SMPTE RECOMMENDED PRACTICE

RP 201-2008
Revision of RP 201-2004

Encoding Film Transfer Information Using Vertical Interval Time Code

Table of Contents

Approved November 26, 2008

Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative Practices. This SMPTE Engineering Document was prepared by Technology Committee S22.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Standard. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

1 Scope

This practice specifies a method of encoding video tape time code, film edge numbers, and production time code into three vertical interval time code lines. This practice is intended for use in post-production as a means of conveying the essential address elements that define the film to tape transfer. Normally this information will not be in the final program version. This practice defines the encoding in two parts; the first part specifies the data that will be encoded and the second part specifies specific methods of encoding the data into three vertical interval lines for analog and digital video signals, and into digital video ancillary data time code.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

3 Normative References

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

SMPTE 12M-1-2008, Television — Time and Control Code

SMPTE 12M-2-2008, Television — Transmission of Time Code in the Ancillary Data Space

SMPTE 254-2008, Motion-Picture Film (35-mm) — Manufacturer-Printed Latent Image Identification Information

SMPTE 266M-2002, Television — 4:2:2 Digital Component Systems — Digital Vertical Interval Time Code

SMPTE 270-2008, Motion-Picture Film (65-mm) — Manufacturer-Printed Latent Image Identification Information — 80 Perforation Repeat

SMPTE 271-2008, Motion-Picture Film (16-mm) — Manufacturer-Printed Latent Image Identification Information

SMPTE 313-2008, Motion-Picture Film (65-mm) — Manufacturer-Printed Latent Image Identification Information — 120 Perforation Repeat

SMPTE RP 195-2004, Use of the Reference Mark in Manufacturer-Printed Latent Image Key Numbers for Unambiguous Film Frame Identification

4 Definitions and Glossary

4.1 Terms Defined by SMPTE 254, SMPTE 270, SMPTE 271, and SMPTE 313

4.1.1 key number: A number, sometimes referred to as an edge number or footage number, that is printed with ink or exposed onto the film at the time of manufacture. The numbers are placed at regular intervals — typically one foot. Film that conforms to SMPTE 254, SMPTE 270, SMPTE 271, or SMPTE 313 use a 12-character alphanumeric key number. For the purposes of this practice, references to key number will refer to the machine-readable key number.

4.1.2 key number repetition rate: The interval at which key numbers repeat on the film stock, measured in perforations.

4.2 Terms Defined by SMPTE RP 195

4.2.1 frame repetition rate: The interval at which exposed film images occur along the film, measured in perforations.

4.3 Terms Defined by This Practice

4.3.1 film feet: The least significant 4 digits of the key number. This number increments every n frame where n is calculated by dividing the key number repetition rate by the frame repetition rate.

4.3.2 film prefix: The part of the key number that is not contained in film feet. This number is used to identify the stock or batch of film. Normally this number does not increment during a single roll of film.

4.3.3 film frame offset: This is the frame offset away from the key number. It is not included as part of the key number. SMPTE RP 195 specifies the procedure for unambiguously identifying the film frame numbers from exposed latent-image key numbers.

4.3.4 feet frame count: This is the number of film frames in the current film foot. For film formats where the key number repetition rate is not evenly divisible by the frame repetition rate, the feet frame count identifies which foot has an extra frame.

5 Definition of the Data Blocks

The encoded data are split into three distinct blocks of data — video tape data, film data, and production data.

5.1 Video Tape Data Block

The video tape data block contains the video tape time information in the time bits. The frame rate of this time code will be 25 frame-per-second time for 625/50 systems, and 29.97 frame-per-second drop frame or nondrop frame for 525/60 systems.

The contents of the user bits will be the VTR user bits or video tape reel number, or any arbitrary hexadecimal values.

5.2 Film Data Block

The film data block contains the key number information from the film, as well as information specifying the film format and pulldown of the transferred frame.

The time bits of the film data block are used to store the pulldown flags, film manufacturer, film gauge, emulsion type, and part of the film prefix. The user bits contain the remainder of the film prefix, the film feet, the film frame offset, and the feet frame count.

Film manufacturer and type IDs are encoded as a hexadecimal nibble. Film emulsion, prefix, and footage are encoded as a pair of packed BCD digits. Frame count is encoded as a binary number. The remainder of the information is bitmap encoded as shown in Tables 1 to 5.

