# USING LIGHT EMITTING DIODES (LEDS)

POLARITY

LEDs are polarized. If you hook them up backwards they won't work. To determine polarity:
If the package is round, look for a flat spot on the edge of the device. The lead wire nearest the flat spot is probably the Cathode or negative lead. If the leads of the LED haven't been cut, the longest lead is usually the Anode or positive lead.

**SCHEMATIC SYMBOL
FOR LED**

Anode +

Cathode -

flat side

Anode
(+)

Cathode
(-)
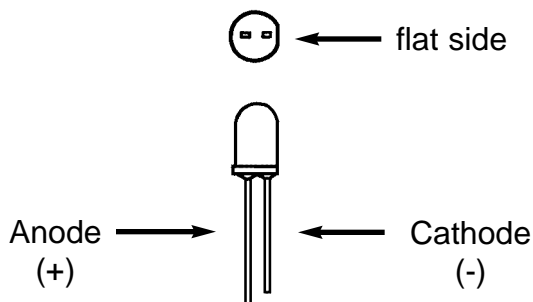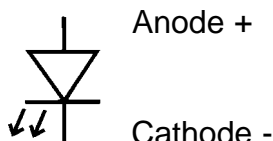
CURRENT LIMITING RESISTOR

LEDs can be operated on almost any voltage as long as they are used with the proper current limiting resistor. Most LEDs require a forward bias voltage of around 2 Volts and consume a current of about 20 mA. Using LEDs on voltages above 3 Volts without an appropriate resistor will probably cause them to burn out quickly, if not immediately. If you don't know the exact specs for the LED you are using, you can usually use 2 Volts @ 20 mA as a starting point for calculating the required resistor. Higher brightness LEDs and specialty LEDs may require higher voltages and currents. If the LED appears too dim, use a slightly lower resistance; if it's too bright raise the resistance. To calculate the resistance use Ohms Law

Resistance = Supply Voltage - Voltage of the LED
                    Current of LED

Eg. To operate a typical 2V LED at 20 mA

$R = \dfrac{Vs-2V}{0.02A}$

for 6V use	200 Ohms
9V use	360 Ohms
12V use	510 Ohms
24V use	1100 Ohms

MULTIPLE LEDS

You can put LEDs in series with one resistor for the whole string. Add up the voltages of all the LEDs in the string. This should not exceed 80 percent of the supply voltage. To calculate the resistance required, the dropped voltage will be the supply voltage minus the total voltage of the LEDs in the string. Series strings can be paralleled if each string has its own dropping resistor.

PARALLEL

SERIES

$Resistance= \dfrac{Vs - V_1}{current}$

$Resistance= \dfrac{Vs - (V_1 + V_2 + V_3)}{current}$

-

Vs

+

The resistor
can be attached
to either leg of the LED.

V_1

R

R

R

V_1 V_2 V_3

R

-

+ Vs