ETSI TS 101 964 V1.1.1 (2001-08)

Technical Specification

Digital Video Broadcasting (DVB);
Control Channel for SMATV/MATV distribution systems;
Baseline Specification

European Broadcasting Union

Union Européenne de Radio-Télévision

EBU·UER

Reference

DTS/JTC-DVB-118

Keywords

broadcasting, control, digital, DVB, SMATV, video

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

Introduction

SMATV/MATV distribution systems, as described in EN 300 473 [1], represent a solution widely adopted for in-building delivery of DVB signals (both satellite and terrestrial) through collective installations. The adoption of the Control Channel specification, which has been defined in accordance with the commercial requirements given in DVB-TM 2342 [7], offers an alternative cost-effective solution to the current implementation of SMATV/MATV systems, especially for the case of small and medium size installations, allowing the delivery of DVB TSs/multiplexes without the constraints of the limited bandwidth available in the installation.

These benefits are achieved by allocating to each user's terminal an individual RF channel on the in-building cable network for the delivery of the DVB services which are remotely selected by the user's terminal controlling the head-end device, installed in the building (e.g. QPSK/QAM transmodulator, QPSK/QPSK frequency converter), via a suitable set of commands. All the equipment which is operated via the Control Channel, i.e. the head-end devices and the user's terminals, are connected through the same coaxial SMATV/MATV installation.

Furthermore, the Control Channel allows each single user of the building to autonomously decide on the possibility of receiving digital broadcasting services through the community installation, without the need of authorization from the other users.

The system model representing this solution is based on two channels (see figure 1):

- Broadcast Channel: a unidirectional broadband delivery channel for video, audio and data services;
- Control Channel: a bi-directional narrow-band channel established between the head-end device and the user's terminal for control and signalling purposes.

The present document describes the message structure and the set of commands and coding used by the Control Channel for SMATV/MATV distribution systems. The specification covers both the approaches adopted for the delivery of satellite signals as identified in EN 300 473 [1], i.e. transmodulation from QPSK to QAM (System A) and direct distribution in QPSK after frequency conversion (System B), as well as the remote control of other head-end devices for broadcast services.

The specification also takes into account the requirements from DVB-TM 2342 [7] in order to achieve the best commonality and ensure the minimum functionality required for operating via the SMATV systems the satellite interactive terminals.

Although primarily focused on SMATV systems for delivery of satellite DVB services, the Control Channel shall also be applicable to MATV systems currently used for terrestrial broadcasting services via VHF/UHF and microwave.

The Control Channel protocol is based on DiSEqC [2] to maintain compatibility with existing products and has the further advantage of being sufficiently flexible to allow for future extensions, if and when needed. The structure of the Control Channel message ensures a robust transmission mechanism.

The Physical layers, described in clauses A.1 and A.2, allow for a general use of the Control Channel in the whole range of SMATV/MATV distribution systems, having different topologies and characteristics. The transmission protocol providing the communication link between the user's terminal and the head-end device makes use of the same commands and coding (see clauses 4 and 5) for both physical layers.

The A.1 solution, which is based on the use of a 22 kHz bus, is suitable for the case of small SMATV/MATV installations using d.c. coupled elements. The A.2 solution, which is based on the use of an RF bus in a frequency range above 10 MHz, provides the capability to pass through community installations using inductive components. So, this second solution potentially allows for a transparent introduction of the Control Channel in most existing SMATV/MATV systems.

