White Paper

DVTEST

Understanding RF Shielded Enclosures

A Comparative Study of Double-Walled and Single-Walled Design

Radio frequency shielding is an approach to avoid undesired energy being coupled into equipment under test. The ability of an enclosure to avoid undesired RF fields to couple to the device under test is known as its Shielding Effectiveness (SE). This term represents the ratio of field strength with and without the enclosure. SE for RF enclosures is always compromised by apertures, slots, cable penetration, etc.

In order to predict the SE of enclosures, various methods have been introduced. Analytical methods can be used to determine SE for enclosures with apertures.

Emerging sensitive wireless devices operate with minimum power levels and require a shielding level of more than 100dB for wireless testing. In this study a new approach to increase the SE of enclosures to more than 100dB is demonstrated.

The enclosure can be considered as a waveguide with only single mode of propagation (TE_{10}). In this paper, the effect and advantages of double-wall on Shielding Effectiveness of RF enclosures are proposed. The effect of considering a gap "d" between walls of enclosure and an offset on apertures are investigated. An enclosure with aluminum walls is modeled and simulated using finite element method in High Frequency Structural Simulator (HFSS, Ansoft).

In *Figure 1*, horn antennas are used to simulate the SE of the enclosure, aluminum walls are considered 0.125" thick. In *Figure 2,* E-field is modeled on a single-wall without any aperture on it.

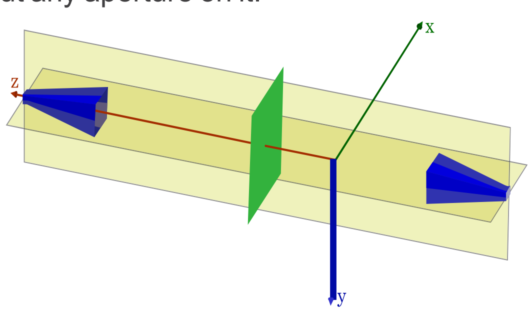

Figure 1: Horn antennas for shielding measurement, single-wall is shown in between two horns.

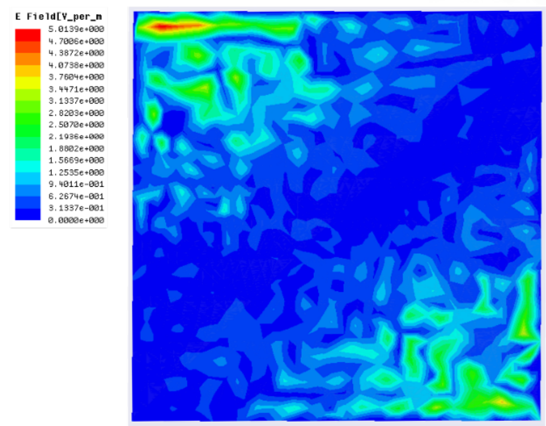

Figure 2: E-field distributed on a wall with no apertures. As it can be seen, field is higher in the edges where the electric current flows. The magnitude of E-field is 5V/m in the corners.

The effect of single aperture on E-field distribution is simulated in *Figure 3*. It is shown that field intensity is doubled around the edges of the aperture.

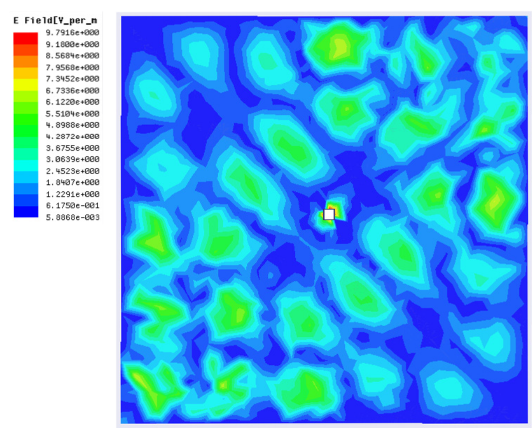

Figure 3: E-field is shown in the case with one single aperture size of 0.1". As it can be seen EM waves are diffracted through the apertures and the field intensity is almost doubled.

The SE is maximum when there is no aperture, but it is not possible for an enclosure to have no aperture, cable, etc. The aim of this study is to model a structure to increase the SE of an enclosure with apertures. We consider two parallel walls with equal thickness and gap "d" as shown in *Figure 4*. In *Figure 5*, SE of structure is shown when the gap is varied.

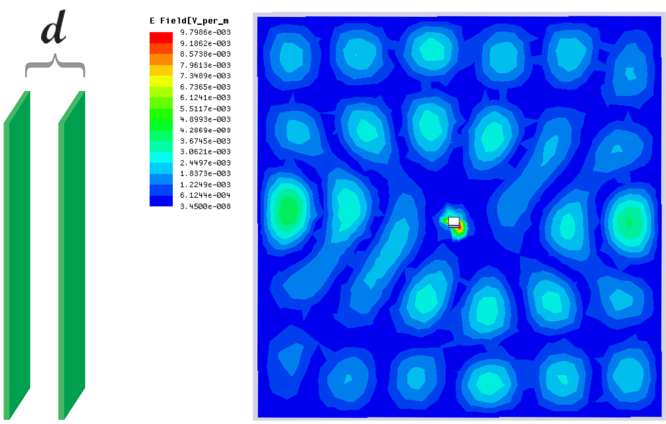

Figure 4: "d" is the gap between walls. E-field for 0.3" gap shows that the intensity is dropped to 9mV/m.

