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INTERNATIONAL STANDARD

3D display devices –
Part 22-1: Measuring methods for autostereoscopic displays – Optical

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FOREWORD

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International Standard IEC 62629-22-1 has been prepared by IEC technical committee 110: Electronic display devices.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of offset crosstalk and 3D pixel crosstalk as 3D crosstalk related property.

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

FDIS	Report on voting
110/784/FDIS	110/797/RVD

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

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

A list of all the parts in the IEC 62629 series, under the general title *3D display devices*, can be found on the IEC website.

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

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- withdrawn,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

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

3D DISPLAY DEVICES –

Part 22-1: Measuring methods for autostereoscopic displays – Optical

1 Scope

This part of IEC 62629-22 specifies optical measuring methods for autostereoscopic display devices. It defines general measuring procedures for optical characteristics of two-view and multi-view displays and integral imaging displays.

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 62629-1-2, *3D display devices – Part 1-2: Generic – Terminology and letter symbols*

ISO/CIE 19476, *Characterization of the performance of illuminance meters and luminance meters*

CIE 15:2004, *Colorimetry*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62629-1-2 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
3D pixel crosstalk
pixel crosstalk by horizontal pixels for one lens pitch

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

CCD	charge-coupled device
DVD	designed viewing distance
FPD	flat panel display
FWHM	full width half maximum
FWTQM	full width at three-quarter maximum
IPD	inter pupil distance

LMD light measuring device

4 Standard measuring conditions

4.1 Standard environmental conditions

4.1.1 Temperature, humidity and pressure conditions

Standard environmental conditions shall be applied for the measurements of autostereoscopic display devices.

The standard environmental conditions for the measurements of autostereoscopic display devices are (25 ± 5) °C temperature, 45 % to 75 % relative humidity, and 86 kPa to 106 kPa pressure.

4.1.2 Illumination conditions

Standard dark room conditions shall be applied.

In standard dark room conditions, the illuminance at any position on the screen (the display device screen) is below 0,3 lx in all directions.

NOTE Illuminance is measured without the measured display or in conditions where the display is turned off.

4.2 Light measuring device

4.2.1 General

The LMD used for measurements of the displays shall be checked for the following criteria and specified accordingly:

- aperture size (window function of LMD) (see 4.2.2);
- sensitivity of the measured quantity;
- errors caused by veiling glare and lens flare (i.e. stray light in optical system);
- timing of data acquisition, low-pass filtering and aliasing effects;
- linearity of detection and data-conversion;
- resolution and moiré when using a two-dimensional LMD.

A point-measurement LMD, such as a spot luminance meter, or a two-dimensional LMD such as a CCD area detector, shall be used for these measurements. A conoscopic type LMD can be used for some measurements. When a two-dimensional LMD and/or a conoscopic type LMD is/are used, they shall be calibrated so that the measurement results correspond to those of the point-measurement LMD. The specification of the LMD used shall be noted in the report as in the example shown in Table 1.

NOTE 1 The point-measurement LMD measures the luminance and/or colour coordinate at each measurement point on the screen. A two-dimensional LMD measures the map of luminance and/or colour coordinate over the measurement area of the screen. A conoscopic type LMD measures the directional characteristics of luminance and/or colour coordinate at each measurement point on the screen.

NOTE 2 A point-measurement LMD usually has higher sensitivity than a two-dimensional LMD. A two-dimensional LMD measures the uniformity of the measuring area more easily than a point-measurement LMD.

Table 1 – Example of reported specification of two-dimensional LMD

CCD resolution	4 096 × 2 048	
CCD A/D dynamic range	More than 12 bits = 4 096 gray scale levels	
Wavelength range	380 nm to 780 nm	
System accuracy	Luminance variation	± 3 %
	CIE 1931 chromaticity coordinates (x, y)	± 0,003
Colorimetric filters	CIE 1931 colour matching functions for a 2° observer	

4.2.2 Aperture size

The aperture size (entrance pupil, see ISO/CIE 19476) of an LMD, including point-measurement and two-dimensional type LMDs (smaller than the size of the object lens of the LMD), shall be equal to or smaller than 8 mm. When a larger aperture LMD is used, the measurement results shall be checked so that the results are equivalent to those of the smaller aperture LMD. The aperture size shall be reported by the supplier (the manufacturer of the 3D display device) in the relevant specification.

