INTERNATIONAL STANDARD

IEC 60728-2

First edition
2002-10

Cabled distribution systems for television and sound signals –

Part 2: Electromagnetic compatibility for equipment



Reference number
IEC 60728-2:2002(E)

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Cabled distribution systems for television and sound signals –

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International Electrotechnical Commission
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PRICE CODE S

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CABLED DISTRIBUTION SYSTEMS FOR TELEVISION AND SOUND SIGNALS –

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.

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

FDIS	Report on voting
100/535/FDIS	100/570/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 committee has decided that this publication remains valid until 2005. At this date, in accordance with the committee's decision, the publication will be

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- withdrawn;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

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INTRODUCTION

Standards of the IEC 60728 series deal with cabled distribution systems for television, sound and interactive multimedia signals including equipment, systems and installations

- for headend-reception, processing and distribution of sound and television signals and their associated data signals and
- for processing, interfacing and transmitting all kinds of interactive signals

using all applicable transmission media.

They cover all kinds of systems such as

- CATV-systems,
- MATV- and SMATV-systems,
- individual receiving systems

and all kinds of equipment installed in such systems.

The extent of these standards is from the antennas, special signal source inputs to the headend or other interface points to the system up to the system outlet or the terminal input, where no system outlet exists.

The standardisation of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals, etc.) is excluded.

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CABLED DISTRIBUTION SYSTEMS FOR TELEVISION AND SOUND SIGNALS –

Part 2: Electromagnetic compatibility for equipment

1 Scope

This standard

– applies to the radiation characteristics and immunity to electromagnetic disturbances of active and passive equipment for the reception, processing and distribution of television, sound and interactive services signals, as dealt with in the following parts of IEC 60728 series:

  IEC 60728-3 – “Active coaxial wideband distribution equipment”

  IEC 60728-4 – “Passive coaxial wideband distribution equipment”

  IEC 60728-5 – “Headend equipment”

  IEC 60728-6 – “Optical equipment”

– 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)[1]

– specifies requirements for maximum allowed radiation, minimum immunity and minimum screening effectiveness.

– describes test methods for conformance testing.

Coaxial cables for cabled distribution systems do not fall under the scope of this standard. Reference is made to the EN 50117 series.

Standardisation in the field of electromagnetic compatibility for any user terminals (for example tuners, receivers, decoders, multimedia terminals etc.) is covered by the IEC CISPR 13 and CISPR 20.

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.

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*
Amendment 1 (1997)
Amendment 2 (1998)

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[1] For the frequency range 3 GHz to 25 GHz for "Screening effectiveness of passive equipment" no requirements apply at present. Methods of measurement and limits are under investigation for inclusion in a future amendment or revised edition.

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IEC 60728-3:2000, *Cabled distribution systems for television and sound signals – Part 3: Active coaxial wideband distribution equipment*

IEC 60728-4:2000, *Cabled distribution systems for television and sound signals – Part 4: Passive coaxial wideband distribution equipment*

IEC 60728-5:2001, *Cabled distribution systems for television and sound signals – Part 5: Headend equipment*

IEC 60728-6:2001, *Cabled distribution systems for television and sound signals – Part 6: Optical equipment*

IEC 60966-2-4:1997, *Radio frequency and coaxial cable assemblies – Part 2-4: Detail specification for cable assemblies for radio and TV receivers (Frequency range 0 to 3 000 MHz, IEC 60169-2 connectors*)

IEC 60966-2-5:1998, *Radio frequency and coaxial cable assemblies – Part 2-5: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 to 1 000 MHz, IEC 60169-2 connectors*

IEC 60966-2-6:1998, *Radio frequency and coaxial cable assemblies – Part 2-6: Detail specification for cable assemblies for radio and TV receivers – Frequency range 0 to 3 000 MHz, IEC 60169-24 connectors*

IEC 61000-3-2:2000, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*
Amendment 1 (2001)

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*
Amendment 1 (1998)
Amendment 2 (2000)

IEC 61000-4-3 2002, *Electromagnetic compatibility (EMC – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test.* Basic EMC Publication

Amendment 1 (2000)
Amendment 2 (2001)

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*
Amendment 1 (2000)

IEC 61000-6-1:1997, *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 1: 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*

CISPR 13:2001, *Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement*

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CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 20:2002, *Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this standard, the definitions given in IEC 60050-161 as well as the following, apply.

3.1.1
radiation (electromagnetic)
1) phenomenon by which energy in the form of electromagnetic waves emanates from a source into space
2) energy transferred through space in the form of electromagnetic waves

[IEV 161-01-10]

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

3.1.2
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]

3.1.3
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]

3.1.4
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 antenna

[IEV 161-03-07]

3.1.5
mains immunity
immunity to mains-borne disturbance

[IEV 161-03-03]

3.1.6
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 level of performance

[IEV 161-03-14, modified]

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3.1.7
immunity limit
specified minimum immunity level

[IEV 161-03-15]

3.1.8
immunity margin
difference between the immunity limit of a device, equipment or system and the electromagnetic compatibility level

[IEV 161-03-16]

3.1.9
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.

3.1.10
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

3.1.11
well-matched
matching condition when the return loss of the equipment complies with the requirements of IEC 60728-3, Table 1

3.1.12
well-screened
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

3.1.13
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

3.1.14
operating frequency range
passband for the wanted signals for which the equipment has been designed

3.1.15
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

3.1.16
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 shall be simulated using two sinewave test signals.

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3.1.17
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

3.1.18
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).

3.1.19
individual receiving system
system designed to provide television and sound signals to an individual household

3.1.20
spurious signals
all unwanted signals in the frequency range of interest

3.1.21
band
nominal operating frequency range of the equipment

3.1.22
electrostatic discharge (ESD)
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[IEV 161-01-22]

3.1.23
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]

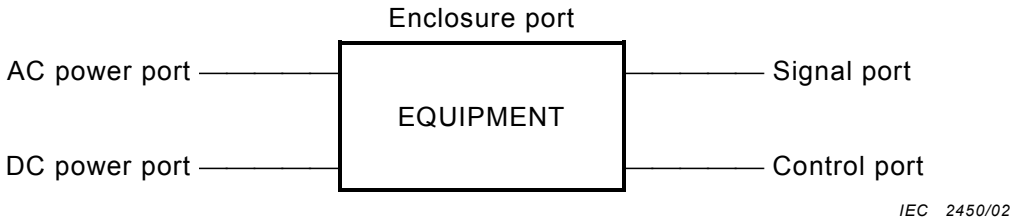
3.1.24
burst
sequence of a limited number of distinct pulses or an oscillation of limited duration

[IEV 161-02-07]

3.1.25
test levels
the preferential range of test level for ESD or fast transient test

3.1.26
port
particular interface of the specific equipment with the external electromagnetic environment

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3.1.27
enclosure port
physical boundary of the equipment through which electromagnetic fields may be transmitted

3.1.28
signal port
point at which a cable for the wanted signal is connected to the equipment

3.1.29
control port
point at which a cable for the control signal is connected to the equipment

3.1.30
a.c. power port
point at which a cable for the a.c. power supply is connected to the equipment

3.1.31
d.c. power port
point at which a cable for the d.c. power supply is connected to the equipment

3.1.32
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 (for example input/output frequencies, IF, video band, etc.)

3.1.33
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 (for example input/output frequencies, IF, video band, etc.)

3.1.34
RF signal port
antenna input port or RF network port

3.1.35
antenna input port
input terminal of the equipment (for example channel converter, DBS tuner,...) under test

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

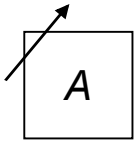
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3.2 Symbols

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.



Sine-wave generator
(10-13-02)



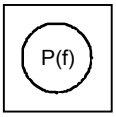
Variable attenuator
(10-16-02)



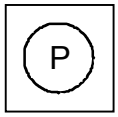
Low-pass filter
(10-16-05)



Signal combiner
(02-01-01)



Spectrum analyser
(02-01-01, 08-01-01)



Power meter
(02-01-01, 08-01-01)



Equipment under test
(02-01-01)



Coupler
(10-09-09)

3.3 Abbreviations

The following abbreviations are used in this standard:

AC or a.c.	Alternating Current
AM	Amplitude Modulation
BSS	Broadcast Satellite Services
CATV	Community Antenna Television (system)
COFDM	Coherent Orthogonal Frequency Division Multiplex
CW	Continuous Wave
DBS	Direct Broadcast Satellite
DC or d.c.	Direct current
DSR	Digital Satellite Radio
EMC	Electromagnetic Compatibility
emf	Electromotive force
EMI	Electromagnetic interference
EUT	Equipment Under Test
FM	Frequency Modulation
FSS	Fixed Satellite Services
IF	Intermediate Frequency
MATV	Master Antenna Television (system)
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SAT	Satellite
S-channel	Special channel
SMATV	Satellite Master Antenna Television (system)
TV	Television
VHF	Very High Frequency
VSB	Vestigial Side Band

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4 Methods of measurements

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.

