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20

COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Limits and methods of measurement of immunity characteristics of sound and television broadcast receivers and associated equipment

Electromagnetic compatibility
Immunity - Product family standard

Discussion document, intended to replace finally, CISPR 20 (1998) as well as EN 55020 (1994) and Amendments

IEC

Reference number
CISPR 20:

CONTENTS

IMMUNITY FROM RADIO INTERFERENCE OF BROADCAST RECEIVERS AND ASSOCIATED EQUIPMENT

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.
This standard does not specify requirements for professional equipment.
This standard describes the methods of measurement and specified limits applicable to sound and television receivers and to associated equipment with regard to their immunity characteristics to disturbing signals.
This publication is also applicable to the immunity of outdoor units of direct to home (DTH) satellite receiving systems for individual reception.

Note: - *satellite receiving systems for collective reception, in particular;*
- *cable distribution head ends (Community Antenna Television, CATV);*
- *community reception systems (Master Antenna Television, MATV)*
are covered by IEC 60728-2.

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 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 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 13	Limits and methods of measurement of radio interference characteristics of sound and television receivers and associated equipment
CISPR 16-1:	Specification for radio disturbance and immunity measuring apparatus and methods Part 1: Radio disturbance and immunity measuring apparatus
CISPR 16-1:	Amendment 1: 1997-07
CISPR 16-2:	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2: Methods of measurement of disturbances and immunity
CISPR 16:	CISPR specification for radio interference measuring apparatus and measuring methods
Note: CISPR 16:	will be withdrawn after CISPR 16-3, Part 3 has been published.
CISPR 22:	Limits and methods of measurement of radio disturbance characteristics of information technology equipment
IEC 60050(161):	International Electrotechnical Vocabulary (IEV), Chapter 161: Electromagnetic Compatibility
IEC 60315-1	Methods of measurement on radio receivers for various classes of emission - Part 1: General considerations and methods of measurement, including audio-frequency measurements
IEC 60728-2	Cabled distribution systems for television and sound systems Part 2: Electromagnetic compatibility of equipment
IEC 61000-4-2:	Electromagnetic compatibility Part 4: Testing and measurement techniques. Section 2: Electrostatic discharge immunity test
IEC 61000-4-3:	Electromagnetic compatibility Part 4: Testing and measurement techniques. Section 3: Radiated,

		radiofrequency, electromagnetic
IEC 61000-4-4:		Electromagnetic compatibility Part 4: Testing and measurement techniques. Section 4: Electrical fast transient/burst immunity test
ETS 300 158	1992	Satellite Earth Stations (SES) Television Receive Only (TVRO-FSS)
ETS 300 249	1993	Satellite Earth Stations (SES) Television Receive Only (TVRO-BSS)

Other publications

ITU-R BS 468-4 - Measurement of audio-frequency noise voltage level in sound broadcasting.

ITU-R BT 471-1 - Nomenclature and description of colour bar signals.

ITU-R BT 500-8 - Methodology for the subjective assessment of the quality of television pictures.

ITU-R BT 470-5 - Conventional television systems.

ITU-R BT 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: ≥ 50 dB.

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 (enclosure or connector) 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 purpose of this standard, the definitions contained in IEC Publication 60050 (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. These sound receivers can be digital receivers with digital incoming signals or receivers with digital processing of digital or analogue incoming signals are included.

4.2 Television receivers are appliances intended for the reception of television broadcast and similar services for terrestrial-, cable- and satellite transmissions. These TV receivers can be digital receivers with digital incoming signals or receivers with digital processing of digital or analogue incoming signals are included.

Note 1: 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.
Infrared connections, for instance for infrared remote control or for infrared headphones are considered to be direct connections.
Connections via the mains plug, local area network or home network are considered to be indirect connections.

Note: Information technology equipment is defined in CISPR 22.

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. Specific unwanted signals are simulating disturbance signals, generated under laboratory conditions.

4.6 Immunity is the ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.
Note 1): 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.
Note 2): For compliance testing it is not necessary to measure the actual immunity level.

4.6.1 Input (or internal) 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.

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. PC FM tuner card	FM Radio	Portable Radio	Car Radio FM	Satellite Radio
	LW, MW, SW (AM)		AM Radio Ant. PC AM tuner card	AM Radio		Car Radio AM	
Television broadcast receivers (TV)			TV Ant. PC TV tuner card	TV	Portable TV	Car TV	Satellite TV
Associated equipment (Ass)	Video tape equipment (recording and/or play-back)	With* (Tun)	Ass. Video Tun. Ant.	Ass. Video Tun.	Portable Ass. Video		
		Without*	Ass. Video				
	Audio tape equipment		Ass. Audio		Portable Ass. Audio		
	Other, e.g. audio amplifiers, record and compact disc players, DVD (digital versitile disc) players, decoders, electronic organs.		Ass. Other		Portable Ass. Other e.g. infrared devices		

* Built-in television broadcast receiving facility.

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.

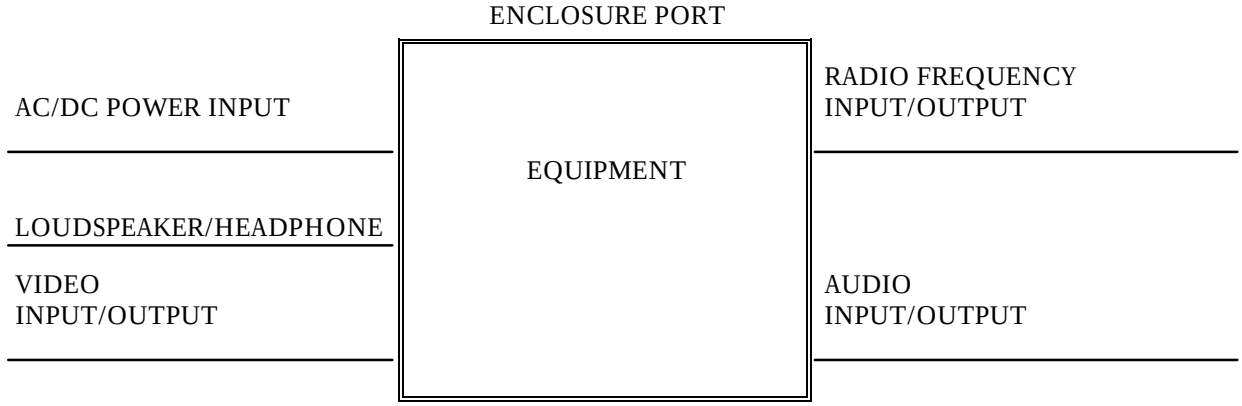


Figure 1 Examples of ports.

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.
- car and boat

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.
The equipment is supposed to operate as intended if the criteria of 6.1.1. and/or 6.1.2. are fulfilled.

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 ≥ 40 dB at a wanted audio signal level of 50 mW, or otherwise specified by the manufacturer.
If, the S/N ratio is less than 40 dB, the performance criteria for audio assessment is the actual S/N ratio minus 3 dB.
In this case, at the beginning of the audio quality evaluation, the actual S/N ratio is measured and noted in the test report as reference value.
For A.M. sound receivers the criterion is ≥ 26 dB at 50 mW.
For A.M. and F.M. car radios and for broadcast receiver cards for computers the criterion is ≥ 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.

7. CONDITIONS DURING TESTING

For equipment for which the wanted signals are not explicitly described in this standard, the nominal signals as specified by the manufacturer shall be applied during the tests. (This is for instance the case with digital audio and video broadcast receivers, CD players, decoders, etc.). The input signal applied during the test shall be included in the technical report. 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 R.M.S. value of the carrier at the peak of the modulation.
The signal level refers in all other cases to the R.M.S. level of the unmodulated carrier.

At transition frequencies the more stringent limit shall apply.

The limit values for the wanted and unwanted signals 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 on the antenna terminals are modified, according to the following formula:

Limit in R Ω, dB(μV) = (Limit in table, dB(μV)) + $10\log_{10}$ 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 sub-clause 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 76 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 setup 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 ITU-R BS 468-4.
   Note: care should be taken that ambient noise does not adversily influence the measurment results.

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.

Figure 2a

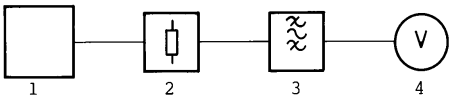


Figure 2b

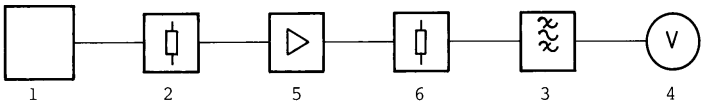
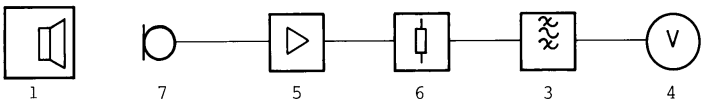


Figure 2c



1 : equipment under test
2 : rated load impedance RL of the audio output
3 : filter, FR (see Annex B) lowpass or bandpass
4 : audio frequency voltmeter V
5 : amplifier A
6 : rated load impedance Ra of the amplifier output
7 : microphone M

Fig. 2 - Audio power output measurement

7.3 MEASUREMENT PROCEDURE FOR VIDEO ASSESSMENT

The standard picture is a pattern consisting of vertical colour bars in accordance with ITU-R BT471-1, 100/0/75/0 (see figure A1b of the ITU-R 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 $f_{line}/2$ 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 ITU-R BT 500-8).
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.

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 U.C.

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 U.C.

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 satellite receivers, for television receivers and for video tape equipment.
Multi-function equipment which perform one or more of the functions included in this clause shall meet the relevant requirements.

8.5 For PC tuner cards immunity requirements for the antenna input connector are applicable according to table 2. PC tuner cards which are separately marketed for incorporation in diverse host units shall be tested in at least one appropriate representative host unit (e.g. PC) of the choice of the card manufacturer.
Measurements are carried out with the tuner card inserted in a personal computer and in operation. Immunity test to ambient electromagnetic fields are not applicable to PC tuner cards.

