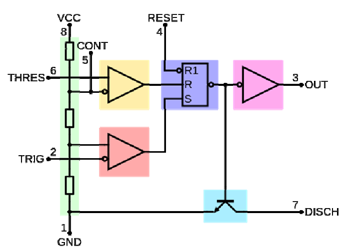
The 555 Timer IC

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package.

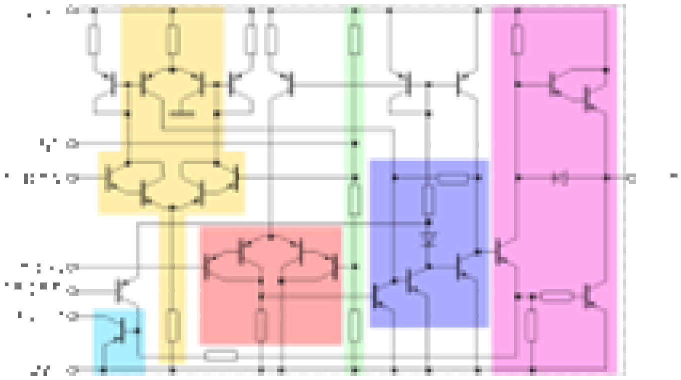
Introduced in 1971 by American company Signetics, the 555 is still in widespread use due to its ease of use, low price, and stability. It is now made by many companies in the original bipolar and also in low-power CMOS types. As of 2003, it was estimated that 1 billion units are manufactured every year.



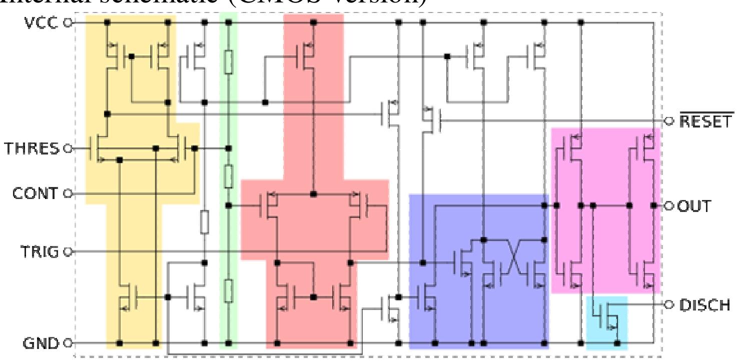
Pin	*Name*	Purpose
1	GND	Ground reference voltage, low level (0 V)
2	TRIG	The OUT pin goes high and a timing interval starts when this input falls below 1/2 of CTRL voltage (which is typically 1/3 V_{CC}, CTRL being 2/3 V_{CC} by default if CTRL is left open).
3	OUT	This output is driven to approximately 1.7 V below $+V_{CC}$, or to GND.
4	RESET	A timing interval may be reset by driving this input to GND, but the timing does not begin again until RESET rises above approximately 0.7 volts. Overrides TRIG which overrides THR.
5	CTRL	Provides "control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THR	The timing (OUT high) interval ends when the voltage at THR ("threshold") is greater than that at CTRL (2/3 V_{CC} if CTRL is open).
7	DIS	Open collector output which may discharge a capacitor between intervals. In phase with output.
8	V_{CC}	Positive supply voltage, which is usually between 3 and 15 V depending on the variation.

Design

Internal schematic



Internal schematic (CMOS version)



The IC was designed in 1971 by Hans Camenzind under contract to Signetics, which was later acquired by Dutch company Philips Semiconductors (now NXP).

Depending on the manufacturer, the standard 555 package includes 25 transistors, 2 diodes and 15 resistors on a silicon chip installed in an 8-pin mini dual-in-line package (DIP-8).[2] Variants available include the 556 (a 14-pin DIP combining two 555s on one chip), and the two 558 & 559s (both a 16-pin DIP combining four slightly modified 555s with DIS & THR connected internally, and TR is falling edge sensitive instead of level sensitive).

