



Light Emitting Diodes:

What you need to know about driving High Brightness LEDs

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Agenda for this section

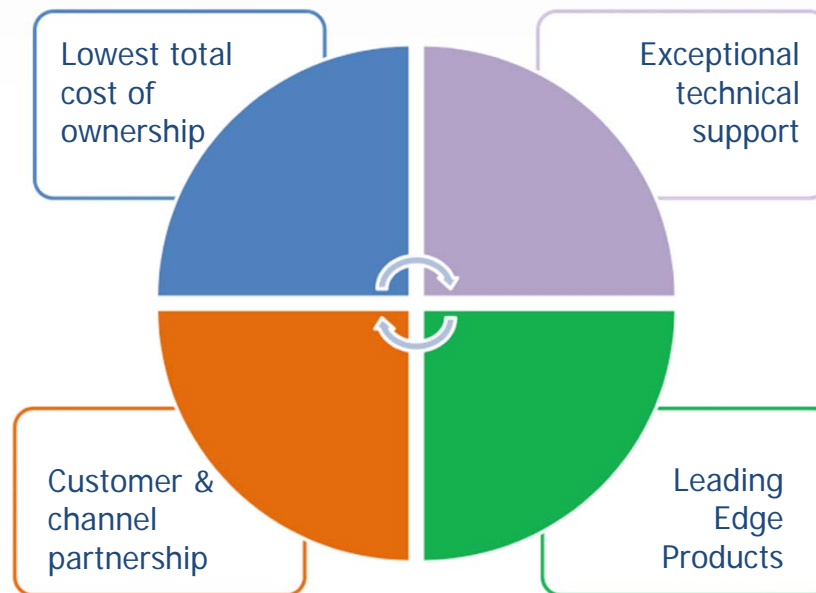
- Introduction to Excelsys
- LED background , commercial and engineering
- How to drive an LED and power supply requirements for this
- Future of power supplies as LED drivers



Introduction to Excelsys

- Headquartered in Cork, Ireland.
- Our core competency is designing high end power supplies that are used in mission critical applications.
- Flagship Xgen product range used in many mission critical designs
 - Medical
 - Industrial
 - Military
- Have been together as a group of engineers for over 14 years now, and have added some young guns to the group over the last few years.
- In 2008 engaged in designing drivers for driving High Brightness LEDs, good alignment with our core competencies.
- Selling globally into North & South America, throughout Europe , Middle East and Far East.

Ethos of Excelsys



Why the take up on LEDs for lighting?

- ☐ Lifetime of 100,000+ hours if you operate them correctly.
- ☐ Durability , no filaments or tubes
- ☐ No Mercury
- ☐ Quicker turn on than florescent
- ☐ Easy to control wavelength of light
- ☐ Significantly more efficient, will cost a lot less to operate

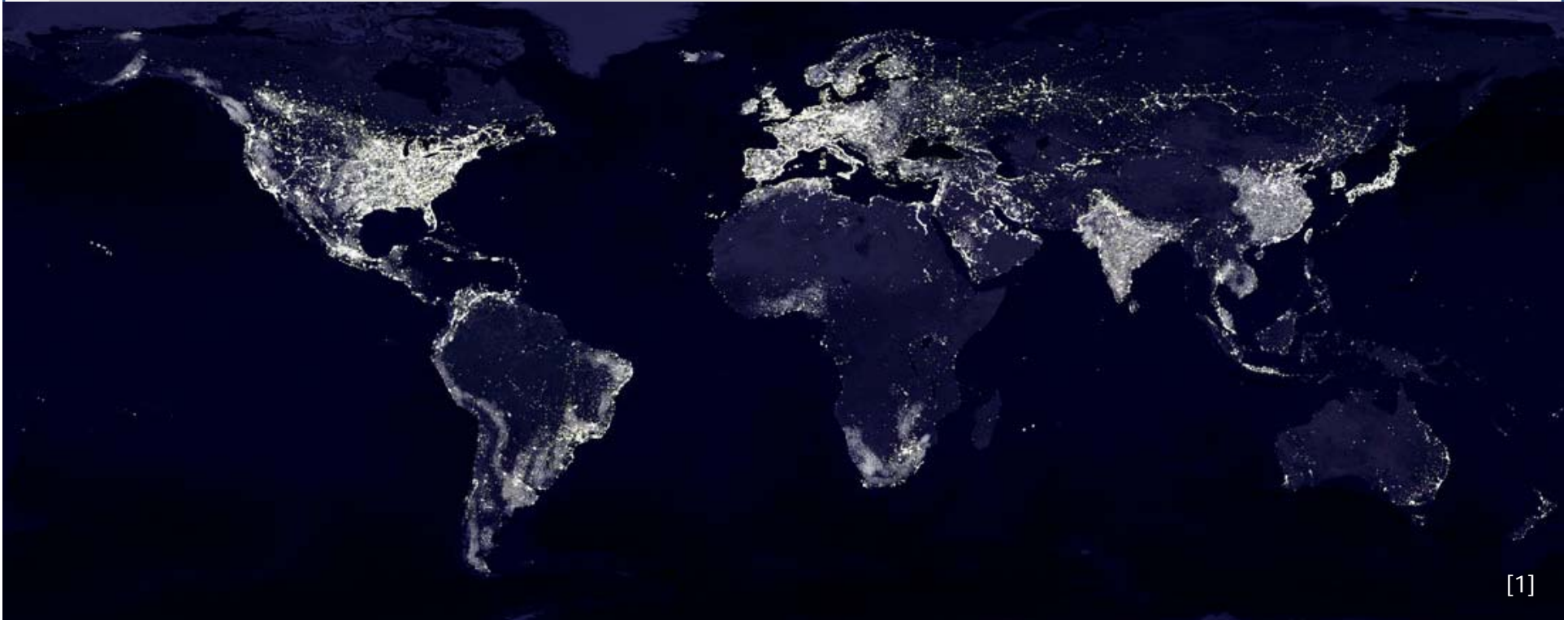
Where the take up on LEDs?

- ❑ Lighting , indoor , outdoor , emergency , special.
- ❑ Entertainment (TV's)
- ❑ What else does a society need to survive and flourish ?
- ❑ Food Cultivation Hydroponics
- ❑ Manufacturing Curing of material
- ❑ Health care Medical
- ❑ Energy Growing Algae to produce oil
- ❑ Communication 'Lifi'



2,651 TWh of electricity consumed (19% of all electricity)

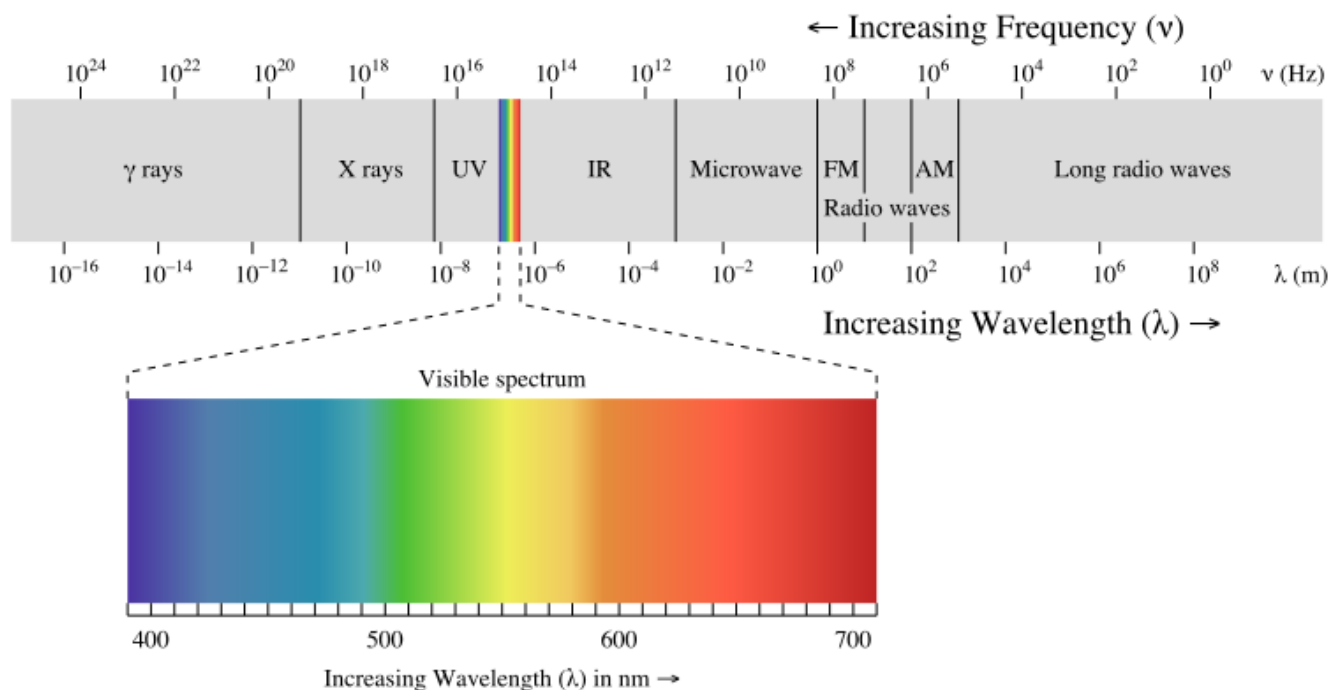
80% increase in global lighting demand projected by 2030



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80% increase in global lighting demand projected by 2030

