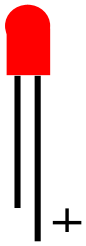
Borders Model Boat Club

www.bordersmodelboatclub.yolasite.com

About Light Emitting Diodes (LEDs,)



LEDs (pronounced “Ell-Eee-Dee”) are low current lamps and are available in sizes from 2mm diameter upwards. They draw far less current and have a longer life than filament lamps. They are compact, and are fairly easy to fit into white metal or plastic lamp mouldings for scale models. To a certain extent they can be reshaped using a file, then polished with “Brasso” to restore the surface finish. The only snag to using them instead of filament bulbs is that they tend to produce a fairly narrow light beam.

As the name suggests, they are diodes, so the positive and negative connections are important. The positive connection is usually the longer of the two leads.

They are manufactured in a large variety of colours, and with a wide range of brightness.

(Note that “white” usually means a harsh brightness, whereas “warm white” is closer to the colour of a tungsten filament bulb.)

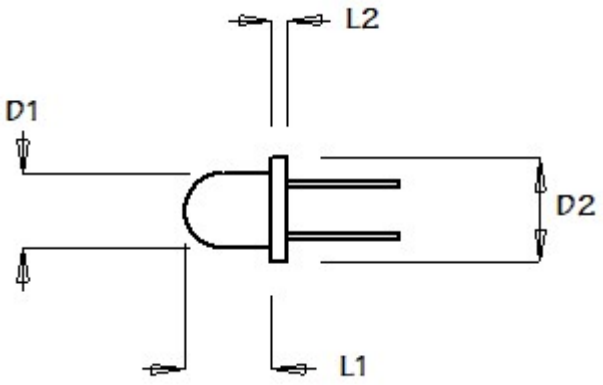
Brightness is usually quoted in mcd (milli-candela). 20 mcd is not very bright and will probably not show up outdoors, and 8000 mcd is dazzlingly bright.

Not all LEDs are the same, it is necessary to look at their properties when using them. The properties usually quoted are the operating current (in milli-Amps) and the forward voltage drop (in Volts) As an example, these might be quoted as 20mA and 2.7 Volts.

What these figures mean is that the optimum operating current of the device is 20mA, and the voltage drop across it when operating is 2.7 Volts.

LED Packages

LEDs come in many shapes and sizes, but the most common discrete components are 3mm dia, 5mm dia and 10mm dia. The table below shows the likely dimensions, but these vary between manufacturers.



	D1	D2	L1	L2
3	3		5.0	1
5	5		8.7	1
10	10		11.6	2

SMD LEDs

These are very small devices intended for Surface Mounting on printed circuit boards, but are increasing being used in models because of their small size. There is a large range of sizes listed by Wikipedia, https://en.wikipedia.org/wiki/SMD_LED , down to a length of about 1mm.

The code for the package is its size so package 1206 is usually 1.2mm x 0.06mm. (But be warned, a few manufacturers use inches)

Connection is usually made by soldering the ends down onto the surface of a printed circuit board, but instead fine wires may be soldered to the ends of the package, while being careful not to overheat the component. This will not be very robust unless the assembly is clued down onto a non conducting surface.

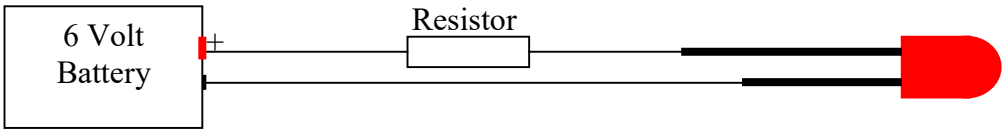
The cathode end is usually marked by a thin coloured line, and is often difficult to recognise.

