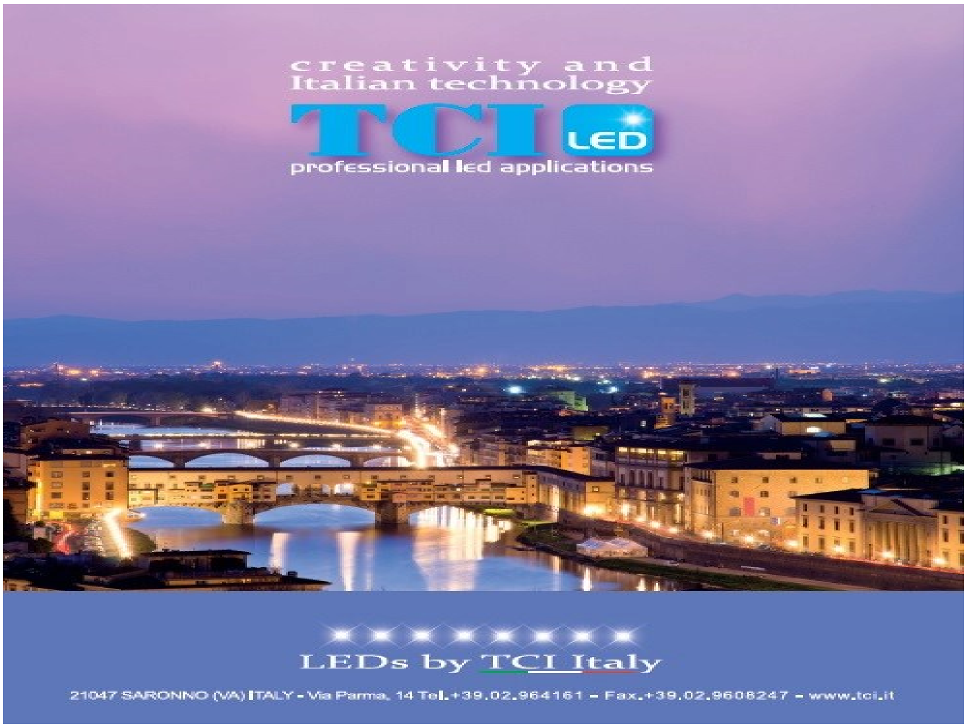

Electronic Drivers for LED & OLED: An Industrial Perspective

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What is a Light Emitting Diode?

A Light Emitting Diode (LED) is an optoelectronic device made up of **inorganic semicontuctor layers** which emit light when stimulated by current.

Electricity is converted into photons: this allows great savings in terms of efficiency compared to other light sources, where most electricity is turned into heat while only a little part becomes light.

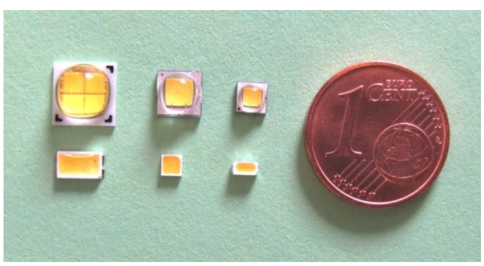
1962: **Nick Holonyak Jr**, a consultant at GE, develops the first LED (indicator lights)

1992: **Shuji Nakamura**, researcher at Nichia Chemical Industries, develops the first BLUE LED, which allows to produce white light. (LEDs enter the lighting market).

1995: the first WHITE LED is introduced

In less than 10 years the efficiency of LED grows from 5 lm/W up to > 100 lm/W and now it can reach 160 lm/W.

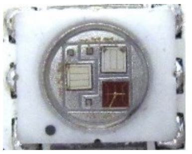
Why are LEDs progressively replacing the other light sources?



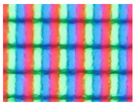
Some examples of inorganic LEDs.

The LED in the top left corner emits the same luminous flux of an old 100W incandescent lamp absorbing only 10W.

