SMPTE RECOMMENDED PRACTICE

RP 121-1993
Revision of RP 121-1988

Tape Dropout Specifications for 1-in Types B and C Video Tape Recorders/Reproducers

1 Scope

1.1 This practice defines the parameters for tape dropouts encountered in the reproduced FM signal of 1-in types B and C video magnetic recorders/reproducers.

1.2 This practice is intended as an aid in the evaluation of dropout characteristics of magnetic tape, not as a specification for recorder/reproducer setup.

2 Basic parameters

Basic parameters of the recorder/reproducer are defined in the following documents:

Type B recorder/reproducer

Basic parameters:	ANSI/SMPTE 15M-1992
Carrier frequencies and preemphasis:	RP 84-1992
Audio frequency response and operating level:	ANSI/SMPTE 17M-1992
Record dimensions:	ANSI/SMPTE 16M-1992
Tracking-control record:	RP 83-1992

Type C recorder/reproducer

Basic parameters:	ANSI/SMPTE 18M-1991
Audio frequency response and operating level:	ANSI/SMPTE 20M-1991
Record dimensions:	ANSI/SMPTE 19M-1991
Video record parameters:	RP 86-1991
Tracking-control record:	RP 85-1991

3 Definition

For the purpose of this practice, a dropout is a momentary random reduction of the recovered frequency modulated rf playback signal that is sufficient to cause a substantial impairment in the video output signal of a 1-in type B or type C tape recorder/reproducer.

4 Specifications

The signal level reduction to be classified as a dropout must be at least 5 µs in duration and have an rf level reduction of 16 dB or more.

5 Measurement conditions

When dropout measurements are conducted, the pole tip protrusion and tape tension of the video recorder/reproducer shall be as follows:

Pole tip protrusion:	Type B	30 µm ± 5 µm
	Type C	60 µm ± 10 µm
Tape tension:	Tape tension for the recorder/reproducer shall be in accordance with the manufacturer's published specifications.	

Approved March 5, 1993

Annex A (informative)
Bibliography

ANSI/SMPTE 15M-1992, Television Analog Recording — 1-in Type B Helical Scan — Basic System Parameters

ANSI/SMPTE 16M-1992, Television Analog Recording — 1-in Type B Helical Scan — Records

ANSI/SMPTE 17M-1992, Television Analog Recording — 1-in Type B Helical Scan — Frequency Response and Operating Level

ANSI/SMPTE 18M-1991, Television Analog Recording — 1-in Type C — Basic System and Transport Geometry Parameters

ANSI/SMPTE 19M-1991, Television Analog Recording — 1-in Type C — Records

ANSI/SMPTE 20M-1991, Television Analog Recording — 1-in Type C Recorders and Reproducers — Longitudinal Audio Characteristics

SMPTE RP 83-1992, Specifications of Tracking Control Record for 1-in Type B Helical-Scan Television Analog Recording

SMPTE RP 84-1992, Reference Carrier Frequencies and Preemphasis Characteristics for 1-in Type B Helical-Scan Television Analog Recording

SMPTE RP 85-1991, Tracking-Control Record for 1-in Type C Helical-Scan Television Tape Recording

SMPTE RP 86-1991, Video Record Parameters for 1-in Type C Helical-Scan Television Tape Recording

SMPTE RECOMMENDED PRACTICE

RP 122-1993
Revision of RP 122-1983

Dimensions of Cemented Splices on 8-mm Type S Motion-Picture Film, Projection Type

1 Scope

This practice specifies the dimensions of cemented splices on 8-mm type S motion-picture film primarily intended for projection.

2 Dimensions

2.1 The dimensions shall be as given in figure 1 and table 1. The position of the splice is defined by dimensions C and D.

2.2 The film width at the splice shall not exceed 8.08 mm (0.318 in). If the film has been widened during scraping, the extra material shall be removed.

2.3 The spliced films shall not be offset by more than 0.05 mm (0.002 in), dimension G, as measured by the difference in the alignment of the reference edge side of the perforation holes on either side of the spliced halves.

2.4 The angle between the respective edges of the spliced film shall be 180° ± 8′. Thus, the spliced film shall be aligned to the extent that, when one portion of the film is placed against a straightedge, the other portion will not deviate more than 0.35 mm (0.014 in) in 15.2 cm (6 in).

NOTE – The splice should never cut into or include a perforation.

Table 1 – Dimensions

Dimensions	Millimeters	Inches
A	1.40 ± 0.20	0.055 ± 0.008
A_1	1.40 ± 0.38	0.055 ± 0.015
B[1)]	11.53 ± 0.03	0.454 ± 0.001
C	7.19 ± 0.10	0.283 ± 0.004
C_1	6.48 ± 0.18	0.255 ± 0.007
D	$5.79\ ^{+0.03}_{-0.10}$	$0.228\ ^{+0.001}_{-0.004}$
D_1	6.48 ± 0.18	0.255 ± 0.007
E	0.30 max	0.012 max
G	0.05 max	0.002 max

1) Dimension B is based on a perforation pitch of 4.23 mm (0.1667 in). Allowance has been made for 0.2% film shrinkage.

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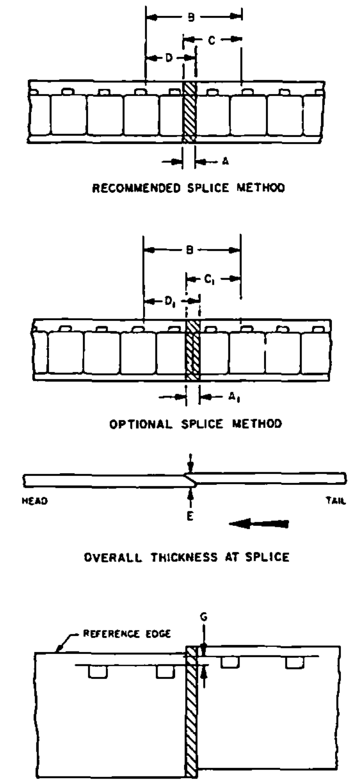

Figure 1 – Splices

Annex A (informative)
Additional data

A.1 Splices for 8-mm type S films have been made narrower than conventional 8-mm splices because narrower splices are less conspicuous on the screen and are less likely to affect the usual curvature of the film as it follows the bends in its path through cine machinery.

A.2 Dimension B controls the longitudinal registration of the two films being spliced. It is measured to the perforations that are most commonly used for registration on splicing blocks and to the nearer edges of these perforations because they are the edges generally used.

A.3 In figure 1, the splice is arranged with the perforations at the top in order to show them as they appear on most splicers. Bevelled splices are recommended, especially for films which will be run over magnetic heads. However, if unbevelled overlap splices are made, it is desirable to orient the films in splicing so that a magnetic head scanning the film would, at a splice, drop down onto the trailing film rather than bump up onto it.

A.4 The scraped area should be limited as closely as possible to the area covered by the overlapping film, in order to prevent the appearance of a white line on the screen.

A.5 Cemented splices are not preferred over taped splices for use in continuous-loop systems.

SMPTE RECOMMENDED PRACTICE

RP 123-1993
Revision of RP 123-1983

Dimensions of Tape Splices on 8-mm Type S Motion-Picture Film, Projection Type

1 Scope

This practice specifies the dimensions of mated cut splices on 8-mm type S motion-picture film made with an adhesive tape and intended only for projection.

2 Normative reference

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

ANSI/SMPTE 149-1988, Motion-Picture Film (8-mm Type S) — Perforated 1R

3 Dimensions

3.1 The dimensions shall be as given in figure 1 and table 1 and apply to a freshly-made splice.

3.2 The mated cut of the film shall fall within the area defined by dimensions A, C, and D. However, if the mated cut is not a straight cut made on one frameline, the cut configuration shall intrude into only one of the two adjoining picture frames.

3.3 The spliced films shall not be offset by more than 0.05 mm (0.002 in), dimension G, as measured by the difference in the alignment of the reference edge side of the perforation holes on either side of the spliced halves.

3.4 The angle between the respective edges of the spliced film shall be 180° ± 8'. Thus, the spliced film shall be aligned to the extent that, when one portion of the film is placed against a straight edge, the other portion will not deviate more than 0.35 mm (0.014 in) in 15.2 cm (6 in).

3.5 Except as described in 3.6, the dimensions of the tape applied to secure the splice shall be such as not to interfere with the film dimensions (especially perforations) as specified in ANSI/SMPTE 149, and fall within the area described by dimension F. The width of the adhesive material should encompass the full width of the film on one side; however, on the second side, it may exclude the perforation area and the sound stripe area.

3.6 If the tape used to form a splice is wrapped around the film, either film edge may be used as the wrap-around edge. However, if the perforated edge is used, it is recommended that the splice add no more than 0.05 mm (0.002 in) to the film width. The overall width of the splice area should not exceed 8.10 mm (0.319 in). If the film is trimmed after the wrap-around splice has been made, the film width shall not be less than 7.92 mm (0.312 in) and shall not affect the perforated edge of the film. Wrap-around splices are not preferred inasmuch as they interfere with the reproduction of magnetic audio records, and should be used only when additional strength is required such as for continuous-loop systems.

NOTES

1 The splice should have a negligible gap between the mated cuts of the film ends and there should not be any film overlap at the splice (see annex A.1).

2 Films joined with tape splices are not acceptable for use as originals in commercial printing operations or those intended for magnetic striping (see SMPTE RP 122 for such usage).

Approved March 5, 1993

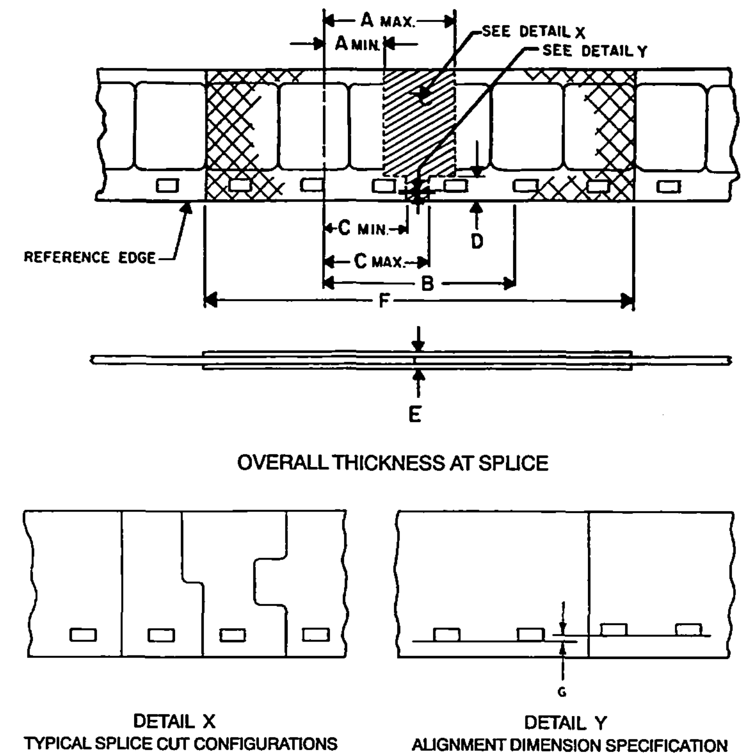

Figure 1 – Tape splices

Table 1 – Dimensions

Dimensions	Millimeters	Inches
A	3.66 min 7.90 max	0.144 min 0.311 max
B[1]	11.53 ± 0.03	0.454 ± 0.001
C	5.00 min 6.55 max	0.197 min 0.258 max
D	1.57 min	0.062 min
E	0.25 max	0.010 max
F	25.4 max	1.00 max
G	0.05 max	0.002 max

[1] Dimension B is based on a perfortion pitch of 4.23 mm (0.1667 in). Allowance has been made for 0.2% film shrinkage.