The NE555 parts were commercial temperature range, 0 °C to +70 °C, and the SE555 part number designated the military temperature range, −55 °C to +125 °C. These were available in both high-reliability metal can (T package) and inexpensive epoxy plastic (V package) packages. Thus the full part numbers were NE555V, NE555T, SE555V, and SE555T. It has been hypothesized that the 555 got its name from the three 5 kΩ resistors used within,[3] but Hans Camenzind has stated that the number was arbitrary.[1]

Low-power versions of the 555 are also available, such as the 7555 and CMOS TLC555.[4] The 7555 is designed to cause less supply noise than the classic 555 and the manufacturer claims that it usually does not require a "control" capacitor and in many cases does not require a decoupling capacitor on the power supply. Those parts should generally be included, however, because noise produced by the timer or variation in power supply voltage might interfere with other parts of a circuit or influence its threshold voltages

Modes

The IC 555 has three operating modes:

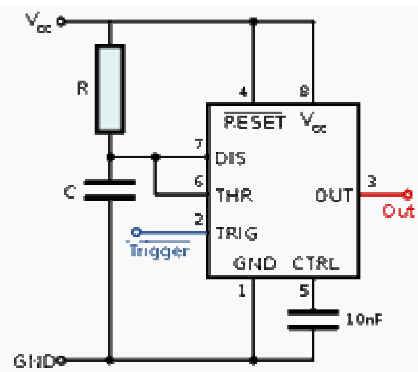
Monostable mode: In this mode, the 555 functions as a "one-shot" pulse generator. Applications include timers, missing pulse detection, bouncefree switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) and so on.

Astable (free-running) mode: The 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation and so on. The 555 can be used as a simple ADC, converting an analog value to a pulse length. E.g. selecting a thermistor as timing resistor allows the use of the 555 in a temperature sensor: the period of the output pulse is determined by the temperature. The use of a microprocessor based circuit can then convert the pulse period to temperature, linearize it and even provide calibration means.

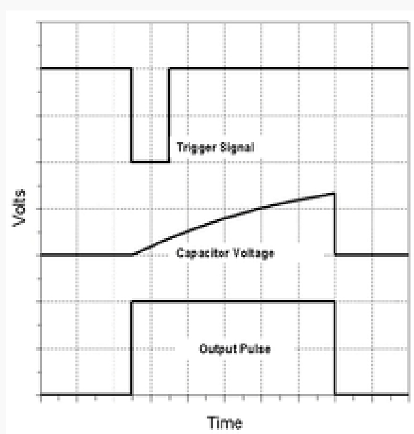
Bistable mode or Schmitt trigger: The 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce-free latched switches.

Monostable

See also: RC circuit



Schematic of a 555 in monostable mode



The output pulse ends when the voltage on the capacitor equals 2/3 of the supply voltage. The output pulse width can be lengthened or shortened to the need of the specific application by adjusting the values of R and C.[5]

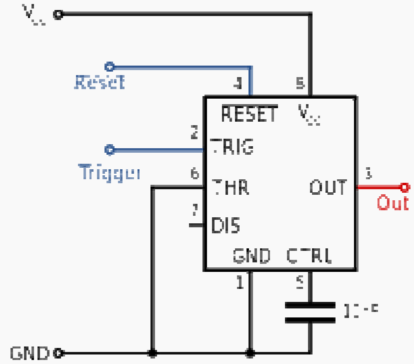
The output pulse width of time *t*, which is the time it takes to charge C to 2/3 of the supply voltage, is given by

$$t = RC\ln(3) \approx 1.1RC$$

where t is in seconds, R is in ohms (resistance) and C is in farads (capacitance).

