# Circuits Using the NE555 Timer

**The NE555 timer and its companion devices, the NE556 dual timer and NE558 quad timer can be used in a number of applications. The device can function both as an astable device and as a monostable device (one-shot) and can be triggered in several of ways. A few circuits will be discussed using these devices. There are many applications, limited by only your ingenuity. A few typical circuits will be presented. By suitable component changes, they may be customized for a particular application, or used as is.**

**The first (Fig 1) is a circuit called the Infrared Firefly. It is a marker device used for surveillance work. It can be packaged on a PC board about the size of a postage stamp, and runs from a nine volt battery. It generates a short pulse every few hundred milliseconds that drives six infrared LEDs. This device is intended to be packaged in a small box with an attached ceramic magnet. It can be placed in an inconspicuous spot on the body of the vehicle to be trailed. The LEDs do not generate any visible light and there is no RF carrier that might be detected with a bug detector. A CCD camera or snooperscope (a device similar to night vision scopes) can be used to "see" the LEDS, which will appear like a firefly or blinking beacon. In this way a vehicle can be "marked" and followed without appearing any different to normal human eyesight. Naturally, visible light LEDs of suitable color(s) can be substituted for the infrared LEDs if desired.**

**In this circuit the NE555 type device is actually a 7555 type CMOS version, and it consumes negligible power. It drives the LEDs ( two separate groups of three series connected LEDs ). A cycle length of around ¾ of a second works well, with a ten percent duty cycle. This saves battery power as it cuts the average drain to about ten percent of that if the LEDS were to be fully on. Each LED string of three series leds draws about 20 mA with a 9 volt supply, so all six LEDS draw about 40 mA. While six LEDs could be connected in series, a higher supply voltage would be needed. The current drawn by the 7555 is very small (about 50 µA at 9V) and can be neglected, so the average current drain is approximately 40 mA x 10 percent or 4 milliamperes. The CMOS version is also advantageous when long delays are needed. Higher resistances and smaller capacitances can be used as contrasted with the NE555 which limits resistor size to about 10 megs. This allows long time delays with more reasonable size components. In this circuit, a 1 uF tantalum capacitor was used for its small size, low leakage, and stability. For a frequency of 1.33 Hz with a ten percent (0.1) duty cycle:**

**$F = 1.4 / (Ra + 2\,Rb)C$ ; Then $1.33 = 1.4/ (Ra + 2Rb)(1)$ and $(Ra + 2Rb) = 1.05$ Meg = 1050K**

**and Duty Cycle = $Rb/(Ra + 2Rb) = 0.1$ Then $Rb = 0.1\,(Ra) + 0.2\,(Rb)$ or $Ra = 8\,Rb$**

**Substituting: $Ra + 2Rb = 10Rb = 1.05$ Megs $Rb = 0.105$ Megs and $Ra = 8Rb = 0.84$ Megs**

**In practice, an 820K resistor could be used for Ra and a 100K for Rb. The values could be increased by a factor of 10 if a 0.1 uF timing cap was used instead of 1 uF. Using surface mount components, with a surface mount IC and LEDS, this circuit can be packaged into a very small configuration, limited by the battery size. This is very close to 50% without needing extra components. The square wave present at pin 3 is fed to a rectifier and filtered to obtain a DC bias voltage. Since very low current is required (a few tenths of a milliampere) small capacitors and large resistors can be used. A frequency of around 50 to 100 kHz is appropriate to minimize component size. Ra and Rb will determine the duty cycle and frequency. Choosing C = .001 µF, a convienient standard value and the frequency to be 100 kHz, :**

**$F = 1.4/(Ra + 2Rb)C$ and therefore $Ra+2Rb = 1.4/(F \times C)$**

**If C = .001 µf and F = 100kHz Then $Ra + 2Rb = 1.4/(.001 \times 100{,}000) = 1.4/100 = .014$ Meg**

**Since Ra was set equal to 0.1Rb, 2.1 Rb = .014 Meg , and Rb = .014/2.1 = .00666 Meg or 6.66K, close to the standard value of 6.8K. Using 6.8K for Rb, then Ra will be 680 ohms.**

