



Recommendation ITU-R BT.1120-8
(01/2012)

Digital interfaces for HDTV studio signals

BT Series
Broadcasting service
(television)



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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.1120-8

Digital interfaces for HDTV studio signals

(Question ITU-R 130/6)

(1994-1998-2000-2003-2004-2005-2007-2012)

Scope

This HDTV interface operates at two nominal clock frequencies, 1.485 GHz and 2.97 GHz, and conveys the uncompressed payload defined in Part 2 of Recommendation ITU-R BT.709. The interface may also be used for carrying packetized data.

The ITU Radiocommunication Assembly,

considering

a) that Recommendation ITU-R BT.709 provides the image format parameters and values for HDTV production and international programme exchange and contains the following HDTV studio standard to cover a wide range of applications:

- 1 125 total lines and 1 080 active lines;
- picture rates of 60¹, 50, 30¹, 25 and 24¹ Hz, including progressive, interlaced and segmented frame transport;

b) that a wide range of equipment based on the above systems has been developed and is commercially available;

c) that many programmes are being produced in the above systems using the above equipments and that in the development of broadcasting and other services there is an increasing need for HDTV production installations;

d) that serial digital interconnection has been developed to provide reliable transparent digital interconnections,

recommends

1 that the specifications described in this Recommendation should be used as bit-serial digital interfaces for HDTV studio signals;

2 that Note 1 is considered as part of the Recommendation.

NOTE 1 – Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (e.g. to ensure interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words “shall” or some other obligatory language such as “must” and the negative equivalents are used to express requirements.

¹ Frame rates of 60/1.001, 30/1.001 and 24/1.001 Hz are also included.

Annex 1

Interfaces for HDTV signals conforming to Recommendation ITU-R BT.709, Part 2²

This Annex specifies digital interfaces for the systems listed in Table 1. Digital coding parameters are listed in Table 2. For the 60, 30 and 24 Hz systems, picture rates having those values divided by 1.001 are also included. Parameter values for these systems are presented in parentheses.

TABLE 1
HDTV systems based on CIF

System	Capture (Hz)	Transport
60/P	60 progressive	Progressive
30/P	30 progressive	Progressive
30/PsF	30 progressive	Segmented frame
60/I	30 interlaced	Interlaced
50/P	50 progressive	Progressive
25/P	25 progressive	Progressive
25/PsF	25 progressive	Segmented frame
50/I	25 interlaced	Interlaced
24/P	24 progressive	Progressive
24/PsF	24 progressive	Segmented frame

1 Digital representation

1.1 Coding characteristics

The HDTV signals to be transported shall comply with the characteristics described in Recommendation ITU-R BT.709, Part 2.

2 Digital interface

The interface provides a unidirectional interconnection. The data signals are in the form of binary information and are coded accordingly:

- video data (10-bit words);
- timing reference and identification codes (10-bit words);
- ancillary data (see Recommendation ITU-R BT.1364).

When 8-bit video data are used, two LSBs of zeros are to be appended to the 8-bit words to form 10-bit words.

² Legacy signals complying with Recommendation ITU-R BT.709, Part 1: See Appendix 3 to Annex 1.

2.1 Serial video data

Y , C_B and C_R signals are handled as 20-bit words by time-multiplexing C_B and C_R components. Each 20-bit word corresponds to a colour-difference sample and a luminance sample. The multiplex is organized as:

$$(C_{B0} Y_0) (C_{R0} Y_1) (C_{B1} Y_2) (C_{R1} Y_3) \dots$$

where Y_i indicates the i -th active luminance sample of a line, while C_{Bj} and C_{Rj} indicate the j -th active colour-difference samples of C_B and C_R components. C_{Bj} and C_{Rj} samples are co-sited with the even numbered Y_i sample due to the half-rate sampling of the colour-difference signals.

The data words corresponding to digital levels $0_{(10)}$ through $3_{(10)}$ and $1\ 020_{(10)}$ through $1\ 023_{(10)}$ are reserved for data identification purposes and must not appear as video data.

R , G , B signals are handled as 30-bit words in addition to the above 20-bit words for Y , C_B , C_R signals.