While using the timer IC in monostable mode, the main disadvantage is that the time span between any two triggering pulses must be greater than the RC time constant.[6]

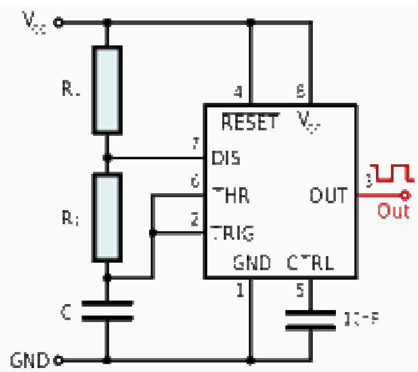
Bistable



Schematic of a 555 in bistable mode

In bistable (also called Schmitt trigger) mode, the 555 timer acts as a basic flip-flop. The trigger and reset inputs (pins 2 and 4 respectively on a 555) are held high via pull-up resistors while the threshold input (pin 6) is simply floating. Thus configured, pulling the trigger momentarily to ground acts as a 'set' and transitions the output pin (pin 3) to Vcc (high state). Pulling the reset input to ground acts as a 'reset' and transitions the output pin to ground (low state). No timing capacitors are required in a bistable configuration. Pin 5 (control voltage) is connected to ground via a small-value capacitor (usually 0.01 to 0.1 uF); pin 7 (discharge) is left floating.[7]

Astable



Standard 555 astable circuit

In astable mode, the 555 timer puts out a continuous stream of rectangular pulses having a specified frequency. Resistor R_1 is connected between V_{CC} and the discharge pin (pin 7) and another resistor (R_2) is connected between the discharge pin (pin 7), and the trigger (pin 2) and threshold (pin 6) pins that share a common node. Hence the capacitor is charged through R_1 and R_2, and discharged only through R_2, since pin 7 has low impedance to ground during output low intervals of the cycle, therefore discharging the capacitor.

In the astable mode, the frequency of the pulse stream depends on the values of R_1, R_2 and C:

$$f = \frac{1}{\ln(2) \cdot C \cdot (R_1 + 2R_2)}$$ [8]

The high time from each pulse is given by:

$$\text{high} = \ln(2) \cdot (R_1 + R_2) \cdot C$$

and the low time from each pulse is given by:

$$\text{low} = \ln(2) \cdot R_2 \cdot C$$

where R_1 and R_2 are the values of the resistors in ohms and C is the value of the capacitor in farads.

The power capability of R_1 must be greater than $\frac{V_{cc}^2}{R_1}$.

Particularly with bipolar 555s, low values of R_1 must be avoided so that the output stays saturated near zero volts during discharge, as assumed by the above equation. Otherwise the output low time will be greater than calculated above. The first cycle will take appreciably longer than the calculated time, as the capacitor must charge from 0V to 2/3 of V_{CC} from power-up, but only from 1/3 of V_{CC} to 2/3 of V_{CC} on subsequent cycles.

To have an output high time shorter than the low time (i.e., a duty cycle less than 50%) a small diode (that is fast enough for the application) can be placed in parallel with R_2, with the cathode on the capacitor side. This bypasses R_2 during the high part of the cycle so that the high interval depends only on R_1 and C, with an adjustment based the voltage drop across the diode. The voltage drop across the diode slows charging on the capacitor so that the high time is a longer than the expected and often-cited ln(2)*R_1C = 0.693 R_1C. The low time will be the same as above, 0.693 R_1C. With the bypass diode, the high time is

$$\text{high} = R_1 C \cdot \ln\left(\frac{2V_{\text{cc}} - 3V_{\text{diode}}}{V_{\text{cc}} - 3V_{\text{diode}}}\right)$$

where V_{diode} is when the diode's "on" current is 1/2 of V_{cc}/R_1 which can be determined from its datasheet or by testing. As an extreme example, when V_{cc}= 5 and V_{diode}= 0.7, high time = 1.00 R_1C which is 45% longer than the "expected" 0.693 R_1C. At the other extreme, when V_{cc}= 15 and V_{diode}= 0.3, the high time = 0.725 R_1C which is closer to the expected 0.693 R_1C. The equation reduces to the expected 0.693 R_1C if V_{diode}= 0.

The operation of RESET in this mode is not well defined, some manufacturers' parts will hold the output state to what it was when RESET is taken low, others will send the output either high or low.

