



## ENH150X1-200/300 Color TFT-LCD Module Features

### GENERAL DESCRIPTION

Panelview provides optically enhanced solutions to the standard Sharp LQ150X1DG16 color active matrix LCD module. The first enhancement is an index matching (IM) film lamination to the front surface of the display polarizer. The IM film is available in two surface treatments - IM/Clear and IM/110 (a 10% diffusion). The second enhancement is the incorporation of a reflective polarizer (RP) providing for up to 40% increase in brightness.

This module is composed of a color TFT-LCD panel, driver ICs, control circuit, power supply circuit and a backlight unit. Graphics and text can be displayed on a 1024 x 3 x 768 dot panel with 262, 144 color by supplying 36-bit data signal (6bit x 2 pixel x RGB), four timing signals, +5V DC supply voltage for TFT-LCD panel driving and supply voltage for backlight.

It is a wide viewing-angle-module (Vertical viewing angle: 120° Horizontal viewing angle: 140°).

Input signal timing conforms with 75Hz mode of VESA standard.

Panelview assumes no responsibility for any damage resulting from the use of the device which does not comply with the instructions and the precautions specified in these specification sheets. Panelview does assume the responsibility for the warranty of the enhanced product.

### MECHANICAL SPECIFICATIONS

| Parameter                   | Specifications                              | Units |
|-----------------------------|---------------------------------------------|-------|
| Display size                | 38 Diagonal                                 | cm    |
|                             | 15.0 Diagonal                               | inch  |
| Active area                 | 304.1 (H) x 228.1 (V)                       | mm    |
| Pixel format                | 1024 (H) x 768 (V)                          | pixel |
|                             | (1 pixel=R=G=B dots)                        | -     |
| Pixel pitch                 | 0.297 (H) x 0.297 (V)                       | mm    |
| Pixel configuration         | R,G,B vertical stripe                       | -     |
| Display mode                | Normally white                              | -     |
| Unit outline dimensions (1) | 335 (W) x 257.9 (H) x 15.9(D)               | mm    |
| Mass                        | 1400 (max)                                  | g     |
| Surface treatment           | IM/Clear (glossy) or IM/110 and hardcoat 3H | -     |

Note:

1. Excluding backlight cables.  
The thickness of module (D) does not contain the projection
2. Outline dimensions are shown in Fig 1.



## INPUT TERMINALS

### TTL-LCD Panel Driving

CN1      The module-side connector      :FX8-60S-SV (Hirose Electric Co., Ltd.)  
            The user-side connector      :FX8-60S-SV (Hirose Electric Co., Ltd.)

| Pin No. | Symbol | Function                     |
|---------|--------|------------------------------|
| 1       | GND    | GND                          |
| 2       | RB0    | RED even data signal (LSB)   |
| 3       | RB1    | RED even data signal         |
| 4       | RB2    | RED even data signal         |
| 5       | RB3    | RED even data signal         |
| 6       | RB4    | RED even data signal         |
| 7       | RB5    | RED even data signal (MSB)   |
| 8       | GND    | GND                          |
| 9       | GB0    | GREEN even data signal (LSB) |
| 10      | GB1    | GREEN even data signal       |
| 11      | GB2    | GREEN even data signal       |
| 12      | GB3    | GREEN even data signal (LSB) |
| 13      | GB4    | GREEN even data signal       |
| 14      | GB5    | GREEN even data signal       |
| 15      | GND    | GND                          |
| 16      | BB0    | BLUE even data signal (LSB)  |
| 17      | BB1    | BLUE even data signal        |
| 18      | BB2    | BLUE even data signal        |
| 19      | BB3    | BLUE even data signal        |
| 20      | BB4    | BLUE even data signal        |
| 21      | BB5    | BLUE even data signal (MSB)  |
| 22      | GND    | GND                          |
| 23      | RA0    | RED odd data signal (LSB)    |
| 24      | RA1    | RED odd data signal          |
| 25      | RA2    | RED odd data signal          |
| 26      | RA3    | RED odd data signal          |
| 27      | RA4    | RED odd data signal          |
| 28      | RA5    | RED odd data signal (MSB)    |
| 29      | GND    | GND                          |
| 30      | GA0    | GREEN odd data signal (LSB)  |
| 31      | GA1    | GREEN odd data signal        |
| 32      | GA2    | GREEN odd data signal        |
| 33      | GA3    | GREEN odd data signal (LSB)  |
| 34      | GA4    | GREEN odd data signal        |
| 35      | GA5    | GREEN odd data signal        |
| 36      | GND    | GND                          |
| 37      | BA0    | BLUE odd data signal (LSB)   |
| 38      | BA1    | BLUE odd data signal         |
| 39      | BA2    | BLUE odd data signal         |
| 40      | BA3    | BLUE odd data signal         |



continued

| Pin No. | Symbol            | Function                                                      |
|---------|-------------------|---------------------------------------------------------------|
| 41      | BA4               | BLUE odd data signal                                          |
| 42      | BA5               | BLUE odd data signal (MSB)                                    |
| 43      | GND               | GND                                                           |
| 44      | GND               | GND                                                           |
| 45      | GND               | GND                                                           |
| 46      | V <sub>SYNC</sub> | Vertical synchronous signal                                   |
| 47      | H <sub>SYNC</sub> | Horizontal synchronous signal                                 |
| 48      | ENAB              | Data enable signal (Signal to settle the display position)(1) |
| 49      | GND               | GND                                                           |
| 50      | GND               | GND                                                           |
| 51      | CKB               | Clock B signal for sampling even data signal                  |
| 52      | CKA               | Clock A signal for sampling odd data signal                   |
| 53      | GND               | GND                                                           |
| 54      | GND               | GND (Reserve)                                                 |
| 55      | GND               | GND (Reserve)                                                 |
| 56      | MODE              | Timing signal select (1)                                      |
| 57      | V <sub>CC</sub>   | +5V power supply                                              |
| 58      | V <sub>CC</sub>   | +5V power supply                                              |
| 59      | V <sub>CC</sub>   | +5V power supply                                              |
| 60      | V <sub>CC</sub>   | +5V power supply                                              |

Note:

\*The shielding case is connected with GND. in the module

- In case MODE is fixed "Low", the display start timing is determined by V<sub>SYNC</sub> and ENAB.  
The vertical display start position and horizontal display start position are determined as described on page 6. Do not keep ENAB "high" during operation.  
In case MODE is fixed on "High" or "Open", the display start timing is determined by only ENAB.

