ETSI

ETSI
TECHNICAL
REPORT

ETR 154

January 1996

Source: EBU/CENELEC/ETSI JTC

Reference: DTR/JTC-DVB-11

ICS: 33.060.20

Key words: broadcasting, satellite, cable, MPEG, systems, video, audio, digital, TV

European Broadcasting Union

EBU
UER

Union Européenne de Radio-Télévision

Digital Video Broadcasting (DVB);
Implementation guidelines for the use of MPEG-2 systems;
Video and audio in satellite and cable broadcasting applications

ETSI

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New presentation - see History box

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Foreword

This ETSI Technical Report (ETR) has been produced under the authority of the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI). This ETR is based on the DVB document A001 revision 1, dated June 1995, and it may be converted into an ETS after market feedback. For this purpose, the wording of an ETS rather than an ETR is used.

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of ETSs in the specific field of broadcasting and related fields. Since 1995 the JTC 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 organisations 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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Introduction

This ETR presents guidelines covering coding and decoding using the MPEG-2 system defined in ISO/IEC 13818 [1].

The guidelines presented in this ETR for the Integrated Receiver-Decoder (IRD) are intended to represent a minimum functionality that all IRDs are assumed to either meet or exceed. It is necessary to specify the minimum IRD functionality for basic parameters, if broadcasters are not to be prevented from ever using certain features. For example, if a significant population of IRDs were produced that supported only the Simple Profile, broadcasters would never be able to transmit Main Profile bit-streams.

Where a feature is mandatory, the word "shall" is used and the text is in italic; all other features are optional. The functionality is specified in the form of constraints on MPEG-2 systems, video and audio which the IRDs are required to decode correctly.

The specification of these baseline features in no way prohibits IRD manufacturers from including additional features, and should not be interpreted as stipulating any form of upper limit to the performance. The guidelines do not cover features, such as the IRD's up-sampling filter, which affect the quality of the displayed picture rather than whether the IRD is able to decode pictures at all. Such issues are left to the marketplace.

The guidelines presented for IRDs observe the following principles:

- wherever practical, IRDs should be designed to allow for future compatible extensions to the bit-stream syntax;
- all "reserved" and "private" bits in MPEG-2 systems, video and audio should be ignored by IRDs not designed to make use of them.

The rules of operation for the encoders are features and constraints which the encoding system should adhere to in order to ensure that the transmissions can be correctly decoded by Baseline IRDs. These may be mandatory or optional. Where a feature or constraint is mandatory, the word "shall" is used and the text is italic; all other features are optional.

Clauses 4 to 6 provide the guidelines for the Digital Video Broadcasting (DVB) systems layer, video and audio respectively. For information, some of the key features are summarised below, but clauses 4 to 6 should be consulted for all definitions:

Systems:
- MPEG-2 Transport Stream (TS) is used;
- Service Information (SI) is based on MPEG-2 program-specific information;
- scrambling is as defined by the Conditional Access (CA) Technical Group;
- conditional access uses the MPEG-2 Conditional Access CA_descriptor.

Video:
- MPEG-2 Main Profile at Main Level is used;
- the frame rate is 25 Hz;
- encoded pictures may have either 4:3, 16:9 or 2.21:1 aspect ratio;
- IRDs support 4:3 and 16:9 and optionally 2.21:1 aspect ratios;
- IRDs support the use of pan vectors to allow a 4:3 monitor to give a full-screen display of a 16:9 coded picture;
- IRDs support a full-screen display of 720 x 576 pixels (and a nominal full-screen display of 704 x 576);
- IRDs provide appropriate upconversion to produce a full-screen display of 544 x 576 and 480 x 576 and a nominal full-screen display of 352 x 576 and 352 x 288 pixels.

Audio:
- MPEG-2 Layer I and Layer II is supported by the IRD;
- the use of Layer II is recommended for the encoded bit-stream;
- IRDs support single channel, dual channel, joint stereo, stereo and the extraction of at least a stereo pair from MPEG-2 compatible multi-channel audio;
- sampling rates of 32 kHz, 44,1 kHz and 48 kHz are supported by IRDs;
- the encoded bit-stream does not use emphasis.

