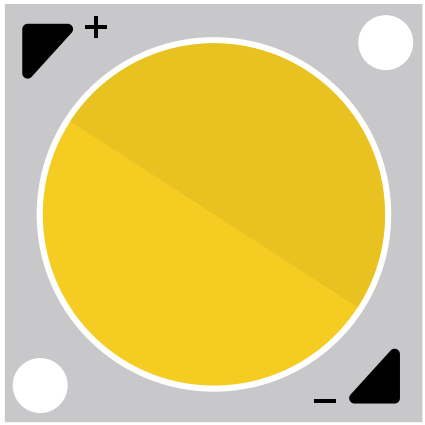
What is an LED?

The LED or Light Emitting Diode is a semi-conducting material that emits light when electrical power is passed through it. Construction, functionality and efficiency varies between manufacturers and performance is evolving and improving year on year while the cost decreases.

As an electrical component, they require a given amount of voltage to operate, much lower than the ~240Volts required to operate old filament technologies; typically between 2-36 Volts depending on their size and application.

Contrary to popular understanding, LEDs do produce heat, which must be managed through heatsink structures. However unlike traditional sources the temperatures emitted are much lower allowing LED luminaires to be used in more sensitive applications such as illuminating artwork, food or textiles.

Enigma stay up to date with LED technology to ensure the most efficient and robust LEDs are used within its products.



LED's come in various sizes and shapes

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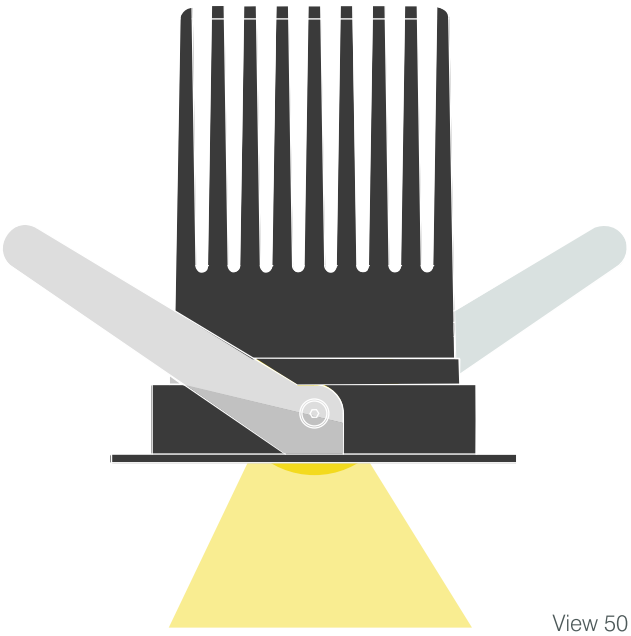
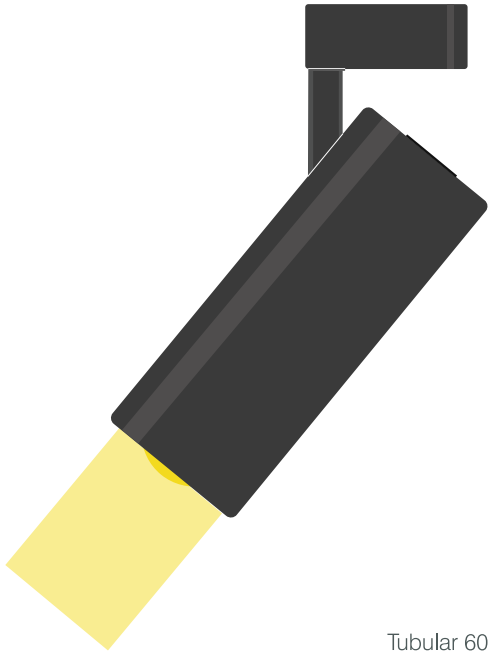
Luminaires

The term luminaire describes the complete light product. It can also be descried as the fitting or fixture.

Enigma are a provider of complete luminaires as well as components, drivers and sources.



