



Benefits from the application of LED lighting solutions. A technology update.

Presented by:

John Hesketh of LPA-Excil Electronics
at Railway Interiors expo 2007

Introduction



- At Railway Interiors 2006, the Author made a presentation focusing on the advantages of LED based lighting schemes and the suitability for rolling stock interior lighting applications.
- Since the 2006 presentation, LED technology has advanced at a phenomenal rate and is currently revolutionising the lighting industry.
- This presentation aims to examine the key areas of advancement and how these advances affect our industry.

Reminder of Key Technology Facts and Benefits

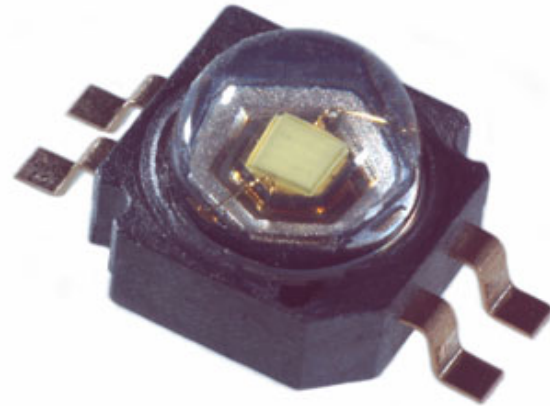


- The LED makes use of a solid state junction to produce photons (light output).
- There are no fragile filaments or gas discharge processes to fail.
- This renders the device immune from the effects of shock and vibration.

Reminder of Key Technology Facts and Benefits



- A typical power LED:



- Typical body dimensions are 7mm square or around 8mm diameter.
- Unlike a filament lamp, the LED requires a specialist constant current power supply rather than a voltage regulated source.

LED Power Supply Arrangements



Long Life Reliability
does not cost the earth

The constant current supply required by the LEDs may be generated either via a centrally located “bulk” power supply unit or via drive electronics built into each individual light head.



Optics



- In order to produce a usable light output, carefully designed secondary optics are required to collect and focus the light output from the LEDs.



Optics and Illumination



- Generally speaking, we have a choice of three beam angles:
 - +/- 6 degrees (spot)
 - +/- 15 degrees (medium)
 - +/- 22.5 degrees (wide)
- Resultant illumination levels at 1 metre from source are typically in the range 30 to 4000 lux dependent on beam angle, quantity and type of LEDs.
- For high illumination levels, LEDs are assembled into arrays.

