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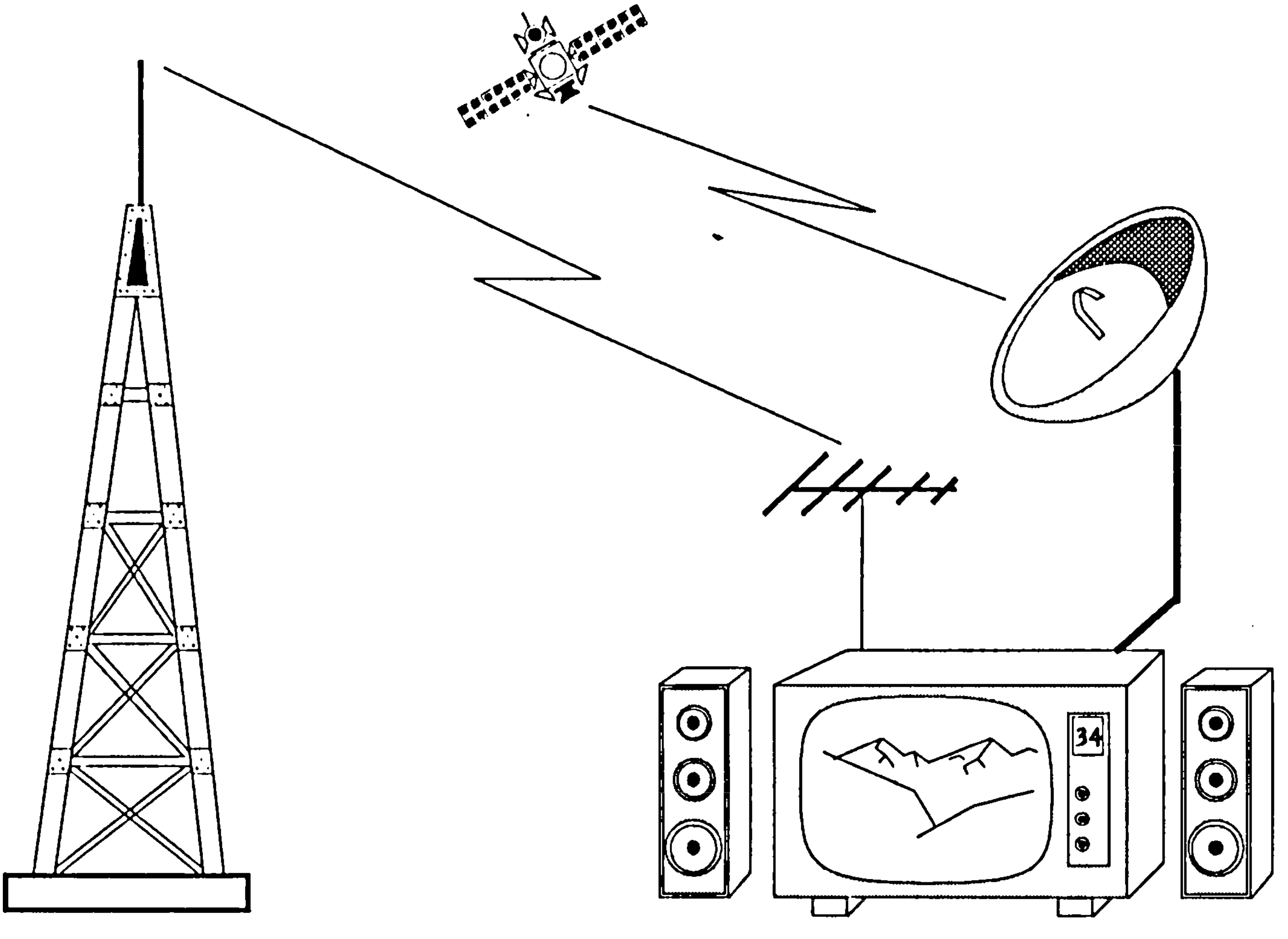

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Recommendation 799 (1992)

Interfaces for digital component video signals in 525 line and 625 line television systems operating at the 4:4:4 level of recommendation 601

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RECOMMENDATION 799

INTERFACES FOR DIGITAL COMPONENT VIDEO SIGNALS IN 525-LINE AND 625-LINE TELEVISION SYSTEMS OPERATING AT THE 4:4:4 LEVEL OF RECOMMENDATION 601

(Question 65/11)

(1992)

The CCIR,

considering

a) that there are clear advantages for television broadcasting organizations and programme producers in digital studio standards which have the greatest number of significant parameter values common to 525-line and 625-line systems;

b) that in implementing the above objectives, agreement was reached on the fundamental encoding parameters of digital television for studios in the form of Recommendation 601;

c) that the worldwide compatible digital approach has permitted the development of equipment with many common features, permitting operating economies and facilitating the international exchange of programmes;

d) that the practical implementation of Recommendation 601 for complex digital studio processes requires definition of details of interfaces at the 4:4:4 level and the data streams traversing them;

e) that such interfaces should have a maximum of commonality between 525-line and 625-line versions;

f) that it is desirable that interfaces be defined in both serial and parallel forms;

g) that digital television signals produced by these interfaces may be a potential source of interference to other services, and due notice must be taken of No. 964 of the Radio Regulations,

recommends

that where interfaces for the 4:4:4 level are required for component-coded digital video signals in television studios, the interfaces and the data streams that will traverse them should be in accordance with the following description, defining both bit-parallel and bit-serial implementations.

1. Introduction

This Recommendation describes the means of interconnecting digital television equipment operating on the 525-line or 625-line standards and complying with the 4:4:4 encoding parameters as defined in Recommendation 601.

