[Evil Mad Scientist Three-Fives Timer Kit]

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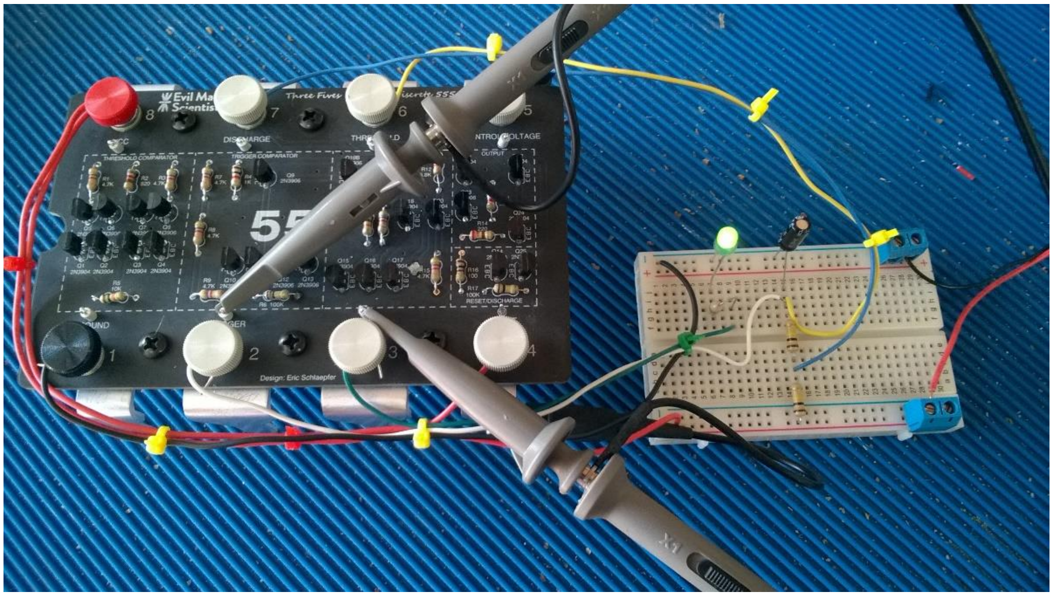
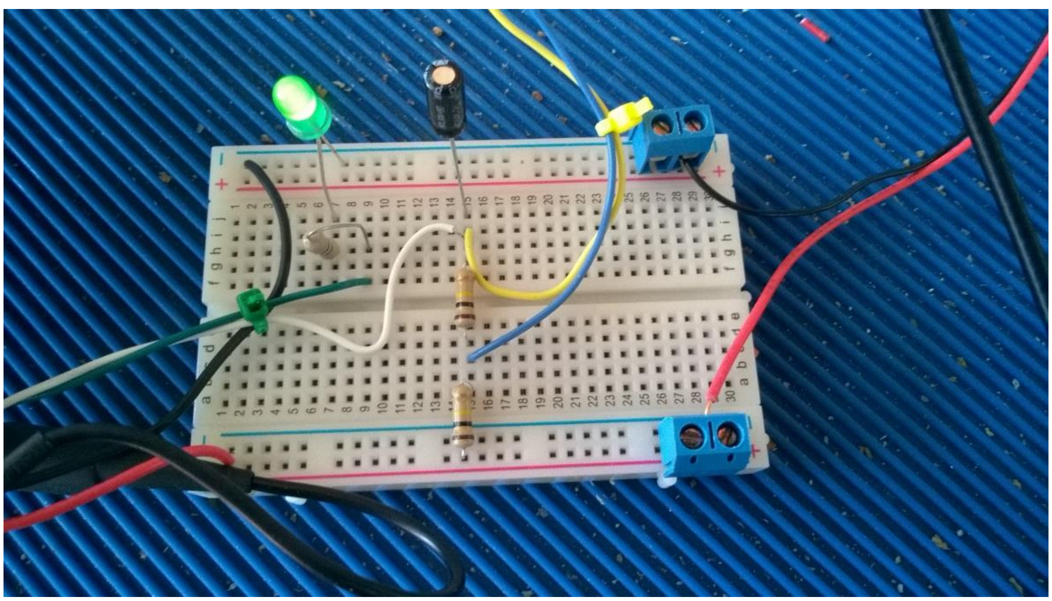


Demo 1: My Three-Fives Kit and Astable circuit (below).



When the 555 timer is configured to be in ASTABLE mode, it produces a constant square wave. Figure 1 shows the RC calculator. It predicts the pattern of the output signal. C_1 charges through R_1 and R_2 but discharges ONLY through R_2. That is why the ON time is longer than the Off time.

