

Digital terrestrial television receivers for the DVB-T system —

Part 1: Baseline receiver specification

The European Standard EN 62216-1:2002 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 62216-1:2002. It is identical with IEC 62216-1:2001.

The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Digital terrestrial television receivers for the DVB-T system
Part 1: Baseline receiver specification
(IEC 62216-1:2001)

Récepteur de télévision numérique
terrestre pour le système DVB-T
Partie 1: Spécification du récepteur
de base
(CEI 62216-1:2001)

Fernsehempfänger für das digitale
terrestrische DVB-T-System
Teil 1: Festlegungen für den Basis-
Empfänger
(IEC 62216-1:2001)

This European Standard was approved by CENELEC on 2002-09-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 62216-1:2001, prepared by IEC TC 100, Audio, video and multimedia systems and equipment, was submitted to the formal vote and was approved by CENELEC as EN 62216-1 on 2002-09-01.

The following dates were fixed:

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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2005-09-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, Annexes A, B, D and ZA are normative and Annexes C, E, F and G are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62216-1:2001 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Television has evolved over the last half century from an up-market entertainment medium to becoming the major information tool around the world.

Television is available to virtually all people around the globe, be it individually or in a community setting.

The advent of the “personal computer”, enabling global reach and instant interaction has escalated the demand for more and more information and the ability to respond to it instantly.

It is thus that the broadcasters and content providers set out to seek new means of delivering higher levels of content, be it in volume or quality using existing or new transport mechanisms available.

Digitalisation, taken from the world of information technology was the obvious choice.

It further brought the added benefits of efficient use of spectrum and energy, not to mention interaction through a return path.

Terrestrial television has to migrate from analogue to digital in order to survive in the new information society.

Without any doubt, all means of information and content dissemination technology will merge over time, provided that sound business models find uptake by consumers at large.

Governments are keen to switch off the inefficient analogue broadcasts for a number of obvious reasons, but only will be able to do so when consumers are confident that the new proposition is attractive and affordable.

Business models are being developed to promote the uptake of digital receivers, however this activity up to now is mainly led by private enterprises targeting the public sector willing to pay for services in addition to those available from established public broadcasters.

This in itself is fine, but will not enable the migration from analogue to digital of all broadcasts, however funded.

The more so as it has led to a variety of incompatible platforms tied to particular TV operators, and this in turn does not allow for economy of scale for all parties concerned, be it content providers, broadcasters, network providers or equipment manufacturers.

After over two years of requirement capture in DigiTAG (Digital Television Action Group) and other fora, EACEM (European Association of Consumer Electronics Manufacturers) decided to address this situation by developing a basic specification as a minimum platform, providing secure reception of broadcast content and associated services. This includes both free to air as well as pay TV services by means of the DVB common interface.

This is in order to provide a stable base from which new applications and services can be built up, and ensuring backwards compatibility for products in the market based on this specification, thus ensuring that the consumer will continue to receive the services they have grown accustomed to.

EACEM has taken into consideration all other documents and specifications that were freely available from various bodies (NorDig Group, ANIEL, etc.) in order to develop a pan European specification.

DIGITAL TERRESTRIAL TELEVISION RECEIVERS FOR THE DVB-T SYSTEM –

Part 1: Baseline receiver specification

1 Scope

This part of IEC 62216 specifies the baseline receiver for the DVB-T system.

It concerns:

- broadcasters, and
- receiver manufacturers.

The objective is to define:

- how to provide broadcasts that are understood by all receivers and enable receivers to provide good facilities to their users;
- the behaviour required from receivers to work well with these broadcasts and to be attractive to consumers.

To avoid doubt, the words “shall”, “should” etc. are used in the traditional way to distinguish issues that are important versus those that are optional. The term “shall” is also used to identify mandatory requirements that are inherited from other specifications that have greater force.

This specification does not consider interactive applications and the data broadcasting that would support them. Subtitling and teletext are considered to be components of TV services. Standalone teletext services are not part of this standard.

This specification primarily addresses terrestrial delivery of digital transmissions.

This specification primarily addresses deployment in countries that use European Latin script based languages.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 62216. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 62216 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60169-2, *Radio-frequency connectors - Part 2: Coaxial unmatched connector*

ISO/IEC 6937, *Information technology – Coded graphic character set for text communication – Latin alphabet*

ISO/IEC 8859-9, *Information technology – 8-bit single-byte coded graphic character sets – Part 9: Latin alphabet No. 5*

ISO/IEC 11172-2, *Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 2: Video*

ISO/IEC 13818-1, *Information technology – Generic coding of moving pictures and associated audio information: systems*

ISO/IEC 13818-2, *Information technology – Generic coding of moving pictures and associated audio information: Video*

ISO/IEC 13818-3, *Information technology – Generic coding of moving pictures and associated audio information: Audio*

ITU-R BT.470-6, *Conventional television systems*

ITU-R BS.775-1, *Multichannel stereophonic sound system with and without accompanying picture*

ITU-R BT.1119-2, *Wide-screen signalling for broadcasting (Signalling for wide-screen and other enhanced television parameters)*

ITU-R BT.1359-1, *Relative timing of sound and vision for broadcasting*

EN 50049-1, *Domestic and Similar Electronic Equipment Interconnection Requirements: Peritelevision Connector*

EN 50221, *Common Interface Specification for Conditional Access and Other Digital Video Broadcasting Decoder Applications*

EN 300 468, *Digital Video Broadcasting (DVB) - Specification for Service Information (SI) in DVB systems*

EN 300 744, *Digital Video Broadcasting (DVB) - Framing structure, channel coding and modulation for digital terrestrial television (DVB-T)*

EN 301 775, *Digital Video Broadcasting (DVB) - Specification for the carriage of Vertical Blanking Information (VBI) data in DVB bitstreams*

ETR 289, *Digital Video Broadcasting (DVB) - Support for Use of Scrambling and Conditional Access (CA) within digital broadcasting systems*

ETR 154, *Digital Video Broadcasting (DVB) - Implementation guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial broadcasting applications*

ETR 162, *Digital Broadcasting Systems for Television Sound and Data services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems*

ETR 211, *Digital Video Broadcasting (DVB) - Guidelines on implementation and usage of Service Information (SI)*

ETS 300 231, *Television Systems - Specification of the domestic video Programme Delivery Control system (PDC)*

ETS 300 294, *Television Systems; 625 - Line television Wide Screen Signalling (WSS)*

ETS 300 472, *Digital Video Broadcasting (DVB) - Specification for conveying ITU-R System B Teletext in DVB bitstreams*

ETS 300 706, *Enhanced Teletext specification*

ETS 300 743, *Digital Video Broadcasting (DVB) - Subtitling systems*

R206-001, *Guidelines for Implementation and Use of the Common Interface for DVB Decoder Applications*

TS 101 699, *Digital Video Broadcasting (DVB) - Extensions to the Common Interface Specification*

3 Abbreviations and symbols

BAT	Bouquet Association Table
bslbf	Bit string, left bit first
CA	Conditional Access
DTTV	Digital Terrestrial Television
DVB	Digital Video Broadcast
EIT	Event Information Table

EIT _{pf}	EIT present/following
EPG	Electronic Programme Guide
IDTV	Integrated Digital Television
MFN	Multi Frequency Network
MTBF	Mean Time Between Failure
NIT	Network Information Table
NVOD	Near Video On Demand
PMT	Program Map Table
PSI	Program Specific Information
RST	Running Status Table
SDT	Service Description Table
SFN	Single Frequency Network
SI	Service Information
STB	Set Top Box
TDT	Time and Date Table
TOT	Time Offset Table
TS	Transport Stream
uimsbf	Unsigned integer most significant bit first
UTC	Universal Time, Co-ordinated

4 Receiver capabilities

The list below gives a general overview of receiver capabilities supported by this specification.

