



Approval

To : General

Date : 2005-03-08

**SAMSUNG TFT-LCD****MODEL NO. : LTM170EX-L21**

Approved by :

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

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**\* Revision History**

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| Date              | Rev. No | Page | Summary                                                        |
|-------------------|---------|------|----------------------------------------------------------------|
| March. 8,<br>2005 | 000     |      | Approval specification of LTM170EX-L21 model was issued first. |

## General Description

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### \* Description

LTM170EX-L21 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 17.0" contains 1280 x 1024 pixels and can display up to 16.2 million colors.

### \* Features

- High contrast ratio, high aperture structure
- TN (Twisted Nematic) mode
- Wide viewing angle
- High speed response
- SXGA (1280 x 1024 pixels) resolution
- Low power consumption
- 2 dual CCFTs (Cold Cathode Fluorescent Tube)
- DE (Data Enable) mode
- LVDS (Low Voltage Differential Signaling) interface (2pixel/clock)
- Compact Size Design
- Pb-free configuration

### \* Applications

Workstation & desktop monitors

Display terminals for AV application products

Monitors for industrial machine

\* If the module is used to other applications besides the above, please contact SEC in advance.

### \* General information

| Items             | Specification                | Unit   | Note |
|-------------------|------------------------------|--------|------|
| Display area      | 337.92(H) x 270.336(V)       | mm     |      |
| Driver element    | a-Si TFT active matrix       |        |      |
| Display colors    | 16.2M                        | colors |      |
| Number of pixels  | 1280 x 1024                  | pixel  |      |
| Pixel arrangement | RGB vertical stripe          |        |      |
| Pixel pitch       | 0.264(H) x 0.264(W)          | mm     |      |
| Display mode      | Normally White               |        |      |
| Surface treatment | Haze 25% , Hard-coating (3H) |        |      |

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**\* Mechanical information**

| Item        |               | Min.  | Typ.  | Max.  | Note |
|-------------|---------------|-------|-------|-------|------|
| Module size | Horizontal(H) | 354.4 | 354.9 | 355.4 | mm   |
|             | Vertical(V)   | 289.8 | 290.3 | 290.8 | mm   |
|             | Depth(D)      | -     | -     | 13.3  | mm   |
| Weight      |               | -     | -     | 1,700 | g    |

**1. Absolute Maximum Ratings****1.1 Absolute ratings of environment**

| Item                                                 | Symbol           | Min. | Max. | Unit | Note    |
|------------------------------------------------------|------------------|------|------|------|---------|
| Storage temperature                                  | T <sub>STG</sub> | -25  | 60   | °C   | (1)     |
| Operating temperature<br>(Glass surface temperature) | T <sub>OPR</sub> | 0    | 50   | °C   | (1)     |
| Shock ( non - operating )                            | Snop             | -    | 50   | G    | (2),(4) |
| Vibration ( non - operating )                        | Vnop             | -    | 1.5  | G    | (3),(4) |

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

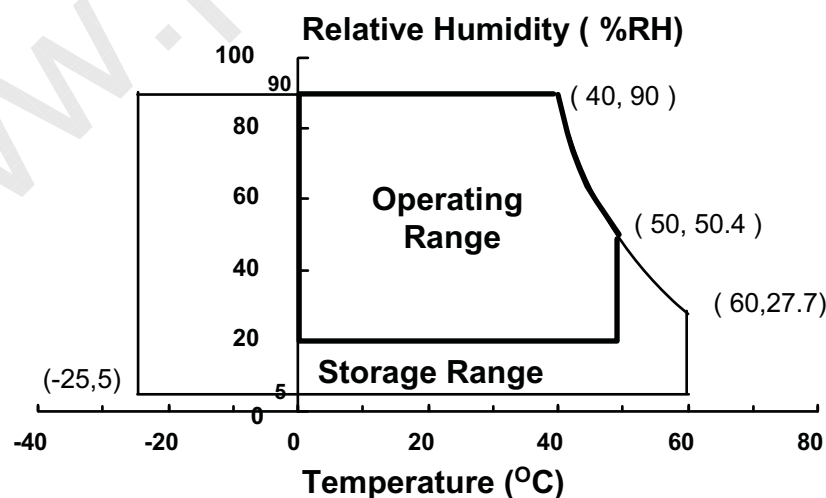
90 % RH Max. ( 40 °C ≥ Ta )

Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.

(2) 11ms, sine wave, one time for ±X, ±Y, ±Z axis

(3) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

(4) At vibration and shock test, the fixture which holds the module to be tested has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.





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## 1.2 ELECTRICAL ABSOLUTE RATINGS

## (1) TFT LCD Module

(V<sub>SS</sub> = GND = 0 V)

| Item                 | Symbol          | Min.                 | Max. | Unit | Note |
|----------------------|-----------------|----------------------|------|------|------|
| Power Supply Voltage | V <sub>DD</sub> | V <sub>SS</sub> -0.5 | 6.5  | V    | (1)  |

Note (1) Within Ta ( 25 ± 2 °C)

## (2) BACK-LIGHT UNIT

(Ta = 25 ± 2°C)

| Item           | Symbol         | Min. | Max. | Unit. | Note    |
|----------------|----------------|------|------|-------|---------|
| Lamp Current   | I <sub>L</sub> | 3.0  | 8.0  | mArms | (1),(2) |
| Lamp Frequency | f <sub>L</sub> | 40   | 80   | kHz   | (1)     |

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

(2) Specified values are for a single lamp.

(Refer to the Note (1) in the page 13 for further information.)



## 2. Optical Characteristics

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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 : TOPCON BM-5A, BM-7, PHOTO RESEARCH PR650  
Eldim EZ-Contrast

(Inverter Freq. : 50kHz)

\* Ta = 25 ± 2°C, VDD=5V, fv= 60Hz, fDCLK=54MHz, IL = 7.5mA<sub>rms</sub>

| Item                                     |         | Symbol           | Condition                                                 | Min.  | Typ.  | Max.  | Unit    | Note         |
|------------------------------------------|---------|------------------|-----------------------------------------------------------|-------|-------|-------|---------|--------------|
| Contrast Ratio<br>(Center of screen)     |         | C/R              | Normal<br>$\phi = 0$<br>$\theta = 0$<br><br>Viewing Angle | 500   | 700   | -     |         | (3)<br>BM-5A |
| Response Time                            | Rising  | T <sub>R</sub>   |                                                           | -     | 2     | 4     | msec    | (5)<br>BM-7  |
|                                          | Falling | T <sub>F</sub>   |                                                           | -     | 6     | 10    |         |              |
| Luminance of White<br>(Center of screen) |         | Y <sub>L</sub>   |                                                           | 250   | 300   | -     | cd/m2   | (6)<br>BM-5A |
| Color Chromaticity<br>(CIE 1931)         | Red     | R <sub>x</sub>   |                                                           | 0.620 | 0.650 | 0.680 |         | (7)<br>PR650 |
|                                          |         | R <sub>y</sub>   |                                                           | 0.300 | 0.330 | 0.360 |         |              |
|                                          | Green   | G <sub>x</sub>   |                                                           | 0.270 | 0.300 | 0.330 |         |              |
|                                          |         | G <sub>y</sub>   |                                                           | 0.570 | 0.600 | 0.630 |         |              |
|                                          | Blue    | B <sub>x</sub>   |                                                           | 0.120 | 0.150 | 0.180 |         |              |
|                                          |         | B <sub>y</sub>   |                                                           | 0.050 | 0.080 | 0.110 |         |              |
|                                          | White   | W <sub>x</sub>   |                                                           | 0.283 | 0.313 | 0.343 |         |              |
|                                          |         | W <sub>y</sub>   |                                                           | 0.299 | 0.329 | 0.359 |         |              |
| Color Chromaticity<br>(CIE 1976)         | Red     | R <sub>u'</sub>  | -                                                         | 0.459 | -     |       |         |              |
|                                          |         | R <sub>v'</sub>  | -                                                         | 0.525 | -     |       |         |              |
|                                          | Green   | G <sub>u'</sub>  | -                                                         | 0.125 | -     |       |         |              |
|                                          |         | G <sub>v'</sub>  | -                                                         | 0.563 | -     |       |         |              |
|                                          | Blue    | B <sub>u'</sub>  | -                                                         | 0.152 | -     |       |         |              |
|                                          |         | B <sub>v'</sub>  | -                                                         | 0.196 | -     |       |         |              |
|                                          | White   | W <sub>u'</sub>  | -                                                         | 0.198 | -     |       |         |              |
|                                          |         | W <sub>v'</sub>  | -                                                         | 0.468 | -     |       |         |              |
| Viewing Angle                            | Hor.    | $\theta$ L       | CR <sub>≥</sub> 10                                        | 65    | 75    | -     | Degrees | (8)<br>BM-5A |
|                                          |         | $\theta$ R       |                                                           | 65    | 75    | -     |         |              |
|                                          | Ver.    | $\phi$ H         |                                                           | 65    | 75    | -     |         |              |
|                                          |         | $\phi$ L         |                                                           | 50    | 60    | -     |         |              |
| Brightness Uniformity<br>(9 Points)      |         | B <sub>uni</sub> |                                                           | -     | -     | 25    | %       | (4)<br>BM-5A |

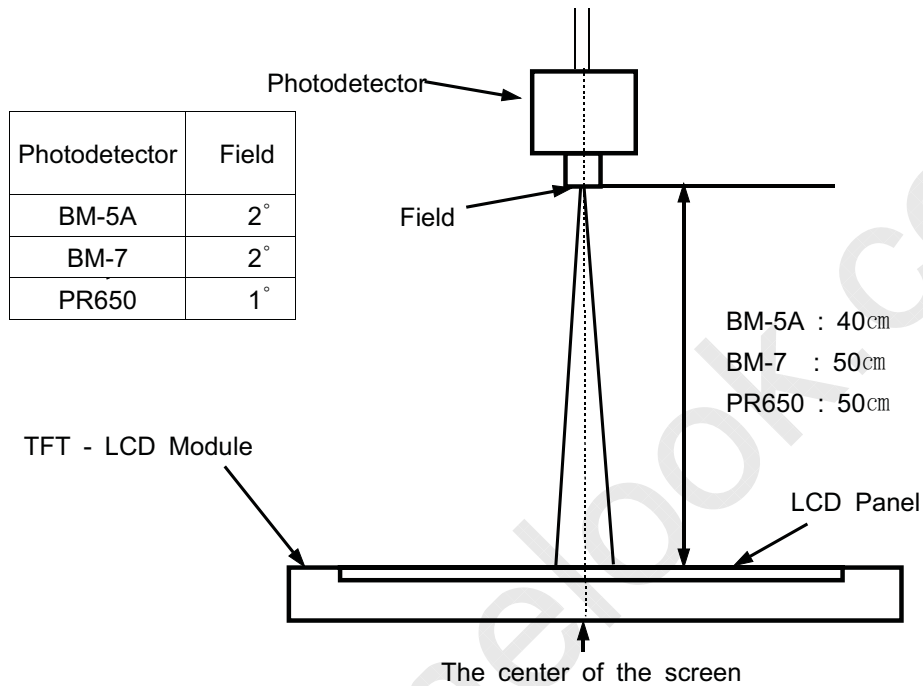
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## Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 30min and 40min after lighting the back-light at the given temperature for stabilization of the back-light. This should be measured in the center of screen.