8.6 An IR remote control unit shall be tested together with the main unit.

9. IMMUNITY REQUIREMENTS FOR THE ANTENNA INPUT CONNECTOR

Table 2:

Parameter	Test specification	Test setup	Applicability	Performance criteria
RF voltage Differential mode	See clauses 9.1 & 9.2	See clause 14 (input immunity)	FM Radio Ant. PC tunercards for FM and TV Car Radio FM Satellite Radio TV Ant. Satellite TV Ass. Video Tun. Ant.	A
RF voltage Common mode 1kHz, AM 80 % depth	See clause 9.3	See clause 15	FM Radio Ant. PC tunercards for FM and TV 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. TV Ant.	A

9.1 REQUIREMENTS FOR INPUT IMMUNITY TO RF VOLTAGES (IN DIFFERENTIAL MODE) OF THE VHF BAND II PART OF 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 for the wanted signal)

f_n MHz	f_f MHz	n_f [dB(µV)] (75Ω) 1 kHz AM at 80% depth	
		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 for the wanted signal)

f_n MHz	f_f MHz	n_f [dB(µV)] (75Ω) 1 kHz FM dev. 40 kHz	
		mono	stereo
98	97.5 & 98.5	85	85
	97.6 & 98.4	85	85
	97.65 & 98.35	80	80
	97.7 & 98.3	72	72
	97.75 & 98.25	63	63
	97.8 & 98.2	59	58
	97.85 & 98.15	57	47
	97.9 & 98.1	53	32
	97.925 & 98.075	49	20
	97.95 & 98.05	41	14
	97.975 & 98.025	34	14
	98	29	20

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. The wanted input signals are specified in 14.2.2.

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 F.M. 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 F.M. at 30 kHz deviation, and
C2: A modulated signal at the relevant frequency of the second sound carrier, 1 kHz F.M. at 30 kHz deviation;
C1 and C2 are applied simultaneously.

D: A modulated signal at the relevant picture carrier frequency, 1 kHz A.M. at 80% depth.

E: A modulated signal 1 kHz A.M. at 80% depth.

F: a standard TV signal with vertical colour bar pattern with unmodulated sound carrier.

TABLE 5 - Limits of input immunity of television receivers for systems B, G and I

Wanted	

channel N	Unwanted signal in channel M						
	Level dB (µV)						Type
	M = N - 5	N - 1	N + 1	N + 5 [2])	N + 9 [2])	N + 11	
N_i, and N_{iii} and N_{H1}	— — 70 63 70	73 61 73 - *x* 73 - *y* —	73 61 73 - *x* 73 - *y* —	— — 70 63 70	68 [1]) 56 [1]) 68 - *x* [1]) 68 - *y* [1]) —	— — 68 61 68	A B C or C_1 C_2 D
N_{iv}	— — 74 67 74	77 65 77 - *x* 77 - *y* —	77 65 77 - *x* 77 - *y* —	80 68 80 - *x* 80 - *y* —	68 56 68 - *x* 68 - *y* —	— — — — —	A B C or C_1 C_2 D
N_v	80 68 80 - *x* 80 - *y* —	77 65 77 - *x* 77 - *y* —	77 65 77 - *x* 77 - *y* —	80 68 80 - *x* 80 - *y* —	— — 62 55 62	— — — — —	A B C or C_1 C_2 D
For systems B and G *x* = 13 dB, *y* = 20 dB For system I (monophonic only) *x* = 10 dB							
[1]) Only for hyperband N_H. [2]) These levels only apply for television systems with a channel spacing of 8 MHz and an IF of 38,9 MHz. For other channel spacing and IF frequencies different image channel or local oscillator interference constraints may apply.							
NOTE 1 - *x* is the relative level (dB) of the first sound carrier (mono sound channel) with respect to the picture carrier. *y* is the relative level (dB) of the second sound carrier (stereo sound channel) with respect to the picture carrier. NOTE 2 - (For China only). For systems D-PAL and K-PAL, the limits apply with the addition of channels (M) N - 4 and N + 4, with the same limits of channels N - 5 and N + 5 and + 10 dB.							

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.

For the purpose of this standard, a television receiver shall meet the limits of Tables 5, or 5a to 5d and 6 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.
Channel N_H	Hyperband	nearest to 375 MHz

See Informative Annex H

TABLE 5a - Limits of input immunity of television receivers for system L

M N	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.

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.

TABLE 5b - Limits of input immunity of television receivers
for systems D-SECAM, K-SECAM (used in Russia)

Wanted channel	Unwanted signal in channel M						
	Level dB(μV)						Type
N	M = N - 4	N - 1	N + 1	N + 4	N + 8	N + 9	
N_i (Channel 2)	— —	73 61	73 61	— —	— —	— —	A B
N_{ii} (Channel 4)	— —	73 61	73 61	— —	— —	— —	A B
N_{iii} (Channel 10)	— — — 70	73 61 63 —	73 61 — 73	— — 70 —	— — — —	— — — 68	A B C D
N_{iv} (Channel 25)	— — — 74	77 65 67 —	77 65 — 70	— — 70 —	— — 66 —	68 56 — —	A B C D
N_v (Channel 55)	80 68 — —	77 65 67 —	77 65 — 67	— — 70 —	— — 62 —	— — — 62	A B C D
NOTE - The wanted channels in brackets are recommended for measurements within each television band.							

Table 5c Limits of input immunity of television receivers for systems PAL D/K (used in central Europe)

N	wanted signal	A dB:V	B dB:V	C dB:V	D dB:V
channel 3	77,25 MHz 70 dB:V				
N+1		73	61		
N-1		73	61		
N+4					
N-4					
N+8					
N+9					
Channel 9	199,25 MHz 70 dB:V				
N+1		73	61		73
N-1		73	61	63	
N+4				70	
N+4					70
N+8					
N+9					68
Channel 26	511,25 MHz 74 dB:V				
N+1		77	65		70
N-1		77	65	67	
N+4				70	
N-4					74
N+8				66	
N+9		68	56		
Channel 55	743,25 MHz 74 dB:V				
N+1		77	65		67
N-1		77	65	67	
N+4				70	
N-4		80	68		
N+8				62	
N+9					62

TABLE 5d - Limits of input immunity of television receivers
for system M-NTSC with a 58, 75 MHz IF
video carrier (used in Japan)

Wanted channel N	Unwanted signal in channel M					
	Level dB (µV)					Type
	M = N - 2	N - 1	N + 1	N + 2	Other	
N_{ii}, N_{iii}	70	60	65	70	70	F
N_{iv}, N_{v}	74	64	69	74	74	F
NOTE 1 - Wanted signal: a standard TV signal with vertical colour bar pattern with modulated sound carrier, level 70 dB(µV) in band II and band III or 74 dB(µV) in band IV and band V, 1 kHz FM at 15 kHz deviation. NOTE 2 - Sound carrier level: 64 dB(µV) in band II and band III or 68 dB (µV) in band IV and band V.						

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

TABLE 6 - Limits of input immunity of television receivers
For the wanted audio signal see 14.2.2.

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

Note - The limits for the wanted channel Ni apply also to the wanted channel N_{ii} when band II is used for systems D-SECAM and K-SECAM.
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.

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 7 . See also 14.2.3for the wanted signal.

TABLE 7 - Limits of input immunity of satellite receivers

M	nf dB(µV) at 75Ω at channel M	wanted and unwanted

N	N-2	N-1	N+1	N+2	signal type
N min +3	70	66	66	70	A1 or A2 or A3
N mid	70	66	70		or A4
N max -3	70	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

For satellite television receivers the wanted and unwanted signals are of the same type and have the same modulation as described in sub-clause 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.

9.3 REQUIREMENTS FOR IMMUNITY TO RF VOLTAGES (IN COMMON MODE) AT ANTENNA TERMINALS

The requirements for receivers, (including car radios and A.M. 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.

Receivers and multi-function equipment shall meet the sound criterion of Sub-clause 6.1.1. and the picture criterion of Sub-clause 6.1.2. as appropriate for unwanted signals of frequencies and levels as specified in Table 8 applied to the antenna terminal.

Video tape equipment
Video tape equipment with built in television broadcast receiving facility in the r.f.-recording mode shall meet the sound criterion of sub-clause 6.1.1. at the audio output terminal of the equipment and the picture criterion of sub-clause 6.1.2. on a test-tv-set under the same test conditions as receivers and multifunction equipment.

TABLE 8 - Limits of immunity to RF voltages (in common mode) of antenna terminals

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

For system L' the test is restricted to the frequency range 26-28 MHz.

Note: According to the measuring procedure the immunity from conducted current is expressed by the e.m.f. level of the unwanted signal generator (Fig. 5 and Fig. 6).

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.
For television receivers and videotape equipment with built-in T.V. broadcast receiving facility in the RF recording mode a limit of 50 dB is applicable.

10 IMMUNITY REQUIREMENTS FOR AUDIO CONNECTORS

10.1 IMMUNITY REQUIREMENTS AT LOUDSPEAKER AND HEADPHONE OUTPUT CONNECTOR.

Table 9

Parameter	Test specification	Test setup	Applicability	Performance criteria
RF voltage Diff. mode 1kKHz, AM 80% depth	See sub-clause 12 Table 12	See clause 18	FM Radio Ant. TV Ant. Ass. Video Tun. Ant. Ass. Video Camcorders, in playback-mode, mains powered Satellite TV See note 1	A

Note 1 The requirements shall also not apply to the equipment functions in the interference frequency ranges listed in Table 14.
Not applicable to A.M. sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

10.2 IMMUNITY REQUIREMENTS FOR AUDIO INPUT AND OUTPUT CONNECTORS (EXCLUDING LOUDSPEAKER AND HEADPHONE)

Table 10

Parameter	Test specification	Test setup	Applicability	Performance criteria
RF voltage Diff. mode 1 kHz, AM 80% depth	See sub-clause 12 Table 13	See clause 18	FM Radio Ant. TV Ant. Ass. Video Tun. Ant. Associated Video Camcorders in playback-mode, maisn powered Satellite TV See note 1	A

Note 1: The requirements shall not apply to the equipment functions in the interference frequency ranges listed in Table 14.
Not applicable to A.M. sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

11. IMMUNITY REQUIREMENTS FOR AC MAINS POWER CONNECTORS

Table 11

Parameter	Test specification	Test setup	Applicability	Performance criteria
RF voltage Common mode 1 kHz, AM 80% depth	See sub-clause 12 Table 12	See clause 18	FM Radio Ant. TV Ant. Ass. Video Tun. Ant. Associated Video Camcorders in playback-mode, mains powered Satellite TV See note 1	A
Electrical fast transients Common mode	1 kV(peak), Tr/Th 5/50 ns, rep. frequency 5 kHz	IEC 61000-4-4 Direct injection Coupling/ decoupling network		B

Note 1: The requirements shall also not apply to the equipment functions in the interference frequency ranges listed in Table 14.
Not applicable to A.M. sound receivers and car radios.
Not applicable to other associated equipment than video tape equipment.

