DEVICE SPECIFICATION FOR

LCD Module

MODEL No.
LS013B7DH06

These parts are complied with the RoHS directive.

☐ CUSTOMER'S APPROVAL

BY

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SHARP CORPORATION
### RECORDS OF REVISION

**Model No.**: LS013B7DH06

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<td>A</td>
<td>First edition</td>
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l) The device in the production is based on RoHS instructions 95/02. And RoHS instructions materials and chlorinated paraffin are not included intentionally.

[Handling Instructions]

【Handling Precautions】

(1) Treat LCD module in dustless surroundings.

(2) Be sure to turn off the power supply when remove the plugged FPC.

(3) Be careful not to give any physical stress onto the circuit of LCD module when you plug a FPC. Physical stress will cause a break or worse connection.

(4) Do not touch or scratch the polarizer with items harder than the surface rating or permanent damage can result.

(5) Since the LCD panel is made of glass, it may break or crack if dropped or bumped on hard surface. Always handle with care.

(6) Be careful to handle this LCD panel in order to avoid injury yourself as this panel is made of glass and have sharp edge. When the panel is broken, do not touch the glass. Although the panel is difficult to be scattered, touching the broken part may hurt your hands.

(7) Since a long contact with water may cause discoloration or spots, wipe it with absorbent cotton or other soft cloth immediately.

(8) This module contains CGS. Please use appropriate anti-static protection methods for all contact with the LCD panel and its electrical circuits.

(9) Do not expose to strong ultraviolet rays such as direct sunlight for a long time.

(10) Liquid crystal contained in the panel may leak if the LCD is broken. If LC material should accidently come in contact with the mouth or eyes rinse with water as soon as possible, following the instructions of the appropriate MSDS.

(11) Use N2-blower such as ionized nitrogen has anti-electrostatic when you blow dusts on Polarizer. 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.

(12) To avoid picture uniformity failure, do not put a seal or an adhesive material on the LCD panel surface.
【Set-Design Precautions】
(1) Disassembly of the LCD panel in any way voids the warranty and may permanently damage the LCD panel.
(2) Do not expose the side of LCD panel and gate driver, etc. on the panel (circuit area outside panel display area) to light as it may not operate properly. Design that shields the side of LCD panel and gate driver, etc. from light is required when mounting the LCD module.
(3) Support for the LCD panel should be carefully designed to avoid the outside of stress specification on glass surface. Be sure to design the cabinet so that the module can be assembled without any extra stress such as warp or twist.
(4) It causes an irregular display and the defective indication, etc., when always put constant pressure on the back of the module. Please do not make the structure to press the back of the module.
(5) In case of attaching a cover glass or touch panel to the front surface, use appropriate measures to avoid degrading optical performance.
(6) To prevent loss of uniformity and prevent the introduction of contamination to the optical path of the LCD panel, please use fine-pitch filters in the air flow of forced ventilation.
(7) Be sure to follow the absolute maximum rating in the specification. The design should consider the surrounding temperature, the fluctuating input signal, and tolerance of the electronic parts. Exceeding values is possible to cause worse characteristic such as burn and/or broken of the parts on LCD module.
(8) Be sure to use LCD module within the recommended Electrical Characteristics and Timing Characteristics of Input Signals conditions. Operating module out of the recommended range is not guaranteed even if it is in the absolute maximum rating.
(9) Follow the power, signal, and supply voltage sequence which the specification indicates, regarding on-off input signal after power on of LCD module.
(10) According to the using application, power circuit protection is recommended at module failure.
(11) When handling LCD modules and assembling them into the cabinet, please avoid long-term storage in the environment of oxidization or deoxidization gas. The use of materials such as reagent, solvent, adhesive, resin, etc. which generate these gasses, may cause corrosion and discoloration of the modules. Do not use the LCD module under such environment.
(12) To avoid picture uniformity failure, do not put a seal or an adhesive material on the LCD panel surface.
(13) Protection film is attached to the module surface to prevent it from being scratched. Peel the film off slowly, just before the use, with strict attention to electrostatic charges. Blow off 'dust' on the polarizer by using an ionized nitrogen.