4.1 Frequency spectrum

- UHF and/or VHF (band III);
- 8 MHz and/or 7 MHz Channel bandwidth;
- supports all DVB-T modulation methods;
- supports both 2K and 8K transmitting methods;
- supports all code rates;
- supports all guard intervals;
- supports hierarchical mode by the demodulator;
- supports portability.

4.2 Conditional access

The receiver is capable of receiving free-to-air as well as pay services. In order to have the necessary flexibility to choose a conditional access (CA) system one common interface slot (according to EN 50221) is foreseen. In future, other means to add new CA systems might be used such as the IEEE 1394 digital interface.

4.3 Return path

If a modem is not embedded then suitable means should be provided for connection to one (for example RS 232) for further interactive applications (for example IPPV).

4.4 Navigator (SI)

The navigator will use the mandatory service information broadcast in the service information table and the event information table to present appropriate service and event information to the user and to allow automatic selection of service features when the user selects a service.

Details can be found in clause 9, which is based on (mandatory) DVB-SI rules.

4.5 Auto installation

The receiver will allow access to all receivable services and will use the mandatory information in the NIT and/or SDT to automate the initialisation of the service list and subsequent updates thereof. See also 9.4.2.

4.6 Teletext carried in digital streams

Support of this feature is the responsibility of the manufacturer. Manufacturers are prepared to support teletext for a transition period. This feature and its signalling is described in clause 11.

4.7 Analogue recording/copy management

Analogue recording via the peritelevision connector (EN 50049-1) is supported.

4.8 Services

The receiver shall support the following services and service features:

- free to air broadcast;
- multi-lingual sound, multi-comments;
- multi-lingual subtitles (DVB subtitles, region based graphics);
- audio broadcast;
- screen formatting for ratios of 4:3 and 16:9.

In addition, the receiver may support:

- teletext linked with a program;
- mosaic services;
- Automatic Format Descriptor (AFD) for flexible screen formatting.

4.9 Future versions of this specification

It is the intention to extend this specification in a backward compatible way towards new types of services and service options and consequent receiver behaviour.

This is the case, in particular for the choice of an API, where it is currently expected that DVB-MHP is an appropriate choice as a generally accepted API for broadly marketable receivers.

In clause 9, the following additions are foreseen:

- Service list and logical channel number handling through the SDT as an additional alternative to the NIT based handling.
- CA replacement service link behaviour (to be confirmed).
- Description of various options available in the present specification to create different variations of services.

- linkage to a software loader.

5 Video system characteristics

5.1 Introduction

This clause defines the digital video encoding standards that shall be used.

It is based on D-Book version 3.0.

5.2 Essential requirements

Broadcast video shall be encoded according to ISO/IEC 13818-2 constrained according to ETR 154. All receivers should be able to meet the minimum decoding requirements set out in ETR 154.

Only the '25 Hz SDTV' variant described in the 'video' clause of ETR 154 is relevant to this specification.

5.3 Constraints and extensions

This clause sets out the additional requirements on the broadcast signals and reception equipment in addition to the DVB requirements in ETR 154.

5.3.1 Support for rapid channel acquisition

To reduce the typical time taken to start decoding a new service, each video elementary stream shall contain a sequence header and associated group of pictures header at an interval no greater than 0,5 s¹⁾. Also, each such sequence header shall be immediately preceded by a PES packet header carrying a PTS.

There is no requirement to set the data alignment indicator flag in the PES packet header or for the broadcast to include a data stream alignment descriptor associated with the video elementary stream in the PMT. If a data stream alignment descriptor is included for a video elementary stream then it shall indicate alignment type '04'.

5.3.2 Picture types

Beyond the requirements of ISO/IEC 13818-2 and the requirement for periodic I pictures implied by 5.3.1, no additional constraints are placed on the sequence of coded picture types. Specifically, no additional constraints are placed on the number of B pictures between I and P pictures. As required by the main profile of ISO/IEC 13818-2, broadcasts may use I, P, B and dual-prime frame types.

5.3.3 ISO/IEC 11172-2 compatibility

ETR 154 requires that video encoding shall conform to the ISO/IEC 13818-2 main profile at main level. This requires support for ISO/IEC 11172-2 'D' pictures and "constrained parameters" video.

Broadcasts conforming to this specification shall not include ISO/IEC 11172-2 'D' pictures or sequences with a horizontal_size greater than 720.

¹⁾ ETR 154 recommends but does not mandate this.

5.3.4 User data

To ensure good functionality in current and future receiver video decoder implementations, a buffer model for user data within the video elementary stream is defined. The currently proposed use for this is to carry the “active format description” described in 6.4.3. This only exploits a small number of the bytes that might be used. Broadcasts are not required to carry this data.

If user data is carried, it shall meet the following buffer model:

- All user data bytes enter a single buffer of size 16 bytes (the user data start code is discarded before data is delivered to the buffer).
- All the data delivered at one time is removed from the buffer no later than 40 ms after it was delivered.

5.3.5 Video alignment

5.3.5.1 Analogue output signal

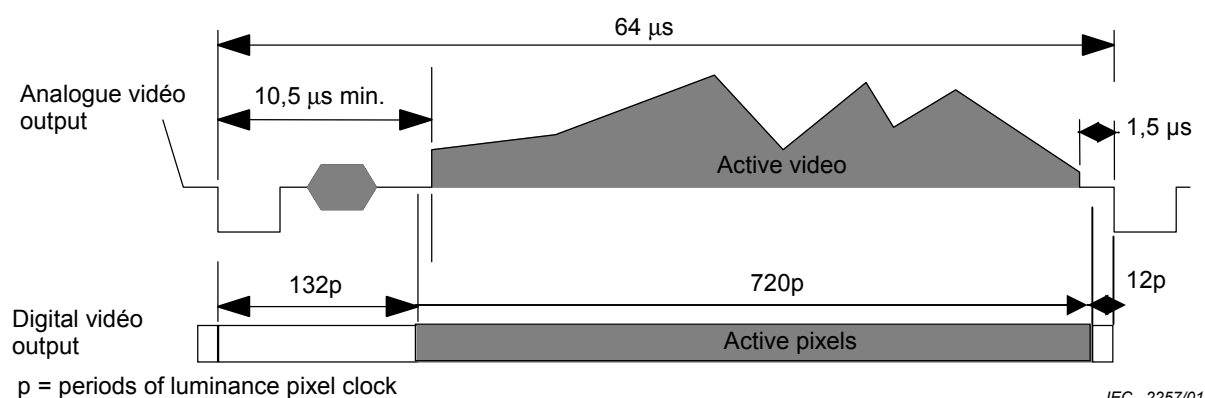


Figure 1 – Relationship between digital video and analogue video

The digital video output of the receiver’s MPEG video decoder and graphics display system domain contains 720 active pixels per line; these shall be aligned to the analogue video output signal as shown in figure 1.

