

**Product Specification**

# SPECIFICATION FOR APPROVAL

- ( ) Preliminary Specification  
 (◆) Final Specification

|       |                  |
|-------|------------------|
| Title | 19" SXGA TFT LCD |
|-------|------------------|

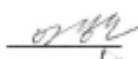
|          |  |
|----------|--|
| Customer |  |
| MODEL    |  |

|          |                      |
|----------|----------------------|
| SUPPLIER | LG Display Co., Ltd. |
| *MODEL   | LB190E02             |
| Suffix   | SL03                 |

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

| APPROVED BY | SIGNATURE<br>DATE |
|-------------|-------------------|
| /           |                   |
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Please return 1 copy for your confirmation with  
your signature and comments.

| APPROVED BY            | SIGNATURE<br>DATE                                                                     |
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## Product Specification

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## Product Specification

## RECORD OF REVISIONS

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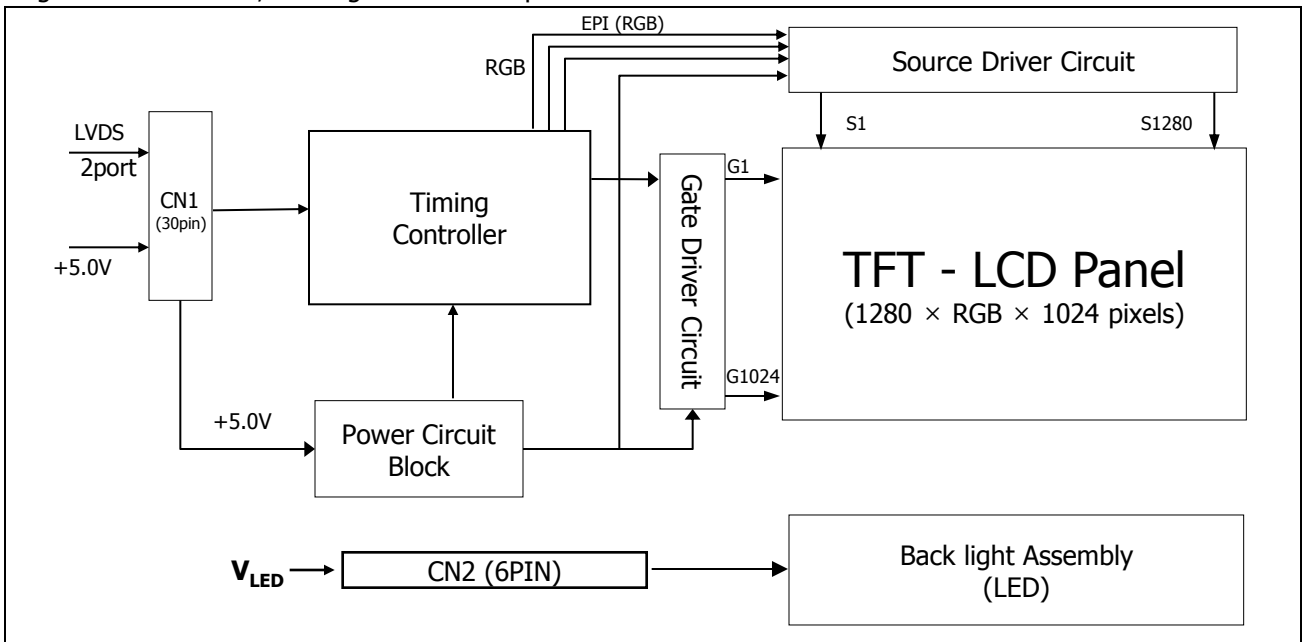
## Product Specification

### 1. General Description

LB190E02 is a Color Active Matrix Liquid Crystal Display with a Light Emitting Diode ( White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 19.0 inch diagonally measured active display area with SXGA resolution (1024 vertical by 1280 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors

It has been designed to apply the 8Bit 2 port LVDS interface.

It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



**[ Figure 1 ] Block diagram**

### General Features

|                        |                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------|
| Active Screen Size     | 19.0 inch (481.84mm) diagonal                                                                  |
| Outline Dimension      | 396.0(H) x 324.0(V) x 12.8(D) mm(Typ.)                                                         |
| Pixel Pitch            | 0.294 mm x 0.294mm                                                                             |
| Pixel Format           | 1280 horiz. by 1024 vert. Pixels. RGB stripe arrangement                                       |
| Color Depth            | 16,7M colors                                                                                   |
| Luminance, White       | 330 cd/m <sup>2</sup> ( Center 1 Point, Typ.)                                                  |
| Viewing Angle(CR>10)   | View Angle Free (R/L 178(Typ.), U/D 178(Typ.))                                                 |
| Power Consumption      | Total ( 15.27) Watt (Typ.) ( (3.75) Watt @V <sub>LCD</sub> , 11.52 Watt @I <sub>s</sub> =90mA) |
| Weight                 | 1250 g (typ.) / 1300g(Max.)                                                                    |
| Display Operating Mode | Transmissive mode, normally black                                                              |
| Panel type             | Forward type                                                                                   |
| Surface Treatment      | Hard coating(3H), Anti-Glare treatment of the front polarizer                                  |

## Product Specification

### 2. Absolute Maximum Ratings

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

**Table 1. ABSOLUTE MAXIMUM RATINGS**

| Parameter                  | Symbol           | Values |     | Units           | Notes       |
|----------------------------|------------------|--------|-----|-----------------|-------------|
|                            |                  | Min    | Max |                 |             |
| Power Input Voltage        | V <sub>LCD</sub> | -0.3   | 6.0 | V <sub>dc</sub> | at 25 ± 2°C |
| Operating Temperature      | T <sub>OP</sub>  | 0      | 60  | °C              | 1, 2, 3     |
| Storage Temperature        | T <sub>ST</sub>  | -20    | 70  | °C              |             |
| Operating Ambient Humidity | H <sub>OP</sub>  | 10     | 90  | %RH             |             |
| Storage Humidity           | H <sub>ST</sub>  | 10     | 90  | %RH             |             |

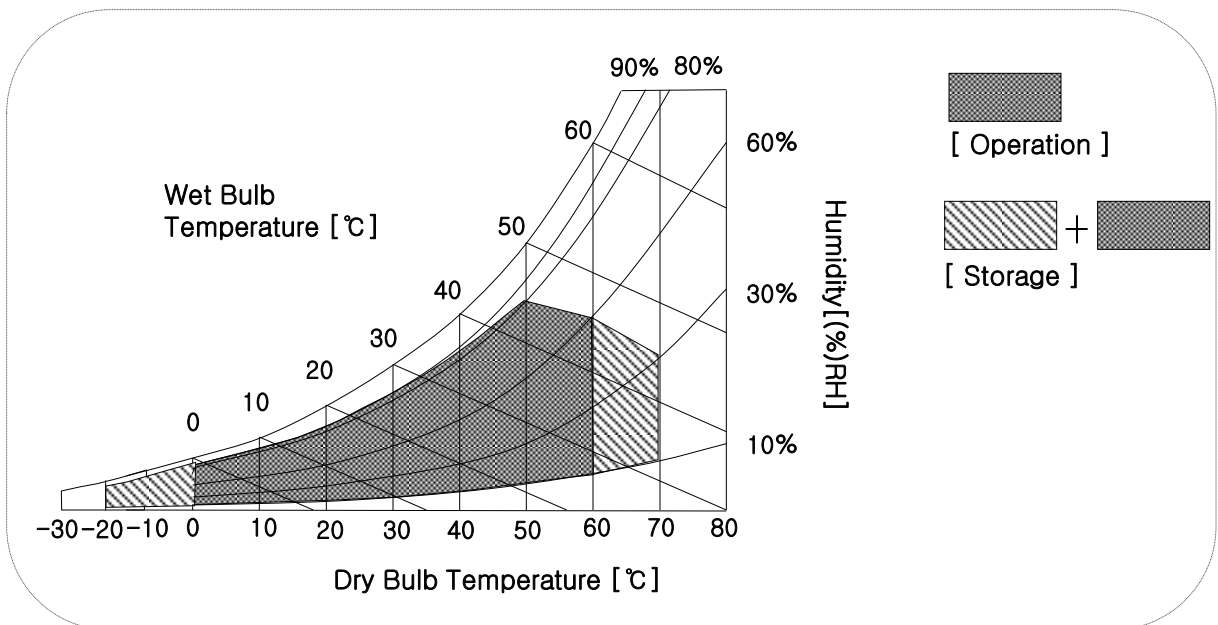
Note : 1. Temperature and relative humidity range are shown in the figure below.

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

2. Maximum Storage Humidity is up to 50°C, 80% RH only for 4 corner light leakage Mura.

3. Storage condition is guaranteed under packing condition

**FIG.2 Temperature and relative humidity**



## Product Specification

### 3. Electrical Specifications

#### 3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The other input power for the LED/Backlight, is typically generated by a LED Driver. The LED Driver is an external unit to the LCDs.