View 50



Tubular 60

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Correlated Colour Temperature (CCT)

Correlated Colour Temperature (CCT) defines the colour appearance of a white light. CCT is defined in degrees Kelvin; a “warm”, orange white is around **2200K**, moving to “neutral” white at around **4000K**, and to “cool”, blue white at **5000K** or more.

Enigma offer a wide range of CCT options across their product range, ensuring complete flexibility and suitability for the application.

Historically LED technology was discredited due of its cool (high CCT) output, whilst sources such as halogen were considered to be a far more attractive option as it produced a warmer (low CCT) light; however with the advancement of LED technology it is now possible to replicate the warm lights previously reserved to halogen and incandescent sources.

2200K	**4000K**
2700K	**5000K**
3000K	**6500K**

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Colour Rendering Index (CRI)

Colour Rendering Index (Ra%) is a metric used within the lighting industry to describe the ability of an emitted light source to accurately represent the colours of objects the light hits. While the numerical value given to a source can be considered a percentage, it is often referred to simply as **90CRI** or **80CRI** for example.

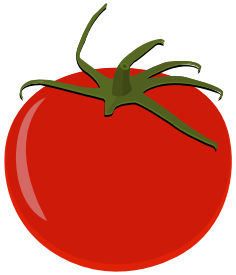
CRI is referenced against natural sunlight which is given an Ra value of 100; therefore Ra100-90 can be considered to be very good, Ra90-80 as good and anything below Ra80 is considered poor.

High CRI values are particularly important in the retail and hospitality sectors where accurately representing the produce can drive increased sales and improve customer satisfaction.

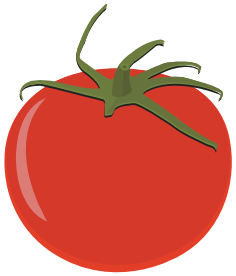
Unlike Colour Correlation Temperature, CRI does not describe the colour of the light itself, rather its ability to faithfully render the colour of an object.

CRI is an area within LED development that still requires improvement and it is very common for LED and luminaire manufacturers to offer products with poor CRI sources.

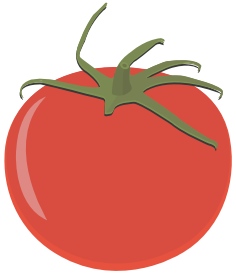
However Enigma offer high **>90CRI** LEDs across its range of products, and continuously source the latest LED technology for its products.



90+ CRI



80+ CRI



70+ CRI

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Lumens (LM)

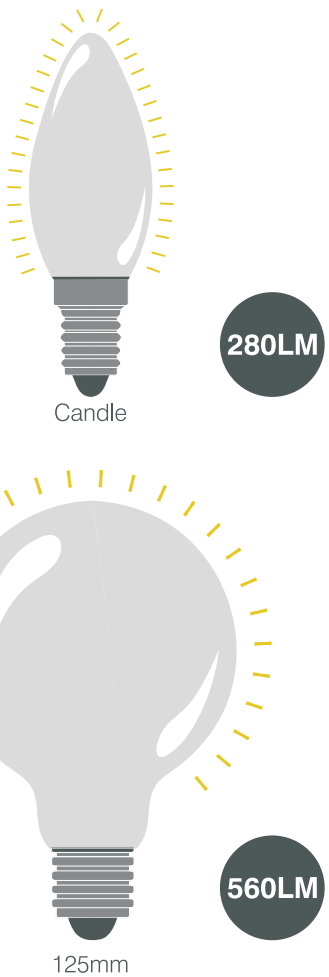
Lumens is the unit of measurement used to describe the quantity of visible light emitted from a light source.

Lumens can be divided into Lamp Lumens and Delivered Lumens. The lamp lumen figure is the total amount of light that a light source emits.

The delivered lumens is the total amount of usable light emitted by a luminaire. If there was nothing obstructing an LED chip and no method of controlling the light to create an attractive or useful beam a luminaire could be considered to have the same delivered lumen value as lamp lumen.

