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TECHNICAL REPORT

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

AMENDMENT 1

Specification for radio disturbance and immunity measuring apparatus and methods –
Part 3: CISPR technical reports

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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FOREWORD

This amendment has been prepared by subcommittee A: Radio-interference measurements and statistical methods, of IEC technical committee CISPR: International special committee on radio interference.

The text of this amendment is based on the following documents:

DTR	Report on voting
CISPR/A/975/DTR	CISPR/A/996/RVC

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

3.2 Abbreviations

Add the following new abbreviation to the existing list:

LCL Longitudinal conversion loss

Add, after the existing Subclause 4.10, the following new Subclause 4.11:

4.11 Parameters of signals at telecommunication ports

4.11.1 General

The maximum signal levels that can be present at telecommunication ports in differential mode are dependent upon, and are limited by, the electrical balance or LCL [85], [86], of the telecommunication ports and the cables or networks to which they are intended to be connected, if the wanted signals are not to appear as unacceptable disturbances across the common mode impedance to ground.

The LCL of a signal port, cable or network causes a portion of any differential mode signals on that port, cable or network to be converted to common mode disturbances, for which a product standard has defined limits [87], [88], [89]. Common mode disturbances (also called antenna mode disturbances, because they are a source of radiated disturbances to the environment) should be limited if interference with the reception of radio signals of all kinds is to be minimized. Common mode disturbances created at a nominally balanced signal port or transmission medium, for example a twisted copper pair, should be controlled and limited, whether or not the port or medium is provided with an overall shield. If a shielded medium is used, deficiencies in the shield itself as well as in the shield connectors, leading perhaps to significant electrical discontinuities, will allow a portion of the common mode disturbances created within the shield environment to appear outside the shield.

The worst-case values for balance and LCL quoted in many network specifications are based upon the desired signal transmission and crosstalk performance of the networks, and do not necessarily have regard for the control of the common mode disturbances considered in the product standard.

To ensure that the physical layer specifications for telecommunication networks do not inadvertently lead to the generation of unacceptable electromagnetic disturbances, it is essential that the EMC implications of the specifications for some critical parameters be considered early in the development of the network standards.

To achieve EMC of telecommunication networks employing twisted pair media, the most important parameters to consider are the:

- levels specified for the wanted transverse or differential mode electrical signals;
- spectral characteristics of the line codes specified for the wanted differential mode signals;
- design of the protocol of the wanted differential mode signals;
- expected electrical balance or LCL of the physical copper media, *in situ*, on which the wanted electrical signals will be conveyed;
- electrical balance or LCL of the telecommunication signal ports that will be connected to the physical media;
- differential mode and the common mode impedances expected for the physical media on which the wanted differential mode signals will be conveyed;
- differential mode and the common mode impedances specified at the telecommunication signal ports on which the wanted differential mode signals will appear;
- shielding effectiveness expected of connectors and shields, if shielded media are to be used.

The influence of the absolute levels of the wanted differential mode signals on the resultant common mode disturbance levels needs little elaboration. In the absence of nonlinearities, the levels of the common mode disturbances produced by differential mode to common mode conversion, due to electrical unbalance of the telecommunication ports or the physical media, will be directly proportional to the levels of the wanted differential mode signals. The spectral characteristics and the protocols specified for the wanted differential mode signals will also have a major influence on the levels of the common mode disturbances appearing on the physical media.

For a given data rate, a differential mode signal employing line coding, designed to spread the signal power across a wide range of frequencies, is less likely to create unacceptable common mode disturbances than is a differential mode signal line code that concentrates the power into a narrow spectral band or bands.

Selection of the signal protocols can significantly influence the spectral characteristics of the differential mode signals. The formats of start and end delimiters, framing and synchronization bit patterns, the bit patterns of tokens, and ultimately the design of the access control protocols, will have a significant influence on how much concentration of differential mode signal power into narrow spectral bands takes place during the various operating states (i.e. high traffic periods, low traffic periods, idle periods) of telecommunication networks. The creation of highly periodic waveforms that persist for lengthy periods of time should be avoided, if the levels of common mode disturbances, created from the differential mode signals on the network, are to be minimized.

4.11.2 Estimation of common mode disturbance levels

Estimations can be made of the levels of common mode disturbances that will be created by differential mode to common mode conversion of the wanted differential mode signals, if the relationships between the important electrical and spectral parameters are known. In particular, estimations can be made of the maximum allowed levels for differential mode signals, if the common mode disturbances created from those are not to exceed the common mode disturbance limits.

Consider two devices connected together in a LAN, for example a nominally balanced telecommunication signal port connected to a nominally balanced unshielded twisted pair terminated in its characteristic impedance. Assume that the electrical unbalance of the combination of these two devices is dominated by the electrical unbalance of the device that exhibits the worst (lowest) LCL. The strength of the common mode disturbances produced by differential mode to common mode conversion through the LCL of that device can be estimated approximately from the equation

$$I_{\mathrm{cm}} \approx V_{\mathrm{T}} - a_{\mathrm{LCL}} - 20\lg\left|2Z_{\mathrm{dm}} \times \frac{Z_{\mathrm{cm}} + Z_{\mathrm{ct}}}{Z_{\mathrm{dm}} + 4Z_{\mathrm{cm}}}\right| \qquad (104)$$

when estimating the common mode current I_{cm},in dB(μA), caused by the differential mode signal voltage, and the equation

$$V_{\mathrm{cm}} \approx V_{\mathrm{T}} - a_{\mathrm{LCL}} - 20\lg\left|\frac{2Z_{\mathrm{dm}}}{Z_{\mathrm{cm}}} \times \frac{Z_{\mathrm{cm}} + Z_{\mathrm{ct}}}{Z_{\mathrm{dm}} + 4Z_{\mathrm{cm}}}\right| \qquad (105)$$

when estimating the common mode voltage V_{cm}, in dB(μV), caused by the differential mode signal voltage V_{T}, in dB(μV), where

a_{LCL} is the LCL, in dB;

Z_{cm} is the common mode impedance presented by the item having the worst (lowest) LCL, in Ω;

Z_{ct} is the common mode impedance presented by the item with the higher LCL, in Ω, and

Z_{dm} is the transverse or differential mode impedance at the telecommunication signal port, in Ω.

The above expressions, which have been derived from relationships developed in [90], implicitly assume that both of the devices in the combination present a transverse or differential mode impedance of Z_{dm}.

By setting the common mode disturbance levels in Equations 104 and 105 equal to the common mode disturbance limits, the maximum allowable transverse or differential mode signal levels can be estimated.

When making use of Equations 104 and 105, it should be recalled that a common mode disturbance limit is a quantity that is specified for comparison with disturbances measured in a defined bandwidth (e.g. 9 kHz), using a specified detector function (quasi-peak or average). Therefore, for the given LCL the maximum allowed differential mode signal levels estimated using these Equations 104 and 105 are those that are allowed to appear in the same bandwidth when measured differentially with the same detector functions.