4.1 Disturbance voltages from equipment

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

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

The measured voltage includes narrow-band interference and broadband interference such as that produced by semiconductor rectifiers.

4.1.1.1 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 narrow-band measurements.

4.1.1.2 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 manufacturer's 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 a value within the specified rating.
- 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 1.

4.1.2 Disturbance voltages from equipment at the a.c. 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.

4.1.3 Measurement of input terminal disturbance voltage

4.1.3.1 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 (for example channel converter, DBS tuner, etc.) under test.

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4.1.3.2 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 2.

4.2 Radiation from active equipment

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

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

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

4.2.1 General measurement requirements

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 have an impedance of 75 Ω or be 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.

Measurements shall be made at the following ports:

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

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.

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Input ports:

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

4.2.2 Methods of measurements

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

For the measurement of radiation in the 5 MHz to 30 MHz frequency range the coupling unit method suitable for coaxial cables with a characteristic impedance of 75 Ω shall be used to measure the conducted emissions from the equipment under test.

NOTE The use of the absorbing clamp method in this frequency range is also possible. This clamp has similar properties as the 150 Ω coupling units and can be used whenever the coupling units cannot be realised or applied (either due to the number of conductors in one cable or due to the size of the installation or for other reasons). The measurement set-up and the calibration factors are shown in the manual of the injection clamp.

4.2.2.1.1 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).
- 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 should 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.

4.2.2.1.2 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.

The cables to the input and output of the equipment should be no 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.

4.2.2.1.3 Operating conditions

The equipment under test shall operate in accordance with the manufacturers recommend-ations 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.

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4.2.2.1.4 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.

4.2.2.1.5 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 3.

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

4.2.2.2.1 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.
- A measuring set of appropriate impedance covering the frequency range of interest.
- A measurement cable of length at least λ/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.

4.2.2.2.2 Equipment layout and connections

The measurement set-up and equipment layout for the "absorbing clamp" method (30 MHz to 950 MHz) is shown in Figures 2, 3 and 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 (for example 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 4.2.2.4

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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.

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 be 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 (for example ferrite rings), placed close to the equipment under test, to avoid measurement errors.

4.2.2.2.3 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 Figures 2 and either 3 or 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.

4.2.2.2.4 Measurement procedure

With the equipment set-up as shown in Figures 2 and 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 $\lambda/2$).

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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.

4.2.2.2.5 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 3.

4.2.2.3 Measurement of radiation in the 950 MHz to 25 GHz frequency range using the “substitution” method

4.2.2.3.1 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).

4.2.2.3.2 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 5a.

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 (for example 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 4.2.2.4.

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

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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 (for example ferrite rings), placed close to the equipment under test, to avoid measurement errors.

4.2.2.3.3 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

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

where:

b is the widest 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.

4.2.2.3.4 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.

4.2.2.3.5 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.

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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 5b.

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.

NOTE 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.

4.2.2.3.6 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 3.

4.2.2.4 Measurement of local oscillator power at the outdoor unit input

4.2.2.4.1 Method of measurement

The power at the outdoor unit input (inclusive of for example polariser, orthomode transducer, bandpass filter, RF waveguide, etc.) shall be measured according to the measurement method described in 4.2.2.3, 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 (for example R120, C120) is available, the local oscillator power can be measured by a power meter combined with a corresponding adapter.

4.2.2.4.2 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 4.

4.3 Immunity of active equipment

a) Introduction

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

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b) Performance criterion

For the scope of this standard, the immunity level will 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
under consideration	for DSR, QPSK, QAM, COFDM

when measured at the output of the equipment under test.

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

4.3.1 Measurement of the external immunity to ambient fields

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

The out-of-band immunity test is only relevant to active equipment connected directly or via a broadband antenna pre-amplifier to receiving antennas.

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

For the 80 MHz to 3 GHz disturbance frequency range 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 3 GHz to 25 GHz frequency range no requirements apply at present.

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

4.3.1.1.1 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 (Figures 13 and 14). For converters, the disturbance field shall be at frequencies outside both the input and output nominal frequency ranges.

For broadband equipment, measurements shall be carried out using a disturbance field at frequencies outside the nominal frequency ranges of the equipment under test (Figures 13 and 14). 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.

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

Equipment with nominal frequency ranges >950 MHz for FM applications:

Test channels with bandwidth	27 MHz
at centre frequencies:	970, 1220, 1470, 1720, 1970, 2220, 2470, 2720, 2970 MHz

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4.3.1.1.2 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 5 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.

4.3.1.1.3 Out-of-band immunity

For the scope of this standard, the external immunity level corresponds to the level of the incident electromagnetic disturbance outside the nominal frequency ranges, which produces a just perceptible interference (see note to 4.3) 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.

4.3.1.1.4 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 4.3.

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.

4.3.1.1.5 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 4.3, and shall comply with the relevant limit given in Table 5.

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4.3.1.2 In-band immunity (unmodulated interfering signal)

For the 150 kHz to 80 MHz disturbance frequency range 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 80 MHz to 3 GHz disturbance frequency range 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 3 GHz to 25 GHz frequency range no requirements apply at present.

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

4.3.1.2.1 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.

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

4.3.1.2.2 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 (Figures 15 and 16). The test frequencies shall be selected to obtain a realistic representation 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.

Equipment with nominal frequency ranges <950 MHz for AM applications:

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

Equipment with nominal frequency ranges >950 MHz for FM applications:

Wanted signal frequencies: 970, 1220, 1470, 1720, 1970, 2220, 2470, 2720, 2970 MHz

4.3.1.2.3 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.

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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 a level of 70 dB(μV) shall be applied to the input.

4.3.1.2.4 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 4.3) under the above-mentioned testing conditions at the output of the equipment under test.

4.3.1.2.5 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 4.3.

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.

4.3.1.2.6 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 4.3 and shall comply with the relevant limit given in Table 6.

4.3.2 Internal immunity (immunity to unwanted signals)

a) 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.

b) 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 4.3.

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c) Test set-up

The test set-up is shown in Figure 6. 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.

d) 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 of 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.

e) Test conditions

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.

f) Internal immunity to out-of-band disturbing signals

The level of the wanted signal shall be adjusted according to the specifications given in 4.3.2 1 for the 47 MHz to 862 MHz frequency range and in 4.3.2 2 for the 10,70 GHz to 12,75 GHz frequency range.

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), comply with the performance criteria (see 4.3).

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 (for example 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.

g) Internal immunity to in-band disturbing signals

The level of the wanted signal shall be adjusted according to the specification given in 4.3.2.2. 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.

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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 complies with the performance criterion given in 4.3.

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.

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

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 complies with the performance criterion given in 4.3.

Measurements shall be performed with the set-up of Figure 6 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 7 and shall be spaced 1 MHz one from the other.

NOTE This requirement shall not apply to channel-selective equipment designed for the frequency range 87,5 MHz to 108 MHz. The method of measurement for this kind of equipment is under consideration.

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.

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 4.3, with the appropriated test specification of Table 7.

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

4.3.2.2.1 Limits of application

The measurement of internal immunity for outdoor-units in the 10,70 GHz to 12,75 GHz frequency range has to be considered 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 6 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 11 and Figure 12. The levels of the two unmodulated carriers (representing the unwanted signal) shall be 6 dB down from that specified in Table 7 and shall be spaced 1 MHz one from the other.

4.3.2.2.2 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 4.3.

This is based on the assumption that at least one wanted signal and one unwanted signal, in accordance with the limit curves given in Figures 11 and 12, are involved.

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The carrier-to-interference ratio of outdoor units for the reception of digital sound radio signals (DSR) and their conversion to the 70 MHz to 862 MHz range (for example to S-channels S2 and S3 with a centre frequency of 118 MHz) is under consideration.

4.3.2.2.3 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.

4.3.2.2.4 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 4.3, with the appropriate test specification of Table 7.

4.3.2.3 Immunity of outdoor units to image frequency signals

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- and/or DSR-signals with output frequencies in the SAT-IF-range and for outdoor units exclusively used for the reception and conversion of DSR-signals to the 70 MHz to 862 MHz frequency range (for example to S-channels S2 and S3 with a centre frequency of 118 MHz).

