SMPTE ST 424:2012
Revision of
SMPTE 424M-2006

SMPTE STANDARD

3 Gb/s Signal/Data Serial Interface

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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 Operations Manual.

SMPTE ST 424 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.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

This standard defines a bit-serial data interface for the transport of 3 Gb/s [nominal] component digital signals or packetized data. The SMPTE ST 425 set of standards define the mapping of various source image formats to the bit-serial data structure defined here in this document. SMPTE 425-0 contains an informative roadmap for 3 Gb/s Signal/Data Serial Interfaces.

1 Scope

This standard defines a bit-serial data structure and coaxial cable interface for the transport of signals with a total payload of 2.970 Gb/s or 2.970/1.001 Gb/s.

This standard specifies the electrical and physical characteristics of a coaxial cable interface suitable for applications 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 30 dB at one-half the clock frequency.

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 References

The following standards contain provisions that, 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 ST 425-1:2011, Source Image Format and Ancillary Data Mapping for the 3Gb/s Serial Interface

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

IEC 61169-8 (2007-2), 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]

4 Source Data

For this interface, the source data shall be a virtual interface consisting of two 10-bit parallel data streams — data stream one and data stream two.

The virtual interface shall be constructed in accordance with SMPTE ST 425-1.

Data for each line of data stream one and data stream two of the virtual interface are divided into four areas: EAV (end of active line) timing reference plus LN and CRC data words; the blanking area optionally containing ancillary data; SAV (start of active video) timing reference; and the digital active line as shown in Figure 1.

5 Parallel Data Format

The 10-bit data words of parallel data stream one and data stream two of the virtual interface, are shown in Figure 1.

By way of example, Figure 1 illustrates the mapping of SMPTE ST 274 4:2:2 ($Y'C'_BC'_R$)/10-bit signals at 60 or 60/1.001 frame rates.

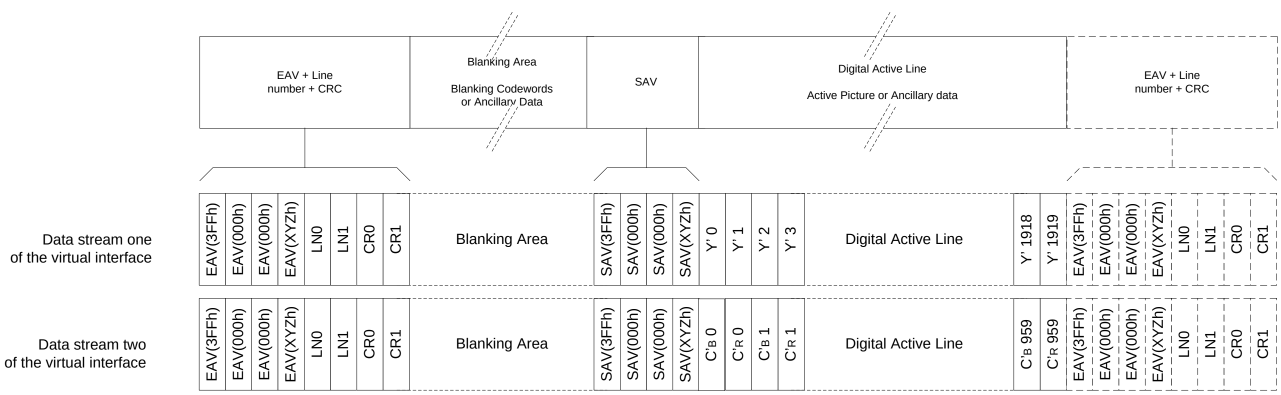

Figure 1 – Example parallel data format for data stream one and data stream two of the virtual interface

6 Serial Data Format

The two parallel data streams of the virtual interface are transmitted over a single channel in bit-serial form after word-multiplexing, parallel-to-serial conversion and scrambling have been applied.

Data stream one and data stream two of the virtual interface shall be multiplexed word-by-word into a single 10-bit parallel stream in the order: data stream two; data stream one; data stream two…….etc, as shown in Figure 2.