NOTE In the measurement of autostereoscopic displays, the aperture size of the LMD greatly affects the measurement results. So the LMD aperture size is defined in this document. The aperture size similar to the size of the pupil of an eye is ideal for the measurements (e.g. crosstalk), but a smaller aperture decreases the sensitivity. The size of 8 mm is small enough for the measurement and large enough for the sensitivity. The exact value of the aperture size of the LMD used will be informed by the LMD supplier. The relation among the aperture size, measuring area size and measuring distance is shown in Figure 1 and explained in 4.3. When a larger aperture LMD is used, the measuring distance is increased as long as the measuring distance does not affect the measurement results by changing the measuring distance.

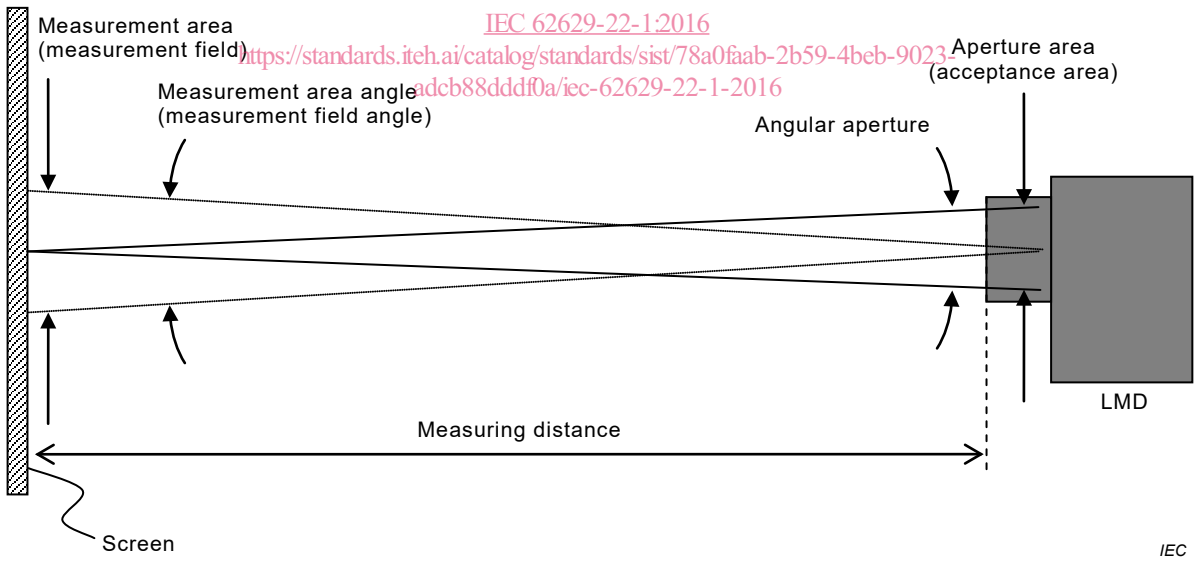


Figure 1 – Measuring system

4.3 Measuring setup

4.3.1 Designed viewing distance

A DVD shall be defined by the supplier in the relevant specification. The DVD is the distance from which proper stereoscopic views are intended to be observed and/or the characteristics of an autostereoscopic display are measured accurately.

For the measurements, the designed viewing distance shall be applied as the measuring distance. The measuring distance shall be fixed when items planned to be evaluated are

measured. Only one designed viewing distance shall be defined and applied to an autostereoscopic display device.

