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

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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 2, dated July 1997, 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 standards 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 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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Digital Video Broadcasting (DVB) Project

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

This ETR presents guidelines covering coding and decoding using the MPEG-2 system layer, video coding and audio coding as defined in ISO/IEC 13818-1 [1], ISO/IEC 13818-2 [2] and ISO/IEC 13818-3 [3] respectively.

The guidelines presented in this ETR for the Integrated Receiver-Decoder (IRD) are intended to represent a minimum functionality that all IRDs of a particular class are required 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.

IRDs are classified in three dimensions as:

- "25 Hz" or "30 Hz", depending on whether the nominal video frame rates based on 25 Hz or 30000/1001 Hz (approximately 29,97 Hz) are supported. It is expected that 25 Hz IRDs will be used in those countries where the existing analogue TV transmissions use 25 Hz frame rate and 30 Hz IRDs will be used in countries where the analogue TV transmissions use 30000/1001 Hz frame rate. There are also likely to be "dual-standard" IRDs which have the capabilities of both 25 Hz and 30 Hz IRDs.
- "SDTV" or "HDTV", depending on whether or not they are limited to decoding pictures of conventional TV resolution. The capabilities of an SDTV IRD are a sub-set of those of an HDTV IRD.
- "with digital interface" or "Baseline", depending on whether or not they are intended for use with a digital bitstream storage device such as a digital VCR. The capabilities of a Baseline IRD are a sub-set of those of an IRD with digital interface.

To give a complete definition of an IRD, all three dimensions need to be specified, e.g. 25 Hz SDTV Baseline IRD.

It should be noted that in DVB systems the source picture format, encoded picture format and display picture format do not need to be identical. For example, HDTV source material may be broadcast as an SDTV bitstream after down-conversion to SDTV resolution and encoding within the constraints of Main Profile at Main Level. The IRD receiving the bitstream may then up-convert the decoded picture for display at HDTV resolution. With suitable down-conversion and up-conversion, the quality of the resultant HDTV picture may be close to that of the original HDTV source.

Another notable feature of the DVB system is that a single Transport Stream (TS) may contain programme material intended for more than one type of IRD. A typical example of this is likely to be the simulcasting of SDTV and HDTV video material. In this case an SDTV IRD will decode and display SDTV pictures whilst an HDTV IRD will decode and display HDTV pictures from the same TS.

Where a feature described in this ETR is mandatory, the word "shall" is used and the text is in *italics*; 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. These constraints 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 summarized below, but clauses 4 to 6 should be consulted for all definitions:

Systems:

- MPEG-2 TS is used;
- Service Information (SI) is based on MPEG-2 program-specific information;
- scrambling is as defined in ETR 289 [5];
- conditional access uses the MPEG-2 Conditional Access CA_descriptor;
- Partial TSs are used for digital VCR applications.

Video:

- MPEG-2 Main Profile at Main Level is used for SDTV;
- MPEG-2 Main Profile at High Level is used for HDTV;
- the 25 Hz SDTV IRD supports 25 Hz frame rate;
- the 25 Hz HDTV IRD supports frame rates of 25 Hz or 50 Hz;
- the 30 Hz SDTV IRD supports frame rates of 24000/1001, 24, 30000/1001 and 30 Hz;
- the 30 Hz HDTV IRD supports frame rates of 24000/1001, 24, 30000/1001, 30, 60000/1001 and 60 Hz;
- SDTV 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 ratio;
- HDTV pictures have 16:9 or 2.21:1 aspect ratio; IRDs support 16:9 and optionally 2.21:1 aspect ratio;
- 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 of SDTV resolution.

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 ETSI Technical Report (ETR) provides implementation guidelines for the use of MPEG-2 audio-visual coding in satellite, cable and terrestrial broadcasting distribution systems. Both Standard Definition Television (SDTV) and High Definition Television (HDTV) are covered. Guidelines for devices equipped with a digital interface intended for digital VCR applications are also given in this ETR. It does not cover applications such as contribution services which are likely to be the subject of subsequent "Guidelines" documents.

