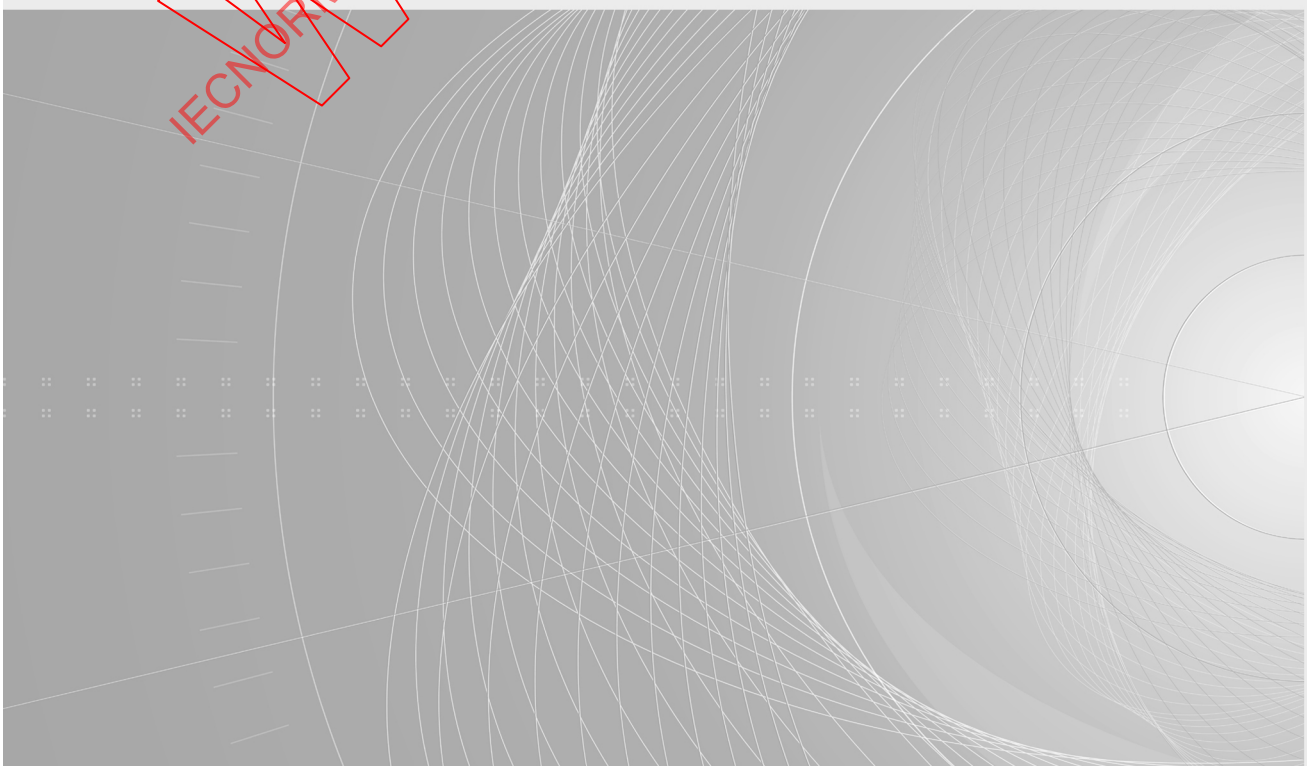
IEC 60728-2

Edition 2.0 2010-01

INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment



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Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 2: Electromagnetic compatibility for equipment

FOREWORD

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International Standard IEC 60728-2 has been prepared by technical area 5: Cable networks for television signals, sound signals and interactive services, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2002, of which it constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– updated scope, added some new terms and definitions;
– added methods of measurement and performance requirements for telecom signal ports of multimedia network equipment;
– updated methods of measurement for immunity and emissions;

– applicability of EMC performance requirements and methods of measurement to different types of equipment.

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

FDIS	Report on voting
100/1620/FDIS	100/1640/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all the parts of the IEC 60728 series, under the general title *Cable networks for television signals, sound signals and interactive services*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television signals, sound signals, interactive services signals, interfaces and their associated data signals, using all applicable transmission media.

This includes

- CATV[1]-networks,
- MATV-networks and SMATV-networks,
- individual receiving networks,

and all kinds of equipment, systems and installations installed in such networks.

The extent of this standardization work is from the antennas, special signal source inputs to the headend or other interface points to the network up to the terminal input.

The standardization of any user terminals (i.e. tuners, receivers, decoders, terminals, etc.) as well as of any coaxial, balanced and optical cables and accessories thereof is excluded.

1 This word encompasses the HFC networks used nowadays to provide telecommunications services, voice, data, audio and video both broadcast and narrowcast.

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 2: Electromagnetic compatibility for equipment

1 Scope

This part of IEC 60728 applies to the radiation characteristics and immunity to electromagnetic disturbance of EM-active equipment (active and passive equipment) for the reception, processing and distribution of television, sound and interactive multimedia signals as dealt with in the following parts of the IEC 60728 series:

– IEC 60728-3 Active wideband equipment for coaxial cable networks
– IEC 60728-4 Passive wideband equipment for coaxial cable networks
– IEC 60728-5 Headend equipment
– IEC 60728-6 Optical equipment

It covers the following frequency ranges:

– Disturbance voltage injected into the mains 9 kHz to 30 MHz
– Radiation from active equipment 5 MHz to 25 GHz
– Immunity of active equipment 150 kHz to 25 GHz
– Screening effectiveness of passive equipment 5 MHz to 3 GHz (25 GHz)[2]

This standard specifies requirements for maximum allowed radiation, minimum immunity and minimum screening effectiveness and describes test methods for conformance testing.

Due to the fact that cable networks, the former cabled distribution systems for television and sound signals, are more and more used for interactive services, these networks may incorporate also equipment, which carry besides the cable network equipment ports also one or more telecom signal port(s) as well as one Ethernet (IP) port. This equipment should be named as multimedia network equipment.

The EMC behaviour of cable network equipment, telecommunication network equipment and multimedia network equipment may be described by the following port structure (see Table 1).

2 For screening effectiveness of passive equipment no requirements apply at present for the frequency range 3 GHz to 25 GHz. Methods of measurement and limits are investigated for inclusion in a future amendment or revised edition.

Table 1 – Port structure of different network equipment

Port name	Cable network equipment	Telecommunication network equipment	Multimedia network equipment
Enclosure	X	X	X
Earth	X	X	X
AC/DC power supply	X	X	X
Control (e.g. alarm)	X	X	X
Antenna input port	X		X
RF network port	X		X
Telecom signal port		X	X
Ethernet (IP) port			X

Table 1 shows that cable network equipment and telecommunication network equipment have four common ports and one respectively two individual port each. Multimedia network equipment carries besides the common ports an antenna input port and/or a RF network port as well as a telecom signal port.

The electromagnetic compatibility requirements for telecommunication network equipment only are standardized in EN 300 386 (mainly) and in EN 301 489-4, those for cable network equipment only are given in this IEC 60728-2.

Equipment for multimedia networks of the above mentioned type has to work under the same EMC conditions as equipment, which is falling under the cable network and the telecommunication network EMC-standards. Due to the fact, that this equipment has to work in close proximity, e.g. in the same operating room, the EMC environmental conditions for all three types of equipment are the same.

This means that multimedia network equipment has to fulfil the EMC requirements of one of the above mentioned standards and in addition the EMC requirements, laid down in the other EMC standard, for the additional port, by which it is connected to the other network.

By this procedure it is ensured that multimedia network equipment fulfils the EMC conditions of one of the above mentioned networks and will neither disturb the respective other system nor will be disturbed by the respective other system via the connecting port.

Coaxial cables for cable networks do not fall under the scope of this standard. Reference is made to the European Standard series EN 50117.

This standard also covers active indoor antennas for which the requirements and the applicable methods of measurement are limited to the radiation and the electrostatic discharge phenomena.

Standardisation in the field of electromagnetic compatibility for any broadcast terminals (e.g. tuners, receivers, decoders, etc.) is covered by the International Standards CISPR 13 and CISPR 20 and for multimedia terminals by CISPR 22 and CISPR 24.

Requirements for the electromagnetic compatibility of receiver leads are laid down in IEC 60966-2-4, IEC 60966-2-5 and IEC 60966-2-6.

2 Normative references

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

CISPR 13, *Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement*

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

CISPR 20, *Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

CISPR 24, *Information technology equipment – Immunity characteristics – Limits and methods of measurement*

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

IEC 60617, *Graphical symbols for diagrams*

IEC 60728 (all parts), *Cable networks for television signals, sound signals and interactive services*

IEC 60728-3:2005, *Cable networks for television signals, sound signals and interactive services – Part 3: Active wideband equipment for coaxial cable networks*

IEC 60966-2-4, *Radio frequency and coaxial cable assemblies – Part 2-4: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 MHz to 3 000 MHz, IEC 61169-2 connectors*

IEC 60966-2-5, *Radio frequency and coaxial cable assemblies – Part 2-5: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 MHz to 1 000 MHz, IEC 61169-2 connectors*

IEC 60966-2-6, *Radio frequency and coaxial cable assemblies – Part 2-6: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 MHz to 3 000 MHz, IEC 61169-24 connectors*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)*

IEC 61000-4-3, E*lectromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

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

IEC 61000-6-1:2005, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61079-1:1992, *Methods of measurement on receivers for satellite broadcast transmissions in the 12 GHz band – Part 1: Radio-frequency measurements on outdoor units*

EN 300 386 V1.3.3 (2005), *Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements*

EN 301 489-4 V1.3.1 (2002) *Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services*

EN 50117 (all parts), *Coaxial cables used in cabled distribution networks*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the definitions contained in IEC 60050(161) apply. The most important definitions of IEC 60050(161) are repeated hereafter with the IEC-numbering given in brackets. In addition, some more specific definitions, used in this standard, are listed.

3.1.1
AC power port
point at which a cable for the AC power supply is connected to the equipment

3.1.2
active equipment
equipment (e.g. amplifiers, converters, etc.), performing signal processing by means of external or internal power supply in a certain frequency range

3.1.3
antenna input port
point at which the equipment under test is directly connected to the receiving antenna(s)

3.1.4
band
nominal operating frequency range of the equipment

3.1.5
burst
sequence of a limited number of distinct pulses or an oscillation of limited duration

[IEV 161-02-07]

3.1.6
cable network equipment
equipment from which cable networks for television signals, sound signals and interactive services are built

NOTE Examples of typical cable network equipment could be found in Part 3, Part 4, Part 5, Part 6 and Part 10 of the IEC 60728 series.

3.1.7
carrier-to-interference ratio
minimum level difference measured at the output of an active equipment between the wanted signal and

– intermodulation products of the wanted signal and/or unwanted signals generated due to non-linearities,

– harmonics generated by an unwanted signal,

– unwanted signals that have penetrated into the operating frequency range,

– unwanted signals that have been converted to the frequency range to be protected (operating frequency range).

3.1.8
control port
point at which a cable for the control signal is connected to the equipment

3.1.9
DC power port
point at which a cable for the DC power supply is connected to the equipment

3.1.10
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

[IEV 161-01-05]

NOTE An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

3.1.11
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

[IEV 161-01-06]

NOTE In English, the terms electromagnetic disturbance and electromagnetic interference designate respectively the cause and the effect, but they are often used indiscriminately.

