SMPTE STANDARD

for Television —
Synchronous Serial Interface for MPEG-2 Digital Transport Stream

Table of Contents **Page**

Approved
November 12, 2010

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.

SMPTE ST 310 was prepared by Technology Committee 32NF.

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 standard describes the physical interface and modulation characteristics for a synchronous serial interface to carry MPEG-2 transport bit streams at rates up to 40 Mb/s. It is a point-to-point interface intended for use in a low-noise environment. The low-noise environment is defined as a noise level that would corrupt no more than one MPEG-2 data packet per day at the transport clock rate. When other transmission systems (e.g., studio-to-transmitter microwave links, etc.) are interposed between devices employing this interface, higher noise levels may be encountered. In such cases, it is recommended that appropriate error correcting methods be used (see Figure 1).

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.
Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3 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 standards indicated below.

IEC 61169-8 (2007-02), Part 8: Sectional Specification — R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6,5 mm (0,256 in) with Bayonet Lock — Characteristic Impedance 50Ω (Type BNC), Annex A (Normative) Information for Interface Dimensions of 75Ω Characteristic Impedance Connector with Unspecified Reflection Factor[1]

---

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

4 Channel Code

4.1 Biphase-mark coding shall be used (see Figure 2).

4.2 The encoding rules are as follows:

- A transition always occurs at the beginning of the bit whatever its value is (0 or 1).
- For logical 1, a transition occurs in the middle of the bit.
- For logical 0, there is no transition in the middle of the bit.

4.3 See annex A for biphase code properties.

5 Signal Levels and Specifications

5.1 The output of the generator or signal source shall be measured across a 75-ohm resistive load connected through a short coaxial cable. Figure 3 depicts the measurement dimensions for amplitude, rise time, and overshoot (see Annex B for the preferred measurement method.)

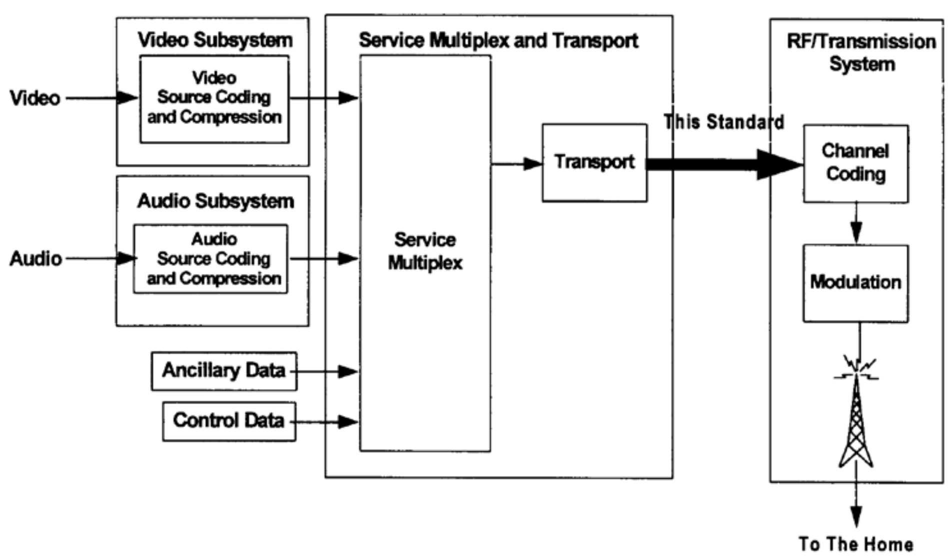

Figure 1 – Example of possible interface use — Transport multiplex transmitter input