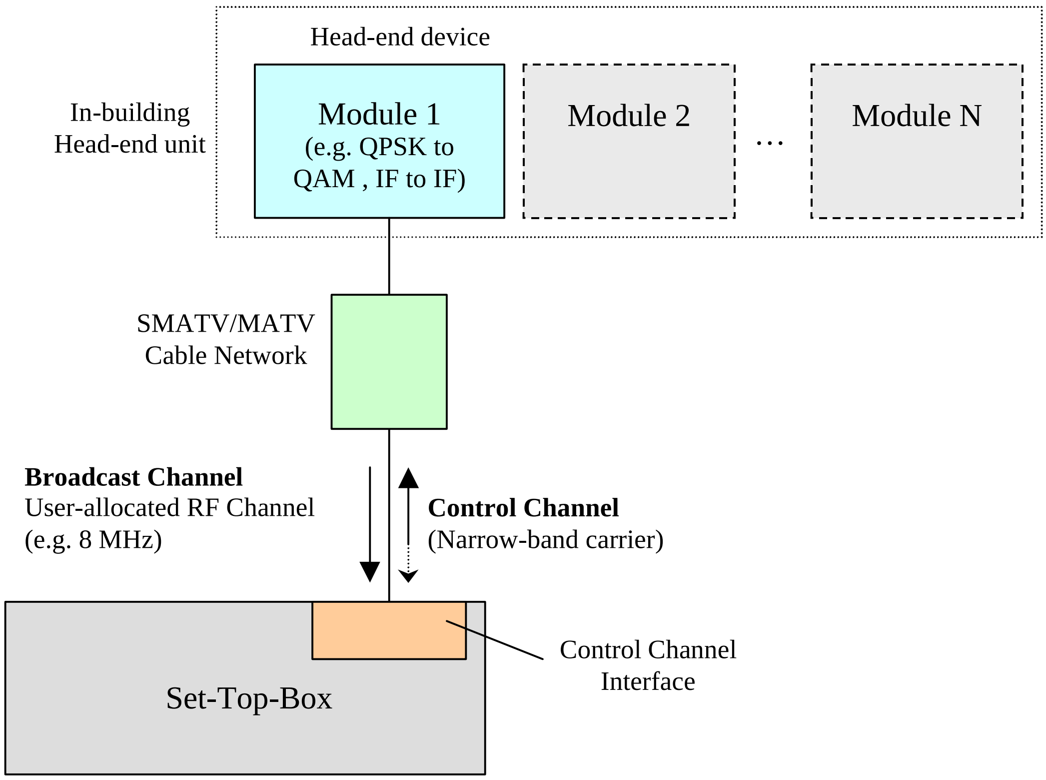


Figure 1: Simplified functional block diagram of the in-building SMATV/MATV System using a Control Channel

1 Scope

The present document specifies the Control Channel for SMATV/MATV distribution systems based on EN 300 743. The present document is intended to provide remote control of the head-end device from the user's terminal through a set of commands in a closed in-building environment for the delivery of broadcast services. Provision for interactive services is out of the scope of the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ETSI EN 300 473: "Digital Video Broadcasting (DVB); Satellite Master Antenna Television (SMATV) distribution systems".

[2] ETSI EN 301 790: "Digital Video Broadcasting (DVB); Interaction channel for satellite distribution systems".

[3] Eutelsat: "Digital Satellite Equipment Control (DiSEqC) Bus Functional Specification version 4.2, February 1998".

[4] ETSI EN 300 421: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[5] ETSI EN 300 429: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for cable systems".

[6] ETSI EN 300 744: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".

[7] DVB-TM 2342: "Commercial Requirements for the addition of a Control Channel to the SMATV/MATV distribution systems".

3 Abbreviations

For the purposes of the present document the following abbreviations apply:

ACK	ACKnowledge
CRC	Cyclic Redundancy Check
DiSEqC	Digital Satellite Equipment Control
DVB-TS	Digital Video Broadcasting-Transport Stream
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
HE	Head End
HED	Head End Device
HP	High Priority
IDU	InDoor Unit
IF	Intermediate Frequency
LP	Low Priority
MATV	Master Antenna TV
MID	Master IDentifier
ODU	OutDoor Unit
OFDM	Orthogonal Frequency Division Multiplexing

PIN	Personal Identification Number
PWK	Pulse Width Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quaternary Phase Shift Keying
RF	Radio Frequency
RS	Reed-Solomon
SID	Slave IDentifier
SMATV	Satellite Master Antenna TV
STB	Set Top Box
TDMA	Time Division Multiple Access
UHF	Ultra High Frequency
VHF	Very High Frequency

4 Message structure

4.1 General

The structure of the Control Channel messages is shown in figure 2.

RUN-IN (3 bytes)	FRAMING	ADDRESS	COMMAND	DATA		DATA	CRC (2 bytes)

Figure 2: Message structure

The RUN-IN bytes are used to provide a reliable reception of messages with large variation in signal level. The value of this 3-byte field is "55 55 0D" (hex. notation).

