# DRAFT
# SMPTE STANDARD

**SMPTE 292M**
Revision of
SMPTE 292M-1998

for Television —
# 1.5 Gb/s[1] Signal/Data Serial Interface



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## Foreword

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SMPTE Standard 292M was prepared by Technology Committee N26.

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[1]Nominal total bit rate.

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## Introduction

This version of SMPTE 292M reflects the industry usage that has evolved over the past years. The original intent of SMPTE 292M was to provide a serial digital connection between HDTV equipment replacing the parallel interface. At that time, uncompressed digital video was considered to be the only payload. This standard has evolved to also carry formatted data within the defined payload areas including ancillary data. Formatting of the data and the types of data to be carried are defined by other SMPTE standards.

## 1 Scope

**1.1** This standard is a transport defining a bit-serial data structure for 1.5 Gb/s [nominal] component signals, SDTV signals mapped into the SMPTE 292M payload, and formatted packetized data.

**1.2** This standard specifies a coaxial cable interface suitable for application where the signal loss does not exceed an amount specified by the receiver manufacturer, typical loss amounts would be in the range of up to 20 dB at one-half the clock frequency.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were 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 standards indicated below.

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

SMPTE 274M-2005, Television — 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE 296M-2001, Television — 1280 x 720 Progressive Image Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE RP 184-2004, Specification of Jitter in Bit-Serial Digital Systems

IEC 60169-8, Sections A.2 and A.3, Amendment 2, Radio-Frequency Connectors. Part 8: R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6,5 mm (0,256 in) with Bayonet Lock — Characteristics Impedance 50 ohms (Type BNC)[1]

## 3 Source format data

**3.1** For this interface, source data shall be 10-bit words. The source data may be packetized data, or an uncompressed video source.

**3.2** For uncompressed 4:2:2 HDTV signals, the interface is two parallel bit streams — one stream is defined as the Y data, and the second stream is the $C_B$,$C_R$ data. These data streams are multiplexed to form the serial data stream. The multiplexing is as shown in figure 3. Other mappings are defined by application documents.

**3.3** Data for each line of the interface are divided into four areas: SAV (start of active video) timing reference, digital active line, EAV (end of active video) timing reference, and digital line blanking as shown in figure 1. The number of words and defined data in each area are specified by the source format or mapping documents.

[1]Please note that the title of this normative reference may be misleading. This standard requires the use of the 75 ohm connector defined in this reference.

**3.4** Parameters for uncompressed HDTV video sources and associated ancillary space are defined by:

SMPTE 274M
SMPTE 296M
SMPTE 260M

(See annex E.)

The total data rate shall be either 1.485 Gb/s or 1.485/1.001 Gb/s. The source format frame rate or mapping documents determines the precise interface clock frequency.

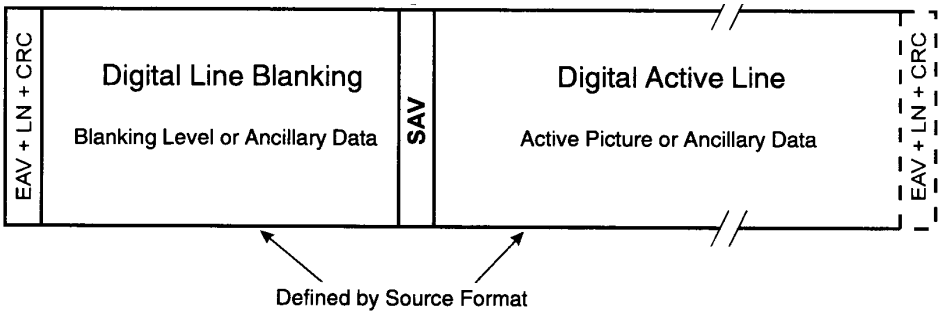



**Figure 1 – Interface horizontal line data**

## 4 Interface data format

**4.1** Digital active line and digital line blanking consist of 10-bit words as defined by the source format document. Data values 000h to 003h and 3FCh to 3FFh are excluded, and are defined in the source video standard.