4.3.2 Measurement area

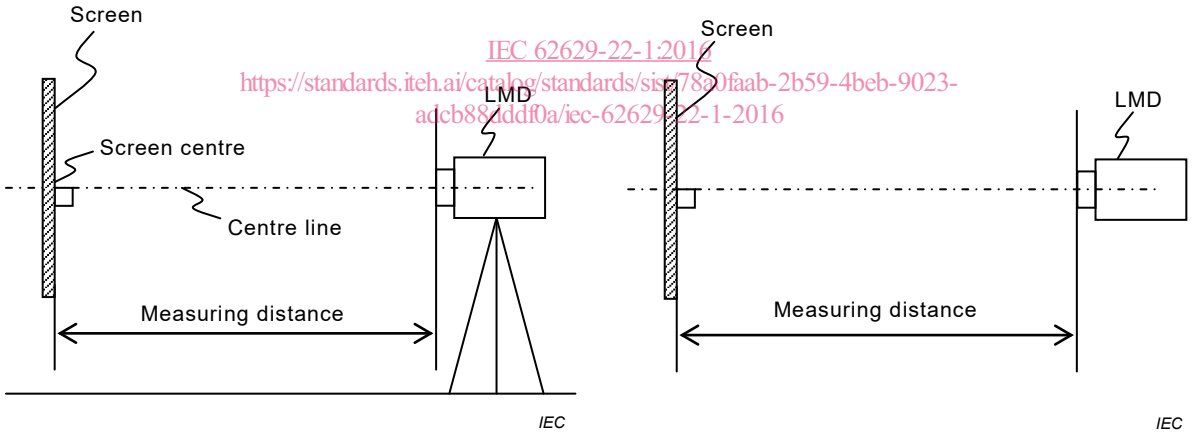
The LMD shall be set at a proper measurement area angle (measurement field angle, see Figure 1) less than or equal to 2°, and shall have a measurement area of at least 500 pixels whose diameter is less than 10 % of the screen height. This area corresponds to having a circular measurement area of at least 26 lines in diameter when the screen has a square pixel consisting of 3 subpixels. If the above conditions cannot be applied, the applied measurement area shall include as many pixels as possible. The applied measuring conditions shall be noted in the report.

NOTE Based on the information given by the supplier, such as number of views and lobe angle, the measurement field angle, aperture angle and measuring distance are determined. The aperture angle is small so that the angular luminance profile can be measured precisely. In general, the more the number of views increases, the smaller the required aperture angle is. In theory, when a smaller aperture is applied, a smaller field angle is desirable. In addition, some autostereoscopic displays are designed so that the screen produces different distribution of light rays to improve 3D observation. When considering these points, the field angle is introduced. The range of measuring distance is decided by the size of the aperture and measurement field. The measuring distance and the field angle are adjusted to achieve a viewing area greater than 500 pixels, whose diameter is less than 10 % of the screen height, if it is difficult to set the field angle above.

4.3.3 Measuring layout

4.3.3.1 Centre point measurement

The measuring layout for a centre point measurement is shown in Figure 2. The aperture of the LMD shall be set at the designed viewing distance.

