RECOMMENDATION ITU-R BT.1381*

SDI-BASED TRANSPORT INTERFACE FOR COMPRESSED TELEVISION SIGNALS IN NETWORKED TELEVISION PRODUCTION BASED ON RECOMMENDATIONS ITU-R BT.656 AND ITU-R BT.1302

(Question ITU-R 238/11)

(1998)

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 and metadata should be streamed in a single container;

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 SMPTE and 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 BT.1302 the Serial Data Transport Interface (SDTI) described in the Annex should be used.

ANNEX

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

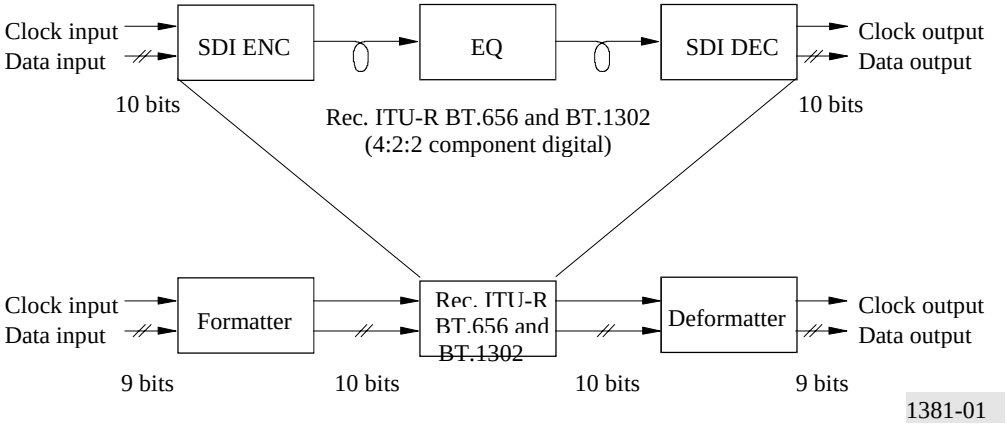
1 Introduction

1.1 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 Figure 1).

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

FIGURE 1

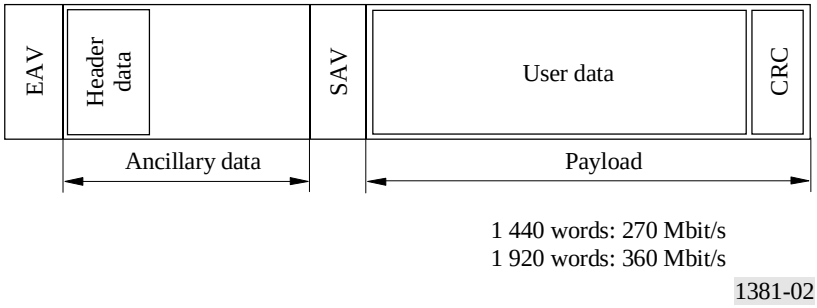
System block diagram



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

FIGURE 2

Signal format (1 line)



1.3 The data stream is intended to transport any packetized data signal over the active lines that have a maximum data rate up to (approximately) 200 Mbit/s for 270 Mbit/s system or (approximately) 270 Mbit/s for 360 Mbit/s system. The maximum data rate may be increased through use of the extended data space as described in Appendix A.

1.4 Additional documents will describe particular applications of this standard 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 system 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 Interface.

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.

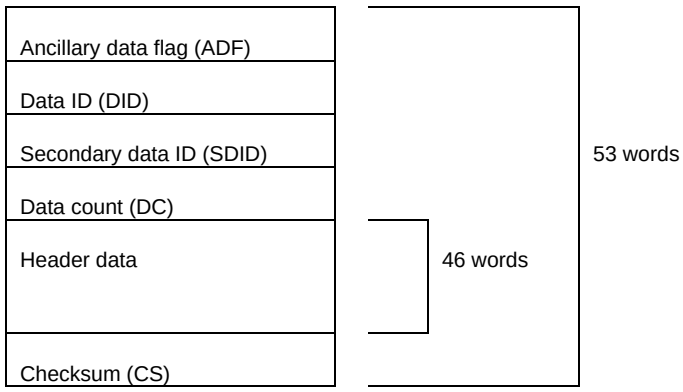
3.5 An ANC data packet forming the header data is placed after EAV, as specified in § 4. All payload is placed between SAV and EAV. The space after the header data but before SAV is available for ANC data as specified by Recommendation ITU-R BT.1364.

