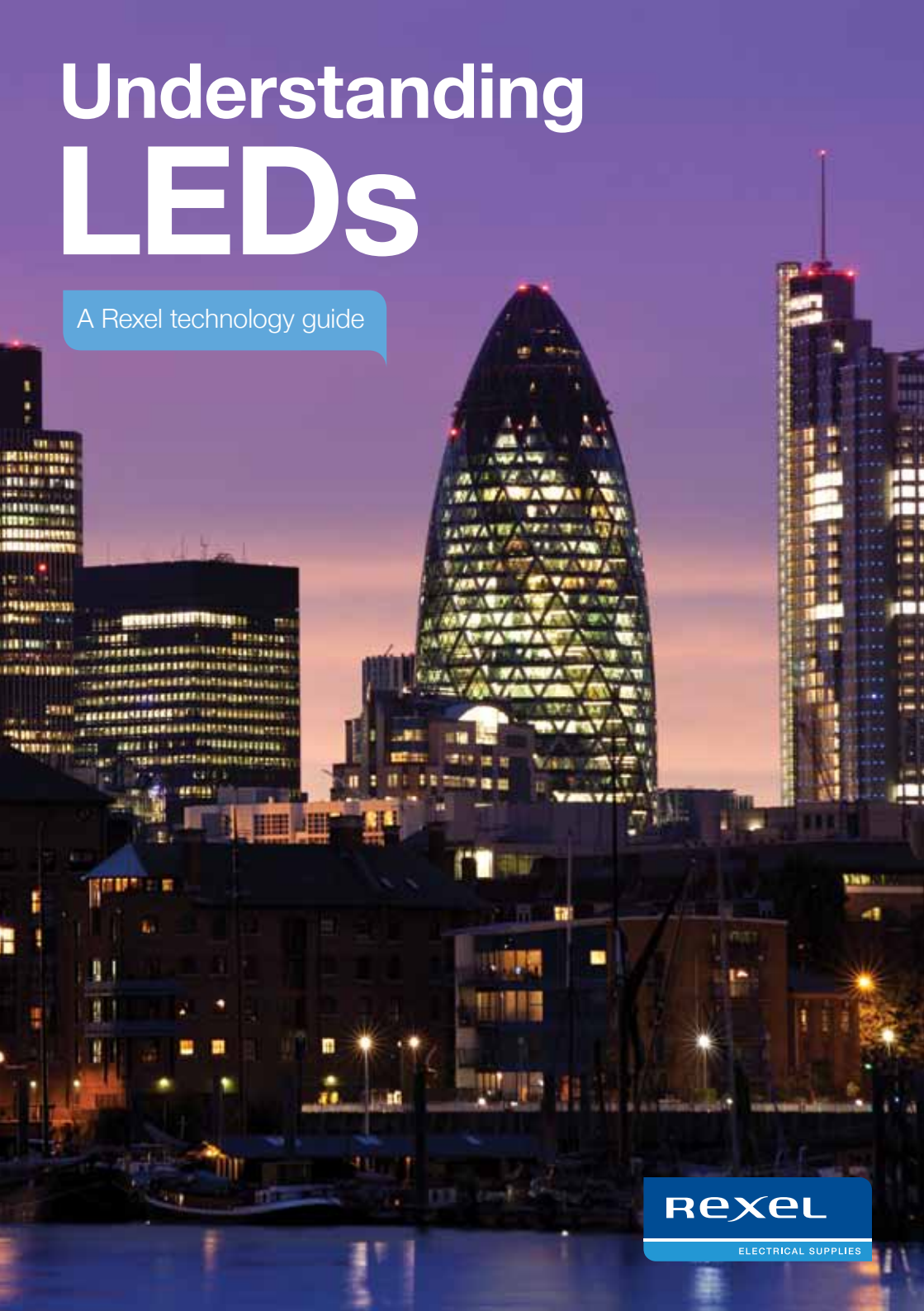
Understanding LEDs

A Rexel technology guide



Rexel
ELECTRICAL SUPPLIES

Why choose Rexel?

Rexel is the largest supplier of electrical products in the world operating in 36 countries and employing over 29,000 employees.

In the UK, Rexel has over 400 branches operating under the banners of Newey & Eyre, WFSenate, Denmans, Wilts, and Parker Merchanting.

Contents

Quick questions and answers

‘Can I save energy and money by changing to LEDs?’

It all depends on your existing installation. The simplest way to find out is to ask the Rexel team for a lighting energy survey. They will tell you where you can save energy and provide a Return on Investment (ROI) spreadsheet showing costs and payback periods. They can also advise on retrofit lamps.

‘LEDs are the most efficient light source available… aren’t they?’

Unfortunately, there is not a simple yes/no answer to this question. The main reason is that LED fittings and retrofits vary enormously in quality. The LED itself, also known as a chip or dye, can be very efficient. However, when it warms up and is inside a light fitting, the output will be considerably less.

Some good LEDs can exceed the efficiency of T8 fluorescent, whereas some low wattage retrofits we have seen were worse than T/H in terms of the amount of light per watt they emitted. LEDs are very directional and the illumination directly under the fitting can be more than fluorescent, but you need to consider the total installation to make a fair judgement.

‘Is an LED downlight more efficient than a compact fluorescent one?’

Normally, the answer is YES but you must make sure that you achieve similar levels of delivered light. As a general rule, CFL downlights where the lamps are horizontal emit more light than the same downlight with vertical mounted lamps.

Also, high wattage CFL downlights generally emit more light per watt than low power ones, e.g. 2 x 24W compared with a single 18W.

