BS EN 55032:2012

Incorporating corrigenda August 2012, December 2012 and September 2013

BSI Standards Publication

Electromagnetic compatibility of multimedia equipment — Emission requirements

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National foreword

This British Standard is the UK implementation of EN 55032:2012, incorporating corrigenda December 2012 and September 2013. It is identical to CISPR 32:2012, incorporating corrigendum August 2012.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, EMC – Policy committee, to Subcommittee GEL/210/11, EMC product standards.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2013

ISBN 978 0 580 84476 8

ICS 33.100.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2012.

Amendments/corrigenda issued since publication

Date	Text affected
31 January 2013	Implementation of CISPR corrigendum August 2012: Notes in Tables B.1, C.1 and D.1 updated; subclause G.2.3, paragraph 2 updated
	Implementation of CENELEC corrigendum December 2012: Date of withdrawal in EN foreword corrected to read 2017-03-05
31 October 2013	Implementation of CENELEC corrigendum September 2013: foreword amended

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 55032

May 2012

Incorporating corrigenda December 2012 and September 2013

ICS 33.100.10

English version

Electromagnetic compatibility of multimedia equipment - Emission requirements
(CISPR 32:2012)

Compatibilité électromagnétique des équipements multimédia - Exigences d'émission
(CISPR 32:2012)

Elektromagnetische Verträglichkeit von Multimediageräten und -einrichtungen - Anforderungen an die Störaussendung
(CISPR 32:2012)

This European Standard was approved by CENELEC on 2012-03-05. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 55032:2012 E

Foreword

The text of document CISPR/I/391/FDIS, future edition 1 of CISPR 32, prepared by CISPR SC I "Electromagnetic compatibility of information technology equipment, multimedia equipment and receivers" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 55032:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-12-05
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-03-05

This document supersedes EN 55013:2013, EN 55022:2010 + AC:2011 and EN 55103-1:2009 + A1:2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard CISPR 32:2012 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

CISPR 16 series	NOTE Harmonized in EN 55016 series.
CISPR 22:2008	NOTE Harmonized as EN 55022:2010 (modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
CISPR 16-1-1 + corr. October + corr. October + A1	2010 2010 2011 2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus	EN 55016-1-1 + A1	2010 2010
CISPR 16-1-2 + corr. January + A1 + A2	2003 2009 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Conducted disturbances	EN 55016-1-2 + A1 + A2	2004 2005 2006
CISPR 16-1-4 + corr. December	2010 2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements	EN 55016-1-4	2010
CISPR 16-2-1 + A1	2008 2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements	EN 55016-2-1 + A1	2009 2011
CISPR 16-2-3 + A1	2010 2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements	EN 55016-2-3 + A1	2010 2010
CISPR 16-4-2	2011	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-2: Uncertainties, statistics and limit modelling - Measurement instrumentation uncertainty	EN 55016-4-2	2011
CISPR 16-4-3 + A1	2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods - Part 4-3: Uncertainties, statistics and limit modeling - Statistical considerations in the determination of EMC compliance of mass-produced products	-	-
IEC 61000-4-6	2008	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2009

Publication	Year	Title	EN/HD	Year
IEC 60050-161	1990	International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility	-	-
ISO/IEC 17025	2005	General requirements for the competence of testing and calibration laboratories	EN ISO/IEC 17025	2005
ANSI C63.5	2006	American National Standard (for) Electromagnetic Compatibility - Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas (9 kHz to 40 GHz)	-	-
IEEE 802.3	-	IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications	-	-

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers protection requirements of Annex I, Article 1(a) of the EU Directive 2004/108/EC, and essential requirements of Article 3.1(b) (emission only) of the EU Directive 1999/5/EC.

Compliance with this standard provides presumption of conformity with the specified essential requirements of the Directive concerned.

WARNING Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

CONTENTS

ELECTROMAGNETIC COMPATIBILITY OF MULTIMEDIA EQUIPMENT –

Emission requirements

1 Scope

NOTE Blue coloured text within this document indicates text aligned with CISPR 35.

This International Standard applies to multimedia equipment (MME) as defined in 3.1.23 and having a rated r.m.s. AC or DC supply voltage not exceeding 600 V.

Equipment within the scope of CISPR 13 or CISPR 22 is within the scope of this publication.

MME intended primarily for professional use is within the scope of this publication.

The radiated emission requirements in this standard are not intended to be applicable to the intentional transmissions from a radio transmitter as defined by the ITU, nor to any spurious emissions related to these intentional transmissions.

Equipment, for which emission requirements in the frequency range covered by this publication are explicitly formulated in other CISPR publications (except CISPR 13 and CISPR 22), are excluded from the scope of this publication.

This document does not contain requirements for in-situ assessment. Such testing is outside the scope of this publication and may not be used to demonstrate compliance with it.

This publication covers two classes of MME (Class A and Class B). The MME classes are specified in Clause 4.

The objectives of this publication are:

1) to establish requirements which provide an adequate level of protection of the radio spectrum, allowing radio services to operate as intended in the frequency range 9 kHz to 400 GHz;
2) to specify procedures to ensure the reproducibility of measurement and the repeatability of results.

2 Normative references

The following reference documents are indispensable for the application of this publication. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*
Amendment 1 (2010)

CISPR 16-1-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances*
Amendment 1 (2004)
Amendment 2 (2006)

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 16-2-1:2008, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*
Amendment 1 (2010)

CISPR 16-2-3:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
Amendment 1 (2010)

CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*

CISPR/TR 16-4-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-3: Uncertainties, statistics and limit modelling – Statistical considerations in the determination of EMC compliance of mass-produced products*
Amendment 1 (2006)

IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

IEEE Sdt 802.3, *IEEE Standard for Information technology – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CMSA/CD) Access Method and Physical Layer Specifications*

ANSI C63.5-2006, *American National Standard (for) Electromagnetic Compatibility - Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas (9 kHz to 40 GHz)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Terms and definitions related to EMC and to relevant phenomena are given in IEC 60050-161. It should be noted that a common set of definitions has been written for both CISPR 32 and CISPR 35 (to be published). It is noted that some terms and definitions will only be used in one of these two publications but for purposes of consistency they are intentionally included in both.

3.1.1
AC mains power port
port used to connect to the mains supply network

NOTE Equipment with a DC power port which is powered by a dedicated AC/DC power converter is defined as AC mains powered equipment.

3.1.2
analogue/digital data port
signal/control port (3.1.28), antenna port (3.1.3), wired network port (3.1.30), broadcast receiver tuner port (3.1.8), or optical fibre port (3.1.24) with metallic shielding and/or metallic strain relief member(s)

3.1.3
antenna port
port, other than a broadcast receiver tuner port (3.1.8), for connection of an antenna used for intentional transmission and/or reception of radiated RF energy

3.1.4
arrangement
physical layout of all the parts of the EUT, local AE and any associated cabling within the measurement or test area

3.1.5
associated equipment
AE
equipment needed to exercise and/or monitor the operation of the EUT

3.1.6
audio equipment
equipment which has a primary function of either (or a combination of) generation, input, storage, play, retrieval, transmission, reception, amplification, processing, switching or control of audio signals

3.1.7
broadcast receiver equipment
equipment containing a tuner that is intended for the reception of broadcast services

NOTE These broadcast services are typically television and radio services, including terrestrial broadcast, satellite broadcast and/or cable transmission.

3.1.8
broadcast receiver tuner port
port intended for the reception of a modulated RF signal carrying terrestrial, satellite and/or cable transmissions of audio and/or video broadcast and similar services

NOTE This port may be connected to an antenna, a cable distribution system, a VCR or similar device.

3.1.9
broadcast satellite outdoor system
antenna and the low-noise amplifier with its associated down-converter, forming part of a satellite reception system

NOTE The indoor receiver's intermediate frequency amplifier and demodulator are excluded.

3.1.10
common mode impedance
asymmetrical mode (see CISPR 16-2-1) impedance between a cable attached to a port and the Reference Ground Plane (RGP)

NOTE The complete cable is seen as one wire of the circuit and the RGP is seen as the other wire of the circuit. The common mode current flowing around this circuit can lead to the emission of radiated energy of EUT.

3.1.11
configuration
operational conditions of the EUT and AE, consisting of the set of hardware elements selected to comprise the EUT and AE, mode of operation (3.1.22) used to exercise the EUT and arrangement (3.1.4) of the EUT and AE

3.1.12
converted common mode current
asymmetrical mode current converted from differential mode current by the unbalance of a cable or network not forming part of an EUT

3.1.13
DC network power port
port, not powered by a dedicated AC/DC power converter and not supporting communication, that connects to a DC supply network

NOTE 1 Equipment with a DC power port which is powered by a dedicated AC/DC power converter is considered to be AC mains powered equipment.

NOTE 2 DC power ports supporting communications are considered to be wired networks ports, for example Ethernet ports which include Power Over Ethernet (POE).

3.1.14
enclosure port
physical boundary of the EUT through which electromagnetic fields may radiate

3.1.15
entertainment lighting control equipment
equipment generating or processing electrical signals for controlling the intensity, colour, nature or direction of the light from a luminaire, where the intention is to create artistic effects in theatrical, televisual or musical productions and visual presentations

3.1.16
Equipment Under Test
EUT
multimedia equipment (MME) being evaluated for compliance with the requirements of this standard

3.1.17
formal measurement
measurement used to determine compliance

NOTE This is often the final measurement performed. It may be carried out following a prescan measurement. It is the measurement recorded in the test report.

3.1.18
function
operation carried out by a MME

NOTE Functions are related to basic technologies incorporated in the MME such as: displaying, recording, processing, controlling, reproducing, transmitting, or receiving single medium or multimedia content. The content may be data, audio or video, either individually or in combination.

3.1.19
highest internal frequency
F_x
highest fundamental frequency generated or used within the EUT or highest frequency at which it operates

NOTE This includes frequencies which are solely used within an integrated circuit.

3.1.20
Information Technology Equipment
ITE
equipment having a primary function of either (or a combination of) entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer

NOTE Examples include data processing equipment, office machines, electronic business equipment and telecommunication equipment.

3.1.21
launched common mode current
asymmetric mode current produced by internal circuitry and appearing at the wired network port of the EUT

NOTE Measurement of the launched common mode current requires the EUT port to be loaded by a perfectly balanced termination.

3.1.22
mode of operation
set of operational states of all functions of an EUT during a test or measurement

3.1.23
MultiMedia Equipment
MME
equipment that is information technology equipment (3.1.20), audio equipment (3.1.6), video equipment (3.1.29), broadcast receiver equipment (3.1.7), entertainment lighting control equipment (3.1.15) or combinations of these

3.1.24
optical fibre port
port at which an optical fibre is connected to an equipment

3.1.25
port
physical interface through which electromagnetic energy enters or leaves the EUT

NOTE See Figure 1.

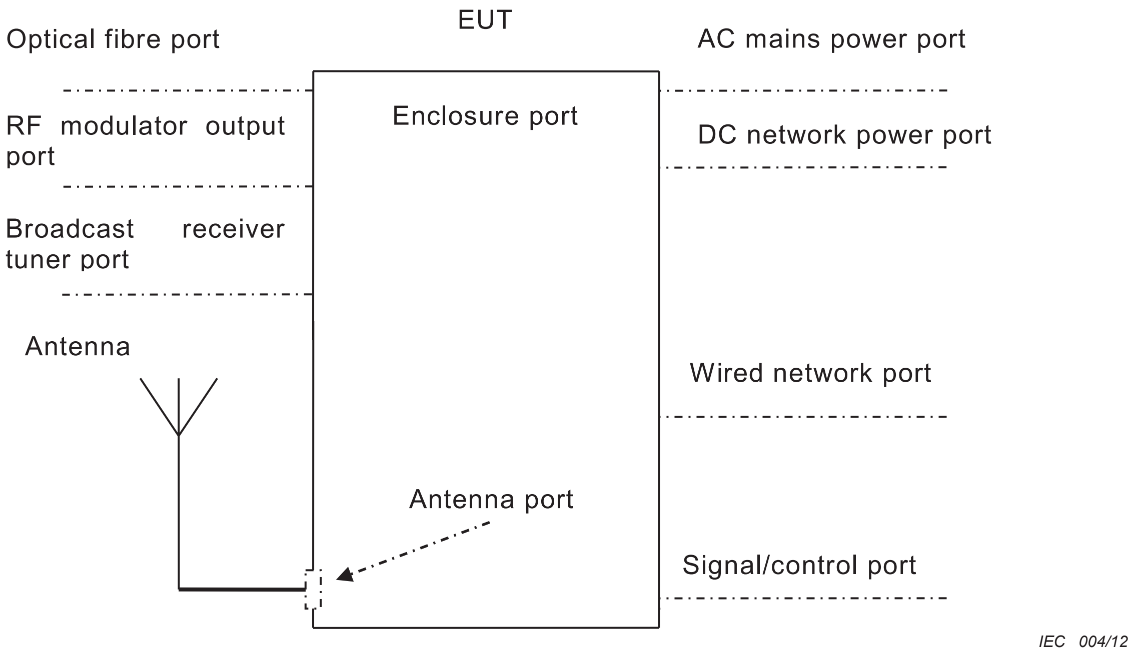

Figure 1 – Examples of ports

3.1.26
primary function
any function of an MME considered essential for the user or for the majority of users that needs to be monitored directly or indirectly during immunity testing

NOTE MME may have more than one primary function. For example the primary functions of a basic television set include broadcast reception, audio reproduction and display.

3.1.27
RF modulator output port
port intended to be connected to a broadcast receiver tuner port in order to transmit a signal to the broadcast receiver

3.1.28
signal/control port
port intended for the interconnection of components of an EUT, or between an EUT and local AE and used in accordance with relevant functional specifications (for example for the maximum length of cable connected to it)

NOTE Examples include RS-232, Universal Serial Bus (USB), High-Definition Multimedia Interface (HDMI), IEEE Standard 1394 (“Fire Wire”).

3.1.29
video equipment
equipment which has a primary function of either (or a combination of) generation, input, storage, display, play, retrieval, transmission, reception, amplification, processing, switching, or control of video signals

3.1.30
wired network port
point of connection for voice, data and signalling transfers intended to interconnect widely-dispersed systems by direct connection to a single-user or multi-user communication network (for example CATV, PSTN, ISDN, xDSL, LAN and similar networks)

NOTE These ports may support screened or unscreened cables and may also carry AC or DC power where this is an integral part of the telecommunication specification.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

AAN	Asymmetric Artificial Network
AC	Alternating Current
AC-3	ATSC standard: digital Audio Compression (AC-3)
AE	Associated Equipment, see 3.1.5.
AM	Amplitude Modulation
AMN	Artificial Mains Network
ATSC	Advanced Television Systems Committee
AV	Audio Visual
BPSK	Binary Phase Shift Keying
CATV	Cable TV network
CISPR	International special committee on radio interference
CM	Common Mode
CMAD	Common Mode Absorbing Device
CVP	Capacitive Voltage Probe
DC	Direct Current
DMB-T	Digital Multimedia Broadcast – Terrestrial
DQPSK	Differential Quadrature Phase Shift Keying
DSL	Digital Subscriber Line

DVB-C	Digital Video Broadcast – Cable
DVB-S	Digital Video Broadcast – Satellite
DVB-T	Digital Video Broadcast – Terrestrial
DVD	Digital Versatile Disc (an optical disc format also known as a Digital Video Disc)
DVB	Digital Video Broadcast
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test, see 3.1.16
FAR	Fully Anechoic Room
FM	Frequency Modulation
FSOATS	Free Space Open Area Test Site
HDMI	High-Definition Multimedia Interface
HID	Human Interface Device
IEC	International Electrotechnical Commission
IF	Intermediate Frequency
ISDB	Integrated Services Digital Broadcasting
ISDB-S	Integrated Services Digital Broadcasting – Satellite
ISDN	Integrated Services Digital Network
ISO	International Standardisation Organisation
ITE	Information Technology Equipment, see 3.1.20
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union – Radio Communication Sector
ITU-T	International Telecommunication Union – Telecommunication Sector
LAN	Local Area Network
LCL	Longitudinal Conversion Loss
LNB	Low-Noise Block converter
MME	Multimedia Equipment, see 3.1.23
MPEG	Moving Picture Experts Group
NSA	Normalized Site Attenuation
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
PC	Personal Computer
POE	Power Over Ethernet
POS	Point Of Sale
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit (including a AC/DC power converter)
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RGP	Reference Ground Plane
SAC	Semi Anechoic Chamber
TV	Television
UHF	Ultra High Frequency

USB	Universal Serial Bus
VCR	Video Cassette Recorder
VHF	Very High Frequency
VSB	Vestigial Side Band
xBase-T	Where x is 10, 100 and 1 000 as defined in the IEEE 802.3 series of standards
xDSL	Generic term for all types of DSL technology

4 Classification of equipment

This standard defines Class A equipment and Class B equipment associated with two types of end-use environment.

Class A equipment is equipment which meets the requirements given in Table A.2, Table A.3, Table A.8, and Table A.10, using the limitations defined in Table A.1 and Table A.7.

Class B equipment is equipment which meets the requirements given in Table A.4, Table A.5, Table A.6, Table A.9, Table A.11 and Table A.12, using the limitations defined in Table A.1 and Table A.7.

The Class B requirements for equipment are intended to offer adequate protection to broadcast services within the residential environment.

Equipment intended primarily for use in a residential environment shall meet the Class B limits. All other equipment shall comply with the Class A limits.

Broadcast receiver equipment is class B equipment.

NOTE Equipment meeting Class A requirements may not offer adequate protection to broadcast services within a residential environment.

5 Requirements

The requirements for equipment covered within the scope of this publication are defined in Annex A.

6 Measurements

6.1 General

This clause defines the measurement facilities and instrumentation specific to the measurement of emissions from MME; it includes by reference the relevant basic requirements given in the CISPR 16 series and other standards shown in the normative references in this standard. It also defines how to configure and arrange the EUT, local AE and associated cabling, and provides the relevant measurement procedures.

The specification of the measurement facility, measurement equipment, procedures, and the arrangement of the measurement equipment to be used are given in the basic standards referred to in the tables in Annex A. Unless otherwise specified, the basic standards shall be used for all aspects of the measurement.

Where there are conflicts in the information presented in the CISPR 16 series and this publication, the content of this publication takes precedence.

The procedures to be used for measurement of emission levels depend upon several elements. These include but are not limited to:

- the type of EUT,
- the type of port,
- the types of cables used,
- the frequency range,
- the mode of operation.

If a single port satisfies the definition of more than one of the types of port defined in this publication, it is subject to the requirements for each of the port types that it satisfies. Where a port is specified by the manufacturer for use with both screened and unscreened cables, the port shall be evaluated with both cable types.

6.2 Host systems and modular EUT

This subclause describes how to configure EUTs that are a host system or modular in nature. Modular systems can comprise different types of module(s), for example the EUT can be:

- an external module, for example an infra-red remote control;
- an internal module, for example a computer hard disk;
- a plug-in module, for example a memory stick;
- a mounted module, for example a sound card or a video card.

Modules intended to be marketed and/or sold separately from a host shall be assessed with at least one representative host system. The modules may be internal, mounted, plug-in or external as illustrated in Figure 2. The port(s) of any module being assessed shall be terminated in accordance with Annex D. The functions of the host device that are specific to the module being assessed shall be exercised during the measurements. Modules shown to meet the requirements of this publication in any one representative host are deemed to meet the requirements of this publication when used in any host. The host and modules used during measurements shall be listed in the test report.

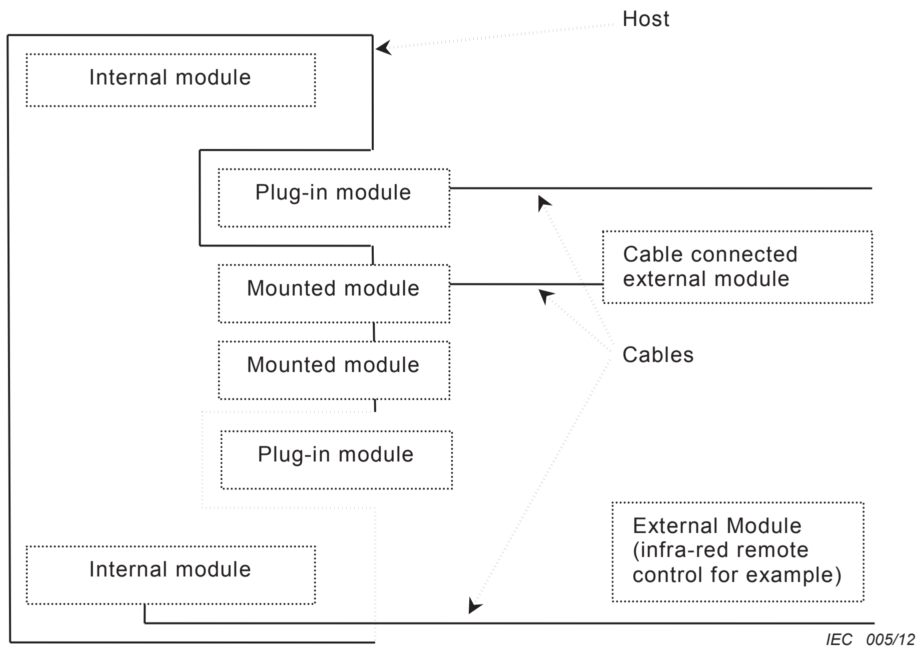

Figure 2 – Example of a host system with different types of modules

Modules whose functionality and connectivity allow them to be either, plug-in, internal, mounted and/or external shall be tested in each of the applicable configurations. However, where it can be shown that one particular configuration provides a worst case, testing in the worst case configuration is sufficient to show compliance.

When the EUT is a host, it shall be configured with modules so that the resulting system is representative of typical use.

In the case where the EUT is a module, the host is considered as an AE.

In the case of plug-in, mounted, external or internal modules, the host shall be located in the measurement area.

6.3 Measurement procedure

Measurements shall be performed as follows:

- using the relevant measurement methods and procedures given in Table A.1, Table A.7 and Annex C, and the EUT exercised in accordance with Annex B;
- with the EUT, local AE and associated cabling configured and arranged, and with ports loaded as shown in 6.2 and Annex D;
- in accordance with supporting information and clarifications defined elsewhere within this publication.

In addition, during prescan measurements, the arrangement of the EUT, the arrangement of the local AE and the placement of cables shall be varied within the range of typical and normal placement to attempt to determine the cable arrangement giving the maximum emission level, as described in Annex D.

The arrangement for formal measurement shall be representative of a typical arrangement of the EUT, local AE and associated cabling.

7 Equipment documentation

The user documentation and/or manual shall contain details of any special measures required to be taken by the purchaser or user to ensure EMC compliance of the EUT with the requirements of this publication. One example would be the need to use shielded or special cables.

Class A equipment shall have the following warning in the instructions for use, to inform the user of the risk of operating this equipment in a residential environment:

> Warning: This equipment is compliant with Class A of CISPR 32. In a residential environment this equipment may cause radio interference.

8 Applicability

Measurements shall be performed on the relevant ports of the EUT according to the appropriate tables given in Annex A.

Where a manufacturer determines from the electrical characteristics and intended usage of the EUT that one or more measurements are unnecessary, the decision and justification not to perform these measurements shall be recorded in the test report.

The following table shows the highest frequency up to which radiated emission measurements shall be performed.

Based upon the value of F_x, Table 1 specifies the highest frequency applicable for the limits given in Table A.3 or Table A.5.

Table 1 – Required highest frequency for radiated measurement

Highest internal frequency **(F_x)**	**Highest measured frequency**
$F_x \leq 108$ MHz	1 GHz
108 MHz $< F_x \leq$ 500 MHz	2 GHz
500 MHz $< F_x \leq$ 1 GHz	5 GHz
$F_x >$ 1 GHz	$5 \times F_x$ up to a maximum of 6 GHz
NOTE 1 For FM and TV broadcast receivers, F_x is determined from the highest frequency generated or used excluding the local oscillator and tuned frequencies. NOTE 2 F_x is defined in 3.1.19.	

Where F_x is unknown, the radiated emission measurements shall be performed up to 6 GHz.

9 Test report

General requirements for compiling a test report taken from 5.10 of ISO/IEC 17025:2005, can be found in Annex F. Sufficient details shall be provided to facilitate reproducibility of the measurements. This shall include photographs of the measurement configuration for the formal measurements where this is appropriate.

