BS EN 55020 : 1995

Incorporating Amendments Nos. 1, 2 and 3

Electromagnetic immunity of broadcast receivers and associated equipment

The European Standard EN 55020 : 1994 with the incorporation of amendment A11 : 1996 has the status of a British Standard

ICS 33.100

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/110, Electromagnetic compatibility, to Subcommittee GEL/110/5, Household sound and vision equipment, upon which the following bodies were represented:

British Radio and Electronic Equipment Manufacturers' Association
Cable Communications Association
ERA Technology Ltd.
Federation of the Electronics Industry
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Summary of pages

The following table identifies the current issue of each page. Issue 1 indicates that a page has been introduced for the first time by amendment. Subsequent issue numbers indicate an updated page. Vertical sidelining on replacement pages indicates the most recent changes (amendment, addition, deletion).

Page	Issue	Page	Issue
Front cover	4	5	2
Inside front cover	4	6 to 15	original
a	3	16	2
b	blank	17 to 19	original
i	original	20	2
ii	4	21 to 51	original
EN title page	4	52	blank
2	4	Inside back cover	original
3	2	Back cover	3
4	2		

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Foreword	2
Text of EN 55020	3

National foreword

This British Standard has been prepared by Subcommittee GEL/210/5 (formerly GEL/110/5) and is the English language version of EN 55020 : 1994 *Electromagnetic immunity of broadcast receivers and associated equipment*, together with its corrigendum : January 1995, published by the European Committee for Electrotechnical Standardization (CENELEC) and is related to CISPR Publication 20 : 1990 *Limits and methods of measurement of immunity characteristics of sound and television broadcast receivers and associated equipment*. Amendment No. 1 : 1996 implements the corrigendum of January 1996 to the English version of EN 55020 : 1995.

Attention is drawn to the provision whereby for products which complied with the requirements of BS 905 : Part 2 : 1991 before 31 December 1996, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for placing those products on the market until 31 December 1998 after which date BS 905 : Part 2 : 1991 will be withdrawn. For new products placed on the market after 31 December 1996, BS EN 55020 : 1995 applies.

Cross-references

Publication referred to	Corresponding British Standard
EN 55022 : 1994	BS EN 55022 : 1995 *Limits and methods of measurement of radio disturbance characteristics of information technology equipment*
IEC 50 (161) : 1990	BS 4727 *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms* Part 1 *Terms common to power, telecommunications and electronics* Group 09 : 1991 *Electromagnetic compatibility*
IEC 801-2 : 1991	BS EN 60801 *Electromagnetic compatibility for industrial-process measurement and control equipment* Part 2 : 1993 *Electromagnetic discharge requirements*
IEC 801-3 : 1984	BS 6667 *Electromagnetic compatibility for industrial-process measurement and control equipment* Part 3 : 1985 *Method of evaluating susceptibility to radiated electromagnetic energy*

Compliance with a British Standard does not of itself confer immunity from legal obligations.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 55020

December 1994

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Descriptors: Electromagnetic compatibility, radio interference, broadcast receiver, associated equipment, method of measurement, immunity, characteristics

English version

Electromagnetic immunity of broadcast receivers and associated equipment

Immunité électromagnétique des récepteurs de radiodiffusion et appareils associés

Störfestigkeit von Rundfunkempfängern und verwandten Geräten der Unterhaltungselektronik

This European Standard was approved by CENELEC on 1994-10-04. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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

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CENELEC

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

oreword

his European Standard has been prepared by ENELEC Sub-Committee 110A, EMC Products.

he first draft, which was submitted to the Unique cceptance Procedure (UAP) in October 1992, was pproved by CENELEC as EN 55020 on 993-07-06. At the same time a draft amendment, ubmitted to UAP as prAA in October 1992, was pproved for inclusion in the European Standard.

, second draft amendment, which grouped two raft International Standards containing proposed mendments to CISPR Publication 20, was ubmitted to UAP in April 1993 and was approved y CENELEC as amendment A11 on 1993-12-08.

, further draft amendment (prAB), which was rst submitted to UAP in June 1993 but failed the ote, was re-submitted to the formal vote in May 994, and was approved.

:LC/SC 110A decided to combine all the drafts into single document, which was approved by :ENELEC as EN 55020 on 4 October 1994.

he following dates were fixed:

Latest date of publication of an identical national standard	(dop) 1995-12-31
Latest date of withdrawal of conflicting national standards	(dow) 1998-12-31

or products which have complied with :N 55020 : 1988 before 1996-12-31, as shown by he manufacturer or by a certification body, this revious standard may continue to apply for lacing products on the market until 1998-12-31.

or new products, placed on the market after 996-12-31, the standard EN 55020 : 1994 applies.

nnexes designated 'normative' are part of the ody of the standard. Annexes designated informative' are given for information only. In this tandard all annexes are normative.

he structure of this standard has been brought in ne with CENELEC Report R110-001 : 1993, Guide r. EMC standardization for product committees.

Contents

		Page
Foreword		2
1	Scope	4
2	Normative references	4
3	Objective	4
4	Definitions	5
5	Description of locations	6
6	Performance criteria	7
6.1	Performance criterion A	7
6.1.1	Evaluation of audio quality	7
6.1.2	Evaluation of picture quality	7
6.2	Performance criterion B	7
6.3	Performance criterion C	7
7	Conditions during testing	7
7.1	Measurement procedure for audio assessment	8
7.2	Audio power-output measurement	8
7.3	Measurement procedure for video assessment	8
8	Applicability	10
9	Immunity requirements for the antenna input connector	11
9.1	Requirements for input immunity to RF voltages (in differential mode) of the VHF band II part of sound receivers and of satellite sound receivers	11
9.2	Requirements for input immunity to RF voltages (in differential mode) of television receivers and video tape equipment (including satellite television receivers)	14
9.3	Requirements for immunity to RF voltages (in common mode)	16
9.3.1	Limits of immunity to RF voltages (in common mode) of antenna terminals of receivers and multifunction equipment	16
9.3.2	Limits of immunity to RF voltages (in common mode) of associated equipment	16
9.4	Requirements for screening effectiveness	16
9.5	Requirements for immunity to electrical fast transients	16
10	Immunity requirements at loudspeaker and headphone output connector	17

		Page
11	Immunity requirements for audio input and output connectors (excluding loudspeaker and headphone)	17
12	Immunity requirements for AC mains power connectors	18
13	Immunity requirements for the enclosure port	18
13.1	Requirements for immunity to ambient electromagnetic fields	18
13.1.1	Equipment with audio functions	18
13.1.2	VHF band II sound broadcast receivers	19
13.1.3	Television broadcast receivers	19
13.1.4	Video tape equipment	19
13.1.5	Associated equipment (except video tape equipment)	20
13.2	Requirements for immunity to RF voltages	20
13.2.1	Limits of immunity to RF voltages of receivers and multifunction equipment	20
13.3	Requirements for immunity to electrostatic discharge	20
14	Measurement of input immunity	21
14.1	Measurement of sound receivers	21
14.1.1	Measuring set-up	21
14.1.2	Measurement with unwanted signals outside the VHF band II range	21
14.1.3	Measurement with unwanted signals inside the VHF band II range	21
14.1.4	Measurement of satellite sound receivers	22
14.2	Measurement of television receivers and video tape equipment	22
14.2.1	Measuring set-up	22
14.2.2	Measuring procedure	22
14.2.3	Measurement of satellite television receivers	22
15	Measurement of immunity to RF voltage (common mode)	22
15.1	Coupling units	22
15.2	Measurement set-up	24
15.3	Measurement circuit	24
15.4	Measurement procedure	26
16	Measurement of screening effectiveness	26
16.1	Measuring set-up for television receivers	26
16.2	Measurement procedure for television receivers	27
16.3	Measuring set-up for VHF band II receivers	28
16.4	Measurement procedure for VHF band II receivers	28
17	Measurement of electrical transients	29
18	Measurement of immunity to induced voltages	29
18.1	Measuring circuit and set-up	29
18.2	Measurement procedure	29
19	Measurement of immunity from radiated fields	32
19.1	The open stripline	32
19.2	Measurement set-up	32
19.3	Measurement procedure	34
20	Measurement of electrostatic discharge	34
21	Significance of the immunity limits	34
	Annex A (normative) Specification of the test-TV-set	35
	Annex B (normative) Specification of filters and weighting network	35
	Annex C (normative) Specification of coupling units and of low-pass filter	36
	Annex D (normative) Matching networks and mains stop filter	41
	Annex E (normative) Construction details of the open stripline	42
	Annex F (normative) Calibration of the open stripline	48

1 Scope

1.1 This standard for immunity requirements applies to television broadcast receivers, sound broadcast receivers and associated equipment intended for use in the residential, commercial and light industrial environment.

1.2 Immunity requirements are given in the frequency range 0 Hz to 400 GHz. Radio-frequency tests outside the specified frequency bands or concerning other phenomena than given in this standard are not required.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

European and International Standards

CISPR 16 : 1987	*CISPR specification for radio interference measuring apparatus and measuring methods* NOTE. CISPR 16-1, *Specification for radio disturbance and immunity measuring apparatus and methods, Part 1: Radio disturbance and immunity measuring apparatus*, was published by IEC in August 1993. After Part 2 and Part 3 have also been published, CISPR 16 : 1987 will be withdrawn.
EN 55022 : 1994	*Limits and methods of measurement of radio disturbance characteristics of information technology equipment (CISPR 22 : 1993)*
IEC 50 (161)	*International Electrotechnical Vocabulary (IEV), Chapter 161: Electromagnetic Compatibility*
IEC 315-1 : 1988	*Methods of measurement on radio receivers for various classes of emission Part 1: General considerations and methods of measurement, including audio-frequency measurements* (harmonized as HD 560.1 S1 : 1990)
IEC 801	*Electromagnetic compatibility for industrial-process measurement and control equipment*
IEC 801-2 : 1991	*Part 2: Electrostatic discharge requirements* (harmonized as EN 60801-2 : 1993)
IEC 801-3 : 1984	*Part 3: Radiated electromagnetic field requirements* (harmonized as HD 481.3 S1 : 1987)
IEC 801-4 : 1988	*Part 4: Electrical fast transient/burst requirements*

Other publications

CCIR Recommendation 468-4 : 1986	*Measurement of audio-frequency noise voltage level in sound broadcasting*
CCIR Recommendation 471-1 : 1986	*Nomenclature and description of colour bar signals*
CCIR Recommendation 500-4 : 1990	*Method for the subjective assessment of the quality of television pictures*
CCIR Report 624-4 : 1990	*Characteristics of television systems*

3 Objective

The objective of this standard is to define the immunity test requirements for equipment defined in the scope in relation to continuous and transient, conducted and radiated disturbances including electrostatic discharges.

These test requirements represent essential electromagnetic immunity requirements.

Test requirements are specified for each port considered.

NOTE 1. This standard does not specify electrical safety requirements for equipment such as protection against electric shocks, unsafe operation, insulation coordination and related dielectric tests.

NOTE 2. In special cases situations will arise where the level of disturbances may exceed the levels specified in this standard e.g. where a hand-held transmitter is used in proximity to an equipment. In these instances special mitigation measures may have to be employed.

4 Definitions

For the purposes of this standard, the definitions contained in IEC Publication 50 (161): *International Electrotechnical Vocabulary (IEV) Chapter 161: Electromagnetic Compatibility,* apply, extended with the following specific definitions.

4.1 Sound receivers are appliances intended for the reception of sound broadcast and similar services for terrestrial-, cable- and satellite transmissions.

NOTE. For the purposes of this standard, the VHF band II covers frequencies from 87,5 MHz to 108 MHz.

4.2 Television receivers are appliances intended for the reception of television broadcast and similar services for terrestrial-, cable- and satellite transmissions.

NOTE 1. For the purposes of this standard, the following frequency bands are defined:

Band I	from 47 MHz to 68 MHz
Band III	from 174 MHz to 230 MHz
Band IV	from 470 MHz to 598 MHz
Band V	from 598 MHz to 862 MHz
S-bands	U.C.
Hyperband	U.C.

In practice not all television receivers are tunable over these complete frequency ranges. On the other hand many television receivers are tunable over additional channels, exclusively used in cable distribution networks.

NOTE 2. Modular units which are part of sound or television receiving systems, like tuners, frequency converters, modulators, etc. are considered to be sound or television receivers respectively.

Tuners may be provided with a broadcast-satellite-receiving stage and with demodulators, decoders, demultiplexers, D/A converters, encoders (e.g. PAL encoders) etc.

Frequency converters may be provided with a broadcast-satellite-receiving stage and with devices which convert the signals to other frequency bands.

Receivers, tuners, or frequency converters may be tunable or may only be able to receive a fixed frequency.

4.3 Associated equipment is either intended to be connected directly to sound or television receivers, or to generate or to reproduce audio or visual information. Excluded are information technology equipment even if they are intended to be connected to a television broadcast receiver.

Connections via the mains plug, local area network or home network are considered to be indirect connections.

NOTE. Information technology equipment is defined in EN 55022.

4.4 Multifunction equipment are appliances in which two or more functions are provided in the same unit, for instance television reception, radio reception, digital clock, tape-recorder or disc player etc.

A non exhaustive survey of receiver and associated equipment types (including the appropriate parts of multifunction equipment) is shown in table 1.

4.5 A disturbance signal is an unwanted signal which may degrade radio reception or cause malfunction in equipment. An unwanted signal is a radio frequency signal which simulates the disturbance signal.

4.6 Immunity is the ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

NOTE. In this standard the specified performance is:

- a specified sound signal-to-interference ratio; and/or
- no greater than just perceptible degradation of the picture when a wanted signal and an unwanted signal occur simultaneously.

In the case of digital sound/data information (e.g. D2MAC) the specified performance for the bit error rate (BER) and/or residual bit error rate (BER_R) is under consideration.

4.6.1 Input immunity is the immunity from unwanted signals present at the antenna input terminal.

4.6.2 Immunity from conducted voltages is the immunity from unwanted signal voltages present at the audio and mains input terminals and audio output terminals.

4.6.3 Immunity from conducted currents is the immunity from unwanted signal (common mode) currents present in cables connected to the equipment.

4.6.4 Immunity from radiated fields is the immunity from unwanted electromagnetic fields present at the equipment.

4.7 Screening effectiveness is the characteristic of a coaxial connector terminal to attenuate the transfer of external currents into internal voltages.

4.8 Port: Particular interface of the specified apparatus with the external electromagnetic environment (see figure 1).

Enclosure port: The physical boundary of the apparatus through which electromagnetic fields may radiate or impinge.

Table 1. Survey (non exhaustive) of receiver and associated equipment types, including the appropriate parts of multifunction equipment

			Intended for mains powering and portable with external power connection facility		Battery powered portable, without external power connection facility (Portable)	Car radio (Car)	Satellite (Satellite)
			With a connection facility for an external antenna	Without a connection facility for an external antenna			
Sound broadcast receivers (Radio)	VHF band II (FM)		FM radio ant.	FM radio	Portable radio	Car radio FM	Satellite radio
	LW, MW, SW (AM)		AM radio ant.	AM radio		Car radio AM	
Television broadcast receivers (TV)			TV ant.	TV	Portable TV		Satellite TV
Associated equipment (Ass)	Video tape equipment (recording and/or play-back)	With* (Tun)	Ass. video tun. ant.		Portable ass. video		
		Without*	Ass. video				
	Audio tape equipment		Ass. audio		Portable ass. audio		
	Other, e.g. audio amplifiers, record and compact disk players, decoders, electronic organs		Ass. other		Portable ass. other		

* Built-in television broadcast receiving facility.

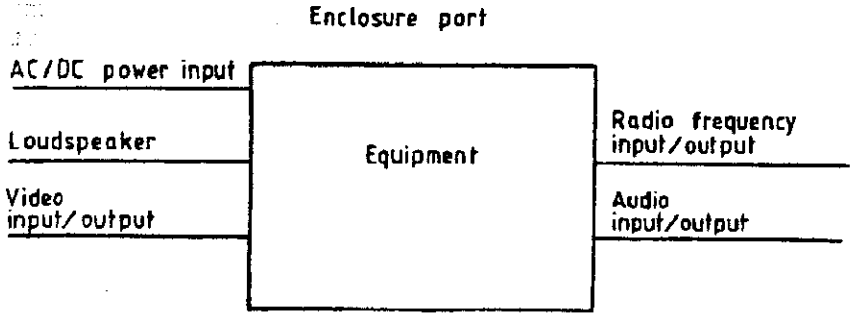


Figure 1. Examples of ports

5 Description of locations

The environments encompassed by this standard are residential, commercial and light-industrial locations, both indoor and outdoor. The following list, although not comprehensive, gives an indication of locations which are included:

- residential properties, e.g. houses, apartments, etc.;
- retail outlets, e.g. shops, supermarkets, etc.;
- business premises, e.g. offices, banks, etc.;
- areas of public entertainment, e.g. cinemas, public bars, dance halls, etc.;
- outdoor locations, e.g. petrol stations, car parks, amusement and sports centres, etc.
- light-industrial locations e.g. workshops, laboratories, service centres, etc.;

Locations which are characterized by being supplied directly at low voltage from the public mains are considered to be residential, commercial or light industrial.

6 Performance criteria

6.1 Performance criterion A

The equipment shall continue to operate as intended during the test.

No change of actual operating state, for example change of channel, is allowed as a result of the application of the test.

Multifunction equipment shall for each function meet the relevant requirements.

Evaluation is carried out for audio and video functions.

6.1.1 *Evaluation of audio quality*

Unless otherwise specified in this standard, the criterion of compliance with the requirement is a wanted to unwanted audio signal ratio of $\geq$ 40 dB at a wanted audio signal level of 50 mW.

For AM sound receivers the criterion is $\geq$ 26 dB at 50 mW. However the criterion for the audio part of TV receivers is $\geq$ 40 dB.

For AM and FM car radios, the criterion is $\geq$ 26 dB at 500 mW.

6.1.2 *Evaluation of picture quality*

In the evaluation of picture interference the wanted test signal produces a standard picture (in the case of video tape equipment on the screen of the test-TV-set) and the unwanted signal produces a degradation of the picture. The degradation may be in a number of forms, such as a superposed pattern, disturbance of synchronization, geometrical distortion, loss of picture contrast, of colour, etc.

