

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Multimedia systems and equipment – Colour measurement and management –  
Part 6: Front projection displays**

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**Systèmes et appareils multimédia – Mesure et gestion de la couleur –  
Partie 6: Ecrans de projection frontale**

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# INTERNATIONAL STANDARD

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**Multimedia systems and equipment – Colour measurement and management –  
Part 6: Front projection displays**

**Systèmes et appareils multimédia – Mesure et gestion de la couleur –  
Partie 6: Ecrans de projection frontale**

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**MULTIMEDIA SYSTEMS AND EQUIPMENT –  
COLOUR MEASUREMENT AND MANAGEMENT –**

**Part 6: Front projection displays**

FOREWORD

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International Standard IEC 61966-6 has been prepared by technical area 2: Colour measurement and management, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This bilingual version (2013-03) corresponds to the monolingual English version, published in 2005-03.

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.

The French version of this standard has not been voted upon.

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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- replaced by a revised edition, or
- amended.

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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*  
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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

### 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

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## 4 Letters and symbols

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

<i>A</i>	display area ratio
<i>N</i>	number of bits in digital data for each channel
<i>M</i>	maximum integer for non-negative <i>N</i> -bits system; $M = 2^N - 1$
<i>D<sub>R</sub></i>	digital data applied for red channel
<i>D<sub>G</sub></i>	digital data applied for green channel
<i>D<sub>B</sub></i>	digital data applied for blue channel
<i>R</i>	normalized input level to red channel
<i>G</i>	normalized input level to green channel
<i>B</i>	normalized input level to blue channel
<i>X</i>	one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values
<i>Y</i>	one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values in candela per square metre
<i>Z</i>	one of measured raw data using spectroradiometers and colorimeters corresponding to tristimulus values
<i>R'</i>	linearized data for red channel taking into account the tone characteristics of the channel

- $G'$  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  $\pm 5$  % 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

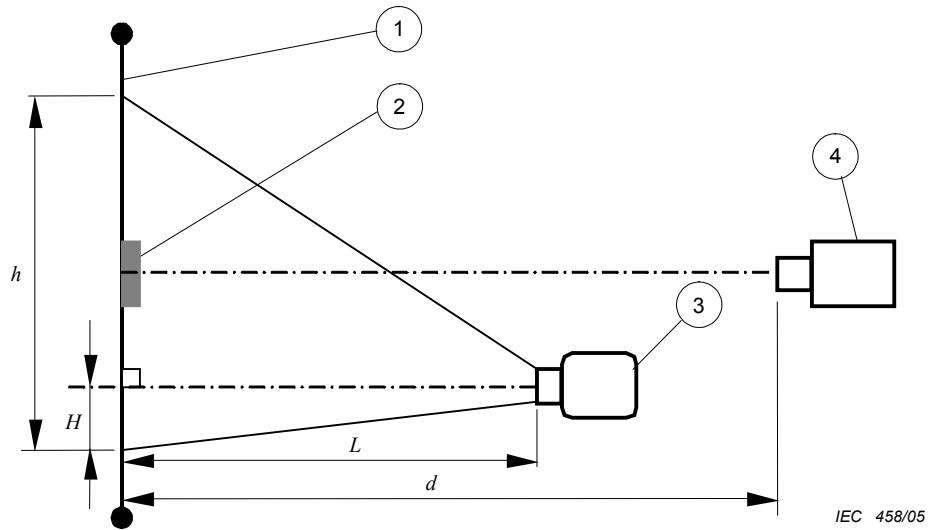
Contrast, brightness and additional adjustments shall be set to the preset positions specified by the manufacturer. If the adjustment is set to another position than the preset, the position or corresponding value shall be reported with the results of measurements.

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.



**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

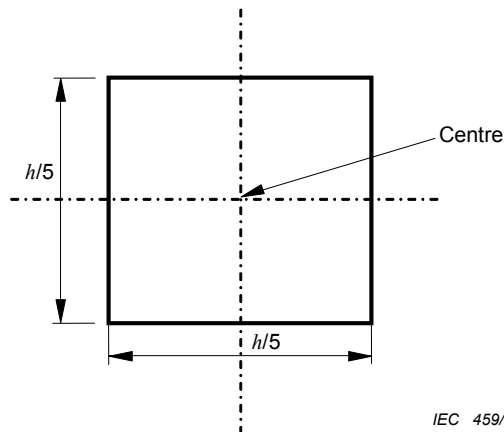
**Figure 1 – Equipment arrangement for measurements (side view)**

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 ( $D_R = 0, D_G = 0, D_B = 0$ ), 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**

### 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

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

where the index  $i$  denotes the  $i$ th 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].<sup>1</sup>

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.

<sup>1</sup> Figures in square brackets refer to the bibliography.

### 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:

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

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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  $D_R = 0, D_G = 0, D_B = 0$ .

### 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.

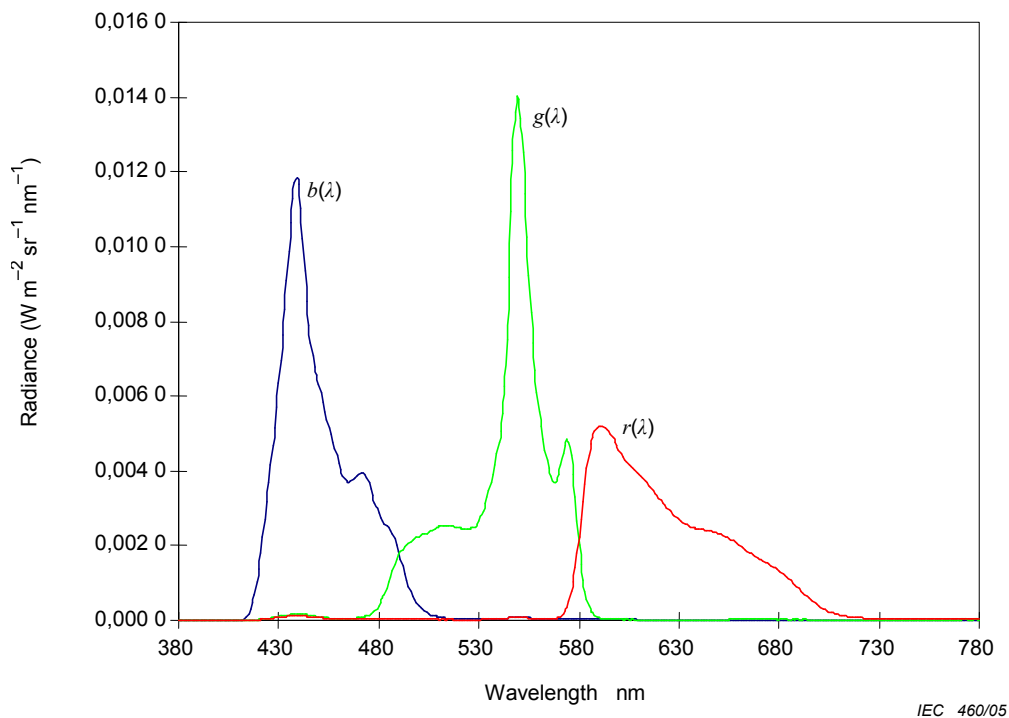
**Table 1 – Input data for peak primaries and peak white**

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 (standards.iteh.ai)
- 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.



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