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Timely Updates on Critical Standards

In this issue

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Do you know about the many Normative Interpretations and Informative Explanations that have been issued for ANSI C63.4-2009 and ANSI C63.5-2006?

In this issue we continue to focus on "news you can use"- i.e., new and pending changes to EMC standards that will cost EMC laboratory owners and manager's money, test time, and/or will impose new or altered testing and staff training procedures.

Nearly everyone involved with making EMC measurements on commercially-available equipment is familiar with the latest version of the Test Method Standard ANSI C63.4-2009, and most have at least referenced the latest version of the EMC Antenna Calibration Standard ANSI C63.5-2006 when sending Antennas out for calibration. However, many users of these documents are unaware that there exist many *NORMATIVE* interpretations that have been formally issued by ASC C63® since the publication of ANSI C634-2009 and ANSI C63.5-2006. Also, in many cases, users of these documents are aware that *NORMATIVE* interpretations exist, but are unclear about where to find them.

In this edition of the ACIL EMC Standards Alert Newsletter, we will review the many normative interpretations and informative explanations that have been formally issued since the original publication dates of ANSI C634-2009 and ANSI C63.5-2006. ***The reason that you should care about these normative interpretations is that they form integral parts of these Standards, and, that Auditors from the Accreditation Bodies can and will cite deficiencies against these normative interpretations. The reason that you should care about the informative explanations is that they elucidate the reasons for a particular concept or approach.***

The full set of normative interpretations as well as informative explanations that relate to ANSI C63.4-2009 and ANSI C63.5-2006 are posted on the C63® web site at the following URL:

http://www.c63.org/documents/misc/posting/new_interpretations.htm

In this edition of the ACIL EMC Standards Alert Newsletter, we will address each of these normative interpretations (in clause-by-clause order) for both ANSI C63.4-2009 and ANSI C63.5-2006, in order to make it easy for allow our readers to make annotations in their copies of these standards and/or to make an easily searched file that contains the text of each of these normative interpretations. Where there is a useful explanation accompanying a interpretation on the same subject, the interpretation is stated herein as well.

Review of C63.4-2009 Interpretations

Clause 4: Measurement Instrumentation

ANSI C63.4-2009 Table 1 (in Clause 4.5 - Antennas) presents the table which shows which antennas shall be used in making compliance radiated emission measurements. Table 1 was originally derived from ANSI C63.2, but differs from it in significant ways. In particular, note that:

1. No hybrid antennas are listed in the Table. Hence, hybrid antennas (i.e., BiconLogs) are NOT allowed to be used when making final radiated emission compliance measurements.
2. Above 1 GHz, only waveguide and double ridge guide horns are listed in the Table. Hence, for example Log Periodic Dipole Array (LPDA) can NOT be used above 1 GHz region.
3. Table 1 states that only *passive* Loop Antennas can be used when making measurements below 30 MHz.

Items 1 and 2 above have been confirmed and clarified by published interpretations. In regards to these two items, it is important to note that the above requirements are ***unchanged*** from the 2003 edition of ANSI C63.4. While it is understood that it may be more convenient and perhaps less time consuming in not changing antennas, that option is NOT allowed in the either the 2009 or 2003 editions of C63.4.

In regards to item 3 above, Table 1 also indicates that only passive loop antennas can be used, notwithstanding the fact that ANSI C63.2 does not add the qualifier "passive". ANSI C63.4 can and does state requirements that are more stringent or are in addition to those stated in ANSI C63.2.

Finally, please note that issue of expanding the list of which test antennas can be employed (and over which frequency ranges) is now being reviewed by the ANSI C63.4 maintenance team, which is working on the development of the 2012 edition of the ANSI C63.4 Standard.

Clause 5: Test Facilities

Clause 5.4.4 provides site validation information and points to Annex D for Normalized Site Attenuation (NSA) for the frequency range 30 MHz to 1 GHz. Clause 5.4.4.2 gives the site validation interval for checking NSA. Unfortunately, there was no information on the site validation interval above 1 GHz.

The interpretation added a paragraph at the end of Clause 5.5 to cover the site validation interval above 1 GHz if the site validation was made using the optional Site VSWR (S-VSWR) method found in CISPR 16-1-4: 2007. The newly-stated interval was written to be similar to that used below 1 GHz, - i.e., that the site validation should be confirmed in the first year of a new site or one that has been changed is some manner. Subsequent intervals may be up to 3 years or shorter based on modifications and frequency of use.

