PROPOSED SMPTE RECOMMENDED PRACTICE

RP 179

Dialect Specification of Page-Line Directory Index for Television, Audio and Film Time and Control Code for Video-Assisted Film Editing

1 Scope

This practice specifies a method of coding film position, film frame to video frame phase relationship, transfer sync points, and production related data into binary groups of SMPTE time and control code.

The dialect specified defines the structure of directory page-lines $0A_h$ to $0F_h$ (page 0, lines 10 through 15), $1A_h$ to $1F_h$ (page 1, lines 10 through 15), $2F_h$ (page 2, line 15), and $D0_h$ to EF_h (pages 13 and 14, lines 0 through 15). This conforms to the multiplexing structure specified in SMPTE 262M.

The page-line directory index, located in binary groups 8 and 7 of each time code frame, fully specifies the type of data stored in the remaining binary groups of that frame.

The encoding method is suitable to both linear time code (LTC) and to vertical interval time code (VITC).

2 Data structure

The page-line directory index, located in binary groups 8 and 7 of each time code frame, fully specifies the type of data stored in the remaining binary groups of that frame.

Data are stored in the binary groups of time and control code as single-frame and multiframe messages. This structure is described in SMPTE 262M. The page-line directory index, shown throughout this practice as a two-digit hexadecimal number, specifies the data stored in the remaining binary groups of time code frame.

2.1 Data types

The transfer of film to video with accompanying audio may be described by a dynamic frame-by-frame definition of the film to video transfer relationship and/or by a sync point and transfer parameters. The application will determine which combination of data is used.

2.2 Dynamic transfer data

Dynamic transfer data consists of information such as film edge numbers which are changing throughout the transfer. These data may be encoded frame by frame as detailed in clause 3.

2.3 Static production data

Static production data include items such as scene, roll, and take numbers which remain constant for a section of a transfer. The data may be encoded at the beginning, before the active portion of the transfer, or as indicated by the application. Static data types and their encoding are detailed in clause 4.

2.4 Sync point data

Sync point data define a common point among sets of dynamically changing data. Where the relationship between dynamically changing sets of data is defined and remains constant, other points prior to and after the sync point may be calculated. The data and their encoding are detailed in clause 5.

3 Dynamic film transfer data

3.1 Bit assignment

The manufacturer's edge number data are specified in the appropriate SMPTE standard for the film gauge.

The frame offset and the units and tens digits of edge number are encoded into binary groups 1 through 4 of each frame. The frame offset is the positive frame offset from the identified edge number location. It is

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encoded as two BCD nibbles. The range of values for the frame offset is from zero to a value dependent on the film gauge and exposure format. Since the frames tens digit will not exceed the value three, only two bits are required.

The remaining two bits in binary group 2 may be used to define the film-to-video field pulldown.

The remaining data is multiplexed into binary groups 6 and 5 with the page-line index in binary groups 8 and 7. The data encoded into binary groups shall be assigned as shown in table 1.

Table 1 – Binary group bit assignment

LTC bits	VITC bits	Binary group	Assignation
4–7	6–9	1	Frames units
12–13	16–17	2	Frames tens
14	18	2	Field 2 update flag
15	19	2	Field 1 update flag
20–23	26–29	3	Edge number units
28–31	36–39	4	Edge number tens
36–39	46–49	5	Multiplexed digit 1
44–47	56–59	6	Multiplexed digit 2
52–55	66–69	7	Line index
60–63	76–79	8	Page index

3.1.1 Field 1 update flag

For the transfer of film media to video, the field one update flag shall be a one if the film frame changed at the beginning of video field one.

3.1.2 Field 2 update flag

For the transfer of film media to video, the field two update flag shall be a one if the film frame changed at the beginning of video field two. When this flag is a one, it identifies the video frame as a hybrid of two film frames.

3.2 Multiplexed data identification

The page-line index defines the contents of the multiplexed digits as shown in table 2. These data are multiplexed into binary groups 6 and 5 with the page-line index in binary groups 8 and 7.

3.3 Manufacturer's edge number

The manufacturer's edge number consists of a manufacturer's identification code, a film emulsion type code, a batch number, and an edge number. This number comprises 14 BCD encoded digits.

