

RECOMMENDATION ITU-R BT.1551

Transport of MPEG-2 recoding data set as ancillary data packets

(Question ITU-R 41/6)

(2001)

The ITU Radiocommunication Assembly,

considering

- a) that digital television broadcasts make use of ISO/IEC 13818-2:2000 MPEG-coded compressed signals;
- b) that there are economic and operational advantages in handling television signals in compressed form in acquisition and production;
- c) that unless special steps are taken, the cascading of ISO/IEC 13818-2:2000 MPEG codecs may lead to degradations of picture quality;
- d) that Recommendation ITU-R BT.1532 and Recommendation ITU-R BT.1550 on MPEG-2 recoding data set for compressed stream format define the data set for near-loss-less cascading based on parameters that can be extracted from the original ISO/IEC 13818-2:2000 MPEG coding parameters in an MPEG decoder;
- e) that Recommendation ITU-R BT.1364 provides basic formatting on ancillary data in a serial digital video stream;
- f) that the recoding data set and compressed recoding data set may be carried in a studio as data packets,

recommends

1 that the ancillary data formatting described in SMPTE Standard 353M-2000 – Transport of MPEG-2 Recoding Information as Ancillary Data Packets, be used as a method for carrying coding parameter information from an ISO/IEC 13818-2:2000 MPEG decoder to any subsequent re-encoder.

Summary of SMPTE Standard 353M-2000

This Standard specifies the mechanism for the transport of MPEG-2 video recoding information as ancillary data packets in an ancillary data space – for example, through Recommendation ITU-R BT.656 and SMPTE 259M interfaces. The video recoding information transported through this mechanism is for the purpose of preserving picture quality at re-encoding stages when cascading MPEG-2 decoders and encoders. Although the specified mechanism operates on 10-bit digital video interfaces, it is by design transparent to systems limited to 8-bit operation.

The principal application of this standard is to allow the preservation of picture quality when cascading video decoders and encoders following ISO/IEC 13818-2.

Note by the Secretariat: The SMPTE Standard 353M-2000, previously referred to as a web link site in electronic form, has been annexed to the text of this Recommendation.

The transport mechanism specified in this standard is compliant with SMPTE 291M. Part of both the vertical blanking ancillary data space, V-ANC, and the horizontal blanking ancillary data space, H-ANC, may be used.

The V-ANC space is used to carry picture rate information only. This is the most basic, highest priority, part of the recoding data set. For low bit rate, long group of pictures applications in particular, it typically brings the largest picture quality improvement step while further refinements are brought when more information is available.

The H-ANC space is used to carry the other part of the recoding data set. The use of the reduced bandwidth indicator, as specified in SMPTE 329M-2000, allows the transmission, more or less, of this part of the recoding data set, depending upon the transmission capacity available in the H-ANC space.

NOTE 1 – SMPTE Standard 353M-2000 is given in Annex 1. SMPTE Standard 353M-2000 and its summary refer to Version 2000 only, which is the version approved by Administrations of Member States of the ITU and Radiocommunication Sector Members participating in the work of Radiocommunication Study Group 6 in application of Resolution ITU-R 45 on 23 December 2001. By agreement between ITU and SMPTE, this Version was provided and authorized for use by SMPTE and accepted by ITU-R for inclusion in this Recommendation. Any subsequent version of SMPTE Standard 353M, which has not been accepted and approved by Radiocommunication Study Group 6 is not part of this Recommendation. For subsequent versions of SMPTE Documents, the reader should consult the SMPTE website: <http://www.smpete.org/>.

SMPTE STANDARD

SMPTE 353M-2000

for Television — Transport of MPEG-2 Recoding Information as Ancillary Data Packets



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1 Scope

This standard specifies the mechanism for the transport of MPEG-2 video recoding information as ancillary data packets in an ancillary data space — for example, through ITU-R BT.656 / SMPTE 259M interfaces.

The video recoding information transported through this mechanism is for the purpose of preserving picture quality at re-encoding stages when cascading MPEG-2 decoders and encoders.

Although the specified mechanism operates on 10-bit digital video interfaces, it is by design transparent to systems limited to 8-bit operation.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE 291M-1998, Television — Ancillary Data Packet and Space Formatting

SMPTE 327M-2000, Television — MPEG-2 Video Recoding Data Set

SMPTE 329M-2000, Television — MPEG-2 Video Recoding Data Set — Compressed Stream Format

3 General

The principal application of this standard is to allow the preservation of picture quality when cascading video decoders and encoders following ISO/IEC 13818-2.

