Honeycomb Ventilation Grill Shielding Effectiveness Measuring Methodology

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Abstract— In the article assessment methodology of shielding effectiveness of ventilation panels of small overall dimensions made in the form of honeycomb with the use of the computer simulation method has been presented. Methodology and description of simulation environment for measuring shielding effectiveness of ventilation panels by the method of computer simulation have been shown. Final effect of simulation software operation is characteristics of shielding effectiveness of a tested ventilation panel in the frequency function. In order to conduct validation of simulation software values of shielding effectiveness for a selected ventilation panel obtained by the computer simulation method have been compared with results obtained due to tests in real laboratory conditions.

1. INTRODUCTION

While designing small in dimension shielding casings assigned for shielding of electronic devices supplied by electric energy it is necessary to provide for this kind of constructions the required:

- shielding effectiveness of ventilation panels used for cooling electronics placed inside a casing,
- shielding effectiveness of shielding casing components, which provide access inside a casing (e.g., inspection doors and windows),
- attenuation of undesirable signals by power supply filters and telecommunication interface filters [1].

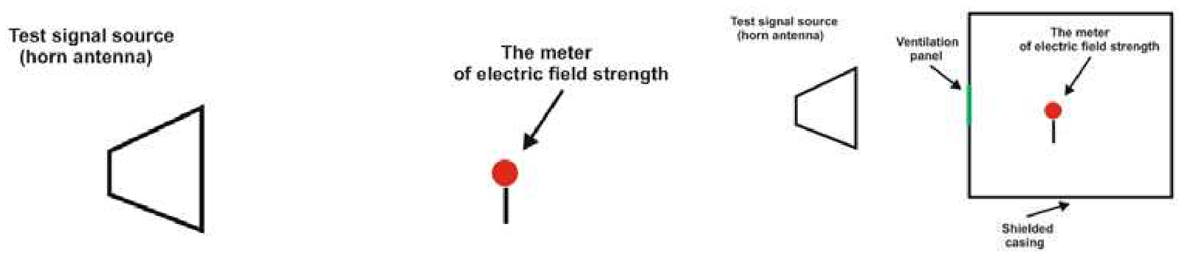
The above mentioned parameters of shielding casing components have a direct influence on resulting shielding effectiveness of the whole shielding casing. That being so, in the design and construction process of shielding casings it is necessary to have tools allowing to assess shielding effectiveness or attenuation of undesirable signals for particular casing components. In this article a tool for assessment of shielding effectiveness of ventilation panels of small overall dimensions made in the form of honeycomb has been suggested and discussed with the use of computer simulation method. Methodology of measuring shielding effectiveness and description of simulation environment have been presented. The final effect of computer simulation is characteristics of shielding effectiveness of ventilation panel in the frequency function. In order to conduct validation of simulation software, values of shielding effectiveness for a selected ventilation panel received by the computer simulation method were compared with results obtained from tests conducted in real laboratory conditions. The study object was a Tecknit ventilation panel of dimensions $152.4\,\mathrm{cm} \times 152.4\,\mathrm{cm}$.

The calculated shielding effectiveness can be used in many applications where the electromagnetic field distribution is needed [9–19].

2. CONCEPTION OF CALCULATION METHODOLOGY OF SHIELDING EFFECTIVENESS OF VENTILATION PANELS BY THE COMPUTER SIMULATION METHOD

At the first stage of suggested algorithm for calculating shielding effectiveness of ventilation panels it is necessary to model in computer simulation environment a tight shielding casing with an installed tested ventilation panel. The condition of obtaining proper results is providing large enough level of shielding effectiveness of walls of shielding casing in which a tested ventilation panel is installed. That level should exceed an expected value of shielding effectiveness of the tested ventilation panel. It can be achieved by selecting suitable parameters of materials describing shielding properties of modelled casing walls. The parameters of materials can be obtained by using measurement methodology described in literature items [7, 8].

Measurement of shielding effectiveness of ventilation panel comes down to making two measurements of electric field strength level at the input of meter of electric field strength for particular frequencies. The first measurement is carried out as so called reference measurement. With a determined value of signal level generated by the test signal source, the level of electric field strength in the place of meter probe installation is measured within a particular distance from transmitting antenna of the test signal probe. After making reference measurement, basic measurement is performed during which a measuring probe is placed inside a modelled shielding casing with an installed ventilation panel. Measurements should be conducted in the same way as during reference measurement. After calculation of the difference of recorded levels of electric field strength corresponding to particular measuring frequencies during reference and basic measurements we will receive the value of shielding effectiveness of modelled shielding casing expressed in decibels. Because of the fact that casing walls are made of material providing much higher shielding effectiveness than shielding effectiveness of a tested ventilation panel, that being so, the received calculation results will match shielding effectiveness of the tested ventilation panel. A simplified block diagram of measuring position for shielding effectiveness of ventilation panels of small overall dimensions is presented in Fig. 1.



(a) (b)

Figure 1: Block diagram of position for measuring shielding effectiveness of ventilation panels of small overall dimensions by the computer simulation method: (a) reference measurement, (b) basic measurement.

Software algorithm for assessment of shielding effectiveness of ventilation panels by the computer simulation method is based on modelled in CST Microwave Studio simulation environment measuring position presented in Fig. 1 using retuned test signal source and meter of electric field strength. User's graphic interface of CST Microwave Studio environment of simulation model using horn transmitting antenna as the source of test signal is presented in Fig. 2.