The test report shall state the mode of operation of the EUT and how its ports were exercised (see Annex B). The test report shall clearly indicate whether the product is compliant with the Class A or Class B limits defined in Annex A.

For each relevant table clause in Annex A, the measurement results of at least the six highest emissions from the type of port being assessed relative to the limit, unless they are 10 dB or more below the limit, shall be recorded in the test report. Where a table clause includes more than one detector, the measurement results of these six emissions shall be recorded for each type of detector.[1] The results shall include the following information for each of these emissions:

- the port assessed (including enough information to identify it);
- for AC power line measurements the line under test, for example line or neutral;
- frequency and amplitude of the emission;
- margin with respect to the specified limit;
- the limit at the frequency of the emission;
- the detector used.

The report shall indicate if fewer than six emissions within 10 dB of the limit are observed.

NOTE It may also be beneficial to record emissions 10 dB or more below the limit. In addition other aspects, such as antenna polarization or turntable azimuth, may be useful to record.

Additionally, the following shall be included in the test report:

- the frequency F_x of the highest internal frequency source within the EUT as defined in 3.1.19. This frequency need not be reported if radiated emissions are measured up to 6 GHz;

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1 It is sufficient to show compliance with all limits and detectors as shown in Figure C.3 to Figure C.5.

- the calculated measurement instrumentation uncertainty for each measurement type performed (see Table 1 of CISPR 16-4-2:2011). No reporting is required if U_{cispr} is not defined for the relevant measurement type;
- the category of cable simulated by the AAN, where emissions from wired network ports are measured using an AAN. See Table C.2;
- the measurement distance for radiated emission measurements as defined in C.2.2.4 and Table A.2 to Table A.6. If another measurement distance is used, the report shall include a description of how the limits were calculated.

Further guidance is given in Annex F.

10 Compliance with this publication

Compliance with this publication requires that the EUT satisfies either the Class A or Class B requirements defined in Annex A, as appropriate. An EUT which fulfils the applicable requirements specified in Annex A is deemed to fulfil the requirements in the entire frequency range from 9 kHz to 400 GHz. No measurements need be performed at frequencies where no requirement is specified.

Where this publication gives options for testing particular requirements with a choice of test methods, compliance can be shown against any of the test methods using the appropriate limit. In any situation where it is necessary to re-test the equipment to show compliance with this publication, the test method originally chosen shall be used in order to guarantee consistency of the results, unless it is agreed by the manufacturer to do otherwise. Requirements for radiated emission measurements are defined in Table A.2 to Table A.6 with the restrictions and limitations defined in Table A.1. Requirements for conducted emission measurements are defined in Table A.8 to Table A.12 with the restrictions defined in Table A.7.

The determination of compliance with this publication shall be based solely on contributions from the EUT. For example, where an AE is required to exercise or monitor the EUT, and emissions from the AE are known to contribute to the overall measured emission of the system being assessed (for example an AE which is a plug-in module for the EUT), the AE selected should, wherever possible, be compliant with relevant emission limits. If the AE is known to cause significant emissions, these emissions may be reduced by mitigation measures, as long as these measures do not reduce the emissions from the EUT. The preferred configuration is that the AE is removed from the measurement area, as allowed by D.1.

Compliance can be shown by measuring the EUT’s emissions when operating its functions simultaneously, individually in turn, or any combination thereof.

11 Measurement uncertainty

The measurement instrumentation uncertainty shall be calculated in accordance with CISPR 16-4-2 and reported as described in Clause 9.

Measurement instrumentation uncertainty shall not be taken into account in the determination of compliance. Refer to CISPR/TR 16-4-3 for guidance on the applicability of the limits to a series produced MME.

Annex A
(normative)

Requirements

A.1 General

The requirements for an EUT covered by this publication are given on a port by port basis in Table A.1 to Table A.12, respectively.

Throughout this annex and unless otherwise stated:

Where the limit value varies over a given frequency range, it changes linearly with respect to the logarithm of the frequency. For example, a graphical representation of the AC mains power port limits defined in Table A.9 is presented in Figure A.1.

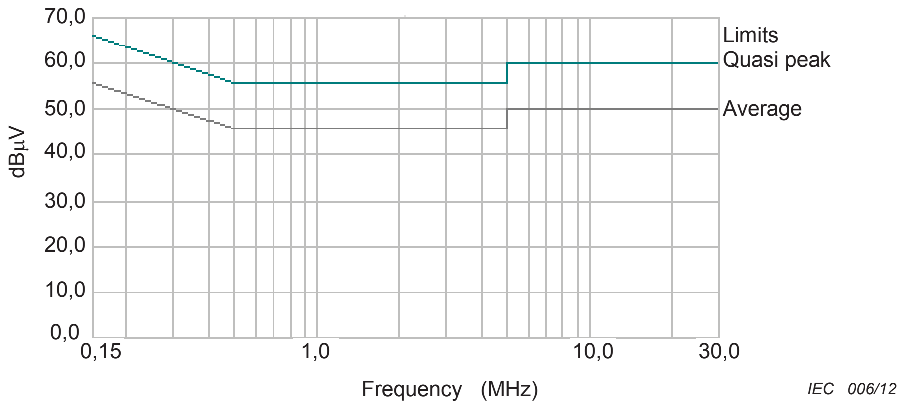


Figure A.1 – Graphical representation of the limits for the AC mains power port defined in Table A.9

- Where there is a step in the relevant limit, the lower value shall be applied at the transition frequency.
- The measurements shall be limited to:
  a) the operating ranges of voltage and frequency as specified for the EUT, having regard to the supply voltage and frequency for the intended market of the EUT.

     Testing at two nominal voltages of 230 V (±10 V) and 110 V (±10 V), using a frequency of 50 Hz or 60 Hz, is normally sufficient for an EUT intended for worldwide use.

  b) the environmental parameters (temperature, humidity and atmospheric pressure) specified for the EUT.

     No additional environmental parameters are defined. It is not necessary to repeat measurements at more than one set of environmental parameters.
- If different detectors have been specified, the EUT shall be assessed using all relevant detectors against the appropriate limits. This procedure can be optimised by use of the decision trees in Figure C.3 to Figure C.5.
- For Ethernet interfaces, measurements are required at the highest data rate supported by the interface.
- The measurement facility validation shall be performed in accordance with the relevant basic standard and, for the purposes of this publication, may be limited to the frequency range where requirements are defined in Annex A.

- Equipment with a DC power port powered by a dedicated AC/DC power converter is considered to be AC mains powered equipment and shall be tested with a power converter. Where the power converter is provided by the manufacturer, the provided converter shall be used.

A.2 Requirements for radiated emissions

The EUT is deemed to comply fully with the radiated emission requirements in this publication when it has been shown to be compliant with the applicable limits as given in Table A.2 to Table A.6 using the specified requirements in the relevant table clause.[2]

Compliance may only be shown at measurement distances for which compliant measurement facility (or site) validation measurements exist for the measurement facility used.

Where limits in a frequency range are given for different types of measurement facility and/or distances, measurements only need to be performed using one combination of measurement facility and distance. The same combination shall be used for all frequencies in the range.

Table A.1 – Radiated emissions, basic standards and the limitation of the use of particular methods

Table clause	Measurement facility	Validation method	Measurement		Limitations and clarifications
			Procedure	Arrangement	
A1.1	SAC or OATS with weather protection cover	5.3 of CISPR 16-1-4	7.3 of CISPR 16-2-3	Annex D	The maximum width of the EUT, local AE and associated cabling shall be within the test volume as demonstrated during the NSA test site validation. The validated measurement volume does not need to encompass any local AE and associated cabling which are located below the RGP or turntable, or remotely located, as described in D.1. NSA verification figures for 5 m facilities are presented in Table C.3.
A1.2	OATS without weather protection cover	5.2 of CISPR 16-1-4	7.3 of CISPR 16-2-3	Annex D	NSA verification figures for 5 m facilities are presented in Table C.3.
A1.3	FSOATS	8.3 of CISPR 16-1-4	7.6.6 of CISPR 16-2-3	Annex D	A facility validated against the FSOATS requirements shall be used for measurements above 1 GHz. The EUT, local AE and associated cabling shall be within the measurement volume as demonstrated during the test site validation. An FSOATS may be a SAC/OATS with RF absorber on the RGP or a FAR.
NOTE As per Clause 2, the version of CISPR 16-1-4 is CISPR 16-1-4:2010. The version of CISPR 16-2-3 is CISPR 16-2-3:2010+A1:2010.					

2 In this publication, table clauses are referenced using an x.y format, where x denotes the table and y denotes the referenced clause by row within the table. For example table clause A1.2 is Table A.1, clause (row) 2.

Table A.2 – Requirements for radiated emissions at frequencies up to 1 GHz for Class A equipment

Table clause	Frequency range MHz	Measurement		Class A limits dB(μV/m)
		Distance m	Detector type/ bandwidth	OATS/SAC (see Table A.1)
A2.1	30 – 230	10	Quasi Peak / 120 kHz	40
	230 – 1 000			47
A2.2	30 – 230	3		50
	230 – 1 000			57
Apply only A2.1 or A2.2 across the entire frequency range.				

Table A.3 – Requirements for radiated emissions at frequencies above 1 GHz for Class A equipment

Table clause	Frequency range MHz	Measurement		Class A limits dB(μV/m)
		Distance m	Detector type/ bandwidth	FSOATS (see Table A.1)
A3.1	1 000 – 3 000	3	Average / 1 MHz	56
	3 000 – 6 000			60
A3.2	1 000 – 3 000		Peak / 1 MHz	76
	3 000 – 6 000			80
Apply A3.1 and A3.2 across the frequency range from 1 000 MHz to the highest required frequency of measurement derived from Table 1.				

Table A.4 – Requirements for radiated emissions at frequencies up to 1 GHz for Class B equipment

Table clause	Frequency range MHz	Measurement		Class B limits dB(μV/m)
		Distance m	Detector type/ bandwidth	OATS/SAC (see Table A.1)
A4.1	30 – 230	10	Quasi Peak / 120 kHz	30
	230 – 1 000			37
A4.2	30 – 230	3		40
	230 – 1 000			47
Apply only table clause A4.1 or A4.2 across the entire frequency range.				

Table A.5 – Requirements for radiated emissions at frequencies above 1 GHz for Class B equipment

Table clause	Frequency range MHz	Measurement		Class B limits dB(μV/m)
		Distance m	Detector type/ bandwidth	FSOATS (see Table A.1)
A5.1	1 000 – 3 000	3	Average/ 1 MHz	50
	3 000 – 6 000			54
A5.2	1 000 – 3 000		Peak/ 1 MHz	70
	3 000 – 6 000			74
Apply A5.1 and A5.2 across the frequency range from 1 000 MHz to the highest required frequency of measurement derived from Table 1.				

Table A.6 – Requirements for radiated emissions from FM receivers

Table clause	Frequency range MHz	Measurement		Class B limit dB(μV/m)	
		Distance m	Detector type/ bandwidth	Fundamental	Harmonics
				OATS/SAC (see Table A.1)	OATS/SAC (see Table A.1)
A6.1	30 – 230	10	Quasi peak/ 120 kHz	50	42
	230 – 300				42
	300 – 1 000				46
A6.2	30 – 230	3		60	52
	230 – 300				52
	300 – 1 000				56
Apply only A.6.1 or A.6.2 across the entire frequency range. These relaxed limits apply only to emissions at the fundamental and harmonic frequencies of the local oscillator. Signals at all other frequencies shall be compliant with the limits given in Table A.4.					

A.3 Requirements for conducted emissions

The EUT is deemed to comply with the conducted emission requirements when it has been shown to be compliant with all applicable limits as given in Table A.8 to Table A.12. The required measurement methods are stated in Table A.7.

Table A.7 – Conducted emissions, basic standards and the limitation of the use of particular methods

Table clause	Coupling device	Basic standard	Validation method	Measurement arrangement	Measurement procedure and clarifications
A7.1	AMN	Clause 7 of CISPR 16-2-1	Clause 4 of CISPR 16-1-2	Annex D	Use the measurement procedures defined in C.3. The impedance and phase requirements of CISPR 16-1-2 in the range 0,15 MHz – 30 MHz apply.
A7.2	AAN	Clause 7 of CISPR 16-2-1	Clause 7 of CISPR 16-1-2 applying the requirements of Table C.2. of this standard	Annex D and C.4.1.1	Use the measurement procedures defined in Clause C.3 and C.4.1.1. Using the clarifications in Clause C.3.6.
A7.3	Current probe	Clause 7 of CISPR 16-2-1	5.1 of CISPR 16-1-2	Annex D and C.4.1.1	
A7.4	CVP	Clause 7 of CISPR 16-2-1	5.2.2 of CISPR 16-1-2	Annex D and C.4.1.1	
A7.5	Matching and combining networks for voltage measurement into 75 Ω	n/a	C.4.2	C.4.2	Use the measurement procedures defined in C.4.2 for the measurement of the unwanted emission voltages at a TV/FM broadcast receiver tuner port
A7.6	Matching network for voltage measurement into 75 Ω	n/a	C.4.3	C.4.3	Use the measurement procedures defined in C.4.3 for wanted signal and emission voltage at the RF modulator output port.
NOTE As per Clause 2, the version of CISPR 16-1-2 is CISPR 16-1-2:2003+A1:2004+A2:2006. The version of CISPR 16-2-1 is CISPR 16-2-1:2008+A1:2010.					

Table A.8 – Requirements for conducted emissions from the AC mains power ports of Class A equipment

<table>
<tr><td colspan="5">Applicable to
1. AC mains power ports (3.1.1)</td></tr>
<tr><th>Table clause</th><th>Frequency range
MHz</th><th>Coupling device
(see Table A.7)</th><th>Detector type
/ bandwidth</th><th>Class A limits
dB(μV)</th></tr>
<tr><td rowspan="2">A8.1</td><td>0,15 – 0,5</td><td rowspan="2">AMN</td><td rowspan="2">Quasi Peak / 9 kHz</td><td>79</td></tr>
<tr><td>0,5 – 30</td><td>73</td></tr>
<tr><td rowspan="2">A8.2</td><td>0,15 – 0,5</td><td rowspan="2">AMN</td><td rowspan="2">Average / 9 kHz</td><td>66</td></tr>
<tr><td>0,5 – 30</td><td>60</td></tr>
<tr><td colspan="5">Apply A8.1 and A8.2 across the entire frequency range.</td></tr>
</table>

Table A.9 – Requirements for conducted emissions from the AC mains power ports of Class B equipment

Applicable to

1. AC mains power ports (3.1.1)

Table clause	**Frequency range** MHz	**Coupling device** (see Table A.7)	**Detector type / bandwidth**	**Class B limits dB(μV)**
A9.1	0,15 – 0,5	AMN	Quasi Peak / 9 kHz	66 – 56
	0,5 – 5			56
	5 – 30			60
A9.2	0,15 – 0,5	AMN	Average / 9 kHz	56 – 46
	0,5 – 5			46
	5 – 30			50

Apply A9.1 and A9.2 across the entire frequency range.

Table A.10 – Requirements for asymmetric mode conducted emissions from Class A equipment

Applicable to

1. wired network ports (3.1.30)
2. optical fibre ports (3.1.24) with metallic shield or tension members
3. antenna ports (3.1.3)

Table clause	**Frequency range** MHz	**Coupling device** (see Table A.7)	**Detector type / bandwidth**	**Class A voltage limits dB(μV)**	**Class A current limits dB(μA)**
A10.1	0,15 – 0,5	AAN	Quasi Peak / 9 kHz	97 – 87	n/a
	0,5 – 30			87	
	0,15 – 0,5	AAN	Average / 9 kHz	84 – 74	
	0,5 – 30			74	
A10.2	0,15 – 0,5	CVP and current probe	Quasi Peak / 9 kHz	97 – 87	53 – 43
	0,5 – 30			87	43
	0,15 – 0,5	CVP and current probe	Average / 9 kHz	84 – 74	40 – 30
	0,5 – 30			74	30
A10.3	0,15 – 0,5	Current Probe	Quasi Peak / 9 kHz	n/a	53 – 43
	0,5 – 30				43
	0,15 – 0,5	Current Probe	Average / 9 kHz		40 – 30
	0,5 – 30				30

The choice of coupling device and measurement procedure is defined in Annex C.

AC mains ports that also have the function of a wired network port shall meet the limits given in Table A.8.

The test shall cover the entire frequency range.

The application of the voltage and/or current limits is dependent on the measurement procedure used. Refer to Table C.1 for applicability.

Testing is required at only one EUT supply voltage and frequency.

Applicable to ports listed above and intended to connect to cables longer than 3 m.

Table A.11 – Requirements for asymmetric mode conducted emissions from Class B equipment

Applicable to 1. wired network ports (3.1.30) 2. optical fibre ports (3.1.24) with metallic shield or tension members 3. broadcast receiver tuner ports (3.1.8) 4. antenna ports (3.1.3)					
Table clause	**Frequency range** MHz	**Coupling device** (see Table A.7)	**Detector type / bandwidth**	**Class B voltage limits dB(μV)**	**Class B current limits dB(μA)**
A11.1	0,15 – 0,5	AAN	Quasi Peak / 9 kHz	84 – 74	n/a
	0,5 – 30			74	
	0,15 – 0,5	AAN	Average / 9 kHz	74 – 64	
	0,5 – 30			64	
A11.2	0,15 – 0,5	CVP and current probe	Quasi Peak / 9 kHz	84 – 74	40 – 30
	0,5 – 30			74	30
	0,15 – 0,5	CVP and current probe	Average / 9 kHz	74 – 64	30 – 20
	0,5 – 30			64	20
A11.3	0,15 – 0,5	Current Probe	Quasi Peak / 9 kHz	n/a	40 – 30
	0,5 – 30				30
	0,15 – 0,5	Current Probe	Average / 9 kHz		30 – 20
	0,5 – 30				20
The choice of coupling device and measurement procedure is defined in Annex C. Screened ports including TV broadcast receiver tuner ports are tested with a common-mode impedance of 150 Ω. This is typically accomplished with the screen terminated by 150 Ω to earth. AC mains ports that also have the function of a wired network port shall meet the limits given in Table A**.9**. The test shall cover the entire frequency range. The application of the voltage and/or current limits is dependent on the measurement procedure used. Refer to Table C.1 for applicability. Testing is required at only one EUT supply voltage and frequency. Applicable to ports listed above and intended to connect to cables longer than 3 m.					

Table A.12 – Requirements for conducted differential voltage emissions from Class B equipment

Applicable to
1. TV broadcast receiver tuner ports (3.1.8) with an accessible connector
2. RF modulator output ports (3.1.27)
3. FM broadcast receiver tuner ports (3.1.8) with an accessible connector

Table clause	**Frequency range** MHz	**Detector type/ bandwidth**	**Class B limits dB(μV) 75 Ω**			**Applicability**
			Other	**Local Oscillator Fundamental**	**Local Oscillator Harmonics**	
A12.1	30 – 950	For frequencies ≤1 GHz Quasi Peak/ 120 kHz For frequencies ≥1 GHz Peak/ 1 MHz	46	46	46	See a)
	950 – 2 150		46	54	54	
A12.2	950 – 2 150		46	54	54	See b)
A12.3	30 – 300		46	54	50	See c)
	300 – 1 000				52	
A12.4	30 – 300		46	66	59	See d)
	300 – 1 000				52	
A12.5	30 – 950		46	76	46	See e)
	950 – 2 150			n/a	54	

a) Television receivers (analogue or digital), video recorders and PC TV broadcast receiver tuner cards working in channels between 30 MHz and 1 GHz, and digital audio receivers.

b) Tuner units (not the LNB) for satellite signal reception.

c) Frequency modulation audio receivers and PC tuner cards.

d) Frequency modulation car radios.

e) Applicable to EUTs with RF modulator output ports (for example DVD equipment, video recorders, camcorders and decoders etc.) designed to connect to TV broadcast receiver tuner ports.

Testing is required at only one EUT supply voltage and frequency.

The term 'other' refers to all emissions other than the fundamental and the harmonics of the local oscillator.

The test shall be performed with the device operating at each reception channel.

The test shall cover the entire frequency range.

Annex B
(normative)

Exercising the EUT during measurement and test signal specifications

B.1 General

This annex specifies the methods for exercising the EUT during the emission measurements.

MME typically have several different functions and numerous modes of operation associated with each function.

For each function, or group of functions selected to exercise the EUT, a number of representative modes of operation, including low power/standby mode, shall be considered for testing. The mode(s) that produce(s) the highest emissions shall be selected for the final measurements.

The EUT shall be operated in the selected mode(s) while the ports are exercised in accordance with this annex.

The emissions from the various ports (as required by this publication) shall be measured while appropriate test signals are applied as specified in this annex.

All ports, including loudspeakers and display devices, shall be exercised in a manner consistent with, and representative of, normal use. Exercising signals, audio levels and display parameters shall be chosen having regard to the intended function of the EUT and shall be such as to allow the correct operation of the EUT to be assessed.

Subsequent clauses give further clarification to aid reproducibility between laboratories. A description of the methods used to exercise the EUT and all relevant ports shall be recorded in the test report. Where a deviation in the application of one of the methods defined in this annex is used (for example using a different signal level or image), a justification shall be included in the test report.

B.2 Exercising of EUT ports

B.2.1 Audio signals

For EUTs that support audio signals, the signal used to exercise the EUT shall be a 1 kHz sinusoidal signal unless otherwise specified as more appropriate by the manufacturer.

B.2.2 Video signals

EUTs that display video images or EUTs with ports that are used to provide video signals shall be exercised in accordance with Table B.1 and configured, where possible, using the parameters given in Table B.2.

Video ports shall output signals, and images shall be displayed, corresponding to the highest complexity level listed in Table B.1 that the EUT is capable of generating.

Table B.1 – Methods of exercising displays and video ports

Complexity Level	Display image	Description	Examples of equipment
4 (Most)	Colour bars with moving picture element	Standard television colour bar signal according to ITU-R BT 1729 with an additional small moving element. See a).	Digital television set, set-top box, personal computer, DVD equipment, video game console, stand alone monitor.
3	Colour bars	Standard television colour bar signal according to ITU-R BT 471-1. See a).	Analogue television set, display on camera, display on photo printer.
2	Text image	Where possible a pattern consisting of all H characters shall be displayed. The character size and number of characters per line shall be set so that typically the greatest number of characters per screen is displayed. If text scrolling is supported on the display, the text shall scroll.	POS terminal, computer terminal without graphic capability.
1 (Least)	Typical display	The most complex display that can be generated by the EUT.	An EUT with proprietary displays and/or not capable of displaying any of the above images, electronic music keyboard, telephone.

a) This display image is also valid for monochrome displays which will display grey scale bars.

When there is more than one display or video port, each display/port shall be exercised appropriately subject to the provisions of B.2.2.

The display images may be modified, when necessary to exercise primary functions of the EUT. Where possible, these modifications should be restricted to the bottom or top half of the display area so that the image defined in the table fills the majority of the display.

For analogue television sets, only colour bars should be displayed, defined in complexity 3.

Table B.2 – Display and video parameters

Function	Setting
Hardware acceleration	Maximum.
Screen settings	Highest effective resolution (including the settings for pixel and frame rate).
Colour quality	Highest colour bit depth.
Brightness, contrast, colour saturation	Use either the factory default settings or typical settings.
Other	Adjusted to obtain a typical picture using settings giving the highest performance.

B.2.3 Digital broadcast signals

Examples of digital broadcast signal specifications are shown in Table B.4.

B.2.4 Other signals

Other ports shall be exercised using the methods defined in Table B.3.

Table B.3 – Methods used to exercise ports

Port	Methods used to exercise port
Broadcast receiver tuner port	The modulation of the RF signal carrier shall be set according to the system for which the EUT is intended. Unless otherwise defined, the input signal level at the relevant ports shall be sufficient to provide a noise-free picture and/or audio In addition refer to B.2.1 and B.2.2 Examples of digital broadcast signal specifications for digital broadcast receiver ports are given in Table B.4. An EUT with broadcast reception functionality shall be assessed with the receiver tuned to any one channel.
Wired network port	A representative signal shall be defined by the manufacturer. For ports supporting Ethernet traffic (for example 100Base-T, 1000Base-T), that can operate at multiple rates, measurements may be limited to mode in which the EUT operates at its maximum rate. When assessing an EUT transmitting 10Base-T Ethernet traffic, apply the following: In order to make reliable emission measurements representative of high LAN utilization it is only necessary to create a condition of LAN utilization in excess of 10 % and sustain that level for a minimum of 250 ms. The content of the test traffic should consist of both periodic and pseudo-random messages in order to emulate realistic types of data transmission. (Examples of pseudo-random messages: files that are compressed or encrypted. Examples of periodic messages: uncompressed graphic files, memory dumps, screen updates, disk images.) If the LAN maintains transmission during idle periods, measurements shall also be made during idle periods.
All other ports not defined above	A representative signal shall be defined by the manufacturer.

