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**EMCTLA
TECHNICAL GUIDANCE NOTE #42
Addendum 1**

Author: *Tim Williams, Elmac Services*

Topic: Interim guidance on ISNs for telecom ports

Background

TGN 42 states, with respect to ports for one or two pair unscreened, balanced cables, that the preferred test is “to use the Annex D ISN adapted for LCL according to 9.5.2., taking into account any amendments to the specification proposed by CISPR/G to make the network acceptable”. However there is considerable controversy over the suitability of currently-available Impedance Stabilising Networks (ISNs) as specified in the third edition of CISPR 22. Two methods have been advanced with respect to the calibration of Longitudinal Conversion Loss (LCL), and it is at present unclear as to which of them best represents the properties of actual cable installations. One manufacturer has already recalled their ISNs for modification, but it is believed that a likely resolution of the problem may mean that all ISNs currently in the field (including those previously modified) will have to undergo further modification. CISPR is taking active steps to reach a resolution, but in the meantime, ISN calibrations for LCL must be regarded as questionable.

Problem

In the light of this situation, how should the advice in TGN 42 referred to above be implemented?

Guidance

In the intervening period until CISPR issues a revised specification, it is recommended that the use of ISNs as specified in clause 9.5.2. and Annex D is suspended for tests in which the LCL specification is crucial to the test outcome. Alternatives are offered in TGN 42 and these may be used, taking into account the guidance given for them. This recommendation remains in place only until such time as an agreed specification is published and implemented in the relevant ISNs. Laboratories are advised to remain in contact with their ISN supplier so that any necessary modifications can be implemented in a timely manner.

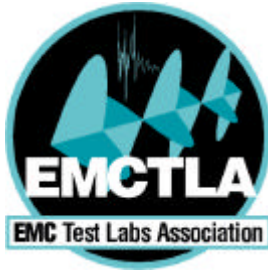
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TECHNICAL GUIDANCE NOTE #42**

Author: Tim Williams, Elmac Services

Topic: Emissions tests on telecom ports as per CISPR 22 (EN 55022)

Background

CISPR 22/EN 55022 edition 3 describes, at clause 9.5 and annexes C and D, conducted emission measurements at telecommunication ports. Because of editorial and technical inconsistencies, the standard is open to various interpretations, particularly in terms of the choice of test method for a given EUT cable type. Also, there is controversy over the specification of the Impedance Stabilizing Network (ISN) given in the standard, which has led to some caution in investing in new networks. These factors result in excessive variation and lack of repeatability between test laboratories in performing the test.

Problem

What are the preferred and alternative test methods for particular cable types?

Guidance

This Guidance Note has been drafted to address the deficiencies in the standard. Until there is agreement in CISPR and a published amendment, test laboratories are encouraged to base their interpretation of the standard and choice of test method on its contents. It is as far as possible consistent with the existing standard and with the interpretations known to be under active discussion in CISPR/G. A preliminary flowchart already circulated by CISPR/G is appended to this document.

Choice and application of test method

In the following table, the tests are ranked in order of preference, depending on cable type.

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Cable type		Guidance on applicable tests	Comment
Unscreened, balanced cables, one or two pair	ISO/IEC11801 cat 3	<p>The preferred test is to use the Annex D ISN adapted for LCL according to 9.5.2. c)2), taking into account any amendments to the specification proposed by CISPR/G to make the network acceptable (but see note 1). The test method is as per C.1.1. The voltage division factor to be used is that which is drawn from the actual calibration of the ISN.</p> <p>If this ISN is not available then a CDN according to IEC 61000-4-6 for balanced pair cables can be substituted as per C.1.1, if it allows correct operation of the EUT. A voltage measurement with a 50Ω receiver at the output port is preferred, but a current measurement with the output port terminated with a 50Ω load is permitted.</p> <p>If this is not possible then the method of C.1.3 must be used, as per the final part of this table.</p> <p>In all cases the test set-up is as per figs 4 – 9 of the standard, as appropriate for tabletop or floor-standing EUTs.</p> <p>If either of the latter two methods are employed then the test laboratory shall make clear in its test report that the method is a substitute for the preferred method, and shall document the reason for choosing it.</p>	<i>The ISN/CDN voltage measurement is preferred over the current measurement since the ISN/CDN is explicitly designed for voltage coupling with the cable; the extra uncertainty introduced by a current probe is eliminated</i>
	ISO/IEC11801 cat 5	As above with an Annex D ISN adapted for LCL according to 9.5.2. c)3)	<i>As above</i>
	All other cables of this type	As above with an Annex D ISN adapted for LCL according to 9.5.2. c)1)	<i>As above</i>
All screened cables		<p>The method of using a 150Ω resistor to the outside surface of the cable screen as per C.1.2 is preferred in general. A voltage measurement using the 150-to-50Ω adaptor is preferred over a current measurement.</p> <p>However, in cases where an IEC 61000-4-6 CDN is available for the type of screened cable under test, using this in the same way as C.1.1. for either a voltage (preferred) or current measurement is regarded as equivalent. In this case, there is no need to measure and report the common mode (CM) impedance.</p> <p>In other cases, the CM impedance need only be measured according to C.2 once for a given setup of ferrite, cable and AE, it is not necessary to repeat this measurement for each test if this</p>	<p><i>The 150-to-50W adaptor method is easier and more repeatable than any of the other variations suggested by the standard.</i></p> <p><i>The common mode impedance of the IEC 61000-4-6 CDN is well enough specified that there is no need for an extra check.</i></p> <p><i>Defining an acceptable CM impedance in terms of the test uncertainty sidesteps the need to dictate a specific minimum value. A lower minimum value will result in a</i></p>