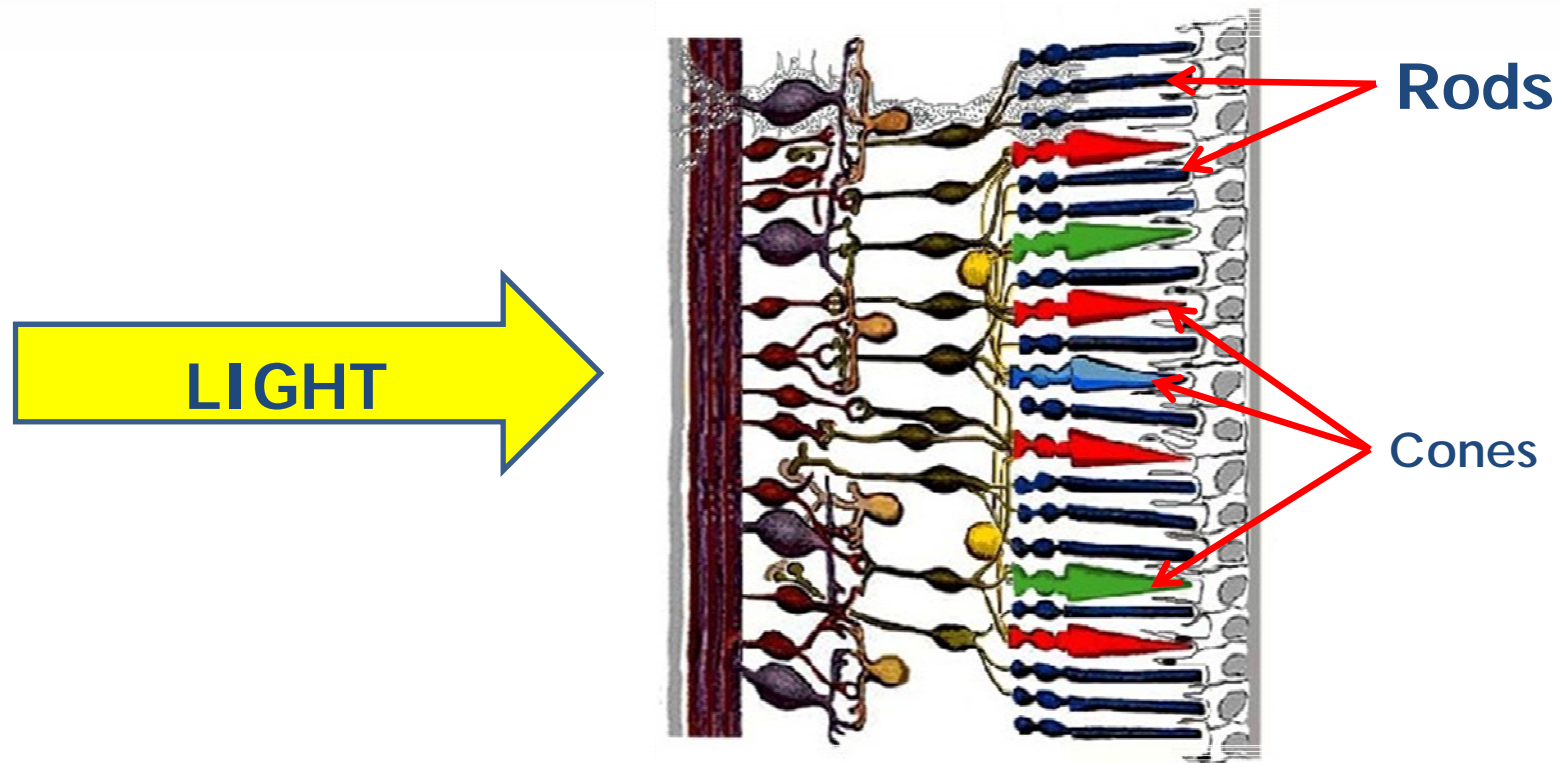
Physics of Light



Any light source can be completely described physically by its **spectral power distribution**, the radiant power at each wavelength

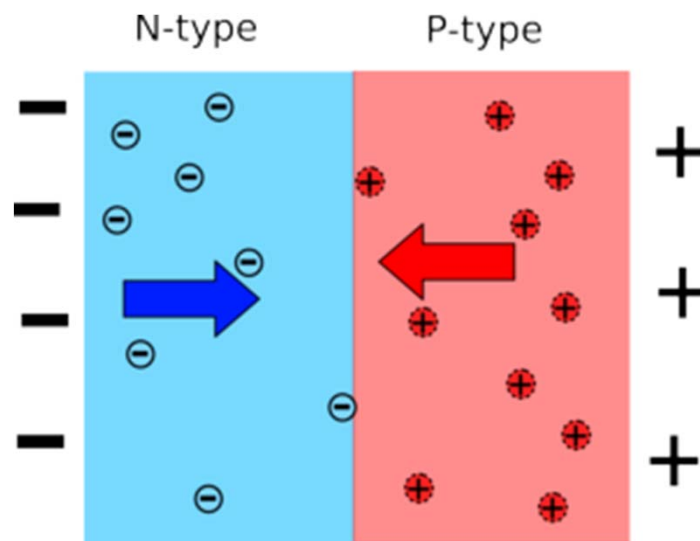
Physics of Light

Retina



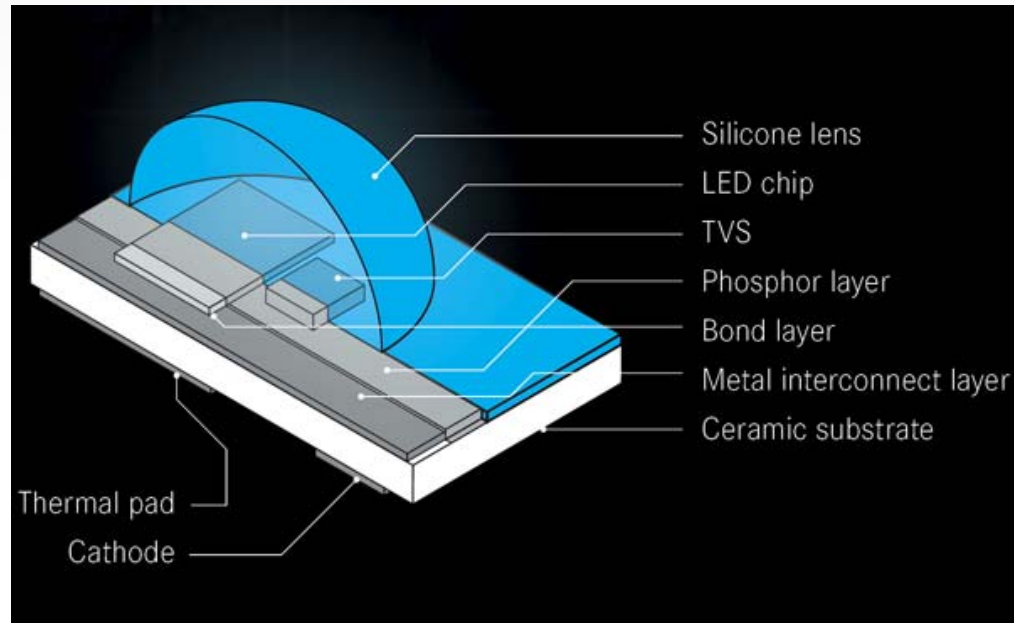
Physics of an LED

- Light Emitting Diode (LED) is a PN junction semiconductor diode that emits a monochromatic light when operated in a forward biased direction



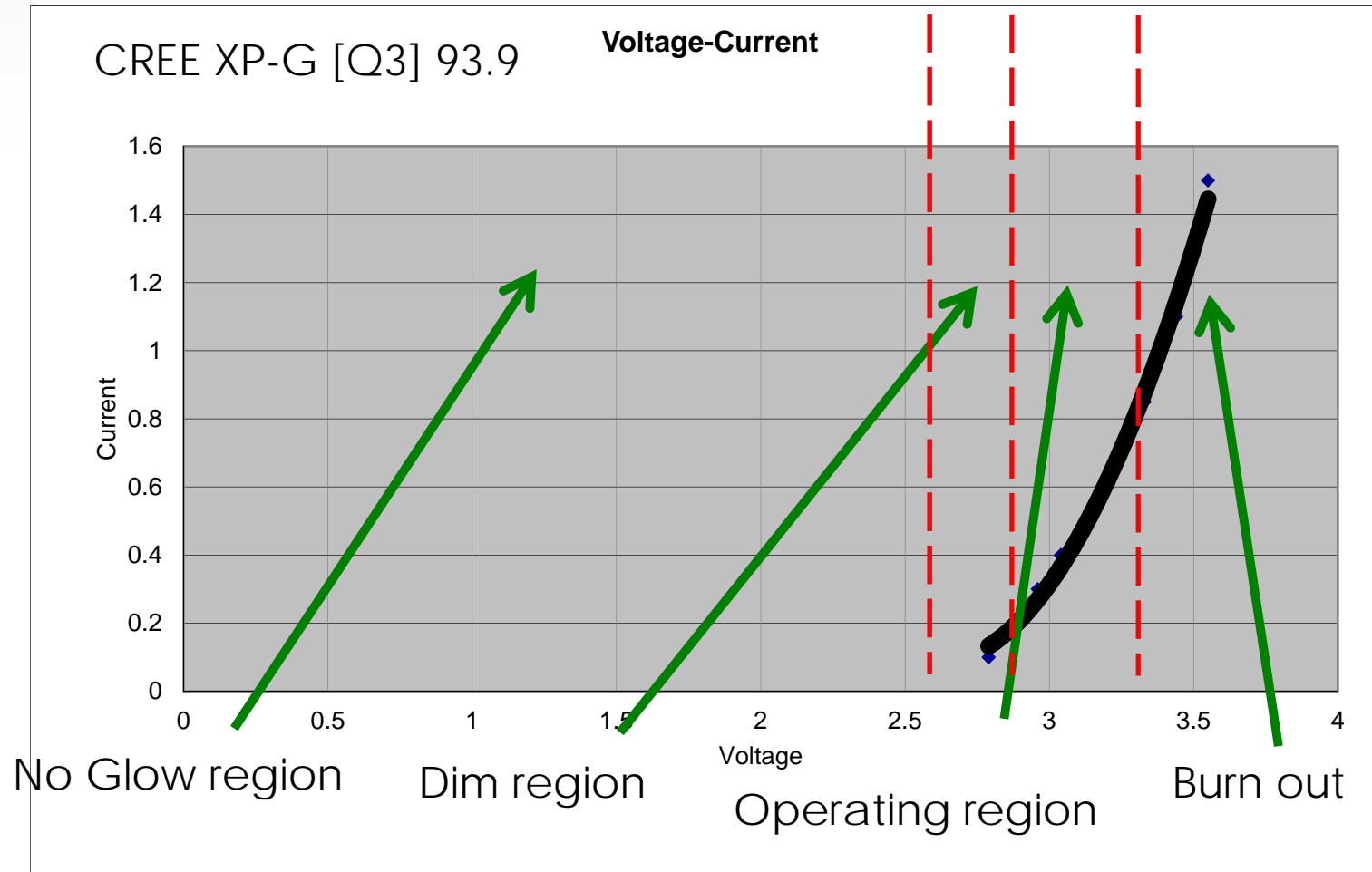
- Effectively a piece of sand that emits lights when a current is passed through it !!

