



Access, Terminals, Transmission and Multiplexing (ATTM); Singlemode Optical Fibre System Specifications for Home Cabling

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ETSI TS 103 247 V1.1.1-2015-09

Reference

DTS/ATTM-02008-2

Keywords

cable, fibre, network, optical

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

Modal verbs terminology

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Introduction

Singlemode non-dispersion shifted optical fibres with step-index according to CENELEC EN 60793-2-50 [5] with cladding diameter of 125 μm (referred to as SM in the present document) are mostly deployed in telecommunication networks. The rise of available transmission [bandwidth](#) per fiber is even significantly faster than e.g. the increase of storage capacity of electronic memory chips, or the increase of computation power of microprocessors. The main advantages of SM are:

- SM is the current communication wireline with the biggest bandwidth (up to 160 Gbit/s)
- SM is the current optical waveguide with the lowest optical losses (< 0,25 dB/km at 1 550 nm, see figure 1)
- SM is the waveguide with the best possibilities for wavelength multiplexing
- SM optical connections have the best developed theory for optical interface with narrow uncertainties
- There are reasonable compatibilities for connecting SM fibres of different types (considering losses)
- Complete immunity to electromagnetic interference (EMI)
- Compared with electrical cables, fiber-optic cables are very lightweight

For all these reasons, SM is potentially the best and most sustainable solution for all telecommunication networks.

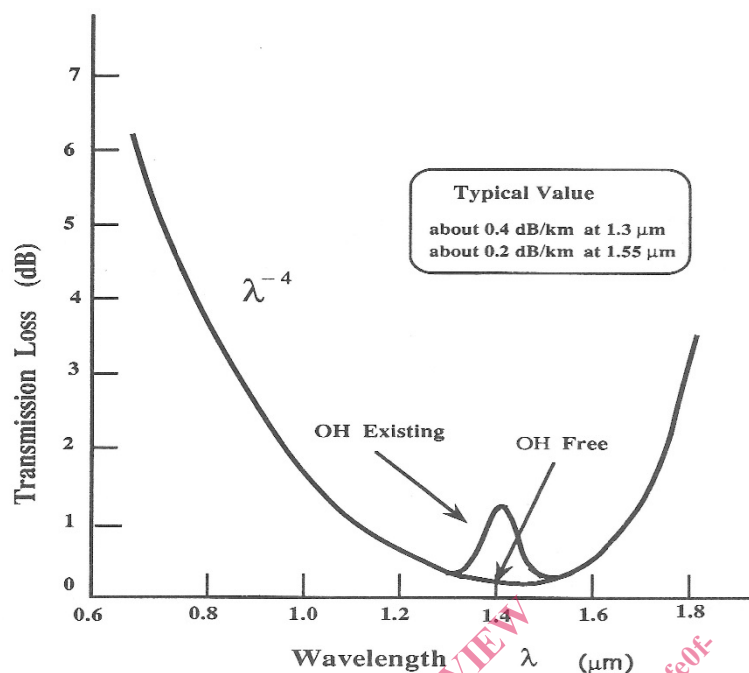


Figure 1: Singlemode fibre attenuation versus wavelength

The home network should not represent a bottleneck for the expected evolution for services such as the introduction of High Definition quality IPTV, multi-room/multi-vision configuration, using different channels seen in different rooms with up to 3 Set Top Boxes (STBs) and high quality video communication via the TV set. More in general, with the "Connected Home", several devices are connected together: the home network can be used, for example, to share multimedia contents not necessarily delivered in real time by access network, but with the paradigm of "download and play" this content can be stored in a device inside the house and use it afterwards. However, this residential network cabling should be easy, fast and cheap to deploy.

The home network should be able to manage multiformat and multiservice characteristics of the information delivered by different service providers.

