385L / 5585 – Laboratory 4 – Switches / 06 MAR 2017 / Due: 20 MAR 2017

Objectives:
1. Understand the workings of a relay/switch
2. Measure the bounce and switching time for a relay
3. Measure the switching time for a solid-state switch
4. Use a transistor as a switch

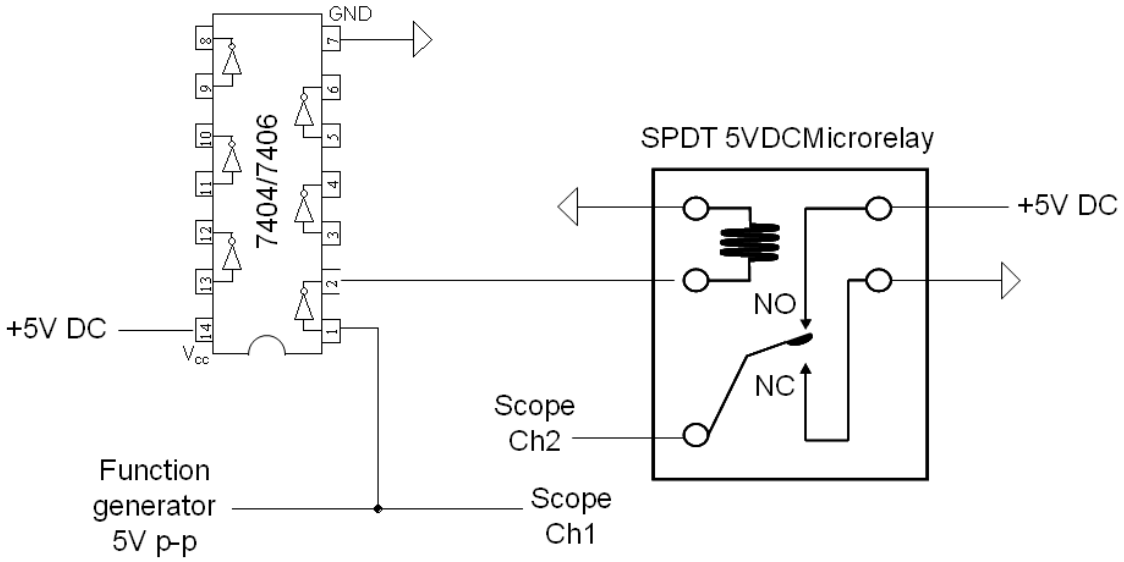
Equipment and Parts:
1. Single-pole double-throw (SPDT) 5VDC microrelay
2. 7404 or 7406 inverter
3. Solid-state switch - DG211CJ
4. Transistor - 2N2222
5. Oscilloscope and function generator

4-1 Electromechanical Relay Switches

Electromechanical relays (EMRs) are used in analog switching applications where very high off and very low on resistances and/or high power are essential. EMRs are relatively slow operating switches and can have considerable bounce associated with them. These characteristics will be measured in this lab section.

The relay used here is a single-pole double-throw electromechanical switch (i.e., the switch has two positions depending on whether the coil is energized). If the coil is not energized then the center contact rests against the normally closed (NC) contact. If the coil is energized the center contact rests against the normally open (NO) contact. A voltage is applied to the coil to change the position of the contactor.

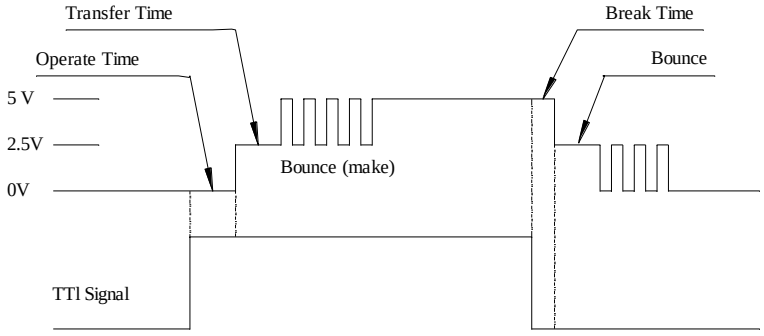
Since the coil requires a fairly large current, a 7404/7406 inverter is used to buffer the transistor-transistor-logic (TTL) output of the function generator. This will also cleanup the TTL transitions produced by the function generator. If you find the inverter does not work as prescribed, bypass it and run your generator voltage directly into the relay coil.



