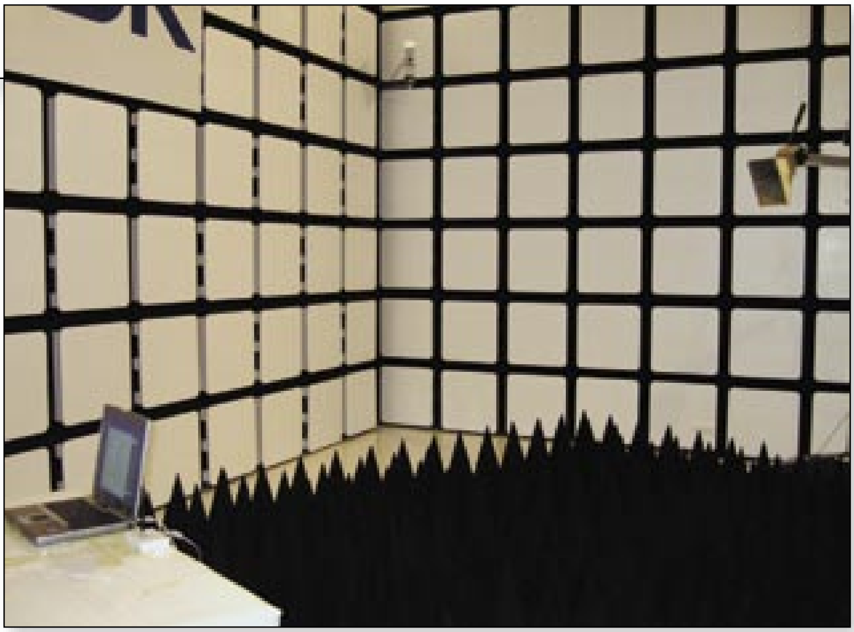
A closer look at UWB regulatory testing

There are many challenges to testing UWB equipment, having a clear understanding of the regulations, therefore, is crucial.

By Pat Carson



In this picture, photographed in the author's lab, measurements of a wireless USB hub from WiQuest Communications are being taken.

In the United States an ultrawideband (UWB) radio must comply with part 15 of title 47 Code of Federal Regulations, 47 CFR. Part 15 deals with unlicensed devices while subpart (f) specifically covers UWB transmitters. Subpart (f) describes several classes of UWB equipment such as ground-penetrating radar, through-wall imaging systems, and handheld/portable and stationary communication systems. It is these communication systems that we are interested in and are referenced as 47 CFR 15.517 indoor UWB systems and 47 CFR 15.519 handheld UWB systems.

In May 2000, the Federal Communications Commission (FCC) issued a Notice of Proposed Rulemaking to amend part 15 of the commission's rules. This move was intended to pave the way for new types of products incorporating UWB technology. After nearly two years of comments and controversial proceedings, the commission issued the First Report and Order allowing the marketing and operation of products that incorporate UWB technology. In 2004, the first UWB communication devices were tested, submitted and received grants for operation in the United States. These first radios were based on different physical layer technologies: Wisair-based multiband orthogonal frequency-division multiplexing (OFDM), General Atomics spectral keying and Freescale direct sequence. Today, the vast majority of UWB communication devices are based on the WiMedia Alliance multiband OFDM standard.

More than four years after UWB products were allowed in the United States, the Japanese ministry that controls radio regulatory issues, the Ministry of Internal Affairs and Communication (MIC), issued regulations allowing the use of UWB technology. Shortly after the MIC regulations were announced, Japan's Telecom Engineering Center (TELEC), issued T406 (www.telec.or.jp/eng/E_T406.html), which describes the test methodology for UWB radio systems.

While the MIC may describe other test methods, the methodology between the FCC and TELEC differ substantially in that compliance measurements for the FCC are done in a radiated environment using anechoic or semi-anechoic chambers (see the figure). In contrast, TELEC prefers conducted measurements if the equipment has an antenna connector. In cases where there is no antenna connector, it allows for radiated measurements. If conducted measurements are performed then performance data of the antenna mounted in the product must also be submitted. Regulations allowing UWB operations are expected soon from other regulatory domains such as Canada, China, Europe and South Korea. Each of these areas is leaning toward conducted measurements similar to the Japanese MIC standard.

