

Properties of LED lighting

Application of LED light fittings for vehicle bodywork and ships

Because LED's are resistant to jolts and vibrations, they are ideal for use in vehicle bodywork and ships. LED light fittings are smaller than fluorescent or compact lamp fittings, which means that load space and headroom can be gained. In addition, no glass is used in LED's, so they are less likely to break than fluorescent or compact lamps. Another important advantage of Dutch Electro LED light fittings is the fact that by applying the so called 10-30 VDC multi-volt versions, the same fitting can be used for both 12 and 24 VDC and separate versions are no longer required, as they are for fluorescent or compact lamp fittings.

Light colour

Dutch Electro supplies LED lighting in various light colours, including three variants of white light:

- 'warm white' (colour temperature $\pm 3000\text{K}$, bandwidth 2900 - 3100K)
- 'natural white' (colour temperature $\pm 4000\text{K}$, bandwidth 4000 - 4200K)
- 'cool white' (colour temperature $\pm 6000\text{K}$, bandwidth 6000 - 6500K).

The colour 'warm white' corresponds to the light of halogen or incandescent lighting. 'Natural white' is comparable to the standard fluorescence colour 840, supplied with the Dutch Electro fluorescent or compact lamp fittings. 'Cool white' is a relatively cold (blue) light colour, similar to xenon light.



warm white ($\pm 3000\text{K}$) natural white ($\pm 4000\text{K}$) cool white ($\pm 6000\text{K}$)

As well as LED's with white light, we also supply red, green or blue LED's.

Colour rendering

In addition to the light colour, the colour rendering (CRI or Ra value) of LED's is another important characteristic to consider. The colour rendering of light sources is a measure of the quality with which colours are rendered. An incandescent light bulb has perfect colour rendering of nearly 100%, while a colour 33 fluorescent tube has a relatively poor colour rendering of 60%. Dutch Electro LED's have a colour rendering comparable to the fluorescent or compact lamps in the Philips 800 series (Ra value 80% minimum).

Lifetime

The lifetime of LED lighting is very high and is a minimum of 50,000 hours. This lifetime is 5 to 10 times more than that of fluorescent or compact lamps. The lifetime of LED's is usually specified for a Lumen Maintenance value of 70% (L70 value). This value relates to the number of hours that the LED can operate until it loses 30% of its original light output. The lifetime of a minimum of 50,000 hours for Dutch Electro LED light fittings can only be guaranteed if the LED's are mounted in an aluminium Dutch Electro housing. In these housings, the heat of the LED's can be conducted away via the aluminium, ensuring optimum thermal management.

LED light fittings on 230 VAC

Dutch Electro LED light fittings are suitable for 12 or 24 VDC as standard. However, with a special LED driver they can also be used with 230 VAC power supply. For the LED spotlights, a dimmable LED driver is also available, allowing a continuous variable operation from 0 - 100%.

Operating temperature LED light fittings

The operating temperature for the LED light fittings is in the range of $-40\text{ }^{\circ}\text{C}$ and $+50\text{ }^{\circ}\text{C}$. Should the ambient temperature become more than $+50\text{ }^{\circ}\text{C}$, then the automatic regulation on our LED modules prevents the modules from becoming overheated. The current will be reduced and the light output will be lowered. As soon as the ambient temperature returns within the range of $-40\text{ }^{\circ}\text{C}$ and $+50\text{ }^{\circ}\text{C}$, the LED light fittings will function at maximum light output again.

Light output lamps

The Lumen per watt ratio of a common light bulb is approximately 10 Lumen per Watt. The largest part of the energy consumption is converted into heat! Only 5% is converted into light!

Fluorescent tubes and compact lamps generate less heat. The Lumen per Watt ratio of a PLS11 Watt compact lamp at room temperature is 80 Lumen per Watt.

With power LED's the light output is even higher; up to 40% of the energy consumption is converted into light. The Dutch Electro power LED's have a Lumen per Watt ratio of 100 to 120 Lumen per Watt. This means that this type of LED's is even more efficient than PLS or PLL compact lamps.