1 Scope

This ETR provides implementation guidelines for the use of MPEG-2 audio-visual coding [1] in satellite and cable broadcasting systems offering conventional resolution digital television. It does not cover applications such as terrestrial broadcasting, interactive services or High Definition Television (HDTV) which are likely to be the subject of subsequent "Guidelines" deliverables.

The rules of operation for the encoders are features and constraints which the encoding system should adhere to in order to ensure that the transmissions can be correctly decoded by Baseline IRDs. These may be recommended or optional.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1]   ISO/IEC IS 13818-1 (1995): "Coding of moving pictures and associated audio - Part 1: Systems".

[2]   ISO/IEC IS 13818-2 (1994): "Coding of moving pictures and associated audio - Part 2: Video".

[3]   ISO/IEC IS 13818-3 (1994): "Coding of moving pictures and associated audio - Part 3: Audio".

[4]   Not available for this edition of the ETR. The DVB Project planned an ETR XXX: "Final Technical Report of the Conditional Access Specialists Group (TM 1244)". The substance of this future ETR is contained in the DVB document TM 1244 which is available at the DVB Project Office in the EBU.

[5]   ETS 300 468 (1995): "Digital broadcasting systems for television, sound and data services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems".

[6]   ISO/IEC 11172-1 (1993): "Information Technology - Coding of moving pictures and associated audio for digital storage media up to about 1,5 Mbit/s - Part 1: Systems".

[7]   ITU-T Recommendation J.17 (1988): "Pre-emphasis used on sound-programme circuits".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

baseline IRD: An IRD which provides the minimum functionality recommended in this ETR.

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

CA	Conditional Access
DVB	Digital Video Broadcasting
ES	Elementary Stream
ESCR	Elementary Stream Clock Reference
I-Frame	Intra-coded Frame
IRD	Integrated Receiver-Decoder

MPEG	Moving Pictures Experts Group
NIT	Network Information Table
PAT	Program Association Table
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Packet IDentifier
PMT	Program Map Table
PSI	Program Specific Information
PSW	Pan and Scan Window
SI	Service Information
STD	Standard Target Decoder
TS	Transport Stream
VCR	Video Cassette Recorder

4 Systems layer

This clause describes the guidelines for encoding the systems layer of MPEG-2 in DVB broadcast bit-streams, and for decoding this layer in the IRD.

The multiplexing of baseband signals and associated data conforms to ISO/IEC 13818-1 [1]. Some of the parameters and fields are not used in the DVB System and these restrictions are described below. *To allow full compliance to ISO/IEC 13818-1 [1] and upward compatibility with future enhanced versions, a DVB IRD shall be able to skip over data structures which are currently "reserved", or which correspond to functions not implemented by the IRD. As an example of this capability, a descriptor tag not yet defined within the DVB System shall be interpreted as a no-action tag, its length field correctly decoded and subsequent data skipped*.

For the same reason, IRD design should be made under the assumption that any legal structure as permitted by ISO/IEC 13818-1 [1] may occur in the broadcast stream even if presently reserved or unused. Therefore the following is assumed:

- *private data shall only acted upon by decoders which are so enabled;*
- *filling out the bit-stream shall be carried out using the normal stuffing mechanism. Reserved fields shall not be used for this purpose. Data of reserved fields shall be set to 0xFF.*

The headings below in this clause are based on ISO/IEC 13818-1 [1]. The numbers in brackets after the headings are the relevant chapter and section headings of ISO/IEC 13818-1 [1].

4.1 Introduction (ISO/IEC 13818-1 [1], section 0)

MPEG-2 systems specify two types of multiplexed data stream: the transport stream and the program stream.

