INTERNATIONAL STANDARD

IEC 61966-6

First edition
2005-03

Multimedia systems and equipment – Colour measurement and management –

Part 6: Front projection displays

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 6: Front projection displays

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The text of this standard is based on the following documents:

CDV	Report on voting
100/835/CDV	100/915/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61966 consists of the following parts, under the general title *Multimedia systems and equipment – Colour measurement and management:*

Part 1: General

Part 2-1: Colour management – Default RGB colour space – sRGB

Part 2-2: Colour management – Extended RGB colour space – scRGB

Part 3: Equipment using cathode ray tubes

Part 4: Equipment using liquid crystal display panels

Part 5: Equipment using plasma display panels

Part 6: Front projection displays

Part 7-1: Colour printers – Reflective prints – RGB inputs

Part 7-2: Colour printers - Reflective prints - CMYK inputs (under consideration)

Part 8: Multimedia colour scanners

Part 9: Digital cameras

Part 10: Quality assessment - Colour image in network systems (under consideration)

Part 11: Quality assessment - Impaired video in network systems (under consideration)

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- reconfirmed;
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INTRODUCTION

The IEC 61966 series of standards defines methods and parameters for colour measurements and colour management for use in multimedia systems and equipment, applicable to colour production and reproduction. Part 6 deals with front projection displays.

The methods of measurement standardized in this part are designed to make possible the objective characterization of colour reproduction of front projection displays which accept red-green-blue analogue and/or digital signals from electrical input terminals and output light corresponding to the intended colour. The measured results are intended to be used for the purpose of equipment-specific colour control in order to attain colour management in open multimedia systems and should generally be adequate for this purpose. However, in some cases, it may be necessary to consider additional factors not addressed in this part of IEC 61966, such as the actual environment in which the front projection display will be used, to achieve the desired colour reproduction.

Readers of this standard are also encouraged to review IEC 61947-1 and IEC 61947-2, which apply to the measurement and documentation of key performance criteria for multimedia projectors.

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MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 6: Front projection displays

1 Scope

This part of IEC 61966 defines input test signals, measurement conditions, methods of measurement and reporting of the measured data, to be used for colour characterization and colour management of front projection displays in multimedia systems.

Colour control within equipment is outside the scope of this part. It does not specify limiting values for various parameters.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-845:1987, *International Electrotechnical Vocabulary (IEV) – Chapter 845: Lighting/*CIE 17.4: 1987, *International Lighting Vocabulary* (Joint IEC/CIE publication)

IEC 61947 (all parts), *Electronic projection – Measurement and documentation of key performance criteria*

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

CIE 15.2:1986, *Colorimetry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-845 and CIE 17.4, as well as the following, apply.

3.1
background
data corresponding to an image surrounding the target colour patch to be measured

3.2
colour control
effort to convert equipment-dependent colour image data to equipment-independent data for a specific colour space including tone characteristics

3.3
colour patch, test area
square colour image on a virtual screen of the front projection display subject to be measured for colour reproduction, in which input data for the red, green and blue channels are kept constant within the image area

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3.4
CRT
colorimetrically well-controlled equipment using cathode ray tubes to present colour images with digital inputs for reference

3.5
effective screen height
vertical dimension of the effective screen area

3.6
effective screen area
area where a picture can be produced

3.7
normalized (image) signal
input signal normalized by its full-scale value, whose level is of interest in calculation and evaluation of colour control function within front projection display (see also equation (1) in 5.3)

3.8
uncertainty (of measurement)
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the particular quantity subject to measurement (see also the IEC Guide to the expression of uncertainty in measurement,1995)

3.9
virtual screen
perfect reflecting diffuser-to-image input data

4 Letters and symbols

The notations consistently adopted in this part of IEC 61966 are summarized below.

A display area ratio

N number of bits in digital data for each channel

M maximum integer for non-negative N-bits system; $M = 2^N - 1$

D_R digital data applied for red channel

D_G digital data applied for green channel

D_B digital data applied for blue channel

R normalized input level to red channel

G normalized input level to green channel

B normalized input level to blue channel

X one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values

Y one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values in candela per square metre

Z one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values

R' linearized data for red channel taking into account the tone characteristics of the channel

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G' linearized data for green channel taking into account the tone characteristics of the channel

B' linearized data for blue channel taking into account the tone characteristics of the channel

X' one of the tristimulus values normalized by Y_n (candela per square metre) for peak white

Y' one of the tristimulus values normalized by Y_n (candela per square metre) for peak white

Z' one of the tristimulus values normalized by Y_n (candela per square metre) for peak white

5 Conditions

5.1 Environmental conditions

All measurements specified in this document shall be carried out in a dark room. Particular attention should be paid to prevent reflected illumination caused by the ambient objects (desktop, wall, etc.) and direct illumination from light-emitting indicators of measuring instruments.

An hour warm-up time should precede this measurement, if not specified by the manufacturer of the equipment.

The mains voltage and frequency shall be at the rated value specified by the manufacturer. If the mains voltage fluctuates, a regulated power supply shall be used to maintain the supply voltage to within ±5 % of the rated value.

Other environmental conditions such as room temperature and relative humidity shall be reported together with the results of measurements.

If additional environmental conditions are described in the manufacturer's specifications, these should be taken into account.

5.2 Conditions for measurements

Contrast, brightness and additional adjustments shall be set to the preset positions specified by the manufacturer. If the adjustment is set to another position than the preset, the position or corresponding value shall be reported with the results of measurements.

Geometrical adjustment shall be set to default position.

The arrangement of equipment for measurements shall be as shown in Figure 1. It incorporates a spectroradiometer or a non-contact colorimeter, depending on the characteristics to be measured.

The diagonal image size on the screen shall be set to the preset size specified by the manufacturer. If no size is specified, it shall be set to 102 cm.

The height of front projection display (H) and the distance between the screen and the head of the front projection display (L) shall be set to the preset positions specified by the manufacturer. They depend on the screen size.

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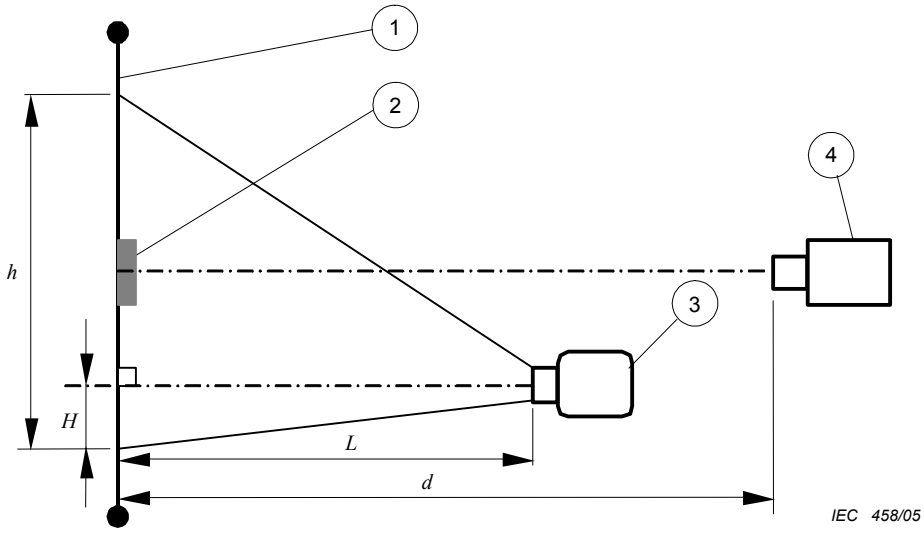


Key

1 Screen
2 Perfect reflecting diffuser
3 Front projection display
4 Spectroradiometer or colorimeter

d Distance between screen and measuring instrument
h Effective screen height
H Height projected image
L Distance from the screen

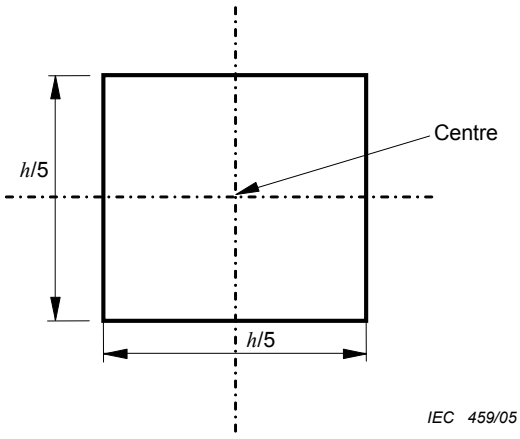
Figure 1 – Equipment arrangement for measurements (side view

The instrument optical axis should be perpendicular to the screen. If another measurement angle is recommended by the manufacturer, it shall be reported together with the results of measurements. The distance d shall be $4h < d < 5{,}5h$.