The criterion of compliance with the requirement is just perceptible degradation by observation of the picture. The screen shall be observed under normal viewing conditions (brightness 15—20 Lux), at a viewing distance of six times the height of the screen.

In the case of video tape equipment the test criteria relate to the picture, assessed on a test-TV-set, which is connected to the video output terminal of the equipment.

6.2 Performance criterion B

The equipment shall continue to operate as intended after the test. No loss of function is allowed after the test when the apparatus is used as intended. No change of actual operating state for example change of channel or stored data and settings is allowed as a result of the application of the test. During the test, degradation of performance is allowed.

6.3 Performance criterion C

Temporary loss of function is allowed, provided the function is self recoverable or can be restored by the operation of the controls.

7 Conditions during testing

Immunity measurements are performed by the application of a wanted test signal and an unwanted signal to the equipment under test. These signals and methods of application are specified in clause **14**.

For the vision component of the wanted TV signal the level refers to the RMS value of the carrier at the peak of the modulation. The signal level refers in all other cases to the RMS level of the unmodulated carrier.

At transition frequencies the more stringent limit shall apply.

The limit values specified for the input immunity correspond to a nominal antenna impedance of 75 Ω. For receivers with nominal antenna impedance other than 75 Ω, these limit values and the level of the wanted signals on the antenna terminals are modified, according to the following formula:

$$\text{Limit in } R\ \Omega,\ \text{dB}(\mu\text{V}) = (\text{Limit in table, dB}(\mu\text{V})) + 10\log_{10} R/75.$$

R is defined as the nominal input impedance.

There shall be 80 % confidence that at least 80 % of the series-produced appliances comply with these limits.

If in the case of video tape (or similar) equipment, the equipment under test has no active audio and/or video output terminals in the relevant operating mode the test-TV-set shall be connected to the modulator output terminal. In this case the sound criterion relates to the audio output terminal of the test-TV-set if appropriate.

The picture quality is assessed as in subclause **6.1.2**. The specification of the test-TV-set is given in annex A.

NOTE. The modulator of the equipment under test should be tuned to the centre channel of its tuning range and the test-TV-set tuned to this channel. Care should be taken that the modulator channel is not equal to the tuned input channel of the equipment under test or to the unwanted channels M as specified in tables 5 and 6.

The modulator output level shall be within the limits 60 to 75 dB(μV) at 75 Ω.

Equipment under test with switchable or adjustable gain at the antenna input (e.g. High/Low-switch) shall be tested in position High or highest gain respectively.

7.1 Measurement procedure for audio assessment

First the wanted test signal is applied to the equipment under test. This produces a wanted audio signal which is measured. The volume control of the equipment under test or test set-up is adjusted to set this audio signal at the required level. The wanted audio signal is then removed by switching off the modulation or the audio test signal.

The 'unwanted' disturbance signal is applied in addition and its frequency is swept through the test range; its level is kept at the relevant limit value.

The evaluation of the interference is made by measuring the level of the unwanted output signal and comparing this to the wanted output signal level.

NOTE. Concerning the measurement procedure for the criterion of sound interference of television receivers the frequency of the unwanted signal is adjusted to the relevant values.

Concerning the measurement procedure for the criterion of sound interference of video tape equipment with automatic modulation control the modulation of the sound carriers of the wanted test signal or the wanted audio test signal must not be switched off continuously but switched off and on at an appropriate low rate (e.g. 10 seconds off and 1 second on).

The equipment under test is considered to meet the requirements if the level of the unwanted audio signal does not at any time exceed the 40 dB or 26 dB level below the wanted audio signal level as appropriate.

7.2 Audio power-output measurement

a) For equipment under test with audio power output available through an external loudspeaker connector, the levels of the wanted and the unwanted audio signals are measured at the external loudspeaker terminals across the load impedance specified by the manufacturer. See figure 2a.

b) For equipment under test with no audio power output, such as a radio tuner, tape or record deck, an audio amplifier shall be provided and connected to the audio output under test. Level measurements are made at the output of the amplifier. The volume control, if any, of the equipment under test shall be set at the midway position. See figure 2b.

The volume control of the audio amplifier provided shall then be adjusted to obtain the required level of the wanted audio signal. The amplifier noise shall be at least 50 dB below the level of the wanted signal. Care shall be taken to ensure that the amplifier is not subjected to the effects of the unwanted signal.

c) For equipment under test with audio power output fed to a built-in loudspeaker having no external loudspeaker connector, the audio signal levels are measured by placing a small high quality microphone (a directional type may be required) close to the front of the built-in loudspeaker under test. The microphone output is fed through a screened cable (ferrite loaded as required) to an external amplifier, filter and audio voltmeter to measure the audio output powers. See figure 2c.

The microphone-audio voltmeter measurement chain shall be calibrated by the use of a loudspeaker of a type similar to the one in the equipment under test, placed at the same distance as that used in the measurement, and supplied with a 1 kHz tone at the required levels. For the measurement of input immunity, filter FR shall be of a 15 kHz low-pass type (see annex B). The audio frequency voltmeter shall be provided with a weighting filter according to CCIR Recommendation 468.

For the measurement of immunity from conducted voltages, radiated fields and conducted currents, filter FR shall be of a 0,5 kHz - 3 kHz band-pass type (see annex B). The audio frequency voltmeter shall be applied without weighting filter.

7.3 Measurement procedure for video assessment

The standard picture is a pattern consisting of vertical colour bars in accordance with CCIR Recommendation 471, 100/0/75/0 (see figure A1b of the CCIR Recommendation).

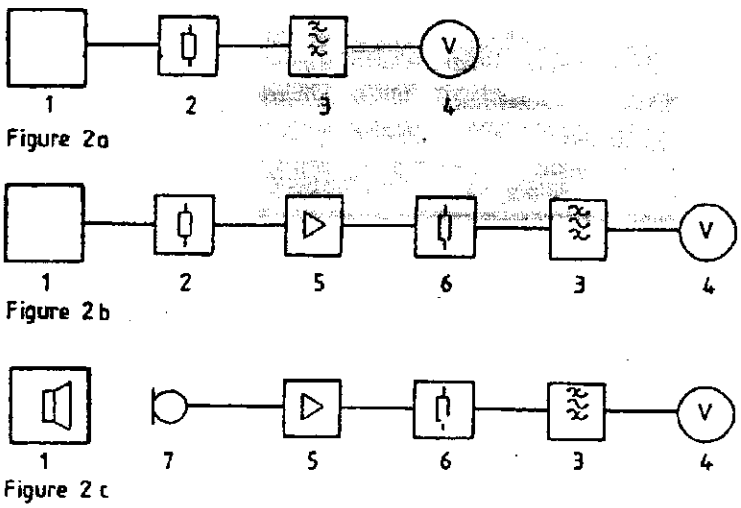
First the wanted signal only is applied to the equipment under test. The controls of the equipment under test are set to obtain a picture of normal brightness, contrast, and colour saturation. This is obtained with the following luminance values:

black part of the test pattern	2 cd/m^2
magenta part of the test pattern	30 cd/m^2
white part of the test pattern	80 cd/m^2.

NOTE. The luminance of the magenta bar shall be set to 30 cd/m^2. If this level cannot be reached, the luminance shall be set as close as possible to 30 cd/m^2. If a value different from 30 cd/m^2 is used, it shall be stated together with the results.

The unwanted signal is then applied in addition, its frequency adjusted to the relevant values (an accuracy of $\pm f_{line}/2$ may be necessary) (f_{line} = 15625 Hz, hor. scan. freq.). The level of the unwanted signal shall be maintained at the relevant limit value at each frequency. The equipment under test is considered to meet the requirement if the conditions of **6.1.2** are met (see CCIR Recommendation 500).

The degradation is more rapidly discerned and the variation of results due to individuals is reduced, if the unwanted signal is switched on and off at a low rate (about 0.5 Hz) during the test. This can be done manually or automatically by an electronic timer.



1. equipment under test
2. rated load impedance R_L of the audio output
3. filter, FR (see annex B) low-pass or handpass
4. audio frequency voltmeter V
5. amplifier A
6. rated load impedance R_A of the amplifier output
7. microphone M

Figure 2. Audio power output measurement

8 Applicability

Tests are applied at the relevant connectors and enclosure port of the equipment according to clauses **9.1** to **9.3**. Tests shall only be carried out where the relevant port(s) or function exist. If more than one specific function exists, for example audio functions, then all these functions shall be tested.

It may be determined from consideration of the electrical characteristics and usage of a particular equipment that some of the tests are inappropriate and therefore unnecessary. In such a case it is required that the decision not to test and the rationale leading to this decision shall be recorded in the test report.

8.1 For battery powered:

- portable sound broadcast receivers;
- portable television broadcast receivers; and other
- portable audio and video equipment; as well as
- video tape equipment;

which have no external power connection facility, immunity requirements are under consideration.

8.2 For:

- sound broadcast receivers;
- television broadcast receivers; and
- video tape equipment with built-in television broadcast receiving facility;

without a connection facility for an external antenna, immunity requirements are under consideration.

8.3 For sound broadcast receivers in the long-wave, medium-wave and short-wave operation mode, immunity requirements are restricted to those in table 2: RF voltage common mode.

8.4 Input immunity requirements apply for the VHF band II part of sound receivers (including car radios), for AM sound receivers, for television receivers and for video tape equipment.

Input immunity requirements for associated equipment other than video tape equipment are under consideration.

Multi-function equipment which performs one or more of the functions included in this clause shall meet the relevant requirements.

Table 2

Parameter	Test specification	Test setup	Applicability	Performance criteria
RF voltage differential mode	See clauses **9.1** and **9.2**	See clause **14** (input immunity)	FM radio ant. Car radio FM Satellite radio TV ant. Satellite TV Ass. video tun. ant.	A
RF voltage common mode	See clause **9.3**	See clause **15**	FM radio ant. Car radio FM Satellite radio TV ant. Satellite TV Ass. video tun. ant. AM radio ant. Car radio AM	A
Screening effectiveness	See clause **9.4**	See clause **16**	FM radio ant.	A
Electrical fast transients common mode	Under consideration	Under consideration	Under consideration	Under consideration

9 Immunity requirements for the antenna input connector

9.1 Requirements for input immunity to RF voltages (in differential mode) of the VHF band II part of sound receivers and of satellite sound receivers

Sound receivers with a VHF band II part shall meet the sound criterion of subclause **6.1.1**. They shall be tested at a tuned frequency f_n and subjected to an unwanted signal of frequency f_f and level n_f as specified in tables 3 and 4. Receivers with mono/stereo facility shall be tested in stereo mode.

Table 3. Limits of input immunity from unwanted signals outside the VHF band II range (see also **14.1.2**)

f_n	f_f	n_f [dB(μV)] (75 Ω) 1 kHz AM at 80 % depth	
MHz	MHz	mono	stereo
87.6	66.2*	80	80
	76.9	80	80
	87.1	80	80
	87.2	80	80
	87.25	80	80
	87.30	72.4	69.2
	87.35	64.8	58.4
	87.40	57.2	47.6
	87.45	49.6	36.8
	87.50	42.0	26.0
107.9	129.3**	80	80
	118.6	80	80
	108.4	80	80
	108.3	80	80
	108.25	80	80
	108.20	72.4	69.2
	108.15	64.8	58.4
	108.10	57.2	47.6
	108.05	49.6	36.8
	108.00	42.0	26.0

* Only applicable for receivers with the local oscillator frequency below the tuned frequency.
** Only applicable for receivers with the local oscillator frequency above the tuned frequency.

Table 4. Limits of input immunity from unwanted signals inside the VHF band II range (see also **14.1.3**)

f_n	f_f	n_f [dB(μV)] (75 Ω) 1 kHz FM dev. 40 kHz	
MHz	MHz	mono	stereo
98	97.6 and 98.6	85	85
	97.6 and 98.4	85	85
	97.65 and 98.35	80	80
	97.7 and 98.3	72	72
	97.75 and 98.25	63	63
	97.8 and 98.2	59	58
	97.85 and 98.15	57	47
	97.9 and 98.1	53	32
	97.925 and 98.075	49	20
	97.95 and 98.05	41	14
	97.975 and 98.025	34	14
	98	29	20

Satellite sound receivers

Satellite sound receivers shall meet the sound criterion of **6.1.1**. The levels of the unwanted signals are specified in table 8. See also **14.1.4**.

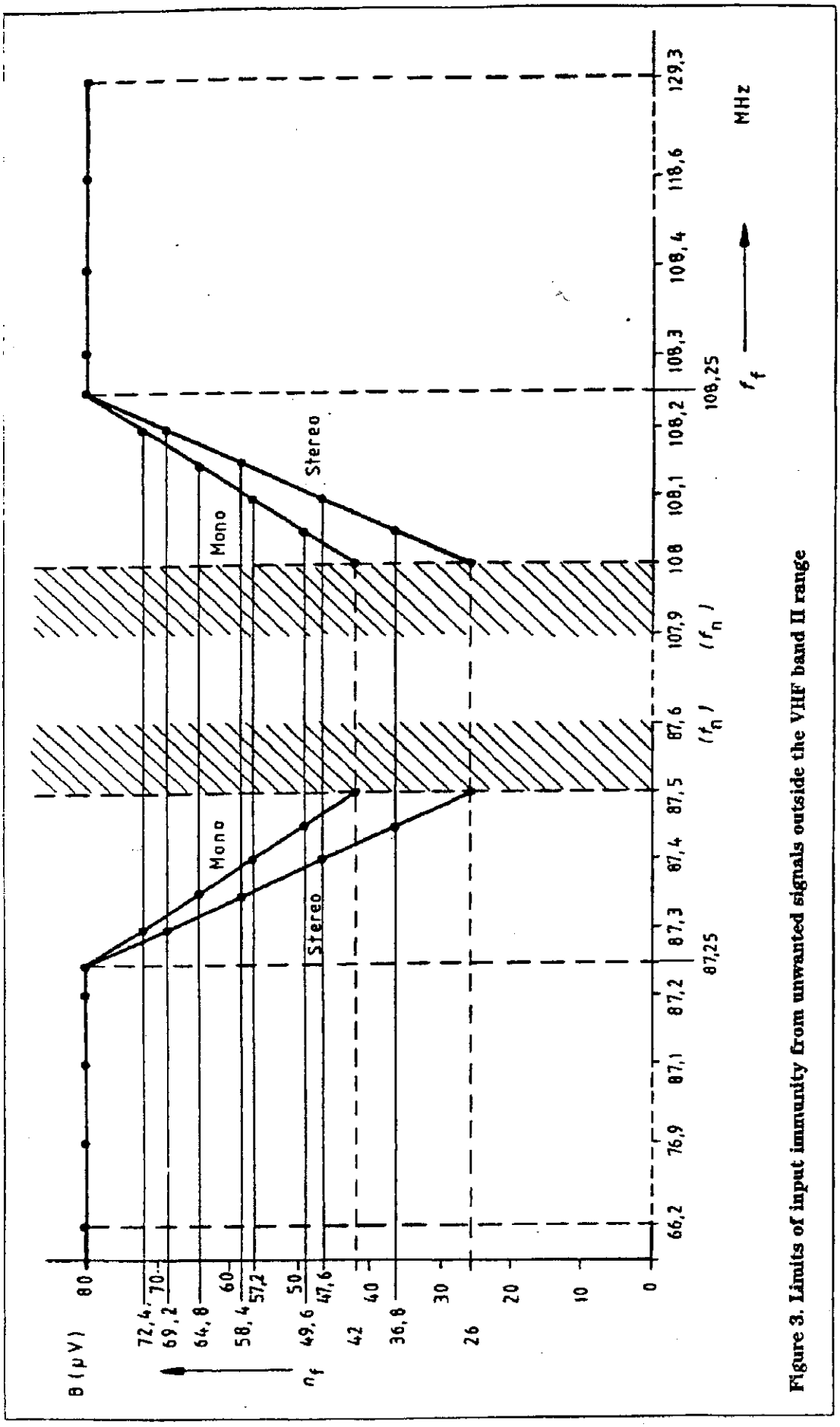


Figure 3. Limits of input immunity from unwanted signals outside the VHF band II range

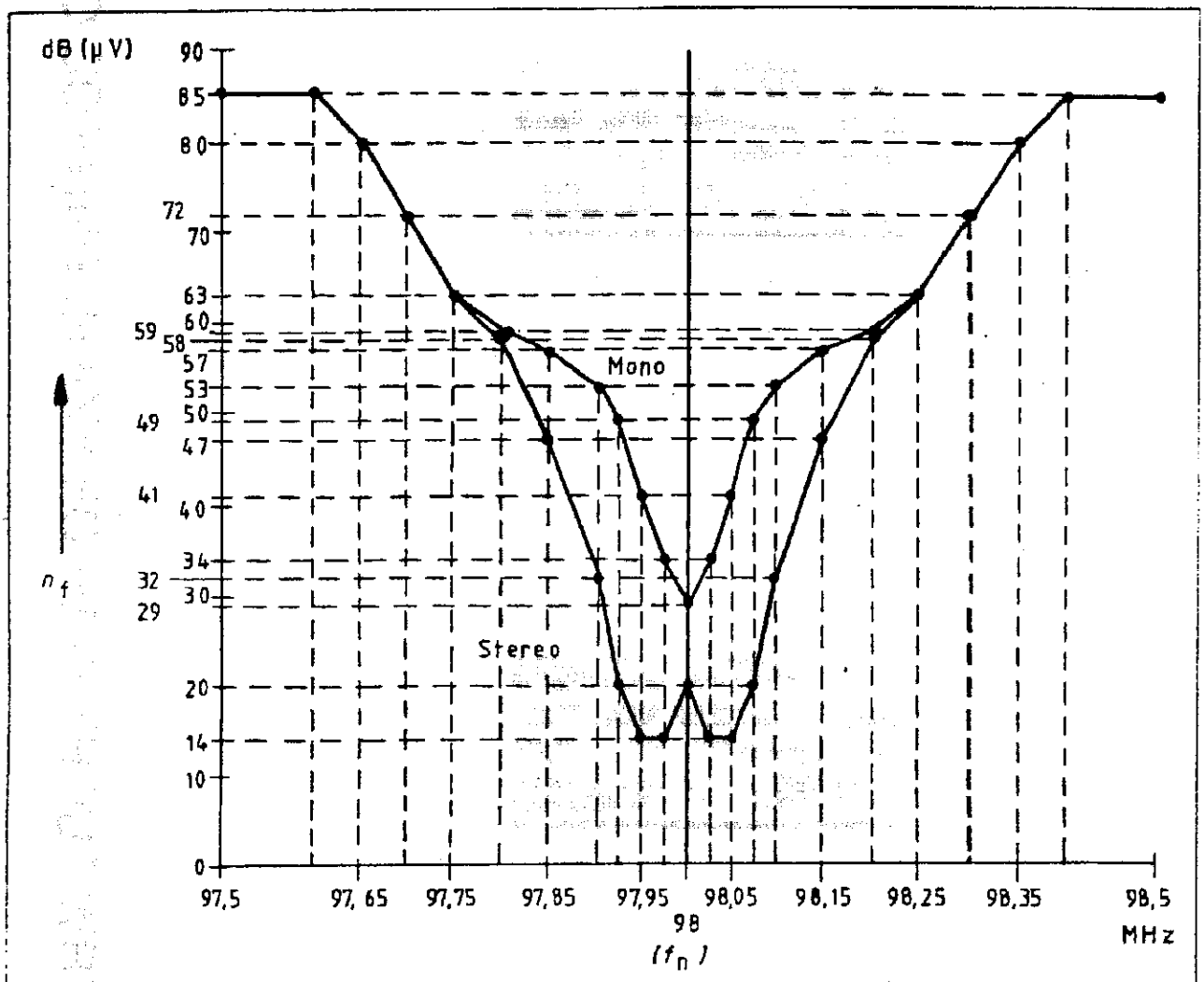


Figure 4. Limits of input immunity from unwanted signals inside the VHF band II range

9.2 Requirements for input immunity to RF voltages (in differential mode) of television receivers and video tape equipment (including satellite television receivers)

Television receivers and video tape equipment with built-in television broadcast receiving facility in the RF recording mode shall be tested at a tuned television channel N and subjected to an unwanted signal in channel M, level n_f, and of the following types.

