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LABORATORY INSTRUMENTATION AND COMPUTING

A Signal Generator for Testing Extracellular Recording Amplifiers and Probes

J. WAYNE ALDRIDGE,[1] SID GILMAN AND IGOR LEVIN[2]

Department of Neurology, University of Michigan

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ALDRIDGE, J. W., S. GILMAN AND I. LEVIN. *A signal generator for testing extracellular recording amplifiers and probes.* BRAIN RES BULL **21**(4) 711–712, 1988.—A portable signal generator that simulates the amplitude and frequency of neuronal signals for testing extracellular recording amplifiers is described. The signal generator is easy to construct and it is extremely useful in tracing signal processing stages in neurophysiological equipment.

Signal generator   Single unit recording   Extracellular   Amplifiers

NEUROPHYSIOLOGICAL investigations involving extracellular recordings require high gain amplifiers, and typically, many other signal processing stages. The large number of processing steps results in a proliferation of connections that must be continually maintained. We found that signal tracing was greatly facilitated by injecting a neuron-like signal at the electrode input point. The signal generator we describe produces an output similar in amplitude and frequency to an extracellular, single unit recording, allowing the entire signal processing pathway to be traced. Compared to previous calibrators, (1–3), this device is much smaller, simpler to construct and easier to use for maintaining signal processing pathways and equipment.

METHOD

The signal generator is a transistor relaxation oscillator designed for low level outputs and low current consumption. The circuit diagram is shown in Fig. 1. Initially, the transistors are switched off and the capacitor charges through the 4.7 megohm resistor. When the voltage on the capacitor exceeds the base voltage of the first transistor in the pair (2N3906) by 0.6 volts the transistors are turned on and the capacitor is discharged. The process then repeats. The square wave output at the collector of the second transistor (2N3904) is attenuated by a resistor voltage divider network and can be trimmed using a variable resistor (5K). The output signal of the oscillator has a frequency of 125 Hz and a duration of 1 millisecond (Fig. 1, inset). An output capacitor removes DC offset and provides three bipolar outputs. A low impedence output with an amplitude of 100 microvolts is available at LoZ (Fig. 1). A signal with a similar amplitude but an output impedence of 1 megohm is available at HiZ (Fig. 1). The high impedance output is used when the input stage of an amplifier must be tested using a more realistic simulation of an electrode's impedence. A third output provides a larger 10 millivolt signal that can be connected directly to an oscilloscope for triggering and as a reference to the processed signal. The circuit operates on one 1.5 volt battery with a current consumption so low that it can operate continuously for a duration near the shelf-life of the battery. To simplify construction, no on-off switch was installed. The circuit was constructed with point-to-point wiring on a small perf board and mounted in a small plastic box. The frequency and amplitude of oscillation is somewhat dependent

[1]Requests for reprints should be addressed to J. Wayne Aldridge, MSc., Ph.D., University of Michigan, Neuroscience Laboratory Building, 1103 East Huron, Ann Arbor, MI 48104.

[2]Present address: EDA Inc., 4095 Packard Road, Ann Arbor, MI 48108.

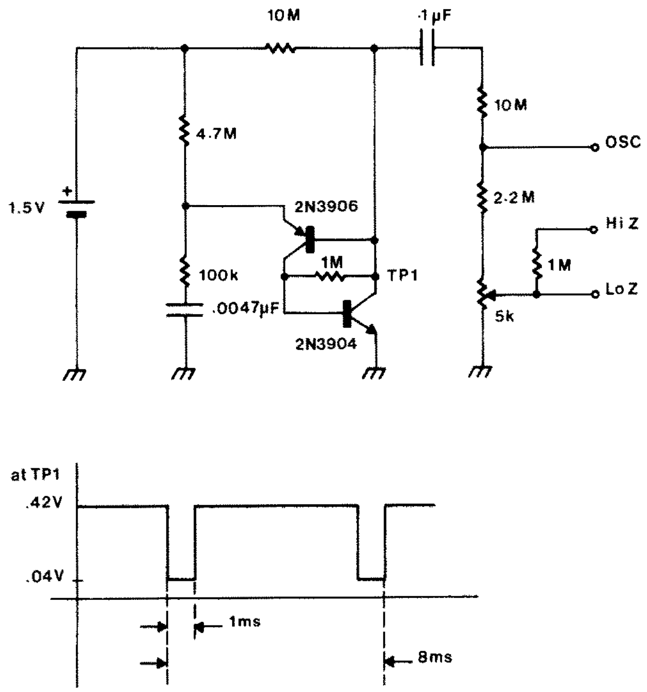

FIG. 1. Schematic diagram of signal generator. The two transistors form a relaxation oscillator whose period is determined by the capacitor and the 4.7 megohm resistor. The 5K resistor is used along with the 2.2 megohm and 10 megohm resistors to attenuate the output. The 0.1 microfarad capacitor removes DC potentials from the output. The output at LoZ and HiZ is set to approximately 100 microvolts. The actual voltage and pattern of oscillation seen at the test point TP1 is shown in the inset. The output voltage of OSC is higher (10 mV) and used for oscilloscope monitoring and triggering the output signal. At HiZ the output has a higher output impedance to simulate more accurately the impedance of a metal microelectrode.

on the battery voltage, however, this dependence can be minimized by using alkaline batteries, which have relatively flat voltage discharge characteristics.

The signal generator is especially useful in tracing through a chain of signal processing stages without having to actually record from an animal. Furthermore, its small size provides a useful debugging tool that can be used during actual recording sessions. Perceived electrode problems are quickly confirmed or ruled-out by temporarily replacing the electrode input with the signal generator. We have been using this device for several years and it has become an indispensable laboratory tool.

ACKNOWLEDGEMENTS

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