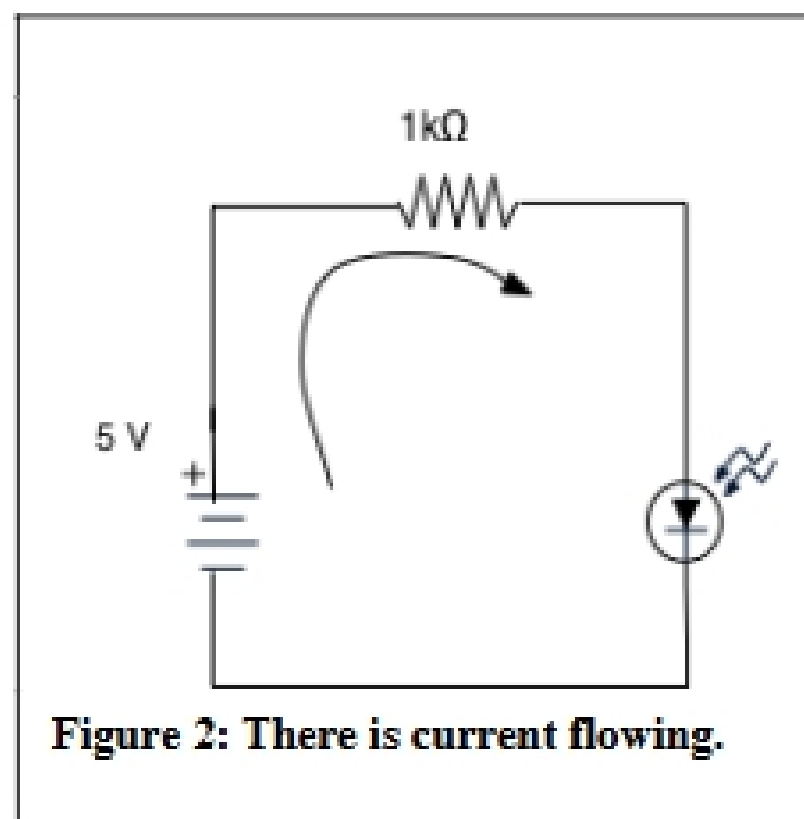
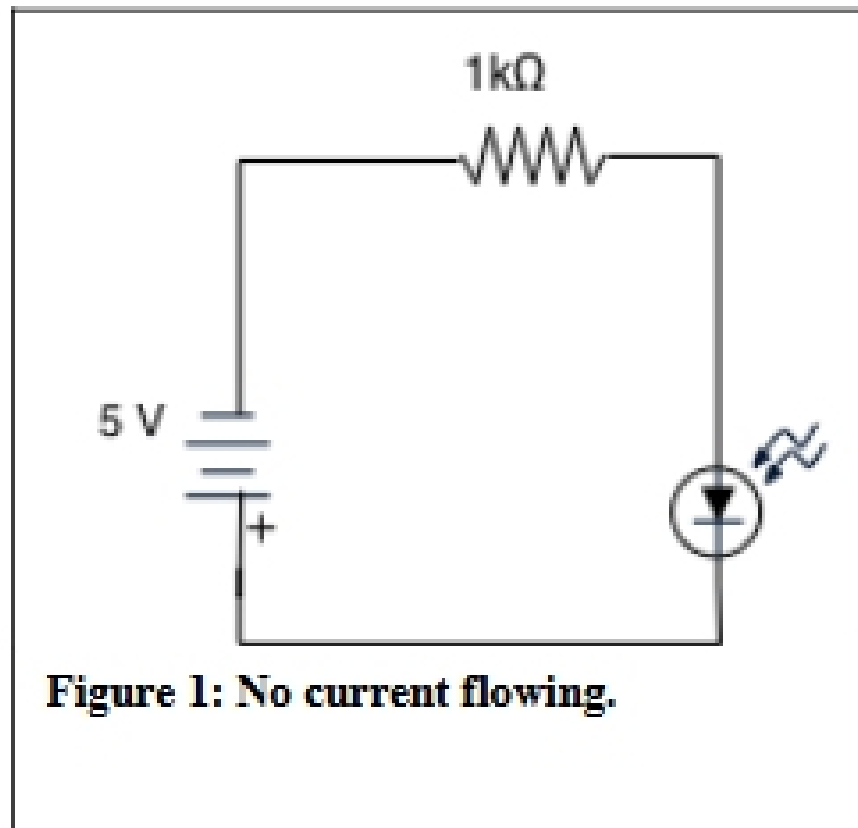


Light Emitting Diodes and Digital Circuits I

The Light Emitting Diode:

The light emitting diode (LED) is used as a probe in the digital experiments below. We begin by studying the properties of the LED.

The LED is first of all a diode. It passes current in one direction but not in the other.



In Figure 1 the diode is biased in the backward direction or “reverse biased” and there is no current flowing through it whereas in Figure 2 the diode is “forward biased” and there is current flowing.

The LED gives off light when it is *forward* biased. The symbol for the LED is:



Experiment 1:

Build the two circuits shown above and observe that the LED glows in only one orientation. Use a variable voltage power supply and watch the LED intensity increase with increasing supply voltage.