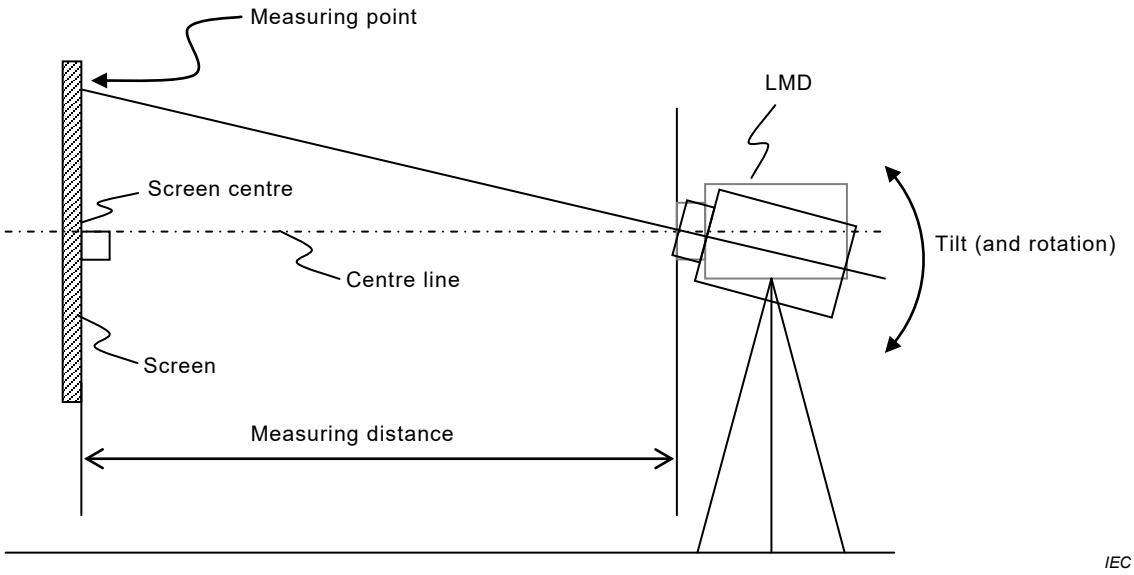


a) Side view **b) Top view**

Figure 2 – Measuring layout for centre point measurement

4.3.3.2 Multi-point measurement

The measuring layout for a multi-point measurement is shown in Figure 3. When a multi-point measurement is carried out using the two-dimensional LMD, the measuring layout shown in Figure 2 shall be applied. In this case the measurement result shall be confirmed to be the same as that measured by the multi-point measurement shown in Figure 3.



NOTE A similar layout is applied to the measurement with rotation.

Figure 3 – Measuring layout for multi-point measurement (side view)

The measuring layout shown in Figure 4 can also be applied to certain measuring items. This layout is suitable for certain measuring items where the display does not strongly depend on LMD positions (i.e. integral imaging display). The layout used for the measurement shall be noted in the report. When a different measuring layout is used, this shall be noted in the report.

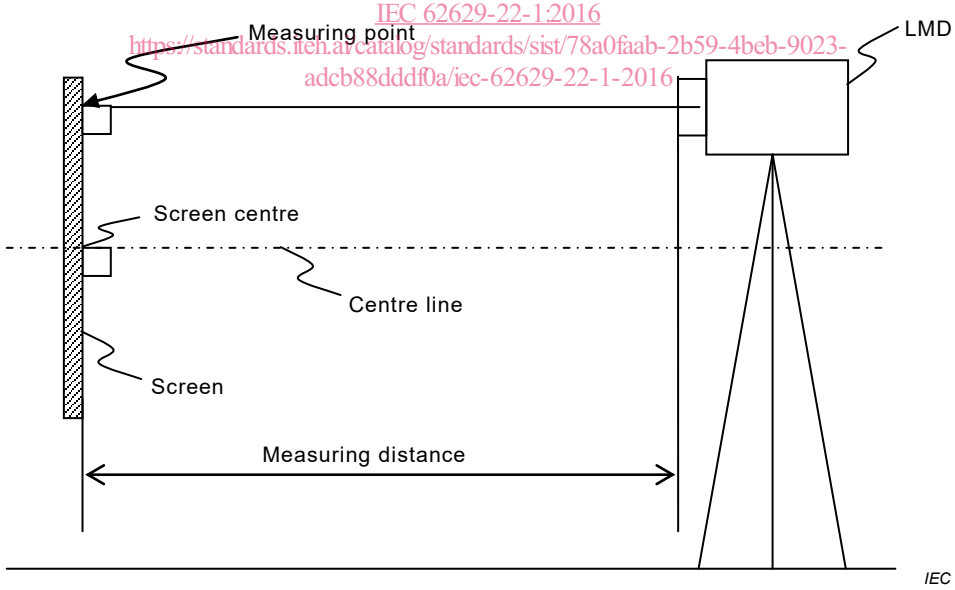
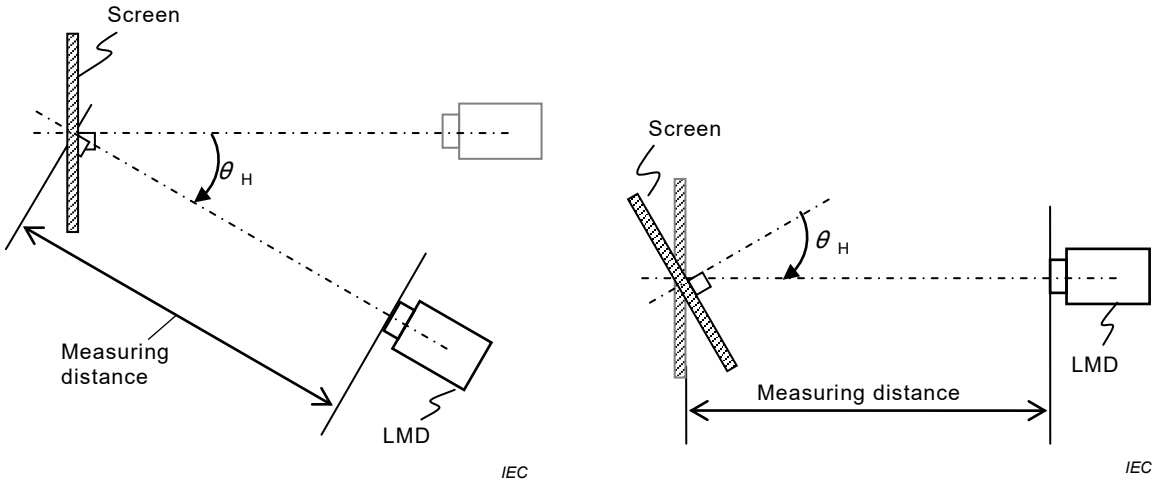