The CRC (Cyclic Redundancy Check) field is 2 bytes long and is based on the following polynomial generator:

$$CRC = X^{16} + X^{12} + X^{9} + X^{5} + X + 1$$

If the message bytes are less than 32, the CRC will be calculated as if the missing bytes were all 0x00.

In case of the 22 kHz bus (see clause A.1), the message structure does not include the RUN-IN and may not include the CRC bytes. Error protection is currently provided by an Odd Parity bit after each byte according to the DiSEqC specification [2].

If required, the first DATA byte after the COMMAND byte should be used to specify the length of the message.

The ADDRESS and COMMAND bytes are not necessarily used in the reply message from the Head-end device to the user terminal.

The maximum length of the message shall be 32 bytes, excluding RUN-IN and CRC. In case of messages longer than 32 bytes they are fragmented into segments of 32 bytes each, using the fragmentation command defined in clause 5.8.

4.2 Framing byte

The Framing byte is used to define the nature of the communication protocol (one or two way) and reply mechanism required (table 1). The user terminal is called "Master" and the corresponding device at the Head-end is called "Slave".

Table 1: Values for the Framing byte

Framing byte Function	Value
Command from Master, No Reply required, First transmission.	0xE0
Command from Master, No Reply required, Repeated transmission.	0xE1
Command from Master, Reply required, First transmission.	0xE2
Command from Master, Reply required, Repeated transmission.	0xE3
"OK" Reply from Slave, No errors detected.	0xE4
Error Reply from Slave - Repeat of message is not required. Command not executable by Slave (e.g. not supported or power fail).	0xE5
Error Reply from Slave - Request repeat of message, Parity Error detected.	0xE6
Error Reply from Slave - Suggest repeat of message, Received message format not correct (e.g. wrong number of bits / bytes).	0xE7
Extended (multi-block) Command from Master, No Reply required (to this message block), First transmission.	0xE8
Extended Command from Master, No Reply required (to this message block), Repeated transmission.	0xE9
Extended Command from Master, Reply required (to this message block), First transmission.	0xEA
Extended Command from Master, Reply required (to this message block), Repeated transmission.	0xEB
"OK" Report from Slave, command understood, Not yet completed, but unknown time to execute.	0xEC 00
"OK" Report from Slave, command understood, Task completion expected within nn seconds (0 < nn < 128 decimal).	0xEC nn
Error Report from Slave, - Repeat of message is not required, EUI-64 of IDU not valid.	0xED E1
Error Report from Slave, Password in the command message not valid (1^{st} to n^{th} attempts - unidentified number of non-final attempts).	0xED F0
Error Report from Slave, Password in the command message not valid n^{th} attempt, (0 < n < 14 decimal).	0xED Fn
Error Report from Slave, Password in the command message not valid Penultimate attempt before locking.	0xED FE
Error Report from Slave, ODU now Locked. Installer required (e.g. 6^{th} to infinite use of wrong password).	0xED FF
Error Report from Slave - Request repeat of message, CRC not valid.	0xEE E2
Error Report from Slave - Suggest repeat of message, No Error codes yet defined.	0xEF nn

4.3 Address byte

The Address byte is used to identify the different device types for the Head-End unit (slave).

Table 2: Values for the Address byte

Address type	Value
All SMATV Head-end devices	0x70
QPSK/QAM transmodulator	0x71
QAM/QAM frequency converter	0x72
QPSK/QPSK IF-IF converter	0x73
OFDM/QAM transmodulator	0x74
Reserved	0x75 to 0x7E
Reserved for future expansion	0x7F

5 List of commands and coding

5.1 General

The list of relevant commands for the Control Channel is based on DiSEqC and is given in table 3. The commands in the range 0x01 and 0x03 to 0x6F, which are standard DiSEqC commands and are used in solutions adopting the 22 kHz bus (see clause A.1), are not reported in table 3 for sake of simplicity, and can be found in [2] and [6]. These commands may also be used with the RF bus (see clause A.2).

