RECOMMENDATION ITU-R BT.1381-2*,**

Serial digital interface-based transport interface for compressed television signals and packetized data in networked television production based on Recommendations ITU-R BT.656 and ITU-R BT.1302

(Question ITU-R 5/6)

(1998-2001-2006)

Summary

This Recommendation specifies a data stream used to transport packetized data within a studio/production centre environment. The data packets and synchronizing signals are compatible with Recommendations ITU-R BT.656 and ITU-R BT.1302 (see Fig. 1).

The ITU Radiocommunication Assembly,

considering

a) that the so-called serial digital interface (SDI) is in widespread use in television production studios and that it is documented in Recommendations ITU-R BT.656 and ITU-R BT.1302;

b) that Recommendation ITU-R BR.1356 – User requirements for application of compression in television production, already exists;

c) that maintaining video signals in compressed form as far as possible throughout the production and post-production process offers the potential of increased operating efficiency;

d) that programme data composed of audio, compressed video, metadata and other packetized data should be streamed in a single or multiple container(s);

e) that a transport mechanism must be established which allows point-to-point and point-to-multipoint routing of these data through a digital production and post-production chain;

f) that the transport should allow synchronous data transfer to alleviate absolute and relative timing between programme data;

g) that the transport mechanism should allow non-real time transfer of programme data;

h) that Working Groups within the Society of Motion Picture and Television Engineers (SMPTE) and the European Broadcasting Union (EBU) have produced a proposal fulfilling all these requirements,

recommends

1 that for applications based on the SDI infrastructure in networked production and post-production based on Recommendations ITU-R BT.656 and ITU-R BT.1302, the serial data transport interface (SDTI) described in Annex 1 should be used.

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* This Recommendation should be brought to the attention of the International Electrotechnical Commission (IEC).

** Radiocommunication Study Group 6 made editorial amendments to this Recommendation in 2003 in accordance with Resolution ITU-R 44.

Annex 1

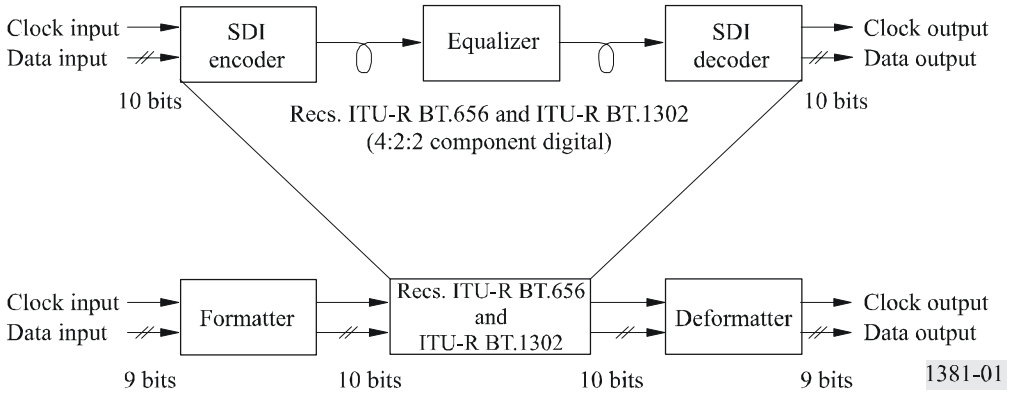
SDI-based transport interface for compressed television signals and packetized data in networked television production

1 Introduction

The carriage of packetized data utilizing the serial digital interface as defined by Recommendation ITU-R BT.656 is defined in this Recommendation. The formatting of the packetized data and the assigned values is covered by this Recommendation. Specific applications are covered by other Recommendations.

FIGURE 1

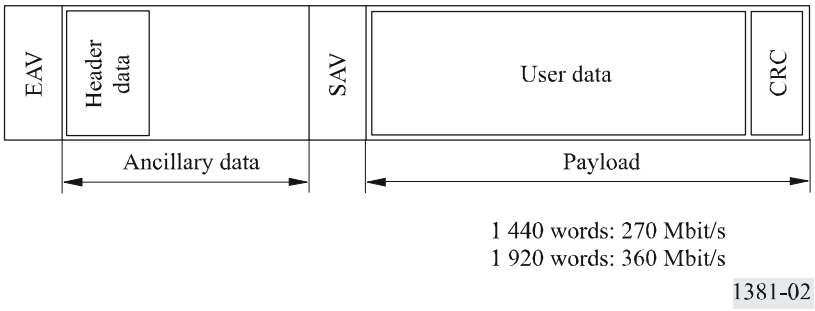
System block diagram



1.1 Parameters of the protocol are compatible with the 4:2:2 component SDI format as shown in Fig. 2.

FIGURE 2

Signal format (1 line)



1.2 The data stream is intended to transport any packetized data signal over the digital active lines that have a maximum data rate up to (approximately) 200 Mbit/s for 270 Mbit/s systems or (approximately) 270 Mbit/s for 360 Mbit/s systems.