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. These constraints may be mandatory, 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 13818-1 (1996): "Coding of moving pictures and associated audio - Part 1: Systems".
- [2] ISO/IEC 13818-2 (1996): "Coding of moving pictures and associated audio - Part 2: Video".
- [3] ISO/IEC 13818-3 rev1 (1997): "Coding of moving pictures and associated audio - Part 3: Audio".
- [4] ISO/IEC 13818-9 (1996): "Coding of moving pictures and associated audio - Part 9: Extension for Real-Time-Interface for systems decoders".
- [5] ETR 289: "Digital Video Broadcasting (DVB); Common Scrambling (CS) system description".
- [6] prEN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".
- [7] ETR 211: "Digital Video Broadcasting (DVB); Guidelines for the usage of Service Information (SI) in DVB systems".
- [8] ISO/IEC 11172-1: "Information Technology - Coding of moving pictures and associated audio for digital storage media up to about 1,5 Mbit/s - Part 1: Systems".
- [9] ITU-T Recommendation J.17 (1988): "Pre-emphasis used on sound-programme circuits".
- [10] IEC CD - 100C/1883: Parts 1 and 4.
- [11] EBU Recommendation R.68: "Alignment level in digital audio production equipment and in digital audio recorders".

3 Definitions and abbreviations

3.1 Definitions

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

25hz SDTV IRD: An IRD which is capable of decoding and displaying pictures based on a nominal video frame rate of 25 Hz from MPEG-2 Main Profile, Main Level bitstreams as specified in this ETR.

25hz SDTV bitstream: A bitstream which contains only Main Profile, Main Level video at 25 Hz frame rate as specified in this ETR.

25hz HDTV IRD: An IRD that is capable of decoding and displaying pictures based on a nominal video frame rate of 25 Hz or 50 Hz from MPEG-2 Main Profile, High Level bitstreams as specified in this ETR, in addition to providing the functionality of a 25 Hz SDTV IRD.

25hz HDTV bitstream: A bitstream which contains only Main Profile, High Level (or simpler) video at 25 Hz or 50 Hz frame rates as specified in this ETR.

30hz SDTV IRD: An IRD which is capable of decoding and displaying pictures based on a nominal video frame rate of 24000/1001 (approximately 23,98), 24, 30000/1001 (approximately 29,97) or 30 Hz from MPEG-2 Main Profile at Main Level bitstreams as specified in this ETR.

30hz SDTV bitstream: A bitstream which contains only Main Profile, Main Level video at 24000/1001, 24, 30000/1001 or 30 Hz frame rate as specified in this ETR.

30hz HDTV IRD: An IRD that is capable of decoding and displaying pictures based on nominal video frame rates of 24000/1001, 24, 30000/1001, 30, 60/1001 or 60 Hz from MPEG-2 Main Profile, High Level bitstreams as specified in this ETR, in addition to providing the functionality of a 30 Hz SDTV IRD.

30hz HDTV bitstream: A bitstream which contains only Main Profile, High Level (or simpler) video at 24000/1001, 24, 30000/1001, 30, 60/1001 or 60 Hz frame rates as specified in this ETR.

baseline IRD: An IRD which provides the minimum functionality to decode transmitted bitstreams as recommended in this ETR. It is not required to have the ability to decode Partial Transport Streams (TSs) as may be received from a digital interface connected to digital bitstream storage device such as a digital VCR.

IRD with digital interface: An IRD which has the ability to decode Partial Transport Streams (TSs) received from a digital interface connected to digital bitstream storage device such as a digital VCR as specified in this ETR, in addition to providing the functionality of a Baseline IRD.

pan vector: Horizontal offset in video frame centre position.

Partial Transport Stream (TS): Bitstream derived from an MPEG-2 TS by removing those TS Packets that are not relevant to one particular selected programme, or a number of selected programmes.

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
HDTV	High Definition TeleVision
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
SDTV	Standard Definition Television
STD	System Target Decoder
TS	Transport Stream
TSDT	Transport Stream Description Table
T-STD	Transport Stream System Target Decoder
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 source bitstream may be transmitted via a satellite, cable or terrestrial channel, or via a digital interface. Subclause 4.1 applies to the encoding of all source bitstreams and their decoding by a Baseline IRD. Subclause 4.2 gives specific information relating to bitstreams transmitted via a digital interface intended for VCR applications and decoding by IRDs equipped with such an interface.

4.1 Broadcast bitstreams and Baseline IRDs

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 be 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].

4.1.1 Introduction (ISO/IEC 13818-1, section 0)

MPEG-2 systems specify two types of multiplexed data stream: the Transport Stream (TS) and the program stream.

Encoding: *The transmitted multiplex shall use the TS.*

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

4.1.2 Packetized Elementary Stream (PES) (ISO/IEC 13818-1, 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.

4.1.3 TS system target decoder (ISO/IEC 13818-1, 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].*

4.1.4 Transport packet layer (ISO/IEC 13818-1, section 2.4.3.2)

4.1.4.1 Null packets

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

4.1.4.2 Transport packet header

4.1.4.2.1 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.