## BACKLIGHT DRIVING

CN2, CN3 The module-side connector: BHR-03VS-1(JST)  
The user-side connector SM02(8.0)B-BHS(JST)

| Pin No. | Symbol            | Function                                  |
|---------|-------------------|-------------------------------------------|
| 1       | V <sub>HIGH</sub> | Power supply for lamp (High voltage side) |
| 2       | NC                | This is electrically opened               |
| 3       | V <sub>LOW</sub>  | Power supply for lamp (Low voltage side)  |

## ABSOLUTE MAXIMUM RATINGS

| Parameter                          | Symbol           | Condition            | Ratings    | Unit |
|------------------------------------|------------------|----------------------|------------|------|
| Input voltage (1)                  | V <sub>I</sub>   | t <sub>A</sub> =25°C | -0.3~ +5.5 | V    |
| +5.0V Supply voltage               | V <sub>CC</sub>  | t <sub>A</sub> =25°C | 0~ +6      | V    |
| Storage temperature (2)            | t <sub>STG</sub> | -                    | -25~ +60   | °C   |
| Operating temperature (Ambient)(2) | T <sub>OPA</sub> | -                    | 0~ +50     | °C   |

Notes:

- CKA, CKB, RAO~RA5, GA0~GA5, BA0~BA5, RB0~RB5, GB0~GB5, BB0~BB5, H<sub>SYNC</sub>, V<sub>SYNC</sub>, ENAB, MODE
- Humidity: 95%RH Max. at t<sub>A</sub> ≤ 40°C. Maximum wet-bulb temperature at 39°C or less at t<sub>A</sub> ≤ 40°C. No condensation.



## ELECTRICAL CHARACTERISTICS

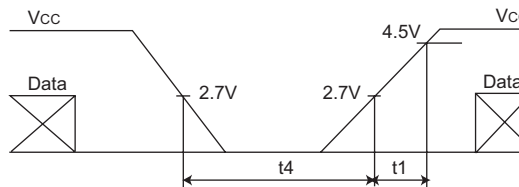
TFT-LCD PANEL DRIVING,  $t_a=25^\circ\text{C}$

| Parameter                       | Symbol              | MIN  | TYP  | MAX      | Unit          | Remarks               |
|---------------------------------|---------------------|------|------|----------|---------------|-----------------------|
| $V_{CC}$                        | Supply voltage      | +4.5 | +5.0 | +5.5     | V             | (1)                   |
|                                 | Current dissipation | -    | 300  | 450      | mA            | (2)                   |
| Permissive input ripple voltage | $V_{RF}$            | -    | -    | 100      | mVp-p         | $V_{CC}=+5.0\text{V}$ |
| Input voltage (Low)             | $V_{IL}$            | GND  | -    | 0.6      | V             | (3)                   |
| Input voltage (High)            | $V_{IH}$            | 2.6  | -    | $V_{CC}$ | V             |                       |
| Input current (Low)             | $I_{IL}$            | -    | -    | 10       | $\mu\text{A}$ | $V_I=\text{GND}$ (3)  |
|                                 |                     | -    | -    | 400      | $\mu\text{A}$ | $V_I=\text{GND}$ (4)  |
| Input current (High)            | $I_{IH}$            | -    | -    | 10       | $\mu\text{A}$ | $V_I=V_{CC}$ (3)      |
|                                 |                     | -    | -    | 600      | $\mu\text{A}$ | $V_I=V_{CC}$ (4)      |

3.3(v) logic is recommended as input signals.

Notes:

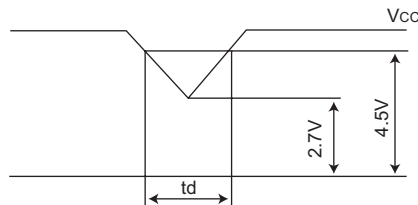
- On-Off conditions for supply voltage  
 $0 < t_1 \leq 10\text{ms}$   
 $t_4 \geq 1\text{s}$



$V_{CC}$ -dip conditions

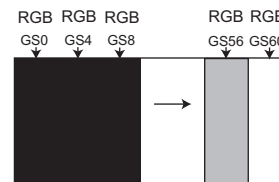
- $2.7\text{V} \leq V_{CC} < 4.5\text{V}$   
 $t_d \leq 10\text{ms}$
- $V_{CC} < 2.7\text{V}$

$V_{CC}$ -dip conditions should also follow the  $V_{CC}$ -turn-on conditions



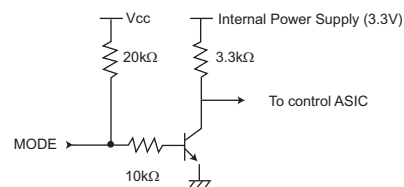
- Typical current situation: 16-gray-bar pattern  
 $V_{CC}=+5.0\text{V}$ ,  
Gray scale: GS(4n)  
 $n=0\sim 15$

The explanation of each gray scale, GS(4n), is described on page 10.