Encoding: *The transmitted multiplex shall use the transport stream.*

Decoding: *All Baseline IRDs shall be able to demultiplex the MPEG-2 transport stream.* Demultiplexing of program streams (as described in sections 0.2 and 0.3 of [1]) is optional.

4.2 Packetized Elementary Stream (PES) (ISO/IEC 13818-1 [1], section 0.4)

Encoding: The creation of a physical Packetized Elementary Stream (PES) by an encoder is not required. ESCR fields and ES rate fields need not be coded.

Decoding: ESCR fields and ES rate fields need not be decoded.

4.3 Transport stream system target decoder (ISO/IEC 13818-1 [1], section 2.4.2)

Encoding: *The system clock frequency shall conform to the tolerance specified in section 2.4.2.1 of ISO/IEC 13818-1 [1].* It is recommended that the tolerance is within 5 parts per million.

Decoding: *The IRD shall operate over the full tolerance range of the system clock frequency specified in section 2.4.2.1 of ISO/IEC 13818-1 [1].*

4.4 Transport packet layer (ISO/IEC 13818-1 [1], section 2.4.3.2)

4.4.1 Null packets

Encoding: *The encoding of null packets (those with PID value 0x1FFF) shall be as specified in ISO/IEC 13818-1 [1].*

4.4.2 Transport packet header

4.4.2.1 transport_error_indicator

Encoding: It is recommended that any error detecting devices in a transmission path should set the **transport_error_indicator** bit when uncorrectable errors are detected.

Decoding: The **transport_error_indicator** flag is set in the transmitted stream it is recommended that the IRD should then invoke a suitable concealment or error recovery mechanism.

4.4.2.2 transport_priority

Decoding: The **transport_priority** bit has no meaning to the IRD, and may be ignored.

4.4.2.3 transport_scrambling_control

Encoding: *The transport_scrambling_control bits shall be set according to table 1, in accordance with ETR XXX [4].*

Table 1: Values for transport_scrambling_control

Value	Description
00	no scrambling of TS packet payload
01	reserved for future DVB use
10	TS packet scrambled with Even key
11	TS packet scrambled with Odd key

Decoding: *These bits shall be read by the IRD, and the IRD shall respond in accordance with table 1.*

4.4.2.4 Packet IDentifier (PID) values for Service Information (SI) Tables

Encoding: The assignment of PID values for SI data is given in ETS 300 468 [5].

4.5 Adaptation field (ISO/IEC 13818-1 [1], section 2.4.3.4)

4.5.1 Random_access_indicator

Encoding: It is recommended that the **random_access_indicator** bit is set whenever a random access point occurs in video streams (i.e. video sequence header immediately followed by an I-frame).

4.5.3 elementary_stream_priority_indicator

Decoding: The **elementary_stream_priority_indicator** bit may be ignored by the IRD.

4.5.4 Program Clock Reference (PCR)

Encoding: *The time interval between two consecutive PCR values of the same program shall not exceed 100 milliseconds as specified in section 2.7.3 of ISO/IEC 13818-1 [1].* It is recommended that this interval should be no greater than 40 milliseconds.

Decoding: *The IRD shall operate correctly with PCRs for a program arriving at intervals not exceeding 100 milliseconds.*

4.5.5   Other fields

This subclause covers the following fields:

-        **original_program_clock_reference_base**;
-        **original_program_clock_reference_extension**;
-        **splice_countdown**;
-        **private_data_byte**;
-        **adaptation_field_extension** (including fields within).

Encoding: These fields are optional in a DVB bit-stream. *The flags that indicate the presence or absence of each of these fields shall be set appropriately.*

Decoding: *IRDs shall be able to accept bit-streams which contain these fields.* IRDs may ignore the data within the fields.

