

FUNDAMENTALS OF LED LIGHTING

What are the benefits,
What are the limitations



Dave Inman
Director of Specifications
Lighting Unlimited Scottsdale,
Arizona

WHAT ARE THE BENEFITS?



LONG LIFE

Between 25,000-100,000 hours +



Before

After

LUMENS PER WATT

More light for less energy



SORAA™



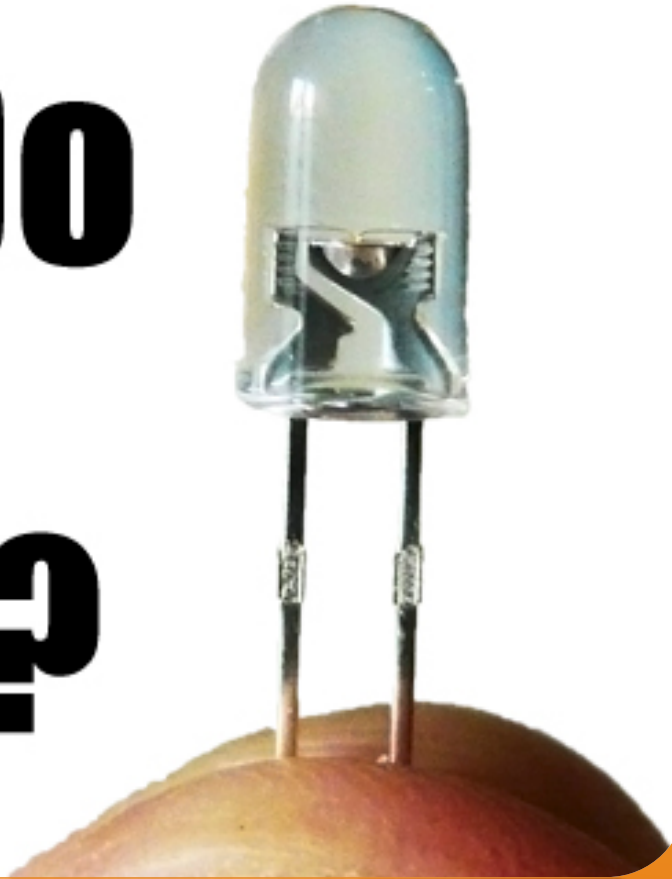
QUALITY OF LIGHT



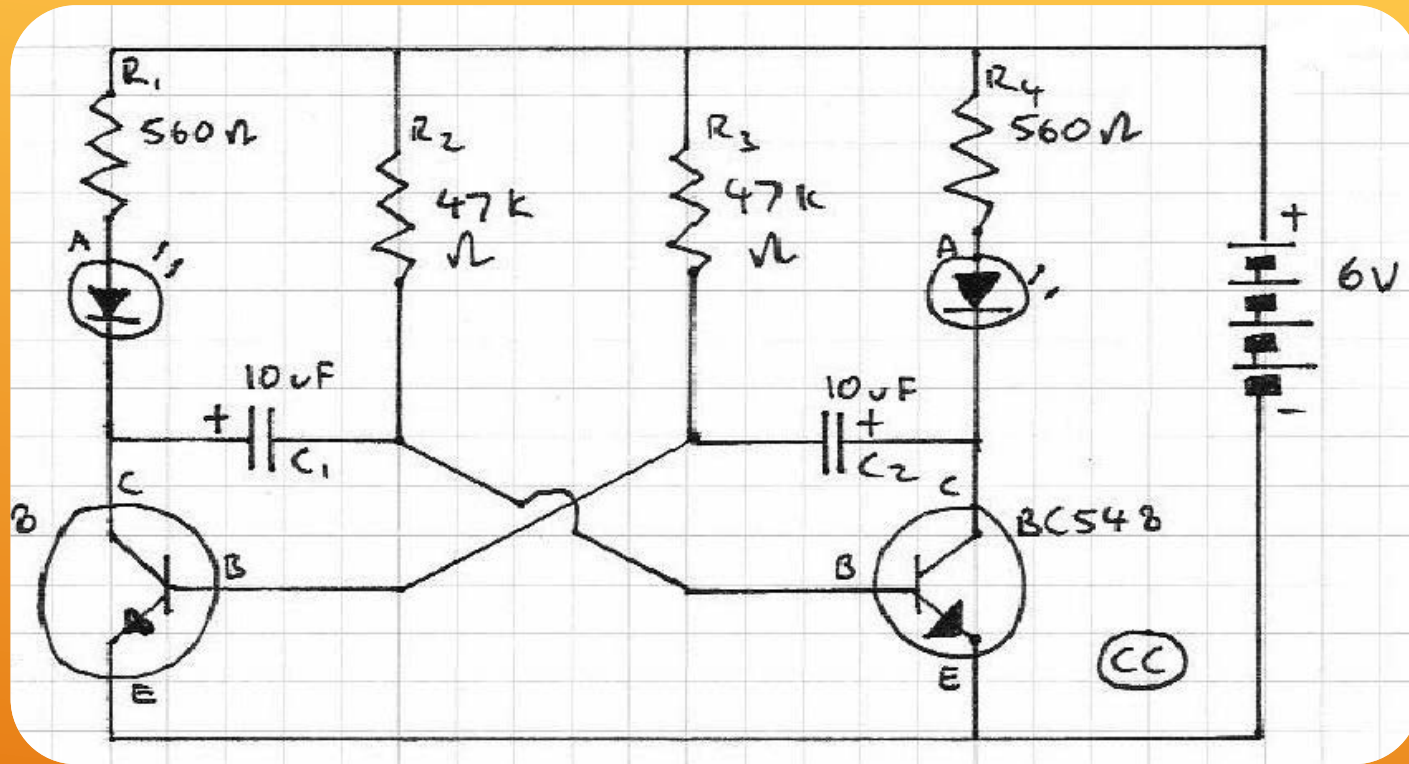
LESS HEAT

Less energy directly
affects how much heat is produced

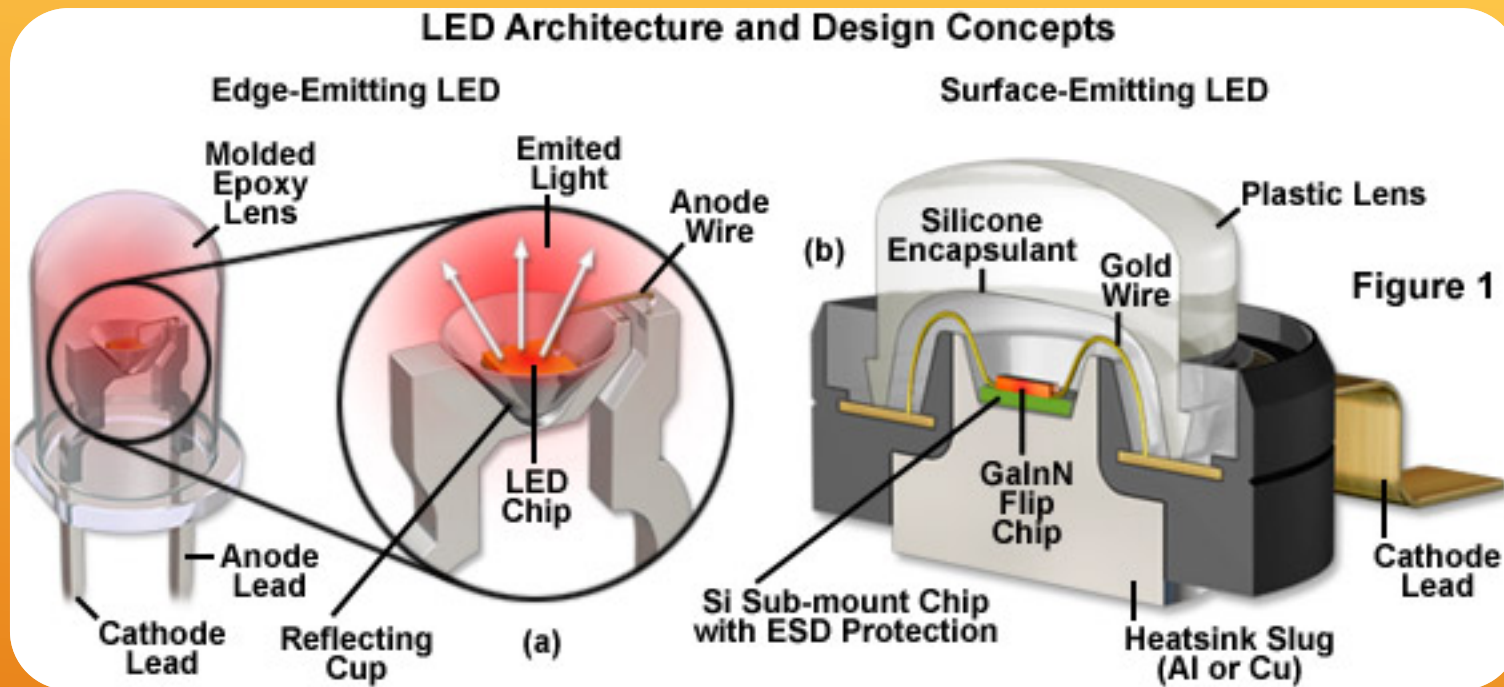
How Do LEDs Work?