Mechanics of an LED

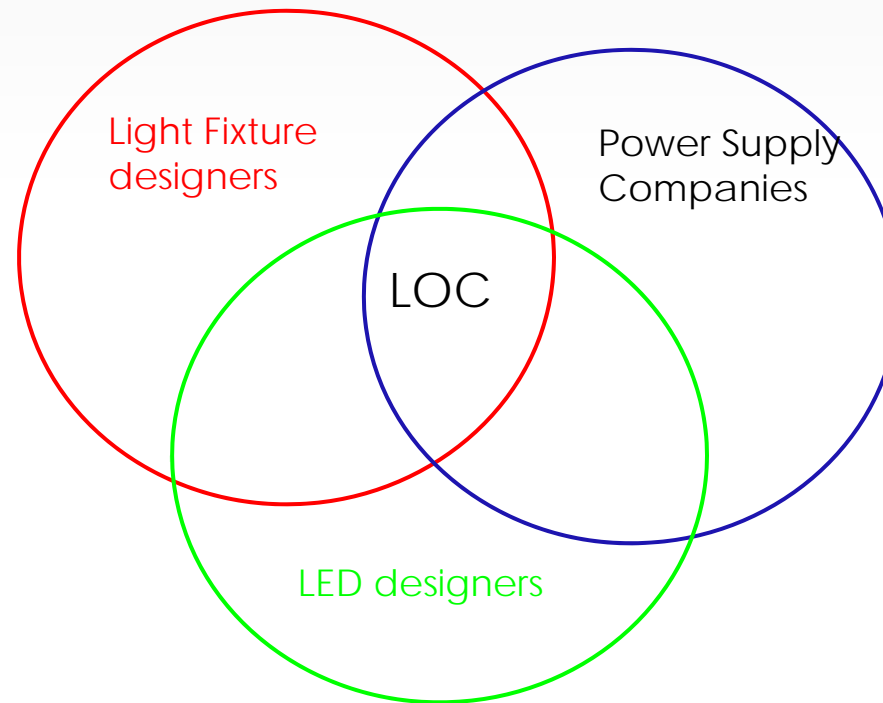


- Die or light emitting semiconductor material, a lead frame where the die is placed, and the encapsulation epoxy which surrounds and protects the die.
- Colour of the light emitted is a function of the material used to make the LED.
- Intensity of light (lumens) is a direct correlation with amount of forward current (I_f)

How to turn on an LED



How to create White Light.

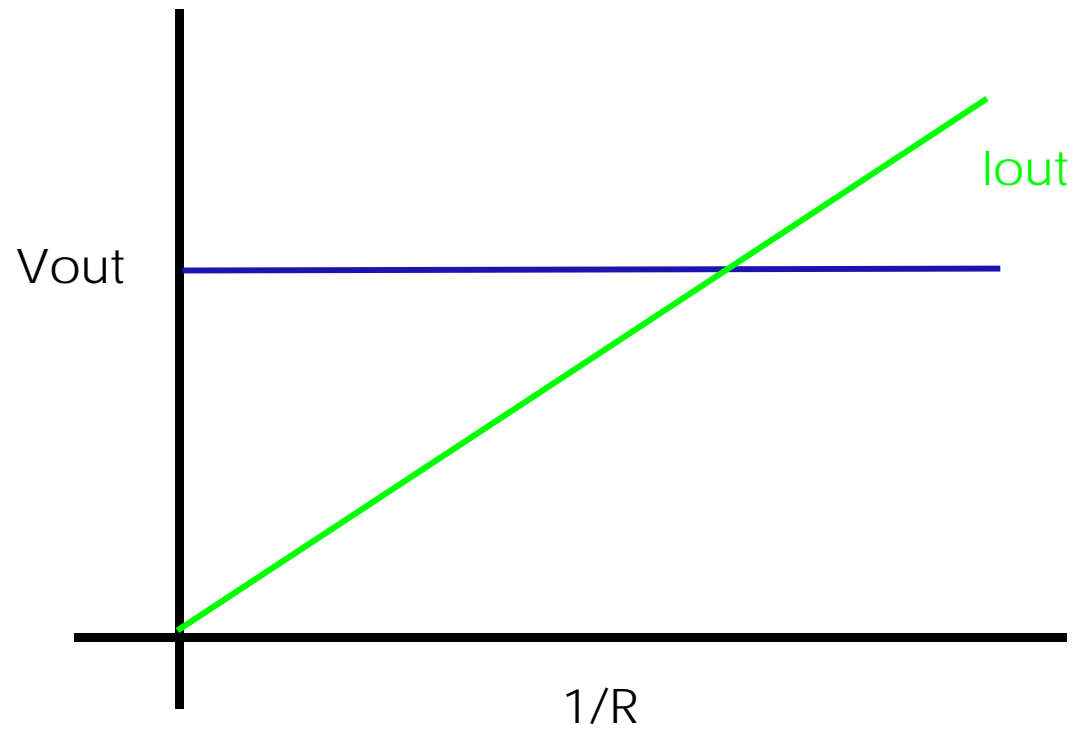


$R + G + B = \text{White Light}$

LOC = Lots of Confusion !!

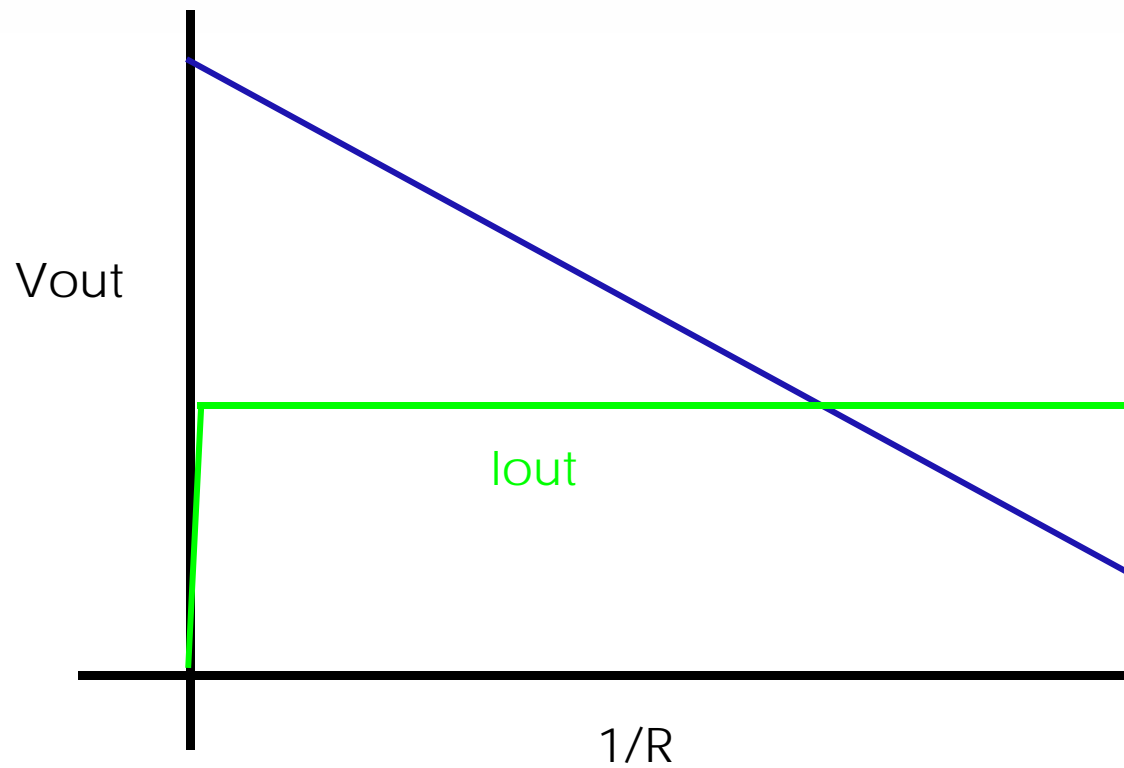
Driving an LED.

