

Product Specification

SPECIFICATION FOR APPROVAL

- () Preliminary Specification
(●) Final Specification

| | |
|-------|---------------------------|
| Title | 23.0" WXGA TFT LCD |
|-------|---------------------------|

| | |
|-------|---------|
| BUYER | General |
| MODEL | |

| | |
|----------|---------------------------------|
| SUPPLIER | LG.Philips LCD Co., Ltd. |
| *MODEL | LC230WX3 |
| SUFFIX | SLA1 |

*When you obtain standard approval,
please use the above model name without suffix

| APPROVED BY | SIGNATURE DATE |
|-------------|----------------|
| / | |
| / | |
| / | |

Please return 1 copy for your confirmation with your signature and comments.

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| J.M.KIM / Manager | |
| PREPARED BY | |
| Y.J.Kim / Engineer | |

**TV Product Development Dept.
LG. Philips LCD Co., Ltd**

Product Specification

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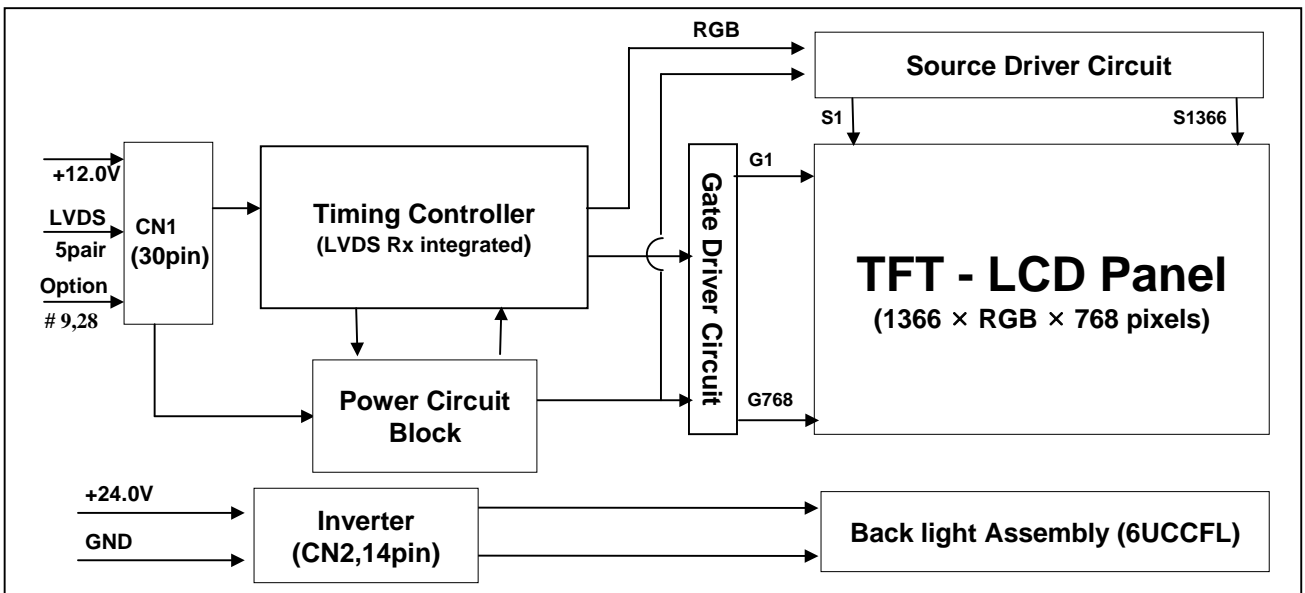
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1. General Description

LC230WX3-SLA1 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(UCCFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 23 inch diagonally measured active display area with WXGA resolution (768 vertical by 1366 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus presenting a palette of more than 16.7M(true) colors.

It has been designed to apply the 8-bit 1 port LVDS interface.

It is intended to support LCD TV, PCTV where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



General Features

| | |
|------------------------|--|
| Active Screen Size | 23 inches (582.96mm) diagonal |
| Outline Dimension | 546.0mm(H) x 318.3mm(V) x 42.1mm(D) (Typ.) |
| Pixel Pitch | 0.124mm x 0.372mm x RGB |
| Pixel Format | 1366 horiz. by 768 vert. pixels RGB stripe arrangement |
| Color Depth | 8-bit, 16.7 M colors |
| Luminance, White | 450 cd/m ² (Center 1 point Typ.) |
| Viewing Angle (CR>10) | Viewing angle free (R/L 178(Typ.), U/D 178(Typ.)) |
| Power Consumption | Total 66.84Watt (Typ.) (Logic=3.24W, Lamp=63.6W [Lamp current=6.5mA]) |
| Weight | 3,800 g (Typ.) 4,000g(Max) |
| Display Operating Mode | Transmissive mode, normally black |
| Surface Treatment | Hard coating(3H), Anti-glare treatment of the front polarizer |

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2. Absolute Maximum Ratings

The followings are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

| Parameter | | Symbol | Value | | Unit | Remark |
|---------------------------------------|--------------------|------------|------------|-----------|------|--------------|
| | | | Min | Max | | |
| Power Input Voltage | LCM | VLCD | -0.3 | 14.0 | Vdc | at 25 ± 2 °C |
| | Backlight inverter | VBL | -0.3 | 27.0 | Vdc | |
| ON/OFF Control Voltage | | VON/OFF | -0.30 | 5.25 | Vdc | |
| Brightness Control Voltage | | Vbr-A | 0.0 | 5.25 | Vdc | |
| Operating Temperature (Ambient Temp.) | | TOP | 0 | 50 | °C | 1 |
| | | Tsur | 0 | 65 | °C | 2 |
| Storage Temperature | | TST | -20 | 65 | °C | 1 |
| Operating Ambient Humidity | | HOP | 10 | 90 | %RH | 1 |
| Storage Humidity | | HST | 10 | 90 | %RH | 1 |

Note : 1. Temperature and relative humidity range are shown in the figure below.

Wet bulb temperature should be 39 °C Max. and no condensation.

2. Abnormal visual problems by panel surface temperature can be occurred in specific range (60 °C ~ 65 °C), But materials(ex : polarizer) are not damaged permanently in this range, T_{sur}.

