Standards and Recommended Practices

Proposed SMPTE Standards

Two Proposed SMPTE Standards are published here for information:

SMPTE 240M, Television — 1125-Line High-Definition Production Systems — Signal Parameters; and

SMPTE 333M, Television — DTV Closed-Caption Server to Encoder Interface.

The proposals are available from Society Headquarters for $13.00 each.

Approved SMPTE Standards

Nine SMPTE Standards were approved recently:

SMPTE 12M-1999, Television, Audio and Film — Time and Control Code;

SMPTE 96-1999, Television — 35- and 16-mm Motion-Picture Film and 2x2-inSlides — Scanned Area and Photographic Image Area for 4:3 AspectRatio;

SMPTE 309M-1999, Television — Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code;

SMPTE 316M-1999, Television Digital Recording — 12.65-mm Type D-9 Component Format — Video Compression — 525/60 and 625/50;

SMPTE 317M-1999, Television Digital Recording — 12.65-mm Type D-9 Component Format — Tape Cassette;

SMPTE 318M-1999, Television and Audio — Reference Signals for the Synchronization of 59.94- or 50-Hz Related Video and Audio Systems in Analog and Digital Areas;

SMPTE 320M-1999, Television — Channel Assignments and Levels on Multichannel Audio Media;

SMPTE 323M-1999, Motion-Picture Film — Channel Assignments and Levels on Multichannel Audio Media; and

SMPTE 325M-1999, Digital Television — Opportunistic Data Broadcast Flow Control.

Available from Headquarters, SMPTE 12M and SMPTE 317M are $20.00 each; SMPTE 96, SMPTE 320M, and SMPTE 323M are $10.00 each; SMPTE 316M is $50.00 per copy; and SMPTE 309M, SMPTE 318M, and SMPTE 325M are $13.00 each.

Approved SMPTE Recommended Practices

The Society approved two SMPTE Recommended Practices:

RP 188-1999, Transmission of Time Code and Control Code in the Ancillary Data Space of a Digital Television Data Stream; and

RP 201-1999, Encoding Film Transfer Information Using Vertical Interval Time Code.

Available from Headquarters, RP 188 is $13.00 and RP 201 is $16.00.

Approved SMPTE Engineering Guideline

An SMPTE Engineering Guideline was approved by the Society:

EG 35-1999, Time and Control Code Time Address Clock Precision for Television, Audio and Film.

It is available from Headquarters for $13.00.

Carlos V. Girod, Jr., P.E.
Director of Engineering

SMPTE STANDARD

SMPTE 240M
Revision of ANSI/SMPTE 240M-1995

for Television — 1125-Line High-Definition Production Systems — Signal Parameters

1 Scope

This standard defines the basic characteristics of the analog video signals associated with origination equipment operating in 1125-line high-definition television production systems. This standard defines *systems operating at 60.00 Hz and 59.94 Hz field rates.*

The digital representation of the signals described in this standard may be found in SMPTE 260M. These two documents define between them both digital and analog implementations of 1125-line HDTV *production systems.*

2 Normative reference

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

SMPTE 260M-1999, Television — 1125/60 High-Definition Production System — Digital Representation and Bit-Parallel Interface

3 Scanning parameters

The video signals represent a scanned raster with the characteristics shown in table 1.

4 System colorimetry and transfer function

The system is intended to create a metameric reproduction (visual color match) of the original scene as if lit by CIE illuminant D_{65}. To this end, the combination of a camera's optical spectral analysis and linear signal matrixing shall match the CIE color-matching functions (1931) of the reference primaries. Further, the *combination of a reproducer's linear matrixing* and reproducing primaries shall be equivalent to the reference primaries (see annex A.1).

Table 1 – Scanned raster characteristics

	1125/60 system	1125/59.94 system
Total scan lines per frame	1125	
Active lines per frame	1035	
Scanning format	Interlaced 2:1	
Aspect ratio	16:9	
Field repetition rate	60.00 Hz ± 10 ppm	59.94... Hz[1] ± 10 ppm
Line repetition rate (derived)	33750.00 Hz	33716.28... Hz[2]

[1]The 59.94... Hz notation denotes an approximate value. The exact value is $\frac{60}{1.001}$

[2]The 33716.28... Hz notation denotes an approximate value. The exact value is $\frac{60 \times 1125}{2 \times 1.001}$

4.1 Chromaticity of reference primaries

The reference red, green, and blue primaries shall have CIE 1931 (x,y) chromaticities as follows:

	CIE *x*	CIE *y*
red	0.630	0.340
green	0.310	0.595
blue	0.155	0.070

4.2 Reference white

The system reference white is an illuminant which causes equal primary signals to be produced by the reference camera, and which is produced by the reference reproducer when driven by equal primary signals. For this system, the reference white is *specified in terms of its 1931 CIE chromaticity coordinates,* which have been chosen to match those of CIE illuminant D_{65}:

	CIE *x*	CIE *y*
white	0.3127	0.3290

4.3 Opto-electronic transfer characteristic of reference camera

The opto-electronic transfer function of the reference camera is defined to be:

$$V_C = \begin{cases} 4L_C & 0 \le L_C < 0.0228 \\ 1.1115 L_C^{0.45} - 0.1115, & 0.0228 \le L_C \le 1 \end{cases}$$

where V_C is the video signal output of the reference camera normalized to the system reference white, and L_C is the light input to the reference camera normalized to the system reference white.

