

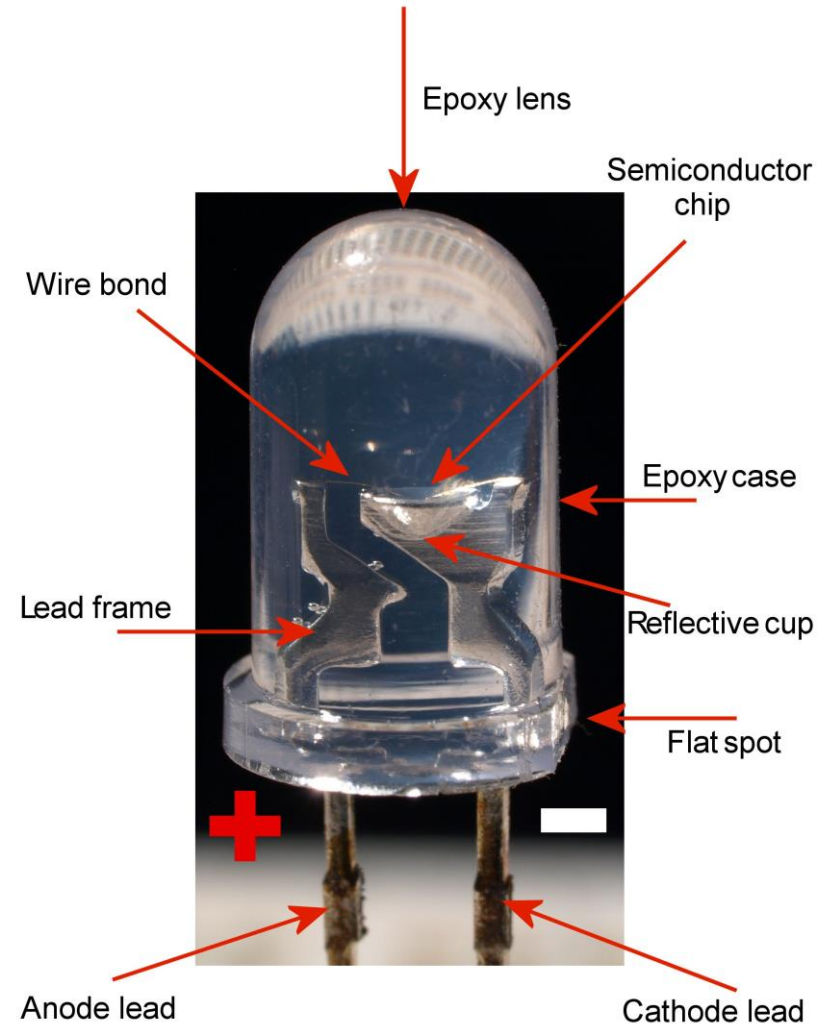
# Lab 3: LEDs

## SUMMER CHALLENGE COURSE SMART LIGHTING

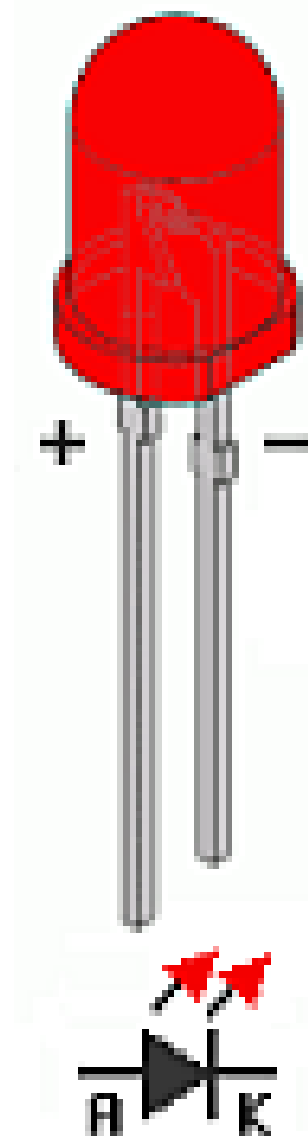
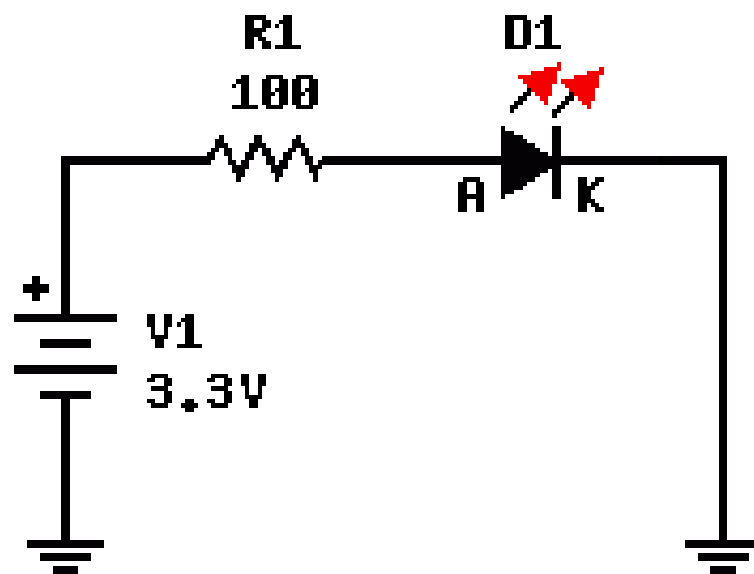
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Slides: Hany Elgala, Ph.D.

- 1957 - LED invented by RCA
- 1968 – First economically mass produced
- LEDs made by Monsanto Corp & Litronix
- 1972 - HP introduces the HP35 calculator using an LED display
- 1993 - Nichia Corp produces the first high brightness LED using phosphor conversion to create white light
- 2009 - European Union bans most incandescent light bulbs



