

Methods of measurement for radio transmitters —

Part 5: Performance characteristics of television transmitters

The European Standard EN 60244-5:1994 has the status of a
British Standard

UDC 621.396.61.083 621.397.13.001.11.001.2 621.317.616.091.092.24 621.391.837.21

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee EPL/12, Radiocommunication, upon which the following bodies were represented:

- British Broadcasting Corporation
- British Radio and Electronic Equipment Manufacturers' Association
- British Telecommunications plc
- Institution of Electrical Engineers
- Radio, Electrical and Television Retailers' Association
- Radiocommunications Agency

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board (L/1), was published under the authority of the Standards Board and comes into effect on 15 June 1995

© BSI 01-2000

The following BSI references relate to the work on this standard:
Committee reference EPL/12
Special announcement in *BSI News* July 1994

ISBN 0 580 24302 8

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Foreword	2
Text of EN 60244-5	5
List of references	Inside back cover

National foreword

This British Standard has been prepared by Technical Committee EPL/12 and is the English language version of EN 60244-5:1994 *Methods of measurement for radio transmitters — Part 5: Performance characteristics of television transmitters*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 244-5:1992, published by the International Electrotechnical Commission (IEC) and is part of a series describing the recommended methods of measurement for assessing the performance of radio transmitters.

This Part of BS EN 60244 describes the methods of measurement for assessing the performance characteristics of television transmitters and is intended to be used for type tests and acceptance or factory tests.

For ease of reproduction, on some of the figures the French text has been retained.

Other Parts of BS EN 60244 published to date are as follows:

- *Part 10:1993, Methods of measurement for television transmitters and transposers employing insertion test signals.*
- *Part 11:1993, Transposers for FM sound broadcasting.*
- *Part 12-1:1994, Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting — Section 12.1 Characteristics to be specified.*
- *Part 12-2:1994, Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting — Section 12.2 Specification sheets.*
- *Part 13:1993, Performance characteristics for FM sound broadcasting.*

It is anticipated that other Parts of IEC Publication 244 will be published as identical British Standards, subject to their harmonization by CENELEC.

Cross-references

Publication referred to	Corresponding British Standard
	BS EN 60244 <i>Methods of measurement for radio transmitters</i>
EN 60244-10:1993 (IEC 244-10:1986)	Part 10:1993 <i>Methods of measurement for television transmitters and transposers employing insertion test signals</i>
EN 60244-12-1:1993 (IEC 244-12-1:1989)	Part 12 <i>Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting.</i> Section 12.1:1994 <i>Characteristics to be specified</i>
EN 60244-12-2:1993 (IEC 60244-12-2:1989)	Part 12 <i>Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting</i> Section 12.2:1994 <i>Specification sheets</i>
EN 60244-13:1993 (IEC 60244-13:1991)	Part 13 <i>Performance characteristics for FM sound broadcasting</i>

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 78, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

English version

Methods of measurement for radio transmitters Part 5: Performance characteristics of television transmitters

(IEC 244-5:1992)

Méthodes de mesure applicables aux émetteurs
radioélectriques
Partie 5: Qualités de fonctionnement des
émetteurs de télévision
(CEI 244-5:1992)

Meßverfahren für Funksender
Teil 5: Übertragungseigenschaften von
Fernsehsendern
(IEC 244-5:1992)

This European Standard was approved by CENELEC on 1993-12-08. 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.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 244-5:1992 could be accepted without textual changes, has shown that no common modifications were necessary for acceptance as a European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 60244-5 on 8 December 1993.

This European Standard replaces HD 236.5 S4:1979.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1994-12-01
- latest date of withdrawal of conflicting national standards (dow) 1994-12-01

Annexes designated “normative” are part of the body of the standard. In this standard Annex A, Annex B and Annex ZA are normative.

Corrigendum

Editorial correction to the English version of IEC 244-5:

Under **2.2**, CCIR Publications, replace “CCIR Recommendation 567-1:1986” by “CCIR Recommendation 567-3:1990” (the title is unchanged).

Contents

	Page
Foreword	2
Introduction	5
1 Scope	5
2 Normative references	5
2.1 IEC publications	5
2.2 CCIR publications	5
3 General terms and definitions	5
3.1 Television transmitter	5
3.2 Description of the television systems and other relevant information	5
3.3 Definitions of performance characteristics	5
3.4 Standard test signals	5
4 General conditions of operation	5
5 General conditions of measurement	6
5.1 Input and output signal arrangements	6
5.2 Measuring equipment	6
5.3 Modulation and power conditions	6
5.4 General characteristics	6
6 Output power, power consumption and power factor	6
6.1 Definitions	6
6.2 Measuring arrangement	6
6.3 Test signal	6
6.4 Measuring procedure	6
6.5 Calculation and presentation of the results	7
7 The characteristic vision levels	7
7.1 Introduction	7
7.2 Setting the characteristic levels to nominal values	7
7.3 Performance of the white clipper	7
7.4 Stability of the reference levels and output power	8
8 Linear distortion	10
8.1 Introduction	10
8.2 Amplitude/radio-frequency characteristic	10
8.3 Amplitude/video-frequency Characteristic	11
8.4 Group-delay/radio-frequency characteristic	11
8.5 Group-delay/video-frequency characteristic	12

	Page		Page
9 Non-linear distortion	12	Annex A (normative)	43
9.1 Introduction	12	A.1 References to the IEV and Recommendations and Reports of the CCIR	43
9.2 Luminance non-linearity	12	A.2 Channels and frequencies allocated to television broadcasting copy	43
9.3 Differential gain and phase	13	A.3 Characteristics of television systems	46
9.4 Chrominance non-linearity	14	A.4 Filters for use in measurements	64
9.5 Chrominance-luminance intermodulation or cross-talk	14	A.5 A low-pass Gaussian filter for eye height measurement (calibrated filter)	69
9.6 Incidental phase modulation	14	Annex B (normative) Test signals	70
10 Waveform distortion	15	Annex ZA (normative) Other international publications quoted in this standard with the references of the relevant European publications	78
10.1 Introduction	15	Figure 1a — Measurement arrangement for output power	25
10.2 2 <i>T</i> -pulse distortion including the pulse-bar ratio	15	Figures 1b and 1c — Demodulator output signals	25
10.3 <i>T</i> -step or <i>T</i> -pulse distortion	16	Figure 2a — Measuring arrangement for setting white clipper and characteristic levels and for stability measurement	26
10.4 Field-time bar tilt	16	Figure 2b	26
10.5 Line-time bar tilt	17	Figure 2c	26
10.6 Luminance bar tilt	17	Figure 2d	26
10.7 Line synchronizing pulse distortion	17	Figure 2e	26
10.8 Field blanking interval distortion	18	Figure 2f	26
10.9 Line tilt	18	Figure 2g	26
10.10 Long-time signal distortion	18	Figure 2h	27
10.11 Chrominance-luminance gain and delay inequality using a composite pulse	19	Figure 2i — Demodulator output signals	27
11 Unwanted modulation	19	Figure 2j	27
11.1 Introduction	19	Figure 2k	28
11.2 Random noise	19	Figure 2l	28
11.3 Low frequency periodic noise	20	Figure 3a — Measuring arrangement for amplitude/frequency characteristics	28
11.4 High frequency periodic noise including intermodulation	21	Figure 3b — Demodulator output	29
11.5 Impulsive noise	21	Figure 3c — Demodulator output	29
12 Special measurements for data signals in the vision signal	22	Figure 3d — Example of amplitude/radio-frequency characteristics with tolerances for system G	29
12.1 Introduction	22	Figure 3e — Example of amplitude/video-frequency characteristics with tolerances for system G	29
12.2 Eye height and eye width	22	Figure 3f — Measuring arrangement for group-delay/frequency characteristics	30
12.3 Position of the penultimate clock run-in-bit	23	Figure 3g — Demodulator output	30
13 Method of measurement of the sound channel(s) of a television transmitter	23	Figure 3h — Examples of group-delay graticule for systems L and G	31
13.1 Introduction	23		
13.2 Measuring arrangement	23		
13.3 Method of measurement of the FM sound channel (single sound)	23		
13.4 Method of measurement of the AM sound channel	23		
13.5 Special measurement for two or more sound channels	23		

