

Video cameras (PAL/SECAM/NTSC) — Methods of measurement —

Part 2: Two- and three-sensor professional cameras

The European Standard EN 61146-2:1997 has the status of a British Standard

ICS 33.160.40

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 December 1997

© BSI 07-1999

ISBN 0 580 28871 4

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
National foreword	ii
Foreword	2
Text of EN 61146-2	5

National foreword

This British Standard is the English language version of EN 61146-2:1997. It is identical with IEC 61146-2:1997.

The UK participation in its preparation was entrusted by Technical Committee EPL/100, Audio, video and multimedia systems and equipment, to Subcommittee EPL/100/3, Equipment and systems in the field of audio, video and audiovisual engineering, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

IEC 61146 consists of the following parts:

- *Part 1: Non-broadcast single-sensor cameras;*
- *Part 2: Two- and three-sensor professional cameras;*
- *Part 3: Non-broadcast camera-recorders;*
- *Part 4: Automatic functions of video cameras and camera recorders.*

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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 42 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.

ICS 33.160.40

Descriptors: Video recording, recording apparatus, video cameras, performance evaluation, measurements, test results, comparison, sensitivity, signal to noise ration, resolution, colour, luminance, distortion, test chart

English version

**Video cameras (PAL/SECAM/NTSC) — Methods of
measurement
Part 2: Two- and three-sensor professional cameras**
(IEC 61146-2:1997)

Caméras vidéo (PAL/SECAM/NTSC)
Méthodes de mesure
Partie 2: Caméras professionnelles à
deux et trois capteurs
(CEI 61146-2:1997)

Videokameras (PAL/SECAM/NTSC)
Meßverfahren
Teil 2: Zwei- und Drei-Sensorkameras
für professionelle Anwendung
(IEC 61146-2:1997)

This European Standard was approved by CENELEC on 1997-10-01. 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

© 1997 CENELEC — All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Foreword

The text of document 100C/59/FDIS, future edition 1 of IEC 61146-2, prepared by SC 100C, Audio, video and multimedia subsystems and equipment, of IEC TC 100, Audio, video and multimedia systems and equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61146-2 on 1997-10-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-07-01

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 Annex A is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61146-2:1997 was approved by CENELEC as a European Standard without any modification.

Contents

	Page		Page
Foreword	2	2.8 Black shading	21
1 General	5	2.8.1 Characteristics to be specified	21
1.1 Scope	5	2.8.2 Measurement conditions	21
1.2 Normative references	5	2.8.3 Method of measurement	21
1.3 Conditions	5	2.8.4 Presentation of results	21
1.3.1 Environmental conditions	5	2.9 White clipping and compression rate	21
1.3.2 Conditions of measurements	5	2.9.1 Characteristics to be specified	21
1.3.3 Reference output levels	7	2.9.2 Measurement conditions	21
2 Video characteristics	7	2.9.3 Method of measurement	22
2.1 Sensitivity	7	2.9.4 Presentation of results	22
2.1.1 Reference subject illumination	7	2.10 Dynamic range and contrast range	22
2.1.2 Reference sensitivity (alternative method)	9	2.10.1 Characteristics to be specified	22
2.1.3 Minimum subject illumination	9	2.10.2 Method of measurement	22
2.2 Resolution	10	2.10.3 Presentation of results	22
2.2.1 Modulation depth	10	2.11 Colour reproduction	22
2.2.2 Common resolution	12	2.11.1 Characteristics to be specified	23
2.3 Signal-to-noise ratio	12	2.11.2 Measurement conditions	23
2.3.1 Characteristics to be specified	12	2.11.3 Method of measurement	25
2.3.2 Measurement conditions	12	2.11.4 Calculation	25
2.3.3 Method of measurement	14	2.11.5 Original colour chip samples	27
2.3.4 Presentation of results	14	2.11.6 Presentation of results	27
2.4 Waveform distortions (streaking)	14	2.11.7 Camera for which only a composite video signal is available	27
2.4.1 Characteristics to be specified	14	2.12 Flare	27
2.4.2 Measurement conditions	14	2.12.1 Characteristics to be specified	28
2.4.3 Method of measurement	16	2.12.2 Measurement conditions	28
2.4.4 Presentation of results	16	2.12.3 Method of measurement	29
2.5 Gamma and white balance tracking characteristics	16	2.12.4 Presentation of results	29
2.5.1 Characteristics to be specified	16	3 Other anomalies	29
2.5.2 Measurement conditions	16	3.1 Moires	29
2.5.3 Method of measurement	17	3.1.1 For a camera which provides R, G, B outputs	29
2.5.4 Presentation of results	17	3.1.2 For a camera which provides composite video output only	29
2.6 Colour and white reproduction non-uniformity	18	3.2 Lag	29
2.6.1 Characteristics to be specified	18	3.2.1 Measurement conditions	29
2.6.2 Measurement conditions	18	3.2.2 Method of measurement	29
2.6.3 Method of measurement	18	3.2.3 Presentation of results	29
2.6.4 Presentation of results	19	3.3 Sticking (image retention)	30
2.7 Tracking error of white shading	19	3.3.1 Measurement conditions	30
2.7.1 Characteristics to be specified	19	3.3.2 Method of measurement	30
2.7.2 Measurement conditions	19	3.3.3 Presentation of results	30
2.7.3 Method of measurement	20	3.4 Blooming	30
2.7.4 Presentation of results	21	3.4.1 Method of measurement	30
		3.4.2 Presentation of results	30