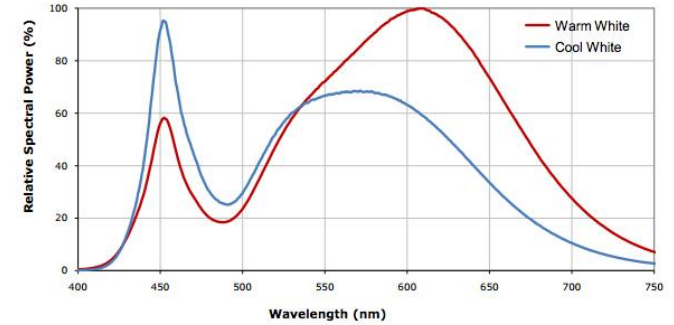
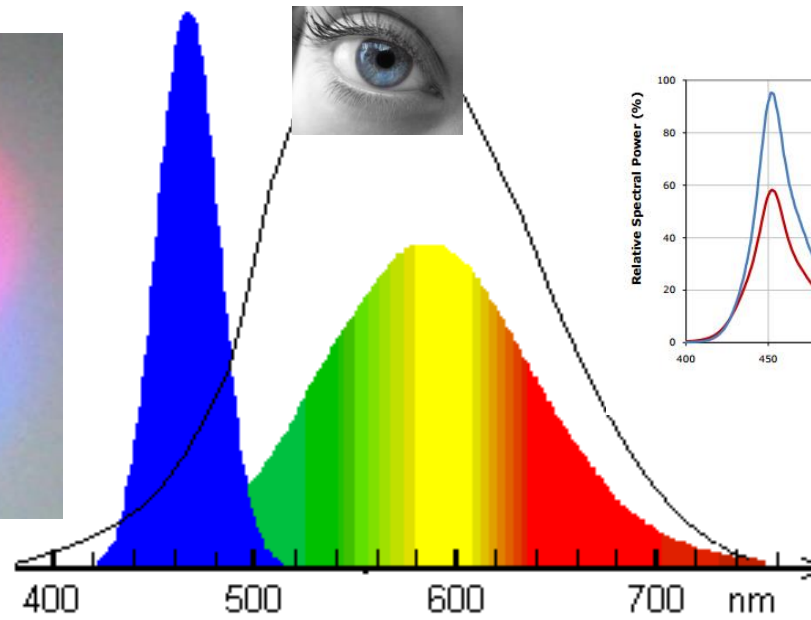
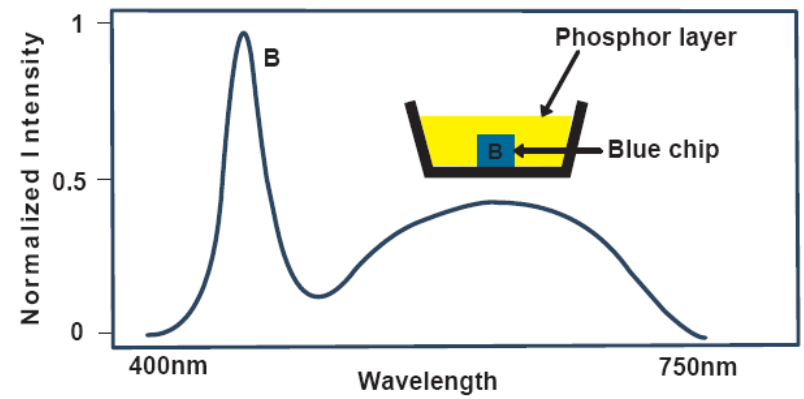
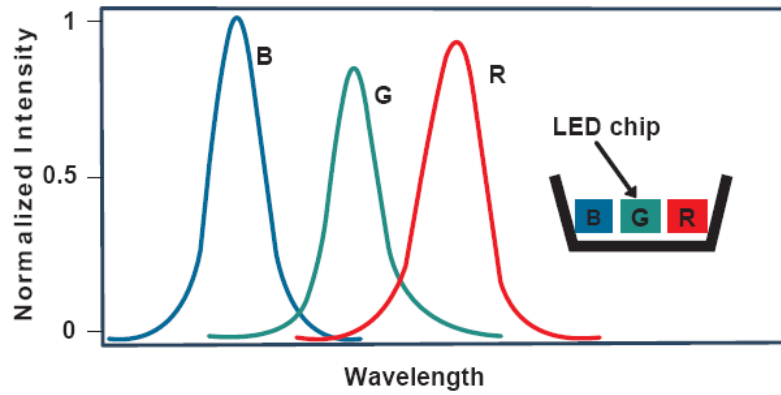
- An LED has two leads: a positive (anode) and a negative (cathode).
- On schematic diagrams, its symbol is similar to the simple diode, with two arrows pointing outwards.
- The anode (+) is marked with a triangle and the cathode (-) with a line.
- Sometimes you'll find additional labels: A or + for anode and K or - for cathode.

