Standards and Recommended Practices

Approved American National Standards

The American National Standards Institute approved three American National Standards on March 24, 1986: ANSI/SMPTE 23M-1986, Video Recording — ½-in. Type F Helical-Scan — Records; ANSI/SMPTE 93-1986, Motion-Picture Film (35-mm) — Perforated BH; and ANSI/SMPTE 146M-1986, Motion-Picture Film — Determination of Speed — 16- and 8-mm Reversal Color Camera Films. Copies of the standards are available for a nominal fee from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

Approved SMPTE Recommended Practices

Three SMPTE Recommended Practices were approved by the Society's Executive Committee for Standards Approval: RP 135-1986, Use of Binary User Groups in Motion-Picture Time and Control Codes; RP 136-1986, Time and Control Codes for 24, 25, or 30 Frame-Per-Second Motion-Picture Systems; and RP 137-1986, Data Tracks on Low-Dispersion Magnetic Coatings on 35-mm Motion-Picture Film. These and other SMPTE Recommended Practices are available from Society Headquarters for $3.00 each.

Approved International Standard

The International Organization for Standardization (ISO) approved an International Standard, the technical content of which is published here for your information. ISO 8590-1985, Cinematography — Audio Records on 35-mm and 70-mm Motion-Picture Release Prints with Magnetic Stripes — Recorded Characteristics, is in agreement with American National Standards ANSI/SMPTE 216-1985, Motion-Picture Film (35-mm) — Recorded Characteristic of Magnetic Audio Records — Four-Track Striped Release Prints; and ANSI/SMPTE 217-1985, Motion-Picture Film (70-mm) — Recorded Characteristic of Magnetic Audio Records — Striped Release Prints. This material is reproduced with permission from the ISO and is copyrighted by the American National Standards Institute, 1430 Broadway, New York, NY 10018, from which copies are available.

—Sherwin H. Becker, Manager of Engineering

ANSI/SMPTE 23M-1986
Revision and Redesignation of
ANSI C98.23M-1980

American National Standard
for video recording— ½-in type F helical-scan— records

Approved March 24, 1986 Sponsor: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the location of the edges of the video, audio, and tracking-control records, the mechanical separation of the simultaneously recorded information of the video and audio records, and the basic electrical parameters as recorded on ½-in type F helical-scan video tape operating at a nominal speed of 190.5 mm/s (7.5 in/s).

2. Referenced Document

This standard is intended for use in conjunction with the following document:

SMPTE Recommended Practice RP 88-1986, Reference Carrier Frequencies and Pre-emphasis Characteristic for ½-in Type F Helical-Scan Video Tape Recording

3. Definitions

3.1 Transverse. Pertaining to dimensions perpendicular to the tape travel.

3.2 Longitudinal. Pertaining to dimensions parallel to the tape travel.

3.3 Downstream. Pertaining to locations on the tape longitudinally displaced from a given reference point in the direction of tape travel.

3.4 Upstream. Pertaining to locations on the tape longitudinally displaced from a given reference point in a direction opposite tape travel.

3.5 Trailing End of Video Track. The upstream end of the video track.

3.6 Transverse Reference Line. An imaginary line on the magnetically recorded tape perpendicular to the reference edge and passing through the trailing edge of the video track at its highest point (trailing edge at the end of the video track).

3.7 Reference Edge. The lower edge of the magnetic tape.

4. General

4.1 Measurement Conditions. The dimensions shall be measured with no transverse or longitudinal tension applied to the tape.

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4.2 Measurement Environment. The temperature shall be 20 C ± 1 C (68 F ± 2 F) with a relative humidity of 50 ± 2 percent.

4.3 Tape Speed. The tape speed shall be 189.55 mm/s (7.4626 in/s) min and 191.45 mm/s (7.5374 in/s) max.

4.4 Video Writing Speed. The video writing speed shall be 11.1 m/s (437 in/s).

4.5 Video Head Drum Diameter. The video head drum diameter shall be 115.820 ± 0.010 mm (4.55984 ± 0.00039 in).

4.6 Video Heads. The video scanning operation shall consist of a two-head helical scanning system.

4.7 Control Track. The control track shall be recorded on a single track (see Fig. 2) by a repeating waveform of nominally 30 Hz.