4.4 Electro-optical transfer characteristic of reference reproducer

The electro-optical transfer function of the reference reproducer is defined to be:

$$L_r = \begin{cases} \frac{V_r}{4}, & 0 \le V_r < 0.0913 \\ \left(\frac{V_r + 0.1115}{1.1115}\right)^{\left(\frac{1}{0.45}\right)}, & 0.0913 \le V_r \le 1 \end{cases}$$

where V_r is the video signal level driving the reference reproducer normalized to the system reference white, and L_r is the light output from the reference reproducer normalized to the system reference white.

5 Video signal definitions

The image is represented by three parallel, time-coincident video signals. Each incorporates a synchronizing waveform. The signals shall be either of the following sets:

Color primary set	Color difference set
E_G' – green	E_Y' – luma
E_B' – blue	E_{PB}' – blue color difference
E_R' – red	E_{PR}' – red color difference

where $[E_G'\ E_B'\ E_R']$ are the signals appropriate to directly drive the primaries of the reference reproducer (being nonlinearly related to light levels as specified in 4.3 and 4.4) and $[E_Y'\ E_{PB}'\ E_{PR}']$ can be derived from $[E_G'\ E_B'\ E_R']$ as follows:

The luma function is specified to be:

$$E_Y' = (0.701 \times E_G') + (0.087 \times E_B') + (0.212 \times E_R') \quad \text{[base equation]}$$

E_{PB}' is amplitude-scaled $(E_B' - E_Y')$, according to:

$$E_{PB}' = \frac{(E_B' - E_Y')}{1.826} \quad \text{[derived equation]}$$

and E_{PR}' is amplitude-scaled $(E_R' - E_Y')$, according to:

$$E_{PR}' = \frac{(E_R' - E_Y')}{1.576} \quad \text{[derived equation]}$$

where the scaling factors are derived from the signal levels given in 7.3.

(See annex A.3 for the derivation of the coefficients in the luma equation, and annex A.4 for a summary of the formulas for converting between the two sets).

6 Reference clock

Signal durations and timings in this standard are specified both in reference clock periods and in microseconds. The reference clock as defined in the following table is the fundamental timing reference in the system.

	1125/60 system	1125/59.94 system
Reference clock periods in total line	2200	2200
Reference clock period – T (derived)	13.468...ns	13.481...ns
Reference clock frequency (derived)	74.25 MHz	74.17... MHz

NOTE – The 74.17... MHz notation denotes an approximate value. The exact value is $\frac{60\times1125\times2200}{2\times1.001}$.

7 Video and synchronizing signal waveforms

The combined video and synchronizing signal shall be as shown in figure 1. For illustrative purposes, a video signal of the form E_Y', E_G', E_B', or E_R' is shown. The details of the synchronizing signal are identical for the E_{PB}' and E_{PR}' color-difference signals.

7.1 Timing

7.1.1 The timing of events within a horizontal line of video is illustrated in figure 1(a) and summarized in table 2. All event times are specified in terms of the reference clock period at the midpoint of the indicated transition.

The analog production aperture extends from the start of active video to the end of active video (see figure 1(a) and annex A.5).

7.1.2 The duration of the various portions of the video and sync waveforms are illustrated in figures 1(b), 1(c), and 1(d), and summarized in table 3.

7.2 Bandwidth

7.2.1 The color primary set [E_G' E_B' E_R'] comprises three equal-bandwidth signals whose nominal bandwidth is 30 MHz.

7.2.2 The color-difference set [E_Y' E_{PB}' E_{PR}'] comprises a luma signal E_Y' whose nominal bandwidth is 30 MHz, and color-difference signals E_{PB}' and E_{PR}' whose nominal bandwidth is 30 MHz for analog originating equipment, and 15 MHz for digital originating equipment.

