Specifications for

Blanview TFT-LCD Monitor

Version 1.0

MODEL: COM22H2N81DLC

Customer's Approval
Signature: ____________________________
Name: _______________________________
Section: ______________________________
Title: ________________________________
Date: ________________________________

ORTUSTECH

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Sales Dept. - Industrial Application
Approved by _________________________

Checked by _________________________

ORTUS TECHNOLOGY CO., LTD.
Product Quality Assurance
Approved by _________________________

Checked by _________________________

Prepared by _________________________

ORTUS TECHNOLOGY CO., LTD.
### Version History

<table>
<thead>
<tr>
<th>Ver.</th>
<th>Date</th>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Oct. 28, 2011</td>
<td>-</td>
<td>First issue</td>
</tr>
</tbody>
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1. Application

This Specification is applicable to 5.52cm (2.2 inch) Blanview TFT-LCD monitor for non-military use.

◎ ORTUS TECHNOLOGY makes no warranty or assume no liability that use of this Product and/or any information including drawings in this Specification by Purchaser is not infringing any patent or other intellectual property rights owned by third parties, and ORTUS TECHNOLOGY shall not grant to Purchaser any right to use any patent or other intellectual property rights owned by third parties. Since this Specification contains ORTUS TECHNOLOGY's confidential information and copy right, Purchaser shall use them with high degree of care to prevent any unauthorized use, disclosure, duplication, publication or dissemination of ORTUS TECHNOLOGY'S confidential information and copy right.

◎ If Purchaser intends to use this Products for an application which requires higher level of reliability and/or safety in functionality and/or accuracy such as transport equipment (aircraft, train automobile etc.), disaster-prevention/security equipment or various safety equipment, Purchaser shall consult ORTUS TECHNOLOGY on such use in advance.

◎ This Product shall not be used for application which requires extremely higher level of reliability and/or safety such as aerospace equipment, telecommunication equipment for trunk lines, control equipment for nuclear facilities or life-support medical equipment.

◎ ORTUS TECHNOLOGY assumes no liability for any damage resulting from misuse, abuse, and/or miss-operation of the Product deviating from the operating conditions and precautions described in the Specification.

◎ If any issue arises as to information provided in this Specification or any other information, ORTUS TECHNOLOGY and Purchaser shall discuss them in good faith and seek solution.

◎ ORTUS TECHNOLOGY assumes no liability for defects such as electrostatic discharge failure occurred during peeling off the protective film or Purchaser's assembly process.

◎ This Product is compatible for RoHS directive.

<table>
<thead>
<tr>
<th>Object substance</th>
<th>Maximum content [ppm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium and its compound</td>
<td>100</td>
</tr>
<tr>
<td>Hexavalent Chromium Compound</td>
<td>1000</td>
</tr>
<tr>
<td>Lead &amp; Lead compound</td>
<td>1000</td>
</tr>
<tr>
<td>Mercury &amp; Mercury compound</td>
<td>1000</td>
</tr>
<tr>
<td>Polybrominated biphenyl series (PBB series)</td>
<td>1000</td>
</tr>
<tr>
<td>Polybrominated biphenyl ether series (PBDE series)</td>
<td>1000</td>
</tr>
</tbody>
</table>
2. Outline Specifications

2.1 Features of the Product

- 2.2 inch diagonal display, 960 [H] x 240 [V] dots.
- Two kinds of input specifications can be selected.
  - "MODE" = "VSS"
    - 8-bit / 16,777,216 colors.
    - Various display controls and functional selection by 3-wire serial communication method.
  - "MODE" = "VDD"
    - 6-bit / 262,144 colors.
    - Various display controls and functional selection by terminal control.
- 3.0V voltage single power source.
- Timing generator [TG], Counter-electrode driving circuitry, Built-in power supply circuit.
- Power save (Standby) mode capable.
- Built-in rush current reduction circuit.
- Built-in panel residual charge reduction circuit.
- Long life & High bright white LED back-light.
- Blanview TFT-LCD, improved outdoor readability.

2.2 Display Method

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display type</td>
<td>TN type 262,144 colors or 16,777,216 colors.</td>
<td></td>
</tr>
<tr>
<td>TN type</td>
<td>Blanview, Normally white.</td>
<td></td>
</tr>
<tr>
<td>Driving method</td>
<td>a-Si TFT Active matrix.</td>
<td></td>
</tr>
<tr>
<td>TFT Active matrix.</td>
<td>Line-scanning, Non-interlace.</td>
<td>Refer to &quot;Dot arrangement&quot;</td>
</tr>
<tr>
<td>Dot arrangement</td>
<td>RGB stripe arrangement.</td>
<td></td>
</tr>
<tr>
<td>Signal input method</td>
<td>6-bit or 8-bit RGB,parallel input.</td>
<td></td>
</tr>
<tr>
<td>Backlight type</td>
<td>Long life &amp; High bright white LED.</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of active area](image-url)
<Features of Blanview>

- Backlight power consumption required to assure visibility. (equivalent to 3.5”QVGA)

- Contrast characteristics under 100,000lx. (same condition as direct sunlight.)

With better contrast (higher contrast ratio), Blanview TFT-LCD has the best outdoor readability in three different types of TFT-LCD.

Below chart shows contrast value against panel surface brightness. (Horizontal: Panel surface brightness/ Vertical: Contrast value) LCD panel has enough outdoor readability above our Standard line.

(ORTUS TECHNOLOGY criteria)
3. Dimensions and Shape

3.1 Dimensions

<table>
<thead>
<tr>
<th>Items</th>
<th>Specifications</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outline dimensions</td>
<td>49.96[H] × 42.95[V] × 2.92[D]</td>
<td>mm</td>
<td>Exclude FPC cable</td>
</tr>
<tr>
<td>Active area</td>
<td>44.16[H] × 33.12[V]</td>
<td>mm</td>
<td>5.52cm diagonal</td>
</tr>
<tr>
<td>Number of dots</td>
<td>960[H] × 240[V]</td>
<td>dot</td>
<td></td>
</tr>
<tr>
<td>Dot pitch</td>
<td>46.0[H] × 138.0[V]</td>
<td>μm</td>
<td></td>
</tr>
<tr>
<td>Surface hardness of the polarizer</td>
<td>3[H] × 138.0[V]</td>
<td>H</td>
<td>Load: 2.0N</td>
</tr>
<tr>
<td>Weight</td>
<td>12.6</td>
<td>g</td>
<td>Include FPC cable</td>
</tr>
</tbody>
</table>
Note 1. Angular deviation of LCD cell from the TFT-LCD monitor’s reference axis shall be less than 
4°.

Note 2. S label is allowed the area shown in the drawing. The thickness of the S label will be added to that of S case’s surface.

Note 3. Recommended FPC connectors
KINCON ELEC. part number: 04-6281-2657 3132F45 (Lower contact)
HIROSE ELECTRIC part number: PHF0G-SMT-0.5MW (Lower contact)
FPC pin assignment differs from a position of Datum Pin of recommended FPC connector. Please notice the difference when designing your circuit with much care.

Note 4. Protective film is affixed on front surface of the screen. Location reference of the protective film shall be 15 mm to the polarizer film.

Note 5. Exercise care not to apply any forces to the side holder of the S case A.

Note 6. In case TFT-LCD monitor is leased to the case of your product, it’s recommended that not for it fixed to display area.

Note 7. Refer to “11. CRITERIA OF JUDGMENT” about the appearance specification of a polarizer.
3.3 Serial Label (S-LABEL)

1) Display Items
S-label indicates the least significant digit of manufacture year (1digit), manufacture month with below alphabet (1letter), model code (5characters), serial number (6digits).

* Contents of Display

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>The least significant digit of manufacture year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Manufacture month</td>
<td>Jan-A</td>
<td>May-E</td>
</tr>
<tr>
<td></td>
<td>Feb-B</td>
<td>Jun-F</td>
<td>Oct-J</td>
</tr>
<tr>
<td></td>
<td>Mar-C</td>
<td>Jul-G</td>
<td>Nov-K</td>
</tr>
<tr>
<td></td>
<td>Apr-D</td>
<td>Aug-H</td>
<td>Dec-L</td>
</tr>
<tr>
<td>c</td>
<td>Model code</td>
<td>22CAC (Made in Japan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22CBC (Made in Malaysia)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22CCC (Made in China)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Serial number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Example of indication of Serial label (S-label)

*Made in Japan

1J22CAC000125

means "manufactured in October 2011, model 22CA, C specifications, serial number 000125"

*Made in Malaysia

1J22CBC000125

means "manufactured in October 2011, model 22CB, C specifications, serial number 000125"

*Made in China

1J22CCC000125

means "manufactured in October 2011, model 22CC, C specifications, serial number 000125"

2) Location of Serial Label (S-label)
Refer to 3.2 "Outward Form".
4. Pin Assignment

