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IS 12429-2 (1988): Time and control code for video tape recorders, Part 2: Vertical-Interval Time Code (VITC) [LITD 7: Audio, Video and Multimedia Systems and Equipment]

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Indian Standard

TIME AND CONTROL CODE FOR VIDEO TAPE RECORDER

PART 2 VERTICAL-INTERVAL TIME CODE (VITC)

Recording Sectional Committee, LTDC 23; Panel for Video Recording and Reproduction Systems, LTDC 23 : P3 [Ref : Doc : LTDC 23 (1238)]

0. Foreword

0.1 This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards on 22 February 1988 on the recommendations of the Recording Sectional Committee and approved by the Electronics and Telecommunication Division Council.

0.2 While preparing this standard, assistance has been derived from IEC Pub 461 'Time and control code for video tape recorders', issued by the International Electrotechnical Commission.

0.3 In reporting the result of a test made in acccordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. Scope

1.1 This standard (Part 2) specifies the format and modulation method to be employed when using the vertical-interval time-and-control code for timing and control purposes on television tape-machines for recordings made in accordance with the 625-lines/50-fields television system.

It also specifies the location of the code within the television signal and its relationship to the longitudinal time-and-control code for television tape recordings defined in Part 1. This standard is applicable for 50 Hz 625 lines system.

2. Terminology

2.1 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part 48)-1978†. shall apply.

3. Modulation Method and Bit-Rate

3.1 *Type of Code* — The modulation method shall be such that each state of the signal corresponds to a binary state and a transition occurs only when there is a change in the data contained in adjacent bit cells. No transition shall occur when adjacent bit cells contain the same data. This system, commonly known as 'non-return to zero' level (NRZ), is illustrated in Fig. 1.

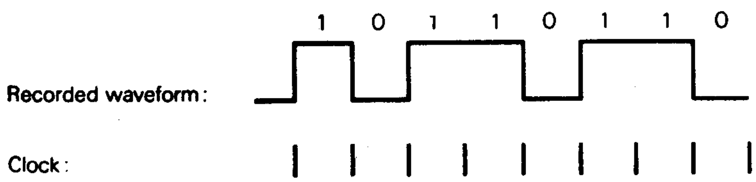

FIG. 1 MODULATION SYSTEM 'NON-RETURN TO ZERO'

3.2 *Bit-Rate* — The bit-rate F_0 shall be as follows:

$$F_0 = F_h \times 116 \pm 200 \text{ bits/s}$$

where F_h is the line frequency.

*Rules for rounding off numerical values (*revised*).
†Electrotechnical vocabulary : Part 48 Recording.

Adopted 22 February 1988 | © March 1990, BIS | Gr 4

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4. Code Format

4.1 *Rate of Change of the Code Word* — Each television frame, comprising an odd-numbered field followed by an even-numbered field*, shall be identified by a complete code word. A code word shall also include a field identification as specified in **5.5.1** (field-mark bit).

4.2 *Composition of the Code Word* — Each code word shall consist of 90 bits, numbered 0 to 89 inclusive.

4.3 *Bit Assignment* — The bits shall be assigned as described below. Their relationship to the longitudinal time-and-control code, as specified in Part 1 is shown in Fig. 2.

0- 1	Sync. bits	0 : fixed one;	1 : fixed zero
2- 5	Units of frames		
6- 9	First binary group		
10-11	Sync. bits	10 : fixed one;	11 : fixed zero
12-13	Tens of frames		
14	Unassigned bit (*see* **5.6**)		
15	Colour lock flag bit (*see* **5.4**)		
16-19	Second binary group		
20-21	Sync. bits	20 : fixed one;	21 : fixed zero
22-25	Units of seconds		
26-29	Third binary group		
30-31	Sync. bits	30 : fixed one;	31 : fixed zero
32-34	Tens of seconds		
35	Binary group flag bit (*see* **5.3.1**)		
36-39	Fourth binary group		
40-41	Sync. bits	40 : fixed one;	41 : fixed zero
42-45	Units of minutes		
46-49	Fifth binary group		
50-51	Sync. bits	50 : fixed one;	51 : fixed zero
52-54	Tens of minutes		
	Binary group flag bit (*see* **5.3.1**)		
56-59	Sixth binary group		
60-61	Sync. bits	60 : fixed one;	61 : fixed zero
62-65	Units of hours		
66-69	Seventh binary group		
70-71	Sync. bits		
72-73	Tens of hours	70 : fixed one;	71 : fixed zero
74	Unassigned bit (*see* **5.6**)		
75	Field mark bit (*see* **5.5**)		
76-79	Eighth binary group		
80-81	Sync. bits	80 : fixed one;	81 : fixed zero
82-89	Cyclic redundancy check group (*see* **4.4**)		