3. Ambient illuminandc should be more than 10 lux.

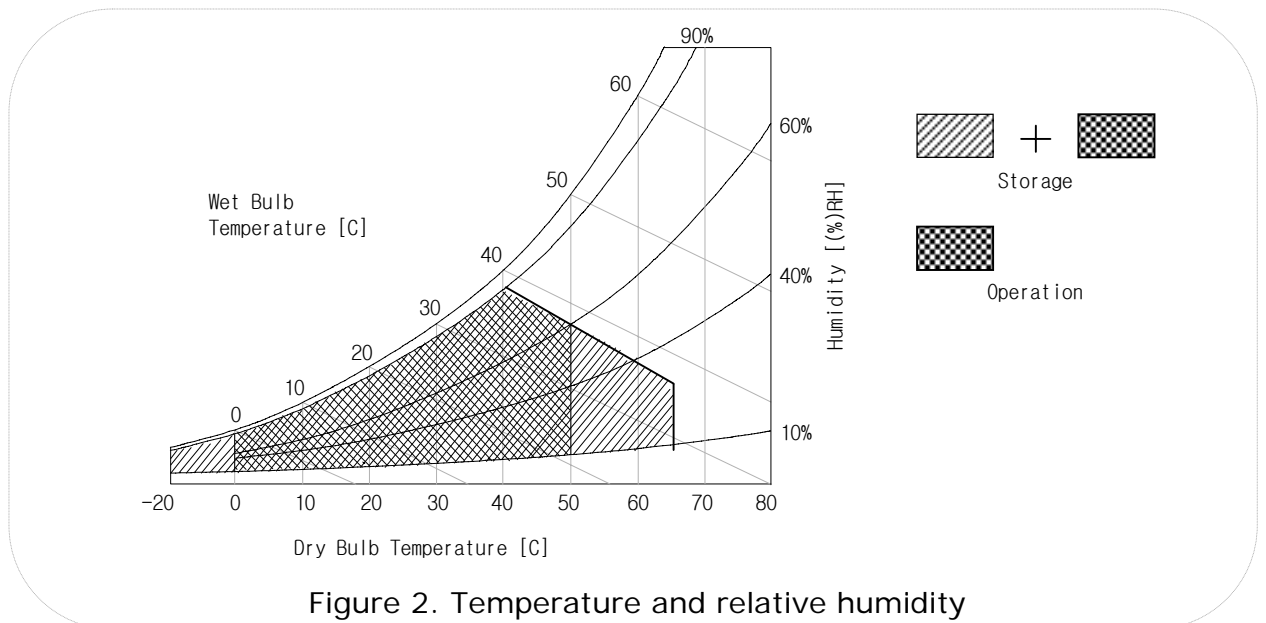


Figure 2. Temperature and relative humidity

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3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The other input power for the UCCFL/Backlight is to power inverter.

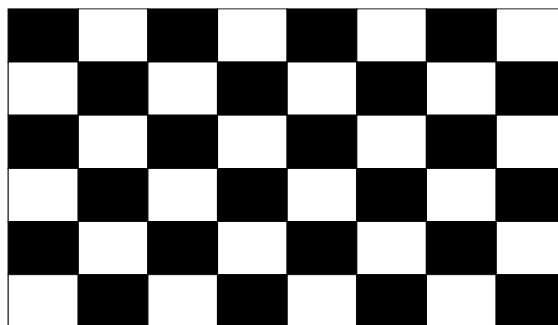
Table 2. ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Value | | | Unit | Note |
|---------------------|-------------------|-------|------|------|-----------------|------|
| | | Min | Typ | Max | | |
| Power Input Voltage | V _{LCD} | 11.4 | 12.0 | 12.6 | V _{DC} | |
| Power Input Current | I _{LCD} | - | 270 | 351 | mA | 1 |
| | | - | 340 | 442 | mA | 2 |
| Power Consumption | P _{LCD} | - | 3.24 | 4.42 | Watt | 1 |
| Rush current | I _{RUSH} | - | - | 3.0 | A | 3 |

Note :

1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

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Table 3. Inverter Electrical Characteristics

| Parameter | Symbol | Condition | Value | | | Unit | Note |
|------------------------------|---------------|---|--------|--------|------|----------|------|
| | | | Min. | Typ. | Max. | | |
| Input Voltage | V_{BL} | | 21.6 | 24.0 | 25.2 | V_{DC} | |
| Input Current | I_{BL} | $V_{BR-A}(max) = 3.3V$ | 2.38 | 2.65 | 2.92 | A | 1, 3 |
| Inrush Current | I_{RUSH} | $V_{BL}=21.6V$ $V_{BR-A}=3.3V$ $EXTV_{BR-B}=100%$ | - | - | 3.82 | A | 5 |
| Power Consumption | P_{BL} | $V_{BR-A} = 3.3V$ | - | 63.6 | 70.1 | Watt | 1, 3 |
| B/L on/off control | $V_{ON/OFF}$ | Lamp ON = High | 2.0 | - | 5.0 | V_{DC} | |
| | | Lamp OFF =Low | 0.0 | - | 0.8 | V_{DC} | |
| Brightness Adj (Analog mode) | V_{BR-A} | | 0 | - | 3.3 | V_{DC} | |
| Brightness Adj (Burst mode) | $EXTV_{BR-B}$ | External Input (PWM) | 20 | - | 100 | % | 4 |
| Frequency (PWM) (Burst mode) | f-B | $V_{BL}=24V$ $EXTV_{BR-B}=PWM$ | - | 180 | - | Hz | 6 |
| Pulse Duty(PWM) (Burst mode) | | High Level | 2.5 | - | 5.0 | V_{DC} | |
| | | Low Level | 0.0 | - | 0.6 | V_{DC} | |
| Lamp Life Time | | | 50,000 | 60,000 | | Hrs | 2 |

Notes :

- The specified current and power consumption are under the typical supply Input voltage, 24.0V.
The ripple voltage of the power supply input voltage is under 0.5 Vp-p.
Inrush current of the power supply input current is under +10% of the typical current
- Specified values are for a single lamp which is aligned horizontally.
The life is determined as the time at which luminance of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at $25 \pm 2^{\circ}C$.
Specified value is when lamp is aligned horizontally.
- Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 2Hrs in a dark environment at $25^{\circ}C \pm 2^{\circ}C$.
- Burst mode is controlled by TV system.
- Rush current is determined at turning on after the unit has been 'OFF' for 2Hrs at $25^{\circ}C \pm 2^{\circ}C$.
- Synchronize PWM by triple with Vsync signal of system.

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3-2. Interface Connections

This LCD employs two kinds of interface connection, a 30-pin connector is used for the module electronics and two 12-pin Connectors are used for the integral backlight system.

3-2-1. LCD Module

- LCD Connector(CN1) : FI-X30SSL-HF (Manufactured by JAE).
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