We first look at CV mode



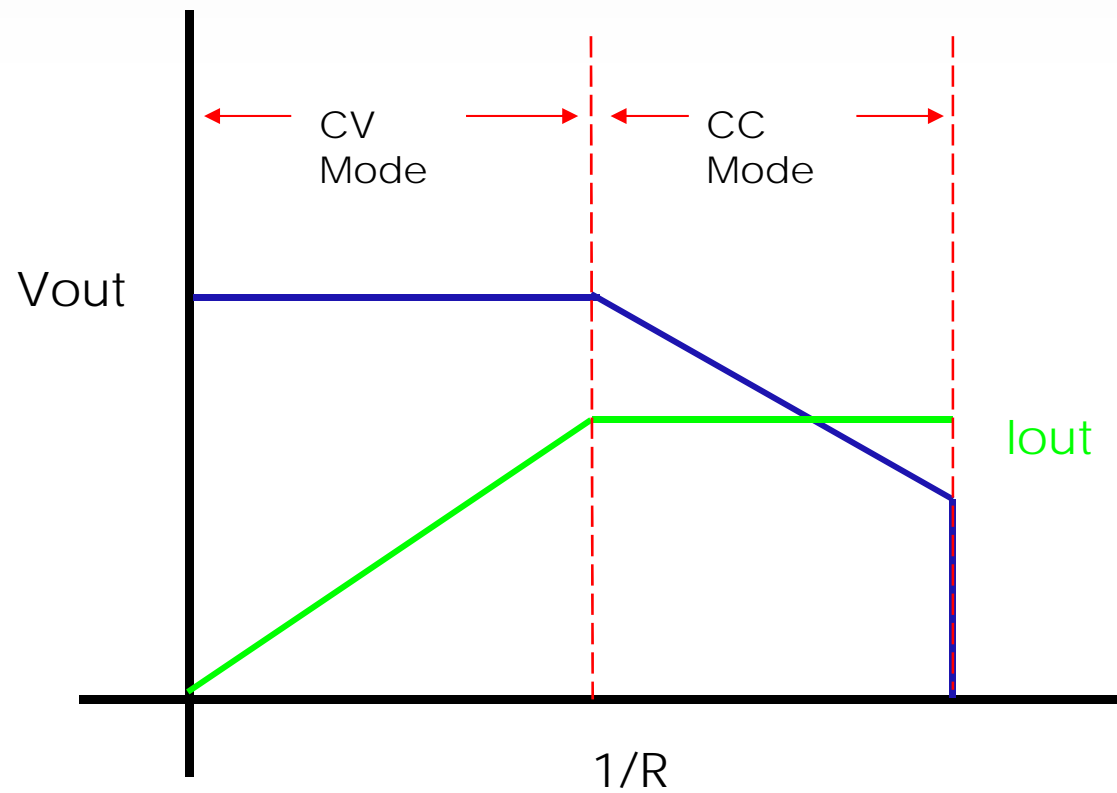
Driving an LED.

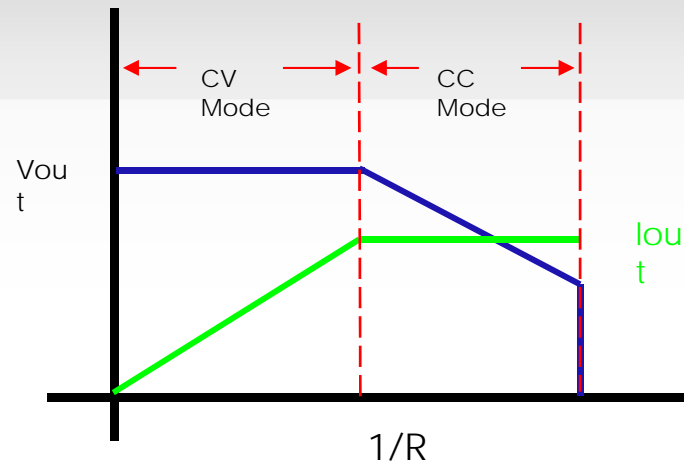
Now look at CC mode



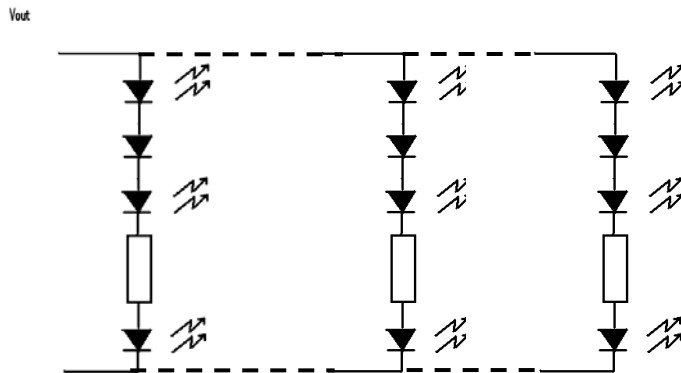
Driving an LED.

CC & CV on the one module



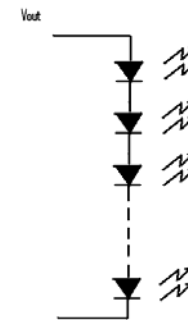


Constant Voltage Power Supply (CV Mode)



Solution: Use in CV mode. Place strings in parallel as long as it does not exceed the point at which it enters CC Mode

Constant Current Power Supply (CC Mode)



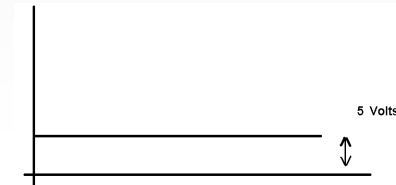
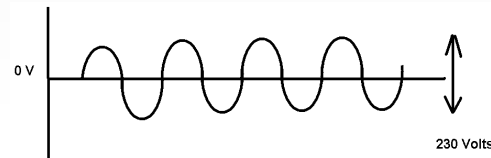
Solution: Force unit to operate in CC mode, and configure string to reflect the voltage and current range

Why do we need an LED driver ?

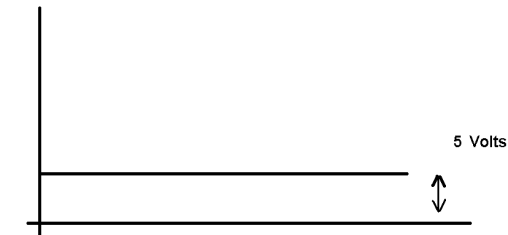
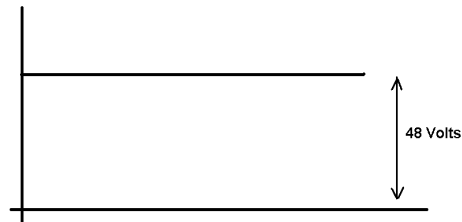
- ❑ AC or DC input , but normally DC output.
- ❑ Must deal with PFC and THD issues
- ❑ Market Leading Efficiency & Power Density
- ❑ Typically IP67 rated , but not always
- ❑ Additional Safety Requirements
- ❑ Onboard protection features (OCP, OVP , SCP , OTP)
- ❑ EMI performance
- ❑ LEDs are non-linear devices (I_f vs. V_f) with a forward voltage that is temperature dependent.

AC or DC input , but normally DC output.

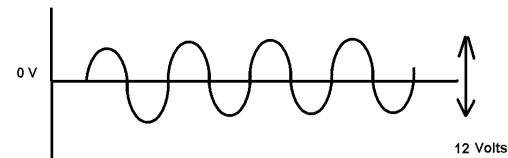
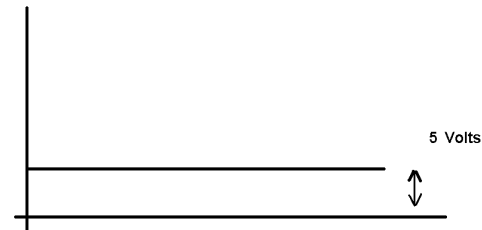
1. AC to DC



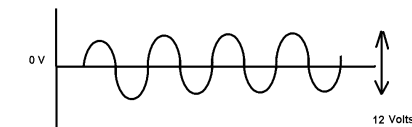
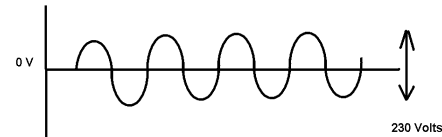
2. DC to DC



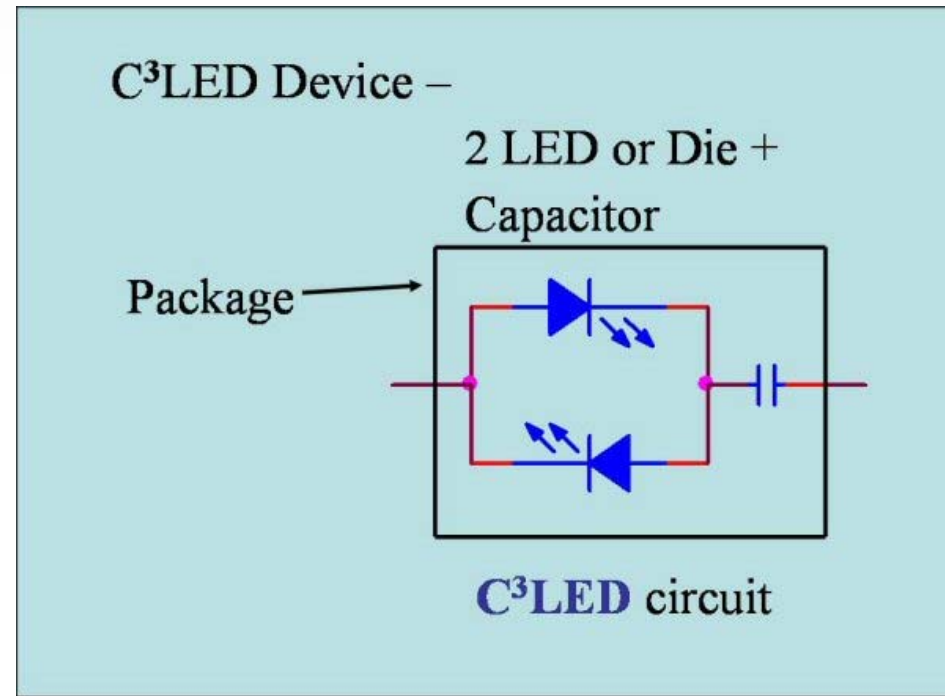
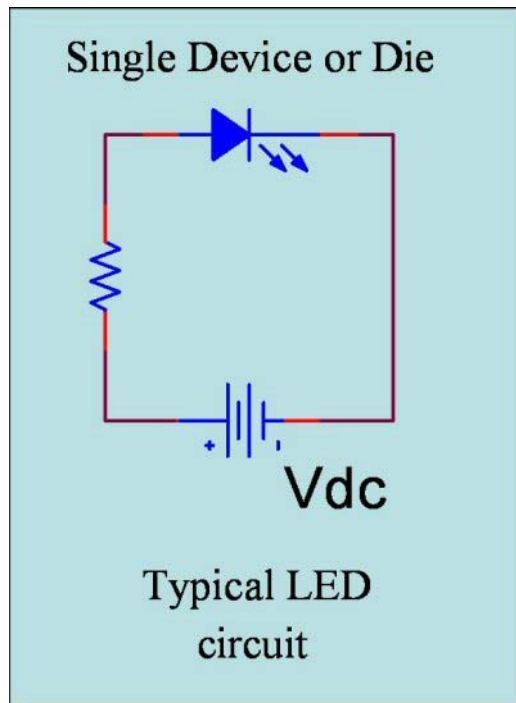
3. DC to AC



