Chunghwa Picture Tubes, Ltd.
Product Specification

To :
Date :

TFT LCD

CLAA057VA01CW

ACCEPTED BY : (V0.6)
Tentative

<table>
<thead>
<tr>
<th>APPROVED BY</th>
<th>CHECKED BY</th>
<th>PREPARED BY</th>
</tr>
</thead>
</table>

Prepared by :
Product Planning Management Division
Small & Medium TFT Product Business Unit
CHUNGHWA PICTURE TUBES, LTD.

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# REVISION STATUS

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<td>2006/9/6</td>
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1. OVERVIEW

CLAA057VAO1CW is a 5.7" color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, and LED backlight.

The 14.52cm (5.7") screen produces a high resolution image that is composed of 640×480 pixel elements in a stripe arrangement. Display 262K colors by 6 bit R.G.B signal input. Use 3.3 Voltage to drive the power of LCD system, and 5 Voltage to drive the LED backlight.

General specifications are summarized in the following table:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Size</td>
<td>5.7 inch (panel diagonal)</td>
</tr>
<tr>
<td>Display Area (mm)</td>
<td>116.16(W)×87.12(H)</td>
</tr>
<tr>
<td>Number of Pixels</td>
<td>640×3(H)×480(V)</td>
</tr>
<tr>
<td>Pixel Pitch (mm)</td>
<td>0.1815(H)×0.1815(V)</td>
</tr>
<tr>
<td>Color Pixel Arrangement</td>
<td>RGB vertical stripe</td>
</tr>
<tr>
<td>Display Mode</td>
<td>Normally white</td>
</tr>
<tr>
<td>Number of colors</td>
<td>262,144</td>
</tr>
<tr>
<td>Viewing Direction</td>
<td>6 o’clock</td>
</tr>
<tr>
<td>Response Time (Tr+Tf)</td>
<td>30ms</td>
</tr>
<tr>
<td>Brightness (cd/m²)</td>
<td>220nit (typ)</td>
</tr>
<tr>
<td>NTSC ratio</td>
<td>50%</td>
</tr>
<tr>
<td>Viewing Angle (BL on, CR ≥ 10)</td>
<td>140 degree(H) × 100degree(V)</td>
</tr>
<tr>
<td>Electrical Interface (data)</td>
<td>TTL</td>
</tr>
<tr>
<td>Power consumption (W)</td>
<td>2W</td>
</tr>
<tr>
<td>Outline Dimension (in mm)</td>
<td>127(W)×100(H)×6.6(D)</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>110g</td>
</tr>
<tr>
<td>BL Unit</td>
<td>LED</td>
</tr>
<tr>
<td>Surface Treatment</td>
<td>Anti-Glare • Hardness: 3H</td>
</tr>
</tbody>
</table>
## 2. ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage</td>
<td>Vcc</td>
<td>-0.5</td>
<td>5.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Signal Input Voltage</td>
<td>DCLK,DE,R0,G0 ,B0~R5,G5,B5</td>
<td>-0.5</td>
<td>Vcc + 0.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Static Electricity</td>
<td>VESDc</td>
<td>-200</td>
<td>+200</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VESDm</td>
<td>-15K</td>
<td>+15K</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>ICC Rush Current</td>
<td>IRUSH</td>
<td>-</td>
<td>1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Operation Temperature</td>
<td>T_{op}</td>
<td>-30</td>
<td>85</td>
<td>°C</td>
<td>*1)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T_{stg}</td>
<td>-40</td>
<td>95</td>
<td>°C</td>
<td>*1)</td>
</tr>
</tbody>
</table>

Remarks:

*1) If users use the product out of the environment operation range (temperature and humidity), it will concern for visual quality.