**4.2** Timing references SAV, EAV, line number, and CRCs for each of the two parallel data streams shall beformatted as shown in figure 2

**4.3** Interface line number data are composed of two words and shall be as shown in table 1.

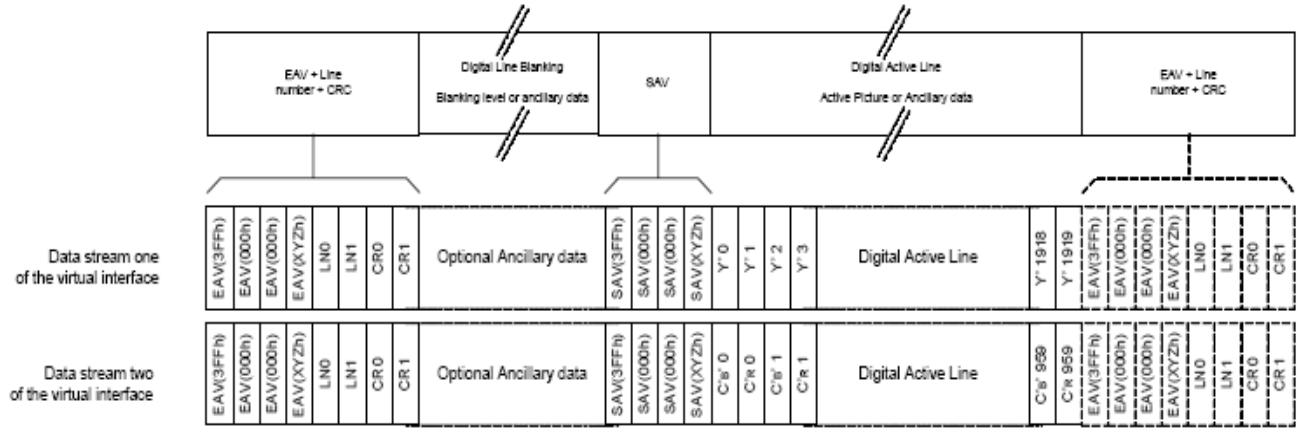



**Figure 2 – Timing reference format for data stream 1 and 2**

**4.4** CRC (cyclic redundancy codes) are used to detect errors in the active digital line and the EAV which follows it. The error detection code consists of two words determined by the polynomial generator equation:

$$CRC(X) = X^{18} + X^5 + X^4 + 1$$

The initial value of the CRC is set to zero. The calculation starts at the first active line word and ends at the final word of the line number, LN1. Two CRCs are calculated, one for the luma data channel, and one for the color difference data channel of the interface as shown in table 2.

NOTE – Users should be aware that the luma channel and color-difference channel of the interface may carry any type of data as defined by the application.

**4.5** Available ancillary data space is defined by the source format.

**Table 1 – Line number data**

| Word | 9 (MSB) | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|
| LN0 | $\overline{B8}$ | L6 | L5 | L4 | L3 | L2 | L1 | L0 | R | R |
| LN1 | $\overline{B8}$ | R | R | R | L10 | L9 | L8 | L7 | R | R |

NOTES

1 L0 – L1 = line number in binary code.
2 R = reserved, set to “0”.

**Table 2 – CRC data**

| Word | 9 (MSB) | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|
| YCR0 | $\overline{B8}$ | CRC8 | CRC7 | CRC6 | CRC5 | CRC4 | CRC3 | CRC2 | CRC1 | CRC0 |
| YCR1 | $\overline{B8}$ | CRC17 | CRC16 | CRC15 | CRC14 | CRC13 | CRC12 | CRC11 | CRC10 | CRC9 |
| CCR0 | $\overline{B8}$ | CRC8 | CRC7 | CRC6 | CRC5 | CRC4 | CRC3 | CRC2 | CRC1 | CRC0 |
| CCR1 | $\overline{B8}$ | CRC17 | CRC16 | CRC15 | CRC14 | CRC13 | CRC12 | CRC11 | CRC10 | CRC9 |

## 5 Serial data format

**5.1** The two source format parallel data streams with EAV and SAV shall be as shown in figure 2 (see also annex D ) and shall be interleaved as shown in figure 3.