If the downlights are for a corridor, consider the distance between the fittings. LED downlights often give a narrower beam than its equivalent CFL, so you might get a less uniform appearance on the walls and floor.

‘How do I choose a good quality LED?’

The quality of LEDs and fittings varies enormously. As a rule, better quality LEDs will have longer life, higher light output, better colour rendering and lower energy consumption. Rexel staff are trained to advise clients on the quality of products available. There is often a choice of equipment available. Always read the data given in the literature carefully.

If a particular aspect is important to you or your customer, read about it in more detail in this leaflet.

‘How do I calculate how much a lamp costs to run in £ per year?’

The calculation is: Watts **x** electrical cost per kWh **x** burning hours per year **/** 1000.

For this, you need to know three things:

- **A** The wattage of the lamp (preferably including the gear losses if you know them, but just the lamp wattage will give you a good idea).
- **B** The cost of electricity per kW/hour. A kW/hour is often called a unit of electricity. A typical figure might be 12p per unit but remember that 12p is £0.12 when you enter the figure in your calculation.
- **C** The burning hours per year. A typical office is 3000 hours, dusk until dawn lighting is 4380 hours.

As an example: 60W **x** £0.12 **x** 3,000 hrs **/** 1000 **=** £21.60

Note that occupancy sensors and dimming can also be used to save energy but it is harder to estimate actual energy savings compared with a simple ‘watts used’ calculation.

‘Can Rexel do the calculations for me?’

Yes, our staff would be pleased to calculate the energy savings for you. Rexel have dedicated teams who will complete full ROI documents that will include energy saved and installation costs.

‘What does rated life mean?’

This is an average figure giving the operating hours when 50% of a batch of lamps/LEDs has failed. Note that after this period, the light output from the still functioning lamps/LEDs will also be lower. **See page 17 for more information.**

‘Why does the back of the LED feel hot?’

LEDs produce their heat over a very small area (often less than 1mm^2) and this heat needs to be conducted away as quickly and uniformly as possible. The LED fitting feels hot because it is usually smaller than its equivalent using another light source. Good quality fittings will have metal heat sinks and fins to dissipate the heat.

‘How do I know if I am buying a cool or warm appearance LED?’

The simplest way is to look on the packaging or luminaire label and look for a figure like 2700K, 3000K, etc. The lower the figure, the warmer the appearance. Cool LEDs will be in the range of 4500K to 6500K, maybe even higher.

Alternatively, switch on the fitting and look at it in daylight. Warm LEDs will be slightly yellow or orange in appearance. **See page 19–20 for more information.**

‘How often do I need to clean an LED fitting?’

A lot of users clean the fitting at the same time as they replace the lamp. Since LEDs have a much longer life, cleaning is not required often.

In clean environments like offices, this may not be a problem especially since most LED fittings do not have reflectors that collect dust. In factories there can be a build up of dust and it is recommended to use a sealed fitting so that only the outside needs to be cleaned.

Remember that the latest edition of BS7671 requires that all electrical equipment is inspected every six years, or sooner. This could be used as an occasion to also clean the luminaire.

‘If I am offered a guarantee, what questions should I ask?’

Firstly, the guarantee should cover complete failure of the luminaire within its rated life.

- You should check what the rated life is.
- Suppliers will normally pay a proportion of the replacement cost equal to the hours operated up to failure.
- Ask if the guarantee covers failure of just some of the LEDs in the luminaire.
- Luminaires with multiple LEDs should also be covered for the failure of some of the individual chips. This will lead to a reduction of light output or, in the case of RGB units, imperfect colour changing.
- Also ask if the guarantee covers light loss over time (see lumen depreciation in the Glossary).
- Ask what the guarantee will cover if the output is less than stated?

‘What is the life of an LED driver?’

Typically drivers are guaranteed for 50,000 operating hours. This is more than 12 years for most installations.

- Ask for the rated life.
- Check the overall operating hours. Also check if there are limitations of use such as interior, exterior, ambient temperature, etc.

‘Where can I get independent advice on LEDs?’

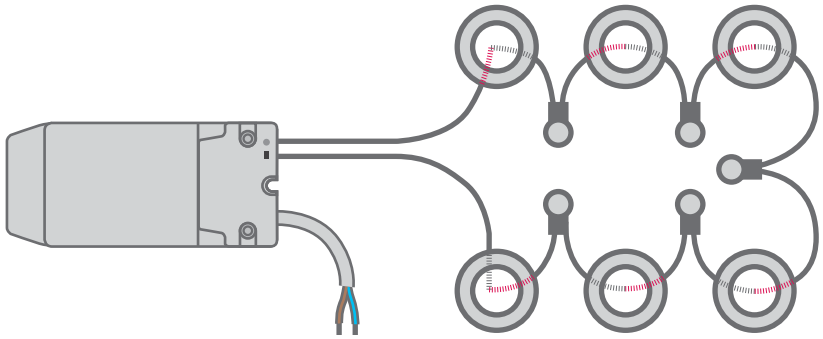
Often there are several products available that can do a similar job. Rexel staff can explain the differences in the range of our quality products. They are there to help you make an informed decision on the purchase of your LED lamp or luminaire.

‘Can I get training from Rexel?’

