Signal Hound®

Antennas and EMC Pre-Compliance Measurements

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Application
NOTE

Objective

You need your product to pass FCC radiated emissions for a Class B device, and dread the thought of multiple visits to the test lab. A little online research shows that your device must have a field strength less than 200 µV/m at 3 m from 216 to 960 MHz, and 500 µV/m at 3 m above 960 MHz. How do you proceed?

Materials

You will need:

- A Signal Hound BB60C and laptop
- Directional antenna with mounts
- Measuring tape
- Flat, non-conductive surface for BB60C, ideally located away from buildings and strong transmitters

Set your antenna at the proscribed distance from the device to test. The antenna selected should cover the frequency of interest, at a minimum from the fundamental through the 5th harmonic of any clocks used (preferably 10th harmonic). An antenna factor table is required.

Wait! I don't have an antenna factor table!

Don't worry. If you know your antenna's gain, use this formula:

AF = -10 log10 (0.01056 * λ2) - G

where AF is the antenna factor in dB/m, λ is the wavelength in meters, and G is antenna's gain in dBi.

If you don't know your antenna's gain, or want a more accurate measurement and have 3 antennas, refer to the section titled "Three Antenna Method". Please note that most antennas only specify a typical gain at a single frequency using a specific mounting style. If accurate measurements are required, calibrating your antennas across your frequency range, using your exact setup, is highly recommended.

Connect your BB60C, launch Spike™, input your antenna factors, and begin testing! The more frequency points you use in your antenna factor table, the better your accuracy. Use around 100 points for a typical sweep. If you run into sensitivity issues, you may need to bring down the noise floor by adding a preamplifier or using a closer test distance and adjusting test limits by 20 log10(d1/d2).

You will want to test your product using several orientations, orienting your antenna for both horizontal and vertical polarization. To pass, your product must be below the limit in all orientations. A margin of 6 dB is recommended, to minimize the chances of surprises on test day.

Three Antenna Method

The three antenna method can be used to generate calibrated antenna gain and antenna factors from 3 uncalibrated antennas.

You will need:

- Three antennas that each cover the frequency range you wish to calibrate
- BB60C and a TG44A or TG124A tracking generator that covers the frequency range
- Measuring tape and antenna mounts, if needed
- Long SMA cables (with adapters if needed)

Set the antennas a fixed distance apart. This distance should be at least 5 wavelengths, more for a directional antenna (double the distance for each 6 dB of expected antenna gain). For small antennas, common distances are 3 meters and 10 meters.

With antennas, polarization is very important. Be consistent with your orientation.

Launch Spike, set up for a passive, high dynamic range insertion loss measurement covering the frequency range of interest. Using the same cables as you will use to connect the antennas, store thru, and then store 20 dB pad for best accuracy.

You will need to make 3 insertion loss measurements across the frequency of interest:

- Insertion loss, antenna 1 to antenna 2
- Insertion loss, antenna 1 to antenna 3
- Insertion loss, antenna 2 to antenna 3

Once you have these insertion loss measurements, calculate the three "gain products" as follows: $G12 = IL12 + 20 \log_{10}(4\pi R / \lambda)$

where G12 is the "gain product" of antenna 1 and antenna 2, IL12 is the insertion loss from antenna 1 to antenna 2 in dB, R is the distance between antenna 1 and 2 in meters, and λ is the wavelength in meters.

Repeat for G13 and G23.

Now, to calculate the gain in dBi for antenna 1: $G1 = (G12 + G13 - G23) / 2$

Use this gain to calculate antenna factor, build an antenna factor table, and begin testing! Spike's scalar network analysis mode provides insertion loss for hundreds of frequencies, so using a spreadsheet for these calculations is encouraged.

Conclusion

With Signal Hound's new EMC Pre-Compliance software, pre-compliance testing is easy and affordable!

Further Reading

Download the Spike and BB60C manuals from SignalHound.com.

About Signal Hound

Signal Hound designs and builds powerful, affordable spectrum analyzers and signal generators for engineers and RF professionals around the globe. Whether you're needing EMC precompliance capabilities in a small two-person shop or spectrum monitoring on a national scale, our test equipment is designed with you in mind. Accurate and powerful enough for mission-critical RF analysis, priced at a point accessible to most, and supported by a talented group of engineers committed to what they do – we truly believe that our devices offer unrivaled value in the test equipment industry.

In business since 1996 and selling our own line of Signal Hound test equipment since 2010, we've built the foundation of our company on years of test equipment repair, service, hardware and software development, and manufacturing experience. Signal Hound is a small company with big goals – and an even bigger commitment to providing our customers with an outstanding experience when purchasing and using our products.

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