LED Tester

Check and compare intensity

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LEDs are used everywhere these days, not just as on/off indicators any more but now also as a source of light. Before you mount an LED in your circuit it would be nice if you could first check whether you have the right type and how much current it needs to have for it to be bright enough.

The simple circuit described here allows you to test LEDs quickly and make a distinction between low-current and high-efficiency types. Low-current LEDs give quite a bit of light with a current of only 1 to 2 mA, while high-efficiency LEDs produce a lot of light at a current of 10 mA or more (refer to the characteristics in **Figure 1**). Moreover, when you design a circuit in which multiple LEDs are going to be on at the same time, it is important that all these LEDs are equally bright at a particular current.

This can also be verified with this test circuit: two (or more) LEDs can be connected in series so that you can select them for equal brightness.

In this circuit we start with an adjustable current source. The current through the LED (or two in series connected LEDs) is adjustable from 0 up to 20 mA. Based on the brightness of the LED(s) while turning the potentiometer from 0 to maximum, you can determine which type of LED(s) you have. A low-current LED will quickly be quite bright at a small current and will not get much brighter when the potentiometer is turned further. On the other hand, a high-efficiency LED will slowly continue to increase in brightness.

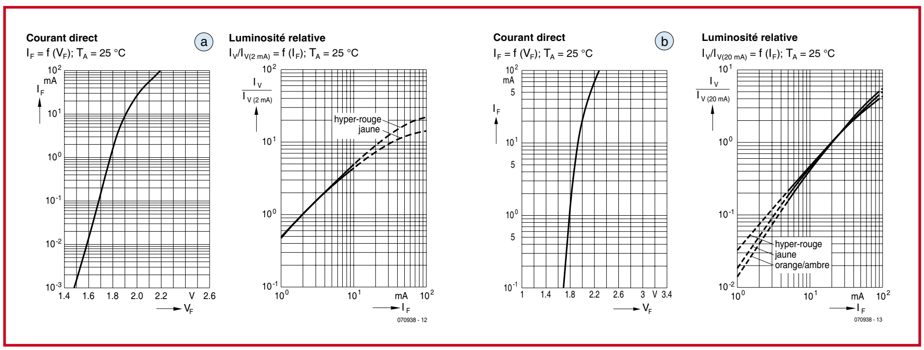
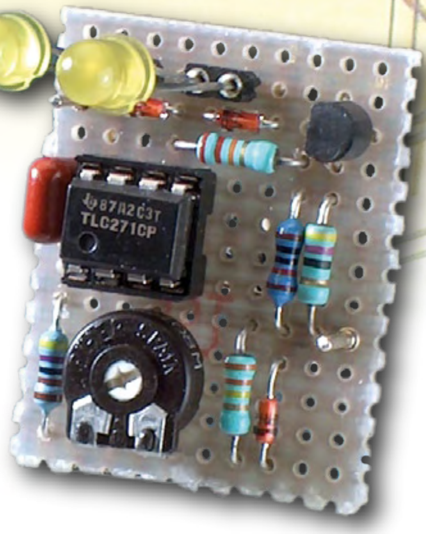


Figure 1. Forward voltage and intensity of a low-current LED (a) and a high-efficiency LED (b).
Source: Osram Opto Semiconductors.

If you would like to select LEDs for equal brightness then you can connect two, or even more than two, in series. Using red LEDs and a power supply voltage of 9 V you can even connect 4 in series, which makes the selection process significantly easier. If you like, you may increase the power supply voltage up to a maximum of 15 V (but not two 9-V batteries in series!). The maximum allowed power supply voltage for the opamp that is used here, a TLC271, is only 16 V. At this voltage you can compare 6 to 8 LEDs (red, yellow or green). The actual maximum number depends on the forward voltage drop of the LEDs under test. With



white LEDs this voltage is about 3.6 V, so at a power supply voltage of 15 V you can only measure 3 at the same time.

Schematic

The circuit (**Figure 2**) consists of the classic current source made from a transistor and an opamp. The opamp compares the voltage drop across the emitter resistor R5 of T1 with the set-point voltage at the wiper of potentiometer P1. The base of T1 is driven via voltage divider R3/R4 by the output of the opamp. The values of this voltage divider have been chosen such that in a potential fault situation (for example when the output of IC1 is driven to the supply rail), the current through T1 can never become too high. This maximum is a little more that 20 mA. (But take note! If you increase the power supply voltage to the entire circuit, the maximum current through T1 in a fault condition will also increase!)

A zener diode (D1) is used to generate a reference voltage in a simple manner, which makes the voltage across P1 independent of the supply voltage. The current through D1 is set frugally at 1 mA and as a result the reference voltage is only 4.2 V, instead of the nominal 4.7 V. The value of R2 was selected so that the voltage across P1 is about 1 V.

Before you fit this resistor, note the actual value of the potentiometer you have. This type of potentiometer often has a tolerance of ±20%. If your potentiometer deviates more than 5% from the nominal value then you can adjust the value of R2 by the same proportion.

P1 is drawn as a preset in the schematic, but if you have a frequent need to select LEDs you can also use a normal potentiometer for P1 and maybe add a graduated scale as well.

A 4.7-V zener diode is connected in parallel with each LED (D2 and D3). The function of these zeners is twofold. On the one hand, when one LED is removed the current through the other LED continues to flow uninterrupted. On the other hand when an LED is connected the wrong way around the zener diode prevents the voltage across the LED from exceeding the maximum reverse blocking voltage. This is often 5 V, but is sometimes specified to be lower than that!

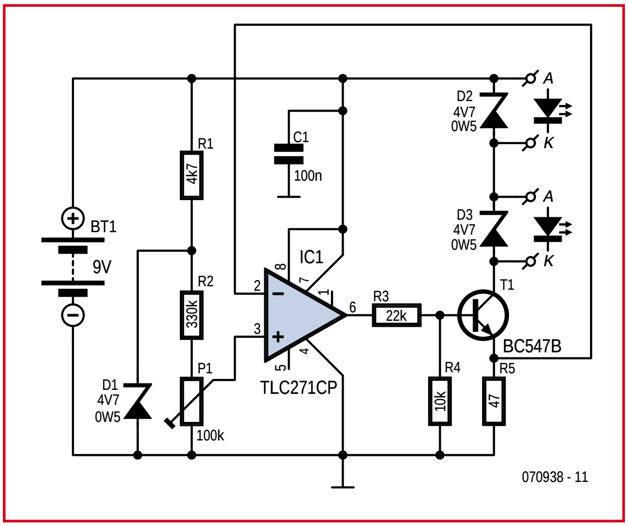


Figure 2. The LED-tester consists of an adjustable current source which can supply up to 20 mA at a power supply voltage of 9 V.

Construction

The best way to build the circuit is to use a small piece of prototyping circuit board. The few parts and the connections between them are easily fitted. To facilitate the quick insertion and removal of the LEDs, it is best if you use 2 times 2 connectors from a turned-pin IC socket.

The maximum current consumption of our prototype was just under 23 mA and the minimum current was 1 mA (the current through R1). The opamp is set to low-power mode by connecting pin 8 to the positive supply voltage; it now consumes mere microamps.

If you want to be able to safely test (many) more LEDs at the same time, you can use a separate, higher power supply voltage for the string of LEDs (but note the maximum ratings of the transistor). If necessary, at very high voltages you can use a power transistor for T1 (and fit a heatsink, if required). However, don't forget to connect a zener diode across each LED, this is much safer.

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