	<p>setup remains the same.</p> <p>In all cases the test set-up is as per figs 4 – 9 of the standard, as appropriate for tabletop or floor-standing EUTs.</p> <p>The phrases “sufficiently large” and “much greater” in respect of the CM impedance shall be interpreted in the light of the laboratory’s declared uncertainties for this test, and assuming that the impedance is purely resistive.</p>	<p><i>greater uncertainty but may be easier to achieve for a given test set-up. The resistive assumption may not be fully justifiable but is a pragmatic approach given the unknown potential for resonances due to the reactive source impedance of the EUT.</i></p>
<p>Unscreened, unbalanced cables or those containing more than two balanced pairs</p>	<p>The test method of C.1.3 is preferred. C.1.4. is only to be applied at the specific request of the customer, at spot frequencies, if emissions at these frequencies breach either voltage or current limits in C.1.3. The common mode impedance must be measured and reported as per C.2 for each frequency. If the common mode impedance cannot be adjusted to 150Ω as mandated by C.1.4, the measurement setup and the actual common mode impedance achieved shall be recorded in the test report.</p> <p>It is not necessary for compliance testing to measure or record the CM impedance if C.1.3. is used.</p> <p>In any case the test set-up is as per figs 4 – 9 of the standard, as appropriate for tabletop or floor-standing EUTs.</p> <p>The design of the capacitive voltage probe used in C.1.3. is not standardized; the test laboratory shall report the actual design used for the measurement and confirm that it allows the instrumentation specifications of CISPR 16-1 to be met.</p>	<p><i>Because ferrites are ineffective at the lower end of the frequency range of this test, it is often not possible to meet the impedance condition imposed by C.1.4. The test is highly unrepeatable as a result, and should be used only as a last resort.</i></p> <p><i>Test laboratories are encouraged to use commonly available designs, suitably calibrated, of capacitive voltage probe for C.1.3.</i></p>

Note 1: Addendum 1 to this TGN discusses the issue of suitability of ISNs

Annex

Discussion of the issues

It is understood that CISPR22/ EN55022 (3rd edition) as presently published and harmonized for the EMC Directive has deficiencies both in the definition of test methods and in the definition of the test equipment with respect to conducted emissions tests on telecommunications ports. This annex reviews these deficiencies.

Related documents

The source document for the conducted emissions test on telecommunication ports is

- [1] CISPR 22 Third edition 1997-11, Information technology equipment – radio disturbance characteristics – limits and methods of measurement

All clause references in this paper refer to this CISPR standard. An amendment is understood to be in progress in CISPR/G but is not yet public. There are some other relevant CISPR standards and drafts:

- [2] CISPR/G/179/CD, Amendment to CISPR 22 to clarify its application to telecommunications systems
- [3] CISPR 16-1: 1999 Clause 5.10
- [4] CISPR/A/252/CD, *Coupling device for measuring signal lines, draft amendment to CISPR 16-1*
- [5] CISPR 16-2: 1996 Clause 2.4.4.3
- [6] CISPR/G/WG1(SAN DIEGO/SELWYN-02) June 1999, *Flowchart For Determining Test Method For Telecommunications Ports*
- [7] CISPR/G/170/CD, *Modification to CISPR 22: Definition of Telecommunications/Network Port*

Refs [3] and [4] relate to the T-network (ISN) specification and not to the test method. Ref [5] refers to the test method but only in the slightest detail. Ref [2] is principally concerned with adding a further method for testing of power line telecommunications ports. Ref [6] is directly relevant to this paper and the flowchart is attached. The introduction to [6] says "In section 9.5 dealing with the measurement of emissions from telecommunications ports, it is difficult to determine the appropriate test for the various types of cables that could be used. Using the flowchart will simplify the process."

