Evaluation of Antenna Coupling based on Measurements and Numerical Simulations

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***Abstract*—Integration of antenna measurements in numerical simulations, based on the equivalent current technique, has been validated in previous activities [1-8]. A link, enabling the export of an accurate numerical model, derived from the measured antenna pattern, to a number of commercial Computational Electromagnetic (CEM) solvers has been created and validated [9-14]. The equivalent current processing and the link have been implemented in the commercial INSIGHT software [4]. This tool has recently been applied to antenna placement problems to investigate the antenna radiation pattern in embedded conditions [1-3].**

This paper discuss an extension of the link between measurements and simulations in antenna placement scenarios applied to the evaluation of antenna coupling problems.

***Keywords*— antenna, simulation, measurement, antenna coupling.**

I. Introduction

The use of Near Field (NF) representation of antenna measured data in terms of equivalent currents, computed by the commercial tool INSIGHT [1-3], is available in most CEM solvers [9-14]. Thanks to this approach, if measured data is available, it can be used to enrich numerical simulations in complex and/or large EM scenarios where antennas are installed. In the previous studies, validation of this approach was focused on determining the antenna radiation pattern in antenna placement problems.

The combination of measurements and simulations can be extended beyond antenna placement which is basically a scattering problem. When a radiator is placed in close proximity with other antennas, coupling becomes a key factor to be evaluated in terms of conducted S parameters. This is a crucial aspect that has not been investigated yet and is presented in this paper.

Analysis has been carried out on a dual slant +45°/-45° polarized array of three identical elements, shown in Figure 1. Only the radiation pattern of the central element of the array has been measured in stand-alone configuration. Then the coupling between the other elements has been predicted from measured data by numerical simulations. Accuracy of the procedure has been investigated by comparison with measured data of the entire array antenna.

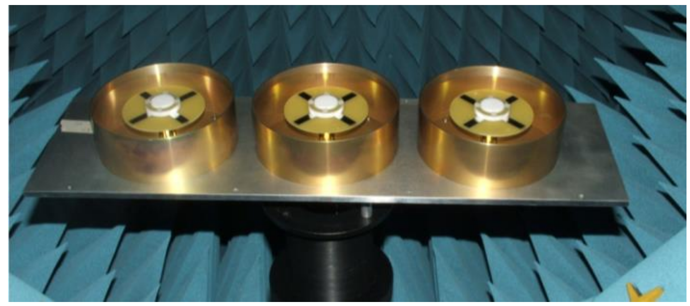


Fig. 1. Linear array of three elements.

II. Testing Procedure

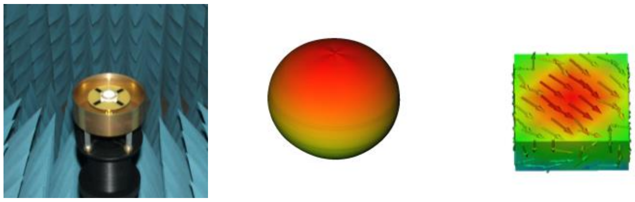
Testing procedure combining measurements and simulations consists in the following steps:

- Measurement of the single element of the array and preparation of the measured NF source;
- Import of NF source in the CEM tool [9] and installation in the array configuration;
- Numerical simulation of the antenna coupling between the measured model and the other two element of the array. Each element has two feeding ports implementing the dual slant polarization.

No information about mechanical and/or electrical parameters are needed, since the measured NF model in terms of equivalent currents fully represents the antenna.

III. Source Preparation

The single element of the array consisting of a cavity-backed crossed-dipole antenna, see Figure 2 (a)-(b), has been measured in the MVG StarLab measurement system [15] in the frequency range [1.7-2.2] GHz, feeding the -45° port. NF equivalent currents representation of the antenna, see Figure 2 (c) at three frequency points (1825MHz, 1940MHz, 2055MHz) have been determined. The +45° port is loaded with 50 ohms. The frequency points under test have been selected in the range where the antenna efficiency is maximized in order to get as more information as possible from the dynamic of the radiation pattern.



(a) (b) (c)

Fig. 2. Source preparation procedure: (a) array single element in the StarLab measurements system; (b) NF radiation pattern @1940MHz; (c) equivalent electric J currents, Huygens box @1940MHz.

IV. SOURCE INSTALLATION

Measured NF source has been imported in the CEM tool [9] (blue box) and installed in the array together with the other elements, as is shown in Figure 3. Antenna ports are illustrated in red color. Ports 1, 3, 5 are -45° polarized, ports 2, 4, 6 are +45° polarized. Position of port 1 and 2 should be known.

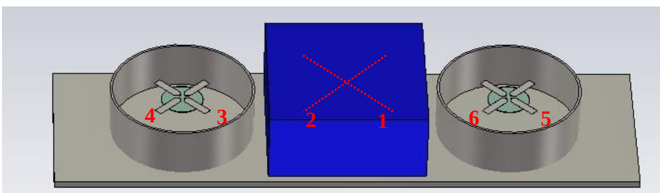


Fig. 3. Installation of the measured source in the array simulated model.

V. RESULTS

The inter-element coupling of the 3 element array has been simulated from the model in Fig. 3 using the measured source and full wave simulation [9]. The coupling between port 1 (-45°) of the central element and the ports of the other elements has been investigated. Measurements conducted on the array in Fig.1 are compared to the simulations as shown in Figure 4.

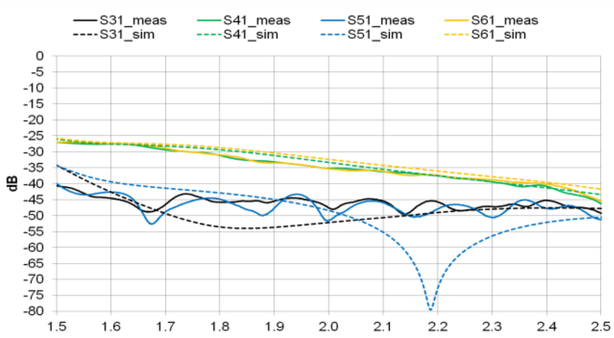


Fig. 4. Antenna coupling between the central element (port 1) and the other two elemennts (ports 3-6). Comparison between measurement (meas) and simulation using the measured NF model of the central elemenet (sim).

The level of port 1 coupling to port 4 and 6 is higher than port 3 and 5, as expected. Comparison in terms of coupling average values over the range: 1.7-2.2 GHz are reported in Table 1. Preliminary agreement is acceptable. Deviation between the measured and simulated S31 and S51 are due to measurement errors that is more evident at this low level of signal.

TABLE I. ANTENNA COUPLING: AVERAGE VALUES 1.7-2.2GHZ.

	S31	S41	S51	S61
Measured [dB]	-45.66	-33.75	-47.13	-33.88
Simulated (NF model) [dB]	-51.89	-32.40	-49.88	-31.47

VI. CONCLUSION

Post-processing by the equivalent current technique enables measured antennas to be used as sources in numerical simulation. In this paper, the method has been applied to evaluate coupling between array elements. The preliminary result are encouraging showing that realistic coupling levels can be determined. The study is still on-going to improve the accuracy of the results and including new test cases of different complexity.

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