	Page		Page
Figure 3i — Example of a graticule for RF group-delay characteristics for system G	31	Figure 6d	39
Figure 4a — Measuring arrangement for luminance non-linearity	31	Figure 7a — Eye-height and eye-width	39
Figure 4b — Differentiated demodulator output	32	Figure 7b — Measuring for eye-height and eye-width	40
Figure 4c — Measuring arrangement for differential gain and phase	32	Figure 7c — Transmitter output: demodulator with sound trap switched on (example of eye height and eye width graticule with synchronous detection)	40
Figure 4d — Picture for amplitude (A) and phase (φ)	32	Figure 8a — Measuring arrangement for the sound channel of a television transmitter (single sound output)	41
Figure 4e — Measuring arrangement for chrominance/luminance intermodulation or crosstalk	33	Figure 8b — Measuring arrangement for the sound channel of a television (multi-channel sound output)	42
Figure 4f — Filtered demodulator output	33	Figure 1 — Levels in the composite signal and details of line-synchronizing signals	48
Figure 4g — Measuring arrangement for incidental phase modulation	33	Figure 2-1 — Diagrams applicable to all systems except M	50
Figure 4h — Demodulator output	34	Figure 2-2 — Diagrams applicable to systems M	51
Figure 4i — Graticule	34	Figure 1 — Low-pass filter diagram	48
Figure 5a — Measuring arrangement	34	Figure 2 — Low-pass filter characteristic	65
Figure 5b — Displayed pulse and bar signal	34	Figure 3 — High-pass filter diagram	65
Figure 5c — Graticule for distortion measurements	34	Figure 4 — High-pass filter characteristic	66
Figure 5d — Graticule for sine squared pulse	35	Figure 5 — Network diagram	66
Figure 5e — Displayed 2 T/T pulse signal	35	Figure 6 — Unified weighting characteristic	67
Figure 5f — Graticule for T step signal	35	Figure 7 — Non-constant resistance network diagram	68
Figure 5g — Displayed T step signal	35	Figure 8 — Constant resistance network diagram	68
Figure 5h — Displayed field time bar signal	35	Figure 9 — Transient response of the network	69
Figure 5i — Displayed line-time bar signal	35	Figure 10 — Gaussian filter	69
Figure 5j — Displayed luminance bar signal	36	Figure 11 — Amplitude and group delay characteristics	70
Figure 5k — Displayed line synchronizing pulse signal	36	Table I — Basic characteristics of video and synchronizing signals	46
Figure 5l — Displayed field-blanking interval signal	36	Table I-1 — Details of line synchronizing signals	49
Figure 5m — Displayed line tilt signal	36	Table I-2 — Details of field synchronizing signals	52
Figure 5n — Displayed black to white signal change shows ringing when employing low frequency sweep	36	Table II — Characteristics of video signal for colour television	53
Figure 5o — Chrominance-luminance gain and delay inequality	37	Table III — Characteristics of the radiated signals (monochrome and colour)	61
Figure 5p	37		
Figure 6a — Measuring arrangement for signal-to-noise ratio	38		
Figure 6b — Measuring arrangement for intermodulation products and spurious single frequency components	38		
Figure 6c — Example of graticule for the display of high frequency periodic noise components and intermodulating products (B/G system)	39		

Introduction

This International Standard is one of a series of parts of IEC 244.

Some of the existing parts of IEC 244 are currently under review and several of these will be revised or withdrawn. When this process is completed, this series of publications will comprise one part dealing with general characteristics, with cross-references to relevant CCIR publications and Radio Regulations (CCIR), and a number of specialized parts, each dealing with particular types of transmitters.

1 Scope

This International Standard describes the methods of measurement for assessing the performance characteristics of television transmitters. To assess all other characteristics, this standard needs to be used in conjunction with the publications quoted in clause 2.

This standard is intended to be used for type tests and acceptance or factory tests.

It is not mandatory to measure all the described characteristics. Additional measurements may be carried out by agreement between customer and manufacturer.

The performance characteristics measured in accordance with this standard make possible the comparison of the results of measurements made by different observers.

Limiting values for acceptable performance are not covered by this standard but, in connection with the presentation of measured characteristics, some data are given for clarity.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 244. 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 244 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.

2.1 IEC publications

IEC 244-1:1968, *Methods of measurement for radio transmitters — Part 1: General conditions of measurement, frequency, output power and power consumption (revision under consideration)*.

Amendment 2, 1989. (Amendment 2 replaces IEC 244-1A.)

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

IEC 244-12-1:1989, *Methods of measurement for radio transmitters — Part 12: Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting — Characteristics to be specified*.

IEC 244-12-2:1989, *Methods of measurement for radio transmitters — Part 12: Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting — Specification sheets*.

IEC 244-13:1991, *Methods of measurement for radio transmitters — Part 13: Performance characteristics for FM sound broadcasting*.

2.2 CCIR publications

CCIR Recommendation 468-4:1986, *Measurement of audio frequency noise voltage level in sound broadcasting*.

CCIR Recommendation 567-1:1986, *Transmission performance of television circuits designed for use in international connections*.

CCIR Recommendation 653:1986, *Teletext systems*.

CCIR Report 624-3:1986, *Characteristics of television systems*.

CCIR Report 795-2:1986, *Transmission of two or more sound programmes or information channels in television*.

3 General terms and definitions

3.1 Television transmitter

The term “television transmitter” is used in this part to refer to that equipment with a video input and one or more audio inputs and a combined vision and sound radio frequency output.

3.2 Description of the television systems and other relevant information

See Annex A, clause A.3.

3.3 Definitions of performance characteristics

These definitions are given in the clauses describing the method of measurement and are in line with those given in IEC 244-12-1 and IEC 244-12-2.

3.4 Standard test signals

The test signals to be used for measuring the vision signal are given in Annex B.

4 General conditions of operation

— The television transmitter shall be tested in the normal operating conditions and at its rated output power.

— The power supply voltage and the environmental conditions shall be stated with the measurement results.

— The television transmitter shall be connected to a test load having a $VSWR \leq 1,05$ within the channel bandwidth.

5 General conditions of measurement

5.1 Input and output signal arrangements

— For each method of measurement, the input and output signal arrangement is given in the form of a diagram (see Annex A).

— The impedance of the test equipment, the test object and all connections between them shall be accurately matched.

— The performance characteristics shall be measured via a directional coupler with a directivity ≥ 34 dB, at the combined vision and sound signal output of the transmitter. A lower directivity can be agreed upon between customer and manufacturer.

5.2 Measuring equipment

Measurements in the videofrequency domain shall be carried out after demodulation of the RF output signal of the directional coupler with a VSB test demodulator with synchronous detection and with sound trap switched on, unless otherwise stated.

The group delay frequency characteristics shall be in accordance with the television system concerned (see Annex A, clause A.3).

Measurement in the audio-frequency domain shall be carried out with a selective sound demodulator or after an intercarrier demodulator.

5.3 Modulation and power conditions

— The video input signal shall have the basic characteristics given in CCIR Report 624 for the standard concerned (see Annex A, clause A.3). Unless otherwise stated; for example, for field-time measurements, video input signals without field synchronizing signals may be used. The sound carrier shall be unmodulated, unless otherwise stated.

— All performance characteristics shall be measured under the following conditions:

- a) the characteristic vision levels shall first be set to nominal values given in CCIR Report 624 for the standard concerned (see Annex A, clause A.3). This shall be measured using the method of measurement given in clause 7;
- b) the vision transmitter shall deliver rated output power. This shall be measured using the method of measurement given in clause 6;

- c) the ratio between this rated output power and that of the sound carrier or carriers shall be in accordance with the standard concerned, given in CCIR Report 624 (see Annex A, clause A.3).

5.4 General characteristics

The methods of measurement of the general characteristics of the transmitter such as frequency stability are described in IEC 244-1.

6 Output power, power consumption and power factor

6.1 Definitions

— The rated output power of a television transmitter is the peak envelope power of the vision signal at the transmitter output.

— The power consumption of the television transmitter is the total input power, from the mains supply measured in watts (W) or kilowatts (kW) including the power requirements for auxiliary equipment. It is defined for specified modulation conditions and at rated output power.

— Power factor is defined in IEC 244-1.

6.2 Measuring arrangement

The measuring arrangement is given in Figure 1a.

The mean output power P_m is measured directly with a calorimetric testload or after a calibrated attenuator or a calibrated directional coupler with a milliwattmeter. Using an RF peak voltmeter, the peak envelope power can be calculated directly.

6.3 Test signal

The vision part of the transmitter shall be modulated with an all black signal (A1) for systems with negative modulation (see Annex B).

The sound carrier(s) shall be unmodulated for systems using FM modulation. In the case of AM modulation (system L), the sound carrier shall be modulated with a test signal ≤ 1 kHz with $m = 90\%$.

6.4 Measuring procedure

6.4.1 Output power

The output power of the television transmitter shall be measured with the sound carrier(s) switched off.

6.4.2 Power consumption and power factor

The power consumption is the input active power of the transmitter and shall be measured with the vision and sound parts in operation, both delivering rated output power. The vision and sound parts of the transmitter shall be modulated in accordance with 6.3.

The input active power (P_j), the input apparent power (P_a) and the power factor shall be measured in accordance with IEC 244-1.

NOTE 1 To compare power consumption relative to cost of ownership the power should be measured with a video input signal at mid-grey level (see test signal A3 in Annex B). In the case of AM sound, 54 % modulation should be used.

NOTE 2 Some specifications give the statistical average power consumption for estimating the costs of ownership. This can only be checked during service with programme signals over an agreed period of time and by measuring the power consumption in this period.