Annex A (informative)
Additional data

A.1 When bent into an arc of approximately 50-mm (2-in) diameter, the spliced film should flex smoothly, with no excessive stiffness or tendency to fold. Tape should always be applied to both sides of the film.

A.2 The transverse cut to provide the mated pairs of film for the tape splice may be made in numerous configurations. Detail X shows only some typical configurations. It is desirable, however, to make the splice as inconspicuous as possible; therefore, the transverse cuts would usually be on the frameline or occur in only one frame.

A.3 Dimension B controls the longitudinal registration of the two films being spliced. It is measured to the perforations that are most commonly used for registration on splicing blocks and to the nearer edges of these perforations because they are the edges generally used.

A.4 If tape splices are made with films to which magnetic oxide has been applied or may be applied, it will be necessary to exclude the splicing material from the magnetic record stripe area.

A.5 Visual disruption of the projected image caused by the splice will be minimized if the length of the splicing tape, dimension F, is kept as short as possible within the requirements of dimensional stability. It is anticipated that, as adhesives are improved, the length of the splicing tape may be reduced to one or two frames. Ideally, the ends of the tape should fall on the framelines to minimize visual disruption.

A.6 When the tape splice is used for special applications such as the repair or joining of the ends in a continuous-loop cartridge, the cut configurations should be made wider, as shown on the right side in detail X, to promote better performance in the projection mechanism. To minimize malfunctions caused by splices in continuous-loop cartridges, tape shoud always be applied to both sides of the film. In certain types of cartridges, when two separate pieces of splicing tapes are used, a more reliable splice is produced when the tapes are offset by one frame.

Annex B (informative)
Bibliography

SMPTE RP 122-1993, Dimensions of Cemented Splices on 8-mm Type S Motion-Picture Film, Projection Type

PROPOSED SMPTE STANDARD

for Television — Bit-Parallel Digital Interface — Component Video Signal 4:2:2 16×9 Aspect Ratio

Table of contents

1 Scope

This standard defines an interface for system M (525/59.94) wide screen, 16×9 aspect ratio, digital television equipment based on CCIR Recommendation 601-2. Two luminance sampling rates are provided, 13.5-MHz sampling providing full-signal compatibility with equipment operating in compliance with ANSI/SMPTE 125M, and 18-MHz sampling providing equivalent horizontal resolution for the 16×9 aspect ratio of this standard as compared to the 4×3 aspect ratio of ANSI/SMPTE 125M. Use of the 18-MHz sampling method also provides 16×9 to the 4×3 aspect ratio translation by sample selection rather than sample interpolation as would be required with 13.5-MHz sampling. The standard has application in the television studio over distances up to 300 m (1000 ft) for 13.5-MHz sampling and 225 m (750 ft) for 18-MHz sampling.

2 Interface characteristics

2.1 The video signal is transmitted in the form of one luminance (Y) and two color-difference components (scaled version of R–Y and B–Y).

2.2 The video signal is transmitted at the 4:2:2 family level of CCIR 601-2, with a nominal luminance sampling frequency of 13.5 MHz or 18 MHz. Provision is made to convey signals at 10-bit precision. Because of the potential use of 8-bit data, all synchronizing signals (EAV, SAV, ANC) must be detected by reference to the eight most significant bits only.

2.3 The bits of the digital code words that describe the video signal are transmitted in a parallel arrangement using 10 conductor pairs as described in 6.2.2. Each pair carries a multiplexed stream of bits (of the same significance) of each of the component signals. Accordingly, the bit rate used in each pair is nominally 27 Mbits/s for 13.5-MHz sampling and 36 Mbits/s for 18-MHz sampling. An eleventh conductor pair carries a clock signal at 27 MHz or 36 MHz, respectively.

2.4 The signals on the interface are transmitted using balanced conductor pairs for a distance up to 50 m (160 ft) for 13.5-MHz sampling and 40 m (120 ft) for 18-MHz sampling without equalization, and up to 300 m (1000 ft) for 13.5-MHz sampling and 225 m (750 ft) for 18-MHz sampling with appropriate equalization.

2.5 The interface consists of one transmitter and one receiver in a point-to-point connection.

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2.6 Parameters of the signal format are chosen to facilitate conversion to and from a serial digital interface format. The serial digital interface defined in SMPTE 259M is the preferred method for the interconnection of digital equipment when cable lengths exceed 50 m.

2.7 The interface allows the transmission of appropriate ancillary signals that may be multiplexed into the data stream during video blanking intervals.

2.8 Where hexadecimal values are used, they are indicated by a subscript h, such as $3FF_h$; other values are decimal.

3 General

3.1 Signal convention

The signaling sense of the voltage appearing across the interconnection cable is positive binary and defined as follows (refer to figure 1):

3.1.1 The A terminal of the transmitter shall be negative with respect to the B terminal for a binary 0 (LOW or L or OFF) state.

3.1.2 The A terminal of the transmitter shall be positive with respect to the B terminal for a binary 1 (HIGH or H or ON) state.

3.2 Signal names

The data lines are designated DATA 0 through DATA 9. The group of 10 signals is identified by placing parentheses around the range of subscripts included, as DATA (0-9). When 8-bit signals are conveyed by the interface, DATA (2-9) shall be used and DATA (0-1) shall be set to zero. DATA 9 is always the most significant bit.

3.3 Component coding considerations

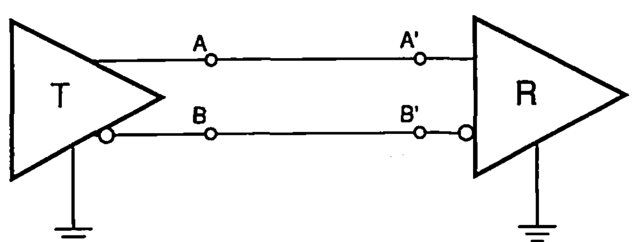
Spectral characteristics of analog signals to be encoded must be restricted to eliminate aliasing. Filters, as described in CCIR 601-2, annex III, may be considered for use with 13.5-MHz sampling and can be scaled for 18-MHz sampling. Designers are cautioned to use filter characteristics that are best suited for their particular product application.

3.4 Sin x/x considerations

The characteristics of the data word at the interface are based on the assumption that the location of any required sin x/x correction is at the point where the digital signal is converted to an analog format.

3.5 Blanking interval considerations

This standard does not require the device feeding the interface to transmit video data during the entire blanking interval. Therefore, ancillary information may be inserted into the horizontal blanking interval by the user within the constraints specified in 4.4 and 4.5.



T = transmitter
R = receiver
A,A' = the data line
B,B' = the return line

Figure 1 – Positive binary signal convention

The vertical blanking duration is a minimum of nine lines. Ancillary information may be inserted into this nine-line interval by the user within the constraints specified in 4.4 and 4.5.

3.6 Signal specifications

All digital signal time intervals are specified at the half-amplitude points. All transitions are specified between the 20% and 80% amplitude points.

3.7 Electromagnetic interference considerations

Digital apparatus can radiate a significant amount of energy at harmonics of the clock frequency. In the case of 13.5-MHz sampling, clock harmonics lie at 121.5 MHz and 243 MHz, both of which are aeronautical distress frequencies. Equipment and system designers must, therefore, pay particular attention to the provision of adequate shielding.

3.8 Document of compliance

It is suggested that any documentation indicating compliance with this standard be written in such a manner that use of 13.5-MHz and/or 18-MHz sampling is clearly defined. This can be accomplished with a suffix to the numerical designation such as SMPTE 267M-13.5 or SMPTE 267M-18.

4 Interface format

4.1 General description

The interface consists of a unidirectional, 11-pair interconnection between a transmitting equipment and a receiving equipment. Video data, timing reference information, and ancillary signals are time multiplexed and transferred on 10 data pairs in NRZ form. An eleventh pair provides a synchronous clock.

4.2 Encoding parameters

Table 1 summarizes the encoding parameter values.

4.3 Interface characteristics

Table 2 specifies the interface characteristics.

4.4 Digital blanking relationship

4.4.1 Horizontal sync relationship — 13.5-MHz sampling

Figure 2a shows the relationship between video signals in the digital and analog domains for 525-line systems. Figure 2b shows the multiplex structure.

Transmitted during each active line are 1440 multiplexed luminance and chrominance values (720 luminance, 360 chrominance C_R, and 360 chrominance C_B values).

Eight of the remaining 276 interface clock intervals are used to transmit synchronizing information; the other 268 interface clock intervals may be used to carry ancillary information.

The first of these 1716 interface clock intervals is designated line word 0 for the purpose of reference only. The 1716 sample words per total line are therefore numbered 0 through 1715. Intervals 0 through 1439, inclusive, contain video data. The interface clock intervals occurring during digital blanking are designated 1440 through 1715.

Intervals 1440 through 1443 are reserved for the end-of-active-video (EAV) timing reference described in 4.5.3. Intervals 1712 through 1715 are reserved for the start-of-active-video (SAV) timing reference described in 4.5.3.

The half-amplitude point of the leading (falling) edge of the analog horizontal sync signal shall be coincident with a sample point which would be conveyed by word 1473 if carried across the interface.

4.4.2 Horizontal sync relationship — 18-MHz sampling

Figure 2c shows the relationship between video signals in the digital and analog domains for 525-line systems. Figure 2d shows the multiplex structure.

Transmitted during each active line are 1920 multiplexed luminance and chrominance values (960 luminance, 480 chrominance C_R, and 480 chrominance C_B values).

Eight of the remaining 368 interface clock intervals are used to transmit synchronizing information; the other 360 interface clock intervals may be used to carry ancillary information.

