DESCRIPTION FOR GENERAL PUBLIC

Microwave measurements significantly differ from electrical measurements performed at lower frequencies. An electrical signal having the frequency of several GHz can be radiated and received by antennas, it can also penetrate objects. These phenomena are widely used in sensor systems utilizing an influence of the measured physical parameter, such as properties of liquid being penetrated by a microwave signal, or displacement of object from which the signal is reflected, on the electrical signal measured by an appropriate apparatus. As fundamental devices serving for such measurements vector network analyzers are commonly used, which nowadays can be found in a majority of microwave laboratories. Such analyzers, however, feature considerable size, significant complexity and high price. Although they work well in laboratory conditions, due to the above drawbacks the cannot be applied in sensor systems operating at microwave frequencies, where circuitry simplicity, possibility of miniaturization, and low costs of the measurement system production are crucial issues. The listed advantages characterize multiport measurement systems, which are suitable for sensor applications as these mentioned above. In general multiport systems are composed of a passive multiport power division network, signal source and power detectors. With the use of at least three power detectors and an appropriately designed power division network one can obtain the functionality of a vector network analyzer utilizing, however, a significantly simpler measurement circuitry. Thus, nowadays the multiport systems are commonly used in sensor systems, e.g., for detection of the angle of signal arrival, remote measurement of displacement and vibration, solution concentration or fat content in milk.

During the previous research the applicant has developed a series of innovatory multiport measurement systems and has conducted a comprehensive analysis of their measurement uncertainty depending on the parameters of the utilized power division network and power detectors. In this analysis it has been shown that the measurement uncertainty of multiport systems results from the power division of the utilized multiport network, and such an uncertainty distribution is non-uniform in terms of the measured complex value. To ensure the best measurement quality it is crucial to provide the lowest uncertainty within the range of values measured be the considered sensor system. It should be emphasized that signals measured by sensor systems usually feature an insignificant variation. However, currently used multiport systems are designed to minimize the average measurement uncertainty for a wide range of the measured values. It is a consequence of their primary application as an alternative for vector network analyzers. Having determined a narrow range of the signal variation for a given sensor application a multiport system can be designed in such a way that in the measurement range being of importance it features the minimum measurement uncertainty. Then the obtained uncertainty can be significantly decreased with respect to the uncertainty of the currently used multiport systems, which is the main research hypothesis of the project. The described multiport systems featuring a narrow measurement range have not been investigated until now. Therefore, the goal of the project is the development of methods for analysis and designing of the multiport measurement systems, which will ensure a significantly reduced measurement uncertainty for a narrow range of variation of a signal corresponding to the measured physical parameter. Moreover, a research on the power division scheme providing the minimum measurement uncertainty, required number of the utilized power detectors, and calibration techniques will be conducted. The developed multiport systems will be utilized in measurements of physical parameters (e.g., solution concentration, or object displacement), which will be their experimental verification.