

# **TFT COLOR LCD MODULE**

**NL6448AC18-12F**

**14cm (5.7 Type)**

**VGA**

**CMOS interface**

**DATA SHEET**

**DOD-PP-2444 (1st edition)**

**This DATA SHEET is updated document from  
PRELIMINARY DATA SHEET DOD-PP-2235(1)**

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Please confirm the sales representative before  
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## INTRODUCTION

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Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the "**Standard**" unless otherwise specified in this document.



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## 1. OUTLINE

### 1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL6448AC18-12F is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

### 1.2 APPLICATION

- For industrial use

### 1.3 FEATURES

- High Luminance
- High contrast
- 6-bit digital RGB signals
- Reversible-scan direction
- LED backlight built in LED driver
- Suitable for setting in the portrait position (See "4.7.2 Setting the LCD module in the portrait position (vertical)").
- Acquisition product for UL60950-1/CSA-C22.2 No.60950-1-03 (File number: E170632)
- Compliant with the European RoHS directive (2011/65/EU)



Difference between NL6448AC18-12F and NL6448AC18-08F

| Item                       | NL6448AC18-12F   | NL6448AC18-08F   |
|----------------------------|--|--|
| Designed viewing direction | At DPSH= Low or Open,<br>At DPSV= High or Open<br>: Normal scan <ul style="list-style-type: none"> <li>• Viewing direction without image reversal<br/>: Right side (3 o'clock)</li> <li>• Viewing direction with contrast peak<br/>: Left side (9 o'clock)</li> <li>• Viewing angle with optimum grayscale (<math>\gamma \approx 2.2</math>)<br/>: Normal axis(perpendicular)</li> </ul> | At DPSH= Low or Open,<br>At DPSV= High or Open<br>: Normal scan <ul style="list-style-type: none"> <li>• Viewing direction without image reversal<br/>: Down side (6 o'clock)</li> <li>• Viewing direction with contrast peak<br/>: Up side (12 o'clock)</li> <li>• Viewing angle with optimum grayscale (<math>\gamma \approx 2.2</math>)<br/>: Normal axis(perpendicular)</li> </ul> |



## 2. GENERAL SPECIFICATIONS

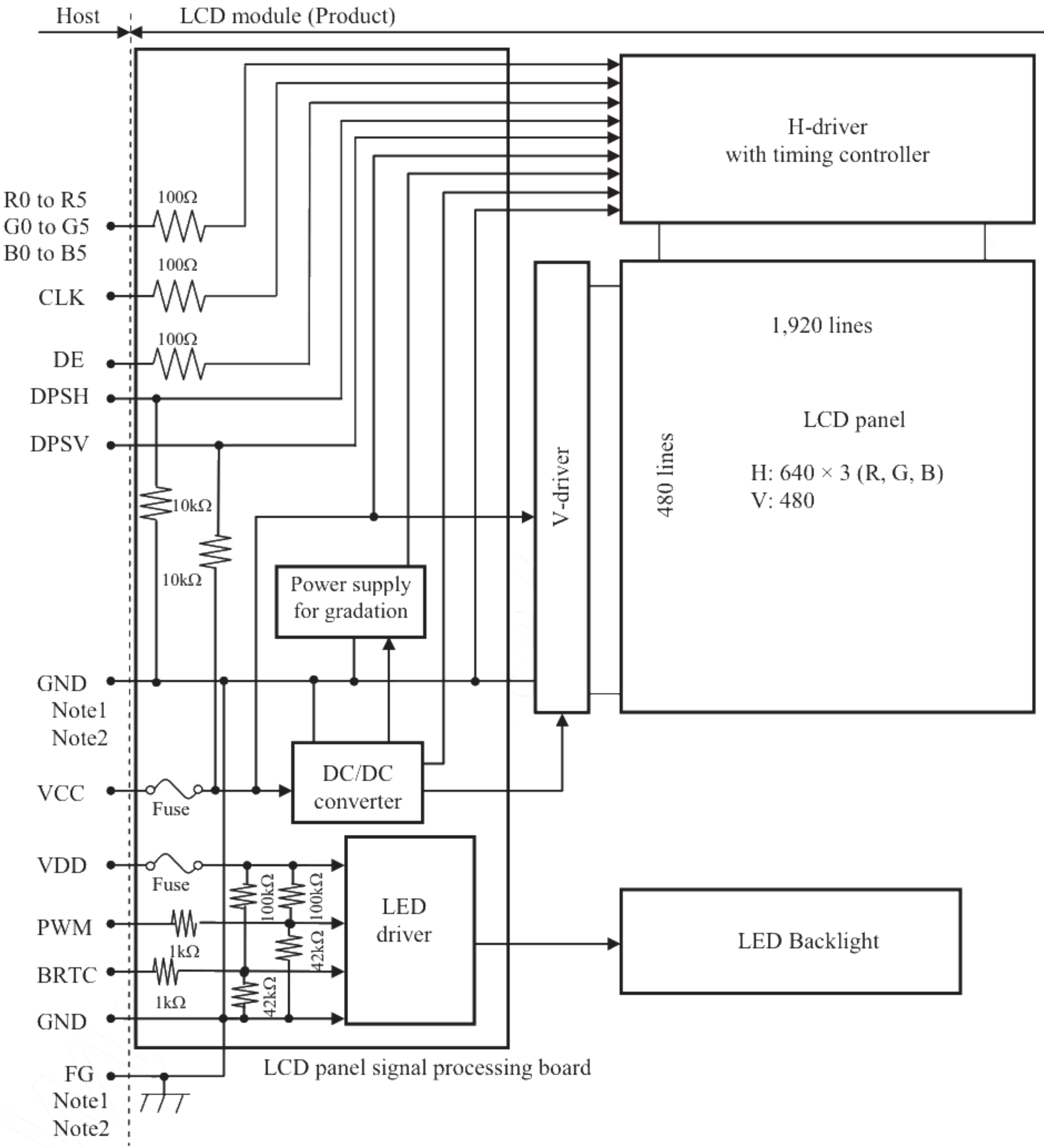
|                                   |  |
|-----------------------------------|--|
| <b>Display area</b>               | 115.2 (H) × 86.4 (V) mm  |
| <b>Diagonal size of display</b>   | 14cm (5.7 inches)  |
| <b>Drive system</b>               | a-Si TFT active matrix   |
| <b>Display color</b>              | 262,144 colors   |
| <b>Pixel</b>                      | 640 (H) × 480 (V) pixels   |
| <b>Pixel arrangement</b>          | RGB (Red dot, Green dot, Blue dot) vertical stripe   |
| <b>Dot pitch</b>                  | 0.06 (H) × 0.18 (V) mm   |
| <b>Pixel pitch</b>                | 0.18 (H) × 0.18 (V) mm   |
| <b>Module size</b>                | 144.0 (W) × 104.6 (H) × 12.3 (D) mm (typ.)   |
| <b>Weight</b>                     | 150g (typ.)  |
| <b>Contrast ratio</b>             | 900:1 (typ.)   |
| <b>Viewing angle</b>              | At the contrast ratio $\geq 10:1$ <ul style="list-style-type: none"> <li>• Horizontal: Right side 80° (typ.), Left side 80° (typ.)</li> <li>• Vertical: Up side 80° (typ.), Down side 80° (typ.)</li> </ul>  |
| <b>Designed viewing direction</b> | At $DPSH = Low$ or $Open$ , $DPSV = High$ or $Open$ : Normal scan <ul style="list-style-type: none"> <li>• Viewing direction without image reversal: Right side (3 o'clock)</li> <li>• Viewing direction with contrast peak: Left side (9 o'clock)</li> <li>• Viewing angle with optimum grayscale (<math>\gamma \approx 2.2</math>): Normal axis (perpendicular)</li> </ul> |
| <b>Polarizer surface</b>          | Antiglare  |
| <b>Polarizer pencil-hardness</b>  | 3H (min.) [by JIS K5600]   |
| <b>Color gamut</b>                | At LCD panel center<br>50% (typ.) [against NTSC color space]   |
| <b>Response time</b>              | $T_{on} + T_{off}$ (10% $\longleftrightarrow$ 90%)<br>18ms (typ.)  |
| <b>Luminance</b>                  | At the maximum luminance control<br>800cd/m <sup>2</sup> (typ.)  |
| <b>Signal system</b>              | 6-bit digital signals for data of RGB colors,<br>Dot clock (CLK), Data enable (DE)   |
| <b>Power supply voltage</b>       | LCD panel signal processing board: 3.3V<br>LED driver: 12.0V   |
| <b>Backlight</b>                  | LED backlight built in LED driver  |
| <b>Power consumption</b>          | At the maximum luminance control, Checkered flag pattern<br>3.6W (typ.)  |

