University of California Berkeley
Department of Electrical Engineering and Computer Sciences
EECS 100, Professor Bernhard Boser, Professor Leon O. Chua

LABORATORY 6 v2

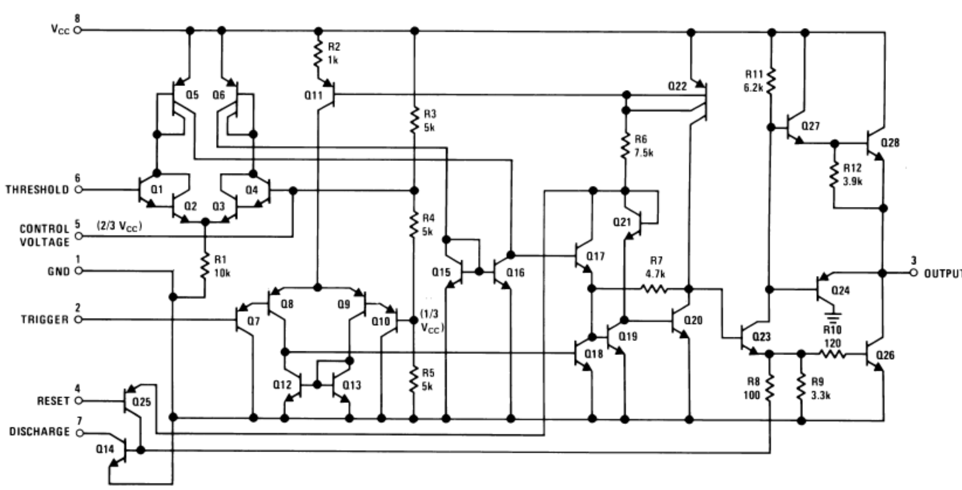
TIMERS AND OSCILLATORS

1. Timers

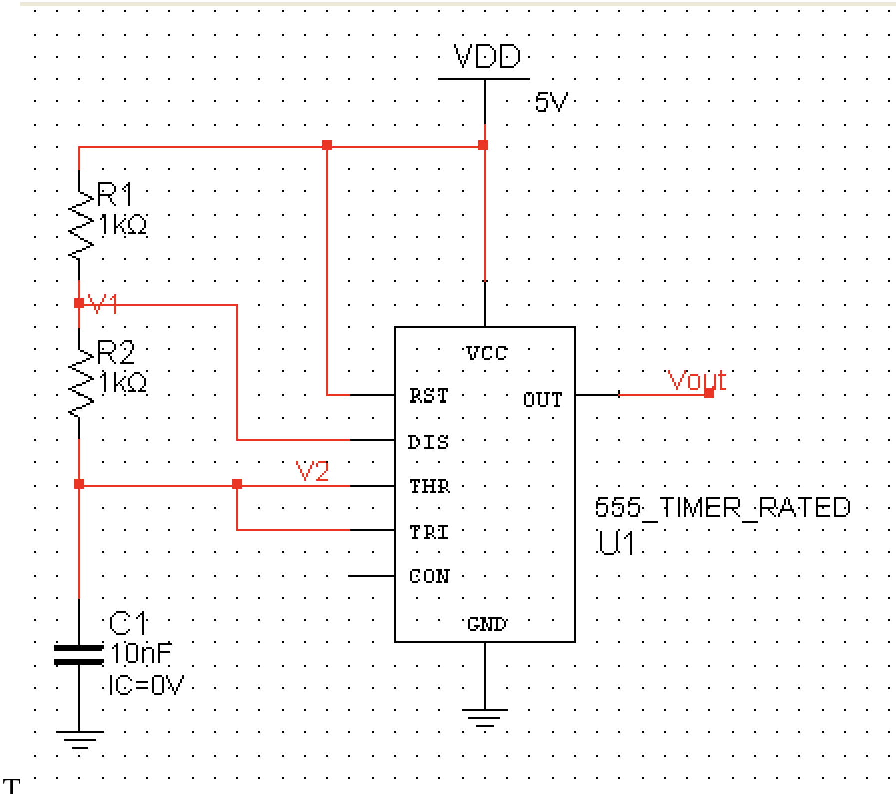
Inductors and capacitors add a host of new circuit possibilities that depend on their ability to “remember”, i.e. to store energy, and thereby signals and information. In this laboratory we will look at simple circuits that use capacitors and inductors: timers. These circuits have many uses. Applications include circuits that automatically turn off lights or equipment after a specified period, (annoying) flashers that make lights blink, or synthesizers used in sirens or electronic organs. Timers are also used by other electronic circuits, for example as computer clocks. In fact, the 555 timer circuit used in this laboratory is one of the most successful ICs ever: Designed 1970 by Hans Camenzind at Signetics (later Philips and now NXP) and introduced 1971 (the same year Intel introduced its first – 4-Bit! – microprocessor executing up to 60,000 instructions per second), sales are still strong with over 1 billion units sold each year! Tell me if you can think of other people who invented something single handedly with similar success and longevity. That Intel microprocessor has long been relegated to museums.

The notorious RC charging and discharging circuit that is at the basis of so many homework and exam problems is also at the center of many timer circuits (exams are practical, after all). For example, the time it takes to charge a capacitor to, say, ½ the supply voltage can be used to delay turning on a device. Likewise, discharging a capacitor from VCC to ½ VCC sets the time to turn a device off. Combine these two circuits and you have a clock turning on and off at a rate set by a capacitor and resistors.