After peeling the protection film off, please do not reattach to the front polarizer. If you reattach and store it long time, surface of the front polarizer changes in quality and it may cause display non-uniformity issue.
(14) Panel is susceptible to mechanical stress and such stress may affect the display. Place the LCD panel on flat surface to avoid stress caused by twist, bend, etc.
(15) To prevent reduction in optical quality and abnormal display, avoid exposure and contamination of the LCD panel from epoxy resin (mine system curing agent) that comes out from the material and the packaging material used for the set side, the silicon adhesive (dealcoholization system and oxime system), and the tray blowing agents (azo-compound), etc. Please confirm LCD panel compatibility with materials employed in your manufacturing and shipping processes.

(16) Since the LCD panel is made of glass, it may break or crack if dropped or bumped on hard surface. Always handle with care.

(17) Please design part arrangement to consider the heat dissipation not to change the local temperature for module.

(18) This product is not water-proof and dust-proof structure.

(19) 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 conveyor, 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: 100Mohms 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.
【Operation Precautions】

(1) Do not use polychloroprene (CR) with LCD module. It will generate chlorine gas, which will damage the reliability of the connection part on LCD panel.

(2) Be sure to use LCD module within the recommended operating conditions. Operating module out of the recommended range is not guaranteed even if it is in the absolute maximum rating.

(3) When handling LCD modules and assembling them into cabinets, please avoid long-term storage in the environment of oxidization or deoxidization gas. The use of materials such as reagent, solvent, adhesive, resin, etc. which generate these gasses, may cause corrosion and discoloration of the modules. Do not use the LCD module under such environment.

(3) To prevent reduction in optical quality and abnormal display, avoid exposure and contamination of the LCD panel from epoxy resin (amine system curing agent) that comes out from the material and the packaging material used for the set side, the silicon adhesive (dealcoholization system and oxime system), and the tray blowing agents (azo-compound), etc.

Please confirm LCD panel compatibility with materials employed in your manufacturing and shipping processes.

(4) If stored at the temperatures lower than the rated storage temperature, the LC may freeze and it may cause LCD panel damage. And if stored at the temperatures higher than the rated storage temperature, the LC will lose its characteristics, and it cannot recover. Please keep it at near room temperature.

(5) Do not operate the LCD panel under outside of electrical specification. Otherwise LCD panel may be damaged.

(6) Do not use the LCD panel under outside of specified driving timing chart. Otherwise LCD panel may not have proper picture quality.

(7) 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.

(8) 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.

(9) It is neither a breakdown nor a defective indication though very slight change in black level might be periodically seen in a black part on the black display image according to the source of light (angle of the luminance and the source of light).

(10) Be sure to follow the absolute maximum rating in the specification. The design should consider the surrounding temperature, the fluctuating input signal, and tolerance of the electronic parts. Exceeding values is possible to cause worse characteristic such as burn and/or broken of the parts on LCD module.

(11) Follow the power, signal, and supply voltage sequence which the specification indicates, regarding on-off input signal after power on of LCD module.

(12) According to the using application, power circuit protection is recommended at module failure.

(13) Nature of dew consideration prevention is necessary when LCD is used for long time under high-temperature and high-humidity.
. [Precautions for Storage]

(1) After opening the package, do not leave the LCD panel in direct sun or under strong ultraviolet ray. Store in the dark place.

(2) In temperature lower than specified rating, liquid crystal material will coagulate. In temperature higher than specified rating, it will liquefies. 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-GND, VDDA-GND) impedance is lowered during use, bus controller should be inserted near LCD module as much as possible.

(3) Polarizer 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 polarizer.

(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. If mouth or eyes come in contact with liquid crystal, rinse with water as soon as possible, following the instructions of the appropriate MSDS.

(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

Follow the regulations when LCD module is scrapped. The government you stay may have some regulations about it.

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.
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1. Applicable Color Memory liquid crystal display

This TFT-LCD module is a reflective active-matrix Color memory liquid crystal display module with CG silicone thin film transistor. Module outline is indicated in Figure 8-1.

