In 1963 at the Leningrad M. A. Bonch-Bruevich Electro-technical Communications Institute a method of multiple-point control of dc voltages with the aid of standard pulses was proposed. On the basis of this method, several types of pulse controlling devices were developed. They include devices for centralized visual control, automatic trigger control, and automatic adjustment [1, 2].

The characteristic property of the pulse controlling devices is that they can be used to control dc voltages without establishing a galvanic connection between the controlled and controlling apparatuses. This simplifies the control of ungrounded circuits.

Using pulses as standard signals simplifies the monitor since the same pulses may be used for switching, readout, and indication of the monitored points. Pulse control allows remote transmission of the number of a failed element (for trigger control) and switching interrogator points when several independent objects are being monitored. A feature of the pulse method of monitoring is its rapidity.

Comparison Elements of the Pulse Controlling Devices. The monitored voltages obtained by the method of standard pulses are appraised on comparison elements that include nonlinear resistances such as semiconductor diodes. The purpose of these elements is to produce variations in the pulses at their output under the influences of the variations of the controlled voltages applied to them. Several diagrams of elements such as these are shown in Fig. 1.

The fundamental component of the comparison element (Fig. 1a) is a diode blocked by the monitored voltage applied to it through an additional resistance. The pulse voltage \( U_p \) is periodically applied to the same diode in its forward direction through a separating capacitor. Depending on the ratio of the pulse amplitudes \( U_{mp} \) and the value of the monitored voltage \( U_k \), the pulses at the output of the element may be practically nonexistent for \( U_{mp} < U_k \) or may have amplitudes determined by the difference \( U_p - U_k \). It is obvious that in such an element a decrease in the monitored voltage will produce an increase in the amplitude at the output of the element and vice versa.

The comparison element in Fig. 1b compares two dc voltages without establishing galvanic contact between them. This element contains two diodes; the pulse voltage at its output depends not only on the ratio of the monitored voltage and the standard pulse, but also on a reference voltage \( U_r \) that blocks diode \( D_2 \). Obviously in this comparison element the amplitudes of the output pulses will be directly proportional to the monitored voltage and inversely proportional to the reference voltage blocking diode \( D_2 \).

The comparison element in Fig. 1c may be used to monitor zero voltages $U_k = 0$ since an output signal appears at the output when the monitored voltage differs by a certain (given) amount from zero. Then the pulse at the output of the comparison element will increase independently of the sign of the exciting monitored voltage. Triggering for each monitored voltage can be set by choosing the reference voltage $U_r$ directly on the comparison element as shown in Fig. 1c.

Comparison elements for pulse monitoring devices may be constructed with other inertialess linear resistances such as stabilitrons. However, the selection of a comparison element should be evaluated for each given case.

The properties of pulse monitoring devices basically depend on the characteristics of the comparison elements. This includes their input impedance referred to the monitored points, gain, and the stability of the output pulses. The characteristics of the comparison element shown in Fig. 1a are discussed below.

The input impedance of this element is linear and its value depends on the operating mode of the device. However, in practical cases when the amplitude of the pulses does not exceed the monitored voltage by more than 1.5 to 2 times, the spacing of the pulses is more than 100 times the pulse width, and the internal resistance of the monitored circuit is much less than the back impedance of the diode, the effect of the mode on the input impedance may be neglected. In this case the input impedance of the comparison element is determined by the back resistance of the diode.

The gain of the comparison element implies the ratio of an increment of the amplitude of the output pulse $\Delta U_{m \text{ out}}$ to an increment of the monitored voltage $\Delta U_k$

$$K = \frac{\Delta U_{m \text{ out}}}{\Delta U_k}.$$