1 Scope

The present document specifies the SM cabling system for multiformat and multiservices optical home area network (HAN) for interoperability among different suppliers. The system comprises of the active optical elements, the cables, connectors and wall plugs.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
- [2] IEEE 802.3: "LAN/MAN CSMA/CD (Ethernet) Access Method".
- [3] CENELEC EN 50399: "Common test methods for cables under fire conditions - Heat release and smoke production measurement on cables during flame spread test - Test apparatus, procedures, results".
- [4] ETSI TS 101 791: "Transmission and Multiplexing (TM); Dense wavelength division multiplexing devices; Common requirements and conformance testing".
- [5] CENELEC EN 60793-2-50: "Optical fibres - Part 2-50: Product specifications - Sectional specification for category B singlemode fibres".
- [6] CENELEC EN 60825-1: "Safety of laser products - Part 1: Equipment classification and requirements".
- [7] CENELEC EN 60875-1: "Fibre optic interconnecting devices and passive components - Non-wavelength-selective fibre optic branching devices - Part 1: Generic specification".
- [8] CENELEC EN 61753-031-2/Ed2: "Fibre optic interconnecting devices and passive components - Performance standard - Part 031- 2: Non-connectorised single-mode 1×N and 2×N non-wavelength-selective branching devices for Category C - Controlled environment".
- [9] CENELEC EN 62074-1: "Fibre optic interconnecting devices and passive components - Fibre optic WDM devices - Part 1: Generic specification".
- [10] CENELEC EN 61754-series: "Fibre optic connector interfaces".
- [11] CENELEC EN 61755 series: " Fibre optic connector optical interfaces".
- [12] EU: "Code of Conduct on Energy Consumption of Broad Band Equipment", version 3 18 November 2008.
- [13] IEC 60884-1: "Plugs and socket-outlets for household and similar purposes - Part 1: General requirements".

- [14] ISO/IEC 8802-3: "Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirements -- Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".
- [15] CENELEC EN 60950-1: "Information technology equipment - Safety - Part 1: General requirements".
- [16] Recommendation ITU-T G.671: "Transmission media and optical systems characteristics - Characteristics of optical components and subsystems, Transmission characteristics of optical components and subsystems".
- [17] Recommendation ITU-T G.9960 (G.hn).
- [18] Recommendation ITU-T K.21: "Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents".
- [19] ETSI ETS 300 019-2-3: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-3: Specification of environmental tests; Stationary use at weatherprotected locations".
- [20] CENELEC EN 50173-1: " Information technology - Generic cabling systems - Part 1: General requirements and office areas".
- [21] CENELEC EN 61755-1: " Fibre optic connector optical interfaces - Part 1: Optical interfaces for single mode non-dispersion shifted fibres - General and guidance".
- [22] CENELEC EN 60794-2 series: "Optical fibre cables; part 2: Indoor cables - Sectional specification".
- [23] CEN EN 13501-6: "Fire Classification of Construction Products and Building elements - Part 6: Classification using test data from reaction to fire tests on electric cables".
- [24] CENELEC EN 60794-1-21: "Optical fibre cables - Part 1-21: Generic specification - Basic optical cable test procedures - Mechanical Tests Methods".
- [25] CENELEC EN 60332-1-2: "Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame".
- [26] CENELEC EN 50267-2-3: Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables - Part 2-3: Procedures - Determination of degree of acidity of gases for cables by determination of the weighted average of pH and conductivity".
- [27] CENELEC EN 61754-20: "Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 20: Type LC connector family".
- [28] CENELEC EN 61754-4: "Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 4: Type SC connector family".
- [29] CENELEC EN 61754-29: "Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 29: Type BLINK connector series".
- [30] CENELEC EN 61754-30: " Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 30: Type CLIK connector series".
- [31] CENELEC EN 61755-1: "Fibre optic connector optical interfaces - Part 1: Optical interfaces for single mode non-dispersion shifted fibres - General and guidance".
- [32] CENELEC EN 61755-2-1: "Fibre optic connector optical interfaces - Part 2-1: Optical interface standard single mode non-angled physically contacting fibres".
- [33] CENELEC EN 61755-2-2: "Fibre optic connector optical interfaces - Part 2-2: Optical interface standard single mode angled physically contacting fibres".

