EMI woes and cures

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Ever since the first poorly shielded home computers caused annoying herringbone patterns or worse on neighbors' television screens, the FCC (Federal Communications Commission) and other agencies worldwide have mandated strict limits to the levels of RF emissions that a digital-logic product can spew into the environment. The usual measurement practice for a new product release is to set up the equipment under test in a large, shielded, anechoic chamber to identify all radiated frequencies greater than 30 MHz and then move the equipment to an open area outdoors for the actual amplitude measurements of each of these frequencies. Many first attempts result in dismal failures.

Once a designer's equipment fails the test, he has to figure out how to fix the problem. Yeah, right. Test of any trial fixes requires an expensive and time-consuming trip to the test site, unless the designers have access to an in-house measurement facility. In most cases, they don't: Anyone who has ever tried to measure the emissions from a single product in a digital-electronics lab that many design teams and their operating hardware share quickly realizes how useless and impossible this attempt is.

My first exposure to EMI (electromagnetic-interference) measurement was in trying to make my multiport, unshielded-twisted-pair Ethernet-hub card comply with FCC Part 15 Class A in a multicard chassis that leaked RF like a sieve. The mechanical designers would not believe that faceplate grounding contacts made from coiled springs were useless at radio frequencies and deemed low-inductance beryllium-copper fingers "too expensive" to use. Management told the hardware engineers to make their boards quieter instead. We did not have a screened room, but we did have a spectrum analyzer and a leftover, front-end, wideband-RF amplifier.

All the other designers' cards for this product failed at the open-area-emissions test site. When my turn came, my card was 20 dB over the limit at the worst frequency of 80 MHz. I had the site technician make a swept plot of the emissions starting from 0 instead of 30 MHz. (The reason? It makes for a paper plot that you can easily interpret later to find the offending frequencies.)

I then went back to the lab, grabbed the spectrum analyzer, sneaked my test setup into the basement, and hung an 80-MHz dipole antenna from the ceiling. Lacking a screened room on the premises, I found that a basement is the next best thing for removing most ambient RF from radiated measurements. I hoped to find ways to reduce the emissions at the board level.

I had three days of RF-emissions-mitigation practice before my colleagues discovered me and moved their test setups down into the basement, too. The presence of their added equipment required me to recalibrate the correction factors between the basement and the open-area site for each radiated frequency. I was not interested in absolute levels, room reflections, or antenna-correction factor; I cared only about how much I could reduce the offending frequencies without raising other frequencies beyond their limits, which I again derived from the differences in their basement-versus-open-area plotted levels. The open-area site gave me the required reduction at each frequency in the plot; I had only to reduce the basement levels by the same amount. Specifically, I had to reduce the 80-MHz emission by 26 dB. This requirement took a lot of explaining to those who could not understand the concept and kept insisting that basement measurements were meaningless.

I did a board re-spin and headed back to the open-area test site. This time, my card passed with a 6-dB margin at the worst frequency of 80 MHz, and we could ship it. Yeehaw! EDN

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