1.3 Additional documents will describe particular applications of this Recommendation and will include details of data formatting and other parameters, such as compression and error correction, if applicable.

2 Normative references

– Recommendation ITU-R BT.656 – 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).

– Recommendation ITU-R BT.1302 – 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 B).

– Recommendation ITU-R BT.1364 – Format of ancillary data signals carried in digital component studio interfaces.

3 General specifications

3.1 This Recommendation describes the assembly of a stream of 10-bit words. The resulting word stream should be serialized, scrambled, coded, and interfaced according to Recommendations ITU-R BT.656 and ITU-R BT.1302.

3.2 The word clock rate should be 27 MHz or 36 MHz in accordance with Recommendation ITU-R BT.601.

3.3 The data word length should be 10 bits: B0 to B9. B9 is the most significant bit (MSB). The nominal data rate for the resulting serial data stream should be 270 Mbit/s or 360 Mbit/s, respectively.

3.4 The timing reference signals (EAV and SAV) occur on every line, and should be as described in Recommendations ITU-R BT.656 and ITU-R BT.1302.

3.5 An ANC data packet forming the header data is placed after EAV, as specified in § 4. All payload is placed between SAV and EAV. The space after the header data but before SAV is available for ANC data as specified by Recommendation ITU-R BT.1364.

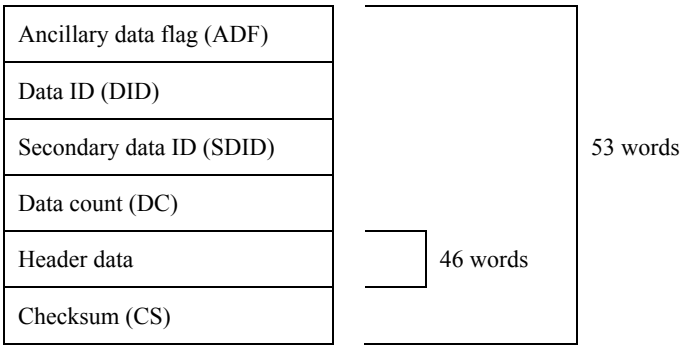
3.6 The signal levels and specifications should be as described in Recommendations ITU-R BT.656 and ITU-R BT.1302.

3.7 Preferred connector type – IEC 60169-8, Sections A.2 and A.3, "Amendment 2, Radio-frequency connectors Part 8: R.F. coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with bayonet lock – Characteristics impedance 50 Ω (type BNC)".

NOTE 1 – IEC 60169-8 is available in electronic version at the following address: http://www.iec.ch/itu.

4 Header data

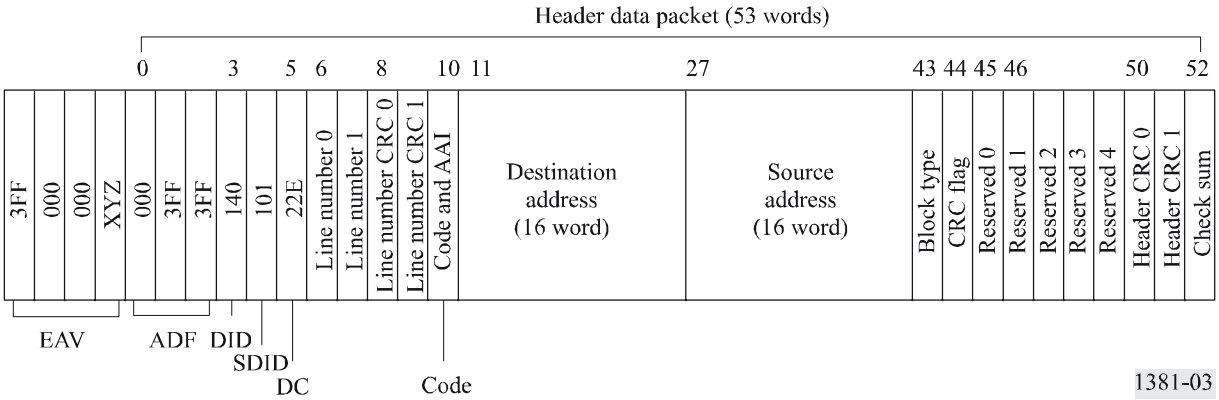
The data structure for the header data should conform to Recommendation ITU-R BT.1364 ancillary data packet (type 2). The header data should be located immediately after the EAV as shown in Fig. 3.