It should be noted that:

- At least the first 9 and the last 9 of the 720 video pixels should be replaced with a blanking level to ensure compliance with ITU-R BT.470-6.
- Optionally, additional blanking may be applied to the start and end of the active video, suppressing further active pixels.
- The position of the first of the 720 active video pixels corresponds to 132 pixel periods ($\approx 9,8 \mu\text{s}$) after the falling edge of line sync.
- The figure is specific for PAL output signals. For receivers with SECAM output signals, similar positioning and blanking shall be done.

5.3.5.2 Overscan

Typically a 5 % border region inside each edge of the 702x576 pixel area is not visible due to CRT overscan.

6 Video display formatting

6.1 Introduction

This clause, which is based on D-Book version 3.0, describes the video format signalling and how it may be used. The receiver response to this signalling is defined in this clause.

This clause:

- Provides a summary of the “applicable standards”.
- Introduces “recommendations for signalling in the video stream”.
- Defines “video format signalling extensions”.
- Defines requirements for “alignment of video and graphics”.

6.2 Video format

The video format shall be encoded as described in ISO/IEC 13818-1, ISO/IEC 13818-2 and EN 300 468 constrained and interpreted as described in ETR 211 and ETR 154 and as clarified and extended below.

Only the ‘25 Hz SDTV’ variant described in the ‘video’ clause of ETR 154 is relevant to this specification.

6.2.1 Requirements for DVB compliance

6.2.1.1 Required format information

The following elements must be included for all video services:

- Video sequence header (ISO/IEC 13818-2). Restricted to “full screen” luminance pixel resolutions of: 720x576, 544x576, 480x576, 352x576 or 352x288 or “less than full screen” resolutions as described in ETR 154.
- Component descriptor (EN 300 468).

6.2.1.2 Optional to broadcast, required to decode

All conformant receivers are required to respond to the above mandatory information and shall also respond to the following optionally broadcast information:

- Video sequence display extension (ISO/IEC 13818-2), provided that the display window has an aspect ratio of 4:3 as described in ETR 154.
- Video picture display extension (ISO/IEC 13818-2), provided that the frame centre vertical offset is zero as described in ETR 154.

It is mandatory to include the video sequence extension in any video sequence that includes the picture display extension (and hence Pan vectors).

- Target background grid descriptor (ISO/IEC 13818-1), provided that the display grid is 720 x 576 as described in ETR 154.
- Video window descriptor (ISO/IEC 13818-1).

6.3 Recommendations for signalling in the video stream

Broadcasts may use any of the formats permitted by DVB (see ETR 154). This clause defines the signalling that must be used when using these formats.

6.3.1 Sequence header

The minimum video format signalling required is the video sequence header. Table 1 tabulates the horizontal scaling factors required to restore video to 720 pixel horizontal resolution with the correct aspect ratio. These factors complement the scaling factors employed by the broadcaster when downsampling the video before encoding.

Table 1 – Horizontal scaling where format is signalled by the sequence header alone

			Source aspect ratio ^{a)}		
horizontal_size	Nominal “full screen” width	Effective horizontal size ^{b)}	4:3	16:9	
545 to 720	720	720	1	4/3 ^{c)}	1
481 to 544	544	540	4/3	16/9	4/3
353 to 480	480	480	3/2	2	3/2
1 to 352	352	360	2	8/3	2
			4:3 display		16:9 display
			Horizontal scaling to fill 720 wide display		

a) From the aspect ratio information.

b) For example, values of horizontal_size from 481 to 544 are treated as 540 when determining the scaling factor to adapt the video for a 720 pixel wide display, i.e. 720/540 = 4/3.

c) These scaling factors apply to a centre cut-out presentation, i.e. the central 3/4 of the coded picture width is scaled by the factor indicated to fill the width of a 4:3 display.

6.3.2 Sequence display extension

6.3.2.1 Pan scan window

Here the sequence display extension describes a 4:3 aspect ratio window within 16:9 coded frame (the position of this window may be controlled by the picture display extension).

Table 2 – Pan scan window

display_horizontal_size			Effective horizontal size ^{a)}	Horizontal scaling	
Min.	Typical ^{b)}	Max.		Window fills 4:3 display	Full frame fills 16:9 display
409	540	540	540	4/3	1
364	408	408	405	16/9	4/3
271	360 ^{c)}	363	360	2	3/2
1	264	270	270	8/3	2
a) Scaling to make the display window fill 4:3 display is $720/\text{effective horizontal size}$.					
b) Recommended to broadcast. Is 3/4 of the nominal “full screen” width.					
c) ETR 154 and DAVIC quote 363 as an example of $480 \times 3/4$.					

6.3.2.2 Non “full screen”

Here the sequence display extension describes a window (4:3 or 16:9) that surrounds the coded frame.

Table 3 – Non “full screen”

display_horizontal_size	effective horizontal size ^{a)}	horizontal scaling to fill display of same aspect ratio ^{b)}	note
720 704	720	1	Distinguished from table 2 as display_horizontal_size ≥ horizontal_size
544 528	540	4/3	
480	480	3/2	
352	360	2	
^{a)} Scaling to make display window fill appropriate display is 720/effective horizontal size.			
^{b)} In other words, to fill a 4:3 display if the aspect ratio information is 0010 ₂ or 16:9 display if the aspect ratio information is 0011 ₂ .			

6.3.3 Constraints on the use of the picture display extension

The picture display extension may be included in broadcasts to define non-zero valued frame centre horizontal offsets.

When provided, receivers shall use this information only when configured to display a 4:3 cut-out from a widescreen source on a 4:3 display. The horizontal offset should be ignored if the material is displayed in a letter box on the 4:3 display.

6.3.3.1 Pan vectors

The term “pan vector” is used in DVB documents (for example ETR 154), however, it is not defined. For the purposes of this specification the term is understood to mean an instance of picture display extension with a non-zero valued frame centre horizontal offset.

ETR 154 forbids the use of pan vectors with a vertical component (sometimes referred to as “scan”) i.e. picture display extension with non-zero valued frame centre vertical offsets are not permitted.

6.3.4 Format switching

Receivers complying with this specification shall be able to continue outputting decoded video pictures undisturbed by changes in the video format parameters provided that these changes are constrained as follows:

- changes are implemented at a sequence boundary;
- vertical_size and display_vertical_size remain unchanged;
- the buffer models defined by MPEG are met;
- the field parity of the first displayed field of the new sequence complements that of the last displayed field of the preceding sequence.

Specifically, this allows the following parameters to be changed:

- coded picture width (horizontal_size), and
- coded pixel aspect ratio (aspect_ratio_information, display_horizontal_size).

6.4 Video format signalling extensions

DVB requires receivers to support 16:9 and 4:3 coded video (support for 2,21:1 is optional). However, additional origination formats are prevalent in some countries (such as the 15:9

format Super 16 film) and invented formats (such as 14:9) may be used to accommodate the delivery of mixed formats to a heterogeneous receiver population.

This clause describes how these additional formats may be conveyed compatibly within the standard DVB coded picture formats.

6.4.1 MPEG signalling

The use of the signalling methods within the MPEG video elementary stream is unchanged from that described previously, i.e. the sequence header and the sequence display extension parameters describe either a 16:9 or a 4:3 aspect ratio coded frame that is either one of the full screen formats or a cropped version of one of these.

