

Broadcast video tape recorders

Part 2. Electrical measurements of analogue composite video signals

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Audio Engineering Society
British Broadcasting Corporation
British Kinematograph, Sound and Television Society
British Tape Industry Association
Federation of the Electronics Industry
ITV Association (ITVA)
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Royal Photographic Society
Royal Television Society

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National foreword

This British Standard has been prepared by Technical Committee EPL/60 and is the English language version of EN 61237-2 : 1995 *Broadcast video tape recorders. Methods of measurement. Part 2 : Electrical measurements of analogue composite video signals*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 1237-2 : 1995, published by the International Electrotechnical Commission (IEC).

BS EN 61237 consists of the following parts:

- | | |
|--------|--|
| Part 1 | <i>Mechanical measurements</i> |
| Part 2 | <i>Electrical measurements of analogue composite video signals</i> |
| Part 3 | <i>Electrical measurements of analogue component video signals</i> |
| Part 4 | <i>Measurements of audio performance¹⁾</i> |
| Part 5 | <i>Electrical measurements of digital composite video signals and digital audio signals¹⁾</i> |
| Part 6 | <i>Electrical measurements of digital component video signals and digital audio signals¹⁾</i> |

Cross-references

Publication referred to	Corresponding British Standard
EN 60244-10 : 1993 (IEC 244-10 : 1986)	BS EN 60244 <i>Methods of measurement for radio transmitters</i> Part 10 : 1993 <i>Methods of measurement for television transmitters and transposers employing insertion test signals</i>
EN 60756 : 1993 (IEC 756 : 1991)	BS EN 60756 : 1993 <i>Non-broadcast video tape recorders. Time base stability</i>
EN 61041-1 : 1995 (IEC 1041-1 : 1990)	BS EN 61041 <i>Non-broadcast video tape recorders. Methods of measurement</i> Part 1 : 1995 <i>General video (NTSC/PAL) and audio (longitudinal) characteristics</i>
HD 527 S1 : 1989 (IEC 883 : 1987)	BS 7595 : 1992 <i>Measuring method for chrominance signal-to-random noise ratio for video tape recorders</i>

¹⁾ In preparation.

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English version

Broadcast video tape recorders
Methods of measurement
Part 2: Electrical measurements of analogue composite video signals

(IEC 1237-2 : 1995)

Magnétoscopes de radiodiffusion
Méthodes de mesure
Partie 2 : Mesures électriques pour les signaux vidéo analogiques composites
(CEI 1237-2 : 1995)

Videobandgeräte für den Rundfunk Meßverfahren
Teil 2 : Elektrische Messungen an Geräten für analoge magnetische Aufzeichnung von zusammengesetzten Videosignalen
(IEC 1237-2 : 1995)

This European Standard was approved by CENELEC on 1994-03-08. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 60B(CO)159 + 159A, future edition 1 of IEC 1237-2, prepared by SC 60B, Video recording, of IEC TC 60, Recording, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61237-2 on 1994-03-08.

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- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-05-01

Annexes designated 'normative' are part of the body of the standard.

Annexes designated 'informative' are given for information only.

In this standard, annex ZA is normative and annexes A, B, C and D are informative.

Annex ZA has been added by CENELEC.

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BROADCAST VIDEO TAPE RECORDERS – METHODS OF MEASUREMENT –

Part 2: Electrical measurements of analogue composite video signals

1 Scope and object

This part of IEC 1237 describes the test signals and measuring methods for equipments mainly dedicated to record/playback analogue composite TV-signals on magnetic tape on reels or in cassettes.

The allowable tolerances for the rated values for acceptable performance are not given in this standard, but may be derived from the specifications for the related system, i.e. appropriate publications, manufacturers' specifications, etc.

The necessary reference and calibration tapes are either mentioned in the specific IEC publication of equipment under test or included in IEC 1105 (reference tapes) and IEC 1295 (calibration tapes).