In order to determine what regulations apply to a device employing UWB communication systems, each of the radio sections must be considered. There are three main areas of interest in a UWB device: the transmitter, the receiver and the digital control circuitry. The transmitter is the intentional emitter portion and includes the signal generation and filtering required to produce the waveform. The FCC considers the antenna to be an integral part of the radio and specifically requires that the antenna be non-separable. It, therefore, becomes part of the transmitting circuitry. This is not the case for MIC where the antenna can be removed and measured separately. In all cases, the regulations require that any unintentional emissions from the receiver meet the applicable limits and must be tested.

In the case of UWB radios, the digital control circuitry is treated differently than other unlicensed devices. Different limits apply to the control circuits of the transmitter, bus control circuits and clock sequences. One must refer to the applicable sections of the rules in order to apply the correct limits and procedures. It is also important to remember that peripherals, support equipment and associated cabling must be included in the measurements, since often times, RF couples to the external ports and can radiate, or conduct, through the cables and radiate. For specifics to equipment spacing, table height and cable routing, refer to the ANSI C63-4 standard, Methods of Measurements of Radio Noise Emission from Low Voltage Electrical and Electronic Equipment (www.ANSI.org). Another document from the International Electrotechnical Commission, IEC60489, should be consulted for specifics on antenna gain measurements (www.iec.ch).

There are many challenges to testing UWB equipment. Since the emission levels and limits are very low and frequencies very high, specialized equipment (low noise amplifier's (LNAs), filters, metrology antennas, etc.) must be employed. Special procedures and equipment are also required for measuring peak power in a 50 MHz bandwidth as well as emissions in the GPS bands and up to 40 GHz. Familiarity with these challenges and procedures will help ensure FCC and TELEC regulatory compliance. EWT

For additional information on FCC and TELEC regulatory rules, check out the following resources:

- Information on radio measurements—UWB/Wireless USB kyoukasyo, Shirou Sakata ed., Impress (2006), Tokyo.
- Detailed treatment of FCC regulator testing of UWB equipment—Ultra Wideband Systems: Technologies and Applications, by Dr. Roberto Aiello, PhD, and Dr. Anuj Batra, PhD.

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a receiver either working at a fixed-adjacent frequency (TFI mode) or hopping into an adjacent channel (FFI mode) to have reception problems. You can see the importance of the test: a problem here would not affect the "violator" radio, but would cause problems with another radio ther by causing consumers to blame the "victim" radio for the problem. Transmit power control testing helps ensure that the radio will be able to use only the transmitter power necessary for the transfer task at hand. As a result, it helps maximize battery life and minimize RF interference to other co-located radios.

A key modulation domain analysis test for WiMedia-based transmitters (as well as most RF technologies) is EVM. For engineers who might be more familiar with digital testing, this test is analogous to the jitter measurements and eye diagrams used to derive the measurement for a digital signal. As with eye diagrams, EVM constellation diagrams are graphical expressions and simple numbers representing a compilation of multiple error sources.

Receiver tests

These tests are more about testing the "breaking" point of the receiver, as you can only test the ability of the receiver to work under various stress conditions, and are preformed using a special transmitter, sometimes referred to as a "Golden Radio." This transmitter has fully controllable transmit characteristics and can operate as a clean "ideal" transmitter. It can also be adjusted to have known impairments or distortion. In this way, the margin of the receiver can be assessed.

First, the engineer must determine whether the receiver meets the frequency tolerance of ±20 ppm as listed in the specification? Using the golden radio, it is simple to sweep the local oscillator (LO) to determine whether the receiver meets the specification, and to stress it to the point where the receiver starts to fail to determine the design's margin. Various other parameters can be assessed as well. For example, how do you determine the effectiveness of the PSD mask requirement, beyond simulation of the design? Using a golden radio, interference can be injected that mimics the type of design issues the PSD was intended to detect. Then interoperability testing can be performed with this intentionally distorted radio, assessing the impact of this particular transmitter impairment on the receiver.

The WiMedia specification was meticulously engineered to ensure that the technologies built on it provide consumers with a reliable, high-speed wireless experience. Testing throughout the implementation stages provides a predictable path to conformance to the dictates of that specification. EWT

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