ANALYSIS OF PHASE DISTRIBUTION OF THE FIELD IN A TRANSMISSION LINE WITH LOSS AND ESTIMATION OF LOSS IMPACT ON ERRORS OF PHASEMETRIC METHOD OF IMPEDANCE MEASUREMENT

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Some analytical relationships for phase distribution of the electromagnetic wave in an unmatched transmission line with loss are derived. The presence of loss results in distortion of phase distribution, manifesting itself in changing extremum values and their coordinates. The cases of the single-probe and two-probe analysis of phase distribution are considered. The author estimates the error of the suggested method of phasemetric measurement of the module and argument of the complex reflection factor when the error is caused by the loss in the transmission line for both cases.

One of the challenging problems in radio measurements consists in improvement of accuracy and in expansion of dynamic range of power in the channel of measurers of the complex reflection factor (CRF). In essence, these devices are the measurers of microwave two-pole impedance.

Extensive use in radio measurements is made of devices based on analysis of amplitude distribution of the electromagnetic wave in a transmission line: measuring lines, impedance pick-ups, multipole reflectometers, etc. [1–3]. These devices can be used in the dynamic range of power not exceeding 30 dB — because of non-quadratic characteristics of the power detectors, installed in these meters for analysis of the amplitude distribution. Efforts to raise the dynamic range of such devices result in a dramatic growth of measurement errors [1, 2].

In our previous works devoted to an ideal line without loss [4, 5], we suggested and investigated the phasemetric method of CRF measurement based on analysis of phase distribution of the electromagnetic wave in a transmission line. It has been proved that in practice this method makes it possible to expand the dynamic range at least by 40 dB — due to elimination of power detectors and the change to phase measurements.

The purpose of this paper is investigation of loss impact on phase distribution of the electromagnetic wave, and estimation of errors of the phasemetric method of measurement caused by this factor.

Consider a segment of length $L$ of a regular transmission line, excited by an unmatched microwave generator in the plane 1–1’ and terminated by an unmatched load $L_d$ in the plane 2–2’ (Fig. 1).

Due to interference of the incident wave and the reflected one, in the transmission line we observe the mixed-wave condition, characterized by a certain amplitude and phase distribution. Let us analyze the phase distribution of the electromagnetic wave along the transmission line and establish the relation between peculiarities of this distribution and the CRF module and argument for the load $L_d$ under the loss conditions in the transmission line. Without loss of generality, the initial phase of the wave $E_o$, falling from generator’s side in the plane 1–1’, is set equal to zero.

The complex amplitude of the resulting wave in some cross-section of the path, at an arbitrary distance $l$ from the plane of the load connection, may be written as [6]
REFERENCES

1. V. D. Starikov, Microwave Measurements with the Use of Measuring Lines [in Russian], Sov. Radio, Moscow, 1969.

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