Novel algorithms for the characterization of n-port networks by using a two-port network analyzer

B. Will (1), I. Rolfes (2), B. Schiek (1)

(1) Ruhr-Universität Bochum, Institut für Hochfrequenztechnik, Universitätsstr. 150, 44801 Bochum

(2) Leibniz Universität Hannover, Institut für Hochfrequenztechnik und Funksysteme, Appelstr. 9A, 30167 Hannover

The measurement of the scattering matrices of n-port networks is an important task. With the so-called multi-port method it is possible to identify the scattering matrix of almost every n-port network by using a vector network analyzer. For this purpose two ports of the n-port network are connected with the network analyzer and the remaining ports are connected to reflecting terminations. In order to specify the scattering matrix of a n-port network with the multi-port method, n reflecting terminations are required from which at least one reflection factor needs to be known.

There are some cases, in which the multi-port method shows weak convergence properties. For example, a 3-port signal divider, consisting of three lines connected in the form of a T-junction, cannot be identified if the reflecting terminations used are short circuits and if the line length is equivalent to an odd integer multiple of a quarter wavelength. This is due to the fact that the two ports connected to the network analyzer become decoupled.

Two new algorithms, named the sub-determinant method and the wave-identification method, respectively, which employ a second set of reflection terminations that have to differ from the first set, allow to identify every n-port network without the necessity to distinguish different cases. If every port is connected to two different reflecting terminations, there is always one situation with a finite coupling between the two ports connected to the network analyzer. Both methods are based on least square algorithms and allow to identify all scattering parameters of a n-port-network directly und uniquely.