Background Statement for SEMI Draft Document 4764D
New Standard: TEST METHOD OF FPD-BASED STEREOSCOPIC DISPLAY WITH ACTIVE GLASSES

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Background Statement:

FPD-based stereoscopic display with active glasses is popular. A test method standard of which should be published for the industry need as soon as possible.

Crosstalk is one of the key performances of 3D display measurement additionally to the 2D display. Therefore, this standard focuses on the test method of the crosstalk and the related.

This document describes the test method of stereoscopic display only with active glasses. The test method of stereoscopic display with passive glasses will be submitted in the other document (document number 4765).

Review and Adjudication Information

<table>
<thead>
<tr>
<th>Group:</th>
<th>Task Force Review</th>
<th>Committee Adjudication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>3D Display Metrology TF</td>
<td>Taiwan FPD Metrology Committee</td>
</tr>
<tr>
<td>Time &amp; Timezone:</td>
<td>2013/10/15</td>
<td>2013/10/18</td>
</tr>
<tr>
<td>Location:</td>
<td>13:00-15:00</td>
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</tbody>
</table>

This meeting’s details are subject to change, and additional review sessions may be scheduled if necessary. Contact Standards staff for confirmation.

Telephone and web information will be distributed to interested parties as the meeting date approaches. If you will not be able to attend these meetings in person but would like to participate by telephone/web, please contact Standards staff.
SEMI Draft Document 4764D
NEW STANDARD: TEST METHOD OF FPD-BASED STEREOSCOPIC DISPLAY WITH ACTIVE GLASSES

1 Purpose
1.1 This standard is provided specifically for the communication between supply channels as well as between manufacturers and consumers.

2 Scope
2.1 This standard is applied to FPD-based stereoscopic display with active glasses. Test methods for the optical properties of 3D luminance, 3D contrast ratio, system crosstalk and 3D chromaticity are included in this document.

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3 Referenced Standards and Documents
3.1 SEMI Standard1
SEMI D59 — 3D Display Terminology
3.2 ISO/CIE Standard2
3.3 VESA Standard3
VESA FPDM 2.0 — Flat Panel Display Measurements Standard
NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

4 Terminology
4.1 Abbreviations and Acronyms
4.1.1 FPD — Flat panel display
4.1.2 LMD — Light measurement device
4.1.3 $L_{X_{1},YZ}$ — “L” means Luminance; The subscript “X” (to be L/R) means left or right channel; the subscript “i” means measured at the location #i on the screen ($i = 0$–$8$); the subscript “Y” (to be w/k) means white or black pattern for the left channel; the subscript “Z” (to be w/k) means white or black pattern for the right channel.
4.1.4 $C_{X_{1},YZ}(u’,v’)$ — “C” means Chromaticity; The subscript “X” (to be L/R) means left or right channel; the subscript “i” means measured at the location #i on the screen ($i = 0$–$8$); the subscript “Y” (to be w/k/r/g/b) means white, black, red, green or blue pattern for the left channel; the subscript “Z” (to be w/k/r/g/b) means white, black, red, green or blue pattern for the right channel.
4.1.5 $P_{i}$ — measurement point at the location #i on the screen ($i = 0$–$8$).

4.2 Definitions
4.2.1 3D chromaticity — chromatic performance of a FPD-based stereoscopic display.

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2 International Commission on Illumination, http://www.cie.co.at/
4.2.2 system white crosstalk (SWC) — system crosstalk while the tested channel patterns is full-screen black and the un-tested channel patterns is full-screen white (shown in Figure 1).

4.2.3 system black crosstalk (SBC) — system crosstalk while the tested channel patterns is full-screen white and the un-tested channel patterns is full-screen black (shown in Figure 2).

4.2.4 active area — the area of a display that is useful for viewing.

Figure 1
System White Crosstalk

Figure 2
System Black Crosstalk
5 Summary of Method

5.1 Environment Conditions

- Temperature: 25°C ± 3 °C
- Humidity: 25% to 75% RH
- Illumination of surrounding: dark room ≤ 1 lux

5.2 Measurement Structure

5.2.1 The following installation is a measurement structure for testing the stereoscopic display with active glasses (see Figure 3).

![Figure 3](image)

**Figure 3**
Measurement Structure for Testing Stereoscopic Display with Active Glasses (top view)

5.2.2 Measuring Points

5.2.2.1 The 9 points measurement is proposed in this test method document. The measuring points are shown in Figure 4. The measuring points of 9 points measurements are notated from P₀ to P₈ respectively.