A perfect reflecting diffuser shall be set on the centre of effective screen area.

The measured light shall be that reflected by a perfect reflecting diffuser.

Test signals applied to the red, green, and blue channels shall result in a colour patch of the size shown in Figure 2 on the screen. The positioning of the colour patch shall be referred to by the centre as in Figure 2. The background shall be black ($D_{\mathrm{R}} = 0$, $D_{\mathrm{G}} = 0$, $D_{\mathrm{B}} = 0$), unless otherwise specified.



NOTE In the case where the appropriate relationship is confirmed, it is acceptable to measure luminous intensity direct instead of using the perfect reflecting diffuser.

Figure 2 – Size of colour patch

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5.3 Input digital data

The relationship between the input digital data, D_{R}, D_{G}, D_{B} of N bits per channel and corresponding normalized signal levels R, G, B for calculations shall be

$$\left.\begin{aligned} R_i &= \frac{D_{\mathrm{R}_i}}{2^N - 1} \\ G_i &= \frac{D_{\mathrm{G}_i}}{2^N - 1} \\ B_i &= \frac{D_{\mathrm{B}_i}}{2^N - 1} \end{aligned}\right\} \quad (1)$$

where the index i denotes the ith measurement step.

NOTE When the input signal is applicable in analogue voltage, the signal level normalized by the maximum input voltage should correspond to the signal level for each step defined in equation (1).

6 Measurement equipment

6.1 Spectroradiometer

A spectroradiometer with the following specification should be used for measurements.

a) Wavelength range	at least 380 nm to 780 nm
b) Field of view	between 0,1° and 2,0°
c) Wavelength uncertainty	less than 0,5 nm at wavelengths specified by the manufacturer of the instrument
d) Scanning interval	5 nm or less
e) Bandpass	5 nm or less
f) Repeatability	0,001 in x, y and 0,5 % in luminance (in candela per square metre) for the light source specified by the manufacturer of instrument
g) Uncertainty	0,005 in x, y for red, green, blue and white of a standard CRT display and 4 % in luminance (in candela per square meter) for white of the CRT display that has a definite x, y and luminance value
h) Polarization error	within 5 %

The (x, y) is the CIE 1931 chromaticity coordinate defined in CIE 15.2.

NOTE 1 Periodic calibration should be carried out with a standard source of known spectral power distribution.

NOTE 2 Further technical details of the design, characterization, and calibration of spectroradiometers can be found in CIE 63 [17] and JIS Z 8724 [7].[1]

NOTE 3 The standard CRT display is referred to because no standard projection display exists. When it is available, the standard CRT should be replaced by the projection display.

If the spectroradiometer used for measurements does not meet the above specifications, the name of the model and the specification of the equipment shall be reported, together with the results of measurements.

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[1] Figures in square brackets refer to the bibliography.

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6.2 Colorimeter

The colorimeter in Figure 1 should have the following specifications.

a) Field of view	Any value between 0,1° and 2,0°
b) Spectral responsivity	conforming to the CIE 2° colour-matching function as defined in ISO/CIE 10527
c) Repeatability	0,002 in x, y and 0,5 % for luminance for a light source specified by the manufacturer of the instrument
d) Uncertainty	0,005 in x, y for red, green, blue and white of the CRT display and 4 % in luminance (in candela per square meter) for white of the CRT display that has a definite x, y and luminance value

The (x, y) is the CIE 1931 chromaticity coordinate defined in CIE 15.2.

NOTE 1 If the original uncertainty of the colorimeter does not meet this recommendation, correction methods are available to improve the accuracy for the CRT display measurement. (See [4] and [11].)

NOTE 2 The instrument should be calibrated periodically to assure the uncertainty recommendation given in d) above.

NOTE 3 The standard CRT display is referred to because no standard projection display exists. When it is available, the standard CRT should be replaced by the projection display.

The readings of the colorimeter, X, Y (in candela per square meter), and Z shall be normalized by the luminance level of a peak neutral colour (white), Y_n (in candela per square metre), as follows:

$$\left.\begin{aligned} X' &= \frac{X}{Y_n} \\ Y' &= \frac{Y}{Y_n} \\ Z' &= \frac{Z}{Y_n} \end{aligned}\right\} \qquad (2)$$

If the colorimeter used for measurements does not meet the above specifications, the name of the model and the specification of the equipment shall be reported, together with the results of measurements.

7 Spectral characteristics and intensity of the primaries and white

7.1 Characteristics to be measured

Spectral radiance distributions and corresponding tristimulus values for the peak of three primaries, red-green-blue, and white.

7.2 Measurement conditions

a) The arrangement of equipment shall be as in Figure 1 with the spectroradiometer.

b) The colour signal shall be so generated that the colour patch is positioned at the centre of the screen under measurement.

c) Digital data for the background shall be $D_R = 0$, $D_G = 0$, $D_B = 0$.

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7.3 Method of measurement

a) The centred colour patches shall be generated following the measurement steps as shown in Table 1, where $M = 2^N - 1$ and N is the number of bits.

Table 1 – Input data for peak primaries and peak white

Steps	Colours	D_R	D_G	D_B
1	Peak red	M	0	0
2	Peak green	0	M	0
3	Peak blue	0	0	M
4	Peak white	M	M	M

b) Spectral radiance distributions $r(\lambda), g(\lambda), b(\lambda), w(\lambda)$ for peak red, green, blue and white images on the screen shall be measured successively by the spectroradiometer.

c) Readings of the spectroradiometer with an emulation function of colorimeters $X_{C'}$, $Y_{C'}$, $Z_{C'}$ shall also be noted, where the suffix C corresponds to R, G, B for primary colours and to W for the peak white, respectively.

7.4 Presentation of results

a) The measured data for spectral radiance distributions shall be reported for the peak colours red, green, blue, and white.

b) The spectral radiance distributions $r(\lambda), g(\lambda), b(\lambda)$ shall be plotted for the peak colours red, green, and blue, respectively, as illustrated in Figure 3.

c) The readings of the spectroradiometer $X_{C'}$, $Y_{C'}$, $Z_{C'}$ for peak red, green, blue and white shall be reported as a table as shown in Table 2.

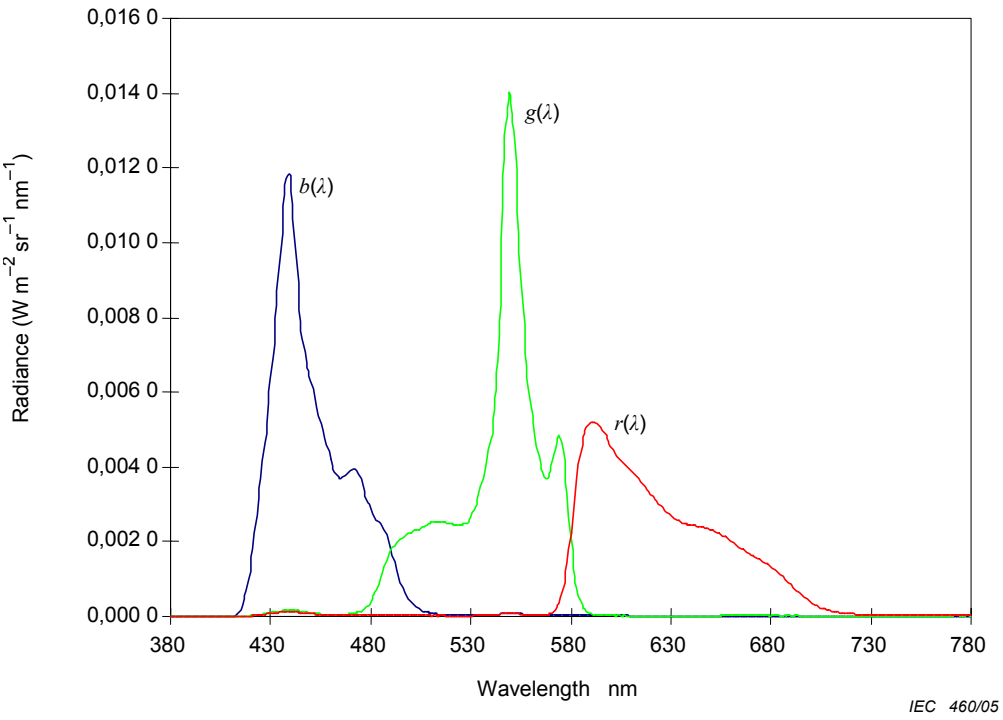

Figure 3 – An example of the spectral radiance distributions $r(\lambda), g(\lambda), b(\lambda)$

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Table 2 – Example of reporting form for colours in maximum excitations

Steps	Colours	X	Y (cd/m^2)	Z
1	Peak red	159,20	95,07	4,58
2	Peak green	113,60	243,30	23,59
3	Peak blue	71,82	16,84	378,60
4	Peak white	509,60	548,60	647,60

8 Basic colorimetric characteristics

8.1 Characteristics to be measured

Linear relation between maximum input excitation and the tristimulus values of light output.

