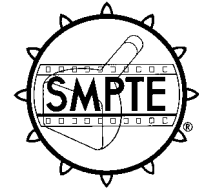


Bit-Parallel Digital Interface for 4:4:4:4 Component Video Signal (Single Link)



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1 Scope

This practice describes the means of interconnecting digital video equipment operating in system M (525/60) and complying with the 4:4:4 encoding parameters as defined in CCIR Recommendation 601-2, annex 1 with a nominal sampling frequency of 13.5 MHz. Provision is made to convey signal at 10-bit precision and to carry a fourth auxiliary channel as part of the signal multiplex (yielding 4:4:4:4 or 4x4 overall). The practice has application in the television studio over distances up to 100 m (320 ft). The characteristics of the interface are summarized below:

1.1 The video signal is transmitted in the form of three color-component signals and an auxiliary signal (G, B, R, and A or Y, C_B, C_R, and A).

1.2 The video signal is transmitted at the 4:4:4 family level of CCIR 601-2, with a nominal

sampling frequency of 13.5 MHz. Provision is made to convey signals at 10-bit precision.

1.3 The bits of the digital code words that describe the video signal are transmitted in a parallel arrangement using 10 conductor pairs. Each pair carries a multiplexed stream of bits (of the same significance) of each of the component signals. Accordingly, the bit rate used in each pair is nominally 54 Mbits/s. An eleventh conductor pair carries a clock signal at 54 MHz.

1.4 The signals on the interface are transmitted using balanced conductor pairs for a distance up to 25 m (80 ft) without equalization and up to 100 m (320 ft) with appropriate equalization.

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

1.6 Parameters of the signal format are chosen to facilitate conversion to and from a serial digital interface format.

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

1.8 Where hexadecimal values are used, they are indicated by a subscript h, such as 3FF_h; other values are decimal.

2 Normative references

The following standard contains provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this

practice are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

SMPTE RP 157-1990, Key Signals

3 General

3.1 Signal convention

The signaling sense of the voltage appearing across the interconnection cable is positive binary and defined as follows (refer to figure 1):

3.1.1 The A terminal of the transmitter shall be negative with respect to the B terminal for a binary 0 (LOW or L or OFF) state.

3.1.2 The A terminal of the transmitter shall be positive with respect to the B terminal for a binary 1 (HIGH or H or ON) state.

3.2 Signal names

The data lines are designated DATA 0 through DATA 9. The group of 10 signals is identified by placing parentheses around the range of subscripts included, as DATA (0-9). DATA 9 is always the most significant bit.

3.3 Sin x/x

The characteristics of the data word at the interface are 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.

3.4 Blanking interval

This practice does not require the device feeding the interface to transmit video data during the entire blanking interval. Therefore, ancillary information may be inserted into the horizontal blanking interval by the user within the constraints specified in 4.4 and 4.5.

The vertical blanking duration is a minimum of nine lines. Ancillary information may be inserted into this nine-line interval by the user within the constraints specified in 4.4 and 4.5.

3.5 Signal specifications

All digital signal time intervals are specified at the half-amplitude points. All transitions are specified between the 20% and 80% amplitude points.

3.6 Electromagnetic interference

Digital apparatus can radiate a significant amount of energy at harmonics of the clock frequency. In the case of 13.5 MHz, clock harmonics lie at 121.5 MHz and 243 MHz, both of which are aeronautical distress frequencies. Equipment and system designers must, therefore, pay particular attention to the provision of adequate screening.

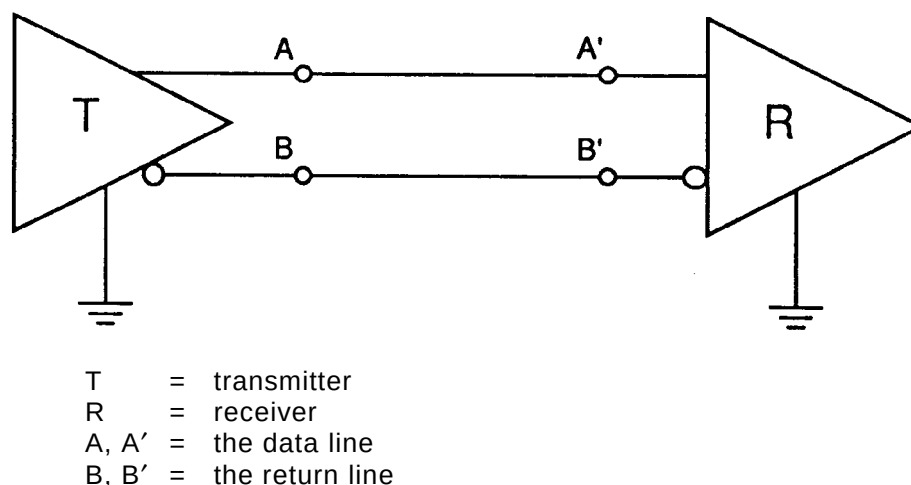


Figure 1 – Positive binary signal convention

4 Interface format

4.1 General description

The interface consists of a unidirectional, 11-pair interconnection between a transmitting equipment and a receiving equipment. Video data, timing reference information, and ancillary signals are time multiplexed and transferred on 10 data pairs in NRZ form. An eleventh pair provides a synchronous clock.