Name	Contents
Pulldown	A bitmapped nibble comprised of three pulldown flags plus the video field flag. The three pulldown flags, PD1, PD2, and PD3, encode the pulldown of the film frame with respect to the video (see tables 2 to 5). The field flag FLD encodes video field information required to make the pulldown complete (0 is encoded for field 1, 1 is encoded for field 2).
Film manufacturer and type ID	A hexadecimal nibble which describes the manufacturer and the type of film being used (see Table 1).
Film emulsion type	A packed BCD digit pair containing the film emulsion type corresponding to the encoded values recovered from the machine-readable bar code (and not the letter codes on the human-readable part of the edge number). When ink numbers are used, the film emulsion type contains the decimal ASCII values of the letter suffix in the ink number prefix. If no letter suffix is used, the decimal ASCII for a space (32) shall be encoded.
Film prefix	Six BCD digits containing the film prefix.
Film feet	Four BCD digits containing the film feet.
Feet frame count	Two bits (FFC2 and FFC1) containing the feet frame count (see Table 1).
Film frame offset	Six bits containing the film frame offset.

5.2.1 Film manufacturer and type ID

See Table 1.

Table 1 – Film types and feet frame counts

Manufacturer ID	Film Manufacturer	Format	Feet frame count	FCC2	FCC1
0	Ink (see note)	35 mm (4 perf)	16	0	0
		16 mm	20	1	0
		16 mm	40	0	1
			Reserved	1	1
1	Agfa	35 mm	16 (4 perf)	0	0
2	Kodak		21 (3 perf dot at head – perf 1)	1	0
3	Fuji		21 (3 perf dot in center – perf 2)	0	1
			22 (3 perf dot at tail – perf 3)	1	1
4	Agfa	Special formats	8 (35 mm 8 perf – VistaVision)	0	0
5	Kodak		24 (65 mm/120 5 perf 60 FPS)	1	0
6	Fuji		32 (35 mm 2 perf)	0	1
			Reserved	1	1
7	Fuji	65/70 mm (120 perf key number cycle)	24 (5 perf)	0	0
8	Kodak		15 (8 perf)	1	0
			12 (10 perf)	0	1
			8 (15 perf)	1	1
9	Fuji	65/70 mm (80 perf key number cycle)	16 (5 perf)	0	0
A	Kodak		10 (8 perf)	1	0
			8 (10 perf)	0	1
			Reserved	1	1
B	Afga	16 mm	Reserved	0	0
C	Kodak		20 (key number and frames)	1	0
D	Fuji		40 (foot and frames)	0	1
			Reserved	1	1
E	ORWO	35 mm (4 perf)	16	0	0
		16 mm	20	1	0
			Reserved	0	1
			Reserved	1	1
F	Reserved				

Note: Film manufacturer 0 is reserved to denote ink numbers which are applied during post-production. They do not correspond to any specific manufacturer.

5.2.2 Pulldown

Three pulldown flags (PD3, PD2, and PDI) uniquely identify any of the video frames that can result from the pulldown sequence. Note that the flags do not change in the middle of a video frame. These flags are encoded along with the video field flag (FLD) to form the pulldown nibble.

Name	Description
PD3, PD1	Used to identify uniquely the pulldown sequence.
PD2	0 = video frame containing the same film image in both fields 1 = video frame containing different film images in each field
FLD	0 = video field 1 1 = video field 2

Table 2 – 23.98 f/s pulldown flags — 525/60 systems

Film frame	FLD (MSB)	PD3	PD2	PD1 (LSB)	Nibble value	Video frame example
A	0	1	0	0	4	0:00
	1	1	0	0	C	
B	0	1	0	1	5	0:01
	1	1	0	1	D	
	0	0	1	1	3	0:02
C	1	0	1	1	B	
	0	0	1	0	2	0:03
D	1	0	1	0	A	
	0	0	0	0	0	0:04
	1	0	0	0	8	
A	0	1	0	0	4	0:05
	1	1	0	0	C	

Table 3 – 29.97 f/s and 25 f/s field 1 dominant pulldown flags

Film frame	FLD (MSB)	PD3	PD2	PD1 (LSB)	Nibble value	Video frame example
A	0	0	0	1	1	0:01
	1	0	0	1	9	
A	0	0	0	1	1	0:02
	1	0	0	1	9	

Table 4 – 29.97 f/s and 25 f/s field 2 dominant pulldown flags

Film frame	FLD (MSB)	PD3	PD2	PD1 (LSB)	Nibble value	Video frame example
C6	0	1	1	1	7	0:01
C7	1	1	1	1	F	
	0	1	1	1	7	0:02
C8	1	1	1	1	F	

