Technical Literature
For
TFT-LCD Module

Model No.  LS013B4DN04

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Mobile Liquid Crystal Display Group
SHARP CORPORATION
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### [For handling and system design]

1. Handle with care as glass is used in this LCD panel. Dropping or contact against hard object may cause cracks or chips.
2. Be careful to handle this LCD panel in order to avoid injury yourself by panel’s edge as this panel is made of glass and might be a sharp edge.
3. Do not scratch the surface of the UV protection film as it is easily damaged.
4. Water droplets on the UV protection film must be wiped off immediately as they may cause color changes, or other defects if remained for a long time.
5. Do not leave the LCD panel in direct sun or under ultraviolet ray.
6. To clean LCD panel surface, wipe clean with absorbent cotton or soft cloth. If further cleaning is needed, use IPA (isopropyl alcohol) and wipe clean lightly on surface only. Do not use organic solvents as it may damage the LCD panel terminal area which uses organic material. Also, do not directly touch with finger. When the terminals cleaning are needed, those should be wiped by a soft cloth or a cotton swab without directly touching by hand.
7. Do not expose gate driver, etc. on the panel (circuit area outside panel display area) to light as it may not operate properly. Design that shields gate driver, etc. from light is required when mounting the LCD module.
8. To avoid circuit failure, do not touch panel terminal area.
9. Support for the LCD panel should be carefully designed to avoid stress that exceeds specification on glass surface.
10. When handling LCD module and assembling them into cabinets, be noted that storage in the environment of oxidization or deoxidization gas and the use of such materials as reagent, solvent, adhesive, resin, and etc. which generate these gasses, may cause corrosion and discoloration of LCD modules.
11. To avoid picture uniformity failure, do not put a seal or an adhesive material on the panel surface.
12. Do not use chloroprene rubber as it generates chlorine gas and affects reliability in LCD panel connective area.
13. Protective film is attached to the surface of UV protection film on LCD panel to prevent scratches or other damages. Remove this protective film before use. In addition, do not attach the protective film which is removed from LCD module again. When the LCD panel which has the reattached protective film is needed to storage for a long time, the UV protection film might have a damage with picture quality failure.
14. Panel is susceptible to mechanical stress and such stress may affect the display. Place the panel on flat surface to avoid stress caused by twist, bend, etc.
15. When transporting LCD panels, secure them in LCD panel tray to avoid mechanical stress. The tray should be conductive to protect LCD panels from static charge. Material used in set or epoxy resin (amine type hardening agent) from packaging, and silicon adhesive (dealcoholized or oxime) all release gas which may affect quality of UV protection film. Do confirm compatibility with user materials.
16. As this LCD module is composed electronic circuits, it is sensitive to electrostatic discharge of 200V or more. Handle with care using cautions for the followings:
   - Operators
     Operators must wear anti-static wears to prevent electrostatic charge up to and discharge from human body.
Equipment and containers
Process equipment such as conveyer, soldering iron, working bench and containers may possibly generate electrostatic charge up and discharge. Equipment must be grounded through 100Mohms resistance. Use ion blower.

Floor
Floor plays an important role in leaking static electricity generated in human body or equipment. If the floor is made of insulated material (such as polymer or rubber material), such static electricity may charge. Proper measure should be taken to avoid static electricity charge (electrostatic earth: 100Mohms). There is a possibility that the static electricity is charged to them without leakage in case of insulating floor, so the electrostatic earth: $1 \times 10^8 \Omega$ should be made.

Humidity
Humidity in work area relates to surface resistance of the persons or objects that generate electrostatics, and it can be manipulated to prevent electrostatic charge. Humidity of 40% or lower increases electrostatic earth resistance and promotes electrostatic charging. Therefore, the humidity in the work area should be kept above 40%. Specifically for film peeling process or processes that require human hands, humidity should be kept above 50% and use electricity removal blower.