4.6   Packetized Elementary Stream (PES) Packet (ISO/IEC 13818-1 [1], section 2.4.3.6)

4.6.1   stream_id

Encoding: *Within a program, no two elementary streams shall have the same **stream_id**.*

4.6.2   PES_scrambling_control

Encoding: *The **PES_scrambling_control** bits shall be set according to table 2, in accordance with ETR XXX [4].*

Table 2: Values for PES_scrambling_control

Value	Description
00	no scrambling of PES packet payload
01	reserved for future DVB use
10	PES packet scrambled with Even key
11	PES packet scrambled with Odd key

Decoding: The **PES_scrambling_control** bits shall be read by the IRD, and the IRD shall respond in accordance with table 2.

4.6.3   PES_priority

Decoding: The **PES_priority** bit may be ignored by the IRD.

4.6.4   copyright and original_or_copy

Encoding: The copyright and **original_or_copy** bits may be set as appropriate.

Decoding: The IRD need not interpret these bits. *The setting of these bits shall not be altered in any digital output from the IRD.*

4.6.5   Trick mode fields

This subclause covers the following fields:

-        **trick_mode_control**;
-        **field_id**;
-        **intra_slice_refresh**;
-        **frequency_truncation**;
-        **field_rep_cntrl**.

Encoding: *These trick mode fields shall not be transmitted in a broadcast bit-stream. Bit-streams for other applications (e.g. for non-broadcast interactive services) may use these fields.*

Decoding: The IRD may skip over any data which is flagged as being in a trick mode, if it does not support decoding of trick modes. If the IRD has a digital interface, it is recommended that this should be capable of outputting the trick mode bit-stream to an external unit such as a digital Video Cassette Recorder (VCR).

4.6.6 additional_copy_info

Encoding: This field may used as appropriate.

Decoding: The IRD need not interpret this field. *The coding of the field shall not be altered in any digital output from the IRD.*

4.6.7 Optional fields

This subclause covers the following fields:

- **ESCR;**
- **ESCR_extension;**
- **ES_rate;**
- **previous_PES_packet_CRC;**
- **PES_private_data;**
- **pack_header();**
- **program_packet_sequence_counter;**
- **MPEG1_MPEG2_identifier;**
- **original_stuff_length;**
- **P-STD_buffer_scale;**
- **P-STD_buffer_size.**

Encoding: These fields are optional in a DVB bit-stream. *The flags that indicate the presence or absence of each of these fields shall be set appropriately.*

Decoding: *The IRD shall be able to accept bit-streams which contain these fields.* The IRD may ignore the data within the fields.

4.6.8 PES_extension_field

The **PES_extension_field** data field is currently "reserved".

Encoding: *This extension field shall not be coded unless specified in the future by MPEG.*

Decoding: *The IRD shall be able to accept bit-streams which contain this field.* The IRD may ignore the data within the field.

4.7 Program Specific Information (PSI) (ISO/IEC 13818-1 [1], section 2.4.4)

The data format for the Network Information Table (NIT) in DVB bit-streams is given in ETS 300 468 [5]. This document also defines additional tables for service information which use Program Specific Information (PSI) private_section structure defined in ISO/IEC 13818-1 [1].

It is recommended that the Program Association Table (PAT) and Program Map Table (PMT) are repeated with a maximum time interval of 100 milliseconds between repetitions.

4.8 Program and elementary stream descriptors (ISO/IEC 13818-1 [1], section 2.6)

4.8.1 video_stream_descriptor and audio_stream_descriptor

Encoding: *The **video_stream_descriptor** shall be used to indicate video streams containing still picture data, otherwise these descriptors may be used when appropriate. If **profile_and_level_indication** is not present, then the video bit-stream shall comply with the constraints of Main Profile at Main Level.*

*If the **audio_stream_descriptor** is not present, then the audio bit-stream shall not use sampling frequencies of 16 kHz, 22,05 kHz or 24 kHz, and all audio frames in the stream shall have the same bit rate.*

Decoding: The IRD may use these descriptors when present to determine if it is able to decode the streams. If neither **video_stream_descriptor** nor **hierarchy_descriptor** is present for a video bit-stream, the IRD may assume that it complies with Main Profile at Main Level constraints.