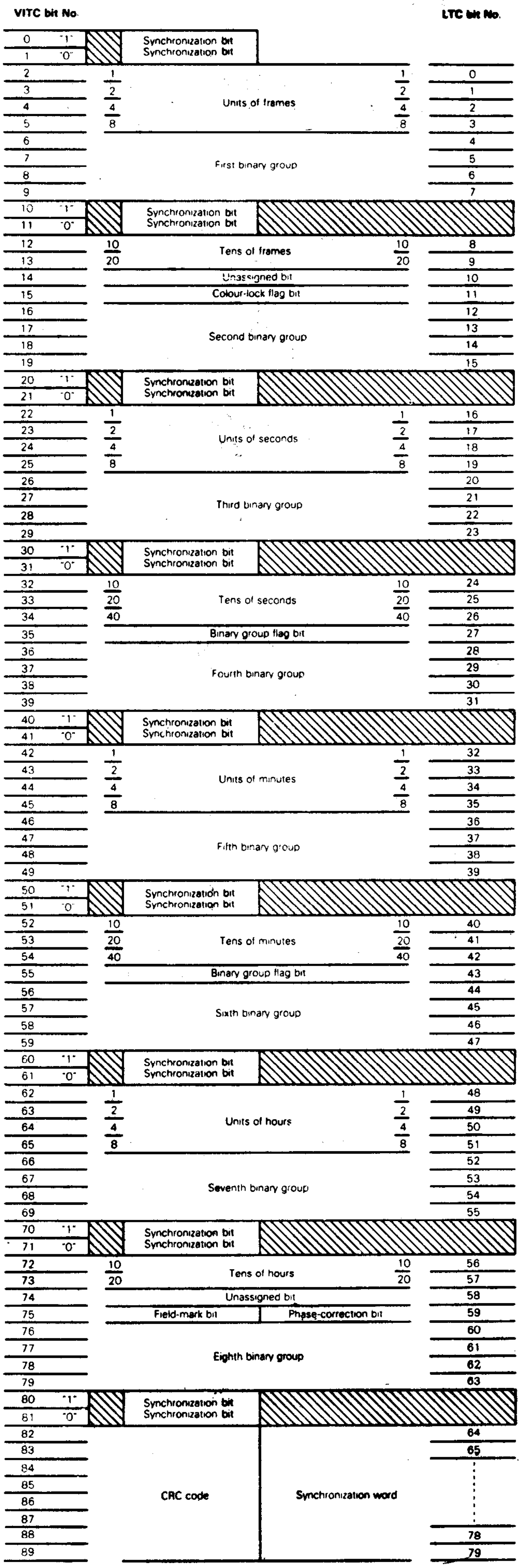
4.4 *Cyclic Redundancy Check* — Eight bits, 82 to 89, are set aside at the end of the code word for error detection by means of cyclic redundancy checking. The generating polynominal of the cyclic redundancy check $G(X)$ will be applied to all bits from 0 to 81 inclusive and shall be as follows:

$$G(X) = X^8 + 1$$

The data information (bits 0 to 81) is represented by a polynomial which is divided by $G(X)$. The division is made according to the laws of the division of the polynomials whose coefficients are elements of the group of two elements (0 and 1). The remainder of the division is added to the product of the polynomial representing the data information (bits 0 to 81) by polynomial X^8, to form the polynomial representing the recorded information (bit 0 to 89). In reply, the division of this last polynomial by $G(X)$ will lead to a zero remainder, unless errors exist in the total data block (CRC based on 'all zeros' remainder system).