Part 1 describes the signal format common to both interfaces.

Part 2 describes the particular characteristics of the bit-parallel interface.

Part 3 describes the particular characteristics of the bit-serial interface.

Supplementary information is to be found in Annex 1.

The interfaces for the 4:4:4 level are based on the use of parallel and serial interfaces already developed for use at the 4:2:2 level and described in Recommendation 656. Whereas at the 4:2:2 level a single interface carries a multiplex of a wideband luminance and two lower-bandwidth colour-difference video signals, at the 4:4:4 level a pair of interfaces is used, each carrying a multiplex of two wideband video signals; this gives capacity for carrying the green, blue and red primary signals or, alternatively, the luminance and two colour-difference signals, together with a fourth wideband signal such as an associated key signal. In this case the signal is at the "4:4:4:4" level.

The interfaces for the 4:4:4 level have been specified for 10-bit* data words: thus they will carry not only 8-bit signals encoded according to Recommendation 601 but also 10-bit signals where additional bits may have been generated during signal processing.

Only two devices will be connected together at one time through one interface.

PART 1

Common signal format of the interfaces

1. Introduction

The interface consists of two unidirectional interconnections between one device and another. The interconnections carry the data corresponding to the television signal and associated data.

The two interconnections are referred to as: link A and link B.

The data signals are carried in the form of binary information coded in ten-bit words. These signals are:

- the video signals themselves;
- digital blanking data;
- timing reference signals;
- ancillary data signals.

These signals are time-multiplexed.

2. *Video data signals*

2.1 *Coding characteristics*

The video data signals are derived by coding of the analogue video signal components in accordance with the 4:4:4 level of Recommendation 601, with the field-blanking definition shown in Table 1.

2.2 *Video data format*

Eight-bit data words resulting from sampling according to Recommendation 601 are carried in the most significant eight bits of the ten-bit interface signal. In this case the remaining least significant bits (LSBs) should be set to zero.

Words in which the 8 most significant bits are all set to 1 or are all set to 0 (i.e. 1111 1111 xx or 0000 0000 xx, where xx represents bits which are either absent – the 8-bit case – or can have any value) are reserved for identification purposes. The corresponding data values are excluded from the data coding range.

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* Within this Recommendation, the contents of digital words are expressed in both decimal and hexadecimal form. To avoid confusion between 8-bit and 10-bit representations, the eight most significant bits are considered to be an integer part while the two additional bits, if present, are considered to be fractional parts.

For example, the bit pattern 10010001 would be expressed as 145_d or 91_h, whereas the pattern 1001000101 is expressed as 145.25_d or 91.4_h.

Where no fractional part is shown, it should be assumed to have the binary value 00.

TABLE 1

Field interval definitions

		625	525
V-digital field blanking			
Field 1	Start (V = 1)	Line 624	Line 1
	Finish (V = 0)	Line 23	Line 10
Field 2	Start (V = 1)	Line 311	Line 264
	Finish (V = 0)	Line 336	Line 273
F-digital field identification			
Field 1	F = 0	Line 1	Line 4
Field 2	F = 1	Line 313	Line 266

Note 1 – Signals F and V change state synchronously with the end of active video timing reference code at the beginning of the digital line.

Note 2 – Definition of line numbers is to be found in Recommendation 470. Note that digital line number changes state prior to 0_H as described in Recommendation 601.

2.3 *Multiplex structure*

The video data words are conveyed in two separate 27 Mword/s data-streams.

The multiplex sequence is:

- for links carrying colour primaries

  link A: $..B_0\ G_0\ R_0\ G_1\ B_2\ G_2\ R_2\ G_3\ B_4...$

  link B: $..B_1\ K_0\ R_1\ K_1\ B_3\ K_2\ R_3\ K_3\ B_5...$

  where R, G, B and K represent the red, green and blue signal data words, and K represents the key signal data words, if present. The first sample of the digital active line shall be B_0 for link A and B_1 for link B.

  The distribution of the red, green, blue and key signals between link A and link B is shown in Fig. 1a).

- for links carrying luminance and colour-difference signals

  link A: $..C_B0\ Y_0\ C_R0\ Y_1\ C_B2\ Y_2\ C_R2...$

  link B: $..C_B1\ K_0\ C_R1\ K_1\ C_B3\ K_2\ C_R3...$

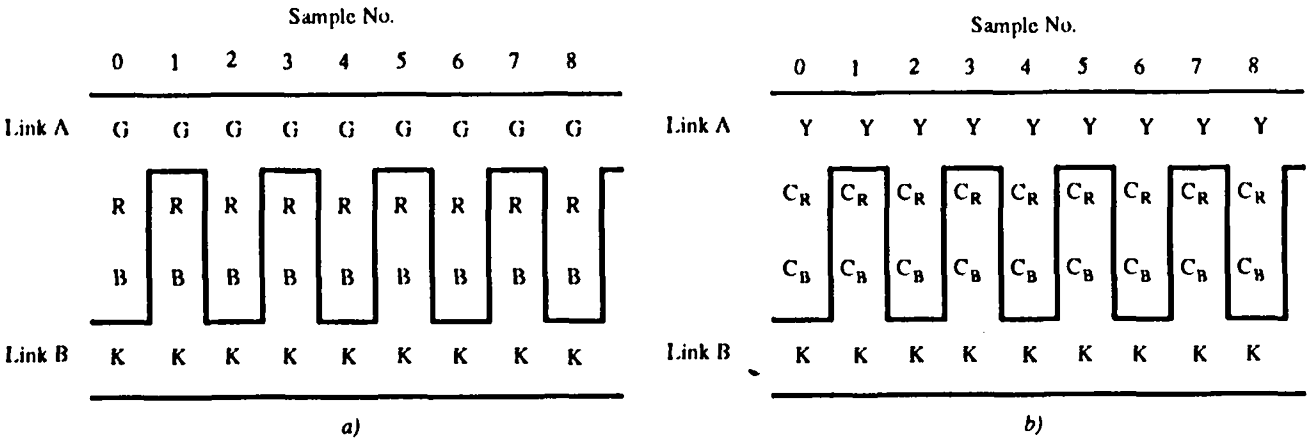
  where Y, C_B and C_R represent the luminance and colour-difference signals respectively, and K represents the key signal data words, if present. The first sample of the digital active line shall be C_B0 for link A and C_B1 for link B. The distribution of the luminance, colour-difference and key signals between link A and link B is shown in Fig. 1b).

