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Kabelska omrežja za televizijske signale, zvokovne signale in interaktivne storitve - 10-1. del: Smernice za uporabo povratnih poti v kabelskih omrežjih

Cable networks for television signals, sound signals and interactive services -- Part 10-1: Guidelines for the implementation of return paths in cable networks

Kabelnetze für Fernsehsignale, Tonsignale und interaktive Dienste -- Teil 10-1: Leitfaden für die Einrichtung von Rückkanälen in Kabelnetzen

Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs -- Partie 10-1: Lignes directrices relatives à la mise en oeuvre de la voie de retour dans les réseaux câblés

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Cable networks for television signals, sound signals and interactive services - Part 10-1: Guidelines for the implementation of return paths in cable networks

Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs - Partie 10-1: Lignes directrices relatives à la mise en oeuvre de la voie de retour dans les réseaux câblés

Kabelnetze für Fernsehsignale, Tonsignale und interaktive Dienste - Teil 10-1: Leitfaden für die Einrichtung von Rückkanälen in Kabelnetzen

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This document (CLC/TR 50083-10-1:2014) has been prepared by CLC/TC 209 "Cable networks for television signals, sound signals and interactive services".

This document supersedes CLC/TR 50083-10-1:2009.

CLC/TR 50083-10-1:2014 includes the following significant technical changes with respect to CLC/TR 50083 10-1:2009:

a) the introduction of a new "General Scope";

b) the introduction of new upper frequency limit 85 MHz for return path as an option;

c) the introduction of some new "Terms and definitions" due to the new general scope and due to the introduction of the extended return path frequency range to 85 MHz;

d) the deletion of Clause B.1 on "Noise power ratio";

e) the deletion of Clause B.2 on "10-tone measurement";

f) the deletion of Clause B.3 on "MER measurement".

EN 50083 is currently composed of the following parts:

— EN 50083-2, *Cable networks for television signals, sound signals and interactive services — Part 2: Electromagnetic compatibility for equipment*;

— CLC/TR 50083-5-1, *Cable networks for television signals, sound signals and interactive services — Part 5-1: IP gateways and interfaces for headends*;

— EN 50083-8, *Cable networks for television signals, sound signals and interactive services — Part 8: Electromagnetic compatibility for networks*;

— EN 50083-9, *Cable networks for television signals, sound signals and interactive services — Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams*;

— EN 50083-10, *Cable networks for television signals, sound signals and interactive services — Part 10: System performance for return paths*;

— CLC/TR 50083-10-1, *Cable networks for television signals, sound signals and interactive services — Part 10-1: Guidelines for the implementation of return paths in cable networks* [the present document].

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

1 Scope

1.1 General

Standards and other deliverables of the EN 50083 and EN 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques.

This includes for instance:

- regional and local broadband cable networks,
- extended satellite and terrestrial television distribution networks and systems,
- individual satellite and terrestrial television receiving systems
- and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems.

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 of the customer premises equipment.

The standardization work will consider coexistence with users of the RF spectrum in wired and wireless transmission systems.

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.

1.2 Specific scope of this Technical Report

This document is intended to provide guidance to network designers on the issues which should be addressed when considering the design of return paths for regional or local broadband networks.

Items such as return path architecture & design, channel performance, channel planning and sources of interference, measurements, segmentation and re-segmentation, in home networks, distortion and commissioning are included. This document is not intended as a design reference but provides details which need to be addressed on individual issues relating to the design of the return path for a regional or local broadband network.

2 Normative references

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

EN 60728-1:2008, *Cable networks for television signals, sound signals and interactive services — Part 1: System performance of forward paths (IEC 60728-1:2007)*

EN 60728-3, *Cable networks for television signals, sound signals and interactive services — Part 3: Active wideband equipment for cable networks (IEC 60728-3)*

EN 60728-4, *Cable networks for television signals, sound signals and interactive services — Part 4: Passive wideband equipment for coaxial cable networks (IEC 60728-4)*

EN 60728-5, *Cable networks for television signals, sound signals and interactive services — Part 5: Headend equipment (IEC 60728-5)*

EN 60728-6, *Cable networks for television signals, sound signals and interactive services — Part 6: Optical equipment (IEC 60728-6)*

EN 60728-10:2014, *Cable networks for television signals, sound signals and interactive services — Part 10: System performance for return paths (IEC 60728-10:2014)*

ETSI EN 302 878 series, *Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services — IP Cable Modems*

ETSI ES 201 488 series, *Access and Terminals (AT); Data Over Cable Systems*

ETSI ES 202 488 series, *Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services — IP Cable Modems*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

NOTE As far as possible the available terms and definitions are taken from IEC 60050 series and are repeated below. The relevant IEV-numbers or other references are given in rectangular brackets after the definition text.

3.1.1
CATV networks
regional and local broadband cable networks designed to provide sound and television signals as well as signals for interactive services to a regional or local area

Note 1 to entry: This was originally defined as Community Antenna Television networks.

3.1.2
common path distortion
intermodulation distortion of downstream signals, mainly due to nonlinearities found at metallic junctions

Note 1 to entry: The distortions are manifest as a series of beats (caused by analogue downstream channels) or a band(s) of noise (caused by digital downstream channels) most noticeably in the upstream path. CPD may also be present in the downstream path, but since it adds with other downstream distortions (i.e. CTB and CSO), caused by active components, it is difficult to differentiate between the two. The nonlinear behaviour found at passive junctions may be due to a number of reasons including corrosion, typically from exposure to the elements, dissimilar metals, contact pressure, and junctions involving connectors contaminated with carbonaceous materials.

3.1.3
downstream direction
direction of signal flow in a cable network from the headend or any other central point (node) of a cable network towards the subscriber

[SOURCE: EN 60728-10:2014, modified]

3.1.4
extended satellite television distribution network or system
distribution network or system designed to provide sound and television signals received by satellite receiving antenna to households in one or more buildings

Note 1 to entry: This kind of network or system could be eventually combined with terrestrial antennas for the additional reception of TV and/or radio signals via terrestrial networks.

Note 2 to entry: This kind of network or system could also carry control signals for satellite switched systems or other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.5
extended terrestrial television distribution network or system
distribution network or system designed to provide sound and television signals received by terrestrial receiving antenna to households in one or more buildings

Note 1 to entry: This kind of network or system could be eventually combined with a satellite antenna for the additional reception of TV and/or radio signals via satellite networks.

Note 2 to entry: This kind of network or system could also carry other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.6
forward path (downstream)
physical part of a cable network by which signals are distributed in the downstream direction from the headend or any other central point (node) of a cable network towards the subscriber

[SOURCE: EN 60728-10:2014, modified]

3.1.7
gateway
functional unit that connects two computer networks with different network architectures

EXAMPLES LAN gateway, mail gateway.

Note 1 to entry: The computer networks may be either local area networks, wide area networks or other types of networks.

[SOURCE: IEC 60050, IEV 732-01-16 – definition altered and original Note 2 turned into the present "EXAMPLES" paragraph]

3.1.8
headend
assembly of equipment feeding signals into a cable network from local or external sources, including equipment for reception and signal processing

[SOURCE: IEC 60050, IEV 723-09-11, modified – definition altered]

Note 1 to entry: The headend may, for example, comprise antenna amplifiers, frequency converters, combiners, separators and generators.

3.1.9
hub

local area distribution point for the insertion and recovery of two-way narrowcast signals such as DOCSIS/EuroDOCSIS with broadcast transmissions from the headend in the RF domain (frequency multiplexing)

3.1.10

hybrid fibre coaxial network
HFC network
cable network which comprises optical equipment and cables and coaxial equipment and cables in different parts

[SOURCE: EN 60728-10:2014]

3.1.11
individual satellite television receiving system
system designed to provide sound and television signals received from satellite(s) to an individual household

Note 1 to entry: This kind of system could also carry control signals for satellite switched systems or other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.12
individual terrestrial television receiving system
system designed to provide sound and television signals received via terrestrial broadcast networks to an individual household

Note 1 to entry: This kind of system could also carry other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.13
ingress noise
noise which is caused by electromagnetic interference into cable networks. Its power decreases with increasing frequency. It is permanently present but slowly varies in its intensity as a function of time

[SOURCE: EN 60728-10:2014]

3.1.14
local broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a local area (e.g. one town or one village)

3.1.15
(network) segment
part of a cable network comprising a set of functions and/or a specific extent of the complete cable network

[SOURCE: EN 60728-10:2014]

3.1.16
network termination unit
NTU
equipment for access to the cable network connected between home network interface (HNI) and system outlet

3.1.17
node
point in a cable network where two or more links are interconnected

[SOURCE: IEC 60050, IEV 715-08-06, modified – definition altered]

3.1.18
Optical Modulation Index
OMI
index which is defined as:

$$m = \frac{\phi_h - \phi_l}{\phi_h + \phi_l}$$

where

ϕ_h is the highest and ϕ_l is the lowest instantaneous optical power of the intensity modulated optical signal. This term is mainly used for analogue systems

[SOURCE: EN 60728-10:2014, modified]

Note 1 to entry: This definition doesn't apply to systems where the input signals are converted and transported as digital baseband signals. In this case the terms modulation depth or extinction ratio defined in 2.6.79 and 2.7.46 of IEC/TR 61931:1998 will be used. A test procedure for extinction ratio is described in EN 61280-2-2.

3.1.19
regional broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a regional area covering several towns and/or villages

3.1.20
return path (upstream)
physical part of a cable network by which signals are transmitted from any subscriber, connected to the network, to the headend or any other central point (node) of a cable network

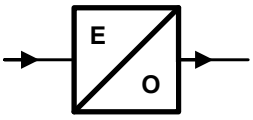
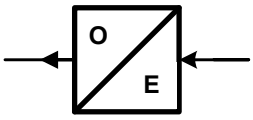
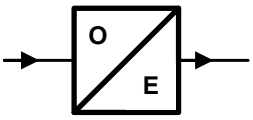
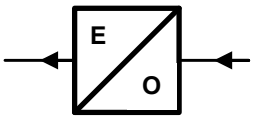
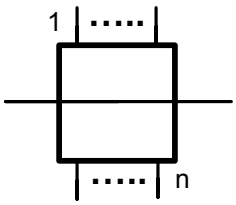
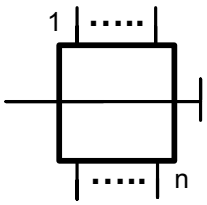
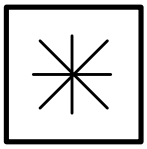
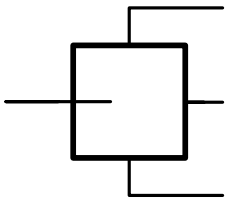
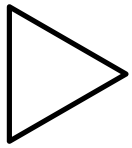
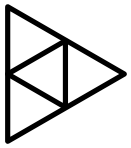
[SOURCE: EN 60728-10:2014, modified]

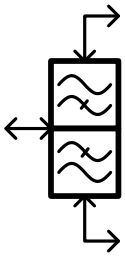
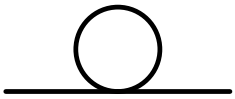
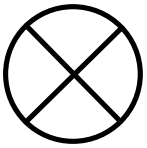
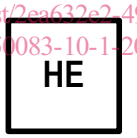
3.1.21
upstream direction
direction of signal flow in a cable network from a subscriber towards the headend or any other central point (node) of a cable network

[SOURCE: EN 60728-10:2014, modified]

3.2 Symbols

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

Symbol	Function	Symbol	Function
	**Optical transmitter forward path**		**Optical transmitter return path**
	**Optical receiver forward path**		**Optical receiver return path**
	**Analogue-Digital Converter**		**Digital-Analogue Converter**
	**Multiplexer** [IEC 60617-S01626]		**De-multiplexer** [IEC 60617-S01626, modified]
	**Attenuator (fixed)** [IEC 60617-S01244]		
	**Tap-off (n ports)**		**Multi-tap (n ports) with terminated feeder line**
	**Distribution network**		**Splitter** **Combiner (in the reverse direction)**
	**Amplifier, one-way** [IEC 60617-S01239]		**Amplifier, two-way** [IEC 60617-S00433]

Symbol	Function	Symbol	Function
	**Low-pass filter** [IEC 60617-S01248]		**High-pass filter** [IEC 60617-S01247]
	**Diplexer**		**Band-pass filter** [IEC 60617-S01249]
	**Fibre cable**		**Multiplier**
	**Equalizer**		**System outlet**
	**Sinewave Generator**		**Headend**
	**Network termination unit**		**Cable modem termination system**
	**AC power supply**		**Returnpath transmitter**
	**Test Receiver**		**Test transmitter**

3.3 Abbreviations

For the purposes of this document, the following abbreviations apply.

AC	Alternating current
ADC	Analogue-to-digital converter
ALSC	Automatic level & slope control

AM	Amplitude modulation
BNI	Building network interface
BNTU	Building network termination unit
C/NLD	Carrier to non-linear distortion ratio
CATV	Community antenna television
CB	Citizens band
CF	Centre frequency
CMTS(s)	Cable modem termination system(s)
CPD	Common path distortion
CPE	Customer premises equipment
CSO	Composite second order
CTB	Composite triple beat
CW	Continuous wave
CWDM	Coarse wavelength division multiplex
DAC	Digital-to-analogue converter
DAVIC	Digital Audio Visual Council
DC	Direct Current
DeMUX	De-multiplexer
DFB	Distributed feedback (laser)
DOCSIS	Data-over-cable service interface specification
DS	Downstream
DVB	Digital video broadcasting
DWDM	Dense wavelength division multiplex
EDFA	Erbium doped fibre amplifier
EMS	Element management system
EuroDOCSIS	European data-over-cable service interface specification
EUT	Equipment under test
FM	Frequency modulation
FP	Fabry-Perot (laser)
FSK	Frequency shift keying
HE	Headend
HF	High frequency
HFC	Hybrid-fibre-coax
HNI	Home network interface
IP	Internet protocol
ISF	Ingress suppression filter
MDU	Multiple dwelling unit
MER	Modulation error ratio
MUX	Multiplexer
NGN	Next generation network

NLD	Non-linear distortion
NPR	Noise power ratio
NTU	Network termination unit
OMI	Optical modulation index
PID	Packet identifier
PIM	Passive intermodulation
PMD	Polarization mode dispersion
PRBS	Pseudo random bit sequence
PSTN	Public switched telephone network
QAM	Quadrature amplitude modulation
QPSK	Quadrature phase shift keying
RF	Radio frequency
RP	Return path
Rx	Receiver
SBC	Session border controller
SDH	Synchronous digital hierarchy
SDU	Single dwelling unit
SIP	Session initiation protocol
SIR	Signal to ingress ratio
STB	Set-top box
SUT	System under test
Tx	Transmitter
US	Upstream
VOD	Video on demand
VoIP	Voice-over-IP
VSB	Vestigial side-band

4 Network architecture

4.1 HFC architecture

Access networks today are required to carry a multitude of different services. As a result, network engineers and architects are challenged to build infrastructures that are able to deliver these new services.

CATV networks, using HFC technologies have become the standard for providing both broadcast and interactive services. In an HFC network the forward path and return path portions are closely linked together. Where needed, for a better understanding, both portions will be considered in this document. This document will however focus primarily on return transmission. The return path portion of such networks is related to the corresponding standard document (EN 60728-10). The return path frequency range of such networks (Figure 1, network portion between reference points) is typically specified up to a maximum frequency range of 5 MHz to 65 MHz; (other frequency ranges, e.g. 5 MHz to 85 MHz, may apply).