Using a LED

There are two circuits which you can use with LEDs

1) Using a dropper Resistor

This is the cheapest way. For example, to use a LED with a 6 Volt supply, you fit a series resistor to control the level of the current.
The circuit is:



To Calculate the Minimum Resistor Size Needed

Suppose the property values for the LED are 20mA and 2.7 Volts, then
The Voltage across the battery is 6Volts
The Voltage across the LED is 2.7 Volts
So the Voltage across the resistor is (6 - 2.7) = 3.3 Volts.
The current flowing is 20 mA (20/1000 Amps)

$$\text{So the Resistance Value is } \frac{\text{Volts}}{\text{Amps}} = \frac{3.3}{0.020} = 165 \text{ Ohms}$$

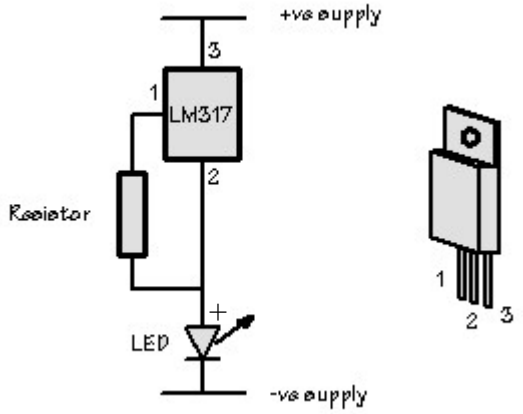
Now you can't buy a 165 Ohm resistor as they are sold in standard "preferred" values. The next larger size available is 180 Ohms, so that is the minimum size to be used. (You must also check the power rating, see Notes below)

If you use a larger value resistor, the LED will still work, but the light will be dimmer.

2.) Using a "Constant Current" Circuit

The problem with using a simple dropper resistor is that the brightness of the LED will alter if the supply voltage is changed. If you expect significant voltage changes, for example, if you use batteries of different voltage rating from time to time, a "Constant Current" circuit can be used.

The circuit below uses a LM317 regulator integrated circuit chip in its constant current mode.



The value of the resistor controls the current. It is chosen so that the required current causes a voltage drop of 1.25 Volts, thus:
To obtain a constant current of 20ma, the value of the resistor is 1.25/.02 = 62.5 ohms.
(The nearest preferred value is 68 ohms).

Note that the supply voltage must be at least 3 volts more than the LED voltage, and that some consideration must be given to the power dissipation in the LM317. (such as: if it gets hot, fit it with a heat sink). The properties of the LM317 device are given in data sheets from various manufacturers.

Tips for using LEDs

Dealing with directionality

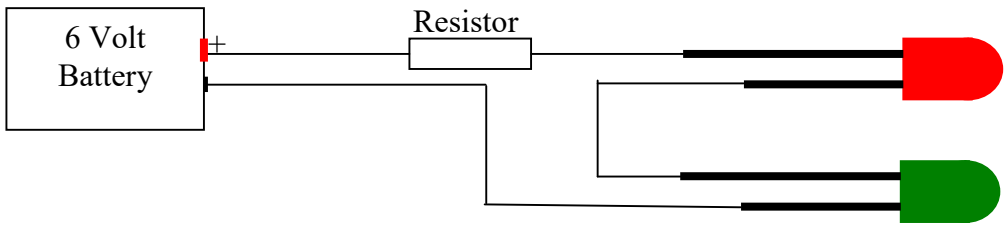
If you are using LEDs for port and starboard navigation lights, it is often most convenient to mount them facing upwards. The directionality of the devices means that most of the light is going in the wrong direction. A way around this is to drill a hole in the end with a 90° countersink and paint the cut surface with aluminium paint. The light will then be reflected nearer to the required direction. Most LEDs are transparent so you can see the working parts inside. When you drill, make sure you do not go too deep and damage them.

Using Optical Fibres

If there is insufficient room to mount an LED where you require a light, you can often use an optical fibre. These are flexible transparent rods available in sizes from 0.5mm upwards. An easy way to couple an optical fibre to a LED is to drill a small hole in the end of the LED, whose diameter matches the fibre, and glue the fibre in using superglue. A model lamp can be shaped from perspex, or transparent styrene sprue left over from a plastic kit and can be connected in a similar manner to the other end of the fibre. When the LED is operated, the model lamp will light up.