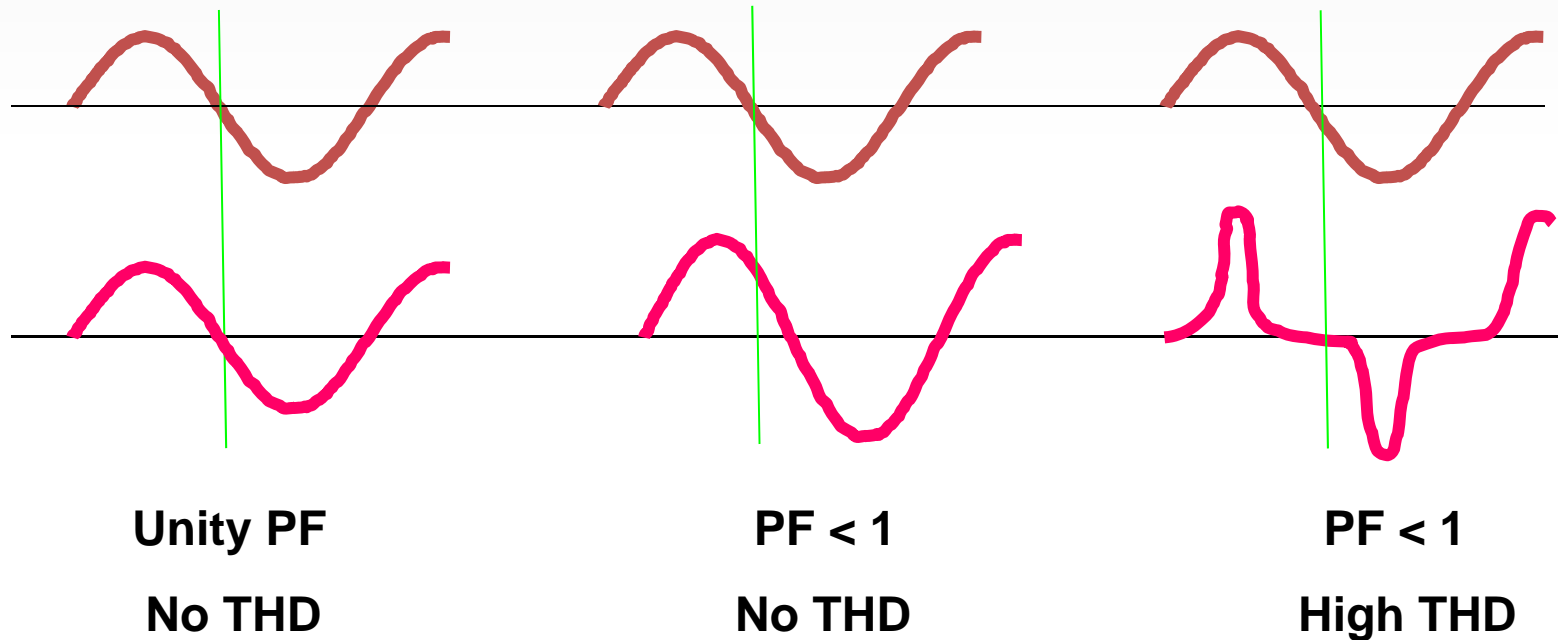
4. AC to AC



AC or DC input , but normally DC output.



Must deal with PFC and THD issues



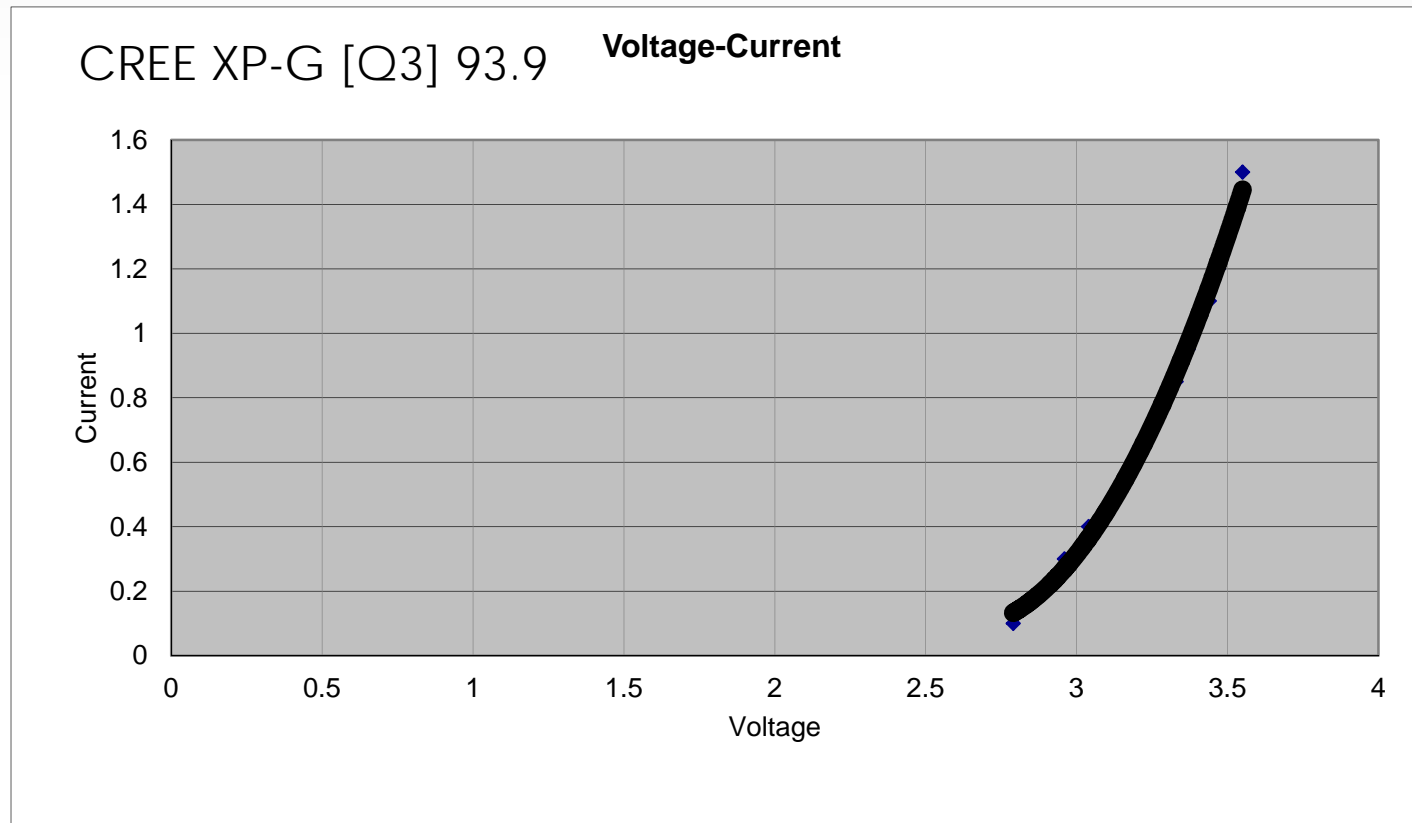
Incandescent light bulbs are purely resistive load, LEDs are not.

