

Display Elektronik GmbH

DATA SHEET

TFT MODULE

DEM 320240D TMH-PW-N

(C-TOUCH)

5,7“ TFT + PCT

Product Specification

Ver.: 0

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1. General Description and Features

DEM 320240D TMH-PW-N(C-TOUCH) is a transmissive type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit. Graphics and texts can be displayed on a QVGA 320 x RGB x 240 dots with 262,144 colors by supplying 18 bits data signal (6bits/each color). The following table described the features of DEM 320240D TMH-PW-N(C-TOUCH).

1.1 Features

- Transmissive and back-light with 30th LEDs are available.
- TN (Twisted Nematic) mode.
- Digital RGB (6bits/color) data transfer.
- Clock signal: latching data at the falling edge.
- RoHS Compliance

1.2 LCD Module

| Item | Specification | Unit |
|--------------------|--|----------|
| Screen Size | 5.7 Inches | Diagonal |
| Display Resolution | 320 x RGB x 240 | Pixel |
| Active Area | 115.20 x 86.40 | mm |
| Display Mode | Normally White Mode / Transmissive / Wide view | -- |
| Pixel Arrangement | R,G,B Vertical Tripe | -- |
| Pixel Size | 0.120 x 0.360 | mm |
| Display Color | 262k Colors | -- |
| Viewing Direction | 12 o'clock (Gray Inversion) | -- |
| Input Interface | Digital RGB (6bits/color) Data Transfer | -- |
| TFT Driver | Source: HX8218A, Gate: HX8615A | -- |

2. Mechanical Information

| Item | | Min. | Typ. | Max. | Unit | Note |
|-------------|----------------|------|--------|------|------|---------|
| Module Size | Horizontal (H) | -- | 144.00 | -- | mm | (1,2,3) |
| | Vertical (V) | -- | 104.60 | -- | mm | (2) |
| | Thickness (T) | -- | 14.90 | -- | mm | (1,3) |
| Weight | | -- | TBD | -- | g | -- |

Note (1) Not include FPC. Refer to the Outline Dimension Drawing as attached.

(2) Back-light unit is included.

(3) Excluding backlight cables.

3. Electrical Specifications

3.1 Absolute Max. Ratings

3.1.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

(Ta=25±2°C, Vss=GND=0)

| Item | Symbol | Min. | Max. | Unit | Note |
|-----------------------|------------------|------|------|------|---------|
| Storage Temperature | T _{STG} | -30 | 80 | °C | (1) |
| Operating Temperature | T _{OPR} | -20 | 70 | °C | (1,2,3) |

Note (1) 95 % RH Max. (40 °C ≥ Ta). Maximum wet-bulb temperature at 39 °C or less. (Ta > 40°C) no condensation.

Note (2) In case of below 0°C, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character

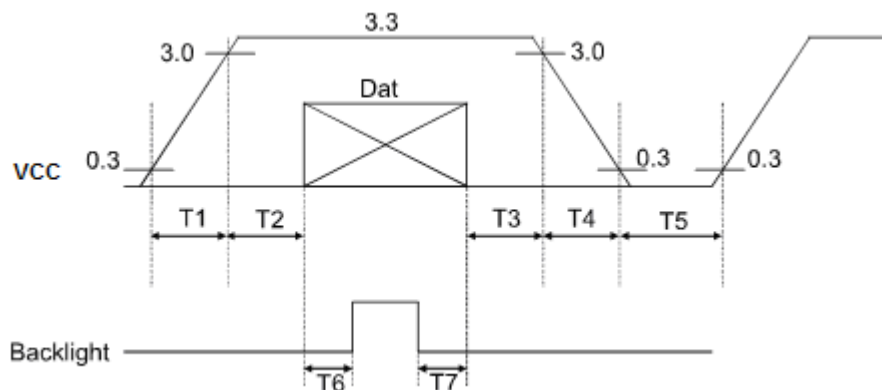
Note (3) Only operation is guaranteed at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

3.1.2 Electrical Absolute Maximum Ratings

(Vss=GND=0)

| Parameter | Symbol | Min. | Max. | Unit | Remark |
|---------------------------------|-------------------------------|------|----------------------|-------|-------------------------|
| Power Supply Voltage | V _{CC} | -0.3 | 5.0 | V | |
| Signal Input Voltage | R0-R5,G0-G5, B0-B5,DCLK,DE | -0.3 | V _{CC} +0.3 | V | -- |
| Permissive Input Ripple Voltage | V _{RF} | -- | 100 | mVp-p | V _{CC} = +3.3V |

Display On/Off Sequence:



Data: DCLK, R0 ~ R5, G0 ~ G5, B0 ~ B5, DE

T1≤10ms, 50ms≤T2, 0<T3≤50ms, 0<T4≤10ms, 1s≤T5, 200ms≤T6, 200ms≤T7

3.2 Electrical Characteristics

3.2.1 DC Electrical Characteristics of the TFT LCD

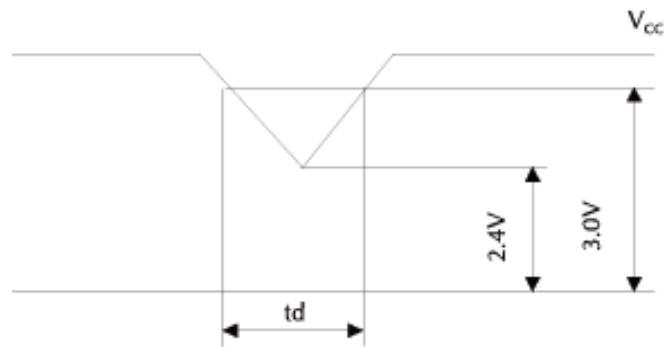
(Ta=25±2°C, Vss=GND=0)

| Item | Symbol | Min. | Typ. | Max. | Unit | Remark |
|-------------------------|--------|--------|------|--------|------|--------|
| Power Supply | VCC | 3.0 | 3.3 | 3.6 | V | Note 1 |
| Input Voltage for Logic | VIH | 0.7VCC | - | VCC | V | |
| | VIL | 0 | - | 0.3VCC | V | |
| Power Supply Current | ICC | | 65 | 80 | mA | Note 2 |