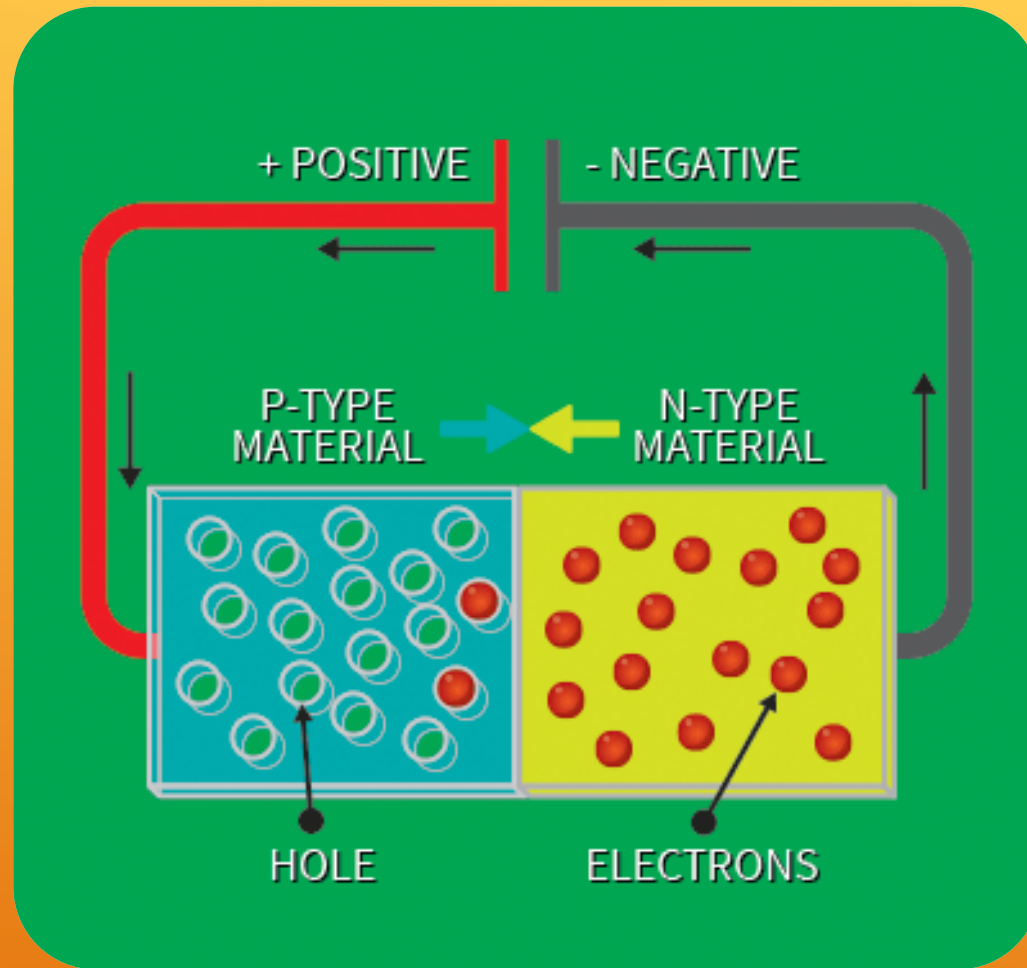
MOBILE



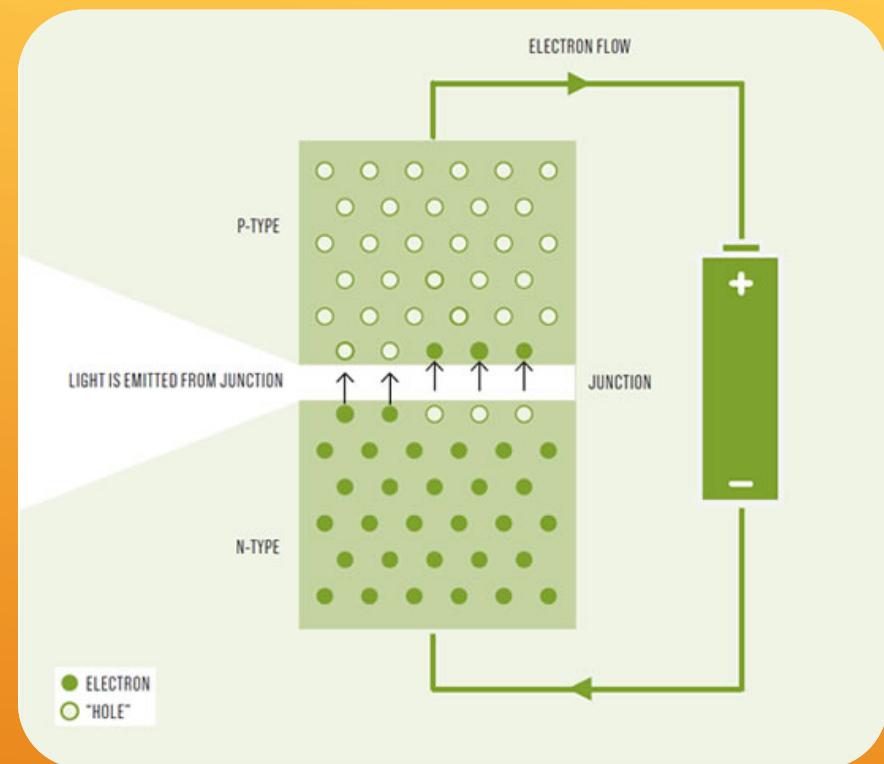
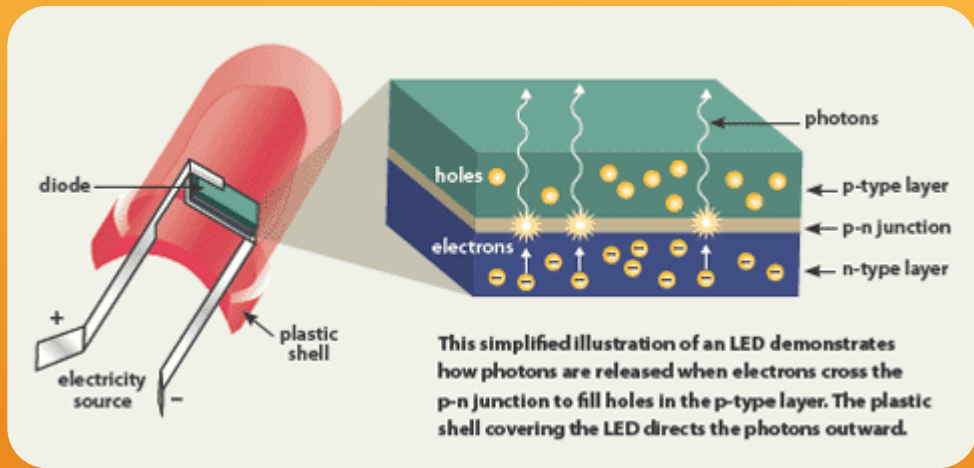
?



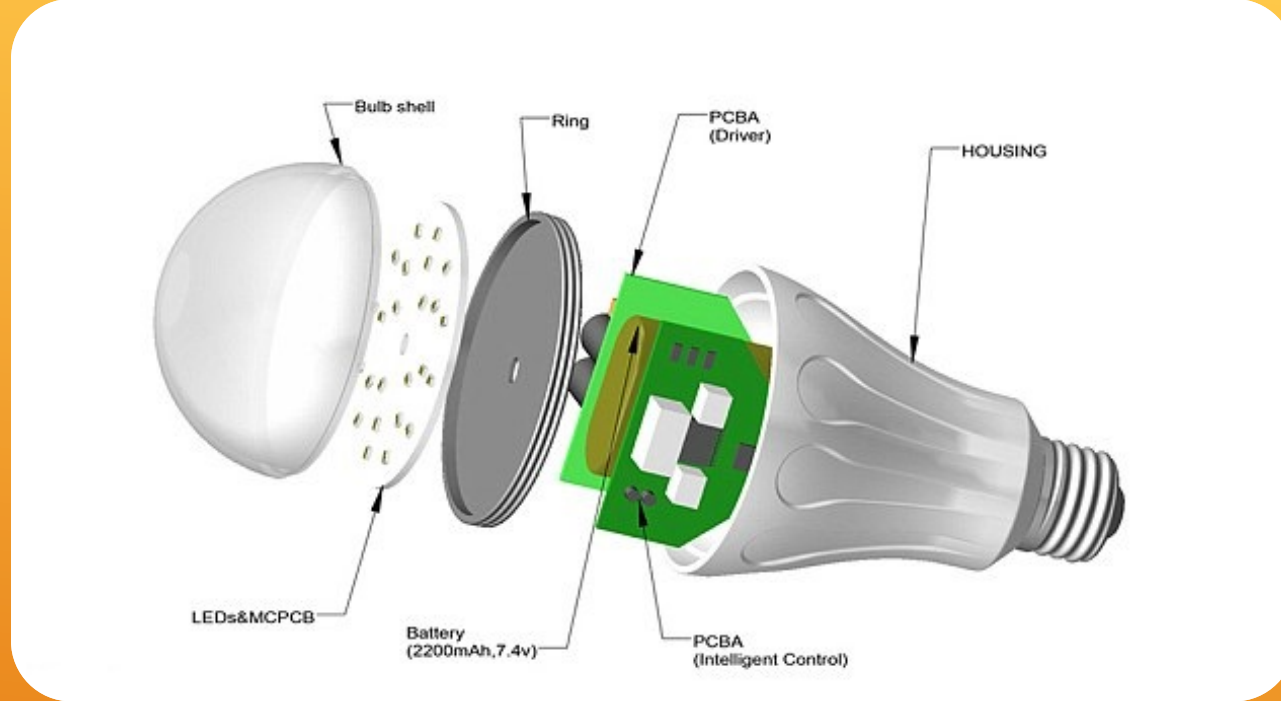
LETS LOOK AT THE COMPONENTS



THE SCIENCE



A CLOSER LOOK



WHAT'S INSIDE?



EVERY 12 TO 13 DAYS A NEW LED PRODUCT
IS INTRODUCED TO THE US MARKET...

WHAT CAN GO WRONG





NOT ALL DIMMERS WORK
THE WAY YOU EXPECT....