2.4 *Interface signal structure*

Figure 2 shows the ways in which the video sample data is incorporated in the interface data stream. Sample identification in Fig. 2 is in accordance with the identification in Recommendation 601.

FIGURE 1

Link contents when used for R, G, B, K and Y, C_R, C_B, K signals



2.5 *Video timing reference signals (SAV, EAV)*

There are two timing reference signals, one at the beginning of each video data block (start of active video, SAV) and one at the end of each video data block (end of active video, EAV) as shown in Fig. 1.

Each timing reference signal consists of a four word sequence in the following format: FF 00 00 XY. (Values are expressed in hexadecimal notation. Words FF, 00 are reserved for use in timing reference signals.) The first three words are a fixed preamble. The fourth word contains information defined field 2 identification, the state of field blanking, and the state of line blanking. The assignment of bits within the timing reference signal is shown below in Table 2.

Bits P_0, P_1, P_2, P_3, have states dependent on the states of the bits F, V and H as shown in Table 3. At the receiver this arrangement permits one-bit errors to be corrected and two-bit errors to be detected.

2.6 *Ancillary data*

Provision is made for ancillary data to be inserted synchronously into the multiplex during the blanking intervals at a rate of 27 Mword/s.

Ancillary data signals may be conveyed in 10-bit form during the line-blanking period only, and in 8-bit form only during the active line periods of lines in the field-blanking. (It should be noted that digital video tape recorders operating in accordance with Recommendation 657 do not record data in the line-blanking period, nor during some lines in the field-blanking period.)

The reserved data values $00.x_h$ and $FF.x_h$ (see § 2.2) are reserved for identification purposes and must not appear in the ancillary data.

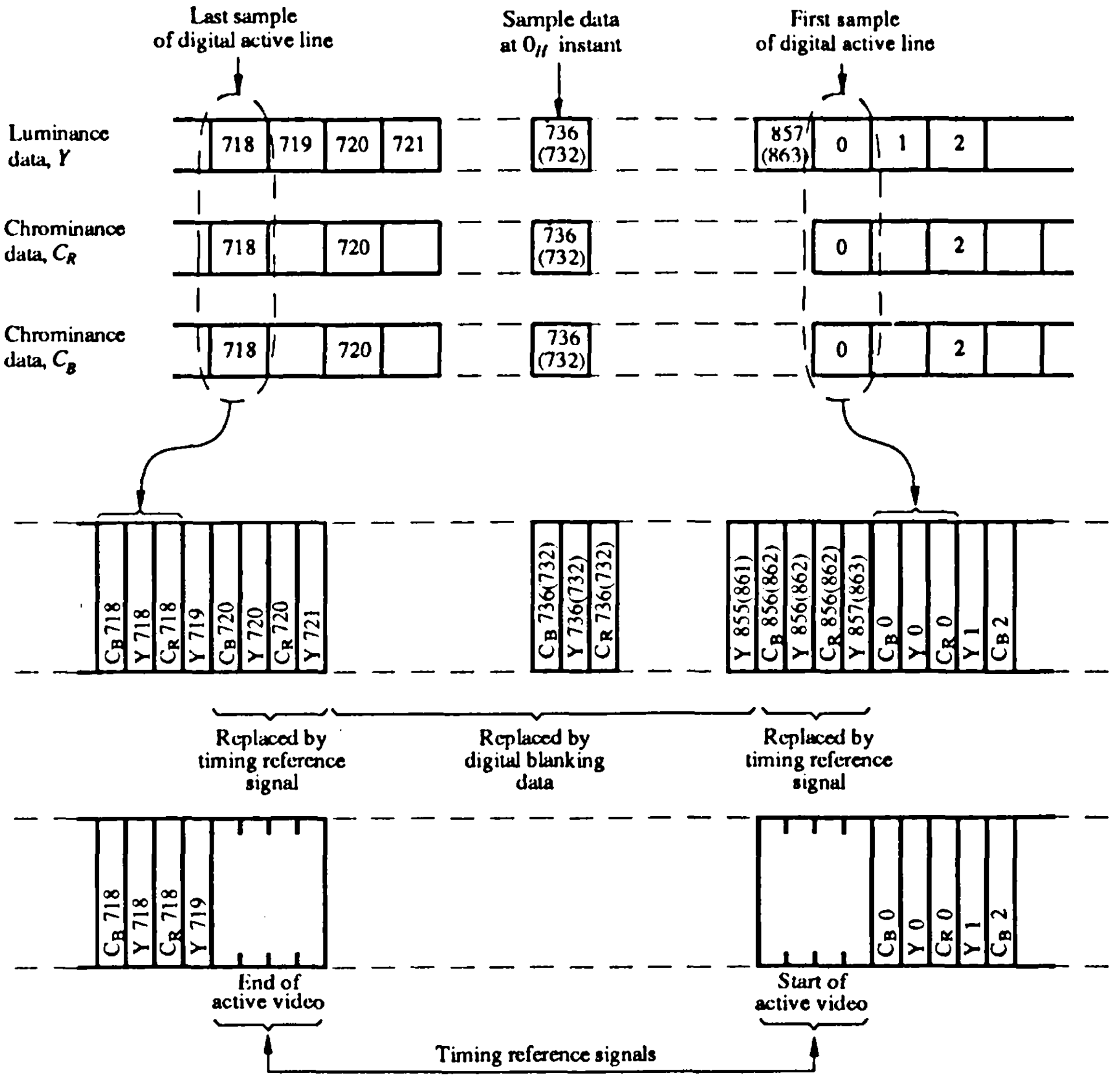
All ancillary data signals carried during the active portions of lines in the field-blanking period must be preceded by the preamble:

00.x FF.x FF.x

Unless it is the intended function of a particular item of equipment, the ancillary signals must not be modified by that equipment.

FIGURE 2

Composition of the data multiplex and position of the timing reference signals, EAV and SAV (shown here for link A carrying Y, C_R, C_B, as an example)



Note 1 – Sample identification numbers in parentheses are for 625-line systems where these differ from those for 525-line systems. (See also Recommendation 803.)

2.7 *Data words during blanking*

During digital blanking the luminance or R, G, B sample values should be set to black, level 10.0_h, and the colour-difference samples set to zero, level 80.0_h. The key samples should be set to peak white, level $EB.0_h$, when not carrying a key signal.

TABLE 2

Video timing reference signal

Data bit number	First word (FF)	Second word (00)	Third word (00)	Fourth word (XY)
9 (MSB)	1	0	0	1
8	1	0	0	F
7	1	0	0	V
6	1	0	0	H
5	1	0	0	P_3
4	1	0	0	P_2
3	1	0	0	P_1
2	1	0	0	P_0
1 (Note 2)	1	0	0	0
0	1	0	0	0

Note 1 – The values shown are those recommended for 10-bit interfaces.

Note 2 – For compatibility with existing 8-bit interfaces, the values of bits D_1 and D_0 are not defined.

F = 0 during field 1
1 during field 2

V = 0 elsewhere
1 during field blanking

H = 0 in SAV
1 in EAV

P_0, P_1, P_2, P_3: protection bits (see Table 3)

MSB: most significant bit

Table 1 defines the state of the V and F bits.

TABLE 3

Protection bits in the timing reference signal

F	V	H	P_3	P_2	P_1	P_0
0	0	0	0	0	0	0
0	0	1	1	1	0	1
0	1	0	1	0	1	1
0	1	1	0	1	1	0
1	0	0	0	1	1	1
1	0	1	1	0	1	0
1	1	0	1	1	0	0
1	1	1	0	0	0	1

PART 2

Bit-parallel interface

1. General

The 10-bit video data for each link is transferred across the interfaces on ten parallel data pairs together with a clock signal on an eleventh pair.

The signals on the interface are transmitted using balanced conductor pairs. Cable lengths of up to 50 m (≈ 160 feet) without equalization and up to 200 m (≈ 650 feet) with appropriate equalization may be employed.

Each interconnection employs a twenty-five pin D-subminiature connector equipped with a locking mechanism (§ 5).

Video data is transmitted in NRZ form in real time (unbuffered) in blocks, each comprising one active television line.

2. Data signal format

The interface carries data in the form of 10 parallel data bits and a separate synchronous clock. Data is coded in NRZ form. The recommended data format is described in Part 1.

3. Link-to-link timing relationship*

The clock transitions for the two links shall lie within 10 ns of each other at the receiver.

4. Clock signal

4.1 General

The clock signal is a 27 MHz square wave where the 0-1 transition represents the data transfer time. This signal has the following characteristics:

Width: 18.5 ± 3 ns

Jitter: Less than 3 ns from the average period over one field.

4.2 Clock-to-data timing relationship

The positive transition of the clock shall occur midway between data transitions as shown in Fig. 3.

5. Electrical characteristics of the interface

5.1 General

Each line driver (source) has a balanced output and the corresponding line receiver (destination) a balanced input (see Fig. 4).

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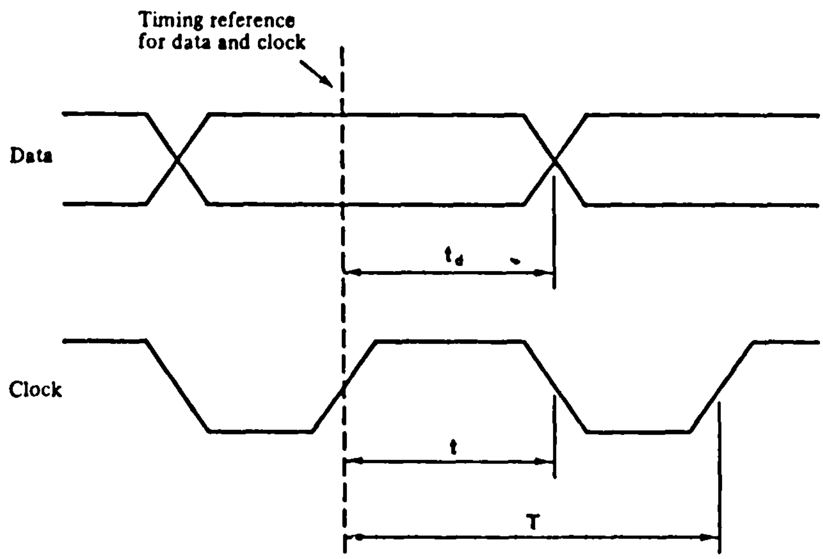
* Where the data receiver incorporates buffering to achieve synchronism between incoming data and an internal reference or between sets of incoming data, this tolerance can be relaxed. However, it is anticipated that a common clock will be used in the sending equipment for both links, so that achieving this tolerance should present little difficulty.