Life Expectancy



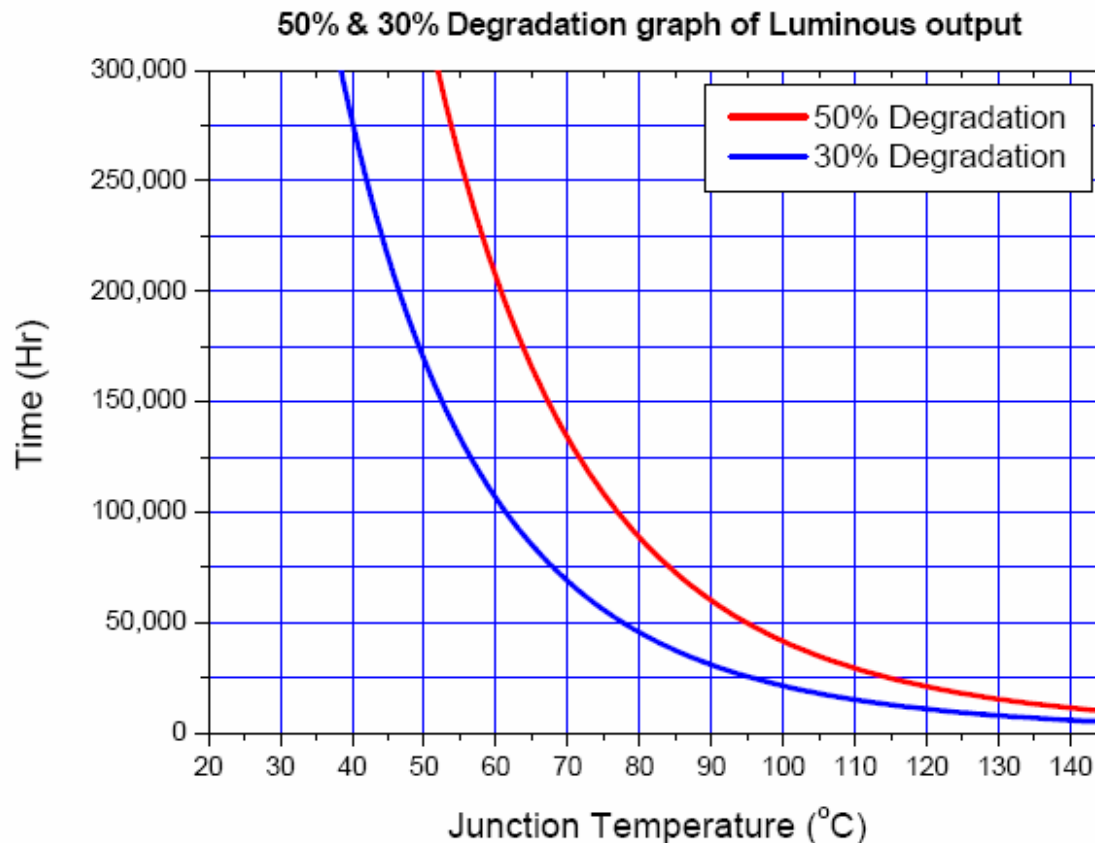
- 50,000 - 100,000 hours to 70% of initial lumen output, assuming optimum thermal management.
- Millions of hours to total electrical failure.
- This compares to 9,000 hours for halogen and 20,000 hours for fluorescent lamps dependent upon drive technology quality.
- The high reliability results in significantly reduced vehicle operating and life cycle costs.

Thermal Management



Long Life Reliability
does not cost the earth

- Correct thermal management is essential in order to maximise life expectancy.

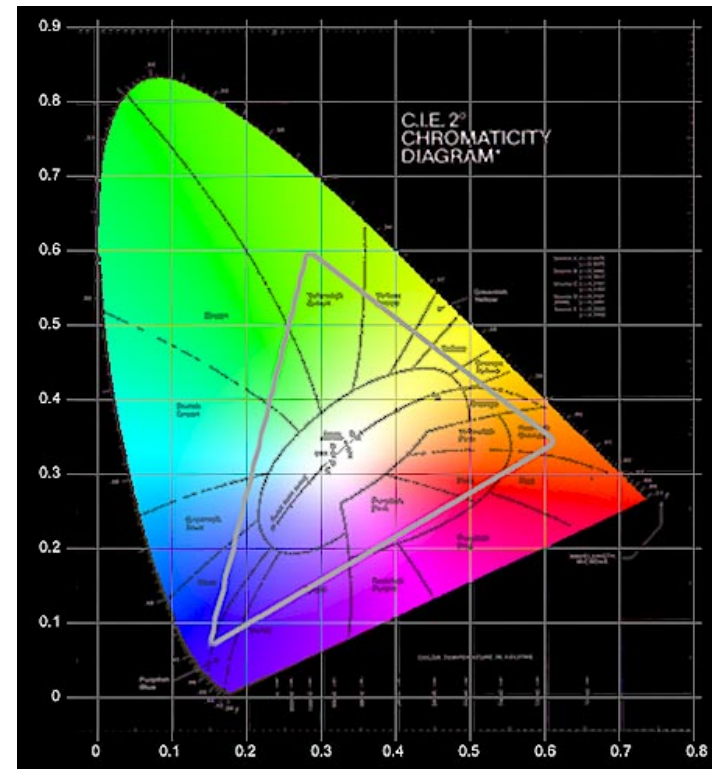


Spectral Output



Long Life Reliability
does not cost the earth

- LEDs are available with a wide choice of light output colours including white which is subdivided into various colour temperature groupings such as warm white, cool white and daylight.



Other LED Benefits



- Low power consumption and high luminous efficacy (lumens per watt).
- This permits the design of highly effective emergency lighting systems with high light output and extended emergency lighting duration.