<table>
<thead>
<tr>
<th>No.</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCOM</td>
<td>Common-electrode driving signal.</td>
</tr>
<tr>
<td>2</td>
<td>D27</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>3</td>
<td>D26</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>4</td>
<td>D25</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>5</td>
<td>D24</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>6</td>
<td>D23</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>7</td>
<td>D22</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>8</td>
<td>D21</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>9</td>
<td>D20</td>
<td>Display data input for (B). 00h for black display</td>
</tr>
<tr>
<td>10</td>
<td>D17</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>11</td>
<td>D16</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>12</td>
<td>D15</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>13</td>
<td>D14</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>14</td>
<td>D13</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>15</td>
<td>D12</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>16</td>
<td>D11</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>17</td>
<td>D10</td>
<td>Display data input for (G). 00h for black display</td>
</tr>
<tr>
<td>18</td>
<td>D07</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>19</td>
<td>D06</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>20</td>
<td>D05</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>21</td>
<td>D04</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>22</td>
<td>D03</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>23</td>
<td>D02</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>24</td>
<td>D01</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>25</td>
<td>D00</td>
<td>Display data input for (R). 00h for black display</td>
</tr>
<tr>
<td>26</td>
<td>BLON</td>
<td>Logic signal output for external backlight circuitry. OPEN.</td>
</tr>
<tr>
<td>27</td>
<td>CS/STBY</td>
<td>Chip select input for serial communication. (Lo: active) STBY:Stanby signal. (Lo:Normal operation, Hi:Stanby operation)</td>
</tr>
<tr>
<td>28</td>
<td>DI/DE</td>
<td>Data input for serial communication. DE:Input data effective signal.</td>
</tr>
<tr>
<td>29</td>
<td>SCK/REV</td>
<td>Clock input for serial communication. REV:Right/Left &amp; Up/Down Display reverse. (Lo:Normal Display,Hi:Reverse Display)</td>
</tr>
<tr>
<td>30</td>
<td>VSYNC</td>
<td>Vertical sync signal input. Vertical sync signal input.(negative polarity)</td>
</tr>
<tr>
<td>31</td>
<td>HSYNC</td>
<td>Horizontal sync signal input. Horizontal sync signal input.(negative polarity)</td>
</tr>
<tr>
<td>32</td>
<td>CLK</td>
<td>Clock input for display.</td>
</tr>
<tr>
<td>33</td>
<td>VSS</td>
<td>GND.</td>
</tr>
<tr>
<td>34</td>
<td>MODE</td>
<td>Input specification selection input.</td>
</tr>
<tr>
<td>35</td>
<td>POCB</td>
<td>Power on clear. (Lo: active)</td>
</tr>
<tr>
<td>36</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>37</td>
<td>RVDD</td>
<td>Internal power supply.</td>
</tr>
<tr>
<td>38</td>
<td>COMDC</td>
<td>Common-electrode drive DC output.</td>
</tr>
<tr>
<td>39</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>40</td>
<td>VSRC</td>
<td>Built-in DAC reference supply.</td>
</tr>
<tr>
<td>41</td>
<td>C1P</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>42</td>
<td>C1M</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>43</td>
<td>C2M</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>44</td>
<td>C2P</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>45</td>
<td>VDD</td>
<td>Power supply input.</td>
</tr>
<tr>
<td>No.</td>
<td>Symbol</td>
<td>Function</td>
</tr>
<tr>
<td>-----</td>
<td>--------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>46</td>
<td>COMOUT</td>
<td>Square wave output for common-electrode.</td>
</tr>
<tr>
<td>47</td>
<td>VDD2</td>
<td>Internal power supply.</td>
</tr>
<tr>
<td>48</td>
<td>VSS</td>
<td>GND.</td>
</tr>
<tr>
<td>49</td>
<td>VSS</td>
<td>GND.</td>
</tr>
<tr>
<td>50</td>
<td>VSS</td>
<td>GND.</td>
</tr>
<tr>
<td>51</td>
<td>C3M</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>52</td>
<td>C3P</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>53</td>
<td>C4M</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>54</td>
<td>C4P</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>55</td>
<td>VVCOM</td>
<td>Voltage output for COMOUT.</td>
</tr>
<tr>
<td>56</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>57</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>58</td>
<td>VGH</td>
<td>Positive supply for gate driver.</td>
</tr>
<tr>
<td>59</td>
<td>C5P</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>60</td>
<td>C5M</td>
<td>Contacting terminal of capacitor for charge pump.</td>
</tr>
<tr>
<td>61</td>
<td>VGL</td>
<td>Negative supply for gate driver.</td>
</tr>
<tr>
<td>62</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>63</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>64</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>65</td>
<td>NC</td>
<td>OPEN.</td>
</tr>
<tr>
<td>66</td>
<td>BLH</td>
<td>LED drive power source . (Anode side)</td>
</tr>
<tr>
<td>67</td>
<td>BLL</td>
<td>LED drive power source . (Cathode side)</td>
</tr>
</tbody>
</table>

- Recommended connector: KYOCERA ELCO 6281 series [04 6281 267 2x2 846+]  
  : HIROSE ELECTRIC CO., LTD. FH26 series [FH26G-67S-0.3SHBW(05)]
- Please refer to the section "3.2 Outward Form" for terminal order.
- Since FPC cable has gold plated terminals, gilt finish contact shoe connector is recommended.
### 5. Absolute Maximum Rating

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Condition</th>
<th>MIN</th>
<th>MAX</th>
<th>Rating</th>
<th>Unit</th>
<th>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VDD</td>
<td>Ta=25°C</td>
<td>-0.3</td>
<td>6.0</td>
<td>VDD</td>
<td>VDD</td>
<td></td>
</tr>
<tr>
<td>Input voltage 1 for logic</td>
<td>VI1</td>
<td></td>
<td>-0.3</td>
<td>VDD+0.3</td>
<td>VDD</td>
<td>VDD</td>
<td>PO CB, CLK, VSYNC, HSYNC, D[27:20], D[17:10], D[07:00], MODE</td>
</tr>
<tr>
<td>Input voltage 2 for logic</td>
<td>VI2</td>
<td></td>
<td>-0.3</td>
<td>6.0</td>
<td>VDD</td>
<td>VDD</td>
<td>CS/STBY, DI/DE, SCK/REV</td>
</tr>
<tr>
<td>LED forward current</td>
<td>IL</td>
<td>Ta = 25°C</td>
<td>--</td>
<td>35</td>
<td>mA</td>
<td></td>
<td>BLH1 - BLL1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta = 70°C</td>
<td>--</td>
<td>15</td>
<td></td>
<td></td>
<td>BLH2 - BLL2</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td></td>
<td>-30</td>
<td>80</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage humidity range</td>
<td>Hstg</td>
<td></td>
<td></td>
<td></td>
<td>Non condensing in an environmental moisture at or less than 40°C90%RH.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Please set "Power-on" and "Power-off" sequences in accordance with the "standby sequence" described later.

### 6. Recommended Operating Conditions

<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>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VDD</td>
<td></td>
<td>2.7</td>
<td>3.0</td>
<td>3.6</td>
<td>V</td>
<td>VDD</td>
</tr>
<tr>
<td>Input voltage 1 for logic</td>
<td>VI1</td>
<td>VDD=2.7~3.6V</td>
<td>0</td>
<td>--</td>
<td>VDD</td>
<td>V</td>
<td>PO CB, CLK, VSYNC, HSYNC, D[27:20], D[17:10], D[07:00], MODE</td>
</tr>
<tr>
<td>Input voltage 2 for logic</td>
<td>VI2</td>
<td></td>
<td>0</td>
<td>--</td>
<td>VDD</td>
<td>V</td>
<td>CS/STBY, DI/DE, SCK/REV</td>
</tr>
<tr>
<td>Common-electrode center voltage</td>
<td>VCOMDC</td>
<td>NOTE1</td>
<td>1.18</td>
<td>1.68</td>
<td>2.18</td>
<td>V</td>
<td>COMDC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MODE=&quot;VSS&quot; VCOMDC[5:0]</td>
<td>=07h~39h</td>
<td>1.18</td>
<td>1.68</td>
<td>2.18</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MODE=&quot;VDD&quot; VCOMDC[5:0]</td>
<td>=07h~39h</td>
<td>1.18</td>
<td>1.68</td>
<td>2.18</td>
<td>V</td>
</tr>
<tr>
<td>Operational temperature range</td>
<td>Top</td>
<td>Note2,3</td>
<td>-20</td>
<td>25</td>
<td>70</td>
<td>°C</td>
<td>Panel surface temperature</td>
</tr>
<tr>
<td>Operating humidity range</td>
<td>Hop</td>
<td>Ta≤30°C</td>
<td>20</td>
<td>--</td>
<td>80</td>
<td>%</td>
<td>Non condensing in an environmental moisture at or less than 30°C80%RH.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta&gt;30°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note1: Common-electrode center voltage indicates that optimum VCOMDC value lies within the bound of these voltages, but it does not mean that the whole range of voltages are the optimum VCOMDC value. This product must to be used with optimized VCOMDC value.

Note 2: This monitor is operatable in this temperature range. With regard to optical characteristics, refer to Item 10. "CHARACTERISTICS".

Note 3: Acceptable Forward Current to LED is up to 15mA, when Ta=+70°C. Do not exceed Allowable Forward Current shown on the chart below.

![Chart showing Allowable Forward Current vs. Ambient Temperature]
7. Characteristics

7.1 DC Characteristics

7.1.1 Display Module

(Unless otherwise noted, Ta=25°C, VDD=3.0V, VSS=0V)

<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>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schmitt Threshold voltage</td>
<td>VP</td>
<td>VDD=2.7~3.6V</td>
<td>0.47VDD</td>
<td>0.60VDD</td>
<td>0.73VDD</td>
<td>V</td>
<td>CS/STBY,DI/DE, SCK/REV,VSYS, HSYNC,D[27:20], D[17:10],D[07:00], CLK,POCB</td>
</tr>
<tr>
<td></td>
<td>VN</td>
<td></td>
<td>0.30VDD</td>
<td>0.43VDD</td>
<td>0.56VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VH</td>
<td></td>
<td>0.08VDD</td>
<td>0.17VDD</td>
<td>0.27VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input Signal Voltage</td>
<td>VIH</td>
<td></td>
<td>0.7VDD</td>
<td>--</td>
<td>VDD</td>
<td>V</td>
<td>MODE</td>
</tr>
<tr>
<td></td>
<td>VIL</td>
<td></td>
<td>0</td>
<td>--</td>
<td>0.3VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Pull up resistor value</td>
<td>Rpu</td>
<td></td>
<td>45</td>
<td>91</td>
<td>182 kΩ</td>
<td></td>
<td>POCB</td>
</tr>
<tr>
<td>Pull down resistor value</td>
<td>Rpd</td>
<td></td>
<td>45</td>
<td>91</td>
<td>182 kΩ</td>
<td></td>
<td>MODE</td>
</tr>
<tr>
<td>Output Voltage1</td>
<td>VDD2</td>
<td></td>
<td>4.8</td>
<td>5.6</td>
<td>6.1</td>
<td>V</td>
<td>VDD2</td>
</tr>
<tr>
<td>Output Voltage2</td>
<td>VGH</td>
<td></td>
<td>12.5</td>
<td>13.3</td>
<td>13.5</td>
<td>V</td>
<td>VGH</td>
</tr>
<tr>
<td>Output Voltage3</td>
<td>VGL</td>
<td></td>
<td>-13.5</td>
<td>-13.3</td>
<td>-12.5</td>
<td>V</td>
<td>VGL</td>
</tr>
<tr>
<td>Output Voltage4</td>
<td>VOH</td>
<td>VDD - 0.5</td>
<td>--</td>
<td>VDD</td>
<td>1.0mA</td>
<td></td>
<td>BLON</td>
</tr>
<tr>
<td></td>
<td>VOL</td>
<td>0</td>
<td>--</td>
<td>0.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Current</td>
<td>IDD</td>
<td>fCLK=6.75MHz</td>
<td>--</td>
<td>8.0</td>
<td>15.0</td>
<td>mA</td>
<td>VDD</td>
</tr>
<tr>
<td>Standby Current</td>
<td>IDDs</td>
<td>MODE=&quot;VSS&quot;,Other input with constant voltage.</td>
<td>--</td>
<td>11.0</td>
<td>30.0</td>
<td>μA</td>
<td>VDD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MODE=&quot;VDD&quot;,Other input with constant voltage.</td>
<td>--</td>
<td>44.0</td>
<td>96.0</td>
<td>μA</td>
<td></td>
</tr>
</tbody>
</table>