4.8.2 hierarchy_descriptor

Encoding: *The **hierarchy_descriptor** shall be used if, and only if, video or audio is coded as more than one hierarchical layer.*

Decoding: *If the descriptor is present and indicates that the bit-stream is a base layer video stream, then the IRD shall be capable of selecting that bit if a **video_stream_descriptor** defines it as Main Profile at Main Level or less.*

4.8.3 registration_descriptor

Encoding: The **registration_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.4 data_stream_alignment_descriptor

Encoding: The **data_stream_alignment_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.5 target_background_grid_descriptor

Encoding: The **target_background_grid_descriptor** may be used when appropriate.

Decoding: *If this descriptor is absent, a default grid of 720 x 576 pixels shall be assumed by the IRD. The IRD shall read this descriptor, when present, to override this default.* The display of correctly windowed video on background grids other than 720 x 576 pixels is optional.

4.8.6 video_window_descriptor

Encoding: The **video_window_descriptor** may be used when appropriate, to indicate the required position of the video window on the screen.

Decoding: *The IRD shall read this descriptor, when present, and position the video window accordingly.*

4.8.7 Conditional Access CA_descriptor

Encoding: *The CA_descriptor shall be encoded as it will be defined in the future ETR XXX [4].*

Decoding: *The IRD shall interpret this descriptor as it will be defined in the future ETR XXX [4].*

4.8.8 ISO_639_Language_descriptor

Encoding: *The **ISO_639_Language_descriptor** shall be present if more than one audio (or video) stream with different languages are present within a program.* It is optional otherwise.

Decoding: *The IRD shall use the data from this descriptor to assist the selection of appropriate audio (or video) stream of program, if more than one stream is available.*

4.8.9   system_clock_descriptor

Encoding: It is recommended that the **system_clock_descriptor** is included in the program_info part of the Program Map Table for each program.

Decoding: The IRD need not make use of this descriptor.

4.8.10   multiplex_buffer_utilization_descriptor

Encoding: The **multiplex_buffer_utilization_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.11   copyright_descriptor

Encoding: The **copyright_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.12   maximum_bitrate_descriptor

Encoding: The **maximum_bitrate_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.13   private_data_indicator_descriptor

Encoding: The **private_data_indicator_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.14   STD_descriptor

Encoding: *The **STD_descriptor** shall be used as specified in ISO/IEC 13818-1 [1].*

Decoding: The IRD need not make use of this descriptor.

4.8.15   IBP_descriptor

Encoding: The **IBP_descriptor** may be used when appropriate.

Decoding: The IRD need not make use of this descriptor.

4.8.16   smoothing_buffer_descriptor

Encoding: It is recommended that the **smoothing_buffer_descriptor** is included in the Program Map Table in the extended program information.

Decoding: The IRD need not make use of this descriptor, but the information may be of assistance to digital VCRs.

Additional descriptors to those defined in ISO/IEC 13818-1 [1] are defined in ETS 300 468 [5].

4.9   Compatibility with ISO/IEC 11172-1 [6] (ISO/IEC 13818-1 [1], section 2.8)

Decoding: Compatibility with ISO/IEC 11172-1 [6] (MPEG-1 Systems) is optional.

5   Video

This clause describes the guidelines for encoding MPEG-2 video in DVB broadcast bit-streams, and for decoding this bit-stream in the IRD.

The video encoding shall conform to ISO/IEC 13818-2 [2]. Some of the parameters and fields are not used in the DVB System and these restrictions are described below. The IRD design should be made under the assumption that any legal structure as permitted by ISO/IEC 13818-2 [2] may occur in the broadcast stream even if presently reserved or unused. *To allow full compliance to the MPEG standard and upward compatibility with future enhanced versions, a DVB IRD shall be able to skip over data structures which are currently "reserved", or which correspond to functions not implemented by the IRD.*

This clause is based on ISO/IEC 13818-2 [2].

