Project: Electronic Cricket

• Idea:
  – Use photoresistor to detect light, only chirp when dark
  – Create sort-of-realistic cricket noise using several oscillators
  – Match to real cricket calls: google “cricket chirping”

• Potential uses: annoy people; investigate cricket social interactions (see Genetic Control of Acoustic Behavior in Crickets – Ron Hoy)

• Components:
  – Photoresistor
  – Oscillators
  – Speaker
Structure of a Cricket Call

- Field cricket:
  - Syll. frequency 4-5 kHz.
  - Syll. Repeat 35 mSec
  - Duty Cycle ~50%
  - Chirp repeat rate ~2-4/sec

From http://www.uni-graz.at/~hartbaue/introduction.html
LM555 Timer

- Used as an oscillator to drive a speaker
- **Trigger**: when \(< \frac{1}{3} \) Vcc, the output is high (Vcc)
- **Threshold input**: when \(> \frac{2}{3} \) Vcc and the trigger is \(> \frac{1}{3} \) Vcc, the output is low (0V). If the trigger is \(< \frac{1}{3} \) Vcc, it overrides the threshold input and holds the output high.
- **Reset input**: when less than about 0.7V, all other inputs are overridden and the output is low.
- **Discharge pin**: This is connected to 0V when the timer output is low and is used to discharge the timing capacitor in astable operation.
LM555 Timer as an oscillator

- Astable operation: The circuit oscillates on its own.
- With the output high, the capacitor C is charged by current flowing through $R_A$ and $R_B$.
- The threshold and trigger inputs monitor the capacitor voltage and when it reaches $\frac{2}{3}V_{cc}$ (threshold), the output becomes low and the discharge pin is connected to 0V.
- The capacitor discharges with current flowing through $R_B$ into the discharge pin. When the voltage falls to $\frac{1}{3}V_{cc}$ (trigger) the output becomes high again and the discharge pin is disconnected, allowing the capacitor to start charging again.
- Adjust duty cycle (time on : total time) by adjusting the ratio between $R_A$ and $R_B$.
- Note that pin 4 (reset) is held at $V_{cc}$ here. You will need change the connection for light sensitivity.

LM555 Timer

- Some equations for astable operation:
  The charge time (output high) is given by:
  \[ t_1 = 0.693 (R_A + R_B) C \]
  And the discharge time (output low) by:
  \[ t_2 = 0.693 (R_B) C \]
  Thus the total period is:
  \[ T = t_1 + t_2 = 0.693 (R_A + 2R_B) C \]
  The frequency of oscillation is:
  \[ f = 1/T = 1.44/ (R_A + 2R_B) C \]
  And the duty cycle is:
  \[ D = t_1/(t_1 + t_2) = (R_A + R_B)/(R_A + 2R_B) \]
LM555

- **Testing:**
  - Pick a large-ish capacitor (say 10μF), and a few different resistors (1kΩ, 10kΩ, 51kΩ, 100kΩ, etc...) or a couple of 10 or 100kΩ potentiometers (variable resistors)
  - Build the circuit to the right *without* the speaker
  - Probe the output with the oscilloscope (Do you see a square wave?)
  - Try different resistors
    - What happens to the frequency?
    - What happens to the duty cycle?

- Next, add the speaker
- Can you hear anything? Adjust the resistors (or cap) until you do
- **CHALLENGE:** Achieve a <50% duty cycle
  - Hint: you might need an additional component
Photoresistor

• Photoresistor Testing:
  – Use the Ohm meter to measure the resistance of the photoresistor.
  – Shine light on the photoresistor. What happens to the resistance?
  – What is the resistance range going from room light to complete darkness?
  – The 555 timer turns on if the voltage at pin 4 is greater than 1 volt. Build a voltage divider to connect to pin 4 which goes above 1 volt in the dark.