At "MODE" = "VSS"

(Unless otherwise noted, Ta=25°C, VDD=3.0V, VSS=0V)

<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>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>VcomDC Adjusted value</td>
<td>VCOMDC</td>
<td>VCOMDC[5:0]=00h</td>
<td>0.94</td>
<td>1.04</td>
<td>1.14</td>
<td>V</td>
<td>COMDC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VCOMDC[5:0]=1Fh</td>
<td>1.56</td>
<td>1.66</td>
<td>1.76</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VCOMDC[5:0]=3Ch</td>
<td>2.14</td>
<td>2.24</td>
<td>2.34</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

(Unless otherwise noted, Ta=25°C, VDD=3.0V, VSS=0V)

<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></th>
</tr>
</thead>
<tbody>
<tr>
<td>BRIGHT Adjusted value</td>
<td>VLC</td>
<td>BRIGHT[5:0]=00h</td>
<td>4.10</td>
<td>4.25</td>
<td>4.40</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CONTRAST[3:0]=Eh</td>
<td>D[7:0]=FFh</td>
<td>0.92</td>
<td>1.07</td>
<td>1.22</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BRIGHT[5:0]=1Ah</td>
<td>D[7:0]=FFh</td>
<td>3.58</td>
<td>3.73</td>
<td>3.88</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CONTRAST[3:0]=Eh</td>
<td>D[7:0]=FFh</td>
<td>0.40</td>
<td>0.55</td>
<td>0.70</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BRIGHT[5:0]=2Ah</td>
<td>D[7:0]=FFh</td>
<td>3.18</td>
<td>3.33</td>
<td>3.48</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CONTRAST[3:0]=Eh</td>
<td>D[7:0]=FFh</td>
<td>0.00</td>
<td>0.15</td>
<td>0.30</td>
<td>V</td>
</tr>
<tr>
<td>CONTRAST Adjusted value</td>
<td>VLC</td>
<td>CONTRAST[3:0]=0h</td>
<td>1.35</td>
<td>1.50</td>
<td>1.65</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VLC(D[7:0]=00h)</td>
<td>3.03</td>
<td>3.18</td>
<td>3.33</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VLC(D[7:0]=FFh)</td>
<td>3.15</td>
<td>3.30</td>
<td>3.45</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

ORTUS TECHNOLOGY CO., LTD.
7.1.2  Backlight

<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>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward current</td>
<td>IL25</td>
<td>Ta=25°C</td>
<td>--</td>
<td>5.0</td>
<td>35.0</td>
<td>mA</td>
<td>BLH – BLL</td>
</tr>
<tr>
<td></td>
<td>IL70</td>
<td>Ta=70°C</td>
<td>--</td>
<td>--</td>
<td>15.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>VL</td>
<td>Ta=25°C, IL=5.0mA</td>
<td>--</td>
<td>8.6</td>
<td>9.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Estimated Life of LED</td>
<td>LL</td>
<td>Ta=25°C, IL=5.0mA</td>
<td>--</td>
<td>(50,000)</td>
<td>--</td>
<td>hr</td>
<td></td>
</tr>
</tbody>
</table>

Note: - The lifetime of the LED is defined as a period till the brightness of the LED decreases to the half of its initial value.
- This figure is given as a reference purpose only, and not as a guarantee.
- This figure is estimated for an LED operating alone.
- As the performance of an LED may differ when assembled as a monitor together with a TFT panel due to different environmental temperature.
- Estimated lifetime could vary on a different temperature and usually higher temperature could reduce the life significantly.
### 7.2 AC Characteristics

#### 7.2.1 Display Module

(Unless otherwise noted, Ta=25 °C, VDD=3.0V, VSS=0V)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
<th>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
</tr>
<tr>
<td>CLK Low period</td>
<td>tw1L</td>
<td>0.1×VDD or less</td>
<td>20</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>CLK High period</td>
<td>tw1H</td>
<td>0.9×VDD or more</td>
<td>20</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Setup time 1</td>
<td>tsp1</td>
<td>10×VDD or more</td>
<td>–</td>
<td>–</td>
<td>ns</td>
</tr>
<tr>
<td>Hold time 1</td>
<td>thd1</td>
<td>10×VDD or less</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Setup time 2</td>
<td>tsp2</td>
<td>10×VDD or less</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Hold time 2</td>
<td>thd2</td>
<td>10×VDD or less</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>CLK frequency</td>
<td>fCLK</td>
<td>10×VDD or less</td>
<td>–</td>
<td>6.75</td>
<td>9.0 MHz</td>
</tr>
</tbody>
</table>

Note: The Rating value of the terminal DI/DE is effective at "MODE" = "VDD".
7.2.2 Serial Communication Block (at "MODE" = "VSS")

(Unless otherwise noted, Ta=25°C, VDD=3.0V, VSS=0V)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
<th>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS setup time</td>
<td>tsp3</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>CS/STBY</td>
</tr>
<tr>
<td>CS hold time</td>
<td>thd3</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>CS/STBY</td>
</tr>
<tr>
<td>DI setup time</td>
<td>tsp4</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>DI/DE</td>
</tr>
<tr>
<td>DI hold time</td>
<td>thd4</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>DI/DE</td>
</tr>
<tr>
<td>CS pulse High period</td>
<td>tw4H</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>CS/STBY</td>
</tr>
<tr>
<td>SCK pulse Low period</td>
<td>tw5L</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>SCK/REV</td>
</tr>
<tr>
<td>SCK pulse High period</td>
<td>tw5H</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>SCK/REV</td>
</tr>
</tbody>
</table>

Note: Unless otherwise noted, each item is defined between each 50% point of signal amplitude.
7.3 Input Timing Characteristics

7.3.1 MODE = "VSS"

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLK frequency</td>
<td>fCLK</td>
<td>--</td>
<td>6.75</td>
<td>9.0 MHz</td>
</tr>
<tr>
<td>VSYNC Frequency</td>
<td>fVSYNC</td>
<td>54</td>
<td>60</td>
<td>66 Hz</td>
</tr>
<tr>
<td>Number of Frame Line</td>
<td>tv</td>
<td>--</td>
<td>262</td>
<td>291 H</td>
</tr>
<tr>
<td>VSYNC Pulse Width</td>
<td>tw2H</td>
<td>4CLK</td>
<td>3H</td>
<td>--</td>
</tr>
<tr>
<td>Vertical Back Porch</td>
<td>tvb</td>
<td>0 Note2</td>
<td>6</td>
<td>31 H VSYNC, HSYNC, D[27:20], D[17:10], D[07:00]</td>
</tr>
<tr>
<td>Vertical Display Period</td>
<td>tvdp</td>
<td>--</td>
<td>240</td>
<td>-- H VSYNC, HSYNC, D[27:20], D[17:10], D[07:00]</td>
</tr>
<tr>
<td>HSYNC frequency</td>
<td>fHSYNC</td>
<td>--</td>
<td>15.7</td>
<td>-- kHz HSYNC</td>
</tr>
<tr>
<td>HSYNC Pulse Width</td>
<td>th</td>
<td>--</td>
<td>429</td>
<td>573 HSYNC, CLK</td>
</tr>
<tr>
<td>Horizontal Back Porch</td>
<td>tw3H</td>
<td>2CLK</td>
<td>--</td>
<td>20 μs</td>
</tr>
<tr>
<td>Horizontal Display Period</td>
<td>thdp</td>
<td>--</td>
<td>320</td>
<td>-- CLK</td>
</tr>
</tbody>
</table>

Note1: This is recommended spec to get high quality picture on display. It is customer's risk to use out of this frequency.
Note2: When Vertical Back Porch is "0", please use odd number for the setting of the total number of lines that compose one field.

7.3.2 MODE = "VDD"

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Applicable terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLK frequency</td>
<td>fCLK</td>
<td>--</td>
<td>6.75</td>
<td>9.0 MHz</td>
</tr>
<tr>
<td>VSYNC Frequency</td>
<td>fVSYNC</td>
<td>54</td>
<td>60</td>
<td>66 Hz</td>
</tr>
<tr>
<td>Number of Frame Line</td>
<td>tv</td>
<td>--</td>
<td>262</td>
<td>291 H</td>
</tr>
<tr>
<td>VSYNC Pulse Width</td>
<td>tw2H</td>
<td>4CLK</td>
<td>3H</td>
<td>--</td>
</tr>
<tr>
<td>Vertical Back Porch</td>
<td>tvb</td>
<td>0 Note2</td>
<td>6</td>
<td>21 H VSYNC, HSYNC, DE, D[27:22], D[17:12], D[07:02]</td>
</tr>
<tr>
<td>Vertical Display Period</td>
<td>tvdp</td>
<td>--</td>
<td>240</td>
<td>-- H D[17:12], D[07:02]</td>
</tr>
<tr>
<td>HSYNC frequency</td>
<td>fHSYNC</td>
<td>--</td>
<td>15.7</td>
<td>-- kHz HSYNC</td>
</tr>
<tr>
<td>HSYNC Pulse Width</td>
<td>th</td>
<td>--</td>
<td>429</td>
<td>573 HSYNC, CLK</td>
</tr>
<tr>
<td>Horizontal Back Porch</td>
<td>tw3H</td>
<td>2CLK</td>
<td>--</td>
<td>20 μs</td>
</tr>
<tr>
<td>HSYNC Cycle</td>
<td>th</td>
<td>--</td>
<td>429</td>
<td>573</td>
</tr>
<tr>
<td>Horizontal Display Period</td>
<td>thdp</td>
<td>--</td>
<td>320</td>
<td>-- CLK</td>
</tr>
</tbody>
</table>