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TABLE 2
Digital coding parameters

Item	Parameter	System									
		60/P	30/P	30/PsF	60/I	50/P	25/P	25/PsF	50/I	24/P	24/PsF
1	Coded signals Y, C_B, C_R or R, G, B	These signals are obtained from gamma pre-corrected signals, namely E'_Y, E'_{C_B}, E'_{C_R} or E'_R, E'_G, E'_B . Also see Recommendation ITU-R BT.709, Part 2									
2	Sampling lattice – R, G, B, Y	Orthogonal, line and picture repetitive									
3	Sampling lattice – C_B, C_R	Orthogonal, line and picture repetitive, co-sited with each other and with alternate ⁽¹⁾ Y samples									
4	Number of active lines	1 080									
5	Sampling frequency ⁽²⁾ (MHz) – R, G, B, Y	148.5 (148.5/1.001)	74.25 (74.25/1.001)		148.5	74.25		74.25 (74.25/1.001)			
	– $C_B, C_R^{(3)}$	74.25 (74.25/1.001)	37.125 (37.125/1.001)		74.25	37.125		37.125 (37.125/1.001)			
6	Number of samples/line – R, G, B, Y	2 200			2 640				2 750		
	– C_B, C_R	1 100			1 320				1 375		
7	Number of active samples/line – R, G, B, Y – C_B, C_R	1 920 960									
8	Position of the first active Y, C_B, C_R sampling instants with respect to the analogue sync timing reference $O_H^{(4)}$ (see Fig. 1)	192 T									

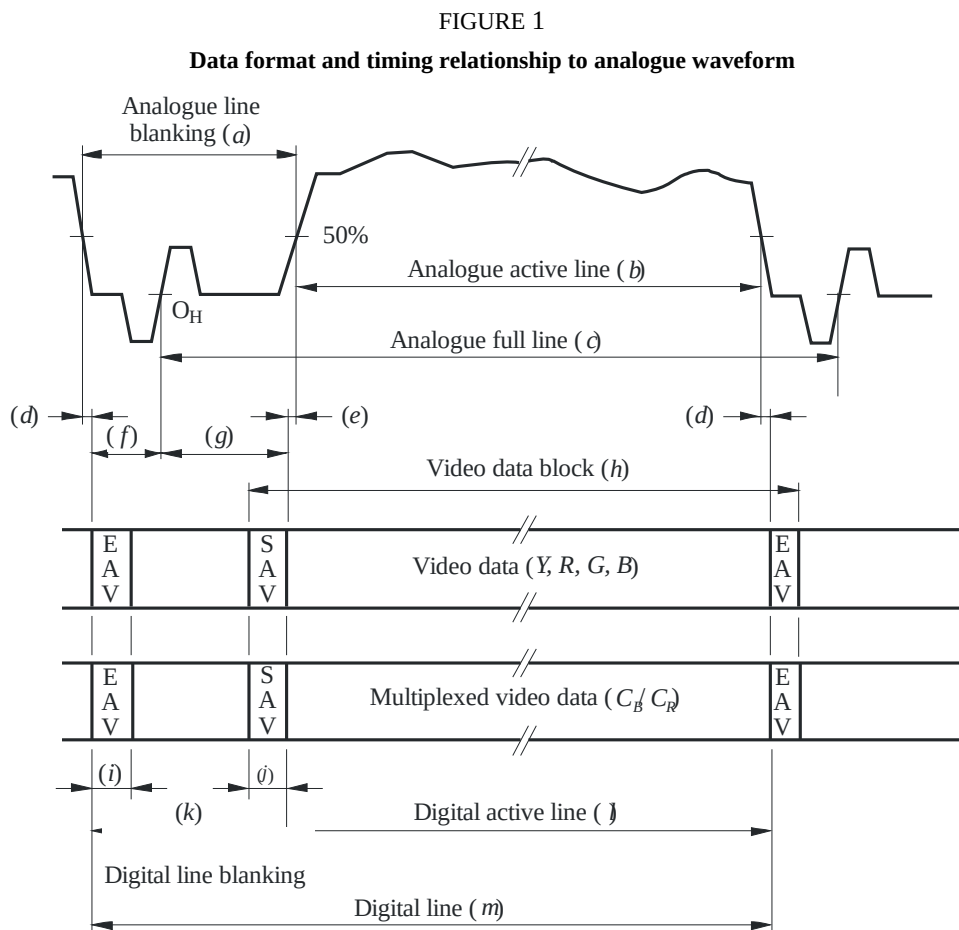
TABLE 2 (*end*)