![Figure 4](image)

**Figure 4**
Measuring Points

H: the width of a display active area
V: the height of a display active area
5.3 Measurement Setup

5.3.1 After warming up the stereoscopic display and the active glasses, apply a full-screen white pattern to left and right channels.

5.3.2 The LMD is set at normal line of each selected point (see Figure 5).

5.3.3 The measuring distance shall be at a distance that is specified by mutual agreement between customer and manufacturer.

5.3.4 Set the lens of active glasses front and parallel to the location of LMD, and ensure that the lens of active glasses shall cover the subtense angle ($\theta_{\text{LMD}}$) of LMD. Use a shade to block any stray light if necessary.

5.3.5 Measure at least 500 pixels or 10 % of the panel pixels (exception shall be verified and reported).

5.3.6 Make sure that the synchronization between the display and active glasses works well (for example, the display shall switch about 120 Hz between left and right images).

![Figure 5](image)

**Figure 5**

LMD Set at Normal Line of Each Selected Point when Measuring the Luminance and Chromaticity

6 Apparatus

6.1 Luminance measurement — Use a luminance meter or spectroradiometer to measure the luminance.

6.2 Color measurement — Use a spectroradiometer or colorimeter to measure the chromaticity.

7 Test Pattern and Measuring Item

7.1 Send test patterns to the stereoscopic display by time sequential format, and synchronized with the active glasses. These test patterns are full-screen images on the display screen (see Table 1).
<table>
<thead>
<tr>
<th>Left channel Pattern</th>
<th>Right channel Pattern</th>
<th>Measuring Item (Luminance ( ^{#1} ))</th>
<th>Measuring Item (Chromaticity ( ^{#2} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-screen white</td>
<td>Full-screen black</td>
<td>( L_{L,\text{wk}} )</td>
<td>( L_{R,\text{wk}} )</td>
</tr>
<tr>
<td>Full-screen white</td>
<td>Full-screen white</td>
<td>( L_{L,\text{ww}} )</td>
<td>( L_{R,\text{ww}} )</td>
</tr>
<tr>
<td>Full-screen black</td>
<td>Full-screen black</td>
<td>( L_{L,\text{kk}} )</td>
<td>( L_{R,\text{kk}} )</td>
</tr>
<tr>
<td>Full-screen black</td>
<td>Full-screen white</td>
<td>( L_{L,\text{kw}} )</td>
<td>( L_{R,\text{kw}} )</td>
</tr>
<tr>
<td>Full-screen red</td>
<td>Full-screen red</td>
<td>( C_{L,\text{rr}}(u',v') )</td>
<td>( C_{R,\text{rr}}(u',v') )</td>
</tr>
<tr>
<td>Full-screen green</td>
<td>Full-screen green</td>
<td>( C_{L,\text{gg}}(u',v') )</td>
<td>( C_{R,\text{gg}}(u',v') )</td>
</tr>
<tr>
<td>Full-screen blue</td>
<td>Full-screen blue</td>
<td>( C_{L,\text{bb}}(u',v') )</td>
<td>( C_{R,\text{bb}}(u',v') )</td>
</tr>
</tbody>
</table>

\(^{\#1}\) For the measuring item of luminance: measuring points \( P_i \) \( i = 0 \) \( -8 \)

\(^{\#2}\) For the measuring item of chromaticity: measuring points \( P_i \) \( i = 0 \)

8 Preparation of Apparatus

8.1 Warm up the measuring equipment for a specified period of time until the measurement values of display luminance are stable (according to the instruction manual of measuring equipment or follow VESA FPDM 2.0).

9 Calibration and Standardization

9.1 The LMD used for luminance and chromaticity measurements shall be calibrated and traced to the accredited laboratory.

10 Procedure

10.1 Set the LMD at the measuring distance, and set left eyeglass in front of the LMD.

10.2 Apply all the test patterns (seven patterns shown in Table 1) to the stereoscopic display, measure and record the luminance/chromaticity of the left channel at each selected point.
10.3 Set the LMD at the measuring distance, and set right eyeglass in front of the LMD.

10.4 Apply all the test patterns (seven patterns shown in Table 1) to the stereoscopic display, measure and record the luminance /chromaticity of the right channel at each selected point.