- Can be smoothly dimmed to 15% or less
- Obvious dimming effect, slight flicker will occur at certain level
- Not dimmable

Can be smoothly dimmed to 15% or less	Transformer																
Obvious dimming effect, slight flicker will occur at certain level	Manufacturer		PHILIPS				OSRAM				OSRAM						
Not dimmable	Country		China				China				Australia						
	Type		ET-E60	ET-S60	ET-E50	ET-K50	ECO-ET60	ECO-ET105			Redback	HTM 105/230-240					
	Trailing/leading		Leading	Leading & Trailing	Leading	Leading	Leading	Leading & Trailing Edge			Leading & Trailing Edge						
Region	Manuf acturer	Country	Type	Type/Load	1 lamp	1 lamp	1 lamp	1 lamp	1 lamp	1 lamp	2 lamps	3 lamps	1 lamp	1 lamp	2 lamps	3 la	
APR	Clipsal	Australia	E3031HD	Universal/RLC													
	Clipsal	Australia	32E450UDM	Universal/RLC													
	kiwi	New Zealand	K005T	Trailing/RC													
	Clipsal	Australia	32E2CFL DM														
	Shin Sung	Korea	SSD-500														
	Clipsal	Australia	32E450TM	Trailing/RC													
	kiwi	New Zealand	K004U														
	PDL	New Zealand	624TMWH														
	Clipsal	HK	KB31RD400														
	Panasonic	Japan	NQ 20345														

ALWAYS REVIEW THE
DIMMER COMPATIBILITY CHART



Titanium Series 4.0 BR30 8W 8BR30G4DIM



Dimmer Switch Compatibility

Brand	Series	Model	Load	Dimmability
LUTRON	Eco-dim	D-603PG	600W	OK
	Maestro	MA-600	600W	OK*
	Diva	DV-600PR	600W	OK
	Skylark Contour	CTCL-153PDH	600W	OK**
	Skylark	S-600	600W	OK
	Toggler	TG-600PR	600W	OK
LEVITON	Vizia +	VP106	600W	OK
	Sure Slide	6633	600W	OK
COOPER	Aspire	9540	1000W	OK

*Minimum 3 lamps

**Minimum 2 lamps

Table Key

OK= Fully compatible

__-__% = Compatible within this range, flicker outside the range

X= Incompatible

*GREEN CREATIVE has provided this dimmer switch compatibility chart for guidance when selecting a dimmer and lamp combination. Our lamps were tested for compatibility with the above listed dimmers. Dimmers that do not appear on the chart might still be compatible but have not been tested. All testing has been performed with a stable main supply. The quality of the local main, existing installation and wiring, as well as different manufacturer versions of the above dimmers may affect dimming performance. Since no assurance can be provided regarding these factors, it is a general recommendation to perform a test on-site prior to installing the LED lamps.

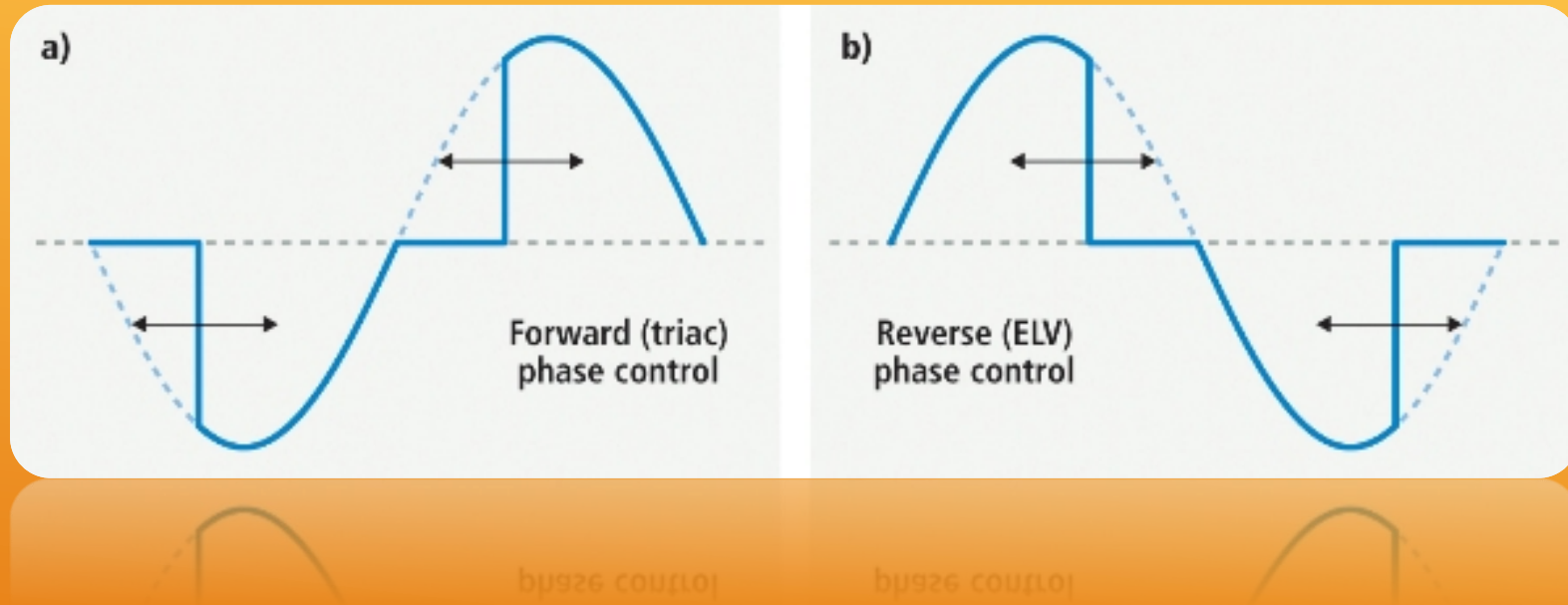
prior to installing the LED lamps.
assurance can be provided regarding these factors, it is a general recommendation to perform a test on-site
well as different manufacturer versions of the above dimmers may affect dimming performance. Since no
been performed with a stable main supply. The quality of the local main, existing installation and wiring, as
dimmers that do not appear on the chart might still be compatible but have not been tested. All testing has
dimmer and lamp combination. Our lamps were tested for compatibility with the above listed dimmers.
GREEN CREATIVE has provided this dimmer switch compatibility chart for guidance when selecting a