6.5 Calculation and presentation of the results

When the mean power (P_m) of the vision signal of the television transmitter is measured, the peak envelope power (P_p) can be calculated as follows:

$$P_p = P_m \times k$$

— For transmitters with negative modulation and 625 line system:

$$k = \frac{64}{4,7 + 59,3 \left| \frac{b}{c} \right|^2}$$

where

$\frac{b}{c}$ is the voltage ratio between blanking level and peak synchronizing level.
See Figure 1b.

— For transmitters with positive modulation (system L):

$k = 1,50$ when P_m is measured without field synchronizing pulses;

$k = 1,39$ when P_m is measured with field synchronizing pulses.

When the RF peak voltage (U_p) is measured, the peak envelope power (P_p) can be calculated as follows:

$$P_p = \frac{U_p^2}{Z}$$

where Z is the impedance of the RF output line (normally 50 Ω).

NOTE For measurement after a calibrated attenuator or directional coupler, the attenuation should be taken into account in the calculations.

7 The characteristic vision levels

7.1 Introduction

The characteristic levels in a vision signal are the blanking level, the peak white level and the peak synchronizing level, corresponding to peak carrier level for negative modulation.

For transmitters with negative modulation, the peak synchronizing level is a measure for the output power.

A white clipper assures that in the case of overmodulation the residual carrier will be kept constant at peak white level. This shall be measured (see 7.2).

Before measuring their stability the characteristic levels shall first be set to nominal values (see 7.3).

The ability of these levels can be affected by:

- variations in the picture content (luminance level variation);
- variations of the synchronizing pulse amplitude of the video input signal;
- hum or noise superimposed upon the video input signal;
- variations of the value of the mains voltage.

7.2 Setting the characteristic levels to nominal values

7.2.1 Measuring arrangement

The measuring arrangement is given in Figure 2a.

The zero carrier pulse in the VSB demodulator shall be switched on.

7.2.2 Test signal

A sawtooth (B1) without superimposed signal (see Annex B) shall be used.

7.2.3 Measuring procedure

The characteristic levels given in CCIR Report 624 shall be set to the nominal values for the standard concerned (see Annex A, clause A.3). For transmitters with negative modulation, see Figure 2d. For transmitters with positive modulation, see Figure 2e. The output power shall be at nominal value.

7.3 Performance of the white clipper

(Applicable only to transmitters with negative modulation.)

7.3.1 Definitions

The performance of the white clipper is given by the change of the white clipping level and the change of the colour sub-carrier amplitude from their initial settings by increasing the luminance of the input signal to a specified level.

7.3.2 Measuring arrangement

The measuring arrangement is given in Figure 2a.

The zero carrier pulse in the VSB demodulator shall be switched on.

7.3.3 Test signals

In order to measure the performance of the white clipper, an all white signal (A2) shall be used (see Annex B). For the influence on the colour sub-carrier, a grey signal with superimposed colour sub-carrier from blanking level to peak white level is used (A3s) (see Annex B).

NOTE Sawtooth signal B1 may also be used instead of signal A2.

7.3.4 Measuring procedure

- Modulate the transmitter with signal A2 or B1 to peak white level and set the white clipping level (w_1) on this level. Determine the synchronizing level (c_1) (see Figure 2b).
- Increase the luminance signal at the input of the transmitter by a specified amount, for example 10 %.
- Determine the clipping level (w_2) and the peak synchronizing level (c_2).
- Replace the input signal by the grey signal with superimposed sub-carrier (A3s) with:
 $x = 350 \text{ mV}$ and $s = 700 \text{ mV}$.
- Determine the peak-to-peak value of the superimposed sub-carrier (s_1) (see Figure 2c).
- Increase the luminance level at the input of the transmitter so that the superimposed sub-carrier at the demodulator output extends to zero carrier level.
- Determine the peak-to-peak value of the superimposed sub-carrier (s_2).

7.3.5 Calculation and presentation of the results

The amount of variation of the clipping level is given by:

$$\left| \frac{w_1}{c_1} - \frac{w_2}{c_2} \right| \times 100 \%$$

The effect on the colour sub-carrier is given by:

$$\frac{s_1}{s_2} \times 100 \%$$

7.4 Stability of the reference levels and output power

7.4.1 Definitions

- For negative modulation:

The variation of the blanking level and the peak white level is the change of their value relative to the associated synchronizing level.

The variation of the peak synchronizing level is a measure of the variation of the output power.

- For positive modulation:

The variation of blanking level is the change of this value relative to the associated peak white level.

The variation of the peak white level is a measure of the variation of the output power.

7.4.2 Measuring arrangement

The measuring arrangement is given in Figure 2a. The zero carrier pulse in the VSB demodulator shall be switched on.

7.4.3 Test signals

For measuring the variation of the blanking level and the peak synchronizing level the transmitter shall be modulated sequentially with an all black signal (A1) and an all white signal (A2) (see Annex B).

For positive modulation, the measurements are carried out on an ITS signal.

For measuring the variation of the peak white level, the transmitter shall be modulated sequentially with a white sawtooth B3 and a black sawtooth B2 (see Annex B).

7.4.4 Measuring procedure for transmitters with negative modulation

7.4.4.1 Stability of the carrier level and blanking level due to luminance level variation

- Modulate the transmitter with an all black signal (A1) and determine the value of the blanking level (b_1) and the peak synchronizing level (c_1) (see Figure 2f).
- Replace the all black signal (A1) by an all white signal (A2) and determine again the blanking level (b_2) and the peak synchronizing level c_2 (see Figure 2b).

7.4.4.2 Stability of peak white level due to luminance variation

- Modulate the transmitter with an all white signal (A2).
- Determine blanking level (b) and synchronizing level (c).
- Replace the white signal at the input by the black sawtooth (B2) and determine the peak white level (w_1) and the peak carrier level (c_1) (see Figure 2h).
- Replace the black sawtooth (B2) by the white sawtooth (B3) and determine the peak white level (w_2) and peak carrier level (c_2) (see Figure 2i).

7.4.4.3 *Stability of synchronizing pulse due to input synchronizing pulse variation*

- Modulate the transmitter with an all white signal (A2).
- Determine blanking level (b) and synchronizing level (c).
- Change the synchronizing pulse amplitude of the input test signal A2 between minimum and maximum values specified in the equipment specifications keeping the peak-to-peak voltage of the luminance signal constant at 700 mV. Determine the blanking level (b_1) and the synchronizing level (c_1) for the minimum synchronizing pulse amplitude of the input signal and determine the blanking level (b_2) and the synchronizing level (c_2) for the maximum synchronizing pulse amplitude of the input signal.

7.4.4.4 *Sensitivity of blanking and peak carrier levels to hum and noise*

- Restore the all white signal (A2) at the input to standardized levels.
- Superimpose hum on the input signal with amplitude and frequency as given in the equipment specification and measure the peak-to-peak value of the residual hum on blanking level (h_1) and on the peak white level (h_2) and measure the synchronizing level (c) (see Figure 2g).
- Add to the video input signal, if applicable, the field synchronizing signals.
- Superimpose noise on the input signal with amplitude and frequency as given in the equipment specification.
- Check on a monitor if noise disturbs the working of the clamp circuit.

7.4.4.5 *Stability of characteristic vision levels due to mains supply voltage variations*

- Restore the all white signal (A2) at the input to standardized levels.
- Vary the mains supply voltage between the two values given in the equipment specifications and determine for minimum voltage the blanking level (b_1), the peak white level (w_1) and peak carrier level (c_1) (see Figure 2b), and determine for maximum voltage the blanking level (b_2), the peak white level (w_2) and the carrier level (c_2) (see Figure 2b).

7.4.5 *Measuring procedure for transmitters with positive modulation*

7.4.5.1 *Stability of the blanking level due to luminance level variation*

- Modulate the transmitter with an all white signal (A2) and determine the value of the blanking level (b_1), and the peak white level (c_1) with ITS on line 17 (SECAM) (see Figure 2j).
- Replace the all white signal (A2) by an all black signal (A1) and determine again the blanking level (b_2) and the carrier (white) level (c_2) (see Figure 2k).

7.4.5.2 *Stability of the synchronizing pulse due to the input synchronizing pulse variation*

- Change the synchronizing pulse amplitude of the input test signal (A1) + ITS between the minimum and maximum values specified in the equipment specification keeping the peak-to-peak voltage of the luminance signal constant at 700 mV, and determine the blanking level (b_1) for the minimum synchronizing pulse amplitude of the input signal and determine the blanking level (b_2) for the maximum synchronizing pulse amplitude of the input signal.

7.4.5.3 *Sensitivity of blanking and peak carrier (white) levels to hum*

- Restore the all white signal (A2) at the input to standardized levels.
- Superimpose hum on the input signal with amplitude and frequency as given in the equipment specification and determine the peak-to-peak value of the residual hum on the blanking level (h_1) and on the peak white level (h_2) and measure the peak carrier (white) level (c) (see Figure 2).
- Superimpose noise on the input signal with amplitude and frequency as given in the equipment specification.
- Check on a monitor if noise disturbs the working of the clamp circuit.

