

TECHNICAL SPECIFICATION

Organic light emitting diode (OLED) displays –
Part 6-5: Measuring methods of dynamic range properties

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TECHNICAL SPECIFICATION

**Organic light emitting diode (OLED) displays –
Part 6-5: Measuring methods of dynamic range properties**

INTERNATIONAL
ELECTROTECHNICAL
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CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms, definitions, and abbreviated terms	6
3.1 Terms and definitions.....	6
3.2 Abbreviated terms.....	6
4 Standard measuring equipment and coordinate system	6
4.1 Light measuring devices	6
4.2 Viewing direction coordinate system	7
5 Measuring conditions.....	8
5.1 Standard measuring environmental conditions	8
5.2 Power supply	8
5.3 Warm-up time	9
5.4 Standard measuring dark-room conditions	9
5.5 Standard set-up conditions	9
6 Measuring methods of dynamic range properties	9
6.1 Peak luminance	9
6.1.1 Purpose.....	9
6.1.2 Measuring conditions.....	10
6.1.3 Set-up	10
6.1.4 Measurement of peak luminance.....	10
6.2 Black level and black constancy.....	11
6.2.1 Purpose.....	11
6.2.2 Measuring conditions.....	11
6.2.3 Set-up	11
6.2.4 Measurement of black level and black constancy according to background.....	12
6.3 Local contrast	13
6.3.1 Purpose.....	13
6.3.2 Measuring conditions.....	13
6.3.3 Set-up	13
6.3.4 Measurement of local contrast.....	13
6.4 Dynamic range coverage	14
6.4.1 Purpose.....	14
6.4.2 Measuring conditions.....	14
6.4.3 Set-up	14
6.4.4 Measurement of dynamic range coverage.....	14
Bibliography.....	16
Figure 1 – Representation of the viewing direction.....	8
Figure 2 – DUT installation conditions.....	9
Figure 3 – Test patterns for peak luminance measurement	10
Figure 4 – Test pattern for black level and constancy measurement.....	12
Figure 5 – Test pattern for local contrast.....	13

Table 1 – Working example for peak luminance 11

Table 2 – Working example for black level and constancy..... 12

Table 3 – Working example for local contrast..... 14

Table 4 – Working example for dynamic range coverage 15

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

Part 6-5: Measuring methods of dynamic range properties

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62341-6-5, which is a technical specification, has been prepared by IEC technical committee 110: Electronic displays.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
110/1017/DTS	110/1063A/RVC

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

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

A list of all parts in the IEC 62341 series, published under the general title *Organic light emitting diode (OLED) displays*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

Part 6-5: Measuring methods of dynamic range properties

1 Scope

This part of IEC 62341 specifies the standard measurement conditions and dynamic range properties for OLED display panels and modules. More precisely, this document focuses on the specific aspects of the dynamic range properties.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62341-1-2:2014, *Organic light emitting diode (OLED) displays – Part 1-2: Terminology and letter symbols*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62341-1-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

dynamic range coverage

capability of the representable dynamic range relative to the reference input signal

EXAMPLE IEC sRGB, BT.1886, BT.2100, BT.2020, SMPTE ST.2084.

3.2 Abbreviated terms

APL average picture level

CIE Commission Internationale de l'Eclairage (International Commission on Illumination)

DUT device under test

LMD light measuring device

4 Standard measuring equipment and coordinate system

4.1 Light measuring devices

The system configurations and/or operating conditions of the measuring equipment shall comply with the structure specified for each item.

To ensure reliable measurements, the following requirements apply to the light measuring equipment:

- 1) Luminance meter^[1]: the instrument's spectral responsivity shall comply with the CIE photopic luminous efficiency function with a $CIE-f_1'$ value no greater than 3 % [2].
- 2) Spectroradiometer: the wavelength range shall be at least from 380 nm to 780 nm, and the wavelength scale accuracy shall be less than $\pm 0,5$ nm.

Errors from spectral stray light within a spectroradiometer can be significant and shall be corrected. A simple matrix method may be used to correct the stray light errors, by which stray light errors can be reduced by one to two orders of magnitudes. Details of this correction method are discussed in the referred document [3]. If the obtained luminance is lower than the LMD limitation, the lower limit of the LMD shall be recorded with the measured luminance.

