Wednesday, November 1, 2023

Extended NE555 Timer Circuits

Overview

- The goals for this project:
  - To explore four projects, two using additional hardware.
  - Ganging two NE555s together for additional functions
    - Switching a flashing signal off and on
    - Making a Siren
  - To extend the functions of the NE555 timer with digital counter IC
    - CD4017 counter to display a progressive row of lights - “Night Rider”
    - CD4060 counter to extend the timer’s range to *days.*

What you’ll need - I’ll supply anything you don’t have.

- Everything you had before plus the following:
  - 10 (or 11) LEDS
  - 11 (or 12) 1 kOhm resistors
  - At least 11 jumper wires
  - (Optionally) A second breadboard
  - 1 2n3904 NPN transistor or equivalent
  - 2 10 kOhm resistors
  - 1 0.1 uF capacitor

I’ll also be supplying a CD4060, a binary counter; and a CD4017, a decade counter. I can also help you out with anything else you might need for these projects.

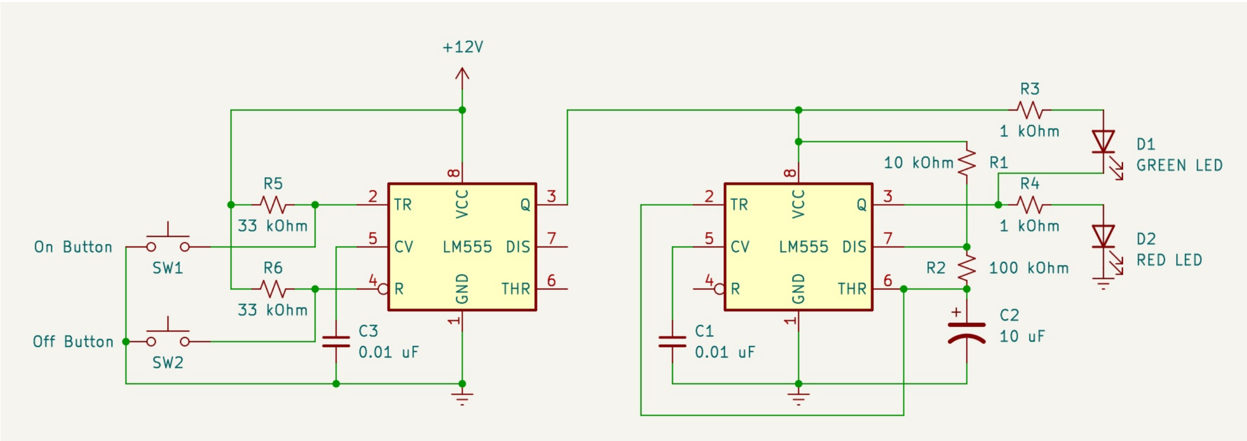
First, some observations about the 555

- When the 555 is started in the Astable mode, as an oscillator, the first cycle is longer than the rest because the timing capacitor is sitting at Zero voltage and needs to charge all the way to 2/3 of the supply voltage. After that, the capacitor only charges and discharges between 1/3 and 2/3 supply voltage.
- Pulling pin 2 low causes the output, pin 3, to go high.
- Pulling pin 4 low, the reset pin, causes the output, pin 3, to go low.

- When pin 3, the output pin, is low, pin 7, the discharge pin, is active - i.e. it provides a path to ground and thus discharging the timing capacitor.