3.1.12
electromagnetic-active equipment
all passive and active equipment carrying RF signals are considered as electromagnetic-active equipment because they are liable to cause electromagnetic disturbances or the performance of them is liable to be affected by such disturbances

3.1.13
electrostatic discharge
ESD
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[IEV 161-01-22]

3.1.14
enclosure port
physical boundary of the equipment through which electromagnetic fields may be transmitted

3.1.15
ethernet (IP) port
point at which a cable for the wanted IP signal is connected to the equipment

3.1.16
Euro-DOCSIS
the European Data Over Cable Service Interface Specification Standard (Euro-DOCSIS) defines interface specifications for cable modems and cable modem termination systems for high-speed data communication over cable networks

3.1.17
external immunity
ability of a device, equipment or system to perform without degradation in the presence of electromagnetic disturbances entering other than via its normal input terminals or antennas

[IEV 161-03-07]

3.1.18
first satellite intermediate frequency range
output frequency range of the outdoor unit which is comprised of the frequency band between 950 MHz and at least 3 GHz or parts thereof

3.1.19
immunity (to a disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20

3.1.20
immunity level
maximum level of a given electromagnetic disturbance incident on a particular device, equipment or system for which it remains capable of operating at a required degree of performance

[IEV 161-03-14]

3.1.21
immunity limit
specified minimum immunity level

[IEV 161-03-15]

3.1.22
immunity margin
ratio of the immunity limit to the electromagnetic compatibility level

[IEV 161-03-16, modified]

3.1.23
in-band immunity
immunity against disturbance at any frequency of the wanted signals carried at the interfaces and used internally within the equipment under test (e.g. input/output frequencies, IF, video band, etc.)

3.1.24
individual receiving system
system designed to provide television and sound signals to an individual household

3.1.25
indoor signal lines
lines which do not leave the building and which are protected by other equipment against outdoor interference (e.g. connections from switching to transmission equipment in the same building)

3.1.26
internal immunity
ability of a device, equipment or system to perform without degradation in the presence of electromagnetic disturbances appearing at its normal input terminals or antenna

[IEV 161-03-06]

3.1.27
mains immunity
immunity to mains-borne disturbance

[IEV 161-03-03]

3.1.28
mains powered equipment
active equipment directly connected to the mains via a separate mains line and fed with the mains voltage

3.1.29
multimedia network equipment
equipment containing broadcast and telecommunication functions

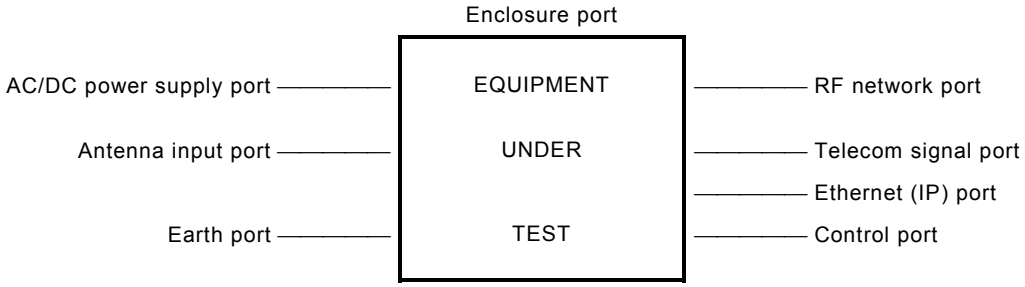
3.1.30
operating frequency range
the passband for the wanted signals for which the equipment has been designed

3.1.31
outdoor signal lines
lines leaving the building and being subjected to outdoor interference

3.1.32
out-of-band immunity
immunity against disturbance from signals outside the frequency band(s) of the wanted signal carried at the interfaces and used internally within the equipment under test (e.g. input/output frequencies, IF, video band, etc.)

3.1.33
passive equipment
equipment (e.g. splitters, tap-offs, system outlets, etc.) not requiring a power supply in order to operate and/or not carrying out signal processing in a certain frequency range

3.1.34
port
particular interface of the specific equipment with the external electromagnetic environment:



3.1.35
radiation (electromagnetic)
a) the phenomenon by which energy in the form of electromagnetic waves emanates from a source into space
b) energy transferred through space in the form of electromagnetic waves

NOTE By extension, the term electromagnetic radiation sometimes also covers induction phenomena.

[IEV 161-01-10]

3.1.36
RF network port
point at which a coaxial cable for the wanted RF signal is connected to the equipment but excluding direct connection to the antenna

3.1.37
RF signal port
antenna input port or RF network port

3.1.38
screening effectiveness
ability of an equipment or system to attenuate the influence of electromagnetic fields from outside the equipment or system or to suppress the radiation of electromagnetic fields from inside the equipment or system

3.1.39
signal port
point at which a cable for the wanted signal is connected to the equipment

3.1.40
spurious signals
all unwanted signals in the frequency range of interest

3.1.41
telecom network equipment
equipment from which telecom networks are built

NOTE Telecommunication network equipment are operated under a licence granted by a national telecommunications authority and provides telecommunications between network termination points (NTPs) (i.e. excluding terminal equipment beyond the NTPs). This covers equipment such as switching equipment (e.g.: local telephone exchanges, remote switching concentrators, international switches, telex switches, network packet switches), non-radio transmission equipment and ancillary equipment [e.g.: multiplexers, line equipment and repeaters (Synchronous Digital Hierarchy (SDH), Plesiochronous Digital Hierarchy (PDH), Asynchronous Transfer Mode (ATM)), Digital Cross Connect systems, network terminations, transmission equipment used in the access network (like XDSL and IP routers)], power supply equipment (central power plant, end of suite power supplies, uninterruptible power supplies, stabilised AC power supplies and other dedicated telecommunication network power supplies, but excludes equipment which is uniquely associated with or integrated in other equipment), supervisory equipment (network management equipment, operator access maintenance equipment, traffic measurement systems, line test units, functional test units).

3.1.42
telecom signal port
point at which a cable for the wanted telecom signal is connected to the equipment

3.1.43
test levels
preferential range of test level for ESD or fast transient test

3.1.44
transient, adjective and noun
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

[IEV 161-02-01]

3.1.45
unwanted signal
signals inside and outside of the operating frequency range that are not considered as wanted signals

NOTE When measuring immunity (to unwanted signals), the unwanted signal is simulated using two sine-wave test signals.

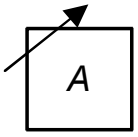
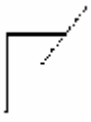
3.1.46
wanted signal
during measurements, the wanted signal shall be simulated using a sinewave test signal having the frequency within the operating frequency range and the appropriate level

3.1.47
well-matched
matching condition in which the return loss of the equipment complies with the requirements of IEC 60728-3, Table 1

3.1.48
well-screened
a test set-up can be considered well-screened if its radiation level, when terminated with a matched load, is at least 20 dB below the expected radiation level of the equipment under test, the test set-up and the equipment being supplied with the same input signal level

3.2 Symbols

The following graphical symbols are used in the figures of this standard. These symbols are either listed in IEC 60617 or based on symbols defined in IEC 60617.

Symbol	Reference number and title	Symbol	Reference number and title
	Level meter [IEC 60617-S00059(2001:07)] [IEC 60617-S00913(2001:07)]		Receiving antenna
	Low pass filter [IEC 60617-S01248(2001:07)]		Variable attenuator [IEC 60617-S01245(2001:07)]
	Signal generator [IEC 60617-SO1226(2001:07)]		Coupling unit
	Transmitting antenna		Equipment under test

3.3 Abbreviations

AC	alternating current	**ALC**	automatic level control
AM	amplitude modulation	**ATM**	Asynchronous Transfer Mode
BSS	broadcast satellite services	**CATV**	Community Antenna Television (system)
COFDM	Coded Orthogonal Frequency Division Multiplex	**CW**	continuous wave
DBS	direct broadcast satellite	**DOCSIS**	Data Over Cable Service Interface Specification
DSR	digital satellite radio	**EMC**	electromagnetic compatibility
emf	electromotive force	**EMI**	electromagnetic interference
Euro-DOCSIS	European specific version of Data Over Cable Service Interface Specification	**EUT**	equipment under test
FM	frequency modulation	**FSS**	fixed satellite services
IF	intermediate frequency	**IP**	internet protocol
LNB	low noise broadband-converter	**MATV**	Master Antenna Television (system)
NTP	Network Termination Point	**PDH**	Plesiochronous Digital Hierarchy
QAM	quadrature amplitude modulation	**QPSK**	quadrature phase shift keying
RF	radio frequency	**SAT**	satellite
S-channel	special channel	**SDH**	Synchronous Digital Hierarchy
SMATV	Satellite Master Antenna Television (system)	**TV**	television
VHF	very high frequency	**VSB**	vestigial side band
xDSL	x Digital Subscriber Line ("x" stands for different versions)		

4 Methods of measurements

4.1 General operating conditions

Measurements shall be, unless otherwise specified, carried out with the rated performance of the equipment under test and at a standard room temperature. If required, additional measurements shall be carried out at the highest and lowest rated ambient temperatures.

The equipment shall be tested including all those sub-assemblies with which it would normally be used.

All operating conditions and configurations, which are only temporarily present while adjustment or service is being made, shall not be tested.

4.2 Disturbance voltages from equipment

4.2.1 Disturbance voltages from equipment in the frequency range from 9 kHz to 30 MHz

4.2.1.1 Introduction

The method described is applicable to the measurement of disturbance voltages from equipment in the frequency range of 9 kHz to 30 MHz on the mains line.

The measured voltage includes narrowband interference and broadband interference such as that produced by semiconductor rectifiers.

4.2.1.2 General measurement requirements

Disturbance voltage measurements should be carried out in a screened room according to the method described in CISPR 13, with the exception that the wanted signal is a sinusoidal carrier. At all frequencies in the range of interest the disturbance voltage injected into the mains by the equipment under test shall be measured by means of a specified artificial mains network with a measuring receiver having a quasi-peak detector for broadband measurements and an average detector for narrowband measurements.

4.2.1.3 Measurement of mains terminal disturbance voltages

Equipment required: According to CISPR 13

Equipment layout and connections: According to CISPR 13

Operating conditions

The equipment under test shall be operated in accordance with the manufacturers recommendations and tested under conditions, which maximise the disturbance voltages.

All RF-ports shall be terminated with non-radiating loads of their nominal impedance. The supply voltage shall be set to values within the specified rating. As a minimum, measurements shall be made at the nominal input voltage and at the lower and upper limit of the specified input voltage range.

Measuring procedure: According to CISPR 13

Presentation of results: According to CISPR 13

The results shall be expressed in terms of dB(μV) and shall comply with the limits given in Table 2.

4.2.2 Disturbance voltages from equipment at the AC mains frequency and its harmonics

If the input current rating is within the scope of IEC 61000-3-2, the limits and test methods of this standard shall apply.

4.2.3 Measurement of input terminal disturbance voltage

4.2.3.1 Method of measurement

The measurement shall be performed according to the method described in CISPR 13 where antenna terminal should be intended as input terminal of the equipment (e.g. channel converter, dBS tuner, etc.) under test.

4.2.3.2 Presentation of the results

The disturbance voltage level of the equipment under test at the local oscillator frequency and its harmonics shall be expressed in terms of input terminal disturbance voltage in dB(μV) and shall comply with the relevant limits given in Table 3.

4.3 Radiation from active equipment

4.3.1 Introduction

The methods described are applicable to the measurement of radiation from active equipment at the signal frequencies, at the local oscillator frequencies and their harmonics and at other relevant frequencies.

In the frequency range 5 MHz to 30 MHz the coupling unit method is used.

In the frequency range 30 MHz to 950 MHz the absorbing clamp method of CISPR 13 is used.

In the frequency range 950 MHz to 25 GHz the substitution method is used.

4.3.2 General measurement requirements

4.3.2.1 Measurement conditions

The measurement cables, coupling devices and terminations shall all be well-matched and well-screened. If these conditions cannot be achieved, appropriate corrections shall be made for the results. Test equipment shall be 75 Ω impedance or provided with appropriate matching pads.

An indoor, or outdoor, site may be used. When indoors, a room of sufficient size must be chosen, so that any reflecting and absorbing objects may be so positioned or sufficiently removed from the measuring set-up that they do not influence the results.

4.3.2.2 Measurement ports

Measurements shall be made at the following ports:

- all RF-ports;
- the mains lead (if any);
- all single or multiple wire connections (if any).