The measurement shall be made according to the method given in 3.10 of IEC 61079-1:1992.

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 4.3, with the limits given in Table 8.

4.4 Screening effectiveness of passive equipment

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

In the 5 MHz to 30 MHz frequency range the “coupling unit” method described in 4.2.2.1 shall be used.

In the 30 MHz to 950 MHz frequency range the “absorbing clamp” method described in 4.2.2.2 is used.

In the 950 MHz to 25 GHz frequency range the “substitution” method described in 4.2.2.3 is used.

4.4.1 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 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.

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.

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4.4.2 Methods of measurements

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

- Equipment required: according to 4.2.2.1.
- Equipment layout and connections: according to 4.2.2.1.
- Operating conditions: according to 4.2.2.1.
- Measurement procedure: according to 4.2.2.1.
- 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 9.

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

- Equipment required: according to 4.2.2.2.
- Equipment layout and connections: according to 4.2.2.2.
- Operating conditions: according to 4.2.2.2.
- Measurement procedure: according to 4.2.2.2.
- 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 9.

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

- Equipment required: according to 4.2.2.3.
- Equipment layout and connections: according to 4.2.2.3.
- Operating conditions: according to 4.2.2.3.
- Measurement procedure: according to 4.2.2.3.
- 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 9.

4.5 Electrostatic discharge immunity test for active equipment

The test method and the procedure shall be the direct contact method of IEC 61000-4-2, (see 8.3.1) according to IEC 61000-6-1, Table 1, item 1.4: Electrostatic discharge.

Performance criterion B (according to IEC 61000-6-1, Clause 5):

> 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 is however allowed. No change of actual operating state or stored data is allowed.

The test specifications are given in 5.5.

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4.6 Electrical fast transient/burst immunity test for a.c. 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, item 4.5: Fast transient.

The test specifications are given in 5.6.

Performance criterion B according to 4.5.

5 Performance requirements

- Emission: the disturbance level shall not exceed the limits specified in 5.1 and 5.2 when measured using the methods given in Clause 4. At the transition frequencies, the lower limit applies.
- Immunity: equipment under test shall meet the performance criterion as specified in 4.3, under the presence of the disturbing levels/limit values specified in 5.3.

5.1 Disturbance voltages from equipment

5.1.1 Limits of mains terminal disturbance voltage

The measurement shall be made in accordance with 4.1.1.

Table 1 – 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.		

5.1.2 Limits of input terminal disturbance voltages

The measurement shall be made in accordance with 4.1.3.

Table 2 – 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

5.2 Radiation

5.2.1 Radiation from active equipment

The measurements shall be made in accordance with 4.2.2.1, 4.2.2.2 or 4.2.2.3.

In case of broadband interference (no single carrier interference), the radiation level is measured with a receiver having a quasi-peak detector and measuring bandwidths as stated in Table 3 (according to CISPR 16-1).

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For single carrier measurements other receivers can also be used.

Table 3 – Limits of radiated disturbance power

Frequency range MHz	Limit values dB(pW)	Measuring bandwidth kHz
5 to 30	27 – 20 [a)]	9
30 to 950	20	120
950 to 2 500	43	1 000
2 500 to 25 000	57	1 000
[a)] decreasing linearly with the logarithm of frequency.		

5.2.2 Local oscillator power at the outdoor unit input

Measurement shall be made in accordance with 4.2.2.4.

Table 4 – Limits of local oscillator terminal power

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

5.3 Immunity of active equipment

5.3.1 External immunity to electromagnetic fields

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

Measurement shall be made in accordance with 4.3.1.1.

Table 5 – Limits of out-of-band immunity (lowest level/field strength for compliance with the performance criterion, given in 4.3)

Frequency range MHz	Level [a)] dB(µv) (emf)	Field strength dB(µV/m)
0,15 to 80	125	
80 to 950		125
950 to 3 000 (FM)		125
3 000 to 25 000		under consideration
[a)] This requirement is not applicable to signal and control ports interfacing with cables whose total length according to the manufacturer's functional specifications may not exceed 3 m. For a.c. and d.c. power ports this requirement shall be applied without restriction.		

5.3.1.2 In-band immunity (unmodulated interfering signal)

Measurement shall be made in accordance with 4.3.1.2.

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Table 6 – Limits of in-band immunity (lowest level/field strength for compliance with the performance criterion, given in 4.3)

Frequency range MHz	Level [a] dB(µv) (emf)	Field strength dB(µV/m)
0,15 to 80	106	
80 to 950		106
950 to 3 000 (FM)		106
3 000 to 25 000		under consideration

[a] This requirement is not applicable to signal and control ports interfacing with cables whose total length according to the manufacturer's functional specifications may not exceed 3 m. For a.c. and d.c. power ports, this requirement shall be applied without restriction.

NOTE 1 For equipment connected directly to receiving antennas, in-band immunity requirements do not have to be applied for the input frequency ranges.

NOTE 2 The external immunity of a complete cable network may be higher than the external immunity of the equipment as a result of the building attenuation, etc.

5.3.2 Internal immunity

Measurement shall be made in accordance with 4.3.2.

Table 7 – Test specification for internal immunity

Frequency range MHz	Level
47 to 68	see Figure 7
87,5 to 108	see Figure 8
174 to 230	see Figure 9
470 to 862	see Figure 10
10 200 to 13 000 [a]	see Figure 11
10 200 to 13 000 [b]	see Figure 12

[a] for FSS outdoor units.

[b] for BSS outdoor units.

5.3.3 Immunity of outdoor units to image frequency signals

Measurement shall be made in accordance with 4.3.2.3.

Table 8 – Limits of immunity to image frequency signals in terms of image suppression ratio

Type of equipment	Output frequency MHz	Limit values dB
Outdoor units	950 to 3 000	40

5.4 Screening effectiveness of passive equipment

Measurement shall be made in accordance with 4.4.2.1, 4.4.2.2 or 4.4.2.3.

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Table 9 – Limits of screening effectiveness of passive equipment within the nominal frequency ranges

Frequency range MHz	Limit value dB	
	Class A	Class B
5 to 30	85	75
30 to 300	85	75
300 to 470	80	75
470 to 950	75	65
950 to 3 000	55	50

NOTE 1 For the specification of the limit values for the screening effectiveness, it has been assumed that the average interfering field strength at the passive equipment will be 106 dB(μV/m). Assuming a coupling factor[2] of about 11 dB (at 175 MHz) and an average signal level in cable network of 70 dB(μV), a screening effectiveness of 85 dB is necessary to achieve a RF carrier-to-interference signal ratio of 60 dB.

NOTE 2 The external immunity of a complete cable network may be higher than the external immunity of the equipment used as a result of the building attenuation, etc.

NOTE 3 Class A equipment shall be used where high external field strengths are expected and it is not possible to plan the channel allocation to avoid these frequencies.

5.5 Electrostatic discharge immunity test for active equipment

Measurements shall be made in accordance with 4.5.

Table 10 – Test specifications for electrostatic discharge immunity test for active equipment

Port	Charge voltage kV	Performance criterion
Enclosure	4	B

5.6 Electrical fast transient/burst immunity test for a.c. power ports

Measurements shall be made in accordance with 4.6.

Table 11 – Test specifications for electrical fast transient/burst immunity test

Port	Charge voltage kV	Performance criterion
AC power	1	B

[2] Ratio of the incident field strength in dB(μV/m) to the disturbing voltage in dB(μV) induced in the equipment (half-wave dipole model).

