Technical Literature
For
TFT-LCD Module

Model No. LS027B4DH01

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Mobile Liquid Crystal Display Group
SHARP CORPORATION
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Handling and System Design

- Handle with care as glass is used in this LCD panel. Dropping or contact against hard object may cause cracks or chips.
- Do not scratch the surface of UV protection film as it is easily damaged.
- Water droplets on the UV protection film must be wiped off immediately as they may cause discoloration or other defects if left for 10 minutes or longer.
- 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.
- To avoid circuit failure, do not touch panel terminal area.
- 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.
- Support for the LCD panel should be carefully designed to avoid stress that exceeds specification on glass
LCD 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..

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.

Do not use chloroprene rubber as it generates chlorine gas and affects reliability in LCD panel connective area.

This LCD module 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 facility
  Process equipment such as conveyer, soldering iron, working bench and containers may possibly generate electrostatic charge and discharge. Equipment must be grounded through 100Mohms resistance.

- 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).

- 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.

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.
Operating the module

- Do not operate the LCD panel above specified voltage as it may cause the LCD panel to fail. Always operate within specified rating.
- Do not use the LCD panel outside AC timing rating, etc., specified in this specification as it may cause display failure. Always use the panel within specified rating.

Storing the module

- After opening the package, do not leave the LCD panel in direct sun or under strong ultraviolet ray. Store in dark place.
- 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.
- Storing
  a. No direct sun light
  b. Store in trays and in dark room
Others

- Operation outside specified environmental conditions cannot be guaranteed.
- As power supply (VDD-GND, VDDA-GND) impedance is lowered during use, bus controller should be inserted near LCD module as much as possible.
- 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.
- Disassembling the LCD module will cause permanent damage to the module. Do not disassemble the module.
- 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.
- 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.
- 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**: 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. Do not hang LCD module by FPC or apply force to FPC.
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1. **Scope of Application**
   Reflective active-matrix type memory liquid crystal display module with WQVGA (400x240) panel which uses CG silicon thin film transistor.

2. **Overview**
   - 2.7” WQVGA monochrome reflective panel
   - 400x240 dot stripe arrangement
   - Display control with serial data signal communication
   - Arbitrary line data update
   - Internal 1bit memory within the panel for data memory
   - Thin, light and compact module with monolithic technology
   - Super low power consumption TFT panel
   - With FPC (Applicable connector: Refer to recommended connector on page 21.)

3. **Mechanical Specification**

   Table 3-1  Module Mechanical Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen Size (Diagonal)</td>
<td>6.86cm (2.7”)</td>
<td>cm</td>
</tr>
<tr>
<td>Viewing Area</td>
<td>58.8 (H) x 35.28 (V)</td>
<td>mm</td>
</tr>
<tr>
<td>Dot Structure</td>
<td>400 (H) x 240 (V)</td>
<td>dot</td>
</tr>
<tr>
<td>Dot pitch</td>
<td>0.147 (H)x 0.147 (V)</td>
<td>mm</td>
</tr>
<tr>
<td>Pixel Arrangement</td>
<td>Stripe arrangement</td>
<td>-</td>
</tr>
<tr>
<td>Module outline dimension (Extruded part not included)</td>
<td>62.8 (W) x 42.82 (H) x 1.53 (D)</td>
<td>mm</td>
</tr>
<tr>
<td>Weight</td>
<td>TBD (TYP)</td>
<td>g</td>
</tr>
<tr>
<td>Surface Hardness</td>
<td>3H or more (Initial)</td>
<td>Pencil hardness</td>
</tr>
</tbody>
</table>

(Remark) Refer to Figure 8-1 for detailed dimension and tolerance.
4. Input Terminal names and function

4-1) Input Terminal

Table 4-1

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Code</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 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: Active)</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>Analog power supply</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>VDD</td>
<td>POWER</td>
<td>Digital power supply</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>EXTMODE</td>
<td>INPUT</td>
<td>COM inversion mode switch terminal</td>
<td>Remark 4-1</td>
</tr>
<tr>
<td>9</td>
<td>VSS</td>
<td>POWER</td>
<td>Logic GND</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>VSSA</td>
<td>POWER</td>
<td>Analog GND</td>
<td></td>
</tr>
</tbody>
</table>

When “H”, connect EXTMODE to VDD and when “L” to VSS.

Remark 4-2] ON/OFF for LCD display only. Memory data is maintained.
When “H”, displays with memory data, and when “L”, displays all white with memory data maintained.

4-2) Recommended Circuit

COM signal serial input
EXTMODE=“L”

External COM signal input
EXTMODE=“H”
5. Absolute Maximum Rating

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>MIN.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog Power Supply</td>
<td>VDDA</td>
<td>-0.3</td>
<td>+5.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Logic Power Supply</td>
<td>VDD</td>
<td>-0.3</td>
<td>+5.8</td>
<td>V</td>
<td>[Remark 5-1]</td>
</tr>
<tr>
<td>Input signal terminal voltage (high)</td>
<td></td>
<td>VDD</td>
<td>V</td>
<td></td>
<td>[Remark 5-2]</td>
</tr>
<tr>
<td>Input signal terminal voltage (low)</td>
<td></td>
<td>-0.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>-30</td>
<td>+80</td>
<td></td>
<td>[Remark 5-3, 4]</td>
</tr>
<tr>
<td>Operating temperature (Panel surface)</td>
<td>Topr1</td>
<td>-20</td>
<td>+70</td>
<td></td>
<td>[Remark 5-5]</td>
</tr>
</tbody>
</table>

[Remark 5-1] Also applicable to EXTMODE.
[Remark 5-2] Applicable to SCLK, SI, SCS, DISP, EXTCOMIN.
[Remark 5-3] Do not exceed this rating in any area of the module.
[Remark 5-4] Maximum wet-bulb temperature should be 57°C or lower. Do not allow condensation.

Condensation may cause electrical leak and the module may not meet its specification.
[Remark 5-5] Operating temperature is temperature that guarantees operation only. For contrast, response speed, and other display quality, module is evaluated at Ta=+25°C.

6. Electrical Characteristics

6-1) TFT LCD Panel Driving Part

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog power Supply</td>
<td>VDDA</td>
<td>+4.8</td>
<td>+5.0</td>
<td>+5.5</td>
<td>V</td>
<td>[Remark 6-1]</td>
</tr>
<tr>
<td>Logic power supply</td>
<td>VDD</td>
<td>+4.8</td>
<td>+5.0</td>
<td>+5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input signal voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>VIH</td>
<td>+2.70</td>
<td>+3.00</td>
<td>VDD</td>
<td>V</td>
<td>[Remark 6-2]</td>
</tr>
<tr>
<td>Low</td>
<td>VIL</td>
<td>VSS</td>
<td>VSS</td>
<td>VSS+0.15</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input leakage current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>IOH</td>
<td>-</td>
<td>-</td>
<td>TBD</td>
<td>uA</td>
<td>[Remark 6-2]</td>
</tr>
<tr>
<td>Low</td>
<td>IOL</td>
<td>-</td>
<td>-</td>
<td>TBD</td>
<td>uA</td>
<td>[Remark 6-2]</td>
</tr>
</tbody>
</table>

VSS(GND) = 0V, Ta = +25°C

[Remark 6-1] Also applicable to EXTMODE="H".
[Remark 6-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.

[Remark 6-2] Can operate below VDD voltage, however, operation around 3V is recommended.

[Remark 6-1] Also applicable to EXTMODE="H".
[Remark 6-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.
6-2) Power Supply Sequence

<table>
<thead>
<tr>
<th>On Sequence</th>
<th>Normal operation</th>
<th>Off sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD/VDDA</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>DISP</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>EXTCOMIN</td>
<td>GND</td>
<td>Normal operation</td>
</tr>
<tr>
<td>SCS</td>
<td>GND □ 2</td>
<td>Normal operation □ 2</td>
</tr>
<tr>
<td>Others</td>
<td>GND □ 2</td>
<td>Normal operation □ 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=□ L □. 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)
- SCLK: Normal Driving

**[ON Sequence]**
1. 5V 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]**
1. Pixel memory initialization time T5: 1V or more
2. VA, VB, VCOM initialization time T6: 1V or more
3. 5V falling time (Depends on IC)

**Remark** Cautions when powering on

- Remark 1) VDD and VDDA should rise simultaneously or VDD should rise first.
- Remark 2) VDD and VDDA should simultaneously or VDD should fall first
### 6-3) Input Signal Basic Characteristics

#### Table 6-3-1

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</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>20</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td>Clock Frequency</td>
<td>fSCLK</td>
<td>1</td>
<td>2</td>
<td></td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Vertical rush duration</td>
<td>tV</td>
<td>49.993</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>10</td>
<td>Hz</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 6-3-2

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</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>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCS falling time</td>
<td>tfSCS</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCS High width</td>
<td>twSCSH</td>
<td>220</td>
<td></td>
<td></td>
<td>us</td>
<td>Data update mode</td>
</tr>
<tr>
<td>SCS Low width</td>
<td>twSCSL</td>
<td>1</td>
<td></td>
<td></td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SCS setup time</td>
<td>tsSCS</td>
<td>3</td>
<td></td>
<td></td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SCS hold time</td>
<td>thSCS</td>
<td>1</td>
<td></td>
<td></td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>SI rising time</td>
<td>trSI</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI falling time</td>
<td>tfSI</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI setup time</td>
<td>tsSI</td>
<td>120</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SI hold time</td>
<td>thSI</td>
<td>190</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK rising time</td>
<td>trSCLK</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK falling time</td>
<td>tfSCLK</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK High width</td>
<td>twSCLKH</td>
<td>200</td>
<td>450</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK Low width</td>
<td>twSCLKL</td>
<td>200</td>
<td>450</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal frequency</td>
<td>fEXTCOMIN</td>
<td>1</td>
<td>20</td>
<td></td>
<td>Hz</td>
<td>Remark 6-3</td>
</tr>
<tr>
<td>EXTCOMIN signal rising time</td>
<td>trEXTCOMIN</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal falling time</td>
<td>tfEXTCOMIN</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal High width</td>
<td>twEXTCOMIN</td>
<td>1</td>
<td></td>
<td></td>
<td>us</td>
<td></td>
</tr>
<tr>
<td>DISP rising time</td>
<td>trDISP</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>DISP falling time</td>
<td>tfDISP</td>
<td>50</td>
<td></td>
<td></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

SCS

SI

SCLK

EXTCOMIN signal

EXTCOMIN

DISP signal

DISP

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

Table 6-4

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Condition 1</td>
<td></td>
<td></td>
<td>T.B.D</td>
<td></td>
<td>uW</td>
<td>[Remark 6-4]</td>
</tr>
<tr>
<td>Measurement Condition 2</td>
<td></td>
<td></td>
<td>T.B.D</td>
<td></td>
<td>uW</td>
<td>[Remark 6-4]</td>
</tr>
</tbody>
</table>

* Measurement Condition 1
  Display mode (no display data update), Display pattern:  Vertical stripe display

* Measurement Condition 2
  Data update mode (with display data update:  1Hz)
  Common inversion with VDD=5V, VDDA=5V, fSCLK=1MHz, fSCS=1Hz, 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
  marging 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 ena inal 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.)

<table>
<thead>
<tr>
<th>Data write period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data is being stored in 1st latch block of binary driver on panel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data transfer period</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

- 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=“L”, 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 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= 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")

<table>
<thead>
<tr>
<th>SCS</th>
<th>tsSCS</th>
<th>tV</th>
<th>twSCSH</th>
<th>tV</th>
<th>twSCSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>tsSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCLK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. 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.
6-6) Input Signal and Screen Display, Gate Address (Line) Setup

Data screen display position \( H, V \)

---

### Gate Line Address Setup

<table>
<thead>
<tr>
<th>Line</th>
<th>AG0</th>
<th>AG1</th>
<th>AG2</th>
<th>AG3</th>
<th>AG4</th>
<th>AG5</th>
<th>AG6</th>
<th>AG7</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L2</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L3</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td></td>
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<tr>
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<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>L238</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L239</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L240</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>
### Table 7-1

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewing Angle CR ∘ 5</td>
<td>H</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>°(Degree)</td>
<td>Remark 7-1</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>°(Degree)</td>
<td></td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>CR.</td>
<td>TBD</td>
<td>14</td>
<td></td>
<td></td>
<td>REMARK 7-2, 3</td>
</tr>
<tr>
<td>Reflection Ratio</td>
<td>R</td>
<td>20</td>
<td></td>
<td></td>
<td>%</td>
<td>REMARK 7-3</td>
</tr>
<tr>
<td>Response Speed Rise</td>
<td>r</td>
<td>50</td>
<td></td>
<td></td>
<td>ms</td>
<td>REMARK 7-3, 4</td>
</tr>
<tr>
<td>Response Speed Fall</td>
<td>d</td>
<td>50</td>
<td></td>
<td></td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>Panel Surface Chromaticity</td>
<td>White</td>
<td>x</td>
<td>0.312</td>
<td></td>
<td></td>
<td>REMARK 7-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>y</td>
<td>0.329</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remark 7-3** Optical Characteristics Measurement Equipment
Contrast ratio, reflective ratio and panel surface chromaticity are measured as shown in figure 7-2, and Response speed is measured as shown in Figure 7-3. Both measurement methods are done in dark Room or equivalent.