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

3.7 The preferred connector type should be as described in Recommendations ITU-R BT.656 and ITU-R BT.1302.

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 Figure 3.

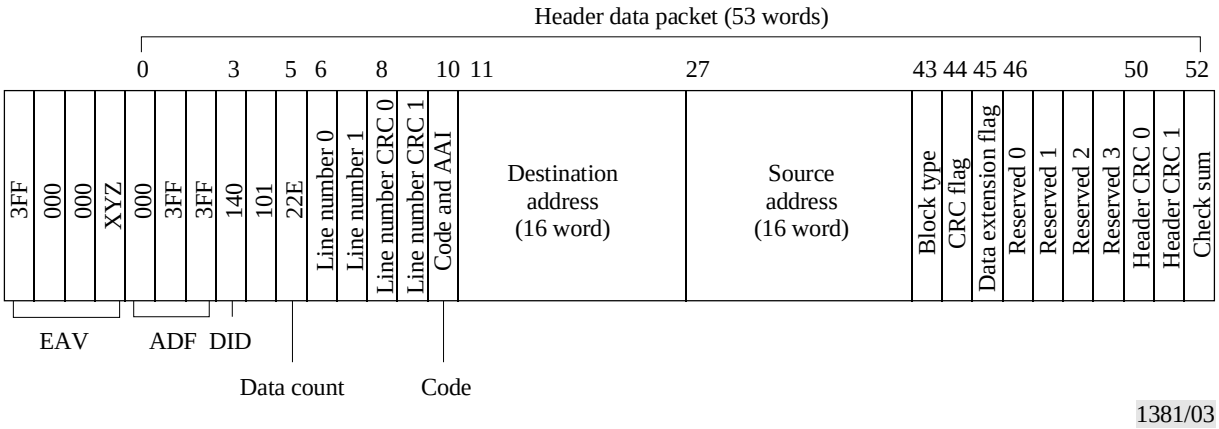


The header data should include the following:

– Line number [2 words]
– Line number CRC [2 words]
– Code and AAI [1 word]
– Destination address [16 words]
– Source address [16 words]
– Block type [1 word]
– CRC flag [1 word]
– Data extension flag [1 word]
– Reserved data [4 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 [40h] 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 [01h] 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 [2Eh] 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 systems, and 1 to 625 for 625 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 Figure 4).

– EP1 is even parity for L7 to L0

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

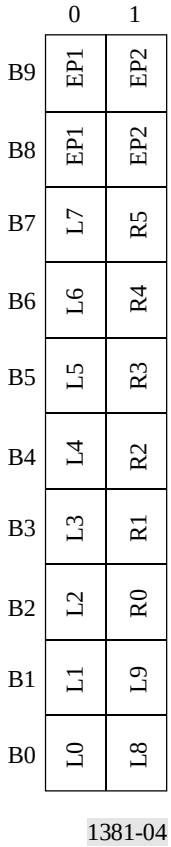
4.3 Line number CRC

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 Figure 5). The generator polynomial for the line number CRC should be $G(X) = X18 + X5 + X4 + 1$, which conforms to Recommendation ITU-T 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 Figure 6).

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

FIGURE 4

Line number



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4.4 Code and AAI (Authorized address identifier)

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

Code: B3 to B0

AAI: B7 to B4

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

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.

