SMPTE ENGINEERING GUIDELINE

Telecine Scanning for Film Transfer to Television

1 Scope

This guideline specifies the maximum film image area and minimum image size range that a telecine should be capable of scanning to transfer motion-picture images to television.

2 Normative references

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

ANSI/SMPTE 7-1988, Motion-Picture Film (16-mm) — Camera Aperture Image and Usage

ANSI/SMPTE 59-1989, Motion-Picture Film (35-mm) — Camera Aperture Images

ANSI/SMPTE 152-1989, Motion-Picture Film (70-mm) — Projectable Image Area

ANSI/SMPTE 201M-1988, Motion-Picture Film (16-mm) — Type W Camera Aperture Image

ANSI/SMPTE 215-1990, Motion-Picture Film (65-mm) — Camera Aperture Image

3 Film image area and size

3.1 The film to video transfer device must be capable of reproducing the total camera aperture area. Film scanning requirements for five film formats are listed in table 1.

3.2 The film to video transfer device must be capable of variable x size, y size, and zoom. The x and y sizes must be independently and continuously variable over a minimum 2:1 range.

3.3 If the film image area selected for video transfer is less than the full intended scene captured by the camera, it should be possible to reposition the scanned area for video transfer anywhere within the available original intended scene image area.

Table 1 – Film scanning requirements

Film format	Maximum height		Maximum width	
	mm	in	mm	in
Super 16 mm	7.57	0.298	12.52	0.493
16 mm	7.59	0.299	10.26	0.404
35 mm	18.72	0.737	24.89	0.980
65 mm	23.52	0.926	52.48	2.066
70 mm*	23.52	0.926	52.48	2.066

*See annex A.

Approved April 1, 1991

Annex A (informative)

It is recognized that for artistic or technical reasons, the variable x, y, and zoom may be independently variable over a greater than 2:1 range. The value given in 3.2 represents a minimum value only.

The maximum dimensions given in clause 3 represent the limiting areas within which the camera aperture may have been positioned. Each width dimension is the specified nominal value from the appropriate standard. Each height dimension is the sum of the specified image height plus the positive tolerance, from the appropriate standard.

For example, in the case of 35 mm

width = 24.89 mm
height = 18.67 mm + 0.05 mm = 18.72 mm

Note that certain 70 mm elements may have images printed perforation to perforation. Therefore, the maximum film image area for 70 mm is the same as for 65 mm.

SMPTE ENGINEERING GUIDELINE

EG 26-1991

Audio Channel Assignments for Digital Television Tape Recorders with AES/EBU Digital Audio Inputs

1 Scope

1.1 This guideline specifies the allocation of input audio signals to digital audio channels on digital television tape recorders (DTTRs) when the inputs are connected through AES/EBU digital interfaces.

1.2 This guideline also specifies preferred assignments of programs to audio recording channels, on the basis of program type, for purposes of program exchange.

2 Normative references

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

ANSI S4.40-1985, Digital Audio Engineering — Serial Transmission Format for Linearly Represented Digital Audio Data

SMPTE 227M, Television Digital Component Recording — 19-mm Type D-1 — Helical Data and Control Records

SMPTE 247M, Television Digital Recording — 19-mm Type D-2 Composite Format — Helical Data and Control Records

EBU Recommendation R48-1988, Allocation of Audio Channels in the D-1 Digital Television Tape Recording Format

3 Definitions

3.1 DTTR digital audio channel: The portion of the recorded data stream on a digital video recorder which contains sampled, quantized, and digitally represented audio information from a single audio channel. DTTRs may contain more than one of these channels, each of which is uniquely identified.

3.2 AES/EBU data stream: A stream of data corresponding to the recommendations of ANSI S4.40-1985 for the serial digital transmission of two channels of periodically sampled and linearly represented digital audio data. The following definitions are quoted from ANSI S4.40-1985:

3.2.1 audio sample data: An audio signal that has been periodically sampled, quantized, and digitally represented in twos complement form.

3.2.2 subframe: A set of audio sample data accompanied by other data containing auxiliary information. Two subframes, one for each channel, are transmitted in sequence in any one period of the source sampling frequency.

3.2.3 frame: A sequence of two subframes, each carrying audio sample data for a single channel, transmitted in one sample period. The first subframe in the frame is subframe A, the second is subframe B. (ANSI S4.40-1985 contains an error in this section, stating that each subframe carries "audio sample data for each of two channels." The document is under revision, and the next issue will conform to the content indicated here.)

Approved April 1, 1991

4 Default channel assignments for DTTRs with four AES/EBU digital inputs

4.1 This clause is applicable to DTTRs equipped with four input connectors and four output connectors conforming to ANSI S4.40-1985. The data streams arriving at these inputs each contain two audio channels, labelled A and B. Each of the channels has a status word identifying the relationship between the A and B channels, as follows:

Status	Meaning
0	Mode not indicated, receiver defaults to two-channel mode
1	Two-channel mode
2	Single-channel mode (monophonic)
3	Primary/secondary mode (subframe A is primary)
4	Stereophonic mode (subframe A is left channel)
5-E	Undefined
F	Vector to byte 3 for future applications

4.2 The four digital audio recording channels in such a DTTR can only accept data from four of the eight incoming audio channels. As the DTTR is not transparent to all possible combinations of inputs, this guideline establishes a convention for the default relationship between audio channels on the input connectors and DTTR digital audio channels.

4.3 The assignment of input channels to DTTR channels in this convention is based upon the status word of the incoming data stream, and the input connector number as follows:

DTTR channel	Input channel carried	Conditions
1	1-A	Always
2	1-B	If input 1 status is 0,1,3,4
	2-A	If input 1 status is 2 or undefined
3	3-A	Always
4	3-B	If input 3 status is 0,1,3,4
	4-A	If input status is 2 or undefined

4.4 Output channels are data-filled, where possible, so as to be identical to the equivalent-numbered input.

4.5 Audio channels which arrive on an input connector, but which cannot be recorded due to the limited number of DTTR digital audio channels, are replaced with a null-filled channel at the identically-numbered output connector.

4.6 As a consequence of this convention, the DTTR is normally constrained to accept two-channel signals only if they appear on input connectors 1 and 3, and will not accept single-channel signals appearing on input connectors 2 and 4, respectively, when channel 1 or 3 is carrying a two-channel signal. Input channels 2-B and 4-B are never recorded.

4.7 The DTTR may, optionally, provide a means to reconfigure the input-to-DTTR and DTTR-to-output channel assignments.

5 Default channel assignments for DTTRs with two AES/EBU digital inputs

5.1 This clause is applicable to DTTRs equipped with two input connectors and two output connectors conforming to ANSI S4.40-1985. In this case, the default allocation of incoming audio channels among the four DTTR digital audio channels is as follows:

DTTR channel	Input data carried
1	1-A
2	1-B
3	2-A
4	2-B

5.2 The DTTR may, optionally, provide a means to reconfigure the input-to-DTTR and DTTR-to-output channel assignments.

6 Channel allocations for program exchange

6.1 For the purpose of inter-company and international exchange of programs, it is advantageous to adhere to a consistent assignment of program types to specific audio channels. This simplifies the task of ensuring correct interface of program content to delivery channels at the playback location, and eases the requirements for labeling tapes.

6.2 Programs for exchange may include one or more of the following categories of audio information recorded in the DTTR digital audio channels:

- Program (complete mix)
- International sound
- Commentary
- Music
- Effects
- SAP (second audio program)

6.3 Any of these, except SAP, may be monophonic or stereophonic.

6.4 The following assignment of categories of audio information to DTTR digital audio channels is recommended, when the types of programs indicated are recorded for exchange purposes:

DTTR channel	1 Monophonic program	2 Stereophonic program	3 Two complete stereophonic programs	4 Monophonic program with separate commentary	5 Stereophonic international sound with two separate commentaries	6 Stereophonic commentary and international sound	7 Non-mixed monophonic program	8 Stereophonic program and SAP
1	complete monophonic mix	complete mix, left	first program, complete mix, left	commentary	first commentary	commentary left	commentary	complete mix, left
2	blank	complete mix, right	first program, complete mix, right	blank	second commentary	commentary right	music	complete mix, right
3	international sound	international sound, left	second program, complete mix, left	international sound	international sound, left	international sound, left	effects 1	SAP
4	blank	international sound, right	second program, complete mix, right	blank	international sound, right	international sound, right	effects 2	blank

PROPOSED SMPTE STANDARD

for Television Analog Recording — 1/2-in Type L — Tapes and Cassettes

1 Scope

This standard specifies the magnetic tapes and video cassettes for the 1/2-in type L helical-scan video tape recorder system.

2 Test conditions

2.1 Tests and measurements shall be made under the following conditions unless otherwise stated:

- Temperature 20°C ± 1°C
- Relative humidity (50 ± 2)%
- Stabilization time 24 hours

2.2 Dimensions shall be as specified in the figures and tables.

3 Mechanical characteristics of video cassettes

3.1 Outside dimensions

3.1.1 Two cassette sizes shall be identified as shown in table 1.

Table 1 – Cassette identification

Model	Outside dimensions (mm)	Figures
S – Small cassette	96 × 156 × 25	1 to 9
L – Large cassette	145 × 254 × 25	10 to 18

NOTE – For purposes of drawing clarity, the S cassette shell is represented as two different shells — oxide tape and metal-particle tape shells. It is the manufacturer's choice to manufacture single or dual shells.