- [34] CENELEC EN 61755-3-1: "Fibre optic connector optical interfaces - Part 3-1: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia PC ferrule, single mode fibre".
- [35] CENELEC EN 61755-3-2: "Fibre optic connector optical interfaces - Part 3-2: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia ferrules for 8 degrees angled-PC single mode fibres".
- [36] CENELEC EN 61300-3-6: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-6: Examinations and measurements - Return loss".
- [37] CENELEC EN 61300-3-34: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-34: Examinations and measurements - Attenuation of random mated connectors".
- [38] CENELEC EN 61300-3-4: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-4: Examinations and measurements - Attenuation".
- [39] CENELEC EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".
- [40] CENELEC EN 55024: "Information technology equipment - Immunity characteristics - Limits and methods of measurement".
- [41] CENELEC EN 61753-031-2: "Fibre optic interconnecting devices and passive components - Performance standard - Part 031-2: Non-connectorized single-mode 1×N and 2×N non-wavelength-selective branching devices for Category C - Controlled environment".
- [42] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC Text with EEA relevance 2012/27/EU.
- [43] Code of Conduct for Broadband Equipment version 3, 18 November 2008.
- [44] Recommendation ITU-T G.657: "Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network".
- [45] Recommendation ITU G.652: "Characteristics of a single-mode optical fibre and cable".
- [46] EN 60794-1-22: "Optical fibre cables - Part 1-22: Generic specification - Basic optical cable test procedures - Environmental Tests Methods".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] IEEE 802.3u: "Local and Metropolitan Area Networks-Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30)".
- [i.2] IEEE 802.3x: "IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation".
- [i.3] IEEE 802.1Q: "IEEE Standard for Local and Metropolitan Area Networks - Virtual Bridged Local Area Networks".
- [i.4] IEEE 802.1p: "IEEE Standard for Local and Metropolitan Area Networks - Supplement to Media Access Control (MAC) Bridges: Traffic Class Expediting and Dynamic Multicast Filtering".

- [i.5] IEEE 802.1D: "IEEE Standard for Local and metropolitan area networks: Media Access Control (MAC) Bridges".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in Recommendation ITU G.671 [16] and the following apply:

access point: physical point where terminal equipment can be connected on physical interface (Home Network Extender) like RJ45®, etc.

global link: transmission link between transmitter and receiver of two connected systems

global link loss: loss of the global link comprising loss of the permanent link and all additional optical elements losses

home network extender: access point located in each room and capable to give access to the multiformat services at the customer by multiplexing (uplink) and demultiplexing (down link)

Home Area Network (HAN): network of optical fibres in homes that considers convergence of communication multiformat services and extends an access from a carrier's central office, broadcast terrestrial, cable or satellite TV or other networks (ICT, BCT, CCCB, etc.)

multiformat: different format of signal (Ethernet, broadcasted TV, Phone, etc.)

multiformat link: link capable to transport over a single medium multiformat signals from the multiformat switch to the extender

multiformat switch: active equipment able to multiplex multiformat signals

multiservice: several services like telephone, TV, Internet, etc.

permanent link: part of the transmission link comprising fixed cabling (fibre and permanent optical elements) with one connector at each end

permanent link loss: loss of the permanent link comprising fibre and permanent optical elements losses

point-to-point link: direct link from one physical point to another physical point
Point-to-MultiPoint link: link from one physical point to several physical points

multiPoint-to-multipoint link: link from several physical points to several physical points

triple play services: triple-play service scenario is one in which voice, video and data are all provided in a single access subscription

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACS	Auto Configuration Server
AP	Access Point
APC	Angled Physical Contact
BCT	Broadcast and Communications Technology
BIDI	Bidirectional
BO	Broadcast Outlet
BOL	Begin-Of-Life
CATV	Cable TV
CCCB	Commands, Controls and Communications in Buildings
CPE	Customer Premises Equipment
CPR	Construction Product Regulation
CWDM	Coarse Wavelength Division Multiplexing
DFB	Distributed feedback