Although the use of ECL technology is not specified, the line driver and receiver must be ECL-compatible, i.e. they must permit the use of ECL for either drivers or receivers.

All digital signal time intervals are measured between the half-amplitude points.

FIGURE 3

Clock-to-data timing (at source)



Clock period (625): $T = \frac{1}{1\,728\, f_H} = 37$ ns

Clock period (525): $T = \frac{1}{1\,716\, f_H} = 37$ ns

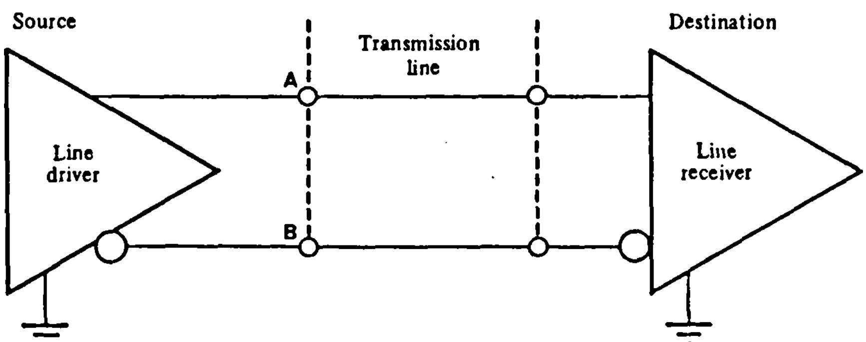
Clock pulse width: $t = 18.5 \pm 3$ ns

Data timing – sending end: $t_d = 18.5 \pm 3$ ns

f_H: line frequency

FIGURE 4

Line driver and line receiver interconnection



5.2 *Logic convention*

The A terminal of the line driver is positive with respect to the B terminal for a binary 1 and negative for a binary 0 (see Fig. 4).

5.3 ***Line driver characteristics*** (source)

5.3.1 ***Output impedance:*** 110 Ω maximum.

5.3.2 ***Common mode voltage:*** −1.29 V ± 15% (both terminals relative to ground).

5.3.3 ***Signal amplitude:*** 0.8 to 2.0 V peak-to-peak, measured across a 110 Ω resistive load.

5.3.4 ***Rise and fall times:*** less than 5 ns, measured between the 20% and 80% amplitude points, with a 110 Ω resistive load. The difference between rise and fall times must not exceed 2 ns.

5.4 ***Line receiver characteristics*** (destination)

5.4.1 ***Input impedance:*** 110 Ω ± 10 Ω.

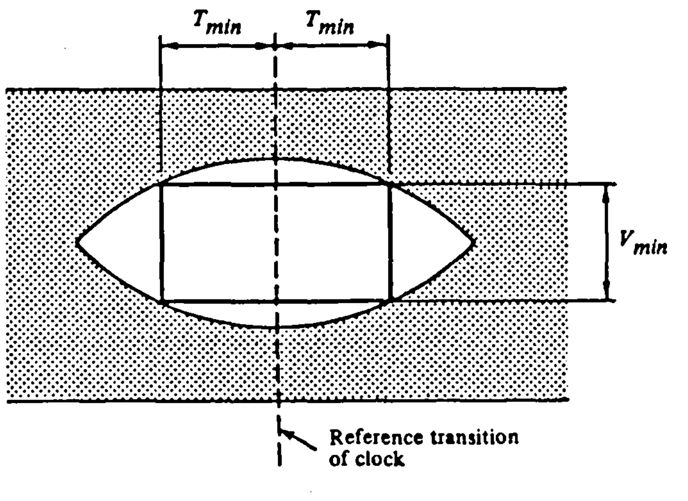
5.4.2 ***Maximum input signal:*** 2.0 V peak-to-peak.

5.4.3 ***Minimum input signal:*** 185 mV peak-to-peak.

However, the line receiver must sense correctly the binary data when a random data signal produces the conditions represented by the eye diagram in Fig. 5 at the data detection point.

FIGURE 5

Idealized eye diagram corresponding to the minimum input signal level



T_{min} = 11 ns

V_{min} = 100 mV

Note 1 – The width of the window in the eye diagram, within which data must be correctly detected comprises ±3 ns clock jitter, ±3 ns data timing (see § 4.2), and ±5 ns available for differences in delay between pairs of the cable. (See also Recommendation 803.)

5.4.4 *Maximum common mode signal:* ±0.5 V, comprising interference in the range 0 to 15 kHz (both terminals to ground).

5.4.5 *Differential delay:* Data must be correctly sensed when the clock-to-data differential delay is in the range between ±11 ns (see Fig. 5).

6. Mechanical details of the connectors

The interface uses the 25 contact type D subminiature connector specified in ISO Document 2110-1980, with the contact assignment shown in Table 4.

Connectors are locked together by a one-piece slide lock on the cable connectors and locking posts on the equipment connectors. Cable connectors employ pin contacts and equipment connectors employ socket contacts. Shielding of the interconnecting cable and its connectors must be employed (see Note 1).

Note 1 – It should be noted that the ninth and eighteenth harmonics of the 13.5 MHz sampling frequency (nominal value) specified in Recommendation 601 fall at the 121.5 and 243 MHz aeronautical emergency channels. Appropriate precautions must therefore be taken in the design and operation of interfaces to ensure that no interference is caused at these frequencies. Emission levels for related equipment are given in CISPR Recommendation: "Information technology equipment – Limits of interference and measuring methods" Document CISPR/B (Central Office) 16. Nevertheless, No. 964 of the Radio Regulations prohibits any harmful interference on the emergency frequencies (see also Recommendation 803).