Figure 4 – Other measuring layout for multi-point measurement (side view)

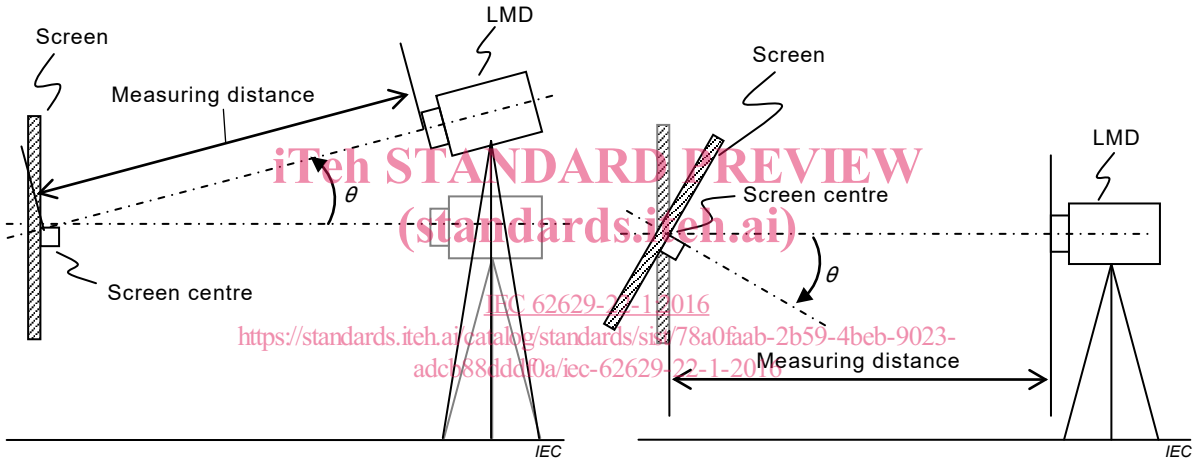
4.3.3.3 Measurement of viewing direction dependency

To measure viewing direction dependency, the characteristics at the centre of the screen are measured from the vertical or horizontal viewing directions defined in each measurement method or relevant specification, as shown in Figure 5 and Figure 6. Instead of moving the LMD, the autostereoscopic display can be tilted vertically or turned horizontally to be measured as shown in Figure 5 b) and Figure 6 b). The horizontal and vertical measuring angular ranges and angular scanning steps shall be defined by the supplier in the relevant specification, and shall be noted in the report.



a) Movement of LMD (top view) **b) Rotation of display (top view)**

Figure 5 – Measuring layout for horizontal viewing direction dependency



a) Movement of LMD (side view) **b) Tilt of display (side view)**

Figure 6 – Measuring layout for vertical viewing direction dependency

4.4 Test signal

The all-pixel white signal, all-pixel black signal, and i^{th}-pixel white signal are defined below:

a) $Im_{\text{all white}}$: all-pixel white signal (at 100 % level) or all-pixel white

NOTE 1 The all-pixel white signal denotes that all pixels on the screen are activated by the input of level 100 %.

b) $Im_{\text{all black}}$: all-pixel black signal (at 0 % level) or all-pixel black

