IEC 60728-4

Edition 3.0 2007-08

INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services – Part 4: Passive wideband equipment for coaxial cable networks

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60728-4

Edition 3.0 2007-08

INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services – Part 4: Passive wideband equipment for coaxial cable networks

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE V

ICS 33.060.40; 33.170

ISBN 2-8318-9265-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 4: Passive wideband equipment for coaxial cable networks

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardisation comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardisation in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardisation (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60728-4 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 third edition cancels and replaces the second edition published in 2000, of which it constitutes a technical revision.

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

- Subclause 3.1 includes several new or modified definitions.
- Clause 4 includes added test methods for attenuation, isolation, through-loss, group delay variation, amplitude frequency response and two carrier intermodulation measurements for second- and third-order products.
- Clause 5 includes updated and new performance requirements.

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

FDIS	Report on voting
100/1243/FDIS	100/1275/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.

For the differences existing in some countries, see Annex B.

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

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

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

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

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television signals, sound signals 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 standardization 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 standardization 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 4: Passive wideband equipment for coaxial cable networks

1 Scope

This part of IEC 60728 applies to system outlets, splitters and taps, passive single or multiple port equipment comprising filters, attenuators, equalizers, galvanic isolators, power injectors, cable splices, terminating resistors and transfer points, but excluding coaxial cables and receiver leads (see 5.2).

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.

There are three grades for all passive equipment except system outlets where there is only one.

Different networks require the same performance and, when integrating networks, upgrading will be avoided.

Practical experience has shown that these three grades meet most of the technical requirements necessary for supplying a minimum signal quality to the subscribers. This classification should not be considered as a requirement but as information for users and manufacturers on the minimum quality criteria of the material required to install networks of different sizes. The system operator should select appropriate material to meet the minimum signal quality at the subscriber's outlet and to optimize cost/performance, taking into account the size of the network and local circumstances.

All requirements and published data should be understood as guaranteed values within the specified frequency range and in well-matched conditions.

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

NOTE The title of some of the parts of the IEC 60728 series will be changed when a new edition is published.

IEC 60966-1, *Radio frequency and coaxial cable assemblies – Part 1: Generic specification – General requirements and test methods*

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

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

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

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

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

IEC 61169-1, *Radio-frequency connectors – Part 1: Generic specification – General requirements and measuring methods*

IEC 61169-2, *Radio-frequency connectors – Part 2: Sectional specification – Radio-frequency coaxial connectors of type 9,52*

IEC 61169-24, *Radio-frequency connectors – Part 24: Sectional specification – Radio-frequency coaxial connectors with screw coupling, typically for use in 75 ohm cable distribution systems (type F)*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

NOTE Some terms have been taken from IEC 60050-723.

3.1.1
active equipment
equipment (for example, amplifiers, converters, etc), performing signal processing by means of external or internal power supply in a certain frequency range

3.1.2
amplitude frequency response
gain or loss of an equipment or system plotted against frequency

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

3.1.4
decibel ratio
ten times the logarithm of the ratio of two quantities of power, P_1 and P_2, i.e.

$$10 \lg \frac{P_1}{P_2} \text{ dB} \quad (1)$$

3.1.5
directional coupler
tap
passive signal splitting equipment, with minimum signal loss between the input port and the output port (through-loss), a specified coupling loss between the input port and the tap port (tap loss), and very high loss between the output port and tap port (isolation)

[IEV 723-09-25, modified]

3.1.6
directivity
attenuation between output port and interface or tap port, minus the attenuation between input and interface or tap port, of any equipment or system

3.1.7
EM-active equipment
all passive and active equipment carrying RF signals are considered as EM-active equipment, either because they are liable to cause electromagnetic disturbances or because the performance of them is liable to be affected by such disturbances

3.1.8
equalizer
equipment designed to compensate over a certain frequency range for the amplitude/frequency distortion or phase/frequency distortion introduced by feeders or equipment

NOTE This equipment is for the compensation of linear distortions only.

3.1.9
feeder
transmission path forming part of a cable network. Such a path may consist of a metallic cable, optical fibre, wave guide or any combination of them. By extension, the term is also applied to paths containing one or more radio links

[IEV 723-09-12, modified]

3.1.10
grade
classification of performance for equipment for use in cable networks. The choice of the appropriate grade depends on, for example,

- size of network;
- structure of network;
- lengths of cable between equipment;
- kind of services;

- kind of signals

NOTE In any case, the system performance requirement should be fulfilled by the design of the network and the choice of the grade of equipment used.

3.1.11
group delay variation
indicates the deviation from a linear phase-frequency response; the group delay is

$$\tau = \frac{\mathrm{d}\varphi}{\mathrm{d}f} \tag{2}$$

where

φ is the phase;

f is the frequency.

Group delay variation (typically in ns) is the difference of the values of τ between the given frequency and the reference frequency

3.1.12
isolation
attenuation between two output, tap or interface ports of any equipment or system

3.1.13
level
level of any power P_1 is the decibel ratio of that power to the standard reference power P_0, i.e.

$$10 \lg \frac{P_1}{P_0} \tag{3}$$

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

$$20 \lg \frac{U_1}{U_0} \tag{4}$$

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.

3.1.14
looped system outlet
device through which the spur feeder passes and to which is connected a receiver lead, without the use of a subscriber's feeder

[IEV 723-09-21]

3.1.15
nominal value
reference value around which a certain tolerance field (plus/minus) is permitted or specified

3.1.16
passive equipment
equipment (for example, splitters, tap-offs, system outlets, etc.) not requiring a power supply in order to operate and/or not carrying out signal processing in a certain frequency range

3.1.17
receiver lead
lead which connects the system outlet to the subscriber equipment

[IEV 723-09-23, modified]

NOTE 1 The meaning of receiver lead may not describe the function of this device if it is used for interactive subscriber equipment; the definition already gives the more general explanation and allows bi-directional services.

NOTE 2 A receiver lead may include filters and balun transformers in addition to the cable.