Note — An explanation of cyclic redundancy checking in the case of 'all zeros' remainder and generating polynomial of the form of $X^n + 1$ is given in Appendix A.

*Odd-numbered fields : (fields 1, 3, 5, 7)
Even-numbered fields : (fields 2, 4, 6, 8)



90 bits per frame:

32 user binary spare bits
18 sync. bits
30 address bits
2 unassigned bits
8 CRC code bits
All unassigned bits are zeros.

FIG. 2 RELATIONSHIP BETWEEN VERTICAL-INTERVAL TIME CODE AND LONGITUDINAL TIME CODE FOR 625/50 SYSTEM

5. Structure of the Coded Data

5.1 *Structure of the Time Label** — The basic structure of the time label is based upon the binary coded decimal (BCD) system. In those cases where the count does not attain 9, only two or three bits are required, rather than four bits as is normal in the BCD code.

5.2 *Assignment of the Time Bits**

Frames

Units Bits 2- 5 : four-bit BCD arranged 1, 2, 4, 8 count 0 to 9.

Tens Bits 12-13 : two-bit BCD arranged 1, 2 count 0 to 2.

Seconds

Units Bits 22-25 : four-bit BCD arranged 1, 2, 4, 8 count 0 to 9,

Tens Bits 32-34 : three-bit BCD arranged 1, 2, 4 count 0 to 5.

Minutes

Units Bits 42-45 : four-bit BCD arranged 1, 2, 4, 8 count 0 to 9.

Tens Bits 52-54 : three-bit BCD arranged 1, 2, 4 count 0 to 5.

Hours

Units Bits 62-65 : four-bit BCD arranged 1, 2, 4, 8 count 0 to 9.

Tens Bits 72-73 : two-bit BCD arranged 1, 2 count 0 to 2.

(The 24-hour clock system is used).

5.3 *Use of Binary Groups**

5.3.1 The binary groups are intended for the storage of supplementary data by the users. The 32 bits within the eight binary groups may be assigned in any way without restrictions if the character set used for the data insertion is not specified and the binary group flag bits No. 35 and 55, both are zero. However, the binary group data contents of the two code words assigned to one picture should be identical.

If an eight-bit character set conforming to ISO Standards 646 and 2022 is signalled by the binary group flag bits No. 35 and 55, the characters should be inserted in accordance with Fig. 3. The information carried by the user bits is not subjected to any regulation.

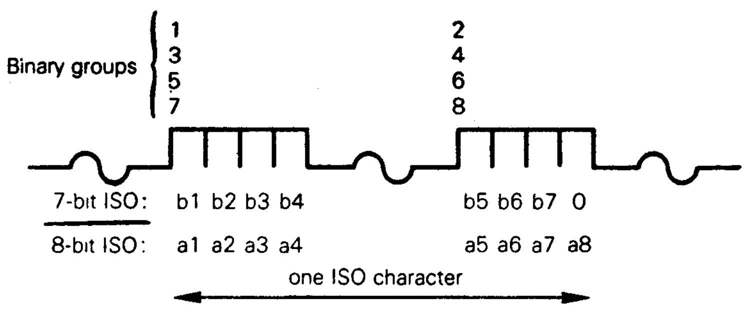


FIG. 3 USE OF BINARY GROUPS OF THE TIME-AND-CONTROL CODE TO DESCRIBE THE ISO CHARACTERS CODED WITH 7 OR 8 BITS

At present, the following truth-table applies:

	Bit 35 (55)
Character set not specified	0
Eight-bit character set conforming to ISO Standards 646 and 2022	1
Unassigned	0
Unassigned	1

The unassigned states of the truth-table cannot be used and their assignment is reserved to the International Electrotechincal Commission.

*These points are identical in both the longitudinal and vertical-interval time codes, with the exception of the bit numbers which are different in the two codes.

It should be noted that, in each time code word, some user bits will be decoded before bits No. 35 and 55 are encountered. The data in these earlier user-bit locations must not be lost.

Note — The International Standard ISO 646 defines two 7-bit Latin character code tables:

a) the basic code table with control and alpha-numerical characters including punctuation marks, ten free positions for national use and some positions with more than one graphic symbol

b) the international reference version (referred to as IRV), where the national positions are filled and a choice is made where more than one graphic symbol is shown in the basic code table.