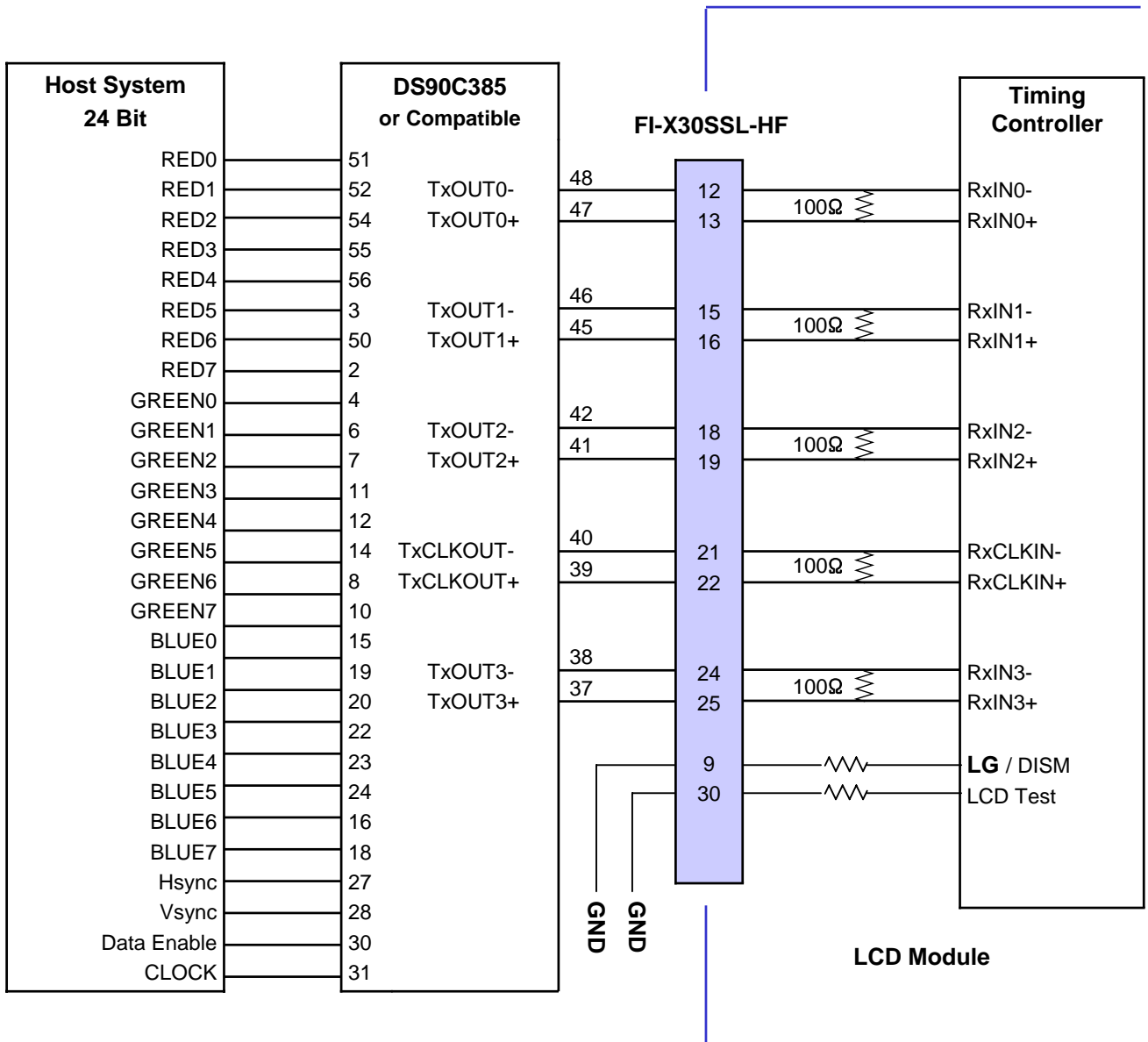
Table 4. MODULE CONNECTOR(CN1) PIN CONFIGURATION

| Pin No. | Symbol | Description | Note |
|---------|---------|-------------------------------|------|
| 1 | VLCD | Power Supply +12.0V | |
| 2 | VLCD | Power Supply +12.0V | |
| 3 | VLCD | Power Supply +12.0V | |
| 4 | VLCD | Power Supply +12.0V | |
| 5 | GND | Ground | |
| 6 | GND | Ground | |
| 7 | GND | Ground | |
| 8 | GND | Ground | |
| 9 | Select | Select LVDS Data format | 1 |
| 10 | NC | NC | |
| 11 | GND | Ground | |
| 12 | RA- | LVDS Receiver Signal(-) | |
| 13 | RA+ | LVDS Receiver Signal(+) | |
| 14 | GND | Ground | |
| 15 | RB- | LVDS Receiver Signal(-) | |
| 16 | RB+ | LVDS Receiver Signal(+) | |
| 17 | GND | Ground | |
| 18 | RC- | LVDS Receiver Signal(-) | |
| 19 | RC+ | LVDS Receiver Signal(+) | |
| 20 | GND | Ground | |
| 21 | RCLK- | LVDS Receiver Clock Signal(-) | |
| 22 | RCLK+ | LVDS Receiver Clock Signal(+) | |
| 23 | GND | Ground | |
| 24 | RD- | LVDS Receiver Signal(-) | |
| 25 | RD+ | LVDS Receiver Signal(+) | |
| 26 | GND | Ground | |
| 27 | NC | NC | |
| 28 | NC | NC | |
| 29 | GND | Ground | |
| 30 | NC(GND) | LCD test | 2 |

- Note:
1. If the pin no. 9 is Ground, Interface format is "LG", and if the pin no. 9 is Vcc(3.3V), Interface format is "DISM". See page 9 and 10.
 2. If pin30 is 3.3V, no-signal is AGP pattern, and if pin30 is ground, no-signal is Black pattern
 3. All GND (ground) pins should be connected together, which should be also connected to the LCD module's metal frame.
 4. All VLCD (power input) pins should be connected together.
 5. Input Levels of LVDS signals are based on the IEA 664 Standard.

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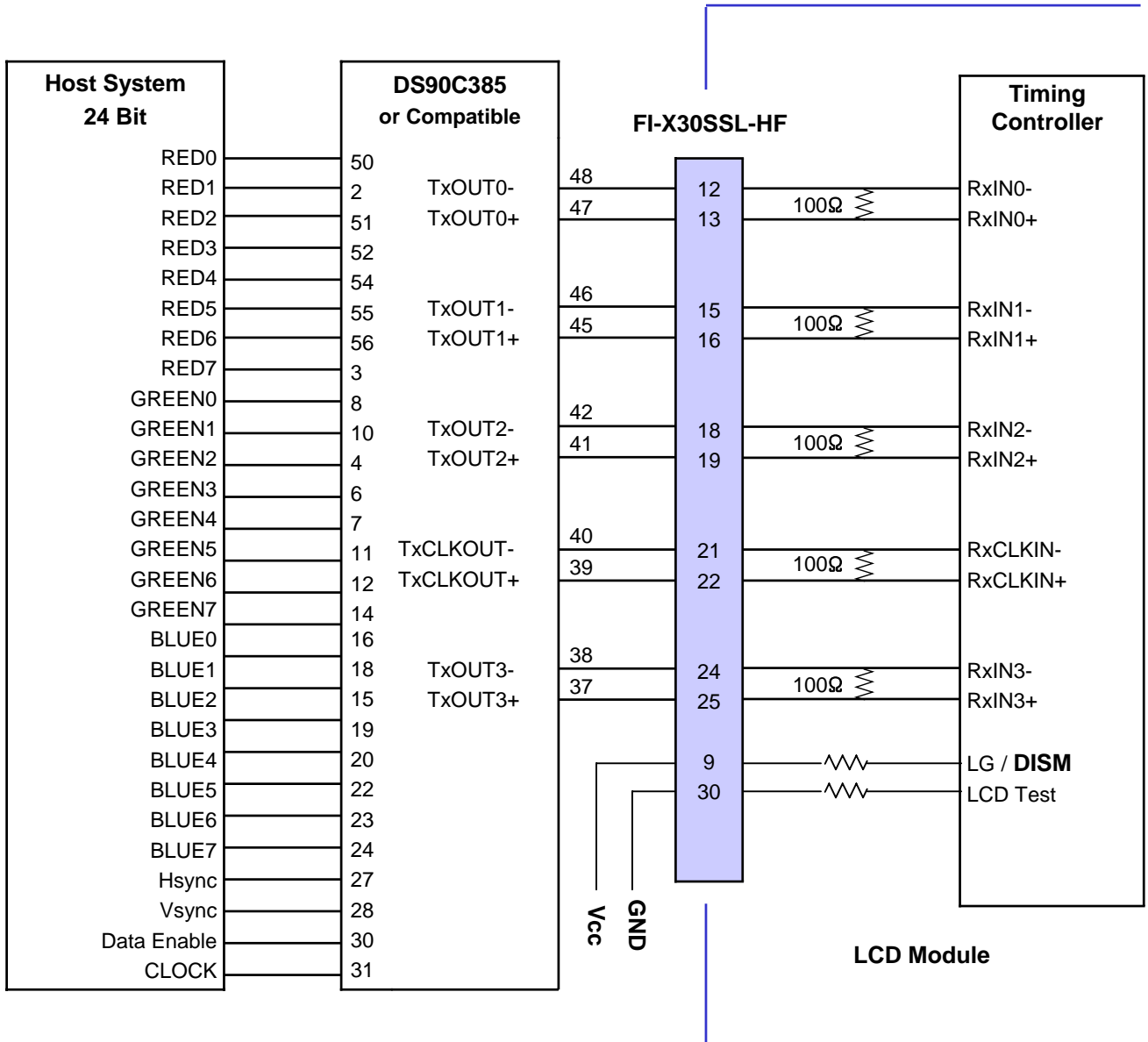
Table 5. REQUIRED SIGNAL ASSIGNMENT FOR LVDS TRANSMITTER (Pin9="L" or "Open")