2. Characteristics

• Reflective active-matrix with slightly transmissive panel of RGB with aspect ratio of 1:1.
• 1.33” screen has 128 x 128 resolution. (16384 pixels stripe array)
• 1 pixel has RGB each 1bit, the pixel can display 8 colors.
• 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.
• Front polarizer surface is Antiglare.
• With FPC (Applicable connecter : Ref to recommended connecter on Page 26)

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</td>
<td>1.33”</td>
<td>inch</td>
</tr>
<tr>
<td>Viewing Area</td>
<td>23.808(H) × 23.808(V)</td>
<td>mm</td>
</tr>
<tr>
<td>Dot configuration</td>
<td>128(H) x 3(RGB) × 128(V)</td>
<td>Dot</td>
</tr>
<tr>
<td>Dot pitch</td>
<td>0.062(H) × 0.186(V)</td>
<td>mm</td>
</tr>
<tr>
<td>Pixel Array</td>
<td>Stripe Array</td>
<td>-</td>
</tr>
<tr>
<td>Outline Dimension</td>
<td>26.82(W) × 31.3(H) × 0.745(D)</td>
<td>mm</td>
</tr>
<tr>
<td>Mass</td>
<td>1.25 typ</td>
<td>g</td>
</tr>
<tr>
<td>Surface Hardness</td>
<td>at least 3H (initial)</td>
<td>Pencil hardness</td>
</tr>
</tbody>
</table>

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

Table 4-1 Pin description

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Symbol</th>
<th>I/O</th>
<th>Configurations</th>
<th>Function</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCLK</td>
<td>INPUT</td>
<td>NoPull</td>
<td>Serial clock signal</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SI</td>
<td>INPUT</td>
<td>NoPull</td>
<td>Serial data input signal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SCS</td>
<td>INPUT</td>
<td>NoPull</td>
<td>Chip select signal (Active of Hi)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>EXTCOMIN</td>
<td>INPUT</td>
<td>NoPull</td>
<td>External COM inversion signal input (Input Square wave or connect the VSS)</td>
<td>Note 4-2</td>
</tr>
<tr>
<td>5</td>
<td>DISP</td>
<td>INPUT</td>
<td>NoPull</td>
<td>Display ON/OFF signal</td>
<td>Note 4-1</td>
</tr>
<tr>
<td>6</td>
<td>VDDA</td>
<td>POWER</td>
<td>-</td>
<td>Power supply (Analog)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>VDD</td>
<td>POWER</td>
<td>-</td>
<td>Power supply (Digital)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>EXTMODE</td>
<td>INPUT</td>
<td>NoPull</td>
<td>Control mode of COM inversion is select terminal (connect the VDD or VSS)</td>
<td>Note 4-2</td>
</tr>
<tr>
<td>9</td>
<td>VSS</td>
<td>GND</td>
<td>-</td>
<td>GND (Digital)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>VSSA</td>
<td>GND</td>
<td>-</td>
<td>GND (Analog)</td>
<td></td>
</tr>
</tbody>
</table>

※ NoPull : Neither Pulled up or Pulled down.

【Note 4-1】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 "Hi", data in the memory will display, when it’s "Lo", white color will display and data in the memory will be saved.

【Note 4-2】When EXTMODE is "Hi", EXTCOMIN signal is enable.
When EXTMODE is "Lo", serial input flag is enable.
"Hi" mode ; connect the EXTMODE to VDD,
"Lo" mode ; connect the EXTMODE and EXTCOMIN to VSS.

4-1) Recommended Circuit

< EXTMODE="Lo" >
COM Signal Serial Flag Input

< EXTMODE="Hi" >
External COM Signal Input

Figure 4-1 Recommended circuit
5. Absolute Maximum Rating

Table 5-1 Absolute Maximum Rating

<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>Analog</td>
<td>VDDA</td>
<td>-0.3</td>
<td>+5.8</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Logic</td>
<td>VDD</td>
<td>-0.3</td>
<td>+5.8</td>
<td>V [Note 5-1]</td>
</tr>
<tr>
<td>Input signal voltage(high)</td>
<td>VDD</td>
<td></td>
<td></td>
<td></td>
<td>[Note 5-2]</td>
</tr>
<tr>
<td>Input signal voltage(low)</td>
<td>-0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>Tstg</td>
<td>-30</td>
<td>80</td>
<td>°C</td>
<td>[Note 5-3,4]</td>
</tr>
<tr>
<td>Operation Temperature</td>
<td>Topr1</td>
<td>-20</td>
<td>70</td>
<td>°C</td>
<td>[Note 5-4,5]</td>
</tr>
</tbody>
</table>

[Note 5-1] Applies to EXTMODE.
[Note 5-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.
[Note 5-3] Do not exceed this temperature in any parts of module.
[Note 5-4] Maximum wet bulb temperature is 57°C or lower. No condensation is allowed.
[Note 5-5] Condensation will cause electrical leak and may cause the module to not meet this specification.