- 3) Gonio photometric systems: the DUT or LMD can be driven by rotating around a horizontal axis and vertical axis; angle accuracy shall be better than $0,5^\circ$.

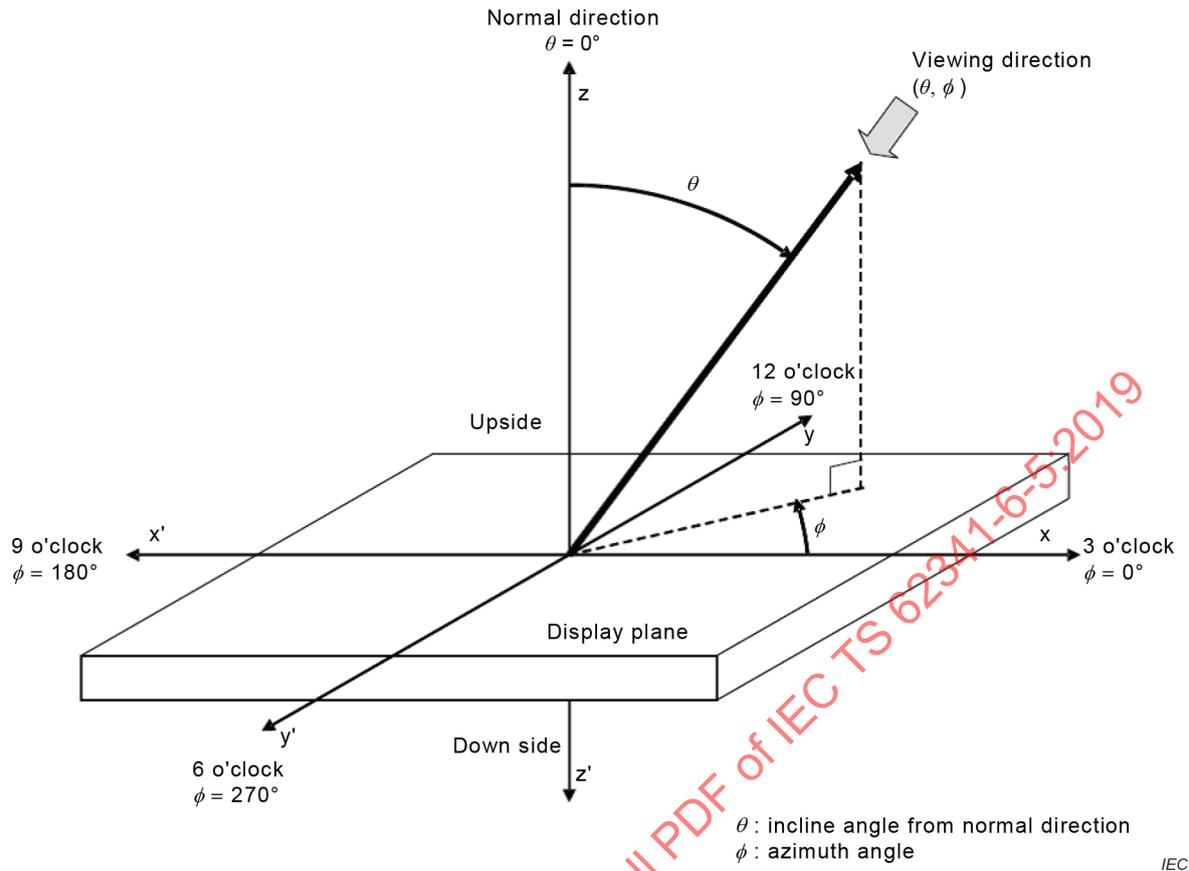
Care shall be taken to ensure that the LMD has enough sensitivity and dynamic range to perform the required task. Before measuring the DUT, the LMD specification shall be checked.

Low luminance measurement is very important for dynamic measurement.