7.4.5.4 *Stability of characteristic vision levels due to mains supply voltage variations*

- Restore the all white signal (A2) at the input to standardized levels.
- Vary the mains voltage between the two values given in the equipment specification and determine for minimum voltage the blanking level (b_1), the peak carrier level (c_1), and determine for maximum voltage the blanking level (b_2), the peak carrier level (c_2); if required, repeat these measurements with a black and white sawtooth.

7.4.6 Calculation and presentation of the results

- a) The variation of the peak carrier level or peak envelope power is given by:

$$20 \log \frac{c_1}{c_2} \text{ dB}$$

- b) The variation of the blanking level is given by:

$$\left| \frac{b_1}{c_1} - \frac{b_2}{c_2} \right| \times 100 \%$$

- c) The variation of the peak white level (only applicable for negative modulation) is given by:

$$\left| \frac{w_1}{c_1} - \frac{w_2}{c_2} \right| \times 100 \%$$

- d) The variation of the synchronizing pulse is given by:

$$\frac{c_1 - b_1}{c - b} \times 100 \% \text{ and } \frac{c_2 - b_2}{c - b} \times 100 \% \text{ for negative modulation}$$

and by:

$$\frac{b_1}{b} \times 100 \% \text{ and } \frac{b_2}{b} \times 100 \% \text{ for positive modulation}$$

- e) For 1 to 4, state the variation of the power supply voltage in percent of the nominal value.
f) The residual hum on the blanking level is given by:

$$\frac{h_1}{c} \times 100 \%$$

- g) The residual hum on the peak white level is given by:

$$\frac{h_2}{c} \times 100 \%$$

- h) For f) and g):

- State the superimposed hum at the input in peak-to-peak voltage of the video signal.
- State the superimposed peak-to-peak noise at the input in of the peak-to-peak voltage.
- State whether the working of the clamp circuit is disturbed by superimposed noise.

8 Linear distortion

8.1 Introduction

The linear distortion is determined by measuring the amplitude and phase of the signal as a function of the frequency. In a distortion free-network, the amplitude is constant and the phase is proportional to the frequency.

8.2 Amplitude/radio frequency characteristic

8.2.1 Definition

The amplitude/radio frequency characteristic is the variation of the amplitude as a function of the frequency of the sideband components when the transmitter is modulated with a sinusoidal signal of constant amplitude and variable frequency, superimposed on a luminance signal of constant level.

NOTE The amplitude/radio-frequency characteristic is sometimes referred to as "sideband characteristic" or "sideband response".

8.2.2 Measuring arrangement

The measuring arrangement is given in Figure 3a. A video analyser is a composite arrangement of a video generator, a sweep generator and analyser and an oscilloscope and may be contained in one case or as separate instruments. The output of the RF sideband adaptor is connected to the video analyser.

Alternatively, a video sweep generator and a RF spectrum analyser can be used.

8.2.3 Test signal

The test signal A4s shall be used comprising a composite video waveform with a sinusoidal sweep signal superimposed on a luminance signal of constant level (see Annex B).

8.2.4 Measuring procedure

- Adjust the luminance level x of the test signal to a value in the demodulated output signal between blanking level and peak white level. Adjust the peak-to-peak amplitude of the superimposed sweep signal s to a convenient value, for example 20 % of the peak synchronizing level (see Figure 3b).
- If required, repeat the measurement for a limited number of values of x between blanking level and peak white level. Care should be taken that the peaks of the superimposed sweep signal do not exceed these levels.
- The repetition rate of the frequency sweep of the analyser may be equal to, or lower than the field frequency. Generally, the accuracy of the measurements will increase with decreasing values of the repetition rate.
- For measurements within the channel bandwidth, any amplitude of the signal s may be chosen which does not produce overmodulation.

— For measurements of the re-inserted lower sideband due to non-linear distortion, the value of x should represent mid-grey level and the peak-to-peak value of s should be from blanking level to peak white level. This condition will produce the maximum out-of-band radiation (see Figure 3c).

8.2.5 Presentation of the results

The results shall be presented as a graph of the oscilloscope display. The values of s and x used during the test shall be stated with the results, together with the reference frequency used.

Figure 3d, shows, as an example, an oscilloscope graticule used for a transmitter operation on system B or G.

NOTE In some test equipments, spot measurements can be made by switching off the sweep and operating the test frequency manually. This is necessary, for example, to determine the amplitude at a specific frequency.

8.3 Amplitude/video-frequency characteristic

8.3.1 Definition

The amplitude/video-frequency characteristic is the variation of the peak-to-peak amplitude as a function of the frequency of the demodulated vision signal, when the transmitter is modulated with a sinusoidal signal of constant amplitude and variable frequency, superimposed on a luminance signal of constant level.

NOTE The amplitude/video-frequency characteristic is sometimes referred to as "overall video-frequency characteristic" or "overall video-frequency response".

8.3.2 Measuring arrangement

The measuring arrangement is given in Figure 3a.

The output of the VSB demodulator is connected to the video analyser.

8.3.3 Test signal

The test signal A4s shall be used comprising a composite video waveform with a sinusoidal sweep signal superimposed on a luminance signal of constant level (see Annex B).

8.3.4 Measuring procedure

Adjust the luminance level x of the test signal to correspond to a mid-grey picture. Adjust the peak-to-peak amplitude of the superimposed sweep signal s to a value in the demodulated output signal from blanking level to peak white level (see Figure 3c).

NOTE 1 When measuring with a demodulator equipped with an *envelope* detector, s should be kept small, for example 10 % of the nominal peak-to-peak amplitude of the vision signal, in order to minimize the effects of quadrature distortion.

NOTE 2 The oscilloscope scanning frequency should be in synchronism with the video sweep frequency, which may be equal to, or lower than, the field frequency. Generally, the accuracy of measurement will increase with decreasing values of the sweep rate.

8.3.5 Presentation of the results

The results shall be presented as a graph of the oscilloscope display. The values of s and x used during the test shall be stated with the results, together with the reference frequency used.

Figure 3e shows, as an example, an oscilloscope graticule used for a transmitter operating on system B or G.

NOTE In some test equipments, spot measurements can be made by switching off the sweep and operating the test frequency manually. This is necessary, for example, to determine the amplitude at a specified frequency.

8.4 Group-delay/radio-frequency characteristic

8.4.1 Introduction

The following method of measurement of the group-delay characteristic enables the measurement of the group-delay of the lower and higher sidebands.

8.4.2 Definition

The group-delay/radio-frequency characteristic is the variation of the group-delay as a function of the frequency of vision sidebands, which is produced when the transmitter is modulated with a sinusoidal signal of constant amplitude and variable frequency superimposed on a luminance signal of constant level.

8.4.3 Measuring arrangement

The measuring arrangement is given in Figure 3f. The RF sideband adaptor is connected to the group-delay test set which consists of a sweep generator, video analyser, phase comparator integrated in one case or as separate instruments.

8.4.4 Test signal

Test signal A4s shall be used with the superimposed signal at variable frequency f_s being modulated in amplitude with a sinusoidal oscillation at fixed frequency f_g , which shall be preferably less than 100 kHz (see Annex B).

The lower the frequency f_g , the higher the resolution of the measurement.

The superimposed signal shall be adjusted to a peak amplitude of 20 % of the peak-to-peak amplitude of the vision signal. The luminance level shall be at mid-grey (see Figure 3g).

8.4.5 Measuring procedure

— Adjust the horizontal and vertical amplitude of the oscilloscope to correspond with the requirements of the appropriate graticule.

— The accuracy of the measurement will increase with decreasing values of sweep rate.

— If required, repeat the measurement with the receiver pre-correction filter out of operation.

- If required, determine the changes in the group-delay characteristic due to variation of the value of luminance level x and superimposed signal s .

8.4.6 Presentation of the results

The results shall be presented as a graph of the oscilloscope display. The values of s and x shall be stated with the results together with the reference frequency, if any. Figure 3i, shows, as an example, an oscilloscope graticule used for a transmitter operating on system G without the receiver pre-correction filter in operation.

NOTE In some test equipments, spot measurements can be made by switching off the sweep and varying the test frequency f_s manually.

8.5 Group-delay/video-frequency characteristic

8.5.1 Definition

The group-delay/video-frequency characteristic is the variation of the group-delay as a function of the frequency of the demodulated vision signal, when the transmitter is modulated with a sinusoidal signal of constant amplitude and variable frequency superimposed on a luminance signal of constant level.

8.5.2 Measuring arrangement

The measuring arrangement is given in Figure 3f.

In order to measure the performance of the transmitter, it is necessary to measure with a demodulator having a constant group-delay up to 5 MHz.

For this reason, the demodulator should be equipped with a sound trap capable of being switched on and off. When the transmitter is equipped with a separate pre-correction group-delay filter for the receiver, it is preferable to switch off this filter.

8.5.3 Test signal

Test signal A4s shall be used with the superimposed signal at variable frequency f_s being modulated in amplitude with a sinusoidal oscillation at fixed frequency f_g , which shall be preferably less than 100 kHz.

The lower the frequency f_g , the higher the resolution of the measurement.

