

# APPROVAL

| PART NO.  | DESCRIPTION                      | REMARKS                                                             |
|-----------|----------------------------------|---------------------------------------------------------------------|
| HT12101LH | LCD MODULE<br>(1024 × RGB × 768) | * ROHS compliant<br>* High Brightness<br>(1,000 cd/m <sup>2</sup> ) |

|                          |  |
|--------------------------|--|
| CUSTOMER APPLICATION P/N |  |
| APPROVED BY              |  |
| DATE                     |  |

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|             |            |              |



**HYES Optoelectronics, Inc.**

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## 1.0 General Description

### 1.1 General Introduction

HT12101LH is a color active matrix TFT LCD module using amorphous silicon TFT's (Thin Film Transistors) as active switching devices. This module has a 12.1 inch diagonally measured active area with XGA resolutions (1024 horizontal by 768 vertical pixel array).

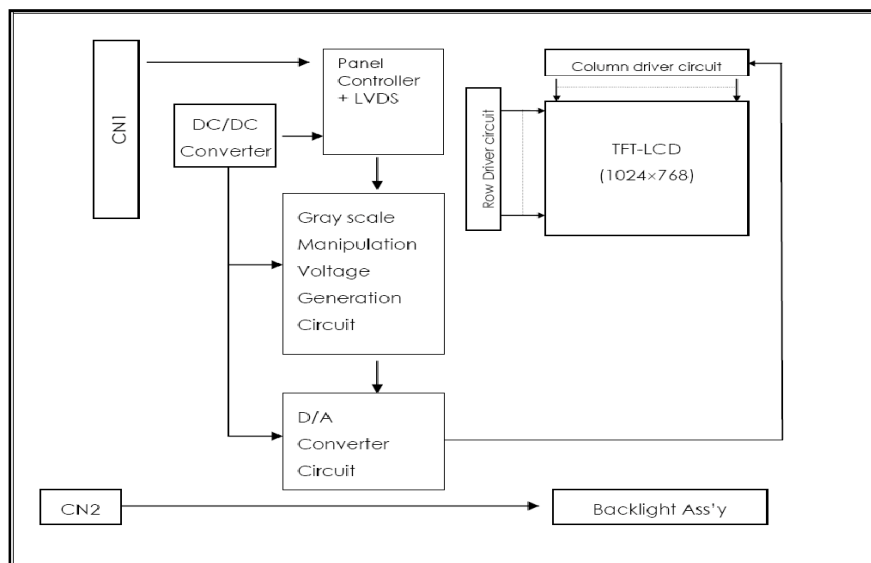
Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical stripe and this module can display 262,144 colors.

The TFT-LCD panel used Ultra high Brightness as Back Light unit using L.E.D Lamps and Pure Light Guide.

► For Application :

- Marine Fish Finder
- Avionics dashboard
- Medical instrument
- Military instrument
- Industrial instrument
- Automobile dashboard etc.

Followings are general diagram at the model HT12101LH.



### 1.2 Features

- 1) Greater Outdoor Readability
- 2) High visibility and durability in outdoor
- 3) High Luminance and Contrast ratio
- 4) Anti reflection and Wide viewing angle
- 5) 6bit color depth, Display 262,144 colors
- 6) Ripple Free
- 7) AFFS technology TFT LCD Module (Hydis)
- 8) High Luminance L.E.D Back-Light Unit

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### 1.3 General Specification

The followings are general specifications

| Parameter           | Specification                                  | Unit              | Remarks           |
|---------------------|------------------------------------------------|-------------------|-------------------|
| TFT Type            | Amorphous silicon TFT                          |                   |                   |
| Active area         | 245.76 (H) ×184.32(V) (12.1" diagonal)         | mm                |                   |
| Number of pixels    | 1024 (H) X 768 (V)                             | pixels            |                   |
| Pixel pitch         | 0.240(H) ×0.240(V)                             | mm                |                   |
| Pixel arrangement   | RGB Vertical stripe arrangement                |                   |                   |
| Display colors      | 262,144 (6 bits)                               | colors            |                   |
| Display mode        | Normally Black, Transmissive Mode              |                   | AFFS              |
| Signal interface    | LVDS                                           |                   |                   |
| Dimensional outline | 274.00±0.5(H) × 206.3±0.5(V) × 14.10(D:max)    | mm                |                   |
| Weight              | 900 g (typ.)                                   | g                 |                   |
| Surface treatment   | Anti-Reflection Hard coating(3H) of Front view |                   |                   |
| Brightness          | 1,100 Typ                                      | cd/m <sup>2</sup> |                   |
| Back-light          | 2 Edge side, White LED type                    |                   |                   |
| Mounting method     | Side mounting                                  |                   |                   |
| Power consumption   | P <sub>D</sub> : 0.7                           | W                 | @ V <sub>cc</sub> |
|                     | P <sub>BL</sub> : 15.1                         | W                 | @ Backlight       |
|                     | P <sub>total</sub> : 15.8                      | W                 |                   |

### 1.4 Absolute Maximum Rate

| Parameter           | Symbol          | Values |                      | Unit            | Remarks                             |
|---------------------|-----------------|--------|----------------------|-----------------|-------------------------------------|
|                     |                 | Min    | Max                  |                 |                                     |
| Logic Power Supply  | V <sub>dd</sub> | -0.3   | 4.0                  | V <sub>dc</sub> | Ta=Room Temp<br><br>With the Heater |
| Logic Input Voltage | V <sub>in</sub> | -0.3   | V <sub>dd</sub> +0.3 | V <sub>dc</sub> |                                     |
| Operating Temp      | T <sub>op</sub> | -20    | +70                  | °C              |                                     |
| Storage Temp        | T <sub>st</sub> | -30    | +80                  | °C              |                                     |

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## 2.0 Mechanical Specification

### 2.1 Mechanical specifications.

| Parameter                    | Min.  | Typ.  | Max.   | Unit | Remarks |
|------------------------------|-------|-------|--------|------|---------|
| Horizontal outline dimension | 273.5 | 274.0 | 274.5  | mm   |         |
| Vertical outline dimension   | 205.8 | 206.3 | 206..8 | mm   |         |
| Thickness                    | -     | -     | 14.1   | mm   |         |
| Lamp cable length            | -     | 250   | -      | mm   |         |
| Weight                       | -     | 900   | -      | g    |         |

