

The SMPTE Operations Manual for Standards states:

At any time, a Technology Committee may revise, amend, or otherwise initiate a new Project on a Stable document.

A Stable document is “In Force”, and not deprecated or withdrawn.

* * * * *

SMPTE “Stable” documents were previously described as “Archived” and the attached document may be marked as “Archived”. The status of a SMPTE document described as “Archived” is exactly as described above for a “Stable” document.

Stable documents may not adhere to the latest style and format of SMPTE documents, or to current usage of normative language. Suitable care should be taken in interpretation.

SMPTE STANDARD

SMPTE 260M-1999

Revision of
SMPTE 260M-1992

for Television — 1125/60 High-Definition Production System — Digital Representation and Bit-Parallel Interface



Page 1 of 29 pages

Table of Contents

- 1 Scope
- 2 Applications
- 3 Normative references
- 4 Digital encoding and format specifications for ANSI/SMPTE 240M analog signals
- 5 Bit-parallel interface
- Annex A Pre- and post-filtering characteristics
- Annex B Production aperture issues
- Annex C Electrical characteristics of the interface
- Annex D Example of cable implementation
- Annex E Eye diagrams

1 Scope

This standard specifies the digital representation of the signal parameters of the 1125/60 high-definition production system as given in their analog form by ANSI/SMPTE 240M.

This standard also specifies the signal format and the mechanical and electrical characteristics of the bit-parallel digital interface for the interconnection of digital television equipment operating in the 1125/60 high-definition production system.

2 Applications

The technical information provided in this standard applies to origination, storage, interconnection, and processing of digital 1125/60 high-definition production system signals as they exist in studio production and post-production environments.

3 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.

ANSI/SMPTE 240M-1995, Television — Signal Parameters — 1125-Line High-Definition Production Systems

ITU-R BT.601-5 (1994), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BT.656-3, Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:2:2 Level of Recommendation ITU-R BT.601 [Part A]

4 Digital encoding and format specifications for ANSI/SMPTE 240M analog signals

4.1 General considerations

This standard complements the technical specifications of the analog signals described in ANSI/SMPTE 240M.

The studies that resulted in this standard have taken into account prior international technical agreements on the digitization of television signals, as documented in ITU-R BT.601 and 656. For ease of comparison, the description of the bit-parallel interface follows the same form as that in ITU-R BT. 656.

The digital coding is based on the use of one luminance, E_Y' , and two color-difference signals, E_{CB}' , and E_{CR}' , or on the use of three primary color signals E_G' , E_B' , E_R' .

E_Y' , E_{CB}' , E_{CR}' are transmitted at the 22:11:11 level of the ITU-R (CCIR) digital hierarchy for digital television signals, with a nominal sampling frequency of 74.25 MHz for the luminance signal and 37.125 MHz for each of the color-difference signals. E_G' , E_B' , E_R' signals are transmitted at the 22:22:22 level of the ITU-R digital hierarchy with a nominal sampling frequency of 74.25 MHz.

Provision is made for the coding of the ANSI/SMPTE 240M signals to a precision of 8 or 10 bits.

Technical information is given in annex A¹⁾ concerning an example of filter characteristics for pre- and post-filtering of the ANSI/SMPTE 240M signals.

This standard describes the bit-parallel digital interface only. The complete specification of the bit-serial interface requires further studies. However, in defining the digital representation, consideration has been given to making the signal format equally applicable to the bit-serial interface.

The interface consists of one transmitter and one receiver in a point-to-point connection.

The bits of the digital code words that describe the video signal are transmitted in parallel using 10 conductor cables (shielded twisted pairs) for each of the component signals. Each pair carries bits at a nominal sample rate of 74.25 Mwords/s. For the transmission of E_Y' , E_{CB}' , E_{CR}' , the color-difference components are time-multiplexed into a single signal E_{CB}'/E_{CR}' of 74.25 Mwords/s.

