SMPTE 344M-2000

SMPTE STANDARD

for Television — 540 Mb/s Serial Digital Interface

1 Scope

This standard specifies a serial digital interface that operates at a nominal rate of 540 Mb/s. This standard has application in the television studio over lengths of coaxial cable where the signal loss does not exceed an amount specified by the receiver manufacturer. Typical loss amounts would be in the range of 20 dB to 30 dB at one-half the clock frequency with appropriate receiver equalization. Receivers designed to work with lesser signal attenuation are acceptable. Separate SMPTE documents specify the mapping of source image formats onto the specified 540 Mb/s serial interface.

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

SMPTE RP 184-1996, Specification of Jitter in Bit-Serial Digital Systems

IEC 60169-8 (1978-01), Radio Frequency Connectors, Part 8: R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6.5 mm (0.256 in) with Bayonet Lock — Characteristic Impedance 50 Ohms (Type BNC)

3 Signal levels and specifications

The specifications in this clause are defined for measurement of the serial output of a source derived from a parallel domain signal whose timing and other characteristics meet good studio practices. Specifications at the output of equipment located at other places in an all-serial digital chain are not addressed by this standard. Clock frequency is the serial clock and is equal to 540 MHz.

3.1 The output of the generator shall be measured across a 75-ohm resistive load connected through a short coaxial cable. Figure 1 depicts the measurement dimensions for amplitude, risetime, and overshoot (see annex A for the preferred measurement method for these parameters).

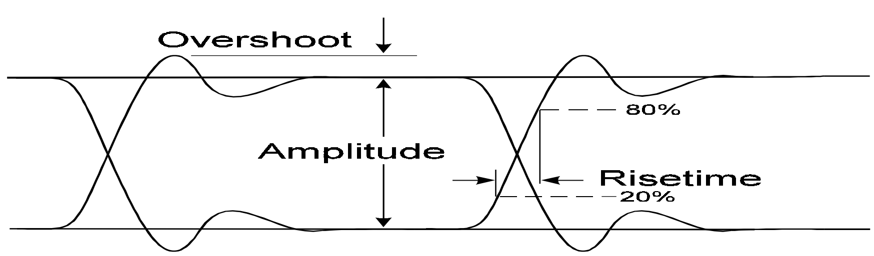

Figure 1 – Waveform measurement dimensions

Approved
September 27, 2000

3.1.1 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 540 MHz.

3.1.2 The peak-to-peak signal amplitude shall be 800 mV ± 10%.

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

3.3 The rise and fall times, determined between the 20% and 80% amplitude points, shall be no less than 0.40 ns, no greater than 0.80 ns, and shall not differ by more than 0.2 ns.

3.4 Overshoot of the rising and falling edges of the waveform shall not exceed 10% of the amplitude.

3.5 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 in table 1 for compliance with this standard.

3.6 The input to the serial receiver 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 540 MHz.

4 Connector and cable types

4.1 The connector shall have mechanical characteristics conforming to the 50-ohm BNC type. Mechanical dimensions of the connector may produce either a nominal 50-ohm or nominal 75-ohm impedance and shall be usable at frequencies up to 540 MHz based on a return loss that is greater than 15 dB. However, the electrical characteristics of the connector and its associated interface circuitry shall provide a resistive impedance of 75 ohms. Where a 75-ohm connector is used, its mechanical characteristics must reliably interface with the nominal 50-ohm BNC type defined by IEC 60169-8.

Table 1 – Measurement parameters

Timing jitter lower band edge	10 Hz	f1
Alignment jitter lower band edge	1 kHz	f2
Upper band edge	>1/10 clock rate	f3
Timing jitter (note 1)	0.2 UI p-p	A1
Alignment jitter, UI = unit interval	0.2 UI p-p	A2
Test signal (note 2)	Color bars	
Serial clock divider (note 3)	≠ 10	N

NOTES

1 Designers are cautioned that the clock in parallel signals conforming to interconnection standards may contain large amounts of jitter. Deriving the serial signal directly from the unfiltered parallel clock could result in excessive serial signal jitter (see annex B for more information on timing 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 is acceptable; however, it may mask word-correlated jitter components. The divider value should be stated in conjunction with jitter specifications.

4.2 Application of this standard does not require a particular type of coax. It is necessary for the coax to be a 75-ohm coax and for the frequency response of the coax, in decibels, to be approximately proportional to 1/ [SQRT (f)] from 1 MHz to 540 MHz to ensure correct operation of automatic cable equalizers over moderate to maximum lengths.

4.3 Return loss of the correctly terminated transmission line shall be greater than 15 dB over a frequency range of 5 MHz to 540 MHz.