5.1   Profile and level

Encoding: *Encoded bit-streams shall comply with the Main Profile Main Level restrictions, as described ISO/IEC 13818-2 [2], section 8.2.* The **profile_and_level_indication** is "01001000" or, if appropriate, "0nnnnnnn", where "0nnnnnnn" > "01001000", indicating a "simpler" profile or level than Main Profile, Main Level.

Decoding: *The IRD shall support the syntax of Main Profile.* Support for profiles and levels beyond Main Profile, Main Level is optional. *If the IRD encounters an extension which it cannot decode, such as one whose identification code is Reserved, Picture Sequence Scaleable, Picture Spatial Scaleable or Picture Temporal Scaleable, it shall discard the following data until the next start code (to allow backward compatible extensions to be added in the future).*

5.2   Frame rate

Encoding: *The frame rate shall be 25 Hz, i.e.* **frame_rate_code** *is "0011".*

Still pictures may be encoded by use of a video sequence consisting of a single intra-coded picture (see definition of still pictures in ISO/IEC 13818-1 [1], section 2.1.48).

Decoding: *All IRDs shall support the frame rate of 25 Hz in the film mode and the field rate of 50 Hz in the video camera mode (i.e.* **frame_rate_code** *of "0011").* Support of other frame and field rates is optional.

IRDs shall be capable of decoding and displaying still pictures, i.e. video sequences consisting of a single intra-coded picture (see definition of still pictures in ISO/IEC 13818-1 [1], section 2.1.48).

5.3   Aspect ratio

Encoding: *The source aspect ratio in DVB bit-streams shall be either 4:3, 16:9 or 2,21:1.* As stated under "Decoding" below, decoding of 2,21:1 aspect ratio is optional for the Baseline IRD.

The field **aspect_ratio_information** *in the sequence header shall have one of the following two values:*

-    *4:3 aspect ratio source:*   *"0010";*
-    *16:9 aspect ratio source:*   *"001".*

It is recommended that pan vectors for a 4:3 window are included in the transmitted bit-stream when the source aspect ratio is 16:9 or 2,21:1. *The vertical component of the transmitted pan vector shall be zero.*

*If pan vectors are transmitted then the **sequence_display_extension** shall be present in the bit-stream and the **aspect_ratio_information** shall be set to ´0010´ (4:3 display). The display_vertical_size shall be equal to the **vertical_size**. The **display_horizontal_size** shall contain the resolution of the target 4:3 display.* The value of the **display_horizontal_size** field may be calculated by the following equation:

$$display\_horizontal\_size = \frac{4}{3} \times \frac{horizontal\_size}{source\ aspect\ ratio}$$

Table 3 below gives some typical examples:

Table 3: Values for display_horizontal_size

horizontal_size $\times$ vertical_size	Source aspect ratio	display_horizontal_size
720 $\times$ 576	16:9	540
	2,21:1	434
544 $\times$ 576	16:9	408
	2,21:1	328
480 $\times$ 576	16:9	363
	2,21:1	289
352 $\times$ 576	16:9	264
	2,21:1	212
352 $\times$ 288	16:9	264
	2,21:1	212

Decoding: *The IRD shall be able to decode bit-streams with values of **aspect_ratio_information** of "0010" and "0011", corresponding to 4:3 and 16:9 aspect ratio respectively.* If the IRD has a digital interface, this should be capable of outputting bit-streams with aspect ratios which are not directly supported by the IRD to allow their decoding and display via an external unit.

All IRDs shall support the use of pan vectors and upsampling to allow a 4:3 monitor to give a full-screen display of a selected portion of a 16:9 coded picture with the correct aspect ratio. IRDs implementing the 2,21:1 aspect ratio should support the use of pan vectors and upsampling to allow a 4:3 monitor to give a full-screen display of a selected portion of a 2,21:1 picture with the correct aspect ratio. Support for pan vectors with non-zero vertical components is optional. *When no pan vectors are present in the transmitted bit-stream, the central portion of the wide-screen picture shall be displayed.* The support of vertical resampling to obtain the correct aspect ratio for a letterbox display of a 16:9 or 2.21:1 coded picture on a 4:3 monitor is optional.

