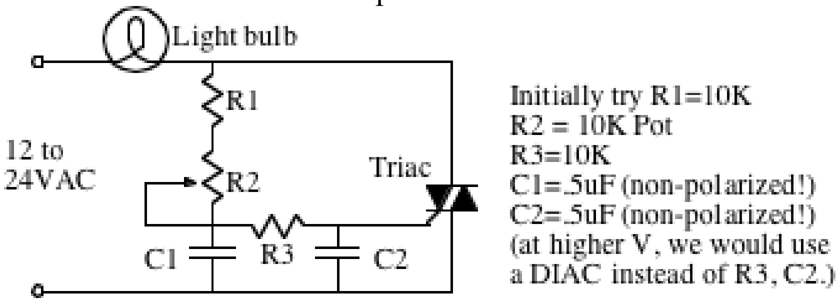
EE252 Electronics 2 Lab #11: Triacs and SCR's

(This lab exercise may need to be modified, depending on parts available.)

Objective: Develop an understanding of thyristors, particularly in control and switching applications.

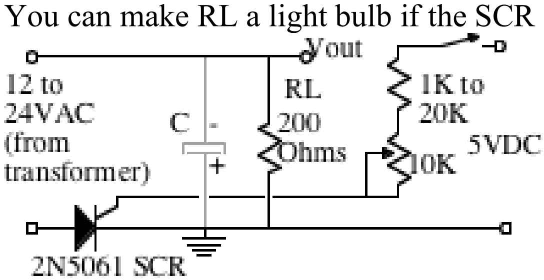
Pre-Lab: Read this and come prepared. Take a look at a copy of the Triac data (BCR6AM12L, Jameco (http://www.jameco.com) part number 2285215. Also, the SCR C106DIG (Jameco part number 2291239). (We expect be able to use the MOC3011 Opto-isolator triac. Look up the data sheet for that (Jameco 26278), sample circuit next page.)

Check out the triac: Build the circuit below. Use adjustment of the potentiometer to vary the phase of the gate signal relative to the primary power to the load. Observe, and graph the AC waveform at the load for the potentiometer extremes and a middle position where it triggers.



If time: Modify your triac to trigger using the opto-triac and a current (limited by a resistor!) through the optical diode. Use the LED of the opto with low V to turn a load (light bulb) on and off. See reverse of this sheet, and opto-isolator data sheet.

Check out SCR's: Build a half wave unfiltered power supply, but using an SCR instead of a diode. For simplicity, we build a negative Voltage supply. (This allows the gate Voltage to be referenced to ground.) Observe the output waveform under different gate currents (by varying the resistors in the gate circuit. (Normally a negative supply would include C. But if we do that, without doing phase based control, we really can only control on – off. SO, SKIP C.) With some SCR's, we've had to go to really large resistors with pot or lower than 5VDC to turn it off! You can make RL a light bulb if the SCR is capable enough to handle the current.



Extra activity BEYOND THE LAB: Build a low or high pass filter for about 1KHz (using an Op-amp active filter perhaps). Rectify the op-amp output to produce a DC Voltage when the filter recognizes a signal. Connect the DC Voltage to a triac (AC) source (the opto-triac circuit is a good choice) to control a load. You have just built one channel of a color organ. Give your schematic, and a description. Try it on some music if you'd like. What amplitude in-band AC signal is needed to trigger the triac consistently?

Report: On a page, put the circuits you used with the waveforms observed to the load (light bulb) under different conditions for both the triac and SCR. Give answers to the questions asked in the lab exercise. Turn in the report at the end of the lab period. This is meant to be easy!

Optical triac usage: The whole point of an opto-isolator is to completely separate all electrical connections, including ground, between one circuit and another, but still being able to control one circuit with the other. The medium used for communication is light. Hence, the term "opto-isolator". These devices come in two basic forms. In one, light acts like a base current to turn on a transistor. (In some devices, the base can also be driven electrically.) The other option is to use a triac or an SCR on the controlled side.

That's the case with the MOC3011 that we will be using. In the peseence of current through the IR Led, the triac is "triggered" allowing current to flow either way. So, this is good for AC control. But, the optical triac is not designed for power handling. It's tiny. The Voltage drop across a triggered triac is about like a diode, approximately .7 Volts, so currents anywhere coles to an Ampere will burn it out. The absolute peak current maximum is 1A, and that can't be tolerated very long. So, what this device is normally used for is to control a larger ordinary triac that is able to turn an AC load on and off. Sample circuits from On Semiconductor are shown below. Resistor "R" is chosen to limit the triggering current. (It triggers at something less than 10 mA, so you want >10mA to trigger it, but not a whole lot more. Once both triacs are triggered, trigger current drops to a low value.)

It's worth mentioning that if the load is inductive, like a motor, special precautions are needed. At the zero crossing of the triac, the triac normally turns off and waits for trigger current to turn on in the other direction. Large currents in an inductive circuit don't like being turned off. So, a "snubber" circuit is needed. That makes managing inductive loads more complicated, and that's not something that you should try to do without a good bit more research.

Both the optical triac and power triac were chosen to handle 120VAC loads, in case you want to control Christmas tree lights to music or some other application. Be careful and follow safety principles for the 120 VAC side of the circuit. The low Voltage side, where the IR LED is, might be powered with a battery or a small independent power supply, and will be safe. That's the beauty of opto-isolators – they are good tools for safety.

MOC3010M, MOC3011M, MOC3012M, MOC3020M, MOC3021M, MOC3022M, MOC3023M

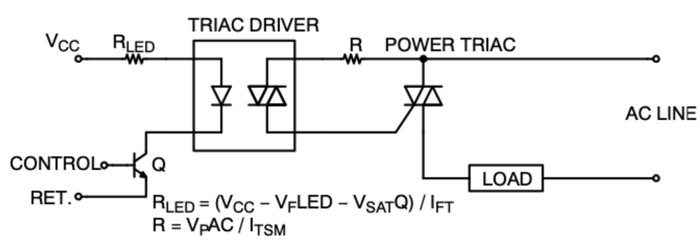
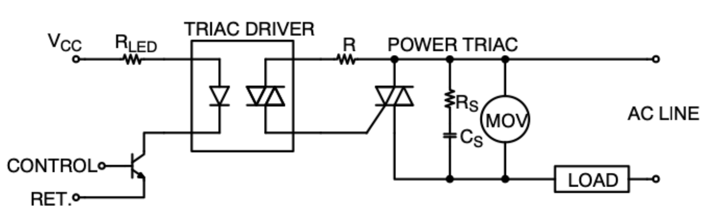


Figure 7. Basic Driver Circuit



Typical Snubber values $R_S = 33\ \Omega$, $C_S = 0.01\ \mu F$
MOV (Metal Oxide Varistor) protects power triac and driver from transient overvoltages > V_{DRM} max

Figure 8. Triac Driver Circuit for Noisy Environments