4.2 Viewing direction coordinate system

The viewing direction is the direction under which the observer looks at the spot of interest on the DUT (see also IEC 62341-1-2:2014, Figure A.2). During the measurement, the LMD replaces the observer, looking from the same direction at a specified spot (i.e. measuring spot, measurement field) on the DUT. The viewing direction is conveniently defined by two angles: the angle of inclination θ (related to the surface normal of the DUT) and the angle of rotation ϕ (also called azimuth angle) as illustrated in Figure 1. The azimuth angle is related to the directions on a watch-dial as follows: $\phi = 0^\circ$ is referred to as the 3-o'clock direction ("right"), $\phi = 90^\circ$ as the 12-o'clock direction ("top"), $\phi = 180^\circ$ as the 9-o'clock direction ("left") and $\phi = 270^\circ$ as the 6-o'clock direction ("bottom").

¹ Numbers in square brackets refer to the Bibliography.



Key

- 3 o'clock: right edge of the screen as seen by the user
- 6 o'clock: bottom edge of the screen as seen by the user
- 9 o'clock: left edge of the screen as seen by the user
- 12 o'clock: top edge of the screen as seen by the user

NOTE This is equivalent to the direction of measurement by the angle of inclination, θ , and the angle of rotation (azimuth angle), ϕ , in a polar coordinate system.

Figure 1 – Representation of the viewing direction

5 Measuring conditions

5.1 Standard measuring environmental conditions

Measurements shall be carried out under the following standard environmental conditions:

- temperature: 25 °C ± 3 °C,
- relative humidity: 25 % RH to 85 % RH,
- atmospheric pressure: 86 kPa to 106 kPa.

When different environmental conditions are used, they shall be noted in the measurement report.

5.2 Power supply

The power supply for driving the DUT shall be adjusted to the rated voltage ±0,5 %. In addition, the frequency of the power supply shall provide the rated frequency ±0,2 %.

5.3 Warm-up time

Measurements shall be carried out after sufficient warming up. Warm-up time is defined as the time elapsed from when the supply source is switched on, and a 100 % grey level of input signal is applied to the DUT, until repeated measurements of the display show a variation in luminance of no more than 2 %/min and 5 %/h.

5.4 Standard measuring dark-room conditions

The luminance contribution from the background illumination reflected off the test display shall be less than 0,01 lx. If these conditions are not satisfied, then background subtraction is required and it shall be noted in the measurement report. In addition, if the sensitivity of the LMD is inadequate to measure these low levels, then the lower limit of the LMD shall be noted in the measurement report.

5.5 Standard set-up conditions

By default, the display shall be installed in the vertical position (Figure 2a)), but the horizontal alternative (Figure 2b)) is also allowed. When the latter alternative is used, it shall be noted in the measurement report.

Luminance, contrast ratio and chromaticity of the white field and other relevant parameters of the displays have to be adjusted to nominal status in the detailed specification and they shall be noted in the measurement report. When there is no level specified, the maximum contrast and/or luminance level shall be used. These adjustments shall be held constant for all measurements, unless noted otherwise in the measurement report. Additional conditions are specified separately for each measuring method.