11 Calculations

11.1 3D luminance is the arithmetic average of the left channel luminance \( L_{L,av} \) and right channel luminance \( L_{R,av} \).

\[
L_{L,av} = \frac{\sum_{i=0}^{8} L_{L,ww}}{9} \tag{1}
\]

\[
L_{R,av} = \frac{\sum_{i=0}^{8} L_{R,ww}}{9} \tag{2}
\]

Where

- \( L_{L,ww} \) is the left channel luminance at each selected point.
- \( L_{L,av} \) is the average of left channel luminance \( L_{L,ww} \).
- \( L_{R,ww} \) is the right channel luminance at each selected point.
- \( L_{R,av} \) is the average of right channel luminance \( L_{R,ww} \).

11.2 3D contrast ratio is separately calculated as left channel average contrast \( CR_{L,av} \) and right channel average contrast \( CR_{R,av} \).

\[
CR_{L,i} = \frac{L_{L,ww}}{L_{L,kk}} \tag{3}
\]

\[
CR_{L,av} = \frac{\sum_{i=0}^{8} CR_{L,i}}{9} \tag{4}
\]

\[
CR_{R,i} = \frac{L_{R,ww}}{L_{R,kk}} \tag{5}
\]

\[
CR_{R,av} = \frac{\sum_{i=0}^{8} CR_{R,i}}{9} \tag{6}
\]

Where

- \( CR_{L,i} \) is the left channel contrast ratio at each selected point.
- \( CR_{L,av} \) is the average of left channel contrast ratio \( CR_{L,i} \).
- \( CR_{R,i} \) is the right channel contrast ratio at each selected point.
- \( CR_{R,av} \) is the average of right channel contrast ratio \( CR_{R,i} \).

11.3 System crosstalk is separately calculated as the left and right channels of system white crosstalk \( SWC_{L,av} \) and \( SWC_{R,av} \) and the left and right channels of system black crosstalk \( SBC_{L,av} \) and \( SBC_{R,av} \).
11.3.1 The left channel system white crosstalk (SWC_{L,av}) and the right channel system white crosstalk (SWC_{R,av}) are separately calculated as following equations (8) and (10),

\[
SWC_{L,i} = \left| \frac{L_{L,i,kw} - L_{L,i,ww}}{L_{L,i,ww} - L_{L,i,kw}} \right| \times 100\% \quad (7)
\]

\[
SWC_{L,av} = \frac{\sum_{i=0}^{8} SWC_{L,i}}{9} \quad (8)
\]

\[
SWC_{R,i} = \left| \frac{L_{R,i,kw} - L_{R,i,ww}}{L_{R,i,ww} - L_{R,i,kw}} \right| \times 100\% \quad (9)
\]

\[
SWC_{R,av} = \frac{\sum_{i=0}^{8} SWC_{R,i}}{9} \quad (10)
\]

Where

- SWC_{L,i} is the left channel system white crosstalk at each selected point.
- SWC_{L,av} is the average of left channel system white crosstalk SWC_{L,i}.
- SWC_{R,i} is the right channel system white crosstalk at each selected point.
- SWC_{R,av} is the average of right channel system white crosstalk SWC_{R,i}.

11.3.2 The left channel system black crosstalk (SBC_{L,av}) and the right channel system black crosstalk (SBC_{R,av}) are separately calculated as following equations (12) and (14),

\[
SBC_{L,i} = \left| \frac{L_{L,i,ww} - L_{L,i,kw}}{L_{L,i,ww} - L_{L,i,kw}} \right| \times 100\% \quad (11)
\]

\[
SBC_{L,av} = \frac{\sum_{i=0}^{8} SBC_{L,i}}{9} \quad (12)
\]

\[
SBC_{R,i} = \left| \frac{L_{R,i,ww} - L_{R,i,kw}}{L_{R,i,ww} - L_{R,i,kw}} \right| \times 100\% \quad (13)
\]

\[
SBC_{R,av} = \frac{\sum_{i=0}^{8} SBC_{R,i}}{9} \quad (14)
\]

Where

- SBC_{L,i} is the left channel system black crosstalk at each selected point.
- SBC_{L,av} is the average of left channel system black crosstalk SBC_{L,i}.
- SBC_{R,i} is the right channel system black crosstalk at each selected point.
- SBC_{R,av} is the average of right channel system black crosstalk SBC_{R,i}. 
11.4 3D Chromaticity (CIE 1976 UCS chromaticity coordinates)