	Page		Page
3.5 Smearing	30	Figure 15 — Specification of arrangement of colour samples for measurement of colour reproduction	24
3.5.1 Method of measurement	30		
3.5.2 Presentation of results	31	Figure 16 — Specification of the test chart for measurement of overall flare (average picture level = 50 %)	28
3.6 Registration	31		
3.6.1 Characteristics to be specified	31	Figure 17 — Specification of the test chart for measurement of localized flare (average picture level = 99 %)	28
3.6.2 Method of measurement	31		
3.6.3 Alternative method of measurement	34	Figure 18 — Specification of the transparent test chart for measurement of smearing and blooming	30
3.7 Geometric distortions	37		
3.7.1 Conventional method	37	Figure 19 — Equipment arrangement for measurement of registration (conventional method)	32
3.7.2 Alternative method	37		
Annex A (informative) Bibliography	41	Figure 20 — Specification of the reflective test chart for measurement of registration (conventional method)	33
Annex ZA (normative) Normative references to international publications with their corresponding European publications	42	Figure 21 — Definition of the zones for a conventional method of measurement of registration	34
Figure 1 — Equipment arrangement for measurement of sensitivity	7		
Figure 2 — Specification of grey scale test chart	8	Figure 22 — Equipment arrangement for the alternative method of measurement of registration	35
Figure 3 — Equipment arrangement for measurement of resolution	11		
Figure 4 — Specification of the transparent test charts for measurement of modulation depth	11	Figure 23 — Specification of the V pattern test chart for the alternative measurement method of registration	35
Figure 5 — Equipment arrangement for measurement of signal-to-noise ratio	13		
Figure 6 — Specification of the reflective test chart for measurements signal-to-noise ratio and white shading	13	Figure 24 — Dimensional specification of V pattern	36
Figure 7 — Equipment arrangement for measurement of waveform distortion	15	Figure 25 — Extraction of timing offsets for calculation of registration errors	36
Figure 8 — Specification of the transparent test chart for measurement of streaking	15		
Figure 9 — Examples of waveforms	16	Figure 26 — Equipment arrangement for measurement of geometric distortion	38
Figure 10 — Equipment arrangement for measurement of gamma and white balance tracking characteristics, colour and white reproduction, white clipping and compression rate, and flare	17		
Figure 11 — Specification of the rectangle	18	Figure 27 — Definition of the zones in the V pattern test chart for measurement of geometric distortion	38
Figure 12 — Equipment arrangement for measurement of tracking error of white shading	19		
Figure 13 — Waveform of the tracking error of white shading	20	Figure 28 — Definitions of barrel and pincushion distortion	39
Figure 14 — Equipment arrangement for measurement of colour reproduction	24		

1 General

1.1 Scope

This part of IEC 61146 applies to the assessment of performance of professional colour video cameras equipped with two and three tubes or solid state imagers, used for educational or industrial purposes and in other applications.

