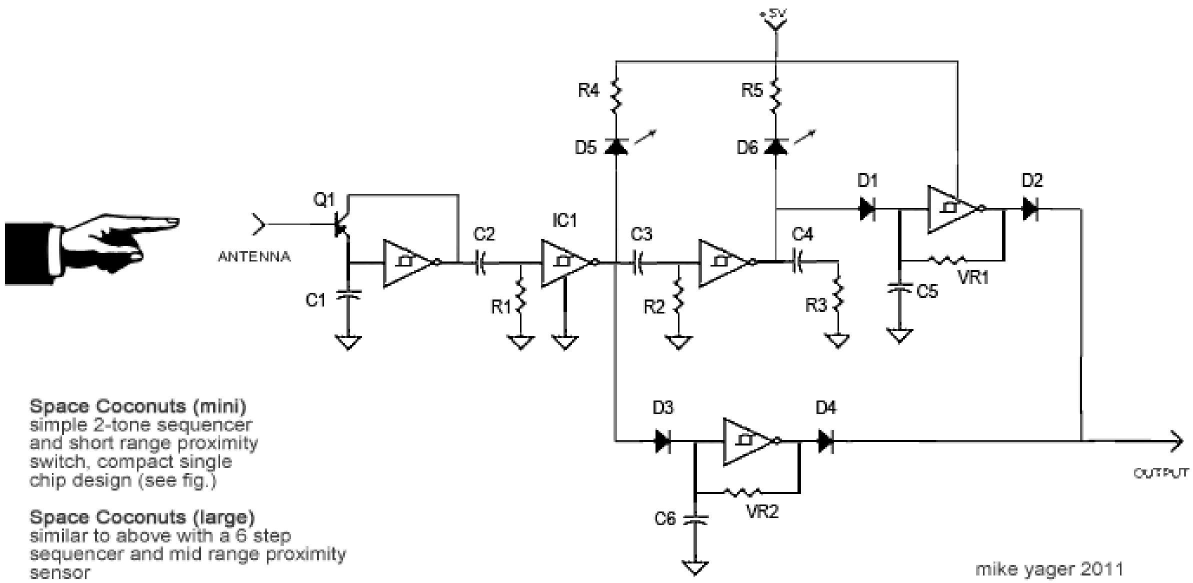
# The Anatomy of a Space Coconut

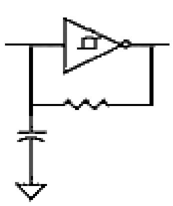
Handout 1: Theory




Parts List

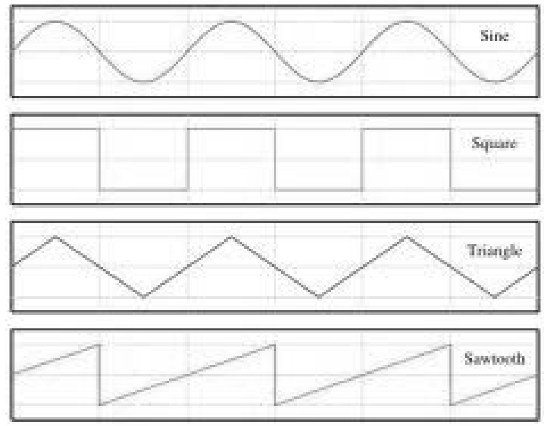
| | |
|---|---|
| IC 1……………………..… | 74HC14 Hex Inverter |
| Q1……………………..…. | Any switching/small signal NPN transistor (2n2222, 2n4401, c945, etc) |
| D1 – D4…………..…… | Any diode (1n4007, 1n914, etc) |
| D5 – D6……………….. | Any LED |
| C1 – C4………………… | 0.1uf |
| C5 – C6……………..….. | 1uf |
| R1 – R3………………… | 1M |
| R4 – R5………………… | 1k |
| VR1 – VR2…………….. | 10k Variable resistor |

The space coconuts are a good introductory project for artists and hobbyists interested in analogue electronics. Their circuit is simple to follow, has wide tolerances for part substitutions, and provides several useful design solutions.



Looking at the diagram, we can breakdown a space coconut into five separate oscillator circuits, like the **astable** oscillator pictured to the left. Handout 2 will explain the symbols used in these diagrams, the parts that they represent and practical construction; for now we will focus on the theory of operation to understand what is happening in the circuit on an organizational level.

An oscillator (or multivibrator) is a kind of circuit that makes a signal which goes back and forth between two values (on and off, high and low, positive and negative, etc.) Oscillators are very common, used in everything from clocks to space shuttles. The time it takes to switch from one state to the other is called the **period** or **frequency** of the oscillator and the pattern of that change is the **waveform**. A signal that changes states gradually would be described as a **sine** wave, while a signal that jumps from one to the other is a **square** wave. Many other waveforms are possible.




Generally speaking, there are three classes of electrical oscillators: **astable, monostable** and **bistable**.

Astable oscillators are not stable in either state (high or low) and they continuously switch between the two.
An astable oscillator with a period of 1 second may be used in to advance a clock for example, while a much faster oscillator switching 200 times per second can play a musical note (in the neighborhood of G.)

Monostable oscillators are stable in one state but not the other. When triggered, a monostable will switch to its unstable state for a certain time and then return to its stable, resting state. This kind of circuit is also called a "one-shot" and is often used to remove noise from button contacts. If my keyboard has 1 **Hertz,** or one cycle per second, "one-shot" circuits on the button inputs then no matter how fast I type the computer will only need to deal with one key stroke per second. This relieves some stress on the computer but may become frustrating for the typist.

Bistable oscillators are stable in both states and switch from one to the other only when triggered. Bistable or "flip-flop" circuits can be used to store information and are the basic building blocks of digital memory circuits and computers. Space coconuts, however, do not believe in flip flopping and so these circuits will not be further discussed.

The coconut circuit begins with an astable oscillator that acts as a proximity sensor. The period of this oscillator is controlled by the distance of participants (or any other large, conducting mass) from an antenna. At rest, the oscillator cycles once every 2 minutes or so but the nearer the participant is, the faster it switches.

Each pulse from the sensor oscillator triggers a chain of monostable oscillators. One monostable switches on for about a second and then turns off, triggering the next monostable in line. The small coconuts have two monostables while the larger ones have a row of six. During the second that each monostable oscillator is on, it lights an LED and also turns on another astable oscillator.

These secondary astable oscillators are much faster. They produce audio frequency signals that can be tuned to any musical note. Every monostable in the chain above has a paired astable audio oscillator so, like a music box, they play a set series of notes.