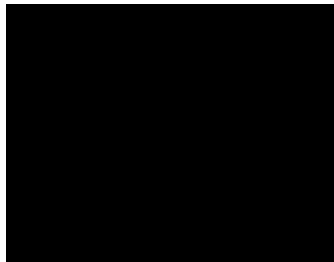
Note1: Vcc-dip conditions

Vcc-dip conditions should also follow the Vcc-turn-on conditions

Td ≤ 10ms



Note2: fv =60Hz , Ta=25°C , Display pattern : Black pattern



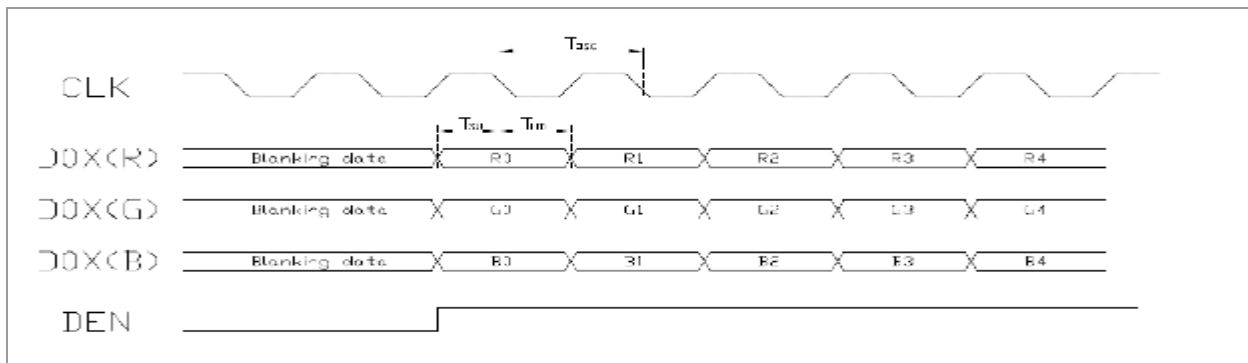
3.3 AC Timing Characteristic of The LCD

3.3.1 Timing Condition

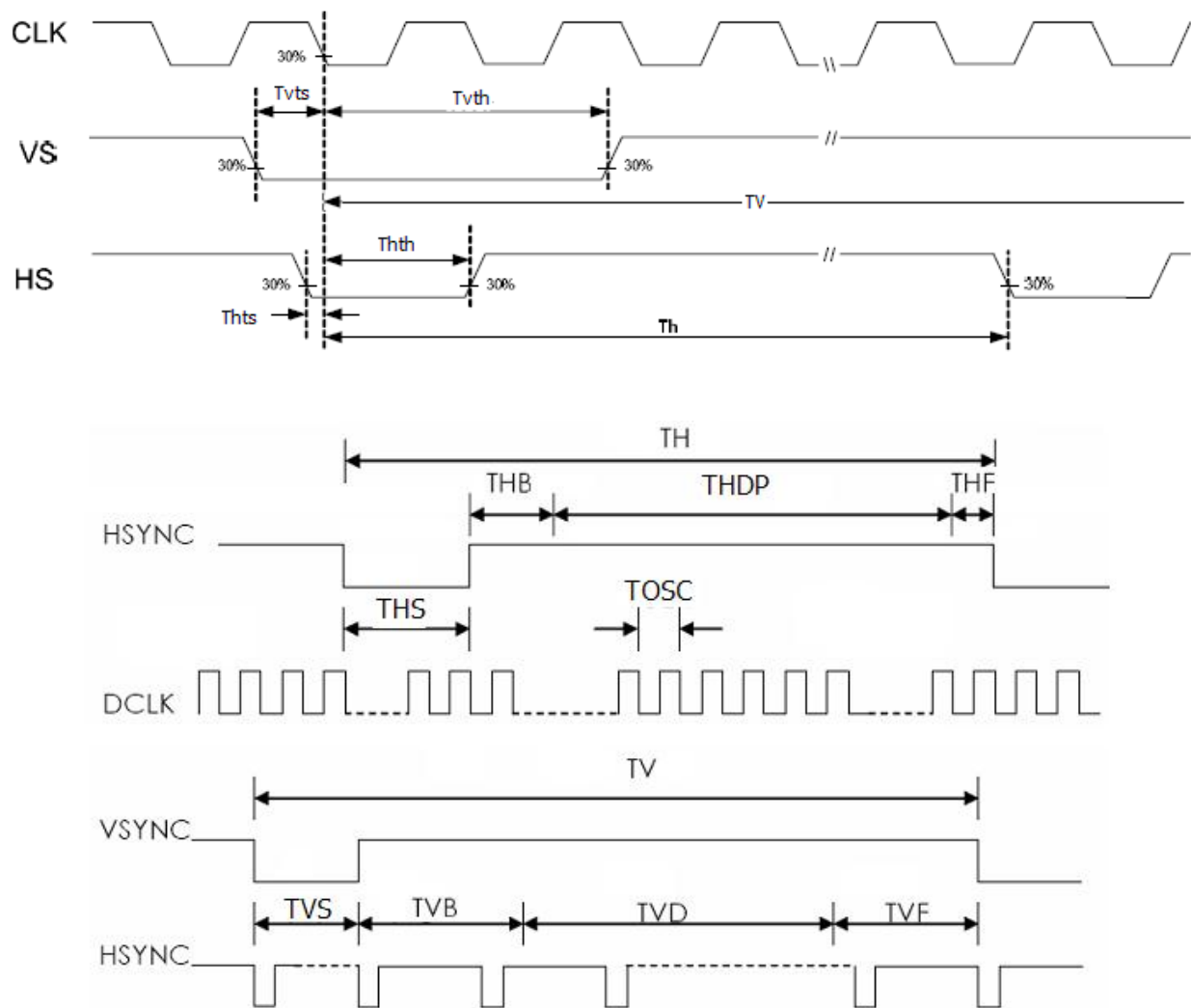
| Signal | Parameter | Symbol | Min. | Typ. | Max. | Unit. | Remark |
|----------|-------------------|--------|------|------|------|-------|--------|
| DCLK | DCLK period | TOSC | - | 156 | - | ns | |
| | Frequency | FOSC | - | 6.4 | - | MHz | |
| RGB DATA | Data setup time | TSU | 12 | - | - | ns | |
| | Data hold time | THD | 12 | - | - | ns | |
| Hsync | Hsync period | TH | - | 408 | - | TOSC | |
| | Hsync pulse width | THS | 5 | 30 | - | TOSC | |
| | Display Period | THDP | | 320 | | TOSC | |
| | Back-Porch | THB | | 38 | | TOSC | |
| | Front-Porch | THF | | 20 | | TOSC | |
| | Hsync setup time | THts | 12 | - | - | ns | |
| | Hsync Hold time | THth | 12 | - | - | ns | |
| Vsync | Vsync period | TV | - | 262 | - | TH | |
| | Vsync pulse width | TVS | - | 3 | - | TH | |
| | Back-Porch | TVB | | 16 | | TH | |
| | Display Period | TVD | | 240 | | TH | |
| | Front Porch | TVF | | 3 | | TH | |
| | Vsync setup time | TVts | 12 | - | - | ns | |
| | Vsync Hold time | TVth | 12 | - | - | ns | |
| DEN | Vsync-DEN time | TVSE | - | 19 | - | TH | |
| | Hsync-DEN time | THE | - | 68 | - | TOSC | |
| | DEN plus width | TEP | - | 320 | - | TOSC | |

