AN INEXPENSIVE AND SIMPLE SOLID STATE TIMER¹

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This circuit (Fig. 1) is based on the unijunction transistor timing circuit shown in the sixth edition of the General Electric Company's *Transistor Manual*. It preserves the temperature and supply-voltage stability of that circuit, but uses a much less costly transistor and eliminates an expensive and fragile miniature sensitive relay. It can operate most 24v dc loads found in the laboratory. It does not need a well-regulated power supply. Total cost is about \$10. Timed intervals may be generated of lengths from 100 msec to many minutes. The advantages of this circuit compared with timers typically found in behavioral laboratories are absolute silence, absence of contacts to deteriorate, relatively short reset period (with no springs or mechanical parts), and wide time range without sacrificing reliability.

Fig. 1. Circuit diagram of timer. Capacitor C is 20mfd to 100mfd 25 or 50v electrolytic; series variable resistor can be as large as 500K; UJT is G.E. 2N2160; SCR is G.E. C15G; diode is RCA 1N538, used for transient suppression to protect SCR; load can be any relay, solenoid, stepper, etc., that requires 24 v dc at 3 amps or less (3 amp limit is set by the SCR used). Wiring C-NC gives a time interval that starts with initiate and ends at end of timer cycle; wiring CNO gives a delay until the end of the timer cycle, and then continues until the initiate (maintained operate) is broken.

The circuit operates as follows. Connection of the circuit to the power supply starts the electrolytic capacitor charging via the 3K protective resistor and the series variable resistor. For any R-C timing combination, the capacitor will eventually reach the 2N2160 unijunction transistor firing voltage which is approximately a fixed proportion of the supply voltage. Upon firing, the 2N2160 delivers a single pulse to the C15G silicon controlled rectifier which turns on, energizing the load, and stays on until the power is disconnected. The load is then de-energized and the circuit returns to its original state.

The silicon controlled rectifier should be mounted on a heat sink (say 2 in. by 2 in. of 1/8 in. aluminum) insulated from circuit ground, because the mounting stud is also the anode of the device.

Calibration data were taken at 18, 24, and 30v. Operating times at 18v were 5% longer than at 24v. Operating times at 30v were identical with those at 24v. Times were measured with a calibrated oscilloscope. The measured times taken with 2 sec inter-trial intervals (reset times) were never as much as 5% longer than those taken with 2 min inter-trial intervals. Data are given here for 24v and 2 min inter-trial intervals. For a C of 100 μ f, a total R of 3K gave 0.425 sec; 38K, 5.4 sec; 100K, 17.6 sec; 470K, 92.6 sec. For a C of 200 μ f, a total R of 470K gave 155 sec. For a C of 20 μ f, a total R of 3K gave 0.086 sec; 38K, 1.18 sec. (It was also determined that for a C of 20 μ f, a total R of 750 ohms gave 0.025 sec. However, for values of total R less than about 3K, the UJT should be protected (at point X) by wiring through a common and its normally closed contact on the relay.)

¹This device was developed in research supported in part by Grant MH-1292 to D. Krech, M. R. Rosenzweig, and E. L. Bennett from the National Institute of Mental Health, USPHS, and in part by Pre-doctoral Fellowship MF-17372 to M. G. Saslow from the National Institute of Mental Health, USPHS.

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