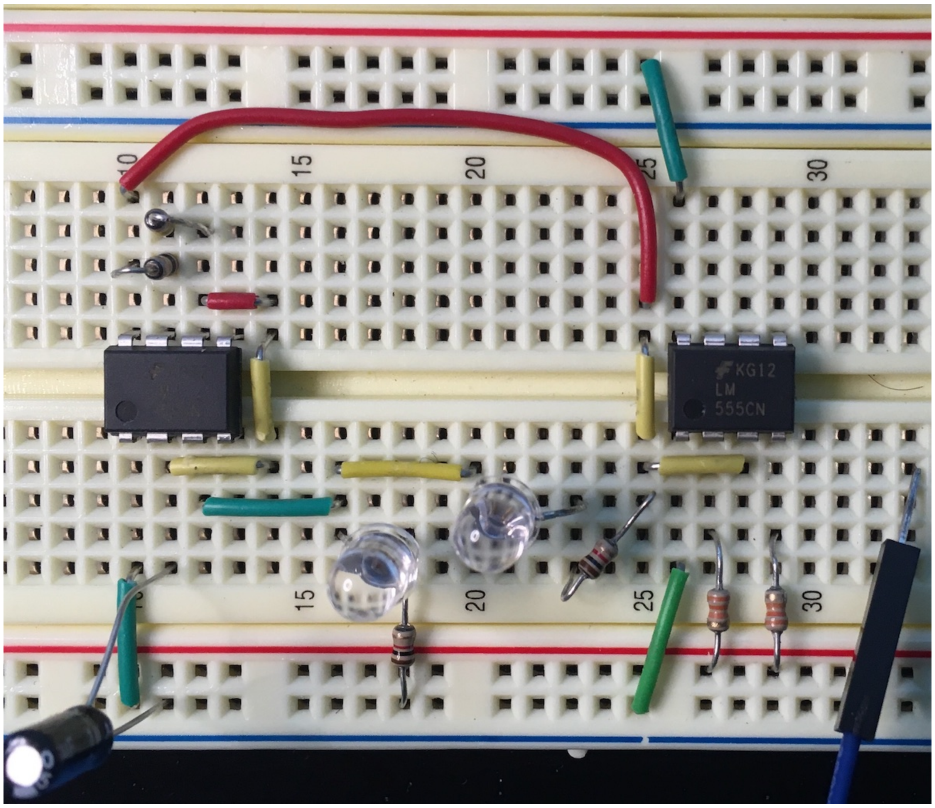
Switching the flashing signal from the previous project, off and on.

- For this project, we're going to start with a simple Red and Green (or Red and Red) flashing circuit like the second project from the last session.
- Then we're going to add toggle circuit like the third project from last session.
- Beyond that, we're actually making very few changes except to remove the LEDs from the switching circuit and use that circuit to power the first, flashing circuit.
- Here's the schematic:



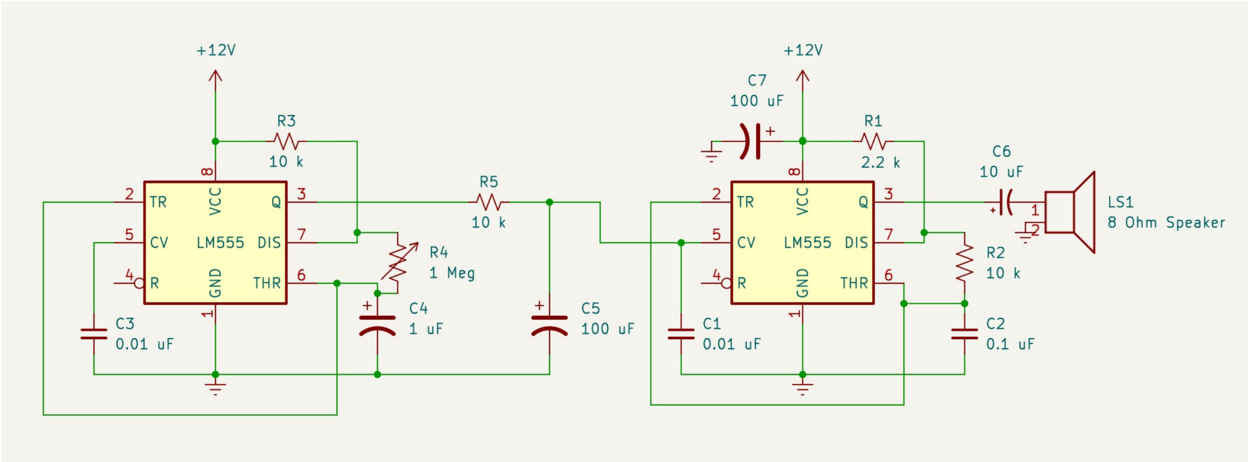
- In this circuit, the controlling 555 is on the left. That toggles the Output pin On or Off.
- The 555 on the right is exactly like the one we built before except that it gets its power, the 12 volts, from the output pin of the first 555 instead of the 12 volt bus.
- Why do this? Well, this is a very sensitive circuit and once toggled, it stays in that state until it is toggled off.