**5.2** Interleaved data shall be serialized with the LSB (least significant bit) of each data word transmitted first.

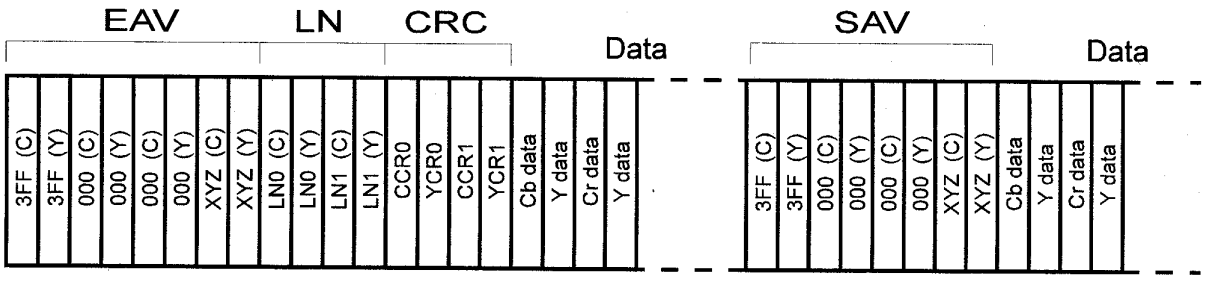



**Figure 3 – Interleaved data stream**

## 6 Channel coding

**6.1** The channel coding scheme shall be scrambled NRZI (non-return to zero inverted). (See annex A.)

**6.2** The generator polynomial for the scrambled NRZ shall be $G_1(X) = X^9 + X^4 + 1$. Polarity-free scrambled NRZI sequence data shall be produced by the generator polynomial $G_2(X) = X + 1$. The input signal to the scrambler shall be positive logic. (The highest voltage represents data 1 and the lowest voltage represents data 0.)

**6.3** The serial interface data word length shall be 10 bits.

## 7 Coaxial cable interface

### 7.1 Signal levels and specifications

These specifications are defined for measurement of the serial output of a source derived from a parallel domain signal.

**7.1.1** The output of the generator shall be measured across a 75-ohm resistive load connected through a 1-m coaxial cable. Figure 4 depicts the measurement dimensions for amplitude, rise-time and overshoot.

**7.1.2** The generator shall have an unbalanced output circuit with a source impedance of 75 ohms and a return loss of at least 15 dB over a frequency range of 5 MHz to the clock frequency of the signal being transmitted.

**7.1.3** The peak-to-peak signal amplitude shall be 800 mV ± 10% measured as specified in section 7.1.1.

**7.1.4** The dc offset, as defined by the mid-amplitude point of the signal, shall be nominally 0.0 V ± 0.5 V.

**7.1.5** The rise and fall times, determined between the 20% and 80% amplitude points shall be no greater than 270ps and shall not differ by more than 100 ps.

**7.1.6** Overshoot of the rising and falling edges of the waveform shall not exceed 10% of the amplitude

**7.1.7** Output amplitude excursions due to signals with a significant dc component occurring for a horizontal line (pathological signals) shall not exceed 50 mV above or below the average peak-to-peak signal envelope. Note, this specification defines a minimum output coupling time constant.

