The Secret Knowledge

Written by Avery Louie
Contributions by Neal Singer and Kevin Mehall

October 5, 2011

Abstract

A compilation of Secret Knowledge documentation. What is the secret knowledge?
According to this email:

"Do you want to make stuff? Cool stuff? Blinking LEDs? Robots? Flying machines?
We will give you all the secret knowledge you need, and help you succeed at finishing projects."

The Secret Knowledge is about learning how to make cool stuff. The idea of this document is to show you some of the things we have made so you can either try to make them, or learn from them. This document does sometimes assume you know how to breadboard or how to use certain components, but as time goes on there will be sections on that as well.
Each chapter can also be used as a handout for some sort of club or lecture series

Chapter 1

The Time is Now? (A blinky light with a 555 timer)

1.1 The Time is Now?

The time to make things is always NOW. Don't wait to do it later, just jump in and start right here, right now. This tutorial will teach you how to set up an IC called a 555 timer as an oscillator, and use it to blink an LED at a frequency you can see.

1.2 Components

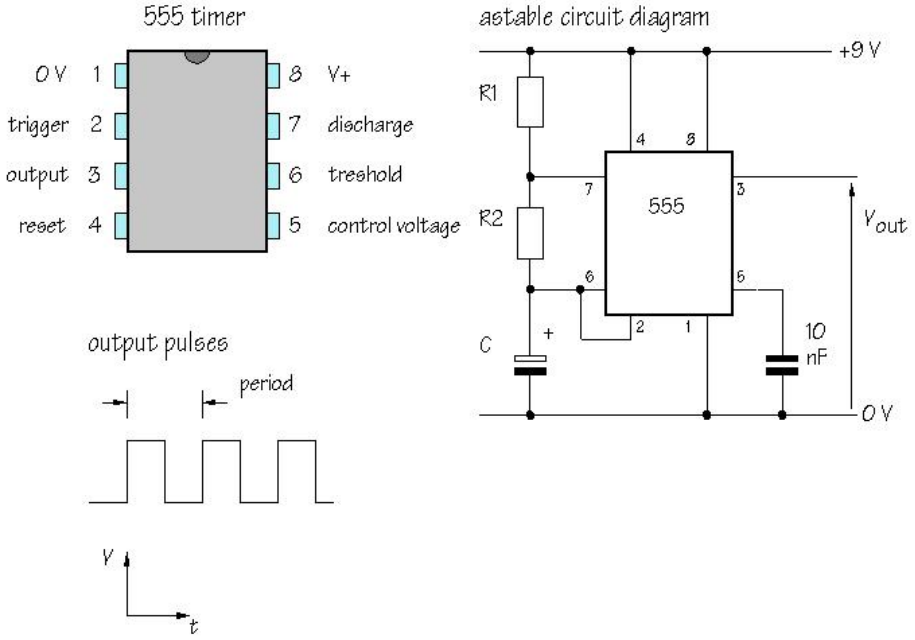
Name	Quantity	Digikey Part No.
1M Ohm Resistor	2	CF18JT1M00TR-ND
1M Potentiometer	1	3352W-105LF-ND
.1uF capacitor	1	478-1831-ND
555 Timer IC	1	7-1963-5-ND
Red LED	1	160-1034-ND
Some wire	some	get it not from digikey

You will also want a breadboard and a power supply (sources for this later).

1.3 Circuit Diagram

This is the circuit we will be using, but we are ommitting the 10nF capacitor on pin 6, and we are going to use +5V power. This image also shows how the pinout of the chip matches up to the pins on the schematic, which is drawn in the European style. For reference, pins are labeled by orienting the notch in

Figure 1.1: The diagram for the circuit, from http://www.doctronics.co.uk



the chip to the "top", then starting on the upper left hand pin and counting the pins counter clockwise, starting with 1. For our purposes, R1 and R2 will be 1 M ohm resistors, and C will be the .1uF capacitor. 3 is the output pin, and should be connected to the anode of the LED, and the cathode should be connected to ground. The cathode is the short lead.

1.4 What does it do?

This is just an good way to learn to breadboard, and to create something cool. The inner workings of the 555 are well documented here: (http://www.falstad.com/circuit/e-555square.html), but are beyond the scope of this project. Very generally, what we are doing is charging capacitor C until it is full and the voltage on pins 6 and 2 reaches some threshold voltage, at which point C is dischaged through R2 into 7. This cycle of charging and discharging turns pin 3 on and off, and the values or R1, R2 and C deterime how fast that happens.