The digital bit-parallel interface uses a 93 multipin connector for transmission of E_Y' , E_{CB}' , E_{CR}' , or for transmission of E_G' , E_B' , E_R' , with 8- or 10-bit precision.

The connecting cable shall carry 31 shielded conductor pairs for transmission of E_G' , E_B' , E_R' signals or for transmission of E_Y' , E_{CB}'/E_{CR}' components and an additional data stream (auxiliary channel). Twenty-one shielded conductor pairs shall be used in the case of E_Y' , E_{CB}'/E_{CR}' transmission.

1) The purpose of the annexes is to convey results of studies on technical matters that relate to the processing of digital signals described in this standard. They also contain information on implementation examples that should be regarded as technical guidelines for equipment design.

The digital video signals on the interface are transmitted using shielded, balanced conductor pairs for distances up to 20 m (65.6 ft) without equalization (see annex D).

The interface allows the transmission of ancillary data that may be multiplexed into the data stream during blanking intervals.

4.2 Encoding parameters

Table 1 specifies the encoding parameter values of the digital representation of ANSI/SMPTE 240M video signals.

4.2.1 Filtering characteristics

The spectral characteristics of the component video signals must be restricted to eliminate aliasing. Various filter designs can be used to accomplish this. One example of such filtering characteristics, when using E_Y' , E_{CB}' , and E_{CR}' signals as defined in table 1, is depicted in annex A, figures A.1 (for E_Y') and A.2 (for E_{CB}' and E_{CR}'). When using E_G' , E_B' , E_R' signals, the characteristics depicted in figure A.1 can be used.

4.2.2 Dynamic range of the analog signals and their relationship to quantization levels

To ensure the proper digital acquisition of large dynamic range signals from cameras (resulting from creative exposure beyond nominal white level in the viewed scene), the following relation between the camera analog signal values and their quantized representation shall be observed:

- an upper level of 700 mv and a black level of 0 mv shall correspond to the absolute maximum (peak-white) and minimum (black level) ANSI/SMPTE 240M signal levels, respectively;
- the effects of camera highlight processing, such as knee and slope characteristics, shall be included within the aforementioned range;
- overshoot/undershoot effects caused by video processing circuitry may exceed the above limits;
- the peak-white level of 700 mv shall correspond to the quantization level 940 in a 10-bit system or to level 235 in an 8-bit system;
- the black level (0 mv) shall correspond to level 64 in a 10-bit system or to level 16 in an 8-bit system.

Table 1 — Encoding parameter values for digital representation of ANSI/SMPTE 240M signals

