

Product Information

ISSUE DATE : 00-11-18
MODEL : LTM213U3-L02

NOTE : This product information is subject to change after 3 months of issuing date

PREPARED BY : AMLCD Application Engineering Group

SAMSUNG ELECTRONICS CO., LTD.



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GENERAL DESCRIPTION

DESCRIPTION

LTM213U3-L01 is a color active matrix TFT(Thin Film Transistor) liquid crystal display(LCD) that uses amorphous silicon TFT as a switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 21.3" contains 1600 x 1200 pixels and can display up to 16.7 million colors with wide viewing angle of 80° of higher in all directions. 6 o'clock direction is the optimum viewing angle.

FEATURES

- High contrast ratio, High aperture structure
- CE(Coplanar Electrode) Mode
- Wide Viewing Angle
- High speed response
- UXGA(1600x1200 pixels) resolution
- Low power consumption
- 6 CCFTs(Cold Cathode Fluorescent Tube)
- DE Only Mode
- Open LDI(DS90CF388)

APPLICATIONS

- Workstation & High end Desktop monitors
- Display terminals for AV application products
- Monitors for Industrial machine

General Information

| ITEM | SPECIFICATION | UNIT | NOTE |
|-------------------|--------------------------------------|-------|------|
| Display area | 432(H) x324(V) (21.3 inch diagonal) | mm | |
| Driver element | a-si TFT active matrix | | |
| Display colors | 16.7M (True 8-bit) | | |
| Number of pixel | 1600 x 1200 | pixel | |
| Pixel arrangement | RGB vertical stripe | | |
| Pixel pitch | 0.27(H) x 0.27(W) | mm | |
| Display Mode | Normally Black | | |
| Surface treatment | Haze 25% , Hard - Coating (3H) | | |



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Mechanical Information

| ITEM | | MIN. | TYP. | MAX. | NOTE |
|-----------------------|----------------|------|-------|---------|------|
| Module size | Horizontal (H) | - | 483.0 | - | mm |
| | Vertical (V) | - | 373.2 | - | mm |
| | Depth (D) | - | - | 30 | mm |
| Weight (W/O inverter) | | - | - | (5,000) | g |

1. ELECTRICAL ABSOLUTE RATINGS

1.1 TFT LCD MODULE

(V_{SS} = GND = 0 V)

| ITEM | SYMBOL | MIN. | MAX. | UNIT | NOTE |
|----------------------|-----------------|----------------------|-------|------|------|
| Power Supply Voltage | V _{DD} | V _{SS} -0.5 | (6.0) | V | (1) |

NOTE (1) Within Ta (25 ± 2 °C)

1.2 BACK-LIGHT UNIT

Ta = 25 ± 2 °C

| ITEM | SYMBOL | MIN. | MAX. | UNIT. | NOTE |
|----------------|----------------|-------|-------|-------------------|------|
| Lamp current | I _L | (3.0) | (7.0) | mA _{rms} | (1) |
| Lamp frequency | f _L | (30) | (60) | KHz | (1) |

NOTE (1) Permanent damage to the device may occur if maximum values are exceeded.
Functional operation should be restricted to the conditions described under Normal Operating Conditions.



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2. OPTICAL CHARACTERISTICS

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (4).

Measuring equipment : TOPCON BM-5A, BM-7

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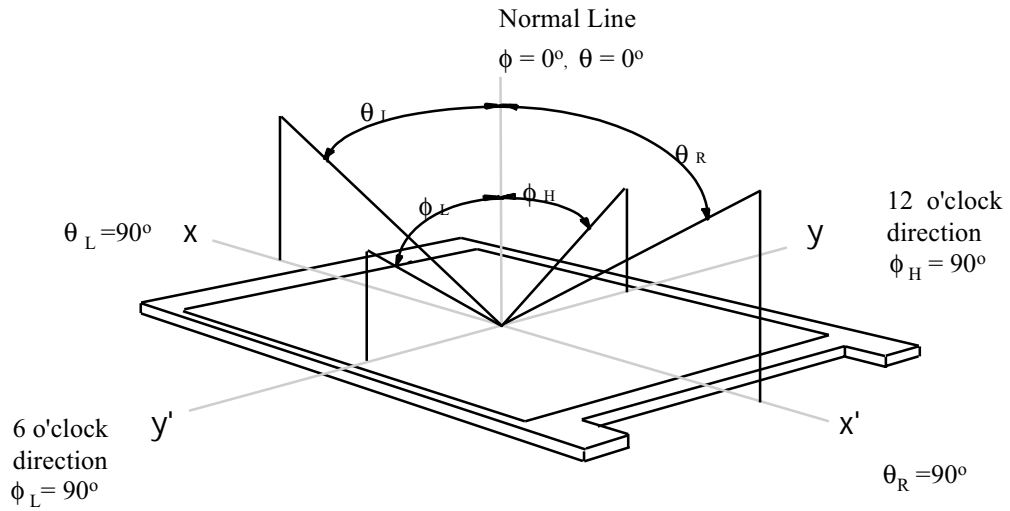
* Ta = 25±2°C , V_{DD} = 5.0V, fv= 60Hz, fdCLK=81MHz, IL = 6.5 mArms

| ITEM | | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT | NOTE |
|--|---------|----------------|---|---------|-------|------|-------------------|---------------|
| Contrast Ratio (Center of screen) | | CR | $\phi = 0,$ $\theta = 0$ Normal Viewing Angle | (300) | - | - | | (1), (2), (4) |
| Response Time at Ta | Rising | T _R | | - | (30) | (40) | msec | (1), (3) |
| | Falling | T _F | | - | (30) | (40) | | |
| Luminance of White (Center of screen) | | Y _L | | (200) | - | - | cd/m ² | (1), (4) |
| Color Chromaticity (CIE) | Red | R _X | | - | 0.612 | - | (1), (4) | |
| | | R _Y | | - | 0.345 | - | | |
| | Green | G _X | | - | 0.317 | - | | |
| | | G _Y | | - | 0.554 | - | | |
| | Blue | B _X | | - | 0.148 | - | | |
| | | B _Y | | - | 0.137 | - | | |
| | White | W _X | - | (0.314) | - | | | |
| | | W _Y | - | (0.346) | - | | | |
| Viewing Angle | Hor. | θ_L | CR ≥ 10 | - | 80 | - | Degrees | |
| | | θ_R | | - | 80 | - | | |
| | Ver. | ϕ_H | | - | 80 | - | | |
| | | ϕ_L | | - | 80 | - | | |