**The 555 can be used as a tone or pulse generator for various purposes. The output can drive loads up to 100 mA under certain conditions. Consult the manufacturers data sheet for a detailed explanation of maximum current and voltage ratings. A circuit of an electronic metronome is shown in figure 2. This circuit generates a variable frequency pulse of from 40 to 200 pulses per minute and drives a speaker, producing a click each cycle. Using a commonly available 1 Meg potentiometer, with a 150 K series resistor for Ra we get a 150K to 1.15M resistance range Since the maximum frequency will be 200 pulses per minute (ppm) this is a frequency of 200/60 = 3.33 Hz. or 300 msec between pulses. If a 20 msec pulse is used to produce a good audible click in the speaker, the duty cycle at 200 ppm will be 20/300 or 6.67 percent. Under these conditions, Ra is 150K (pot set at zero resistance) Then Rb/Ra+2Rb will equal .0667. As Ra is 150K with the pot set at zero resistance:**

**Rb/(Ra + 2Rb) = .0667 ,and then .0667Ra = .867Rb or Rb= .076 Ra = 11.5K (Closest standard value of 12K will be used)**

**Then F = 1.4/(Ra + 2Rb) C and solving for C,**

**C = 1.4/F(Ra + 2Rb) where C in uF; R in Megs; F is in Hz**

**C = 1.4/3.33( .174) = 2.416 uF (use a 2.2 uf 10% tantalum electrolytic)**

**Then F = 1.4/(0.174)(2.2) = 3.657 Hz, this is 3.657 x 60 = 219.4 ppm**

**As a check, at full resistance pot setting Ra + 2Rb will be 1.174 Megs. Using C = 2.2 uF**

**Then F = 1.4/(1.174) (2.2) = 0.542 Hz , this is 0.542 x 60 = 32.5 ppm. Therefore, the 40 to 200 ppm range is covered with room to spare.**

**Since frequency is inversely proportional to capacitance, substituting a smaller capacitor will increase the frequency. If we wanted a 300 Hz minimum frequency, the 2.2 uf capacitor can be changed by a factor of 3.33/300 = 0.0111 and would be .0244 uf (use .0022 µF in parallel with .022 µF for standard values to get 0.0242 uF, close enough). This would give a range of 300 to 1500 Hz. A log taper pot is recommended for a smoother acting control, as this will make it less critical to adjust at the high frequency end of the frequency range.**

**The next circuit (Fig 3) is a voltage converter using the 555. While dedicated ICs for this purpose are available, for non-critical applications the common NE555 or 7555 can be used instead, without the trouble of obtaining the specialized IC. Fig 3 shows a circuit to obtain negative bias for an automatic gain control application. Minus 5 volts was required, but +12V was the only DC supply available. The NE555 is set up as a square wave oscillator of about 40 percent duty cycle. Ideally 50 percent duty cycle would be used in this application, but without a few extra components this is not possible. If Ra is made equal to 0.1Rb, the duty cycle will be:**

**Duty Cycle = Rb / 2.1Rb or 47.6 percent**

**The square wave appearing at the output (pin 3) is fed to C2. C2 couples the square wave to rectifier diode D1 and filter network R1 and C3. The negative DC output appears across C1. Depending on load, up to -8 volts DC is available for biasing purposes. If more current is needed, smaller values of R2 and larger values of C3 could be used. The DC voltage output will not exhibit very close regulation, but it will be good enough for intended bias purposes. One of the 79L series of regulators could be used to regulate the output voltage to –5 volts, if desired. This circuit could be run at low frequencies if RFI generation is a consideration, as larger but still reasonable component values could be used. If C was made equal to 1 uF and C3 was 1000 uF, the circuit would run at 100 Hz with similar performance.**

**The NE555 can be frequency modulated by another NE555 to produce tones whose frequency varies with time. Pin 5 sets the threshold voltage at which the internal comparator causes the internal flip flop to change state. Normally this is 2/3 Vcc, but since it is derived from an internal resistive divider, it is possible to superimpose an external modulation signal on it. Shifting this voltage will change the time on the R-C charging curve when the threshold is reached, and this causes a change in frequency. A positive going voltage lowers the frequency, a negative raises it. Fig 4 shows how this can be done. IC1 generates a low frequency square wave. The output voltage is used to shift the threshold of IC2. This circuit will produce alternating high and low tones. Fig 5 shows a way to generate a swept tone. The capacitor voltage is read with an emitter follower and used to shift the threshold voltage with a sawtooth. By using waveshaping circuits and inverters to reverse the sawtooth polarity, many different sound patterns can be generated.**

