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Title: BS EN IEC 60728-114 Cable networks for television signals, sound signals and interactive services

Part 114:

Optical transmission systems using RFoG technology

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER:
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SUPERSEDES DOCUMENTS:
100/3606/NP, 100/3641/RVN

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

SECRETARIAT:
Japan

SECRETARY:
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 CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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.

TITLE:

<p>Optical transmission systems using RFoG technology (TA5)</p>

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 114: Optical transmission systems using RFoG technology

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.
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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

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

168 The list of all the parts of the IEC 60728 series, under the general title *Cable networks for*
169 *television signals, sound signals and interactive services*, can be found on the IEC website.

170 This standard follows closely (where applicable) the ANSI/SCTE 174 2018 standard “Radio
171 Frequency over Glass / Fiber-to-the-Home (RFG) Specification / Extension”. In agreement with
172 SCTE¹ major parts of ANSI/SCTE 174:2018 have been copied into this standard.

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

- 176 • reconfirmed,
- 177 • withdrawn,
- 178 • replaced by a revised edition, or
- 179 • amended.

180

¹ SCTE = Society of Cable Telecommunications Engineers

181 INTRODUCTION

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

- 187 • regional and local broadband cable networks,
- 188 • extended satellite and terrestrial television distribution systems,
- 189 • individual satellite and terrestrial television receiving systems,

190 and all kinds of equipment, systems and installations used in such cable networks, distribution
191 and receiving systems.

192 The extent of this standardization work is from the antennas and/or special signal source inputs
193 to the headend or other interface points to the network up to the terminal input of the customer
194 premises equipment.

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

197 The standardization of any user terminals (i.e., tuners, receivers, decoders, multimedia
198 terminals, etc.) as well as of any coaxial, balanced and optical cables and accessories thereof
199 is excluded.

200 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 |

201

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*

- 240 IEC 60529: Consolidated version from 2013, *Degrees of protection provided by enclosures (IP*
241 *Code)*
- 242 IEC 60728-2:2018, *Cable networks for television signals, sound signals and interactive services*
243 *– Part 2: Electromagnetic compatibility of equipment*
- 244 IEC 60728-3:2018, *Cable networks for television signals, sound signals and interactive services*
245 *– Part 3: Active wideband equipment for cable networks*
- 246 IEC 60728-6:2011, *Cable networks for television signals, sound signals and interactive services*
247 *– Part 6: Optical equipment*
- 248 IEC 60728-10:2014, *Cable networks for television signals, sound signals and interactive*
249 *services – Part 10: System performance of return path*
- 250 IEC 60728-11:2016, *Cable networks for television signals, sound signals and interactive*
251 *services – Part 11: Safety*
- 252 IEC 60728-13:2010, *Cable networks for television signals, sound signals and interactive*
253 *services – Part 13: Optical systems for broadcast signal transmissions*
- 254 IEC 60728-13-1:2017, *Cable networks for television signals, sound signals and interactive*
255 *services – Part 13-1: Bandwidth expansion for broadcast signal over FTTH system*
- 256 IEC 60728-106:2022, *Cable networks for television signals, sound signals and interactive*
257 *services – Part 106: Optical equipment for systems loaded with digital channels only*
- 258 IEC 60793-2-50:2018, *Optical fibres – Part 2-50: Product specifications – Sectional*
259 *specification for class B single-mode fibres*
- 260 IEC 60794-3-11:2010, *Optical fibre cables – Part 3-11: Outdoor cables – Product specification*
261 *for duct, directly buried, and lashed aerial single-mode optical fibre telecommunication cables*
- 262 IEC 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*
- 263 IEC 61169-2:2007, *Radio-frequency connectors – Part 2: Sectional specification – Radio*
264 *frequency coaxial connectors type 9,52*
- 265 IEC 61169-24:2019, *Radio-frequency connectors – Part 24: Sectional specification – Radio-*
266 *frequency coaxial connectors with screw coupling, typically for use in 75 Ω cable networks (type*
267 *F)*
- 268 IEC 61280-1-1:2013, *Fibre optic communication subsystem basic test procedures – Part 1-1:*
269 *Test procedures for general communication subsystems – Transmitter output optical power*
270 *measurement for single-mode optical fibre cable*
- 271 IEC 61280-1-3:2010, *Fibre optic communication subsystem test procedures – Part 1-3: General*
272 *communication subsystems – Central wavelength and spectral width measurement*
- 273 IEC 61754-4:2013, *Fibre optic interconnecting devices and passive components – Fibre optic*
274 *connector interfaces – Part 4: Type SC connector family*
- 275 IEC TR 61931:1998, *Fibre optic – Terminology*