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3. BLOCK DIAGRAM



Note1: Relation between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module is as follows.

|         |           |
|---------|-----------|
| GND- FG | Connected |
|---------|-----------|

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds to be connected together in customer equipment.

## 4. DETAILED SPECIFICATIONS

## 4.1 MECHANICAL SPECIFICATIONS

| Parameter    | Specification   | Unit |
|--------------|---|------|
| Module size  | 144.0 ± 0.5 (W) × 104.6 ± 0.5 (H) × 12.3 ± 0.5 (D)      Note1 | mm   |
| Display area | 115.2 (H) × 86.4 (V)      Note1                               | mm   |
| Weight       | 150 (typ.), 165 (max.)  | g    |

Note1: See "8. OUTLINE DRAWINGS".

## 4.2 ABSOLUTE MAXIMUM RATINGS

| Parameter                  |                                   | Symbol        | Rating           | Unit             | Remarks          |       |
|----------------------------|-----------------------------------|---------------|------------------|------------------|------------------|-------|
| Power supply voltage       | LCD panel signal processing board | VCC           | -0.3 to +5.0     | V                | Ta= 25°C         |       |
|                            | LED driver                        | VDD           | -0.3 to +15.0    |                  |                  |       |
| Input voltage for signals  | Display signals<br>Note1          | VD            | -0.3 to VCC+0.3  | V                |                  |       |
|                            | Function signals<br>Note2         | VF            |                  |                  |                  |       |
|                            | Function signal for LED driver    | PWM           | -0.3 to +5.5     | V                |                  |       |
|                            |                                   | BRTC          | -0.3 to +VDD+0.1 | V                |                  |       |
| Storage temperature        |                                   | Tst           | -30 to +80       | °C               | -                |       |
| Operating temperature      |                                   | Front surface | TopF             | -30 to +80       | °C               | Note3 |
|                            |                                   | Rear surface  | TopR             | -30 to +80       | °C               | Note4 |
| Relative humidity<br>Note5 |                                   | RH            | ≤ 95             | %                | Ta ≤ 40°C        |       |
|                            |                                   |               | ≤ 85             | %                | 40°C < Ta ≤ 50°C |       |
|                            |                                   |               | ≤ 55             | %                | 50°C < Ta ≤ 60°C |       |
|                            |                                   |               | ≤ 36             | %                | 60°C < Ta ≤ 70°C |       |
|                            |                                   |               | ≤ 24             | %                | 70°C < Ta ≤ 80°C |       |
| Absolute humidity<br>Note5 |                                   | AH            | ≤ 70<br>Note6    | g/m <sup>3</sup> | Ta= 80°C         |       |

Note1: CLK, DE, DATA (R0 to R5, G0 to G5, B0 to B5)

Note2: DPSH, DPSV

Note3: Measured at LCD panel surface (including self-heat)

Note4: Measured at LCD module's rear shield surface (including self-heat)

Note5: No condensation.

Note6: Water amount at Ta= 80°C and RH= 24%



### 4.3 ELECTRICAL CHARACTERISTICS

#### 4.3.1 LCD panel signal processing board

(Ta= 25°C)

| Parameter                               |      | Symbol | min.   | typ.         | max.         | Unit  | Remarks                           |  |
|---|------|--------|--------|--------------|--------------|-------|-----------------------------------|--|
| Power supply voltage                    |      | VCC    | 3.0    | 3.3          | 3.6          | V     | -                                 |  |
| Power supply current                    |      | ICC    | -      | 155<br>Note1 | 230<br>Note2 | mA    | at VCC= 3.3V                      |  |
| Permissible ripple voltage              |      | VRPC   | -      | -            | 100          | mVp-p | for VCC<br>Note3, Note4,<br>Note5 |  |
| Logic input voltage for display signals | High | VDH    | 0.7VCC | -            | VCC          | V     | CMOS level                        |  |
|   | Low  | VDL    | 0      | -            | 0.3VCC       |       |                                   |  |
| Input voltage for DPSH signal           | High | VFH1   | 0.7VCC | -            | VCC          | V     |                                   |  |
|   | Low  | VFL1   | 0      | -            | 0.3VCC       |       |                                   |  |
| Input voltage for DPSV signal           | High | VFH2   | 0.7VCC | -            | VCC          |       |                                   |  |
|   | Low  | VFL2   | 0      | -            | 0.3VCC       |       |                                   |  |
| Input current for DPSH signal           | High | IFH1   | -      | -            | 800          | μA    | -                                 |  |
|   | Low  | IFL1   | -800   | -            | -            |       |                                   |  |
| Input current for DPSV signal           | High | IFH2   | -      | -            | 800          |       |                                   |  |
|   | Low  | IFL2   | -800   | -            | -            |       |                                   |  |

Note1: Checkered flag pattern [by IEC 61747-6]

Note2: Pattern for maximum current

Note3: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.