The superimposed signal shall be adjusted to a peak-to-peak amplitude of 20 % of the peak-to-peak amplitude of the vision signal. The luminance level shall be at mid-grey level (see Figure 3g).

8.5.4 Measuring procedure

- Switch off the sound trap in the VSB demodulator.
- Switch off the sound carrier in the transmitter.
- Adjust the horizontal and vertical amplitudes of the oscilloscope to correspond with the requirements of the appropriate graticule.
- The accuracy of the measurement will increase with decreasing values of sweep rate.
- If required, repeat the measurement with the sound trap of the demodulator switched on.
- If required, repeat the measurement with both receiver pre-correction filter and sound trap switched off.
- If required, determine the changes in the group-delay characteristic, due to variation of the value of luminance level x and superimposed signal s .

8.5.5 Presentation of the results

The results shall be presented as a graph of the oscilloscope display.

The values of s and x shall be stated with the results together with the reference frequency, if any.

Figure 3h shows, as examples, oscilloscope graticules used for a transmitter operating on system G or L with the pre-correction filter in the transmitter and the sound trap in the demodulator switched off.

NOTE In some test equipments, spot measurements can be made by switching off the sweep and varying the test frequency f_s manually.

9 Non-linear distortion

9.1 Introduction

The amplitude and phase characteristics mentioned in clause 8 are not only a function of frequency, but may also depend on the amplitude of the luminance signal and/or the chrominance signal.

This results in the following non-linear distortions:

- luminance non-linearity;
- differential gain and differential phase;
- performance of the colour bar signal;
- chrominance-luminance intermodulation or chrominance-luminance cross-talk;
- incidental phase modulation.

9.2 Luminance non-linearity

9.2.1 Definition

The luminance non-linearity or amplitude distortion of the luminance signal is the change in the gain of the luminance signal as a function of the associated luminance level.

9.2.2 Measuring arrangement

The measuring arrangement is given in Figure 4a. The demodulator output is connected to an oscilloscope through a differentiating network (see Annex A, clause A.4).

NOTE The differentiating network can be a part of the oscilloscope.

9.2.3 Test signal

The test signal is a five-step staircase (C1). To measure the non-linearity with changing values of the average picture level, the transmitter shall be modulated with a five-step staircase followed by three black lines (black staircase C2) or three white lines (white staircase C3) (see Annex B).

9.2.4 Measuring procedure

- Modulate the transmitter with test signal C1.
- The differentiating network at the output of the demodulator transforms the staircase into a series of pulses (see Figure 4b).
- Determine the greatest pulse amplitude ($A_{\max}$) and smallest pulse amplitude ($A_{\min}$) in the demodulated video signal on the oscilloscope.
- If required, repeat for other values of the average picture level the measurement with the black and white staircase (C2 and C3 respectively) (see Annex B).

9.2.5 Calculation and presentation of the results

The luminance non-linearity is calculated as follows and presented as a percentage:

$$\left| \frac{A_{\max} - A_{\min}}{A_{\max}} \right| \times 100 \%$$

Alternatively, the luminance linearity can be calculated as follows:

$$\left| \frac{A_{\min}}{A_{\max}} \right| \times 100 \%$$

9.3 Differential gain and phase

9.3.1 Definition

Differential gain or phase is the change in gain or phase of the chrominance sub-carrier relative to the gain or phase at blanking level as a function of the associated luminance level.

NOTE The definition of differential gain is also valid for the change in gain of medium and higher video frequencies.

9.3.2 Measuring arrangement

The measuring arrangement is given in Figure 4c. For the differential gain, the demodulator output is connected to an oscilloscope through a band-pass filter to suppress all components in the video signal except the chrominance sub-carrier.

For the differential phase, the demodulator output is connected to a phase meter. Alternatively, a special instrument can be used to measure differential gain and phase sequentially or simultaneously.

The differential phase shall be measured with both synchronous detection and envelope detection. Both values shall be recorded.

NOTE Differential phase measurements made using only synchronous demodulation are not advisable, because they may be affected by the presence of incidental phase modulation.

9.3.3 Test signal

The test signal is a staircase or a saw-tooth with a superimposed signal $\leq 10 \%$ (of the luminance (C1s or B1s) at chrominance sub-carrier frequency (see Annex B).

To measure the differential gain and phase on other values of the average picture level, the transmitter shall be modulated with the signals given above followed by three black lines (black signal C2s or B2s) or three white lines (white signal C3s or B3s) (see Annex B).

NOTE If required, the luminance level of the test signal should extend in the blacker than black region and/or in the whiter than white region.

9.3.4 Measuring procedure

- Determine the maximum peak-to-peak amplitude $A_{\max}$, the minimum peak-to-peak amplitude $A_{\min}$ of the chrominance sub-carrier (see Figure 4d).
- Determine the peak-to-peak amplitude A_0 at blanking level (see Figure 4d).
- Set the phase at blanking level at 0° .
- Determine the maximum positive ($+\Delta\varphi_{\max}$) and negative ($-\Delta\varphi_{\max}$) phase difference relative to the 0° phase at blanking level.
- Repeat the measurement of the differential phase with the demodulator switched to envelope detection.
- If required, repeat these measurements using a black and white staircase (C2s and C3s respectively) or sawtooth (B2s and B3s respectively).

9.3.5 Calculation and presentation of the results

The differential gain is calculated as follows:

$$X = \left| \frac{A_{\max}}{A_0} - 1 \right| \quad \text{and} \quad Y = \left| \frac{A_{\min}}{A_0} - 1 \right| \times 100 \%$$

The differential phase is presented in degrees both positive ($+\Delta\varphi_{\max}$), and negative ($-\Delta\varphi_{\max}$) relative to the phase at blanking level.

If required, the peak-to-peak value of the differential gain ($X + Y$) and the differential phase ($|+\Delta\varphi_{\max}| + |-\Delta\varphi_{\max}|$) can be presented.

The level as a percentage of the superimposed sub-carrier at blanking level and the highest and lowest luminance level shall be stated.

For the differential phase measurement, the type of detection used (envelope or synchronous) shall be stated.

9.4 Chrominance non-linearity

(Under consideration.)

9.5 Chrominance-luminance intermodulation or cross-talk

9.5.1 Definition

Chrominance-luminance intermodulation or cross-talk relates to the change in the amplitude of the luminance signal as a function of the amplitude of the associated chrominance signal.

9.5.2 Measuring arrangement

The measuring arrangement is given in Figure 4e.

The demodulator output is connected to an oscilloscope through a low-pass filter to suppress the chrominance sub-carrier frequency.

9.5.3 Test signal

The test signal is a mid-grey luminance bar with or without superimposed colour sub-carrier signal (D or D' depending on the system) (see Annex B).

To determine the reference level which corresponds to peak white level, an all white signal (A2) shall be used in the case of signal D . In the case of signal D' , part C1 of the signal can be used as a reference (see Annex B).

9.5.4 Measuring procedure

- The transmitter shall be modulated with an all white signal A2 for 625 line systems or with signal D' for 525 line systems (see Annex B).
- Determine the deflection from blanking level to peak white level (a_0).
- Replace the all white signal by the luminance bar signal D for 625 line systems.
- Determine the luminance level (a_1) of that part of the signal where the chrominance signal at the input of the transmitter is not present (point b6 of Figure 4f).
- Determine the luminance level (a_2) of that part of the signal where the chrominance signal at the input of the transmitter is maximum (point b5). See Figure 4f for signal D after filtering.

9.5.5 Calculation and presentation of the results

The intermodulation or cross-talk is calculated as follows:

$$\left| \frac{a_1 - a_2}{a_0} \right| \times 100 \%$$

9.6 Incidental phase modulation

9.6.1 Introduction

Incidental phase modulation is the term for unwanted synchronous phase modulation of the vision carrier.

Phase modulation causes differential phase distortion and intercarrier noise in the audio signal in the case of intercarrier demodulation.

9.6.2 Definition

Incidental phase modulation is the change in phase of the vision carrier due to the variation in amplitude of the vision signal between peak white level and peak synchronizing level.

NOTE In the synchronizing region, the change in phase is not dependent on picture content and will give a permanent intercarrier buzz. In the picture region, the buzz is mainly dependent on the picture content. For this reason, the two different values of the incidental phase modulation may be specified and measured separately for both regions.

9.6.3 Measuring arrangement

The measuring arrangement is given in Figure 4g.

The “in phase” and “quadrature” output of the synchronous demodulator is connected to an X-Y oscilloscope via low-pass filters with a cut-off frequency at 0,3 MHz to reduce clutter on the display. The “in-phase” output is connected to the vertical amplifier.

The combination of the demodulator and the oscilloscope shall have equal gain in both channels.

9.6.4 Test signal

The transmitter shall be modulated with a five step staircase C1 (see Annex B).

9.6.5 Measuring procedure

- Check if the total gain of the demodulator and the oscilloscope has equal gain in both channels.
- Switch on the zero carrier pulse of the demodulator. The phase control of the demodulator shall be on automatic lock.
- Position the zero carrier luminance dot on the vertical reference line by adjusting the d.c. setting of the oscilloscope (see Figure 4h).
- Increase the gain of the horizontal amplifier of the oscilloscope by a factor f (e.g. $\times 10$) in order to increase the accuracy of the measurement.