- Here's a picture of that circuit. Note: The 555s are backward. The controlling 555 is on the right. I just added it there because the flashing circuit was already on my breadboard.

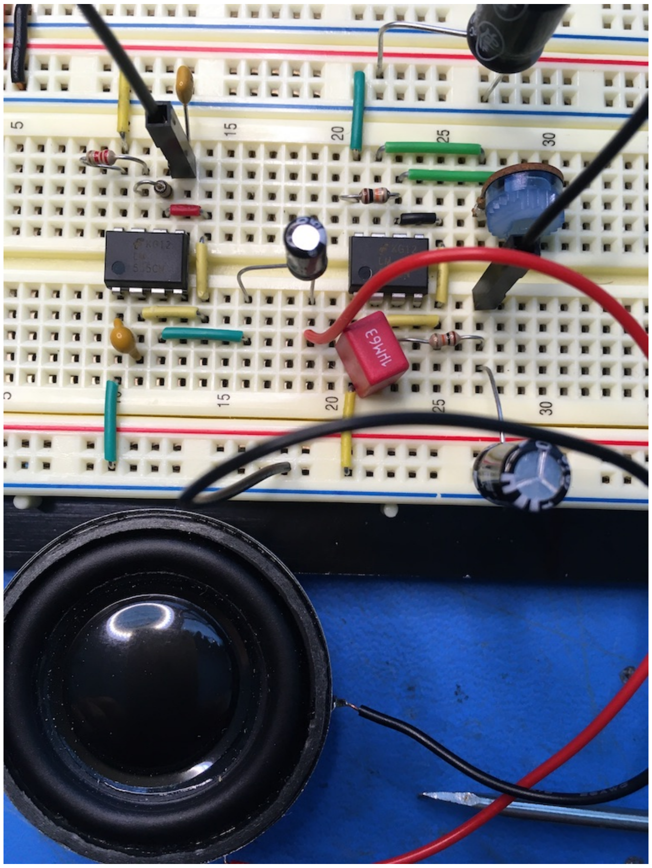


A 555 Siren

- Up to now, we haven't touched pin 5 except to put a capacitor from that pin to ground.   Now, however, we're going to use that pin to vary the frequency of the oscillator
- In the schematic that follows, you'll see that both 555s are oscillators. The one on the left is a slower on that we made before (with a 1 Meg resistor between pins 7 & 6).
- The output of that 555 is directed, via a RC circuit, to pin 5 of the 555 on the right.
- Here's the schematic:
- Also note that there is a large value electrolytic capacitor from the 12 volt bus to ground. This is necessary to stabilize this circuit.
- Otherwise, the resistance values shown are chosen to produce an oscillation somewhere around 750 Hz.