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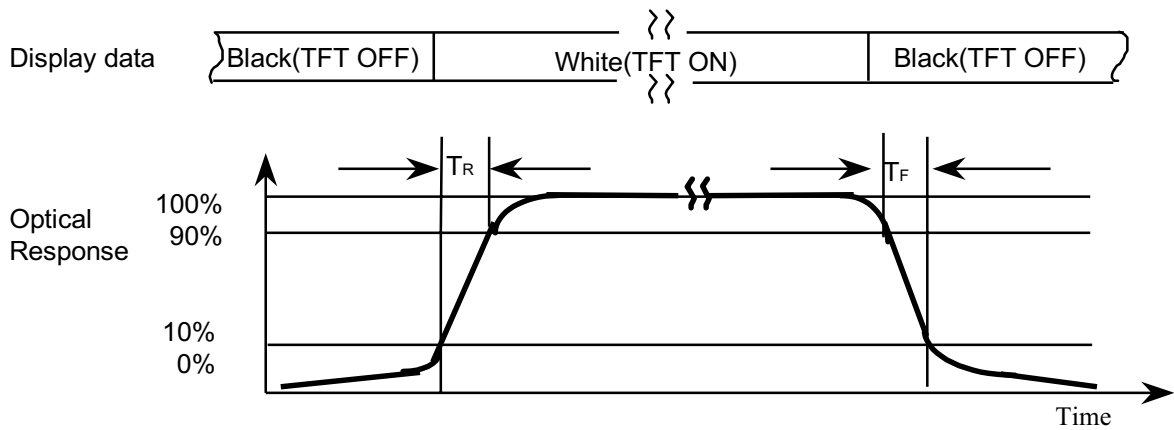
Note 1) Definition of Viewing Angle : Viewing angle range ($10 \leq CR$)



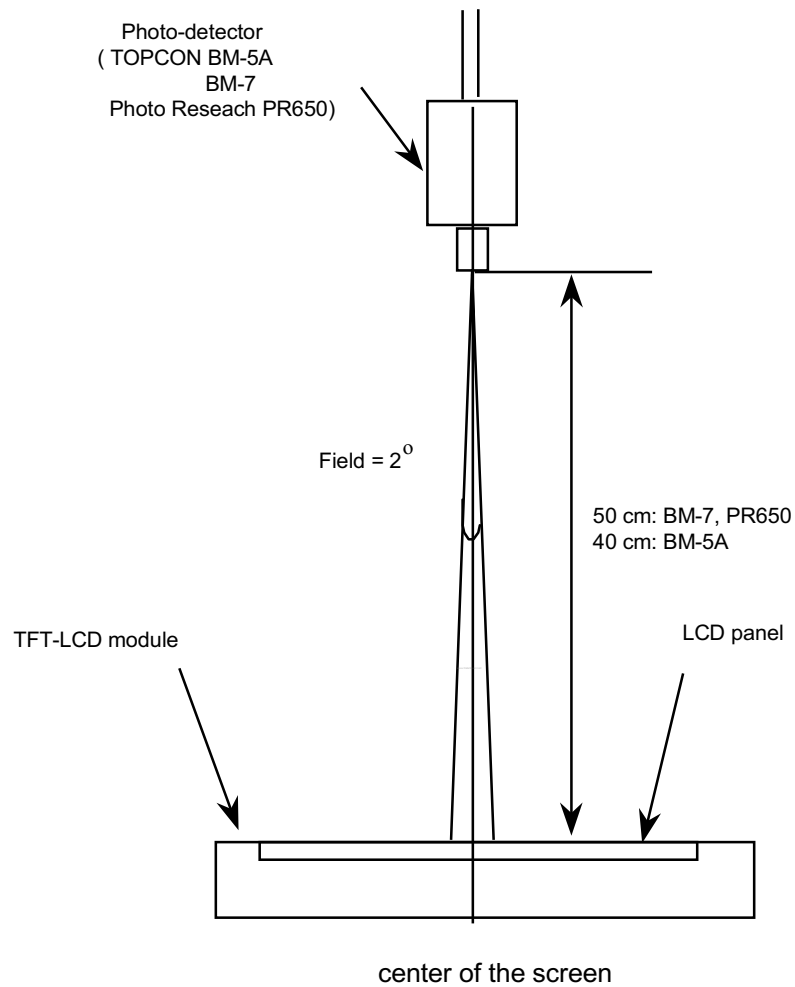
Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at the center of the screen

$$CR = \frac{\text{Luminance with all pixels white (Gmax)}}{\text{Luminance with all pixels black (Gmin)}}$$

Note 3) Definition of Response time : Sum of T_R, T_F



Note 4) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen. Each lamp current : 6.5mA (Refer to the note(1) in the page 10 for more information.) Environment condition : $T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$