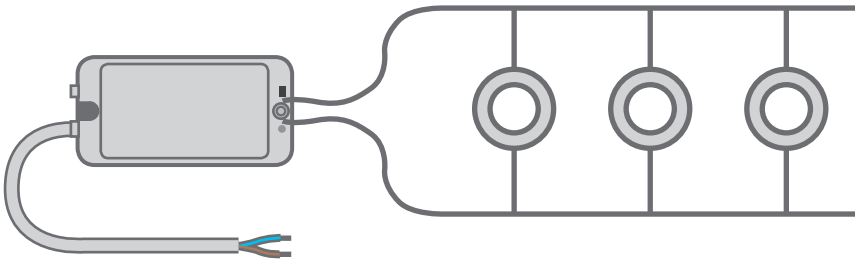
Yes. Rexel offer training to its customers on all aspects of lighting. Ask your local manager for information.

‘Why are some fittings wired in series and some others in parallel? What does it mean?’

To achieve the highest output and power from the LED chip requires intelligent electronics and a constant current output. This is only achievable with series wiring. In a **series circuit** the current is the same through all the components.



In a **parallel circuit**, all the components receive the same voltage across them but the current passing through may be different depending on the characteristics of each component.



Why is everyone talking about LEDs?

The main reason is that they are the first really new light source in twenty years.

Although LEDs were first commercially manufactured in the 1960s, it is only in the past 15 years that they have been used in commercial lighting applications. Before then, they were mainly used on indicator boards and signalling. Recently, high power LEDs have been developed, 1W and above, which means that they can produce useful quantities of light. LEDs are now found in every area of lighting application.

Their advantage over conventional light sources is their long life, efficiency and small size. Being solid state electronic devices, they are also very suited to mass production techniques. Solid State Lighting, SSL, is another aspect of the spread of high volume, modern technology electronic products such as mobile phones, personal computers and TVs.

The interest in LEDs comes with the speed of product development. The LED chip manufacturers produce greater and greater efficiencies year on year. Think how the power of PCs has developed. Early LEDs were hardly more efficient than Tungsten Halogen, whereas the latest chips are almost as efficient as high pressure sodium and yet produce white light.

Other advantages of LEDs are:

- Like other solid state devices, they can very easily be controlled digitally. Hence dimming and colour mixing can be programmed and integrated simply with other devices and services from a PC, building management systems or over the internet. They can be switched on and off instantly.
- LEDs do generate heat, but the actual beam of light from a luminaire is cool. There is no UV or IR in the beam; so LEDs can be used to light materials which are sensitive to heat and daylight. Do remember that the actual fitting will become warm or even hot, depending on its wattage.
- They can withstand impact and vibration better than conventional sources because there are no filaments or support wires to fail. Consequently, they are suited to extreme environments.
- The cooler they are, the more efficient they become and their life is extended.
- They are mercury-free and safe for the environment.
- Their small size and low heat output means they are suitable for confined spaces and shallow ceilings.

Types of LED and how they work

Older LEDs used on panels as indicator lights were typically 3mm or 5mm diameter and consumed very little power, e.g. less than 1/20 of a watt. Unsurprisingly, they did not emit much useful light. Also, they were often individually soldered on to the circuit board. Nowadays, much higher power LED chips, typically, >1W, are available either singly or grouped on a module.

It is important to remember that all LEDs are DC devices requiring just a few volts to operate. However, when incorporated into luminaires, the circuit boards inside are almost always configured to take a 230V AC supply. The exception is very small luminaires where the transformer or driver is remote.

Most high power LEDs are fed from a constant current driver. Typically, the current drawn by the LED itself is 350mA, 700mA or 1000mA. Since the voltage across each LED is around 3V, they are often described as 1W, 2W or 3W LEDs.

It is important to realise that LEDs emit less light when they warm up. This can be as much as 50% less in a poorly designed fitting. Related to this, a fitting with one LED is comparatively more efficient than the same fitting with more LEDs in it. This is due to the extra heat.

The construction of the fitting is of critical importance in how much light it emits. The most important aspect being that it must keep the LEDs cool. The best luminaires have large metal fins. The worst performing have no heat sinks and are made of plastic.

High power LEDs require an electronic device to control the current to them. This is known as a driver.

What drivers do

Drivers are always electronic devices. Unlike a transformer which supplies a steady output voltage and the current varies with the power drawn, the driver maintains a constant current and it is the driver output voltage that varies.

High power LEDs are connected in series – compare this with LV halogen lamps fed from a transformer where several lamps are connected in parallel. **Always check the wiring diagram supplied with the fitting before making any connections.**

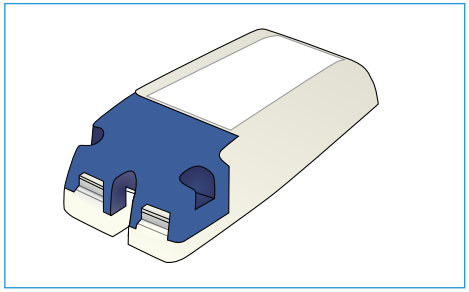
Most drivers have 350mA or 700mA output. There will be a label on the driver telling you what the output current is and how many LEDs can be connected. Note that as extra load is put on, the output voltage rises. This is limited to 50V under the EU Low Voltage Directive. The driver also protects the LEDs from normal supply voltage fluctuations and occasional ‘spikes’.

Drivers are normally integrated into the luminaire. However, luminaires which contain just one high power LED usually have a remote driver. A typical driver will control 12 or 36 LEDs. Drivers used for colour changing have three output terminals for the RGB LEDs. IP rated drivers are available for exterior applications.

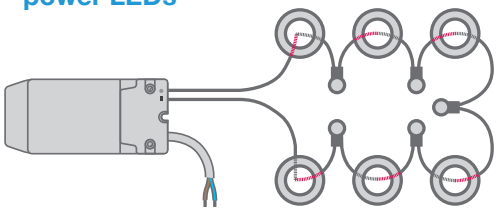
Most, but not all, drivers will be able to dim the LEDs and will have connections for a DMX or DALI signal. The signal is also used for colour change on RGB systems. Note that it is rare for the driver to be programmable. Normally, it receives a signal from a scene-set device, wall plate or building management system.

