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Integrated Broadband Cable Telecommunication Networks (CABLE); Cable Equipment Operations within its Frequency Band

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Integrated broadband cable telecommunication networks (CABLE).

Modal verbs terminology

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Introduction

As written in the scope the signal characteristics are defined across the operating frequency and in accordance with network equipment built to European standards.

Clause 4 gives an overview of the cable network system architecture characteristics to support delivery of a wide range of digital entertainment and informational programming via the use of a hybrid fibre/coaxial network. It provides details of the frequency allocation and usage for digital television signals carried on the cable plant using channelization though different modulation. This clause presents also characteristcis of the various signals delivered to the non-radio end user equipment for fixed broadcasting and broadband electronic communication services, in particular those services delivered by cable operators in Europe, analogue television, digital television, telephony and high speed data (internet).

Clause 5 gives details of the signal characteristics of European CATV systems and their protection criteria in terms of the minimum and maximum signal levels and the signal to noise level thresholds before the desired signal is disturbed to a level that impacts its reception by the non-radio end user equipment for fixed broadcasting and broadband electronic communication services. Three instances of harmful interference from new radio services (NRS) operating in the frequency bands occupied currently by cable networks is considered , the first is between the NRS and coaxial part of the network (both in-home and external), the second is defined between the NRS system and a remote cable headend receiver and the third type of interference is defined from the NRS system on the non-radio end user equipment itself (e.g. cable modem, settopbox, digital cable receivers, etc.).

Clause 6 gives calculation methods in terms of the limits of unwanted signals and their relevant characteristcis that can influence the reception of the delivered signal by the cable network to non-radio end user equipment for fixed broadcasting and broadband electronic communication services. Equations are derived based on noise margins and maximum interference levels for calculations of acceptable limits across different operating frequency ranges and modulations. The limits derived are based on the characteristcis of cable distribution networks built according to European standards and industry best practices. Calculations of maximum EIRP limits for no degradable service (dBm) i.e. to mitigate impact to the non-radio end user equipment for fixed broadcasting and broadband electronic communication services are presented in relation to the distance between the radio transmitter and cable system. The graphs given present typical use cases with modulation and signal maximum and minimum levels as operated by European cable networks.

Clause 7 contains references to experiments that are representative as realistic situations with respect to the calculated results.

Clause 8 gives a summary of the potential impact from new radio services operating within the frequency bands currently used by cable networks to non-radio end user equipment for fixed broadcasting and broadband electronic communication services.

1 Scope

The present document defines the transmitted signal characteristcis delivered across a HFC cable network to the customer network interfaces distributed within the home network received and processed by the consumer end terminals for reception of multimedia services.

The signal characteristics are defined across the operating frequency and in accordance with network equipment built to European standards.

The present document provides valuable input to engineers and developers containing the technical basis to take into account when developing harmonized technical conditions for new radio services operating in the same frequency range as currently occupied by cable distribution networks.

It presents the technical basis for coexistence between these new radio services and existing non-radio end-user equipment for fixed broadcasting and broadband electronic communication services, specifically those services delivered by European cable based systems (PAL/SECAM, DVB-C, Euro-DOCSIS).

The impact to non-radio end user equipment for fixed broadcast and broadband electronic communication services is given in terms of the operational characteristics of the wanted signals and tolerable limits of the unwanted signals as a factor of the distance between them before the unwanted interfering signal will disrupt the end users equipment for fixed broadcasting and broadband electronic communication services (e.g. digital and analogue television, internet high speed data and telephony services).

2 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.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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

2.1 Normative references

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

[1] CENELEC EN 60728-1: "Cable networks for television signals, sound signals and interactive services - Part 1: System performance of forward paths".

NOTE: This European Standard supersedes EN 50083-7:1996 + A1:2000 + corrigendum August 2007.

[2] ETSI TS 102 639-2: "Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 2: Physical Layer [ITU-T Recommendation J.222.1 (07/2007), modified]".

[3] Recommendation ITU-T J.222.1: "Third-generation transmission systems for interactive cable television services - IP cable modems: Physical layer specification".

[4] CENELEC EN 50083-2: "Cable networks for television signals, sound signals and interactive services = Part2: Electromagnetic compatibility for equipment".

[5] CENELEC EN 50117-2-1:2005+A1:2008: "Coaxial cables - Part 2-1: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz - 3000 MHz".

[6] CENELEC EN 50289-1-6:2002: "Communication cables - Specifications for test methods - Part 1-6: Electrical test methods - Electromagnetic performance".

[7] CENELEC EN 55020: "Sound and television broadcast receivers and associated equipment - Immunity characteristics - Limits and methods of measurement".

[8] CISPR 20: "Sound and television broadcast receivers and associated equipment - Immunity characteristics - Limits and methods of measurement".

[9] G531/01077/09: "Measurement Report: Immunity of integrated TV receivers, settop boxes and data-modems connected to broadband cable and TV networks against radiation from LTE user equipment". .

[10] PG ESKM: Final Report - Project Group: "Investigation of EMC scenarios cable/radio with mobile applications in the frequency range 470 MHz to 862 MHz" of the EMC group of the ATRT.

[11] Carl T. Jones Testing 2008/2009: "Carl-T Jones, TVBD direct pickup interference tests, 2009".

[12] ETSI EN 300 429: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for cable systems".

2.2 Informative references

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.

Not applicable.

3 Symbols and abbreviations

3.1 Symbols

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

dB	decibel
dBm	decibel-milliwatt
dBmV	decibel-millivolt
dBuV	decibel microvolt
dBuV/m	decibel microvolt per meter
E [V/m]	electric field in Volts/meter
k [1/m]	Antenna factor for half wavelength dipole
MHz	Mega Hertz
Ohm	SI unit of electrical resistance
U [V]	induced voltage in volts
W	Watts

3.2 Abbreviations

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

BER	Bit Error Rate
BS	Base Station
C/I	Carrier to Interference
C/N	Carrier to Noise
CATV	Cable Television
CISPR	Comité international spécial des perturbations radioélectriques
CM	Cable Modem
CMTS	Cable Modem Termination System
DVB-C	Digital Video Broadcasting for Cable
EIRP	Equivalent Isotropically Radiated Power
EMI	Electromagnetic Interference

ESKM	EMC Scenario's Cable and Mobile
Euro-DOCSIS	European Data Over Cable Service Interface Specification
FEC	Forward Error Correction
FM	Frequency Modulation
HE	Headend
HFC	Hybrid Fibre Coax
IP	Internet Protocol
LTE	Long Term Evolution
MPEG2	Motion Picture Experts Group 2
NCTA	National Cable & Telecommunications Association
NRS	New Radio Services
NTSC	National Television System Committee
ON	Optical Node
PAL	Phase Alternative Line
PDU	Protocol Data Unit
PG ESKM	Project Group EMC Scenario's Cable and Mobile
PG	Project Group
PID	Packet Identifier
PSI/SI	Program Specific Information/Service Information
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
SECAM	Sequential Color With Memory
STB	Settopbox
TDM	Time Division Multiplexing
TS	Terminal Station
TS	Transport Stream
TV	Television
TVBD	Television Band Device
UE	User Equipment
US	Upstream
USA	United States of America
VOD	Video on Demand
WDM	Wavelength Division Multiplexing
WSD	White Space Device

4 Cable Network Architecture Characteristics

The architecture of an HFC network is shown in figure 1. A digital backbone is used to bring the different signals to the headends (HE in the figure). From each headend fibers are used to connect to the different optical nodes in the field. The part between the headend and optical node is shown in more detail in figure 2.

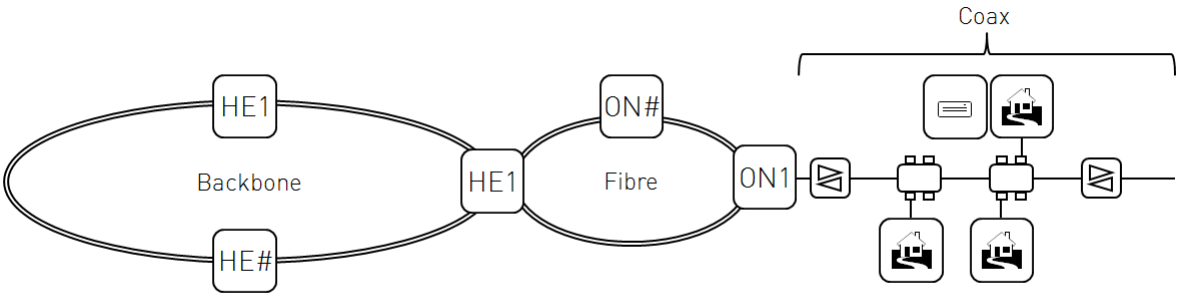

Figure 1: Architecture of cable network

Logically, two fibers are used between each node and the headend. One for the downstream (forward) signal and one for the upstream (return) signal. It is possible to also carry multiple signals over a single fiber using techniques like WDM.

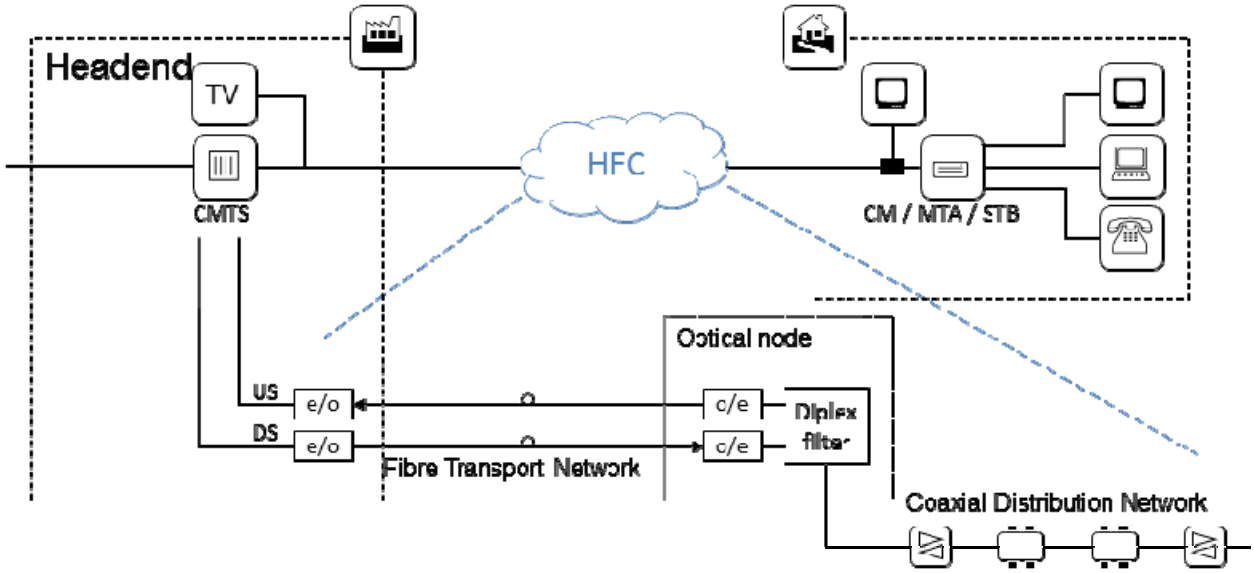

Figure 2: HFC-part of cable operator network

On the coaxial part of the network, both the upstream and downstream signals are present. By using a different frequency band, it is possible to use bidirectional electrical amplifiers in the coaxial part of the network. In the coaxial part, taps are used to bring the signal to each individual household. The upstream spectrum that is used in Europe goes from 5 to 65 MHz. In the downstream the frequencies between 87,5 MHz up to 1 002 MHz are used. Coaxial cables used in CATV networks have a characteristic impedance of 75 Ohm.

4.1 RF Spectrum Usage

The spectrum in the downstream is used for the delivery of different services to the households:

- Analogue Television and FM radio.
- Digital Television (including VOD).
- Internet (IP).
- Telephony (runs over IP).

In CATV networks signals for analogue TV, digital TV and EuroDOCSIS (IP) are placed in the cable frequency spectrum one next to the other without causing interference to each other. It is important to note that due to the broadcast nature of a cable network the **full spectrum** is typically occupied.

An example of a possible spectrum allocation is shown in figure 3.

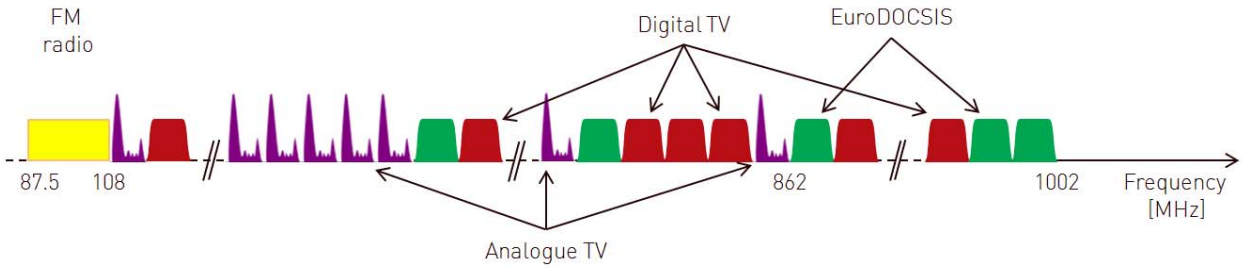

Figure 3: Example spectrum usage

4.1.1 Analogue television

In Europe, analogue television is offered using PAL or SECAM modulation, PAL and SECAM are analogue modulation techniques. One TV-channel occupies 7 or 8 MHz of bandwidth. Operators typically offer a significant number of analogue TV channels (30 or more). The biggest advantage of analogue television is that users only need a TV-set, and as such can easily (inexpensively) watch television on multiple sets.

Analogue television channels can be located anywhere in the RF spectrum from 108 up to 862 MHz.

4.1.2 Digital Television

Digital Television includes both broadcast digital TV and Video-on-Demand services. DVB-C is the technology used on cable networks for the transmission of the signal on the cable. DVB-C defines the digital modulation technique (QAM) and Forward Error Correction. The FEC-scheme is fixed and is Reed-Solomon with 16 bytes for error correction/detection per 188 useful bytes. As modulation 64QAM and 256QAM are used. The bandwidth used for a DVB-C signal is 8 MHz. This corresponds to a raw bitrate of about 42 Mbit/s for 64QAM and about 56 Mbit/s for 256QAM. The DVB-C system (framing structure, channel coding and modulation) is described in EN 300 429 [12].

The content of this bitstream is called an MPEG2 transport stream (TS). Within such a transport stream multiple TV-channels are present, packets of the different channels are multiplexed in this stream. Each packet has an identifier (PID) that identifies to which stream it belongs. Within this stream, special packets (predefined PIDs) are used to also transport signaling information (PSI/SI) to the receivers. These packets also contains information on where other streams are located, which programs are available.

Digital television channels can be located anywhere in the RF spectrum from 108 up to 1 002 MHz.

4.1.3 Internet (EuroDOCSIS)

Internet services in a cable network are provided over EuroDOCSIS technology. EuroDOCSIS uses the same modulation techniques as digital television (i.e. DVB-C with 64QAM or 256QAM). The cable modem termination system (CMTS) is the device located in the headend that generates the downstream signals and receives the upstream signals. In EuroDOCSIS one or more downstream channels (each 8 MHz) are used to transport data and signaling packets to the cable modems. Cable modems share the bandwidth of these channels. Up to EuroDOCSIS 2.0 a cable modem is only demodulating a single downstream channel of 8 MHz (note that this is still shared with other modems). With EuroDOCSIS 3.0 channel bonding is used, with this technology a single modem can use multiple (currently typically 4 to 8) downstream channels at the same time, these are of course still shared with other modems. The downstream channels are placed in the same spectrum as digital television and can be allocated anywhere in the RF spectrum from 108 MHz up to 862 MHz. EuroDOCSIS 3.0 defines the frequency space above 862 MHz and up to 1 002 MHz as an option.

For the return path EuroDOCSIS uses the frequency spectrum between 5 and 65 MHz. Modems are assigned upstream channels to use by the CMTS. A single upstream channel is shared in a TDM-way by different modems, the CMTS acts as the master and controls which modem is allowed to transmit at what time.

4.1.4 Telephony

Telephony in a cable network is provided over IP. As such it runs on top of EuroDOCSIS. This means that if the EuroDOCSIS system is not functional, telephony will not be functional anymore as well.

5 Signal characteristics and protection criteria

This clause provides an overview and requirements of the signal characteristics of European CATV systems. The minimum, maximum and typical signal levels together with their required signal-to-noise ratio shall be specified and are determining factors when a maximum tolerated noise level is defined.

Once this noise level is reached in the band of the desired signal (which is considered 8 MHz bandwidth in the present document), either as a result of background noise in the CATV network or induced by a LTE transmitter, the service will be disturbed.