ATTESTATION AND CHECKING OF MEASURING INFORMATION SYSTEMS BASED ON THE USE OF A COMPUTER

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In various branches of industry the testing and control of complex products is seeing the ever wider spread of automatic measuring and information systems (AIIS), the central assemblage of which is a digital computer. Similar systems are being used especially widely in the testing of motors [1-3]. In [2-4] there is a consideration of problems in defining the precision indicators of AIIS's.

The overwhelming majority of AIIS's of the type under consideration are being developed and manufactured for enterprises in a restricted number without mass production, and as a result these systems can be attested and checked by departmental metrological organs.

The normalized metrological characteristics for the set of measuring agents forming automatic measuring systems, including those belonging to the automatic control systems are defined by GOST 8.009-72. However, in setting up the AIIS's, which carry out complicated mathematical processing, a number of additional problems arise: should the attestation of the AIIS include in itself the determination of the precision indicators for the output parameters and of the characteristics of the goods which are being checked; precisely what precision indicators should be monitored in the checks; how to determine the main errors of the AIIS in drafting, if only the main errors of individual transformers are known.

The AIIS's used in the testing of complex products carry out oblique measurements of a number of parameters calculated from the results of measurements on certain physical quantities.

The algorithm for processing the results of measurements may include an approximation of the results of oblique measurements of functions of one or another sort, which express the dependence of some calculated parameters on others (construction of characteristics), and also the checking of the values of the monitored parameters given definite values of the parameters arguments.

A similar type of problem is solved for example by the AIIS, used in testing motors [1]. Obviously the most important metrological characteristics of the systems under consideration include the precision indicators of the measurements. The measurement errors of the output parameters include, apart from instrumental errors and errors of mathematical processing, also errors caused by the method of measurement (for example from the number of measurements of a fluctuating parameter on a given time base).

Given a definite measurement method, the method errors depend on the behavior with respect to the time of the physical quantities, the values of which are determined by direct measurements. These errors can change from one product to another.

In practice, in any case of the use of an AIIS to check complex products of machine construction, there is no opportunity to determine experimentally the measurement errors of the parameter which is being checked and it is necessary to determine these errors by calculation.

In the USA, in order to evaluate the maximum measurement error in testing motors, they use a method [2] in which there is expert evaluation of the upper limit of the systematic error introduced by each influencing factor, and the total error is determined by quadratic summation; random errors are evaluated from the statistical data and the upper limit is determined of the total random error given a confidence limit of probability of 0.95. The maximum error of an AIIS is determined by arithmetic summation of the upper limits of the total systematic and

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and random errors. The method set forth is used to determine errors of the systems introduced into use. Interesting properties of it are the use of expert evaluation of the systematic errors and methods of summing them.

It is obvious that the measurement errors in output parameters of goods, which depend on the type dimensions of the monitored goods, and sometimes on peculiarities of the monitored sample, cannot usefully be employed in attesting and verifying the AIIS, so one has to use precision indicators of individual measuring circuits. In this context as the final transformer of the measuring circuit one must consider the computer working in accordance with a program for calculating the value of the physical quantity for measuring which the circuit under consideration is designed.

These indicators can be used also in attesting and checking automation systems, which, apart from the functions of collecting, processing and presenting information, also carry out control functions.

In checking an AIIS, just as in checking ordinary instruments, it is necessary to compare the results of measuring any physical quantity in definite conditions with a system and checking agents which possess higher accuracy. Obviously the checking must be carried out with a definite type of input signal. The simplest case is checking in static conditions. It is in precisely these conditions that most instruments are checked (manometers, consumption meters, tachometers, etc.).

In order to check the measuring circuits of the systems under consideration it is advisable to use the basic errors which should be determined during their attestation and normalized in technical conditions on the AIIS.

Let us consider the problem of determining the basic error of the AIIS's measuring circuit at the planning stage.

The method of determining the basic error of the measuring circuit is based on the information which the designer nowadays has at his disposal. Given fuller data on the metrological characteristics of individual circuit transformers, in accordance with GOST 8.009-72, it will be possible to improve considerably the stringency of the calculation methods used and the reliability of the results obtained.

Figure 1 shows by way of an example the circuit for measuring the pressure in a measuring and information system put together on the basis of modules belonging to a computer technology assemblage system.

The measured parameter P is transformer 1 into the frequency of a variable current, and then in the transformer 2 the signal received from the primary transformer is transformed into a sequence of pulses of the same frequency which have the amplitude and duration required for further transmission and transformation. When the commutator 3 is switched on the sequence of pulses falls onto the input of the frequency-digital transformer block 4, in which the frequency of the pulses is transformed into a number N connected with the frequency which is being transformed. The commutator 3 and the transformer 4 are so designed as to be joined in an installation for feeding in the frequency signals (IFFS) (UVChS).

The number N so obtained is connected with P by a familiar relationship determined in the present case by graduating the measuring circuit through simultaneous loading by means of the hydraulic press of the primary transformer and of the model manometer in the range in which one is interested, with successive approximation to the relationship which is being obtained by a polynomial of which the coefficients are found by the method of least squares.

In the measuring process the computer, having obtained the number N from the IFFS, calculates the value of P by means of the relationship just mentioned.

In order to evaluate the accuracy of a system like this only the basic errors of the measuring transformers are used, without indicating the random and systematic errors and other data (GOST 8.009-72). In these conditions it is possible to try to evaluate the basic error of the measuring circuit.

Measuring circuits designed to measure and check very important parameters in goods are graduated in assembled form.

By way of a typical method of engineering calculation for the basic error in a measuring circuit subject to graduation in assembled form, we adduce the method of computing the measuring circuit for the pressure shown in the Figure, assuming that during the checking normal working conditions are guaranteed for all its modules. (When measurements have to be made with high accuracy normal working conditions can be guaranteed in use as well).