6. Electrical characteristics

6-1) TFT LCD panel drive

Table 6-1 Recommended operating Condition

<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 voltage</td>
<td>Analog</td>
<td>VDDA</td>
<td>+4.8</td>
<td>+5.0</td>
<td>+5.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Logic</td>
<td>VDD</td>
<td>+4.8</td>
<td>+5.0</td>
<td>+5.5</td>
<td>V [Note 6-1]</td>
</tr>
<tr>
<td>Input signal voltage</td>
<td>Hi</td>
<td>VIH</td>
<td>+2.7</td>
<td>+3.0</td>
<td>&quot;VDD&quot;</td>
<td>V [Note 6-2]</td>
</tr>
<tr>
<td></td>
<td>Lo</td>
<td>VIL</td>
<td>VSS</td>
<td>VSS</td>
<td>VSS+0.15</td>
<td>V</td>
</tr>
</tbody>
</table>

*It can be operated below VDD voltage, however, operation around 3V is recommended.
[Note 6-1] Applies to EXTMODE="Hi"
[Note 6-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.
6-2) Power supply sequence

On Sequence

VDD/VDDA (5V)

Disp

EXTCOMIN

SCS

SI, SCLK

Normal operation

GND

GND

GND

GND

GND

Normal operation

Normal operation

 ※Refer to timing chart and AC timing characteristics for detail
 ※1 ③ and ④ may be opposite
 (however, TCOM polarity inversion will not occur even with EXTCOMIN between DISP="Lo". 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) = “Hi” or write white
 SCLK: Normal Driving

[ON Sequence]

(1) 5V rise time (depends on IC)
(2) Pixel memory initialization
  T2: 1 time 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
   T5: 1 time or more Initialize with M2 (all clear flag) or write all screen white

(6) VA, VB, VCOM initialization time
   T6: 30us or more

(7) 5V falling time (Depends on IC)

(Note) Precautions at ehte time of power on and power off.
※1) When power on, VDD and VDDA are same timem or VDD should be faster than the VDDA.
※2) When power off, VDD and VDDA are same time or VDDA shoud be faster than the VDD.
### 6-3) Input signal characteristics

**Table 6-3-1**  Recommend Operating Conditions and DC Characteristics

<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>1</td>
<td>35</td>
<td>Hz</td>
<td>[Note 6-3]</td>
</tr>
<tr>
<td>Clock frequency</td>
<td>fSCLK</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Vertical Interval</td>
<td>tV</td>
<td>28.6</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>17.5</td>
<td>Hz</td>
<td></td>
</tr>
</tbody>
</table>

[Note 6-3] Please use frame frequency in the range where there are no problems with the display quality.

**Table 6-3-2**  Input Signal timing Parameters

<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>212</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td>Display update mode</td>
</tr>
<tr>
<td>SCS Low duration</td>
<td>twSCSL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>us</td>
<td>Display mode</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>-</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 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>-</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>200</td>
<td>450</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>SCLK Low duration</td>
<td>twSCLKL</td>
<td>200</td>
<td>450</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN signal freq</td>
<td>fEXTCOMIN</td>
<td>1</td>
<td>1</td>
<td>35</td>
<td>Hz</td>
<td>[Note 6-4] [Note 6-5]</td>
</tr>
<tr>
<td>EXTCOMIN rising time</td>
<td>trEXTCOMIN</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN falling time</td>
<td>tfEXTCOMIN</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>EXTCOMIN High duration</td>
<td>thlEXTCOMIN</td>
<td>1</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>

[Note 6-4] When data is written for displaying continuously, EXTCOMIN frequency should be made the same frame frequency or lower.

---

Figure 6-2  EXTCOMIN Signal 1
【Note 6-5】When the display is maintained after writing of the displayed data, is not applied.
(Please keep SCS in the state of L when you maintain current display after writing of the display data.)