Table 5 – 24 f/s pulldown flags — 625/50 systems

Film frame	FLD (MSB)	PD3	PD2	PD1 (LSB)	Nibble value	Video frame example
A1	0	1	0	0	4	0:00
	1	1	0	0	C	
A2	0	1	0	0	4	0:01
	1	1	0	0	C	
A3	0	1	0	0	4	0:02
	1	1	0	0	C	
A4	0	1	0	0	4	0:03
	1	1	0	0	C	
A5	0	1	0	0	4	0:04
	1	1	0	0	C	
A6	0	1	0	0	4	0:05
	1	1	0	0	C	
A7	0	1	0	0	4	0:06
	1	1	0	0	C	
A8	0	1	0	0	4	0:07
	1	1	0	0	C	
A9	0	1	0	0	4	0:08
	1	1	0	0	C	
A10	0	1	0	0	4	0:09
	1	1	0	0	C	
A11	0	1	0	0	4	0:10
	1	1	0	0	C	
B1	0	1	0	1	5	0:11
	1	1	0	1	D	
	0	0	1	1	3	0:12
C1	1	0	1	1	B	
	0	1	1	0	6	0:13
C2	1	1	1	0	E	
	0	1	1	0	6	0:14
C3	1	1	1	0	E	
	0	1	1	0	6	0:15
C4	1	1	1	0	E	
	0	1	1	0	6	0:16
C5	1	1	1	0	E	
	0	1	1	0	6	0:17
C6	1	1	1	0	E	
	0	1	1	0	6	0:18
C7	1	1	1	0	E	
	0	1	1	0	6	0:19
C8	1	1	1	0	E	
	0	1	1	0	6	0:20
C9	1	1	1	0	E	
	0	1	1	0	6	0:21
C10	1	1	1	0	E	
	0	1	1	0	6	0:22
C11	1	1	1	0	E	
	0	0	1	0	2	0:23
D1	1	0	1	0	A	
	0	0	0	0	0	0:24
	1	0	0	0	8	

5.2.3 Film data block example

For a sample 35-mm (4 perf) key number KJ12 3456 7890+12

Manufacturer's code: 2 – Letter code K for Kodak is encoded as 2 for 35-mm

Film type: 96 – Film type 5296 has letter code J

Prefix: 123456

Footage: 7890

Frames: C – Binary representation of 12 frames

Pulldown: 4 – A frame pulldown and field 1

6 Production Data Block

The production data block contains the production time code in the time bits which are encoded in a format similar to SMPTE 12M-1. The user bits of the production data block shall contain the in-camera or audio time and frame count.

The default frame rate of production time code will be 25 f/s for 625/50 systems, and 29.97 f/s drop frame or nondrop frame for 525/60 systems. The frame rate is encoded into two flag bits as follows:

PFR2	PFR1	Frame rate
0	0	24 / 23.98
1	0	25
0	1	29.97
1	1	Other (manually set up on reader)

The user bits will normally contain the user bits of the audio time code or in-camera time code. Two flag bits are used to indicate the format of the user bit encoding as follows:

UBF2	UBF1	User bit encoding format
0	0	Not encoded (8 hexadecimal digits)
0	1	Encoded according to date / camera ID format (see below)
1	0	Reserved
1	1	Reserved

The data / camera ID format of the user bits is defined as follows:

- The year (00-99) is encoded into 7 bits
- The month (01 to 12) is encoded into 4 bits
- The day (01 to 31) is encoded into 5 bits
- Each camera ID digit is a hexadecimal digit containing values 0 to F. The full camera ID is 4 hexadecimal digits.

7 Encoding the Data into 3 VITC Lines

7.1 Format Overview

The encoded data shall be contained in a block of three consecutive lines of the vertical interval. There shall be an optional block of 3 lines for redundancy. Although the actual choice of lines is up to the user, the line ranges in Table 6 are recommended.

Table 6 – Recommended line numbers

	525/60	625/50
Block 1	14-15-16 (277-278-279)	14-15-16 (327-328-329)
Block 2 (optional	17-18-19 (280-281-282)	19-20-21 (332-333-334)

The first line of the block shall be defined as the one occurring closer to vertical sync (i.e., for a block in lines 14-16, line 14 shall be the first line). The block of VITC lines shall contain the data given in Table 7.

Table 7 – Data encoding into VITC lines

	Time bits	User bits	CRC
First line	VTR time	VTR user bits or hexadecimal digits	Normal
Second line	Key number prefix	Key number count + frames	Inverted
Third line	Production time	ATR / In-camera user bits	Special

The video tape data line (first line) shall be encoded with the normal SMPTE 12M-1 CRC checkword so that existing VITC readers built into the tape machines can access this information. Each of the other two lines shall be encoded with their own unique CRC so that there will not be any confusion from existing VITC readers as to the meaning of the three sets of data. The film data line (second line) CRC will be the inverse of the SMPTE 12M-1 CRC. The production data line (third line) CRC has the high-order nibble inverted.