Market Leading Efficiency & Power Density



- ❑ Loss in efficiency means heat is built up internally
- ❑ More heat means less reliability
- ❑ 50% reduction for 10 degree rise in temperature
- ❑ If you want to reduce size, must increase efficiency

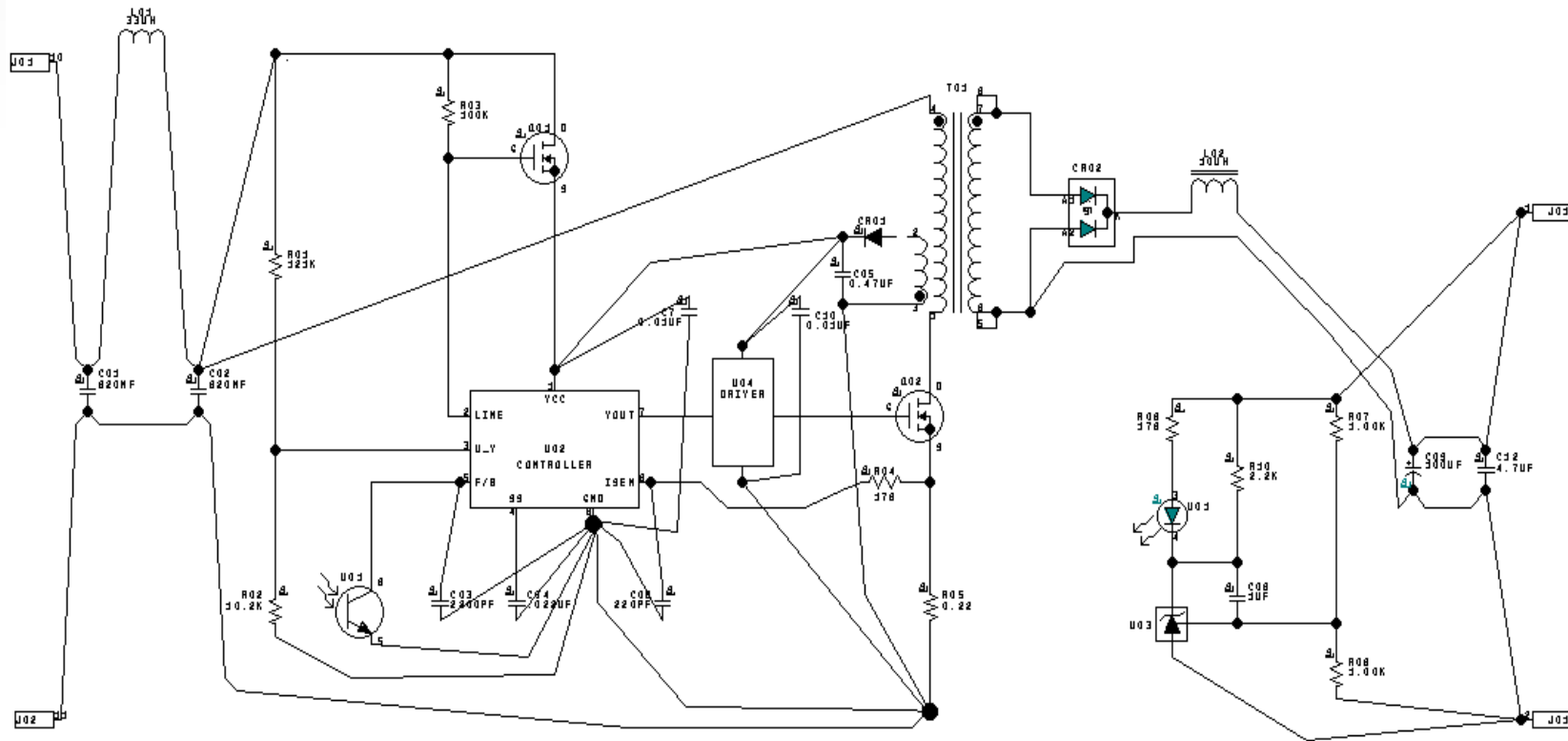
LEDs are non-linear & temperature dependant



Additional Considerations

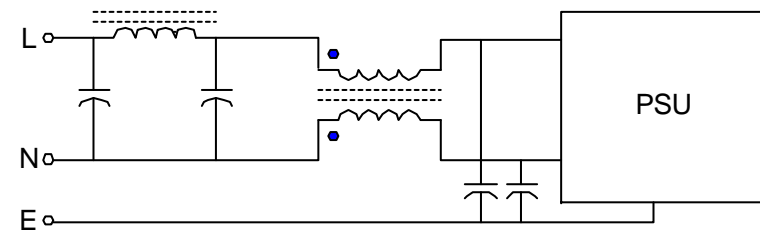
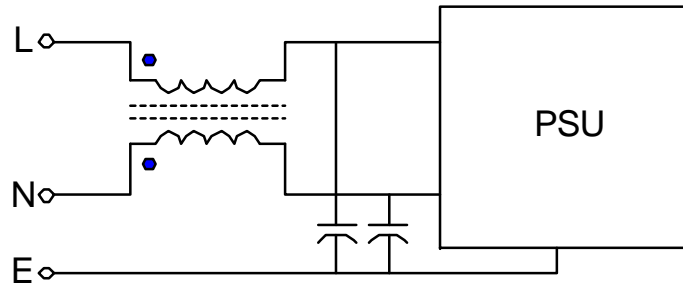
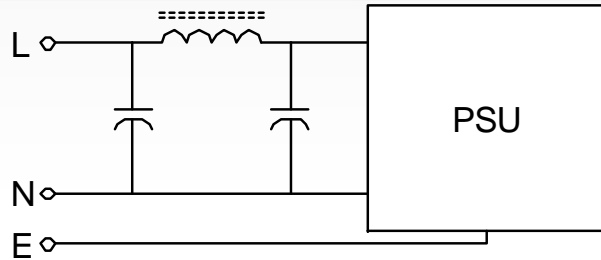
- ☐ Class 2 power supplies
- ☐ Class I v's Class II
- ☐ Class C
- ☐ UL recognised (UL8750)
- ☐ Protection circuitry
- ☐ EMI performance
- ☐ Reliability

EMI performance

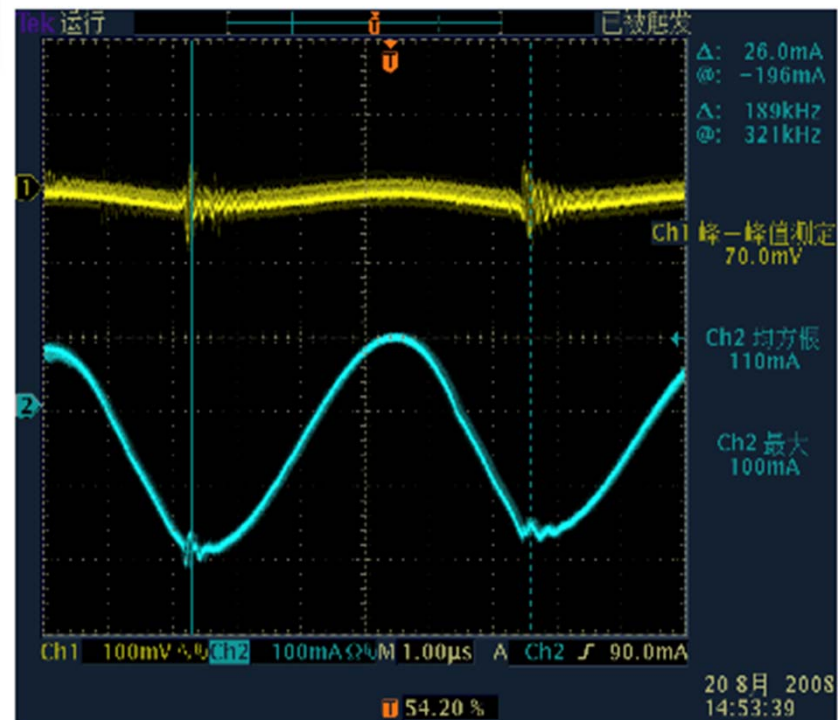


Look how this now differs when drawn as connected

EMI performance : eliminate the need for filters



Reliability



- ❑ Electrolytics are the weakest link in the chain

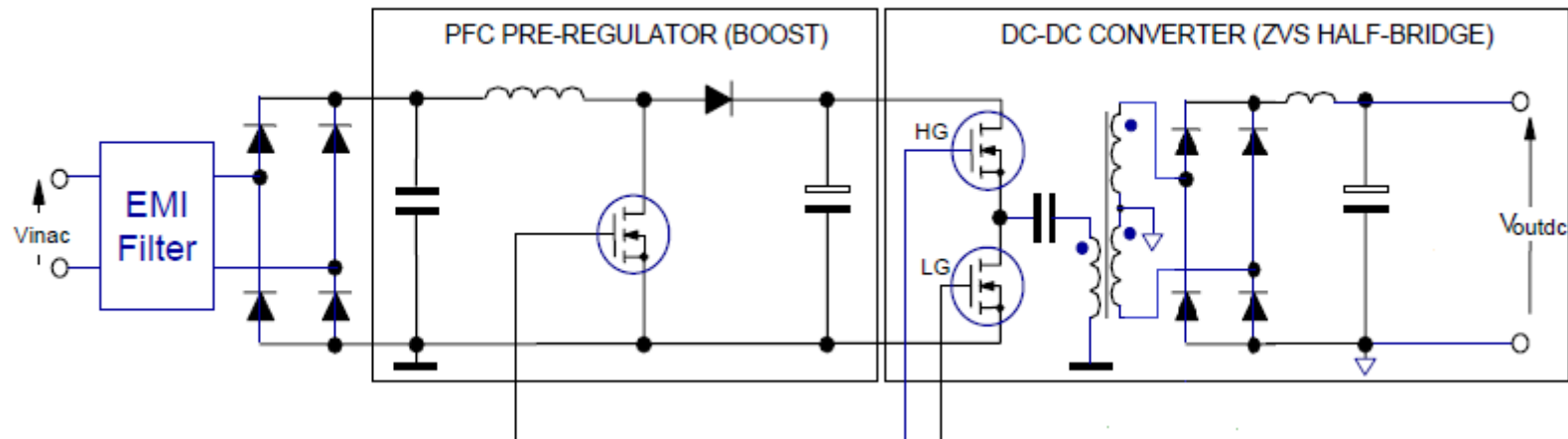
How to reduce cost without compromise

- ❑ Folded metal cases v's aluminium extrusions for outer case.
- ❑ Polyurethane based potting compound, more cost effective than silicon based material.
- ❑ Also need to understand the implications of this , dielects change with materials.
- ❑ Single v's double insulated cables.
- ❑ Commonality of components and circuit building blocks allows better cost structure
- ❑ Reduced size means reduced transportation costs