This standard defines the transport of MPEG-2 video recoding information in the ancillary data space provided by digital video interfaces. In addition, the transport mechanism specified in this standard has been designed so that it can work with digital video systems in which operation is limited to 8-bit resolution.

The following shall apply:

- The transported MPEG-2 video recoding information shall be compliant with the MPEG-2 video recoding data set as defined in SMPTE 327M.
- This data set shall be formatted according to the stream format defined in SMPTE 329M.
- This formatted data set shall be transported in the form of ancillary (ANC) data packets as specified in SMPTE 291M.

The transport mechanism specified in this standard shall be compliant with SMPTE 291M. Part of both the

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vertical blanking ancillary data space, V-ANC, and the horizontal blanking ancillary data space, H-ANC, shall be used.

The V-ANC space shall be used to carry picture rate information only. This is the most basic, highest priority, part of the recoding data set. For low bit rate, long GOP applications in particular, it typically brings the largest picture quality improvement step while further refinements are brought when more information is available.

The H-ANC space shall be used to carry the other part of the recoding data set. The use of the reduced bandwidth indicator, as specified in SMPTE 329M, will allow the transmission, more or less, of this part of the recoding data set, depending upon the transmission capacity available in the H-ANC space.

4 Definitions

4.1 aligned (temporally): In the scope of this standard, it means temporally aligned; arranged so that information related to a picture (frame or field) is inserted within the blanking interval of that decoded picture.

4.2 cascading: The process where video that has once been coded (compressed) is subsequently decoded and coded once more. This cascaded step could carry on for any number of generations.

4.3 coding: The process by which an uncompressed video sequence is compressed to a bit stream that conforms to ISO/IEC 13818-2.

4.4 decoder: A compressed bitstream decoder that complies with ISO/IEC 13818-2.

4.5 MPEG profile/level: As defined in ISO/IEC 13818-2.

4.6 MPEG-2 video recoding data stream: A bitstream conveying the MPEG-2 video recoding data set in the compressed stream format as defined in SMPTE 329M.

4.7 picture: As defined in ISO/IEC 13818-2.

4.8 picture rate information: In this standard, this corresponds to the coding information from the ISO/IEC 13818-2 bitstream that relates to the

whole picture, plus some additional information derived from sequence and GOP headers, but excluding slice() and macroblock() information.

4.9 recoding data access unit: A section of the MPEG-2 video recoding data stream which contains in compressed format the recoding data of a single picture including any sequence and GOP headers that could precede that picture.

4.10 recoding data set: As defined in SMPTE 327M.

4.11 transcoding: A conversion within the MPEG-2 video elementary stream domain, such as bit-rate changing or changing the group of pictures (GOP) structure.

4.12 video: In this standard, a signal conforming to ITU-R BT.601.

4.13 video access unit: As defined in ISO/IEC 13818-1.

4.14 video elementary stream: An ordered series of bits conforming to ISO/IEC 13818-2.

5 Ancillary data packet formatting for transport of MPEG-2 video recoding data set

5.1 Ancillary video recoding data packet structure

An ancillary video recoding data packet shall be of constant length. It shall contain MPEG-2 video recoding data preformatted as defined in SMPTE 329M.

The ancillary video recoding data packets shall be type 2 and shall be transmitted in the ancillary data space as defined in SMPTE 291M (see figure 1).

5.2 Ancillary video recoding data packet formatting

The ADF, DID, SDID, DC, and CS words shall be compliant with SMPTE 291M.

The recoding data control (RDC), recoding data block number (RDBN), recoding data block extension (RDBE), recoding data bandwidth information (RDBI), and cyclic redundancy check (CRC) words are further defined below (see table 1).