3.2 Datum planes

3.2.1 Datum plane Z is determined by three datum spots, A, B, and C, as indicated in figures 3A and 12A.

3.2.2 Datum plane X shall be orthogonal to datum plane Z and include the center of datum holes (a) and (b), as shown in figures 2A/2B and 11.

3.2.3 Datum plane Y shall be orthogonal to both datum planes X and Z and include the center of datum hole (a), as shown in figures 2A/2B and 11.

3.3 Window area and label area

The crosshatched areas in figures 1A/1B and 10, defined as the label/window area, shall not protrude beyond the height of the cassette surface.

3.4 Manufacturer's identification holes

Three manufacturer's holes, referred to as recognition holes, shall be provided. (Refer to figures 2A/2B and 11.)

3.4.1 Tape type identification hole

Hole one shall identify the tape type within the cassette. The detected state "1" shall indicate metal-oxide tape; detected state "0" shall indicate metal-particle tape. Detection of tape type by the machine shall determine mode 1 or mode 2 operation.

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3.4.2 Tape thickness identification hole

Hole two shall identify tape thickness. Detected state "1" shall identify 20 µm tape; detected state "0" shall identify 15 µm tape.

3.4.3 Reel hub diameter identification hole

Hole three shall identify the reel hub diameter. Detected state "1" shall identify a small hub; detected state "0" shall identify a large hub. (See figures 6 and 15 for details concerning usage.)

3.5 Safety tab and plug

3.5.1 Usage

Use of the safety tab (for oxide) and safety plug (for metal) is intended to activate or produce a record lock-out condition in the event the safety tab or plug is activated.

3.5.2 S cassette

The S cassette may contain either oxide or metal-particle tape. When loaded with oxide tape, the safety tab (for oxide), as shown in figures 2A/2B, shall activate the mode 1 record lock-out condition if the tab is removed. A hole 10 mm minimum deep from datum plane Z, sec. CC in figures 2A/2B, defines the mechanical tolerances for the sensing device.

When loaded with metal-particle tape, the safety tab (for oxide) shall be removed (preventing the record condition for machines capable of mode 1 operation). The safety plug defined by sec. DD in figure 2B defines the mechanical tolerances for the sensing device. Detection of no hole shall cause the record lock-out condition for mode 2 to exist.

3.5.3 L cassette

The L cassette contains only one safety plug. If the safety plug is removed, both mode 1 and mode 2 record lock-out is activated. Dimensions of the safety plug are shown in sec. C-C of figure 11. The cassette may be loaded with either oxide or metal-particle tape.

3.5.4 Deformation

The safety tab and plug shall not be deformed over 0.3 mm when a force of 2.0 N is applied, using a 2.5-mm diameter rod.

3.6 Reels

3.6.1 The dimensions of the reels shall be in accordance with those given in figures 6 and 15.

3.6.2 The reels shall be automatically locked when the cassette is ejected from the video tape recorder or player unit.

3.6.3 The reels shall be automatically unlocked when the cassette is inserted into the video tape recorder/player unit. The reel shall be completely released when the cassette lid is opened 27.5 mm or more from datum plane Z.

3.6.4 The reels in the cassette shall be pressed by the reel spring with a specified force under the conditions specified in figures 7 and 16. The reel spring shape shall conform to figure 7 for the S cassette and figure 16 for the L cassette. The spring force shall be 1.5 N ± 0.5 N for the S cassette and 3.4 N ± 0.5 N for the L cassette when the reel is depressed to 2.0 mm +0.2 mm −0.1 mm above datum plane Z.

3.7 Cassette lid

3.7.1 The cassette shall be provided with a lid that is automatically unlocked when the cassette is inserted into the video tape recorder/player unit and automatically locked when the cassette is ejected.

3.7.2 The force needed to open the lid shall be 1.5 N or less. (See figures 9 and 18.)

3.7.3 The lid shall open 29.0 mm, as shown in figures 4 and 13, when the cassette is inserted into the video tape recorder/player unit.

3.7.4 The lid shall be unlocked when the lid lock lever is shifted in either direction A or B, as illustrated in figures 8 and 17. The force needed to unlock the lid shall not be greater than 1 N in the A direction and not greater than 1.5 N in the B direction.

4 Magnetic tape

4.1 Type

The magnetic tape used for 1/2-in type L helical-scan video tape recorders shall be either oxide tape or metal-particle tape.

4.2 Base material

The base material shall be polyester or its equivalent.

4.3 Tape width

The width of the magnetic tape shall be 12.65 mm ± 0.01 mm.

4.4 Tape thickness

The thickness of the magnetic tape shall be as shown in table 2.

4.5 Coercivity

Two levels of coercivity shall be permitted: Class 720 tape (mode 1 operation) oxide; class 1500 tape (mode 2 operation) metal particle.

4.6 Transmissivity

Transmissivity shall be less than 5% measured over the range of wavelengths 700 nm to 900 nm.

4.7 Offset yield strength

The offset yield strength shall be greater than 19.6 N.

4.8 Residual elongation

The residual elongation of the magnetic tape shall be less than 0.15%. (Test method: Apply a 13.9 N load to a 1 m long and 12.65 mm wide test tape for 10 minutes. Remove the load and measure the tape length after a 0.2 N load is continuously applied for another 10 minutes.)

4.9 Magnetic orientation

The magnetic particles shall be longitudinally oriented.

5 Leader and trailer tape

5.1 Mechanical characteristics

The leader and trailer tape shall contain a metal foil providing conductivity per centimeter of more than 200 S (mho) so that the magnetic tape automatically stops running when this end is detected in the recorder.

5.2 Leader and trailer tape dimensions

5.2.1 Tape width

The width of the leader and trailer tape shall be 12.65 mm ± 0.03 mm.

5.2.2 Tape thickness

The thickness of the leader and trailer tape shall be less than 45 µm.

5.2.3 Tape length

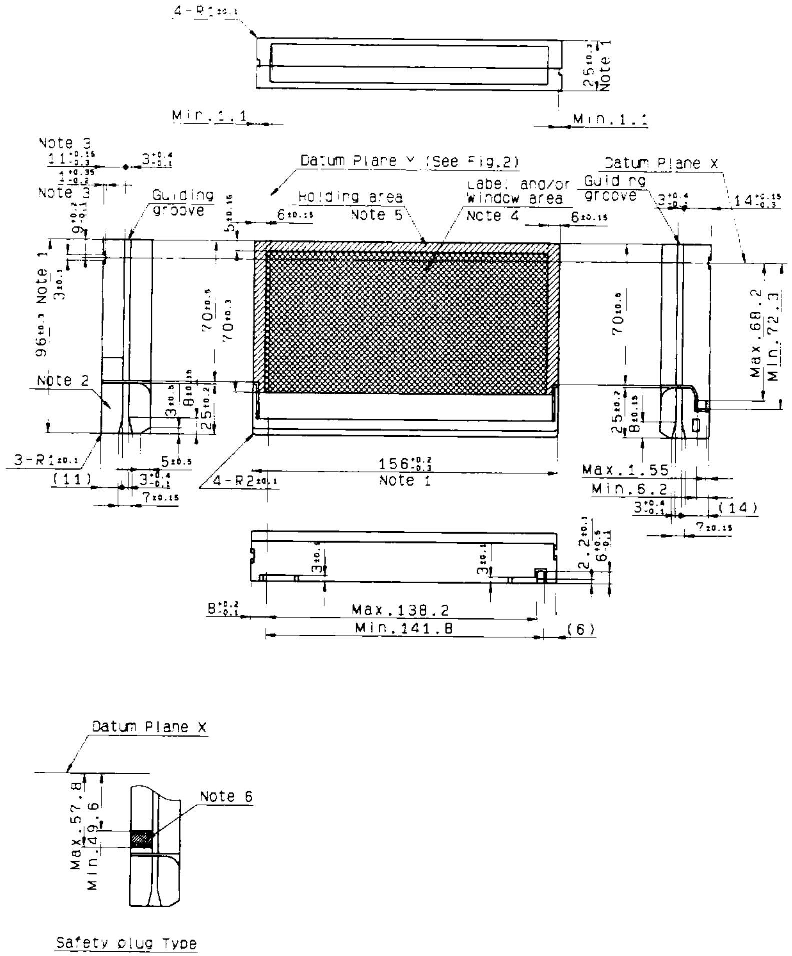
The length of the leader tape, L_1, and the trailer tape, L_2, specified in figure 19, shall be as shown in table 3.

5.3 Offset yield strength

The offset yield strength of the leader and trailer tape shall be greater than 29.4 N.