Note4: The permissible ripple voltage includes spike noise.

Note5: The load variation influence does not include.



## 4.3.2 LED driver

(Ta= 25°C)

| Parameter                     |       | Symbol           | min. | typ. | max.         | Unit  | Remarks                           |
|-------------------------------|-------|------------------|------|------|--------------|-------|-----------------------------------|
| Power supply voltage          |       | VDD              | 10.8 | 12.0 | 13.2         | V     | Note1                             |
| Power supply current          | Note2 | IDD              | -    | 260  | 310<br>Note3 | mA    | Note4                             |
| Permissible ripple voltage    |       | VRPD             | -    | -    | 200          | mVp-p | for VDD<br>Note2, Note5,<br>Note6 |
| Input voltage for PWM signal  | High  | VDFH1            | 2.0  | -    | 5.3          | V     | Note7                             |
|                               | Low   | VDFL1            | -    | -    | 0.8          | V     |                                   |
| Input voltage for BRTC signal | High  | VDFH2            | 2.0  | -    | VDD          | V     |                                   |
|                               | Low   | VDFL2            | -    | -    | 0.8          | V     |                                   |
| Input current for PWM signal  | High  | IDFH1            | -    | -    | 300          | μA    | Note7                             |
|                               | Low   | IDFL1            | -300 | -    | -            | μA    |                                   |
| Input current for BRTC signal | High  | IDFH2            | -    | -    | 500          | μA    |                                   |
|                               | Low   | IDFL2            | -500 | -    | -            | μA    |                                   |
| PWM frequency                 |       | f <sub>PWM</sub> | 200  | -    | 10k          | Hz    | Note8, Note9                      |
| PWM duty cycle                |       | DRPWM            | 1    | -    | 100          | %     | Note10, Note11                    |
| PWM pulse width               |       | tPWH             | 1    | -    | -            | μs    |                                   |

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.

Note2: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on.

Note3: This value excludes peak current such as overshoot current.

Note4: At the maximum luminance control

Note5: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.

Note6: The permissible ripple voltage includes spike noise.

Note7: See "3. BLOCK DIAGRAM".

Note8: A recommended f<sub>PWM</sub> value is as follows.

$$f_{\text{PWM}} = \frac{2n-1}{4} \times f_v$$

(n = integer, f<sub>v</sub> = frame frequency of LCD module)

Note9: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note10: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than minimum value. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

Note11: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

### 4.3.3 Fuse

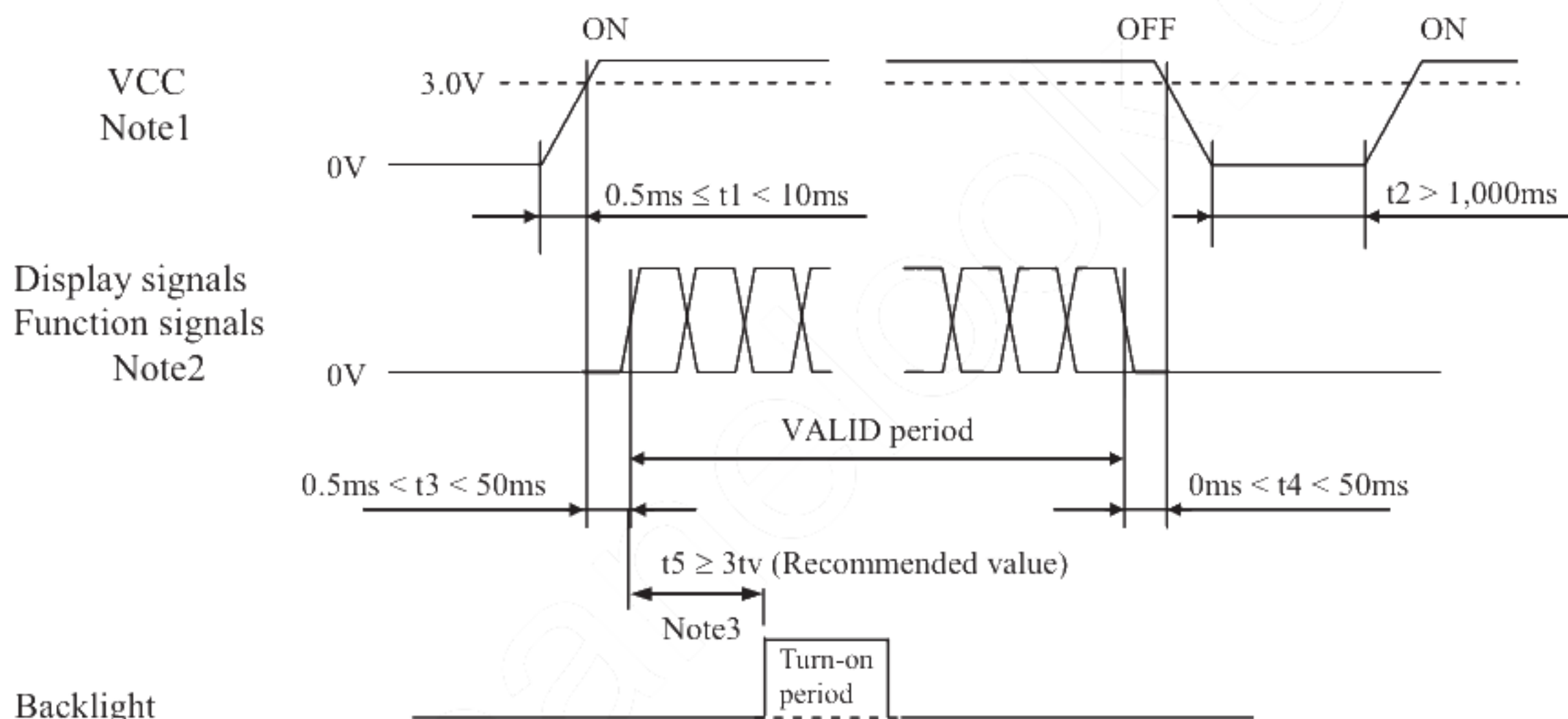


| Parameter | Fuse       |                         | Rating      | Fusing current | Remarks |
|-----------|------------|-------------------------|-------------|----------------|---------|
|           | Type       | Supplier                |             |                |         |
| VCC       | FCC16152AB | KAMAYA ELECTRIC CO.,LTD | 1.5A<br>36V | 3.0A           | Note1   |
| VDD       | FCC16152AB | KAMAYA ELECTRIC CO.,LTD | 1.5A<br>36V |                |         |