Other LED Benefits



Long Life Reliability
does not cost the earth

- Cool beam temperature due to absence of infra content.
- A typical halogen lamp operates at around 80 deg C surface temperature at the light emitting surface.
- In contrast, a typical LED down light containing three LEDS, generates just 10 deg C rise at the light emitting surface.
- This results in increased passenger safety due to reduced touch temperature and enhanced comfort, particularly in reading light applications.
- Additionally, the reduced heat output significantly reduces air conditioning loads.

Key Technology Improvement 2005 to 2007



- Luminous efficacy (lumens per watt).
- White light colour temperature availability and control.
- Device compatibility with automated assembly processes.

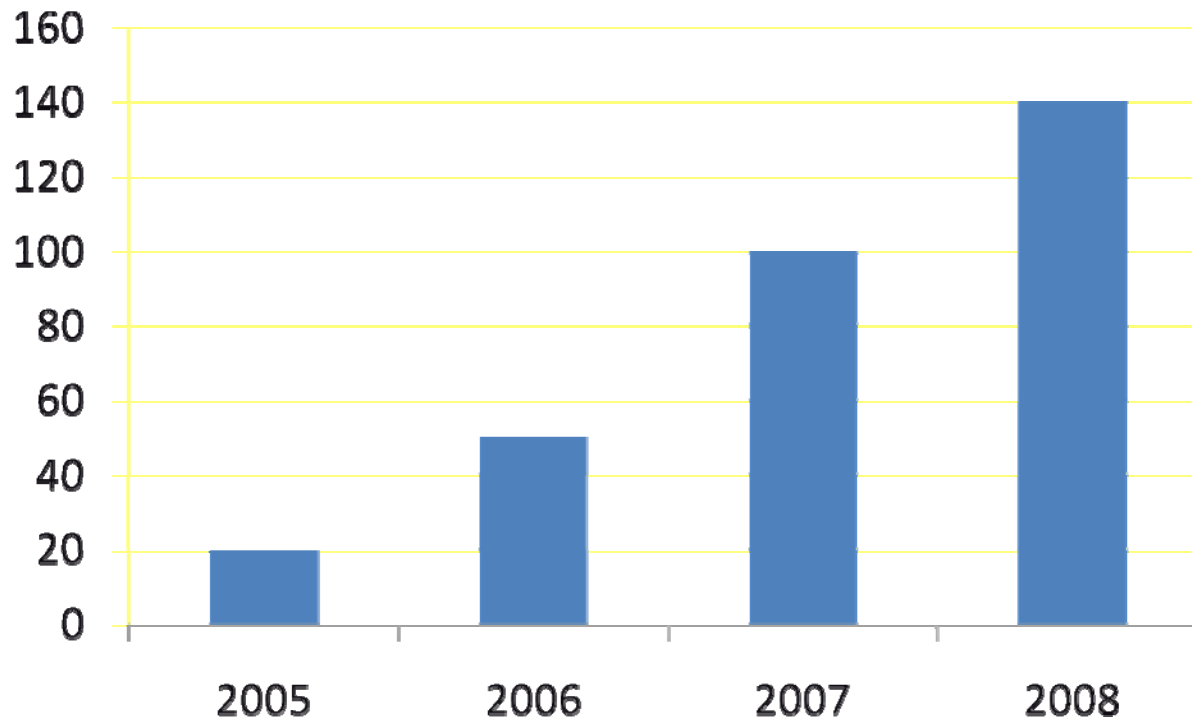
1st Area of Improvement

Luminous efficacy



*Long Life Reliability
does not cost the earth*

lm/w

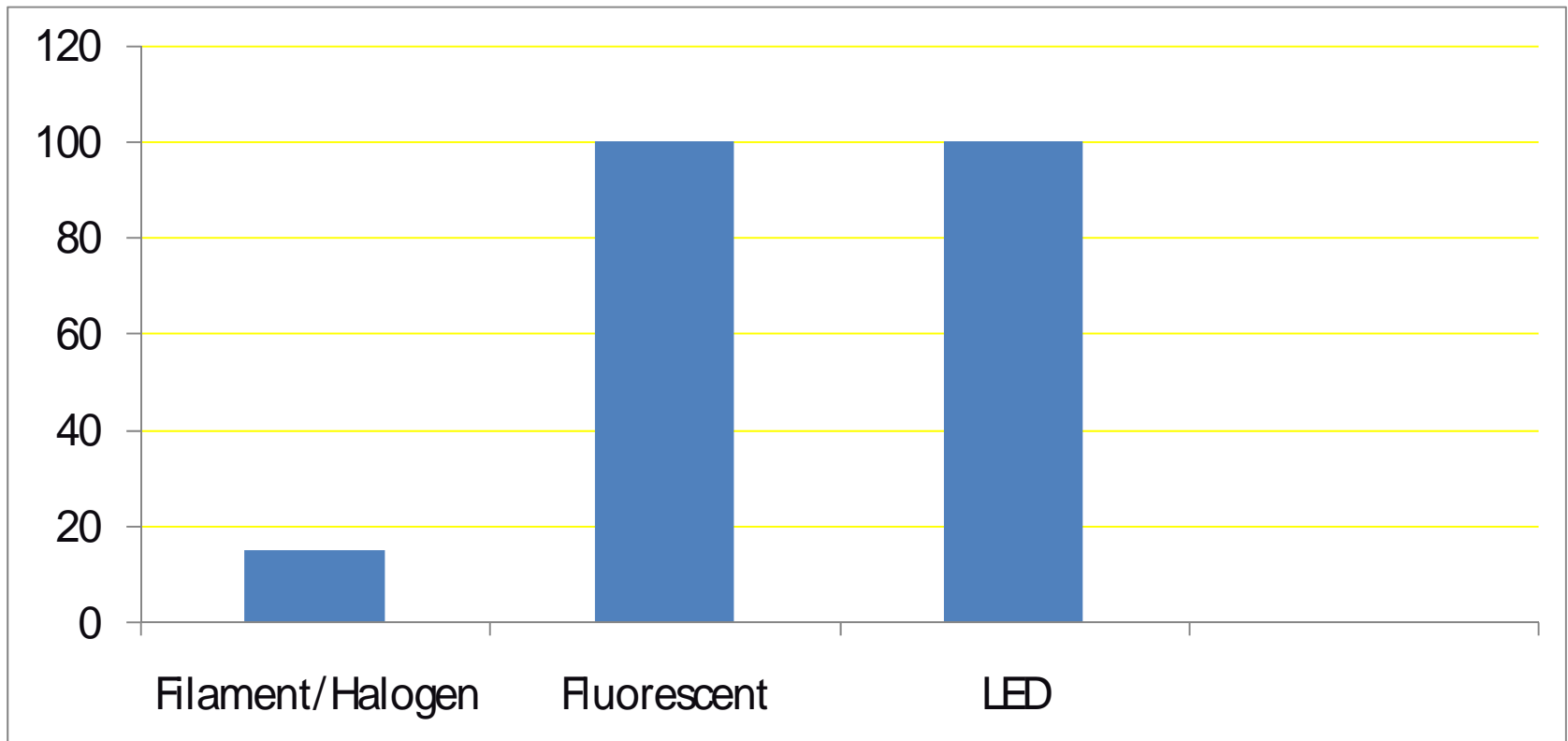


LED Luminous Efficacy.

A Comparison to Conventional Light Sources.



lm/w



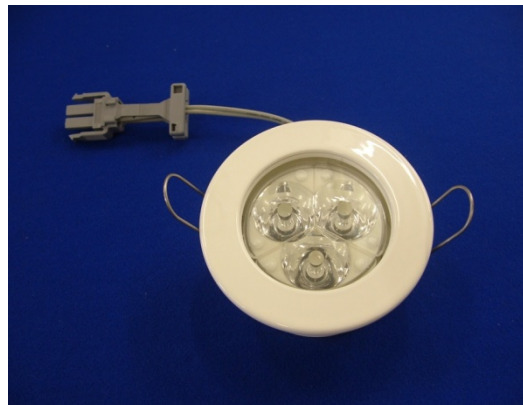
Applications.

Halogen Replacement.



*Long Life Reliability
does not cost the earth*

- The advances in technology have permitted direct replacement of halogen dichroic lamps.
- LPA-Excil are currently working on projects replacing 10 watt and 20 watt halogen dichroic style down lights with LED solutions consuming just 3 watts. These solutions achieve comparable illumination levels.



