










Powering (Driving) LEDs


Diana Izvorska



What is an LED?

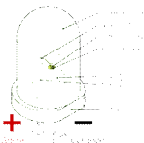
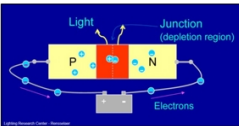
- LED = Light Emitting Diode
- High efficiency
 - More light output per Watt than other types of "bulb"
- Long life
 - Incandescent 1,000hrs
 - Fluorescent 10,000hrs
 - LED 50,000hrs
- Shock resistant
 - Solid state device



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

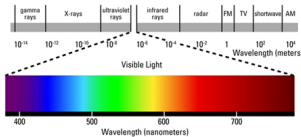
LED colours

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 (Al ₂ O ₃), Zinc selenide (ZnSe)
White	3.0V to 3.5V	Gallium nitride (GaN [if AlGaIn 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 (AlGaIn)



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)




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)



LED applications

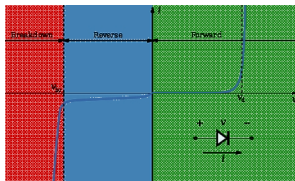
- Lighting applications
 - Domestic
 - Street
 - Tunnel
 - Decorative / Stage / Architectural
- Display applications
 - Applications that require dimming & control
 - Moving signs
 - Traffic signals including railways
- Light generation not for human eye
 - Data transmission
 - Machine vision
 - Pulse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



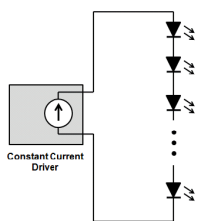
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Driver configurations