In contrast, if the option of simply laying down a 2.4 m by 2.4 m area of absorbing material on the ground plane between the EUT and the receiving antenna has been selected by the EMC Test Lab, there would not have been a method of site validation used in the first place, and hence there would not be any site validation interval.

Clauses 5, 6, and 7: All relating to LISNs

Clause 6 specifies that for power units that plug directly into a mains/power plug, they shall be tested on the table top using an extension cord to plug into the LISN below it. Clause 5 requires that the extension cord and the LISN together must meet the impedance requirement for the LISN (albeit with a slight relaxation of the upper tolerance of the LISN alone impedance). There was skepticism that the relaxed upper tolerance of the LISN impedance could be met using an extension cord. The interpretation issued noted that in a peer-reviewed paper by Tsaliovich and Moongilan that was presented at the 1990 EMC Symposium, detailed instructions were provided showing how to make such an extension cord. In effect, their extension cord was comprised of three coaxial lines where the center conductors are the current carrying conductors. Trimming capacitors located at the end of the coaxial lines were used to meet the overall impedance requirements. This arrangement meets the requirements for the use of extension cords as indicated in Clause 7.

Clause 8: Radiated emission measurements (1 GHz to 40 GHz)

Questions are continually being asked about the meaning of keeping the receive antenna in the "cone of radiation" of the source of emissions when making final compliance measurements above 1 GHz. To meet this requirement, the receiving antenna has to be aimed or pointed towards the source of emissions as the receiving antenna is raised from 1 m to 4 m. The FCC issued Public Notice 746324 dated March 9, 2007 entitled "Electric Field Radiated Emission Measurements above 1 GHz" that supports this requirement. Although the Public Notice was addressed to ANSI C63.4-2003, the interpretation states that the text of this requirement was not changed in the 2009 edition, and so still holds. In order to comply with this requirement, a means to point the horn antenna at the EUT as the horn antenna is raised in height from 1 m to 4m above the ground plane is required. This can be accomplished by using an articulated antenna positioner. It can also be accomplished using manual means, for instance, by using a "tilt head" from a tripod to allow the elevation angle of the horn antenna to be adjusted.

Clause 10: Test reports

A request was made to remove the requirement in Clause 10.2.4 to report the date the test equipment was calibrated and the calibration interval. The rationale for this request was that this information is on file at the EMC Test Laboratory and it was thus unnecessary and burdensome to include it in the test report. The interpretation noted that calibration date records are usually kept in electronic form and that this information can easily be added to the test report by an electronic editing process. It was therefore determined that there was no reason to remove this requirement. Additionally, the interpretation emphasized the value of having a check of the test equipment being "in-calibration" when the test is performed.

Annex B: LISN calibration

There are two measurement procedures for calibrating LISNs in Annex B of ANSI C63.4. Unfortunately, you get different results if you calibrate with these two procedures - one using a signal generator and a receiver/spectrum analyzer and the other using a network analyzer. The differences came down to a missing "T" connector in the network analyzer procedure. The interpretation containing the corrected test setup block diagrams can be found at the following URL: http://c63.org/documents/misc/posting/C63.4_LISN_calibration_interpretation_jan2010.pdf

In addition to correcting the test setup diagrams, corrections needed to the text of the network analyzer procedure. These corrections are summarized below:

1. *The barrel connector in step 2) was deleted.*
2. *In step 4) the following text was added: "Do not change any of the settings on the network analyzer".*
3. *In step 5) the text was replaced with "Follow network analyzer manufacturer's instructions to measure the received signal over the frequency range of interest".*
4. *In step 6) the text was replaces with "Subtract results from step B.4 b) 5) from the results of step B.4 b) 3) to obtain the LISN insertion loss (in dB)*

Finally Note 1 was revised and now states: "If using the network analyzer the internal calibration routine cannot be used, otherwise a systematic error is introduced that is directly related to the actual impedance of the LISN."