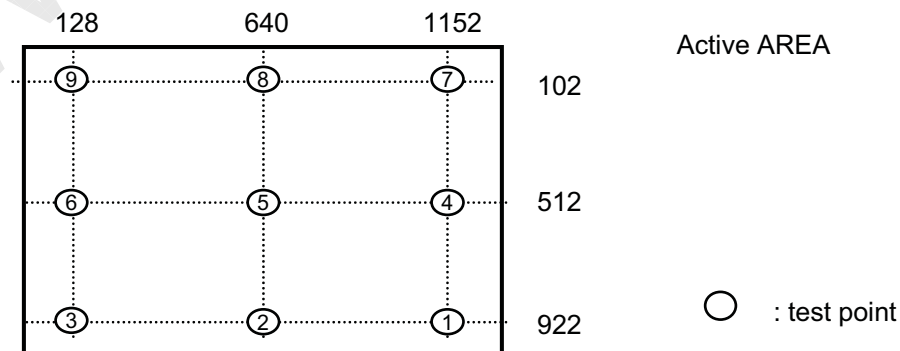
Single lamp current : 7.5mA (Refer to the note(1) in the page 13 for more information.)

Environment condition :  $T_a = 25 \pm 2\text{ }^{\circ}\text{C}$



Optical Measuring Equipment Setup

## Note (2) Definition of test point



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## Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G_{\max}}{G_{\min}}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

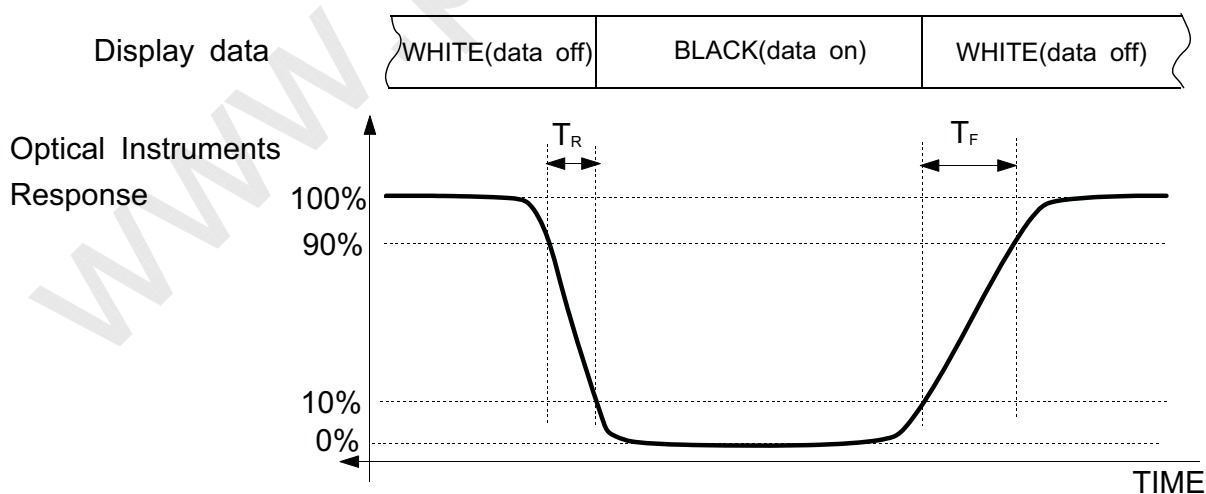
## Note (4) Definition of 9 points brightness uniformity

$$B_{uni} = 100 * \frac{(B_{\max} - B_{\min})}{B_{\max}}$$

Bmax : Maximum brightness

Bmin : Minimum brightness

## Note (5) Definition of Response time : Sum of Tr, Tf



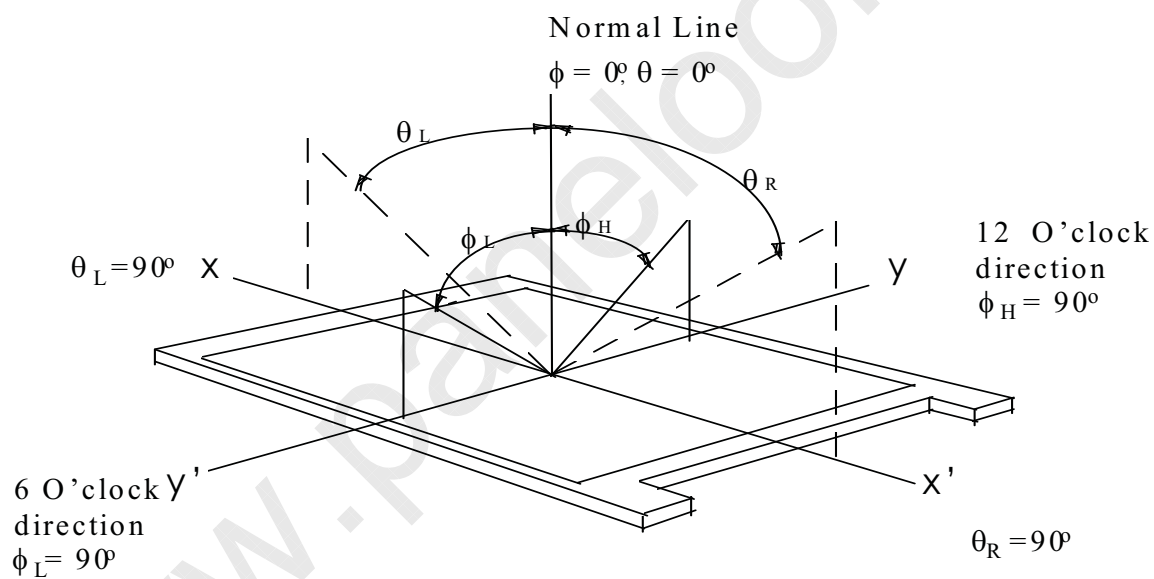
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Note (6) Definition of Luminance of White : Luminance of white at center point⑤

Note (7) Definition of Color Chromaticity (CIE 1931, CIE1976)

Color coordinate of Red, Green, Blue & White at center point⑤

Note (8) Definition of Viewing Angle : Viewing angle range ( $CR \geq 10$ )



### 3. Electrical Characteristics

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#### 3.1 TFT LCD MODULE

Ta = 25°C

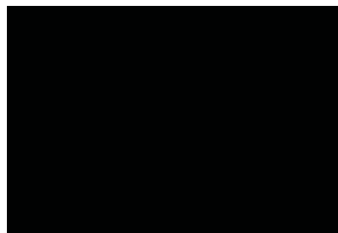
| Item                    |           | Symbol            | Min.                       | Typ. | Max.   | Unit | Note    |
|-------------------------|-----------|-------------------|----------------------------|------|--------|------|---------|
| Voltage of Power Supply |           | V <sub>DD</sub>   | 4.5                        | 5.0  | 5.5    | V    | (1)     |
| Interface type          |           | LVDS              | DS90C383/385 DS90C386 Pair |      |        |      |         |
| Current of Power Supply | (a) Black | I <sub>DD</sub>   | -                          | 600  | -      | mA   | (2),(3) |
|                         | (b) White |                   | -                          | 500  | -      | mA   |         |
|                         | (c) Dot   |                   | -                          | 700  | 850    | mA   |         |
| Vsync Frequency         |           | f <sub>V</sub>    | 55                         | 60   | 77     | Hz   | (4)     |
| Hsync Frequency         |           | f <sub>H</sub>    | 56.7                       | 64   | 82.082 | kHz  |         |
| Main Frequency          |           | f <sub>DCLK</sub> | 40.0                       | 54   | 69.28  | MHz  |         |
| Rush Current            |           | I <sub>RUSH</sub> | -                          | -    | 3.0    | A    | (5)     |

Note (1) The connector for display data & timing signal should be connected.(V<sub>SS</sub>=0V)

(2) f<sub>V</sub>=60Hz, f<sub>DCLK</sub> = 54MHz, V<sub>DD</sub> = 5.0V, DC Current.