7.3 Levels

The video signals are represented in analog form as follows:

E_Y', E_G', E_B', E_R' signals:

Reference black level	0	(mV)
Reference white level	700	(mV)
Synchronizing level	± 300	(mV)

E_{PB}', E_{PR}' signals:

Reference zero signal level	0	(mV)
Reference peak levels	± 350	(mV)
Synchronizing level	± 300	(mV)

All signals:

Sync pulse amplitude	300 ± 6	(mV)
Amplitude difference between positive- and negative going sync pulses	<6	(mV)

Table 2 – Timing of events of a video line

	Reference clock periods
Rising edge of sync (timing reference)	0
Trailing edge of sync	44
Start of active video	192
End of active video	2112
Leading edge of sync	2156

Table 3 – Duration of video and sync waveforms

		Reference clock periods	Time (µs) 1125/60	Time (µs) 1125/59.94	Tolerance (µs)
a		44	0.593	0.593	± 0.040
b		88	1.185	1.186	– 0.000 + 0.081
c		44	0.593	0.593	± 0.040
d		132	1.778	1.780	± 0.040
e		192	2.586	2.588	– 0.000 + 0.081
f	(Sync rise time)	4	0.054	0.054	± 0.020
	Total line	2200	29.630	29.659	
	Active line	1920	25.859	25.884	+ 0 – 0.162

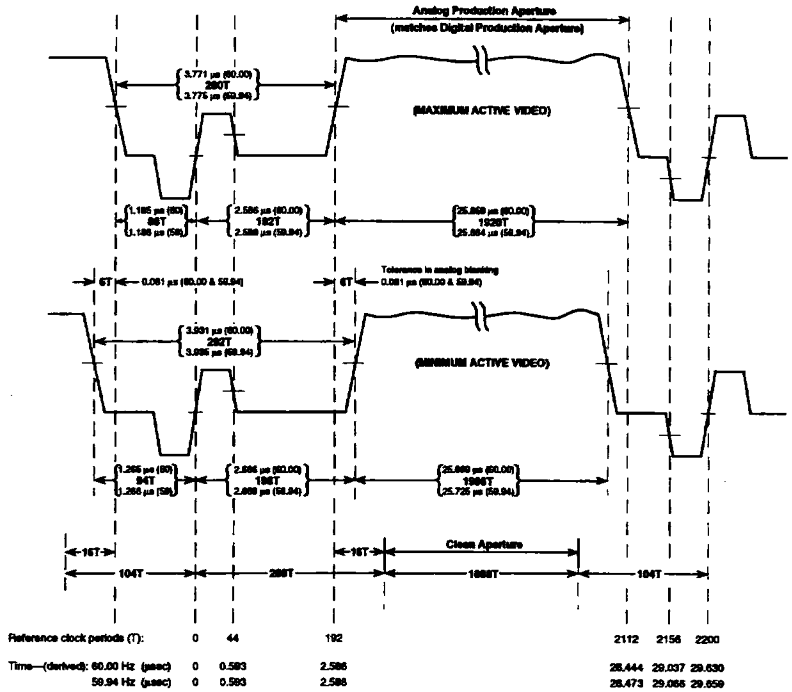

Figure 1(a) – Timing of events within a video line

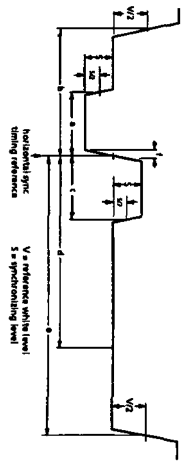

Figure 1(c) – Detail of line blanking period

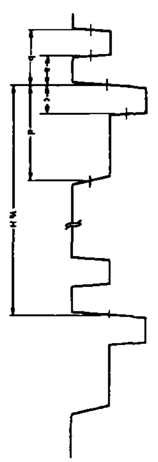

Figure 1(d) – Detail of field synchronizing pulse

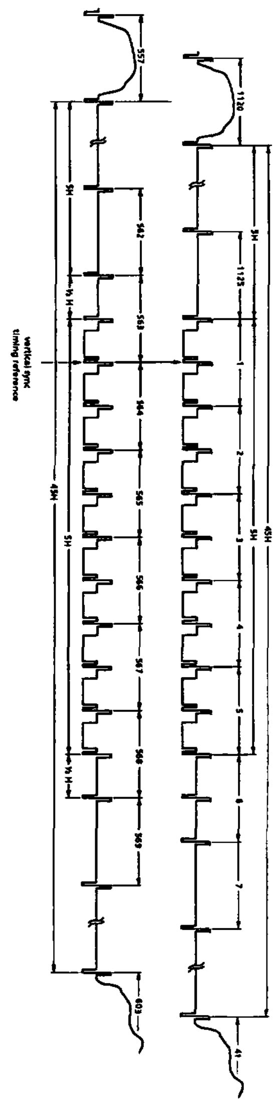

Figure 1(b) – Detail of field blanking periods

Annex A (informative)
Additional data

A.1 System colorimetry

The parameter values in clause 4 are based on current practice and technical constraints. It is recognized that the availability of a wider color gamut is highly desirable in an originating system. Furthermore, it is useful, for purposes of picture processing, to have available video signals proportional to light levels.

