

TO :
DATE : March. 19. 2004

SAMSUNG TFT-LCD
MODEL NO. : LTS280Q1-PE1

Customer Approval

Any Modification of Spec is not allowed without SEC's permission.

Approved by : _____

AMLCD Division Mobile Display Team

Samsung Electronics Co . , LTD.



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Revision History

Approval

| Data | Rev. No. | Page | Summary |
|---------------|----------|------|---------------------|
| Mar. 19. 2004 | 000 | | Rev.000 was issued. |

General Description

* Description

LTS280Q1-PE1 is a transfective type 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 module(TFT-LCD panel, driver ICs and FPC), a Back-light unit and a touch screen panel. The resolution of a 2.83" contains 240 x 320 pixels and can display up to 262,144 colors.

* Features

- Transfective type.
- 6 LED Back-light
- Using the Touch Screen Panel(Flim to Glass type)
- Line Inversion mode.
- Low Power Consumption.

* Applications

- Display terminals for PDA application products.
- Smart phone / Game machine / Camcoder.

* General Information

| Items | Specification | Unit | Note |
|-------------------|------------------------|---------|------|
| Display area | 43.2(H) x 57.6(V) | mm | - |
| Driver element | a-Si TFT active matrix | - | - |
| Display colors | 262,144 | colors | - |
| Number of pixels | 240(H) x RGB x 320(V) | pixel | - |
| Pixel arrangement | RGB vertical stripe | - | - |
| Pixel pitch | 0.180(H) x 0.180(V) | mm | - |
| Display mode | Normally White | - | - |
| Viewing Direction | 12:00 | o'clock | - |

* Mechanical Information

| Item | | Min. | Typ. | Max. | Unit | Note |
|------------|---------------|------|------|------|------|------|
| Model size | Horizontal(H) | 52.7 | 52.9 | 53.1 | mm | (1) |
| | Vertical(V) | 71.5 | 71.7 | 71.9 | mm | |
| | Depth(D) | | 4.75 | 5.0 | mm | |
| Weight | - | - | 38 | g | | |

Note (1) Touch screen panel, FPC and Back-light unit are included.

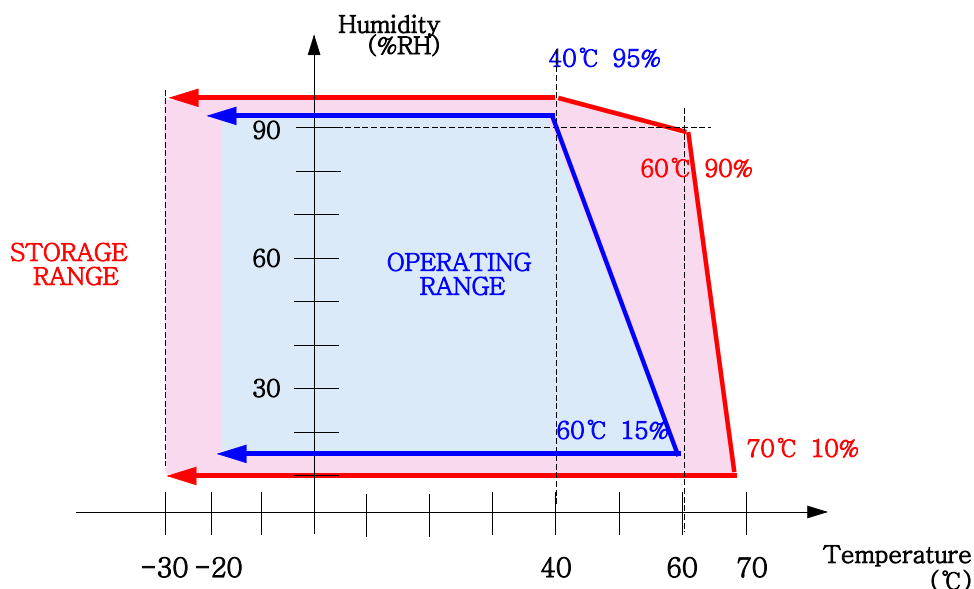
1. Absolute Maximum Ratings

1.1 Absolute Ratings of Environment

| Item | Symbol | Min. | Max. | Unit | Note |
|--|------------------|------|------|------|-------------|
| Storage temperature | T _{STG} | -30 | 70 | °C | (1),(5) |
| Operating temperature (Ambient temperature) | T _{OPR} | -20 | 60 | °C | (1),(2),(5) |
| Vibration (Non - operating) | V _{nop} | 10 | 500 | Hz | (3),(4) |

Note (1) 90 % RH Max. ($40\text{ }^{\circ}\text{C} \geq T_a$)

Maximum wet-bulb temperature at $39\text{ }^{\circ}\text{C}$ or less. ($T_a > 40\text{ }^{\circ}\text{C}$) No condensation.



(2) In case of below 0° , 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 characteristics.

(3) $(10 \Leftrightarrow 500\text{Hz})^{6\text{CYC}}$ 10min/Cycle, $3G_{pk,,}$ for each X, Y, Z axis.

(4) At testing vibration, the fixture in holding the module to be tested have to be hard and rigid enough so that the module would not be twisted or bent by the fixture.

(5) If product is exposed to high temperatures for extended time, there is a possibility of the polarizer film damage which could degrade the optical characteristics.

1.2 Electrical Absolute Ratings

(1) TFT-LCD Module

(Ta = Room Temp, V_{SS}=GND=0V)

| Characteristics | Symbol | Min. | Max. | Unit | Note |
|-------------------------------|------------------|------|-----------------------|------|------|
| Power supply(analog, digital) | V _{DD} | 2.7 | 3.6 | V | - |
| Power supply(gate on) | V _{ON} | 13 | 17 | V | - |
| Power supply(gate off) | V _{OFF} | -11 | -7 | V | - |
| Common Voltage | V _{COM} | -0.3 | 5.5 | V | DC |
| Input voltage | V _I | -0.3 | V _{DD} + 0.3 | V | - |

(2) Back-Light Unit

(Ta = Room Temp)

| Characteristics | Symbol | Min. | Max. | Unit | Note |
|-----------------|----------------|------|------|------|------|
| Current | I _B | - | 25 | mA | (1) |

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded.
Functional operation should be restricted to the conditions described under normal operating conditions.

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 (3), (4).

Measuring equipment: LCD-7200, BM-5A, BM-7, PR-650, EZ-Contrast

*This includes optical characteristics of TSP.

(Ta = Room Temp)

* Optical Characteristics can be changed without special notice

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Note | | |
|--------------------------------------|------------|-------------|---------------|---------|-------|-------|-----------------|---------------------|------------------|
| Reflectance | Rf | B/L Off | 4 | 7 | - | % | (5) LCD-7200 | | |
| Contrast ratio (Center point) | C/R1 | B/L On | 100 | 150 | - | - | (6) BM-5A | | |
| | C/R2 | B/L Off | 3 | 6 | - | - | (6) LCD-7200 | | |
| Luminance of white (Center point) | YL | B/L On | 80 | 110 | - | cd/m2 | (7) BM-5A | | |
| White uniformity | Uw | B/L On | 70 | - | - | % | (9) BM-5A | | |
| Response time | Rising:Tr | Tr+Tf | B/L On | - | 35 | 50 | msec | (8) BM-7 | |
| | Falling:Tf | | B/L Off | | | | | | |
| Color chromaticity (CIE 1931) | White | Wx1 | B/L On | 0.210 | 0.310 | 0.410 | - | (9) PR-650 | |
| | | | | 0.230 | 0.330 | 0.430 | | | |
| | White | Wy1 | B/L Off | 0.210 | 0.310 | 0.410 | | (10) LCD-7200 | |
| | | | | 0.250 | 0.350 | 0.450 | | | |
| Viewing angle | Hor. | $\theta L1$ | $C/R \geq 10$ | 40 | 50 | - | Degrees | (11) Ez-Contrast | |
| | | $\theta R1$ | | 30 | 40 | - | | | |
| | Ver. | $\phi H1$ | B/L On | 30 | 40 | - | | | |
| | | $\phi L1$ | | 40 | 50 | - | | | |
| | Hor. | $\theta L2$ | $C/R \geq 2$ | B/L Off | 40 | 50 | | - | (11) LCD-7200 |
| | | $\theta R2$ | | | 40 | 50 | | - | |
| Ver. | $\phi H2$ | B/L Off | B/L Off | 40 | 50 | - | | | |
| | $\phi L2$ | | | 40 | 50 | - | | | |