Parameter		Value
Matrix formulas	E_Y' , E_{CB}' , E_{CR}' E_G' , E_B' , E_R'	E_Y' , E_{CB}' , E_{CR}' are derived from gamma corrected values of E_G , E_B , E_R as defined by the linear matrix specified in ANSI/SMPTE 240M.
Number of samples per line	Video components	E_Y' 2200 E_G' 2200 E_{CB}' 1100 E_B' 2200 E_{CR}' 1100 E_R' 2200
	Auxiliary channel	2200
Sampling structure	E_G' , E_B' , E_R' , luminance signal E_Y' , auxiliary channel Color difference signals (E_{CB}' , E_{CR}')	Identical sampling structures – Orthogonal sampling, line, field, and frame repetitive. Samples are co-sited with odd (1st, 3rd, 5th, ...) E_Y' samples in each line.
Sampling frequency The tolerance of the sampling frequency shall be ± 10 ppm.	Video components Auxiliary channel	E_Y' 74.25 MHz E_G' 74.25 MHz E_{CB}' 37.125 MHz E_B' 74.25 MHz E_{CR}' 37.125 MHz E_R' 74.25 MHz 74.25 MHz
Form of encoding		Uniformly quantized, PCM 8 or 10 bits per sample for each of the video component signals and the auxiliary channel.
Active number of samples per line	Video components Auxiliary channel	E_Y' 1920 E_G' 1920 E_{CB}' 960 E_B' 1920 E_{CR}' 960 E_R' 1920 1920
Timing relationship between video data and the analog synchronizing waveform		The time duration between the end of active video (EAV) timing reference code and the reference point 0H (see figure 1) of the horizontal sync waveform is 88 clock intervals.
Correspondence between video signal levels and quantization levels NOTE — These values refer to precise nominal video signal levels. Signal processing may occasionally cause the signal level to deviate outside this range.	8 bit system: E_G' , E_B' , E_R' , luminance signal E_Y' , auxiliary channel Each color difference signal (E_{CB}' , E_{CR}')	220 quantization levels with the black level corresponding to level 16 and the peak white level corresponding to level 235. 225 quantization levels symmetrically distributed about level 128, which corresponds to the zero signal.
	10 bit system: E_G' , E_B' , E_R' , luminance signal E_Y' , auxiliary channel Each color difference signal (E_{CB}' , E_{CR}')	877 quantization levels with the black level corresponding to level 64 and the peak white level corresponding to level 940. 897 quantization levels symmetrically distributed about level 512, which corresponds to the zero signal.
Quantization level assignment	8-bit system	254 of the 256 levels (digital levels 1 through 254) of the 8-bit word shall be used to express quantized values. Data levels 0 and 255 shall be reserved to indicate timing references.
NOTE — These values refer to precise nominal video signal levels. Signal processing may occasionally cause the signal level to deviate outside this range.	10-bit system	1016 of the 1024 levels (digital levels 4 through 1019) of the 10-bit word shall be used to express quantized values. Data levels 0 to 3 and 1020 to 1023 shall be reserved to indicate timing references.