TABLE 4

Contact assignments

Contact	Signal line
1	Clock
2	System ground A
3	Data 9 (MSB)
4	Data 8
5	Data 7
6	Data 6
7	Data 5
8	Data 4
9	Data 3
10	Data 2
11	Data 1
12	Data 0
13	Cable shield
14	Clock return
15	System ground B
16	Data 9 return
17	Data 8 return
18	Data 7 return
19	Data 6 return
20	Data 5 return
21	Data 4 return
22	Data 3 return
23	Data 2 return
24	Data 1 return
25	Data 0 return

Note 1 – The cable shield (contact 13) is for the purpose of controlling electromagnetic radiation from the cable. It is recommended that contact 13 should provide high-frequency continuity to the chassis ground at both ends and, in addition, provide d.c. continuity to the chassis ground at the sending end (see also Recommendation 803).

PART 3

Bit-serial interface

1. General

The multiplexed data stream of 10-bit words (as described in Part 1) is transmitted over a single channel in bit-serial form. Prior to transmission, additional coding takes place to provide spectral shaping, word synchronization and to facilitate clock recovery.

The 10-bit data for each link is transferred across the interface as a serial data-stream in unbalanced form and at an impedance of 75 Ω.

2. Link-to-link timing relationship*

The interface must operate correctly when the electrical lengths of the two interconnections between line sender and receiver differ by up to 10 ns.

3. Coding

The uncoded serial bit-stream is scrambled using the generator polynomial $G1(x) \cdot G2(x)$, where

$G1(x) = x^9 + x^4 + 1$ to produce a scrambled NRZ signal, and

$G2(x) = x + 1$ to produce a polarity-free NRZI sequence.

4. Order of transmission

The least significant bit of each 10-bit word shall be transmitted first.

5. Logic convention

The signal is transmitted in NRZI form, for which the bit polarity is irrelevant.

6. Transmission medium

The bit-serial data-stream can be conveyed using either a coaxial cable (§ 7) or fibre optic bearer (§ 8).

7. Characteristics of the electrical interface

7.1 *Line driver characteristics* (source)

7.1.1 *Output impedance*

The line driver has an unbalanced output with a source impedance of 75 Ω and a return loss of at least 15 dB over a frequency range of 10-270 MHz.

7.1.2 *Signal amplitude*

The peak-to-peak signal amplitude lies between 800 mV ± 10% measured across a 75 Ω resistive load directly connected to the output terminals without any transmission line.

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* Where the data receiver incorporates buffering to achieve synchronism between incoming data and an internal reference or between sets of incoming data, this tolerance can be relaxed. However, it is anticipated that a common clock will be used in the sending equipment for both links, so that achieving this tolerance should present little difficulty.

7.1.3 *DC offset*

The DC offset with reference to the mid amplitude point of the signal lies between +0.5 and −0.5V.

7.1.4 *Rise and fall times*

The rise and fall times, determined between the 20% and 80% amplitude points and measured across a 75 Ω resistive load connected directly to the output terminals, shall lie between 0.75 and 1.50 ns and shall not differ by more than 0.50 ns.

7.1.5 *Jitter*

The timing of the rising edges of the data signal shall be between ±10% of the clock period, as determined over a period of one line.

7.2 ***Line receiver characteristics*** (destination)

7.2.1 ***Terminating impedance***

The cable is terminated by 75 Ω with a return loss of at least 15 dB over a frequency range of 10 to 270 Hz.

7.2.2 ***Receiver sensitivity***

The line receiver must sense correctly random binary data either when connected directly to a line driver operating at the extreme voltage limits permitted by § 7.1.2, or when connected via a cable having a loss of 40 dB at 270 MHz and a loss characteristic of $1/\sqrt{f}$.

Over the loss range 0-12 dB no equalization adjustment is required; beyond this range adjustment is permitted.

7.2.3 ***Interference rejection***

When connected directly to a line driver operating at the lower limit specified in § 7.1.2, the line receiver must correctly sence the binary data in the presence of a superimposed interfering signal at the following levels:

d.c.	±2.5 V
below 1 kHz:	2.5 V peak-to-peak
1 kHz to 5 MHz:	100 mV peak-to-peak
Above 5 MHz:	40 mV peak-to-peak.

7.3 ***Cables and connectors***

7.3.1 ***Cable***

It is recommended that the cable chosen should meet any relevant national standards on electromagnetic radiation.

Note 1 – It should be noted that the ninth and eighteenth harmonics of the 13.5 MHz sampling frequency (nominal value) specified in Recommendation 601 fall at the 121.5 and 243 MHz aeronautical emergency channels. Appropriate precautions must therefore be taken in the design and operation of interfaces to ensure that no interference is caused at these frequencies. Emission levels for related equipment are given in CISPR Recommendation: "Information technology equipment – Limits of interference and measuring methods" (Document CISPR/B (Central Office) 16). Nevertheless, No. 964 of the Radio Regulations prohibits any harmful interference on the emergency frequencies (see also Recommendation 803).

7.3.2 ***Characteristic impedance***

The cable used shall have a nominal characteristic impedance of 75 Ω.

7.3.3 Connector characteristics

The connector shall have mechanical characteristics conforming to the standard BNC type (IEC Publication 169-8 (1978)), and its electrical characteristics should permit it to be used at frequencies up to 500 MHz in 75 Ω circuits.

8. Characteristics of the optical interface

To be defined (see Annex 1).

