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Microwave Networks I

Session Chair: Eric Bergeault, ENST, Paris, FRANCE

WEPB4-7.

MICROWAVE MULTIMETER FOR THE HIGH LEVEL POWER CONTROL.

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Abstract

This report is devoted to the problem of designing and constructing the built-in multiprobe analyzers of microwave signals and fider parameters. There has been considered the structure of a universal passig power sensor based on absorbing wall principle and used for high level passing power measurements.

Multimeter operation principle

The report is devoted to the problem of designing the built-in multiprobe analyzer of microwave signals and fider parameters, called multimeter. The multimeter operation principle is based on automatic processing of signals from five passing power sensors spaced on $\lambda_m/6$ in the wave-guide between the generator and the load, where λ_m - is middle wavelength of the waveguide wave band [1]. The processing unit of the multimeter calculates incident, reflected and passing to the load power, module and phase of the load reflection coefficient by a special algorithm. Rigidly programmed monocrystal microcomputer used as the processing unit realizes this algorithm, including adaptive one, that takes into account frequency change in the working waveguide wave band.

The processing algorithm

The calculation algorithm of the measured parameters has been obtained from the equation system solution for the passing power sensor signals. There has been suggested the choice criterion of the sensor arrangement on the waveguide, that ensures the best stability of the signal processing algorithm to some disturbance. There also has been considered the error sources and the way to minimize them using the mathematical apparatus of linear algebra. Having chosen conditionality number criterion, an imitational modeling was made taking into account main factors resulting in distortions. The dependencies characterizing the algorithm stability to external action at different distances between neighboring sensors were obtained and the choice of optimal equidistant sensor arrangement in the transmission line was substantiated from the minimal error point of view. As the analysis showed, such a distance was one sixth of the wavelength in the waveguide.

In the frequency band it is suggested to trace out frequency change introducing a correction coefficient, calculated on the basis of the signals during the measurements, into the algorithm. It can be realized by means of additional sensors use. When the working wavelength differs twice from the middle one, then the sensors, arranged twice closer than initially, are switched on.

The passing power sensors

Thermistors, bolometers, volume thermocouples and others can be used as sensors. The authors suggested sensors based on the absorbing wall principle for the transmission line measurements of high level average and pulse power [2]. One version of such sensors intends substitution of one of the regular waveguide walls for thin constantan film (20÷50 mkm), the temperature distribution on it's surface repeats power distribution in the waveguide with certain accuracy. Arising systematic errors are taken into account while processing sensor signals, i.e. algorithmically. In this case the thin film equidistant thermocouples, based on bismuth and surma, are recommended as temperature sensors. Technologically this version is complicated. Another suggested version of the sensor based on the absorbing wall principle can be considered as universal and more technological and recommended for serial production. This sensor consists of a cylindrical housing, an absorbing element and a ring formed thermopile battery placed inside the carcass. The absorbing element represents a thin absorbing wall of nickel, constantan or stainless steel brazed to the housing endface. The sensor is screwed in the waveguide wall in such a way, that the absorbing element stands flush with the internal waveguide wall surface. This sensor is exchangeable and can be graduated in any cross-section of the waveguide by a sample device, for example by a calorimetric powermeter. The sensor transformation coefficient is almost independent of frequency band, when electromagnetic wave polarization in the waveguide is circular. The use of a DC amplifier in the processing unit allows to increase dynamic band of the multimeter up to 60÷80 dB. The measurement error components are analyzed in the report, the whole measurement error is less than ±5%.

References

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