In order to obtain signals proportional to light levels, nonlinear processing is needed to remove the nonlinear characteristic given in 4.3. The equations given in 4.4 should be applied.

An approach to achieving the wider color gamut is under study which will involve retaining the reference primaries of 4.1 for the basic color coding and enlarging the color gamut by allowing negative RGB primary signals. (Consideration is also being given to the possibility of adopting the reference primaries specified in ITU-R BT.709, which are very close to the primaries specified in this standard.) The YP_bP_r signals derived from these extended-range RGB signals using the equations of clause 5 will fall within normal signal ranges.

A.2 Relationship between basic and derived parameters

Certain parameters have been determined as basic and fundamental system parameters. The values of all other system parameters can be derived from those chosen as basic, as shown in this annex.

Basic parameters:

- Field repetition rate (F) specified in clause 3.
- *Total scan lines per frame (S) specified in clause 3.*
- Reference clock periods in total line (R) specified in clause 6.

Computation of derived parameters:

- Line repetition rate (L): L = S ŏ F/2
- Reference clock frequency (C): C = S ŏ R ŏ F/2
- Reference clock period (T): T = (S ŏ R ŏ F/2)–1

A.3 Derivation of the luma equation

A.3.1 Discussion of the luma function

It is common practice to encode the R,G,B component signals into a signal which conveys luminance information, and two signals which convey chrominance information. This was essential in the case of NTSC, PAL, and SECAM, *where backwards compatibility with an existing mono*chrome system was required; and it is advantageous in modern systems, where the lower sensitivity of the eye to high-frequency chroma information can be exploited to reduce the bandwidth of the chroma signals.

The luminance function Y is defined by the CIE, and represents the brightness response of a standard observer. It is possible to determine the contributions of red, green, and blue light from a given phosphor set operating at a specified white point which are required to synthesize a true CIE luminance value for each scene element. The computation is summarized in A.3.2.

Because CRT phosphors do not respond linearly to electrical stimulation, the signals driving the phosphors must be preconditioned with an inverse nonlinearity. The preconditioning, usually called gamma correction, is normally done in the camera for several reasons. As a consequence, the RGB signals which are available for encoding are not linear with respect to light and cannot be linearly combined into a signal *which represents true CIE luminance. The encoded signal* which is produced will be called luma in order to permit clarity in terminology. Although the luma function does not represent the exact luminance of the scene element, it is common practice to encode it using the coefficient values derived for the luminance function.

For the purpose of this standard, the precise coefficient values are computed according to the method of A.3.2. The values are then rounded to three decimal places of accuracy, and those rounded values are defined as exact coefficient values in the specification of the luma equation in clause 5.

A.3.2 Luminance function coefficients for a phosphor set

The luminance function Y for a given phosphor set and white reference point is the mixture of the red, green, and blue lights (R,G,B) which represents the perceived brightness of scene elements.

The proportions of R,G,B which must be mixed to yield the correct value of Y can be calculated from the chromaticity coordinates of the reproducer primaries, and the chromaticity of reference white (i.e., the color reproduced when the reference reproducer is driven by equal primary signals), according to well-known methods.

Stated briefly, the equation for Y can be found as follows:

$$Y = [J_r y_r \;\; J_g y_g \;\; J_b y_b] \bullet \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

where J_g, J_b, and J_r are derived according to:

$$\begin{bmatrix} J_r \\ J_g \\ J_b \end{bmatrix} = \begin{bmatrix} x_r & x_g & x_b \\ y_r & y_g & y_b \\ z_r & z_g & z_b \end{bmatrix}^{-1} \bullet \begin{bmatrix} \left(\frac{x_w}{y_w}\right) \\ 1 \\ \left(\frac{z_w}{y_w}\right) \end{bmatrix}$$

and x_r,y_r,z_r are the chromaticity coordinates of the red primary; x_g,y_g,z_g are the chromaticity coordinates of the green primary; x_b, y_b, z_b are the chromaticity coordinates of the blue primary; and x_w, y_w, z_w are the chromaticity coordinates of reference white.