3.1.18
r.f. data port
r.f. interface port to connect an interactive data equipment (for example, a modem) and passes return band (upstream), as well as distribution (downstream) frequency band

3.1.19
splice
connecting device with barrel(s) accommodating electrical conductor(s) with or without additional provision to accommodate and secure the insulation

[IEV 581-05-11]

3.1.20
splitter
equipment in which the signal power at the (input) port is divided equally or unequally between two or more (output) ports

NOTE This equipment may be used in the reverse direction for combining signal energy.

3.1.21
spur feeder
feeder to which splitters, subscriber taps or looped system outlets are connected

[IEV 723-09-16, modified]

3.1.22
standard reference power and voltage
in cable networks the standard reference power, P_0, is 1/75 pW

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

The standard reference voltage, U_0, is 1 μV.

3.1.23
subscriber feeder
feeder connecting a subscriber tap to a system outlet or, where the latter is not used, direct to the subscriber equipment

[IEV 723-09-17, modified]

NOTE A subscriber feeder may include filters and balun transformers.

3.1.24
subscriber tap
equipment with one or more ports for connecting a subscriber feeder to a spur feeder

3.1.25
system outlet
equipment for interconnecting a cable network and a receiver lead

3.1.26
transfer point
interface between the cable network and the internal network of the building, each of which may be separately owned. The transfer point may contain a voltage-dependent device and/or a galvanic isolator

3.1.27
well-matched
matching condition when the return loss of the equipment is sufficient that the expected error can be neglected

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

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 database.

Symbol	Terms	Symbol	Terms
	voltmeter [IEC 60617-S00059(2001:07)] [IEC 60617-S00913(2001:07)]		oscilloscope [IEC 60617-S00059(2001:07)], [IEC 60617-S00922(2001:07)]
	ampere meter [IEC 60617-S00059(2001:07)] [IEC 60617-S00910(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)]		detector with LF-amplifier [IEC 60617-S00118] [IEC 60617-S01239]
	equipment under test [IEC 60617-S00059(2001:07)]		adjustable a.c. voltage source
	system outlet		low pass filter [IEC 60617-S01248(2001:07)]
	looped through system outlet		high pass filter [IEC 60617-S01247(2001:07)]
	variable attenuator [IEC 60617-S01245(2001:07)]		r.f. choke [IEC 60617-S00583(2001:07)]
	ground [IEC 60617-S00200(2001:07)]		variable resistor [IEC 60617-S00557(2001:07)]
	capacitor [IEC 60617-S00567(2001:07)]		

3.3 Abbreviations

AC	alternating current
AM	amplitude modulation
CATV	community antenna television (system)
dBc	dBc means dB in relation to carrier level
DC	direct current
EM	electromagnetic
EMC	electromagnetic compatibility
EUT	equipment under test
FM	frequency modulation
HP	high pass
IP Class	international protection class
LF	low frequency
LP	low pass
MATV	master antenna television (system)
Q grade(s)	quality grade(s)
RF	radio frequency
RMS	root mean square
SMATV	satellite master antenna television (system)
TV	television

4 Methods of measurement

4.1 Attenuation

4.1.1 Test equipment

The following test equipment is required:

- tuneable r.f. signal generator;
- variable calibrated attenuator;
- r.f. switch;
- spectrum analyser or selective voltmeter.

NOTE This test set is used as the basic method of measurement; normally, a network analyser is used.

4.1.2 Measurement procedure

The equipment shall be connected as shown in Figure 1. Both r.f. switches shall be set to position A. The variable attenuator shall be adjusted until a reference line on the spectrum analyser or a reference value on the selective voltmeter is met. The value a_1 in dB of the variable attenuator shall be read. Both r.f. switches shall be set to position B. The variable attenuator shall be adjusted until the reference (line) is met again. The value a_2 in dB of the variable attenuator shall be read.

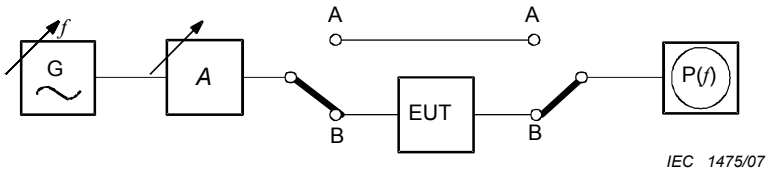


Figure 1 – Test set-up for the measurement of attenuation

The attenuation in dB of the EUT for the chosen frequency is $a_1 - a_2$. This procedure shall be repeated at all relevant frequencies for the EUT.

4.1.3 Presentation of the results

The attenuation of the EUT is expressed in dB, with reference to the chosen frequencies.

4.2 Isolation

4.2.1 Definition

The isolation measured in dB is the attenuation ratio between two outputs of a component if the signal is inserted in one of these outputs.

4.2.2 Test equipment

The following test equipment is required:

- tuneable RF signal generator;
- variable calibrated attenuator;
- spectrum analyser or selective voltmeter;
- RF switch.

NOTE This test set is used as the basic method of measurement; normally, a network analyser is used

4.2.3 Measurement procedure

The equipment shall be connected as shown in Figure 2. Both RF switches shall be set to position A. The variable attenuator shall be adjusted until a reference line on the spectrum analyser or a reference value on the selective voltmeter is met. The value a_1 in dB of the variable attenuator shall be read. Both RF switches shall be set to position B. The variable attenuator shall be adjusted until the reference line is met again. The value a_2 in dB of the variable attenuator shall be read. The signal shall be inserted into output port 2, the detector connected to output port 1 and the procedure repeated.

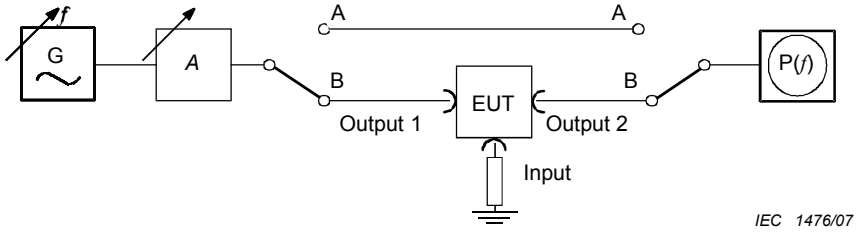


Figure 2 – Test set-up for the measurement of isolation

The isolation in dB of the EUT for the chosen frequency is $a_1 - a_2$. This procedure shall be repeated at all relevant frequencies for the EUT.