Note1: This is recommended spec to get high quality picture on display. It is customer's risk to use out of this frequency.
Note2: When Vertical Back Porch is "0", please use odd number for the setting of the total number of lines that compose one field.
Note3: When DE keeps "Lo" for 21H and 77CLK or longer, start capturing data automatically from "22H and 78CLK".
7.4 Driving Timing Chart

- Vertical Timing

- Horizontal Timing
7.5 Example of Driving Timing Chart

7.5.1 MODE = "VSS"(fCLK=6.75MHz)

-Vertical Timing

- Horizontal Timing

D[27:20]
D[17:10]
D[07:00]

6H = VDISP
VDISP = 6

42CLK = HDISP + 3
HDISP = 39
7.5.2 MODE = "VDD"(fCLK=6.75MHz)

-Vertical Timing

- Horizontal Timing
8. Description of Operation

8.1 Power Supply

8.1.1 VDD2 Charge Pump

![VDD2 Charge Pump Diagram]

8.1.2 VGH Charge Pump

![VGH Charge Pump Diagram]

8.1.3 VGL Charge Pump

![VGL Charge Pump Diagram]

Please use ceramic capacitors with B property for external capacitors.
8.2 Serial Communication

Serial communication control block in the LCD monitor is described below. Serial communication control function is effective at "MODE" = "VSS".

8.2.1 Feature Description

Serial communication control block is consist of registers that store data entered from CS, SCK, DI terminals and DAC that outputs control voltages to each part according to the data loaded from these registers. All registers are set to initial values at power-on. Electrostatics or noises may re-set the registers to improper values. It is advisable to set up serial communication as frequently as possible as liquid crystal could degrade if such state is left untreated for a long time.

8.2.2 Serial Communication Timing

After input signal of CS drops from Hi to Lo, the Shift Resister loads 12 bits of serial data from DI at the rising edge of the input signal of SCK. Mode register and DAC register load the stored data at the rising edge of the input signal of CS. When loaded DI data during the low period of CS is less than 12 bits, all loaded data are discarded. When loaded DI data during the low period of CS is 12 bits or more, the last read of 12 bits is used. Each command is executed by VSYNC immediately after the rising edge of CS. Serial Communication Control Block is configurable at any time during display and standby mode as it is completely independent from other circuitry run by CLK in the monitor.
### 8.2.3 Serial Communication Data

Configuration of serial data for DI terminal

<table>
<thead>
<tr>
<th>Register</th>
<th>Address</th>
<th>Number of bits for data</th>
<th>Preset value</th>
<th>User setting value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRIGHT</td>
<td>0 0 0 0 0 6 (DI6-DI11)</td>
<td>- - 0 1 0 1 1 0</td>
<td>- -</td>
<td>User setting</td>
</tr>
<tr>
<td>VCOMDC</td>
<td>1 0 0 0 6 (DI6-DI11)</td>
<td>- - 1 1 1 1 1 1</td>
<td>- -</td>
<td>Optimum setting for each monitor</td>
</tr>
<tr>
<td>CONTRAST</td>
<td>0 1 0 0 4 (DI4-DI7)</td>
<td>0 1 1 1 - - - -</td>
<td>- -</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL1</td>
<td>3 (DI9-DI11)</td>
<td>- - - - 0 0 1</td>
<td>- -</td>
<td>User setting</td>
</tr>
<tr>
<td>VDISP</td>
<td>5 (DI4-DI8)</td>
<td>1 0 1 0 1 - - -</td>
<td>- -</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL2</td>
<td>3 (DI9-DI11)</td>
<td>- - - - 0 0 0</td>
<td>- -</td>
<td>User setting</td>
</tr>
<tr>
<td>HDISP</td>
<td>0 0 1 0 8 (DI4-DI11)</td>
<td>0 1 0 1 0 0 1 0</td>
<td>0 1 0 0 1 1 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL3</td>
<td>1 0 1 0 8 (DI4-DI11)</td>
<td>0 1 0 0 1 1 0</td>
<td>0 1 0 0 1 1 0</td>
<td>User setting</td>
</tr>
<tr>
<td>FUNC1</td>
<td>0 1 1 0 8 (DI4-DI11)</td>
<td>0 0 0 1 0 0 0 0</td>
<td>0</td>
<td>User setting</td>
</tr>
<tr>
<td>FUNC2</td>
<td>1 1 0 0 8 (DI4-DI11)</td>
<td>0 0 1 1 1 1 0 0</td>
<td>0 1 0 0 - -</td>
<td>User setting</td>
</tr>
<tr>
<td>FUNC3</td>
<td>0 0 0 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>FUNC4</td>
<td>0 0 0 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL4</td>
<td>0 1 0 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL5</td>
<td>1 1 0 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 1 0 0 0 0 0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL6</td>
<td>0 0 1 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL7</td>
<td>1 0 1 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL8</td>
<td>0 1 1 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
<td>User setting</td>
</tr>
<tr>
<td>PANEL9</td>
<td>1 1 1 1 8 (DI4-DI11)</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 1</td>
<td>User setting</td>
</tr>
</tbody>
</table>

**Configuration of FUNC1 Register**

<table>
<thead>
<tr>
<th>bit</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI4</td>
<td>TEST 0</td>
<td>Please fix it to &quot;0&quot;.</td>
</tr>
<tr>
<td>DI5</td>
<td>Vertical flip display</td>
<td>Flip image vertically (from top to bottom). 0: Normal, 1: Vertical flip</td>
</tr>
<tr>
<td>DI6</td>
<td>Horizontal flip display</td>
<td>Flip image horizontally (from side to side). 0: Normal, 1: Horizontally flip</td>
</tr>
<tr>
<td>DI7</td>
<td>Backlight control</td>
<td>Set BLON signal that controls external backlight circuitry. 0: Low 1: High</td>
</tr>
<tr>
<td>DI8</td>
<td>Standby control</td>
<td>Switch between standby and operation. 0: standby, 1: operation</td>
</tr>
<tr>
<td>DI9</td>
<td>TEST 1</td>
<td></td>
</tr>
<tr>
<td>DI10</td>
<td>TEST 2</td>
<td>Please fix it to &quot;0&quot;.</td>
</tr>
<tr>
<td>DI11</td>
<td>TEST 3</td>
<td></td>
</tr>
</tbody>
</table>

**Configuration of FUNC2 Register**

<table>
<thead>
<tr>
<th>bit</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI4</td>
<td>HSYNC polarity</td>
<td>Change polarity of HSYNC. 0: Positive polarity, 1: Negative polarity</td>
</tr>
<tr>
<td>DI5</td>
<td>VSYNC polarity</td>
<td>Change polarity of VSYNC. 0: Positive polarity, 1: Negative polarity</td>
</tr>
<tr>
<td>DI6</td>
<td>CLK polarity</td>
<td>Change polarity of CLK. 0: Noninversion 1: Inversion</td>
</tr>
<tr>
<td>DI7</td>
<td>TEST 4</td>
<td>Please fix to &quot;1&quot;.</td>
</tr>
<tr>
<td>DI8</td>
<td>TEST 5</td>
<td>Please fix it to &quot;0&quot;.</td>
</tr>
<tr>
<td>DI9</td>
<td>TEST 6</td>
<td></td>
</tr>
<tr>
<td>DI10</td>
<td>Unused</td>
<td>-</td>
</tr>
<tr>
<td>DI11</td>
<td>Unused</td>
<td></td>
</tr>
</tbody>
</table>
### Configuration of FUNC3 Register

<table>
<thead>
<tr>
<th>bit</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI4</td>
<td>Test 7</td>
<td>Please fix it to &quot;0&quot;.</td>
</tr>
<tr>
<td>DI5</td>
<td>Test 8</td>
<td></td>
</tr>
<tr>
<td>DI6</td>
<td>GM1[0]</td>
<td>Register for gamma potential correction when input data D[*7:*0] is 192(=C0h).</td>
</tr>
<tr>
<td>DI7</td>
<td>GM1[1]</td>
<td></td>
</tr>
<tr>
<td>DI8</td>
<td>GM1[2]</td>
<td></td>
</tr>
<tr>
<td>DI9</td>
<td>GM2[0]</td>
<td>Register for gamma potential correction when input data D[*7:*0] is 148(=94h).</td>
</tr>
<tr>
<td>DI10</td>
<td>GM2[1]</td>
<td></td>
</tr>
<tr>
<td>DI11</td>
<td>GM2[2]</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration of FUNC4 Register

<table>
<thead>
<tr>
<th>bit</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI4</td>
<td>Test 9</td>
<td>Please fix to &quot;1&quot;.</td>
</tr>
<tr>
<td>DI5</td>
<td>Select gamma correction curve</td>
<td>Select gamma correction curves. 0: built-in gamma correction curve 1: user-established gamma correction curve</td>
</tr>
<tr>
<td>DI6</td>
<td>GM3[0]</td>
<td>Register for gamma potential correction when input data D[*7:*0] is 108(=6Ch).</td>
</tr>
<tr>
<td>DI7</td>
<td>GM3[1]</td>
<td></td>
</tr>
<tr>
<td>DI8</td>
<td>GM3[2]</td>
<td></td>
</tr>
<tr>
<td>DI9</td>
<td>GM4[0]</td>
<td>Register for gamma potential correction when input data D[*7:*0] is 64(=40h).</td>
</tr>
<tr>
<td>DI10</td>
<td>GM4[1]</td>
<td></td>
</tr>
<tr>
<td>DI11</td>
<td>GM4[2]</td>
<td></td>
</tr>
</tbody>
</table>

---

**-TEST 0 to TEST 9**

Please fix DI4, DI9 through DI11 of the FUNC1 registers to "0".
Please fix DI7 of FUNC2 to "1", DI8 and DI9 of FUNC2 to "0". DI10 and DI11 are no connection.
Please fix DI4 and DI5 of FUNC3 to "0".
Please fix DI4 of FUNC4 to "1".