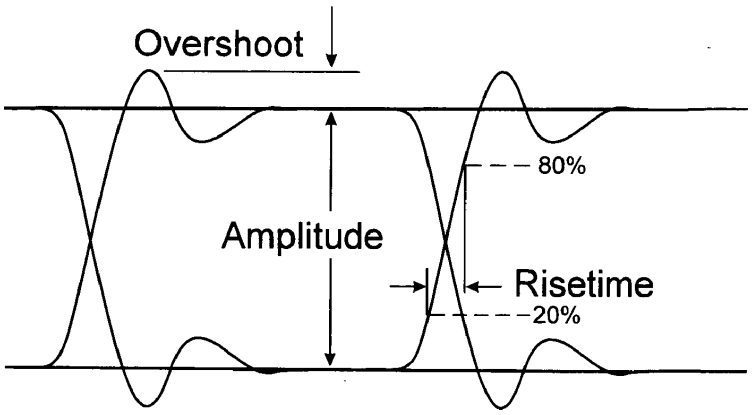



**Figure 4 – Waveform measurement dimensions**

**7.1.8** The jitter in the timing of the transitions of the data signal shall be measured in accordance with SMPTE RP 184. Measurement parameters are defined in SMPTE RP 184 and shall have the values shown in table 3 for compliance with this standard.

**7.1.9** The receiver of the serial interface signal shall present an impedance of 75 ohms with a return loss of at least 15 dB over a frequency range of 5 MHz to the clock frequency of the signal being transmitted.

**7.1.10** Receivers operating with input cable losses in the range of up to 20 dB at one-half the clock frequency are nominal; however, receivers designed to work with greater or lesser signal attenuation are acceptable.

**7.1.11** When connected to a line driver operating at the lower limit of voltage permitted by section 7.1.3, the receiver must sense correctly the binary data in the presence of the superimposed interfering signal at the following levels:

| | |
|---|---|
| dc | ± 2.5V |
| Below 5kHz | < 2.5V p-p |
| 5kHz to 27MHz | < 100mV p-p |
| Above 27MHz | < 40mV p-p |

**Table 3 – Jitter specifications**

| | | | |
|---|---|---|---|
| B1 | 10 Hz | Timing jitter lower band edge | |
| B2 | 100 kHz | Alignment jitter lower band edge | |
| B3 | > 1/10 the clock rate | Upper band edge | |
| A1 | 1 UI | Timing jitter | (Note 1) |
| A2 | 0.2 UI | Alignment jitter (UI = unit interval) | |
| Test signal | Color bar test signal | | (Note 2) |
| n | ≠10 (preferred) | Serial clock divided | (Note 3) |

NOTES

1 Designers are cautioned that parallel signals may contain jitter up to 2 ns p-p. Direct conversion of such signals from parallel to serial could result in excessive serial signal jitter.

2 Color bars are chosen as a nonstressing test signal for jitter measurements. Use of a stressing signal with long runs of zeros may give misleading results.

3 Use of a serial clock divider value of 10 may mask word correlated jitter components.

4 See SMPTE RP 184 for definition of terms

### 7.2 Connector and cable types

**7.2.1** The male and female connectors shall be 75 ohm BNC as defined in IEC 60169-8, sections A.2 and A.3

**7.2.2** Application of this standard does not require a particular type of coaxial cable. It is necessary for the frequency response of the coaxial cable loss, in decibels, to be approximately proportional to $1/\sqrt{f}$ from 1 MHz to the clock frequency of the signal being transmitted to ensure correct operation of automatic cable equalizers over moderate to maximum lengths.

**7.2.3** Return loss of the correctly terminated transmission line shall be greater than 15 dB over a frequency range of 5 MHz to the clock frequency of the signal being transmitted.

## **Annex A** (informative)
## **Channel code**

When scrambled NRZI channel coding is applied to certain video signals (informally called pathological signals), repeated long strings of 19 or 20 zeros may occur during the period of one horizontal television line. A stressing test signal is defined in RP 198 that will help in evaluating channel performance.

