American Council of Independent Laboratories

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Timely Updates on Critical Standards

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In this issue

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Further review of draft CISPR 32 (to replace CISPR 22 & 13)

In the last Standards Alert we introduced the committee draft of the new CISPR 32 *"Electromagnetic compatibility of multimedia equipment - Emission"* , noting possible impact to both EMC testing labs and others that deal with such standards. In particular, Annexes A through C were discussed which covered:

Annex A: Test Instrumentation
Annex B: Exercising the EUT during measurements &specifications of test signals
Annex C: Measurement procedures, instrumentation and supporting information

The source document was CIS/I/295 CD. The working group in charge of this activity met in October to review the voting national committee's (NC) comments and to resolve these in the next committee draft. (If the resolutions are close to a consensus, the revised document may go to the next stage, which is a committee draft for vote by the NCs.) **If there are significant changes to the draft CISPR 32 we will summarize them in the fourth Standards Alert in the first quarter of 2010.**

But in the meantime, here is information on the Annexes D through J.

Annex D: Arrangement of EUT and Associated Equipment

The good news is that the premise for the EUT setup remains, i.e., it should be in a typical arrangement and use. They added testing in "standby mode" for receivers as this may be a higher emission mode.

Cable construction and type must be also typical of use. They introduced a new table on cable lengths and arrangements as well as a new table covering EUT spacing, distances, and tolerances. For the first time, the effective cable lengths *and* the tolerance of those lengths are stated explicitly as well as the cable termination (or simulator) and how it is bundled. If the actual termination is one of actual use, the termination shall be terminated in impedances representing both the common and differential mode of that normally attached in use. Cables that are longer or shorter than specified in the standard or too stiff to bend must "meander." Meander means laid out in a somewhat random arrangement. Test laboratories will have to carefully note these lengths and layouts, especially the tolerance and spacing between components of the EUT in order to be able to reproduce the test results.

As was the case for CISPR 22, the insulation on top of the ground plane can be up to 15 cm to allow floor standing products to be kept on the shipping pallet which is that high. Also where there are multiple cables of the same type connected to the EUT, at least one of the cables should have a termination, and if needed for operation of the EUT, one cable should be connected to associated equipment (AE) which normally receives traffic from the EUT. The other cables remain unterminated. So test labs need to be sure that the customer provides the necessary AE and the cables typically used. The "maximization rule" covers when to stop adding cables. This is different than the 2 dB rule in C63.4-2009. With both rules, you stop maximizing when there is less than a 2 dB change in emissions. This is the starting point for the 2 dB rule and the ending point for the draft CISPR 32. In C63.4-2009, if the emissions continue to rise as cables are added, even though the rise is less than 2 dB, the maximization process continues if the rise brings the emission level close to the limit. So in essence, the CISPR 32 proposed process will take less time, but will not necessarily get the maximum emissions that may exceed the limit.

The standard allows for testing in a fully absorber lined room (FAR, using the reference ground plan as either the top of the absorbing material on top of the turntable or the turntable surface itself which is at the elevation of the top of the floor absorber underneath the turntable surface.

Then there are sections on table top, floor standing and combination arrangements. Several figures demonstrate what the text says. There are a few differences from that shown in ANSI C63.4. For example, conducted emissions have an alternative for table top testing as in CISPR 22, i.e., either an 80 cm or a 40 cm high table top is allowed. For the former, a conductive wall is the reference ground plane; for the latter situation, the reference ground plane is the conductive floor underneath the table top. There remains the arrangement when making Telecom port measurements, not required by the FCC and hence are not in C63.4.

For floor standing equipment, there is now a specification on how to arrange long (>10 meters) power cables treated as inter-unit cabling. This may require special non-conductive supports to maintain the separation from the ground plane. For combination floor standing and table top EUTs, there are two ground planes to deal with. For the floor standing portion of the EUT, the reference ground plane is the floor ground plane; for the table top portion, the ground plane can be either the conductive horizontal floor or a vertical conductive wall. The one to select will be driven by the option of table top height for the conductive emission measurement.