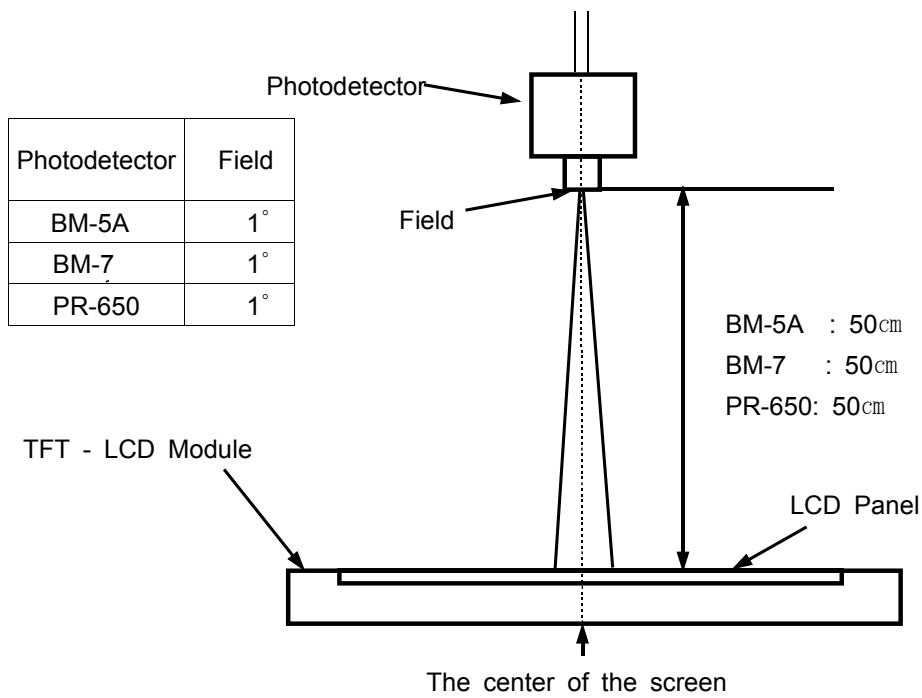
Note (1) The optical characteristics is measured with Back-light and Touch screen panel.

(2) If product is exposed to high temperatures for extended time, there is a possibility of the polarizer film damage which could degrade the optical characteristics.

Note (3) Test Equipment Setup for the Transmissive Mode (Back-light On)

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.

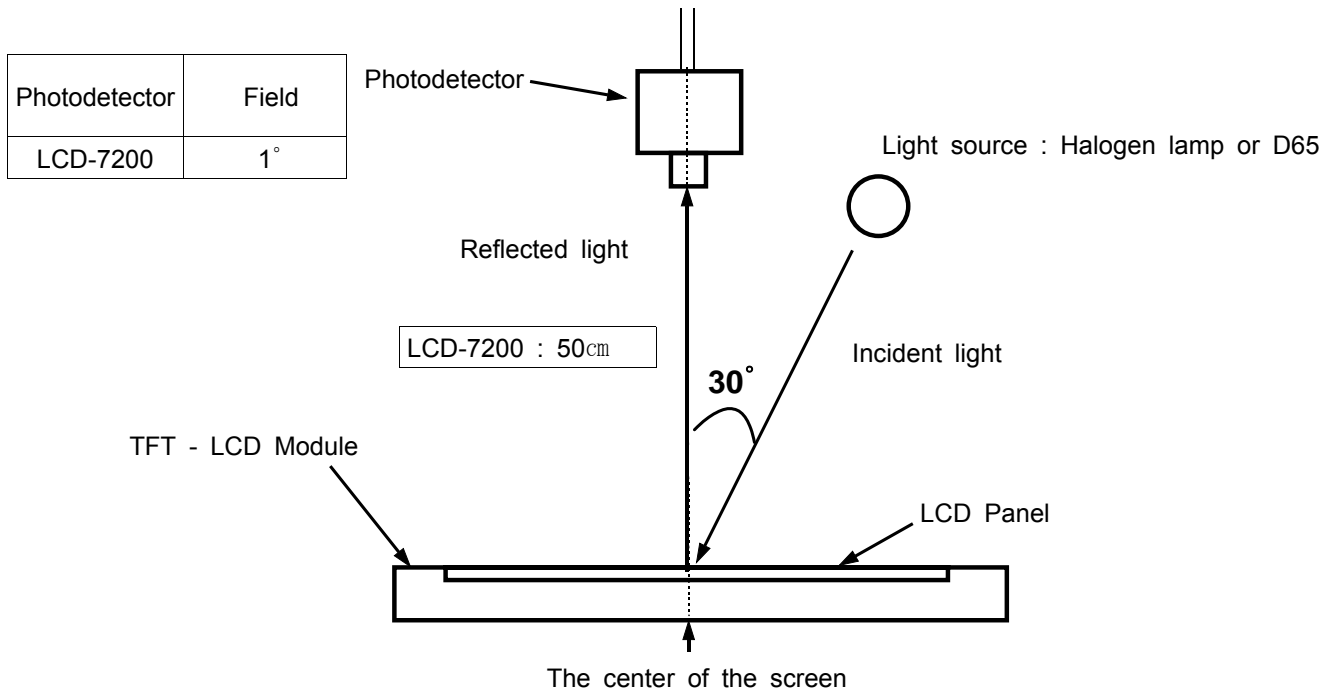
- Back-light Current : 15mA
- Back-Light On condition



Note (4) Test Equipment Setup for the Reflective Mode (Back-light Off)

After stabilizing and leaving the panel alone at a given temperature for 30min, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30min after lighting of reference light source. The reflected light intensity should be measured in the center of screen. The incident angle of the light source is 30° to the normal direction where the photodetector is positioned.

- Back-Light Off Condition



Note (5) Definition of Reflectance : The reflectance is relative quantity to the standard white BaSO₄ or MgO plate that the reflectance of the standard white plate is the 100%.

$$\text{Reflectance} = \frac{\frac{\text{Intensity of the reflected light on LCD}}{\text{Intensity of the incident light on BaSO}_4 \text{ plate}}}{\frac{\text{Intensity of the reflected light on BaSO}_4 \text{ plate}}{\text{Intensity of the incident light on BaSO}_4 \text{ plate}}} \times 100\%$$

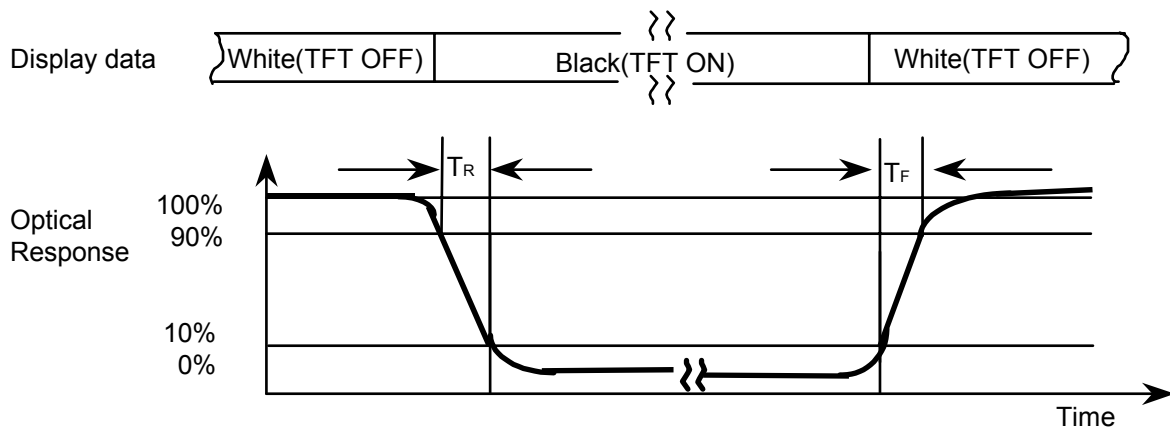
Note (6) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point of the panel. If Back-light is on state, it is the light source and the BM-5A will be used to measure.

$$C/R = \frac{G_{\max}}{G_{\min}}$$

* Gmax : Luminance with all pixels white
* Gmin : Luminance with all pixels black

Note (7) Definition of Luminance of White : Luminance of white at center point.
In this case, the incident light is not from the light source but from the Back-light that generates the reflected light source on LCD in the dark room.