The principal object of this standard is to describe the methods of measurement, test signals and procedures which may apply to characteristics of video recording/playback machines mainly intended for professional use. The measuring methods described hereafter do not directly concern home equipment and it would appear that some will be difficult to apply to them.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1237. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1237 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 244-10: 1986, *Methods of measurement for radio transmitters – Part 10: Methods of measurements for television transmitters and transposers employing insertion test signals*

IEC 756: 1991, *Non-broadcast video tape recorders – Time base stability*

IEC 883: 1987, *Measuring method for chrominance signal-to-random noise ratio for video tape recorders*

IEC 1041-1: 1990, *Non-broadcast video tape recorders – Methods of measurement – Part 1: General video (NTSC/PAL) and audio (longitudinal) characteristics*

IEC 1041-2: 1994, *Non-broadcast video tape recorders – Methods of measurements – Part 2: Video characteristics chrominance*

CCIR Recommendation 471-1: 1990, *Nomenclature and description of colour bar signals (Vol. XI-1)*

CCIR Recommendation 567-3: 1990, *Transmission performance of television circuits designed for use in international connections (Vol. XII)*

3 General

This standard deals with the application of measuring methods designed for general use television production and transmission as well as special measurement techniques for television tape machines.

The methods are applicable to acceptance tests, performance comparisons and, as far as possible, to routine checks. To insure that the results obtained at a specific time at a specific place are comparable to other measurements it is advisable to specify the test signals, measuring devices and types of tapes used together with the results obtained.

Since measurements of television tape machines on the basis of a single test-line per field may not be fully representative of the full-field performance (see 5.2 and 5.3), they may give results which differ from those obtained or calculated with full-field test signals. Therefore it is necessary to additionally specify the measuring method i.e.

- single line measurement (line number);
- block measurement (start-line, step-by-step line(s), number of steps);
- full-field measurement.

Additionally it should be stated if the selection of lines coincides with a single record/playback head only.

4 Test conditions

If not otherwise stated all measurements shall be carried out at the following atmospheric conditions.

Temperature	(20 ± 1) °C
Relative humidity	(50 ± 2) %
Air pressure	86 kPa to 106 kPa
Conditioning before testing	24 h

5 Measuring methods and test signals

5.1 *Manual and automatic measurements*

If an automatic measuring device is designed to give reliable results under the special conditions of television tape recording/playback as e.g. drop-out, jitter, time-base errors, head switching or partly insufficient head-to-tape contact, a significant improvement in measuring speed, accuracy and comparability of results can be achieved.

Therefore preference was given to measuring methods which can be carried out by automatic measuring equipment or which are suitable for automatic measuring techniques.

Except where a distinction is made in particular clauses between manual and automatic methods of measurement, the measurement procedures given in this standard are valid for both methods. However, although in the case of automatic measurements the procedure is carried out automatically by the test signal analyzer, the various steps are described as if they were performed manually.

5.2 *Measurement of differences between adjacent tracks (fields/segments)*

All currently standardized recording formats make use of segmented recording techniques. The length of the segments (tracks) varies between approximately 16 lines and one field where the latter is often termed "non segmented recording" which only indicates that there is no cut within the field.

Since two or more heads are used for record and playback of the video information to and from the tracks it is desirable to restrict the measurement to segments related to a specific head. This requires a special signal arrangement which provides identical information to the heads or segments in turn.

A suitable arrangement for most formats is to repeat a packet of up to 16 different signals of a duration of one line within a field and to make the signals identical in both fields.

5.3 *Procedure of measurement*

The measurements shall be carried out by measuring the playback signal after recording on the same equipment (best-case configuration).

In certain particular cases, if the multigeneration-performance of a video recording system is measured, the measurements shall be carried out by measuring the playback signal after recording on a different machine (worst-case configuration).

If the television tape machine under test is equipped with external controls, e.g. tracking control, gain control, etc. these controls shall be set to their preset or mid-position for all measurements.

5.4 Test signals

5.4.1 Introduction

A representative range of test signals is shown in annexes B and C (figures B.1 to B.6 and C.1 to C.7). For ease of reference they are indicated by roman numerals. The test signals elements are defined in annex A.