Item	Parameter	System									
		60/P	30/P	30/PsF	60/I	50/P	25/P	25/PsF	50/I	24/P	24/PsF
9	Coding format	Uniformly quantized PCM for each of the video component signals 8- or 10-bit/sample									
10	Quantization level assignment ⁽⁵⁾ – Video data – Timing reference	$1_{(8)}$ through $254_{(8)}$ or $4_{(10)}$ through $1\ 019_{(10)}$ $0_{(8)}$ and $255_{(8)}$ or $0_{(10)}$ thru $3_{(10)}$ and $1\ 020_{(10)}$ thru $1\ 023_{(10)}$									
11	Quantization levels ⁽⁶⁾ – Black level R, G, B, Y – Achromatic level C_B, C_R – Nominal peak – R, G, B, Y – C_B, C_R	$16_{(8)}$ or $64_{(10)}$ $128_{(8)}$ or $512_{(10)}$ $235_{(8)}$ or $940_{(10)}$ $16_{(8)}$ and $240_{(8)}$ or $64_{(10)}$ and $960_{(10)}$									
12	Filter characteristics	See Recommendation ITU-R BT.709									

- (1) The first active colour-difference samples are co-sited with the first active Y sample.
- (2) The sampling clock must be locked to the line frequency. The tolerance on frequency is $\pm 0.001\%$.
- (3) C_B, C_R sampling frequency is half of luminance sampling frequency.
- (4) T denotes the duration of the luminance sampling clock or the reciprocal of the luminance sampling frequency.
- (5) When 8-bit words are treated in 10-bit system, two LSBs of zeros are to be appended to the 8-bit words.
- (6) These levels refer to precise nominal video levels. Signal processing may occasionally cause the signal level to deviate outside these ranges.

2.2 Video timing relationship with analogue waveform

The digital line occupies m clock periods. It begins at f clock periods prior to the reference transition (O_H) of the analogue synchronizing signal in the corresponding line. The digital active line begins at g clock periods after the reference transition (O_H). The values for m , f and g are listed in Table 3. See Fig. 1 and Table 3 for detailed timing relationships in the line interval.



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For interlaced and segmented frame systems, the start of digital field/segment is fixed by the position specified for the start of the digital line. See Fig. 2a) and Table 4a) for detailed relationships in the field/segment interval.

For progressive systems, the start of the digital frame is fixed by the position specified for the start of the digital line. See Fig. 2b) and Table 4b) for detailed relationships in the frame interval.

2.3 Video timing reference codes SAV and EAV

There are two timing reference codes, one at the beginning of each video data block SAV and the other at the end of each video data block EAV. These codes are contiguous with the video data, and continue during the field/frame/segment blanking interval, as shown in Fig. 2.