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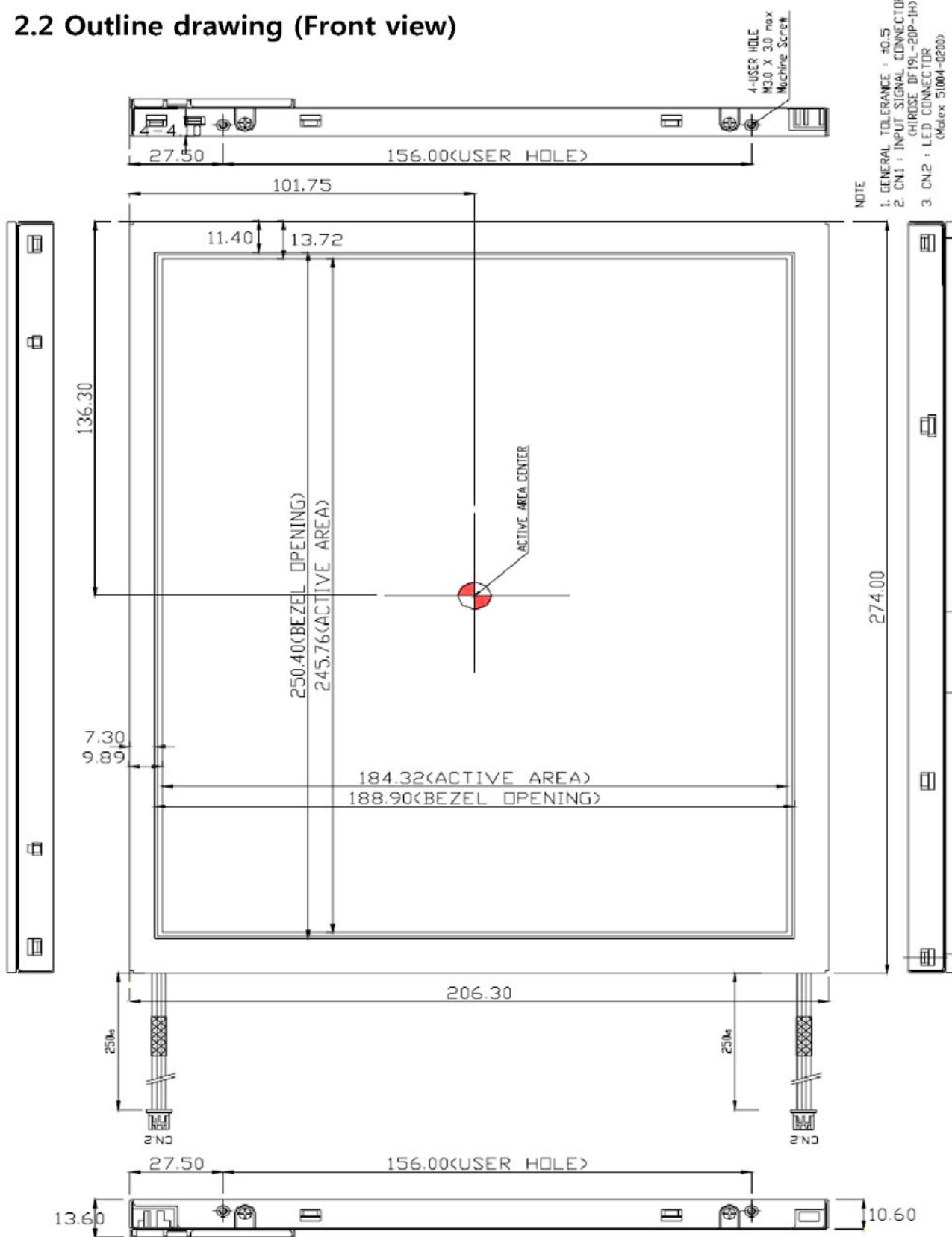
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## 2.2 Outline drawing (Front view)



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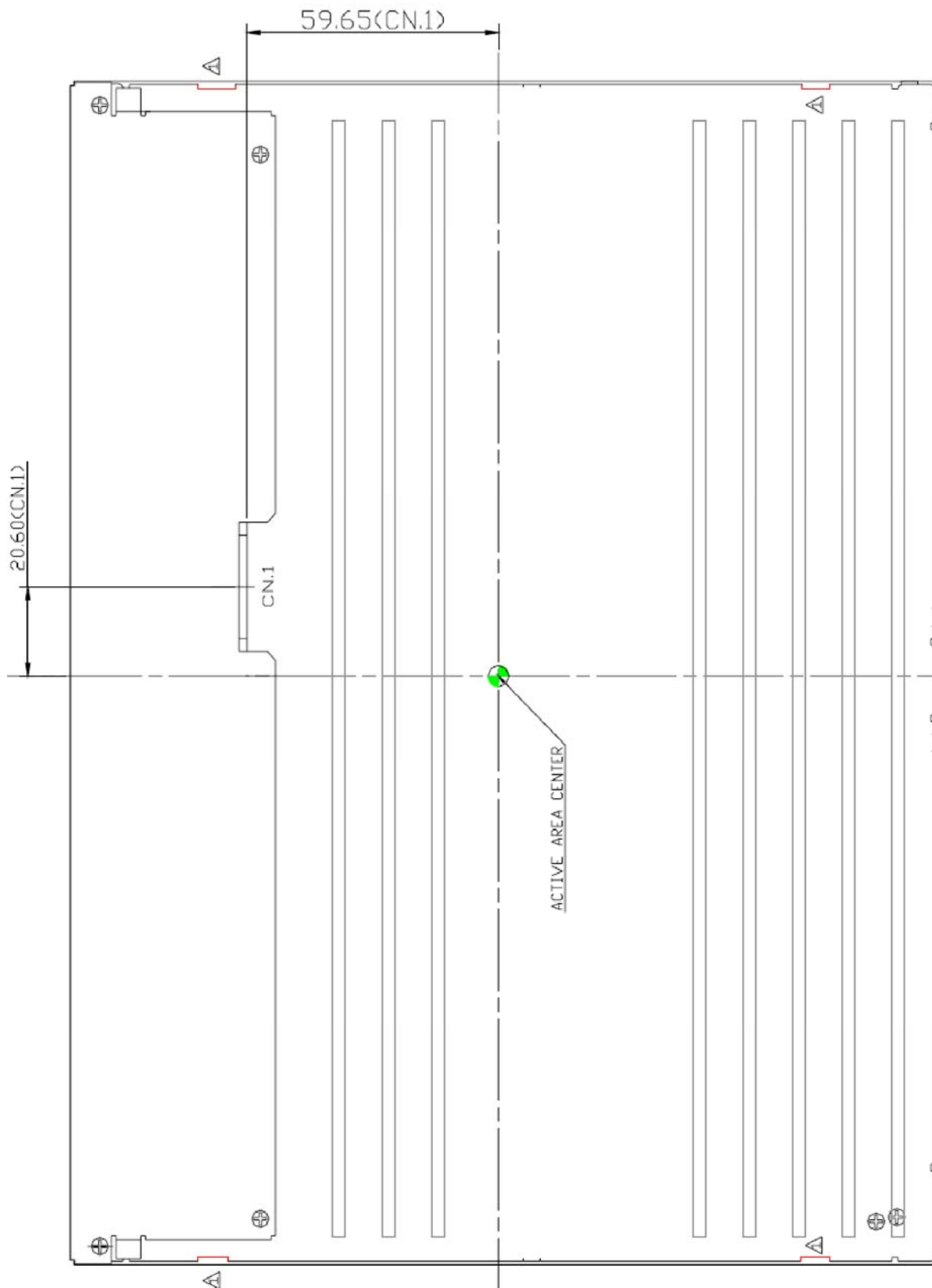
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### 2.3 Outline drawing (Rear view)



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## 3.0 Electrical Specification