4.3.2.3 Measurement frequencies

Measurements shall be made at the following frequencies:

a) single channel equipment

- at the vision and sound carrier frequencies;
- at any other frequency where disturbance can occur.

b) wideband equipment

- at the highest and lowest vision carrier frequencies in each used band and at a selection of intervening frequencies chosen to give a realistic representation of the radiation pattern throughout the operating frequency range.
- at any other frequency where disturbance can occur.

c) frequency converters

Output ports and mains lead (if any):

– at the input and output vision and sound carrier frequencies,
– at all local oscillator fundamental frequencies,
– at any local oscillator harmonic, and any other frequencies where disturbance can occur.

Input ports

– at all local oscillator fundamental frequencies,
– at selected local oscillator harmonics, or other frequencies (as above).

4.3.3 Methods of measurements

4.3.3.1 Measurement of radiation in the frequency range 5 MHz to 30 MHz

4.3.3.1.1 General

For the measurement of radiation in the frequency range 5 MHz to 30 MHz the coupling unit method shall be used to measure the conducted emissions from the equipment under test.

This method, in general, is the same as the current injection method described in IEC 61000-4-6 with the difference that in this case no disturbing currents are injected into the connected cables, but the conducted emissions are measured.

NOTE The use of an absorbing or injection clamp is also possible in this frequency range. For this purpose the clamp used must have similar properties in this frequency range as the 150 Ω coupling units and can be used whenever the coupling units cannot be realised or applied (i.e. due to the number of conductors in one cable or due to the size of the installation). The measurement set-up and the calibration factors shall be given in the manual of the used clamp.

4.3.3.1.2 Equipment required

The following equipment is required:

– one or more signal generators for the wanted signals;
– a RF measuring receiver or spectrum analyser covering the frequency range of interest;
– combiners (for pilot signals);
– appropriate coupling units (see CISPR 20); and
– well screened terminating loads and cables.

NOTE 1 All equipment used for the measurement set-up must be well screened to avoid inaccurate measuring results. Especially the coaxial coupling units have to be designed for a screening effectiveness greater than 100 dB.

NOTE 2 It shall be ascertained that the level of background interfering signals (ingress) is at least 10 dB below the relevant limit, otherwise the result may be significantly affected.

4.3.3.1.3 Equipment layout and connections

The layout of the test equipment is shown in Figure 1. The equipment under test is placed 10 cm above a metallic ground plane of dimension 1 m × 2 m. The coupling units are inserted into the cables. The wanted signal generator is connected to the coupling unit which is connected to the input of the equipment under test. The RF measuring receiver shall be connected to the measuring output of each coupling unit successively. The cables connecting the coupling units to the equipment under test shall be as short as possible.

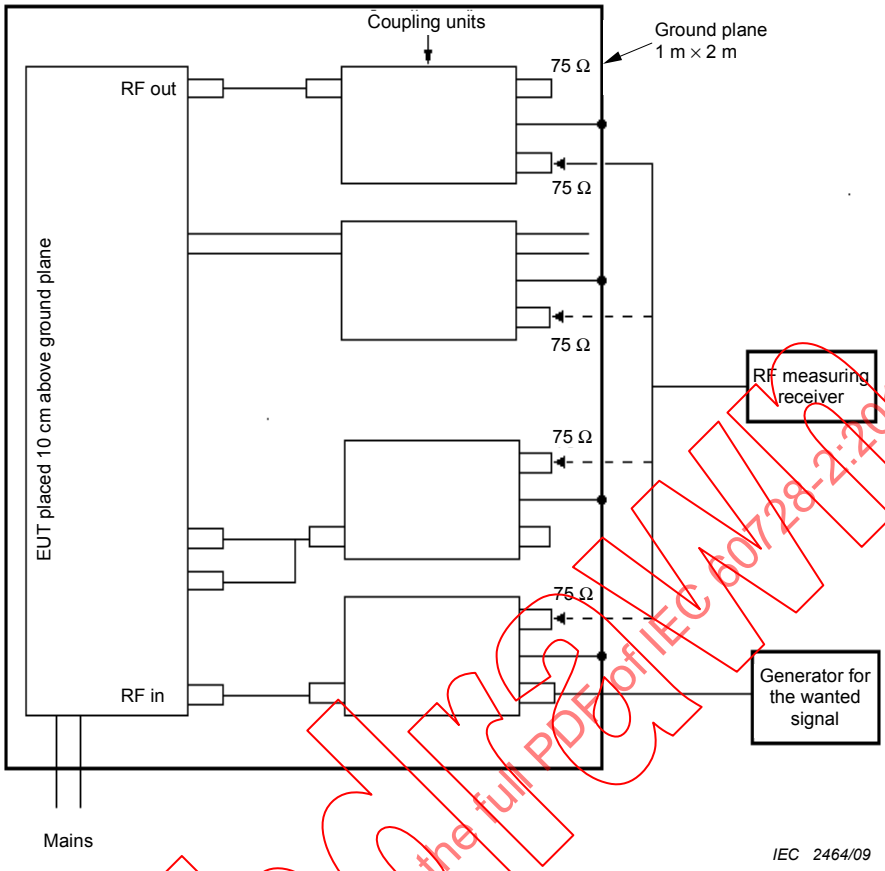


Figure 1 – Measurement set-up for radiation measurements in the frequency range 5 MHz to 30 MHz using the coupling unit method

The cables to the input and output of the equipment should be not longer than 30 cm and the mains lead (if any) should be bundled to give a length of 30 cm. The distance between the leads or cables and the ground plane shall be not less than 3 cm.

The mains lead (if any) is not connected to a coupling unit but shall be provided with absorbing devices to avoid the influence of disturbance voltages on the mains lead.

4.3.3.1.4 Operating conditions

The equipment under test shall operate in accordance with the manufacturers recommendations and under conditions which maximise the radiation. The maximum rated output level shall be used for the test and stated on the equipment or accompanying data sheet by the manufacturer.

4.3.3.1.5 Measurement procedure

The generator for the wanted signal is adjusted to the required test frequency and its level is set to the maximum specified operating level at the output of the equipment.

The measuring receiver is successively connected to all coupling units. All unused ports shall be terminated.

For each measuring frequency the maximum reading is noted.

4.3.3.1.6 Presentation of the results

The readings on the measuring set have to be corrected according to the coupling attenuation of the used coupling units.

For coupling units with R = 75 Ω the coupling attenuation is 3 dB.

In this case a measuring receiver of 75 Ω impedance has to be used.

NOTE Alternatively, coupling units with R = 100 Ω can be used for measuring receivers with 50 Ω input impedance. In this case the coupling attenuation is about 5 dB (4,77 dB).

The radiation level of the equipment under test shall be expressed in terms of power in dB(pW) and shall comply with the limits given in Table 4.

4.3.3.2 Measurement of radiation in the frequency range 30 MHz to 950 MHz using the "absorbing clamp" method

4.3.3.2.1 Equipment required

The equipment required for the absorbing clamp method is listed below:

– a signal generator covering the frequency range of interest and of sufficient output power;
– an absorbing clamp conforming to CISPR 16-1-1;
– a measuring set of appropriate impedance covering the frequency range of interest;
– a measurement cable of length at least $\lambda/2$ (at the lowest frequency of interest) plus 0,6 m and of appropriate impedance;
– screened terminating loads of appropriate impedance and design;
– all necessary coupling devices of an appropriate design;
– a mains filter able to remove extraneous noise from the mains supply in the frequency range of interest;
– absorbing devices such as ferrite rings sufficient to suppress signals from the equipment under test on its input and mains leads;
– a suitable coaxial changeover switch.

4.3.3.2.2 Equipment layout and connections

The measurement set-up and equipment layout for the absorbing clamp method (30 MHz to 950 MHz) is shown in Figure 2, Figure 3 and Figure 4.

The equipment under test shall be placed at a height of approximately 1 m above the ground on a non-metallic support on which the absorbing clamp can be accommodated and moved.

If no input signal is required (e.g. for measurements of local oscillator radiated power) the input shall be terminated by means of a well screened load. For measurements of local oscillator power at the input of the outdoor unit, see 4.3.3.4.

The output of the equipment under test shall be connected to a measurement cable of the same characteristic impedance and the cable shall be terminated with the nominal impedance of the output via the coaxial switch.

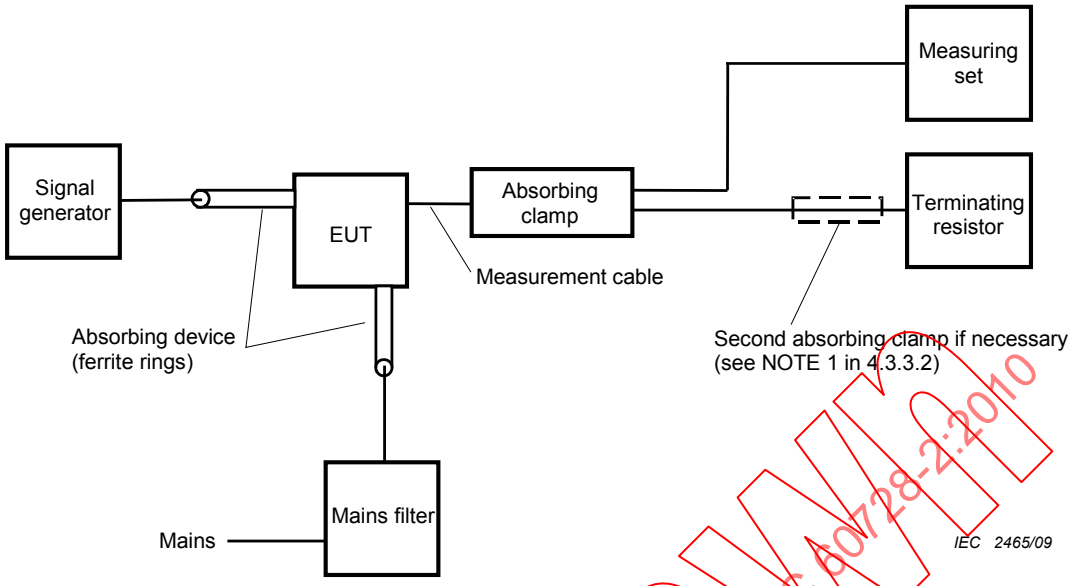


Figure 2 – Absorbing clamp method (30 MHz to 950 MHz)

Well-screened cables shall be connected to the terminals of the equipment under test as specified by the manufacturer. When a direct connection cannot be made due to the dimension of the well-screened cable, an adaptor shall be used.

The unused outputs, if any, of the equipment under test shall be terminated with their nominal impedance by means of non-radiating loads directly connected without any cabling.

The mains lead, if any, shall be placed vertically and connected to the mains outlet through a suitable mains filter. Any excess length of the mains lead shall be coiled up neatly at the filter end.

The mains lead and the signal generator coaxial cable shall be provided with suitable absorbing devices (e.g. ferrite rings), placed close to the equipment under test, to avoid measurement errors.

4.3.3.2.3 Operating conditions

The equipment under test shall be operated in accordance with the manufacturer's recommendations.

The equipment under test shall be tested under conditions, which maximise the radiation. The maximum rated output level shall be used for the test and stated on the equipment or accompanying data sheet by the manufacturer.

The supply voltage shall be set to a value within the specified rating.

Adjustable controls accessible to the user or installer shall be set so as to maximise radiation.

