LPA EXCIL ELECTRONICS

Rail Interior Lighting Specialists

Railway Interiors expo 2011

Long Life Reliability
does not cost the earth

Rail Business Awards 2010
Winner
Environmental Innovation of the Year

LED Technology Overview

- The LED is a totally solid state “PN junction” device
- No fragile filaments or gas discharge processes to fail
- Perfect for rolling stock use where vibration is an issue.
- When a constant current is passed via the PN junction, photons are released.
- A phosphor coating internal to the device controls the colour temperature of light emitted.
- The high luminous efficacy levels compared to traditional light sources result in significant energy savings.

LED Technology Overview

- The LED is capable of ultra long service life.
- In order to achieve long service life the device must be:
  - Correctly thermally managed
    - Heat must be efficiently routed away from the junction
  - Correctly driven electrically
    - With regulated constant current
    - With a fully rolling stock compliant driver (power supply)
    - With a driver which protects the LEDs from the harsh surges and transients present on the vehicle supply

Lumen Maintenance, Service Life and MTBF

- **Lumen maintenance** is defined as the life at which the lumen output has decayed to 70% of its initial value
- If optimally designed, LED systems achieve 50 to 100K hours to 70% initial lumen output and even more if used in conjunction with dimming systems (discussed later)
- **Service life** is the time to the point where illumination levels fail to meet specified/designed requirements e.g. EN13272
- This is the most relevant figure
- **Mean time between failure** is the average time between electrical failures
- The LED has potential to realise tens of millions of hours MTBF, but this can be significantly compromised by poor electrical and/or thermal design

LED Technology Overview
Optics

- In order that the LED output lumens may be converted into useable light, optics must be employed
- Down lights would tend to use lenses

- Fluorescent replacement luminaires would use diffusers.

Two distinctive approaches:

Direct projection
Edge illuminated

LED Technology
A Decade of Progress
Efficacy

- **Year 2001**
- 20 lm/W cool white, 10 lm/W warm white
- Warm white availability issues

- **Year 2011**
- 120 lm/W cool white, 85 lm/W warm white
- Warm white widely available and more or less standard in rolling stock interior illumination

LED Technology
A Decade of Progress
Colour temperature

- **Year 2001**
- Colour bins not well established
- LED manufacturers not in tune with the needs of the lighting industry
- LED manufacturers “Take what you are given” attitude.

- **Year 2011**
- ANSI colour binning to +/-150K control
- LED manufacturers much more aware of lighting industry requirements
- LED manufacturers much more accommodating

LED Technology
A Decade of Progress
Manufacturability

- **Year 2001**
- Manual intervention required, LEDs not compatible with surface mount reflow soldering process.
- **Year 2011**
- LEDS fully compatible with surface mount automated pick and place and re-flow solder process.

LPA-Excil Automated SMD Line

Established Technology Application Examples

Waratah-Australia-100% LED Solution

Established Technology Application Examples

London Underground

SNCF-AGC

London Underground

Established Technology Application Examples

Singapore LTA-Diffuser removed

Singapore LTA-Diffuser in place

Panorama car-Canada

A New Generation LED Background

- Historically, two generic LED types have existed:
- Power LEDs or high brightness, specifically designed for the illumination industry

- These offer high efficacy, good colour rendering and carefully controlled colour and intensity binning
- Signal LEDs, not designed for illumination but are none the less finding their way into low grade illumination products

- These devices are designed for indication purposes, have low efficacy, low colour rendering and poor colour control.

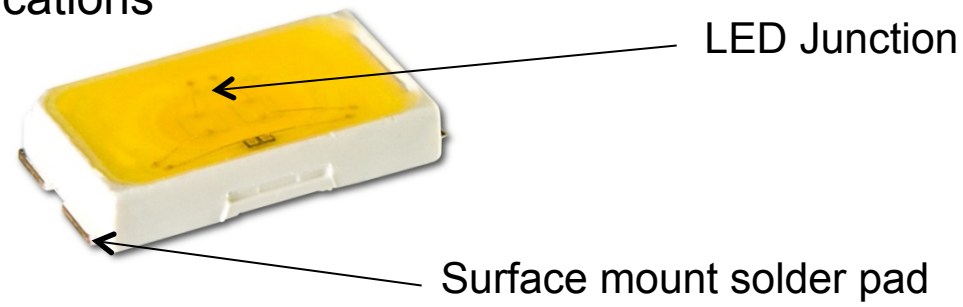
A New Generation LED

•Known as **“Chip LED”** technology

•The technology has existed for some years but performance has improved radically within the past two years

•Employs power/high brightness LED technology but at reduced power levels and in a smaller package

•Designed specifically to fulfil the requirements of illumination applications



•A larger number may be used within a luminaire resulting in greater evenness and uniformity of illumination

•A 1200mm length luminaire would contain typically 300 LEDs.