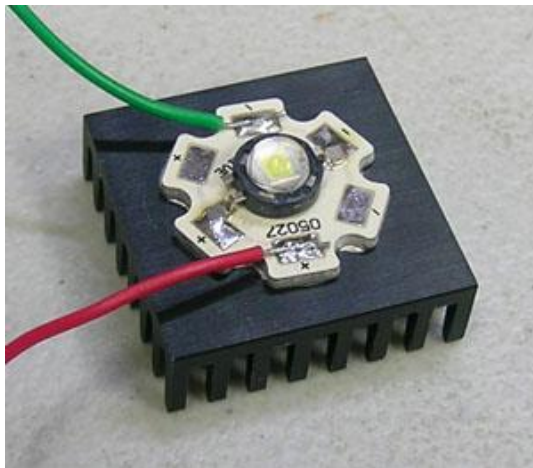
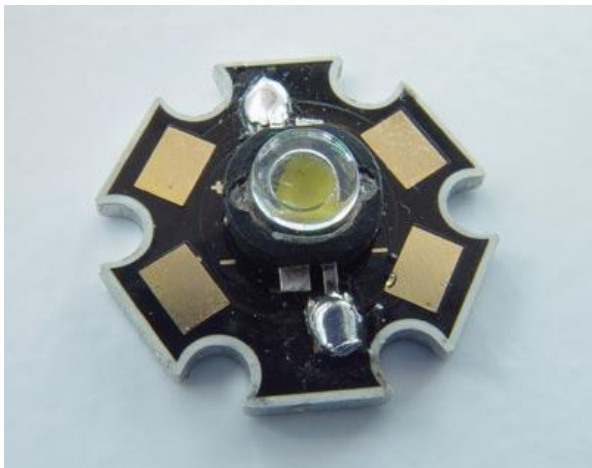
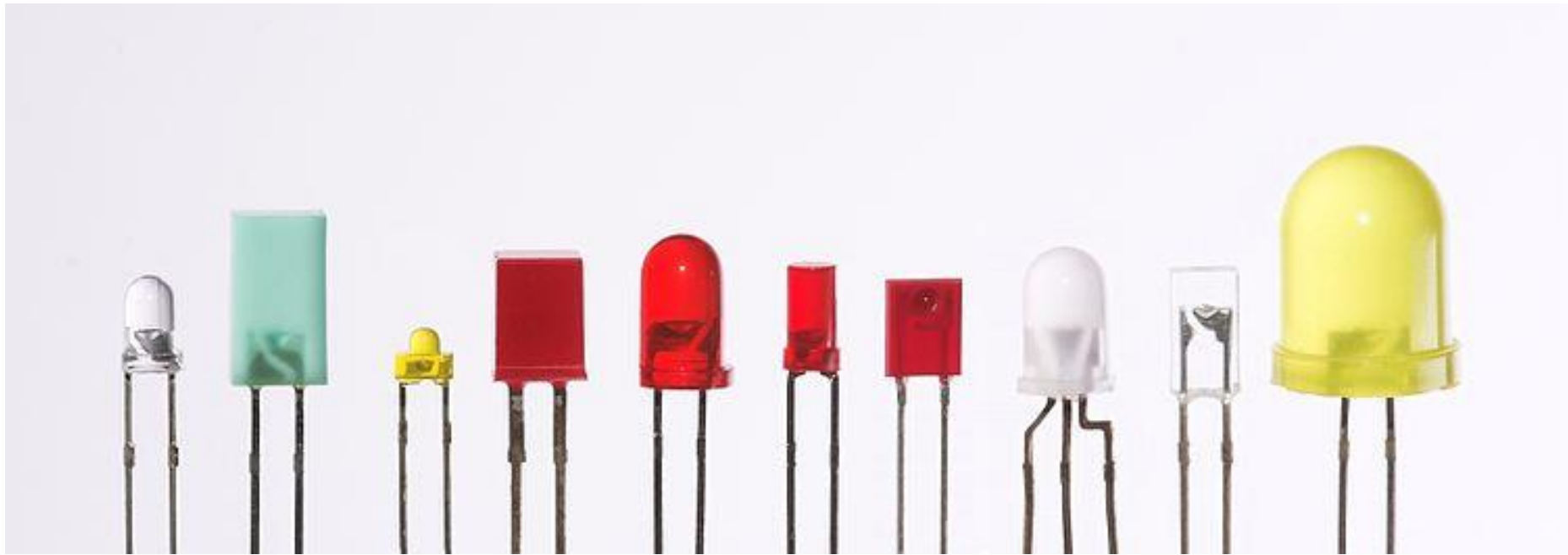