4.2.4 Presentation of the results

The isolation of the EUT is expressed in dB with reference to the chosen frequencies.

4.3 Through-loss

4.3.1 Definition

The through-loss, measured in dB, is the difference in signal level between the input and the looped-through output of the equipment.

4.3.2 Test equipment

The following test equipment is required:

- tuneable r.f. signal generator;
- variable calibrated attenuator;
- r.f. switch;
- spectrum analyser or selective voltmeter.

NOTE This test set is used as the basic method of measurement; normally, a network analyser is used

4.3.3 Measurement procedure

The equipment shall be connected as shown in Figure 3. Both r.f. switches shall be set to position A. The variable attenuator shall be adjusted until a reference line on the spectrum analyser or a reference value on the selective voltmeter is met. The value a_1 in dB of the variable attenuator shall be read. Both r.f. switches shall be set to position B. The variable attenuator shall be adjusted until the reference (line) is met again. The value a_2 in dB of the variable attenuator shall be read.

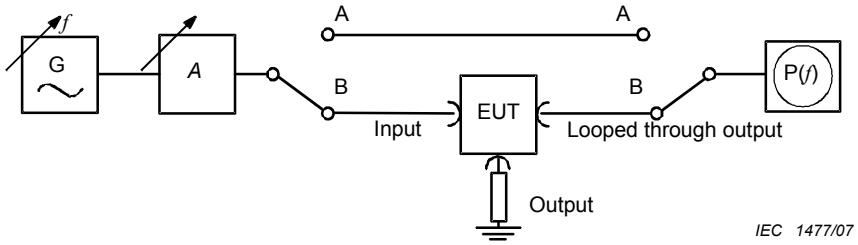


Figure 3 – Measurement of through-loss

The insertion loss in dB of the EUT for the chosen frequency is $a_1 - a_2$.

4.3.4 Presentation of the results

The insertion loss of the EUT is expressed in dB, with reference to the chosen frequency.

4.4 Group delay variation

4.4.1 Definition

Group delay variation is defined as the deviation from a linear phase-frequency response.

4.4.2 Test equipment

A network analyser is required.

4.4.3 Method of measurement

For the measurement of group delay, a network analyser shall be used. To ensure a reliable test result, the instructions of the test set manufacturer shall be met.

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

$$\tau_g = \frac{\Delta\varphi}{360° \cdot f_m} \tag{5}$$

where

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

f_m is the frequency of the test signal in Hertz;

τ_g is the group delay in seconds.

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

4.4.4 Presentation of the result

The group delay variation is expressed in ns in the frequency range of the EUT.

4.5 Amplitude frequency response

For the measurement method of amplitude frequency response, see 4.1. The amplitude response of an equipment or system is presented as $a_1 - a_2$, plotted against frequency.

4.6 Return loss

Return-loss measurements shall be carried out as laid down in IEC 60728-3. Unused ports shall be well-matched in 75 Ω or open/shorted if required.

4.7 Hum modulation of carrier

4.7.1 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 variation a of the envelope around the carrier A caused by the hum modulating this carrier, i.e.

$$\text{carrier/hum ratio} = 20 \lg \frac{A}{a} \text{ [dB]}$$

Figure 4 illustrates the definition of the hum modulation of a carrier.

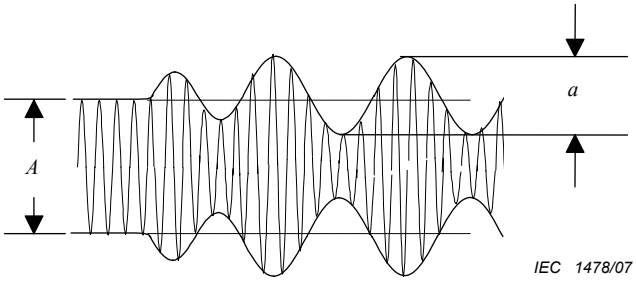


Figure 4 – Carrier/hum ratio

4.7.2 Description of the method of measurement

4.7.2.1 General

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

For measuring purposes, sinusoidal signals are used. Taking into account the maximum admissible voltage or the maximum admissible current, the worst value for the operating frequency range shall be published.

NOTE For cable networks, the peak value of the supply voltage or of the supply current can be higher than the value resulting from calculation using the corresponding waveform factor.

For measurement an oscilloscope method is used.

4.7.2.2 Test equipment

The following test equipment is required:

- adjustable voltage source;
- variable load resistor;
- power inserter;
- variable calibrated attenuator;
- oscilloscope;
- voltmeter (r.m.s.);
- ampere meter;
- tuneable r.f. signal generator with sufficient phase-noise and hum-modulation ratio, including AM capability (400 Hz);
- detector including (battery-powered) low-frequency amplifier and 1 kHz LP filter in the output, to suppress low-frequency distortion (an HP-filter at the input shall be used).

4.7.2.3 Connection of test equipment

The connection scheme for locally powered EUT is shown in Figure 5; the connection scheme for remotely powered EUT is shown in Figure 6.