4.8 Television Signal System. The system of the television signal shall be as follows: The number of fields per second (n_f) is nominally 60 and the number of scanning lines per field (n_H) is 262.5.

4.9 Recording System. Audio signals shall be directly recorded on the audio track at the specified recording level by the alternating-current bias system. The video head recording current for the FM signal should be ± 1.5 dB at the optimum record current at 4 MHz. The carrier frequency for recording video signals by FM shall be assigned as follows: The higher frequency shall be assigned to white in the picture and the lower frequency to sync tip. Control signals shall be directly recorded on the control track at more than the saturated recording level. The waveform and polarity of control signals shall conform to Fig. 8.

4.10 Video Head Switching. The switching position of two heads, as shown in Fig. 5, lies within 5 horizontal scanning lines (H) ± 5 from the front edge of the vertical sync signal. The rf output of both video heads shall extend past the switching point by approximately 2 horizontal lines to provide ± 2 horizontal lines of overlap.

5. Dimensions

The transverse and longitudinal dimensions shall be as specified in the figures and table.

6. Position of Audio and Control-Track Heads

The position of the audio and control-track heads shall be as shown in Fig. 1 for optimum tracking. Optimum tracking provides maximum output from the heads when playing back a reference tape.

7. Audio Record Displacement

Program audio or other information which is time-coincident with video information recorded at a point, S_v, of any video track shall be recorded on Audio Record No. 1 at a distance, L, downstream from that point, S_v (see Fig. 1).

8. Tape Back-Tension

The tape back-tension shall be 0.45 ± 0.05 N (46 ± 5 gf) when measured as specified below. The tension shall be measured as indicated in Fig. 6 as the tape comes off the entrance guide post. A 177.8-mm (7-in) reel, filled with tape to a diameter of 132 ± 1 mm (5.20 ± 0.04 in), shall be inserted in the recorder, and the tape threaded past the entrance guide post. The tension shall be measured with a suitable spring balance as the tape is smoothly pulled off the reel at a uniform speed approximately equal to normal tape speed.

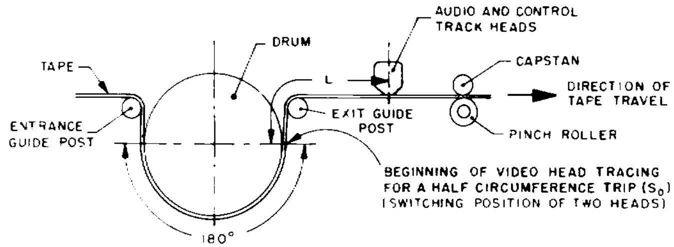


Fig. 1
Position of Audio and Control Track Heads as Viewed from Top of Drums

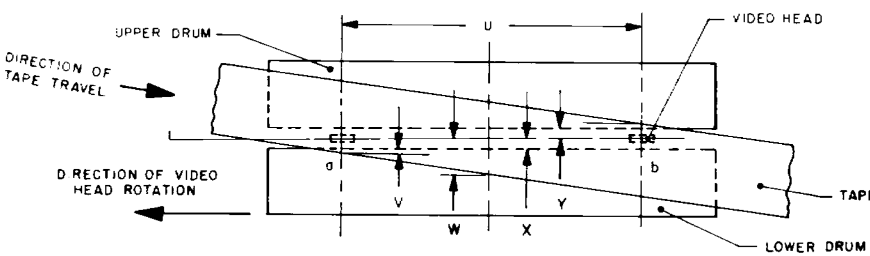


Fig. 2
Relationship among Upper and Lower Drum, Video Heads and Tape

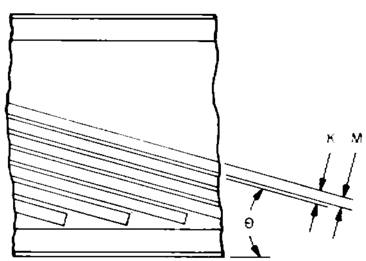


Fig. 3
Track Angle, Pitch and Width

	Dimensions	Millimeters	Inches
K	Video track pitch	0.173 ± 0.003	0.00681 ± 0.00012
L	Audio and control head position	81.0 ± 0.1	3.189 ± 0.004
M	Video track width	0.10 min	0.0039 min
U		180° on circumference of drum	
V		0.73 ± 0.05	0.0287 ± 0.0020
W	Video width center	6.23 ± 0.05	0.2453 ± 0.0020
X		0.75 ± 0.25	0.0295 ± 0.0098
Y		1.00 nom	0.0394 nom
θ		3° 7′ 43″	