Experiment 2:

Set up the forward-biased circuit. Use the oscilloscope to measure the voltage across the LED as the power supply voltage is increased. You should find that when the LED is glowing normally the voltage is saturated at about 2 volts, as sketched below in Figure 4.

Experiment 3:

Set up the forward-biased circuit in Figure 3. It is the same circuit as far as the LED is concerned, but it enables you to measure the voltage across the resistor without worrying about ground connections. Measure the current in the circuit by using an oscilloscope to measure the voltage across the 1 k Ω resistor. (With $R = 1\text{ k}\Omega$, the current in milliamperes (mA) is directly equal to the voltage in volts). Observe the increasing brightness as a

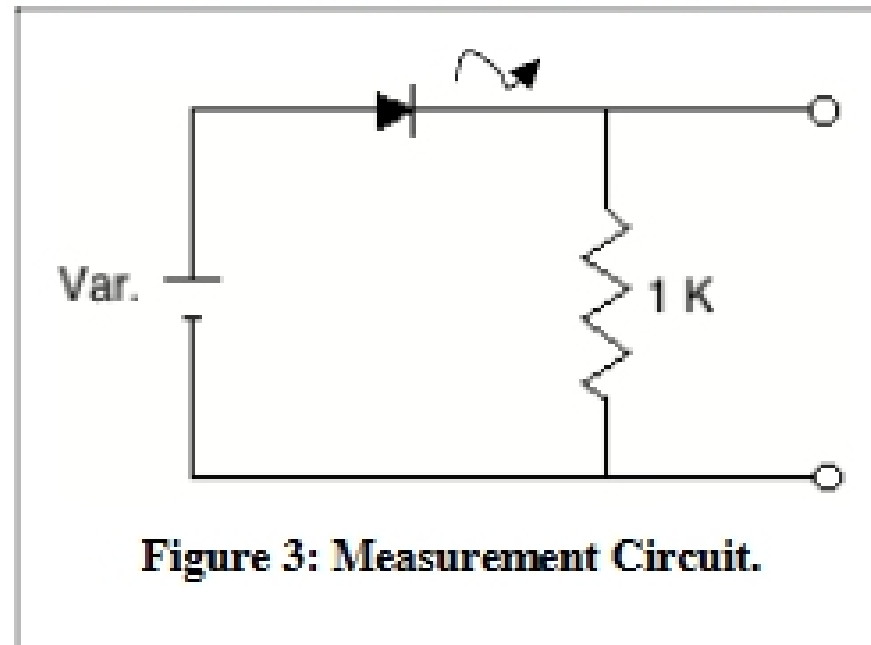


Figure 3: Measurement Circuit.

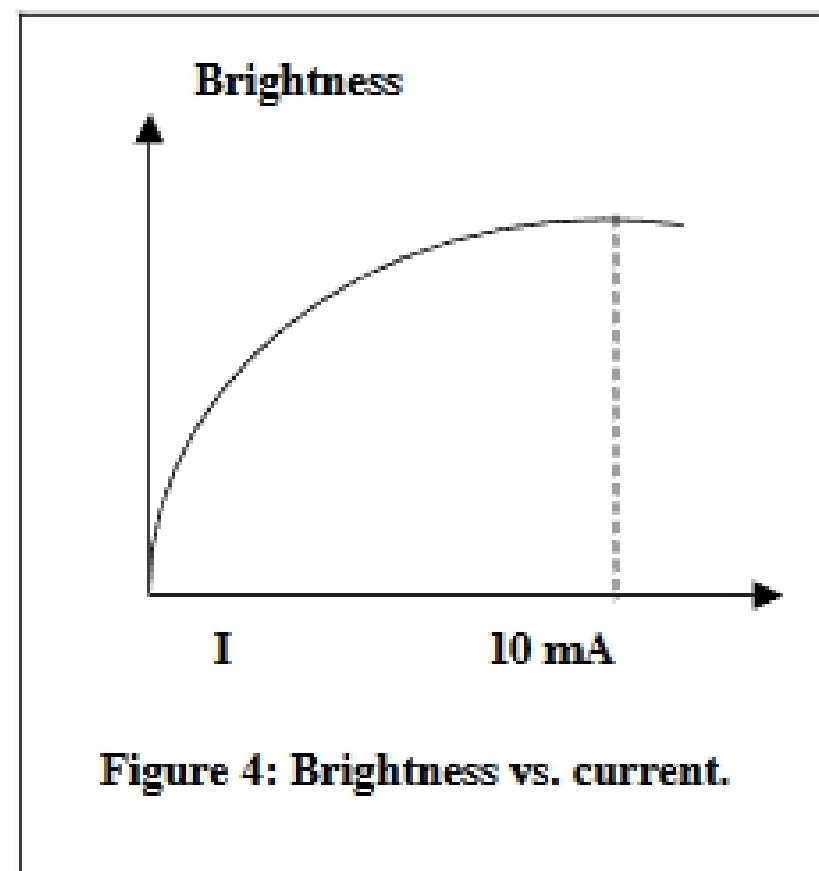


Figure 4: Brightness vs. current.

function of current as you increase the supply voltage. You should find that a current between 5 and 10 mA gives a normal glow.