8.2 Method of measurement

a) The reported results of measurement in 7.4 shall be used to obtain tristimulus values to characterize the three primaries, red-green-blue, and white. The luminance in cd/m^2 shall be normalized as follows for red, green, blue and white replacing the suffix C by R, G, B, W:

$$\left.\begin{aligned} X'_C &= \frac{X_C}{Y_n} \\ Y'_C &= \frac{Y_C}{Y_n} \\ Z'_C &= \frac{Z_C}{Y_n} \end{aligned}\right\} \tag{3}$$

where the normalization factor Y_n is the measured luminance value for peak white Y_w which is reported in Table 2.

b) The CIE 1931 xy chromaticity coordinate values, x_C, y_C shall be calculated for primary colours and for white as defined in CIE 15.2, where the suffix C corresponds to R, G, B for primary colours, and W for white, respectively.

$$\left.\begin{aligned} x_C &= \frac{X'_C}{X'_C + Y'_C + Z'_C} \\ y_C &= \frac{Y'_C}{X'_C + Y'_C + Z'_C} \\ z_C &= 1 - x_C - y_C \end{aligned}\right\} \tag{4}$$

c) The elements of a 3×3 matrix, $\mathbf{S}$, defined as

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \mathbf{S} \begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} \tag{5}$$

shall be decided as in

$$\mathbf{S} = \begin{pmatrix} x_R/y_R & x_G/y_G & x_B/y_B \\ 1 & 1 & 1 \\ z_R/y_R & z_G/y_G & z_B/y_B \end{pmatrix} \begin{pmatrix} S_R & 0 & 0 \\ 0 & S_G & 0 \\ 0 & 0 & S_B \end{pmatrix} \tag{6}$$

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where S_R, S_G, S_B are solutions of equation (7);

$$\begin{pmatrix} x_R/y_R & x_G/y_G & x_B/y_B \\ 1 & 1 & 1 \\ z_R/y_R & z_G/y_G & z_B/y_B \end{pmatrix} \begin{pmatrix} S_R \\ S_G \\ S_B \end{pmatrix} = \begin{pmatrix} x_W/y_W \\ 1 \\ z_W/y_W \end{pmatrix} \quad (7)$$

8.3 Presentation of results

a) The tristimulus values multiplied by 100 and the CIE 1931 xy chromaticity coordinates values shall be reported as a table, as shown in Table 3.

Table 3 – Example of reporting form

Colours	Tristimulus values			Chromaticity coordinates	
	X'	Y'	Z'	x	y
Peak red	29,02	17,33	0,84	0,615	0,367
Peak green	20,71	44,35	4,30	0,299	0,639
Peak blue	13,09	3,07	69,01	0,154	0,036
Peak white	92,89	100,00	118,05	0,299	0,321

NOTE CIE 1976 UCS coordinate values, u', v' and CIELAB values, L^*, a^*, b^* may additionally be reported.

b) The coefficient matrix shall be reported as shown.

$$\mathbf{S} = \begin{pmatrix} 0{,}383\ 1 & 0{,}337\ 3 & 0{,}208\ 6 \\ 0{,}228\ 8 & 0{,}722\ 3 & 0{,}048\ 9 \\ 0{,}011\ 0 & 0{,}070\ 0 & 1{,}099\ 4 \end{pmatrix} \quad (8)$$

c) The correlated colour temperature T_{CP} defined in 5.5 of CIE 15.2, for peak white shall also be calculated and reported in Kelvins, together with the deviation Δ_{uv}.

NOTE For the actual procedure to calculate correlated colour temperatures, refer to [16].

9 Tone characteristics

9.1 Characteristics to be measured

Non-linear transfer relationship between the normalized input signal level applied to each of the red, green and blue channels and the normalized luminance level of a front projection display.

9.2 Measurement conditions

a) The arrangement of the equipment shall be as in Figure 1.

b) The input data D_R, D_G, D_B for measurement step i shall be so applied as to generate colour patches (see Figure 2) positioned at the centre of the screen under measurement.

c) The digital input data for the background shall be $D_R = 0$, $D_G = 0$, $D_B = 0$.

NOTE 1 For the relationship between digital data D_R, D_G, D_B and values of R, G, B, see equation (1) in 5.3.

NOTE 2 If analogue input is used, the input signal should be at the same level as in the digital data.

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9.3 Method of measurement

a) The centred colour patches shall be displayed for equally stepped values of input data from $0, \frac{1}{m}2^N, \frac{2}{m}2^N, \ldots$, to $M = 2^N - 1$, where $m+1$ is the number of data, and should be more than 32, and N is the number of bits, for each of the three channels. For the red channel measurement, $D_G = D_B = 0$, for the green channel, $D_R = D_B = 0$, and for the blue channel, $D_R = D_G = 0$ shall be kept, respectively.

b) The readings of the colorimeter for each colour patch on the screen shall be recorded successively and noted as X_C^i, Y_C^i, Z_C^i where the suffix C should be replaced by R , G and B for red, green, blue channels, respectively; and a superfix i corresponds to measurement steps, i = 0,1,2,,, m .

c) The measured tristimulus values shall be normalized by the values corresponding to the maximum excitation for the last step m with input data $M = 2^N - 1$.

$$\left.\begin{aligned} X''_{iC} &= \frac{X_C^i}{X_C^m} \\ Y''_{iC} &= \frac{Y_C^i}{Y_C^m} \\ Z''_{iC} &= \frac{Z_C^i}{Z_C^m} \end{aligned}\right\} \qquad (9)$$

where the suffix C shall be replaced by each of R , G and B .

9.4 Presentation of results

The measured and normalized data X''_i, Y''_i and Z''_i for $i = 0$ to $i = m$ shall be reported as plots for C = R , G , B with interpolated non-linear transfer relation, as shown in Figures 4a, 4b and 4c.

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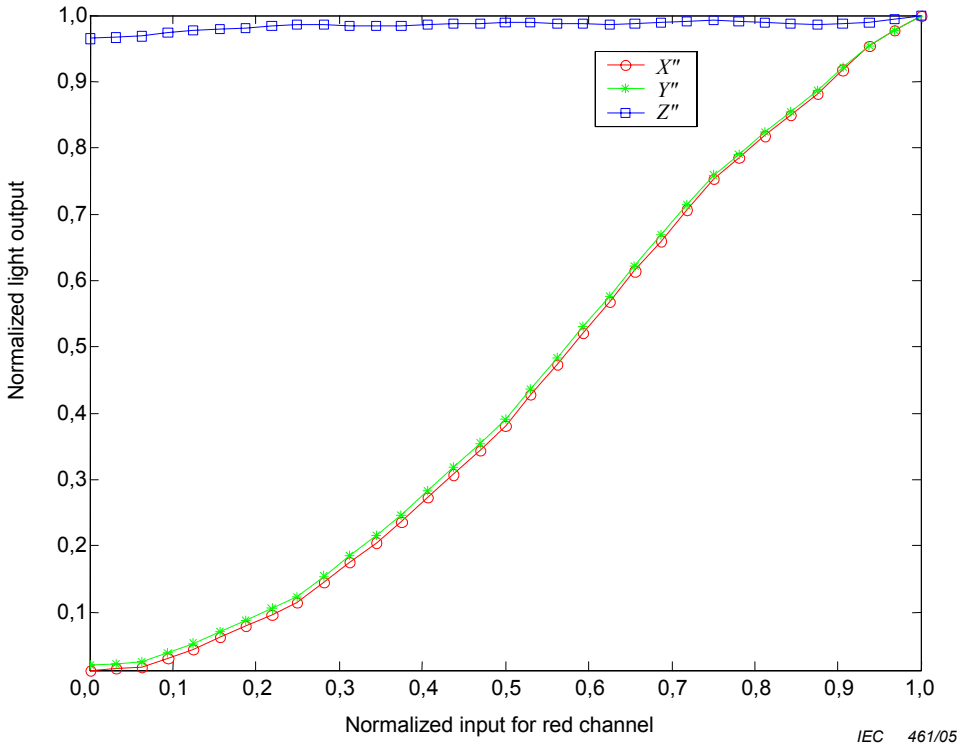