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

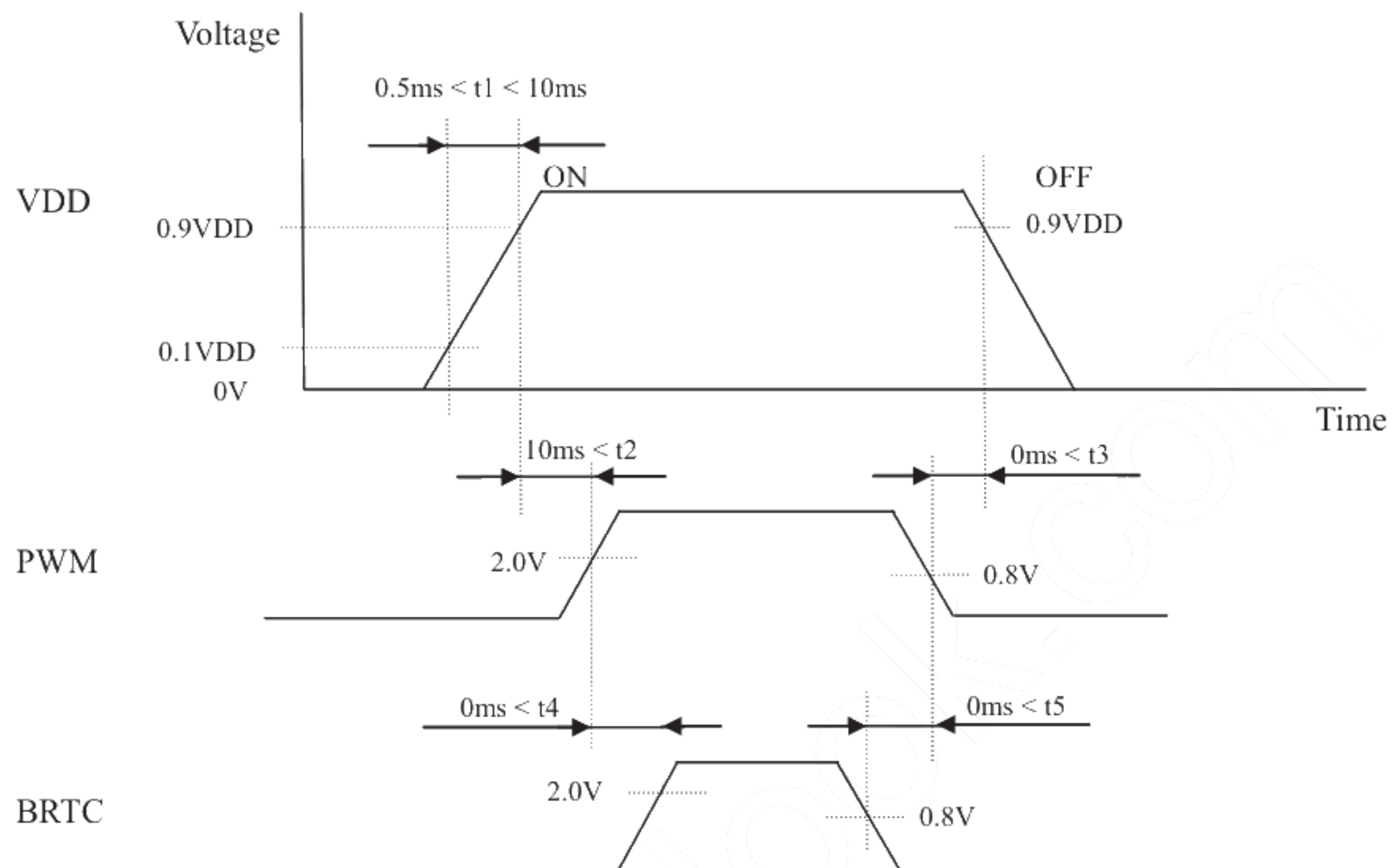
## 4.4 POWER SUPPLY VOLTAGE SEQUENCE

### 4.4.1 LCD panel signal processing board





## 4.4.2 LED driver



Note1: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

## 4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

## 4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): 089H33-000100-G2-R (STARCONN)

Adaptable plug: [0.5mm pitch, Bottom Contact Type]

| Pin No. | Symbol | Signal                                 | Remarks  |
|---------|--------|--|--|
| 1       | GND    | Ground                                 | Note1  |
| 2       | CLK    | Dot clock                              | -  |
| 3       | N.C.   | -                                      | Keep this pin Open.  |
| 4       | N.C.   | -                                      |  |
| 5       | GND    | Ground                                 | Note1  |
| 6       | R0     | Red data (LSB)                         | Least significant bit  |
| 7       | R1     | Red data                               | -  |
| 8       | R2     | Red data                               |  |
| 9       | R3     | Red data                               |  |
| 10      | R4     | Red data                               |  |
| 11      | R5     | Red data (MSB)                         | Most significant bit   |
| 12      | GND    | Ground                                 | Note1  |
| 13      | G0     | Green data (LSB)                       | Least significant bit  |
| 14      | G1     | Green data                             | -  |
| 15      | G2     | Green data                             |  |
| 16      | G3     | Green data                             |  |
| 17      | G4     | Green data                             |  |
| 18      | G5     | Green data (MSB)                       | Most significant bit   |
| 19      | GND    | Ground                                 | Note1  |
| 20      | B0     | Blue data (LSB)                        | Least significant bit  |
| 21      | B1     | Blue data                              | -  |
| 22      | B2     | Blue data                              |  |
| 23      | B3     | Blue data                              |  |
| 24      | B4     | Blue data                              |  |
| 25      | B5     | Blue data (MSB)                        | Most significant bit   |
| 26      | GND    | Ground                                 | Note1  |
| 27      | DE     | Data enable signal                     | -  |
| 28      | VCC    | Power supply                           | Note1  |
| 29      | VCC    | Power supply                           |  |
| 30      | DPSH   | Selection of Horizontal scan direction | High : Right and Left reverse scan<br>Low or Open: Normal scan Note2 |
| 31      | DPSV   | Selection of Vertical scan direction   | High or Open: Normal scan<br>Low : Up and Down reverse scan Note2    |
| 32      | N.C.   | -                                      | Keep this pin Open.  |
| 33      | GND    | Ground                                 | Note1  |

Note1: All GND and VCC terminals should be used without any non-connected lines.

Note2: See "4.7 DISPLAY POSITIONS AND SCANNING DIRECTIONS".