“Pan vectors” may be included in a broadcast that also uses the active format description. “Pan vectors”, and the active format description provide alternative, mutually exclusive, methods of displaying widescreen material on a 4:3 display.

6.4.2 DVB signalling

The EN 300 468 component descriptor shall be appropriate for the coded frame type of the video, i.e. 4:3 or 16:9 (with or without “Pan vectors”).

6.4.3 Active format description

Active format descriptions as defined in annex B of ETR 154 serve to describe the portion of the 16:9 or 4:3 coded frame that is “of interest”. The format descriptions are informative in nature and are provided to assist receivers to optimise their presentation of video.

Table 4 (copied from ETR 154) illustrates the various formats.

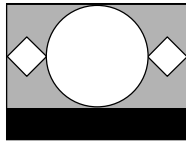
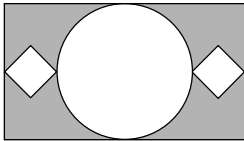
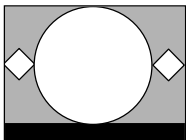
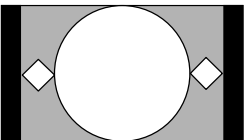
6.4.3.1 Broadcaster rule

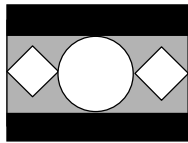
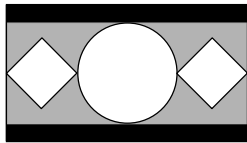
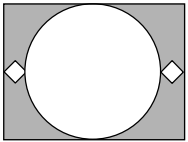
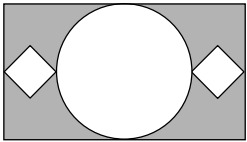
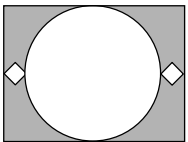
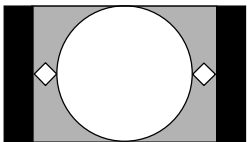
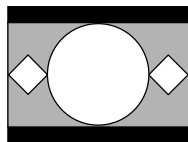
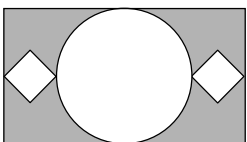
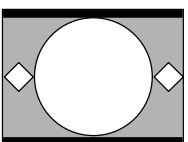
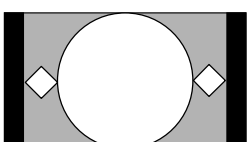
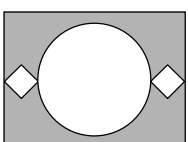
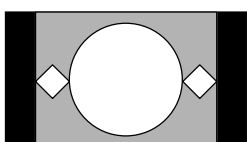
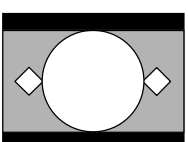
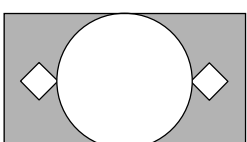
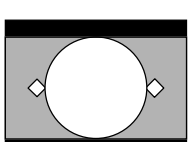
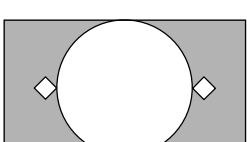
If the area of interest is smaller than the full coded frame then it is recommended to transmit the active format description to indicate the area of interest.

6.4.3.2 Manufacturer rule

It is recommended that receivers use this active format description (if transmitted) to allow optimised presentation.

Table 4 – Formats described by the active_format description

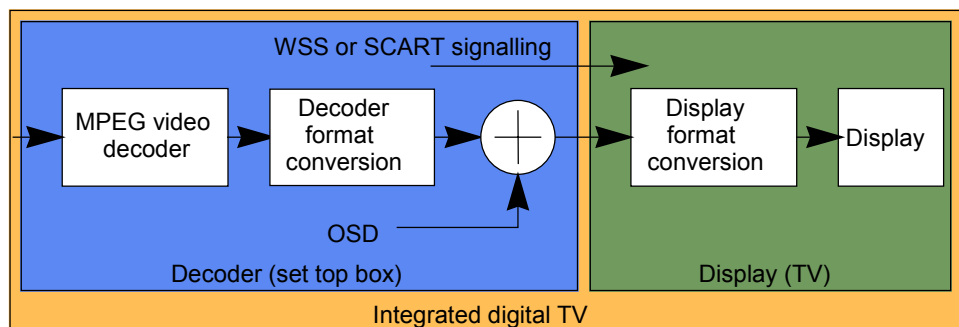
active_format		Full frame aspect ratio	
Value	Meaning	4:3	16:9
0000 – 0001	Reserved for future use		
0010	Box 16:9 (top)		
0011	Box 14:9 (top)		

active_format		Full frame aspect ratio	
Value	Meaning	4:3	16:9
0100	Box > 16:9 (centre)		
0101 – 0111	Reserved for future use		
1000	Active format is the same as the coded frame		
1001	4:3 (centre)		
1010	16:9 (centre)		
1011	14:9 (centre)		
1100	Reserved for future use		
1101	4:3 (with shoot and protect 14:9 centre)		
1110	16:9 (with shoot & protect 14:9 centre)		
1111	16:9 (with shoot & protect 4:3 centre)		
^{a)} It is recommended to use the 4:3 coded frame mode to transmit 4:3 source material rather than using a pillar box to transmit it in a 16:9 coded frame. This allows for higher horizontal resolution on both 4:3 and 16:9 sets.			

6.4.3.3 Receiver processing

6.4.3.3.1 Reference model

The reference model for the video format processing elements in the set top box, TV and integrated digital TV are illustrated in figure 2. The behaviour of the integrated digital TV is logically equivalent to that of a set top box attached to a TV. The display format signalling between the set top box and the display is Line 23 WSS (see 6.4.3.7) and/or peritelevision connector pin 8. Within an integrated digital TV, the signalling is logically equivalent to WSS but could be conveyed by other means.



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Figure 2 – Receiver and display format processing reference model

In the reference model the output of the MPEG video decoder is logically 720 x 576, the processing applied to this by the decoder format conversion is described in tables 5 and 8. In many practical implementations the processes in the decoder format conversion are an integral part of the MPEG video decoder. This does not affect the logical reference model.

The decoder format conversion is principally concerned with the processing provided in 16:9 displays to accept 4:3 signals.

6.4.3.4 STB with 4:3 display

6.4.3.4.1 STB response

Table 5 shows the response of a set top box to all broadcast formats when connected to a 4:3 aspect ratio display.

Table 5 – Processing by STB connected to 4:3 TV

Broadcast format			STB into 4:3 display		
Description of format	On-air signalling		Decoder format conversion	Signalling to TV	
	MPEG	active_ format		WSS codes for aspect ratio	Peritelevision connector Pin 8
16:9 letter box (top)	4:3	0010	FF	0010	12 V
14:9 letter box (top)		0011		0100	
>16:9 letter box		0100		1011	
4:3		1000		0001	
		1001			
16:9 letter box		1010		1101	
14:9 letter box		1011		1000	
Full 4:3 shoot & protect 14:9		1101		0111	
16:9 LB shoot & protect 14:9		1110		1101	
16:9 (with shoot & protect 4:3 centre)		1111			
16:9 letter box (top)	16:9	0010	According to user preference. See table 6		
14:9 letter box (top)		0011	CCO ^{a)}	0001	12 V
>16:9 letter box		0100	According to user preference. See table 7		
16:9		1000	According to user preference. See table 6		
4:3 pillar box		1001	CCO	0001	12 V
16:9		1010	According to user preference. See table 6		
14:9 pillar box		1011	CCO ^{a)}	0001	12 V
4:3 PB shoot & protect 14:9		1101	CCO	0001	12 V
Full 16:9 shoot & protect 14:9		1110	According to user preference. See table 6 ^{b)}		
Full 16:9 shoot & protect 4:3		1111	According to user preference. See table 6		
^{a)} Or 14:9 letter box if available.					
^{b)} A 14:9 letter box is preferable to 16:9 letter box in this case.					

