**Introduction**

A demonstration printed circuit board (PCB) was developed to allow customers to measure the shielding effectiveness of the GORE™ snapSHOT® shield as a fully integrated “board-level” shielding device. Traditional removable-lid cans are the closest board-level shielding alternative that allow for repairability of components under the shield on completed PCBs (Ref. 5). Of course, the GORE™ snapSHOT® shield provides many other benefits to the designer including multiple cavities from a single shield, very low profile flexible shield geometries, and light weight. This test board incorporates both a removable-lid can and a single cavity GORE™ snapSHOT® shield so the user can evaluate the shielding effectiveness of both solutions.
Background

The technique for the test board was developed by Gore and is published in several trade journals and technical symposiums (Ref. 1, 2, 3 and 4). The key part of the test board is the “inefficient radiator” that is used as both the aggressor, or source, and receiver, or components under the shield. The test mimics the effect of having electronic components on a PCB “interfere” with other components on the same PCB. This way, one radiator is outside, or next to, the shield and the other is inside the shield. The user can demonstrate electromagnetic coupling with and without the shield attached.

Procedure

The procedure to use the test board is straightforward. There are three SMA socket connectors on the bottom of the test board that attach to 3 small radiators on the other side. Note that the radiators are terminated with small chip resistors, so that input power should be kept under about +20 dBm. The test equipment needed can either be a vector network analyzer (VNA) or a spectrum analyzer with tracking generator. The advantage of using a VNA over a spectrum analyzer is that it is easy to measure the insertion loss (S21) between the two radiators. However, the main disadvantage is a lower dynamic range than a spectrum analyzer with tracking generator.

The first step is to measure the insertion loss between the center radiator and the radiators on either side; one is under the removable-lid can and the other is under the GORE™ snapSHOT® shield. The next step is to attach the shields and re-measure the insertion loss between the respective radiators. Finally, the difference in insertion loss, or coupling, between the radiators with and without a shield attached can be considered the shielding effectiveness.

Description of Results

The test data provided below was taken using a separate RF synthesizer set to +17 dBm and a Spectrum analyzer that has about -120 dBm sensitivity. This configuration yields about 130 dB of dynamic range. This amount of dynamic range is important if the user wants to look at lower frequencies. Figure 1 shows the raw coupling, or insertion loss, between the radiators for the two conditions of the shield off versus on. With no shield attached (SSo_ave and RLo_ave) the data shows the average coupling over 10 test boards. One can see that the maximum coupling is about 30 dB, but it drops off significantly below 1.5 GHz, which limits the practical use of the test board to about 500 MHz, due to limited dynamic range. The other thing to note is that, although the goal is to make the radiator have a monotonic response over the frequency band, there is a slight resonance at about 3.5 GHz. This will show-up as a systematic anomaly throughout all of the data. The last point to address is that of cavity resonance, which is discussed in Ref. 1, 2 and 5. For the size of the test shields, the first resonance frequency resides at about 10 GHz. This means that when the shield is attached, you will see a marked decrease in shielding effectiveness of the shield at this frequency. This phenomenon is simple physics and cannot easily be avoided. Therefore, the designers should keep the size of the cavity small enough to push cavity resonances out of his or her operating frequency range. The average coupling (shown in Figure 1 as RLC_ave and SSC_ave) shows the response with the lids attached and shows the resonant frequency of the cavities.
To determine the shielding effectiveness of the shield, you would take the difference in the insertion loss, or coupling, with the lid off versus the lid on. Figure 2 shows this (from Figure 1) for the removable-lid can and the GORE™ snapSHOT® shield. Again, the data shows an average over 10 test boards. You can see the slight resonance behavior at about 3.5 GHz due to the test fixture. This is an anomaly of this configuration of the test board and radiators. You can also see the loss of shielding effectiveness at the cavity resonances. Over all, you will notice that the GORE™ snapSHOT® shield provides 15 to 25 dB shielding effectiveness improvement over the removable-lid can. This was also demonstrated in past shielding tests, see Ref. 5.

References


snapSHOT® EMI Shield Test Kit