ECE 205 Lab – NE555

Challenge: 555 Timer and R-C Circuits

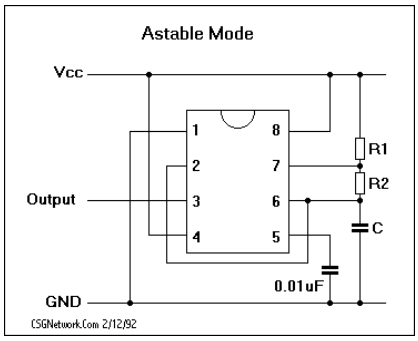
One of the oldest integrated circuits which remains popular today (40+ years after it was introduced) is the "555" timer. Try searching on "555" in Google-Images, and you will get an idea of how popular this device is.

The specific part number of 555 chip in our Kit is the LM555, and we have both Texas Instruments (LM555) and STMicroelectronics (NE555) datasheets on our Resources page on the course website.

Operation of the circuit:
The NE555 integrates the following components. First, there is an internal transistor which allows an external capacitor (denoted C) to charge and discharge. Second, there is an input called threshold to discharge the capacitor. When the voltage on the threshold surpasses .67*Vcc (where Vcc is the battery voltage, around 9 V), the transistor is put into discharge mode. Finally, there is an input called the trigger to charge the capacitor. When the voltage on the trigger is below .33*Vcc, the transistor is put into charge mode.

The NE555 when operating in astable multivibrator mode it works as follows:

Initially the capacitor is at 0 V. Because this is below the trigger voltage (.33*Vcc), the internal transistor in the 555 will start charging the capacitor through R1+R2. This forms an R-C circuit with C and Req=R1+R2. The capacitor continues to charge until it hits the threshold voltage (.67*Vcc), upon which time the 555 will start discharging. The discharge also forms a R-C circuit, but the Req in this case is only R2. When the capacitor has discharged to below the trigger voltage, the process repeats.



Challenge: Construct an astable multivibrator (oscillator) circuit, and use the oscilloscope to confirm/deny that R2 determines the discharge time, but R1+R2 determines the charge time.

- use fixed values for R2 (1k), and C (.5µF, within 20%)
- use **at least two** different values for R1. Record the waveform(s): $V_C(t)$ (from Pin 6, to GND), and Vout (Pin 3, to GND)
- Use a photoresistor for R1, and connect a speaker from Pin 3 (Output) to GND, to create a light-sensitive musical instrument.

Resources provide by the Lab:

- 9V Battery (for Vcc)
- Components required to create the astable multivibrator circuit above on your breadboard
- One earbud or headphone speaker

Prelab Deliverables:

a) Suppose you create the above circuit with R1=R2=1k, and C=.5µF. Sketch the resulting waveform (see page 11 of the TI Datasheet). What will be the period (=1/frequency) of the waveform produced by this circuit?

b) If you want to display at least two full cycles of the waveform on the oscilloscope, what should you choose as the "timebase" setting for the oscilloscope?
   timebase = time-per-division on the oscilloscope (horizontal width of each small box)
   10*timebase = one full screen
   timebase (typically) follows a 1-2-5 pattern, so you will have to pick the "best-fit"
   (…0.1ms, 0.2ms, 0.5ms, 1ms, 2ms, 5ms, 10ms, 20ms, 50ms, 100ms…)

Required Deliverables:

- Obtain sufficient data from the oscilloscope display to be able to confirm that the discharge time depends on R2, while the charge time depends on both R1 and R2.
  - Make measurements for **at least two** different values of R1.
    - Historically, one would photograph the oscilloscope screen, then make measurements (using a straightedge/scale) from an enlarged print of the photo
    - The oscilloscope has a USB port which can be used to save files. Use this feature to create good waveforms for your lab report
    - Alternatively, your TA will explain how to use BenchVue to capture the oscilloscope screen
    - Capture both the waveform of the output and the waveform of the capacitor voltage
    - Make the TA smile by making sounds with your circuit ☺
- TA signoffs (from showing your graphs - at least 4 – two sets of charge/discharge curves, and two sets of output waveforms from the oscilloscope – you can use two channels to capture output and discharge onto the same screen)

Not many integrated circuits (chips) have their own Wikipedia page (hint – it's worth reading…)

Finally, ECE 205 will not grade you on the neatness of the circuit that you build…

- Messy circuits are a nightmare to debug.

Keep it neat. Use colors to mean something. Make it look like the schematic!