# IEC 60728-7-1

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# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside

## Cable networks for television signals, sound signals and interactive services – Part 7-1: Hybrid Fibre Coax Outside Plant status monitoring – Physical (PHY) layer specification



## Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs – Partie 7-1: Surveillance de l'état des installations extérieures des réseaux hybrides à fibre optique et câble coaxial – Spécification de la couche physique (PHY)



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# VERSION REDLINE

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# CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## Part 7-1: Hybrid Fibre Coax Outside Plant status monitoring – Physical (PHY) layer specification

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**IEC 60728-7-1 edition 1.1 contains the first edition (2003-10) [documents 100/576/CDV and 100/683/RVC] and its amendment 1 (2015-04) [documents 100/2417/FDIS and 100/2481/RVD].**

**In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.**

International Standard IEC 60728-7-1 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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

The following differences exist in some countries:

The Japanese *de facto* standard (NCTEA S-006) concerning requirements for the HFC outside plant management, which was published in 1995, has already been available in Japan. The purpose of this standard is to support the design and implementation of interoperable management systems for HFC cable networks used in Japan. (see Table 4)

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# INTRODUCTION

~~Standards of the IEC 60728 series deal with cable networks for television signals, sound signals and interactive services including equipment, systems and installations for~~

- ~~head-end reception, processing and distribution of television and sound signals and their associated data signals, and~~
- ~~processing, interfacing and transmitting all kinds of signals for interactive services~~

~~using all applicable transmission media.~~

~~All kinds of networks like~~

- ~~CATV-networks,~~
- ~~MATV-networks and SMATV-networks,~~
- ~~individual receiving networks~~

~~and all kinds of equipment, systems and installations installed in such networks, are within this scope.~~

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.



This includes for instance

- 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 system outlet or~~ the terminal input~~, where no system outlet exists~~ 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 and optical cables and accessories ~~therefore~~ thereof is excluded.

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

# Part 7-1: Hybrid Fibre Coax Outside Plant status monitoring – Physical (PHY) layer specification

## 1 Scope

This part of IEC 60728 specifies requirements for The Hybrid Fibre Coax (HFC) Outside Plant (OSP) Physical (PHY) Layer Specification and is part of the series of specifications developed by the Hybrid Management Sub-Layer (HMS) subcommittee under the SCTE. The purpose of the HMS specification is to support the design and implementation of interoperable management systems for evolving HFC cable networks. The HMS Physical (PHY) Layer Specification describes the physical layer portion of the protocol stack used for communication between HMS-compliant transponders interfacing to managed outside plant network elements (NE) and a centralized head-end element (HE).

This standard describes the PHY layer requirements that must be implemented by all *Type 2* and *Type 3* compliant OSP HMS transponders on the HFC plant and the controlling equipment in the head-end. Any exceptions to compliance with this standard will be specifically noted herein as necessary. Refer to Table 1 for a full definition of the type classifications.

Electromagnetic Compatibility (EMC) is not specified in this standard and is left to the vendor to ensure compliance with local EMC regulatory requirements. Other than operating temperature, physical parameters such as shock, vibration, humidity, etc., are also not specified and left to the vendor's discretion.



Transponder type classifications referenced within the HMS series of standards are defined in Table 1.

**Table 1 – Transponder type classifications**

| Type | Description | Application |
|---|---|---|
| Type 0 | Refers to legacy transponder equipment, which is incapable of supporting the HMS specifications | This transponder interfaces with legacy network equipment through proprietary means.<br>This transponder could be managed through the same management applications as the other types through proxies or other means at the head-end |
| Type 1 | Refers to stand-alone transponder equipment (legacy or new) which can be upgraded to support the HMS specifications | This transponder interfaces with legacy network equipment through proprietary means.<br>Type 1 is a standards-compliant transponder (either manufactured to the standard or upgraded) that connects to legacy network equipment via a proprietary interface |
| Type 2 | Refers to a stand-alone, HMS-compliant transponder | This transponder interfaces with network equipment designed to support the electrical and physical specifications defined in the HMS standards.<br>It can be factory or field-installed.<br>Its RF connection is independent of the monitored NE |
| Type 3 | Refers to a stand-alone or embedded, HMS-compliant transponder | This transponder interfaces with network equipment designed to support the electrical specifications defined in the HMS standards.<br>It may or may not support the physical specifications defined in the HMS standards.<br>It can be factory-installed. It may or may not be field-installed.<br>Its RF connection is through the monitored NE |

## 2 Normative references

None.

## 3 Terms, definitions and abbreviations

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

**3.1**
**forward ~~spectrum~~ path band**
~~the pass-band~~ continuous set of frequencies in HFC cable systems with a lower edge of between 48 MHz and 87,5 MHz, depending on the particular geographical area, and an upper edge that is typically in the range of 300 MHz to ~~860~~ 1 000 MHz depending on implementation

Note 1 to entry: Due to different channel spacing plans in use, this upper frequency limit may not be exactly 1 000 MHz, but some megahertz higher, e.g. 1 002 MHz or 1 006 MHz. The notation 1 000 MHz in this standard is intended to include such small deviations.