The requirements for conducted emission testing are similar to that in CISPR 22 with additional clarity. Again, the two table top heights are allowed. For conducted emission measurements in a FAR, a ground reference plane is needed and hence the *test lab will have to install it for the conducted emission testing and then remove it for radiated emission testing.*

Emission measurements can be performed in either of three test facilities, i.e., an open area test site (OATS), an absorber line ground plane OATS abbreviated by FSOATS where the FS stands for free space, and a semi anechoic chamber. Here there is no allowance for having the artificial mains network (line impedance stabilization network) mounted above the ground plane. If overhead cable trays are used between floor standing equipment the tray is shown as being non-conductive in the figure, but there was no reference to this specification in the text. As it stands now, if the manufacturer specifies a metallic overhead cable tray, use it. Finally, there is a reference to another Annex (Annex I) for testing outdoor units of broadcast satellite receivers.

Annex E: (Informative) Guidance for emission measurements using CISPR 16 methods

The section introduces measurements by both manual and automatic methods. This is informative and not a requirement to be exactly followed, but has good suggestions to be considered. Virtually all of the information applies to radiated emission measurements, beginning with an overview of manual versus automated measurements. Automation is recommended for basic measurements. There is a flow chart based on using "maximum hold" characteristics of the measurement instrumentation with the detector set to record peak signals. It, in essence, helps find a frequency list of emissions from the EUT while exercising the EUT in its typical modes of operation and cable arrangement. This is described in some detail by reference to methods found in CISPR 16. It also suggests variable turntable speeds to capture emissions during the EUT cycling time. Variable turntable rotation speeds are generally not available and so **the test lab may have to modify their turntable rotation speed with a variable speed motor.**

Prescan measurements are identified followed by the final measurements which now are called "formal" measurements largely based on the list of emission frequencies found during prescan. If the position of the cabling for maximum radiated emissions during prescan was not definitive, more cable positioning is required in the formal measurements to seek the maximum emissions as the turntable is rotated and the antenna height and polarizations are changed. There is a single sentence as to what to do when performing conducted emission testing. It states that you go to the port (or cable) being measured to find each significant frequency selected during prescan, and then measure the emissions with the appropriate measurement instrumentation detector.

There are two flow charts that aid in the discussion. The flow charts contain decision trees indicating what to do when peak, quasi peak and average measurements are recorded to compare to the appropriate limits. The information is straight forward and will not be presented here.

Annex F: (Informative) Test report contents summary This annex contains what should be recorded in the test report. Requirements are referenced to where they appear in the standards and in Clause 5.10 of IEC/ISO 17025, the document for competency of test laboratories. The level of details are also shown for each item in the report. This will immensely assist the test lab during any lab assessment by an accrediting body.

Annex G: (Informative) Support Information for the measurement procedures defined in Clause C.3.1 This annex shows diagrams of asymmetrical artificial networks used to terminate a wide variety of lines and cable types needed for telecom port measurements. It covers most types of telecom pair conductor configurations as well as coaxial cables. Similar figures are contained in CISPR 22. At least two additional ports need to be connected to a 150 ohm common mode impedance to ground as is the cable/line under test.

The longitudinal conversion loss of the terminations should match as close a possible the LCL of the telephone pairs. Its impact on the measurements is discussed in some detail. This is done so that the measurement replicates as much as possible the conversion of the wanted signal into the common mode signal which is most representative of the interfering potential radiated away from the line/cable.

There is a table that shows the advantages and disadvantages of the various methods of measuring the magnitude of the common mode current (or voltage across a termination) that will cause interference. This table also indicates the relative uncertainty of the various measurement methods contained in Annex C which was described in Standards Alert 2.