5 Channel coding

5.1 The channel coding shall be scrambled NRZI.

5.2 The generator polynomial for the scrambled NRZ shall be $G_1(X) = X^9 + X^4 + 1$. The polarity-free scrambled NRZI sequence shall be produced by $G_2(X) = X + 1$. $G_1(X)$ shall be applied before $G_2(X)$ when encoding signals. The order of $G_1(X)$ and $G_2(X)$ is reversed when decoding signals. The input signal to $G_1(X)$ shall be positive logic (the highest voltage represents data 1 and the lowest voltage data 0 [see annex C]).

5.3 The data word length shall be 10 bits.

6 Transmission order

The LSB of any data word shall be transmitted first.

7 Serial data format

7.1 To maintain synchronization and word alignment at the serial receiver, EAV and SAV timing references shall be inserted into the data stream.

7.2 EAV and SAV timing references shall be inserted on a line basis and shall be formatted as shown in figures 2 and 3.

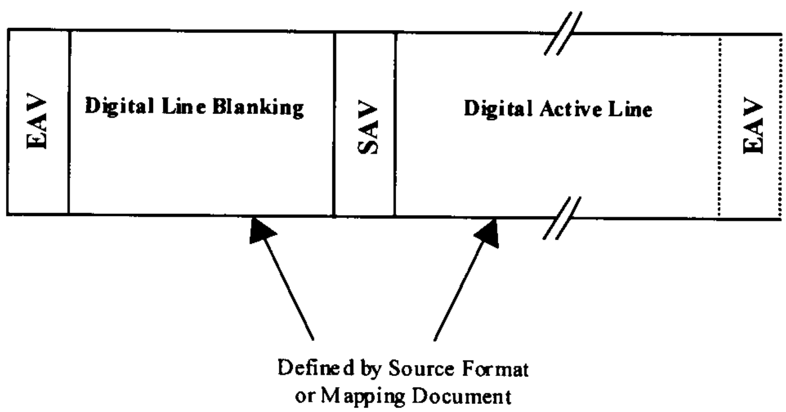

Figure 2 – Television horizontal line data

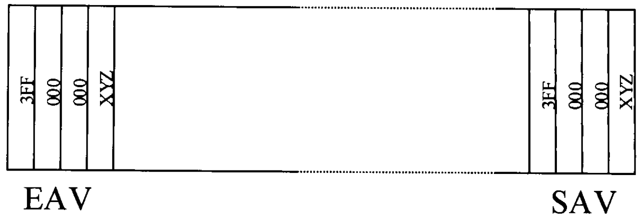

Figure 3 – Timing reference format

7.3 The maximum spacing between SAV and EAV timing references shall be 60 µs.

7.4 Available ancillary data space is defined by the source format. The ancillary data header shall consist of the three words 000_h, $3FF_h$, $3FF_h$ with formatting of the ancillary data packet defined by SMPTE 291M. Data values 000_h to 003_h and $3FC_h$ to $3FF_h$ are excluded from user ancillary data.

7.5 Data words 3FF and 000 shall be used only for EAV/SAV timing references and ancillary data headers. Source format mapping documents shall ensure that 3FF and 000 are treated as reserved words. Source format mapping documents shall ensure compatibility with 8-bit systems by ensuring that data values in the range $3FC_h$ to $3FF_h$ are treated as equivalent to $3FF_h$ for the purpose of detecting ancillary data flags or EAV/SAV timing references.

7.6 Appropriate values for XYZ words within EAV and SAV timing references shall be defined in the relevant source format mapping document.

7.7 Since not all source formats have the same timing reference data, a modification may be required prior to serialization in order to meet the requirements of 7.1 and 7.2. Where additional words are required for EAV/SAV sequences, data words from the adjacent digital blanking area shall be used. Modifications are typically made using a coprocessor in the parallel domain. Source format mapping documents shall define the details of such modifications.

8 Source format mapping documents

Source format mapping documents shall specify the mapping of source image formats onto the 540 Mb/s serial interface defined in this standard. Mapping documents shall specify how to generate 54 MHz parallel data streams appropriate for serialization in accordance with this standard.

Annex A (informative)
Waveform measurement method

The preferred method for measuring serial digital waveform amplitude, risetime, and overshoot is using an oscilloscope with at least a 2-GHz bandwidth. Input impedance of the oscilloscope should be 75 ohms with a return loss greater than 20 dB to 540 MHz. Measurements should be made using a 2-m length of high-quality coax between the transmitter and the oscilloscope.

Annex B (informative)
Timing jitter specification

Low-frequency jitter in the range of 10 Hz to 1 kHz is indicated by the difference between timing jitter (A1) and alignment jitter (A2) measurements. Although purely digital systems will operate correctly with significant amounts of low-frequency jitter, this standard (3.5) specifies a tight tolerance for timing jitter to ensure operation in mixed digital/analog systems.