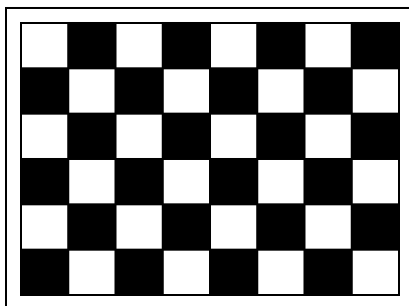
**Table 2-1. ELECTRICAL CHARACTERISTICS**

| Parameter                  | Symbol             | Values |      |      | Unit | Notes |
|----------------------------|--------------------|--------|------|------|------|-------|
|                            |                    | Min    | Typ  | Max  |      |       |
| MODULE :                   |                    |        |      |      |      |       |
| Power Supply Input Voltage | V <sub>LCD</sub>   | 4.5    | 5.0  | 5.5  | Vdc  | 4     |
| Power Supply Input Current | I <sub>LCD</sub>   | -      | 750  | 975  | mA   | 1     |
|                            |                    | -      | 1020 | 1330 | mA   | 2     |
| Power Consumption          | P <sub>C</sub> TYP | -      | 3.75 | 4.88 | Watt | 1     |
|                            | P <sub>C</sub> MAX | -      | 5.10 | 6.63 | Watt | 2     |
| Differential Impedance     | Z <sub>m</sub>     | 90     | 100  | 110  | Ohm  |       |
| Rush current               | I <sub>RUSH</sub>  | -      | -    | 3.0  | A    | 3     |

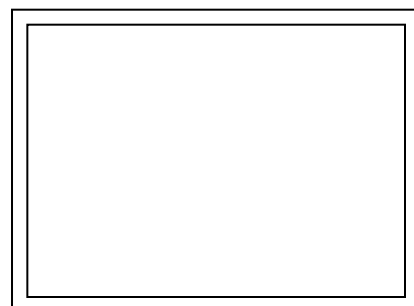
Note :

1. The specified current and power consumption are under the V<sub>LCD</sub>=5.0V, 25 ± 2°C, f<sub>v</sub>=60Hz condition whereas Typical Power Pattern[Mosaic] shown in the [ Figure 3 ] is displayed.
2. The current is specified at the maximum current pattern.
3. Maximum Condition of Inrush current :  
The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%.(min.).
4. V<sub>LCD</sub> level must be measured between two points on PCB of LCM (V<sub>LCD</sub> (test point) ~ LCM Ground)  
(Test condition : maximum power pattern, 25°C, f<sub>v</sub>=60Hz)

- **Power consumption** (V<sub>LCD</sub> =5V, 25°C, f<sub>v</sub> (frame frequency)=60Hz condition)



**Typical power Pattern**



**Maximum power Pattern**

**FIG.3 Mosaic pattern & White Pattern for power consumption measurement**

## Product Specification

**Table 2-2. ELECTRICAL CHARACTERISTICS of LED bar in normal operating condition**

| Parameter          | Symbol | Values |       |       | Unit | Notes   |
|--------------------|--------|--------|-------|-------|------|---------|
|                    |        | Min.   | Typ.  | Max.  |      |         |
| LED String Current | Is     | -      | 90    | 95    | mA   | 1, 2    |
| LED String Voltage | Vs     | -      | 32.0  | 34.0  | V    | 1, 3    |
| Power Consumption  | PBar   | -      | 11.52 | 12.24 | Watt | 1, 2, 5 |
| LED Life Time      | LED_LT | 50,000 | -     | -     | Hrs  | 4       |

Notes) The LED bar consists of 40 LED packages, 4 strings (parallel) x 10 packages (serial)

1. The specified values are for single LED bar.
2. The specified current is defined as the input current for single LED string with 100% duty cycle.
3. The specified voltage is the input LED string voltage at typical current 100% duty cycle.
4. The LED life time is defined as the time when the LED PKG brightness reach to the 50% of initial value under the conditions at  $T_a = 25 \pm 2^\circ\text{C}$  and typical LED string current.
5. The power consumption shown above does not include the loss of external LED driver.  
 The typical power consumption is calculated as  $P_{\text{Bar}} = V_s(\text{Typ.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$ .  
 The maximum power consumption is calculated as  $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$ .

## Product Specification

### 3-2. Interface Connections

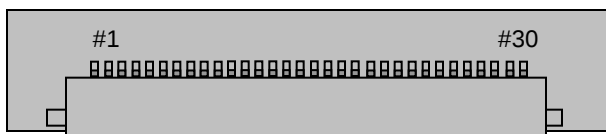
#### 3-2-1. LCD Module

- LCD Connector(CN1). : IS100-L30B-C23 (UJU)
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

**Table 3. MODULE CONNECTOR(CN1) PIN CONFIGURATION**

| No | Symbol  | Description                              | No | Symbol           | Symbol                                       |
|----|---------|------------------------------------------|----|------------------|----------------------------------------------|
| 1  | FR0M    | Minus signal of odd channel 0 (LVDS)     | 16 | SR1P             | Plus signal of even channel 1 (LVDS)         |
| 2  | FR0P    | Plus signal of odd channel 0 (LVDS)      | 17 | GND              | Ground                                       |
| 3  | FR1M    | Minus signal of odd channel 1 (LVDS)     | 18 | SR2M             | Minus signal of even channel 2 (LVDS)        |
| 4  | FR1P    | Plus signal of odd channel 1 (LVDS)      | 19 | SR2P             | Plus signal of even channel 2 (LVDS)         |
| 5  | FR2M    | Minus signal of odd channel 2 (LVDS)     | 20 | SCLKINM          | Minus signal of even clock channel (LVDS)    |
| 6  | FR2P    | Plus signal of odd channel 2 (LVDS)      | 21 | SCLKINP          | Plus signal of even clock channel (LVDS)     |
| 7  | GND     | Ground                                   | 22 | SR3M             | Minus signal of even channel 3 (LVDS)        |
| 8  | FCLKINM | Minus signal of odd clock channel (LVDS) | 23 | SR3P             | Plus signal of even channel 3 (LVDS)         |
| 9  | FCLKINP | Plus signal of odd clock channel (LVDS)  | 24 | GND              | Ground                                       |
| 10 | FR3M    | Minus signal of odd channel 3 (LVDS)     | 25 | NC               | No Connection.(I2C Serial interface for LCM) |
| 11 | FR3P    | Plus signal of odd channel 3 (LVDS)      | 26 | NC               | No Connection.(I2C Serial interface for LCM) |
| 12 | SR0M    | Minus signal of even channel 0 (LVDS)    | 27 | NC               | Ground                                       |
| 13 | SR0P    | Plus signal of even channel 0 (LVDS)     | 28 | V <sub>LCD</sub> | Power Supply +5.0V                           |
| 14 | GND     | Ground                                   | 29 | V <sub>LCD</sub> | Power Supply +5.0V                           |
| 15 | SR1M    | Minus signal of even channel 1 (LVDS)    | 30 | V <sub>LCD</sub> | Power Supply +5.0V                           |

- Note: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
2. All V<sub>LCD</sub> (power input) pins should be connected together.
3. Input Level of LVDS signal is based on the IEA 664 Standard.



**IS100-L30B-C23 (UJU)**



**Rear view of LCM**

**FIG.3 Connector diagram**

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**Table 4. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (TI:SN75LVDS83) Transmitter**