[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 Annex A of this reference.

The single 10-bit parallel interface so produced shall have an interface frequency of 297 MHz or 297/1.001 MHz.

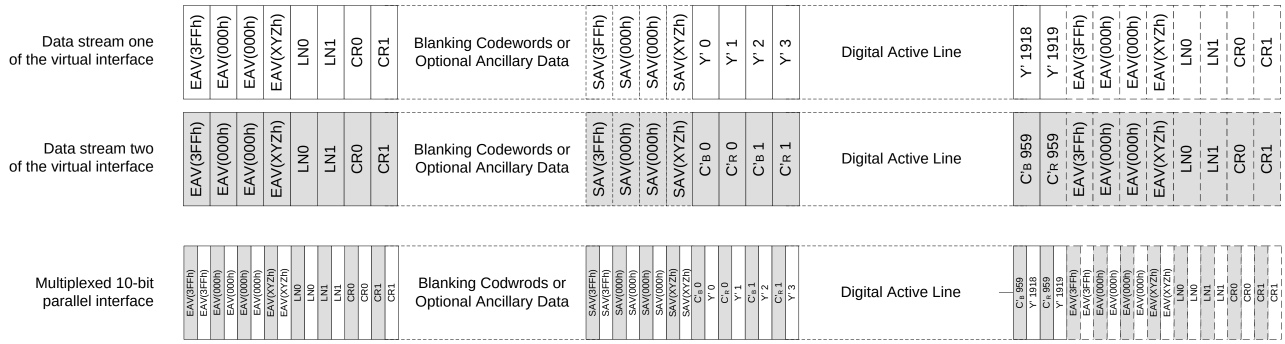

Figure 2 – 10-bit multiplex of data stream one and data stream 2

Multiplexed data shall be serialized with the LSB (least significant bit) of each data word transmitted first at a serial data rate of 2.97 Gb/s or 2.97/1.001 Gb/s.

The channel coding scheme shall be scrambled NRZI (non-return to zero inverted). (See Annex B.)

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, where the highest voltage represents data 1 and the lowest voltage represents data 0.

7 Coaxial Cable Interface

7.1 Generator Signal Levels and Specifications

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

The output of the generator shall be measured across a 75-ohm resistive load connected through a 1 meter coaxial cable and 75 ohm BNC connectors meeting the requirements defined in Section 7.2. Figure 3 depicts the measurement dimensions for amplitude, rise-time and overshoot.

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 the frequency range of 5 MHz to one-half the clock frequency and at least 10 dB over the frequency range one-half the clock frequency up to the clock frequency of the signal being transmitted.

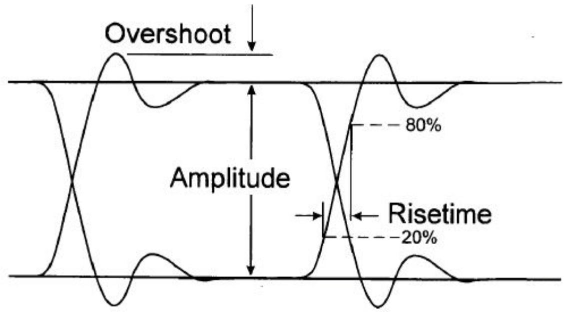

Figure 3 – Waveform measurement dimensions

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

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

The rise and fall times, determined between the 20% and 80% amplitude points shall be no greater than 135 ps and shall not differ by more than 50 ps.

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

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. (In effect, this specification defines a minimum output coupling time constant).

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 1 for compliance with this standard.

Table 1 – Jitter specifications

f1	10 Hz	Timing jitter lower band edge
f3	100 kHz	Alignment jitter lower band edge
f4	> 1/10 the clock rate	Upper band edge
A1	2 UI	Timing jitter (Note 1)
A2	0.3 UI	Alignment jitter (UI = unit interval) (Note 2)
Test signal	Color bar test signal	(Note 3)
n	≠10 (preferred)	Serial clock divided (Note 4)

Notes:

1 Designers are cautioned that parallel signals could 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 This should be considered an absolute maximum requirement. An alignment jitter specification of 0.2 UI or better is strongly recommended.