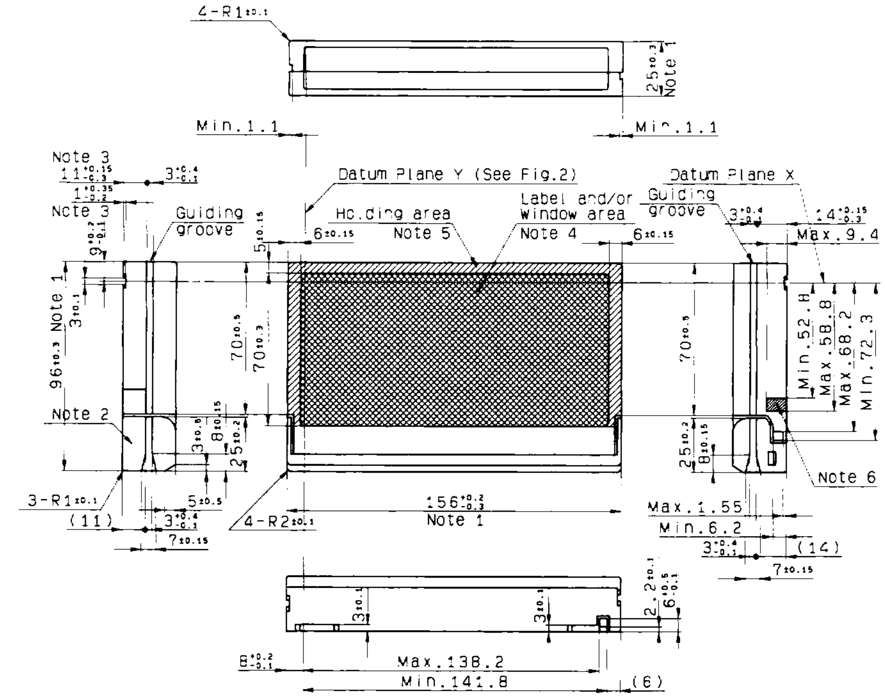
5.4 Splicing break strength

The spliced portion between the magnetic tape and the leader or trailer tape shall withstand a tension of 14.7 N.



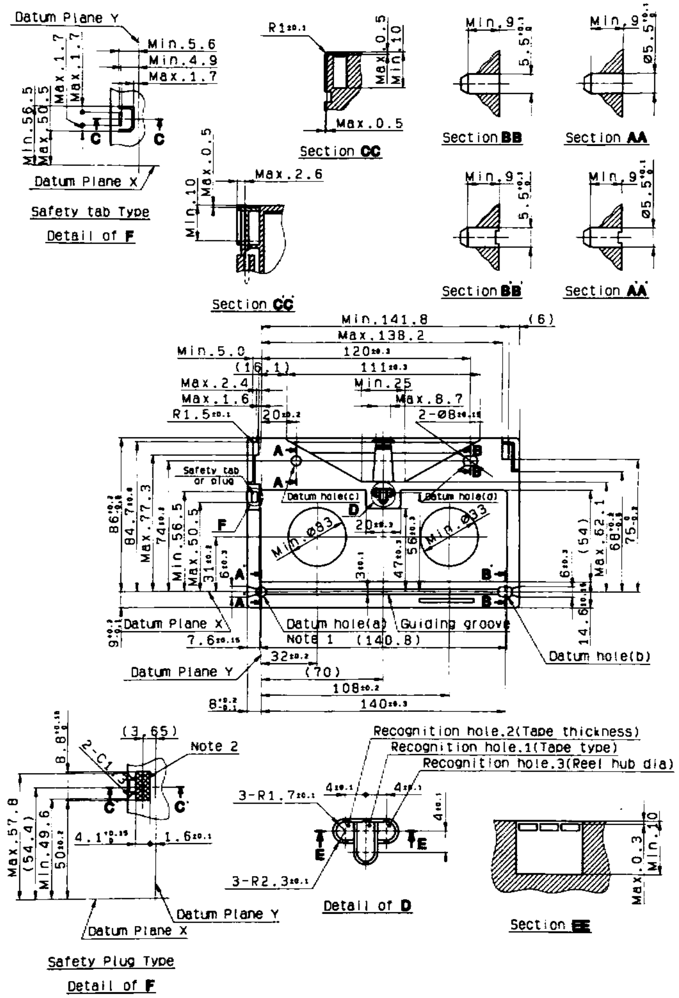
NOTES
1 The dimensions are inspected by using limit gauges.
2 No part of the lid shall protrude beyond the bottom plane of the cassette during the opening and closing motion of the lid.
3 This dimension shall be specified from datum plane Z.
4 Label and/or window area is available for the label and/or window (crosshatched area).
5 The cassette may be held in position by the recorder and/or player unit on this holding area (hatched area).
6 The fine hatched area shows the acceptable range of the plug notch position and depth at the side when the plug is used.

Figure 1A — Appearance of video cassette top and side view (oxide tape S cassette)



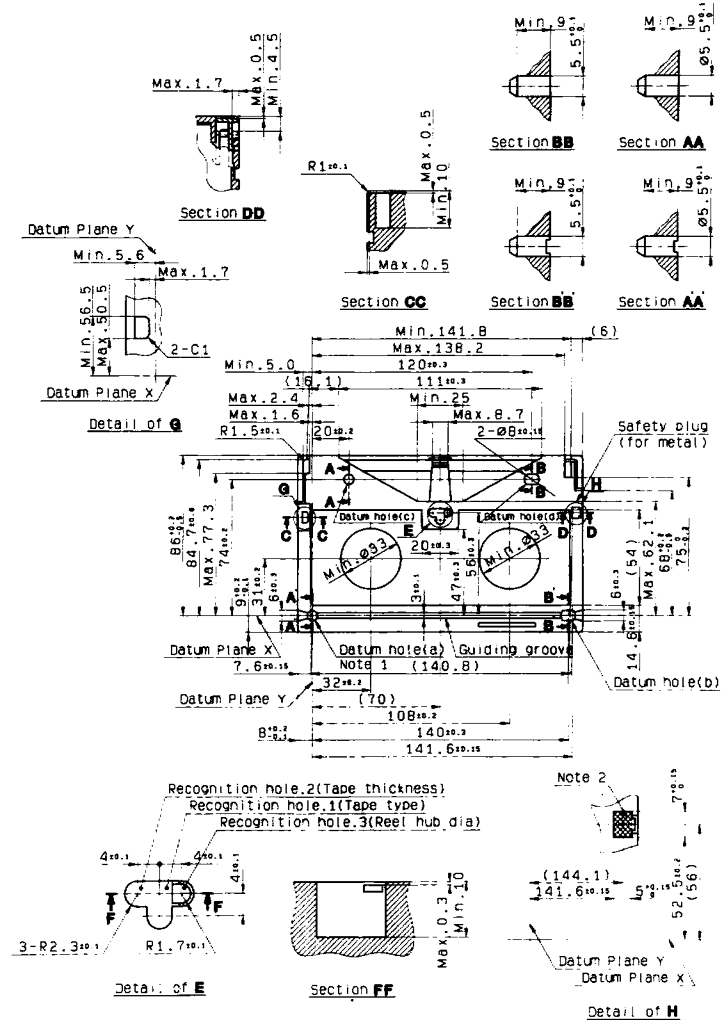
NOTES
1 The dimensions are inspected by using limit gauges.
2 No part of the lid shall protrude beyond the bottom plane of the cassette during the opening and closing motion of the lid.
3 This dimension shall be specified from datum plane Z.
4 Label and/or window area is available for the label and/or window (crosshatched area).
5 The cassette may be held in position by the recorder and/or player unit on this holding area (hatched area).
6 The fine hatched area shows the acceptable range of the plug notch position and depth at the side when the plug is used.

Figure 1B — Appearance of video cassette top and side view (metal tape S cassette)



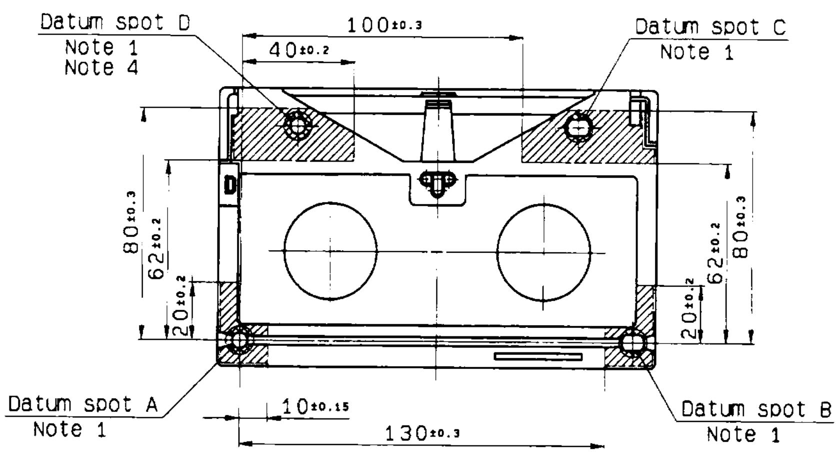
NOTES
1 Datum hole (a) is primary.
2 The crosshatched area shows the VTR detection area.

Figure 2A — Appearance of video cassette bottom view (oxide tape S cassette)



NOTES
1 Datum hole (a) is primary.
2 The crosshatched area shows the VTR detection area.