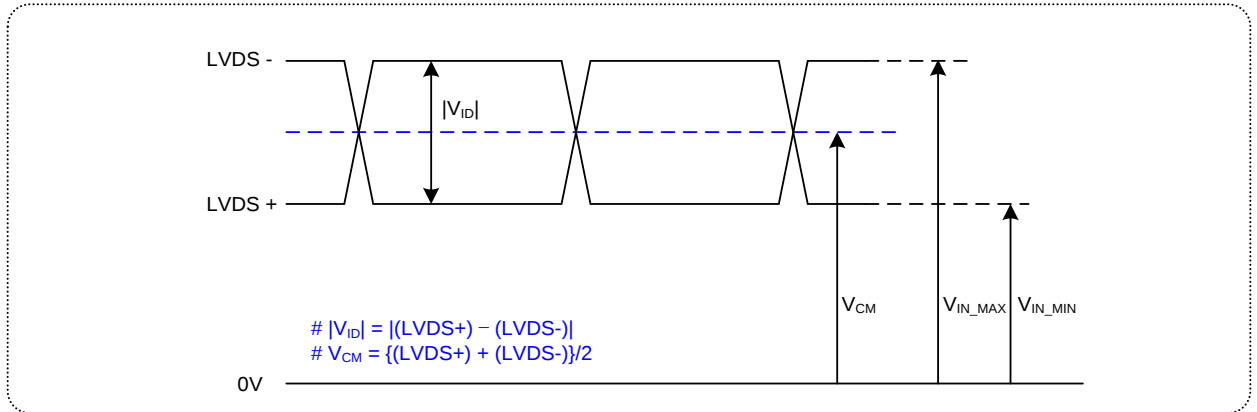
| Pin # | Pin Name | Require Signal             | Pin # | Pin Name                | Require Signal                           |
|-------|----------|----------------------------|-------|-------------------------|------------------------------------------|
| 1     | Vcc      | Power Supply for TTL Input | 29    | GND                     | Ground pin for TTL                       |
| 2     | D5       | TTL Input (R7)             | 30    | D26                     | TTL Input (DE)                           |
| 3     | D6       | TTL Input (R5)             | 31    | T <sub>x</sub> CLKIN    | TTL Level clock Input                    |
| 4     | D7       | TTL Input (G0)             | 32    | PWR DWN                 | Power Down Input                         |
| 5     | GND      | Ground pin for TTL         | 33    | PLL GND                 | Ground pin for PLL                       |
| 6     | D8       | TTL Input (G1)             | 34    | PLL Vcc                 | Power Supply for PLL                     |
| 7     | D9       | TTL Input (G2)             | 35    | PLL GND                 | Ground pin for PLL                       |
| 8     | D10      | TTL Input (G6)             | 36    | LVDS GND                | Ground pin for LVDS                      |
| 9     | Vcc      | Power Supply for TTL Input | 37    | TxOUT3 +                | Positive LVDS differential data output 3 |
| 10    | D11      | TTL Input (G7)             | 38    | TxOUT3 –                | Negative LVDS differential data output 3 |
| 11    | D12      | TTL Input (G3)             | 39    | T <sub>x</sub> CLKOUT + | Positive LVDS differential clock output  |
| 12    | D13      | TTL Input (G4)             | 40    | T <sub>x</sub> CLKOUT – | Negative LVDS differential clock output  |
| 13    | GND      | Ground pin for TTL         | 41    | T <sub>x</sub> OUT2 +   | Positive LVDS differential data output 2 |
| 14    | D14      | TTL Input (G5)             | 42    | T <sub>x</sub> OUT2 –   | Negative LVDS differential data output 2 |
| 15    | D15      | TTL Input (B0)             | 43    | LVDS GND                | Ground pin for LVDS                      |
| 16    | D16      | TTL Input (B6)             | 44    | LVDS Vcc                | Power Supply for LVDS                    |
| 17    | Vcc      | Power Supply for TTL Input | 45    | T <sub>x</sub> OUT1 +   | Positive LVDS differential data output 1 |
| 18    | D17      | TTL Input (B7)             | 46    | T <sub>x</sub> OUT1 –   | Negative LVDS differential data output 1 |
| 19    | D18      | TTL Input (B1)             | 47    | T <sub>x</sub> OUT0 +   | Positive LVDS differential data output 0 |
| 20    | D19      | TTL Input (B2)             | 48    | T <sub>x</sub> OUT0 –   | Negative LVDS differential data output 0 |
| 21    | GND      | Ground pin for TTL Input   | 49    | LVDS GND                | Ground pin for LVDS                      |
| 22    | D20      | TTL Input (B3)             | 50    | D27                     | TTL Input (R6)                           |
| 23    | D21      | TTL Input (B4)             | 51    | D0                      | TTL Input (R0)                           |
| 24    | D22      | TTL Input (B5)             | 52    | D1                      | TTL Input (R1)                           |
| 25    | D23      | TTL Input (RSVD)           | 53    | GND                     | Ground pin for TTL                       |
| 26    | Vcc      | Power Supply for TTL Input | 54    | D2                      | TTL Input (R2)                           |
| 27    | D24      | TTL Input (HSYNC)          | 55    | D3                      | TTL Input (R3)                           |
| 28    | D25      | TTL Input (VSYNC)          | 56    | D4                      | TTL Input (R4)                           |

Notes : 1. Refer to LVDS Transmitter Data Sheet for detail descriptions.  
 2. 7 means MSB and 0 means LSB at R,G,B pixel data

## Product Specification

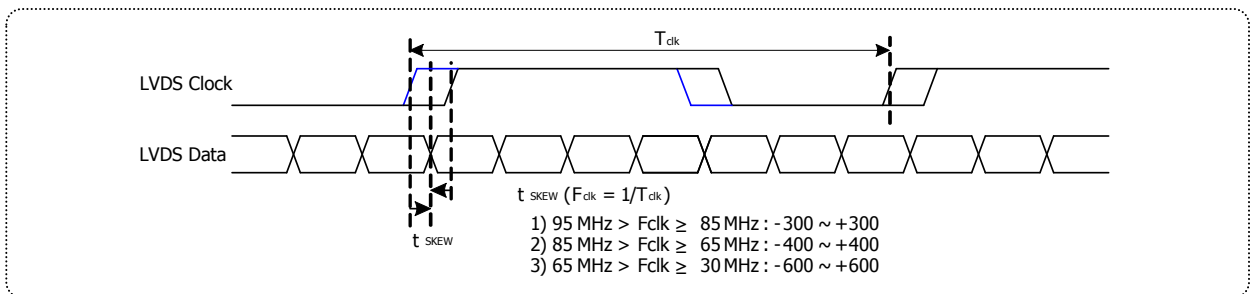
### LVDS Input characteristics

#### 1. DC Specification



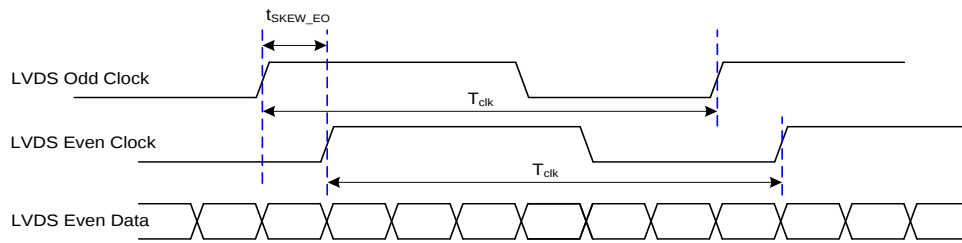
| Description                   | Symbol          | Min | Max | Unit | Notes |
|-------------------------------|-----------------|-----|-----|------|-------|
| LVDS Differential Voltage     | $ V_{ID} $      | 200 | 600 | mV   | -     |
| LVDS Common mode Voltage      | $V_{CM}$        | 1.0 | 1.5 | V    | -     |
| LVDS Input Voltage Range      | $V_{IN}$        | 0.7 | 1.8 | V    | -     |
| Change in common mode Voltage | $\Delta V_{CM}$ | -   | 250 | mV   | -     |

#### 2. AC Specification



| Description                                   | Symbol               | Min   | Max   | Unit             | Notes                            |
|-----------------------------------------------|----------------------|-------|-------|------------------|----------------------------------|
| LVDS Clock to Data Skew Margin                | t <sub>skew</sub>    | - 300 | + 300 | ps               | 95MHz > F <sub>clk</sub> ≥ 85MHz |
|                                               | t <sub>skew</sub>    | - 400 | + 400 | ps               | 85MHz > F <sub>clk</sub> ≥ 65MHz |
|                                               | t <sub>skew</sub>    | - 600 | + 600 | ps               | 65MHz > F <sub>clk</sub> ≥ 30MHz |
| LVDS Clock to Clock Skew Margin (Even to Odd) | t <sub>skew_EO</sub> | - 1/7 | + 1/7 | T <sub>clk</sub> | -                                |

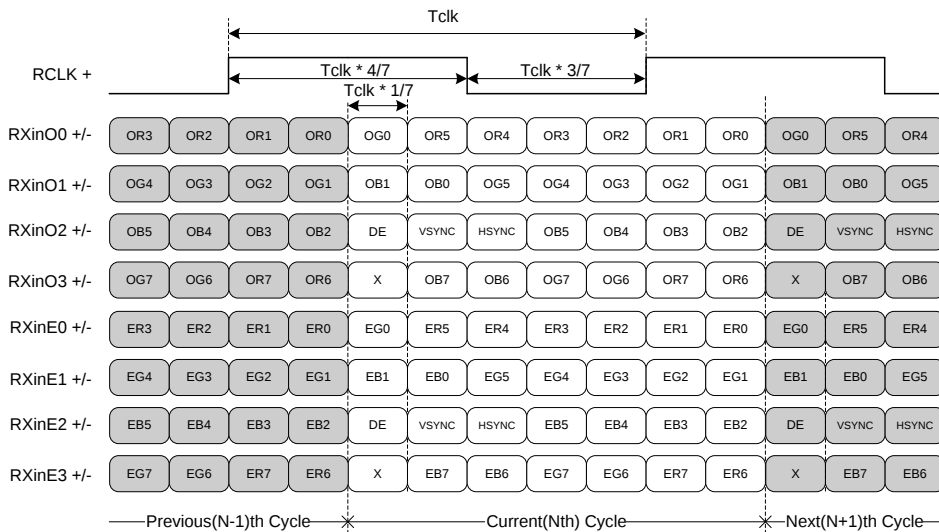
## Product Specification



< Clock skew margin between channel >

### 3. Data Format

#### 1) LVDS 2 Port



|     |    |
|-----|----|
| MSB | R7 |
|     | R6 |
|     | R5 |
|     | R4 |
|     | R3 |
|     | R2 |
|     | R1 |
| LSB | R0 |