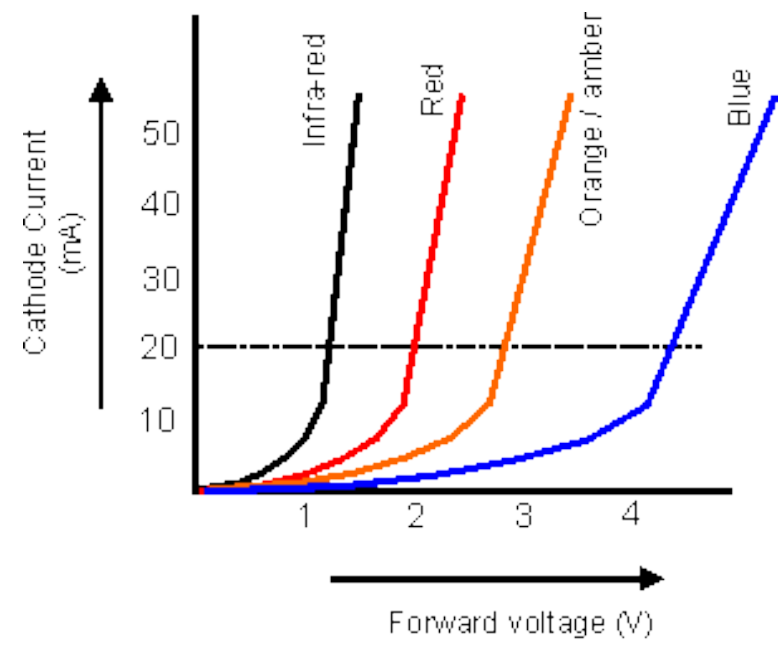
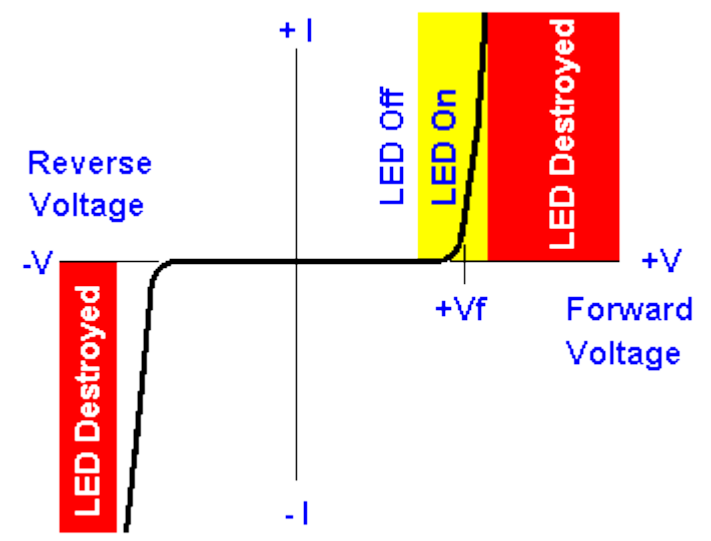
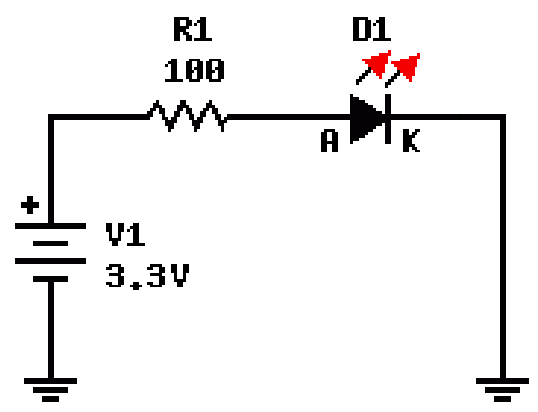
Typical LED Characteristics			
Semiconductor Material	Wavelength	Colour	$V_F$ @ 20mA
GaAs	850-940nm	Infra-Red	1.2v
GaAsP	630-660nm	Red	1.8v
GaAsP	605-620nm	Amber	2.0v
GaAsP	585-595nm	Yellow	2.2v
AlGaP	550-570nm	Green	3.5v
SiC	430-505nm	Blue	3.6v

- Gallium Arsenide (GaAs) - infra-red
- Gallium Arsenide Phosphide (GaAsP) - red to infra-red, orange
- Aluminium Gallium Phosphide (AlGaP) - green
- Silicon Carbide (SiC) - blue as a substrate

