

# Design Considerations for Effective LED Integration

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LED Lamps • LED Displays • LED Assemblies  
LED Lighting Solutions • Design Support & Testing  
Manufacture • Research • Development

Or...

# Designing LED Lights is *EASY* ...

Designing LED Lights is *EASY* ...  
... to Get *WRONG* ! ...



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# How Easy?

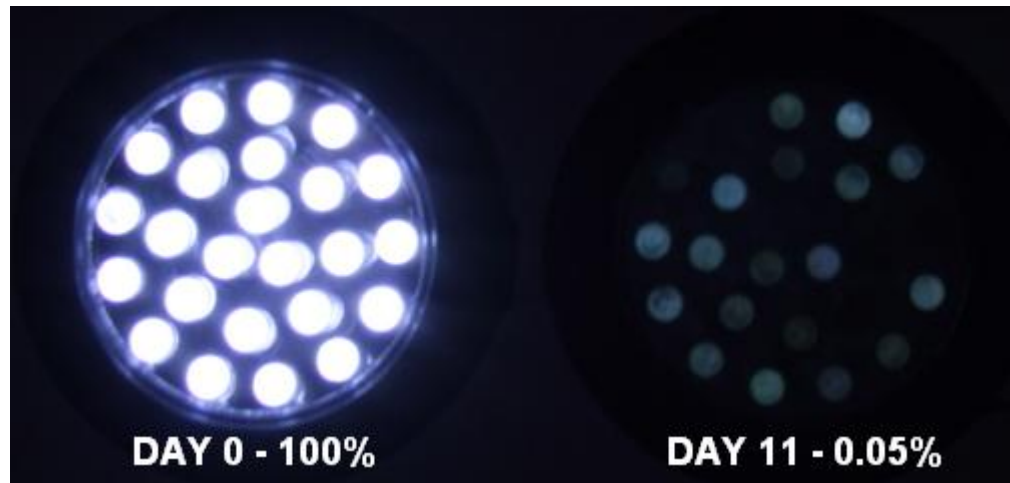
## How Easy?

An everyday example:

24 LEDs in a magnetic clip light  
Powered by 3 AAA batteries  
Cost £4.99



## How Easy?



L70 ~1hr !

## How Easy?

You can buy *candles* that last longer than this for the same money and give out the same light for *14 days* continuously!





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So How do we Get it *Right*?

So How do we Get it *Right*?



We have to wear many different hats!



## LED *Expert*



## LED *Expert*

Cost	{-per Lm / -per Cd / -per LED ...}
Availability	{can you really buy what you want? ...}
Luminous efficiency	{Lm/electricalW / Lm/opticW ...}
Light extraction efficiency	{beam shape, size, uniformity ...}
Manufacturability	{SMT reflowable, handling ...}
Physical size	{lots of choice!}
Light power rating	{efficiency, eye safety ...}
Colour	{range, colour rendering ...}
Reliability	{MTBF, L70 ...}
Viewing angle	{integral lenses, circular/elliptical ...}
Multi sourcing	{desirable if possible ...}
Patents	{hot issue! ...}
...	

## OPTICS *Engineer*



## OPTICS *Engineer*

Transmissive optics (lenses etc)

Cost

Material choice

{PC, PMMA ...}

Transmission efficiency

{big concern ...}

Type

{within-LED, separate, standard, bespoke ...}

Manufacturability

{mounting, handling ...}

Beam pattern quality

{colour stability, colour mixing ...}

Diffusion

{prismatic, random ...}

Reflective optics (reflectors!)

Growth area ?

GLARE

## ELECTRONICS *Engineer*



# ELECTRONICS *Engineer*

CONSTANT CURRENT!

Passive Current Control  
Active Current Control

{resistors ...}  
{linear, switched mode ...}

Low vs High Voltage  
AC / DC  
Power factor correction  
Dimming / modulation  
LED protection  
Topology series / parallel  
LED junction temperature  
...

} all affect: {

Cost  
Efficiency  
Electromagnetic compatibility  
Reliability  
Intellectual property  
...

## THERMAL *Engineer*



## THERMAL *Engineer*

LED temperature CRITICALLY controls:

- LED lifetime
- LED efficiency

There's only one place for heat to go – into the environment by:

- Conduction {to body of product, via water ...}
- Convection {heatsinks ...}
- Radiation {from body of product ...}

How to move heat:

- PCB {Metal core, FR4, exotic ...}
- Thermal I/F {gap fillers, greases, phase change materials ...}
- Heatsinks {standard, bespoke ...}
- Enclosure {use product body itself ...}
- Exotics

...

## Chemist



## Chemist

LEDs are NOT chemically inert!

Sealed LEDs => reliability problems

Unsealed LEDs => oxidation problems

LED silicone encapsulants can react with:

- Adhesives

- Cleaning agents

- Sealants

- Mould release agents

- ...

Conformal coatings – LED compatible?

## PRODUCTION *Engineer*



## PRODUCTION *Engineer*

LED “bin” grading

Production bin management

Binning standards

ESD hazards

Mechanical issues

Packaging

Test

...

{colour, brightness, voltage ...}

{segregate, dither ...}

{harmony may be emerging? ...}

{handling ...}

{SMT handling, humidity ...}

{lens integrity ...}

{what/how?, eye safety ...}

## TEST *Engineer*



## TEST *Engineer*

Test/measurement during DESIGN of:

Optics	{photometer, goniometer, spectrometer ...}
Electronics	{efficiency, EMC ...}
Environmental	{temperature, humidity, vibration ...}
LED Tj	{LED pn junction temperature ...}

Test/measurement during MANUFACTURING of:

Some of the above ...

LIFE TEST is very important as LED technology is moving so fast ...



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But you do need to understand *many disparate disciplines...*

Or –

Choose a *partner* with these skills!





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Thank You !