The International Standard ISO 2022 gives code extension techniques from the 7-bit code of ISO 646 to 8-bit codes, based on the use of the 'escape' command of the basic code table of ISO Standard 646. With character-combinations following the 'escape' command, access is given to a library of centrally registered character sets. This library consists of national character sets like the American ASCII although versions for special (for example broadcast) applications may also be included and registered. This central registration is done by the French national standardization office (AFNOR).

5.4 *Colour-Lock Signalisation*

5.4.1 The colour-lock flag bit No. 15, shall be set to 1 when the time-code is locked to the associated PAL colour signal in accordance with the eight-field sequence and when the video signal has the 'preferred subcarrier-to-line-sync. phase. The definition of field 1 in the eight-field sequence of the PAL signal is described in Appendix B.

5.5 *Field Mark Bit*

5.5.1 The field-mark bit No. 75, shall be set to 1 during fields, 2, 4, 6 and 8, and to 0 during fields 1, 3, 5 and 7. The field-mark bit enables a VITC decoder to identify odd and even numbered fields without reference to the field synchronizing signal.

5.6 *Unassigned Bits**

5.6.1 Bits No. 14 and 74 are reserved for future assignment and shall be zeros until specified by the IEC.

6. Relationship Between the Vertical-Interval Time Code and the Television Signals Prior to Recording

6.1 *Association of Code Words and Television Fields* — Each code word is associated with the particular television field at the beginning of which it is generated. It is an important operational requirement that decoding delays are compensated, where possible, so as not to corrupt the production and post-production process.

6.2 *Timing of the Code Word*

6.2.1 *Duration of the code word*

6.2.1.1 The code word starts at the leading edge of the first synchronizing bit (bit 0). The 90 bits shall be evenly spaced and, nominally, shall occupy 49·655 μs of the television line (*see* Fig. 4).

6.2.2 *The position of the code word on the line* — It is important that the data signal does not corrupt the line-blanking interval of the video signal. For this reason, the half-amplitude point of the leading edge of the first data bit shall not occur earlier than 625/50 : 11·2 μs after the half-amplitude point of the leading edge of the line synchronizing pulse. Likewise, if the last data bit in the code word is a 1, the half-amplitude point of its trailing edge shall occur not later than 625/50 : 1·9 μs before the half-amplitude point of the leading edge of the following line synchronizing pulse. Hence 625/50 : 50·9 μs of the available unblanked line may contain the code word (*see* Fig. 4).

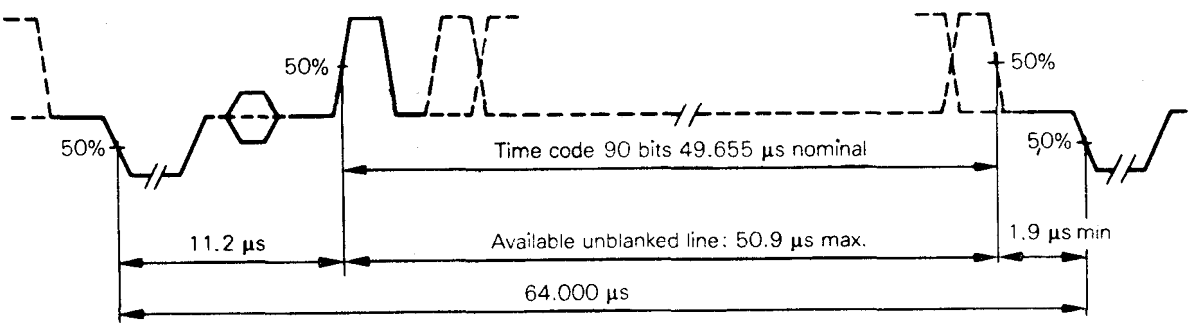


FIG. 4 POSITION OF THE CODE WORD ON THE LINE (625/50)

*These points are identical in both the longitudinal and vertical-interval time codes with the exception of the bit numbers which are different in the two codes.