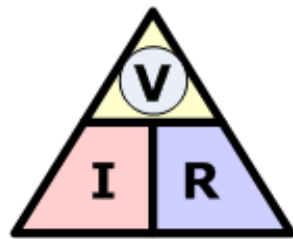




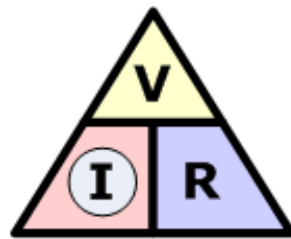




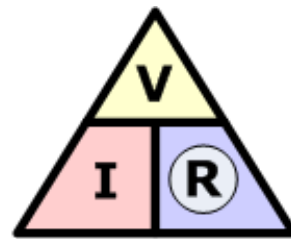
- Electrical Power, (P) in a circuit is the amount of energy that is absorbed or produced within the circuit.
- A source of energy such as a voltage will produce or deliver power while the connected load absorbs it.
- The quantity symbol for power is P and is the product of voltage multiplied by the current with the unit of measurement being the **Watt** (W).



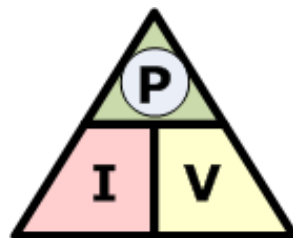