## 4.5.2 LED driver

CN2 socket (LCD module side): SM06B-SRSS-TB(LF)(SN) (JST Co. Ltd)

Adaptable plug: SHR-06V-S-B (JST Co. Ltd)

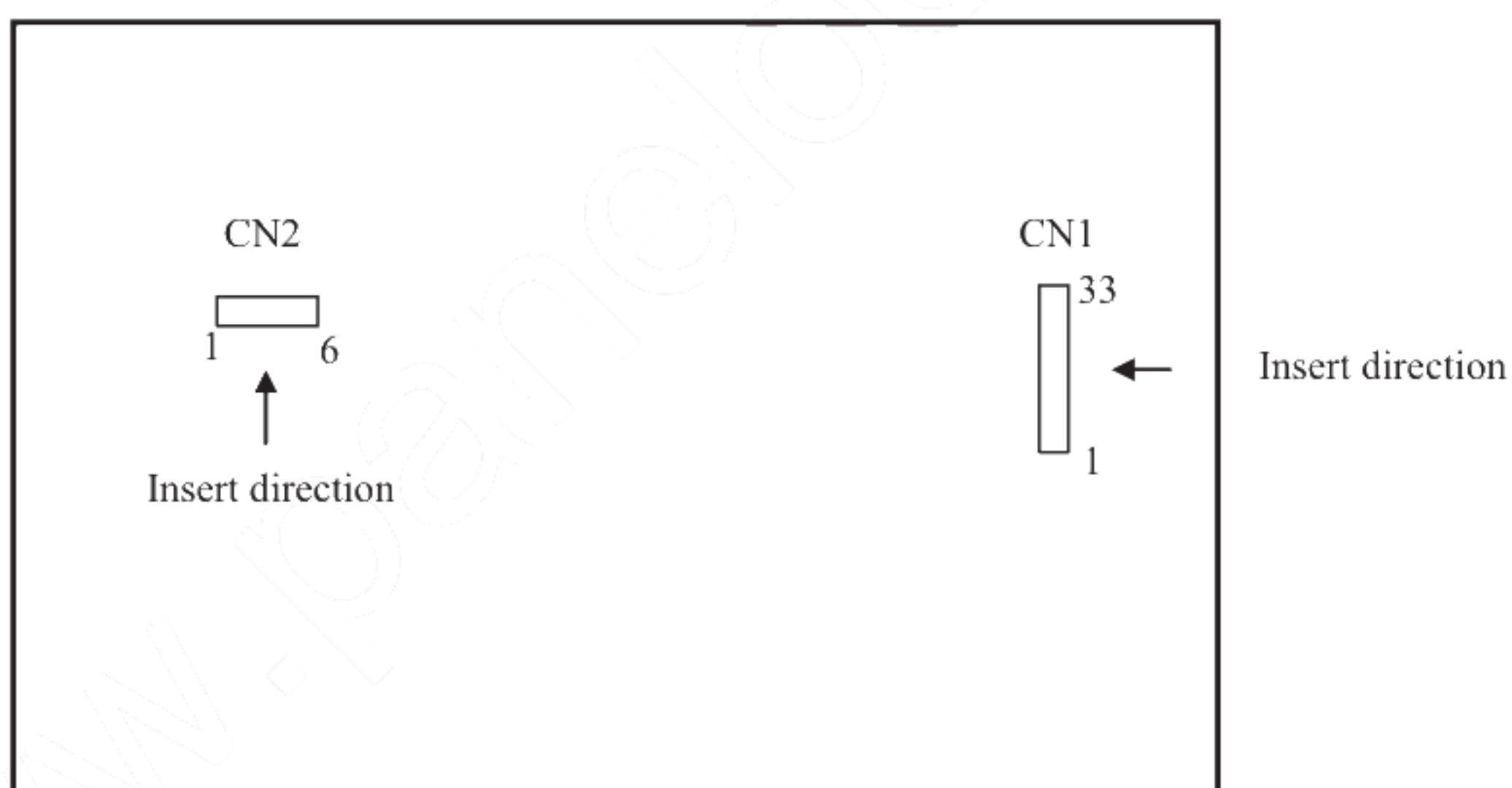


| Pin No. | Symbol | Function                 | Remarks  |
|---------|--------|--------------------------|--|
| 1       | VDD    | Power supply             | Note1  |
| 2       | VDD    | Power supply             |  |
| 3       | GND    | Ground                   |  |
| 4       | GND    | Ground                   |  |
| 5       | PWM    | Luminance control        | PWM Dimming<br>Open: Max. Luminance              |
| 6       | BRTC   | Backlight ON/OFF control | High or Open: Backlight ON<br>Low: Backlight OFF |

Note1: All GND and VDD terminals must be connected to appropriate terminals.

## 4.5.3 Positions of socket

Rear side



#### 4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display 262,144 colors with 64 gray scales. Also the relation between display colors and input data signals is as follows.

| Display colors   |         | Data signal (0: Low level, 1: High level) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------|---------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                  |         | 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  |
|                  | 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  |
|                  | 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  |
|                  | 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  |
| Red gray scale   | 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  |
|                  | dark    | 0   | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | ↑       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | ↓       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | bright  | 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  |
| Green gray scale | 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  |
|                  | dark    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | ↑       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | ↓       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | bright  | 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  |
| Blue gray scale  | 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  |
|                  | dark    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
|                  | ↑       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | ↓       |   |    |    | :  |    |    |    |    | :  |    |    |    |    |    | :  |    |    |    |
|                  | bright  | 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  |



## 4.7 DISPLAY POSITIONS AND SCANNING DIRECTIONS

### 4.7.1 Setting the LCD module in the landscape position (horizontal)

#### (1) Display positions



The following table is the coordinates per pixel.

|            |            |       |            |       |             |             |
|------------|------------|-------|------------|-------|-------------|-------------|
| D( 1, 1)   | D( 2, 1)   | • • • | D( X, 1)   | • • • | D(639, 1)   | D(640, 1)   |
| D( 1, 2)   | D( 2, 2)   | • • • | D( X, 2)   | • • • | D(639, 2)   | D(640, 2)   |
| •          | •          | •     | •          | •     | •           | •           |
| •          | •          | •     | •          | •     | •           | •           |
| •          | •          | •     | •          | •     | •           | •           |
| D( 1, Y)   | D( 2, Y)   | • • • | D( X, Y)   | • • • | D(639, Y)   | D(640, Y)   |
| •          | •          | •     | •          | •     | •           | •           |
| •          | •          | •     | •          | •     | •           | •           |
| •          | •          | •     | •          | •     | •           | •           |
| D( 1, 479) | D( 2, 479) | • • • | D( X, 479) | • • • | D(639, 479) | D(640, 479) |
| D( 1, 480) | D( 2, 480) | • • • | D( X, 480) | • • • | D(639, 480) | D(640, 480) |

Note1: See "4.7.1 (2) Scanning directions".

#### (2) Scanning directions

The following figures are seen from a front view.