FIGURE 5

Line number CRC

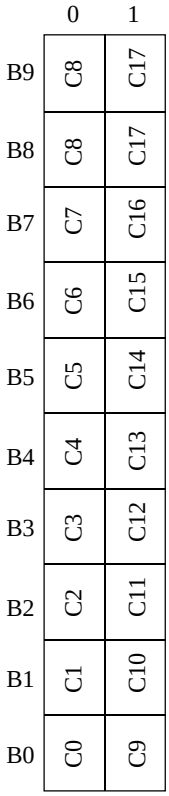
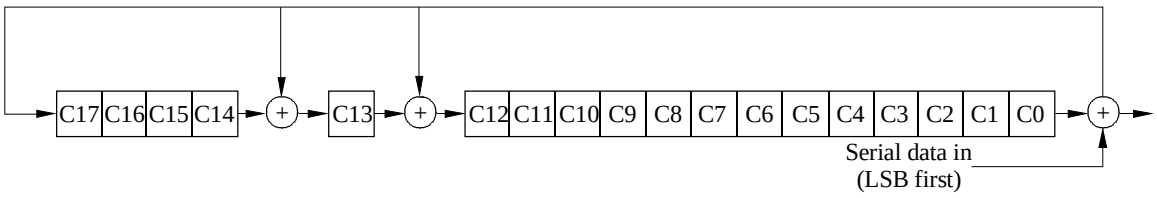


FIGURE 6

Generator polynomial



4.4.2 AAI

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

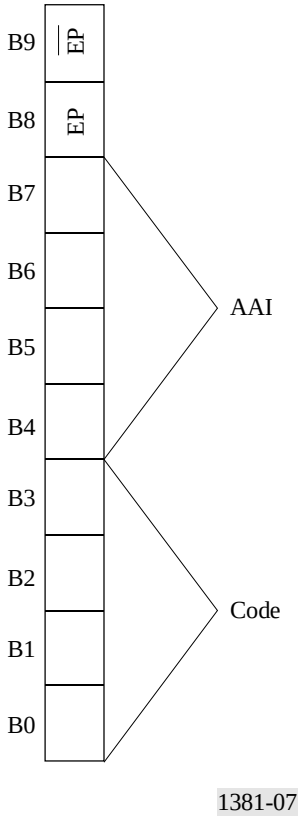
	B7	B6	B5	B4
Unspecified format:	0	0	0	0
IPv6 address*:	0	0	0	1

* 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 Figure 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.

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

NOTE – The Error Correction Code (ECC) will be determined individually in accordance with each application.

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

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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4.6.1 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).

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 other, or on the next line. For block lengths exceeding the payload of one line, code and AAI through data extension flag within the header data should be repeated for each line that carries part of the block.

TABLE 1

Fixed block size

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

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

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

– [01h]: The CRC should be inserted at the end of the payload

– [00h]: The CRC should not be inserted at the end of the payload

– [02h] – [FFh]: Reserved

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

4.8 Data extension flag

The use of the data extension facility is optional.

The data extension flag should consist of one word. The data extension flag is intended to indicate whether there are extension data packets loaded after the header data and before the SAV. Extension data packets should conform to the format defined in Appendix A.

– B7 to B0

– [00h]: No extension data packet

– [01h]: One extension data packet

– [02h]: Two extension data packets

– [03h] - [FFh]: Reserved

– B8 is even parity for B7 to B0

– B9 is the complement of B8.

NOTE – 360 Mbit/s system may contain two extension data packets when [02h] is used, since the maximum size of the user data in the ANC packet is restricted to 255 words.

4.9 Header expansion reserved data

The header expansion reserved data should be positioned after the data extension flag. The default value for the reserved data is [200h].

4.10 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.