— Adjust the phase control on the demodulator so that the dot corresponding to synchronizing level corresponds with the vertical reference line.

— Determine by trigonometry the maximum angle (φ_{tot}) between the dots in the region from peak white level to synchronizing level (see Figure 4h).

— If required, determine by trigonometry the maximum angle (φ_p) between the dots in the region from peak white level and blanking level and the maximum angle (φ_s) between blanking level and synchronizing level.

NOTE Direct reading of the incidental phase modulation is possible when a graticule is used (see Figure 4i). The factor f should be stated on the graticule.

9.6.6 Presentation of the results

The incidental phase modulation shall be given in degrees.

The values calculated from Figure 4h shall be divided by factor f . This factor shall be stated with the results.

NOTE In principle, the tangents of the angles should be divided by factor f ; for angles $< 10^\circ$, the angle itself can be divided by factor f .

The levels between which the incidental phase is calculated shall be mentioned.

10 Waveform distortion

10.1 Introduction

Waveform distortion relates to departures in the shape of a video signal from its original shape.

This clause deals with the measurements of the waveform distortion both in the picture and in the blanking intervals of the video signal.

The measurements in the picture interval of the signal concern:

— transient characteristics, using the following test signal:

- a) $2T$ pulse;
- b) T step or T pulse.

These signals are characterized by the time:

$$T = \frac{1}{2f_c}$$

where f_c is the nominal upper video frequency of the television system concerned. The half-amplitude duration time of the sine-squared pulse and the rise time of the step function signal are integer multiples of T .

For $f_c = 5 \text{ MHz}$,

$T = 100 \text{ } \mu\text{s}$, $2T = 200 \text{ ms}$, $20T = 2 \text{ } \mu\text{s}$;

— luminance amplitude tilt is measured by means of the following test signals:

- c) field-time bar;
- d) line-time bar;
- e) luminance bar.

The luminance tilt is mainly caused by phase distortion in the transmitter. The result of the measurement can, however, be influenced by "line tilt" due to incorrect d.c. restoration in the transmitter.

Measurements in the blanking interval of the video signal concern:

- f) distortion of line-synchronizing pulse;
- g) distortion of field-synchronizing pulse.

In addition to the above measurements, this clause also deals with measurements of the distortion on the output signal, caused by auxiliary processes in the transmitter and the measuring demodulator.

These measurements are:

- h) line signal distortion;
- i) long time signal distortion.

Finally, the $20T$, $12,5T$ or $10T$ pulse distortion caused by gain and delay inequality between the chrominance and luminance components in the composite $20T$, $12,5T$ or $10T$ pulse is described in this clause.

10.2 $2T$ -pulse distortion including the pulse-bar ratio

10.2.1 Introduction

The $2T$ pulse is a sine-square pulse and has a half-amplitude duration time of $2T$. As all main frequency components of the pulse are within the video-frequency band of the television standard concerned, any pulse distortion is caused by the transmitter itself.

10.2.2 Definition

The $2T$ pulse distortion relates to the departure of the $2T$ pulse from its ideal shape.

10.2.3 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.2.4 Test signal

Test signal H shall be used for 625 line systems and H' for 525 line systems as given in Annex B.

10.2.5 Measuring procedure

- Modulate the transmitter with test signal H or H' depending on the system.
- Display the demodulated signal on the oscilloscope as in Figure 5b.

— Determine the amplitude (a_2) between b_2 and reference point b_1 and amplitude (a_1) between b_{11} and b_7 in the output signal.

— Alternatively, a graticule can be used in which the measuring points intersect the graticule points (see Figure 5c).

— Employ the oscilloscope graticule shown in Figure 5d, and display the demodulated signal on the oscilloscope as in Figure 5e.

— Adjust the oscilloscope so that:

- the time base corresponds to the time scale line on the graticule, where:

$$T = \frac{1}{2f_c}$$

and the $2T$ pulse is symmetrically disposed around the vertical axis through the time reference 0;

- the baseline of the pulse coincides with the time scale line of the graticule and the peak of the $2T$ pulse is at the 100 % line of the graticule.

10.2.6 Calculation and presentation of the results

— The results shall be presented as a graph of the oscilloscope display.

— Calculate the $2T$ pulse-bar ratio $100 \left(\frac{a_1}{a_2} \right) \%$

and/or state whether the pulse is within the specified K -rating tolerance as given in the graticule.

— State whether the pulse shape is within the specified K -rating tolerance as given in the graticule.

10.3 T -step or T -pulse distortion

10.3.1 Introduction

The luminance step signal is a sine-squared step with a rise time of T which corresponds to the highest degree of picture definition possible in the television system concerned. However, the signal is affected by ringing, i.e. damped oscillations in the output signal because of the limiting effect of the upper video frequency.

10.3.2 Definition

The T step distortion relates to the departure of the step from its ideal shape.

10.3.3 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.3.4 Test signal

Test signal F as given in Annex B shall be used. Alternatively, a T -pulse (test signal F') can be used.

The square wave signal has a repetition rate of integral multiple of the line frequency. For 625 line systems, a repetition rate of 250 kHz is used.

10.3.5 Measuring procedure

— The transmitter shall be modulated with test signal F or F'.

— Employ an oscilloscope graticule. Display the signal on the oscilloscope as given in Figure 5g and Figure 5e. Examples of graticules are given in Figure 5f and Figure 5d.

— Adjust the oscilloscope for the 250 kHz square wave so that the time base corresponds to the time scale of the graticule, where:

$$T = \frac{1}{2f_c}$$

and the steady-state level of the signal coincides with the levels A and B on the graticule. The leading edge of the step intersects the C on the graticule.

— Repeat the same measurement for the trailing edge.

— Adjust the oscilloscope for the T pulse-as described in 10.2.5 for the $2T$ pulse, employing the graticule Figure 5d.

— If required, repeat, in the case of the 250 kHz square wave, the measurement for other values of the luminance level x and the peak-to-peak level of the square waves s or, in the case of the T pulse, for other values of the peak-to-peak amplitude(s) (see Figure 5d).

10.3.6 Presentation of the results

— The results shall be presented as a graph of the oscilloscope display. The values of s and x used shall be given with the results.

— State whether the pulse is within the specified K -rating tolerance as given in the graticule.

10.4 Field-time bar tilt

10.4.1 Definition

The field-time bar tilt is the difference between the amplitudes of the field-time bar 250 μ s after the half-amplitude point of its leading edge and 250 μ s before the half-amplitude point of its trailing edge. It is expressed as the ratio to the nominal bar amplitude.

The field-time bar tilt is also expressed as a K -rating which is the ratio of the largest difference between one of the two edge amplitudes above and the nominal field bar amplitude. It is expressed as the ratio to the nominal bar amplitude.

10.4.2 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.4.3 Test signal

Test signal G as given in Annex B shall be used.

10.4.4 Measuring procedure

- The transmitter shall be modulated with test signal G.
- Display the demodulated signal on the oscilloscope as in Figure 5h.
- Determine the amplitude a_2 between point b_2 and reference point b_1 .
- Determine the amplitude a_3 between point b_1 and b_3 and amplitude a_1 between b_1 and b_4 .
- Alternatively, a graticule can be used (see Figure 5c).

10.4.5 Presentation of the results

Calculate bar tilt:

$$\left| \frac{a_1 - a_3}{a_2} \right| \times 100 \%$$

and present the result in per cent.

Calculate K-field bar-rating:

$$\left| \frac{a_1 - a_2}{a_2} \right| \times 100 \% \text{ and } \left| \frac{a_3 - a_2}{a_2} \right| \times 100 \%$$

and present the larger value of the two.

The result may alternatively be presented as a graph of the oscilloscope display stating whether the pulse is within the specified *K*-rating tolerance as given in the graticule.

10.5 Line-time bar tilt

10.5.1 Definition

The line-time bar tilt is the difference between the amplitudes of the line-time bar 1 μ s after the half-amplitude point of its leading edge and 1 μ s before the half-amplitude point of its trailing edge. It is expressed as the ratio to the nominal bar amplitude.

The line-time bar tilt is also expressed as a *K*-rating which is the ratio of the largest difference between one of the above edges amplitudes and the nominal line bar amplitude. It is expressed as the ratio to the nominal bar amplitude.

10.5.2 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.5.3 Test signal

Test signal E as given in Annex B shall be used.

10.5.4 Measuring procedure

- The transmitter shall be modulated with test signal E.
- Display the demodulated signal on the oscilloscope as in Figure 5i.

- The procedure is the same as that described in 10.4.4.

10.5.5 Presentation of the results

Calculate and present the line bar tilt or *K*-line bar-rating as described in 10.4.5.

10.6 Luminance bar tilt

10.6.1 Introduction

The luminance bar tilt is the tilt of a luminance bar having a half-amplitude duration of 10 μ s in 625 line systems and 17,9 μ s in the 525 line systems. The ITS signal may be used as alternative to the line-bar signal during programme.