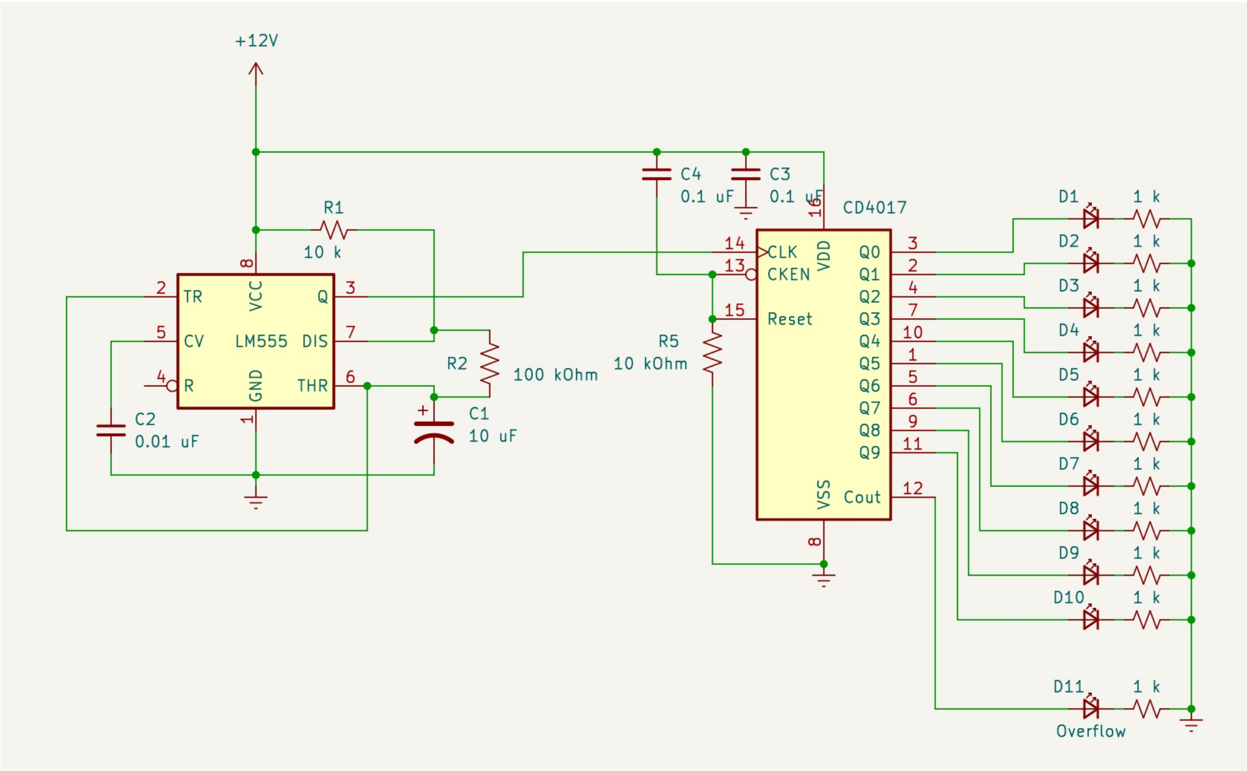
- Here's a photo of that circuit.



- Like before, this breadboard circuit is “backwards” for the same reason.
- It actually works pretty well.

Counting to 10

- For this project, we'll need the following:
  - NE555 timer
  - A CD4017 decade counter
  - 11 - LEDs, any color
  - 12 - 1 kOhm resistor
  - 2 - 10 kOhm resistor
  - 1 - 100 kOhm resistor
  - 1 - 10 uF Electrolytic capacitor
  - 2 - 0.1 uF Capacitor
  - 1 - 0.01 uF capacitor
  - Lots of jumpers jumpers
- Here's the schematic



- Here, instead of taking the 555 output to drive an LED, it serves as the clock input to the decade counter chip, CD4017.
- The wiring is relatively straightforward.
  - Make the 555 timer as before for a single blinking LED except don't include the LED!
  - Plug in the CD4017 chip on the board and connect the power pins, pin 16 and pin 8, to the 12 volt and ground respectively.

- Also put a 0.1 uF capacitor, C3, from pin 16 to ground. This stabilized the counter.
- Attach a 0.1 uF capacitor, C4, to pin 13/15 to the 12 volt bus.
- Attach a 10 kOhm resistor between pin 15 and ground and then connect pin 13 to pin 15.
- Now, attach the pin3 output pin of the 555 counter to the input CLK pin, pin 14, of the CD4017.