Note (8) Definition of Response time : Sum of Tr ,Tf



Note (9) Definition of Color Chromaticity (CIE 1931), (Back-light: On)

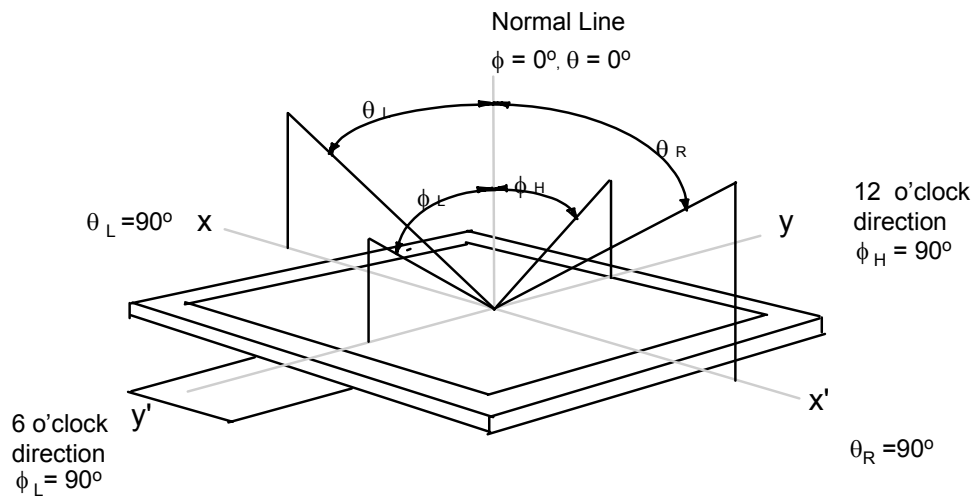
Note (10) Definition of Color Chromaticity (CIE 1931), (Back-light: Off)

Color coordinate of white at center point.

It should be measured at vertical direction on Back-light off state

* Light Source : D65.

Note (11) Definition of Viewing Angle : Viewing angle range (CR≥2)



3. Electrical Characteristics

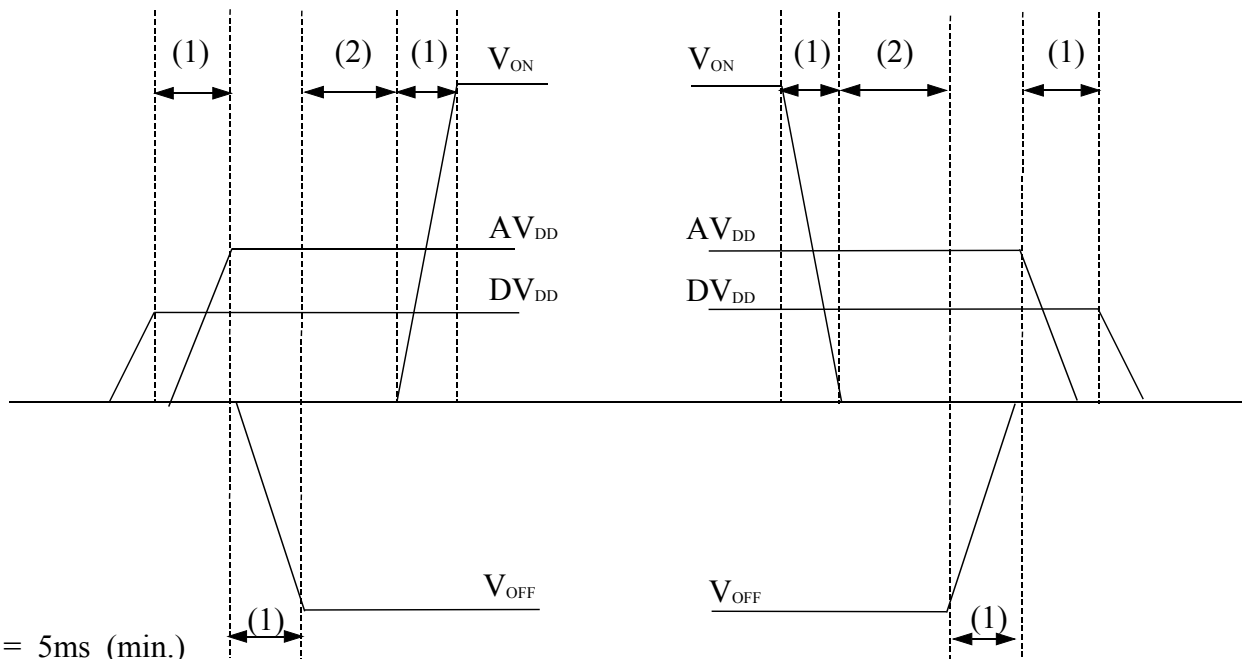
3.1 TFT-LCD Module

(Input Voltage = 3.3V, Ta = Room Temp)

| Characteristics | | Symbol | MIN. | TYP. | MAX. | Unit | Note |
|------------------------|----------------------|----------------|---------|------|---------|------|---------|
| Digital supply voltage | | DVDD | 3.0 | 3.3 | 3.6 | V | |
| Analog supply voltage | | AVDD | 4.5 | 5 | 5.5 | V | |
| Gate On voltage | | VON | 14 | 15 | 16 | V | |
| Gate Off voltage | | VOFF | -11 | -10 | -9 | V | |
| Common voltage | | VCOMH (Vpp) | 3.5 | 4.3 | 5.0 | V | |
| Digital supply current | | IDVDD | - | 1.1 | 2.0 | mA | |
| Analog supply current | | IAVDD | - | 6.3 | 10.0 | mA | |
| Gate supply current | | IVON/ VOFF | - | 0.3 | 0.5 | mA | |
| Input voltage | Source driver (High) | VIHS | 0.8DVDD | - | DVDD | V | |
| | Source driver (Low) | VILS | GND | - | 0.2DVDD | V | |
| Power Dissipation | White | PW | - | 30 | 40 | mW | (1),(2) |
| | Black | PB | - | 45 | 55 | mW | |
| | Vertical Stripe | PV | - | 40 | 50 | mW | |

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

- Power On : DV_{DD} → AV_{DD} → V_{OFF} → V_{ON} → Data
- Power Off : Data → V_{ON} → V_{OFF} → AV_{DD} → DV_{DD}

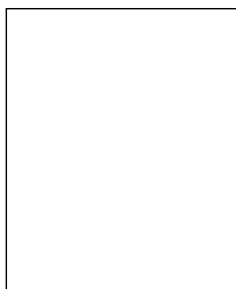


(1) = 5ms (min.)
 (2) = 10ms (min.)

Note (1) Condition : TFT-LCD module only with typ. electrical characteristics

(2) Power dissipation check pattern

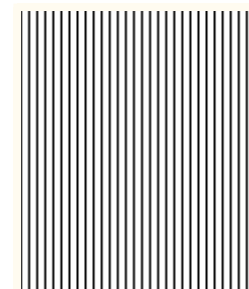
[White patten]



[Black patten]



[Vertical Stripe patten]



3.2 Back-Light Unit

The Back-light system is an edge-lighting type with 6 white LED(Light Emitting Diode)s.
The characteristics of 6 white LEDs are shown in the following tables.

(Ta = Room Temp)

| Characteristics | Symbol | Min. | Typ. | Max. | Unit | Note |
|-------------------|----------|------|------|------|------|------|
| Current | I_B | - | 15 | 25 | mA | (1) |
| Power Consumption | P_{BL} | - | 300 | 500 | mW | (2) |

Note (1) 6 white LEDs serial type.