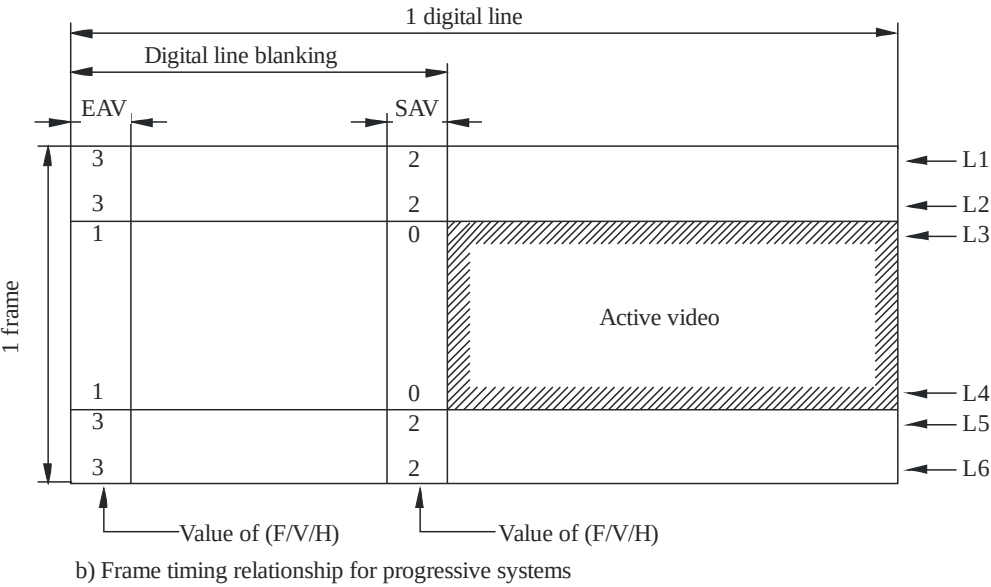
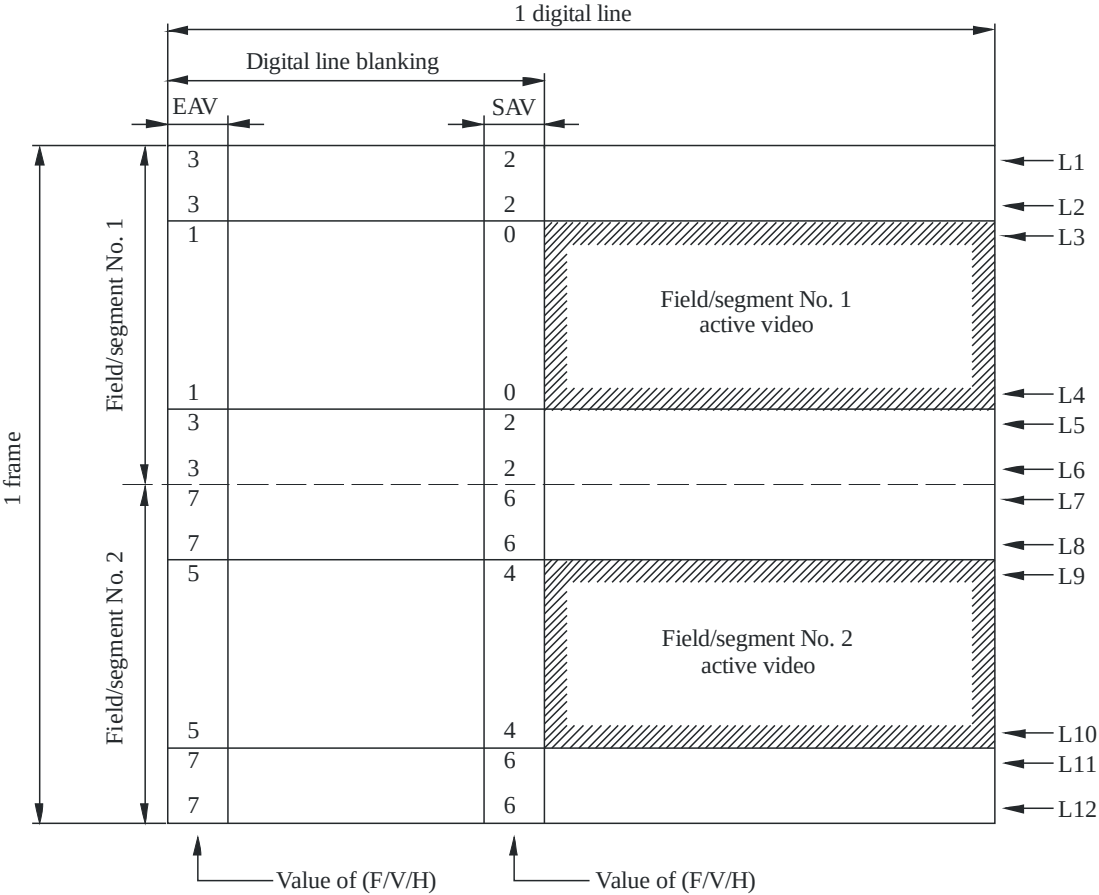
TABLE 3
Line interval timing specifications