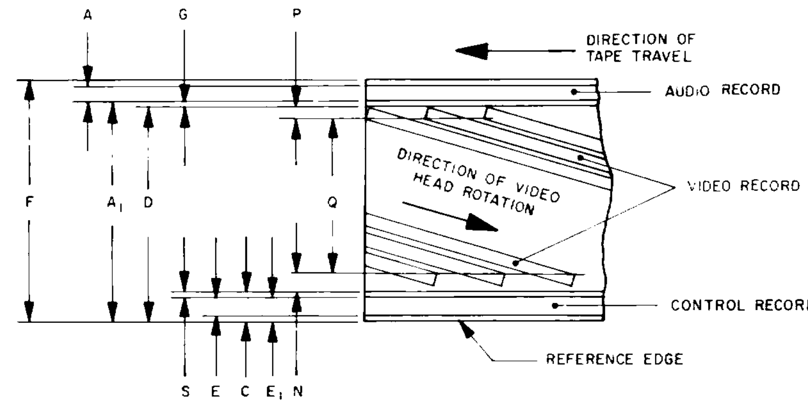


Fig. 4
Tape Dimensions and Track Configuration

	Dimensions	Millimeters	Inches
A	Audio track width	0.94 ± 0.05	0.0370 ± 0.0020
A_1	Audio reference	11.61 min	0.4571 min
C	Lower limit video area	0.86 min	0.0339 min
D	Upper limit video area	11.51 max	0.4531 max
E	Control track width	0.8 ± 0.1	0.031 ± 0.004
E_1	Control track reference	0.81 max	0.0319 max
F	Tape width	12.65 ± 0.05	0.4980 ± 0.0020
G	Control track to video guard band	0.15 ± 0.02	0.0059 ± 0.0008
N*	Scan end overlap	0.275 nom	0.01083 nom
P*	Scan start overlap	0.275 nom	0.01083 nom
Q*	Video area width	10.10 ± 0.01	0.3976 ± 0.0004
S	Audio to video guard band	0.10 ± 0.02	0.0039 ± 0.0008

*It is acceptable if a part of the scan start overlap width (P) or scan end overlap width (N) is missing from the video track; but the range of the video width (Q) must be correct.