Let's look at a finished design as an example

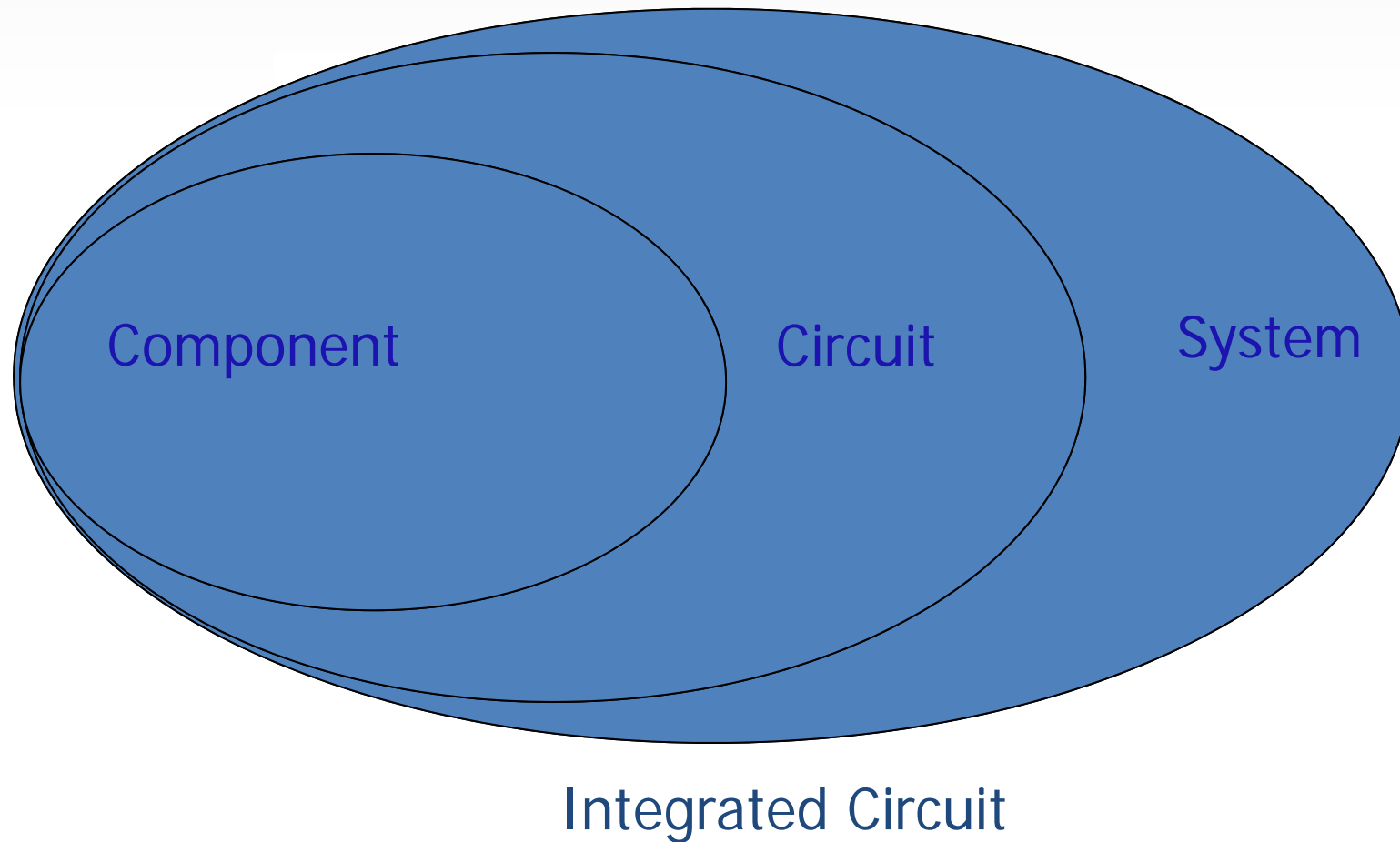
- ❑ LD Product range from Excelsys Technologies
- ❑ Three main product ranges in the LD product range
 - ❑ LDV , constant voltage
 - ❑ LDC , constant current
 - ❑ LDB , constant voltage & constant current
- ❑ Market leading efficiency and power density (91% eff for 100 Watts)
- ❑ EN 55015 Class B conducted and radiated emissions
- ❑ OCP , OVP , Short Cct protection
- ❑ Huge interest in Ireland , Europe and North America for this part

Topology Overview



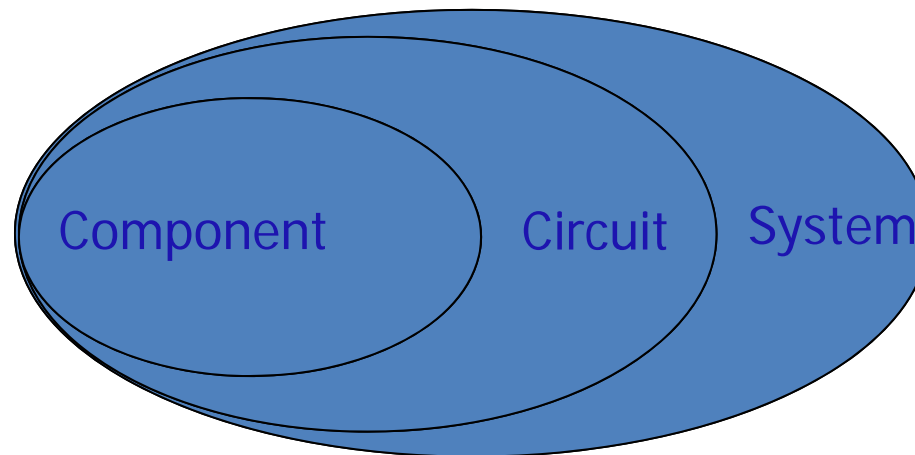
- EMI Filter
- Bridge Rectification
- Active PFC Control (Boost)
- Zero Voltage Switching (Half-Bridge) – High Efficiency, >96% achievable
- Diode Rectification + Hold-up Capacitor

Future of Power Supplies



Future of Power Supplies

- ❑ More integrated approaches from vendors
- ❑ Nett Result is that we will see an decrease in size