Power supply of LED fittings

Battery chargers

Dutch Electro light fittings must to be connected to a DC power supply (12 or 24 VDC). The DC power needs to be drawn from either a battery or a AC to DC power converter. Problems often occur when the DC power is drawn directly from a "regular" battery charger and without the battery being connected. In that situation peak voltages can damage the electronics. Therefore a battery charger should always be connected to the battery, and never directly to the light fittings. The battery operates as a capacitor and levels off peak voltages of the battery charger.

Peak voltage

All LED light fittings must be connected directly to the battery via a separate power cable. Other "consumers" may not be connected to this power cable, in order to avoid peak voltages (inducted voltage). Peak voltages are hazardous to the electronics and decrease the life time of LED light fittings. Therefore the electric circuits of lighting and other "consumers" such as tail lifts always are to be separated.

Low voltage

LED lights also operate at low voltage, so below their nominal voltage. With 12 VDC batteries the voltage may drop to a maximum of 10 VDC and with 24 VDC batteries the voltage may drop to about 22 VDC without problems for the LED's. Low voltage problems for instance occur when:

- bad or broken batteries and/or alternators;
- vehicles such as market vans with very low driving distances and where the lighting is operated for a long time, without the battery being charged in a proper way because the engine doesn't run enough;
- electric circuits with too thin power cables (see calculation of power loss in a cable on the next page).

Charge voltage

In vehicles the charge voltage of a battery is normally delivered through an alternator. This charge voltage is not a problem for Dutch Electro LED lights which are connected to the battery. The charge voltage of 12 VDC batteries normally is about 14 VDC and the charge voltage of 24 VDC batteries is about 28 VDC.

Calculation of voltage loss in wiring

Voltage loss can be caused by wiring that is too thin.

In case of a high voltage loss, the fittings will operate on insufficient voltage.

The maximum voltage loss should not exceed 5%.

Voltage loss in a copper cable can be calculated as follows:

$$\frac{2 \times \text{distance between battery and fittings (in meters)} \times \text{factor } 0.0175}{\text{Cable diameter in mm}^2} \times \text{amperage (combined total of all lamps)} = \text{voltage loss}$$

In a 12 VDC installation, the maximum affordable voltage loss is 5% of 12 VDC = 0.6 VDC and in a 24 VDC installation the maximum affordable voltage loss is 5% of 24 VDC = 1.2 VDC.

Example: A truck with 10 fittings of 1.5 Ampère each, distance to battery 15 meter, cable 2.5 mm² has a voltage loss of

$$\frac{2 \times 15 \times 0.0175}{2.5} \times (10 \times 1.5) = 3.15 \text{ VDC.}$$

In this example a thicker cable or multiple cables will have to be used, since the voltage loss should not exceed 5%.

Cleaning polycarbonate diffusers on LED fittings

Dutch Electro LED fittings are, in general, equipped with polycarbonate diffusers.

These diffusers need to be cleaned in the following order:

- *Dusting*
Dust with a soft, damp cloth or chamois. Dry or gritty cloths may cause surface scratches and create a static electric charge on the surface of the polycarbonate diffusers.
- *Lukewarm cleaning*
Clean polycarbonate diffusers with mild soap and lukewarm water. Use a clean soft cloth, applying only light pressure. Rinse with clean water and dry by blotting with a damp cloth or chamois.
- *Do not apply*
Window cleaning sprays, kitchen scouring compounds or solvents such as acetone, gasoline, alcohol, oils, carbon tetrachloride or lacquer thinner or any substance that is not compatible with these polycarbonate diffusers. These can scratch the surface and / or weaken the products causing small surface cracks called 'crazing'.

Reverse polarity protection

All Dutch Electro LED modules are protected against reversed polarity. If the positive and negative leads are connected to the wrong terminal, the fitting will not function, but the built in protection will prevent it from getting damaged. Once the positive and negative leads are connected correctly, the fitting will function accordingly.