### 3.1 Electrical specifications.

| Parameter         | Symbol | Min.   | TYP.   | Max. | Unit | Remark  |
|-------------------|--------|--------|--------|------|------|---------|
| LCD Module        |        |        |        |      |      |         |
| Input Voltage     | VDD    | 3.0    | 3.3    | 3.6  | Vdc  |         |
| Input Current     | IDD    |        | 240    |      | mAdc | Note1,2 |
| Power Consumption | PD     |        | 0.7    |      | W    | Note1,2 |
| Back-Light        |        |        |        |      |      |         |
| Operating Voltage | VBL    | 17.7   | 18.6   | 20.4 | Vdc  |         |
| Operating Current | IBL    |        | 0.810  |      | Adc  |         |
| Power Consumption | PBL    |        | 15.1   |      | W    |         |
| Life time         |        | 30,000 | 50,000 |      | Hrs  | Note3   |

**Notes:**

1. The current draw and power consumption specified is for 3.3 Vdc at 25°C and fv at 60Hz.  
(at Black pattern displayed)
2. Logic level are specified for VDD of 3.3 Vdc at 25°C. The values specified apply to all logic inputs; Hsync, Vsync, Clock, data signals, etc.
3. End of Life shall be determined by the time when any of the following is satisfied under continuous lighting at 25°C and IBL = 810[mA] Max Only.  
(Intensity drops to 50% of the Initial Value)
4. LED BLU Load voltage should be about 17.7V~20.4V at 405mA Maximum current each top & bottom sides.

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## 4.0 Optical Specification

### 4.1 Optical specifications

The test of Optical specifications shall be measured in a dark room (ambient luminance  $\leq 1$  lux And temperature =  $25 \pm 2^\circ\text{C}$ ) with the equipment of luminance meter system and test unit shall be located at an approximate distant 50cm from the LCD surface at a viewing angle of  $\theta$  and  $\phi$  equal to  $0^\circ$ . We refer to  $\theta\phi=0$  ( $=\theta 3$ ) as the 3 o'clock direction,  $\theta\phi=90$  ( $=\theta 12$ ) as the 12 o'clock direction. ("upward"),  $\theta\phi=180$  ( $=\theta 9$ ) as the 9 o'clock direction ("left") and  $\theta\phi=270$  ( $=\theta 6$ ) as the 6 o'clock direction ("bottom"). While scanning  $\theta$  and or  $\phi$ , the center of the measuring spot on the Display surface shall stay fixed. The backlight should be operating for 60 minutes prior to measurement... VDD shall be  $3.3 \pm 0.3\text{V}$  at  $25^\circ\text{C}$ . Optimum viewing angle direction is 6 o'clock.

| Parameter                  |                           | Symbol        | Condition                                                          | Min. | Typ.    | Max. | Unit              | Remark  |
|----------------------------|---------------------------|---------------|--------------------------------------------------------------------|------|---------|------|-------------------|---------|
| Viewing Angle range        | Horizontal                | $\Theta_3$    | CR > 10                                                            | -    | 80      | -    | Deg.              | Note 1  |
|                            |                           | $\Theta_9$    |                                                                    | -    | 80      | -    | Deg.              |         |
|                            | Vertical                  | $\Theta_{12}$ |                                                                    | -    | 80      | -    | Deg.              |         |
|                            |                           | $\Theta_6$    |                                                                    | -    | 80      | -    | Deg.              |         |
| Luminance Contrast ratio   |                           | CR            | $\Theta = 0^\circ$                                                 | -    | 450 : 1 | -    |                   | Note 2  |
| Center Luminance of White  | 1 Point                   | $Y_w$         | $\Theta = 0^\circ$<br>VBL =16.5V<br>IBL = 405mA<br>(with 2channel) | 850  | 1,000   | -    | cd/m <sup>2</sup> |         |
| White Luminance uniformity | 5 Points                  | $\Delta Y5$   |                                                                    | 70   | 75      | -    | %                 | Min/Max |
| White Chromaticity         |                           | $W_x$         | $\Theta = 0^\circ$                                                 |      | 0.311   |      |                   | Note 3  |
|                            |                           | $W_y$         |                                                                    |      | 0.338   |      |                   |         |
| Reproduction of color      | Red                       | $R_x$         |                                                                    |      | 0.547   |      |                   |         |
|                            |                           | $R_y$         |                                                                    |      | 0.331   |      |                   |         |
|                            | Green                     | $G_x$         |                                                                    |      | 0.314   |      |                   |         |
|                            |                           | $G_y$         |                                                                    |      | 0.518   |      |                   |         |
|                            | Blue                      | $B_x$         |                                                                    |      | 0.153   |      |                   |         |
|                            |                           | $B_y$         |                                                                    |      | 0.141   |      |                   |         |
| Response Time              | Ttotal<br>( $T_r + T_d$ ) |               | Ta= 25° C<br>$\Theta = 0^\circ$                                    | -    | 40      | -    | ms                |         |
| Color Reproduction         |                           | -             | -                                                                  | -    | 40      | -    | %                 |         |
| Cross Talk                 |                           | CT            | $\Theta = 0^\circ$                                                 | -    | -       | 2.0  | %                 |         |

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#### Notes

1. Viewing angle is the angle at which the contrast ratio is greater than 10.  
The viewing angles are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (see FIGURE1 as below).
2. Contrast measurements shall be made at viewing angle of  $\Theta = 0$  and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state.

Luminance Contrast Ratio (CR) is defined mathematically as  $CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$

3. The color chromaticity coordinates specified in Table 4. shall be calculated from the spectral data measured with all pixels first in red, green, blue, and white. Measurements shall be made at the center of the panel.

## 4.2 Overview of test condition.

| Items             | Condition                        | Items                                       | Condition         |
|-------------------|----------------------------------|---------------------------------------------|-------------------|
| Ambient luminance | 1 Lux Under                      | Temperature                                 | 25 degree C +/- 2 |
| Test equipment    | Goniometer and BM5               | Distance from test equipment to LCD Surface | 50 cm             |
| Angle of test     | 0 degree<br>(Distance 6 p'clock) |                                             |                   |
| VDD               | 3.30 +/- 0.3 V                   | Saturation time of brightness               | 30 min            |

Figure 1. Measurement Set Up

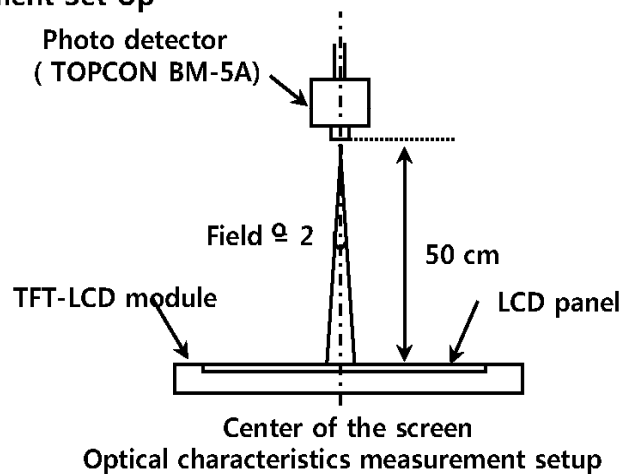
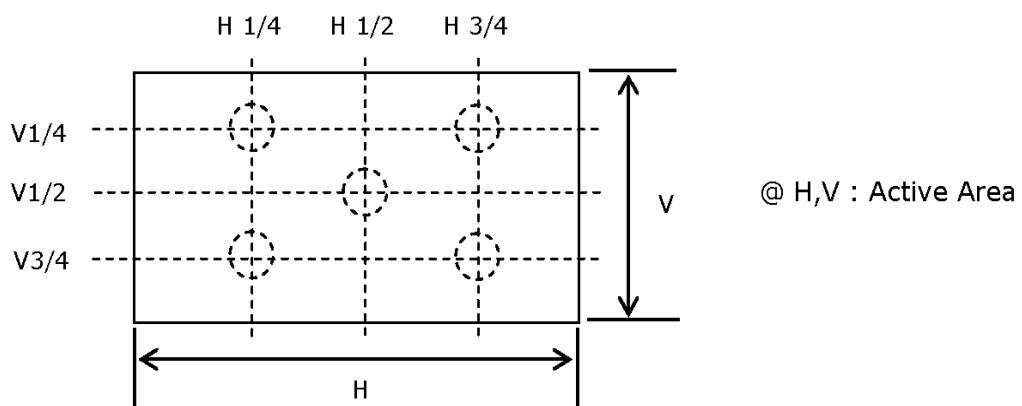