Three manufacturers' data sheets for the ISNs specified in 9.5.2 of the standard have been reviewed.

- [8] Rohde & Schwarz data sheet, Coupling Networks ENY
- [9] Schaffner data sheet, Telecommunications line test components
- [10] Fischer Custom Communications, Inc. data sheet, FCC T-LISN T4

Some of the issues covered in this paper were identified by Steve Scott for an ECMA working group and his recommendations and discussion are incorporated herein.

- [11] *Problems with CISPR 22:1997 re. Measurement of conducted emissions from telecom ports*, Steve Scott, IBM

Review and discussion of the present CISPR requirement

This section is tabulated in order of appearance in the standard for ease of reference.

	Standard requirement	Comment
1	<p>Tables 3 (class A) and 4 (class B) of CISPR 22 apply current and voltage limits to the conducted common mode disturbance at telecommunication ports. Either the voltage or the current limits shall be met, except for the measurement method of C.1.3 where both limits shall be met. The limits are related by a constant factor of 44dB to allow for a fixed common mode impedance of 150Ω in the impedance stabilization network (ISN). “Telecommunications ports” are defined as ports which are intended to be connected to telecommunication networks (PSTN, ISDN), local area networks (Ethernet, Token Ring) and similar networks.</p>	<p><i>Although theory says that current and voltage measurements should be equivalent, in practice they may not be, and it would be helpful to express a preference for one or the other in cases of dispute.</i></p> <p><i>[2] extends the definition to PLT networks</i></p> <p><i>[7] refines the definition to explicitly exclude ports generally intended for interconnection of components of an ITE system under test</i></p>
2	<p>Table 4 includes at note 3, “Provisionally, a relaxation of 10dB over the frequency range of 6 MHz to 30MHz is allowed for high-speed services having significant spectral density in this band. However, this relaxation is restricted to the common mode disturbance converted by the cable from the wanted signal”.</p>	<p><i>It is not clear how a test laboratory is to distinguish, during the test, the source and mode of conversion of the disturbance. In practice, this has yet to cause a serious problem, and the 10dB relaxation may disappear with a future amendment which redefines the ISN specification.</i></p>
3	<p>Clause 9.5.1 specifies “methods of conformance testing”; explicitly for Category 3 and 5 cable ports, the ISNs with lower LCLs which match the cable characteristics are preferred (Alternative 2), but the higher LCL (which may give lower apparent emissions) is also apparently allowed by Alternative 1 for these cables; the wording does not state to what <i>other</i> non-Category 3 or 5 cable ports this clause might apply</p>	<p><i>It is unclear how “conformance testing” according to this clause should be differentiated from testing according to 9.5.3.1, for two- or four-wire balanced pair cables. Also, it is not stated how a test house should decide whether to use Alternative 1 or 2 for a particular case.</i></p> <p><i>Further note: both [4] and [8] state that for alternative 2 the EUT should be tested twice, the second time with the ISN inverted, “in order to avoid compensation by an inverse unsymmetry of the EUT”. This is not in the standard.</i></p>

4	Sub-paras a) – e) of 9.5.2 define the properties of an ISN (T-network) for unscreened balanced pairs. e) gives an example voltage division factor of -9.5dB.	<p><i>It is suggested that some of these specifications are unattainable. It is understood to be impossible to satisfy simultaneously the specified LCL requirements and the specified ISN impedance requirements. Ref [4] addresses this issue and there is an "ISN taskforce" in CISPR/G with proposed changes in circulation. Three suppliers of ISNs quote the values of c)1) as modified by [4], i.e. an LCL of $>(80 - 3)$dB, in their specs [8][9][10]. It is also understood that CISPR/G intend to modify the knee frequency in the 50- and 60-dB LCL specifications, which will require a modification to the adaptors. There is a suggestion that some networks are currently subject to long lead times and even recall, perhaps to allow them to meet the updated specification.</i></p> <p><i>Some test laboratories incorrectly interpret the 9.5dB voltage division factor as normative.</i></p>
5	9.5.2 third para includes the sentence "Until a suitable ISN is specified for screened and unbalanced cables, it is permitted to connect such cables to an AE or a simulator instead of an ISN. The actual load shall be reported and the common mode impedance shall be measured and stated in the test report."	<p><i>Clauses 9.5.3.3 and .4 explicitly require method C.1.2 for <u>screened</u> cables. There is no actual contradiction here but the lack of reference to Annex C is confusing. 9.5.3.5 requires either C.1.3 or C.1.4 for <u>unbalanced</u> cables; there is no requirement for measuring common mode impedance in C.1.3.</i></p> <p><i>Further note: [2] replaces the phrase "unbalanced cables" in the title of 9.5.3.5 with "unbalanced dedicated telecommunication cables".</i></p>
6	Clauses 9.5.3.1 and 9.5.3.2 specify the use of an ISN and the method of Annex C.1.1. For single and dual-pair cables, the ISN is shown in Annex D (which corresponds to the ISNs specified in Clause 9.5.2). Annex C.1 seems to suggest that it deals with alternative methods which do not use the ISNs specified in 9.5.2, and the footnote states that the ISN is different from the one specified in Annex D. Clauses 9.5.3.1/2 and C.1.1 therefore appear to conflict with each other	<p><i>It is understood that the intended meaning is that Clauses 9.5.3.1 and 9.5.3.2 require the use of an ISN as specified in Clause 9.5.2 / Annex D, together with the method of Annex C.1.1, but as an alternative, the CDN as used in IEC 61000-4-6 may be used, also with the method of Annex C.1.1.</i></p> <p><i>Practically, an IEC 61000-4-6 CDN used as an ISN may not be sufficiently well specified in terms of its wanted signal performance to be useable on some wideband data ports.</i></p>
7	Annex C figures C.1 to C.4 show the measurement setup for the associated measurement methods. There are also set-up diagrams in figures 4 to 9 of the main standard.	<p><i>Figures C.1-4 are inconsistent with some aspects of the main set-up diagrams in Figs 4-9 of the standard, particularly in the case of floor-standing equipment. The most likely interpretation is that figures C.1-4 are intended as schematics only.</i></p>