DIY	Do It Yourself
DVB	Digital Video Broadcasting
DVB-S	Digital Video Broadcasting - Satellite
DVB-T	Digital Video Broadcasting - Terrestrial
DWDM	Dense Wavelength Division Multiplexing
EMI	Electro Magnetic Interference
EOL	End-Of-Life
Ext	Extender
FMT	Fibre Management Tray
FSAN	Full Service Access Network
FTTH	Fiber To The Home
GL	Global Link
GOF	Glass Optical Fibre
GPON	Gigabit Passive Optical Network
GTW	Gateway
HAN	Home Area Network
HD	Home Distributor
HDMI	High Definition Multimedia Interface
HG	Home Gateway
ICT	Information and Communications Technology
IP	Internet Protocol
IPTV	Internet Protocol Television
LAN	Local Area Network
LC	Lucent Connector
LD	Laser Diode
LNB	Low Noise Block
MAC	Media Access Control
MC	Mediaconverters
MS	Multiformat Switch
MTBF	Mean Time Between Failures
OFE	Optical FrontEnd
ONT	Optical Network termination
OTO	Optical Telecommunication Outlet
P2P	Point-to-Point
PC	Physical Contact
PCI	Peripheral Component Interconnect
PD	Photo Diode
PF	Perfluorinated
PIN	Positive Intrinsic Negative
PL	Permanent Link
POF	Plastic Optical Fibre
PON	Passive Optical Network
PVC	PolyVinyl Chloride
QoE	Quality of Experience
QoS	Quality of Service
RF	Radio Frequency
RoF	Radio over Fibre
RoHS	Restriction of the Use of Certain Hazardous Substances
SC	Subscriber Connector
SEF	Subscriber Entry Facilities
SFP	Small Form-factor Pluggable
SM	Single Mode
STB	Set Top Box
SW	Switch
TDMA	Time division multiple access
TO	Telecommunications Outlet
TOS	Type of Service
TV	Television
TVoIP	Television over IP
TX	Tranceiver
UHF	Ultra High Frequency
UTP5	Unshielded Twisted Pair (Category 5)

UWB	Ultra Wide Band
VAC	Volts Alternating Current
VCSEL	Vertical Cavity Surface Emitting Laser
VDSL2	Very high bit-rate Digital Subscriber Line
VLAN	Virtual Local Area Network
WDM	Wavelength Division Multiplexing

4 HAN architecture evolution

4.1 Introduction

HAN includes active and passive networks deployed at the customer's site (apartment or building) between the Home Distributor (HD) and the end-user devices (TV, PC, telephone, surveillance, etc.).

The Home Distributor is located at the SEF (Subscriber Entrance Facilities) and includes the ENTI (External Network Testing Interface) and active equipments (CPE as Customer Premises Equipment) like Home Gateway (HG), Multiformat Switch (MS), etc.

The HD is connected with optical links to optical TO/BO (Telecommunications Outlet/Broadcast Outlet) where the end-user devices are connected via converters or extenders if needed.

The inputs to STB from terrestrial TV and satellite TV should be copper or fibre cables.