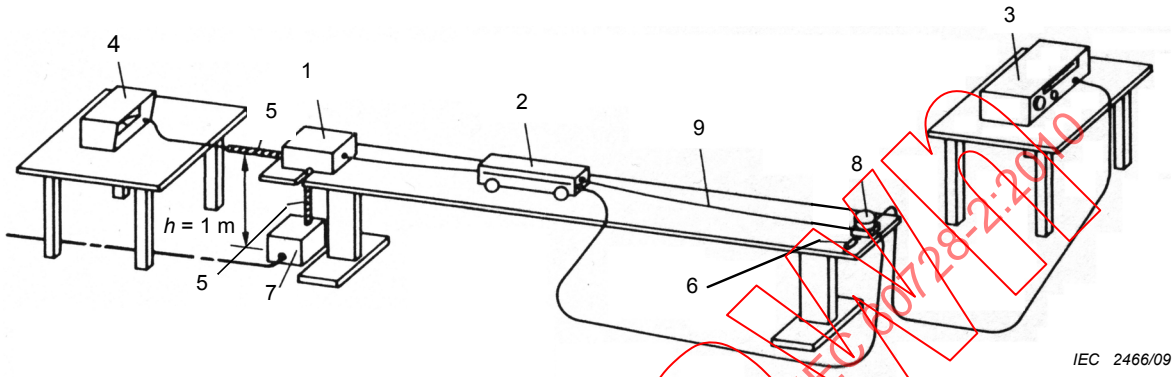
The signal generator at the input shall be adjusted so that the maximum rated output level, within the operating range of the equipment under test, is used.

For sensibly consistent results the dispositions of the signal generator cable preceding the absorbing device, the mains lead, the measurement cable beyond the absorbing clamp and their proximity to other items shall not influence the readings on the measuring set by more

than ±1 dB. This can be checked by moving the cables and by running the hand along their length after setting up the equipment in accordance with Figure 2 and either Figure 3 or Figure 4.

NOTE 1 At frequencies below about 100 MHz it may be necessary to add a second absorbing clamp at the far end of the measurement cable as shown in Figure 2. This is to compensate for the reduced absorption of the clamp at these frequencies.

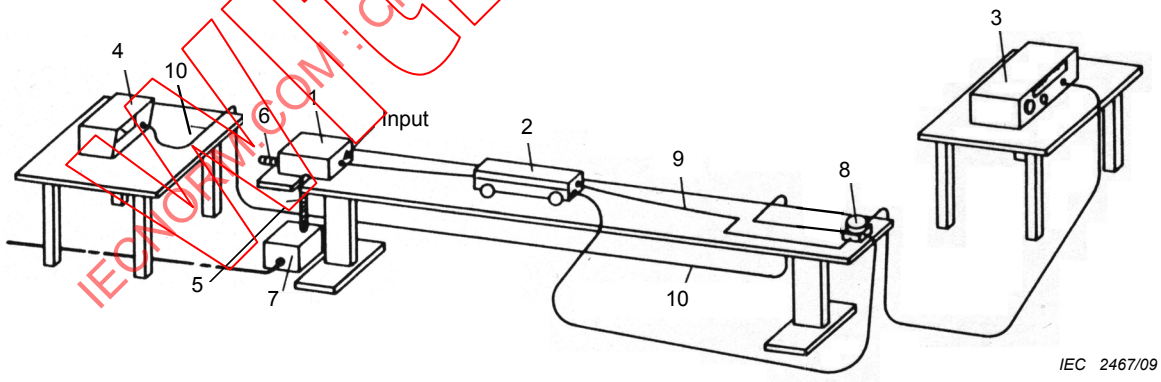
NOTE 2 The absorbing clamp can be calibrated in accordance with the relevant clauses of CISPR 16-1.



Key

1 = equipment under test	6 = terminating resistor	Coaxial switch	Switch-Pos
2 = absorbing clamp	7 = mains filter	Measure radiation	3 – 2, 6 9
3 = measuring set	8 = coaxial switch	Check level	3 – 9, (6 – 2)
4 = signal generator	9 = measurement cable		
5 = absorbing device			

Figure 3 – Example of general measurement set-up



Key

1 = equipment under test	6 = terminating resistor	Coaxial switch	Switch-Pos
2 = absorbing clamp	7 = mains filter	Measure radiation	3 – 2, 10 9
3 = measuring set	8 = coaxial switch	Check level	3 – 10, (9 – 2)
4 = signal generator	9 = measurement cable		
5 = absorbing device	10 = input signal cable		

Figure 4 – Example of measurement set-up for measurements on the input port of active equipment

4.3.3.2.4 Measurement procedure

With the equipment set-up as shown in Figure 2 and Figure 3, and the measurement cable coupled to an output port of the equipment under test, the absorbing clamp is positioned at the equipment end of the measurement cable and the coaxial switch placed in the check level position. Adjust the signal generator to the test frequency and to an input level that will give the maximum rated output level from the equipment under test.

Tune the measuring set. Turn the coaxial switch to the measure radiation mode. Move the absorbing clamp along the cable away from the equipment until a maximum reading is obtained on the measuring set (at a spacing of about $\lambda/2$).

This procedure is repeated for each of the test frequencies and for each of the measurement ports.

For radiation measurements on a frequency converter output port, note that the input signal generator shall be set in turn to the input frequencies used and the measuring set tuned to each of the particular output frequencies.

For radiation measurements on the mains lead of active equipment, the equipment shall be connected as shown in Figure 3, except that the mains lead without absorbing devices, extended if necessary, shall pass through the absorbing clamp in place of the measurement cable. Measurements shall be carried out as described above except that the check-level position of the coaxial switch is inoperative with this arrangement. Set the signal generator output level to that used when measuring the output port.

4.3.3.2.5 Presentation of results

The readings on the measurement set have to be corrected according to the calibration curve of the absorbing clamp to obtain the radiated power.

The radiation level of the equipment under test shall be expressed in terms of substituted power in dB (pW) and shall comply with the limits given in Table 4.

4.3.3.3 Measurement of radiation in the frequency range 950 MHz to 25 GHz using the substitution method

4.3.3.3.1 Equipment required

The equipment required for the substitution method is listed below:

– a signal and/or pilot frequency generator covering the frequency range of interest and of sufficient output power;
– suitable receiving antennas covering the frequency range(s) of interest;
– suitable calibrated transmitting antennas covering the frequency range(s) of interest;
– a spectrum analyser of appropriate impedance covering the frequency range of interest;
– high-quality connecting coaxial cables of appropriate impedance;
– screened terminating loads of appropriate impedance and design;
– a mains filter able to remove extraneous noise from the mains supply in the frequency range of interest;
– a low-noise preamplifier (if needed).

4.3.3.3.2 Equipment layout and connections

The equipment under test shall be placed on a support of non-metallic material, the height of which shall be 1 m above the ground, as shown in Figure 5.

Equipment, which needs an input signal and/or pilot frequencies, shall be connected to a suitable signal and/or pilot frequency generator through a well-screened coaxial cable.

If no input signal is required (e.g. for measurements of local oscillator radiated power), the input shall be terminated by means of a well-screened load. For measurements of local oscillator power at the input of the outdoor unit, see 4.3.3.4.

The unused outputs, if any, of the equipment under test shall be terminated with their nominal impedance by means of well-screened loads.

The mains lead, if any, shall be placed vertically and connected to the mains outlet through a suitable mains filter. Any excess length of the mains lead shall be coiled up neatly at the filter end.

The mains lead and the signal generator coaxial cable shall be provided with suitable absorbing devices (e.g. ferrite rings), placed close to the equipment under test, to avoid measurement errors.

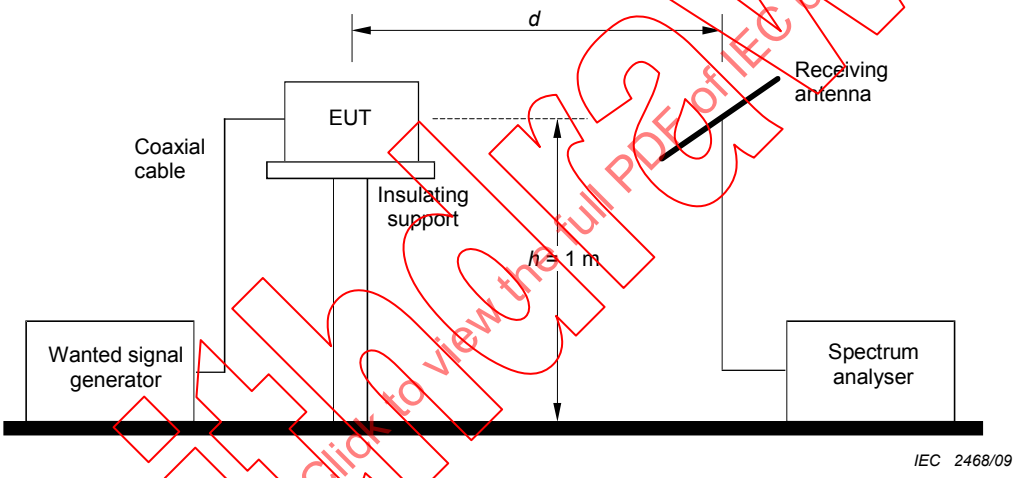


Figure 5 – Measurement set-up for the "substitution" radiation method – First measurement step

4.3.3.3.3 Operating conditions

The equipment under test shall operate in accordance with the manufacturers recommendations and under conditions, which maximise the radiation. The maximum rated output level shall be used for the test and stated on the equipment or accompanying data sheet by the manufacturer.

The measurements shall be made with a directional antenna of small aperture capable of making separate measurements of the vertical and horizontal polarisation of the radiated field. The height above the ground of the centre line of the antenna shall be the same as the height of the approximate radiation centre of the equipment under test.

In order to avoid the influence of the ground reflection on the results, it is recommended to use a suitable horn antenna. In that case no metallic ground plane is needed. To fulfil the Fraunhofer conditions the measuring distance shall be

$$d > 2\ b^2/\lambda$$

where

b is the wider dimension of the horn mouth;

λ is the wavelength corresponding to the test frequency.

The measuring set used in this frequency range usually consists of a spectrum analyser. If the radiation level is low, a low-noise preamplifier may be needed.

4.3.3.3.4 Test site validation

The validation of the test site shall be determined as follows. A transmitting antenna shall be mounted at the position where it is intended that the approximate radiation centre (usually the volume centre) of the equipment under test is to be placed. The receiving antenna shall be placed at the same position as that chosen for the actual measurements. The two antennas shall be placed so that they have the same polarisation, which shall be perpendicular to an imaginary line between them. Tests shall be made in the horizontal and vertical polarisation planes.

The test site shall be considered suitable for the purpose of measurement at a test frequency if the indication on the measuring set changes by no more than 1,5 dB when the centre of the transmitting antenna is moved from 0 cm to 20 cm in any direction from its initial position.

NOTE The gain of the applied transmitting antenna in dB above the half-wave dipole shall be taken into account.

4.3.3.3.5 Measurement procedure

Measurements shall be made by the substitution method with the antenna having both horizontal and vertical polarisations and the turntable with the equipment under test shall be rotated. The equipment shall be rotated in all planes. The highest level of radiation measured shall be noted at each measuring frequency.

Then the equipment under test is replaced by a calibrated transmitting antenna supplied by a standard generator. Its centre shall be placed in the same initial position of the equipment centre according to Figure 6.