*2) Test Condition: IEC 61000-4-2, 
VESDc: Contact discharge to input connector 
VESDm: Contact discharge to module

*3) The input pulse-current measurement system as below:

![Diagram](image)

Control signal: High(+3.3V) → Low(GND)
Supply Voltage of rising time should be from R3 and C2 tune to 550 us.
3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ</th>
<th>Max.</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage For LCD</td>
<td>V_CCC</td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
<td>V</td>
<td>*1)</td>
</tr>
<tr>
<td>Power Supply Voltage For LED</td>
<td>V_LED</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Logic Input Voltage</td>
<td>V_IH</td>
<td>VCC*0.7</td>
<td>--</td>
<td>VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_IL</td>
<td>0</td>
<td>--</td>
<td>VCC*0.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>ADJ Input Voltage</td>
<td>V_IH</td>
<td>3.0</td>
<td>--</td>
<td>3.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_IL</td>
<td>GND</td>
<td>--</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:

*1) VCC – dip condition:
- When 2.7 V ≤ VCC < 3.0 V, td ≤ 10 ms.
- VCC > 3.0 V, VCC-dip condition should be same as VCC-turn-on condition.

3.2 TFT-LCD current consumption

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ</th>
<th>Max.</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD power current</td>
<td>I_CCC</td>
<td>--</td>
<td>140</td>
<td>190</td>
<td>mA</td>
<td>*1)</td>
</tr>
<tr>
<td>LED power current</td>
<td>I_LED</td>
<td>300</td>
<td>350</td>
<td>mA</td>
<td>*2)</td>
<td></td>
</tr>
</tbody>
</table>

*1) Typical: Under 64 gray pattern
    Maximum: Under black pattern

*2) Typical: When V_LED is 5.0V
    Maximum: When V_LED is 4.5V
3.3 Power・Signal sequence

$t1 \leq 10\text{ms}$  
$50\text{ms} \leq t2$  
$0 < t3 \leq 50\text{ms}$  
$0 < t4 \leq 10\text{ms}$

$t1$  
$t2$  
$t3$  
$t4$  
$t5$  
$t6$  
$t7$

$\text{Vin}=3.3\text{V}$

LCD Power Supply

Logic Signal

Backlight Power Supply

Data: RGB DATA, DCLK, DENA
### 4. INTERFACE CONNECTION

(a) **CN1**: Starconn 089N40-000R00-G2

<table>
<thead>
<tr>
<th>Pin NO.</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U/D</td>
<td>Up / Down Display Control</td>
</tr>
<tr>
<td>2</td>
<td>DMS</td>
<td>DE / SYNC Mode Selection</td>
</tr>
<tr>
<td>3</td>
<td>Hsync</td>
<td>Horizontal SYNC.</td>
</tr>
<tr>
<td>4</td>
<td>V_{LED}</td>
<td>Power Supply for LED</td>
</tr>
<tr>
<td>5</td>
<td>V_{LED}</td>
<td>Power Supply for LED</td>
</tr>
<tr>
<td>6</td>
<td>V_{LED}</td>
<td>Power Supply for LED</td>
</tr>
<tr>
<td>7</td>
<td>Vcc</td>
<td>Power Supply for LCD</td>
</tr>
<tr>
<td>8</td>
<td>Vsync</td>
<td>Vertical SYNC.</td>
</tr>
<tr>
<td>9</td>
<td>DE</td>
<td>Data Enable</td>
</tr>
<tr>
<td>10</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>11</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>12</td>
<td>ADJ</td>
<td>Adjust for LED brightness</td>
</tr>
<tr>
<td>13</td>
<td>B5</td>
<td>Blue Data 5 (MSB)</td>
</tr>
<tr>
<td>14</td>
<td>B4</td>
<td>Blue Data 4</td>
</tr>
<tr>
<td>15</td>
<td>B3</td>
<td>Blue Data 3</td>
</tr>
<tr>
<td>16</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>17</td>
<td>B2</td>
<td>Blue Data 2</td>
</tr>
<tr>
<td>18</td>
<td>B1</td>
<td>Blue Data 1</td>
</tr>
<tr>
<td>19</td>
<td>B0</td>
<td>Blue Data 0 (LSB)</td>
</tr>
<tr>
<td>20</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>21</td>
<td>G5</td>
<td>Green Data 5 (MSB)</td>
</tr>
<tr>
<td>22</td>
<td>G4</td>
<td>Green Data 4</td>
</tr>
<tr>
<td>23</td>
<td>G3</td>
<td>Green Data 3</td>
</tr>
<tr>
<td>24</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>25</td>
<td>G2</td>
<td>Green Data 2</td>
</tr>
<tr>
<td>26</td>
<td>G1</td>
<td>Green Data 1</td>
</tr>
<tr>
<td>27</td>
<td>G0</td>
<td>Green Data 0 (LSB)</td>
</tr>
<tr>
<td>28</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>29</td>
<td>R5</td>
<td>Red Data 5 (MSB)</td>
</tr>
<tr>
<td>30</td>
<td>R4</td>
<td>Red Data 4</td>
</tr>
<tr>
<td>31</td>
<td>R3</td>
<td>Red Data 3</td>
</tr>
<tr>
<td>32</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>33</td>
<td>R2</td>
<td>Red Data 2</td>
</tr>
<tr>
<td>34</td>
<td>R1</td>
<td>Red Data 1</td>
</tr>
<tr>
<td>35</td>
<td>R0</td>
<td>Red Data 0 (LSB)</td>
</tr>
<tr>
<td>36</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>37</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>38</td>
<td>DCLK</td>
<td>Clock Signals</td>
</tr>
<tr>
<td>39</td>
<td>V_{SS}</td>
<td>Power Ground</td>
</tr>
<tr>
<td>40</td>
<td>L/R</td>
<td>Left / Right Display Control</td>
</tr>
</tbody>
</table>
Remarks:
1) ADJ adjust brightness to control Pin, Pulse duty the bigger the brighter.