4.1.4.2.2 transport_priority

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

4.1.4.2.3 transport_scrambling_control

Encoding: *The transport_scrambling_control bits shall be set according to table 1, in accordance with ETR 289 [5].*

Table 1: Coding of transport_scrambling_control bits

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.*

4.1.4.2.4 Packet Identifier (PID) values for Service Information (SI) Tables

Encoding: The assignment of PID values for SI data is given in EN 300 468 [6].

4.1.5 Adaptation field (ISO/IEC 13818-1, section 2.4.3.4)

4.1.5.1 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).

4.1.5.2 elementary_stream_priority_indicator

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

4.1.5.3 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.*

4.1.5.4 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.*

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

4.1.6.1 stream_id

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

4.1.6.2 PES_scrambling_control

Encoding: *The **PES_scrambling_control** bits shall be set according to table 2, in accordance with ETR 289 [5].*

Table 2: Coding of PES_scrambling_control bits

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.*

4.1.6.3 PES_priority

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

4.1.6.4 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.*

4.1.6.5 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, storage applications, etc.) 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 intended for digital VCR applications, it is recommended that it supports decoding of trick modes as indicated in subclause 2.2.

4.1.6.6 additional_copy_info

Encoding: This field may be 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.*

4.1.6.7 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.

4.1.6.8 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.

4.1.7 Program Specific Information (PSI) (ISO/IEC 13818-1, section 2.4.4)

The data formats for the Transport Stream Description Table (TSDT) and Network Information Table (NIT) in DVB bit-streams are given in EN 300 468 [6]. This ETS 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 Transport Stream Description Table (TSDT), Program Association Table (PAT) and Program Map Table (PMT) are repeated with a maximum time interval of 100 milliseconds between repetitions.

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

4.1.8.1 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.

4.1.8.2 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.*

4.1.8.3 registration_descriptor

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

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

4.1.8.4 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.

4.1.8.5 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 × 576 pixels shall be assumed by a 25 Hz IRD, a default grid of 720 × 480 pixels shall be assumed by a 30 Hz 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 × 576 pixels is optional for a 25 Hz SDTV IRD, the display of correctly windowed video on background grids other than 720 × 480 pixels is optional for a 30 Hz SDTV IRD.*

4.1.8.6 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.*

4.1.8.7 Conditional Access CA_descriptor

Encoding: *The CA_descriptor shall be encoded as defined in ETR 289 [5].*

Decoding: *The IRD shall interpret this descriptor as defined in ETR 289 [5].*

4.1.8.8 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.*

4.1.8.9 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.

4.1.8.10 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.

4.1.8.11 copyright_descriptor

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

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

4.1.8.12 maximum_bitrate_descriptor

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

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

4.1.8.13 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.

4.1.8.14 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.

4.1.8.15 IBP_descriptor

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

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

4.1.8.16 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 EN 300 468 [6], and guidelines for their use are provided in ETR 211 [7]: "Guidelines on implementation and usage of Service Information".

4.1.9 Compatibility with ISO/IEC 11172-1 (ISO/IEC 13818-1, section 2.8)

Decoding: Compatibility with ISO/IEC 11172-1 [8] (MPEG-1 Systems) is optional.

4.1.10 Storage Media Interoperability

It is recommended that the total bitrate of the set of service components, associated PMT and PCR packets anticipated to be recorded by a consumer, should not exceed 9 000 000 bit/s.

It is recommended that the parameters `sb_size` and `sb_leak_rate` in the `smoothing_buffer_descriptor` remain constant for the duration of an event. The value of the `sb_leak_rate` should be the peak attained during the event. The `short_smoothing_buffer_descriptor` is defined in EN 300 468 [6] and guidelines for its use are provided in ETR 211 [7].

4.2 Bitstreams from storage applications and IRDs with digital interfaces

This subclause covers both the treatment of Partial TSs which result from external program selection and Trick Play information received from a storage device. MPEG-2 PSI and DVB SI tables for use specifically in storage applications are defined in EN 300 468 [6].

4.2.1 Partial TSs

Partial TSs for transfer on a digital interface, e.g. for digital VCR applications, have been defined in IEC CD-100C/1883 [10]. A Partial TS may be created by selection of TS Packets from one or more program(s), including PSI Packets.