Transportation/Storage
Containers and styroform used in transporation and storage may charge electrostatic (from friction and peeling) or electrostatic charge from human body, etc. may cause containers and styroform to have induced charge. Proper electrostatic measure should be taken for containers and storage material.
[For operating LCD module]

(1) Do not operate the LCD panel under outside of electrical specification. Otherwise LCD panel may be damaged.
(2) Do not use the LCD panel under outside of specified driving timing chart. Otherwise LCD panel may not have proper picture quality.
(1) Do not operate the LCD panel under outside of electrical specification. Otherwise LCD panel may be damaged.
(2) Do not use the LCD panel under outside of specified driving timing chart. Otherwise LCD panel may not have proper picture quality.
(3) A still image should be displayed less than two hours, if it is necessary to display still image longer than two hour, display image data must be refreshed in order to avoid sticking image on LCD panel.
(4) If LCD module takes a static electricity, as the display image which is written into pixel memory might not be displayed, Data update should be executed frequently.

[Precautions for Storage]

(1) After opening the package, do not leave the LCD panel in direct sun or under strong ultraviolet ray. Store in dark place.
(2) In temperature lower than specified rating, liquid crystal material will coagulate. In temperature higher than specified rating, it isotropically liquifies. In either condition, the liquid crystal may not recover its original condition.
   Store the LCD panel in at or around room temperature as much as possible.
   Also, storing the LCD panel in high humidity will damage the polarizer. Store in normal room temperature as much as possible.
(3) Keeping Method
   a. Don't keeping under the direct sunlight.
   b. Keeping in the tray under the dark place.
[Other Notice]

(1) Operation outside specified environmental conditions cannot be guaranteed.

(2) As power supply (VDD-VSS, VDDA-VSSA) impedance is lowered during use, bus controller should be inserted near LCD module as much as possible.

(3) UV protection film is applied over LCD panel surface. Liquid crystal inside LCD panel deteriorates with ultraviolet ray. The panel should not be left in direct sun or under strong ultraviolet ray for prolonged period of time even with the UV protection film.

(4) Disassembling the LCD module will cause permanent damage to the module. Do not disassemble the module.

(5) If LCD panel is broken, do not ingest the liquid crystal from the broken panel. If hand, leg, or clothes come in contact with liquid crystal, wash off immediately with soap.

(6) ODS (specific chlorofluorocarbon, specific halon, 1-1-1 trichloroethane, carbon tetrachloride) are not used or contained in material or all production processes of this product.

(7) Observe all other precautionary requirements in handling general electronic components.

Discarding liquid crystal modules

LCD Panel : Dispose of as glass waste. This LCD module contains no harmful substances.

- The liquid crystal panel contains no dangerous or harmful substances.
- This liquid crystal panel contains only an extremely small amount of liquid crystal (approximately 100mg) and therefore it will not leak even if the panel should break.
- Its median lethal dose (LD50) is greater than 2,000 mg/kg and a mutagenetic (Aims test: negative) material is used.

FPC : (1) FPC bend R should be 0.45mm or greater and R should be even.

- In LCD panel an connective area, do not bend FPC into UV protection film side.

(2) Do not hang LCD module by FPC or apply force to FPC.
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<th>Page</th>
</tr>
</thead>
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<tr>
<td>11. Reliability Test Conditions</td>
<td>27</td>
</tr>
</tbody>
</table>
1. Outline
   This TFT-LCD module is a reflective active matrix memory liquid crystal display module with CG silicone thin film transistor. Module outline is indicated in fig 8-1.

2. Characteristics
   - Reflective panel of white and black with aspect ratio of 1:1
   - 1.3” screen has 96x 96 resolusion. (9216 pixels stripe array)
   - Display control by serial data signal communication.
   - Arbitrary line data renewable.
   - 1bit internal memory for data storage within the panel.
   - Thin, light-weight and compact module with monolithic technology.
   - Super low power consumption TFT panel.
   - FPC attached (Applicable connectors: Please refer to the page 21 “Recommended Connectors”

3. Mechanical Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen size</td>
<td>3.4 (1.3”)</td>
<td>cm</td>
</tr>
<tr>
<td>Viewing Area</td>
<td>24.192 (H) × 24.192 (V)</td>
<td>mm</td>
</tr>
<tr>
<td>Dot configuration</td>
<td>96 (H) × 96 (V)</td>
<td>Dot</td>
</tr>
<tr>
<td>Dot pitch</td>
<td>0.252 (H) × 0.252 (V)</td>
<td>mm</td>
</tr>
<tr>
<td>Pixel Array</td>
<td>Stripe Array</td>
<td>-</td>
</tr>
<tr>
<td>Outline Dimension</td>
<td>28.2 (W) × 32.34 (H) × 1.40 (D)</td>
<td>mm</td>
</tr>
<tr>
<td>Mass</td>
<td>3.6 (TYP )</td>
<td>g</td>
</tr>
<tr>
<td>Surface Hardness</td>
<td>3H</td>
<td>Pencil hardness</td>
</tr>
</tbody>
</table>