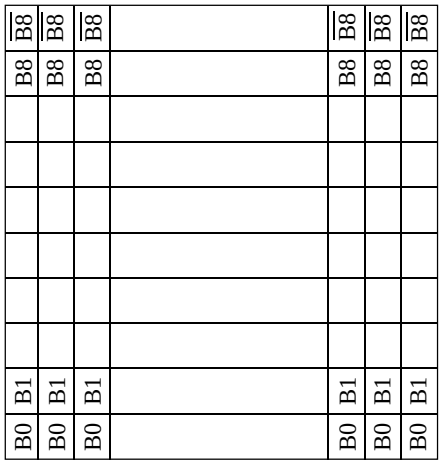
5.1 Data block

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 Figure 9).

FIGURE 9

Data block



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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 Figure 10 for the fixed block size, and Figure 11 for the variable block size.

FIGURE 10

Data structure (fixed block size)

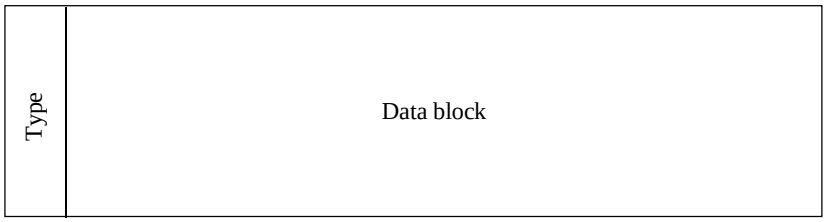

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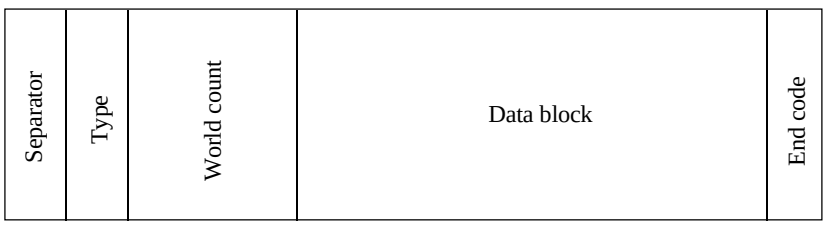
FIGURE 11

Data structure (variable block size)



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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: [309h]

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

Endcode: [30Ah]

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 Figure 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

	0	1	2	3
B9	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$	$\overline{EP}$
B8	EP	EP	EP	EP
B7	C7	C15	C23	C31
B6	C6	C14	C22	C30
B5	C5	C13	C21	C29
B4	C4	C12	C20	C28
B3	C3	C11	C19	C27
B2	C2	C10	C18	C26
B1	C1	C9	C17	C25
B0	C0	C8	C16	C24

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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

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).

TABLE 2

Data type

Type	Description
101h 102h 203h 104h 205h 206h 107h 108h 209h 20Ah 10Bh 20Ch 10Dh 10Eh 20Fh 110h	SXV (1)
211h 212h 113h 214h 115h 116h 217h 218h 119h 11Ah 21Bh 11Ch 21Dh 21Eh 11Fh 120h	

Type	Description
241h 242h 143h 244h 145h 146h 247h 248h 149h 14Ah 24Bh 14Ch 24Dh 24Eh 14Fh 250h	DV CAM-1
151h 152h 253h 154h 255h 256h 157h 158h 259h 25Ah 15Bh 25Ch 15Dh 15Eh 25Fh 260h	MPEG-2 P/S (2) MPEG-2 T/S (3)

1) Betacam SX Video;

2) MPEG-2 Program Stream;

3) MPEG-2 Transport Stream;

TABLE 2 *(continued)*

Type	Description
221h 222h 123h 224h 125h 126h 227h 228h 129h 12Ah 22Bh 12Ch 22Dh 22Eh 12Fh 230h	DVCPRO1/Digital S DVCPRO2
131h 132h 233h 134h 235h 236h 137h 138h 239h 23Ah 13Bh 23Ch 13Dh 13Eh 23Fh 140h	
281h 282h 183h 284h 185h 186h 287h 288h 189h 18Ah 28Bh 18Ch 28Dh 28Eh 18Fh 290h	SXA (4)

