Shielding Effectiveness of Reverberant Equipment Enclosures Measured in Reverberation Chamber

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The unwanted influence of electromagnetic waves on electronic devices or systems can originate from various sources. When these waves interact with susceptible electronic components, they can induce unwanted currents or voltages, disrupting normal operation and potentially causing malfunctions. The shielding effectiveness (SE) of an enclosure is a measure of how well an enclosure can attenuate or block electromagnetic waves, essentially shielding sensitive electronics from the harmful effects of electromagnetic interference (EMI).

When measuring in a reverberation chamber, the SE can be defined as the ratio of the average power density of the incident electromagnetic waves to the average power density of the transmitted waves inside the enclosure. In metallic enclosures, the incident electromagnetic power density solely penetrates through apertures. The walls of the enclosure, and the enclosed objects contribute to attenuation through reflection and partial absorption, depending on the enclosures and object's conductivity and the wave frequency.

The average transmission cross section (ATCS) quantifies the ability of an aperture to transmit incident electromagnetic waves into the enclosure and the average absorption cross sections (AACS) measure the ability of the enclosure walls and the contents to absorb incident electromagnetic waves. For an electrically large enclosure, which can be considered reverberant, accurately predicting the SE of an enclosure becomes complex when its interior contents vary.

Our proposed method is an advancement to the Power Balance technique and uses the ATCS of the aperture and the AACS of the walls to predict SE with diverse contents. The incident electromagnetic wave interacts with the apertures, walls, and contents within the cavity, leading to transmission, reflection, and absorption. By incorporating the measured or calculated ATCS and AACS of each element, we can mathematically model these interactions and predict the overall SE for a specific content configuration with known AACS. By accounting for the specific characteristics of both the enclosure and its contents, the predictions enable the SE of the enclosure with the specific contents to be evaluated rather than the SE of an empty enclosure as with other techniques.

The method can be readily adapted to various enclosure designs and content configurations, making it a powerful tool for diverse applications even for the enclosure with electrically small apertures. By incorporating the concepts of transmission and absorption cross sections, our proposed method paves the way for more accurate and versatile SE predictions and can revolutionize the design of effective EMI shielding solutions, ensuring the reliable operation of electronic systems in an increasingly electromagnetically cluttered world.

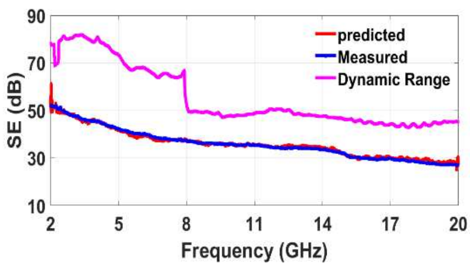

Figure 1. The comparison of predicted and measured values of the SE shown in Fig. 2

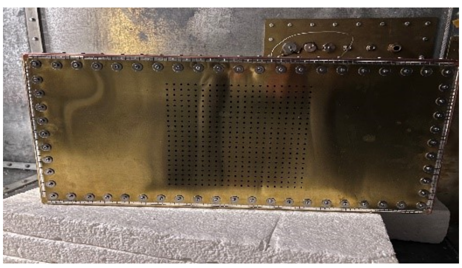

Figure 2. The enclosure and the aperture comprising an array of circular holes – the enclosure's dimension is 300×500×600 (mm)

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