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

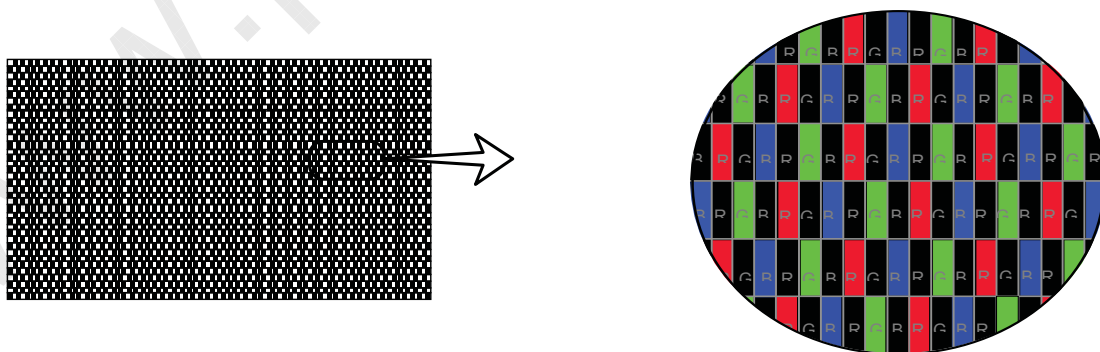
a) Black Pattern



b) White Pattern



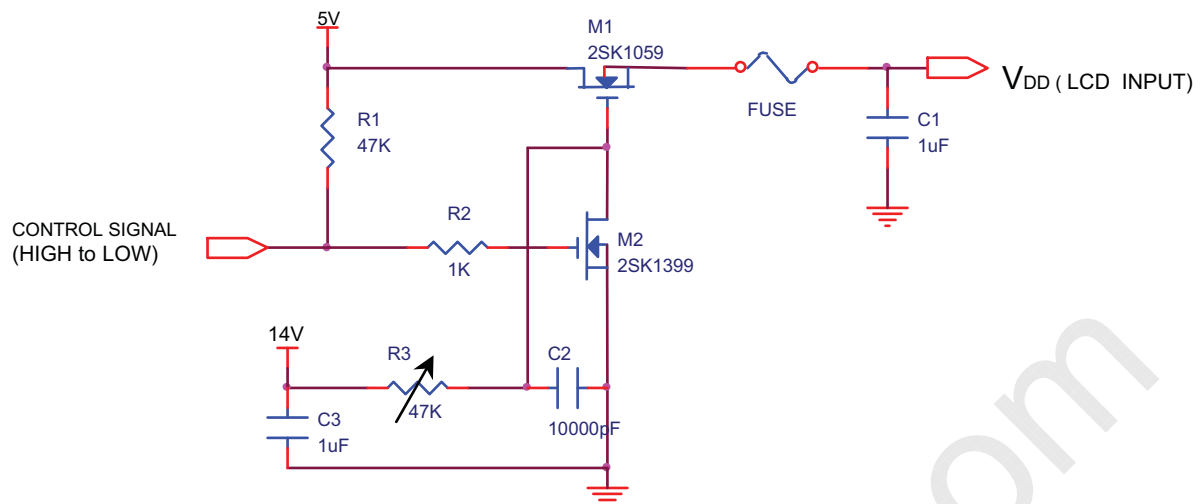
c) Dot Pattern



(4) At low Vsync frequency, under 60Hz, flicker level can increase at specific pattern.

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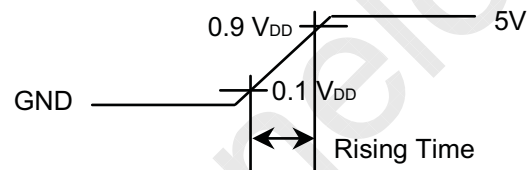
## (5) Measurement Conditions



Control Signal : High(+5V) → Low(Ground)

All Signal lines to panel, except for power 5V : Ground

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



### 3.2 BACK-LIGHT UNIT

The back-light system is an edge - lighting type with 2 dual CCFTs ( Cold Cathode Fluorescent Tube ) The characteristics of two dual lamps are shown in the following tables.

Ta=25 ± 2°C

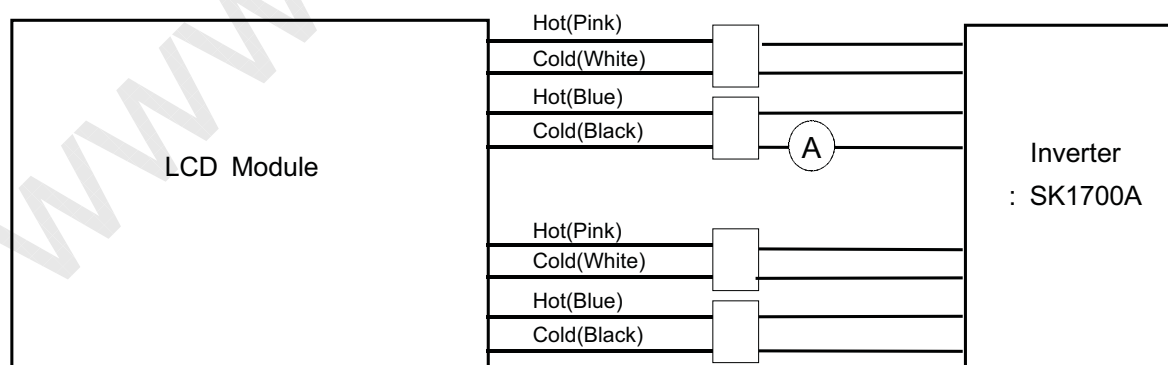
| Item                | Symbol          | Min.             | Typ. | Max. | Unit              | Note |
|---------------------|-----------------|------------------|------|------|-------------------|------|
| Lamp Current        | IL              | 3.0              | 7.5  | 8.0  | mArms             | (1)  |
| Lamp Voltage        | VL              | -                | 565  | -    | Vrms              |      |
| Lamp Frequency      | fL              | 40               | -    | 60   | kHz               | (2)  |
| Operating Life Time | Hr              | 50,000           | -    | -    | Hour              | (3)  |
| inverter waveform   | asymmetry rate  | W <sub>asy</sub> | -    | -    | 10                | %    |
|                     | distortion rate | W <sub>dis</sub> | -    | -    | $\sqrt{2} \pm 10$ | %    |
| Startup Voltage     |                 | Vs               | -    | -    | 0°C : 1,800       | Vrms |
|                     |                 |                  |      |      | 25°C : 1,580      |      |

**Note) The wave form of the inverter output voltage must be area symmetric and the design of the inverter must have specifications for the modularized lamp.**

The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter. When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(poor lighting, flicker, etc.) never occur. When you confirm it, the module should be operated in the same condition as it is installed in your instrument.

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

Refer to the block diagram of the back-light unit in the next page for more information.  
Specified values are for a single lamp.



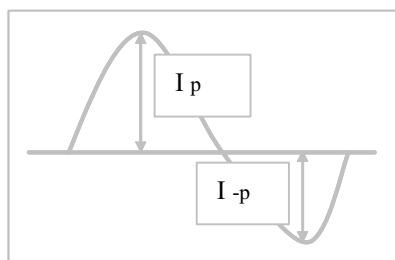
(2) Lamp frequency which may produce interference with horizontal synchronous frequency may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

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- (3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of  $T_a = 25 \pm 2^\circ\text{C}$  and  $I_L = 7.5\text{mA}_{\text{rms}}$  for a lamp until the brightness becomes 50% or lower than its original value. Operating condition is lamp unit itself, not module assembly at operating current 7.5mA.
- (4) If an inverter has shutdown function, it should keep its output for over 1 second even if the lamp connector is open. Otherwise the lamps may not be turned on.
- (5) Because the inverter uses high voltage, please disconnect it from the power before assembling or disassembling.
- (6) The output of the inverter must have symmetrical(negative and positive) voltage waveform and current waveform.

Please do not use the inverter which has unsymmetrical voltage and current and spike wave. Designing a system inverter intended to have better display performance, power efficiency and lamp reliability, please follow the requirements the below. They would help increase the lamp lifetime and reduce leakage current.

- a. The asymmetry rate of the inverter waveform should be less than 10%.
  - b. The distortion rate of the waveform should be within  $\sqrt{2} \pm 10\%$ .
- \* Inverter output waveform had better be more similar to ideal sine wave.



\* Asymmetry rate:

$$|I_p - I_{-p}| / I_{\text{rms}} \times 100\%$$

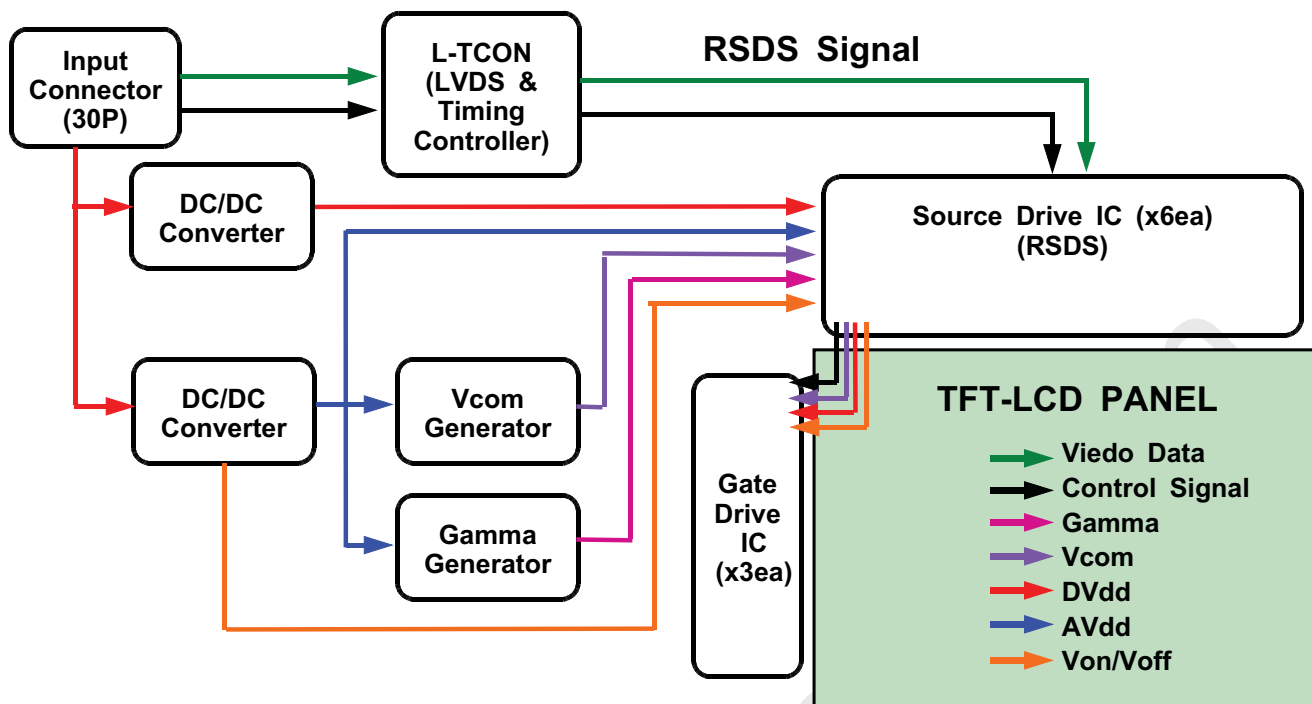
\* Distortion rate

$$I_p \text{ (or } I_{-p}) / I_{\text{rms}}$$

## 4. Block Diagram

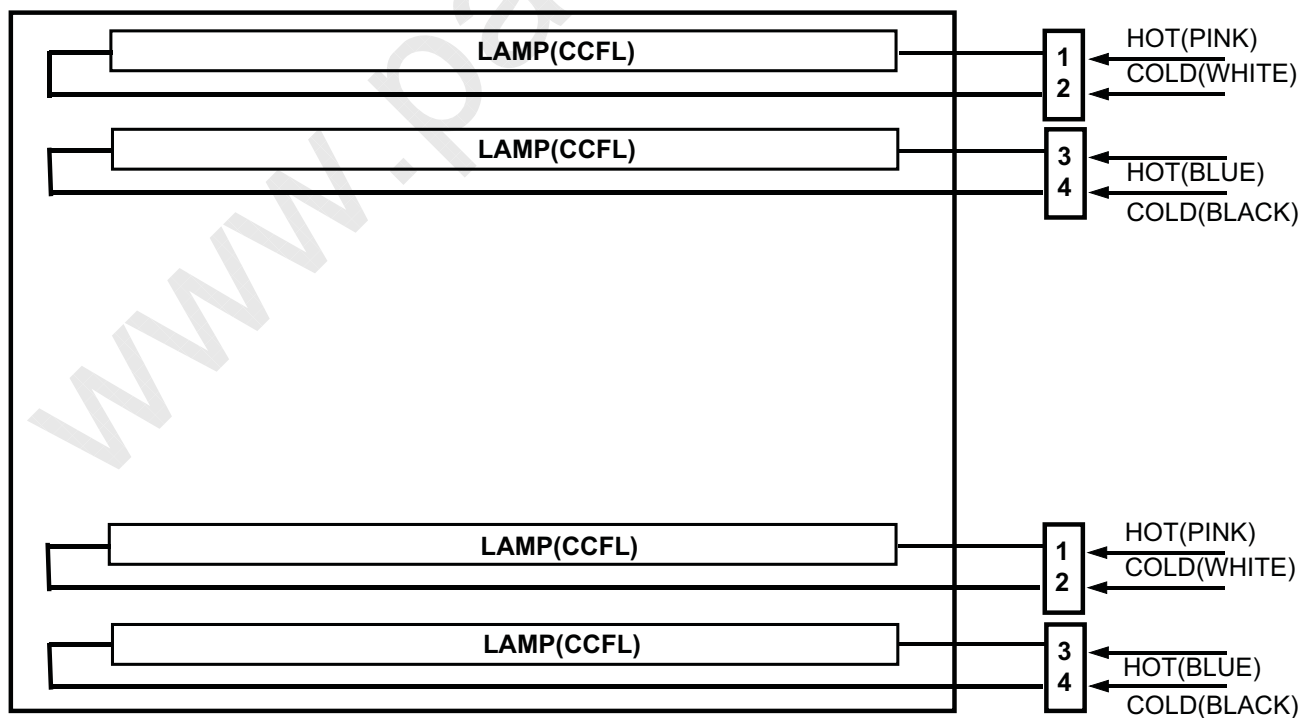
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### 4.1 TFT LCD MODULE



### 4.2 BACK-LIGHT UNIT

Connector : Yeonho 35001HS-02L or equivalent



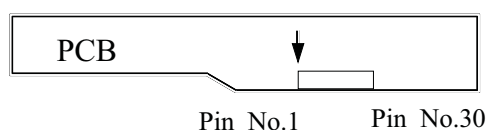
## 5. Input Terminal Pin Assignment

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### 5.1. Input Signal & Power ( Connector : UJU IN-30-OB 100 or equivalent )

| PIN NO | SYMBOL          | FUNCTION                                          |
|--------|-----------------|---------------------------------------------------|
| 1      | RX00-           | Negative Transmission Data of Pixel 0 (ODD data)  |
| 2      | RX00+           | Positive Transmission Data of Pixel 0 (ODD data)  |
| 3      | RX01-           | Negative Transmission Data of Pixel 1 (ODD data)  |
| 4      | RX01+           | Positive Transmission Data of Pixel 1 (ODD data)  |
| 5      | RX02-           | Negative Transmission Data of Pixel 2 (ODD data)  |
| 6      | RX02+           | Positive Transmission Data of Pixel 2 (ODD data)  |
| 7      | GND             | Power Ground                                      |
| 8      | RXOC-           | Negative Sampling Clock (ODD data)                |
| 9      | RXOC+           | Positive Sampling Clock (ODD data)                |
| 10     | RX03-           | Negative Transmission Data of Pixel 3 (ODD data)  |
| 11     | RX03+           | Positive Transmission Data of Pixel 3 (ODD data)  |
| 12     | RXE0-           | Negative Transmission Data of Pixel 0 (EVEN data) |
| 13     | RXE0+           | Positive Transmission Data of Pixel 0 (EVEN data) |
| 14     | GND             | Power Ground                                      |
| 15     | RXE1-           | Negative Transmission Data of Pixel 1 (EVEN data) |
| 16     | RXE1+           | Positive Transmission Data of Pixel 1 (EVEN data) |
| 17     | GND             | Power Ground                                      |
| 18     | RXE2-           | Negative Transmission Data of Pixel 2 (EVEN data) |
| 19     | RXE2+           | Positive Transmission Data of Pixel 2 (EVEN data) |
| 20     | RXEC-           | Negative Sampling Clock (EVEN data)               |
| 21     | RXEC+           | Positive Sampling Clock (EVEN data)               |
| 22     | RXE3-           | Negative Transmission Data of Pixel 3 (EVEN data) |
| 23     | RXE3+           | Positive Transmission Data of Pixel 3 (EVEN data) |
| 24     | GND             | Power Ground                                      |
| 25     | NC              | No Connection                                     |
| 26     | NC              | No Connection                                     |
| 27     | NC              | No Connection                                     |
| 28     | V <sub>DD</sub> | Power Supply : +5V                                |
| 29     |                 |                                                   |
| 30     |                 |                                                   |

Note) Start from left side





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## 5.2 LVDS Interface

## 5.2.1 Odd pixel data (1st pixel data)

| 1st LVDS Transmitter ( <b>DS90C383, DS90C385</b> ) Signal Interface |        |                     |                            |                    |                                 |                |
|---------------------------------------------------------------------|--------|---------------------|----------------------------|--------------------|---------------------------------|----------------|
| Device Input Pin                                                    |        | Device Input Signal |                            | Output Signal      | To LTM170EX Interface ( CN101 ) |                |
| No                                                                  | Symbol | Symbol              | Function                   |                    | Terminal                        | Symbol         |
| 51                                                                  | TXIN0  | RO0                 | Red Odd Pixel Data (LSB)   | TXOUT0-<br>TXOUT0+ | No. 1<br>No. 2                  | RXO0-<br>RXO0+ |
| 52                                                                  | TXIN1  | RO1                 | Red Odd Pixel Data         |                    |                                 |                |
| 54                                                                  | TXIN2  | RO2                 | Red Odd Pixel Data         |                    |                                 |                |
| 55                                                                  | TXIN3  | RO3                 | Red Odd Pixel Data         |                    |                                 |                |
| 56                                                                  | TXIN4  | RO4                 | Red Odd Pixel Data         |                    |                                 |                |
| 2                                                                   | TXIN5  | RO7                 | Red Odd Pixel Data (MSB)   | TXOUT3-<br>TXOUT3+ | No. 10<br>No. 11                | RXO3-<br>RXO3+ |
| 3                                                                   | TXIN6  | RO5                 | Red Odd Pixel Data         | TXOUT0-<br>TXOUT0+ | No. 1<br>No. 2                  | RXO0-<br>RXO0+ |
| 4                                                                   | TXIN7  | GO0                 | Green Odd Pixel Data (LSB) | TXOUT1-<br>TXOUT1+ | No. 3<br>No. 4                  | RXO1-<br>RXO1+ |
| 6                                                                   | TXIN8  | GO1                 | Green Odd Pixel Data       |                    |                                 |                |
| 7                                                                   | TXIN9  | GO2                 | Green Odd Pixel Data       |                    |                                 |                |
| 8                                                                   | TXIN10 | GO6                 | Green Odd Pixel Data       |                    |                                 |                |
| 10                                                                  | TXIN11 | GO7                 | Green Odd Pixel Data (MSB) |                    |                                 |                |
| 11                                                                  | TXIN12 | GO3                 | Green Odd Pixel Data       | TXOUT2-<br>TXOUT2+ | No. 5<br>No. 6                  | RXO2-<br>RXO2+ |
| 12                                                                  | TXIN13 | GO4                 | Green Odd Pixel Data       |                    |                                 |                |
| 14                                                                  | TXIN14 | GO5                 | Green Odd Pixel Data       |                    |                                 |                |
| 15                                                                  | TXIN15 | BO0                 | Blue Odd Pixel Data (LSB)  |                    |                                 |                |
| 16                                                                  | TXIN16 | BO6                 | Blue Odd Pixel Data        |                    |                                 |                |
| 18                                                                  | TXIN17 | BO7                 | Blue Odd Pixel Data (MSB)  | TXOUT3-<br>TXOUT3+ | No. 10<br>No. 11                | RXO3-<br>RXO3+ |
| 19                                                                  | TXIN18 | BO1                 | Blue Odd Pixel Data        | TXOUT1-<br>TXOUT1+ | No. 3<br>No. 4                  | RXO1-<br>RXO1+ |
| 20                                                                  | TXIN19 | BO2                 | Blue Odd Pixel Data        | TXOUT3-<br>TXOUT3+ | No. 10<br>No. 11                | RXO3-<br>RXO3+ |
| 22                                                                  | TXIN20 | BO3                 | Blue Odd Pixel Data        |                    |                                 |                |
| 23                                                                  | TXIN21 | BO4                 | Blue Odd Pixel Data        |                    |                                 |                |
| 24                                                                  | TXIN22 | BO5                 | Blue Odd Pixel Data        |                    |                                 |                |
| 50                                                                  | TXIN27 | RO6                 | Red Odd Pixel Data         |                    |                                 |                |