PHASE CUT DIMMING

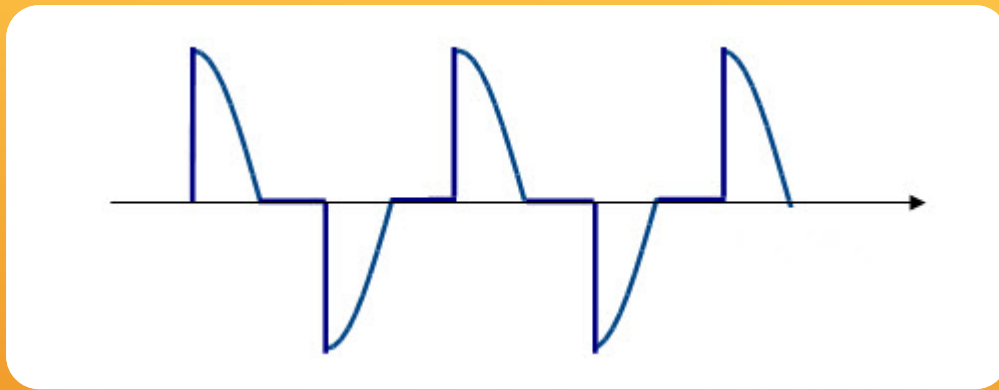




Typical products that use Phase Cut Dimming

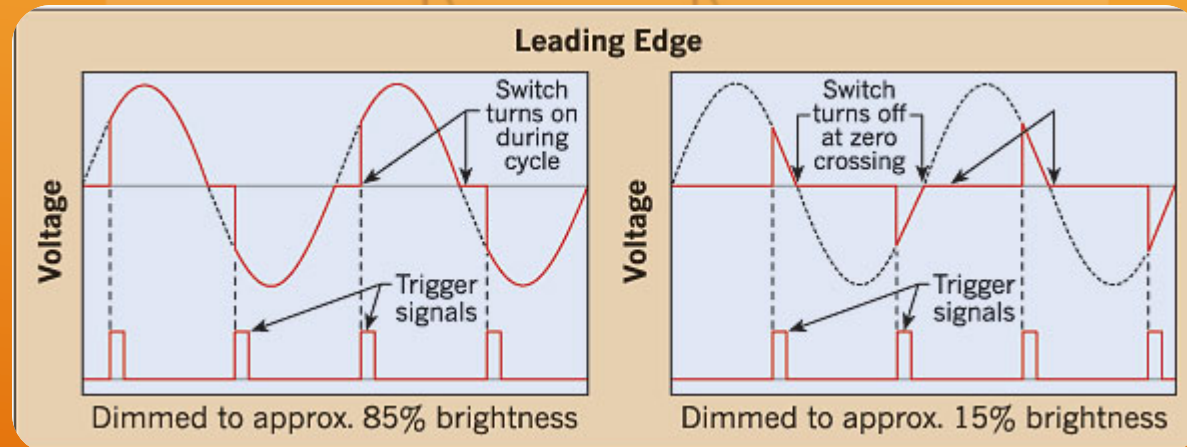


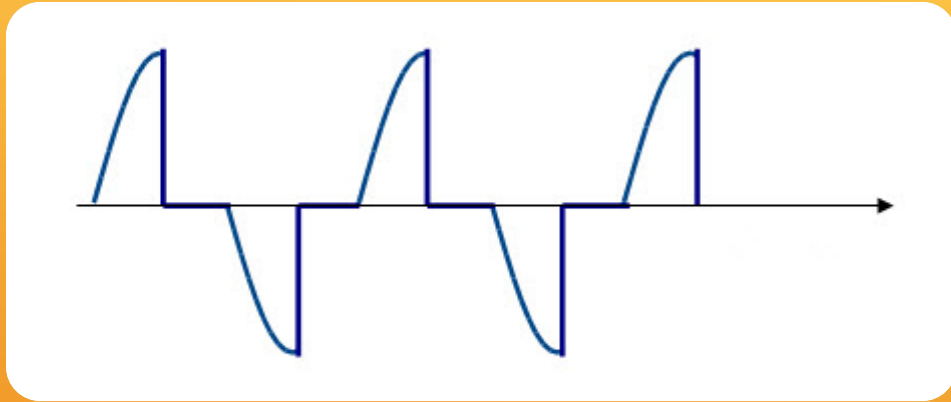
TRAILING EDGE VS. LEADING EDGE



LEADING EDGE (TRIAC)

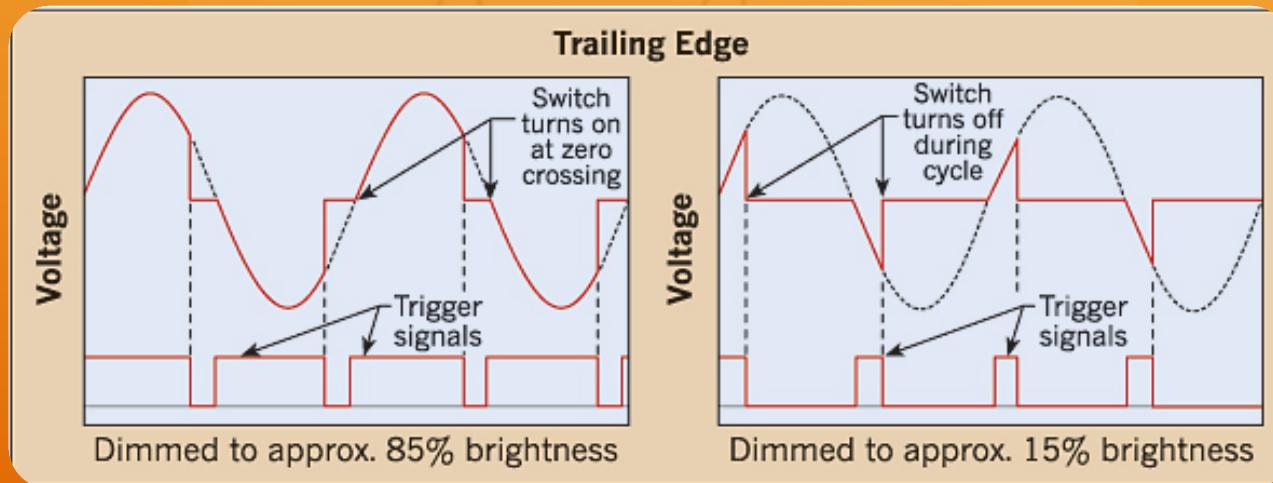
- Incandescent or magnetic low voltage (resistive load)
- Current is turned off at the front of the wave form.
- Inrush of voltage every half cycle, produces high inrush current applied to LED components causing buzzing and flickering.
- Less dimming range 35%-100%
- Most common type of dimmer currently in use.





TRAILING EDGE (ELECTRONIC LOW VOLTAGE)

- Electronic Low Voltage (capacitive loads)
- Current is turned off at the back of the waveform,
- No inrush of voltage, or buzzing, less chance for flickering.
- Better dimming range typical 15%-100%



Dimmer loading rules have changed



Energy Efficiency &
Renewable Energy

- Minimum load varies by dimmer **and LED source**
- Maximum load varies by dimmer **and LED source**

Dimmer	Source	Possible loading
600W incandescent	60W incandescent 	1-10
600W incandescent	12W LED 	1-30? 3-10
600W ELV	50W halogen 	1-12
600W ELV	10W LED 	1-30? 2-30

MINIMUM LOAD

-Phase Cut Dimmers as well as Electronic Low Voltage Transformers often have minimum loads.