Note that the five Reply messages of table 3 from the Head-End to the user terminal do not have a specific Command byte (see clause 4.1), but are identified by the Framing byte as defined in table 1.

Table 3: List of the SMATV/MATV Control Channel Commands

Command	Command Byte (hex)	Direction STB <-> Head-End device
Reset	0x00	-->
Stand-by	0x02	-->
(reserved)	0x70 to 0x72	
Tuning	0x73	-->
Installation Status Request	0x74	-->
(reserved)	0x75 to 0x77	
Configuration	0x78	-->
Maintenance	0x79	-->
Resource Inquiry	0x7A	-->
(reserved)	0x7B to 0x7E	
Message Fragmentation	0x7F	
Command Reply (ACK)	-	<--
Installation Status Reply	-	<--
Configuration Reply	-	<--
Maintenance Reply	-	<--
Resource Reply	-	<--

5.1a Reset

This command is used to reset the Head-end devices.

Table 4: Reset

Syntax	No. of bits
Reset() {	
Framing	8
Address	8
reset_command	8
pin_code	16
}	

Framing

As defined in clause 4.2.

Address

As defined in clause 4.3.

reset_command

As defined in table 3.

pin_code

Code for the authentication of the user's device at the Head-end. It may also provide information for privacy protection. This pin_code is made of two bytes: an 8-bit Master Identifier (MID) and an 8-bit Slave Identifier (SID). Some of the 16 bits can be used for privacy protection.

5.2 Stand-by

This command is used to allow for energy saving in the Head-end.

Table 5: Stand-by

Syntax	No. of bits
Stand-by() {	
Framing	8
Address	8
stand-by_command	8
pin_code	16
}	

stand-by_command

As defined in table 3.

5.3 Tuning

This command is used for tuning the head-end device, e.g. the QPSK to QAM transmodulator.

Table 6: Tuning

Syntax	No. of bits
Tuning() {	
Framing	8
Address	8
tuning_command	8
pin_code	16
frequency	16
symbol_rate	16
inner_FEC_scheme	3
spectral_inversion	1
(reserved)	4
delivery_system_descriptor	16
}	

tuning_command

As defined in table 3.

frequency

Binary value of the centre frequency of the tuned channel:

- Source = satellite (Address = 0x71 or 0x73): frequency in MHz (0 to 65 536 MHz)
- Source = Terrestrial and Cable (Address = 0x72 or 0x74): frequency as multiples of 25 kHz (maximum frequency: 1 638,4 MHz)

symbol_rate

The symbol-rate is indicated as binary value in ksymbol/s (0 ÷ 65 536).

inner_FEC_scheme

This field indicates the code rate of the inner FEC scheme (convolutional code) of the transmission mode. In case of hierarchical channel coding, this value indicates the inner FEC scheme of the high priority (HP) stream. The values of this 3-bit field are listed in table 7.

The value 0x00 refers to an FEC scheme whose value must be automatically identified by the head-end device other than the seven code rates (1/2 to 7/8).

Table 7: Values for inner_FEC_scheme

Inner_FEC_scheme	Value
Automatic searching	0x00
1/2	0x01
2/3	0x02
3/4	0x03
4/5	0x04
5/6	0x05
6/7	0x06
7/8	0x08

spectral_inversion

'0' = spectral inversion

5.3.1 delivery_system_descriptor

The delivery_system_descriptor, which is the last two bytes of the tuning command, depends on the modulation (i.e. address type, see table 2) of the signal, whether it is from satellite, cable or terrestrial. Table 8 gives the function of each bit in the three different cases.

Table 8: Coding of the delivery_system_descriptor field

Syntax	No. of bits
if (Address = 0x71 or 0x73) {	
frequency_band	1
polarization	1
position	1
option	1
(fixed - same as DiSEqC "port group")	4
(reserved)	8
} else if (Address = 0x72) {	
source_select	3
constellation	3
(reserved)	10
} else if (Address = 0x74) {	
source_select	3
constellation	3
bandwidth	2
guard_interval	2
inner_FEC_scheme-LP_stream	3
hierarchy_information	2
transmission mode	1
}	

a) For satellite/QPSK (Addresses 0x71 and 0x73) [3]:

The first byte of the delivery_system_descriptor is identical to the data byte for DiSEqC [2].

frequency_band

This bit indicates the frequency band (0 = low band, 1 = high band).

polarization

This bit indicates the satellite polarization (0 = vertical/rhc, 1 = horizontal/lhc).

position

This bit indicates which satellite position is selected; in conjunction with the "option" bit up to 4 different orbital locations or positions can be supported.

option

This bit can be used to select additional satellite positions (see above) or other functions as required.

b) For cable/QAM (Address 0x72) [4]:

source_select

This 3 bit field allows up to 8 different QAM sources to be selected.

constellation

This field indicates the constellation pattern used on a cable delivery system. The values of this 3-bit field are listed in table 9.

Table 9: Values for constellation

Constellation	Value
16-QAM	0x01
64-QAM	0x02
Reserved	other values

c) For terrestrial/OFDM (Address 0x73) [5]:

source_select

This 3-bit field allows up to 8 different OFDM sources to be selected (e.g. different antennas).

constellation

This field indicates the constellation pattern used on a terrestrial delivery system. The values of this 3-bit field are listed in table 10.

Table 10:Values for constellation

Constellation	Value
QPSK	0x00
16-QAM	0x01
64-QAM	0x02
Reserved	other values

bandwidth

This 2-bit field indicates the bandwidth of the terrestrial signal:

Table 11: Values for bandwidth

Bandwidth	Value
8 MHz	0x01
7 MHz	0x02
reserved	other values

inner_FEC_scheme-LP_stream

In case of hierarchical channel coding, this field indicates the inner FEC scheme of the low priority (LP) stream, otherwise it is ignored. The values of this 3-bit field are listed in table 7.

hierarchy_information

This field indicates whether the OFDM transmission is hierarchical and, if so, what the α (constellation parameter) value is. The values of this 2-bit field are listed in table 12.

Table 12: Values for hierarchy_information

Hierarchy_information	Value
Non-hierarchical	0x00
α = 1	0x01
α = 2	0x02
α = 4	0x03

guard_interval

This field indicates the guard interval of the OFDM signal. The values of this 2-bit field are listed in table 13.

Table 13: Values for guard_interval

guard_interval	Value
1/32	0x00
1/16	0x01
1/8	0x02
1/4	0x03

transmission_mode

This field indicates the OFDM transmission mode (0 = 2k, 1 = 8k).

5.4 Installation Status Request

The Installation Status Request command interrogates the Head-End device to detect new Head-End Modules, having SID equal to 0, and to establish their type. This command is used during the installation phase by polling through all address categories to find all allocated SIDs/MIDs and RF channels that are already used in the network.

Table 14: Installation Status Request

Syntax	No. of bits
Installation_status_request() {	
Framing	8
Address	8
Installation_status_request_command	8
pin_code	16
}	

installation_status_request_command

As defined in table 3.

5.5 Configuration

This command communicates to the Head-End device all the technical parameters of the configuration to be adopted by the new device (i.e. proposed pin_code, frequency, modulation, etc.). This command can be used also for changing settings to the device after the installation procedure.

Table 15: Configuration

Syntax	No. of bits
Configuration() {	
Framing	8
Address	8
Configuration_command	8
pin_code	16
proposed_pin_code	16
frequency_used	16
modulation_used	8
symbol_rate_used	16
outerFEC_used	4
(reserved)	4
}	

configuration_command

As defined in table 3.

proposed_pin_code

new values for MID and SID.

frequency_used

Binary value of the centre frequency of the RF channel (e.g. 8 MHz if address = 0x71, 0x72 or 0x74, 40 MHz if address = 0x73) allocated to the delivery of the DVB signals from the Head-end to the specific user through the building cable distribution network:

- Distribution in QPSK (Address = 0x73): frequency as multiples of 50 kHz
  (maximum frequency: 3 276,8 MHz)

- Distribution in QAM (Address = 0x71, 0x72 or 0x74): frequency as multiples of 25 kHz
  (maximum frequency: 1 638,4 MHz)

modulation_used

This 8-bit field specifies the modulation scheme used on the building cable network. The values are listed in table 16.