Encoding *The Partial TS shall be fully MPEG compliant with reference to MPEG-2 "Extension for Real-Time-Interface for systems decoders" (ISO 13818-9) [4].*

Decoding *Devices equipped with a digital interface intended for digital VCR applications shall accept the bursty character of a Partial TS with gaps of variable length between the TS Packets.*

4.2.2 Decoding of Trick Play data (ISO/IEC 13818-1, section 2.4.3.7)

Encoding *Trick mode operation shall be signalled by use of the `DSM_trick_mode` flag in the header of the video Packetized Elementary Stream (PES) packets. During trick mode playback the storage device shall construct a bitstream which is syntactically and semantically correct, except as outlined in the note below.*

Decoding *It is recommended that devices decode the `DSM_trick_mode_flag` and the eight bit trick mode field. Devices which decode the trick mode data shall follow the normative requirements detailed in ISO/IEC 13818-1 [1], 2 for all values of the `trick_mode_control` field.*

NOTE: Trick Mode Semantic Constraints

The bitstream delivered to the decoder during trick mode shall comply with the syntax defined in the MPEG-2 standard. However, for the following video syntax elements, semantic exceptions apply in the presence of the DSM_trick_mode field:

- bit_rate
- vbv_delay
- repeat_first_field
- v_axis_positive
- field_sequence
- subcarrier
- burst_amplitude
- subcarrier_phase

A decoder cannot rely on the values encoded in these fields when in trick mode.

Similarly, for the systems layer, the following semantic exceptions apply in the presence of the DSM_trick_mode field:

- maximum spacing of PSI information may exceed 400ms,
- maximum spacing of PTS or DTS occurrences may exceed 700ms,
- PES packets may be void of video data to indicate a change in trick mode byte,
- a PES packet void of video data may contain a PTS to indicate effective presentation time of new trick mode control.
- when trick_mode status is true, the elementary stream buffers in the T-STD may underflow

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.

Subclause 5.1 applies to 25 Hz SDTV IRDs and broadcasts intended for reception by such IRDs; subclause 5.2 applies to 25 Hz HDTV IRDs and broadcasts intended for reception by such IRDs; subclause 5.3 applies to 30 Hz SDTV IRDs and broadcasts intended for reception by such IRDs; subclause 5.4 applies to 30 Hz HDTV IRDs and broadcasts intended for reception by such IRDs.

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-2 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 25 Hz SDTV IRDs and Bitstreams

5.1.1 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 25 Hz SDTV IRD shall support the decoding of Main Profile Main Level bitstreams. 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).*

5.1.2 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 25 Hz SDTV IRDs shall support the decoding and display of video material with a frame rate of 25 Hz interlaced (i.e. **frame_rate_code** of "0011"). Support of other frame and field rates is optional.

25 Hz SDTV 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)

5.1.3 Aspect ratio

Encoding: The source aspect ratio in 25 Hz SDTV bit-streams shall be either 4:3, 16:9 or 2.21:1. Note that decoding of 2.21:1 aspect ratio is optional for the 25 Hz SDTV IRD.

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

- 4:3 aspect ratio source: "0010";
- 16:9 aspect ratio source: "0011";
- 2.21:1 aspect ratio source: "0100".

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:

$$\text{display_horizontal_size} = \frac{4}{3} \times \frac{\text{horizontal_size}}{\text{source aspect ratio}}$$

Table 3 gives some typical examples:

Table 3: Values for display_horizontal_size

horizontal_size × vertical_size	Source aspect ratio	display_horizontal_size
720 × 576	16:9	540
544 × 576	16:9	408
480 × 576	16:9	360
352 × 576	16:9	264
352 × 288	16:9	264

Decoding: The 25 Hz SDTV 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 25 Hz SDTV 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 the 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.

5.1.4 Luminance resolution

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

- *720 × 576;*
- *544 × 576;*
- *480 × 576;*
- *352 × 576;*
- *352 × 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 25 Hz SDTV IRD shall be capable of decoding pictures with luminance resolutions as shown in table 4 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	16:9 Monitors
720 × 576	4:3	× 1	× 3/4 (note 1)
	16:9	× 4/3 (note 2)	× 1
	2.21:1	× 5/3 (note 3)	× 5/4 (note 4)
544 × 576	4:3	× 4/3	× 1 (note 1)
	16:9	× 16/9 (note 2)	× 4/3
	2.21:1	× 20/9 (note 3)	× 5/3 ⁴⁾
480 × 576	4:3	× 3/2	× 9/8 (note 1)
	16:9	× 2 (note 2)	× 3/2
	2.21:1	× 5/2 (note 3)	× 15/8 (note 4)
352 × 576	4:3	× 2	× 3/2 (note 1)
	16:9	× 8/3 (note 2)	× 2
	2.21:1	× 10/3 (note 3)	× 5/2 (note 4)
352 × 288	4:3	× 2	× 3/2 (note 1)
	16:9	× 8/3 (note 2)	× 2
	2.21:1	× 10/3 (note 3)	× 5/2 (note 4)
		(and vertical upsampling × 2)	(and vertical upsampling × 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:	The upsampling with this value is applied to the pixels of the 16:9 picture to be displayed on a 4:3 monitor.		
NOTE 3:	The upsampling with this value is applied to the pixels of the 2.21:1 picture to be displayed on a 4:3 monitor. Upsampling from 2.21:1 pictures for display on a 4:3 monitor is optional in the IRD.		
NOTE 4:	The upsampling with this value is applied to the pixels of the 2.21:1 picture to be displayed on a 16:9 monitor. Upsampling from 2.21:1 pictures for display on a 16:9 monitor is optional in the IRD.		