Table 1 – Encoding parameters

Coded signals: These values are obtained from the gamma precorrected signals	Y = 0.299R + 0.587G + 0.114B C_R = 0.713 (R–Y) = 0.500R – 0.419G – 0.081B C_B = 0.564 (B–Y) = 0.500B – 0.169R – 0.331G
Number of samples per line:	13.5-MHz sampling: Total / Active; 18-MHz sampling: Total / Active
– luminance (Y)	858 / 720; 1144 / 960
– each color-difference signal (C_R, C_B)	429 / 360; 572 / 480
– total number of samples	1716 / 1440; 2288 / 1920
Sampling structure:	Orthogonal: line, field, and frame repetitive; C_R and C_B samples are cosited with odd (1st, 3rd, 5th) samples in each line
Sampling frequency:	13.5-MHz sampling; 18-MHz sampling
– *luminance (Y)*	13.5-MHz nominal; 18-MHz nominal
– each color-difference signal (C_R, C_B)	6.75-MHz nominal; 9-MHz nominal
Form of encoding:	Uniformly quantized, PCM, 10 bits per sample, for the luminance and each color-difference signal.
Correspondence between video signal levels and quantization levels:	
– luminance (Y)	877 quantization levels with the black level corresponding to level 64 and the peak white level corresponding to level 940.
– each color-difference signal (C_B, C_R)	897 quantization levels symmetrically distributed about level 512, corresponding to the zero signal.

Table 2 – Interface characteristics

Digital format	Parallel: 11 balanced signal pairs carrying clock and 10 data bits
Interface clock, 13.5-MHz sampling	27.0 MHz nominal
Interface clock, 18-MHz sampling	36.0 MHz nominal
Voltage levels	Standard ECL (10K or 10KH series)
Driver impedance	Standard ECL (10K or 10KH series)
Receiver impedance	110 ohms nominal, balanced