The header data should include the following:

– Line number [2 words]
– Line number CRC [2 words]
– Code and authorized address identifier (AAI) [1 word]
– Destination address [16 words]
– Source address [16 words]
– Block type [1 word]
– CRC flag [1 word]
– Reserved data [5 words]
– Header CRC [2 words]

FIGURE 3
Header data structure



4.1 Ancillary data formatting

The ADF, DID, SDID, DC, and CS should conform to Recommendation ITU-R BT.1364.

4.1.1 Data ID (DID)

The data ID should have the value of 40_h for B7 to B0.

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

4.1.2 Secondary data ID (SDID)

The secondary data ID should have the value of 01_h for B7 to B0.

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

4.1.3 Data count (DC)

The data count should represent 46 words for the header with the value $2E_h$ for B7 to B0.

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

4.2 Line number

4.2.1 The line number should represent the number from 1 to 525 for 525-line systems, and 1 to 625 for 625-line systems in order to check the data continuity.

4.2.2 The line number should be contained within L9 to L0. R5 to R0 are reserved and set to zero (see Fig. 4).

– EP1 is even parity for L7 to L0

– EP2 is even parity for R5 to R0, L9, L8.

4.3 Line number CRC

Following each line number, a line number CRC should be inserted. The line number CRC applies to the data ID through the line number for the entire ten bits (see Fig. 5). The generator polynomial for the line number CRC should be $G(x) = x^{18} + x^5 + x^4 + 1$, which conforms to ITU-T Recommendation X.25 – Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit (see Fig. 6).

Line number CRC should be contained in C17 to C0, and the initial value should be set to all ones.

4.4 Code and AAI

Both code and AAI should consist of four bits (see Fig. 7).

Code: B3 to B0

AAI: B7 to B4

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

FIGURE 4

Line number

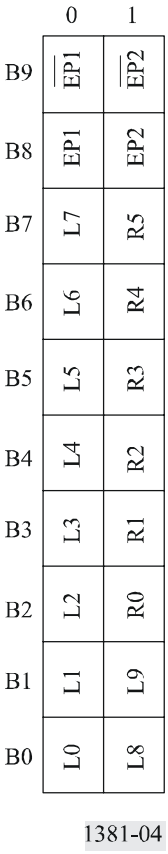


FIGURE 5

Line number CRC

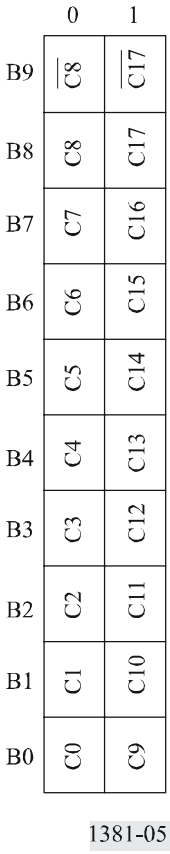
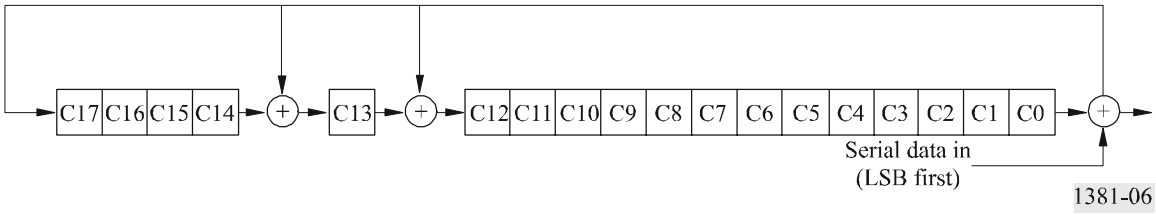


FIGURE 6

Generator polynomial



4.4.1 Code

The code is intended to identify the length of the payload with the following values. The payload should be contained in the area between SAV and EAV.