**-User Setting Values**

Please use "User setting values" to set up PANEL1 through PANEL9, DI4, DI9 through DI11 of FUNC1, DI7 through DI9 of FUNC2, DI4, DI5 of FUNC3 and DI4 of FUNC4.
Use of unspecified values may cause malfunction.
8.2.4 Detailed Description of Function

(1) Bright Control (BRIGHT)

Bright setting values is controlled by 6 bit (DI6 through DI11) of BRIGHT registers. The display lightens in proportion to data value while VLCD changes inversely with the data value. Initial value of BLACK[00h] is 3.73V and WHITE[FFh] is 0.55V when the CONTRAST register is Eh.

The amount of change in VLCD is 0.02V per LSB.

Recommended Operating Range
The register shall be set in 00h to 2Eh range.

<table>
<thead>
<tr>
<th>BRIGHT[5:0]</th>
<th>VLCD(BLACK)</th>
<th>VLCD(WHITE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00h</td>
<td>4.25V</td>
<td>1.07V</td>
</tr>
<tr>
<td>01h</td>
<td>4.23V</td>
<td>1.05V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>1Ah</td>
<td>3.73V</td>
<td>0.55V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>2Dh</td>
<td>3.35V</td>
<td>0.17V</td>
</tr>
<tr>
<td>2Eh</td>
<td>3.33V</td>
<td>0.15V</td>
</tr>
</tbody>
</table>

(2) Common Electrode Center Voltage (VCOMDC)

Common-electrode center voltage is controlled by 6-bit (DI6 through DI11). The voltage is proportional to data values. Each TFT monitor has to be optimized to its own optimum value separately. This optimization is mandatory. If not implemented, liquid crystal of TFT monitor will be degraded by long operation.

Initial value of VCOMDC is 2.30V.

Recommended Operating Range
Since VCOMDC has its optimum value somewhere between 1.18V and 2.18V, the register should be set in 07h to 39h range.

<table>
<thead>
<tr>
<th>VCOMDC[5:0]</th>
<th>VCOMDC (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00h</td>
<td>1.04V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>06h</td>
<td>1.16V</td>
</tr>
<tr>
<td>07h</td>
<td>1.18V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>39h</td>
<td>2.18V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>3Fh</td>
<td>2.30V</td>
</tr>
</tbody>
</table>
(3) Contrast Control (CONTRAST)

Contrast is controlled in 16 levels by 4-bit (DI4 through DI7) CONTRAST register.
Contrast is proportional to data values.
Contrast does not affect aforementioned bright control.

Initial value of Contrast is 3.18V.
Amount of change in contrast is 0.12V per LSB.

<table>
<thead>
<tr>
<th>CONTRAST[3:0]</th>
<th>VLCD(BLACK)-VLCD(WHITE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0h</td>
<td>1.50V</td>
</tr>
<tr>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>Eh</td>
<td>3.18V</td>
</tr>
<tr>
<td>Fh</td>
<td>3.30V</td>
</tr>
</tbody>
</table>

(4) Panel Setting 1 (PANEL 1)

PANEL 1 register 3-bit (DI9 and DI11) can select operating conditions from 8 choices.
Please set this register to these values.

<table>
<thead>
<tr>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
(5) Vertical Flyback Time Set (VDISP)

The length of vertical flyback period can be set from 0 to 31H by 5-bit of DI4 through DI8 of VDISP register. When VSYNC and HSYNC are negative polarity, "Lo" period of VSYNC is detected at the rising edge of HSYNC. The setting value of VDISP is determined by the number of horizontal periods from the first detection of VSYNC=Lo to the first line's display data input. Please set VDISP=1 as shown in "Example 1" even if the display data of the first line is input.

When the pulse width of VSYNC extends over two or more H as shown in "Example 3", the setting value is determined by the number of horizontal periods from the first detection of VSYNC=Lo to the first line's display data input. When the initial value is "0", the first line's display data needs to be inputted immediately after VSYNC as shown in "Example 4".

When VDISP=0, please use odd number for the setting of the total number of lines that compose one field. This function can also be used for vertical display range setup (Vertical position setup).

Example 1 : VDISP=1(01h)

Example 2 : VDISP=1(01h)

Example 3 : VDISP=3(03h)

Example 4 : VDISP=0(00h)
(6) Panel Setting 2 (PANEL2)

PANEL 2 register 3-bit (DI9 and DI11) can select operating conditions from 8 choices.
Please set this register to these values.

<table>
<thead>
<tr>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(7) Horizontal Flyback Period Setting (HDISP)

Horizontal flyback time can be set from 5 to 258CLK by HDISP register with 8-bit of DI14 thru DI11.
However, set value of 0 or 1 is prohibited. Actual flyback time is "setting value plus 3CLK".
When initial value is 74, a data after a lapse of 74 + 3CLK=77CLK from the rising edge of HSYNC is displayed
as shown in the following chart.

This function can also be used for horizontal display range setup (Horizontal position setup).

Example : HDISP=74(4Ah)

```
<table>
<thead>
<tr>
<th>HSYNC</th>
<th>CLK</th>
<th>D[27:20]</th>
<th>D[17:10]</th>
<th>D[07:00]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Valid data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

(8) Panel Setting 3 (PANEL3)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11
of PANEL 3 register.
Please set this register to these values.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
(9) Function Set 1 (FUNC1)

FUNC1 register sets and controls the following functions by its each bit of DI5,DI6,DI7 and di8.

- **Vertical Flip Display (Up/Down)**
  DI5=0 for normal display, DI5=1 for vertical flip display
  After completing the setup by serial communication, the selected display mode is carried out by VSYNC.
  (Normal display is defined when FPC of the monitor is place downside.)

- **Horizontal Flip Display (Right/Left)**
  DI6=0 for normal display, DI6=1 for horizontal flip display
  The selected display mode is executed at VSYNC after setup by serial communication.

  (Please refer to the section 8.3 for Display Data Transfer)

- **Backlight Control**
  DI7 switches the backlight driver IC. BLON terminal outputs set value of DI7.
  Since its output level is VDD or VSS, this function can also be used for other controls than the backlight.
  After completing the setup by serial communication, the selected display mode is carried out by VSYNC.

- **Standby Mode**
  DI8=0 for standby mode, DI8=1 for normal operation
  Since default value of DI8 after power on is "0", it automatically goes to standby mode.
  Power consumption is significantly reduced in standby mode by disabling the timing generator and
  the LCD driving circuitry, and disconnecting current lines.
  No image is displayed (white raster display) during standby mode unless DI8 is set to 1 for normal operation
  by serial communication. Serial data can be received by serial communication block even in standby mode.
  Please refer to the section 8.4 "Standby (Power save) Sequence" for standby mode and power on/off sequence.
  When normal operation is switched to standby mode, afterimage treatment is carried out before switching
  to standby mode.
(10) Function Set 2 (FUNC2)

FUNC2 register sets and controls the following functions by its each bit of DI4 thru DI6.

- HSYNC, VSYNC, CLK Polarity Switching
  Polarity of HSYNC is switched by DI4. DI4=0 for positive polarity input, DI4=1 for negative polarity input.
  Polarity of VSYNC is switched by DI5. DI5=0 for positive polarity input, DI5=1 for negative polarity input.
  Polarity of CLK is switched by DI6. DI6=0 for non-inversion, DI6=1 for inversion.

Initial value of DI4, DI5 and DI6 are "1". The following chart shows polarity of each signal at the initial value.
Please set change of VSYNC, HSYNC and display data at the rising edge of CLK.

```
VSYNC
HSYNC
CLK
D[27:20]
D[17:10]
D[07:00]
```

Polarity of each signal can be changed independently by logic of DI4, DI5 and DI6.

Example 1: DI4=0, DI5=1, DI6=1 (HSYNC has positive polarity and Hi active)

```
VSYNC
HSYNC
CLK
D[27:20]
D[17:10]
D[07:00]
```

Example 2: DI4=1, DI5=0, DI6=1 (VSYNC has positive polarity and Hi active)

```
VSYNC
HSYNC
CLK
D[27:20]
D[17:10]
D[07:00]
```

Example 3: DI4=DI5=1, DI6=0 (CLK is reversed, data is read at the rising edge of CLK.)