Figure 4a – Red channel

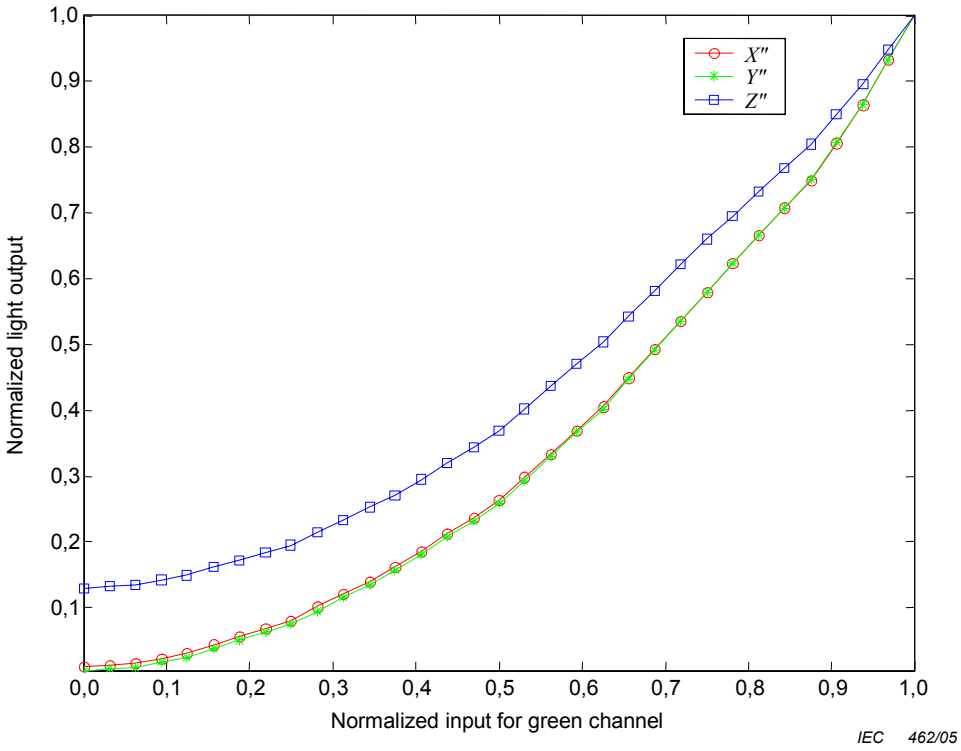

Figure 4b –Green channel

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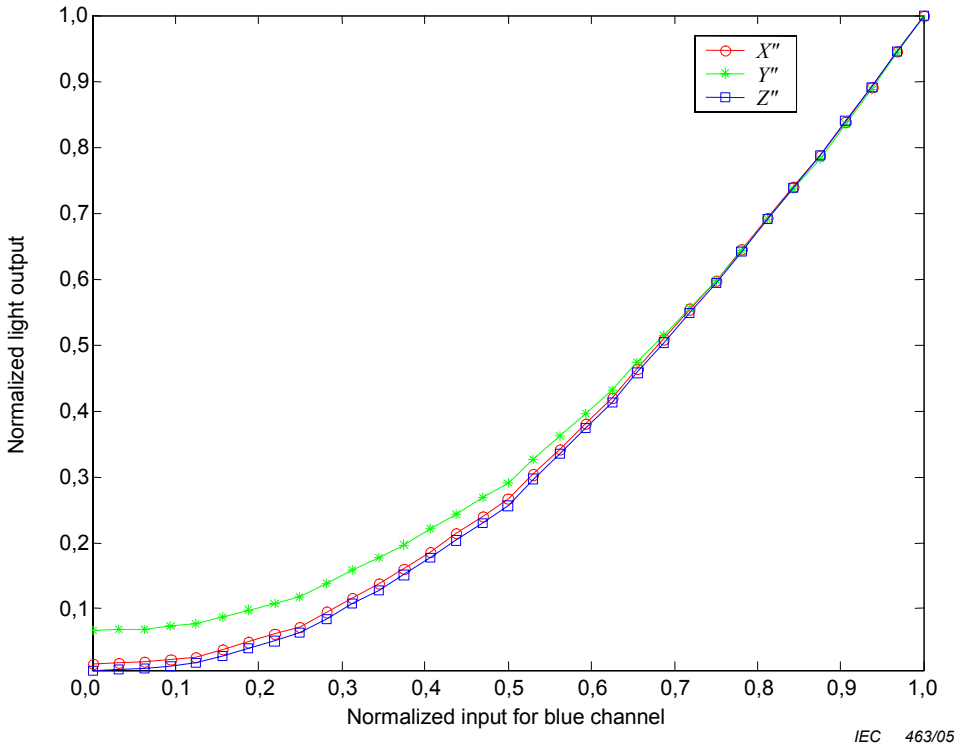

Figure 4c – Blue channel

Figure 4 – Measured points and interpolated curves

The basic normalized data defined by equation (9) in item c) of 9.3 shall also be reported as a table as shown in Table 4.

Table 4 – Example set of basic normalized data for tone characteristics

i	X''_R	Y''_R	Z''_R	X''_G	Y''_G	Z''_G	X''_B	Y''_B	Z''_B
0	0,0111	0,0187	0,9636	0,0101	0,0045	0,1297	0,0169	0,0669	0,0066
1	0,0136	0,0214	0,9657	0,0127	0,0069	0,1327	0,0180	0,0680	0,0076
2	0,0162	0,0240	0,9679	0,0152	0,0094	0,1357	0,0190	0,0692	0,0086
3	0,0302	0,0384	0,9722	0,0233	0,0174	0,1427	0,0233	0,0732	0,0129
4	0,0441	0,0527	0,9764	0,0315	0,0253	0,1496	0,0276	0,0773	0,0173
5	0,0614	0,0702	0,9786	0,0440	0,0379	0,1610	0,0389	0,0876	0,0287
6	0,0788	0,0877	0,9807	0,0565	0,0504	0,1723	0,0502	0,0979	0,0401
7	0,0961	0,1052	0,9829	0,0691	0,0630	0,1837	0,0615	0,1082	0,0515
8	0,1134	0,1227	0,9850	0,0816	0,0755	0,1951	0,0728	0,1185	0,0629
9	0,1438	0,1534	0,9845	0,1015	0,0956	0,2141	0,0948	0,1382	0,0849
10	0,1742	0,1841	0,9839	0,1215	0,1157	0,2331	0,1167	0,1580	0,1068
11	0,2046	0,2148	0,9834	0,1414	0,1358	0,2522	0,1387	0,1777	0,1287
12	0,2351	0,2455	0,9829	0,1613	0,1558	0,2712	0,1606	0,1974	0,1507
13	0,2711	0,2816	0,9845	0,1867	0,1813	0,2956	0,1870	0,2210	0,1773
14	0,3072	0,3177	0,9861	0,2120	0,2067	0,3200	0,2134	0,2446	0,2038
15	0,3433	0,3539	0,9877	0,2374	0,2321	0,3445	0,2398	0,2683	0,2304