RGB LEDs



A RGB LED is a device made up of a red, a green and a blue LED. By combining these 3 colours it is possible to reproduce all the chromatic spectrum. If red, green and blue are turned on alltogether, white light is generated:

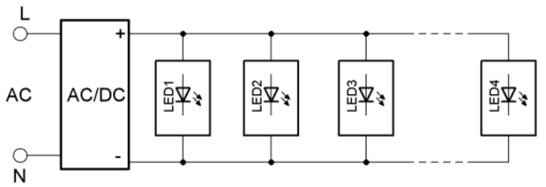


enlargment of the white area of a monitor

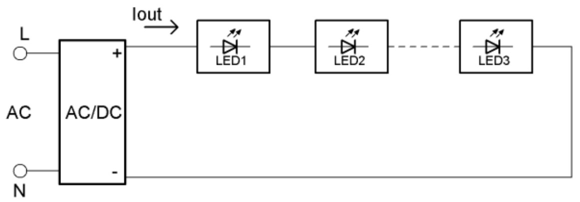
Power supply for LEDs

A LED is a low voltage device (typical voltage of a white LED: 3V) which requires something to turn the mains voltage (230Vac in Europe; 110Vac or 277Vac in the USA…) into a lower one, suitable to its operation:

Constant Voltage VS Constant Current drivers



CONSTANT VOLTAGE POWER SUPPLY



CONSTANT CURRENT POWER SUPPLY

Main features of LED drivers

- Rated voltage: 110-127Vac; 220-240Vac; 277Vac
- Power output; Voltage output; Current output;
- Dimmable (1…10V, PUSH, DALI) / Not dimmable
- Protection against mains spikes
- SELV / not SELV
- Dip-switch (?)
- Ripple
- Lifetime
- Country of origin

UNIVERSALE 20

TCI LED

Direct current electronic drivers with DIP-SWITCH
Alimentatori elettronici in corrente continua con DIP-SWITCH

Made in Europe

constant CURRENT | constant VOLTAGE

RIPPLE FREE

SELV

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ACTIVE PFC | DIP-SWITCH | 2kV DIFF. 4kV COMM. | COOKER HOOD | SAFETY PROTECTIONS

Rated Voltage
Tensione Nominale
220 ÷ 240 V

Frequency
Frequenza
50...60 Hz

AC Operation range
Tensione di utilizzo AC
198 ÷ 264 V

DC Operation range
Tensione di utilizzo DC
170 ÷ 280 V

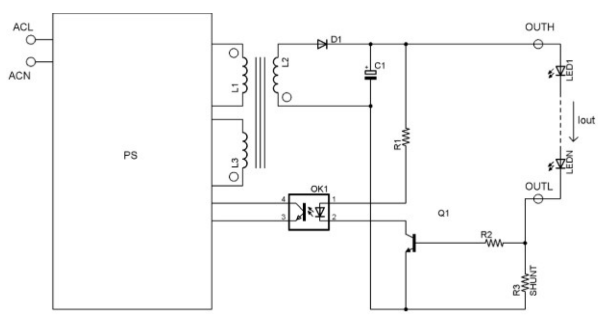
Power
Potenza
0 ÷ 20 W

Maximum current output ripple
Max. ondulazione della corrente uscita
≤ 3%(1)

Article Articolo	Code Codice	P out W	V out DC	I out DC	n° LED max.(1)	V out max.	ta °C	tc °C	λ max. Power Factor	η max. Efficiency(1)
UNIVERSALE 20(3)	122201	Constant current output - Uscita in corrente costante					-25...+50	80(2)	0,97	>88
		13	10...54	250 mA cost.	16...18	59				
UNIVERSALE 20 BI	122201BI	19	2...54	350 mA cost.	16...18					
		20	2...50	400 mA cost.	15/16					
		20	2...44	450 mA cost.	12...14					
		20	2...40	500 mA cost.	11/12					
		20	2...37	550 mA cost.	10/11					
		20	2...34	600 mA cost.	9/10					
		20	2...29	700 mA cost.	8/9					
		Constant voltage output - Uscita in tensione costante								
		16	24 cost.	700 mA max.	-	-				

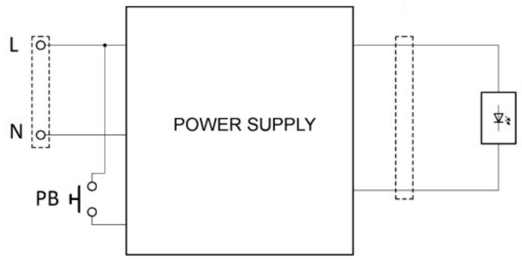
(1) Referred to V_{in} = 230 V, 100% load - Riferito a V_{in} = 230 V, carico 100%
(2) Tc = 75°C for Pout ≤16W

Simplest current regulation method



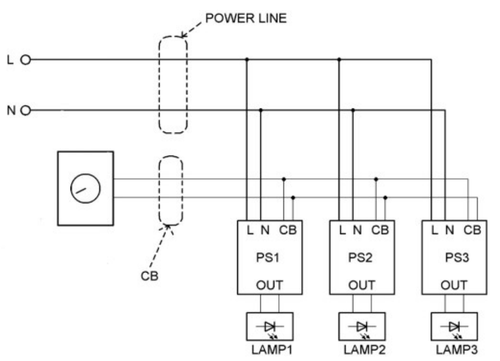
The level of the current output can be set by using this formula:
Iout = Vbe/R3
Vbe = around 0,7V at 25°C ambient temperature
R3 = shunt value

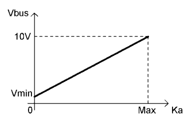
Dimming by means of a push button



This dimming method is tipically used for single lamps, because synchronization problems may arise in case of multiple-lamps installations.