Table 16: Values for modulation_used

modulation_used	Value
QPSK	0x00
16-QAM	0x01
32-QAM	0x02
64-QAM	0x03
128-QAM	0x04
256-QAM	0x05
reserved	other values

symbol_rate_used

This 16-bit field specifies the symbol rate used on the building cable network. It is indicated as binary value in ksymbol/s (0 to 65 536). The value 0x00 is used if a simple frequency conversion is performed.

outer_FEC_used

This field indicates the outer Forward Error Correction (FEC) scheme (e.g. Reed-Solomon) used on the building cable network. The values of this 4-bit field are listed in table 17.

Table 17: Values for outer_FEC_used

Cable_outer_FEC	Value
not applicable	0x00
No outer FEC	0x01
RS(188,204)	0x02
reserved	other values

5.6 Maintenance

Void

5.7 Resource Inquiry

The Resource Inquiry command asks the Head-End device to inform the STB about its identity and characteristics.

Table 18: Resource Inquiry

Syntax	No. of bits
Resource_inquiry() {	
Framing	8
Address	8
Resource_inquiry_command	8
pin_code	16
}	

resource_inquiry_command

As defined in table 3.

5.8 Message Fragmentation

This command is used for messages longer than 32 bytes. In this case the message is fragmented into segments of exactly 32 bytes. The last segment will be stuffed by 0x00.

Table 19: Message Fragmentation

Syntax	No. of bits
Message_fragmentation() {	
Framing	8
Address	8
Message_fragmentation_command	8
pin_code	16
total_number_of_segments	8
segment_number	8
data	25x8
}	

message_fragmentation_command

As defined in table 3.

total_number_of_segments

The total number of 32-byte segments that the message has been divided into.

segment_number

Indicator of present segment. At the first segment this field is equal to the total number of segments and is decreased every message down to one.

data

Encapsulated segmented message.

5.9 Command Reply (ACK)

This message is sent from the Head-End to the STB as a generic reply to those commands which do not need a specific reply. It carries an acknowledgement (e.g. 0xE4, see table 1) of the command on the basis of the CRC and on the validity of the received command and data.

Table 20: Command Reply

Syntax	No. of bits
Command_reply() {	
Framing	8
pin_code	16
information	8
}	

information

This byte gives information about the nature of the ACK (i.e. error codes, time to completion, etc.). It corresponds to the second byte indicated in table 1.

5.10 Installation Status Reply

The Installation Status Reply message is a response of the Head-end device to the Installation Status Request command sent by the Set-Top-Box during the installation procedure. Through this message, the Head-end device informs the STB about its characteristics (modulation, symbol rate, FEC, etc.) and the RF channel used.

Table 21: Installation Status Reply

Syntax	No. of bits
Installation_Status_reply() {	
Framing (= 0xE4: Ack)	8
pin_code	16
address	8
frequency_used	16
modulation_used	8
symbol_rate_used	16
outerFEC_used	4
(reserved)	4
}	

Description for **frequency_used, modulation_used, symbol_rate_used, outerFEC_used** is given as in clause 5.5.

5.11 Configuration Reply

The Head-End device confirms back to the STB the configuration requested through the Configuration command of clause 5.5, or indicates a new value of the parameters. Value 0x00 means no indication from the Head-End device.

Table 22: Configuration Reply

Syntax	No. of bits
Configuration_reply() {	
Framing (= 0xE4: Ack)	8
pin_code	16
address	8
frequency_used	16
modulation_used	8
symbol_rate_used	16
outerFEC_used	4
(reserved)	4
}	

Description for **frequency_used, modulation_used, symbol_rate_used, outerFEC_used** is given as in clause 3.5.

5.12 Maintenance Reply

Void

5.13 Resource Reply

The Resource Reply message is a response of the Head-end device to the Resource Inquiry command. Through this message, the Head-end device informs the STB about its identity and characteristics.

Table 23: Resource Reply

Syntax	No. of bits
Resource_reply() {	
Framing	8
pin_code	16
message_length	8
address	8
frequency_used	16
modulation_used	8
symbol_rate_used	16
outerFEC_used	4
(reserved)	4
manufacturer_code	16
availability	3
(reserved)	5
for (i=0; i<message_length-13; i++) {	
additional data	8
}	
}	

message_length

This field indicates the length of the message.

manufacturer_code

This field is reserved to manufacturer. It is set to 0x00 if not used.

availability

This field indicates whether the device is available or not. The values of this 3-bits field are listed in table 24.