- Note: 1. The LCD Module uses a 100 Ohm[Ω] resistor between positive and negative lines of each receiver input.
 2. Refer to LVDS Transmitter Data Sheet for detail descriptions. (DS90C385 or Compatible)
 3. '7' means MSB and '0' means LSB at R,G,B pixel data.

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Table 6. REQUIRED SIGNAL ASSIGNMENT FOR LVDS TRANSMITTER (Pin9="H")



- Note: 1. The LCD Module uses a 100 Ohm[Ω] resistor between positive and negative lines of each receiver input.
 2. Refer to LVDS Transmitter Data Sheet for detail descriptions. (DS90C385 or Compatible)
 3. '7' means MSB and '0' means LSB at R,G,B pixel data.

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3-2-2. Backlight Inverter

- Inverter Connector : S14B-PH-SM3 Side entry type (manufactured by JST).
- Mating Connector : PHR-14 or Equivalent

Table 7. INVERTER CONNECTOR PIN CONFIGURATION

| Pin | Symbol | Signal assignment | Note |
|-----|----------------------|--------------------------|--|
| 1 | VBL | 24V Power Input | |
| 2 | VBL | 24V Power Input | |
| 3 | VBL | 24V Power Input | |
| 4 | VBL | 24V Power Input | |
| 5 | VBL | 24V Power Input | |
| 6 | GND | GROUND | 1 |
| 7 | GND | GROUND | |
| 8 | GND | GROUND | |
| 9 | GND | GROUND | |
| 10 | GND | GROUND | |
| 11 | V _{BR-A} | Analog dimming | 0V(min) ~ 3.3V(max) |
| 12 | ON / OFF | Backlight ON/OFF control | ON : 2.4 ~ 5.0V OFF : 0.0 ~ 0.6V |
| 13 | EXTV _{BR-B} | External PWM signal | Rising edge : Lamp on Falling edge : Lamp off |
| 14 | Error out | Backlight status output | Normal : 0V Abnormal : External pull-up |

Note :

1. GND is connected to the LCD module's metal frame.



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3-3. Signal Timing Specifications

This is the signal timing required at the input of LVDS Transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

Table 8. TIMMING TABLE

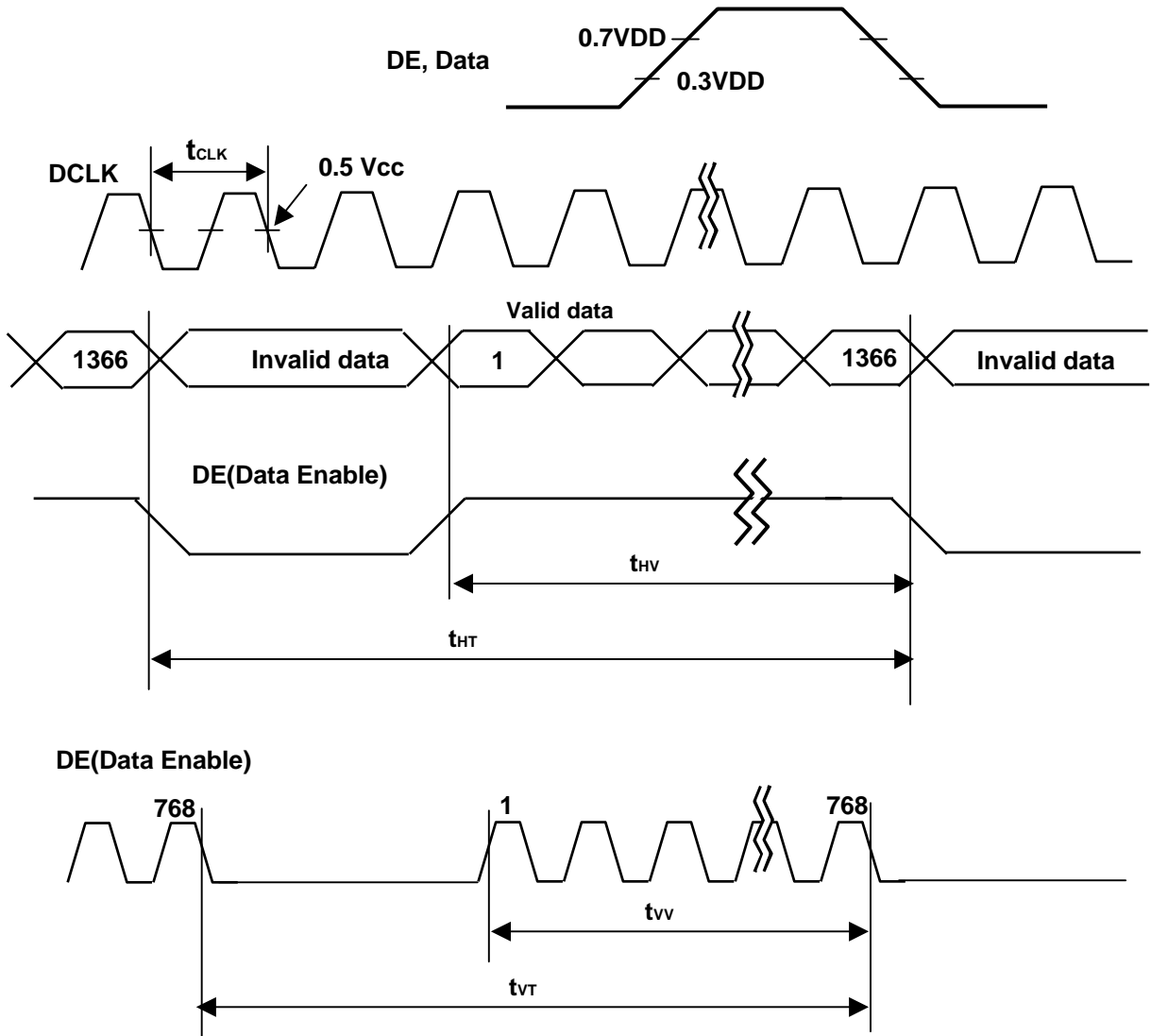
| ITEM | | Symbol | Min. | Typ. | Max. | Unit | Note |
|-------|---------------|-----------------|------|------|-----------|-------|--|
| Clock | Frequency | f_{CLK} | 68 | 72.3 | 82 | MHz | |
| Hsync | Frequency | f_H | 45 | 47.4 | 53 | KHZ | 3 |
| | Display Valid | t_{HV} | 1366 | 1366 | 1366 | Clks | |
| | Blank | $t_{HT}-t_{HV}$ | 90 | 162 | 410 | Clks | |
| | Total | t_{HT} | 1456 | 1528 | 1776 | Clks | |
| Vsync | Frequency | f_V | 47 | 60 | 66 | HZ | 3 |
| | Display Valid | t_{VV} | 768 | 768 | 768 | Lines | PAL : 47~53Hz, NTSC : 57~63Hz |
| | Blank | $t_{VT}-t_{VV}$ | 7 | 22 | 295 | Lines | |
| | Total | t_{VT} | 775 | 790 | 1063 | Lines | |