5.1.5 Chromaticity Parameters

Encoding: It is recommended that the chromaticity co-ordinates of the ideal display, opto-electronic transfer characteristic of the ideal display and matrix coefficients used in deriving luminance and chrominance signals from the red, green and blue primaries be explicitly signalled in the encoded bitstream by setting the appropriate values for each of the following 3 parameters in the **sequence_display_extension()**: **colour_primaries**, **transfer_characteristics**, and **matrix_coefficients**.

*Within 25 Hz SDTV bitstreams, if the **sequence_display_extension()** is not present in the bitstream or **colour_description** is zero, the chromaticity shall be implicitly defined to be that corresponding to **colour_primaries** having the value 5, the transfer characteristics shall be implicitly defined to be those corresponding to **transfer_characteristics** having the value 5 and the matrix coefficients shall be implicitly defined to be those corresponding **matrix_coefficients** having the value 5. This set of parameter values corresponds signals compliance with ITU-R Recommendation BT.470-3 System B, G, I.*

5.1.6 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.*

5.1.7 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 1: *Increasing the frequency of video sequence headers and I-frames will reduce channel hopping time but will reduce the efficiency of the video compression.*

NOTE 2: *Having a regular interval between I-frames may improve trick mode performance, but may reduce the efficiency of the video compression.*

5.2 25 Hz HDTV IRDs and Bitstreams

5.2.1 Profile and level

Encoding: *Encoded 25 Hz HDTV bit-streams shall comply with the Main Profile High Level restrictions, as described ISO/IEC 13818-2 [2], section 8.2. The **profile_and_level_indication** is "01000110" or, if appropriate, "0nnnnnnn", where "0nnnnnnn" > "01000110", indicating a "simpler" profile or level than Main Profile, High Level.*

Decoding: *The 25 Hz HDTV IRD shall support the decoding of Main Profile High Level bitstreams. This requirement includes support for "simpler" profiles and levels, including Main Profile at Main Level, as defined in table 8-15 of ISO/IEC 13818-2 [2]. Support for profiles and levels beyond Main Profile, High 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).**

5.2.2 Frame rate

Encoding: *The frame rate shall be 25 Hz or 50 Hz, i.e. **frame_rate_code** is "0011" or "0110".*

The source video format for 50 Hz frame rate material shall be progressive. The source video format for 25 Hz frame rate material may be interlaced or progressive.

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 25 Hz HDTV IRDs shall support the decoding and display of video material with a frame rate of 25 Hz progressive, 25 Hz interlaced or 50 Hz progressive (i.e. **frame_rate_code** of "0011" or "0110") within the constraints of Main Profile at High Level. Support of other frame and field rates is optional.*

25 Hz HDTV 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)

5.2.3 Aspect ratio

Encoding: *The source aspect ratio in 25 Hz HDTV bit-streams shall be 16:9 or 2.21:1. Note that decoding of 2.21:1 aspect ratio is optional for the 25 Hz HDTV IRD.*

*The **aspect_ratio_information** in the sequence header shall have the value "0011" or "0100".*

Decoding: *The 25 Hz HDTV IRD shall be able to decode bit-streams with **aspect_ratio_information** of value "0011", corresponding to 16:9 aspect ratio. The support of the aspect ratio 2.21:1 is optional. 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.*

5.2.4 Luminance resolution

Encoding: *The encoded picture shall have a full-screen luminance resolution within the constraints set by Main Profile at High Level, i.e. it shall not have more than:*

*1152 lines per frame,
1920 luminance samples per line,
62 668 800 luminance samples per second.*

It is recommended that the source video for 25 Hz HDTV Bitstreams has a luminance resolution of:

*1080 lines per frame and
1920 luminance samples per line,
with an associated frame rate of 25 Hz, with two interlaced fields per frame.*

The source video may or may not be down-sampled prior to encoding.

The use of other encoded video resolutions within the constraints of Main Profile at High Level is also permitted. Annex A of this ETR provides examples of supported full screen luminance resolutions. In addition, non full-screen pictures may be encoded for display at less than full-size.

