Estimation of Effectiveness of EMI Gaskets by using Results of Standardized Measurements

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***Abstract*—A technique for evaluating the effectiveness of the use of EMI gaskets is proposed. These conductive gaskets are designed to protect against electromagnetic interference and installed, for example, at the joints of metal sheets and in the slots of doorways of shielded rooms. The technique makes it possible to calculate the in-situ shielding effectiveness of an EMI gasket by using the standardized shielding effectiveness of this gasket (which is taken from the datasheet of the gasket or measured in accordance with applicable standards) and the geometrical characteristics of the places of gasket mounting (i.e., shape and size of the slot). The technique is validated by comparing the calculated and measured values of the shielding effectiveness in a wide frequency range (from 800 MHz to 18 GHz) for various types of the EMI gaskets (finger-spring gaskets, wire-mesh gaskets, conductive cloth pads) placed in slots of various sizes and shapes (straight, curved).**

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

I. INTRODUCTION

The shielding is one of the most commonly used methods for protecting a system (a vehicle, a ship, an aircraft, etc.) against the intended and unintended electromagnetic impact. There is a set of standards [1] – [9] used for measurement of the shielding effectiveness (SE).

IEEE Std. 299 [1] is intended for providing uniform measurement procedures and contains techniques for determining the effectiveness of electromagnetic shielding of enclosures having all dimensions greater than or equal to 2.0 m at frequencies from 9 kHz to 18 GHz (extendable to 50 Hz and 100 GHz, respectively). Standard IEC 61000-4-23 [2] contains test methods for verifying the protection levels provided by individual shielding components within the system and description of test procedures and measurements. Standard IEC 61000-4-21 [4] provides a technique for measurement of the SE of EMI gaskets by using a reverberation chamber. Standards ASTM D4935-18 [5] and SAE-ARP 1705-1981 [6] are based on the features of coaxial transmission line for measurement of the SE of samples made of conductive materials, absorbers, composites, or metamaterials in a wide frequency range.

Standard SAE-ARP 1173-2004 [7] provides a technique that can be used for testing of gaskets made of various materials (in accordance with [8]). Unfortunately, there are very little references about the use of this technique for measurement of gasket's SE in product catalogues published by manufacturers. On the contrary, standard MIL-DTL-83528 [9], which also determines the procedures of SE measurement for conductive gaskets, is widely used in the datasheets of manufacturers. Standard CHO-TP09 is similar to MIL-DTL-83528 [9], and it has wider scope; this standard is developed for a group of manufacturers of protection means, and only members of this group use it.

We suppose after [10] that MIL-DTL-83528 [9] is so popular by the following reason: for a given gasket, the values of the SE measured by [9] are much higher than the values measured by [7], so the manufacturers can promote their gaskets more effectively if they use [9] for the measurements.

The objective of this paper is to develop an analytical technique for calculating the in-situ SE of an EMI gasket installed in a slot of arbitrary size and shape by using the following initial data: geometric parameters of the slot and the gasket's SE measured according to the standard [7] or [9] (the latter SE can also be taken from the datasheet of the gasket). In addition, the technique must allow calculating the gasket's SE defined in terms of [7] (relative to slot) by using its SE defined in terms of [9] (relative to open window).

II. ESTIMATION OF SHIELDING EFFECTIVENESS OF EMI GASKETS

A. Techniques for Measurement of Shielding Effectiveness

The procedure of measurement of screen's SE in accordance with [2] is in the measurement of the power P_0 received by the antenna installed inside an enclosure, when the window is open, and power P_P received when the window is closed by the protection solution under test (transmitting power and distance between antennas is constant during measurements). The corresponding SE for EM wave is calculated by formula:

$$S_P = 10\log(P_0/P_P). \quad (1)$$

Definition of shielding effectiveness (1) corresponds to procedure of standard [9] for measurement of gasket SE. However, not only the gasket, but the metal sheet closes the window.

In accordance with [11], the shielding effectiveness of gasket (the contribution of gasket installed in slot in the wall