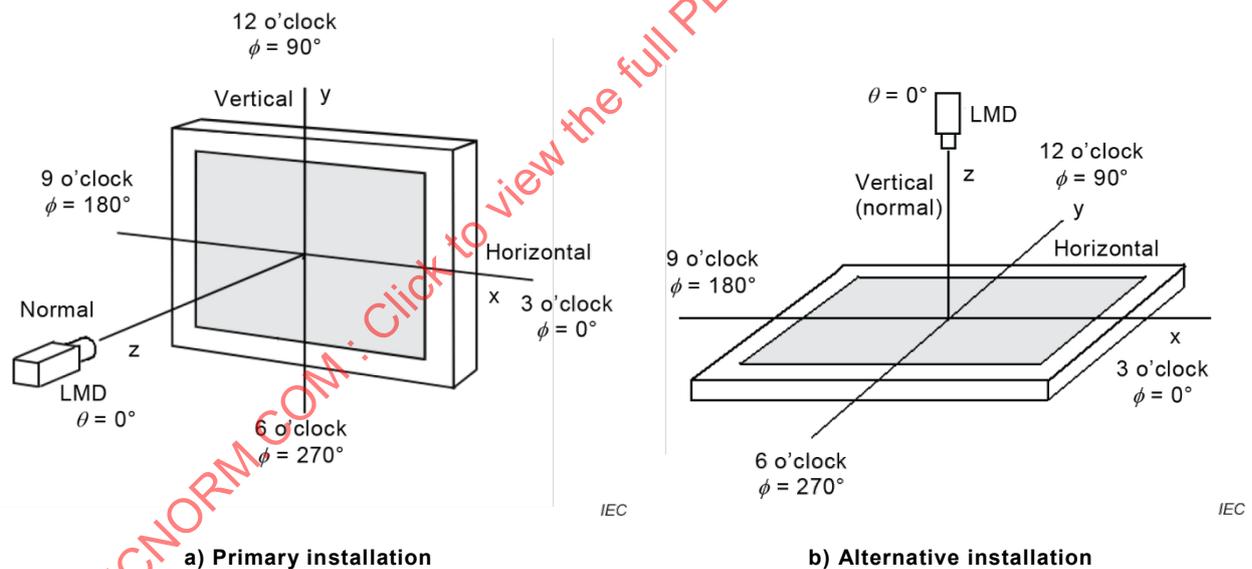


Figure 2 – DUT installation conditions

6 Measuring methods of dynamic range properties

6.1 Peak luminance

6.1.1 Purpose

The purpose of this method is to evaluate luminance with size-varying peak size in the perpendicular, horizontal and vertical viewing direction.

NOTE The white luminance can be varied by the power management function depending on the APL loading of the display. The peak luminance measured in small area highlights can exhibit a different luminance than larger area patches with the same input signal. For multi-primary displays, the peak luminance of the highlights can be enhanced by boosting the white luminance beyond the sum of the individual RGB primaries, while still maintaining the white chromaticity.

6.1.2 Measuring conditions

Standard measuring is implemented under standard dark-room and set-up conditions.

6.1.3 Set-up

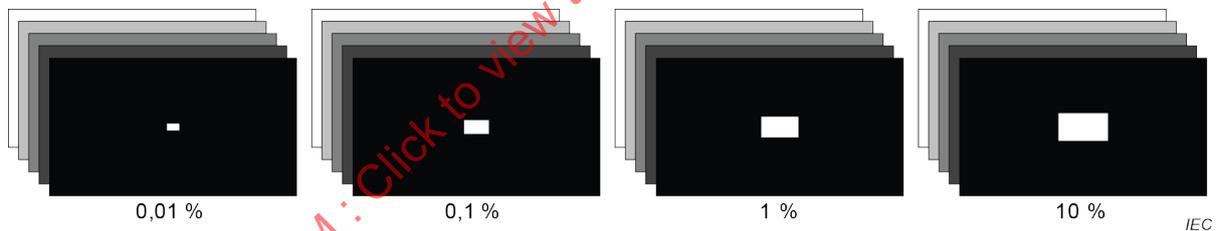
- 1) Apparatus: An LMD to measure the luminance of the DUT; a driving power source; a driving signal equipment; and a geometric mechanism as illustrated in Figure 2.
- 2) Mount the display and LMD in a mechanical system that allows the display to be measured along its vertical and horizontal planes, which lie normal to the display surface.
- 3) Align the LMD perpendicularly to the display surface ($\theta = 0, \phi = 0$), and position it in the centre of the display.

6.1.4 Measurement of peak luminance

- 1) Apply the required input signal(s) using the test pattern for peak luminance measurement to the DUT as shown in Figure 3. These test patterns are specified as equivalent digital RGB input levels of 8 bits, 10 bits or 12 bits.

Some displays cannot apply the small size of the pattern to measure the field size. If it is not possible to apply the 0,01 % test pattern, then a test pattern as close as possible to that value should be used and should be reported.

- 2) Measure the centre luminance (L_0) of each test pattern with various window sizes and background grey levels perpendicular to the display surface ($\theta = 0^\circ, \phi = 0^\circ$). The measurement area shall cover at least 500 pixels, or demonstrate equivalent results with fewer sampled pixels.
- 3) Measure the luminance ($L_{\theta,\phi}$) of each test pattern with various window sizes and background grey levels, as the LMD steps through the various angles in the horizontal and vertical viewing planes.
- 4) Report the measured data. Table 1 shows an example of the results.



