Engineering note: LEDs and how to use them

LEDs feature a specific voltage drop, depending on type and colour:

<table>
<thead>
<tr>
<th>Color</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>1.7V</td>
</tr>
<tr>
<td>Orange</td>
<td>2V</td>
</tr>
<tr>
<td>Yellow</td>
<td>2V</td>
</tr>
<tr>
<td>Green</td>
<td>2V</td>
</tr>
<tr>
<td>Blue</td>
<td>3.4V</td>
</tr>
<tr>
<td>White</td>
<td>3.4V</td>
</tr>
</tbody>
</table>

Check the datasheet for exact voltage drop and rated current!

Always use a series resistor:

How to Calculate the series resistor:

Example: operate a red LED (1.7V) on a 9Vdc source.

Required LED current for full brightness: 5mA

(this can be found in the datasheet of the LED)

Solution: (Supply voltage - LED voltage) / required current = series resistance in ohms

\[(9 - 1.7) / 0.005 = 1460\] (closest value: use a 1k5 resistor)

Required resistor power handling = voltage over resistor x current passed through resistor

\[(9-1.7) \times 0.005 = 0.036W\] (a standard 1/4W resistor will do the job)
Never connect leds in parallel without series resistor!

LEDs in series:

How to calculate the series resistor:

Example: 3 x red led (1.7v) on 9v battery

Required led current for full brightness: 5mA

(this can be found in the datasheet of the led)

Solution: \((\text{Supply voltage} - \text{number of leds} \times \text{led voltage})/\text{required current} = \text{series resistance in ohms}\)

\[(9 - 3 \times 1.7)/0.005 = 780\] (use an 820 ohm resistor)
Engineering note: Power leds do's and don'ts

Do:
- Screw the led firmly onto an appropriate heatsink
- Use a series resistor or current limit circuit

Don't:
- Use the led without a heatsink!
- Use the led beyond the max. operating current
- Look directly into the lightsource

Engineering note: Open collector outputs

An open collector output can be compared to a switch which switches to ground when operated.

Example: How to switch an LED by means of an open collector output
Engineering note: Relay contacts and how to use

Common mistake:

This will not work!

Remember: Relay outputs are switches i.e. there is no voltage coming out of them. You have to apply an external source.

So, how to you connect a load to a relay output: