# SLOVENSKI STANDARD
# oSIST prEN IEC 60728-114:2023

**01-maj-2023**

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**Optični prenosni sistemi s tehnologijo RFoG (TA5)**

Optical transmission systems using RFoG technology (TA5)



**Ta slovenski standard je istoveten z:** **prEN IEC 60728-114:2023**



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**ICS:**

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|---|---|---|
| 33.160.01 | Avdio, video in avdiovizualni sistemi na splošno | Audio, video and audiovisual systems in general |
| 33.180.20 | Povezovalne naprave za optična vlakna | Fibre optic interconnecting devices |

**oSIST prEN IEC 60728-114:2023** **en,fr,de**

# 100/3883/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

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IEC TA 5 : CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES

| | |
|---|---|
| SECRETARIAT: | SECRETARY: |
| Japan | Mr Hiroo Tamura |
| OF INTEREST TO THE FOLLOWING COMMITTEES: | PROPOSED HORIZONTAL STANDARD: ☐ |
| | Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary. |

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

| | |
|---|---|
| ☒ SUBMITTED FOR CENELEC PARALLEL VOTING | ☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING |
| **Attention IEC-CENELEC parallel voting**<br><br>The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.<br><br>The CENELEC members are invited to vote through the CENELEC online voting system. | |



This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of

- any relevant patent rights of which they are aware and to provide supporting documentation,
- any relevant “in some countries” clauses to be included should this proposal proceed. Recipients are reminded that the enquiry stage is the final stage for submitting "in some countries" clauses. See AC/22/2007.

TITLE:

**Optical transmission systems using RFoG technology (TA5)**

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

This project was approved to proceed to the CDV stage at the TA5 meeting that was held on November 18.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## Part 114: Optical transmission systems using RFoG technology

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International Standard IEC 60728-14 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 International Standard is based on the following documents:

| NP | Report on voting |
|---|---|
| 100/3xxx/FDIS | 100/3xxx/RVD |

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available

at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The list of all the 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.

This standard follows closely (where applicable) the ANSI/SCTE 174 2018 standard “Radio Frequency over Glass / Fiber-to-the-Home (RFoG) Specification / Extension”. In agreement with SCTE[1] major parts of ANSI/SCTE 174:2018 have been copied into this standard.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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



[1] SCTE = Society of Cable Telecommunications Engineers

# INTRODUCTION

Standards and other deliverables of the IEC 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.

- regional and local broadband cable networks,
- extended satellite and terrestrial television distribution 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.



The Annexes provide the following information.

Annex A describes implementation notes with design consideration based on this standard

Annex B describes the system loss specification

Annex C describes multiple CMTS operation

Annex D gives a design guideline of housings for R-ONU protection

Annex E contains information on the effect of off-state optical power on SNR of transmission signal

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

# Part 114: Optical transmission systems using RFoG technology

## 1 Scope

This part of IEC 60728 describes the system and equipment specification of FTTH/FTTB (fibre to the home/fibre to the building) networks where information is transmitted in both, forward and return path directions using RF subcarrier multiplexing technology, and where the return path transmission uses additionally time division multiple access technique imposed by the transmission of the return path signals using a TDMA (e.g. TDMA mode of DOCSIS) protocol. Such systems are called RF over Glass (RFoG) and consist of an RFoG optical network unit (R-ONU), an optical distribution network based on xPON structure, and an RFoG optical return path receiver. This standard specifies the basic system parameters and methods of measurement for RFoG systems in order to assess the system performance and its performance limits.

The detailed description of physical layer is out of the scope of this standard and it does not include IP transport technologies.



## 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.



IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-31:2008, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-40:1976, *Environmental testing – Part 2-40: Tests – Test Z/AM: Combined cold/low air pressure tests*

IEC 60529: Consolidated version from 2013, *Degrees of protection provided by enclosures (IP Code)*

IEC 60728-2:2018, *Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility of equipment*

IEC 60728-3:2018, *Cable networks for television signals, sound signals and interactive services – Part 3: Active wideband equipment for cable networks*

IEC 60728-6:2011, *Cable networks for television signals, sound signals and interactive services – Part 6: Optical equipment*

IEC 60728-10:2014, *Cable networks for television signals, sound signals and interactive services – Part 10: System performance of return path*

IEC 60728-11:2016, *Cable networks for television signals, sound signals and interactive services – Part 11: Safety*

IEC 60728-13:2010, *Cable networks for television signals, sound signals and interactive services – Part 13: Optical systems for broadcast signal transmissions*

IEC 60728-13-1:2017, *Cable networks for television signals, sound signals and interactive services – Part 13-1: Bandwidth expansion for broadcast signal over FTTH system*

IEC 60728-106.202x, *Cable networks for television signals, sound signals and interactive services – Part 106: Optical equipment for systems loaded with digital channels only*

IEC 60793-2-50:2018, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60794-3-11:2010, *Optical fibre cables – Part 3-11: Outdoor cables – Product specification for duct, directly buried, and lashed aerial single-mode optical fibre telecommunication cables*

IEC 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61169-2:2007, *Radio-frequency connectors – Part 2: Sectional specification – Radio frequency coaxial connectors type 9,52*

IEC 61169-24:2019, *Radio-frequency connectors – Part 24: Sectional specification – Radio-frequency coaxial connectors with screw coupling, typically for use in 75 Ω cable networks (type F)*

IEC 61280-1-1:2013, *Fibre optic communication subsystem basic test procedures – Part 1-1: Test procedures for general communication subsystems – Transmitter output optical power measurement for single-mode optical fibre cable*

IEC 61280-1-3:2010, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Central wavelength and spectral width measurement*

IEC 61754-4:2013, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 4: Type SC connector family*

IEC TR 61931:1998, *Fibre optic – Terminology*

277 ISO/IEC/IEEE Standard 8802-3:2021, *Standard for Ethernet*

278 # 3 Terms, definitions, symbols and abbreviations

279 ## 3.1 Terms and definitions

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

281 ISO and IEC maintain terminological databases for use in standardization at the following
282 addresses:

283 • IEC Electropedia: available at http://www.electropedia.org/
284 • ISO Online browsing platform: available at https://www.iso.org/obp/ui

285

286 **3.1.1**
287 **equivalent input noise current density**
288 notional input noise current density which, when applied to the input of an ideal noiseless device,
289 produces an output noise current density equal in value to that observed at the output of the
290 actual device under consideration

291 Note 1 to entry: It can be calculated from the RF signal-to-noise ratio (see IEC 60728-106) of a device or system.



292 **3.1.2**
293 **flatness**
294 difference between the maximum and the minimum RF gain or attenuation not taking into
295 account the slope within the specified modulation frequency range of a device or system



296 **3.1.3**
297 **headend system**
298 system comprising modulators, demodulators, CMTS, an optical transmitter with optional optical
299 amplifiers and a WDM for the transmission of analogue video as well as digitally modulated
300 signals located at the central office side of the optical network

301 Note 1 to entry: The headend system is equipped with an optical return path receiver receiving digitally modulated
302 signals of data in the return path direction to enable e.g. VoIP, VOD and internet services.

303 Note 2 to entry: V-OLT is a part of the headend system and deals with video transmission in the forward path only.

304 **3.1.4**
305 **local broadband cable network**
306 network designed to provide sound and television signals as well as signals for interactive
307 services to a local area (e.g. one town or one village)

308 **3.1.5**
309 **WDM device**
310 wavelength selective branching device (used in WDM transmission systems) in which optical
311 signals can be transferred between two predetermined ports, depending on the wavelength of
312 the signal

313 **3.1.6**
314 **noise power ratio**
315 **NPR**
316 ratio of the signal power density to the power density of the combined noise and intermodulation
317 distortion

**3.1.7**
**off-state optical power**
residual optical output power emitted from the fibre of the R-ONU when the laser is switched to off-state

Note 1 to entry: In a typical burst mode transmitter, for fast switching operation, the laser bias may be kept near the threshold bias level to avoid turn-on and turn-off delays. The off-state optical power affects the system performance when a large number of transmitters are connected to the same distribution network.

**3.1.8**
**optical amplifier**
**OA**
optical waveguide device containing a suitably pumped, active medium which is able to amplify an optical signal

[SOURCE: IEC TR 61931:1998, 2.7.75]

**3.1.9**
**optical distribution network**
**ODN**
passive optical network (PON) mainly consisting of optical fibres and splitters

**3.1.10**
**optical receiver**
**Rx**
receive fibre optic terminal device accepting at its input port a modulated optical carrier, and providing at its output port the corresponding demodulated electrical signal (with the associated clock, if digital)



Note 1 to entry: For the purposes of this standard, optical receivers may have more than one output port providing electrical RF signals.