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i	X''_R	Y''_R	Z''_R	X''_G	Y''_G	Z''_G	X''_B	Y''_B	Z''_B
16	0,3794	0,3900	0,9893	0,2627	0,2576	0,3689	0,2661	0,2919	0,2570
17	0,4263	0,4364	0,9882	0,2983	0,2938	0,4027	0,3043	0,3269	0,2958
18	0,4732	0,4827	0,9872	0,3340	0,3301	0,4366	0,3425	0,3619	0,3346
19	0,5201	0,5291	0,9861	0,3696	0,3663	0,4705	0,3807	0,3968	0,3733
20	0,5670	0,5755	0,9850	0,4052	0,4026	0,5043	0,4189	0,4318	0,4121
21	0,6134	0,6214	0,9866	0,4489	0,4470	0,5432	0,4638	0,4732	0,4575
22	0,6598	0,6673	0,9882	0,4927	0,4913	0,5821	0,5087	0,5146	0,5030
23	0,7062	0,7132	0,9898	0,5364	0,5357	0,6210	0,5535	0,5560	0,5484
24	0,7526	0,7591	0,9914	0,5802	0,5801	0,6599	0,5984	0,5974	0,5938
25	0,7848	0,7907	0,9898	0,6226	0,6228	0,6960	0,6457	0,6437	0,6422
26	0,8170	0,8223	0,9882	0,6651	0,6656	0,7320	0,6929	0,6899	0,6905
27	0,8492	0,8539	0,9866	0,7075	0,7083	0,7680	0,7402	0,7362	0,7389
28	0,8814	0,8855	0,9850	0,7500	0,7511	0,8040	0,7874	0,7825	0,7873
29	0,9175	0,9200	0,9872	0,8066	0,8074	0,8501	0,8386	0,8344	0,8390
30	0,9536	0,9545	0,9893	0,8632	0,8636	0,8963	0,8898	0,8864	0,8907
31	0,9768	0,9773	0,9946	0,9316	0,9318	0,9481	0,9449	0,9432	0,9453
32	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000

10 Other characteristics

10.1 Inter-channel dependency

10.1.1 Characteristics to be measured

Inter-channel relationship between input data and tristimulus values, X', Y', Z' of displayed colours.

The relationship depending upon channel interaction shall be defined as follows:

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \mathbf{ST} \begin{pmatrix} 1 \\ R' \\ G' \\ B' \\ R'G' \\ G'B' \\ B'R' \\ R'G'B' \end{pmatrix} \tag{10}$$

where the variables R', G', B' are data obtained by interpolation of measured data which are reported as X''_R, X''_G, X''_B in Table 4, and dependent variables X', Y', Z' are measured and normalized tristimulus values of light output, as in 8.2. In equation (10), $\mathbf{S}$ and $\mathbf{T}$ are 3×3 and 3×8 matrices respectively defined as follows:

$$\mathbf{S} = \begin{pmatrix} s_{11} & s_{12} & s_{13} \\ s_{21} & s_{22} & s_{23} \\ s_{31} & s_{32} & s_{33} \end{pmatrix} \tag{11}$$

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$$\mathbf{T} = \left(\begin{array}{c|ccc|ccc|c} t_{0X} & t_{1X} & t_{2X} & t_{3X} & t_{4X} & t_{5X} & t_{6X} & t_{7X} \\ t_{0Y} & t_{1Y} & t_{2Y} & t_{3Y} & t_{4Y} & t_{5Y} & t_{6Y} & t_{7Y} \\ t_{0Z} & t_{1Z} & t_{2Z} & t_{3Z} & t_{4Z} & t_{5Z} & t_{6Z} & t_{7Z} \end{array}\right) \quad (12)$$

NOTE The matrix S is the dominant relation obtained and reported in 8.3, and the matrix T defines cross-channel relations among red-green-blue channels.

10.1.2 Measurement conditions

a) The arrangement of the equipment shall be as in Figure 1.

b) The colour signal shall be so applied as to generate the colour patch positioned at the centre of the screen under measurement.

c) The input data for the background shall be $D_R = 0$, $D_G = 0$, $D_B = 0$.

10.1.3 Method of measurement

a) The centred colour patches shall be displayed with the input data following the measurement steps, as shown in Table 5, for 32 colours.

Table 5 – Digital driving levels to generate colour patches for measurement of interchannel dependency

Step. *i*	Colour	D_R	D_G	D_B
1	grey 1	D_1	D_1	D_1
2	grey 2	D_2	D_2	D_2
3	grey 3	D_3	D_3	D_3
4	grey 4	D_4	D_4	D_4
5	grey 5	D_5	D_5	D_5
6	grey 6	D_6	D_6	D_6
7	grey 7	D_7	D_7	D_7
8	grey 8	D_8	D_8	D_8
9	red 1	D_4	D_0	D_0
10	red 2	D_6	D_2	D_2
11	red 3	D_8	D_0	D_0
12	red 4	D_8	D_4	D_4
13	green 1	D_0	D_4	D_0
14	green 2	D_2	D_6	D_2
15	green 3	D_0	D_8	D_0
16	green 4	D_4	D_8	D_4
17	blue 1	D_0	D_0	D_4
18	blue 2	D_2	D_2	D_6

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Table 5 *(continued)*

Step. *i*	Colour	$\boldsymbol{D}_{\mathrm{R}}$	$\boldsymbol{D}_{\mathrm{G}}$	$\boldsymbol{D}_{\mathrm{B}}$
19	blue 3	D_0	D_0	D_8
20	blue 4	D_4	D_4	D_8
21	yellow 1	D_4	D_4	D_0
22	yellow 2	D_6	D_6	D_2
23	yellow 3	D_8	D_8	D_0
24	yellow 4	D_8	D_8	D_4
25	magenta 1	D_4	D_0	D_4
26	magenta 2	D_6	D_2	D_6
27	magenta 3	D_8	D_0	D_8
28	magenta 4	D_8	D_4	D_8
29	cyan 1	D_0	D_4	D_4
30	cyan 2	D_2	D_6	D_6
31	cyan 3	D_0	D_8	D_8
32	cyan 4	D_4	D_8	D_8

In Table 5, the values of data D_k shall be

$$D_k = \begin{cases} 2^{N-3}k & \text{for } k = 0,...,7, \\ 2^{N-3}k - 1 & \text{for } k = 8. \end{cases} \tag{13}$$

where N is the number of bits for each channel.

NOTE If the analogue input is used, the input signal should be of the same level as the digital data.

b) The tristimulus values X'_i, Y'_i, Z'_i normalized in accordance with equation (2), shall successively be measured by the colorimeter for i = 1 to i = 32 for all colour patches in the screen.

c) The data R'_i, G'_i, B'_i, corresponding to D_{R}, D_{G}, D_{B} in Table 5, shall be calculated and the values of coefficient matrix, $\mathbf{T}$, defined in equation (10) shall be calculated by the following equation

$$\mathbf{T} = \mathbf{S}^{-1}\left(\left(\mathbf{D}^t\mathbf{D}\right)^{-1}\mathbf{D}^t\mathbf{A}\right)^t \tag{14}$$

where

$$D = \left(\begin{array}{c|ccc|ccc|c} 1 & R'_1 & G'_1 & B'_1 & R'_1G'_1 & G'_1B'_1 & B'_1R'_1 & R'_1G'_1B'_1 \\ 1 & R'_2 & G'_2 & B'_2 & R'_2G'_2 & G'_2B'_2 & B'_2R'_2 & R'_2G'_2B'_2 \\ : & : & : & : & : & : & : & : \\ 1 & R'_{32} & G'_{32} & B'_{32} & R'_{32}G'_{32} & G'_{32}B'_{32} & B'_{32}R'_{32} & R'_{32}G'_{32}B'_{32} \end{array}\right) \tag{15}$$

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$$\mathbf{A} = \begin{pmatrix} X'_1 & Y'_1 & Z'_1 \\ X'_2 & Y'_2 & Z'_2 \\ : & : & : \\ X'_{32} & Y'_{32} & Z'_{32} \end{pmatrix} \tag{16}$$

10.1.4 Presentation of results

a) The values of coefficient matrix $\mathbf{T}$ shall be reported as shown in the example.

$$\mathbf{T} = \left(\begin{array}{c|ccc|ccc|c} \text{-0,2109} & \text{1,0591} & \text{0,3193} & \text{0,0101} & \text{-0,1782} & \text{-0,3815} & \text{0,0752} & \text{0,3864} \\ \text{-0,3062} & \text{0,1954} & \text{1,2655} & \text{0,4591} & \text{-0,3091} & \text{-0,4925} & \text{-0,3309} & \text{0,2921} \\ \text{-0,1892} & \text{0,1343} & \text{0,1982} & \text{0,8673} & \text{-0,2507} & \text{-0,0809} & \text{-0,0646} & \text{0,1712} \end{array}\right) \tag{17}$$

b) The measured data shall also be reported as shown in Table 6.