(Note) Detail dimension and tolerance are shown in fig. 8-1
4. Input terminal names and functions

Table 4-1

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Symbol</th>
<th>I/O</th>
<th>Function</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCLK</td>
<td>INPUT</td>
<td>Serial clock signal</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SI</td>
<td>INPUT</td>
<td>Serial data input signal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SCS</td>
<td>INPUT</td>
<td>Chip select signal</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>EXTCOMIN</td>
<td>INPUT</td>
<td>External COM inversion signal input (H: enable)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DISP</td>
<td>INPUT</td>
<td>Display ON/OFF signal</td>
<td>Remark 4-2</td>
</tr>
<tr>
<td>6</td>
<td>VDDA</td>
<td>POWER</td>
<td>Power supply (Analog)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>VDD</td>
<td>POWER</td>
<td>Power supply (Digital)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>EXTMODE</td>
<td>INPUT</td>
<td>COM inversion select terminal</td>
<td>Remark 4-1</td>
</tr>
<tr>
<td>9</td>
<td>VSS</td>
<td>GND</td>
<td>GND(Digital)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>VSSA</td>
<td>GND</td>
<td>GND(Analog)</td>
<td></td>
</tr>
</tbody>
</table>

Remark 4-1: When it’s "H", EXTCOMIN signal is enable. And when it’s "L", serial input flag is enable.

When it’s "H", EXTCOMIN signal is enable. And when it’s "L", serial input flag is enable.

"H" mode; connect the EXTMODE to VDD, "L" mode; connect the EXTMODE to VSS.

Remark 4-2: The display ON/OFF signal is only for display. Data in the memory will be saved at the time of ON/OFF.

When it’s "H", data in the memory will display, when it’s "L", white color will display and data in the memory will be saved.

4-2 Recommended circuit:
5. Absolute Maximum Rating

Table 5-1 (GND = 0V)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td>VDDA</td>
<td>-0.3</td>
<td>+ 3.6</td>
<td>V</td>
<td>[Remark5-1]</td>
</tr>
<tr>
<td>Analog</td>
<td>VDD</td>
<td>-0.3</td>
<td>+ 3.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Logic</td>
<td>VDD</td>
<td>-0.3</td>
<td>+ 3.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input signal voltage (high)</td>
<td>VDD</td>
<td></td>
<td></td>
<td>V</td>
<td>[Remark5-2]</td>
</tr>
<tr>
<td>Input signal voltage (low)</td>
<td>VDD</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>Tstg</td>
<td>TBD</td>
<td>TBD</td>
<td>°C</td>
<td>[Remark5-3,4]</td>
</tr>
<tr>
<td>Operation Temperature (at panel surface)</td>
<td>Top1</td>
<td>-10</td>
<td>+ 60</td>
<td>°C</td>
<td>[Remark5-5]</td>
</tr>
</tbody>
</table>

[Remark5-1] Applies to EXTMODE.
[Remark5-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.
[Remark5-3] Do not exceed this temperature in any parts of module.
[Remark5-4] Maximum wet bulb temperature is 57°C or lower. No condensation is allowed.
Condensation will cause electrical leak and may cause the module to not meet this specification.
[Remark5-5] Operating temperature is the temperature that guarantees only for the operation.
For contrast, response time, and other display quality determination, use Ta = + 25°C.
6. Electrical characteristics

6-1) TFT LCD panel drive

Table 6-1  Recommended operating Condition  
VSS(GND) = 0V, Ta = +25°C

<table>
<thead>
<tr>
<th>Item</th>
<th>symbol</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog</td>
<td>VDDA</td>
<td>+2.7</td>
<td>+3.0</td>
<td>+3.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Logic</td>
<td>VDD</td>
<td>+2.7</td>
<td>+3.0</td>
<td>+3.3</td>
<td>V</td>
<td>[Remark6-1]</td>
</tr>
<tr>
<td>Input signal voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hi</td>
<td>VIH</td>
<td>VDD-0.1</td>
<td>VDD</td>
<td>V</td>
<td>[Remark6-2]</td>
<td></td>
</tr>
<tr>
<td>Lo</td>
<td>VIL</td>
<td>VSS</td>
<td>VSS+0.1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Remark6-1] Applies to EXTMODE = "H"

