Statistical Distribution of the Induced Voltage in Two Coupled Wave-chaotic Cavities

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***Abstract*— According to the BLT EM topology, a large complicated system can be systematically broken into a topological network on which the BLT equation is implemented to compute the induced voltage or current. In this paper, the BLT equation is applied to a network of two wave-chaotic cavities that connected by a transmission line when excited at the source port. The statistical distribution of the induced voltage calculated by BLT equation will be presented, which is in good agreement with that by others methods.**

Key words- BLT equation, wave chaos, induced voltage

I. INTRODUCTION

The well-known BLT EM topology was formulated by Drs. C. Baum, T. K. Liu and F. M. Tesche in 1978 to analyzing the RF coupling into large complicated enclosures such as aircrafts, ships and buildings [1]. In this paper, a simple network including two wave-chaotic cavities connected by a cable (see fig.1) is chosen to implement the BLT equation and the statistics of the induced voltage will be presented as well as compared with that computed by other methods.

II. EXPERIMENTS

Fig. 1 is the schematic diagram of the experiment setup. Each cavity is a real computer box and excited by two ports. The mode stirrer comprises a central copper shaft and two orthogonally-oriented blades coated with aluminum foil. First, measure the scattering matrix of each box, denoted by $\boldsymbol{S_{1\text{-}2}}$ and $\boldsymbol{S_{3\text{-}4}}$ respectively. By rotating the shaft for 250 different positions, at each position, the scattering matrix is measured from 4GHz to 15GHz in 11001 equally space steps. Second, connect port 2 and port 3 with a 1m coaxial cable and measure the ensemble of the scattering matrix between port 1 and port 4, denoted by $\boldsymbol{S_{1\text{-}4}}$. In addition, the scattering properties of the cable is measured, denoted by $\boldsymbol{S_c}$.

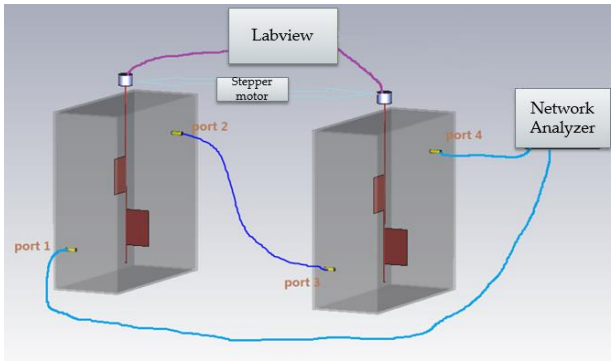

Figure 1. Schematic diagram of the experiment setup

III. DATA ANALYSIS

Assuming that the excitation at port 1 is a voltage source with a flat spectrum of 1V, when the port 2 and port 3 are connected, three methods are used to calculate the induced voltage V_4 at port 4: a) compute V_4 by the directly measured $\boldsymbol{S_{1\text{-}4}}$; b) calculate the scattering properties between port1 and port4 from $\boldsymbol{S_{1\text{-}2}}$, $\boldsymbol{S_{3\text{-}4}}$ and $\boldsymbol{S_c}$ by electrical network theory to compute V_4; c) apply the BLT equation.

Randomly selecting a frequency range, making the probability density function (PDF) of V_4 for all the positions, it's found that the PDFs of V_4 calculated from the above three ways are in good agreement. Fig. 2 presents the PDFs in 6GHz-7GHz. Fig.3 shows the PDFs for the full test frequency range from 4GHz to 15GHz.

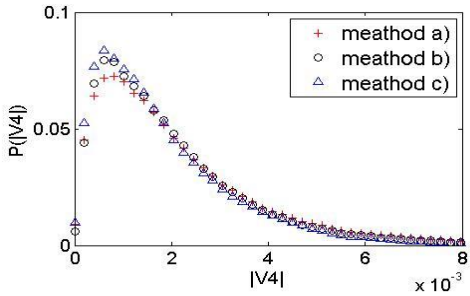

Figure 2. PDFs of induced voltages in 6GHz-7GHz

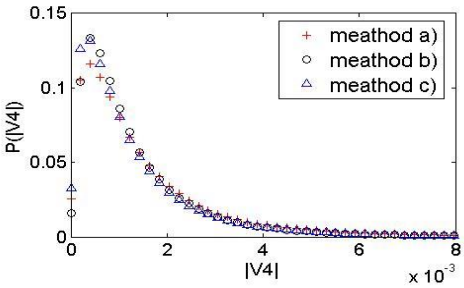

Figure 3. PDFs of induced voltages in 4GHz-15GHz

IV. CONCLUSION

It's concluded that the BLT can be applied to calculate the induced voltage on a topological network of wave-chaotic cavities. By cooperating with the random coupling model which characterizes the statistical fluctuation of the scattering matrix of a wave-chaotic cavity, it's expected to make statistical prediction of the induced voltage at target point within a large complicated system when exposed to HPM radiation.

REFERENCES:

[1]. Baum, C.E., T.K. Liu and F.H. Tesche, on the analysis of general multiconductor transmission-line networks. Interaction Note 350, 1978.