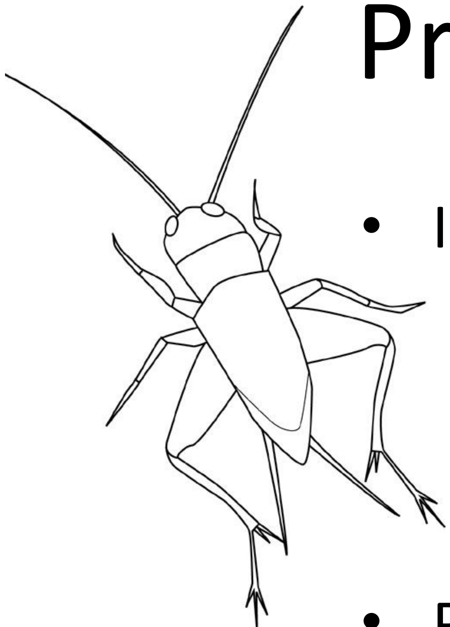
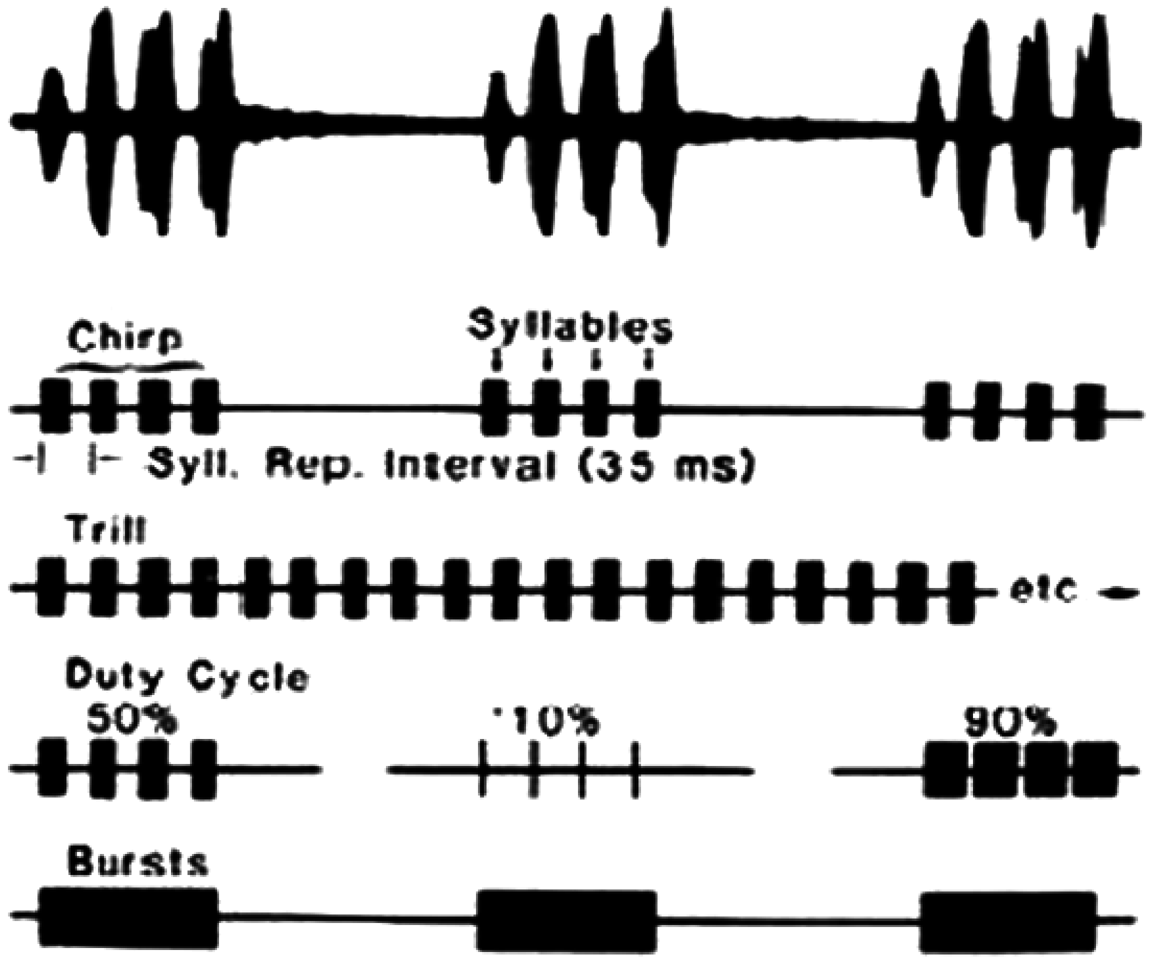
Project: Electronic Cricket