Figure 2B — Appearance of video cassette bottom view (metal tape S cassette)

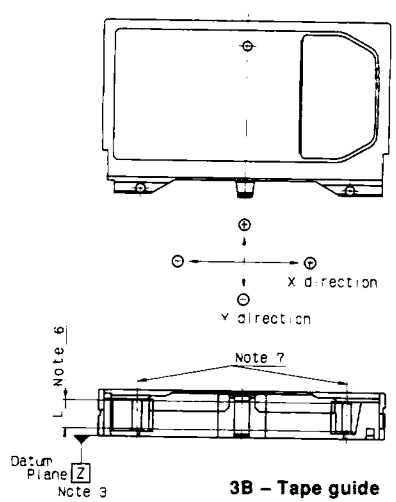


3A – Datum spots and supported areas

NOTES
1 Datum spots shall be 10 mm in diameter.
2 The four hatched areas, which are supported areas, shall be coplanar within 0.05 mm of each datum spot.
3 Datum plane Z shall be determined by the three datum spots, A, B, and C.
4 Datum spot D shall be coplanar within 0.3 mm of datum plane Z.
5 Areas within 1 mm from the edge of the cassette shall not be used as supported areas.
6 Reel flange clearance, L: 15 mm.
7 Perpendicularity of tape guides (even if they are tapered) is specified as follows:

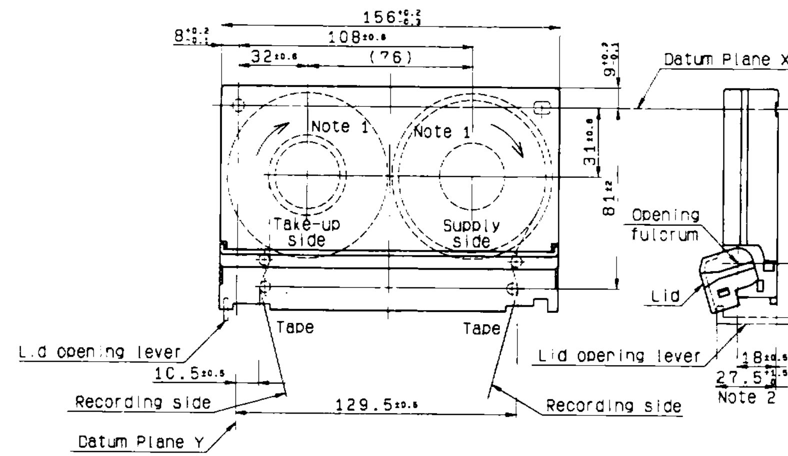
Guide	Direction X	Direction Y
Supply side	0 ± 0.15 mm	0 ± 0.15 mm
Take-up side	0 ± 0.15 mm	0 ± 0.15 mm

X and Y are the coordinates of the projection of the upper center of tape guides on the plane which includes the lower center of tape guides as the origin and are parallel to datum plane Z.



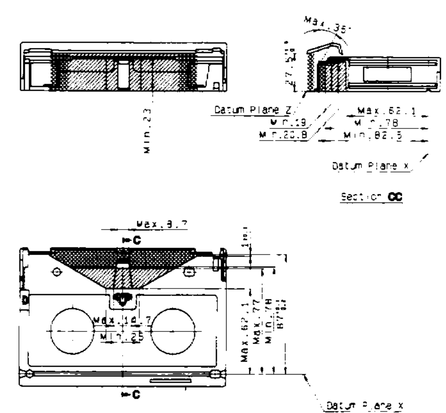
3B – Tape guide

Figure 3 — Datum spots, supported areas and tape guides (S cassette)



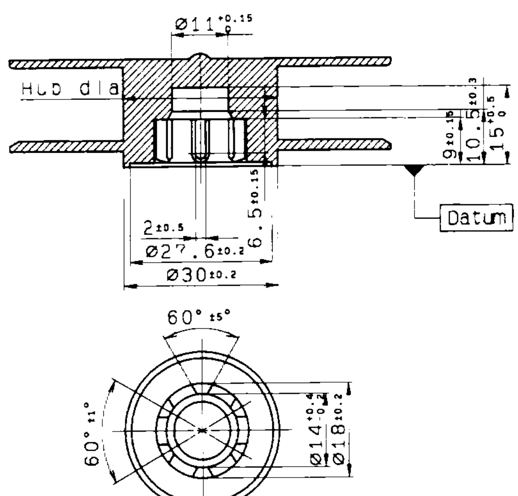
NOTES
1 Rotating direction during forward operation.
2 The opening range of the lid in the recorder or player unit is 27.5 mm +1.5 mm –0.0 mm.

Figure 4 — Location of cassette reels in the recorder and/or player (S cassette)



NOTES
1 The hatched area is where the loading mechanism of the video tape recorder and/or player unit positions the video cassette when it is inserted.
2 The hatched and crosshatched areas are so designed that the loading mechanism of the video tape recorder and/or player unit unwinds and extends the magnetic tape toward the drum head after the lid opens.

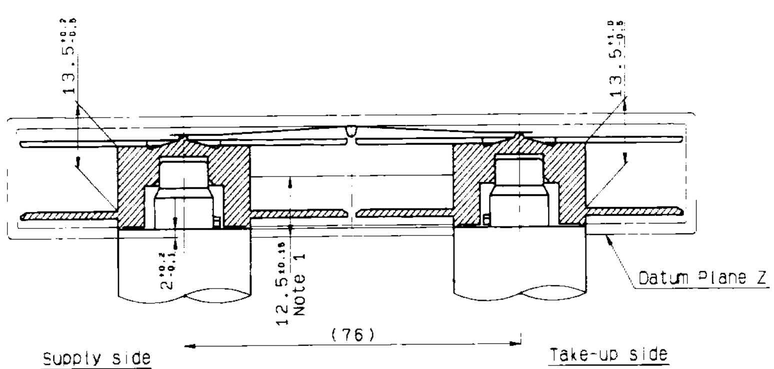
Figure 5 — Protecting lid of cassette (S cassette)



Nominal recording time	Hub diameter of reels
≤10Min.	Ø53.3±0.2 mm
>10Min.	Ø30±0.2 mm

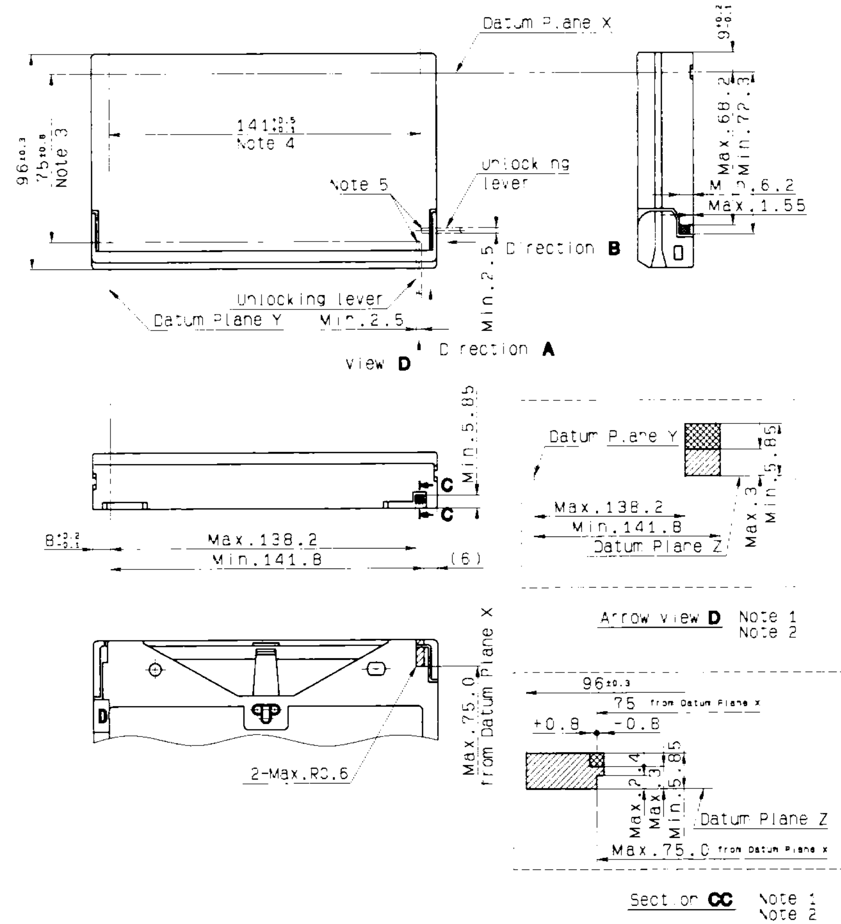
NOTE – Recording time is specified for the tape speed of 118.582 mm/s.

Figure 6 — Reel of cassette (S cassette)



NOTE – Center of tape wound on reel when cassette is inserted in recorder/player.

Figure 7 — Relationship between reels and reel spindles (S cassette)



NOTES

1 The crosshatched and hatched areas show the allowable total areas where the unlocking lever, extending from the video tape recorder and/or player unit, can be inserted into a cassette.

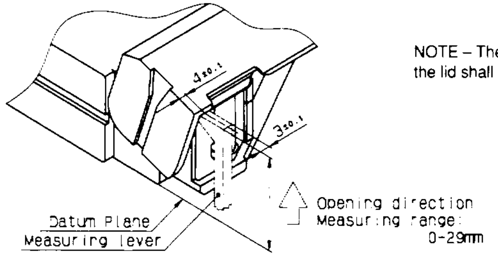
2 The crosshatched area shows the range of the unlocking lever insertion which permits the lid to be unlocked.

3 Allowable range within which the unlocking lever can be inserted in A direction.

4 Allowable range within which the unlocking lever can be inserted in B direction.

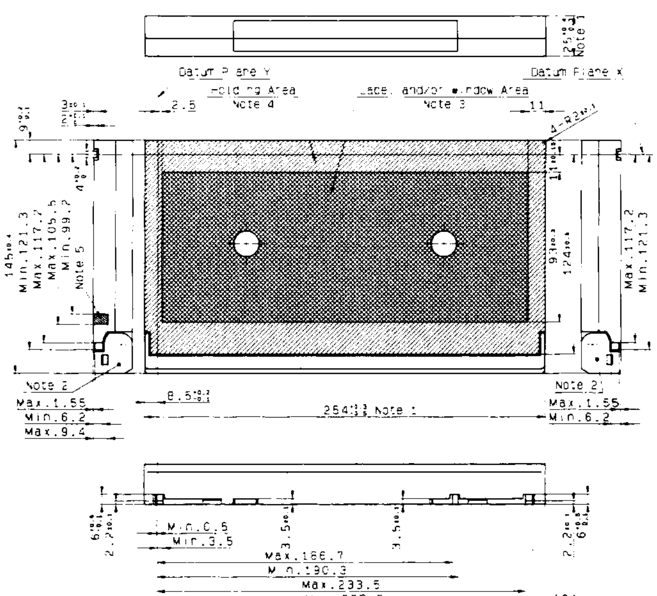
5 The tip of the unlocking lever shall be shaped into a semicircle or hemisphere of which the radius is one half the unlocking lever width.

