MICROPROCESS MEASUREMENT CHANNEL UNDER GROUP 
SWITCHING OF RESISTIVE SENSORS

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A method and a version of designing multichannel measurement converter of a microprocessor system designated for carrying out measurements utilizing resistive sensors are described. To simplify the circuitry implementation of the hardware it is suggested to combine algorithmic methods of providing accuracy with the measuring procedures.

A number of measurement problems in automatization of technological processes, scientific investigation and trials involving complex objects are associated with measuring numerous parameters of the same type. To measure these parameters, resistive sensors (such as wire and semiconductor thermoresistances) are widely used. The availability of computational devices in modern measurement systems allows us to utilize — when designing multi-channel measurement converters (MMC) — the basic principle of their construction which combine maximal simplicity of their circuitry implementation with the feasibility of algorithmic methods of providing for metrological reliability and implementation of measuring procedures. In particular, the application of testing methods to provide for accuracy of measurements allows us to eliminate from MMC's sources of supporting voltages and currents, the elements which require a long term and temperature stabilization of parameters as well as utilization of unstabilized feeding sources.

To simplify the circuitry implementation of MMC with a group switching-in of resistive sensors it is proposed to utilize the model depicted in Fig. 1. Resistive sensors \( R_{x1}, ..., R_{xn} \) are switched-in sequentially with a calibrating resistor \( R_0 \). In the circuit with sensors and calibrating resistor the same current \( I_0 \) passes through which generates a drop in voltage on the sensors \( U_{x1}, ..., U_{xn} \) and \( U_0 \) proportional to their resistances. The input commutator \( BK \), condenser \( C \) and an auxiliary key \( S_2 \) form a multichannel device of selection and storage. A special feature of such a connection of the measuring circuit and the condenser with key elements is the possibility of measuring a drop in voltage directly on the sensors rather than relative to the overall wire. Moreover, a sequential combining of resistive sensors allows us to feed them by means of a single current which — as it will be shown below — may be nonstabilized. This allows us to simplify the implementation and to decrease the energy consumption for the MMC excluding sources of a stable current. A buffer amplifier \( A \) with a high input resistance and an analog—digital converter (ADC) are also included in the MMC.

At the initial state the keys \( S1.0 \) and \( S2 \) are in a closed position. The key \( S2 \) is opened only when the voltage at the given channel is measured, i.e., during a cycle of ADC's operation. At the end of each conversion cycle the key \( S2 \) returns to its initial position. In the first operational cycle the key \( S2 \) is opened and at the output of the MMC a code \( N_H \) is formed corresponding to the zero input potential \( U_H = 0 \). After the first cycle is completed, the key \( S2 \) is returned into the initial closed position. At the beginning of the second cycle the key \( S2 \) is being opened and the key \( S1.1 \) is closed. Moreover, at the input of the amplifier \( A \) the voltage \( U_0 \) sets up almost instantaneously and is being converted into code \( N_0 \). The key \( S1.2 \) closes up at the third cycle and at the input of the amplifier the voltage difference \( U_1 - U_0 = U_{x1} \), is attained which corresponds to the code \( N_1 \). Here the resistance of the first sensor is

\[
R_{x1} = \frac{U_{x1} - U_0}{I_0} = \frac{N_1 - N_0}{N_0 - N_0} R_0.
\]
Fig. 1. A model of switching-in of resistive sensors.

Analogously for the resistance of the $i$-th sensor we have

$$R_{ei} = \frac{U_i - U_{i-1}}{I_0} = \frac{N_i - N_{i-1}}{N_0 - N_1} R_0.$$  

The main advantages of such a measuring method are the absence of requirements related to long-term stability of the current in the measuring circuit $I_0$ and an automatic correction of errors in the measuring channel due to the introduction of a correction $N_H$. This permits us to simplify substantially the circuitry implementation of a MMC excluding the elements which require long-term and temperature stability of characteristics and simultaneously to reduce the requirements concerning the stability of the feeding voltages in the measuring circuit as well as the converter as a whole. The main requirements here is the linearity of the conversion characteristic which is substantially simpler to implement. It should also be noted that in the case when the amplifier $A$ possesses a high input resistance, the resistive sensors can be connected to the MMC without taking any measures to compensate for the effect of resistances of the connecting wires.

Based on the construction principles described above, a MMC for resistive sensor have been developed whose operational model is presented in Fig. 2. The basic units of a MMC are: a multichannel input commutator $BK$, a device for selection and storage with a control transfer coefficient $DSS$ on the operational amplifier $OA$, ADC of time-pulse conversion, an address counter of the channel $CA$ and a control system $CS$. At the beginning of measurement procedure an initial address of the channel $ACO$ is introduced into the address counter $CA$ by means of a signal of loading clearance $SLP$. The initialization of the operation is assured by a simultaneous feeding of an external signal $TAKT$ at the counter $CA$ and the control system $CS$. The $CA$ transfers the address of the selected channel $AK$ at the input commutator $BK$. The signal controlling scheme $UK$ opens the keys $SW2$ and $SW3$ and clears the count at the counter of the results $CP$ into the ADC. The signal at the input of the integrator $U_i$ changes in accordance with a linear law. The cycle pulses fill in the counter $CP$. As soon as the equality of the voltages $U_i = U_{th}$ is attained, the threshold element generates a signal which via the $CS$ closes the keys $SW2$ and $SW3$. The signal $ZPR$ from the $SC$ prevents further counting by the $CP$; the $CS$ generates the readiness signal $REA$ which indicates the completion of the conversion with the result in the form of a digital code $N_t$ in the counter $CP$. After the result of the conversion is computed by the microprocessor, the next cycle commences and so on.

Two special features of circuitry implementation of a MMC ought to be mentioned. The possibility of a change in the coefficient of transmission of the scheme DSS by feeding the control signal $COS$ is accounted for which allows us to utilize sensors with very different nominal resistances. To convert positive as well as negative voltages a displacement voltage is fed via the resistor $R_{sm}$. 

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