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Powering (Driving) LEDs

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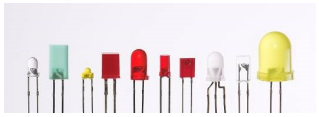
What is an LED?

- LED = Light Emitting Diode
- High efficiency
  - More light output per Watt than other types of "bulb"
- Long life
  - Incandescent 1,000hrs
  - Fluorescent 10,000hrs
  - LED 50,000hrs
- Shock resistant
  - Solid state device



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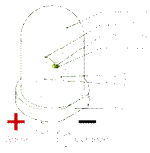
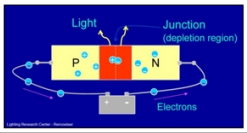
How does it work?

- Electrons flow from negative to positive through P-N junction.
- Inside the junction they combine with holes and release light
- The light colour is determined by the material used





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LED colours

Colour	Potential difference	Materials
Infrared	1.6V	Aluminium gallium arsenide (AlGaAs
Red	1.8V to 2.1V	Aluminium gallium arsenide (AlGaAs), Gallium arsenide phosphide (GaAsP), Gallium phosphide (GaP)
Orange	2.2V	Aluminium gallium indium phosphide (AlGaInP), Gallium arsenide phosphide (GaAsP)
Yellow	2.4V	Aluminium gallium indium phosphide (AlGaInP), Gallium arsenide phosphide (GaAsP), Gallium phosphide (GaP)
Green	2.6V	Aluminium gallium phosphide (AlGaP), Aluminium gallium indium phosphide (AlGaInP), Gallium nitride (GaN)
Blue	3.0V to 3.5V	Gallium nitride (GaN), Indium gallium nitride (InGaN), Silicon carbide (SiC), Sapphire (Al2O3), Zinc selenide (ZnSe)
White	3.0V to 3.5V	Gallium nitride (GaN [if AlGaN Quantum Barrier present]), Gallium nitride (GaN) based – Indium gallium nitride (InGaN) active layer
Ultraviolet	3.5V	Indium gallium nitride (InGaN), Aluminium nitride (AlN), Aluminium gallium nitride (AlGaN)

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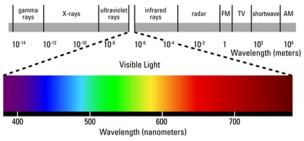
Efficiency

- Incandescent, fluorescent and HID radiate across the entire spectrum
- LED's are highly efficient as they radiate light at very specific frequencies.
- LED's have a very high Spectral Power Density (SPD)



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Light output (Lumens / Watt)

Lumens	Incandescent Bulb	Compact Fluorescent	LED
450	40W (11.25)	12W (37.5)	4W (112.5)
800	60W (13.3)	14W (57.1)	7W (114.3)
1100	75W (14.6)	20W (55)	10W (110)
1600	100W (16)	25W (64)	18W (88.9)
2600	150W (10.7)	40W (65)	25W (104)

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LED applications

- Lighting applications
  - Domestic
  - Street
  - Tunnel
  - Decorative / Stage / Architectural
- Display applications
  - Applications that require dimming & control
  - Moving signs
  - Traffic signals including railways
- Light generation not for human eye
  - Data transmission
  - Machine vision
  - Pulse Oximeters
  - Plant growth stimulators

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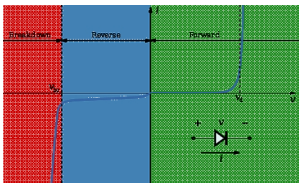
Driving LED's

- Simple, low power, safe voltage
- Forward voltage varies according to LED colour (material composition)
- Forward current increases at a very large rate as voltage increases
- An LED is a current driven device
- Dimming via PWM is preferred



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Driver configurations

- Series: Very simple but high drive voltage & not fault tolerant
- Parallel: Lower drive voltage but low fault tolerance
- Matrix: Similar drive voltage to Parallel but higher fault tolerance
- Multi Channel: Highly accurate and fault tolerant but higher cost