Figure 2. White Luminance (Center) and Uniformity Measurement Locations (5 points)



. White luminance : Center Luminance of white is defined as luminance values of center 1 point.

. Uniformity of 5 points : The White luminance uniformity on LCD surface is expressed as :  $\Delta Y5 = \text{Minimum Luminance of five points} / \text{Maximum Luminance of five points}$  ( see Figure 2).

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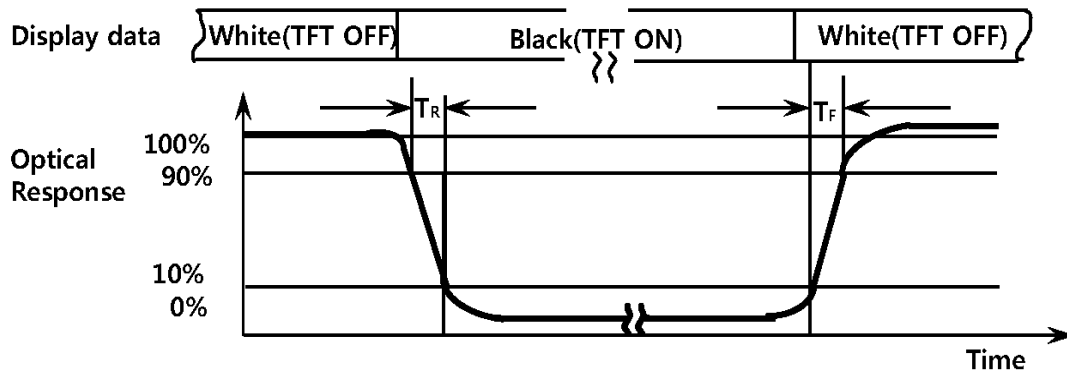
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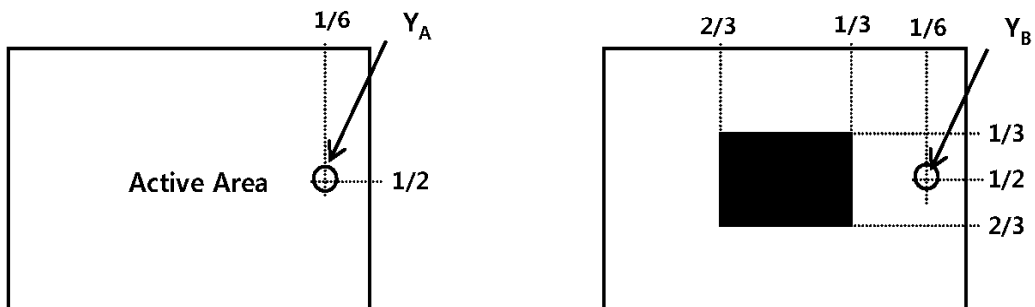
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Figure 3. Response Time Testing



The electro-optical response time measurements luminance to change from 10 % to 90 % is Td and 90 % to 10 % is Tr.

Figure 4. Cross Modulation Test Description



Test point of  $Y_A / Y_B$  : Point of  $Y_B$  (1/6 , 1/2)

$$\text{Cross-Talk (\%)} = \left| \frac{Y_R - Y_A}{Y_B} \right| \times 100$$

Where:

$Y_A$  = Initial luminance of measured area (cd/m<sup>2</sup>)

$Y_B$  = Subsequent luminance of measured area (cd/m<sup>2</sup>)

## 5.0 Interface Connection.

### 5.1 Electrical interface connection

#### Interface Signal ( CN1 )

| Used Connector     | DF19L-20P-1H or Equivalent | Hirose                           |
|--------------------|----------------------------|----------------------------------|
| Matching Connector | DF19L-20P-1C or Equivalent | Hirose                           |
| Pin                | Symbol                     | Description                      |
| 1                  | VDD                        | Power Supply 3.3V                |
| 2                  | VDD                        | Power Supply 3.3V                |
| 3                  | VSS                        | GND                              |
| 4                  | VSS                        | GND                              |
| 5                  | RIN0-                      | Transmission Data of Pixel 0 (-) |
| 6                  | RIN0+                      | Transmission Data of Pixel 0 (+) |
| 7                  | VSS                        | GND                              |
| 8                  | RIN1-                      | Transmission Data of Pixel 1 (-) |
| 9                  | RIN1+                      | Transmission Data of Pixel 1 (+) |
| 10                 | VSS                        | GND                              |
| 11                 | RIN2-                      | Transmission Data of Pixel 2 (-) |
| 12                 | RIN2+                      | Transmission Data of Pixel 2 (+) |
| 13                 | VSS                        | GND                              |
| 14                 | RCLK IN-                   | Sampling Clock (-)               |
| 15                 | RCLK IN+                   | Sampling Clock (+)               |
| 16                 | VSS                        | GND                              |
| 17                 | NC                         | No Connection                    |
| 18                 | NC                         | No Connection                    |
| 19                 | VSS                        | GND                              |
| 20                 | VSS                        | GND                              |

#### Back-Light ( CN2 )

| Used Connector | 51004-0200 or Equivalent | Molex                                    |
|----------------|--------------------------|------------------------------------------|
| Pin            | Symbol                   | Description                              |
| 1              | VBL                      | LED Lamp power Input 17.7Vdc(Typ) : Pink |
| 2              | GND                      | GND : White                              |