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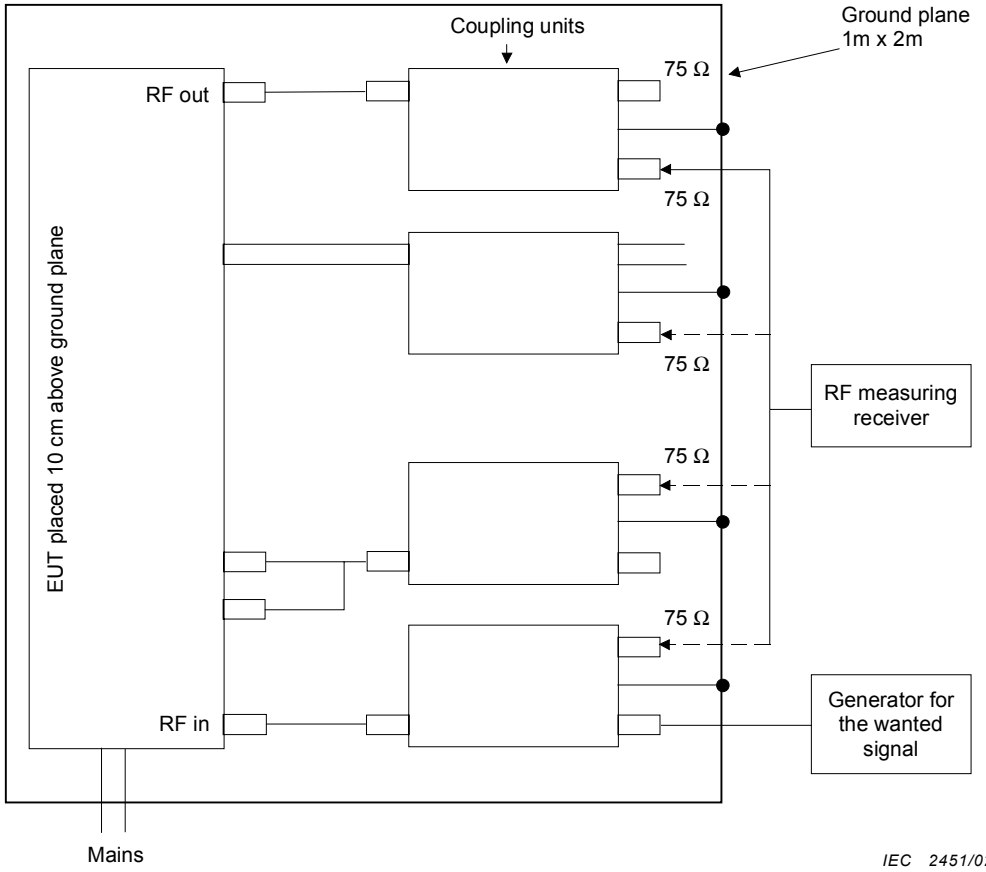


Figure 1 – Measurement set-up for radiation measurements in the 5 MHz to 30 MHz frequency range using the "coupling unit" method

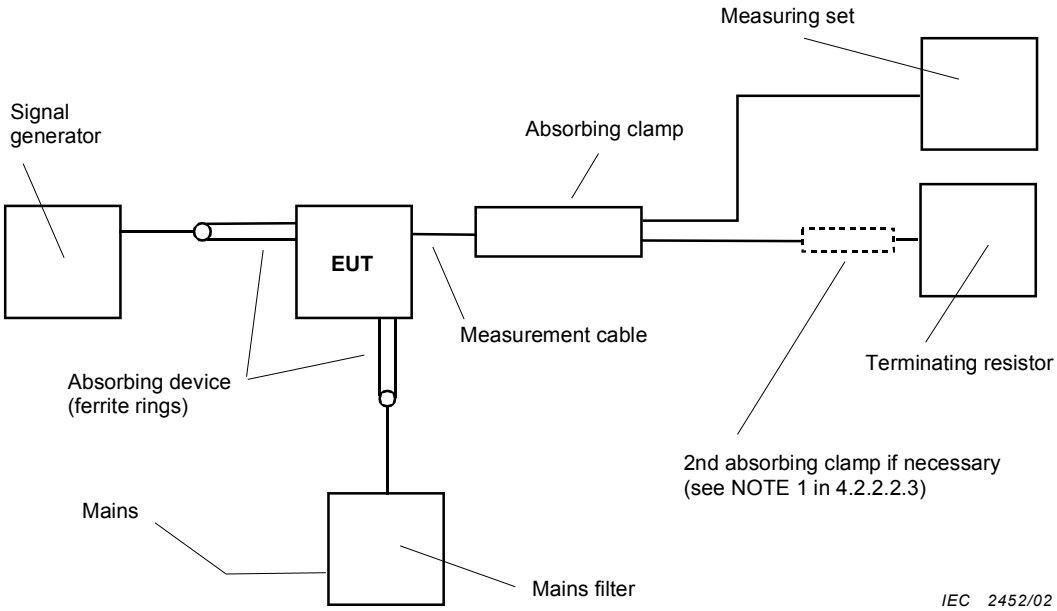
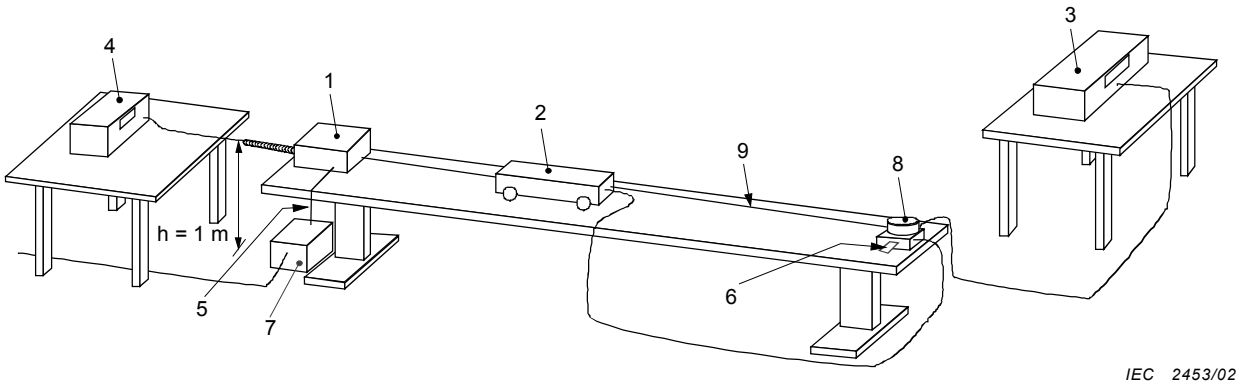


Figure 2 – Absorbing clamp method (30 MHz to 1 GHz)

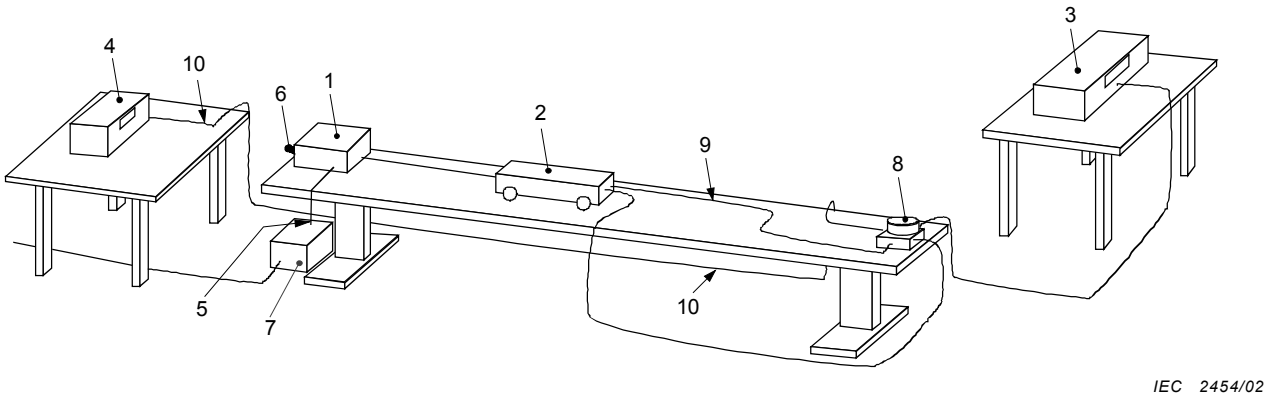
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Key

1	Equipment under test	6	Terminating resistor	Coaxial switch position:
2	Absorbing clamp	7	Mains filter	– measure radiation: 3 – 2 , 6 – 9
3	Measuring set	8	Coaxial filter	– 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 position:
2	Absorbing clamp	7	Mains filter	– measure radiation: 3 – 2 , 10 – 9
3	Measuring set	8	Coaxial filter	– 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 an active equipment