Table 2 – Multiplexed data identification

Page-line	Multiplexed data	Digit 2	Digit 1
Manufacturer's edge code			
OF	Film manufacturer code	10's	1's
OE	Emulsion type code	10's	1's
OD	Film batch	100,000's	10,000's
OC	Film batch	1000's	100's
OB	Film batch	10's	1's
OA	Film Edge number	1000's	100's
Film roll number			
1F	Film roll number	1000's	100's
1E	Film roll number	10's	1's
Footage and footage frame offset			
1D	Film footage	100,000's	10,000's
1C	Film footage	1000's	100's
1B	Film footage	10's	1's
1A	Footage frame offset	10's	1's
Transfer status and event trigger			
2F	Status and event	See figure 1	

A manufacturer's edge number may be replaced by an edge code and this shall be indicated by setting the manufacturer's identification code to FF(hex).

The frame offset from the edge number location and the two least significant digits of the edge number are encoded on each frame. The remaining digits of the manufacturer's edge code are multiplexed.

3.4 Footage and footage frame offset

The footage count and an offset from the footage mark are multiplexed as BCD encoded digits.

3.5 Film roll number

The film roll number is multiplexed as hexadecimal encoded digits.

3.6 Transfer data

The transfer data byte conveys specific information about the film transfer. The interpretation of this data byte is shown in figure 1.

3.6.1 Status bit definition

The individual bits of a 4-bit binary coded nibble define the status of film transfer data.

BINARY GROUP 6				BINARY GROUP 5			
7	6	5	4	3	2	1	0
STATUS BITS				EVENT CODE			

NOTES

1 Status bit

Status bit	Description
7	1 = Edge number valid
6	1 = Edge number contrary count direction
5	Unassigned
4	Unassigned

2 Event code

Event code	Description
0	Unassigned
1	Speed lock achieved
2	Zero frame crossing
3	Physical film splice
4	Edge number discontinuity
5	Speed lock lost
6	Full stop
7	Edge number status change
8	GPI trigger
9	Unassigned
10 A	Unassigned
11 B	Unassigned
12 C	Unassigned
13 D	Unassigned
14 E	Unassigned
15 F	Clear multiplexed data

Figure 1 – Transfer data byte

3.6.1.1 Edge number valid

This bit is set to one if the manufacturer's edge number is valid.

3.6.1.2 Edge number contrary count direction

This bit is set to one if the edge number count direction is contrary to count direction of the time address.

3.6.2 Event code definition

A 4-bit hexadecimal coded nibble defines events which may occur during a film-to-video transfer. Only one event may be identified at a time. If two events occur simultaneously, the event with the higher number shall be encoded first unless defined otherwise by the application.

3.6.2.1 Speed lock achieved

The event code is set equal to one to indicate that the film speed has achieved stable play speed.

3.6.2.2 Zero frame crossing

The event code is set equal to two to indicate the passage of a designated film frame. This is normally associated by an absolute footage count being equal to zero.

3.6.2.3 Physical film splice

The event code is set equal to three to indicate that a film splice has been detected.

3.6.2.4 Edge number discontinuity

The event code is set equal to four to indicate that a discontinuity in the edge number count has been detected.

3.6.2.5 Speed lock lost

The event code is set equal to five to indicate that the film speed has left play speed.

3.6.2.6 Full stop

The event code is set equal to six to indicate that the film speed has come to a full stop.

3.6.2.7 Edge code status change

The event code is set equal to seven to indicate that the edge number status has changed. The edge number status as described in 3.6.1.1 indicates the condition after the change.

3.6.2.8 GPI trigger

The event code is set equal to eight to indicate that an external trigger has occurred.

3.6.2.9 Unassigned

The event codes 0 and 9 through 15 are unassigned and reserved for future definition.

3.7 Multiplexing order

As each frame is uniquely defined by its page-line index, no special order is required for multiplexing data. The order and repetition of data shall be as defined by the application.

4 Directory page D — Static production data

All of the production data are encoded as standard 7-bit ISO character or BCD numbers. The format for most types of data is basically the same. The information multiplexed in the binary groups of time code is determined by the application. One item or all of them may be included. Data are stored in the binary groups of time and control code as single-frame and multiple-frame messages (see table 3).

4.1 Page-line D0, D1 — Scene (2 frames)

The scene data are encoded in two frames identified by page-lines D0 and D1. Six ISO characters are provided for scene.

4.2 Page-line D2 — Take (1 frame)

The take data are encoded in one frame identified by page-line D2. Three ISO characters are provided for take.