**3.2**
**full ~~spectrum~~ path band**
~~combined~~ combination of forward ~~and return spectrums~~ path band and return path band in HFC cable systems ~~and excludes~~ excluding any guard band

**3.3**
**guard band**
unused frequency band between the upper edge of the usable return ~~spectrum~~ path band and the lower edge of the usable forward ~~spectrum~~ path band in HFC cable systems



**3.4**
**network element (NE)**
active element in the outside plant that is capable of receiving commands from a head-end element (HE) in the head-end and, as necessary, providing status information and alarms back to the HE



**3.5**
**open system interconnection (OSI)**
framework of International Organization for Standardization (ISO) standards for communication between multi-vendor systems that organizes the communication process into seven different categories that are placed in a layered sequence based on the relationship to the user. Each layer uses the layer immediately below it and provides services to the layer above. Layers 7 through 4 deal with end-to-end communication between the message source and destination, and layers 3 through 1 deal with network functions

**3.6**
**physical (PHY) layer**
layer 1 in the Open System Interconnection (OSI) architecture; the layer that provides services to transmit bits or groups of bits over a transmission link between open systems and which entails electrical, mechanical and handshaking procedures

**3.7**
**return ~~spectrum~~ path band**
~~pass-band~~ continuous set of frequencies in HFC cable systems with a lower edge of 5 MHz and an upper edge that is typically in the range of 42 MHz to 65 MHz depending on the particular geographical area

**3.8**
**transponder**
device in the outside plant that interfaces to outside plant NEs and relays status and alarm information to the HE. It can interface with an active NE via an arrangement of parallel analogue, parallel digital and serial ports

**3.9**
**un-modulated carrier**
carrier resting on the ‘mark’ frequency rather than on the channel’s centre frequency

### 3.10 Abbreviated terms

| | |
|---|---|
| ANSI | American National Standards Institute |
| BER | Bit Error Rate |
| C/R | Carrier-to-Noise Ratio |
| C/(N+I) | Carrier to Noise-plus-Interference Ratio |
| CW | Continuous Wave |
| EMC | Electromagnetic Compatibility |
| FSK | Frequency Shift Keying |
| HE | Head-end Element |
| HFC | Hybrid Fibre Coax |
| HMS | Hybrid Management Sub-Layer |
| LSB | Least Significant Bit |
| MSB | Most Significant Bit |
| NE | Network Element |
| MAC | Media Access Control |
| OSP | Outside Plant |
| PHY | Physical |
| RF | Radio Frequency |
| SCTE | Society of Cable Telecommunications Engineers |



## 4 HMS reference architecture forward and return channel specifications

The reference architecture for the HMS series of specifications is illustrated in Figure 1.

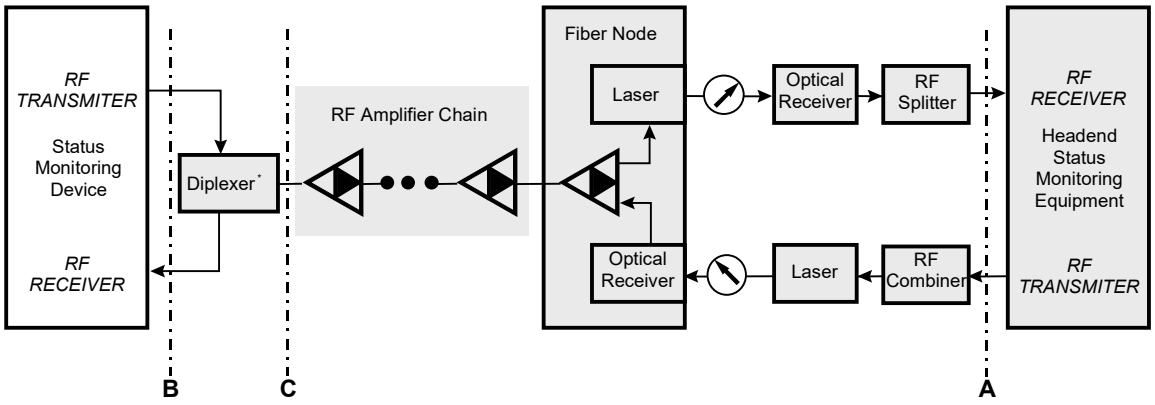


**Figure 1 – HMS reference architecture diagram**

All quantities relating to forward channel transmission or reverse channel reception are measured at point A in Figure 1. All quantities relating to forward channel reception or reverse channel transmission are measured at point B for two-port devices and point C for single port devices as shown in Figure 1.

### 4.1 HMS specification documents

A list of documents in the HMS specifications family is provided in Table 2.