The following clauses give the specific details of the encoding of each line.

7.2 First Line — Video Tape Data Block

The video tape data block is encoded into the first line using standard SMPTE 12M-1 format encoding. The CRC of this line will be the normal SMPTE 12M-1 CRC.

7.3 Second Line — Film Data Block

The film data block is encoded into the second line. The CRC shall be the ones complement of the normal SMPTE 12M-1 CRC. Table 8 shows how the film data block is mapped into the VITC bits of the line.

7.4 Third Line — Production Data Block

The production data block is encoded into the third line in a format similar to SMPTE 12M-1. The CRC shall be calculated in the same way as the normal SMPTE 12M-1 CRC, but will have the high-order nibble inverted. Table 9 shows how the production data block is mapped to the VITC bits.

When the user bits are encoded to the date/camera/ID format (see clause 6), the data shall be mapped to the VITC bits as given in Table 9.

Table 8 – Film data block mapping into VITC blocks

Time nibbles	VITC bit number	Contents
Hours tens	72-75	Pulldown (see Tables 2 to 5)
Hours units	62-65	Film manufacturer and type ID (see Table 1)
Minutes tens	52-55	Film emulsion type 1 (MS digit)
Minutes units	42-45	Film emulsion type 2 (LS digit)
Seconds tens	32-35	Prefix 1 (MS digit)
Seconds units	22-25	Prefix 2
Frames tens	12-15	Prefix 3
Frames units	02-05	Prefix 4
User bit group	VITC bit number	Contents
Group 8 (hours tens)	76-79	Prefix 5
Group 7 (hours units)	66-69	Prefix 6 (LS digit)
Group 6 (minutes tens)	56-59	Footage 1 (MS digit)
Group 5 (minutes units)	46-49	Footage 2
Group 4 (seconds tens)	36-39	Footage 3
Group 3 (seconds units)	26-29	Footage 4 (LS digit)
Group 2 (frames tens)	18-19	Feet frame count
	16-17	Frames 2 MSB
Group 1 (frame units)	06-09	Frames 4 LSB

Table 9 – Production data block mapping into VITC bits

Time nibbles	VITC bit number	Contents
Hours tens	75	PFR2, frame rate flag 2
	74	PFR1, frame rate flag 1
	72-73	Hours tens of production time (0-2)
Hours units	62-65	Hours units of production time
Minutes tens	55	UBF2, user bit format flag 2
	52-54	Minutes tens of production time (0-5)
Minutes units	42-45	Minutes units of production time
Seconds tens	35	UBF1, user bit format flag 1
	32-34	Seconds tens of production time (0-5)
Seconds units	22-25	Seconds units of production time
Frames tens	15	Reserved, set to zero
	14	Production time drop frame flag
	12-13	Frames tens of production time
Frames units	02-05	Frames units of production time
User bit group	VITC bit number	Contents
Group 8 (hours tens)	76-79	Year, 4 MS bits
Group 7 (hours units)	67-69	Year, 3 LSB
	66	Month, MSB
Group 6 (minutes tens)	57-59	Month, 3 LSB
	56	Day, MSB
Group 5 (minutes units)	46-49	Day, 4 LSB
Group 4 (seconds tens)	36-39	Camera ID 1 (MS digit)
Group 3 (seconds units)	26-29	Camera ID 2
Group 2 (frames tens)	16-19	Camera ID 3
Group 1 (frame units)	06-09	Camera ID 4 (LS digit)

8 Encoding the Data into Ancillary Data Space

8.1 Format Overview

The encoded data shall be contained in three ancillary data time code packets per field as defined in SMPTE 12M-2. Table 10 shows the recommended line numbers that are to be encoded.

The data is mapped into ancillary data time code packets as shown in Table 11.

Table 10 – Recommended line numbers ancillary time code

	525/60	625/50
Video tape data block	14 (277)	14 (327)
Film data block	15 (278)	15 (328)
Production data block	16 (279)	16 (329)

Table 11 – Data encoding into ancillary data

	Time bits	User bits	SMPTE 12M-2 DBB1 coding (hex values) transferred from reader	SMPTE 12M-2 DBB1 coding (hex values) locally generated
Video tape data block	VTR time	VTR user bits or hexadecimal digits	01	7D
Film data block	Key number prefix	Key number count + frames	06	7E
Production data block	Production time	ATR / In-camera user bits	07	7F

The following clauses give the specific details of the encoding of each of the data blocks.

8.2 Video Tape Data Block

The video tape data block is encoded as normal vertical interval time code. The bit definitions are defined in SMPTE 12M-2.