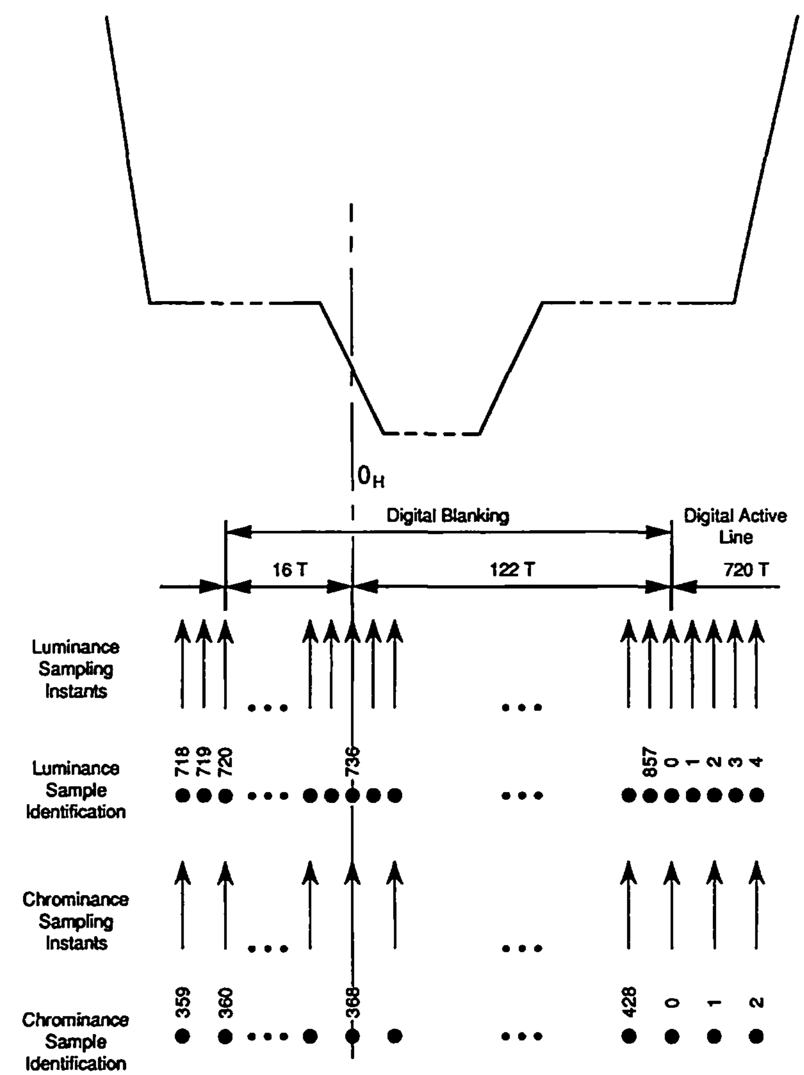


Figure 2a – Horizontal sync relationship — 13.5-MHz sampling

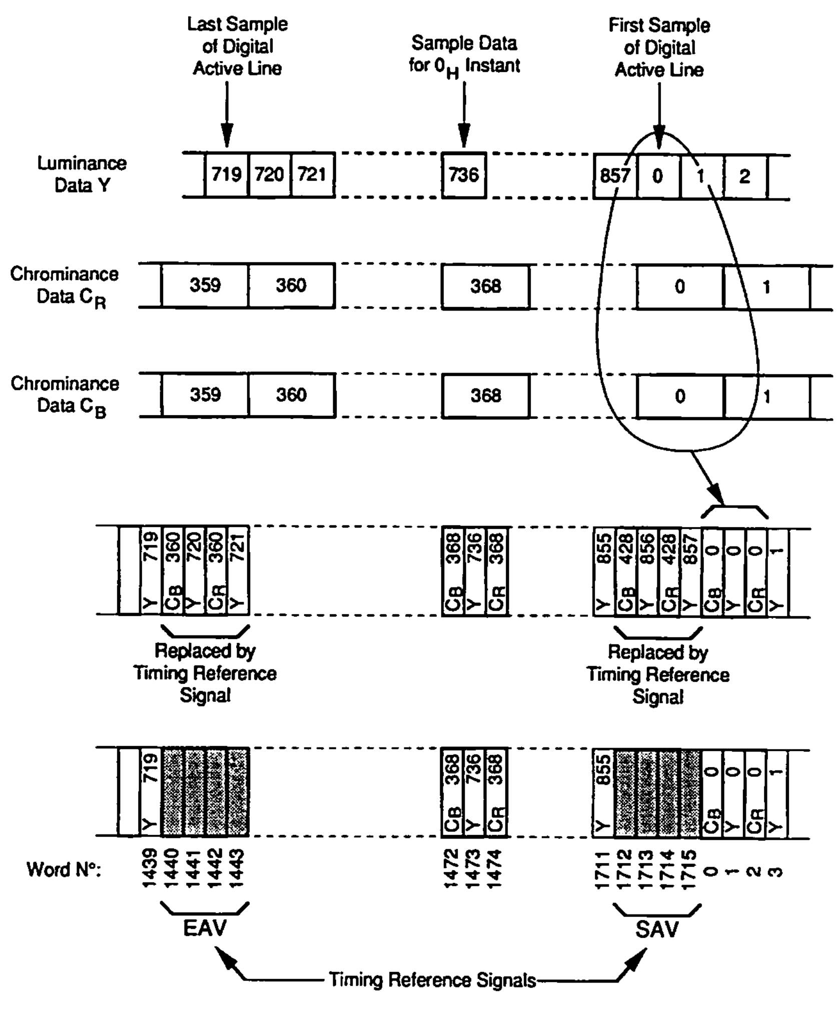


Figure 2b – Multiplex structure — 13.5-MHz sampling

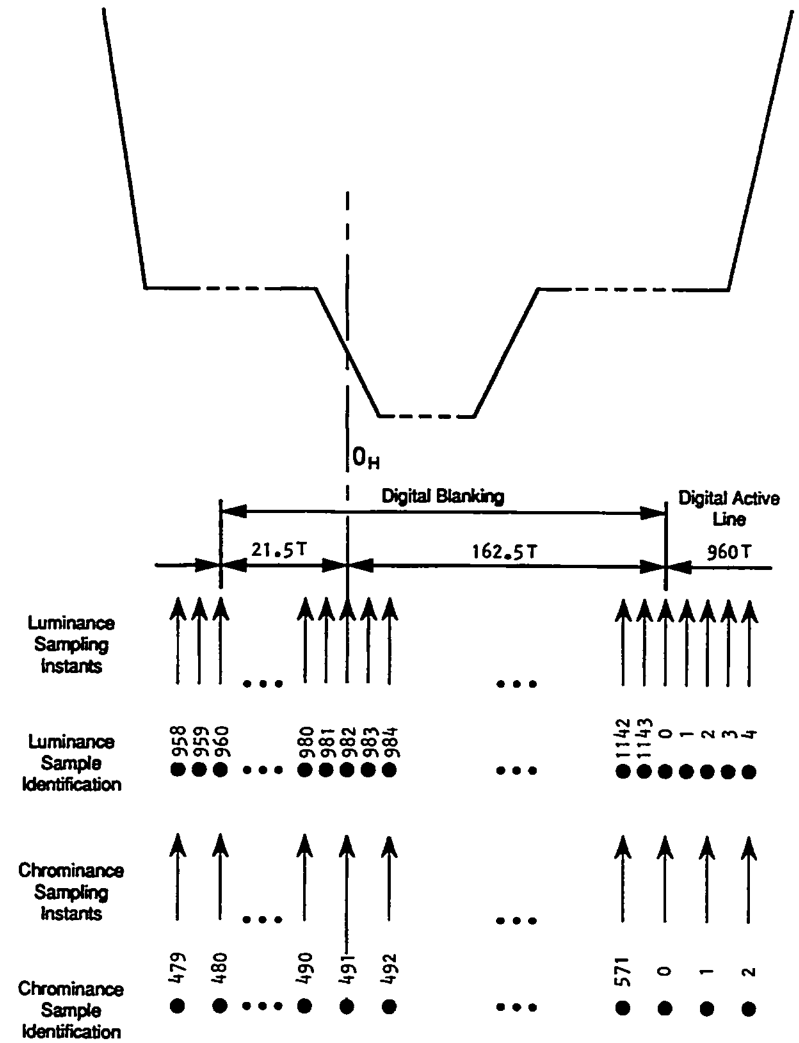


Figure 2c – Horizontal sync relationship — 18-MHz sampling

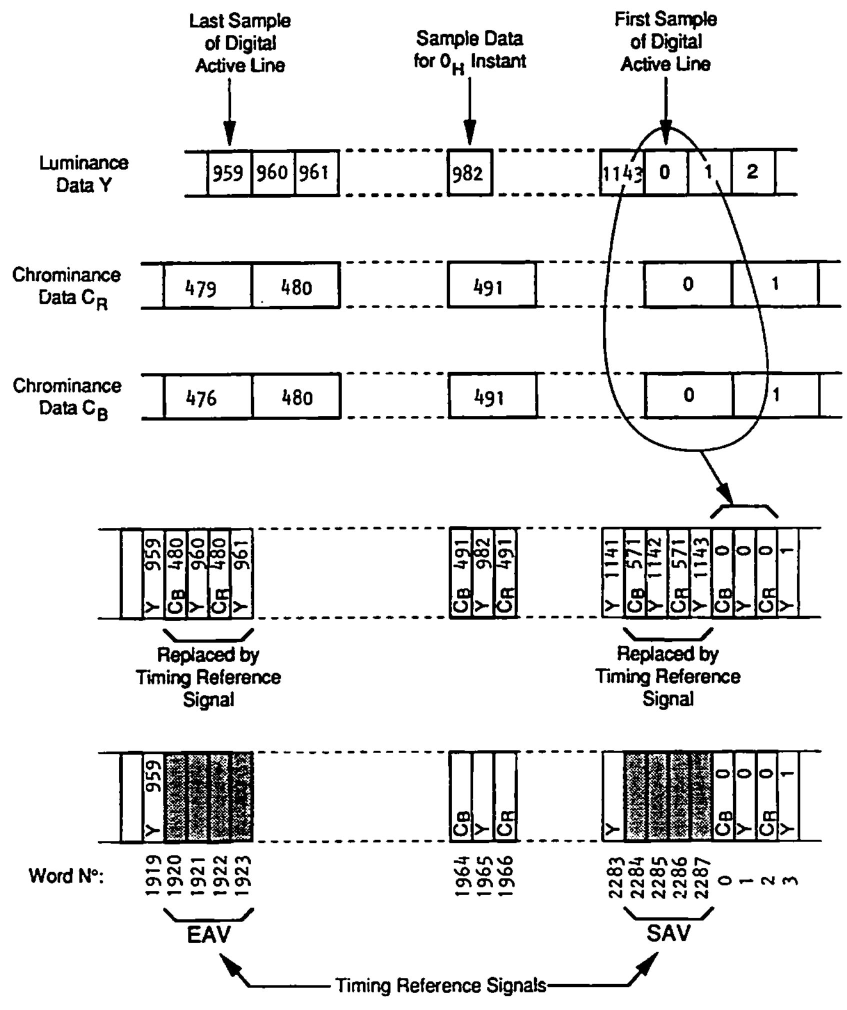


Figure 2d – Multiplex structure — 18-MHz sampling

The first of these 2288 interface clock intervals is designated line word 0 for the purpose of reference only. The 2288 sample words per total line are therefore numbered 0 through 2287. Intervals 0 through 1919, inclusive, contain video data. The interface clock intervals occurring during digital blanking are designated 1920 through 2287.

Intervals 1920 through 1923 are reserved for the end-of-active-video (EAV) timing reference described in 4.5.3. Intervals 2284 through 2287 are reserved for the start-of-active-video (SAV) timing reference described in 4.5.3.

The half-amplitude point of the leading (falling) edge of the analog horizontal sync signal shall be halfway between the sample points which would be conveyed by luminance samples 981 and 982 if carried across the interface. Placement of horizontal sync between the two samples is explained by figure G.1.

4.4.3 Vertical sync relationship

Figure 3 shows the relationship between video signals in the digital and analog domains for 525-line systems.

4.5 Video data signal format

4.5.1 Data signal format

Data is transmitted across the interface on 10 data pairs: DATA 0 through DATA 9. DATA 9 is the most significant bit (MSB). Of the 1024 levels, 1016 are used to express quantized values (digital levels 4 through 1019 or 004_h through $3FB_h$ in the hexadecimal representation) of the 10-bit word.

Data levels 0 to 3 and 1020 to 1023 (000_h to 003_h and $3FC_h$ to $3FF_h$ in the hexadecimal representation) are reserved to indicate timing references.

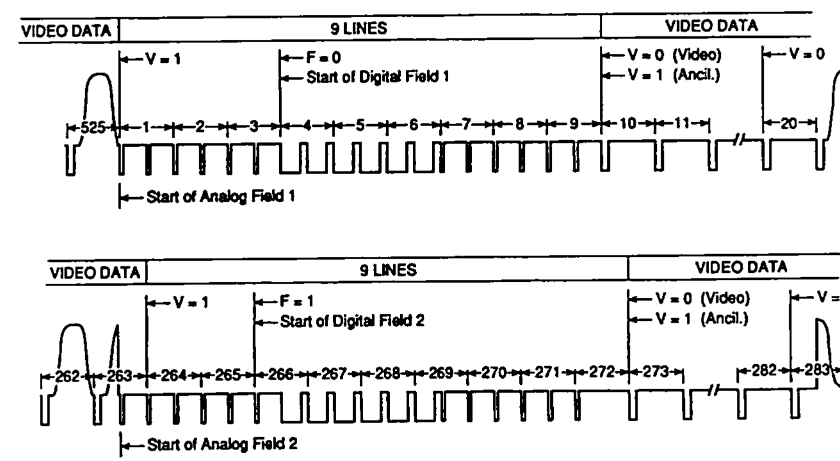


Figure 3 – Relationship of video data/vertical sync

4.5.2 Multiplex structure

The video data words shall be conveyed as a 27 Mword/s multiplex for 13.5-MHz sampling and 36 Mword/s multiplex for 18-MHz in the following order:

C_B Y C_R [Y] C_B...

where the three words C_B Y C_R refer to cosited samples, the following word [Y] being an isolated luminance-only sample. The C_B and C_R samples are cosited with the first and subsequent alternate Y samples (0, 2, 4...) on each line. (See figures 2b and 2d.) The first video data word in each active line period shall be C_B.

4.5.3 Timing reference signals — Video

Figures 2a and 2c show the position of the timing reference signals with respect to horizontal blanking in the multiplexed data stream. It is implicit that the timing reference signals are contiguous with the video data, when present, and continue through the vertical blanking interval.

Each timing reference signal consists of a four-word sequence in the following format:

3FF 000 000 XYZ

Because of the existence of both 8-bit and 10-bit data, for detection purposes all values in the ranges 000_h-003_h and $3FC_h$-$3FF_h$ must be considered equivalent to 000_h and $3FF_h$, respectively.

The first three words are a fixed preamble. The fourth word shall contain information defining:

– even field (field 2) identification;
– state of vertical blanking;
– state of horizontal blanking.

Figure 4 is a spatial representation of the timing reference signals during a television frame. Assignment of bits within the fourth word is shown in table 3. P0, P1, P2, and P3 have states dependent on states of bits F, V, and H according to table 4. Lines are numbered from 1 through 525 as shown in figure 3. Vertical blanking in the digital interface is in full-line increments. EAV and SAV are the digital horizontal synchronization signals and occur on every line.

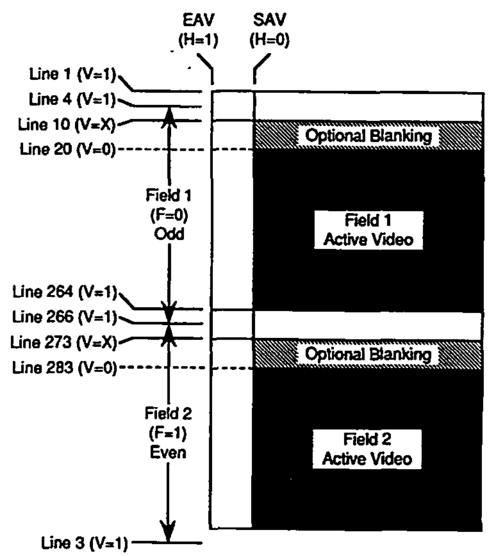


Figure 4 – Timing reference signal locations

Table 3 – Timing reference signals

13.5/18-MHz sampling Bit	Words 1440/1920 and 1712/2284	Words 1441/1921 and 1713/2285	Words 1442/1922 and 1714/2286	Words 1443/1923 and 1715/2287	
9	1	0	0	1	Fixed
8	1	0	0	F	F = 0 during field 1 F = 1 during field 2
7	1	0	0	V	V = 0 during active video V = 1 during vertical blanking
6	1	0	0	H	H = 1 for EAV H = 0 for SAV
5	1	0	0	P3	See table 4
4	1	0	0	P2	
3	1	0	0	P1	
2	1	0	0	P0	
1	1	0	0	0	
0	1	0	0	0	

NOTES
1 Some equipment can only sense the eight most significant bits.
2 The H, V, and F bits (bits 6-8) provide all the necessary information. Bits 2-5 provide error detection and correction information.
3 Each 525-line digital video frame is divided into two fields. Field 1 contains 262 complete horizontal lines. Field 2 contains 263 complete horizontal lines.
4 The protection bits allow correction of all single-bit errors and detection of two-bit errors.

Table 4 – Protection bit states

Bit	9	8	7	6	5	4	3	2	1	0
		F	V	H	P3	P2	P1	P0		
	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

The interval starting at EAV and ending with SAV is the digital horizontal blanking period as shown in figures 2b and 2d.

Small blocks of data, less than 268 words in total length for 13.5-MHz sampling and 360 words in total length for 18-MHz sampling, including the HANC sequence (as described in 4.6.1), can be transmitted within the horizontal blanking period on every line.

Large blocks of data, up to 1440 words in total length for 13.5-MHz sampling and up to 1920 words in total length for 18-MHz sampling, including the VANC sequence, can be transmitted within the interval starting with the end of SAV and terminating with the beginning of EAV on lines 1 through 19 and 264 through 282 only.

Video data will not be present on lines 1-9 and 264-272 and may optionally be present on lines 10-19 and 273-282. Ancillary data could be optionally transmitted in the active portion of these lines.

The words during:

- horizontal blanking period on every line;
- the active portion of lines 1-9 and 264-272;
- the active portion of lines 10-19 and 273-282 (when video data is present)

not used to transmit ancillary data must have the following values:

- the words corresponding to Y samples must have the value 040_h;

- the words corresponding to C_B and C_R samples must have the value 200_h.

4.6 Ancillary data signal format

Ancillary data may be inserted in any portion of the data stream not occupied by timing reference signals or video data (see 4.4.1, 4.4.2, and 4.4.3). Two categories of ancillary data, HANC and VANC, are defined for different portions of the data stream. Note that the three-word header used to identify ancillary data is the same for HANC and VANC.

4.6.1 HANC data

HANC data are permitted in all horizontal intervals, but not in the active portion of lines. HANC data are of 10-bit format, and each block of HANC data is preceded by the three-word ancillary data header 000_h $3FF_h$ $3FF_h$.

Because of the existence of 8-bit data, for detection purposes all values in the ranges 000_h-003_h and $3FC_h$-$3FF_h$ must be considered equivalent to 000_h and $3FF_h$, respectively.

The ancillary data header may occur multiple times during each horizontal blanking period if different blocks of data are transmitted.

All permitted data identification words and data formats will protect the values (000_h to 003_h) and ($3FC_h$ to $3FF_h$).

4.6.2 VANC data

VANC data are permitted only in the active portion of lines 1-13, 15-19, 264-276, and 278-282. (Lines 14 and 277 are reserved for digital vertical interval time code [DVITC] and video index.) VANC data are of 8-bit format, and each block of VANC data is preceded by the three-word ancillary data header 000_h $3FF_h$ $3FF_h$.

Because of the existence of 8-bit data, for detection purposes all values in the ranges 000_h-003_h and $3FC_h$-$3FF_h$ must be considered equivalent to 000_h and $3FF_h$, respectively.

The ancillary data header may occur multiple times during each line period if different blocks of data are transmitted.

All permitted data identification words and data formats will protect the values (000_h to 003_h) and ($3FC_h$ to $3FF_h$).