10.6.2 Definition

The luminance bar tilt is the difference between the amplitudes of the luminance bar 1 μ s after the half-amplitude point of its leading edge and 1 μ s before the half-amplitude point of its trailing edge. It is expressed as the ratio to the nominal bar amplitude.

The luminance bar tilt is also expressed as a *K*-rating which is the ratio of the largest difference between one of the above edges amplitudes and the nominal luminance bar amplitude. It is expressed as the ratio to the nominal bar amplitude.

10.6.3 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.6.4 Test signal

Test signal H shall be used for the 625 line systems and test signal H' for the 525 line system as they are given in Annex B.

10.6.5 Measuring procedure

- The transmitter shall be modulated with test signal H or H'.
- Display the demodulated signal on the oscilloscope as in Figure 5j.
- The procedure is the same as that described in 10.4.4.

10.6.6 Presentation of the results

Calculate and present the bar tilt as described in 10.4.5.

10.7 Line synchronizing pulse distortion

10.7.1 Definition

The line synchronizing pulse distortion relates to the departure of pulse from its ideal shape and position.

10.7.2 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.7.3 Test signal

Test signal A3 shall be used (see Annex B).

10.7.4 Measuring procedure

- Modulate the transmitter with test signal A3.
- Display the demodulated line synchronizing interval of the signal on the oscilloscope as in Figure 5k.
- Adjust the oscilloscope so that the time base is calibrated, for example, 1 cm = 1 μ s.
- Measure half-amplitude duration t_1 , the interval time t_2 , and the pulse amplitudes a_1 and a_2 as given in Figure 5k.
- If required, measure the rise time of the leading and trailing edge between 10 % and 90 % of the amplitude (see Figure 5k).

10.7.5 Presentation of the results

Calculate the overshoot of the synchronizing pulse amplitude as follows:

$$\frac{(a_1 - a_2)}{a_2} \times 100 \%$$

Calculate the time difference between t_1 of the input signal and output signal, then make the same calculation for t_2 .

If required, calculate the difference in build-up time between in and output signal.

10.8 Field blanking interval distortion

10.8.1 Definition

The field-blanking interval distortion relates to the maximum change in the blanking level during the field-blanking interval relative to the nominal level.

10.8.2 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.8.3 Test signal

Test signal A1 shall be used with field synchronizing signal (see Annex B).

10.8.4 Measuring procedure

- Modulate the transmitter with test signal A1 and field synchronizing pulses if not present.
- Display the demodulated field blanking interval of the signal on the oscilloscope as shown in Figure 5l.
- Measure the amplitudes a_1 , a_2 , a_3 and a_4 as given in Figure 5l.

10.8.5 Presentation of the results

Calculate the maximum change during the field-blanking interval for example

$$\left(\frac{a_1 - a_3}{a_2} \right) \times 100 \text{ or } \left(\frac{a_4 - a_2}{a_2} \right) \times 100 \% \text{ whichever is the greater.}$$

10.9 Line tilt

10.9.1 Introduction

Line tilt may be caused by an incorrect d.c. restoration process in the television transmitter.

10.9.2 Definition

Line tilt is the tilt of the line between the back porch after d.c. restoration and front porch in the vision signal.

10.9.3 Measuring arrangement

The measuring arrangement is given in Figure 5a.

10.9.4 Test signal

Test signal A1 shall be used (see Annex B).

10.9.5 Measuring procedure

- The transmitter shall be modulated with test signal A1.
- Display the demodulated signal on the oscilloscope as shown in Figure 5m.
- Measure the amplitudes a_1 and a_2 as given in Figure 5m.

10.9.6 Presentation of the results

Calculate the line tilt: $\left(\frac{a_1 - a_2}{a_2} \right) \times 100 \%$ and present the result in per cent.

10.10 Long-time signal distortion

10.10.1 Introduction

Long-time signal distortion or “bounce” can arise due to poor design of RC blocking circuits, or d.c. restoration failures in the video section of the transmitter. Another main cause may be due to poorly designed power supplies. The distortion usually shows itself as a very low frequency ringing as a result of rapid change in the average picture level.

10.10.2 Definition

Long-time signal distortion or “bounce” is the maximum low frequency blanking level ringing of the video signal waveform resulting from a transient change in luminance level.

10.10.3 Measuring arrangement

The measuring arrangement is given in Figure 5a. The zero-carrier pulse in the VSB demodulator shall be switched on.

10.10.4 Test signal

The test signals A1 (an all black signal) and A2 (an all white signal) shall be used (see Annex B).

10.10.5 Measuring procedure

- Modulate the transmitter alternatively with an all black and an all white signal switched automatically at a convenient low frequency between 0,1 Hz and 2 Hz.
- Adjust the sweep time and the repetition frequency of the oscilloscope to display the transition period and any waveform distortion present as given in Figure 5n.
- Measure the peak-to-peak amplitude value of the largest overshoot on blanking level.

10.10.6 Presentation of the results

Calculate the ratio:

$$\left| \frac{a_1}{a_2} \right| \times 100 \%$$

The results may be presented as a graph of the oscilloscope display.

10.11 Chrominance-luminance gain and delay inequality using a composite pulse

10.11.1 Introduction

The composite pulse is a test signal formed by adding a 100 % amplitude modulated chrominance subcarrier with an nT pulse to the nT where n depends on the television system concerned, that is 10 or 20 for 625 line systems (half-amplitude duration 2 μ s or 1 μ s) and 12,5 for 525 line systems. Baseline distortion is caused by gain and/or delay inequality between the chrominance and luminance components in the signal.

10.11.2 Definition

The chrominance-luminance gain and delay inequality is the difference in amplitude respectively in time of the nT pulse (luminance part) and the envelope of the modulated chrominance subcarrier (chrominance part) expressed in per cent of the nT pulse and in nanoseconds respectively.

10.11.3 Measuring arrangement

The measuring arrangement is given in Figure 5a. An equalizer to neutralize the gain and delay inequality shall be inserted between the demodulator and the video oscilloscope. Alternatively, the gain and delay inequality can be determined by measuring the baseline distortion and using the nomogram of Figure 5p.

10.11.4 Test signal

Test signal H shall be used for 625 line systems and signal H' for 525 line systems.

For system I, it may be required to use a $10T$ pulse instead of a $20T$ pulse.

10.11.5 Measuring procedure

- Display the nT pulse as given in Figure 5o.
- Adjust the equalizer so that the gain and delay inequality is neutralized. The baseline will be flat in this case.
- Read the gain and delay inequality from the equalizer.
- As an alternative, measure the amplitudes $U_{\max}$, U_a and U_b .
- Determine the gain and delay inequality by using the appropriate nomogram. An example is given in Figure 5p.

NOTE The results may be affected by other distortions.

10.11.6 Presentation of the results

The gain inequality shall be presented in per cent (positive) when the chrominance exceeds the luminance.

The delay inequality shall be presented in nanoseconds (positive) when the chrominance lags the luminance. In case the luminance exceeds the chrominance, the sign is negative; also when the chrominance leads.

11 Unwanted modulation

11.1 Introduction

Unwanted modulation in the vision signal may be classified as follows:

- random noise;
- low frequency periodic noise;
- high frequency periodic noise including intermodulation products;
- impulsive noise.

Unwanted modulation occurs primarily in the separate vision and sound part of the transmitter but combining the two parts may also introduce additional unwanted modulation when the combining network has insufficient decoupling.

Intermodulation products may be produced by interaction between the sound channel(s) and the vision channel when a common radio frequency amplifier is used.

Intermodulation products outside the channel bandwidth are also measured in this clause.

Unwanted modulation in the sound is dealt with in clause 13.

11.2 Random noise

11.2.1 Introduction

Random noise is caused by electronic components and may affect picture quality.

11.2.2 Definition

The signal-to-random noise ratio is the ratio, expressed in decibels, of the peak-to-peak voltage of a reference signal extending from blanking level to peak white level in the demodulated signal, to the r.m.s. voltage of the (weighted) noise in a frequency band, the upper and lower limits of which are defined by a band limiting filter.

11.2.3 Measuring arrangement

The measuring arrangement given in Figure 6a, shall be used with the following filters in the video measuring set:

- a low-pass filter. The cut-off frequency of this filter shall be in accordance with the system used (4,2 MHz for systems M and N, 5 MHz for system B-G, 5,5 MHz for system I, for example). A 5 MHz filter is given in CCIR Recommendation 567 (see Annex A, clause A.4).
- a high-pass filter to eliminate the d.c. component and the components in the lower part of the video band, for example those due to power supply hum. The cut-off frequency of the filter shall be 10 kHz (see Annex A, clause A.4).
- a weighting network as specified in CCIR Recommendation 567 (see Annex A, clause A.4).

The noise measuring set shall measure peak-to-peak values and r.m.s. values and shall ignore the presence of line and field-blanking pulses.