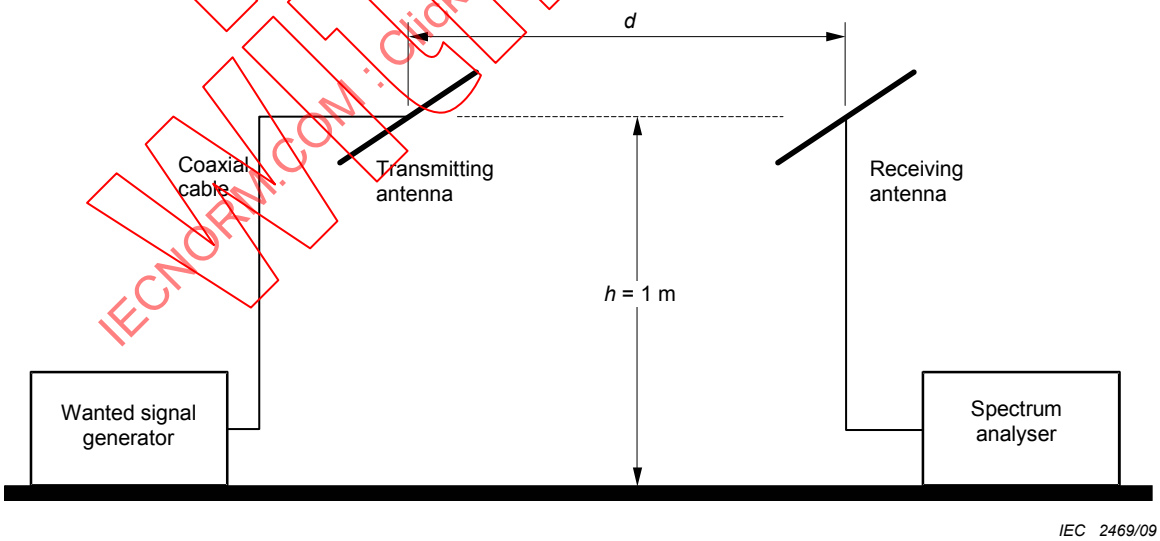


Figure 6 – Measurement set-up for the substitution radiation method – Second measurement step

For each measuring frequency the output level of the generator is adjusted in order to give the same reference indication on the spectrum analyser as achieved with the EUT. The level of the available power of the generator, increased by the radiating antenna gain above the half-wave dipole, is taken as the level of the radiated power of the equipment under test at the considered frequency.

The equivalent radiated power is given by the following equation:

$$P = P_g - A_c + G_a$$

where

P is the equivalent radiated power in dB(pW);

P_g is the available power of the generator in dB(pW);

A_c is the loss of any cables and adaptors between generator and antenna in dB;

G_a is the gain of the transmitting antenna in dB referred to the half-wave dipole antenna.

It shall be ascertained that, when the equipment under test is switched off, the level of background noise is at least 10 dB below the relevant limit, otherwise the reading may be significantly affected.

4.3.3.3.6 Presentation of the results

The radiation level of the equipment under test shall be expressed in terms of substituted power in dB(pW) and shall comply with the relevant limits given in Table 4.

4.3.3.4 Measurement of local oscillator power at the outdoor unit input

4.3.3.4.1 Method of measurement

The power at the outdoor unit input (inclusive of e.g. polariser, orthomode transducer, bandpass filter, RF waveguide, etc.) shall be measured according to the measurement method described in 4.3.3.3, with the exception that the equipment does not need any input signals from a signal generator.

If a suitable interface at the input of the outdoor unit (e.g. R120, C120) is available, the local oscillator power can be measured by a power meter combined with a corresponding adapter.

4.3.3.4.2 Presentation of the results

The power level of the equipment under test shall be expressed in terms of substituted power in dB(pW) and shall comply with the relevant limits given in Table 5.

4.3.3.5 Measurement of active indoor antennas

4.3.3.5.1 Method of measurement

The radiation of active indoor antennas shall be measured in the frequency range 30 MHz to 1 000 MHz according to the field strength method described in CISPR 22.

The measurements shall be carried out with the EUT operating as intended (output terminated with the nominal impedance) but with no input signal.

4.3.3.5.2 Presentation of the results

The radiation level of the equipment under test shall be converted from field strength to power expressed in dB(pW) and shall comply with the relevant limits given in Table 4. The following formula shall be used for calculation

$$P = E - F_C$$

where

P is the radiated power in dB(pW);

E is the measured field-strength in dB(μV/m);

F_C is the correction factor (7,3 dB for the measuring distance of 3 m).

4.4 Immunity of active equipment

4.4.1 General

Any RF signal entering the equipment may produce interference. Unwanted signals can appear at the output of the equipment when disturbance frequencies are entering because of poor immunity

- generate intermodulation products with the wanted signal and other signals being distributed or transfer their modulation through crossmodulation to the wanted signal,
- beat with oscillator signals or their harmonics or with other signals being distributed,
- fall in the nominal frequency ranges of the equipment.

NOTE Some interference can be avoided by a judicious choice of distributed channels.

4.4.2 Performance criterion

Performance criterion A (according to IEC 61000-6-1) shall be applied.

The equipment shall operate as intended during the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. No change of actual operating state or stored data is allowed.

For the scope of this standard, the immunity level shall correspond to the level of the incident electromagnetic disturbance, which produces a just perceptible interference at the output of the equipment under test, when a specified operating level is present at the input or output of the equipment under test.

It is assumed that the just perceptible interference corresponds to an in-channel RF wanted-to-unwanted signal ratio of:

60 dB	for AM-VSB-TV and FM radio
35 dB	for FM-TV

in an analogue environment and, in a digital environment, to a

BER of 1 X 10^{-4} before Reed Solomon and after Viterbi error correction	for QPSK, QAM, COFDM

when measured at the output of the equipment under test.

NOTE 1 For digitally modulated signals the system performance limits ensure a service that is quasi-free of interruption.

NOTE 2 DVB-C QAM signals do not use Viterbi error correction and impulse or narrowband interference may result in degraded performance.

NOTE 3 For compliance testing it is not necessary to measure the actual level of immunity, but only to ensure that the immunity requirements of Clause 5 are complied with.

4.4.3 Measurement of the external immunity to ambient fields

4.4.3.1 Out-of-band immunity (modulated interfering signal)

4.4.3.1.1 Test method

Out-of-band immunity test is only relevant to active equipment where in-band immunity is not required.

For the disturbance frequency range 150 kHz to 80 MHz measurements shall be made with the injection method described in IEC 61000-4-6.

For the disturbance frequency range 80 MHz to 3 GHz measurements shall be made on a test site using the radiated field method described in IEC 61000-4-3 (extended to 3 GHz, using suitable antennas).

For the frequency range 3 GHz to 25 GHz, no requirements apply at present.

NOTE Methods of measurement and limits are investigated for inclusion in a future amendment or revised edition.

4.4.3.1.2 Test frequencies

For single channel equipment, measurements shall be carried out using a disturbance field at frequencies outside the nominal frequency ranges of the equipment under test (see Figure 7 and Figure 8). For converters the disturbance field shall be at frequencies outside both the input and output nominal frequency ranges.

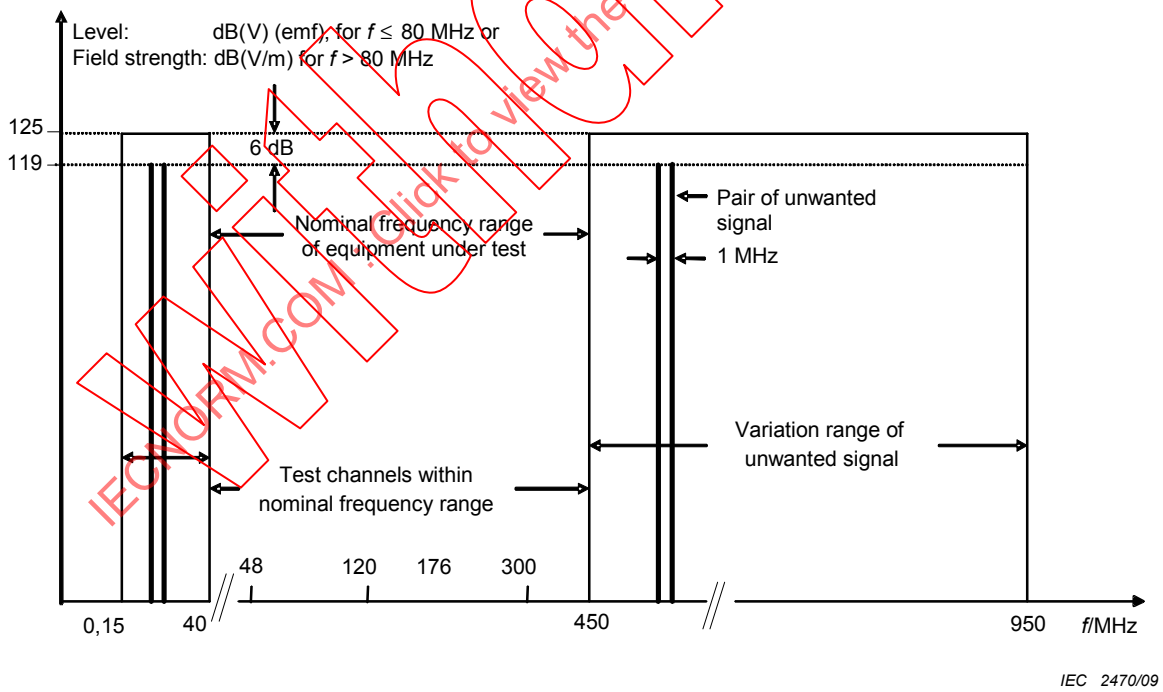


Figure 7 – Frequency allocation for out-of-band immunity measurement of active equipment with nominal frequency range below 950 MHz for AM applications (Example: VHF broadband amplifier; bandwidth 40 MHz to 450 MHz)

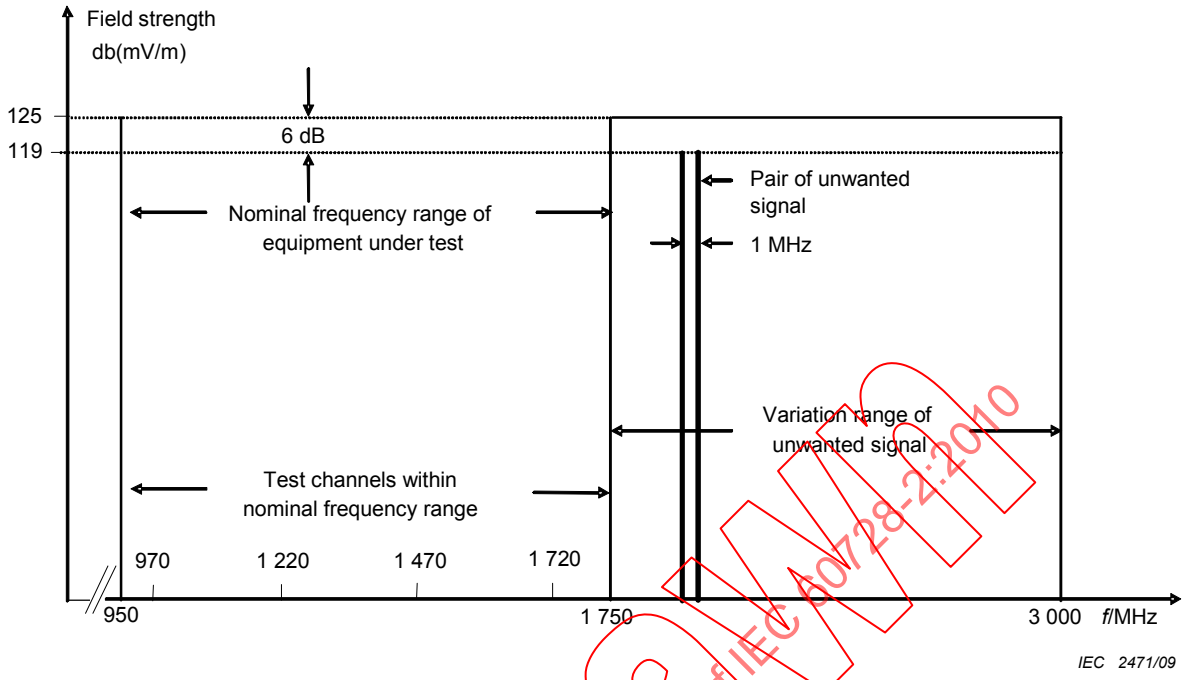


Figure 8 – Frequency allocation for out-of-band immunity measurement of active equipment with nominal frequency range above 950 MHz for FM applications (Example: IF amplifier bandwidth 950 MHz to 1 750 MHz)

For broadband equipment, measurements shall be carried out using a disturbance field at frequencies outside the nominal frequency ranges of the equipment under test (see Figure 7 and Figure 8) The wanted channels to be tested shall be taken at least at the following centre frequencies that fall within the nominal frequency ranges of the equipment under test.