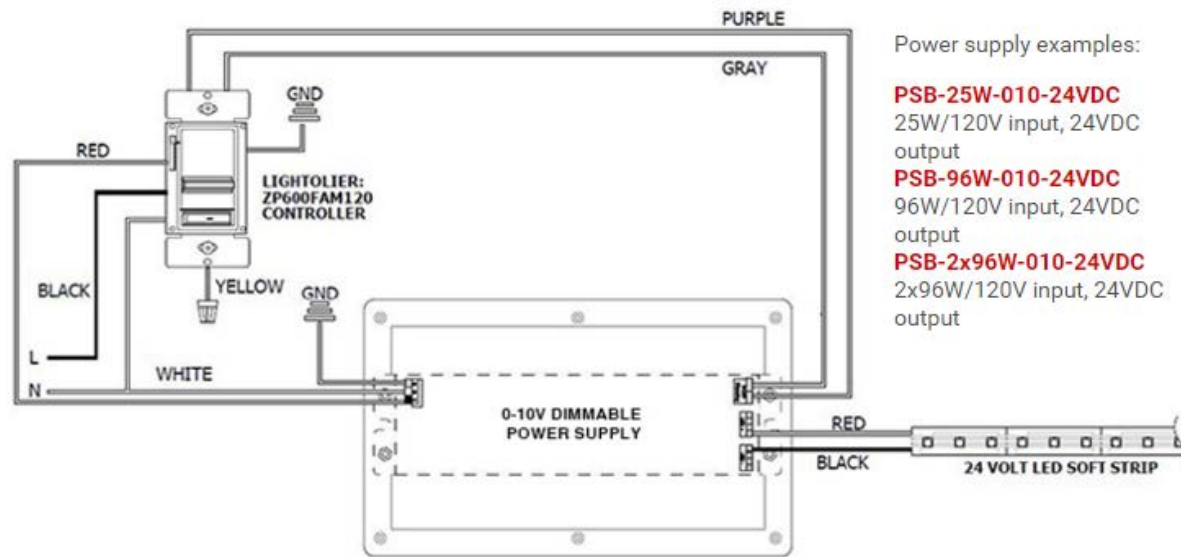
-Minimum load issues can arise during dimming operation.

0-10V DIMMING



Typical products that use 0-10v Dimming

Wiring example for 0-10V dimming application.



- Smooth dimming
- No Flicker
- Designed to work with LED
- Widest Dimming Range 1%-100%

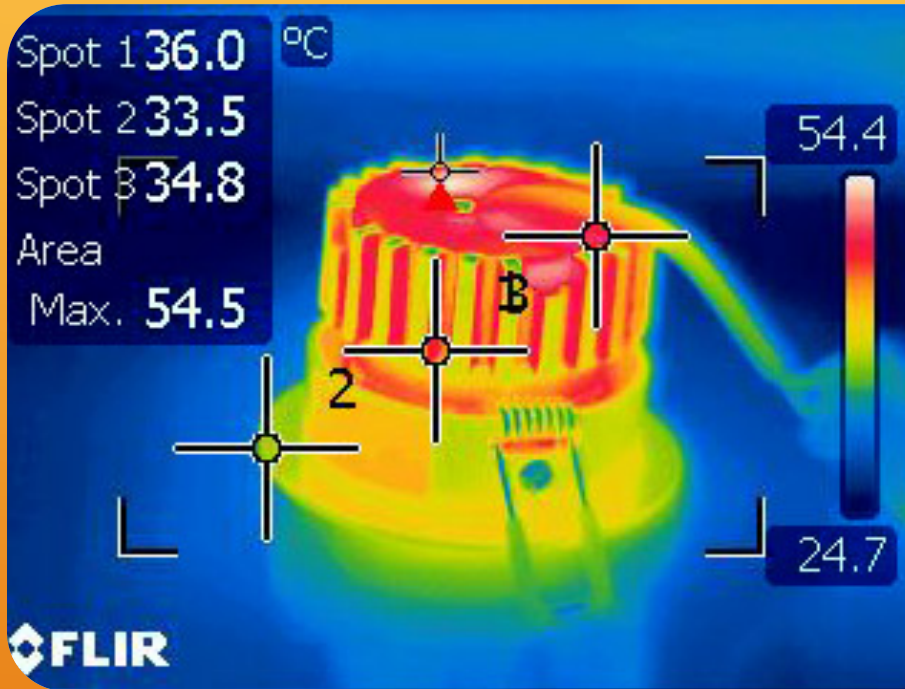


HEAT CAN BE A REAL PROBLEM





THIS IS NOT THE ANSWER



PROPER THERMAL MANAGEMENT IS A MUST

Non Enclosed Rated

PAR38 19W HO 277V TITANIUM LED SERIES GREENCREATIVE



PRO

19W REPLACES
250W Hal.
39W CMH
80% Energy Savings

\$919 Savings per lamp*

- Direct line voltage 120-277V - Not compatible with ballasts
- Replaces 250W Halogen & 39W CMH
- High 10,000+ candela output
- Powerful light output 1775 lumens
- Exceptional efficacy 93 LPW in Warm White
- Even beam distribution

40,000 H 120-277V UNIVERSAL 93 LPW EFFICACY

5 YR WARRANTY CRI (Ra) NON ENCL.

UL LISTED FC lighting facts LM 79 LM 80 TM 21 IES

Enclosed Rated

PAR38 17W 277V TITANIUM CRI^{SP} LED SERIES 4.0 GREENCREATIVE



CRISP

17W REPLACES
120W Hal.
80% Energy Savings

\$331 Savings per lamp*

- Direct line voltage 120-277V - Not compatible with ballasts
- Exceptional color rendering CRI 90
- Richer reds and natural skin tones (R9 50, R13 90)
- Tight LED binning for consistent CCT across all lamps
- Suitable for use in totally enclosed fixtures
- Wet location rated for outdoor use

40,000 H 120-277V UNIVERSAL WET LOCATION

5 YR WARRANTY CRI (Ra) ENCLOSED**

UL LISTED FC lighting facts LM 79 LM 80 TM 21 IES

MAKE SURE THE PRODUCTS ARE RATED FOR THE APPLICATION THEY ARE INTENDED FOR.