Notes:

1. The performance of the electro-optical characteristics are may be influenced by variance of the vertical refresh rates.
2. Above timing table is only valid for DE Mode.
3. H sync ,V sync don't care.(for only DE Mode)

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3-4. Signal Timing Waveforms



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3-5. Color Data Reference

The brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 9. COLOR DATA REFERENCE

| Color | | Input Color Data | | | | | | | | | | | | | | | | | | | | | | | |
|-------------|------------------|------------------|----|----|----|-----|----|----|----|-------|----|----|----|-----|----|----|----|------|----|----|----|-----|----|----|----|
| | | RED | | | | | | | | GREEN | | | | | | | | BLUE | | | | | | | |
| | | MSB | | | | LSB | | | | MSB | | | | LSB | | | | MSB | | | | LSB | | | |
| | | R7 | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7 | G6 | G5 | G4 | G3 | G2 | G1 | G0 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| 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 |
| | Red (255) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green (255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue (255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 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 |
| | 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 |
| RED | RED (000) Dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED (001) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ... | ... | | | | | | | | ... | | | | | | | | ... | | | | | | | |
| | RED (254) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED (255) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GREEN | GREEN (000) Dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN (001) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ... | ... | | | | | | | | ... | | | | | | | | ... | | | | | | | |
| | GREEN (254) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN (255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BLUE | BLUE (000) Dark | 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 (001) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | ... | ... | | | | | | | | ... | | | | | | | | ... | | | | | | | |
| | BLUE (254) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| | BLUE (255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

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3-6. Power Sequence

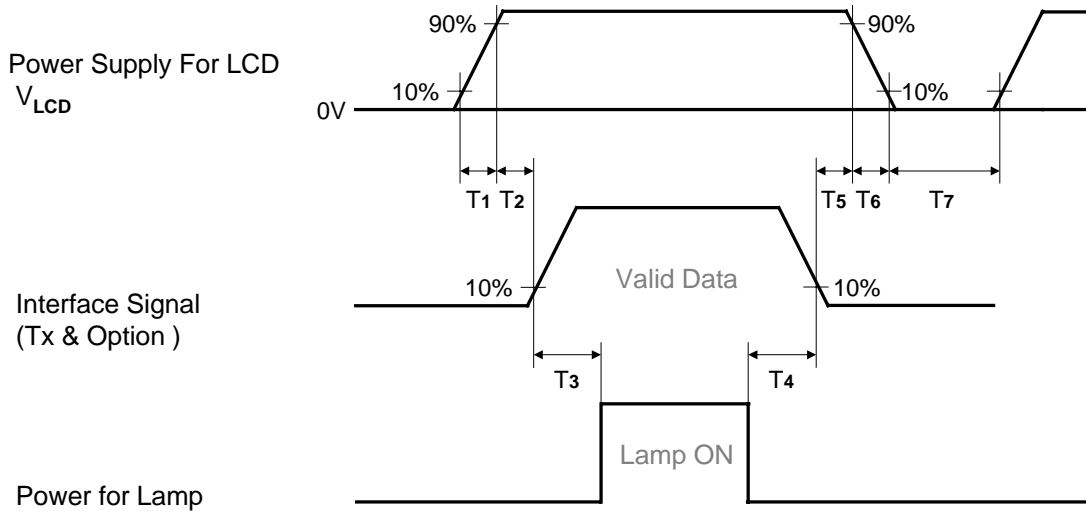


Table 10. POWER SEQUENCE

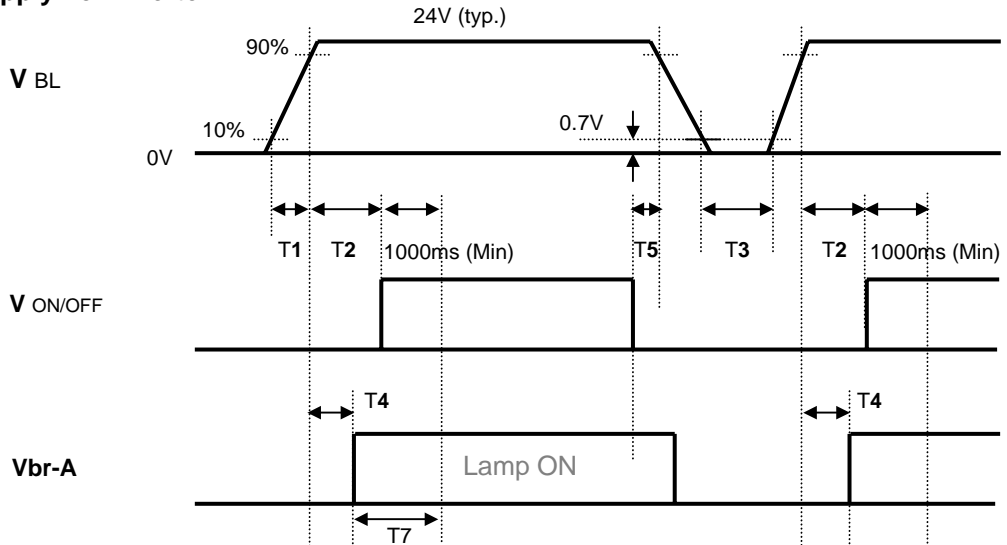
| Parameter | Value | | | Unit |
|-----------|-------|-----|-----|------|
| | Min | Typ | Max | |
| T1 | 0.01 | - | 20 | ms |
| T2 | 0.01 | - | 50 | ms |
| T3 | 200 | - | - | ms |
| T4 | 200 | - | - | ms |
| T5 | 0.01 | - | 50 | ms |
| T6 | - | - | - | ms |
| T7 | 2.0 | - | - | s |

- Note :
1. Please avoid floating state of interface signal at invalid period.
 2. When the interface signal is invalid, be sure to pull down the power supply V_{LCD} to 0V.
 3. The case when the T2/T5 exceed maximum specification, it operates protection pattern(Black pattern) till valid signal inputted. There is no reliability problem.
 4. The T3/T4 is recommended value, the case when failed to meet a minimum specification, abnormal display would be shown. There is no reliability problem.