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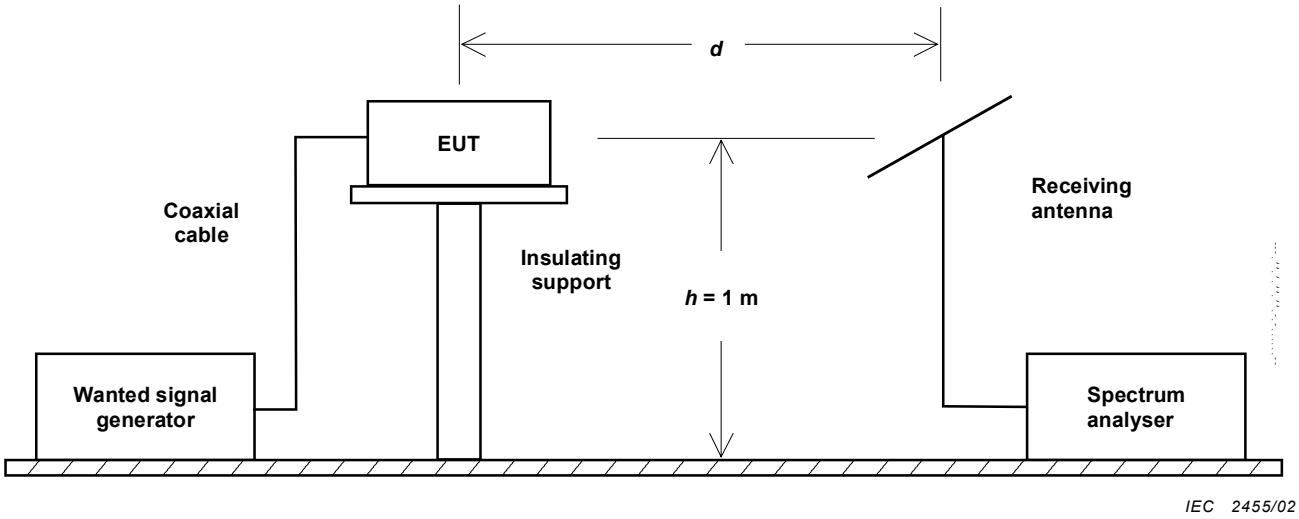


Figure 5a – First measurement step

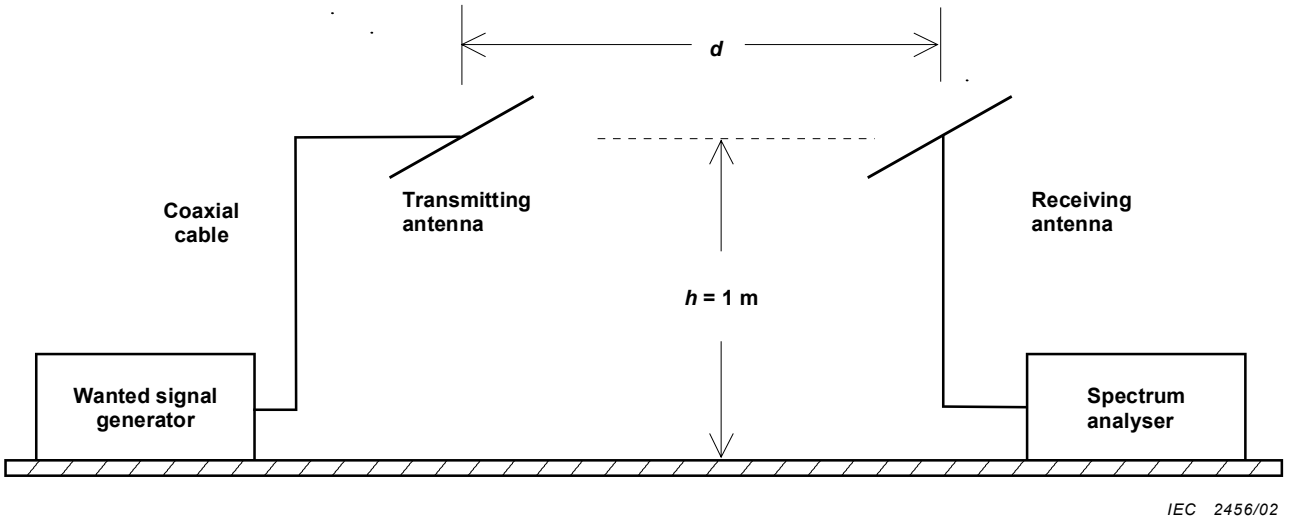


Figure 5b – Second measurement step

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

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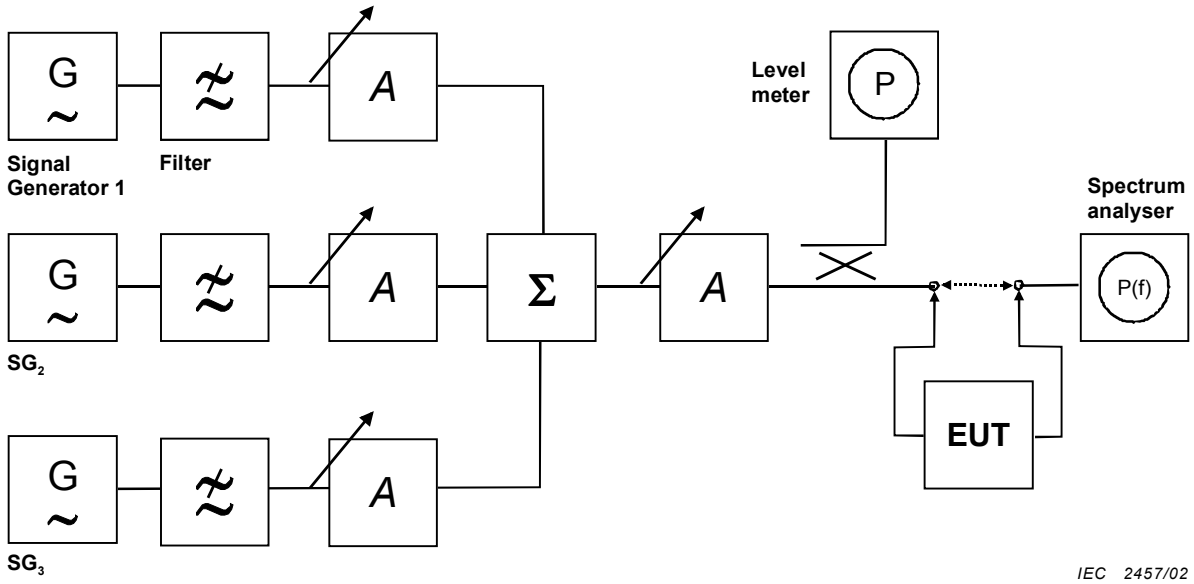
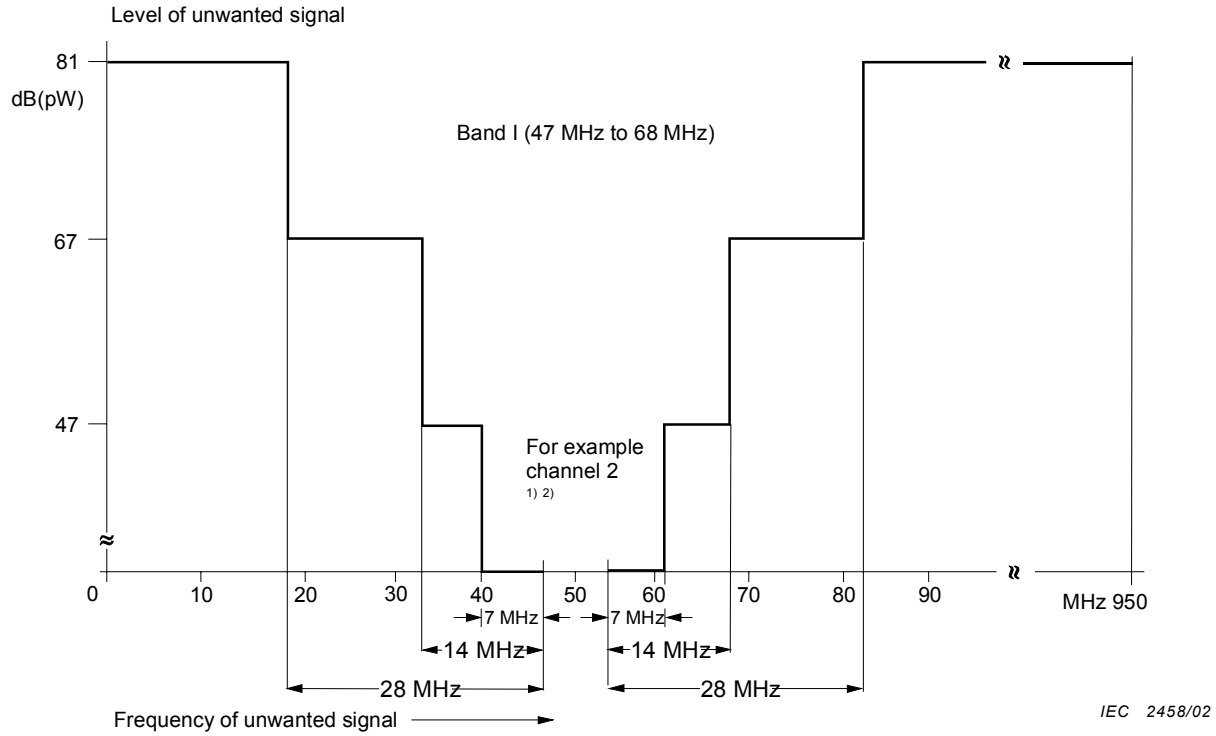


