MULTIPROBE MICROWAVE MULTIMETER ERROR ESTIMATION A PRIORI

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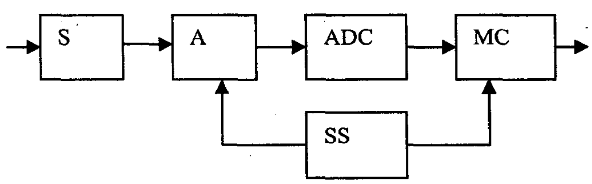
At a functional design stage there is a necessity of a prior estimation of general error in connection with the requirement specification. Thus such element and structural links should be selected, that the estimation has not left for limits by given one. Pursuant to a technique of general error definition it is necessary to know or to set limiting values of individual components of errors, their distribution functions and to distinguishing from them dominant ones, to study a capability of correction.

In multiprobe microwave multimeter the following series transformations is performed: analogue transformation, digitization of an analog quantity, digital processing of the digitized values under the algorithms realized by programs. The structure and contents of model is given, which one describes transformation of error and its accumulation, at stages of measurement transformation. Construction of model we begin from one measurement channel observation.

The metrology model of a channel is under construction on the basis of a functional diagram. It serves for the description of metrology properties, and also for an estimation of the influential factors and degree of their influencing on measurement result. Metrology model is set of mathematical descriptions of relation of an input signal of measurement device from an input signal with taking into consideration of all possible influential factors. Thus, for each measuring unit it is necessary to reveal the influential factors and to evaluate error caused by them. The functional diagram of a channel multiprobe microwave multimeter is given in figure



S-sensor, ADC-analog-digital converterь, SS-supply source, MC-microcontroller

The sensor error has some components, first of all error is caused by a frequency dependence of a sensor transformation coefficient. About a distribution law of this error there are no information, therefore, the supposition about an rectangular error distribution is made, so transformation coefficient error in the freguency range is 4 %.

The temperature change of feedback loop resistance of the amplifier can cause gain coefficient change, that is additional multiplicative error. Taking into account a little temperature coefficient of resistance of resistors, it is possible to suspect, that the adding multiplicative error caused by the amplifier will be ten time less than error of other units of a measurement channel. For an operational amplifier exist temperature drift of zero. The error is distributed under the normal law with standard deviation 0,25 %. Also we shall calculate error from nonlinearity of the amplifier, that is distributed by rectangular law is 0,46 %.

Let's calculate error of a discretization of an eight-bit analog-digital converter, equal half of rightmost bit. As a distribution law of error even than standard deviation is 0,11 %. For an analog-digital converter there is an error of an initial zero drift, setting norms we shall receive standard deviation 0,04 %. The influential factors for an analog-digital converter is temperature and reference voltage. The error of ADC nonlinearity is additional errors. Supply source has instability 0,005 %. The error distribution corresponds to the triangular law. Let's estimate summary additive and multiplicative error component at a confidence coefficient 0,95 and confidence factor 1,1 Sad=0,59 % Smul=7,8 of %. (main error contribution is given by sensor).

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After digitization there is a transformation of error during algorithmic processing. The algorithm error estimation is performed in two stages. At the first stage, because of an initial set of equations linearity, the inverse matrix will be used to express standard deviation of intermediate variable through standard deviation of sensors

$$(\sigma P)^2 = \left(\frac{1}{2(\cos\theta - 1)}\right)^2 (\sigma P_1)^2 + \left(\frac{\cos\theta}{(\cos\theta - 1)}\right)^2 (\sigma P_2)^2 + \left(\frac{1}{2(\cos\theta - 1)}\right)^2 (\sigma P_3)^2$$

$$(\sigma \Delta P \cos\varphi)^2 = \left(\frac{1}{2(\cos\theta - 1)}\right)^2 (\sigma P_1)^2 + \left(\frac{1}{2(\cos\theta - 1)}\right)^2 (\sigma P_2)^2 + \left(\frac{1}{2(\cos\theta - 1)}\right)^2 (\sigma P_3)^2$$

$$(\sigma \Delta P \sin\varphi)^2 = \left(\frac{1}{2\sin\theta}\right)^2 (\sigma P_1)^2 + \left(\frac{1}{2\sin\theta}\right)^2 (\sigma P_3)^2$$

Weighting coefficients are

$$w1 = \frac{-\Gamma}{P_{na\partial}(1+\Gamma^2)}, \quad w2 = \frac{\cos\varphi(1+\Gamma^2)}{2P_{na\partial}(1-\Gamma^2)}, \quad w3 = \frac{\sin\varphi(1+\Gamma^2)}{2P_{na\partial}(1-\Gamma^2)}$$

$$w4 = \frac{(1+\Gamma^2)}{(1-\Gamma^2)}, \quad w5 = \frac{-2\Gamma\cos\varphi}{(1-\Gamma^2)}, \quad w6 = \frac{-2\Gamma\sin\varphi}{(1-\Gamma^2)}$$

$$w6 = 0, \quad w7 = \frac{\cos\varphi}{2\Gamma P_{na\partial}}, \quad w8 = \frac{-\sin\varphi}{2\Gamma P_{na\partial}}$$

From here

$$\sigma_\Gamma = \sqrt{(w1)^2(\sigma P_1) + (w2)^2(\sigma P_2)^2 + (w3)^2(\sigma P_3)^2}$$

$$\sigma_{P_{np}} = \sqrt{(w4)^2(\sigma P_1) + (w5)^2(\sigma P_2)^2 + (w6)^2(\sigma P_3)^2}$$

$$\sigma_\varphi = \sqrt{(w7)^2(\sigma P_1) + (w8)^2(\sigma P_2)^2 + (w9)^2(\sigma P_3)^2}$$

From calculation results draw conclusion. That there is a relation of accuracy of measurements of single-wavelength multimeter to frequency, the error increases on edges(boundarice) of frequency, and the minimum takes place at phase spacing interval between adjacent transmitters 120°. So there are two direction for further investigation, first of them is increasing of frequency band by structurally algorithmic methods, the second is grounding an optimality sensor dislocation apart 120° on base of conditionality number.

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