Comparison of Low-Cost Shielding Materials

Ian Sturdevant*(1), Bryan Stewart(1), Coley Burgess(1), and Russell P. Jedlicka(1)
(1) Klipsch School of Electrical and Computer Engineering, New Mexico State University, Las Cruces NM 88003
{isturdev, brystewa, cburgess, rjedlick} @nmsu.edu

Electromagnetic shielding techniques have received considerable attention with respect to the protection of critical systems. To complement that work, this empirical study focused upon low-cost techniques to provide moderate levels of shielding in the 400 MHz to 3 GHz band appropriate for protection of civilian infrastructure; e.g., commercial enterprise. The need for safeguarding commercial and industrial activities has become more important with the increased dependence upon electronic devices and the proliferation of wireless networks. In contrast to hardening a facility, the question addressed here is "how can moderate levels of low-cost protection be achieved with minimal impact upon the activity?" This effort investigated materials for use on walls as well as apertures, particularly those suited for shielding existing structures.

Products such as paint additives and fabrics were compared to aluminum foil and various sizes of wire mesh for reducing the penetration through walls while specialized tint materials were considered for reducing coupling through windows. Fabrics were also measured. To quantify the effectiveness of the materials themselves, a shielded enclosure was constructed and filled with radio frequency (RF) absorber to simulate a half space. One side of the enclosure had an 18" x 18" aperture over which the materials to be tested were placed, the remaining walls were covered with absorber. A vector network analyzer was used in conjunction with two wide-band, log-periodic antennas to illuminate the materials under test and receive the signal inside the shielded enclosure. The measurements were performed under three conditions: 1) free space, 2) with the unloaded aperture, and 3) with the material under test covering the 18" x 18" aperture. The transmission coefficient through the aperture without any material present was a close approximation to the free space result so condition 2) was used as the baseline. Amplitude/phase measurements for 14 different materials were recorded and the shielding effectiveness was determined by a ratio of the material measurement to that of the unloaded aperture. They were also compared to the case when the aperture was covered with a solid metal plate.

The complete set of measurements will be presented. To summarize the results and establish a bound for the range of treatments considered, it was observed that a single coat of paint with a conductive additive provided about 0.5 dB reduction in the signal while aluminum foil provided a nominal 60 dB level of shielding. Application of the specialized window tint material resulted in about 20 dB of isolation while the shielding of a metallized fabric was highly dependent upon how it was constrained at the edges but could provide between 30 and 50 dB rejection across the band of interest, if properly installed. The wire mesh configurations measured were in good agreement with published results (K.F. Casey, "Electromagnetic Shielding Behavior of Wire-Mesh Screens," IEEE Trans. EMC, Vol. 30, Aug 1988, pp 298-306) and as such provide a level of confidence in all other results presented.