12 REQUIREMENTS FOR IMMUNITY TO RF VOLTAGES

12.1 Limits of immunity to RF voltages of mains supply terminal and loudspeaker and headphone terminals

Equipment as listed in Table 9 and 11 shall meet, except as stated in Sub-clause 12.3 for each function, the sound criterion of Sub-clause 6.1.1. and the picture criterion of Sub-clause 6.1.2. as appropriate. They shall be tested using unwanted signals of frequencies and levels specified in Table12 applied to the mains (in common mode) and loudspeaker and headphone terminals (in differential mode).

TABLE 12 - Limits of immunity to RF voltages of mains, loudspeaker and headphone terminals

Frequency MHz	Level [dB(μV)] (e.m.f.)
0.15 to 30	130
30 - 100	120
100 to 150	120-110 decreasing linearly with the logarithm of the frequency

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

Equipment as listen in Table 10 shall meet, except as stated in Sub-clause 12.3. for each function, the sound criterion of Sub-clause 6.1.1. and the picture criterion of Sub-clause 6.1.2. as appropriate. They shall be tested using unwanted signals of frequencies and levels specified in Table 13 applied to the corresponding terminal.

TABLE 13 - 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.

12.3 Exceptions to the limits

The requirements in Sub-clause 12.1 and 12.2 shall not apply to the equipment functions in the interference frequency ranges listed in Table 14. The requirements in Sub-clauses 12.1 and 12.2 shall also not apply to television receivers and associated equipment in the frequency range $f_c \pm$ 1,5 MHz, in which f_c is the colour sub-carrier frequency.

TABLE 14 - 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
F.M. sound receivers	$f_i \pm$ 0,5 MHz	none
Television receivers	f_i-2 MHz to f_v+2 MHz (for system B, G & I, L, D, K, M); 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.

13 IMMUNITY REQUIREMENTS FOR THE ENCLOSURE PORT

Table 15

Parameter	Test specification	Test setup	Applicability	Performance criteria
Radio frequency electromagnetic field 1 kHZ, AM at 80% depth r.f.-e.m. field 1) keyed carrier	See sub-clause 13.1 900 ±5 MHz, 3 V/m, 50 % duty cycle, 200 Hz rep. freq.	Clause 13.1 & 19 IEC 61000-4-3	FM Radio Ant. TV Ant. Ass. Video Tun. Ant. Associated equipment Satellite TV	A A
Electrostatic discharge	8 kV air discharge 4 kV contact discharge	IEC 61000-4-2		B

Note 1 - As an alternative method, a non-homogeneous field strength ≥ 3 V/m of similar characteristics as the test specification (e.g. generated by a dummy G.S.M. portable telephone) may be applied in a shielded room. In case of dispute measurements shall be carried out in accordance with IEC 61000-4-3.

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 and associated equipment.

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 VHF BAND II SOUND BROADCASTRECEIVERS

FOR equipment with a VHF band II sound broadcast reception table 16 applies

TABLE 16
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 $f_o < f_t$

13.1.2 TELEVISION BROADCAST RECEIVERS

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

TABLE 17 - Test specification for television receivers operating in

the reception function

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

* for system B, G & I, D, K, M, L
** 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

Receivers and multifunction equipment operating in the monitor mode shall also meet the requirement of 125 dBµV/m in the frequency range 150 kHz to 150 MHz. For the frequency range f_c ± 1,5 MHz the limit of 101 dBµV/m applies.

13.1.3 ASSOCIATED VIDEO TAPE EQUIPMENT

Video tape equipment in both recording and playback mode as appropriate shall meet the requirement of:
- Table 17 for equipment with built in television broadcast receiving facility in the RF-recording mode;
- Table 19 for all equipment in the video recording mode (except for f_c ± 1,5 MHz, for which the limit 101 dBµV/m applies);
- Table 18 for all equipment in the playback mode.

TABLE 18 - 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

13.1.4 OTHER ASSOCIATED EQUIPMENT

For equipment with audio functions other than related to broadcast reception, for instance infrared headphones, table 19 applies. For infrared headphones the frequency band $f_{mod} \pm f_{diff}$ is exempted (f_{mod} = internal frequency for the modulation of the IR carrier, f_{diff} = sidebands depending on the kind of modulation)

TABLE 19 - Test specification for equipment with audio functions

Frequency MHz	Level dB(µV/m)
0.15 to 150	125

For Compact Disc and Mini Disc equipment in both recording or playback mode the requirements of Table 19 shall be met.

For outdoor units of Direct to Home satellite receiving systems (FSS and BSS) Table 19 is applicable (see also ETS 300 158 and ETS 300 249, both subclause 5.5.2).
For Digital Video Disc equipment in both recording or playback mode Table 19 is applicable (for the sound and video

function)
Infrared remote controls shall be tested against the same field strength limit as defined for the equipment to which it is intended to signal.
During the test the infrared remote control shall not generate a control signal unintentionally and shall maintain its functions.

For camcorders in playback mode, when powered via the external power connection facility, the requirements of Table 20 shall be met.

TABLE 20 - Test specification for camcorders in the playback mode

Frequency MHz	Level dB (µV/m)
0,15 - 45	115
45 - 150	125

13.2 REQUIREMENTS FOR IMMUNITY TO ELECTROSTATIC DISCHARGE

Requirements for electrostatic discharge apply to the enclosure port and the housing of plugs and sockets. Connector pins and receptors are excluded from ESD tests. See Table 15.

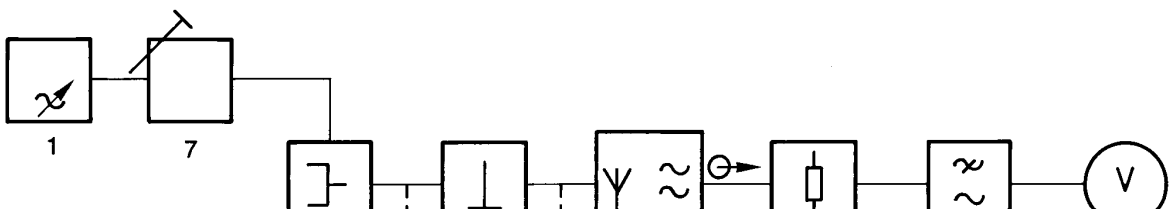
14. MEASUREMENT OF INPUT IMMUNITY

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 3 . 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 Sub-clauses 7.1 and 7.2.



1. Unwanted signal generator G1
2. Wanted signal generator G2
3. Load resistor RL
4. Low pass filter (see Appendix 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)

Fig. 3. - Measuring set up for input immunity measurement of sound broadcast receivers

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 75Ω (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 75Ω (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.

14.2 MEASUREMENT OF TELEVISION RECEIVERS AND VIDEO TAPE EQUIPMENT

14.2.1 MEASURING SET-UP

The measuring set-up is shown in figure 4 . The principle of operation is similar to the measuring set-up of figure 3 and the remarks in Sub-clause 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 75Ω within the VHF range or 74 dB(µV) referred to 75Ω 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 Sub-clause 9.2.

Measurements shall be made according to Sub-clauses 7.1 and 7.3 at the wanted signal frequencies and the unwanted signal frequencies given in Tables 5, 5a to 5d, 6 and 7.

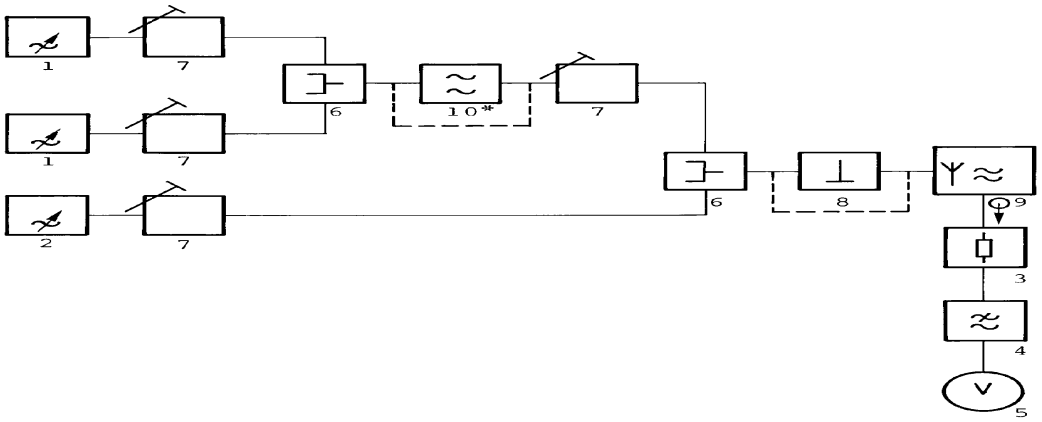
14.2.3 MEASUREMENT OF SATELLITE TELEVISION RECEIVERS

For television satellite receivers the measuring set up is the same as shown in figure 4 , 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 dBμV) at 75 Ω.

Measurements shall be made with the wanted signal at the frequencies given in column N of Table 7, the unwanted signals in the channels listed in column M of Table 7.

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



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.