- CKA, CKB, RAO~RA5, GA0~GA5, BA0~BA5, RB0~RB5, GB0~GB5, BB0~BB5,  
 $H_{SYNC}$ ,  $V_{SYNC}$ , ENAB

- MODE  
Input circuit of MODE is shown in right figure.





## BACKLIGHT DRIVING SECTION

The backlight system is an edge-lighting type with single CCFT (Cold Cathode Fluorescent Tube).

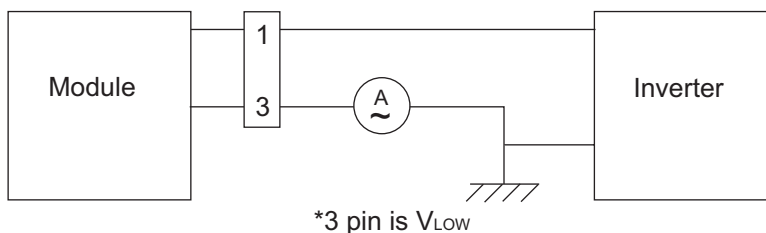
The characteristics of a single lamp are shown in the following table.  $t_A=25^{\circ}\text{C}$

The value mentioned below is at the case of one CCFT.

| Parameter              | Symbol | MIN   | TYP | MAX  | Unit              | Remark                      |
|------------------------|--------|-------|-----|------|-------------------|-----------------------------|
| Lamp current           | $I_L$  | 2.5   | 6.0 | 6.5  | mA <sub>rms</sub> | (1)                         |
| Lamp voltage           | $V_L$  | -     | 690 | -    | V <sub>rms</sub>  | $t_A=25^{\circ}\text{C}$    |
| Lamp power consumption | $P_L$  | -     | 4.1 | -    | W                 | (2)                         |
| Lamp frequency         | $F_L$  | 20    | 60  | 70   | KHz               | (3)                         |
| Kickoff voltage        | $V_s$  | -     | -   | 850  | V <sub>rms</sub>  | $t_A=25^{\circ}\text{C}$    |
|                        |        | -     | -   | 1450 | V <sub>rms</sub>  | $t_A=0^{\circ}\text{C}$ (4) |
| Lamp life time         | $L_L$  | 50000 | -   | -    | hour              | (5)                         |

Notes:

1. A lamp can be lit in the range of the lamp current shown above.  
Maximum rating for current is measured by high frequency current measurement equipment connected to VLOW at circuit shown below. (Note: To keep enough kick-off voltage and necessary steady voltage for CCFT.)  
Lamp frequency: 20~60kHz  
Ambient temperature: 0~50°C



2. Referential data per one CCFT by calculation ( $I_L \times V_L$ ).  
The data does not include loss at inverter.
3. Lamp frequency of inverter may produce interference with horizontal synchronous frequency, and this may cause horizontal beat on the display. Therefore, adjust lamp frequency keep inverter far from module or use electronic shielding between inverter and module to avoid interference.
4. The voltage above this value should be applied to the lamp for more than 1 second to startup. Otherwise, the lamp may not be turned on.
5. Lamp life time is defined as the time when either (1) or (2) under the continuous operation under the condition of  $t_A=25^{\circ}\text{C}$  and  $I_L=6.0 \pm 0.5\text{mA}_{rms}$ 
  1. Brightness becomes 50% of the original value under standard condition.
  2. Kick-off voltage at  $t_A=0^{\circ}\text{C}$  exceeds maximum value, 1450 V<sub>rms</sub>.

The performance of the backlight, for example life time or brightness, is influenced by the characteristics of the DC-AC inverter for the lamp. When designing or ordering the inverter, make sure that poor lighting caused by the mismatch of the backlight and the inverter (mis-lighting, flicker, etc.) do not occur. Once this is confirmed, the module should be operated in the same condition as it is installed in the instrument.



## TIMING CHARACTERISTICS OF INPUT SIGNALS

### H-V mode (MODE = "Low")

Timing diagrams of input signal are shown in Fig. 2

### TIMING CHARACTERISTICS

| Parameter Clock                            |             | Symbol          | Min. | Typ. | Max.      | Unit    |
|--------------------------------------------|-------------|-----------------|------|------|-----------|---------|
| Clock A<br>Clock B                         | Frequency   | $1/T_C$         | 25   | 32.5 | 40        | MHz     |
|                                            | High Time   | $T_{CH}$        | 9    | -    | -         | ns      |
|                                            | Low Time    | $T_{CL}$        | 9    | -    | -         | ns      |
|                                            | Duty ratio  | $T_{CH}/T_{CL}$ | 0.67 | 1.00 | 1.50      | -       |
| Data                                       | Set up time | $T_{DS}$        | 8    | -    | -         | ns      |
|                                            | Hold time   | $T_{DH}$        | 8    | -    | -         | ns      |
| Horizontal sync.<br>signal                 | Cycle       | TH              | 16.6 | 20.7 | -         | $\mu$ s |
|                                            |             |                 | 528  | 672  | 860       | clock   |
|                                            | Pulse width | $TH_P$          | 2    | 68   | -         | clock   |
| Horizontal display start                   |             | $TH_{BP}$       | -    | 148  | -         | clock   |
| $H_{SYNC}$ -Clock phase difference         |             | $TF_C$          | 5    | -    | -         | ns      |
| Vertical sync. signal                      | Cycle       | TV              | -    | 16.7 | -         | ms (1)  |
|                                            |             |                 | 773  | 806  | 990       | line    |
|                                            | Pulse width | $TV_P$          | 1    | 6    | -         | line    |
| Vertical data start start                  |             | $TV_{BP}$       | 35   | 35   | 35        | line    |
| $H_{SYNC}$ - $V_{SYNC}$ . phase difference |             | $TV_H$          | 1    | -    | $TH-TH_P$ | clock   |

Notes: 1. In case of lower frequency, deterioration of the display quality, flicker, etc. may occur.