Table 24: Values for availability

Availability	Value
Available	0x00
Not Available	0x01
Device Failure	0x02
Unauthorized User	0x03
Stand-by	0x04
reserved	other values

additional_data

Proprietary information defined by the manufacturer.

Description for **frequency_used, modulation_used, symbol_rate_used, outerFEC_used** is given as in clause 5.5.

Annex A (normative): Physical layers

The Physical layers, described in clauses A.1 and A.2, allow for the use of the Control Channel in the whole range of SMATV/MATV distribution systems, having different topologies and characteristics (i.e. available frequency bandwidth, type of network components, user taps, etc.).

The Control Channel is exclusively intended to provide remote control of the head-end device from the user's terminal through a set of commands in a closed in-building environment for the delivery of broadcasting services. All the equipment which is operated via the Control Channel, i.e. the head-end devices and the user's terminals, are connected through the same coaxial SMATV/MATV installation.

The A.1 solution, based on the 22 kHz bus, is suitable for use in small SMATV/MATV installations adopting d.c. coupled elements. The A.2 solution, based on an RF Control Channel bus, is of general use in most SMATV/MATV installations which currently adopt inductively coupled components.

For both cases the transmission protocol providing the communication link between the user's terminal and the head-end device is based on DiSEqC and makes use of the same commands and coding (see clauses 4 and 5).

In the communication between the user's terminal (STB) and the Head-End Device (HED) a master-slave approach is used where the STB is the master. For this reason an HED can transmit a message only after a request from STB.

A.1 Physical layer based on a 22 kHz bus

This Control Channel between the user's terminal and the Head-End is based on a 22 kHz PWK (Pulse Width Keying) signal as used by DiSEqC [2]. The circuit implementation has to follow the description in the DiSEqC bus functional specification. In order to maintain backward compatibility with existing DiSEqC processors (typically 8 bit microprocessors) and to allow for the transmission of longer messages, these will be subdivided into blocks of 8 bytes. Details are reported in the Guidelines for Implementation document [6].

A.1.1 Main characteristics

Carrier frequency 22 kHz ± 20 %

Bus load impedance (R) 15 Ω ± 5 %

DC supply

Bus load inductance (L_B) 270 µH ± 5 %

Bus load capacitance (C_B) typically 470 nF

Current source

Current amplitude 43 mA ± 10 %

Source impedance > 10 kΩ

22 kHz carrier detection device resistance (R_r) typically between 5 kΩ and 10 kΩ

DC block capacitor (C_r) typically a few nF, but depends on the value R_r. It should be chosen so as to give a time constant of around 100 µs

Bit definition

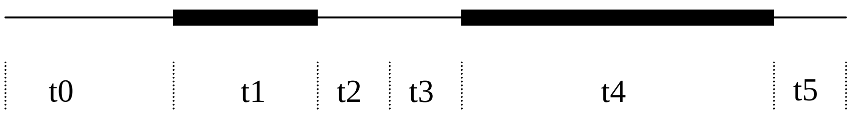
Timing base	0,5 ms ± 0,1 ms
Bit length	1,5 ms
"0"	1,0 ms burst + 0,5 ms pause
"1"	0,5 ms burst + 1,0 ms pause

A.1.2 Multiaccess via the 22 kHz bus

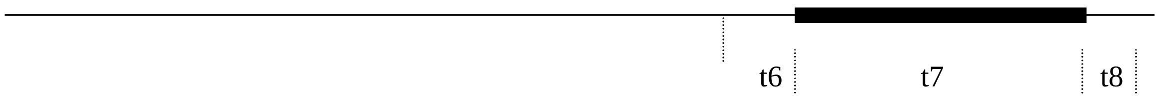
This multiaccess specification provides a solution for small SMATV networks typically with QPSK/QPSK head-ends, as is often typical in IF distribution systems, where all elements (outlets, splitters, couplers, etc.) are d.c. coupled and all terminals are connected in parallel to the bus.