Table 3 – Directory page D, lines 0 to F definitions

Binary group	8	7	6	5	4	3	2	1
Scene	D	0	Character 1		Character 2		Character 3	
Scene	D	1	Character 4		Character 5		Character 6	
Take	D	2	Character 1		Character 2		Character 3	
Video reel	D	3	Character 1		Character 2		Character 3	
Video reel	D	4	Character 4		Character 5		Character 6	
Film roll	D	5	Character 1		Character 2		Character 3	
Film roll	D	6	Character 4		Character 5		Character 6	
Sound roll	D	7	Character 1		Character 2		Character 3	
Sound roll	D	8	Character 4		Character 5		Character 6	
Production number	D	9	Character 1		Character 2		Character 3	
Production number	D	A	Character 4		Character 5		Character 6	
Transfer date	D	B	Year		Month		Day	
			Tens	Units	Tens	Units	Tens	Units
Message prefix	D	C	Type		Byte count		Checksum	
Message string	D	D	Character 1		Character 2		Character 3	
Message suffux	D	E	Type		Byte count		Checksum	
Unassigned	D	F	Character 1		Character 2		Character 3	

4.3 Page-lines D3, D4 — Video reel number (2 frames)

The video reel number is encoded in two frames identified by page-lines D3 and D4. Six ISO characters are provided for the video reel number.

4.4 Page-lines D5, D6 — Film roll number (2 frames)

The film roll number is encoded in two frames identified by page-lines D5 and D6. Six ISO characters are provided for the film roll number.

4.5 Page-lines D7, D8 — Sound roll number (2 frames)

The sound roll number is encoded in two frames identified by page-lines D7 and D8. Six ISO characters are provided for the sound roll number.

4.6 Page-lines D9, DA — Production number (2 frames)

The production number is encoded in two frames identified by page-lines D9 and DA. Six ISO characters are provided for the production number.

4.7 Page-line DB — Date (1 frame)

The date is encoded in one frame identified by page-line DB. Six BCD digits are provided for the date.

4.8 Page-lines DC, DD, and DE — Message string (3 to 87 frames)

A message string can be encoded in binary groups over a number of frames. It is identified by three different page-lines in the directory index.

4.8.1 Page-line DC

Page-line DC is a message prefix that contains a checksum, a message specifier, and the byte count of the message to follow with a maximum of 255 ISO characters. If the byte count is not known at the beginning of the message, then a zero shall be entered.

4.8.2 Page-line DD

Page-line DD identifies a frame that contains three ISO characters that are part of the message string. One to 85 frames, all identified by page-line DD, are sent for a message length of 1 to 255 characters. The

byte count of this message is specified in the message prefix and again in the message suffix.

4.8.3 Page-line DE

Page-line DE is a message suffix with the same content as the message prefix. The byte count must be shown, and it cannot be zero unless the message length is actually zero. The suffix indicates the end of the message string.

4.9 Page-line DF

Page-line DF is unassigned (1 frame).

4.10 Message characters

Up to three 8-bit characters may be stored in one frame. Each character may be an 8-bit binary character, a 7-bit ISO character with even parity, or may be divided into two 4-bit BCD or hex characters. Where there is space not filled in a message frame, the remaining characters shall be filled with nulls.

4.11 Checksum

Error detection may be provided for as an 8-bit checksum. Refer to page-line directory standard SMPTE 262M.

5 Directory page E — Sync point data

Directory page E is used to specify sync point information. Sync point data are encoded as ISO characters, BCD, and hex numbers. A sync point defines a specific frame relationship between a frame of the SMPTE time code that contains the multiplexed user bits and a specific frame of film or an SMPTE time code frame from another source such as an audio tape. Two format nibbles are included in the specification to identify the format of the film, the speed of the transfer, and the video-to-film phase relationship. Five frames are required to define a film edge to video sync point and three frames are required to define a sync point between two different time codes. Given the sync point data, it is a simple process to calculate the corresponding number precisely for any video field (see table 4).

All items are not required in the multiplex cycle. The application may select any combination desired.

5.1 Page-lines E0-E4 — Film latent number sync point (5 frames)

The film latent number is a number that is put on the film by the manufacturer. It has two major variations:

The traditional edge number contains both ISO characters and BCD numbers generally incrementing every foot and is human readable only.