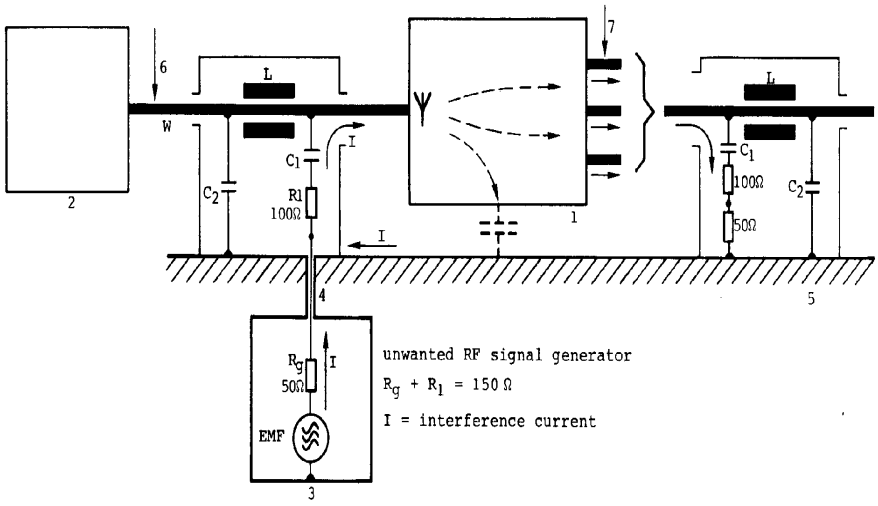
(3, 4 and 5 may be replaced by figure 2b or 2c if appropriate or in the case of video tape equipment under test connected to the audio output terminal of the test-tv-set).

Fig. 4 - Measuring set up for input immunity measurement of television receivers and video tape equipment.

15. MEASUREMENT OF IMMUNITY TO RF VOLTAGE (COMMON MODE) AT ANTENNA TERMINAL.

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 general principle of the measurement is illustrated in figure 5 . 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 terminals provided by coupling units.



L : isolating inductance
C1&C2 : capacitors with low RF impedance (if the ac/dc conditions allow, this 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)

Fig. 5 - General principle of the current injection method

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 Appendix C.

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. Where applicable, these cables shall be of a coaxial type with a transfer impedance of maximally 50 Ω/m at 30 MHz.

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 lay-out which shall be recorded with the test results.

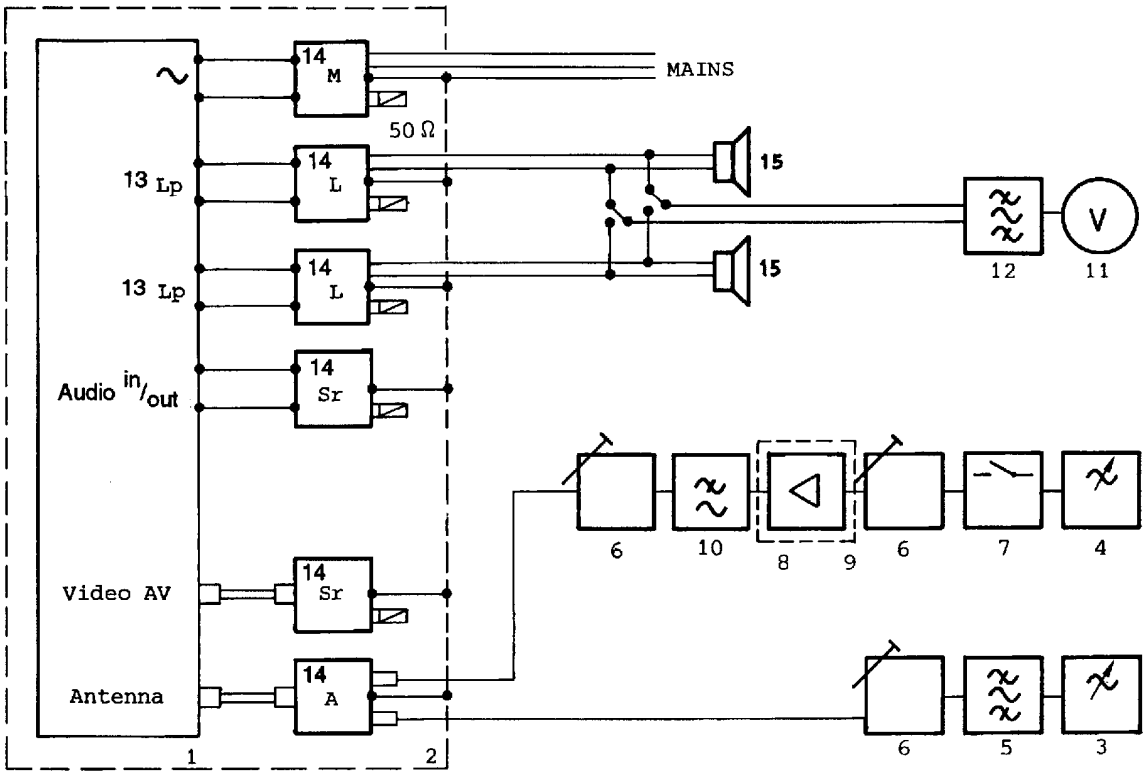
The maximum number of coupling units used in a test shall be six. In the case of equipment under test with more than six terminals, coupling units shall be used for at least one of each type of terminals, if present, as follows: RF input, mains, two loudspeaker outputs (if stereo) video input and audio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

15.3 MEASUREMENT CIRCUIT

The measurement circuit is given in figure 6 .

The wanted radio- or television signal including the sound part is supplied by generator G1, followed by a channel filter F_c 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.



1 : equipment under test
2 : metal plate 2 m x 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)
15 : dummy load simulating the nominal impedance of the loudspeaker

Fig. 6 - Measurement principle for the immunity from conducted currents

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 50Ω load to the power amplifier output and defines the source 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. 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.

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 Sub-clause 7.2.

15.4 MEASUREMENT PROCEDURE

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 system B, G & 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, I and D, K the sound carrier is frequency modulated with 1 kHz at a frequency deviation of 50 kHz. For system M see table 5a. 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, L and D, K.

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

16. MEASUREMENT OF SCREENING EFFECTIVENESS

The screening effectiveness of the antenna terminal of a 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 RECEIVERS

The measuring set-up is shown in figure 7.

The 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 wanted signal generator is connected via the signal combiner, to the antenna terminals of the 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 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 receiver. If the output impedance of the wanted signal 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 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 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:

$$S_c = U_s - A - U[dB]$$

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.

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 I, III, IV and 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 analyser 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.

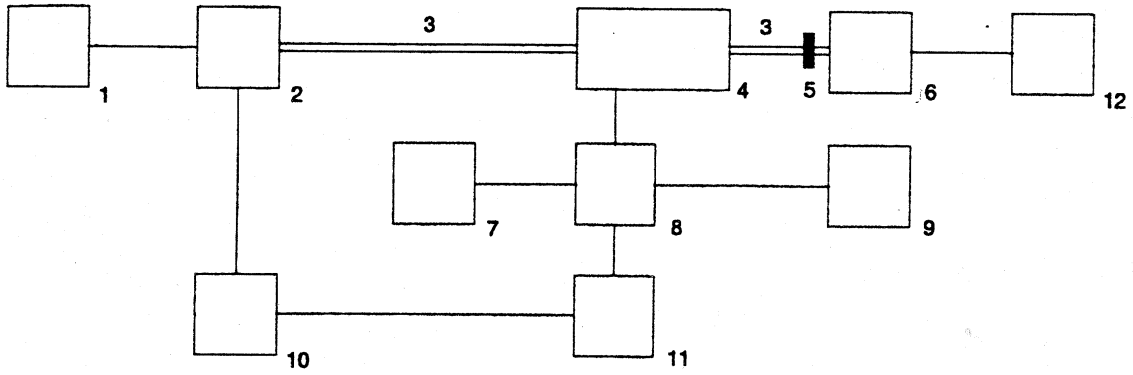
The variable attenuator shall be adjusted so that the picture degradation or the measured interfering video component remains constant when the coaxial transfer switch is operated.

The screening effectiveness S_e is given by the formula:

$$S_e = A_a + A_c - A[dB]$$

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 or wanted signal generator
2 : Signal combiner
3 : Measurement cable
4 : Absorbing clamp;
5 : High grade connector
6 : Receiver under test
7 : Matching load
8 : Coaxial transfer switch
9 : Disturbance generator
10 : Matching network
11 : Variable attenuator
12 : Spectrum analyzer or audio-frequency voltmeter

Fig. 7 - Measuring set-up for the screening effectiveness of the antenna terminals of a television receiver.

16.3 MEASUREMENT PROCEDURE FM SOUND RECEIVERS

Measurements shall be carried out at the frequency of the centre channel of the FM band available in the receiver under test.

Note 1: Receivers with built-in antenna are excluded.
Note 2: Car radios are under consideration.

If an FM sound receiver has a 300Ω balanced input, then a 75Ω/300 Ω balun shall be inserted to carry out the measurements on that actual input.

Note 3: The balun should not influence measuring results.

The FM sound receiver is fed by a generator providing a wanted signal with a level of 60 dBµV (1) at the antenna terminals at the tuned frequency of the receiver.

The receiver shall be adjusted to produce a reference audio output of 50 mW (see 6.1.1.) measured at the loudspeaker load terminals.

After having adjusted the reference audio output level, the 1 kHz audio modulation of the wanted signal shall be removed.

An unmodulated signal at a frequency 1 kHz higher or lower than the centre frequency of the wanted channel shall be injected via the coaxal transfer switch and absorbing clamp.

The interference is measured at the loudspeaker load terminals with a frequency selective voltmeter or a spectrum analyser tuned at a frequency of 1 kHz.

The disturbance level shall be adjusted to provide a convenient level of the interfering audio component, e.g. 40 dB below the reference level.

Note 4: When connecting a measuring instrument to the audio output of the receiver under test. It may be necessary to apply suitable ferrite rings to this connection or make use of an optical connection with suitable adaptors.

Starting from a position close to the antenna terminal of the receiver under test, 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 measured interfering audio output level remains constant when the coaxial transfer switch is operated.

The screening effectiveness S_e is given in the formula:

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

where
A_a is the setting of the variable attenuator (dB);
A_c is the insertion lose of the signal combiner and matching network (dB);
A is the insertion loss of the absorbing clamp (dB).

Note 5: 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 receiver. Hence it may be necessary to perform an additional test of the total immunity to ambient fields (see 13.1).