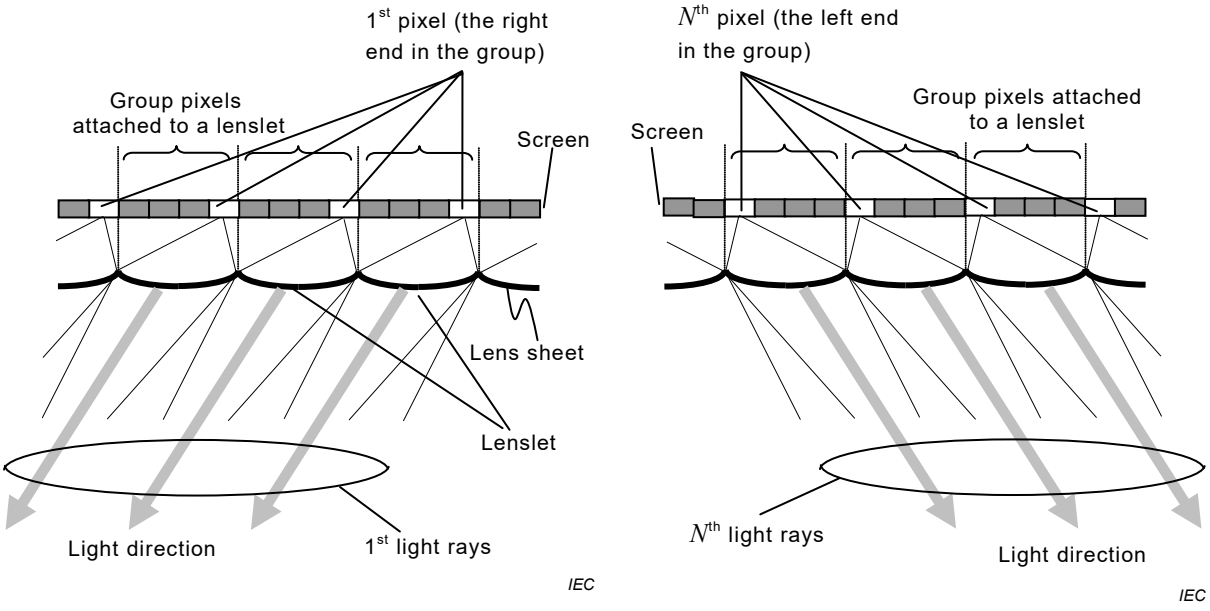
NOTE 2 The all-pixel black signal denotes that all pixels on the screen are suppressed by the input of level 0 %.

c) Im_i: i^{th} -pixel white signal (at 100 % level) with the other pixel blackened or i^{th} -pixel white,where i is 1 to N (see Figure 7) and N is the number of views (multi views). For temporal use, the i^{th} light ray white signal (at 100 % level) with the other light rays blackened or the i^{th} light ray white can be used.

NOTE 3 The i^{th} pixel white signal indicates that only i^{th} pixels in the group are activated by the input of 100 % level.

NOTE 4 Light ray is explained in Annex A.

The signal details of signals for the i th-pixel white signal, or the details of the pixels and lenslet as shown in Figure 7 shall be described by the supplier in the relevant specification.



Key □: pixel at level 100 %, ■: pixel at level 0 %, Im_1 and Im_N are 1st and N^{th} pixel white signals

a) Test image (Im_1) **b) Test image (Im_N)**

NOTE As shown in a), every pixel at the right end in the group (every 1st pixel) is at level 100 %, and as shown in b), so is every pixel on the left end in the group (every N^{th} pixel).

Figure 7 – Two examples of the relation between pixel and lenslet in multi-view display

4.5 Standard measuring points

The centre point (one-point) and multi-point (three-point, five-point or nine-point) measurements are applied. The measuring points are shown in Figure 8. The measuring point of one-point measurement is named P_0. In multi-point measurements the three points are P_0, P_6 and P_8, the five points and nine points are from P_0 to P_4 and from P_0 to P_8, respectively.

The n by m points for 3D crosstalk variation on screen are shown in Figure 9. The applied number of measuring points (n by m) shall be defined by the supplier in the relevant specification.

The applied measuring points are defined in each measurement item. If other measuring points are applied, this shall be defined by the supplier in the relevant specification.

NOTE One-point measurement is carried out to obtain the typical characteristics at the centre of the screen. Others are carried out to obtain deviations, averages and uniformities.