A manufacturer's edge number has been introduced which is both human- and machine-readable. The machine readability is provided by a bar code. The edge number is a 14-digit BCD number that increments every foot (16 4-perforation frames) in 35-mm and every half foot (20 frames) in 16-mm. An edge number also contains a 2-digit manufacturer's ID code and a 2-digit film emulsion-type code.

Since no piece of film can contain both traditional edge numbers and manufacturer's edge numbers, the same page-line directory assignment can be used for both. A single bit called the key number flag is used to identify which type of film is specified. The key number flag bit is the most significant bit of binary group 4 in page-line E3. In a traditional key number, this bit is always zero with a 7-bit ISO character. In a manufacturer's edge number sync point, this bit is set to one and the rest of the bits in binary group 4 are set to zero. This eliminates any possibility of confusion when reading the data (see table 4).

5.1.1 Film edge number sync point (5 frames)

A traditional edge number can contain six characters of ISO followed by 6 BCD digits that generally increment every foot. A traditional edge number is encoded in a sync point as follows (see table 4):

Page-line E0: Binary groups 1 and 2 contain two format nibbles. These specify the type of film, the speed of transfer, and the film-to-video phase relationship at the sync point (see 5.4). Binary groups 3 and 4 specify the film sync point edge number frame offset. Binary groups 5 and 6 specify the film sync point edge number units and tens.

Page-line E1: Binary groups 1 to 4 specify the film sync point edge number third to sixth significant digits. Binary groups 5 and 6 define ISO character 1 of the film sync point.

Table 4 – Directory page E, line 0 to F definitions

Binary group							
8	7	6	5	4	3	2	1
Film edge number sync point							
		Film					
E	0	Edge number		Frames		Format	
		10's	1's	10's	1's	2	1
		Film					
E	1	Edge number		Edge number		Edge number	
		Character 1		100K	10K	1000	100
		Film					
E	2	Edge number		Edge number		Edge number	
		Character 4		Character 3		Character 2	
		Video		Film			
E	3	Frames		Edge number		Edge number	
		10's	1's	Charcter 6		Character 5	
		Video					
E	4	Hours		Minutes		Seconds	
		10's	1's	10's	1's	10's	1's
Film manufacturer's edge number sync point							
		Film					
E	0	Edge number		Frames		Format	
		10's	1's	10's	1's	2	1
		Film					
E	1	Edge number		Edge number		Edge number	
		10M	1M	100K	10K	1000	100
		Film					
E	2	Mfg. code		Film type		Edge number	
		10's	1's	10's	1's	1G	100M
		Video					
E	3	Frames		8	0	0	0
		10's	1's				
		Video					
E	4	Hours		Minutes		Seconds	
		10's	1's	10's	1's	10's	1's

(continued)

Table 4 (concluded)

Binary group							
8	7	6	5	4	3	2	1
Film ink edge number sync point							
		Film					
E	5	Ink edge number		Frames		Format	
		10's	1's	10's	1's	2	1
		Film					
E	6	Ink edge number		Ink edge number		Ink edge number	
		Character 1		100K	10K	1000	100
		Film					
E	7	Ink edge number		Ink edge number		Ink edge number	
		Character 4		Character 3		Character 2	
		Video		Film			
E	8	Frames		Ink edge number		Ink edge number	
		10's	1's	Character 6		Character 5	
		Video					
E	9	Hours		Minutes		Seconds	
		10's	1's	10's	1's	10's	
Film time code sync point							
		Film time code					
E	A	Seconds		Frames		Format	
		10's	1's	10's	1's	2	1
		Video time code		Film time code			
E	B	Frames		Hours		Minutes	
		10's	1's	10's	1's	10's	1's
		Video time code					
E	C	Hours		Minutes		Seconds	
		10's	1's	10's	1's	10's	1's
Audio time code sync point							
		Audio time code					
E	D	Seconds		Frames		Format	
		10's	1's	10's	1's	2	1
		Video time code		Audio time code			
E	E	Frames		Hours		Minutes	
		10's	1's	10's	1's	10's	1's
		Video time code					
E	F	Hours		Minutes		Seconds	
		10's	1's	10's	1's	10's	1's

Page-line E2: Binary groups 1 and 2 define ISO character 2, binary groups 3 and 4 define ISO character 3, and binary groups 5 and 6 define ISO character 4.

