

INTERNATIONAL STANDARD



**Cable networks for television signals, sound signals and interactive services –
Part 1-1: RF cabling for two way home networks**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
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 It also gives information on projects, withdrawn and replaced publications.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

INTERNATIONAL STANDARD



**Cable networks for television signals, sound signals and interactive services –
Part 1-1: RF cabling for two way home networks**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE

XA

ICS 33.060.30; 33.160.01

ISBN 978-2-88910-260-0

CONTENTS

| | |
|---|----|
| FOREWORD..... | 5 |
| INTRODUCTION..... | 7 |
| 1 Scope..... | 9 |
| 2 Normative references | 10 |
| 3 Terms, definitions, symbols and abbreviations..... | 12 |
| 3.1 Terms and definitions | 12 |
| 3.2 Symbols | 18 |
| 3.3 Abbreviations | 19 |
| 4 Methods of measurement for the home network..... | 20 |
| 5 Performance requirements of the home network..... | 21 |
| 5.1 General..... | 21 |
| 5.2 Impedance | 22 |
| 5.3 Performance requirements at the terminal input | 22 |
| 5.3.1 General | 22 |
| 5.3.2 Signal level..... | 22 |
| 5.3.3 Other parameters | 22 |
| 5.4 Performance requirements at system outlets | 23 |
| 5.4.1 Minimum and maximum carrier levels | 23 |
| 5.4.2 Mutual isolation between system outlets..... | 23 |
| 5.4.3 Isolation between individual outlets in one household..... | 23 |
| 5.4.4 Isolation between forward and return path | 23 |
| 5.4.5 Long-term frequency stability of distributed carrier signals at any system outlet..... | 23 |
| 5.5 Performance requirements at the HNI..... | 23 |
| 5.5.1 Minimum and maximum carrier levels at HNI1 | 23 |
| 5.5.2 Minimum and maximum carrier levels at HNI2 and HNI3..... | 23 |
| 5.6 Carrier level differences in the home network from HNI to system outlet..... | 23 |
| 5.7 Frequency response within a television channel in the home network..... | 24 |
| 5.7.1 General | 24 |
| 5.7.2 Amplitude response..... | 24 |
| 5.7.3 Group delay..... | 24 |
| 5.8 Random noise produced in the home network | 25 |
| 5.9 Interference produced into down stream channels within a home network | 25 |
| 5.9.1 General | 25 |
| 5.9.2 Multiple frequency intermodulation interference..... | 25 |
| 5.9.3 Intermodulation noise | 25 |
| 5.9.4 Crossmodulation..... | 26 |
| 6 Home network design and examples | 26 |
| 6.1 General..... | 26 |
| 6.2 Basic design considerations | 26 |
| 6.3 Implementation considerations | 27 |
| 6.4 Home networks with coaxial and balanced cables | 27 |
| 6.4.1 General | 27 |
| 6.4.2 Network examples | 27 |
| 6.4.3 Calculation examples | 28 |
| 6.4.4 General considerations..... | 38 |