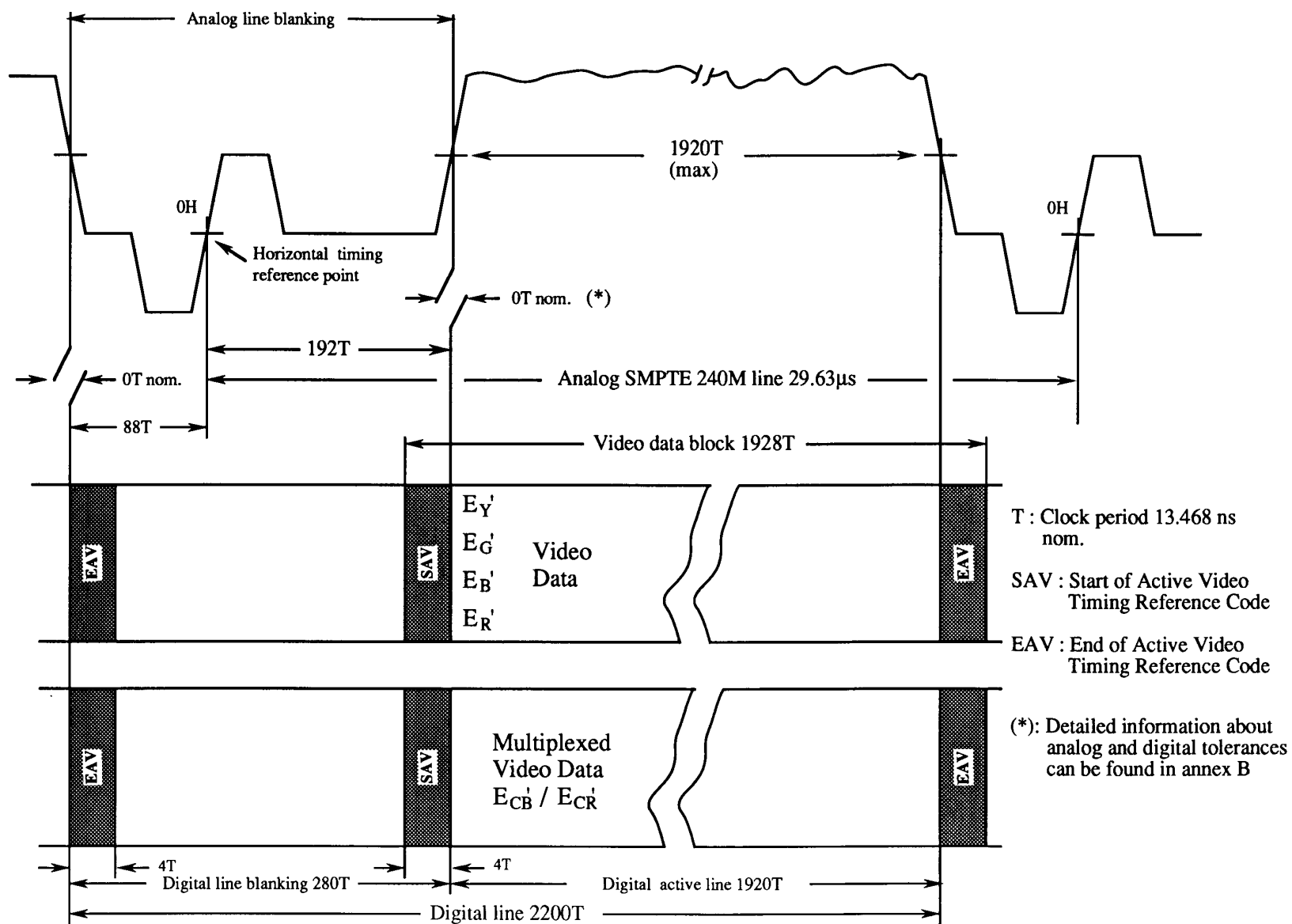


Figure 1 – Data format and timing relationship to analog ANSI/SMPTE 240M waveform

4.3 Common signal format for digital interfaces

4.3.1 General description

The digital interface provides a unidirectional inter-connection between a single source and a single destination. A signal format common to both parallel and serial interfaces is described below. The data signals shall be in the form of binary information coded in 8- or 10-bit words. These signals are:

- video data;
- timing reference codes;
- ancillary data;
- identification codes.

The characteristics of the data word at the interface shall be based on the assumption that the location of any required $\sin(x)/x$ correction is at the point where the digital signal is converted to an analog format.

4.3.2 Video data

4.3.2.1 Coding characteristics

The video data are in compliance with ANSI/SMPTE 240M and with the field blanking definition shown in table 2.

4.3.2.2 Video data format

For a 10-bit system, the data levels 0 to 3 and 1020 to 1023 (000_h to 003_h and 3FC_h to 3FF_h in the hexadecimal representation) shall be reserved for timing identification purposes. Consequently, data levels 4 through 1019 (004_h through 3FB_h) shall be used to express quantized signal values.

For an 8-bit system, data levels 0 and 255 (00_h and FF_h) shall be reserved to indicate timing references. Digital levels 1 through 254 (01_h through FE_h) shall be used to represent quantized signal values.

The video data words shall be conveyed across the digital interface using multiple bit-parallel channels; luminance E_Y' and time-multiplexed color-difference signal $E_{CB'}/E_{CR'}$ or the three primary color signals E_G' , E_B' , E_R' . Each parallel channel consists of 8 or 10 bits and the transmission rate shall be 74.25 Mwords/s. Co-sited samples of the two color-difference signals shall be time-multiplexed in the order $E_{CB'}$ and $E_{CR'}$.

4.3.2.3 Timing relationship between video data and the analog synchronizing waveform

4.3.2.3.1 Line interval

Figure 1 depicts the timing relationship between the digital video and the analog line sync waveform. The digital active line shall begin 192 clock periods after the rising edge of the analog, tri-level, line sync pulse (the zero crossing point is labelled 0H in figure 1). The precise timing shall be specified between half-amplitude points. Lines shall be numbered from 1 through 1125 as shown in figures 2A and 2B.