Note : If DEN is fixed to low, the SYNC mode is used. Otherwise DE mode is used. When SYNC mode is used, 1st data start from 68th CLK after H-sync falling

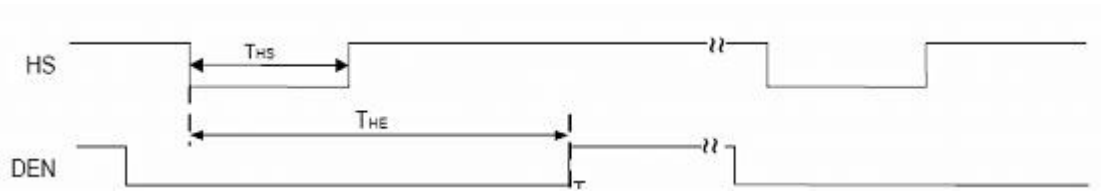
3.3.2 Clock and Data Waveform



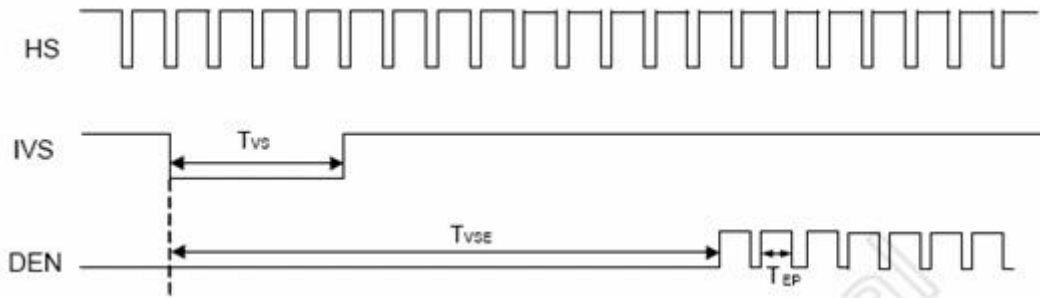
3.3.3 Clock and Sync waveforms



3.3.4 HS and horizontal control timing waveforms



3.3.5 HS and vertical control timing waveforms



3.4 Backlight Unit

The Back-light system is an edge-lighting type with 30 white LED (Light Emitting Diode)s. The characteristics of 30 white LEDs are shown in the following tables.

(Ta= Room Temp)

| Characteristics | | Symbol | Min. | Typ. | Max. | Unit | Note |
|---------------------------|------|----------|-------|------|------|------|------|
| Current of Backlight Unit | | I_B | - | 200 | 250 | mA | (1) |
| Voltage of Backlight Unit | | V_B | - | 9.6 | 10.5 | V | |
| Power Consumption | | P_{BL} | - | 1920 | 2625 | mW | (2) |
| LED Lifetime | 25°C | - | 50000 | | | hr | (3) |

Note (1) LEDS in 3 series x 10 parallel type.

(2) Where $I_B = 200\text{mA}$, $V_B = 9.6$, $P_{BL} = V_B \times I_B$

(3) The environmental conducted under ambient air flow, at $T_a=25\pm 2^\circ\text{C}$, $60\%\text{RH}\pm 5\%$

4. Optical Characteristics

4.1 Optical characteristic of the LCD

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 (1).

Measuring equipment: BM-5A, BM-7

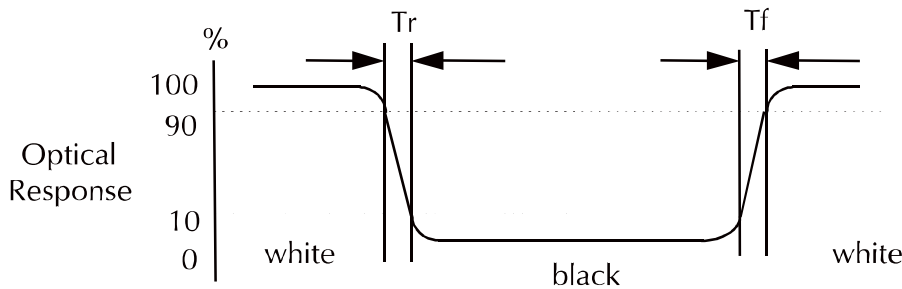
| Item | Symbol | Condition | Min | Type | Max | Unit | Note |
|-------------------------------|----------------|----------------------------|---------------------------|-------|-------|-------------------|--------|
| Brightness | | | 540 | 630 | -- | cd/m ² | |
| Response Time | T _r | θ=0° | - | 15 | 20 | ms | . |
| | T _f | | -- | 25 | 35 | ms | |
| Contrast Ratio | CR | At optimized viewing angle | 300 | 450 | -- | -- | |
| Color Gamut | NTSC % | -- | -- | 50 | -- | % | |
| Color Chromaticity (CIE 1931) | Red | R _x | θ=0° Normal Viewing Angle | 0.610 | 0.640 | 0.670 | -- |
| | | R _y | | 0.314 | 0.344 | 0.374 | |
| | Green | G _x | | 0.268 | 0.298 | 0.328 | -- |
| | | G _y | | 0.553 | 0.583 | 0.613 | |
| | Blue | B _x | | 0.107 | 0.137 | 0.167 | -- |
| | | B _y | | 0.139 | 0.159 | 0.179 | |
| | White | W _x | | 0.282 | 0.312 | 0.342 | -- |
| | | W _y | | 0.309 | 0.339 | 0.369 | |
| Viewing Angle (12H) | Hor. | θ _R | CR≥10 | 55 | 65 | -- | Degree |
| | | θ _L | | 55 | 65 | -- | |
| | Ver. | φ _H | | 55 | 65 | -- | |
| | | φ _L | | 40 | 50 | -- | |

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".