Optical characteristics measurement setup

3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE

Ta= 25 ± 2 °C

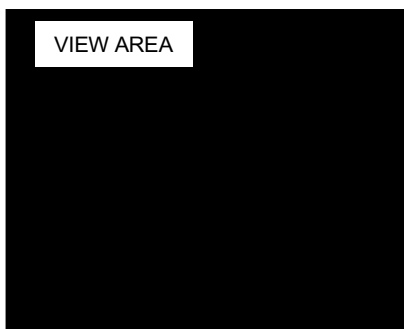
| ITEM | SYMBOL | MIN | TYP | MAX | UNIT | NOTE |
|-------------------------|-------------------|-----|--------|--------|------|----------|
| Voltage of Power Supply | V _{DD} | 4.5 | 5.0 | 5.5 | V | |
| Current of Power Supply | Black | - | (1100) | - | mA | (1)(3)*a |
| | Mosaic | - | (1600) | - | mA | (1)(3)*b |
| | 2line vertical | - | (2100) | (2300) | mA | (1)(3)*c |
| Vsync Frequency | f _V | - | 60 | - | Hz | |
| Hsync Frequency | f _H | - | 75 | - | kHz | |
| Main Frequency | f _{DCLK} | - | 81 | - | MHz | (2) |
| Rush Current | I _{rush} | - | - | (6.0) | A | (4) |

Note (1) f_V=60Hz, f_{DCLK} =81MHZ, V_{DD} = 5.0V, DC Current.

(2) Main pixel clock frequency is the value which is measured at the input of Timing controller.

(3) Power dissipation check pattern(LCD Module only)

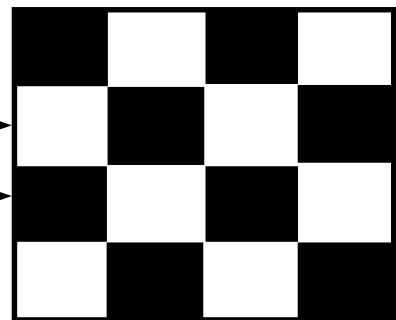
*a) Black Pattern



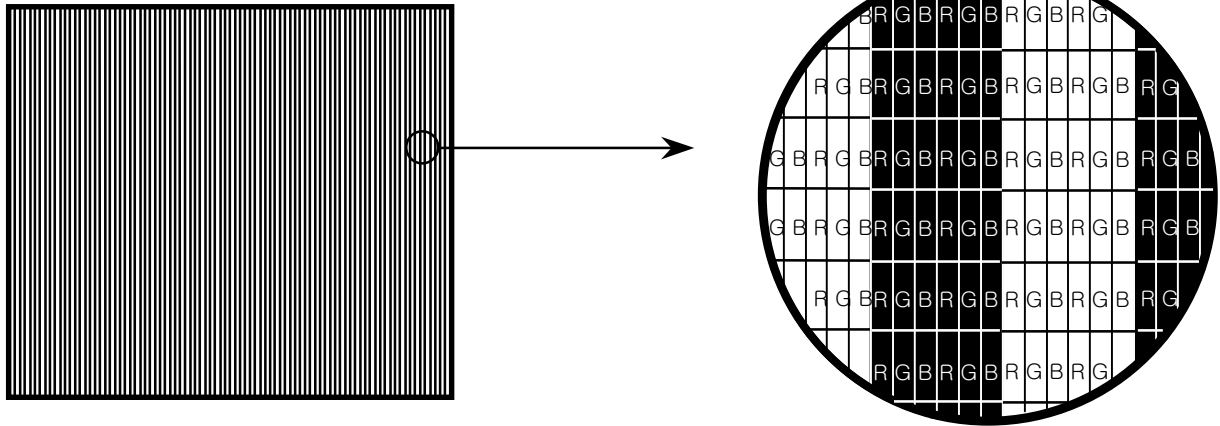
Display Brightest Gray Level →

Display Darkest Gray Level →

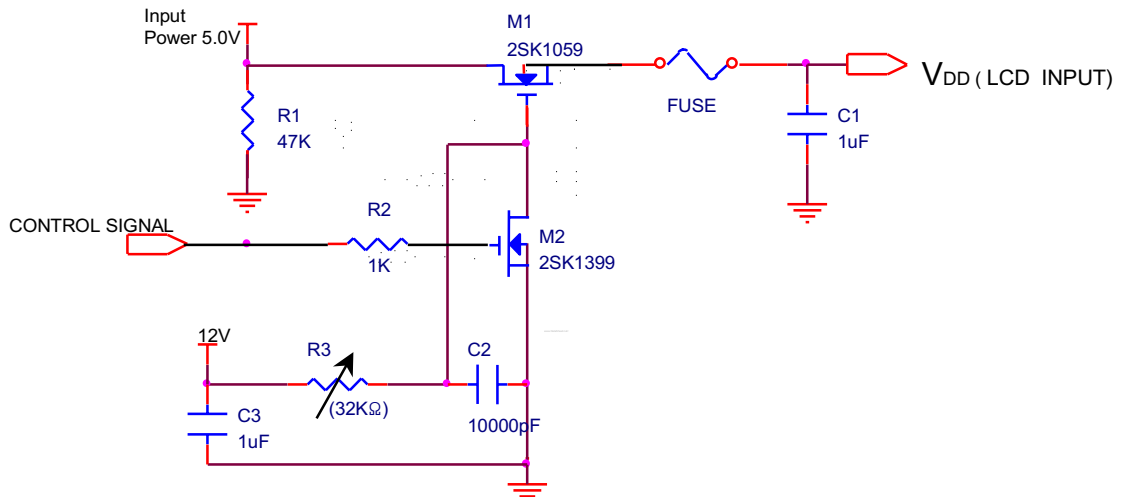
*b) Mosaic Pattern



*c) 2line Vertical stripe pattern



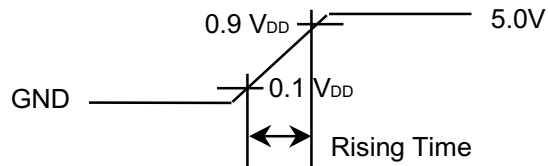
(4) Measurement Conditions



Note : Control Signal : High(+5.0V) -->Low(Ground)

All Signal lines to panel except for power 5.0V : Ground

The rising time of supplied voltage is controlled to 470us by R3 and C2 value.