Table B.4 – Examples of digital broadcast signal specifications

General	DVB	ISDB	ATSC	DMB-T
Standard	TR 101154	-	ATSC Standard A/65	System-A (DAB/Eureka-147)
Source coding	MPEG-2 video MPEG-2 audio	MPEG-2 video MPEG-2 audio	MPEG-2 video AC-3 audio	H.264/MPEG-4 AVC
Data Coding	Optional	Optional	Optional	Optional
Video elementary stream	Colour bar, with small moving element	Colour bar, with small moving element	Colour bar, with small moving element	Colour bar, with small moving element
Video bit rate	6 MBit/s	6 MBit/s	6 MBit/s	(1 ~ 11) Mbit/s
Audio elementary stream for reference measurement	1 kHz/full range –6 dB	1 kHz/full range –6 dB	1 kHz/full range –6 dB	1 kHz/full range –6 dB
Audio elementary stream for noise measurement	1 kHz/silence	1 kHz/silence	1 kHz/silence	1 kHz/silence
Audio bit rate	192 kbit/s	192 kbit/s	192 kbit/s	192 kbit/s
Terrestrial TV	**DVB-T**	**ISDB-T**	**ATSC**	**DMB-T**
Standard	EN 300 744	ARIB STD-B21 ARIB STD-B31	ATSC 8VSB	System-A (DAB/Eureka-147)
Level	50 dB(μV)/75 Ω-VHF B III 54 dB(μV)/75 Ω-UHF B IV/V	34 dB(μV) to 89 dB(μV)/75 Ω	54 dB(μV) (using ATSC 64)	18 dB(μV) ~ 97 dB(μV)
Channel	6 to 69	-	2 to 69	-
Frequency	-	470 MHz to 770 MHz, 5,7 MHz bandwidth		174 MHz ~ 216 MHz
Modulation	OFDM	OFDM	8 VSB or 16 VSB	DQPSK, Transmission: OFDM
Mode	2k or 8k	8k, 4k, 2k	-	-
Modulation scheme	16 or 64 QAM or QPSK	QPSK, DQPSK, 16 QAM, 64 QAM	-	-
Guard interval	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 1/16, 1/32	-	-
Code rate	1/2, 2/3, 3/4, 5/6, 7/8	1/2, 2/3, 3/4, 5/6, 7/8	2/3	-
Useful bit rate	Variable MBits	-	19,39 MBit/s	-
Information bit rate: max	31,668 MBit/s	23,234 MBit/s	-	-
Satellite TV	**DVB-S**	**DVB-S (Communication satellite)**	**ISDB-S(Broadcasting satellite)**	**None**
Specification	EN 300 421	ARIB STD-B1	ARIB STD-B20 ARIB STD-B21	-
Level	60 dB(μV)/75 Ω	48 dB(μV) to 81 dBμV/75 Ω	48 dB(μV) to 81 dB(μV)/75 Ω	-
Frequency	0,95 GHz to 2,15 GHz	12,2 GHz to 12,75 GHz	11,7 GHz to 12,2 GHz	-
Frequency 1st IF	-	1 000 MHz to 1 550 MHz, 27 MHz bandwidth	1 032 MHz to 1 489 MHz, 34,5 MHz bandwidth	-
	-	12,5 GHz to 12,75 GHz	11,7 GHz to 12,2 GHz	-
Modulation	QPSK	QPSK	TC8PSK, QPSK, BPSK	-
Code Rate	3/4	1/2, 2/3, 3/4, 5/6, 7/8	2/3(TC8PSK), 1/2, 2/3, 3/4, 5/6, 7/8(QPSK,	-

General	DVB	ISDB	ATSC	DMB-T
			BPSK)	
Useful bit rate	38,015 MBit/s	29,2 MBits/s (r=3/4)	-	-
Information bit rate	-	19,4 MBit/s to 34,0 MBit/s	-	-
Information bit rate: max	-	34,0 MBit/s	52,17 MBit/s	-
Cable TV	**DVB-C**	**ISDB-C**	**ATSC**	-
Specification	EN 300 429 ES 201 488 ES 202 488-1 EN 302 878 (DOCSIS)	JCTEA STD-002 JCTEA STD-007	ANSI/SCTE 07	-
Level	67 dBμV at 75 Ω for 256 QAM 60 dBμV at 75 Ω for 64 QAM	49 dB(μV) to 81 dB(μV)/75 Ω (64 QAM) TDB (256 QAM)	60 dB(μV)/75 Ω	-
Frequency	110 MHz to 862 MHz	90 MHz to 770 MHz, 6 MHz bandwidth	88 MHz to 860 MHz	-
Modulation	16/32/64/128/256 QAM	64 QAM or 256 QAM	64 QAM or 256 QAM	-
Useful bit rate	38,44 MBit/s (64 QAM) and 51,25 MBit/s (256 QAM) at 6,952 Mbaud (8 MHz channel)	-	26,970 MBit/s (64 QAM), 38,810 MBit/s (256 QAM)	-
Transmission bit rate	41,71 MBit/s (64 QAM) 55,62 MBit/s (256 QAM) at 6,952 Mbaud (8 MHz channel)	31,644 MBit/s (64 QAM) 42,192 MBit/s (256 QAM)	-	-
Information bit rate	51,25 MBit/s (256 QAM) at 6,952 Mbaud (8 MHz channel)	29,162 MBits/s 38,883 MBits/s (256 QAM)	-	-
Return path	-	-	5 MHz to 40 MHz, QPSK	-

Annex C
(normative)

Measurement procedures, instrumentation and supporting information

C.1 General

This annex provides additional information, measurement procedures and requirements to supplement the normative references defined in Table A.1 and Table A.7. Further supporting information is also provided in Annex G (informative).

This annex is divided into 3 main clauses:

C.2 Instrumentation and supporting information;

C.3 General measurement procedures;

C.4 MME-related measurement procedures.

C.2 Instrumentation and supporting information

C.2.1 General

Each piece of measurement apparatus shall comply with the relevant requirements defined in the basic standards given in Table A.1 and Table A.7.

C.2.2 Using CISPR 16 series as the basic standard

C.2.2.1 General

The measuring receiver shall be in accordance with Clause 4 of CISPR 16-1-1:2010. Detectors and bandwidths shall be as specified in the relevant tables in Annex A, and as further defined in this Annex, and in Annex A of CISPR 16-1-1:2010.

If the level of an isolated emission exceeds any relevant limit, it shall be ignored, provided that the following two conditions are met when measured over a two minute interval:

1) the emission does not exceed the limit for more than 1 s;
2) the emission does not exceed the limit more than once in any 15 s observation period.

Care shall be taken to avoid overloading the measurement system. See Annex E.

Measurement instruments provided with RF preselectors, which automatically follow the frequency being scanned, shall have a sufficiently long measurement time on each frequency to avoid errors in the measured amplitude values.

When using spectrum analysers during prescan (see C.3.2) measurements, the video bandwidth of the measurement instrument should be equal to, or greater than, the resolution bandwidth in order not to influence the measurement results. Other settings of resolution and video bandwidth may be used, but care should be taken to ensure the settings do not adversely influence the results.

C.2.2.2 Antennas for radiated emissions measurements

Any suitable broadband linearly polarised antenna or tuned dipole may be used during measurements. These shall be calibrated in free space conditions using the procedures in ANSI C63.5.

C.2.2.3 Ambient signals

If ambient signals are masking EUT emissions then the procedure defined in Annex A of CISPR 16-2-3:2010 shall be used to reduce the impact of each ambient. The frequencies and levels of the ambient signals masking EUT emissions shall be recorded in the test report.

C.2.2.4 Boundary of the EUT, local AE and associated cabling and measurement distance for radiated emissions measurements

The EUT and local AE shall be arranged in the most compact practical arrangement within the test volume, while respecting typical spacing and the requirements defined in Annex D. The central point of the arrangement shall be positioned at the centre of the turntable. The measurement distance is the shortest horizontal distance between an imaginary circular periphery just encompassing this arrangement and the calibration point of the antenna. See Figure C.1 and Figure C.2.

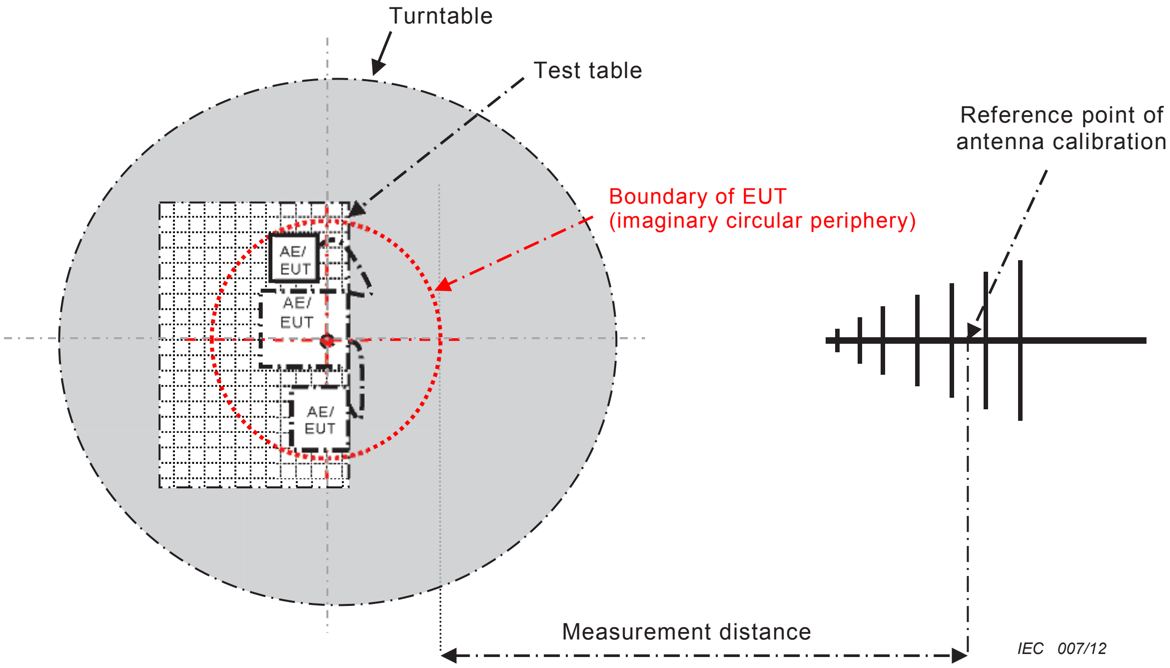


Figure C.1 – Measurement distance

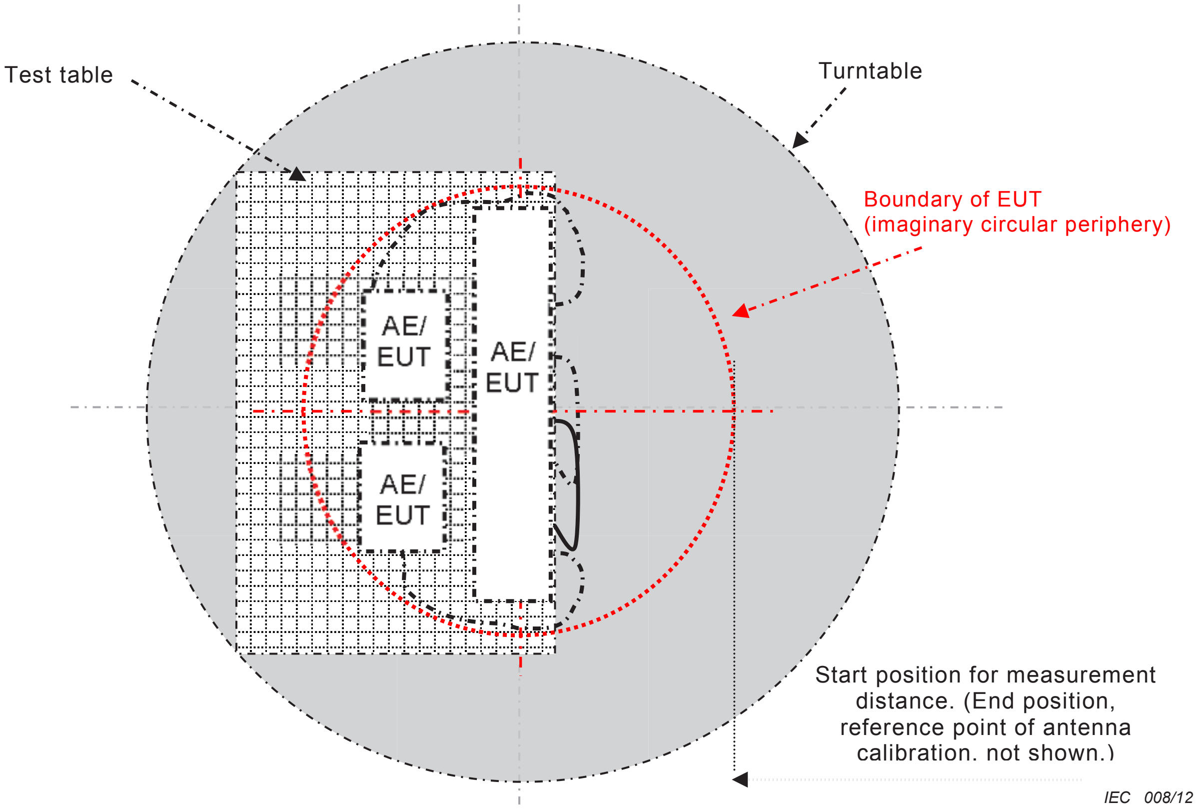


Figure C.2 – Boundary of EUT, Local AE and associated cabling

Where possible any HID should be placed in a typical arrangement. HID may be placed at the front edge of the table if the table is not deeper than 1 m. If a deeper table is used, the HID may only be placed at the front edge if this does not increase the size of the imaginary circular periphery, otherwise the HID may be placed at a distance of 1 m from the back edge of the table to the front of the HID.

Where AE is placed outside the test area (as described in D.1.1), this remotely located AE and its associated cabling shall not be considered to be within the circular periphery for the purposes of defining the measurement distance.

Where a test facility has been validated (in accordance with Tables 1 and 2 of CISPR 16-1-4:2010 or in C.3) for a different measurement distance not defined in Table A.2 to Table A.6, the measurement may be performed at that distance. In this case the limit L_2, corresponding to the selected measurement distance d_2, shall be calculated by applying the following formula:

$$L_2 = L_1 + 20 \log(d_1/d_2)$$

Where L_1 is the specified limit in dBμV/m at the distance d_1; and, L_2 is the new limit for distance d_2. The distances d_1 and d_2 use the same unit, such as m.

In addition, when using this formula, the test report shall show the limit L_2 and the actual measurement distance d_2. To ensure consistency of calculation, wherever possible the limits for the 10 m measurement distance (up to 1 GHz) and the 3 m measurement distance (above 1 GHz) shall be used as the basis for calculations of limits at other measurement distances.

The minimum measurement distance for radiated emission testing for frequencies below 1 GHz shall be 3 m and for frequencies above 1 GHz shall be 1 m.

C.2.3 EUT cycle time and measurement dwell time

The cycle time is the period for the EUT to complete one entire operation. A dwell time longer than the cycle time shall normally be used during all formal measurements. The dwell time may be limited to 15 s.

C.3 General measurement procedures

C.3.1 Overview

The radiated and conducted emissions shall be assessed against the relevant requirements in Annex A, using the appropriate procedures defined in Table A.1 and Table A.7. The following subclauses provide a general overview taking into account the test facilities where the measurements are performed. Further information is also contained inC.4 and Annex G.

In order to speed-up the measurement procedure, peak detectors may be used in accordance with the decision trees defined in Figure C.3 to Figure C.5.

C.3.2 Prescan measurements

The purposes of a prescan measurement are to determine the frequencies at which the EUT produces the highest level of emissions and to help select the configuration(s) to be used in the formal measurements. For details on prescan measurements refer to Annex E.

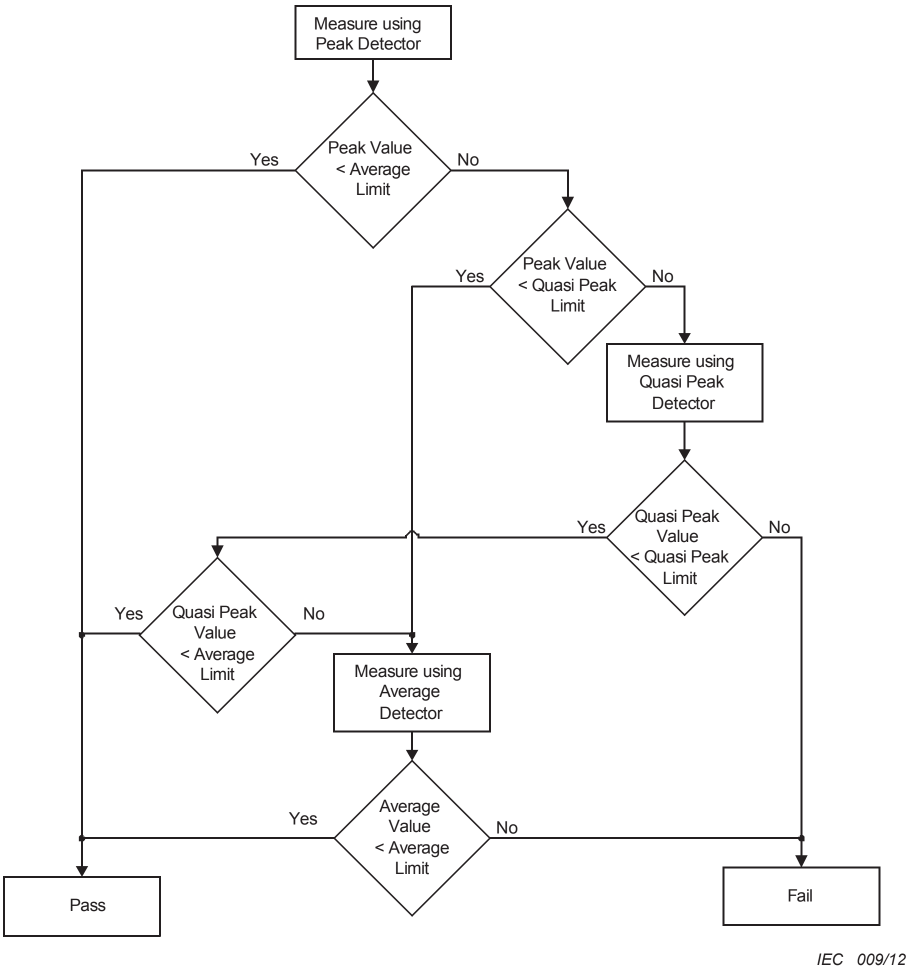


Figure C.3 – Decision tree for using different detectors with quasi peak and average limits

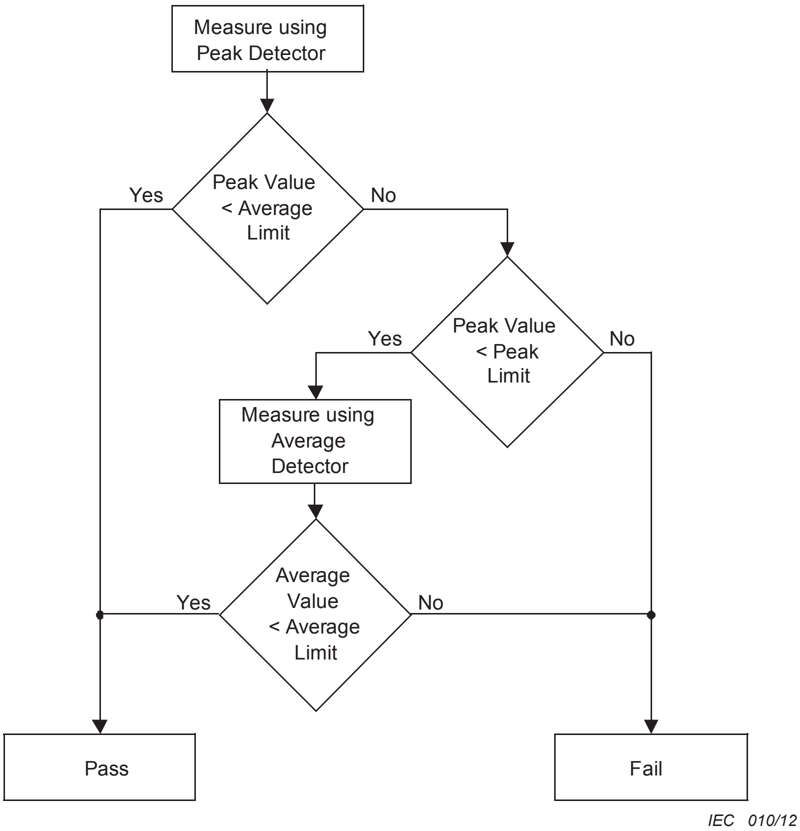


Figure C.4 – Decision tree for using different detectors with peak and average limits

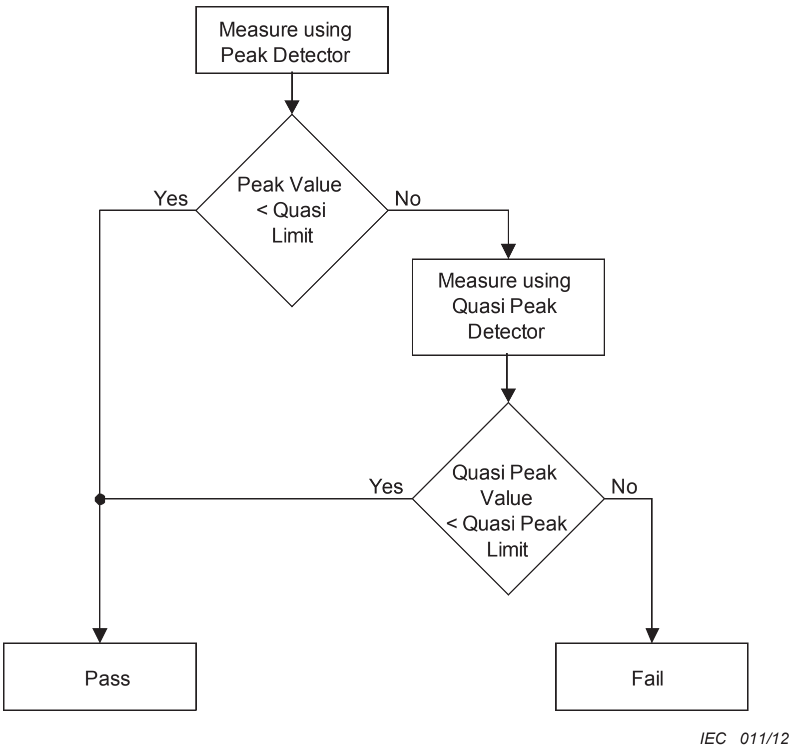


Figure C.5 – Decision tree for using different detectors with a quasi-peak limit

C.3.3 Formal measurements

The configuration(s) found during the prescan measurement that produce(s) the highest amplitude emission relative to the limit shall be used for the formal measurement. Where prescan measurements have not been performed, the formal measurements shall be performed using the configuration(s) that are expected to produce the highest amplitude emissions relative to the limit; and, the reasons for the selection shall be given in the test report.

The formal measurements shall be performed using a compliant measurement facility as defined in Table A.1 and Table A.7. The measurements shall be performed in accordance with the basic standards and the requirements of this document.

C.3.4 Specifics for radiated emission measurements

Formal emissions measurements shall determine the highest emission level at any frequency at which a limit is set, considering the following:

- antenna polarization (horizontal and vertical);
- full rotation of the EUT, local AE and associated cabling (through 360 degrees);
- antenna height.

Where measurements are made using an OATS/SAC, the antenna height scan shall be restricted to a range of 1 m to 4 m above the RGP.

Where measurements are made using a FSOATS, the antenna height scan shall encompass those heights defined in Figure 14, Figure 15 and Table 2 of CISPR 16-2-3:2010.