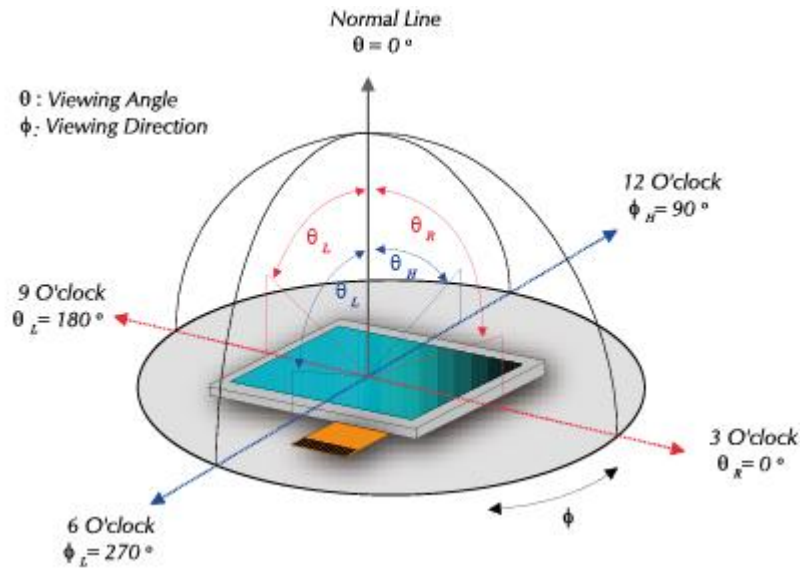


c. Definition of contrast ratio:

$$\text{Contrast Ratio (CR)} = \frac{\text{Brightness measured when LCD is at "white state"}}{\text{Brightness measured when LCD is at "black state"}}$$

d. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

e. View Angle



f. Definition of Luminance of White: Luminance of white at the center points

| | |
|---------------------------------|----------|
| Light Source of Back-Light Unit | LED Type |
|---------------------------------|----------|

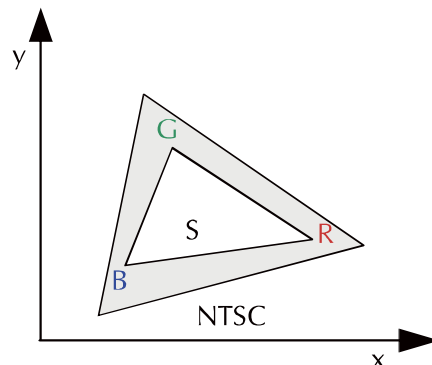
g. Definition of White Uniformity

$$\text{White Uniformity} = \frac{\text{Min. luminance of white among 9-points}}{\text{Max. luminance of white among 9-points}}$$

h. The definition of Color Gamut -Color Chromaticity CIE 1931

Color coordinate of white & red, green, blue at center point.