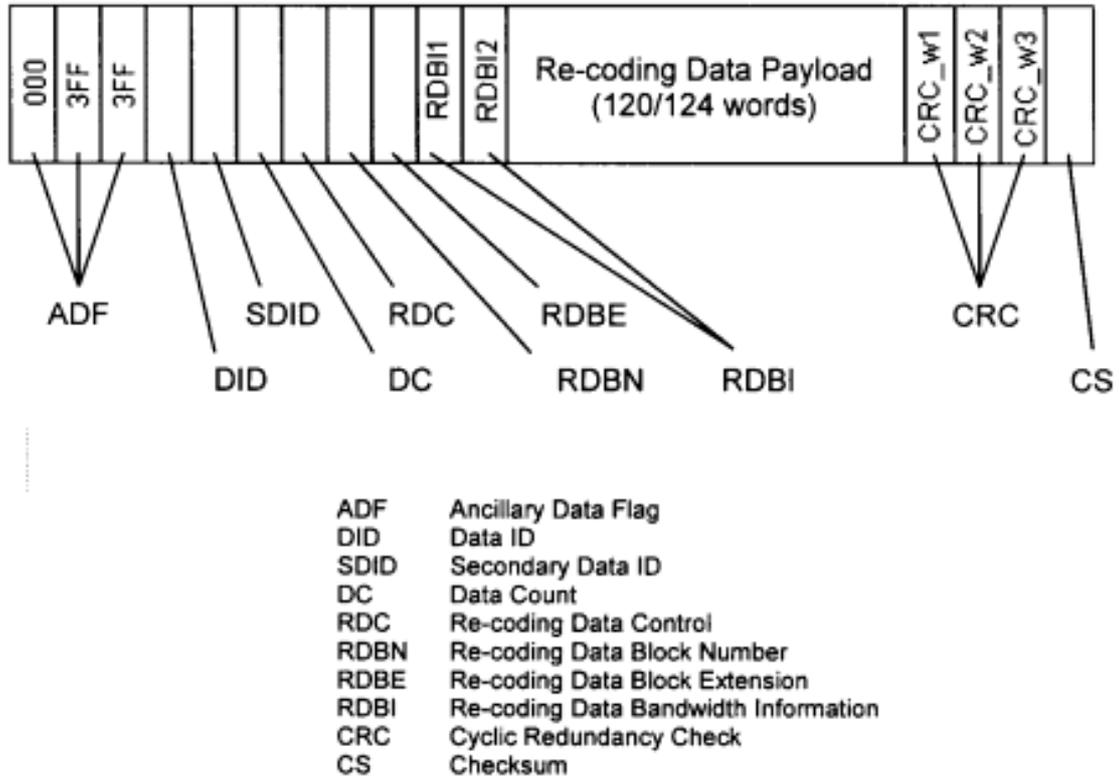


Figure 1 – Structure of the ancillary recoding data packets

Table 1 – Ancillary recoding data packet syntax

Ancillary recoding data packet () {	Number of words
ADF	3
DID	1
SDID	1
DC	1
Recoding data control	1
If (recoding_data_start_flag == 1) {	
Recoding data block number	1
Recoding data block extension	1
Recoding data bandwidth information	2
}	
Recoding data payload()	120 / 124 ¹⁾
CRC()	3
Checksum	1
}	

1) 120 if recoding_data_start_flag is one; 124 otherwise.

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– Ancillary data flag (ADF)

The ADF shall have the value 000h 3FFh 3FFh.

– Data ID (DID)

The DID shall have the value of [08h] for B7 through B0.

B8 is even parity for B7 through B0; B9 is the complement of B8.

– Secondary data ID (SDID)

For recoding data transported into the V-ANC space, the SDID shall have the value of [08h] for B7 through B0.

For recoding data transported into the H-ANC space, the SDID shall have the value of [0Ch] for B7 through B0.

B8 is even parity for B7 through B0; B9 is the complement of B8.

– Data count (DC)

The DC shall have the value [80h] for B7 through B0, representing the fixed 128-word recoding data packet size.

B8 is even parity for B7 through B0; B9 is the complement of B8.

– Recoding data control (RDC)

The RDC shall specify the start and the continuity of a recoding data access unit in the recoding data stream (see table 2).

The `recoding_data_start_flag`, when set to one, shall indicate that the recoding data payload of this recoding data packet will begin with the first byte of a recoding data access unit. The `recoding_data_start_flag` shall be otherwise set to zero.

The `V-ANC_stop_flag`, when set to one, shall indicate the last ancillary recoding data packet located in the V-ANC data space. This means that the next ancillary recoding data packet (if any) for the current recoding data access unit is to be found in the H-ANC data space.

The `continuity_counter` is an unsigned integer value incrementing by one at each consecutive recoding data packet, starting with the value 1 for the first recoding data packet of a recoding data access unit (`recoding_data_start_flag` = 1). The `continuity_counter` wraps around to zero after its maximum value of 15, and continues again.

– Recoding data block number (RDBN)

The RDBN defines the number of recoding data packets that are used to transport a recoding data access unit. This word shall be present in the recoding data packet only if the `recoding_data_start_flag` is set to one in this packet (see table 3).

