# IEC 60728-5

Edition 2.0 2007-08

# INTERNATIONAL STANDARD



## Cable networks for television signals, sound signals and interactive services – Part 5: Headend equipment

IEC 60728-5:2007(E)

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

## Part 5: Headend equipment

## FOREWORD

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

This second edition cancels and replaces the first edition published in 2001, of which it constitutes a technical revision.

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

- Revised title and scope
- Clause 3, several new terms and definitions
- Subclause 4.1, Methods of measurement for digitally modulated signals
- Subclause 4.6.2, RF signal-to-noise ratio ($S_{D,RF}/N$) for digitally modulated signals

- Subclause 4.8.2, Procedure for the measurement of group delay variation on DVB channel converters
- Subclause 4.9, Phase noise of an RF carrier
- Subclause 4.15, Decoding margin (Teletext)
- Annex D, Special national conditions
- Annex E, Correction factors for noise
- Annex F, Digital signal level and bandwidth
- Annex G, Minimum frequency distance of converted satellite signals in the IF range
- Annex H, Measurement errors which occur due to mismatched equipment
- Annex I, Correction factor for spectrum analyser

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

| FDIS | Report on voting |
|---|---|
| 100/1244/FDIS | 100/1276/RVD |

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

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

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

The actual list of all parts of the IEC 60728 series can be found on the IEC website.

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

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

For special national conditions existing in some countries, see Annex D.

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

# INTRODUCTION

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

This includes

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

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

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

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



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

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

## Part 5: Headend equipment

## 1 Scope

This part of IEC 60728 defines the characteristics of equipment used in the headends of terrestrial broadcast and satellite receiving systems (without satellite outdoor units and without those broadband amplifiers in the headend as described in IEC 60728-3). The satellite outdoor units for FSS are described in ETSI ETS 300 158, for BSS in ETSI ETS 300 249. Test methods for both types (FSS and BSS) of satellite outdoor units are laid down in ETSI ETS 300 457.

This standard

- covers the frequency range 5 MHz to 3 000 MHz,
- identifies performance requirements for certain parameters,
- lays down data publication requirements for certain parameters,
- stipulates methods of measurements;
- introduces minimum requirements defining quality grades (Q-grades).

This standard defines the overall characteristics for upstream/downstream signals between external sources/sinks (for example, antennas, cable modem termination systems, etc.) and the system interface to the cable network. In the case of modular headend systems, also single equipment as modulators, converters, etc. are described. Cable modem termination systems, encrypters, decrypters, etc. are not described in this standard. If such equipment is used in headends, the relevant parameters for RF, video, audio and data interfaces should be met.

According to the definitions in 3.1, the headends are divided into the following three quality grades:

- Grade 1: central headend;
- Grade 2: hub headend or hubsite;
- Grade 3: MATV headend/individual reception headend.

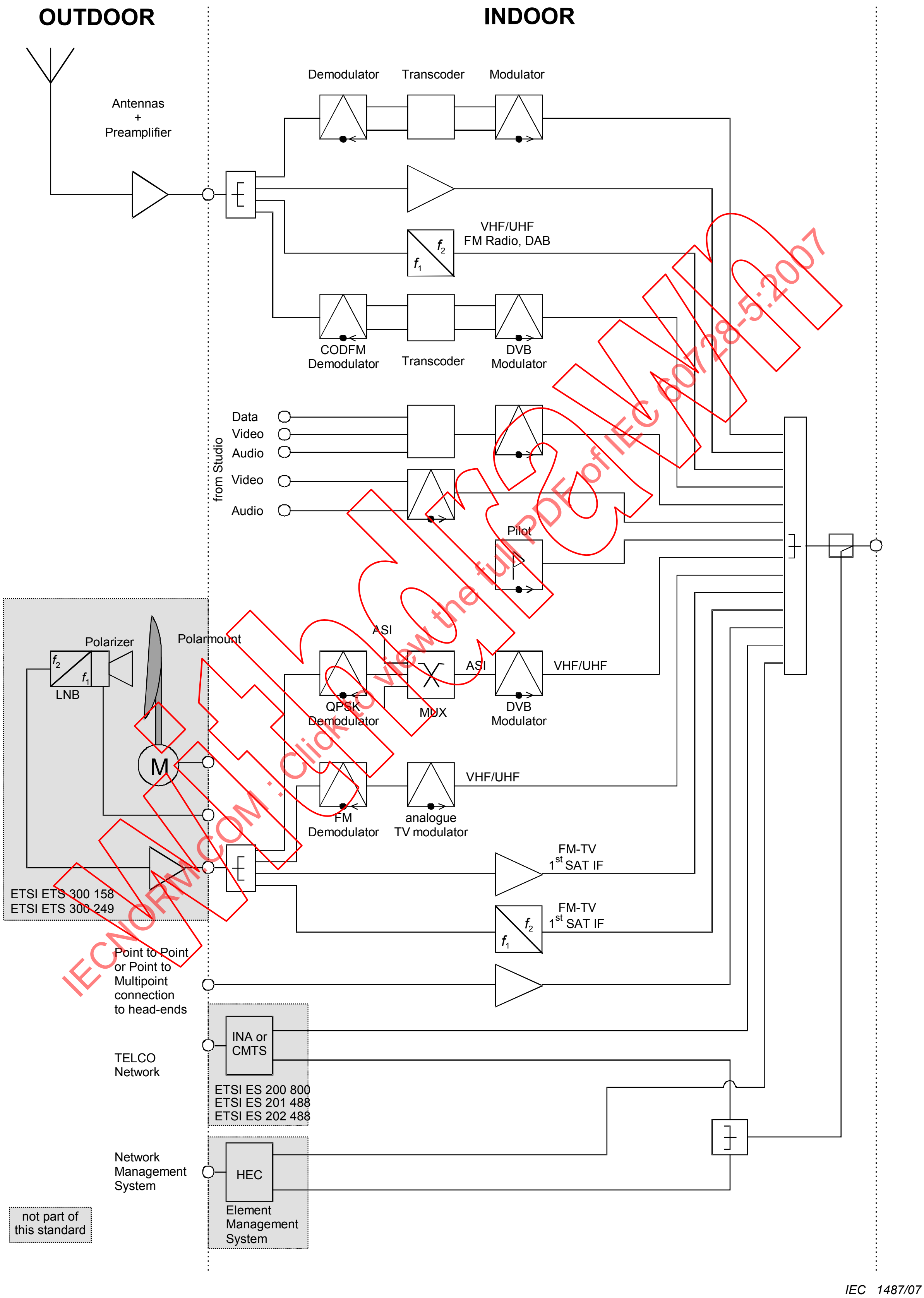



**Figure 1 – Example of headend**

## 2 Normative references

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

IEC 60068 (all parts), *Environmental testing*

IEC 60130-9, *Connectors for frequencies below 3 MHz – Part 9: Circular connectors for radio and associated sound equipment*

IEC 60244-5, *Methods of measurement for radio transmitters – Part 5: Performance characteristics of television transmitters*

IEC 60417, *Graphical symbols for use on equipment*

NOTE IEC 60417 can be consulted on the IEC website.

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60617, *Graphical symbols for diagrams*

IEC 60728-1, *Cable networks for television signals, sound signals and interactive services – Part 1: System performance of forward paths*

IEC 60728-2, *Cabled distribution systems for television and sound signals – Part 2: Electromagnetic compatibility for equipment*

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

IEC 60728-11, *Cable networks for television signals, sound signals and interactive services – Part 11: Safety*

IEC 61319-1, *Interconnections of satellite receiving equipment – Part 1: Europe*

ISO/IEC 13818-1, *Information technology – Generic coding of moving pictures and associated audio information: Systems*

ISO/IEC 13818-2, *Information technology – Generic coding of moving pictures and associated audio information: Video*

ISO/IEC 13818-3, *Information technology – Generic coding of moving pictures and associated audio information – Part 3: Audio*

ISO/IEC 13818-4, *Information technology – Generic coding of moving pictures and associated audio information – Part 4: Conformance testing*

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

ITU-R Report BT.624-4, *Characteristics of television systems*

ITU-T Recommendation J.61, *Transmission performance of television circuits designed for use in international connections*

ITU-T Recommendation J.101, *Measurement methods and test procedures for teletext signals*

ETSI EN 300 421, *Digital Video Broadcasting (DVB): Framing structure, channel coding and modulation for 11/12 GHz satellite services*

ETSI EN 300 429, *Digital Video Broadcasting (DVB): Framing structure, channel coding and modulation for cable systems*

ETSI EN 300 468, *Digital Video Broadcasting (DVB): Specification for Service Information (SI) in DVB systems*

ETSI EN 300 473, *Digital Video Broadcasting (DVB): Satellite Master Antenna Television (SMATV) distribution systems*

ETSI EN 300 744, *Digital Video Broadcasting (DVB): Framing structure, channel coding and modulation for digital terrestrial television*

ETSI EN 302 307, *Digital Video Broadcasting (DVB): Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications*

ETSI ETS 300 163, *Television systems; NICAM 728: Specification for transmission of two-channel digital sound with terrestrial television systems B, G, H, I and L*

ETSI TR 101 211, *Digital Video Broadcasting (DVB): Guidelines on implementation and usage of Service Information (SI)*



# 3 Terms, definitions, symbols and abbreviations

## 3.1 Terms and definitions

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

NOTE Terms and definitions defined in the IEV (IEC 60050-312, IEC 60050-702, IEC 60050-713, IEC 60050-723) are used as far as possible.

**3.1.1**
**amplitude frequency response**
gain or losses of an equipment or system plotted against frequency

**3.1.2**
**antenna preamplifier**
amplifier (often a low noise type) associated with an antenna

**3.1.3**
**attenuation**
ratio of the input power to the output power of an equipment or a system, usually expressed in decibel

[IEV 312-06-06, modified]

**3.1.4**
**automatic gain control (AGC)**
automatic control of an equipment to maintain the level of the signal at its output constant, using the signal to be controlled as the control stimulus

[IEV 702-09-30, modified]

**3.1.5**
**back-off**
nominal difference of the lower level to a higher reference level

**3.1.6**
**carrier-to-intermodulation ratio (*C/I*)**
difference in decibels between the carrier level at a specified point in a system or in an equipment and the level of a specified intermodulation product or combination of products

**3.1.7**
**carrier-to-noise ratio (*C/N*)**
difference in decibels between the vision or sound carrier level at a given point in the system and the noise level at that point (measured within a bandwidth appropriate to the television or radio system in use)

[IEV 713-11-21, modified]

**3.1.8**
**combiner**
equipment in which the signals arriving at two or more input ports are fed to a single output port

NOTE Some forms of this equipment may be used in the reverse direction as splitters.

**3.1.9**
**composite intermodulation noise (*CIN*)**
sum of noise and intermodulation products from digital modulated signals

**3.1.10**
**composite intermodulation noise ratio (*CINR*)**
ratio of the signal level and the CIN level

**3.1.11**
**decibel ratio**
ten times the logarithm of the ratio of two quantities of power $P_1$ to $P_2$, i.e.

$$10 \lg \frac{P_1}{P_2} \text{ [dB]} \qquad (1)$$

**3.1.12**
**frequency converter**
equipment for changing the carrier frequency of one or more signals

**3.1.13**
**gain**
ratio of the output power to the input power of any equipment or system, usually expressed in decibels

[IEV 702-02-11, modified]

**3.1.14**
**grade**
classification of performance for equipment for the use in cable networks. The choice of the appropriate grade is depending on, for example,

– size of network
– structure of network
– lengths of cable between equipment
– kind of services

– kind of signals

NOTE The essential requirement is that the system performance specification is fulfilled by the design of the network and choice of the grade of equipment used.

**3.1.15**
**headend**
equipment, which is connected between receiving antennas or other signal sources and the remainder of the cable network, to process the signals to be distributed

[IEV 723-09-11, modified]

NOTE The headend may, for example, comprise antenna amplifiers, frequency converters, combiners, separators and generators.

**3.1.16**
**headend for individual reception**
headend supplying an individual household; this type of installation may include one or more system outlets

**3.1.17**
**hub headend (hubsite)**
headend used to feed the entire operating network in the service area (local distribution) via multiple optical or RF trunks; the hubsite has no local signal acquisition

**3.1.18**
**image carrier power**
"power", in relation to a vision-modulated carrier, is defined as the power at the peak of the modulation envelope (i.e. the maximum RMS voltage squared, divided by the resistance)

**3.1.19**
**intermodulation**
process whereby the non-linearity of equipment in a system produces spurious output signals (called intermodulation products) at frequencies which are linear combinations of those of the input signals

[IEV 702-07-64, modified]

**3.1.20**
**landline link (cable or radio)**
point-to-point or point-to-multipoint connection to headends

**3.1.21**
**level**
level of any power $P_1$ is the decibel ratio of that power to the standard reference power $P_n$, i.e.

$$10 \lg \frac{P_1}{P_0} \tag{2}$$

level of any voltage $U_1$ is the decibel ratio of that voltage to the standard reference voltage $U_0$, i.e.

$$20 \lg \frac{U_1}{U_0} \tag{3}$$

NOTE This may be expressed in decibels (relative to 1 µV in 75 Ω) or more simply in dB(µV) if there is no risk of ambiguity.

**3.1.22**
**local headend**
headend having stand-alone signal acquisition or fed from central headend; distribution to hubsites via optical or RF trunks and possibly some local area distribution

**3.1.23**
**MATV headend**
headend used in blocks of flats and in built-up sites to feed TV channels and FM radio channels into the house network or the spur network

**3.1.24**
**modulation error ratio (*MER*)**
sum of the squares of the magnitudes of the ideal symbol vectors divided by the sum of the squares of the magnitudes of the symbol error vectors of a sequence of symbols

$$MER = 10\ \lg \left\{ \frac{\sum_{j=1}^{N} \left( I_j^2 + Q_j^2 \right)}{\sum_{j=1}^{N} \left( \delta I_j^2 + \delta Q_j^2 \right)} \right\} [\text{dB}] \qquad (4)$$

The result is expressed as a power ratio in dB.

**3.1.25**
**MPEG-2**
refers to the ISO/IEC 13818 series. System coding is defined in ISO/IEC 13818-1, video coding in ISO/IEC 13818-2, audio coding in ISO/IEC 13818-3

**3.1.26**
**multiplex**
stream of all the digital data carrying one or more services within a single physical channel

**3.1.27**
**out-of-band emissions**
emissions on a frequency or on frequencies immediately outside the necessary bandwidth, which results from the modulation process, but excluding spurious emissions

**3.1.28**
**phase noise**
phase instability of random nature; The sources of random sideband noise in an oscillator are thermal noise, flicker noise and shot noise.

NOTE Each time the signal is frequency processed, this signal is degraded by an addition of phase noise due to phase noise of the local oscillator. Frequency converters or modulators generate phase noise.

**3.1.29**
**central headend**
headend from which signals are delivered to a local headends via a long-distance terrestrial link; no local distribution

**3.1.30**
**satellite master antenna television system (SMATV)**
system which is designed to provide sound and television signals to the households of a building or group of buildings. Two system configurations are defined in ETSI EN 300 473 as follows:

- SMATV system A, based on transparent transmodulation of QPSK satellite signals into QAM signals to be distributed to the user;

- SMATV system B, based on direct distribution of QPSK signals to the user, with two options:
  - SMATV-IF distribution in the satellite IF band (above 950 MHz);
  - SMATV-S distribution in the VHF/UHF band, for example in the extended S-band ( 230 MHz to 470 MHz)

**3.1.31**
**$S_{D,RF}/N$**
signal-to-noise ratio for a digitally modulated signal intended in the RF band

**3.1.32**
**service information (SI)**
digital data describing the delivery system, content and scheduling/timing of broadcast data streams, etc. including MPEG-2 PSI together with independently defined extensions

**3.1.33**
**shoulder attenuation**
ratio between signal and spectrum re-growth outside channel

**3.1.34**
**spurious emissions**
emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information, including harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but excluding out-of-band emissions

**3.1.35**
**standard reference power and voltage**
in cable networks, 1/75 pW

NOTE 1 This is the power dissipated in a 75 Ω resistor with an RMS voltage drop of 1 µV across it.

NOTE 2 The standard reference voltage $U_0$ is 1 µV.

**3.1.36**
**subscriber equipment**
equipment at the subscriber premises such as receivers, tuners, decoders, video recorders

**3.1.37**
**symbol rate stability**
short-term variation of symbol rate due to signal processing; for instance, caused by zero packet stuffing in headend equipment

**3.1.38**
**transport stream (TS)**
data structure defined in ISO/IEC 13818-1 which is the basis of the digital video broadcasting (DVB) related standards

**3.1.39**
**unwanted emissions**
consisting of spurious and out-of-band emissions

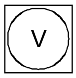
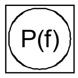
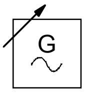
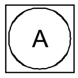
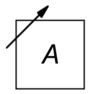
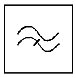
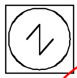
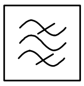
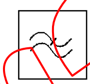
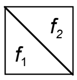
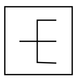
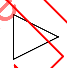
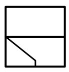
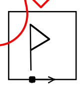
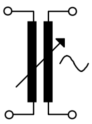
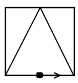
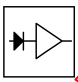
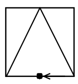
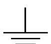
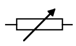
**3.1.40**
**well-matched**
matching condition when the return loss of the equipment complies with the requirements of Table 3 of IEC 60728-3

NOTE Through mismatching of measurement instruments and the measured equipment, measurement errors are possible. Comments on the estimation of such errors are given in Annex H.