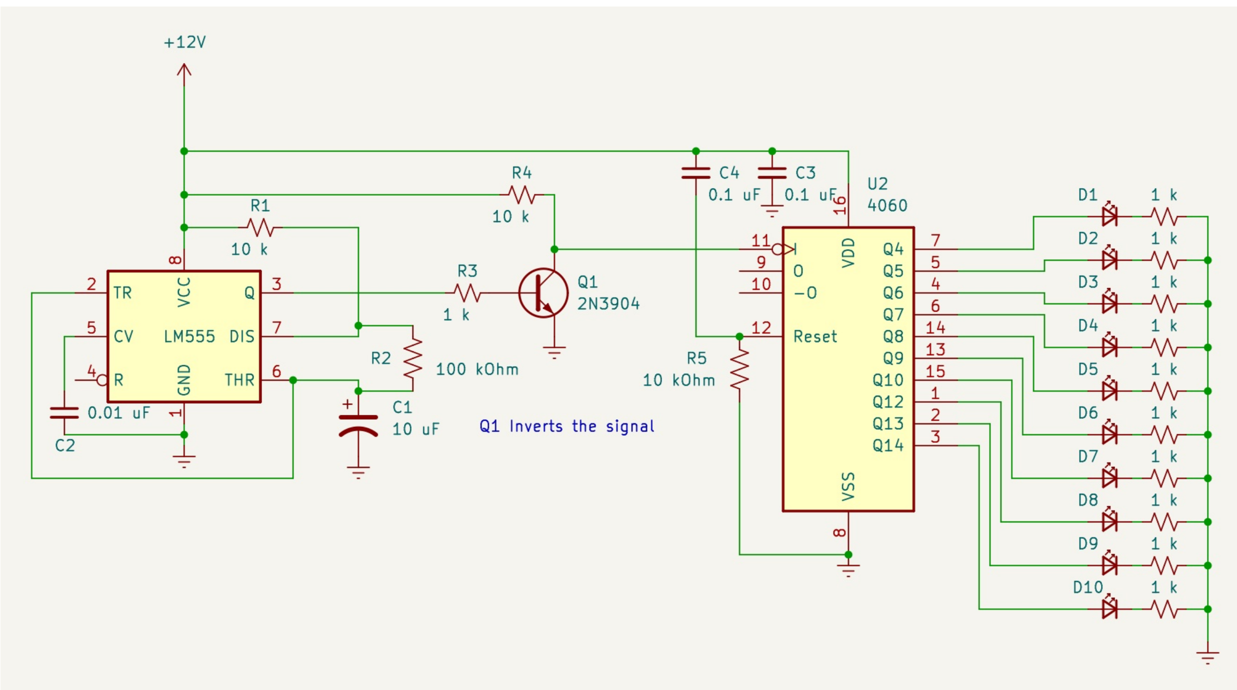
- Now for the display part.
  - On a separate breadboard if you have one, attach 11 LEDs across the center trough. Make sure the long leads are all on the same side.
  - Now, attach a 1 kOhm resistor between each LED's cathode (short leg) to the ground bus line.
- Finally connect each LED's Anode side, (the long leg)
- I should warn you at this point. The output pins on the CD4017 are NOT in any particular IC order. Pay attention, therefore, to which LED goes to which pin.
- Also, to complete the LED wiring you have to connect the Ground Bus (blue) to the main circuit board Ground bus.
- To change the rate of the counter, just change the capacitor, C1 to a larger (to make it slower) or smaller (to make if faster) value.

A Binary counter

- For this project, we'll be using many of the components we used in the last one but we'll be substituting a different counter - a CD4060
- This counter is technically called a "ripple counter" in that each stage, when reset to zero, increments the following stage. As a result, each successive stage divides the count by a factor of 2 according to the following scheme:
  - 1 - 2
  - 2 - 4
  - 3 - 8
  - 4 - 16 (this is the first stage with an output on this IC)
  - 5 - 32
  - 6 - 64
  - 7 - 128
  - 8 - 256
  - 9 - 512
  - 10 - 1,024
  - 11 - 2,048 (no output of this stage of the count on this IC)
  - 12 - 4,096
  - 13 - 8,192
  - 14 - 16,384
- This means you can multiply the time between each "click" by up to 16,384 times! It all depends on which output you chose to monitor.
- There are a few other things about this particular IC that are important to understand.