4.2 Encoding parameters

Table 1 summarizes the encoding parameter values, which are in accordance with CCIR 601-2.

4.3 Interface characteristics

Table 2 specifies the interface characteristics.

Table 1 – Encoding parameters

Matrixing formulas:	$Y = 0.299R + 0.587G + 0.114B$ $C_B = 0.564 (B-Y) = 0.500B - 0.169R - 0.331G$ $C_R = 0.713 (R-Y) = 0.500R - 0.419G - 0.081B$	
Number of samples per line:	Total	Active
-- each of the 3 video components	858	720
-- auxiliary channel	858	720
-- total number of samples	3432	2880
Sampling structure:	Orthogonal: line, field, and frame repetitive.	
Sampling frequency:		
-- each of 3 video components	13.5 MHz nominal	
-- auxiliary channel	13.5 MHz nominal	
Form of encoding:	Uniformly quantized, PCM, 10 bits per sample, for each of the primary signals and the auxiliary channel.	
Correspondence between video signal levels and quantization levels:		
-- each of the 3 primaries (G, B, R), the luminance signal (Y), and the auxiliary channel.	877 quantization levels with the black corresponding to level 64 and the peak white level corresponding to level 940.	
-- each color-difference signal (C_B , C_R)	897 quantization levels symmetrically distributed about level 512, corresponding to the zero signal.	

Table 2 – Interface characteristics

Digital format:	Parallel: 11 balanced signal pairs carrying clock and 10 data bits
Interface clock:	54.0 MHz nominal
Voltage levels:	Standard ECL (10KH series)
Driver impedance:	Standard ECL (10KH series)
Receiver impedance:	110 ohms nominal, balanced

4.4 Digital blanking relationship

4.4.1 Horizontal sync relationship

Figure 2 shows the relationship between video signals in the digital and analog domains for 525-line systems. Figure 3 shows the multiplex structure.

Transmitted during each active line are 2880 multiplexed green, red, blue, and auxiliary or luminance, chrominance, and auxiliary values.

Eight of the remaining 552 interface clock intervals are used to transmit synchronizing information; the other 544 interface clock intervals may be used to carry ancillary information.

The first of these 3432 interface clock intervals is designated line word 0 for the purpose of reference only. The 3432 sample words per total line are, there-

fore, numbered 0 through 1715. Intervals 0 through 3431, inclusive, contain video data. The interface clock intervals occurring during digital blanking are designated 2880 through 3431.

Intervals 2880 through 2883 are reserved for the end-of-active video (EAV) timing reference described in 4.5.4. Intervals 3428 through 3431 are reserved for the start-of-active-video (SAV) timing reference described in 4.5.4.

The half-amplitude point of the leading (falling) edge of the analog horizontal sync signal shall be coincident with a sample point which would be conveyed by word 2945, if carried across the interface.

4.4.2 Vertical sync relationship

Figure 4 shows the relationship between video signals in the digital and analog domains for 525-line systems.