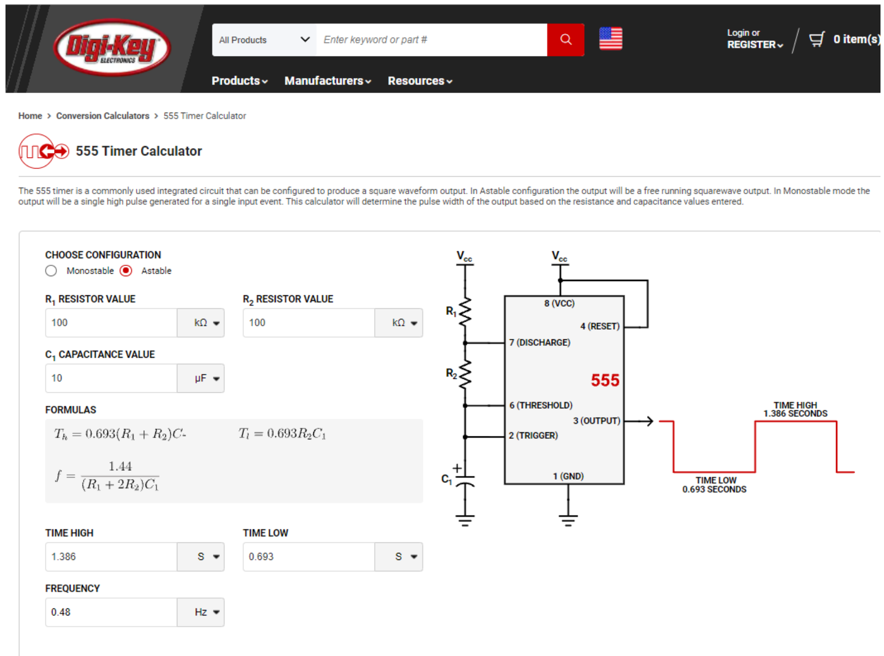


Figure 1: The calculator shows the on/off time and frequency when the 555 is in "Astable" mode. That means it is producing a square wave.

This timing pattern is readily visible in Figure 2. Also notice the actual duty cycle measures 1.6 sec but the calculated time is 1.38 sec. Keep this in mind when choosing components. The calculator assumes extremely high accuracy for the resistors and capacitor.

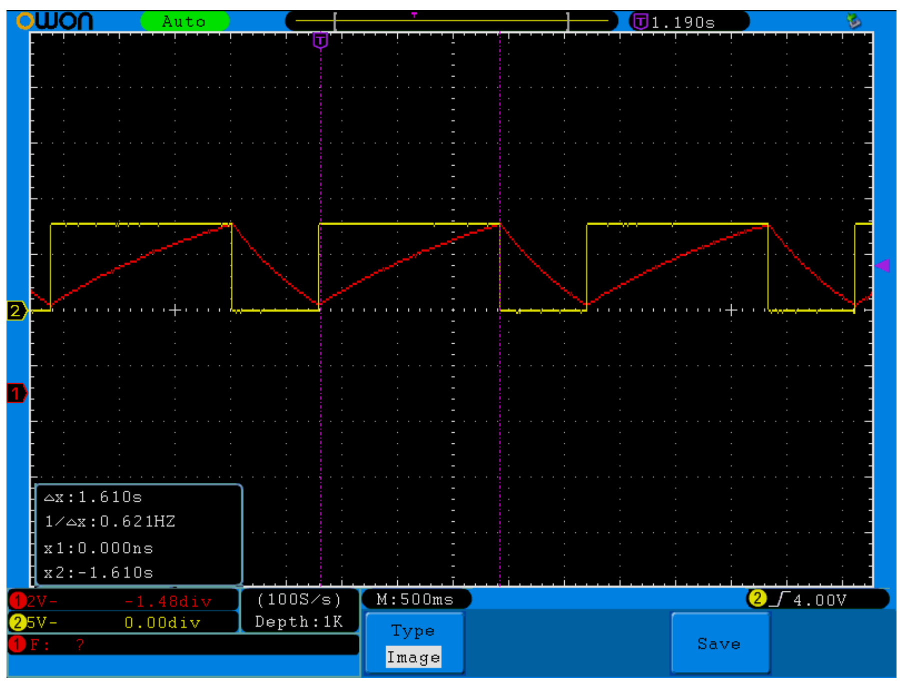


Figure 2: Duty cycle = 1.6sec. Red trace is the Trigger pin and shows capacitor charging/discharging.