The terms concerning the components and values of a composite colour video signal are given after figure A.3.

5.4.2 Amplitudes and characteristics of test signals

The peak-to-peak amplitude of a monochrome composite video signal, e.g. from sync tip to white level, shall be

$$1,0 V_{p-p}$$

The nominal value of the luminance component and the amplitude of the synchronizing pulses differs between the television systems as shown in table 1.

The nominal value of the luminance component is regarded as 100 %.

Table 1 – Nominal signal amplitudes for 625-line and 525-line standard

	625-line standards	525-line standards
Luminance (Y)	700 mV = 100 %	714 mV = 100 % IRE
Sync	–300 mV	–286 mV

All other test signal amplitudes may be expressed as a percentage of the nominal value of the luminance component.

Unless otherwise stated the characteristics of the synchronising signal and the characteristics of the chrominance signal shall be in accordance with the CCIR television standard relevant to the television tape equipment under test.

5.4.3 Test signal arrangement

For manual or automatic measurement under identical conditions, the active field period shall contain a specific picture test signal for measurement of the video characteristics.

However, particularly in case of automatic measurements, a signal arrangement as mentioned in 5.2 may be used. This supports simultaneous measurements of different parameters and renders reliable results by averaging values obtained from the specific picture test signal of successive packets within a field. Unless otherwise stated the specific picture test signal shall be identical in each horizontal line of the active field period, e.g. regarding amplitude, frequency, phase, timing, etc.

6 Measurements of characteristics

6.1 Amplitudes of output signals in E-E mode and playback

6.1.1 Luminance bar amplitude error

Introduction

The luminance bar amplitude error is the difference between the actual luminance bar amplitude and its nominal value, expressed as a percentage of the nominal value.

The sign of the error is positive if the bar amplitude is greater than the nominal value.

Measurement procedure

- Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- Measure the difference in level between point b_1 and b_2 , and record this value $U_{1,2}$ in millivolts.
- Calculate the error from the expression:

$$100 \frac{U_{1,2} - U_0}{U_0} \quad (\%)$$

where U_0 is the nominal value of the luminance bar amplitude.

6.1.2 Synchronizing pulse amplitude error

Introduction

The synchronizing pulse amplitude error is the difference between the actual amplitude of the synchronizing pulse and its nominal value, expressed as a percentage of the nominal value.

The sign of the error is positive if the synchronizing pulses are larger than the nominal value.

Measurement procedure

- Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- Measure the difference in level between points b_8 and b_9 , and record this value $U_{8,9}$ in millivolts.
- If a manual method of measurement is used, calculate the error from the formula:

$$S_0 = 100 \frac{U_{8,9} - U_{s0}}{U_{s0}} \quad (\%)$$

where U_{s0} is the nominal value of the synchronizing pulse amplitude at the output given in table 1.

6.1.3 Burst amplitude error

Introduction

The burst amplitude error is the difference between the actual amplitude of the burst and its nominal value, expressed as a percentage of the nominal value.

The signal of the error is positive if the actual burst amplitude is larger than the nominal value.

Measurement procedure

- Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- Measure the burst amplitude and record this value U_b in millivolts.
- Calculate the error from the expression