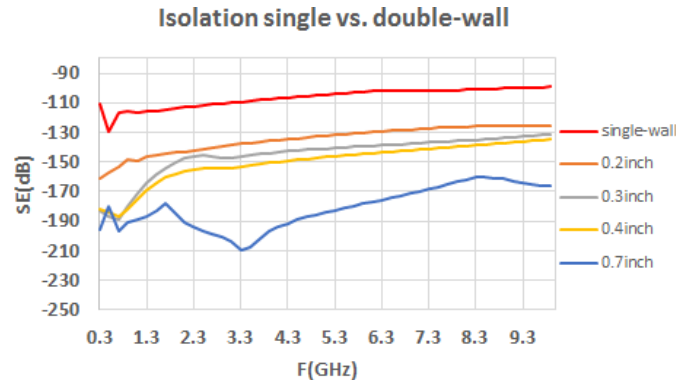

Figure 5: Shielding Effectiveness of the structure increases with increasing "d".

As another approach to increase the Shielding Effectiveness of enclosure, the effect of an offset for apertures on both walls is investigated. Figure 6 demonstrates this effect.

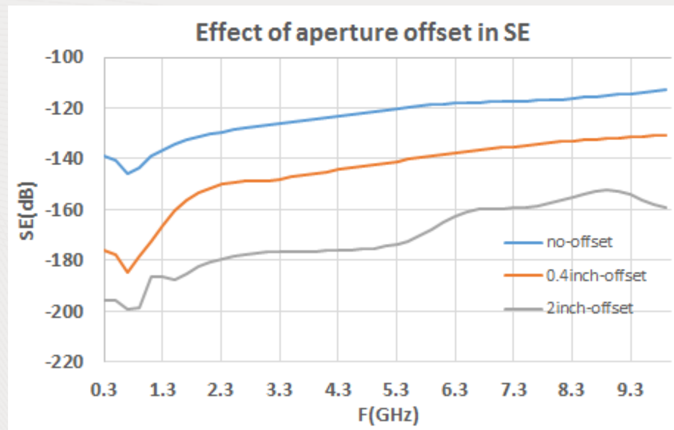

Figure 6: This graph shows SE variation for no-offset, 0.4", 2" between apertures.

The ultimate design for double-wall enclosure is presented to increase the SE. In order to investigate effect of "Material-A" on the Shielding Effectiveness, a rectangular box made of "Material-A" is inserted between two walls. The simulation is repeated and results are shown in *Figure 8*.

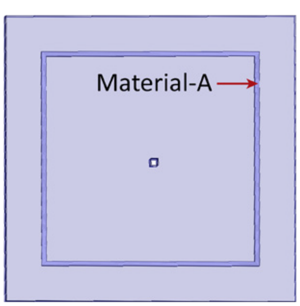

Figure 7: Top view image of double-wall design demonstrates insertion of "Material-A" between two walls to increase the shielding effectiveness.

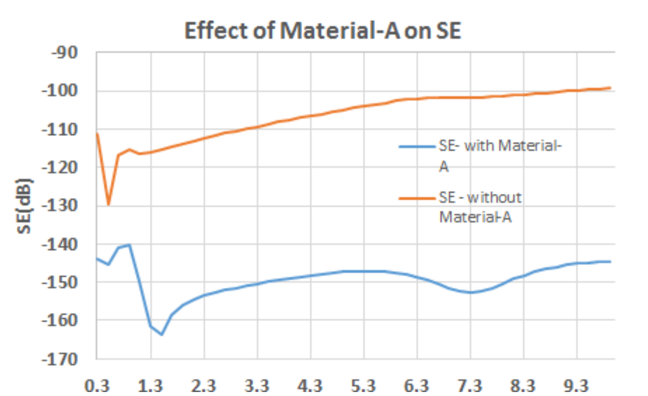

Figure 8: Shielding Effectiveness of two cases. With and without "Material-A" in between walls.

The distribution of E-field on single and double-wall configurations is shown in this study. Based on the findings, E-field is more concentrated on the edges or apertures. When compared to single-wall, double-wall design with gap “d” between walls has shown higher SE. Depending on the gap “d”, double-wall provides 40-70dB higher SE compared to single-wall. As it is demonstrated in *Figure 6*, double-wall with an offset between apertures shows higher SE compared to the case without offset.

Ultimately, maximum Shielding Effectiveness can be achieved when “Material-A” is inserted between walls.

Measured Shielding Effectiveness (SE) for RF enclosures

dbSafe RF Enclosure	Shielding Effectiveness (SE)
Single-wall	DC-3GHz (80-90dB) 3-5GHz (70-75dB) 5-9GHz (60-70dB) 9-13GHz (50-60dB)
Double-wall	DC-6GHz (100dB) 6-8GHz (90dB) 8-13GHz (80dB)
Double-wall Advanced	DC-6GHz (120dB) 6-8GHz (100-110dB) 8-13GHz (90-100dB)