Symbol	Parameter	Value									
		60/P	30/P	30/PsF	60/I	50/P	25/P	25/PsF	50/I	24/P	24/PsF
	Number of active <i>Y</i> samples per line	1920									
	Luminance sampling frequency (MHz)	148.5 (148.5/ 1.001)	74.25 (74.25/1.001)			148.5	74.25			74.25 (74.25/1.001)	
<i>a</i>	Analogue line blanking (<i>T</i>)	+12 280 −0			+12 280 −0			+12 280 −0			
<i>b</i>	Analogue active line (<i>T</i>)	+0 1 920 −12									
<i>c</i>	Analogue full line (<i>T</i>)	2 200			2 640			2 750			
<i>d</i>	Duration between end of analogue active video and start of EAV (<i>T</i>)	0-6									
<i>e</i>	Duration between end of SAV and start of analogue active video (<i>T</i>)	0-6									
<i>f</i>	Duration between start of EAV and analogue timing reference O _H (<i>T</i>)	88			528			638			
<i>g</i>	Duration between analogue timing reference O _H and end of SAV (<i>T</i>)	192									
<i>h</i>	Video data block (<i>T</i>)	1 928									
<i>i</i>	Duration of EAV (<i>T</i>)	4									
<i>j</i>	Duration of SAV (<i>T</i>)	4									
<i>k</i>	Digital line blanking (<i>T</i>)	280			720			830			
<i>l</i>	Digital active line (<i>T</i>)	1 920									
<i>m</i>	Digital line (<i>T</i>)	2 200			2 640			2 750			

NOTE 1 – The parameter values for analogue specifications expressed by the symbols *a*, *b* and *c* indicate the nominal values.

NOTE 2 – *T* denotes the duration of the luminance clock or the reciprocal of the luminance sampling frequency.

FIGURE 2
Video timing reference codes SAV and EAV



Note 1 – The values of (F/V/H) for EAV and SAV represent the status of bits for F, V, and H; in a way that the three-bit word composed of F, V, H represents a binary number expressed in decimal notation (F corresponding to MSB and H to LSB). For example, the value 3 represents the bits of F = 0, V = 1 and H = 1.

Each code consists of a four-word sequence. The bit assignment of the word is given in Table 5. The first three words are fixed preamble and the fourth word carries the information that defines field identification (F), field/frame blanking period (V), and line blanking period (H). In an 8-bit implementation bits Nos. 9 to 2 inclusive are used.

The bits F and V change state synchronously with EAV at the beginning of the digital line.

The value of protection bits, P_0 to P_3 , depends on the F, V and H as shown in Table 6. The arrangement permits one-bit errors to be corrected and two-bit errors to be detected at the receiver, but only in the 8 MSBs, as shown in Table 7.

TABLE 4

a) Field/segment interval timing specifications for interlaced and segmented frame systems

Symbol	Definition	Interface digital line number
	Number of active lines	1 080
L1	First line of field/segment No. 1	1
L2	Last line of digital field/segment blanking No. 1	20
L3	First line of field/segment No. 1 active video	21
L4	Last line of field/segment No. 1 active video	560
L5	First line of digital field/segment blanking No. 2	561
L6	Last line of field/segment No. 1	563
L7	First line of field/segment No. 2	564
L8	Last line of digital field/segment blanking No. 2	583
L9	First line of field/segment No. 2 active video	584
L10	Last line of field/segment No. 2 active video	1 123
L11	First line of digital field/segment blanking No. 1	1 124
L12	Last line of field/segment No. 2	1 125

NOTE 1 – Digital field/segment blanking No. 1 denotes the field/segment blanking period that is prior to the active video of field/segment No. 1, and digital field/segment blanking No. 2 denotes that prior to the active video of field/segment No. 2.

b) Frame interval timing specifications for progressive systems

Symbol	Definition	Interface digital line number
	Number of active lines	1 080
L1	First line of frame	1
L2	Last line of digital frame blanking	41
L3	First line of active video	42
L4	Last line of active video	1 121
L5	First line of digital frame blanking	1 122
L6	Last line of frame	1 125