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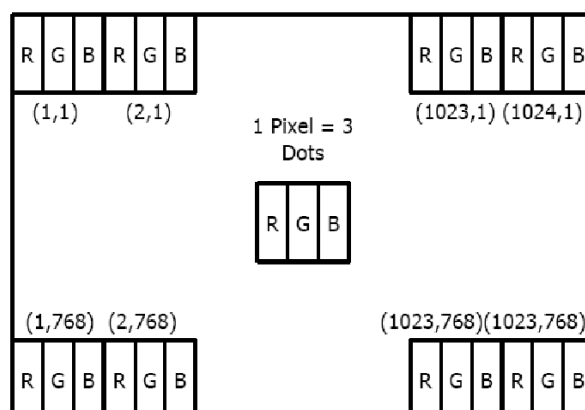
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## 5.2 LVDS Transmitter : THC63LVDM83A or equivalent (8bit Transmitter)

| Input Signal | Transmitter |          | Interface      |              | DF19KR-20P-1H | Remark |
|--------------|-------------|----------|----------------|--------------|---------------|--------|
|              | Pin no.     | Pin no.  | System(Tx)     | TFT-LCD(Rx)  | Pin No.       |        |
| R0           | 51          | 48<br>47 | Out0-<br>Out0+ | IN0-<br>IN0+ | 5<br>6        |        |
| R1           | 52          |          |                |              |               |        |
| R2           | 54          |          |                |              |               |        |
| R3           | 55          |          |                |              |               |        |
| R4           | 56          |          |                |              |               |        |
| R5           | 3           |          |                |              |               |        |
| G0           | 4           | 46<br>45 | OUT-<br>OUT+   | IN1-<br>IN1+ | 7<br>8        |        |
| G1           | 6           |          |                |              |               |        |
| G2           | 7           |          |                |              |               |        |
| G3           | 11          |          |                |              |               |        |
| G4           | 12          |          |                |              |               |        |
| G5           | 14          |          |                |              |               |        |
| B0           | 15          | 42<br>41 | OUT2-<br>OUT2+ | IN2-<br>IN2+ | 9<br>12       |        |
| B1           | 19          |          |                |              |               |        |
| B2           | 20          |          |                |              |               |        |
| B3           | 22          |          |                |              |               |        |
| B4           | 23          |          |                |              |               |        |
| B5           | 24          |          |                |              |               |        |
| Hsync        | 27          |          |                |              |               |        |
| Vsync        | 28          |          |                |              |               |        |
| DE           | 30          |          |                |              |               |        |
| MCLK         | 31          | 40       | CLKOUT-        | CLKIN-       | 11            |        |
|              |             | 39       | CLKOUT+        | CLKIN+       | 12            |        |

**Data Input Format**  
Display position  
of Input data



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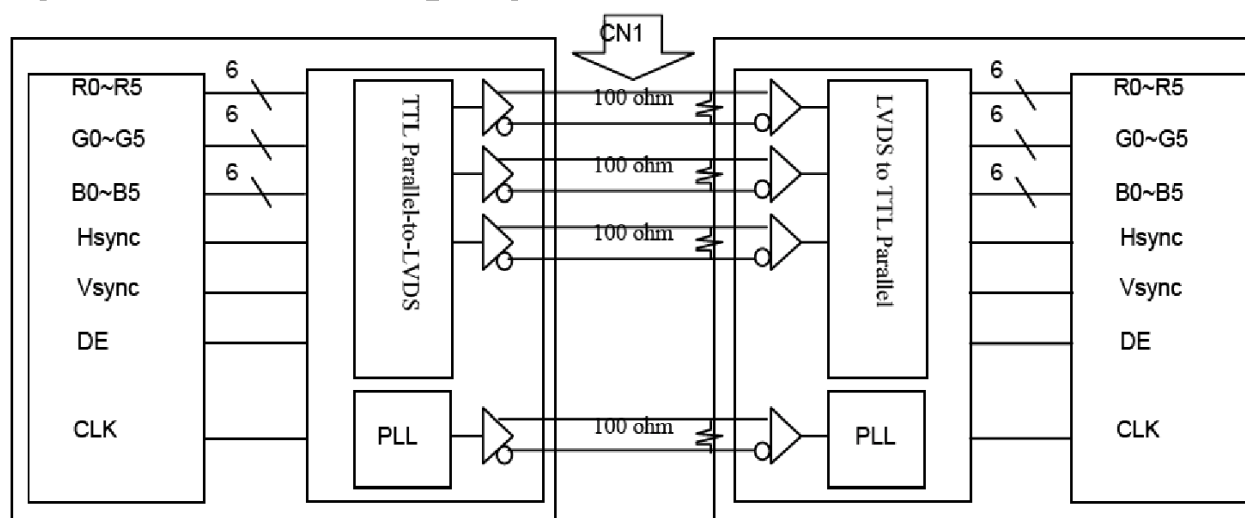
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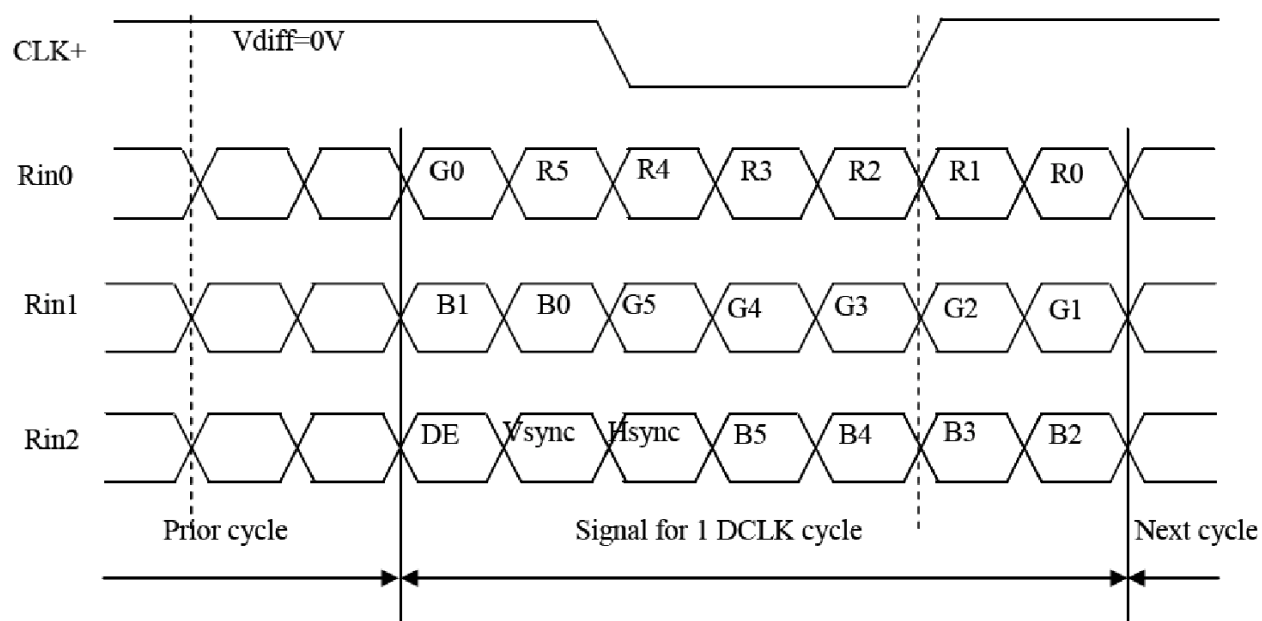
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### [ LVDS Interface Block Diagram ]