	B3	B2	B1	B0
Reserved for SDI:	0	0	0	0
1 440-word payload:	0	0	0	1
1 920-word payload:	0	0	1	0

NOTE – Code = "0000" is used where uncompressed 4:2:2 data are transmitted in the following line. However, uncompressed and compressed signals should not be mixed in the same signal.

Other codes should be registered with SMPTE (see § 7).

NOTE – Code = "1000" is reserved for 143 Mbit/s applications.

4.4.2 AAI

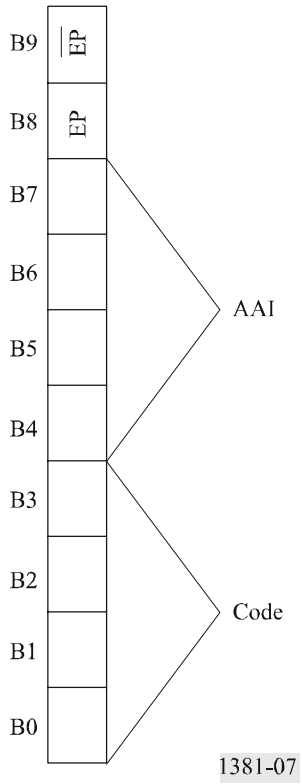
The AAI is intended to identify the format of the destination and source address words with 16 different states.

	B7	B6	B5	B4
Unspecified format:	0	0	0	0
IPv6 address*:	0	0	0	1

* IETF (Internet Engineering Task Force) Request for Comments (RFC-1883), IPv6, Internet Standard Track Protocol.

Other AAIs should be registered with SMPTE (see § 7).

FIGURE 7
Code and AAI



4.5 Destination and source address

The destination and source address represents the address of the devices within the connection according to the AAI. Sixteen bytes are allocated for both destination and source address with the following structure (see Fig. 8):

– Address: B7 to B0

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

When all 16 bytes are zero filled in accordance with AAI = “0000”, it should indicate the universal address to all devices connected to the interface. Also, it is the default condition when no destination and source address is required.

FIGURE 8

Destination and source address

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B9	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$
B8	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP
B7	A7	A15	A23	A31	A39	A47	A55	A63	A71	A79	A87	A95	A103	A111	A119	A127
B6	A6	A14	A22	A30	A38	A46	A54	A62	A70	A78	A86	A94	A102	A110	A118	A126
B5	A5	A13	A21	A29	A37	A45	A53	A61	A69	A77	A85	A93	A101	A109	A117	A125
B4	A4	A12	A20	A28	A36	A44	A52	A60	A68	A76	A84	A92	A100	A108	A116	A124
B3	A3	A11	A19	A27	A35	A43	A51	A59	A67	A75	A83	A91	A99	A107	A115	A123
B2	A2	A10	A18	A26	A34	A42	A50	A58	A66	A74	A82	A90	A98	A106	A114	A122
B1	A1	A9	A17	A25	A33	A41	A49	A57	A65	A73	A81	A89	A97	A105	A113	A121
B0	A0	A8	A16	A24	A32	A40	A48	A56	A64	A72	A80	A88	A96	A104	A112	A120

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4.6 Block type

The block type should consist of one word and is intended to indicate the segmentation of the payload. Either fixed block size or variable block size may be selected. B7 or B6 is the prefix to define the fixed block data structure as follows:

	B7	B6
Fixed block size without ECC:	0	0
Fixed block size with ECC:	0	1
Unassigned:	1	0
Reserved*:	1	1

* The reserved prefix (B7, B6) = (1, 1) can only be used with the variable block size whose value is 01_h for B5 to B0.

NOTE 1 – The error correction code (ECC) will be determined individually in accordance with each application.

4.6.1 Fixed block size

The possible segmentation of the fixed block size and the values for B5 to B0 are shown in Table 1.

Each data packet (data type + data block) should be placed one right after the other.

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

Other block types should be registered with SMPTE (see § 7).