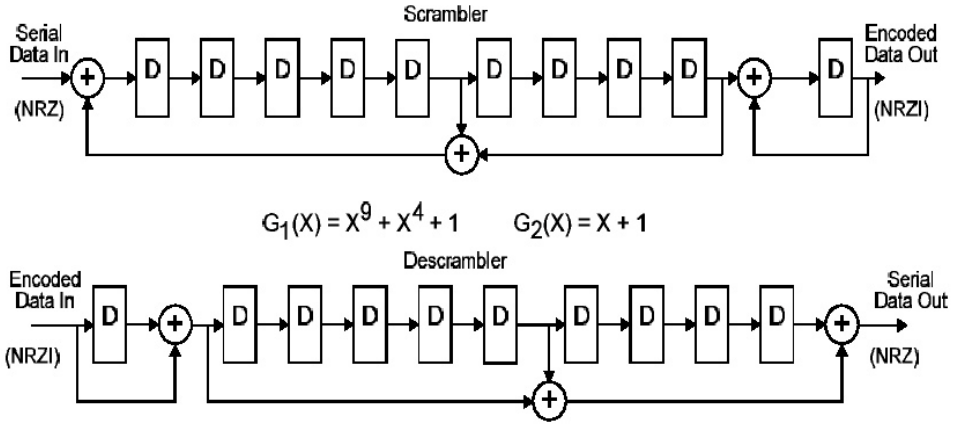



**Figure A.1 – Example 1 of a possible implementation**

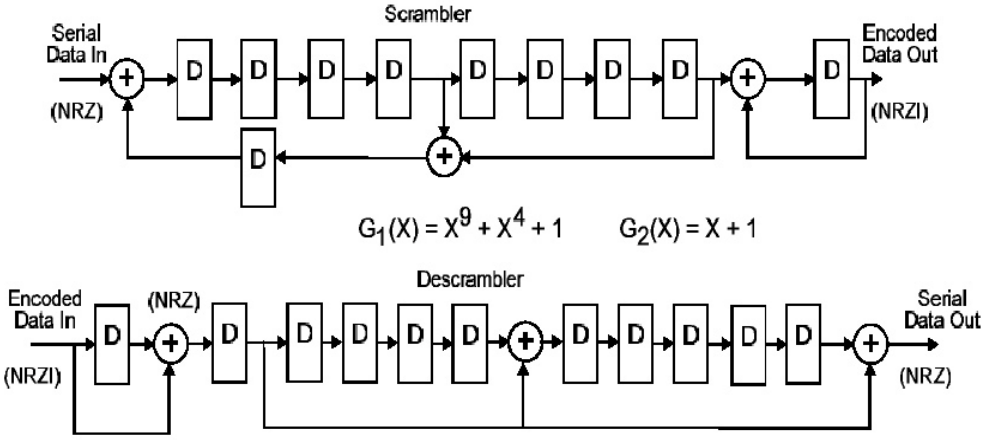



**Figure A.2 – Example 2 of a possible implementation**

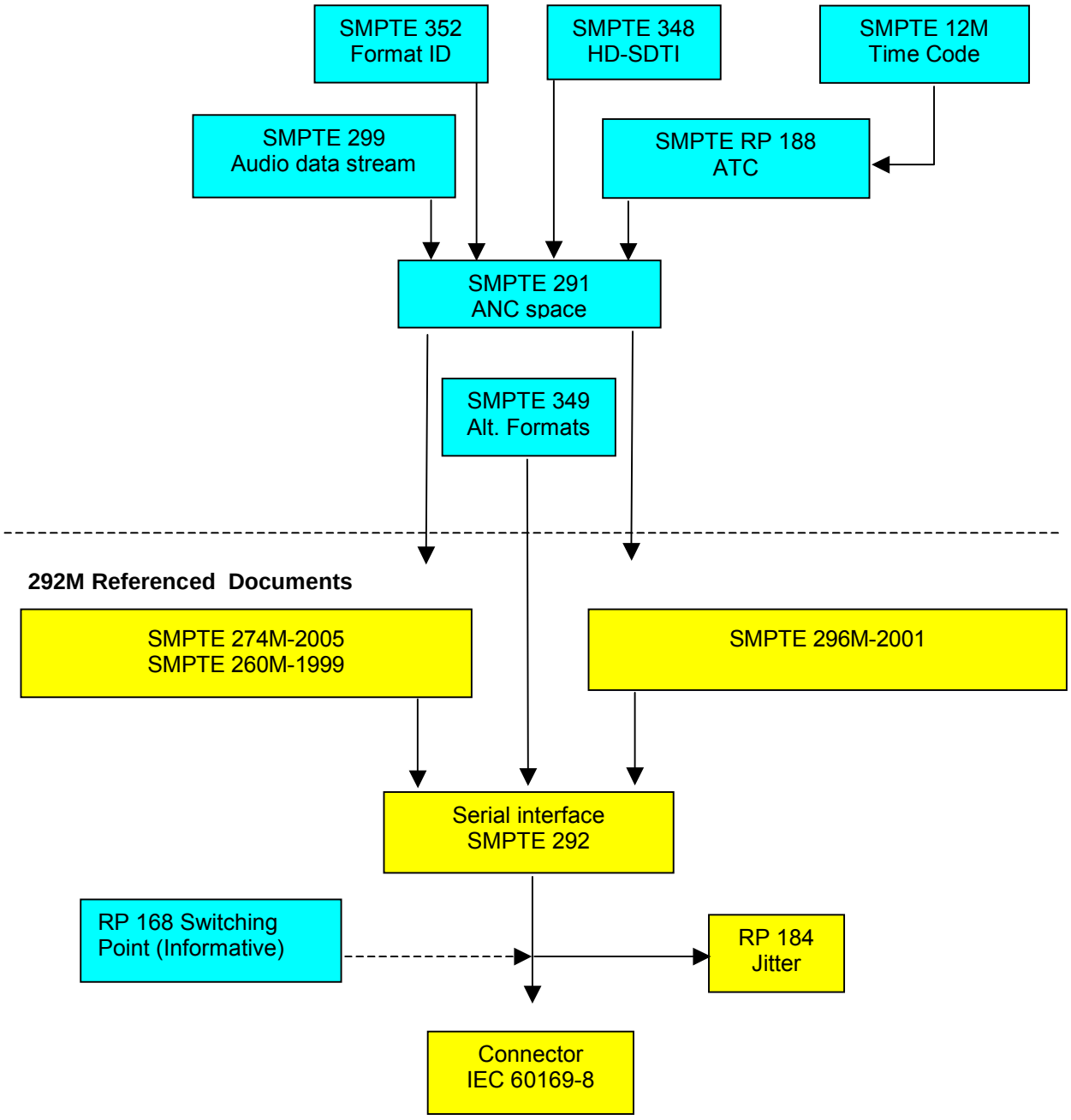
## **Annex B** (informative)
## **Receiver Type**

Receivers conforming to the specifications of section 7.1.11 should be labelled ‘‘Type A.’’ Receivers that may not conform to the specifications of section 7.1.11 should be labelled ‘‘Type B.’’

## **Annex C** (informative)
## **SMPTE 292M Road map**

SMPTE 296M-2001, 1280 x 720 Progressive Image Sample Structure – Analog and Digital Representation and Analog Interface
SMPTE 349M-2001, Transport of Alternate Source Image Formats through SMPTE 292M
SMPTE 274M-2005, 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates
SMPTE 260M-1999, 1125/60 High-Definition Production System – Digital Representtion and Bit-Parallel Interface
SMPTE RP 184-2004, Specification of Jitter in Bit-Serial Digital Systems
IEC 60169-8, Sections A.2 and A.3, Amendment 2, Radio-Frequency Connectors. Part 8: R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6,5 mm (0,256 in) with Bayonet Lock – Characteristics Impedance 50 ohms (Type BNC)

**Examples of optional applications**



## **Annex D** (informative)
## **Timing reference codes**

These codes, specified in the video source standards, are included as a convenience to designers.

| Word | 9 (MSB) | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3FF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XYZ | 1 | F | V | H | P3 | P2 | P1 | P0 | 0 | 0 |

NOTES

1 F = 0 during field 1; F = 1 during field 2.

2 V = 0 elsewhere; V = 1 during field blanking.

3 H = 0 in SAV; H = 1 in EAV.

4 MSB = most significant bit; LSB = least significant bit.

5 P0, P1, P2, P3 are protection bits defined below.

| Bit | 9 (MSB) | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 Fixed | F | V | H | P3 | P2 | P1 | P0 | 0 Fixed | 0 Fixed |
| 200h | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 274h | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 2ACh | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 2D8h | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 31Ch | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 368h | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 3B0h | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 3C4h | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |

## **Annex E** (informative)
## **Source signal formats**

SMPTE 274M —

| System No. | System nomenclature | Luma or R'G'B' samples per active line (S/AL) | Active lines per frame (AL/F) | Frame rate (Hz) | Interface sampling frequency fs (MHz) | Luma sample periods per total line (S/TL) | Total lines per frame |
|---|---|---|---|---|---|---|---|
| 1 | 1920 × 1080/60/P | 1920 | 1080 | 60 | 148.5 | 2200 | 1125 |
| 2 | 1920 × 1080/59.94/P | 1920 | 1080 | $\frac{60}{1.001}$ | $\frac{148.5}{1.001}$ | 2200 | 1125 |
| 3 | 1920 × 1080/50/P | 1920 | 1080 | 50 | 148.5 | 2640 | 1125 |
| 4 | 1920 × 1080/60/I | 1920 | 1080 | 30 | 74.25 | 2200 | 1125 |
| 5 | 1920 × 1080/59.94/I | 1920 | 1080 | $\frac{30}{1.001}$ | $\frac{74.25}{1.001}$ | 2200 | 1125 |
| 6 | 1920 × 1080/50/I | 1920 | 1080 | 50 | 74.25 | 2640 | 1125 |
| 7 | 1920 × 1080/30/P | 1920 | 1080 | 30 | 74.25 | 2200 | 1125 |
| 8 | 1920 × 1080/29.97/P | 1920 | 1080 | $\frac{30}{1.001}$ | $\frac{74.25}{1.001}$ | 2200 | 1125 |
| 9 | 1920 × 1080/25/P | 1920 | 1080 | 25 | 74.25 | 2640 | 1125 |
| 10 | 1920 × 1080/24/P | 1920 | 1080 | 24 | 74.25 | 2750 | 1125 |
| 11 | 1920 × 1080/23.98/P | 1920 | 1080 | $\frac{24}{1.001}$ | $\frac{74.25}{1.001}$ | 2750 | 1125 |

SMPTE 296M —

| System No. | System nomenclature | Luma or R'G'B' samples per active line (S/AL) | Active lines per frame (AL/F) | Frame rate (Hz) | Luma or R'G'B' sampling frequency fs (MHz) | Luma sample periods per total line (S/TL) | Total lines per frame |
|---|---|---|---|---|---|---|---|
| 1 | 1280 × 720/60 | 1280 | 720 | 60 | 74.25 | 1650 | 750 |
| 2 | 1280 × 720/59.94 | 1280 | 720 | 60/1.001 | 74.25/1.001 | 1650 | 750 |
| 3 | 1280 × 720/50 | 1280 | 720 | 50 | 74.25 | 1980 | 750 |
| 4 | 1280 × 720/30 | 1280 | 720 | 30 | 74.25 | 3300 | 750 |
| 5 | 1280 × 720/29.97 | 1280 | 720 | 30/1.001 | 74.25/1.001 | 3300 | 750 |
| 6 | 1280 × 720/25 | 1280 | 720 | 25 | 74.25 | 3960 | 750 |
| 7 | 1280 × 720/24 | 1280 | 720 | 24 | 74.25 | 4125 | 750 |
| 8 | 1280 × 720/23.98 | 1280 | 720 | 24/1.001 | 74.25/1.001 | 4125 | 750 |

SMPTE 260M —

The system nomenclature for SMPTE 260M is 1920 × 1035 (1035 active lines) constrained to 60/60/$^{1.001}$. All other parameters are the same as for SMPTE 274M.

**Annex F** (informative)
**Bibliography**

SMPTE 259M-1997, Television — SDTV/Digital Signal Data — Serial Digital Interface

SMPTE 291M-1998, Television — Ancillary Data Packet and Space Formatting

SMPTE RP 198-1998, Bit-Serial Digital Checkfield for Use in High-Definition Interfaces