9w PAR20 LED



9w PAR20 LED



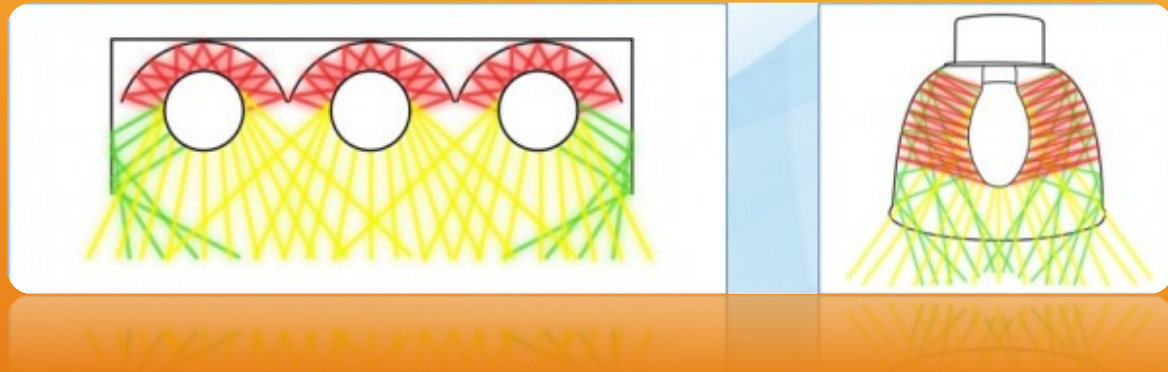
JUST BECAUSE IT'S "LED" DOESN'T MEAN IT'S A
GREAT PRODUCT....

- LED product should be “passively cooled”
- Heat should be more prevalent at the heat sink NOT the diode
- Warranty should be at least 3 year
- Is there optical control?
- Is it listed?

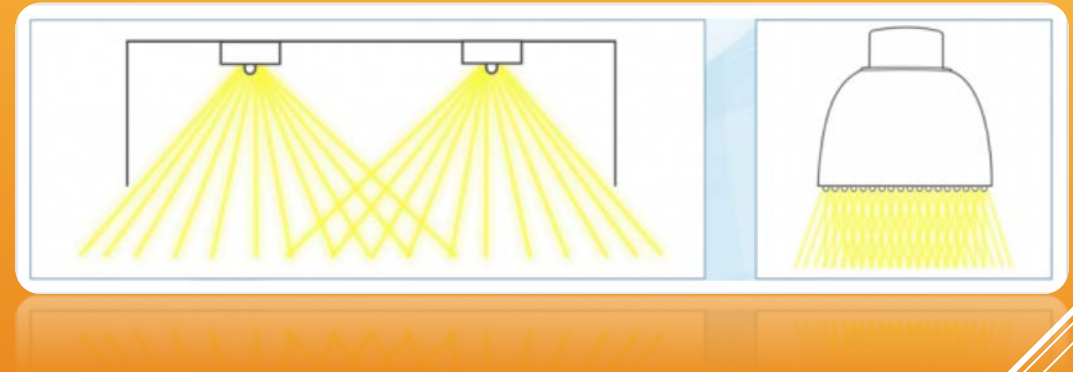


WHAT TO LOOK FOR IN A QUALITY PRODUCT

Relative Photometry



Absolute Photometry



LIGHT IS DELIVERED DIFFERENTLY WITH LED

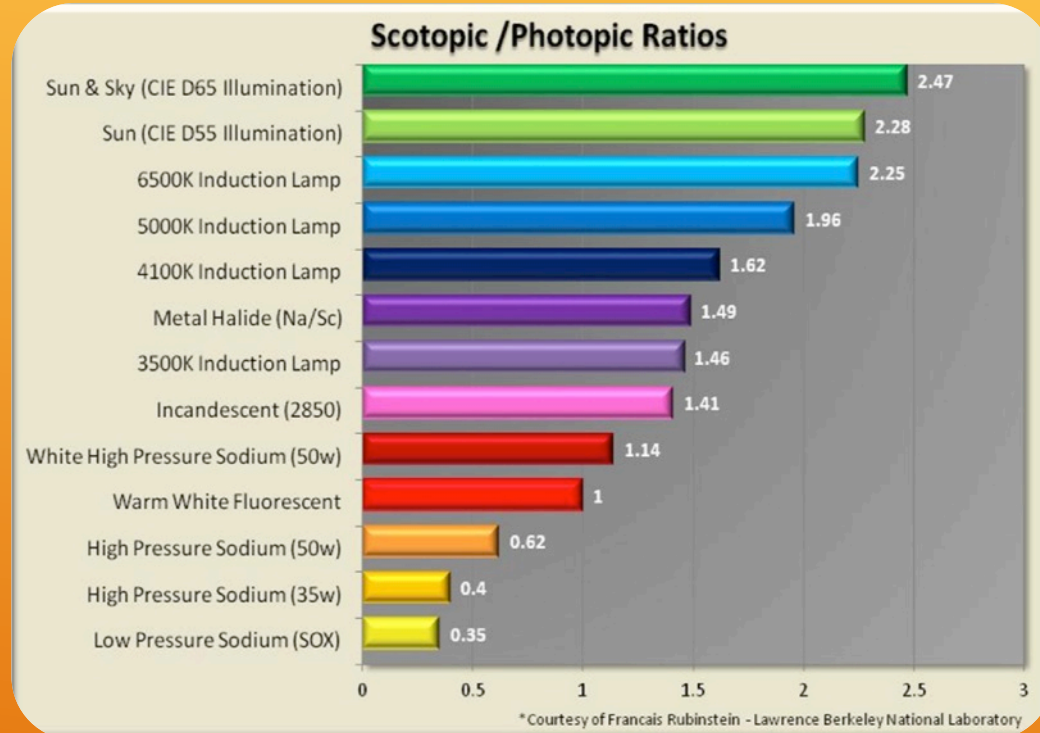
- Divide the total mean lumens of the “to be replaced source” by 3
- Take $1/3$ that value
- Multiply by the S/P ratio if CCT or Kelvin Temperature is changing.

REPLACEMENT RULE OF THUMB



$$45,000 / 3 = 15,000$$

HPS400



SP CHART EXAMPLE

Find the closest light source you intend to replace, and find the closest light source or color temp to your intended replacement.

