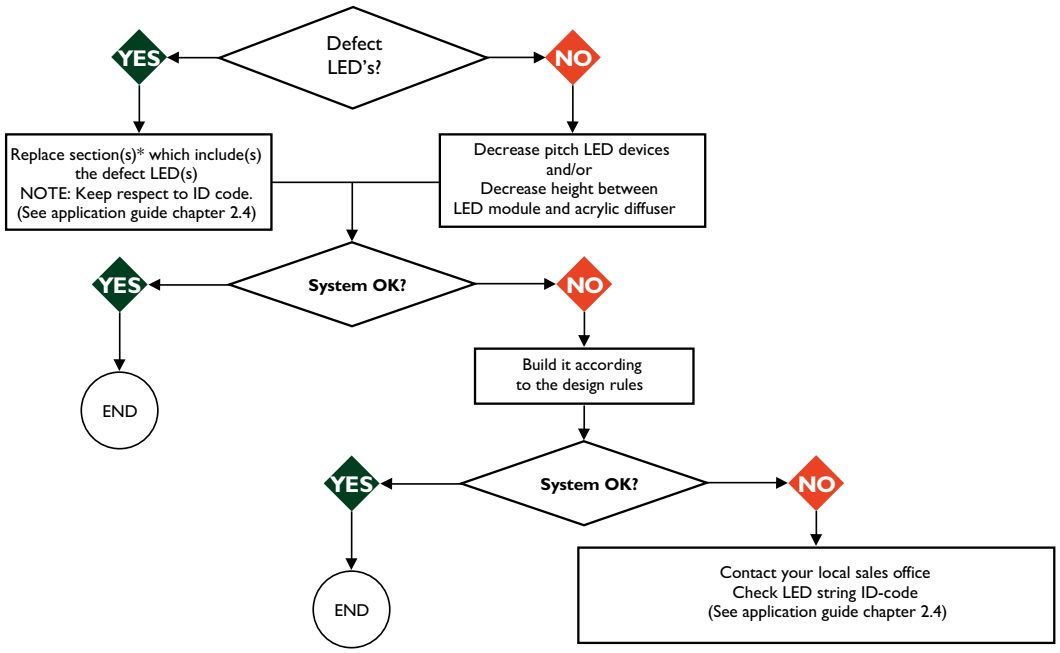


*The number of LEDs per LED string section depend on the LED color:
- Affinium low power (green, warm white, cool white, and bluish white): four LEDs (1 LED driver device and 3 LED devices)
- Affinium low power (red, blue and amber): five LEDs (1 LED driver device and 4 LED devices)
- Affinium medium power (blue, amber, warm white, cool white, and bluish white on request): five LEDs (1 LED driver device and 4 LED devices)

6.6 Fluctuation in light output



6.7 Partial light output



*The number of LEDs per LED string section depend on the LED color:
- Affinium low power (green, warm white, cool white, and bluish white): four LEDs (1 LED driver device and 3 LED devices)
- Affinium low power (red, blue and amber): five LEDs (1 LED driver device and 4 LED devices)
- Affinium medium power (blue, amber, warm white, cool white, and bluish white on request): five LEDs (1 LED driver device and 4 LED devices)

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