Unwanted signal types:

A: an unmodulated signal at the picture carrier frequency of the relevant channel M;

B: two unmodulated signals each at the level as given in the table, one at the relevant picture carrier frequency +0.5 MHz and the other at the picture carrier frequency −0,5 MHz;

C: a modulated signal at the relevant sound carrier frequency, 1 kHz FM at 30 kHz deviation;
C shall be applied to receivers for countries in which mono-sound television signals of the systems B and G can be received.
For television receivers for countries in which also two-sound-channel-television-signals of the systems B and G with two frequency modulated sound carriers can be received (even for one-sound-channel-television-receivers):

C1: a modulated signal at the relevant frequency of the first sound carrier, 1 kHz FM at 30 kHz deviation; and

C2: a modulated signal at the relevant frequency of the second sound carrier, 1 kHz FM at 30 kHz deviation;

C1 and C2 are applied simultaneously.

D: a modulated signal at the relevant picture carrier frequency, 1 kHz AM at 80 % depth;

E: a modulated signal 1 kHz AM at 80 % depth.

For the purposes of this standard, a television receiver shall meet the limits of tables 5, 6 and 7 as appropriate for all channels for which it is designed.

For tests for conformity of appliances in series production (see clause 21) a television receiver shall be tested on one channel in each band for which it is designed, using the channel N for which the picture carrier frequency is nearest to the following frequencies:

Channel N_i	in Band I	nearest to 55 MHz
Channel N_{iii}	in Band III	nearest to 203 MHz
Channel N_{iv}	in Band IV	nearest to 503 MHz
Channel N_v	in Band V	nearest to 743 MHz

See note 1 in 4.2.

For system L, signal D is an amplitude modulated signal at the relevant picture carrier frequency 1 kHz at 80 % depth. This signal is also used in a second measurement for simulating the unwanted signal at the sound carrier frequency. In that case the limits indicated in the table have to be reduced by 5 dB.

For input immunity measurements on TV receivers equipped with a 'fine tuning' adjustment, easily accessible to the user, readjustment of the receiver oscillator is allowed (up to ± 250 kHz) referred to its nominal frequency, in order to minimize the interference, while maintaining the quality of picture and sound.

Table 5. Limits of input immunity of television receivers for systems B, G and I

N \ M	n_f [dB (μV)] (75 Ω) in channel M						Unwanted signal type
	N − 5	N − 1	N + 1	N + 5	N + 9	N + 11	
N_i	–	73	73	–	–	–	A
	–	61	61	–	–	–	B
N_{iii}	70	73 − x	73 − x	70	–	68	C − C1
	63	73 − y	73 − y	63	–	61	C2
	70	–	–	70	–	68	D
N_{iv}	–	77	77	80	68	–	A
	–	65	65	68	56	–	B
	74	77 - x	77 − x	80 − x	68 − x	–	C − C1
	67	77 − y	77 − y	80 − y	68 − y	–	C2
	74	–	–	–	–	–	D
N_v	80	77	77	80	–	–	A
	68	65	65	68	–	–	B
	80 − x	77 − x	77 − x	80 − x	62	–	C − C1
	80 − y	77 − y	77 − y	80 − y	55	–	C2
	–	–	–	–	62	–	D

x is the relative level (dB) of the first sound carrier (mono sound channel) with respect to the vision carrier;
y is the relative level (dB) of the second sound carrier (stereo sound channel) with respect to the vision carrier;
x = 13 and y = 20 for systems B and G; x = 10 for system I.

NOTE. N ± m indicates the frequency of the picture carrier of the tuned television channel, plus or minus m times the channel frequency bandwidth. The test signal shall be applied at this frequency if a limit value is tabulated.

Table 6. Limits of input immunity of television receivers for system L

N \ M	n_f [dB(μV)] (75 Ω) in channel M				Unwanted signal type
	M ≤ N − 2	N − 1	N + 1	M ≥ N + 2	
04	68*	–	–	–	D
08	71	68	68	71	D
25	75	72	72	75	D
55	75	72	72	75	D

* For channel N = 04, the unwanted signal shall only be applied in channel M = 02.

Table 7. Limits of input immunity of television receivers for systems B, G, I and L

N \ M	n_f dB(μV) at 75 Ω	Unwanted signal	
		Freq. in MHz	Type
N_i	89	26-30	E
N_{iii}	104	26-30	E

Satellite television receivers

Satellite television receivers shall meet the sound criterion of 6.1.1 and the picture criterion of 6.1.2. The levels of the unwanted signals are specified in table 8. See also 14.2.3. The wanted and unwanted signals are of the same type and have the same modulation as described in subclause 14.2.2. The characteristics are:

A1: Channel distance 38,36 MHz with a deviation sensitivity of 13,5 MHz/V and a dispersal of 0,6 MHz for MAC receivers.

A2: Channel distance 29,5 MHz with a deviation sensitivity of 16 MHz/V and a dispersal of 2 MHz for PAL receivers.

A3: Channel distance 42 MHz with a deviation sensitivity of 22 MHz/V and a dispersal of 2 MHz for MAC receivers able to receive wide band (33 MHz) signals. A3 type signal applies also to SECAM receivers.

A4: Channel distance 50 MHz with a deviation sensitivity of 22,5 MHz/V and a dispersal of 2 MHz for PAL receivers able to receive this wide band signal.

NOTE. The deviation sensitivity is defined for the zero dB point of the pre-emphasis network.

Measurements with type A4 need not be carried out if measurements with type A2 have been performed.

Table 8. Limits of input immunity of satellite receivers

N \ M	n_f dB(μV) at 75 Ω at channel M				Wanted and unwanted signal type
	N – 2	N – 1	N + 1	N + 2	
N min + 3	70	66	66	70	A1 or A2 or A3 or A4
N mid	70	66	66	70	
N max – 3	70	66	66	70	

N min: Lowest channel of the receiver in the relevant band.
N mid: Middle channel of the receiver in the relevant band.
N max: Highest channel of the receiver in the relevant band.

9.3 Requirements for immunity to RF voltages (in common mode)

The requirements for receivers, (including car radios and AM receivers), multifunction equipment and video tape equipment concerning the immunity to RF voltages in common mode are restricted to the antenna terminals and to the frequency range from 26 MHz to 30 MHz.

Requirements are applied to equipment operating in the receiving mode. Requirements for other terminals and for associated equipment are under consideration.

9.3.1 *Limits of immunity to RF voltages (in common mode) of antenna terminals of receivers and multifunction equipment*

Receivers and multifunction equipment shall meet the sound criterion of subclause **6.1.1** and the picture criterion of subclause **6.1.2** as appropriate for unwanted signals of frequencies and levels, as specified in table 9, applied to the antenna terminal.

Table 9. Limits of immunity to RF voltages (in common mode) of antenna terminals

Frequency MHz	Level [dB(μV)] (e.m.f.)
26 - 30	126

NOTE. According to the measuring procedure the immunity from conducted current is expressed by the e.m.f. level of the unwanted signal generator (figure 7 and figure 8).

9.3.2 *Limits of immunity to RF voltages (in common mode) of associated equipment*

9.3.2.1 *Video tape equipment*

Video tape equipment with built in television broadcast receiving facility in the RF-recording mode shall meet the sound criterion of subclause **6.1.1** at the audio output terminal of the equipment and the picture criterion of subclause **6.1.2** on a test-TV-set under the same test conditions as described in subclause **9.3.1**.

9.3.2.2 *Other associated equipment*

Under consideration.

9.4 Requirements for screening effectiveness

Requirements for screening effectiveness apply to the coaxial antenna terminals, if any.

The screening effectiveness of the coaxial antenna terminal of VHF band II sound receivers shall not be less than 20 dB at 98,0 MHz.

Limits of screening effectiveness for TV receivers and video tape equipment and satellite receivers are under consideration.

NOTE. For television receivers and videotape equipment with built-in TV broadcast receiving facility in the RF recording mode a provisional limit of 50 dB is recommended, to gain experience.

9.5 Requirements for immunity to electrical fast transients

Under consideration.

10 Immunity requirements at loudspeaker and headphone output connector

Table 10

Parameter	Test specification	Test set-up	Applicability	Performance criteria
RF voltage diff. mode 1 KHz, AM 80 % depth	See subclause 13.2	See clause 18	FM radio ant. TV ant. Ass. video tun. ant. Ass. video Satellite radio Satellite TV See note 1	A
Electrical fast transients common mode	Under consideration	Under consideration	Under consideration	Under consideration

NOTE 1. The requirements shall also not apply to the equipment functions in the interference frequency ranges listed in table 20.
Not applicable to AM sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

11 Immunity requirements for audio input and output connectors (excluding loudspeaker and headphone)

Table 11

Parameter	Test specification	Test set-up	Applicability	Performance criteria
RF voltage diff. mode 1 kHz, AM 80 % depth	See subclause 13.2	See clause 18	FM radio ant. TV ant. Ass. video tun. ant. Associated video Satellite radio Satellite TV See note 1	A
Electrical fast transients common mode	Under consideration	Under consideration	Under consideration	Under consideration

NOTE 1. The requirements shall not apply to the equipment functions in the interference frequency ranges listed in table 20.
Not applicable to AM sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

12 Immunity requirements for a.c. mains power connectors

Table 12				
Parameter	**Test specification**	**Test set-up**	**Applicability**	**Performance criteria**
RF voltage common mode 1 kHz, AM 80 % depth	See subclause 13.2	See clause 18	FM radio ant. TV ant. Ass. video tun. ant. Associated video Satellite radio Satellite TV See note 1	A
Electrical fast transients common mode	Under consideration	Under consideration	Under consideration	Under consideration

NOTE 1. The requirements shall also not apply to the equipment functions in the interference frequency ranges listed in table 20.
Not applicable to AM sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

13 Immunity requirements for the enclosure port

Table 13				
Parameter	**Test specification**	**Test set-up**	**Applicability**	**Performance criteria**
Radio frequency electromagnetic field 1 kHZ, AM at 80 % depth	See subclause 13.1	Clauses 13.1 and 19	FM radio ant. TV ant. Ass. video tun. ant. Associated video Satellite radio Satellite TV	A
Electrostatic discharge	Under consideration	Under consideration	Under consideration	Under consideration

13.1 Requirements for immunity to ambient electromagnetic fields

Requirements apply for immunity from radiated fields for equipment providing audio, video, VHF band II sound, and television functions.

Requirements for associated equipment other than video tape equipment are under consideration.

NOTE. The inaccuracy of the measurements of radiated disturbance (in general less then 5 dB) should be taken into account in the evaluation of the measured values. The given limits are absolute values which may not be exceeded due to the measurement inaccuracy.

13.1.1 *Equipment with audio functions*

For equipment with audio functions other than related to broadcast reception, table 14 applies.

Table 14. Test specification for equipment with audio functions	
Frequency MHz	**Level** dB(µV/m)
0.15 to 150	125

13.1.2 *VHF band II sound broadcast receivers*

For equipment with a VHF band II sound broadcast reception, table 15 applies.

Table 15 Limits of immunity to ambient electromagnetic fields of VHF band II reception functions of sound receivers

Frequency MHz	Level dB(μV/m)
0,15 to 150	125
Except frequency bands:	
$(f_i - 0,5)$ to $(f_i + 0,5)$	101
$(f_o - 0,5)$ to $(f_o + 0,5)$	109
$(f_{im} - 0,5)$ to $(f_{im} + 0,5)$	109
87,5 to 108[1)]	109
The tuned channel	Under consideration

[1)] The frequency range 87,5 to 108 MHz can be varied depending on the use of the FM frequency band on a national basis.

NOTE.

f_i	intermediate frequency (= 10,7 MHz)
$f_o = f_t \pm f_i$	local oscillator frequency
$f_{im} = f_t \pm 2f_i$	image frequency
f_t	tuned frequency

Where:

sign ' + ' applies when $f_o > f_t$

sign ' − ' applies when $f_o < f_t$

13.1.3 *Television broadcast receivers*

For equipment with a broadcast television receiver function, table 16 applies.

Receivers and multifunction equipment operating in the monitor mode shall also meet the requirement of 125 dB(μV/m) in the frequency range 150 kHz to 150 MHz. For the frequency range $f_c \pm 1,5$ MHz the limit of 101 dB(μV/m) applies.

Table 16. Test specification for television receivers operating in the reception function

Frequency MHz	Level dB(μV/m)
0,15 - 47	125
Except	
$(f_c - 1,5)$ to $(f_c + 1,5)$	101
$(f_s - 0,5)$ to $(f_s + 0,5)$	101
$(f_i - 2)$ to $(f_v + 2)^*$	101
$(f_v - 2)$ to $(f_i + 2)^{**}$	101
47 - 87	109
87 - 108	125
108 - 144	109
144 - 150	125
Excluding the tuned channel	

* For systems B, G and I.
** For system L.
f_i, f_v, f_s and f_c are defined as:
f_i is the sound intermediate frequency;
f_v is the vision intermediate frequency;
f_s is the intercarrier sound frequency;
f_c is the colour sub-carrier frequency.

13.1.4 *Video tape equipment*

Video tape equipment in both recording and playback mode as appropriate shall meet the requirements of:

- table 16 for equipment with built in television broadcast receiving facility in the RF-recording mode;
- table 14 for all equipment in the video recording mode (except for $f_c \pm 1,5$ MHz, for which the limit 101 dB(μV/m) applies);
- table 17 for all equipment in the playback mode.

Table 17. Test specification for video tape equipment in the playback mode

Frequency MHz	Level dB(μV/m)
0,15 to 2,5	125
2,5 to 4,25	120
4,25 to 6,25	115
6,25 to 10	120
10 to 150	125

13.1.5 ***Associated equipment (except video tape equipment)***

Under consideration.

13.2 Requirements for immunity to RF voltages

Requirements apply for the immunity to RF voltages of mains input, audio output and input terminals of receivers (except AM sound receivers and car radios), multifunction equipment and video tape equipment.

Requirements for associated equipment other than video tape equipment are under consideration.

13.2.1 ***Limits of immunity to RF voltages of receivers and multifunction equipment***

13.2.1.1 *Limits of immunity to RF voltages of mains supply terminals and loudspeaker and headphone terminals*

Receivers and multifunction equipment shall meet, except as stated in subclause **13.2.1.3**, for each function, the sound criterion of subclause **6.1.1** and the picture criterion of subclause **6.1.2** as appropriate. They shall be tested using unwanted signals of frequencies and levels specified in table 18, applied to the mains and loudspeaker and headphone terminals.

13.2.1.2 *Limits of immunity to RF voltages of audio input and output terminals (except loudspeaker and headphone terminals)*

Receivers and multifunction equipment shall meet, except as stated in subclause **13.2.1.3**, for each function, the sound criterion of subclause **6.1.1** and the picture criterion of subclause **6.1.2** as appropriate. They shall be tested using unwanted signals of frequencies and levels specified in table 19, applied to the corresponding terminal.

13.2.1.3 *Exceptions to the limits*

The requirements in subclauses **13.2.1.1** and **13.2.1.2** shall not apply for television receivers and associated equipment in the frequency range $f_c \pm 1{,}5$ MHz, in which f_c is the colour subcarrier frequency. The requirements in subclause **13.2.1.1** and **13.2.1.2** shall also not apply to the equipment functions in the interference frequency ranges listed in table 20.

13.3 Requirements for immunity to electrostatic discharge

Under consideration.

Table 18. Limits of immunity to RF voltages of mains, loudspeaker and headphone terminals

Frequency MHz	0,15 – 30	30 – 100	100 – 150
Level [dB(μV)] (e.m.f.)	130	120	120 – 110 decreasing linearly with the logarithm of the frequency

Table 19. Limits of immunity to RF voltages of audio input and output terminals (except loudspeaker and headphone terminals)

Frequency MHz	Level [dB(μV)] (e.m.f.)
0,15 to 1,6	80 – 90 increasing linearly with the logarithm of the frequency
1,6 to 20	90 – 120 increasing linearly with the logarithm of the frequency
20 to 100	120
100 to 150	120 – 110 decreasing linearly with the logarithm of the frequency

Table 20. Additional unwanted signal frequencies to be excluded in tests on sound and television reception functions

Function	Frequency range	
	The tuned channel in all cases, plus	
	the if channel	other frequencies
FM sound receivers	$f_i \pm 0{,}5$ MHz	none
Television receivers	f_i – 2 MHz to f_v + 2 MHz (for systems B, G and I) f_v – 2 MHz to f_i + 2 MHz (for system L)	$f_s \pm 0{,}5$ MHz

f_i is the sound intermediate frequency;
f_v is the vision intermediate frequency;
f_s is the intercarrier sound frequency.