A.4 Transformation between [E_R' E_G' E_B'] and [E_Y' E_{PB}' E_{PR}']

The transformations between the two sets are:

$$\begin{bmatrix} E_G' \\ E_B' \\ E_R' \end{bmatrix} = \begin{bmatrix} 1.000 & -0.227 & -0.477 \\ 1.000 & 1.826 & 0.000 \\ 1.000 & 0.000 & 1.576 \end{bmatrix} \begin{bmatrix} E_Y' \\ E_{PB}' \\ E_{PR}' \end{bmatrix}$$

$$\begin{bmatrix} E_Y' \\ E_{PB}' \\ E_{PR}' \end{bmatrix} = \begin{bmatrix} 0.701 & 0.087 & 0.212 \\ -0.384 & 0.500 & -0.116 \\ -0.445 & -0.055 & 0.500 \end{bmatrix} \begin{bmatrix} E_G' \\ E_B' \\ E_R' \end{bmatrix}$$

A.5 Picture boundaries

The production aperture defined by this standard comprises a picture made up of 1920 reference clock periods (T) horizontally by 1035 lines vertically. The 1920T width of this analog production aperture is specified at 50% video level, and represents the maximum active video permissible under this standard. It is good practice to adjust and operate all studio equipment with this minimal amount of blanking. This analog production aperture has identical dimensions to the digital production aperture of SMPTE 260M.

In practical system implementations, blanking may be wider, up to the amount (6T at each end) specified by the tolerance in table 3. If the full amount of the tolerance is exercised at start and end of active picture, the minimum active video is obtained.

A.6 Reference reproducer and actual monitors

In 4.4, the electro-optical transfer characteristics of the reference reproducer are defined. This reference reproducer does not represent the transfer characteristics of a real monitor; rather, it is a mathematical description of a transfer function that is the exact inverse of the reference camera opto-electronic transfer function leading to a linear system that is convenient for many analyses. Experience has shown that, for the most pleasing subjective picture quality, television systems are often adjusted to have an overall light transfer characteristic represented by a power function whose exponent is slightly greater than unity. Therefore, real reproducers will often implement a transfer function whose power function exponent is somewhat greater than the value specified in this standard.

Annex B (informative)
Bibliography

ITU-R BT.709-3 (02/98), Parameter Values for the HDTV Standards for Production and International Programme Exchange

PROPOSED SMPTE STANDARD

for Television — DTV Closed-Caption Server to Encoder Interface

Table of contents

1 Scope

1.1 Purpose

This standard defines a standard for interoperation of digital television closed-caption (DTVCC) data server devices and video encoders. The caption data server devices provide partially-formatted EIA 708 data to the video encoders using the request/response protocol and interface defined in this standard. The video encoder completes the formatting and includes the EIA 708 data in the video elementary stream picture-level user_data field.

1.2 Application

This standard describes an interface for transmission of DTVCC data from a caption server to video encoder.

1.3 Organization

The clauses of this standard are organized as follows:

- Clause 1: Provides this general introduction;
- Clause 2: Lists references and documents;
- Clause 3: Provides definition of terms and a list of acronyms and abbreviations used in this standard;
- Clause 4: Describes the serial interface used;
- Clause 5: Describes the communications protocol.

2 Normative references

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

ANSI/EIA/TIA 574-1990, Synchronous Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange[1]

ATSC A/53 (16 Sep 1995), ATSC Digital Television Standard

EIA 708-A-1998, Specification for Digital Television (DTV) Closed Captioning

[1] ANSI/EIA/TIA 574 is an extension of ANSI/EIA/TIA 232-E that specifies a 9-pin connector and speeds faster than 20 kb/s; i.e., an RS-232 port on an IBM-compatible personal computer (ANSI/EIA/TIA 232-E specifies neither a 9-pin connector nor speeds faster than 20 kb/s).

THIS PROPOSAL IS PUBLISHED FOR COMMENT ONLY

3 Definitions

3.1 Compliance notation

As used in this standard, *shall* denotes a mandatory provision of the standard. *Should* denotes a provision that is recommended, but not mandatory. *May* denotes a feature whose presence does not preclude compliance, that may or may not be present at the option of the implementer.

3.2 Acronyms and abbreviations

The following acronyms and abbreviations are used within this specification:

3.2.1 ATSC: Advanced Television Systems Committee.

3.2.2 DTVCC: Digital Television Closed Captioning.

3.3 Definition of terms

The following terms are used throughout this standard:

3.3.1 caption server: A device that delivers DTVCC formatted data for insertion in picture-level user-data within an MPEG video elementary stream.

3.3.2 video encoder: A device that encodes video into MPEG compressed format.

3.4 Section and data structure syntax notation

This standard contains symbolic references to syntactic elements. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code), and may consist of character strings that are not English words (e.g., dynrng).

The formats of sections and data structures in this standard are described using a C-like notational method employed in ISO/IEC 13818-1.

4 Physical interface

The physical interface between the caption server and the video encoder shall be an ANSI/EIA/TIA 574 interface, with restrictions as specified in 4.2.

4.1 9-pin connector

The encoder shall be DCE and provide a female 9-pin connector as described in ANSI/EIA/TIA 574 with the pin-out described in table 1.