For large size recoding data access units where the recoding data block number exceeds 63, an extension field is signaled by 6 extra bits. These bits are located in the RDBE word. A zero value for the `recoding_data_block_number` (including the 6 extension bits) means unknown size.

– Recoding data block extension (RDBE)

The RDBE contains the 6 extension bits (MSBs) of the `recoding_data_block_number`. This word shall be present in the recoding data packet only if the `recoding_data_start_flag` is set to one in this packet (see table 4).

The value of this 6-bit word shall be zero when the `recoding_data_block_number` is lower than 64.

– Recoding data bandwidth indicator (RDBI)

The RDBI words contain information relative to the recoding data stream content. These two words shall be present in the recoding data packet only if the `recoding_data_start_flag` is set to one in this packet (see table 5).

In `RDBI_1`, the first RDBI word, B2 shall reproduce `rd_bw_flag` value present in the current recoding data access unit; B3 and B4 shall reproduce the `rd_bw_indicator` value present in the current recoding data access unit; Bits B5 through B7 are reserved for future use. By default, they shall be set to zero.

`RDBI_2`, the second RDBI word, is reserved for future use. By default, this word shall be set to the value 200h.

Table 2 – Recoding data control

RDC (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDC bit 7 through bit 0
B7	Recoding_data_start_flag
B6	V-ANC_stop_flag
B5	Continuity_counter[3]
B4	Continuity_counter[2]
B3	Continuity_counter[1]
B2	Continuity_counter[0]
B1	Set to 0
B0	Set to 0

Table 3 – Recoding data block number

RDBN (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDBN bit 7 through bit 0
B7	Recoding_data_block_number[5]
B6	Recoding_data_block_number[4]
B5	Recoding_data_block_number[3]
B4	Recoding_data_block_number[2]
B3	Recoding_data_block_number[1]
B2	Recoding_data_block_number[0]
B1	Set to 0
B0	Set to 0

Table 4 – Recoding data block extension

RDBE (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDBE bit 7 through bit 0
B7	Recoding_data_block_number[11]
B6	Recoding_data_block_number[10]
B5	Recoding_data_block_number[9]
B4	Recoding_data_block_number[8]
B3	Recoding_data_block_number[7]
B2	Recoding_data_block_number[6]
B1	Set to 0
B0	Set to 0

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Table 5 – RDBI_1 – Recoding data bandwidth information – First word

RDBI_1 (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDBI bit 7 through bit 0
B7	Reserved (default value = 0)
B6	Reserved (default value = 0)
B5	Reserved (default value = 0)
B4	Rd_bw_indicator[1]
B3	Rd_bw_indicator[0]
B2	Rd_bw_flag
B1	Set to 0
B0	Set to 0

– Recoding data payload formatting

The 120 or 124 recoding data payload words (RDW) of an ancillary recoding data packet are formatted as shown in tables 6 and 7, depending on the ancillary data space location.

Table 6 indicates the payload word structure for recoding data packets located in the V-ANC data space for which the recoding data stream shall be partitioned in 4-bit words where the MSB is the first occurring bit in the recoding data stream. The recoding data stream is always byte aligned (see note 1). Each byte shall be partitioned into two 4-bit recoding data words. Bits B2 and B3 of the recoding data words are reserved for future use. By default, they shall be set to zero.

Table 7 indicates the payload word structure for recoding data packets located in the H-ANC data space for which the recoding data stream shall be partitioned in 6-bit words where the MSB is the first occurring bit in the recoding data stream. The recoding data stream is always byte aligned (see note 1). Each group of 3 consecutive bytes shall be partitioned into 4 consecutive words (6-bit recoding data words). The value of unused bits in each group of 3 consecutive bytes shall be set to zero.

The recoding data payload shall not contain information from more than one recoding data access unit. For the case where a recoding data access unit does not fit an entire number of recoding data packets, stuffing words set to the value 200_h shall be used to fill the last recoding data packet.

When the recoding_data_start_flag is set to one, the recoding data packet payload shall start with the first byte of the recoding data access unit.

In order to prevent overload of the ancillary data space, any stuffing byte from the recoding data stream shall be removed.

NOTES

1 Recoding data are formatted as a compressed stream format and are subsequently byte aligned on MPEG-2 start codes.

2 For the case where the rd_bw_indicator is less than 3, or rd_bw_flag=0, the last recoding data packet located within the V-ANC data space (V-ANC_stop_flag = 1) shall only contain picture rate information. Stuffing words set to the value 200_h shall be used to fill this last recoding data packet of the V-ANC data space.