This part of IEC 61146 defines test patterns, measurement conditions, and methods of measurement, so as to enable the comparison of the results of measurements.

The methods of measurement are designed to enable the assessment of the performance of cameras by using light input from the lens and any electrical outputs of the cameras, for example, R-G-B signals, Y-C separate signals, and composite video signals.

This standard does not specify limiting values for various parameters.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61146. 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 61146 are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 61146-1:1994, *Video cameras (PAL/SECAM/NTSC) — Methods of measurement — Part 1: Non-broadcast single-sensor cameras.*

ISO/CIE 10526:1991, *CIE colorimetric standard illuminants.*

ISO/CIE 10527:1991, *CIE colorimetric standard observers.*

EBU Techn. 3237:1983, *Methods of measurement of the colorimetric fidelity of television cameras.* Corrigendum (1989)

Supplement 1:1989, *Measurement procedures.*

Publication CIE 15.2:1986, *Colorimetry.*

1.3 Conditions

1.3.1 Environmental conditions

All measurements shall be carried out within the environmental conditions specified by the manufacturer of the camera under assessment.

The environmental conditions during measurement, at least the temperature and the relative humidity, shall be reported together with the results of measurements.

An adequate warm up time shall be allowed.

1.3.2 Conditions of measurements

The measurements shall be carried out either by measuring the output signals of the device when the camera is shooting different test charts, depending on the characteristic to be measured, or by measuring the distortions on a monitor screen.

1.3.2.1 Test charts

All the test charts used for measurement shall be specified with the results, together with the lighting conditions (illumination intensity, correlated colour temperature, etc.).

The test charts shall be shot by the camera so that the frame limited by the arrows coincides exactly with the edges of the picture displayed on the video monitor in underscan mode.

The test charts may be either reflective or transparent. Where there is a choice, the reflective test chart shall be used in questionable cases.

1.3.2.2 Illumination

The illumination of reflective test charts shall be performed by two spotlights with a correlated colour temperature of $3\,200\text{ K}^{+100\text{K}}_{-200\text{K}}$ placed at 45° with respect to the perpendicular axis of the centre of the test charts, as shown in Figure 1.

A uniform illumination should be obtained by adjusting the distance of the spotlights or by defocusing them. The illumination can also be adjusted by other means without changing the colour temperature. It is recommended to maintain the supply voltage constant during the measurements. The light box used for transparent test charts shall be a diffusing surface, illuminated by a light source with a stabilised power supply.

The subject illumination of the reflective chart shall be $2\,000\text{ lx} \pm 5\%$. The luminance of the diffusion surface of the light box used for a transparent test chart shall be $636\text{ cd/m}^2 \pm 5\%$.

1.3.2.3 Reference conditions

The camera shall be placed so that its optical axis coincides with the perpendicular passing through the centre of the test chart, the camera being adjusted for normal operation conditions. If switching is possible, the measurements should be made in the following setting conditions, using the standard lens specified by the manufacturer of the camera (see note below), unless otherwise stated:

- a) focal length of the lens is adjusted to the mean value corresponding to normal operation;
- b) iris is set to $f/5,6$;
- c) white balance is set, manually or automatically, to the position corresponding to the correlated colour temperature of the illuminant;
- d) white balance is further adjusted using a white test chart (see Figure 6) with the output signals as the reference value;
- e) bias light is set ON, when applicable;
- f) black level corrector is ON, when applicable;
- g) flare corrector is ON;
- h) black balance is set for an output voltage of 35 mV with lens capped;
- i) colour matrixing corrector is OFF;
- j) contour corrector is OFF;
- k) noise reducer is OFF;
- l) aperture correction is OFF;
- m) black and white shading correctors are ON and optimized;
- n) gamma corrector is set to OFF;
- o) gain is set to 0 dB ;
- p) knee and auto-knee functions are set to OFF where appropriate.

NOTE If a zoom lens is recommended by the manufacturer, the measurement may be carried out using the narrowest and the widest angle of the lens. In this case, the type of the lens and the setting should be reported with measured results.