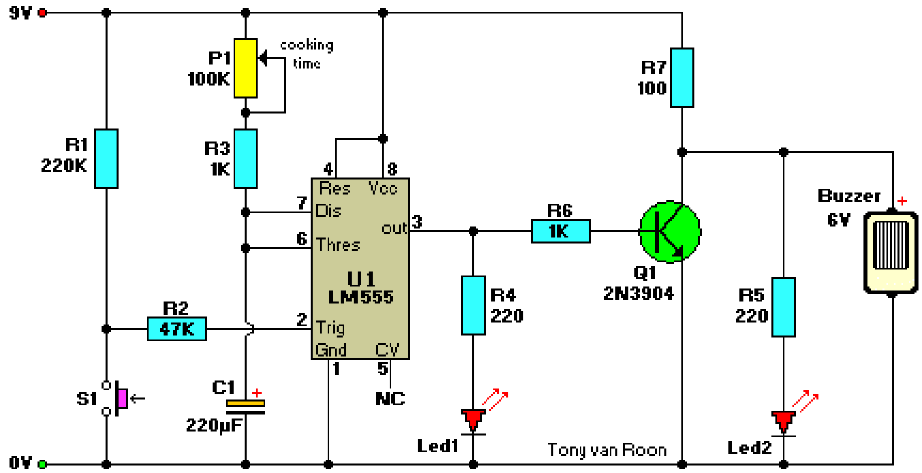
Specifications[edit]

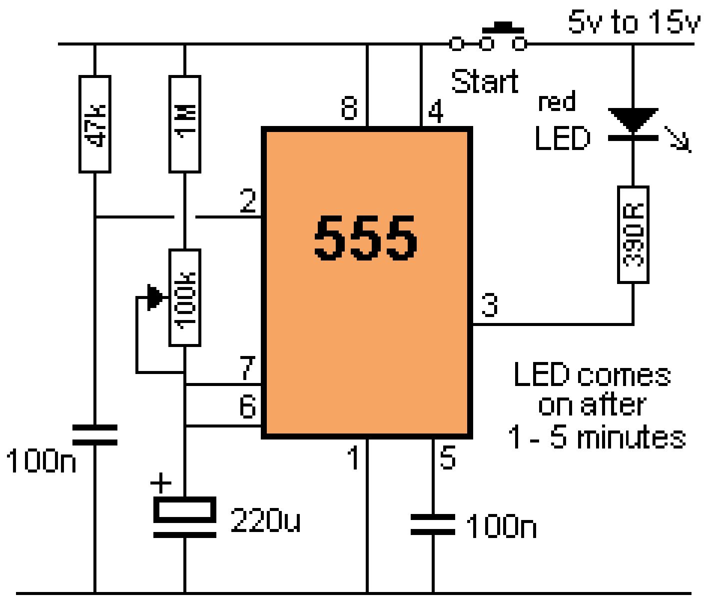
These specifications apply to the NE555. Other 555 timers can have different specifications depending on the grade (military, medical, etc.).

Supply voltage (V_{CC})	4.5 to 15 V
Supply current (V_{CC} = +5 V)	3 to 6 mA
Supply current (V_{CC} = +15 V)	10 to 15 mA
Output current (maximum)	200 mA
Maximum Power dissipation	600 mW
Power consumption (minimum operating)	30 mW@5V, 225 mW@15V
Operating temperature	0 to 70 °C

