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Short communication

AMPLITUDE DISCRIMINATOR FOR BIOLOGICAL IMPULSES

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Abstract. A simple amplitude discriminator with two ways of triggering DC-level monitoring is described. This system is based on easily available inexpensive integrated circuits.

In the method of extracellular recording both the phase ratio and amplitude of the action potentials are to a considerable degree dependent upon the position of the microelectrode in relation to the neuron under observation. This feature of extracellular recording is of no importance as long as the patterns (of neuronal discharges) are analyzed without a computer. When we attempt a mathematical analysis of neuronal spike trains which aims at discovering some regularities in neuronal response to a given stimulus, that is, at defining its response patterns, it is necessary to convert the action potential into a standard electrical pulse. The pulse must have constant parameters, precisely defined by the requirements of the computer, such as amplitude, rise time and duration.

Conversion of action potentials into standard pulses that can be accepted by a computer is accomplished by devices called discriminators of biological impulses (triggers). These devices have an adjustable level of standard pulse triggering, which ensures the selection of the required action potential from the complex recordings of bioelectrical activity. There are several electronic solutions to this problem (1, 2). They are based, as a rule, on the mode of action of the Schmitt flip-flop system or the

bistable generator of Eccles–Jordan. The design of the discriminators differs mainly in the method of monitoring the standard pulse triggering levels and in the ways of monitoring their operating accuracy.

The discriminator of bioelectrical impulses designed by us operates as a voltage comparator and is designed to be an interface between conventional biological amplifiers (in the ON-line system) or magnetic tape recorders (in the OFF-line system) and various analyzers working on TTL input levels. Due to the use of integrated circuits the apparatus is inexpensive and its construction easy. The use of an additional Z system (modulation of the oscilloscope beam's brightness at the moment of standard pulse generation) allows an instantaneous identification of a biological potential converted into a standard pulse. It also greatly simplifies the setting of the triggering level of the discriminator and makes it easier to photograph the potential from the oscilloscope screen.

The amplitude discriminator for biological potentials consists of the following functional units: preamplifier with input divider, comparator, reference system, phase invertor and modulation system Z (Fig. 1). The functions of each unit are briefly described below.

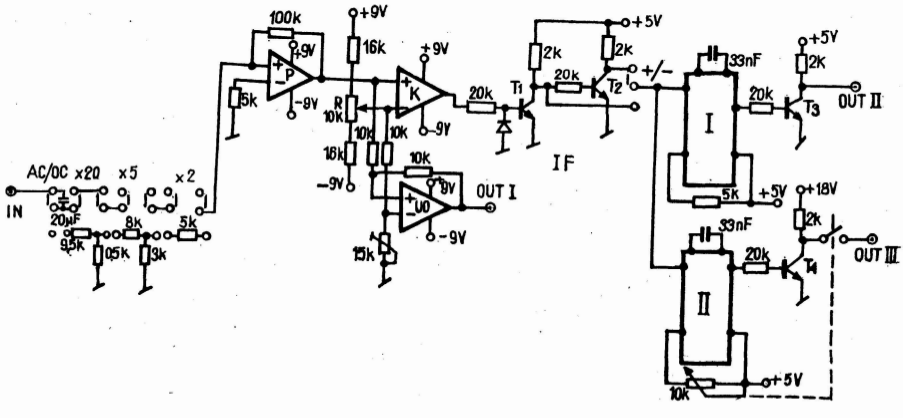

Fig. 1. Schematic diagram of the amplitude discriminator. For detailed description see text.

The measured action potentials of a neuron are led through the input divider to the preamplifier P, from which, after initial amplification, they are led simultaneously to comparator K and reference system UO (these systems are based on operational amplifiers SN-74709). In the reference system with unity gain, a summation of the input signal with the reference level takes place. After the summation, the signal is carried to the first output, marked "out-I" on the diagram.

In the comparator K the signal is compared with the triggering level set at the required value with the vernier potentiometer R. The differential signal arising as a result of this operation is fed to the phase invertor. The +/− switch allows one to choose the positive or negative part of the signal for triggering. The selected differential signal is conducted to two independent forming systems. These systems are based on univibrators (SN-74121). The first of them generates a standard pulse supplied by the transistor T_3 (type BSX-98) to the standard pulse output, marked "out II" on the diagram. The second forming system generates an impulse modulating the brightness of the beam. The pulse from this system has a constant amplitude and controlled duration. After amplification at transistor T_4, the pulse is fed to the control output III.

The discriminator described above can monitor the standard pulse triggering level in two ways. The first type of standard pulse triggering control is performed by the reference system. That system has to shift, in relation to zero level, the mean value of the sweep studied by the negative value of the triggering voltage. It allows a precise setting of the triggering level on the oscilloscope. The release of the standard pulse takes place precisely at the crossing point of the studied waveform with the zero level. The advantages of this method are apparent when we want to select and analyze some impulses from a burst of action potentials. The other method of setting the triggering level involves the use of the brightness modulation system Z. Actually, this system facilitates the taking of photographs of the sweeps from the face of oscilloscope and considerably improves their technical quality. Because the beginning of the beam brightening signals the moment of standard pulse initiation this system can also be used for monitoring the triggering level. Such a method of selection of triggering level is of particular advantage in the studies of sporadically appearing action potentials or in the recording of potentials in chronic experiments on unanesthetized animals, that is in conditions when the analysis time is limited.

1. CALVIN, N. H. 1973. Some simple spike separation techniques for simultaneously recorded neurons. Electroenceph. Clin. Neurophysiol. 34: 94–96.
2. MILLAR, J. 1983. A "Wavegate" spike discriminator for sorting extracellular nerve action potentials. J. Neurosci. Meth. 7: 157–164.

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