NOTE Window size (the dimension of the window size is proportional to the dimensions of the active area.): 0,01 %, 0,1 %, 1 %, 10 %.

Background grey level: 0, 255, 511, 767, 1 023.

Figure 3 – Test patterns for peak luminance measurement

Table 1 – Working example for peak luminance

Reporting – Sample data								
Peak luminance at various angles								
Pattern number	Window size (%)	Background grey level (10-bit case)	Luminance values from different angles					
			$(\theta, \phi) = (0, 0)$	θ_1, ϕ_1	θ_2, ϕ_2	θ_3, ϕ_3	θ_4, ϕ_4	θ_5, ϕ_5
1	0,01	0						
2	0,1	0						
3	1	0						
4	10	0						
5	0,01	255						
6	0,1	255						
7	1	255						
8	10	255						
9	0,01	511						
10	0,1	511						
11	1	511						
12	10	511						
13	0,01	767						
14	0,1	767						
15	1	767						
16	10	767						
17	0,01	1 023						
18	0,1	1 023						
19	1	1 023						
20	10	1 023						
	Min.							
	Max.							

6.2 Black level and black constancy

6.2.1 Purpose

The purpose of this method is to evaluate the display's black level and constancy which are affected by luminance loading in the perpendicular, horizontal and vertical viewing direction.

6.2.2 Measuring conditions

Standard measurement is implemented under standard dark-room and set-up conditions.

6.2.3 Set-up

- 1) Apparatus: An LMD to measure the luminance of the DUT; a driving power source; a driving signal equipment; and a geometric mechanism as illustrated in Figure 2.
- 2) Mount the display and LMD in a mechanical system that allows the display to be measured along its vertical and horizontal planes, which lie normal to the display surface.
- 3) Align the LMD perpendicularly to the display surface ($\theta = 0$, $\phi = 0$), and position it in the centre of the display.

6.2.4 Measurement of black level and black constancy according to background

- 1) Apply the required input signal(s) to the DUT using the test patterns for the black level and constancy measurement as shown in Figure 4. These test patterns are specified as equivalent digital RGB input levels of 8 bits, 10 bits or 12 bits.
- 2) Measure the centre luminance (L_0) of each pattern perpendicularly to the display surface ($\theta = 0^\circ, \phi = 0^\circ$). The measurement area shall cover at least 500 pixels, or demonstrate equivalent results with fewer sampled pixels. A mask or stray-light-elimination tube can be required to prevent a veiling glare in the detector when measuring the black level.
- 3) Measure the luminance ($L_{\theta,\phi}$) of each pattern, as the LMD steps through the various angles in the horizontal and vertical viewing planes.
- 4) Calculate the constancy of the black level, C , using Formula (1):

$$C = \max [|L_{k,0} - L_{k,i}|] \tag{1}$$

where

$L_{k,0}$ is the black luminance of the centre at the 0 grey background level,

$L_{k,i}$ is the black luminance of the centre at the i grey background level ($i = 255, 511, 767, 1\ 023$).

- 5) Report the measured data and calculated data. Table 2 shows an example of the results.



IEC

NOTE Background grey level: 0, 255, 511, 767, 1 023.

Figure 4 – Test pattern for black level and constancy measurement

Table 2 – Working example for black level and constancy

Reporting – Sample data						
Black level and constancy at various angles						
Pattern number	Background level	Luminance values at different angles				
		$(\theta, \phi)=(0,0)$	θ_1, ϕ_1	θ_2, ϕ_2	θ_3, ϕ_3	θ_4, ϕ_4
1	0					
2	255					
3	511					
4	767					
5	1 023					
Max.						
Min.						
C						

6.3 Local contrast

6.3.1 Purpose

The purpose of this method is to evaluate the expression of white and black when they are displayed simultaneously on a same frame.

6.3.2 Measuring conditions

Standard measuring is implemented under standard dark-room and set-up conditions.

6.3.3 Set-up

- 1) Apparatus: An LMD to measure the luminance of the DUT; a driving power source; a driving signal equipment; and a geometric mechanism as illustrated in Figure 2.
- 2) Mount the display and LMD in a mechanical system that allows the display to be measured along its vertical and horizontal planes, which lie normal to the display surface.
- 3) Align the LMD perpendicularly to the display surface ($\theta = 0$, $\phi = 0$), and position it in the centre of the display.