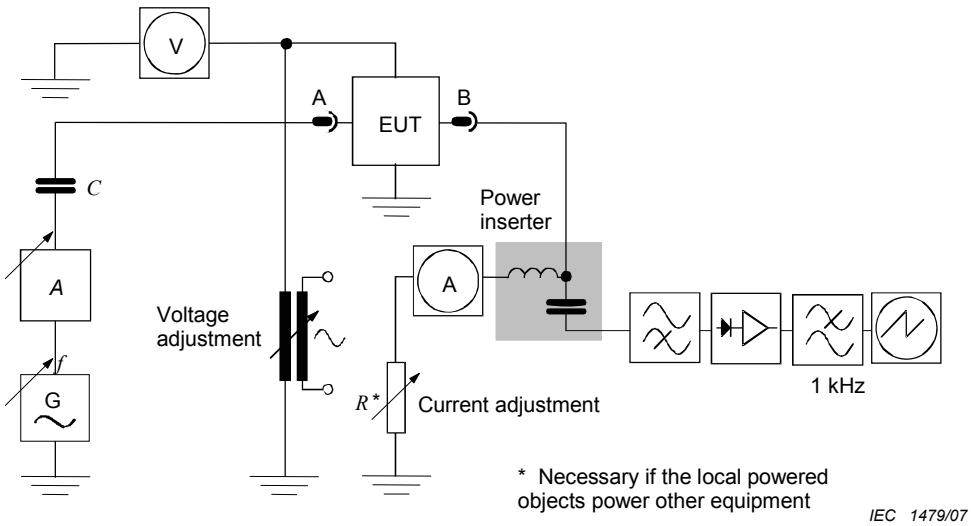


Figure 5 – Test set-up for power injectors

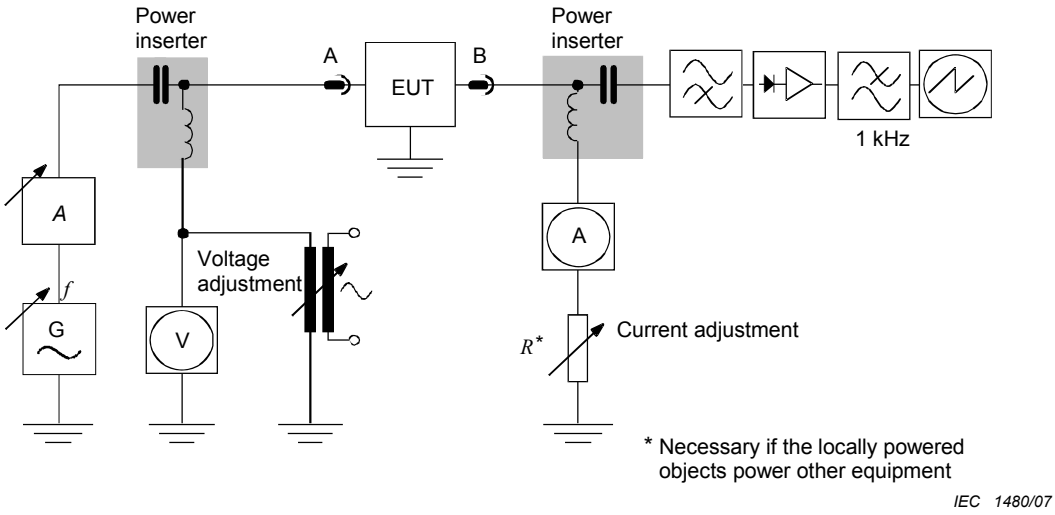


Figure 6 – Test set-up for passive equipment, excluding power injectors

4.7.3 Measuring procedure

4.7.3.1 Set-up of calibration

The reference signal is generated by means of the RF signal generator shown in Figure 5 and Figure 6. An r.f. carrier frequency that suits the TV channel under consideration shall be chosen and modulated to a depth of 1 % at a frequency of 400 Hz. The r.f. signal generator shall be adjusted to an appropriate level and the peak-to-peak value of the demodulated AM signal (c in Figure 7) read on the oscilloscope. This is the reference signal. With 1 % modulation this value is:

$$-20 \lg (0{,}01) = 40 \text{ dB} \qquad (6)$$

The modulation of the signal generator shall be switched off. The remaining value, m, in Figure 7 is the value to be measured.

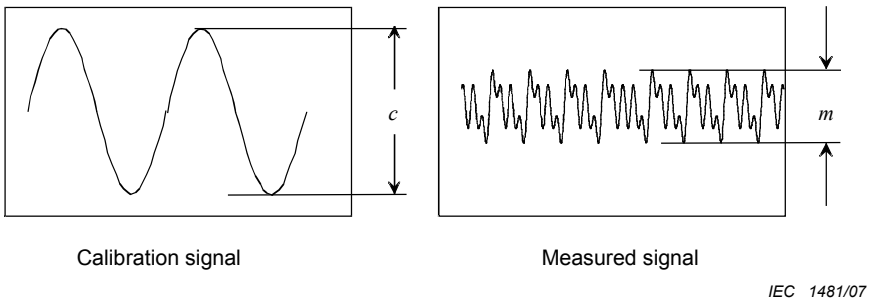


Figure 7 – Oscilloscope display

The suitability of the measuring set-up shall be checked by connecting points A and B together and measuring the inherent hum of the set-up. The calculation of the hum-modulation ratio is given in 4.7.4. This value should be at least 10 dB better than the values to be measured on items of equipment. For measurements with set-up for locally powered EUT, the set-up shown in Figure 5 shall be used for check. The subsequent measurements shall be carried out in suitable increments through the entire operating frequency range. The measured value is independent of the r.f. level; however, the r.f. level should be at least the magnitude of the EUT operating level.

4.7.3.2 Locally powered EUT

The EUT shall be adjusted to maximum or minimum operating voltage using the transformer. The supply current depends on the power requirement of the EUT.

The signal generator shall be modulated with the reference signal and the level at point B shall be adjusted by means of an attenuator in such a way that neither the EUT is overdriven nor the detector is within a non-admissible operating range. The peak-to-peak amplitude, c, of the demodulated reference signal, which is displayed on the oscilloscope, shall be noted. Then the reference signal shall be switched off and the peak-to-peak value, m, of the remaining signal measured.

In addition, for EUT with remote supply terminals, the maximum admissible peak current for the respective terminal shall be adjusted by means of resistor R.

4.7.3.3 Remotely supplied EUT

For remotely supplied EUT, the general procedure described in 4.7.3.2 shall be followed. The only difference is that the supply energy is routed to the equipment via an r.f. terminal. In the case where there are several r.f. interfaces available for power insertion, each of these interfaces shall be included in the measurement procedure in a suitable manner.

4.7.4 Calculating the hum-modulation ratio

4.7.4.1 Frequency range

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

4.7.4.2 Individual EUT

The hum-modulation ratio [EUT] is equal to 40 dB + 20 lg (c/m) [dB] for 1 % reference modulation depth.

For other chosen reference modulation depths, the value 40 dB shall be replaced by the result of the term –20 lg (modulation depth).

4.7.4.3 Cascaded EUT

For high hum-modulation ratios, it can be useful to cascade several EUT for better determination of the measuring values. Then, to calculate the individual EUT, the following formula shall be used.