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3-6-2. Sequence for Inverter

Power Supply For Inverter



ExtVbr-B : 1. Lamp ON at PWM Rising Edge and Lamp OFF at PWM Falling Edge.
2. EXTVBR-B has Same sequence with Vbr-A

3-6-3. Deep condition for Inverter

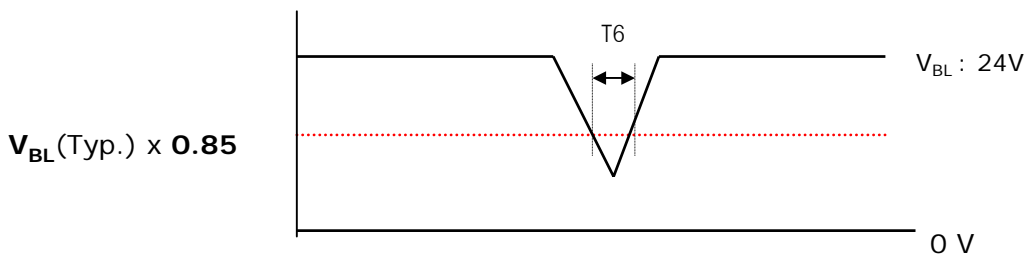


Table 11. Power Sequence for Inverter

| Parameter | Values | | | Units | Remarks |
|-----------|--------|-----|-----|-------|---------------------------|
| | Min | Typ | Max | | |
| T1 | 20 | - | - | ms | 1 |
| T2 | 500 | - | - | ms | |
| T3 | 200 | - | - | ms | 2 |
| T4 | 0 | - | - | ms | 4, 5 |
| T5 | 10 | - | - | ms | |
| T6 | - | - | 10 | ms | $V_{BL}(Typ) \times 0.85$ |
| T7 | 1000 | - | - | ms | |

- Note** :
1. T1 describes rising time of 0V to 24V and is not applied at restarting time.
 2. When the Inverter is shut-down by ARC protection, T3 need 3.3sec
 3. When V_{BL} (24V) is supplied always, there is no reliability problem.
 4. T4(max) is less than T2.
 5. In T7 section, ExtVbr-B should be duty 100% and Vbr-A is recommended 3.3V.

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4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' for 30min in a dark environment at $25 \pm 2^\circ\text{C}$. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0° .

It is presented additional information concerning the measurement equipment and method in FIG. 1.

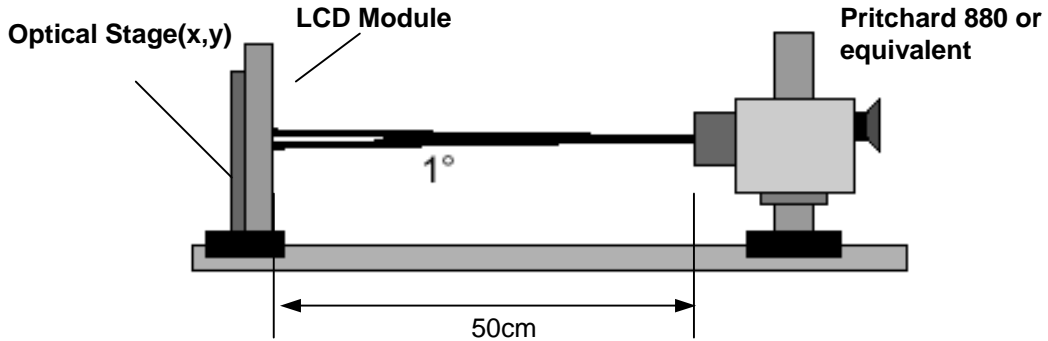


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 12. OPTICAL CHARACTERISTICS

$T_a = 25 \pm 2^\circ\text{C}$, $V_{LCD} = 12.0\text{V}$, $f_v = 60\text{Hz}$, $D_{clk} = 72\text{MHz}$, $V_{br-A} = \text{Max}$, $\text{ExtVbr} = 100\%$

| Parameter | Symbol | Value | | | Unit | Note | |
|-----------------------------|-----------------------------------|------------|--------------|-------|-------------------|--------|---|
| | | Min | Typ | Max | | | |
| Contrast Ratio | CR | 600 | 800 | | | 1 | |
| Surface Luminance, white | L_{WH} | 350 | 450 | | cd/m ² | 2 | |
| Luminance Variation | δ_{WHITE} 5P | | | 1.6 | | 3 | |
| Response Time | Rise Time | Tr_R | - | 9 | 16 | ms | 4 |
| | Decay Time | Tr_D | - | 9 | 16 | | |
| Color Coordinates [CIE1931] | RED | R_x | Typ -0.03 | 0.637 | Typ +0.03 | | |
| | | R_y | | 0.337 | | | |
| | GREEN | G_x | | 0.276 | | | |
| | | G_y | | 0.605 | | | |
| | BLUE | B_x | | 0.146 | | | |
| | | B_y | | 0.062 | | | |
| | WHITE | W_x | | 0.272 | | | |
| | W_y | 0.278 | | | | | |
| Viewing Angle (CR>10) | | | | | | | |
| | x axis, right($\phi=0^\circ$) | θ_r | 85 | 89 | - | degree | 5 |
| | x axis, left ($\phi=180^\circ$) | θ_l | 85 | 89 | - | | |
| | y axis, up ($\phi=90^\circ$) | θ_u | 85 | 89 | - | | |
| | y axis, down ($\phi=270^\circ$) | θ_d | 85 | 89 | - | | |
| Gray Scale | | | 2.2 | | | | 6 |

Product Specification

Notes 1. Contrast Ratio(CR) is defined mathematically as :

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at the center point(1).

2. Surface luminance is luminance value at the center point across the LCD surface 50cm from the surface with all pixels displaying white.
For more information, see FIG 2.
3. The variation in surface luminance , δ WHITE is defined as :

$$\delta \text{ WHITE}(5P) = \text{Maximum}(L_{on1}, L_{on2}, L_{on3}, \dots, L_{on5}) / \text{Minimum}(L_{on1}, L_{on2}, L_{on3}, \dots, L_{on5})$$
 Where L_{on1} to L_{on5} are the luminance with all pixels displaying white at 5 locations .
For more information, see FIG 2.
4. Response time is the time required for the display to transition from black to white (Rise Time, Tr_R) and from white to black (Decay Time, Tr_D).
For additional information, see FIG 3.
5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information, see FIG 4.
6. Gray scale specification
Gamma Value is approximately 2.2.
For more information, see Table 13.

Table 13. GRAY SCALE SPECIFICATION

| Gray Level | Luminance [%] (Typ) |
|------------|---------------------|
| L0 | 0.13 |
| L15 | 0.24 |
| L31 | 0.78 |
| L47 | 1.81 |
| L63 | 3.46 |
| L79 | 6.04 |
| L95 | 9.48 |
| L111 | 13.60 |
| L127 | 18.14 |
| L143 | 24.46 |
| L159 | 32.38 |
| L175 | 41.63 |
| L191 | 51.64 |
| L207 | 63.18 |
| L223 | 75.52 |
| L239 | 88.89 |
| L255 | 100 |