Figure 6 – Measurement set-up for internal immunity test

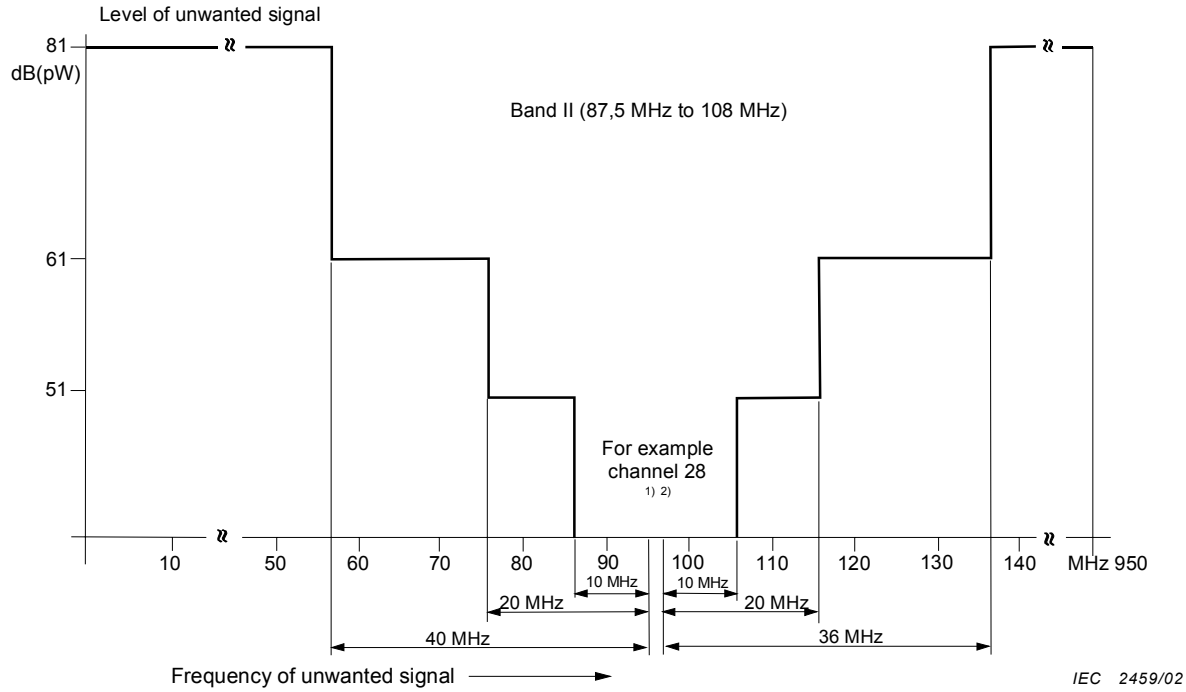


[1] Depending on the nominal frequency range of the active equipment (single channel equipment/broadband equipment), each half of the curve shall be shifted to the relevant band edges. For multiband equipment it may be necessary to combine the relevant limit curves (Figures 7 to 10).

[2] Level of wanted signal according to 4.3.2.1.

Figure 7 – Levels of unwanted signals for the internal immunity of active equipment in Band I (47 MHz to 68 MHz)

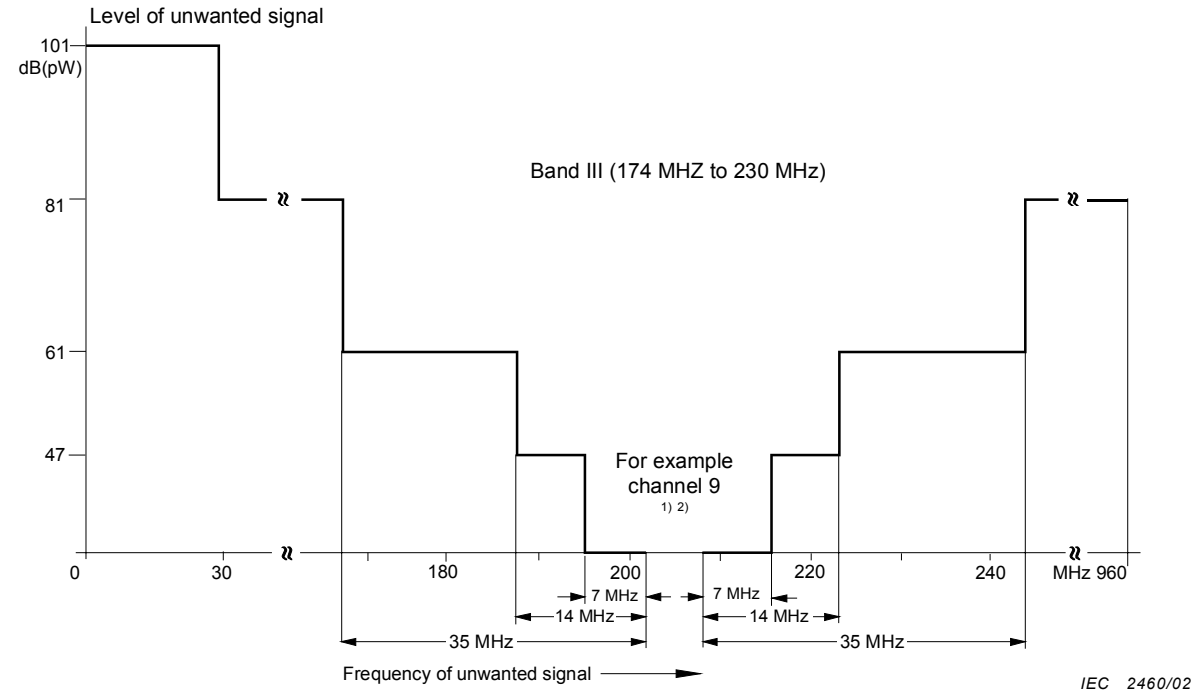
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[1] Depending on the nominal frequency range of the active equipment (single channel equipment/broadband equipment), each half of the curve shall be shifted to the relevant band edges. For multiband equipment it may be necessary to combine the relevant limit curves (Figures 7 to 10).

[2] Level of wanted signal according to 4.3.2 1.

Figure 8 – Levels of unwanted signals for the internal immunity of active equipment in Band II (87,5 MHz to 108 MHz)



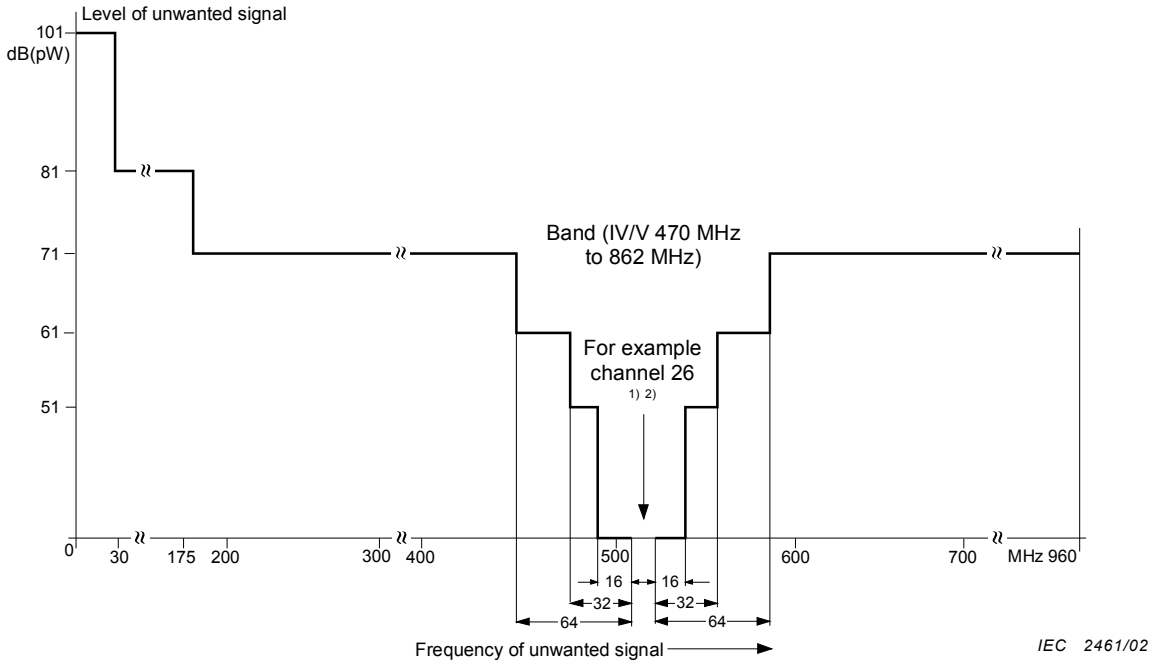
[1] Depending on the nominal frequency range of the active equipment (single channel equipment/broadband equipment), each half of the curve shall be shifted to the relevant band edges. For multiband equipment it may be necessary to combine the relevant limit curves (Figures 7 to 10).