[Remark6-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.
6-2) Power supply sequence

<table>
<thead>
<tr>
<th></th>
<th>On Sequence</th>
<th>Normal operation</th>
<th>Off sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD/VDDA (5V)</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
</tr>
<tr>
<td>DISP</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
<td>⬜  ⬜  ⬜  ⬜  ⬜  ⬜  ⬜</td>
</tr>
<tr>
<td>EXTCOMIN</td>
<td>⬜  2</td>
<td>Normal operation</td>
<td>⬜  2</td>
</tr>
<tr>
<td>SCS</td>
<td>⬜  2</td>
<td>Normal operation</td>
<td>⬜  2</td>
</tr>
<tr>
<td>Others</td>
<td>⬜  2</td>
<td>Normal operation</td>
<td>⬜  2</td>
</tr>
</tbody>
</table>

- Refer to timing chart and AC timing characteristics for detail
- 1 ⬜ and ⬜ may be opposite (however, TCOM polarity inversion will not occur even with EXTCOMIN between DISP= LoginForm. Also, when DISP and EXTCOMIN are simultaneously started up, allow 30us or more before SCS starts up (It may be less than 60us).
- 2 Setting value for pixel memory initialization
- SCS=Driving accordingly to clear pixel internal memory method (use all clear flag or write all screen white)
- S1=M2 (all clear flag) = “H” or write white
- SCLK: Normal Driving

[ON Sequence]
(1) 3V rise time (depends on IC)
(2) Pixel memory initialization T2: 1V or more Initialize with M2 (all clear flag) or write all screen white
(3) Release time for initialization of TCOM latch T3: 30us or more
   Time required to release COM related latch circuit initialization which is initializing using DISP signals
(4) TCOM polarity initialization time T4: 30us or more
   Time required initializing TCOM polarity accordingly to EXTCOMIN input

[Normal Operation]
Duration of normal driving

[Off Sequence]
(5) Pixel memory initialization time T5: 1V or more
(6) VA, VB, VCOM initialization time T6: 1V or more
(7) 3V falling time (Depends on IC)

[Remark] Precautions at ehte time of power on and power off.

Remark 1) When power on, VDD and VDDA are same time or VDD should be faster than the VDDA.
Remark 2) When power off, VDD and VDDA are same time or VDDA should be faster than the VDD.
### 6-3) Input signal characteristics

Table 6-3-1

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame frequency</td>
<td>fSCS</td>
<td>1</td>
<td>-</td>
<td>60</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td>Clock frequency</td>
<td>fSCLK</td>
<td>0.5</td>
<td>-</td>
<td>1</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Vertical Interval</td>
<td>tV</td>
<td>16.66</td>
<td>-</td>
<td>1000</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>COM Frequency</td>
<td>fCOM</td>
<td>0.5</td>
<td>-</td>
<td>30</td>
<td>Hz</td>
<td></td>
</tr>
</tbody>
</table>

Table 6-3-2

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCS Rising time</td>
<td>trSCS</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCS Falling Time</td>
<td>tfSCS</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCS High duration</td>
<td>twSCSH</td>
<td>136</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SCS Low duration</td>
<td>twSCSL</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SCS set up time</td>
<td>tsSCS</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCS hold time</td>
<td>thSCS</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SI Rising time</td>
<td>trSI</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI Falling time</td>
<td>tfSI</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI set up time</td>
<td>tsSI</td>
<td>380</td>
<td>*1</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI hold time</td>
<td>thSI</td>
<td>440</td>
<td>*1</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK Rising time</td>
<td>trSCLK</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK Falling time</td>
<td>tfSCLK</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK High duration</td>
<td>twSCLKH</td>
<td>450</td>
<td>950</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK Low duration</td>
<td>twSCLKL</td>
<td>450</td>
<td>950</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal frequency</td>
<td>fEXTCOMIN</td>
<td>1</td>
<td>60</td>
<td>Hz</td>
<td></td>
<td>[Remark 6-3]</td>
</tr>
<tr>
<td>EXTCOMIN signal rising time</td>
<td>fEXTCOMIN</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal falling time</td>
<td>fEXTCOMIN</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signalHigh duration</td>
<td>fEXTCOMINH</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>DISP Rising time</td>
<td>trDISP</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>DISP Falling time</td>
<td>tfDISP</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