NOTE 1: The limit of 62 668 800 luminance samples per second of Main Profile at High Level excludes the use of the maximum allowed picture resolution at 50 Hz frame rate.

NOTE 2: If the recommended source video format is encoded without down-sampling it gives 51 840 000 luminance samples per second and therefore falls within the allowed range for Main Profile at Main Level.

Decoding: *The 25 Hz HDTV IRD shall be capable of decoding and displaying pictures with luminance resolutions within the constraints set by Main Profile at High Level.*

5.2.5 Chromaticity Parameters

Encoding: *The chromaticity co-ordinates of the ideal display, opto-electronic transfer characteristic of the source picture and matrix coefficients used in deriving luminance and chrominance signals from the red, green and blue primaries shall be explicitly signalled in the encoded HDTV bitstream by setting the appropriate values for each of the following 3 parameters in the **sequence_display_extension()**: **colour_primaries**, **transfer_characteristics**, and **matrix_coefficients**.*

It is recommended that ITU-R BT.709 colorimetry is used in the 25 Hz HDTV bitstream, which is signalled by setting **colour_primaries** to the value 1, **transfer_characteristics** to the value 1 and **matrix_coefficients** to the value 1.

Decoding: *The 25 Hz HDTV IRD shall be capable of decoding bitstreams with any allowed values of **colour_primaries**, **transfer_characteristics** and **matrix_coefficients**. It is recommended that appropriate processing be included for the accurate representation of pictures using BT.709 colorimetry.*

5.2.6 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.*

5.2.7 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 1: *Increasing the frequency of video sequence headers and I-frames will reduce channel hopping time but will reduce the efficiency of the video compression.*

NOTE 2: *Having a regular interval between I-frames may improve trick mode performance, but may reduce the efficiency of the video compression.*

5.2.8 Backwards Compatibility

Decoding: *In addition to the above, a 25 Hz HDTV IRD shall be capable of decoding any bitstream that a 25 Hz SDTV IRD is required to decode, as described in 5.1.*

5.3 30 Hz SDTV IRDs and Bitstreams

5.3.1 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).*

5.3.2 Frame rate

Encoding: *The frame rate shall be either 24000/1001, 24, 30000/1001 or 30 Hz, i.e. the **frame_rate_code** field shall be encoded with one of the following values: "0001", "0010", "0100" or "0101".*

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 30 Hz SDTV IRDs shall support the decoding and display of Main Profile @ Main Level video with a frame rate of 24000/1001, 24, 30000/1001 or 30 Hz. Support of other frame 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)

5.3.3 Aspect ratio

Encoding: *The source aspect ratio in 30 Hz SDTV bit-streams shall be either 4:3, 16:9 or 2.21:1. Note that decoding of 2.21:1 aspect ratio is optional for the 30 Hz SDTV IRD.*

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

- 4:3 aspect ratio source: "0010";
- 16:9 aspect ratio source: "0011";
- 2.21:1 aspect ratio source: "0100".

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:*

$$\text{display_horizontal_size} = \frac{4}{3} \times \frac{\text{horizontal_size}}{\text{source aspect ratio}}$$

Table 5 gives some typical examples:

Table 5: Values for display_horizontal_size

horizontal_size × vertical_size	Source aspect ratio	display_horizontal_size
720 × 480	16:9	540
640 × 480	16:9	480
544 × 480	16:9	408
480 × 480	16:9	360
352 × 480	16:9	264
352 × 240	16:9	264

Decoding: *The 30 Hz SDTV 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 30 Hz SDTV 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 the 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.*

5.3.4 Luminance resolution

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

- 720 × 480;
- 640 × 480;
- 544 × 480;
- 480 × 480;
- 352 × 480;
- 352 × 240.

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 30 Hz SDTV IRD shall be capable of decoding pictures with luminance resolutions as shown in table 6 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 6: Resolutions for Full-screen Display from IRD