## HORIZONTAL DISPLAY POSITION

The horizontal display position is determined by ENAB signal and the input data corresponding to the rising edge ENAB signal is displayed at the left end of the active area.

| Parameter                                  |             | Symbol   | MIN        | TYP | MAX      | Unit  |
|--------------------------------------------|-------------|----------|------------|-----|----------|-------|
| Enable signal                              | Set-up time | $T_{ES}$ | 8          | -   | $T_C-10$ | ns    |
|                                            | Pulse width | $T_{EP}$ | 10         | 512 | 512      | clock |
| $H_{SYNC}$ -enable signal phase difference |             | $TH_E$   | $TH_P + 1$ | 148 | $TH-512$ | clock |

Do not keep ENAB "Low" during operation.

## VERTICAL DISPLAY POSITION

The vertical display position is the 35th line from the falling edge of  $V_{SYNC}$  (Fig. 2)

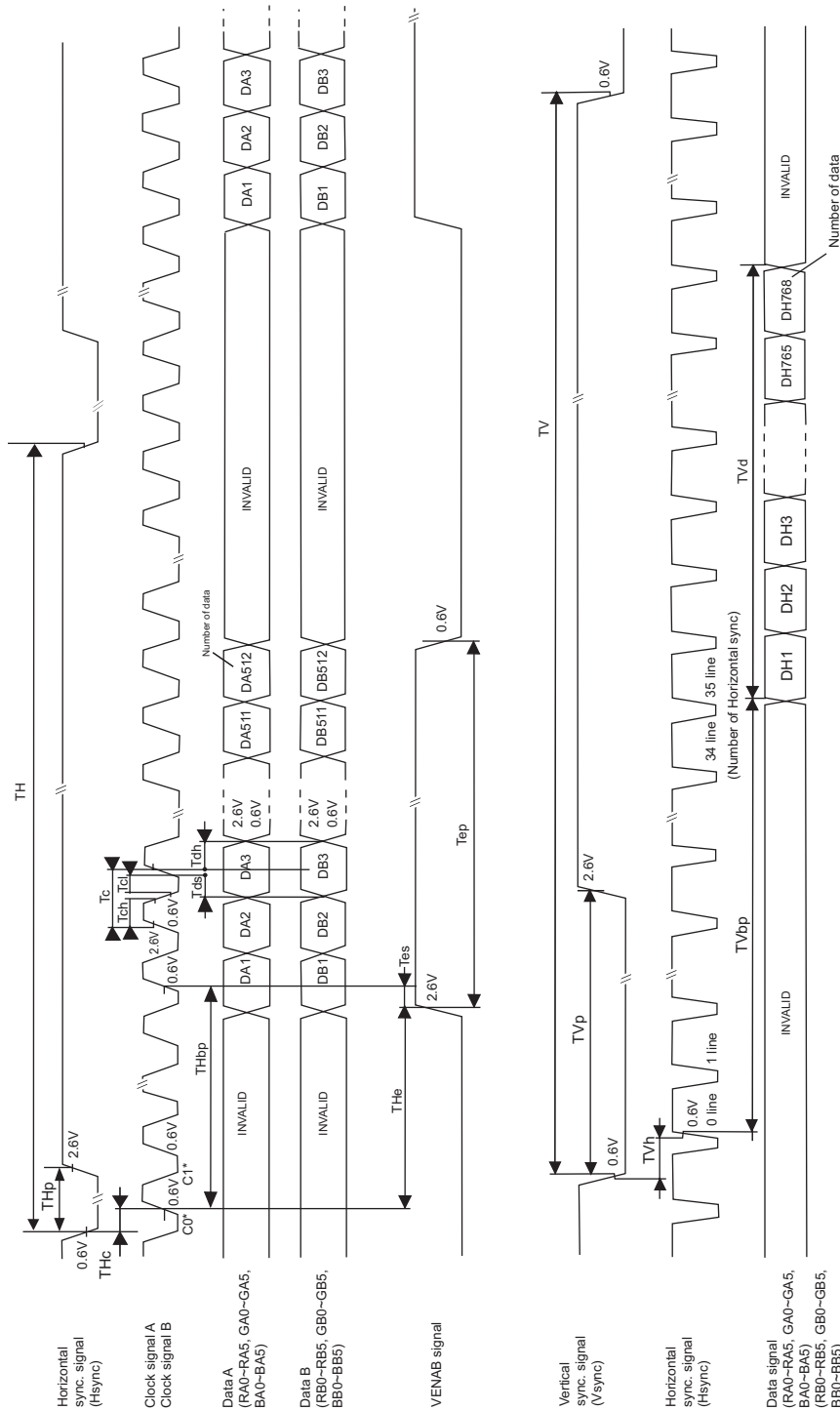


Fig 2 Input Signal Waveforms (H-V Mode)



## ENAB mode (MODE - "High" or "Open")

Timing diagrams of input signal are shown in Fig. 3

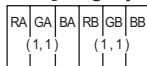
### TIMING CHARACTERISTICS

| Parameter               |                   | Symbol  | Min. | Typ. | Max.  | Unit  |
|-------------------------|-------------------|---------|------|------|-------|-------|
| Clock A<br>Clock B      | Frequency         | I/Tc    | 25   | 32.5 | 40    | MHz   |
|                         | Hi time           | Tch     | 9    | -    | -     | ns    |
|                         | Low time          | Tcl     | 9    | -    | -     | -     |
|                         | Duratio           | TcW Tcl | 0.67 | 1.00 | 1.50  | -     |
| Data                    | Se time           | Tds     | 8    | -    | -     | ns    |
|                         | Hold time         | Tdh     | 8    | -    | -     | us    |
| Data enable<br>signal   | Setup time        | Tes     | 8    | -    | Tc 10 | ns    |
|                         | Horizontal period | TH      | 16.6 | 20.7 | -     | U s   |
|                         |                   |         | 528  | 672  | 860   | clock |
|                         | Horizontal period | THp     | 10   | 512  | 512   | clock |
|                         | Vertical period   | TV      | 770  | 806  | 990   | line  |
| Vertical blanking width | TVb               | 2       | 38   | 222  | line  |       |

Note: If using an extended vertical period, the deterioration of display quality, flicker, etc. may occur.