**Remark 6-3**] EXTCOMIN frequency should be made lower than frame frequency.
SCS, SI, SCLK signal

EXTCOMIN signal

DISP signal

- SCS, SI, SCLK, DISP, EXTCOMIN: 3V input voltage
6-4) Power consumption (Average)

Table 6-4

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition 1</td>
<td></td>
<td>6</td>
<td>TBD</td>
<td>TBD</td>
<td>μW</td>
<td>[Remark 6-4]</td>
</tr>
<tr>
<td>Condition 2</td>
<td></td>
<td>12</td>
<td>TBD</td>
<td>TBD</td>
<td>μW</td>
<td>[Remark 6-4]</td>
</tr>
</tbody>
</table>

* Measurement Condition 1
  Display mode (no display data update),
  Common inversion fSCS=1Hz, with VDD=3V, VDDA=3V, fSCLK=0.5MHz, Display pattern: Vertical stripe display

* Measurement Condition 2
  Data update mode (with display data update: 1Hz)
  Common inversion fSCS=1Hz with VDD=3V, VDDA=3V, fSCLK=0.5MHz, Display pattern: Vertical stripe display

[Remark 6-4] This is value in steady condition, not the value of peak power at the time of COM operation. Some margin for power supply is recommended. We recommend capacitor for VDD and VDDA. (If VDD and VDDA are on separate systems, we recommend capacitor for each.)
6-5) Input Signal Timing Chart

6-5-1 Data update mode (1 line)

Updates data of only one specified line.  (M0="H", M2 = "L")

M0: Mode flag. Set for “H”. Data update mode (Memory internal data update)
   When “L”, display mode (maintain memory internal data).
M1: Frame inversion flag.
   When “H”, outputs VCOM="H", and when “L”, outputs VCOM="L".
   When EXTMODE="H", it can be “H” or “L”.
M2: All clear flag.
   Refer to 6-5-4) All Clear Mode to execute clear.
DUMMY DATA: Dummy data. It can be “H” or “L" (“L" is recommended.)

Data write period
   Data is being stored in 1st latch block of binary driver on panel.
Data transfer period
   Data written in 1st latch is being transferred (written) to pixel internal memory circuit.

For gate line address setting, refer to 6-6) Input Signal and Display.

M1: Frame inversion fl is enabled when EXTMODE="L".
When SCS becomes L, M0 and M2 are cleared.
6-5-2 Data Update Mode (Multiple Lines)

Updates arbitrary multiple lines data. (M0="H", M2 = "L")

M0: Mode flag. Set for “H”. Data update mode (Memory internal data update)
When “L”, display mode (maintain memory internal data).

M1: Frame inversion flag.
When “H”, outputs VCOM="H", and when “L”, outputs VCOM="L".
When EXTMODE="H", it can be “H” or “L”.

M2: All clear flag.
Refer to 6-5-4) All Clear Mode to execute clear.

DUMMY DATA: Dummy data. It can be “H” or “L” (“L” is recommended.)

- Data write period
  Data is being stored in 1st latch block of binary driver on panel.

- Data transfer period
  For example, during GL2nd line data transfer period, GL 2nd line address is latched and GL1st line data is transferred from 1st latch to pixel internal memory circuit at the same time.

- For gate line address setting, refer to 6-6) Input Signal and Display.
- Input data continuously.
- M1: Frame inversion flag is enabled when EXTMODE= "L"
- When SCS becomes "L" M0 and M2 are cleared.
6-5-3 Display Mode

Maintains memory internal data (maintains current display). \( (M0=\text{"L"}, \ M2 = \text{"L"}) \)

M0: Mode flag. Set for “H”. Data update mode (Memory internal data update)
   When “L”, display mode (maintain memory internal data).

M1: Frame inversion flag.
   When EXTMODE=“H”, it can be “H” or “L”.