<u>Greater power = greater lumen output.</u>

Enigma strives to use the most efficient optical design and the highest quality materials to ensure the maximum amount of the emitted light from the LED chip reaches its desired target therefore increasing the efficiency of the products.



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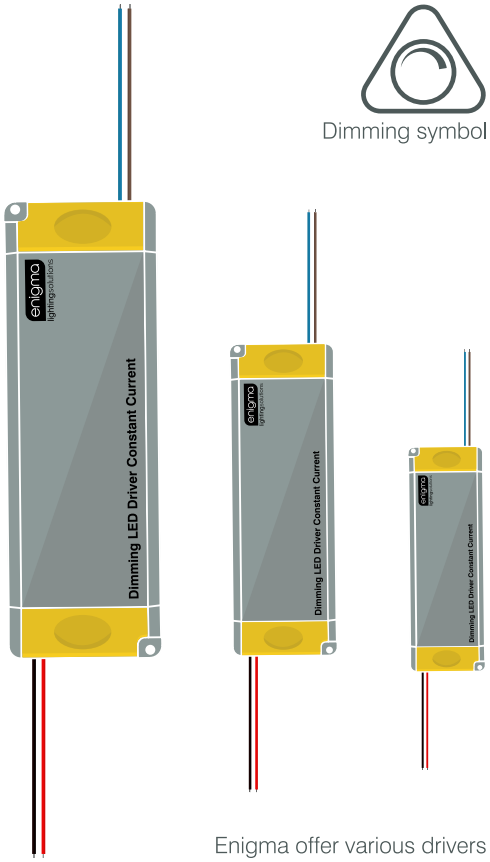
LED Drivers

The Driver is the name given to the power supply unit required to deliver electrical power to an LED luminaire. They regulate and reduce mains voltage to the much smaller amounts required to safely power an LED chip. Drivers can be either remote (external) to the product, or integrated (internal) within the product. Commonly high power luminaires have remote drivers, and products such as track or surface spots or filament lamps have integrated drivers.

The driver can determine whether a luminaire is dimmable or not and there are a number of dimming protocols to consider. These are Mains Dimmable (AKA: phase dim, TRIAC, leading edge, trailing edge, PWM), 1-10 Volt, DALI and DMX.

Drivers are not 100% efficient, they require a certain amount of power to operate. The higher quality the driver the better quality its dimming performance and its efficiency. Their efficiency is often referred to as their power factor.

Enigma use trusted partners and suppliers to ensure the highest quality of dimming and maximum efficiency.



Dimming symbol

Enigma offer various drivers

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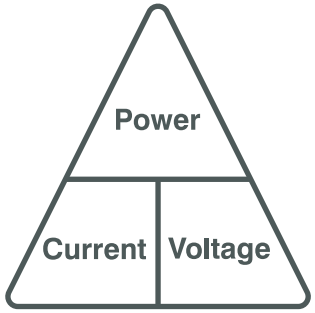
Power (W)

The Power necessary to illuminate an LED chip is delivered by the LED Driver and like all electrical components the LED chip requires a very specific amount of electrical power to operate. The two key metrics needed to describe or calculate electrical power (Watts/W) are Current (amps/A or milliamps/-mA) and Voltage (volts/V). The Power necessary to produce light from an LED can be calculated by multiplying the Current and the Voltage.



Power = Current x Voltage
Current = Power ÷ Voltage
Voltage = Power ÷ Current

Constant Current and Constant Voltage

The power necessary to run an LED chip can be delivered in two ways; with a constant amount of current or constant amount of voltage. These two methods of powering LEDs are known as Constant Current (CC) and Constant Voltage (CV).

In the most part higher power luminaires are powered through a constant current signal and lower power luminaires are powered through a constant voltage signal.

Downlights and spotlights are commonly powered through a Constant Current driver which offer a fixed current output while the voltage varies to meet the necessary demands of the chip. The typical current outputs for LED drivers are 350mA, 500mA, 700mA or 1000mA.

Small luminaires and LED tape for example are powered from a Constant Voltage driver delivering typically a fixed 12Volts or 24Volts and a variable current output.