Experiment 4:

Calculate the current in the circuit in Figure 5 below.

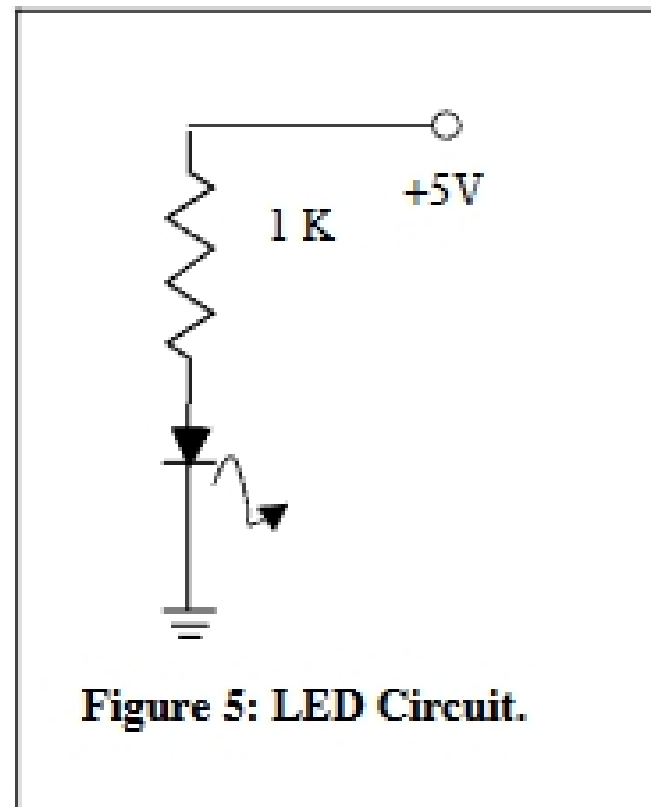


Figure 5: LED Circuit.

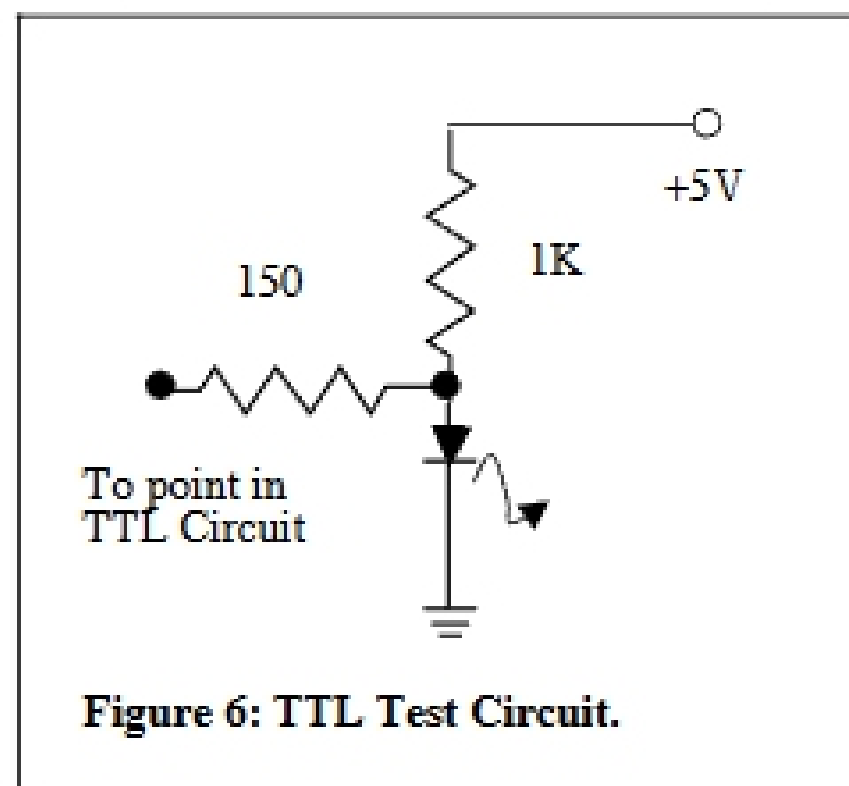


Figure 6: TTL Test Circuit.

The answer to the question on Figure 5 is: "about 3 mA". We use the circuit shown in Figure 6 to determine whether a point in a TTL circuit is logically high or logically low. If it is high then this point will not cause much voltage drop on the 1k resistor and the LED will glow. If the point is low then it will sink current, causing a voltage drop on the 1k resistor, and the LED will not glow.

7400 Quad Input NAND Gate

Before doing this lab you should review the truth tables for AND, NAND, OR and NOR gates, on page 238 of DH.

We consider the TTL (transistor-transistor logic) device called the 7400. It is part of the TTL family of digital logic devices whose names all begin with 74. All members of this family operate from a power supply of + 5V. The members are all compatible in that outputs from one will serve as inputs for another.