The actual impedance values with the tolerance used for the LISN alone (+/- 20 percent) and +30/-20 percent for an LISN with an extension cord used on the EUT side of the LISN were recalculated using the circuits in Figures 2 and 3 in ANSI C63.4-2009. The interpretation also notes that the LISN impedance values shown in Figure 1 of ANSI C63.4-2009 Figure 1 are correct, and that the previous computations which led to Figure 1 in the ANSI C63.4-2003 edition were incorrect. Thus, Figure 1 of ANSI C63.4-2003 is incorrect as well.

Annex D: Site Validation 30 MHz to 1000 MHz

It should be first noted than ANSI C63.5-2006 is the ***only*** edition of ANSI C63.5 that can be used for calibrating antennas for the making radiated emission measurements in accordance with ANSI C63.4-2009.

Two of the most important changes in ANSI 63.5-2006 were as follows:

- the introduction of the use of "Free-Space" Antenna Factors - which must be used when making radiated emission measurements on products (i.e., EUTs) in accordance with ANSI C63.4;

- the introduction of GSCFs (Geometry Specific Correction Factors) - which must be used when making Site Validation Measurements below 1 GHz in accordance with ANSI C63.4.

For the case of biconical antennas used for both product measurements and site validation measurements, an understanding of Annex G (and especially the Figure G.2 flowchart) in ANSI C63.5-2006 is essential. For the case of Log-Periodic Dipole Array Antennas used for both product measurements and site validation measurements, an understanding of Annex H in ANSI C63.5-2006 is essential.

With the publication of ANSI C63.5-2006 (antenna calibration), there was a need to modify the equations for Normalized Site Attenuation equations in Annex D of ANSI C63.4 to account for the changes in antenna calibration processes in ANSI C63.5-2006.

The synchronizing needed was to amend the NSA Equation D.1 in ANSI C63.4-2009 Annex D. This required changing the Correction Factor, $\Delta AFtot$, in equation D.1 to the GSCF as defined in ANSI C63.5-2006. Revised wording has also been added in Clause D.2 of Annex D in ANSI C63.4-2009 stating that the applicable GSCF values are to be used as determined by antenna calibrations performed per ANSI C63.5-2006. Among other things, this means that the Correction Factors for tuned dipoles in the tables in ANSI C63.4 are no longer used for broadband antennas.

Review of ANSI C63.5-2006 Interpretations

Scope

There are several ways to calibrate antennas. The most commonly used method is the Standard Site Method (SSM) - sometimes called the "three antenna method" - and as a result, this method in particular is fully described in ANSI C63.5-2006. The other methods allowed and listed in the scope of ANSI C63.5-2006 are the reference antenna, equivalent capacitance substitution, standard transmitting loop, standard antenna, and standard field methods. It is up to the test lab to decide which calibration to request of an antenna calibration laboratory or for the test lab itself to use if internal lab calibrations are performed.

Cross linkage with ANSI C63.4-2009

Questions have been raised regarding whether or not hybrid or other broadband antennas may be calibrated in accordance with ANSI C63.5-2006 and then used for product compliance testing above 1 GHz in accordance with ANSI C63.4-2009. An interpretation has been issued that, among other things, reiterates that ANSI C63.5-2006 does NOT contain requirements for radiated emission testing, and, that the requirements for radiated emission testing are contained only in ANSI C63.4. Table 1 of ANSI C63.4-2009 lists only those antennas that are allowed to be used, and the frequency ranges over which those antennas can be used. Table 1 of ANSI C63.4-2009 DOES NOT include hybrid antennas. Clause 4.5 of ANSI C63.4-2009 states that antennas used for making measurements shall be calibrated in accordance with ANSI C63.5-2006. It is important to note that ANSI C63.5-2006 is a general standard for calibrating all sorts of antennas, including but not limited to those required to be used in ANSI C63.4-2009.

Annex A: Determination of the maximum received field for Tables 2 and 3 in Clause 5.1 of ANSI C63.5-2006

The direct path length between the transmit antenna and the receiving antenna is d1; the reflective path length off the ground plane is d2. In ANSI 63.5-2006, the equations were identical which is obviously wrong. The correction made was to replace the minus sign in the d2 equation with a plus sign. The reference to the source of these equations is a paper by Al Smith. That reference is [14] not [11] as shown ANSI 63.5-2006. This incorrect reference number appears in three places: Annex A, at the top of page 7, and the bottom of page 9. These three locations should all show reference [14].