1.5 Further Experimentation

In the componentes section, there is a part number for a potentiometer, or variable resistor. This is a resistor that changes its value based on a dial or

knob that you can adjust. Try replacing R1 or R2 with the potentiometer. For this application, you want to connect the middle pin and one of (it doesent matter which) of the outside pins to the places where the resistor would have gone. Try changing the resistance. What does it do?

Chapter 2

Servos

2.1 Servos

Servos are actuators that control the position of a rotary shaft. Basically, you tell it what angle to move to instead of what speed or tourque to go at. Instead of going into how servos work, the goal is to learn how to operate a servo with PWM. We will build on the previous excersise with 555 timers and build a servo controller.

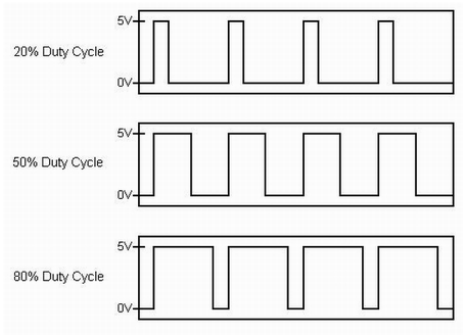
2.1.1 PWM???

PWM stands for Pulse Width Modulation. That just means that we are changing the length of the pulses sent. A PWM signal can be described with two parameters: duty cycle and frequency. Frequency is how many "cycles" of on and off to happen in one second. That is, if the pulse is high for 5ms, and low for 5ms, it takes a total of 10ms for one cycle. That means 100 cycles would happen in 1 second, so the frequency is 100 Hz (100 cycles per second).
Duty cycle is the ratio of on to total time per cycle. In the previous example, the pulse was high for 5ms and low for 5ms. That means the on time is half the total time of the cycle, meaning it has a 50% duty cycle.

2.1.2 Servo Control

Servos like to have a frequency of 20-50Hz (I like to stick to 20). They don't really care about the duty cycle, but they do care about the width (time) of the high pulse. Generally, .9 ms pulses set the servo to its "lowest" position, and 2.1 ms pulses set it to its "highest" position. These positions are different angles that the servo turns to. The goal here is to create a control circuit for a servo with a 555 timer. This presents a large problem, because a 555 has a minimum duty cycle of about 50%, and the servo needs a duty cycle of 10% (at 20 hz).
We solve this problem with an inverter built out of a transistor. This lets us

Figure 2.1: PWM duty cycles, from http://zone.ni.com



swap the up and down times on the pulse, so a 90% duty cycle becomes a 10% duty cycle, but with the same frequency.

2.2 Components

Name	Quantity	Digikey Part No.
5.1M Ohm Resistor	1	CF14JT5M10CT-ND
1M Potentiometer	1	3352W-105LF-ND
10K Ohm Resistor	1	P10KW-1BK-ND
.1uF capacitor	1	478-1831-ND
555 Timer IC	1	7-1963-5-ND
NPN transistor	1	2N3904TFCT-ND
Servo	1	get from hobby king or other hobby supplier
Some wire	some	get it not from digikey

2.3 Circuit Diagram

This poorly drawn diagram is more or less the same as the previous project, except at R2 has been replaced by a potentiometer, and additional circiuitry has been added to the output. To connect the servo, you need to figure out which wire is for ground, which wire is for power, and which wire is for signal. If your servo doesent have documentation on it, google it or use the convention that black/brown is ground, red is power, and whatever is left is signal. In this diagram, signal is the middle wire.
As far as connecting the transistor, you should check out the datasheet. A useful graphic is provided here:

Figure 2.2: Badly drawn circuit diagram

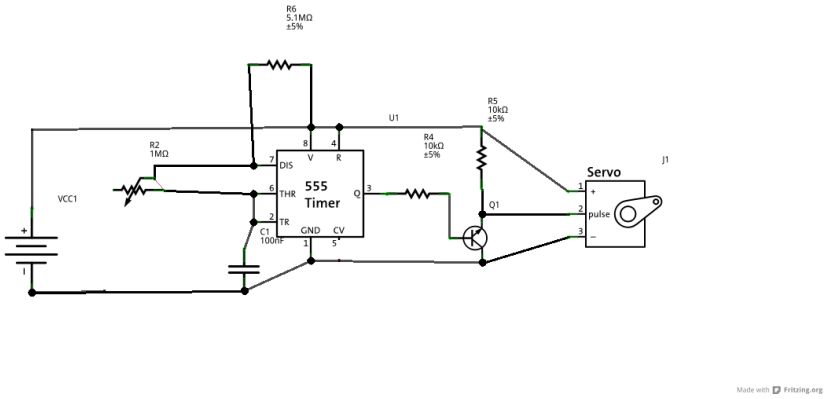


Figure 2.3: NPN transistor. C stands for collector, B for base and E for emitter