### 3.2 Symbols

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

NOTE Numbers in brackets ([ ]) refer to symbols in IEC 60617.

| Symbols | Terms | Symbols | Terms |
|---|---|---|---|
|   | **voltmeter** **[IEC 60617-S00059(2001:07)]** **[IEC 60617-S00913(2001:07]** |   | **spectrum analyser** **[IEC 60617-S00059(2001:07)]** **[IEC 60617-S00910(2001:07)]** |
|   | **variable generator** **[IEC 60617-S00081(2001:07)]** **[IEC 60617-S01225(2001:07)]** **[IEC 60617-S01403(2001:09)]** |   | **ampere meter** **[IEC 60617-S00059(2001:07)]** **[IEC 60617-S00910(2001:07)]** |
|   | **equipment under test** **[IEC 60617-S00059(2001:07)]** |   | **variable attenuator** **[IEC 60617-S01245(2001:07)]** |
|  | **high pass filter** **[IEC 60617-S01247(2001:07)]** |  | **oscilloscope** **[IEC 60617-S00059(2001:07)],** **[IEC 60617-S00922(2001:07)]** |
|  | **band pass filter** **[IEC 60617-S01249(2001:07)]** |  | **low pass filter** **[IEC 60617-S01248(2001:07)]** |
|   | **frequency converter** **[IEC 60617-S00213(2001:07)]** |  | **band stop filter** **[IEC 60617-S01250(2001:07)]** |
|  | **splitter** |  | **amplifier** **[IEC 60617-S01239(2001:07)]** |
|  | **tap** |  | **pilotgenerator** |
|  | **adjustable AC voltage source** |  | **modulator** **[IEC 60617-S01278(2001:07)]** |
|  | **detector with LF-amplifier** **[IEC 60617-S00641(2001:07)** **IEC 60617-S01239(2001:07)]** |  | **demodulator** **[IEC 60617-S01278(2001:07)]** |
|  | **ground** **[IEC 60617-S00200(2001:07)]** |  | **variable resistor** **[IEC 60617-S00557(2001:07)]** |

### 3.3 Abbreviations

| | | | |
|---|---|---|---|
| AC | alternating current | AF | audio frequency |
| AFC | automatic frequency control | AGC | automatic gain control |
| ALC | automatic level control | AM | amplitude modulation |
| BER | bit error ratio | BSS | broadcast satellite services |
| BW | bandwidth | C/N | carrier to noise (ratio) |
| CATV | community antenna television (system) | CH | channel |
| CIN | composite intermodulation noise | CINR | composite intermodulation noise ratio |

| | | | |
|---|---|---|---|
| CMTS | cable modem termination system | COFDM | coded orthogonal frequency division multiplexing |
| CPE | common phase error | CW | continuous wave |
| DVB | digital video broadcasting | DVB-C | Digital video broadcasting, cable |
| DVB-S | Digital video broadcasting, satellite | EMC | electromagnetic compatibility |
| EUT | equipment under test | FM | frequency modulation |
| FSS | fixed satellite services | HEC | headend controller |
| HP | high pass | ICI | inter-carrier interference |
| IF | intermediate frequency | INA | interactive network adaptor |
| IP class | international protection class | ITS | insertion test signal |
| LF | low frequency | LNC | low noise converter |
| LP | low pass | LUM NL | luminance non-linearity |
| MATV | master antenna television (system) | MER | modulation error ratio |
| MMDS | microwave multichannel distribution systems | MPEG | motion picture experts group |
| MTBF | meantime between failure | MVDS | multichannel video distribution system |
| NF | noise figure | NICAM | near-instantaneously companded audio multiplex |
| OFDM | orthogonal frequency division multiplexing | PAL | phase alternating line |
| PSK | phase shift keying | Q grade(s) | quality grade(s) |
| QAM | quadrature amplitude modulation | QPSK | quaternary phase shift keying |
| RF | radio frequency | RMS | root mean square |
| RSBW | resolution bandwidth | S/N | signal to noise (ratio) |
| SAT IF | (1st) satellite intermediate frequency | SECAM | séquentiel couleur à mémoire |
| SHF | super high frequency | SI | service information |
| SMATV | satellite master antenna television (system) | TS | transport stream |
| T-STD | Transport Stream System Target Decoder | TV | television |
| TVRO | television receive only (system) | VCO | voltage-controlled oscillator |
| VHF | very high frequency | VSB-IF | vestigial sideband intermediate frequency |

# 4 Methods of measurement

## 4.1 Methods of measurement for digitally modulated signals

### 4.1.1 Introduction

The methods of measurement for digitally modulated signals differ from those for analogue modulation for several reasons.

a) The carrier is not present in the modulated signal and therefore cannot be measured (i.e. DVB systems using PSK or QAM modulation) or there are thousands of carriers (i.e. DVB systems using OFDM modulation).

b) The modulated signal has a spectrum that is flat in the bandwidth and is similar to noise.

c) The parameters that affect the quality of the received signal are related to the bit and word errors introduced by the channel (noise, amplitude and phase response inequalities, echoes, etc.) before demodulation and error correction.

### 4.1.2 Basic assumptions and measurement interfaces

The methods of measurement for digitally modulated signals are based on the assumption that

a) the MPEG-2 TS is the specified input and output signal for all the baseline systems, i.e. for satellite, cable, SMATV, MMDS/MVDS and terrestrial distribution; as an alternative the MPEG-4 TS can be used as input and output signal for the baseline systems satellite, cable, and SMATV,

b) the digitally modulated signals received by satellite are modulated in the PSK format, i.e. according to ETSI EN 300 421 and ETSI 302 307 for the QPSK format, or according to ETSI EN 302 307 for the 8PSK and APSK formats, and can be distributed in the same format in cable systems (SMATV systems),

c) the digitally modulated signals received by satellite are distributed in CATV systems in the QAM format, i.e. according to ETSI EN 300 429,

d) the digitally modulated signals received from terrestrial broadcasting in the OFDM format are distributed in SMATV/CATV systems in the same OFDM format; sometimes it is more efficient in terms of frequency economy to convert the signal to DVB-C as described in ETSI EN 300 429,

e) an I/Q baseband signal source for PSK, QAM or OFDM formats is available, as described in IEC 60728-1; appropriate interfaces are accessible and are consistent with the DVB-SI documents (see ETSI TR 101 211 and ETSI EN 300 468),

f) a reference receiver for PSK, QAM or OFDM formats is available (for details, see IEC 60728-1), where appropriate interfaces are indicated,

g) the decoder implementation will not affect the consistency of the results. The MPEG-2 T-STD model constraints, as defined in ISO/IEC 13818-1 (MPEG-2 system), shall be satisfied as specified in ISO/IEC 13818-4 (MPEG-2 compliance testing).

### 4.1.3 Signal level for digitally modulated signals

#### 4.1.3.1 Introduction

This measuring method applies to the measurement of the level of digitally modulated signals using QPSK (ETSI EN 300 421 and ETSI EN 302 307), 8PSK or APSK (ETSI EN 302 307), QAM (ETSI EN 300 429, ETSI EN 300 473), and COFDM (ETSI EN 300 744) formats.

Because the modulated signal is similar in characteristics to white noise, the measurement is based on the use of a suitable spectrum analyser, able to tune the frequency range of the channel and to display the whole bandwidth, to measure spectral power density. The result may be expressed as dB(mW/Hz). The signal level in dB(mW) or in dB(μV) can be calculated if the bandwidth is known.

The measurement can be performed at the system outlet, at the output of distribution equipment (passive or active), at the output of the headend or at the output of an outdoor unit (SHF receiver) for satellite reception.

#### 4.1.3.2 Equipment required

The equipment required is a spectrum analyser having a known noise bandwidth and a calibrated display of the tuned signal. The calibration accuracy should preferably be within ±0,5 dB and shall be stated with the results.

The equipment shall be able to tune over the nominal frequency range of the system.

#### 4.1.3.3 Connection of the equipment

Connect the measuring equipment to the system outlet or to the point where the measurement shall be performed, using a suitable cable and connectors, taking care to maintain correct impedance matching.

#### 4.1.3.4 Measurement procedure

a) When signal levels are to be measured where a high ambient field is present, the measuring equipment shall be checked for spurious readings. Connect a shielded termination to its input cable, place both the meter and the lead approximately in their measuring positions and check that there is a negligible reading at the frequency(ies) and on the meter ranges to be used.
b) Tune the channel that must be measured (selecting the centre frequency of the spectrum analyser) and select the span and level settings to show the whole channel whose bandwidth depends on the type of modulation used (see Annex F);
c) Set the *RSBW* of the spectrum analyser to 100 kHz and set the video bandwidth low enough to obtain a smooth display (100 Hz if available).
d) Measure the level *S* of the flat top of the displayed signal in dB(μV) or in dB(mW), using the display line cursor if this feature is available.
e) If the spectrum of the signal does not have a flat top, due to echoes, measure the signal level at the centre frequency of the channel.
f) Measure on the displayed channel the upper and lower frequencies at the channel edges where the level is 3 dB lower than the maximum level S; the difference between these two frequencies is assumed to be the equivalent signal bandwidth *BW*, expressed in Hz.
g) Calculate the level $S_{D,RF}$ of the signal using the following formula:

$$S_{D,RF} = S + 10\,\lg\left[\frac{BW}{RSBW}\right] + K_{sa} \qquad (5)$$

where

$S_{D,RF}$ is the signal level for a digitally modulated signal;

$S$ is the displayed signal level (flat top);

$BW$ is the signal bandwidth;

$RSBW$ is the resolution bandwidth of the spectrum analyser;

$K_{sa}$ is the correction factor.

The correction factor $K_{sa}$ depends on the measuring equipment used and shall be provided by the manufacturer of the measuring equipment or obtained by calibration. The value of the correction factor for a typical spectrum analyser is about 1,7 dB (see also Annex I).

The correction factor is not necessary if the measuring equipment can be set to display the level in dB(mW/Hz) units. In this case the level $S_{D,RF}$ of the signal can be obtained from the measured maximum level $S$ using the following formula:

$$S_{D,RF} = S + 10 \lg(BW) \tag{6}$$

where

$S_{D,RF}$ is the signal level for a digitally modulated signal;

$S$ is the displayed maximum signal level;

$BW$ is the signal bandwidth (in Hz).

In this formula the bandwidth $BW$ shall be expressed in Hz.

NOTE This measuring method actually measures the $S + N$ level. The contribution of noise is considered negligible if the level of noise displayed outside the channel band is at least 15 dB lower than the maximum level displayed within the channel band. This noise level includes that of the measuring equipment (spectrum analyser) which should be at least 10 dB lower than the noise level displayed outside the channel band in order not to affect the results. Otherwise, the contribution of noise (due to the system or the equipment under test and to the measuring equipment) should be taken into account in the measurement of signal level $S$ (see Annex F).

#### 4.1.3.5 Presentation of the results

The measured level is expressed in dB(µV) or dB(mW) with reference to the $BW$ and referred to 75 Ω or in dB(mW/Hz). The accuracy of the measuring equipment shall be stated with the results.

### 4.2 Single-channel intermodulation specification for channel amplifier and frequency converter

Frequencies and levels of test carriers, as shown in Figure 2, simulate a colour television transmission where $f_a$, $f_b$ and $f_c$ respectively correspond to vision carrier, colour subcarrier and sound carrier. The most significant intermodulation products are:

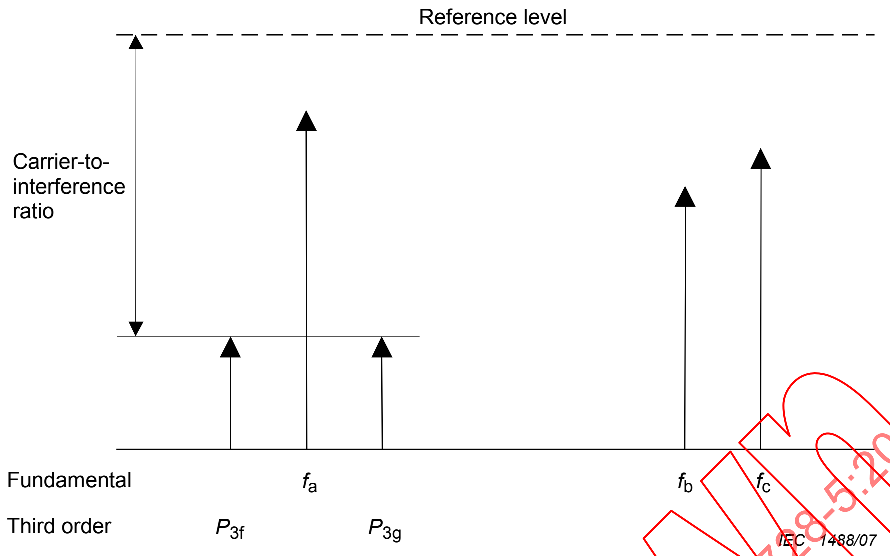
$$P_{3f} = f_a + f_b + f_c \tag{7}$$

$$P_{3g} = f_a + f_c - f_b \tag{8}$$

The carrier levels for different television systems are given in Table 1.

**Table 1 – Test signal levels in decibels relative to reference level**

| Test signal | | Relative signal level dB | |
|---|---|---|---|
| | | System | |
| | | B, G, H, I, D, D1, K | L |
| Vision carrier | $f_a$ | −8 | 0 |
| Colour subcarrier | $f_b$ | −17 | 0 |
| Sound carrier | $f_c$ | −10 | 0 |




NOTE Levels of measuring signals are to be adjusted as in Table 1.

**Figure 2 – Frequencies and levels of test carriers**



### 4.3 Three-carrier intermodulation measurement

The specifications for the measurement of three-carrier intermodulation apply to sub-band, full-band and multi-band amplifiers or multi-channel frequency converters.

In television band amplifiers, the simultaneous transmission of multi-channel programming may cause mutual interference between vision carriers through cross-modulation. The carrier-to-cross-modulation distortion ratio is defined as the difference between the level of a given test carrier and the level of the cross modulation products produced by interfering signals and falling near that test carrier.

This method of measurement is used to simulate transfer of modulation between two television signals. The test carrier having the frequency $f_a$ is an unmodulated wanted signal, while the carriers having the frequencies $f_b$ and $f_c$ represent the sidebands of a 100 % AM interfering signal (Table 2 and Figure 3).

**Table 2 – Test signal levels in decibels relative to reference level**

| Test signal | | Relative signal level<br>dB |
|---|---|---|
| Test frequency | $f_a$ | 0 |
| Interfering frequency | $f_b$ | –6 |
| Interfering frequency | $f_c$ | –6 |

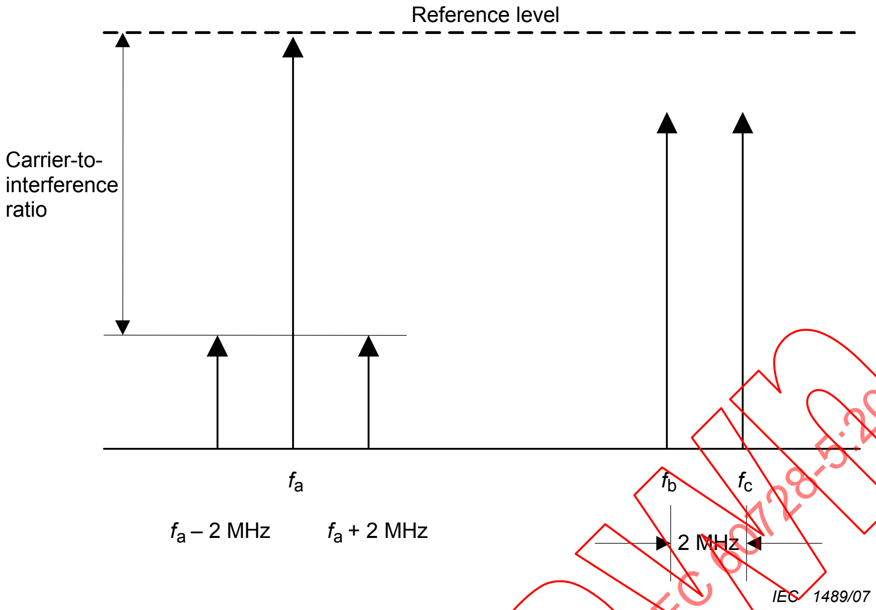



**Figure 3 – Test carrier and interfering products in the pass band**

The carriers having the frequencies $f_a$, $f_b$ and $f_c$ shall be varied over the entire frequency range.

NOTE If the equal carrier method of measurement as described in IEC 60728-3 is used, the output level giving the appropriate signal-to-distortion ratio must be increased by 6 dB.

### 4.4 Two carrier intermodulation measurements for second- and third-order products

#### 4.4.1 Introduction

The two-carrier method is applicable to the measurement of the ratio of the carrier to a single intermodulation product at a specified point within a cable network. The method can also be used to determine the intermodulation performance of individual items of equipment.

Second-order products are encountered only in wideband equipment and systems covering more than one octave and can be measured using two signals.

Third-order products are encountered in both wideband and narrowband equipment and systems and, depending on the type, can also be measured using two signals.

### 4.4.2 Intermodulation products with test signals at frequencies $f_a$ and $f_b$

Second-order products: $P_{2a} = f_b - f_a$

$P_{2b} = f_a + f_b$

NOTE Not applicable to narrowband equipment unless the frequency range covered by the equipment is such that $2f_{min} < f_{max}$.

Third-order products: $P_{3a} = 2f_a - f_b$ where $2f_a > f_b$

$P_{3a} = f_b - 2f_a$ where $2f_a < f_b$

$P_{3b} = 2f_b - f_a$

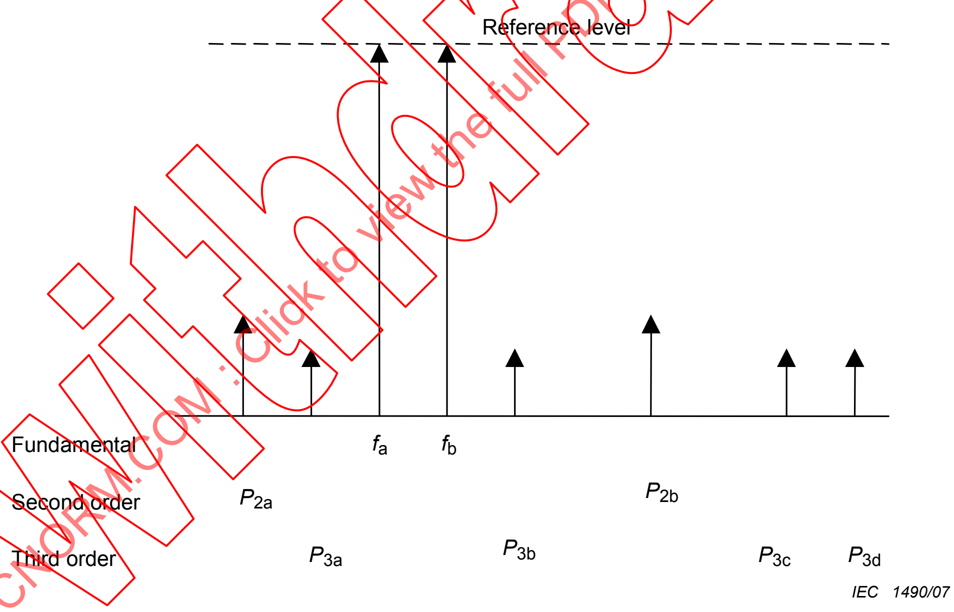
$P_{3c} = 2f_a + f_b$

$P_{3d} = 2f_b + f_a$

### 4.4.3 Signal levels

The two test carriers shall be set to the reference level.