Hum-modulation ratio [EUT] = *Hum-modulation ratio* [cascaded] +20 lg n [dB]

where

n is the number of cascaded EUT.

4.7.4.4 Loop-value correction

If a set-up calibration correction is required, the following formula shall be used.

$$\textit{Hum-modulation ratio}\ [\text{EUT}] = -20\lg\left(10^{-\frac{\textit{measured value}}{20}} - 10^{-\frac{\textit{calibration correction}}{20}}\right)[\text{dB}] \qquad (7)$$

4.7.5 Presentation of the results

The hum-modulation ratio is expressed in dB.

4.8 Two-carrier intermodulation measurements for second- and third-order products

Splitters, taps and directional couplers contain ferrite transformers. These transformers are non-linear and produce harmonic and intermodulation products.

These are predominately third-order products and are insignificant (greater than 120 dBc), providing the ferrite cores are not magnetised. If the cores become magnetized then significant second-order products may be produced. Third harmonic products remain low.

Ferrite transformers saturate easily when subjected to d.c. or pulse voltages. A typical splitter input transformer will saturate in less than 10 V/μs. Following this saturation, the core will remain magnetized.

It is not possible to stop equipment becoming magnetized in the CATV environment.

In order to carry out harmonic or intermodulation tests, it is therefore necessary to magnetize equipment prior to test in order to simulate worst-case conditions. The surge immunity test described in 5.1.6.2 provides adequate magnetization and may be used to precondition the equipment under test.

As an alternative to the surge immunity test, a 25 V/500 μs pulse should be applied to each port via a 300 Ω source impedance prior to testing.

In circuits each ferrite core appears as a coherent harmonic generator with a source impedance determined by the relevant circuit elements. It is thus imperative that all of the equipment ports are correctly terminated at all frequencies to enable correct measurements to be taken.

For splitters and taps, the return path signal is applied to each output port OP_x and measurements are taken at either or both output ports via diplex filters (see Figure 8). The harmonic signal present at the input port IP is of no significance.

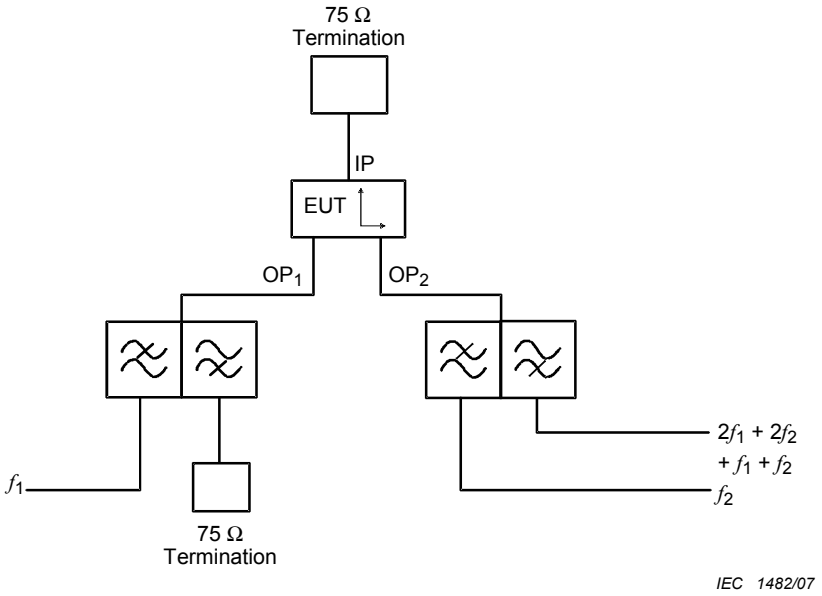


Figure 8 – Harmonic/Intermodulation test circuit

Values for f_1 and f_2 are given in Table 3. Compensation should be made for the insertion loss of the diplexers, which typically should have less than 1 dB loss at f_2 and $2 \cdot f_2$ and a stop-band loss greater than 80 dB. The crossover frequency should be approximately $\sqrt{2 \cdot f_1 \cdot f_2)}$.

5 Performance requirements and recommendations

5.1 General performance requirements and recommendations

5.1.1 Safety

The relevant safety requirements as laid down in IEC 60728-11 shall be met.

5.1.2 Electromagnetic compatibility (EMC)

The relevant EMC requirements laid down in IEC 60728-2 shall be met. The EMC class A or B shall be published. It is recommended that “Class A” or “Class B” be indicated on the product.

5.1.3 Environmental

Manufacturers shall publish relevant environmental information on their products in accordance with the requirements of the following publications.

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
Climatic category of component or equipment for storage and operation as defined in Annex A of	IEC 60068-1
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
Vibration (sinusoidal) Annex B of	IEC 60068-2-6

NOTE For requirements in Finland, see Clause B.1.

This will enable users to judge the suitability of the product with regard to four main requirements: storage, transportation, installation, and operation.

5.1.4 Marking

5.1.4.1 Marking of equipment

Each piece of equipment shall be legibly and durably marked with the manufacturer's name and type number.

5.1.4.2 Marking of ports

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

5.1.5 Impedance

The nominal impedance of all passive equipment shall be 75 Ω.

5.1.6 Degradation of performance caused by overvoltages

5.1.6.1 Introduction

Surges caused by overvoltages from switching and lightning transients may degrade the performance of passive equipment.

For products with surge protection the manufacturer shall indicate "surge-proof" in the product information and in the data sheet. For this equipment, the following requirements shall be met.

5.1.6.2 Surge immunity

Passive equipment used at the subscriber premises and the spur feeder shall comply with performance criterion B (according to IEC 61000-6-1) after a surge voltage of 1 kV according to IEC 61000-4-5 (class 2, test level 2) has been applied. It shall be applied between the inner and the outer conductor of each port.

5.1.6.3 Degradation of intermodulation performance

After the test according to 5.1.6.2, the intermodulation requirements as specified in 5.3.4.8 (system outlets) and 5.4.3.10 (splitters and taps) should still be met.

5.2 Performance requirements and recommendations for receiver lead

The performance requirements and recommendations for receiver leads are stated in IEC 60966-1, IEC 60966-2-4, IEC 60966-2-5 and IEC 60966-2-6.