TABLE 1

Fixed block size

Block type (B5-B0)	Block size	270 Mbit/s	360 Mbit/s
01_h	1 438 (1 437) words	1 block	1 block
02_h	719 (718) words	2 blocks	2 blocks
03_h	479 (478) words	3 blocks	4 blocks
04_h	359 (358) words	4 blocks	5 blocks
09_h	1 918 (1 917) words	–	1 block
$0A_h$	959 (958) words	1 block	2 blocks
$0B_h$	639 (638) words	2 blocks	3 blocks
11_h	766 (765) words	1 block	2 blocks
12_h	383 (382) words	3 blocks	5 blocks
13_h	255 (254) words	5 blocks	7 blocks
14_h	191 (190) words	7 blocks	10 blocks
21_h	5 (4) words	287 blocks	383 blocks
22_h	9 (8) words	159 blocks	213 blocks
23_h	13 (12) words	110 blocks	147 blocks
24_h	17 (16) words	84 blocks	112 blocks
25_h	33 (32) words	43 blocks	58 blocks
26_h	49 (48) words	29 blocks	39 blocks
27_h	65 (64) words	22 blocks	29 blocks
28_h	97 (96) words	14 blocks	19 blocks
29_h	129 (128) words	11 blocks	14 blocks
$2A_h$	193 (192) words	7 blocks	9 blocks
$2B_h$	257 (256) words	5 blocks	7 blocks
$2C_h$	385 (384) words	3 blocks	4 blocks
$2D_h$	513 (512) words	2 blocks	3 blocks
$2E_h$	609 (608) words	2 blocks	3 blocks
31_h	62 (61) words	23 blocks	30 blocks
32_h	153 (152) words	9 blocks	12 blocks
33_h	171 (170) words	8 blocks	11 blocks
34_h	177 (176) words	8 blocks	10 blocks
35_h	199 (198) words	7 blocks	9 blocks
36_h	256 (255) words	5 blocks	7 blocks
37_h	144 (143) words	10 blocks	13 blocks
38_h	160 (159) words	9 blocks	12 blocks

NOTE 1 – Values in parenthesis indicate the number of user data words excluding a data type word.

4.6.2 Variable block size

The variable block size should have the following value:

	B7	B6	B5	B4	B3	B2	B1	B0
Variable block size:	1	1	0	0	0	0	0	1

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

With the variable block size, any size of consecutive block data words is permitted. The next data packet can be either placed immediately after the previous one, or on the next line. For block lengths exceeding the payload of one line, code and AAI through reserved 0 within the header data should be repeated for each line that carries part of the block.

4.7 Payload CRC flag

The payload CRC flag should consist of one word. The payload CRC flag is intended to indicate the presence of the payload CRC with the following values:

– B7 to B0

– 01_h: The CRC should be inserted at the end of the payload

– 00_h: The CRC should not be inserted at the end of the payload, the space may be used for data

– 02_h - FF_h: Reserved

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

4.8 Header expansion reserved data

The header expansion reserved data should be positioned after the CRC flag. The default value for the reserved data is 200_h.

4.9 Header CRC

Following each ancillary data header, the header CRC should be inserted. The header CRC applies to the code through the reserved data for the entire ten bits. The generator polynomial for the header CRC should be the same as the line number CRC.

5 User data signal format

User data may be present on any line in the area between SAV and EAV. Some applications may constrain the use of certain lines.

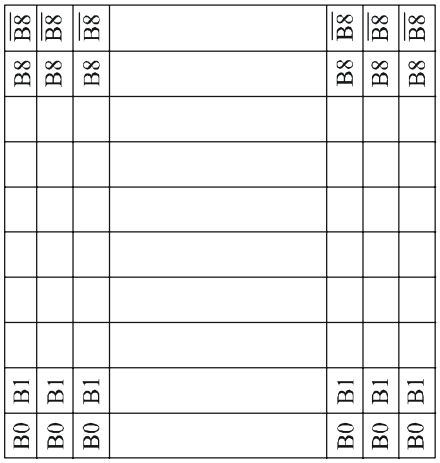
– Although data may exist on any line, it should be noted that data can be corrupted during a switch.

5.1 Data block

The data block should consist of either 8-bit words plus even parity or 9-bit words contained in B8 to B0.

B9 of the user data word should be set to the complement of B8 (see Fig. 9).

FIGURE 9
Data block



5.2 Data block header

Each data block should be preceded by the data block header. The data structure for the data block header should be as shown in Fig. 10 for the fixed block size, and Fig. 11 for the variable block size.