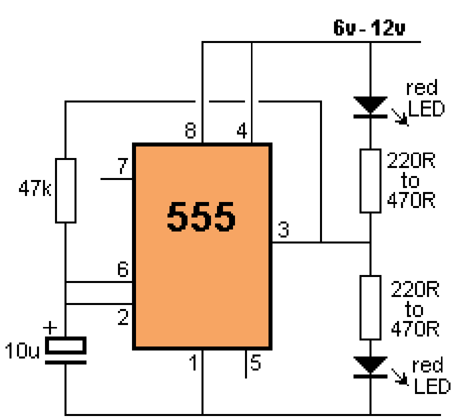
Egg Timer

http://www.uoguelph.ca/~antoon



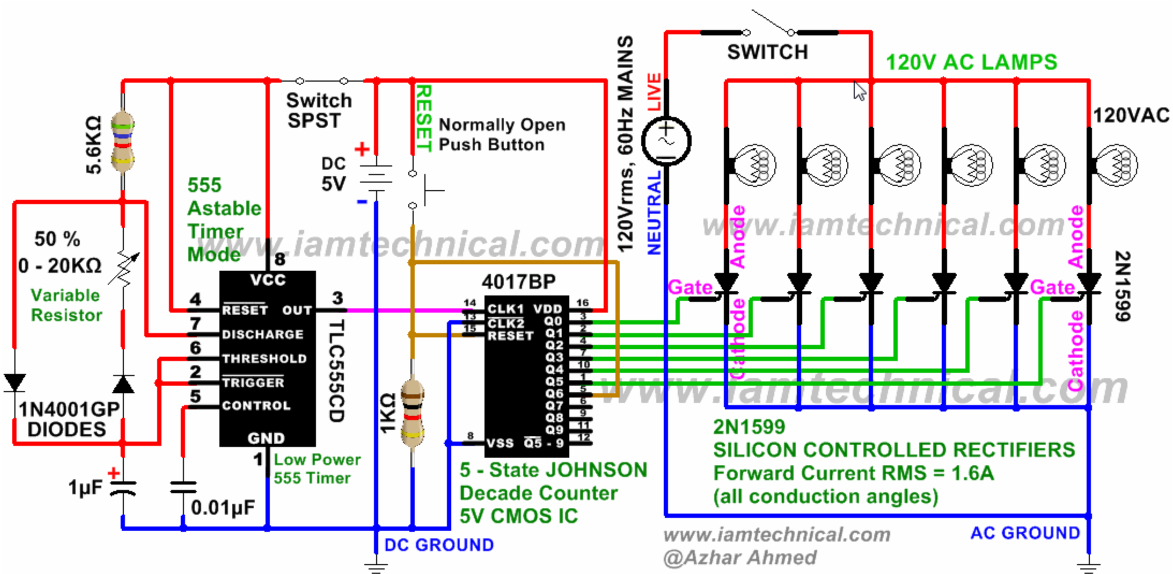


1 - 5 min TIMER

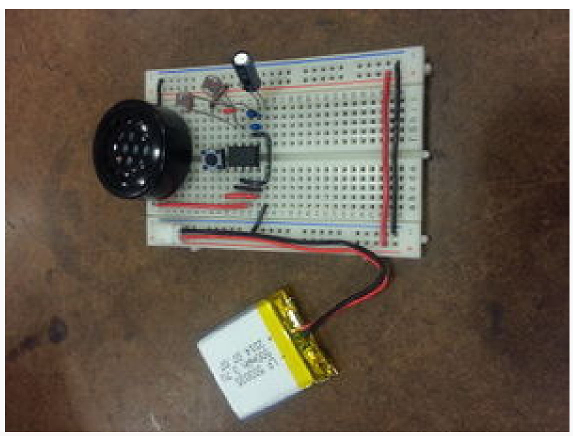


FLASHING LIGHTS

555 Timer Disco Flashing Lights Circuits

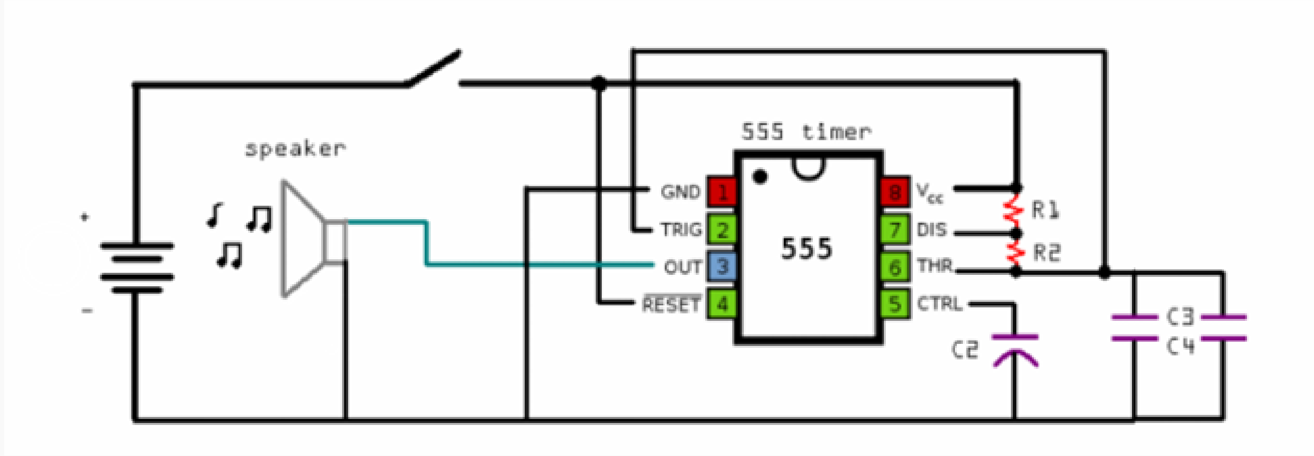


Digital Synthesizer



Digital Synthesizer (Iyal Suresh)

The Digital Synthesizer is the first project in the OPS series. It uses a 555 timer along with photoresistors to output square waves to a speaker, the frequency of which is proportional to the amount light is entering the photoresistors. As the amount of light increases and decreases, different frequencies will be heard coming from the speaker.



Digital Synthesizer

Parts for the Project

For this project, you will be using the photoresistors in the kit as R1 and R2. For the capacitors and all future non-variable resistor needs, the lab has several drawers full of components, so get what you need from there (and feel free to keep them).

Also, you're encouraged to experiment with different capacitor values, but the following component values are guaranteed to work.
C2 = 0.1 uF
C3 = .22 uF