4.7 Digital vertical interval time code and video index

Digital vertical interval time code (DVITC) and video index, if present, are carried by the data in the active portion of lines 14 and 277.

4.7.1 DVITC

This signal, if present, is carried by the luminance data in the active portion of lines 14 and 277.

4.7.2 Video index

This signal, if present, is carried by the color-difference data in the active portion of lines 14 and 277. A total of 90 8-bit data words is represented serially by DATA(2) of the 720 color-difference samples of the active portion of the line for 13.5-MHz sampling. A total of 90 8-bit data words is represented serially by DATA(2) of the 960 color-difference samples of the active portion of the line for 18-MHz sampling.

The first color-difference word of the active portion of the line (word 0 of the multiplexed signal, normally a C_B sample) represents the least significant bit (bit 0) of video index word 0. The second color-difference word represents bit 1 of the same word, etc. The last *color-difference word of the active portion of the line* (word 1438 of the multiplexed signal, normally a C_R sample) represents the most significant bit (bit 7) of video index word 89 for 13.5-MHz sampling. The color-difference word 1438 of the active portion of the multiplexed signal (normally a C_R sample) represents the most significant bit (bit 7) of video index word 89 *for 18-MHz sampling.*

For all samples, a value of 204_h represents a binary one for the appropriate video index bit, and a value of 200_h represents a binary zero for the appropriate video index bit.

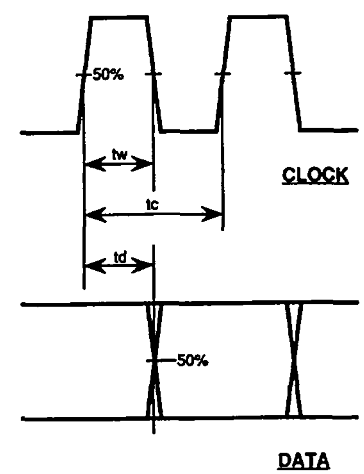
This transmission method ensures that, after digital to analog conversion, the video signal may be sent to an NTSC encoder without any requirement for special blanking. DVITC will be preserved through the encoder *without interference from any video index* information which may be present.

4.8 Clock signal

4.8.1 Clock signal description (at transmitter)

For 13.5-MHz sampling, the clock signal is a 27-MHz square wave as shown in figure 5. The clock pulse width (tw) is 18.5 ns ± 3 ns.

For 18-MHz sampling, the clock signal is a 36-MHz square wave as shown in figure 5. The clock pulse width (tw) is 13.9 ns ± 2 ns.



Parameter	13.5-MHz sampling	18-MHz sampling
tw	18.5 ns ± 3 ns	13.9 ns ± 2 ns
tc	37.0 ns (nominal)	27.8 ns (nominal)
td	18.5 ns ± 3 ns	13.9 ns ± 2 ns
f_h	15.734 ... kHz (nominal)	

Figure 5 – Clock to data timing (at transmitter)

4.8.2 Clock jitter

For 13.5-MHz sampling, the peak-to-peak jitter between rising edges shall be within 3 ns of the average time of the rising edge computed over at least one field.

For 18-MHz sampling, the peak-to-peak jitter between rising edges shall be within 2 ns of the average time of the rising edge computed over at least one field.

NOTE – Designers of equipment receiving signals from this interface should consider that the jitter requirements for a digital to analog converter may be more restrictive than those of the interface.

4.8.3 Clock data timing relationship

The positive transition of the clock signal nominally occurs midway between data transitions (figure 5).

5 Electrical characteristics

5.1 General

The 11 signals shall be transmitted via balanced signal pairs. Although the use of ECL technology is not specified, the line driver and receiver must be ECL-compatible to permit the use of standard ECL parts for either or both ends in applications where such ECL parts are deemed adequate. (Standard ECL parameters are provided in annex A.)

5.2 Transmitter characteristics

5.2.1 Output impedance

The transmitter shall have a balanced output with a maximum output impedance of 110 ohms.

5.2.2 Common mode voltage

The average of the voltages on the two terminals of the line driver shall be -1.3 V ± 15% with reference to the ground terminal.

5.2.3 Signal amplitude

The generated signal shall lie between 0.8 V peak-to-peak and 2.0 V peak-to-peak, measured across a 110-ohm resistor connected to the output terminals without any transmission line.

5.2.4 Rise and fall times

Rise and fall times shall be no longer than 5 ns and differ by not more than 2 ns, as measured between the 20% and 80% amplitude points across a 110-ohm resistor connected to the output terminals without any transmission line.

5.3 Receiver characteristics

5.3.1 Terminating impedance

The cable shall be terminated by 110 ohms ± 10 ohms.

5.3.2 Maximum input signal

The line receiver must sense properly the binary data when connected directly to a line driver operating at the extreme voltage limits permitted by 5.2.3.

5.3.3 Input sensitivity

The receiver shall require a differential input voltage of no more than 185 mV to correctly attain the intended binary state.

5.3.4 Common mode rejection

The receiver shall operate correctly in the presence of common mode noise having a maximum amplitude of 0.5 V.

5.3.5 Differential delay

The receiver shall operate with a differential delay between the received clock and any received data signals up to 11 ns for 13.5-MHz sampling and 7 ns for 18-MHz sampling.

6 Mechanical characteristics

6.1 General

This clause defines the mechanical specifications for the interface of digital video systems used in environments where the physical distance between devices is limited and the general physical environment can be termed interior.

6.2 Interconnecting cable characteristics

The interface is designed to operate with a nominal signal pair impedance of 110 ohms.

6.2.1 Cable length

The majority of applications of this interface involve lengths less than 50 m for 13.5-MHz sampling and 40 m for 18-MHz sampling. For these lengths, cables with reasonable uniformity will generally give satisfactory results. For cable lengths greater than 50 m for 13.5-MHz sampling and 40 m for 18-MHz sampling, the cable and termination characteristics become more critical, in some cases requiring equalization.

6.2.2 Cable construction

The cable shall contain 12 pairs of conductors of which 11 pairs shall be used as signal lines. The remaining pair shall be used as system ground.

The cable shall be constructed to minimize the effects of crosstalk between signal lines, the susceptibility of the signal lines to external noise, and the transmission of interface signals to the external environment.

The cable shall contain an overall shield to minimize radiation, carried through the cable assembly and connectors via the cable shield pins and the connector body at each end.

The cable shall be constructed to minimize the differential delay between any two conductor pairs.

6.3 Connector characteristics

6.3.1 Mechanical considerations

The connectors shall have the mechanical characteristics conforming to the industry standard 25 contact D subminiature connector described below. Additional information may be found in MIL-C-24308C.

(Most applications of this interface require that the connectors be inserted many times. ECL voltage and current levels are relatively low. The materials used in the connector should be appropriate to the application.)

6.3.2 Connector contact assignments

The connector contact assignments shall be in accord with table 5.

6.3.3 Cable connector assembly

Cable connectors employ pin contacts and equipment connectors employ socket contacts (see figure 6).

6.3.4 Connector retaining mechanism

The cable connectors shall be provided with #4-40 mounting screws and the equipment connectors shall be provided with female screw locks or mating threads as shown in annex B.

Table 5 – Connector contact assignments

Pin	Signal line	Pin	Signal line
1	Clock	14	Clock return
2	System ground A	15	System ground B
3	DATA 9	16	DATA 9 return
4	DATA 8	17	DATA 8 return
5	DATA 7	18	DATA 7 return
6	DATA 6	19	DATA 6 return
7	DATA 5	20	DATA 5 return
8	DATA 4	21	DATA 4 return
9	DATA 3	22	DATA 3 return
10	DATA 2	23	DATA 2 return
11	DATA 1	24	DATA 1 return
12	DATA 0	25	DATA 0 return
13	Cable shield		

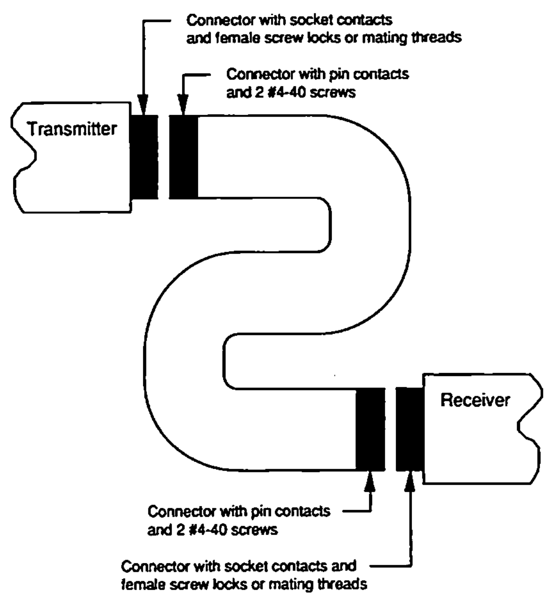


Figure 6 – Cable connector assembly

Annex A (normative)
ECL 10,000 and 10H000 parameters

A.1 Standard ECL parameters

"Standard ECL" in this application means an integrated circuit device of the ECL 10,000 or 10H000 series or equivalent. Typical key parameters are:

System power supply (V): –4.7 V to -5.7 V; –5.2 V nominal;

Logic states with respect to ground (typical): "1" = –0.8 V = High (H); "0" = –1.85 V = Low (L);

Output impedance: Open emitter-follower output (7 ohm typical) to drive terminated lines;

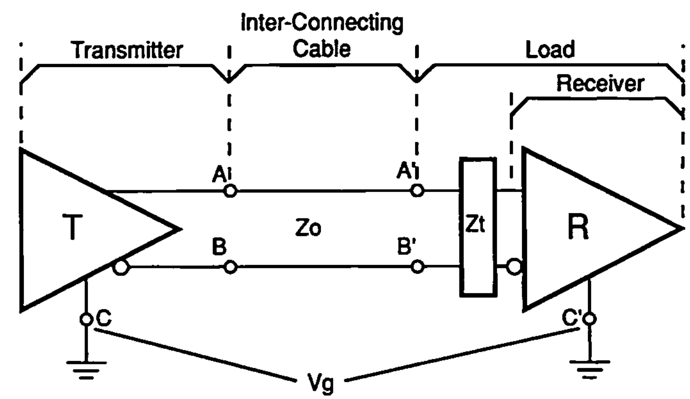
Propagation delay ECL 10,000: 2-3 ns per gate; typical edge speeds are 2-3 ns (20% to 80%);

Propagation delay ECL 10H000: 1-2 ns per gate; typical edge speeds are 1-2 ns (20% to 80%).

A.2 Balanced interface circuit

Each circuit consists of three parts as shown in figure A.1: the line driver, the balanced interconnecting cable, and the load. The line driver is comprised of a single transmitter (T) with a low-output impedance. The load is comprised of a single receiver (R), and a cable termination impedance (Zt).

Electrical characteristics of the receiver without cable termination shall conform to standard balanced ECL specifications. Use of a cable termination (Zt) is mandatory. Zt shall be nominally 110 ohms.



