BROAD BAND SENSORS CALIBRATION BY A GTEM CELL

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ABSTRACT

Increasing interest of public for non ionizing radiation hazard and local authorities surveillance necessity demand for -easy to use, reliable measurement instrumentation [1]. Triaxial sensors, with their inherent large frequency response, are excellent candidates to reduce in field difficulties related to narrow band tools utilization, as antennas connected to spectrum analyzer. GTEM cell [2,3] is a relatively novel tool in EMC field, the use of which seems overcome some limitations of standard TEM cells [4] and antennas. The continuos improvement in theory of operation and manufacturing broadens its field of application from canonical electromagnetic compatibility radiated immunity and radiated emission tests [5,6]. The large operation frequency range (from DC to some GHz) and the compact design, well suited to laboratory use, offers the opportunity of conduct fast tests at a convenient location.

1. INTRODUCTION

A preliminary GTEM cell (EMCO 5302 model) characterization is presented in order to investigate its capability in broad band sensors calibration. VSWR, Electric Field Uniformity, etc., are measured and their values compared to specifications. A compact broad band electric field sensor is used to assess consistency and repeatability of measurements. Comparison between GTEM data and field strength values evaluated by this sensor, independently calibrated by manufacturer, is displayed and the optimum position of the sensor inside the test volume is investigated. In order to optimize test time and repeatability an *ad hoc* software is implemented to drive all used instrumentation. Finally, critical evaluation of GTEM performances is presented and suggestions are given to improve its reliability.

2. MATERIALS AND METHODS

In fig. 1 is presented a scheme of GTEM cell we investigated about. This model is sufficiently compact to occupy a modest room volume, and its weight is tolerable by common bench.

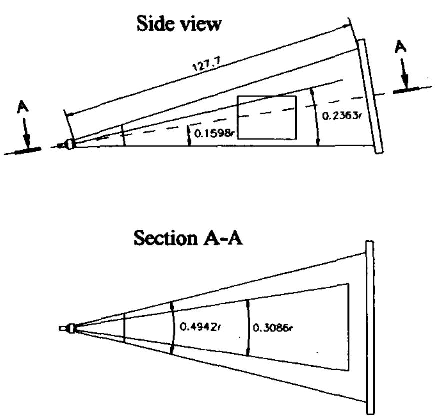

Fig. 1: Side and plant view of EMCO 5302 GTEM! model.

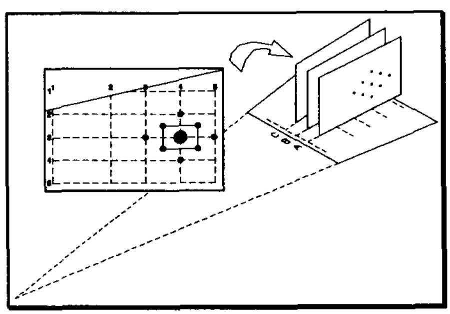

Fig. 2: Layout of measurement points. On each plane orizontal spacing is 4.5 cm and vertical spacing is 3 cm. Points in the inner surface were chosen midway closer neighbors. Planes separation ranges from 3 cm near the apex cell to 4.1 cm near the end cell.

After first evaluations was evident that results were not affected by door position, therefore it was removed to improve inside access. All measurements were so performed using lateral door aperture.

Field uniformity has been evaluated in three vertical planes bounding a volume of trapezoidal shape of approximately 8 (w) x 13.5 (l) x 14 (h) cm^3 (fig. 2). On each plane twenty-five measurement points were selected, even if only highlighted ones are presented. The central point is halfway septum height.

Experimental set up differs according to parameter to be measured. Time domain measurements were performed with a TDR HP 54121T and a RF Impedance Analyzer HP 4191A directly connected to cell input. Field measurements were performed using a HP 437B Power Meter, a Farnell PSG 1000 RF Source, a Kalmus 747LC 50W amplifier, a Werlatone 1795 coupler and an Alenia broad band Electric Field sensor 18RV1001-1. All instruments were driven by appropriate software LabVIEW based (National Instruments), developed by the authors, *via* a GPIB bus. In fig. 3 is shown a typical test set up.

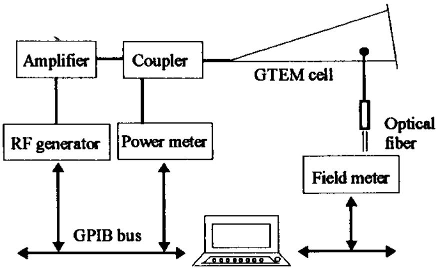

Fig. 3: Electric Field measurements test set up.