Page-line E3: Binary groups 1 and 2 define ISO character 5 and binary groups 3 and 4 define ISO character 6. The most significant bit of binary group 4 is the key number flag bit. This eighth bit is always zero with a 7-bit ISO character. Binary groups 5 and 6 define the sync point time code frames.

Page-line E4: Binary groups 1 and 2 define the sync point time code seconds. Binary groups 3 and 4 define the sync point time code minutes. Binary groups 5 and 6 define the sync point time code hours.

5.1.2 Film manufacturer's edge number sync point (5 frames)

A manufacturer's edge number contains 14 BCD digits that increment every foot for 35-mm and every half foot for 16-mm. It also contains film manufacturer and film type ID codes. An edge number is encoded in a sync point as follows (see table 4):

Page-line E0: Binary groups 1 and 2 contain two format nibbles. These specify the type of film, the speed of transfer, and the film-to-video phase relationship at the sync point (see 5.4). Binary groups 3 and 4 specify the film sync point edge number frame offset. Binary groups 5 and 6 specify the film sync point key number units and tens.

Page-line E1: Binary groups 1 to 6 specify the film sync point edge number 3rd to 8th significant digits.

Page-line E2: Binary groups 1 and 2 specify the film sync point edge number 9th and 10th significant digits. Binary groups 3 and 4 specify the film emulsion type code. Binary groups 5 and 6 specify the film manufacturer's ID code.

Page-line E3: Binary groups 1 to 3 are set to zero. The number 8 is put in binary group 4. Binary groups 5 and 6 define the sync point time code frames.

Page-line E4: Binary groups 1 and 2 define the sync point time code seconds. Binary groups 3 and 4 define the sync point time code minutes. Binary groups 5 and 6 define the sync point time code hours.

5.2 Page-lines E5-E9 – Film code number sync point (5 frames)

Page-lines E5 to E9 are used for film ink edge code numbers and contain 6 characters of ISO followed by 6 BCD digits that generally increment every foot. The ink edge code number is usually put on by the editing staff during the post-production process. It is used to provide sync relationship between the film picture and the film sound on a sprocket magnetic medium. An ink edge code number can co-exist with a latent number; consequently, the page-line directory will allow both to be encoded simultaneously. An ink edge code number is encoded in a sync point as follows (see table 4):

Page-line E5: Binary groups 1 and 2 contain two format nibbles. These specify the type of film, the speed of transfer, and the film-to-video phase relationship at the sync point (see 5.4). Binary groups 3 and 4 specify the film sync point edge number frame offset. Binary groups 5 and 6 specify the film sync point ink edge number units and tens.

Page-line E6: Binary groups 1 to 4 specify the film sync point edge number 3rd to 6th significant digits. Binary groups 5 and 6 define ISO character 1 of the film sync point.

Page-line E7: Binary groups 1 and 2 define ISO character 2. Binary groups 3 and 4 define ISO character 3. Binary groups 5 and 6 define ISO character 4.

Page-line E8: Binary groups 1 and 2 define ISO character 5. Binary groups 3 and 4 define ISO character 6. The most significant bit of binary group 4 is the key number flag bit. This eighth bit is always zero with a 7-bit ISO character. Binary groups 5 and 6 define the sync point time code frames.

Page-line E9: Binary groups 1 and 2 define the sync point time code seconds. Binary groups 3 and 4 define the sync point time code minutes. Binary groups 5 and 6 define the sync point time code hours.

5.3 Page-lines EA-EC – Film time code sync point (3 frames)

A film time code sync point defines a specific frame relationship between a frame of the SMPTE time code that contains the multiplexed user bits and a specific frame of film with a film time code associated with it.

A film time code number is encoded in a sync point as follows (see table 4):

Page-line EA: Binary groups 1 and 2 contain two format nibbles. These specify the type of film, the speed of transfer, and the film-to-video phase relationship at the sync point (see 5.4). Binary groups 3 and 4 specify the sync point film time code frames. Binary groups 5 and 6 specify the sync point film time code seconds.

Page-line EB: Binary groups 1 and 2 specify the sync point film time code minutes. Binary groups 3 and 4 specify the sync point film time code hours. Binary groups 5 and 6 define the sync point video time code frames.