Approval

## 5.2.2 Even pixel data (2nd pixel data)

| 2nd LVDS Transmitter ( <b>DS90C383</b> , <b>DS90C385</b> ) Signal Interface |        |                     |                             |                    |                                 |                |
|-----------------------------------------------------------------------------|--------|---------------------|-----------------------------|--------------------|---------------------------------|----------------|
| Device Input Pin                                                            |        | Device Input Signal |                             | Output Signal      | To LTM170EX Interface ( CN101 ) |                |
| No                                                                          | Symbol | Symbol              | Function                    |                    | Terminal                        | Symbol         |
| 51                                                                          | TXIN0  | RE0                 | Red Even Pixel Data (LSB)   | TXOUT0-<br>TXOUT0+ | No. 12<br>No. 13                | RXE0-<br>RXE0+ |
| 52                                                                          | TXIN1  | RE1                 | Red Even Pixel Data         |                    |                                 |                |
| 54                                                                          | TXIN2  | RE2                 | Red Even Pixel Data         |                    |                                 |                |
| 55                                                                          | TXIN3  | RE3                 | Red Even Pixel Data         |                    |                                 |                |
| 56                                                                          | TXIN4  | RE4                 | Red Even Pixel Data         |                    |                                 |                |
| 2                                                                           | TXIN5  | RE7                 | Red Even Pixel Data (MSB)   | TXOUT3-<br>TXOUT3+ | No. 22<br>No. 23                | RXE3-<br>RXE3+ |
| 3                                                                           | TXIN6  | RE5                 | Red Even Pixel Data         | TXOUT0-<br>TXOUT0+ | No. 12<br>No. 13                | RXE0-<br>RXE0+ |
| 4                                                                           | TXIN7  | GE0                 | Green Even Pixel Data (LSB) | TXOUT1-<br>TXOUT1+ | No. 15<br>No. 16                | RXE1-<br>RXE1+ |
| 6                                                                           | TXIN8  | GE1                 | Green Even Pixel Data       |                    |                                 |                |
| 7                                                                           | TXIN9  | GE2                 | Green Even Pixel Data       |                    |                                 |                |
| 8                                                                           | TXIN10 | GE6                 | Green Even Pixel Data       |                    |                                 |                |
| 10                                                                          | TXIN11 | GE7                 | Green Even Pixel Data (MSB) |                    |                                 |                |
| 11                                                                          | TXIN12 | GE3                 | Green Even Pixel Data       | TXOUT2-<br>TXOUT2+ | No. 18<br>No. 19                | RXE2-<br>RXE2+ |
| 12                                                                          | TXIN13 | GE4                 | Green Even Pixel Data       |                    |                                 |                |
| 14                                                                          | TXIN14 | GE5                 | Green Even Pixel Data       |                    |                                 |                |
| 15                                                                          | TXIN15 | BE0                 | Blue Even Pixel Data (LSB)  |                    |                                 |                |
| 16                                                                          | TXIN16 | BE6                 | Blue Even Pixel Data        |                    |                                 |                |
| 18                                                                          | TXIN17 | BE7                 | Blue Even Pixel Data (MSB)  | TXOUT3-<br>TXOUT3+ | No. 22<br>No. 23                | RXE3-<br>RXE3+ |
| 19                                                                          | TXIN18 | BE1                 | Blue Even Pixel Data        | TXOUT1-<br>TXOUT1+ | No. 15<br>No. 16                | RXE1-<br>RXE1+ |
| 20                                                                          | TXIN19 | BE2                 | Blue Even Pixel Data        | TXOUT3-<br>TXOUT3+ | No. 22<br>No. 23                | RXE3-<br>RXE3+ |
| 22                                                                          | TXIN20 | BE3                 | Blue Even Pixel Data        |                    |                                 |                |
| 23                                                                          | TXIN21 | BE4                 | Blue Even Pixel Data        |                    |                                 |                |
| 24                                                                          | TXIN22 | BE5                 | Blue Even Pixel Data        |                    |                                 |                |
| 50                                                                          | TXIN27 | RE6                 | Red Even Pixel Data         |                    |                                 |                |



Approval

## 5.3 BACK-LIGHT UNIT

|       | Pin No.               | Input                            | Color | Function     |
|-------|-----------------------|----------------------------------|-------|--------------|
| Upper | 1                     | Hot1                             | Pink  | High Voltage |
|       | 2                     | Cold1                            | White | Ground       |
|       | 3                     | Hot2                             | Blue  | High Voltage |
|       | 4                     | Cold2                            | Black | Ground       |
| Lower | 1                     | Hot1                             | Pink  | High Voltage |
|       | 2                     | Cold1                            | White | Ground       |
|       | 3                     | Hot2                             | Blue  | High Voltage |
|       | 4                     | Cold2                            | Black | Ground       |
|       | Connector<br>Part No. | Yeonho 35001HS-02L or equivalent |       |              |

Approval

## 5.4 Input Signals, Basic Display Colors and Gray Scale of Each Color

| COLOR                     | DISPLAY<br>(8bit) | DATA SIGNAL |    |    |    |    |    |    |    |    |    |       |    |    |    |    |    |    |    |    |    |      |    |    |    |   |      |   |  | GRAY<br>SCALE<br>LEVEL |  |  |
|---------------------------|-------------------|-------------|----|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|----|----|------|----|----|----|---|------|---|--|------------------------|--|--|
|                           |                   | RED         |    |    |    |    |    |    |    |    |    | GREEN |    |    |    |    |    |    |    |    |    | BLUE |    |    |    |   |      |   |  |                        |  |  |
|                           |                   | R0          | R1 | R2 | R3 | R4 | R5 | R6 | R7 | G0 | G1 | G2    | G3 | G4 | G5 | G6 | G7 | B0 | B1 | B2 | B3 | B4   | B5 | B6 | B7 |   |      |   |  |                        |  |  |
| BASIC<br>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  | 0 | 0    | - |  |                        |  |  |
|                           | BLUE              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1 | -    |   |  |                        |  |  |
|                           | GREEN             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | -    |   |  |                        |  |  |
|                           | CYAN              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1 | -    |   |  |                        |  |  |
|                           | RED               | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | -    |   |  |                        |  |  |
|                           | MAGENTA           | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 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  | 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  | 1 | -    |   |  |                        |  |  |
| GRAY<br>SCALE<br>OF RED   | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R0   |   |  |                        |  |  |
|                           | DARK<br>↑         | 1           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R1   |   |  |                        |  |  |
|                           |                   | 0           | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R2   |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | R3~  |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | R252 |   |  |                        |  |  |
|                           | ↓<br>LIGHT        | 1           | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R252 |   |  |                        |  |  |
|                           |                   | 0           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R252 |   |  |                        |  |  |
|                           | RED               | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | R252 |   |  |                        |  |  |
| GRAY<br>SCALE<br>OF GREEN | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G0   |   |  |                        |  |  |
|                           | DARK<br>↑         | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G1   |   |  |                        |  |  |
|                           |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G2   |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | G3~  |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | G252 |   |  |                        |  |  |
|                           | ↓<br>LIGHT        | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G252 |   |  |                        |  |  |
|                           |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G252 |   |  |                        |  |  |
|                           | GREEN             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | G252 |   |  |                        |  |  |
| GRAY<br>SCALE<br>OF BLUE  | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | B0   |   |  |                        |  |  |
|                           | DARK<br>↑         | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | B1   |   |  |                        |  |  |
|                           |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0    | 0  | 0  | 0  | 0 | B2   |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | B3~  |   |  |                        |  |  |
|                           |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :  | :     | :  | :  | :  |    |    | :  | :  | :  | :  | :    | :  |    |    |   | B252 |   |  |                        |  |  |
|                           | ↓<br>LIGHT        | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 1  | 1  | 1    | 1  | 1  | 1  | 1 | B252 |   |  |                        |  |  |
|                           |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1 | B252 |   |  |                        |  |  |
|                           | BLUE              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1 | B252 |   |  |                        |  |  |

Note) Definition of Gray :

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

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



## 6. Interface Timing

Approval

### 6.1 Timing Parameters ( DE only mode )

| SIGNAL                         | ITEM                  | SYMBOL | MIN.  | TYP. | MAX.  | UNIT   | NOTE     |
|--------------------------------|-----------------------|--------|-------|------|-------|--------|----------|
| Clock                          | Frequency             | 1/Tc   | 40    | 54   | 69.28 | MHz    | (1), (2) |
|                                | High Time             | TCH    | 4     | -    | -     | nsec   |          |
|                                | Low Time              | TCL    | 4     | -    | -     | nsec   |          |
| Data                           | Setup Time            | TDS    | 4     | -    | -     | nsec   |          |
|                                | Hold Time             | TDH    | 4     | -    | -     | nsec   |          |
| Data Enable                    | Setup Time            | TES    | 4     | -    | -     | nsec   |          |
| Frame Frequency                | Cycle                 | Tv     | 18.18 | 16.7 | 12.99 | msec   |          |
|                                |                       |        | 1031  | 1066 | -     | lines  |          |
|                                | Frequency             | TVD    | 55    | 60   | 77    | Hz     | (3)      |
| Vertical Active Display Term   | Display Period        | TvB    | 1024  | 1024 | 1024  | lines  |          |
|                                | Vertical Blank Period | TH     | 8     | -    | -     | lines  |          |
| One Line Scanning Time         | Cycle                 | THD    | 752   | 844  | 1130  | clocks |          |
| Horizontal Active Display Term | Display Period        |        | 640   | 640  | 640   | clocks |          |