The total power of a luminaire or length of tape is therefore determined by the voltage required to illuminate the chip, multiplied by the amount of current being delivered by the driver.
Enigma accurately matches its LED products to the correct LED Driver to ensure maximum efficiency and suitability. By offering this fully wired luminaire it removes the hassle of the customer pairing LEDs and drivers.

Efficiency

The defining characteristic of an LED over its predecessors and the predominant reason for its global adoption as the mainstream light source today is its efficiency.

In its most basic terms, efficiency is defined as the amount of power required to produce an amount of light. Power is measured in Watts and light output is measured in Lumens. Therefore the unit of measurement for lighting efficiency is lumens per watt (lm/W).

Light from an LED chip needs to be controlled and manipulated by optical devices to create an optical Beam. The more effective these optical devices are at controlling the light and getting it where its supposed to be, the more efficient the product is. Light delivered by the LED is known as Lamp Lumens, while light delivered by the whole luminaire is known as Luminaire Lumens.

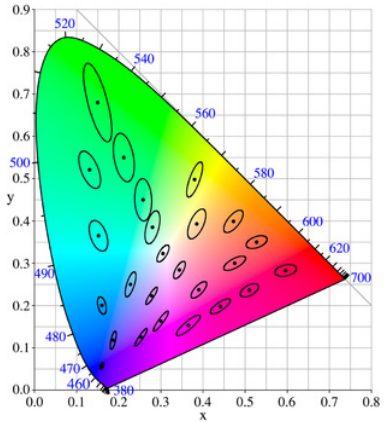
The driver and LED themselves consume a portion of the total electrical power, the higher the quality components and the effectiveness of how they are run can determine the electrical power needed to operate the luminaire.

The power delivered to the LED from the driver is often called the Lamp Wattage, while the total power drawn by the LED and the Driver is often called the circuit wattage or System Wattage.

While many companies will highlight the most attractive set of numbers to describe their products efficiency, wherever possible Enigma publish the delivered Luminaire Lumens and the total Circuit

Macadam Ellipse (SDCM)

The human eye has evolved to be extremely sensitive to colour variation.
The Macadam Ellipse is a grouping of colours that are deemed indistinguishable from each other by the human eye. The ellipse's themselves are drawn from a colour graph known as a Chromaticity Diagram.

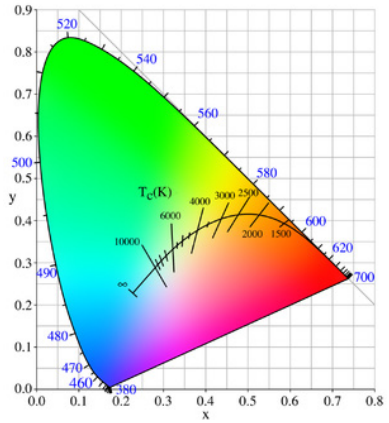


Black Body Curve

The Black Body Curve is a line drawn on the Chromaticity Diagram that demonstrates colour/light that can be described as white. It covers warm (orange) light through neutral white to cool (blue) light.

Binning

Due to the nature of LED mass-manufacture there is an inevitable degree of tolerance within the colour consistency of individual LEDs.



Binning is the term given to categorising LEDs by colour. These bins are labelled according to their proximity to the reference colour on the black body curve. The bin tolerance levels are known as steps, whereby LEDs that are very similar are said to be within "1 step" binning or Macadam ellipse of each other, less similar are in "2 step", etc all the way to 7 step binning.

Enigma lighting wherever possible aim to use 2 step LED chips. These are the most readily available LEDs for architectural lighting and while detectable through measuring devices their consistency is near imperceptible by the human eye.