Table 6 – Example of normalized tristimulus values (matrix A)

i	*X′*	*Y′*	*Z′*
1	0,0146	0,0147	0,0168
2	0,0494	0,0497	0,0560
3	0,1190	0,1201	0,1313
4	0,2223	0,2254	0,2429
5	0,3607	0,3673	0,3949
6	0,5309	0,5408	0,5850
7	0,7555	0,7676	0,8133
8	0,9551	1,0000	1,0720
9	0,0969	0,0589	0,0115
10	0,2498	0,1550	0,0570
11	0,3908	0,2331	0,0329
12	0,4991	0,3494	0,2321
13	0,1131	0,2041	0,0448
14	0,2453	0,4274	0,1225
15	0,5101	0,9259	0,1868
16	0,5046	0,7912	0,3352
17	0,0494	0,0487	0,2130
18	0,1562	0,1383	0,5187
19	0,2085	0,2096	0,9351
20	0,3693	0,3220	0,9515
21	0,1795	0,2234	0,0448
22	0,4288	0,5073	0,1237
23	0,7833	1,0078	0,1895
24	0,8076	0,9330	0,3378
25	0,1599	0,1142	0,2207
26	0,3820	0,2717	0,5306
27	0,6711	0,4840	0,9701
28	0,6818	0,5026	0,9736
29	0,1205	0,1803	0,2428
30	0,3081	0,4354	0,5803
31	0,5354	0,8161	1,0577
32	0,6315	0,8389	1,0570

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10.2 Spatial non-uniformity

10.2.1 Characteristics to be measured

Non-uniformity of lightness (see IEV 845-03-54 and IEV 845-03-56) and chromaticity coordinates over the entire screen.

10.2.2 Measurement conditions

The arrangement of the equipment shall be as in Figure 1.

10.2.3 Method of measurement

The method of measurement shall be in accordance with one of 10.2.3.1, 10.2.3.2 and 10.2.3.3 depending upon requirement.

10.2.3.1 Measurement at 25 points

a) The data $D_R = M$, $D_G = M$, $D_B = M$ shall be applied to display white over the entire screen, where $M = 2^N - 1$ and N is the number of bits.

b) Tristimulus values X_i , Y_i , Z_i shall be measured using the colorimeter at 25 points ($1 \le i \le 25$) as shown in Figure 5.

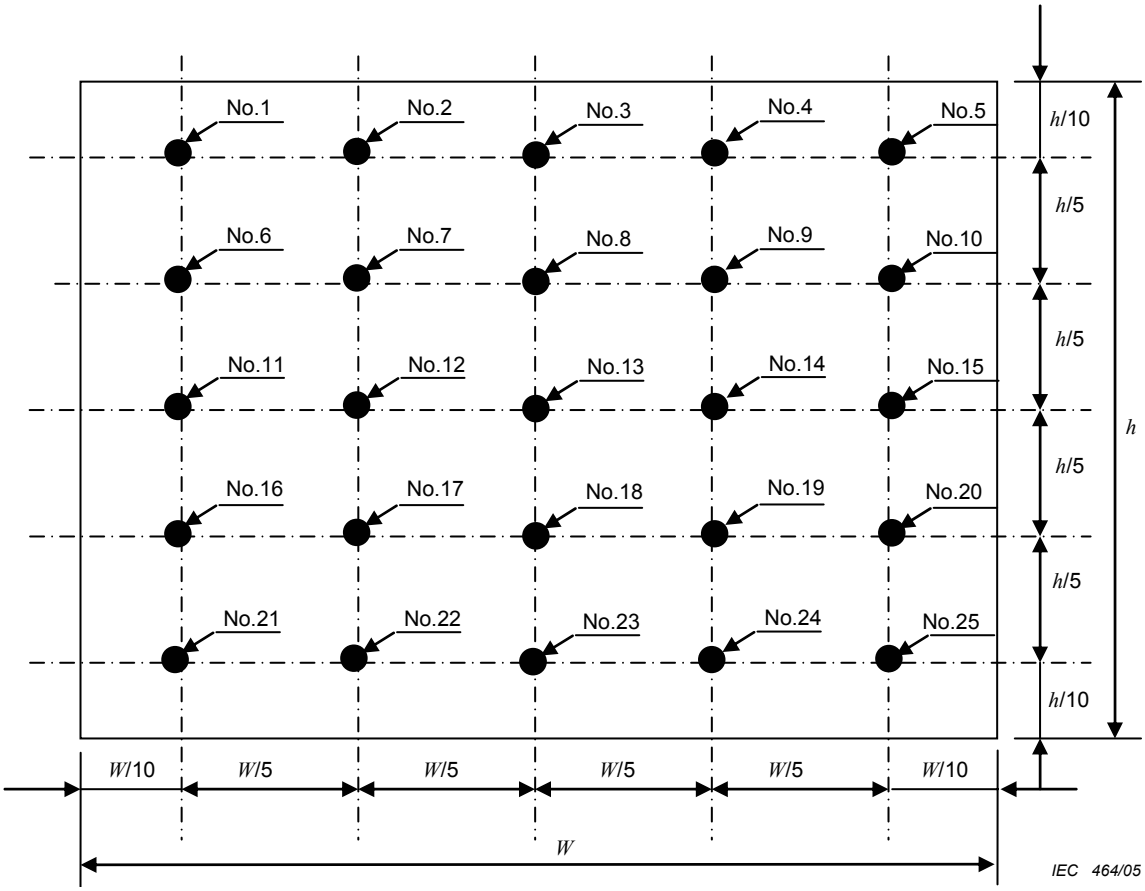

Figure 5 – Measurement points for spatial non-uniformity (25 points)

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c) The following colour differences in CIE 1976 UCS and CIE 1976 L^*, a^*, b^* coordinate systems shall be calculated with a reference data X_{13}, Y_{13}, Z_{13} at the centre of the screen.

$$\left.\begin{aligned} \Delta u'_i &= u'_i - u'_{13} \\ \Delta v'_i &= v'_i - v'_{13} \\ \Delta u'v'_i &= \sqrt{\Delta u_i'^2 + \Delta v_i'^2} \\ \Delta L^*_i &= L^*_i - L^*_{13} \\ \Delta C^*_{\mathrm{ab}_i} &= \sqrt{(a^*_i - a^*_{13})^2 + (b^*_i - b^*_{13})^2} \end{aligned}\right\} \quad (18)$$

where u', v' and L^*, a^*, b^* are defined by CIE 15.2 as in

$$\left.\begin{aligned} u'_i &= \frac{4X_i}{X_i + 15Y_i + 3Z_i} \\ v'_i &= \frac{9Y_i}{X_i + 15Y_i + 3Z_i} \end{aligned}\right\} \quad (19)$$

$$\left.\begin{aligned} L^*_i &= 116\left(\frac{Y_i}{Y_{13}}\right)^{\frac{1}{3}} - 16 \\ a^*_i &= 500\left[\left(\frac{X_i}{X_{13}}\right)^{\frac{1}{3}} - \left(\frac{Y_i}{Y_{13}}\right)^{\frac{1}{3}}\right] \\ b^*_i &= 200\left[\left(\frac{Y_i}{Y_{13}}\right)^{\frac{1}{3}} - \left(\frac{Z_i}{Z_{13}}\right)^{\frac{1}{3}}\right] \end{aligned}\right\} \quad (20)$$

NOTE These equations are valid for $\frac{Y_i}{Y_{13}} \geq 0{,}008856$.

10.2.3.2 Measurement at 9 points

a) The data $D_{\mathrm{R}} = M$, $D_{\mathrm{G}} = M$, $D_{\mathrm{B}} = M$ shall be applied to display white over the entire screen, where $M = 2^N - 1$ and N is the number of bits.

b) Tristimulus values X_i, Y_i, Z_i shall be measured using the colorimeter at 9 points ($1 \leq i \leq 9$) as shown in Figure 6.