Color Gamut : NTSC(%) = (RGB Triangle Area / NTSC Triangle Area) x 100

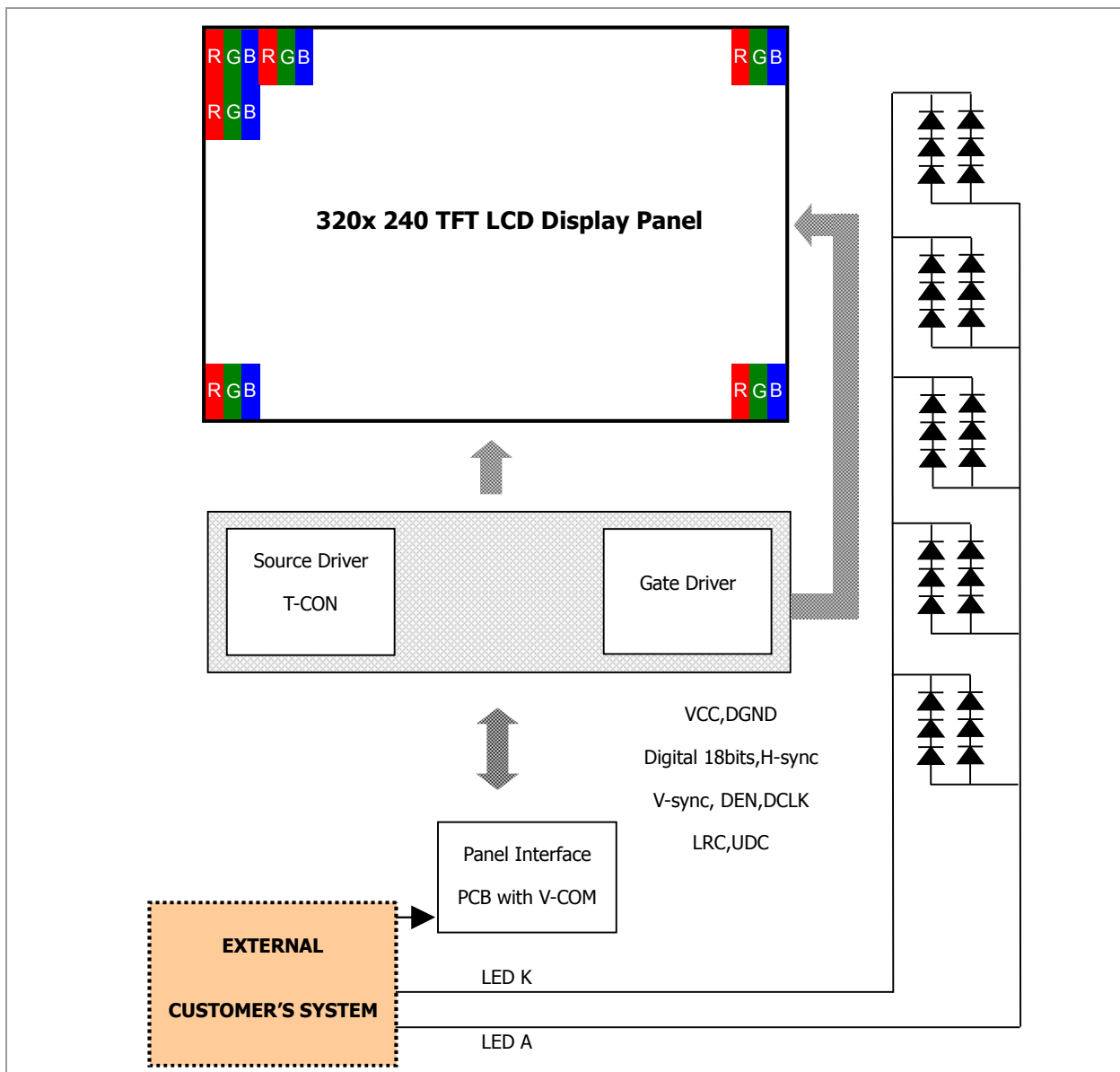


5. I/O Terminal

5.1 Pin Assignment

| Pin No. | Symbol | I/O | Function | Remark |
|---------|--------|-----|---|---------|
| 1 | VSS | P | GND | |
| 2 | DCLK | I | Clock signal for sampling each data signal | |
| 3 | HS | I | Horizontal synchronous signal (Negative) | |
| 4 | VS | I | Vertical synchronous signal (Negative) | |
| 5 | VSS | I | GND | |
| 6 | R0 | I | RED data signal (LSB) | |
| 7 | R1 | I | RED data signal | |
| 8 | R2 | I | RED data signal | |
| 9 | R3 | I | RED data signal | |
| 10 | R4 | I | RED data signal | |
| 11 | R5 | I | RED data signal (MSB) | |
| 12 | VSS | P | GND | |
| 13 | G0 | I | GREEN data signal (LSB) | |
| 14 | G1 | I | GREEN data signal | |
| 15 | G2 | I | GREEN data signal | |
| 16 | G3 | I | GREEN data signal | |
| 17 | G4 | I | GREEN data signal | |
| 18 | G5 | I | GREEN data signal (MSB) | |
| 19 | VSS | P | GND | |
| 20 | B0 | I | BLUE data signal(LSB) | |
| 21 | B1 | I | BLUE data signal | |
| 22 | B2 | I | BLUE data signal | |
| 23 | B3 | I | BLUE data signal | |
| 24 | B4 | I | BLUE data signal | |
| 25 | B5 | I | BLUE data signal(MSB) | |
| 26 | VSS | P | GND | |
| 27 | DEN | I | Signal to settle the horizontal display position (Positive) | |
| 28 | VCC | P | 3.3V power supply | |
| 29 | VCC | P | 3.3V power supply | |
| 30 | R/L | I | Horizontal display mode select signal L: Normal H: Left / Right reverse mode | Note5-1 |
| 31 | U/D | I | Vertical display mode select signal H: Normal L: Up / Down reverse mode | Note5-1 |
| 32 | NC | -- | No Connection | |
| 33 | VSS | P | GND | |

5.2 Block Diagram



5.3 Backlight Unit (BLU)

| Pin No. | Symbol | Function | Remark |
|---------|--------|--------------------------------|--------|
| 1 | LEDA | Power Supply for LED backlight | Red |
| 2 | LEDK | GND for LED backlight | Black |

5.4 Basic Display Color and Gray Scale

| | Color & Gray Scale | Data Signal | | | | | | | | | | | | | | | | | |
|-------------|--------------------|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | | R5 | R4 | R3 | R2 | R1 | R0 | G5 | G4 | G3 | G2 | G1 | G0 | 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 |
| | Red(0) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(0) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue(0) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 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 |
| Red | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red(1) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red(2) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Red(31) | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Red(62) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red(63) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Green(31) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Green(62) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(63) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Blue | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue(1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Blue(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Blue(31) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| | Blue(62) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| | Blue(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

Each basic color can be displayed in 64 gray scales from 6 bit data signals. With the combination of total 18 bit data signals, the 262,144-color display can be achieved on the screen.

6. Projected capacitive touch Screen Panel Specifications**Electrical Characteristics**

| Item | Specification | Unit |
|-----------------------------|---|-------------|
| Screen Size | 5.7inches | Diagonal |
| Type | Transparent Type Projected Capacitive Touch Panel | -- |
| Input Mode | Human's Finger | -- |
| Sensor Active Area | 117.2 (W) × 88.4 (H) | mm |
| Interface | I2C | -- |
| Cover glass pencil-handness | 6H(min) by JIS K5400 | -- |
| Digital Power Supply | 2.8 ~ 3.6 | V |
| Power Consumption | TBD | mA |
| IC solution | IC : FT5406EE8 | |

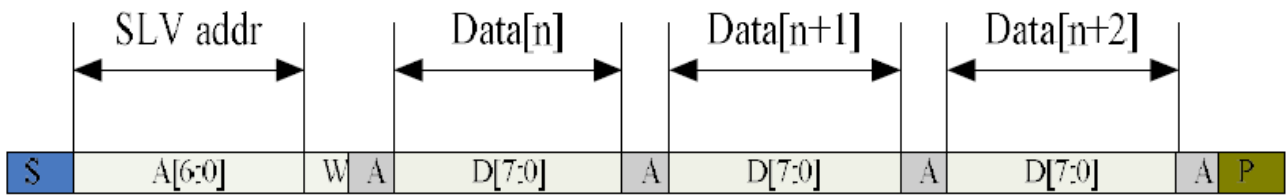
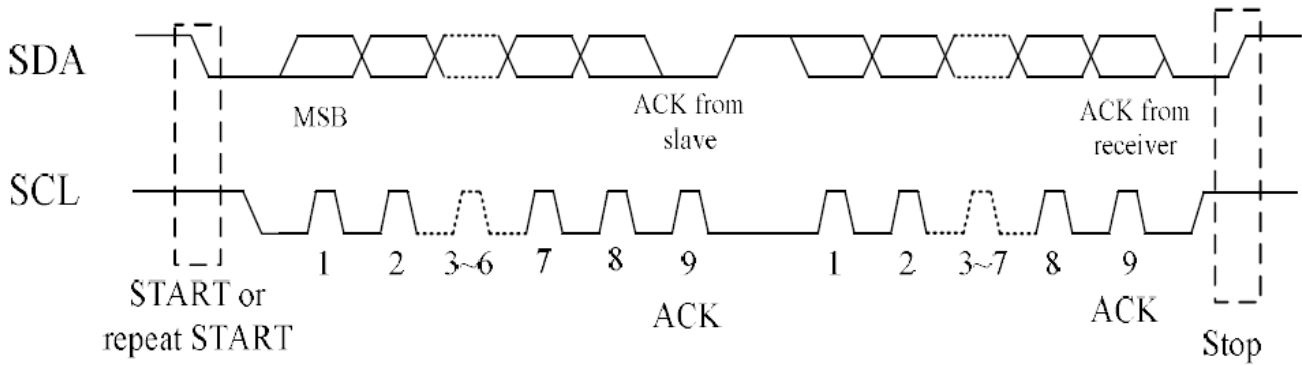
Pin Assignments and Definitions (Connector Part No: "FH34SJ-6S-1.0SH" or equivalent.)