2) ADJ signal =0~3.3V, operation frequency:20±10KHZ

3) VSS Pin must ground contact, can not be floating.

4) U/D and L/R are controled function

<table>
<thead>
<tr>
<th>L/R</th>
<th>U/D</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Normally display</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Left and Right opposite</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Up and Down opposite</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Left and Right opposite, Up and Down opposite</td>
</tr>
</tbody>
</table>

*5) DMS (Selection DE/SYNC mode)

<table>
<thead>
<tr>
<th>DMS</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DE Mode</td>
</tr>
<tr>
<td>0</td>
<td>SYNC Mode</td>
</tr>
</tbody>
</table>
### 5. INPUT SIGNAL (DE ONLY MODE)

#### 5.1 Timing Specification

<table>
<thead>
<tr>
<th>characteristics</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dot Clock</td>
<td>$F_{Osc}$</td>
<td>23</td>
<td>25</td>
<td>30</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Horizontal Period</td>
<td>$T_H$</td>
<td>750</td>
<td>800</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Valid</td>
<td>$T_{HV}$</td>
<td>640</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Blank</td>
<td>$T_{HBlank}$</td>
<td>110</td>
<td>160</td>
<td>260</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Period</td>
<td>$T_V$</td>
<td>515</td>
<td>525</td>
<td>560</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Valid</td>
<td>$T_{VV}$</td>
<td>480</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Blank</td>
<td>$T_{VBlank}$</td>
<td>35</td>
<td>45</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Frequency</td>
<td>$F_v$</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>Hz</td>
<td></td>
</tr>
</tbody>
</table>

#### SYNC MODE

<table>
<thead>
<tr>
<th>characteristics</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Period</td>
<td>$T_H$</td>
<td>750</td>
<td>800</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Pulse Width</td>
<td>$T_{hP}$</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>T_{Osc}</td>
<td></td>
</tr>
<tr>
<td>Horizontal Pulse Width + Back Proch</td>
<td>$T_{hPb}$</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>T_{Osc}</td>
<td></td>
</tr>
<tr>
<td>Horizontal Front Proch</td>
<td>$T_{f}$</td>
<td>64</td>
<td>114</td>
<td>214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Valid</td>
<td>$T_{vP}$</td>
<td>640</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Period</td>
<td>$T_v$</td>
<td>515</td>
<td>525</td>
<td>560</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Pulse Width</td>
<td>$T_{vP}$</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>T_{h}</td>
<td></td>
</tr>
<tr>
<td>Vertical Pulse Width + Back Proch</td>
<td>$T_{vPb}$</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>T_{h}</td>
<td></td>
</tr>
<tr>
<td>Vertical Front Proch</td>
<td>$T_v$</td>
<td>1</td>
<td>11</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Valid</td>
<td>$T_{vV}$</td>
<td>480</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Frequency</td>
<td>$F_v$</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>Hz</td>
<td></td>
</tr>
</tbody>
</table>