Finally there is a discussion on the use of a capacitive voltage probe to measure the total common mode voltage across the 150 ohm termination impedance. The parallel impedance is well within the 150 +/- 20 ohm requirement as at 30 MHz, the capacitive voltage probe reduces the 150 ohms to about 148 ohms which is well within the tolerance of the terminating impedance itself.

If the total common mode impedance is not 150 ohms, the measurement of voltage or the current alone is not acceptable due to a high level of measurement uncertainty. If both voltage and current are measured and compared to their respective limits, there will be a worse case estimation of the emission.

In summary this Annex contains a wealth of information to explain the attributes of Annex C port measurements, especially for the required telecom port measurement required outside the US.

Annex H: (Informative) Alternative test methods with limits for the enclosure port. This annex is probably the most interesting as it identifies alternative methods for measuring radiated emissions using GTEM transmission lines and reverberation techniques. Meeting the limit identified with each alternative test method **does not** constitute compliance with this standard. **But it is clear that while this is for information, there are limits shown and published standards that apply to testing using these techniques. Hence, testing labs should prepare for customers asking to use these approaches.**

Table H1 provides a review of the basic requirements for using these test techniques. There is a column of limitations, such as for GTEM testing the product cannot have conductive cables attached to it, e.g., battery operated. There is no limitation for reverberation use, but clearly such chambers do not function without sufficient modes to be stirred. This usually means for practical size reverberation chambers that the lowest emission measurements cannot be made under about 200 MHz as there are insufficient modes generated about the EUT.

The remaining tables give "suggested" limits above and below 1 GHz for both the GTEM and the reverberation alternate test methods. For GTEM testing, it suggests that the supporting table for the EUT be made from non-resinous material such as Polystyrene foam (DOW Floormate 500). In reality, the standards should simply suggest checking the effect of the support table using the technique in CISPR 16-1-4. Figures show where to place the EUT in each of the two test chambers. The axis to be used in rotating the EUT in the GTEM is in Figure H3. There is no need to rotate the EUT when performing radiated emission testing in a reverberation chamber.

Annex I: (Informative) Supporting information for the measurement of outdoor units of broadcast satellite receivers This is a specialized test for the emissions coming from an outdoor satellite receiver. In this measurement the receiving measurement antenna position is adjusted to be in line with the EUT antenna beam axis, which is specified by the manufacturer. It is implied that it is difficult to give a constant field of wanted satellite broadcast signal because of the narrow beam of the parabola antenna. It is therefore not necessary for the EUT to receive a specified input signal. There are figures showing the test setup.

Annex: J (Informative) Screening effectiveness (or CATV-signal leakage) measurement for receivers This is also a highly specialized test where the leakage from a tuner that is receiving or attached to a CATV signal source is measured. What is measured is the ratio between the maximum power at the input of the EUT and the highest measured radiate emission power. The table J1 indicates how to convert radiate emission power into a field strength limit. Then the measurement is the same as that for radiated emission measurements at 3 or 10 meter separation in a semi-anechoic chamber/open area test site or a fully absorber lined room.

Radiated Emission Test Site Validation update

ANSI C63.4 has for well over two decades contained test site validation which is the highly familiar normalized site attenuation (NSA). Since NSA is heavily dependent on the antenna factors of the receiving and transmitting antennas, these antennas need to be calibrated in a specified way. Any corrections or added information needed for determining NSA is covered in C63.4. The required antenna calibration method is in C63.5. Recently the FCC has issued a public notice stating

(http://hraunfoss.fcc.gov/edocs public/attachmatch/DA-09-2478A1.pdf)

that they will accept applications for certification of equipment tested either to the 2003 or the 2009 edition of C63.4. That means that there are now three editions of C63.5 (i.e., 1988, 1998 and 2006) which are referenced in the 2003 and 2009 editions of C63.4. ASC C63® has requested that the FCC remove this ambiguity and simply reference the latest edition of C63.5 which is the 2006 edition. This acceptance is expected, but the timing is unknown. The issue then is the difference in the calibration and application to NSA with the 2006 edition of C63.5 which is described below.