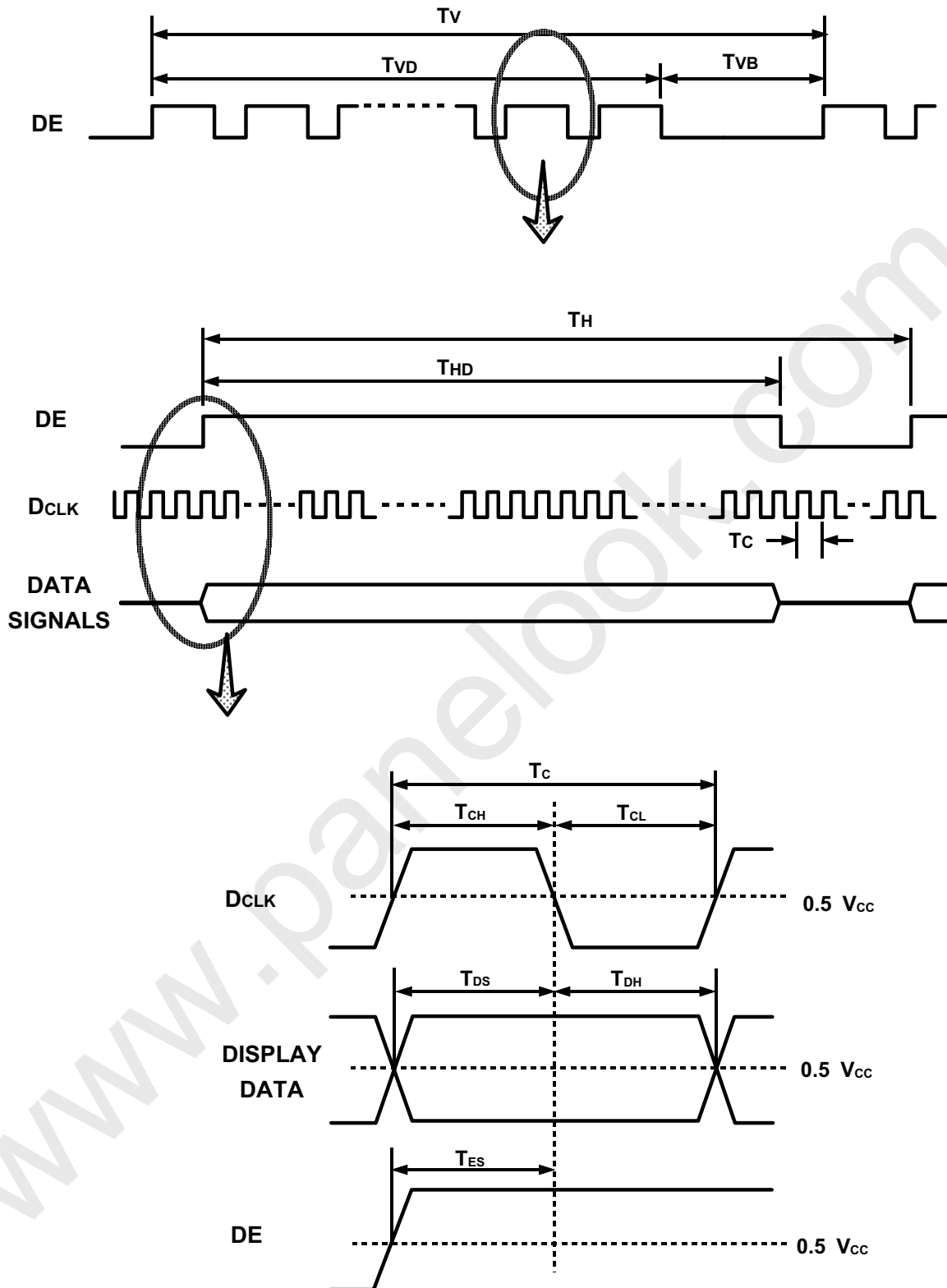
Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

(2) Internal Vcc = 3.3V

(3) At low Vsync frequency, Under 60Hz, flicker level can increase at specific pattern.

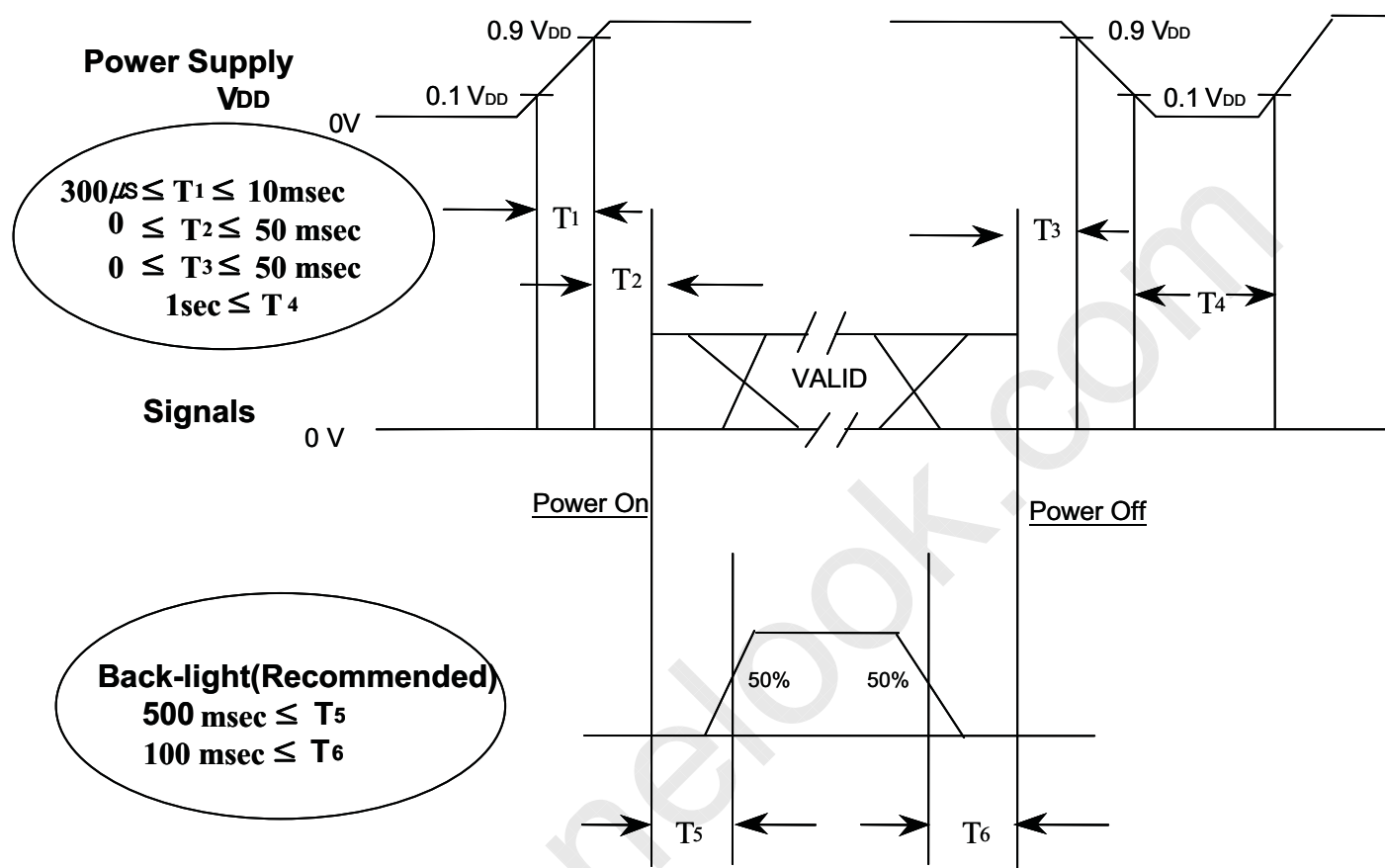
Approval

## 6.2 Timing diagrams of interface signal ( DE only mode )



### 6.3 Power ON/OFF Sequence

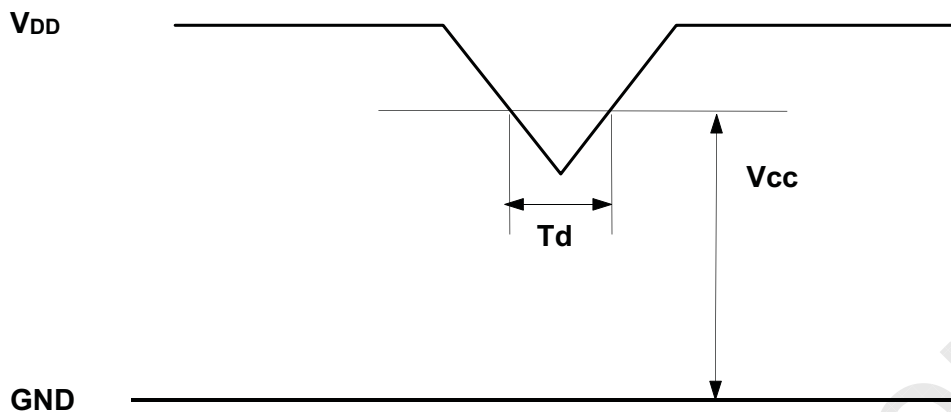
To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the diagram below.



Power ON/OFF Sequence

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

Approval

6.4 V<sub>DD</sub> Power Dip Condition

$$4.5V \leq V_{DD} \leq 5.5V$$

$$\text{if } V_{DD}(\text{typ}) \times 20\% \leq V_{cc} \leq V_{DD}(\text{typ}) \times 10\%,$$

$$\text{then, } 0 < T_d \leq 20\text{msec}$$

## NOTE

- (1) The above conditions are for the glitch of the input voltage.
- (2) For stable operation of an LCD module power, please follow them.  
i.e., if  $V_{DD} \times 20\% \leq V_{cc} \leq \text{typ } V_{DD} \times 10\%$ ,  
then T<sub>d</sub> should be less than 20ms.