For equipment, which does not have a nominal frequency, range (e.g. power supplies, control units) measurements shall be carried out in the whole specified disturbance frequency range.

a) Equipment with nominal frequency ranges <950 MHz for AM applications

Test channels with bandwidth	8 MHz
at centre frequencies	48, 120, 176, 300, 480, 680, 850 MHz

b) Equipment with nominal frequency ranges >950 MHz for FM applications

Test channels with bandwidth	27 MHz
at centre frequencies	970, 1 220, 1 470, 1 720, 1 970, 2 220, 2 470, 2 720, 2 970 MHz

4.4.3.1.3 Test conditions

In all cases, the measurement of the out-of-band immunity of equipment involves an evaluation of the effects of the disturbance field on the normal output signal.

The equipment under test shall be operated at its nominal power supply voltage and under typical conditions, whether manual or automatic.

All unused inputs and outputs shall be correctly terminated using screened termination loads. Any manual controls shall be adjusted to give maximum gain and the correct amplitude/frequency response.

The wanted signal generator shall be set to the wanted channel frequency f_V.

The output level of the wanted signal generator is adjusted to give the specified maximum level at the output of the equipment under test.

The disturbing field is simulated by two discrete carriers (two unwanted signals), the field strength levels of which are 6 dB down from the reference level in Table 6 and spaced 1 MHz away from each other. The reference frequency for the two unwanted signals shall be the arithmetical mean value of their individual frequencies.

4.4.3.1.4 Out-of-band immunity

For the scope of this standard, the external immunity level will correspond to the level of the incident electromagnetic disturbance outside the nominal frequency ranges, which produces a just perceptible interference (see NOTE 3 to 4.4.2) at the output of the equipment under test, when the maximum output level, as defined and published by the manufacturer, is present at the output.

4.4.3.1.5 Measurement procedure

The wanted signal generator shall be adjusted to give the test conditions above, the signal level at the output of the equipment under test being measured using the measuring receiver or spectrum analyser.

The measuring receiver or spectrum analyser shall then be tuned to the two amplitude interference products (f_V − 1 MHz and f_V + 1 MHz) within the wanted channel and the output levels of the unwanted signal generators are adjusted simultaneously to obtain, at the output of the equipment under test, an RF carrier-to-interference signal ratio which complies with the performance criterion given in 4.4.2.

The equipment under test shall be rotated in all planes and the minimum output level of the unwanted signal generator shall be noted at each measuring frequency.

Harmonics of the disturbing signals shall not be taken into account.

In the case of equipment provided with automatic level control, care shall be taken to keep the wanted signal level and pilot levels constant.

4.4.3.1.6 Presentation of the results

The results are expressed in terms of the lowest field strength in dB(μV/m) for the performance criterion given in 4.4.2, and shall comply with the relevant limit given in Table 6.

4.4.3.2 In-band immunity (unmodulated interfering signal)

4.4.3.2.1 Test method

For the disturbance frequency range 150 kHz to 80 MHz measurements shall be made with the injection method described in IEC 61000-4-6, but with the disturbing frequencies in accordance with in-band definition.

For the disturbance frequency range 80 MHz to 3 GHz measurements shall be made on a test site using the radiated field method described in IEC 61000-4-3 (extended to 3 GHz, using suitable antennas).

For the frequency range 3 GHz to 25 GHz no requirements apply at present.

NOTE Methods of measurement and limits are investigated for inclusion in a future amendment or revised edition.

4.4.3.2.2 Equipment required

The test equipment required for the measurement of the in-band immunity of equipment is listed below:

- a signal generator covering the frequency range of interest and representing the respective wanted signal, as well as pilot-signal generators, as required;
- a power RF generator covering the frequency range of interest and of sufficient output power to feed the transmitting antenna and/or stripline (unwanted signal);
- a measuring receiver or spectrum analyser;
- suitable combiners, test cables and terminating loads all of which shall be well-matched and well-screened.

Test equipment for connection to the unit under test shall be of 75 Ω impedance or provided with appropriate matching pads.

4.4.3.2.3 Test frequencies

Measurements shall be carried out using a CW disturbance field, the frequency of which is placed 2 MHz ± 0,5 MHz from the wanted signal (see Figure 9 and

Figure **10**). The test frequencies shall be selected to obtain a realistic presentation of the in-band immunity over the nominal frequency range. The wanted signal frequency and the disturbance frequencies shall be selected to fall within the wanted channel in the case of channel-selective equipment.

In the case of broadband equipment, the following centre frequencies that fall within the band of the equipment under test shall be used. The unwanted signal shall be 2 MHz ± 0,5 MHz from the wanted signal.

a) Equipment with nominal frequency ranges <950 MHz for AM applications

Wanted signal frequencies: 27, 48, 144, 176, 300, 470, 680, 860 MHz

b) Equipment with nominal frequency ranges >950 MHz for FM applications

Wanted signal frequencies: 970, 1 220, 1 470, 1 720, 1 970, 2 220, 2 470, 2 720, 2 970 MHz

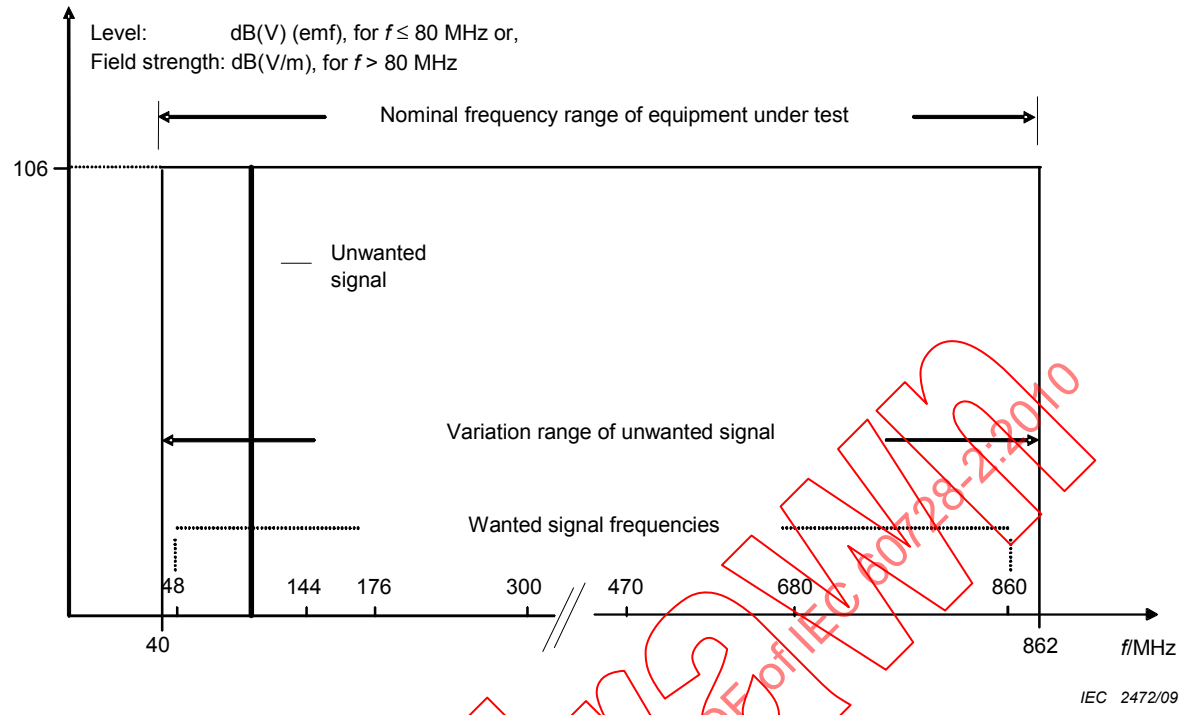


Figure 9 – Frequency allocation for in-band immunity measurement of active equipment with nominal frequency range below 950 MHz for AM applications (Example: broadband amplifier; bandwidth 40 MHz to 862 MHz)

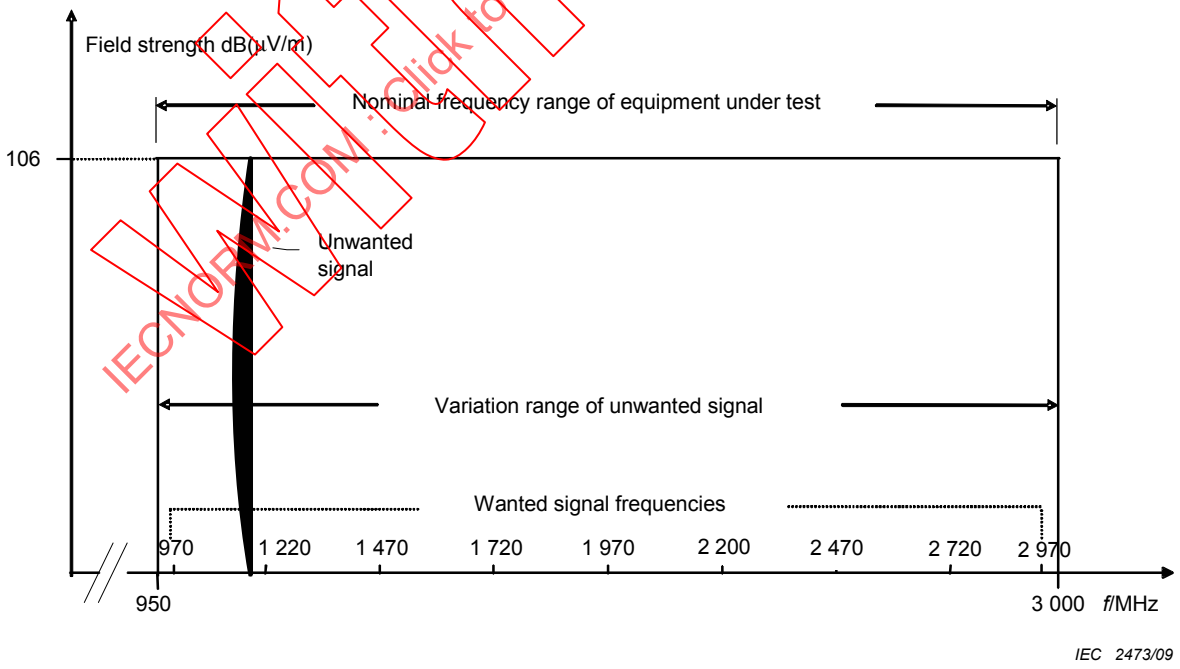


Figure 10 – Frequency allocation for in-band immunity measurement of active equipment with nominal frequency range above 950 MHz for FM applications (Example: IF amplifier; bandwidth 950 MHz to 3000 MHz)

4.4.3.2.4 Test conditions

In all cases, the measurement of the in-band immunity of equipment involves an evaluation of the effects of the disturbance field on the normal output signal.

The equipment under test shall be operated at its nominal power supply voltage and under typical conditions, whether manual or automatic.

All unused inputs and outputs shall be correctly terminated using screened terminating loads. Any manual controls shall be adjusted to give maximum gain and the correct amplitude/frequency response.

A wanted signal with the lowest specified or standardised input level shall be applied to the input. If no input level is specified by the manufacturer the wanted signal shall be applied with a level of 70 dB(μV).

NOTE For Euro-DOCSIS this minimum input level for instance is specified at 43 dB(μV) for 64-QAM signals.

4.4.3.2.5 In-band immunity

For the scope of this standard, the in-band immunity will correspond to the level of the incident electromagnetic disturbance within the nominal frequency ranges, which produces a just perceptible interference (see performance criterion given in 4.4.2) under the above-mentioned testing conditions at the output of the equipment under test.