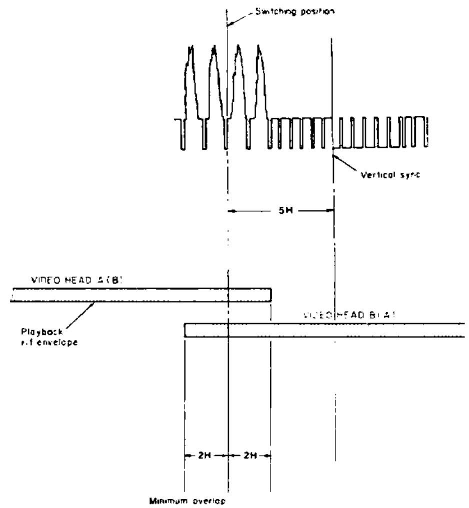


Fig. 5
Switching Position of Two Video Heads

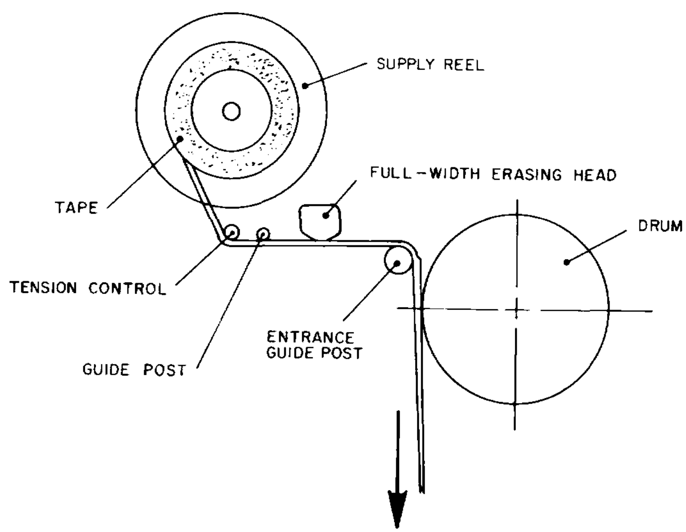


Fig. 6
Tape Back-Tension as Seen from Top of Supply Reel and Drums

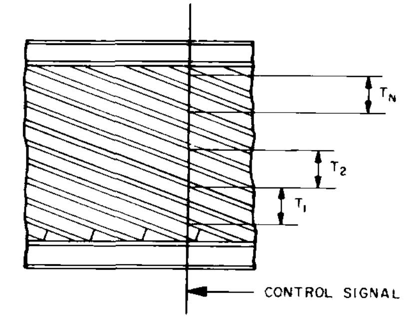


Fig. 7
Video Track Straightness on Magnetic Coated Surface Side of Tape

NOTE: Video track pitch in the tape-width direction is represented by T_1 through T_N. If T_0 is given as a theoretical value, then $T_0 = 0.3474$ mm (0.013677 in) when the number of fields per second is 59.94 and the nominal tape speed is 190.5 mm/s (7.5 in/s).

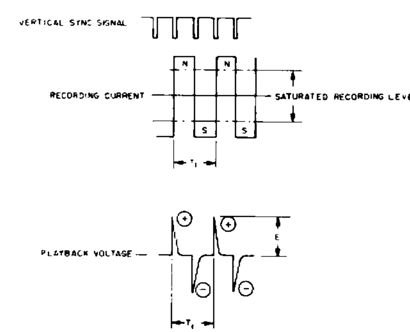


Fig. 8
Waveform and Polarity of Control Signals

Notes:

1. $n_f = 60$ nominal
2. $n_H = 262.5$
3. $T_1 = 33.3$ ms nominal
4. When the polarity changes from the S pole to the N pole, a positive pulse voltage shall be obtained.
5. The reference pulse shall be of a positive pulse voltage.
6. The waveform of the recording current need not be a square wave if it is considered that interchangeability of recorded tapes can be maintained.

American National Standard
for motion-picture film (35-mm)— perforated BH

Approved March 24, 1986 — Sponsor: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the cutting and perforating dimensions for 35-mm motion-picture film with a BH-type perforation and a perforation pitch of either 0.1866 or 0.1870 in (4.740 or 4.750 mm).

2. Referenced American National Standard

This standard is intended for use in conjunction with the following American National Standard:

ANSI/SMPTE 223M-1985, Motion-Picture Film—Safety Film

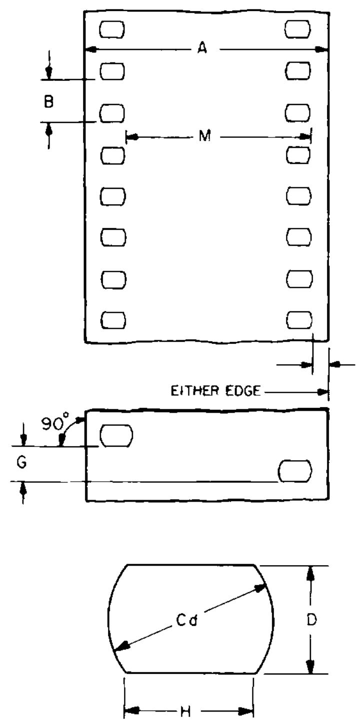
3. Dimensions

3.1 The dimensions shall be as given in the figure and table.

3.2 The dimensions pertain to a safety film as defined in ANSI/SMPTE 223M-1985.

3.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23°C ± 1°C (nominally converted to 73°F ± 2°F) and a relative humidity of 50 ± 2 percent. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.