Drivers do emit some heat but much less than the equivalent wire-wound transformer.

A typical driver for internal use



Series wiring diagram for high power LEDs



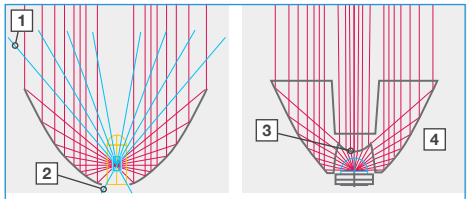
Why LED fittings are efficient

As a source of light, LEDs have several advantages over conventional lamps.

Compared with conventional lamps, the efficiency of LEDs is increasing very rapidly. Other light sources only make small incremental improvements over time. LEDs are also inherently controllable with a digital signal. This means they can be simply integrated with other building services.

Their small size means that the light beam can be directed accurately just where you need it; they do not emit light in all directions. This means that very little light is wasted from reflection inside the luminaire.

Diagram showing light path in conventional and LED luminaire



Reflector HID

1 Uncontrolled flux

2 Lost flux

LED collimator

3 The direct flux is controlled by a lens

4 TIR (Total Internal Reflection)

Note that collimator is high grade optical plastic and has lower losses than light reflecting off polished aluminium.

LEDs have a big efficiency advantage when it comes to colour. Most white light sources such as fluorescent lamps use filters to produce the required colour and the unwanted light is wasted energy. LEDs, by their nature are narrow wavelength colours and other colours are produced by combining RGB in different proportions rather than filtering.

Why the luminaire construction makes the fitting perform better

LED chips work best when they run cool. Although they are comparatively low power, their size is very small and so there can be regions of high temperature. The performance of an LED is usually defined by its 'junction temperature'. The higher this is, the shorter the life. As a rule, higher power LEDs have higher junction temperatures and so the luminaire must be constructed so as to channel away the heat from the chip as fast as possible. Most good quality luminaires have large heat sinks, often with fins. The worst performing have no heat sinks and are made of plastic.

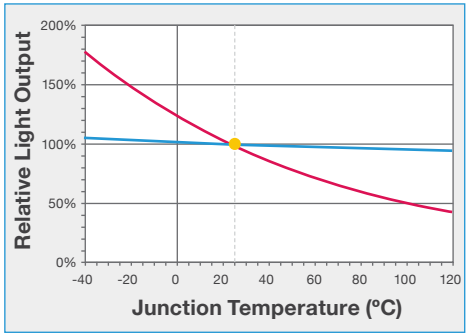
The junction temperature changes depending on the construction of the luminaire. Well made luminaires have low junction temperatures. This prolongs the life of the LEDs.

For exterior fittings, the luminaires must be thoroughly sealed and gasketted. LEDs are particularly susceptible to moisture so you must ensure that you are satisfied with the weather-proofing. We recommend that fittings used outside are IP65 or more. If the fittings are recessed in the ground, IP68 is recommended if there is any chance of puddles forming because the fittings are, in effect, submersed.

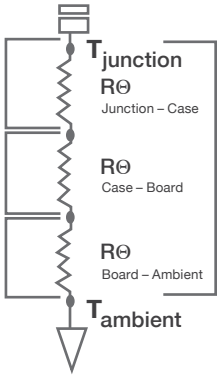
Overheating is not normally a problem as long as the heat from the LEDs is transferred to the luminaire body, as mentioned above.

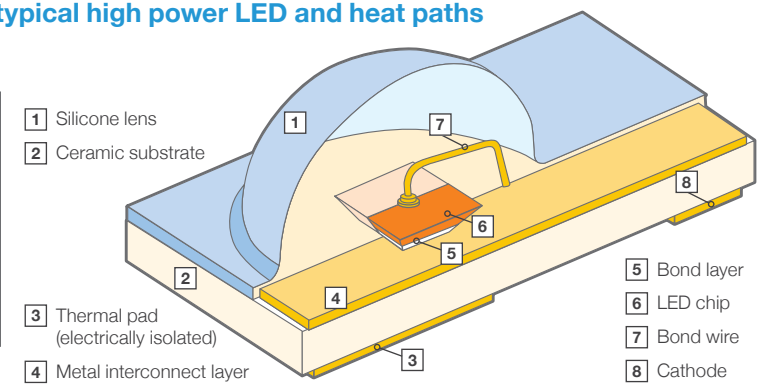
Typical good quality heat sink

How output varies with increasing LED temperature



Construction of typical high power LED and heat paths





1 Silicone lens

2 Ceramic substrate

3 Thermal pad (electrically isolated)

4 Metal interconnect layer

5 Bond layer

6 LED chip

7 Bond wire

8 Cathode

LED plug-ins and retrofits

LV halogen, tungsten filament or CFL replacements

Most of these units have the appearance of a conventional lamp and are used as direct replacements for the existing one. Some are available for 12V supply fed from a transformer, e.g. Direct replacements for 50mm dichroic LV downlights. These are often known as GU10 replacements, but GU10 actually refers to the lampholder pins.

Q You should check that the replacement unit will fit the luminaire. Many have slightly different dimensions from the lamp they are replacing. Also, not all LV downlights have a GU10 base.

A It may be necessary to get a sample of the retrofit lamp to ensure it fits your particular light fitting.

Q As with complete LED luminaires, it is important to ask the supplier for the lumen output and to compare this with the unit you are replacing.