4.4.3.2.6 Measurement procedure

The wanted signal generator shall be adjusted to give the test conditions specified above, the signal levels at the output of the equipment under test being measured using the measuring receiver or the spectrum analyser. The frequency of the unwanted signal shall then be varied over the nominal frequency ranges and its level is adjusted to obtain, at the output of the equipment under test, an RF carrier-to-interference signal ratio which complies with the performance criterion given in 4.4.2.

The measurements shall be carried out at the test frequencies listed above. The highest interference is expected when the frequency of the unwanted signal lies within the test channel, but also all other interference signals which may occur due to conversion or intermodulation with the participation of the unwanted signal within the nominal frequency ranges, shall be evaluated.

The equipment under test shall be rotated in all planes and the minimum output level of the unwanted signal generator shall be noted at each measuring frequency.

Harmonics of the disturbing signal shall not be taken into account.

In the case of equipment provided with automatic level control, care shall be taken to keep the wanted signal level and pilot levels constant.

4.4.3.2.7 Presentation of the results

The results shall be expressed in terms of the lowest field strength level in dB(μV/m) for the performance criterion given in 4.4.2 and shall comply with the relevant limit given in Table 7.

4.4.4 Internal immunity (immunity to unwanted signals)

4.4.4.1 General

4.4.4.1.1 Method of measurement

The measurement methods specified below serve to determine the immunity of an active equipment to disturbance by unwanted signals occurring both outside of its operating frequency range (out-of-band disturbance) and within of its operating frequency range (in-band disturbance).

If the equipment under test are frequency converters that serve to convert one or more RF input frequency ranges to one or more RF output frequency ranges, the measurements shall account for possible combination products of wanted signals, unwanted signals and the local oscillator frequency.

4.4.4.1.2 Internal immunity level

For the scope of this standard, the internal immunity level is the maximum level of the unwanted signal applied to the input terminals which comply with the performance criterion given in 4.4.2.

4.4.4.1.3 Test set-up

The test set-up is shown in Figure 11. The test equipment and auxiliary items shall be properly interconnected with their characteristic impedances and be well-matched over the operating frequency range.

Prior to measurements the test set-up shall be checked to ensure that it is sufficiently free of internally generated distortion products. Mutual modulation of test signal sources can be avoided by increasing the attenuation between signal generators.

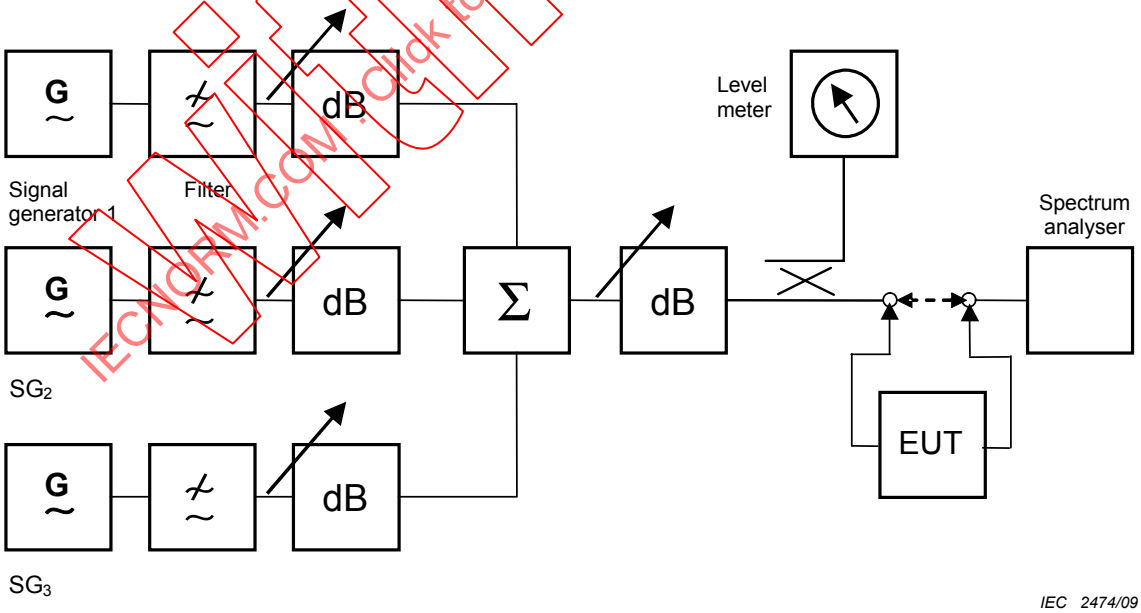


Figure 11 – Measurement set-up for internal immunity test

4.4.4.1.4 Measurement procedure

The measurement shall be carried out based on the three signal measurement method, where the unwanted signal is simulated by two discrete carriers that are 6 dB down from the reference level and spaced a specified amount away from each other.

The equipment under test shall be subjected to disturbance by unwanted signals in accordance with the relevant limit curves.

4.4.4.1.5 Test condition

The limit curves specify the minimum levels of unwanted signals at which the equipment shall meet the performance requirement.

The limit curve to be applied shall be appropriately selected for the operating frequency range of the equipment under test and be adapted to the limits of the operating frequency range, if required.

At the output of the equipment under test, all RF carrier-to-interference signal ratios are measured by means of a measuring receiver or spectrum analyser and the worst value is noted.

4.4.4.1.6 Internal immunity to out-of-band disturbing signals

The level of the wanted signal shall be adjusted according to the specifications given in 4.4.4.2 for the frequency range 47 MHz to 862 MHz and in 4.4.4.3 for the frequency range 10,70 GHz to 12,75 GHz.

For measurements of immunity to out-of-band disturbing signals, the unwanted out-of-band signals shall be applied to the input of the equipment under test in accordance with the relevant limit curve.

It is permitted to introduce a system-specific level reduction of 3 dB when making measurements on a converter designed for circular polarisation, but exposed to disturbance by unwanted signals with linear polarisation.

At the output of the equipment under test measurements shall be made in order to determine if all intermodulation products generated by wanted and unwanted signals or by unwanted signals alone, or involving the oscillator frequency (if applicable), shall comply with performance criteria (see 4.4.2).

During measurements the wanted signal shall be tuned over the operating frequency range. The worst result shall be noted in each case.

If different input frequency ranges (e.g. different planes of polarisation) are combined by a equipment to form a single output frequency range any unwanted signals that fall within the operating output frequency range after conversion shall be considered as intermodulation products.

4.4.4.1.7 Internal immunity to in-band disturbing signals

The level of the wanted signal shall be adjusted according to the specification given in 4.4.4.3. For measurements of immunity to in-band disturbing signals, the simulated unwanted signal shall be applied to the input of the equipment under test in accordance with the relevant limit curve.

It is permitted to introduce a system-specific level reduction of 3 dB when making measurements on a converter designed for circular polarisation, but exposed to disturbance by unwanted signals with linear polarisation.

At the output of the equipment under test measurements shall be made in order to determine if all intermodulation products generated by the wanted and unwanted signals and falling within the operating frequency range shall comply with the performance criterion given in 4.4.2.

If different input frequency ranges are combined to form a single output frequency range, unwanted signals that fall outside of their original input frequency range shall be considered as distortion products.

4.4.4.2 Internal immunity in the frequency range 47 MHz to 862 MHz

4.4.4.2.1 General

For active equipment processing signals directly supplied by receiving antennas the output level of all intermodulation products, that fall within the frequency passband of the equipment under test, shall be such that the carrier-to-interference ratio shall comply with performance criterion given in 4.4.2.

4.4.4.2.2 Method of measurement

Measurements shall be performed with the set-up of Figure 11 using one wanted signal in one of the television or radio broadcast bands and one unwanted modulated signal represented by two unmodulated carriers. The level of the wanted signal shall be adjusted to the specified maximum operating level (according to IEC 60728-3). The levels of the two unmodulated carriers (representing the unwanted signal) shall be 6 dB down from that specified in Table 8 and shall be spaced 1 MHz one from the other.

NOTE This requirement does not apply to channel-selective equipment designed for the frequency range 87,5 MHz to 108 MHz.

With sub-band, full-band and multi-band amplifiers, frequency converters or similar equipment the level of the wanted signal shall be increased by 3 dB.

Selective circuits (channel filters, bandpass filters and similar) that are necessary to meet the requirements regarding immunity to unwanted signals shall be integral parts of active equipment, that is, the equipment shall not be operative without these circuits.

4.4.4.2.3 Presentation of the results

The results are expressed in terms of carrier-to-interference ratio in dB and shall comply with the performance criterion given in 4.4.2, with the appropriated test specification of Table 8.

4.4.4.3 Internal immunity in the frequency range 10,70 GHz to 12,75 GHz

4.4.4.3.1 Limits of application

The measurement of internal immunity for outdoor-units in the frequency range 10,70 GHz to 12,75 GHz has to be seen as recommendation to assure the proper operation of satellite receiving outdoor units at least in CATV and MATV headend applications. If applied to outdoor units, measurements shall be performed with the set-up of Figure 11 using one unmodulated wanted signal and one unwanted modulated signal represented by two unmodulated carriers. The level of the wanted signal shall be adjusted as given in Figure 12 and Figure 13. The levels of the two unmodulated carriers (representing the unwanted signal) shall be 6 dB down from that specified in Table 8 and shall be spaced 1 MHz one from the other.

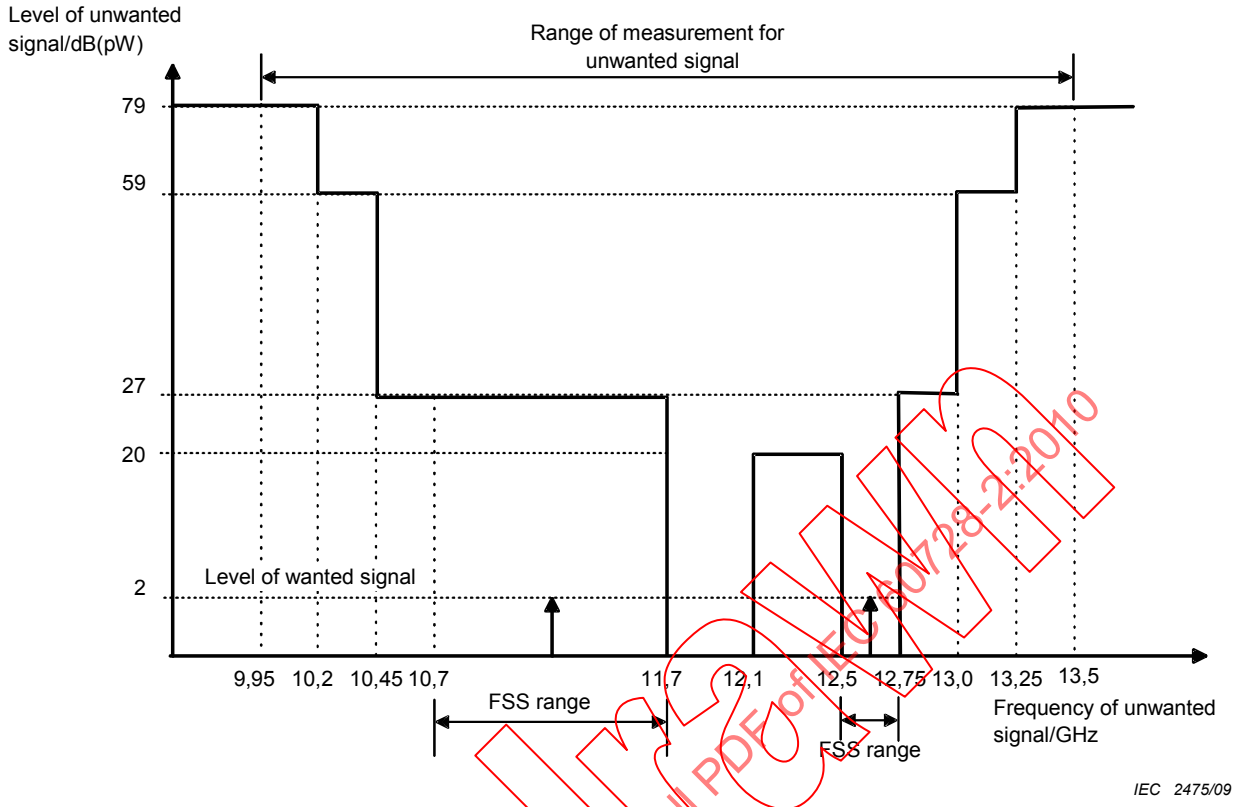


Figure 12 – Levels of wanted and unwanted signals for the internal immunity of FSS receiving outdoor units