6.2.3 *The position of the code word in the field-blanking interval* — There is no need to precisely define the position of the VITC word in the field-blanking interval. It is recommended, however, that each broadcaster selects the position of the VITC words in the vertical interval as required, taking notice of the following points:

a) In order to protect the VITC reading process against drop-outs, the VITC word shall be repeated on two non-adjacent available lines in the vertical interval of the recorded video signal, but not earlier than : line 6 (319) or later than line 22 (335). It must be kept in mind that for certain recordings, the use of some of these lines might interfere with other signals inserted in the field-blanking interval of a television signal and that in SECAM lines 7 to 15 (320 to 328) are occupied by field-identification signals.

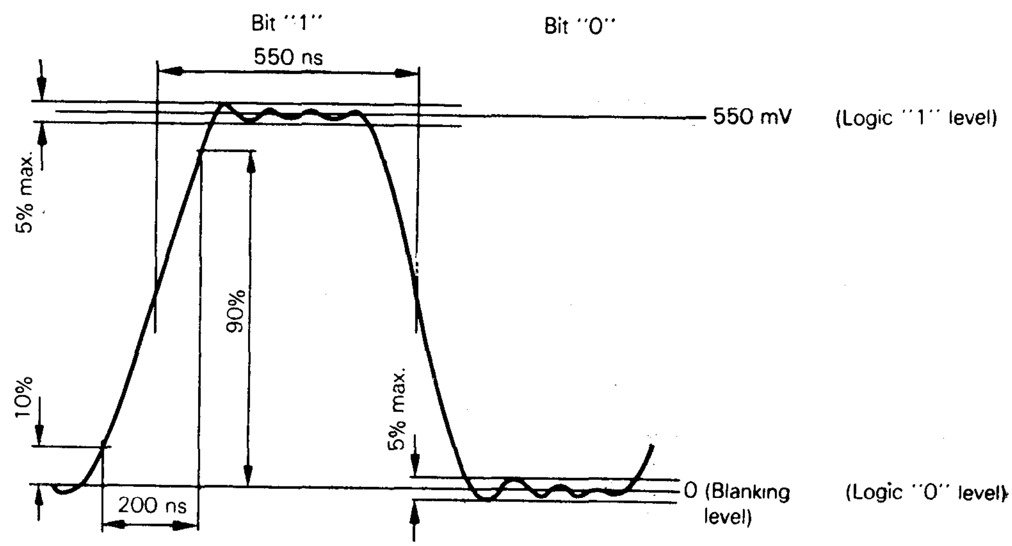
b) To avoid decoding errors which may arise in the presence of skew, an adequate margin should be allowed between the video head switching points and the recorded VITC words.

6.3 *Relationship Between the Time Address and the Associated Colour Television Signal* — This specification is identical to **6.2** of Part 1 : Longitudinal time code (LTC).

7. Specifications of the Characteristics of the VITC Signal Prior to Recording

7.1 *Prefiltering the Data Signal Prior to its Addition to the Video Signal* — To avoid distortion of higher-order harmonics of the VITC signal by the chrominance circuits of some types of equipment, the data signal should be lowpass filtered before it is added to the video signal. The transient response of the filter should be such that the data signal meets the overshoot and rise time specified in **7.2**.

7.2 *Waveform of the VITC Signal* — The data signal added to the video signal should conform to the following specifications in Fig. 5:



Data amplitude: logic "0":	blanking level
Data amplitude: logic "1":	+ 550 ± 50 mV with respect to blanking level
Clock period:	0·55 μs approx. (*see* **3.2**)
Rise and fall times of data transitions:	200 ± 50 ns
Maximum overshoot/undershoot:	5 percent of peak-to-peak amplitude

FIG. 5 WAVEFORM OF THE CODE SIGNAL

APPENDIX A

(*Clause* 4.4)

THE USE OF CYCLIC REDUNDANCY CHECK CODES FOR ERROR DETECTION

Fundamentally the encoding of a cyclic redundancy code (CRC) is equivalent to dividing the information data, in this case the VITC signal, interpreted as a binary number by some other binary number (divisor), and appending the result to the data block. The new binary number so obtained is an exact multiple of the divisor so that if the division is repeated a zero remainder will result, unless errors exist in the total data block. It is possible that multiple errors will also result in a zero remainder and the choice of the divisor is important in reducing the likelihood of this occurrence, bearing in mind the way errors may be introduced.