### [ LVDS Input Signal ]



## 6.0 Signal Timing Specification

### 6.1 LVDS Transmitter Input

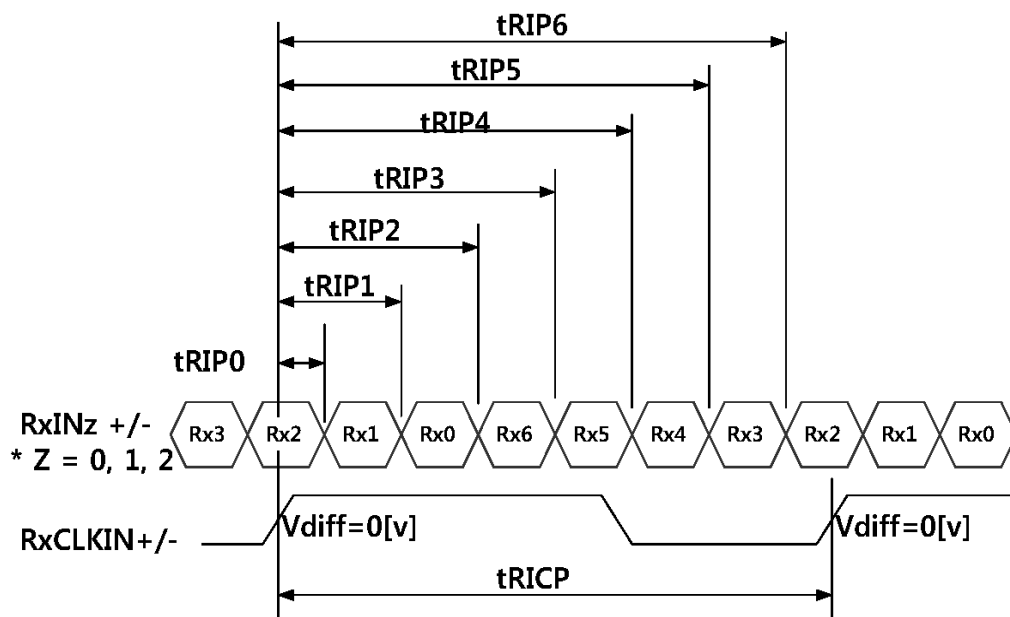
De mode only.

| Item                      |             | Symbol | Min  | Typ  | Max  | Unit   |
|---------------------------|-------------|--------|------|------|------|--------|
| Clock                     | Frequency   | 1/Tc   | 1    | 65   | 80   | MHz    |
|                           | High Time   | Tch    | 4.5  | -    | -    | Ns     |
|                           | Low Time    | Tcl    | 4.5  | -    | -    | Ns     |
| Data                      | Set-up Time | Tds    | 2.7  | -    | -    | Ns     |
|                           | Hold Time   | Tdh    | 0    | -    | -    | Ns     |
| Data enable setup Time    |             | Tes    | 2.7  | -    | -    | Ns     |
| Frame Period              |             | Tv     | 772  | 806  | 1022 | Lines  |
| Vertical Display Period   |             | Tvd    | 768  | 768  | 768  | Lines  |
| One line scanning Period  |             | Th     | 1100 | 1344 | 2046 | Clocks |
| Horizontal Display Period |             | Thd    | 1024 | 1024 | 1024 | Clocks |

## 6.2 LVDS Rx interface timing parameter

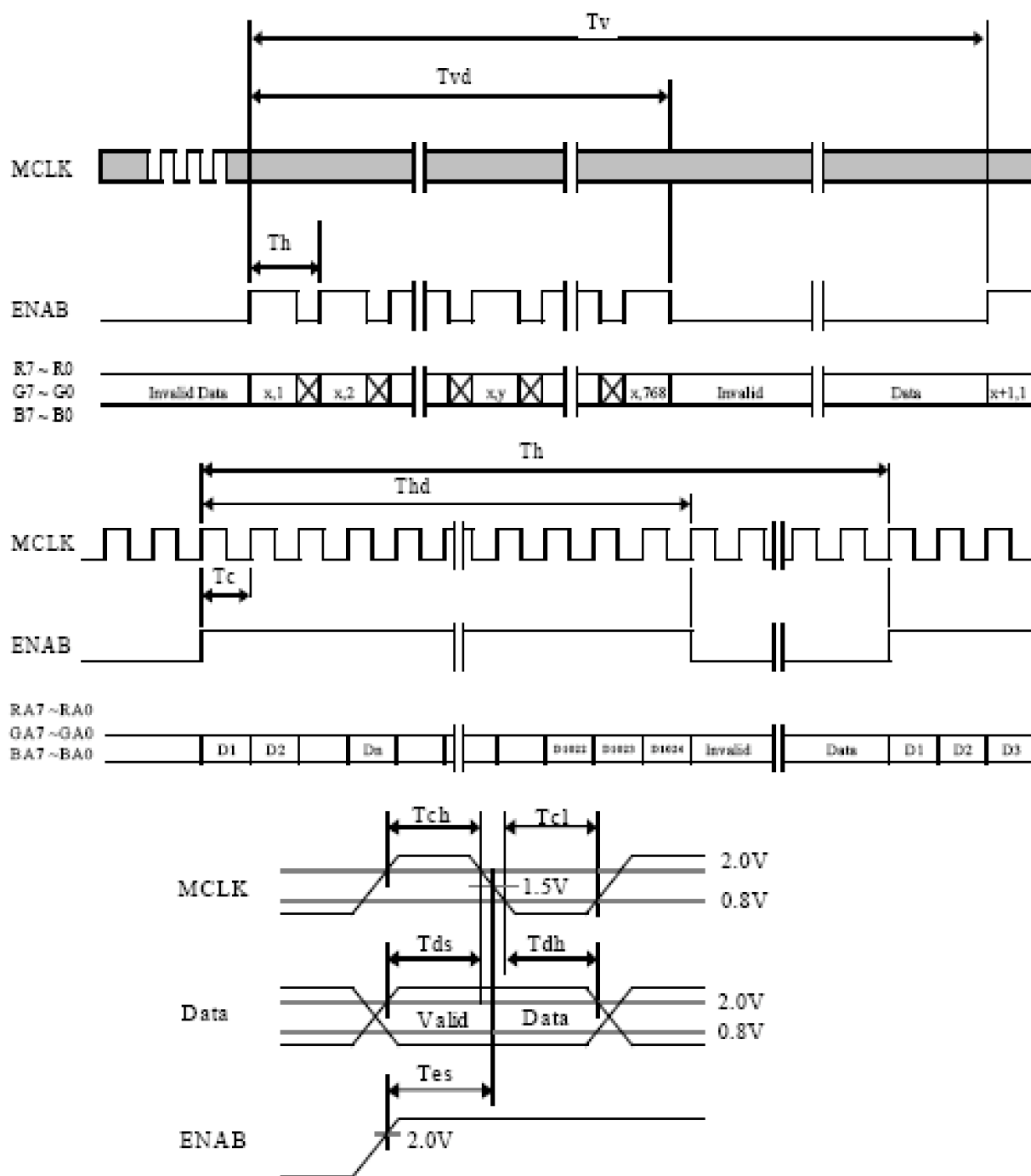
The specification of the LVDS Rx interface timing parameter is listed in below table.