Turing this simple idea into a complete electronic circuit calls for several functions in addition to the capacitor and charging and discharging resistors. Switches are used to alter between charging and discharging cycles. Comparators determine when a certain voltage level has been reached. Altogether quite a few components are needed to build that timer circuit. The 555 timer includes all these functions in an 8-pin package. The circuit diagram of the 555 is reproduced below:



Since you have not studied capacitors and inductors in lecture (yet), you will be responsible for just building two simple circuits in this lab. The first circuit is the above mentioned 555 timer circuit. The fact that you simply apply power to the chip to get a square wave output should be fascinating:



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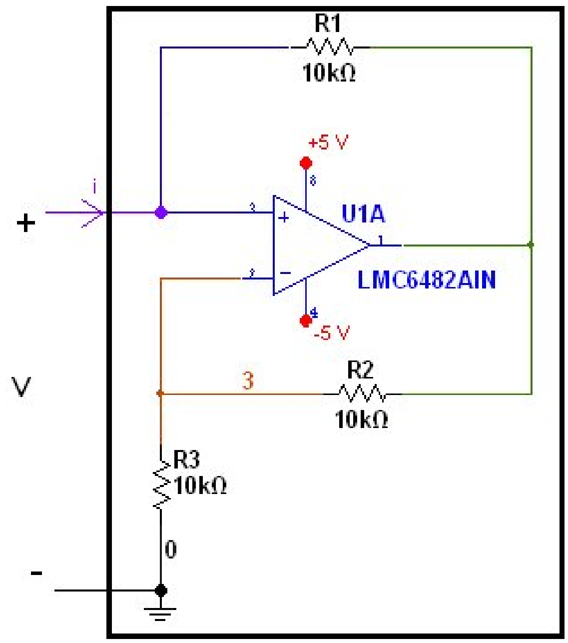
2. Oscillators: Negative Resistance Concepts

In the previous section, you saw how a timer chip can be used to build a square wave generator. An analogous approach is to use a negative resistor. You will use an op-amp to realize the negative resistor in this part of the lab. The actual details of building the oscillator will again be revisited later in lecture, after you learn about inductors and capacitors.

The circuit in the black box below realizes a negative resistor (or Negative Impedance Converter, NIC). You can see that the op-amp can be considered as a two-terminal (one-port) device.


R1
10kΩ
+5 V
i
+
U1A
LMC6482AIN
-5 V
V
3
R2
10kΩ
R3
10kΩ
0
-

LAB REPORT

Lab Session:

Name 1: SID:

Name 2: SID:

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1. Timers

1. Perform a transient analysis in Multisim to verify your square wave output. Turn in a copy a plot showing V_{out}, V_1, and V_2 as a function of time. Note that Multisim has a built-in component for the 555 timer.

Multisim output ___ of 10 **P**

2. Now build the timer circuit in the laboratory. Power it from a 5V supply and check the waveforms with the oscilloscope. Explain discrepancies with the simulation:

Comparison of circuit with simulation ___ of 3 **M**

3. Derive the i-v characteristic of the op-amp negative impedance converter. Show your work below. ___ of 10 **P**

4. Simulate the op-amp negative impedance converter using MultiSim. Using the Agilent Multimer and a DC source in MultiSim, fill in the table of values in the lab section of this report. ___ of 10 **P**

5. Build the circuit in lab. Use the + 6 V supply and the Agilent Multimeter to fill the table of values in the lab section of this report. Compare these values to the i-v graph obtained from hand calculations and the i-v from MultiSim. Explain any discrepancies. ___ of 10 **M**

PRELAB SUMMARY

Lab Session:

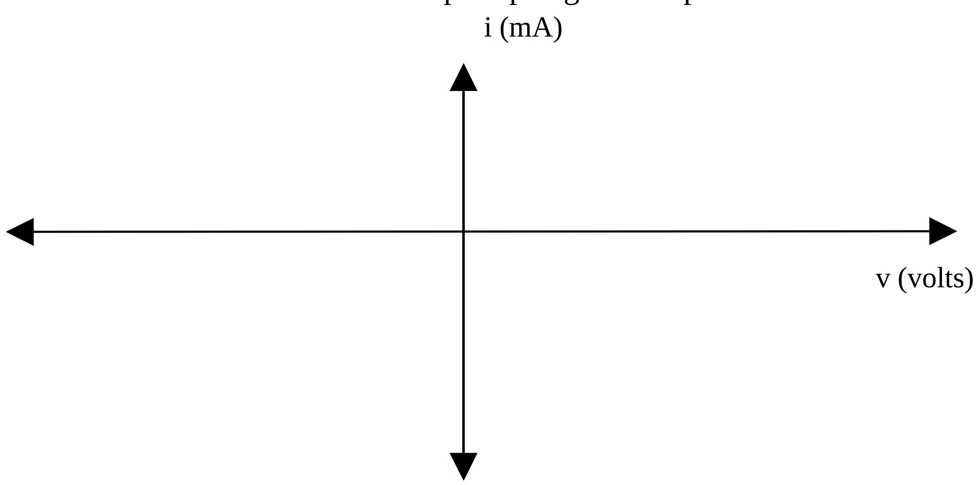
Name 1: SID:

Name 2: SID:

Summarize your prelab (P) results here and turn this in at the beginning of the lab session.

1. Attach MultiSim output of 555 timer functionality. Show V1, V2 and Vout.

2. Sketch the i-v characteristic of the op-amp negative impedance converter below.



3. Fill in the table below using the results from your MultiSim simulation.

v (volts)	i (mA)
-5.2	
-5	
-4	
-3	
-2.5	
-1.5	
-0.5	
0	
0.5	
1.5	
2.5	
3	
4	
5	
5.2	

SUGGESTIONS AND FEEDBACK

Time for completing prelab:

Time for completing lab:

Please explain difficulties you had and suggestions for improving this laboratory. Be specific, e.g. refer to paragraphs or figures in the write-up. Explain what experiments should be added, modified (how?), or dropped.