5.3 Performance requirements and recommendations for system outlets

5.3.1 Safety

Safety isolation can be incorporated in the system outlet and may be a requirement of local regulations. The isolation shall meet the requirements of IEC 60728-11 for isolated system outlets.

5.3.2 Quality grading

There is only one quality grade.

5.3.3 Mechanical requirements

5.3.3.1 Conduit box

The system outlet shall be compatible with the conduit box used, which may be nationally or internationally standardized.

5.3.3.2 Interface ports

An IEC 61169-2 male connector shall be used for the TV interface port. An IEC 61169-2 female connector shall be used for the radio interface port.

These connectors shall conform to IEC 61169-1. As an alternative, female F-connectors in accordance with IEC 61169-24 may be used.

5.3.4 Electrical parameters and requirements

5.3.4.1 Definitions

For outlets with integral filters, a relaxation of 3 dB in return loss and isolation requirements is permissible in the pass-band edges. The pass-band edge is defined to be 8 MHz above the lower and 8 MHz below the upper cut-off frequencies for AM-TV and, respectively, 30 MHz for FM-TV, 4 MHz for FM-radio and 2 MHz for return path.

5.3.4.2 Return loss

The minimum return loss shall be according to Table 1 and Table 2.

Table 1 – Return loss of system outlets

Port	Frequency range	Requirement
Input	5 MHz to 10 MHz	Shall be published
	10 MHz to 47 MHz	≥14 dB
	47 MHz to 950 MHz	≥(14 dB – 1,5 dB/octave) but ≥10 dB ≥10 dB in 87,5 to 108 MHz range
	950 MHz to 3 000 MHz	≥10 dB decreasing linearly to 6 dB
TV	47 MHz to 950 MHz	≥(14 dB – 1,5 dB/octave), but ≥10 dB [a]
FM radio	87,5 MHz to 108 MHz	≥10 dB
RF data	5 MHz to 10 MHz	Shall be published
	10 MHz to 47 MHz	≥14 dB
	47 MHz to 950 MHz	≥(14 dB – 1,5 dB/octave) but ≥10 dB
	950 MHz to 3 000MHz	≥10 dB decreasing linearly to 6 dB
Satellite	950 MHz to 3 000 MHz	≥10 dB decreasing linearly to 6 dB

[a] Recommended minimum value 10 dB up to 950 MHz.

NOTE The specifications in Table 1 are not applicable for system outlets in Japan (see Clause B.3).

Table 2 – Return loss of looped-through system outlets

Port	Frequency range	Requirement
Input	5 MHz to 10 MHz	Shall be published
	10 MHz to 47 MHz	≥18 dB
	47 MHz to 950 MHz	≥18 dB – 1,5 dB/octave
	950 MHz to 3 000 MHz	≥10 dB decreasing linearly to 6 dB
Output (looped through)	5 MHz to 10 MHz	Shall be published
	10 MHz to 47 MHz	≥18 dB
	47 MHz to 950 MHz	≥(18 dB – 1,5 dB/octave)
	950 MHz to 3 000 MHz	≥10 dB decreasing linearly to 6 dB
TV	47 MHz to 950 MHz	≥(14 dB – 1,5 dB/octave), but ≥10 dB
FM radio	87,5 MHz to 108 MHz	≥10 dB
RF data	5 MHz to 10 MHz	Shall be published
	10 MHz to 47 MHz	≥14 dB
	47 MHz to 950 MHz	≥(14 dB – 1,5 dB/octave) but ≥10 dB
	950 MHz to 3 000MHz	≥10 dB decreasing linearly to 6 dB
Satellite	950 MHz to 3 000 MHz	≥10 dB decreasing linearly to 6 dB
NOTE 1 The specifications in Table 2 are not applicable for system outlets in Japan (see Clause B.3).		
NOTE 2 For requirements in the Netherlands, see Clause B.2		

NOTE If two independent cable modems according to the DOCSIS specification are connected to one system outlet, second-order intermodulation products caused by the cable modems should be not higher than 6 dB(µV), taking into account a signal level of 120 dB(µV) injected by the cable modems.

For looped-through system outlets, the input return loss in the frequency range from 10 MHz to 950 MHz shall be at least 10 dB, decreasing linearly to 6 dB at 3 000 MHz, with the interface ports either open- or short-circuited.

5.3.4.3 Frequency range

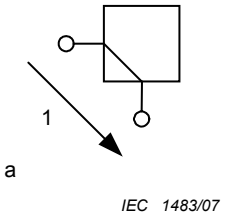
The operating frequency range of the system outlet shall be published.

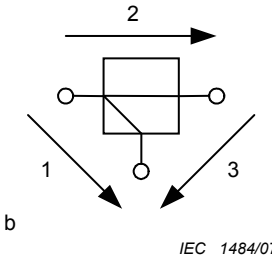
5.3.4.4 Losses

The nominal attenuation and its tolerance for

- interface port loss;
- through loss;
- isolation,

as defined in Figure 9, shall be published.





1: Interface port loss
2: Through-loss
3: Isolation

a) System outlet b) Looped-through system outlet

Figure 9 – Types of losses of system outlets

NOTE The looped-through system outlet shall provide enough isolation from the output to each interface port to meet at least the system requirements of IEC 60728-1 (mutual isolation between system outlets).

5.3.4.5 Amplitude frequency response flatness

The flatness of the amplitude frequency response from the input port to all other ports shall be published.

Peak-to-peak narrowband flatness to the output port/s (looped-through only) shall be within 0,2 dB in a band of 0,5 MHz and 0,5 dB in a band of 7 MHz.

5.3.4.6 Isolation between interface ports

All system outlets shall meet the following requirements.

The minimum attenuation between TV and radio interface ports shall be 10 dB over the operating frequency range.

The minimum attenuation between broadband interface ports shall be 20 dB over the operating frequency range.

Where filters are incorporated in the system outlet, the selectivity shall be published.

5.3.4.7 Group delay variation

Shall be published.

5.3.4.8 Intermodulation in system outlets

On the basis of the test method described in 4.8, it is required that the manufacturer shall specify the maximum return path signal level [dB(μV)] according to Table 3.

This requirement is valid before and after the test with overvoltages (see 5.1.6).