Page-line EC: Binary groups 1 and 2 specify the sync point video time code seconds. Binary groups 3 and 4 specify the sync point video time code minutes. Binary groups 5 and 6 specify the sync point video time code hours.

5.4 Film format nibbles

Both of these format nibbles apply to latent edge numbers, latent key numbers, ink edge code numbers, and film time code.

Film format nibble 1 is a hex digit which specifies the film format and the number of frames per edge number. Codes 0 and 1 are defined for 16-mm. Codes 2 to 5 are defined for 35-mm. Codes 6 to F are currently undefined (see table 4).

Film format nibble 2 defines the film-to-video sync point phase relationship and the transfer speed. Hex codes 0 to 7 are defined for basic film transfer rates, and codes 9 to F are currently undefined. Film transfer speed is not directly indicated, but can be easily derived from the pulldown type and the frame rate of the time code (see table 4).

The 2:3 transfer map at the bottom of table 4 shows the mapping between film and video frames. This standard sequence repeats every four film frames and every five video frames. SMPTE has defined an A-frame sync point as a two-field film frame transfer that begins on field one of a video frame as shown. When looking at the linear time for each film frame in the sequence, film frames A, B, C, and D map most closely to video frames A, B, C, and D. The M (mid-frame) video frame is exactly half of two film frames in both linear and 2:3 pull-down transfers. Consequently, this mid-frame is unique and has to be treated as a special case in list management and other functions.

5.5 Page-lines ED-EF – Audio time code sync point (3 frames)

An audio sync point defines a specific frame relationship between a frame of the SMPTE time code that contains the multiplexed user bits and a specific frame of another SMPTE time code written on an audio medium. An audio time code number is encoded in a sync point as follows (see table 4):

Page-line ED: Binary groups 1 and 2 contain two audio time code format nibbles. These specify the type of audio time code used. Binary groups 3 and 4 specify the sync point audio time code frames. Binary groups 5 and 6 specify the sync point audio time code seconds.

Page-line EE: Binary groups 1 and 2 specify the sync point audio time code minutes. Binary groups 3 and 4 specify the sync point audio time code hours. Binary groups 5 and 6 specify the sync point video time code frames.

Page-line EF: Binary groups 1 and 2 specify the sync point video time code seconds. Binary groups 3 and 4 specify the sync point video time code minutes. Binary groups 5 and 6 specify the sync point video time code hours.

5.6 Audio time code format nibbles

Audio time code format nibble 1 is a hex digit which specifies the time code written on the audio media. Zero to 4 are defined and codes 5 to F are currently undefined (see table 4).

Audio time code format nibble 2 is currently undefined.

6 Unassigned bits

Unassigned bits shall be set to zero until assigned by SMPTE.

7 Binary group flag bits

When the data structure conforms to this format, the binary group flag bits shall be set in accordance with SMPTE 12M as shown in table 5. For vertical interval application, this flag designation shall be repeated in both video fields.

8 Correspondence between VITC and LTC

The data in the binary groups of VITC may change between field 1 and field 2. Where this occurs, the value encoded into the binary groups of the LTC code shall be the data from the binary groups of VITC field 1.

Table 5 – Binary group flag values for page-line encoding

		24- and 30-fps systems		25-fps systems	
Binary group flag	Bit value	LTC bit	VITC bit	LTC bit	VITC bit
BGF2	1	59	75	43	55
BGF1	0	58	74	58	74
BGF0	1	43	55	27	35

Annex A (informative)
Bibliography

SMPTE 12M, Television, Audio and Film — Time and Control Code

SMPTE 170M, Television — Composite Analog Video Signal — NTSC for Studio Applications

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

SMPTE 262M, Television, Audio and Film — Storage and Transmission of Data — Binary Groups of Time and Control Codes

SMPTE 270, Motion-Picture Film (65-mm) — Manufacturer-Printed Latent Image Identification Information

SMPTE 271, Motion-Picture Film (16-mm) — Manufacturer-Printed Latent Image Identification Information

ISO/IEC 646:1991, Information Technology — ISO 7-Bit Coded Character Set for Information Interchange

ISO 2022:1986, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques

PROPOSED SMPTE RECOMMENDED PRACTICE

Spectral Conditions for Measuring Printing Density in Motion-Picture Negative and Intermediate Films

Introduction

When a motion-picture color negative or intermediate film is printed, the dyes in the negative or intermediate modulate the red, green, and blue exposures of the print material. The printing densities of the negative are a measure of this exposure modulation. Printing density is the density of the negative as "seen" by the printer and print material.