M2: All clear flag.
   Refer to 6-5-4) All Clear Mode to execute clear.

DUMMY DATA: Dummy data. It can be “H” or “L” (“L” is recommended.)

- M1: Frame inversion flag is enabled when EXTMODE=\( \text{L} \)
- When SCS becomes “L”, M0 and M2 are cleared.
6-5-4  All Clear Mode

Clears memory internal data and writes white. (M0="L", M2 = "H")

M0: Mode flag.
   Set it "L".
M1: Frame inversion flag.
   When “H”, outputs VCOM="H", and when “L”, outputs VCOM="L".
   When EXTMODE="H", it can be “H” or “L”.
M2: All clear flag.
   Set it “H”
DUMMY DATA: Dummy data. It can be “H” or “L” ("L" is recommended.)

□ M1: Frame inversion flag is enabled when EXTMODE="L".
□ When SCS becomes L M0 and M2 are cleared.
6-5-5 COM Inversion

There are two types of inputs, COM signal serial input (EXTMODE="L") and external COM signal input (EXTMODE="H").

**EXTMODE="L"**

M1 LC polarity inversion flag: If M1 is "H" then VCOM="H" is output. If M1 is "L" then VCOM="L" is output.

- 1 LC inversion has been changed by M1 flag statement.
- 2: The periods of plus polarity and minus polarity should be same length as much as possible.

**EXTMODE="H"**

1) about the EXTCOM IN signal when SCS signal is H.

- 1 LC inversion polarity has been set by the rising timing of EXTCOMIN in internal circuit block as COMZ signal,
- 2: The period of EXTCOMIN should be constant.

2) about the EXTCOM IN signal when SCS signal is L.

- 3 LC inversion polarity has been set by the rising timing of EXTCOMIN in internal circuit block as COMZ signal,
- 4: The period of EXTCOMIN should be constant.
6-6) Input Signal and Display, Gate address(Line) Setting

Data position in display \((H,V)\)

<table>
<thead>
<tr>
<th></th>
<th>P1,L1</th>
<th>P2,L1</th>
<th>P3,L1</th>
<th></th>
<th>P96,L1</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1,L2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1,L3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Display side up

```
| L1 | H | L | L | L | L | L | L |
| L2 | L | H | L | L | L | L | L |
| L3 | H | H | L | L | L | L | L |
| L94| L | H | H | H | L | H | L |
| L95| L | H | H | H | H | L | H |
| L96| L | L | L | L | L | H | H |
```

Line

Gate line address setting
### 7. Optical characteristics

**Table 7-1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>View angle</td>
<td>H</td>
<td>21,622</td>
<td>60</td>
<td></td>
<td>°(degree)</td>
<td>[Remark 7-1]</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>011</td>
<td>60</td>
<td></td>
<td>°(degree)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>012</td>
<td>60</td>
<td></td>
<td>°(degree)</td>
<td></td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>CR.</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
<td>[Remark 7-2, 3]</td>
</tr>
<tr>
<td>Reflectivity ratio</td>
<td>R</td>
<td></td>
<td>50</td>
<td></td>
<td>%</td>
<td>[Remark 7-3]</td>
</tr>
<tr>
<td>Response time</td>
<td>Rise</td>
<td>τr</td>
<td>50</td>
<td></td>
<td>ms</td>
<td>[Remark 7-3, 4]</td>
</tr>
<tr>
<td></td>
<td>Fall</td>
<td>τd</td>
<td>50</td>
<td></td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>Panel Chromaticity</td>
<td>White</td>
<td>x</td>
<td></td>
<td>0.313</td>
<td></td>
<td>[Remark 7-3]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>y</td>
<td></td>
<td>0.338</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Rremark 7-3] Optical characteristics measurement equipment.

Figure 7-2 is for contrast ratio, reflectivity ratio, and panel chromaticity measurement, and figure 7-3 is for response time measurement. Both are to be conducted in a dark or room equivalent to a dark room.