- First, it's input is "inverted" which means that it counts each time the input goes from High to Low. That's opposite of the last processor. To account for that, we have to add a "pre inverter" to the pulse coming from the 555 counter.
- Second, as I've mentioned, some of the stages do not have output pins associated with them. That really isn't a big deal because you can either speed up or slow down the input clock to account for the outputs you do have.
- Third, this particular IC actually has an oscillator, like the 555, built right into it. We're not going to use that for this project but suffice to say, you can use this binary counter all by itself. Pins 9 and 10 are used for the oscillator RC circuit.
- Lastly, this counter will also work with a crystal controlled clock source. That allows extremely good accuracy. With a single crystal cut to 32,768 Hz, we can produce an output that is EXACTLY 2 Hz or 0.5 seconds per pulse. You can keep time with that!

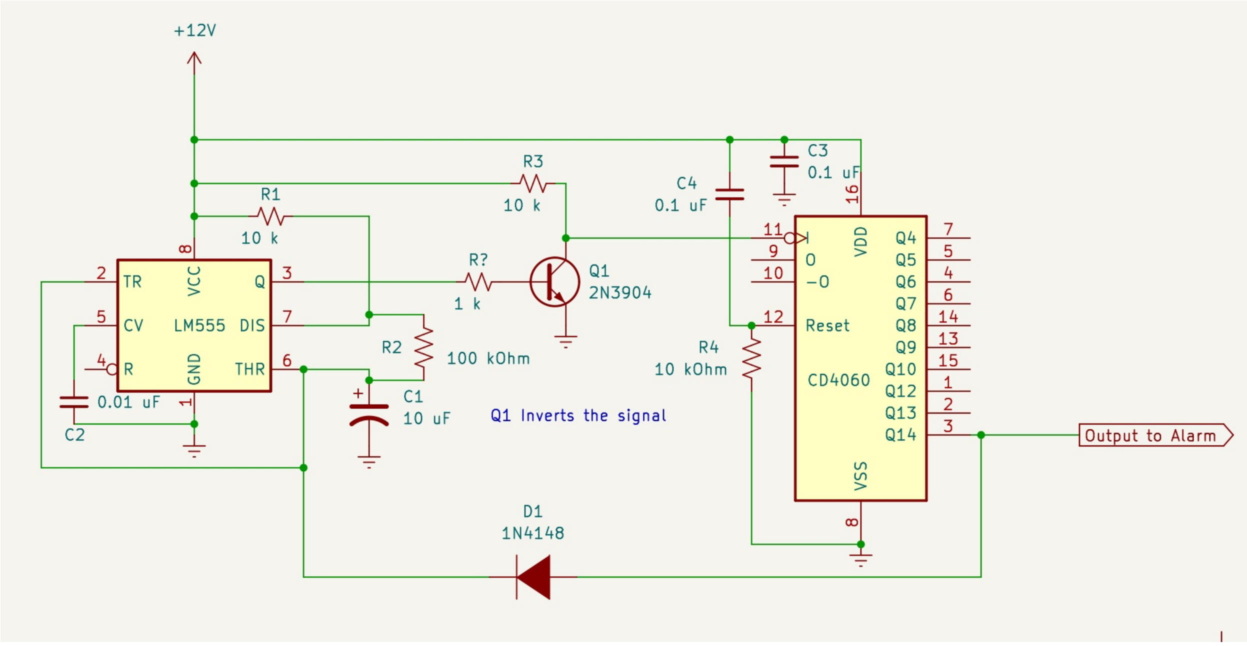
- The schematic is as follows:



- At first glance, this looks very much like the previous circuit. The difference is that this one has Q1 functioning as a signal inverter. It changes positive pulses to negative ones for the counter to use.
- The outputs look the same but there are a few differences:
  - The diodes go to different pins on the IC
  - There is no "overflow" output. When they're all lit, the next pulse resets everything to zero.
- Change C1 to 0.1 uF and watch it count much faster.
- C3 and C4, 0.1 uF capacitors, make the counter start at the from zero and count correctly.

