FIELD INVESTIGATION OF PARALLEL-PLATE EMC SIMULATOR

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ABSTRACT

This paper deals with analysis electromagnetic field distribution in parallel-plate EMC simulator and presents results of simulation and measure for expansion of simulator working region in frequency domain.

1. INRODUCTION

Nowadays, it becomes quite important to assess electronic devices from the point of view of electromagnetic immunity against RF interferences. It is due to progress of terrestrial and also satellite radio and television broadcasting and especially to great expand of mobile communications. It is necessary to generate homogeneous electromagnetic field of high intensity and defined waveform to test electromagnetic compatibility of given devices. This is the purpose of EMC simulators.

2. SIMULATORS APPROXIMATED BY WIRES

This paper interests in analysis near-field radiation of wideband parallel-plate EMC simulator for testing electromagnetic immunity of large objects. Especially, it examines how the structure of electromagnetic field in working region of simulator is modified according to changes in number of wires.

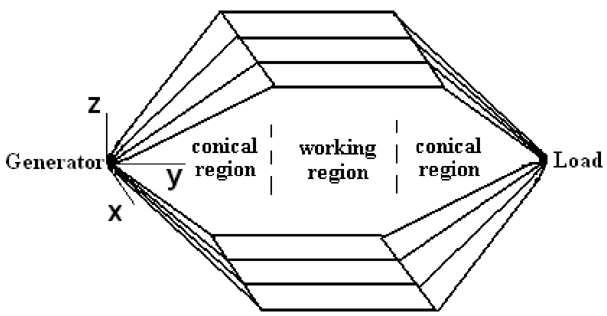

Fig. 1: Hexadrical EMC simulator

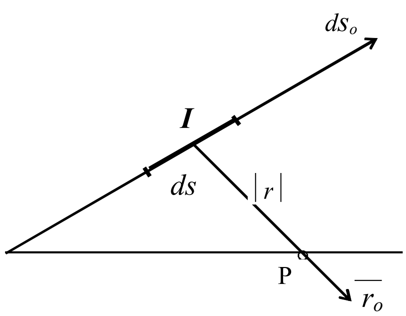

Fig. 2: Evaluation of field intensity

Fig.1 shows the shape of hexadrical simulator. It is metallic strip line which can be symmetrical and also asymmetrical and consisting of three parts. Side parts are sloping so that connection of power supply and matched load can be easily done. Simulator is usually made of plane system of equidistant parallel connected wires. If we consider only side wiring not the center part we are talking about so-called rhombic simulator. Tested device is then placed in the middle of the simulator among the wires.

2.1. THEORETICAL CALCULATION OF FIELD DISTRIBUTION OF EMC SIMULATOR

The main idea of calculation of field among the simulator wires is to divide the wires into finite number of small elements *ds*. Expression for radiation of elementary dipole in harmonic stabilized state is used to evaluate contribution of each segment to total electric field *E* and magnetic field *H* in the point of observation P [2]

$$\vec{E} = \frac{I ds}{4\pi}\frac{k^3}{\omega\varepsilon}\left[\frac{\vec{r}_o \times (\vec{r}_o \times \vec{ds}_o)}{kr} + \frac{3(\vec{r}_o \cdot \vec{ds}_o)\cdot\vec{r}_o - \vec{ds}_o}{(kr)^2} - \frac{3(\vec{r}_o \cdot \vec{ds}_o)\cdot\vec{r}_o - \vec{ds}_o}{(kr)^3}\right] e^{-jkr}\cdot e^{j\omega t} \qquad (1)$$

$$\vec{H} = \frac{I ds}{4\pi}k^2\left[\frac{j}{kr} + \frac{1}{(kr)^2}\right](\vec{ds}_o \times \vec{r}_o)\cdot e^{-jkr}\cdot e^{j\omega t} , \qquad (2)$$

where $d\bar{s}_o$ and $\bar{r}_o$ are unit vectors in direction of element *ds* and in direction from the center of element to point P as is shown in Fig.2. It is clear that distribution of field inside the simulator depends mainly on the number and position of wires and on the current distribution in them.

3. FIELD DISTRIBUTION INSIDE THE SIMULATOR

Important demand on simulator is homogeneity of field in the working area and resulting workable space inside the simulator. Positions in which differences in intensity were less than ± 3dB were set as the working area. 8-wire hexadrical simulator (symmetrical) (see Fig.1) was analyzed. The center horizontal part was placed from 7 m to 12 m from the feeding point of the antenna and the total length was 15 m. The width of central part was 4,5 m a the height was 4,9 m. The wires were placed equidistantly.