– Cyclic redundancy check (CRC)

Recoding data packets are protected with a 16-bit CRC. The CRC shall be calculated over the recoding data packet excluding ADF, DID, SDID, and DC words. The CRC applies to the entire 10-bit word (LSB first) where bits B1 and B2 shall always be set to zero (0). The CRC polynomial is:

$$\text{CRC}(16\text{-bit}) = X^{16} + X^{12} + X^5 + 1.$$

The generator polynomial circuitry is described in figure 2. All registers shall be set to one (1) at initialization; i.e., at the start of every packet (see table 8).

Table 6 – Payload words in the recoding data packets located in V-ANC data space

RDW (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDW bit 7 through bit 0
B7	4-bit recoding data word MSB
B6	4-bit recoding data word
B5	4-bit recoding data word
B4	4-bit recoding data word LSB
B3	Reserved (default value = 0)
B2	Reserved (default value = 0)
B1	Set to 0
B0	Set to 0

Table 7 – Payload words in the recoding data packets located in H-ANC data space

RDW (10-bit word)	Assignment
B9	Not B8
B8	Even parity for data contained in RDW bit 7 through bit 0
B7	6-bit recoding data word MSB
B6	6-bit recoding data word
B5	6-bit recoding data word
B4	6-bit recoding data word
B3	6-bit recoding data word
B2	6-bit recoding data word LSB
B1	Set to 0
B0	Set to 0

Table 8 – CRC words of recoding data packets

CRC words	B9 msb	B8	B7	B6	B5	B4	B3	B2	B1	B0 lsb
CRC_w1	Not B8	Parity B0-B7	C5	C4	C3	C2	C1	C0	0	0
CRC_w2	Not B8	Parity B0-B7	C11	C10	C9	C8	C7	C6	0	0
CRC_w3	Not B8	Parity B0-B7	0	0	C15	C14	C13	C12	0	0

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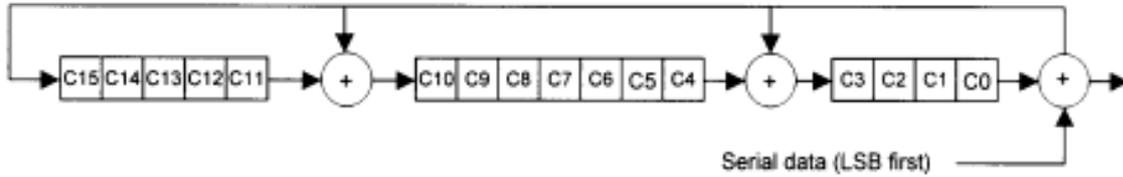


Figure 2 – CRC generator polynomial circuit diagram

– Checksum (CS)

This word shall be calculated as defined by SMPTE 291M.

5.3 Spatio-temporal alignment of the ancillary video recoding data

The video recoding information located in the ancillary data space shall be temporally aligned with the active video content.

More precisely, the first packet conveying the first data of a recoding data access unit shall be inserted in the blanking interval of the first video field covered by this recoding data access unit.

A recoding data access unit is a section of the recoding data stream which contains the compressed format of a single picture. The exact definition of an access unit can be found in ISO/IEC 13818-1 and is transposable to the recoding data access unit definition. According to the MPEG-2 ISO/IEC 13818-2 definition, a picture can address one, two, or three

consecutive video fields depending on its structure. Consequently, each recoding data access unit can cover one to three consecutive video fields.

The spatial alignment of the coded images specified in SMPTE RP 202 shall apply to the MPEG-2 encoding process from which the recoding data stream is derived.

5.4 Recommended location of ancillary recoding data packets

Insertion of ancillary recoding data packets within the vertical blanking interval shall be permitted in any available location following the vertical interval switching point line, as defined in RP 168 for the line standard in use.

Insertion of ancillary recoding data packets within the horizontal blanking interval shall be permitted in any available location adjacent to the active picture (EAV, SAV timing reference bit $V = 0$) for the line standard in use, excluding the area where H-ANC and V-ANC overlap (see figure 3).