$$100 \frac{U_b - U_{b0}}{U_{b0}} \quad (\%)$$

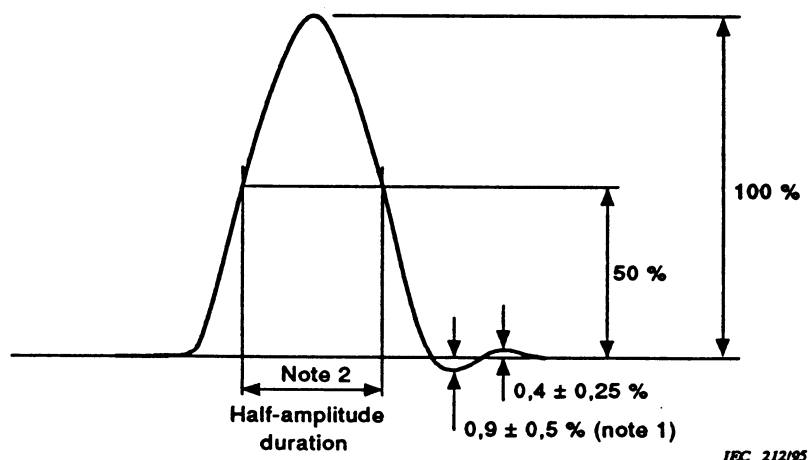
where U_{b0} is the nominal value of the burst amplitude.

6.2 Short and line time distortions

6.2.1 K_{2T} factor

Introduction

2T pulse shape distortion relates to the departure of the 2T pulse from its ideal shape. The performance with respect to this type of distortion is normally given in terms of a rating factor, K , for which numerical limits are assigned in the equipment specification. It is measured by means of an appropriate graticule for the relevant television standard and equipment specification.



NOTES

- Values result from a specific analogue Thomson-filter. By using digitally generated signals better values can be achieved.
- The half-amplitude duration shall be:
 - 200 ns $\pm$ 3 % for 625-line systems;
 - 250 ns $\pm$ 3 % for 525-line systems.

Figure 1 – Shape of the standardized 2T pulse

Measurement procedure for a manual method of measurement

- a) Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- b) Employ the oscilloscope graticule shown in figure 2 and adjust the oscilloscope so that:
 - the sweep velocity corresponds to the time scale of the graticule;
 - blanking level coincides with the horizontal axis through level reference point "0 %" of the graticule;
 - the peak of the 2T pulse falls on the horizontal line through level reference point "100 %";
 - the half-amplitude points of the 2T pulse are symmetrically disposed about the vertical axis through time reference point "0".
- c) State whether the waveform is within the specified K-rating tolerance, or state the measured K-rating factor.

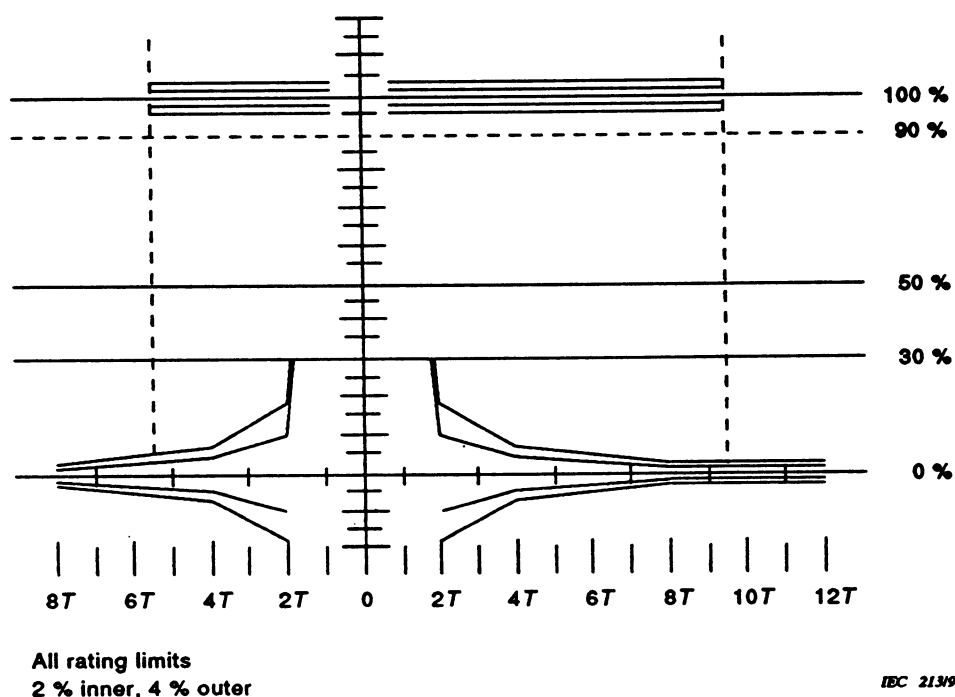


Figure 2 – Example of oscilloscope graticule for the measurement of 2T pulse shape distortion

