

5.3 Laboratory Procedure / Summary Sheet

Group: \_\_\_\_\_ Names: \_\_\_\_\_  
 \_\_\_\_\_

- (1) Build the simple LED indicator circuit shown below (without the 2nd resistor). See Figure 4.7 in Lab 4 to identify the LED polarity. Gradually increase  $V_{in}$  from 0 V to 5 V and record  $V_{in}$  and measure  $V_D$  when you consider the LED to be on. Also **calculate** (don't measure) the current  $I_D$  based on the recorded voltages.

$V_{in} =$  \_\_\_\_\_

$V_D =$  \_\_\_\_\_

$I_D =$  \_\_\_\_\_

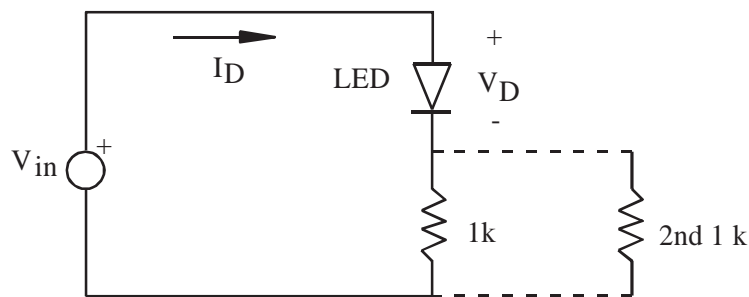


Figure 5.2 LED Circuit

- (2) Add the second resistor in parallel and repeat the same experiment.

$V_{in} =$  \_\_\_\_\_

$V_D =$  \_\_\_\_\_

$I_D =$  \_\_\_\_\_

Explain what happened and why.

- (3) Build a simple transistor switch (see figure below) using a 2N3904 small signal transistor and a base resistor ( $R_B$ ) of  $1\text{ k}\Omega$ . Use the variable voltage power supply or the function generator dc output for  $V_{in}$  so it can be adjusted later in small increments. Use the DC power supply for the  $10\text{V}$  source.

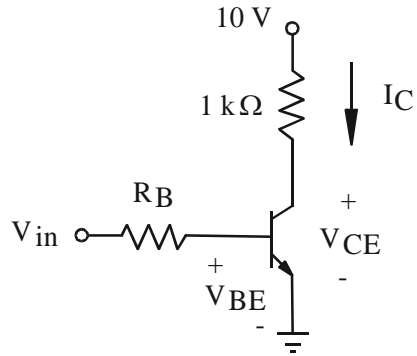


Figure 5.3 Transistor Switch

Use the 2N3904 datasheet provided in Section 5.2 to help you **draw and label the pins on the figure below** and to record the following values:

maximum allowed  $I_C =$  \_\_\_\_\_ maximum allowed  $V_{CE} =$  \_\_\_\_\_

minimum required  $V_{BE}$  for saturation = \_\_\_\_\_

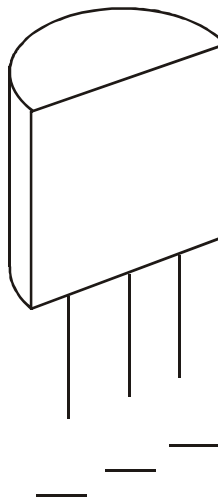


Figure 5.4 2N3904 Pin-out

Vary  $V_{in}$  as indicated in the table below and record the associated values for  $V_{BE}$  and  $V_{CE}$ . Use  $R_B = 1\text{ k}\Omega$  for the base resistor.

$V_{in}$	$V_{BE}$	$V_{CE}$
0.0		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1.0		

Describe your conclusions about when saturation occurs for the transistor.

Change the base resistor ( $R_B$ ) to  $10\text{ k}\Omega$  and repeat the measurements.

$V_{in}$	$V_{BE}$	$V_{CE}$
0.0		
0.4		
0.5		
0.7		
0.9		
1.1		
1.3		
1.5		

What is the effect of a larger base resistor? Why?

- (4) Build the circuit shown in Figure 5.5 with a TIP31C transistor (note the pinout shown in the right side of the diagram below) and a 1.5V-3V DC motor. The TIP31C transistor is required to provide adequate current to the motor. Be sure to use the flyback diode as shown. This diode provides protection to the transistor when control signal  $V_{in}$  is turned off. Flyback diodes are recommended when switching inductive loads such as motors and solenoids. The 1N4001 power diode is well suited to this motor since the motor current is well within the surge current capacity of the diode.