C63.5-2006 changes the way antennas are calibrated and the geometry of the calibration setup from the 1988 and 1998 editions of C63.5, which are still referenced in C63.4-2003. In the 1988 edition, the antennas could be calibrated for both horizontal and vertical polarizations at 3 and 10 meter separation (transmit heights of 1 and 2 meters) to get Antenna Factors (AFs) for each polarization use. In the 1998 edition, there was a major thrust to be in "synch" with the international work in IEC/CISPR. This meant that vertical polarization measurements were removed and it was clearly stated that the preferred measurement geometry is to use only 10 meter separation with the transmit antenna at 2 meter height. To not immediately dismiss all the 1988 specifications, the transmit height of 1 meter and 3 meter separation were kept as options to the 2 meter transmit height and 10 meter separation.

The main issue is that antennas for use with C63.4-2009 MUST be calibrated using the C63.5-2006 edition.

All equations and derivations of NSA in C63.4 from the 2003 to the 2009 edition are unchanged. The antenna factors that are used in the C63.4 equation for NSA are now those derived from the new calibration procedure found in the normative reference C63.5-2006. This standard only permits one calibration configuration using the Standard Site Method (SSM) to calibrate antennas. This is different than in earlier versions of C63.5. That configuration has the transmit antenna 2 m above the ground plane, the separation to the antenna under calibration is 10 m and the antennas are horizontally polarized. This provides near free space AFs using SSM (3 antenna method).

To obtain free space AFs for biconical antennas, you need to determine the impedance of the antenna balun, either 50 ohms or 200 ohms, which is used in equation G.1 to yield the free space AFs. That is where you stop if you are only using the antenna for radiated emission measurements.

An additional step is needed if an NSA measurement is performed. In this case you need to correct for the geometry you have at your test site, i.e., validating for either a 3 meter site or a 10 meter site. This correction includes many measurement conditions in addition to the one cited in C63.4 (mutual coupling). This term is now called geometry specific correction factor (GSCF). For NSA, equation F.2 in C63.5-2006 replaces the equation D.1 in C63.4-2009 for NSA. The following changes in C63.5-2006 supersede the description in C63.4-2009 **for biconical antennas only:**

- AFs are free space AFs rather than the near free space factors obtained by applying the 1988 and 1998 editions of C63.5.
- These new free space factors are calculated taking into account the balun impedance differences and their effect. Table G.1 is used for this consideration as its values are subtracted from the near free space factors which are given by calibrating at a 2 meter height of the transmit antenna and a 10 meter separation.
- Free space antenna factors are inserted in equation G.2.
- NSA then is calculated for either a 3 meter or 10 meter separation using GSCF's which replaces the mutual coupling between antennas correction term indicated in C63.4.

Each broadband antenna will need to have its GSCF determined if it is to be used for NSA testing. Annex H in C63.5-2006 provides the method to determine these values for antennas other than biconical antennas, or biconical antennas that do not meet the stated physical dimensions (figure G1). This involves measuring a pair of antennas in all site validation configurations on a reference site (a standard antenna calibration site which meets certain requirements), and computing the GSCF based on these measurements.

What does this all mean?