A Poor quality literature often states the output from the chip and not the complete assembly. You can often spot this if the literature always gives exactly the same lumens/watt value for all the different sizes and variations available.

Many of these retrofit units just quote the LED wattage. However, it is often the case that the current drawn is higher than might be expected due to the very low power factor. In domestic premises, this may not matter because most homes are fitted with a wattmeter. On the other hand, most commercial premises have VA meters and these charge according to the total current drawn.

Q Ask the supplier for the value of the current drawn from the mains.

A The packaging of the retrofit should show the current drawn, e.g. 0.35mA. On a 230V supply this is 8VA but we have seen examples where the labelling stated 4W, i.e. the power factor is only 50%.

Fluorescent lamp replacements

There are two types available. The better ones are straightforward replacements for a T8 fluorescent lamp. They are suitable for wire-wound control gear and you simply change over the lamp and starter canister. The advantage of these is that no rewiring is necessary. Normally, the luminaire guarantee is unaffected.

The other retrofit LED lamp involves rewiring the luminaire and bypassing the control gear so that mains voltage is applied directly to the lamp cap. In this case, the 'LED tube' has its own gear built in (normally at the end of the tube). The big disadvantage of these retrofits is that you lose the luminaire guarantee and you become responsible for the electrical safety of the luminaire. The Lighting Industry Federation, LIF, does not endorse this type of lamp.

In terms of light output, a good quality, nominal 1200mm 'LED tube' retrofit gives 1200lm–1500lm and consumes 22–25W. This is a 30%–40% saving in energy compared with the 36W T8 it replaces, but remember that the T8 emits a lot more light. Depending on the type of luminaire and its age, the illumination level will be different using the LED replacement.

Since the LED lamps are quite directional, achieved illumination levels directly underneath the luminaire may only be a little bit lower than from the fluorescent unit. However, it is likely that the vertical surfaces such as walls and people's faces will be darker or have harsher shadowing. This can be overcome by installing extra wall lights or uplights but then the energy saving from the LEDs may be lost.

If you are using twin lamp luminaires, consider the orientation of the lamp pins. You might find that the lampholder will direct the light sideways.

Typical arrangement of lamp pins

Pins are in this orientation:

Pins likely to be in this orientation:

Light output

Is a retrofit really equal to a 50W halogen?

Light output is measured in lumens and a 50W T/H downlight emits about 600lm in a 90 degree beam.

Q Ask your supplier for the lumen output of their LED fitting, not just the chip.

A If they just quote the intensity, you need to ask for the beam angle and compare it with the existing T/H lamp. If in doubt, make a side by side comparison.

You must look at the total size of the patch of light and what the overall illumination is. This is less important if you want a narrow spotlight. It becomes much more relevant if you are lighting an area such as a kitchen worktop, bathroom or lounge.

Does the light look the same? LEDs tend to look 'cold' in comparison with halogen and warmer-looking LEDs give lower illumination than cool ones.

Think whether you need dimming. Low voltage halogen lamps are easy to dim and their appearance becomes warmer when they get dimmer. Most LEDs appear dull when they are dimmed.

Q You should check the compatibility of the LED with the existing dimming system. Most LED drivers are incompatible with halogen lamp dimmers and leading edge dimmers in general. Note that some systems may appear compatible but produce flicker at low levels of illumination.

A Your supplier should give you a clear answer if the retrofit is compatible.

There are various methods to dim LEDs, fluorescent and T/H. The actual process requires specialist knowledge of electronics. Ask for the Rexel Technical Datasheet http://www.rexelsenate.co.uk/media/uploads/

LEDs normally use pulse width modulation, PWM, for dimming.

LED luminaire manufacturers often have a list of approved dimmer suppliers. T/H is dimmed using a method known as leading edge or trailing edge.

What is the life of an LED?

LEDs can continue to operate long past their useful life. Apart from vandalism and the rare manufacturing defect, the LEDs will emit light almost indefinitely, even if it is only a tiny fraction of what it gave when new.

There are two factors to consider. Firstly, like all light sources, their output reduces over time. For general lighting applications, the end of life is considered to be when the output drops to 70% of the initial value. This is shown on technical datasheets as L70.

For critical applications you might want to use L90 whereas for wayfinding such as the edges of decking or pool lights, L50 might be acceptable. Note that the Lx value is for the LED chip operating inside the particular luminaire. Bare chip values are meaningless because the construction of the luminaire makes a big difference (maybe as much as 50%) to the actual light output.

Secondly, in multi-chip modules or luminaires containing more than one LED, there will be some failures and so these reduce the total light emitted. This is known as the Failure Fraction, Fy. Again, the Fy value should be stated for the luminaire.

The effective lifetime of an LED luminaire is thus a combination of the reduction in light and how many have failed (Lx and Fy).

A manufacturer might claim 50,000 hours which is about 6 years if they are on all the time.

Q Ask your supplier to say how many will have failed at 50,000 hours.

A They should be able to give you a figure or show a curve with failures over time.