Table 3 – Maximum return path signal level derived from maximum allowed intermodulation distortion level in the downstream frequency band

Test frequency in MHz		Max. level in dB(µV)
Return path (upstream)	f_1 = 60 f_2 = 65	Shall be specified
Distribution (downstream)	$2f_1$ = 120 $f_1 + f_2$ = 125 $2f_2$ = 130	≤ 15 ≤ 15 ≤ 15

NOTE 1 These frequencies should be applied in the case where the return path frequency band is specified up to 65 MHz. For other return path frequency bands, f_2 is the highest specified return path frequency and $f_1 = f_2 – 5$ MHz.

NOTE 2 An intermodulation level of 15 dB(µV) gives a signal to spurious ratio of 45 dB in the case where the forward signal level is 60 dB(µV).

5.4 Performance requirements and recommendations for splitters and taps

5.4.1 Description

Splitters and taps are used in the coaxial cable network and the subscriber network. A splitter divides the signal power at the input port equally or unequally between two or more (output) ports. A tap contains, in addition to its input and output ports, one or more tap ports.

A subscriber tap provides the principal isolation between subscribers. There are three quality grades. The grade of the equipment shall be published.

Taps and splitters may incorporate an a.c. or a d.c. bypass.

5.4.2 Mechanical requirements for connectors

The type of cable connection used shall be published.

5.4.3 Electrical parameters and requirements

5.4.3.1 Return loss

The minimum return loss for the specified grade shall be according to Table 4.

Table 4 – Return loss of splitters and taps

Frequency range	Requirement		
	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	≥22 dB	≥18 dB	≥14 dB
47 MHz to 950 MHz	≥(22 dB – 1,5 dB/octave)	≥(18 dB – 1,5 dB/octave)	≥(14 dB – 1,5 dB/octave) but ≥10 dB
950 MHz to 3 000 MHz	≥14 dB decreasing linearly to 10 dB	≥10 dB decreasing linearly to 6 dB	≥10 dB decreasing linearly to 6 dB
NOTE The specifications in Table 4 are not applicable for splitters and taps in Japan (see Clause B.4).			

For subscriber taps of grade 1 and grade 2, the input return loss in the frequency range from 10 MHz to 950 MHz shall be at least 10 dB, decreasing linearly to 6 dB at 3 000 MHz, with the interface ports either open- or short-circuited.

5.4.3.2 Frequency range

The operating frequency range shall be published.

5.4.3.3 Splitter loss

The nominal attenuation between input port and output port/s, and its tolerance, shall be published.

5.4.3.4 Tap loss

The nominal attenuation between input port and tap port/s, and its tolerance, shall be published.

5.4.3.5 Through-loss (taps only)

The nominal attenuation between input port and output port, and its tolerance, shall be published.

5.4.3.6 Amplitude frequency response flatness

The flatness of amplitude frequency response from the input to output and tap ports shall be published.

Narrowband peak-to-peak flatness at the output port shall be within 0,2 dB in a band of 0,5 MHz and 0,5 dB in a band of 7 MHz.

5.4.3.7 Group delay variation

Shall be published.

5.4.3.8 Hum modulation

For equipment incorporating an a.c. bypass, the value of the hum modulation shall be published in dB at the worst case of powering current of the equipment.

5.4.3.9 Isolation

5.4.3.9.1 Splitters

The isolation between all (output) ports shall be according to Table 5.

Table 5 – Isolation of splitters

Frequency range	Requirement		
	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	≥22 dB	≥18 dB	≥14 dB
47 MHz to 950 MHz	≥(22 dB – 1,5 dB/octave)	≥(18 dB – 1,5 dB/octave)	≥(14 dB – 1,5 dB/octave) but ≥10 dB
950 MHz to 3 000 MHz	≥14 dB decreasing linearly to 10 dB	≥10 dB decreasing linearly to 6 dB	≥10 dB decreasing linearly to 6 dB
NOTE The specifications in Table 5 are not applicable for splitters in Japan (see Clause B.4).			

5.4.3.9.2 Taps

The manufacturer shall publish the figures for isolation (between output and tap(s), or between all taps).

NOTE Subscriber taps should provide enough isolation from the output to each tap port or between all taps within one equipment to meet at least the system requirements of IEC 60728-1.

5.4.3.10 Intermodulation in splitters and taps

The manufacturer shall specify the maximum return path signal. For the requirements, see 5.3.4.8

5.5 Performance requirements and recommendations for all other passive equipment

5.5.1 Description

These equipment include

- transfer points;
- power injectors;
- cable splices;
- galvanic isolators;
- terminating resistors;
- filters;
- equalizers.

The quality grade shall be published.

5.5.2 Mechanical requirements for connectors

The type of cable connection used shall be published.

5.5.3 Electrical parameters and requirements

5.5.3.1 Return loss

The minimum return loss for the specified grade shall be according to Table 6.

Table 6 – Return loss for all other passive equipment

Frequency range	Requirement		
	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	≥22 dB	≥18 dB	≥14 dB
47 MHz to 950 MHz	≥(22 dB – 1,5 dB/octave)	≥(18 dB – 1,5 dB/octave)	≥(14 dB – 1,5 dB/octave) but ≥10 dB
950 MHz to 3 000 MHz	14 dB decreasing linearly to 10 dB	10 dB decreasing linearly to 6 dB	10 dB decreasing linearly to 6 dB
NOTE The specifications in Table 6 are not applicable for other passive equipment in Japan (see Clause B.5).			

For filters, no specifications shall be met within the stop band.

5.5.3.2 Frequency range

The operating frequency range shall be published.

For equipment with integral filters, a relaxation of 3 dB in return loss and isolation is permissible in the pass-band edges.

The pass-band edge is defined to be 8 MHz above the lower and 8 MHz below the upper cut-off frequency for AM-TV and, respectively, 30 MHz for FM-TV, 4 MHz for FM radio and 2 MHz for return path.

5.5.3.3 Insertion loss

The insertion loss and its tolerances shall be published.

5.5.3.4 Amplitude frequency response flatness

The flatness of the amplitude frequency response between input and output ports shall be published.