FIGURE 10
Data structure (fixed block size)

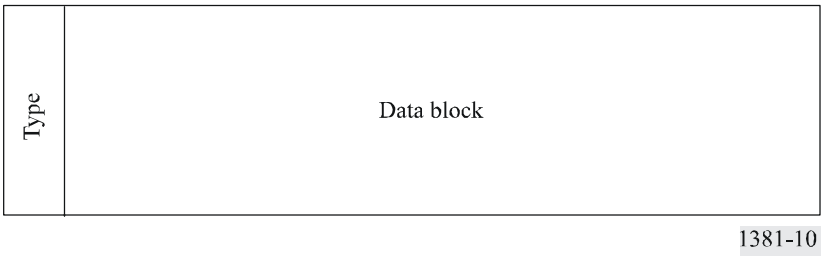
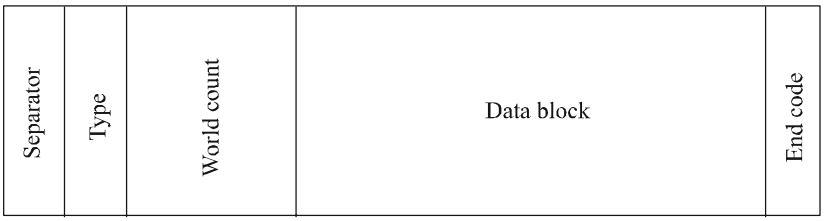


FIGURE 11
Data structure (variable block size)



5.2.1 Separator and endcode

The separator, endcode, and wordcount should be inserted, if the block type is identified as variable block size. Each data block starts with the separator and ends with the endcode. The values of separator and endcode should be as follows:

Separator: 309_h

B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	0	0	0	0	1	0	0	1

Endcode: $30A_h$

B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	0	0	0	0	1	0	1	0

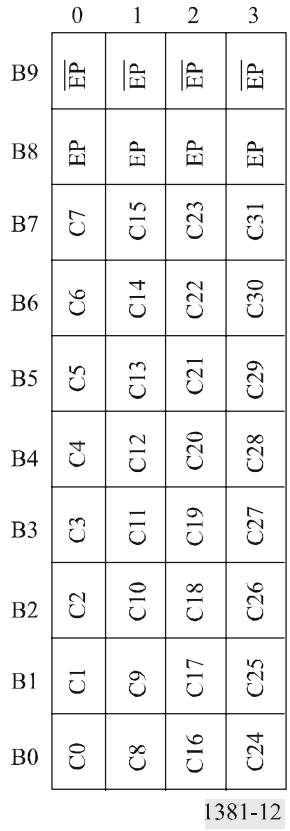
5.2.2 Wordcount

The wordcount should consist of four words as shown in Fig. 12. The wordcount represents the number of data block words. The wordcount should be contained in C31 to C0, and should be interpreted as a single 32-bit binary value.

– EP1 is even parity for C7 to C0
– EP2 is even parity for C15 to C8
– EP3 is even parity for C23 to C16
– EP4 is even parity for C31 to C24.

FIGURE 12

Wordcount



When no wordcount is indicated, the value of the wordcount should be set to all zeros for C0 to C31.

It is the intent of this standard that all receiving equipment should attempt to decode data, even if the wordcounts are expected but not present.

5.2.3 Data type[1]

The data type should consist of one word. The data type identifies the type of data stream and may have 256 different states (see Table 2).

– Data type: B7 to B0
– B8 is even parity for B7 to B0
– B9 is the complement of B8.

Other data types should be registered with SMPTE (see § 7).

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[1] Designers should be aware that a previous revision of Recommendation ITU-R BT.1381 permitted as an "invalid data type" code value 100_h. Receiving equipment should be able to process invalid data type 100_h.

TABLE 2

Data type

Type	Description
101_h	
102_h	SXV[1]
203_h	
104_h	CP-System
205_h	CP-Picture
206_h	CP-Audio
107_h	CP-Data
108_h	
209_h	
$20A_h$	
$10B_h$	
$20C_h$	
$10D_h$	
$10E_h$	
$20F_h$	
110_h	
211_h	SDTI-PF
212_h	
113_h	
214_h	
115_h	
116_h	
217_h	
218_h	
119_h	
$11A_h$	
$21B_h$	
$11C_h$	
$21D_h$	
$21E_h$	
$11F_h$	
120_h	

Type	Description
241_h	DV CAM-1
242_h	
143_h	
244_h	
145_h	
146_h	
247_h	
248_h	HD CAM D-11
149_h	
$14A_h$	
$24B_h$	
$14C_h$	
$24D_h$	
$24E_h$	
$14F_h$	
250_h	
151_h	
152_h	MPEG-2 P/S[2]
253_h	MPEG-2 T/S[3]
154_h	
255_h	
256_h	
157_h	
158_h	
259_h	
$25A_h$	
$15B_h$	
$25C_h$	
$15D_h$	
$15E_h$	
$25F_h$	
260_h	