Clause 6: Reference antenna method

A question was raised about whether or not Schwarzbeck VHAP and UHAP dipoles could be used as reference antennas for the reference antenna method in the frequency range 30 MHz to 1000 MHz. ANSI C63.5-2006 only allows the use Roberts Dipoles as reference antennas. Roberts Dipoles are tuned, half-wave resonant dipoles with series-parallel coaxial stub baluns. The Schwarzbeck VHAP and UHAP antennas are NOT tuned, half-wave resonant dipoles with series-parallel coaxial stub baluns. Thus, they do not meet the ANSI C63.5-2006 requirements for a reference antenna and hence cannot be used for that purpose.

ANSI C63.5-2006 Annex G: Biconical dipole antenna correction factors (30 MHz to 200 MHz) for calibration and normalized site attenuation

A question was raised regarding the allowable interpolation method or methods to be used between frequencies when calibrations were performed. An interpretation was issued stating that linear interpolation shall be used to determine antenna factors in between the actual calibration frequencies.

An explanation clarifying which antenna factors are to be applied for both product testing and for site validation (i.e., for NSA) measurements was issued. It references the flowchart given in ANSI C63.5-2006 Annex G Figure G.2. That flow chart indicates that using the standard site method for calibrating biconical antennas in the 30 to 200 MHz frequency band gives a near free space antenna factor. To get the free space antenna factor, a conversion factor is added. These factors depend on the balun impedance (i.e., 50 Ohms or 200 Ohms, as applicable) and are given in Table G.1. For product testing, you would use the Antenna Factors derived at this point. If Antenna Factors are needed for NSA measurements, you have to further amend the Free Space Antenna Factor for the geometry that is used (i.e., for measurement distances of either 3 or 10 meters). These additional corrections are called Geometry Specific Correction Factors. They are found in Tables G.2 (for the case of a 10 meter measurement distance) and G.3 (for the case of a 3 meter measurement distances). These GSCFs are then inserted in Equation G.2 (which is the equation for NSA).

Also, it should be noted that Figure G.2 incorrectly shows Equation F.2 instead of Equation G.2.

ANSI C63.5-2006 Table 1 and Annex H: Procedure for measuring geometry-specific corrections factors for broadband antennas and reference-site requirements

ANSI C63.5-2006 provides methods for calibrating a wide range of antennas. The purpose of ANSI C63.5-2006 Table 1 is to show which calibration method(s) applies to each of the antenna types shown. The headings show the general application of the antennas when testing products, and, when performing Site Validation (i.e., NSA) in the frequency range 30 MHz to 1000 MHz.

It should be noted that a row in Table 1 of ANSI C63.5-2006 shows the specific antenna calibration methods to be used for "broadband hybrid" antennas for both product testing and Site Validation (i.e., NSA determination). Notwithstanding this fact, Table 1 in ANSI C63.4-2009 prohibits the use of "broadband hybrid" antennas for final Radiated Emissions compliance testing of products and prohibits the use of "broadband hybrid" antennas for Site Validation (NSA determination). These prohibitions are repeated in the third paragraph of Clause D.1 in Annex D of ANSI C63.4-2009), which only allows the use of biconicals, log periodic dipole arrays, and tunable dipoles for NSA measurements.

ANSI C63.5-2006 Annex H:

A question was raised as to the use of semi-anechoic chambers (SACs) for *antenna calibration* (as an alternative to the use of an open area test site (OATS)). ANSI C63.5-2006 Annex H Clause H.2 4 lists as a requirement that a weather protection enclosure is not allowed. Also, ANSI C63.5-2006 Annex H Clause H.2 5, states that there shall be no objects within 10 m of the edge of the ground plane. These requirements were stated for an OATS. It should be noted that an OATS continues to be the standard test site for all ANSI C63 Standards, including ANSI C63.4-2009 and ANSI C63.5-2006. Thus, any other proposed antenna calibration site would still have to meet the attributes in ANSI C63.5-2006 Clause H.2. Hence, semi anechoic chambers are not allowed to be used for antenna calibrations performed in accordance with ANSI C63.5-2006.

In addition, SACs cannot be used to determine the Geometry Specific Correction Factors (GSCFs), because a SAC has a weather-protected enclosure and does not have the 10 meter separation between the edge of the ground plane and the closest object (in this case, to the wall of the semi-anechoic chamber).

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