- For SSM, antenna factors must now be calibrated in the geometry of transmit antenna height of 2 meters and the receiving antenna 10 meters away with the antennas in the horizontal polarization. These are called "near free space (NFS)" AFs.
- For biconical antennas, there is a correction subtracted from the value found in item (a) above to get free space antenna factors (FSAFs). For other broadband antennas, there are no correction factors. The near free space antenna factors are treated as the FSAFs.
- The next step is to perform the NSA measurement as is shown in C63.4 for either a 3 or 10 meter test site.
- Insert the new FSAFs (or the near free space AFs for antennas other than standard biconical antennas) instead of the AFs found in the 1988 and 1998 editions of C63.5.
- The last step then is to subtract the GSCF for either the 3 m or 10 meter site as appropriate. For biconicals use the table G.2 (for 10 m) and G.3 (for 3 m). For other broadband antennas, use Annex H. Note that using this Annex states that the antenna calibration site itself has to meet further requirements to derive these GSCFs for antennas other than biconicals. So the test lab has to ensure that the calibration labs meet these additional site requirements for them to report the necessary GSCFs.
- You now have the NSA for the test site under study.

The basic equations in C63.4 still hold as it says to use the antenna factors as calibrated using C63.5-2006. The correction factor that is shown in C63.4 as a mutual coupling correction when using tuned dipoles is now changed to the GSCF using the tables in C63.5-2006 for biconical antennas or Annex H for other broadband antennas. Therefore, the correction factor for tuned dipoles table in C63.4 is NOT used anymore for broadband antennas. There is a statement in C63.4 that the correction is zero or close to zero for broadband antennas. This has to be amended.

So C63.4 is needed for NSA as it has the calculated NSA for a perfect test site over a semi-infinite conductive ground plane. **For the actual measurement of NSA, the equation in C63.4-2009 is sufficient with the changing of the correction factor "delta AFtot" to "GSCF" and then uses the appropriate GSCF value as determined from C63.5-2006.**

Converting test site below 1 GHz to one useful above 1 GHz Clause 5.5 of C63.4-2009 has two methods of converting a test site that is validated up to 1 GHz into one that is used above 1 GHz. The principal is to move to a "near" free space environment suppressing reflections from the conductive floor sufficiently not to affect the measurement results. One method is strictly based on placing absorbers on the ground plane while the other has a figure of merit to meet using multiple measurements between the transmit antenna position/s and the receiving antenna position (where the receiving antenna would normally be placed for emission measurements.

The first method is met by placing absorbers between the transmit antenna point and the receiving antenna position. The absorbers must be rated to attenuate signals at least 20 dB normally incident to the absorbers up to 18 GHz (although the clause has application up to 40 GHz). The area covered for a 3 meter site is 2.4 by 2.4 meters in area. For a larger separation distance, there is a requirement to increase proportionally the area that is absorber loaded.

The other method is one developed by the IEC/CISPR contained in CISPR 16-1-4, called the site VSWR method (SVSWR). This method covers the range 1 to 18 GHz. The site validation criteria is based on many measurements where the transmit antenna is located within the test volume and the receiving antenna is at the position used for testing products. The criterion is that of all these measurements (with the receiving antenna at the same height as the transmitting antenna), the highest received signal by the receiving antenna less the lowest received signal at the same point for each test position geometry has to be less than or equal to 6 dB—or less than or equal to 2 to 1 in linear units. Use either a spectrum analyzer or a receiver as this is a ratio measurement with the same source unmodulated signal.

The quick review is that the transmit location is at four different places in the test volume (usually defined as the cylindrical volume with the cross section of the turntable area). At each one of these positions there are 6 transmit points spaced apart at different dimensions between 2 and 40 cm. So there are 4 times 6 or 24 positions. At each position both the horizontal and vertical polarizations are measured. That brings the total up to 48 measurements. Finally there are two heights of the transmit antenna: 1 meter above the ground plane (in a FAR that has absorbers on the turntable for table top testing, this is still the floor of the chamber) and to the top of the equipment to be tested, which is termed the top of the test volume cylinder. That now totals 96 measurement sets.

As an example of how the SVSWR is computed, for each of the four transmit positions on the turntable, you measure the received signal with the source at constant output for each of the 6 separations. You then correct the received signal level by taking into account the effect of the different separations.

