MEASURING ODD- AND EVEN-MODE PROPAGATION CONSTANTS OF COUPLED-LINES BY MEANS OF THE LATTICE NETWORK

Alberto Hernández-Escobar[1], Elena Abdo-Sánchez[1], Jaime Esteban[2], Teresa M. Martín-Guerrero[1], Carlos Camacho-Peñalosa[1]

[1] Departamento de Ingeniería de Comunicaciones, E.T.S. Ingeniería de Telecomunicación, Universidad de Málaga Andalucía Tech, Bulevar Louis Pasteur 35, 29010 Málaga, Spain

[2] Information Processing and Telecommunications Center, E.T.S. Ingenieros de Telecomunicación, Universidad Politécnica de Madrid, Avenida Complutense 30, 28040 Madrid, Spain

{ahe, elenaabdo, teresa, ccp}@ic.uma.es, jesteban@etc.upm.es

ABSTRACT

A classic method for measuring the propagation constant of transmission lines is the one proposed by Bianco and Parodi more than four decades ago [1]. It is based on the invariance of the cross ratio of four complex numbers under a bilinear transformation. This means that it is possible to extract the value of the propagation constant (both real and imaginary parts) of an arbitrary transmission line (TL) by measuring, through an arbitrary (and unique) two-port, the input reflection coefficient of four TL sections of different lengths provided they are terminated by the same load. The accuracy of the original method can be greatly improved by measuring a higher number of TL sections and taking all the possible combinations of four lines.

The performance of the method can be further improved by properly selecting the section lengths. In doing so it is possible to measure with high accuracy both the attenuation and phase constants over a very wide frequency band from only reflection coefficient measurements.

In this contribution, an extension of the Bianco-Parodi method for measuring odd- and even-mode propagation constants of coupled-lines from only two-port measurements is described. The method requires four coupled-line sections with different lengths, loaded with the same arbitrary impedances, and connected to the network analyser by the same symmetric four-port. The resulting structure is a symmetric two-port that can be modelled by a lattice network [2]. It can be easily proved that each of the two lattice network branch impedances are independently controlled by the odd- and even-mode propagation constants, respectively. As a consequence, it is possible to extract both propagation constants, by using twice the Bianco-Parodi method, from only the S-parameters of the overall two-ports.

Again, by increasing the number of coupled-line sections and with a proper choice of their lengths, it is possible to obtain a high accuracy over a very wide frequency band. As in the original method, no calibration is required.

The performance of the described method has been initially assessed by extracting the odd- and even-mode propagation constants from numerically simulated measurements. Experimental work is on progress.

REFERENCES

[1] B. Bianco and M. Parodi, “Measurement of the effective relative permittivities of microstrip,” Electronics Letters, Vol. 11, No. 3, pp. 71-72, 1975.

[2] J.E. Page, J. Esteban, and C. Camacho-Peñalosa, “Lattice Equivalent Circuits of Transmission-Line and Coupled-Line Sections,” IEEE Transactions on Microwave Theory and Techniques, vol. 59, no. 10, pp. 2422-2430, October 2011.