An example showing products formed when $2 f_a > f_b$ is shown in Figure 4.




NOTE The sequence of the intermodulation products will depend on the fundamental frequency chosen.

**Figure 4 – Example showing products formed when $2 f_a > f_b$**

## 4.5 Carrier-to-spurious signal ratio at the output

### 4.5.1 Carrier-to-spurious signal ratio at the output of equipment for AM-TV systems

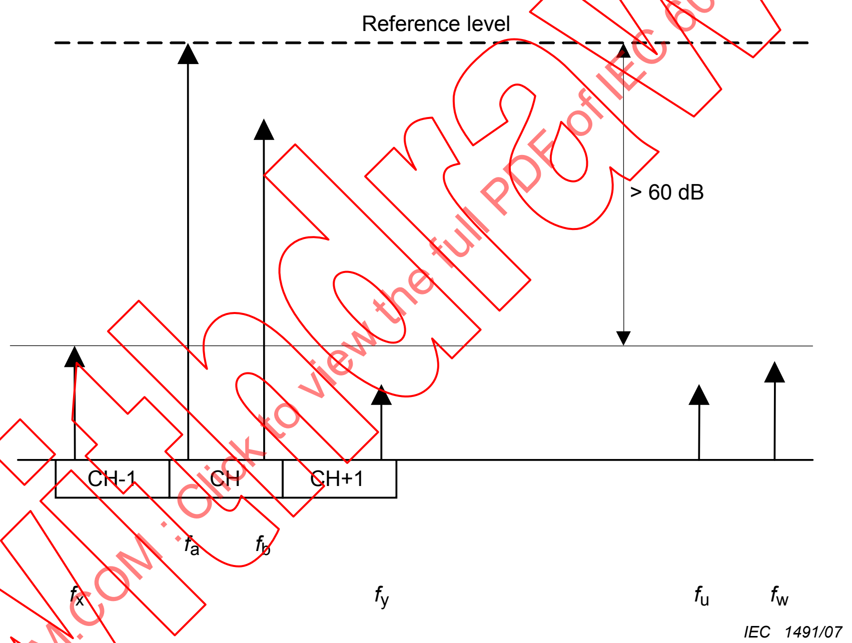
The carrier-to-spurious signal ratio at the output, out of channels, is applied between 40 MHz and 862 MHz.

The carrier levels are given in Table 3.

**Table 3 – Test signal levels in decibels relative to reference level**

| Test signal | | Relative signal level dB | |
|---|---|---|---|
| | | System | |
| | | B, G, I, D, D1,K | L |
| Vision carrier | $f_a$ | 0 | 0 |
| Sound carrier | $f_b$ | −10 | 0 |

The carrier-to-spurious signal ratio in the output is shown in Figure 5.






$f_x = 2f_a - f_b$; $f_y = 2f_b - f_a$

$f_u$, $f_w$ are examples for all other spurious outputs

**Figure 5 – Carrier-to-spurious signal ratio in the output**

If for channel processing in CH-1 and CH+1 the difference between the intermodulation products $f_x$ and $f_y$ and the reference level is less than 60 dB, the equipment shall be marked with the note: "not suitable for adjacent channel operation".

### 4.5.2 Carrier-to-spurious signal ratio at the output of equipment for FM-TV systems

Carrier-to-spurious signal ratio at the output of equipment for FM TV systems, out of channels and in channels between 950 MHz and 3 000 MHz shall be in accordance with Figure 6.

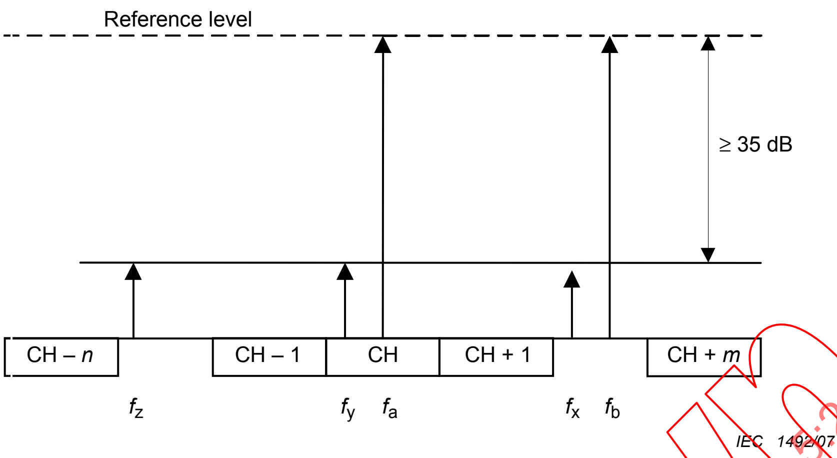



**Figure 6 – Carrier-to-spurious signal ratio at the output**

Values $f_x$, $f_y$ and $f_z$ are intermodulation products between $f_a$ and $f_b$ or with other signals occurring in the system like oscillator frequency signals; $f_b$ is varied within the whole transmission range assigned to the equipment except for the useful channel regarded.

### 4.5.3 Shoulder attenuation

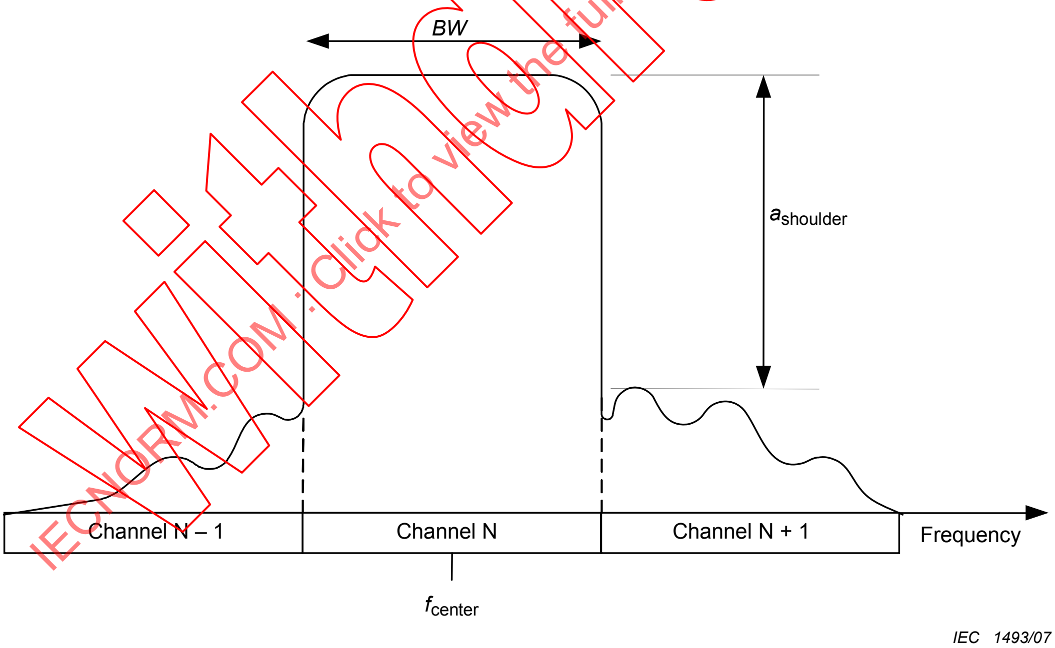



**Figure 7 – Shoulder attenuation**

The shoulder attenuation is measured as the difference between the top of channel N and maximum noise like spurious of channel N measured in the adjacent channels N + 1 or channel N-1 respectively (see Figure 7).

The resolution bandwidth of the measurement should be 10 kHz.

## 4.6 Signal-to-noise measurement

### 4.6.1 Television carrier-to-noise ratio (analogue modulated signals)

#### 4.6.1.1 Introduction

The method described is applicable to the measurement of the carrier-to-random-noise ratio within an analogue television channel at a specified point within a cable network. The method of measurement actually determines carrier-(plus noise)-to-noise ratio; however, the difference between this and the carrier-to-noise ratio is very small if the value exceeds 20 dB.

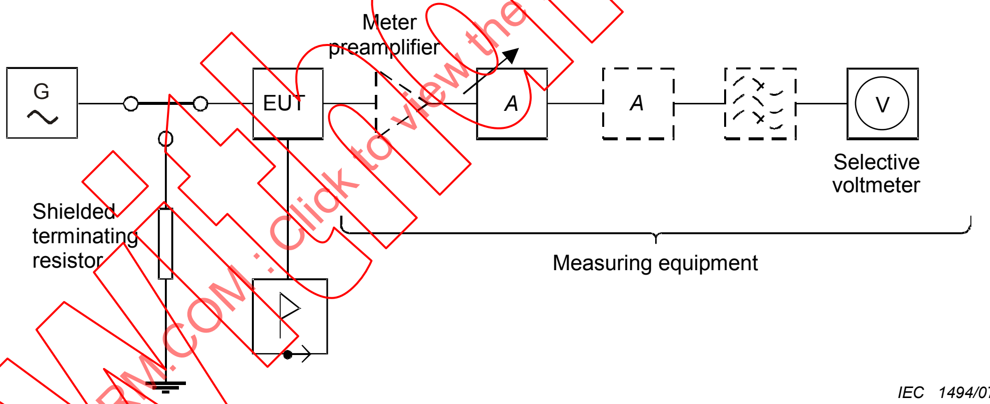
The method assumes that the random noise is evenly distributed within the channel.

The following equipment is required:

- selective voltmeter with a known noise bandwidth less than that of the channel to be measured;
- CW signal generator covering the frequencies at which the tests are to be carried out;
- variable attenuator with a range greater than the carrier-to-noise ratio expected;
- shielded terminating resistor.

NOTE Additional items may be necessary, for example, to ensure correct calibration and operation of the test equipment (see 4.6.1.3).

The equipment shall be connected as in Figure 8.




NOTE Dotted lines signify items, which may be required

**Figure 8 – Arrangement of test equipment for carrier-to-noise ratio measurement**

#### 4.6.1.2 Measurement procedure

##### 4.6.1.2.1 General

The test set-up shall be well-matched and the sensitivity of the measuring equipment (see Annex H) shall be known over the frequency range of the channel to be measured.

Where the system to be measured includes AGC, tests shall be carried out at minimum and maximum levels of signal input.

Where the system to be measured includes ALC, pilot signals of the correct type, frequency and level shall be maintained throughout the tests.

#### 4.6.1.2.2 Calibration

The selective voltmeter shall be calibrated and checked for satisfactory operation as follows:

- level correction, average/RMS or peak/RMS (see 4.6.1.3.3);
- noise bandwidth (see Annex F).

#### 4.6.1.2.3 Other checks

- Sensitivity (see 4.6.1.3)
- Noise (see 4.6.1.3.4.1)
- Intermodulation (see 4.6.1.3.4.2)
- Overload (see 4.6.1.3.4.3)

#### 4.6.1.2.4 Measurement

Set the signal generator to the vision carrier frequency of the channel to be tested and adjust its output, and those of the different points of the system as far as the point of measurement, to obtain the specified system operating levels throughout;

Connect the variable attenuator and selective voltmeter (and other items, if required; see 4.6.1.3) to the point of measurement. Tune the voltmeter to the reference signal and note the attenuator value $a_1$ required to obtain a convenient voltmeter reading $U_R$; The attenuator value $a_1$ should be slightly greater than the signal-to-noise ratio expected at the point of measurement.

Disconnect the generator and replace it by the shielded terminating resistor, or, if the reference signal is used for AGC, retune the voltmeter within the channel such that it is influenced only by random noise. Reduce the attenuator setting to the value $a_2$ required to again obtain the same voltmeter reading $U_R$;

The carrier-to-noise ratio in decibels is given by

$$C/N = a_1 - a_2 - C_m - C_b \quad (9)$$

where

$a_1$ is the attenuator value for the reference signal;

$a_2$ is the attenuator value for the noise;

$C_m$ is the voltmeter level correction factor (see 4.6.1.3.3.1);

$C_b$ is the bandwidth correction factor (see 4.6.1.3.3.2).



### 4.6.1.3 Equipment required – Additional items

#### 4.6.1.3.1 Voltmeter preamplifier

If the sensitivity of the selective voltmeter is not adequate for the levels of noise expected at the point of measurement, a suitable preamplifier of the correct input impedance and considerably flat response over the channel to be measured will be necessary. This preamplifier should be included as part of the measuring equipment when making the checks described in 4.6.1.3.4.

#### 4.6.1.3.2 Voltmeter input filter

If the selectivity of the selective voltmeter is not adequate to reduce to an insignificant level the effects of "out-of-channel" signals on the measurement of the noise voltage, a suitable filter having a considerably flat response over the channel to be measured will be required as shown in Figure 8.

In this case, it is important that the matching between the filter and the preceding equipment shall be such that it results in a return loss of not less than 20 dB within the frequency range of the channel to be measured, and that the whole measuring equipment shall satisfy all the requirements of Annex H.

Where this is in doubt, an attenuator of sufficient value to satisfy this requirement should be included as shown in Figure 8.

#### 4.6.1.3.3 Correction factors

##### 4.6.1.3.3.1 Level correction factor $C_m$

If a selective voltmeter responding to the average value of the applied voltage but calibrated in RMS values (assuming a sinusoidal input signal) is employed, it will indicate a level approximately 1 dB below the RMS value of the applied noise voltage in its noise bandwidth. In this instance, $C_m$ may be taken as 1 dB.

If a selective voltmeter of the peak reading type is used, a correction appropriate to the particular instrument shall be employed as $C_m$.

##### 4.6.1.3.3.2 Bandwidth correction factor $C_b$

This correction factor takes into account the difference between the noise bandwidth of the selective voltmeter $B_m$ and that of the appropriate television system $B_{TV}$.

$$C_b = 10 \lg \frac{B_{TV}}{B_m} \text{ [dB]} \tag{10}$$

##### 4.6.1.3.3.3 Noise bandwidth $B_{TV}$

The noise bandwidth $B_{TV}$ for various television systems is given in Table 4.

**Table 4 – Noise bandwidth**

| System | I | B,D1,G | D,K | L |
|---|---|---|---|---|
| $B_{TV}$ (MHz) | 5,08 | 4,75 | 5,75 | 5,58 |

The values in Table 4 shall be used when determining $C_b$ (see 4.6.1.3.3.2)

#### 4.6.1.3.4 Preliminary checks on the measuring equipment for carrier-to-noise ratio

##### 4.6.1.3.4.1 Noise

With the input to the measuring equipment terminated and the variable attenuator set to zero, tune the voltmeter over the frequency range of interest and check that the reading remains negligible relative to that expected when measuring the system noise.

##### 4.6.1.3.4.2 Intermodulation

Connect signals, corresponding to those which will be present at the point of measurement, via a matched directional coupler to the measuring equipment. Tune the meter to any significant intermodulation product and note the lowest value of the signal/intermodulation ratio within the channel being considered. This ratio should exceed the minimum carrier-to-noise ratio expected at the point of measurement by an amount relevant to the accuracy desired. For example, 20 dB would result in an error of less than 1 dB.

If this requirement is not met, an appropriate channel pass-band filter to attenuate one of the signals should be included as indicated in Figure 8, and the checks of 4.6.1.3.4.1 and 4.6.1.3.4.2 should be repeated.

NOTE This check relating to intermodulation is necessary only if ALC pilot signals or other signals are present during the carrier-to-noise ratio tests.

#### 4.6.1.3.4.3 Overload

Connect signals as in 4.6.1.3.4.2 and attenuate one of them to a level comparable with that of the noise voltage expected at the point of measurement. Tune the meter to the low-level signal. Tune the low-level signal and the meter in step over the frequency range of the channel to be measured and check that the meter reading does not change when the high-level signals are switched off and on.

If this requirement is not met, a filter to attenuate one or more of the signals should be included as indicated in Figure 8, and all the above checks should be repeated as described in 4.6.1.3.4.2.

#### 4.6.1.3.5 Calibration of the noise bandwidth $B_m$ of the selective voltmeter

A well-matched noise generator is required, having a known bandwidth $B_g$ (see NOTE 1) and an output voltage of known RMS value $U_g$ sufficient to give a convenient reading on the voltmeter.

The voltmeter is connected to the noise generator (see NOTE 2) and tuned to a test frequency. The true RMS voltage $U_m$ is measured (see 4.6.1.3.3). This procedure is repeated at each test frequency.

The noise bandwidth of the voltmeter ($B_m$) is given by

$$B_m = B_g \left( \frac{U_m}{U_g} \right)^2 \tag{11}$$

where $B_m$ and $B_g$ are in the same units, for example megahertz, and $U_m$ and $U_g$ are in the same units, for example microvolts.

NOTE 1 $B_g$ will usually be taken as 1 MHz and $U_g$ is calculated for this bandwidth from information provided by the manufacturer of the noise generator.

NOTE 2 The noise generator may consist of a noise diode source followed by an appropriate amplifier.

### 4.6.2 RF signal-to-noise ratio ($S_{D,RF}/N$) for digitally modulated signals

#### 4.6.2.1 Introduction

This measuring method applies to the measurement of the RF signal-to-noise ratio $S_{D,RF}/N$ of digitally modulated signals using the QPSK, QAM, COFDM formats.

Because the modulated signal is similar in characteristics to white noise, the measurement is based on the use of a suitable spectrum analyser, able to tune the frequency range of the channel and to display the whole bandwidth, as well as to measure the spectral power densities of both the signal and the noise.

The measurement can be performed at the system outlet, at the output of distribution equipment (passive or active), at the output of the headend or at the output of an outdoor unit (SHF receiver) for satellite reception.

#### 4.6.2.2 Equipment required

The equipment required is a spectrum analyser having a calibrated display of the tuned signal and which shall be able to tune over the frequency range of the system under test.

#### 4.6.2.3 Connection of the equipment

Connect the measuring equipment to the system outlet or to the point where the measurement shall be performed, using a suitable cable and connectors, taking care to maintain correct impedance matching.