| | | |
|-----------------------|---|----|
| 6.4.5 | Home network design in a MATV system | 39 |
| 6.4.6 | Return path examples..... | 39 |
| 6.5 | Different home network type (HNI3 Case C) (glass or plastic fibre optic network) | 39 |
| 6.6 | Different home network type (HNI3 Case D) | 40 |
| 6.6.1 | General | 40 |
| 6.6.2 | Wireless links inside the home network | 40 |
| 6.6.3 | Applications of IEEE 802.11 (WLAN) | 41 |
| 6.6.4 | Available bands in the 2 GHz to 6 GHz frequency range | 42 |
| 6.6.5 | Main characteristics of a WLAN signal | 42 |
| 6.6.6 | Main characteristics of coaxial cables | 43 |
| 6.6.7 | Characteristics of WLAN signals at system outlet | 43 |
| 6.6.8 | Characteristics of signals at the TV system outlet | 44 |
| 6.6.9 | Example of duplexers and power splitters near the HNI | 44 |
| 6.6.10 | Example of system outlet for coaxial TV connector and WLAN antenna | 44 |
| 6.6.11 | Examples of WLAN connection into home networks | 45 |
| Annex A (informative) | Wireless links versus cable links | 50 |
| Annex B (informative) | Isolation between radiating element and system outlet | 53 |
| Annex C (informative) | MIMO techniques of IEEE 802.11n | 55 |
| Bibliography | | 57 |
| Figure 1 | – Examples of RF home network types | 8 |
| Figure 2 | – Examples of location of HNI for various home network types | 15 |
| Figure 3 | – Examples of home network implementation using coaxial or balanced cables | 28 |
| Figure 4 | – Signal levels at HNI1 (flat splitter response) | 30 |
| Figure 5 | – Signal levels at HNI1 (+6 dB compensating splitter slope) | 31 |
| Figure 6 | – Signal levels at HNI2 (L_1) (flat splitter/amplifier response) | 32 |
| Figure 7 | – Signal levels at HNI2 (+6 dB compensating splitter/amplifier slope) | 32 |
| Figure 8 | – Signal levels at HNI3 (flat splitter/amplifier response) | 36 |
| Figure 9 | – Signal levels at HNI3 (+6 dB compensating splitter/amplifier slope) | 36 |
| Figure 10 | – Example of a home network using optical fibres | 39 |
| Figure 11 | – Example of a home network using cable connection and cable/wireless connection | 41 |
| Figure 12 | – Example of a coupler (tandem coupler) to insert WLAN signals into the home distribution network | 44 |
| Figure 13 | – Example of system outlet for coaxial TV connector and WLAN antenna | 44 |
| Figure 14 | – Assumed properties of the filters in the system outlet | 45 |
| Figure 15 | – Reference points for the examples of calculation of link loss or link budget | 45 |
| Figure B.1 | – Required isolation and attenuation of a cut-off waveguide, with cut-off frequency of 2 275 MHz and a length (L) of 25 cm or 15 cm | 53 |
| Figure C.1 | – Principle of MIMO techniques according to IEEE 802.11n | 55 |
| Table 1 | – Methods of measurement of IEC 60728-1 applicable to the home network | 21 |
| Table 2 | – Amplitude response variation in the home network | 24 |
| Table 3 | – Group delay variation in the home network | 24 |

| | |
|--|----|
| Table 4 – Example of home network implementation with coaxial cabling (passive) from HNI1 to system outlet | 33 |
| Table 5 – Example of home network implementation with coaxial cabling (active) from HNI2 to system outlet | 33 |
| Table 6 – Example of home network implementation with balanced pair cables (active) from HNI3 to coaxial terminal input (Case A) | 37 |
| Table 7 – Example of home network implementation with balanced pair cables (active) from HNI3 to coaxial system outlet (Case B)..... | 37 |
| Table 8 – Maximum EIRP according to CEPT ERC 70-03 | 42 |
| Table 9 – Available throughput of the WLAN signal..... | 43 |
| Table 10 – Minimum signal level at system outlet (WLAN antenna)..... | 43 |
| Table 11 – Loss from the system outlet to WLAN base station | 46 |
| Table 12 – Direct connection between two system outlets (TV outlets)..... | 47 |
| Table 13 – Link budget between a WLAN equipment and the “WLAN base station” | 47 |
| Table 14 – Wireless connection between two WLAN equipment..... | 48 |
| Table 15 – Connection from a SO to a WLAN equipment | 49 |
| Table A.1 – Maximum distance for a wireless link (WLAN) in free space or inside a home | 51 |
| Table A.2 – Maximum length of the cable..... | 52 |
| Table C.1 – MCSs that are mandatory in IEEE 802.11n | 56 |

Preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CABLE NETWORKS FOR TELEVISION SIGNALS,
SOUND SIGNALS AND INTERACTIVE SERVICES –****Part 1-1: RF cabling for two way home networks**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization 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 Standardization (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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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 60728-1-1 has been prepared by technical area 5: Cable networks for television signals, sound signals and interactive services, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

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

| FDIS | Report on voting |
|---------------|------------------|
| 100/1622/FDIS | 100/1645/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.