(2) Where $I_B = 15\text{mA}$, $V_B = 20\text{V}$, $P_{BL} = V_B \times I_B$

4. Touch Screen Panel Specifications

4-1. Electrical Characteristics

| Item | Min. | Typ. | Max. | Unit | Note |
|-----------------------|------|------|------|------------|---------------------------|
| Linearity | -1.5 | - | 1.5 | % | Analog X and Y directions |
| Terminal resistance | 200 | - | 900 | Ω | X(Film side) |
| | 200 | - | 900 | Ω | Y(Film side) |
| Insulation resistance | 25 | - | - | M Ω | DC 25V |
| Voltage | - | 5 | 7 | V | DC |
| Chattering | - | 8 | 10 | ms | 100k Ω pull-up |
| Transparency | 80 | 83 | - | % | - |

Caution (1) : Do not operate it with a thing except a polyacetal pen(tip R0.8mm or less) or a finger, especially those with hard or sharp tips such as a ball point pen or a mechanical pencil.

4-2. Mechanical & Reliability Characteristics

| Item | Min. | Typ. | Max. | Unit | Note |
|-------------------------------|------------------|------|------|------------|-----------|
| Activation force | - | 15 | 80 | g | (1) |
| Durability-surface scratching | Write 120,000 | - | - | characters | (2) |
| Durability-surface pitting | 1,000,000 | - | - | touches | (3) |
| Durability-chemical | - | - | - | - | (4) |
| Surface hardness | 3 | - | - | H | JIS K5400 |

Note (1) Pen : 80g or less (R0.8mm)

Finger : 80g or less (R8.0mm)

(2) Measurement for Surface area

- Stylus Pen has a 20mm×20mm area

- Force :250g

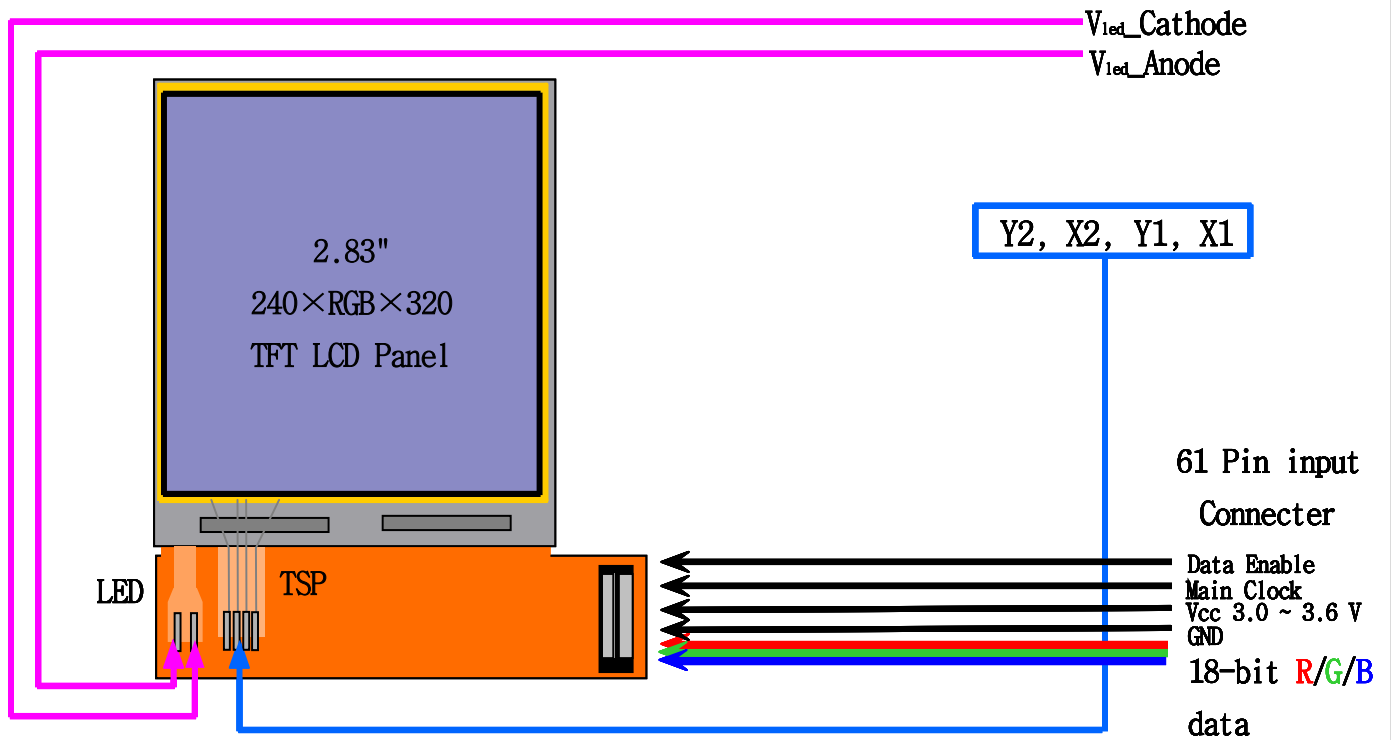
- Speed : 1000 characters/hour

(3) Each Touch by R0.8mm Stylus pen & 500gf load

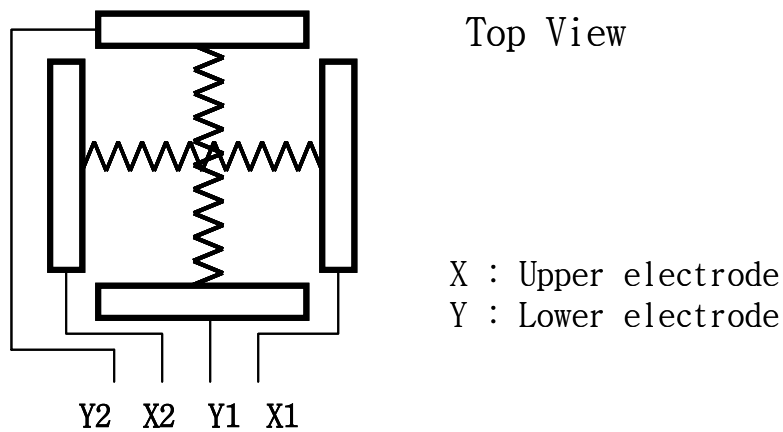
(4) After Dropping a drop of Toluene (or Acetone, Methanol, crude Ethanol), brushing with Fabrics for 3 min. Don't be detected uneven point.

5. Block Diagram

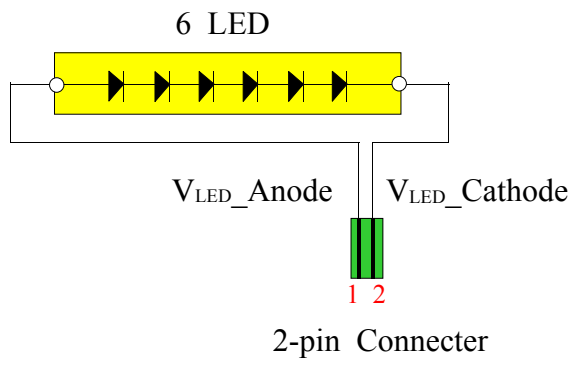
5.1 TFT-LCD Block Diagram



5.2 Touch Screen Panel (Front view)



5.3 Back-light Unit (Front view)



| Pin No. | Symbol | I/O |
|---------|-------------|---------|
| 1 | LED_ANODE | Anode |
| 2 | LED_CATHODE | Cathode |