Motion-picture films are manufactured so as to reproduce properly a gray scale with matched gammas in the final print, and the negatives and intermediate films are designed to present matched printing density gammas to the print materials. Thus, the printing densities of a negative will correctly measure the relative gammas of the negative. Printing densities can be measured relative to a 100% transmitting reference, to the film D_{min}, or to a reference gray step. In the latter case, an ideal film would have matched, superimposed red, green, and blue gray scale printing densities.

The printing exposures are determined by the product of the spectral power distribution of the printing light source, any spectral filtration in the printer, and the spectral sensitivities of the print material. Ideally, a measure of printing density would exactly duplicate these properties. This is not possible in practice owing to the large variety of printers and materials that exist. The practical goal in specifying a printing density measure is to require that the printing density measurement correctly specifies the printing gammas of typical motion-picture color negative and intermediate materials.

1 Scope

This practice defines the spectral conditions for the measurement of printing density gammas of motion-picture color negative and intermediate materials.

2 Spectral conditions for printing density measurements

The spectral conditions for the measurement of printing density of motion-picture negative and intermediate materials are tabulated in table 1. These spectral responses, labeled R G and B respectively, are arbitrarily normalized to have unit response at the peak sensitivity. In actual use, the densitometer would be adjusted to cause zero density to correspond to a 100% transmitting material or to the D_{min} of the film being measured. This instrument zero adjustment will have the effect of renormalizing the data of table 1.

3 Application

The following equations define the relationship between printing density and printing exposure which is determined by measurements using the spectral responses of table 1:

$$E_R = \frac{\int R_\lambda \times TF_\lambda d_\lambda}{\int R_\lambda \times TS_\lambda d_\lambda}$$

$$E_G = \frac{\int G_\lambda \times TF_\lambda d_\lambda}{\int G_\lambda \times TS_\lambda d_\lambda}$$

$$E_B = \frac{\int B_\lambda \times TF_\lambda d_\lambda}{\int B_\lambda \times TS_\lambda d_\lambda}$$

where R G and B refer to the spectral responses in table 1, TF is the film sample spectral transmittance, and TS is the spectral transmittance of the reference used to normalize the data or to adjust the zero of the measurement.

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The printing densities relate to the printing exposures as follows:

$PD_R = LOG_{10} (E_R)$

$PD_G = LOG_{10} (E_G)$

$PD_B = LOG_{10} (E_B)$

Table 1 – Spectral conditions for the measurement of motion-picture film printing density

W.L. (nm)	R	G	B
360	0.0000	0.0000	0.0000
370	0.0000	0.0000	0.0000
380	0.0000	0.0000	0.0052
390	0.0000	0.0000	0.0628
400	0.0000	0.0000	0.1692
410	0.0000	0.0000	0.4141
420	0.0000	0.0000	0.7625
430	0.0000	0.0000	1.0000
440	0.0000	0.0000	0.8754
450	0.0000	0.0000	0.5512
460	0.0000	0.0000	0.2619
470	0.0000	0.0005	0.1075
480	0.0000	0.0012	0.0262
490	0.0000	0.0049	0.0018
500	0.0000	0.0366	0.0000
510	0.0000	0.2714	0.0000
520	0.0000	0.7152	0.0000
530	0.0000	1.0000	0.0000
540	0.0000	0.8779	0.0000
550	0.0000	0.4584	0.0000
560	0.0000	0.1317	0.0000
570	0.0000	0.0079	0.0000
580	0.0000	0.0025	0.0000
590	0.0000	0.0013	0.0000
600	0.0000	0.0000	0.0000
610	0.0010	0.0000	0.0000
620	0.0177	0.0000	0.0000
630	0.0913	0.0000	0.0000
640	0.2223	0.0000	0.0000
650	0.4917	0.0000	0.0000
660	0.8267	0.0000	0.0000
670	1.0000	0.0000	0.0000
680	0.7937	0.0000	0.0000
690	0.4487	0.0000	0.0000
700	0.1907	0.0000	0.0000
710	0.0752	0.0000	0.0000
720	0.0097	0.0000	0.0000
730	0.0000	0.0000	0.0000
740	0.0000	0.0000	0.0000

Annex A (informative)
Bibliography

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