- 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

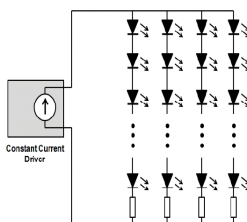
Output Power	Output Voltage	Output Current	Output Voltage Range to Constant Current Mode	Efficiency*	Model Number
50 W	12.0 V	4.16 A	8.5-12.0 V	84.0%	OL500P12
50 W	24.0 V	2.08 A	16.5-24.0 V	86.0%	OL500P24
50 W	36.0 V	1.39 A	24.5-36.0 V	86.0%	OL500P36
50 W	48.0 V	1.04 A	36.5-48.0 V	86.0%	OL500P48
50 W	60.0 V	0.83 A	48.5-60.0 V	86.0%	OL500P60
75 W	24.0 V	3.13 A	16.5-24.0 V	86.0%	OL750P24
75 W	36.0 V	2.08 A	24.5-36.0 V	87.0%	OL750P36
75 W	48.0 V	1.56 A	36.5-48.0 V	86.0%	OL750P48
75 W	60.0 V	1.25 A	48.5-60.0 V	86.0%	OL750P60
100 W	12.0 V	8.33 A	8.5-12.0 V	86.0%	OL100P12
100 W	24.0 V	4.17 A	16.5-24.0 V	86.0%	OL100P24
100 W	36.0 V	2.78 A	24.5-36.0 V	86.0%	OL100P36
100 W	48.0 V	2.08 A	36.5-48.0 V	86.0%	OL100P48
100 W	60.0 V	1.67 A	48.5-60.0 V	86.0%	OL100P60
100 W	72.0 V	1.39 A	60.5-72.0 V	86.0%	OL100P72
100 W	84.0 V	1.19 A	72.5-84.0 V	86.0%	OL100P84
100 W	96.0 V	1.04 A	84.5-96.0 V	86.0%	OL100P96
100 W	108.0 V	0.93 A	96.5-108.0 V	86.0%	OL100P108
100 W	120.0 V	0.83 A	108.5-120.0 V	86.0%	OL100P120
100 W	144.0 V	0.69 A	144.5-144.0 V	86.0%	OL100P144
100 W	168.0 V	0.59 A	168.5-168.0 V	86.0%	OL100P168
100 W	192.0 V	0.52 A	192.5-192.0 V	86.0%	OL100P192
100 W	216.0 V	0.46 A	216.5-216.0 V	86.0%	OL100P216
100 W	240.0 V	0.42 A	240.5-240.0 V	86.0%	OL100P240
100 W	264.0 V	0.38 A	264.5-264.0 V	86.0%	OL100P264
100 W	288.0 V	0.35 A	288.5-288.0 V	86.0%	OL100P288
100 W	312.0 V	0.32 A	312.5-312.0 V	86.0%	OL100P312
100 W	336.0 V	0.30 A	336.5-336.0 V	86.0%	OL100P336
100 W	360.0 V	0.28 A	360.5-360.0 V	86.0%	OL100P360
100 W	384.0 V	0.26 A	384.5-384.0 V	86.0%	OL100P384
100 W	408.0 V	0.24 A	408.5-408.0 V	86.0%	OL100P408
100 W	432.0 V	0.23 A	432.5-432.0 V	86.0%	OL100P432
100 W	456.0 V	0.22 A	456.5-456.0 V	86.0%	OL100P456
100 W	480.0 V	0.21 A	480.5-480.0 V	86.0%	OL100P480
100 W	504.0 V	0.20 A	504.5-504.0 V	86.0%	OL100P504
100 W	528.0 V	0.19 A	528.5-528.0 V	86.0%	OL100P528
100 W	552.0 V	0.18 A	552.5-552.0 V	86.0%	OL100P552
100 W	576.0 V	0.17 A	576.5-576.0 V	86.0%	OL100P576
100 W	600.0 V	0.17 A	600.5-600.0 V	86.0%	OL100P600
100 W	624.0 V	0.16 A	624.5-624.0 V	86.0%	OL100P624
100 W	648.0 V	0.15 A	648.5-648.0 V	86.0%	OL100P648
100 W	672.0 V	0.15 A	672.5-672.0 V	86.0%	OL100P672
100 W	696.0 V	0.14 A	696.5-696.0 V	86.0%	OL100P696
100 W	720.0 V	0.14 A	720.5-720.0 V	86.0%	OL100P720
100 W	744.0 V	0.13 A	744.5-744.0 V	86.0%	OL100P744
100 W	768.0 V	0.13 A	768.5-768.0 V	86.0%	OL100P768
100 W	792.0 V	0.12 A	792.5-792.0 V	86.0%	OL100P792
100 W	816.0 V	0.12 A	816.5-816.0 V	86.0%	OL100P816
100 W	840.0 V	0.12 A	840.5-840.0 V	86.0%	OL100P840
100 W	864.0 V	0.11 A	864.5-864.0 V	86.0%	OL100P864
100 W	888.0 V	0.11 A	888.5-888.0 V	86.0%	OL100P888
100 W	912.0 V	0.11 A	912.5-912.0 V	86.0%	OL100P912
100 W	936.0 V	0.10 A	936.5-936.0 V	86.0%	OL100P936
100 W	960.0 V	0.10 A	960.5-960.0 V	86.0%	OL100P960
100 W	984.0 V	0.10 A	984.5-984.0 V	86.0%	OL100P984
100 W	1008.0 V	0.10 A	1008.5-1008.0 V	86.0%	OL100P1008
100 W	1032.0 V	0.09 A	1032.5-1032.0 V	86.0%	OL100P1032
100 W	1056.0 V	0.09 A	1056.5-1056.0 V	86.0%	OL100P1056