Typical halogen
dichroic replacement.

Halogen Replacement



- A recent project involved replacement of 12V, **20 Wa** 12 degree beam angle dichroic reflector type lamps.
- The luminous intensity of the original fit lamp = **3100 cd**
- The lamp was replaced by three, 80 lm/W LEDs used in conjunction with a narrow beam (12 degree) lens with lens factor 17.1 cd/lm. Total consumption just **4.5 watts!**
- The resultant luminous intensity of the LED replacement was $3 \times 80 \times 17.1 =$ **4104 cd.**
- We therefore achieved an increased luminous intensity and a **15.5 W** power saving per fitting!

Fluorescent Replacement



- LPA-Excil are also involved with interior lighting solutions where LEDs are the sole light source and do not require supplementary fluorescent or halogen support.
- A recent system employed 120 single LED down light fittings per vehicle.
- The illumination standard to be met was EN13272 and UIC555 calling for 150 lux at 0.8 above floor.

Fluorescent Replacement. Illumination Calculation.



- Ceiling height = 2.1 m.
- Illumination requirement 150 lux at 0.8m above floor.
- LED output is 75 lumens, lens is medium beam, 5.5 cd/lm.
- Fitting luminous intensity = $75 \times 5.5 = 412$ cd.
- Resultant illumination = $412 \cos 0 / (2.1 - 0.8)^2 = \underline{243}$ lux
- This figure exceeds the required specification.

Fluorescent Replacement



*Long Life Reliability
does not cost the earth*



2nd Area of Improvement

White Light Colour Control



- White Light LEDs are now available in three distinct colour bands:

Warm White	2650 to 3500 K
Natural White	3500 to 4500 K
Cool White	4500 to 7500 K

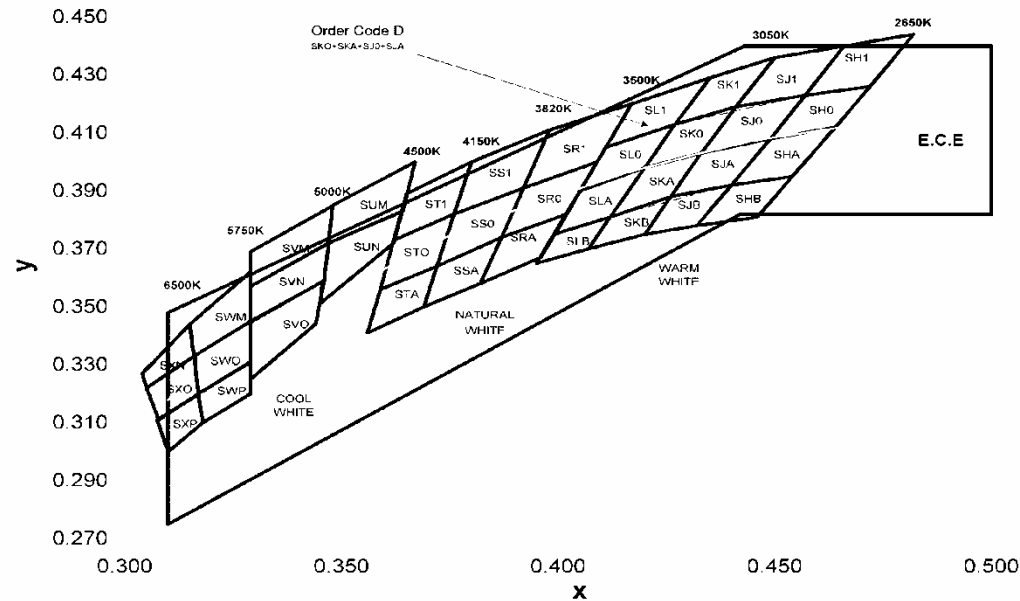


- These categories are subdivided into colour bins.

Typical Colour Binning



Long Life Reliability
does not cost the earth



This tighter control of colour temperature enables greater consistency in lighting schemes and enables conventional light sources to be colour matched.

3rd Area of Improvement.