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3.2 BACK - LIGHT UNIT

The back-light system is an edge-lighting type with 6 CCFTs(Cold Cathode Fluorescent Tube). The characteristics of each lamp is shown in the following tables.

Ta=25±2°C

| ITEM | SYMBOL | MIN | TYP | MAX | UNIT | NOTE |
|---------------------|----------------|-------|-------|---------------|-------------------|-----------------------|
| Lamp Current | I _L | (6.2) | (6.5) | (6.8) | mA _{rms} | (1) |
| Lamp Voltage | V _L | - | (860) | - | V _{rms} | |
| Lamp Frequency | f _L | (30) | - | (60) | kHz | (2) |
| Operating Life Time | H _r | (TBD) | - | - | Hour | (3) (25 °C) (0 °C) |
| Startup Voltage | V _s | - | - | (1300)(25 °C) | V _{rms} | (4) |
| | | | | (1800) (0 °C) | | |

Note) The method of measurement's inverter should be used PWM(Pulse Width Modulation).

The waveform of the inverter output voltage must be area symmetric and the design of the inverter must have specifications for the modularized lamp.

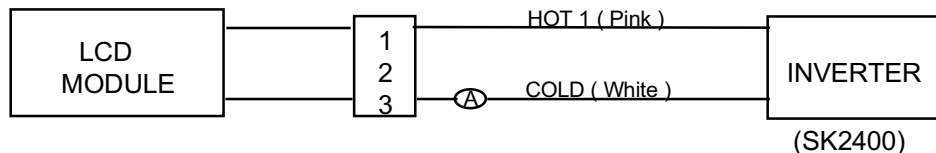
The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(miss lighting, flicker, etc.) never occur. When you confirm it, the module should be operated in the same condition as it is installed in your instrument.

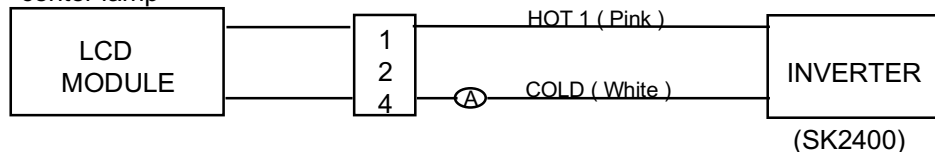
Note (1) Lamp current is measured with current meter for high frequency as shown below.

Refer to the block diagram of the back-light unit in the next page for more information.

* side lamps



* center lamp



(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of Ta=25±2°C and I_L = 6.5mA_{rms} for each lamp until the brightness becomes 50% or lower than it's original value.

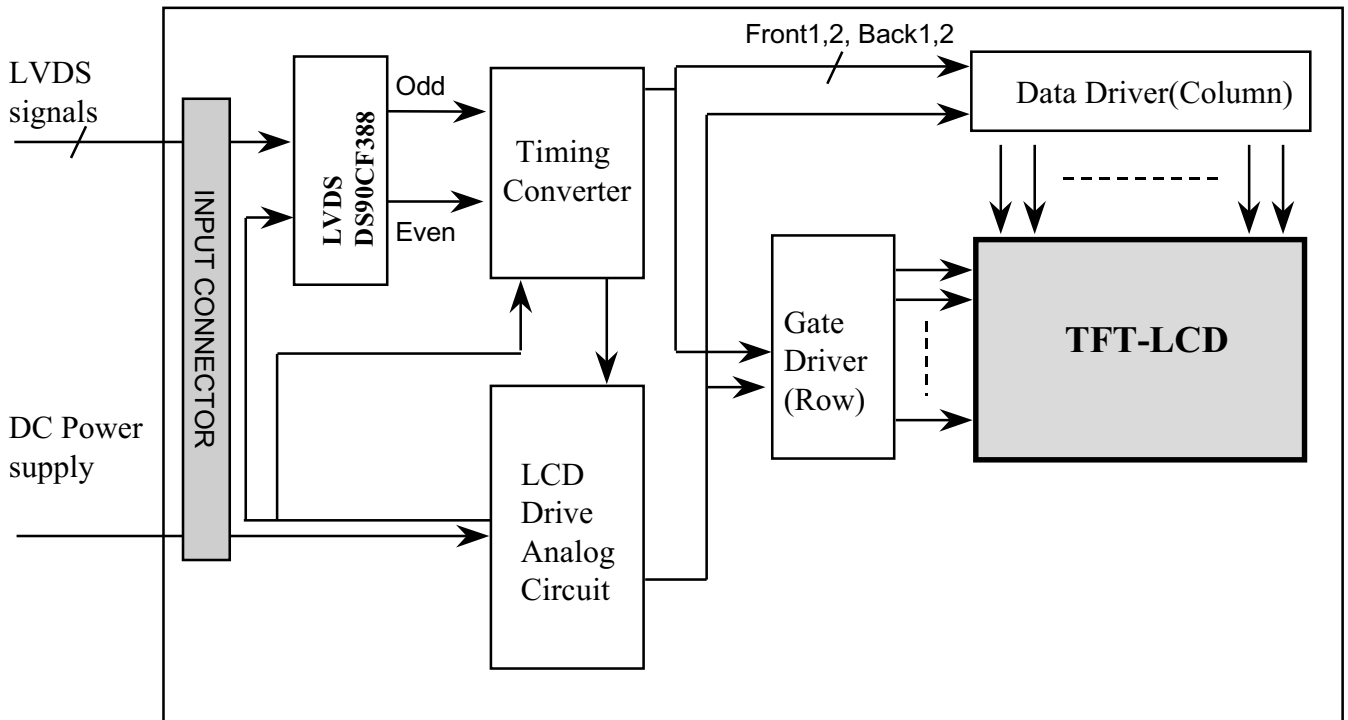
(4) The voltage above this value should be applied to the lamps for more than 1 second to startup. Otherwise the lamps may not to be turned on.