3 Color bars are chosen as a non-stressing test signal for jitter measurements. Use of a stressing signal with long runs of zeros could give misleading results.

4 Use of a serial clock divider value of 10 could mask word correlated jitter components.

5 See SMPTE RP 184 for definition of terms.

7.2 Receiver Signal Levels and Specifications

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 one-half the clock frequency of the signal being transmitted and at least 10 dB over a frequency range from one-half the clock frequency up to the clock frequency of the signal being transmitted.

Receivers operating with input cable losses in the range of up to 30 dB at one-half the clock frequency are typical; however, receivers designed to work with greater or lesser signal attenuation are acceptable.

When connected to a line driver operating at the lower limit of voltage permitted by Section 7.1, it is recommended but not required that the receiver correctly senses 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

Note: Manufacturers are encouraged to indicate if receivers are conforming to the specification of Section 7.2. If so, they are “Type A” receivers. If not, they are “Type B” receivers.

7.3 Connector and Cable Types

7.3.1 BNC connectors

75-ohm BNC connectors that are usable at frequencies >3.0 GHz – based on a return loss at 3.0 GHz that is greater than 10 dB – shall be used on equipment and installations that are compliant with this standard. The mechanical characteristics of the preferred connector shall conform to the 75-ohm BNC as defined in IEC 61169-8, Annex A.

7.3.2 Other connectors

Other application-specific connector types may also be used so long as they meet the electrical requirements as defined in Section 7.3.1. Manufacturers are encouraged to indicate in publications which connector type is being used.

7.3.3 Cables

75-ohm video coax cable that is specified for operation at frequencies >3.0 GHz shall be used in installations that are compliant with this standard. It is necessary for the frequency response of the coaxial cable loss, in decibels, to be approximately proportional to $\sqrt{f}$ from 1 MHz to the clock frequency of the signal being transmitted to ensure correct operation of automatic cable equalizers over moderate to maximum cable lengths.

Return loss of the correctly terminated transmission line shall be greater than 15 dB over a frequency range of 5 MHz to one-half the clock frequency of the signal being transmitted and greater than 10 dB over the range one-half the clock frequency to the clock frequency of the signal being transmitted.

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 297:2006) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 297-2006). Documents with the same root number (e.g. 297) and publication year (e.g. 2006) are functionally identical.

SMPTE 425-0:2012-06, SMPTE Bit-Srial Interfaces at 3 Gb/s — Roadmap for the 425 Document Suite

SMPTE ST 292-1:2012, 1.5 Gb/s Signal/Data Serial Interface

SMPTE ST 297:2006, Television — Serial Digital Fiber Transmission System for SMPTE 259M, SMPTE 344M, SMPTE 292 and SMPTE 424M Signals

SMPTE ST 2051:2010, Two-Frame Marker for 50-Hz and 60(/1.001)-Hz Progressive Digital Video Signals on 1.5 Gb/s and 3 Gb/s Interfaces

SMPTE RP 168:2009, Definition of Vertical Interval Switching Point for Synchronous Video Switching

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

SMPTE EG 34:2004, Pathological Conditions in Serial Digital Video Systems

Annex B Channel Code (Informative)

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

Possible generator polynomial implementations are given in Figures B.1 and B.2.