17. MEASUREMENT OF ELECTRICAL TRANSIENTS.

Test equipment, test setup and test procedure shall be according to IEC 61000-4-4, based on the use of a coupling/decoupling network.

18. MEASUREMENT OF IMMUNITY TO INDUCED VOLTAGES

18.1 MEASURING CIRCUIT AND SETUP

Figure 8 shows the measuring circuit and setup 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 8 .

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 cable supplying the RF voltage to the audit input and output terminals of the equipment under test shall be of a coaxial type with a transfer impedance of 50 mΩ/m at a maximum at 30 MHz.
In case the terminals of the equipment under test are non-shielded (e.g. loudspeaker terminals) the connection from the coaxial cable to the terminals shall be kept as short as possible. The shield of the coaxial cable shall be connected to the metal plate, as close as possible to the terminals of the coupling unit and by a connection as short as possible.
To avoid ground loop problems (e.g. hum, RF coupling) it is recommended that measuring instruments such as audio power meter 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 50Ω coaxial type, up to the terminal under test (e.g. also for loudspeaker and headphone ports).

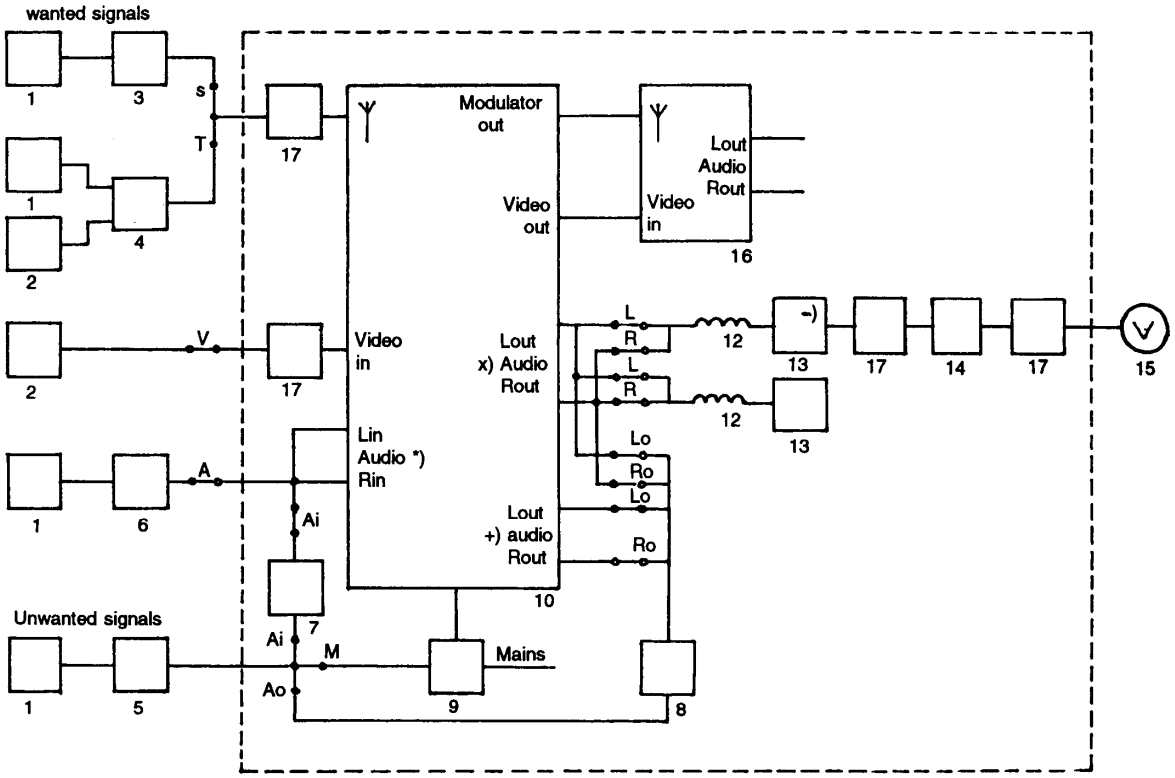
The unused input terminals and the loudspeaker and/or headphone or any other audio output terminals are terminated with appropriate load resistors as specified by the manufacturer or in the relevant standard.

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.



*) Channel 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 Ω) 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 (Rs - RG1)
Rs = rated source impedance of the audio input (1 Ω in the case of video tape equipment)
7 : RC network for audio inputs RC
8 : RC network for audio outputs RC
9 : mains stop filter MSF
10 : equipment under test
11 : metal plate 2 m x 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 voltmeter 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).

Fig. 8 - Measurement of immunity from induced voltages at:
- mains input
- headphones
- speakers
- audio output

- audio input

Table 21

Function of the connections in figure 8

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
Audio tape recorder playback [1] and auxiliary	1 kHz, 500 mV (e.m.f.)	Mains power supply
VHF band II [1]	60 dB(µV) at 75 Ω at a frequency of 98 MHz 1 kHz freq. mod. 40 kHz deviation	or Loudspeaker
TV [1] and video recording from r.f. 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	or Headphones or Audio output terminals
Video recording [2] and TV monitor mode	1 kHz, 500 mV (e.m.f.) and video signal, 1V 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)

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 8 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 Sub-clause 7.3.

For the measurement the unwanted signal is applied to the terminal under test by making the connections of figure 8 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).

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.

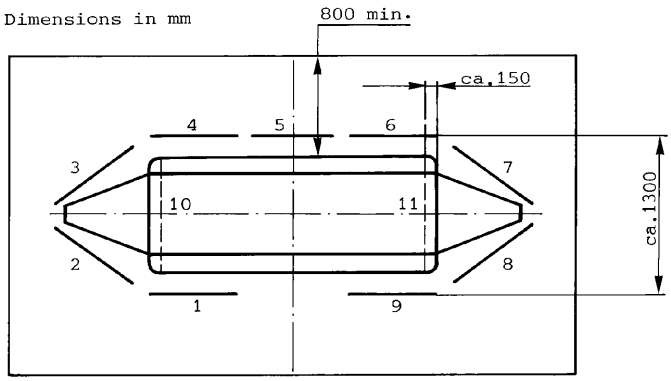
19.1 THE OPEN STRIPLINE

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.

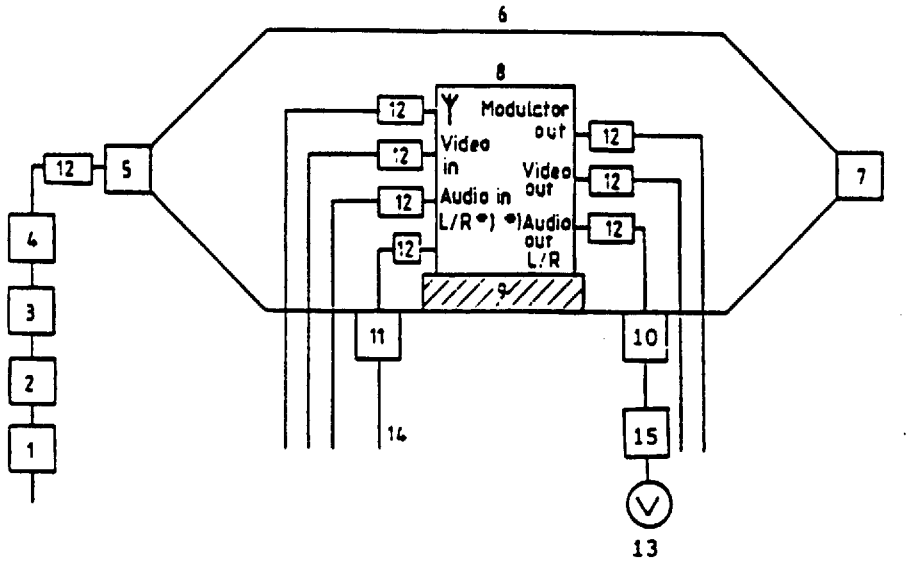
The required field strength is adjusted with the equipment under test inside the set up as described in 19.2. The equipment however is switched off during the adjustment.
The input voltage of the stripline is set to produce the correct voltage at the measuring plate, corresponding with the required field strength; for one frequency, e.g. 15 MHz.
The correction factor K1, 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.



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

Fig. 9 - Example of the arrangement of an open stripline TEM device in combination with absorbing plates inside a screened room with dimensions of 3 m x 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 150Ω (see figure E.6)
8 : equipment under test
9 : non-metallic support
10 : loudspeaker bandstop filter LBS (see figure E.8)
11 : mains bandstop filter MBS (see figure E.7)
12 : sheath current chokes (ferrite cores) (sh)
13 : audio frequency voltmeter (V)
14 : mains cable
15 : band pass filter (see figure B2)

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

Fig. 10 - Measurement principle for the immunity of broadcast receivers from radiated fields in the frequency range 0.15 MHz to 150 MHz

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 9 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 10.

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 Ω/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 10 shows the circuit used. For adjusting the wanted signals the audio or video controls of the equipment under test are set as described in Sub-clauses 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 Sub-clause 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.

Test generator, test setup and test procedure shall be according to IEC 61000-4-2.
For double and re-inforced insulated equipment, for non-grounded metallic parts of Class II equipment and for portable equipment, repetitive tests may be more onerous when the EUT cannot discharge sufficiently before the next ESD pulse is applied. Therefore sufficient time shall be allowed between the applied pulses.

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 equipment, 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, I, D, K, and M 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 A.M. 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 sub-clauses 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 Table 5a, upto Table 7 as appropriate) for at least 3 dB.

Additional requirement:

- 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 ITU-R BT 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: ≥ 50 dB.
- Audio-signal-to-noise-ratio, weighted by weighting network according to ITU-R BT 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.
- 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.

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 ≥ 25 dB
attenuation at 0,5 kHz ≤ 5 dB
attenuation at 1 kHz ≤ 0,5 dB (ref. point)
attenuation at 3 kHz ≤ 5 dB
attenuation at 10 kHz ≥ 25 dB

An example of a 0.5 kHz to 3 kHz band pass filter is given in figure B.1.