Figure 8 — Allowable and operating ranges for unlocking the lever of cassette lid (S cassette)



NOTE – The maximum force to open the lid shall be 1.5 N.

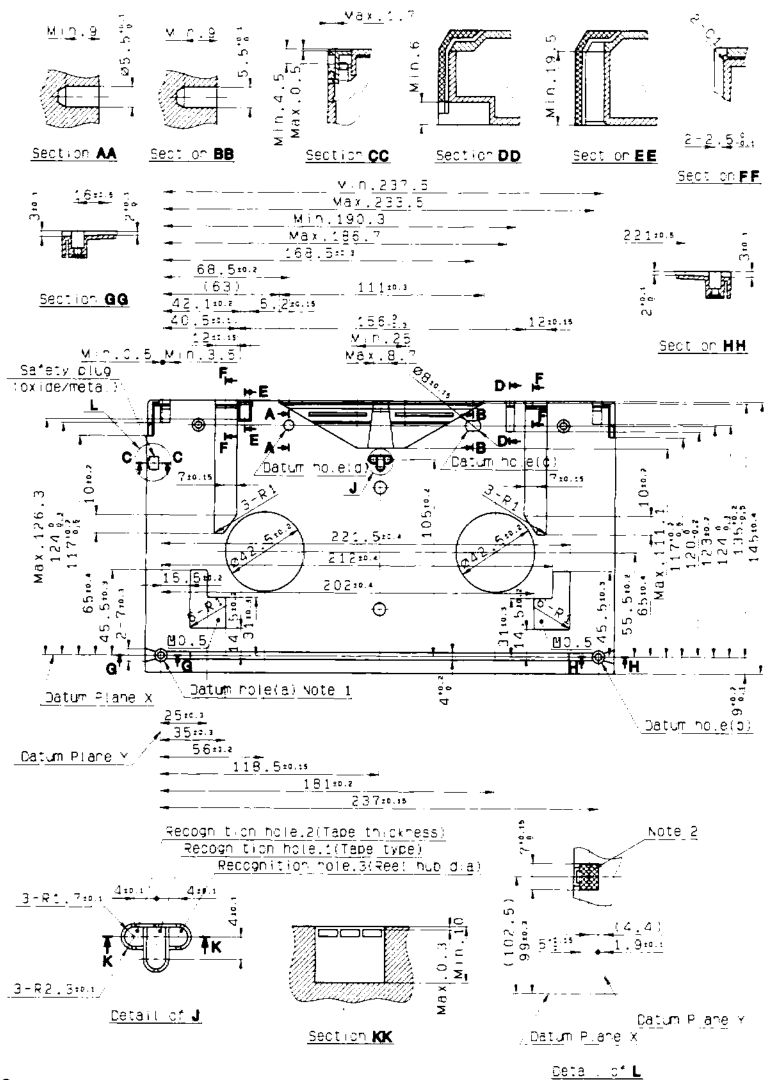
Figure 9 — Force needed to open the lid (S cassette)



NOTES

1 The dimensions are inspected by using limit gauges.
2 No part of the lid shall protrude beyond the bottom plane of the cassette during the opening and closing motion of the lid.
3 Label and/or window area is available for the label and/or window (crosshatched area).
4 The cassette may be held in position by the recorder and/or player unit on this holding area (hatched area).
5 The fine hatched area shows the acceptable range of the plug notch position and depth at the side when the plug is used.

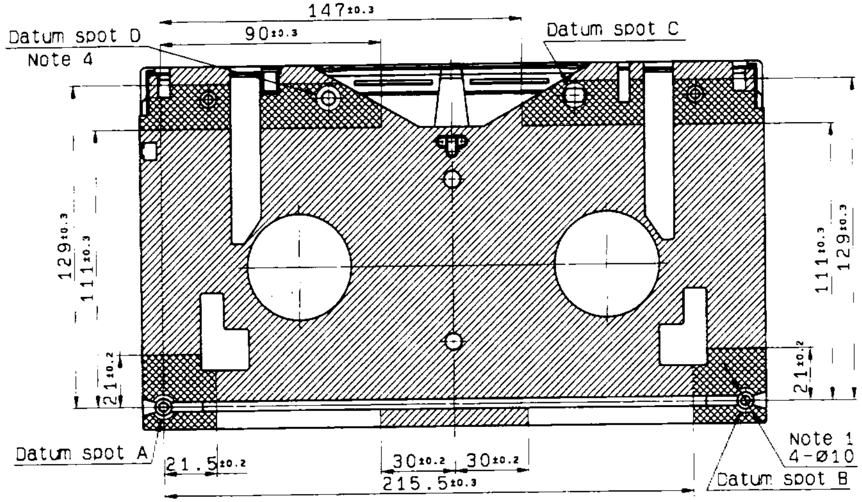
Figure 10 — Appearance of video cassette top and side view (oxide and metal L cassette)



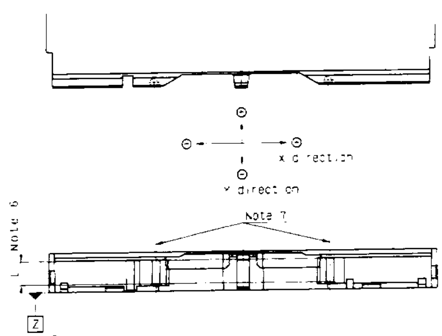
NOTES

1 Datum hole (a) is primary.
2 The crosshatched area shows the VTR detection area.

Figure 11 — Appearance of video cassette bottom view (oxide and metal L cassette)



12A — Datum spots and supported areas



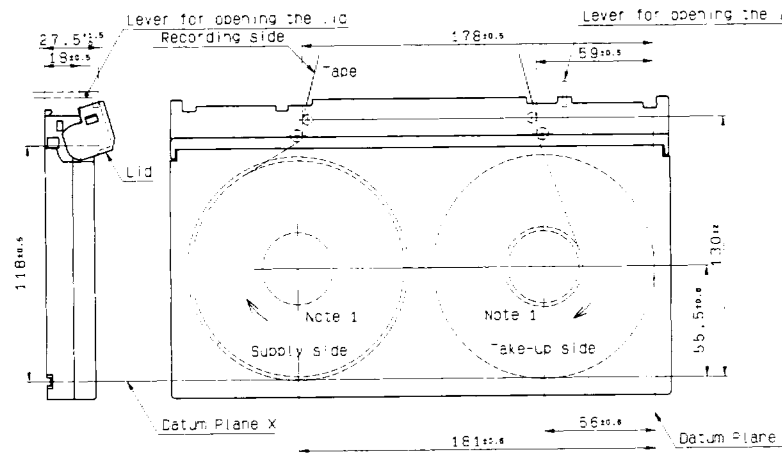
12B — Tape guide

NOTES
1 Datum spots shall be 10 mm in diameter.
2 The four crosshatched areas, which are supported areas, shall be coplanar within 0.05 mm of each datum spot. The four crosshatched areas shall be coplanar with the hatched area.
3 Datum plane Z shall be determined by the three datum spots, A, B, and C.
4 Datum spot D shall be coplanar within 0.3 mm of datum plane Z.
5 Areas within 1 mm from the edge of the cassette shall not be used as supported areas.
6 Reel flange clearance, L: 15 mm.
7 Perpendicularity of tape guides (even if they are tapered) is specified as follows:

Guide	Direction X	Direction Y
Supply side	0 ± 0.15 mm	0 ± 0.15 mm
Take-up side	0 ± 0.15 mm	0 ± 0.15 mm

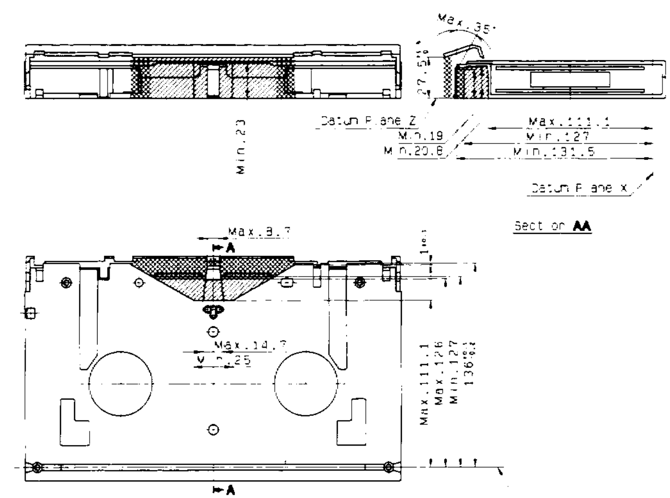
X and Y are the coordinates of the projection of the upper center of tape guides on the plane which includes the lower center of tape guides as the origin and are parallel to datum plane Z.