6.3.4 Measurement of local contrast

- 1) Apply the required input signal(s) to the DUT using the white centred box and surrounding black screen pattern as shown in Figure 5.
- 2) Measure the luminance of each point from L1 to L9, perpendicularly to the display surface ($\theta = 0^\circ$, $\phi = 0^\circ$). The measurement area shall cover at least 500 pixels, or demonstrate equivalent results with fewer sampled pixels. A mask or stray-light-elimination tube can be required to prevent veiling glare in the detector when measuring the black level.
- 3) Measure the luminance ($L_{\theta,\phi}$) of each location, as the LMD steps through the various angles in the horizontal and vertical viewing planes.
- 4) Calculate the local contrast, CR_L , using Formula (2):

$$CR_L = \frac{8L_c}{L_1 + L_2 + L_3 + L_4 + L_5 + L_6 + L_7 + L_8} \quad (2)$$

where

L_c is the luminance of the centre

L_i is the black surround at the eight locations.

- 5) Report the calculated data. Table 3 shows an example of the results.

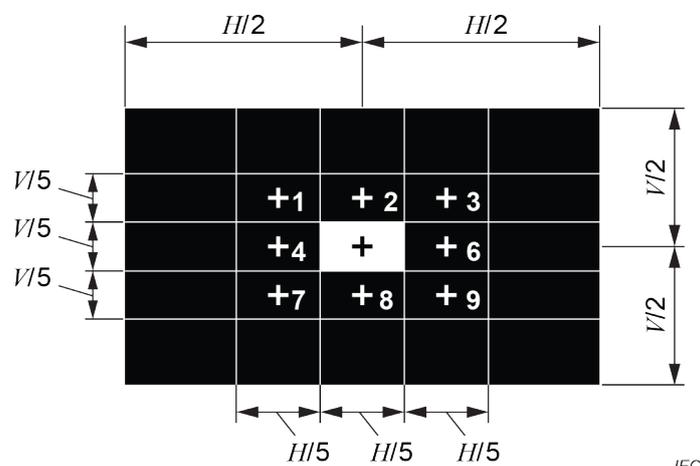


Figure 5 – Test pattern for local contrast

Table 3 – Working example for local contrast

Reporting – Sample data					
Local contrast at various angles					
CR_L values at different angles					
$(\theta, \phi)=(0,0)$	θ_1, ϕ_1	θ_2, ϕ_2	θ_3, ϕ_3	θ_4, ϕ_4	θ_5, ϕ_5

6.4 Dynamic range coverage

6.4.1 Purpose

The purpose of this method is to measure the capability of the representable dynamic range relative to the reference input signal. The dynamic range coverage is the ratio of the DUT luminance range to the reference range from black to white.

6.4.2 Measuring conditions

Standard measuring is implemented under standard dark-room and set-up conditions.

6.4.3 Set-up

- 1) Apparatus: An LMD to measure the luminance of the DUT; a driving power source; a driving signal equipment; and a geometric mechanism as illustrated in Figure 2.
- 2) Mount the display and LMD in a mechanical system that allows the display to be measured along its vertical and horizontal planes, which lie normal to the display surface.
- 3) Align the LMD perpendicularly to the display surface ($\theta = 0, \phi = 0$), and position it in the centre of the display.

6.4.4 Measurement of dynamic range coverage

- 1) Follow the procedures in 6.1.4 and 6.2.4 to determine L_w and L_k .
- 2) Calculate the maximum and minimum values of L_w and L_k using Formulae (3), (4), (5) and (6):

$$L_{w.max} = \max(L_{w.i}) \tag{3}$$

$$L_{w.min} = \min(L_{w.i}) \tag{4}$$

where, $i = 1,2,3$ to 20. The test patterns are the same as 6.1.4.

$$L_{k.max} = \max(L_{k.i}) \tag{5}$$

$$L_{k.min} = \min(L_{k.i}) \tag{6}$$

where, $i = 1,2,3, \dots, 5$. The test patterns are the same as in 6.2.4.

- 3) Calculate the maximum and minimum values of the dynamic range, R_{dr} , using Formulae (7) and (8):