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Exploring Shielding Effectiveness of Shielded Enclosures Across Reverberant, Transition, and Resonant Frequency Regions

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The shielding effectiveness (SE) of a shielded enclosure is highly dependent on multiple factors, including the enclosure's size, internal contents, and the frequency of interest. Well-established methods exist for evaluating shielding effectiveness (SE) in electrically large enclosures operating in the reverberant frequency range. By transitioning from reverberant into the resonant frequency range, enclosures exhibit more complex shielding behavior. This study investigates the SE behavior of the enclosures across three frequency regions, reverberant, transition, and resonant through measurements conducted in a reverberation chamber (RC).

The experimental setup consists of a 600mm × 500mm × 300mm conducting enclosure (Fig. 1) with a 140mm × 40mm aperture, tested inside an RC with mechanical stirring. SE measurements were conducted using a set of monopole antennas mounted on the enclosure walls and on instrumented Transmission Line Representative Contents (TL ReCos), which mimic the printed circuit boards usually installed inside shielded enclosures (Fig. 1). The frequency range of interest spans from 300MHz to 2.3GHz (resonant, transition, and reverberant frequency ranges for the enclosure under consideration).

As it can be seen from Fig. 2, the SE results highlight distinct shielding behaviors across the three frequency regions. In the reverberant frequency range, the enclosure exhibits relatively stable SE values with minimal dependence on antenna positioning. However, in the transition region, significant variations in SE emerge. In the resonant frequency range, discrete resonances dominate, leading to sharp fluctuations in SE leading to negative SE values at some frequency points. Additionally, the results demonstrate that SE is highly influenced by the internal contents of the enclosure, the placement of antennas, and the frequency of operation.

These findings show the importance of considering the transition region when evaluating shielding performance. Future work will focus on developing predictive models to better characterize SE behavior in the transition and resonant frequency ranges, ultimately aiding in the design of improved shielding strategies for electronic enclosures operating in complex EM environments.

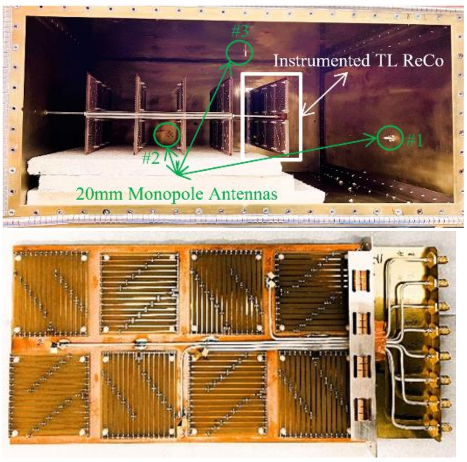

Fig. 1. The placement of TL ReCos and antennas inside enclosure (top), and the instrumented TL ReCo (bottom).

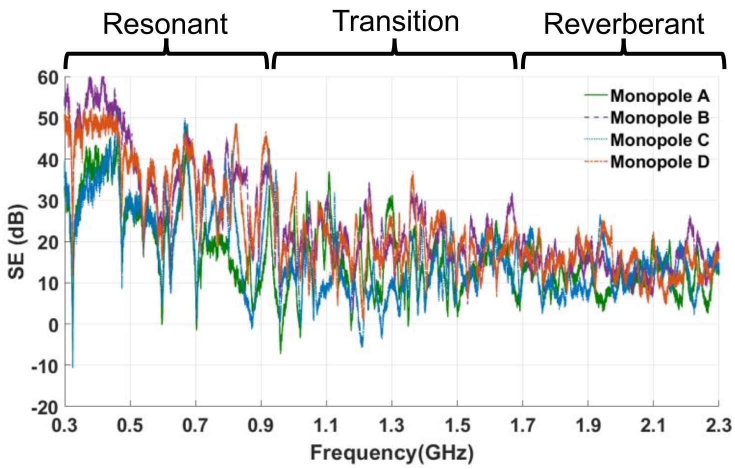

Fig. 2. SE calculated using the monopole antennas on the instrumented TL ReCo representing resonant, transition, and reverberant frequency range.

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