![Diagram of measurement equipment](image-url)
[Remark7-1] Definition of Viewint Angle

[Remark7-2] Definition of Contrast Ratio

\[
\text{Contrast ratio (CR)} = \frac{\text{Reflection intensity in white display}}{\text{Reflection intensity in black display}}
\]

[Remark7-4] Respons time (Change in reflection ratio)

It's defined by the time change of optical receiver output when signal is input to display white or black
8. Module outline

8-1) Outline dimension of the 1.3” (96×96) panel with FPC type

![Diagram 8-1]

Fig. 8-1

< Recommended Connector >  SMK (Bottom Contact)  FP12 Series:  CFP-4610-0150F

8-2) FPC Bend Specification

When bending FPC, bend where specified in Condition (1) and the bend R should be more than R specified in Condition (2). FPC is not to contact glass edge, and there should be no stress to connective area between panel and FPC.

Condition (1)  FPC bend recommended area:  0.8mm – 6.0mm from glass edge.

Condition (2)  Minimum bend R:  Inner diameter R0.45

![Diagram 8-2]

Fig. 8-2

Remark 8-1  Do not bend backward (toward UV protection film side)

Remark 8-2  Bend frequency:  3 times or less (Repeat bend condition:  180° ～ 0°)

< Recommended Connector of 180 degree bent FPC >
SMK  (Contact side: upper side)  FP-12 series  :  CFP-4510-0150F
9. External capacitors

Fig. 9-1 External capacitor recommendation capacity value

<Recommended capacity value>

C1 :DISP- VSS: rank B  0.1uF Ceramic capacitor
C2 :VDDA- VSS: rank B  1uF  Ceramic capacitor
C3 :VDD- VSS: rank B  1uF  Ceramic capacitor

Above circuit and parts are only recommendation.
For actual use, please evaluate their conformity with your system and design.
(Capacitor pressure resistance can be larger than resistance indicated above.)
10. Package

10-1) Serial number (Ink-jet print) will be indicated on serial number label as indicated in Figure 10-1 outline dimension figure.

Print structure

Serial number specifications
A: single figure of the year
B: month(1,2,...,9,X,Y,Z)
C: day
D: serial number

Fig. 10-1 Serial number print position

10-2) Forwarding form

1) Piling number of cartons: Max 12
   Package quality in a carton: 800pcs

2) Storage condition
   • Temperature: 0℃ to 40℃
   • Humidity: 60%RH or lower (at 40℃)
     There should be no condensation at low temperature and high humidity.
   • Atmosphere: No harmful gas, such as acid or alkali, which causes severe corrosion on electronic parts and wiring, are to be detected.
   • Period: About 3 months
   • Opening the package: in order to prevent electrostatic damage to TFT modules, room humidity should be made over 50%RH and take effective measure such as use of earth when opening the package.
10-3) Package

Fig. 10-2 Package Form
11. Reliability Test Conditions

11-1) Reliability test items

Table 11-1

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Test condition</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 High temperature storage test</td>
<td>Ta=80 degrees Celsius 240h</td>
<td></td>
</tr>
<tr>
<td>2 Low temperature storage test</td>
<td>Ta=35 degrees Celsius 240h</td>
<td></td>
</tr>
<tr>
<td>3 High temperature and high humidity</td>
<td>Tp=40 degrees Celsius/95%RH 240h</td>
<td></td>
</tr>
<tr>
<td>operating test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 High temperature operating test</td>
<td>Tp=70 degrees Celsius 240h</td>
<td></td>
</tr>
<tr>
<td>5 Low temperature operating test</td>
<td>Tp=-20 degrees Celsius 240h</td>
<td></td>
</tr>
<tr>
<td>6 Shock test (Non operating test)</td>
<td>Ta=-30 degrees Celsius (1h)~+80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>degrees Celsius (1h) / 5 cycle</td>
<td></td>
</tr>
<tr>
<td>7 Electro static discharge test</td>
<td>±200V, 200pF(0Ω) each terminal: 1 time</td>
<td></td>
</tr>
</tbody>
</table>

[Remark] Ta = Ambient temperature, Tp = Panel temperature

(Evaluation method)
In the standard condition, there shall be no practical problems that may affect the display function.

11-2) Panel surface stress specification

Panel surface stress specification has been defined as a parameter “Force of stress [N]” without no picture failure.
Load testing : Minimum 120[N]
Test condition:

Test structure : LCD panel with UV protection film
Press point : Center of LCD panel
Press Jig : φ10mm column
Press speed : 1mm / minute
Support : fixed on stage
Press time : 5 seconds after achievement of the press strength, then release it.