14 Measurement of input immunity

14.1 Measurement of sound receivers

For these measurements, the wanted and the unwanted signal frequencies shall be adjusted with an accuracy of ± 1 kHz.

14.1.1 *Measuring set-up*

The measuring set-up is shown in figure 5. The unwanted signal generator (1) and the wanted signal generator (2) are interconnected by means of the coupling network (6). To avoid mutual interference between the two generators the coupling loss can be increased with the attenuators (7). The output of the coupling network, the source impedance of which shall be 75 Ω, shall be matched to the antenna terminal of the equipment under test by the network (8), if necessary. The audio output power is measured according to subclauses 7.1 and 7.2.

14.1.2 *Measurement with unwanted signals outside the VHF band II range*

The wanted input signal at the antenna terminal shall be at a level of 60 dB(μV) referred to 75 Ω (see clause 7), frequency modulated with 1 kHz at a frequency deviation of 40 kHz. For the measurement of receivers in the stereo mode the wanted signal shall have additionally a 19 kHz pilot tone with a frequency deviation of 7.5 kHz.

The unwanted signal shall be amplitude modulated with 1 kHz at 80 % depth.

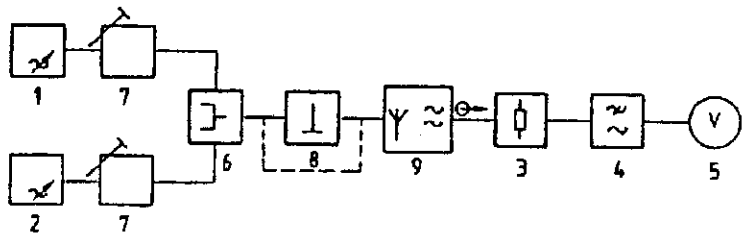
Measurements shall be made according to subclause 7.1 at the wanted signal frequencies and the unwanted signal frequencies given in table 3.

14.1.3 *Measurement with unwanted signals inside the VHF band II range*

The wanted input signal at the antenna terminal shall be at a level of 60 dB(μV) referred to 75 Ω (see clause 7), frequency modulated with 1000 Hz at a frequency deviation of 75 kHz (40 kHz for car radios). For the measurement of receivers in the stereo mode the wanted signal shall have additionally a 19 kHz pilot tone with a frequency deviation of 7.5 kHz.

The unwanted signal shall be frequency modulated with 1 kHz at a frequency deviation of 40 kHz.

Measurements shall be made according to subclause 7.1 at the wanted signal frequency and the unwanted signal frequencies given in table 4.



1. Unwanted signal generator G1
2. Wanted signal generator G2
3. Load resistor R_L
4. Low pass filter (see annex B)
5. Audio frequency voltmeter (with weighting network according to CCIR Recommendation 468)
6. Coupling network
7. Attenuators
8. Matching and/or balancing network
9. Equipment under test

(3, 4 and 5 may be replaced by figure 2b or 2c if appropriate)

Figure 5. Measuring set up for input immunity measurement of sound broadcast receivers

14.1.4 *Measurement of satellite sound receivers*

For satellite sound receivers the measuring set-up is the same as in figure 5 with the wanted signal supplied by the generator G2 in channel N for which the receiver is designed, modulated with a 1 kHz tone. In the case of digital satellite radio the wanted signal supplied by the generator G2 in channel N is a QPSK (quadrature phase shift keyed) signal to provide a 1 kHz audio tone at the output of one of the audio channels as a reference signal.

The level of the wanted signal at the terminals for the 1st satellite IF band shall be 60 dB(μV) at 75 Ω.

Measurements shall be made with the wanted signal at the frequencies given in column N of table 8, the unwanted signals in the channels listed in column M of table 8.

Only the signal type shall be used for which the receiver is designed.

NOTE. In the case of digital sound/data information (e.g. D2-MAC) the specific performance for the bit error rate (BER) and/or residual bit error rate (BER_R) is under consideration.

14.2 Measurement of television receivers and video tape equipment

14.2.1 *Measuring set-up*

The measuring set-up is shown in figure 6. The principle of operation is similar to the measuring set-up of figure 5 and the remarks in subclause 14.1.1 apply. The low-pass filter (10) is added to prevent influence of the measuring results by harmonics of the unwanted signal generators.

14.2.2 *Measuring procedure*

The wanted input signal at the antenna terminal shall be a standard television signal with the picture carrier level of 70 dB(μV) referred to 75 Ω within the VHF range or 74 dB(μV) referred to 75 Ω within the UHF range. The picture modulation shall be a vertical colour bar pattern. For systems B, G and I the sound carrier is frequency modulated with 1 kHz at a frequency deviation of 30 kHz. For system L the sound carrier is amplitude modulated with 1 kHz at 54 % depth. The sound carrier level is $70 - x$ dB(μV) within the VHF range or $74 - x$ dB(μV) within the UHF range where $x = 13$ for systems B and G and $x = 10$ for systems I and L.

For the measurement of television receivers and video tape equipment for countries in which also two-sound-channel-television-signals of the systems B and G with two frequency modulated sound carriers can be received, (even for one-sound-channel-equipment) the wanted input signal shall be a two-sound-channel-signal. The second sound carrier with the level $70 - y$ dB(μV) or $74 - y$ dB(μV) with $y = 20$ dB, is also frequency modulated with 1 kHz at a frequency deviation of 30 kHz and additionally with the 54,6875 kHz pilot-tone with the identification for two independent sound channels at a frequency deviation of 2,5 kHz.

The unwanted signals shall be as described in subclause 9.2.

Measurements shall be made according to subclauses 7.1 and 7.3 at the wanted signal frequencies and the unwanted signal frequencies given in tables 5, 6 and 7.

14.2.3 *Measurement of satellite television receivers*

For television satellite receivers the measuring set-up is the same as shown in figure 6, but the signal generators G1 and G2 are both frequency modulated with a colour bar signal as specified in 7.3.

The level of the wanted signal at the terminals for the 1st satellite IF band shall be 60 dB(μV) at 75 Ω.

Measurements shall be made with the wanted signal at the frequencies given in column N of table 8, the unwanted signals in the channels listed in column M of table 8.

Only the signal type shall be used for which the receiver is designed.

15 Measurement of immunity to RF voltage (common mode)

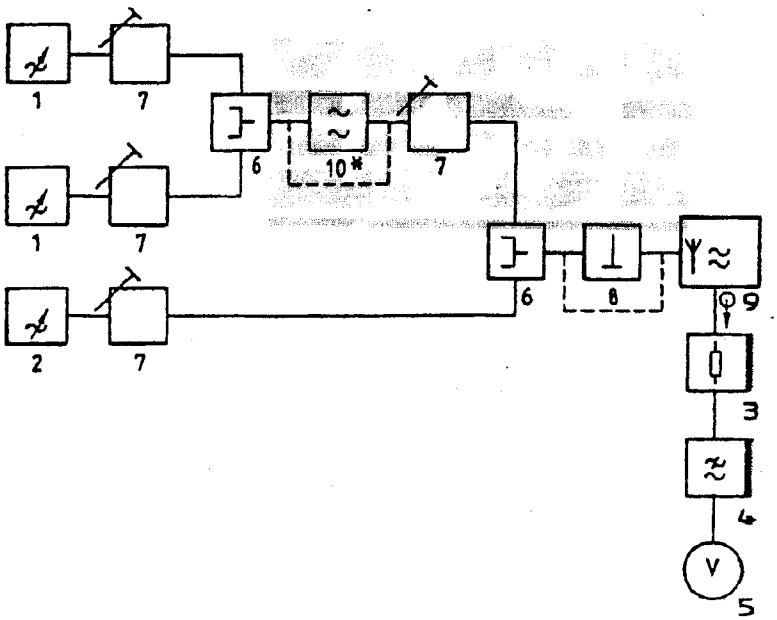
NOTE. The current requirement in this standard is limited to tests on antenna input leads and at 26 - 30 MHz interference frequency range only. The method, however, can be used to test other leads and other frequencies.

The general principle of the measurement is illustrated in figure 7. The effects of interference signals induced onto a lead of an equipment in an actual situation are simulated by the injection of an unwanted signal current on the lead through a suitable coupling unit. In the case of unshielded leads the unwanted current is injected in common mode onto the conductors. In the case of coaxial or shielded cables the unwanted current is injected onto the outer conductor or the shield of the cable. The current flows through the equipment under test returning to the generator through the earth capacitance of the equipment under test and through the load impedances of the other terminal provided by coupling units.

15.1 Coupling units

The coupling units contain RF chokes and resistive networks for the injection of unwanted signal currents. The impedance of the unwanted signal voltage source and the load impedances are standardized at 150 Ω and the coupling units are designed to provide this impedance. They also permit the passage of the wanted test signal, other signals, and mains supply.

Four types of coupling units have been found to be required to provide for frequency, connector, and cable variations. Constructional details and performance checks of coupling units are contained in annex C.



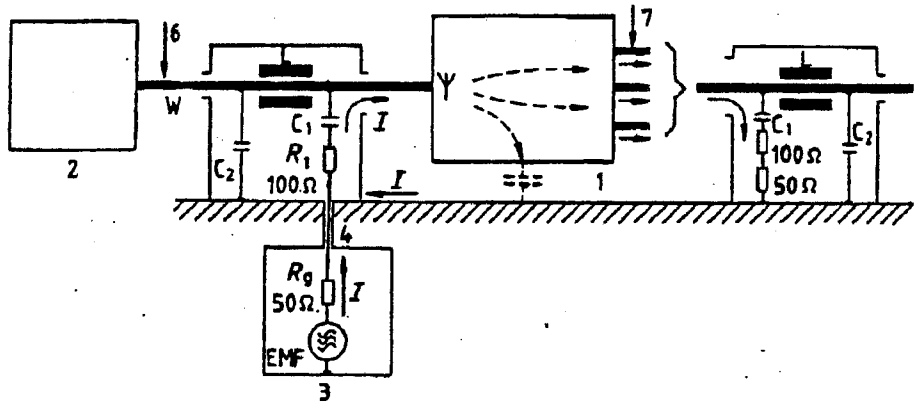
1. Unwanted signal generators G1
2. Wanted signal generator G2
3. Load resistor
4. Low pass filter (see annex B)
5. Audio frequency voltmeter (with weighting network according to CCIR Recommendation 468)
6. Coupling networks
7. Attenuators
8. Matching and/or balancing network
9. Equipment under test*)
10. Low-pass filter**)

*)If video tape equipment then in connection with the test-TV-set.

**)To prevent influence of the measuring results by harmonics of the unwanted signal generator, the cut-off frequency of the filter shall be specified depending on the adequate unwanted signal frequencies.

(3, 4 and 5 may be replaced by figure 2b or 2c if appropriate or in the case of video tape equipment under test connected to the audio output terminal of the test-TV-set).

Figure 6. Measuring set-up for input immunity measurement of television receivers and video tape equipment



L: isolating inductance

C_1 and C_2: capacitors with low RF impedance (if the ac-dc conditions allow, these capacitors should be replaced by a direct connection)

I: interference current

$R_g + R_1 = 150\ \Omega$

1: Equipment under test

2: Wanted signal generator

3: Unwanted RF signal generator

4: Connecting cable

5: Metal plate

6: Coaxial cable, twisted pair or multi-lead cable (screened)

7: Other cables for mains, loudspeakers, etc., each terminated with a coupling unit (150 Ω)

Figure 7. General principle of the current injection method

15.2 Measurement set-up

The equipment under test is placed 0,1 m above a metallic ground plane of dimensions 2 m by 1 m. The coupling units are inserted into the various cables respectively. The cables linking the coupling units to the equipment under test shall be as short as possible, in particular the lead to the antenna input of the equipment under test shall be not longer than 0,3 m.

The mains lead, if not cut, shall be bundled to give a length of less than 0,3 m. The distance between the leads and the ground plane shall be 30 to 50 mm. The mains lead shall be fixed in a well defined layout which shall be recorded with the test results.

The maximum number of coupling units used in a test shall be six. In the case of equipment under test with more than six terminals, coupling units shall be used for at least one of each type of terminals, if present, as follows: RF input, mains, two loudspeaker outputs (if stereo) video input and audio input with the lowest specified input level.

15.3 Measurement circuit

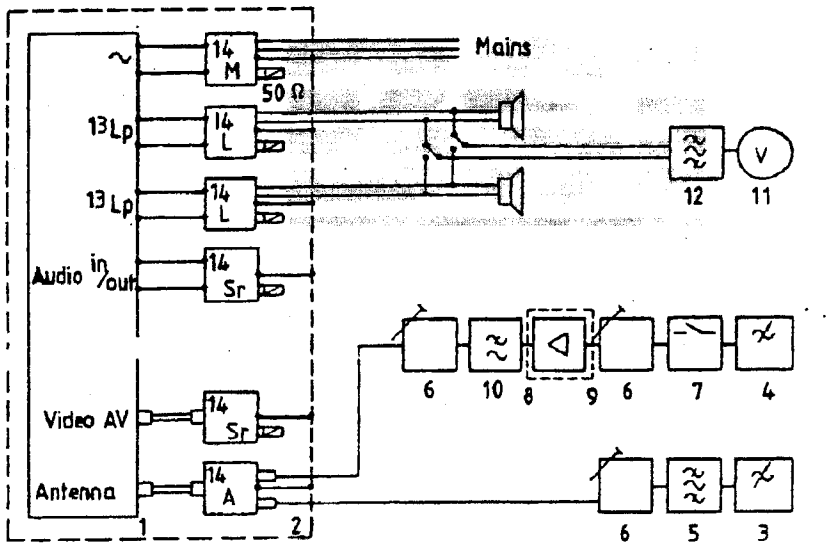
The measurement circuit is given in figure 8.

The wanted radio or television signal including the sound part is supplied by generator G1, followed by a channel filter Fc and an attenuator T3.

The unwanted signal current is supplied by generator G2, followed by switch S1, attenuator T1, wide-band amplifier Am, low-pass filter F and attenuator T2. For immunity tests on receivers or video tape equipment in frequency ranges other than the reception bands, a low-pass filter F is required to attenuate the harmonics of the unwanted signal source which could otherwise interfere directly with the IF and RF channels of the equipment under test. For the same reason the power amplifier Am is, if necessary, placed in a shielded (Sh) box to prevent direct radiation.

NOTE. Annex C describes the performance requirement of the low-pass filter F.

Attenuator T2 (6 to 10 dB) provides a matched 50 Ω load to the power amplifier output and defines the source impedance.



1: Equipment under test
2: Metal plate, 2 m × 1 m P
3: Generator of wanted signal G1
4: Generator of unwanted signal G2
5: Channel filter Fc
6: Attenuators T1, T2, T3
7: Switch S1
8: Amplifier Am
9: Shielded box Sh
10: Low pass filter F
11: Audio frequency voltmeter V
12: Bandpass filter FR (see annex B)
13: Loudspeaker connectors Lp
14: Coupling units M, L, Sr, A (see annex C)

Figure 8. Measurement principle for the immunity from conducted currents

If an equipment under test requires another apparatus in order to function properly, that additional apparatus shall be considered as part of the measuring equipment and precautions shall be taken to ensure that the additional apparatus is not subject to the unwanted signal. These precautions may include additional earthing of coaxial shields, shielding, and insertion of RF filters on, or application of ferrite rings to, the connecting cables.

Ground terminals of equipment under test shall be connected to the ground plane through a 150 Ω resistor.

The audio output power levels shall be measured according to subclause 7.2.

15.4 Measurement procedure

The wanted AM radio signal shall be at a level of 46 dB(μV), referred to 75 Ω, amplitude modulated with 1 kHz at 30 % depth at the frequencies 250 kHz for LW band, 1 MHz for MW band and 16 MHz for SW band.

The wanted FM radio signal shall be tuned at 98,0 MHz and shall be at a level of 44 dB(μV) referred to 75 Ω, frequency modulated with 1 kHz, 22,5 kHz deviation.

The wanted television signal shall be at a picture carrier level of 70 dB(μV) referred to 75 Ω modulated with a vertical colour bar pattern:

- at the picture carrier frequency in the lowest of the channels N_i, N_{iii}, N_{iv} and N_v available in the equipment under test for systems B, G and I as appropriate;
- at the picture carrier frequency in the lowest of the channels 04, 08, 25, 55 available in the equipment under test for system L as appropriate.

For systems B, G and I the sound carrier is frequency modulated with 1 kHz at a frequency deviation of 30 kHz. For system L the sound carrier is amplitude modulated with 1 kHz at 54 % depth. The sound carrier level is $70 - x$ dB(μV) where $x = 13$ for systems B and G and $x = 10$ for systems I and L.

The unwanted signal is amplitude modulated at 1 kHz at 80 % depth. Measurements shall be carried out according to subclauses 7.2 and 7.3.

16 Measurement of screening effectiveness

The screening effectivencss of the antenna terminal of a television receiver is given by its immunity to the in-channel disturbance signal, injected into the screen of the antenna coaxial cable.

16.1 Measuring set-up for television receivers

The measuring set-up is shown in figure 9.

The television receiver under test is placed on a non-metallic table, the height of which shall be 0,8 m. At the side of the receiver antenna terminal, a non-metallic table 4 m long shall be placed at the same height to provide for movement of the absorbing clamp. An RF signal generator, coaxial transfer switch and variable attenuator are placed on a third table.

The pattern generator is connected via the signal combiner, to the antenna terminals of the television receiver by a measurement cable (a high-grade coaxial cable) with a high-grade connector. The measurement cable is positioned in a straight line. The height of the television receiver shall be adjusted as necessary to bring the antenna terminals to the correct position. The characteristic impedance of the measurement cable shall have the same value as the nominal impedance of the television receiver. If the output impedance of the pattern generator, signal combiner and/or measurement cable are different, they shall be matched to each other by means of matching networks.

