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Edition 1.0 2003-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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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

FOREWORD

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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 bilingual version (2012-08) corresponds to the monolingual English version, published in 2003-10.

This standard was submitted to the national committees for voting under the Fast Track Procedure as the following documents:

CDV	Report on voting
100/576/CDV	100/683/RVC

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

The French version of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn;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)

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.

The extent of this standardization work is from the antennas, special signal source inputs to the head-end or other interface points to the network up to the system outlet or the terminal input, where no system outlet exists.

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 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. 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. 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. It can be factory or field-installed. 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. It may or may not support the physical specifications defined in the HMS standards. It can be factory-installed. It may or may not be field-installed. 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
the pass-band 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 MHz depending on implementation

3.2
full spectrum
combined forward and return spectrums in HFC cable systems and excludes any guard band

3.3
guard band
unused frequency band between the upper edge of the usable return spectrum and the lower edge of the usable forward spectrum 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
pass-band 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.

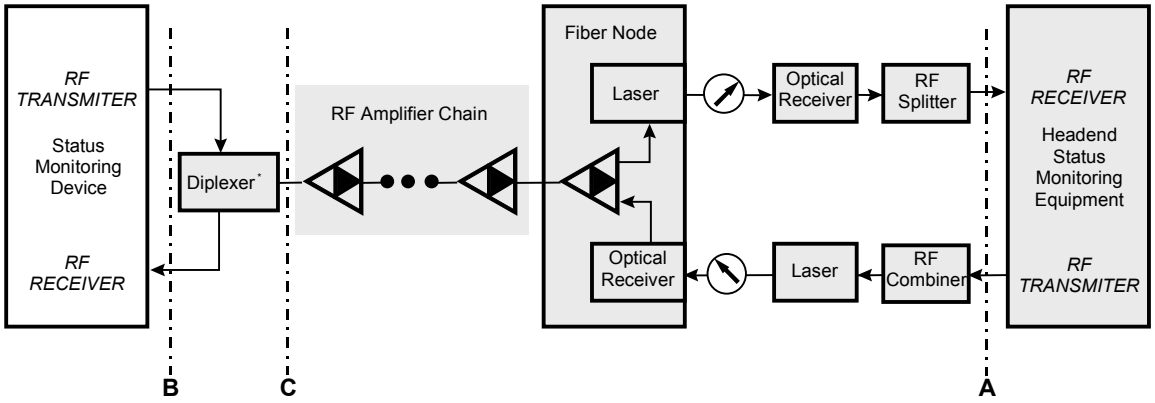

Figure 1 – HMS reference architecture diagram

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 and return spectrum

The forward spectrum in HFC cable systems refers to the pass band 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 MHz depending on implementation. Analogue television signals in 6 MHz or 8 MHz channels are assumed to be present on the forward spectrum as well as other narrowband and wideband digital signals.

The return spectrum 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 as well as analogue television signals in 6 MHz or 8 MHz channels.

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

Table 3 – Spectral limits by geographical area

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

4.2.2 Transmission levels

The nominal level of the forward spectrum 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 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, 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.

5.3 Byte-based transmission

The physical layer provides *byte-based* communications in both directions, between a managed NE and the head-end. It delivers bytes from one end of the channel to the other end of the channel.

5.4 Byte formats and transmission order

Bytes on both forward and return channels are ten bits in length. They contain one start bit, eight bits of data, and one stop bit. The start bit has binary value '0', and the stop bit has binary value '1'.

Throughout this standard, bits labelled '0' are the least significant bits (LSBs). The LSB of a single byte is always transmitted first following the start bit. Bits labelled '7' are the most significant bits (MSBs). The MSB of a single byte is always transmitted last followed by the stop bit. The transmission order is summarized in Figure 2.

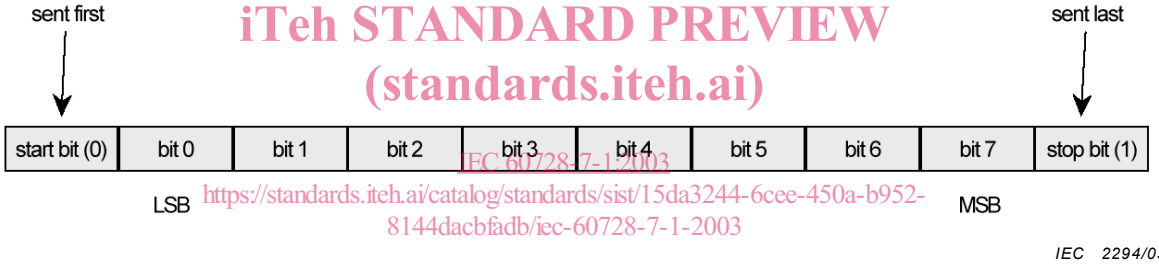

Figure 2 – Bit transmission order

5.5 Packet-based transmission

Transmission in both forward and return channels is implemented using packets. Transmission on the forward channel is continuous; there is no gap in RF output between packets. Packets are separated by a continuous sequence of bits having value '1', i.e. 'mark' tone. The channel is said to 'rest on mark' between packets.

Transmission on the return channel is accomplished with burst packets. Packets are separated by periods of silence when the transmitter is turned off. Burst communication is used in the return path of HFC systems because of its ability to solve the many-to-one multiple access characteristic by allowing terminals to 'take turns' transmitting.

5.6 Duplex operation

The physical layer implementation in HMS-compliant transponders interfacing to OSP NEs shall support half-duplex operation. There is no requirement for full-duplex operation.

5.7 Forward and return channel specifications

HMS PHY channel RF and modulation specifications for the forward and return communications channels are shown in Table 4. Descriptions of each parameter are provided following that table. Any exceptions to compliance with the specifications in Table 4 will be specifically noted in this document as necessary.