**Table 2 – HMS document family**

| HMS notation | Title |
|---|---|
| SCTE HMS PHY | HMS Outside Plant Status Monitoring – Physical (PHY) Layer Specification |
| SCTE HMS MAC | HMS Outside Plant Status Monitoring – Media Access Control (MAC) Layer Specification |
| SCTE HMS PSTIB | HMS Outside Plant Status Monitoring – Power Supply to Transponder Interface Bus (PSTIB) Specification |
| SCTE HMS ALARMS MIB | HMS Alarms Management Information Base |
| SCTE HMS COMMON MIB | HMS Common Management Information Base |
| SCTE HMS FIBERNODE MIB | HMS Fiber Node Management Information Base |
| SCTE HMS PROPERTY MIB | HMS Alarm Property Management Information Base |
| SCTE HMS PS MIB | HMS Power Supply Management Information Base |
| SCTE ROOT MIB | SCTE Root Management Information Base |
| SCTE HMS GEN MIB | HMS Power Supply Generator Management Information Base |
| SCTE HMS TIB MIB | HMS Transponder Interface Bus Management Information Base |
| SCTE HMS DOWNLOAD MIB | HMS Transponder Firmware Download Management Information Base |
| SCTE HMS TREE MIB | HMS Root Object Identifiers Management Information Base |



### 4.2 Functional assumptions

#### 4.2.1 Forward path band and return ~~spectrum~~ path band

The forward ~~spectrum~~ path band in HFC cable systems refers to the ~~pass band~~ continuous set of frequencies with a lower edge of between 48 MHz and 87,5 MHz, depending on the particular geographical area, and an upper edge that is typically in the range of 300 MHz to ~~860~~ 1 000 MHz depending on implementation. Analogue television signals in 6 MHz or 8 MHz channels are assumed to be present on the forward ~~spectrum~~ path band as well as other narrowband and wideband digital signals.

The return ~~spectrum~~ path band in HFC cable systems refers to the pass band of frequencies with a lower edge of 5 MHz and an upper edge that is typically in the range of 42 MHz to 65 MHz depending on the particular geographical area. Narrowband and wideband digital signals may be present on the return ~~spectrum~~ path band as well as analogue television signals in 6 MHz or 8 MHz channels.

The full ~~spectrum~~ path band in HFC cable systems refers to the combined forward and return ~~spectrums~~ path bands and excludes any guard band. The guard band refers to the unused frequency band between the upper edge of the usable return ~~spectrum~~ path band and the lower edge of the usable forward ~~spectrum~~ path band. Specific limits on forward and return ~~spectrum~~ path band for various geographical areas are detailed in Table 3.

**Table 3 – Spectral limits by geographical area (North America and Europe)**

| Geography | Return ~~spectrum~~ path band | | Forward ~~spectrum~~ path band | |
|---|---|---|---|---|
| | Minimum frequency | Guard band lower limit | Guard band upper limit | Maximum frequency |
| North America | 5 MHz | 42 MHz | 48 MHz | 1 000 GHz |
| Europe 1 | 5 MHz | 30 MHz | 47 MHz | 862 MHz |
| Europe 2 | 5 MHz | 50 MHz | 70 MHz | ~~862~~ 1 000 MHz |
| Europe 3 | 5 MHz | 65 MHz | 87,5 MHz | ~~862~~ 1 000 MHz |

### 4.2.2 Transmission levels

The nominal level of the forward ~~spectrum~~ path band HMS carrier(s) is targeted to be no higher than –10 dB relative to analogue video nominal carrier levels. The nominal power level of the return ~~spectrum~~ path band HMS carrier(s) will be as low as possible to achieve the required margin above noise and interference. Uniform power loading per unit bandwidth is commonly followed in setting signal levels on the return ~~spectrum~~ path band, with specific levels established by the cable network operator to achieve the required carrier-to-noise and carrier-to-interference ratios.



## 5 Physical layer specification

This clause describes version 1.0 of the HMS PHY layer specification. The PHY layer describes rules that govern the transmission of bytes from one device to another. The specific requirements of the HMS PHY layer are detailed in this clause.

### 5.1 Separate forward and return channels

The one-way communication channel from the HE to a managed OSP NE is referred to as the *forward* channel. The one-way communication channel from a managed OSP NE to the HE is referred to as the *return* channel. Both the forward and the return channels are placed on specific centre frequencies. The forward and return channels' centre frequencies are different. Since the NEs only listen to the forward channel, they cannot listen to return channel transmissions from other NEs. This channel separation is a result of the sub-band split between the forward and return portions of the typical HFC plant spectrum.

### 5.2 Single forward and return path channels

To keep management of carrier frequencies simple, each HMS-based status monitoring system has a single forward channel and a single return channel. This does not preclude the use of multiple monitoring systems, each with its own individual forward and return RF channels.