A, A' = data line
B, B' = return line
Zt = cable termination
A, B = transmitter interface points
A', B' = load interface points
C = transmitter circuit ground
C' = load circuit ground
Vg = ground potential difference
Zo = cable characteristic impedance

Figure A.1 – Balanced interface circuit

Annex B (normative)
Connector characteristics

The interface employs the 25 contact D subminiature connector, with the connectors on the transmitter and receivers using socket contacts and the connectors on the cable both using pin contacts. Connectors are locked together by two #4-40 screws on the cable connectors, which go in female screw locks mounted on the equipment connector.

Detailed dimensions for the connector are given in MIL-C-24308C.

The relative position of the connector and the female screw lock is defined in figure B.1. Recommended minimum connector spacing is defined in figure B.2.

It is recommended that the cable connectors employ a conductive backshell to maintain shielding of the signal conductors. Care must be taken to select designs that are appropriate for use with the screw-latching method specified.

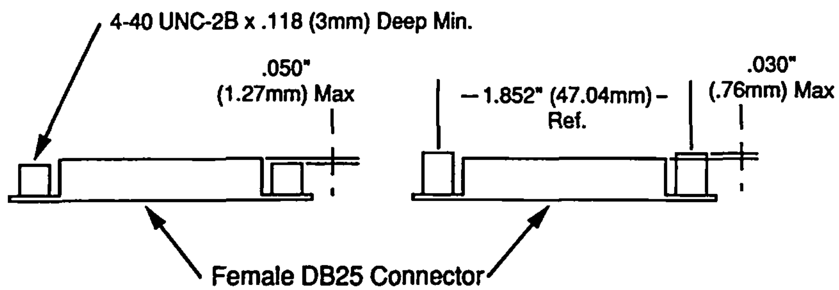


Figure B.1 – Female screw lock mounting

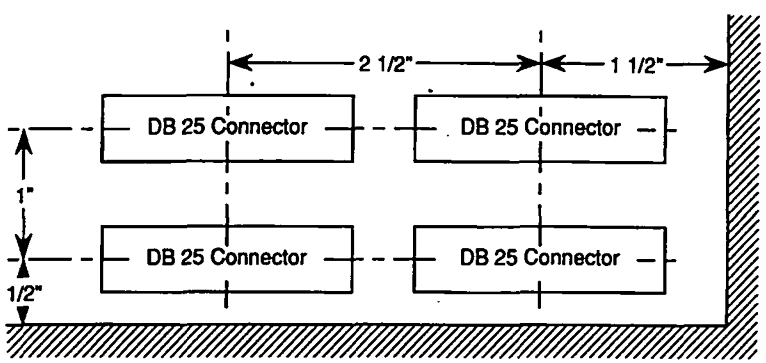


Figure B.2 – Minimum connector spacing

Annex C (informative)
Cable shield pin

The cable shield (pin 13) is for the purpose of controlling electromagnetic radiation from the cable. It is recommended that pin 13 provide high-frequency continuity to the chassis ground at both ends and, in addition, provide DC continuity to the chassis ground at the transmit end.

Annex D (informative)
Connector orientation

Vertical or horizontal mounting: Contact 1 uppermost.

Annex E (informative)
Monochrome operation

Monochrome operation at 29.97 Hz frame rate can be achieved by setting the color-difference signals (C_B, C_R) to zero (200_h).

Annex F (informative)
Error detection and correction in the video timing reference signal

Table F.1 enables single-bit errors in the fourth bytes of EAV and SAV to be corrected. Double errors, and some multiple-bit errors, are detected but not corrected. The table gives corrected values for bits 8, 7, and 6 where possible. Multiple errors are denoted by asterisks.

Table F.1 – Error correction table

Received P3 – P0	Received bits 8, 7, and 6 (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	010	*
1110	*	*	*	011	*	101	110	*
1111	*	001	010	*	100	*	*	*

Annex G (informative)
Picture centering

Relative horizontal picture centering for 13.5-MHz and 18-MHz sampling structures is shown in figure G.1.

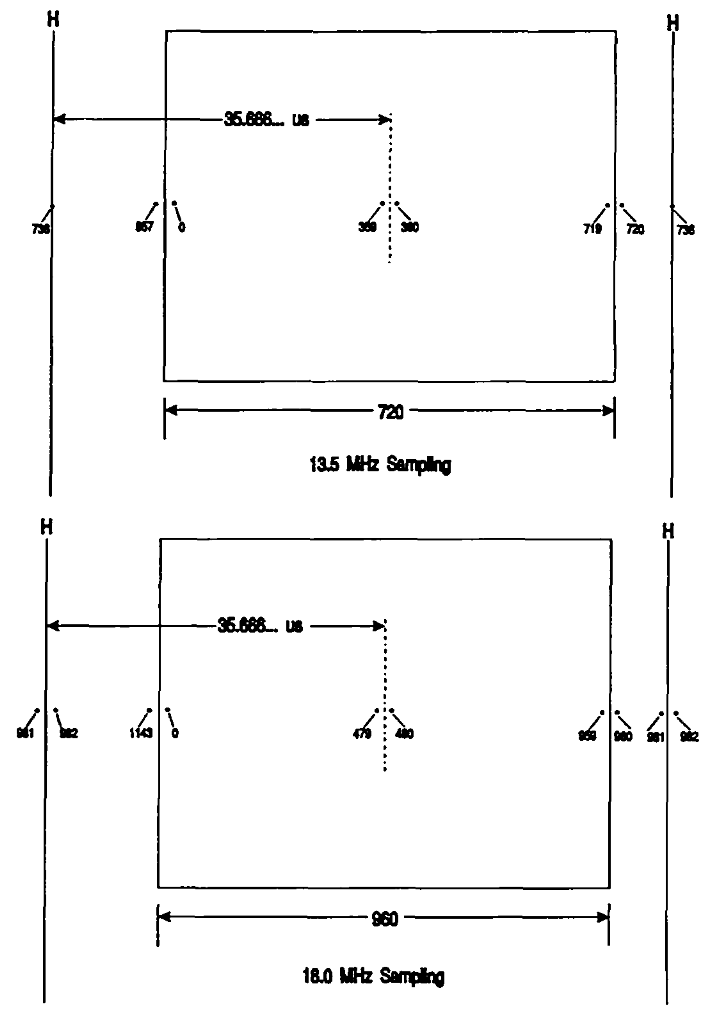


Figure G.1 – Horizontal picture centering for 525/59.94 component systems

Annex H (informative)
Bibliography

ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

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

MIL-C-24308C, General Specification for Connectors, Electric, Rectangular, Nonenvironmental, Miniature, Polarized Shell, Rack and Panel

CCIR Recommendation 601-2, Encoding Parameters of Digital Television for Studios

CCIR Report 962-1, The Filtering, Sampling and Multiplexing for Digital Encoding of Colour Television Signals

Documents are in preparation to cover auxiliary signals (HANC, VANC, DVITC, and video index), but are not yet available.

PROPOSED SMPTE STANDARD

SMPTE 268M

File Format for Digital Moving-Picture Exchange (DPX)

1 Scope

1.1 This standard defines a file format for the exchange of digital moving pictures on a variety of media between computer-based systems. It does not define the characteristics of input or output devices or displays. This format will be known as the SMPTE digital picture exchange format version 1.0, or DPX in short form. The file extension will be .dpx.

1.2 This flexible, resolution-independent file format describes pixel-based (raster) images with attributes defined in the binary file header. Each file represents a single image with up to eight image elements. Image elements are defined as a single component (e.g. luminance) or multiple components (e.g. red, green, and blue) as defined by table 1.

1.3 Image data is packed for efficient storage with the option to pad to 32-bit word boundaries. Multibyte quantities may be stored with either the most significant byte first or the least significant byte first, where first means in the location with the lowest address, or the first byte in sequence from a byte-serial data channel. Both byte-order conventions are supported. The "magic number" in field 1 of the file information section is used to distinguish the byte order (annex A provides an historical perspective for the existence of the two byte-order conventions).

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.

ANSI X3.4-1986 (R1992), Information Processing — Coded Character Set — 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

ANSI/IEEE 754-1985 (R1991), Binary Floating-Point Arithmetic

ANSI/SMPTE 12M-1986, Television — Time and Control Code — Video and Audio Tape for 525-Line/60-Field Systems

ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 254-1992, Motion-Picture Film (35-mm) — Manufacturer-Printed, Latent Image Identification Information

SMPTE 240M-1988, Television — Signal Parameters — 1125/60 High-Definition Production System

CCIR Recommendation 601-2, Encoding Parameters of Digital Television for Studios

CCIR Recommendation 709-1, Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange

3 File

3.1 The file contains four sections:

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Table 1 – Image element descriptors

Value	Components (and order in unpacked stream)
0	User defined (or unspecified single component)
1	Red (R)
2	Green (G)
3	Blue (B)
4	Alpha (matte)
6	Luminance (Y)
7	Chrominance (C_B, C_R, subsampled by two)
8	Depth (Z)
9	Composite video
10–49	Reserved for future single components
50	R,G,B
51	R,G,B, alpha
52	Alpha, B, G, R
53–99	Reserved for future RGB ++ formats
100	C_B, Y, C_R, Y (4:2:2) — based on SMPTE 125M
101	C_B, Y, a, C_R, Y, a (4:2:2:4)
102	C_B, Y, C_R (4:4:4)
103	C_B, Y, C_R, a (4:4:4:4)
104–149	Reserved for future C_BYC_R ++ formats
150	User-defined 2-component element
151	User-defined 3-component element
152	User-defined 4-component element
153	User-defined 5-component element
154	User-defined 6-component element
155	User-defined 7-component element
156	User-defined 8-component element
157–254	Reserved for future formats

NOTES

1 These values describe the components that make up an image element and their order. A pixel consists of 1-8 components as specified by field 21.6. All components in an image element have the same number of bits and the same data metric. It is anticipated that this table will be expanded as additional component types and interleaves become common practice.

2 For any of the subsampled C_B, Y, C_R formats, a pixel for the purposes of run-length encoding and component packing is really two picture elements. The pixels per line specified in field 19 refer to the number of picture elements in the original image and must be an even number.

Generic file information, image information, data format, and image origination information (fixed length);

Motion-picture and television industry-specific information (fixed length);

User-defined information. This section provides an extended area for customized information needed by some users. The format of this section is not defined by the standard. This section is variable length with a minimum length of 1 Mbyte. It may be of zero length;

Image data.

3.2 Each field in the file header contains data of specified types. The valid types (and undefined values) for each field are:

Type	Undefined value
U8 unsigned 8-bit integer	FF hex
U16 unsigned 16-bit integer	FFFF hex
U32 unsigned 32-bit integer	FFFFFFFF hex
R32 32-bit real number (IEEE floating point)	0xFFFFFFFF hex
ASCII	0 hex (NULL character)

3.3 To provide a streamlined path for implementation and testing, a core set of fields has been identified with a "C" in the field designation table. This core set contains:

The minimum amount of information that a reader needs to read and interpret a file;

A core-compliant reader must read the core fields, but need not read the others;

A core-compliant writer must fill the core fields with valid values (undefined values are not permitted). Non-core fields must be filled with UNDEFINED values if the correct value is not known.