1.3.2.4 Equipment arrangement

Unless otherwise stated, the equipment arrangement shown in Figure 1 or Figure 3 should be used. The test equipment shall have the following specifications:

- a) oscilloscope
 - with external television synchronization,
 - adjustable delay relative to the field interval,
 - marker pulse output which can be used to mark on the monitor the part of the picture signal which is displayed on the oscilloscope;
- b) lightmeter
 - with a cosine corrector;
- c) video signal outputs shall be properly terminated by $75\ \Omega$.

1.3.3 Reference output levels

Unless otherwise specified, the reference luminance Y and R, G, B output levels are assumed to be 700 mV peak-to-peak for PAL and SECAM systems, and 714 mV peak-to-peak for NTSC systems. The level shall be measured from the blanking level to the peak white level.

2 Video characteristics

2.1 Sensitivity

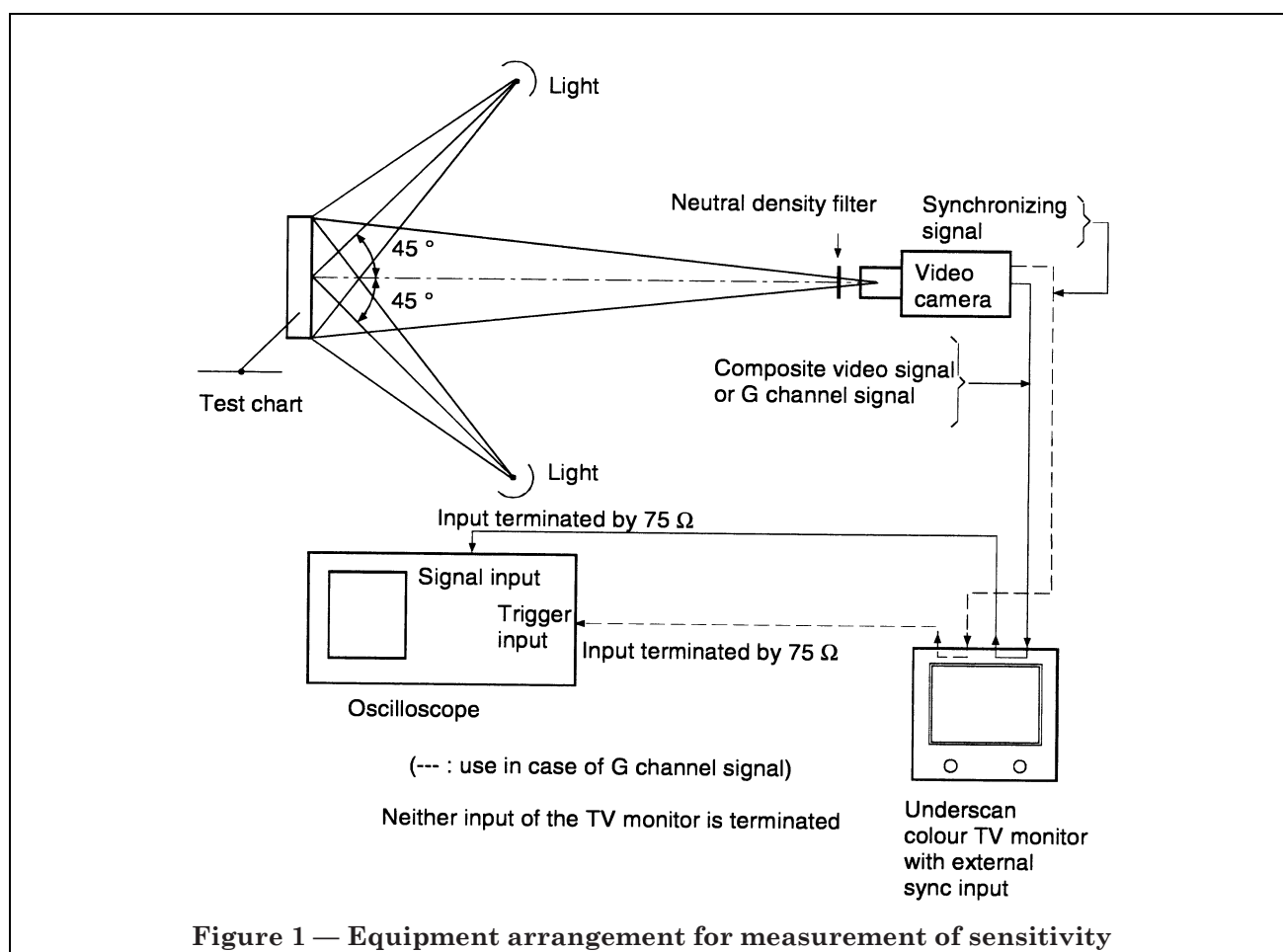
2.1.1 Reference subject illumination

2.1.1.1 Characteristic to be specified

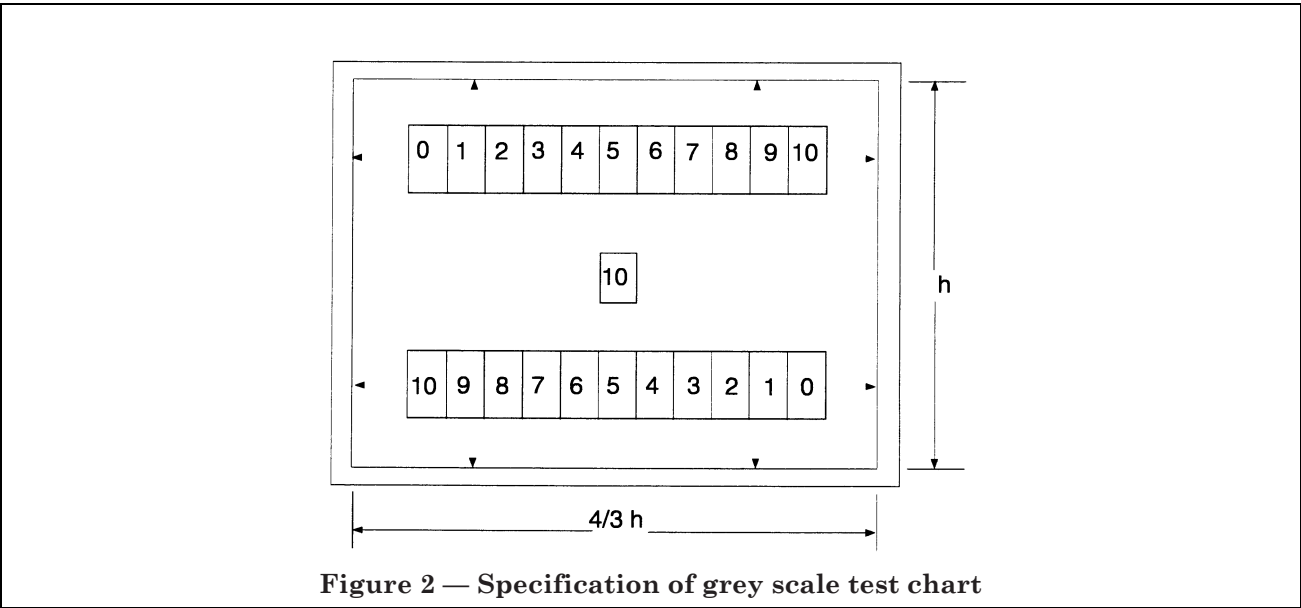
The illumination of the subject which is needed to produce the reference amplitude (100 %) at the output, either of the green channel signal or the composite video signal with the given iris setting.

2.1.1.2 Measurement conditions

- a) The arrangement for measurement shall be as shown in Figure 1.