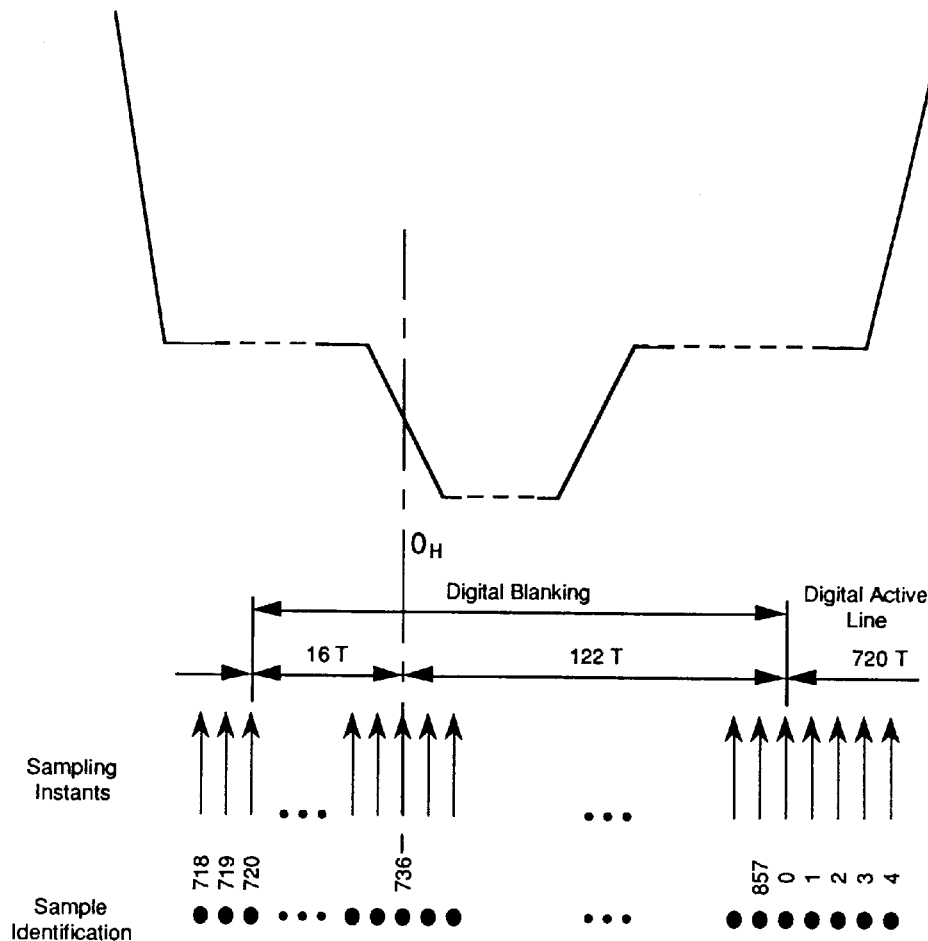


Figure 2 – Horizontal sync relationship

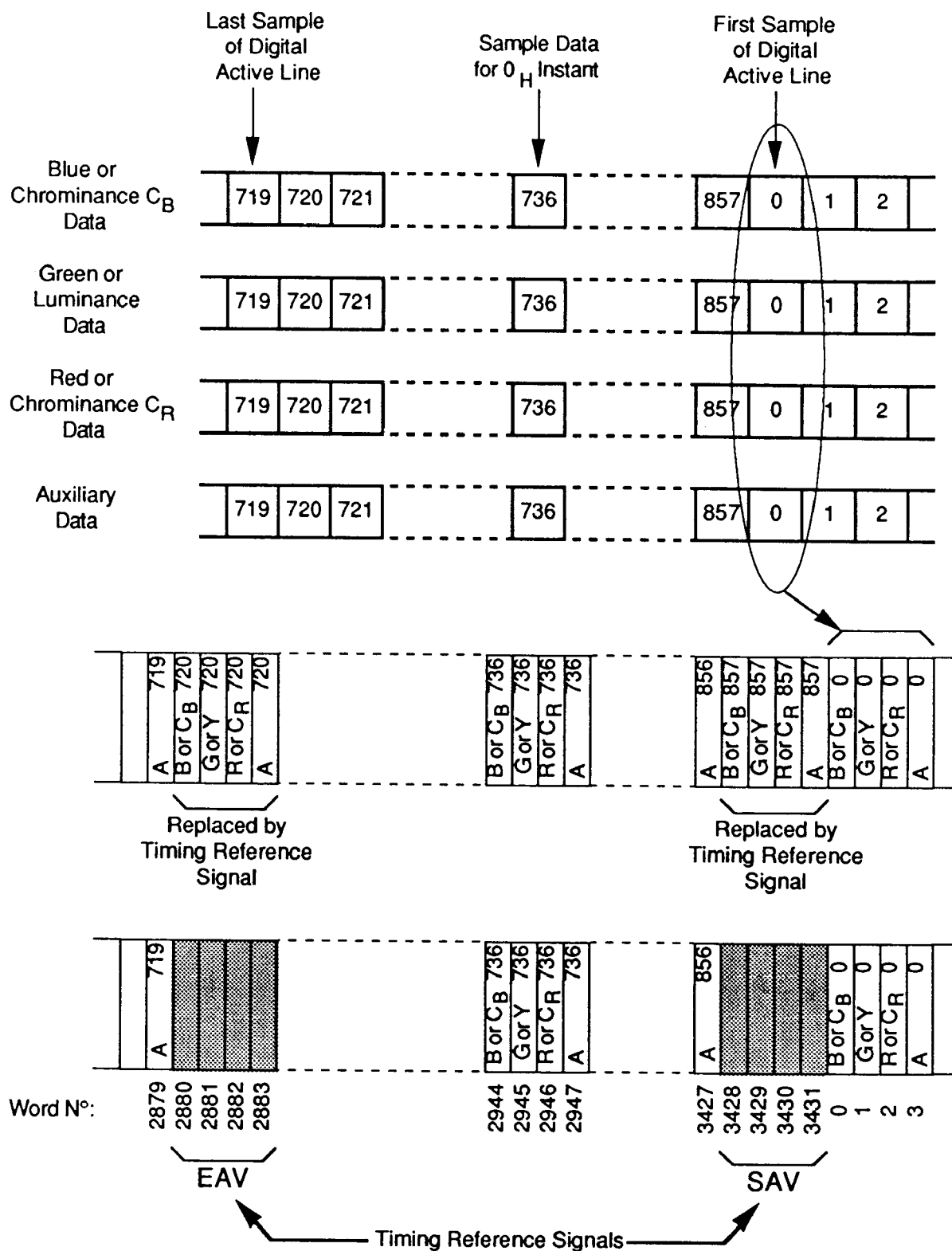


Figure 3 – Multiplex structure

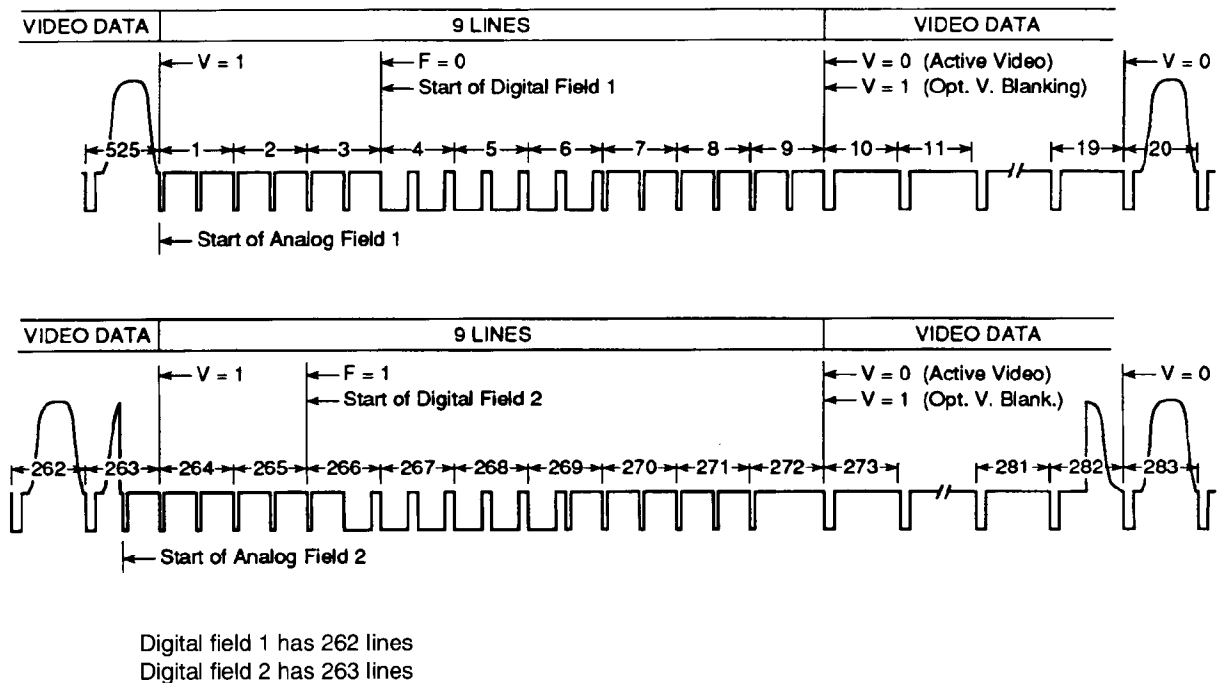


Figure 4 -- Relationship of video data/vertical sync

4.5 Video data signal format

4.5.1 Data signal format

Data is transmitted across the interface on 10 data pairs: DATA 0 through DATA 9. DATA 9 is the most significant bit (MSB). Of the 1024 levels (digital levels 4 through 1019 or 004_h through 3FB_h in the hexadecimal representation) of the 10-bit word, 1016 are used to express quantized values.

Data levels 0 to 3 and 1020 to 1023 (000_h to 003_h and 3FC_h to 3FF_h in the hexadecimal representation) are reserved to indicate timing references.

4.5.2 Auxiliary signal

The auxiliary signal (A) is used to transmit the key signal associated with the G, B, R or the Y, C_B, C_R signals. The auxiliary signal channel can also be used to transmit a Y signal for monitoring in the case of G, B, R signals or for other purposes.

4.5.2.1 Key signal

On the key signal, black level (040_h) represents complete transparency and white level (3AD_h) represents complete opacity. The key signal should comply with SMPTE RP 157.

4.5.3 Multiplex structure

The video data words shall be conveyed as a 27-Mword/s multiplex in the following order:

B G R A B ... or C_B Y C_R A C_B ...

The first video data word in each active line period shall be B or C_B.

4.5.4 Timing reference signals — Video

Figure 2 shows the position of the timing reference signals with respect to horizontal blanking in the multiplexed data stream. It is implicit that the timing reference signals are contiguous with the video data,