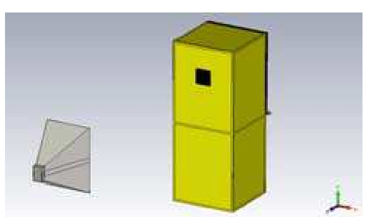


Figure 2: User's graphic interface of CST Microwave Studio environment of simulation model using horn transmitting antenna as the source of test signal.

Figure 3: Ventilation panel installed in the real shielding casing.

3. SOFTWARE VALIDATION FOR ASSESSMENT OF SHIELDING EFFECTIVENESS OF VENTILATION PANELS BY THE COMPUTER SIMULATION METHOD

In order to check correctness of simulation software operation for assessment of shielding effectiveness of ventilation panels, values of shielding effectiveness for a selected ventilation panel obtained by the computer simulation method have been compared with results obtained during laboratory tests with the use of real measuring position. The study object was the Tecknit ventilation panel of dimensions 152.4 cm × 152.4 cm. To conduct measurement of shielding effectiveness of the above ventilation panel in laboratory conditions it was installed in shielding casing which effectiveness is much higher than expected shielding effectiveness of the tested ventilation panel. Parameters of ventilation panel and shielding casing are equal to parameters of their computer models used during tests with the computer simulation method. The view of physically made shielding casing with installed ventilation panel is presented in Fig. 3. The structure of measuring position and principle of shielding effectiveness measurement along with discussion of measurement results are shown below.

The algorithm idea of measuring shielding effectiveness of ventilation panels in real laboratory conditions comes down to performance of two measurements of electric field strength level at the input of meter of electric field strength for particular frequencies. The first measurement is made as so called reference measurement and is carried out with meter of electric field strength placed directly in front of test signal transmitting antenna. The second measurement, defined as basic, is made with meter of electric field strength, which probe is placed inside shielding casing with installed ventilation panel. After calculating the difference of recorded electric field strength levels corresponding to particular measuring frequencies during reference and basic measurements we will receive the value of shielding effectiveness of modelled shielding casing expressed in decibels. The above measurement algorithm coincides with methodology of calculating shielding effectiveness of ventilation panels by the computer simulation method described in chapter two of this article.

In Fig. 4, measurement results of shielding effectiveness of the Tecknit ventilation panel of dimensions 152.4 cm × 152.4 cm are presented. They were conducted with the laboratory method (green and black curve) and the computer simulation method with the use of horn transmitting antenna (blue curve). The results obtained by the laboratory measurement method coincide with the results received by the computer simulation method over test signal frequency equal to 1.3 GHz. Divergences of shielding effectiveness levels of ventilation panel below the frequency 1.3 GHz result first of all from using rod antenna as a measuring antenna of electric field strength. The used length of rod antenna does not correspond to frequency range of test signal below 1.3 GHz. During measurements a longer measuring antenna could not be used due to limited dimensions of the used shielding casing.

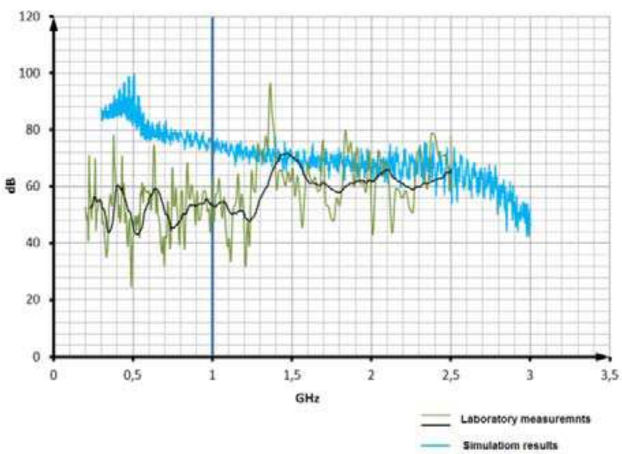


Figure 4: Values of the level of shielding effectiveness of ventilation panel received by the methods of laboratory tests and computer simulation.

Because of difficulties with selection of a type of measuring antenna and its size, measurement of shielding effectiveness with the laboratory test method has significant limitations particularly for lower frequency range. As measurement antenna can be used optional antenna [2–6] tuned to the frequency of the test signal. That being so, it seems appropriate to use laboratory measurements for higher frequencies of test signal and simulation tests for lower measurement frequencies.

The presented comparison of results of laboratory and simulation tests allows only to validate both methods of determining shielding effectiveness over the frequency 1.3 GHz for the applied measurement environment and study object.

4. CONCLUSIONS

In the article assessment methodology of shielding effectiveness by the method of computer simulation of ventilation panels of small overall dimensions made in the form of honeycomb was presented. The presented methodology of calculating shielding effectiveness by the computer simulation method seems appropriate for the whole frequency range, especially for low frequency range where using measurements with real laboratory station is impossible due to inability of using measuring antennas of overall dimensions matched to wave length of test signal and enabling their installation inside the small tested shielding casing. Measuring antennas of large dimensions compared to overall dimensions of the tested ventilation panel corresponding to low frequencies are impossible to use in real laboratory station.

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