Annex C (informative)
Generator polynomial implementations

Generator polynomial implementations are shown in figures C.1 and C.2.

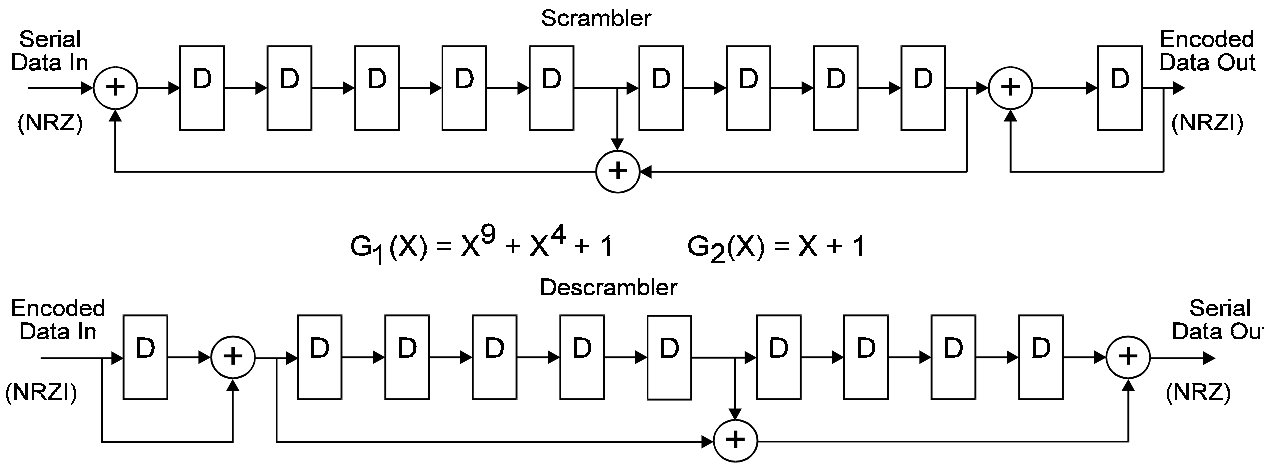

Figure C.1 – Possible generator polynomial — Method 1

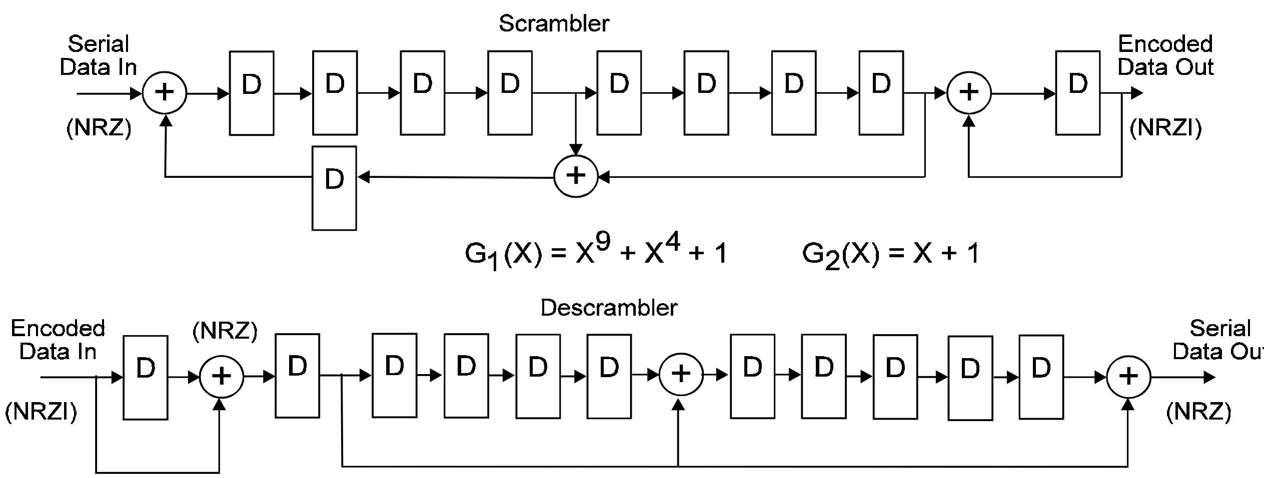

Figure C.2 – Possible generator polynomial — Method 2

Annex D (informative)
Bibliography

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{sc}$ Composite Digital Signals — Serial Digital Interface

SMPTE 292M-1998, Television — Bit-Serial Digital Interface for High-Definition Television Systems