Coded Picture		Displayed Picture Horizontal upsampling	
Luminance resolution (horizontal × vertical)	Aspect Ratio	4:3 Monitors	16:9 Monitors
720 × 480	4:3	× 1	× 3/4 (note 1)
	16:9	× 4/3 (note 2)	× 1
	2:21:1	× 5/3 (note 3)	× 5/4 (note 4)
640 × 480	4:3	× 9/8	× 27/32 ¹⁾
544 × 480	4:3	× 4/3	× 1 (note 1)
	16:9	× 16/9 (note 2)	× 4/3
	2:21:1	× 20/9 (note 3)	× 5/3 (note 4)
480 × 480	4:3	× 3/2	× 9/8 (note 1)
	16:9	× 2 (note 2)	× 3/2
	2:21:1	× 5/2 (note 3)	× 15/8 (note 4)
352 × 480	4:3	× 2	× 3/2 (note 1)
	16:9	× 8/3 (note 2)	× 2
	2:21:1	× 10/3 (note 3)	× 5/2 (note 4)
352 × 240	4:3	× 2	× 3/2 (note 1)
	16:9	× 8/3 (note 2)	× 2
	2:21:1	× 10/3 (note 3)	× 5/2 (note 4)
		(and vertical upsampling × 2)	(and vertical upsampling × 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:	The upsampling with this value is applied to the pixels of the 16:9 picture to be displayed on a 4:3 monitor.		
NOTE 3:	The upsampling with this value is applied to the pixels of the 2.21:1 picture to be displayed on a 4:3 monitor. Upsampling from 2.21:1 pictures for display on a 4:3 monitor is optional in the IRD.		
NOTE 4:	The upsampling with this value is applied to the pixels of the 2.21:1 picture to be displayed on a 16:9 monitor. Upsampling from 2.21:1 pictures for display on a 16:9 monitor is optional in the IRD.		

5.3.5 Chromaticity Parameters

Encoding: It is recommended that the chromaticity co-ordinates of the ideal display, opto-electronic transfer characteristic of the ideal display and matrix coefficients used in deriving luminance and chrominance signals from the red, green and blue primaries be explicitly signalled in the encoded bitstream by setting the appropriate values for each of the following 3 parameters in the **sequence_display_extension()**: **colour_primaries**, **transfer_characteristics**, and **matrix_coefficients**.

*Within 30 Hz SDTV bitstreams, if the **sequence_display_extension()** is not present in the bitstream or **colour_description** is zero, the chromaticity shall be implicitly defined to be that corresponding to **colour_primaries** having the value 6, the transfer characteristics shall be implicitly defined to be those corresponding to **transfer_characteristics** having the value 6 and the matrix coefficients shall be implicitly defined to be those corresponding **matrix_coefficients** having the value 6. This set of parameter values signals compliance with SMPTE 170M.*

5.3.6 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.

5.3.7 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 1: Increasing the frequency of video sequence headers and I-frames will reduce channel hopping time but will reduce the efficiency of the video compression.

NOTE 2: Having a regular interval between I-frames may improve trick mode performance, but may reduce the efficiency of the video compression.

5.4 30 Hz HDTV IRDs and Bitstreams

5.4.1 Profile and level

Encoding: *Encoded 30 Hz HDTV bit-streams shall comply with the Main Profile High Level restrictions, as described ISO/IEC 13818-2 [2], section 8.2. The **profile_and_level_indication** is "01000110" or, if appropriate, "0nnnnnnn", where "0nnnnnnn" > "01000110", indicating a "simpler" profile or level than Main Profile, High Level.*

Decoding: *The 30 Hz HDTV IRD shall support the decoding of Main Profile High Level bitstreams. This requirement includes support for "simpler" profiles and levels, including Main Profile at Main Level, as defined in table 8-15 of ISO/IEC 13818-2 [2]. Support for profiles and levels beyond Main Profile, High 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).*

5.4.2 Frame rate

Encoding: *The frame rate shall be 24000/1001, 24, 30000/1001, 30, 60000/1001 or 60 Hz, i.e. **frame_rate_code** is "0001", "0010", "0100", "0101", "0111" or "1000".*

The source video format for 24000/1001, 24, 60000/1001 and 60 Hz frame rate material shall be progressive. The source video format for 30000/1001 and 30 Hz frame rate material may be interlaced or progressive.

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 30 Hz HDTV IRDs shall support the decoding of video material with a frame rate of 24000/1001, 24, 30000/1001, 30, 60000/1001 or 60 Hz (i.e. **frame_rate_code** of "0001", "0010", "0100", "0101", "0111" or "1000") within the constraints of Main Profile at High Level. Support of other frame rates is optional.

30 Hz HDTV IRDs shall support the display of video whose source frame rate is 24000/1001, 24, 30000/1001, 30, 60000/1001 or 60 Hz progressive. 30 Hz HDTV IRDs shall support the display of video whose source frame rate is 30000/1001 or 30 Hz interlaced.

30 Hz HDTV 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)

5.4.3 Aspect ratio

Encoding: The source aspect ratio in 30 Hz HDTV bit-streams shall be 16:9 or 2.21:1. Note that decoding of 2.21:1 aspect ratio is optional for the 30 Hz HDTV IRD.

The **aspect_ratio_information** field in the sequence header shall have the value "0011" or "0100".

Decoding: The 30 Hz HDTV IRD shall be able to decode bit-streams with **aspect_ratio_information** of value "0011", corresponding to 16:9 aspect ratio. 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.

