IMPROVED SOLID STATE DELAY TIMER ALLOWS INEXPENSIVE SHORT INTERVAL TIMING¹

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An earlier article (Saslow and Markowitz, 1964) described an inexpensive and simple solid state delay timer of high reliability and versatility. A load is energized at some adjustable time after the application of an operate signal of duration longer than the delay interval. Although this device offered several advantages, such as silent operation and relative insensitivity to voltage fluctuations, the shortest reliable time period with the original components was approximately 25 msec (and this required some special wiring to protect the unijunction transistor). By changing two components and without increasing complexity, it is possible to build an even more useful timer (Fig. 1). Cost remains under \$10.

Fig. 1. Circuit diagram of timer. Capacitor C may be 0.0033 μ f to 100 μ f at 25 or 50 v; the series variable resistor may be as large as 300K. Diode shown with dotted lines is required for transient suppression and SCR protection when inductive loads such as relays are used. Maximum load current of SCR is 1 amp. Time interval begins with closing of switch to positive terminal of power supply.

A cheaper and more effective unijunction transistor (UJT) (G.E. 2N2646) has been used, and a more sensitive silicon controlled rectifier (SCR) (G.E. 2N2323/C5F) has been substituted.

This SCR will fire with capacitance (C) values considerably below those previously required. It is now possible to use a minimum resistance (R) value of 3K, sufficient to protect the UJT without special wiring, yet allowing generation of much shorter time intervals. The working model reliably produces intervals as short as 18 μ sec.

The SCR (G.E. C15G) in the original model required a heat sink at maximum load current (3 amp). The new SCR (G.E. 2N2323/C5F) does not require a heat sink; however, its maximum load current is only 1 amp.

The circuit operates as follows. Connection to the power supply starts C charging via R (R includes a 3K protective resistor and a series variable resistor). For any R-C combination, C will eventually charge to the UJT firing voltage, which is approximately a fixed proportion of the supply voltage. Upon firing, the UJT delivers a single positive pulse to the SCR, which turns on, energizing the load, and remains on until power is interrupted. This returns the circuit to its original state, turning off the load.

Using this timing circuit, with the variable part of R at zero ohms and with a positive supply voltage of 22.5 v, the relationship between C and delay time was thus: C of 20 μ f, 140 msec; 10 μ f, 60 msec; 2 μ f, 10 msec; 0.5 μ f, 2.5 msec; 0.05 μ f, 250 μ sec; 0.02 μ f, 100 μ sec; 0.01 μ f, 50 μ sec; 0.0068 μ f, 40 μ sec; 0.0033 μ f, 18 μ sec. Times were measured with a calibrated oscilloscope with the 1K SCR load shown. Each timer must be calibrated by the

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builder because manufacturers' C values are nominal values. If zero tolerance components were used, the delay for a C of 20 μ f would be exactly twice that for 10 μ f, and so on.

Time delays greater than 140 msec may be generated by increasing C or R or both. In general, it is better to use as large an R as possible (up to about 300K), because the smaller C is, the faster it will discharge, permitting rapid but accurate repetitive operation.

The 1K SCR load shown was used for purposes of calibration. Any relay or device which requires less than 1 amp at supply voltage may be substituted. Inductive loads, such as relays, must have a reverse-connected silicon diode (Saslow, 1964) in parallel to protect the SCR (dotted lines in Fig. 1).

This new timer should be useful for the control and production of brief stimuli and for the delayed operation of high-speed relays. By condenser-coupling to the 1K SCR load, it is possible to produce pairs of clicks separated by an adjustable delay. A Sonalert® can be substituted for the 1K SCR load, in order to produce brief tone bursts. When this is done,

the timer functions as an interval timer, not as a delay timer. A maintained operate is still required.

A comparison of the Saslow-Markowitz (1964) UJT-SCR timer with the design of Tapp and Clark (1964) indicates that the former is more independent of temperature and supply voltage level. The objection of Tapp and Clark that the UJT-SCR circuit requires a +24 v "operate" rather than a ground "operate" is not serious, given the advantages of stability. To get a ground "operate", one need only use a relay. A future article, will describe several variations on our basic circuit, including a grounded "operate" without relays as well as many more useful additions and substitutions.

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