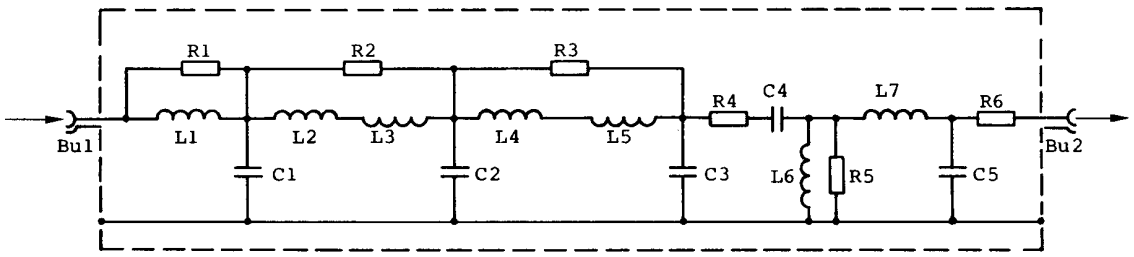


Fig. B.1 - Band pass filter 0,5 kHz to 3 kHz

L1 ... L5 = 33 mH Micro-inductance
*L6 = 650 mH Four-slit-core
L7 Broad-band-choke
R1 ... R3 = 4,7 kΩ C1 ... C3 = 22 nF
R4 = 100 Ω C4 = 0,1 µF
R5 = 8,2 kΩ C5 = 2,2 nF
R6 = 820 Ω

*1450 Wdg 0,115Ø Cul, solderable
Bu1, Bu2 BNC-F 50Ω

B.3. WEIGHTING NETWORK

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

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 5 . 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 50Ω source impedance is injected via a 100Ω 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 150Ω. 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 AC: for use with coaxial cables carrying wanted rf signals. The construction details are shown in figure C.1

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

Type LC: 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 lay-out 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 150Ω. 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).

   When the generator impedance is 50Ω the resistor has a value of 100 Ω. In the antenna line coupling unit type A this 100Ω 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 100Ω. This unit has been designed as a delta artificial mains network and presents a symmetrical and asymmetrical equivalent resistive impedance of 150Ω to the equipment under test.

b. The RF chokes shall present a sufficiently high RF impedance (with respect to 150Ω) 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 uH or 2 x 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

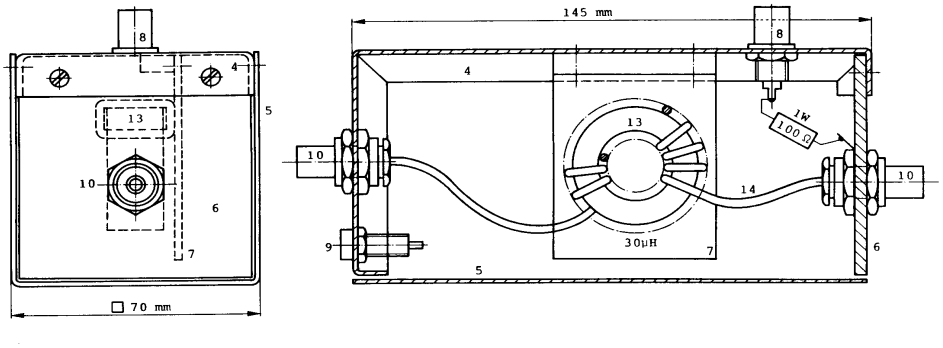
The purpose of this filter is to attenuate the harmonics of the unwanted signal source. The frequency response of the filter F shall have a sharp cut off at a frequency of a few MHz below the frequency band to be protected (IF and reception band) and shall have a high attenuation in this frequency band. 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.

To unwanted signal source



To EUT

Schematic diagram and construction details

To wanted signal source

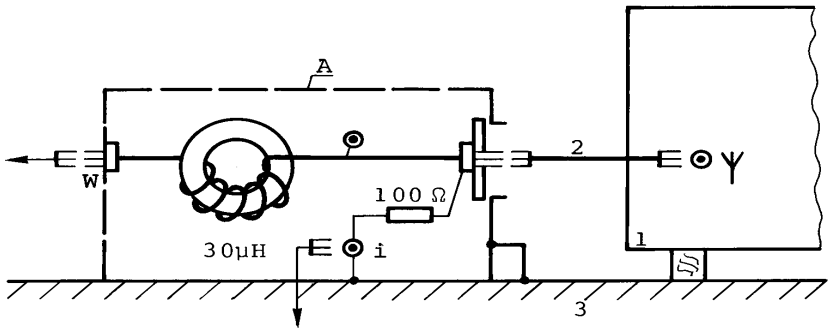
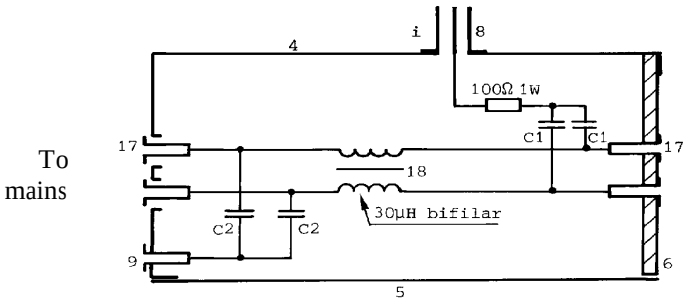


Fig. C.1 - Coupling unit type VCS (for coaxial antenna input)

1. Equipment under test
2. Coaxial antenna cable
3. Metal ground plane PL
4-5. Metallic case 145 mm x 70 mm x 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 C (see annex G) with N turns of 2,4 mm outer diameter co-axial cabel to produce 30 µH.
14. Coaxial cable type RG-188 A/U, 50 R 2.4 mm outer diameter

To unwanted signal source



Schematic diagram and construction details

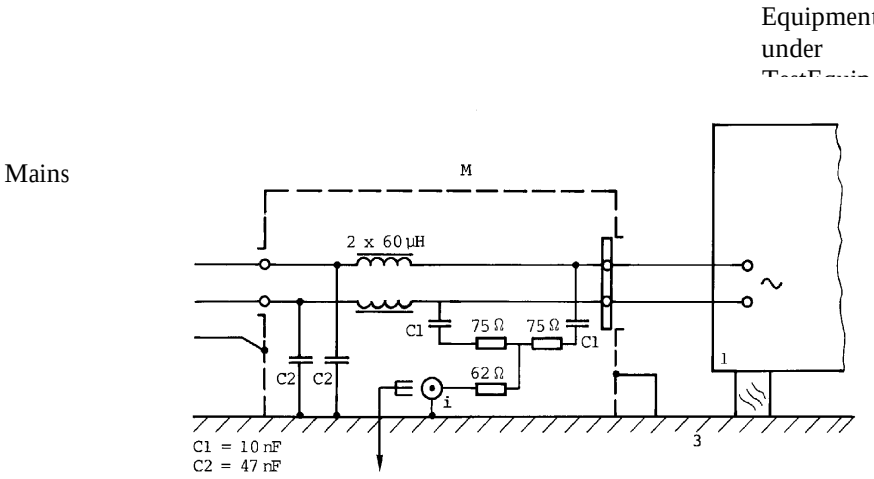


Fig. C.2 - Coupling unit type MC (for mains lead)

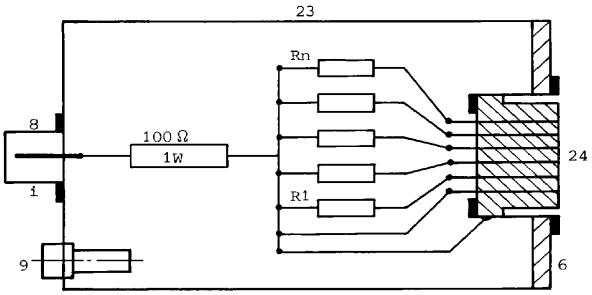
Pos. 1 and 3 to 9 as for figure C.1
11. Mains socket for equipment under test (2 insulated banana jacks)
12. Mains plug (2Pin + ground)
15. Two ferrite rings type C (see annex G) with N turns each insulated copper wire to produce 60µH each
16. Copper wire 0.8 mm, insulated, 1.8 mm outer diameter
Pos. 4-5-6-8-9: as for figure C.1
17. Insulated banana jacks
18 . Inductance 30µH asymmetrical
Core : 1 ferrite ring, type C (see annex G)
Winding: N turns with a twisted pair (2 leads, copper wire 0,6 mm diameter, insulated, 1,2 mm outer diameter to produce 30µH)
Mounting of the inductance similar to fig. C1. Capacitors : C1 = 10 nF; C2 = 47 nF.

Fig. C.3 - Coupling unit type LC (for loudspeaker leads)

Schematic diagram and simplified construction drawing

To unwanted signal
source or to 50Ω

To EUT



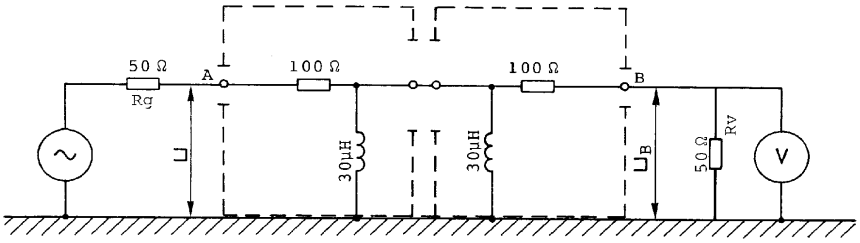
Pos. 6-8-9: as for f
23 : Metallic case 100 mm x 55 mm x 55 mm
24 : Multiple pins connector or DIN-socket

R1 ... Rn: Matched load resistance

Examples: Coupling units Sr for audio equipment:

Phono magn.:	2 x 2.2 kΩ
Phono crystal:	2 x 470 kΩ
Microphone:	2 x 600 Ω
Tuner:	2 x 47 kΩ
Tape in/out:	4 x 47 kΩ
Audio in/out:	4 x 47 kΩ

Fig. C.4 - Coupling unit type Sr with load resistances



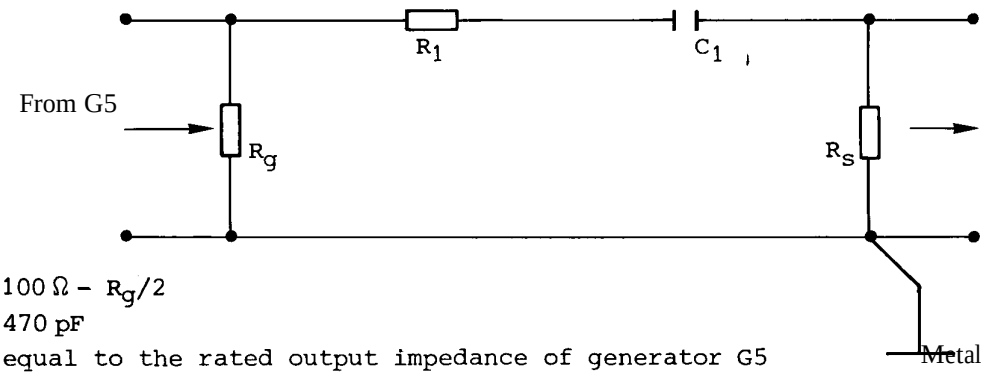
Rg = internal resistance of generator
Rv = internal resistance of voltmeter

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

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).