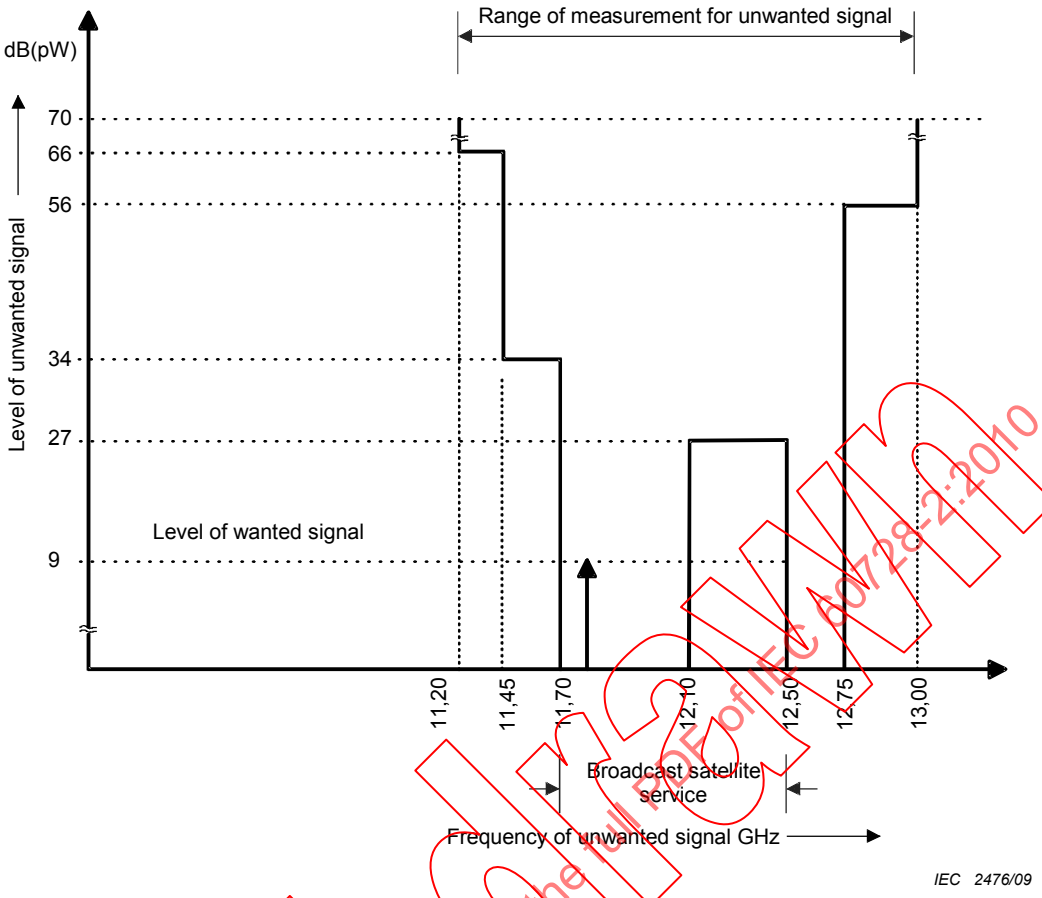


Figure 13 – Levels of wanted and unwanted signals for the internal immunity of BSS receiving outdoor units

4.4.4.3.2 Single outdoor unit

All intermodulation products at the output of the outdoor unit, falling within the output SAT-IF-frequency range, shall give a carrier-to-interference ratio which complies with the performance criterion given in 4.4.2.

This is based on the assumption that at least one wanted signal and one unwanted signal, in accordance with the limit curves given in Figure 12 and Figure 13, are involved.

4.4.4.3.3 Multiple outdoor units

When using multiple outdoor units with a combined output, the distortion products caused by unwanted signals and/or wanted signals, falling within the frequency ranges produced by the multiple outdoor units, shall be at least 35 dB below the output level of the wanted signal.

4.4.4.3.4 Presentation of the results

If this measurement is applied, the results are expressed in terms of carrier-to-interference ratio in dB and should comply with the performance criterion given in 4.4.2, with the appropriate test specification of Table 8.

4.4.4.4 Immunity of outdoor units to image frequency signals

4.4.4.4.1 Method of measurement

The immunity to image frequency signals is given by the image frequency rejection ratio. It shall be measured for outdoor units used for the reception and conversion of FM-TV-signals with output frequencies in the SAT-IF-range.

The measurement shall be made according to the method given in 3.10 of IEC 61079-1.

4.4.4.4.2 Presentation of the results

The results are expressed in terms of image suppression ratio in dB and shall comply with the performance criterion given in 4.4.2, with the limits given in Table 9.

4.5 Screening effectiveness of passive equipment

4.5.1 Introduction

The methods described are applicable to the measurement of screening effectiveness of passive equipment.

In the frequency range 5 MHz to 30 MHz the coupling unit method described in 4.3.3.1 shall be used.

In the frequency range 30 MHz to 950 MHz the absorbing clamp method described in 4.3.3.2 is used.

In the frequency range 950 MHz to 25 GHz the substitution method described in 4.3.3.3 is used.

4.5.2 General measurement requirements

The measurement cables, coupling devices and terminations shall all be well-matched and well-screened. Test equipment shall be of 75 Ω impedance.

An indoor, or outdoor, site may be used. When indoors, a room of sufficient size shall be chosen, so that any reflecting and absorbing objects may be so positioned or sufficiently removed from the measuring set-up that they do not influence the results.

Measurements shall be made at the following ports:

– all RF-ports;
– all single or multiple wire connections (if any).

Measurements shall be made at a selection of frequencies chosen to give a realistic representation of the screening effectiveness throughout the operating frequency range.

4.5.3 Methods of measurements

4.5.3.1 Measurement of screening effectiveness in the frequency range 5 MHz to 30 MHz using the "coupling unit" method

Equipment required: According to 4.3.3.1.

Equipment layout and connections: According to 4.3.3.1.
The mains lead (if any) is also connected to a coupling unit.

Operating conditions: According to 4.3.3.1.

Measurement procedure: According to 4.3.3.1.

Presentation of the results

When a passive equipment is tested, its screening effectiveness a_s shall be given in terms of the ratio, expressed in decibels, between the maximum power at the input of the equipment under test and the corrected highest measured conducted power at each frequency of measurement. The results shall comply with the limits given in Table 10.

4.5.3.2 Measurement of screening effectiveness in the frequency range 30 MHz to 950 MHz using the "absorbing clamp" method

Equipment required: According to 4.3.3.2.

Equipment layout and connections: According to 4.3.3.2.

Operating conditions: According to 4.3.3.2.

Measurement procedure: According to 4.3.3.2.

Presentation of results

When a passive equipment is tested, its screening effectiveness a_s shall be given in terms of the ratio, expressed in decibels, between the maximum power at the input of the equipment under test and the highest measured radiated power at each frequency of measurement. The results shall comply with the limits given in Table 10.

4.5.3.3 Measurement of screening effectiveness in the frequency range 950 MHz to 25 GHz using the "substitution" method

Equipment required: According to 4.3.3.3.

Equipment layout and connections: According to 4.3.3.3.

Operating conditions: According to 4.3.3.3.

Measurement procedure: According to 4.3.3.3.

Presentation of results

When a passive equipment is tested, its screening effectiveness a_s shall be given in terms of the ratio, expressed in decibels, between the maximum power at the input of the equipment under test and the highest measured radiated power at each frequency of measurement. The results shall comply with the limits of Table 10.

4.6 Electrostatic discharge immunity test for active equipment

The test method and the procedure shall be the direct contact method of IEC 61000-4-2, according to IEC 61000-6-1, Table 1 – Immunity – Enclosure port – Item 1.5: Electrostatic discharge.

Performance criterion B (according to IEC 61000-6-1):

The equipment shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be

replaced by a permissible loss of performance. During the test, degradation of performance however is allowed. No change of actual operating state or stored data is allowed.

The test specifications are given in 5.6.

4.7 Electrical fast transient/burst immunity test for AC power ports

The test method and the procedure shall be those given in IEC 61000-4-4, according to IEC 61000-6-1, Table 4 – Immunity – input and output AC power ports – Item 4.5: Fast transients.

The test specifications are given in 5.7.

Performance criterion B according to 4.6.

4.8 Methods of measurement for telecom signal ports of multimedia network equipment

Telecom signal ports of multimedia network equipment (i.e. cable network equipment with additional telecom signal port(s)) shall be tested according to EN 300 386.

5 Performance requirements

5.1 General

5.1.1 Emission performance requirements

The disturbance level shall not exceed the limits specified in 5.2 and 5.3 when measured using the methods given in Clause 4. At the transition frequencies, the lower limit applies.

5.1.2 Immunity performance requirements

Equipment under test shall meet the performance criterion as specified in 4.4.2 under the presence of the disturbing levels/limit values specified in 5.4.

5.2 Disturbance voltages from equipment

5.2.1 Limits of mains terminal disturbance voltage

Measurement shall be made in accordance with 4.2.1.

Table 2 – Limits of mains terminal disturbance voltage

Frequency range MHz	**Limit values** dB(µV)	
	Quasi peak	**Average value**
0,009 to 0,15	Under consideration	
0,15 to 0,5	66 to 56 [a]	56 to 46 [a]
0,5 to 5	56	46
5 to 30	60	50
[a] Decreasing linearly with the logarithm of the frequency.		

5.2.2 Limits of input terminal disturbance voltages

Measurement shall be made in accordance with 4.2.3.

Table 3 – Limits of input terminal disturbance voltages

Frequency range MHz	Oscillator frequency	Level (75 Ω) dB(μV)
30 to 3 000	Fundamental	46
30 to 3 000	Harmonics	46

5.3 Radiation

5.3.1 Radiation from active equipment

Measurements shall be made in accordance with 4.3.3.1, 4.3.3.2 or 4.3.3.3.

The radiation level is measured with a receiver having measuring bandwidths and detectors as stated in Table 4 (reproduced from CISPR 16-1-1).

For single carrier measurements also other receivers can be used.

Table 4 – Limits of radiated disturbance power

Frequency range MHz	Limit values dB(pW)	Measuring bandwidth kHz	Detector
5 to 30	27 – 20 [a], [b]	9	Quasi-peak
5 to 30	33 [c]	9	Quasi-peak
30 to 950	20	120	Quasi-peak
950 to 2 500	43	1 000	Peak
2 500 to 25 000	57	1 000	Peak
[a] Decreasing linearly with the logarithm of frequency. [b] For active equipment which is not powered via a mains line [c] For mains powered equipment			
NOTE The limit of 50 dB(μV) for disturbance voltages on the mains line in the frequency range 5 MHz to 30 MHz is corresponding to a radiated disturbance power of 33 dB(pW). To avoid different limits for the mains line and other ports the radiation requirements for equipment having a mains line is increased to 33 dB(pW).			

5.3.2 Local oscillator power at the outdoor unit input

Measurement shall be made in accordance with 4.3.3.4.

Table 5 – Limits of local oscillator terminal power

Frequency range GHz	Level dB(pW)
2,5 to 25	30