ANNEX 1

Notes concerning interfaces for digital video signals in 525-line and 625-line television systems

1. Introduction

This Annex includes supplementary information on subjects not yet fully specified, and indicates studies in which further work is required.

2. Definitions

Interface is a concept involving the specification of the interconnection between two items of equipment or systems. The specification includes the type, quantity and function of the interconnection circuits and the type and form of the signals to be interchanged by these circuits.

A parallel interface is an interface in which the bits of a data word are sent simultaneously via separate channels.

A serial interface is an interface in which the bits of a data word, and successive data words, are sent consecutively via a single channel.

3. Ancillary data signals

3.1 Introduction

The specification for ancillary data signals in § 2.5 of Recommendation 656 covers only the parameters essential for the proper operation of the interface, i.e. preamble and location suitable for ancillary data signals. This section deals with additional format specifications that will be necessary for practical operation, together with a review of some projected applications.

3.2 Ancillary data signals format specifications

Mechanisms are being studied for both 8-bit and 10-bit ancillary data signals. They include procedures to spread long messages of linked sub-messages, and error detection and protection processes.

3.2.1 8-bit ancillary data signals

Studies held within the EBU have resulted in the reservation of lines 20 and 333 (625-line television systems) for equipment and self-checking purposes, and in the specification of the insertion mechanism as follows:

All ancillary data signals carried during the active portions of lines in the field-blanking period must be preceded by the preamble:

00.x FF.x FF.x ZZ.x

When ZZ has the value 15_h ((8,4) Hamming-coded form of D9-D6 set to 0000) this indicates that there are no further ancillary data signals on that line. Any value of ZZ other than 15_h must be interpreted as indicating the presence of an ancillary signal immediately following the preamble.

The insertion of an ancillary data signal must result in the change of ZZ from 15_h and must be accompanied by the insertion, immediately after the inserted data of the preamble 00.x FF.x FF.x 15.x to indicate that the remainder of the line is available for the insertion of further ancillary signals.

Further consideration is being given to a five-word header to follow the preamble:

Data type:	TT_1 TT_2 TT_3	3 words (4 bits Hamming (8,4) coded)
Data length:	LL_1 LL_2	2 words (4 bits Hamming (8,4) coded)

Except for the preamble, all data are protected by a (8,4) Hamming code.

3.2.2 10-bit ancillary data signals

Consideration is being given (on the basis of studies conducted by the SMPTE) to a three-word header to follow the preamble:

Data identification (ID):	DID	1 word (8 bits + even and odd parity bits)
Data block number:	DBN	1 word (8 bits + even and odd parity bits)
Data count:	DC	1 word (8 bits + even and odd parity bits)

A checksum word is added at the end of the message.

3.3 Survey of applications based on ancillary data signals

3.3.1 Time code

Studies are in progress within the SMPTE to specify a time code carried by a signal called digital vertical interval time code (DVITC), that makes use of all the luminance data of one active line. The values chosen for these luminance data are specified in order that the D/A luminance waveform of the line fits in with the analogue waveform of a vertical interval time code signal.

3.3.2 Digital audio

Work is in progress within the SMPTE in order to specify the transport of up to 4 channels of 20-bit digital audio AES/EBU on a scrambled serial digital video interface at 270 Mbit/s. This transport mechanism is based on the use of 10-bit ancillary data signals. Work is in progress in order to support the optional additional 4 bits of the AES/EBU multiplex.

3.3.3 Monitoring and diagnostics

Studies are being conducted by the SMPTE in order to monitor the good operation of 10-bit digital video interfaces by generating error detection check-words and status flags, and by checking the validity of the check-words after transmission. The insertion of check-words and status flags is based on the draft format of 10-bit ancillary data signals.

3.3.4 Other applications

Other applications are being considered, including Teletext, programme production and technical operation.

In addition, there exists detailed specifications covering panning information data in MAC/packet and HD-MAC/packet systems, and the digital assistance (DA) data in HD-MAC/packet systems.

4. Parallel interfaces

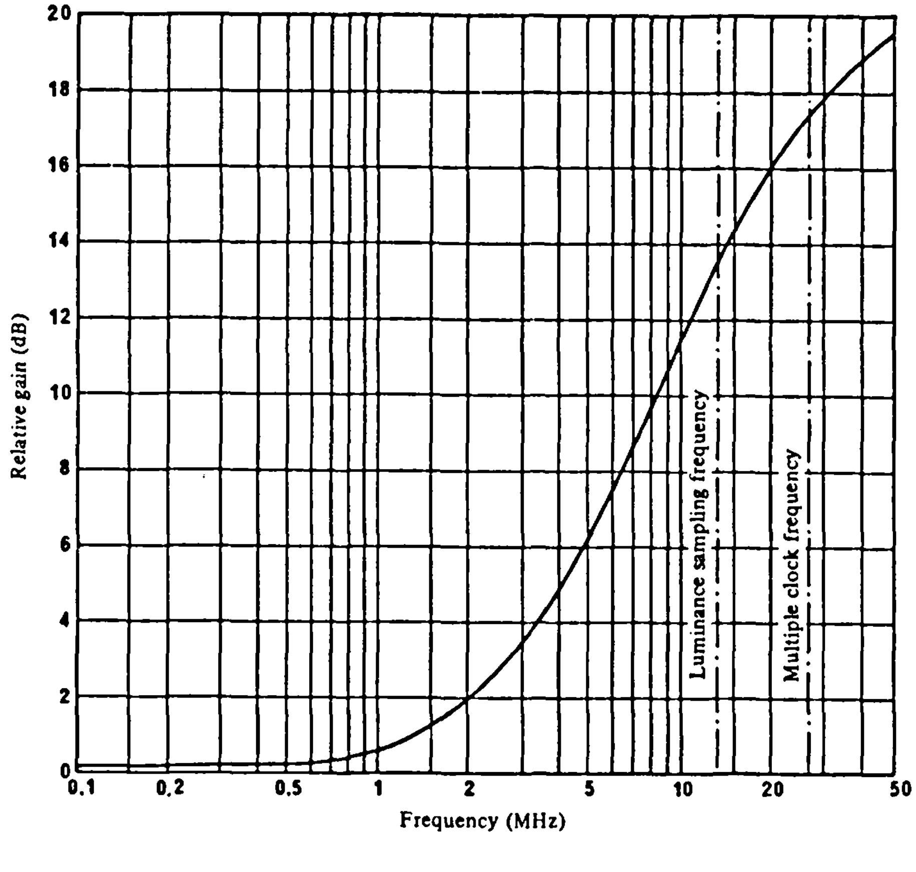
Appropriate coding of the clock signal, such as the use of an alternating parity (AP) coding, has been shown to extend the interconnection distance by reducing the effects of cable attenuation.