Figure 6-3 EXTCOMIN Signal 2

6-4) Signal Timing

※ SCS, SI, SCLK, DISP, EXTCOMIN: 3V input voltage

Figure 6-4 Signal Timing
6-5) Power consumption

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Display mode</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>(no display data update)</td>
<td></td>
<td>25</td>
<td>120</td>
<td>uW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Display pattern : Black display</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[Note 6-5]</td>
</tr>
<tr>
<td>Condition 2</td>
<td>Data update mode with display update 1Hz (1fram/sec)</td>
<td></td>
<td>60</td>
<td>300</td>
<td>uW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Display pattern : Vertical stripe display</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[Note 6-5] [Note 6-6]</td>
</tr>
</tbody>
</table>

[Note 6-5]
- a) SCLK=Lo 、SCS=Lo 、SI=Lo  (after writed Black data)
- b) It measures after writed Black data.

[Note 6-6]
- a) fSCS=1.0Hz （Except in the time of writing, it is set to SCS=Lo .）

Common inversion with VDD=5.0V, VDDA=5.0V, fCLK=1.0MHz, EXTMODE=VDD, EXTCOMIN=1Hz

[ Common Note ]
- a) This is value in steady condition, not the value of peak power at the time of COM operation.
- b) Some marging for power supply is recommended.
- c) We recommend capacitor for VDD and VDDA.

     (If VDD and VDDA are on separate systems, we recommend capacitor for each.)

* LC inversion :
  - LC material is needed alternative polarity driving as changing timing which should be 1Hz.
    ( LC inversion frequency 1Hz is COM frequency 0.5Hz)
  as shown Figure 6-5

![Figure 6-5 COM inversion frequency](image-url)
6-6) Input Signal Timing Chart

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

Updates data of only one specified line.  (M0="Hi", M2="Lo")

![Diagram of data update mode by 1 line]

Figure 6-6 Data update mode by 1 line

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

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

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

DUMMY DATA: Dummy data. It can be “Hi” or “Lo” (“Lo” 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 6-7) Input Signal and Display.
※ M1: Frame inversion flag is enabled when EXTMODE="Lo".
※ When SCS becomes “Lo”, M0 and M2 are cleared.
6-6-2 Data Update Mode (Multiple Lines)

Updates arbitrary multiple lines data. (M0=“Hi”, M2=“Lo”)

**M0:** Mode flag.
- Set for “Hi”. Data update mode (Memory internal data update)
- When “Lo”, display mode (maintain memory internal data).

**M1:** Frame inversion flag.
- When “Hi”, outputs VCOM=“Hi”, and when “Lo”, outputs VCOM=“Lo”.
- When EXTMODE=“Hi”, it can be “Hi” or “Lo”.

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

**DUMMY DATA:** Dummy data. It can be “Hi” or “Lo” (“Lo” 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 6-7) Input Signal and Display.
※ Input data continuously.
※ M1: Frame inversion flag is enabled when EXTMODE=“Lo”.
※ When SCS becomes “Lo”, M0 and M2 are cleared.
6-6-3 Display Mode

Maintains memory internal data (maintains current display). (M0="Lo", M2="Lo")

Figure 6-8  Display mode

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

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

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

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

※ M1: Frame inversion flag is enabled when EXTMODE="Lo"
※ When SCS becomes “Lo”, M0 and M2 are cleared.
6-6-4  All Clear Mode

Clears memory internal data and writes white.  (M0=“Lo”, M2=“Hi”)

M0: Mode flag.
   Set it “Lo”.

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

M2: All clear flag.
   Set it “Hi”

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

※ M1:  Frame inversion flag is enabled when EXTMODE=“Lo”.
※ When SCS becomes “Lo”, M0 and M2 are cleared.
6-6-5 COM Inversion

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

EXTMODE="Lo"

Figure 6-10  COM Inversion (EXTMODE=Lo)

M1: LC polarity inversion flag:

- If M1 is "Hi" then VCOM="Hi" is output.
- If M1 is "Lo" then VCOM="Lo" 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="Hi" (COM inversion timing has two conditions)

Figure 6-11  COM Inversion 1 (EXTMODE=Hi)
Figure 6-12  COM Inversion 2  (EXTMODE=Hi)

②: the EXTCOMIN input during low period of the SCS signal.

※4 LC inversion polarity has been set by the rising edge of EXTCOMIN.

※5 The period of EXTCOMIN should be constant.
6-7) Input Signal and Display, Gate address(Line) Setting

<Data position in display[H,V]>

<table>
<thead>
<tr>
<th>GL</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>
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<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>0</td>
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<td>1</td>
<td>1</td>
<td>0</td>
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<td>1</td>
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</tbody>
</table>

<Gateway address setting>

GL: Gate address line

Display side up

P*: Pixels position
L*: Gate address line

<Block diagram of the pixel>

Consists of 3 dots of RGB

<Color Data Table>

<table>
<thead>
<tr>
<th>Color</th>
<th>DR*</th>
<th>DG*</th>
<th>DB*</th>
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<tbody>
<tr>
<td>Black</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Red</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Green</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Yellow</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Blue</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Magenta</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cyan</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>White</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 6-13 Data position
### 7. Optical specification

#### Table 7-1 Optical specification

<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>Viewing angle range CR ≥ 2</td>
<td>Horizontal: 821,922</td>
<td>40</td>
<td>60</td>
<td>-</td>
<td>°(degree)</td>
<td>[Note 7-1]</td>
</tr>
<tr>
<td></td>
<td>Vertical: 611</td>
<td>40</td>
<td>60</td>
<td>-</td>
<td>°(degree)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>612</td>
<td>40</td>
<td>60</td>
<td>-</td>
<td>°(degree)</td>
<td></td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>CR</td>
<td>15</td>
<td>24</td>
<td>-</td>
<td></td>
<td>[Note 7-2, 3]</td>
</tr>
<tr>
<td>Reflectivity ratio</td>
<td>R</td>
<td>6.5</td>
<td>8.5</td>
<td>-</td>
<td>%</td>
<td>[Note 7-3]</td>
</tr>
<tr>
<td>Transmissivity ratio</td>
<td>T</td>
<td>-</td>
<td>0.15</td>
<td>-</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td>Rise: τr</td>
<td>-</td>
<td>10</td>
<td>20</td>
<td>ms</td>
<td>[Note 7-3, 4]</td>
</tr>
<tr>
<td></td>
<td>Fall: τd</td>
<td>-</td>
<td>20</td>
<td>40</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>Panel Chromaticity</td>
<td>White: x</td>
<td>-</td>
<td>0.30</td>
<td>-</td>
<td></td>
<td>[Note 7-3]</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td>-</td>
<td>0.34</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red: x</td>
<td>-</td>
<td>0.41</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>y</td>
<td>-</td>
<td>0.31</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green: x</td>
<td>-</td>
<td>0.30</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>y</td>
<td>-</td>
<td>0.40</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blue: x</td>
<td>-</td>
<td>0.21</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>y</td>
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<td>0.28</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTSC ratio</td>
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<td>6.0</td>
<td>-</td>
<td>%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Note 7-1] Definition of Viewing Angle

![Figure 7-1 Definition of Viewing Angle](image-url)
[Note 7-2] Definition of Contrast Ratio

The contrast ratio is defined as the following.

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

[Note 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 equipment to a dark room.
[Note 7-4] 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.

Figure 7-4  Respons time
8. Module outline

8-1) Outline dimension of the 1.33” (128 x 128) panel
The outline dimensions are shown in Figure 8-1 (Page.32)

![Module outline diagram]

Table 8-1  Recommended Connector No.1 (Bottom side)

<table>
<thead>
<tr>
<th>Product manufacturer</th>
<th>Series</th>
<th>Part number</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panasonic</td>
<td>Y5B</td>
<td>AYF531035</td>
<td>Bottom side (Bottom and Upper)</td>
</tr>
<tr>
<td>SMK</td>
<td>FP12</td>
<td>CFP-4610-0150F</td>
<td>Bottom side</td>
</tr>
</tbody>
</table>

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

![FPC Bend Specification diagram]

【Note 8-1】Do not bend backward (toward polarizer film side)
【Note 8-2】Bend frequency: 3 times or less (Repeat bend condition: 180° ~ 0°)
Table 8-2  Recommended Connector No.2  ( Upper side )

<table>
<thead>
<tr>
<th>Product manufacturer</th>
<th>Series</th>
<th>Part number</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panasonic</td>
<td>Y5B</td>
<td>AYF531035</td>
<td>Upper side (Bottom and Upper)</td>
</tr>
<tr>
<td>SMK</td>
<td>FP12</td>
<td>CFP-4510-0150F</td>
<td>Upper side</td>
</tr>
</tbody>
</table>

9. Display Qualities

Please refer to the outgoing Inspection Standard.