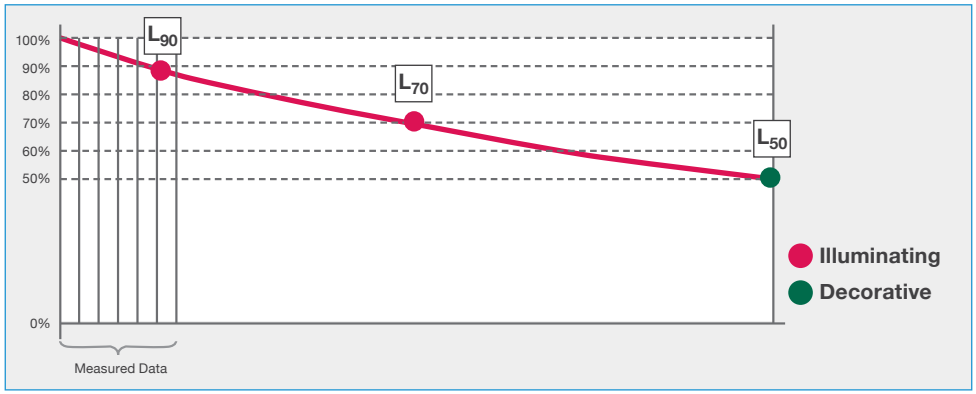
Q Ask how much of the light output has reduced from new.

A Again, they should be able to give you a figure or show a curve with the reduction in light output over time.

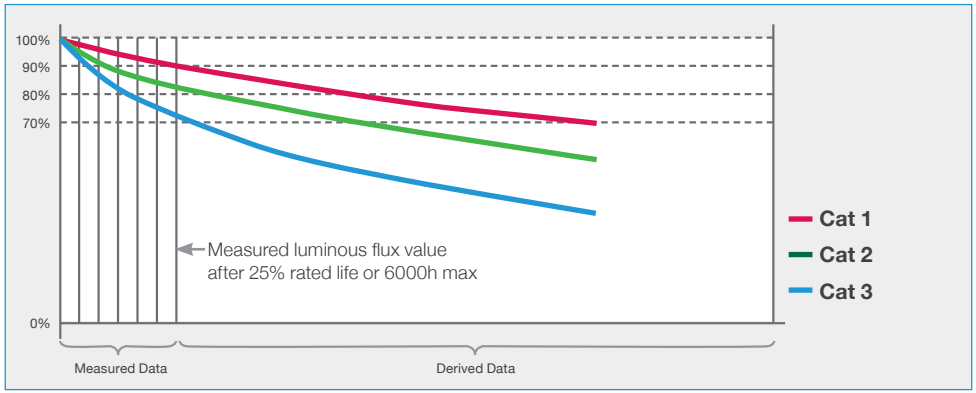
Q Will they replace the failures with new ones or just a proportion?

The best manufacturers will quote data according to IES LM-80-08 which is a standard method of testing and presenting LED lumen depreciation. The IES is the Illuminating Engineering Society of the USA.

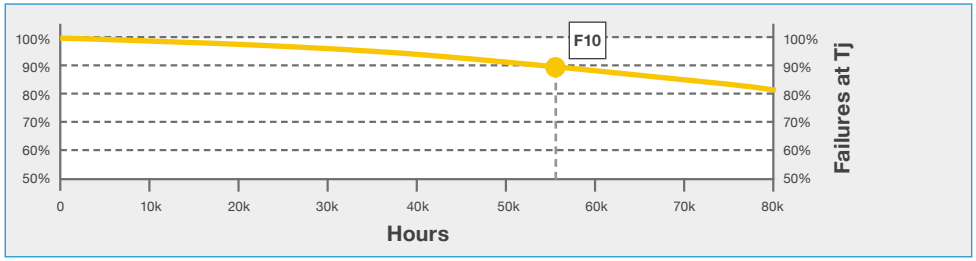
Typical loss of light output over time



How different quality chips affect life



Typical failure curve



Colour rendering and colour temperature

Colour rendering

How well a light source reveals colours is often denoted by the initials CRI, Colour Rendering Index. It compares the light source such an LED with a reference standard such as daylight or a filament lamp. Until recently, the comparison was based on eight standard colours and known as Ra8. However, the preferred measure for LEDs is Ra14. This has additional saturated colours and gives a better indication of the LED's ability to reproduce colours.

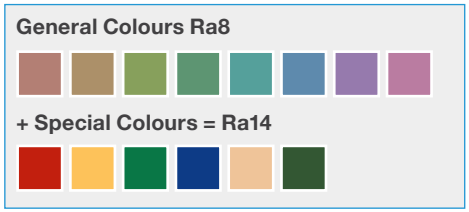
Q Ask for the Ra14 CRI from your supplier.

A If they give you the Ra8, you may still be OK but get an actual sample fitting if the application is critical.

For most applications, a CRI of more than 80 is sufficient but for paintings and other critical uses, ask for a CRI >90.

White light is normally produced by using a blue chip with a yellow phosphor coating. Sometimes an RGB chip is used but this is difficult to dim satisfactorily. Both 'cool' and 'warm' white can be produced by varying the composition of the phosphor.

Specifying the performance of LEDs

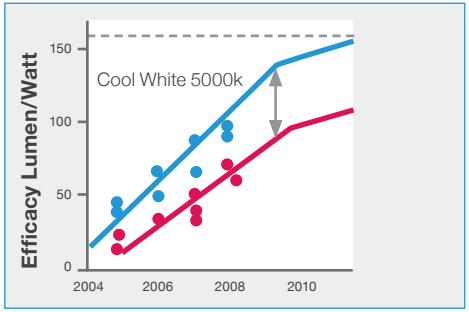


The Colour Rendering Index Ra8 uses eight general colours. Ra8 is not suitable for LEDs due to their spectra. The addition of seven 'Special' colours, including Red, Yellow, Blue, and Green, gives better results. Hence use Ra14.

Q Ask your supplier for the lumen output of the actual LED you want to use.

A A 6000K LED might give 30% more light than a 3000K of the same wattage.

Difference in light output of cool and warm



Note: Bare chip data. Light emitted from actual luminaire will be a lot less. Source: DOE report 2009.