#### 4.6.2.4 Measurement procedure

a) Tune the channel that shall be measured (selecting the centre frequency of the spectrum analyser) and select the span and level settings to show the whole channel whose bandwidth depends on the type of modulation used. In Table F.1, examples of the equivalent signal *BW* of digitally modulated signals are given.

b) Set the *RSBW* of the spectrum analyser to 100 kHz and set the video bandwidth low enough to obtain a smooth display (100 Hz if available). If a different setting is used, this must be the same when measuring the signal level and the noise level.

c) Measure the level *S* of the flat top of the displayed signal in dB(μV) or in dB(mW), using the display line cursor if this feature is available.

   NOTE If the spectrum of the signal does not have a flat top, due to echoes, measure the signal level at the centre frequency of the channel.

d) Switch off the channel at the input of the system or of the equipment under test, terminating the input port with a matched impedance (or depointing the antenna, if the measurement is performed at the output of an outdoor unit for satellite reception) and measure the noise level *N* in the same units as the signal level (in dB(μV) or in dB(mW) or in dB(mW/Hz)).

e) Calculate the RF signal-to-noise ratio $S_{D,RF}/N$ by the following formula:

$$S_{D,RF}/N = S\,[dB(\mu V)] - N\,[dB(\mu V)] \quad dB \tag{12}$$

or

$$S_{D,RF}/N = S\,[dB(mW)] - N\,[dB(mW)] \quad dB \tag{13}$$

or

$$S_{D,RF}/N = S\,[dB(mW/Hz)] - N\,[dB(mW/Hz)] \quad dB \tag{14}$$

where

$S_{D,RF}/N$ is the RF signal-to-noise ratio, in dB;

$S$ is the signal level in dB(μV), dB(mW) or dB(mW/Hz)

$N$ is the noise level in dB(μV), dB(mW) or dB(mW/Hz)

NOTE This measuring method actually measures the $(S_{D,RF} + N)/N$ ratio. The measuring equipment (spectrum analyser) should have a noise level at least 10 dB lower than the noise level displayed outside the channel band in order not to affect the results. Otherwise, the contribution of the measuring equipment noise in the measurement of the noise level *N* should be taken into account (see Annex E).

#### 4.6.2.5 Presentation of the results

The measured signal-to-noise ratio $S_{D,RF}/N$ is expressed in dB.

### 4.7 Differential gain and phase for PAL/SECAM signals

#### 4.7.1 Introduction

The methods described are applicable to the measurement of differential gain and differential phase for complete systems and items of equipment thereof. The test signals employed are in both cases those recommended in ITU-T Recommendation J.61, and are shown in Figure 10 and Figure 11. The definitions are also those given in the same recommendation.

It is intended that these measurements be carried out with test signals inserted at the system headend. They may be either of the full field type or, where convenient, may be inserted in the field blanking period.

The use of frame inserted test signals available on the broadcast TV channels is not generally recommended as these are subject to variations beyond the control of the user. However, where such signals of known stability and of adequate quality are available, they may be used to carry out these measurements.

#### 4.7.2 Differential gain (for PAL/SECAM only)

##### 4.7.2.1 Definition

Differential gain is expressed by two values, $x$ (%) and $y$ (%), which represent the two peak amplitudes of the sub-carrier relative to the amplitude of the sub-carrier at blanking level. In the case of a monotonic characteristic, either $x$ or $y$ will be zero.

Differential gain, in percentage referred to blanking level, can be found from the following expressions.

$$x = \left| \frac{A_{max} - A_0}{A_0} \right| \cdot 100\ \% \qquad y = \left| \frac{A_{min} - A_0}{A_0} \right| \cdot 100\ \% \qquad (15)$$

Peak-to-peak differential gain ($DG_{pp}$) can be found from the following expression.

$$DG_{pp} = \left| \frac{A_{max} - A_{min}}{A_0} \right| \cdot 100\ \% \qquad (16)$$

where

$A$ is the amplitude of the sub-carrier on one of the other treads of the staircase;

$A_0$ is the amplitude of the received sub-carrier at blanking level.

##### 4.7.2.2 Equipment required

The test set-up shall be well-matched and shall consist of:

- an oscilloscope which will not contribute significant distortion to the signal displayed;
- a modulator (unless transmitted test signals in the field blanking interval are to be used) having the following characteristics:
  - RF characteristics (excluding sound) corresponding to ITU-R Report BT.624-4, and appropriate to the television transmission system used;
  - video signal input requirement of 1 V peak-to-peak composite;
  - modulated output signal of a convenient amplitude;

- a demodulator having characteristics appropriate to the television transmission system used;
- two attenuators variable in steps of not more than 1 dB;
- band-pass filter with $f_0$ = 4,43 MHz and a bandwidth of 0,5 MHz;
- a test signal generator providing signals having characteristics appropriate to the television transmission system under consideration, as specified in ITU-T Recommendation J.61 (signal D2) (see Figure 10).

NOTE Most commercially available test signal generators will provide this signal as part of a composite test line.

#### 4.7.2.3 Connection of the equipment

The equipment shall be connected as in Figure 9.

#### 4.7.2.4 Measurement procedure

With point A connected direct to point B (see Figure 9), adjust attenuator $A_1$ for an output level sufficient to drive the system to be tested and attenuator $A_2$ to obtain the correct input level to the demodulator.

Insert the appropriate band-pass filter after the demodulator (see Figure 9) and measure the differential gain by examining the modified staircase waveform (see Figure 11 and 4.7.2.1).

Ensure that the distortion of the test signal caused by the control loop (test equipment) is small compared with the maximum distortion allowed for the system or equipment to be tested.

NOTE 1 Where the linearity of the modulator/demodulator is such that on systems B and G (10 % residual carrier) this requirement cannot be met, it will be necessary either to reduce the sub-carrier amplitude or to ignore the sixth (uppermost) tread.

Connect the system or equipment to be tested between points A and B and disconnect the band-pass filter. Adjust attenuator $A_2$ to return the input level to the demodulator to the one mentioned above.

Reinsert the band-pass filter and measure the maximum differential gain by examining the modified staircase waveform (see also Figure 11 and 4.7.2.1).

NOTE 2 This figure includes the distortion due to the test equipment as well as the system or equipment under test.



### 4.7.3 Differential phase

#### 4.7.3.1 Definition

Differential phase is expressed by two values, *x* and *y*, in degrees, which represent the two peak phases of the sub-carrier relative to the phase of the sub-carrier at blanking level. In the case of a monotonic characteristic, both *x* and *y* will be zero.

Differential phase, in degrees, referred to blanking level, can be found from the expressions below:

$$x = \left|\phi_{max} - \phi_0\right| \quad (17)$$

$$y = \left|\phi_{min} - \phi_0\right|$$

Peak-to-peak differential phase ($DPH_{pp}$) in degrees can be found from the expression:

$$DPH_{pp} = |\phi_{max} - \phi_{min}| \quad (18)$$

where

$\varphi_0$ is the phase of the received sub-carrier at blanking level;

$\varphi$ is the phase of the sub-carrier on one of the other treads of the staircase.

#### 4.7.3.2 Equipment required

- A modulator (unless transmitted test signals in the field blanking interval are to be used) having the following characteristics:
  - RF characteristics (excluding sound) corresponding to ITU-R Report BT.624-4, and appropriate to the television transmission system used;
  - video signal input requirement of 1 V peak-to-peak composite;
  - a modulated output signal of a convenient amplitude.
- A demodulator having characteristics appropriate to the television transmission system used;
- Two attenuators variable in steps of not more than 1 dB;
- A test set capable of measuring the difference in phase of the subcarrier at each tread of the staircase, with reference to the blanking level;
- A test waveform generator (unless transmitted test signals in the field blanking intervals are to be used) providing signals having characteristics appropriate to the television transmission system under consideration, as specified in ITU-T Recommendation J.61 (signal D2), although a lower chrominance amplitude of the chrominance component would be acceptable.

NOTE 1 Most commercially available test signal generators will provide this signal as part of a composite test line.

NOTE 2 Certain types of test sets require the presence of a colour burst during the back porch period of the test signal.

#### 4.7.3.3 Connection of the equipment

The equipment shall be connected as in Figure 9.

#### 4.7.3.4 Measurement procedure

With point A connected direct to point B (see Figure 9), adjust attenuator $A_1$ for an output level sufficient to drive the system to be tested and attenuator $A_2$ to obtain the correct input level to the demodulator. Connect the differential phase test set.

Ensure that the distortion of the test signal due to the control loop (test equipment) is small compared with the maximum distortion allowed for the system or equipment to be tested (see also NOTE 2 of 4.7.2.4).

Connect the system or equipment to be tested between points A and B. Adjust attenuator $A_2$ to return the input level to the demodulator to that mentioned above.

Determine the relative sub-carrier phases corresponding to the six treads of the staircase waveform. The differential phase of the system or equipment under test is the maximum phase change between the blanking level tread and that of any other tread of the staircase.

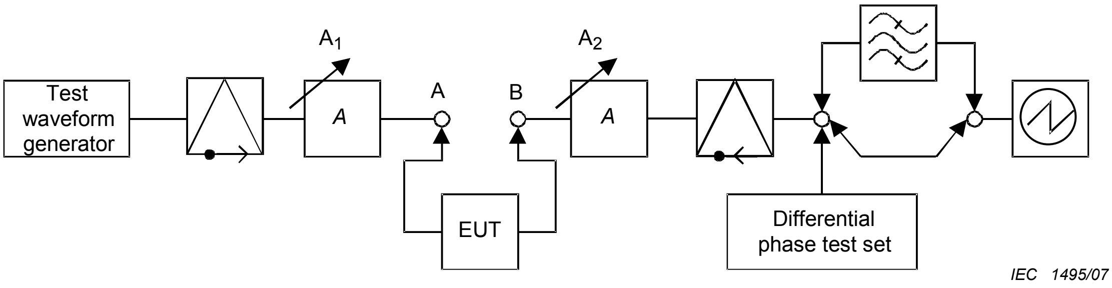



**Figure 9 – Arrangement of test equipment for measurement of differential gain and phase**

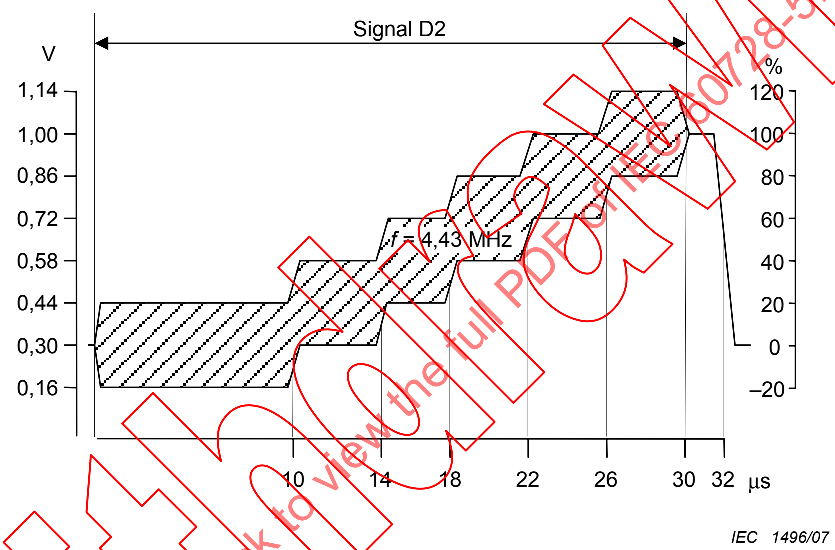



**Figure 10 – Signal D2 waveform**

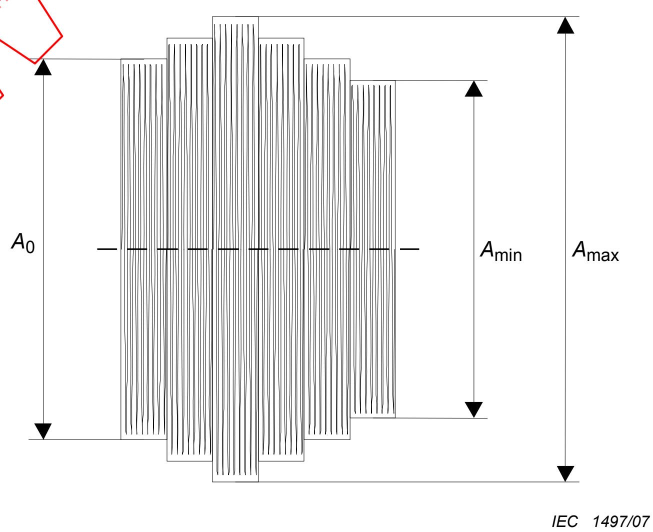



**Figure 11 – Example of modified staircase**

## 4.8 Group delay measurements

### 4.8.1 Group delay variation of analogue TV signals

#### 4.8.1.1 Definition

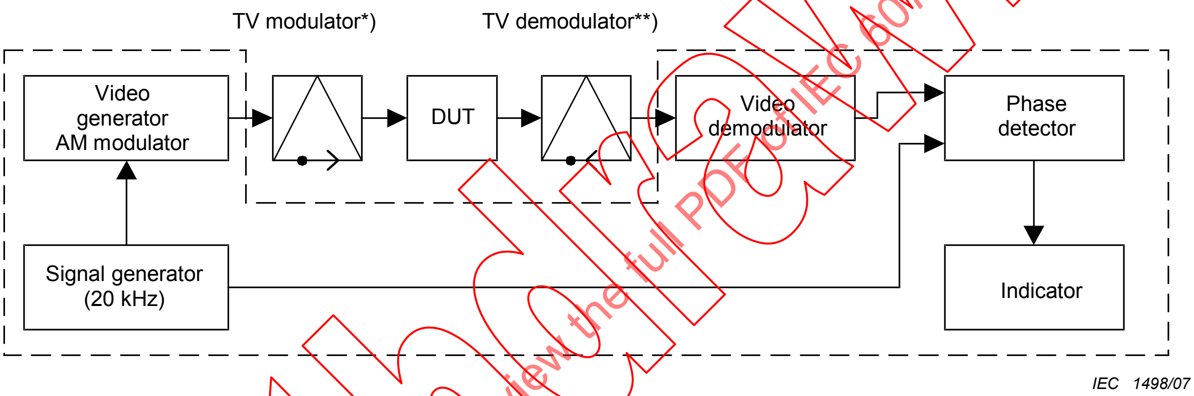
Group delay variation is defined as the deviation from a linear phase-frequency response. This deviation is measured as the difference between the maximum and the minimum slope of the phase-frequency response within the channel.

NOTE For analogue systems the measurements are made in the video band 25 Hz to 5,0 MHz (for standards D, K within the video band 25 Hz to 6,0 MHz) related to the reference frequency of 200 kHz.

For NICAM 728 the reference frequency is the NICAM carrier.

#### 4.8.1.2 Method of measurement

The method of measurement corresponds to IEC 60244-5 and is shown in Figure 12.




*) for TV modulator measurements, remove TV modulator and connect video generator directly to the equipment to be tested

**) for TV demodulator measurements, remove TV demodulator and connect the equipment to be tested directly to the video demodulator

**Figure 12 – Measuring set-up for determining the group delay variation**



The complete measuring set-up (apart from the TV modulator and TV demodulator) is available as a commercial measuring instrument (dotted line).

The output signal from the video generator/AM modulator is a carrier, which is amplitude-modulated with a 20 kHz signal. Sync pulses are added to the signal and it is sent through the TV modulator to the equipment under test. After demodulation, the signal is passed to a phase detector where the phase shift of the test tone in relation to the modulation signal is measured.

The phase shift is expressed as group delay by means of the formula:

$$\tau_g = \frac{\Delta\varphi}{360° \times f_m} \quad (19)$$

where

$\Delta\varphi$ is the phase difference in degrees;

$f_m$ is the frequency of the test signal in Hertz;

$\tau_g$ is the group delay in seconds.

The TV modulator is set to the vision carrier of the TV channel. The measuring level shall be the nominal input level of the test item as prescribed by the manufacturer.

The TV demodulator is set to receive the selected TV channel. The frequency of the AM modulator is varied within the range 0,1 MHz to 4,43 MHz, and the measurement is repeated so that the group delay is expressed as a function of the frequency within the video band for the test item.

The group delay variation is determined by using the formula above, or is read directly on the commercial measuring instrument.

### 4.8.2 Procedure for the measurement of group delay variation on DVB channel converters

#### 4.8.2.1 Introduction

To measure the group delay time on DVB channel converters (for the conversion of QPSK, COFDM or QAM modulated signals), the split-frequency procedure (which has already proven itself as viable for measurements on conventional converters), presents itself as a solution.

#### 4.8.2.2 Principle

An RF carrier signal is amplitude-modulated on the transmitter side by a sine signal with the split frequency $f_S$ (see Figure 13). The object of the delay time measurement is the envelope which is created by amplitude modulation. The delay time of a specific point of the envelope (preferably the maximum of the envelope) running through the measured equipment will be registered. The phase of the split frequency on the reception side, regained by demodulation, is then compared with the reference phase of the split frequency on the transmitter side.

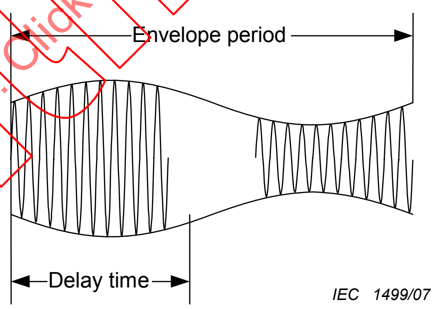



**Figure 13 –RF signal (time domain) amplitude-modulated with a split-frequency signal**

The spectral presentation of the measuring principle is shown in Figure 14.

The test signal, composed of the three spectral components of the carrier frequency $f_c$, the lower sideband $f_c - f_S$ and the upper sideband $f_c + f_S$ frequency, is swept through the examined transmission range.

The delay time between $f_c - f_S$ and $f_c + f_S$ is averaged. The aperture of the measuring set-up is $2f_S$.