\* ODD = 1st Pixel  
EVEN = 2nd Pixel

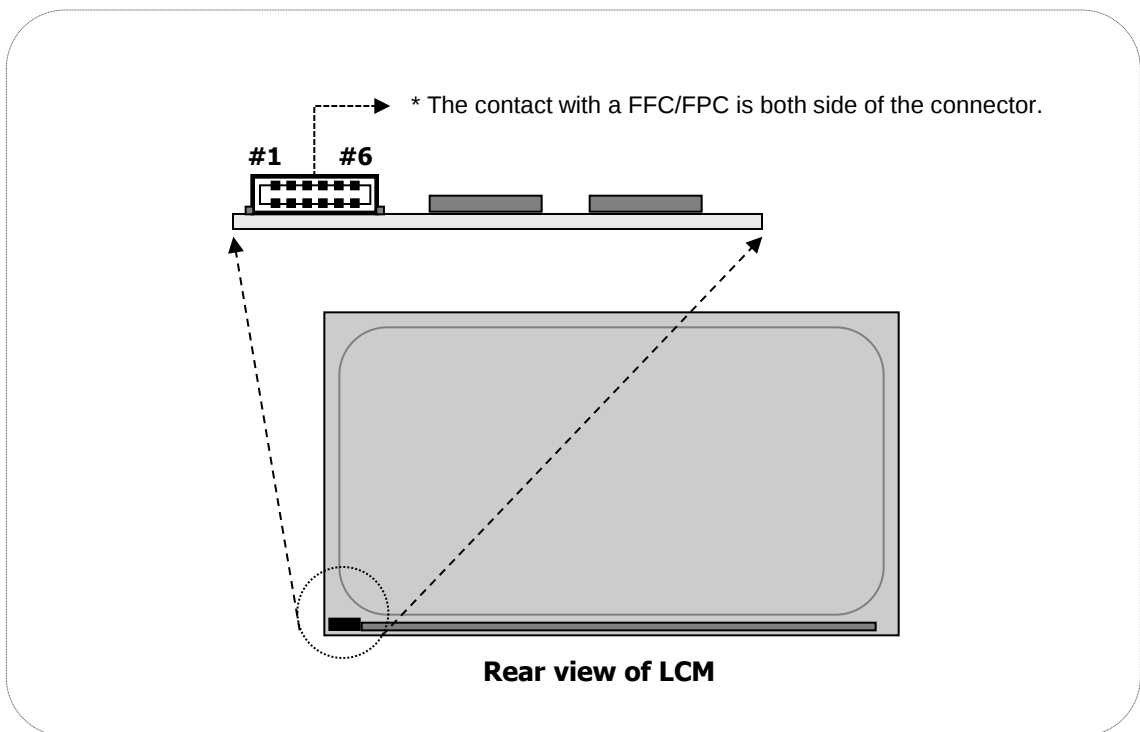
< LVDS Data Format >

## Product Specification

**Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2)**

The LED interface connector is a model 05010HR-06C(G) manufactured by Yeonho Electronics.  
 The mating connector is a FFC/FPC specified in LED interface connector specification.  
 The pin configuration for the connector is shown in the table below. The contact with a FFC/FPC is both side of the connector.

| Pin | Symbol | Description                     |
|-----|--------|---------------------------------|
| #1  | FB1    | Channel1 Current Feedback       |
| #2  | FB2    | Channel2 Current Feedback       |
| #3  | VLED   | LED power supply (common anode) |
| #4  | VLED   | LED power supply (common anode) |
| #5  | FB3    | Channel3 Current Feedback       |
| #6  | FB4    | Channel4 Current Feedback       |


**[ Figure 5 ] Backlight connector view**

## Product Specification

### 3-3. Signal Timing Specifications

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

**Table 6. TIMING TABLE**

| ITEM       | Symbol    |      | Min  | Typ  | Max  | Unit | Note |
|------------|-----------|------|------|------|------|------|------|
| DCLK       | Period    | tCLK | 14.7 | 18.5 | 23.6 | ns   |      |
|            | Frequency | -    | 42.3 | 54.0 | 68.4 | MHz  |      |
| Horizontal | total     | tHP  | 688  | 844  | 940  | tCLK |      |
|            | Frequency | fH   | 49.4 | 64.0 | 81.3 | KHz  |      |
|            | Blanking  |      | 48   | 204  | 300  | tCLK |      |
|            | valid     | tWH  | 640  | 640  | 640  | tCLK |      |
| Vertical   | total     | tVP  | 1040 | 1066 | 1320 | tHP  |      |
|            | Frequency | fV   | 47   | 60   | 76   | Hz   |      |
|            | Blanking  |      | 16   | 42   | 296  | tHP  |      |
|            | valid     | tWV  | 1024 | 1024 | 1024 | tHP  |      |

Note:

1.The value of Hsync period,Hsync width and Hsync valid should be even number times of tCLK.

If the value is odd number times of tCLK, it can make asynchronous signal timing and cause abnormal display.

2.The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.

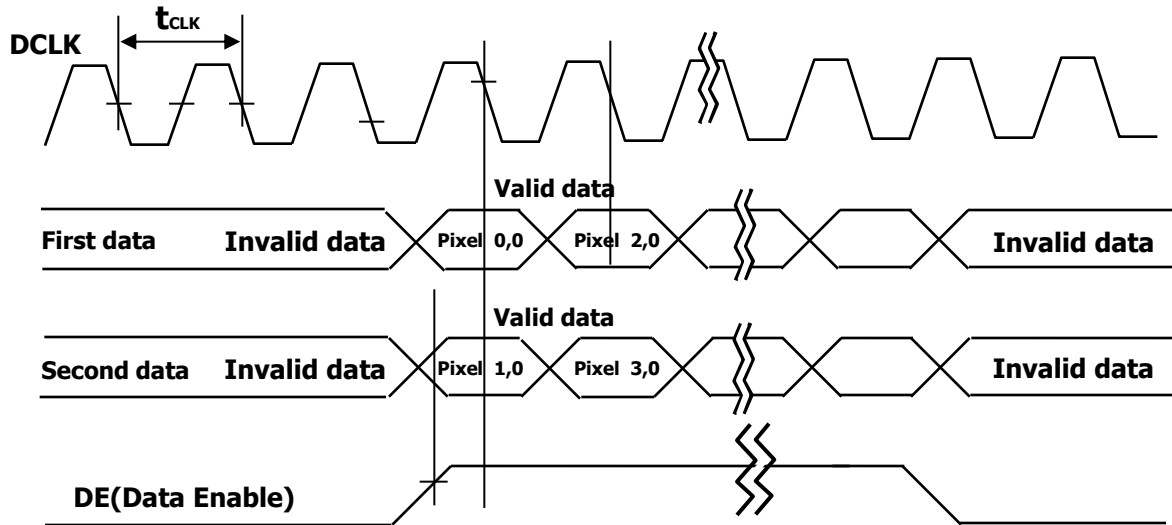
3.The value of Hsync Period, Hsync Width, and Horizontal Back Porch should be divided by 4 without a remainder.