5.4 Luminance resolution

Encoding: *The encoded picture shall have a full-screen luminance resolution (horizontal $\times$ vertical) of one of the following values:*

- *720 $\times$ 576;*
- *544 $\times$ 576;*
- *480 $\times$ 576;*
- *352 $\times$ 576;*
- *352 $\times$ 288.*

In addition, non full-screen pictures may be encoded for display at less than full-size (when using one of the standard up-conversion ratios at the IRD).

Decoding:

> *The IRD shall be capable of decoding pictures with luminance resolutions as shown in table 4 below and applying upsampling to allow the decoded pictures to be displayed at full-screen size. In addition, IRDs shall be capable of decoding lower picture resolutions and displaying them at less than full-size after using one of the standard up-conversions, e.g. a horizontal resolution of 704 pixels within the 720 pixel full-screen display.*

Table 4: Resolutions for Full-screen Display from IRD

Coded Picture		Displayed Picture Horizontal upsampling	
Luminance resolution (horizontal × vertical)	Aspect Ratio	4:3 Monitors (PSW = Pan & Scan window)	16:9 Monitors
720×576	4:3 16:9 2,21:1	$\times 1$ PSW $\times 4/3$ (PSW $\times 5/3$)[2]	($\times 3/4$)(note 1) $\times 1$ (PSW $\times 5/4$)(note 2)
544×576	4:3 16:9 2,21:1	$\times 4/3$ PSW $\times 16/9$ (PSW $\times 20/9$)(note 2)	($\times 1$)(note 1) $\times 4/3$ (PSW $\times 5/3$)(note 2)
480×576	4:3 16:9 2,21:1	$\times 3/2$ PSW $\times 2$ (PSW $\times 5/2$)(note 2)	($\times 9/8$)(note 1) $\times 3/2$ (PSW $\times 15/8$)(note 2)
352×576	4:3 16:9 2,21:1	$\times 2$ PSW $\times 8/3$ (PSW $\times 10/3$)(note 2)	($\times 3/2$)(note 1) $\times 2$ (PSW $\times 5/2$)(note 2)
352×288	4:3 16:9 2,21:1	$\times 2$ PSW $\times 8/3$ (PSW $\times 10/3$)(note 2) (and vertical upsampling $\times 2$)	($\times 3/2$)(note 1) $\times 2$ (PSW $\times 5/2$)(note 2) (and vertical upsampling $\times 2$)
NOTE 1: Upsampling of 4:3 pictures for display on a 16:9 monitor is optional in the IRD, as 16:9 monitors can be switched to operate in 4:3 mode.			
NOTE 2: Upsampling of pan and scan window from 2.21:1 pictures for display on a 4:3 or 16:9 monitor is optional in the IRD.			

5.5 Chrominance

Encoding: *The operation used to downsample the chrominance information from 4:2:2 to 4:2:0 shall be indicated by the parameter **chroma_420_type** in the picture coding extension.* A value of zero indicates that the fields have been downsampled independently. A value of one indicates that the two fields have been combined into a single frame before downsampling. It is desirable that the fields are downsampled independently (i.e. **chroma_420_type** = 0) to allow the IRD to use less memory for picture reconstruction.

Decoding: It is desirable that the operation used to upsample the chrominance information from 4:2:0 to 4:2:2 should be dependent on the parameter **chroma_420_type** in the picture coding extension.

5.6 Video sequence header

Encoding: It is recommended that a video sequence header, immediately followed by an I-frame, be encoded at least once every 500 milliseconds. If quantiser matrices other than the default are used, the appropriate **intra_quantiser_matrix** and/or **non_intra_quantiser_matrix** are recommended to be included in every sequence header.

NOTE: Increasing the frequency of video sequence headers and I-frames will reduce channel hopping time but will reduce the efficiency of the video compression.