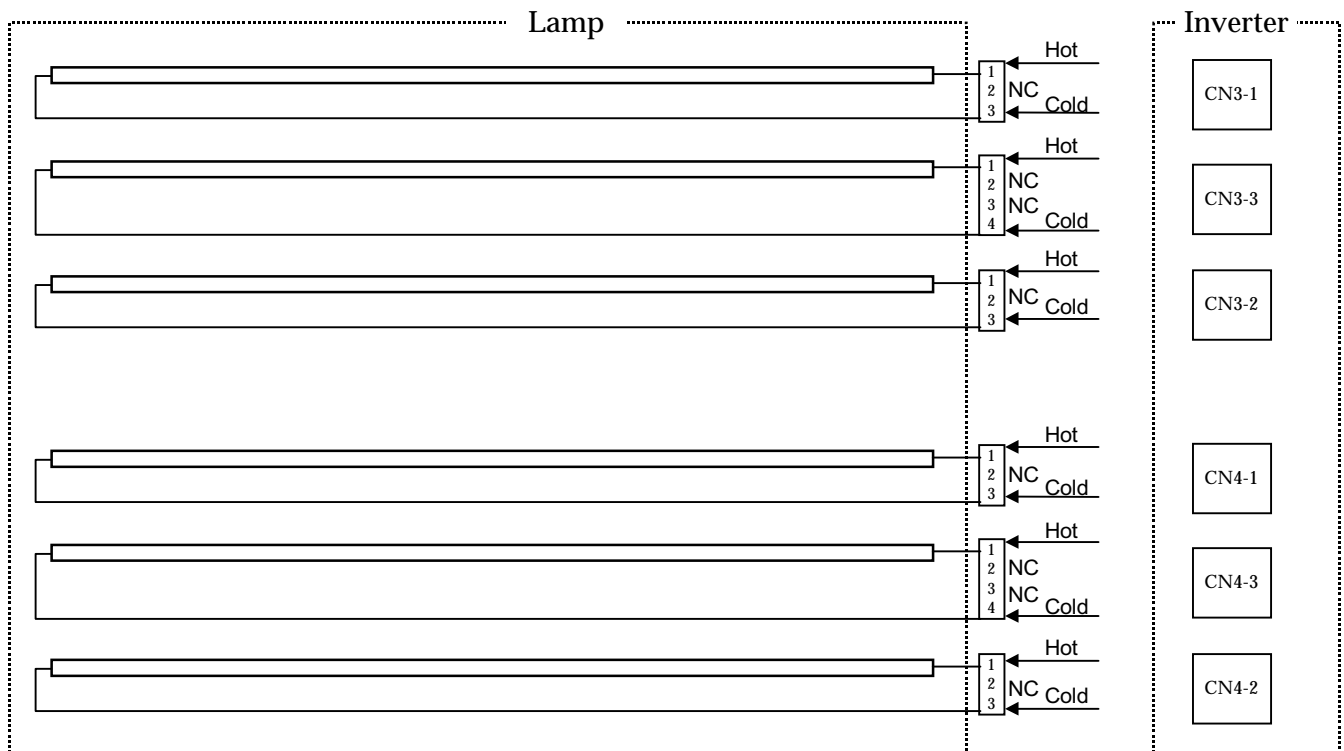
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4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 BACK- LIGHT UNIT



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5. INPUT TERMINAL PIN ASSIGNMENT

5.1. Input Signal (Connector : JAE F1-WE31P-HF)
(Mating Connector :JAE F1-WE31S-HF)

| 387 No. | Tx Signal | JAE31P No. | 388 No. | Rx Signal | Remark |
|---------|-----------|---------------|---------|-----------|--------------|
| | | 31 (Reserved) | | Reserved | Service Port |
| | | 30 (Reserved) | | Reserved | Service Port |
| | | 29 (Reserved) | | Reserved | Service Port |
| | | 28 (Reserved) | | Reserved | Service Port |
| | | 27 (Reserved) | | Reserved | Service Port |
| 28 | TxOut7+ | 26 | 79 | RxOut7+ | Twisted Pair |
| 29 | TxOut7- | 25 | 80 | RxOut7- | |
| | | 24 (GND) | | | Twisted Pair |
| | | 23 (GND) | | | |
| 31 | TxOut6+ | 22 | 82 | RxOut6+ | Twisted Pair |
| 32 | TxOut6- | 21 | 83 | RxOut6- | |
| 33 | TxOut5+ | 20 | 84 | RxOut5+ | Twisted Pair |
| 34 | TxOut5- | 19 | 85 | RxOut5- | |
| 36 | TxOut4+ | 18 | 86 | RxOut4+ | Twisted Pair |
| 37 | TxOut4- | 17 | 87 | RxOut4- | |
| | | 16 (GND) | | | Twisted Pair |
| | | 15 (GND) | | | |
| 38 | TxOut3+ | 14 | 89 | RxOut3+ | Twisted Pair |
| 39 | TxOut3- | 13 | 90 | RxOut3- | |
| 41 | TxOutCLK+ | 12 | 91 | RxOutCLK+ | Twisted Pair |
| 42 | TxOutCLK- | 11 | 92 | RxOutCLK- | |
| | | 10 (GND) | | | Twisted Pair |
| | | 9 (GND) | | | |
| 44 | TxOut2+ | 8 | 94 | RxOut2+ | Twisted Pair |
| 45 | TxOut2- | 7 | 95 | RxOut2- | |
| 46 | TxOut1+ | 6 | 96 | RxOut1+ | Twisted Pair |
| 47 | TxOut1- | 5 | 97 | RxOut1- | |
| 49 | TxOut0+ | 4 | 98 | RxOut0+ | Twisted Pair |
| 50 | TxOut0- | 3 | 99 | RxOut0- | |
| | | 2 (GND) | | | Twisted Pair |
| | | 1 (GND) | | | |



