A PRECISION INTERRUPT SWITCH WITH A VARIABLE DUTY CYCLE (NOTE)

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In many branches of science there are pieces of equipment which are operated in a periodic manner. From time-lapse photography to simulated night-and-day cycles or the periodic monitoring of transducer outputs, a variable-duty cycle switch is required. Mains-operated clocks with adjustable cam followers fulfil this need in the laboratory but are not suitable for remote field equipment.

The precision interrupt switch described here was designed to provide a variable duty cycle, from seconds to hours, for battery-operated field equipment as well as general laboratory use. It was used to control a battery-powered chart recorder being used to monitor hydrological events in a remote area.

CIRCUIT AND OPERATION

The circuit diagram of the switch is set out in Figure 1. It is based on a crystal clock and a divider network, the output of which drives a power transistor switch controlling either a relay or the equipment directly.

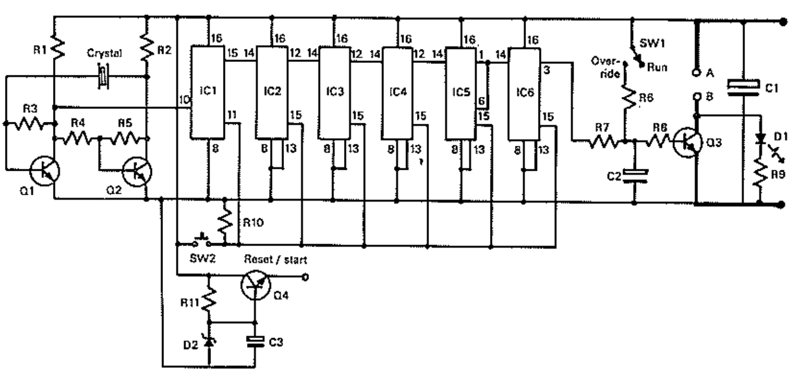

FIG. 1—Circuit diagram of the precision interrupt switch. Components are: Q1, 2–TIS92; Q3, 4–TIP33A; D1–LED; D2–9.1V Zener 1W; IC1–CD4040; IC2, 3, 4, 6–CD4017; IC5–CD4018; XTAL–204.8 kHz; SW1–S.P.D.T.; SW2–S.P.N.O. Push on; R1, 2–1.5 k Ω; R3–22 k Ω; R4, 5–47 k Ω; R6–2.7 k Ω; R7, 8–10 k Ω; R9–4.7 k Ω; R10–1 k Ω; R11–560 k Ω; C1–2000 µF 50 V; C2–15 to 25 µF 15 V; C3–100 µF 15 V. Note that a heat sink is required for Q3 and Q4.

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With a clock frequency of 204.8 kHz, the output from IC1 is 100 Hz. This is further divided through a series of decade counters IC2, 3, 4, and 6 and a programmable divide-by-n counter IC5. In use, the final duty cycle was set at 1 minute on and 9 minutes off. A reset switch, SW2, clears the divider network to all zeros, and the output will go 'on' with the first pulse from the clock. If a different output pin from IC6 is selected, the switch-on can be delayed up to 9 minutes after resetting.

An override switch, SW1, was provided to enable the equipment to be set up. This switch does not affect the duty-cycle output from the divider network. The output across points A and B will switch 10 volts at 10 amps for a 12-volt supply. If the full 12 volts are required, a relay should be fitted between A and B, and the relay contacts used to switch the power. A diode must be inserted across the relay coil to protect Q3. The diode D1 glows when the switch is 'off' and indicates that the circuit is powered up and operating.

In operation, the switch can be used to control the whole instrument or only a part of it, such as a drive motor. However, care should be taken to ensure that the equipment will tolerate frequent starting and stopping. Some types of DC motors will be damaged from this type of operation, but stepping motors normally operated in a pulsed mode are quite amenable to frequent switching.

Although only one output switch is shown in the circuit (Fig. 1) each output of IC6 can control an individual switch so that up to 10 inputs can be sequentially connected to a data logger if required.

The regulated 9-volt supply output was provided to power sundry auxiliary equipment on site.

CONCLUSIONS

The unit was successfully used with a three-pen Chessell 301 chart recorder. This recorder has a current drain of 1.2-1.5 amps at 12 volts when operating, and even with a battery pack of 90 amp hour capacity, it would normally need to be serviced at least once every 75 hours. Using

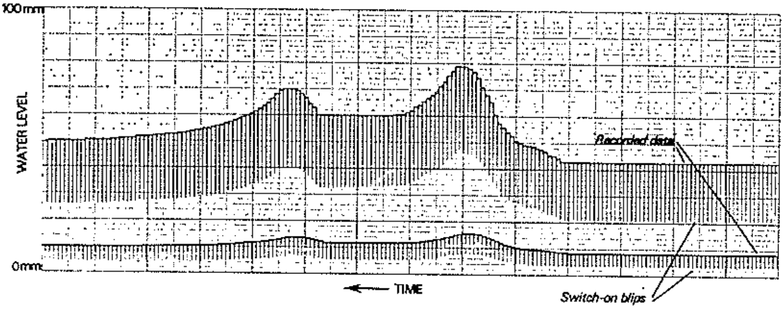

FIG. 2—A typical trace from the recorder, showing a small hydrograph as recorded using the interrupt switch and the water-level transducer of Anderson and Burt (1978). The blip occurs at the beginning of each 'on' period, which lasts 1 minute.

the interrupt switch with a duty cycle of 1 minute in 10 minutes, the same battery pack will last for up to 750 hours. Thus the between-service time can be increased to 30 days—which is an obvious advantage for a long-term study in a remote area.

Except when the parameter being monitored is changing very rapidly the loss of detail is minor and the greatest time error is 9 minutes. Figure 2 is a typical hydrograph obtained using the interrupt switch while monitoring a water-level transducer of the type described by Anderson and Burt (1978). The recorder switch-on blips at the beginning of each 'on' period are useful for checking the exact time of the event. With a long period between hydrological events, and the consequent recording of much redundant data, the saving in chart paper is also an advantage.

REFERENCE

Anderson, M. G.; Burt, T. P. 1978: Time-synchronised stage recorders for the monitoring of incremental discharge inputs to small streams. *Journal of Hydrology, Netherlands, 37*: 101-109.