Comparative Analysis of Selected Methods for Measuring the Shielding Effectiveness of Planar Materials

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***Abstract* — While numerous techniques exist to measure the shielding properties of planar materials, selecting the appropriate method remains a challenge due to inherent procedural differences. This article evaluates the features, limitations and comparative challenges of key characterization methods, providing a comprehensive framework for selecting the optimal testing methodology.**

Keywords — *electromagnetic compatibility shielding effectiveness, dynamic range of test setup for shielding effectiveness measurements, ASTM D4935–18, EN 50147-1, GTEM cell*

I. INTRODUCTION

Shielding effectiveness (SE) measurements evaluate how well materials and structures block electromagnetic interference, but their accuracy depends heavily on the test setup's dynamic range (DR). Selecting an appropriate technique to measure the shielding properties of planar materials is challenging due to inherent procedural differences across available methods. This article evaluates the features, limitations, and comparative challenges of key characterization methods, focusing specifically on ASTM D4935–18, EN 50147-1, and GTEM cell-based measurements.

In Section II the core concept of shielding effectiveness and dynamic range are explored.

Sections III, IV and V are devoted to selected measurement techniques, covering

- brief description of the method,
- the test setup,
- advantages and disadvantages,
- measurement results.

Section VI focuses on the analysis and comparison of the results obtained for a single selected material using the GTEM chamber and in accordance with ASTM D4935–18, respectively.

II. DYNAMIC RANGE

A. Dynamic Range

Dynamic Range in SE measurements quantifies a system's capability to measure both strong and weak electromagnetic signals. Expressed in dB, DR is the difference between the maximum and minimum signal levels the setup can accurately detect. In our case we define DR as ratio of field level for unshielded (fully open) and fully shielded (fully closed) aperture. Since signal measured by fully closed aperture drops below our detection level we use the ambient noise floor as the practical minimum. The DR value in dB can be obtained using [1]:

$$DR^E = 20\log(|E_{WS}|/|E_A|), \quad (1)$$

$$DR^H = 20\log(|H_{WS}|/|H_A|), \quad (2)$$

where:

DR^E – DR in dB measured for E,

DR^H – DR in dB measured for H,

$|E_A|$ – absolute value of ambient noise in V/m,

$|H_A|$ – absolute value of ambient noise in A/m,

$|E_{ws}|$ – absolute value of field without shielding in V/m,

$|H_{ws}|$ – absolute value of field without shielding in A/m.

B. Shielding Efectiveness

Shielding effectiveness quantifies how efficiently a material or structure attenuates electromagnetic radiation. Measured in decibels, this metric directly reflects protective capability — higher decibel values correspond to superior shielding performance.SE value in decibels can be obtained using [1]:

$$SE^E = 20\log(|E_{WS}|/|E_s|), \quad (3)$$

$$SE^H = 20\log(|H_{WS}|/|H_S|), \quad (4)$$

where:

SE^E – SE in dB measured for E,

SE^H – SE in dB measured for H,

$|E_S|$ – absolute value of field with shielding in V/m,

$|H_S|$ – absolute value of field with shielding in A/m.