276 IEEE Standard 802.3-2018, *IEEE Standard for Ethernet*

277 **3 Terms, definitions, symbols and abbreviations**

278 **3.1 Terms and definitions**

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

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

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

284

285 **3.1.1** 286 **equivalent input noise current density**

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

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

291 **3.1.2** 292 **extended satellite television distribution network or system**

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

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

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

299 **3.1.3** 300 **extended terrestrial television distribution network or system**

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

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

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

307 **3.1.4** 308 **fibre optic branching device** 309 **<optical> <fibre> branching device** 310 **<optical> splitter**

311 DEPRECATED: <optical> <fibre> coupler
312 device, possessing three or more optical ports, which shares optical power among its ports in
313 a predetermined fashion, at the same wavelength or wavelengths, without wavelength
314 conversion

315 Note 1 to entry: The ports may be connected to fibres, sources, detectors, etc.

316 [SOURCE: IEC TR 61931:1998, definition 2.6.21]

317 **3.1.5**
318 **flatness**
319 difference between the maximum and the minimum RF gain or attenuation not taking into
320 account the slope within the specified modulation frequency range of a device or system

321 **3.1.6**
322 **headend system**
323 system comprising modulators, demodulators, CMTS, an optical transmitter with optional optical
324 amplifiers and a WDM for the transmission of analogue video as well as digitally modulated
325 signals located at the central office side of the optical network

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

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

329 **3.1.7**
330 **individual satellite television receiving system**
331 system designed to provide sound and television signals received from satellite(s) to an
332 individual household

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

335 **3.1.8**
336 **individual terrestrial television receiving system**
337 system designed to provide sound and television signals received via terrestrial broadcast
338 networks to an individual household

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

341 **3.1.9**
342 **local broadband cable network**
343 network designed to provide sound and television signals as well as signals for interactive
344 services to a local area (e.g. one town or one village)

345 **3.1.10**
346 **multiplexing device**
347 **WDM device**
348 wavelength selective branching device (used in WDM transmission systems) in which optical
349 signals can be transferred between two predetermined ports, depending on the wavelength of
350 the signal

351 [SOURCE: IEC TR 61931:1998, definition 2.6.51]

352 **3.1.11**
353 **noise power ratio**
354 **NPR**
355 ratio of the signal power density to the power density of the combined noise and intermodulation
356 distortion

357 **3.1.12**
358 **off-state optical power**
359 residual optical output power emitted from the fibre of the R-ONU when the laser is switched to
360 off-state

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

3.1.13**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, definition 2.7.75]

3.1.14**optical distribution network****ODN**

passive optical network (PON) mainly consisting of optical fibres and splitters

3.1.15**optical receiving unit****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)

[SOURCE: IEC TR 61931:1998, definition 2.9.7]

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

3.1.16**optical modulation index**

optical modulation index m is defined as

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

where ϕ_h is the highest and ϕ_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, definition 3.1.10, modified – repetition of "optical modulation" has been deleted.]

3.1.17**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, definition 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.

3.1.18

optical transmitting unit

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

[SOURCE: IEC TR 61931:1998, definition 2.9.6]

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

3.1.19

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

3.1.20

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:

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

where

U is the electrical output level in dB(μV)

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

x is the reference output level in dB(μV)

3.1.21

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.]

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

441 [SOURCE: IEC TR 61931:1998, definition 2.7.56]

442 **3.1.22**

443 **relative intensity noise**

444 **RIN**

445 ratio of the mean square of the intensity fluctuations in the optical power of a light source to the
446 square of the mean of the optical output power

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

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

450 [SOURCE: IEC 60728-106:2022, 4.15]

451 **3.1.23**

452 **RFoG optical network unit**

453 **R-ONU**

454 fibre optic terminal comprising an optical receiver for reception of analogue signals and an
455 optical transmitter for the transmission of analogue signals originating from the customer side
456 of the optical network and a coaxial interface for the transmission of analogue signals to the
457 customer network and reception of analogue signals from the customer network generally
458 consisting of digital data using a TDMA (e.g. TDMA mode of DOCSIS) protocol

459 **3.1.24**

460 **signal-to-crosstalk ratio**

461 **SCR**

462 level difference of desired signal level and worst case of other services single frequency
463 crosstalk signal measured at RF output port of optical receiver

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

$$R_{\text{SC}} = D - U_{\text{OS}} \quad (4)$$

465

466 where

467 D is the nominal level of the desired signal in $\text{dB}(\mu\text{V})$ at RF output port of optical receiver;

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

470 Note 2 to entry: SCR is expressed in dB.

471 **3.1.25**

472 **signal-to-noise ratio**

473 **SNR**

474 level difference of desired signal level and noise level

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

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

477 **3.1.26**

478 **slope**

479 gain or attenuation difference at two defined frequencies between two ports of a device or
480 system