6.2.2 2T/bar ratio

Introduction

The 2T sine-squared pulse/bar ratio error is the difference between the amplitude of the 2T pulse (section B_1) and the luminance bar (section B_2) of the test signals I (figure B.1) or V (figure C.1), expressed as a percentage of the luminance bar amplitude. The amplitude of the 2T pulse is the difference between the level at point b_5 and the level at reference point b_7 .

The sign of the error is positive if the amplitude of the $2T$ pulse is greater than the luminance bar amplitude.

Some measuring equipment may indicate the $2T$ pulse/bar ratio itself, rather than the error.

Measurement procedure

- Select test signal I (figure B.1) for 625-line systems or test V (figure C.1) for 525-line systems.
- Measure the amplitude of the $2T$ pulse, $U_{7,11}$, between points b_{11} and b_7 .
- Calculate the error from the expression

$$100 \frac{U_{7,11} - U_{1,2}}{U_{1,2}} \quad (\%)$$

6.2.3 Bar tilt

Introduction

The luminance bar tilt is the difference between the level of the luminance bar (section B_2) at point b_3 of the test signals I (figure B.1) or V (figure C.1) $1 \mu\text{s}$ after the half-amplitude point of its leading edge, and the level at point b_4 , $1 \mu\text{s}$ before the nominal half-amplitude point of its trailing edge, expressed as a percentage of the luminance amplitude.

The sign of the bar tilt is positive if the level of the luminance bar at point b_4 is higher than the level at point b_3 .

Measurement procedure

- Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- Measure the difference in level, $U_{3,4}$, between points b_3 and b_4 .
- Calculate the bar tilt from the expression:

$$100 \frac{U_{3,4}}{U_{1,2}} \quad (\%)$$

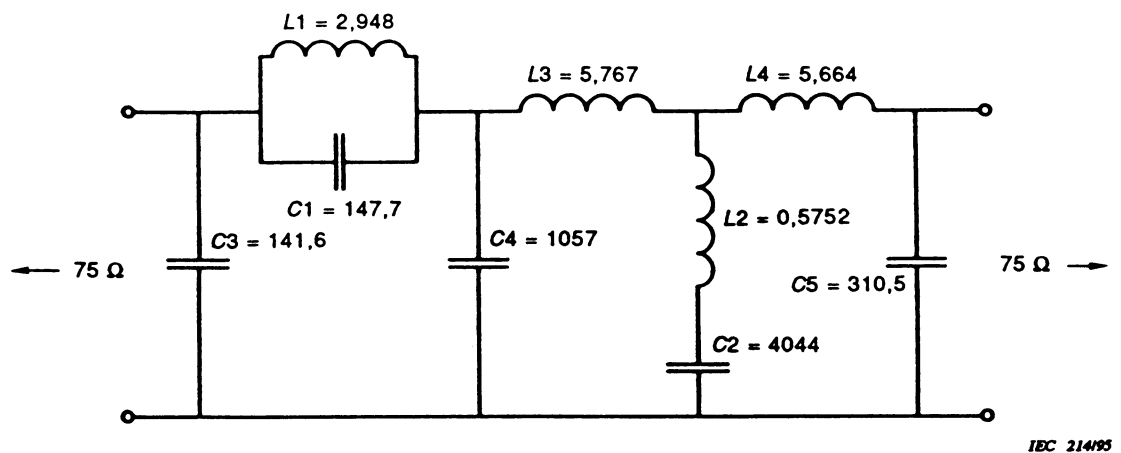
6.2.4 Base-line distortion

Introduction

Base-line distortion is expressed as the difference between the level at point b_7 of the test signals I (figure B.1) or V (figure C.1), $1 \mu\text{s}$ after the half-amplitude point of the trailing edge of the luminance bar (section B_2), and the level at reference point b_1 , expressed as a percentage of the luminance bar amplitude.