| Item | Name | I/O | Unit |
|-------------|-------------|------------|-------------------------------|
| 1 | GND | P | Ground |
| 2 | SDA | I/O | I2C Data |
| 3 | SCL | I | I2C Clock |
| 4 | VDD | P | Power |
| 5 | INT | I | Interrupt request to the host |
| 6 | RST | I | External Reset, active low |

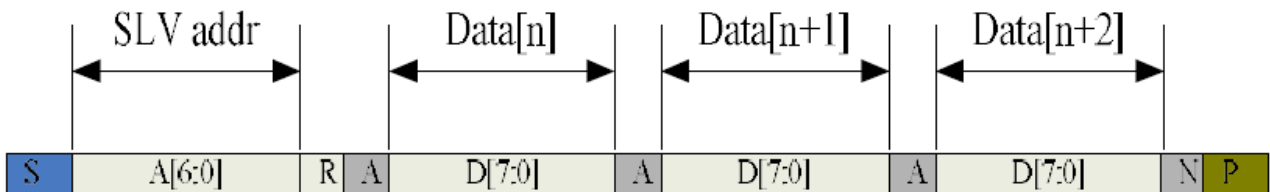
7. FUNCTIONAL DESCRIPTION

7.1 I2C Communication

The I2C is always configured in the Slave mode. The data transfer format



I2C master write, slave read



I2C master read, slave write

| Mnemonics | Description |
|-----------|--|
| S | I2C Start or I2C Restart |
| A[6:0] | Slave address A[6:4]: 3'b011 A[3:0]: data bits are identical to those of I2CCON[7:4] register. |
| W | 1'b0: Write |
| R | 1'b1: Read |
| A(N) | ACK(NACK) |
| P | STOP: the indication of the end of a packet (if this bit is missing, S will indicate the end of the current packet and the beginning of the next packet) |

I2C Interface Timing Characteristics

| Parameter | Unit | Min | Max |
|--|------|-----|-----|
| SCL frequency | KHz | 0 | 400 |
| Bus free time between a STOP and START condition | us | 4.7 | \ |
| Hold time (repeated) START condition | us | 4.0 | \ |
| Data setup time | ns | 250 | \ |
| Setup time for a repeated START condition | us | 4.7 | \ |
| Setup Time for STOP condition | us | 4.0 | \ |

8. Dimensional Outlines

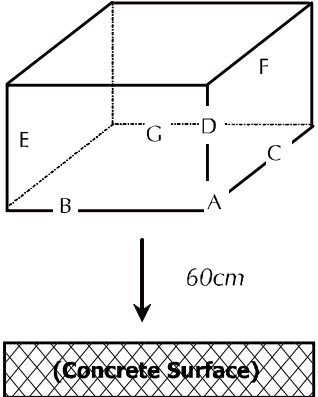
No change on display and in operation under the following test condition.

Condition: Unless otherwise specified, tests will be conducted under the following condition.

Temperature: 20±5°C.

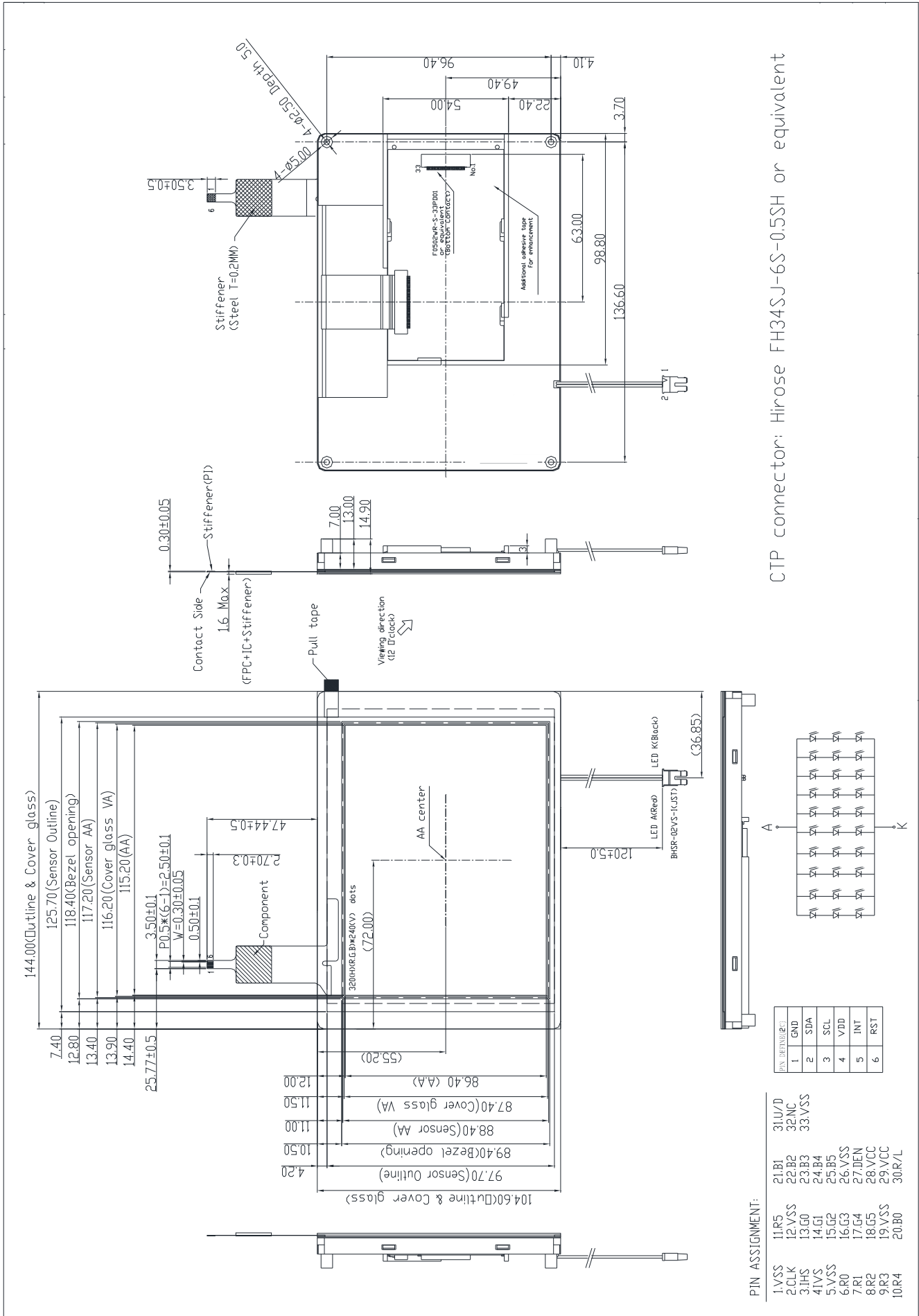
Humidity: 65±5%RH.

