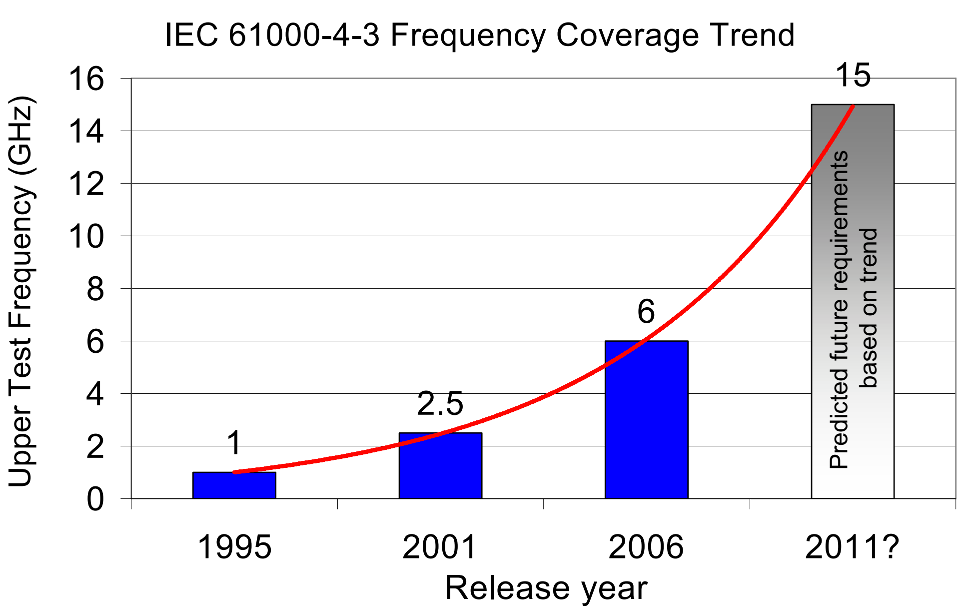
APPLICATION NOTE #43
TEST BEYOND THE SPECS
Why test higher in frequency and field strength?
IEC 61000-4-3:2006's frequency explosion

By: Jason Smith, Applications Engineer Supervisor & Pat Malloy, Senior Applications Engineer

An increasing number of new and proposed EMC standards are pushing the upper frequency test limits further up in the microwave spectrum. The latest EMC standard released, IEC 61000-4-3:2006, is no exception. The upper frequency test limit has been increased from 2.5 GHz to 6 GHz to reflect the increased use of the microwave spectrum, primarily by wireless communication devices. While the standard is written to take into account some of the present threats that equipment may be susceptible to, regrettably, it does not cover all potential threats.

With the world's ever growing hunger for more sophisticated communication and control devices, it's a sure bet that more of the microwave spectrum will be used to accommodate new electronic products in the near future. In addition to this "frequency creep" issue, EMC standards fail to take into account the possibility of transmitters operating in close proximity which can produce RF fields considerably greater than those mandated in the standard.

From a manufactures perspective, it is prudent to consider these "worst case" scenarios involving higher test frequencies and test levels to insure quality assurance and reliability and ultimately maintain customer satisfaction and loyalty. The alternative of just testing to the required specifications may provide an initial cost savings, but in the long run can prove disastrous if your customer discovers problems with one of your products that just "squeaked" through a minimal EMC testing protocol.



Reference

Radiated Immunity testing:

The testing of electronic products to withstand a given electromagnetic energy field while maintaining an acceptable degree of performance. The electromagnetic field is representative of what the product under test may be exposed to in normal use.

Typical sources for RF interference include:

Electronic digital devices operated nearby, some with clock frequencies exceeding 2GHz.
Transmitters: Walkie-talkies, mobile phones, WiFi, WiMAX, Bluetooth, …
Electric motors and generators

History of IEC 61000-4-3

As the nature of electronic products has changed over the years, immunity standards have changed to reflect the ever increasing complexity of electronic gear. For example, increasing clock speeds and transmission frequencies have forced the IEC to test for immunity at frequencies unheard of a decade ago. Note the progression in the upper frequency test limit (frequency creep) of the primary commercial immunity standard shown below:

IEC 1000-4-3:1995…Original release coverage of 80 MHz to 1 GHz
IEC 61000-4-3:2001…Released with frequency coverage 80 MHz to 2.5 GHz
IEC 61000-4-3:2006…Released with frequency coverage 80 MHz to 6 GHz

The graph on the first page clearly shows the increasing test frequency trend. The next release of IEC 61000-4-3 is scheduled for 2011 and if the past is any prediction of future requirements, it is apparent that the test frequency will possibly be in the 15 GHz region.