Figure 12 — Datum spots, supported areas and tape guides (L cassette)



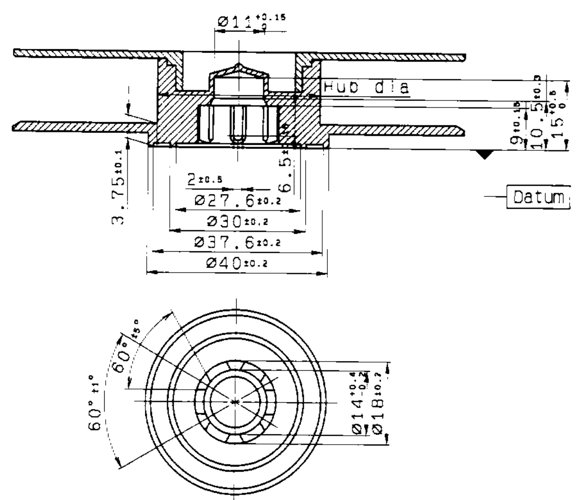
NOTES
1 Rotating direction during forward operation.
2 The opening range of the lid in the recorder and/or player unit is 27.5 mm +1.5 mm −0 mm.

Figure 13 — Location of cassette reels in the recorder and/or player (L cassette)



NOTES
1 The hatched area is where the loading mechanism of the video tape recorder and/or player unit positions the vide cassette when it is inserted.
2 The hatched and crosshatched areas are so designed that the loading mechanism of the video tape recorder and/or player unit unwinds and extends the magnetic tape toward the drum head after the lid opens.

Figure 14 — Protecting lid of cassette (L cassette)



Nominal recording time	Hub diameter of reels
≦30Min.	Ø53.3±0.2 mm
≧60Min.	Ø36±0.2 mm

NOTE – Recording time is specified for the tape speed of 118.582 mm/s.

Figure 15 — Reel of cassette (L cassette)

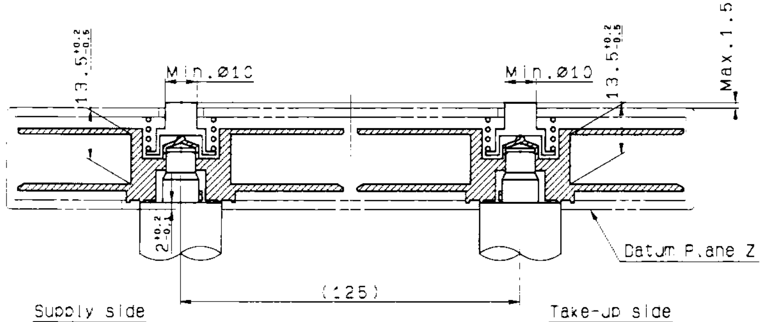
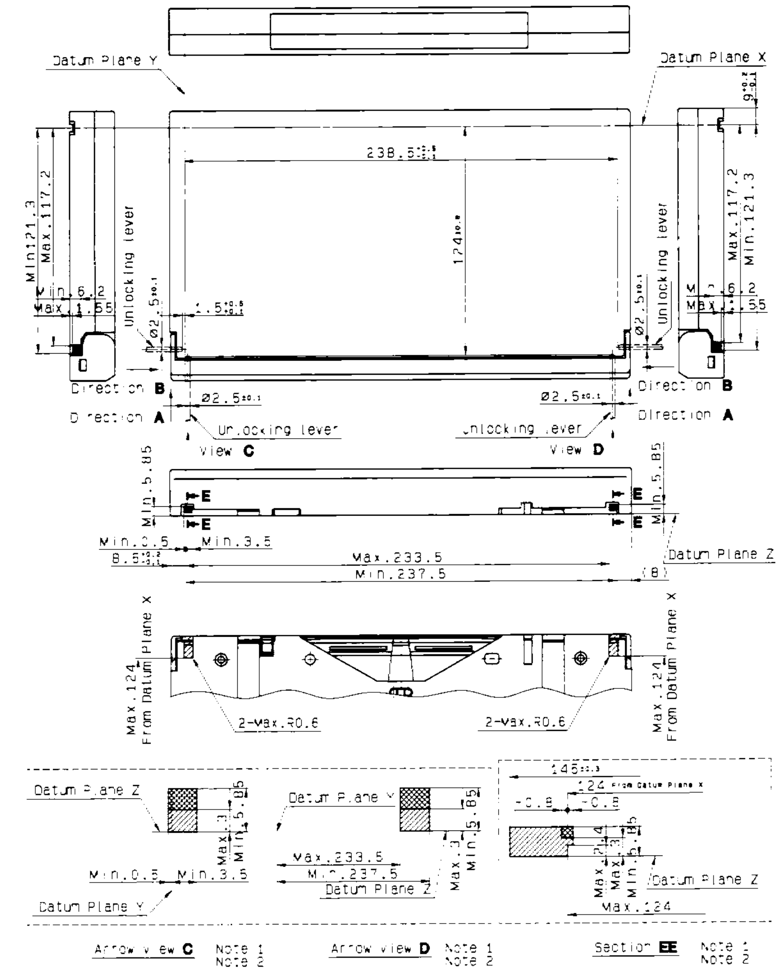


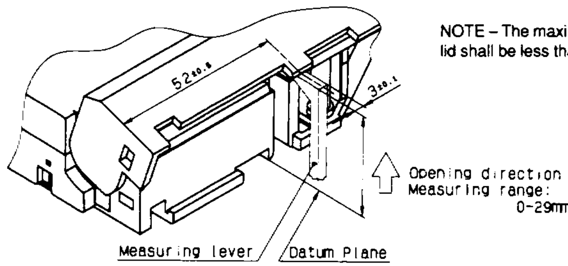
Figure 16 — Relationship between reels and reel spindles (L cassette)



NOTES

1 The crosshatched and hatched areas show the allowable total area where the unlocking lever, extending from the video tape recorder and/or player unit, can be inserted into a cassette.
2 The crosshatched area shows the range of the unlocking lever insertion which permits the lid to be unlocked.
3 Allowable range within which the unlocking lever can be inserted in A direction.
4 Allowable range within which the unlocking lever can be inserted in B direction.
5 The tip of the unlocking lever shall be shaped into a semicircle or hemisphere of which the radius is one half the unlocking lever width.

Figure 17 — Allowable and operating ranges for unlocking the lever of the cassette lid (L cassette)



NOTE – The maximum force to open the lid shall be less than 1.5 N.

Figure 18 — Force needed to open the lid (L cassette)

Table 2 — Tape thickness

S cassette			L cassette		
Nominal recording time (min)	Magnetic tape thickness (μm)		Nominal recording time (min)	Magnetic tape thickness (μm)	
	Oxide tape	Metal-particle tape		Oxide tape	Metal-particle tape
5	19.0 to 21.0	14.1 to 15.3	5	19.0 to 21.0	14.1 to 15.3
10			10		
15			15		
20			20		
30	14.1 to 15.3		30		
			60	14.1 to 15.3	
			90		

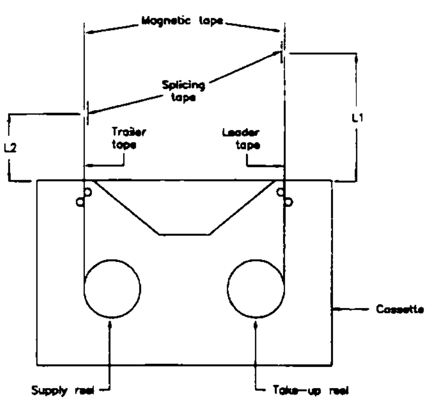


Figure 19 — Leader and trailer tape

Table 3 — Leader and trailer tape length

Length (mm)	S cassette	L cassette
L_1	250 ± 30	280 ± 20
L_2	$70\ ^{+10}_{-20}$	$90\ ^{+10}_{-20}$

Annex A (informative)
Bibliography

SMPTE 229M, Television Analog Recording — 1/2-in Type L — Records

SMPTE 230M, Television Analog Recording — 1/2-in Type L — Electrical Parameters, Control Code and Tracking Control

SMPTE RP 144, Basic System and Transport Geometry Parameters for 1/2-in Type L Format

SMPTE Journal, September 1991

PROPOSED SMPTE STANDARD

SMPTE 125M

for Television — Bit-Parallel Digital Interface — Component Video Signal 4:2:2

Table of contents

1 Scope

This standard defines an interface for system M (525/60) digital television equipment based on CCIR Recommendation 601. The standard has application in the television studio over distances up to 300 m (1000 ft). The characteristics of the interface are summarized below:

1.1 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).

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

1.3 The bits of the digital code words that describe the video signal are transmitted in a *parallel arrangement using ten conductor pairs.* 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 Mb/s.* An eleventh conductor pair carries a clock signal at 27 MHz.

1.4 The signals on the interface are transmitted using balanced conductor pairs for a distance up to 50 m (160 ft) without equalization and up to 300 m (1000 ft) with appropriate equalization.

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

1.6 Parameters of the signal format are chosen to facilitate conversion to and from a serial *digital interface format.*

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

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

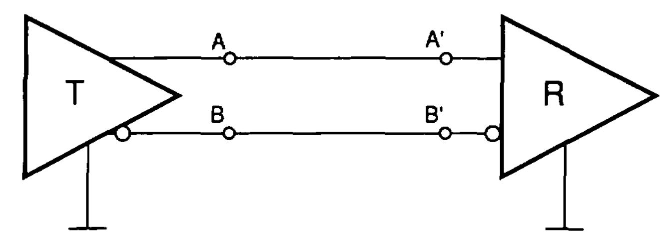
2 General considerations

2.1 Signal convention

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

2.1.1 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.*

2.1.2 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.