- 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

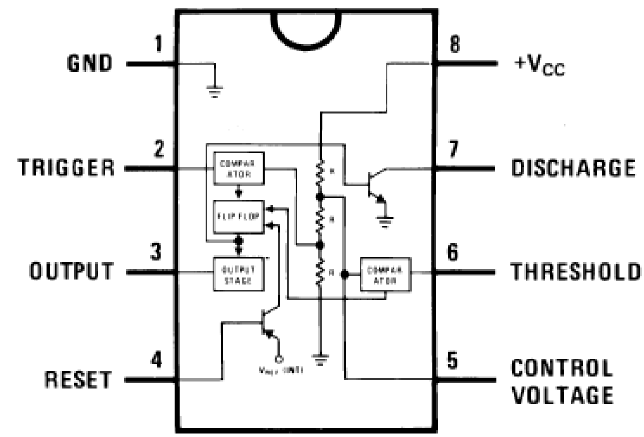
Structure of a Cricket Call

- 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

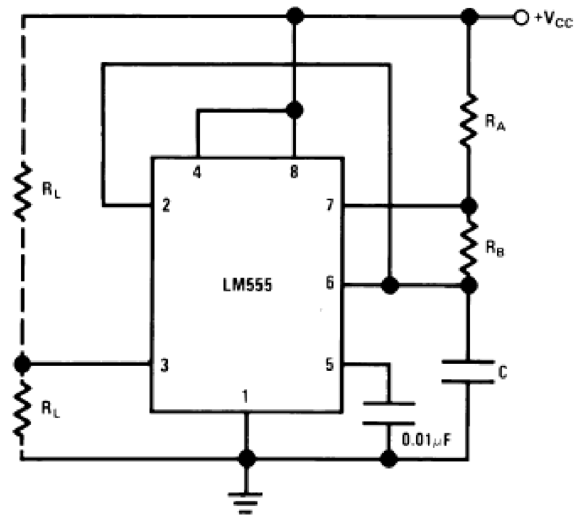
LM555 Timer



- Used as an oscillator to drive a speaker
- **Trigger:** when < $^1/_3$ Vcc, the output is high (Vcc)
- **Threshold input:** when > $^2/_3$ Vcc and the trigger is > $^1/_3$ Vcc, the output is low (0V). If the trigger is < $^1/_3$ 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

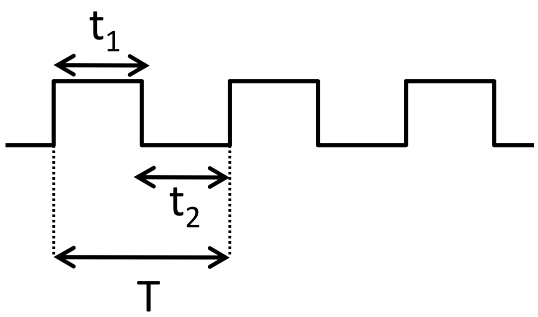
- Astable operation: The circuit oscillates on its own.
- With the output high, the capacitor C is charged by current flowing through R_A and R_B.
- The threshold and trigger inputs monitor the capacitor voltage and when it reaches $^2/_3$Vcc (threshold), the output becomes low and the discharge pin is connected to 0V.
- The capacitor discharges with current flowing through R_B into the discharge pin. When the voltage falls to $^1/_3$Vcc (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 Vcc here. You will need change the connection for light sensitivity.



From http://www.national.com/ds/LM/LM555.pdf

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:

$$T = t_1 + t_2 = 0.693\ (R_A + 2R_B)\ C$$

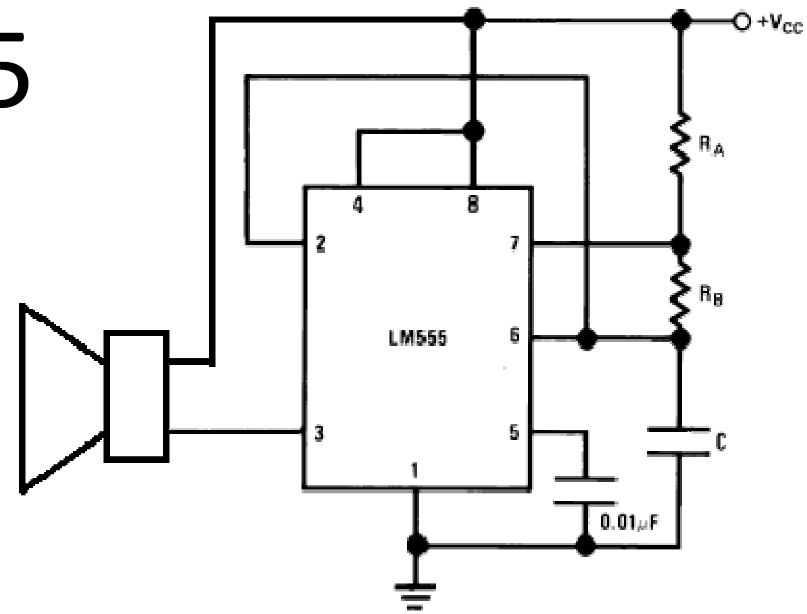
The frequency of oscillation is:

$$f = 1/T = 1.44/\ (R_A + 2R_B)\ C$$

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.