The absorbing clamp is placed around the measurement cable with its coupling transformer towards the television receiver. It shall be suitable for use at the test frequency as specified in CISPR Publication 16.

The disturbance signal generator shall be connected to the coaxial transfer switch which in turn is connected to either the absorbing clamp, or the receiver under test via the variable attenuator, matching network, signal combiner and measurement cable. A load having the same impedance as the disturbance generator and absorbing clamp shall be connected to the coaxial transfer switch to terminate the non-selected disturbance signal path.

All reflecting or absorbing objects shall not be closer than 0,8 m to the measuring set-up.

The quality of the measurement cable and its connector shall be checked by using the measuring set-up shown in figure 9. The television receiver under test shall be replaced by a selective voltmeter and the pattern generator by a screened matched load. The disturbance signal generator shall be connected via the coaxial transfer switch to the absorbing clamp.

Let S_c be the value determined by the formula:

$$S_c = U_s - A - U \text{ [dB]}$$

where:

U_s is the output level of the generator [dB(μV)];

A is the insertion loss of the clamp [dB];

U is the maximum voltage measured by the selective voltmeter when moving the clamp [dB(μV)].

The quality of the measurement cable and its connector is considered satisfactory if, at all frequencies, S_c is 10 dB greater than the immunity limit specified for the receiver under test.

16.2 Measurement procedure for television receivers

Measurements shall be carried out at the frequency of the centre channel of each television band available in the receiver under test (as for the internal immunity measurements, see 9.2).

The television receiver is fed by a pattern generator providing a signal level of 70 dB(μV) at the antenna terminals, and shall be tuned and adjusted to produce a normal picture successively in channel N_i, N_{iii}, N_{iv} and N_v (channel 04, 08, 25 and 55 for system L). An unmodulated disturbance signal, 1 MHz from the vision carrier and inside the wanted channel, shall be injected via the coaxial transfer switch and absorbing clamp.

The interference can either be observed at the television receiver screen or, in case the receiver has a video output connector, measured at this connector with a selective measuring instrument, e.g. a spectrum analyzer tuned to the 1 MHz interfering video component.

In case the interference is observed at the screen, the disturbance signal frequency shall be adjusted within the range of ± 8 kHz for maximum interference and the level shall be adjusted to produce a just perceptible degradation of the picture quality.

In case the interference is measured, the disturbance signal level shall be adjusted to provide a convenient level of the interfering video component, e.g. 20 dB below the black to white level.

NOTE. When connecting a measuring instrument to the video output of the receiver under test, it may be necessary to apply suitable ferrite rings to this connection or to make use of an optical connection with suitable adaptors.

Starting from a position close to the antenna terminals of the television receiver, the absorbing clamp shall be moved along the measurement cable to the position of the first maximum of interference.

The variable attenuator shall be adjusted so that the picture degradation or the measured interfering video component remains constant when the coaxial transfer switch is operated.

The screening effectiveness S_e is given by the formula:

$$S_e = A_a + A_c - A \text{ [dB]}$$

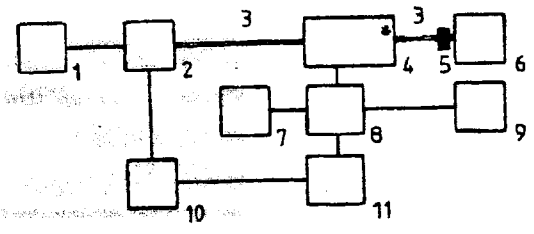
where:

A_a is the setting of the variable attenuator [dB];

A_c is the insertion loss of the signal combiner and matching network [dB];

A is the insertion loss of the absorbing clamp [dB].

NOTE. The immunity test performed with the current injection method may not be sufficient to assess the total immunity to radiated fields of the combination of the measurement cable, its connector and television receiver. Hence it may be necessary to perform an additional test of the total immunity to ambient fields of the above mentioned combination.



1: Pattern generator
2: Signal combiner
3: Measurement cable
4: Absorbing clamp; *: coupling transformer
5: High-grade connector
6: Receiver under test
7: Matching load
8: Coaxial transfer switch
9: Disturbance generator
10: Matching network
11: Variable attenuator

Figure 9. Measuring set-up for the screening effectiveness of the antenna terminals of a television receiver

16.3 Measuring set-up for VHF band II receivers

The measuring setup is shown in figure 9A.

The equipment under test is placed on a non-metallic table T1 of height 0,8 to 1,0 m. At the side of the antenna input terminal of the equipment under test, a non-metallic table T2 of length 4 m shall be placed at the same height to provide for movement of the measuring device, an absorbing clamp Cp. An RF signal generator G is placed on a third table T3.

The signal generator G is connected to the antenna input terminal of the equipment under test by a high-grade coaxial cable Ca using a high-grade connector Con. The height of the equipment under test shall be adjusted as necessary to bring the antenna input terminal to the correct position. The characteristic impedance of the coaxial cable shall be the same value as the nominal input impedance of the antenna input of the equipment under test. The source impedance of the generator, if different, shall be matched to the impedance of the coaxial cable through a matching network Mn.

The absorbing clamp Cp is placed around the cable with its coupling transformer towards the equipment under test. The absorbing clamp shall be suitable for use at the test frequency as specified in the relevant clause of CISPR Publication 16. The output from the clamp shall be measured using a calibrated measuring receiver.

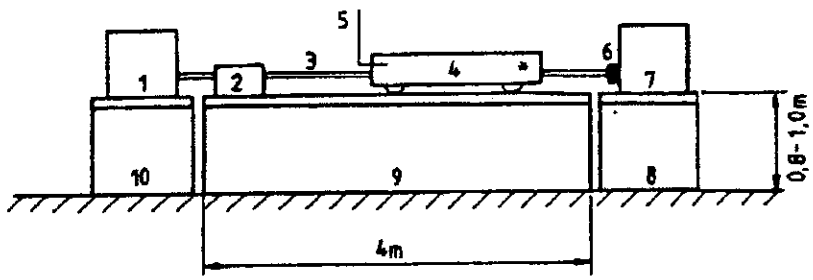
All reflecting or absorbing objects shall be no nearer than 0,8 m to the measuring set-up.

The quality of the coaxial cable and the connector is tested as follows. The equipment under test is replaced by a matched termination to the cable. A measurement is made according to the procedure in the following subclause. The measured value S shall be at least 30 dB at 98,0 MHz.

16.4 Measurement procedure for VHF band II receivers

The equipment under test is connected to the generator G, but not connected to the mains supply. The signal from the generator is at the test frequency and unmodulated. It is adjusted to a sufficiently high level according to the sensitivity of the measuring receiver used. Let this level be P_s [dB(pW)].

Starting from a position adjacent to the antenna terminal of the equipment under test, the absorbing clamp is moved along the coaxial cable to the position of the first maximum of the signal. The power dissipated in the measuring receiver is in this situation P_e [dB(pW)]. The insertion loss (attenuation) of the clamp is a_k [dB] and the correction for the clamp calibration is a_f [dB].



1: Signal generator G
2: Matching network Mn
3: High-grade coaxial cable Ca
4: Absorbing clamp Cp; *: Coupling transformer
5: To measuring receiver
6: High grade connector Con
7: Equipment under test
8: Non-metallic table T1
9: Non-metallic table T2
10: Table T3

Figure 9A. Measuring set-up for the screening effectiveness of the antenna terminals of VHF band II receivers

The screening effectiveness is given by the formula:

$$s\,[\mathrm{dB}] = P_s\,[\mathrm{dB(pW)}] - P_e\,[\mathrm{dB(pW)}] - a_k\,[\mathrm{dB}] - a_f\,[\mathrm{dB}]$$

$$= P_s\,[\mathrm{dB(pW)}] - 10\ \mathrm{lg}\left(\frac{N_e^2\,[\mu\mathrm{V}]^2}{R_e\,[\Omega]\cdot 1\,[\mathrm{pW}]}\right) - a_k\,[\mathrm{dB}] - a_f\,[\mathrm{dB}]$$

$N_e(\mu V)$ is the reading of the measuring receiver;

R_e is the impedance of the measuring receiver.

$$= P_s\,[\mathrm{dB(pW)}] - 20\ \mathrm{lg}\left(\frac{N_e\,[\mu\mathrm{V}]}{1\,[\mu\mathrm{V}]}\right) + 10\ \mathrm{lg}\left(\frac{R_e\,[\Omega]}{1\,[\Omega]}\right) - a_k\,[\mathrm{dB}] - a_f\,[\mathrm{dB}]$$

If the insertion loss of the absorbing clamp is 17 dB (a usual value) and the impedance of the measuring receiver is 50 Ω, the screening effectiveness S is given by the formula:

$$S[\mathrm{dB}] = P_s[\mathrm{dB(pW)}] - N_e[\mathrm{dB}(\mu\mathrm{V})] - a_f[\mathrm{dB}]$$

Measurements shall be made at the frequencies specified in subclause **9.4** as applicable to the equipment under test.

17 Measurement of electrical transients

Under consideration.

18 Measurement of immunity to induced voltages

18.1 Measuring circuit and set-up

Figure 10 shows the measuring circuit and set-up for receivers, video tape and audio equipment.

The wanted test signal (see table 22) is supplied by generators G1, G2, G3 and G4 via the respective connections A or V or S or T and the unwanted signal is supplied by generator G5. Network RC_i matches the RF disturbance source to the input impedance of the relevant audio terminal and a similar network RC_o is used to match the output terminals. Mains stop filter MSF is used to inject the unwanted signal at the mains terminal and acts as a stopfilter for unwanted signals from the mains network.

Annex D shows the circuits of the networks RC_i and RC_o and the mains stopfilter of figure 10.

The equipment under test is placed 0,1 m above the centre of a metal ground plane of dimensions 2 m by 1 m. The mains lead shall be bundled to a length less than 0,3 m and connected in the shortest possible way to the mains stop filter MSF. The connection between the metal ground plane and the shield of the RF cable at the audio input and output terminals shall be as short as possible. To avoid ground loop problems (e.g. hum, RF coupling) it is recommended that measuring instruments such as audio power meters and signal generators are of the ungrounded type. Alternatively the instruments may each be powered via individual mains isolation transformers.

For connection to the phono or tape input, care shall be taken to ensure an efficient shielding against mains pick-up. The earth conductors of the cable at the signal generator output and of the networks RC_o, RC_i and MSF are connected to the metal plate.

As a rule the connecting cables shall be of the 50 Ω coaxial type, up to the terminal under test (e.g. also for loudspeaker and headphone ports).

The unused input terminals and the loudspeaker and/or headphone or any other audio output terminals are terminated with appropriate load resistors as specified by the manufacturer or in the relevant standard.

For stereo or two channel sound television equipment respectively the unwanted signal is simultaneously fed to the two audio input channels. The output terminals of the channels are fed as well as measured separately.

Prior to measurements a check shall be carried out to see that no interference signal penetrates directly into the measuring equipment.

The audio output power levels are measured according to subclause **7.2**.

In table 22 the conditions for the measurement are given for receivers, video tape and audio equipment. The wanted signals are specified according to the operating mode of the equipment under test and provided by generators G3 and G1, or G4 and G2 and G1 or G1 or G2.

The unwanted signal shall be amplitude modulated with 1 kHz at 80 % depth, supplied by generator G5.

18.2 Measurement procedure

For adjusting, the wanted signals are set, dependent on the type of equipment under test and its operating mode, by making the connections of figure 10 as follows: A for audio terminals, V for video terminals (simultaneously audio signal at audio terminals), S for antenna terminals (sound broadcast signal) and T for antenna terminals (television broadcast signal). The audio controls of the equipment under test, other than the volume control, are set at normal position. The volume control is adjusted to obtain an audio output power of 50 mW (or 500 mW) (see **7.2** for audio power measuring arrangements). For stereo equipment the balance control shall be adjusted to obtain 50 mW (or 500 mW) from both channels. The video controls of the equipment under test are set to

obtain a picture as described in subclause 7.3.

For the measurement, the unwanted signal is applied to the terminal under test by making the connections of figure 10 as follows: A_I for audio input terminals, M for the mains lead and A_O for audio output terminals.

The connections L, R respectively L_O, R_O are for adjusting and/or measurement of the adequate output channels.

For television receivers and video tape equipment in the RF- recording mode, measurements are carried out with the wanted signal in the lowest of the channels N_i, N_{iii}, N_{iv} and N_v available in the equipment under test (or the lowest of the channels 04, 08, 25 or 55 for system L).

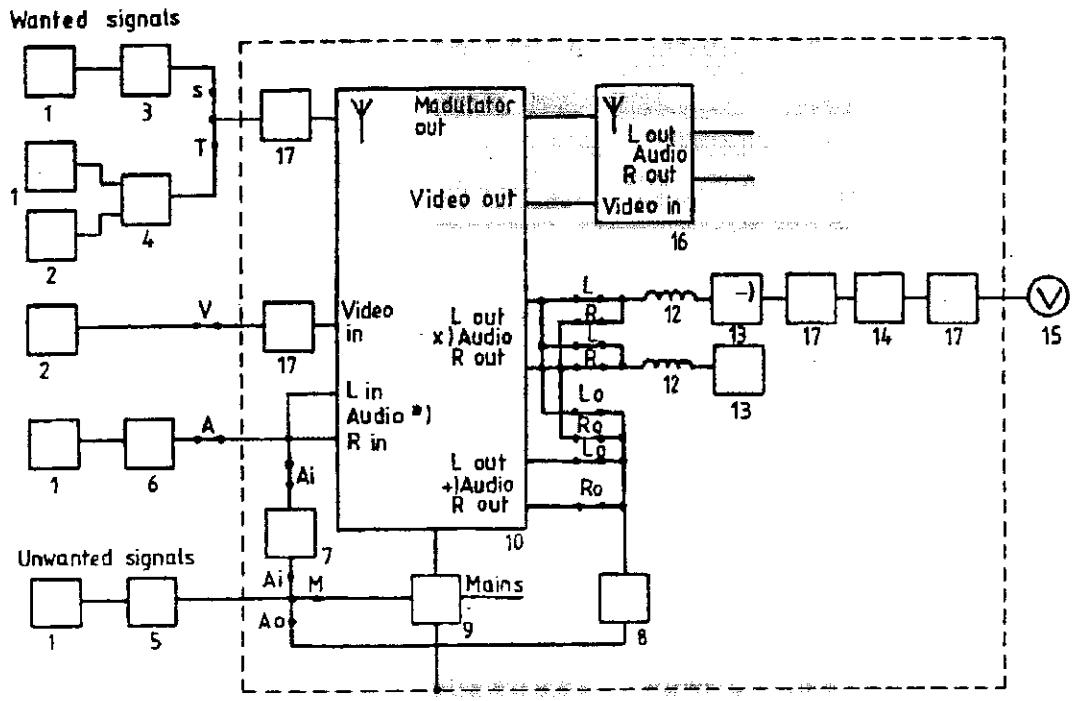
Table 21. Function of the connections in figure 10

A	1 kHz (G1) at the audio inputs
V	Video signal (G2) at the video input
S	Modulated wanted signal for sound receivers (G3 and G1) at the antenna input
T	Modulated wanted signal for television receivers and video tape equipment (G4 and G2 and G1) at the antenna input
A_I	Unwanted signal at the audio inputs
M	Unwanted signal at the mains lead
A_O	Unwanted signal at the audio outputs L_O: at the left channel R_O: at the right channel
L	Adjustment or measurement of channel L
R	Adjustment or measurement of channel R

Table 22. Measurement conditions for the test of immunity from conducted voltages

Operating mode of receiver/video tape equipment	Wanted signal for adjustment of reference output power/reference picture	Unwanted signal injection into receiver connection
Phono[1]	1 kHz, 500 mV (e.m.f.) (crystal) 1 kHz, 5 mV (e.m.f.) (magnet) 1 kHz, 0,5 mV (e.m.f.) (coil)	Audio input terminals; or Mains power supply; or Loudspeaker; or Headphones; or Audio output terminals
Audio tape recorder playback[1] and auxiliary	1 kHz, 500 mV (e.m.f.)	
VHF band II[1]	60 dB(μV) at 75 Ω at a frequency of 98 MHz 1 kHz freq. mod. 40 kHz deviation	
TV[1] and video recording from RF sources[2]	Standard colour TV channel signal (colour bar); sound carrier 1 kHz freq. mod. 30 kHz deviation (or ampl. mod. 54 % for system L) 70 dB(μV) at 75 Ω Wanted signal in the lowest of the channels N_i, N_{iii}, N_{iv} and N_v (M channels the lowest of channels: 04, 08, 25 or 55 for system L) available in the equipment under test	
Video recording[2] and TV monitor mode	1 kHz, 500 mV (e.m.f.) and video signal, 1 V between white and synchron level (applying also during measurement procedure)	

[1] Receivers.
[2] Video tape equipment (in the playback mode the wanted signals are supplied by a test-tape recorded with the adequate signals).



*) Channels 1 and 2 in the case of two channel sound television equipment.
x) Audio power output provided for adjusting and measurement.
+) Other audio outputs.
-) To be left out in case of high-resistance (> 10 kΩ) audio output impedance.

1: AF generator 1 kHz G1
2: Video generator G2
3: RF generator G3 for FM
4: RF generator G4 for TV
5: RF generator G5 for unwanted signal
6: Impedance (R_s – RG1)
R_s = rated source impedance of the audio input (1 kΩ in the case of video tape equipment)
7: RC network for audio inputs RC_i
8: RC network for audio outputs RC_o
9: Mains stop filter MSF
10: Equipment under test
11: Metal plate 2 m × 1 m (P)
12: RF choke 100 µH (L)
13: Rated load impedance of the audio output RL
14: Band-pass filter BP (input impedance 10 kΩ)
15: Audio frequency volumeter V
16: Test-TV-set TTS
17: Sheath current choke (ferrite cores) sh

(12, 13, 14 and 15 may be replaced by figure 2b or 2c if appropriate).

Figure 10. Measurement of immunity from induced voltages at:
- mains input
- headphones
- speakers
- audio output
- audio input

19 Measurement of immunity from radiated fields

A homogeneous, electromagnetic wave under free space conditions can be simulated by a guided wave of the TEM (transverse electromagnetic) mode travelling between two flat conducting surfaces. In this case the electric field component is perpendicular, and the magnetic field component parallel, to the conductors. The open TEM stripline is specified in this standard.