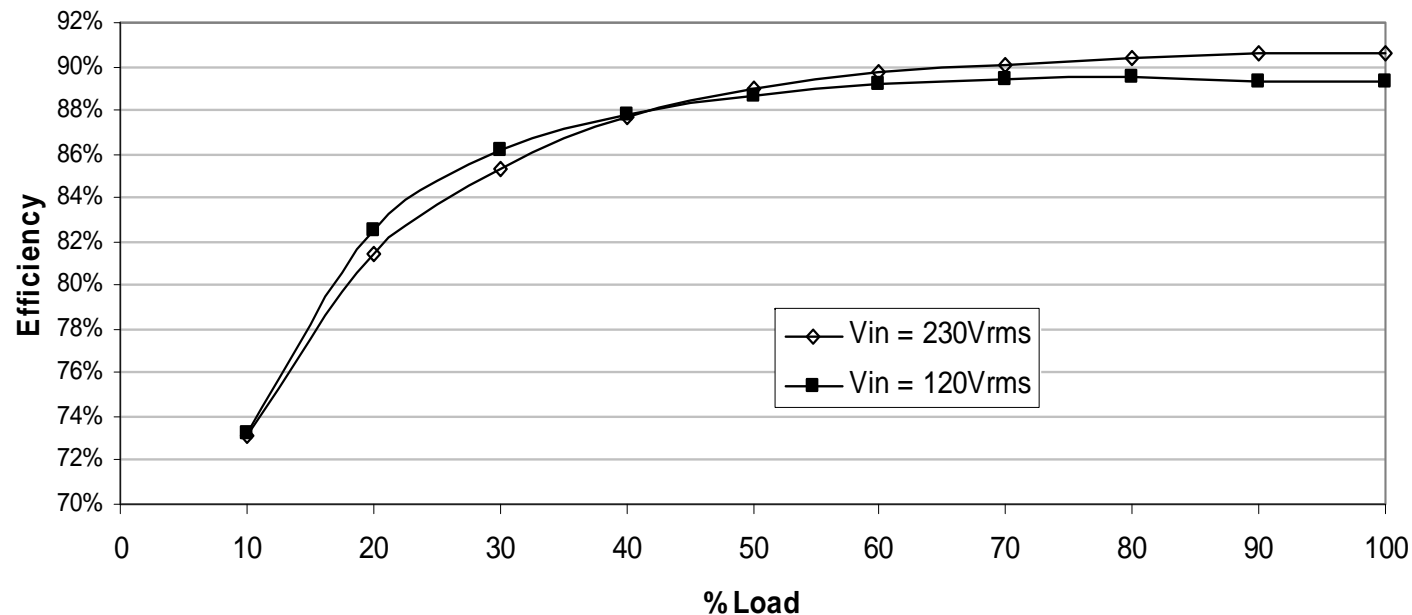


Integrated Circuit

Future of Power Supplies

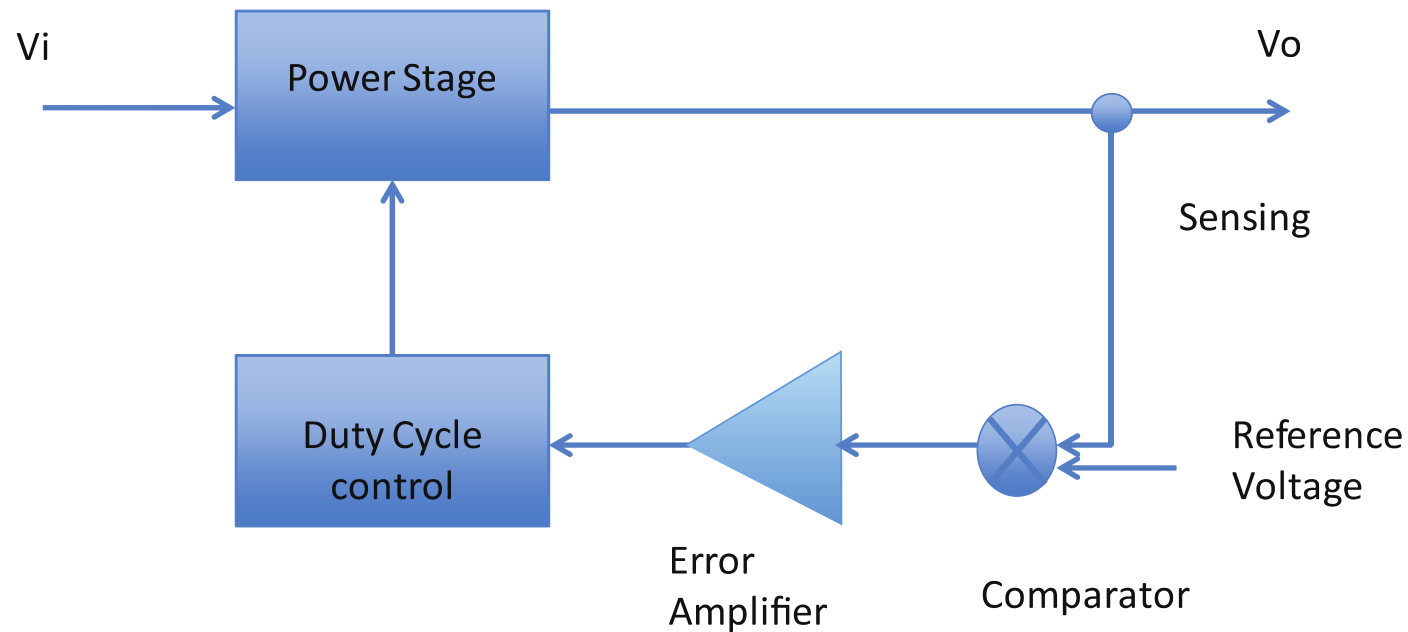
- Performance of the power supply, not just at highlighted operating points, but also over all line and load conditions

LDV100-024SN Efficiency Vs Load



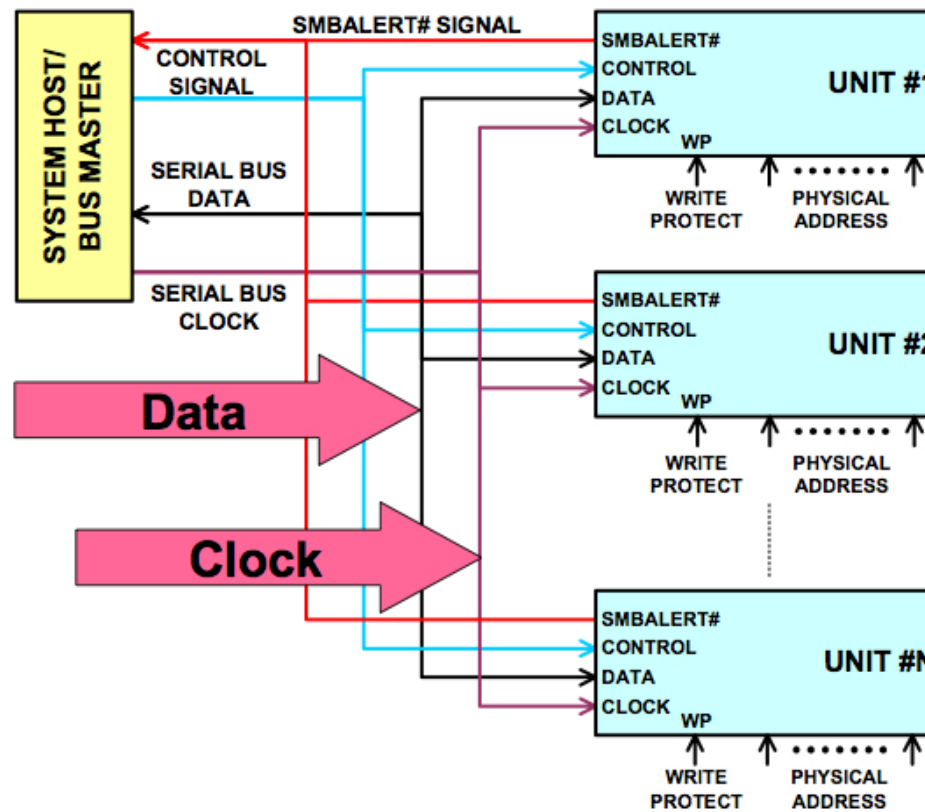
Future of Power Supplies

- Closing the loop with digital control



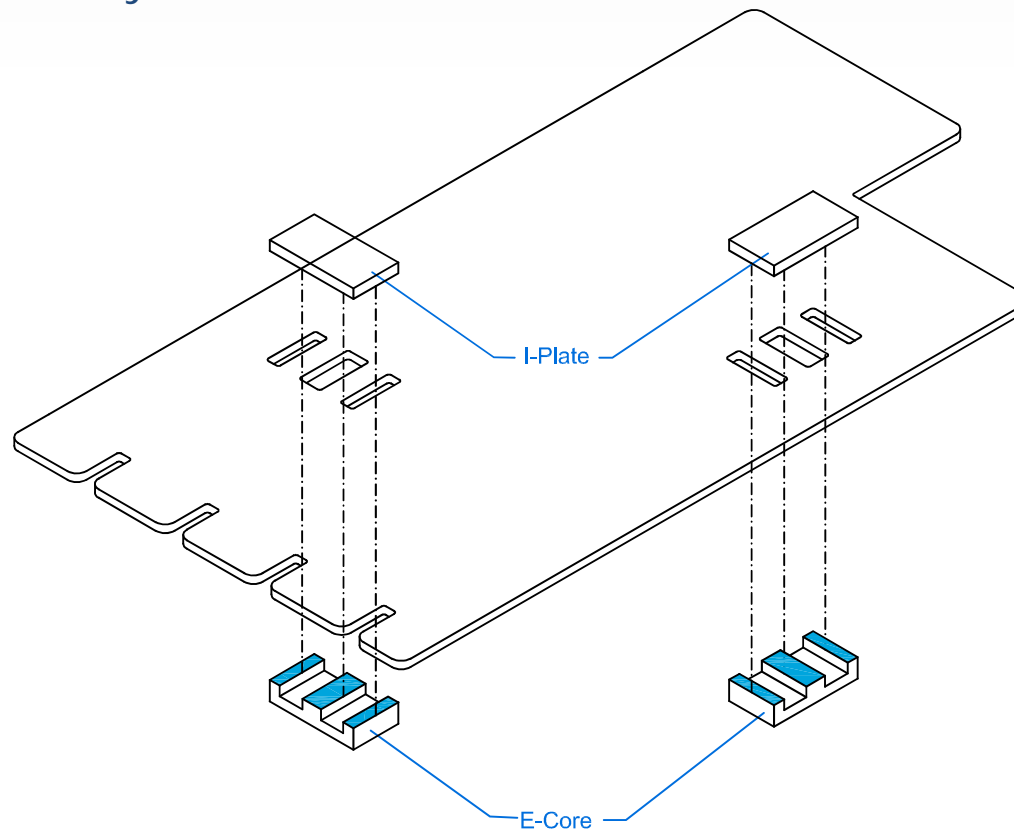
Future of Power Supplies

- Interface and smart features.



Future of Power Supplies

- ❑ Transformer design improvements will continue to increase power density.

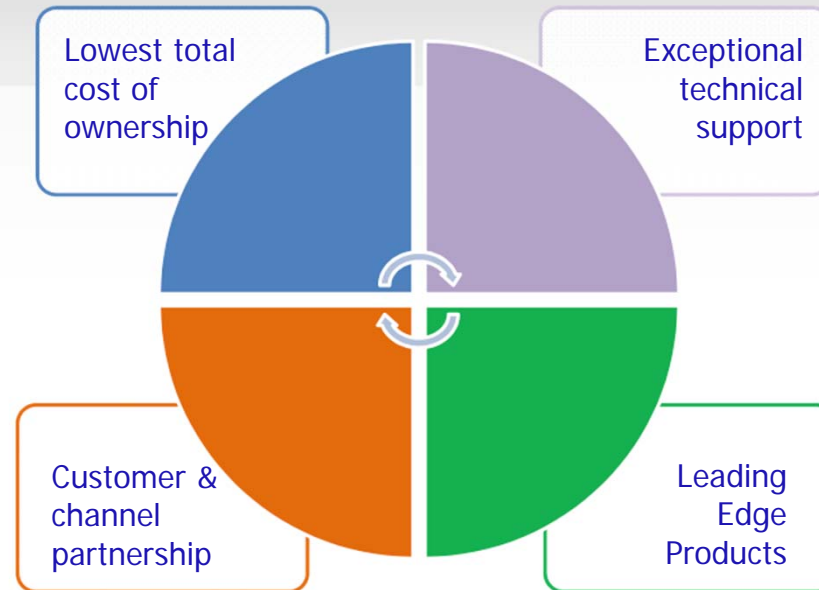


Future of Power Supplies

- ☐ Will be significantly different to the one we see available on the market now
- ☐ Much higher levels of efficiency will become the norm.
- ☐ Will integrate much higher levels of complexity in terms of power monitoring and performance.
- ☐ More integration of Systems on Chips (SOC's)
- ☐ Will continue to reduce in size, whilst maintaining reliability.
- ☐ No single element will cause a rollercoaster effect, but will be incremental & continuous improvements.

What I hoped you have gained from this

- ❑ *You can now start to see why LEDs are taking significant traction in the lighting market and possibly other markets.*
- ❑ *Hopefully you can now start to appreciate the challenges facing a design team as we go through the specification and design stages.*
- ❑ *You have an insight into the future of LED power supplies, but who really knows where this will take us ?*



- ❑ *Excelsys Technologies Ltd. :- a modern world-class power supplies design company providing quality products to OEM equipment manufacturers around the world.*
- ❑ *Achieved by combining the latest technology, management methods and total customer service philosophy*
- ❑ *Further information on our products can also be found at www.excelsys.com*