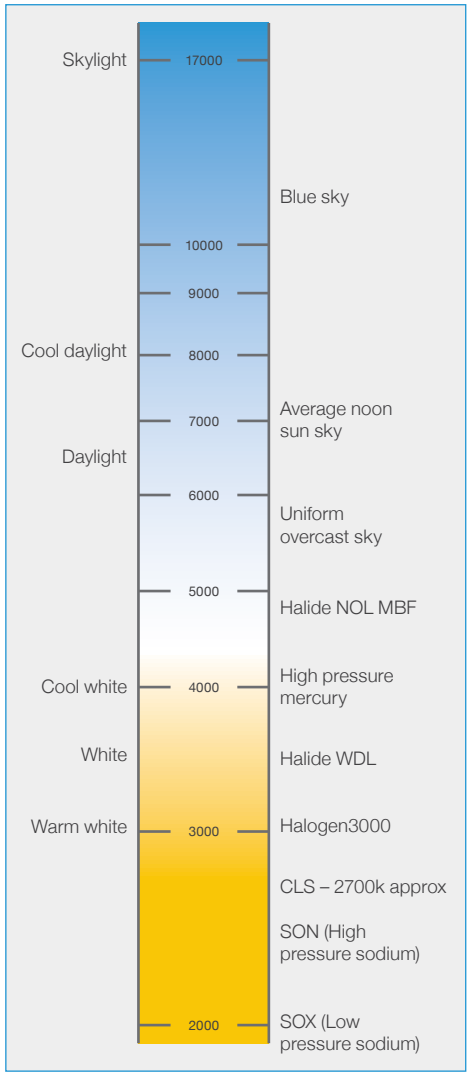
Colour temperature

Whether the light emitted looks cool or warm is known as the colour appearance or colour temperature, abbreviated to CCT. It is often shown in sales literature as degrees Kelvin (K).

Warm LEDs, 2700K or 3000K, are used where you want a relaxing light. Typical applications would be homes or restaurants with a warm atmosphere/ ambience. Indoors, they are best suited to low levels of illumination.

Cool LEDs are mostly used in fast food restaurants or buildings with lots of glass and steel. Indoors, they work better at high levels of illumination – at low levels they can appear dull or grey. Outside, cool LEDs are good for lighting water features such as fountains. In-ground pavers for wayfinding and exterior steplights would also use cool LEDs. Apart from their greater efficiency, cool light is associated with night-time; think how moonlight appears.

Remember that warm LEDs produce less light per watt than cool ones. Similarly, high CRI LEDs produce less light per watt than low CRI.



Colour changing

LEDs are very good at producing deep, saturated colours. Luminaires with RGB LEDs can produce a whole spectrum of colours and sequences by the addition of a simple control panel. For example, yellow is produced by combining Red and Green LEDs. You can also achieve white light by combining the RGB LEDs in the right proportion. This is often known as 'white-mix' and most suppliers will have a preset button or address on the driver or controller.

Colour changing is achieved by sending a signal to the driver (often the driver is inside the fitting). There are a variety of signal protocols such as DMX, DALI, etc. However, there are quite simple systems aimed at the domestic market where programming and scene setting can be done from a wall plate.

Colour mixing

More sophisticated systems use software where the scenes are configured on a PC or Mac and then uploaded to the wall plate. Often these scenes are combined with AV equipment, such as home theatres, and it is recommended to use the services of a specialist supplier and installer.

The best colour change luminaires use four colours. Either RGBW (white) or RGBA (amber).

Effect, mood and application by colour temperature

Colour temperature	Warm white 2700K	White 3000K	Neutral 3500K	Cool white 4000K	Daylight 5000–6500K
Effects and moods	Warm, cosy, soft	Friendly, personal	Inviting	Neat, clean, efficient	Bright, alert, energy giving
Applications	Homes, hotel receptions, restaurants	Retail stores, libraries	Offices, showrooms	Offices, classrooms, hospitals, lecture theatres	Medical exam areas, jewellery stores, shopping centres

CIE colour rendering groups

CIE colour rendering group	CIE general colour rendering index Ra8	Accuracy required	Typical applications
1A	Ra >90	Critical colour matching	Art galleries, museums, printing works
1B	Ra 80–90	Accurate colour judgements required	Prestige offices, hotels, retail where colour is important, private homes
2	80–60	Moderate colour rendering required	Storerooms, general offices
3	60–40	True colour recognition of little importance	Most exterior applications
4	40–20	Not recommended for colour matching	Exterior car parks

Glossary of terms and abbreviations

Binning

A term used by chip manufacturers to sort the LEDs by colour, light output, voltage. White LEDs can vary in colour appearance. You should always make sure that the LEDs originate from the same bin. Colour differences are measured in MacAdam ellipses where one ellipse is just noticeable. For critical applications the bin should have the smallest number of ellipses. Seven is common but three or four are more uniform in appearance.

BMS

Building Management System. LEDs can be easily controlled by a digital signal and so can be integrated simply into other BMS functions, such as security, daylight controls, and presence detection.

Candela

The SI unit of luminous intensity. This unit is most often seen on polar curves, where it shows the intensity of light in any given direction. Take care reading it; it can easily be misinterpreted.

CCT

Correlated Colour Temperature. This describes how warm or cool a light source appears and is measured in degrees Kelvin (K). The lower the value in K, the warmer the source appears.

CCW

Circuit watt. The electricity consumed by the luminaire including losses in the control gear/driver. Wire-wound control gear consumes more watts than its equivalent electronic one.

CFL

Compact Fluorescent Lamp.