3.4 Dimension H is a calculated value.



	Dimensions	Inches		Millimeters	
A	Film width	1.377	± 0.001	34.975	± 0.025
B	Perforation pitch (long)	0.1870	± 0.0004	4.750	± 0.010
B'	Perforation pitch (short)	0.1866	± 0.0004	4.740	± 0.010
C_d	Perforation width (diameter)	0.1100	± 0.0004	2.794	± 0.010
D	Perforation height	0.0730	± 0.0004	1.854	± 0.010
E	Edge to perforation	0.079	± 0.002	2.01	± 0.05
G	Perforation misalignment	0.001	max	0.03	max
H	Perforation chord width (BH perforation)	0.082	calculated	2.08	calculated
L	100 consecutive perforation pitches (long)	18.700	± 0.015	474.98	± 0.38
L'	100 consecutive perforation pitches (short)	18.660	± 0.015	473.96	± 0.38
M	Lateral perforation displacement	1.109	± 0.001	28.17	± 0.03

NOTE 1: The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, a code designation for the perforation shape (BH, KS, DH, or CS) or the number of rows of perforations (1R, 2R, etc.), depending upon which is the significant factor, or the perforation pitch without the decimal point.

NOTE 2: The metric conversion of Dimension A is purposely chosen and shown to three dimensional places to prevent the maximum width dimension from exceeding 35 mm.

Appendix

(This Appendix is not part of the American National Standard, but is included for information only.)

A1. The user is reminded that, as a plastic, film can change dimensions temporarily due to moisture or temperature, or permanently due to solvent loss or strain effect.

A2. Film for positive use has a longitudinal pitch 0.2 percent longer than its companion negative. Shrinkage of the negative during aging and processing prior to printing will generally not exceed 0.2 percent. Thus, the negative stock is expected to be 0.3 ± 0.1 percent shorter than the positive. This difference will minimize slippage between the two on the 12-in (305-mm) circumference sprocket of the printer, assuming a film thickness of 0.0055 to 0.0065 in (0.140 to 0.165 mm).

A3. The uniformity of pitch, hole size, and margin (Dimensions B, C_d, D, and E) is an important variable affecting steadiness. Variations in these dimensions from roll to roll are of little significance compared to variations from one perforation to the next within any small group of consecutive perforations. As an example, the uniformity of the margin is uniquely critical for optical printing. During the printing process, the placement of the image on the film is usually with respect to successive lateral pairs of perforations at one-frame intervals. During subsequent projection, however, the portion of the image projected is usually located, not by these perforations, but by the edge of the film. The lateral steadiness of the projected image is, therefore, directly related to the frame-to-frame uniformity of the margin.

A4. For historical background on the development of this standard, refer to A. J. Miller and A. C. Robertson, "Motion-picture film — its size and dimensional characteristics," Jour. SMPTE, 74: 3-11, Jan. 1965.

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ANSI/SMPTE 146M-1986
Revision and Redesignation of
ANSI PH22.146M-1980

American National Standard
for motion-picture film—determination of speed—16- and 8-mm reversal color camera films

Approved March 24, 1986 | Sponsor: Society of Motion Picture and Television Engineers

1. Scope

1.1 Specifications. This standard specifies a method for the determination of American National Standard speed of 16-mm, 8-mm Type R, and 8-mm Type S reversal color camera films intended for direct projection in motion-picture photography.

1.2 Basic Standard. American National Standard ANSI/ISO 2240-1982, ANSI PH2.21-1983 constitutes the basis for this standard. All sections of that standard, except Sec. 5.3.5, are to be considered part of this standard.

2. Referenced American National Standards

This standard is intended for use in conjunction with the following American National Standards:

ANSI PH2.15-1964 (R1976), Automatic Exposure Controls for Cameras

ANSI/ISO 2240-1982, ANSI PH2.21-1983, Photography (Sensitometry)—Color Reversal Camera Films—Determination of ISO Speed

3. Exposure Time

Exposure time shall be between 1/25 and 1/50 second.

Appendix

(This Appendix is not part of the American National Standard, but is included for information only.)