Table 1 – 9-pin connector pin-out

Pin	Signal	Signal source	Description
1	NC	N/A	Not connected
2	TXD	Video encoder	Serial data transmit
3	RXD	Caption server	Serial data receive
4	NC	N/A	Not connected
5	GND	N/A	Signal ground
6	NC	N/A	Not connected
7	RTS	Caption server	Request to send. The video encoder shall ignore the state of this pin.
8	CTS	Video encoder	Clear to send. When asserted, the caption server may transmit data to the video encoder
9	NC	N/A	Not connected

4.2 Interface parameters

The video encoder shall provide an ANSI/EIA/TIA 574 interface with the parameter settings from table 2.

Table 2 – ANSI/EIA/TIA 574 interface parameters

Parameter	Setting
Baud rate	38,400 b/s
Data bits	8
Parity	None
Stop bits	1
Start bits	1

5 Communications protocol

The caption server shall provide data to the video encoder as the video encoder requests it. The communications protocol is described below.

5.1 Closed caption packet

The caption server shall provide captioning data to the video encoder using the syntax described in table 3.

Table 3 – Bit stream syntax for closed-caption packet

```
Syntax                                          Bits    Format
Closed_caption_packet() {
    SOH                                         8       0x01
    cc_service_available                        1       bslbf
    cc_message_type                             7       uimsbf
    cc_message_length                           8       uimsbf
    if (cc_message_type == 0x44) {
        for (i = 0;
            i < cc_message_length – 3;
            i + = 3) {
                Marker                          5       11111
                cc_valid                        1       bslbf
                cc_type                         2       bslbf
                data_byte_1                     8       bslbf
                data_byte_2                     8       bslbf
        }
    } else if (cc_message_type == 0x53) {
        caption_service_number                  8       bslbf
        service_data_byte_1                     8       bslbf
        service_data_byte_2                     8       bslbf
        service_data_byte_3                     8       bslbf
        service_data_byte_4                     8       bslbf
        service_data_byte_5                     8       bslbf
        service_data_byte_6                     8       bslbf
        for (i = 0; i < N; i++) {
                filler_byte                     8       bslbf
        }
    }
    packet_checksum                             8       uimsbf
    EOT                                         8       0x04
}
```

SOH – ASCII SOH, fixed packet prefix.

cc_service_available – This 1-bit field is set to 1 to indicate that the caption server has caption service information available for transfer.

cc_message_type – This 7-bit unsigned integer specifies the type of table, based on table 4.

Table 4 – cc_message_type values

cc_message_type	Meaning
0x00 – 0x43	SMPTE reserved
0x44	DTVCC/NTSC data
0x45 – 0x52	SMPTE reserved
0x53	Caption service data
0x54 – 0x6f	SMPTE reserved
0x70 – 0x7f	User reserved

cc_message_length – 8-bit field specifying the number of bytes in this packet, SOH through EOT inclusive.

marker – This 5-bit field shall be set to 11111.

cc_valid – This 1-bit field indicates that the subsequent data_byte_1 and data_byte_2 are valid. This field carries the same meaning as ATSC A/53, 5.2.

cc_type – This 2-bit field indicates the type of data carried in data_byte_1 and data_byte_2. This field carries the same meaning as ATSC A/53, 5.2.

data_byte_1, data_byte_2 – These fields carry DTVCC or NTSC data. These fields carry the same meaning as ATSC A/53, 5.2.

caption_service_number – This field carries the caption service number. This field shall have a value between 0x01 - 0x10 (inclusive). This field carries the same meaning as ATSC A/65, 6.7.3. Note that the least significant 6 bits of this field are a duplication of the least significant 6 bits of service_data_byte_4 (see 5.6 for additional information).

service_data_byte_*n* – These 6 fields carry caption service data. These fields carry the same meaning as ATSC A/65, 6.7.3.

filler_byte – This 8-bit field carries reserved information when cc_message_type is reserved in table 4.

packet_checksum – This 8-bit field shall contain the 8-bit value necessary to make the arithmetic sum of the entire packet (SOH through EOT, inclusive) modulo 256 equal zero.

EOT – ASCII EOT, fixed packet postfix.

5.2 Encoder requests and responses

The video encoder sends messages to the closed-caption server to indicate status and request additional data. The messages sent by the video encoder are carried via the syntax defined in table 5.

Table 5 – Bit-stream syntax for encoder requests and responses

Syntax	Bits	Format
Encoder_req_resp() {		
service_data_inhibit	1	bslbf
req_or_resp	7	uimsbf
}		

service_data_inhibit – When set to 1, the caption server shall not send a closed_caption_packet() with message_type = 0x53 in response(s) to this encoder_req_resp(). If req_or_resp == 0x06 or req_or_resp == 0x15, this field shall be ignored.

req_or_resp – This 7-bit field shall have values from table 6.

