SHIELDING EFFECTIVENESS TESTING

Once a shielded enclosure of any type has been developed and constructed, methods must now be provided in which to determine the actual shielding effectiveness of this enclosure. The most practical way to specify shielding effectiveness is in dB which will enable one to know how well a given enclosure will reduce his particular signal level that he is trying to eliminate. MIL-STD-285 is the current military specification regarding shielding effectiveness testing. However, a much later specification, the IEEE 299 spells out in much more detail how shielding effectiveness tests can be performed at various frequencies in the magnetic field, electric field, plane wave and microwave field techniques are discussed. These four basic types of tests normally cover given frequency ranges with some possible overlapping. They are as follows: for the magnetic or H field frequencies from 30 Hz on up to 1 MHz; for the electric or E field, from 30 Hz to 25 MHz; for the plane wave field, from 25MHz to 1000MHz; and for the microwave, from 2GHz to 10GHz. Shielding effectiveness tests are also performed at higher frequencies but at the present time no specific standard for testing has been developed.

The magnetic field and electric field shielding effectiveness testing distance between antennas, position of antennas, and maximizing of signal responses is very important in determining the accurate level of shielding effectiveness for a given enclosure. For a given homogeneous material of infinite length and width, position of the loop antenna with one another will not cause any variation in the value of shielding effectiveness determined. That is to say whether the loops are coaxial with respect to one another or coplaner in either the vertical or horizontal plane. Variations in shielding effectiveness readings with the different loop positions occur in the practical sense in that there are seams or discontinuities at the edges of panels, at filter panel locations, at access door openings, air vent openings, and other wave guide type openings provided to permit different types of services to enter the enclosure. Coplanar loop measurements tend to produce the lowest readings when testing seems at both the door and between adjacent panels.

Determining the shielding effectiveness of a given panel or air vent opening, with coaxial oriented loop antennas will pinpoint the areas directly between the loops in a more conclusive manner. Measurements made at a vertical and horizontal corner such as between a floor and wall panel, and a ceiling and wall panel, will be normally less than for a parallel plane wall between the two antennas. In evaluating a shielded enclosure, therefore, consideration should be given to the various configurations when the shielded material meets at right angles or some other angle other than a plane sheet.

IEEE STD-299 attempts to standardize its techniques for problems of types such as this. For enclosures which are small, an adapation of loop sizes and distance between loops must be made. In performing electric field measurements it is important that the vertical rod antenna on both of the receiving unit and the transmitting unit be maintained at a constant distance before and after the insertion of the shield,and that the antennas be as perpindicular as possible and at the same height. Electric field test procedures have been designed for interpreting shielding effectiveness of plane surfaces rather than corners or intricately designed enclosures. If an electric field measurement is required to be performed at the corner of a enclosure, the readings in general tend to be slightly higher for a given material when compared to a plane sheet of the material.

Electric field tests are normally of more value on single wall constructed enclosures of screening type or perforated type of shield. Distance is important between the antennas because the ratio of field intensity to distance is inversely proportional to the distance squared whereas in the magnetic field, the distance factor is further compounded in that the shielding effectiveness or field intensity is inversely proportional to the distance cubed. By being extremely careful with the distances and heights of the receiving and transmitting antennas, with respect to measurements made with and without the shield inserted between them, repeatable shielding effectiveness values can be obtained which are very reliable.

The next series of tests normally performed on a shielded enclosure are the plane wave tests. Plane wave evaluation of enclosure frequencies are normally selected in the 400 to 1000MHz range. The higher the frequency the greater potential of leaks occurring from small openings such as may occur around doors, access panels, filters, both the power line type and the wave guide air vent filters. The transmitting antennas is set approximately 6 to 8 ft. away from the side area of the enclosure that you wish to test. The receiver is placed inside of the shielded enclosure and the receiving antenna is fed through a narrow closed opening of the door and probed approximately 1 or 2 ft. in front of the enclosure in the path of the transmitting antenna. The maximum field is measured and is the known field without enclosure. The receiving antenna is then brought into the enclosure, the door closed and the area 1 ft. away from the enclosure wall is probed in its entirety. The rest of the room area is probed for a maximum reading. The difference in the maximum reading without enclosure and with the enclosure is the shielding effectiveness of the enclosure. To localize leakage points, a small loop probe approximately 3 to 4 inches in diameter of several turns is very useful.

Plane wave tests results are usually repeatable on a basis of approximately + or −5dB. In an enclosure that is approximately 10 x 10 ft. square the antenna is placed on each of the four sides if at all possible. In practical instances other objects in the way such as walls, and partitions, will modify the number of sides that one is able to check. However, this does not say that the other walls will not be tested, in that the plane wave field will move in all directions around the area and will locate any leaks that may tend to form on the other sides not directly exposed to the transmitting antenna. Certain leaky enclosures, depending upon the size have a reasonant frequency that can be picked up due to the dimensions of the enclosure. This can be found in IEEE 299 which discusses the reasonant characteristics. If this frequency should fall in an area where you will be using the enclosure extensively or you know that there would be a high level of signal present at a given frequency, it may be wise to also check that frequency. The single shielded enclosure is more prone to exhibit the wave guide cavity affect. Variations and differences of a few feet will affect the readings very much. The approximate error due to a 2 ft change in distance from going from the outside to the inside of the enclosure would be in the area of approximately 1 to 2 dB. At plane wave frequencies the path loss is less than inverse to the distance ratio.

In performing microwave shielding effectiveness tests, the frequency range of 1GHz to 10GHz is normally investigated. The microwave antenna which is normally a wave guide antenna is set up at a distance of approximately 6 to 8 ft. from the area to be tested. The microwave receiving antenna is placed directly in line with the transmitting antenna and oriented for maximum pickup on the receiver output indicator. The receiving antenna is placed inside the enclosure, the door closed and the area directly opposite the transmitting antenna is probed first for indication of signals entering the enclosure.

In conclusion, one can have reliable and repeatative readings if care is taken in antenna placement and maintainence of constant power output to the particular antenna being used for the particular test being made. With a reliable shielding effectiveness test result good shielding design can be achieved.