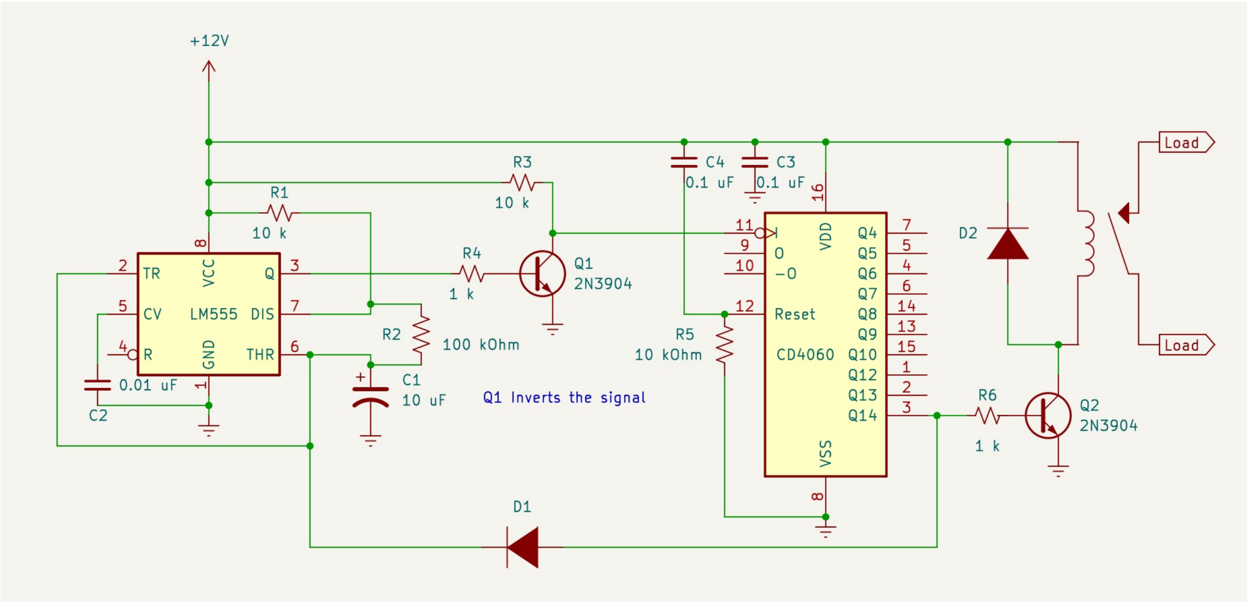
A Very Long Timer

- The preceding circuit can easily be modified to make a very long timer circuit.
- For the long timer, you don't need any LEDs, just a single Diode.
- Connect the diode from the Q14 pin, pin 3 on this IC, to pin 6-2 (they are tied together) on the 555 IC.
- When Q14 goes high, that turns the counter off. At the same time, you can use that output to do just about anything you want, like sound an alarm.
- Here's the schematic



- The circuit shown will set off the alarm in about 4 1/2 hours!
- Sorry, no picture of these circuits.

- Here's the circuit driving a relay



Conclusion(s)

- The NE555 and it's variants have been around for over 50 years! They are still quite functional and, as you can see, can do a lot of things with simple components.
- Advantages:
  - Will operate on a wide range of voltages
  - Has an output of nearly 200 mA - 10 times more that from most conventional ICs.
  - Is at the heart of some devices we still use today - like your garage door opener.
- So, when you think "timing", think 555.