6. Input Terminal Pin Assignment

6.1 TFT-LCD Module (Mating Connector : 61PIN (Part Name:FH23-61S-0.3SHW, HIROSE))

| Pin No | Symbol | Description | Remark |
|--------|--------|--------------------------|--------|
| 1 | DE | DATA ENABLE | - |
| 2 | MCLK | MAIN CLOCK | - |
| 3 | ENABLE | IC RESET | - |
| 4 | TSP1 | TSP Interface Signal Y2 | - |
| 5 | VSS | DIGITAL ground | - |
| 6 | VCOM | Common Voltage | - |
| 7 | VCOM | Common Voltage | - |
| 8 | AVSS | ANALOG ground | - |
| 9 | VOFF | Gate off Voltage | - |
| 10 | VOFF | Gate off Voltage | - |
| 11 | VON | Gate on Voltage | - |
| 12 | VON | Gate on Voltage | - |
| 13 | VSS | DIGITAL ground | - |
| 14 | TSP2 | TSP Interface Signal X2 | - |
| 15 | VCOMR | Input High Level of VCOM | - |
| 16 | VCOMS | OUTPUT | - |
| 17 | VCOMS | OUTPUT | - |
| 18 | VCOMC | Test pin | - |
| 19 | AVSS | Analog ground | - |
| 20 | VDD | Logic Power | - |
| 21 | VDD | Logic Power | - |
| 22 | AVDD | Analog Power | - |
| 23 | AVDD | Analog Power | - |
| 24 | TSP3 | TSP Interface Signal Y1 | - |
| 25 | VSS | DIGITAL ground | - |
| 26 | CLW1 | IC OPTION | (1) |
| 27 | TSP4 | TSP Interface Signal X1 | - |
| 28 | SDT1 | IC OPTION | (1) |
| 29 | PD17 | R5 | (2) |
| 30 | PD16 | R4 | |
| 31 | PD15 | R3 | |
| 32 | PD14 | R2 | |
| 33 | PD13 | R1 | |
| 34 | PD12 | R0 | |

| Pin No | Symbol | Description | Remark |
|--------|------------|--------------------------|--------|
| 35 | PD11 | G5 | (2) |
| 36 | PD10 | G4 | |
| 37 | PD9 | G3 | |
| 38 | PD8 | G2 | |
| 39 | PD7 | G1 | |
| 40 | PD6 | G0 | |
| 41 | PD5 | B5 | |
| 42 | PD4 | B4 | |
| 43 | PD3 | B3 | |
| 44 | PD2 | B2 | |
| 45 | PD1 | B1 | |
| 46 | PD0 | B0 | |
| 47 | VREF4P | Gamma Voltage (Positive) | - |
| 48 | VREF3P | Gamma Voltage (Positive) | - |
| 49 | VREF2P | Gamma Voltage (Positive) | - |
| 50 | VREF1P | Gamma Voltage (Positive) | - |
| 51 | VREF0P | Gamma Voltage (Positive) | - |
| 52 | VREF4N | Gamma Voltage (Negative) | - |
| 53 | VREF3N | Gamma Voltage (Negative) | - |
| 54 | VREF2N | Gamma Voltage (Negative) | - |
| 55 | VREF1N | Gamma Voltage (Negative) | - |
| 56 | VREF0N | Gamma Voltage (Negative) | - |
| 57 | MAIN_LED + | LED Power(Anode) | - |
| 58 | MAIN_LED + | LED Power(Anode) | - |
| 59 | MAIN_LED - | LED Power(Cathode) | - |
| 60 | MAIN_LED - | LED Power(Cathode) | - |
| 61 | NC | No Connection | - |

Remark (1) CLW1 : Set the delay amount of line cycle clock

i . High : 30 clock delay

ii . Low : 0 clock delay

SDT1 : Set the delay amount of source output

i . High : 25 clock delay

ii . Low : 10 clock delay

(2) LSB : PD0, PD6, PD12

MSB : PD5, PD11, PD17

6.2 Back-Light Unit (Connector : 2 pin FPC Solder type)

| Pin No. | Symbol | Function |
|---------|-------------|-------------|
| 1 | LED_ANODE | LED Anode |
| 2 | LED_CATHODE | LED Cathode |

6.3 Touch Screen Panel (Connector : 4Pin FPC Solder type)

| Pin No. | Symbol | I/O | Function |
|---------|--------|--------|--|
| 1 | X1 | Right | Right electrode - differential analog |
| 2 | Y1 | Bottom | Bottom electrode - differential analog |
| 3 | X2 | Left | Left electrode - differential analog |
| 4 | Y2 | Top | Top electrode - differential analog |

6.4 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 | G0 | G1 | G2 | G3 | G4 | G5 | B0 | B1 | B2 | B3 | | B4 |
| BASIC COLOR | BLACK | 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 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| | GREEN | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | - |
| | CYAN | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| | RED | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | MAGENTA | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | - |
| | YELLOW | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | - |
| | WHITE | 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 | R0 |
| | DARK ↑ | 1 | 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 | R2 |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | R3~R60 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | | |
| | LIGHT ↓ | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R61 |
| | | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R62 |
| RED | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R63 | |
| GRAY SCALE OF GREEN | BLACK | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G1 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | G2 |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | G3~G60 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | | |
| | LIGHT ↓ | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | G61 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | G62 |
| GREEN | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | G63 | |
| GRAY SCALE OF BLUE | BLACK | 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 | 1 | 0 | 0 | 0 | 0 | B1 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | B2 |
| | | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | B3~B60 |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | | |
| | LIGHT ↓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | B61 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | B62 |
| BLUE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | B63 | |

Note) Definition of Gray :

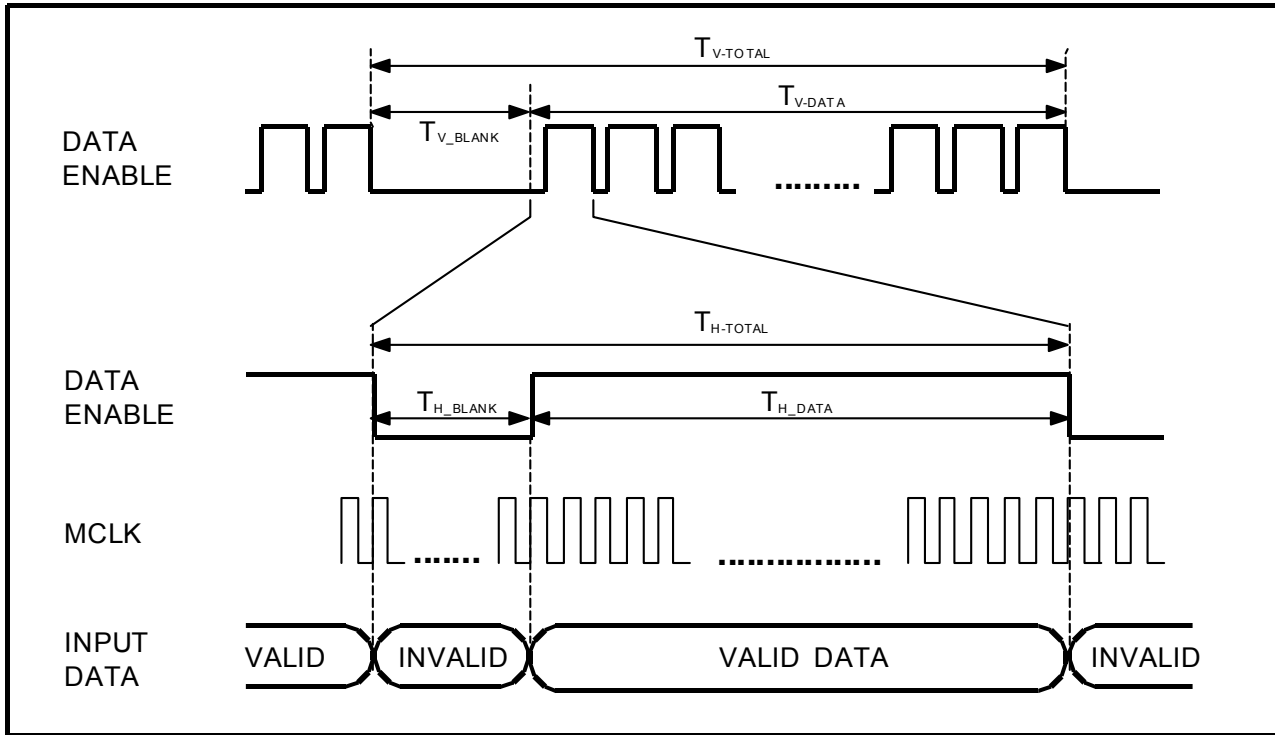
R_n : Red Gray, G_n : Green Gray, B_n : Blue Gray (n = Gray level)

