# EMC “Myths Versus Reality” #5

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## *THE PERFORMANCE OF SHIELDS*

The myth: The representation of shield performance (in dB) as applied to products will be identical for EM fields developed internally to the product compared to fields externally impinging on the shield.

The reality: The performance of the shield will probably be very different for the two field conditions, perhaps by significant performance.

Shielding performance essentially involves a transfer function presented to the propagation of electromagnetic fields that are impinging upon the shield. For shielding, the intent of the transfer function is a matter of optimizing the ***mismatches*** of impedance: from the electromagnetic wave impedance compared to the shield impedance; and within the shield material itself, from the boundary of the shield surfaces compared to the “core” impedance of the material (assuming that the material is multiple skins depths of thickness).

The ***first effect*** of any shield in the process of transfer functions, is to mismatch the impedance of the impinging electromagnetic wave at the boundary surface of the shield. As with any impedance mismatch in a transmission line, the mismatch causes a reflection loss. The greater the ratio of impedance mismatch, the greater the reflection loss from the shield will be. When shields are thick enough to present multiple skin depths at the frequencies of interest, and assuming that the shield metal is a “sandwich” of highly conductively plated surfaces (such as electro-tin) applied to a different material (such as cold rolled steel) an additional transfer function of loss is noted. This loss is observed as the ***second effect*** of shielding as an additional “inter-boundary” impedance mismatch within the material itself. These mismatches set up greater shielding performance by promoting losses within the materials.

As a consequence of these processes, it can be conceptualized that ***the ratio*** of the various mismatches in the transfer functions holds the key to shielding performance!

Consider that to contain, capture, electromagnetic waves within a product that are sourced from the circuits and circuit boards of the product, the dimensional proximity from the sources to the shield surfaces will be relatively small (often less than 1cm). As a process of the transfer functions and as described in our tutorial program, EMCT (Module 3), the wave impedance from the internal sources to the shield will probably be found in the region of approximately 10 to 50 Ohms. (Near-field, magnetic dominant mode). Should the impedance of the shield material be in the approximation of 5 Ohms, then the anticipated first effect of reflection loss (10 / 5 to 50 / 5 = 2:1 to 10:1) would be in the area of 6 to 20 dB.

Contrast this performance against what would occur if the electromagnetic wave impedance were to be sourced in the far-field, tens of meters away from the product shields. In that condition, the electromagnetic wave impedance would probably be that of the impedance of space, or approximately 377 Ohms. In this condition, the first effect performance of the shield would become based on an impedance reflection ratio of about 75:1 (377 / 5), or about 38 dB even without considering other transfer function losses that may be evident within the material properties.

These significant differences in shield material performance also imply why shields may exhibit very different performance values when used and measured on a product, compared to the values represented by a shielding manufacturer: This is because the product may present to the shielding surfaces a very different electromagnetic wave impedance characteristic compared to that used for evaluation of the materials themselves for “catalogue” purposes.