Experience has shown that a density level selected as optimum for a transparency is influenced by screen luminance. A less dense transparency is selected if the screen luminance is reduced. Because of the difference in screen luminance typical of 35-mm slide projection (approximately 137 candelas per square meter [40 foot-lamberts]) and that typical of 16-mm motion-picture film projection (assumed to range from approximately 48 to 62 cd/m² [14 to 18 fL]), a variation in preferred picture density may lead to a desire for approximately ⅓ camera stop increase in exposure for the latter. This difference is not considered sufficient to warrant a change in the sensitometric test method for motion-picture use. However, many 8-mm projection conditions are different enough in luminance from 55 cd/m² (16 fL) to require lighter or darker pictures. American National Standard ANSI PH2.15-1964 suggests that an adjustment which permits ⅓ stop more exposure for 8-mm films is permissible. This is standard practice by camera manufacturers. However, since there is no standard for 8-mm projection, it is not practical to write a separate standard for determining speed of 8-mm films.

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SMPTE RECOMMENDED PRACTICE — RP 135-1986

Use of Binary User Groups in Motion-Picture Time and Control Codes

1. *Scope*

This practice specifies a method of coding data into the binary user groups of time and control codes for motion-picture systems. The type of data recorded is useful in the production of motion pictures.

This practice also specifies a directory system to accommodate the various types of data that may need to be recorded. Whether or not to use a particular type of data, and if used, the repetition frequency, is left to the discretion of the equipment manufacturer and/or the user.

This practice also specifies the use of a checksum in one of the binary user groups.

2. *Referenced Document*

The following document is intended to be used in conjunction with this practice:

SMPTE Recommended Practice on Time and Control Codes for 24, 25 or 30 Frame-Per-Second Motion-Picture Systems, RP 136-1986

3. *Binary Group Flag Bits*

When the data format corresponding to this practice is used, the binary group flag bits specified in RP 136-1986 shall be set as follows:

Bit 43 of the type C code or bit 67 of the type B code shall be set to a zero. Bit 59 of the type C code or bit 83 of the type B code shall be set to a one.

4. *Data Structure*

4.1 There are 8 binary groups specified in RP 136-1986, each consisting of four bits. Unless otherwise specified, when a group of these bits is used to represent a number of characters, the bit with the lowest number specified in RP 136-1986 shall be the least significant bit, and the bit with the highest number shall be the most significant bit.

4.2 The first binary group shall be used as a data identification index, identifying the data in the second through seventh binary groups as specified below and as shown in Table 1. There are 16 possible index values, numbered 0 through 15. Each frame of time and control code may thus contain only one type of data, depending on the value of the data identification index. A sequence of more than one frame may be required, therefore, to record all the required data. However, the choice of which data types to use and their repetition frequency is left to the discretion of the user and/or manufacturer.

4.3 The eighth binary group shall be used as a checksum. It shall contain the negative of the modulo-16 sum of the first through seventh binary groups.

4.4 Directory

4.4.1 Entry 0. When the value of the data identification index is zero, the bits of the second through seventh binary groups shall be used as individual flags as defined in Table 2. Flag bits that are not used or that are unassigned should be set to zero.

4.4.2 Entry 1. When the value of the data identification index is one, the bits of the second through seventh binary groups shall be used to record the date in binary coded decimal format. The binary groups shall be assigned as follows:

Binary Group	Contents
Second	Units of the day of the month
Third	Tens of the day of the month
Fourth	Units of the month
Fifth	Tens of the month
Sixth	Units of the year
Seventh	Tens of the year

The date will be displayed in increasing quantities of time: day, month, year.

4.4.3 Entry 2. When the value of the data identification index is two, the bits of the second through seventh binary groups shall be used to record a production identification number or code in binary coded decimal format.

4.4.4 Entry 3. When the value of the data identification index is three, the bits of the second through seventh binary groups shall be used to record a four-digit equipment identification number or code. For example, if more than one

Approved 23 April 1986

camera is used, the camera number could be recorded. This code may be alphanumeric and shall be recorded with the 6-bit character set described in Sec. 5. Any of the character symbols may also be used.