4.3.2.3.2 Field interval

The start of the digital field shall be determined by the position specified by the start of the digital line. The digital field shall start coincident with the end of active video (EAV) timing reference code of the lines indicated in table 2. Field blanking in the digital interface shall be in full-line increments.

4.3.2.4 Video timing reference codes (SAV, EAV)

There shall be two timing reference codes, one at the beginning of each video data block (start of active video, SAV) and another at the end of each video data block (end of active video, EAV). These codes are shown in figure 1. The timing reference codes shall be

Table 2 — Field interval definition

V: Digital field blanking		
Field 1	Start (V=1)	Line 1121
	Finish (V=0)	Line 41
Field 2	Start (V=1)	Line 558
	Finish (V=0)	Line 603
F: Digital field identification		
Field 1	F = 0	Line 1
Field 2	F = 1	Line 564
NOTES		
1 Signals F and V shall change state synchronously with the end of active video (EAV) timing reference code, at the beginning of the digital line.		
2 Definition of line numbers is given in ANSI/SMPTE 240M. Digital line numbers shall change state prior to the horizontal timing reference point (0H), as shown in figure 1.		

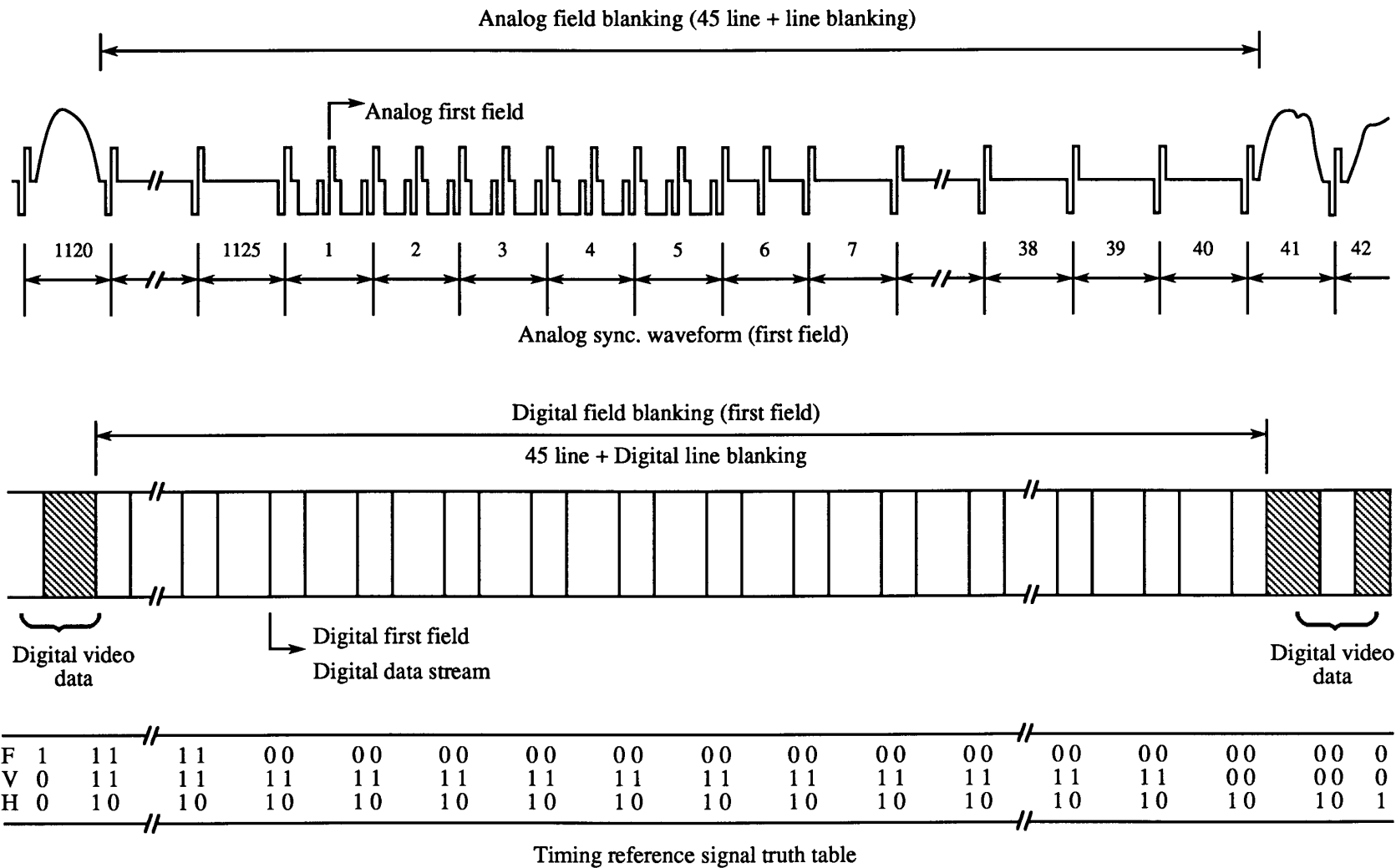
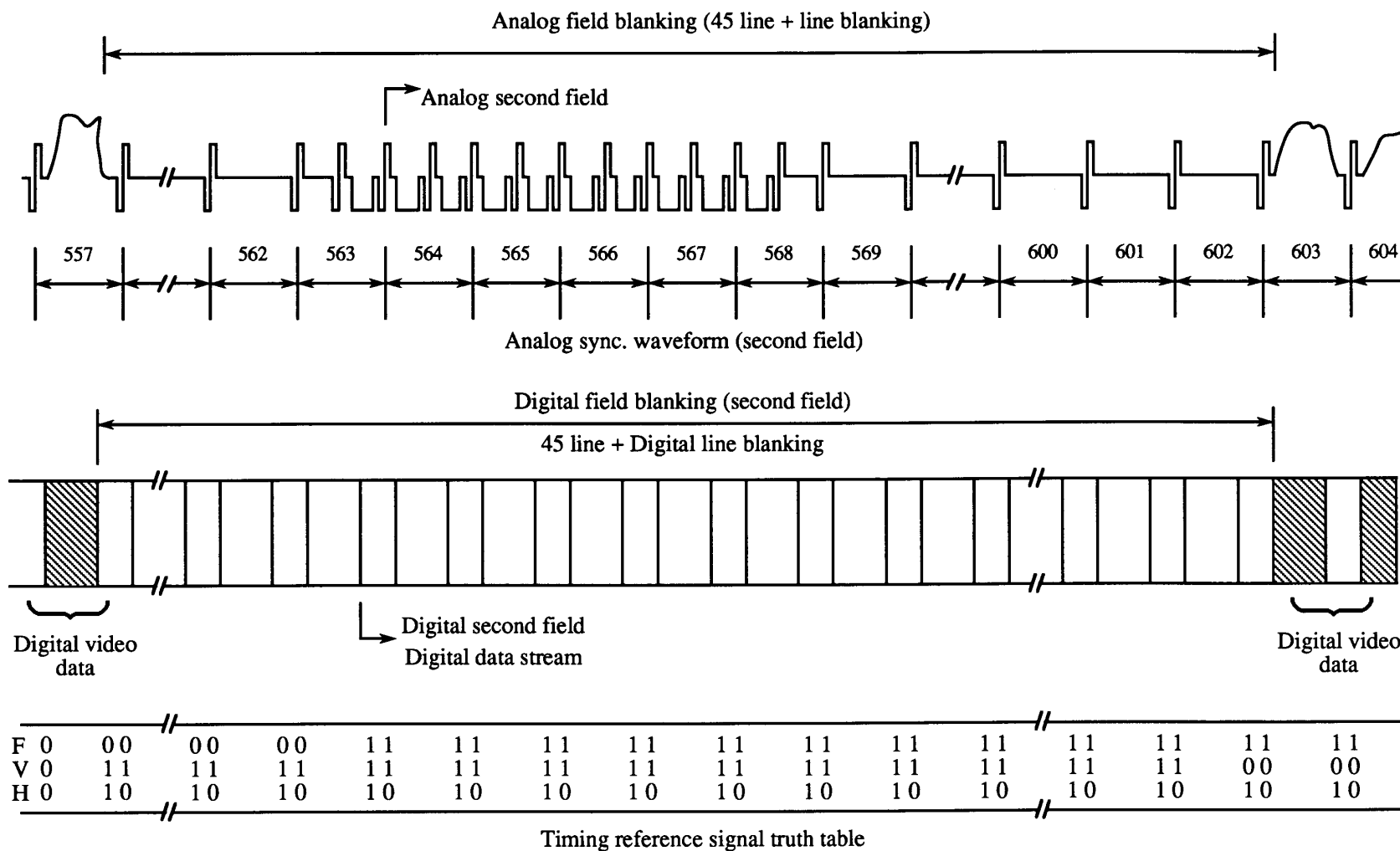