The sign of the base-line distortion is positive if the level at point b_7 is higher than the level at point b_1 .

The measurements are made with the bandwidth of the video signal limited by the network described in figure 3 or by an equivalent technique.



NOTES

- 1 f_{oo} is the frequency of the first zero of the output/input transfer function.
- 2 Inductances are given in μH , capacitances in pF.
- 3 For further details see MacDiarmid and Phillips, Proc. IEE, Vol 105B, 440.

Figure 3 – Thomson filter diagram ($f_{oo} = 3,3 \text{ MHz}$)

Measurement procedure

- a) Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- b) Measure the difference in level, $U_{1,7}$ between points b_1 and b_7 .
- c) Calculate the distortion from the expression:

$$100 \frac{U_{1,7}}{U_{1,2}} \quad (\%)$$

6.3 Chrominance-luminance gain inequality

Introduction

Chrominance-luminance gain inequality is the difference between the peak-to-peak amplitude of the chrominance signal in section G_1 or G_2 (or in section G) of the test signal IV (figure B.4) or VI (figure C.2) and the amplitude of a reference luminance signal, expressed as a percentage of this amplitude.

The sign of the gain inequality is positive if the amplitude of the chrominance signal is greater than that of the luminance bar.

Measurement procedure

- a) Select test signal IV (figure B.4) for 625-line systems or test signal VI (figure C.2) for 525-line systems.
- b) Measure the peak-to-peak amplitude U_5 of the chrominance signal in section G_1 or G_2 for 625-line systems, or in section G for 525-line systems, at the time defined by point b_5 .

- c) Measure the amplitude of the luminance bar $U_{1,2}$ as previously described.
- d) Calculate the gain inequality from the expressions:

- for 625-line systems: $100 \frac{U_5 - U_{1,2}}{U_{1,2}} \quad (\%)$

- for 525-line systems: $100 \frac{U_5 - 0,8 U_{1,2}}{0,8 U_{1,2}} \quad (\%)$

6.4 Chrominance-luminance delay inequality

Introduction

Chrominance-luminance delay inequality is the time difference, in nanoseconds, between the luminance and the chrominance component of the composite 20T pulse (or the composite 10T pulse for system I) of the test signal I (figure B.1) or the composite 12,5T pulse of the test signal V (figure C.1).

The sign of the delay inequality is positive if the axis of symmetry of the chrominance component lags behind the axis of symmetry of the luminance component.

Measurement procedure

- a) Select test signal I (figure B.1) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- b) Measure the time difference between the luminance part of the pulse and the envelope of the chrominance part of the pulse in nanoseconds.

Method using a nomogram

The chrominance-luminance gain inequality and chrominance-luminance delay inequality may also be determined by measuring the amplitudes $U_{\max}$, U_a and U_b of the composite 20T-pulse (see figure 4) and by using the appropriate nomogram (see e.g. (ROSMAN), (SIOCOS), (MALLON and WILLIAMS)).

NOTE – In this case, if chrominance-luminance cross-talk is present, this will affect the results of the measurements, as it will not be possible to discriminate between cross-talk and delay inequality on the shape of the waveform and base-line of the T pulse.