| Item         | Symbol | Min             | Typ         | Max             | Unit | Remark |
|--------------|--------|-----------------|-------------|-----------------|------|--------|
| PLL Set      | tRPLL  | -               | -           | 10.0            | msec |        |
| CLKIN Period | tRICP  | 12.50           | 15.38       | 21.16           | nsec |        |
| Input Data 0 | tRIP0  | -0.4            | 0.0         | +0.4            | nsec |        |
| Input Data 1 | tRIP1  | tRICP/7-0.4     | tRICP/7     | tRICP/7+0.4     | nsec |        |
| Input Data 2 | tRIP2  | 2 × tRICP/7-0.4 | 2 × tRICP/7 | 2 × tRICP/7+0.4 | nsec |        |
| Input Data 3 | tRIP3  | 3 × tRICP/7-0.4 | 3 × tRICP/7 | 3 × tRICP/7+0.4 | nsec |        |
| Input Data 4 | tRIP4  | 4 × tRICP/7-0.4 | 4 × tRICP/7 | 4 × tRICP/7+0.4 | nsec |        |
| Input Data 5 | tRIP5  | 5 × tRICP/7-0.4 | 5 × tRICP/7 | 5 × tRICP/7+0.4 | nsec |        |
| Input Data 6 | tRIP6  | 6 × tRICP/7-0.4 | 6 × tRICP/7 | 6 × tRICP/7+0.4 | nsec |        |



## 7.0 Timing Waveforms Interface Signal

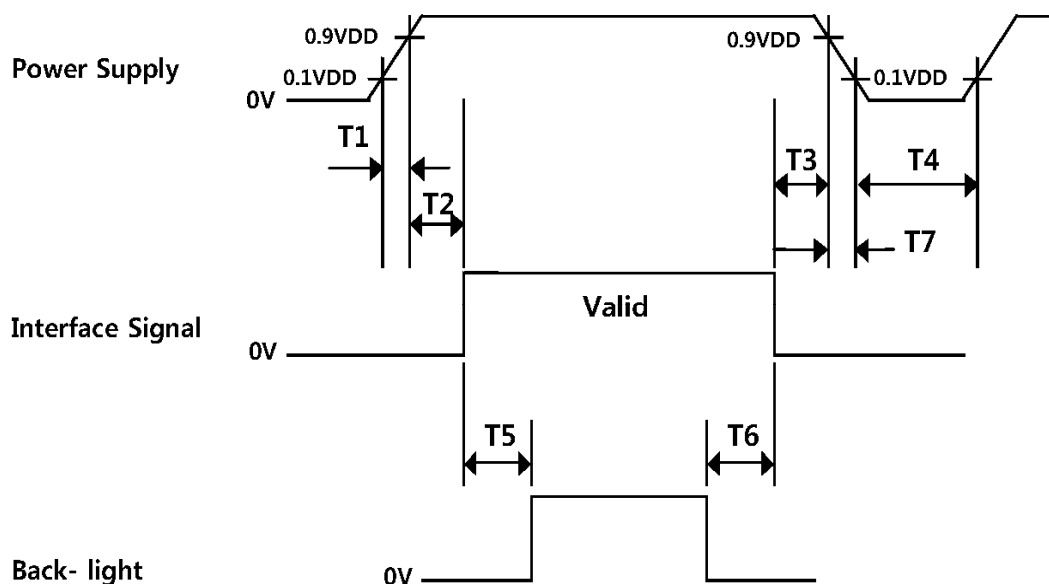
### 7.1 Timing Waveforms



## 8.0 Power Sequence & Block Diagram

### 8.1 Power Sequence

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

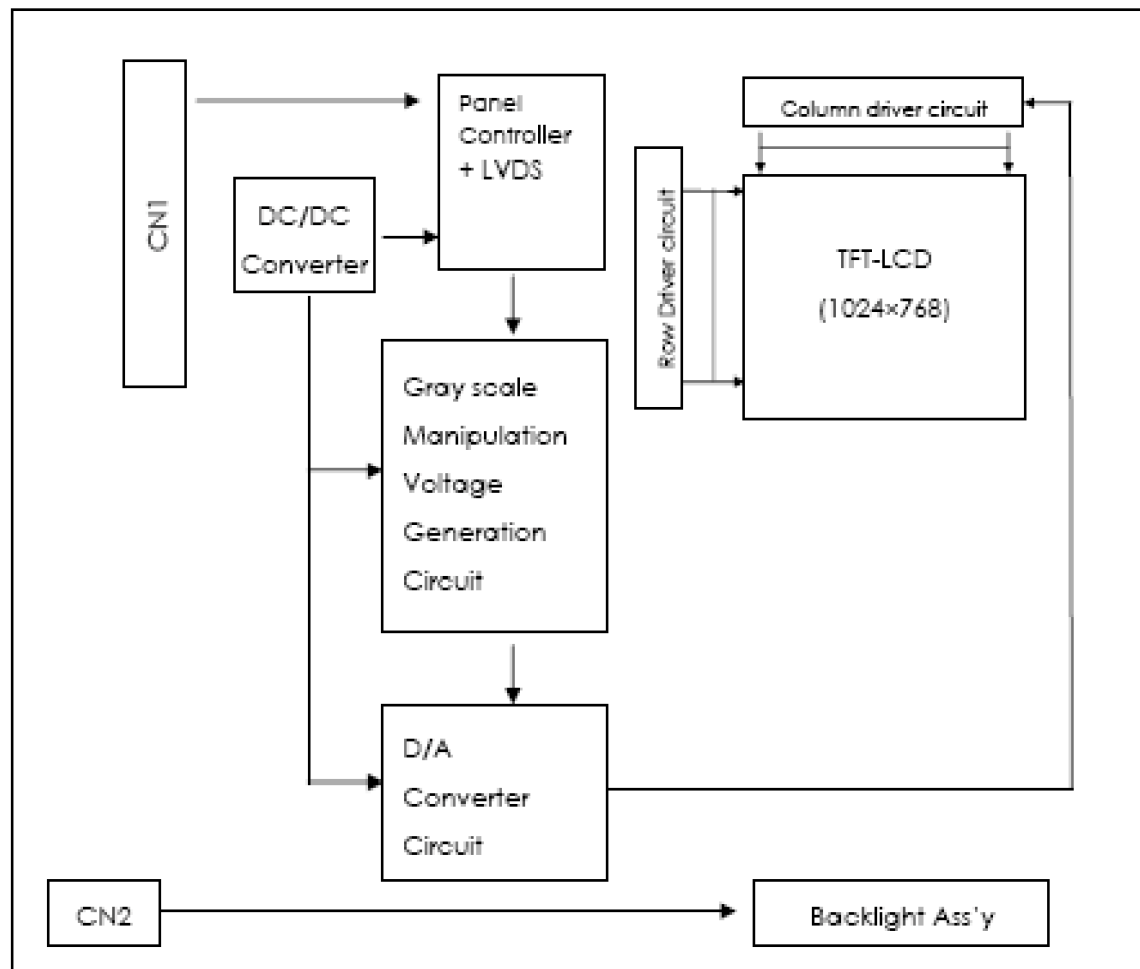


| Parameter | Min | Typ. | Max | Unit |
|-----------|-----|------|-----|------|
| T1        | 0   | -    | 10  | ms   |
| T2        | 0   | -    | 50  | ms   |
| T3        | 0   | -    | 50  | ms   |
| T4        | 1   | -    | -   | sec  |
| T5        | 100 | -    | -   | ms   |
| T6        | 100 | -    | -   | ms   |
| T7        | 0   | -    | 10  | ms   |

#### Notes

1. When the power supply VDD is 0 V, keep the level of input signals on the low or keep high impedance.
2. Do not keep the interface signal high impedance when power is on.  
Back light must be turn on after power for logic and interface signal are valid.