11.4.1 \( C_{L,ww}(u',v'), C_{L,rr}(u',v'), C_{L,gg}(u',v') \) and \( C_{L,bb}(u',v') \) are the CIE 1976 UCS chromaticity coordinates with full-screen white, full-screen red, full-screen green and full-screen blue patterns that measured from left channel respectively. And, \( C_{R,ww}(u',v'), C_{R,rr}(u',v'), C_{R,gg}(u',v'), C_{R,bb}(u',v') \) are the CIE 1976 UCS chromaticity coordinates with full-screen white, full-screen red, full-screen green and full-screen blue patterns that measured from right channel respectively.

NOTE 1: The Chromaticity Coordinates \((u', v')\) should be calculated from the CIE 1931 chromaticity coordinates \((x, y)\).

\[
\begin{align*}
    u' &= \frac{4x}{3 + 12y - 2x} \\
    v' &= \frac{9y}{3 + 12y - 2x}
\end{align*}
\]

12 Reporting Results

12.1 3D Luminance

Table 2 3D Luminance Report Form

<table>
<thead>
<tr>
<th>Measuring Point</th>
<th>Full-Screen White</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Channel</td>
<td>Right Channel</td>
</tr>
<tr>
<td>Luminance (cd/m²)</td>
<td>P₀</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P₁</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P₃</td>
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</tr>
<tr>
<td></td>
<td>P₄</td>
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</tr>
<tr>
<td></td>
<td>P₅</td>
<td></td>
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<tr>
<td></td>
<td>P₆</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P₇</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P₈</td>
<td></td>
</tr>
<tr>
<td>Average of 9 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D Luminance</td>
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<td></td>
</tr>
</tbody>
</table>
12.2 3D Contrast Ratio

Table 3 3D Contrast Ratio Report Form

<table>
<thead>
<tr>
<th>Measuring Point</th>
<th>Contrast ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>P₀</td>
<td></td>
</tr>
<tr>
<td>P₁</td>
<td></td>
</tr>
<tr>
<td>P₂</td>
<td></td>
</tr>
<tr>
<td>P₃</td>
<td></td>
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<tr>
<td>P₄</td>
<td></td>
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<tr>
<td>P₅</td>
<td></td>
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<tr>
<td>P₆</td>
<td></td>
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<td>P₇</td>
<td></td>
</tr>
<tr>
<td>P₈</td>
<td></td>
</tr>
<tr>
<td>Average of 9 points</td>
<td></td>
</tr>
</tbody>
</table>

12.3 System Crosstalk

Table 4 System Crosstalk Report Form

<table>
<thead>
<tr>
<th>Measuring Point</th>
<th>System White Crosstalk</th>
<th>System Black Crosstalk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Channel</td>
<td>Right Channel</td>
</tr>
<tr>
<td>System Crosstalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P₀</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P₁</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Average of 9 points</td>
<td></td>
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</tbody>
</table>
12.4 3D Chromaticity

Table 5 3D Chromaticity Report Form (CIE 1976 UCS chromaticity coordinates)

<table>
<thead>
<tr>
<th>Chromaticity (P₀ point)</th>
<th>Left Channel</th>
<th>Right Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Channel</td>
<td>Right Channel</td>
<td></td>
</tr>
<tr>
<td>full-screen white</td>
<td>full-screen white</td>
<td></td>
</tr>
<tr>
<td>full-screen red</td>
<td>full-screen red</td>
<td></td>
</tr>
<tr>
<td>full-screen green</td>
<td>full-screen green</td>
<td></td>
</tr>
<tr>
<td>full-screen blue</td>
<td>full-screen blue</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chromaticity (P₀ point)</th>
<th>Left Channel</th>
<th>Right Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left channel</td>
<td>Right channel</td>
<td></td>
</tr>
<tr>
<td>full-screen white</td>
<td>full-screen white</td>
<td></td>
</tr>
<tr>
<td>full-screen red</td>
<td>full-screen red</td>
<td></td>
</tr>
<tr>
<td>full-screen green</td>
<td>full-screen green</td>
<td></td>
</tr>
<tr>
<td>full-screen blue</td>
<td>full-screen blue</td>
<td></td>
</tr>
</tbody>
</table>

13 Related Documents


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