If no prescan has been performed, then the formal measurements shall be carried out across the entire frequency range.

C.3.5 Specifics for conducted emission measurements on the AC mains power ports

Testing shall include measurements on all live and neutral lines (or ports).

For guidance on elements of conducted measurements see 6.5.1 of CISPR 16-2-1:2008+A1:2010.

C.3.6 Specifics for conducted emission measurements on analogue/digital data ports

MME may have different types of analogue/digital data ports to which different requirements apply as stated in Annex A. As a minimum, one port of each type shall be exercised and assessed against the requirements. The measurement procedures shall be selected using the information given in Table C.1 and elsewhere in this clause.

When an EUT has multiple analogue/digital data ports of the same type, at least one port of each type shall be assessed. Where it has been shown by pre-scanning or some other technique that the ports are similar in their emission performance, only a single port need be assessed.

For guidance on elements of conducted measurements see 6.5.1 of CISPR 16-2-1:2008+A1:2010.

C.3.7 Specifics for conducted emission measurements on broadcast receiver tuner ports

One of each port type (digital, analogue, satellite etc.) shall be assessed using the measurement procedures defined in C.4.2.

For guidance on elements of conducted measurements see 6.5.1 of CISPR 16-2-1:2008+A1:2010.

C.3.8 Specifics for conducted emission measurements on RF modulator output ports

One of each port type shall be assessed using the measurement procedure defined in clause C.4.3.

For guidance on conducted measurements see 6.5.1 of CISPR 16-2-1:2008+A1:2010.

C.4 MME-related measurement procedures

C.4.1 Measurement of conducted emissions at analogue/digital data ports

C.4.1.1 Measurement procedure selection

The purpose of these tests is to measure the common mode emission at analogue/digital data ports of an EUT. Appropriate measurement procedures are defined in Table C.1.

Table C.1 – Analogue/digital data port emission procedure selection

	Cable type	Number of pairs	Example of relevant figures	Measurement type	Procedures
1	Balanced Unscreened	1 (2 wire) 2 (4 wire) 3 (6 wire) 4 (8 wire)	Figure G.1 to Figure G.3 Figure G.2 to Figure G.5 Figure G.3 Figure G.3 or Figure G.6 or Figure G.7	Voltage	C.4.1.6.2.
2	Balanced Unscreened	See a)	n/a	Voltage and Current	C.4.1.6.4 .
3	Screened or Coaxial	n/a	Figure G.8 Figure G.9 Figure G.10	Voltage	C.4.1.6.2.
4	Screened or Coaxial	n/a	n/a	Voltage or Current	C.4.1.6.3
5	Unbalanced cables	n/a	n/a	Voltage and Current	C.4.1.6.4
6	AC Mains	n/a	AMN CISPR 16-1-2:2003+A1:2004+A2:2006 Figure 4 and Figure 5	Voltage	Apply the requirements of Table A.8 or Table A.9, as appropriate. The AMN shall be used as a voltage probe.

Where used, an AAN shall satisfy all the requirements defined in C.4.1.2.

Where used, the current probe shall satisfy the requirements defined in C.4.1.4 and the CVP shall satisfy the requirements defined in C.4.1.5.

The mains voltage shall be supplied to the EUT via the AMN used when measuring the mains terminal emission voltages according to Table A.8 or Table A.9.

Where used, the AAN shall be selected in accordance with C.4.1.3.

Care shall be taken when measuring common mode current with an AAN in the circuit to ensure that the test method accurately measures both the launched and converted components of the common mode current.

The procedure defined in C.4.1.6.2 gives results with the lowest measurement uncertainty.

a) Ports connected to cables with more than 4 balanced pairs or where the port is unable to function correctly when connected through an AAN.

C.4.1.2 Characteristics of AAN

Measurement of common mode (asymmetric mode) current or voltage emissions at wired network ports for attachment of unscreened balanced pairs shall be performed with the wired network port connected by a cable to an AAN. The AAN shall define the common mode termination impedance seen by the wired network port during the emission measurements.

The combination of the AAN and all appropriate adapters required to connect to the EUT and AE shall have the following properties:

a) The common mode termination impedance in the frequency range 0,15 MHz to 30 MHz shall be 150 Ω ± 20 Ω, phase angle 0 ± 20°.

b) The AAN shall provide sufficient isolation against emissions from an AE or load connected to the wired network port being assessed. The attenuation of the AAN, for common mode emissions originating from the AE, shall be such that the measured level of these emissions at the measuring receiver input is at least 10 dB below the relevant emission limit.

The preferred minimum isolation is:

- 35 dB to 55 dB, increasing linearly with the logarithm of the frequency across the range 0,15 MHz to 1,5 MHz ;
- 55 dB across the range 1,5 MHz to 30 MHz

NOTE Isolation is the ratio of the common mode emission originating in an AE to that consequentially appearing at the EUT port of the AAN.

c) The AAN shall meet the longitudinal conversion loss (LCL) requirements stated in Table C.2 from 0,15 MHz to 30 MHz. Actual LCL values to simulate different cables are defined in Table C.2.

Table C.2 – LCL values

Cable category	LCL dB	Tolerance
3 (or better)	$L_{LCL}(\mathrm{dB}) = 55 - 10\lg\left[1+\left(\frac{f}{5}\right)^2\right]$	±3 dB
5 (or better)	$L_{LCL}(\mathrm{dB}) = 65 - 10\lg\left[1+\left(\frac{f}{5}\right)^2\right]$	±3 dB for f <2 MHz −3 dB/+4,5 dB for f between 2 MHz and 30 MHz
6 (or better)	$L_{LCL}(\mathrm{dB}) = 75 - 10\lg\left[1+\left(\frac{f}{5}\right)^2\right]$	±3 dB for f <2 MHz −3 dB/+6 dB for f between 2 MHz and 30 MHz
Coaxial	n/a	n/a

NOTE 1 f has the units of MHz in the above formulas.

NOTE 2 These LCL values are approximations of the LCL values of typical unscreened balanced cables in representative environments. The specification for category 3 is considered representative of the LCL values of typical telecommunication copper access networks.

d) The insertion loss or other deterioration of the signal quality in the wanted signal frequency band caused by the presence of the AAN shall not significantly affect the normal operation of the EUT.

e) The tolerance on the voltage division factor (V_{vdf}) shall be ±1 dB from 0,15 MHz to 30 MHz. The AAN voltage division factor is calculated as follows:

$$V_{vdf} = 20\text{Log}_{10}\left|\frac{V_{cm}}{V_{mp}}\right| \text{dB}$$

where

V_{cm} is the common mode voltage appearing across the common mode impedance presented to the EUT by the AAN; and,

V_{mp} is the resulting receiver voltage measured directly at the voltage measurement port of the AAN.

The voltage division factor shall be added to the measured voltage measured by the receiver directly at the voltage measurement port of the AAN and the result compared with the voltage limits in Table A.10 or Table A.11 as applicable.

C.4.1.3 Selection of AAN for unscreened balanced multi-pair cables

The type of AAN is selected according to the number of pairs physically in the cable excluding any pairs which do not have a galvanic connection to any part of the EUT, including ground.

The AAN described in Figure G.4 to Figure G.7 are only appropriate for use where there are no unconnected pairs in the cable. The AANs shown in Figure G.1 to Figure G.3 are suited to any situation, including those where the use of some of the pairs is unknown, or some pairs are known to be unconnected.

C.4.1.4 Current probe characteristics

The current probe shall have a uniform frequency response without resonances within the frequency range of interest. It shall be capable of operating without saturation effects caused by the operating currents in the primary winding.

The insertion impedance of the current probe shall not exceed 1 Ω. See 5.1 of CISPR 16-1-2:2003+A1:2004+A2:2006.

C.4.1.5 Characteristics of the CVP

The CVP defined in 5.2.2 of CISPR 16-1-2:2003+A1:2004+A2:2006 shall be used.

C.4.1.6 Measurements at wired network ports, antenna ports and optical fibre cables having metallic screens or strength members

C.4.1.6.1 Choice of measurement procedure

This clause describes the various measurement procedures that can be used to measure the common mode conducted emission of analogue/digital data ports. Depending on the cable type, different procedures may be used, each with its advantages and disadvantages. See G.2.

C.4.1.6.2 Measurement procedure using an AAN

Measurement is made at wired network ports using AANs with longitudinal conversion losses as defined in Table C.2. The AAN for the cable category specified by the equipment documentation provided to the user shall be used. The level of emissions from the EUT shall not exceed the applicable limits of Annex A.

When emission voltage measurements are performed, the AAN shall provide a voltage measurement port suitable for connection to a measuring receiver while simultaneously satisfying the analogue/digital data port common mode termination impedance requirements.

For unscreened cables containing balanced pairs, an AAN conforming to C.4.1.2 shall be used. The LCL values of the AAN shall be within the tolerance given in Table C.2 for an AAN appropriate to the cable category connected to the EUT.

The procedure shall be as follows:

- arrange the EUT, local AE and associated cabling (examples are given Annex D);
- measure the voltage at the measurement port of the AAN;
- correct the measured voltage by adding the AAN voltage division factor (V_{vdf}) defined in C.4.1.2 e);
- compare the corrected voltage with the limit.

C.4.1.6.3 Measurement procedure using a 150 Ω load connected to the outside surface of the cable screen

This procedure can be used for all types of coaxial cables, screened multi-pair cables or optical fibre cables having metallic screens or strength members.

The procedure shall be follows:

- Arrange the EUT, local AE and associated cabling, generally as shown in Figure D.4 or Figure D.5, replacing the CVP in Figure D.4 by a 150 Ω adaptor. The current probe to EUT horizontal distance may be increased to 0,8 m. Alternatively in Figure D.5, the AAN shall be replaced by the 150 Ω adaptor/current probe combination.
- Break the external protective insulation (exposing the shield) and connect a 150 Ω resistor with a physical connection between the cable screen and the RGP. The 150 Ω resistor shall be ≤0,3 m from the outside surface of the screen to ground. For further information refer to G.2.5.
- Insert a ferrite tube or clamp between the 150 Ω connection and the AE.
- Measure the current with a current probe and compare to the current limit. Use the procedure given in C.4.1.7 to measure the asymmetric common mode impedance from the 150 Ω resistor towards the AE, which should be much greater than 150 Ω so as not to affect the measurement at frequencies emitted by the EUT.
- The separation distance between the AE and the ground plane is not critical if the impedance of the ferrite is higher than that given in G.2.5. If this cannot be achieved, then the AE shall be placed at 0,4 m from a vertical or horizontal RGP, as defined for the EUT in Table D.1.

The voltage measurement may also be performed in parallel with the 150 Ω resistor with a high impedance probe. Alternatively, the measurement may be performed using a "150 Ω to 50 Ω adaptor" described in IEC 61000-4-6 as the 150 Ω load and applying the appropriate correction factor (9,5 dB in case of the "150 Ω to 50 Ω adaptor").

C.4.1.6.4 Measurement procedure using a combination of current probe and CVP

As an AAN is not used in this procedure, the common mode impedance is not stabilized. The emissions from the EUT shall be measured using both the voltage and current probes and the measured levels compared with the voltage and the current limits respectively.

The procedure shall be as follows:

Arrange the EUT, local AE and associated cabling as defined in Annex D, either as shown in Figure D.4 or as shown in Figure D.5, replacing the AAN with the current probe/CVP combination.

A CMAD or similar device may be used between the AE and the current probe/CVP combination.

The AE shall be placed 0,4 m from a vertical or horizontal RGP, as defined for the EUT in Table D.1. Where appropriate, the EUT shall be powered using an AMN placed on the RGP. The AMN shall be placed >0,10 m from the nearest edge of the RGP. The EUT power cord shall be routed away from the cable used for the measurements to minimize coupling or crosstalk effects.

The current shall be measured with the current probe and the results compared with the current limits.

The voltage shall be measured with the CVP specified in C.4.1.5.

- The voltage measured shall be corrected at each frequency of interest as follows:
  - if the current margin with respect to the current limit is ≤6 dB, the actual current margin shall be subtracted from the measured voltage;
  - if the current margin with respect to the current limit is >6 dB, 6 dB shall be subtracted from the measured voltage.
- The adjusted voltage shall be compared with the applicable voltage limit.
- Both the measured current and the corrected voltage shall be below the applicable current and voltage limits at all frequencies for the EUT to be deemed compliant with this publication.

C.4.1.7 Measurement of cable, ferrite and AE common mode impedance

There are three possible procedures for the measurement of the CM impedance. Procedure 1 below shall only be used if both loop lengths are less than 1,25 m.

This condition is necessary to minimise loop resonance(s) that could affect the impedance measurement and increase measurement uncertainty. In all other cases either Procedure 2 or Procedure 3 shall be used to measure the common mode impedance.

Procedure 1:

- The drive probe 50 Ω system shall be calibrated. See Figure C.6.
- Drive voltage (V_1) shall be applied from a signal generator into the drive probe and the resulting current (I_1) in the measurement probe shall be recorded.
- The cable used for the measurement from the EUT shall be disconnected and shall be shorted to ground at the EUT end.
- The same drive voltage (V_1) shall be applied to the cable with the same drive probe.
- The current shall be measured with the same measurement probe, and the asymmetrical common mode impedance of the cable, ferrite and AE combination shall be calculated by comparing the current reading (I_2) measured by the current probe with the previously measured current (I_1).

  The common mode impedance is $50 \times I_1 \div I_2$. For example, if I_2 is half I_1, then the common mode impedance is 100 Ω.

Procedure 2:

An impedance analyser shall be connected between the screen of the cable attached to the EUT port being assessed and the RGP, at the position where the 150 Ω resistor would be attached. The EUT shall not be powered during this measurement. The arrangements defined in C.4.1.6.3 apply. The measurement set-up is similar to that presented in Figure G.15.

Procedure 3:

Using a network analyser, a current probe and a CVP, the common mode voltage and current shall be measured. The ratio of the voltage to the current on the cable attached to the EUT port under test, as measured with the network analyser, defines the common mode impedance. The measurement set-up is similar to that presented in Figure G.15.

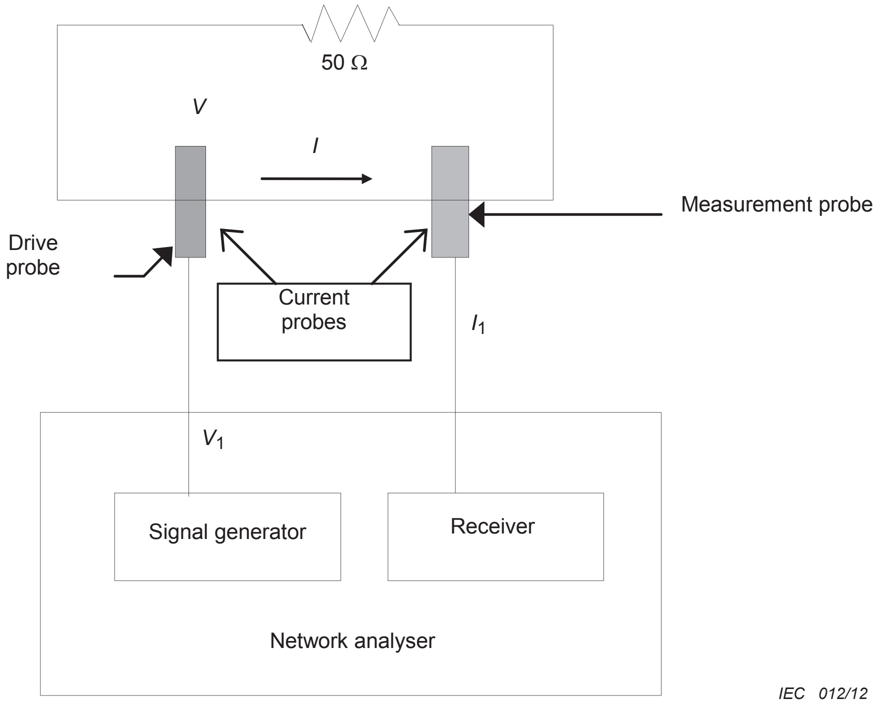


Figure C.6 – Calibration fixture

C.4.2 Measurement of emission voltages at a TV/FM broadcast receiver tuner ports in the frequency range 30 MHz to 2,15 GHz

C.4.2.1 General

When measurements are performed at the TV/FM broadcast receiver tuner port of the EUT, a signal generator generating an unmodulated carrier shall be used to feed the receiver input with an RF signal at the tuned frequency of the EUT. (see Annex B)

The output level of the signal generator shall be set to produce 60 dB(μV) for FM receivers or 70 dB(μV) for TV receivers. In each case the level specified is the voltage across the 75 Ω impedance input terminal of the receiver.

C.4.2.2 Connection of AE (signal generator)

The TV/FM broadcast receiver tuner port of the EUT and the AE (signal generator) shall be connected to the input of the measurement device by means of coaxial cables and a resistive combining network (or another suitable device). The combining network or device used shall have a minimum attenuation of 6 dB between the AE and the measurement device. See Figure C.7.

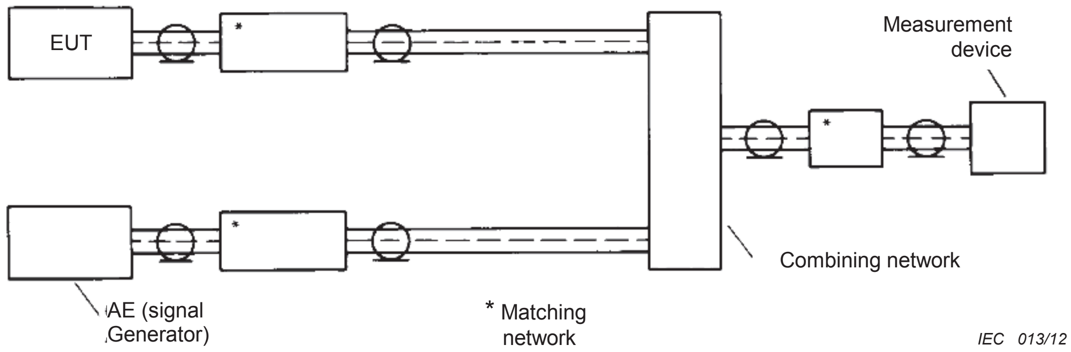


Figure C.7 – Circuit arrangement for measurement of emission voltages at TV/FM broadcast receiver tuner ports

The impedance as seen from the TV/FM broadcast receiver tuner port of the EUT shall be equal to the nominal antenna input impedance for which the port has been designed. The EUT shall be tuned to the wanted signal from the AE (signal generator). The emission level shall be measured across the relevant frequency range taking into account the attenuation between the EUT TV/FM broadcast receiver tuner port and the measurement device.

NOTE 1 RF currents flowing from the chassis of the receiver to the outer surface of the screen of the coaxial cables should be prevented from penetrating into the coaxial system and thus causing erroneous measuring results, for example by means of ferrite tubes.

NOTE 2 Attention should be given to possible overloading of the input stage of the measuring device due to the output signal of the AE (signal generator).

C.4.2.3 Presentation of the results

The results shall be expressed in terms of the emission voltage in dB(μV). The specified input impedance of the TV/FM broadcast receiver tuner port shall be stated with the results.

C.4.3 Measurement of the wanted signal and emission voltage at RF modulator output ports, in the frequency range 30 MHz to 2,15 GHz

C.4.3.1 General

If an EUT has an RF modulator output port (for example video recorders, camcorders, decoders) additional measurements of the wanted signal level and emission voltage at its RF modulator output port shall be performed.

C.4.3.2 Measurement procedure

The RF modulator output port of the EUT is connected to the input of the measuring device by means of a coaxial cable and a matching network (if necessary) as shown in Figure C.8. The characteristic impedance of the cable shall be equal to the nominal output impedance of the EUT. The EUT shall produce an RF carrier modulated by a video signal defined in Annex B.

The RF output level shall be obtained by adding the insertion loss of the matching network to the indication of the measuring device (tuned to the video carrier frequency and its harmonics).

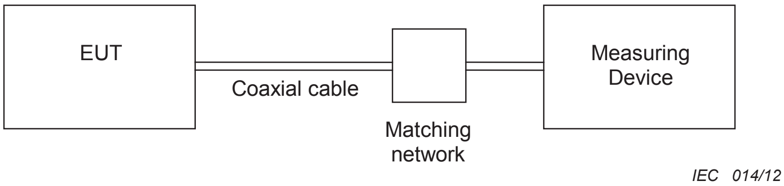


Figure C.8 – Circuit arrangement for the measurement of the wanted signal and emission voltage at the RF modulator output port of an EUT

C.4.4 Additional Normalized Site Attenuation (NSA) values

The procedure defined in CISPR 16-1-4:2010 and values presented in Table C.3 shall be used to perform NSA at the 5 m distance where this is needed.

Table C.3 – 5 m OATS/SAC NSA values

Polarization	Horizontal		Vertical	
D (m)	5	5	5	5
H_1 (m)	1 – 4	1 – 4	1 – 4	1 – 4
H_2 (m)	1	2	1	1,5
Frequency (MHz)	NSA (dB)			
30,00	20,7	15,6	11,4	12,0
35,00	18,2	13,3	10,1	10,7
40,00	16,0	11,4	8,9	9,6
45,00	14,1	9,8	7,9	8,6
50,00	12,4	8,5	7,1	7,8
60,00	9,5	6,3	5,6	6,3
70,00	7,2	4,6	4,3	5,2
80,00	5,3	3,2	3,3	4,3
90,00	3,7	2,0	2,4	3,5
100,00	2,3	1,0	1,6	2,9
120,00	0,1	-0,7	0,3	2,1
140,00	-1,7	-2,1	-0,6	1,7
160,00	-3,1	-3,3	-1,3	1,0
180,00	-4,3	-4,4	-1,8	-1,0
200,00	-5,3	-5,3	-2,0	-2,6
250,00	-7,5	-6,7	-3,2	-5,5
300,00	-9,2	-8,5	-6,2	-7,5
400,00	-11,8	-11,2	-10,0	-10,5
500,00	-13,0	-13,3	-12,5	-12,6
600,00	-14,9	-14,9	-14,4	-13,5
700,00	-16,4	-16,1	-15,9	-15,1
800,00	-17,6	-17,3	-17,2	-16,5
900,00	-18,7	-18,4	-17,4	-17,6
1 000,00	-19,7	-19,3	-18,5	-18,6

These data apply to antennas that have at least 250 mm of RGP clearance when the centre of the antenna is 1 m above the RGP in vertical polarization.

D measurement distance
H_1 height of the receiving antenna
H_2 height of the transmitting antenna

Annex D
(normative)

Arrangement of EUT, local AE and associated cabling

D.1 Overview

D.1.1 General

The intention of this publication is to measure the emissions from the EUT in a manner that is consistent with its typical arrangement and use. The measurement arrangement of the EUT, local AE and associated cabling shall be representative of normal practice.

An EUT or part of an EUT (including necessary AE within the measurement volume) which is intended to be positioned on the floor during normal operation shall be arranged as floor standing equipment. All other EUT (table-top, wall mounted or table-top/wall mounted) shall be arranged as table-top EUT, unless placing the EUT in this way would create a physical safety hazard.

All cables that are considered part of the EUT shall be arranged as for normal use subject to length restrictions given in Table D.1 and subject to the requirement to minimise the size of the arrangement. For example, the keyboard and mouse of a personal computer set-up shall be placed in front of the monitor.

Arrangements such as placing AE below the RGP or placing AE outside the measurement area when it is normally located distant from the EUT may be used to limit the effects of adverse AE emissions or to reduce measurement time, as long as the arrangement can be shown not to reduce the emissions measured from the EUT.

An EUT intended for rack mounting may be arranged in a rack or as table-top equipment. An EUT that can be used in both floor standing and table-top configurations, or both floor standing and wall mounted configurations, shall be assessed in a table-top arrangement. However, if the usual installation is floor standing, then that arrangement shall be used.

The type and construction of cables used in the measurement set-up shall be consistent with normal or typical use. Cables with mitigation features (for example, screening, tighter/more twists per length, ferrite beads) shall only be used if it is the intention that all deployments will use these features. If the cable(s) have mitigation features, this detail shall be specified in the test report. Manufacturer-supplied or commercially available cabling shall be used, as specified in the installation manual or user manual.