This is done by using 20 log the ratio of the test distance to a test distance that is selected as the reference distance. So for example, at 1 meter transmit height, you do a sweep of 1 to 18 GHz or use individual frequencies (no more than 50 MHz in step size) to capture the received signal strength at each frequency or over the frequency span for horizontal polarization. Do this for each of the four test locations. Then repeat this for vertical polarization and perform similar measurements as for the horizontal polarization case. For each test position measurement (with corrections for different separation distances as needed), you record the highest received signal for each frequency and test position and compare it to the lowest received signal for each frequency and test position. The differences in dB have to be less than or equal to 6 dB for that polarization. You do the same for the vertical polarization measurements and those have to be less than or equal to 6 dB.

Next you use the same process with the transmit and receive antennas moved to the height of the test volume which depends on the height of the highest EUT to be measured. The differences in highest received signal and lowest received signal for all the positions and polarizations noted above must also be less than or equal to 6 dB.

If the differences in all measurement sets are less than or equal to 6 dB, the site is validated for testing between 1 and 18 GHz where the frequencies in that range were used in the validation process. If not, the areas where the differences exceeded 6 dB need to be investigated.

A flow chart illustrates circumstances that allow reducing the amount of testing because all of the four positions are not required. For example, less testing is indicated if the diameter of the test volume is less than 1.5 m and if the differences between the height of the test volume minus the 1 meter height is less than 0.5 m. But in any case, there is significant work in completing this validation process. But it is only needed once if nothing impacting the absorbing capability of the test chamber or the size of the test volume is changed Of course, periodic checks are recommended. The transmit antenna characteristics are covered in CISPR 16-1-4. It shows the required E and H-field patterns needed to perform this validation procedure.

Note: ASC C63® is working on a companion site validation project and has assigned a publication number of C63.25. It uses time domain gating to "see" exactly areas in the chamber where deficiencies in the absorber placement or extent are and hence where the user must upgrade to meet the validation criterion. It is likely that this technique will also be considered by the international standards community. The concern now is that using either of these techniques will come to the same validation conclusion of pass or fail. That will be assessed by test labs that want to do site validation using CISPR 16-1-4 as well as the new time domain technique. For more information and possibly being part of this testing round robin, contact Bill Stumpf, your ACIL representative on C63®. Look for his coordinates on the C63® web site www.c63.org and then click on "C63 main committee" button. There you will click on the "C63® Members List" button. The first entry shows Bill's email address if you click on his name.

Upcoming EMC Standards meetings/workshops

The next ASC C63® meetings will be held the week of April 19th 2010 at the IEEE headquarters in Piscataway, NJ. Visit the ***C63®*** website for the particulars (www.c63.org). ACIL is a voting member of ***C63®***, and observers are welcome.

Next workshops

ANSI C63.10 on wireless transmitter measurements to meet the FCC Rules will be held on June 15 & 16, 2010 at UL in Northbrook, IL. Information on registration will be posted to the iNARTE web site soon (www.narte.org)

ANSI C63.4/C63.5-Time Domain workshops will be held the Friday and Saturday before the start of the EMC Symposium in Ft. Lauderdale, FL on July 23 & 24, 2010. Registration will be part of the advance program for the Symposium when published.

A High Energy Interference workshop is planned for early February or March at Washington Labs in Gaithersburg, MD. Look for the announcement soon on the iNARTE web site.

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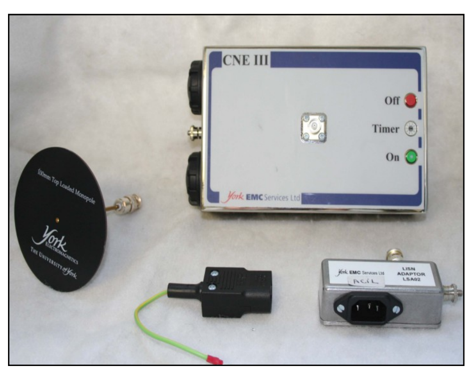

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