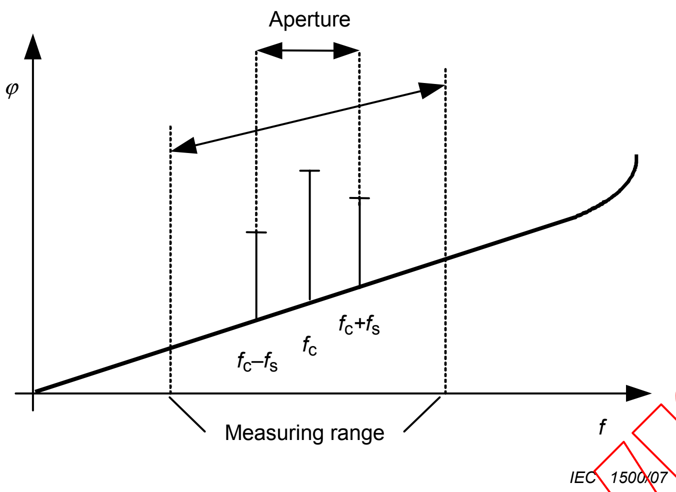



**Figure 14 – Spectral presentation of the group delay measurement**

The measurement of the group delay time corresponds to the measurement of the phase difference in the $2f_S$ range:

$$\tau_g = \left( \frac{\varphi_{fc+fs} - \varphi_{fc-fs}}{2f_s} \right) \quad (20)$$

Looked at from the mathematical point of view, this is the approximation for the differential quotient of the phase angle, relative to the time constituting the group delay time.

$$\tau_g = \frac{d\varphi}{df} \quad (21)$$

### 4.8.2.3 Description of the measuring set-up

Figure 15 shows a measuring set-up realised with scalar network analysers (suitable for measuring the frequency-dependant amplitude-frequency response) equipped with a group delay time option.

NOTE 1 Existing AGC or AFC of the EUT should be switched off during the measurements in order to avoid invalid measurement results.

NOTE 2 If the signals are noisy, auxiliary means such as video filters and specific averaging mode may be used.

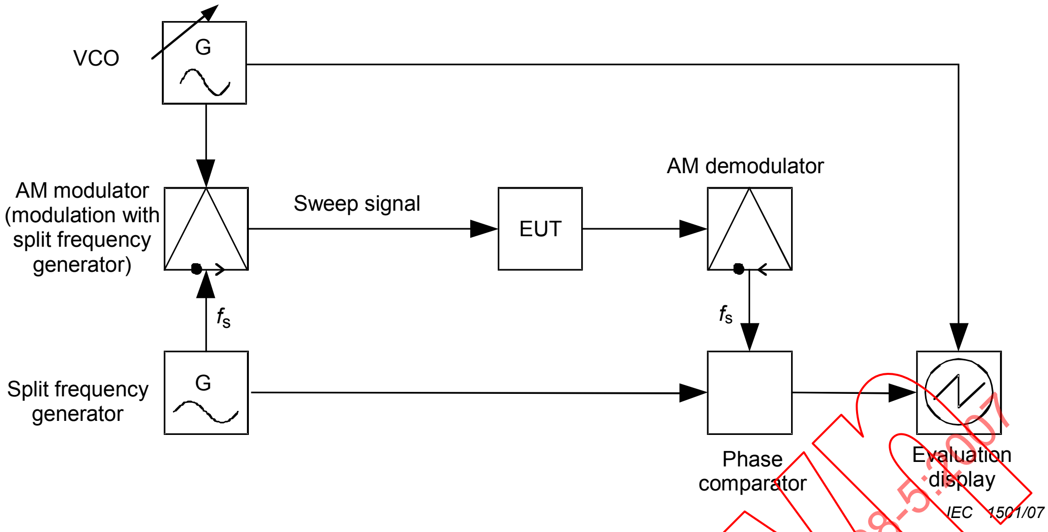



**Figure 15 – Description of the measuring set-up**

The amplitude modulation of the sweep signal from the VCO, generated by the LF signal coming from the split-frequency generator, is carried out in the AM modulator. The amplitude-modulated sweep signal is applied to the equipment under test. The output of the equipment under test is connected to the AM demodulator, where the LF signal of the split frequency is regained by demodulation of the envelope. The demodulated signal is then applied to the phase comparator where the phase difference in relation to the reference signal generated by the split-frequency generator is determined. The delay time difference – which is displayed – is then derived from the ascertained phase difference (see equation (20)).

### 4.8.2.4 Choice of the aperture

The chosen split frequency must permit an adequately high measurement resolution to be attained for a sufficiently small aperture (required for narrowband filters (Figure 16a) or for surface acoustic wave filters (Figure 16b) the group delay ripple of which is to be determined).

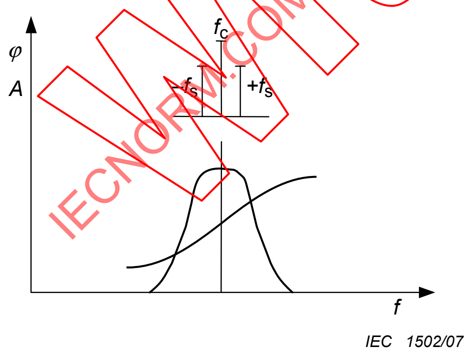



**Figure 16a – Narrow band filter**

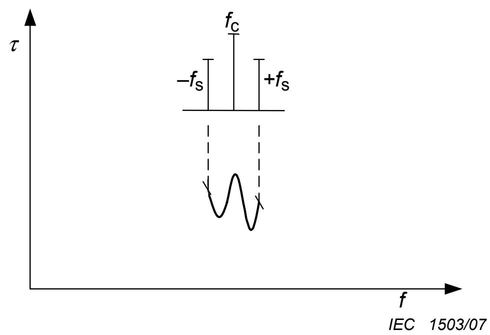



**Figure 16b – Surface acoustic wave filter: Group delay ripple measured with too high split frequency**

**Figure 16 – Choices of measuring aperture (value of the split frequency) for various measurement tests**

A split frequency of 20 kHz demands that, at the lower measuring limit of 1 ns, the measurements of a minimum phase angle of 0,01° shall be possible.

Split-frequency values between 10 kHz and 20 kHz proved in practice sufficiently correct for surveys of surface acoustic wave filters (group delay ripple).

It is also important that the envelope's oscillation period of $1/f_S$ shall always be bigger than the measured group delay time, in order to ensure that the registered maximum of the envelope can be uniquely defined after having passed through the measured equipment.

## 4.9 Phase noise of an RF carrier

### 4.9.1 Introduction

This measuring method is able to provide an indication of the phase noise of a carrier due to the phase or frequency fluctuations of an oscillator used in an equipment of the cable network (i.e., in a frequency converter).

For PSK, APSK or QAM modulation formats, using such an oscillator with digitally modulated signals, phase noise may result in a sampling uncertainty in the receiver, because the carrier regeneration cannot follow the phase fluctuations. Phase noise outside the loop bandwidth of the carrier recovery circuit leads to a circular smearing of the constellation points in the I/Q plane. This reduces the operating margin (noise margin) of the system and may directly increase the BER.

In an OFDM system the phase noise can cause CPE, which affects all carriers simultaneously and which can be corrected by using continual pilots, and ICI which is noise-like and that cannot be corrected.

The effects of CPE are similar to any single carrier system and the phase noise, outside the loop bandwidth of the carrier recovery circuit, leads to a circular smearing of the constellation points in the I/Q plane. This reduces the operating margin (noise margin) of the system and may directly increase the BER.

The effects of ICI are peculiar to OFDM and cannot be corrected for. This shall be taken into account as part of the total noise of the system.

The measurement is performed at the system outlet of a cable network, while an unmodulated carrier is applied at the input of the headend or at the input of the distribution network, depending on which part of the system is to be measured.

The headend can include modulation converters (from PSK, APSK to QAM format).

NOTE This measuring method should be performed under out-of-service conditions.



### 4.9.2 Equipment required

The following equipment is required:

a) an RF signal generator for the frequency bands of input signals at the headend or the distribution network;

NOTE The phase noise characteristic of the signal generator should be sufficiently lower (at least 10 dB) than that to be measured. If this is not known, a preliminary check should be performed.

b) a spectrum analyser able to tune the nominal frequency range of the system.

### 4.9.3 Connection of the equipment

The measuring set-up for the phase noise measurement is shown in Figure 17.

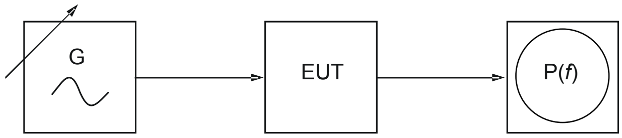



**Figure 17 – Test set-up for phase noise measurement**

The measuring equipment shall be connected taking care to maintain correct impedance matching and using suitable cables and connectors.

### 4.9.4 Measurement procedure

a) Set the carrier frequency of the RF signal generator to that of the channel where the measurement shall be performed;

b) Adjust the carrier level of the RF signal generator to obtain the same level at the system outlet as in normal operating conditions;

c) Tune the spectrum analyser on the same channel; Select the centre frequency of the spectrum analyser, the span and level settings to show the carrier and its sidebands due to the phase noise;

d) Set the *RSBW* of the spectrum analyser to 300 Hz and the video bandwidth to 30 Hz or 10 Hz;

e) Measure the unmodulated carrier level *C* in dB(mW);

f) Measure the level $PN_{(fm)}$ in dB(mW), of each component in one noise sideband and note its frequency $f_m$.

g) Convert the measured value of *PN* to one hertz bandwidth, using the following formula:

$$PN_{0(fm)} = PN_{(fm)} - 10\lg(RSBW) + K_{sa} \text{ dB} \quad (22)$$

where *RSBW* is the resolution bandwidth of the spectrum analyser.

NOTE 1 The correction factor $K_{sa}$ depends on the measuring equipment used and should be provided by the manufacturer of the measuring equipment or obtained by calibration.

NOTE 2 The value of the correction factor for a typical spectrum analyser is about 1,7 dB (see Annex I).

NOTE 3 The correction factor is not necessary if the measuring equipment can be set to display the noise level in dB(mW/Hz) units. In this case the $PN_{0(fm)}$ value is obtained directly.

h) Calculate the phase noise performance of the carrier, defined as the ratio of the measured power in one sideband component, on a per hertz bandwidth spectral density basis, to the total signal power:

$$\alpha_{(fm)} = PN_{0(fm)} - C \;\; [\text{dB(Hz}^{-1})] \quad (23)$$

NOTE For this measurement it is assumed that contributions from amplitude modulation to the noise spectrum are negligible compared to those from frequency modulation and that the *RSBW* is much smaller than $f_m$.

### 4.9.5 Presentation of the results

The measured phase noise $PN_0$, expressed in dB(Hz$^{-1}$), is plotted versus the frequency distance $f_m$ away from the carrier as indicated in Table 5.

**Table 5 – Frequency distances for phase noise measurement**

| Modulation format | $f_a$ | $f_b$ | $f_c$ | $f_d$ | $f_e$ |
|---|---|---|---|---|---|
| PSK, APSK and QAM | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 1 000 kHz |
| OFDM (2 k and 8 k systems) | 1 kHz | 10 kHz | 100 kHz | 1 000 kHz | - |

Examples of measurement results are given in Figure 18.

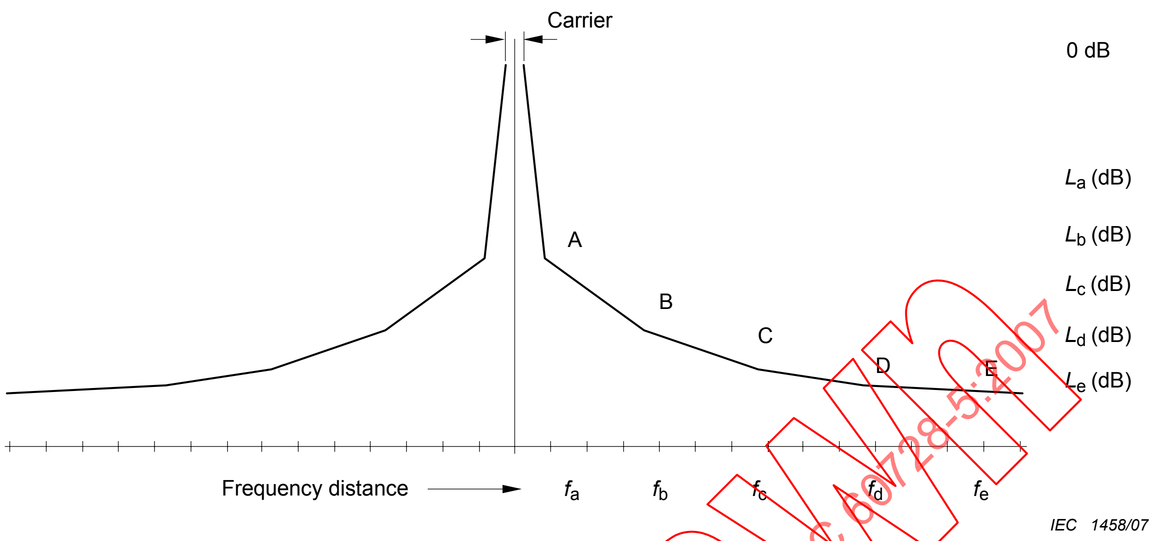



**Figure 18a – PSK, APSK and QAM formats**

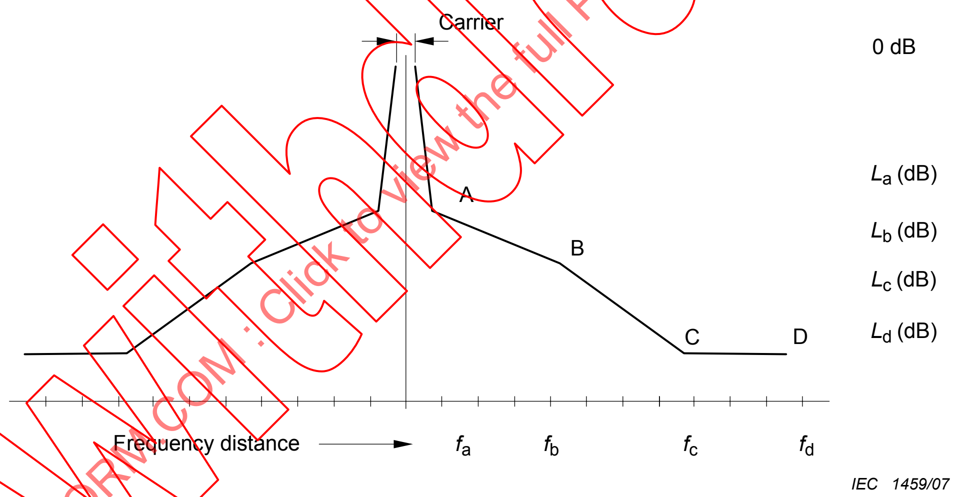



**Figure 18b – OFDM format**

**Figure 18 – Mask for phase noise measurements**

## 4.10 Hum modulation of carrier

### 4.10.1 Definition

The interference ratio for hum modulation is the ratio stated in dB between the peak-to-peak value of the unmodulated carrier and the peak-to-peak value of one of the two envelopes caused by the hum modulated to this carrier.

NOTE This method is not applicable for modulators and demodulators.

The hum modulation ratio (carrier/hum ratio) is shown in Figure 19.

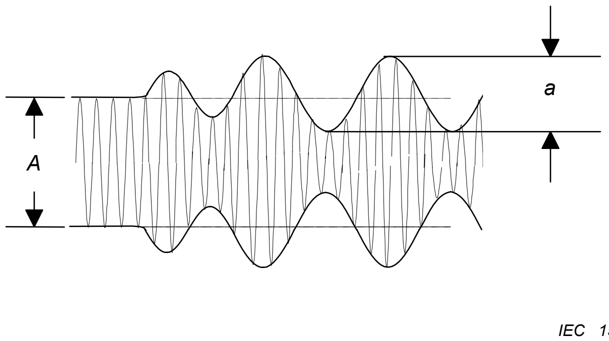



**Figure 19 – Carrier/hum ratio**

$$Carrier/hum\ ratio = 20 \cdot \lg \frac{A}{a} \ [\text{dB}] \quad (24)$$

### 4.10.2 Description of the method of measurement

#### 4.10.2.1 General

This measurement method is valid for radio and TV signal equipment within a cable network that is supplied with alternating current, 50 Hz.

The measurement shall be made over the specified supply voltage and power range.

To measure the equipment under test oscilloscope method is used.

#### 4.10.2.2 Test equipment required:

- Variable load resistor
- Adjustable voltage source
- Variable attenuator
- Oscilloscope
- Voltmeter (RMS)
- Amperemeter
- Tunable RF signal generator with sufficient phase noise and hum modulation ratio, including AM capability (400 Hz)
- Detector including (battery powered) LF-amplifier and 1 kHz LP-filter in the output, to suppress low frequency distortion (A HP-filter at the input shall be used)

#### 4.10.2.3 Connection of Test Equipment

The connection is shown in Figures 20 and 21.

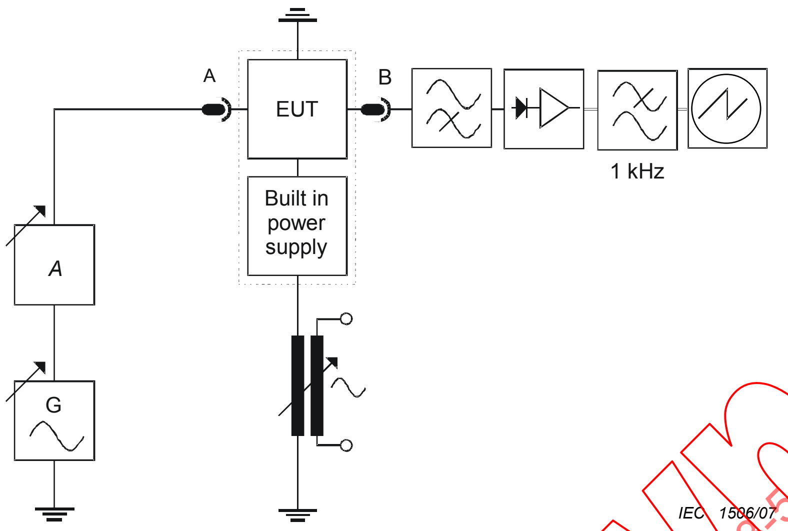



**Figure 20 – Test set-up for equipment with built-in power supply**

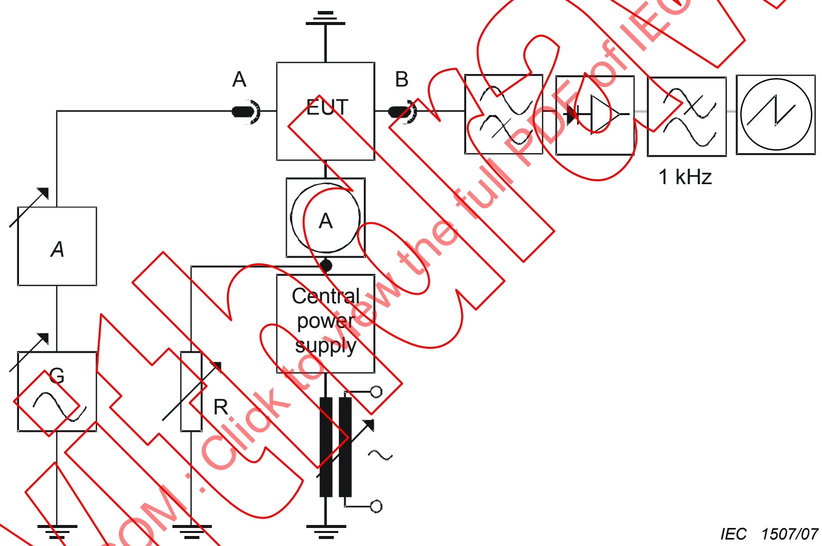



**Figure 21 – Test set-up for equipment with external power supply**



### 4.10.3 Measuring Procedure

#### 4.10.3.1 Set-up of calibration

The reference signal is generated by means of the RF signal generator shown in Figure 20 and Figure 21. Select an RF carrier frequency that suits the TV channel under consideration and modulate it to a depth of 1% at a frequency of 400 Hz. Adjust the RF signal generator to an appropriate level and read the peak-to-peak value of the demodulated AM signal ("*c*" in Figure 22) on the oscilloscope. This is the reference signal. With 1 % modulation this value is -20 log (0,01) = 40 dB. The modulation of the signal generator has to be switched off. The remaining value "*m*" in Figure 22 is the value to be measured.