Where the active_format code is a reserved value, or the active_format code is absent, the behaviour is as if the active_format code was 1000.

6.4.3.4.2 User preferences for displaying 16:9

4 user preferences for presentation of widescreen material are defined in table 6. In the first three cases, the STB provides processing to format 16:9 video for 4:3 display. In the fourth case, the STB outputs the 16:9 format signal as if it was addressing a 16:9 display. This mode allows a 4:3 display with special features (such as letter box processing) to format the video to its aspect ratio.

Table 6 – User options for displaying 16:9 on 4:3

Selected Mode	Decoder format conversion	WSS codes for aspect ratio	Peritelevision connector Pin 8
16:9 Letter Box	16:9 LB	1101	12 V
14:9 Letter Box	14:9 LB	1000	
Centre Cut-Out	CCO	0001	
Use TV's feature	FF	1110	6 V

6.4.3.4.3 User preferences for displaying >16:9

4 user preferences for presentation of "cinemascope" material (>16:9) are defined in table 7. In the first three cases, the STB provides processing to format >16:9 video for 4:3 display. In the fourth case, the STB outputs the >16:9 format signal as if it was addressing a 16:9 display. This mode allows a 4:3 display with special features (such as letter box processing) to format the video to its aspect ratio.

Table 7 – User options for displaying >16:9 on 4:3

Selected mode	Decoder format conversion	WSS codes for aspect ratio	Peritelevision connector pin 8
16:9 letter box	16:9 LB	1011 (>16:9 LB centre) ^{a)}	12 V
14:9 letter box	14:9 LB	1101 (16:9 LB centre) ^{a)}	
Centre cut-out	CCO	1000 (14:9 LB centre) ^{a)}	
Use TV's feature	FF	1110 ^{b)}	6 V
^{a)} The WSS code indicated in this cell probably corresponds to the number of active lines in the output signal of the STB for the material being processed. ^{b)} ETS 300 294 does not have a way to indicate the active area being less than full frame for the "16:9 anamorphic" mode.			

6.4.3.4.4 Key

- FF Full frame
The output of the decoder is the full width & height of the coded frame.
- LB Letter Box
The coded frame is reduced to a 16:9 (or 14:9) letter box and presented within a 4:3 raster.
- CCO Centre Cut-Out
The central 4:3 aspect ratio region of the 16:9 frame is extracted and output as a 4:3 raster.

6.4.3.4.5 WSS signalling with 4:3 display

Although 4:3 displays generally are not expected to respond to the aspect ratio information WSS codes (see table 9), this signalling is provided to ensure correct behaviour if the video is recorded and then subsequently displayed on a TV that supports WSS.

6.4.3.5 STB with 16:9 display

Table 8 shows the response of a set top box to all broadcast format when connected to a 16:9 aspect ratio display.

Table 8 – Processing by STB connected to 16:9 TV

Broadcast format			STB into 16:9 display		
Description of format	On-air signalling		Decoder format conversion	Signalling to TV	
	MPEG	active_format		WSS	Peritelevision connector Pin 8
16:9 letter box (top)	4:3	0010	FF	0010	12 V
14:9 letter box (top)		0011		0100	
>16:9 letter box		0100		1011	
4:3		1000		0001	
		1001			
16:9 letter box		1010		1101	
14:9 letter box		1011		1000	
Full 4:3 shoot & protect 14:9		1101		0111	
16:9 letter box shoot & protect 14:9		1110		1101	
16:9 (with shoot & protect 4:3 centre)		1111			
16:9	16:9	0010	FF	1110	6 V
14:9 pillar box		0011			
>16:9 letter box		0100			
16:9		1000			
4:3 pillar box		1001	CCO	0001	12 V
16:9		1010	FF	1110	6 V
14:9 pillar box		1011			
4:3 pillar box shoot & protect 14:9		1101	CCO	0111	12 V
Full 16:9 shoot & protect 14:9		1110	FF	1110	6 V
Full 16:9 shoot & protect 4:3		1111			

6.4.3.6 Integrated 16:9 TV

The response of an integrated 16:9 TV to the broadcast format described in 6.4 should be equivalent to the combined response of a set top box (see 6.4.3.5) and a 16:9 TV.

6.4.3.7 Wide Screen signalling (WSS)

It is recommended to insert WSS according to ETS 300 294/ITU-R BT.1119-2 into the analogue output signal.

6.4.3.7.1 Aspect ratio bits

The aspect ratio bits shall be set according to the previous clauses, with the following meaning (reproduced from ETS 300 294/ITU-R BT.1119-2).

Table 9 – WSS codes for aspect ratio

WSS Code ^{a)} bits 0-3	Description
0001	Full format 4: 3
1000	Box 14:9 centre
0100	Box 14:9 top
1101	Box 16:9 centre
0010	Box 16:9 top
1011	Box > 16:9 centre
0111	Full format 4:3 (shoot and protect 14:9 centre)
1110	Full format 16: 9 anamorphic
^{a)} This bit ordering follows the ETS specification (i.e. bslbf). The ITU specification writes the bits d_3 - d_0 . The specifications are identical as in both cases the transmission order is d_0 to d_3 .	

6.4.3.7.2 Other WSS bits

The non-aspect ratio bits in the WSS signal (bits b_4 ... b_{13}) convey additional information. If WSS information is broadcast according to EN 301 775 (see 11.4), the values bits b_4 ... b_{13} from the broadcast signal can be copied from this information. If no such information is broadcast, the receiver shall set these bits to a meaningful value:

Table 10 – Values for other WSS bits

WSS bit(s)	Value	Comment
b_4 film mode	0	No information regarding field paring is available
b_5 colour coding	0	No Motion Adaptive Colour Plus
b_6 helper	0	No helper signal present
b_7 reserved	0	
b_8 subtitles within teletext	0/1	Set to 1 if DVB SI teletext descriptor with teletext_type=0x02 present
b_9 , b_{10} subtitling mode	00	If no DVB subtitling is inserted
	10/01	If DVB subtitling is inserted, the receiver can deduce whether this subtitling information is placed in the active video part (WSS – see 11.4.2) and/or in the black bar part, and set these bits accordingly
b_{11} surround sound	0/1	Deduce from DVB SI component descriptor (and MPEG stream_type)
b_{12} , b_{13} copyright information	...	???

6.4.3.7.3 Additional temporal specification for WSS outputs

If WSS is inserted,

- the WSS shall first be output in line 23 of the first frame to which it applies;
- the same WSS status bits shall be transmitted in each subsequent frame until the video format changes.

6.5 Recommendations for ISO/IEC 13818-1 signalling

As described in ETR 154 the target background grid descriptor and video window descriptor may be used within broadcasts to position the video output within a 720 x 576 display grid.