10. External capacitors

![Diagram of external capacitors]

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCLK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SCS</td>
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<td></td>
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</tr>
<tr>
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<td>EXTCOMIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DISP</td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>VDDA</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>VDD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>EXTMODE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>VSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>VSSA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10-1  External capacitor recommendation capacity value

<Recommended capacity value>

C1: DISP – VSS : rank B  0.1uF Ceramic capacitor
C2: VDDA- VSSA : rank B  1.0uF Ceramic capacitor
C3: VDD – VSS : rank B  1.0uF 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.)
11. Marking

11-1) Displayed by printing. (Ink-jet print)

The display position is shown in Figure. 11-1 Outline dimension diagram.

Display contents

<table>
<thead>
<tr>
<th>Line</th>
<th>Making</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YMDDP</td>
<td>Y : Single-digit year (Last digit of the year) (0,1,- - 8,9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M : Single-digit Month (1,2,--,9,X,Y,Z)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DD : Digit of the day (01,--,31)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P : Code of manufacture</td>
</tr>
<tr>
<td>2</td>
<td>01234A</td>
<td>01234 : Five-digit in Consecutive number (Traceability number)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A : Product revision</td>
</tr>
</tbody>
</table>
12. Packaging form

12-1) Carton storage condition

1) Piling number of cartons. : 8
2) Package quantity in one carton : 1120 pcs
3) Carton size (Typ.) : 528 mm x 363 mm x 228 mm
4) Total mess : 6.8kg
   (One carton filled with (1120) modules)
5) Carton store environment:
   • Temperature:
     0～40℃
   • 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.
   • 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.
   • Direct sunlight
     Please keep the product in a dark room or cover the product to protect from direct sunlight.
   • Atmospheric condition
     Please refrain from keeping the product with possible corrosive gas or volatile flux.
   • Prevention of dew
     Do not place directly on the floor, and please store the product carton either on a wooden pallet or a stand to avoid dew condensation. In order to obtain moderate ventilation in the pallet's bottom surfaces, arrange correctly in the fixed direction.
     Please place the product cartons away from the storage wall. Be careful of the inside of a warehouse to ventilate well and please consider installation of a ventilator. Manage to rapid temperature change under natural environment.
   • Vibration
     Please refrain from keeping the product in the place which always has vibration.
   • Storage Period:
     Within above mentioned conditions, maximum storage period should be 3 months
12-2) Packaging form figure

The packing condition is shown in Figure. 12-1

The packaging is designed such that the module does not break during transit.

Figure. 12-1  Packaging Form
13. Reliability Test Conditions

13-1) Reliability Test Items

Table 13-1 Reliability Test Items

<table>
<thead>
<tr>
<th>No.</th>
<th>Test Item</th>
<th>Condition</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High temperature storage test (Non operating test)</td>
<td>$T_a=80^\circ C$</td>
<td>240h</td>
</tr>
<tr>
<td>2</td>
<td>Low temperature storage test (Non operating test)</td>
<td>$T_a=-30^\circ C$</td>
<td>240h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No condensation)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>High temperature and high humidity operating test</td>
<td>$T_p=40^\circ C/95% RH$</td>
<td>240h</td>
</tr>
<tr>
<td>4</td>
<td>High temperature operating test</td>
<td>$T_p=70^\circ C$</td>
<td>240h</td>
</tr>
<tr>
<td>5</td>
<td>Low temperature operating test</td>
<td>$T_p=-20^\circ C$</td>
<td>240h</td>
</tr>
<tr>
<td>6</td>
<td>Thermal Shock test (Non operating test)</td>
<td>$T_a=-30^\circ C$ (1h)~+80 ^\circ C$ (1h) / 5 cycle</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Electro static discharge test</td>
<td>±200V, 200pF(0Ω) each terminal: 1 time (contact mode)</td>
<td></td>
</tr>
</tbody>
</table>

(Note) $T_a$ = Ambient temperature  
$T_p$ = Panel surface temperature

Result Evaluation Criteria

Under the display quality test conditions with normal operation state, these shall be no change which may affect practical display function.

(*)normal operation state : Temperature:15～35°C, Humidity:45～75%, Atmospheric pressure:86～106kpa)
Figure 8-1 Module outline