Type	Description
161h 162h 263h 164h 265h 266h 167h 168h 269h 26Ah 16Bh 26Ch 16Dh 16Eh 26Fh 170h	
271h 272h 173h 274h 175h 176h 277h 278h 179h 17Ah 27Bh 17Ch 27Dh 27Eh 17Fh 180h	
1C1h 1C2h 2C3h 1C4h 2C5h 2C6h 1C7h 1C8h 2C9h 2CAh 1CBh 2CCh 1CDh 1CEh 2CFh 1D0h	SXC (5)

4) Betacam SX Audio;

5) Betacam SX control;

TABLE 2 *(end)*

Type	Description
191h 192h 293h 194h 295h 296h 197h 198h 299h 29Ah 19Bh 29Ch 19Dh 19Eh 29Fh 2A0h	
1A1h 1A2h 2A3h 1A4h 2A5h 2A6h 1A7h 1A8h 2A9h 2AAh 1ABh 2ACh 1ADh 1AEh 2AFh 1B0h	
2B1h 2B2h 1B3h 2B4h 1B5h 1B6h 2B7h 2B8h 1B9h 1BAh 2BBh 1BCh 2BDh 2BEh 1BFh 2C0h	

Type	Description
2D1h 2D2h 1D3h 2D4h 1D5h 1D6h 2D7h 2D8h 1D9h 1Dah 2DBh 1DCh 2DDh 2DEh 1DFh 1E0h	FC (6)
2E1h 2E2h 1E3h 2E4h 1E5h 1E6h 2E7h 2E8h 1E9h 1EAh 2EBh 1ECh 2EDh 2EEh 1EFh 2F0h	User application
1F1h 1F2h 2F3h 1F4h 2F5h 2F6h 1F7h 1F8h 2F9h 2FAh 1FBh 2FCh 1FDh 1FEh 2FFh	User application
100h	Invalid data

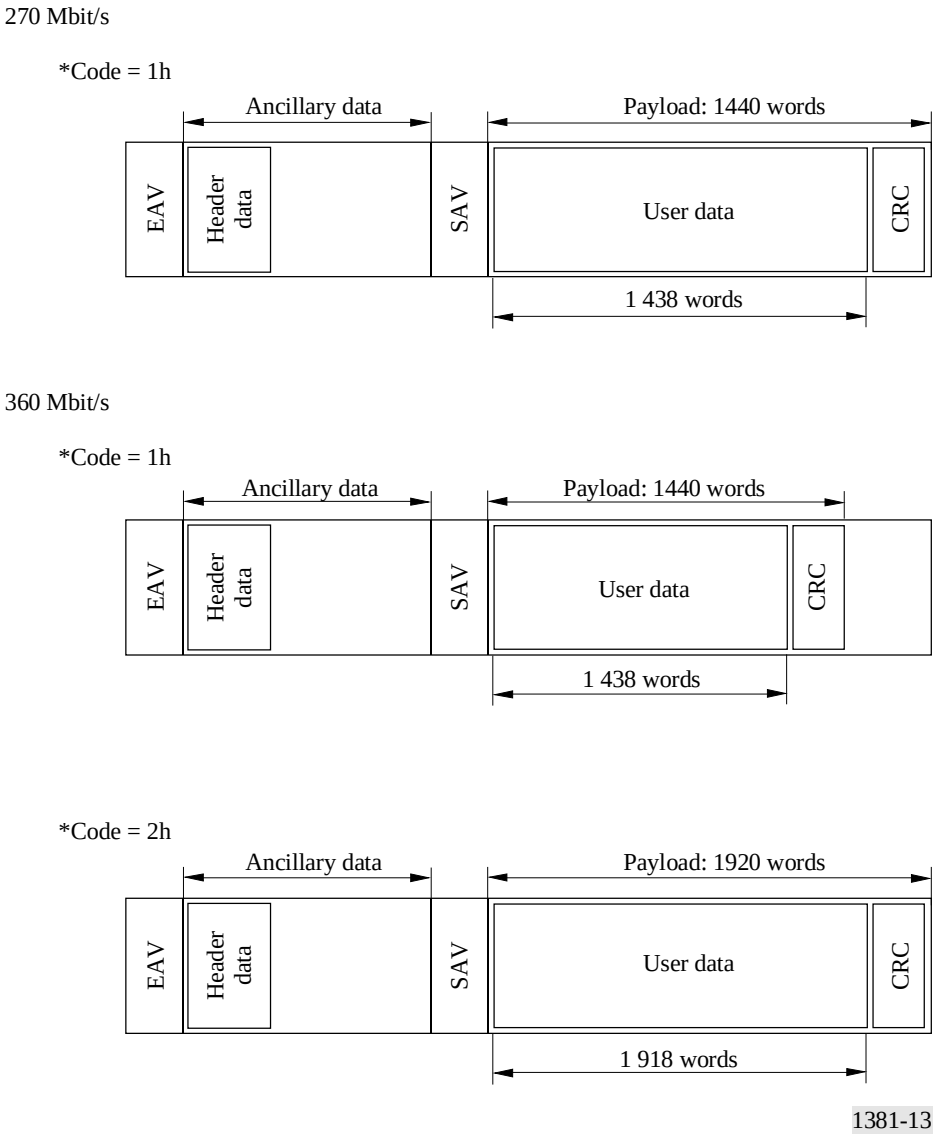
6) Fibre Channel.