LED Technology Comparison

LED TYPE	Power LED	Chip LED
Visual aspect		
Luminous efficacy (warm white)	85lm/W	100lm/W
Lumen Maintenance (to 70% light output)	100,000 hours	>60,000 hours
CRI	>80	>80
Cooling system	Requires aluminium thermal substrate	Requires standard FR4 PCB
Current	Up to 1A	Up to 160mA
Visual aspect	Spotting visible	Not visible when a high number of devices are utilised
Application	Localised application (spot light, step light, reading light...) General lighting systems which solely rely on indirect illumination High Lumen Maintenance	Direct lighting when a large surface area with unconventional shape or dimensions has to be illuminated with good uniformity Chip LED Lumen/£ ratio is also more competitive than Power LEDs

Visual Aspect

Power LED

Chip LED

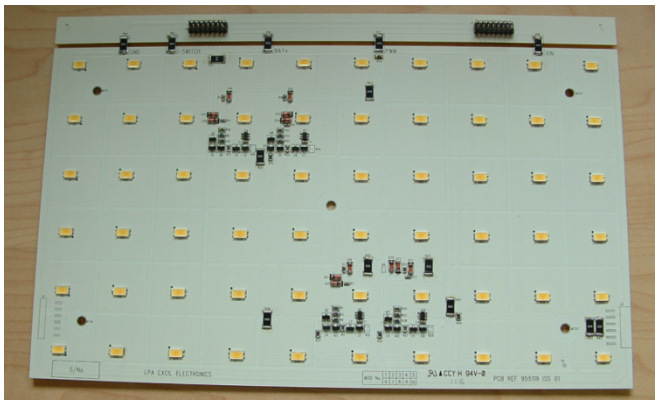
Glass

Polycarbonate

LumiMatrix™

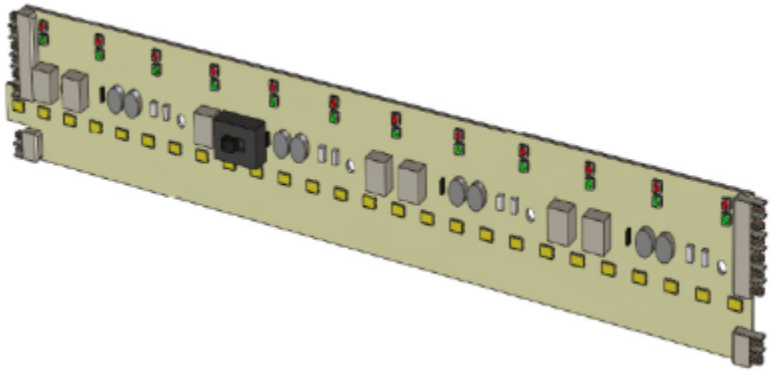
- LED luminaire just 30 mm thick
- Hundreds of chip LEDs utilised
- Even and uniform illumination
- Flexible LED pitch and light output to meet specific illumination requirements
- Total flexibility of shape and dimensions
- Available as a light engine (PCB) or full luminaire
- Built in drive electronics & optional emergency battery back-up
- Typically 12 years service life
- Typically 33% energy saving
- Dimmable

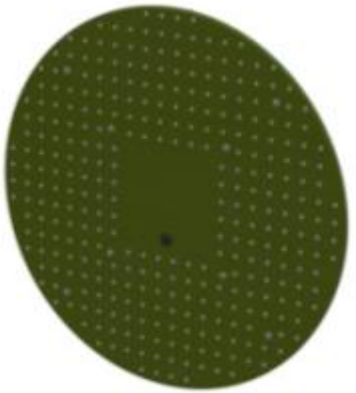
LumiMatrix™



- LEDs are split into banks of 15 with separate drive electronics per bank
- One central bulk power converter interfaces the vehicle control supply to the LED circuits
- 300 LEDs per 1200mm luminaire
- Typically 90% power conversion efficiency
- LEDs driven at just 25mA for equivalent 36W T8 lumen output
- Power consumption per device typically between 64mW and 160mW
- Luminaire power consumption for equivalent of 36W T8 output just 27W

Configuration Flexibility





LED Dimming

- LEDs offer complete control of lumen output
- Dimmable down to 10% of full output (0% for LumiMatrix™)
- May be controlled in a stepped or continuously variable manner.
- Dimming may be utilised to maximise energy savings
- Dimming improves lumen maintenance resulting in extended system life.
- Provides a more pleasant passenger environment.

Methods of Dimming

Analogue Reduction In Drive Current

- Used for localised dimming of a small number of light sources
- Dimming interface can be either via a potentiometer, 0-10V analogue control, or logic control
- LED colour variation results but typically less than 0.002 on the chromaticity charts X and Y axis
- Tolerances in drive current at low intensity illumination levels can result in visible differences in lumen output at the light source.