#### 5.2 Timing sequence (Timing chart)
Horizontal Timing Sequence

- **CLK**: Clock signal
- **DATA (R, G, B)**: Signal with data for Red, Green, and Blue
- **DEN**: Data enable signal
- **Tosc**: Oscillation time
- **Tsu**: Sync pulse rise time
- **Tnd**: Sync pulse fall time
- **Thbk**: Back porch time
- **Thv**: Front porch time
- **Nh**: Horizontal period

Vertical Timing Sequence

- **LINE DATA**: Line data signal
- **Tvk**: Vertical blanking time
- **Tv**: Vertical period
- **Tvbk**: Back porch time
- **Tvv**: Front porch time

DE mode Timing
Sync mode Timing
5.3 Color Data Assignment

<table>
<thead>
<tr>
<th>COLOR</th>
<th>INPUT</th>
<th>R DATA</th>
<th>G DATA</th>
<th>B DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DATA</td>
<td>MSE</td>
<td>LSE</td>
<td>MSE</td>
</tr>
<tr>
<td>BLACK</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RED(63)</td>
<td>1 1 1 1 1 1 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>BASIC</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GREEN(63)</td>
<td>0 0 0 0 0 0 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>COLOR</td>
<td>BLUE(63)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CYAN</td>
<td>0 0 0 0 0 0 0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MAGENTA</td>
<td>1 1 1 1 1 1 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>YELLOW</td>
<td>1 1 1 1 1 1 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WHITE</td>
<td>1 1 1 1 1 1 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RED(0)</td>
<td>0 0 0 0 0 0 0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RED(1)</td>
<td>0 0 0 0 0 0 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RED(2)</td>
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<tr>
<td>RED</td>
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<tr>
<td>RED(62)</td>
<td>1 1 1 1 1 1 0</td>
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<tr>
<td>RED(63)</td>
<td>1 1 1 1 1 1 1</td>
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<tr>
<td>GREEN(0)</td>
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<td>GREEN</td>
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<tr>
<td>GREEN(62)</td>
<td>0 0 0 0 0 0 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>GREEN(63)</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BLUE(0)</td>
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<tr>
<td>BLUE(1)</td>
<td>0 0 0 0 0 0 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>BLUE(2)</td>
<td>0 0 0 0 0 1 0</td>
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<td>0</td>
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<tr>
<td>BLUE</td>
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<tr>
<td>BLUE(62)</td>
<td>0 0 0 0 0 0 0</td>
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<tr>
<td>BLUE(63)</td>
<td>0 0 0 0 0 0 1</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

Remarks:
(1) Definition of Gray Scale
  color(n) : n is series of Gray Scale
  The more n value is, the bright Gray Scale.
(2) Data: 1-High, 0-Low
6. BLOCK DIAGRAM
7. MECHANICAL DIMENSION

7.1 Front Side

[Unit : mm]

7.2 Rear Side
Remark : Un-indication tolerance is ±0.3mm
### 8. OPTICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SYMBOL</th>
<th>CONDITION</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Constrast Ratio</td>
<td>CR</td>
<td>Point-5</td>
<td>200</td>
<td>300</td>
<td>--</td>
<td></td>
<td>*1)*2)*3)</td>
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<tr>
<td>Luminance</td>
<td>Lw</td>
<td>Point-5</td>
<td>180</td>
<td>220</td>
<td>--</td>
<td>cd/m²</td>
<td>*1)*3)</td>
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<tr>
<td>Luminance Uniformity</td>
<td>ΔL</td>
<td></td>
<td>70</td>
<td>80</td>
<td>--</td>
<td>%</td>
<td>*1)*3)</td>
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<tr>
<td>Response Time</td>
<td>Tr+ Tf</td>
<td>Point-5</td>
<td>--</td>
<td>30</td>
<td>50</td>
<td>ms</td>
<td>*1)*3)*5)</td>
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<tr>
<td>Viewign Angle</td>
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<td>Horizontal</td>
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<td>Vertical</td>
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<td></td>
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<tr>
<td>White</td>
<td>Wx</td>
<td>CR ≥ 10</td>
<td>120</td>
<td>140</td>
<td>--</td>
<td>°</td>
<td>*1)*2)*4)</td>
</tr>
<tr>
<td></td>
<td>Wy</td>
<td></td>
<td>80</td>
<td>100</td>
<td>--</td>
<td>°</td>
<td>*1)*2)*4)</td>
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<td>Red</td>
<td>Rx</td>
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<td>0.580</td>
<td>0.610</td>
<td>0.640</td>
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<tr>
<td></td>
<td>Ry</td>
<td></td>
<td>0.306</td>
<td>0.336</td>
<td>0.366</td>
<td></td>
<td>*1)*3)</td>
</tr>
<tr>
<td>Green</td>
<td>Gx</td>
<td>Point-5</td>
<td>0.300</td>
<td>0.330</td>
<td>0.360</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Gy</td>
<td></td>
<td>0.544</td>
<td>0.574</td>
<td>0.604</td>
<td></td>
<td>*1)*3)</td>
</tr>
<tr>
<td>Blue</td>
<td>Bx</td>
<td></td>
<td>0.116</td>
<td>0.146</td>
<td>0.176</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>By</td>
<td></td>
<td>0.080</td>
<td>0.110</td>
<td>0.140</td>
<td></td>
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</tr>
</tbody>
</table>