Due to the large bit-length, the communication capacity is limited so that the number of user's terminals should be restricted (about 12 on a single cable) to allow an acceptable "zapping" behaviour in practice. Furthermore, to avoid collision problems, a suitable access control scheme is required, which is described below, capable to ensure a maximum access time of about 1,5 s, in the case all users are switching at the same time.

User terminal (master) message with anticollision header:



Reply from head-end:



A.1.2.1 Timing

The description of the timing parameters and relevant values are reported in table A.1. Additional information is given in [6].

Table A.1: Definition of anti-collision timing parameters

Time interval	Meaning	Value
t0	first watching time	$t2_{max}$ + 4 ms
t1	bus test take-over time (22 kHz burst)	number of time intervals (4 ms) depends on number of STB's
t2	second watching time	number of time intervals (4 ms) depends on number of STB's
t3, t5	guard interval	2 ms
t4	message to head-end	depends on head-end type
t6	guard interval (minimum value)	2 ms
t7	message from head-end	depends on content/STB
t8	guard interval (minimum value)	2 ms

A.2 Physical layer based on a RF bus

The RF Control Channel bus is based on 2-FSK modulation of a single RF carrier in a frequency range above 10 MHz, which is shared by all the Control Channel devices of the in-building cable network.

A.2.1 Main characteristics

Frequency: f_0 = 10,7 MHz (see note 1)

or/and f_0 = 18 MHz
or/and f_0 = 70 MHz

Modulation: 2-FSK; Δf = 67 kHz

Bit length: 10 µs

Bit definition:

"0" $f_0 - \Delta f$

"1" $f_0 + \Delta f$

Tx. max power level

STB 98 dB(µV) (75 Ω)

Head-end unit 108 dB(µV) (75 Ω)

Rx. min. power level

STB 53 dB(µV) (75 Ω)

Head-end unit 43 dB(µV) (75 Ω)

Tx. spectral mask: ≤ -60 dB @ f_0 - 2 MHz ≤ f ≤ f_0 + 2 MHz (see note 2)

NOTE 1: The choice of the frequency will be made according to the different networks and national channelling.

NOTE 2: The Tx spectral mask is intended to avoid spectrum interference from the control channel onto the adjacent TV channels and/or other signals, if present.

A.2.2 Multiaccess via the RF bus

Because of the directional characteristics of the inductive network components, the messages sent by one terminal to the head-end are not detected by the other terminals. Therefore the approach described in clause A.1.2 cannot be adopted. The access system is then based on an Aloha scheme randomly exploiting the channel transmission resources in a time-division mode, i.e. whenever a terminal has an information to be sent, transmission is started without checking if the channel is free or busy. This implies a non-null probability of message collision on the channel. However, the receiving device (Head-end and user's terminal) is able to detect the correctness of the message thanks to the CRC. An automatic mechanism of acknowledge and command repetition may be adopted.

The performance of the multiaccess system based on the Aloha scheme without acknowledge has been evaluated [6] under typical configurations of SMATV/MATV distribution systems in term of collision probability as function of message duration and of number of user terminals. Given the maximum message length of 32 bytes, which corresponds to the maximum message duration around 2,5 ms, the results indicate an acceptable performance (about 97 % probability of success) in the case of 40 user's terminals connected to the distribution network.

A.2.3 Optional Frequency Extension

In particular cases where fast response application is needed and/or a large number of devices are connected to the same SMATV/MATV network, a "single channel" frequency (f_0) may not be sufficient to meet the requirement of fast tuning/access to the user's selected DVB Transport Streams. In such a "multiple channel" mode, additional carriers, in a mixed TDMA/FDMA configuration, can be used, where f_a is the frequency separation between adjacent carriers. The frequency allocation of the additional carriers shall be as follows:

Frequency (Fc): $f_0 + n\, f_a$ $n = 1, 2, \ldots$; fa = 500 kHz

Tx. spectral mask: $\leq$ -30 dB @ $Fc- f_a \leq f \leq Fc + f_a$

All the parameters of the physical layer and transmission protocol are the same as for the case of the "single channel" mode.

History

Document history		
V1.1.1	August 2001	Publication