- b) The test chart shall be a logarithmic grey scale chart reflective type, see Figure 2 (EIAJ test chart C3 as in Annex A of IEC 61146-1, or equivalent). The reflectance of the white area at the centre is 89,9 %. If the reflectance is other than 89,9 %, see note of 2.1.1.4. γ equals 2,2 and reflectance of background equals 18 %.



Step number	Reflectance	Step number	Reflectance
n	%	n	%
0	2,0	6	37,8
1	4,5	7	48,6
2	8,1	8	63,0
3	13,0	9	77,3
4	19,8	10	89,9
5	27,9		

- c) The camera setting shall be as stated in 1.3.2.3.
- 2.1.1.3 Method of measurement
- a) The G-channel output or luminance output level corresponding to the white part at the centre is monitored by an oscilloscope. The intensity of illumination shall be so adjusted that the output level is 714 mV for NTSC cameras or 700 mV for PAL/SECAM cameras. The level shall be measured from the blanking level. The intensity of illumination may be adjusted by changing the distance between spotlights and the chart or by inserting neutral density filters in front of the lens. The density, D , shall be noted when the filters are in use. Otherwise, $D = 0$.
- b) The intensity, I_0 , of the illumination shall be measured.
- c) The reference sensitivity in terms of the subject illumination I_{ref} shall be calculated by the following equation:
- $$I_{\text{ref}} = 10^{-D} I_0$$

2.1.1.4 Presentation of results

The results of measurement I_{ref} shall be reported together with the specification of lens as follows:

subject illumination _____ lx (f/5,6);

specification of the lens _____ .