Using LEDs in Series

There are times, such as when modelling navigation lights, when two or more LEDs are used. They may be connected in series, thus:



To Calculate the Minimum Resistor Size Needed

Suppose the property values for the LED are:

Red	2.1 Volts	20 ma
Green	3.3 Volts	20 ma

The Voltage across the battery is 6Volts
The Voltage across the LEDs is 2.1 + 3.3 = 5.6 Volts
So the Voltage across the resistor is (6 - 5.6) = 0.4 Volts.
The current flowing is 20 mA (20/1000 Amps)

$$\text{So the Resistance Value is } \frac{\text{Volts}}{\text{Amps}} = \frac{0.40}{0.020} = 20 \text{ Ohms}$$

Now you can't buy a 20 Ohm resistor as they are sold in standard "preferred" values. The next larger size available is 22 Ohms (22R), so that is the minimum size to be used. (You must also check the power rating, see the Notes below)

Note that this calculation requires the current rating of the two LEDs to be the same. If that is not the case, the LED with the higher current rating will appear slightly dimmer, but will still work.

USEFUL LINKS

www.componentshop.co.uk A supplier of LEDs and Optical Fibres which are suitable for model use.

www.bosunsmate.org/seamanship/lights.php A List of Navigation Light Configurations

http://pdf.datasheetcatalog.com/datasheet/texasinstruments/lm317.pdf LM317 data sheet

A Note about Resistors

When resistance values are quoted, often a letter is substituted for the decimal point.
The meanings of the letters are:

	R means times 1	(Upper Case letter)
	k means times 1,000	(Lower Case Letter)
	M means times 1,000,000	(Upper Case Letter)

so R10 means 1/10 ohm
1R0 means one ohm
10R means 10 ohms
1k0 means one thousand ohms
10k means ten thousand ohms
1M0 means one million ohms, and so on

Power Rating of Resistors

The power dissipated in a resistor is calculated by multiplying the value of the current flowing through it by the voltage drop across it.
So if the current is 20mA (0.020 Amps) and the voltage drop is 3.3 Volts, then

Power Dissipated = 0.020 x 3.3 = 0.066 Watts

The power rating of the resistor must be greater than this.

Resistors are sold in 0.125, 0.25, 0.5, 1.0 etc watt ratings. (0.25 is the most common and cheapest)

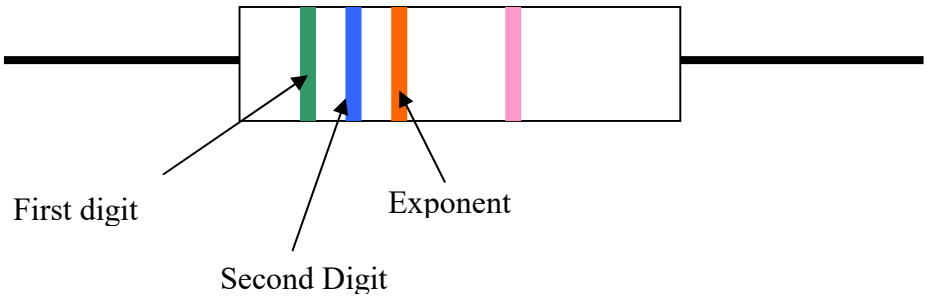
The Preferred Values

The value of a resistor is usually defined by a two digit number plus the multiplier.

The standard values are:

10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 times a decade multiplier.

Resistors are marked with coloured bands to denote the value



The colours represent numbers, as follows:

Black = 0	Orange= 3	Blue = 6	White = 9
Brown = 1	Yellow= 4	Purple = 7	
Red = 2	Green = 5	Grey = 8	

The example above is 56 x 10^3 (56kΩ)