**Remarks:**

*1) Measure condition: 25°C ±2°C, 60±10%RH, under 10 Lux in the dark room, BM-5A (TOPCON), viewing angle 2°, VCC=3.3V, VDD=3.3V.

*2) Definition of contrast ratio:

Contrast Ratio (CR) = (White) Luminance of ON ÷ (Black) Luminance of OFF

*3) Definition of luminance:

\[ L = 500 \text{mm} \]
Definition of Luminance Uniformity:
Measure white luminance on the point 5 as figure8-1
Measure white luminance on the point 1~9 as figure8-1
\[ \Delta L = \frac{L_{(MIN)}}{L_{(MAX)}} \times 100\% \]

*4) Definition of Viewing Angle(θ, ψ), refer to Fig8-2 as below:

*5) Definition of Response Time (White-Black)
9. RELIABILITY TEST

9-1. Temperature and humidity

<table>
<thead>
<tr>
<th>TEST ITEMS</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temperature Operation</td>
<td>85°C • 240H</td>
</tr>
<tr>
<td>High Temperature Storage</td>
<td>95°C • 240H</td>
</tr>
<tr>
<td>High Temperature High Humidity Operation</td>
<td>60°C • 90%RH • 240H (No condensation)</td>
</tr>
<tr>
<td>Low Temperature Operation</td>
<td>-30°C • 240H, Backlight unit always turn on</td>
</tr>
<tr>
<td>Low Temperature Storage</td>
<td>-40°C • 240H</td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>-30°C (0.5Hr) ~ 85°C (0.5Hr) 200 cycles</td>
</tr>
</tbody>
</table>

9-2. Shock and Vibration

<table>
<thead>
<tr>
<th>TEST ITEMS (Non-operation)</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock</td>
<td>• Shock level:980m/s² (equal to 100G)</td>
</tr>
<tr>
<td></td>
<td>• Waveform: half sinusoidal wave, 6ms.</td>
</tr>
<tr>
<td></td>
<td>• Number of shocks: one shock input in each direction of three mutually perpendicular axes for a total of three shock inputs.</td>
</tr>
<tr>
<td>Vibration</td>
<td>• Frequency range: 8~33.3Hz</td>
</tr>
<tr>
<td>(Non-operation)</td>
<td>• Stoke: 1.3mm</td>
</tr>
<tr>
<td></td>
<td>• Vibration: sinusoidal wave, perpendicular axis (both x, y, z axis: 2Hrs).</td>
</tr>
<tr>
<td></td>
<td>• Sweep: 2.9G, 33.3Hz-400Hz</td>
</tr>
<tr>
<td></td>
<td>• Cycle: 15 min</td>
</tr>
</tbody>
</table>

9-3. Judgment standard

The Judgment of the above test should be made as follow:
Pass: Normal display image with no obvious non-uniformity and no line defect. Partial transformation of the module parts should be ignored.
Fail: No display image, obvious non-uniformity, or line defect.