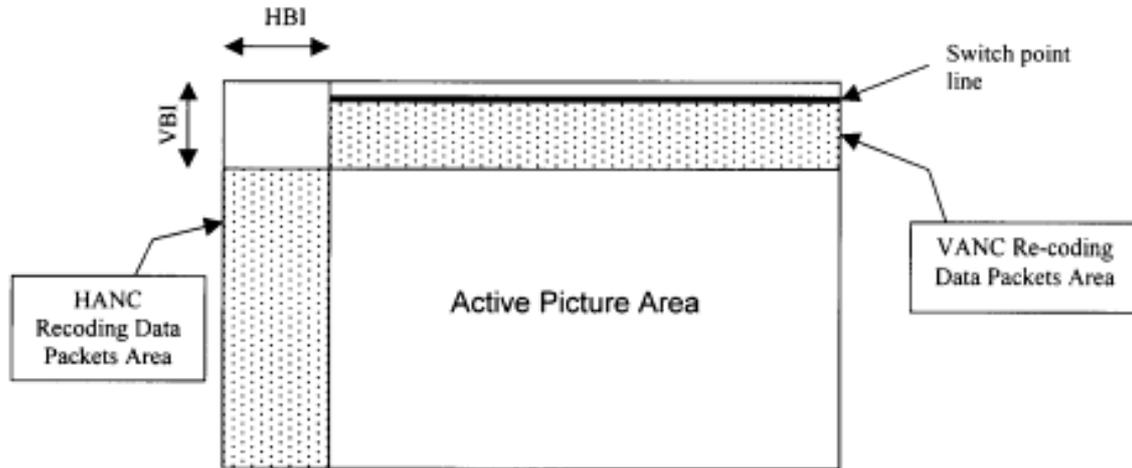


Figure 3 – Ancillary recoding data packet location

Annex A (informative)
Using the MPEG-2 video recoding data set

This annex is a summary of some information described in detail in SMPTE 327M.

The MPEG-2 video recoding data set allows a full description of the MPEG-2 parameter set that characterizes any MPEG-2 encoding process.

According to this recoding data set, it is accepted, from a theoretical point of view, that any MPEG-2 encoding equipment could generate an identical MPEG-2 bitstream from a given digital video signal.

The MPEG-2 recoding data set is expected to be used in many practical recoding applications where the environment can introduce extra constraints. For example, the bit-rate of any recoding stage may or may not differ from that of the previous encoding stage. This means that the recoding data set will not necessarily be fully reused at any further stage.

Another critical aspect of any recoding process is the bandwidth available for the transport of the MPEG-2 recoding

data set. In many practical applications, a reduced set of the generic MPEG-2 recoding data set must be addressed. This is specified in SMPTE 327M, where the `red_bw_indicator` is introduced to signal four different subsets of the recoding data set (see table A.1).

Each subset describes a reduced recoding data set. This starts from (`red_bw_indicator = 0`) down to picture-rate-only information (`red_bw_indicator = 3`). The intermediate level 2 (`red_bw_indicator = 2`) is dedicated to quantization information only. The intermediate level 1 (`red_bw_indicator = 1`) is the full-bandwidth case (`red_bw_indicator = 0`) where the position of `slice_start`, `skipped_mb`, and `mb_quant` are not guaranteed.

Note that extra information, such as `num_coef_bits`, `num_mv_bits`, and `num_other_bits`, is available only when `red_bw_flag = 0`.

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Table A.1 – Reduced bandwidth indicators

red_bw_indicator											
num_coef_bits, num_mv_bits, num_other_bits											
q_scale_code, q_scale_type											
Motion_type, mv_vert_field_sel[r][s], mv[r][s][t]											
mb_mfwd, mb_mbwd											
mb_pattern											
Coded_block_pattern											
mb_intra											
slice_start											
dct_type											
mb_quant											
skipped_mb											
Indicator.0	0	1	1	1	1	1	1	1	1	1	1
Indicator.1	0	1	1	1	1	0	1	0	1	0	0
Indicator.2	0	1	0	0	0	0	0	0	0	0	0
Indicator.3	0	0	0	0	0	0	0	0	0	0	0
NOTE – 0 = this information is not present; 1 = this information exists.											

Annex B (informative)

Bibliography

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{sc}$ Composite Digital Signals — Serial Digital Interface

SMPTE RP 168-1993, Definition of Vertical Interval Switching Point for Synchronous Video Switching

SMPTE RP 202, Video Alignment for MPEG-2 Coding

ITU-R BT.601-5 (10/95), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BT.656-4 (02/98), Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:2:2 Level of Recommendation ITU-R BT.601 (Part A)

ITU-T H.222.0 with amend 1-2, ISO/IEC 13818-1 (1996-04), Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

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