## Input Data Signals and Display Position on the Screen

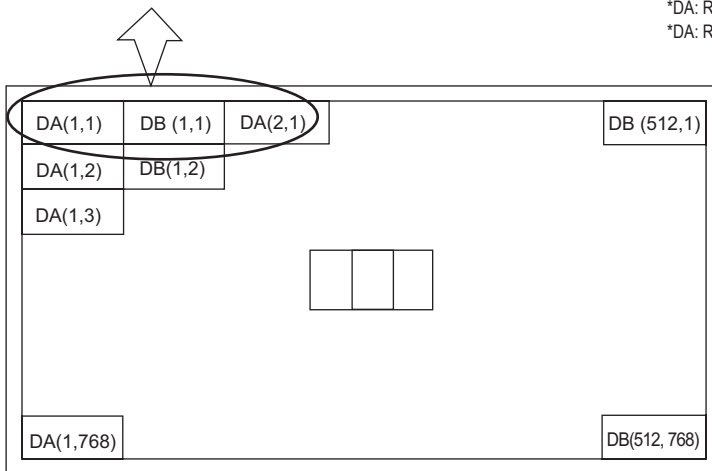
Graphics and text can be displayed at 1024 x 3 x 768 dots on a panel with 262, 144 colors by supplying 36 bit data signal (6bit/color [64 gray scale] x 3 x 2 pixel).



Two pixel-data are sampled at the same time.

\*DA: RA0~RA5, GA0~GA5, BA0~BA5

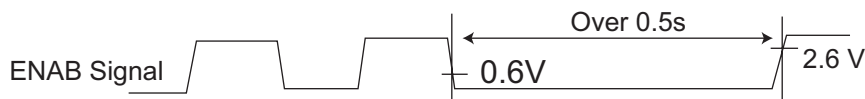
\*DB: RB0~RB5, GB0~GB5, BB0~BB5



Display position of Input data (H,Y)

## Sleep Mode

This LCD module stops operation, and the picture of the LCD module becomes completely white, if ENAB signal stays "Low" for over 0.5 sec. Follow the above input signal timing for normal operation.



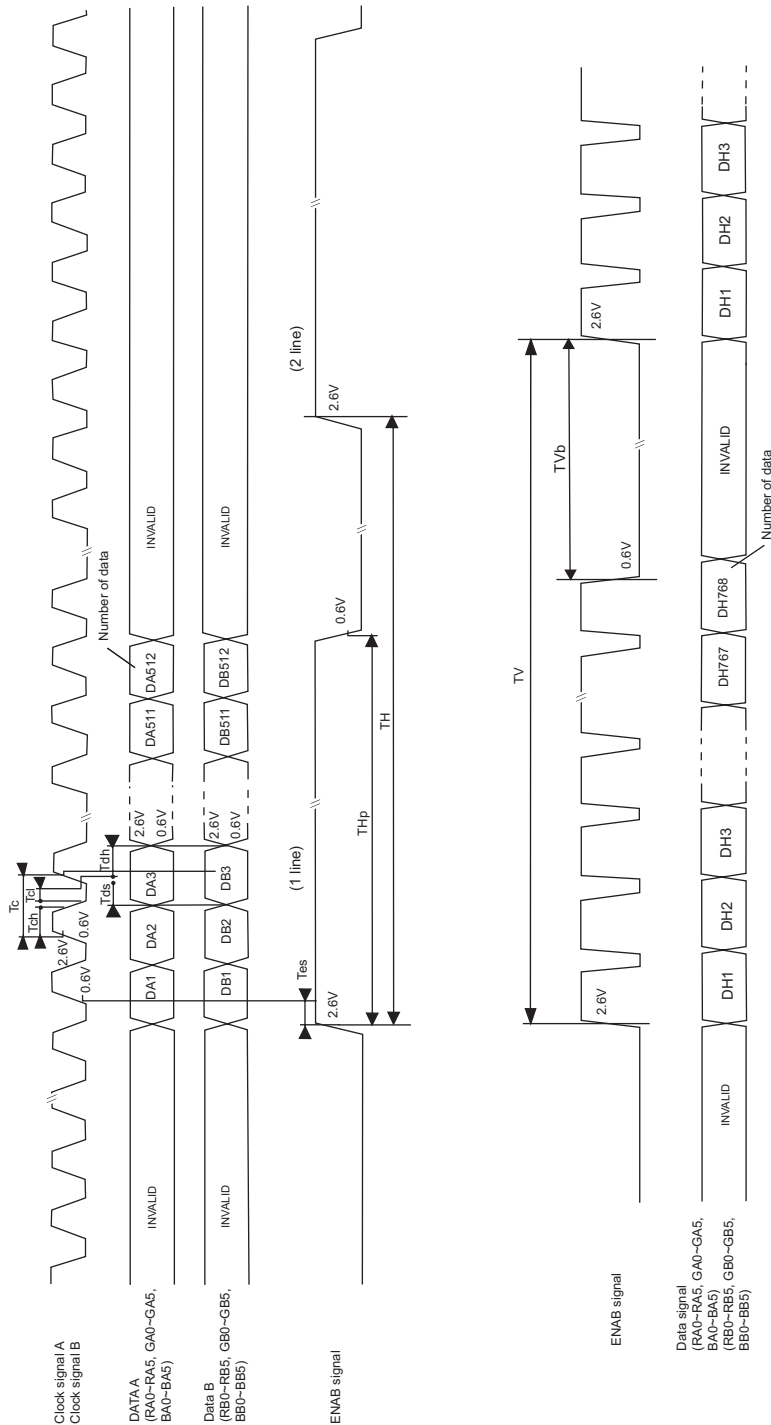


Fig 3 Input Signal Waveforms (ENAB Mode)