TABLE 5
Bit assignment for video timing reference codes

Word	Bit number									
	9 (MSB)	8	7	6	5	4	3	2	1	0 (LSB)
First	1	1	1	1	1	1	1	1	1	1
Second	0	0	0	0	0	0	0	0	0	0
Third	0	0	0	0	0	0	0	0	0	0
Fourth	1	F	V	H	P ₃	P ₂	P ₁	P ₀	0	0
Interlaced and segmented frame system F = 1 during field/segment No. 2 = 0 during field/segment No. 1 V = 1 during field/segment blanking = 0 elsewhere H = 1 in EAV = 0 in SAV										
Progressive system F = 0 V = 1 during frame blanking = 0 elsewhere H = 1 in EAV = 0 in SAV										

NOTE 1 – P₀, P₁, P₂, P₃ in the fourth word are the protection bits (see Table 6).

TABLE 6
Protection bits for SAV and EAV

	SAV/EAV bit status			Protection bits					
Bit 9 (fixed)	8 (F)	7 (V)	6 (H)	5 (P ₃)	4 (P ₂)	3 (P ₁)	2 (P ₀)	1 (fixed)	0 (fixed)
1	0	0	0	0	0	0	0	0	0
1	0	0	1	1	1	0	1	0	0
1	0	1	0	1	0	1	1	0	0
1	0	1	1	0	1	1	0	0	0
1	1	0	0	0	1	1	1	0	0
1	1	0	1	1	0	1	0	0	0
1	1	1	0	1	1	0	0	0	0
1	1	1	1	0	0	0	1	0	0

TABLE 7

Error corrections using protection bits (P_3 - P_0)

Received bits 5-2 for P_3 - P_0	Received bits 8-6 for F, V and H							
	000	001	010	011	100	101	110	111
0000	000	000	000	–	000	–	–	111
0001	000	–	–	111	–	111	111	111
0010	000	–	–	011	–	101	–	–
0011	–	–	010	–	100	–	–	111
0100	000	–	–	011	–	–	110	–
0101	–	001	–	–	100	–	–	111
0110	–	011	011	011	100	–	–	011
0111	100	–	–	011	100	100	100	–
1000	000	–	–	–	–	101	110	–
1001	–	001	010	–	–	–	–	111
1010	–	101	010	–	101	101	–	101
1011	010	–	010	010	–	101	010	–
1100	–	001	110	–	110	–	110	110
1101	001	001	–	001	–	001	110	–
1110	–	–	–	011	–	101	110	–
1111	–	001	010	–	100	–	–	–

NOTE 1 – The error correction applied provides a DEDSEC (double error detection – single error correction) function. The received bits denoted by “–” in the table, if detected, indicate that an error has occurred but cannot be corrected.

2.4 Ancillary data

Ancillary data may optionally be included in the blanking intervals of a digital interface according to this Recommendation. The ancillary signals shall comply with the general rules of Recommendation ITU-R BT.1364.

The horizontal blanking interval between the end of the error detection code words and the start of SAV may be employed to convey ancillary data packets.

Ancillary data packets may be conveyed in the vertical blanking interval between the end of SAV and the start of EAV as follows:

- in a progressive system during lines 1 through 41 inclusive, and 1 122 through 1 125 inclusive;
- in an interlaced system during lines 1 through 20 inclusive, and lines 561 through 583 inclusive, and 1 124, 1 125 inclusive;

- on any line that is outside the vertical extent of the picture as noted above and that is not employed to convey vertical blanking interval signals that can be represented in the analogue domain through direct (D/A) conversion;
- ancillary data packets should not be placed in the area which may be affected by switching as defined in Table 2, Appendix 3 to Annex 1, Recommendation ITU-R BT.1364.

2.5 Data words during blanking

The data words occurring during digital blanking intervals that are not used for the timing reference codes (SAV and EAV), line number data, the error detection codes or ancillary data (ANC) are filled with words corresponding to the following blanking levels, appropriately placed in the multiplexed data:

- $64_{(10)}$ for Y, R, G, B signals
- $512_{(10)}$ for C_B, C_R (time-multiplexed colour-difference signal).

3 Bit-parallel interface

The bit-parallel interface defined in previous versions of this Recommendation is no longer in use and its use is deprecated.