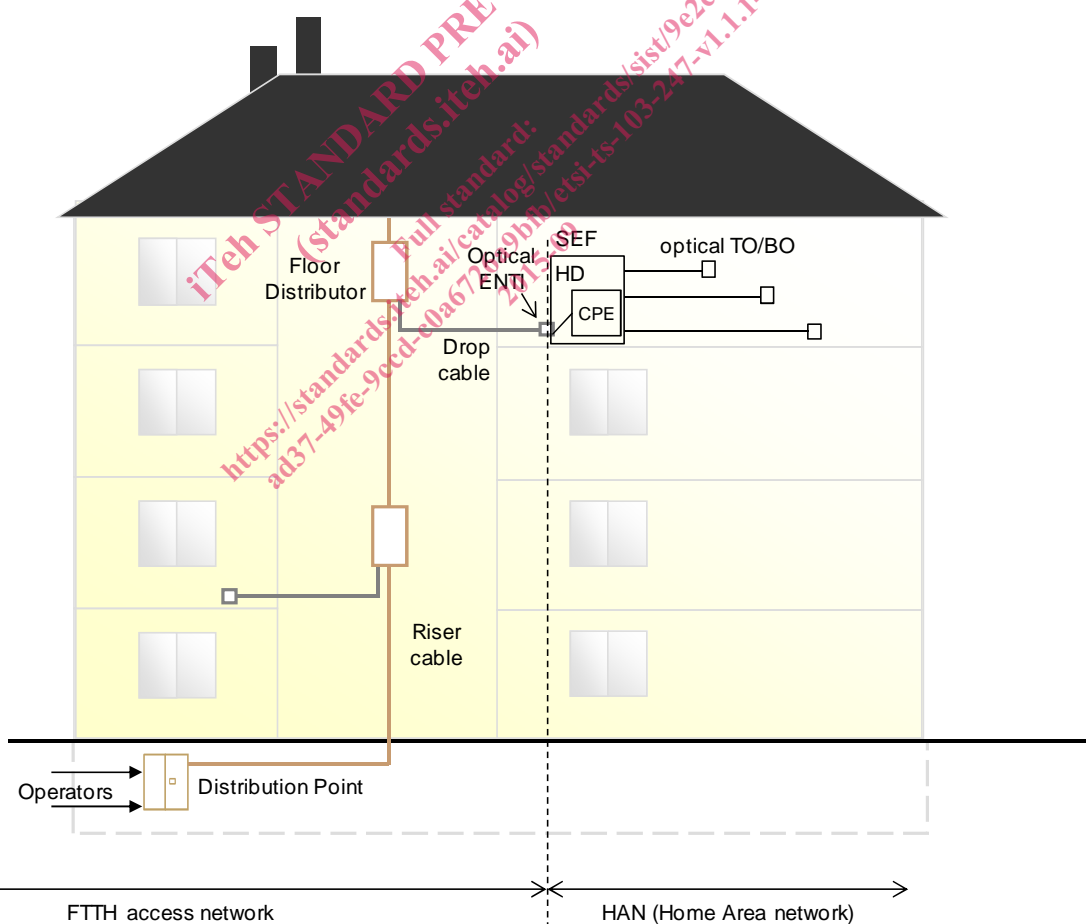


Figure 2: FTTH and HAN cabling system scope

Increasing the bit rate to meet the requirements related to the richness of the contents and high interactivity, and taking into account the heterogeneity of the signals to be delivered are the two major challenges which drive the HAN evolutions.

Data exchanges (traffic) have drastically increased in the Home Area Network (HAN) these last years and this expansion is expected to indubitably go on for a long time. First, because significant progress has been accomplished during the last years in the access networks: with continuously increasing bit rate on copper networks thanks to xDSL technologies, or as well with the Fiber-To-The-Home (FTTH) deployments, it is now possible to deliver rich contents up to the user's door. The second reason is the steadily increasing number of interconnected devices inside the home, implementing multi-Gigabit interfaces such as USB-3 (4,8 Gbit/s) or Thunderbolt (10 Gbit/s).

However, besides the need for high capacity, another major challenge lies in the great heterogeneity of signals to be delivered in the home. Actually, the HAN is the convergence point of many competing worlds, as computer, telecommunication, consumer electronics and several types of signals have to be considered: IP data for triple play services, Radio Frequency (RF) signals for broadcast TV (terrestrial, satellite or cable TV), specific formats as High Definition Multimedia Interface (HDMI) signals or related to various very high bit rate interfaces for example. Today, separate network segments are used in the home, each carrying one type of service (Ethernet cables for IP data, coaxial cable for broadcasted terrestrial or satellite TV, HDMI cables for high definition digital video). This situation is expected to be soon unacceptable by the customer, and the only solution is a structured home network able to carry all these signals on a unique convergent infrastructure. In addition, to guarantee effectiveness, safety and comfort in use, the medium used to realize the HAN is expected to be integrated inside the walls of the home: singlemode optical fiber then appears as a very good candidate to implement such a multifunction and future-proof network, as its performances allows facing further evolutions of HAN requirements.

4.2 HAN architectures

4.2.1 Different architecture

Today, the HAN architecture is a single format active star network dedicated to services based on Ethernet or IP technology. Two other multifunction architectures, taking into account additional types of signals encountered in the home, are described in the present document: the first one, a mid-term approach, is based on multifunction active star architecture, while the second one is a longer term solution based on a passive star and CWDM technology.

4.2.2 Single format HAN

Most home networks are presently based on a single format active star. A Home Gateway typically placed at the apartment entrance, where the external access network is terminated with the ENTI (External Network Testing Interface), acts as a central switch, being the node of an active star. Customer's premises are connected to this Home Gateway through point-to-point (P2P) links (or wireless links), as shown at figure 3. Only one type of data, based on Ethernet or IP protocols, is supported by this single format network.



Figure 3: Point-to-Point IP architecture