To permit correct operation with longer interconnection links, the line receiver may incorporate equalization.

When equalization is used, it may conform to the nominal characteristics of Fig. 6. This characteristic permits operation with a range of cable lengths down to zero. The line receiver must satisfy the maximum input signal condition of § 4.4 of Part 2 of Recommendation 656.

FIGURE 6

Line receiver equalization characteristic for small signals



5. Serial interfaces

The transmission of signals can be achieved in both electrical form, using coaxial cable, and in optical form using an optical fibre. Coaxial cables would probably be preferred for connections of medium length, while preference would go to optical fibres for very long connection lengths.

It is possible to implement a system for measuring the bit error ratio (BER) at the receiving end of the connection and thus automatically monitoring its performance.

In a fully integrated digital installation or system it may be useful for all interconnections to be transparent to any appropriate digital stream, irrespective of the message content. Thus, although the interface will be used to transmit a video signal, it should be "transparent" to the message content, i.e. it should not base its operation on the known structure of the message itself.

6. Optical interfaces

The need for specifications for optical interfaces has been recognized, and several approaches are currently under study. These include multi-mode fibre systems, monomode carrying a single signal or time division multiplexed signals (TDM), and also wavelength division multiplexes (WDM). The following is a tentative specification for a single-signal monomode system.

6.1 Source characteristics

6.1.1 Output wavelength

1300 nm nominal.

Maximum spectral line width 150 nm between half power points.

6.1.2 Output power

Maximum: 0 dBm.

Minimum: –25 dBm.

6.1.3 Logic convention

Maximum power output corresponds to the signalling of a logical 1.

6.1.4 Rise and fall times

To be decided.

6.1.5 Jitter

To be decided.

6.1.6 Isolation

Transmitter must withstand 10% of its output power returned by reflection.

6.2 Optical fibre link

FIBRE (compatible with optical fibre specified in CCITT Recommendation G.652)

Fibre type	– single mode
Dimensions: mode field dia.	– 9-10 μm ± 10%
cladding	– 125 μm
Operating window	– around 1300 nm
Mode field concentricity	– <3 μm
Cladding non circularity	– <2%
Cut-off wave length	– 1100-1280 nm
Attenuation at 1300 nm	– <1 dB/km
Maximum dispersion (1270-1340 nm)	– 6 ps/nm · km
CONNECTOR	
Type	– biconical

6.3 Destination characteristics

6.3.1 Sensitivity

Input power for a mean bit error ratio of 1 in 10^9: –35 dBm.

Maximum input power: –20 dBm.

6.3.2 *Maximum input power*

Receiver shall operate with a mean bit error ratio better than 1 in 10^9 up to a power level of –20 dBm.

7. Interference with other services

Processing and transmission of digital data, such as digital video signals at high data rates produces a wide spectrum of energy that has the potential to cause cross-talk or interference. In particular, attention is drawn in Recommendation 656 to the fact that the ninth and eighteenth harmonics of the 13.5 MHz sampling frequency (nominal value) specified in Recommendation 601 fall at the 121.5 and 243 MHz aeronautical emergency channels. Appropriate precautions must therefore be taken in the design and operation of interfaces to ensure that no interference is caused at these frequencies. Permitted maximum levels of radiated signals from digital data processing equipment are the subject of various national and international standards, and it should be noted that emission levels for such related equipment are given in CISPR Recommendation: "Information technology equipment – Limits of interference and measuring methods" Document CISPR/B (Central Office) 16.

In the case of the bit-parallel interface, work carried out by the Canadian Broadcasting Corporation (CBC) indicates that, with a correct shielding of the cables, no interference problem with other services is to be expected. Radiation levels should comply with the limits given in Table 5. These limits are equivalent to those of the FCC in the United States of America.

TABLE 5

Limits of spurious emissions (CSA Class A)

Frequency (MHz)	Maximum field strength at 30 m (dB(μV/m))
30-88	30
88-216	50
216-1 000	70

Transmission by optical fibres eliminates radiation generated by the cable and also prevents conducted common-mode radiation, but the performance of coaxial cable can also be made near-perfect. It is believed that the major portion of any radiation would be from the processing logic and high-power drivers common to both methods. Due to the wideband, random nature of the digital signal, little is gained by frequency optimization.

8. Conclusion

Further studies are required:

- to establish the types of ancillary signals to be carried, including their characterization and location in the data stream, and to propose international standards as necessary;
- on the practical methods required to ensure acceptably low levels of radiated interference from the digital signals;
- on optical interfaces for bit-serial signals.