Triangular waves from 555 have adjustable symmetry

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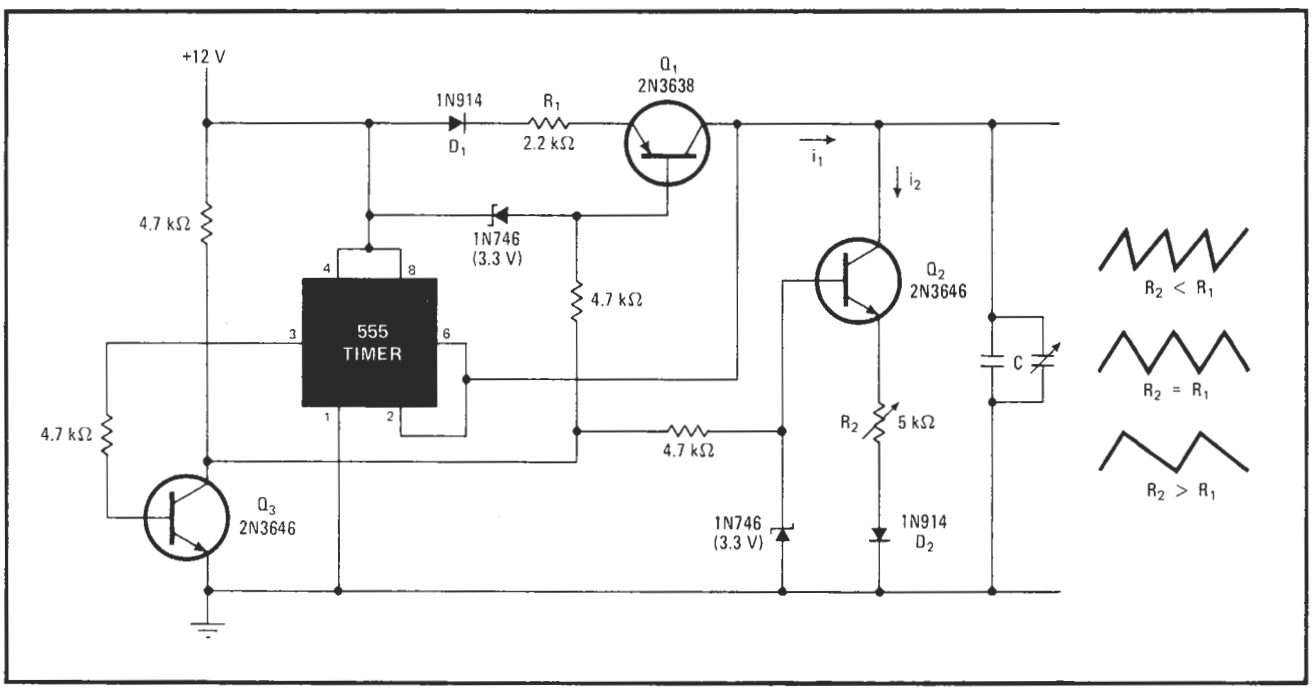
The fixed-frequency triangular waveform so often required in pulse-duration modulators or sweep generators too often turns out costly to implement. Though operational-amplifier circuits can develop a triangular wave by integration of a square wave, the tips of the triangle become blunt at frequencies above 10 kilohertz unless expensive devices with high slewing rates are used. Also, though single-package voltage-controlled oscillators provide triangular output, they are not cost-effective for fixed-frequency applications, and most have high current drain. However, an inexpensive 555 timer and some transistors can generate triangular waves at frequencies up to about 100 kHz.

The circuit shown generates a triangular waveform by alternately charging and discharging a capacitor. The transistors Q_1 and Q_2 with their zeners act as a switched-current source and a switched-current sink that are activated by Q_3. When Q_3 is on so that its collector is low, the Q_1 current source is switched on, and a current i_1 charges capacitor C. The linear voltage ramp that appears across C corresponds to the charging law $dV/dt = i_1/C$.

Voltage V across the capacitor increases until it reaches a level that is two thirds of the supply voltage, which is the upper trip point of the 555 timer. The voltage at pin 3 of the timer then goes low, turning off Q_3. Since the collector of Q_3 is thus made high, the Q_1 current source is deactivated, and the Q_2 current sink is switched on. The capacitor is discharged by i_2 until the lower trip point of the 555 timer is reached, at one third of the supply voltage. At this point the 555 changes state and the cycle repeats. Thus the output voltage varies from 4 V to 8 V if the supply is 12 V.

Q_1 and Q_2 may be any high-gain pnp and npn transistors, such as 2N3638 and 2N3646. Q_3 may be any npn switching transistor, such as 2N3646. The forward voltage drops of D_1 and D_2 ensure turn-off of Q_1 and Q_2. Resistor R_2 is a symmetry adjustment, controlling the discharge rate of C by varying i_2. For the values shown, the frequency in hertz of the symmetrical triangular wave form is roughly 75/C, where C is in microfarads; thus, C determines the frequency. □



Ups and downs. Triangular waveform is generated across capacitor C by alternately charging and discharging through emitter-follower constant-current sources consisting of transistors Q_1 and Q_2 plus their zener diodes. Current sources are turned on and off by 555 timer.