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

Figure 1 — Positive binary signal convention

2.2 Signal names

The data lines are designated DATA 0 through DATA 9. The group of ten 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.

2.3 SinX/X considerations

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

2.4 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 3.4 and 3.5

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 3.4 and 3.5.

2.5 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.

2.6 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, 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 screening.

3 Interface format

3.1 General description

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

3.2 Encoding parameters

Table 1 summarizes the encoding parameter values.

3.3 Interface characteristics

Table 2 specifies the interface characteristics.

3.4 Digital blanking relationship

3.4.1 Horizontal sync relationship

Figure 2a shows the relationship between video signals in the digital and analog domain 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 3.5.3.

Intervals 1712 through 1715 are reserved for the start-of-active-video (SAV) timing reference described in 3.5.3.

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.

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: – luminance (Y) – each color-difference signal (C_R, C_B) – total number of samples	Total / Active 858 / 720 429 / 360 1716 / 1440
Sampling structure:	Orthogonal: line, field, and frame repetitive; C_R and C_B samples are cosited with odd (1st, 3rd, 5th) Y samples in each line
Sampling frequency: – luminance (Y) – each color-difference signal (C_R, C_B)	 13.5 MHz nominal 6.75 MHz nominal
Form of encoding:	Uniformly quantized, PCM, 10 bits per sample, for the luminance signal and each color-difference signal. (For 8-bit encoding see 2.2.)
Correspondence between video signal levels and quantization levels:	
– luminance signal (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_R, C_B)	897 quantization levels symmetrically distributed about level 512, corresponding to the zero signal

Table 2 — Interface characteristics

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

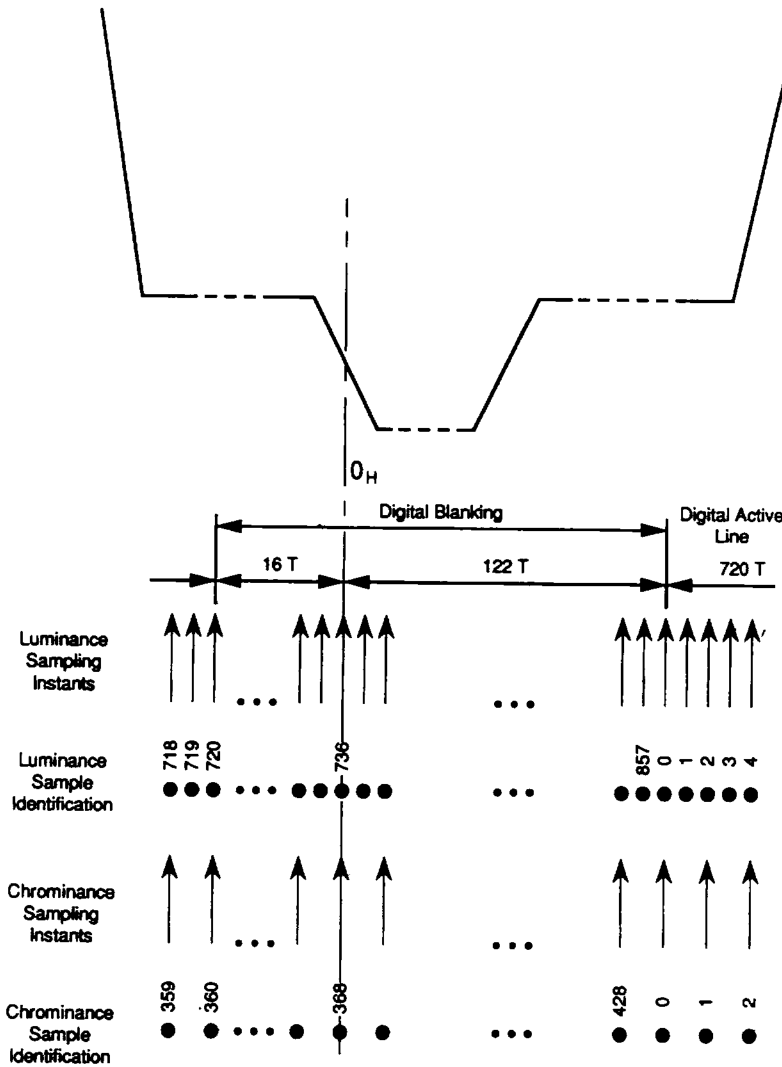


Figure 2a — Horizontal sync relationship

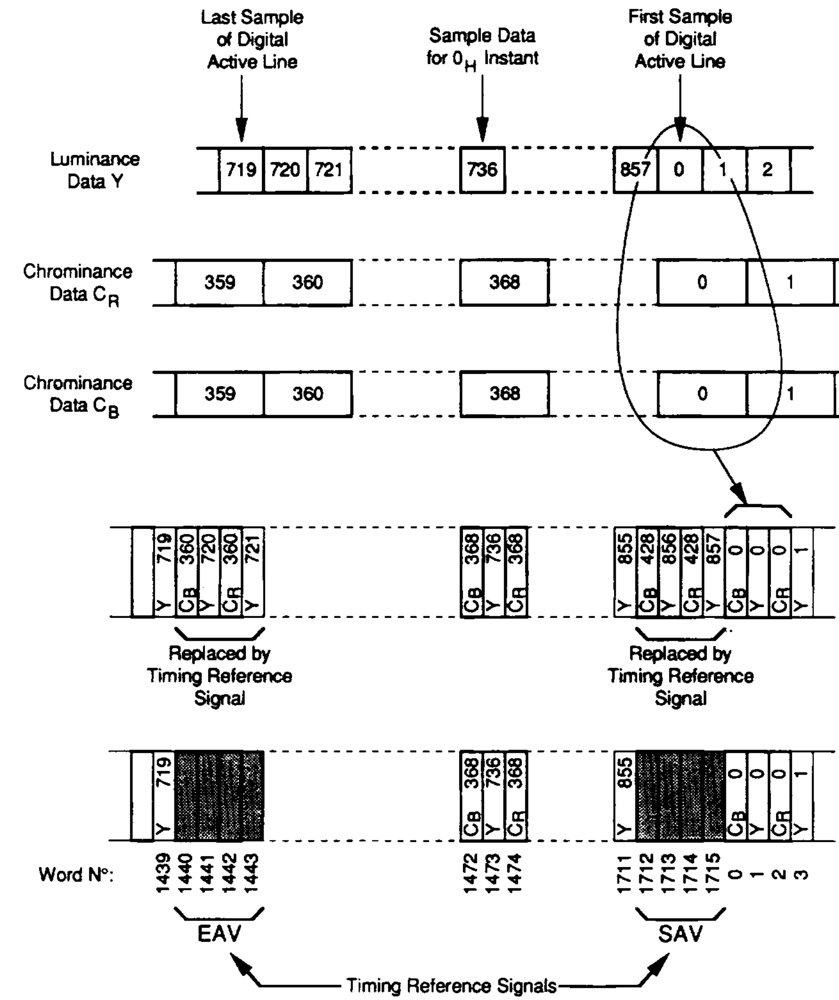


Figure 2b — Multiplex structure

3.4.2 Vertical sync relationship

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

3.5 Video data signal format

3.5.1 Data signal format

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

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.

3.5.2 Multiplex structure

The video data words shall be conveyed as a 27 megaword/s multiplex 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 figure 2B.) The first video data word in each active line period shall be C_B.

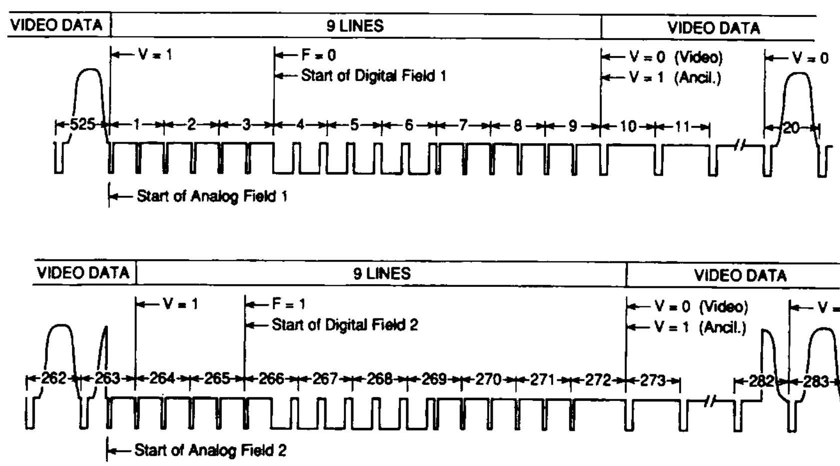
3.5.3 Timing reference signals – Video

Figure 2a shows 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- and 10-bit equipment, 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.



Digital field 1 has 262 lines
Digital field 2 has 263 lines

Figure 3 — Relationship of video data/vertical sync

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.

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

Small blocks of data, less than 268 words in total length, including the HANC sequence (as described in 3.6.1), can be transmitted within the horizontal blanking period on every line.

Large blocks of data, up to 1440 words in total length, including the ANC 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.

