<u>Computational Electromagnetics in Commercial EMC Measurements</u>

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Computational electromagnetics (CEM) is a growing tool in the hands of EMC engineers, not only in the design process, but it also plays an important role in measurements. In particular, the qualification of an open area test site to make accurate EMC measurements is being re-examined in light of the availability and use of CEM.

A large portion of an EMC engineer's time is typically spent at a measurement facility. Testing may begin when early prototypes become available, and the specifics of the test vary depending on the completeness and type of product. To show compliance to most EMC regulations, it is required to measure the radiated field strength under very specific conditions. The antenna must be located three or ten meters from the device under test (DUT) and raised from one to four meters above the test site groundplane. In addition, the DUT is rotated a full 360 degrees so that the maximum field strength in this region is obtained.

Today, detailed computational models of open area test sites are being used to provide accurate theoretical references for normalized site attenuation (NSA) measurements. It is required that a test site shall not deviate from the reference value by more than 4 dB. It has been shown that the reference values previously used are inadequate, having errors of almost 2 dB. The sources of error include the use of infinitesimal antennas as source and receive antennas. This assumption ignores coupling effects between antennas and the groundplane. In the early days of the FCC regulations, the site attenuation curves flattened below 80 MHz in recognition of the mutual coupling between tuned dipoles, but there was no means to allow for any other type of antenna.

The detailed NSA models include the geometry of both transmit and receive antennas. This ensures that an accurate representation of the mutual coupling between the antennas and the loading effects of the test site groundplane are fully included. This means that one model no longer fits all test sites; different antennas and even different baluns must be included to get precise models. A major benefit of the improved theoretical models is that it will be easier for many sites to meet the requirements.

When making engineering measurements or trouble shooting problems, a very wide range of test methods are used in addition to far field measurements. These methods include measurements of circuit values in the near field, in TEM or GTEM cells, in reverberation chambers, or in semi- and fully- anechoic chambers. The choice is mostly dependent on the facilities available, but each engineer will have his favorites for a particular type of product. It is extremely difficult to correlate between these very different methods and in general each engineer uses his experience and best judgment to get the work done in the most timely manner.

As the art of EMC measurements matures, the limitations of the present methods are being carefully scrutinized, and some of the other options are being considered as viable measurement methods for regulatory purposes. For this to happen, it is necessary not only for all of these techniques to be fully understood, but also how they relate to one another. Of particular interest today is the use of reverberation chambers and fully anechoic rooms (FAR).

In the future, as the number of acceptable test methods expands, it will be necessary to provide accurate theoretical models for use as references for each of these methods. This is yet another area where CEM provides the only viable method available to the EMC community by which measurement accuracy may be improved.