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 Figure 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 – 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:

a) Originator (name, affiliation, date)

b) Brief description of request

c) Proposed name components (code, AAI, block type, data type)

d) Related documents (if any)

e) Value to be registered

f) Description of each value.

APPENDIX A

Data extension

The specifications contained in this appendix are still under consideration in some countries.

In order to increase the amount of data carried on a line beyond that which can be incorporated in the digital active line, it is possible to insert an additional ancillary data packet following the header data in the Horizontal Ancillary (HANC) to carry the extension data. The format of this additional ancillary data packet conforms to Recommendation ITU-R BT.1364 and its presence is indicated by the data extension flag in the header data (see 4.8) being active.

An ancillary data packet used to carry extension data is identified by the data ID (DID) and secondary data ID (SDID) having the following values:

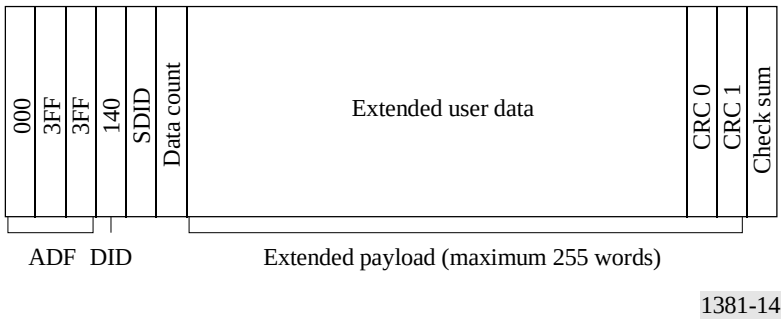
– DID: [40h] for B7 to BO

– SDID: (To be assigned).

The format of the extended data ancillary data packet is shown in Figure 14. The extended user data should incorporate a two-word CRC generated using the same generator polynomial as the payload CRC (see 5.3) when the payload CRC flag in the header data is active (payload CRC flag = [101h]). The CRC applies to DID, SDID, DC, and extended user data.