Methods of Dimming

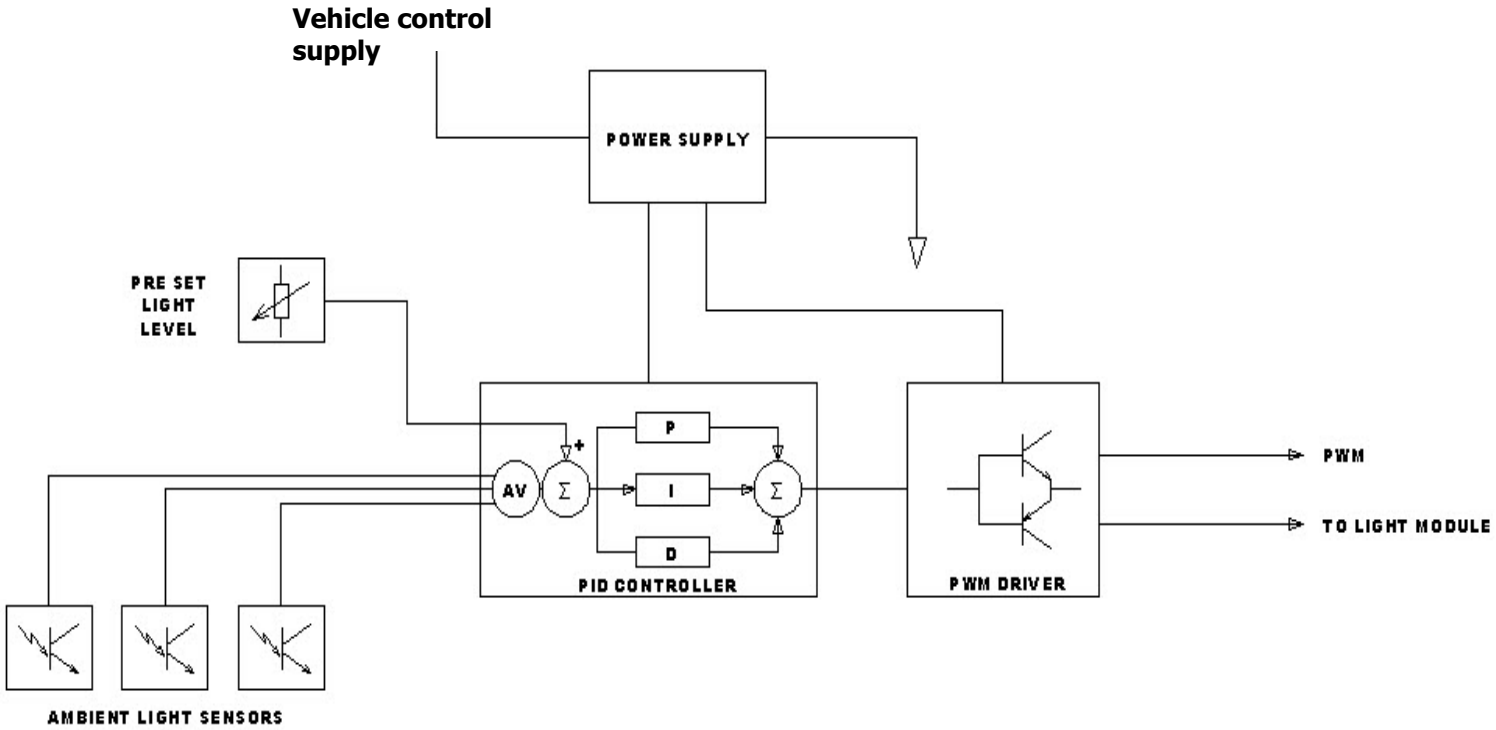
Pulse Width Modulation

- The PWM mark to space ratio determines the dim level
- Multiple lights can be controlled by the same PWM signal. This gives perfectly matched dimming levels of all light sources on the system
- No colour variation across the full dimming range
- PWM frequency from 250Hz to 1kHz with no visible flickering
- The dimming interface is via a PWM controller
- The PWM controller may feature in a control system as part of an ambient light responsive system

Ambient Light Responsive Control

- LED lumen output is adjusted in response to ambient lighting conditions
- Several ambient light sensors (phototransistors) are mounted within the vehicle
- An intelligent control system averages the sensor outputs and applies a processing algorithm in order to attain the correct response characteristics
- The algorithm must reject regular undulations but yet provide a quick response to sudden darkness i.e. tunnel entry
- Ambient light responsive systems significantly extend LED life and save significant amounts of energy as the LEDs are only fully driven in the complete absence of daylight

Ambient Light Responsive Control



LED Technology Choice

- Ultimately, the choice between using Power or Chip LEDs requires understanding of customers requirements:
    - Illumination levels
    - Uniformity
    - Service life
    - Maintenance arrangements
    - Commercial aspects

Conclusions
LED Solutions Offer:

- Ultra high reliability
- Significantly reduced operating costs
- Substantial energy savings
- Reduced environmental impact (no lamp disposals)
- Low temperature lumen output as the light beam is free from ultraviolet and infrared content.
- Enhanced emergency lighting performance
- Total control flexibility

Thank You

Any Questions?

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