TABLE 2 (*continued*)

Type	Description	Type	Description
221_h 222_h 123_h 224_h 125_h 126_h 227_h 228_h 129_h $12A_h$ $22B_h$ $12C_h$ $22D_h$ $22E_h$ $12F_h$ 230_h	DVCPRO1/Digital S DVCPRO2	161_h 162_h 263_h 164_h 265_h 266_h 167_h 168_h 269_h $26A_h$ $16B_h$ $26C_h$ $16D_h$ $16E_h$ $26F_h$ 170_h	
131_h 132_h 233_h 134_h 235_h 236_h 137_h 138_h 239_h $23A_h$ $13B_h$ $23C_h$ $13D_h$ $13E_h$ $23F_h$ 140_h	HD-D5	271_h 272_h 173_h 274_h 175_h 176_h 277_h 278_h 179_h $17A_h$ $27B_h$ $17C_h$ $27D_h$ $27E_h$ $17F_h$ 180_h	

TABLE 2 (*continued*)

Type	Description
281_h 282_h 183_h 284_h 185_h 186_h 287_h 288_h 189_h $18A_h$ $28B_h$ $18C_h$ $28D_h$ $28E_h$ $18F_h$ 290_h	SXA(4)
191_h 192_h 293_h 194_h 295_h 296_h 197_h 198_h 299_h $29A_h$ $19B_h$ $29C_h$ $19D_h$ $19E_h$ $29F_h$ $2A0_h$	

Type	Description
$1C1_h$ $1C2_h$ $2C3_h$ $1C4_h$ $2C5_h$ $2C6_h$ $1C7_h$ $1C8_h$ $2C9_h$ $2CA_h$ $1CB_h$ $2CC_h$ $1CD_h$ $1CE_h$ $2CF_h$ $1D0_h$	SXC(5)
$2D1_h$ $2D2_h$ $1D3_h$ $2D4_h$ $1D5_h$ $1D6_h$ $2D7_h$ $2D8_h$ $1D9_h$ $1Da_h$ $2DB_h$ $1DC_h$ $2DD_h$ $2DE_h$ $1DF_h$ $1E0_h$	FC(6)

TABLE 2 (*end*)

Type	Description
$1A1_h$ $1A2_h$ $2A3_h$ $1A4_h$ $2A5_h$ $2A6_h$ $1A7_h$ $1A8_h$ $2A9_h$ $2AA_h$ $1AB_h$ $2AC_h$ $1AD_h$ $1AE_h$ $2AF_h$ $1B0_h$	64 channel AES
$2B1_h$ $2B2_h$ $1B3_h$ $2B4_h$ $1B5_h$ $1B6_h$ $2B7_h$ $2B8_h$ $1B9_h$ $1BA_h$ $2BB_h$ $1BC_h$ $2BD_h$ $2BE_h$ $1BF_h$ $2C0_h$	

Type	Description
$2E1_h$ $2E2_h$ $1E3_h$ $2E4_h$ $1E5_h$ $1E6_h$ $2E7_h$ $2E8_h$ $1E9_h$ $1EA_h$ $2EB_h$ $1EC_h$ $2ED_h$ $2EE_h$ $1EF_h$ $2F0_h$	
$1F1_h$ $1F2_h$ $2F3_h$ $1F4_h$ $2F5_h$ $2F6_h$ $1F7_h$ $1F8_h$ $2F9_h$ $2FA_h$ $1FB_h$ $2FC_h$ $1FD_h$ $1FE_h$ $2FF_h$	
200_h	Invalid data