100 W	1080.0 V	0.09 A	1080.5-1080.0 V	86.0%	OL100P1080
100 W	1104.0 V	0.09 A	1104.5-1104.0 V	86.0%	OL100P1104
100 W	1128.0 V	0.08 A	1128.5-1128.0 V	86.0%	OL100P1128
100 W	1152.0 V	0.08 A	1152.5-1152.0 V	86.0%	OL100P1152
100 W	1176.0 V	0.08 A	1176.5-1176.0 V	86.0%	OL100P1176
100 W	1200.0 V	0.08 A	1200.5-1200.0 V	86.0%	OL100P1200
100 W	1224.0 V	0.08 A	1224.5-1224.0 V	86.0%	OL100P1224
100 W	1248.0 V	0.07 A	1248.5-1248.0 V	86.0%	OL100P1248
100 W	1272.0 V	0.07 A	1272.5-1272.0 V	86.0%	OL100P1272
100 W	1296.0 V	0.07 A	1296.5-1296.0 V	86.0%	OL100P1296
100 W	1320.0 V	0.07 A	1320.5-1320.0 V	86.0%	OL100P1320
100 W	1344.0 V	0.07 A	1344.5-1344.0 V	86.0%	OL100P1344
100 W	1368.0 V	0.06 A	1368.5-1368.0 V	86.0%	OL100P1368
100 W	1392.0 V	0.06 A	1392.5-1392.0 V	86.0%	OL100P1392
100 W	1416.0 V	0.06 A	1416.5-1416.0 V	86.0%	OL100P1416
100 W	1440.0 V	0.06 A	1440.5-1440.0 V	86.0%	OL100P1440
100 W	1464.0 V	0.06 A	1464.5-1464.0 V	86.0%	OL100P1464
100 W	1488.0 V	0.05 A	1488.5-1488.0 V	86.0%	OL100P1488
100 W	1512.0 V	0.05 A	1512.5-1512.0 V	86.0%	OL100P1512
100 W	1536.0 V	0.05 A	1536.5-1536.0 V	86.0%	OL100P1536
100 W	1560.0 V	0.05 A	1560.5-1560.0 V	86.0%	OL100P1560
100 W	1584.0 V	0.05 A	1584.5-1584.0 V	86.0%	OL100P1584
100 W	1608.0 V	0.04 A	1608.5-1608.0 V	86.0%	OL100P1608
100 W	1632.0 V	0.04 A	1632.5-1632.0 V	86.0%	OL100P1632
100 W	1656.0 V	0.04 A	1656.5-1656.0 V	86.0%	OL100P1656
100 W	1680.0 V	0.04 A	1680.5-1680.0 V	86.0%	OL100P1680
100 W	1704.0 V	0.04 A	1704.5-1704.0 V	86.0%	OL100P1704
100 W	1728.0 V	0.04 A	1728.5-1728.0 V	86.0%	OL100P1728
100 W	1752.0 V	0.03 A	1752.5-1752.0 V	86.0%	OL100P1752
100 W	1776.0 V	0.03 A	1776.5-1776.0 V	86.0%	OL100P1776
100 W	1800.0 V	0.03 A	1800.5-1800.0 V	86.0%	OL100P1800
100 W	1824.0 V	0.03 A	1824.5-1824.0 V	86.0%	OL100P1824
100 W	1848.0 V	0.03 A	1848.5-1848.0 V	86.0%	OL100P1848
100 W	1872.0 V	0.03 A	1872.5-1872.0 V	86.0%	OL100P1872
100 W	1896.0 V	0.02 A	1896.5-1896.0 V	86.0%	OL100P1896
100 W	1920.0 V	0.02 A	1920.5-1920.0 V	86.0%	OL100P1920
100 W	1944.0 V	0.02 A	1944.5-1944.0 V	86.0%	OL100P1944
100 W	1968.0 V	0.02 A	1968.5-1968.0 V	86.0%	OL100P1968
100 W	1992.0 V	0.02 A	1992.5-1992.0 V	86.0%	OL100P1992
100 W	2016.0 V	0.02 A	2016.5-2016.0 V	86.0%	OL100P2016
100 W	2040.0 V	0.02 A	2040.5-2040.0 V	86.0%	OL100P2040
100 W	2064.0 V	0.01 A	2064.5-2064.0 V	86.0%	OL100P2064
100 W	2088.0 V	0.01 A	2088.5-2088.0 V	86.0%	OL100P2088
100 W	2112.0 V	0.01 A	2112.5-2112.0 V	86.0%	OL100P2112
100 W	2136.0 V	0.01 A	2136.5-2136.0 V	86.0%	OL100P2136
100 W	2160.0 V	0.01 A	2160.5-2160.0 V	86.0%	OL100P2160
100 W	2184.0 V	0.01 A	2184.5-2184.0 V	86.0%	OL100P2184
100 W	2208.0 V	0.01 A	2208.5-2208.0 V	86.0%	OL100P2208
100 W	2232.0 V	0.01 A	2232.5-2232.0 V	86.0%	OL100P2232
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100 W	2328.0 V	0.01 A	2328.5-2328.0 V	86.0%	OL100P2328
100 W	2352.0 V	0.01 A	2352.5-2352.0 V	86.0%	OL100P2352
100 W	2376.0 V	0.01 A	2376.5-2376.0 V	86.0%	OL100P2376
100 W	2400.0 V	0.01 A	2400.5-2400.0 V	86.0%	OL100P2400
100 W	2424.0 V	0.01 A	2424.5-2424.0 V	86.0%	OL100P2424
100 W	2448.0 V	0.01 A	2448.5-2448.0 V	86.0%	OL100P2448
100 W	2472.0 V	0.01 A	2472.5-2472.0 V	86.0%	OL100P2472
