Technique for Evaluating the Contribution of Protective Means to Shielding Effectiveness of Heterogeneous Wall

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***Abstract*—The model of shielding of electric, magnetic, and electromagnetic fields by a heterogeneous wall is improved, and a technique for applying this model to the description of technical solutions used to improve the shielding effectiveness of buildings, bodies of vehicles and ships, cases of electronic equipment, etc. is developed. An experimental validation of the developed technique is carried out for the case of shielding a magnetic field by metal wire meshes in the frequency range from 100 kHz to 100 MHz and for the case of shielding an electromagnetic field by a wire mesh, metal foil tapes, wire mesh gasket, cloth pad gasket, and finger spring gaskets in the frequency range from 800 MHz to 18 GHz.**

***Keywords*—electromagnetic compatibility, electromagnetic shielding, EMI gaskets, electromagnetic measurements**

I. Introduction

A required shielding effectiveness (SE) of system hull or equipment case can be obtained by using of EMI gaskets [1] – [4] and other types of protective means such as wire meshes, shielding films, metal foil, etc. The choice of technical solutions providing the required SE is based on the analysis of peculiarities of mounting place (dimensions, shape, surface finishing), corrosion resistance [5], ensuring the tightness of the joining, and a number of other technological requirements [1] – [3], [6], [7].

When designing the system hulls and equipment cases, there is a problem of choosing an EM gasket that meets the technological requirements and provides the necessary SE. A technique for evaluating the SE of gaskets installed in a mounting place of a given size and shape (in-situ SE) is proposed in [8]. The technique [8] uses the gasket's SE that must be specified by manufacturer (the standard according to which the SE was measured by manufacturer, e.g. [9]–[12], and the characteristics of the measurement setup are also required) or measured. Unfortunately, the manufacturer's data does not contain this information in most cases.

On the contrary, the material and geometric parameters of protective means are usually available (often specified by the manufacturers, or easily obtainable experimentally). For example, for metal meshes, the type of mesh, the shape and size of the holes, the material of the wire, wire's diameter, and the dimensions of the mesh cell are provided. For finger spring gaskets, the width of the fingers, the distance between them, the metal thickness and conductivity are specified.

The objective of this work is to develop a universal technique that allows evaluating the SE of protective means based on their type, material characteristics and geometric parameters of protective means and their mounting places. The technique for evaluating the SE of protective means must also meet the following requirements specific to EMC analysis: provide an adequate assessment of SE over a wide frequency range, avoiding underestimation by more than 15 dB and overestimation by more than 5 dB; have a high computational efficiency.

II. Model of Shielding of Electric and Magnetic Fields by Combined Wall

A. Problem Formulation and Initial Data

The combined wall is a wall consisting of regions with different SE [13] (Fig. 1). Given geometric and physical parameters of the regions, it is required to calculate the SE of the combined wall by power:

$$S_P = P_0 / P_S, \tag{1}$$

where P_S is the radiation power received by an antenna in the shielded zone and P_0 is the power received by the same antenna in the same point if the wall is absent (see Fig. 1).

Radiation sources can be electric or magnetic dipoles. The source area can be free space, or it can be a volume of a resonator or waveguide, for example, when solving the problem of propagation of EM radiation from one compartment to another. To calculate the SE in the case of a dipole source located in free space, it is necessary to set the distance r_d from antenna phase center to the shield. If the source area is a resonator (waveguide), it is necessary to set parameters of the resonator in order to determine its wave impedance.

The shield is a combined wall (see Fig. 1). To calculate the SE of a combined wall, it is necessary to specify the dimensions of each region belonging to the wall and physical characteristics of the regions. The regions of the combined