19.1 The open stripline

The constructional details of a suitable open stripline are shown in annex E. The open stripline has a frequency range usable up to 150 MHz and may be used for equipment under test up to 0.7 m high. The characteristic impedance of the stripline is 150 Ω.

The calibration and testing of the measuring set-up is performed as in annex F.

The required field strength is adjusted with the equipment under test inside the set-up as described in 19.2. The equipment, however, is switched off during the adjustment.

The input voltage of the stripline is set to produce the correct voltage at the measuring plate, corresponding with the required field strength; for one frequency, e.g. 15 MHz.

The correction factor K_1, established by the calibration, is taken into account during the further measurement procedure.

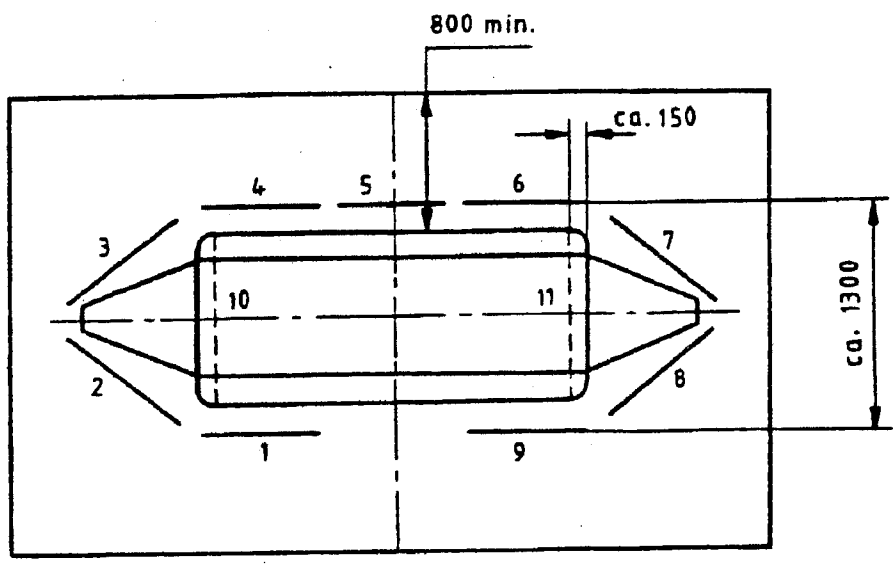
The use of TEM devices of other dimensions or types is acceptable if it is shown that in the relevant frequency range the results do not differ by more than 2 dB from the values measured in the recommended stripline.

19.2 Measurement set-up

The stripline shall be placed on non-metallic supports at least 0,8 m from the floor, and the top conductor plate shall be no closer than 0,8 m from the ceiling.

When used in a room, the stripline shall be spaced at least 0,8 m from its open longitudinal sides to walls or other objects. When used inside a screened room, RF absorbing plates shall be placed in the space between the sides of the stripline and the walls of the screened room. Figure 11 shows the arrangement.

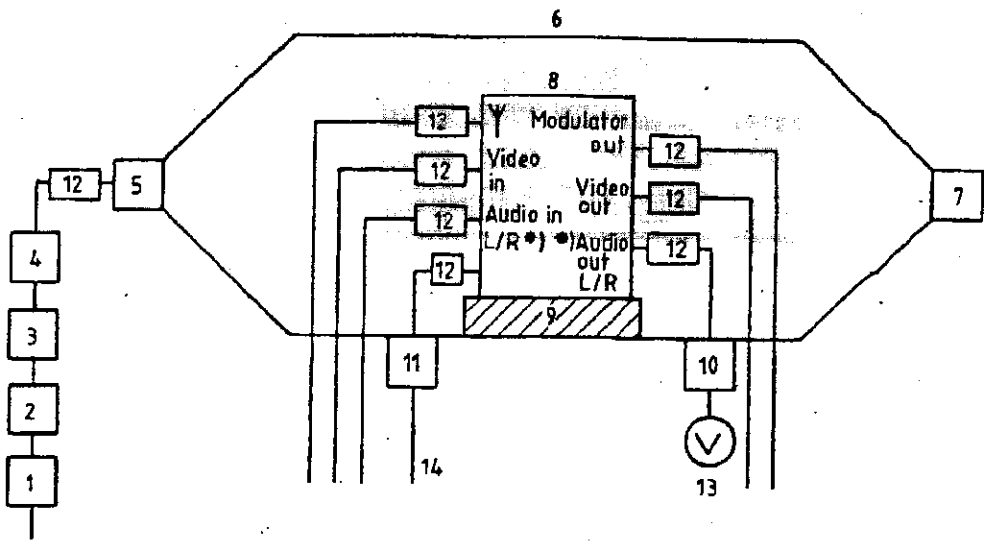
The equipment under test is placed on a non-metallic support, 0,1 m high, in the centre of the stripline in the same position as for normal home usage (e.g. in the case of portable equipment), see figure 12.



Dimensions in mm.

1-11: absorbing plates with dimensions of approximately 0.8 m × 0.6 m

Figure 11. Example of the arrangement of an open stripline TEM device in combination with absorbing plates inside a screened room with dimensions of 3 m × 3,5 m



1: AF generator 1 kHz G1
2: RF generator G2 for unwanted signal
3: Wideband power amplifier Am 0,15 MHz to 150 MHz
4: Low-pass filter F
5: Matching network MN (see figure E.5)
6: Open stripline device TEM
7: Terminating impedance 150 Ω (see figure E.6)
8: Equipment under test
9: Non-metallic support
10: Loudspeaker bandstop filter BS (see figure E.8)
11: Mains bandstop filter M (see figure E.7)
12: Sheath current chokes (ferrite cores) (sh)
13: Audio frequency voltmeter (V)
14: Mains cable

*) Channels 1 and 2 in the case of two channel sound television equipment.

Figure 12. Measurement principle for the immunity of broadcast receivers from radiated fields in the frequency range 0,15 MHz to 150 MHz

Connecting leads to the equipment under test are inserted through holes in the base conductor plate of the stripline, the lengths of the leads inside the stripline shall be as short as possible and completely surrounded by ferrite rings to attenuate induced currents. The transfer impedance of coaxial cables used shall be no higher than 50 mΩ/m at 30 MHz. The mains lead shall be bundled to a length less than 0,3 m.

Any balanced-to-unbalanced transformer used shall be connected to the equipment under test with leads as short as possible.

Terminals of the equipment under test not used during the measurement shall be terminated with shielded resistors matching the nominal terminal impedance.

If an equipment under test requires another apparatus in order to function properly, that additional apparatus shall be considered as part of the measuring equipment and precautions shall be taken to ensure that the additional apparatus is not subject to the unwanted signal. This requires generally the placing of the other apparatus outside the stripline. For the connections to the antenna terminal or to the video input terminal of the equipment under test, a high-grade coaxial cable with a high-grade connector at the antenna or video input terminal side shall be used. These precautions may include additional earthing of coaxial shields, shielding, and insertion of RF filter on, or application of ferrite rings to, the connecting cables.

19.3 Measurement procedure

Figure 12 shows the circuit used. For adjusting the wanted signals the audio or video controls of the equipment under test are set as described in subclauses **7.2** and **7.3**. During the adjustment procedure the unwanted signal (generator G2) is switched off. The wanted signals are specified in table 22.

For the measurement, the unwanted signal is supplied by generators G1 and G2 which is connected through wide-band amplifier Am, and low-pass filter F to matching network MN of the stripline. The wide-band amplifier Am may be required to provide the necessary field strength. The stripline is loaded with a terminating impedance TI.

Care shall be taken with respect to the harmonic level of the RF output of the generator G2 and in particular the output of the wide-band amplifier Am. Harmonics may influence the measurement if they coincide with the tuned channel or the IF channel of the equipment under test. In some cases provisions shall be made to reduce the harmonic level adequately by inserting a suitable low-pass filter F. Annex C describes the checking procedure for low-pass filters.

The audio output power levels shall be measured according to subclause **7.2**.

The unwanted signal shall be amplitude modulated with 1 kHz at 80 % depth, supplied by generator G2 and amplifier Am.

Measurements shall be performed while taking clauses **6** and **7** into account.

20 Measurement of electrostatic discharge

Under consideration.

21 Significance of the immunity limits

21.1 The significance of the immunity limits in this standard for type approved equipment shall be that on a statistical basis at least 80 % of the mass produced equipment comply with the limits with at least 80 % confidence.

21.2 Tests shall be made:

21.2.1 Either on a sample of equipment of the type, using the statistical method of evaluation set out in item **21.4**;

21.2.2 or, for simplicity's sake, on one equipment only.

21.3 Subsequent tests are necessary from time to time on equipment taken at random from production, especially in the case referred to in item **21.2.2**. The banning of sales or the withdrawal of a type approval, as a result of a dispute, shall be considered only after tests have been carried out in accordance with item **21.2.1**.

21.4 Statistical assessment of compliance shall be made as follows.

This test shall be performed on a sample of not less than seven items. Compliance is judged from the condition that the number of equipments which do not meet the immunity limits does not exceed c in a sample of size n.

Table 23

n	7	14	20	26	32
c	0	1	2	3	4

Should the test on the sample result in non-compliance with the requirements in subclause **21.2.1**, then a second sample may be tested and the results combined with those from the first sample, and compliance checked for the larger sample.

For general information, see CISPR Publication 16, Section Nine: *Statistical Considerations in the Determination of Limits of Radio Interference.*

Annex A (normative)

Specification of the test-TV-set

For systems B, G and I the test-TV-set shall be a two-channel-sound television broadcast receiver with an automatic frequency control facility (AFC) and with appropriate video input terminals for connection with the video output terminals of video tape equipment, but without a sound muting circuit.

For system L, the test-TV-set shall be an AM sound television broadcast receiver, with an automatic frequency control facility (AFC) and with appropriate video and audio terminals for connection with a video tape equipment.

The test-TV-set shall at least meet the immunity requirements for television receivers specified in this standard in subclauses **9.2**, **9.3**, **9.4** and **13.1**, when measured according to the relevant methods of measurement of this standard, and the input immunity shall overstep the limits of table 5 (or tables 6 or 8 as appropriate) for at least 3 dB.

Additional requirements.

- Screen diagonal size: ≥ 50 cm.
- Picture definition, measured at the picture tube electrode by using a multiburst test pattern: 4 MHz, level −6 dB related to 1 MHz.
- Focusing: optimum.
- Video-signal-to-noise-ratio, weighted by weighting network according to CCIR Recommendation 567, noise voltage level as RMS-value, related to the video output level of the receiver, when monochrome picture with colour-burst and for the antenna signal level of 70 dB(μV) at 75 Ω: ≥ 60 dB.
- Audio-signal-to-noise-ratio, weighted by weighting network according to CCIR Recommendation 468, noise voltage level as quasi-peak-value, related to the 1 kHz audio output level of the receiver of 50 mW for antenna signal level of 70 dB(μV) at 75 Ω and frequency deviation of the sound carrier 30 kHz: ≥ 43 dB (≥ 46 dB recommended).
- Suppression of the line-frequency at the audio output terminals, relation equal to audio-signal-to-noise-ratio, measured selective with bandwidth ≤ 150 Hz as RMS-value: ≥ 43 dB (≥ 46 dB recommended).

Annex B (normative)

Specification of filters and weighting network

B.1 Low-pass filter 15 kHz

The low pass filter shall comply with the following characteristics:

cut-off frequency (3 dB) at 15 kHz

attenuation for operating frequencies up to 10 kHz	≤ 0,5 dB
attenuation at 15 kHz	≤ 3 dB
attenuation at 19 kHz	≥ 50 dB

The low pass filter shall be terminated with its characteristic impedance.

B.2 Band-pass filter 0,5 kHz to 3 kHz

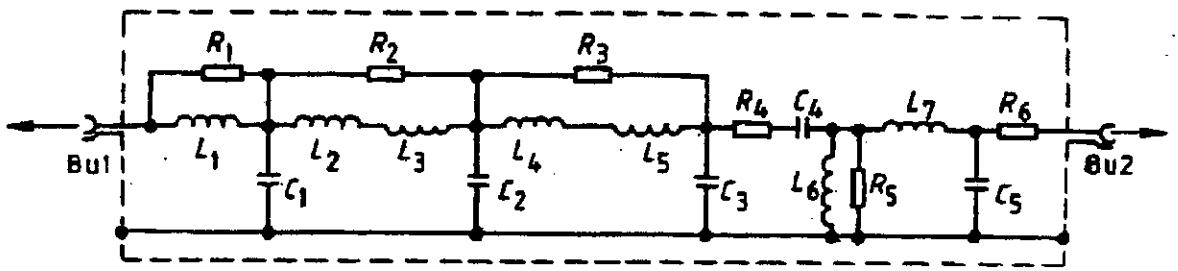
The band pass filter shall comply with the following characteristics:

attenuation at 0,1 kHz	≥30 dB
attenuation at 0,5 kHz	≤ 3 dB
attenuation at 1 kHz	≤ 0,5 dB
attenuation at 2 kHz	≤ 0,5 dB
attenuation at 3 kHz	≤ 3 dB
attenuation at 10 kHz	≥25 dB

An example of an 0,5 kHz to 3 kHz band-pass filter is given in figure B.1.

B.3 Weighting network

For some audio-output measurements a psofometric filter shall be placed in front of the audio-frequency voltmeter. The psofometric filter shall comply with CCIR Recommendation 468 (see subclause **26.3** of IEC/CISPR Publication 16, 1987).



$L_1 \ldots L_5$ = 33 mH	Micro-inductance
*L_6 = 650 mH	Four-slit-core
L_7	Broad-band-choke
$R_1 \ldots R_3$ = 4,7 kΩ	$C_1 \ldots C_3$ = 22 nF
R_4 = 100 Ω	C_4 = 0,1 µF
R_5 = 8,2 kΩ	C_5 = 2,2 nF
R_6 = 820 Ω	

*1450 Wdg 0,115 ϕ *CuI, solderable*
Bu1, Bu2 BNC-F 50 Ω

Figure B.1 Band-pass filter 0,5 kHz to 3kHz

Annex C (normative)

Specification of coupling units and of low-pass filter

These devices are used for the measurement of immunity from conducted currents in the frequency range 0,15 MHz to 150 MHz.

C.1 Construction of the coupling units

The coupling units are designed to inject the unwanted signal current onto a lead connected to the terminal under test, and to isolate the other leads and apparatus connected to the equipment under test from the effect of the unwanted signal current. The units are used also to define the asymmetric impedance to earth of leads connected to equipment under test terminals which are not under test.

The principle of operation is illustrated in figure 7. The inductance L presents a high RF impedance to the injected current. The filter L/C2 isolates the terminal under test. The unwanted signal from an RF generator with 50 Ω source impedance is injected via a 100 Ω resistor and a blocking capacitor C1 onto the leads or the shield of a coaxial cable.

The coupling units shall have a resulting resistive source impedance of 150 Ω. With this source impedance it has been found that there is a good correlation between the RF interference fieldstrength acting on an installation and the e.m.f. applied in the conducted current measurement to produce the same degradation. Therefore the immunity of an apparatus is expressed in terms of this e.m.f. level.
There are four types of coupling units.

Type A: For use with coaxial cables carrying wanted RF signals. The construction details are shown in figure C.1

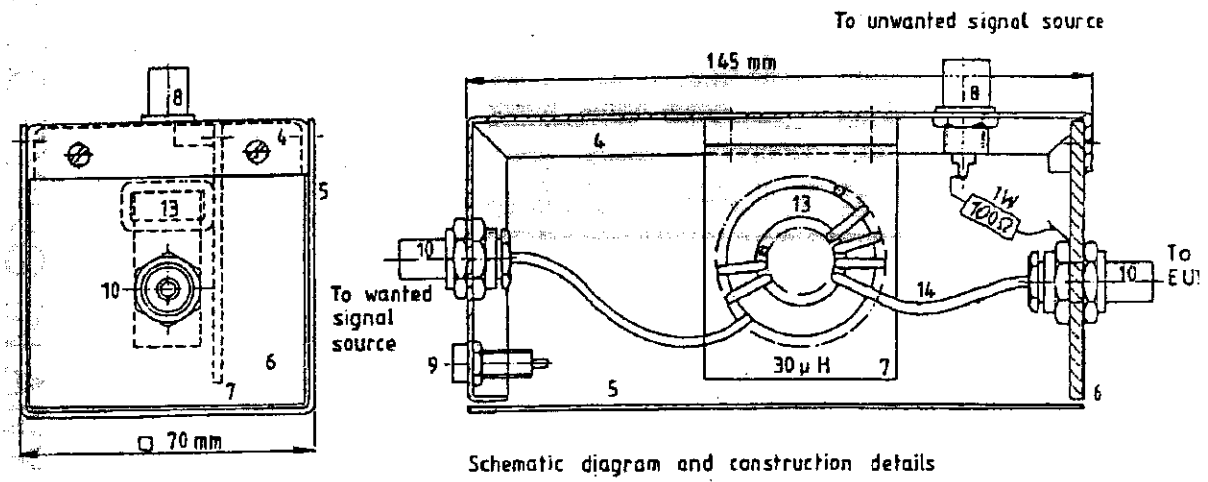
Type M: For use with mains leads. The construction details are shown in figure C.2

Type L: For use with loudspeaker leads. The construction details are shown in figure C.3

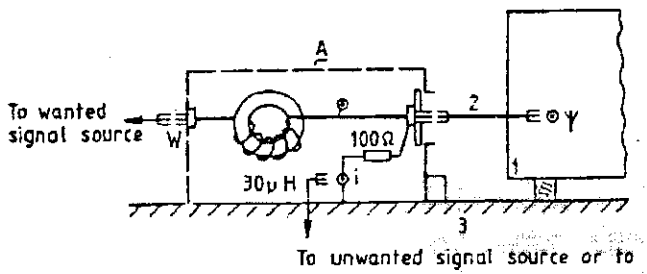
Type Sr: For use where there is no requirement to provide a through path for a wanted signal. All leads of the cable are terminated with a matched load resistance. The construction details are shown in figure C.4

In the layout of all coupling units, precautions have to be taken to keep the parasitic capacitance as low as possible for the output terminals which conduct the injected current. Those terminals are to be mounted on an insulating plate. It should be noted that the metal cases of the units are to be grounded carefully to the ground plane using large size copper braid and unpainted cases.
The following general requirements apply.

a) All types of coupling units have a resulting resistive source impedance of 150 Ω. The value of the series resistor included in the unit is adjusted according to the source impedance of the unwanted signal generator (combination of G2 + Am + T2 in figure 8).