4. The polarity of Hsync, Vsync is not restricted.

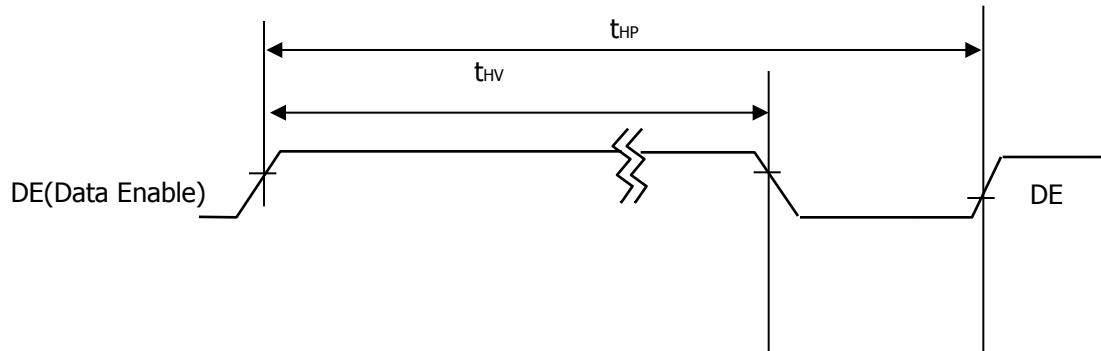
## Product Specification

### 3-4. Signal Timing Waveforms

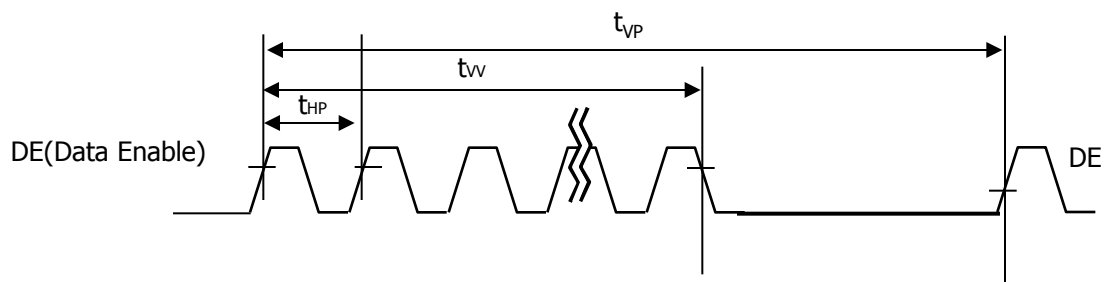
#### 1. DCLK, DE, DATA waveforms



#### 2. Horizontal waveform



#### 3. Vertical waveform



## Product Specification

### 3-5. Color Input Data Reference

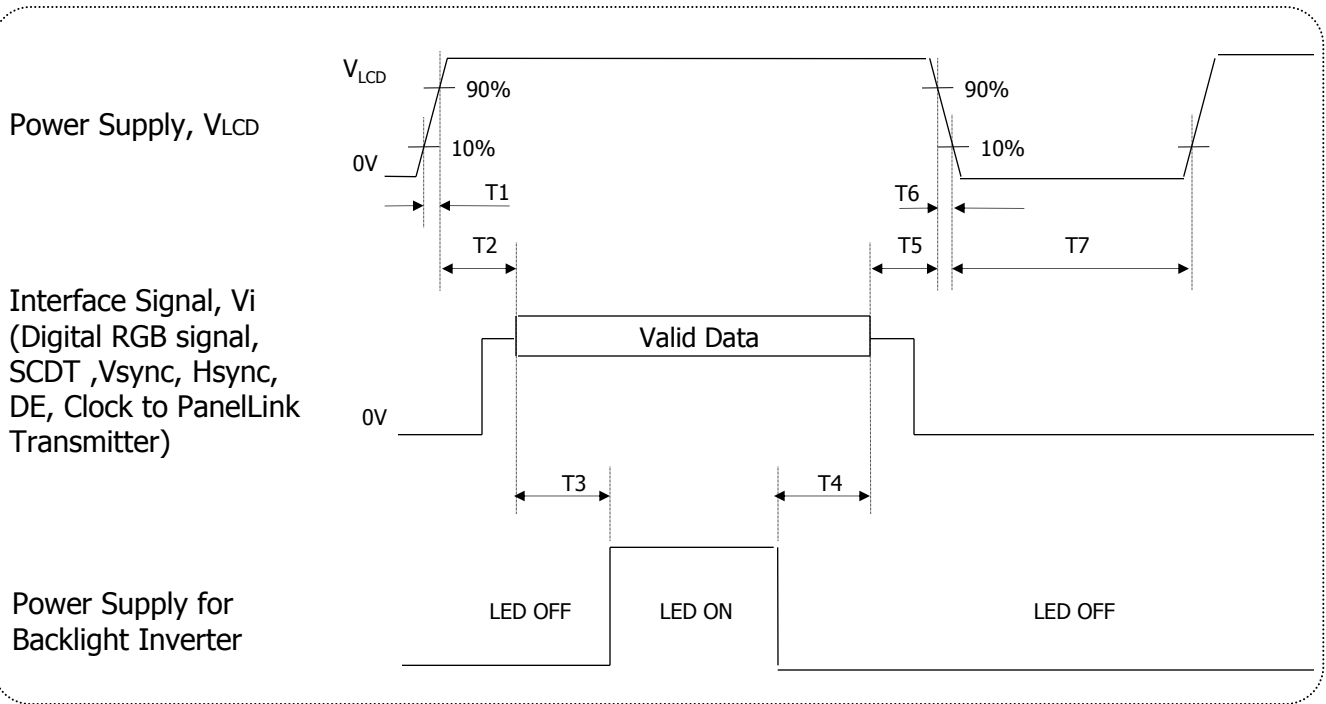
The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

**Table 7. COLOR DATA REFERENCE**

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

## Product Specification

### 3-6. Power Sequence



**FIG.5 Power sequence**

**Table 8. POWER SEQUENCE**

| Parameter | Values |     |     | Units |
|-----------|--------|-----|-----|-------|
|           | Min    | Typ | Max |       |
| T1        | 0.5    | -   | 10  | ms    |
| T2        | 0.01   | -   | 50  | ms    |
| T3        | 500    | -   | -   | ms    |
| T4        | 200    | -   | -   | ms    |
| T5        | 0.01   | -   | 50  | ms    |
| T7        | 1000   | -   | -   | ms    |

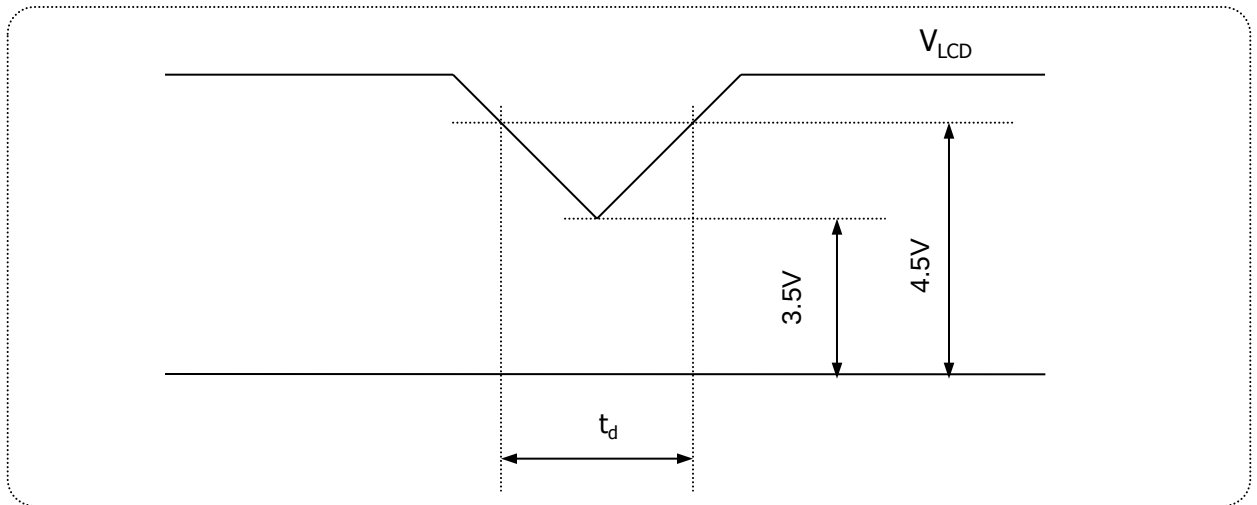
**Notes :**

- Power sequence should be kept all the time including below cases for normal operation.
  - AC/DC Power On/Off
  - Mode change (Resolution, frequency, timing, sleep mode, Color depth change, etc. )

The violation of power sequence can cause a significant trouble in display and reliability.
- Please avoid floating state of interface signal during signal invalid period.
- When the interface signal is invalid, be sure to pull down the  $V_{LCD}$  (0V).
- Please turn off the power supply for LED when the level of  $V_{LCD}$  changes to prevent noise issue.

## Product Specification

### 3-7. $V_{LCD}$ Power Dip Condition



**FIG.6 Power dip condition**

For proper operation, stable power supply of  $V_{LCD}$  is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification in page 16 exactly.

#### 1) Dip condition

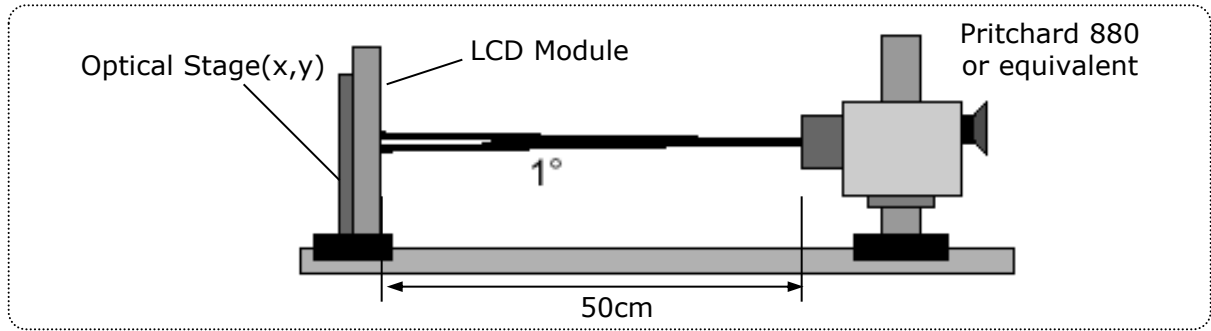
$$3.5V \leq V_{LCD} < 4.5V, \quad t_d \leq 20ms$$

## Product Specification

### 4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at  $25 \pm 2^\circ\text{C}$ . The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of  $\Phi$  and  $\theta$  equal to  $0^\circ$  and aperture 1 degree.

FIG. 4 presents additional information concerning the measurement equipment and method.