## Approval

## 6.5 LVDS Input Characteristics

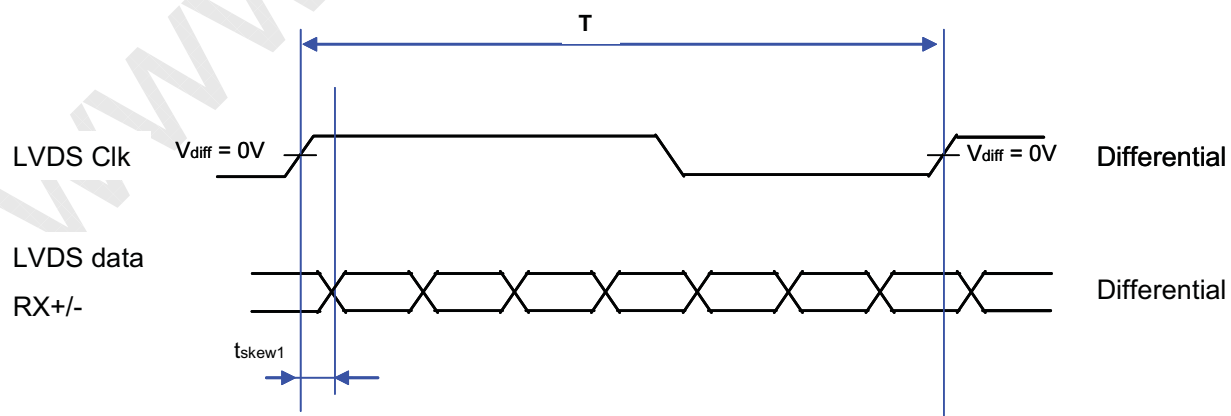
## 6.5.1 FPD-link (LVDS) Receiver input (RxCLKO/EP/N; RxIN/E[y]P/N, y=0,1,2,3)

| Symbol       | Parameter                                      | Conditions                 | Min                | Typ | Max                  | unit    |
|--------------|------------------------------------------------|----------------------------|--------------------|-----|----------------------|---------|
| $V_{THLVDS}$ | Differential input high threshold              | $V_{CM} = +1.2V$           |                    |     | +100                 | mV      |
| $V_{TLLVDS}$ | Differential input low threshold               |                            | -100               |     |                      | mV      |
| $V_{IN}$     | Input voltage range (single-ended)             |                            | 0                  |     | 2.4                  | V       |
| $ V_{ID} $   | Differential input voltage                     |                            | 100                |     | 600                  | mV      |
| $V_{CM}$     | Common mode voltage                            |                            | 0+<br>$ V_{ID} /2$ |     | 2.4-<br>$ V_{ID} /2$ | V       |
| $I_{IN}$     | Input current                                  | $V_{IN}=2.4V, V_{DD}=3.6V$ |                    |     | $\pm 10$             | $\mu A$ |
|              |                                                | $V_{IN}=0V, V_{DD}=3.6V$   |                    |     | $\pm 10$             | $\mu A$ |
| RPLLS        | FPD-link receiver phase lock look wake-up time |                            |                    |     | 10                   | ms      |
| tskew        | skew between LVDS clock & LVDS data            | $F=85MHz$<br>$V_{DD}=3.3V$ | -380               |     | 380                  | psec    |

## Note

(1) LVDS Receiver DC parameters are measured under static and steady conditions which may not be reflective of its performance in the end application.

(2) tskew



where tskew : skew between LVDS clock & LVDS data,

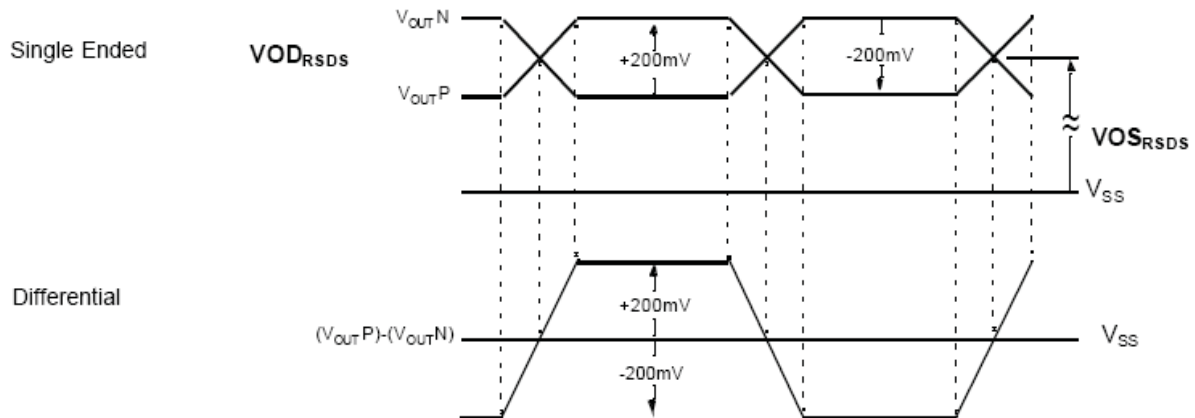
T : 1 period time of LVDS clock

cf) (-/+ ) of 380psec means LVDS data goes before or after LVDS clock.

Approval

6.5.2 RSDS<sub>TM</sub> Output (F/BCLKP/N, FBz[y]P/N; z=R, G, B, y=0, 1, 2) $R_T=100\ \Omega$ ,  $I_{PI}=100\ \mu A$ 

| Symbol              | Parameter                   | Conditions | Min | Typ       | Max | unit |
|---------------------|-----------------------------|------------|-----|-----------|-----|------|
| VOD <sub>RSDS</sub> | Differential Output Voltage |            |     | $\pm 200$ |     | mV   |
| VOS <sub>RSDS</sub> | Offset Voltage              |            |     | 1.3       |     | V    |



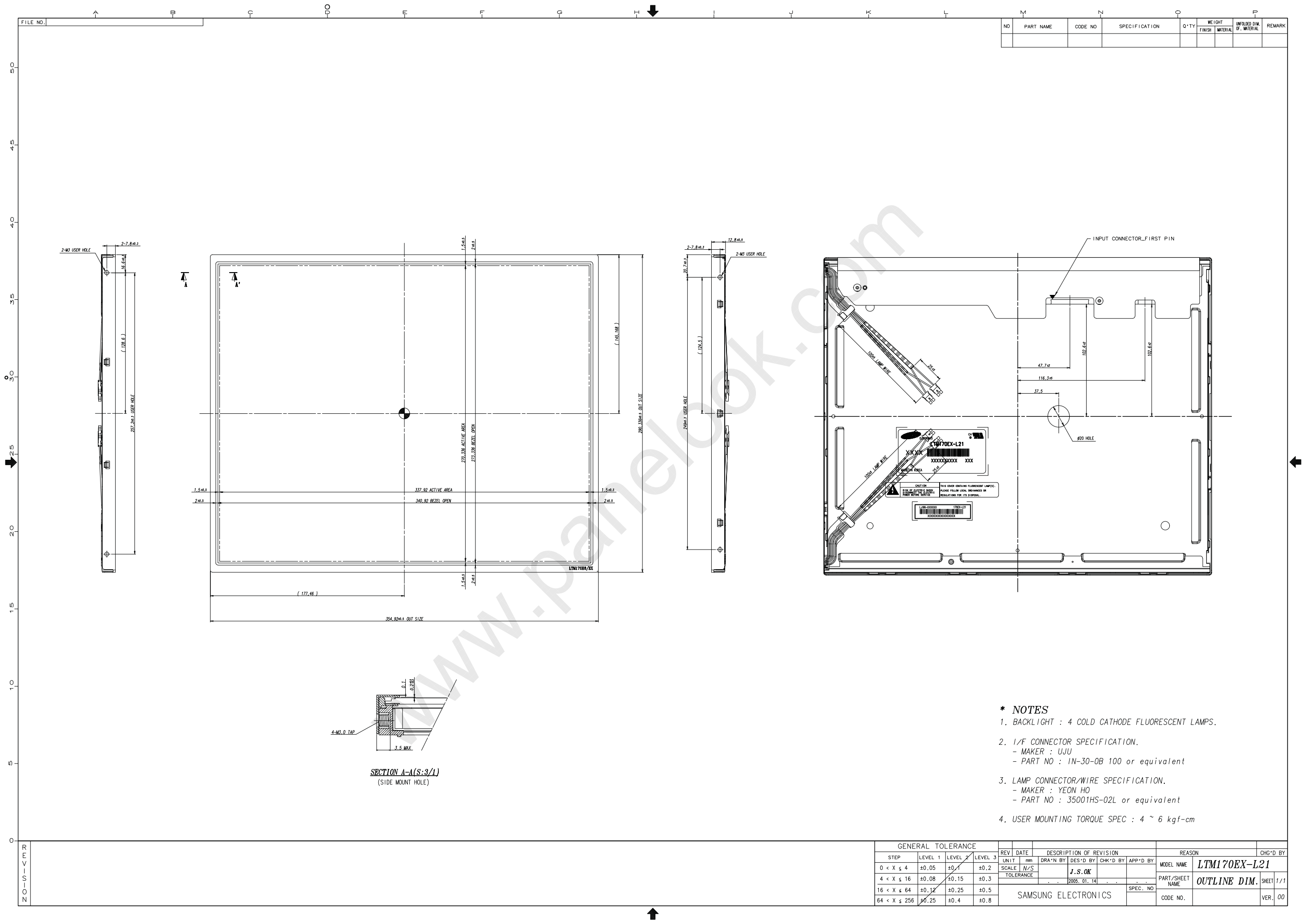


## 7. Outline Dimension

[ Refer to the next page ]