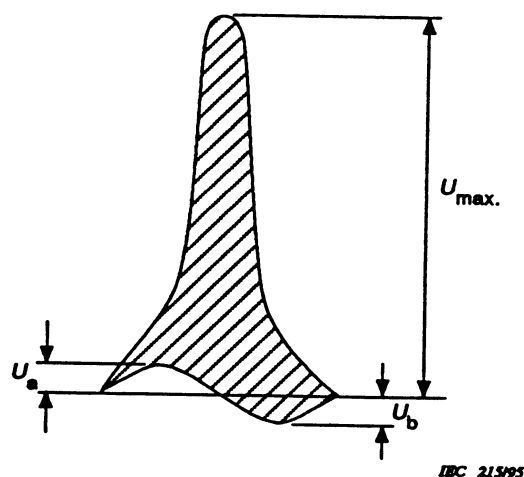


Figure 4 – Chrominance-luminance delay inequality

6.5 Amplitude/frequency characteristics

6.5.1 Luminance

Introduction

The amplitude/video frequency characteristic is determined by measuring the ratio between (1) the peak-to-peak amplitude of each sine-wave signal at the different video frequencies in section C_2 of the test signal II (figure B.2) or VI (figure C.2) and (2) the peak-to-peak amplitude of the reference luminance signal in section C_1 when test signal II is used, or half the peak-to-peak amplitude when test signal VI is used.

Alternatively, the luminance bar in section B_2 of test signals I (figure B.1) or V (figure C.1) may be taken as the reference luminance signal $U_{1,2}$.

Measurement procedure

- Select test signal II (figure B.2) for 625-line systems or test signal VI (figure C.2) for 525-line systems.
- Measure the peak-to-peak amplitude U_{C1} between the mid-duration points of the reference luminance in section C_1 .
- Measure the peak-to-peak amplitude U_{C2} at the mid-duration point of each sine-wave signal in section C_2 for each frequency up to the highest in accordance with the television standard concerned.
- For each frequency of the sine-wave signal, calculate the ratio
 - for 625-line systems:

$$20 \log \frac{U_{C2}}{U_{C1}} \text{ (dB)} \quad \text{or} \quad 20 \log \frac{U_{C2}}{0,6 U_{1,2}} \text{ (dB)}$$

- for 525-line systems:

$$20 \log \frac{2U_{C2}}{U_{C1}} \text{ (dB)} \quad \text{or} \quad 20 \log \frac{2U_{C2}}{U_{1,2}} \text{ (dB)}$$

- Tabulate the ratios as a function of video frequency.

6.5.2 Chrominance

Introduction

The amplitude/frequency characteristics of modulated chrominance information may be determined by comparing the amplitudes of the colour carrier signals in the $\sin^2$ envelopes of F_1 to F_4 in test signal IX (figure B.5) for 625-line systems, where the values of B_1 and B_2 are equal to those in test signal I (figure B.1) and the half-amplitude durations of F_1 to F_4 are 4,0 μs , 2,0 μs , 1,2 μs and 0,6 μs .

This method however needs further investigations.

For 525-line systems, use the test signal VII indicated in figure C.3.

6.6 Non-linear distortions

6.6.1 Differential gain

Introduction

Differential gain is defined as the maximum change in amplitude of the chrominance sub-carrier signal relative to the amplitude of this signal at blanking level, resulting from a change in amplitude of the associated luminance signal.

The measurements are made at the differing luminance levels of the chrominance staircase in section D_2 of test signals III (figure B.3) or V (figure C.1) disregarding the highest level, unless this is specifically required, e.g. as in system I.

A band-pass filter is used to separate the chrominance sub-carrier signal from the luminance signal.

Measurement procedure

- Select test signal III (figure B.3) for 625-line systems or test signal V (figure C.1) for 525-line systems.
- Measure the peak-to-peak amplitude of the chrominance sub-carrier at the differing luminance levels, including the sub-carrier at blanking level at the point b_{10} .
- Calculate the values of x and $-y$ from the formula:

$$x = 100 \frac{A_{\max} - A_0}{A_0} \quad (\%) \quad \text{and} \quad -y = 100 \frac{A_{\min} - A_0}{A_0} \quad (\%)$$

where $A_{\max}$ and $A_{\min}$ are the largest and the smallest peak-to-peak amplitudes of the chrominance sub-carrier measured in item b) above, and A_0 is the peak-to-peak amplitude at blanking level.

- The differential gain is given by both the values of x and $-y$. The peak-to-peak value of differential gain is given by $x + y$.