8	Annex C measurement method C.1.1 describes the measurement set-up when using IEC61000-4-6 CDNs, for measuring unshielded balanced one- or two-pair ports	<i>C.1.1. is not of itself controversial, except that the relationship between C.1.1. and 9.5.1 needs to be clarified, and a preference should be expressed for voltage or current measurement.</i>
9	Annex C measurement method C.1.2 describes the measurement set-up using a 150Ω resistor to the outside surface of the shield, for measuring screened cables. It requires breaking the screen to insert the resistor, applying a ferrite clamp, and measuring the resulting common mode impedance using the method of C.2. Either a current measurement or voltage measurement for limits comparison is allowed.	<i>This method is also non-controversial, but a preference should be expressed for voltage or current measurement. Also, guidance should be given as to how thoroughly to measure the common mode impedance and what is meant by “much greater than 150W”. Although a plain 150W resistor is shown in the figure, it should also be permissible to use an IEC61000-4-6 CDN for screened cables if this is available and suitable.</i>
10	Annex C measurement methods C.1.3 and C.1.4 describe the measurement set-up for cables that do not fit either of the methods of C.1.1 and 2. C.1.3 requires a test both with a voltage probe and with a current probe. The EUT shall meet both current and voltage limits; at non compliant frequencies it is permissible also to perform the measurement with method C.1.4. The text appears to refer to Fig C.3 but this is not explicit.	<i>On the face of it, C.1.3. is straightforward, although two measurement scans are needed, and there are concerns that it can be substantially more pessimistic than would be an equivalent test with a 150W ISN. However the capacitive voltage probe is a controversial item, since its specification (impedance >1MW, capacitance <5pF) mandates an active probe whose design is not yet standardized, and may not cope with the CISPR pulse response requirements. Also, as noted in item 5, there is a requirement to report the common mode impedance, but that should not be necessary if both current and voltage limits are met, and C.1.3 does not specify it.</i>
11	C.1.4 is an alternative to C.1.3 in which the common mode impedance is measured at spot frequencies and set to 150Ω by repositioning the ferrite absorber. The current is measured and compared to the current limits. The text appears to refer to Fig C.4 but this is not explicit.	<i>According to 9.5.3.5, the two methods are equal alternatives, but the wording of C.1.4 and the note in 9.5.3.5. suggest that the test of C.1.4 is intended only as a backstop for those frequencies which are non-compliant in C.1.3. This latter interpretation is confirmed by the WG1 flowchart. In practice, setting the common mode impedance to 150W by moving the ferrite is rarely successful, which leads to poor repeatability of this test, and is also cumbersome.</i>
12	C.2, figs C.4 and C.5 describe the measurement of the common mode impedance of the cable, ferrite and AE system, by a ratiometric approach with reference to a calibration of two current probes in a 50Ω system. It is mandated by the methods of C.1.2 and C.1.4.	<i>The measurement is cumbersome, has the potential to damage the EUT and/or AE and substantially increases the test time. It should not be necessary to perform it for every test if the AE and cable/ferrite setup remains the same between tests. Guidance to this effect should be given. Alternative or preferred methods using readily available test equipment should be provided.</i>

CISPR/G/WG1(SAN DIEGO/SELWYN-02) June 1999
 Flowchart for determining test method for telecommunications ports