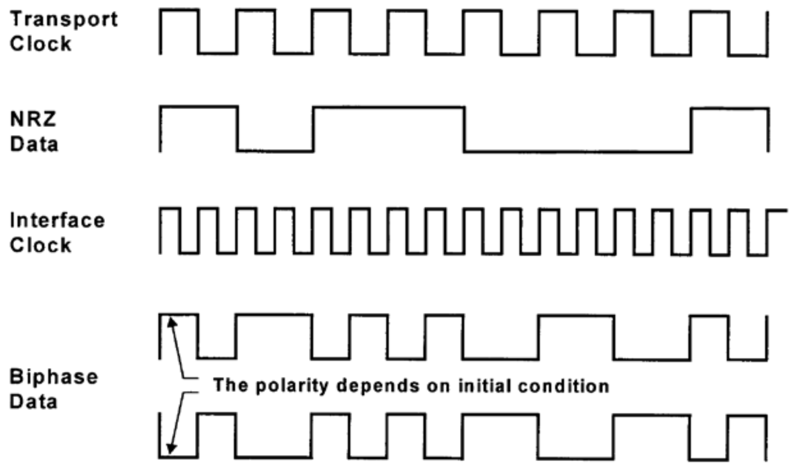

Figure 2 – Biphase mark coding scheme

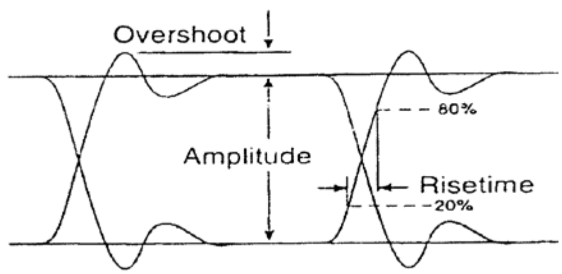

Figure 3 – Waveform measurement dimensions

5.1.1 The generator or signal source shall have an unbalanced output circuit with a source impedance of 75 ohms and a return loss of at least 30 dB over a frequency range from 100 kHz to the interface clock frequency.

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

5.2 The dc offset as defined by the amplitude midpoint of the signal shall be nominally 0.0 V ± 0.5 V.

5.3 The rise and fall times determined between the 20% and 80% amplitude points shall be no less than 0.4 ns and no greater than 5.0 ns and shall not differ by more than 1.6 ns.

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

5.5 The interface clock jitter, drift, and wander requirements are specified in both the frequency and time domain. Drift and wander in 5.5.1 are specified in the frequency domain, below 1 Hz. The 1-Hz limit prevents the drift rate specification from imposing jitter limits tighter than those described in 5.5.2. Jitter timing error in 5.5.2 is specified in the time domain. Both 5.5.1 and 5.5.2 are presented in table form in Annex C.

5.5.1 The interface clock frequency error (drift limit) shall not exceed ± 2.8 ppm. The rate of frequency change (drift rate) shall not exceed 0.028 ppm/s. These two measurements should ignore timing error terms occurring at a 1-Hz or higher rate.

5.5.2 The jitter in the timing of the interface signal transitions shall not exceed 2 ns p-p, measured over a bandwidth of 1 Hz to 1/100 of the interface clock frequency.

5.5.3 The specifications of 5.5.1 and 5.5.2 are combined in Annex D and formed into a template showing the maximum jitter allowed.

Note: This specification follows the general method described in SMPTE RP 184 with two exceptions: 1) the specification extends below 10 Hz and 2) the jitter value is specified in seconds rather than unit intervals. Using SMPTE RP 184 nomenclature, f1 = 1 Hz, f4 = (1/100 fclk), UI = 2 ns.

6 Transmission Order

The MSB of any data word shall be transmitted first.

7 Connector and Cable Types

7.1 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 a nominal 75-ohm impedance and shall be usable at frequencies up to 850 MHz. 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 61169-8.

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

7.3 A receiver shall operate with up to 3-dB amplitude loss at half the interface clock frequency.

Annex A (Informative)
Biphase Code Characteristics

Three properties of biphase-mark coding are:

1) The interface clock frequency is twice that of the transport clock.
2) No dc component in the spectrum (see Figure A.1).
3) A carrier is always present, even for continuous data of ones or zeros.

Consider two ATSC data streams encoded using the coding method described in 4.2:

Case 1. When all zeros are sent, the encoding rules are: A transition always occurs at the beginning of the bit whatever its value (0 or 1). For logical 0, there is no transition in the middle of the bit. Case 1 would create a continuous 9.69-MHz clock.

Case 2. When all ones are sent, the encoding rules are: A transition always occurs at the beginning of the bit whatever its value (0 or 1). For logical 1, a transition occurs in the middle of the bit. Case 2 would create a continuous 19.39-MHz clock.

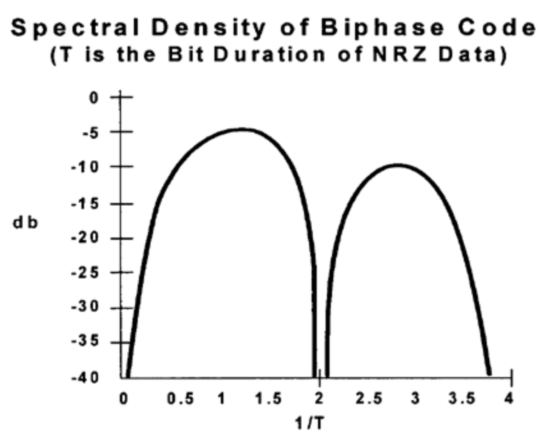

Figure A.1 – Spectral density biphase code

Annex B (Informative)
Waveform Measurement Method

The preferred method for measuring serial digital waveform amplitude, rise time, and overshoot is using a 1-GHz bandwidth oscilloscope. Input impedance of the oscilloscope should be 75 ohms with a return loss greater than 20 dB to 400 MHz. Measurements should be made using a coaxial cable between the transmitter and oscilloscope with no more than 0.15 dB loss at the interface clock frequency.

