ECSE 371 APPLIED CIRCUIT DESIGN L. Sears

Lab #9: Triacs and Phase Control **V24.1**

Review the course Canvas documents on "Triacs". (H&H does not cover triacs).
For Saturday, provide preliminary schematics for Problem 2 and Problem 3. Triac datasheet:
https://www.mouser.com/datasheet/2/848/bt139-600e-1520116.pdf

1. TRIAC Static Characteristics

A) Using a BT139 triac (or equivalent), a DC bench supply, and a 13V, #194 bi-pin lamp, measure and **record** the trigger current, I_{GT}, of the triac in each quadrant. Remember that the triac will trigger on extremely short pulses (from "pot-wiper bounce"). Therefore, instead of using a pot to vary the gate current, use a fixed, series resistor and a smoothly-variable bench power supply to provide gate current. Repeat the test several times, looking for repeatability.

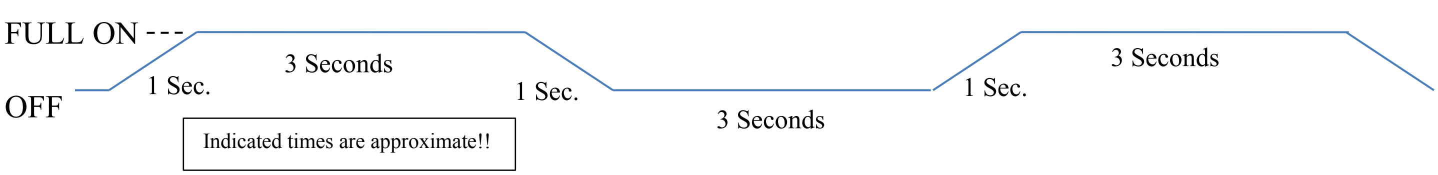
B) Measure and **record** the holding current, I_H, and latching current, I_L, of this triac. Again, beware of pot-wiper bounce and do **not** use a pot for a load; instead use a bench supply and a fixed resistor (33-47 ohm) as a load. Slowly vary the power supply to provide interruption-free main-terminal current (the power-supply voltage should change very smoothly). This technique is especially important as you reduce the main-terminal current to measure I_H. Compare your measured values with the data-sheet values. For recitation: have your test results ready for review.

2. Lamp Dimmer

A) Design and build a triac phase-control lamp dimmer that will drive a #194 lamp with full-wave AC. Use the "13VAC" transformer as the only power supply; a separate power supply is not to be used to power the control circuitry. Lamp brightness is to be controlled by a potentiometer and must be adjustable from completely OFF to full ON, without any spurious, unexpected operation. **Record** waveforms of lamp current and triac voltage at several conduction angles **(P).** Use a current probe to view lamp current. You may NOT use a Diac in your design; they are no longer available in low- voltage versions; you may, however, employ a similar a ramp/discharge type of circuit with a comparator, etc; You might even try a UJT or PUT; see notes below.
How much power is the triac dissipating at full load? For recitation: **provide a complete schematic.**

3. AC Lamp Flashing Circuit.

Design a lamp- flashing circuit that will flash the #194 lamp at a rate of approximately 3 seconds (full) ON and 3 seconds OFF. Your circuit is to incorporate circuitry so that the lamp gradually turns ON and OFF over a ramp period of about 1 second. Note that a thoughtful design will be extremely simple. Power at 13VAC. Brightness and times need not be adjustable.



For recitation**: Provide have your lab report ready and be prepared to demonstrate operation.**

4. Line-Operated Lamp Flashing Circuit. *Design only.*

Design the circuit, was similar to that in Part 3, that will operate on 120 VAC and operate a 60 W, 120 V lamp. This is a design-only project. Simulate the circuit to verify the design. Note that CircuitLab does not support TRIACS so you will have to fudge that. Please contact the instructor if you would like to build and test the circuit. We do not have a defibrillator in the lab, but we do have safety glasses.

5. DC (SCR) lamp flasher.
The purpose of this project is to demonstrate the use of SCRs in DC circuits. Design a circuit which cycles a 12-14V, #194 lamp ON and OFF with a period of 2-3 seconds. The duty- cycle will be approximately 50%. The lamp is to be driven with a BT151 SCR from Lab stock, so your circuit must use at least one SCR. The circuit is to be operated on 14VDC from a bench power supply.

BT151 datasheet: https://www.mouser.com/datasheet/2/302/BT151-650R-350521.pdf

Lab #9 Comments on Parts 2 , 3, 4, and 5. Please read carefully.

1. You may wish to consider using a bridge rectifier. However, it is unlikely that you will find any advantage in using one with these lab projects: Since a triac can already handle AC, and since your load must operate on AC, and since a bridge rectifier is expensive and (in real life) may require a heat sink, using a bridge rectifier to carry the load current (in addition to the Triac) is a very bad idea.
2. Regarding analog switches: their use is tempting, but please remember that an analog switch (a) has a lot of series resistance and cannot handle power; (b) is relatively costly and fragile; and therefore, should only be used for appropriate, low-level, analog applications. It should not be used in place of digital logic (except in rare cases where you have one left over).
3. A resistor between the gate and MT1 is not necessary; as is probably shown somewhere on the data sheet, manufacturers put a 100 to 200 ohms in that position.
4. Because you are operating your circuits in Part 2 and Part 3 on a low-voltage transformer, and are not driving an inductive load, a snubber network and an RFI filter network are unnecessary. If this were a "real" production application, the RFI filter would be necessary whenever you are using phase control; the snubber is usually a good idea also, but protected, "snubberless" TRIACS are available. Without the snubber, TRIACS can and will randomly fire for an occasional half-cycle due to line transients.
5. Pay extra attention to your overall circuit and power supply configuration; it can get a little bit confusing.
6. You might initially muse upon using a Diac (SBS trigger diode, or "Sidac") or a in your designs. This is a very pleasant thought, but don't proceed until you carefully consider the specifications and application. The DIAC is a bidirectional part but, of course, it can also be used on DC. Unfortunately, low-voltage Diacs are no longer available, so you can't use them for Part 2 or Part 3. You should probably stick to a straightforward design using one- shots. If you have any questions about the suitability of your design, please send me a preliminary schematic.

The Unijunction or PUT (Programmable Unijunction Transistor) are sometimes an excellent choice for simple TRIAC or SCR circuits. They are unipolar, unfortunately, so their use on AC take some thought. We have 2646 UJT's available; ask. For information:

https://www.electronics-tutorials.ws/power/unijunction-transistor.html

https://www.instructables.com/Circuit-Collection-of-the-Programmable-Unijunction/

7. In most cases, your circuit will need an internal DC supply. Please do not overdesign this! At most you will need a Zener diode, a resistor, and capacitor. And maybe not even that.
8. You are **not** to use opto-coupled TRIACS or SCRs in this lab. Very sorry.
9. A current probe is very handy to view load current in phase-control applications. Any of the current probes in the lab should work OK, even the antiques. Remember: **do not clamp a current probe on an uninsulated conductor.**

In 2017, HACK- A- DAY held a contest to design the "most ridiculously complicated" lamp flasher.

The instructor's entry is here: https://www.youtube.com/watch?v=WrLFBjAWVM8