```
VSYNC
HSYNC
CLK
D[27:20]
D[17:10]
D[07:00]
```
(11) Function Set 3, 4 (FUNC 3, 4)

- Gamma Curve Correction Select

DI5=0 of FUNC 4 Register:
Deactivate user configurable gamma correction circuitry.
Use built-in gamma curve.

DI5=1 of FUNC 4 Register:
Activate user configurable gamma correction circuitry.
Use user configurable gamma correction curve.

- Setting Method of User Configurable Gamma Correction Curve

GM1 thru GM4 corrects each following gamma potential respectively.

\[
\begin{align*}
&\text{GM1}[2:0] \rightarrow \text{Input data D[7:0]} = \text{Register for gamma potential correction at 192(=C0h)} \\
&\text{GM2}[2:0] \rightarrow \text{Input data D[7:0]} = \text{Register for gamma potential correction at 148(=94h)} \\
&\text{GM3}[2:0] \rightarrow \text{Input data D[7:0]} = \text{Register for gamma potential correction at 108(=6Ch)} \\
&\text{GM4}[2:0] \rightarrow \text{Input data D[7:0]} = \text{Register for gamma potential correction at 64(=40h)}
\end{align*}
\]

Below chart shows characteristic curve of gray scale input data - liquid crystal applied voltage.
Input value of "0" is assumed to be 0% of applied voltage to liquid crystal, and input value of "225" is assumed to be 100% of applied voltage to liquid crystal. Adjustable range of GM1 thru GM4 registers are described below.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>00h</td>
<td>No correction</td>
<td>No correction</td>
<td>No correction</td>
<td>No correction</td>
</tr>
<tr>
<td>01h</td>
<td>54.5%</td>
<td>66.7%</td>
<td>75.8%</td>
<td>84.8%</td>
</tr>
<tr>
<td>02h</td>
<td>51.5%</td>
<td>63.6%</td>
<td>72.7%</td>
<td>81.8%</td>
</tr>
<tr>
<td>03h</td>
<td>48.5%</td>
<td>60.6%</td>
<td>69.7%</td>
<td>78.8%</td>
</tr>
<tr>
<td>04h</td>
<td>45.5%</td>
<td>57.6%</td>
<td>66.7%</td>
<td>75.6%</td>
</tr>
<tr>
<td>05h</td>
<td>42.4%</td>
<td>54.5%</td>
<td>63.6%</td>
<td>72.7%</td>
</tr>
<tr>
<td>06h</td>
<td>39.4%</td>
<td>51.5%</td>
<td>60.6%</td>
<td>69.7%</td>
</tr>
<tr>
<td>07h</td>
<td>36.4%</td>
<td>48.5%</td>
<td>57.6%</td>
<td>66.7%</td>
</tr>
</tbody>
</table>

This follows resistance split ratio of built-in gamma curve in the range of 0 to 255, and 0% to 100% of voltage.
When no correction is made to gamma potential of GM1 to GM4;
The voltages at "0" and "255" are fixed in accordance with the contrast and brightness settings,
and voltages at 1 to 254 are determined by resister split ratio produced by the driver IC built-in gamma curve resister.
(Refer to the chart in previous page)
Liquid crystal applied voltage takes the values of 45.7%, 58.5%, 66.4% and 74.8% when input date is
64, 108, 148 and 192 respectively.

When correction is made to any of GM1 to GM4 by user;
The voltage is corrected in accordance with a correction point and its set value configured by user.
The voltages at 1 to 254 are determined by resister split ratio between voltage at 0 and 225 and input data.

Example:
Darken gray scale in black side.
→ Change liquid crystal applied voltage at the 64 point to darken side.
(12) Panel Select 4 (PANEL 4)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 4 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(13) Panel Select 5 (PANEL 5)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 5 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(14) Panel Select 6 (PANEL 6)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 6 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(15) Panel Select 7 (PANEL 7)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 7 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(16) Panel Select 8 (PANEL 8)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 8 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(17) Panel Select 9 (PANEL 9)

Select operating condition of the signal generated by driver IC in accordance with 8-bit of DI4 to DI11 of PANEL 9 register. Please set this register to this value.

<table>
<thead>
<tr>
<th>DI4</th>
<th>DI5</th>
<th>DI6</th>
<th>DI7</th>
<th>DI8</th>
<th>DI9</th>
<th>DI10</th>
<th>DI11</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
8.3 Display Data Transfer

Input display data to D[27:20], D[17:10], D[07:00]. D*0: LSB, D*7: MSB

- Horizontal Timing and Order of Input Data

Display data shall be input in synchronization with CLK. Polarity of CLK can be selected by DI16 of FUNCTION SET 2 (FUNC2). (at "MODE" = "VSS")

Normal display: Normal display is defined as the orientation that the FPC cable on the TFT monitor is placed on the downside.

* Above timing chart shows correlation between input data and pixels in visual way and it is not actual timing chart.

- Vertical Timing and Order of Input Data

Transfer of display data that consist of 240 lines in 1 field is explained below. The correlations between input line and display line at normal display and vertical flip display are described below.

Normal display: Normal display is defined as the orientation that the FPC cable on the TFT monitor is placed on the downside.

* Above timing chart shows correlation between input data and pixels in visual way and it is not actual timing chart.
8.4 Standby (Power Save) Sequence

When "MODE" = "VSS", serial communication signals of CS, DI and SCK shall be input after VDD stabilizes at 
\[ VDD \geq 0.9 \times VDD \] for more than 20 msec or more after power on.
All initial values of serial data shall be set during this standby mode.
Other logic input signals of HSYNC, VSYNC, D[27:20], D[17:10], D[07:00] and CLK shall be input simultaneously 
after power on (specified period marked ① in next page). All input signals shall be set to a fixed DC to 
reduce power consumption during standby mode.

Please follow the recommended power on/off sequence described below.

① Right after power on, serial communication registers are initialized.
Therefore, standby control bit takes the value of "0".
By this procedure the LCD goes into standby mode which significantly reduces power consumption of the LCD.
No image is displayed (white raster display) on the screen and internal power circuit is deactivated 
during standby mode.
Sync signal and display data (HSYNC, VSYNC, D[27:20], D[17:10], D[07:00], CLK) start to input before standby mode 
is released by serial communication.

② When the standby control bit is set to "1" by serial communication or the terminal "STBY" turn to "Lo" from "Hi",
the standby mode is released by following VSYNC and the power supply circuit of building into begins operating.
No image is displayed (white raster display) on the screen for 5 fields from the following VSYNC 
after the release of standby mode.

③ LCD goes into normal display (display under normal operation) at the timing of VSYNC after completion 
of the procedure described in ②. Backlight shall be lit up 1 or more field after going to normal display.

④ Standby mode can be established by setting standby control bit to "0" by serial communication or 
the terminal "STBY" turn to "Hi" from "Lo".
Display data is changed to FFh at VSYNC that comes right after this serial communication, 
and afterimage treatment is performed for 2 fields of VSYNC. Displayed image under normal display is 
immediately changed to white raster display by this treatment.
Continue to input sync signal (HSYNC, VSYNC, CLK) during this period.

⑤ LCD goes into standby mode, which is same as ① above, at the timing of VSYNC after completion 
of the procedure described in ④. Serial communication data is retained during standby mode.
Serial communication signal and input signal can be deactivated.

② to ④ repeats same procedures as described above.

Below procedure must be followed for power-off.

① Implement standby setting.
② After standby setting, continue to input sync signals (HSYNC, VSYNC, CLK) during 
the image treatment period (until VSYNC after 2 fields subsequent to standby setting).
③ After ②, power off VDD after 30msec or more.
④ Stop the sync signals (HSYNC, VSYNC, CLK) subsequent to afterimage treatment period and no later than VDD off.
Note 1: Power off VDD more than 30 msec after VSYNC that arrives 2 fields from standby set.

Note 2: Input CLK during the period of inputting sync signals (HSYNC, VSYNC) and display data D[27:20], D[17:10], D[07:00], CLK, CS, DI, SCK) (Note 2)

Note 3: Due consideration needs to be given to power supply capacity as bigger current (inrush current) flows at standby release.

Note 4: Serial communication signals should be input after VDD stabilizes at VDD > [0.9 x VDD] V for more than 20 msec. And initial values of all serial data should be set during this period before standby release.

Note 5: Backlight should be turned on after 5 field from starting display. Backlight should be turned off before standby is set.

Voltage values shown in this chart are typical values, not fixed values.
8.5 Power On Sequence

There is the following limit between a power on period and the serial communication setting.

Power-on-clear circuit diagram

POCB terminal is connected to VDD through the pull-up resistor (Rpu). When rising of VDD takes long time, POCB will have unstable and unpredictable waveform. Please determine value of external capacitor by which POCB takes 1.107 V or less at VDD is 2.7V.

Serial Communication Prohibition Period

Power on

Standby period

Standby Release

VDD

POCB

Power-on-clear signal

(POC)

CLK, HSYNC, VSYNC,
D[27:20], D[17:10], D[07:00]

CS, DI, SCK

Serial communication prohibit period (20ms)

Note 1: All logic input signals are ignored during input period (POC is Hi).

Note 2: Serial communication signals shall be input after VDD stabilizes at VDD ≥ [0.9×VDD]V for more than 20 msec or more after power on.
In case of rapid startup after power-on, directly control POCB terminal.

Power-on-clear circuit diagram

In case of directly controlling POCB terminal, POCB terminal should be set to "Lo" at Power-on. POCB should be changed to "Hi" after VDD is exceeding 2.7V. Serial communication is prohibited while POCB is "Lo".
8.6 Other Functions

- Built-in Panel Residual Charge Reduction Circuit
  When the power turns off in accordance with the mandatory procedure described in the section
  "8.4 Standby (Power save) Sequence", afterimage treatment is carried out after standby mode is set.
  This circuit automatically reduces panel's residual charge and prevents afterimage for a long time
  even if standby mode setting fails to be made before power-off.
9. Circuit

9.1 Driving Circuit Example(Module) ["MODE" = "VSS"]

This circuit is solely for reference purpose and optimum circuit and components values may be different. User's due consideration and evaluation must be given to this circuit design and component values prior to their intended use.

TFT LCD MODULE REFERENCE CIRCUIT

ORTUS TECHNOLOGY CO., LTD.
9.2 Driving Circuit Example(Module) ["MODE" = "VDD"]

This circuit is solely for reference purpose and optimum circuit and components values may be different. User's due consideration and evaluation must be given to this circuit design and component values prior to their intended use.

ORTUS TECHNOLOGY CO., LTD.
9.3 LED Circuit
10. Characteristics

10.1 Optical Characteristics

< Measurement Condition >

- Measuring instruments: CS1000 (KONICA MINOLTA), LCD7000 (OTSUKA ELECTRONICS), EZcontrast160D (ELDIM)
- Driving condition: VDD = 3.0V, VSS = 0V, Optimized VCOMDC
- Backlight: IL = 5.0mA
- Measured temperature: Ta = 25°C

### Table: 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>Note No.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise time</td>
<td>TON</td>
<td>VLCD = 0.69V → 3.87V</td>
<td>—</td>
<td>—</td>
<td>40</td>