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

※R₅,G₅,B₅ : MSB R₀,G₀,B₀ : LSB

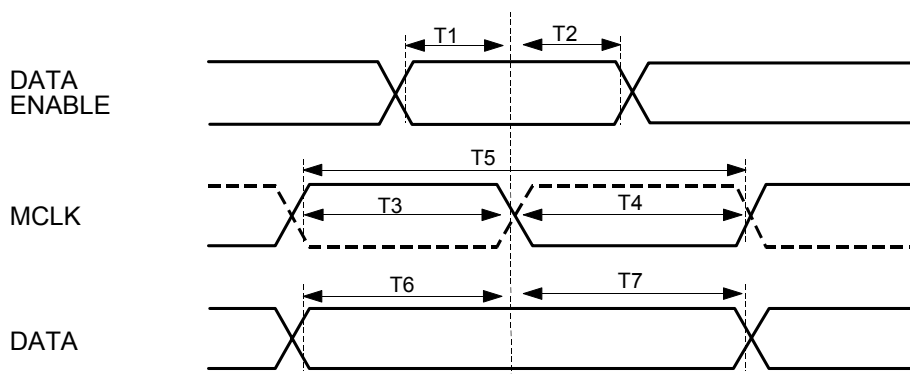
7. Interface Timing

7.1 Timing Diagrams of Interface Signal



| Parameter | Symbol | Minimum | Typical | Maximum | Unit |
|-----------------------|---------------|---------|---------|---------|-------|
| Vertical Total | $T_{V-TOTAL}$ | 327 | 332 | - | Lines |
| Vertical Blank Time | $T_{V-BLANK}$ | 7 | 12 | - | Lines |
| Vertical Display | T_{V-DATA} | 320 | 320 | - | Lines |
| Horizontal Total | $T_{H-TOTAL}$ | 254 | 266 | 479 | MCLK |
| Horizontal Blank Time | $T_{H-BLANK}$ | 14 | 26 | 239 | MCLK |
| Horizontal Display | T_{H-DATA} | 240 | 240 | - | MCLK |
| MCLK | f_{MCLK} | 4.98 | 5.298 | - | MHz |

7.2 AC Characteristic



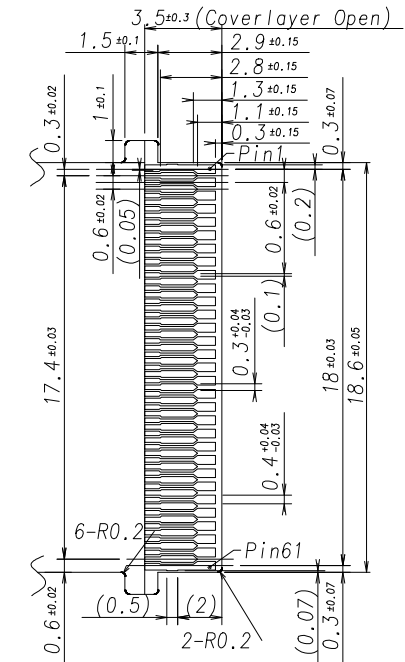
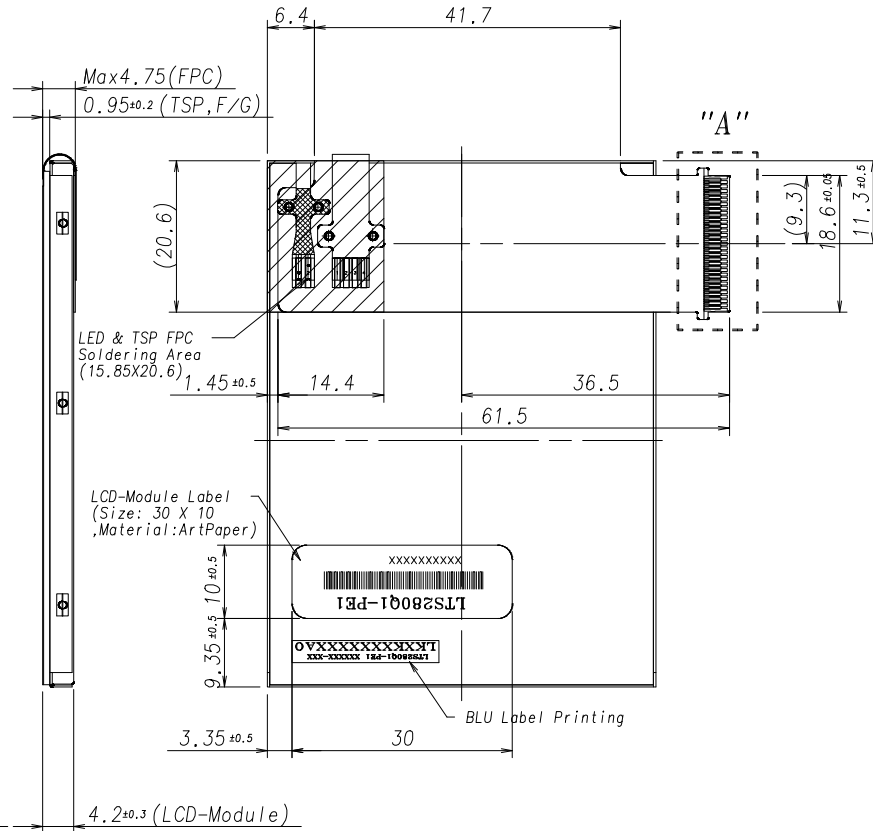
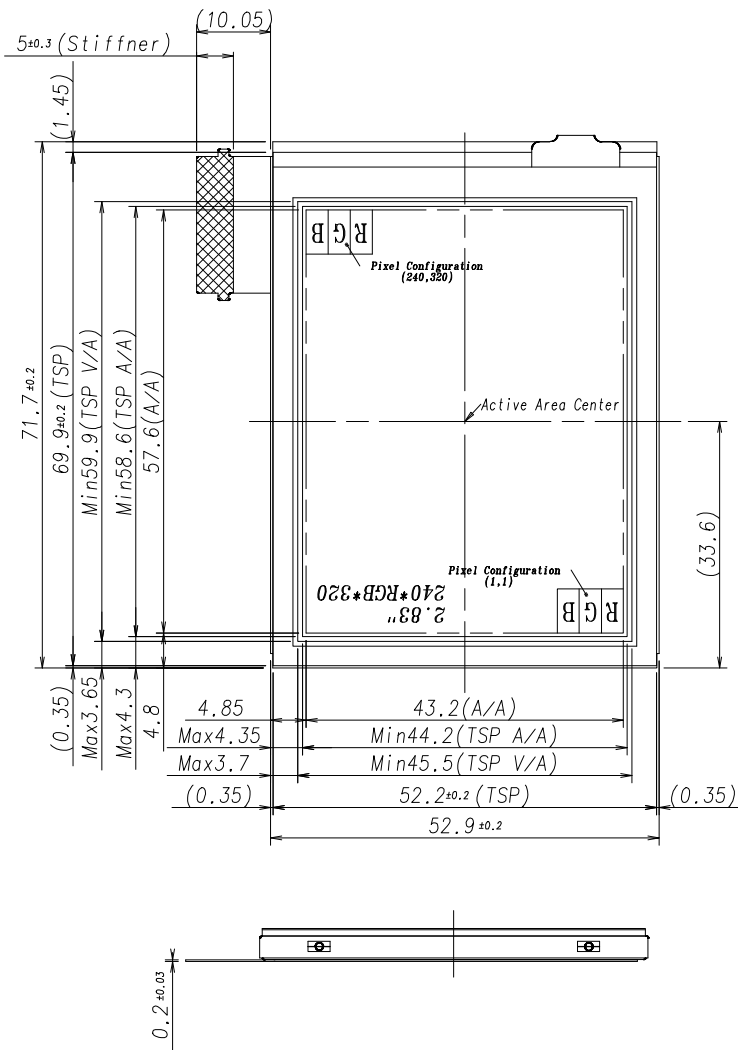
| Parameter | Symbol | Min | Typ | Max | Unit |
|-----------------------|--------|------------------|-----|------------------|------|
| DE Setup | T1 | 30 | - | - | ns |
| DE Hold | T2 | 30 | - | - | ns |
| MCLK High Level Pulse | T3 | 40 | - | - | ns |
| MCLK Low Level Pulse | T4 | 40 | - | - | ns |
| MCLK Cycle Time | T5 | 100 | - | - | |
| DATA Setup | T6 | 30 | - | - | ns |
| DATA Hold | T7 | 30 | - | - | ns |
| Rising/Falling time | | - | - | 25 | ns |
| LOGIC INPUT | VIH | $0.7 \times VDD$ | - | VDD | V |
| | VIL | 0 | - | $0.3 \times VDD$ | V |
| POWER | VDD | 2.5 | - | 3.6 | V |