Figure 2A – First digital field (F = 0)



contiguous with the video data, when present, and continue through the field blanking interval. The SAV and EAV codes shall be the digital interface line synchronization signals and shall be carried on every line by all component signals, namely, EY' , ECB' , ECR' , and EG' , EB' , ER' . The interval starting at EAV and ending with SAV shall be the digital line blanking period as shown in figure 1.

Each timing reference code shall consist of a four-word sequence in the following format for a 10-bit system: $3FF_h$, 000_h , 000_h , XYZ_h (in hexadecimal notation). The first three words shall be a fixed preamble. The fourth word contains information defining:

- field 2 identification;
- state of field blanking;
- state of line blanking.

The assignment of bits within the timing reference codes shall be as shown in table 3.

For an 8-bit system, the bits of each timing reference word are selected starting from the MSB of each of the words specified in table 3 (note that FF_h and 00_h are reserved for use in timing reference codes).

Bits P0, P1, P2, and P3 in table 3 have logic values that depend on the states of bits F, V, and H and are shown in table 4. At the receiver this arrangement permits one-bit errors to be corrected and two-bit errors to be detected.

4.3.2.5 Ancillary data

NOTE — The precise location of the ancillary data blocks and the coding of words 3, 4, and 5 (see figure 3) requires further study.

Table 3 — Video timing reference codes

Bit Number										
Word	9 (MSB)	8	7	6	5	4	3	2	1	0 (LSB)
First	1	1	1	1	1	1	1	1	1	1
Second	0	0	0	0	0	0	0	0	0	0
Third	0	0	0	0	0	0	0	0	0	0
Fourth	1	F	V	H	P3	P2	P1	P0	0	0
F= 0 during field 1 1 during field 2			V= 0 elsewhere 1 during field blanking			H= 0 in SAV 1 in EAV				
NOTES										
1 P0, P1, P2, P3: protection bits (see table 4).										
2 MSB: most significant bit.										
3 LSB: least significant bit.										
4 Table 2 defines the logic state of the V and F bits.										

Table 4 — Protection bits for SAV and EAV

Bit No.	9	8	7	6	5	4	3	2	1	0
Function	1 Fixed	F	V	H	P3	P2	P1	P0	0 Fixed	0 Fixed
0	1	0	0	0	0	0	0	0	0	0
1	1	0	0	1	1	1	0	1	0	0
2	1	0	1	0	1	0	1	1	0	0
3	1	0	1	1	0	1	1	0	0	0
4	1	1	0	0	0	1	1	1	0	0
5	1	1	0	1	1	0	1	0	0	0
6	1	1	1	0	1	1	0	0	0	0
7	1	1	1	1	0	0	0	1	0	0