$$V = I \times R$$



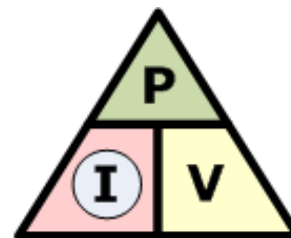
$$I = \frac{V}{R}$$



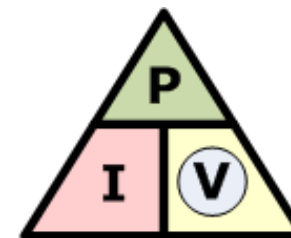
$$R = \frac{V}{I}$$



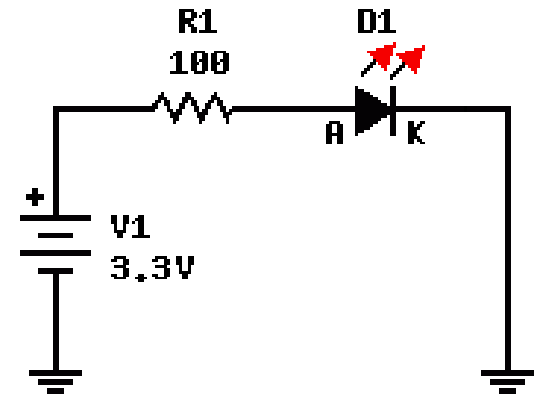
$$P = I \times V$$



$$I = \frac{P}{V}$$

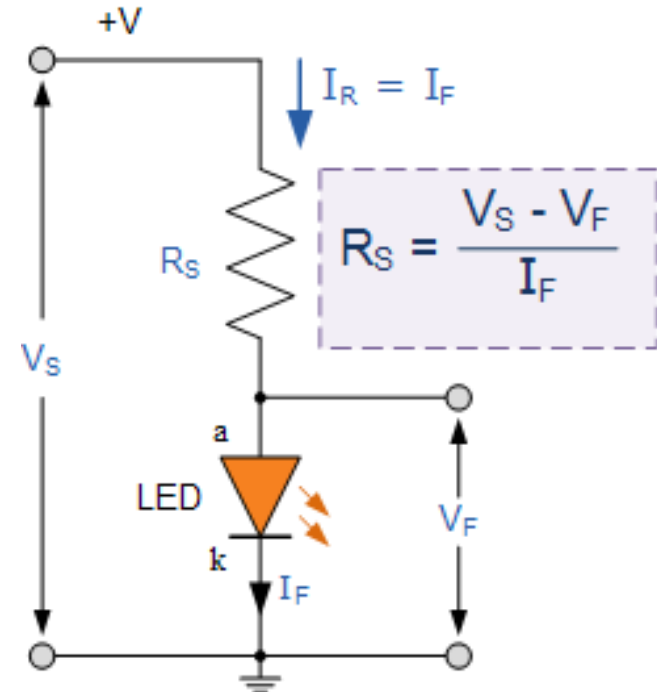
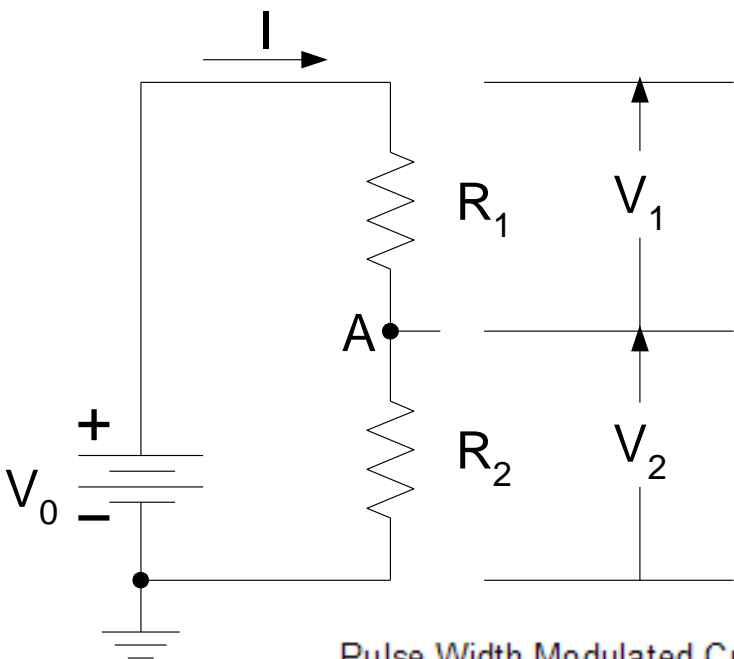


$$V = \frac{P}{I}$$

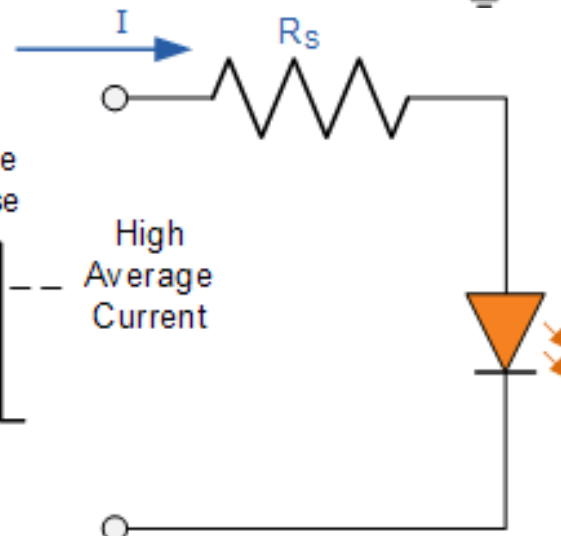
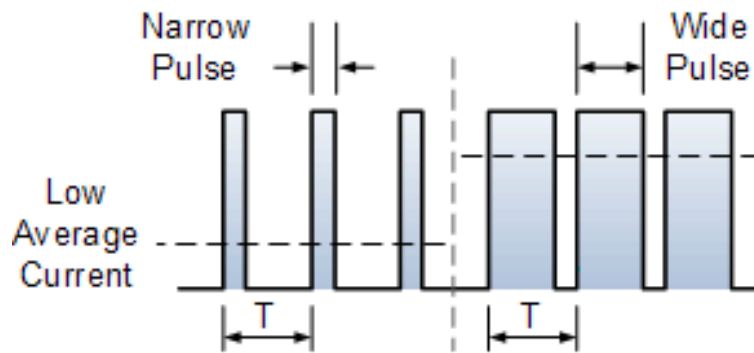




$$V_0 = V_1 + V_2 = IR_1 + V_2$$



Pulse Width Modulated Current



$$I_{average} = I_{peak} \cdot D$$