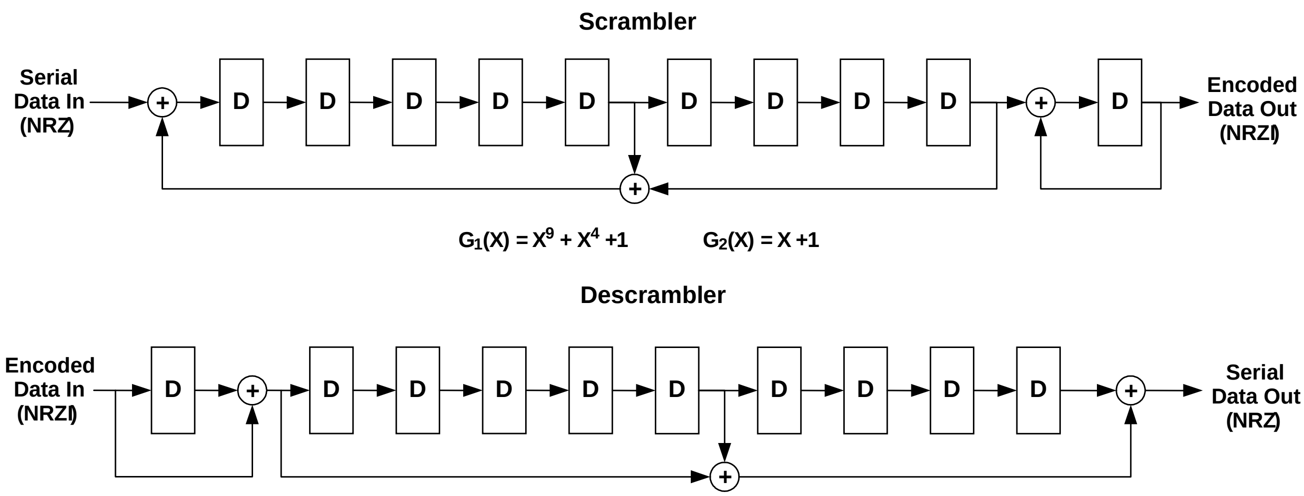

Figure B.1 – Possible Generator polynomial – Method 1

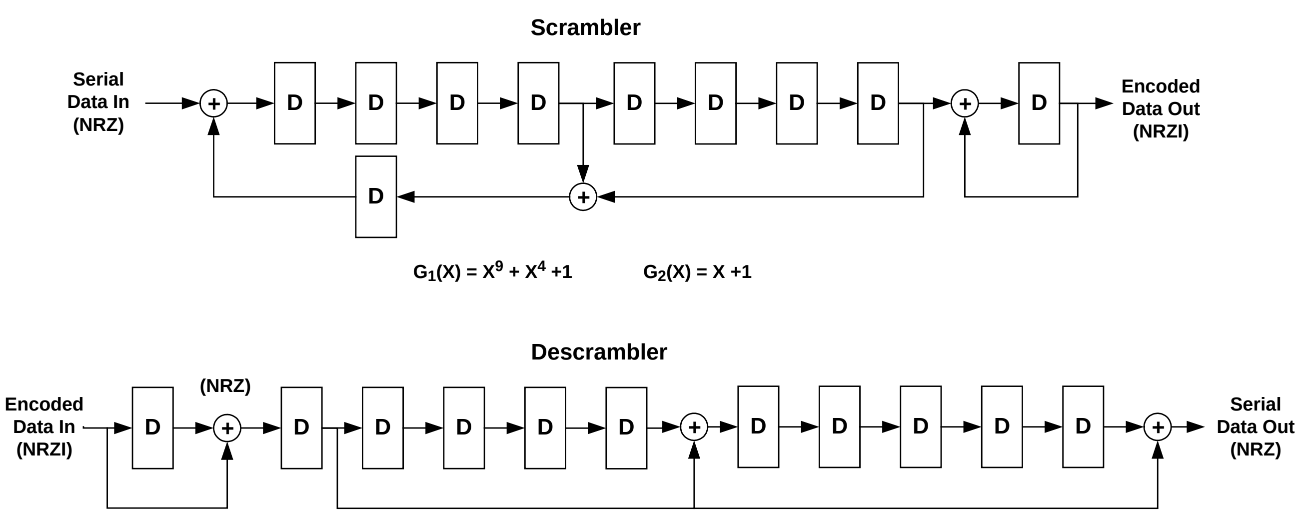

Figure B.2 – Possible Generator polynomial – Method 2