**3.1.11**
**optical modulation index**
optical modulation index $m$ is defined as

$$m = \frac{\phi_h - \phi_l}{\phi_h + \phi_l} \quad (1)$$

where $\phi_h$ is the highest and $\phi_l$ is the lowest instantaneous optical power of the intensity modulated optical signal

Note 1 to entry: This definition does not 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 are used. A test procedure for extinction ratio is described in IEC 61280-2-2.

[SOURCE: IEC 60728-6:2011,3.1.10, modified – repetition of "optical modulation" has been deleted.]

**3.1.12**
**optical return loss**
**return loss**
**ORL**
ratio of the total reflected power to the incident power from an optical fibre, optical device, or optical system, and defined as:

$$-10\lg\frac{P_r}{P_i} \quad (2)$$

where

$P_r$ is the reflected power;

$P_i$ is the incident power

Note 1 to entry: When referring to a reflected power from an individual component, reflectance is the preferred term.

[SOURCE: IEC TR 61931:1998, 2.6.49]

Note 2 to entry: For the purposes of this standard, the term reflectance is used for optical amplifiers only. The term optical return loss is used for ports of all other types of equipment.

Note 3 to entry: The term return loss is also used for electrical ports. The definition relates to electrical powers in this case.

Note 4 to entry: The ratio is expressed in dB.

**3.1.13**
**optical transmitter**
**Tx**
transmit fibre optic terminal device accepting at its input port an electrical signal and providing at its output port an optical carrier modulated by that input signal



Note 1 to entry: For the purposes of this standard, optical transmitters may have more than one input port accepting electrical RF signals.

**3.1.14**
**radio frequency over glass**
**RFoG**

transmission technology on optical networks where information is transmitted in both, forward and return path directions, using RF subcarrier multiplexing technology, and where the return path transmission uses additionally time division multiple access technique imposed by the transmission of the return path signals using a TDMA (e.g. TDMA mode of DOCSIS) protocol

**3.1.15**
**reference output level of an optical receiver**
offset $x$ by which the electrical output level of an optical receiver can be calculated from the optical input level at a modulation index of $m$ = 0,05 using the following equation:

$$U = 2\ P_{opt,RX} + x\ \text{dB}(\mu\text{V}) \quad (3)$$

where

$U$ is the electrical output level in dB(μV)

$P_{opt,RX}$ is the optical input level in dB(mW)

$x$ is the reference output level in dB(μV)

**3.1.16**
**responsivity**
ratio of an optical detector's electrical output to its optical input at a given wavelength

Note 1 to entry: The responsivity is expressed in ampere per watt (A/W) or volts per watt (V/W) of incident radiant power.

Note 2 to entry: Sensitivity is sometimes used as an imprecise synonym for responsivity.

[SOURCE: IEC 60050-731:1991, 731-06-36, modified – "given wavelength" has been added and Note 1 has been clarified.]

Note 3 to entry: The wavelength interval around the given wavelength may be specified.

[SOURCE: IEC TR 61931:1998, 2.7.56]

**3.1.17**
**relative intensity noise**
**RIN**
ratio of the mean square of the intensity fluctuations in the optical power of a light source to the square of the mean of the optical output power

Note 1 to entry: The RIN is usually expressed in dB($Hz^{-1}$) resulting in negative values.

Note 2 to entry: The value for the RIN can be calculated from the results of a RF signal-to-noise measurement for the system.

[SOURCE: IEC 60728-106.202x, 4.15]

**3.1.18**
**RFoG optical network unit**
**R-ONU**
fibre optic terminal comprising an optical receiver for reception of analogue signals and an optical transmitter for the transmission of analogue signals originating from the customer side of the optical network and a coaxial interface for the transmission of analogue signals to the customer network and reception of analogue signals from the customer network generally consisting of digital data using a TDMA (e.g. TDMA mode of DOCSIS) protocol

**3.1.19**
**signal-to-crosstalk ratio**
**SCR**
level difference of desired signal level and worst case of other services single frequency crosstalk signal measured at RF output port of optical receiver

Note 1 to entry: SCR is defined by the following equation:

$$R_{SC} = D - U_{OS} \tag{4}$$

where

$D$ is the nominal level of the desired signal in dB(μV) at RF output port of optical receiver;

$U_{OS}$ is the worst-case level of another service's single frequency crosstalk in dB(μV) at RF output port of the optical receiver.

Note 2 to entry: SCR is expressed in dB.

**3.1.20**
**signal-to-noise ratio**
**SNR**
level difference of desired signal level and noise level

Note 1 to entry: SNR is defined for both, analogue and digital modulated signals in IEC 60728-13.

[SOURCE: IEC 60728-13:2010, 3.1.19]