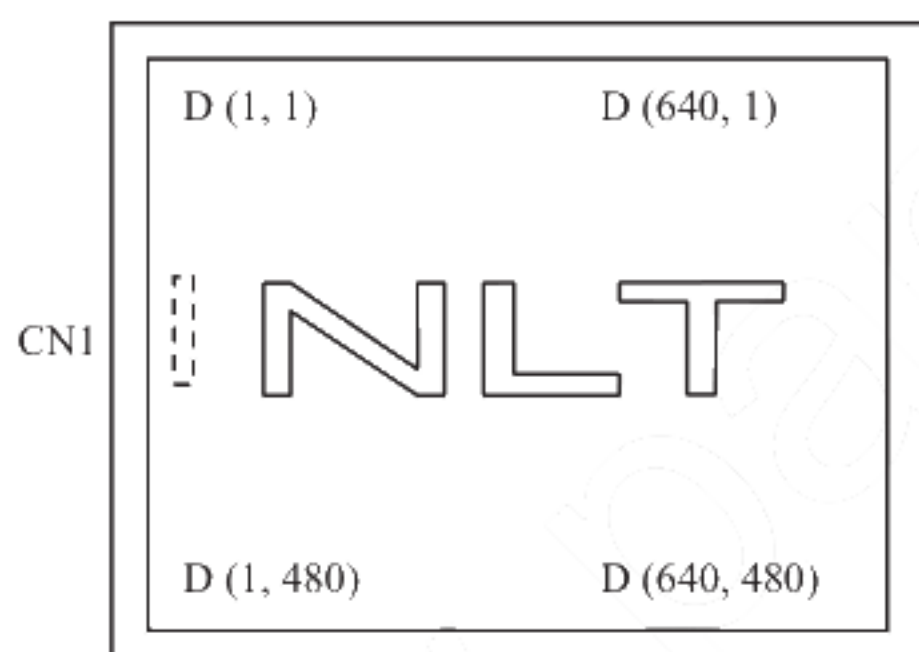


Figure1. DPSH= Low or Open (Normal scan)  
DPSV= High or Open (Normal scan)

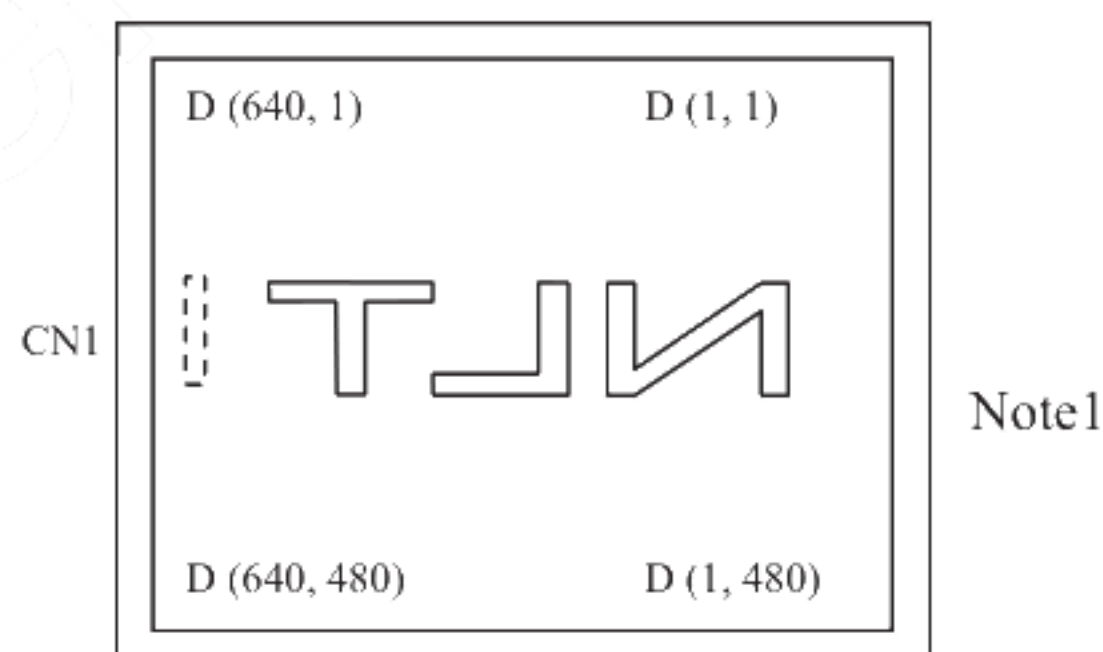


Figure2. DPSH= High (Reverse scan)  
DPSV= High or Open (Normal scan)

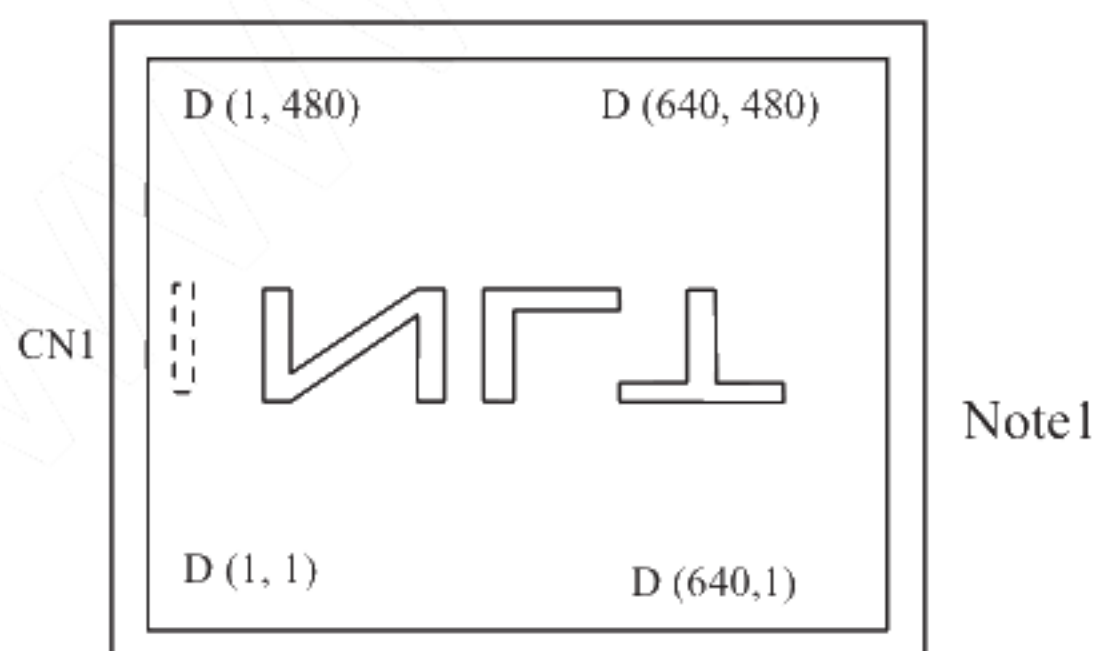


Figure3. DPSH= Low or Open (Normal scan)  
DPSV= Low (Reverse scan)