Tests will be not conducted under functioning state.

| No. | Parameter | Condition | Notes |
|-----|----------------------------|--|-------|
| 1 | High Temperature Operating | 70°C±2°C, 240hrs (Operation state). | |
| 2 | Low Temperature Operating | -20°C±2°C, 240hrs (Operation state). | 1 |
| 3 | High Temperature Storage | 80°C±2°C, 240hrs. | 2 |
| 4 | Low Temperature Storage | -30°C±2°C, 240hrs. | 1,2 |
| 5 | Damp Proof Test | 40°C±2°C, 90~95%, 240hrs. | 1,2 |
| 6 | Vibration Test | Total fixed amplitude: 1.5mm. Vibration Frequency: 10~55Hz. One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes. | 3 |
| 7. | Shock Test | To be measured after dropping from 60cm high on the concrete surface in packing state.  <i>Dropping method corner dropping:</i> <i>A corner: Once edge dropping.</i> <i>B, C, D edge: Once face dropping.</i> <i>E, F, G face: Once.</i> | |

- Notes:
1. No dew condensation to be observed.
 2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
 3. Vibration test will be conducted to the product itself without putting I in a container.

9. Dimensional Outlines



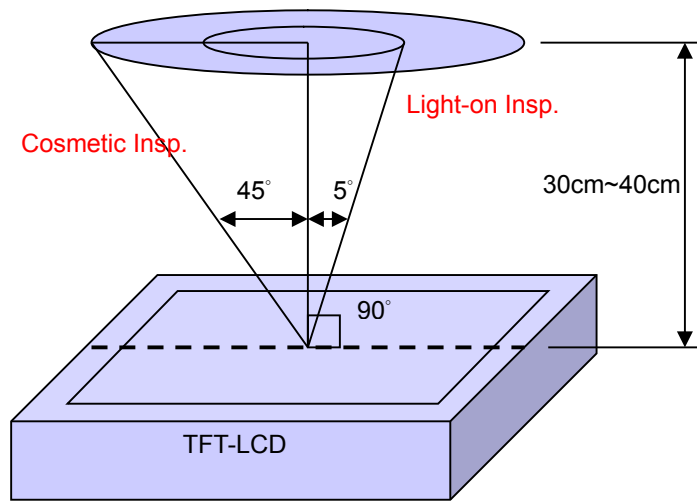
CTP connector: Hirose FH34SJ-6S-0.5SH or equivalent

10. Incoming Inspection Standards

10.1 Inspection and Environment Conditions

10.1.1 Inspection Conditions:

- (1) Inspection Distance: 35 cm±5cm
- (2) View Angle : Light-on Inspection Angle : ±5°
Cosmetic Inspection Angle : ±45°



(perpendicular to LCD panel surface)

10.1.2 Environment Conditions:

| | | |
|----------------------|-----------------------|-------------------|
| Ambient Temperature | | 23°C ±5°C |
| Ambient Humidity | | 55±10%RH |
| Ambient Illumination | Cosmetic Inspection | more than 600 Lux |
| | Functional Inspection | 300~500 Lux |

10.1.3 Sampling Conditions:

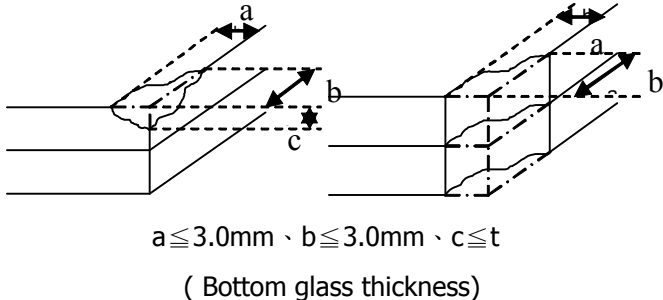
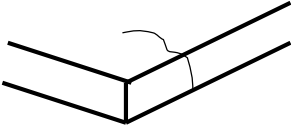
- (1) Lot Size: Quantity of shipment lot per model
- (2) Sampling Method:

| | | |
|---------------|--------------|--|
| Sampling Plan | | MIL-STD-105E |
| | | Normal Inspection, Single Sampling Level II |
| AQL | Major Defect | 1.0% |
| | Minor Defect | 1.5% |

(3) The classification of Major(MA) and Minor(MI) defects is shown as 3. Inspection Criteria.