Output Power	Output Voltage	Output Current	Output Voltage Range in Constant Current Mode	Efficiency*	Model Number
50 W	12.0 V	4.20 A	8.5-12.0 V	84.0%	DLG50PS12
50 W	24.0 V	2.10 A	19.0-24.0 V	86.0%	DLG50PS24
50 W	36.0 V	1.40 A	26.0-36.0 V	88.0%	DLG50PS36
50 W	48.0 V	1.05 A	35.0-48.0 V	88.0%	DLG50PS48
59 W	12.0 V	4.90 A	8.5-12.0 V	84.0%	DLG70PS12
75 W	24.0 V	3.15 A	19.0-24.0 V	86.0%	DLG75PS24
74 W	30.0 V	2.45 A	22.0-30.0 V	87.0%	DLG75PS30
75 W	36.0 V	2.10 A	26.0-36.0 V	88.0%	DLG75PS36
67 W	48.0 V	1.40 A	35.0-48.0 V	88.0%	DLG75PS48
75 W	54.0 V	1.40 A	37.0-54.0 V	88.0%	DLG75PS54
100 W	12.0 V	8.30 A	8.5-12.0 V	88.0%	DLG100PS12
100 W	15.0 V	6.60 A	10.0-15.0 V	88.0%	DLG100PS15*
100 W	24.0 V	4.20 A	14.0-24.0 V	90.0%	DLG100PS24
100 W	30.0 V	3.30 A	22.0-30.0 V	90.0%	DLG100PS30
100 W	36.0 V	2.80 A	26.0-36.0 V	90.0%	DLG100PS36
100 W	48.0 V	2.10 A	34.0-48.0 V	90.5%	DLG100PS48
100 W	57.0 V	1.75 A	43.0-57.0 V	90.5%	DLG100PS57*

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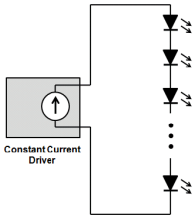
Series configuration



- String voltage is a sum of the forward voltage of all LED's and can be high
- No problems with current imbalance as only one string
- No ballast resistors are required
- Failure of an LED (short circuit) has virtually no impact on the rest of the string
- Failure of an LED (open circuit) will turn off the rest of the string as no current can flow

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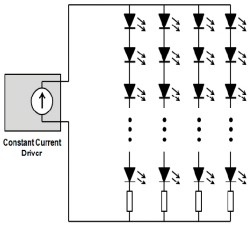
Parallel configuration



- Total string voltage is reduced by a factor of the number of strings
- Current imbalance can result from small variation in forward voltage in each leg
- Ballast resistor is used to help balance the current in each leg but this reduces total efficiency
- Failure of any LED (short or open circuit) will result in increased current flow and stress:
- Short circuit will cause increased current flow in the effected leg and dimming of the others
- Open circuit will cause failure of the effected leg and increased current flow in the others

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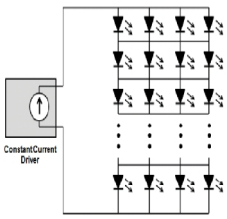
Matrix configuration



- String voltages remain at the same level as in parallel configuration
- Current imbalance can still result from variations in forward voltage but due to multiple return paths can not be corrected with ballast resistors
- Pre-screened/higher quality LED's are needed to reduce the forward voltage variations
- Failure of any LED short circuit will prevent all LED's in that row from operating but current flow in all others will remain unchanged
- Failure open circuit will result in increased current flow in all other LED's in that row

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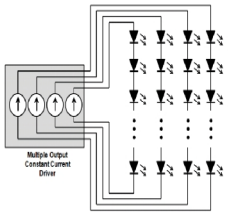
Multi-channel configuration



- String voltage remains at same levels as Parallel and matrix configurations
- Each string has a dedicated constant current supply and is not effected by other strings
- Failure effects of any LED are limited to that particular string.
- Failure short circuit will result in no effect on the others in the string
- Failure open circuit will result in the string being unable to operate but no additional stress caused to any other
- More complex and expensive due to the need for multiple (lower power) drivers

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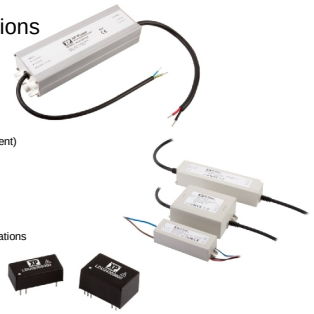
LED driver considerations

- High efficiency, high power factor
- Match current and voltage to LED configuration
- Dimming control (PWM or variable current)
- Outdoor use (IP67)
- UMSUG regulations
- EN61000-3-2 class C for lighting applications
- Input voltage 277VAC for USA
- Approvals & EMC



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