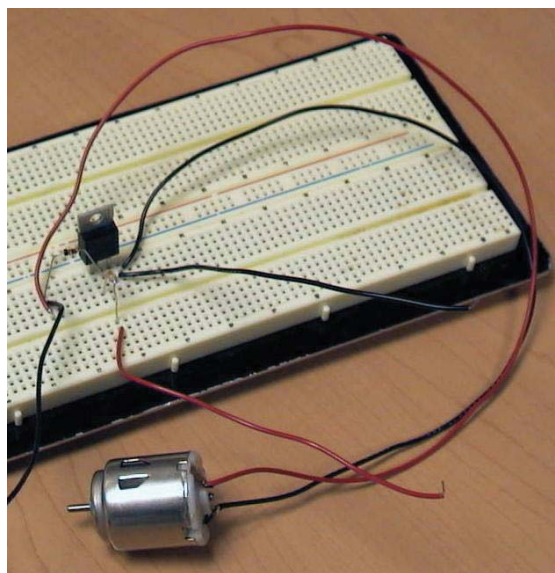
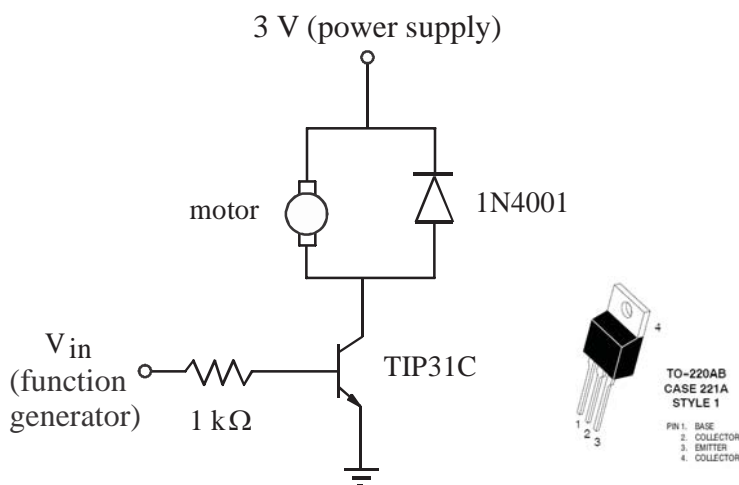


Figure 5.5 Motor and Flyback Diode

Gradually increase  $V_{in}$  from 0 V to 5 V and describe what happens.

Apply a 5Vpp, 2.5V dc offset (0 to 5V) square wave input to  $V_{in}$ . Start with a low frequency (e.g., 1 Hz) and then try some higher frequencies, increasing the frequency in 1 Hz increments up to 20 Hz and then 10 Hz increments up to 100 Hz. Describe what happens to the motor.

Explain how the flyback diode works.

- (5) Examine the photo-interrupter and look at its specifications. Build the circuit shown in Figure 5.6, using the resistors indicated. Note that a single 5V source can be used to provide both voltage signals, and the ground for the input and output circuits must be connected to be common.

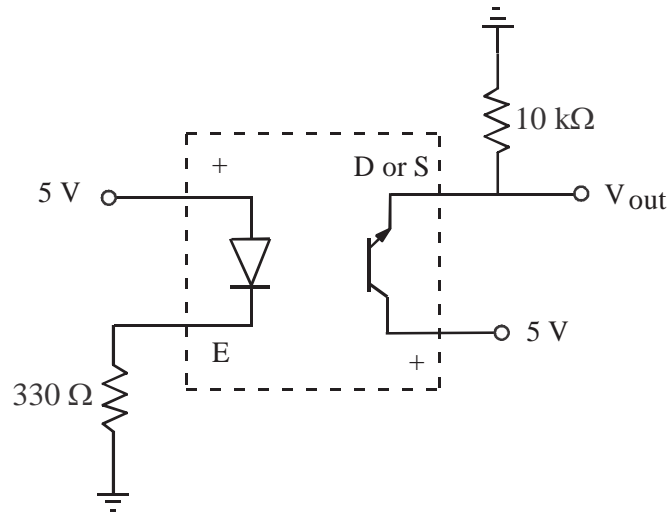


Figure 5.6 Photo-interrupter

Measure the output voltage ( $V_{out}$ ) with and without the beam interrupted (e.g., with a thick sheet of paper or a plastic card). What conditions (interrupted or not) correspond to the high and low states of the output? Explain why each condition results in the respective state.

Why are the resistors required?