Narrowband peak-to-peak flatness shall be within 0,2 dB in a band of 0,5 MHz and 0,5 dB in a band of 7 MHz.

If the equipment incorporates a filter, the selectivity shall be published.

5.5.3.5 Group delay variation

The group delay variation in the specified frequency range shall be published.

5.5.3.6 Hum modulation

For equipment incorporating an a.c. bypass the value of the hum modulation shall be published in dB at the maximum specified powering current of the equipment.

Annex A
(informative)

Measurement errors which occur due to mismatched equipment

The matching condition when the error introduced by the mismatch of the equipment facing the EUT and that of the equipment under test (EUT) is acceptable. Examples of maximum errors of measurement results are given in Figure A.1 and Figure A.2.

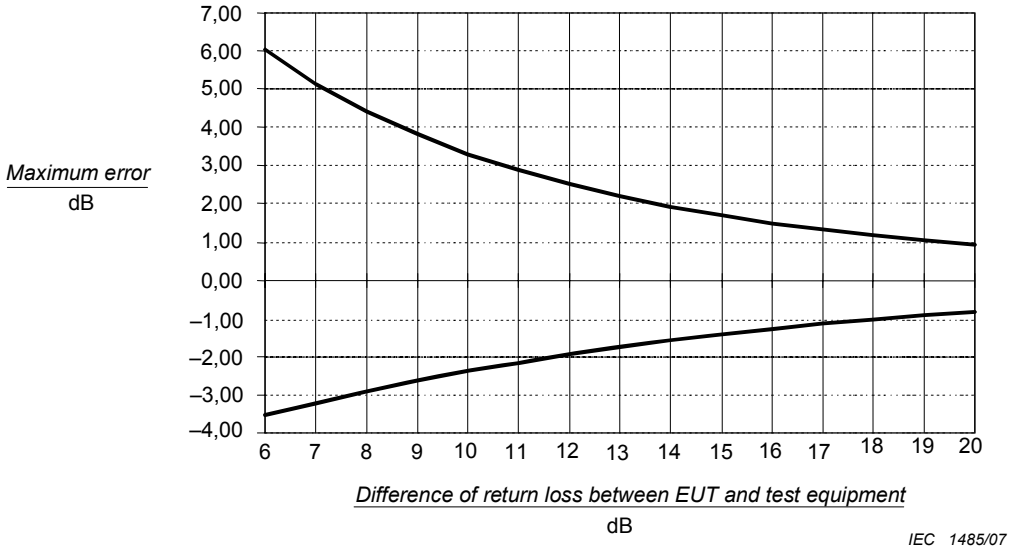


Figure A.1 – Error concerning return loss measurement

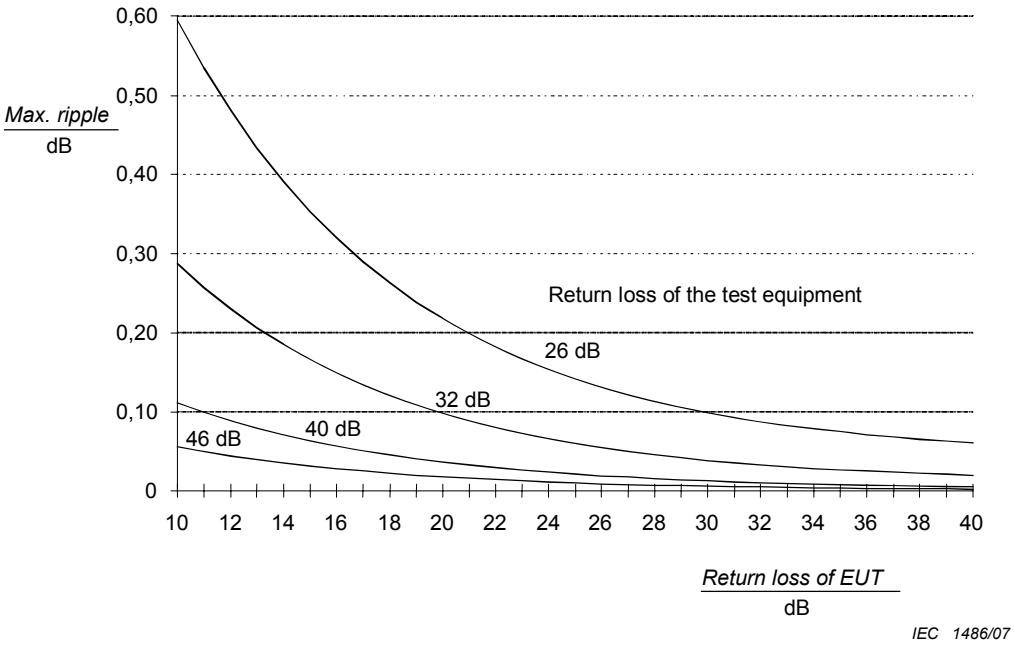


Figure A.2 – Maximum ripple

The return loss of test equipment should be at least 10 dB better than the expected EUT value.

Annex B
(informative)

Differences in some countries

B.1 Subclause 5.1.3, Finland

In Finland, all equipment installed in locations that are not temperature controlled should meet their requirements within the temperature range -40 °C to +55 °C.

B.2 Subclause 5.3, Table 2, Netherlands

(Dutch Technical Regulations for CATV networks (Technische Voorschriften voor Centrale Antenne Inrichtingen, 3e uitgave), 21 December 1977, which are valid for CATV networks in accordance with Article 21 of the Dutch Telecommunications law (Stb. 1988, 520)).

The use of looped system outlets is not allowed.

B.3 Subclause 5.3, Table 1 and Table 2, Japan

The specifications in Table 1 and 2 are under consideration for the system outlet in Japan.

B.4 Subclause 5.4, Table 4 and Table 5, Japan

The specifications in Table 4 and 5 are under consideration for splitters and taps in Japan.

B.5 Subclause 5.5, Table 6, Japan

The specifications in Table 6 are under consideration for other passive equipment in Japan.

Bibliography

IEC 60050-581, *International Electrotechnical Vocabulary – Chapter 581: Electromechanical components for electronic equipment*

IEC 60050-723, *International Electrotechnical Vocabulary – Chapter 723: Broadcasting: Sound, television, data*

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
P.O. Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch