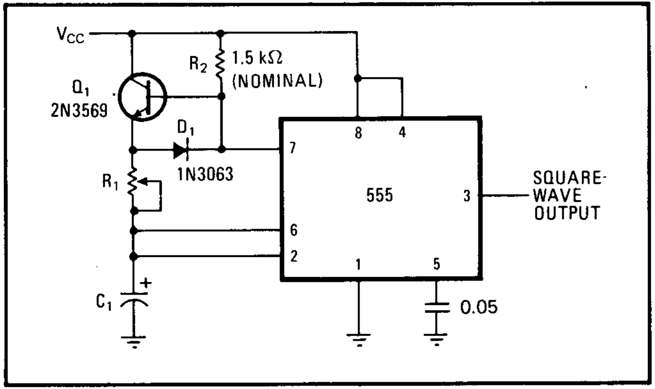
Generator's duty cycle stays constant under load

by Arthur R. Klinger
School of Health Care Sciences, Sheppard AFB, Wichita Falls, Texas

In the 555 timer, configured as a square-wave generator, adding one transistor and a diode to the RC timing network permits the frequency to be varied over a wide range while maintaining a constant 50% duty cycle [see also *Electronics*, Sept. 19, p. 112].

In one simple configuration, a capacitor's charge and discharge currents flow through only one resistor. The



Workhorse. This configuration of the 555 timer can drive a heavy load without distorting its square-wave output, even over a very wide frequency range, unlike simpler hookups.

high and low periods should be equal at any frequency, but, with heavy loads, the output may be offset by 1 volt or more from V_{cc} or ground. This varies the potentials across the RC network, creating quite large changes in duty cycle or frequency. Noise on the output lines can also cause erratic changes in the periods.

The circuit shown in the diagram removes the timing network from the output. While the timer's output is high, Q_1 is biased into saturation by R_2, so that charging current passes through Q_1 and R_1 to C. When the output goes low, the discharge switch (pin 7) cuts off Q_1 and discharges the capacitor through R_1 and D_1. With the same impedance in both paths, the high and low periods of the square wave are equal.

Q_1 should have a high β value so that R_2 can be large and still drive the transistor into saturation. With R_2 large, the IC's discharge transistor, which can sink 20 to 30 milliamperes, gets most of that current from the discharging capacitor and very little through R_2. The voltage drops in Q_1, D_1, and the internal discharge switch decrease the effective voltage across R_1, causing the actual periods to be slightly longer than those given by the astable and bistable formulas in the data sheets—0.69RC and 1.1RC, respectively. A high-conductance germanium or Schottky diode for D_1 would minimize these diode-voltage drops in D_1 and Q_1.

For precise square waves, the on characteristic of Q_1 should be the same as that of D_1 and the IC's internal pull-down switch. To optimize this balance, set the timing network to its highest frequency range, and adjust R^2 while monitoring the square wave output. Once adjusted at this frequency, an excellent square wave is maintained for all combinations of R_1 and C_1.

Since the usual current-limiting resistor is not needed, the minimum value of R_1 can be as little as a few hundred ohms. Such a small resistance carries large charge and discharge currents, leading to a frequency range twice as wide as the usual configuration provides. For example, if R_1 = 10 megohms, the frequency range can exceed 20,000 to 1 for a single choice of C. □