<td>ms</td>
<td>1</td>
<td>※</td>
</tr>
<tr>
<td>Fall time</td>
<td>TOFF</td>
<td>VLCD = 3.87V → 0.69V</td>
<td>—</td>
<td>—</td>
<td>60</td>
<td>ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>Backlight ON</td>
<td>CR</td>
<td>VLCD = 3.87V / 0.69V</td>
<td>240</td>
<td>400</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Backlight OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viewing angle</td>
<td>Left</td>
<td>δL</td>
<td>VLCD = 3.87V / 0.69V</td>
<td>40</td>
<td>—</td>
<td>—</td>
<td>deg</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>δR</td>
<td></td>
<td>40</td>
<td>—</td>
<td>—</td>
<td>deg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up</td>
<td>δU</td>
<td>CR ≥ 10</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>deg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Down</td>
<td>δD</td>
<td></td>
<td>45</td>
<td>—</td>
<td>—</td>
<td>deg</td>
<td></td>
</tr>
<tr>
<td>V-T threshold voltage</td>
<td>V90</td>
<td></td>
<td></td>
<td>0.9</td>
<td>1.2</td>
<td>1.5</td>
<td>V</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>V50</td>
<td></td>
<td></td>
<td>1.4</td>
<td>1.7</td>
<td>2.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V10</td>
<td></td>
<td></td>
<td>2.0</td>
<td>2.3</td>
<td>2.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>White V-T Curve</td>
<td></td>
<td></td>
<td></td>
<td>White V-T Curve</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Chromaticity</td>
<td>x</td>
<td>VLCD = 0.69V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Contrast angle</td>
<td>CRφ</td>
<td></td>
<td>-10</td>
<td>-3</td>
<td>4</td>
<td>deg</td>
<td>6</td>
<td>Downward ※</td>
</tr>
<tr>
<td>Burn-in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Center brightness</td>
<td>VLCD = 0.69V</td>
<td></td>
<td>210</td>
<td>300</td>
<td>—</td>
<td>cd/m²</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Brightness distribution</td>
<td>VLCD = 0.69V</td>
<td></td>
<td>70</td>
<td>—</td>
<td>—</td>
<td>%</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

* Note number 1 to 9: Refer to the APPENDIX of "Reference Method for Measuring Optical Characteristics".

※ Measured in the form of LCD module.

---

**Graph:**

White V-T characteristics

- Transmittance [%] vs. VLCD [V]

**Legend:**

- White V-T Curve
- Reference Method for Measuring Optical Characteristics

ORATUS TECHNOLOGY CO., LTD.
10.2 Temperature Characteristics

< Measurement Condition >
Measuring instruments: CS1000 (KONICA MINOLTA), LCD7000 (OTSUKA ELECTRONICS)
Driving condition: VDD = 3.0V, VSS = 0V
Optimized VCOMDC
VLCD = \(| V_{\text{sigpp}} + V_{\text{compp}} | / 2\)
Backlight: IL = 5.0mA

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Ta = −10°C</th>
<th>Ta = 70°C</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast ratio</td>
<td>CR</td>
<td>40 or more</td>
<td>40 or more</td>
<td>Backlight ON</td>
</tr>
<tr>
<td>Response time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>TON</td>
<td>200 msec or less</td>
<td>30 msec or less</td>
<td>*</td>
</tr>
<tr>
<td>Fall time</td>
<td>TOFF</td>
<td>300 msec or less</td>
<td>50 msec or less</td>
<td>*</td>
</tr>
<tr>
<td>Display Quality</td>
<td>No noticeable display defect or ununiformity should be observed.</td>
<td>Use the criteria for judgment specified in the section 11.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Measured in the form of LCD module.
11. Criteria of Judgment

11.1 Defective Display and Screen Quality

Test Condition: Observed TFT-LCD monitor from front during operation with the following conditions
Driving Signal: Raster Patter (RGB in monochrome, white, black)
Signal condition: VLCD: 0.69V, 1.65V, 3.87V (3steps)
Observation distance: 30 cm
Illuminance: 200 to 350 lx
Backlight: IL=5.0mA

<table>
<thead>
<tr>
<th>Defect item</th>
<th>Defect content</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line defect</td>
<td>Black, white or color line, 3 or more neighboring defective dots</td>
<td>Not exists</td>
</tr>
<tr>
<td>Dot defect</td>
<td>Uneven brightness on dot-by-dot base due to defective TFT or CF, or dust is counted as dot defect (brighter dot, darker dot)</td>
<td>Refer to table 1</td>
</tr>
<tr>
<td></td>
<td>High bright dot: Visible through 2% ND filter at VLCD=3.87V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low bright dot: Visible through 5% ND filter at VLCD=3.87V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dark dot: Appear dark through white display at VLCD=1.65V</td>
<td></td>
</tr>
<tr>
<td>Dirt</td>
<td>Point-like uneven brightness (white stain, black stain etc)</td>
<td>Invisible through 1% ND filter</td>
</tr>
<tr>
<td>Foreign particle</td>
<td>Point-like</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.25mm&lt;φ</td>
<td>N=0</td>
</tr>
<tr>
<td></td>
<td>0.20&lt;φ≤0.25mm</td>
<td>N≤2</td>
</tr>
<tr>
<td></td>
<td>φ≤0.20mm</td>
<td>Ignored</td>
</tr>
<tr>
<td>Liner</td>
<td>3.0mm&lt;length and 0.08mm&lt;width</td>
<td>N=0</td>
</tr>
<tr>
<td></td>
<td>length≤3.0mm or width≤0.08mm</td>
<td>Ignored</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>Use boundary sample for judgment when necessary</td>
</tr>
</tbody>
</table>

Table 1

<table>
<thead>
<tr>
<th>Area</th>
<th>High bright dot</th>
<th>Low bright dot</th>
<th>Dark dot</th>
<th>Total</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>Permissible distance between same color bright dots (includes neighboring dots): 3 mm or more</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>Permissible distance between same color high bright dots (includes neighboring dots): 5 mm or more</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<Landscape model>

Division of A and B areas
- B area: Active area
- Dimensional ratio between A and B areas: 1: 4: 1
(Refer to the left figure)
11.2 Screen and Other Appearance

Testing conditions

<table>
<thead>
<tr>
<th>Observation distance</th>
<th>30cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminance</td>
<td>1200~2000 lx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Criteria</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarizer</td>
<td>Flaw: Ignore invisible defect when the backlight is on.</td>
<td>Applicable area: Active area only (Refer to the section 3.2 &quot;Outward form&quot;)</td>
</tr>
<tr>
<td></td>
<td>Stain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bubble</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dent</td>
<td></td>
</tr>
<tr>
<td>S-case</td>
<td>No functional defect occurs</td>
<td></td>
</tr>
<tr>
<td>FPC cable</td>
<td>No functional defect occurs</td>
<td></td>
</tr>
</tbody>
</table>
# 12. Reliability Test

<table>
<thead>
<tr>
<th>Test item</th>
<th>Test condition</th>
<th>number of failures / number of examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Durability test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High temperature storage</td>
<td>Ta=80°C</td>
<td>240H</td>
</tr>
<tr>
<td>Low temperature storage</td>
<td>Ta=-30°C</td>
<td>240H</td>
</tr>
<tr>
<td>High temperature &amp; high humidity storage</td>
<td>Ta=60°C, RH=90% non condensing</td>
<td>240H</td>
</tr>
<tr>
<td>High temperature operation</td>
<td>Tp=70°C</td>
<td>240H</td>
</tr>
<tr>
<td>Low temperature operation</td>
<td>Tp=-20°C</td>
<td>240H</td>
</tr>
<tr>
<td>High temp &amp; humid operation</td>
<td>Tp=40°C, RH=90% non condensing</td>
<td>240H</td>
</tr>
<tr>
<td>Thermal shock storage</td>
<td>-30→→→80°C(30min/30min)</td>
<td>100 cycles</td>
</tr>
<tr>
<td>Electrostatic discharge test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Non operation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C=200pF, R=0Ω, V=±200V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each 3 times of discharge on and power supply and other terminals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface discharge test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Non operation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C=250pF, R=100Ω, V=±12kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each 5 times of discharge in both polarities on the center of screen with the case grounded.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPC tension test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull the FPC with the force of 3N for 10 sec. in the direction - 90-degree to its original direction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPC bend test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull the FPC with the force of 3N for 10 sec. in the direction -180-degree to its original direction. Reciprocate it 3 times.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total amplitude 1.5mm, f=10~55Hz, X,Y,Z directions for each 2 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use ORTUS TECHNOLOGY original jig (see next page) and make an impact with peak acceleration of 1000m/s² for 6 msec with half sine-curve at 3 times to each X, Y, Z directions in conformance with JIS 60068-2-27-1995.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packing test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packing vibration-proof test</td>
<td>Acceleration of 19.6m/s² with frequency of 10→55→10Hz, X,Y,Z direction for each 30 minutes</td>
<td></td>
</tr>
<tr>
<td>Packing drop test</td>
<td>Drop from 75cm high. 1 time to each 6 surfaces, 3 edges, 1 corner</td>
<td></td>
</tr>
</tbody>
</table>

Note: Ta=ambient temperature  Tp=Panel temperature

※ The profile of high temperature/humidity storage and High Temperature/humidity operation 
(Pure water of over 10MΩ·cm shall be used.)

---

**Diagram:**

- Storage: 60°C operation: 40°C
- 25°C ordinary temperature
- Relative humidity
- 90%RH
- 75%RH
- 60%RH
- Ordinary humidity

---

ORTUS TECHNOLOGY CO., LTD.
Table 2. Reliability Criteria

Measure the parameters after leaving the monitor at the ordinary temperature for 24 hours or more after the test completion.

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display quality</td>
<td>No visible abnormality shall be seen.</td>
<td></td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>40 or more</td>
<td>Backlight ON</td>
</tr>
</tbody>
</table>

ORTUS TECHNOLOGY Original Jig

Tension Test Method for FPC cable

Bend Test Method for FPC cable

ORTUS TECHNOLOGY CO., LTD.
13. Packing Specifications

Step 1. Each product is to be placed in one of the cut-outs of the tray with the display surface facing downward. (20 products per tray)

Step 2. Each tray is to be piled up in same orientation and the trays in a stack of 10. One empty tray is to be put on the top of stack of 10 trays.

Step 3. 2 packs of moisture absorbers are to be placed on the top tray as shown in the drawing. Put piled trays into a sealing bag. Vacuum and seal the sealing bag with the vacuum sealing machine.

Step 4. The stack of trays in the plastic back is to be inserted into an inner carton.

Step 5. A corrugated board is to be placed on the top and on the bottom of the inner carton. The two corrugated boards and the inner carton is to be inserted into an outer carton.

Step 6. The outer carton needs to be sealed with packing tape as shown in the drawing. The model number, quantity of products, and shipping date are to be printed on the outer carton. If necessary, shipping labels or impression markings are to be put on the outer carton.

Step 7. The outer carton is to be inserted into an extra outer carton with same direction. The extra outer carton needs to be sealed with packing tape as shown in the drawing.