Figure 3 shows the OFF time is .78 sec while the calculated time is .69 sec. For our purposes, these discrepancies are insignificant.

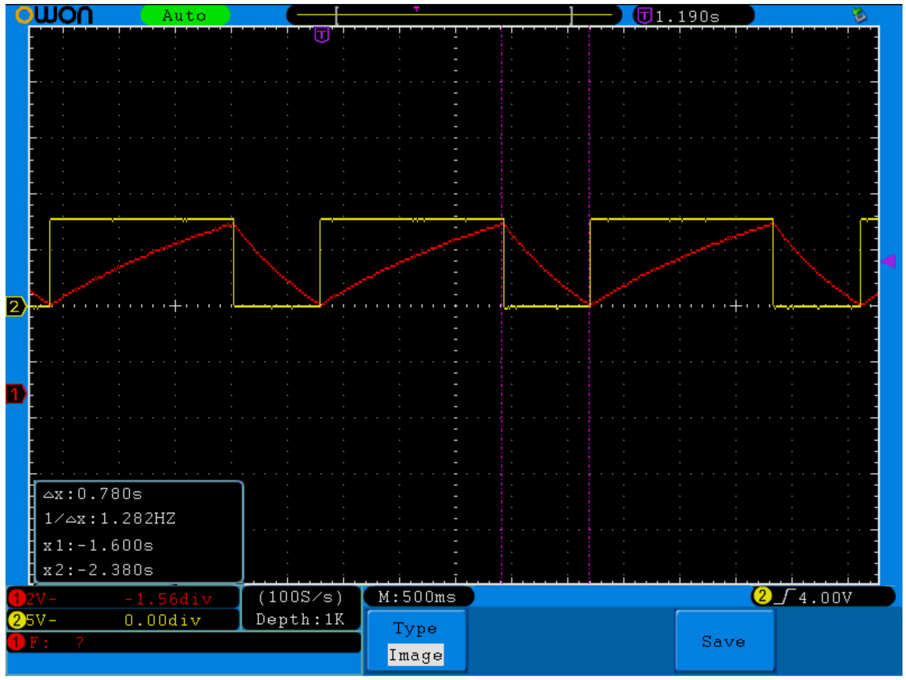


Figure 3: Here the OFF time is .78sec

Digging Deeper

Figure 4 shows a "blinky" circuit simulation in Multisim. In this example, C_1 charges via R_1 and R_3. When C_1 is 1/3 charged the IC is triggered (Pin 2) and the LED turns on. Pin 4 monitors the voltage on C_1 and when it reaches 2/3 of max charge it turns the output off (LOW).

C_1 is discharged via R3 on pin 7 (discharge). Inside the IC there is a transistor that, when turned on, grounds pin 7 and that is how C_1 discharges.

When the voltage on C_1 drops to 1/3 its capacity, pin 7 is turned off and the charge cycle repeats.

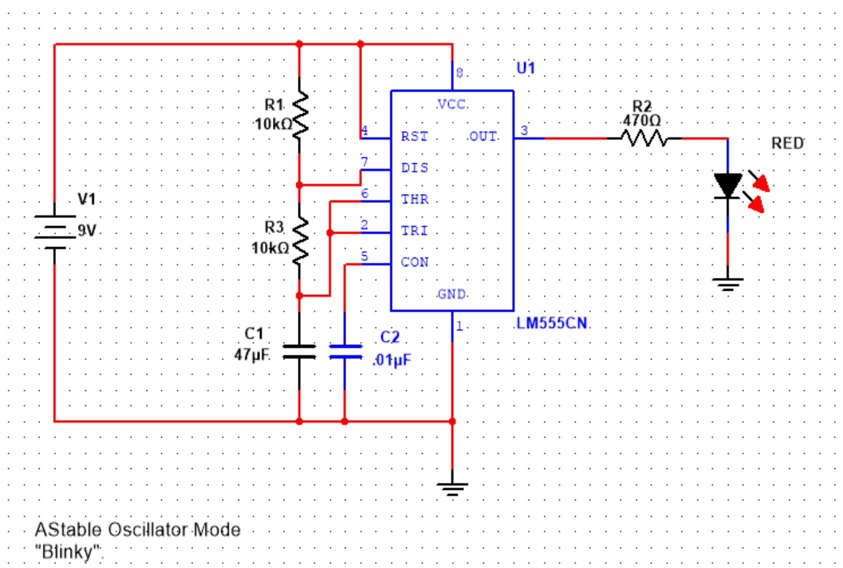


Figure 4: "Astable" Mode. The combination of R1, R2, & C1 determine the blink rate of the LED.