4 Bit-serial interface

4.1 Data format

The bit-serial data consists of video data, video timing reference codes, line number data, error detection codes, ancillary data and blanking data. Each data has a word-length of 10 bits, and is represented as parallel data before serialization. Two parallel streams (i.e. luminance data Y and colour-difference data C_B/C_R) are multiplexed and serialized in accordance with § 4.2.

4.1.1 Video data

The video data shall be 10-bit words representing $Y, C_B/C_R$ of the video systems defined in § 1.

4.1.2 Video timing reference codes

The video timing reference codes, SAV and EAV shall have the same format as that defined in § 2.

4.1.3 Interface line number data

The line number data is composed of two words indicating the line number. The bit assignment of the line number data is shown in Table 8. The line number data shall be located immediately after EAV.

TABLE 8
Bit assignment of the line number data

Word	b9 (MSB)	b8	b7	b6	b5	b4	b3	b2	b1	b0 (LSB)
LN0	Not b8	L6	L5	L4	L3	L2	L1	L0	R	R
LN1	Not b8	R	R	R	L10	L9	L8	L7	R	R

L0 (LSB)-L10 (MSB): line number in binary code.

R: reserved (set to zero).

4.1.4 Error detection codes

The error detection codes, cyclic redundancy check codes (CRCC), which are used to detect errors in active digital line, EAV and line number data, consist of two words and are determined by the following polynomial generator equation:

$$EDC(x) = x^{18} + x^5 + x^4 + 1$$

Initial value of the codes is set to zero. The calculation starts at the first word of the digital active line and ends at the final word of the line number data. Two error detection codes are calculated, one for luminance data (YCR) and one for colour-difference data (CCR). The bit assignment of the error detection codes is shown in Table 9. The error detection codes shall be located immediately after the line number data.

TABLE 9
Bit assignment for error detection codes

Word	b9 (MSB)	b8	b7	b6	b5	b4	b3	b2	b1	b0 (LSB)
YCR0	Not b8	CRCC8	CRCC7	CRCC6	CRCC5	CRCC4	CRCC3	CRCC2	CRCC1	CRCC0
YCR1	Not b8	CRCC17	CRCC16	CRCC15	CRCC14	CRCC13	CRCC12	CRCC11	CRCC10	CRCC9
CCR0	Not b8	CRCC8	CRCC7	CRCC6	CRCC5	CRCC4	CRCC3	CRCC2	CRCC1	CRCC0
CCR1	Not b8	CRCC17	CRCC16	CRCC15	CRCC14	CRCC13	CRCC12	CRCC11	CRCC10	CRCC9

NOTE 1 – CRC0 is the MSB of error detection codes.

4.1.5 Ancillary data

The ancillary data shall have the same rules as that defined in § 2.4.

4.1.6 Blanking data

The blanking data words during digital blanking intervals that are not used for SAV, EAV, the line number data, the error detection codes and the ancillary data, shall be filled with the 10-bit words as defined in § 2.5.