Cables connecting to AE located outside the measurement area shall drop directly to, but be insulated from, the RGP (or turntable where applicable), and then be routed directly to the place where they leave the test site. The thickness of the insulation shall not be more than 150 mm. However, cables which would normally be bonded to ground should be bonded to the RGP in accordance with normal practice or the manufacturer’s recommendation.

During conducted emission measurements on analogue/digital data ports, the cable between the EUT and the measurement device or probe shall be as short as possible and satisfy the requirements given in Table D.1.

Where practical, any excessive length in cables shall be bundled non-inductively, at the mid point between the EUT and the AMN, for the conducted emission measurement. The bundle length shall be less than 0,4 m to satisfy the distances given in Table D.1.

Non-inductive bundling means that the cable is shortened by overlapping loops arranged with alternate end loops wound in opposite directions using the minimum practicable bend radius. Where bundling cannot be achieved, coiling of the cables shall be avoided.

The effective length of all loop-back cables not routed overhead shall be longer than 2 m. Where possible, loop-back cables shall be arranged so that outgoing line is not closely coupled to the return.

Where possible, the effective length of mains cables shall be 1 m ± 0,1 m.

Cable length is the distance between cable connector ends, excluding any protruding pins, when the cable is laid straight. The effective cable length, is the distance between cable connector ends, excluding any protruding pins, when the cable includes one or more bundles. The effective cable length will be shorter than the actual length if the cable has been bundled.

Loads and/or devices simulating typical operating conditions shall be connected to at least one of each type of interface port of the EUT. If loading (or terminating) with a device of actual usage is not feasible, the port should preferably be loaded with a simulator. Where these options are not practical the port shall be loaded by the application of a typical impedance considering both the common and differential modes. These loads and/or devices shall be connected via a cable if this represents normal usage.

Where there are multiple ports of the same type the manufacturer shall determine whether to load these additional ports, considering:

- maximisation of the emission levels, for example, when adding additional cables does not significantly affect the emission level (for example varies less than 2 dB), it can be assumed a maximum has occurred;
- reproducibility;
- achievement of a representative configuration having regard to other requirements in this clause.

For example, additional cables with or without terminations may be connected to the EUT ports. This process may also be applied to establishing the number of similar elements (plug-in modules, internal memory, and so forth) within the EUT.

Where the EUT has more than one analogue/digital data port, ports shall be selected for testing as follows:

- if there are multiple similar ports on the same card or module type, then it is acceptable to assess one typical port,
- where there are ports of the same type on different card or module types, then it is acceptable to assess one typical port on each card or module types.

The test report shall identify the ports assessed.

An EUT which requires a dedicated ground connection shall be bonded to the RGP or to the chamber wall with a grounding connection that is similar to that used in practice.

See Figure D.1 through Figure D.10 for examples of arrangements

Requirements for EUT spacing and distances are given in Table D.1.

Table D.1 – Arrangement spacing, distances and tolerances

No.	Element	Spacing/ Distances	Tole-rance (±)	Measure-ment
1	Spacing between any two elements on the measurement table	≥0,1 m	10 %	Both
2	Spacing between any two elements where one or more of the elements are not on a table-top	Typical	n/a	Both
3	Minimum distance between the rack (or cabinet) contain the EUT and the vertically rising cabling which would normally leave the measurement facility	0,2 m	10 %	Both
4	Spacing between AMN and EUT	0,8 m	10 %	Conducted
5	Spacing between AMN and local AE	≥0,8 m	10 %	Both
6	Spacing between AAN and EUT	0,8 m	10 %	Conducted
7	Horizontal spacing between EUT and current probe (or 150 Ω resistor) Spacing between current probe and 150 Ω resistor Spacing between 150 Ω resistor and optional ferrites (CMAD)	0,3m to 0,8m 0,1 m 0,1 m	10 %	C.4.1.6.3
8	Horizontal spacing between EUT and current probe Spacing between current probe and CVP Spacing between 150 Ω resistor and optional ferrites (CMAD)	0,3 m 0,1 m 0,1 m	10 %	C.4.1.6.4
9	Spacing between AAN and local AE	≥0,8 m	n/a	Conducted
10	Measurement distance when testing frequencies up to 1 GHz. See Table A.2, A.4 and A.6	3 m - 10 m	± 0,1 m	Radiated
11	Measurement distance when testing frequencies above 1 GHz. See Table A.3, and A.5	1 m - 10 m	± 0,1 m	Radiated
12	Spacing between: EUT, local AE and associated cabling; and metal surfaces other than the RGP This spacing does not apply when a combination of table-top and floor-standing equipment is tested. In this case the table-top EUT may be 0,4 m from the vertical RGP as shown in Figure D.7.	≥0,8 m	10 %	Conducted
13	Thickness of insulation between floor standing EUT, local AE and associated cabling and the RGP	≤0,15 m	10 %	Both
14	Height to the top of table for radiated measurements	0,8 m	± 0,01 m	Radiated
15	Height to the top of table for conducted measurements	0,8 m or 0,4 m	± 0,01 m	Conducted
16	Spacing between table-top EUT, local AE and associated cabling and the RGP For testing analogue/digital data ports, the line under test shall be kept 0,4 m distant from the RGP for as long as possible before being run to the termination point. For testing using C.4.1.6.3 this also includes the cable from the measurement device to the AE. The section of cable running to and from the termination point shall be exempt from the spacing to the RGP requirement given here.	0,4 m	10 %	Conducted
17	Spacing between: table-top EUT/AE cables or bundled EUT/AE cables draped over the back of the table; and the RGP This may be achieved by a non-conductive support.	0,4 m above the RGP	10 %	Both
18	Height of the cables connecting table-top and floor standing parts	Lowest of: 0,4 m; or connector height	10 %	Both

Measurement types have the following meaning:
- Conducted = All types of conducted measurements
- Radiated = All types of radiated measurements
- Both = All types of conducted measurements and all types of radiated measurements

Where manufacturer-provided cables have to be used and are too short to meet the requirements of this table, the equipment shall be arranged to be as close to the requirements of this table as is reasonably practical and the actual arrangement shall be described in the test report.

The EUT, local AE and associated cabling shall be arranged in the most compact practical arrangement while respecting typical spacing and the requirements of this table.

Where the EUT is a module as defined in Figure 2, the distances specified relative to the EUT are measured to the surface of the host.

Where the EUT is rack mounted, the distances specified relative to the EUT are measured to the surface of the rack.

Tolerance value aligned with the CISPR 16 series.

D.1.2 Table-top arrangement

The following specific arrangements apply.

Equipment, including the power supply, intended for table-top use shall be placed on a non-conductive table of sufficient size to hold the EUT, local AE and associated cabling. Where practical, the rear of the EUT should be flush with the rear of the table.

For radiated measurements the table shall be made of a material with a dielectric constant which minimises the impact on the results. Subclause 5.5.2 of CISPR 16-1-4:2010 describes a measurement to help ensure that the dielectric qualities of the material used for construction of the table are appropriate.

The arrangement of external power supply units (including AC/DC power converters) shall meet the requirements of Table D.1. Where possible, cables that connect between modules or units shall hang over the back of the table. If a cable hangs closer than 0,4 m from the horizontal RGP (or floor), the excess shall be folded at the cable centre into a bundle no longer than 0,4 m, such that the bundle is 0,4 m above the horizontal RGP.

If the mains port input cable is less than 0,8 m long, (including power supplies integrated in the mains plug) an extension cable shall be used such that the external power supply unit is placed on the measurement table. The extension cable shall have similar characteristics to the mains cable (including the number of conductors and the presence of ground connection). The extension cable shall be treated as part of the mains cable.

Power supply output cables shall be treated as inter-unit cables.

Equipment may be stacked if this is a normal arrangement for this equipment.

Example measurement arrangements are given in Figure D.1 to Figure D.5 and Figure D.8.

D.1.3 Floor standing arrangement

Where cable routing is specified by the manufacturer, this routing shall be used.

Where the inter-unit cabling is typically routed overhead, it shall be routed vertically to an overhead support. Overhead inter-unit cables shall rise from the first unit up to the support, run along the support, and drop down into the other unit. Overhead exit cables shall rise from the first unit up to the support, run along the support to a specified distance, drape down to the RGP, and route out of the facility to remote AE. Excess cable shall be bundled non-inductively on, but separated from, the RGP (respecting separation distances as defined in Table D.1).

Mains cabling shall drape vertically to (but be insulated from) the horizontal RGP.

The EUT shall be insulated (by insulation of maximum thickness of 150 mm) from the horizontal reference ground plane. If the equipment requires a dedicated ground connection, this shall be provided and bonded to the RGP.

Examples are given in Figure D.6 and Figure D.9.

D.1.4 Combinations of table-top and floor standing EUT arrangement

The following specific arrangements apply.

For the assessment of a combination of table-top and floor standing EUT, two RGPs are required. The horizontal plane is always the RGP for the floor standing equipment while the RGP for the table-top equipment during conducted emission measurements may be either horizontal or vertical. The inter-unit cables between a table-top unit and a floor standing unit which are long enough to drape on the horizontal RGP shall be non-inductively bundled (or if too short or stiff for bundling, arranged but not-coiled) and placed on the table or supported at 0,4 m or at the height of the lowest cable entry point if this is below 0,4 m.

Examples of general arrangements are given in Figure D.7 and Figure D.10.

D.2 MME-related conditions for conducted emission measurement

D.2.1 General

During measurements of conducted emissions, any required dedicated ground connection of the EUT shall be made to the reference point of the AMN. Where not otherwise provided or specified by the manufacturer, this ground connection shall be of the same length as the mains port cable and run parallel to the mains port cable at a separation distance of not more than 0,1 m.

"Coaxial" broadcast receiver tuner ports shall be connected to an AAN (or a CDN as defined in IEC 61000-4-6) that provides a 150 Ω common mode termination to ground and is bonded to the RGP.

In addition to the general principles given above the following requirements apply.

The mains cable of the unit being assessed shall be connected to one AMN. All other units of the EUT and AE shall be connected to a second (or multiple) AMN(s). It is acceptable to connect these other equipments to an AMN via extension cables that include one or multiple socket outlets. Where additional socket outlets are needed, the extension shall be as short as practical. All AMNs shall be bonded to a RGP.

For AMNs mounted below the RGP an extension cable may be used. The AMN specification shall be met at the connection point for the EUT (the end of the extension cable or power strip) with at least 0,8 m spacing between the EUT and the connection point on the extension cable.

Where the EUT is a collection of equipment with multiple units, each having its own power cable, the point of connection for the AMN is determined by the following rules:

- for an EUT that has several modules, each with its own power cable (however terminated) and for which the manufacturer provides a power strip (multi-socket mains splitter) with a single power cable for connection to the external power source, a single measurement shall be performed at the mains input to that power cable;
- power cables or terminals which are not specified by the manufacturer to be connected via a host unit shall be measured separately;
- power cables or field wiring terminals (mains input terminals) which are specified by the manufacturer to be connected via a host unit or other power-supplying equipment shall be connected as described by the manufacturer;
- where a special connection is specified, the necessary hardware to effect the connection shall be supplied by the manufacturer for the purpose of this measurement.

In all other cases the conducted emissions on each individual EUT with its own power cable that is terminated in a power supply plug of a standard design (IEC/TR 60083 for example) shall be measured separately.

Any AAN used during conducted emission measurements shall be selected and configured to be representative of the network in which the EUT is intended to operate. All ports of the AAN shall be correctly terminated in accordance with D.1. Where the 1 m requirement cannot be achieved, because of the position of the power input port/wired network port, then the effective length shall be as short as possible. In the case of EUTs including floor standing equipment the cable connecting the analogue/digital data port to the AAN may be positioned perpendicular to the EUT for a distance between of 0,3 m and 0,8 m then drop vertically to the horizontal RGP before being extended to the AMN/AAN. In these cases any bundling may be located on the ground plane

D.2.2 Specific conditions for table-top equipment

The RGP shall have a minimum size of 2 m by 2 m and shall extend a minimum of 0,5 m beyond the EUT, local AE and associated cabling in all directions.

Alternative 1: The measurement shall be performed using a vertical RGP. The rear of the EUT, local AE and associated cabling shall be 0,4 m from the vertical RGP. All ground planes in use shall be bonded together. AMN(s) and AAN(s) in use shall be bonded to either the vertical RGP or other metal planes bonded to it.

The portions of signal cables that hang over the rear of the table shall be positioned at a distance of 0,4 m from the vertical RGP and no less than 0,4 m from any horizontal RGP bonded to the vertical RGP. If necessary, maintain the separations using a fixture made of non-conductive material with an appropriate dielectric constant.

An example of the measurement arrangement is given in Figure D.2.

Alternative 2: The measurement shall be performed with a horizontal RGP. The EUT, local AE and associated cabling shall nominally be spaced 0,4 m above the horizontal RGP.

Example measurement arrangements are given in Figure D.3 and Figure D.5.

D.2.3 Specific requirements for floor standing equipment

If conducted emission measurements are undertaken within a SAC, the EUT, local AE and associated cabling shall be configured as defined in D.2.1. whilst meeting the general principles given in D.1.1. The AE cable routing shall be overhead if the EUT is designed for this configuration. Example measurement arrangements are given in Figure D.6.

D.2.4 Specific requirements for combined table-top and floor standing equipment

The configuration for conducted emission measurements shall be as defined in D.2.1 whilst meeting the general principles given in D.1.1.

The table-top equipment shall be assessed using alternative 1 or alternative 2 in D.2.2. The floor standing equipment shall be assessed on a horizontal RGP. If a vertical RGP is used for the table-top equipment, care shall be taken that the floor standing equipment is at least 0,8 m from the vertical RGP. This may require that the spacing between the table-top equipment and floor standing equipment be set at a small and convenient distance, greater than the 0,1 m spacing stated in Table D.1.

Example measurement arrangements are given in Figure D.7.

D.3 MME-related requirements for radiated measurement

D.3.1 General

Unless some other configuration is typical of normal use, or specified by the manufacturer, mains cables shall drop directly to the RGP before being routed to the mains power outlet. This outlet should not protrude above the RGP. If the outlet has a metal case, it shall be bonded to the RGP. If the mains outlet has a protective earth, it shall be bonded to the RGP. If used, the AMN shall be installed under the RGP.

D.3.2 Requirements for table-top equipment

Excess length of cables shall only be included in the arrangement to represent normal installation and shall be bundled in line with D.1.1. An example measurement arrangement is given in Figure D.8.

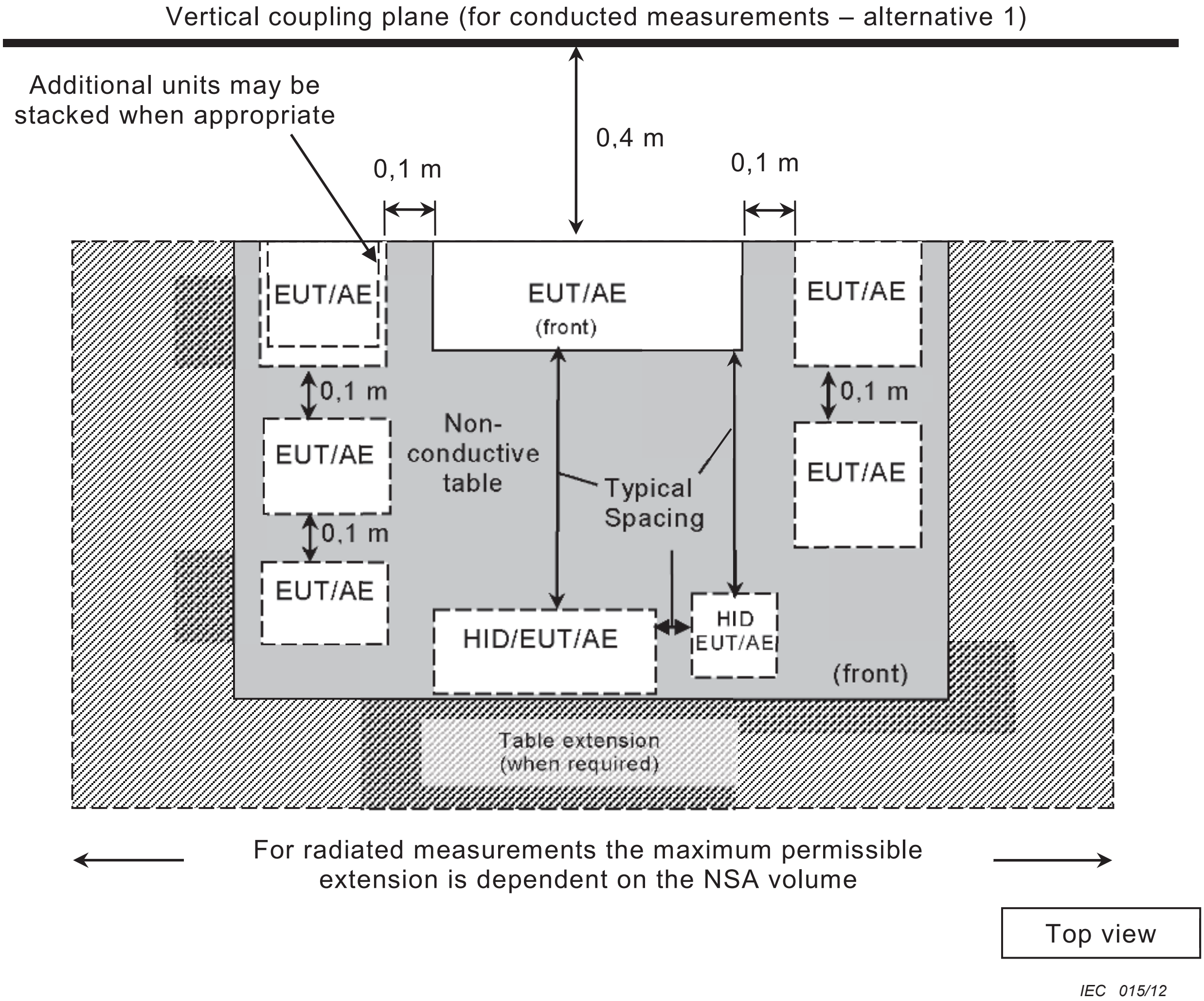
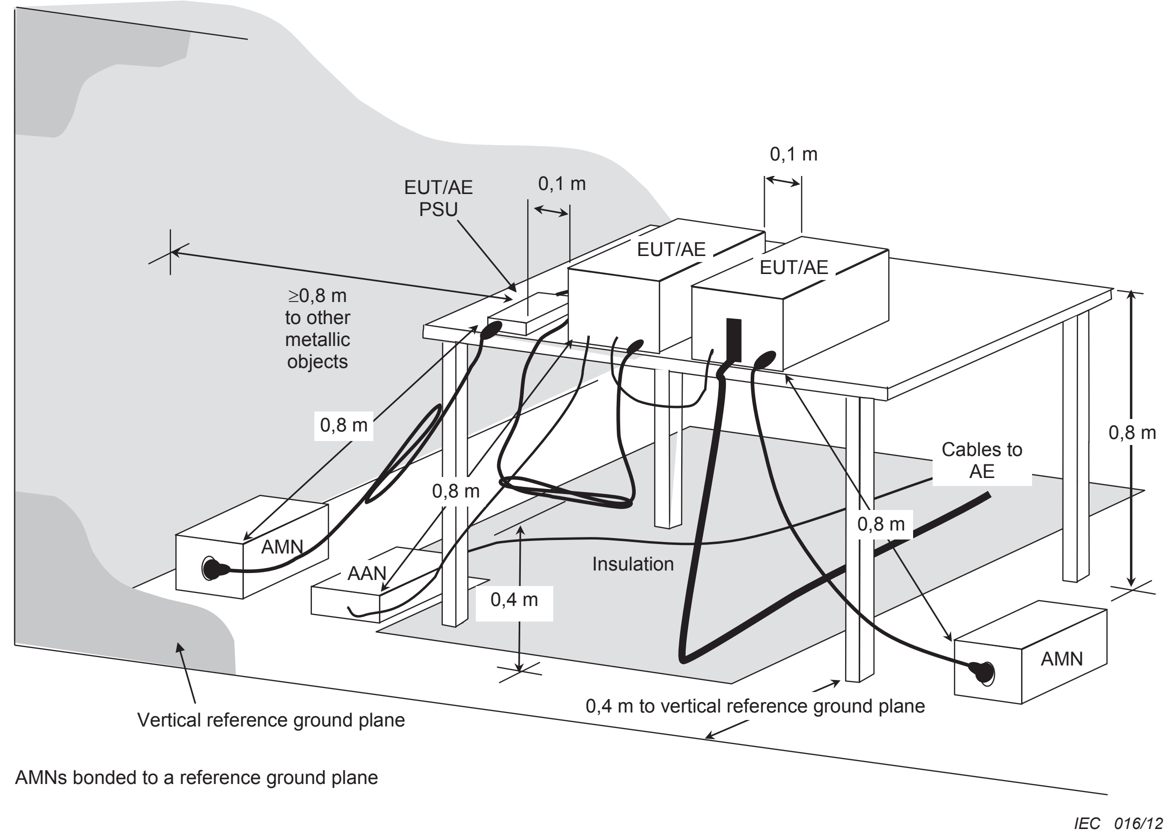
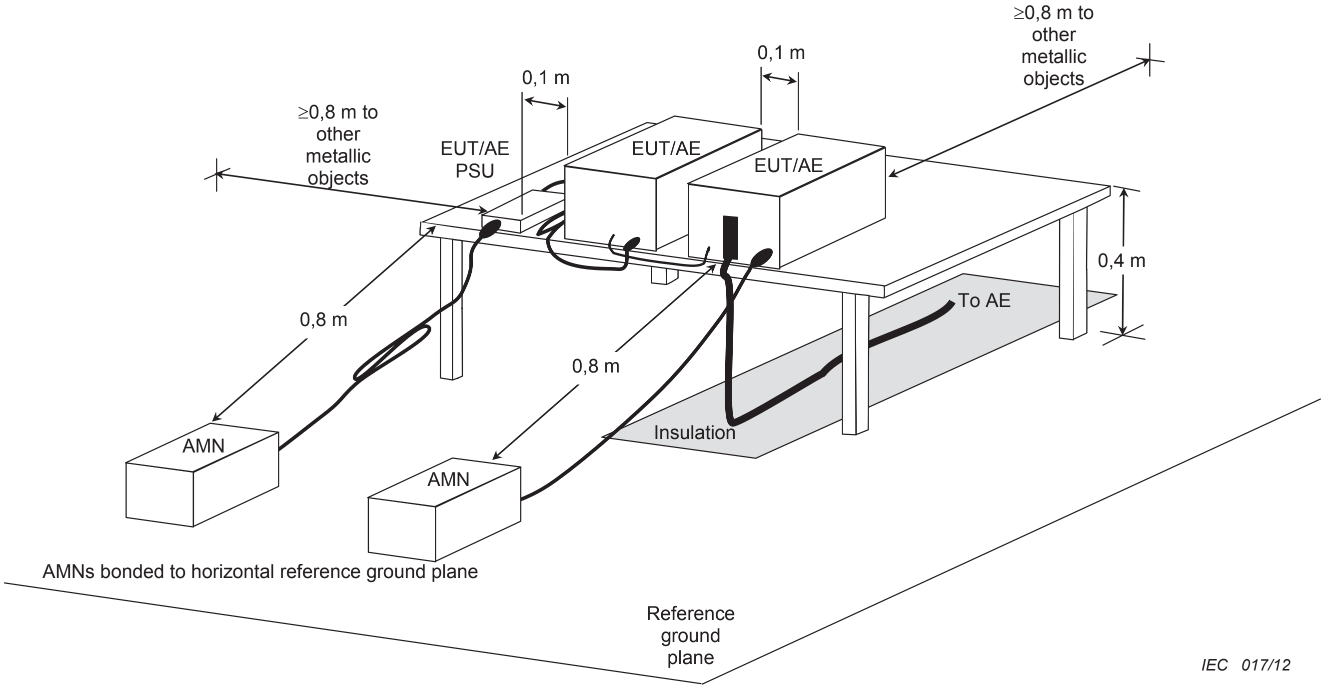


Figure D.1 – Example measurement arrangement for table-top EUT (Conducted and radiated emission) (Top view)



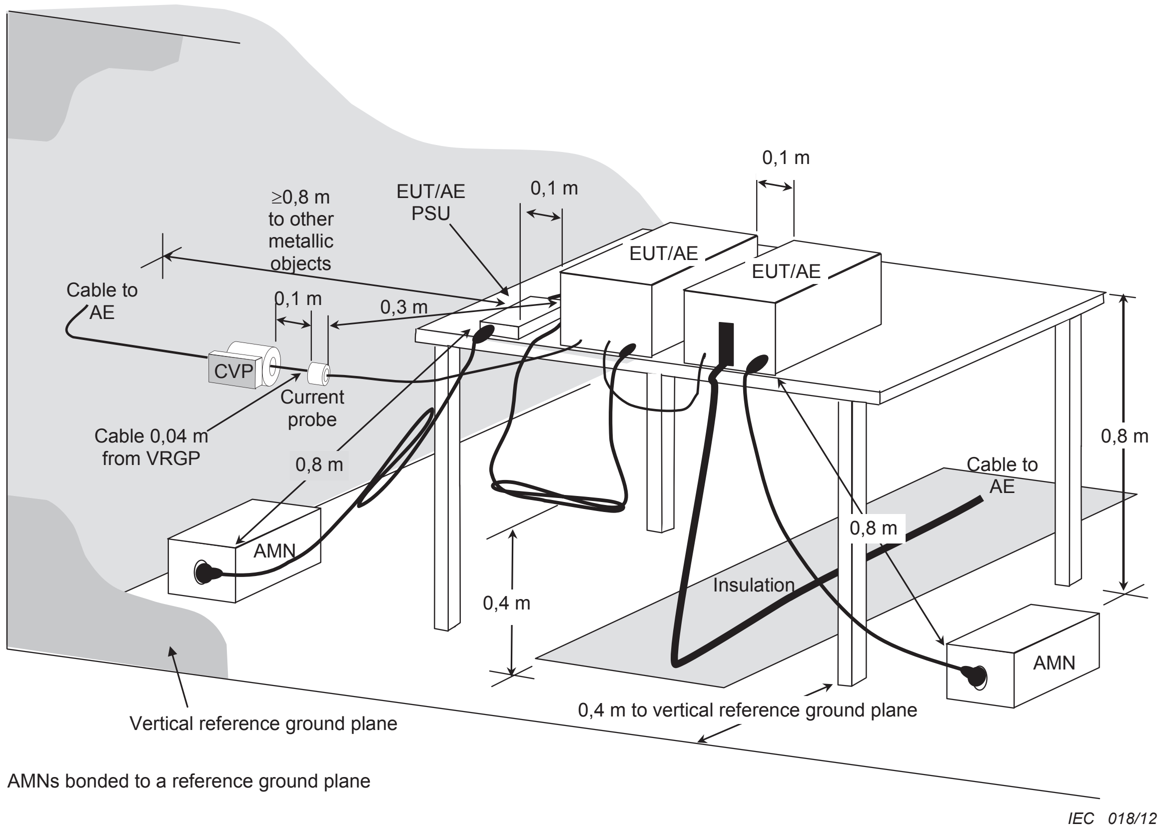
NOTE The 0,8 m distance specified between EUT/AE/PSU and AMN/AAN, is applicable only to the EUT being measured. If the device is AE then it shall be ≥0,8 m.