FIGURE 14

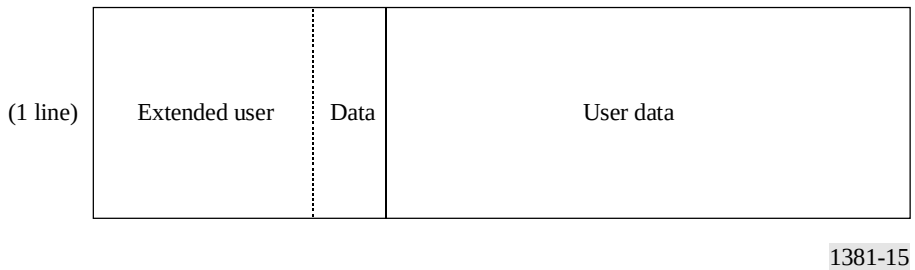
Data structure



The extended user data and the user data in the active line are treated as a contiguous data block as shown in Figure 15.

FIGURE 15

Data block



In the case of using a fixed block size with the extension data, a new block type needs to be registered with the SMPTE Registration Authority as described in § 7.

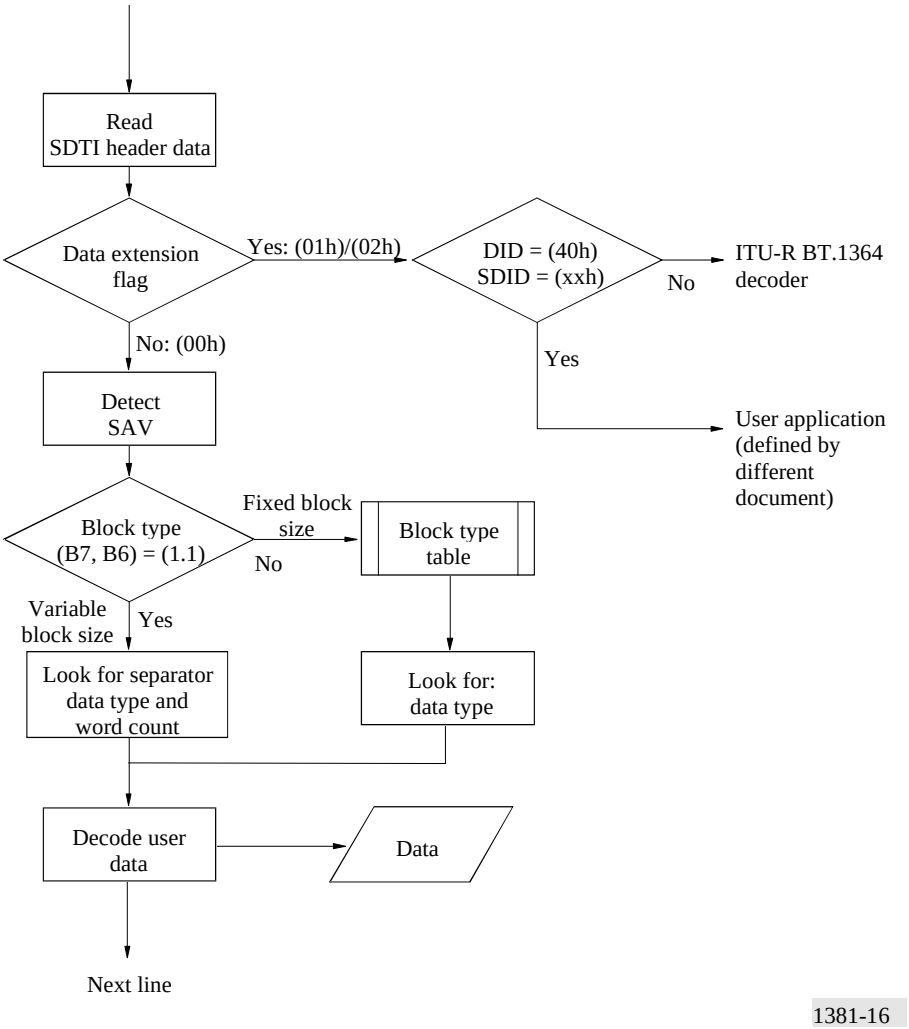
APPENDIX B

Data extension flow chart

A data extension flow chart is shown in Figure 16.

FIGURE 16

Flow chart



Bibliography

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