**FIG. 7 Optical Characteristic Measurement Equipment and Method**

**Table 9. OPTICAL CHARACTERISTICS**

( $T_a = 25^\circ\text{C}$ ,  $V_{\text{LCD}} = 5\text{V}$ ,  $f_v = 60\text{Hz}$ ,  $D_{\text{clk}} = 108\text{MHz}$ ,  $I_s = 90\text{mA}$ )

| Parameter                                           |                | Symbol               | Values       |       |              | Units  | Notes |
|-----------------------------------------------------|----------------|----------------------|--------------|-------|--------------|--------|-------|
|                                                     |                |                      | Min          | Typ   | Max          |        |       |
| Contrast Ratio                                      |                | CR                   | 600          | 900   | -            |        | 1     |
| Surface Luminance, white                            |                | L <sub>WH</sub>      | 260          | 330   | -            | cd/m²  | 2     |
| Luminance Variation                                 |                | δ <sub>WHITE</sub>   | -            | -     | 1.33         |        | 3     |
| Response Time                                       | Gray To Gray   | T <sub>GTG_AVR</sub> | -            | 14    | 25           | ms     | 4     |
| Color Coordinates<br>[CIE1931]<br><i>(By PR650)</i> | RED            | R <sub>x</sub>       | Typ<br>-0.03 | 0.635 | Typ<br>+0.03 |        |       |
|                                                     |                | R <sub>y</sub>       |              | 0.349 |              |        |       |
|                                                     | GREEN          | G <sub>x</sub>       |              | 0.314 |              |        |       |
|                                                     |                | G <sub>y</sub>       |              | 0.632 |              |        |       |
|                                                     | BLUE           | B <sub>x</sub>       |              | 0.153 |              |        |       |
|                                                     |                | B <sub>y</sub>       |              | 0.064 |              |        |       |
|                                                     | WHITE          | W <sub>x</sub>       |              | 0.314 |              |        |       |
|                                                     | W <sub>y</sub> |                      | 0.338        |       |              |        |       |
| Color Shift                                         | Horizontal     | θ <sub>CST_H</sub>   | -            | 176   | -            | Degree | 5     |
|                                                     | Vertical       | θ <sub>CST_V</sub>   | -            | 176   | -            |        |       |
| Viewing Angle (CR>10)                               |                |                      |              |       |              |        |       |
| General                                             | Horizontal     | θ <sub>H</sub>       | 170          | 178   | -            | Degree | 6     |
|                                                     | Vertical       | θ <sub>V</sub>       | 170          | 178   | -            |        |       |
| GSR @ 60dgree<br>(Gamma shift rate)                 | Horizontal     | δ <sub>Gamma_H</sub> | -            | -     | 20           | %      | 7     |
|                                                     | Vertical       | δ <sub>Gamma_V</sub> | -            | -     | 20           |        |       |
| Gray Scale                                          |                | -                    |              | 2.2   |              |        | 8     |

## Product Specification

Notes:

1. **Contrast ratio (CR)** is defined mathematically as :  
It is measured at center point (1)

$$\text{Contrast ratio} = \frac{\text{Surface luminance with all white pixels}}{\text{Surface luminance with all black pixels}}$$

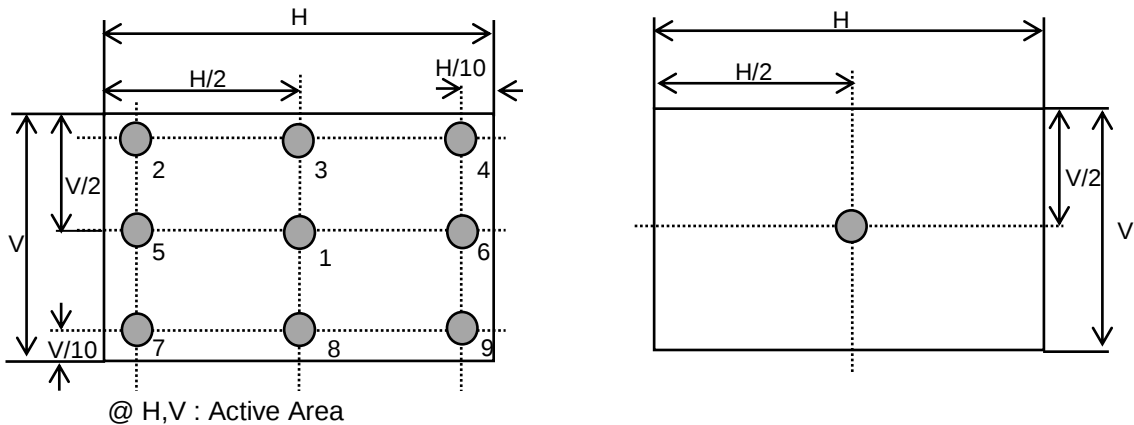
2. **Surface luminance** is the luminance value at center 1 point (1) across the LCD surface 50cm from the surface with all pixels displaying white.  
For more information see Figure 7.

3. The **variation in surface luminance** ,  $\delta_{\text{WHITE}}$  is defined as :

$$\delta_{\text{WHITE}} = \frac{\text{Maximum (P1,P2, ..., P9)}}{\text{Minimum (P1,P2, ..., P9)}}$$

For more information see Figure 8.

**FIG 8. Luminance measuring point**



<Measuring point for luminance variation>

<Measuring point for surface luminance>

4. The **Gray to Gray response time** is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray ".

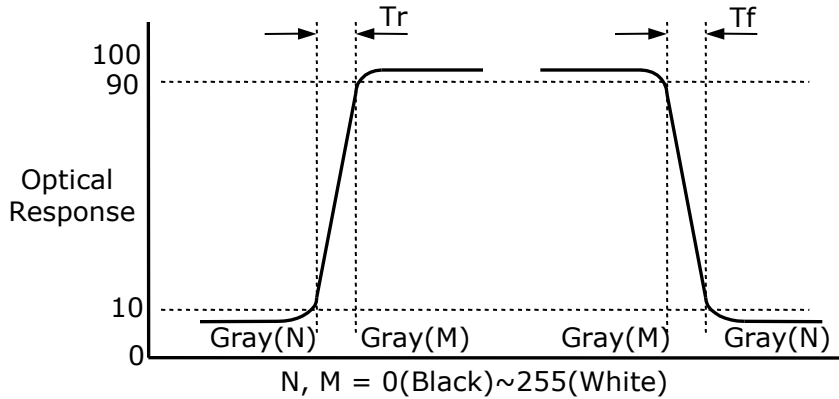
- Gray step : 5 Step
- TGTG\_AVR is the total average time at rising time and falling time for "Gray To Gray ".
- By RD80S

**Table 10. GTG Gray Table**

| Gray to Gray |      | Rising Time |      |      |     |    |
|--------------|------|-------------|------|------|-----|----|
|              |      | G255        | G191 | G127 | G63 | G0 |
| Falling Time | G255 |             |      |      |     |    |
|              | G191 |             |      |      |     |    |
|              | G127 |             |      |      |     |    |
|              | G63  |             |      |      |     |    |
|              | G0   |             |      |      |     |    |

## Product Specification

Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".



**FIG 9. Response Time**

5. Color shift is the angle at which the average color difference for all Macbeth is lower than 0.04.

For more information see FIG.9 **(By EZ Contrast)**

- Color difference ( $\Delta u'v'$ )

$$u' = \frac{4x}{-2x + 12y + 3}$$

$$v' = \frac{9y}{-2x + 12y + 3}$$

$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$$Avg(\Delta u'v') = \frac{\sum_{i=1}^{24} (\Delta u'v')_i}{24}$$

$u'_1, v'_1$  :  $u'v'$  value at viewing angle direction

$u'_2, v'_2$  :  $u'v'$  value at front ( $\theta=0$ )

$i$  : Macbeth chart number (Define 23 page)

- Pattern size : 25% Box size

- Viewing angle direction of color shift : Horizontal, Vertical

6. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG.10 **(By PR880)**

7. GSR is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG.11 and FIG.12 **(By EZ Contrast)**

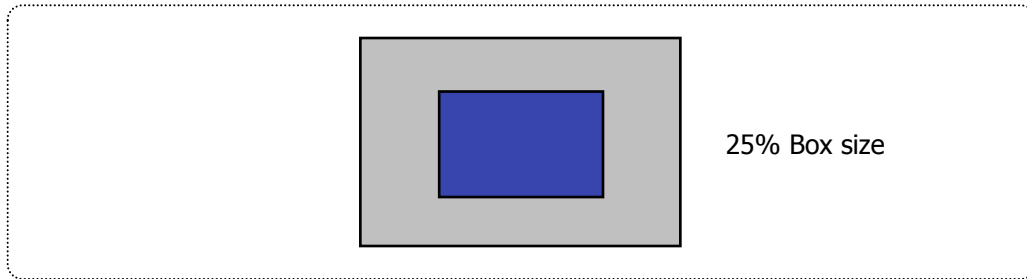
- GSR ( $\delta_{\text{Gamma}}$ ) is defined as :

$$GSR = \left( 1 - \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}} \right) \times 100$$

8. Gamma Value is approximately 2.2. For more information see Table 11.

## Product Specification

Color shift is defined as the following test pattern and color.



