NOTES

Conversion of a printing calculator to an inexpensive printing counter

DONALD A. CZECH

Marquette University, Milwaukee, Wisconsin 53233

A procedure is described for simple conversion of a printing calculator to an inexpensive printing counter. The unit is particularly useful for unattended data collection. A timing circuit controls printout of accumulated data at specified time intervals.

It is often necessary to record the occurrence and pattern of discrete events over extended periods of time. A standard procedure is to input switch closures or other brief signals into a printing counter that can be programmed, either internally or externally, to print accumulated counts at specified time intervals. Commercially available printout counters and associated electronics are usually expensive. This paper describes a relatively inexpensive method using a printing calculator. Printout intervals can be controlled with timing devices commonly found in psychology laboratories, or with simply constructed timing circuits.

Any commercially available printing calculator can be used if it has three features: constant addition, a print/no-print feature, and a key that can activate the print mechanism when the calculator is in the no-print mode. A calculator without automatic shut-off is preferred, although this feature can be bypassed. The constant addition feature permits the user to initially enter any desired value (e.g., a "1"), after which each subsequent activation of the addition ("+" key) (or the "=" key on some calculators) increments the total count by the value originally entered. Thus, successive input signals can be accumulated without the usual requirement of alternately entering the value and activating the addition key.

We selected a Sharp EL-1185, although other makes and models can be used (e.g., Sears Micro PD12, Sharp EL-1187, and Unitrex Classic 10). All are small hand-held units.

The required solder connections on the EL-1185 printed circuit board are shown in Figure 1. All operations are performed by closure of switches wired in parallel with the appropriate calculator keys. Connections are made from circuit board points to miniature female connectors glued to the outside of the case. Phono pick-up arm cable (32 AWG, stranded) is led out through a small hole drilled in the case. The male connectors are wired to the appropriate remote switches. For calculators other than the Sharp, one needs simply to locate two points that are connected to the two

Figure 1. Printed circuit board of Sharp EL-1185, showing connections that are shorted for incrementing constant (Points 1 and 2) and for activating printer (Points 3 and 4). Inset shows diagram of circuits.

contact areas (pads) for the key that normally controls the desired operation. Shorting out these points performs the operation, thereby verifying correctness of the selection.

With the Sharp the calculator is cleared and the desired numerical value selected by manually depressing the appropriate keys. Depressing the number key enters the constant to be incremented by each switch closure reflecting a behavioral event. The unit is then ready to accept data. Each time Switch A (wires 1 and 2 shorted) is closed, another entry is made and accumulated. Since the printer is always kept in the no-print mode, no printout occurs. At the end of a programmed time interval, switch B is momentarily closed, which causes the calculator to print the accumulated total. Unless cleared, this total remains in storage and additional closures of Switch A continue the accumulation of data. While additional circuitry can easily be added to clear and then reenter the constant at the end of each counting period, it is unnecessary if the user is willing to subtract successive printout totals to give the number of events counted during the preceding period. The units can be cleared and the constant reentered at some convenient time, perhaps once every 24 h or every week, depending on the duration of the experiment or the calculator capacity.

Figure 2. Schematic of timing circuit. External timing components should be of high quality. For example, resistors should be metal film types; acceptable low-leakage capacitors include polycarbonate, polystyrene, and tantalum types. Voltage/current requirements of the relay coil may necessitate inserting a relay driver (e.g., Signetics NE582) between the "one-shot" output and the coil. All resistance values are in ohms. Sample values provide for time intervals of 15, 30, 60, and 120 min. (Permission to reprint granted by Signetics Corporation, a subsidiary of U. S. Philips Corporation, 811 East Arques Avenue, P.O. Box 409, Sunnyvale, California 94086.)

Any appropriate timing circuit can be used to provide momentary closure of the print switch. We are currently using a Grason-Stadler Model 784 recycling timer; however, very simple and inexpensive timing circuits can be constructed (e.g., "Signetics Analog Manual," 1976; "Signetics Data Manual," 1976; Wolach, 1980). A circuit capable of providing a wide range of time intervals is shown in Figure 2 ("Signetics Analog Manual," 1976). The two halves of a 556 integrated circuit are connected in tandem with a binary counter connected in between. The first timer section (one half of the 556) operates as an astable multivibrator (i.e., clock) with the output signal applied to the N8281 counter. The counter provides four selectable time-interval outputs. The desired output is used to trigger the second half of the 556 (connected as a monostable multivibrator or "one-shot"), which in turn drives the coil of the print switch. The period of the astable multivibrator is determined by selecting appropriate values for R_a , R_b , and C ,

such that the total time period (in seconds) = $.693(R_a + 2R_b)C$.

These units have been used in the laboratory to obtain hourly counts of barpresses and activity wheel revolutions. It is important to note that the unit described here can be operated as a printing calculator whenever it is not being used as a counter, without requiring circuit changes.

REFERENCES

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