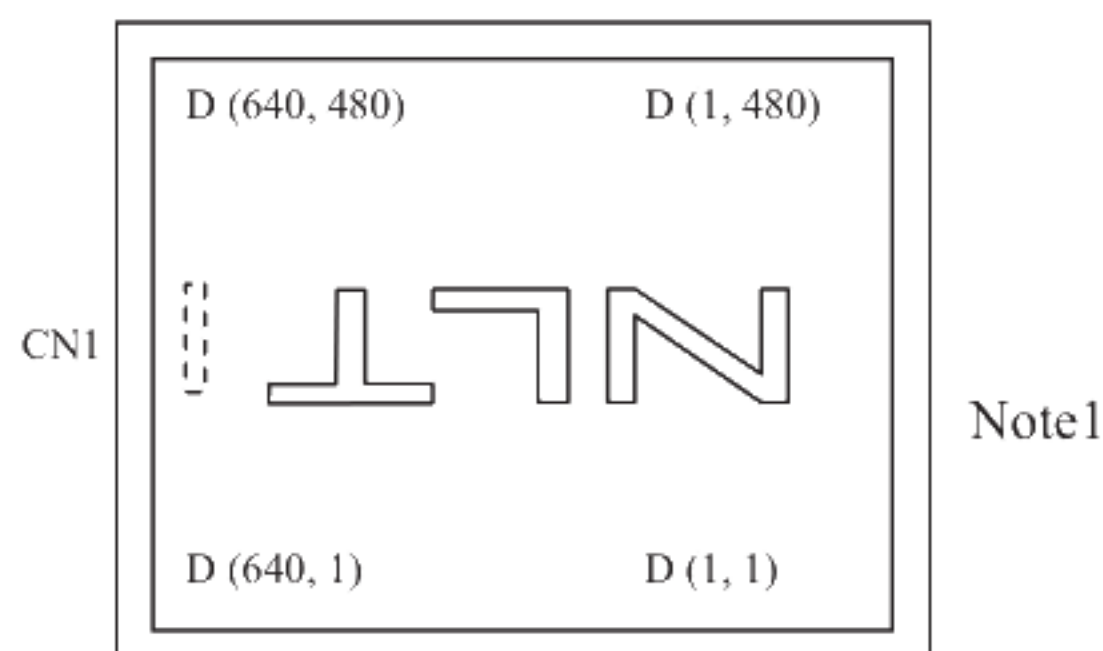


Figure4. DPSH= High (Reverse scan)  
DPSV= Low (Reverse scan)

Note1: Meaning of D (X, Y)

D (X, Y): Input data signals for LCD panel signal processing board



## 4.7.2 Setting the LCD module in the landscape position ((vertical)

## (1) Display positions



The following table is the coordinates per pixel.

|           |           |     |           |     |            |            |
|-----------|-----------|-----|-----------|-----|------------|------------|
| D(640, 1) | D(640, 2) | ... | D(640, Y) | ... | D(640,479) | D(640,480) |
| D(639, 1) | D(639, 2) | ... | D(639, Y) | ... | D(639,479) | D(639,480) |
| •         | •         | •   | •         | •   | •          | •          |
| •         | •         | •   | •         | •   | •          | •          |
| •         | •         | •   | •         | •   | •          | •          |
| D( X, 1)  | D( X, 2)  | ... | D( X, Y)  | ... | D( X,479)  | D( X,480)  |
| •         | •         | •   | •         | •   | •          | •          |
| •         | •         | •   | •         | •   | •          | •          |
| •         | •         | •   | •         | •   | •          | •          |
| D( 2, 1)  | D( 2, 2)  | ... | D( 2, Y)  | ... | D( 2,479)  | D( 2,480)  |
| D( 1, 1)  | D( 1, 2)  | ... | D( 1, Y)  | ... | D( 1, 479) | D( 1,480)  |

Note1: See "4.7.2 (2) Scanning directions".

## (2) Scanning directions

The following figures are seen from a front view.

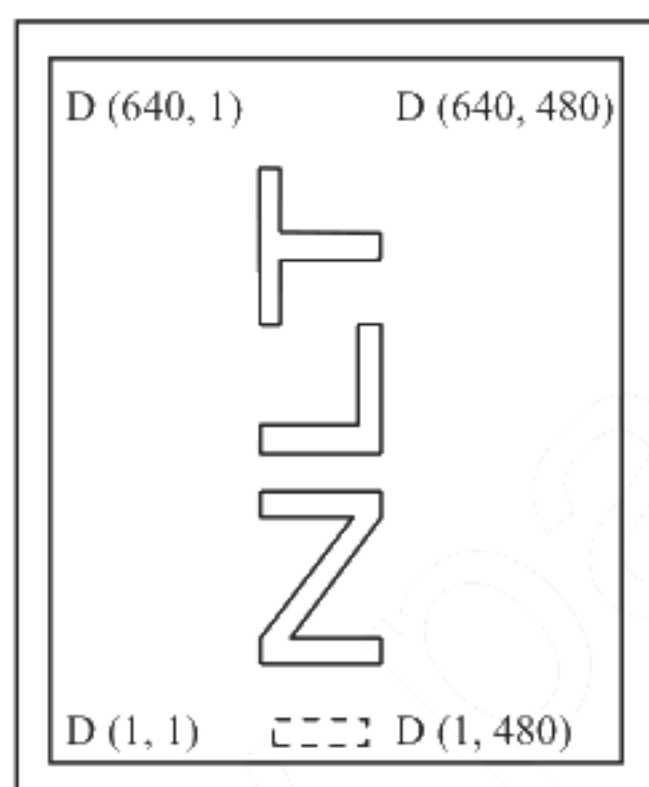


Figure1. DPSH= Low or Open (Normal scan)  
DPSV= High or Open (Normal scan)