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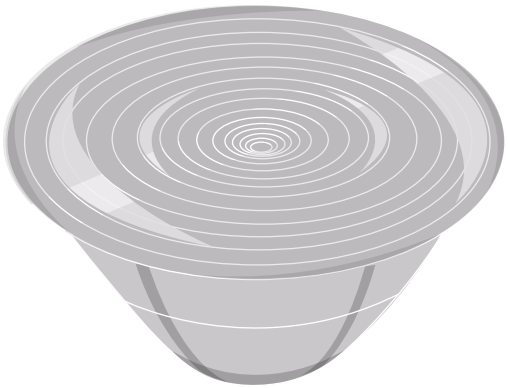
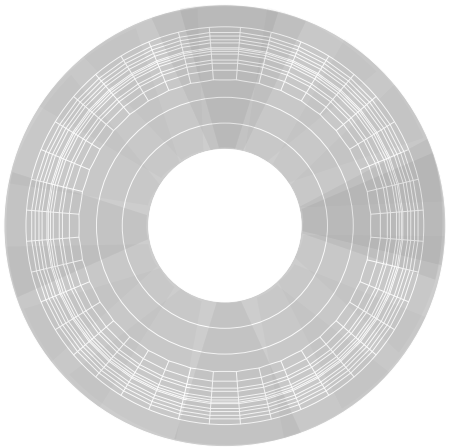
Beam Control / Optics

The light from an LED tends to be given off in an uncontrolled spread of light. This spread of light is uncontrolled and is often hard to use in a luminaire. To produce luminaires that can be used in real world applications LED Optics or Reflectors are required. These are the components within an LED luminaire that control or focus the light produced by an LED Chip. Through the use of optics and reflectors it is possible to produce accurate and desired beam angles of light. These range from super spot at around 5° up to super wide at nearly 60°.



Various optics avaliable

Optics tend to refer to clear plastic or silicone pieces that use the refractive properties of clear materials to manipulate the light to focus or spread the light from the chip as required. Reflectors are more recognisable as the mirror finish cone structures and these reflect the light into controlled and usable beams.



Various reflectors avaliable

The beam angle of light produced by a luminaire can be measured using photometric testing and the results from these tests are published as photometric files. These photometric files can be used within lighting design software programs such as DIALUX and RELUX. The photometric files allow lighting designers to produce accurate models of spaces and determine the number and type of luminaire best suited for their application.

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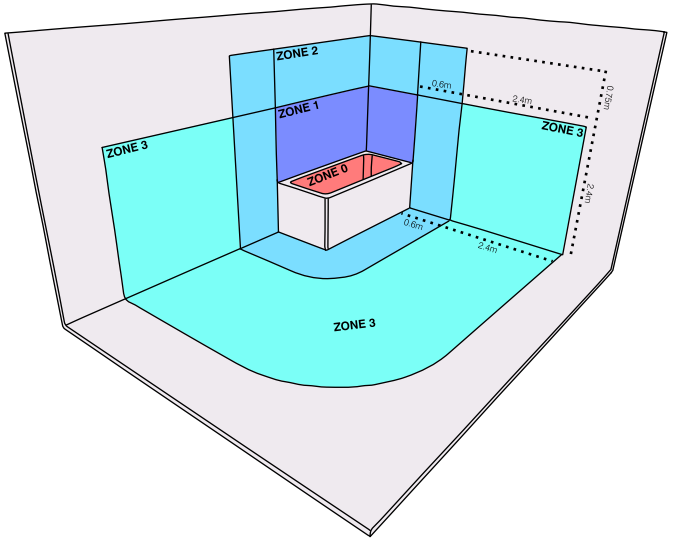
IP Rating

IP or “Ingress Protection” refers to the international standard EN60529. It is the scale used to define how effectively sealed a product is from intrusion from solid bodies and moisture.

The scale is defined by a two digit number, whereby the first digit refers to the level of protection against solid bodies and the second digit refers to the level of protection against moisture.

The IP rating of a product determines where a product can be installed. For example when installing luminaires into a bathroom it is critical to follow the bathroom zone regulations. The below diagram outlines these zones and the IP rating of products permitted within these zones.