NOTE When the reflectance of the white part is other than 89,9% the actual reflectance R % shall be measured, and the effective intensity I_0 shall be calculated by the following equation:

$$I_0 = \frac{R}{89,9} I'_0$$

where I'_0 is the illumination level of the chart.

2.1.2 Reference sensitivity (alternative method)

2.1.2.1 Characteristic to be specified

The iris value which is needed to produce the rated amplitude (100 %) at the output, either of the green channel signal or the composite video signal with the given illumination of the subject.

2.1.2.2 Measurement conditions

- The arrangement for measurement shall be as shown in Figure 1.
- The test chart shall be a logarithmic grey scale chart (reflective type, see Figure 2) whose reflectance of the white area at the centre is 89,9 %. If the reflectance is other than 89,9 %, see note of 2.1.1.4.
- The illumination of the subject and the camera setting shall be the same as mentioned in 1.3.2.2 and 1.3.2.3 respectively.

2.1.2.3 Method of measurement

- The G-channel output or luminance output level corresponding to the white part at the centre is monitored by an oscilloscope. The level shall be measured from the blanking level. The iris shall be so adjusted that the output level is 714 mV for NTSC cameras or 700 mV for PAL/SECAM cameras. The iris f-number shall be noted.
- If the iris f mark is placed between two f-stops (for instance f/4 and f/5,6), the following procedure shall be applied:
 - the iris mark shall be adjusted to the higher f/number (that is f/5,6 in the above example) and noted as f_h ;
 - the illumination of the test chart shall be increased until the output reaches the reference level as mentioned above;
 - the new illumination I_n of the test chart shall be measured and noted;
 - the final iris value shall be calculated by means of the following formula:

$$f = \sqrt{\frac{2\,000}{I_n}} f_h^2$$

2.1.2.4 Presentation of results

The results shall be reported together with the specification of the lens as follows:

sensitivity: _____ (2 000 lx);

specification of the lens: _____ .

NOTE Subject illuminance I_{ref} and sensitivity f_{ref} are related as in the following equations:

$$I_{\text{ref}} = 2\,000 \times \left(\frac{4}{f_{\text{ref}}}\right)^2 \text{ (lx)}$$

$$f_{\text{ref}} = 4 \times \sqrt{\frac{2\,000}{I_{\text{ref}}}}$$

2.1.3 Minimum subject illumination

2.1.3.1 Characteristic to be specified

The minimum subject illumination value which is needed to produce a half of the reference amplitude (100 %) at the output, either of the green channel signal or the composite video signal.

2.1.3.2 Measurement conditions

- The arrangement for measurement shall be as shown in Figure 1.
- The test chart shall be a logarithmic grey scale chart (reflective type, see Figure 2) whose reflectance in the white area at the centre of the chart is 89,9 %. If the reflectance is other than 89,9 %, see note 1 of 2.1.3.4. The illumination of the test chart shall be the same as mentioned in 1.3.2.2.
- The camera setting shall be the same as mentioned in 1.3.2.3. except that the iris is set wide open (see note 2 of 2.1.3.4), gamma compensation is ON, and either gain setting is at maximum or automatic gain control mode is selected.

2.1.3.3 Method of measurement

a) The output level shall be measured from the blanking level by an oscilloscope, inserting neutral density filter(s) in front of the lens to produce an output signal level of 50 % of the reference level as defined in 1.3.3.

b) The density D of the neutral density filter(s) shall be noted and the minimum subject illumination $I_{\min}$ shall be calculated by the following equation:

$$I_{\min} = 2\,000 \times 10^{-D}$$

2.1.3.4 Presentation of results

The result of measurement shall be reported as follows:

minimum subject illumination $I_{\min}$ _____ lx;

specification of the lens _____ ;

iris setting _____ ;

gain _____ dB.