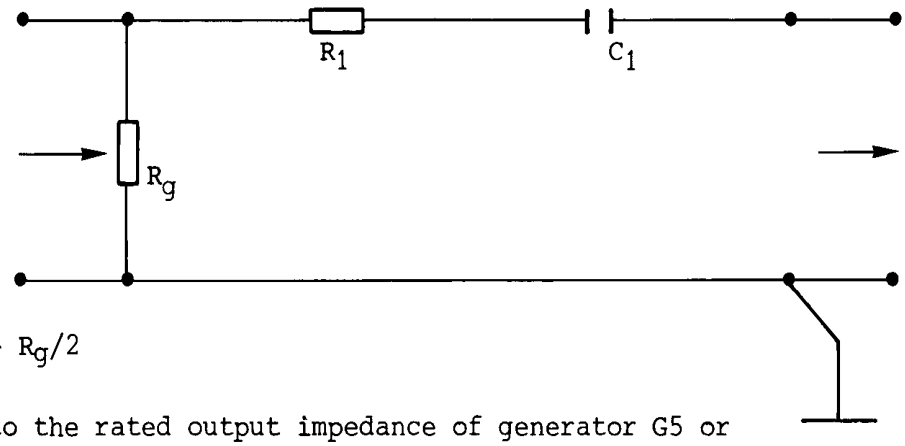
ANNEX D (Normative) - MATCHING NETWORKS AND MAINS STOP FILTER



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.

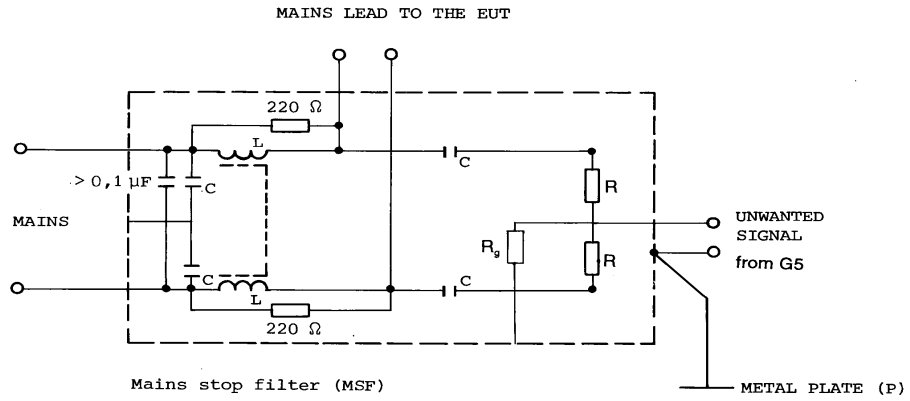
RC network for audio inputs (RC_i)

Fig. D.1 - RC network for audio inputs (RÇ)



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.

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.

Fig. D.3 - Mains stop filter (MSF)

ANNEX E (Normative) - Construction information for the open stripline and for the mains and loudspeaker band-stop filter

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 (Figure E.5 and E.6 respectively).

A circuit of the mains band-stop filter MBS is given in Figure E.7. The filter used should have a minimum attenuation of 20 dB between 150 kHz and 30 MHz, and 50 dB between 30 MHz and 150 MHz , when measured with a 50 Ω source and load.

A circuit for the loudspeaker band-stop filter LBS is given in figure E.8. The filter used should have a minimum attenuation of 20 dB between 150 kHz and 30 MHz, and 50 dB between 30 MHz and 150 MHz, when measured with a 50 Ω source and load.

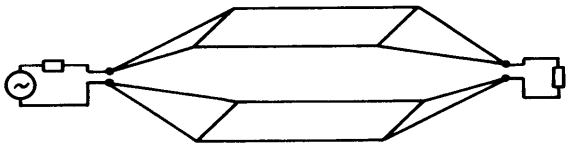
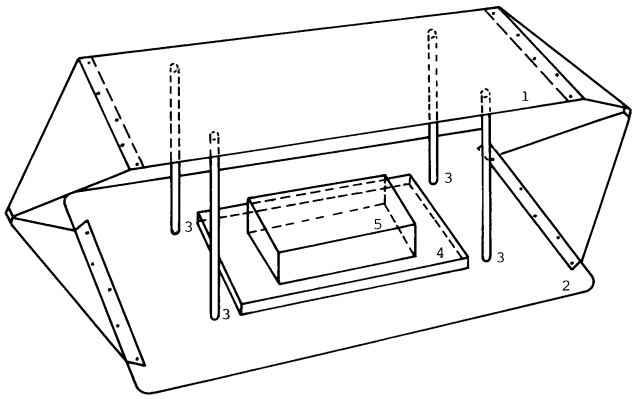
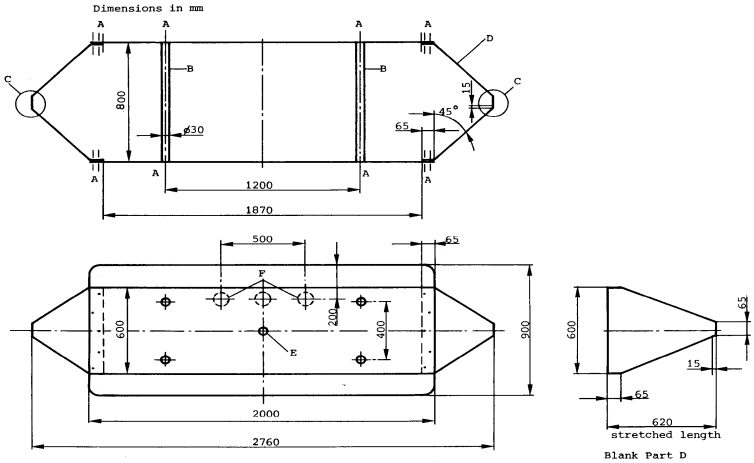


Fig. E.1 - Open stripline TEM device, basic configuration with matching network and terminating impedance



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

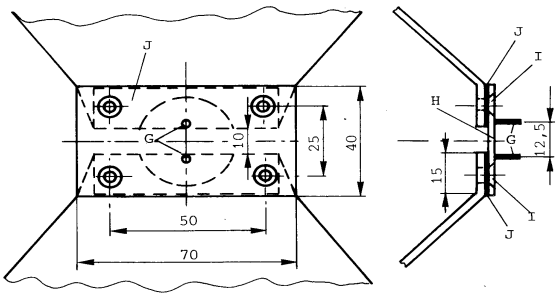
Fig. E.2 - Overview of an open stripline TEM device



Material metal thickness 3 mm to 5 mm

A: Threaded screws M 5 x 15, maximum length 30 mm
B: Plastic bracings
C: Detail see Fig. 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

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



G: Connection pins Ø 1.3 mm to Ø 1.5 mm, conductively connected to J
H: Insulating plate 4 mm thick
I: Threaded screws M 5 x 10 (countersunk head)
J: Contact intermediate plate made of tinplate 0.5 mm thick

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

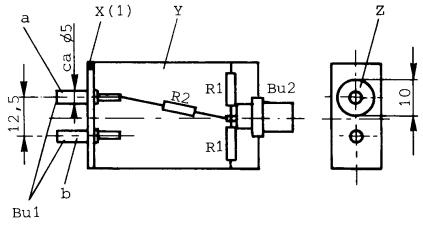


Fig. E.5 - Matching network MN

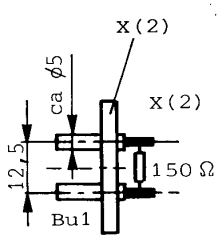


Fig. E.6 - Terminating impedance TI

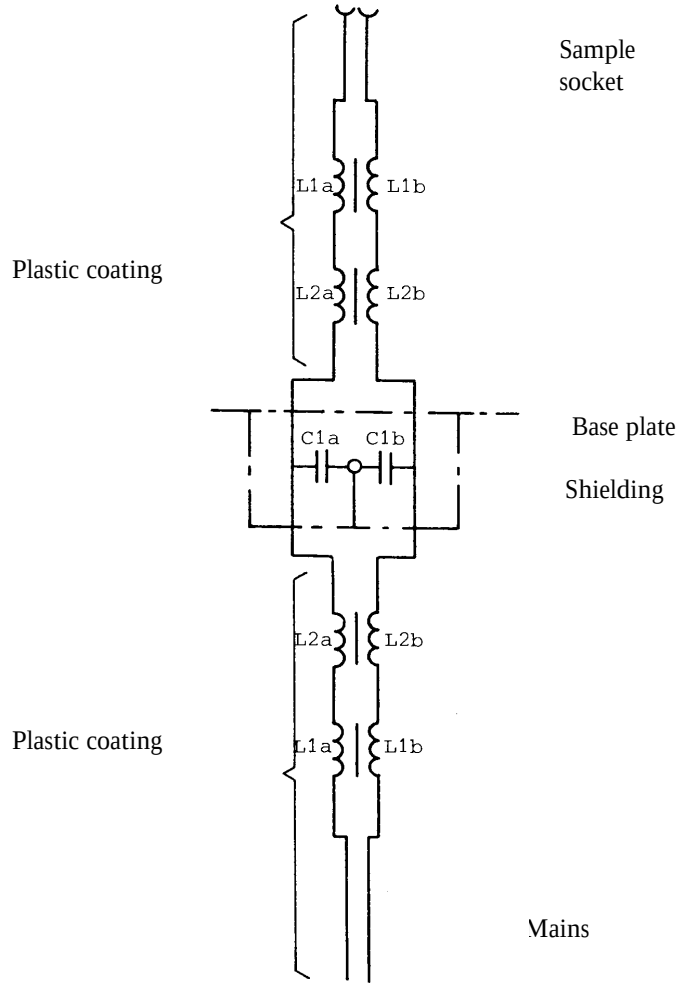
RI - 122,4 Ω (2x) * soldered-in as close as possible
R2 - 122,5 Ω *