8.3 Film Data Block

The film data block is encoded with DBB1 code of 06 (hex) when the data are being transferred from a reader device on the ANC formatter or 7E (hex) when it is a locally generated code in the ANC formatter. Table 12 shows how the film data block is mapped into the time code bits. SMPTE 12M-2 defines how these bits are mapped into the ANC time code packets.

8.4 Production Data Block

The production data block is encoded with a DBB1 code of 07 (hex) when the data are being transferred from a reader device on the ANC formatter or 7F (hex) when it is a locally generated code in the ANC formatter. Table 13 shows how the film data block is mapped into the time code bits. SMPTE 12M-2 defines how these bits are mapped into the ANC time code packets.

When the user bits are encoded to the date/camera/ID format (see clause 6), the data shall be mapped as given in Table 13.

Table 12 – Film data block mapping

Time nibbles	VITC bit number	Contents
Hours tens	56-59	Pulldown (see Tables 2 to 5)
Hours units	48-51	Film manufacturer and type ID (see Table 1)
Minutes tens	40-43	Film emulsion type 1 (MS digit)
Minutes units	32-35	Film emulsion type 2 (LS digit)
Seconds tens	24-27	Prefix 1 (MS digit)
Seconds units	16-19	Prefix 2
Frames tens	08-11	Prefix 3
Frames units	00-03	Prefix 4
User bit group	VITC bit number	Contents
Group 8 (hours tens)	60-63	Prefix 5
Group 7 (hours units)	52-55	Prefix 6 (LS digit)
Group 6 (minutes tens)	44-47	Footage 1 (MS digit)
Group 5 (minutes units)	36-39	Footage 2
Group 4 (seconds tens)	28-31	Footage 3
Group 3 (seconds units)	20-23	Footage 4 (LS digit)
Group 2 (frames tens)	14-15	Feet frame count
	12-13	Frames 2 MSB
Group 1 (frame units)	04-07	Frames 4 LSB

Table 13 – Production data block mapping

Time nibbles	VITC bit number	Contents
Hours tens	59	PFR2, frame rate flag 2
	58	PFR1, frame rate flag 1
	56-57	Hours tens of production time (0-2)
Hours units	48-51	Hours units of production time
Minutes tens	43	UBF2, user bit format flag 2
	40-42	Minutes tens of production time (0-5)
Minutes units	32-35	Minutes units of production time
Seconds tens	27	UBF1, user bit format flag 1
	24-26	Seconds tens of production time (0-5)
Seconds units	16-19	Seconds units of production time
Frames tens	11	Reserved, set to zero
	10	Production time drop frame flag
	08-09	Frames tens of production time
Frames units	00-03	Frames units of production time
User bit group	VITC bit number	Contents
Group 8 (hours tens)	60-63	Year, 4 MS bits
Group 7 (hours units)	53-55	Year, 3 LSB
	52	Month, MSB
Group 6 (minutes tens)	45-47	Month, 3 LSB
	44	Day, MSB
Group 5 (minutes units)	36-39	Day, 4 LSB
Group 4 (seconds tens)	28-31	Camera ID 1 (MS digit)
Group 3 (seconds units)	20-23	Camera ID 2
Group 2 (frames tens)	12-15	Camera ID 3
Group 1 (frame units)	04-07	Camera ID 4 (LS digit)

Annex A (Informative)
Calculating the Modified CRC

This annex contains additional information on encoding the modified CRCs used for the film data block and the production data block.

A.1 Calculating Film Data Block CRC

The normal SMPTE 12M-1 CRC is calculated first. The resulting 8-bit CRC is exclusive-ored with the hexadecimal value 0FF to obtain the film data block CRC.

A.2 Calculating Production Data Block CRC

The normal SMPTE 12M-1 CRC is calculated first. The resulting 8-bit CRC is exclusive-ored with the hexadecimal value 0F0 to obtain the production data block CRC.

Revision Notes

This revision incorporates Amendment #1 to RP 201 approved October 8, 2004. The purpose of this revision is to document the current industry practice for identifying the 35-mm 2-perf film format in the 3-line VITC encoding of Film Transfer information. It also documents the current industry practice of identifying film manufactured by ORWO and having the latent edge code the manufacturer code of 00.

The changes are summarized below:

1. The following sections have been added to be in conformance with other SMPTE documents: Table of Contents, Foreword and Intellectual Property.

2. "Section 2, Conformance Notation" has been added and all sections following have been renumbered (including all references to sections within the document).

3. Normative References in Section 3 have been updated.

4. Table 1 (section 5.2.1) has been revised.