Table 6 - Encoder requests and responses

Value	Name	Meaning
0x06	ACK	Previous transfer acknowledged
0x15	NAK	Previous transfer was not received, or was not completely received, or was received with an invalid checksum.
0x1a	SYN0[1]	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x05.
0x1b	SYN5	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x14.
0x1c	SYN10	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x23.
0x1d	SYN15	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x32.
0x1e	SYN20	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x41.
0x1f	SYN25	Transfer closed_caption_packet() with cc_message_type == 0x44 and cc_message_length == 0x50.

[1]Note that SYNx is used to refer to SYN0, SYN5, SYN10, SYN15, SYN20, or SYN25.

5.3 Startup case

At startup, the video encoder shall initiate communication by sending an encoder_req_resp() with req_or_resp = SYNx. Timeout shall be as described in 5.4.

At startup, the caption server shall be in a quiescent state.

5.4 Normal case

The video encoder shall send encoder_req_resp() with req_or_resp = SYNx to request DTVCC data. The caption server shall respond to an encoder_req_resp() packet with req_or_resp = SYNx with a closed_caption_packet() with cc_message_type == 0x44. The video encoder shall respond to a closed_caption-packet() with cc_message_type == 0x44 with an encoder_req_resp() with req_or_resp = ACK or NAK.

If the encoder_req_resp() with req_or_resp = SYNx was sent with service_data_inhibit == 0, the caption server may send a closed_caption_packet() with cc_message_type == 0x53 after sending a closed_caption_packet() with cc_message_type == 0x44. In this case, the video encoder shall respond to the closed_caption_packet() with cc_message_type == 0x53 with an encoder_req_resp() with req_or_resp = ACK or NAK.

The caption server should send a closed_caption_packet() with cc_message_type == 0x53 when there is new caption service information available for transmission, as indicated by cc_service_available in the previous closed_caption_packet() with cc_message_type == 0x44.

If caption service information becomes available after the cc_service_available bit in a closed_caption_packet() has been sent, a closed_caption_packet() with cc_message_type == 0x53 shall not be sent until after the video encoder has sent an encoder_req_resp() with req_or_resp = SYNx and service_data_inhibit == 0.

5.5 Timeout

If the video encoder has sent an encoder_req_resp() with req_or_resp = SYNx, and a complete closed_caption_packet() message has not been received within 500 ms of the transmission of the encoder_req_resp() with req_or_resp = SYNx, the video encoder shall discard any partial closed_caption_packet() message received and restart communication by sending an encoder_req_resp() with req_or_resp = SYNx.

If the caption server has sent an entire closed_caption_packet() message, the caption server shall ignore subsequent encoder_req_resp() with req_or_resp = SYNx until one of the following conditions have been satisfied: 500 ms have passed since transmission of the last byte of the closed_caption_packet() message, or an encoder_req_resp() with req_or_resp = ACK is received, or an encoder_req_resp() with req_or_resp = NAK is received.

5.6 Caption services

5.6.1 Addition of caption services

The caption server shall indicate additional caption services by sending a closed_caption_packet() with a caption_server_number different from the existing values of caption_service_number.

5.6.2 Modification of caption services

The caption server shall indicate modifications of existing caption services by sending a closed_caption_packet() with a caption_service_number value that duplicates an existing caption_service_number. The values of service_data_byte_*n* shall be interpreted to be correct for the caption_service_number specified, effective immediately.

5.6.3 Removal of caption services

The caption server shall indicate removal of existing caption services by sending a closed_caption_packet() with a caption_service_number value that duplicates an existing caption_service_number value, with service_data_byte_n set to the value zero (0x00).

5.7 Protocol state tables

The message exchange protocol state for the video encoder is fully described in table 7. Note the following shorthand: ccp(a) means closed_caption_packet() received with cc_message_type = a. The message exchange protocol state for the caption server is fully described in table 8. Note the following shorthand: ccp(a,b) means closed_caption_packet() sent with cc_message_type = a, caption_service_available = b.

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Table 7 – Video encoder protocol states

State number	Condition	Action	Next state	Timer
Initial state	None	Set local variable caption_service_available to 0	1	
1	caption_service_available == 0	Send SYNx service_data_inhibit ignored	2	Start T1 500-ms countdown
	caption_service_available == 1 and caption service data desired	Send SYNx service_data_inhibit = 0		
	caption_service_available == 1 and caption service data not desired	Send SYNx service_data_inhibit = 1		
2	Receive complete ccp (0x44), checksum matches. Local variable caption_service_available == 1 and last sent service_data_inhibit = 0	Send ACK, save received caption_service_available in local variable	3	Start T1 500-ms countdown
	Receive complete ccp (0x44), checksum matches.	Send ACK, save received caption_service_available in local variable	1	Stop T1
	Receive complete ccp (0x44), checksum does not match. Previous caption_service_available == 1 and last sent service_data_inhibit = 0	Send NAK, save received caption_service_available in local variable	3	Start T1 500-ms countdown
	Receive complete ccp (0x44), checksum does not match.	Send NAK, save received caption_service_available in local variable	1	Stop T1
3	Receive complete ccp (0x53), checksum matches.	Send ACK	1	Stop T1
	Receive complete ccp (0x53), checksum does not match.	Send NAK	1	Stop T1
Any	T1 expires	Discard buffered data, set local variable caption_service_available to 0	1	Stop T1