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5.2. Input Power (Connector : Molex 53261-1290)
 (Mating Connector : Molex 51021-1200)

| Pin No | Symbol | Function |
|--------|--------|------------------|
| 1 | +5V | Power Supply +5V |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | GND | Power Ground |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |

5.3 BACK - LIGHT UNIT

| PIN No. | INPUT [ch1] , [ch2] | Color | Function |
|--------------------|--------------------------------|-------|--------------|
| 3-1-1 | HOT | Pink | High Voltage |
| 3-1-2 | N.C. | - | - |
| 3-1-3 | Cold | White | Ground |
| 3-2-1 | HOT | Pink | High Voltage |
| 3-2-2 | N.C. | - | - |
| 3-2-3 | Cold | White | Ground |
| 3-3-1 | HOT | Pink | High Voltage |
| 3-3-2 | N.C. | - | - |
| 3-3-3 | | | |
| 3-3-4 | Cold | White | Ground |
| 4-1-1 | HOT | Pink | High Voltage |
| 4-1-2 | N.C. | - | - |
| 4-1-3 | Cold | White | Ground |
| 4-2-1 | HOT | Pink | High Voltage |
| 4-2-2 | N.C. | - | - |
| 4-2-3 | Cold | White | Ground |
| 4-3-1 | HOT | Pink | High Voltage |
| 4-3-2 | N.C. | - | - |
| 4-3-3 | | | |
| 4-3-4 | Cold | White | Ground |
| Connector Part No. | JST BHR-03VS-1, JST BHR-04VS-1 | | |



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5.4 Input Signal, Basic Display Colors and Gray Scale of Each Colors

| COLOR | DISPLAY | DATA SIGNAL | | | | | | | | | | | | | | | | | | | | | | | | GRAY SCALE LEVEL |
|---------------------|---------|-------------|----|----|----|----|----|----|-------|----|----|----|----|----|----|------|----|----|----|----|----|----|----|----|---------|------------------|
| | | RED | | | | | | | GREEN | | | | | | | BLUE | | | | | | | | | | |
| | | R0 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | G0 | G1 | G2 | G3 | G4 | G5 | G6 | G7 | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | |
| BASIC COLOR | BLACK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | BLUE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| | GREEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | CYAN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| | RED | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | MAGENTA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| | YELLOW | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | WHITE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| GRAY SCALE OF RED | BLACK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R0 | |
| | DARK ↑ | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R1 | |
| | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R2 | |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | R3~R252 |
| | LIGHT ↓ | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R253 | |
| | | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R254 | |
| | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R255 | |
| | RED | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R255 | |
| GRAY SCALE OF GREEN | BLACK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G0 | |
| | DARK ↑ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G1 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G2 | |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | G3~G252 | |
| | LIGHT ↓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G253 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G254 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G255 | |
| | GREEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G255 | |
| GRAY SCALE OF BLUE | BLACK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | B0 | |
| | DARK ↑ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | B1 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | B2 | |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | B3~B252 | |
| | LIGHT ↓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | B253 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | B254 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | B255 | |
| | BLUE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | B255 | |

Note) ▶ Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

▶ Input Signal : 0 = Low level voltage, 1 = High level voltage



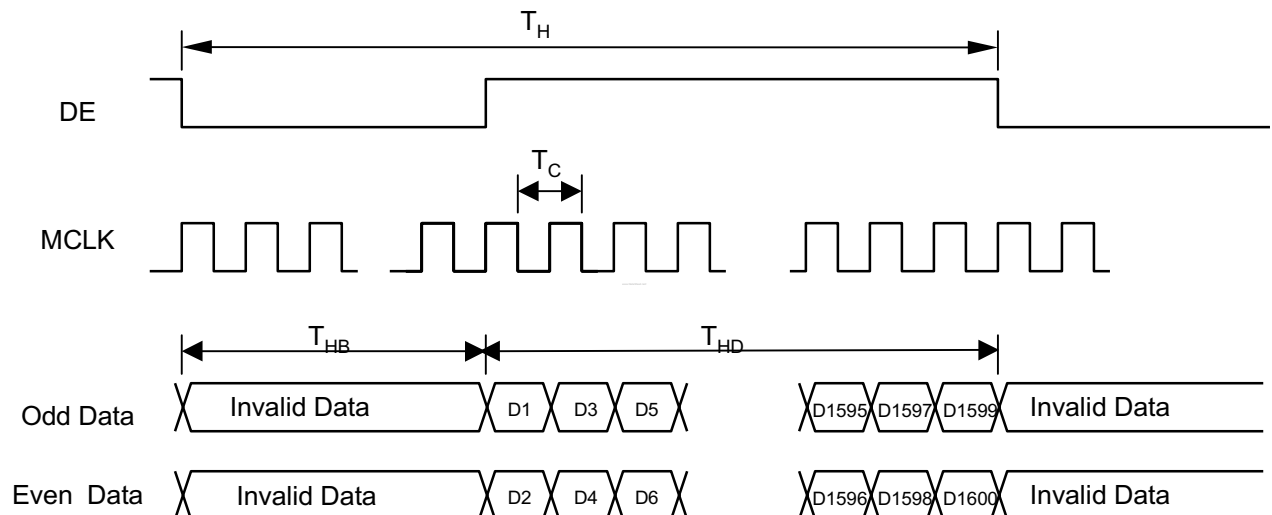
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6. INTERFACE TIMING