HPS @ 2000K (S/P Ratio .62)



LED @ 4000K (S/P Ratio 1.49)

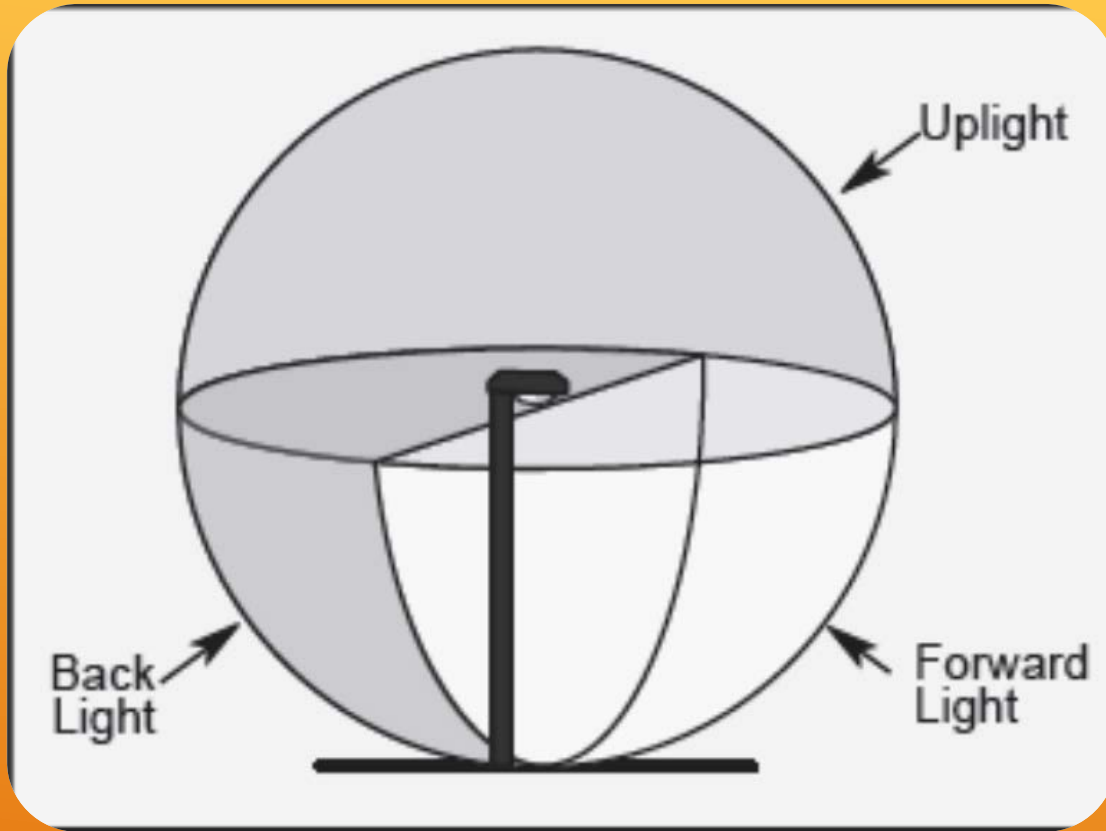


EXAMPLE

If our total value is 15,000 mean lumens and we apply our SP multiplier

$$15,000 \times .62 = 9,300$$

$$15,000 \times 1.49 = 22,300$$



- "Forward Light"

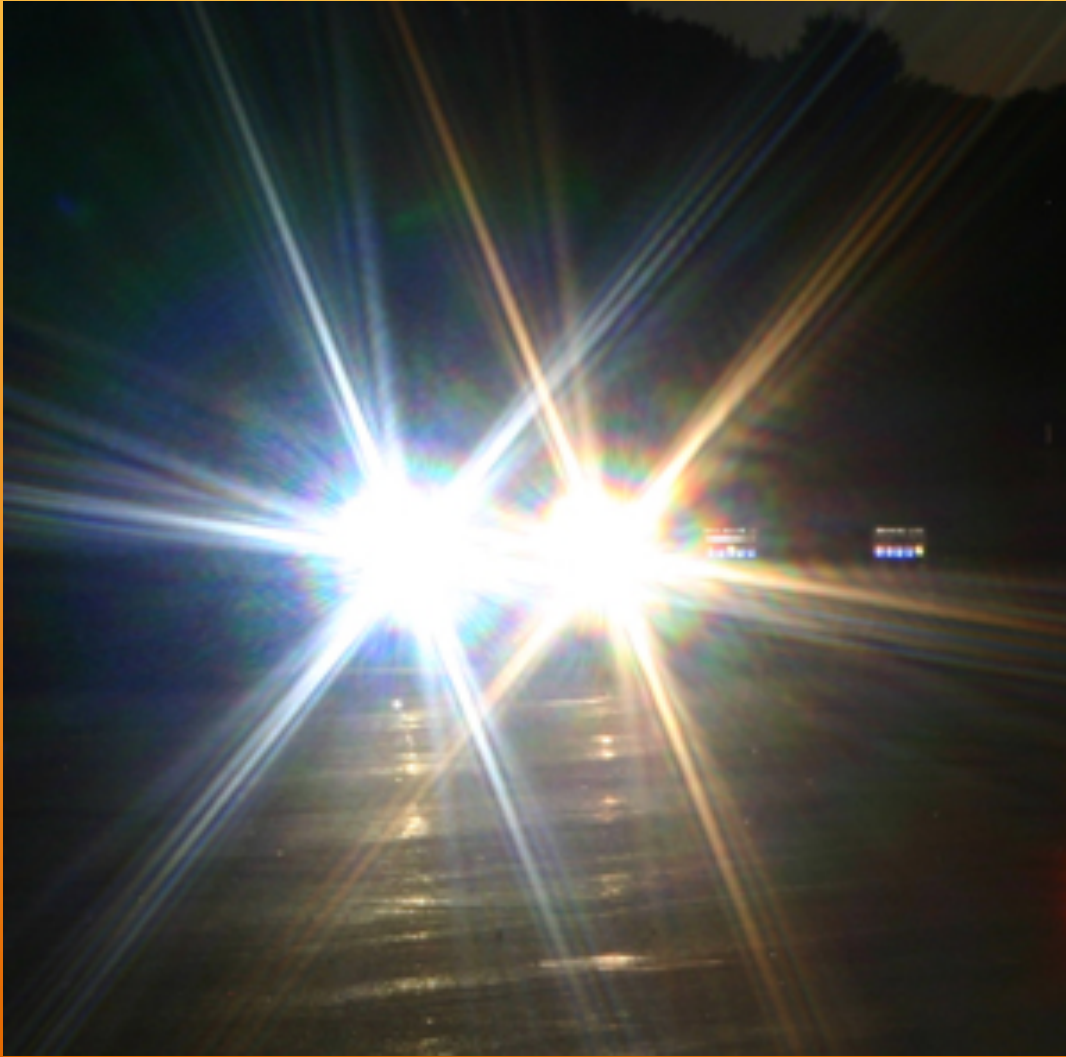
- Backward Light

- Uplight

- Glare

"the amount of light emitted from a luminaire in unwanted directions"

WHAT IS BUG RATING AND WHY IS IMPORTANT



UNWANTED LIGHT

Is no fun....



OUR NEIGHBORS
DON'T LIKE IT



OUR NIGHT SKY IS IMPORTANT



Maciej Winiarczyk/Guzellian
Maciej Winiarczyk/Guzellian

ESPECIALLY IF IT DOES THIS....