11.2.4 Test signals

For the reference, an all white signal (A2) shall be used. The noise shall be measured with an all black signal (A1), an all white signal (A3) and, if required, a grey signal (A3).

11.2.5 Measuring procedure

- Modulate the transmitter with test signal E.
- Calibrate the noise measuring set on 0 dB reference level which is the peak-to-peak value of the luminance bar.
- Modulate the transmitter with test signal A1.
- Insert the low- and high-pass filter and the weighting network in circuit.
- Repeat the measurement with test signal A2 and with test signal A3, if required.
- If required, repeat the measurements with the sound carrier(s) modulated with maximum deviation for FM or with a specified modulation factor for AM.
- If required, repeat the measurements without the weighting network.

11.2.6 Presentation of the results

State the signal-to-noise ratio in decibels for the different luminance levels, stating whether weighted or unweighted, and the filters used.

State whether it is weighted or unweighted noise.

State the filters used for each measurement.

11.3 Low frequency periodic noise

11.3.1 Introduction

Low frequency periodic noise may be caused by power supply hum or by other electrical or mechanical influences.

11.3.2 Definition

The signal-to-low frequency periodic noise ratio is the ratio, expressed in decibels, of the peak-to-peak amplitude of a reference signal extending from blanking level to peak white level in the demodulated signal, to the peak-to-peak amplitude of the periodic noise.

11.3.3 Measuring arrangement

The measuring arrangement given in Figure 6a, shall be used.

The noise measuring set shall be provided with a low-pass filter with a cut-off frequency of 10 kHz. Other low-pass filters with a lower cut-off frequency may be used.

11.3.4 Test signals

The test signals given in 11.2.4 shall be used.

11.3.5 Measuring procedure

- The procedure is the same as the procedure given in 11.2.5.
- Insert the low-pass filter.
- The noise measuring set shall measure the peak-to-peak value of the periodic noise at blanking level, white level and, if required, at grey level.
- If required, repeat the measurements with the sound carrier(s) modulated with maximum deviation (FM) or with a specified modulation factor (AM).

NOTE For analysing the periodic noise, the hum and other low frequency periodic noise components may be displayed on an oscilloscope.

11.3.6 Presentation of the results

State the signal-to-low frequency periodic noise ratio in decibels for the different luminance levels.

State the cut-off frequency of the filter(s) used.

Photographs of the oscilloscope display will show the character of the periodic noise.

11.4 High frequency periodic noise including intermodulation

11.4.1 Introduction

High frequency periodic noise consists of unwanted single frequency components detectable above the random noise level in the r.f. signal.

Single frequency components outside the channel bandwidth are spurious or out-of-band emissions and can be measured using the same method.

Single frequency components can be generated by:

- local oscillators, especially if generated by synthesis;
- up conversion from i.f. to the transmission channel;
- intermodulation in the sound and vision amplifier and when common sound and vision amplifier is used in the final amplifier.

Intermodulation occurs in the sound amplifier between the sound carrier(s) and the vision signal due to insufficient decoupling between the sound and vision section of a transmitter.

This can also be the reason for intermodulating products in the vision amplifier.

Common amplification can generate intermodulating products between all the vision and sound signals if there is insufficient linearity.

11.4.2 Definition

The high frequency periodic noise level is expressed in decibels, and is the ratio of the peak amplitude of the single frequency component to the peak amplitude of the vision carrier.

11.4.3 Measuring arrangement

The measuring arrangement given in Figure 6b, shall be used.

A spectrum analyser is connected to the directional coupler.

11.4.4 Test signals

Test signal A3 s shall be used. The superimposed signal s shall extend from blanking level to peak white level.

Some specifications require, for the colour subcarrier frequency, a superimposed signal corresponding to a saturated red signal. Examples of standard levels are given in Figure 6d.

11.4.5 Measuring procedure

- Set the level of the vision carrier (U_1) on the analyser display at 0 dB. The analyzer should have an intermediate frequency bandwidth of at least 1 MHz.
- Modulate the transmitter with test signal A3 s. The frequency of s shall be about 1,5 MHz.

— Check with the spectrum analyser the correct amplitude of the upper, sideband signal (U_2), the vision carrier (U_1) and the sound carrier(s) (U_3 and U_4) (see Figure 6c).

— Measure the levels (U_i) of the single frequency components in the channel bandwidth and outside the channel bandwidth in dB relative to 0 dB reference level.

— Repeat the measurement for a limited number of frequencies of s within the video band including the colour subcarrier.

— If required, repeat in the case of AM sound the measurement with the sound carrier modulated to maximum modulation factor.

— For system L, it is required to measure single frequency components also without modulation of the vision carrier.

NOTE Ensure that no intermodulating products or other single frequency components displayed on the spectrum analyser are introduced or accentuated by the instrument. This can be checked by varying the F-input attenuator and noting that the levels displayed follow those indicated by the attenuator.

11.4.6 Presentation of the results

Present the results in the form of a table.

State with the results the frequency of the unwanted components and spurious signals together with the frequency and the level of s.

Some specifications ask for the intermodulating product levels within the channel bandwidth referred to the sideband level.

The spurious signals or out-of-band signals may be calculated in absolute power levels. See IEC 244-1.

State with the results the reference frequency used.

The results may also be presented as a series of graphs from the display of the analyser (see Figure 6c).

11.5 Impulsive noise

11.5.1 Introduction

This type of interference is associated with ignition, contacts in electrical machinery, etc.

No general method of measurement can be laid down. This type of noise may be observed during a long period by photographing an oscilloscope display connected to the output of the noise measuring set in order to record the impulse.

A limitation of the noise bandwidth during observation can facilitate the measurement.

12 Special measurements for data signals in the vision signal

12.1 Introduction

A common technique used to evaluate the effects of the various distortions introduced by the television transmitter on the quality of a “non-return to zero” (NRZ) data signal, such as teletext, is the measurement of the eye diagram characteristics. Reference is made to CCIR Recommendation 653 in which the four teletext systems are described.

The eye diagram is obtained by superimposing data bits on the screen of an oscilloscope with a time base of a fraction of the bit rate (6 to 7 Mbits/s).

An example of an eye diagram is shown in Figure 7a, from which the following parameters are identified:

- (L_0) all zero level;
- (L_1) all ones level;
- (S) mid-level;
- (A_0) basic data amplitude;
- (a_0) zero overshoot;
- (a_1) ones overshoot;
- $(A_{\max})$ outer maximum amplitude at the sampling instant;
- $(A_{\min})$ inner minimum amplitude at the sampling instant;
- $(T_{\min})$ smallest bit interval at the mid-level;
- (T_0) bit interval;
- (t_0) sampling instant.

12.2 Eye height and eye width

12.2.1 Definitions

Eye height (EH): the eye height is the smallest difference in amplitude which may exist between any “zero” pulse and any “one” pulse over all signal sampling positions ($A_{\min}$). It is expressed as a proportion of the basic data amplitude (A_0).

Eye width (EW): the eye width is the smallest bit interval ($T_{\min}$). It is expressed as a proportion of the basic bit interval (T_0).

12.2.2 Measuring arrangement

The measuring arrangement is given in Figure 7b.

The insertion test signal generator shall provide frame synchronizing signals. The data signal shall be inserted in one of the data lines. The output of the demodulator shall be connected to one of the following instruments:

- a) an oscilloscope with line selector. The linear time base shall be synchronized with clock frequency;

- b) a teletext analyser connected to an oscilloscope;

- c) as b), but giving the measuring result automatically.

For calibrating the basic amplitude (A_0), a low-pass filter may be used. An example is given in Annex A, clause A.5. This filter eliminates overshoots but introduces a 2 % reduction of the eye height which should be taken into account with the result.

12.2.3 Test signal

The data signal shall be made up of a pseudo-random sequence of sufficient length (> 255 bits) (see test signal I in Annex B).

Alternatively, the normal teletext signal corresponding to the standard concerned can be used.

An example of a teletext signal is given in Annex B, signal I'.

The transmitter shall be modulated with a mid-grey picture, an all white and all black picture.

12.2.4 Measuring procedure (with oscilloscope)

— Set the level of the data signal in accordance with the standard concerned (see CCIR Recommendation 653).

— Measure the EH and EW as follows (see Figure 7a).

— Determine the basic data amplitude (A_0) and the bit-interval (T_0) of the eye diagram at the mid-level (S) after switching on the low-pass filter.

— Switch off the low-pass filter.

— Determine the sampling instant (t_0) and the inner amplitude ($A_{\min}$) at the sampling instant.

— Determine the smallest bit interval ($T_{\min}$) at the mid-level (S).

— Repeat the measurement with an all black picture and an all white picture.

12.2.5 Calculation and presentation of the results

$$\text{The EH} = \left(\frac{A_{\min}}{A_0} \right) \times 100 \%$$

$$\text{The EW} = \left(\frac{T_{\min}}{T_0} \right) \times 100 \%$$

State with the results the average picture level.

For completeness, a graph of the oscilloscope display may be presented (see Figure 7a).

Alternatively, a graticule such as the one shown in Figure 7c, may be used.