## 8.2 Block Diagram



## 9.0 Input Signals , Basic display colors & Gray scale of colors

Each color is displayed in sixty-four gray scales from a 6 bit data signal input. A total of 262,144 colors are derived from the resultant 18 bit data.

| Colors & Gray Scale         |          | Red Data |    |    |    |    |    | Green Data |    |    |    |    |    | Blue Data |    |    |    |    |    |
|-----------------------------|----------|----------|----|----|----|----|----|------------|----|----|----|----|----|-----------|----|----|----|----|----|
|                             |          | R5       | R4 | R3 | R2 | R1 | R0 | G5         | G4 | G3 | G2 | G1 | G0 | B5        | B4 | B3 | B2 | B1 | B0 |
| Basic Colors                | Black    | 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  | 1         | 1  | 1  | 1  | 1  | 1  |
|                             | Green    | 0        | 0  | 0  | 0  | 0  | 0  | 1          | 1  | 1  | 1  | 1  | 1  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Cyan     | 0        | 0  | 0  | 0  | 0  | 0  | 1          | 1  | 1  | 1  | 1  | 1  | 1         | 1  | 1  | 1  | 1  | 1  |
|                             | Red      | 1        | 1  | 1  | 1  | 1  | 1  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Magenta  | 1        | 1  | 1  | 1  | 1  | 1  | 0          | 0  | 0  | 0  | 0  | 0  | 1         | 1  | 1  | 1  | 1  | 1  |
|                             | Yellow   | 1        | 1  | 1  | 1  | 1  | 1  | 1          | 1  | 1  | 1  | 1  | 1  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | White    | 1        | 1  | 1  | 1  | 1  | 1  | 1          | 1  | 1  | 1  | 1  | 1  | 1         | 1  | 1  | 1  | 1  | 1  |
| Gray Scale 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  | 1  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Darker   | 0        | 0  | 0  | 0  | 1  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | △        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | ▽        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | Brighter | 1        | 1  | 1  | 1  | 0  | 1  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | ▽        | 1        | 1  | 1  | 1  | 1  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Red      | 1        | 1  | 1  | 1  | 1  | 1  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
| Gray Scale 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          | 0  | 0  | 0  | 0  | 1  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Darker   | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 1  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | △        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | ▽        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | Brighter | 0        | 0  | 0  | 0  | 0  | 0  | 1          | 1  | 1  | 1  | 0  | 1  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | ▽        | 0        | 0  | 0  | 0  | 0  | 0  | 1          | 1  | 1  | 1  | 1  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | Green    | 0        | 0  | 0  | 0  | 0  | 0  | 1          | 1  | 1  | 1  | 1  | 1  | 0         | 0  | 0  | 0  | 0  | 0  |
| Gray Scale 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          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 1  |
|                             | Darker   | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 1  | 0  |
|                             | △        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | ▽        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | Brighter | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 1         | 1  | 1  | 1  | 0  | 1  |
|                             | ▽        | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 1         | 1  | 1  | 1  | 1  | 0  |
|                             | Blue     | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 1         | 1  | 1  | 1  | 1  | 1  |
| Gray Scale Of White & Black | Black    | 0        | 0  | 0  | 0  | 0  | 0  | 0          | 0  | 0  | 0  | 0  | 0  | 0         | 0  | 0  | 0  | 0  | 0  |
|                             | △        | 0        | 0  | 0  | 0  | 0  | 1  | 0          | 0  | 0  | 0  | 0  | 1  | 0         | 0  | 0  | 0  | 0  | 1  |
|                             | Darker   | 0        | 0  | 0  | 0  | 1  | 0  | 0          | 0  | 0  | 0  | 1  | 0  | 0         | 0  | 0  | 0  | 1  | 0  |
|                             | △        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | ▽        | ↓        |    |    |    |    |    | ↓          |    |    |    |    |    | ↓         |    |    |    |    |    |
|                             | Brighter | 1        | 1  | 1  | 1  | 0  | 1  | 1          | 1  | 1  | 1  | 0  | 1  | 1         | 1  | 1  | 1  | 0  | 1  |
|                             | ▽        | 1        | 1  | 1  | 1  | 1  | 0  | 1          | 1  | 1  | 1  | 1  | 0  | 1         | 1  | 1  | 1  | 1  | 0  |
|                             | White    | 1        | 1  | 1  | 1  | 1  | 1  | 1          | 1  | 1  | 1  | 1  | 1  | 1         | 1  | 1  | 1  | 1  | 1  |

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## Appendix 1. Reliability Test Condition

<Table. Reliability test condition>

| No | Test Items                                       | Conditions                                                                                       |
|----|--------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1  | High temperature storage test                    | Ta = 80 °C, 240 hrs                                                                              |
| 2  | Low temperature storage test                     | Ta = -30 °C, 240 hrs                                                                             |
| 3  | High temperature & high humidity operation test  | Ta = 50 °C, 85%RH, 240 hrs                                                                       |
| 4  | High temperature operation test                  | Ta = 70 °C, 240hrs(without BLU & TSP)                                                            |
| 5  | Low temperature operation test                   | Ta = -20 °C, 240hrs                                                                              |
| 6  | Thermal shock                                    | Ta = -20 °C ↔ 70 °C (0.5 hr), 100 cycle                                                          |
| 7  | Vibration test<br>(non-operating)                | Gravity / AMP : 1.5G<br>Frequency : 10~300Hz for X,Y,Z axis<br>Period : 30 minutes for each axis |
| 8  | Shock test<br>(non-operating)                    | Gravity : 120G<br>Pulse width : 6ms, half sine wave(X,Y,Z)                                       |
| 9  | Electro-static discharge test<br>(non-operating) | Air : 150 pF, 330Ω, 10 KV<br>Contact : 150 pF, 330Ω, 5 KV                                        |

Note 1. : Low temperature storage test and Low temperature operation test condition is as assembled with heater.

Note 2. : ON/OFF Cycle

TFT Display module will be capable co being operated over 24,000 ON/OFF cycles (as Backlight & Vcc PWR On / Off)

Note 3. : Mean time between Failure

TFT Display module and interface board assembly (excluding the Backlight) shall have a mean time between failures of 35,000 hours with a confidence level 90%

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## Appendix 2. Handling & Cautions

### (1) Cautions when taking out the module

- Pick the pouch only, when taking out module from a shipping package.

### (2) Cautions for handling the module

- As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
- As the LCD panel and back - light element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
- As the surface of the polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
- Do not pull the interface connector in or out while the LCD module is operating.
- Put the module display side down on a flat horizontal plane.
- Handle connectors and cables with care.

### (3) Cautions for the operation

- When the module is operating, do not lose CLK, ENAB signals. If any one of these signals is lost, the LCD panel would be damaged.
- Obey the supply voltage sequence. If wrong sequence is applied, the module would be damaged.

### (4) Cautions for the atmosphere

- Dew drop atmosphere should be avoided.
- Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.

### (5) Cautions for the module characteristics

- Do not apply fixed pattern data signal to the LCD module at product aging.
- Applying fixed pattern for a long time may cause image sticking.

### (6) Other cautions

- Do not disassemble and/or re-assemble LCD module.
- Do not re-adjust variable resistor or switch etc.
- When returning the module for repair or etc., Please pack the module not to be broken. We recommend to use the original shipping packages.