The division is not an exact arithmetic process since, for example, carry terms are ignored (we make $1 + 1 = 0$), but it is sufficiently analogous to be interpreted as a polynomial division with powers of x representing positions in a binary sequence where the coefficients are 0 or 1. Thus the polynomial used in the VITC encoding scheme $x^8 + 1$ is equivalent to 100000001. If the information data is also represented as a polynomial, then performing a modified algebraic division will provide the required remainder.

For example, consider data sequence 10101101 divided by 10001, expressing both as polynomials, leads to:

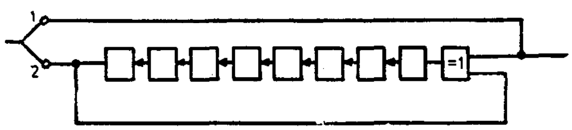
$$
\begin{array}{rl}
 & x^3 + x \\
x^4 + 1 \,\big) & x^7 + x^5 + x^3 + x^2 + 1 \\
 & \underline{x^7 + x^3} \\
 & x^5 + x^2 + 1 \\
 & \underline{x^5 + x} \quad \leftarrow \text{subtraction is interpreted as addition without borrowing} \\
 & x^2 + x + 1 \quad \leftarrow \text{remainder}
\end{array}
$$

The remainder is then 0111. Appending this to the data sequence gives 101011010111 which as a polynomial is $x^{11} + x^9 + x^7 + x^6 + x^4 + x^2 + x + 1$.

Division of this polynomial by $x^4 + 1$ gives.

$$
\begin{array}{rl}
 & x^7 + x^5 + x^2 + x + 1 \\
x^4 + 1 \,\big) & x^{11} + x^9 + x^7 + x^6 \quad x^4 + x^2 + x + 1 \\
 & \underline{x^{11} \quad x^7} \\
 & x^9 + x^5 + x^4 + x^2 + x + 1 \\
 & \underline{x^9 + x^5} \\
 & x^6 + x^5 + x^4 + x^2 + x + 1 \\
 & \underline{x^6 + x^2} \\
 & x^5 + x^4 + x + 1 \\
 & \underline{x^5 + x} \\
 & x^4 + 1 \\
 & \underline{x^4 + 1} \\
 & \leftarrow \text{zero remainder}
\end{array}
$$

The important feature of the CRC is the ease of implementation, in which the process of division is provided by shift registers with feedback paths.



Thus for the polynomial $x^8 + 1$ an eight-stage shift register with an exclusive-OR addition of output to input is all that is required. During the passage of information data, the switch is in position 1 and the data is fed to the channel while simultaneously the division is performed in the shift register. After all the input data is transmitted the shift register contains the remainder and after switching to position 2 this may be clocked out to the channel. When the process is repeated on decoding, the shift register should contain all zeros if no errors exist.

A further important property is that CRC coding has known properties when burst errors are encountered, for example, in magnetic recording. Irrespective of the length of the information sequence a fixed probability of misdetection occurs which, in the case of the polynomial $x^8 + 1$ for example, is 1/256 for burst errors of 10 or longer. This is sufficient in practice, particularly when supplemented by other knowledge of how well the VITC signal is recovered.

APPENDIX B

(*Clause* 5.4.1)

DEFINITION OF FIELD ONE IN THE EIGHT-FIELD SEQUENCE OF THE PAL SIGNAL

A complete repetition period of the synchronizing signals of the PAL video signal consists of a sequence of eight fields.

For the sake of clear communication, the IEC and the CCIR have numbered the successive fields of one repetition period of a PAL video signal by adopting the following definition of field one of the eight successive fields:

At the half-amplitude point of the leading edge of the line synchronizing pulse of line 1 of field 1, the phase of the extrapolated E'_u component of the video burst may accept the following values:

$$-90^\circ < \varphi E'_u \leqslant 90^\circ$$

Note — The E'_u component of the video burst is defined in CCIR Report No. 624-2, Fig. 4.

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