Approval

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## 8. Reliability Test

## Approval

| Test Items                   |                   | Conditions                                                    | Time/Cycle        | Sample |
|------------------------------|-------------------|---------------------------------------------------------------|-------------------|--------|
| HTOL*                        |                   | 50°C , Bias                                                   | 500 hrs           | 12     |
| LTOL*                        |                   | 0°C , Bias                                                    | 500 hrs           | 5      |
| THB**                        |                   | 40°C / 95% , Bias                                             | 500 hrs           | 5      |
| HTS***                       |                   | 70°C , No Bias                                                | 500 hrs           | 5      |
| LTS***                       |                   | -30°C , No Bias                                               | 500 hrs           | 5      |
| Thermal Cycle                |                   | -20°C/30min ~ +60°C/30min , No bias                           | 100 cycle         | 5      |
| Box Drop                     |                   | 1 angle , 3 edge , 6 side , 66 cm                             |                   | 5      |
| Shock<br>(Non-operating)     |                   | 50G , 11msec , $\pm$ x/y/z axis                               | 1time/ $\pm$ axis | 3      |
| Vibration<br>(Non-operating) |                   | 1.5G , 10~300 Hz<br>x/y/z axis , sweep rate : 10 min          | 30min/axis        | 3      |
| ESD                          | Non<br>-Operating | CDM : 150pF, 330 $\Omega$ , 9point, 3 times/point             | $\pm$ 10kV        | 3      |
|                              | Operating         | Contact : 150pF, 330 $\Omega$ , 100point, once/point          | $\pm$ 8kV         | 3      |
|                              |                   | Air(non-contact) : 150pF, 330 $\Omega$ , 100point, once/point | $\pm$ 15kV        | 3      |

### [ Result Evaluation Criteria]

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

\* HTOL/ LTOL : High/Low Temperature Operating Life

\*\* THB : Temperature Humidity Bias

\*\*\* HTS/LTS : High/Low Temperature Storage

## 9. PACKING

Approval

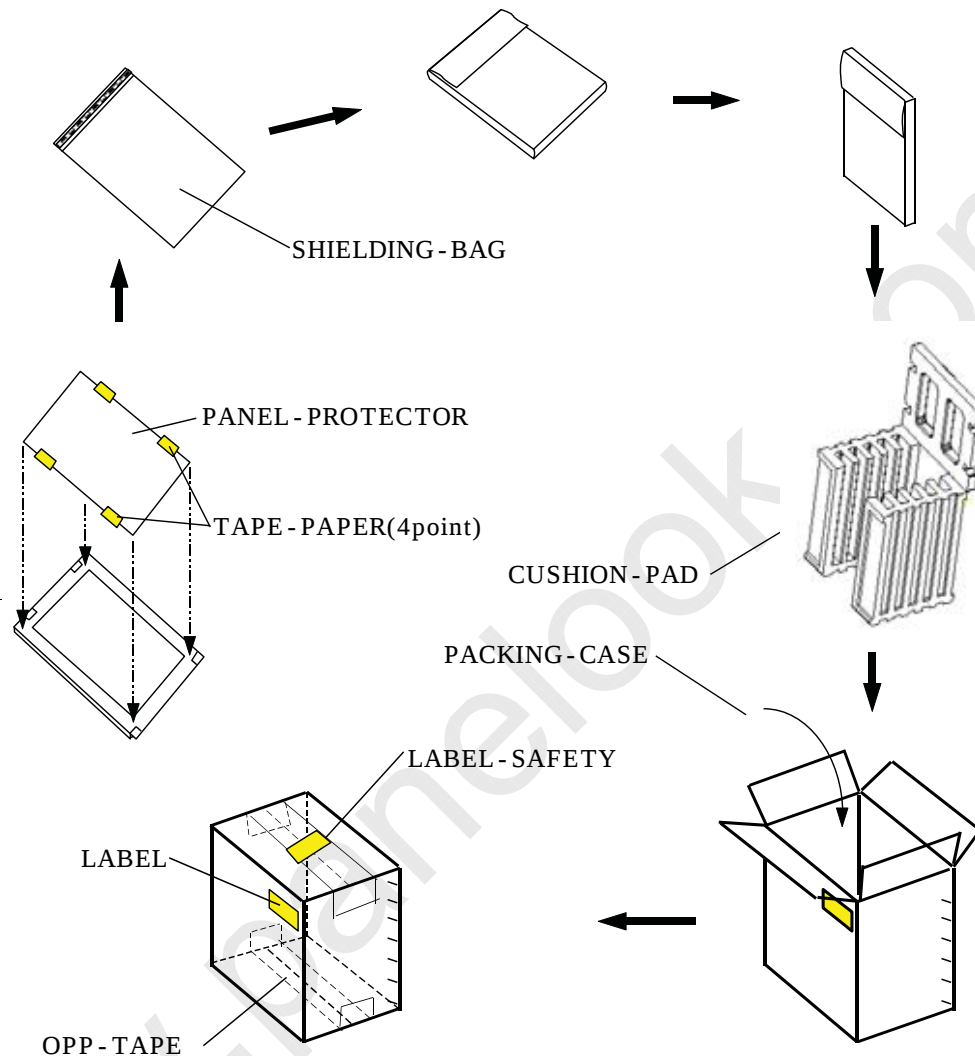
### 9.1 CARTON (Internal Package)

#### (1) Packing Form

Corrugated fiberboard box and corrugated cardboard as shock absorber

#### (2) Packing Method

##### a) Without Inverter



- NOTE) 1) TOTAL Weight : Approx. 10 kg  
 2) Acceptance number of piling : 5 sets  
 3) Carton size : 390(W) X 320(D) X 410(H)  
 4) MAX accumulation quantity : 5 cartons

Approval

## (3) Packing Material

| No | Part name                                          | Quality |
|----|----------------------------------------------------|---------|
| 1  | Static electric protective sack                    | 5       |
| 2  | Packing case(Inner box)<br>included shock absorber | 1 set   |
| 3  | Pictorial marking                                  | 2 pics  |
| 4  | Carton                                             | 1 set   |

## 10. MARKING &amp; OTHERS

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

(1) Parts number : LTM170EX-L21

(2) Revision code : Two letters

(3) Customer code : One letter

X XX

└── Revision Code  
└── Customer Code

(4) Lot number : 5 E 4 E 00210A

└── Lot Number  
└── Month  
└── Year  
└── Device  
└── Line

## (5) Nameplate Indication

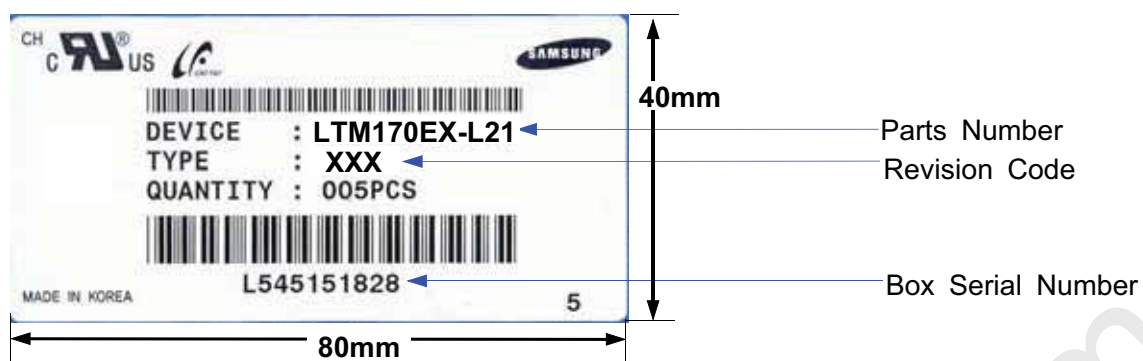


Week Code : 0452

└── Week  
└── Year

Approval

## (6) Packing box attach



## (7) Others

## 1. After service part

(Lamps cannot be replaced because of the narrow bezel structure.)



## 11. Inspection Criteria

Approval

When products are shipped, incoming inspection should be carried out with a sampling inspection based on MIL-STD-105E level II by AQL 1.0%.

### CHANGE CONTROL

Design of the product may be changed regarding the specifications, appearance, parts used, circuits, etc. for product improvement.

If a design change is judged to affect the specifications of this product, supplier should inform customer of the change in advance.

### QUALITY CONTROL

In the event of a product failure under normal operating conditions, a product trouble or a functional disorder that can be deemed to be the responsibility of supplier, supplier should repair the fault or replace the product free of charge within one year from the product delivery date. However, supplier does not take responsibility for the product quality in the case of modifications not specified by supplier.

### MAINTENANCE

The specifications of the functions of maintenance parts may be partially changed within the range which provides equivalent or better quality.

In principle, maintenance parts should be product units.

When stopping manufacturing this product, supplier should notify customer in advance.

### HANDLING OF DOUBTFUL POINTS

Any doubt not stipulated in this specification is to be resolved by mutual agreement between customer and supplier, and supplier should make efforts for improvement in good faith.



## 12. General Precautions

Approval

### 12.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.
- (b) Because the inverter use high voltage, it should be disconnected from power before it is assembled or disassembled.
- (c) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFT back-light.
- (d) Note that polarizers are very fragile and could be damage deasily. Do not press or scratch the surface harder than a HB pencil lead.
- (e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.
- (f) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (g) 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.
- (h) 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 with soap thoroughly.
- (i) Protect the module from static, or the CMOS Gate Array IC would be damaged.
- (j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (k) Do not disassemble the module.
- (l) Do not pull or fold the lamp wire.
- (m) Do not adjust the variable resistor located on the module.
- (n) Protection film for polarizer on the module should be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (o) Pins of I/F connector should not be touched directly with bare hands.



## 12.2 Storage

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

## 12.3 Operation

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

## 12.4 Others

- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (c) Do not exceed the absolute maximum rating value. ( supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)  
Otherwise the module may be damaged.
- (d) If the module keeps displaying the same pattern for a long period of time, the image may be "sticked" to the screen.  
To avoid image sticking, it is recommended to use a screen saver.
- (e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.
- (f) Please contact SEC in advance when you display the same pattern for a long time.