A 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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

- CATV¹-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, 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.

The reception of television signals inside a building requires an outdoor antenna and a distribution network to convey the signal to the TV receivers.

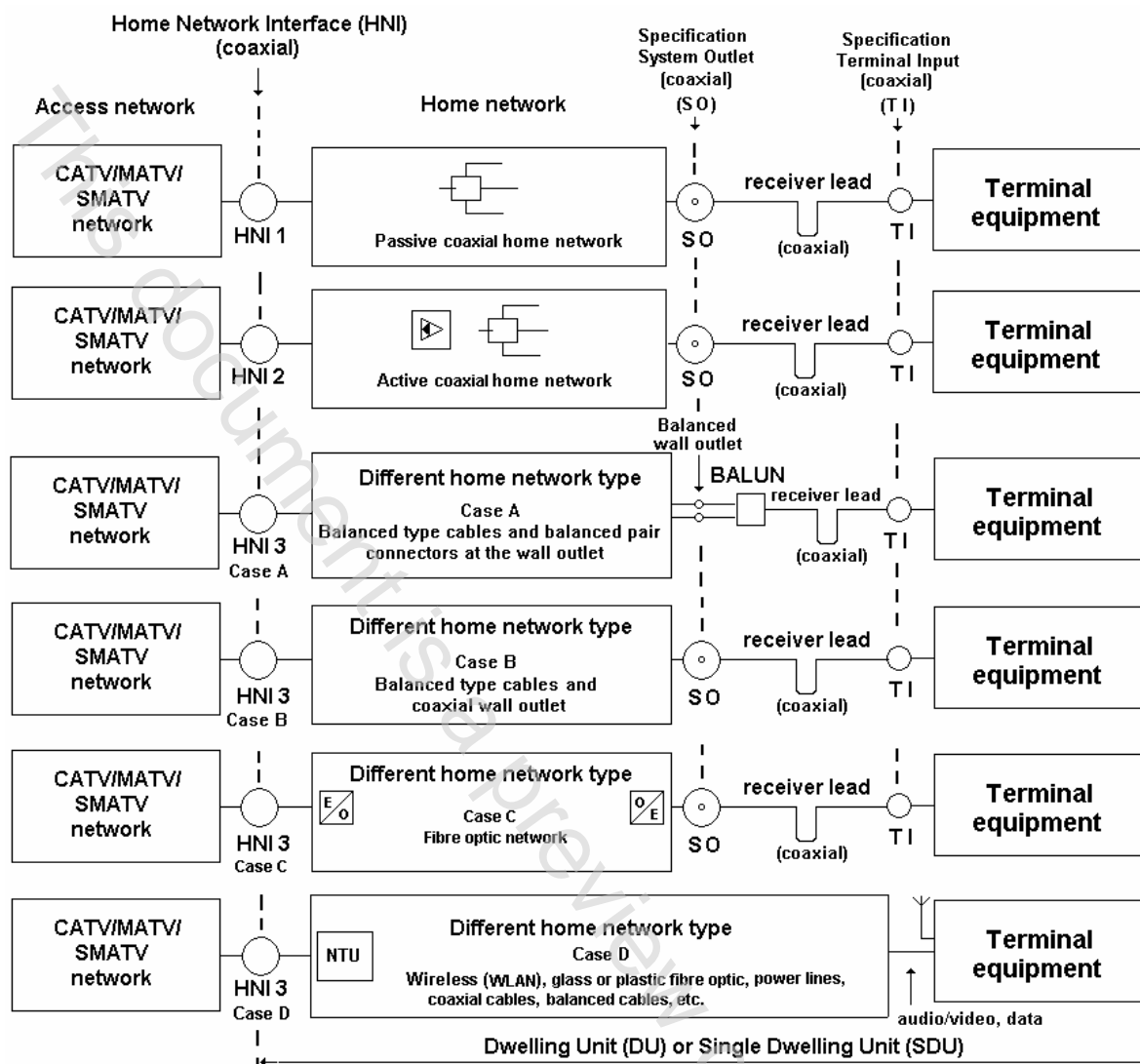
This part of the IEC 60728 deals with the requirements and implementation guidelines for a home network that can be realised with different techniques. The following types of home networks (HN) are possible:

- passive coaxial home network;
- active coaxial home network;
- different home network types.

Figure 1 shows typical situations that are possible when considering RF home networks.

The RF home network can be realised using coaxial cables, balanced cables, optical cables or radio links.

¹ This word encompasses the Hybrid Fibre Coaxial (HFC) networks used nowadays to provide telecommunications services, voice, data and audio and video both broadcast and narrowcast.



IEC 2523/09

Figure 1 – Examples of RF home network types

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

Part 1-1: RF cabling for two way home networks

1 Scope

This part of IEC 60728 provides the requirements and describes the implementation guidelines of RF cabling for two-way home networks; it is applicable to any home network that distributes signals provided by CATV/MATV/SMATV cable networks (including individual receiving systems) having a coaxial cable output. It is also applicable to home networks where some part of the distribution network uses wireless links, for example in place of the receiver cord.

This part of IEC 60728 is therefore applicable to RF cabling for two-way home networks with wired cords or wireless links inside a room and primarily intended for television and sound signals operating between about 5 MHz and 3 000 MHz. The frequency range is extended to 6 000 MHz for distribution techniques that replace wired cords with a wireless two-way communication inside a room (or a small number of adjacent rooms) that uses the 5 GHz to 6 GHz band.

In a building divided into apartment blocks, the distribution of the signals inside the home starts from the home network interface (HNI) up to the system outlet or terminal input. The requirements at the system outlet are given in IEC 60728-1, Clause 5 and the requirements at the HNI are given in IEC 60728-1, Clause 7. In Clause 5 of this standard additional requirements are given.

This standard deals with various possibilities to distribute signals in a home network, using coaxial cables, balanced pair cables, fibre optic cables (glass or plastic) and also wireless links inside a room (or a small number of adjacent rooms) to replace wired cords.

This standard gives references to basic methods of measurement of the operational characteristics of the home cable network in order to assess its performance.

All requirements refer to the performance limits, which are obtained between the input(s) at the home network interface (HNI) and the output at any system outlet when terminated in a resistance equal to the nominal load impedance of the system, unless otherwise specified. Where system outlets are not used, the above applies to the terminal input.

NOTE 1 If the home network is subdivided into a number of parts, using different transmission media (e.g. coaxial cabling, balanced cabling, optical cabling, wireless links) the accumulation of degradations should not exceed the figures given below.

NOTE 2 Performance requirements of return paths as well as special methods of measurement for the use of the return paths in cable networks are described in IEC 60728-10.

Clause 5 defines the performance limits measured at system outlet or terminal input for an unimpaired (ideal) test signal applied at the HNI. Under normal operating conditions for any analogue channel and meeting these limits, the cumulative effect of the impairment of any single parameter at the HNI and that due to the home network will produce picture and sound signals not worse than Grade four on the five-grade impairment scale contained in ITU-R BT.500. These requirements are given in IEC 60728-1-2. For digitally modulated signals the quality requirement is a QEF (Quasi Error Free) reception.

This standard describes the physical layer connection for home networks. Description of protocols required for Layer 2 and higher layers is out of the scope of this standard. Logical connections between devices within the home network are therefore not always guaranteed.