## INPUT SIGNALS, BASIC DISPLAY COLORS AND GRAY SCALE OF EACH COLOR

|                     | Colors & Grayscale | Data signal |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---------------------|--------------------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                     |                    | Gray Scale  | RA0 | RA1 | RA2 | RA3 | RA4 | RA5 | GA6 | GA7 | GA2 | GA3 | GA4 | GA5 | BA0 | BA1 | BA2 | BA3 | BA4 | BA5 |
|                     |                    |             | RB0 | RB1 | RB2 | RB3 | RB4 | RB5 | GB6 | GB7 | GB2 | GB3 | GB4 | GB5 | BB0 | BB1 | BB2 | BB3 | BB4 | BB5 |
| Basic Color         | 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   | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   |
|                     | Cyan               | -           | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
|                     | Red                | -           | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | Magenta            | -           | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   |
|                     | Yellow             | -           | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 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              | GS0         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | ↑<br>Darker        | GS1         | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | GS2         | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | ↓           |     |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     | ↓   |     |     |     |
|                     | ↓<br>Brighter      | ↓           |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     |     | ↓   |     |     |     |
|                     |                    | GS250       | 1   | 0   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | GS251       | 0   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | Red                | GS252       | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| Gray Scale of Green | Black              | GS0         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | ↑<br>Darker        | GS1         | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | GS2         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | ↓           |     |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     | ↓   |     |     |     |
|                     | ↓<br>Brighter      | ↓           |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     |     | ↓   |     |     |     |
|                     |                    | GS250       | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | GS251       | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | Green              | GS252       | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   |
| Gray Scale of Blue  | Black              | GS0         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                     | ↑<br>Darker        | GS1         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 0   |
|                     |                    | GS2         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   |
|                     |                    | ↓           |     |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     | ↓   |     |     |     |
|                     | ↓<br>Brighter      | ↓           |     |     | ↓   |     |     |     |     | ↓   |     |     |     |     |     |     | ↓   |     |     |     |
|                     |                    | GS250       | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 1   | 1   | 1   | 1   |
|                     |                    | GS251       | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   |
|                     | Blue               | GS252       | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 1   |

Notes:

- 0: Low level voltage 1: High level voltage.
- Each basic color can be displayed in 64 gray scales from 6 bit data signals.
- According to the combination of total 18 bit data signals, the 262, 144-color display can be achieved on the screen.



## OPTICAL CHARACTERISTICS

$t_A=25^{\circ}\text{C}$ ,  $V_{CC}=+5\text{V}$

| Parameter                                |            | Symbol          | Condition | Min        | Typ        | Max    | Unit              | Remarks                        |
|------------------------------------------|------------|-----------------|-----------|------------|------------|--------|-------------------|--------------------------------|
| Viewing Angle Range                      | Horizontal | θ21, θ22        | CR≥5      | 60         | 70         | -      | Deg.              | (1, 4)                         |
|                                          | Vertical   | θ11             |           | 45         | 60         | -      | Deg.              |                                |
|                                          |            | θ12             |           | 50         | 60         | -      | Deg.              |                                |
| Contrast Ratio                           |            | CRn             | θ = 0°    | 200        | 300        | -      | -                 | (2, 4)                         |
| Response Time                            | Rise       | tr              |           | -          | 10         | 25     | ms                | (3, 4)                         |
|                                          | Decay      | td              |           | -          | 35         | 50     | ms                |                                |
| Chromaticity of White                    |            | x               |           | 0.283      | 0.313      | 0.343  | -                 | (4)                            |
|                                          |            | y               |           | 0.299      | 0.329      | 0.359  | -                 |                                |
| Chromaticity of Red                      |            | x               |           | 0.549      | 0.578      | 0.608  | -                 | (4)                            |
|                                          |            | y               |           | 0.302      | 0.332      | 0.362  | -                 |                                |
| Chromaticity of Green                    |            | x               |           | 0.280      | 0.310      | 0.340  | -                 | (4)                            |
|                                          |            | y               |           | 0.520      | 0.550      | 0.580  | -                 |                                |
| Chromaticity of Blue                     |            | x               |           | 0.123      | 0.153      | 0.183  | -                 | (4)                            |
|                                          |            | y               |           | 0.100      | 0.130      | 0.160  | -                 |                                |
| Luminance of white<br>IM, film<br>IM, RP |            | Y <sub>LI</sub> |           | 150<br>200 | 200<br>300 | -<br>- | cd/m <sup>2</sup> | IL=6.0mA <sub>rms</sub><br>(4) |
| White Uniformity                         |            | δw              |           | -          | -          | 1.35   | -                 | (5)                            |

Notes:

- The measurements shall be executed 30 minutes after lighting at rating. (typical condition:  $I_L=6\text{mA}_{rms}$ ) The optical characteristics shall be measured in a dark room or equivalent state with the method shown in Fig. 4 below.