[2] Level of wanted signal according to 4.3.2.1.

Figure 9 – Levels of unwanted signals for the internal immunity of active equipment in Band III (174 MHz to 230 MHz)

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[1] Depending on the nominal frequency range of the active equipment (single channel equipment/broadband equipment), each half of the curve shall be shifted to the relevant band edges. For multiband equipment it may be necessary to combine the relevant limit curves (Figures 7 to 10).

[2] Level of wanted signal according to 4.3.2.1.

Figure 10 – Levels of unwanted signals for the internal immunity of active equipment in Band IV/V (470 MHz to 862 MHz)

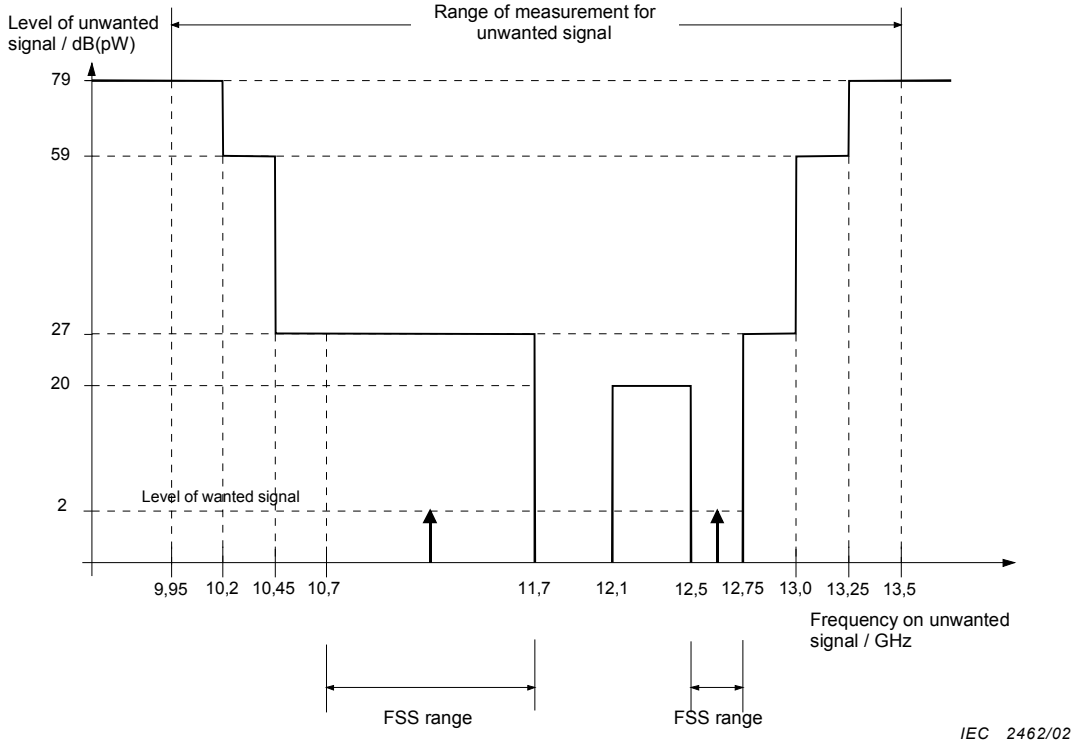


Figure 11 – Levels of wanted and unwanted signals for the internal immunity of FSS receiving outdoor units

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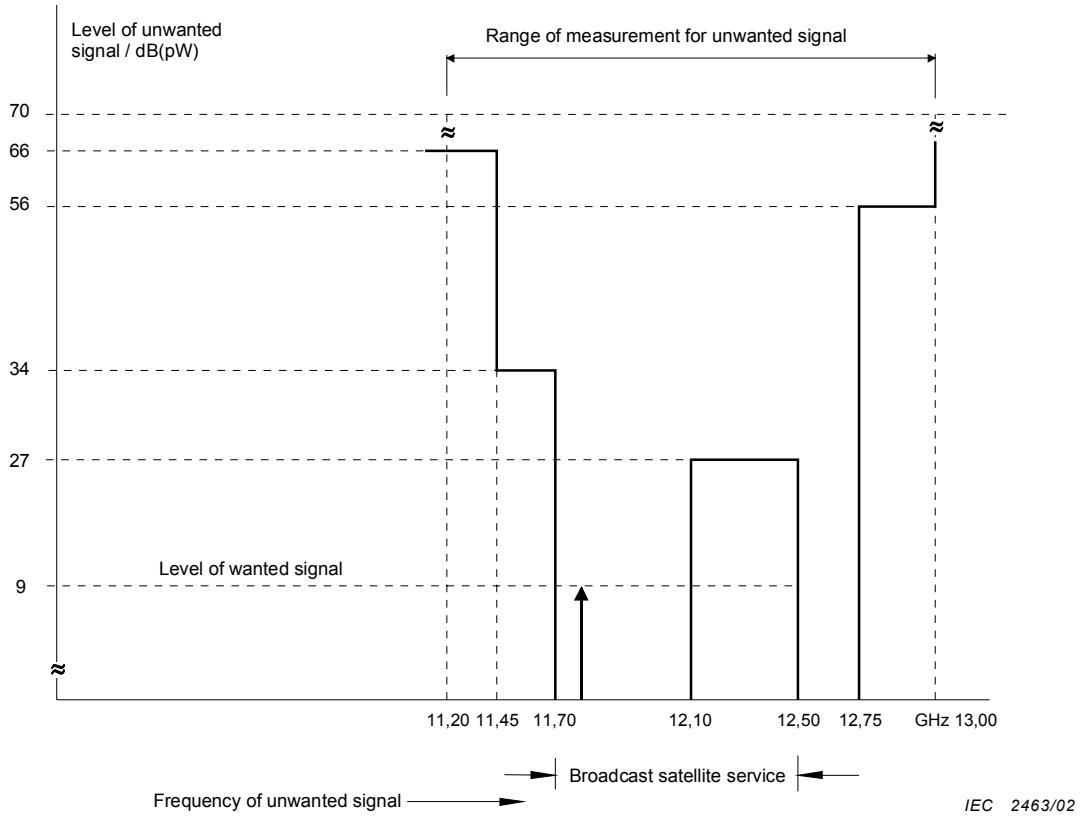


Figure 12 – Levels of wanted and unwanted signals for the internal immunity of BSS receiving outdoor units

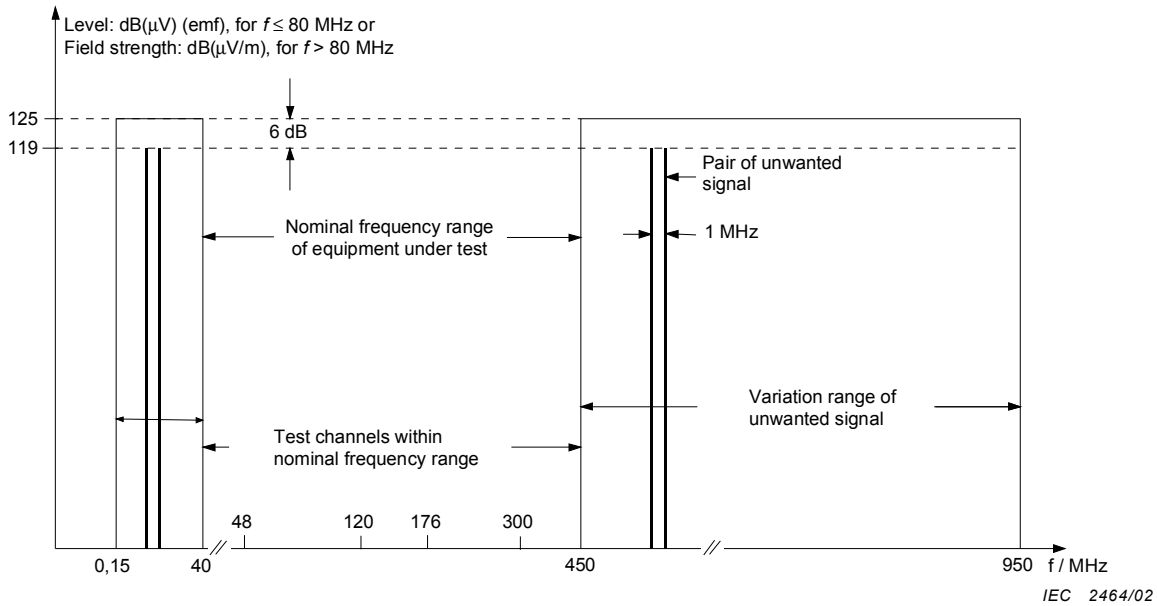


Figure 13 – Frequency allocation for out-of-band immunity measurement of active equipment with a nominal frequency range below 950 MHz for AM applications (example: VHF broadband amplifier; bandwidth 40 MHz to 450 MHz)