3.4 Unless stated otherwise, all references in this standard to binary data, sizes, offsets, and lengths are in units of bytes. Positions within the file are specified in terms of the number of bytes from the beginning of the file, with the first byte designated as byte 0. Offsets to individual fields are specified from the first byte.

3.5 All ASCII character strings are terminated by a NULL (zero) byte.

4 Definitions

The reference field number from clauses 5 and 6 is indicated in brackets at the end of the definition:

4.1 magic number: Indicates the start of the image file and is used to determine byte order. The file format allows machines to create files in either of the two most common byte orders, whichever is easier for that machine. Byte-order translation is only required for machines reading files that were created on a machine with reverse byte order. Programs creating DPX files should write the magic number with the ASCII value of "SDPX" (0x53445058 hex). Programs reading DPX files should use the first four bytes to determine the byte order of the file. The first four bytes will be S, D, P, X if the byte order is most significant byte first, or X, P, D, S if the byte order is least significant byte first. [1]

4.2 ditto key: Indicates that all fields are the same as the previous frame in the sequence except for fields related to the frame number (48, 50, 58, 61). Also, the offsets to the image data (21.12) will change if run-length encoding is used. The ditto key is a read-time shortcut only, and the other fields in the header must still be filled in when the file is created. [5]

4.3 creation date/time: Is defined as YYYY:MM:DD:HH:MM:SS:LTZ. [10]

4.4 encryption key: Indicates that the image data is encrypted to prevent unauthorized use. The default is FFFFFFFF for no encryption. Any other value indicates that the image data is encrypted and this value can be used as the encryption key. Note that the header data is not encrypted. [15]

4.5 image orientation: Indicates the orientation of the image data required for display. The possible orientations are listed in table 2. The standard orientation for core set images (code 0) is left to right (line direction) and top to bottom (frame direction). [17]

A data structure (group of fields) is repeated for each image element. An image element can contain a

single component or multiple components, as defined in table 1. All components in an image element have the same number of bits, transfer function, and colorimetric specification. [21]

4.6 reference low data code value: Defines the minimum expected code value for image data. For printing density, the default value is 0. For CCIR 601-2 luminance, the default value is 16. [21.2]

4.7 reference low quantity represented: Defines the corresponding signal level or measured value to the reference low data code value. For printing density, the default is a density of 0.00. For CCIR 601-2, the luminance default is 0 mV. [21.3]

4.8 reference high data code value: Defines the maximum expected code value for image data. For 10-bit printing density, the default code value is 1023. For CCIR 601-2 luminance, the default value is 235. [21.4]

4.9 reference high quantity represented: Defines the corresponding signal level or measured value to the reference high data code value. For printing density, the default is a density of 2.047. For CCIR 601-2 luminance, the default is 700 mV. [21.5]

4.10 descriptor for image element n: Defines the components that make up an image element and their pixel-packing order. The valid components are listed in table 1. [21.6]

4.11 transfer characteristic: Defines the amplitude transfer function used to transform the data from a linear original. The inverse of the transfer function is needed to recreate a linear image element (see table 5A). [21.7]

4.12 colorimetric specification: Defines the appropriate color reference primaries (for additive color systems like television) or color responses (for printing density) (see table 5B). [21.8]

4.13 bit size: Defines the number of bits for each component in the image element. All components must have the same bit size. Valid bit sizes are 1-, 8-, 10-, 12-, and 16-bit integer, and 32- and 64-bit IEEE floating point (see table 3A). [21.9]

4.14 packing: For image element n, defines the data-packing mode. The valid options are listed in table 3B. [21.10]

4.15 encoding: For image element n, defines whether or not the element is run-length encoded. The valid options are listed in table 3C. [21.11]

Table 2 – Image orientation code

Code	Line direction	Frame direction
0[1)]	Left to right	Top to bottom
1	Right to left	Top to bottom
2	Left to right	Bottom to top
3	Right to left	Bottom to top
4	Top to bottom	Left to right
5	Top to bottom	Right to left
6	Bottom to top	Left to right
7	Bottom to top	Right to left
8–254	Reserved for future use	

[1)] Orientation 0 is the only one supported in the core set file format.

Table 3A – Valid bit sizes for image elements

1	integer
8	integer
10	integer
12	integer
16	integer
32	IEEE floating point (R32)
64	IEEE floating point (R64)

Table 3B – Component data packing method

0	Packed into 32-bit words[1)]
1	Filled to 32-bit words[2)]
2–7	Reserved for future use

NOTE – This table contains the values for field 21.10, component data packing. Note that all components in a pixel (including the run-length flag if used) are the same bit size (a diagram illustrating the packing of 8-, 10-, 12-, and 16-bit channels into 32-bit words is included in annex B).

[1)]For 1-bit components, the component pixels are first packed into bytes with the left-most (first) pixel bit in the least significant bit of the byte. The bytes are then sequenced according to the order specified by field 21.10 and packed into 32-bit words in the same manner as 32-bit data.

[2)]1-, 8-, and 16-bit data never needs filling; therefore, the corresponding states are not needed.

Table 3C – Component data encoding method

0	No encoding applied
1	Run-length encoded[1)]
2–7	Reserved for future use

NOTE – This table contains the values for field 21.11, component data encoding. Only run-length encoding is specified at this time, but there is provision for future expansion.

[1)]With run-length encoding, the components of consecutive pixels are grouped into "runs" which are preceded by a run-length flag. The RL flag has the same size as each component. Once again, the resulting data stream is packed as specified by field 21.10.

The least significant bit of the run-length flag signals a run of pixels which are all the same if set, and a run of pixels which are all different if clear. The remaining bits indicate the number of pixels in the run. In the case of a run of all the same pixels, the flag word is followed by a single pixel which is to be replicated to fill out the run. In the case of a run of all different pixels, the flag is followed by a run-length of pixels.

Runs will always break at scan-line boundaries. Packing will always break to the next 32-bit word at scan-line boundaries.

4.16 offset: To data for image element n, defines the offset in bytes to the image data for element n from the beginning of the file. [21.12]

4.17 end-of-line padding: Specifies the number of padded bytes at the end of each line. The default is 0 (no padding). [21.13]

4.18 end-of-image padding: Specifies the number of padded bytes at the end of each image element. The default is 0 (no padding). [21.14]

4.19 X offset: Defines the line offset (in pixels) from the first pixel in the original image. The default is 0. This is useful if an image is cropped and the user wishes to specify its location with respect to the original contiguous image. [30]

4.20 Y offset: Defines the frame offset (in lines) from the first line in the original contiguous image. The default is 0. [31]

4.21 X center: Defines the X image center in pixel units (floating point). [32]

4.22 Y center: Defines the Y image center in line units (floating point). [33]

4.23 X original size: Defines the number of pixels per line in the original image. [34]

4.24 Y original size: Defines the number of lines per image in the original image. [35]

4.25 source image filename: Defines the source image from which this image was extracted or processed. [36]

4.26 source image date/time: Defines the creation time of the source image from which the image was extracted or processed. [37]

4.27 border validity: Defines the region of an image that is eroded due to edge-sensitive filtering operations. The X-left, X-right, Y-top, and Y-bottom value defines the width of the eroded border. The default is 0,0,0,0 in pixel units (no erosion). [40]

4.28 pixel aspect ratio: Is specified as the ratio of a horizontal integer and a vertical integer. For example, a SMPTE 240M signal has a pixel aspect ratio of approximately 0.9583, which is 1920 active pixels and 1035 active lines in a 16:9 frame, and is specified as 16560:17280 or 23:24. [41]

4.29 frame position in sequence: Defines the frame number in the image sequence. [50]

4.30 sequence length: Defines the total number of frames in the image sequence. [51]

4.31 held count: Specifies how many sequential frames for which to hold the current frame. In animation, it is often desirable to hold identical frames. [52]

4.32 shutter angle: Defines the shutter angle in degrees of the motion-picture camera. This specifies the temporal sampling aperture. [54]

4.33 frame identification: A user-defined field that labels select frames as key frames or wedge frames, etc. [55]

4.34 slate information: A user-defined ASCII field for recording production information from the camera slates. [56]

4.35 field number: Of the first field in the file, may be 1 or 2 for component video, 1 to 4 for NTSC or component video decoded from NTSC, or 1 to 12 for PAL or component video decoded from PAL. Color frame sequence information is useful when decoding and subsequently re-encoding component video. The field number is set to 0 where field designation is inappropriate. [61]

4.36 video signal standard: Defines the video source. Video signal standards are listed in table 4. [62]

4.37 time offset from sync to first pixel (microseconds): Defines the edge of the digital image with respect to sync and the sampling phase which is necessary to reconstruct a composite image. The sync reference is the reference edge of horizontal sync. [67]

Table 4 – Video signal standard

Code	Signal standard
0	Undefined[1)]
1	NTSC
2	PAL
3	PAL-M
4	SECAM
5–49	Reserved for composite video
50	YC_BC_R CCIR 601-2 525-line, 2:1 interlace, 4:3 aspect ratio
51	YC_BC_R CCIR 601-2 625-line, 2:1 interlace, 4:3 aspect ratio
52–99	Reserved for component video
100	YC_BC_R CCIR 601-2 525-line, 2:1 interlace, 16:9 aspect ratio
101	YC_BC_R CCIR 601-2 625-line, 2:1 interlace, 16:9 aspect ratio
102–149	Reserved for future widescreen
150	YC_BC_R 1050-line, 2:1 interlace, 16:9 aspect ratio
151	YC_BC_R 1125-line, 2:1 interlace, 16:9 aspect ratio (SMPTE 240M)
152	YC_BC_R 1250-line, 2:1 interlace, 16:9 aspect ratio
153–199	Reserved for future high-definition interlace
200	YC_BC_R 525-line, 1:1 progressive, 16:9 aspect ratio
201	YC_BC_R 625-line, 1:1 progressive, 16:9 aspect ratio
202	YC_BC_R 787.5-line, 1:1 progressive, 16:9 aspect ratio
203–254	Reserved for future high-definition progressive

1) For the undefined video signal standard, it is necessary to specify the following fields that would otherwise be fully specified by selecting one of the video signal standards:

68 Gamma
69 Black level code value
70 Black gain
71 Breakpoint
72 Reference white level code value

4.38 gamma: Defines the power law exponent that represents the gamma correction applied to a video image. In the expression, $Y = X^{1/gamma}$, the default gamma for NTSC is 2.2. [68]

4.39 black level code value: Defines the digital code value representing reference black (camera lens capped, RGB signal set to 0 mV). For CCIR 601-2, the default black level code value is 16. [69]