Step 8. The model number, quantity of products, and shipping date are to be printed on the extra outer carton. If necessary, shipping labels or impression markings are to be put on the extra outer carton.

Remark: The return of packing materials is not required.

<table>
<thead>
<tr>
<th>Packing item name</th>
<th>Specs., Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Tray</td>
<td>A-PET</td>
</tr>
<tr>
<td>② Sealing bag</td>
<td></td>
</tr>
<tr>
<td>③ Inner carton</td>
<td>Corrugated cardboard</td>
</tr>
<tr>
<td>④ Inner board</td>
<td>Corrugated cardboard</td>
</tr>
<tr>
<td>⑤ Outer carton</td>
<td>Corrugated cardboard</td>
</tr>
<tr>
<td>⑥ Drier</td>
<td>Moisture absorber</td>
</tr>
<tr>
<td>⑦ Packing tape</td>
<td></td>
</tr>
<tr>
<td>⑧ Extra outer carton</td>
<td>Corrugated cardboard</td>
</tr>
</tbody>
</table>

Dimension of extra outer carton
- D : Approx. (338 mm)
- W : Approx. (549 mm)
- H : Approx. (198 mm)

Quantity of products packed in one carton: 200
Gross weight : Approx. 6.7Kg
14. Handling Instruction
14.1 Cautions for Handling LCD panels

<table>
<thead>
<tr>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Do not make an impact on the LCD panel glass because it may break and you may get injured from it.</td>
</tr>
<tr>
<td>(2) If the glass breaks, do not touch it with bare hands. Fragment of broken glass may stick you or you cut yourself on it.</td>
</tr>
<tr>
<td>(3) If you get injured, receive adequate first aid and consult a medical doctor.</td>
</tr>
<tr>
<td>(4) Do not let liquid crystal get into your mouth. If the LCD panel glass breaks, try not let liquid crystal get into your mouth even though no toxic property of liquid crystal has been confirmed.</td>
</tr>
<tr>
<td>(5) If liquid crystal adheres, rinse it out thoroughly. If liquid crystal adheres to your cloth or skin, wipe it off with rubbing alcohol or wash it thoroughly with soap. If liquid crystal gets into eyes, rinse it with clean water for at least 15 minutes and consult an eye doctor.</td>
</tr>
<tr>
<td>(6) If you scrap this product, follow a disposal standard of industrial waste that is legally valid in the community, country or territory where you reside.</td>
</tr>
<tr>
<td>(7) Do not connect or disconnect this product while its application products is powered on.</td>
</tr>
<tr>
<td>(8) Do not attempt to disassemble or modify this product as it is precision component.</td>
</tr>
<tr>
<td>(9) If a part of soldering part has been exposed, and avoid contact (short-circuit) with a metallic part of the case etc. about FPC of this model, please. Please insulate it with the insulating tape etc. if necessary. The defective operation is caused, and there is a possibility to generation of heat and the ignition.</td>
</tr>
<tr>
<td>(10) Since excess current protection circuit is not built in this TFT module, there is the possibility that LCD module or peripheral circuit become feverish and burned in case abnormal operation is generated. We recommend you to add excess current protection circuit to power supply.</td>
</tr>
</tbody>
</table>

This mark is used to indicate a precaution or an instruction which, if not correctly observed, may result in bodily injury, or material damages alone.
14.2 Precautions for Handling

1) Wear finger tips at incoming inspection and for handling the TFT monitors to keep display quality and keep the working area clean.
   Do not touch the surface of the monitor as it is easily scratched.

2) Wear grounded wrist-straps and use electrostatic neutralization blowers to prevent static charge and discharge when handling the TFT monitors as the LED in this TFT monitors is damageable to electrostatic discharge.
   Properly set up equipment, jigs and machines, and keep working area clean and tidy for handling the TFT monitors.

3) Avoid strong mechanical shock including knocking, hitting or dropping to the TFT monitors for protecting their glass parts. Do not use the TFT monitors that have been experienced dropping or strong mechanical shock.

4) Do not use or storage the TFT monitors at high temperature and high humidity environment.
   Particularly, never use or storage the TFT monitors at a location where condensation builds up.

5) Avoid using and storing TFT monitors at a location where they are exposed to direct sunlight or ultraviolet rays to prevent the LCD panels from deterioration by ultraviolet rays.

6) Do not stain or damage the contacts of the FPC cable. Otherwise, it may cause poor contact or deteriorate reliability of the FPC cable.

7) Do not bend or pull the FPC cable or carry the TFT monitor by holding the FPC cable.

8) Peel off the protective film on the TFT monitors during mounting process.
   Refer to the section 14.5 on how to peel off the protective film.
   We are not responsible for electrostatic discharge failures or other defects occur when peeling off the protective film.

14.3 Precautions for Operation

1) Since this TFT monitors are not equipped with light shielding for the driver IC, do not expose the driver IC to strong lights during operation as it may cause functional failures.

2) When turning off the power, turn off the input signal before or at the same timing of switching off the power.

3) Optimize VCOMDC within recommended operating conditions.
   * When VCOMDC is not an optimal value, flicker and image sticking will be occurred.

4) Do not plug in or out the FPC cable while power supply is switch on.
   Plug the FPC cable in and out while power supply is switched off.

5) Do not operate the TFT monitors in the strong magnetic field. It may break the TFT monitors.

6) Do not display a fixed image on the screen for a long time.
   Use a screen-saver or other measures to avoid a fixed image displayed on the screen for a long time. Otherwise, it may cause burn-in image on the screen due the characteristics of liquid crystal.
14.4 Storage Condition for Shipping Cartons

Storage environment

- Temperature 0 to 40°C
- Humidity 60%RH or less
  - No-condensing occurs under low temperature with high humidity condition.
- Atmosphere No poisonous gas that can erode electronic components and/or wiring materials should be detected.
- Time period 3 months
- Unpacking To prevent damages caused by static electricity, anti-static precautionary measures (e.g. earthing, anti-static mat) should be implemented.
- Maximum piling up 7 cartons

14.5 Precautions for Peeling off the Protective film

The followings work environment and work method are recommended to prevent the TFT monitors from static damage or adhesion of dust when peeling off the protective films.

A) Work Environment
a) Humidity: 50 to 70 %RH, Temperature 15 to 27°C
b) Operators should wear conductive shoes, conductive clothes, conductive finger tips and grounded wrist-straps. Anti-static treatment should be implemented to work area's floor.
c) Use a room shielded against outside dust with sticky floor mat laid at the entrance to eliminate dirt.

B) Work Method
The following procedures should taken to prevent the driver ICs from charging and discharging.
a) Use an electrostatic neutralization blower to blow air on the TFT monitors to its lower left when the FPC cable is facing to the downside.
  - Optimize direction of the blowing air and the distance between the TFT monitors and the electrostatic neutralization blower.
b) Put an adhesive tape (Scotch tape, etc) at the lower left corner area of the protective film to prevent scratch on surface of TFT monitors.
c) Peel off the adhesive tape slowly (spending more than 2 secs to complete) by pulling it to opposite direction.

Direction of blowing air
- Optimize air direction and the distance
APPENDIX
Reference Method for Measuring Optical Characteristics and Performance

1. Measurement Condition (Backlight ON)
Measuring instruments: CS1000 (KONICA MINOLTA), LCD7000 (OTSUKA ELECTRONICS), EZcontrast160D (ELDIM)
Driving condition: Refer to the section "Optical Characteristics"
Measured temperature: 25°C unless specified
Measurement system: See the chart below. The luminance meter is placed on the normal line of measurement system.
Measurement point: At the center of the screen unless otherwise specified

Dark box at constant temperature

![Diagram showing measurement setup]

Measurement is made after 30 minutes of lighting of the backlight.
Measurement point: At the center point of the screen
Brightness distribution: 9 points shown in the following drawing.

<Landscape model>

![Diagram showing brightness distribution]

Dimensional ratio of active area

Backlight IL=5.0mA
Measurement Condition (Contrast ratio Backlight OFF only)
- Measuring instruments: LCD7000 (OTSUKA ELECTRONICS), Ring Light (40,000 lx, φ58)
- Driving condition: Refer to the section "Optical Characteristics"
- Measured temperature: 25°C unless specified
- Measurement system: See the chart below.
- Measurement point: At the center of the screen.

---

![Diagram showing measurement setup]

- Luminance meter
- Ring Light (φ58)
- TFT monitor
- 300mm distance
- 80mm distance
- 20° angle
## 2. Test Method

<table>
<thead>
<tr>
<th>Notice</th>
<th>Item</th>
<th>Test method</th>
<th>Measuring instrument</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Response time</td>
<td>Measure output signal waveform by the luminance meter when raster of window pattern is changed from white to black and from black to white.</td>
<td>LCD7000</td>
<td>Black display VLCD=3.87V White display VLCD=0.69V TON Rise time TOFF Fall time</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image1" alt="Graph" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Contrast ratio</td>
<td>Measure maximum luminance Y1(VLCD=0.69V) and minimum luminance Y2(VLCD=3.87V) at the center of the screen by displaying raster or window pattern. Then calculate the ratio between these two values. Contrast ratio = Y1/Y2 Diameter of measuring point: 8mmφ</td>
<td>CS1000 LCD7000</td>
<td>Backlight ON Backlight OFF</td>
</tr>
<tr>
<td>3</td>
<td>Viewing angle Vertical</td>
<td>Move the luminance meter from right to left and up and down and determine the angles where contrast ratio is 10.</td>
<td>EZcontrast160D</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>V-T threshold value</td>
<td>Change VLCD by 0.1V step and plot the points where the luminance is 90% as V90, 50% as V50 and 10% as V10 of maximum luminance.</td>
<td>LCD7000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>White chromatically</td>
<td>Measure chromaticity coordinates x and y of CIE1931 colorimetric system at VLCD = 0.69V Color matching faction: 2°view</td>
<td>CS1000</td>
<td></td>
</tr>
<tr>
<td>Notice</td>
<td>Item</td>
<td>Test method</td>
<td>Measuring instrument</td>
<td>Remark</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>--------</td>
</tr>
<tr>
<td>6</td>
<td>Maximum contrast angle</td>
<td>Move the luminance meter vertically to the display from its normal line and measure the angles where contrast ratio reaches its highest value.</td>
<td>EZcontrast160D</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Burn-in</td>
<td>Visually check burn-in image on the screen after 2 hours of “window display” (VLCD=0.69V/3.87V).</td>
<td>CS1000</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Center brightness</td>
<td>Measure the brightness at the center of the screen.</td>
<td>CS1000</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Brightness distribution</td>
<td>(Brightness distribution) = 100 x B/A %</td>
<td>CS1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A : max. brightness of the 9 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B : min. brightness of the 9 points</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>