Annex C (Informative)
Signal Specifications

ATSC modulator symbol clock (Fsym) is defined as: Fsym = 4.5E6 x (684/286) = 10,762,237.76 Hz.

The ratio of modulator symbol clock to 8-VSB transport clock is defined as: 313 Ftp = 564 Fsym, which produces 8-VSB transport stream of 19,392,658.46 bits/s and a transport clock of 19,392,658.46 Hz.

The ratio of modulator symbol clock to 16-VSB transport clock is defined as: 313 Ftp = 1128 Fsym, which produces 16-VSB transport stream of 38,785,316.92 bits/s and a transport clock of 38,785,316.92 Hz (see Table C.1).

Table C.1 – Clock rates and related specifications

Signal	Clock frequency	2.8 ppm drift limit	0.028 ppm drift rate	Jitter measurement upper frequency limit (f4)
Symbol clock	10.76 ... MHz	± 30 Hz	0.30 Hz/s	110 kHz
8-VSB transport stream	19.39 ... MHz	± 54 Hz	0.54 Hz/s	190 kHz
16-VSB transport stream	38.78 ... MHz	± 108 Hz	1.10 Hz/s	390 kHz

Annex D (Normative)
Jitter Template

The jitter and wander requirements in 5.5 can be described with a template showing the maximum timing error allowed as a function of frequency (see Figure D.1).

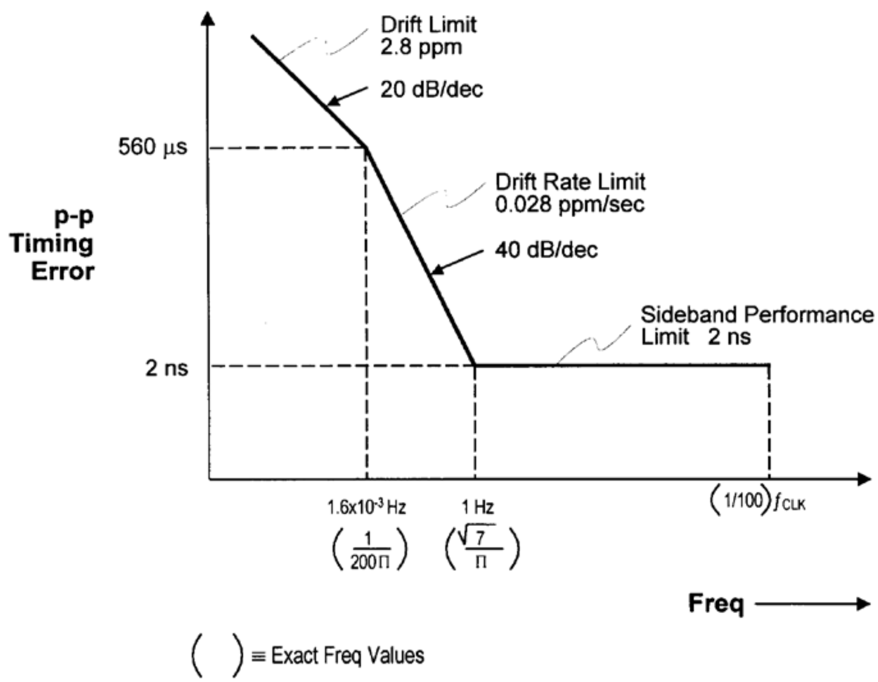

Figure D.1 – Jitter template

Annex E (Informative)
Bibliography

ATSC A/53, ATSC Digital Television Standard, Part 2:2007, RF/Transmission System Characteristics

ATSC A/53, ATSC Digital Television Standard, Part 3: 2009, Service Multiplex and Transport Subsystem Characteristics

ATSC A/64B (May 2008), Transmission Measurement and Compliance for Digital Television

ISO/IEC 13818-1:2007, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

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

Revision Notes

This revision incorporates Amendment #1 to SMPTE ST 310. 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. Section 3, Normative References has been updated.

4. Annex E, Bibliography has been updated.