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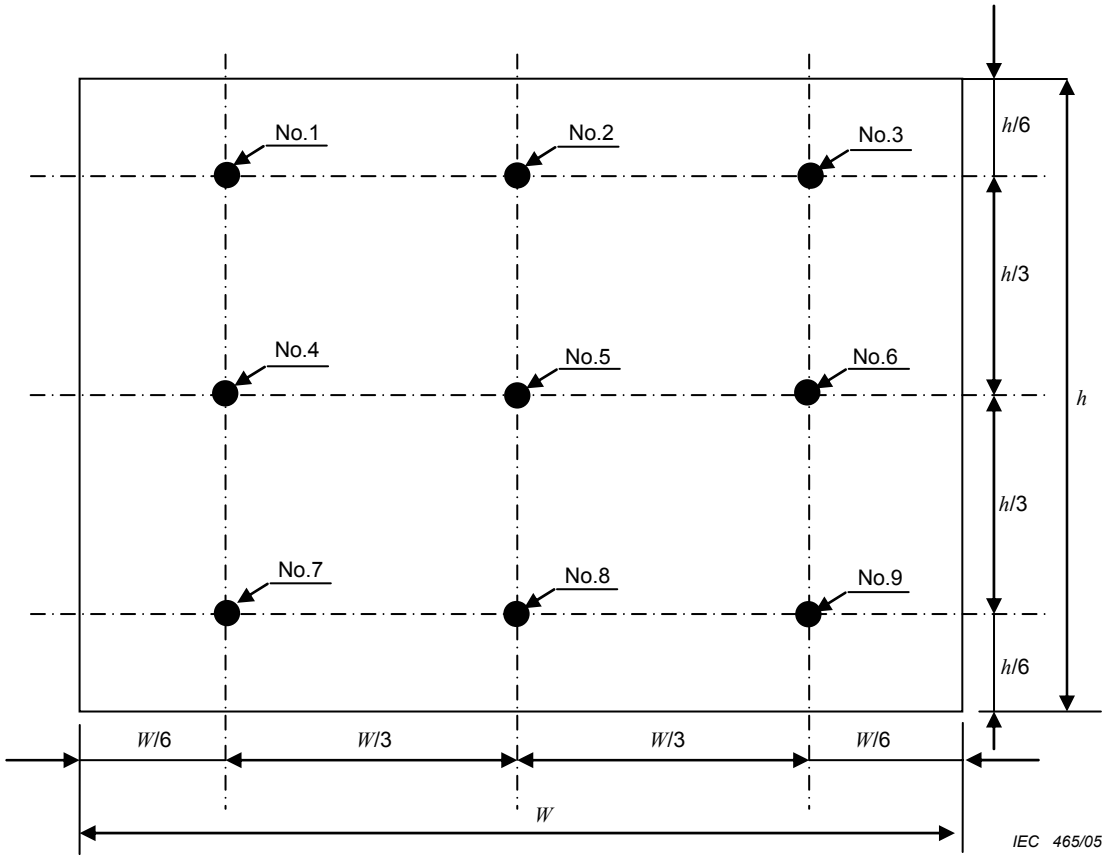

Figure 6 – Measurement points for spatial non-uniformity (9 points)

c) The following colour differences in CIE 1976 UCS and CIE 1976 L^*, a^*, b^* coordinate systems shall be calculated with a reference data X_5, Y_5, Z_5 at the centre of the screen.

$$\left.\begin{aligned} \Delta u'_i &= u'_i - u'_5 \\ \Delta v'_i &= v'_i - v'_5 \\ \Delta u'v'_i &= \sqrt{\Delta u_i'^2 + \Delta v_i'^2} \\ \Delta L^*_i &= L^*_i - L^*_5 \\ \Delta C^*_{ab_i} &= \sqrt{(a^*_i - a^*_5)^2 + (b^*_i - b^*_5)^2} \end{aligned}\right\} \quad (21)$$

where u', v' and L^*, a^*, b^* are defined by CIE 15.2 as in

$$\left.\begin{aligned} u'_i &= \frac{4X_i}{X_i + 15Y_i + 3Z_i} \\ v'_i &= \frac{9Y_i}{X_i + 15Y_i + 3Z_i} \end{aligned}\right\} \quad (22)$$

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$$\left.\begin{aligned} L_i^* &= 116\left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}} - 16 \\ a_i^* &= 500\left[\left(\frac{X_i}{X_5}\right)^{\frac{1}{3}} - \left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}}\right] \\ b_i^* &= 200\left[\left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}} - \left(\frac{Z_i}{Z_5}\right)^{\frac{1}{3}}\right] \end{aligned}\right\} \quad (23)$$

NOTE These equations are valid for $\frac{Y_i}{Y_5} \geq 0{,}008856$.

10.2.3.3 Measurement at 13 points

a) The data $D_R = M$, $D_G = M$, $D_B = M$ shall be applied to display white over the entire screen, where $M = 2^N - 1$ and N is the number of bits.

b) Tristimulus values X_i, Y_i, Z_i shall be measured using the colorimeter at 13 points ($1 \leq i \leq 13$) to be in agreement with IEC 61947-1 and IEC 61947-2 as shown in Figure 7. The four corner points 10, 11, 12 and 13 are located at 10 % of the distance from the corner itself to the centre of point 5.

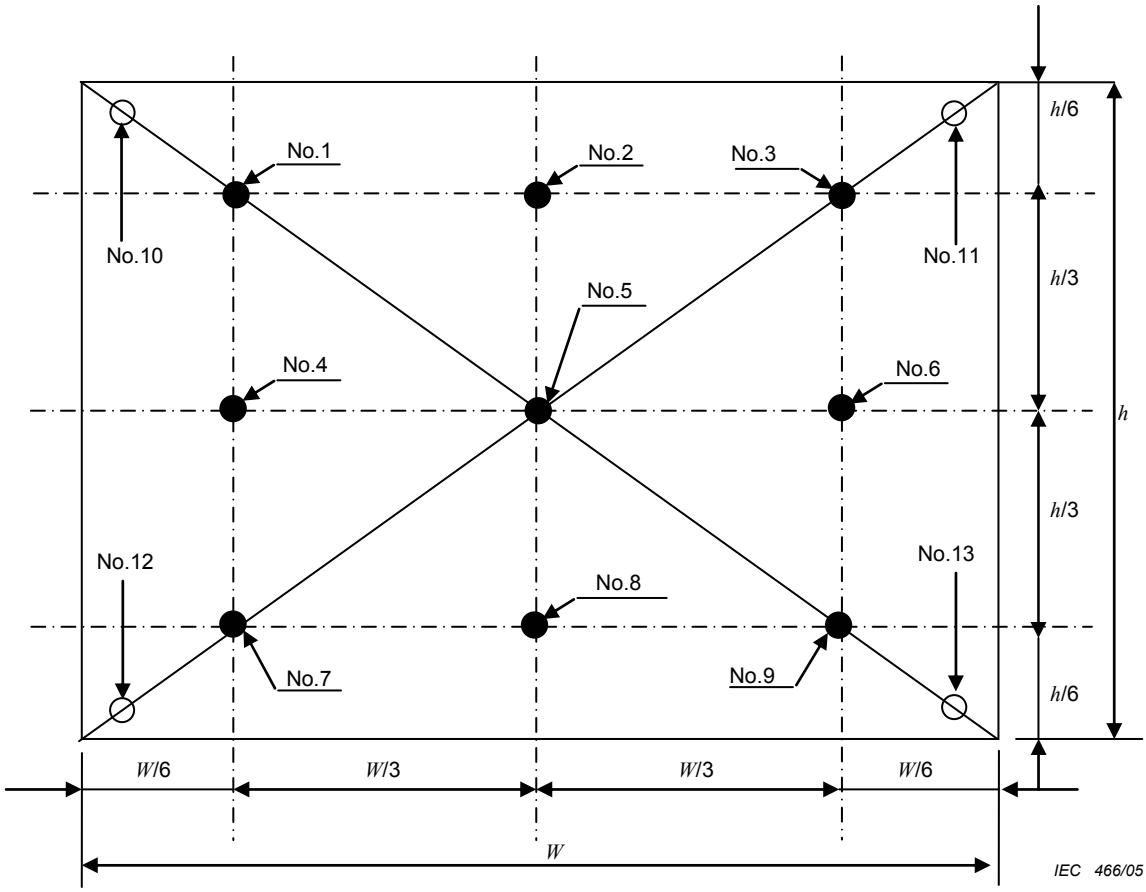

Figure 7 – Measurement points for spatial non-uniformity (13 points)

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c) The following colour differences in CIE 1976 UCS and CIE 1976 L^*, a^*, b^* coordinate systems shall be calculated with a reference data X_5, Y_5, Z_5 at the centre of the screen.

$$\left.\begin{aligned} \Delta u'_i &= u'_i - u'_5 \\ \Delta v'_i &= v'_i - v'_5 \\ \Delta u'v'_i &= \sqrt{\Delta u_i'^2 + \Delta v_i'^2} \\ \Delta L^*_i &= L^*_i - L^*_5 \\ \Delta C^*_{ab_i} &= \sqrt{(a^*_i - a^*_5)^2 + (b^*_i - b^*_5)^2} \end{aligned}\right\} \quad (24)$$

where u', v' and L^*, a^*, b^* are defined by CIE 15.2 as in

$$\left.\begin{aligned} u'_i &= \frac{4X_i}{X_i + 15Y_i + 3Z_i} \\ v'_i &= \frac{9Y_i}{X_i + 15Y_i + 3Z_i} \end{aligned}\right\} \quad (25)$$

$$\left.\begin{aligned} L^*_i &= 116\left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}} - 16 \\ a^*_i &= 500\left[\left(\frac{X_i}{X_5}\right)^{\frac{1}{3}} - \left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}}\right] \\ b^*_i &= 200\left[\left(\frac{Y_i}{Y_5}\right)^{\frac{1}{3}} - \left(\frac{Z_i}{Z_5}\right)^{\frac{1}{3}}\right] \end{aligned}\right\} \quad (26)$$

NOTE These equations are valid for $\frac{Y_i}{Y_5} \geq 0{,}008856$.