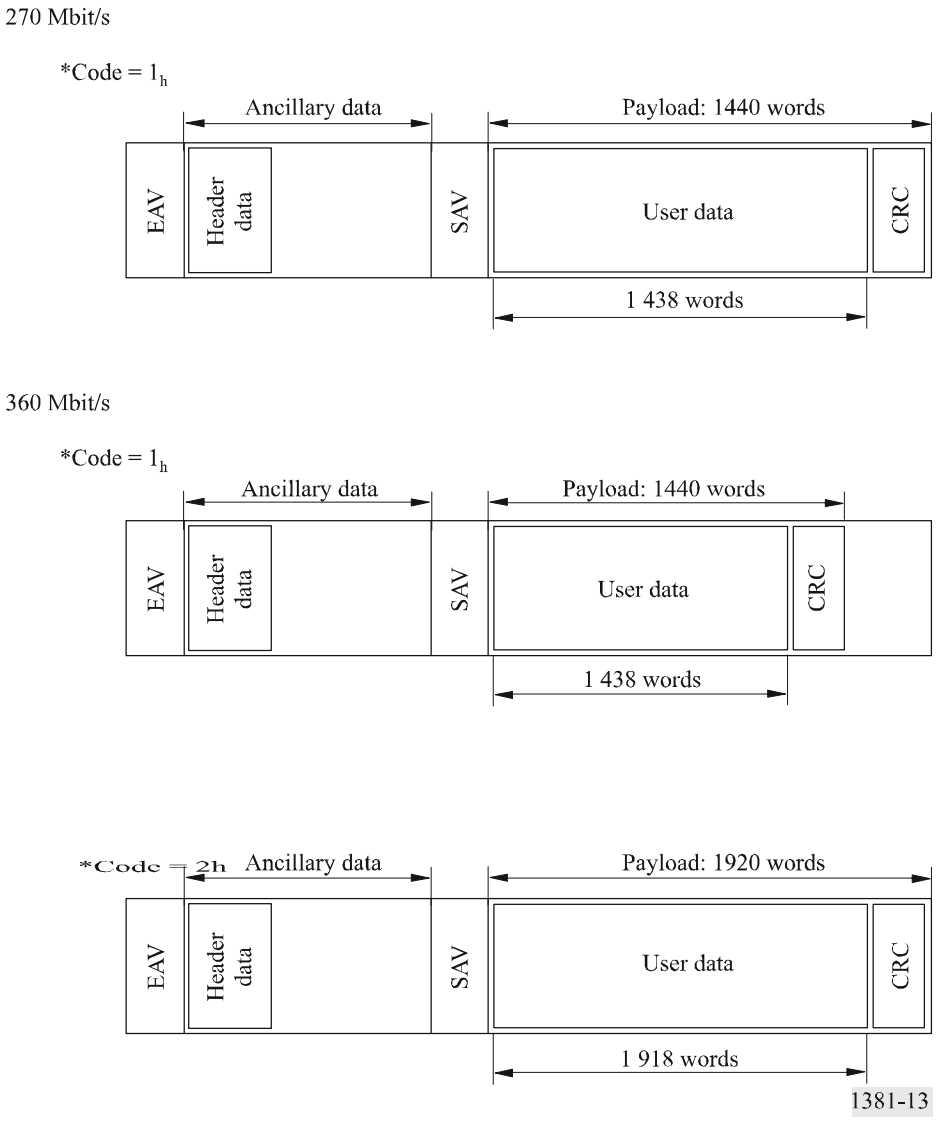
(1) Betacam SX Video.
(2) MPEG-2 Program Stream.
(3) MPEG-2 Transport Stream.
(4) Betacam SX Audio.
(5) Betacam SX Control.
(6) Fibre Channel.

5.3 Payload CRC

The payload CRC, if the payload CRC flag is active, should be inserted at word number addresses 1 438-1 439 for 1 440-word payload, and 1 918-1 919 for 1 920-word payload (see Fig. 13). The payload CRC applies to word number addresses 0-1 437 for 1 440-word payload, and 0-1 917 for 1 920-word payload. The generator polynomial for the header payload CRC should be the same as the line number CRC and the header CRC.

FIGURE 13

Payload CRC position



6 Error detection and handling (EDH)

Error checking data locations should always be protected (see Recommendation ITU-R BT.1304).

NOTE 1 – The data structure of the interfaces for 18 MHz sampled 4:2:2 (see Recommendation ITU-R BT.1302) and 4:2:0p (525P) (see Recommendation ITU-R BT.1362) is different in 360 Mbit/s. This affects the location of the EDH, if present, and manufacturers and users should pay attention if the EDH is located by counting data words from EAV.

7 Code, AAI, block type, data type registrations

New “code”, “AAI”, “block type”, or “data type” should be registered through the SMPTE Registration Authority. Requests for registration of new types require the items below:

– Originator (name, affiliation, date).
– Brief description of request.
– Proposed name components (code, AAI, block type, data type).
– Related documents.
– Value to be registered.
– Description of each value.