Figure D.2 – Example measurement arrangement for table-top EUT (Conducted emission measurement – alternative 1)



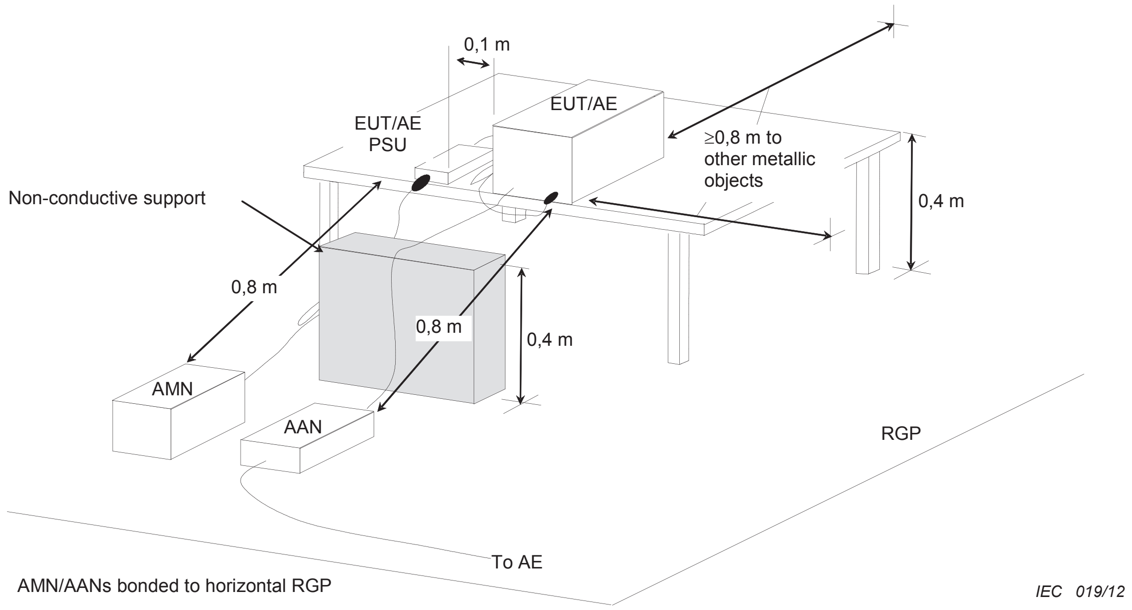
NOTE The 0,8 m distance specified between EUT/local AE/PSU and AMN, is applicable to the EUT. If the device is AE then it shall be ≥0,8 m.

Figure D.3 – Example measurement arrangement for table-top EUT (Conducted emission measurement – alternative 2)



NOTE The 0,8 m distance specified between EUT/local AE/PSU and AMN/AAN, is applicable to the EUT. If the device is AE then it shall be ≥0,8 m.

Figure D.4 – Example measurement arrangement for table-top EUT measuring in accordance with C.4.1.6.4



NOTE The 0,8 m distance specified between EUT/local AE/PSU and AMN/AAN, is applicable to the EUT. If the device is AE then it shall be ≥0,8 m.

Figure D.5 – Example measurement arrangement for table-top EUT (Conducted emission measurement – alternative 2, showing AAN position)

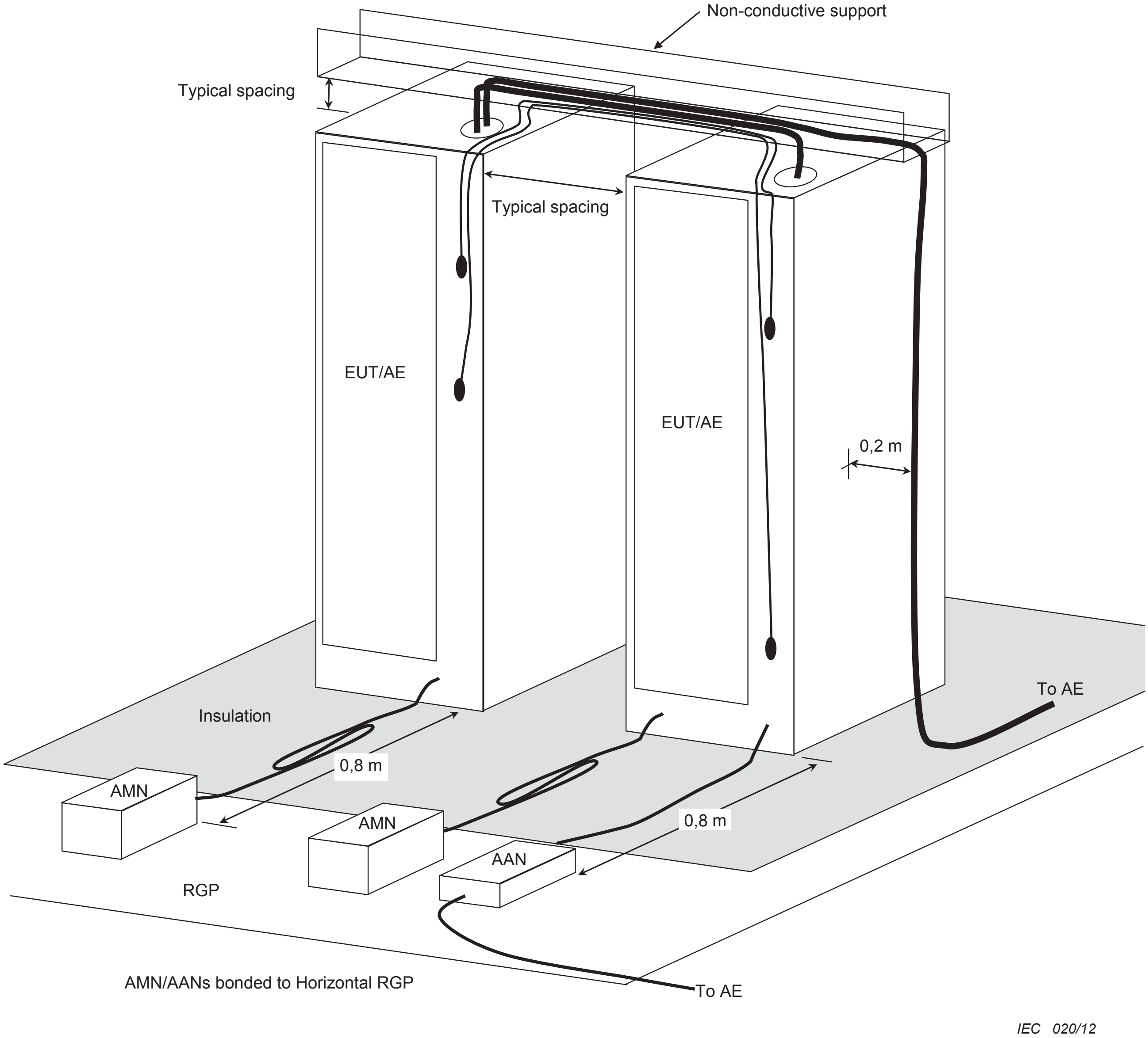
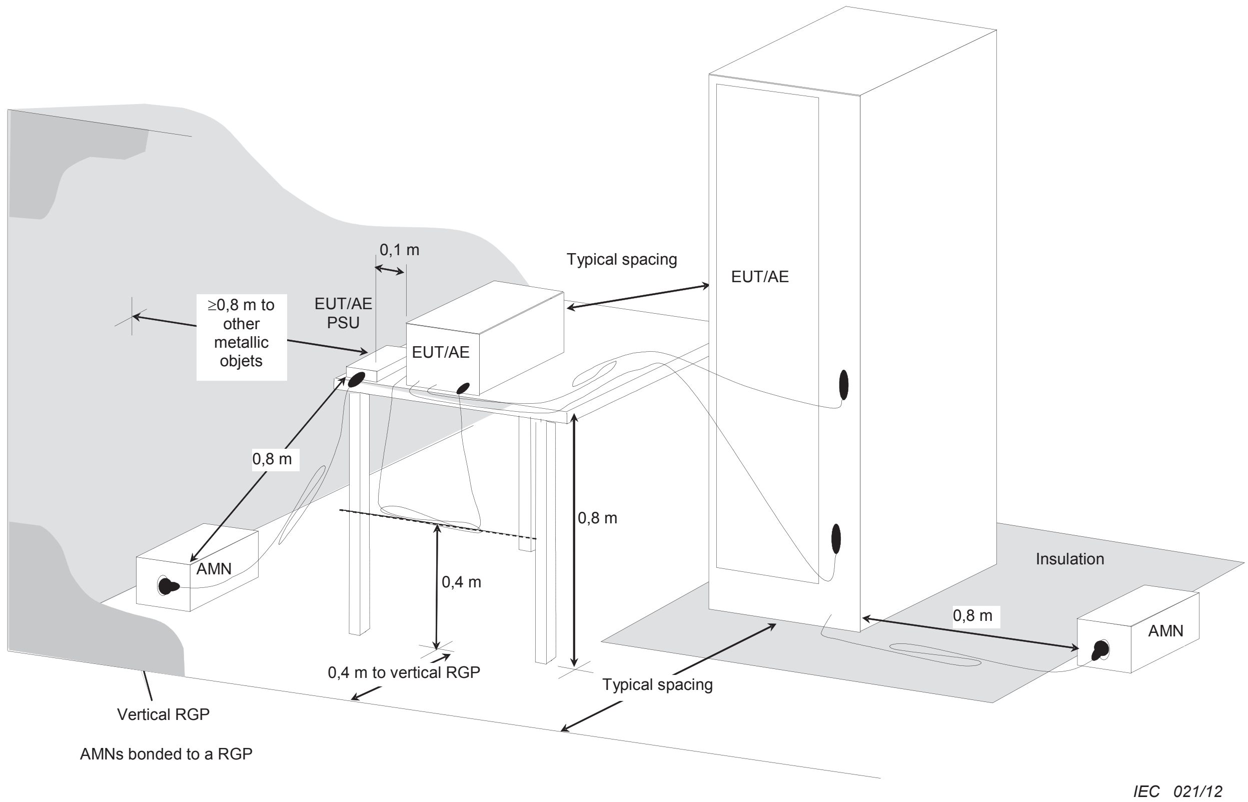


Figure D.6 – Example measurement arrangement for floor standing EUT (Conducted emission measurement)



NOTE The 0,8 m distance specified between EUT/local AE/PSU and AMN, is applicable to the EUT. If the device is AE then it shall be ≥0,8 m.

Figure D.7 – Example measurement arrangement for combinations of EUT (Conducted emission measurement)

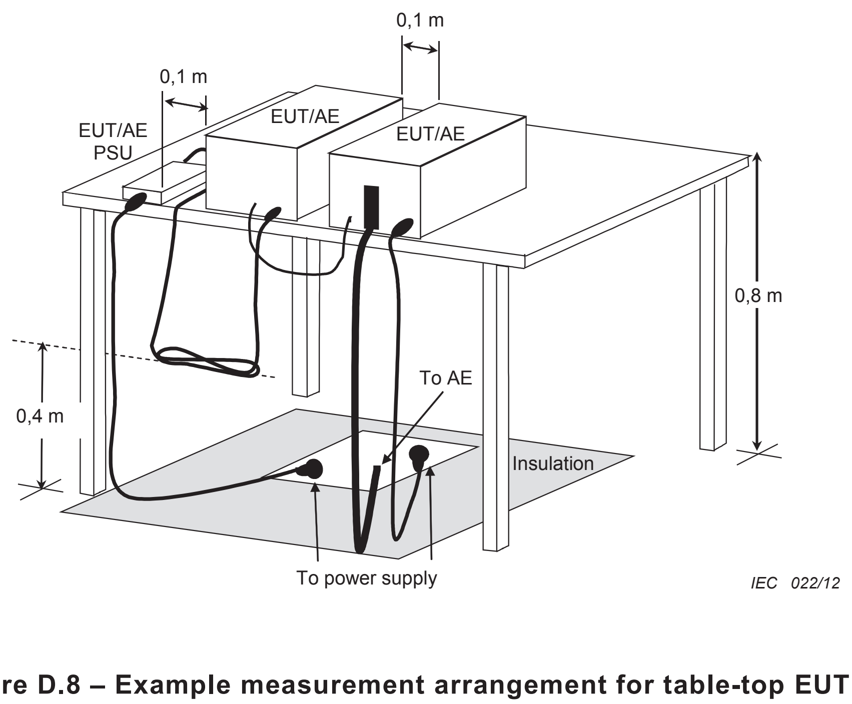


Figure D.8 – Example measurement arrangement for table-top EUT (Radiated emission measurement)

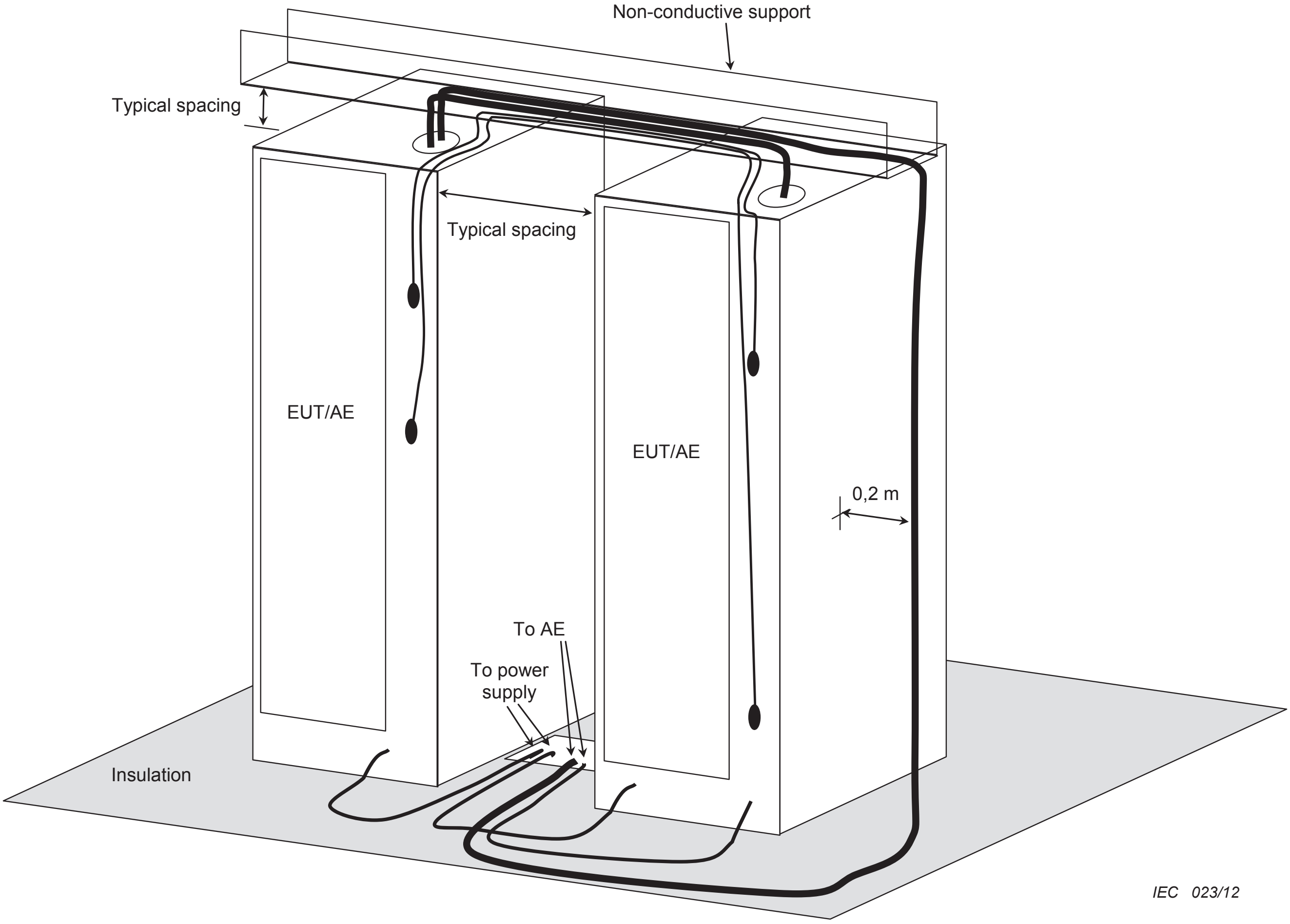


Figure D.9 – Example measurement arrangement for floor standing EUT (Radiated emission measurement)

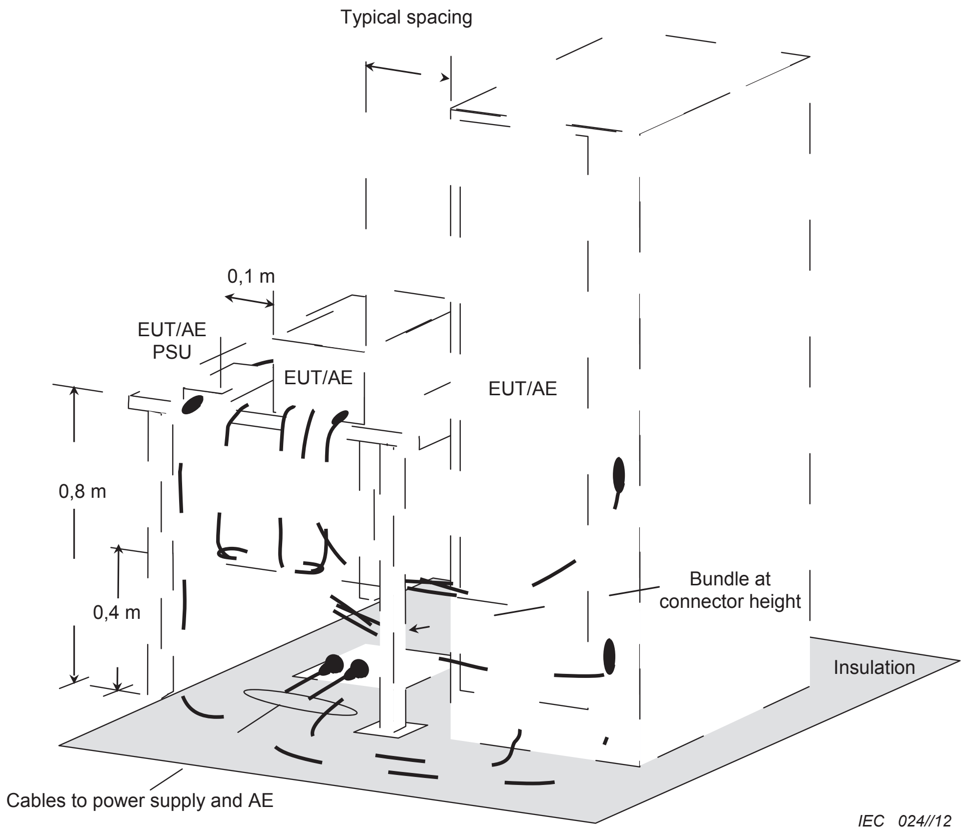


Figure D.10 – Example measurement arrangement for combinations of EUT (Radiated emission measurement)

Annex E
(informative)

Prescan measurements

The purposes of a prescan measurement are to determine the frequencies at which an EUT produces the highest level of emissions and to help select the configuration(s) to be used in the formal measurements.

Prescanning should be performed on various EUT configurations to find the configuration(s) that produce(s) the highest amplitudes with respect to the limit. This configuration should then be used during formal measurements.

The number of configurations to be considered is dependent upon the complexity of the EUT. Therefore, a quick and simple procedure should be established for comparative purposes so that the impact of varying the configuration can be found. Changes in configurations which may be considered include:

- mode of operation, as defined in 3.1.22;
- supply voltage discussed in A.1;
- arrangement discussed in Annex D;
- number and arrangement of modules within a system. See Figure 2;
- number of cables attached applying the criteria in D.1.1;
- position of cables, local AE and HID as required in Annex D.

The prescan method attempts to closely emulate the formal procedure so that effective comparisons can be achieved. For example, a limited height SAC would be an appropriate prescan facility followed by an OATS/SAC for formal measurements. An effective prescan will give confidence that the configuration which produces the highest amplitude emission with respect to the limit has been found.

Prescan measurements may be performed with spectrum analysers without pre-selection provided that precautions are used to ensure that the instrument is not overloaded.

A simple procedure to check for overload is to repeat a measurement with an attenuator (for example, 6 dB) added at a convenient point in the measurement path so that the signal present at any active or nonlinear stage of the measurement path (amplifiers, limiters, receivers, and so forth) is reduced by a known amount. If the measured signal level does not decrease by approximately the value of the attenuator used (within 0,5 dB), then the measurement system may be overloaded and steps should be taken to correct the problem. Further details are given in Annex B of CISPR 16-2-1:2008+A1:2010.

Annex F
(informative)

Test report contents summary

Guidance for compiling a test report can be found in ISO/IEC 17025. References to ISO/IEC 17025:2005 and requirements defined in relevant clauses of that standard are given in Table F.1. See Clause 9 for general reporting requirements. Additional information may also be added to the test report as necessary.