C4 = .22 uF

Which one is the 555 Timer and where is Pin 1?
In your kit there are a couple of different IC. If you look closely, the 555 Timer chip will have something along the lines of "NE555" written on it. Pin 1 is located to the left of the notch on the top of the IC, and additional there is a dot next to pin 1. The other pins follow counter clockwise from this pin (pin 2 is below pin 1, and pin 8 is on the opposite side).

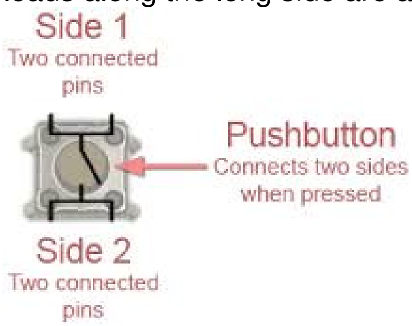
How do I connect my capacitors?

If your capacitor looks like this:  then the longer lead is positive and **MUST** be connected to the point of higher voltage.

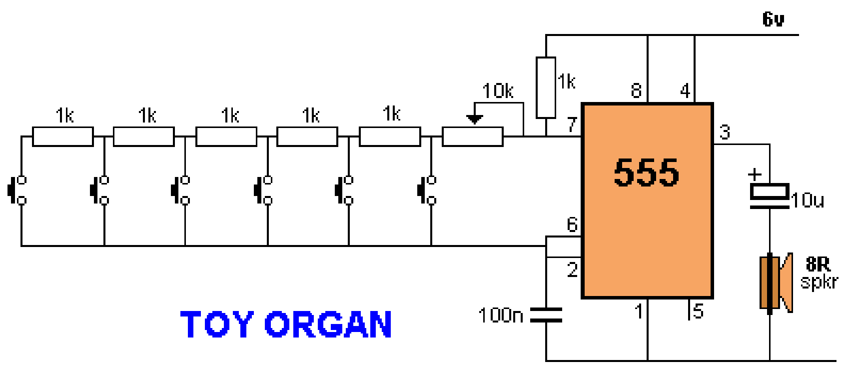
If your capacitor looks like one of these:  then there is no difference between the leads and you can connect it however you want.

How does the button work?

You can test the button with a DMM, but if you need an answer, I'll provide one. There are 4 leads on the button, in a rectangular shape. When the button is pressed, any two diagonal leads become connected. The 2 leads along the long side are always connected, whether or not the button is



down.



The Atari Punk Console