Check the suitability of the measuring set-up by connecting points A and B together and measuring the set-up's inherent hum. The calculation of the Hum Modulation Ratio is given in 4.10.4. This value should be at least 10 dB better than the values to be measured on items of equipment. The subsequent measurements shall be carried out in suitable increments through the entire operating frequency range. The measured value is independent from the RF level, however, the RF level should be at least the magnitude of the operating level of the equipment under test.

#### 4.10.3.2 Equipment with built-in power supply

Adjust the equipment under test to the whole range of the operating voltage using the transformer. The supply current depends on the power requirement of the equipment under test.

Modulate the signal generator with the reference signal and adjust the level at point B by means of an attenuator such that neither the measured equipment is overdriven nor the detector is within a non-admissible operating range. Note down the peak-to-peak amplitude "*c*" of the demodulated reference signal, which is displayed on the oscilloscope. Then switch off the reference signal and measure the peak-to-peak value "*m*" of the remaining signal.

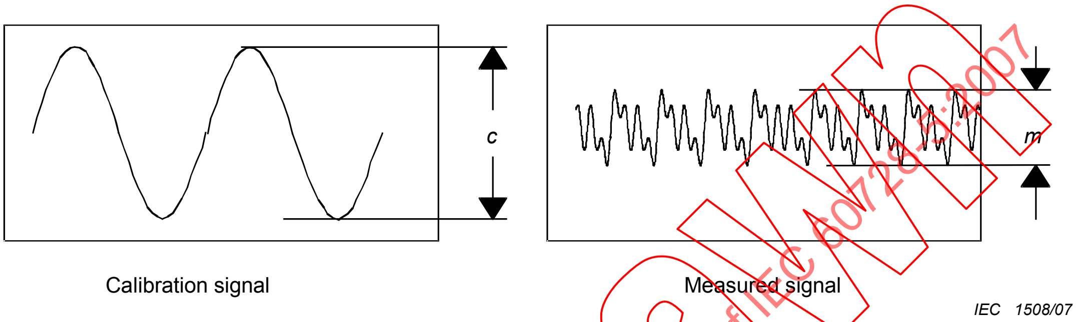



**Figure 22 – Oscilloscope display**

#### 4.10.3.3 Equipment with external power supply

Adjust the equipment under test to the whole range of the operating voltage using the transformer. The supply current depends on the power requirement of the equipment under test. In addition, for the equipment with external power supply adjust the maximum admissible peak current of the power supply using the external resistor.

Modulate the signal generator with the reference signal and adjust the level at point B by means of an attenuator in such a way that neither the measured equipment is overdriven nor the detector is within a non-admissible operating range. Note down the peak-to-peak amplitude "*c*" of the demodulated reference signal, which is displayed on the oscilloscope according to Figure 22. Then switch off the reference signal and measure the peak-to-peak value "*m*" of the remaining signal.

### 4.10.4 Calculating the hum modulation ratio

The considered frequency range is from 50 Hz to 1 kHz.

#### 4.10.4.1 Individual equipment under test

$$\textit{Hum modulation ratio}_{\,[\mathrm{EUT}]} = 40 + 20\ lg\left(\frac{c}{m}\right)\ [\mathrm{dB}] \qquad (25)$$

for 1 % reference modulation depth

For other chosen reference modulation depths, the value 40 dB has to be replaced by the result of the term: −20 lg (modulation depth).

#### 4.10.4.2 Loop Value Correction

In case a set-up calibration correction is required use the following formula:

$$\textit{Hum modulation ratio}_{[EUT]} = -20 \lg \left(10^{-\frac{\textit{measured value}}{20}} - 10^{-\frac{\textit{calibration correction}}{20}}\right) [\text{dB}] \qquad (26)$$

## 4.11 2T-pulse response, *K*-factor

The main purpose of the measurement is the evaluation of the luminance transmission behaviour in the lower and middle video frequency range.

A test waveform generator should be used to provide a sine-squared pulse of half amplitude duration equal to 2*T*, where *T* is the periodic time appropriate to the TV system under consideration. For 625-line systems, *T* = 100 ns. The test signals are in accordance with ITU-T Recommendation J.61 (signal B1).

Synchronous demodulation should be used.

Figure 23 shows the *K*-factor mask, which shall be achieved for Quality Grade 2 equipment or systems.

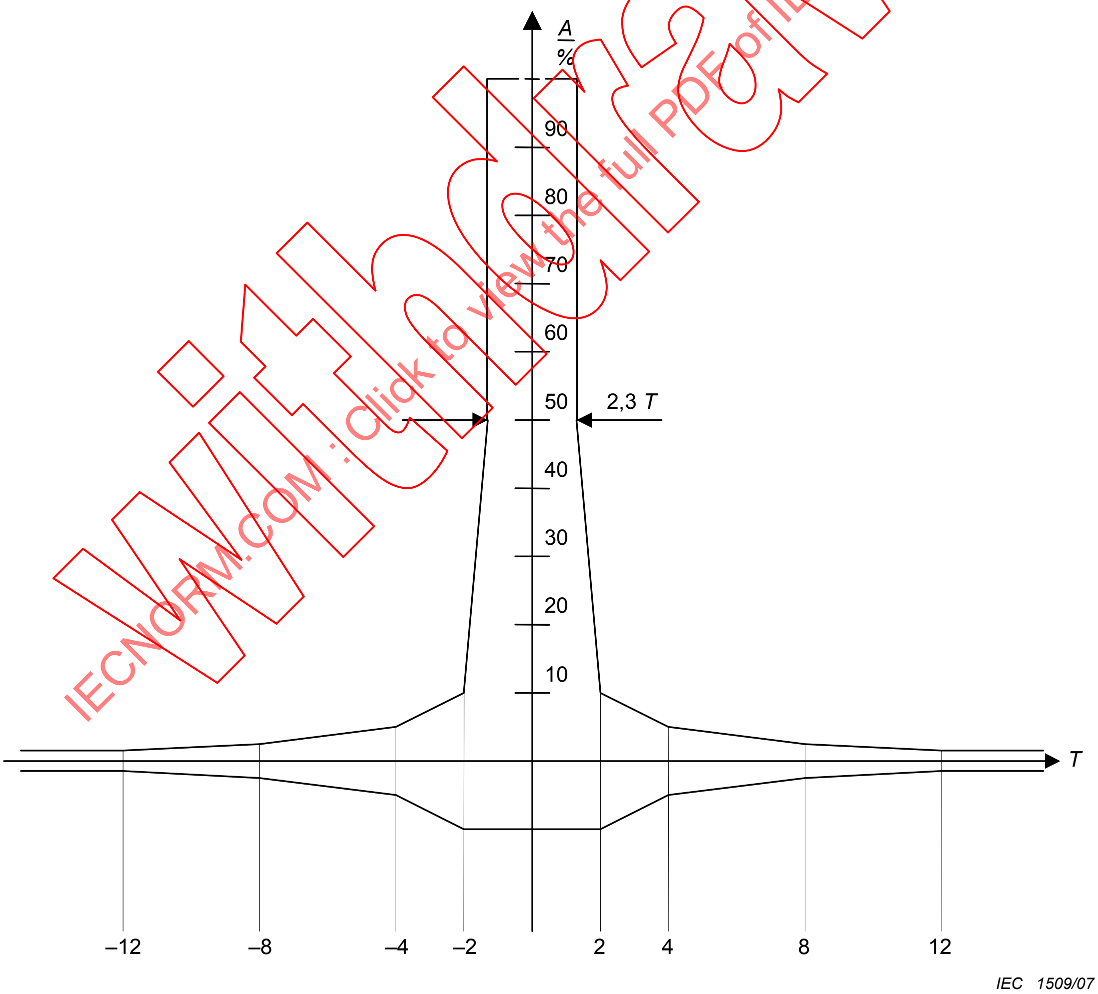


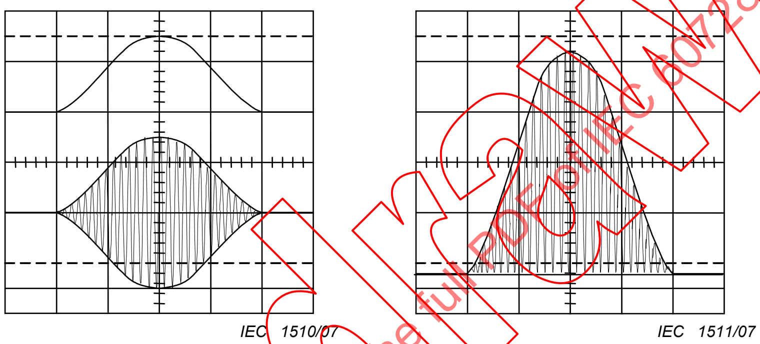

**Figure 23 – *K*-factor mask for Quality Grade 2**

### 4.12 Chrominance-luminance delay inequalities (20T-pulse method)

The 20T-pulse has a half-amplitude duration of 2 µs. It develops from a chrominance sub-carrier which is first modulated with a $\sin^2$ signal and then superimposed with the same signal as used for modulation (Figure 24). It has two spectrum ranges of the same bandwidth and the same amplitude in the luminance and chrominance ranges. Due to its pulse spectrum the 20T-pulse is particularly suitable for testing colour TV systems. Its baseline distortion is used to detect amplitude and delay time errors in the chrominance sub-carrier range. Amplitude-only errors cause a symmetric baseline distortion and a variation of the pulse amplitude. Delay-time-only errors cause an asymmetric baseline distortion and no variations of the pulse amplitude.

Only synchronous demodulation should be used.

Figure 25 gives the pulse deformation caused by amplitude and delay time errors as well as how to determine the magnitude of the errors.




a) Luminance frequency portion and chrominance subcarrier pulse

b) 20T-pulse (ITU-T Rec. J.61 – Signal F)

**Figure 24 – Generation of 20T-pulse**

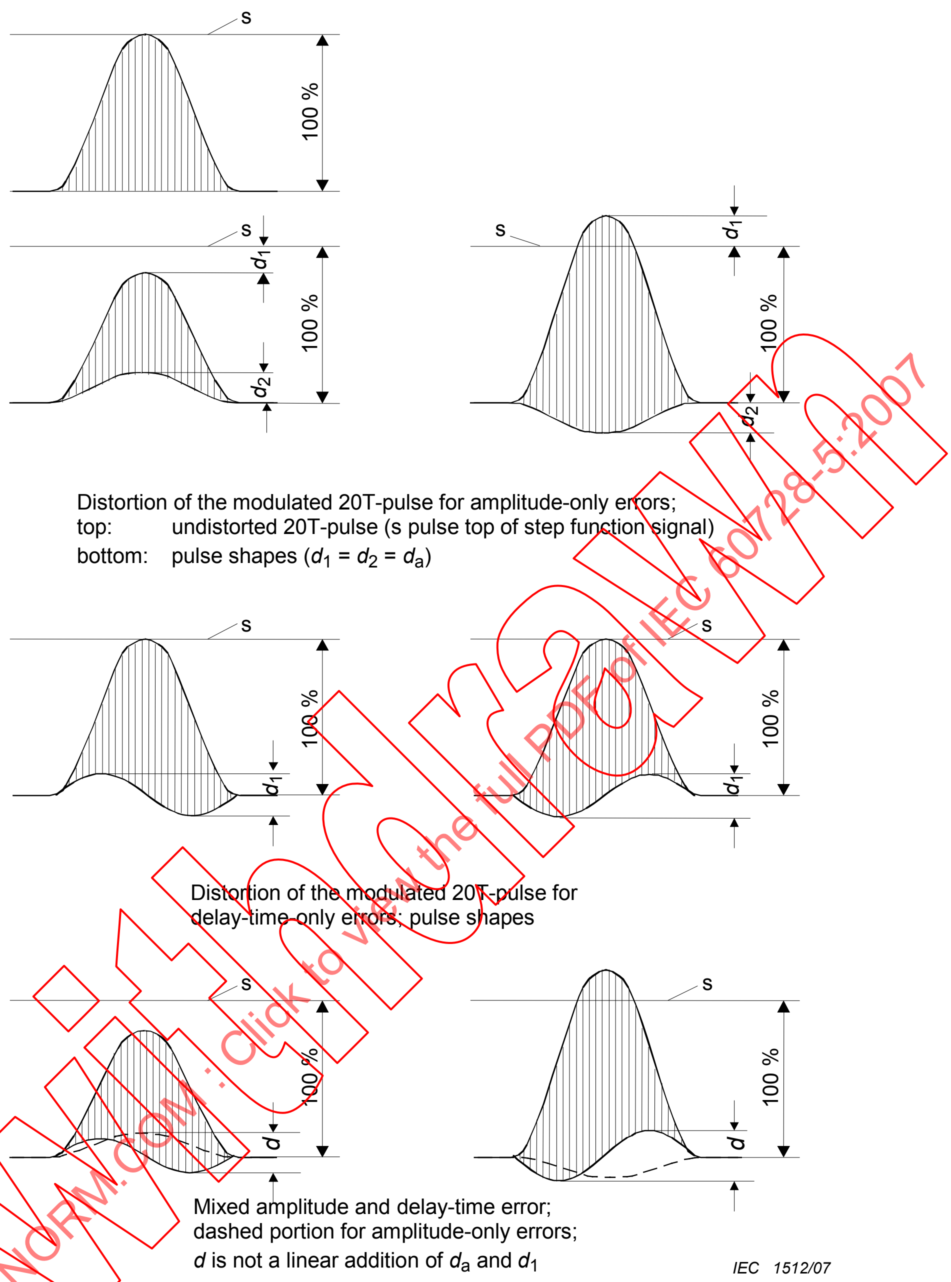





**Figure 25 – Example of amplitude and delay error using 20T-pulse**

## 4.13 Luminance non-linearity

Luminance non-linearity ($LUM_{NL}$) describes the changing gain for different output levels. It is defined by the linearity figure (minimum-to-maximum slope of the output characteristic).

To determine it, the staircase signal shall be used (Figure 26). The different step heights in the output signal – originally of equal height in the input signal – form the figure for the static linearity. In order to measure the output signal, it is differentiated. Each step transition generates a voltage peak, which is proportional to the relevant step height (Figure 26).

$$LUM_{NL} = \frac{A_{min}}{A_{max}} \qquad (27)$$

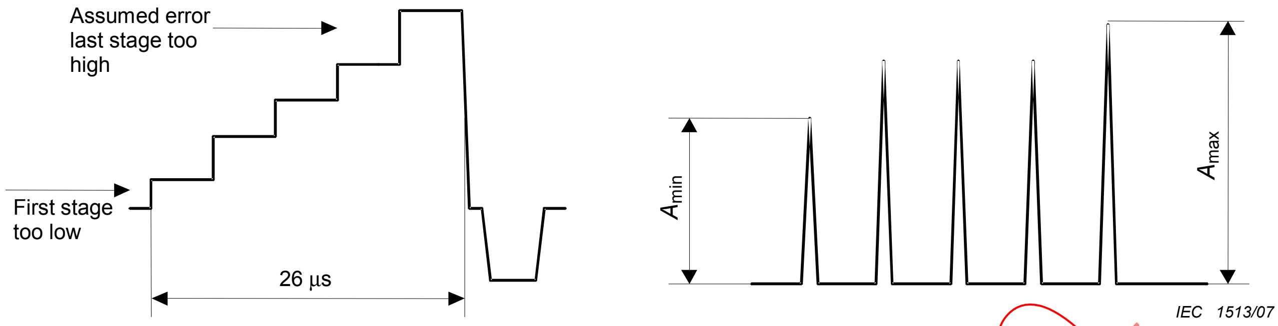



**Figure 26 – Staircase signal for measurement of luminance non-linearity before and after differentiation**



## 4.14 Intermodulation distortion (FM stereo radio)

### 4.14.1 Introduction

In case wanted audio signals are inserted into a stereo transmission system, additional noise occurs besides the harmonics due to the addition and subtraction of the audio signal of the non-linearity and the pilot. The intermodulation products $f_p + f_1$, $f_p - f_1$, $2f_p + f_1$, $2f_1 - f_p$ take effect on the multiplex band or directly on the base band (Figure 27). The required transmission quality is obtained by a defined minimum spacing between noise signals and useful signals.