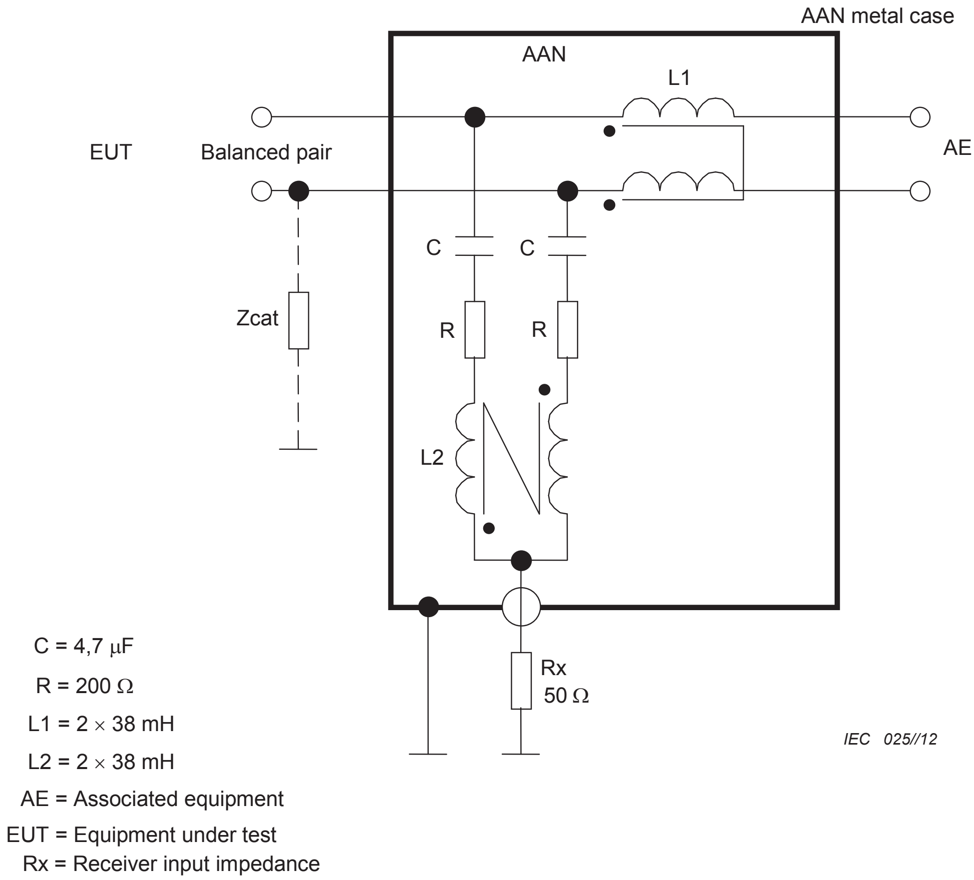
Table F.1 – Summary of information to include in a test report

Item	CIRSP32 Clause or subclause	ISO/IEC 17025:2005 clause or subclause	Details to be included
Measurement arrangement	Annex D	5.10.1	Description of the final configuration.
Host and modules	6.2	5.10.1	Description of the host and modules.
Applicability	8	5.10.3.1 a) and e)	Decision and justification not to measure.
Special measures	7	5.10.1	Description of special measures needed to ensure compliance.
Highest internal frequency	8	5.10.1	Value of F_X. See 3.1.19
General guidance	9	5.10 all (5.10.2 especially)	At least: 1. Class of limit (Class A or Class B) that is appropriate for the EUT. 2. Mode of operation of the EUT. 3. How the ports were exercised.
General content	9	5.10.1, 5.10.2	Photographs of the measurement configuration and arrangement for the formal measurements
Emissions data and calculations	9, Annex A, C.2.2.4	5.10.1	Tabular data should be presented covering the requirements of C.2.2.4.
Emission details	9	5.10.1	Pertinent information for each emission.
AAN category	9	5.10.1	Category of AAN used during wired network port measurement.
Calculated Measurement uncertainty	9	5.10.3.1.c), 5.10.4.1 b), 5.10.4.2	Calculated measurement uncertainty for each measurement performed.
Compliance statement	9, 10	5.10.2 1), 5.10.3.1 b)	Class of limit whose requirements the EUT satisfies.
Measurement distance used	Annex A, C.2.2.4	5.10.1	Measurement distance used during testing and, where relevant, how the limit was calculated.
Exercising of ports	Annex A, Annex B	5.10.1	Description of the procedures used to exercise the ports. Justification of any non-standard procedures used. Specifically for Ethernet: the data rate used.
Ambients	C.2.2.3	5.10.3.1 a)	Procedure used to reduce the impact of ambients.
Position of cables	Annex D	5.10.1	The disposition of the excess cable shall be noted. Also record cable lengths if those defined cannot be achieved.
Table-top EUT arrangement	Annex D	5.10.1	Measurement arrangement alternative used for the conducted emission measurement.

Annex G
(informative)

Support information for the measurement procedures defined in C.4.1.1

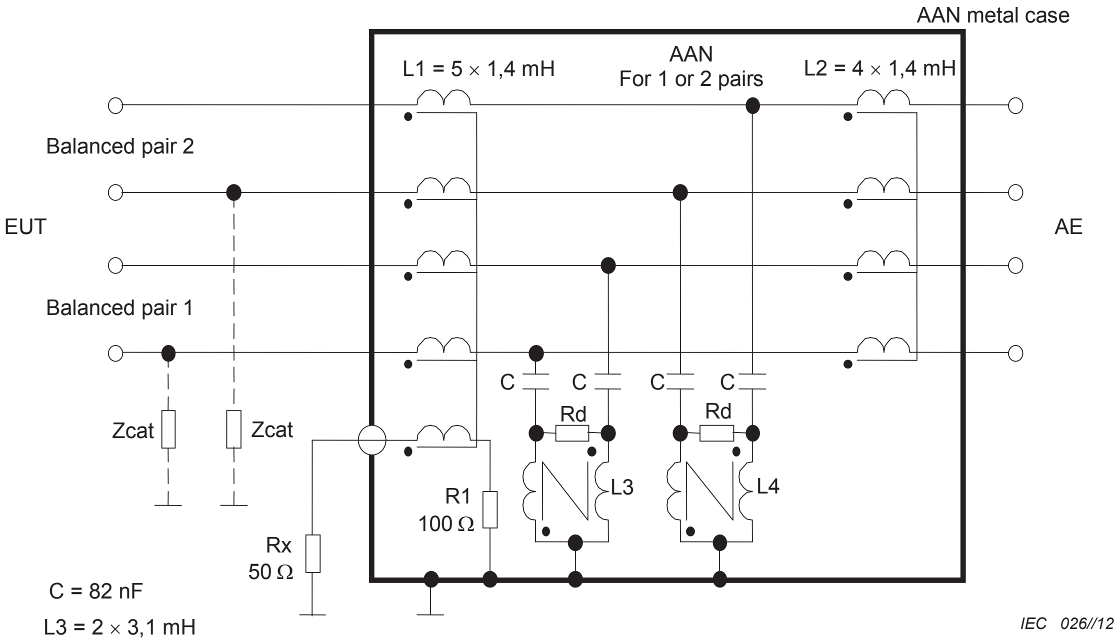
G.1 Schematic diagrams of examples of asymmetric artificial networks



NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

Figure G.1 – Example AAN for use with unscreened single balanced pairs



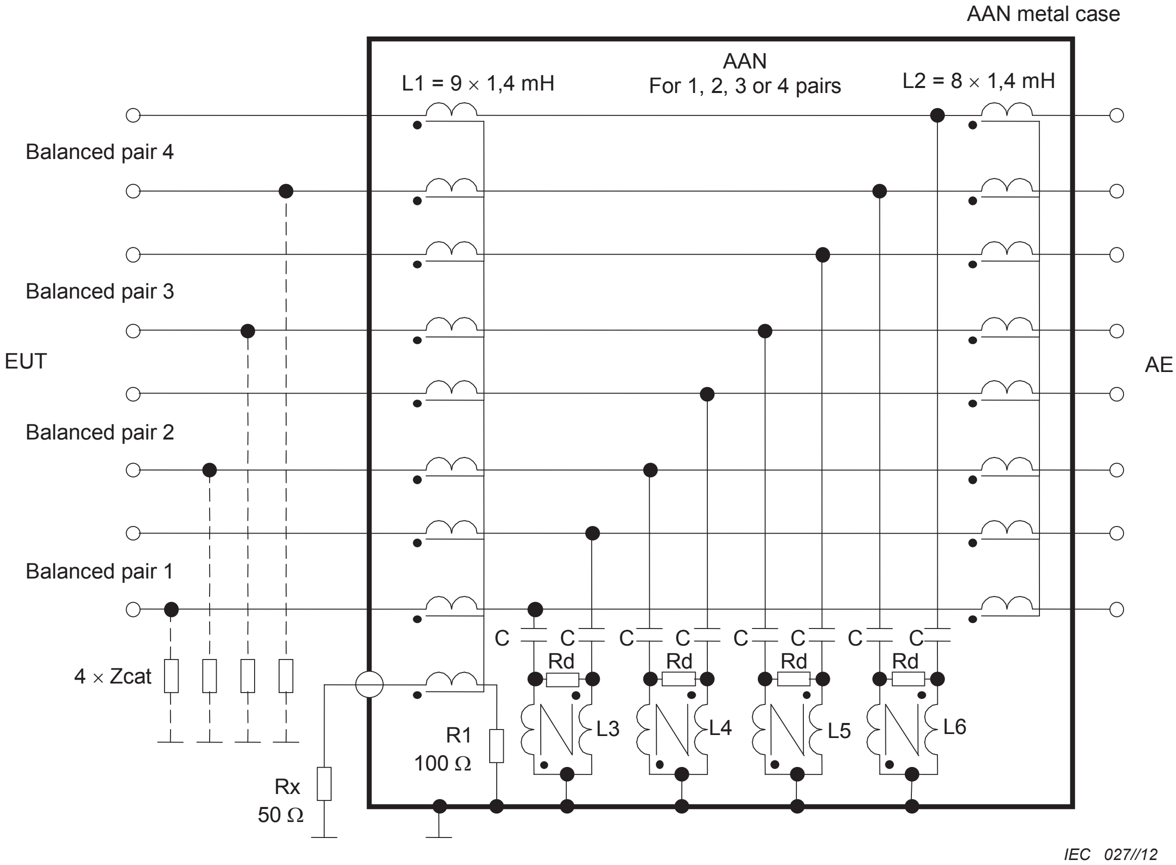
C = 82 nF
L3 = 2 × 3,1 mH
L4 = 2 × 3,1 mH
Rd = 390 Ω
AE = Associated equipment
EUT = Equipment under test
Rx = Receiver input impedance
L3 and L4 provide a transverse inductance across each pair = 4 × 3,1 mH = 12,4 mH

NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 This AAN can be used to measure common mode emissions equally well on a single unscreened balanced pair or on two unscreened balanced pairs.

Figure G.2 – Example AAN with high LCL for use with either one or two unscreened balanced pairs



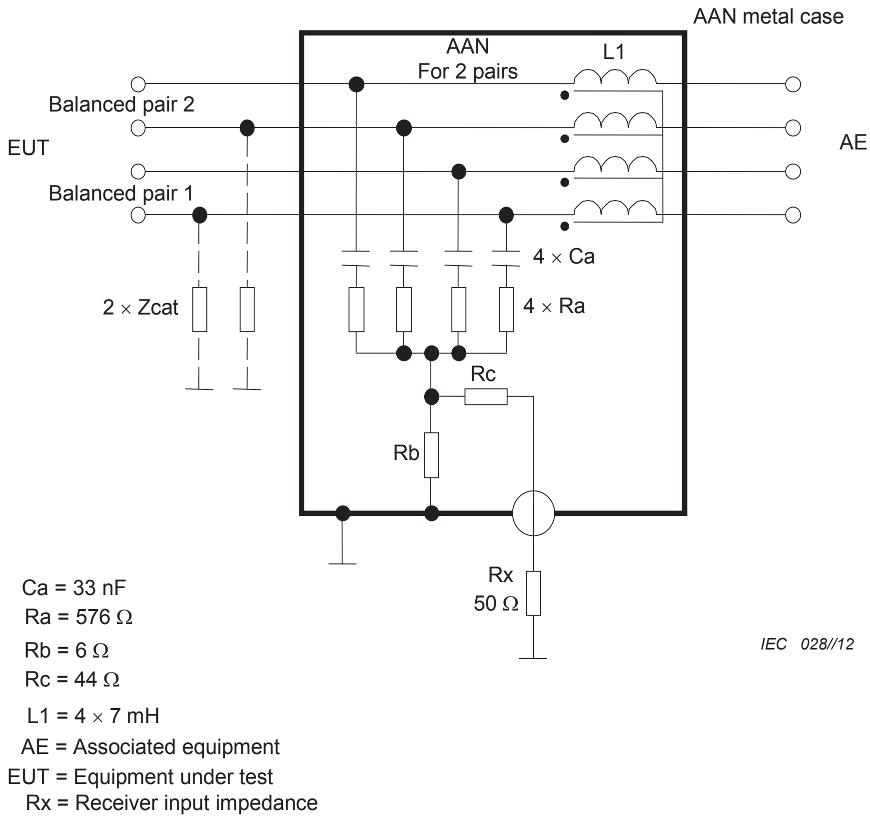
C = 82 nF
Rd = 390 Ω
AE = Associated equipment
EUT = Equipment under test
Rx = Receiver input impedance
L3, L4, L5 and L6 = 2 × 3,1 mH
L3, L4, L5, and L6, provide a transverse inductance across each pair = 4 × 3,1 mH = 12,4 mH

NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 This AAN can be used to measure common mode emissions equally well on a single unscreened balanced pair, or on two, three or four unscreened balanced pairs.

Figure G.3 – Example AAN with high LCL for use with one, two, three, or four unscreened balanced pairs

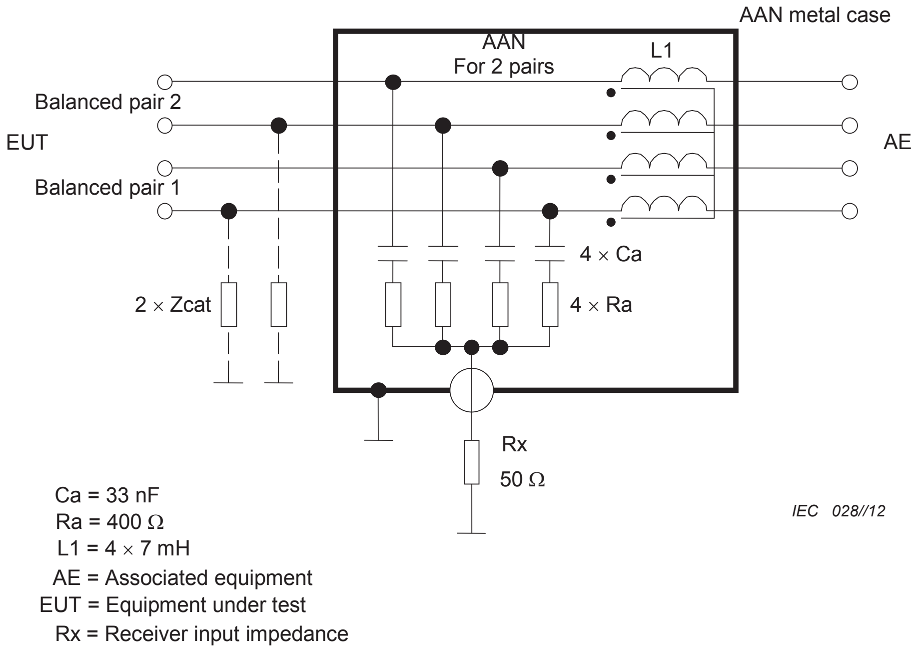


NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 34 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 Care should be taken when using this AAN for cables which may have an unused pair, see C.4.1.3

Figure G.4 – Example AAN, including a 50 Ω source matching network at the voltage measuring port, for use with two unscreened balanced pairs

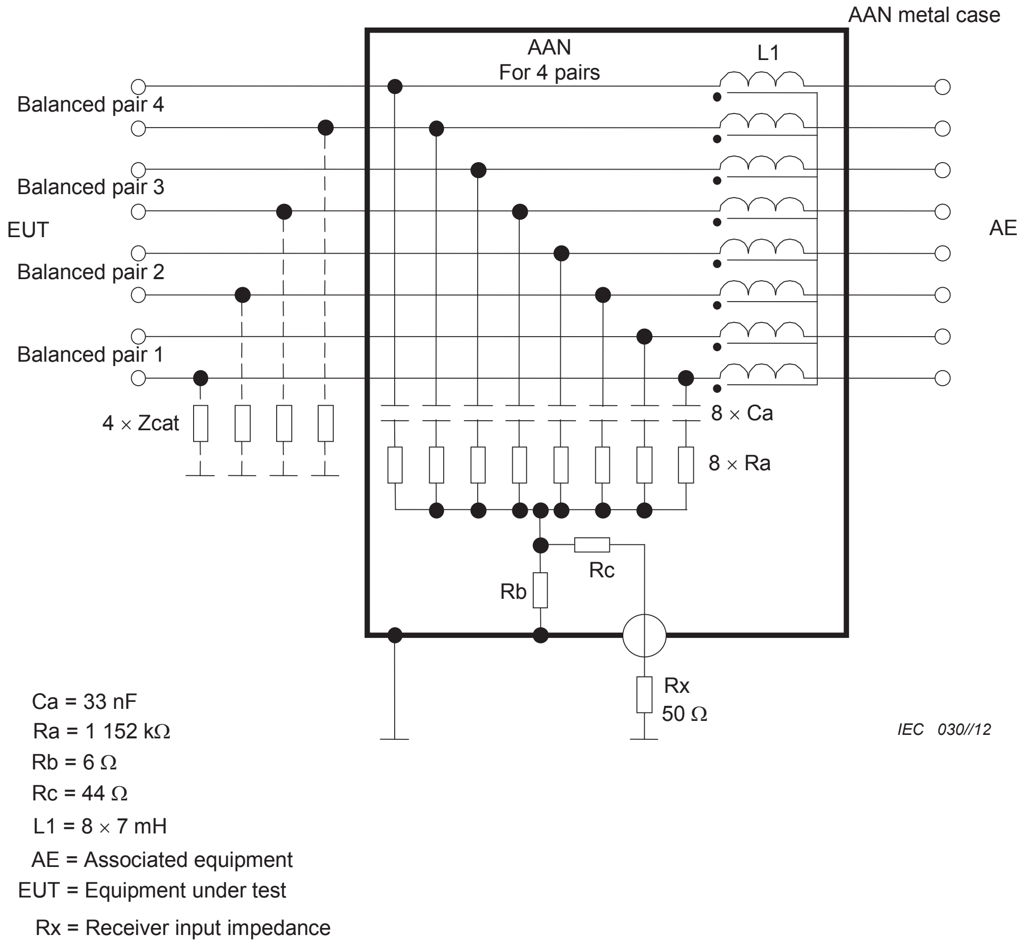


NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 Care should be taken when using this AAN for cables which may have one or more unused pairs, see C.4.1.3.

Figure G.5 – Example AAN for use with two unscreened balanced pairs

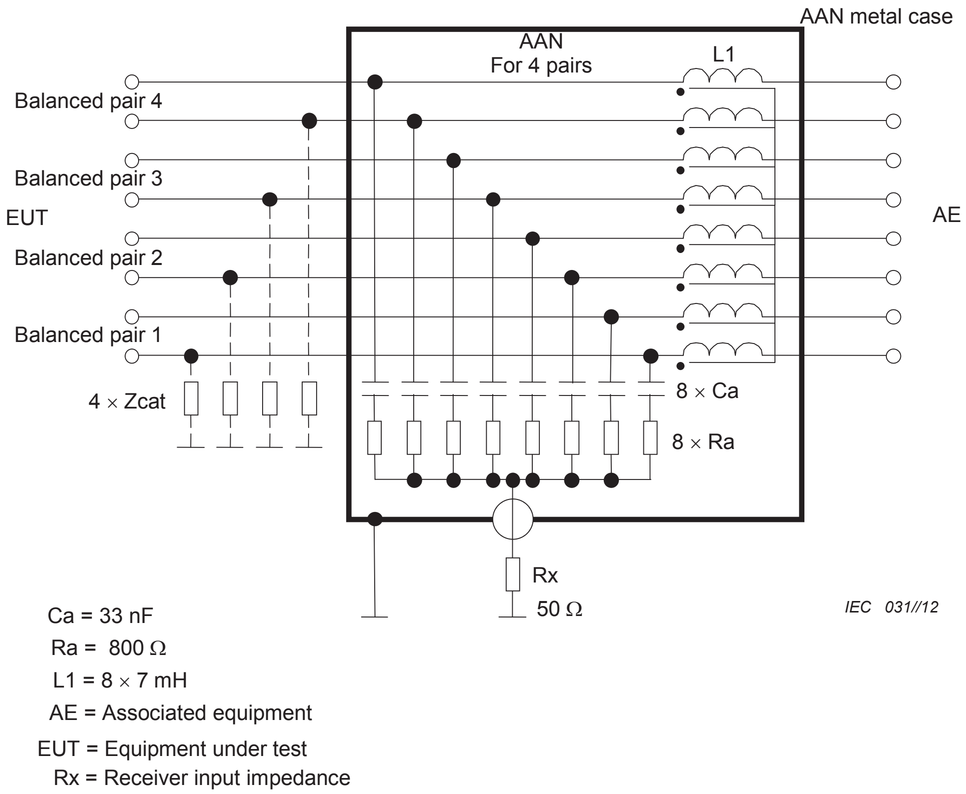


NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 34 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 Care should be taken when using this AAN for cables which may have unused pairs, see C.4.1.3.

Figure G.6 – Example AAN, including a 50 Ω source matching network at the voltage measuring port, for use with four unscreened balanced pairs

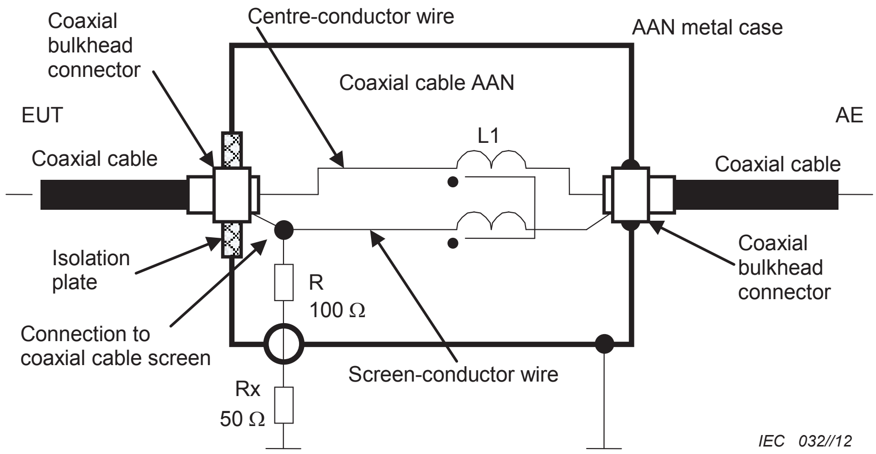


NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 Zcat provides the unbalance required to adjust the LCL of the AAN to the values specified in Table C.2.

NOTE 3 Care should be taken when using this AAN for cables which may have unused pairs, see C.4.1.3.

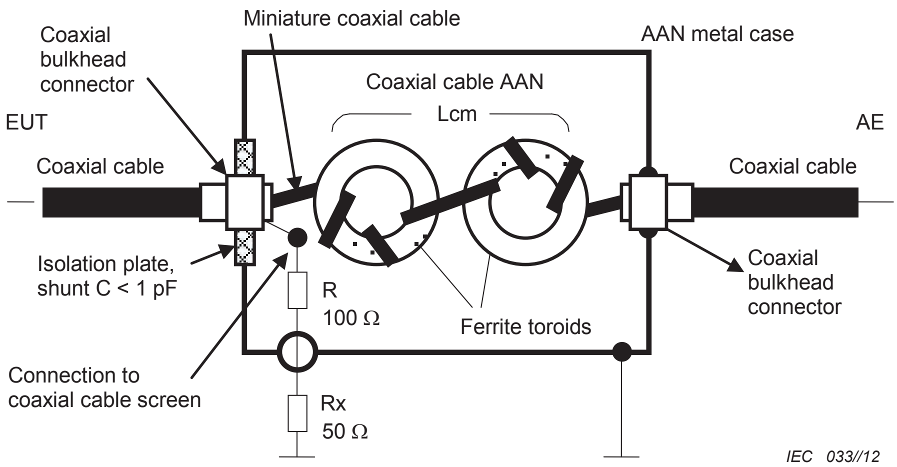
Figure G.7 – Example AAN for use with four unscreened balanced pairs



AE = Associated equipment
EUT = Equipment under test
Rx = Receiver input impedance
Common mode choke L1 = 2 × 7 mH

NOTE Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

Figure G.8 – Example AAN for use with coaxial cables, employing an internal common mode choke created by bifilar winding an insulated centre-conductor wire and an insulated screen-conductor wire on a common magnetic core (for example, a ferrite toroid)



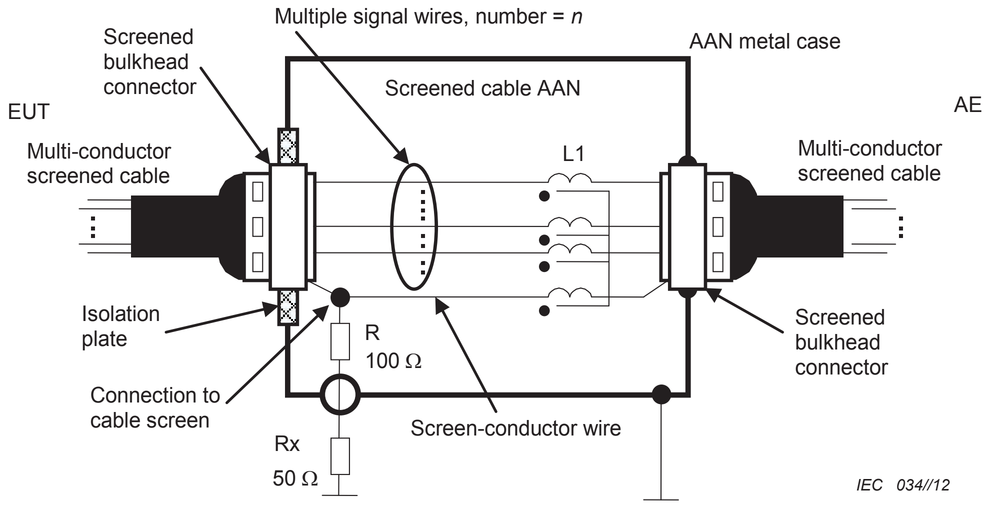
AE = Associated equipment
EUT = Equipment under test
Rx = receiver input impedance

Common mode choke Lcm > 9 mH, total parasitic shunt C < 1 pF

NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 More toroids may be needed to fully meet the requirements for AANs.

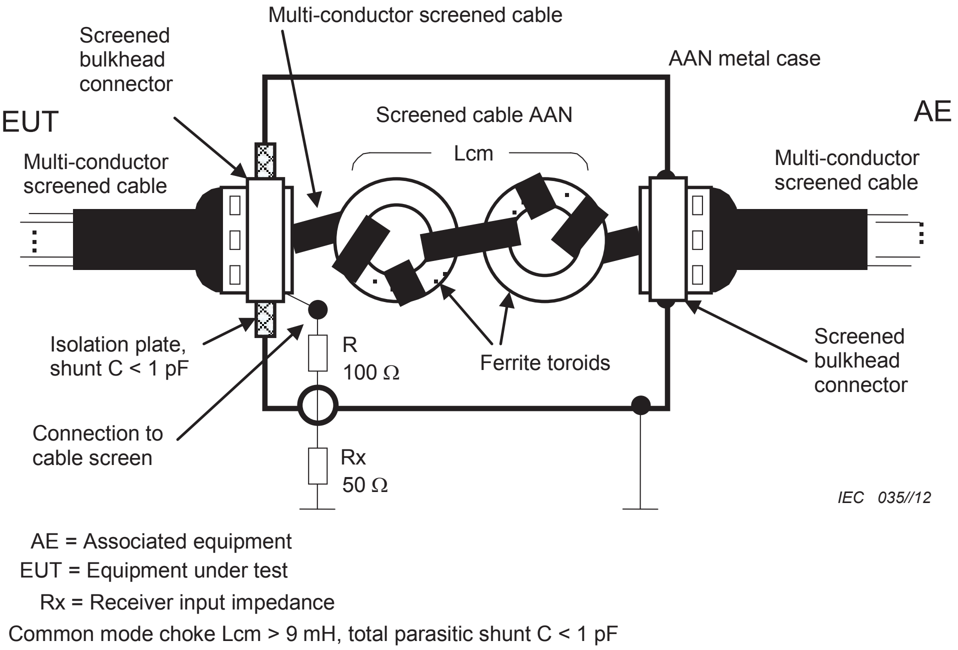
Figure G.9 – Example AAN for use with coaxial cables, employing an internal common mode choke created by miniature coaxial cable (miniature semi-rigid solid copper screen or miniature double-braided screen coaxial cable) wound on ferrite toroids



AE = Associated equipment
EUT = Equipment under test
Rx = Receiver input impedance
Common mode choke L1 = (n + 1) × 7 mH, where n = number of signal wires

NOTE Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

Figure G.10 – Example AAN for use with multi-conductor screened cables, employing an internal common mode choke created by bifilar winding multiple insulated signal wires and an insulated screen-conductor wire on a common magnetic core (for example, a ferrite toroid)



NOTE 1 Nominal voltage division factor defined in C.4.1.2 e) = 9,5 dB.

NOTE 2 More toroids may be needed to fully meet the requirements for AANs.

Figure G.11 – Example AAN for use with multi-conductor screened cables, employing an internal common mode choke created by winding a multi-conductor screened cable on ferrite toroids

G.2 Rationale for emission measurements and procedures for wired network ports

G.2.1 Limits

The emission voltage (or current) limit is defined for an asymmetric common mode load impedance of 150 Ω (as seen by the EUT at the AE port during the measurement). This standardisation is necessary in order to obtain reproducible measurement results, independent of the undefined asymmetric common mode impedance at the AE and the EUT.

In general, the asymmetric common mode impedance seen by the EUT at the AE port is not defined unless an AAN is used. If the AE is located outside the shielded room, the asymmetric common mode impedance seen by the EUT at the AE port can be determined by the asymmetric common mode impedance of the feed through-filter between the measurement set-up and the outside world. A π-type filter has a low common mode impedance whilst a T-type filter has a high asymmetric common mode impedance.

AANs do not exist for all types of cables used by MME. It is therefore also necessary to define other (non-invasive) measurement procedures that do not use AANs.

Normally, there are several other cables (or ports) present at the EUT. At least the connection to the mains port is present in most cases. The asymmetric common mode impedance of these other connections (including a possible ground connection) and the presence or absence of these connections during the measurement can influence the measurement result significantly, particularly for small EUTs. Therefore the asymmetric common mode impedance of the non-measured connections has to be defined during the assessment of small EUTs. It is sufficient to have, in addition to the port being assessed, at least two additional ports connected to a 150 Ω common mode impedance (normally by using an AAN with the RF measurement port terminated with 50 Ω) in order to reduce this influence to a negligible amount.

Coupling devices for non-shielded balanced pairs should also simulate the typical LCL value of the lowest cabling category (worst LCL) specified for the wired network port being measured. The idea of this requirement is to take into account the transformation of the symmetrical signal into a asymmetric common mode signal, which might contribute to possible radiated disturbance when the EUT is used in the real application. Asymmetry in the AAN is deliberately introduced to yield the specified LCL value. This asymmetry may enhance or cancel the asymmetry of the EUT. In the interest of determining the worst case emissions and optimization of measurement repeatability, consideration should therefore be given to repeating the measurement with the LCL imbalance on each wire of a balanced pair when using the appropriate AAN as defined in C.4.1.2.

Since imbalance on each balanced pair will contribute to the total conducted common mode emission, all combinations of imbalance on all balanced pairs should be considered. For a single balanced pair, this has a relatively minor measurement impact – the two wires are reversed. However, for two balanced pairs, the number of LCL loading combinations (and therefore measurement configurations) is four. For four balanced pairs, the number of loading combinations grows to sixteen. Such numbers have a significant impact on measurement time and measurement documentation. Such measurements are not usually implemented, but if carried out the connection to AAN should be carefully documented.

The RF measurement port of an AAN not connected to the measuring receiver should be terminated with 50 Ω.

Table G.1 – Summary of advantages and disadvantages of the procedures described in C.4.1.6

Procedure	C.4.1.6.2	C.4.1.6.3	C.4.1.6.4
Advantages	Only possible if AANs with appropriate transmission properties are available For unscreened cables containing balanced pairs, the LCL values of the AAN are within the tolerance in Table C.2 of an AAN appropriate to the cable category connected to the EUT.	Non-invasive (except removing the insulation of the shielded cable) Always applicable to shielded cables Small measurement uncertainty for higher frequencies	Non-invasive Always applicable No underestimation (represents the worst case estimation)
Disadvantages	Only possible if appropriate AANs are available Invasive (needs appropriate cable connections) Needs an individual AAN for each cable type (results in a high number of different AANs) No isolation is generally provided by an AAN to symmetric signals from the AE	Increased measurement uncertainty for very low frequencies (<1 MHz) Alteration of the cable insulation is necessary Reduced isolation against emissions from the AE side (compared to the procedure in C.4.1.6.2)	Overestimation is possible if common mode impedance at the AE is not close to 150 Ω Increased uncertainty for some extreme conditions of frequency and impedance No isolation against emissions from the AE side (compared to the procedure in C.4.1.6.3) Does not assess the interference potential that arises due to conversion of the symmetric signal due to the LCL of the cable network to which the EUT will be connected

G.2.2 Combination of current probe and CVP

The procedure described in C.4.1.6.4 has the advantage of being applicable in a non-invasive way to all types of cables. However, unless the asymmetric common mode impedance seen by the EUT at the AE connection is 150 Ω, the procedure in C.4.1.6.4 will show a result which is in general too high, but never too low (worst case estimation of the emission).

G.2.3 Basic ideas of the CVP

The method described in C.4.1.6.4 uses a CVP to measure the asymmetric common mode voltage. There are two approaches to the construction of a CVP. For either approach, if a 150 Ω common mode impedance is present, the capacitance of the CVP to the cable attached to the EUT port being assessed will appear as a load in parallel with the 150 Ω common mode impedance.

The common mode impedance tolerance is ±20 Ω over the frequency range of 0,15 MHz to 30 MHz. If the CVP loading is to reduce the 150 Ω common mode impedance down to no less than 130 Ω, the capacitive loading of the CVP to the cable attached to the EUT port being assessed should be <5 pF at 30 MHz (the worst case frequency). At 30 MHz, the impedance of 5 pF is approximately 1 062 Ω, which, in parallel with 150 Ω results in a combined common mode impedance of approximately 148,5 Ω.

A first possible CVP construction approach is for the probe to be a single capacitor that relies on physical distance from the cable attached to the EUT port being measured to achieve the <5 pF loading. This style of CVP is described in 5.2.2 of CISPR 16-1-2:2003+A1:2004+A2:2006.

A second possible construction uses two coupling devices in series. A first capacitive coupling device in close proximity to the cable attached to the EUT port being assessed (the device is actually in physical contact with the insulation of the cable attached to the EUT port being assessed). The second device is a standard oscilloscope-type voltage probe having an impedance >10 MΩ with a probe capacitance <5 pF. The theory is that the probe capacitance in series with the capacitance of the capacitive coupling device presents only the probe capacitance to the cable attached to the EUT port being assessed. In practice, it is possible, given the physical size of the capacitive coupling device, to have a large stray capacitance in parallel with the probe capacitance. If this occurs, the total capacitive loading will be greater than that of the probe itself, and the requirement to have <5 pF loading may be violated. If this technique is employed, the capacitive loading should be verified by measurement and not rely on theory. This capacitance measurement can be made with any capacitance meter that can operate over the 0,15 MHz to 30 MHz frequency range. The capacitance is measured between the cable attached to the EUT port being assessed (all wires in the cable are connected together at the connection point to the meter) and the RGP. The same type of cable used in the conducted emissions measurement should be used for this capacitance measurement.

NOTE This procedure has the lowest uncertainty if the length of cable between the EUT and AE is less than 1,25 m. Significantly longer cables are subject to standing waves that can adversely affect voltage and current measurements. For long cables where both the voltage and current limits cannot be met, changes to the measurement configuration may need to be implemented.

G.2.4 Combination of current and voltage limit

If the common mode impedance is not 150 Ω, the measurement of the voltage or the current alone is not acceptable because of a very high measurement uncertainty due to the undefined and unknown common mode impedances. If however both voltage and current are measured with current and voltage limits applied simultaneously, the result is a worst case estimation of the emission as explained below. The basic circuit for which the limit is defined is shown in Figure G.12.

This circuit is the reference for which current and voltage limits are derived. Any other measurement has to be compared to this basic circuit. Z_1 is an unknown parameter of the EUT. Z_2 is 150 Ω in the reference measurement.

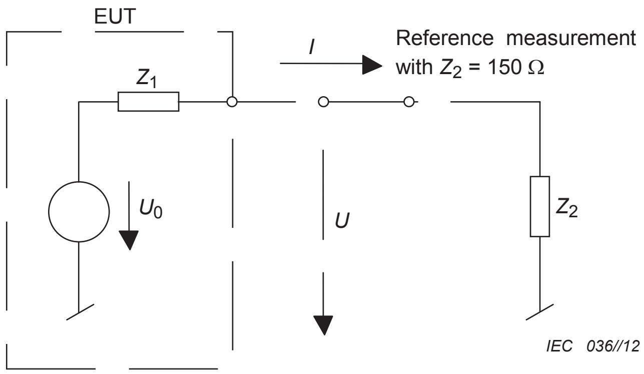


Figure G.12 – Basic circuit for considering the limits with defined common mode impedance of 150 Ω

If the measurement is performed without defining the common mode impedance seen by the EUT, the simplified circuit is as shown in Figure G.12, where the common mode impedance Z_2 seen by the EUT is defined by the AE and can have any value. Therefore Z_1 as well as Z_2 are unknown parameters of the measurement.

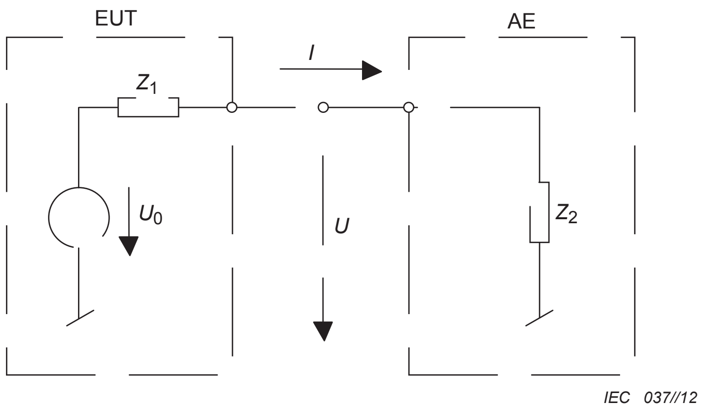


Figure G.13 – Basic circuit for the measurement with unknown common mode impedance

If the measurement is performed according to the circuit of Figure G.12 the limit of current and the limit of voltage are equivalent. The relation between current and voltage are always 150 Ω and either of the two can be used to determine the compliance with the limit. This is not the case if Z_2 is not 150 Ω. See Figure G.13.

It is important to be aware that the quantity determining the compliance with the limit is not the source voltage U_0. The disturbance voltage has to be measured at a standardized Z_2 of 150 Ω and depends on Z_1, Z_2, and U_0 together. The limit value can be reached with an EUT containing a high impedance Z_1 and a high source voltage U_0, or with a lower U_0 combined with a lower impedance Z_1.

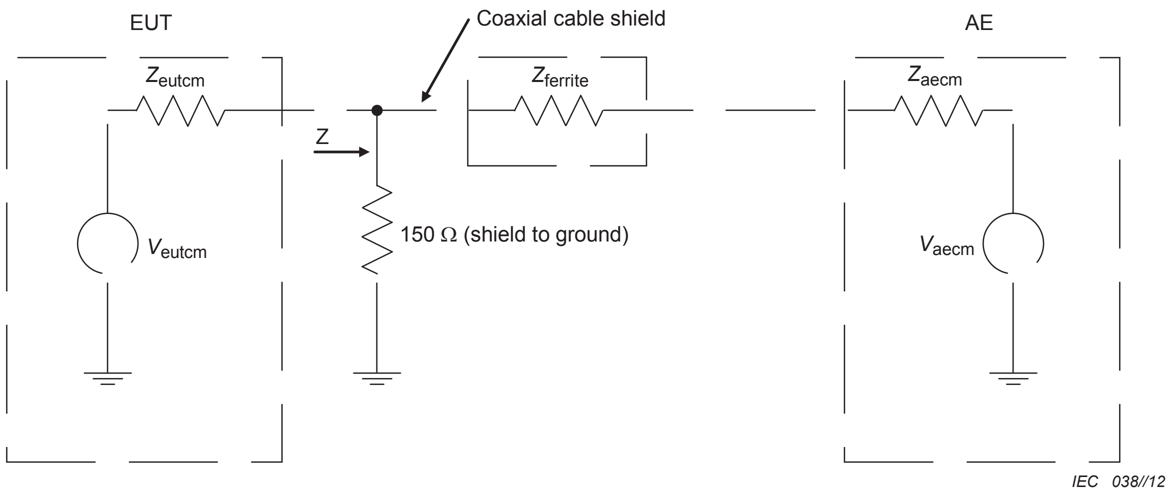
In the more general case of Figure G.13 where Z_2 is not defined, it is not possible to measure the exact value of the interference voltage. Since Z_1 and U_0 are not known, it is not possible to derive the interference voltage, even if the value of Z_2 is known (or is measured or calculated from I and U). If for example an EUT, having excessive emissions, is measured only by determining the voltage in an arrangement with low Z_2 (Z_2 <150 Ω) at the AE side, then the EUT might seem to comply with the limits. By contrast, if the same EUT is measured only by measuring the current in a measurement set-up with high Z_2, (for example by adding ferrites) the EUT might again seem to comply with the limits.

However, it can be shown that, if the current limit and the voltage limit are applied simultaneously, an EUT with emissions exceeding the limits is always discovered by exceeding either the current limit (if Z_2 is <150 Ω) or the voltage limit (if Z_2 is >150 Ω).

If the common mode impedance of the AE (Z_2) is far from 150 Ω, it is possible that an EUT, which would comply with the limits if measured with Z_2 = 150 Ω, may be rejected. However an EUT not complying with the limits will never be accepted. The measurement according to C.4.1.6.4 is therefore a worst case estimation of the emission. If an EUT exceeds the limit with this procedure, it is possible the EUT would comply with the limits if it could be measured with Z_2 = 150 Ω. If emission measurements of the EUT by this procedure were compared to a power limit derived from the voltage and current limits, a more accurate measure of the interference potential into 150 Ω is possible.

G.2.5 Ferrite requirements for use in C.4.1.1

Subclause C.4.1.6.3 defines a measurement set-up for measuring the common mode conducted emissions on the shield of a coaxial cable. A 150 Ω load is specified to be connected between the coaxial shield and the RGP as described in C.4.1.6.3. Ferrites are shown placed over the coaxial shield between the 150 Ω load and the AE. The characteristics of the ferrites necessary to satisfy the requirements of C.4.1.6.3 are given below.



Key

V_{eutcm}	common mode voltage generated by the EUT
Z_{eutcm}	common mode source impedance of the EUT
V_{aecm}	common mode voltage generated by the AE
Z_{aecm}	common mode source impedance of the AE
$Z_{ferrite}$	impedance of the ferrites

NOTE The combined impedance (Z) is 150 Ω, $Z_{ferrite}$, and Z_{aecm}.

Figure G.14 – Impedance layout of the components in the method described in C.4.1.6.3

Figure G.14 shows all of the basic impedances involved in the method described in C.4.1.6.3. The ferrites are specified in C.4.1.6.3 to provide a high impedance such that "…the common mode impedance towards the right of the 150 Ω resistor shall be sufficiently large as to not affect the measurement." This impedance is shown in Figure G.14 as "*Z*".

The above quotation from C.4.1.6.3 infers that the combined series impedance of $Z_{ferrite}$ and Z_{aecm} should not load down the 150 Ω resistor. The general approach in this standard for tolerance on 150 Ω common mode loads is ± 20 Ω over the frequency range of 0,15 MHz to 30 MHz. Combining these two concepts, the combined series impedance of $Z_{ferrite}$ and Z_{aecm} in parallel with the 150 Ω resistor (*Z* in Figure G.14) should be no lower than 130 Ω. This in turn implies that this relationship must hold regardless of the value of Z_{aecm}.

To establish the impedance characteristics of the ferrites, only two cases need to be considered: Z_{aecm} = open circuit and Z_{aecm} = short circuit. If the ferrites can be selected to satisfy these requirements, any value of Z_{aecm} will be acceptable.

- Case 1: Z_{aecm} = open circuit

The combined series impedance of $Z_{ferrite}$ and Z_{aecm} is also an open circuit. An open circuit in parallel with the 150 Ω load is 150 Ω. $Z_{ferrite}$ can be of any value.

- Case 2: Z_{aecm} = short circuit

The combined series impedance of $Z_{ferrite}$ and Z_{aecm} is equal to $Z_{ferrite}$. The value of $Z_{ferrite}$ in parallel with the 150 Ω resistor will then be no lower than 130 Ω. In equation form:

$$[(150)(z_{ferrite})]/(150 + z_{ferrite}) \geq 130\ \Omega$$

Solving for $Z_{ferrite}$ yields a value of 1 000 Ω. This implies that the ferrites selected for this application should have a minimum impedance of 1 000 Ω over the frequency range of 0,15 MHz to 30 MHz. For a given set of ferrites, the minimum impedance (jωL) will occur at the minimum frequency of 0,15 MHz.

Combining the two cases cited above, it is seen that Case 2 at 0,15 MHz sets the minimum requirements for the impedance of ferrites so this value (or greater) would be acceptable.

To determine whether the selected ferrites will accomplish the intended function, the measurement set-up shown in Figure G.15 is suggested. A traditional impedance meter or analyser can be used to measure the impedance between point *Z* and the reference ground. Another approach is to measure the individual voltage and current at point *Z* (*I* and *V* in Figure G.15) and calculate the impedance. As a minimum, the impedance measurement should be made at 0,15 MHz. It would be advisable, however, to measure the impedance across the entire 0,15 MHz to 30 MHz range to ensure that no stray capacitance associated with the ferrites and the coaxial cable degrades the ferrite impedance. This is of concern since laboratory data have shown that it is unlikely that desired impedance can be achieved with a single pass of the coaxial cable through the ferrites. Multiple passes through the ferrites are necessary. This increases chances of stray capacitance adversely affecting the impedance of the ferrites. The capability to achieve the desired impedance versus frequency has been demonstrated in the laboratory.

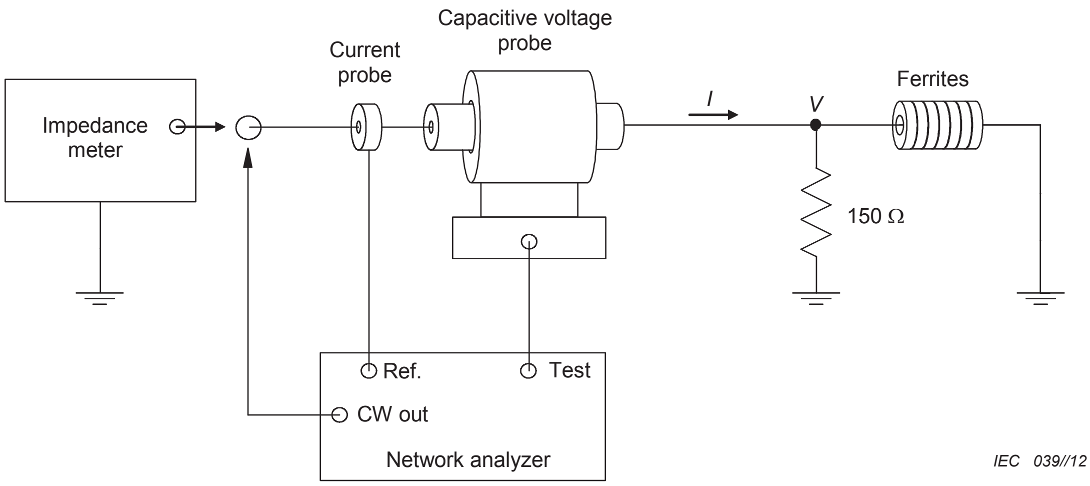


Figure G.15 – Basic measurement setup to measure combined impedance of the 150 Ω and ferrites

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