Minimum Installation Requirements for Domestic Bathrooms		
ZONE	MINIMUM IP RATING	POWER SUPPLY
ZONE 0	IP67	LOW VOLTAGE
ZONE 1	IP44	LOW VOLTAGE
ZONE 2	IP44	LOW VOLTAGE OR MAINS
ZONE 3	NO IP RATING REQUIRED	LOW VOLTAGE OR MAINS



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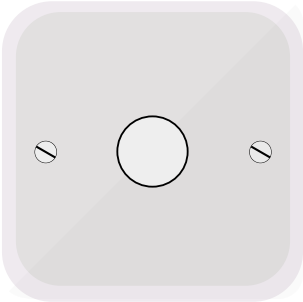
Dimming - Part 1

Dimming LED luminaires is one of the most disputed areas currently within the lighting industry. Unlike traditional technologies LEDs themselves are not dimmable rather they require specific dimmable drivers and it is the type and quality of the dimmable drivers that determines the performance of a luminaire's dimming.



Rotary Dimmer

There are 4 main types of protocols used to dim luminaires.

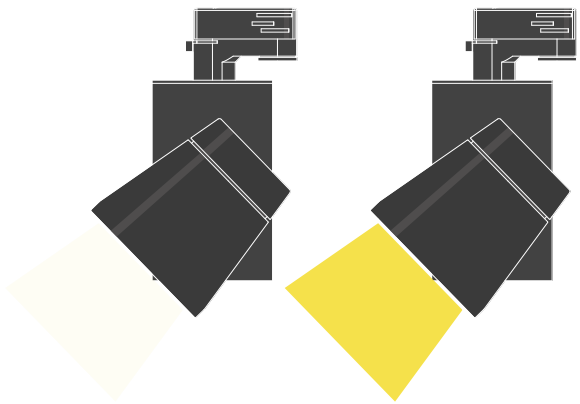
Mains Dimmable (AKA Leading and Trailing Edge, Phase Dimming, TRIAC). This is the most commonly used method and the most cost effective. It is commonly used in domestic installations, though not exclusively. It can be simply operated from a rotary dimmer switch/controller which chops up, therefore reducing the power being fed to the LED. It can offer very good performance, but require some testing to match the correct dimmer switch to LED Driver.

1-10V Dimming (AKA analogue dimming or 0-10V). Was one of the earliest dimming control protocols. In essence the dimmer or controller sends a DC voltage signal between 1 and 10 Volts to the driver. This signal voltage determines the percentage light output. This means a 10Volt signal should be 100% light output and a 1V signal voltage relates to 10% output. 1-10V dimming requires an extra pair of cables as well as the power cables to send the signal from the dimmer switch/controller to the driver.

Dimming - Part 2

DALI (Digital Addressable Lighting Interface). As the name suggests this protocol is a digital based system. It provides 256 levels of brightness ranging between 0-100%.
Each DALI driver can be programmed with a specific address making it individually controllable. When a signal from the controller is received by the driver it is interpreted by the driver and the light output is adjusted. Similar to 1-10V, DALI requires an extra pair of cables as well as the power cables to send the signal from the dimmer switch/controller to the driver.

DMX (Digital Multplexing). DMX was developed initially for theatrical applications. Though not as commonly used in domestic applications it is still a preference for coloured lighting and moving luminaires. Like 1-10V and DALI dimming it requires an extra pair of cables to send a signal from the controller to the driver.



Dali dimming allows you to choose the brightness of the luminaire

DMX originally developed for theatre

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Life Time

One of the great advantages of LED lighting over conventional technologies is its long life time. When correctly designed with sufficient thermal management it is possible to dramatically extend the lifetime of an LED luminaire above that of tungsten filament based technologies. While unlikely to critically fail, an LED will degrade over time. The amount of light will slowly reduce. The time it takes to reduce by a given amount can be considered its lifetime. It has become standard to measure the length of time it takes for an LED to reach 70% of its original light output. This is known as the LM70 (Lumen Maintenance of 70%). This LM70 figure is provided in hours.

While LM70 and chip lifetime is based on hours, Enigma base their product guarantee on years, from the date of delivery.

Enigma base their products on years not hours.

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