100 W	2496.0 V	0.01 A	2496.5-2496.0 V	86.0%	OL100P2496
100 W	2520.0 V	0.01 A	2520.5-2520.0 V	86.0%	OL100P2520
100 W	2544.0 V	0.01 A	2544.5-2544.0 V	86.0%	OL100P2544
100 W	2568.0 V	0.01 A	2568.5-2568.0 V	86.0%	OL100P2568
100 W	2592.0 V	0.01 A	2592.5-2592.0 V	86.0%	OL100P2592
100 W	2616.0 V	0.01 A	2616.5-2616.0 V	86.0%	OL100P2616
100 W	2640.0 V	0.01 A	2640.5-2640.0 V	86.0%	OL100P2640
100 W	2664.0 V	0.01 A	2664.5-2664.0 V	86.0%	OL100P2664
100 W	2688.0 V	0.01 A	2688.5-2688.0 V	86.0%	OL100P2688
100 W	2712.0 V	0.01 A	2712.5-2712.0 V	86.0%	OL100P2712
100 W	2736.0 V	0.01 A	2736.5-2736.0 V	86.0%	OL100P2736
100 W	2760.0 V	0.01 A	2760.5-2760.0 V	86.0%	OL100P2760
100 W	2784.0 V	0.01 A	2784.5-2784.0 V	86.0%	OL100P2784
100 W	2808.0 V	0.01 A	2808.5-2808.0 V	86.0%	OL100P2808
100 W	2832.0 V	0.01 A	2832.5-2832.0 V	86.0%	OL100P2832
100 W	2856.0 V	0.01 A	2856.5-2856.0 V	86.0%	OL100P2856
100 W	2880.0 V	0.01 A	2880.5-2880.0 V	86.0%	OL100P2880
100 W	2904.0 V	0.01 A	2904.5-2904.0 V	86.0%	OL100P2904
100 W	2928.0 V	0.01 A	2928.5-2928.0 V	86.0%	OL100P2928
100 W	2952.0 V	0.01 A	2952.5-2952.0 V	86.0%	OL100P2952
100 W	2976.0 V	0.01 A	2976.5-2976.0 V	86.0%	OL100P2976
100 W	3000.0 V	0.01 A	3000.5-3000.0 V	86.0%	OL100P3000
100 W	3024.0 V	0.01 A	3024.5-3024.0 V	86.0%	OL100P3024
100 W	3048.0 V	0.01 A	3048.5-3048.0 V	86.0%	OL100P3048
100 W	3072.0 V	0.01 A	3072.5-3072.0 V	86.0%	OL100P3072
100 W	3096.0 V	0.01 A	3096.5-3096.0 V	86.0%	OL100P3096
100 W	3120.0 V	0.01 A	3120.5-3120.0 V	86.0%	OL100P3120
100 W	3144.0 V	0.01 A	3144.5-3144.0 V	86.0%	OL100P3144
100 W	3168.0 V	0.01 A	3168.5-3168.0 V	86.0%	OL100P3168
100 W	3192.0 V	0.01 A	3192.5-3192.0 V	86.0%	OL100P3192
100 W	3216.0 V	0.01 A	3216.5-3216.0 V	86.0%	OL100P3216
100 W	3240.0 V	0.01 A	3240.5-3240.0 V	86.0%	OL100P3240
100 W	3264.0 V	0.01 A	3264.5-3264.0 V	86.0%	OL100P3264
100 W	3288.0 V	0.01 A	3288.5-3288.0 V	86.0%	OL100P3288
100 W	3312.0 V	0.01 A	3312.5-3312.0 V	86.0%	OL100P3312
100 W	3336.0 V	0.01 A	3336.5-3336.0 V	86.0%	OL100P3336
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Series configuration



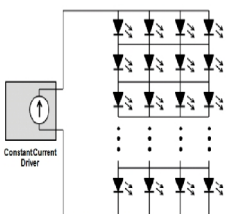
- String voltage is a sum of the forward voltage of all LED's and can be high
- No problems with current imbalance as only one string
- No ballast resistors are required
- Failure of an LED (short circuit) has virtually no impact on the rest of the string
- Failure of an LED (open circuit) will turn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

Parallel configuration



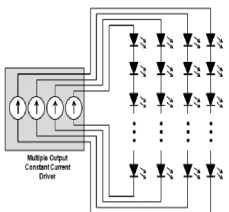
- Total string voltage is reduced by a factor of the number of strings
- Current imbalance can result from small variation in forward voltage in each leg
- Ballast resistor is used to help balance the current in each leg but this reduces total efficiency
- Failure of any LED (short or open circuit) will 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

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

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

XP XP Power

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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