Dimming by means of a control bus



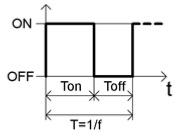


1-10V CB: 1V=Minimum Level 10V=100%

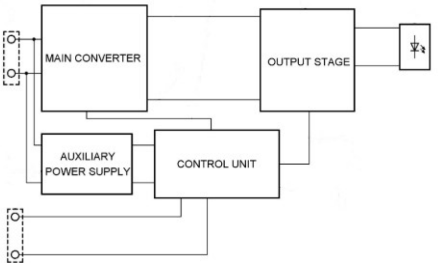
Suitable for large appliances with large number of luminaires
Analog bus: 1-10V
Standard buses: DALI (1Khz Baud Rate)
DMX (500Khz Baud Rate)

PWM – Pulse Width Modulation

LED dimming by means of a push button or a bus are both based on the PWM modulation of the current output.
The current generator is turned on-off at a frequency «f» with a fixed value chosed between 200Hz…400Hz with a duty Cycle «D=Ton/T.
The human eye will perceive an **average ligh flux Ldim** obtained by:
D * Lmax. There is no risk of spectral change of the LED light source as each LED is supplied with the same current level. It can be implemented easily beacuse all microcontrollers can provide PWM signals for the current modulation.
It is also possible to use an analog dimming method: it means to change the absolut current value, for standard OLEDs there is no risk of spectral change.

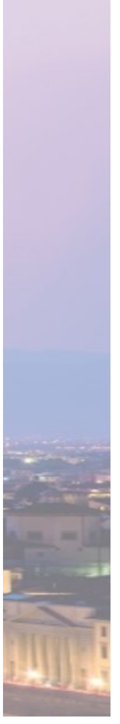


Block Diagram of a LED power supply



- **Main converter**: usually a PFC converter.
- **Output stage**: a current generator supplied by the PFC output Voltage, a control signal can turn on-off the output current.
- **Control unit**: a microcontroller with inputs connected to the control bus and one PWM output signal for the dimming function.
- **Auxiliary power supply**: a small power supply for the control unit, it can be integrated in the main converter.

What is an Organic Light Emitting Diode?



An Organic Light Emitting Diode (LED) is a device made up of several **organic semicontuctor layers** which emit light when stimulated by current.

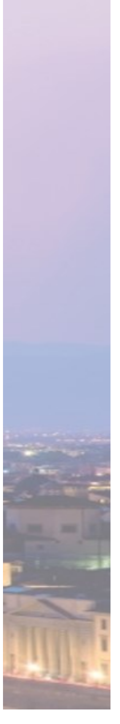
Differently from standard LEDs the light surface is greater but the efficiency is still lower: average 50 lm/W vs >100 lm/W

OLEDs are design elements that when turned on give a diffuse and soft light, with no glare nor annoying shadows. When turned off they do not affect the layout of the place where they are installed thanks to their thickness as well as their lightness.

For the above reasons OLEDs are now mostly suitable for decorative lighting, furniture, shop windows or museum cases.

The chance to produce flexible OLEDs opens to new lighting design horizons.

Main features of OLEDs



- Extremely thin: around 1mm (for handling purposes)
- Extremely light: around 18g
- No glare, no great shadows
- No hot spot, the heat is distributed over a large area
- No UV
- Lifetime up to 50.000h

Power supply for OLEDs

Just like standard LEDs, OLEDs are developed to operate with constant current. The main difference lies in two further specific circuits that an OLED driver must be provided with:

1) One detect circuit to manage possible short circuits: differently from LEDs, when there is a short circuit the OLED turns off but its voltage does not go down to 0V. For this reason it is required a detect circuit which intervenes and interrupts the supplied current, avoiding that the area affected by the short circuit overheats or even literally burns;

2) One detect circuit which manages the End Of Life of the OLED and the consequent degradation of the organic materials by regulating the supplied current.

New challenge: the development of a driver which can manage optimally several OLEDs connected in series or in parallel way.