Wire the relay circuit shown above. The circuit is designed to produce 0 V when the center contact is in the normally closed (NC) position, 5 V when it is in the normally open (NO) position, and 2.5 V when between positions. This will allow for a voltage level based measurement of the bounce time.

Set the function generator to generate a square wave with 5 V p-p voltage at a frequency of 10 Hz. Observe the function generator output and the voltage of the relay on the oscilloscope. The pattern on the screen should be as shown in the figure on the following page.

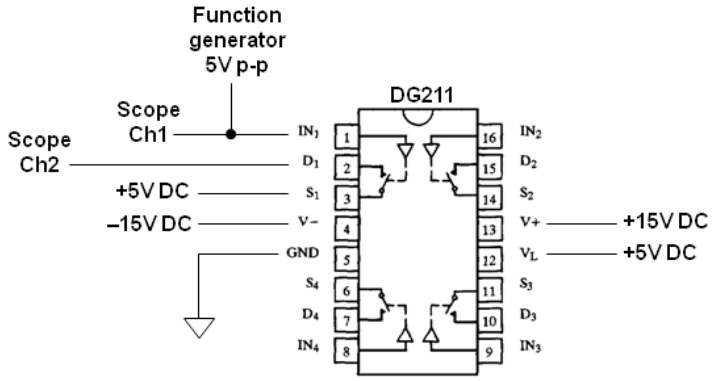
You may have to use the delay settings on the oscilloscope to observe the pattern. Measure the operate, transfer, bounce, and break times on the scope. Perform the measurements for at least three different function generator frequencies, including 10 Hz, 50 Hz, and 75 Hz. Also determine at what frequency the contact fails to connect with the normally open contact (hint: you can hear it fail).

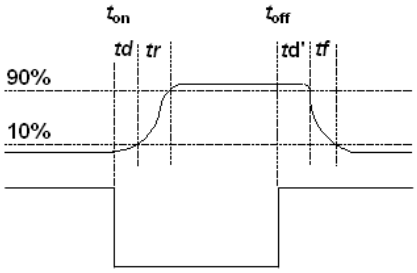


4-2 Solid-State Switches

Mount a DG211CJ quad single-pole single-throw analog switch on the bread board. The inputs labeled IN are the inputs which control the switch state. If IN is low the switch is closed, and if IN is high the switch is open. The signal to be switched is input at pins labeled S and the output is available at pins labeled D. These are not interchangeable.

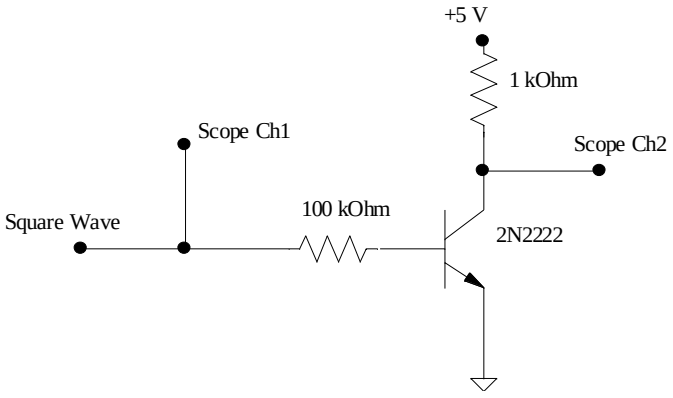
Wire the circuit below. Monitor the input signal and the output signal on the oscilloscope. Set the function generator to generate a square wave with 5V p-p voltage at 10 kHz and measure the time delays for both on and off operation. Also measure the transition time to change from off to on and from on to off. The delay times are shown in the figure below. Repeat the measurements at frequencies of 50 and 100 kHz.





4-3 Transistor Switches

Transistors may also act as switches. Here, wire a 2N2222 in a common base configuration based on the pin assignments and circuit diagram shown below. Begin with no capacitor in the circuit and set the function generator to 10 kHz. Adjust the amplitude and offset of the function generator and observe the effect on the output waveform.



PIN	DESCRIPTION
1	emitter
2	base
3	collector, connected to case

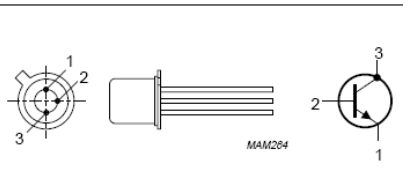


Fig.1 Simplified outline (TO-18) and symbol.

For several settings of the input voltages, all unipolar, measure the transition times. Do not exceed 10 V p-p for the input waveform. Place a small cap in parallel with the base resistor and measure the transition times for the same settings as before. Describe the effects of the capacitor on the switching times.