4.4.5 Entry 4. When the value of the data identification index is four, the bits of the second through seventh binary groups shall be used to record a four-digit scene number. This number may be alphanumeric and shall be recorded with the 6-bit character set described in Sec. 5. Any of the character symbols may also be used.

4.4.6 Entry 5. When the value of the data identification index is five, the bits of the second through seventh binary groups shall be used to record a four-digit take number. This number may be alphanumeric and shall be recorded with the 6-bit character set described in Sec. 5. Any of the character symbols may also be used.

4.4.7 Entry 6. When the value of the data identification index is six, the bits of the second through seventh binary groups shall be used to record a four-digit roll number. For example, when recording sound, this number could identify the roll of magnetic tape, or when shooting pictures, this roll could identify the roll of film. This number may be alphanumeric and shall be recorded with the 6-bit character set described in Sec. 5. Any of the character symbols may also be used.

4.4.8 Entries 7 through 14. These index values are unassigned and shall not be used. Their assignment is reserved to the SMPTE.

Table 1
Directory

Index	Data	Digits	Format
0	Flags	24	Binary
1	Date (DDMMYY)	6	BCD
2	Production number	6	BCD
3	Equipment identification	4	6-BIT CHAR
4	Scene number	4	6-BIT CHAR
5	Take number	4	6-BIT CHAR
6	Roll number	4	6-BIT CHAR
7-14	Unassigned		
15	Extended directory		

Table 2
Flags

Bit No. Type C	Bit No. Type B	Data Zero	Data One
12	36	Pictures	Audio
13	37	Sync sound or picture	No sound/no picture
14	38	To be printed	Not printed
15	39	Sync speed	Not sync speed
20	44	Day photography	Night photography
21	45	Daylight	Tungsten

4.4.9 Entry 15. When the value of the data identification index is 15, an extended directory is invoked. The second binary group becomes an extended data identification index and data is recorded in the third through seventh binary groups. No extended data identification values are assigned at this time and their assignment in the future is reserved to the SMPTE. Until they are assigned, a data identification index of 15 shall not be used.

5. *Six-Bit Character Format*

5.1 Certain types of data are recorded using a six-bit character set. This section specifies the allocation of the four-bit user groups when recording this type of data and the character set to be used.

5.1.1 Use of the Bits. The data bits of the second through seventh binary groups shall be assigned as specified in Table 3.

Table 3
Data Bit Assignment

Bits, Type C Code	Bits, Type B Code	Use
12,13,14,15,20,21	36,37,38,39,44,45	Least significant character
22,23,28,29,30,31	46,47,52,53,54,55	Character
36,37,38,39,44,45	60,61,62,63,68,69	Character
46,47,52,53,54,55	70,71,76,77,78,79	Most significant character

5.1.2 Character Set. The character set shall be as defined in Table 4. This character set is a sub-set of the one defined in International Standard ISO 2022-1982, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques.

Table 4
Six-Bit Character Set

Character	Binary Equivalent	Decimal Equivalent	Character	Binary Equivalent	Decimal Equivalent
space	000000	0	@	100000	32
!	000001	1	A	100001	33
"	000010	2	B	100010	34
#	000011	3	C	100011	35
$	000100	4	D	100100	36
%	000101	5	E	100101	37
&	000110	6	F	100110	38
'	000111	7	G	100111	39
(	001000	8	H	101000	40
)	001001	9	I	101001	41
*	001010	10	J	101010	42
+	001011	11	K	101011	43
,	001100	12	L	101100	44
-	001101	13	M	101101	45
.	001110	14	N	101110	46
/	001111	15	O	101111	47
0	010000	16	P	110000	48
1	010001	17	Q	110001	49
2	010010	18	R	110010	50
3	010011	19	S	110011	51
4	010100	20	T	110100	52
5	010101	21	U	110101	53
6	010110	22	V	110110	54
7	010111	23	W	110111	55
8	011000	24	X	111000	56
9	011001	25	Y	111001	57
:	011010	26	Z	111010	58
;	011011	27	[	111011	59
<	011100	28	\	111100	60
=	011101	29	]	111101	61
>	011110	30	^	111110	62
?	011111	31	—	111111	63