. Outline Dimensions

8.1 Module Outline Dimensions (Total Assa'y)

- Refer to the Next Page.

| NO | PART NAME | CODE NO | SPECIFICATION | Q'TY | SPEC NO | REMARK |
|----|-------------------|---------|---------------|------|---------|--------|
| 1 | OUTLINE-DIMENSION | | LTS280Q1-PE1 | | | |



Detail "A" (S=3/1)
PIN ASSIGNMENT

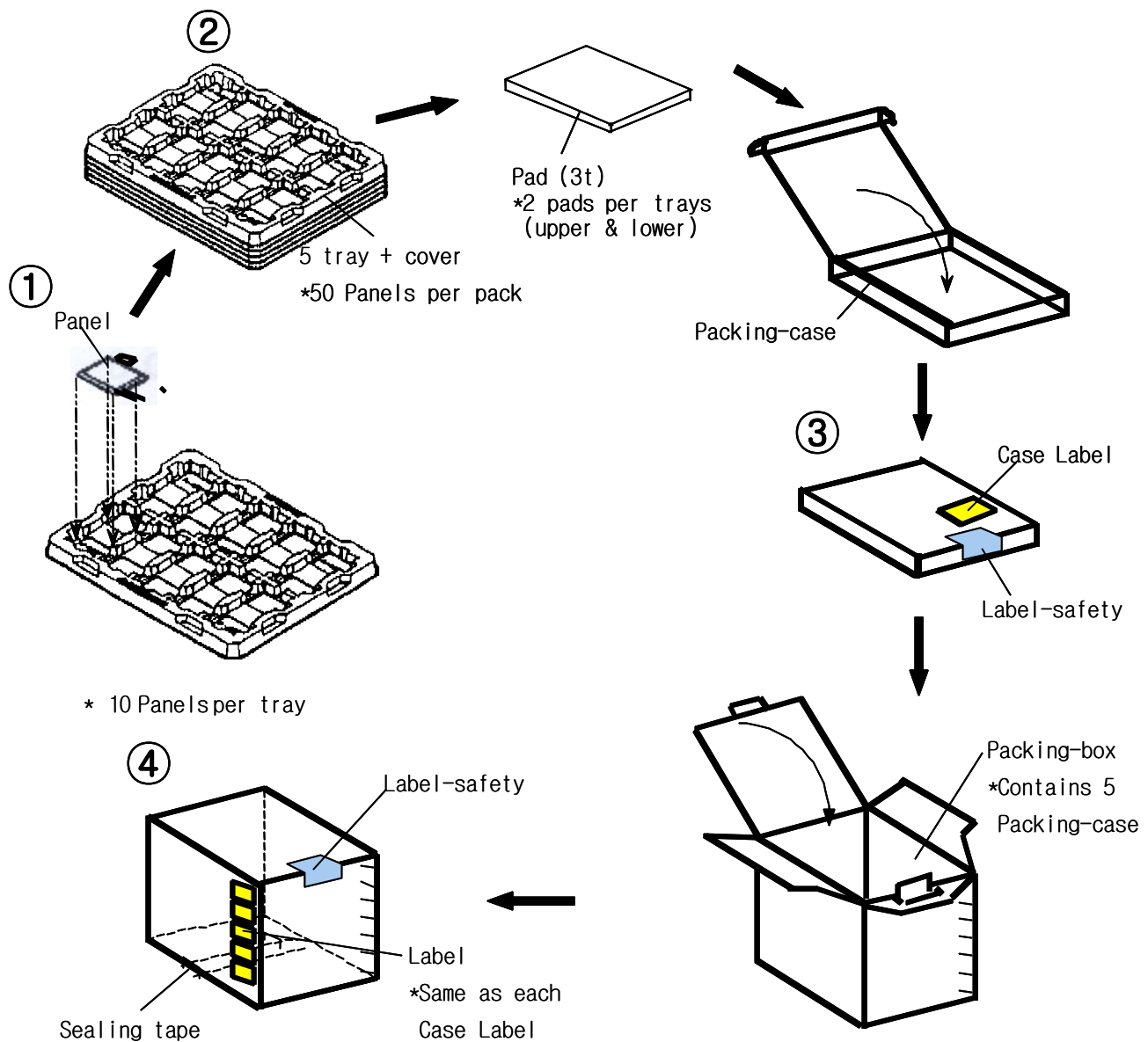
| No | Name | No | Name | No | Name | No | Name |
|----|--------|----|--------|----|---------|----|-----------|
| 1 | DE | 17 | VCOMS2 | 33 | PD13 | 49 | VREF 2P |
| 2 | MCLK | 18 | VCOMC | 34 | PD12 | 50 | VREF 1P |
| 3 | ENABLE | 19 | AVSS3 | 35 | PD11 | 51 | VREF 0P |
| 4 | TSP1 | 20 | VDD1 | 36 | PD10 | 52 | VREF 4N |
| 5 | VSS1 | 21 | VDD2 | 37 | PD9 | 53 | VREF 3N |
| 6 | VCOM1 | 22 | AVDD1 | 38 | PD8 | 54 | VREF 2N |
| 7 | VCOM2 | 23 | AVDD2 | 39 | PD7 | 55 | VREF 1N |
| 8 | AVSS1 | 24 | TSP3 | 40 | PD6 | 56 | VREF 0N |
| 9 | VOFF1 | 25 | VSS2 | 41 | PD5 | 57 | MAINLED+1 |
| 10 | VOFF2 | 26 | CLW1 | 42 | PD4 | 58 | MAINLED+2 |
| 11 | VON1 | 27 | TSP4 | 43 | PD3 | 59 | MAINLED-1 |
| 12 | VON2 | 28 | SDT1 | 44 | PD2 | 60 | MAINLED-2 |
| 13 | DVSS2 | 29 | PD17 | 45 | PD1 | 61 | NC |
| 14 | TSP2 | 30 | PD16 | 46 | PD0 | | |
| 15 | VCOMR2 | 31 | PD15 | 47 | VREF 4P | | |
| 16 | VCOMS1 | 32 | PD14 | 48 | VREF 3P | | |

Note
 1. Connector : Hirose FH23-61S-0.3SHW
 Number of Pos - 61Pins
 2. Unspecified tolerance is the LEVEL3
 of General tolerance

PRELIMINARY

| GENERAL TOLERANCE | | | | | DISCRIPTION OF REVISION | | | | REASON | | CHK'D BY |
|-------------------|---------|---------|---------|---------------------|-------------------------|----------|----------|----------|----------|-------------------|-----------|
| STEP | LEVEL 1 | LEVEL 2 | LEVEL 3 | REV | DATE | DRA'N BY | DES'D BY | CHK'D BY | APP'D BY | MODEL NAME | CHK'D BY |
| 0 < X ≤ 4 | ±0.05 | ±0.1 | ±0.2 | UNIT | mm | | | | | LTS280Q1-PE1 | |
| 4 < X ≤ 16 | ±0.08 | ±0.15 | ±0.3 | SCALE | 1/1 | K.Y.LEE | D.C.KIM | Y.B.CHU | | OUTLINE DIMENSION | SHEET 1/1 |
| 16 < X ≤ 64 | ±0.12 | ±0.25 | ±0.5 | TOLERANCE | LEVEL3 | 04.01.30 | 04.01.30 | 04.01.30 | | | |
| 64 < X ≤ 256 | ±0.25 | ±0.4 | ±0.8 | SAMSUNG ELECTRONICS | | | | SPEC. NO | | | VER. 04 |

9. Packing



Note (1) Total : Case: Approx. 2.4 Kg

Box: Approx. 12.1 Kg

(2) Size : Case: 490(W) x 342(D) x 58(H)

Box: 505(W) x 355(D) x 319(H)

(3) Pad Material : Polyethylene Foam T=3.0

(4) Resistance of tray surface : $10^3 \sim 10^6 \Omega$

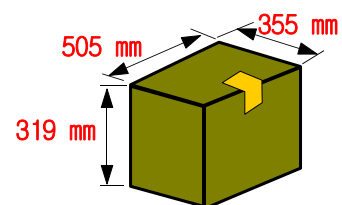
(5) ESD of tray surface : 20~100V

(6) Place the panels in the tray facing the direction shown in the figure.