2 Normative references

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

IEC 60050-705, *International Electrotechnical Vocabulary – Chapter 705: Radio wave propagation*

IEC 60050-712, *International Electrotechnical Vocabulary – Chapter 712: Antennas*

IEC 60050-725, *International Electrotechnical Vocabulary – Chapter 725: Space radiocommunications*

IEC 60617, *Graphical symbols for diagrams*

IEC 60728-1:2007, *Cable networks for television signals sound signals and interactive services – Part 1: System performance of forward paths*

IEC 60728-1-2, *Cable networks for television signals sound signals and interactive services – Part 1-2: Performance requirements for signals delivered at system outlet in operation*

IEC 60728-3:2005, *Cable networks for television signals sound signals and interactive services – Part 3: Active wideband equipment for coaxial cable networks*

IEC 60728-10, *Cable networks for television signals, sound signals and interactive services – Part 10: System performance of return paths*

IEC 60966 (all parts), *Radio frequency and coaxial cable assemblies*

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 MHz 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 MHz 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 MHz to 3 000 MHz, IEC 61169-24 connectors*

IEEE 802.11, 1999 *IEEE Standards for Information Technology – Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Network – Specific Requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*²

² Parts of IEEE 802.11 are reproduced in ISO/IEC 8802-11:2005, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specification*

IEEE 802.11a-1999, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications – Amendment 1: High-speed Physical Layer in the 5 GHz band*

IEEE 802.11b-1999 Supplement to 802.11-1999, *Wireless LAN MAC and PHY specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band*

IEEE 802.11e-2005, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Amendment 8: Medium Access Control (MAC) Quality of Service Enhancements*

IEEE 802.11g-2003 *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications – Amendment 4: Further Higher-Speed Physical Layer Extension in the 2.4 GHz Band*

IEEE 802.11h-2003 *IEEE Standard for Information technology – Telecommunications and Information Exchange Between Systems – LAN/MAN Specific Requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Spectrum and Transmit Power Management Extensions in the 5GHz band in Europe*

IEEE 802.11n/D4.0, March 2008 Active Unapproved Draft – *IEEE Draft STANDARD for Information Technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Amendment 4: Enhancements for Higher Throughput*

IEEE 802.16-2004 *IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems (WiMax)*

ITU-R Recommendation BT.500, *Methodology for the subjective assessment of the quality of television pictures*

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

ITU-T Recommendation J.63, *Insertion of test signals in the field-blanking interval of monochrome and colour television signals*

EN 50117-2-4, *Coaxial cables – Part 2-4: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz to 3000 MHz*

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

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

ETSI EN 300 473, *Digital Video Broadcasting (DVB): 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*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 60050-705, IEC 60050-712 and IEC 60050-725, apply.

NOTE The most important definitions are repeated below.

3.1.1

active home network

home network that uses active equipment (for example, amplifiers) in addition to passive equipment like splitters, taps, system outlets, cables and connectors up to the coaxial RF interface (input and/or output) of the terminal equipment for distributing and combining RF signals

3.1.2

antenna

that part of a radio transmitting or receiving system which is designed to provide the required coupling between a transmitter or a receiver and the medium in which the radio wave propagates

NOTE 1 In practice, the terminals of the antenna or the points to be considered as the interface between the antenna and the transmitter or receiver should be specified.

NOTE 2 If the transmitter or receiver is connected to its antenna by a feeder line, the antenna may be considered to be a transducer between the guided radio waves of the feeder line and the radiated waves in space.

[IEV 712-01-01]

3.1.3

attenuation

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

3.1.4

balun

device for transforming an unbalanced voltage to a balanced voltage or vice-versa. The term is derived from balanced to unbalanced transformer.

3.1.5

bit error ratio

BER

ratio between erroneous bits and the total number of transmitted bits

3.1.6

broadcast and communication technologies

BCT

group of applications including RF distribution of sound signals and video signals

NOTE For this standard, this is a group of applications using the HF band (3 MHz to 30 MHz), the VHF band (30 MHz to 300 MHz) and the UHF band (300 MHz to 3 000 MHz) for transmission of television signals, sound signals and interactive services, as well as for in-home inter-networking.