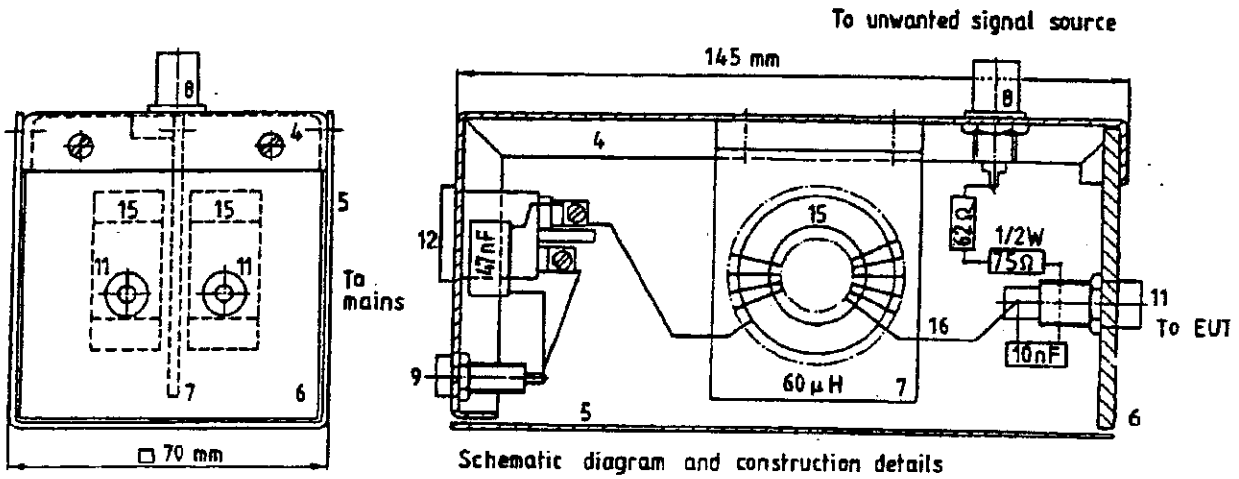


Schematic diagram and construction details

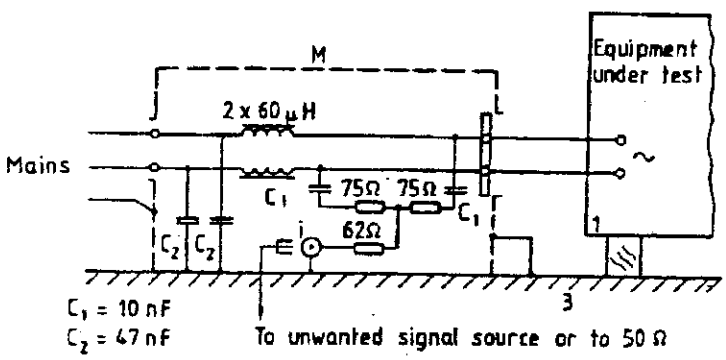


1. Equipment under test
2. Coaxial antenna cable
3. Metal ground plane PL
4-5. Metallic case 145 mm × 70 mm × 70 mm (part 5 placed on the groundplane PL)
6. Front plate (insulating material)
7. Supporting plate for chokes (insulating material)
8. Coaxial connector, BNC
9. Ground jack
10. Coaxial connector, BNC (for coaxial cable assembly)
13. Ferrite ring type 4C6 or similar, 36 mm outer diameter × 23 mm inner diameter × 15 mm thickness, with 14 turns of coaxial cable with 2,4 mm outer diameter
14. Coaxial cable type RG-188 A/U, 50 R 2,4 mm outer diameter

Figure C.1 Coupling unit type A (for coaxial antenna input)



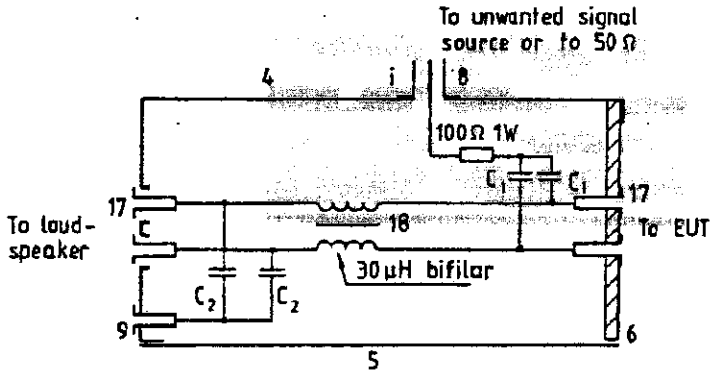
Schematic diagram and construction details



Pos. 1 and 3 to 9 as for figure C.1

11. Mains socket for equipment under test (2 insulated banana jacks)
12. Mains plug (2 pin + ground)
15. 2 ferrite rings type 4C6 or similar, 36 mm × 23 mm × 15 mm, with 20 turns each, insulated copper wire
16. Copper wire 0,8 mm, insulated, 1,8 mm outer diameter

Figure C.2 Coupling unit type M (for mains lead)



Schematic diagram and simplified construction drawing

Pos. 4-5-6-8-9: as for figure C.1

17: Insulated banana jacks

18: Inductance 30 µH asymmetrical

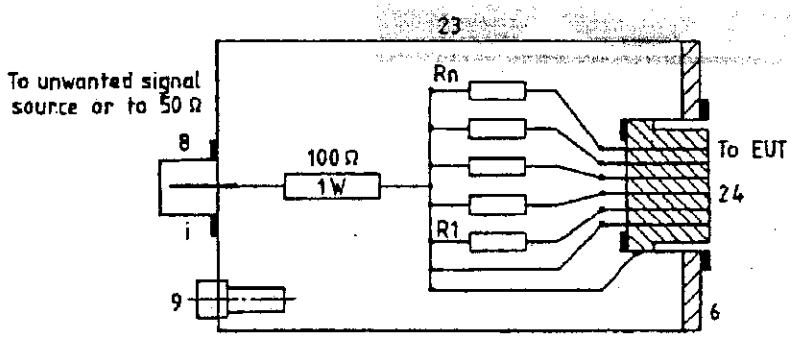
Core: 1 ferrite ring, type 4C6 or similar, 36 mm φ × 23 mm φ × 15 mm

Winding: 14 turns with a twisted pair (2 leads, copper wire 0,6 mm φ, insulated, 1,2 mm outer diameter)

Mounting of the inductance similar to figure C.1

Capacitors: C_1 = 10 nF; C_2 = 47 nF

Figure C.3 Coupling unit type L (for loudspeaker leads)



Schematic diagram and simplified construction drawing

Pos. 6-8-9: as for figure C.1

23: Metallic case 100 mm × 55 mm × 55 mm

24: Multiple pins connector or DIN-socket

R1 ... Rn: Matched load resistance

Examples: Coupling units Sr for audio equipment:

Phono magn.: 2 × 2,2 kΩ

Phono crystal: 2 × 470 kΩ

Microphone: 2 × 600 Ω

Tuner: 2 × 47 kΩ

Tape in/out: 4 × 47 kΩ

Audio in/out: 4 × 47 kΩ

Figure C.4 Coupling unit type Sr with load resistances

When the generator impedance is 50 Ω the resistor has a value of 100 Ω. In the antenna line coupling unit type A this 100 Ω resistor is bonded to the shield of the coaxial output connector in the unit. In the mains coupling unit type M the unwanted current is injected asymmetrically on both mains leads through an equivalent resistance of 100 Ω. This unit has been designed as a delta artificial mains network and presents a symmetrical and asymmetrical equivalent resistive impedance of 150 Ω to the equipment under test.

b) The RF chokes shall present a sufficiently high RF impedance (with respect to 150 Ω) over the whole frequency range.

c) The shielding effectiveness of the coaxial cable (including the 0,3 m cable length between the unit and the equipment under test) and coaxial connector used for the antenna coupling unit type A shall be at least 10 dB better than the shielding effectiveness of the elements used in the antenna input circuit of the equipment under test (input connector, cable and tuner).

NOTE. For the coupling units described in figures C.1 to C.4, with coils of 30 μH or 2 × 60 μH in parallel, the above requirements a) and b) are met within the frequency range 1,5 MHz to 150 MHz. These coupling units can also be used in the frequency range 0,5 MHz to 1,5 MHz for provisional tests. Coupling units to cover 0,15 MHz to 30 MHz are in preparation.

C.2 Performance checks for coupling units

In the frequency range up to 30 MHz the total asymmetric impedance (RF choke in parallel with the 150 Ω resistor), measured between the shield of the type A coupling unit output connector and the ground plane as well as between the joint terminals of the mains coupling unit type M and the ground plane, shall have a modulus of 150 Ω ± 20 Ω and a phase angle less than 20 degrees.

In the frequency range of 30 MHz to 150 MHz the insertion loss of two identical coupling units in tandem shall be measured in a 50 Ω system. The method and the requirements are given in figure C.5.

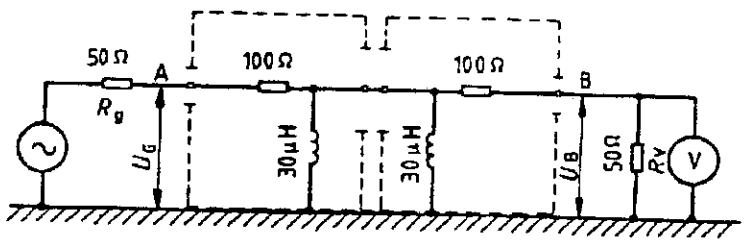
C.3 Performance checks for the low-pass filter F

The purpose of this filter is to attenuate the harmonics of the unwanted signal source. The frequency response of the filter F shall have a sharp cut off at a frequency of a few MHz below the frequency band to be protected (IF and reception band) and shall have a high attenuation in this frequency band. The requirements for this filter depend on the spectral purity of the signal generator and power amplifier. The overall generator-amplifier-filter chain is tested in the following way (the example being the test for TV receivers).

A calibrated RF signal generator with 50 Ω output impedance is directly connected to the disturbance source input of coupling unit A in figure 8, replacing the generator-amplifier-filter chain. The frequency is swept through the IF and RF reception channels of the TV receiver, and the RF voltages required to cause just perceptible interference are noted.

Then the levels of the harmonics generated in the above frequency ranges by the combined set-up (G2 + Am + F) are measured at the output of T2, setting the highest levels used during the immunity tests.

The attenuation of the filter is considered adequate if the levels of the harmonics are at least 10 dB below the voltages noted in the preceding test.

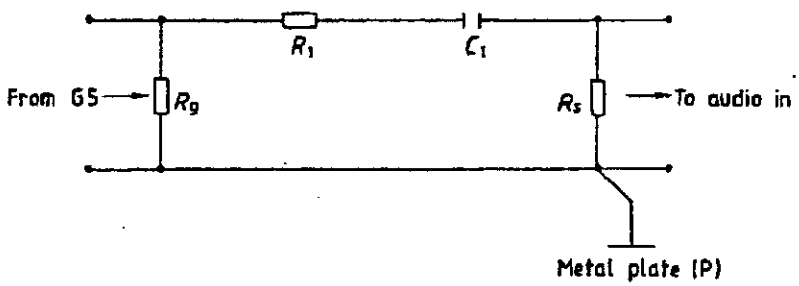


R_g = internal resistance of generator
R_v = internal resistance of voltmeter

The insertion loss U_G/U_B of two identical coupling units measured according to this figure should be within 9,6 and 12,6 dB in the frequency range 30 MHz to 150 MHz. U_G is the reading of the voltmeter, when the generator and the voltmeter are directly connected together.
NOTE. The two units shall be connected together with very short wires (shorter than 10 mm).

Figure C.5 Measuring set-up to check the insertion loss of the coupling units in the frequency range 30 MHz to 150 MHz

Annex D (normative)
Matching networks and mains stop filter



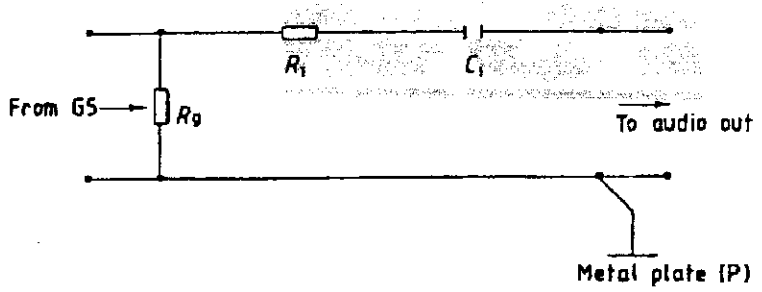
R_1 = 100 Ω − R_g/2

C_1 = 470 pF

R_g: Equal to the rated output impedance of generator G5 or high-pass filter HP as appropriate

R_s: Equal to the rated source impedance of the audio input

Figure D.1 RC network for audio inputs (RC_i)

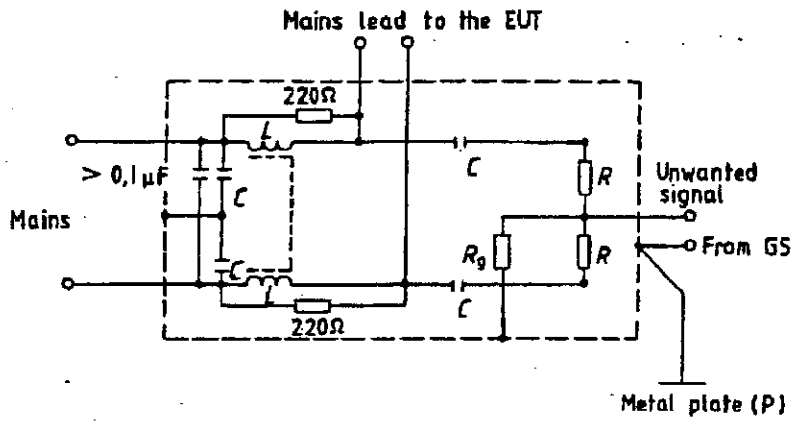


R_1 = 100 Ω − R_g/2

C_1 = 470 pF

R_g: Equal to the rated output impedance of generator G5 or high-pass filter HP as appropriate

Figure D.2 RC network for audio outputs (RC_o)



L = 100 µH

C = 3,3 nF

R = 200 Ω − R_g

R_g: equal to the rated output impedance of generator G5 or high-pass filter HP as appropriate

Figure D.3 Mains stop filter (MSF)

Annex E (normative) Construction details of the open stripline

The basic configuration of the open stripline TEM device is given in figure E.1, an overview is given in figure E.2.

The nominal dimensions of the metal plates are given in figure E.3.

The construction details of both ends are given in figure E.4 together with the dimensions of the matching network MN and the terminating impedance TI (Figures E.5 and E.6 respectively).

The circuit of the mains band-stop filter M is given in figure E.7.

The circuit of the band-stop filter BS for loudspeaker signal decoupling is shown in figure E.8.

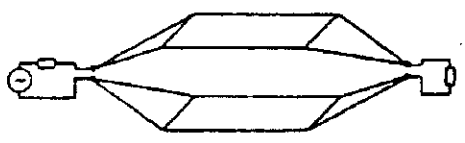
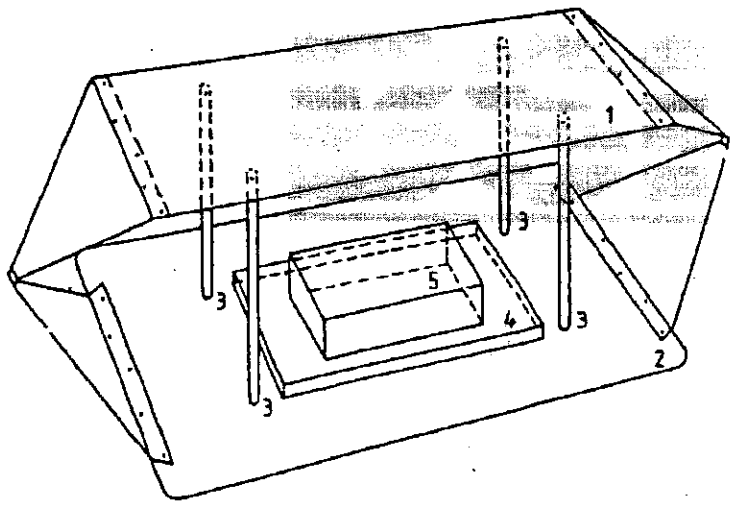
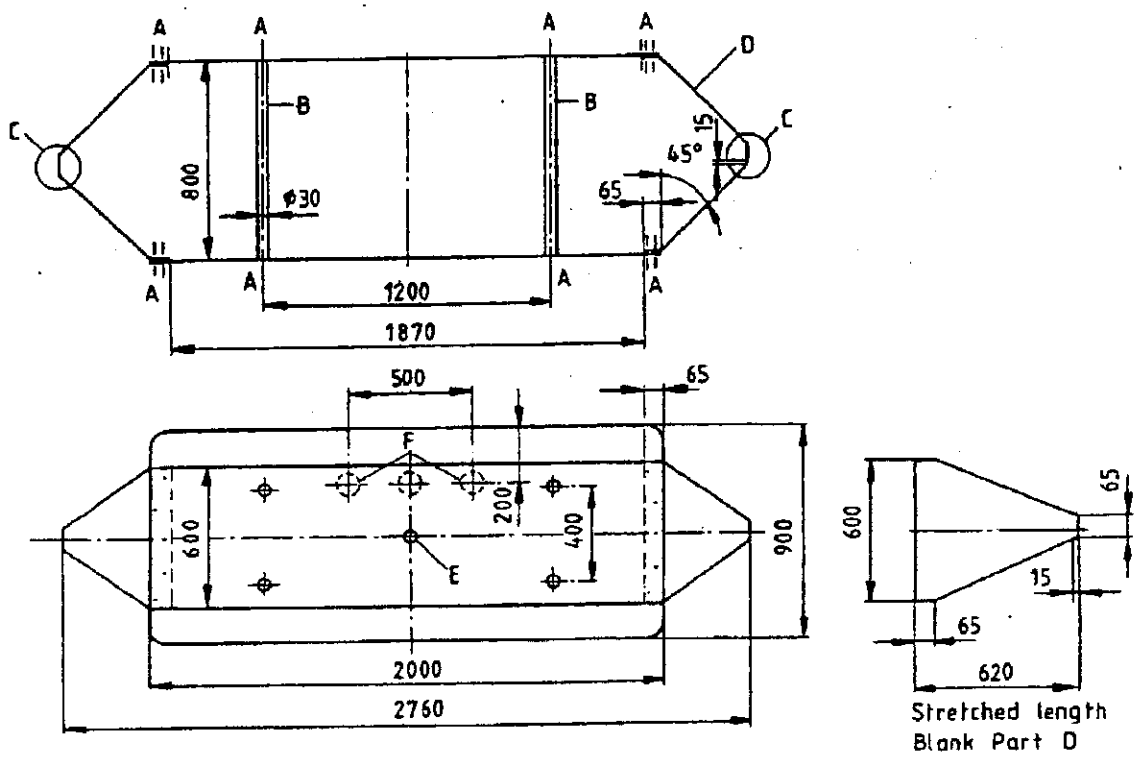


Figure E.1 Open stripline TEM device, basic configuration with matching network and terminating impedance



1. Metal top-plate (2 m × 0,6 m) parallel to
2. Metal base-plate (2 m × 0,9 m)
3. Plastic bracings (0,8 m) 4 ×
4. Non-metallic support
5. Equipment under test

Figure E.2 Overview of an open stripline TEM device



Dimensions in mm.