(7) Place 5 tray and cover(empty tray) and pads inside the packing-case.

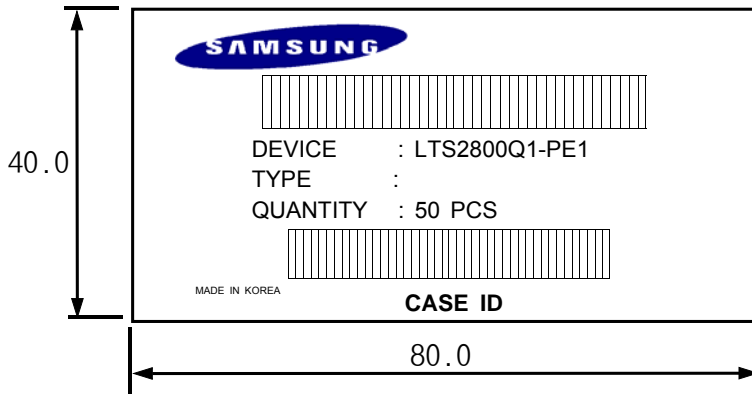
(8) Place 5 packing-case inside the packing-box.(Affix the label)

(9) Seal the packing-box. Affix the label-safety.

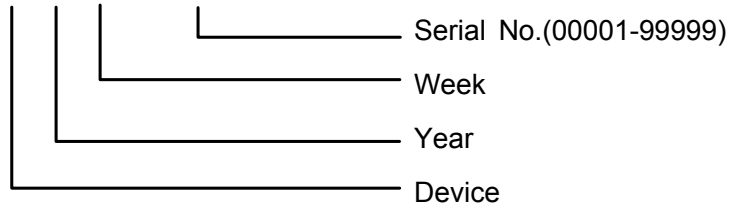


10. Marking & Others

(1) Packing case attach



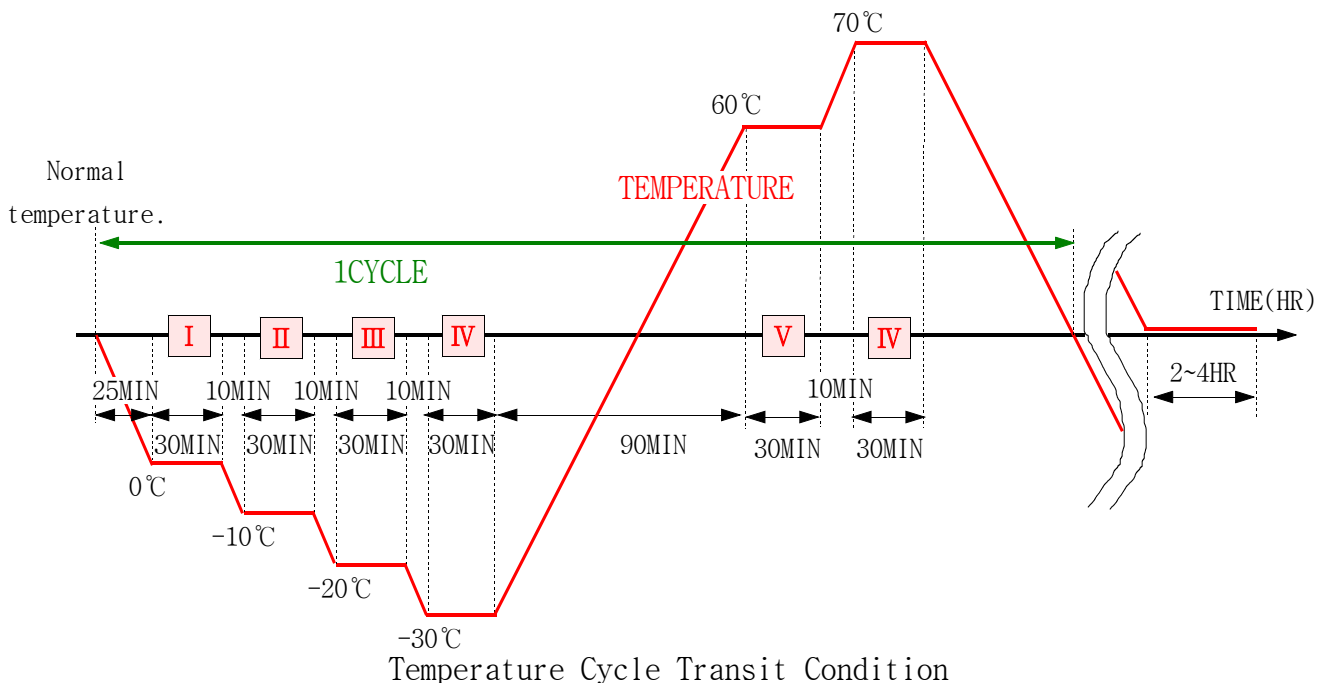
CASE ID : NA 0 00 00001



11. Reliability Test Result except Touch Screen Panel

| Item | Condition | Sample Size | Test Result |
|---------------------------------------|---|-------------|-------------|
| High Temperature Operating Life test | 60 °C, 250HR | 12EA | PASS |
| Low Temperature Operating Life test | -20 °C, 250HR | 5EA | PASS |
| Thermal Humidity Bias | 40 °C, 95%RH, 250HR | 5EA | PASS |
| High Temperature Storage test | 70 °C, 250HR | 5EA | PASS |
| Low Temperature Storage test | - 30 °C, 250HR | 5EA | PASS |
| Thermal Cycle | Operating test 25 °C → (-20 °C ⇔ 60 °C) ^{12CYC} → 25 °C 30Min 1 °C/Min 30Min | 5EA | PASS |
| | Storage test 25 °C → (-25 °C ⇔ 70 °C) ^{100CYC} 30Min 3Min 30Min | 5EA | PASS |
| Wet Humidity Temperature Storage test | 60 °C, 90%RH, 250HR | 5EA | PASS |
| Low Pressure(Altitude) Storage test | 115mbar, 25 ± 3 °C, 72HR | 3EA | PASS |
| Power ON/OFF test | ON/OFF time: 10sec/10sec, 36000Cycles | 5EA | PASS |
| ESD CDM | Contact ± 4kV, 150pF/330 Ω, 4Corner 5times/Corner | 5EA | PASS |
| | Air ± 8kV, 150pF/330 Ω, 4Corner 5times/Corner | 5EA | PASS |

Note (1) For touch screen panel, refer to The Specification of Touch Screen Panel.



12. General Precautions

12.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly. Be careful not to twist and bend the module.
- (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 back-light unit.
- (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 Integrated Gate Circuit.
- (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) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (l) Pins of I/F connector shall not be touched directly with bare hands.

12.2 Storage

- (a) Do not leave the panel 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.

12.3 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 3.1 "Power on/off sequence"

12.4 Others

- (a) The liquid-crystal is deteriorated by ultraviolet rays. Do not leave it in direct sunlight and strong ultraviolet rays for many hours.
- (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, and so on)
Otherwise the panel may be damaged.
- (d) If the panel 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 panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.