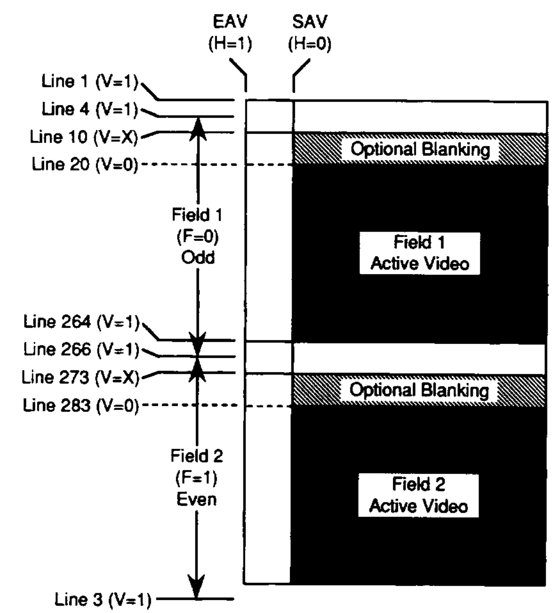


Figure 4 — Timing reference signal locations

Table 3 — Timing reference signals

Bit	Word 1440 *and* 1712	Word 1441 *and* 1713	Word 1442 *and* 1714	Word 1443 *and* 1715	
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	See table 4
3	1	0	0	P1	See table 4
2	1	0	0	P0	See table 4
1	1	0	0	0	
0	1	0	0	0	

NOTES
1 Some equipments can only sense the eight most significant bits.
2 The H, V, and F bits (bits 6-8) provide all the necessary state 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 F	7 V	6 H	5 P3	4 P2	3 P1	2 P0	1	0
	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 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 not 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.

3.6 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 3.4.1 and 3.4.2). 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, although 8-bit representation of the header is permitted for VANC only.

3.6.1 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 3FF 3FF

Because of the existence of both 8- and 10-bit equipment, 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 $3FF_h$).

3.6.2 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 3FF 3FF

Because of the existence of both 8- and 10-bit equipment, 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 $3FF_h$).

3.7 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.

3.7.1 DVITC

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

3.7.2 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.

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 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.

3.8 Clock signal

3.8.1 Clock signal description (at transmitter)

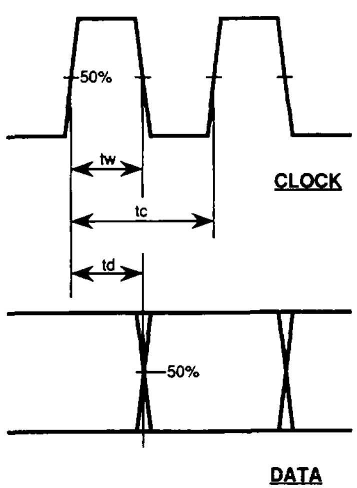
The clock signal is a 27-MHz square wave as shown in figure 5. The clock pulse width (tw) is 18.5 ns ± 3 ns.

3.8.2 Clock jitter

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.

3.8.3 Clock data timing relationship

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



$tw = 18.5 \text{ ns} \pm 3 \text{ ns}$

$tc = \dfrac{1}{1716\, f_h} = 37 \text{ ns (nominal)}$

$td = 18.5 \text{ ns} \pm 3 \text{ ns}$

$f_h = 15.734\ldots \text{KHz (nominal)}$

Figure 5 — Clock to data timing (at transmitter)

4 Electrical characteristics

4.1 General

The eleven 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.

4.2 Transmitter characteristics

4.2.1 Output impedance

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

4.2.2 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.

4.2.3 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.

4.2.4 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.

4.3 Receiver characteristics

4.3.1 Terminating impedance

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

4.3.2 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 4.2.3.

4.3.3 Input sensitivity

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

4.3.4 Common mode rejection

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

4.3.5 Differential delay

The receiver shall operate with a differential delay between the received clock and any received data signals up to 11 ns.

5 Mechanical characteristics

5.1 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."

5.2 Interconnecting cable characteristics

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

5.2.1 Cable length

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

5.2.2 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.

5.3 Connector characteristics

5.3.1 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.)

5.3.2 Connector contact assignments

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

5.3.3 Cable connector assembly

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

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		

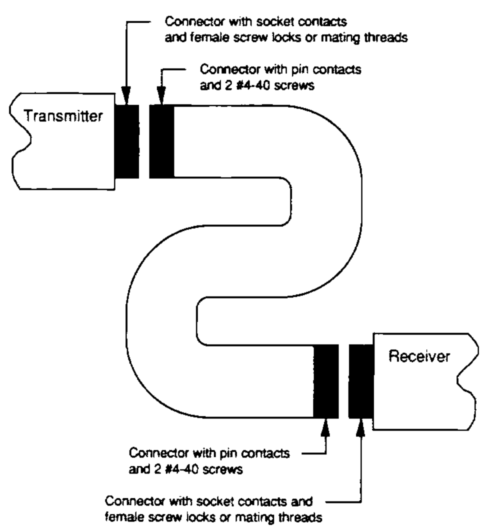


Figure 6 — Cable connector assembly

5.3.4 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 with mating threads as shown in annex B.

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

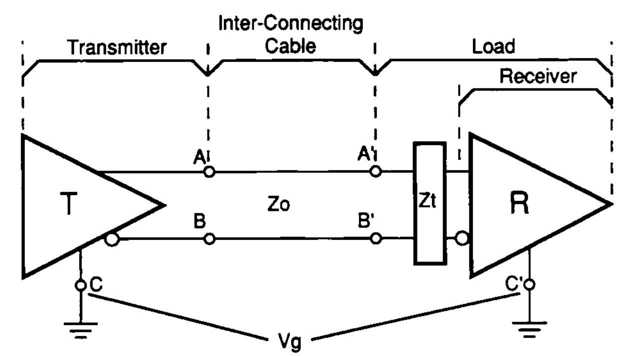
Propagation delay ECL 10,000: 2-3 ns per gate; typical edge speeds are 2-3 ns (20% to 80%)

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.

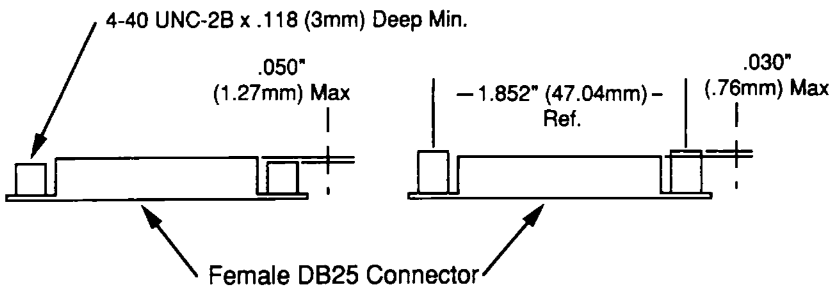


Figure B.1 — Female screw lock mounting

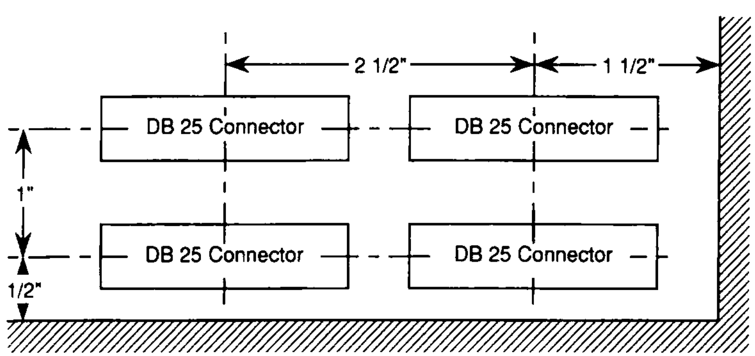


Figure B.2 — Minimum connector spacing

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)
Information on correspondence between this standard and previous (8-bit) specifications of the interface

Table G.1 shows the connector pinout correspondence between the old 8-bit system and the new 10-bit system.

Earlier specifications of this interface did not require that Data A and Data B be driven by the transmitter, or that electrical continuity be maintained on pins 11, 12, 24, and 25. Designers of equipment and systems should be aware that system components built to earlier specifications may result in floating inputs for DATA (0-1).

When a 10-bit signal is received by an 8-bit device, simple truncation or rounding may result in spatial correlation of the noise introduced and visible "striations" in the displayed picture. Designers of equipment and systems should consider the use of techniques such as randomized rounding, if appropriate to their application, when the number of bits must be reduced.

Table G.1 — Connector pinout correspondence

Old 8-bit system	Connector pin number	New 10-bit systems
Clock	1	Clock
System ground A	2	System ground A
Data 7 (MSB)	3	Data 9 (MSB)
Data 6	4	Data 8
Data 5	5	Data 7
Data 4	6	Data 6
Data 3	7	Data 5
Data 2	8	Data 4
Data 1	9	Data 3
Data 0	10	Data 2
Data A	11	Data 1
Data B	12	Data 0
Cable shield	13	Cable shield
Clock return	14	Clock return
System ground B	15	System ground B
Data 7 return	16	Data 9 return
Data 6 return	17	Data 8 return
Data 5 return	18	Data 7 return
Data 4 return	19	Data 6 return
Data 3 return	20	Data 5 return
Data 2 return	21	Data 4 return
Data 1 return	22	Data 3 return
Data 0 return	23	Data 2 return
Data A return	24	Data 1 return
Data B return	25	Data 0 return

Annex H (informative)
Bibliography

CCIR Recommendation 601, Encoding Parameters of Digital Television for Studios

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

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

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