Now look at Figure 5. This shows the output signal on pin 3. Notice the duty cycle is > 50%. That is because the capacitor (C1) charges through BOTH R_1 & R_3 but only discharges through R_3. So even though my resistors are both 10K, the "ON" time is twice that of the "OFF" time. We will look at an alternative circuit in a moment that will show how to get around this limitation.

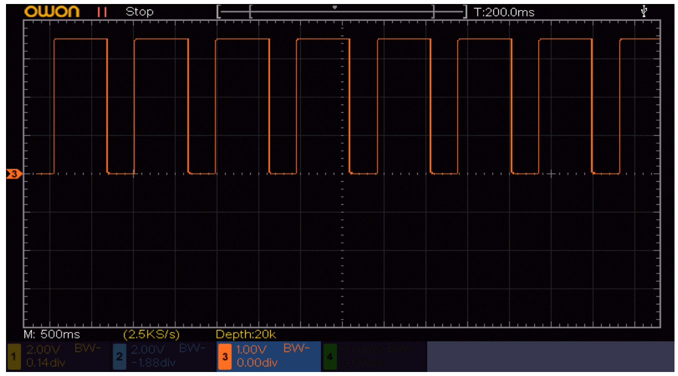


Figure 5: Scope image of the output from LM555 in Astable mode.

Blinky Version 2

Now let's examine this variation of the original circuit. If you want the duty cycle of the timer to be 50%, then we need to make sure that the capacitor is charged and discharged through the same value resistor. Look at Figure 6.

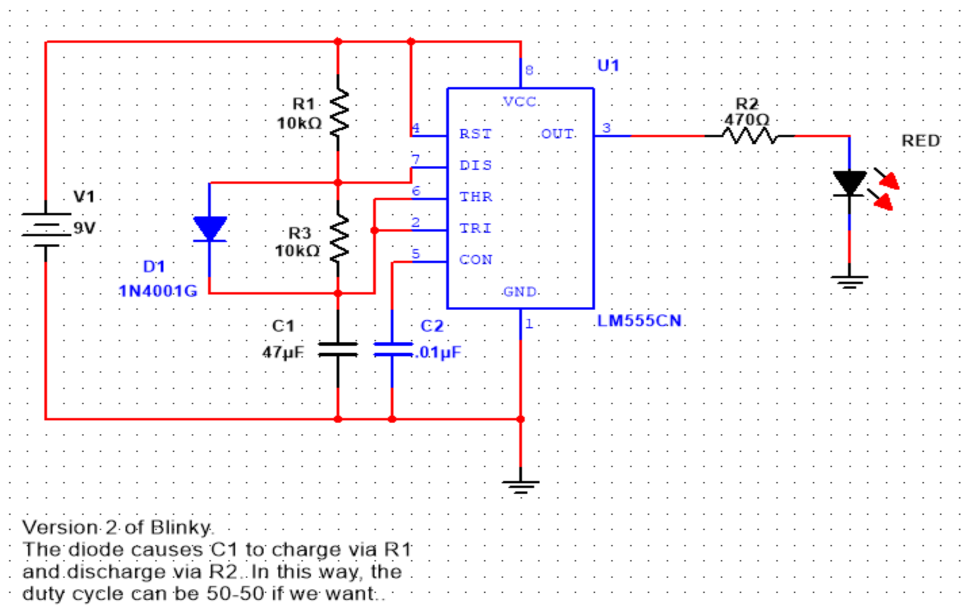


Figure 6: This shows the "Blinky" circuit set up to run at a 50% duty cycle. The addition of D_1 allows C_1 to charge through R_1 and discharge through R_3. Since they are the same value, the duty cycle is 50%.

I added a silicone diode across R_3. When power is turned on, current flows through R_1 to C_1. R_3 is taken out of the circuit by the conducting diode. If you use a diode, use these formulas:

T_{Period} = .7 X (R1 +2R3) X C1
T_{high} = .7 X R1 X C1
T_{low} = .7 X R3 X C1

When the timer stops, C_1 is discharged through R_3 only because D_1 is reversed biased. Thus, the "ON" and "OFF" periods will be the same (Figure 7). Now we can see the relationship between the RC time constant and the output wave form. The RC charge time and discharge time are equal.