In addition to this, the position of the video output within the display shall be restricted to even (chroma) pixel and even (field) line ordinates.

6.6 Alignment of video and graphics

6.6.1 Video with graphics

The graphics system used by subtitling addresses a 720 x 576 pixel space. The output of the ISO/IEC 13818-2 video decoder is centred vertically and horizontally within this space after upsampling (see figure 2).

If the result of the upsampling process is *less* than 720 pixels wide then the output of the video decoder shall be centred within the region of 720 active digital video pixels. Also, centring should be used to position the video decoder output vertically within the 576 active lines of the analogue display.

If the result of the upsampling process is *greater* than 720 pixels wide then the output of the video decoder shall be cropped symmetrically to fit within the region of 720 active video pixels.

6.6.2 Uncertainty of position of graphics over video

For some transmission modes, (those labelled with “According to user preference” in table 5), the user is free to choose the processing in the block “Decoder Format Conversion” in figure 2.

Since the insertion of graphics (for example subtitles) is performed after this block, such a choice will influence the positioning of graphics relative to the video signal, as made apparent by the following example (illustrated in figure 3):

Consider a broadcast of 16:9 material with subtitles (top row in the figure) and three viewers, one with a 16:9 set and two with 4:3 sets. The viewer with the 16:9 set sees the entire video frame (the second row in the figure). The first 4:3 viewer has selected the “centre cut out” mode (the third row), while the second 4:3 viewer has selected the “letterbox” mode (the fourth row).

As becomes apparent from the figure, the area of video obscured by the subtitles is different for each of these viewing modes.

Broadcasters shall be aware of this uncertainty.

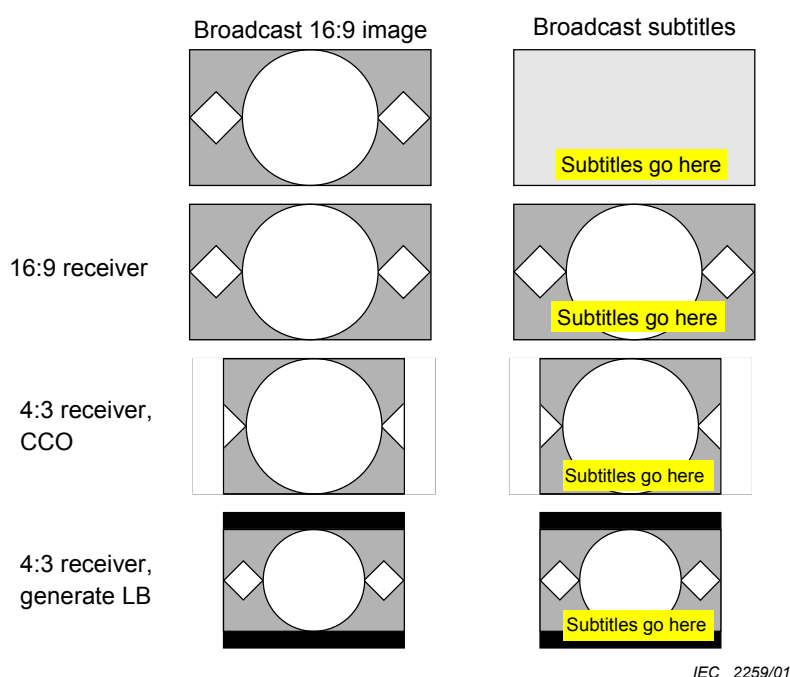


Figure 3 – Uncertainty of positioning graphics over video

7 Audio system characteristics

7.1 Introduction

This clause, based on D-Book version 3.0, defines the digital audio encoding standards that shall be used in all broadcasts.

7.2 Essential requirements

All audio components of the broadcast shall be encoded according to ISO/IEC 13818-3 constrained according to ETR 154.

7.2.1 Scope of requirements

These requirements on audio signals apply to applications including, but not limited to, those listed below:

- primary and other language audio channels for television programmes;
- audio only 'radio' services;
- audio description (for the visually impaired);
- clean dialogue (for the hearing impaired).

7.2.2 Synchronisation

The A/V synchronisation in radiated signals shall be according to ITU-R BT.1359-1.

Receivers are recommended not to introduce more than ± 5 ms relative delay between the video and any audio component (relative to the times indicated by their respective PTSs).

NOTE Set top boxes are not required to accommodate any additional relative delay introduced by the TV that presents the signal to the user.

Where additional independent audio components are decoded from the same service (for example normal programme audio and audio description or normal programme and clean commentary) receivers should not introduce more than ± 5 ms of relative delay between the audio components.

7.2.3 Decoding requirements

All receivers shall provide at least one audio decoder able to meet the minimum decoding requirements set out in above. Preferably receivers should implement more than one audio decoder to enable, for example, the concurrent decoding of both the normal audio and the audio description for a television programme. See 7.4.2.

7.3 Constraints and extensions

7.3.1 Surround sound

7.3.1.1 Digitally coded

Surround sound may optionally be provided as a digital multichannel audio service component, thereby giving freedom of artistic exploitation to the programme makers. The allocation of channels, particularly for a 5.1 digital multichannel service is given in ITU-R BS.775-1.

7.3.1.2 Surround sound

Multichannel audio signals may optionally be matrixed onto suitably coded MPEG audio stereo signals to generate a service which can be decoded using surround sound decoders. Provision of surround sound decoders in receivers is optional.

7.4 Audio description

7.4.1 Background (informative)

Audio description is an “ancillary service” primarily provided for the visual impaired. It provides a spoken description of the video component of a service.

NOTE Provision of audio description for a proportion of programmes is a licence requirement for digital terrestrial broadcasts in the UK.

The audio description is delivered as a mono audio stream in addition to the normal programme audio. This clause specifies the coding of this audio stream and provides background on how receiving equipment might operate.

7.4.2 Receiver implementation minima

Receivers are recommended to provide at least one method to deliver audio description to viewers.

The preferred method is to provide two audio decoders, as illustrated in figure 4. These could be implemented on a module connected via the common interface.

7.4.3 Signalling

This clause is principally concerned with the signalling used to implement the programme provider control of programme volume. Other controls, and the method for presentation of the “described” and/or “standard” sound outputs are addressed for information below.

7.4.3.1 Level control

Three contributions to the “described” output sound level can be identified. These are illustrated in Figure 4.