10.1.4 Inspection Criteria

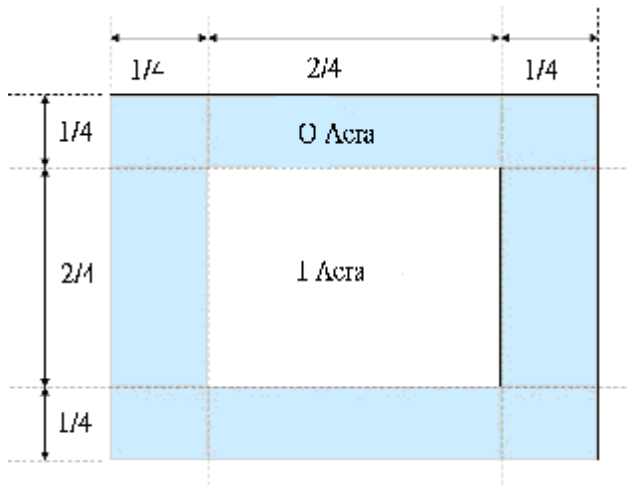
10.1.4.1 Cosmetic Inspection(Panel):

| Item | Judgment Criteria | Classification |
|---------------------------------------|---|----------------|
| Chipping on Panel |  <p>$a \leq 3.0\text{mm}$、$b \leq 3.0\text{mm}$、$c \leq t$ (Bottom glass thickness)</p> | MA |
| Scratch on Panel *Note-2 | <p>$W \leq 0.05\text{mm}$ or $L < 5\text{mm}$: Ignored $0.05\text{mm} < W \leq 0.1\text{mm}$ and $L \leq 5\text{mm}$: $N \leq 5$ $W > 0.1\text{mm}$ or $L > 5\text{mm}$: Not allowed</p> | MI |
| Bubble or Dent on Panel *Note-3 | <p>$D \leq 0.2\text{mm}$: Ignored $0.2\text{mm} < D \leq 0.3\text{mm}$: $N \leq 5$ $D > 0.3\text{mm}$: Not allowed</p> | MI |
| Panel Crack |  <p>Not Allowed crack</p> | MA |
| Bezel Deformation | Obvious deformation is not allowed. | MI |
| Bezel Oxidation | Not allowed if it rusts continuously over 1 cm (It is out of warranty with rusted tin plate) | MI |
| Bezel Scratch | $L \leq 20\text{mm}$, $W \leq 0.2$, $N \leq 3$ | MI |
| Metal Squash Dent /Flange(Front Side) | $D(W) \leq 1, L \leq 3, N \leq 3;$ | MI |
| B/L High Voltage Wire Denudation | Not allowed | MA |
| Polarizer flaw or leak out resin | Defect is defined as the active area. | MI |
| Outline Dimension | Must in Spec, refer to related product spec. | MI |

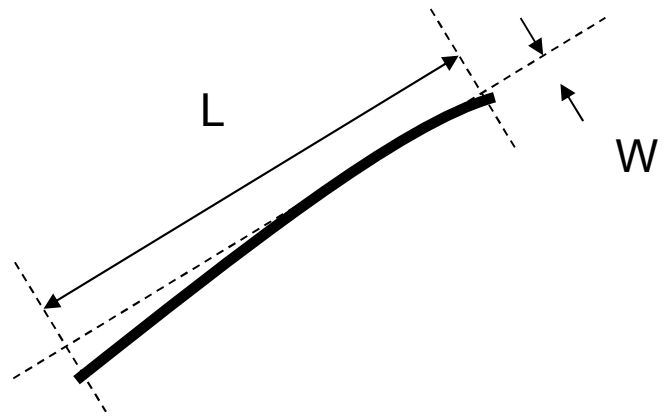
10.1.4.2 Functional Inspection:

| Item | Judgment Criteria | | | Classification | |
|---|--|--|---------------------|----------------|----|
| | Area(Note1) | I | O | | |
| Point Defect | Bright dot | Random | 2 | | MI |
| | | 2 dots adjacent | 0 | 0 | |
| | | 3 dots adjacent or more | 0 | 0 | |
| | Dark dot | Random | 3 | | |
| | | 2 dots adjacent | 0 | | |
| | | 3 dots adjacent or more | 0 | 0 | |
| | Total Dot Defect | | 5 | | |
| | Distance | Distance between Bright and Bright dot | $L \geq 5\text{mm}$ | | |
| | | Distance between Bright and Dark dot | $L \geq 5\text{mm}$ | | |
| | | Distance between Dark dot | $L \geq 5\text{mm}$ | | |
| (1) It is defined as Point Defect if defect area > 0.5dot (2) It is ignored if defect area $\leq 0.5\text{dot}$ (3) Weak point defect will be defined as Bright Dot if it can be observed through ND filter 5%(Full Screen Black Inspection) | | | | | |
| Line Defect | Obvious vertical or horizontal line defect is not allowed. | | | MA | |
| Mura | Not allowed if it can be observed through ND Filter 5 % | | | MI | |
| Foreign Material in spot shape *Note-3 | $D \leq 0.2\text{mm}$: Ignored $0.2\text{mm} < D \leq 0.5\text{mm}$: $N \leq 8$ $D > 0.5\text{mm}$: Not allowed | | | MI | |
| Foreign Material in line or spiral shape *Note-4 | $W \leq 0.05\text{mm}$ or $L \leq 5\text{mm}$: Ignored $0.05\text{mm} < W \leq 0.2\text{mm}$ and $L 1.0\text{mm} \leq 5\text{mm}$: $N \leq 8$ $W > 0.2\text{mm}$ or $L > 5\text{mm}$: Not allowed | | | MI | |
| Display Function Abnormal | No Malfunction can be allowed | | | MA | |

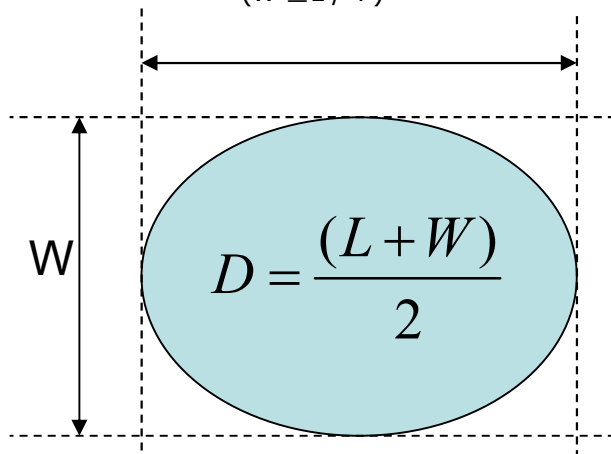
Note-1 : I/O Area Definition



Note-2 : Polarizer Scratch



Note-3 : Spot Foreign Material
($W \geq L / 4$)



Note-4 : Line or Spiral Foreign Material
($W < L / 4$)