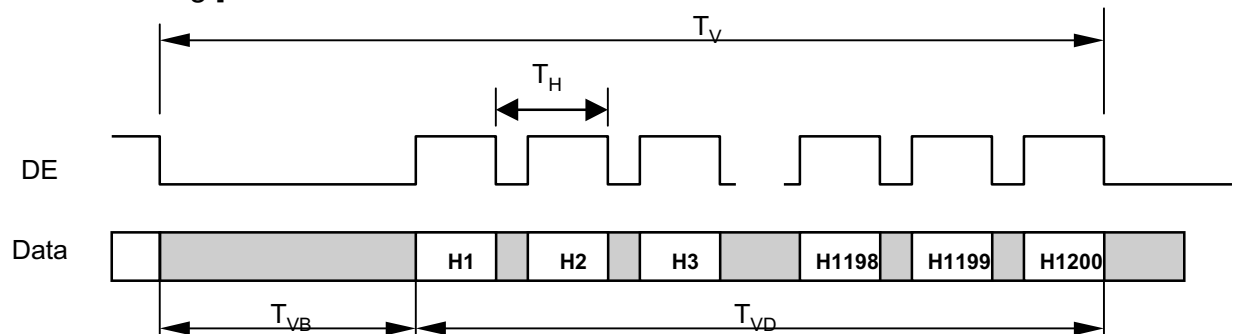
6.1 Timing Parameters and diagram of Interface signal (DE Only Mode)

| Item | Symbol | Min | Typ | Max | Unit |
|-----------------|------------------|-----------------|------|------|--------|
| Clock Frequency | 1/T _c | 60 | 81 | 82 | MHz |
| Horizontal | Total Period | T _H | 1080 | 1090 | Pixels |
| | Active Period | T _{HD} | 800 | 800 | Pixels |
| | Blank Period | T _{HB} | 100 | 280 | Pixels |
| Vertical | Total Period | T _V | - | 1250 | Lines |
| | Active Period | T _{VD} | 1200 | 1200 | Lines |
| | Blank Period | T _{VB} | 8 | - | 50 |

[Horizontal Timing]



[Vertical Timing]

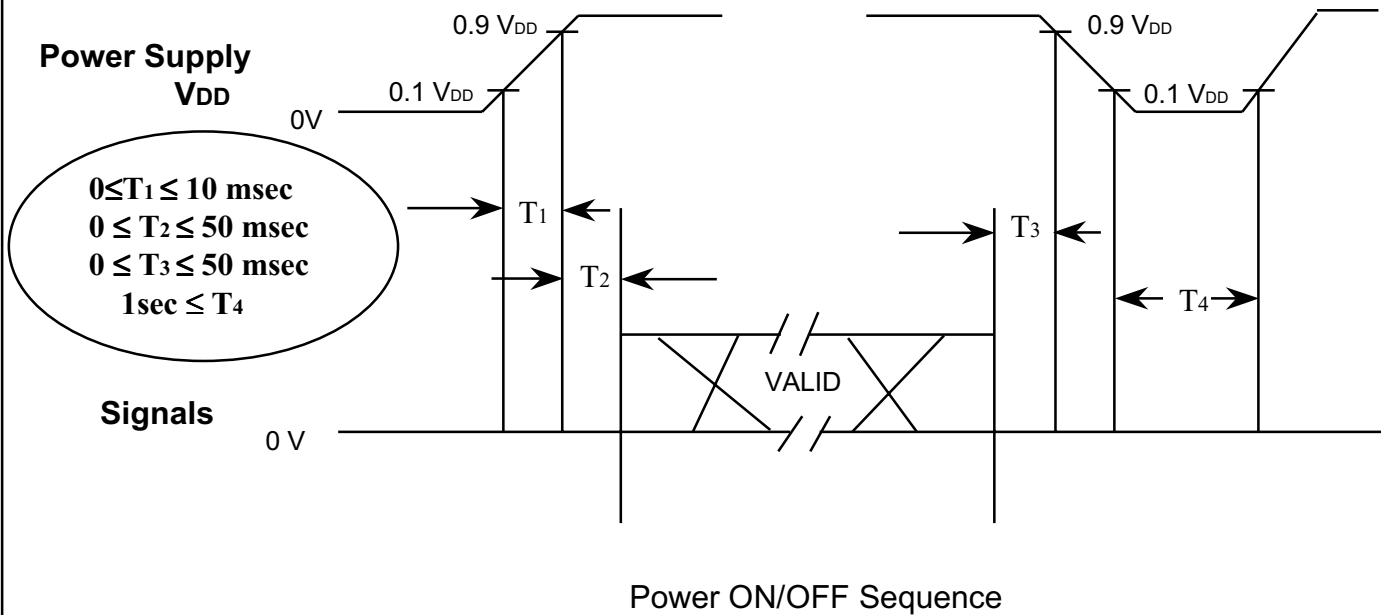


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6.2 Power ON/OFF Sequence

: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the diagram below.