Figure 7-2 Measurement of contrast, reflective ratio and panel surface chromaticity
Remark 7-1 Definition of Viewing Angle

Remark 7-2 Definition of Contrast Ratio
Defined as shown in below formula

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

Remark 7-4 Definition of Response Speed (Reflection Ratio Change)
Input signal for white and black as shown below and define by the change in time it takes for optical receiver output.

Figure 7-3 Measurement of response speed
8. Outline Dimension

Figure 8-1  2.7” WQVGA Monochrome Outline Dimension

<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

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>  SMK (Top Contact)  FP12 series  CFP-4510-0150F
9. External Circuit Example

Figure 9-1 External Circuit (Recommended)

< Recommended Capacitor >

C1: Between DISP-VSS, B characteristics 0.1uF ceramic capacitor
C2: Between VDDA-VSS, B characteristics 0.1uF or more cerac capacitor
C3: Between VDD-VSS, B characteristics 1uF or more 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. External Power Supply Circuit

An external power supply circuit is necessary to drive the memory LCD with 3V battery.

Table 10-1 shows recommended power supply ICs.

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Model No.</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SII</td>
<td>S-8821</td>
<td>Charge pump type</td>
</tr>
<tr>
<td>National Semiconductor</td>
<td>LM2750</td>
<td>Charge pump type</td>
</tr>
</tbody>
</table>

Remark 10-1: For detailed specification, refer to specification for each power supply IC.
Remark 10-2: To use, set constant value after sufficient evaluation of actual application.

Electrical Characteristics

Table 10-2

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Vin [V]</th>
<th>Vout</th>
<th>Iout [A]</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-8821</td>
<td>2.8</td>
<td>4.9</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>LM2750</td>
<td>2.7</td>
<td>4.8</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>5.6</td>
<td>5.2</td>
<td></td>
</tr>
</tbody>
</table>

Remark 10-3: For detailed specification, refer to specification for each power supply IC.
Remark 10-4: To use, set constant value after sufficient evaluation of actual application.

Reference Circuit

Reference circuit is shown below.
11. **Packaging**

11-1 Lot number

Will be indicated on serial number label as indicated in Figure 11-1 outline dimension figure.

Serial number specification

- Last digit of the year
- Month and date of manufacture
- 5 digit consecutive numbers

---

Figure 11-1 Serial number print location
11-2) Package Storing

- Maximum number of carton in a stack: 8 cartons
- Maximum quantity of units in carton: 800 units per carton

- Storage condition
  - Temperature: 0~40°C
  - Humidity: 60%RH or lower (at 40°C)
  
  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.

11-3) Packaging

Packaging condition is shown in Figure 11-2.

Figure 11-2 Packaging Condition
12. Reliability Test Conditions

12-1) Reliability test items

Table 12-1 Reliability test items

<table>
<thead>
<tr>
<th>Test items</th>
<th>Test condition</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 High temperature storage</td>
<td>Ta=80 °C</td>
<td>240h</td>
</tr>
<tr>
<td></td>
<td>(Non-operating)</td>
<td></td>
</tr>
<tr>
<td>2 Low temperature storage</td>
<td>Ta=-30 °C</td>
<td>240h</td>
</tr>
<tr>
<td></td>
<td>(Non-operating)</td>
<td></td>
</tr>
<tr>
<td>3 High temperature/humidity</td>
<td>Tp=40 °C/95%RH</td>
<td>240h</td>
</tr>
<tr>
<td>operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 High temperature</td>
<td>Tp=70 °C</td>
<td>240h</td>
</tr>
<tr>
<td>operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Low temperature operation</td>
<td>Tp=-20 °C</td>
<td>240h</td>
</tr>
<tr>
<td>6 Heat shock</td>
<td>Ta=-30 °C (1h)~+80 °C (1h)/cycle=5cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Non-operating)</td>
<td></td>
</tr>
<tr>
<td>7 Electrostatic discharge</td>
<td>±200V, 200pF(0 nF) 1 time/each terminal</td>
<td></td>
</tr>
</tbody>
</table>

【Note】Ta=Surrounding temperature, Tp=Panel temperature

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

12-2) Panel surface stress specification

“Force of stress [N]” without display failure (display non-uniformity) is defined as follow:
Load testing (minimum): 120[N] or higher

Test conditions) Module: LCD panel
Load point: LCD panel center (glass cloth tape applied in load point area)
Press jig: □ 10mm cylinder
Press speed: 1mm/minute
Support: Secured on stage
Press time: Hold for 5 seconds after reaching test press load and then release