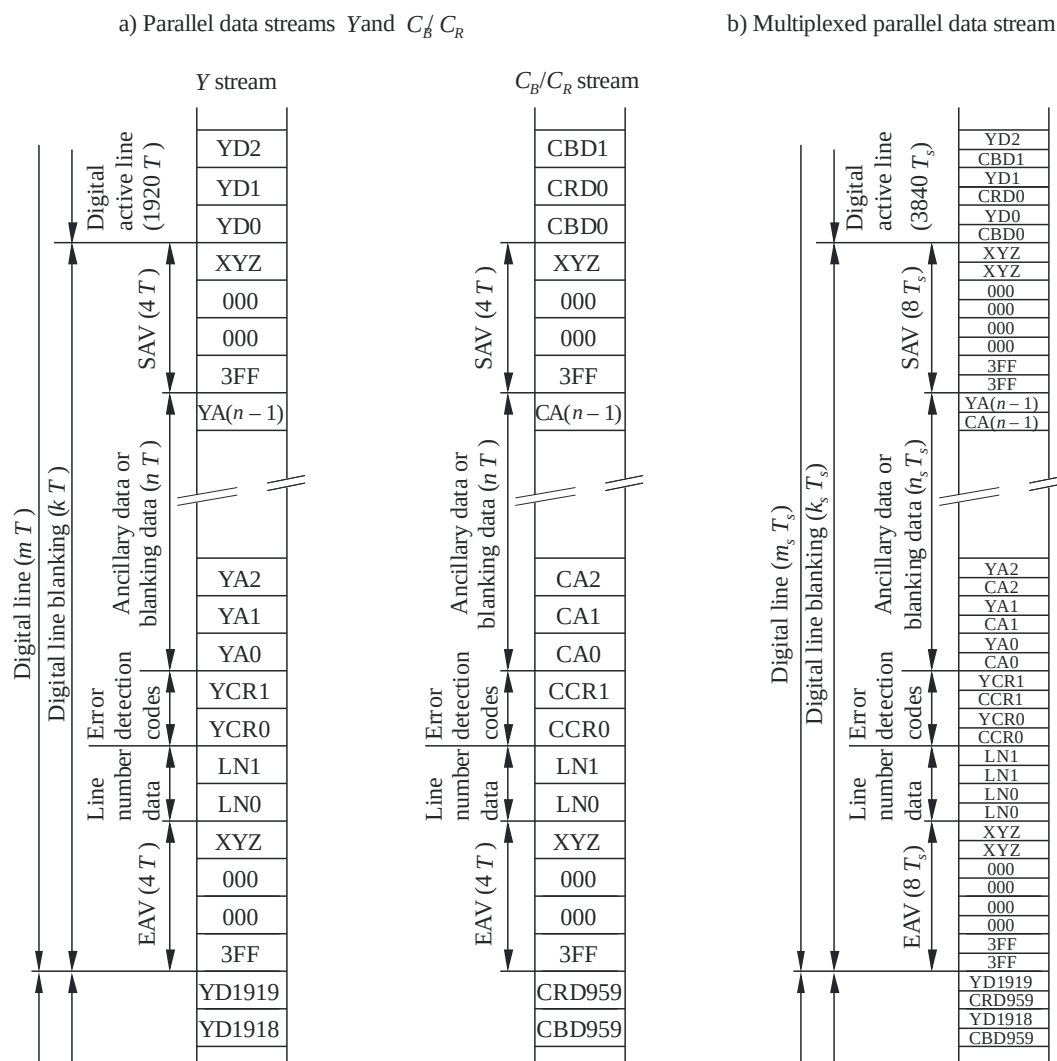
4.2 Transmission format

The two parallel data streams are transmitted over a single channel in bit-serial form after word-multiplexing, parallel-to-serial conversion and scrambling.

4.2.1 Word-multiplexing

The two parallel streams shall be multiplexed word by word into a single 10-bit parallel stream in the order of C_B , Y , C_R , Y , C_B , Y , C_R , Y ... (See Fig. 3 and Table 11).

FIGURE 3
Data stream mapping



- Yd0 - YD1919: Digital luminance data Y
 CBD0 - CBD959: Digital colour-difference data C_B
 CRD0 - CRD959: Digital colour-difference data C_R
 YA0 - YA267(n-1): Ancillary data or blanking data in Y stream
 CA0 - CA267(n-1): Ancillary data or blanking data in C_B/C_R stream

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In the case of 50/P or 60/P, an alternate format is also available. See § 4.5 and § 4.6.

4.2.2 Serializing

The LSB of each 10-bit word in the word-multiplexed parallel stream shall be transmitted first in the bit-serial format.

4.2.3 Channel coding

The channel coding scheme shall be scrambled NRZ inverted (NRZI). The serialized bit stream shall be scrambled using the following generator polynomial equation:

$$G(x) = (x^9 + x^4 + 1) (x + 1)$$

The input signal to the scrambler shall be positive logic. (The highest voltage represents data 1 and the lowest voltage represents data 0.)

4.2.4 Serial clock

TABLE 10
Serial clock frequency values

Parameter	Value									
	60/P	30/P	30/PsF	60/I	50/P	25/P	25/PsF	50/I	24/P	24/PsF
Serial clock frequency (GHz)	1.485 for dual-link operation 2.97 for single-link operation (2.97/1.001)	1.485 (1.485/1.001)			1.485 for dual-link operation 2.97 for single-link operation	1.485			1.485 (1.485/1.001)	