CIE

Commission Internationale de l'Eclairage. Also known as the International Commission on Lighting. This is a global, independent, non-profit organisation that deals with all aspects of lighting knowledge and research. It makes recommendations that are often then used as national Codes of Practice.

Cold Lumen

See 'Lumen'.

Colour Rendering

The effect of a light source on the colour appearance of objects compared with their colour appearance under a reference light source such as a tungsten filament lamp or daylight.

Delivered Light

The amount of light a luminaire delivers to a surface. It is measured in lux.

LEDs are directional and so tend to deliver a greater proportion of their light to where it is wanted.

DMX

Digital Multiplex. A signalling protocol for controlling dimming and colour mixing. It originated in the theatre but is now used in commercial applications and domestic AV systems.

Driver

See main text for a full description. This is similar to a transformer except that it produces a constant current as the output.

Efficacy

A way of describing the efficiency of a light source. It is measured in lm/W.

Hot Lumen

See 'Lumen'.

IR

Infrared. In this booklet, used to mean heat both radiated (in a beam) and conducted (through the body of the fitting).

LED

Light Emitting Diode.

Lumen

Abbreviated to 'lm'. This is the basic quantity of light (the SI term is luminous flux). It tells you nothing about the colour, intensity or quality of light but it is a description of how much light the source emits. Related to the lumen is lux.

Hot and Cold Lumen

These terms have no scientific or engineering meaning. However, they are sometimes used in sales literature. 'Cold' lumens refer to the output from the bare chip at the instant it is switched on for a fraction of a second. 'Hot' lumens refer to the output from the chip or luminaire once it is running. The terms were originated to show the difference in light output from the headline figure quoted for the chip and its actual performance in use.

Lumen Depreciation

This simply refers to the reduction in output over time. The data is normally shown as a graph with the percentage reduction shown against hours. It is also stated as output after a certain period, e.g. L70 at 50,000 hours, meaning that the output is 70% of the initial output after 50,000 hours.

Luminaire

The correct term for what is generally called a light fitting or light fixture. Strictly speaking, a luminaire is the apparatus containing the light source.

Lux

Abbreviated to 'lx', this is the unit of illumination level (the SI term is illuminance). One lux is one lumen per square metre. An office might be lit to 300 lux, a domestic lounge to 50 lux. Note that this is an average; it does not tell you how uniform the light is spread over the area. Neither does it tell you anything about the quality of light or its colour.

mA

Milliamp, a thousandth of an amp. High power LEDs are often described by the current they draw because they are constant current devices, e.g. 350mA. This is the same as 0.35A. Since high power LEDs are typically around 3V, a 350mA LED is often described as a 1W or 1.2W source. Similarly, a 700mA is often called a 2W LED.

Power Factor

Where the voltage and current are in phase, the wattage drawn is simply the product of the two. However, in LED, fluorescent and discharge lamp circuits, the voltage and current are slightly out of phase, meaning that more current is drawn than the wattage suggests. Thus the product of the voltage and current is greater than the wattage. Power factor is defined as watts/volts x amps. Many LED luminaires and retrofits are designed to have a power factor > 85%. However, poorer quality retrofits can have PFs of 50% and thus draw twice the current the wattage would imply.

PWM

Pulse Width Modulation. The most common method used to dim LEDs. Note that colour mixing is also achieved in the same way by varying the amount of power to each RGB LED. PWM turns the LEDs on at high frequency, so reducing the ON time lessens the light output.

Rated Life

This is an average figure giving the operating hours when 50% of a batch of lamps/LEDs has failed. Note that after this period, the light output from the still functioning lamps/LEDs will also be lower.

RGB

Red, Green, Blue. These three colours can be combined to produce almost any colour. But it may not be possible to achieve the exact hue. This is important if you are trying to match a particular paint colour.

SI

Système international d'unités. Also known as the International System of Units. The metric system of units, e.g. metre, kilogram.

SHR

Space/Height Ratio. A technical term describing how far apart you can mount the fittings and still achieve reasonably uniform lighting. An SHR of 1.5:1 means you can install the fittings 1.5 times the

mounting height apart. Generally, LED fittings have to be mounted closer together than their equivalent fluorescent or metal halide ones.

SSL

Solid State Lighting. This is a general term referring to all electronic light sources. This not only refers to LEDs but also to OLEDs, PLEDs, flat panels, etc.

T/H

Tungsten Halogen is, in essence, a filament lamp made much smaller and with the addition of halogens to increase efficiency. Typically, a 50W reflector lamp will emit 600lm, so the efficacy is 12lm/W. Don't confuse tungsten halogen lamps with metal halide which are a completely different light source.

UV

Ultraviolet. This is short wave radiation and is damaging to materials such as fabric, paints and plastics.

Where can I get more information?

Rexel

Rexel Renewable Energy
www.rexelrenewableenergy.co.uk

Rexel Energy Solutions
www.rexelenergysolutions.co.uk

Rexel Group
www.rexel.co.uk

National Telephone
020 8596 7483

LED publications

Guidelines for specification of LED lighting products 2011 produced by: LIF, SLL, ILP, HEMSA, PLDA, IALD.

Visit any of their websites to download the document.

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Organisations

Lighting Industry Federation (LIF)
www.lif.co.uk

Electrical Contractors Association (ECA)
www.eca.co.uk

The Lighting Association (LA)
www.lightingassociation.com

The Society of Light and Lighting (SLL)
www.sll.org.uk

The Institution of Lighting Professionals (ILP)
www.theilp.org.uk

The Institution of Engineering and Technology (IET)
www.theiet.org

Carbon Trust
www.carbontrust.co.uk

Understanding LEDs

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