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#109

SHIELDING MEASUREMENT

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Shielded enclosures are used to either contain RF emissions from an electronics equipment or to protect the equipment from outside RF emissions or both. The design of the enclosures is determined by its use. The shielding effectiveness depends upon the properties of the enclosure materials, the incident RF wave impedance, the number and configuration of discontinuities in the shield, and whether the enclosure contains the emitter or the receptor.

Enclosures that are used to contain RF emissions are normally designed for maximum absorption loss, whereas enclosures that are used to exclude RF emissions are designed for maximum reflection loss. Shielding effectiveness for the various types of fields is measured by first establishing an incident magnetic, electric, or plane wave field strength level without the shield being present, and then recreating the original field strength levels with the shield present.

The ratio of the field levels with and without the shield present is the measured shielding effectiveness. These shielding effectiveness (SE) levels, at each of the measured frequencies, are normally presented in terms of decibels, as follows:

$$SE\ (dB) = 20 \log (Fi/Fe)$$

Where: Fi = Incident Field Strength (before shielding)
Fe = Exiting Field Strength (after shielding)

Shielding effectiveness measurements should attempt to correlate with the use of the enclosure. This means that if the enclosure is being used to contain RF energy, an RF energy emission source should be placed inside the enclosure during testing. If the enclosure is being used to exclude RF energy, the receiver should be placed inside the enclosure during testing. Frequently no attempt is made to correlate the shielding effectiveness measurements with the use of the enclosure because users/specifiers blindly call out the use of MIL-STD-285 without knowing that the shielding values are different when measured from the inside to the outside as compared to measuring from the outside to the inside.

MIL-STD-285, which was released in 1956, is the most well-known of the shielding requirements documents. MIL-STD-285 is used to determine if the shielded enclosure is adequate to protect the equipment contained within the enclosure from outside RF sources. The MIL-STD-285 measurement procedure requires pairs of either loop, rod, or dipole antennas capable of operating at the test frequencies to be set up outside the enclosure, at a separation distance of two feet plus the enclosure wall thickness. A high-level signal source is connected to one of the antennas and used to transmit a high-level reference field. This field is measured using a calibrated receiver which is connected to the other antenna. The two antennas are then positioned with the transmitting antenna twelve inches from the outside of the enclosure wall and the receiving antenna located twelve inches from the inside of the enclosure wall. The high-level reference field is re-established, the enclosure integrity secured, and the attenuated field is then measured. The reduction of the field strength in dB is thus the attenuation of the enclosure.

The standard ignores the problems of reflections from the conducting wall surfaces, enclosure resonance, and antenna loading. These problems introduce errors into the measurements which must be minimized during the measurement procedures.

No measurements are required by MIL-STD-285 to determine how much attenuation the enclosure provides for RF sources located inside the enclosure because that was not the original intent of the specification. If this test were performed, the data would indicate lower shielding effectiveness than is indicated by the method called out in the standard. The method in the standard includes the reflection loss from the surface of the shield material and results in worst case data. Unfortunately most of the commercial/industrial shielding measurements documents in existence today are modifications of MIL-STD-285 and indicate higher rather than lower shielding effectiveness.

TEMPEST shielding requirements called out in NACSEM 5204 for NSA 65/5, NSA 65/6, and NSA 73-2A uses essentially the same measurement techniques as called out in MIL-STD-285 except that the transmitting antenna is located inside the shielded enclosure in order to simulate the containment of TEMPEST information. There are some other subtle differences regarding antenna placement and attenuation requirements which depend upon the use of the enclosure, but otherwise the standards are very similar.

The only shielding measurement standard that attempted to provide the user with attenuation data for both emission and susceptibility was the proposed EIA RS-310 modular electronic rack standard. This proposed standard required that two sets of measurements be made with the transmit antenna located both inside and outside the equipment rack. Testing becomes very difficult for small enclosures because of antenna loading; ie: the changes in the characteristics of the antenna that are caused by its close spacing to the conductive walls of the enclosure. However, the measured data would allow users to determine the suitability of the enclosure for both emissions and susceptibility protection.