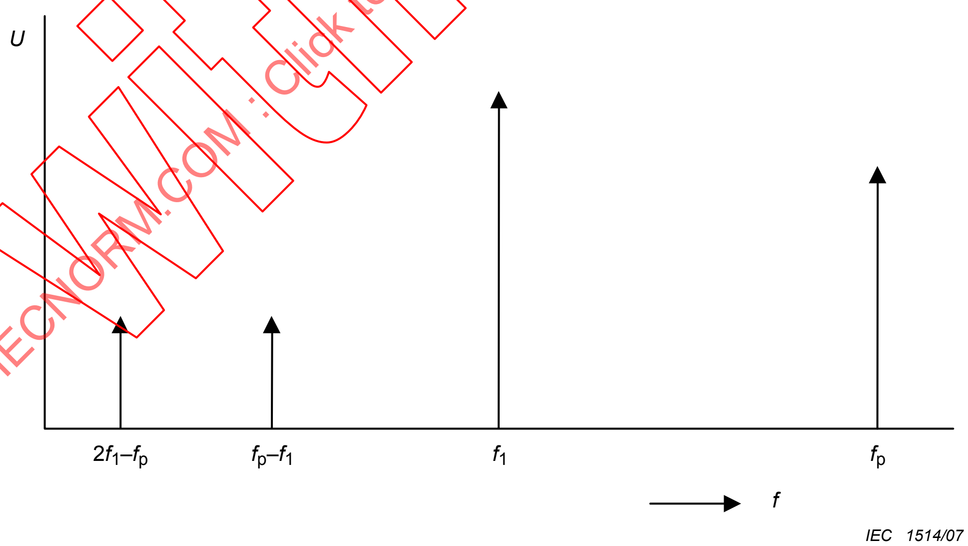



**Figure 27 – Example of a possible frequency combination displayed on a spectrum analyser**

### 4.14.2 Equipment required

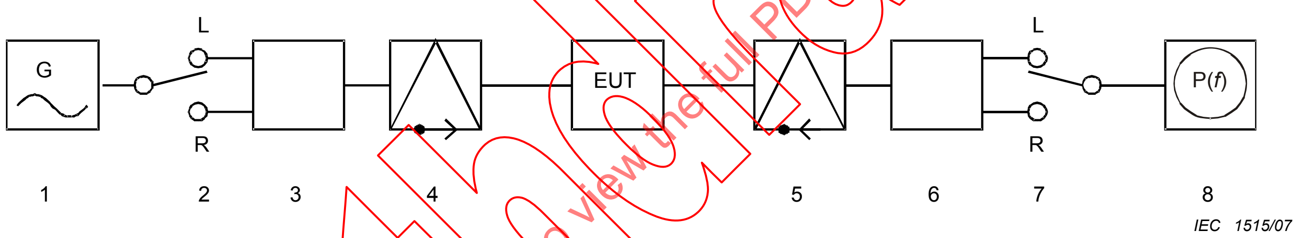
| Item (Figure 28) | Quantity | Designation |
|---|---|---|
| 1 | 1 | Audio signal generator 40 Hz to 15 kHz |
| 8 | 1 | Audio spectrum analyser |
| 2, 7 | 1 | Audio switch |

Additionally required depending on equipment under test:

| Item (Figure 28) | Quantity | Designation |
|---|---|---|
| 3 | 1 | Stereo coder |
| 4 | 1 | FM modulator |
| 5 | 1 | FM demodulator |
| 6 | 1 | Stereo decoder |

### 4.14.3 Connection of equipment

The equipment shall be connected as shown in Figure 28.




NOTE Depending on the application, components 3, 4, 5 and 6 can be the equipment under test.

**Figure 28 – Arrangement of test equipment for intermodulation distortion**

### 4.14.4 Measurement

The two stereo channels shall be measured separately. The test value, which is compared to the minimum value, is the worst signal-to-noise ratio determined during all measurements.

Switch 2 shall be set to position L = left. The reference level is determined to be 400 Hz. Now, with the pilot audio signal switched off, the level of an audio signal generator is adjusted in such a way that a frequency deviation of 40 kHz results for stereo transmission equipment. Then, the pilot audio signal is switched on. The reference point of the spectrum analyser shall be adjusted to the 400 Hz signal level.

Any audio frequency between 40 Hz and 15 kHz shall not fall below the admissible minimum spacing.

Switch 2 shall be set to position R = right. The same adjustment procedure shall also be performed for this transmission channel.

### 4.15 Decoding margin (Teletext)

#### 4.15.1 Definition

The decoding margin of a text TV signal is defined in ITU-T Recommendation J.101.

The voltage difference is expressed in per cent in relation to 66 % of the ITS bar.

The text TV generator delivers a text TV signal which is inserted in given TV lines.

In the ITS inserter an 'ITS line 19' test signal is added (test signal 17 according to ITU-T Recommendation J.61). The resulting signal is fed to an VSB IF modulator. In the up-converter the IF signal is converted to the relevant TV channel. The output signal from the equipment under test is connected to a synchronous demodulator, and the demodulated signal is fed to a decoding margin meter. The measurement levels are adjusted as follows:

| | |
|---|---|
| Output of ITS inserter: | Nominal video, 1 $V_{pp}$ |
| Output of RF modulator: | Recommended input level of test item |

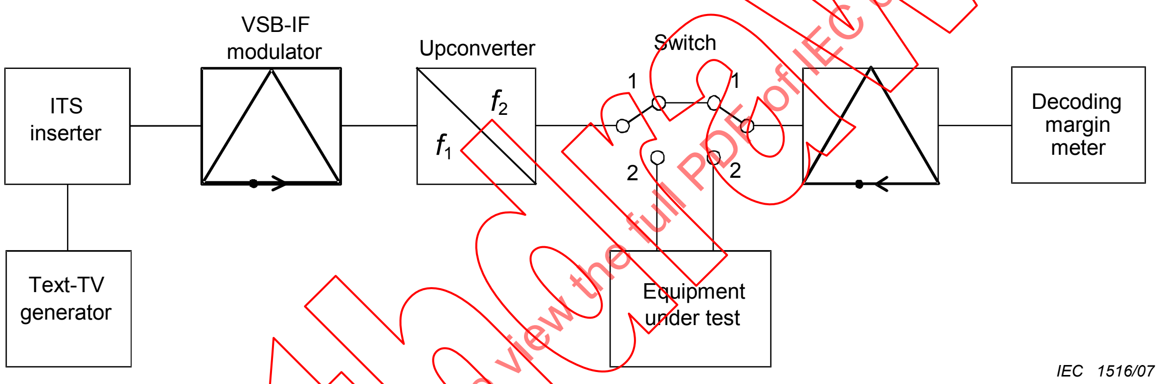



**Figure 29 – Principal measuring set-up for determination of decoding margin**



#### 4.15.2 Method of measurement and measuring set-up (Figure 29)

First a reference measurement is performed without the test item (switches in position 1) and the decoding margin is determined *DM1*. For TV channel converters the reference measurement is performed at the input and output frequencies of the converter. The resulting reference decoding margin (*DM1*) is the average of the two measurements.

The test equipment is inserted in the measuring set-up and after adjustment of frequencies and levels the resulting decoding margin *DM2* is read.

The deterioration of the decoding margin will then be: (*DM1* – *DM2*)/*DM1*.

*DM2* expresses the quality of the data channel.

#### 4.15.3 Applicability of measuring set-up

The decoding margin measured at the reference measurement *DM1* shall be as high as possible.

# 5 Performance requirements and recommendations

## 5.1 Safety

The safety requirements of all equipment shall conform to IEC 60728-11, where applicable.

## 5.2 Electromagnetic compatibility

The relevant EMC requirements as laid down in IEC 60728-2 shall be met.

## 5.3 Environmental

Manufacturers shall publish relevant environmental information on their products in accordance with the requirements of the publications listed in Table 6. This will enable users to judge their suitability with regards to four main requirements: storage, transportation, installation and operation.

**Table 6 – Publications for environmental requirements of headend equipment**

| Environmental requirements | Standards containing requirements |
|---|---|
| **Storage** | |
| (simulated effects of) | IEC 60068-2-48 |
| | |
| **Transportation** | |
| Air freight (combined cold and low pressure) | IEC 60068-2-40 |
| Road transport (bump test) | IEC 60068-2-29 |
| Road transport (shock test) | IEC 60068-2-27 |
| | |
| **Installation or maintenance** | |
| Topple or drop test | IEC 60068-2-31 |
| Free fall test | IEC 60068-2-32 |
| | |
| **Operation** | |
| IP Class protection provided by enclosures | IEC 60529 |
| Cold | IEC 60068-2-1 |
| Dry heat | IEC 60068-2-2 |
| Damp heat | IEC 60068-2-30 |
| Change of temperature (test Nb) | IEC 60068-2-14 |
| Climatic category of component or equipment | for storage and operation as defined in Appendix A of IEC 60068-1 |
| Microphony | Under normal conditions (Ventilation, opening of doors in racks, etc) mechanical vibrations shall not influence the quality of the signals.<br>Under heavy influence from the environment where disturbance could occur, normal operation should be re-established within a few seconds. |



### 5.4 Marking

#### 5.4.1 Marking of equipment

Each equipment shall be legibly and durably marked with manufacturers name and type number.

#### 5.4.2 Marking of ports

It is recommended that symbols in accordance with IEC 60417 and IEC 60617 database should be used when marking ports.

## 6 Equipment characteristics required to be met

### 6.1 General

The specifications given in Clause 6 represent limits which shall be met over the specified frequency range of the respective equipment. The manufacturer may publish these specifications in his data sheets.

NOTE For special national conditions, see Annex D.

### 6.2 Power supply voltage

The power supply voltage shall be 230 V ± 10 %, 50 Hz or 110 V ± 10 %, 60 Hz.

### 6.3 RF signal requirements

#### 6.3.1 Impedance (input)

The nominal input impedance shall be 75 Ω.

NOTE There is also headend equipment with 50 Ω available.

#### 6.3.2 Impedance (output)

The nominal output impedance shall be 75 Ω.

NOTE There is also headend equipment with 50 Ω available.

#### 6.3.3 Return loss (input, output) of equipment

**Table 7 – Return loss (input, output) of equipment**

| Frequency range | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| 5 MHz to 10 MHz | Shall be published | Shall be published | Shall be published |
| 10 MHz to 47 MHz | ≥ 18 dB | ≥ 14 dB | ≥ 10 dB |
| 47 MHz to 950 MHz | ≥ (18 dB – 1,5 dB/octave) but ≥ 10 dB | ≥ (14 dB – 1,5 dB/octave) but ≥ 10 dB | ≥ 10 dB |
| 950 MHz to 3 000 MHz | ≥ 10 dB | ≥ 6 dB (for input) ≥ 10 dB decreasing linearly to 6 dB (for output) | ≥ 6 dB (for input) ≥ 10 dB decreasing linearly to 6 dB (for output) |
| NOTE See Annex A for definition of the specified test frequency range. | | | |

#### 6.3.4 Return loss (output) of headend

**Table 8 – Return loss (output) of headend**

| Frequency range | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| 5 MHz to 10 MHz | Shall be published | Shall be published | Shall be published |
| 10 MHz to 47 MHz | ≥ 18 dB | ≥ 14 dB | ≥ 10 dB |
| 47 MHz to 950 MHz | ≥ (18 dB – 1,5 dB/octave) but ≥ 10 dB | ≥ (14 dB – 1,5 dB/octave) but ≥ 10 dB | ≥ 10 dB |
| 950 MHz to 3 000 MHz | 10 dB decreasing linearly to 6 dB | 10 dB decreasing linearly to 6 dB | 10 dB decreasing linearly to 6 dB |

### 6.3.5 Typical back off for digital against analogue signals

**Table 9 – Typical levels of digital signals with respect to analogue signals (back off)**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| COFDM | −16 dB | | |
| QPSK (DVB-S/-S2) | −16 dB | | |
| 8PSK (DVB-S2) | −16 dB | | |
| 16 QAM<br>64 QAM<br>256 QAM | −16 dB<br>−10 dB<br>−4 dB … −6 dB | | |

### 6.3.6 Immunity against other signals in the FM radio and TV range

For immunity against other signals in the FM radio and TV range, see IEC 60728-2.

### 6.3.7 Carrier-to-spurious-signals ratio at output in the frequency range of 40 MHz to 862 MHz

#### 6.3.7.1 Carrier-to-spurious-signals ratio of an analogue TV channel

The carrier-to-spurious-signals ratio of an analogue TV channel at the output and in the frequency range of 40 MHz to 862 MHz shall be ≥60 dB.

The measurement method and notes for adjacent channel operation and exception are described in 4.5.

#### 6.3.7.2 Carrier-to-spurious-signals ratio of digital modulated channel with respect to the peak level of an analogue TV carrier

**Table 10 – Carrier-to-spurious-signals ratio of digital modulated channel with respect to the peak level of an analogue TV carrier**

| Modulation scheme | Sine wave spurious | Other spurious |
|---|---|---|
| 16 QAM | ≥60 dB | ≥57 dB |
| 64 QAM | ≥60 dB | ≥57 dB |
| 256 QAM | ≥60 dB | ≥57 dB |
| QPSK (DVB-S/-S2) | ≥60 dB | ≥57 dB |
| 8 PSK (DVB-S2) | ≥60 dB | ≥57 dB |
| COFDM | ≥60 dB | ≥57 dB |
| NOTE For other spurious signals, the resolution bandwidth should be 1 MHz. | | |

### 6.3.8 Image rejection for AM TV and FM radio

See IEC 60728-2.

### 6.3.9 Carrier to local oscillator signal ratio at the output for AM TV and FM radio

The carrier to local oscillator signal ratio at the output for AM TV and FM radio shall be ≥ 60 dB.

NOTE Measured at the minimum output level.

### 6.3.10 Frequency stability

#### 6.3.10.1 Definition

The signal frequency stability is defined as the maximum deviation to the nominal signal frequency.

#### 6.3.10.2 Frequency stability for FM radio related to the nominal FM radio frequency

The frequency stability for FM radio measured as deviation to the nominal FM radio frequency shall be ≤12 kHz.

#### 6.3.10.3 Frequency stability for AM TV related to the nominal AM TV frequency

**Table 11 – Frequency stability for AM TV related to the nominal AM TV frequency**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| AM TV without data | | ±75 kHz | |
| AM TV with data | | ±30 kHz | |

#### 6.3.10.4 Long-term frequency stability for digital modulated signals

**Table 12 – Long-term frequency stability for digital modulated signals**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| COFDM | | ±30 kHz | |
| QPSK | | ±200 kHz | |
| 8PSK (DVB-S2) | | ±200 kHz | |
| 16 QAM | | ±100 kHz | |
| 64 QAM | | ±100 kHz | |
| 256 QAM | | ±100 kHz | |

NOTE 1 The figure for QPSK is valid for signal conversion in the headend only; for the outdoor unit, see ETSI ETS 300 158 or ETSI ETS 300 249.

NOTE 2 ± 30 kHz for DOCSIS signals.

For COFDM, QPSK and 8PSK the values in Table 12 are related to frequency converters.

### 6.3.10.5 Shoulder attenuation for digital modulated signals

**Table 13 – Shoulder attenuation for digital modulated signals**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| 16 QAM | 37 dB | 34 dB | 31 dB |
| 64 QAM | 43 dB | 40 dB | 37 dB |
| 256 QAM | 49 dB | 46 dB | 43dB |

For the method of measurement, see 4.5.3.

### 6.3.11 Phase noise of digital modulated signals at the output of the headend

For any RF carrier of a digitally modulated signal (PSK or QAM) at the output of the headend, the phase noise shall be lower than the values $L_a$, $L_b$, $L_c$, $L_d$, $L_e$ given in Table 14 at the frequency distances $f_a$, $f_b$, $f_c$, $f_d$, $f_e$ from the carrier (see also Figure 18a).

**Table 14 – Phase noise of a DVB signal (PSK and QAM)**

| **Signal modulation** | **Frequency distance** | **Phase noise $L_i$** dB(Hz$^{-1}$) | | | | |
|---|---|---|---|---|---|---|
| | $f_a$, $f_b$, $f_c$, $f_d$ ,$f_e$ → | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 1 000 kHz |
| | Symbol rate ↓ | $L_a$ | $L_b$ | $L_c$ | $L_d$ | $L_e$ |
| QPSK (DVB-S) | > 5 Msymbol/s | -40 | -55 | -75 | -80 | -100 |
| QPSK (DVB-S2) | > 5 Msymbol/s | -40 | -55 | -75 | -80 | -100 |
| 8 PSK (DVB-S2) | | -40 | -55 | -75 | -80 | -100 |
| 16 QAM | > 3,5 Msymbol/s | | -32 | -74 | -94 | -104 |
| | 1,7/3,5 Msymbol/s | | -41 | -80 | -100 | -104 |
| 64 QAM | > 3,5 Msymbol/s | | -38 | -80 | -100 | -110 |
| | 1,7/3,5 Msymbol/s | | -47 | -86 | -106 | -110 |
| 256 QAM | > 3,5 Msymbol/s | | -44 | -86 | -106 | -116 |
| | 1,7/3,5 Msymbol/s | | -53 | -92 | -112 | -116 |

For a digitally modulated signal in the OFDM format, the phase noise can cause CPE, which affects all the carriers simultaneously, and ICI.

For any RF carrier of a DVB signal modulated in the OFDM format, measured with the method of measurement given in 4.9, the value of phase noise shall be lower than the values $L_a$, $L_b$, $L_c$, $L_d$ given in Table 15 at the frequency distances $f_a$, $f_b$, $f_c$, $f_d$ from the carrier (see also Figure 18b).

**Table 15 – Phase noise of a DVB signal (OFDM)**

| **Signal modulation** | **Frequency distance** | **Phase noise $L_i$** dB(Hz$^{-1}$) | | | |
|---|---|---|---|---|---|
| COFDM<br>2 k and 8 k | $f_a$, $f_b$, $f_c$, $f_d$ → | 1 kHz | 10 kHz | 100 kHz | 1 000 kHz |
| | | $L_a$ | $L_b$ | $L_c$ | $L_d$ |
| | | -75 | -85 | -110 | -110 |

### 6.3.12 In-channel group delay variation for digital modulated signals

**Table 16 – In-channel group delay variation for digital modulated signals**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| COFDM | NA | NA | 100 ns |
| QPSK (DVB-S/-S2) | NA | NA | 100 ns |
| 8 PSK (DVB-S2) | NA | NA | 100 ns |
| 16 QAM | 20 ns | 60 ns | 100 ns |
| 64 QAM | 20 ns | 60 ns | 100 ns |
| 256 QAM | 20 ns | 60 ns | 100 ns |

For method of measurement, see 4.8.2.

### 6.3.13 In-channel peak-to-peak amplitude response variation for digitally modulated signals

The value of in-channel peak-to-peak amplitude response variation in the pass-band up to 0,85 $f_N$ shall be lower than the figures given in Table 17.

NOTE $f_N$ is the Nyquist frequency.