Product Specification

Measuring point for surface luminance & measuring point for luminance variation

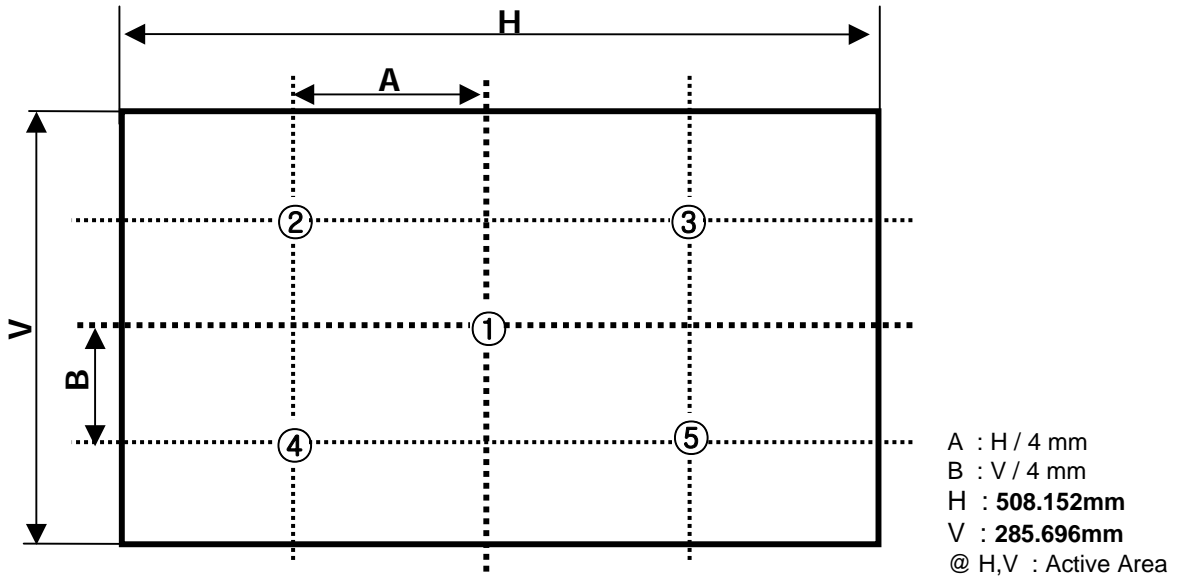


FIG. 2 Measure Point for Luminance

The response time is defined as the following figure and shall be measured by switching the input signal for Black to White and White to Black.

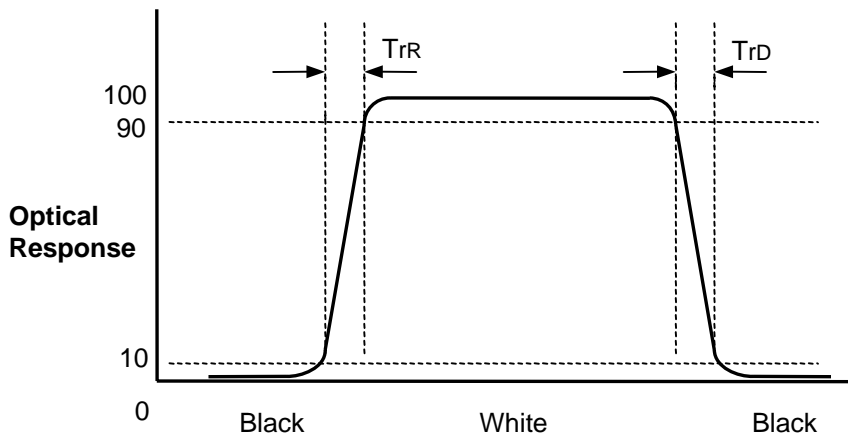


FIG. 3 Response Time

Product Specification

Dimension of viewing angle range

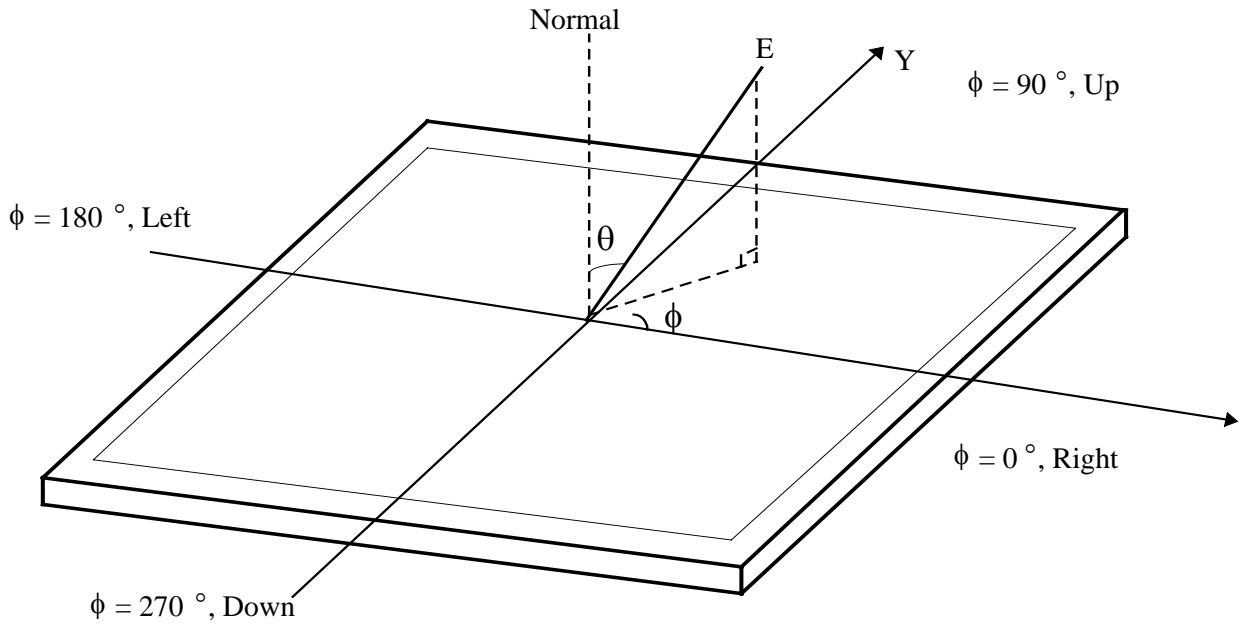


FIG. 4 Viewing angle

Product Specification

5. Mechanical Characteristics

The following items provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD module.