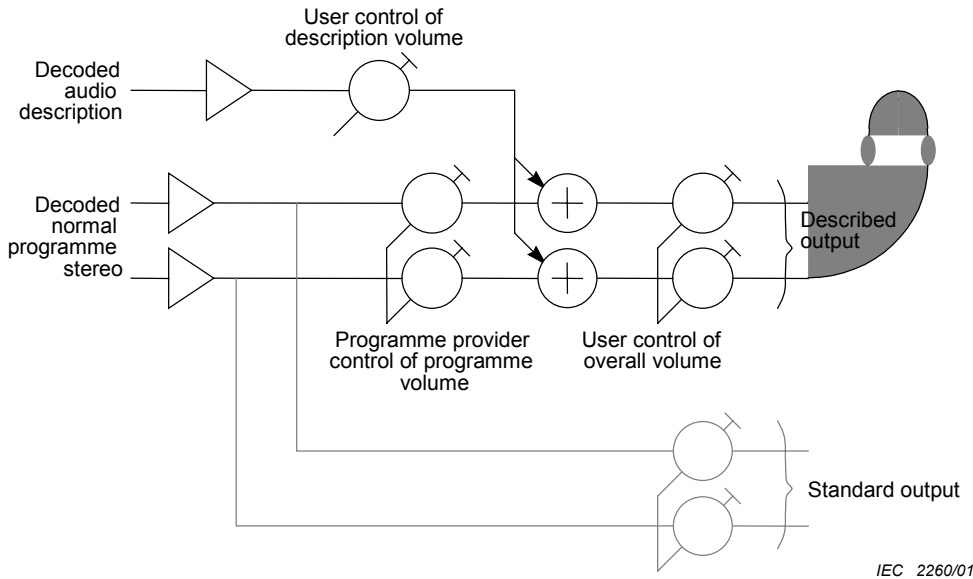


Figure 4 – Illustration of control of audio level

7.4.3.2 Placement control

Signalling is provided to allow the broadcaster to place the “describer” at any preferred horizontal position within the sound field (speech from out-of-vision commentators is often placed to one side in the stereo image).

7.4.3.3 Syntax & semantics

Audio description streams shall carry the audio description descriptor defined in table 11 in their PES_private_data field of the PES packet header.

Table 11 – Audio description descriptor

Syntax	Value	Data	Comment
AD_descriptor(){			
reserved	1111	4 bslbf	
AD_descriptor_length	1000	4 bslbf	
AD_text_tag	0x4454474144	40 bslbf	6 byte string
AD_revision_tag	0x01	8 bslbf	
AD_fade_byte	0xYY	8 bslbf	FADE byte
AD_pan_byte	0xYY	8 bslbf	PAN byte
reserved	0xFFFFFFFFFFFFF	56 bslbf	
}			

7.4.3.3.1 AD_descriptor_length

The descriptor length gives the number of significant bytes following the length field (i.e. 8).

7.4.3.3.2 AD_text_tag

The tag is a 5 character string of ASCII characters as a simple and unambiguous means of distinguishing this from any other PES_private_data.

If a receiver does not recognise this tag it should ignore the audio description stream carrying it.

7.4.3.3.3 AD_revision_tag

The tag is extended by a 1 byte version designator.

Descriptors with the same text tag (0x4454474144) but a higher revision tag shall be backwards compatible with this specification, i.e. the syntax and semantics of the fade and pan byte fields will be identical but additionally some of the reserved bytes may be used for new signalling.

Receivers recognising the main text tag but an earlier revision (lower tag value) should decode the stream based on the fields of the descriptor that it understands and should ignore any additional parameters.

7.4.3.3.4 AD_fade_byte

The fade byte takes values between 0x00, representing no fade of the normal programme sound, and 0xFF, representing no normal programme sound.

Over the range 0x00 to 0xFE one lsb of this field represents an attenuation step of approximately 0,3 dB giving a range of about 77 dB. 0xFF represents no normal programme sound.

7.4.3.3.5 AD_pan_byte

The pan byte takes values between 0x00, representing a central forward presentation of the audio description, and 0xFF, each increment representing a $360/256$ degree ($\sim 1,4^\circ$) step clockwise looking down on the listener. See figure 5.

7.4.3.3.6 Reserved

The remaining 7 bytes of the PES_private_data field are set to 0xFF and reserved for future use.

7.4.3.4 Example

When including this descriptor in an audio stream PES-packet, the PES-packet header syntax will be as shown in table 12.

Table 12 – Illustration of PES packet header

Syntax	Value	Data	Comment
Packet_start_code_prefix	0x000001	24 bslbf	
stream_id	0xYY	8 uimbsf	Actually '110ZZZZ'
PES_packet_length	0xYYYY	16 uimbsf	As appropriate
'10'	10	2 bslbf	
PES_scrambling_control	YY	2 bslbf	As appropriate
PES_priority	Y	1 bslbf	
data_alignment_indicator	Y	1 bslbf	
copyright	Y	1 bslbf	
original_or_copy	Y	1 bslbf	
PTS_DTS_flags	10	2 bslbf	If PTS present
ESCR_flag	0	1 bslbf	
ES_rate_flag	Y	1 bslbf	As appropriate
DSM_trick_mode_flag	0	1 bslbf	
additional_copy_info_flag	0	1 bslbf	
PES_CRC_flag	Y	1 bslbf	As appropriate
PES_extension_flag	1	1 bslbf	
PES_header_data_length	0xYY	8 uimbsf	As appropriate
'0010'	0010	4 bslbf	
PTS[32..30]	YYY	3 bslbf	As appropriate
'1'	1	1 bslbf	
PTS[29..15]	YYYYYYYYYYYYYYY	15 bslbf	As appropriate
'1'	1	1 bslbf	
PTS[14..0]	YYYYYYYYYYYYYYY	15 bslbf	As appropriate
'1'	1	1 bslbf	
if (ES_rate_flag == '1') {etc.}			
if (PES_CRC_flag == '1') {etc.}			
PES_private_data_flag	1	1 bslbf	
pack_header_field_flag	0	1 bslbf	
program_packet_sequence_counter_flag	0	1 bslbf	
P-STD_buffer_flag	0	1 bslbf	
reserved	111	3 bslbf	
PES_extension_flag_2	0	1 bslbf	
AD_descriptor(){			
reserved	1111	4 bslbf	
AD_descriptor_length	1000	4 bslbf	In version 1
AD_text_tag	0x4454474144	40 bslbf	6 byte string
AD_revision_tag	0x01	8 bslbf	
AD_fade_byte	0xYY	8 bslbf	FADE byte
AD_pan_byte	0xYY	8 bslbf	PAN byte
reserved	0xFFFFFFFFFFFFFFF	56 bslbf	
}			
for (i=0; i<N1; i++) {			
stuffing_byte			If required
}			
// and now follows the PES data //			

7.4.3.5 Interpretation of pan information

The definition of “pan” is compatible with future systems that might employ digital multi-channel surround sound for normal programme audio. Where the normal programme audio is stereo, the range of values for “pan” are limited to the interval 0xEB...0x00...0x15.