5.4.4 Luminance resolution

Encoding: The encoded picture shall have a full-screen luminance resolution within the constraints set by Main Profile at High Level, i.e. it shall not have more than:

1152 lines per frame,
1920 luminance samples per line,
62 668 800 luminance samples per second.

It is recommended that the source video for 30 Hz HDTV Bitstreams has a luminance resolution of:

1080 lines per frame and
1920 luminance samples per line,
with an associated frame rate of 30000/1001 (approximately 29,97) Hz with two interlaced fields per frame.

The source video may or may not be down-sampled prior to encoding.

The use of other encoded video resolutions within the constraints of Main Profile at High Level is also permitted. Annex A of this ETR provides examples of supported full screen luminance resolutions. In addition, non full-screen pictures may be encoded for display at less than full-size.

NOTE 1: The limit of 62 668 800 luminance samples per second of Main Profile at High Level excludes the use of the maximum allowed picture resolution at 60 Hz and 60000/1001 frame rates.

NOTE 2: If the recommended source video format is encoded without down-sampling it gives 62 145 854 luminance sample per second and therefore falls within the allowed range for Main Profile at Main Level.

Decoding : *The 30 Hz HDTV IRD shall be capable of decoding and displaying pictures with luminance resolutions within the constraints set by Main Profile at High Level.*

5.4.5 Chromaticity Parameters

Encoding: *The chromaticity co-ordinates of the ideal display, opto-electronic transfer characteristic of the source picture and matrix coefficients used in deriving luminance and chrominance signals from the red, green and blue primaries shall be explicitly signalled in the encoded HDTV bitstream by setting the appropriate values for each of the following 3 parameters in the **sequence_display_extension()**: **colour_primaries**, **transfer_characteristics**, and **matrix_coefficients**.*

It is recommended that ITU-R BT.709 colorimetry is used in the 30 Hz HDTV bitstream, which is signalled by setting **colour_primaries** to the value 1, **transfer_characteristics** to the value 1 and **matrix_coefficients** to the value 1.

Decoding: *The 30 Hz HDTV IRD shall be capable of decoding bitstreams with any allowed values of **colour_primaries**, **transfer_characteristics** and **matrix_coefficients**. It is recommended that appropriate processing be included for the accurate representation of pictures using BT.709 colorimetry.*

5.4.6 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.

5.4.7 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 1: Increasing the frequency of video sequence headers and I-frames will reduce channel hopping time but will reduce the efficiency of the video compression.

NOTE 2: Having a regular interval between I-frames may improve trick mode performance, but may reduce the efficiency of the video compression.

5.4.8 Backwards Compatibility

Decoding: *In addition to the above, a 30 Hz HDTV IRD shall be capable of decoding any bitstream that a 30 Hz SDTV IRD is required to decode, as described in 5.3.*

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 recommended level for reference tones for transmission is 18 dB below clipping level, in accordance with EBU Recommendation R.68 [11].

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 multi-channel audio, backwards compatible to MPEG-1 (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 recommended.*

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 [9] 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.*

Annex A (informative): Examples of full screen luminance resolutions for SDTV and HDTV

vertical_size_value	horizontal_size_value	aspect_ratio_information	frame_rate_code (note 1)	progressive_sequence (note 2)
1152	1440	16:9	25	0
			25	1
1080	1920	16:9	23.976, 24, 29.97, 30	1
			25	0
			29.97, 30	0
1035	1920	16:9	25	0
			29.97, 30	0
			25, 50	1
720	1280	16:9	23.976, 24, 29.97, 30, 59.94, 60	1
			50	1
	720	4:3, 16:9	25	1
			25	0
576	544	4:3, 16:9	25	1
			25	0
	480	4:3, 16:9	25	1
			25	0
	352	4:3, 16:9	25	1
			25	0
	720	4:3, 16:9	59.94, 60	1
			23.976, 24, 29.97, 30	1
			29.97, 30	0
	640	4:3	59.94, 60	1
480			23.976, 24, 29.97, 30	1
			29.97, 30	0
	544	4:3, 16:9	23.976, 29.97	1
			29.97	0
	480	4:3, 16:9	23.976, 29.97	1
			29.97	0
	352	4:3, 16:9	23.976, 29.97	1
			29.97	0
288	352	4:3, 16:9	25	1
240	352	4:3, 16:9	23.976, 29.97	1

NOTE 1: Shaded "frame_rate_code" values indicate 30 Hz bitstreams, clear values 25 Hz bitstreams.

NOTE 2: Shaded "progressive_sequence" values indicate SDTV, clear values HDTV bitstreams.

History

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