**Fig 6 shows a timer for controlling the length of time a device is powered up. By producing delays using the timer, devices requiring very short times (light displays, photographic enlargers, cameras, etc) to those requiring hours (lighting systems, battery chargers, etc) can be controlled. For safety reasons, an optoisolator is used to isolate the circuit from the AC power source by controlling a triac or solid state relay (not shown). The circuit uses the timer in the monostable mode. It is initiated by a triggering pulse applied to pin 2. This voltage can be derived from a manual switch of some sort (push button, etc), or a logic circuit and must drive this pin below 1/3Vcc. The time interval in this application is:**

**$T = 1.1\ RC$ where $R = \mathrm{Meg}\Omega$ and $C = \mathrm{uFd}$**

**There are many, many other uses for these timers. It is recommended to consult the manufacturers application notes and the literature for more examples and ideas for their circuit applications.**

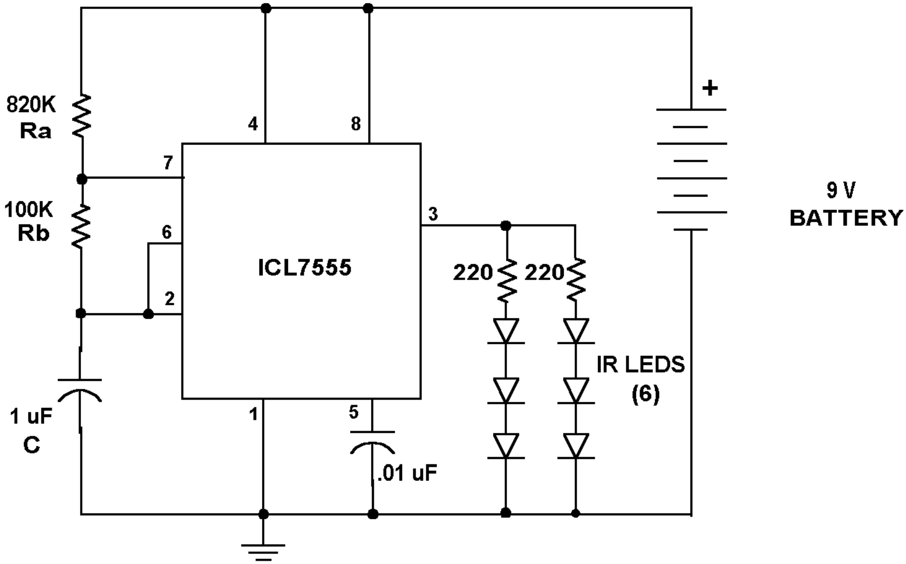

FIG 1
INFRARED FIREFLY BEACON

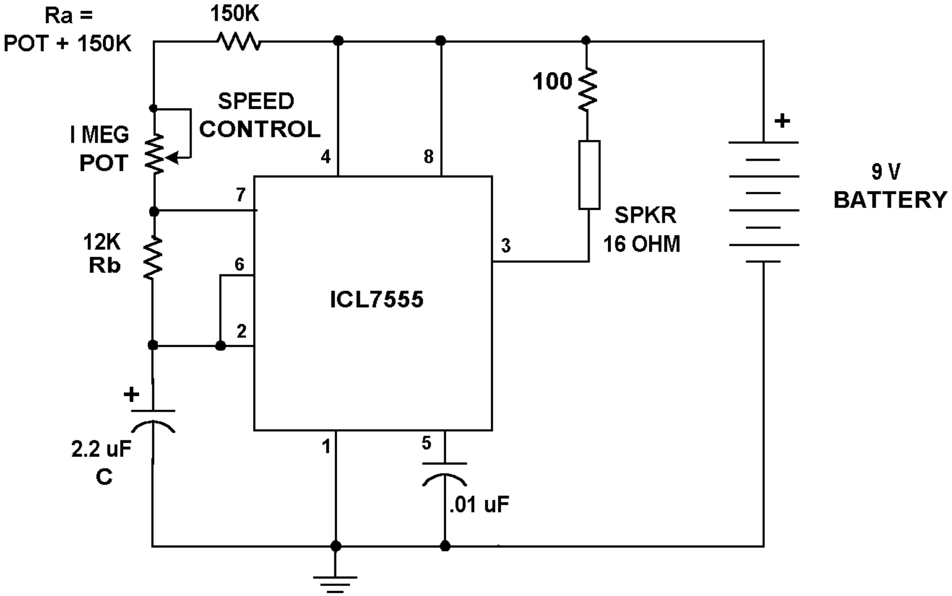

FIG 2
METRONOME CIRCUIT

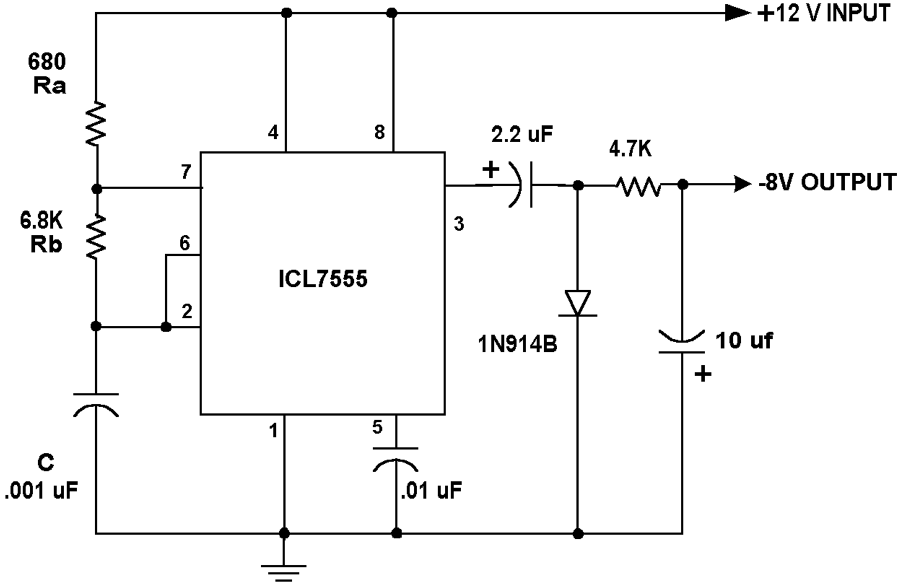

FIG 3
DC-DC CONVERTER CIRCUIT

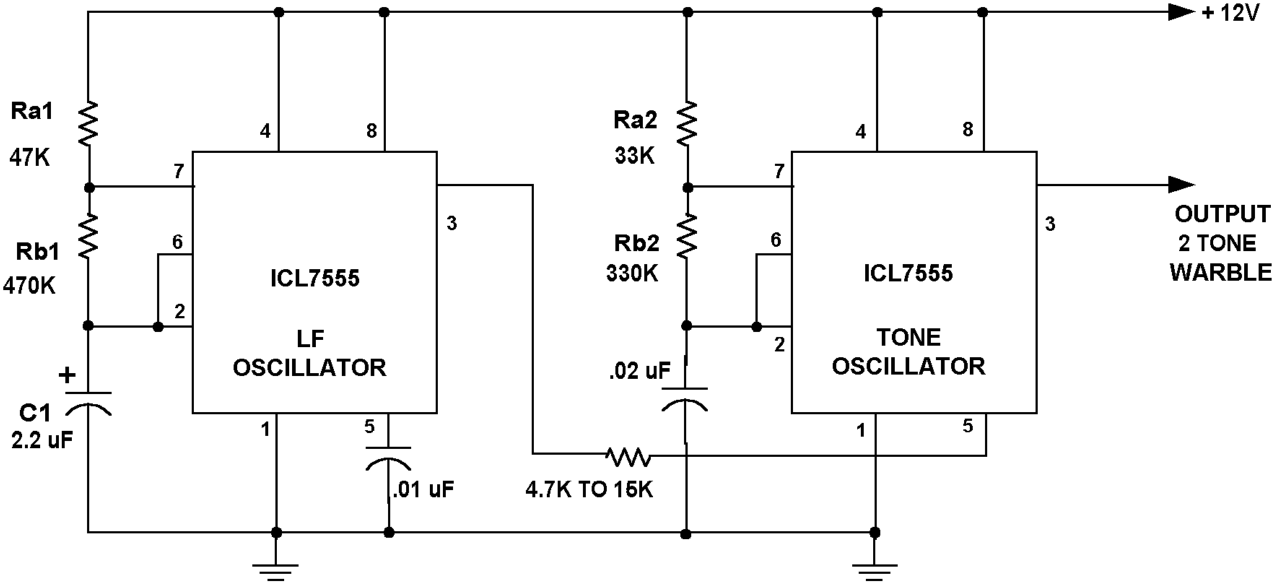

FIG 4
WARBLING TONE GENERATOR

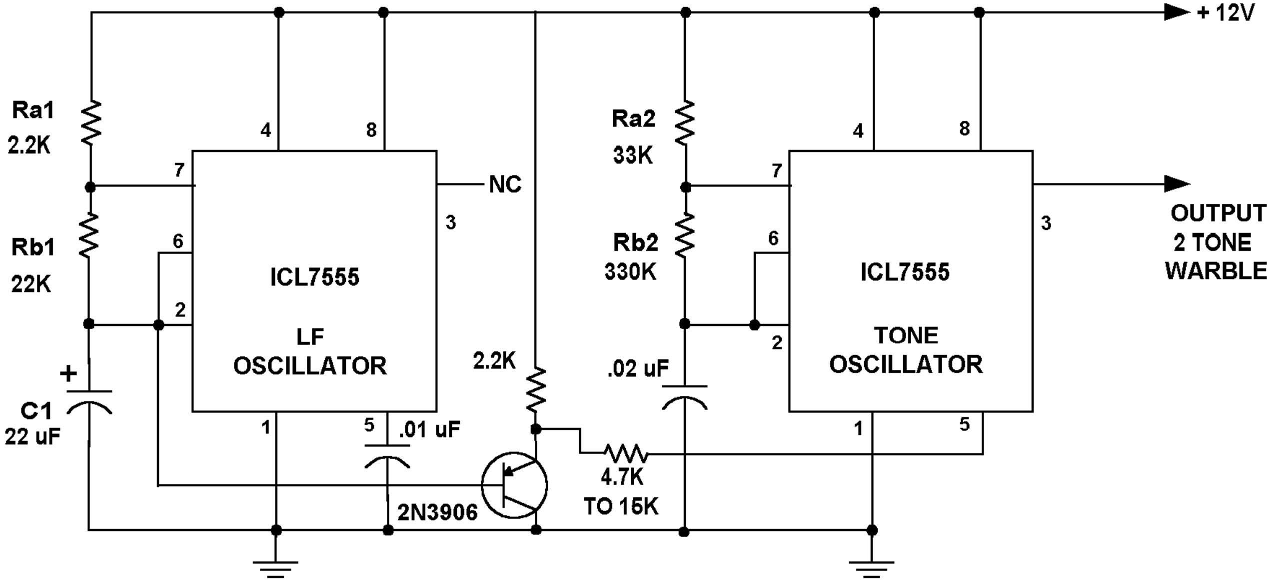

FIG 5
SLIDING TONE GENERATOR

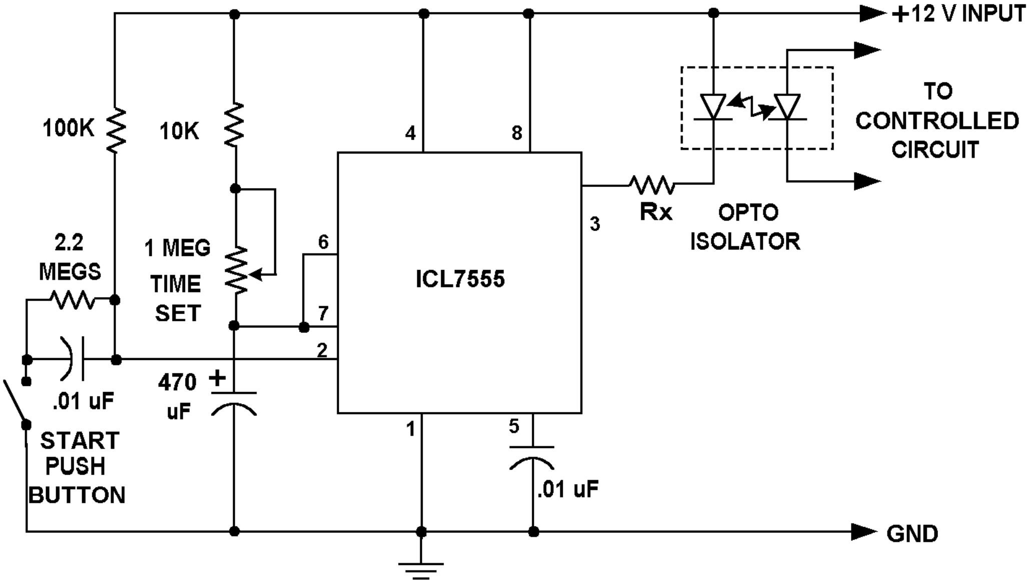

FIG 6
TIMER CIRCUIT