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

Bu2: Coaxial socket 50Ω

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

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



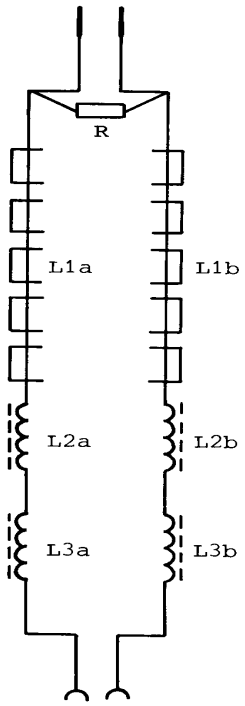
L_{1a}, L_{1b} : Inductance approximately 30µH in between 1MHz and 50 MHz
core : 1 ferrite ring type A (see annex G);
winding : N turns to produce 30µH.
))))))))

L_{2a}, L_{2b} : Inductance approximately 300µH, up to 1 MHz
core : 1 ferrite ring type B (see annex G);
winding : N turns to produce 300µH.

))))))))
C_{1a}, C_{1b} : Coupling capacitors of 3.3 nF

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

Plug and socket
connection to equipment under test



Bushing for B and pass filter (fig. B.1)
connection

R: Nominal terminating impedance
L_{1a}, L_{1b} : 5 ferrite beads each

))))))))

L_{2a}, L_{2b} : Inductance approximately 70µH, in between 1 MHz and 60 MHz
core : 1 ferrite ring type A (see Annex G)
winding : N turns 0,6 mm diameter enamelled copper wire to produce 70µH.

))))))))

L_{3a}, L_{3b} : Inductance approximately 2 mH, up to1 MHz
core : 1 ferrite ring type B (see Annex G)
winding : N turns 0,6 mm diameter enamelled copper wire to produce 2 mH.

Non conductive materials shall be used for mounting and casing

Fig. E.8 - Band stop filter type LBS (for loudspeaker connection)

ANNEX F (Normative) - CALIBRATION OF THE OPEN STRIPLINE

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

$$e = u / h$$

where e is in volts/meter
u is in volts
h is in meters

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 fieldstrength 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 x 200 mm is positioned 10 mm above the base-plate of the stripline. The r.f.-voltage of the measuring-plate (1) related to the base-plate of the stripline is measured by using a r.f.-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 K1:

$$K1 = \left(\frac{\text{measured voltage value at the measuring-plate}}{\text{nominal voltage value}} \right)$$

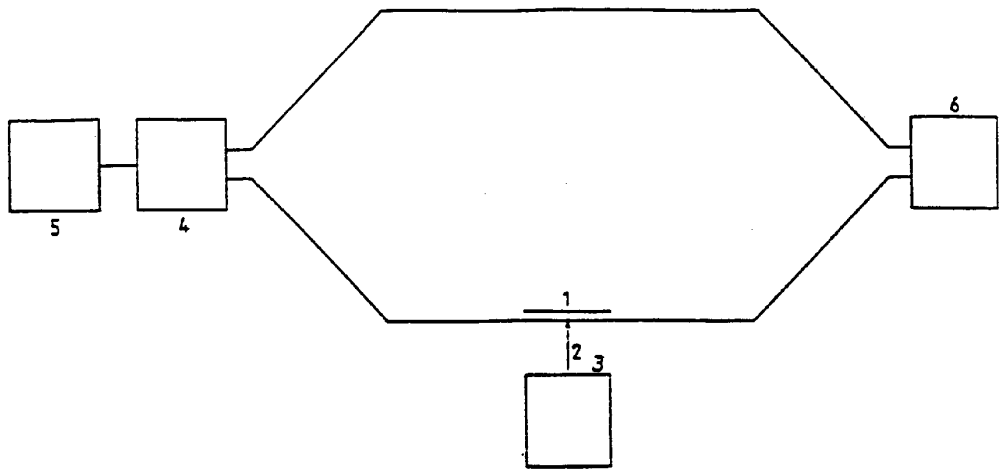
Narrowband deviations are excepted beginning at a level, for which the relative bandwidth

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

is less than 10%.

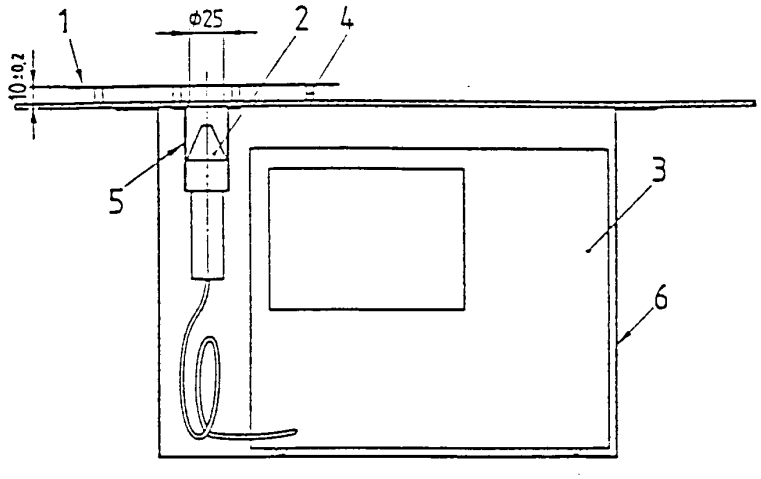
It shall be verified whether spurious influence interferes the measuring result during the calibration procedure. With switched on or switched off unwanted signal generator (5) and r.f.-matched shortening of the measuring-plate (1) the basic voltage indication of the r.f.-millivoltmeter (3) shall be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

Note: The earth side of the measuring-probe (2) shall be direct and r.f.-matched connected to the base-plate of the stripline at the feed through point. If appropriate the r.f.-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 r.f.-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 x 200 ± 0,5 mm x 1 mm
2. Measuring-probe
3. R.f.-millivoltmeter
4. Matching network
5. Unwanted signal generator
6. Termination resistor 150 e

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



1. Measuring-plate of metal 200 ± 0,5 mm x 200 ± 0,5 mm x 1 mm
2. Measuring-probe
3. R.f.-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 x 250 ± 1,2 mm x 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

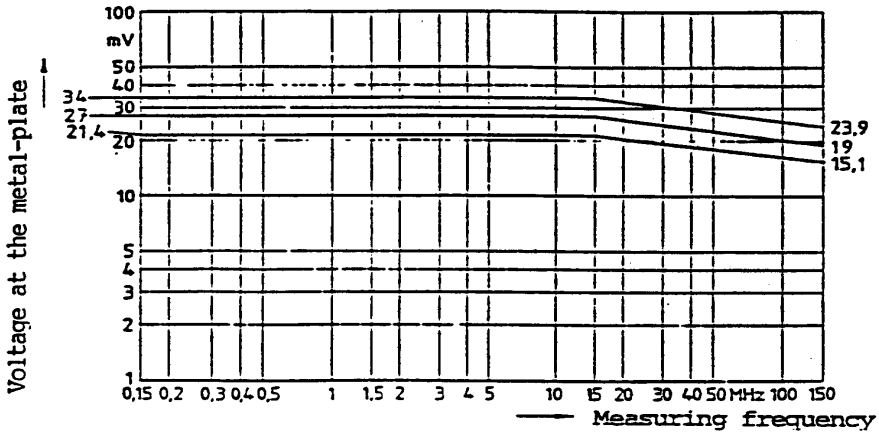


Figure F.3 - Voltage at the measuring-plate depending on the measuring frequency for 10 V e.m.f. voltage level of the unwanted signal generator and the ranges of the limited deviations of ± 2 dB for the measuring set-up. The field strength within the stripline is then ≈ 3 V/m.

9 - Annex G (Normative) Ferrite core sizes and materials

Table G1 : Ferrite Core Sizes and materials

Core	A	B	C
Material	Nickel/Zinc	Manganese/Zinc	Nickel/Zinc
Outside diameter	13 to 17 mm	15 to 25 mm	30 to 50 mm
Cross sectional area	40 to 60 mm^2	100 to 140 mm^2	170 to 230 mm^2
Initial permeability	50 - 200	2.000 to 7.500	50 to 200
Reduction in permeability permitted at high frequencies	50 % @ 60 MHz 75 % @ 100 MHz	50 % @ 0.6 MHz 75 % @ 1.0 MHz	50 % @ 60 MHz 75 % @ 100 MHz
Saturation flux density	> 300 mT	> 300 mT	> 300 mT

The number of turns (N) to produce the required inductance can be calculated from the inductance factor

(A_L) of the specific core selected, i.e. $N = \sqrt{L/A_L}$.

ANNEX H

H1. For the European Region, the VHF band II covers frequencies from 87.5 MHz to 108 MHz.
(Notes to be added for Japan and Eastern Europe, if necessary).

For regions outside Europe the band allocations to be specified.

H2. For the European region, 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
Hyperband	from 302 MHz to 470 MHz

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.

H3. Channel frequencies for system D (VHF), (used in Russia)

Channel	Vision	Sound
1	49.75 MHz	56.25 MHz
2	59.25 MHz	65.75 MHz
3	77.25 MHz	83.75 MHz
4	85.25 MHz	91.75 MHz
5	93.25 MHz	99.75 MHz
6	175.25 MHz	181.75 MHz
7	183.25 MHz	189.75 MHz
8	191.25 MHz	197.25 MHz
9	199.25 MHz	205.75 MHz
10	207.25 MHz	213.75 MHz
11	215.25 MHz	221.75 MHz
12	223.25 MHz	229.75 MHz