3.1. COMPARISON OF THEORETICAL CALCULATION

Using the MATLAB and the technique described in section 2.1 values of field intensity *E* and *H* on frequencies 40 MHz, 60 MHz and 80 MHz were achieved. Field distribution inside the simulator was examined in four planes z = 0,2 m , 0,8 m, 1,4 m and 2 m bounded by $x \in \langle -3;3\rangle\, m$, $y \in \langle 1;14\rangle\, m$ depending on the height of the plane. Magnetic field distribution in plane z = 0,2 m on the frequency 40 MHz is shown in Fig. 3.

To verify theoretical results of field distribution obtained by (1) and (2) same structure was simulated in 4nec2. Also measurement of magnetic field distribution on a dimension reduced model of hexadrical simulator was carried out.

The results of analysis of magnetic field distribution using program 4nec2 in plane *z* = 0,2 m is shown in Fig. 4. Measurement of the magnetic field was carried out on a made of asymmetrical hexadrical simulator. Scale factor of the model was 1:10 (Fig. 5). Coaxial cable ended probe and selective microvoltmeter R & S (Fig. 5) were used to measure intensity of magnetic field. Measurement results of magnetic field distribution in plane z = 2 cm on frequency of 400 MHz is shown in Fig. 6.

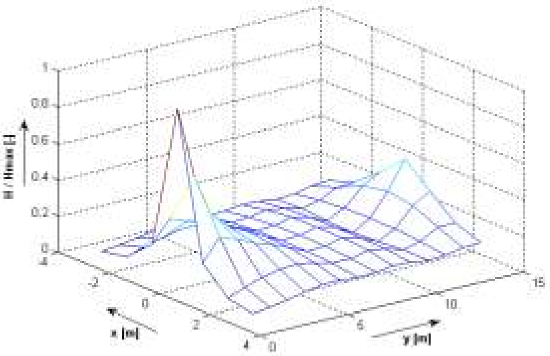

Fig. 3: Magnetic field distribution (MATLAB)

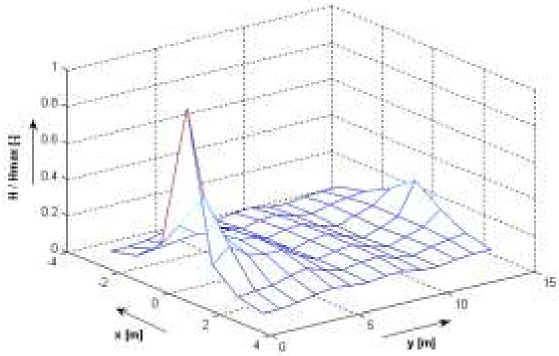

Fig. 4: Magnetic field distribution (4nec2)

Fig. 5: Made model of simulator and shielded loop with selective microvoltmeter

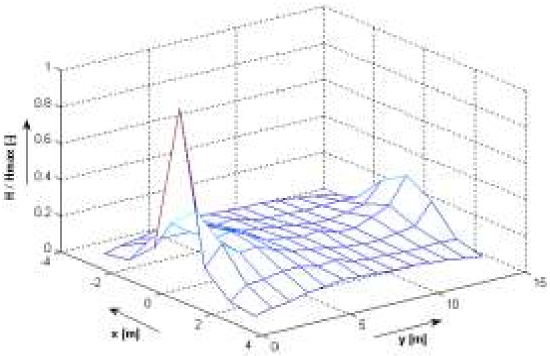

Fig. 6: Magnetic field distribution

4. CONCLUSION

Using (1) and (2) and comparing with results from moment method (4nec2) and from measurement dimensions of working area 8-wire simulator were specified. It was find out that field distribution in the working area of simulator changes slowly. Greater non-uniformity of distribution is in transverse direction than in lengthwise. Intensity grows towards the input part or the load and on sides of the area intensity drop is greater than in the middle of the horizontal part. It is due to the decreasing of distances between wires in the conical part of the antenna. Position under the sloping part of simulator in distance 2 m (z = 0 m) can be still regarded as the working area because of fulfilment of the criterion. Notice that structure of the field near the input part is more suitable that the field near the load. Therefore it is recommended to place tested devices near the input part. Field distribution in the working area do not dramatically changes with the change of frequency.

REFERENCES

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[2] STRATON, J. A. Theory of electromagnetic field. Prague, SNTL 1961