6.6.2 Differential gain versus frequency

Introduction

In video recording systems using usual low frequency carrier FM-modulation or "colour-under" processing, "differential gain" indicated in clause 6.6.1 does not indicate non-linear distortion precisely because of the influence of the characteristics in the FM domain or separation recording of chrominance signal.

In such cases it is advisable to use different superposed carrier frequency as modulation on the staircase in test signals III (figure B.3) or V (figure C.1). Superposed carrier frequencies can be e.g. 1,0 MHz, 2,0 MHz, 3,0 MHz.

The measuring procedure is the same as indicated in 6.6.1.

6.6.3 Differential phase

Introduction

Differential phase is defined as the maximum change in phase of the chrominance sub-carrier signal relative to the phase of this signal at blanking level, resulting from the change in amplitude of the associated luminance signal.

The measurements are made at the differing luminance levels of the chrominance staircase in section D_2 of test signals III (figure B.3) and V (figure C.1) disregarding the highest level, unless this is specifically required, e.g. as in system I.

A band-pass filter is used to separate the chrominance sub-carrier signal from the luminance signal.

Measurement procedure

- Select test signal III (figure B.3) for 625-line systems and test signal V (figure C.1) for 525-line systems.
- Measure the phase difference, $\Delta\phi$, between the chrominance sub-carrier at the differing luminance levels and the chrominance sub-carrier at blanking level at the point b_{10} .
- The differential phase, expressed in degrees, is given by both the maximum positive phase difference $\Delta\phi_p$, and maximum negative phase difference $\Delta\phi_n$.

The peak-to-peak value of differential phase is given by $\Delta\phi_p + \Delta\phi_n$.

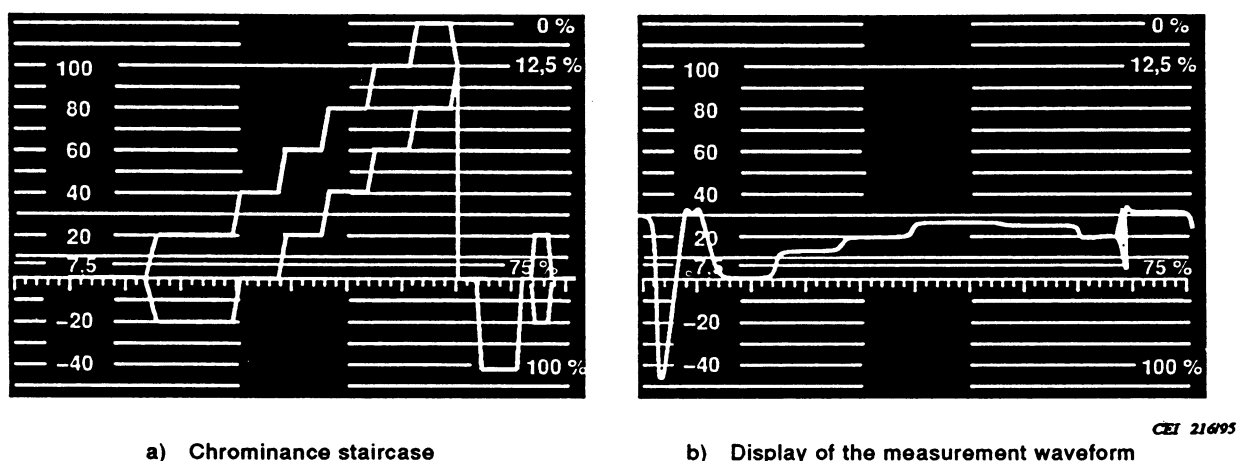


Figure 5 – Measurement of differential phase

6.6.4 Group delay

Test equipment specifically designed for the measurement of group delay in video tape recorders is now available. Alternatively, a new waveform, the multipulse, has been devised which allows group delay to be measured over a range of frequencies within the video pass band. The waveform is shown in figure B.6 and consists of five $20T$ pulses modulated by a range of frequencies. The assessment of group delay may be obtained by a similar method to that used with the chrominance pulse (see 6.3 and 6.4).