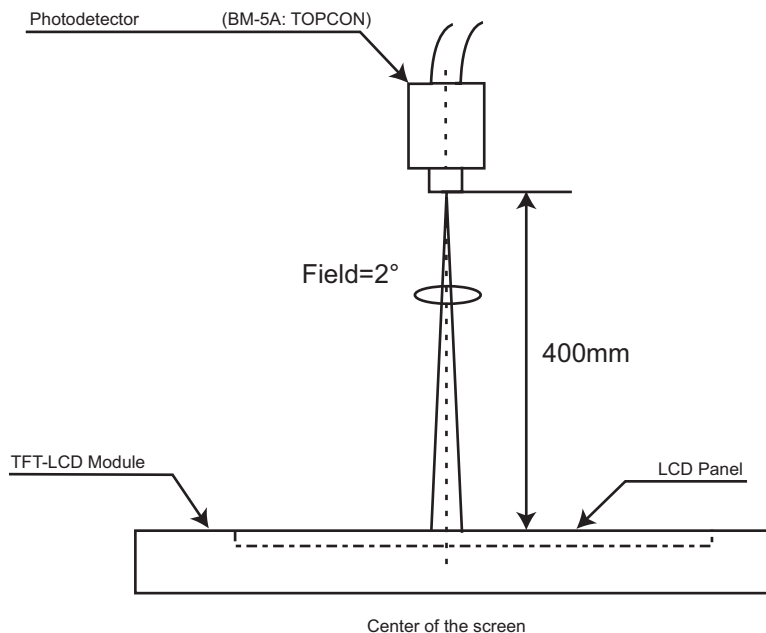
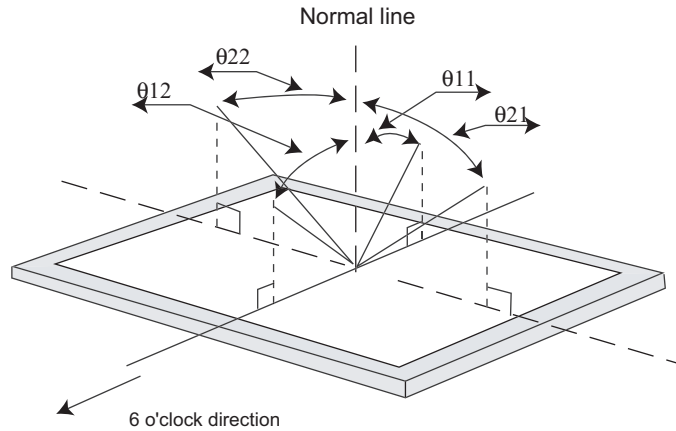


Fig. 4. Optical Characteristics Measurement Method



Notes:

1. Definition of viewing angle range:

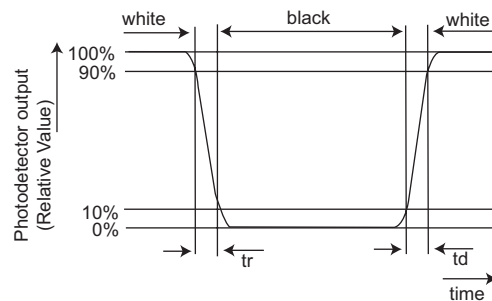


2. Definition of contrast ratio

$$\text{Contrast Ratio (CR)} = \frac{\text{Luminance (brightness) with all pixels white}}{\text{Luminance (brightness) with all pixels black}}$$

3. Definition of response time

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



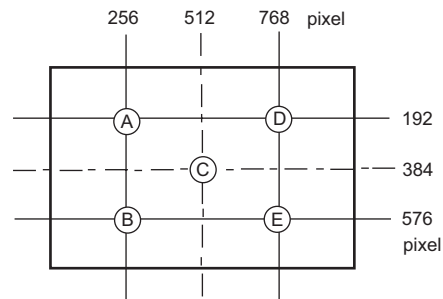
4. This shall be measured at the center of the screen.

5. Definition of white uniformity:

White uniformity is defined as the following with five measurements.

(A-E).

$$\sigma_w = \frac{\text{Maximum Luminance of five points (brightness)}}{\text{Minimum Luminance of five points (brightness)}}$$





## HANDLING PRECAUTIONS

1. Be sure to turn off the power supply when inserting or disconnecting the cable.
2. Be sure to design the cabinet so that the module can be installed without any extra stress such as warp or twist.
3. Since the front polarizer is easily damaged, pay attention not to scratch it.
4. Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
5. When the panel surface is soiled, wipe it with absorbent cotton or other soft cloth.
6. Since the panel is made of glass, it may break crack or internal wire breaking if dropped or bumped on hard surface. Handle with care.
7. Since CMOS LSI is used in this module, take care of static electricity and injure the human earth when handling.
8. This module has its circuitry PCBs on the rear side and should be carefully handled in order not to be stressed.
9. When designing the cabinet, take into consideration the access to the backlight assembly.
10. When some pressure is added onto the module from rear side constantly, it causes display non-uniformity issues, functional defect, etc. Such a design should be avoided.

## RELIABILITY TEST ITEMS

| No. | Test items                                        | Conditions                                                                         |                                                                                                                                                                     |
|-----|---------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | High temperature storage test                     | $t_A=60^{\circ}\text{C}$                                                           | 240h                                                                                                                                                                |
| 2   | Low temperature storage test                      | $t_A=-25^{\circ}\text{C}$                                                          | 240h                                                                                                                                                                |
| 3   | High temperature and high humidity operating test | $t_A=40^{\circ}\text{C}$ , 95%RH<br>(No condensation)                              | 240h                                                                                                                                                                |
| 4   | High temperature operating test                   | $t_A=50^{\circ}\text{C}$ (The panel temp. must be less than $60^{\circ}\text{C}$ ) | 240h                                                                                                                                                                |
| 5   | Low temperature operating test                    | $t_A=0^{\circ}\text{C}$                                                            | 240h                                                                                                                                                                |
| 6   | Vibration Test<br>(Non-operating)                 | Frequency<br><br>Sweep time<br>Test Period                                         | :10~57Hz/Vibration width (one side): 0.075mm<br>:58~500Hz/Gravity: 9.8m/s <sup>2</sup><br>:11 minutes, sine wave<br>:3 hours (1 hour for each direction of X, Y, Z) |
| 7   | Shock test<br>(non-operating)                     | Max gravity<br>Pulse width<br>Direction                                            | :490m/s <sup>2</sup><br>:11 minutes, half sine wave<br>:±X, ±Y, ±Z (once for each direction.)                                                                       |