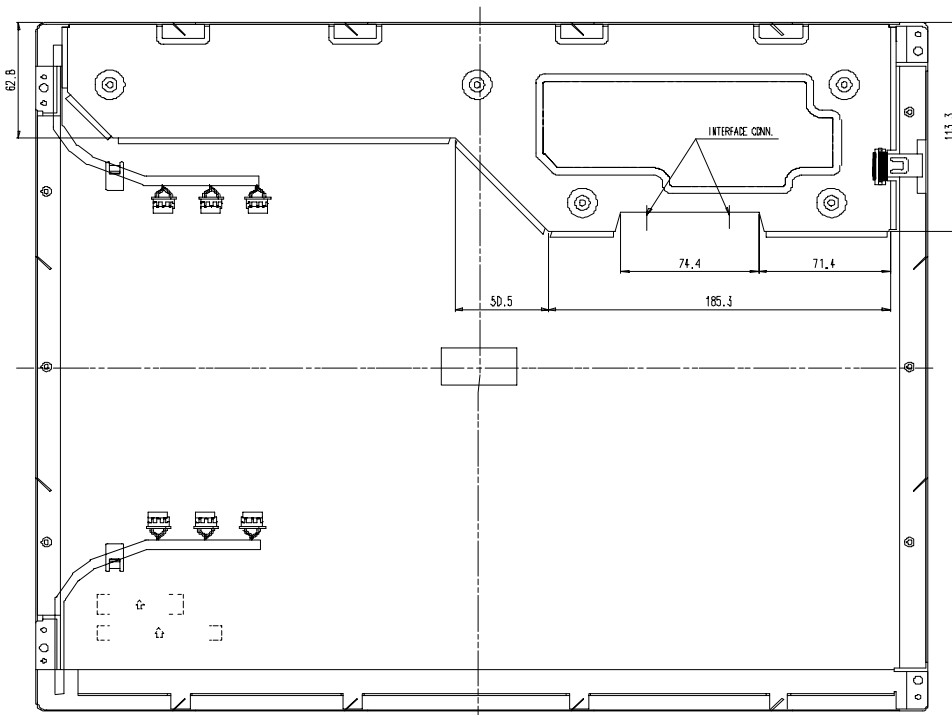
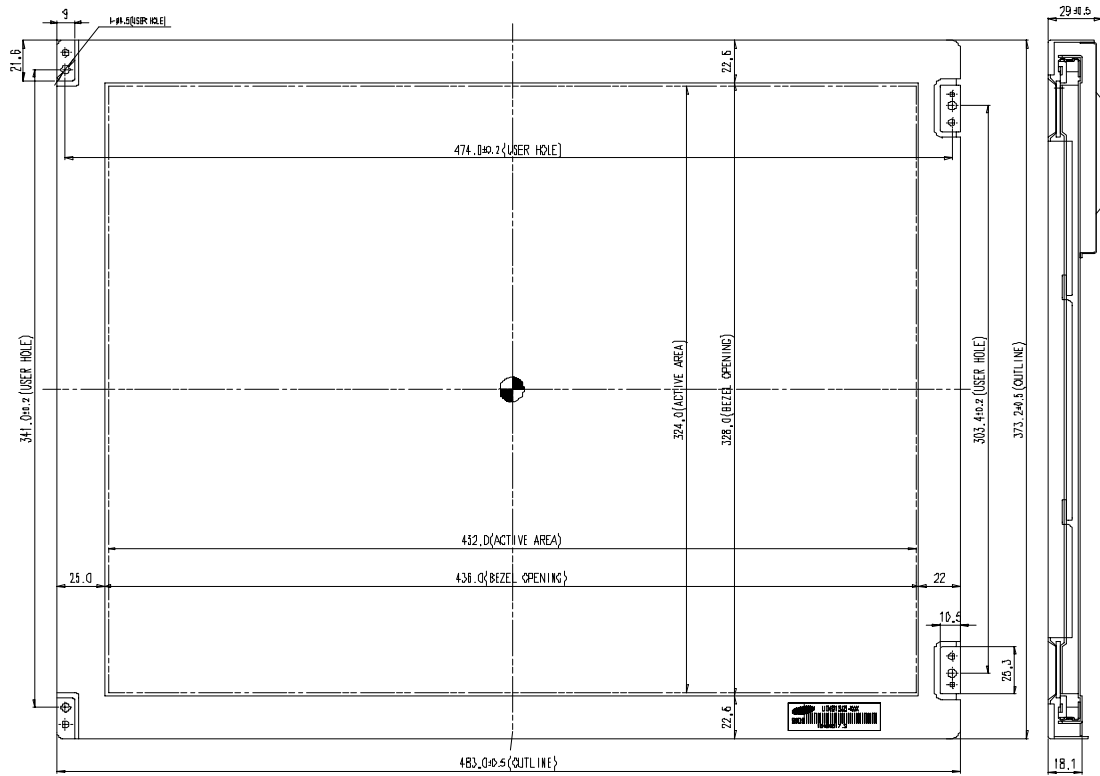
NOTE.

- (1) The supply voltage of the external system for the module input should be the same as the definition of V_{DD}.
- (2) Apply the lamp voltage within the LCD operation range. When the back-light turns on before the LCD operation or the LCD turns off before the back-light turns off, the display may momentarily become white.
- (3) In case of V_{DD} = off level, please keep the level of input signals on the low or keep a high impedance.
- (4) T₄ should be measured after the module has been fully discharged between power off and on period.
- (5) Interface signal shall not be kept at high impedance when the power is on.



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7. OUTLINE DIMENSION



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8. GENERAL PRECAUTIONS

8.1 Handling

- (a) When the module is assembled, It should be attached to the system firmly using every mounting holes. Be careful not to twist and bend the modules.
- (b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFT back-light.
- (c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.
- (d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.
- (e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (f) The desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane. Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (h) Protect the module from static, it may cause damage to the CMOS Gate Array IC.
- (i) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (j) Do not disassemble the module.
- (k) Do not pull or fold the lamp wire.
- (l) Do not adjust the variable resistor which is located on the back side.
- (m) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (n) Pins of I/F connector shall not be touched directly with bare hands.



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8.2 Storage

- (a) Do not leave the module in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35 °C and relative humidity of less than 70%.
- (b) Do not store the TFT-LCD module in direct sunlight.
- (c) The module shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

8.3 Operation

- (a) Do not connect, disconnect the module in the “ Power On” condition.
- (b) Power supply should always be turned on/off by the item 6.3 “ Power on/off sequence “.
- (c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (d) The cable between the back-light connector and its inverter power supply shall be a minimized length and be connected directly . The longer cable between the back-light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

8.4 Others

- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (c) Do not exceed the absolute maximum rating value. (the supply voltage variation, input voltage variation, variation in part contents and environmental temperature, so on) Otherwise the module may be damaged.
- (d) If the module displays the same pattern continuously for a long period of time, it can be the situation when the image “sticks” to the screen.
- (e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.



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