NOTE 1 If the reflectance of the white part is other than 89,9 %, the actual reflectance R % shall be measured, and the minimum subject illumination $I_{\min}$ shall be calculated by the following equation:

$$I_{\min} = 2\,000 \times \frac{R}{89,9} 10^{-D} \text{ lx}$$

NOTE 2 Zoom is set so as to attain the maximum output level.

2.2 Resolution

2.2.1 Modulation depth

2.2.1.1 Characteristics to be specified

The contrast transfer function (CTF) is the ratio in percentage between amplitudes of the signals with fundamental frequencies of 0,5 MHz (40 TV lines) and 5 MHz (400 TV lines).

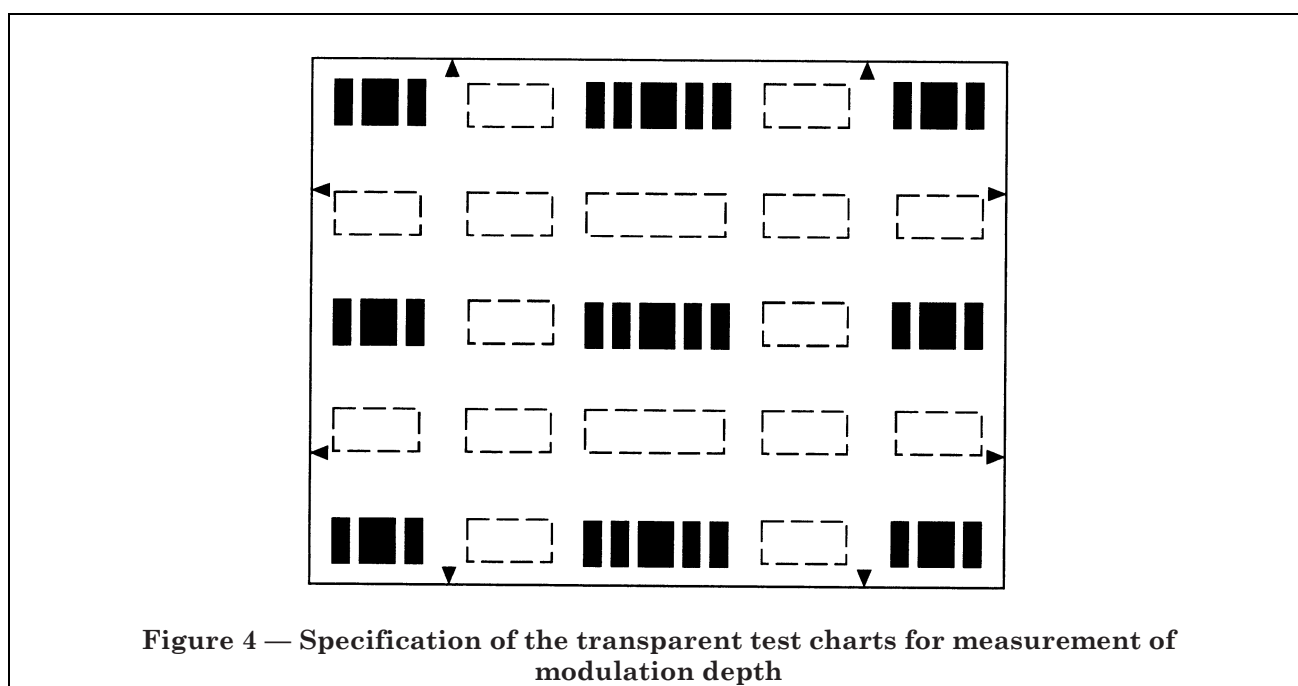
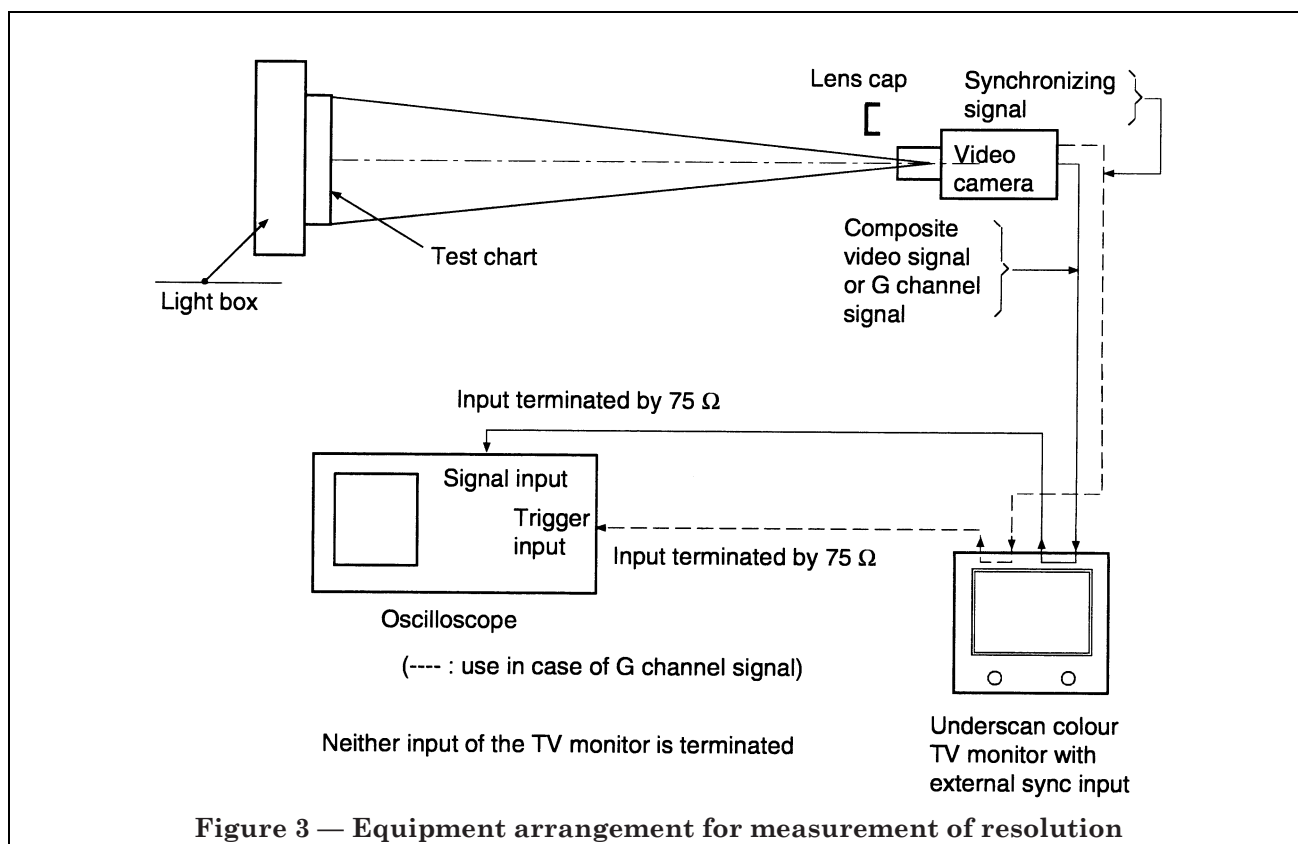
2.2.1.2 Measurement conditions

a) The arrangement for measurement shall be as shown in Figure 3.

b) The test chart shall be of a transparent type, as shown in Figure 4 on which are nine groups composed of black and white vertical bars. The thickness of these bars shall be such that the horizontally scanned signals at the camera output have frequencies of 0,5 MHz (40 TV lines) and 5 MHz (400 TV lines).

c) The camera setting shall be as mentioned in 1.3.2.3, except for the black level, which shall be set to the blanking level when the lens is capped.

d) The illumination of the test chart shall be adjusted so that the group of bars at the centre corresponding to 0,5 MHz is reproduced with an output level of 100 % for the white bars and 0 % for the black bars. Care should be taken of the effects due to black and white clipping.



2.2.1.3 Method of measurement

- The output level should be measured on each of the nine groups of bars for either G channel output or luminance signal output at 0,5 MHz and 5 MHz.
- Each measurement shall be made during the active line period of a selected line which crosses centrally over the group of bars to be measured.