(Result Evaluation Criteria)

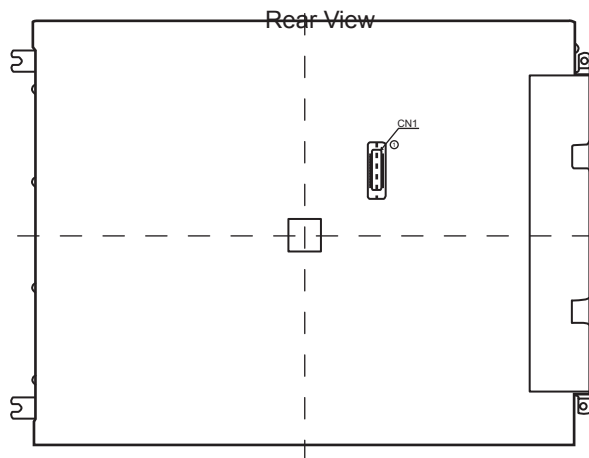
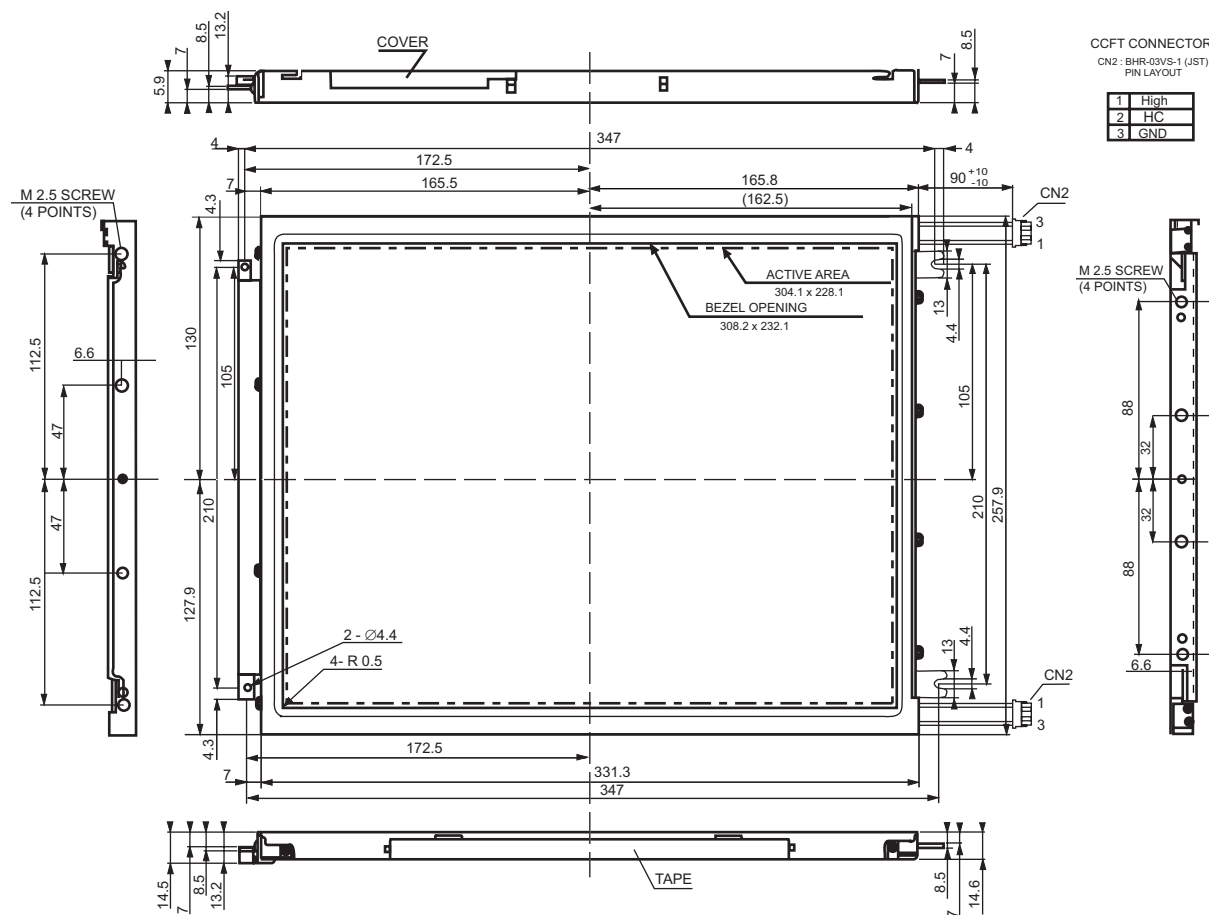
Under the display quality test conditions with normal operation state, there shall be no change which may affect practical display function.

## PACKING FORM

1. Piling number of cartons: 5 cartons
2. Package quantity in one carton: 5 modules
3. Carton size: 410mm(W)x 225mm(H) x 500mm(D)
4. Total weight of 1 carton filled with full modules: 8850g

## OTHERS

1. Disassembling the module can cause permanent damage and should be strictly avoided.
2. Be careful since image retention may occur when a fixed pattern is displayed for a long time.



1. UNSPECIFIED TOLERANCE TO BE  $\pm 0.5$
2. WARP AND FLOATING FOR PCB AND CHASSIS ARE EXCLUDED FROM THE THICKNESS AND DIMENSIONS OF THE UNIT.