**Table 17 – In-channel peak-to-peak amplitude response variation of DVB signals**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| COFDM | NA | NA | 6 dB |
| QPSK (DVB-S/-S2) | NA | NA | 6 dB |
| 8 PSK (DVB-S2) | NA | NA | 6 dB |
| 16 QAM | 1 dB | 2 dB | 3 dB |
| 64 QAM | 1 dB | 2 dB | 3 dB |
| 256 QAM | 1 dB | 2 dB | 3 dB |

### 6.3.14 Stability of sound intercarrier

**Table 18 – Stability of sound intercarrier**

<table>
<tr><th></th><th>Grade 1</th><th>Grade 2</th><th>Grade 3</th><th>NOTE</th></tr>
<tr><td>Mono or unmodulated carrier</td><td>±5 kHz</td><td colspan="2">±15 kHz</td><td></td></tr>
<tr><td>Stereo or dual sound</td><td colspan="2">The difference between sound sub-carriers shall be maintained (precision half-line offset)</td><td>±1 kHz</td><td></td></tr>
<tr><td>NICAM 728, Standard I<br>NICAM 728, Standard B/G</td><td>6 552 kHz<br>5 850 kHz</td><td colspan="2">$\pm 1 \times 10^{-6}$ above the vision carrier</td><td>For NICAM, see ETSI ETS 300 163</td></tr>
</table>

### 6.3.15 Stability of residual carrier amplitude

**Table 19 – Stability of residual carrier amplitude**

| | Grade 1 | Grade 2 | Grade 3 | NOTE |
|---|---|---|---|---|
| Standard B/G/D/D1/K | $10\ \%\ ^{+2,5\ \%}_{-0\ \%}$ | $10\ \%\ ^{+10\ \%}_{-0\ \%}$ | | Measured with black-to-white amplitude and nominal video level |
| Standard I | 20 % ± 2 % | 20 % ± 5 % | | |

### 6.3.16 Frequency stability – SAT IF/IF converter

**Table 20 – Frequency stability – SAT IF/IF converter**

| Frequency range | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| 0,95 GHz to 2,150 GHz | ± 500 kHz | | |

### 6.3.17 Typical modulation error ratio (MER) for a QAM signal

The modulation error ratio MER is defined in 3.1.24. The measurement of MER is a fast and simple method that can provide an indication of the quality of the digital service at the cable headend output interface. This measurement will provide a first indication of the margin to failure of the digital service. It can be used as a signal quality check during headend installation, and as a maintenance tool for basic monitoring of signal quality through the cable TV network.

**Table 21 – Minimum requirements for MER for different QAM modulation schemes**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| 16 QAM | 33 dB | 31 dB | 28 dB |
| 64 QAM | 39 dB | 37 dB | 34 dB |
| 256 QAM | 40 dB | 38 dB | 35 dB |

The measurement shall be performed as described in IEC 60728-1. For the measurement the use of an equaliser is assumed.

### 6.3.18 Minimum *C/N* values at the output of the headend

This parameter is specified for terrestrial COFDM converters and satellite QPSK IF/IF converters.

**Table 22 – *C/N* values for converters at the headend output**

| Modulation scheme | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| COFDM | NA | NA | Values specified in ETSI EN 300 744 +6 dB |
| QPSK (DVB-S) | NA | NA | 12,3 dB |
| QPSK (DVB-S2) | NA | NA | 11,4 dB |
| 8 PSK (DVB-S2) | NA | NA | 16 dB |

The values in Table 22 are related to the code rates 7/8 (DVB-S) and 9/10 (DVB-S2).

## 6.4 Composite video signal requirements

### 6.4.1 Impedance

The nominal input impedance shall be 75 Ω.

NOTE Due to its higher mechanical stability, a 50 Ω BNC connector (IEC 60169-8) is recommended also for an impedance of 75 Ω in the video frequency range.

### 6.4.2 Return loss

**Table 23 – Return loss**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| ≥34 dB | ≥26 dB | |
| NOTE Values in nominal transmission range | | |

### 6.4.3 Signal voltage

**Table 24 – Signal voltage**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| (1 ± 0,1) $V_{pp}$ | | (1 ± 0,3) $V_{pp}$ |

### 6.4.4 Polarity

The polarity is negative going.

NOTE Sync. level is the lowest or the most negative value.

### 6.4.5 Offset voltage

The offset voltage shall be ≤ 2,75 V at 75 Ω.

## 6.5 Audio signal requirements

### 6.5.1 Input impedance

The nominal input impedance shall be ≥ 600 Ω.

NOTE See 7.18

### 6.5.2 Output impedance

The nominal output impedance shall be ≤ 30 Ω.

NOTE See 7.18.

### 6.5.3 Signal level

**Table 25 – Signal level**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| AM TV modulator standard B/G/D/D1/K/I [1)] | +6 dB(mW) for ± 30 kHz deviation | | |
| AM TV modulator standard L | 6 dB(mW) = 50 % AM | - 6 dB(mW) = 50 % AM | |
| FM radio modulator | +6 dB(mW) for ± 40 kHz deviation | | |

[1)] $f_m$ = 400 Hz, pre- and de-emphasis 50 μs.

## 6.6 Requirements for decoding margin (teletext)

The decoding margin from the input to the output of the headend shall not deteriorate more than the requirements shown in Table 26.

**Table 26 – Requirements for decoding margin (Teletext)**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| 15 % | 25 % | 35 % |

For the method of measurement, see 4.15.

## 6.7 IF signal requirements (AM-TV)

### 6.7.1 Impedance

The nominal impedance shall be 75 Ω.

NOTE An impedance of 75 Ω is recommended for all grades. Connectors according to IEC 61169-2 are recommended.

### 6.7.2 Return loss

**Table 27 – Return loss – IF signal**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| ≥18 dB | ≥14 dB | |

## 6.8 Antennas for terrestrial reception

### 6.8.1 Impedance

The nominal impedance shall be 75 Ω.

### 6.8.2 Return loss

**Table 28 – Return loss – Antennas for terrestrial reception**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| ≥18 dB | ≥14 dB | |

## 6.9 Antenna amplifier

For antenna amplifiers see the corresponding parameters of 6.3.

# 7 Equipment characteristics required to be published

## 7.1 General

All applicable parameters given in Clause 7 shall be published as worst-case figures on data sheets. For some parameters, in addition, recommended values are given in this clause.

## 7.2 Environmental conditions

The minimum amount of information to be published on environmental conditions shall be that covered by 5.3, Operation.

**Table 29 – Recommended temperature ranges**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Operating temperature range | 0 °C to +55 °C | –40 °C to +55 °C Northern Europe<br>–20 °C to +55 °C Central Europe<br>–10 °C to +60 °C Southern Europe | |
| Operating temperature range within the specification limits | 5 °C to +45 °C | 5 °C to +55 °C | –10 °C to +55 °C |
| NOTE For special national conditions, see Annex D. | | | |



Specifications shall be met at temperatures reached after 30 min of warm-up time.

## 7.3 Maximum permissible output level

The maximum permissible output level shall be specified on the data sheets as well as on the equipment.

The values are valid for the following minimum carrier-to-interference ratios given in Tables 30 to 34.

**Table 30 – Carrier-to-third-order intermodulation ratio for maximum output level of channel amplifiers/frequency converters**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Standard B/G/I/D/D1/K | ≥66 dB | ≥54 dB | ≥54 dB |
| Standard L | ≥48 dB | ≥48 dB | ≥42 dB |

For the measurement method, see 4.2.

**Table 31 – Carrier-to-third-order intermodulation ratio for maximum output level of sub-band, full band, multi-band amplifiers and multi-channel frequency converters for AM TV (not for channel amplifier)**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Standard B/G/I | ≥80 dB | ≥66 dB | ≥66 dB |
| Standard L | ≥64 dB | ≥64 dB | ≥64 dB |
| For FM radio | ≥60 dB | ≥60 dB | ≥60 dB |

For the measurement method, see 4.3

**Table 32 – Carrier-to-second-order intermodulation ratio for maximum output level of sub-band, full band, multi-band amplifiers and frequency converters for AM TV or FM radio (not for channel amplifier)**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| | ≥60 dB | |

NOTE Only for products being generated by signals in the range 87,5 MHz to 108 MHz and falling in the range 174 MHz to 230 MHz.

For the measurement method, see 4.4.

**Table 33 – Carrier-to-intermodulation ratio for maximum output level of FM-TV channel amplifiers/frequency converters**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| | ≥60 dB | |

For the measurement method, see 4.5.2

**Table 34 – Carrier-to-third-order intermodulation ratio for maximum output level of FM TV full band, sub-band amplifiers**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| | ≥35 dB | |

For the measurement method, see 4.4.

NOTE 1 This value includes a margin for additional reception of TV signals at a later time.

NOTE 2 Not applicable to narrowband equipment unless the frequency range covered by the equipment is such that $2f_{min} < f_{max}$.

## 7.4 Operating range for output level

State the minimum and maximum permissible output levels in order to determine the operating range, if necessary.

## 7.5 TV standard

Specify the TV standard(s) for which the equipment is intended.

See Annex C for the recommended selectivity diagram for adjacent channel transmission.

## 7.6 Clamp

Where clamping is employed, specify on the data sheets the method used and the level of performance achieved.

## 7.7 Noise figure

### 7.7.1 Equipment without AGC

State the worst value at maximum gain in the specified frequency range. This range is described in Annex A.

### 7.7.2 Equipment with AGC

Publish the graph for noise in the specified operating range. Alternatively, *C/N* or *S/N* may be published.

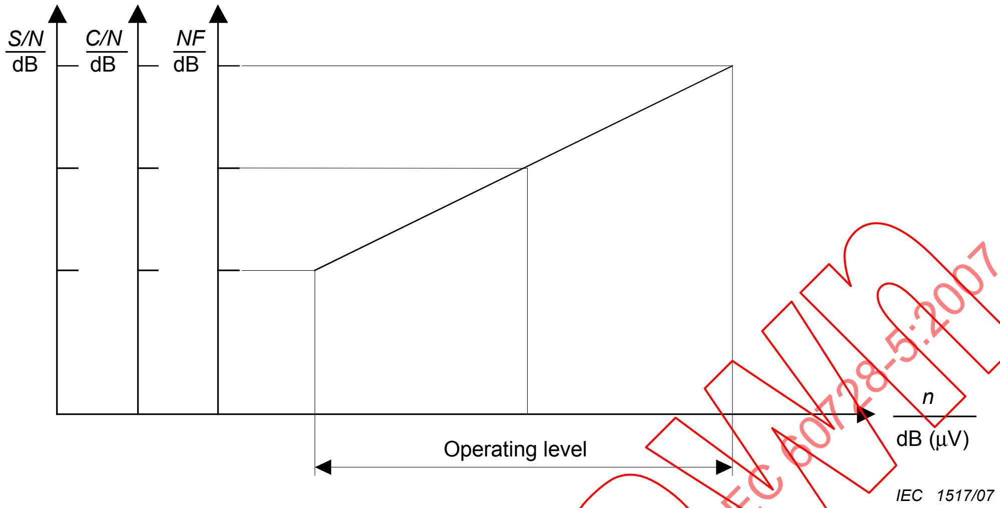



**Figure 30 – Example of diagram of *NF*, *C/N* or *S/N* for equipment with AGC**



## 7.8 Data control signals, description of interface

For data control signals, the following values shall be stated on the data sheets:

- impedance;
- voltage or level;
- polarity;
- bit rate;
- protocol;
- connector.

## 7.9 Output level stability for TV modulators, TV converters and pilot generators

State the output level stability for TV modulators, pilot generators and TV converters. It is recommended that the values given in Table 35 should be met.

**Table 35 – Output level stability for TV modulators and TV converters**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| ±0,5 dB | ±1,0 dB | ±2,5 dB |

The input level range for conditions mentioned shall be provided.

## 7.10 Pilot signal

The pilot signal shall be supplied at a constant level. The accuracy of the pilot signal level should be ±0,25 dB.

NOTE The pilot signal can be a CW or modulated carrier.

## 7.11 Differential gain and phase

### 7.11.1 Differential gain

**Table 36 – Recommendation for differential gain**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Standard B/G/I/D/D1/K and standard L | 5 % | 8 % | 14 % |

For the measurement method, see 4.7.2

### 7.11.2 Differential phase

**Table 37 – Recommendation for differential phase**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Standard B/G/I/D/D1/K | 3° | 6° | 12° |
| Standard L | 5° | 8° | 12° |

For the measurement method, see 4.7.3.

## 7.12 Group delay variation for analogue TV signals

For details on method of measurement of video frequency, see 4.8.

For measurements concerning AM TV at RF frequencies use a measuring range between 0,5 MHz and 4,43 MHz apart from the vision carrier. Use a measuring aperture of ≤40 kHz.

**Table 38 – Recommendation for group delay variation**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| AM TV standard B/G/I/D/D1/K | 50 ns | 80 ns | 80 ns |
| AM TV standard L | See Annex C | | |
| FM TV | Under consideration | | |

The values are valid for 0,1 MHz to 4,43 MHz. All values shall be within a tolerance range; a reference is not stated.

For recommendations for modulators Grade 1 and Grade 2, see Annex C.

For the measurement method, see 4.8.

### 7.13 Luminance non-linearity

**Table 39 – Recommendation for luminance non-linearity**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Standard B/G/I | 3 % | 3 % | 8 % |
| Standard L | 5 % | 5 % | 10 % |

NOTE Different videocrypt systems require better values (for example, ≤2%).

For the measurement method, see 4.13.

### 7.14 2T-pulse

The displayed pulse should be within the graticule defined in 4.11. The *K*-factor masks for quality grades 1, 2 and 3 are defined in Table 40.

**Table 40 – *K*-factor masks for 2T-pulse responses**

| T | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| ±0 | +100 % - 6 % | +100 % - 12 % | +100 % - 24 % |
| ±2 | ±6 % | ±12 % | ±24 % |
| ±4 | ±3 % | ±6 % | ±12 % |
| ±8 | ±1,5 % | ±3 % | ±6 % |
| ±12 | ±1 % | ±1,5 % | ±3 % |

### 7.15 20T-pulse

For the measurement method, see 4.12; value under consideration.

### 7.16 Hum modulation

The value of the hum modulation shall be given in dB over the specified output range, excepted for modulators, demodulators and frequency converters for analogue signals.

For the measurement method, see 4.10.

NOTE 1 The value only applies to channels carrying signals.

NOTE 2 In some countries with TV-standard I the NICAM carrier frequency and bit rate are locked to each other. In this case, the intercarrier frequency should be precisely maintained.

### 7.17 Television carrier-to-noise ratio

For the measurement method, see 4.6.1. The conditions of measurements including the defined bandwidth shall be stated.

### 7.18 Audio in TV

Specify on the data sheets if the audio input is balanced or unbalanced. It is recommended that a balanced input and a connector according to IEC 60130-9 (Annex B) should be used.

Audio signal-to-noise-ratio shall be measured with weighting according to ITU-R Rec. BS.468-4 and quasi-peak detection.

## 7.19 Processing units for FM radio

### 7.19.1 Audio input

Specify on the data sheets if the audio input is balanced or unbalanced. It is recommended that a balanced input and a connector according to IEC 60130-9 (Annex B) should be used.

### 7.19.2 Stereo crosstalk

It is recommended that the crosstalk suppression of the stereo channels should be better than 30 dB in the frequency range 200 Hz to 10 kHz. State the values together with the test frequencies.

### 7.19.3 Total harmonic distortion

It is recommended that the total harmonic distortion ratio produced by an FM converter within the range 40 Hz to 15 kHz should be better than 46 dB when using a test signal generator modulated with a signal in the range 40 Hz to 7,5 kHz and set to provide an FM signal having 40 kHz deviation.

### 7.19.4 Intermodulation distortion

It is recommended that the resulting intermodulation products should not be less than 40 dB below the level of the wanted reference audio. For the measurement method, see 4.14.

### 7.19.5 Deviation, pre-emphasis

Values for deviation and pre-emphasis shall be published.

## 7.20 Antennas for terrestrial reception

### 7.20.1 Antenna gain

The minimum gain of the receiving antenna regarding the half-wave dipole as to the nominal impedance of 75 Ω and a linear polarization stating the relevant frequency range shall be supplied on the data sheets.

### 7.20.2 Sidelobe suppression

**Table 41 – Recommendations for sidelobe suppression**

| Grade 1 | Grade 2 | Grade 3 |
|---|---|---|
| >18 dB | >18 dB | >10 dB |

NOTE The values refer to the maximum of the main lobe.

### 7.20.3 Return loss of antennas

It is recommended that the return loss of the antenna when measured with respect to its specific impedance should be not less than given in Table 42.

**Table 42 – Recommendation for return loss of antennas**

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| TV channel antenna | >20 dB | >16 dB | >14 dB |
| TV multi-channel antenna | >16 dB | >14 dB | >14 dB |
| FM antenna | >14 dB | >10 dB | >10 dB |

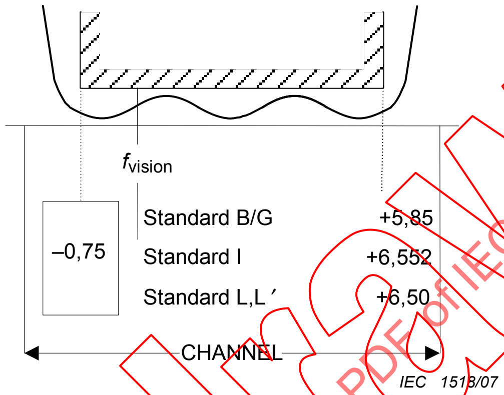
### 7.21 Control signals for outdoor units

Control signals for outdoor units shall meet the specifications of IEC 61319-1.

# Annex A
(normative)

# Definition of the specified test frequency range for return loss and noise figure

## A.1 Test frequency range for TV channel processor




NOTE When measuring noise, it should be taken into consideration that the bandwidth of the measuring system used is within the transmission bandwidth of the equipment under test. The lowest measuring point using standard B/G is, for example:

$f_{vision}$ -0,75 MHz + 1/2 measuring bandwidth

**Figure A.1 – Test frequency range for TV channel processors**

## A.2 Test frequency range for sub-band, full-band, multi-band amplifier

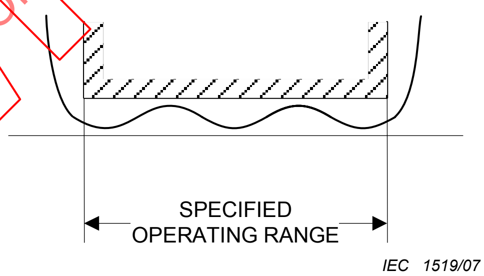



**Figure A.2 – Test frequency range for sub-band, full-band, multi-band amplifier**