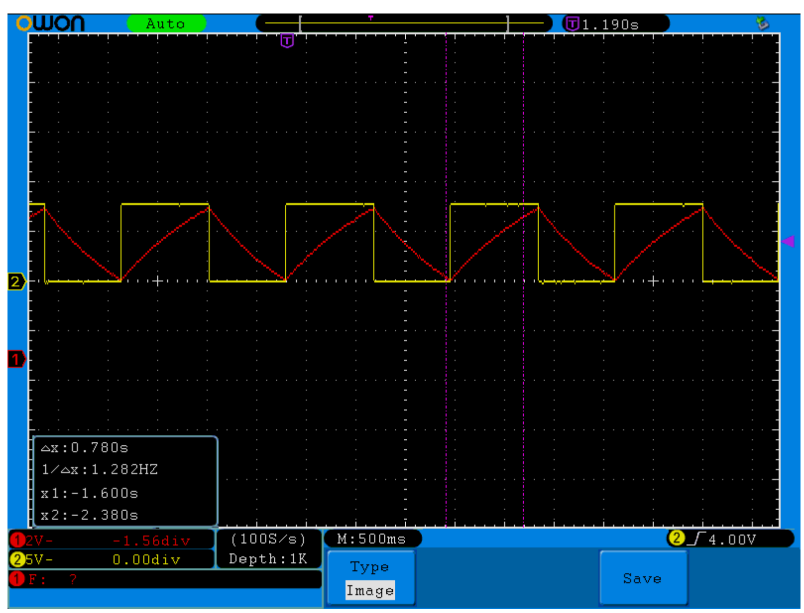


Figure 7: Here the square wave has the same ON and OFF time because the diode prevents the capacitor from charging through both resistors.

Figure 8 is a photo of the 1N4001 silicone diode in the circuit. Notice the diode is *reversed* biased. The cathode (-) lead is connected to the positive (+) lead of the capacitor. This is what allows the capacitor to charge *and* discharge through only one resistor. As long as the resistors are of equal value, the ON/OFF times will be the same.

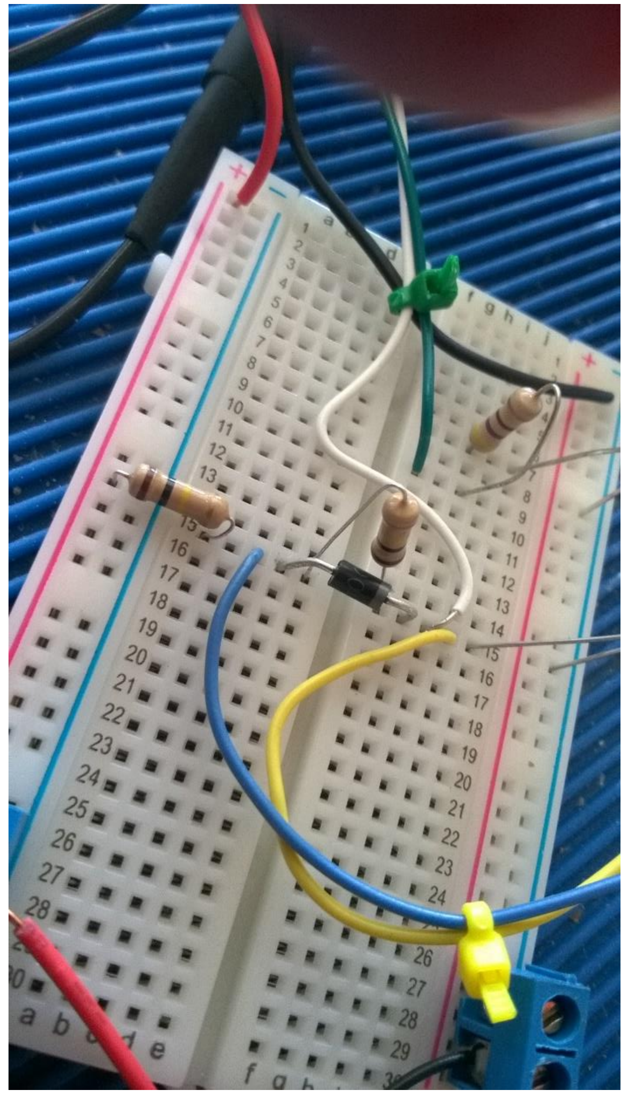


Figure 8: Image of my circuit with a diode across the output resistor in the voltage divider. This prevents the capacitor from charging through both resistors and only discharging through one of them.