An automatic system for measuring average R-R interval

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In studies where many readings of average R-R interval are required, it is a time-consuming task to do this manually by measuring the R-R interval on a strip

chart recorder record. Therefore, it is desirable to have an automatic method of measuring the average R-R interval from a predetermined number of R waves. The system described here will print out the average R-R interval in seconds, 10ths of seconds, and 100ths of seconds of seven heart beats, together with the time into the experiment that the reading was printed out. This same method can be used to

A	B	F
0 low	0 low	1 high
0 low	1 high	1 high
1 high	0 low	1 high
1 high	1 high	0 low

Fig. 1. Positive-logic two-input NAND truth table.

average any number of heart beats.

The system described here was constructed with standard solid-state modules and a printer.¹ At the beginning of the experiment, the START pushbutton² is depressed, then the READ pushbutton is depressed. This will reset all flip-flops and the printer (Figs. 2 and 3). Next, activating the READ pushbutton will allow the following R wave to let pulses from the time base accumulate in the printer registers. Finally, the eighth R wave

Fig. 2. System logic diagram.

Fig. 3. System wiring diagram.

(seven R-R intervals) will reset the system and cause the average R-R interval and time to be printed.

Since the NAND function will be used in this system, a few definitions appear to be in order. The truth table for two-input positive-logic NAND (Fig. 1) shows that if either of the inputs is 0, the output is 1. Therefore, by applying an 0 to one input of a two-input NAND gate, the other input is inhibited, because, regardless of its state, the output will be 1.

Next, the theory of operation will be considered (Fig. 2). Activating the READ pushbutton produces a pulse that sets Flip-flop D, and the 1 out of Flip-flop D enables NAND Gate 1. On the other input of NAND Gate 1 is a negative-going pulse from One Shot 1, which is produced by the R wave. Note here that the adjustable Schmitt trigger is set to trigger only on the R wave by observing the indicator lamp of One Shot 1. If the interval between neon discharges is obviously too short, it would indicate that the R and T waves are both triggering the one shot. The condition would be corrected by increasing the trigger level of the Schmitt trigger. Then this pulse produced by the R wave will advance the divide-by-8 counter composed of Flip-flops A, B, and C. When these flip-flops are in any state other than reset, they will enable pulses from the time base to go through NAND Gate 6 and advance the printer.

The time base was set to produce a sensitivity of .01 sec. If only one R-R interval were to be measured, the time base would be set at .01 sec. But since seven R-R intervals are to be averaged, the time base is seven times .01 sec or .07 sec. This same basic method can be used to average more or less than seven heart beats by changing the counter (Flip-flops A, B, and C) and the time base.

Finally, when the eight R wave arrives (seven R-R intervals) Flip-flop C will trigger One Shot 2. This one shot will do three things. First it will reset Flip-flop D, thus inhibiting NAND Gate 1, and stop succeeding R waves from advancing the divide-by-8 counter (Flip-flops A, B, and C). Next, it will reset the divide-by-8 counter (Flip-flops A, B, and C). Lastly, it will cause the printer to print the time and average R-R interval. The system is now back in its initial state waiting for another READ pulse.

NOTES

1. Manufactured by Lehigh Valley Electronics, Box 125, Fogelsville, Pa. 18051.

2. It should be noted that START and READ can be initiated by other programming equipment in the experiment.

A transition from an electrode to coaxial cable

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A problem in the use of glass microelectrodes is the attachment of the pipette to coaxial cable for low noise recording. The transition described below provides a reliable simple means that also has sufficient rigidity to be held in a simple fixture. We have had a good bit of successful experience with it and find it to be much simpler to fabricate than a previously described electrode (Frey, Fraser, Siefert, & Brish, 1968) that was designed for chronic implant.

The transition is fabricated from an Amphenol 27-8 subminiature connector, a piece of rubber stopper, and 24-ga wire or tubing (stainless steel, platinum, silver, or other material). The final configuration is shown in Fig. 1. As may be seen, only the shell of the connector is used. The other components supplied for assembly within the shell are discarded.

A cork borer is used to cut a piece of rubber stopper that is pushed into the position shown. The fit should be tight. A 20-ga hypodermic needle is then passed through the center of the stopper and up through the top of the shell to act as a channel for the wire. The wire is passed through the needle and the needle withdrawn. As this is done, the wire is positioned as shown in the figure. The wire may then be kinked as shown to make a good friction fit within the glass pipette.

The end of the wire at the threaded end of the connector acts as the connector pin and mates with a female Amphenol 27-7 subminiature coaxial connector. The 27-7 connector is mounted on RG 196 coaxial cable that can be connected to an emitter follower and oscilloscope.

The end of the wire that acts as the mating pin within the 27-8 shell must be 24 ga in order to mate with the 27-7 connector. If the wire within the connector is larger in diameter, or if tubing is used, it must be tapered down to 24 ga at the pin

end so that it can mate with the 27-7 connector.

We have also used this transition as a hood electrode in isolated nerve fiber work. In this application, the hood typically must be smaller than 24 ga. This can be handled by using a 24-ga stainless steel tube within the shell. A portion of a 2-cm section of 36-ga stainless steel wire is then inserted into the tube and the tube crimped on it. No solder is used since the junction can get wet with saline. A hood can then be formed in the 36-ga wire left projecting from the end of the tube.

The connection to the indifferent electrode is not critical and can be made in a variety of ways. One way we have found useful is by a stainless steel wire soldered, with stainless steel solder, to the shell of the 27-7 connector.

REFERENCES

- FREY, A. H., FRASER, A., SIEFERT, E., & BRISH, T. A coaxial pathway for recording from the cat brain stem during illumination with UHF energy. *Physiology & Behavior*, 1968, 3, 363-364.

Fig. 1. Electrode to cable transition.