Material metal thickness 3 mm to 5 mm

A: Threaded screws M 5 × 15, maximum length 30 mm

B: Plastic bracings

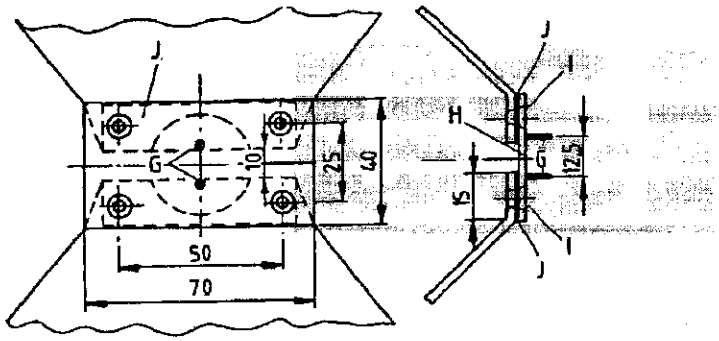
C: Detail see figure E.5

D: Blank at contacts (good electrical contact required with A and C)

E: Hole 25 mm in base plate for measuring probe

F: Holes, 50 mm in base plate for mains cable passage

Figure E.3 Constructional details of an open stripline, TEM device



G: Connection pins ϕ 1,3 mm to ϕ 1,5 mm, conductively connected to J

H: Insulating plate 4 mm thick

I: Threaded screws M 5 × 10 (countersunk head)

J: Contact intermediate plate made of tinplate 0,5 mm thick

Figure E.4 Supplementary constructional details of the open stripline TEM device

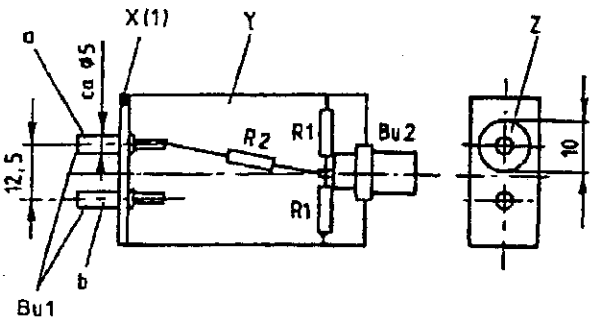


Figure E.5 Matching network MN

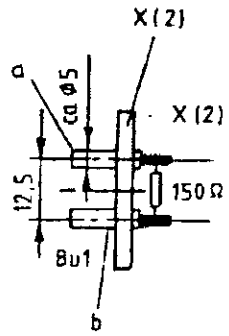


Figure E.6 Terminating impedance TI

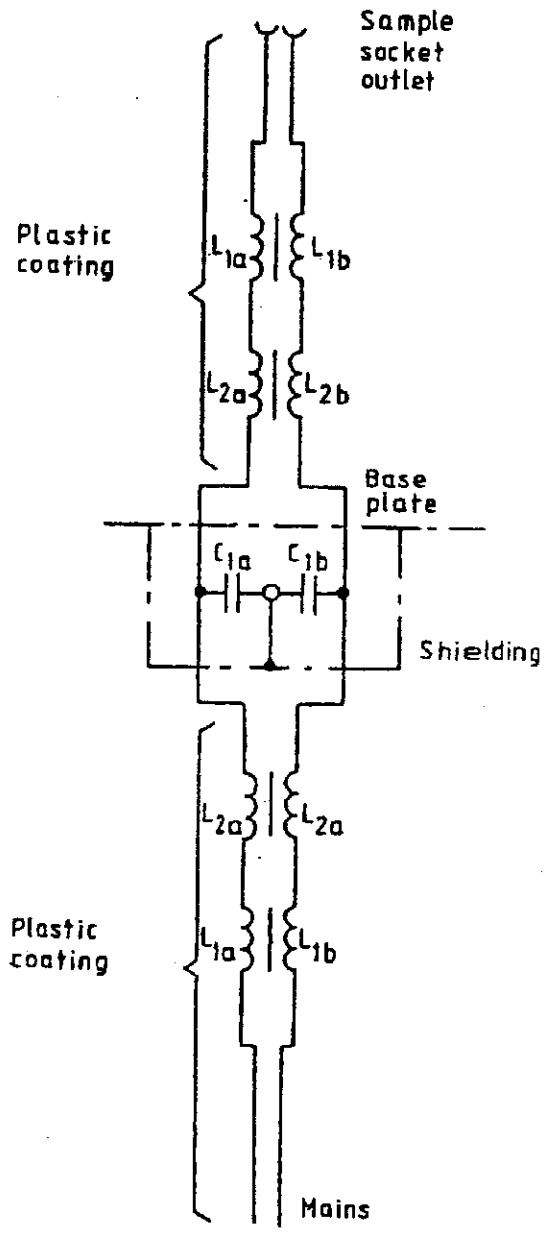
R1 - 122,4 Ω (2×) } soldered-in as close as possible
R2 - 122,6 Ω }

Bu1: Plug sockets for pins, suited to G
Plug socket a: insulated
Plug socket b: connected to casing

Bu2: Coaxial socket 50 Ω

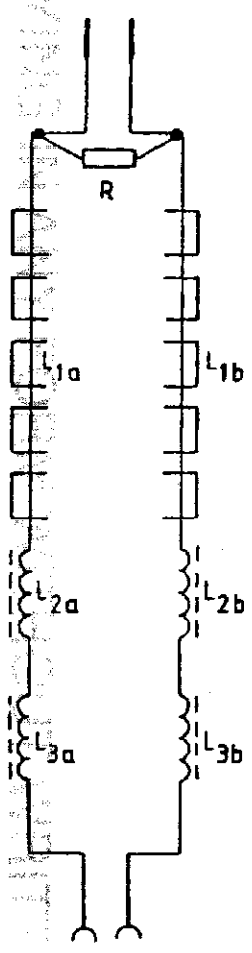
X(1), X(2): Plastic plates approx. 3 mm thick
Y: Metal casing, approx. 40 mm × 30 mm × 15 mm, shown open
Z: Opening in metal casing

The matching network is suitable for a signal generator output impedance Z_o = 50 Ω



L_{1a}, L_{1b}:	2 × 10 bifilar windings on annular ferrite core of a minimum size of 15/10/5 (15 outer diameter, 10 inner diameter, 5 thickness)
Frequency range: L_{1a}, L_{1b}: = 30 µH	1 MHz up to 60 MHz
L_{2a}, L_{2b}:	2 × 10 bifilar windings on annular ferrite core of a minimum size of 20/11/11
Frequency range: L_{2a}, L_{2b} = 300 µH	up to 1 MHz
C_{1a}, C_{1b}:	Coupling capacitors of 3,3 n

Figure E.7 Band-stop filter circuit for mains connection (M)



R: Nominal terminating impedance

L_{1a}, L_{1b}: 5 ferrite beads each

L_{2a}, L_{2b}: 15 windings of 0,6 enamelled copper on annular ferrite core of a minimum size 15/10/5

Frequency range: 1 MHz up to 150 MHz

L_{2a}, L_{2b} = 70 µH

L_{3a}, L_{3b}: 25 windings of 0,6 enamelled copper on annular ferrite core of a minimum size 20/11/11

Frequency range: up to 1 MHz

L_{3a}, L_{3b} = 2 mH

Non conductive materials shall be used for mounting and casing

Figure E.8 Circuit arrangement of band-stop filter for loudspeaker signal decoupling (BS)

Annex F (normative)

Calibration of the open stripline

An empty stripline with plates at distance h, should, for an input voltage u, furnish a field strength e given by:

$$e = u/h$$

where

e is in volts/metre;

u is in volts;

h is in metres.

In practice deviation from this relationship may be caused by mechanical tolerances, material losses, internal reflections causing standing waves, radiation, etc. These deviations are in general dependent on frequency. For this reason it is necessary to calibrate a transfer factor T (in dB) for each stripline given by:

$$T = E - U$$

where

U in [dB(V)] is the input voltage measured at the input to the adapting network of the stripline;

E in [dB(V/m)] is the field strength of the TEM wave.

For testing the field strength within the stripline according to figure F.1 a metal plate (1) with the dimensions 200 mm × 200 mm is positioned 10 mm above the base-plate of the stripline. The RF-voltage of the measuring-plate (1) related to the base-plate of the stripline is measured by using an RF- millivoltmeter (3) or an appropriate measuring apparatus. The termination by the measuring apparatus should be ≈ 3 pF parallel to ≥ 100 kΩ. The capacity of the measuring-plate (1) related to the base-plate of the stripline is ≈ 35 pF. Above 10 MHz the termination resistance may decrease depending on the frequency (e.g. to 10 kΩ for 100 MHz). An example for the arrangement of the measuring apparatus is shown in figure F.2.

The voltage value at the measuring-plate (1) for an unmodulated signal from the unwanted signal generator of 10 V e.m.f. shall correspond with the curve of figure F.3. This test shall be done for the measuring frequency range. Deviations greater than the limited deviations of ± 2 dB shall be taken into account, depending on the frequency, by the correction factor K_1:

$$K_1 = \frac{\text{measured voltage value at the measuring-plate}}{\text{nominal voltage value}}$$

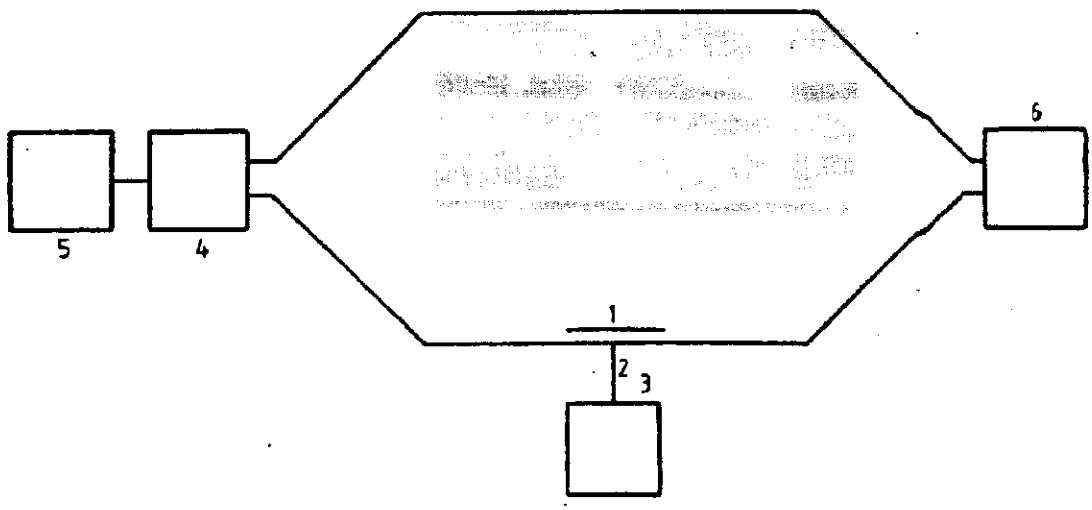
Narrowband deviations are excepted beginning at a level, for which the relative bandwidth

$$\frac{2(f_2 - f_1)}{f_2 + f_1} \times 100\ [\%]$$

is less than 10%.

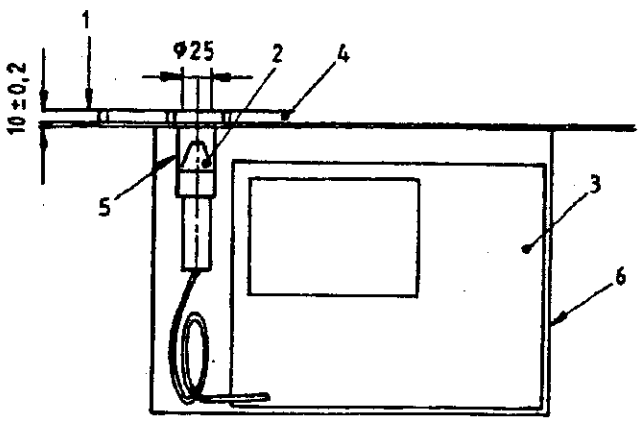
It shall be verified whether spurious influence interferes with the measuring result during the calibration procedure. With switched on or switched off unwanted signal generator (5) and RF-matched shortening of the measuring-plate (1) the basic voltage indication of the RF-millivoltmeter (3) shall be negligible.

NOTE. The earth side of the measuring-probe (2) shall be direct and RF-matched connected to the base-plate of the stripline at the feed through point. If appropriate, the RF-millivoltmeter (3) is to be placed in a one-side-open metal-box (6) under the measuring point or beside it. Care shall be taken to perfect RF-matched (large-sized) connection of the metal-box (6) with the base-plate and with the millivoltmeter (3) (see figure F.2).



1. Measuring-plate of metal, 200 ± 0,5 mm × 200 ± 0,5 mm × 1 mm, 10 ± 0,2 mm above the centre of the base-plate
2. Measuring-probe
3. RF-millivoltmeter
4. Matching network
5. Unwanted signal generator
6. Termination resistor 150 Ω

Figure F.1 Circuit arrangement for calibration of the measuring set-up



1. Measuring-plate of metal 200 ± 0,5 mm × 200 ± 0,5 mm × 1 mm
2. Measuring-probe
3. RF-millivoltmeter
4. Plastic distance pieces, total cross-area of all plastic distance pieces max. 1 % of the plane of item 1
5. Connection to the base-plate of the stripline total min. 25 mm wide
6. Metal-box = 350 ± 1,2 mm × 250 ± 1,2 mm × 250 ± 1,2 mm, at the back closed, with the base-plate of the stripline several times tight contacted

Figure F.2 Example of additional arrangement for enquiry of the calibration curve

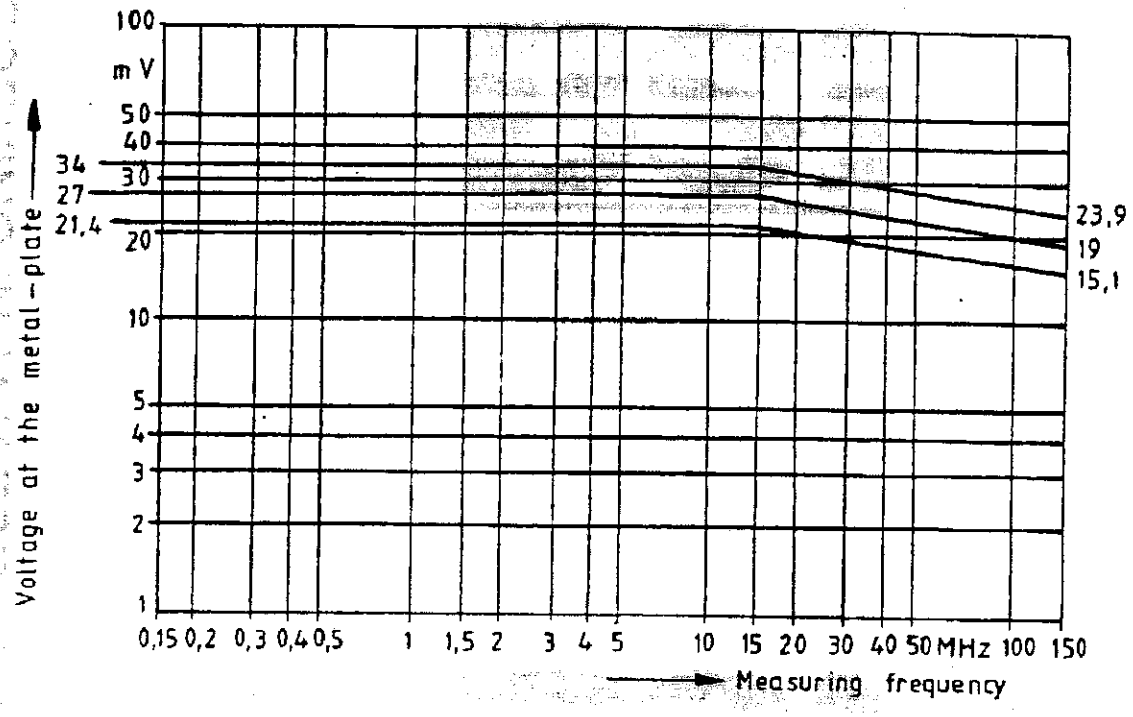


Figure F.3 Voltage at the measuring-plate depending on the measuring frequency for 10 V e.m.f. voltage level of the unwanted signal generator and the ranges of the limited deviations of ± 2 dB for the measuring set-up. The field strength within the stripline is then ≈3 V/m