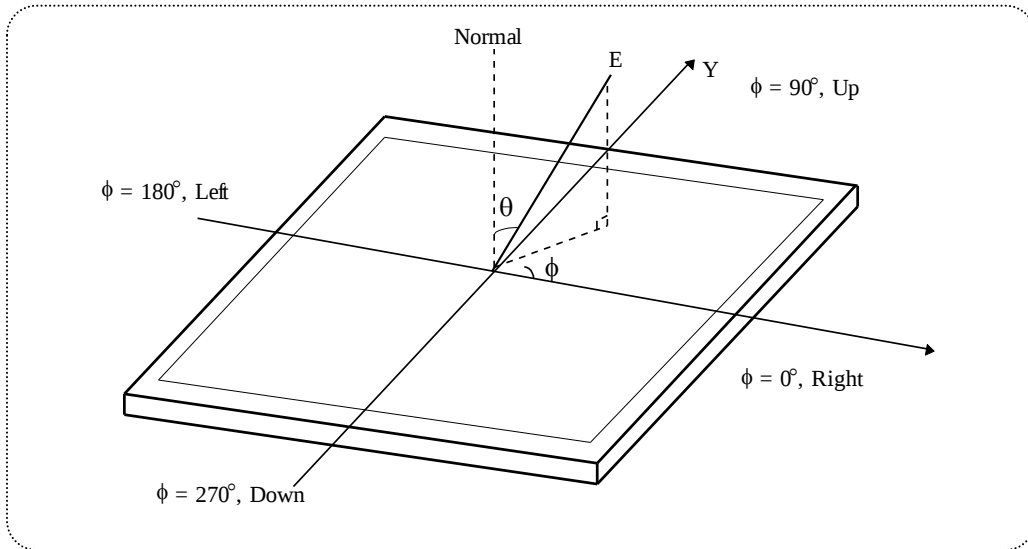
**FIG.9 Color Shift Test Pattern**

Average RGB values in Bruce RGB for Macbeth Chart

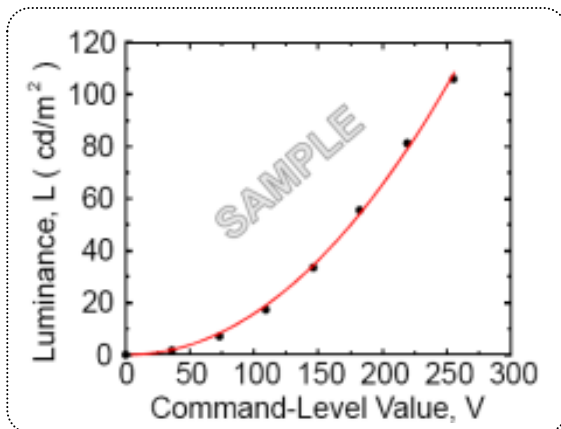
|   | Dark skin (i=1) | Light skin    | Blue sky     | Foliage   | Blue flower  | Bluish green  |
|---|-----------------|---------------|--------------|-----------|--------------|---------------|
| R | 98              | 206           | 85           | 77        | 129          | 114           |
| G | 56              | 142           | 112          | 102       | 118          | 199           |
| B | 45              | 123           | 161          | 46        | 185          | 178           |
|   | Orange          | Purplish blue | Moderate red | Purple    | Yellow green | Orange yellow |
| R | 219             | 56            | 211          | 76        | 160          | 230           |
| G | 104             | 69            | 67           | 39        | 193          | 162           |
| B | 24              | 174           | 87           | 86        | 58           | 29            |
|   | Blue            | Green         | Red          | Yellow    | Magenta      | Cyan          |
| R | 26              | 72            | 197          | 241       | 207          | 35            |
| G | 32              | 148           | 27           | 212       | 62           | 126           |
| B | 145             | 65            | 37           | 36        | 151          | 172           |
|   | White           | Neutral 8     | Neutral 6.5  | Neutral 5 | Neutral 3.5  | Black         |
| R | 240             | 206           | 155          | 110       | 63           | 22            |
| G | 240             | 206           | 155          | 110       | 63           | 22            |
| B | 240             | 206           | 155          | 110       | 63           | 22            |

## Product Specification

Dimension of viewing angle range.

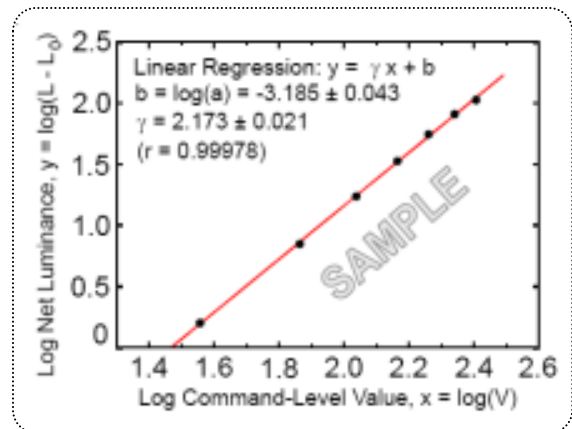


**FIG.10 Viewing angle**



**FIG.11 Sample Luminance vs. gray scale  
(using a 256 bit gray scale)**

$$L = aV^r + L_b$$



**FIG.12 Sample Log-log plot of luminance  
vs. gray scale**

$$\log(L - L_b) = r \log(V) + \log(a)$$

Here the Parameter  $a$  and  $\gamma$  relate the signal level  $V$  to the luminance  $L$ .  
 The GAMMA we calculate from the log-log representation (FIG.11)

## Product Specification

**Table 11. Gray Scale Specification**

| Gray Level | Relative Luminance [%] (Typ.) |
|------------|-------------------------------|
| 0          | 0.11                          |
| 31         | 1.08                          |
| 63         | 4.72                          |
| 95         | 11.49                         |
| 127        | 21.66                         |
| 159        | 35.45                         |
| 191        | 53.00                         |
| 223        | 74.48                         |
| 255        | 100                           |

**Product Specification****5. Mechanical Characteristics**

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

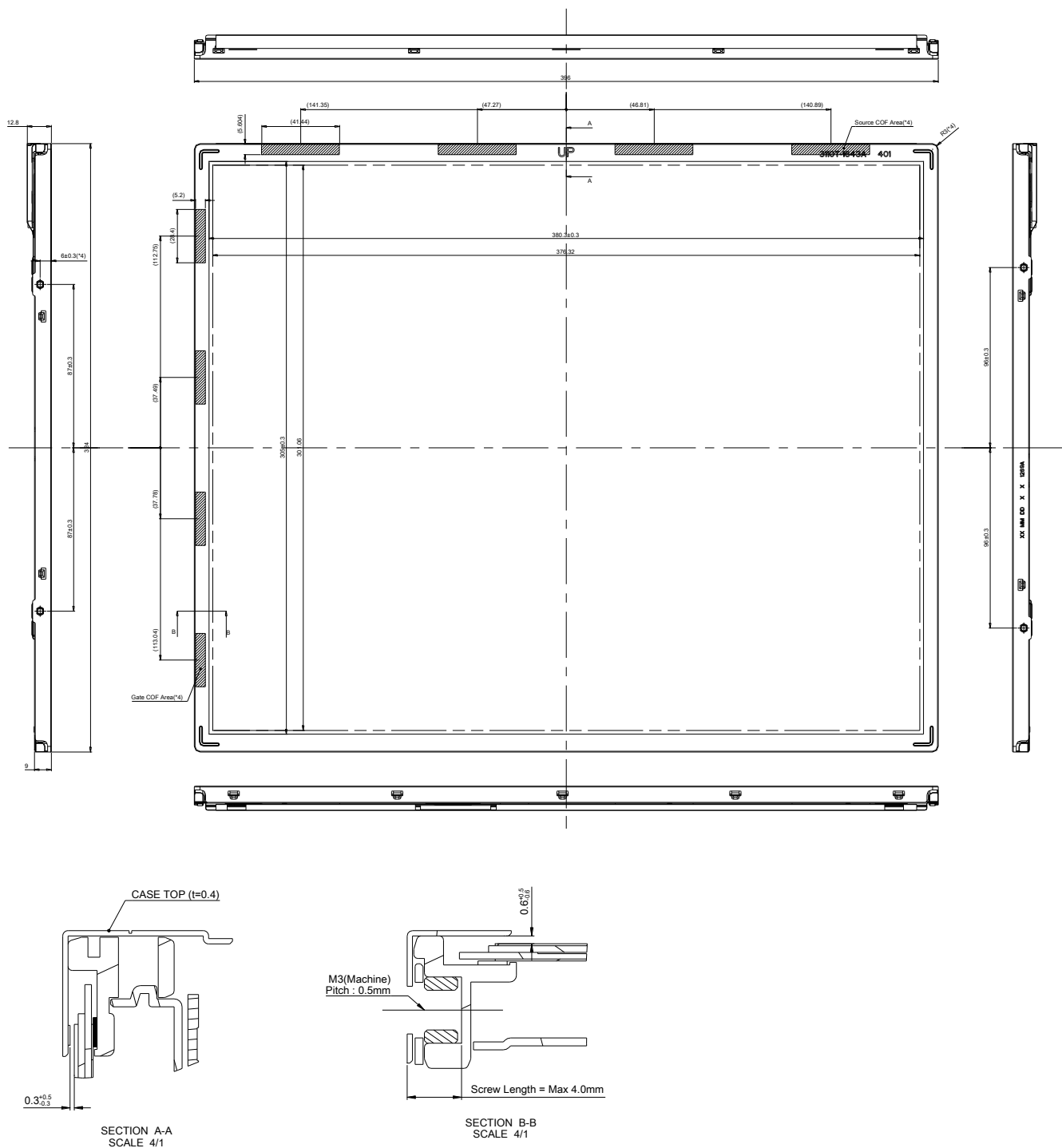
|                     |                                                                 |          |
|---------------------|-----------------------------------------------------------------|----------|
| Outline Dimension   | Horizontal                                                      | 396.0mm  |
|                     | Vertical                                                        | 324.0mm  |
|                     | Depth                                                           | 12.8mm   |
| Bezel Area          | Horizontal                                                      | 380.3mm  |
|                     | Vertical                                                        | 305.0mm  |
| Active Display Area | Horizontal                                                      | 376.32mm |
|                     | Vertical                                                        | 301.06mm |
| Weight              | Typ. 1250g / Max. 1300g                                         |          |
| Surface Treatment   | Hard coating(3H)<br>Anti-Glare treatment of the front polarizer |          |