Automated Assembly Compatibility



- Initially, power LEDs had to be hand soldered because the LED dome could not withstand the heat of automated re-flow solder processes.
- Most power LED devices are now compatible with surface mount pick and place and reflow processes which significantly reduces assembly time and costs.



LPA-Excil automatic pick and place and re-flow solder line.

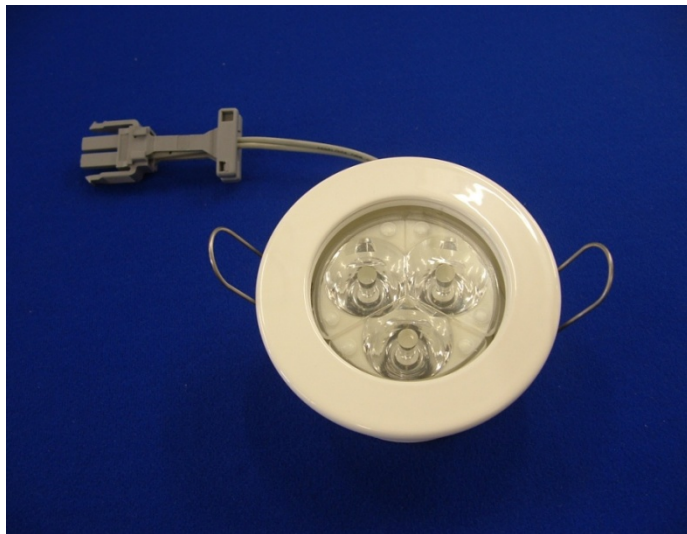
Product and Application Examples

General LED illumination

Triple LED Fixed Beam Position



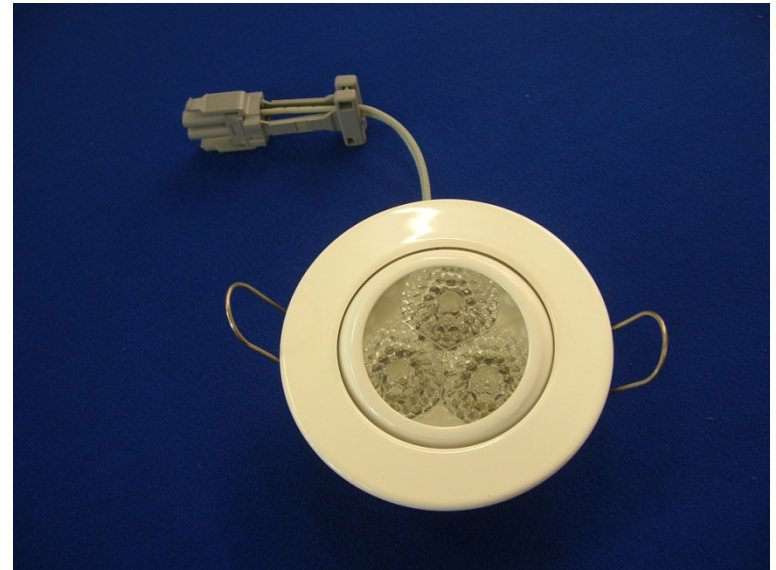
- Available in narrow, medium and wide beam angles.
- Applications range from reading lights to general purpose down lights.



Product and Application Examples

General LED Illumination

Single and Triple LED, Adjustable Beam Position



Product and Application Examples

Self Contained LED Emergency Light



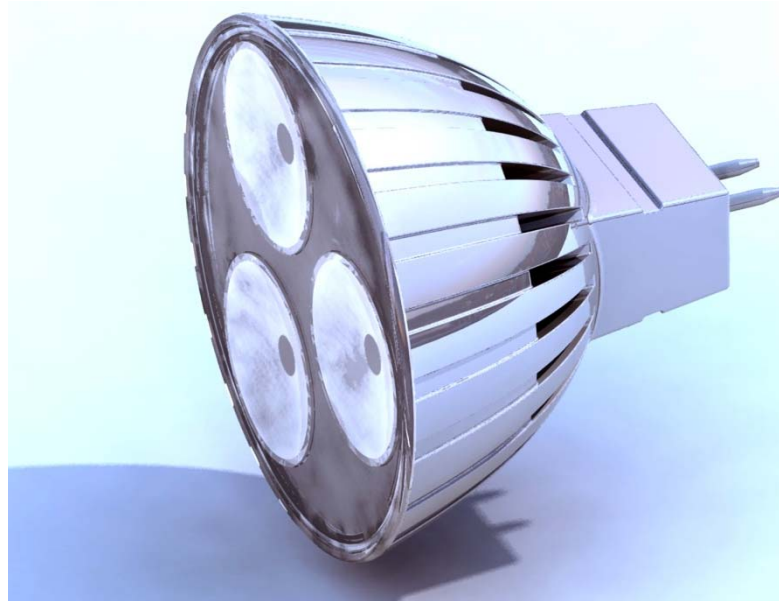
Provides in excess of three hours emergency lighting duration from built in batteries in the event of power failure.