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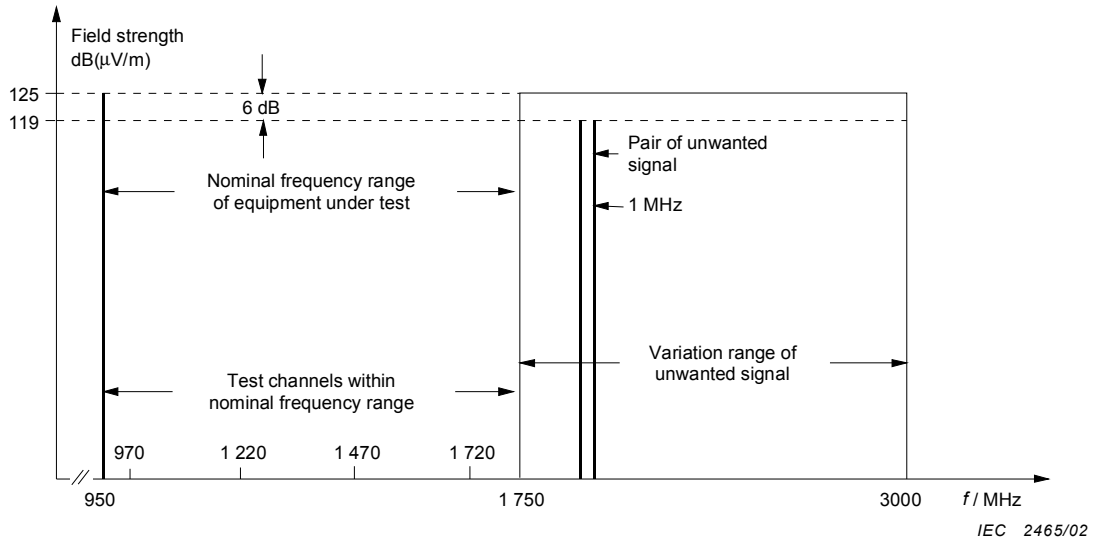


Figure 14 – Frequency allocation for out-of-band immunity measurement of active equipment with a nominal frequency range above 950 MHz for FM applications (example: IF amplifier; bandwidth 950 MHz to 1750 MHz)

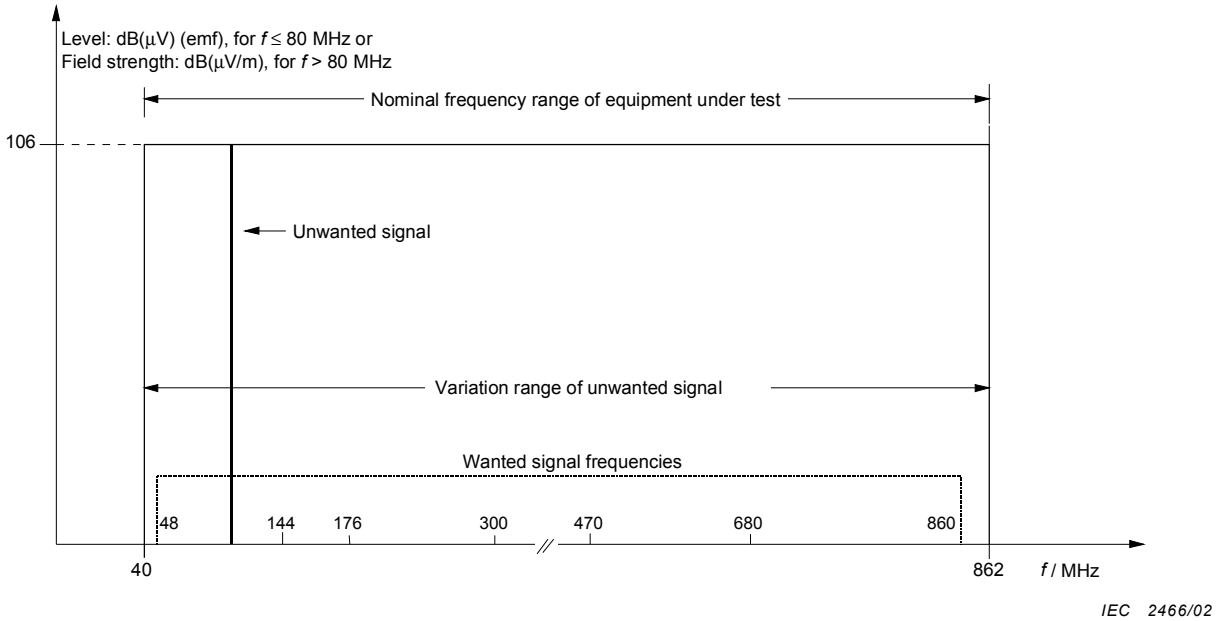


Figure 15 – Frequency allocation for in-band immunity measurement of active equipment with nominal frequency range below 950 MHz for AM applications (example: broadband amplifier; bandwidth 40 MHz to 862 MHz)

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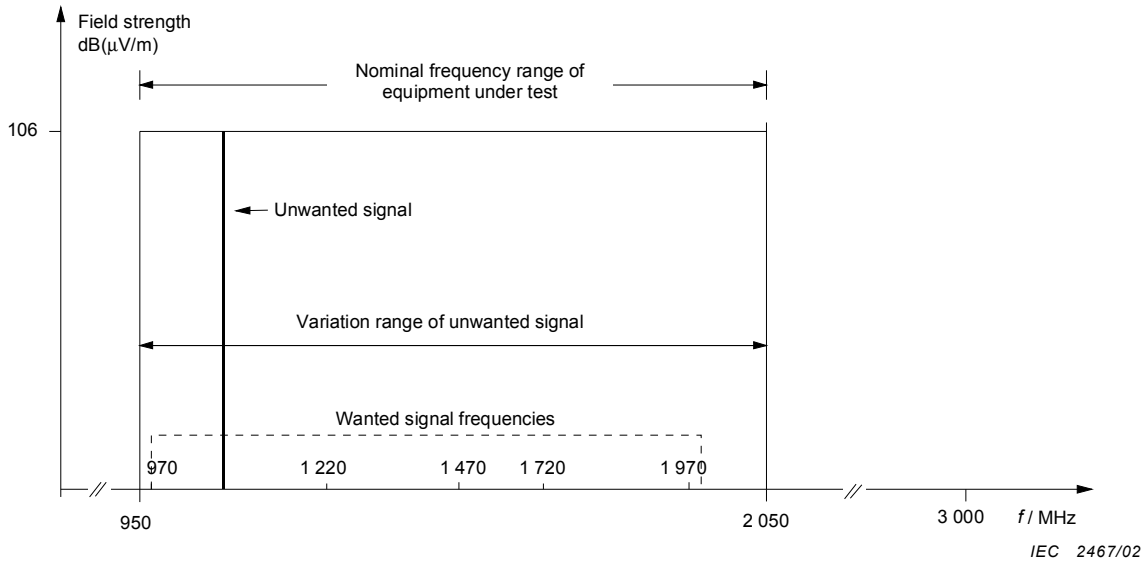


Figure 16 – Frequency allocation for in-band immunity measurement of active equipment with a nominal frequency range above 950 MHz for FM applications (example: IF amplifier; bandwidth 950 MHz to 2 050 MHz)

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ISBN 2-8318-6652-9



ICS 33.060.40; 33.100

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