Table 8 – Caption server protocol states

State number	Condition	Action	Next state	Timer
Initial state	None		1	
1	Received SYNx; new caption service data not available	Send ccp(0x44, 0)	2	Start T2, 500-ms countdown
	Received SYNx; new caption service data is available, service_data_inhibit == 1	Send ccp(0x44, 1)	2	
	Received SYNx; new caption service data is available, service_data_inhibit == 0	Send ccp(0x44, 1)	3	
2	ACK received		1	Stop T2
	NAK received			
3	ACK received, more caption service data is available	Send ccp(0x53, 1)	4	Start T2, 500-ms countdown
	NAK received, more caption service data is available	Send ccp(0x53, 1)		
	ACK received, more caption service data is not available	Send ccp(0x53, 0)		
	NAK received, more caption service data is not available	Send ccp(0x53, 0)		
4	ACK received		1	Stop T2
	NAK received			
5	T2 expires		1	Stop T2

Annex A (informative)
Related standards

Users are advised that work is underway to document further standards for transfer of caption data along with additional ancillary data and metadata using a streaming type protocol, as opposed to the request/response type protocol employed in this standard. To the extent possible, the techniques and coding methods used herein and in the later documents will have been coordinated. For applications requiring additional functionality, reference to the later standards will be available from SMPTE headquarters.

Annex B (informative)
Bibliography

ANSI/EIA/TIA 232-E-1991, Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

ATSC A/65 (23 Dec 97), Program and System Information Protocol for Terrestrial Broadcast and Cable

ISO/IEC 13818-1:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

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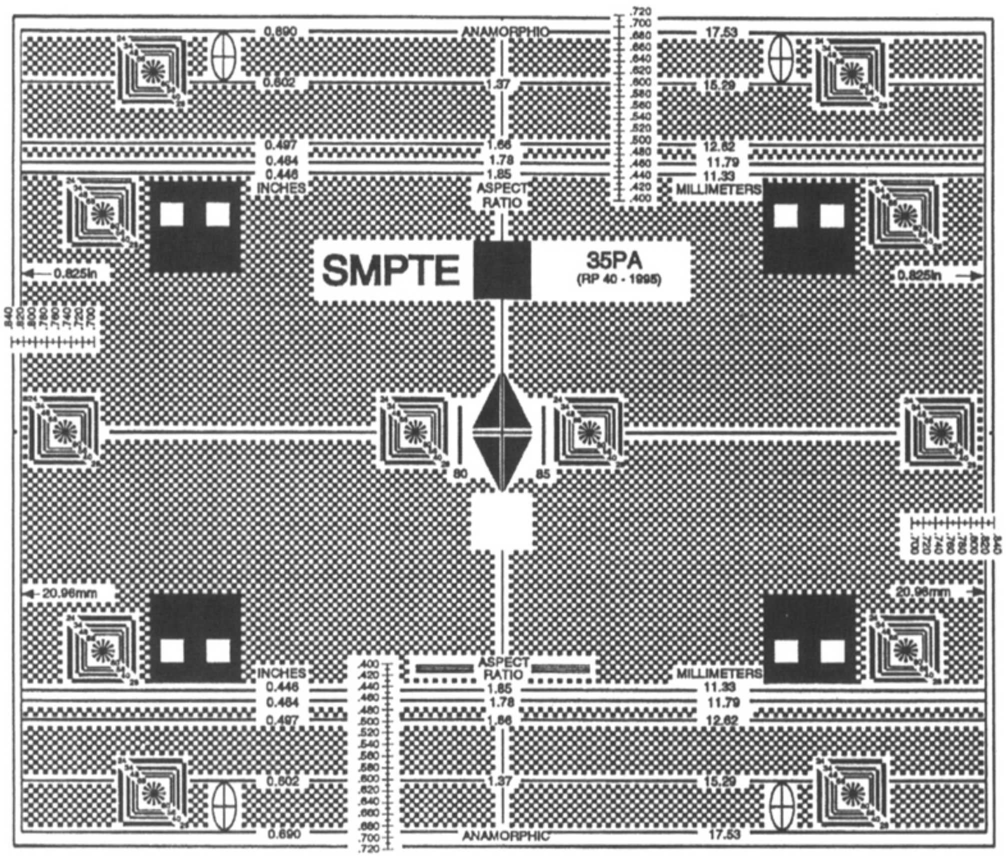

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