Why did the current EMC standard push the upper test frequency from 2.5 GHz to 6 GHz?

Wireless digital communications now cover frequency ranges up to 6 GHz. Annex G of IEC 61000-4-3:2006 list some of the common transmission standards used throughout the world today clearly showing operating frequencies approaching 6 GHz. The standard does not consider all RF interference sources (see the Wireless band table below) nor does it include new emerging technologies.

Wireless frequency coverage

Most industrial countries regulate use of the RF spectrum and have mapped out allocations for frequency usage up to 300 GHz. Given our insatiable need for more frequency bandwidth, it's just a matter of time before additional chunks of bandwidth are licensed for not only emerging wireless applications, but for yet unimagined systems of the future.

Wireless bands

WiMAX IEEE 802.16:2004	2 GHz to 66 GHz; presently assigned up to 5.825 GHz
WiMAX IEEE 802.16e	2 GHz to 11 GHz; presently assigned up to 3.8 GHz
Proposed UWB	3.1 GHz to 10.6 GHz
Broadcast auxiliary remote TV service, news gathering, intercity relay, and studio transmitter link	6.425 GHz to 6.525 GHz 6.875 GHz to 7.025 GHz 7.075 GHz to 7.125 GHz
Fixed microwave links for dam flood gates, remote weather data, remoting of vessel traffic info, air traffic control radar data	7.125 GHz to 7.9 GHz 8.025 GHz to 8.4 GHz
Maritime radars & radiolocation	9.2 GHz to 9.5 GHz

In addition Radar used for commercial aircraft, military, naval vessels, and police operate at frequencies up to, and in some cases, exceeding 60 GHz.

Finding an acceptable solution

It is important to change the mind set from what is the minimum requirements a product needs to meet as mandated by adherence to the current EMC test standard, to what can be done to increase product quality and safety, and therefore customer satisfaction. Keep in mind that EMC standards are always going to be lagging the actual frequencies in use because the IEC can only include transmitting technologies that are available at the time of the standards release. In addition, they do not take into account extreme cases were the transmitter may be in close proximity resulting in RF fields exceeding the maximum test levels called out in the standard. Since the IEC can not predict how technology evolves, by necessity, the standard is designed to be a minimum base line for testing.

While some electronic products can benefit from applying a "minimum base line test" philosophy, products that are of a critical nature must be held to a much higher acceptance level. For example, if one is manufacturing collision avoidance systems for military or commercial aircraft or automotive ABS systems, minimal EMC testing is not advisable.

Over testing is not a particularly new concept. Many manufacturers of so called non-critical products have for years tested at twice the required test voltage to insure EMC compliance. Given the existing rush to push further into the microwave spectrum, it is now practical to also "push" the upper test frequency past that required in the standard.

How should one proceed to set up a viable test protocol? One extreme path to cover all your bases would be to test to a "worst case scenario". This requires that all possible RF/microwave sources be identified, along with their maximum power levels and operating frequencies. Then one must apply an acceptable safety margin to both field level and frequency range to cover variations and the unexpected. This is a daunting task, not to mention the enormous expense involved in applying this worst case philosophy.

A more reasonable solution would be the adoption of a "design to meet" criteria in the product development. A design to meet criteria would be a goal for the product to exhibit an inherent degree of EMC ruggedness. This approach involves the application of a modest safety margin to all the required EMC test levels. For example, a requirement of 3 V/m at a frequency of 10 GHz could translate to a test conducted at 10 V/m up to 20 GHz.

When your product conforms to an EMC test that applies these extended levels, the margin you have built into the product insures a high level of quality and reliability and also provides a technical barrier to protect your market share. Keep in mind that while the current issue of the commercial IEC EMC standard mandates relative modest test levels up to a maximum frequency of 6 GHz, other segments of the marketplace are already operating and testing at 18 to 40 GHz on a routine basis. Some of these manufacturers could likely be your competitors.

In summary, ever changing applications requiring additional microwave spectrum are best handled by a testing philosophy that applies a reasonable amount of "over testing" that involves the extension of not only voltage levels (an time-honored practice) but also an extension in the upper test frequency. By gearing up now to test to higher frequencies, a manufacturer will be positioned to deal with the inevitable increase when the next EMC standard is released. As a result of applying larger safety margins in EMC testing, one can provide products that stand the test of time and stand up to the quality customers expect and deserve.