3. TDR MEASUREMENTS

Fig. 4 presents the TDR of cell in two different configurations. Traditional time axis is replaced with length axis to improve readability. Connector section shows most of the noise, as expected. Some variations are present in the transition zone where septum meets resistors. It is worth that, substantially, impedance does not exceed 54 Ω in the working region (approximately 78-105 cm far from apex). Various tests were made to assess influence of external factors on data repeatability and a negligible impedance variation is only present in correspondence with side aperture. As a matter of fact, TDR measurement with opened side door presents variation of about 1 Ω.

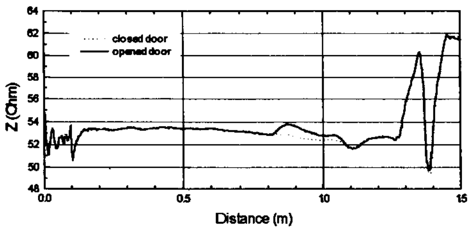

Fig. 4: TDR measurement of GTEM cell with closed and opened side door.

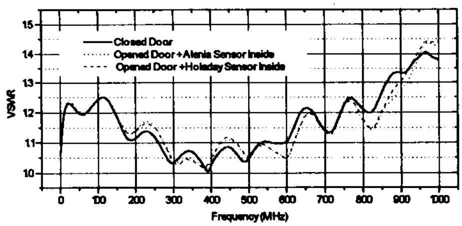

Fig. 5: VSWR measurement of GTEM cell: closed side door (continuum), opened side door with Alenia sensor inside (dotted) and opened side door with Holaday sensor inside.

Further analysis was made computing VSWR of the cell (fig. 5). Specifications declare a value (1.5:1) higher than our result, but manufacturer documentation includes a graph where VSWR is in substantial agreement with present data. Most range shows a value less than 1.2 while a maximum of 1.4 is found at 966 MHz.

Sensor insertion changes a little the shape, but not in a significant way. On the other hand, different sensors (e.g., Holaday STE sensor) were proved to identify eventual problems, but results show no significant differences.

4. FIELD MEASUREMENTS

Electric Field Strength measurements have been used to state field uniformity inside the cell. This parameter is relevant because it is related with the maximum DUT volume the cell can house. The generated fields were around 100 V/m with a 300 V/m full range.

In fig. 6 a comparison between the central point (position B[3,4]) and the rightmost one (position B[3,5]) is shown. The maximum difference is 2.7 dB at 940 MHz.

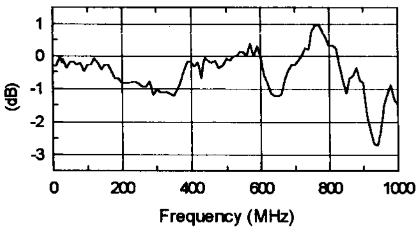

Fig. 6: Electric Field Uniformity on plane B between the central point (position B[3,4]) and the rightmost one (position B[3,5]).

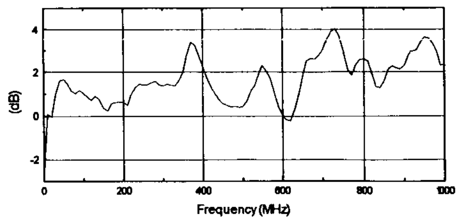

Fig. 7: Electric Field Strength difference between GTEM cell values and Alenia sensor at the central point position.

It is worth to point out that most of data differs for less than 1 dB. Analogue results hold for the other positions. These preliminary results allow a moderate optimism in the optic of a possible use of GTEM cell as sensor calibrator.

Fig. 7 shows the results of comparison between Electric Field Strength measured at position B[3,4] (central point) by the Alenia RV181001-1 sensor (calibrated by the manufacturer) and the Electric Field Strength as computed by geometrical GTEM parameters. The latter calculus was implemented by a dedicated software and correction for coupler insertion loss, coupler coupling factor and GTEM VSWR were taken into account. In the worst case the mismatch is comprised in 4 dB.

5. CONCLUSIONS

GTEM cell is becoming a valuable tool in performing some specific test up to now realizable only by means of different integrated approaches as TEM cells and anechoic chambers or large OATS sites. In particular, some interesting perspectives open in the field of sensors calibration. Drawbacks found at certain frequencies suggest that further investigations are required, but results in the most of frequency range are valuable ones.

Attention must be paid in frequency characterization of instrumentation in use. In our experience, common ten points often delivered with instrument by manufacturer are inadequate to probably describe the behavior in the full working range and interpolation is a rough expedient to solve the lack of data.

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