6 Audio

This clause describes the guidelines for encoding MPEG-2 audio in DVB broadcast bit-streams, and for decoding this bit-stream in the IRD.

The audio encoding shall conform to ISO/IEC 13818-3 [3]. Some of the parameters and fields are not used in the DVB System and these restrictions are described below. The IRD design should be made under the assumption that any legal structure as permitted by ISO/IEC 13818-3 [3] may occur in the broadcast stream even if presently reserved or unused. *To allow full compliance to ISO/IEC 13818-3 [3] and upward compatibility with future enhanced versions, a DVB IRD shall be able to skip over data structures which are currently "reserved", or which correspond to functions not implemented by the IRD. For example, an IRD which is not designed to make use of the ancillary data field shall skip over that portion of the bit-stream.*

This clause is based on ISO/IEC 13818-3 [3].

6.1 Audio mode

Encoding: *The audio shall be encoded in one of the following modes:*

- *MPEG-1 single channel;*
- *MPEG-1 dual channel;*
- *MPEG-1 joint stereo;*
- *MPEG-1 stereo;*
- *MPEG-2 compatible multi-channel audio (dematrix procedure = 0 or 1).*

Decoding: *The IRD shall be capable of decoding the following audio modes:*

- *MPEG-1 single channel;*
- *MPEG-1 dual channel;*
- *MPEG-1 joint stereo;*
- *MPEG-1 stereo.*

The IRD shall be capable of decoding at least the basic stereo information from an MPEG-2 compatible multi-channel audio bit-stream. Full decoding of an MPEG-2 multi-channel audio bit-stream is optional.

6.2 Compression layer

Encoding: *The encoded bit-stream shall use either Layer I or Layer II coding (**layer** = "11" or "10" respectively).* Use of Layer II is preferred.

Decoding: *IRDs shall be capable of decoding at least Layer I and Layer II.* Support for Layer III decoding (**layer** = "01") is optional.

6.3 Bit rate

Encoding: *The value of **bitrate_index** in the encoded bit-stream shall be one of the 14 values from "0001" to "1110" (inclusive).*

For Layer I, these correspond to bit rates of: 32, 64, 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416 or 448 kbits/s.

For Layer II, these correspond to bitrates of: 32, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320, 384 kbits/s.

For MPEG-2 encoded bit-streams with total bitrates greater than 448 kbit/s for Layer I or 384 kbit/s for Layer II, an extension bit-stream shall be used. The bit rate of that extension may be in the range of 0 to 682 kbit/s.

Decoding: *IRDs shall be capable of decoding bit-streams with a value of **bitrate_index** from "0001" to "1110" (inclusive).* Support for the free format bit rate (**bitrate_index** = "0000") is optional.

6.4   Sampling frequency

Encoding: *The audio sampling rate of primary sound services shall be 32 kHz, 44,1 kHz or 48 kHz.* Sampling rates of 16 kHz, 22,05 kHz, 24 kHz, 32 kHz, 44,1 kHz or 48 kHz may be used for secondary sound services.

Decoding: *The IRD shall be capable of decoding audio with sampling rates of 32 kHz, 44,1 kHz and 48 kHz.* Support for sampling rates of 16 kHz, 22,05 kHz and 24 kHz is optional.

6.5   Emphasis

Encoding: *The encoded bit-stream shall have no emphasis (**emphasis** = "00").*

Decoding: *The IRD shall be capable of decoding audio with no emphasis.* Support for 50/15 microseconds de-emphasis and ITU-T Recommendation J.17 [7] de-emphasis (**emphasis** = "01" or "11") is optional.

6.6   Cyclic redundancy code

Encoding: *The parity check word (**crc_check**) shall be included in the encoded bit-stream.*

Decoding: It is recommended that the IRD use **crc_check** to detect errors and subsequently invoke suitable concealment or muting mechanisms.

History

Document history	
January 1996	First Edition
February 1996	Converted into Adobe Acrobat Portable Document Format (PDF)