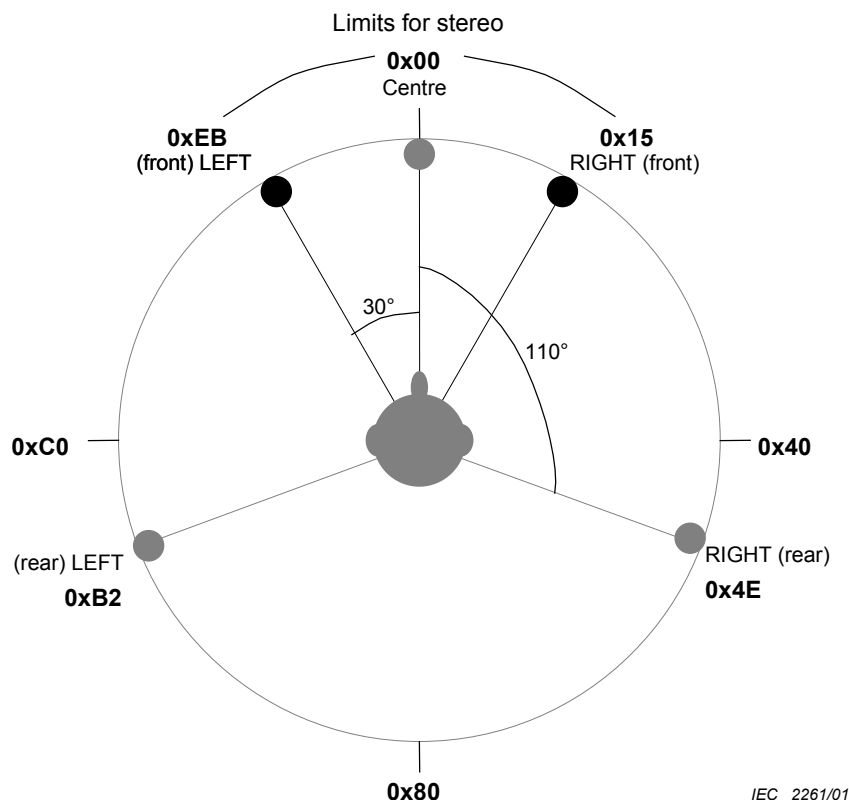


Figure 5 – Mapping of pan byte onto sound presentation

7.4.4 Constraints on audio description stream coding

The audio description stream shall comply with ETR 154 constrained as follows: it shall be encoded as a mono MPEG-1 layer II audio.

7.4.5 Implementation notes

7.4.5.1 Default states and error conditions

Unless signalling in a selected audio description stream indicates otherwise, the normal programme audio should be output without attenuation.

Receivers may ignore the pan information, but if they do so they must position the audio description centrally (i.e. as if pan byte = 0x00).

7.4.5.2 Time of application

All PES packets conveying audio description audio streams shall include an audio description descriptor. The value of fade and pan byte in any PES packet shall apply to all access units commencing within that PES packet.

7.4.5.2.1 Error resilience (informative)

If due to some fault or error condition the audio description descriptor is absent or recognisably corrupted, the receiver should revert to the default state (fade = 0x00, pan = 0x00) after a suitable delay.

7.4.5.2.2 Attack and decay (informative)

Values for “fade” will be transmitted 5 to 10 times per second. This allows the service provider to signal gradual changes of “fade”. Receivers should not implement any additional time constants.

7.4.5.3 Approximation of pan and fade (informative)

7.4.5.3.1 Pan

Receivers may ignore pan information completely. See 7.4.5.1.

7.4.5.3.2 Fade

Receivers may treat all non-zero values of fade as 0xFF, i.e. completely replacing the normal programme audio with audio description when fade is non-zero. This allows audio description and normal programme audio to be decoded with a single audio decoder. However, this is not the preferred implementation.

7.4.5.4 Equalisation of delays (informative)

In certain implementations, for example where the audio description AND normal programme audio are decoded and mixed by a in decoder addition to the normal decoder of the receiver, the listener may be exposed to normal programme audio from two different decoders. It is desirable to minimise or prevent exposing the listener to differential delays of this kind.

7.4.5.5 Implementation routes (informative)

The approach shown in Figure 4 uses two audio decoders (either integrated within a receiver or added in an ancillary decoder module). This is the implementation assumed by service providers.

Figure 6 illustrates an alternative low cost approach where a single decoder can be switched between the normal and description audio streams when ‘fade’ is non-zero.

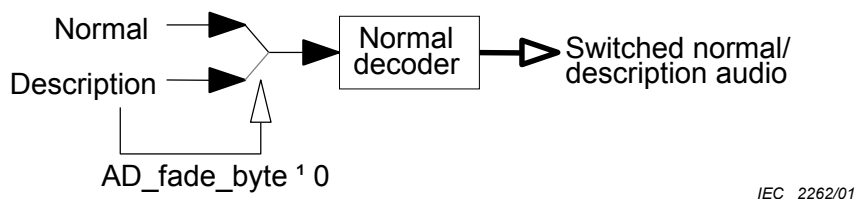


Figure 6 – The “cold-cut” approach

Figures 7 and 8 illustrate a number of alternative approaches where a single decoder in an ancillary decoder module augments the normal decoder in the receiver.

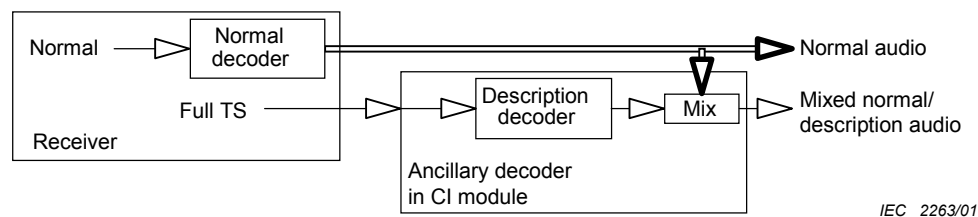


Figure 7 – Generic single external decoder approach

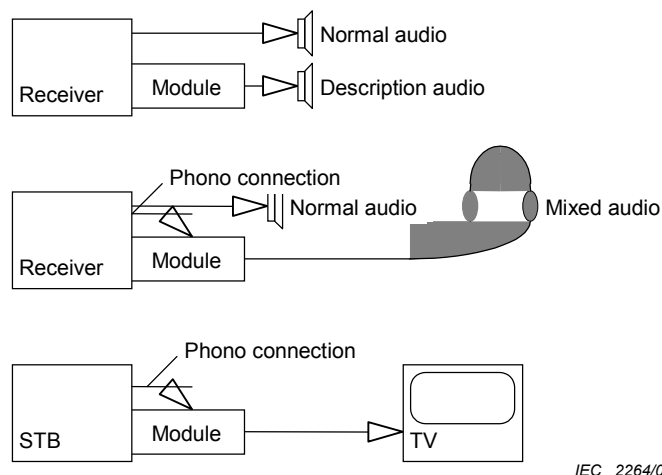


Figure 8 – Possible single external decoder approaches

7.5 Audio only services

It is recommended that if a service only contains an audio component, the receiver should display a banner to indicate the programme or service name.

NOTE However, receivers in “radio mode” may have no functioning display so SI messages such as this may not be presented to the user.

7.6 PSI signalling

The normal programme audio stream and the audio description stream shall be distinguished by signalling in the PSI Program Map table (PMT). In the ISO_639_language_descriptor for normal programme sound, the value of the audio_type field shall be 0x00 (undefined). In the ISO_639_language_descriptor for audio description, the value of the audio_type field shall be 0x03 (visual impaired commentary).

8 Multiplex and transport stream characteristics

8.1 Scope

This clause, based on D-Book version 3.0, defines the transport stream standards that shall be used in all broadcasts.

8.2 Essential requirements

8.2.1 Multiplexing

The multiplexing of baseband signals and associated data conforms to ISO/IEC 13818-1 constrained according to ETR 154.

The PID and section filtering requirements for all broadcasts shall be such that they can be received by receivers meeting the requirements set out below.

8.2.1.1 Multiplex flexing

Broadcasts may instantaneously alter the bit rate allocated to program components or services provided that at all times the multiplex, and the streams within it, continue to comply with the buffer models defined for them in ISO/IEC 13818-1, ISO/IEC 13818-2, ISO/IEC 13818-3 etc.

NOTE This enables the dynamic allocation of capacity between elementary streams within the transport multiplex. This allows the broadcaster freedom to trade technical quality and quantity of programme services within a