10.2.4 Presentation of results

The presentation of results shall be in accordance with either 10.2.4.1, 10.2.4.2 or 10.2.4.3 depending on the selected method of measurement.

10.2.4.1 Method of measurement specified in 10.2.3.1

As indices of non-uniformity, the calculated results $\Delta u'$, $\Delta v'$, $\Delta u'v'$, ΔL^* and ΔC^*_{ab} for $1 \leq i \leq 25$ shall be reported as a table, as shown in Table 7.

NOTE A simple index, such as the maximum $\Delta u'v'$ recommended by 6.2 of ISO 9241-8 [5] may be reported.

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Table 7 – Example of reporting form

Position	$\Delta u'$	$\Delta v'$	$\Delta u'v'$	ΔL^*	ΔC^*_{ab}
1	–0,0004	–0,0001	0,0005	–4,39	0,37
2	–0,0017	–0,0017	0,0024	–0,72	1,67
3	–0,0013	0,0006	0,0015	–4,75	1,37
4	–0,0006	0,0035	0,0036	–0,07	3,20
5	–0,0008	0,0015	0,0017	–8,63	1,54
6	0,0006	–0,0010	0,0012	–5,98	1,11
7	–0,0005	–0,0014	0,0015	1,60	1,12
8	–0,0003	0,0002	0,0004	–1,62	0,36
9	–0,0002	0,0018	0,0018	3,04	1,64
10	0,0003	0,0010	0,0010	–2,77	0,77
11	0,0004	0,0005	0,0007	–5,11	0,44
12	–0,0006	–0,0012	0,0013	–7,59	0,89
13	0,0000	0,0000	0,0000	0,00	0,00
14	–0,0007	0,0014	0,0016	2,79	1,54
15	–0,0001	0,0010	0,0010	–5,37	0,84
16	–0,0007	0,0013	0,0015	0,09	1,45
17	–0,0006	0,0031	0,0031	1,84	2,83
18	0,0009	–0,0008	0,0012	1,30	1,23
19	–0,0006	0,0026	0,0027	–0,17	2,41
20	–0,0008	0,0015	0,0017	–6,40	1,53
21	–0,0023	0,0040	0,0046	2,18	4,53
22	–0,0025	0,0014	0,0029	4,98	2,94
23	–0,0008	0,0027	0,0028	6,41	2,75
24	–0,0012	0,0051	0,0053	5,84	5,04
25	–0,0017	0,0035	0,0038	0,47	3,67

10.2.4.2 Method of measurement specified in 10.2.3.2

As indices of non-uniformity, the calculated results $\Delta u', \Delta v', \Delta u'v', \Delta L^*$ and ΔC^*_{ab} for $1 \le i \le 9$ shall be reported as a table, as shown in Table 8.

NOTE A simple index, such as the maximum $\Delta u'v'$ recommended by 6.2 of ISO 9241-8 [5], may be reported.

Table 8 – Example of reporting form

Position	$\Delta u'$	$\Delta v'$	$\Delta u'v'$	ΔL^*	ΔC^*_{ab}
1	–0,0005	–0,0011	0,0012	–2,29	0,85
2	–0,0008	0,0004	0,0009	–3,16	0,85
3	–0,0003	0,0020	0,0020	–1,95	1,77
4	–0,0001	–0,0003	0,0003	–6,33	0,22
5	0,0000	0,0000	0,0000	0,00	0,00
6	–0,0004	0,0012	0,0013	–1,14	1,20
7	–0,0016	0,0024	0,0029	2,30	2,87
8	0,0000	0,0011	0,0011	3,91	0,92
9	–0,0011	0,0033	0,0035	0,10	3,24

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10.2.4.3 Method of measurement specified in 10.2.3.3

As indices of non-uniformity, the calculated results $\Delta u'$, $\Delta v'$, $\Delta u'v'$, ΔL^* and ΔC^*_{ab} for $1 \le i \le 13$ shall be reported as a table, as shown in Table 9.

NOTE Simple index such as the maximum $\Delta u'v'$ recommended by 6.2 of ISO 9241-8 [5] may be reported.

Table 9 – Example of reporting form

Position	$\Delta u'$	$\Delta v'$	$\Delta u'v'$	ΔL^*	ΔC^*_{ab}
1	–0,0005	–0,0011	0,0012	–2,29	0,85
2	–0,0008	0,0004	0,0009	–3,16	0,85
3	–0,0003	0,0020	0,0020	–1,95	1,77
4	–0,0001	–0,0003	0,0003	–6,33	0,22
5	0,0000	0,0000	0,0000	0,00	0,00
6	–0,0004	0,0012	0,0013	–1,14	1,20
7	–0,0016	0,0024	0,0029	2,30	2,87
8	0,0000	0,0011	0,0011	3,91	0,92
9	–0,0011	0,0033	0,0035	0,10	3,24
10	–0,0004	–0,0001	0,0005	–4,39	0,37
11	–0,0008	0,0015	0,0017	–8,63	1,54
12	–0,0008	0,0015	0,0017	–6,40	1,53
13	–0,0017	0,0035	0,0038	0,47	3,67

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Bibliography

[1] IEC 61966-2-1, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*

[2] IEC 61966-3, *Multimedia systems and equipment – Colour measurement and management – Part 3: Equipments using cathode ray tubes*

[3] IEC TTA-3:1997, Hiroaki Ikeda, Masato Abe, and Yasuhiko Higaki: *Equipment independent colour reproduction systems,* IEC Technical Trend Assessment, No. 3, IEC Geneva (1997)

[4] Y. Ohno, J.E. Hardis: *Four-color matrix method for correction of tristimulus colorimeters,* Proc. of IS&T/SID Color Imaging Conference, pp. 301–305 (November 1997)

[5] ISO 9241-8:1997, *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 8: Requirements for displayed colours*

[6] Pefferkorn, S., Vienot, F., Chiron, A. and Brettel, H. *Problem of spectroradiometric calibration of polarized displays,* Conference Proceedings of the 13th International Display Research Conference, pp. 443-446 (1993)

[7] JIS Z 8724:1997, *Methods of colour measurement – Light-source colour*

[8] CIE 122:1996, *The relationship between digital and colorimetric data for computer-controlled CRT displays*

[9] ASTM E 1455:1996, *Standard practice for obtaining colorimetric data from a visual display*

[10] EBU tech. 3273-E: *Methods of measurement of the colorimetric performance of studio monitors,* European Broadcasting Union (Oct., 1993).

[11] STM designation E 1455-92: *Standard Practice for Obtaining Colorimetric Data from a Visual Display Unit Using Tristimulus Colorimeters*, American Society of Testing and Materials (1992).

[12] ASTM designation E 1336-91: *Obtaining colorimetric data from a video display unit by spectro-radiometry,* American Society of Testing and Materials (1991)

[13] ASTM designation E 1341-91: *Obtaining spectroradiometric data from radiant sources for Colorimetry,* American Society of Testing and Materials (1991).

[14] CIE 87: 1990, *Colorimetry of self-luminous displays – A bibliography*

[15] CIE 60: 1984, *Vision and the visual display unit work stations*

[16] R. Robertson: *Computation of correlated color temperature and distribution temperature,* J.Opt. Soc. Amer, Vol. 58, No. 11, pp. 1528–1535 (Nov., 1968)

[17] CIE 63: 1984, *The spectroradiometric measurement of light sources*

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