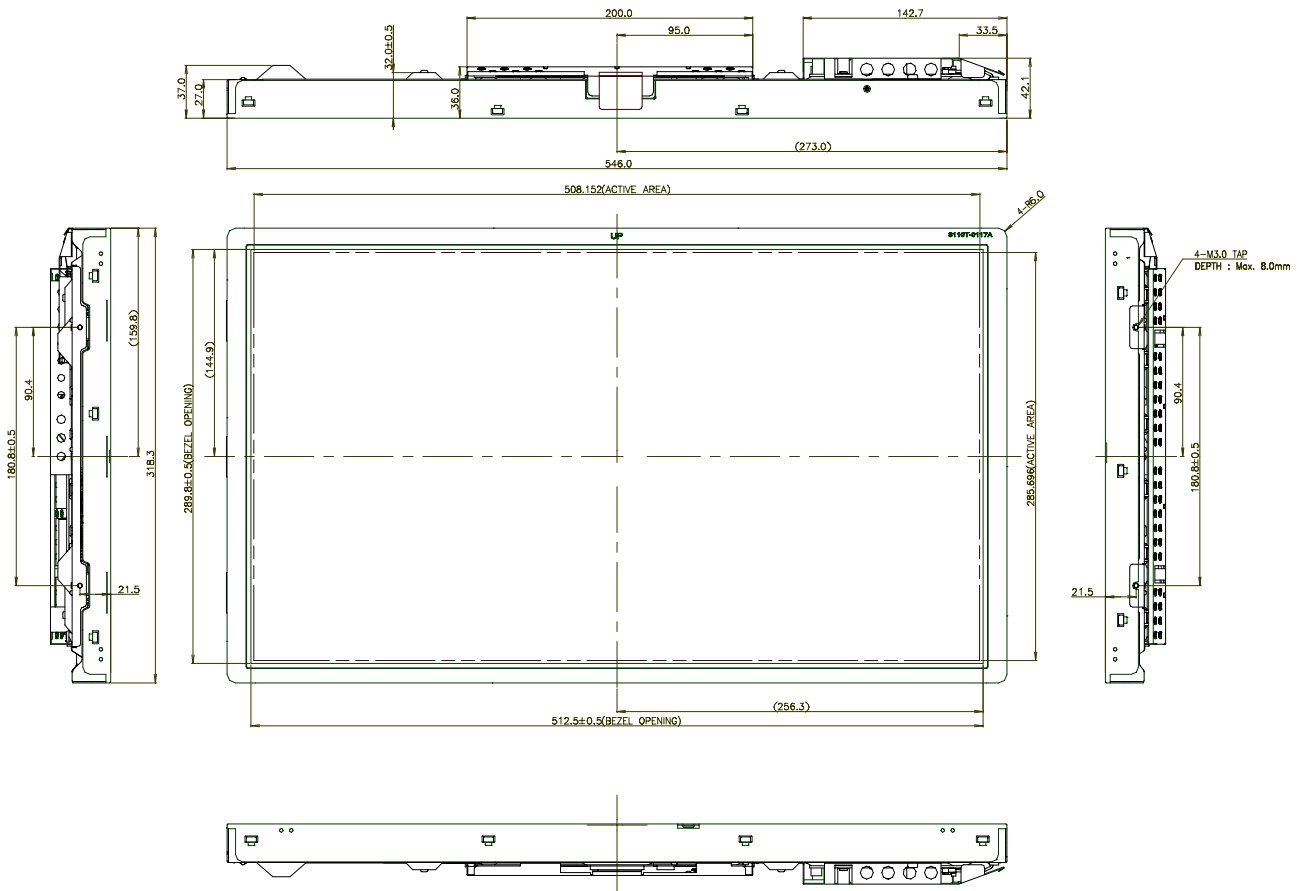
Table 14. MECHANICAL CHARACTERISTICS

| | | |
|---------------------|---|------------------|
| Outline Dimension | Horizontal | 546.0mm |
| | Vertical | 318.3mm |
| | Depth | 42.1mm |
| Bezel Area | Horizontal | 512.5mm |
| | Vertical | 289.8mm |
| Active Display Area | Horizontal | 508.152mm |
| | Vertical | 285.696mm |
| Weight | (Typ.) 3,800 (g), (Max.) 4,000(g) | |
| Surface Treatment | Hard coating(3H) Anti-glare treatment of the front polarizer | |

Note : Please refer to a mechanic drawing in terms of tolerance at the next page.

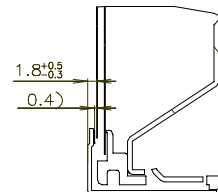
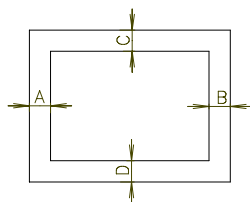
Product Specification

<FRONT VIEW>



NOTES

- UNSPECIFIED DIMENSIONAL TOLERANCES TO BE ±1.0mm.
- GAP BETWEEN TOP CASE AND GLASS IS 0.4^{+0.3}₀
- MAXIMUM ALLOWABLE DEPTH OF REAR SIDE USER MOUNT HOLE IS 5.0mm
- TILT AND A PARTIAL DISPOSITION TOLERANCE OF DISPLAY AREA ARE AS FOLLOW.
 - X-DIRECTION : |A-B| < 1.0mm
 - Y-DIRECTION : |C-D| < 1.0mm



SECTION A-A
SCALE 1/1

Product Specification

6. Reliability

Table 15. ENVIRONMENT TEST CONDITION

| No | Test Item | Condition |
|----|-----------------------------------|--|
| 1 | High temperature storage test | 60°C, 500h |
| 2 | Low temperature storage test | -20°C, 500h |
| 3 | High temperature operation test | 50°C, 80%RH, 500h 60°C, 500h (2000h) |
| 4 | Low temperature operation test | 0°C, 500h (1000h) |
| 5 | Heat cycle test | -20°C ~ 60°C, 30min/5min/30min, 100cycles |
| 6 | Soldering heat cycle test | -40°C ~ 80°C, 30min/5min/30min, 200cycles |
| 7 | Vibration test (non-operating) | Wave form : random Vibration level : 1.0Grms Bandwidth : 10-500Hz Duration : X,Y,Z, 10 min One time each direction |
| 8 | Shock test (non-operating) | Shock level : 100Grms Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction |
| 9 | ESD test | Condition : 150pF,330 ohm Case , air Evaluation : ±15kV |
| 10 | Humidity Storage test | Ta= 40 °C ,70%RH(240hr) |

Note : After Reliability Test , display function should be kept as the result evaluation.

Product Specification

7. International standards

7-1. Safety

- a) UL 60950-1:2003, First Edition, Underwriters Laboratories, Inc.,
Standard for Safety of Information Technology Equipment.
- b) CAN/CSA C22.2, No. 60950-1-03 1st Ed. April 1, 2003, Canadian Standards Association,
Standard for Safety of Information Technology Equipment.
- c) EN 60950-1:2001, First Edition,
European Committee for Electrotechnical Standardization(CENELEC)
European Standard for Safety of Information Technology Equipment.

7-2. EMC

- a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHz to 40GHz. "American National Standards Institute(ANSI), 1992
- b) C.I.S.P.R "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." International Special Committee on Radio Interference.
- c) EN 55022 "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." European Committee for Electrotechnical Standardization.(CENELEC), 1998 (Including A1: 2000)

Product Specification

8. Packing

8-1. Designation of Lot Mark

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

A,B,C : SIZE(INCH)
E : MONTH
G : ASSEMBLY CODE

D : YEAR
F : FACTORY CODE
H ~ M : SERIAL NO.

Note

1. YEAR

| | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|------|------|
| Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Mark | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

2. MONTH

| | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mark | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C |

3. FACTORY CODE

| | | | |
|--------------|----------|-------------|---------|
| Factory Code | LPL Gumi | LPL Nanjing | HEESUNG |
| Mark | K | C | D |

4. SERIAL NO.

| | |
|------|---|
| Mark | 100001~199999, 200001~299999, 300001~399999, ..., A00001~A99999,, Z00001~Z99999 |
|------|---|

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8-2. Packing Form

- a) Package quantity in one box : 4 pcs
- b) Box Size : 530mm X 310mm X 327mm

Product Specification

9. Precautions

Please pay attention to the followings when you use this TFT LCD module.

9-1. Mounting Precautions

- (1) You must mount a module using holes arranged in four corners or four sides.
- (2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- (3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- (6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)
- (7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.

9-2. Operating Precautions

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time (required time that brightness is stable after turned on) becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) 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.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.
(if not, it causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.

Product Specification

9-3. Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

9-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

9-6. Handling Precautions for Protection Film

- (1) The protection film is attached to the bezel with a small masking tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer.
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- (2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
- (3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.