Complies with Euro norm lighting standard EN13272.

New Product Release



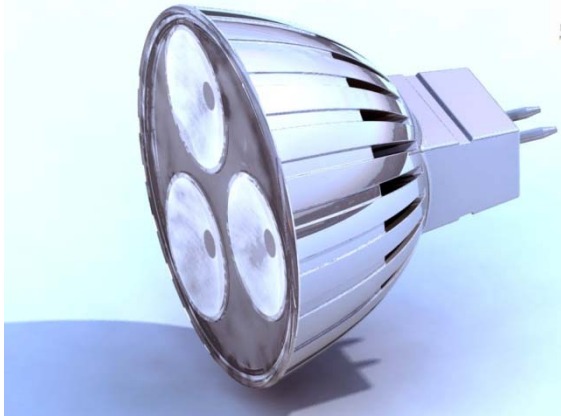
- LED technology replacement for the popular MR16 style halogen dichroic lamp.



New Product Release



Dichroic LED replacement

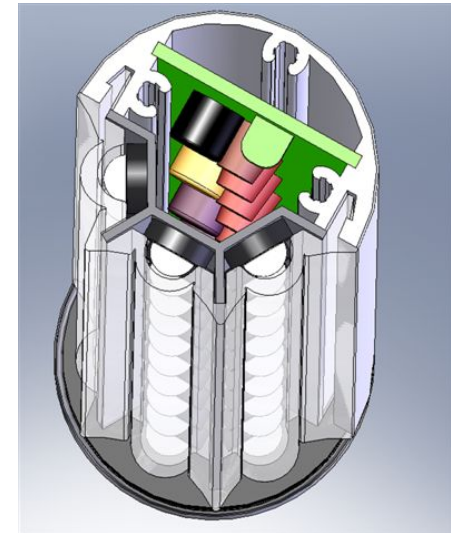


- Integrated power supply.
 - 8 to 16V DC or AC operation.
 - Fully railway compliant.
 - Ultra high reliability, “fit and forget” solution.
-
- Incorporates 3 x 1 watt power LEDs.
 - Comparable luminous intensity of a 20 watt MR 16 halogen lamp.
 - An 80% power saving over the equivalent lumen output halogen lamp.
 - Cool front face, just 10 °C rise compared to 80 °C for a halogen lamp.
 - Available in cool, natural and warm white with a choice of beam angles.
 - Visit the LPA Excil Electronics stand for a product demonstration.

Product and Application Examples An LED Fluorescent Replacement. (A Concept)



Long Life Reliability
does not cost the earth



Application Examples



Long Life Reliability
does not cost the earth



Interior illumination utilising LEDs as the sole light source.



Toilet Mirror Effects Lighting.



Illumination via handrail mounted LEDs.



Luggage rack incorporating LED illumination.

Conclusions



What advantages do LEDs offer ?

- Ultra high reliability resulting in significantly reduced vehicle operating costs. Case studies have illustrated that the payback period can be as short as 2 years.
- Increased reliability resulting in reduced environmental impact.
- With outputs of 100 lm/W and greater, LEDs are now serious contenders for general interior illumination schemes.
- Low temperature light beam resulting in a more comfortable and less hazardous passenger environment.
- Low power consumption offers huge energy savings and maximises emergency lighting performance.
- All Crucial factors in modern, competitive rolling stock operation.



*Long Life Reliability
does not cost the earth*

Thank You

Any Questions?