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

## Product Specification

**<FRONT VIEW>**

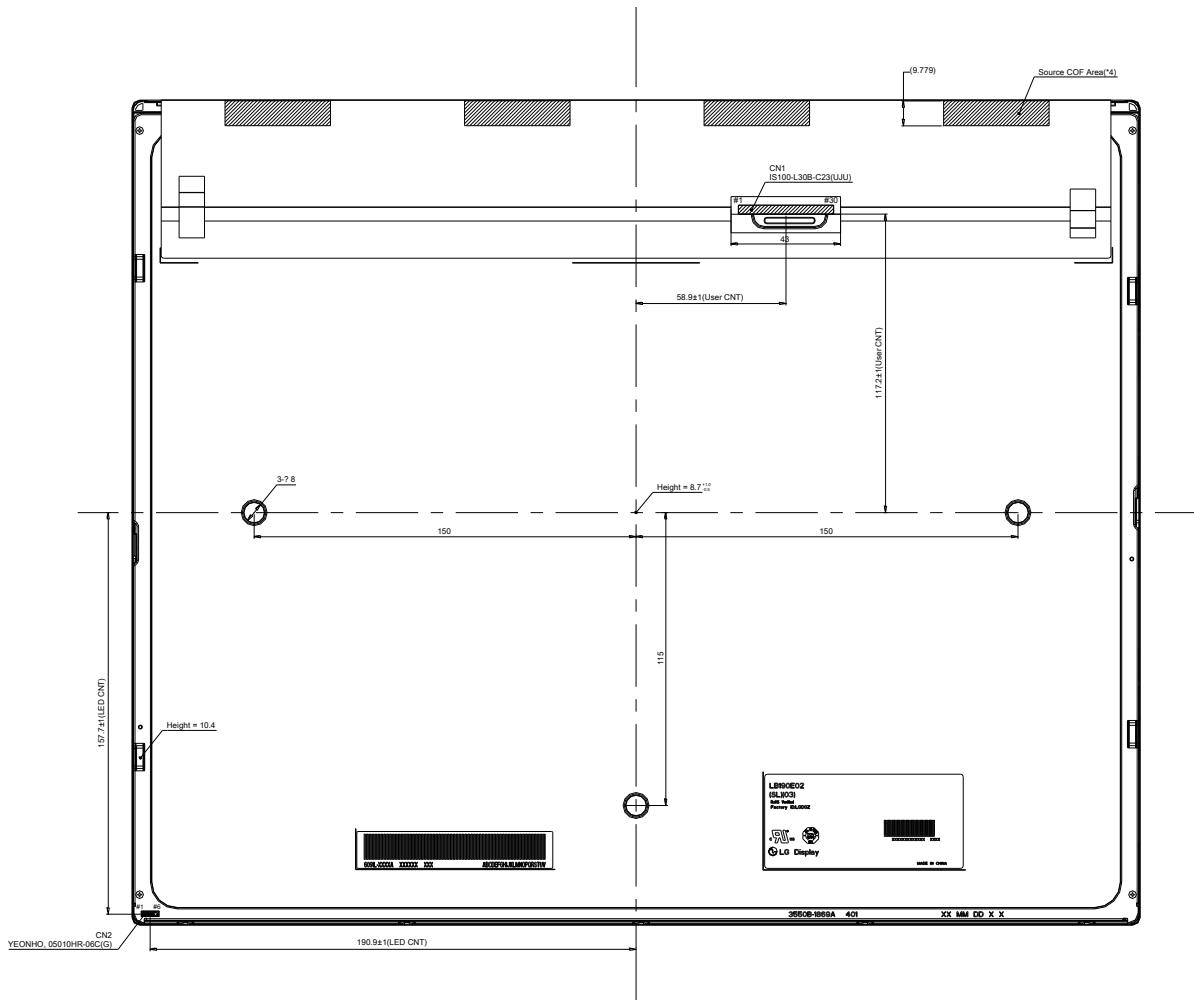
**Note) Unit:[mm], General tolerance:  $\pm 0.5\text{mm}$**



## Product Specification

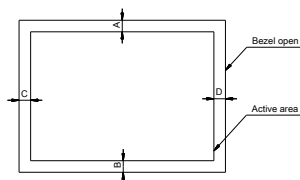
### <REAR VIEW>

Note) Unit:[mm], General tolerance:  $\pm 0.5\text{mm}$



#### Notes

- Unspecified tolerances are to be  $\pm 0.5$
- Tilt and partial disposition tolerance of display area are as following.
  - Y-direction :  $|A-B| \leq 1.4$
  - X-direction :  $|C-D| \leq 1.4$



- Torque of User Hole(Mount) : 3.0~4.0kgf.cm
- I/F Connector Specification(CN1) : IS100-L30B-C23(UJU)
- LED Connector Specification(CN2) : 05010HR-06C(G), YEONHO
- The COF area is weak & sensitive, so please don't press the COF area
- Outline Dimension is not including Tape & Cover Shield thickness

## Product Specification

### 6. Reliability

Environment test condition

| No | Test Item                                   | Condition                                                                                                                          |
|----|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| 1  | High temperature storage test               | Ta= 70°C 240h                                                                                                                      |
| 2  | Low temperature storage test                | Ta= -20°C 240h                                                                                                                     |
| 3  | High temperature operation test             | Ta= 60°C 240h                                                                                                                      |
| 4  | Low temperature operation test              | Ta= 0°C 240h                                                                                                                       |
| 5  | Vibration test<br>(non-operating)           | Wave form : random<br>Vibration level : 1.00G RMS<br>Bandwidth : 10-300Hz<br>Duration : X, Y, Z, 10 min<br>One time each direction |
| 6  | Shock test<br>(non-operating)               | Shock level : 100G<br>Waveform : half sine wave, 2ms<br>Direction : $\pm X$ , $\pm Y$ , $\pm Z$<br>One time each direction         |
| 7  | Humidity condition Operation                | Ta= 50 °C ,80%RH                                                                                                                   |
| 8  | Altitude<br>operating<br>storage / shipment | 0 - 16,000 feet(4,876m)<br>0 - 40,000 feet(12,192m)                                                                                |

Note 1. Result Evaluation Criteria:

TFT-LCD panels test should take place after cooling enough at room temperature.

In the standard condition, there should be no particular problems that may affect the display function.

※. T<sub>a</sub>= Ambient Temperature

## Product Specification

**7. International Standards****7-1. Safety**

- a) UL 60950-1, Underwriters Laboratories Inc.  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- b) CAN/CSA -C22.2 No.60950-1-07, Canadian Standards Association.  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- d) IEC 60950-1, The International Electrotechnical Commission (IEC).  
Information Technology Equipment - Safety - Part 1 : General Requirements

**7-2. Environment**

- a) RoHS, Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011

## Product Specification

### 8. Packing

#### 8-1. Designation of Lot Mark

a) Lot Mark

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

A,B,C : SIZE(INCH)

E : MONTH

D : YEAR

F ~ M : SERIAL NO.

Note

1. YEAR

| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|------|------|------|------|------|------|------|------|------|------|------|
| Mark | A    | B    | C    | D    | E    | F    | G    | H    | J    | K    |

2. MONTH

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

b) Location of Lot Mark

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

#### 8-2. Packing Form

a) Package quantity in one box : 12 pcs

b) Box Size : 408 X 355 X 474mm

## Product Specification

### 9. PRECAUTIONS

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

#### 9-1. MOUNTING PRECAUTIONS

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

#### 9-2. OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :  
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)  
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.  
(if not, it causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) When LCMs are used for public display defects such as Yogore, image sticking can not be guarantee.
- (11) LCMs cannot support "Interlaced Scan Method"

## Product Specification

### **9-3. ELECTROSTATIC DISCHARGE CONTROL**

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

### **9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE**

Strong light exposure causes degradation of polarizer and color filter.

### **9-5. STORAGE**

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

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

### **9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM**

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