4.40 black gain: Defines the linear gain applied to signals below the breakpoint (this is 4.0 for SMPTE 240M). [70]

4.41 breakpoint: Defines the signal level above which the gamma law is applied (this is 0.0228 of full scale for SMPTE 240M). [71]

4.42 reference white level code value: Defines the digital code value representing reference white (90% reflectance white card, RGB signal set to 700 mV). For CCIR 601-2, the default reference white level code value is 235. [72]

4.43 integration time: Defines the temporal sampling aperture of the television camera; most useful for CCD cameras. [73]

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5 Generic image data

5.1 File information

Field	Offset	Length	Type	Core	Content
1	0	4	U32	C	Magic number (SDPX ASCII)
2	4	4	U32	C	Offset to image data in bytes
3	8	8	ASCII	C	Version number of header format (V1.0)
4	16	4	U32	C	Total image file size in bytes
5	20	4	U32		Ditto key (0 = same as previous frame; 1 = new)
6	24	4	U32		Generic section header length in bytes
7	28	4	U32		Industry specific header length in bytes
8	32	4	U32		User-defined header length in bytes
9	36	100	ASCII		Image filename
10	136	24	ASCII		Creation date/time: YYYY:MM:DD:HH:MM:SS:LTZ
12	160	100	ASCII		Creator
13	260	200	ASCII		Project name
14	460	200	ASCII		Right to use or copyright statement
15	660	4	U32		Encryption key (FFFFFFFF unencrypted)
16	664	104	TBD		Reserved for future use

5.2 Image information

Field	Offset	Length	Type	Core	Content
17	768	2	U16	C	Image orientation (see table 2)
18	770	2	U16	C	Number of image elements (1-8)
19	772	4	U32	C	Pixels per line
20	776	4	U32	C	Lines per image element
21			Data structure for each image element:		
21.1	780	4	U32	C	Data sign (0 = unsigned; 1 = signed) Core set images are unsigned.
21.2	784	4	U32		Reference low data code value
21.3	788	4	R32		Reference low quantity represented
21.4	792	4	U32		Reference high data code value
21.5	796	4	R32		Reference high quantity represented
21.6	800	1	U8	C	Descriptor for image element 1 (see table 1)
21.7	801	1	U8	C	Transfer characteristic for image element 1 (see table 5A)
21.8	802	1	U8	C	Colorimetric specification for image element 1 (see table 5B)
21.9	803	1	U8	C	Bit size for image element 1 (see table 3A)
21.10	804	2	U16	C	Packing for image element 1 (see table 3B)
21.11	806	2	U16	C	Encoding for image element 1 (see table 3C)
21.12	808	4	U32	C	Offset to data for image element 1
21.13	812	4	U32		End-of-line padding for image element 1
21.14	816	4	U32		End-of-image padding for image element 1
21.15	820	32	ASCII		Description of image element 1

5.2 Image information (continued)

Field	Offset	Length	Type	Content
22	852	72	Structure	Image element 2
23	924	72	Structure	Image element 3
24	996	72	Structure	Image element 4
25	1068	72	Structure	Image element 5
26	1140	72	Structure	Image element 6
27	1212	72	Structure	Image element 7
28	1284	72	Structure	Image element 8
29	1356	52	TBD	Reserved for future use

5.3 Image orientation information

Field	Offset	Length	Type	Content
30	1408	4	U32	X offset
31	1412	4	U32	Y offset
32	1416	4	R32	X center
33	1420	4	R32	Y center
34	1424	4	U32	X original size
35	1428	4	U32	Y original size
36	1432	100	ASCII	Source image filename
37	1532	24	ASCII	Source image date/time: YYYY:MM:DD:HH:MM:SS:LTZ
38	1556	32	ASCII	Input device name
39	1588	32	ASCII	Input device serial number
40	1620	8	U16*4	Border validity: XL, XR, YT, YB border
41	1628	8	U32*2	Pixel aspect ratio (horizontal:vertical)
42	1636	28	TBD	Reserved for future use

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Table 5A – Transfer characteristic

Code	Transfer characteristic
0	User defined
1	Printing density
2	Linear
3	Logarithmic
4	Unspecified video
5	SMPTE 240M
6	CCIR 709-1
7	CCIR 601-2 system B or G (625)
8	CCIR 601-2 system M (525)
9	Composite video (NTSC); see SMPTE 170M
10	Composite video (PAL); see CCIR 624-4
11	Z (depth) – linear
12	Z (depth) – homogeneous (distance to screen and angle of view must also be specified in user-defined section)
13-254	Reserved for future use

Table 5B – Colorimetric specification

Code[1)]	Colorimetric specification
0	User defined
1	Printing density
2	Not applicable
3	Not applicable
4	Unspecified video
5	SMPTE 240M
6	CCIR 709-1
7	CCIR 601-2 system B or G (625)
8	CCIR 601-2 system M (525)
9	Composite video (NTSC); see SMPTE 170M
10	Composite video (PAL); see CCIR 624-4
11	Not applicable
12	Not applicable
13-254	Reserved for future use

[1)]The codes are assigned to correspond to those in table 5A, except where there is no appropriate colorimetric specification.

6 Industry-specific data

6.1 Motion-picture film information

Field	*Offset*	*Length*	*Type*	*Content*
43	1664	2	ASCII	Film mfg. ID code (2 digits from film edge code)
44	1666	2	ASCII	Film type (2 digits from film edge code)
45	1668	2	ASCII	Offset in perfs (2 digits from film edge code)
47	1670	6	ASCII	Prefix (6 digits from film edge code)
48	1676	4	ASCII	Count (4 digits from film edge code)
49	1680	32	ASCII	Format – e.g., Academy
50	1712	4	U32	Frame position in sequence
51	1716	4	U32	Sequence length (frames)
52	1720	4	U32	Held count (1 = default)
53	1724	4	R32	Frame rate of original (frames/s)
54	1728	4	R32	Shutter angle of camera in degrees
55	1732	32	ASCII	Frame identification – e.g., keyframe
56	1764	100	ASCII	Slate information
57	1864	56	TBD	Reserved for future use

6.2 Television information

Field	Offset	Length	Type	Content
58	1920	4	U32	SMPTE time code
59	1924	4	U32	SMPTE user bits
60	1928	1	U8	Interlace (0 = noninterlaced; 1 = 2:1 interlace)
61	1929	1	U8	Field number
62	1930	1	*U8*	*Video signal standard (see table 4)*
63	1931	1	U8	Zero (for byte alignment)
64	1932	4	R32	Horizontal sampling rate (Hz)
65	1936	4	R32	Vertical sampling rate (Hz)
66	1940	4	R32	Temporal sampling rate or frame rate (Hz)
67	1944	4	R32	Time offset from sync to first pixel (μs)
68	1948	4	R32	Gamma
69	1952	4	R32	Black level code value
70	1956	4	R32	Black gain
71	1960	4	R32	Breakpoint
72	1964	4	R32	Reference white level code value
73	1968	4	R32	Integration time (s)
74	1972	76	TBD	Reserved for future use

7 User defined data

Field	Offset	Length	Type	Content
75	2048	32	ASCII	User identification
76	2080	xx	TBD	User defined — Postage stamp, processing logs, etc. Length is variable with maximum length of 1 Mbyte.

8 Image data

Field	Offset	Length	Type	Content
77	xx	xx	Array U8*4	Image data should start at block boundary (8-K blocks *are recommended for efficient use of tape-storage devices.*

Annex A (informative)
Byte-order conventions

Digital computers save information in a form commonly known as bits. For convenient (and fast) information manipulation, most computers manipulate more than one bit at a time. They manipulate multiple bits as a symbol, the most common of which is a byte (8 bits). A further extension of this concept is to manipulate more than one byte at a time, working with multibyte words. The word size is built into the computer hardware and cannot be altered by software.

As computers were developed, there was no standardization between different types of computers and data format. Two different orderings of bytes in words were developed in parallel. Early on, there were arguments for standardization of byte order. However, the arguing proponents became entrenched and now there is an equal number of both types of systems in use.

When one generates files on one type of computer for exchange with another, the receiver of the file must know what type of computer generated it in order to interpret it properly. The most common automatic method for doing this is to create a magic number. The magic number is a multi-byte word with the largest number of bytes per word that the file will contain. Each byte of the magic number is different from all others and the magic number is published with the file format specification. This magic number is then coded into the file reader software so that the reader can define *the byte order of the computer generating the file. If the* file-reading computer sees the magic number in its correct format, then it has the same byte order as the file-generating computer. If not, the reading computer must convert all the multibyte words in the file into its own byte order before it can use the data.

The reason that most file formats (including SMPTE DPX) do not dictate a particular byte order is that it unfairly burdens one-half of the computers in use. These computers, even when communicating between themselves exclusively, would have to convert all of the multibyte words when creating a file and convert them back when reading a file.

Annex B (informative)
Data-packing diagram

B.1 Packing

This diagram illustrates the packing of 8-, 10-, 12-, and 16-bit components into 32-bit words, using the most-significant-byte-first convention.

```
8-bit component(s):
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0        datum 3    datum 2    datum 1    datum 0  |
4        datum 7    datum 6    datum 5    datum 4  |

10-bit component(s):
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0      | d3|  datum 2   |   datum 1   |  datum 0   |
4      |  d6 |   datum 5   |   datum 4   | datum 3 |
8      |   d9  |   datum 8   |   datum 7   | datum 6 |
12     | ...

10-bit component(s) filled to 32-bit word boundaries:
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0      | 00|  datum 2   |   datum 1   |  datum 0    |
4      | 00|  datum 5   |   datum 4   |  datum 3    |
                                                   |

12-bit component(s):
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0      |  datum 2 |    datum 1   |    datum 0      |
4      |  d5 |    datum 4    |    datum 3    |  d2 |
8      |     datum 7    |    datum 6    |  datum 5 |

12-bit component(s) filled to 16-bit word boundaries:
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0      | 0000|    datum 1    | 0000|    datum 0    |
4      | 0000|    datum 3    | 0000|    datum 2    |
```

NOTE – This does not follow the precedent of the 10-bit filled case, but this form can be handled efficiently by most machines as an array of short words. It costs nothing, as the same number of bits/word are wasted.


```
16-bit component(s):
bytes:                     bits:
       | 33222222 | 22221111 | 11111100 | 00000000 |
       | 10987654 | 32109876 | 54321098 | 76543210 |
0      |       datum 1       |       datum 0       |
4      |       datum 3       |       datum 2       |
```

B.2 Method used to construct table

For the nonfilled formats, the zero datum (component) is placed in the least significant n bits of the first 32-bit word. The next datum is placed in the next most significant n bits. When a datum no longer fits in the remaining bits of a 32-bit word, it is broken, with as many least significant bits as will fit placed in the first 32-bit word, and the remaining bits placed in the low-order bits of the next 32-bit word.

Any bits in the last word of a scan line left over will be filled with zeroes. That is to say that the packing is broken on scan-line boundaries.

Annex C (informative)
Bibliography

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