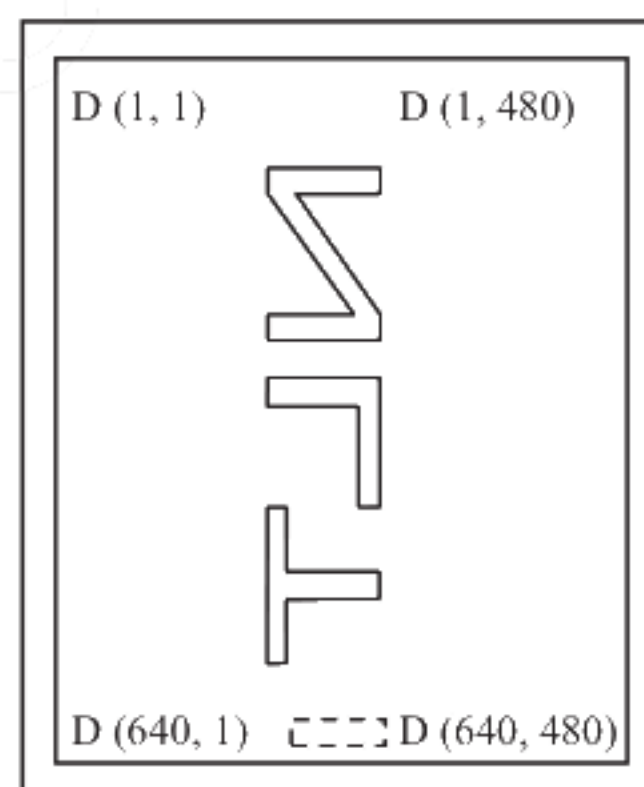


Figure2. DPSH= High (Reverse scan)  
DPSV= High or Open (Normal scan)

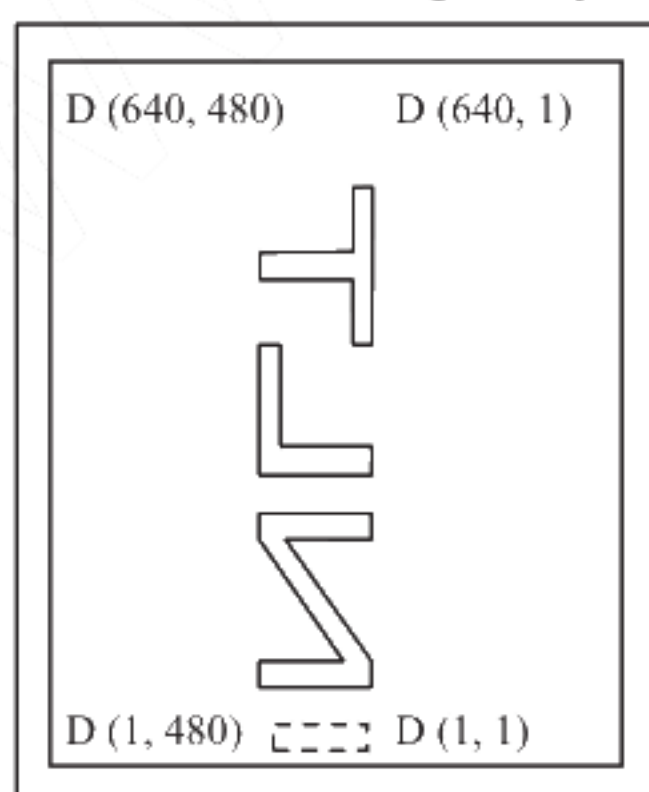


Figure3. DPSH= Low or Open (Normal scan)  
DPSV= Low (Reverse scan)

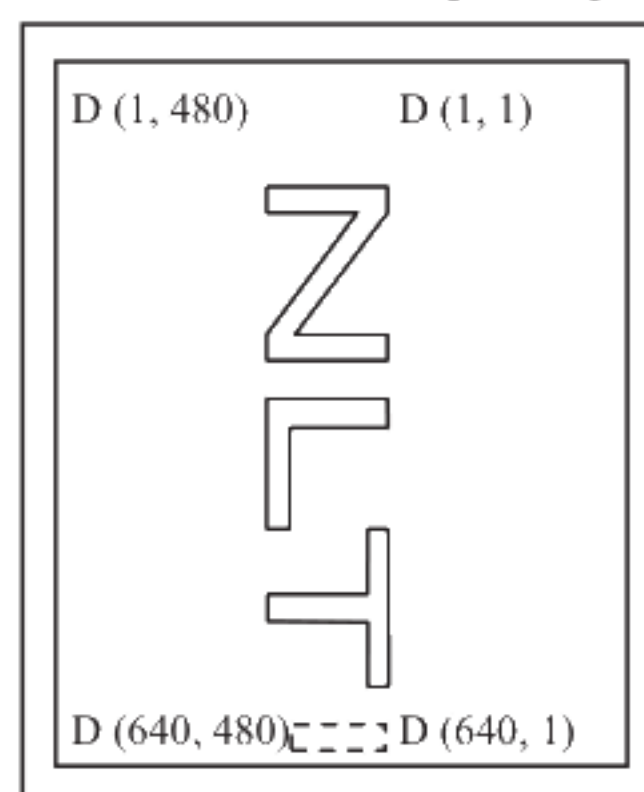


Figure4. DPSH= High (Reverse scan)  
DPSV= Low (Reverse scan)

Note1: Meaning of D (X, Y)

D (X, Y): Input data signals for LCD panel signal processing board



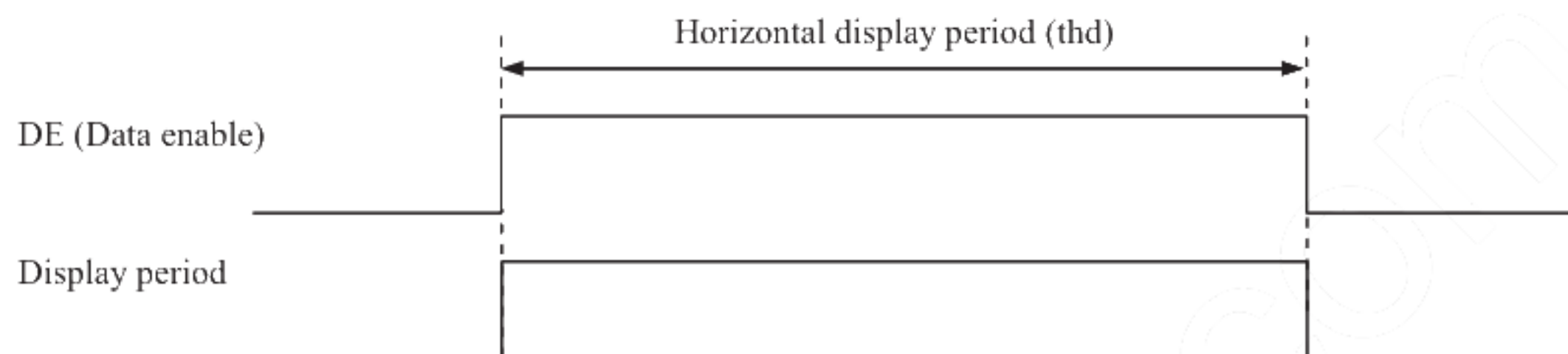


## 4.8 INPUT SIGNAL TIMINGS

### 4.8.1 Outline of input signal timings

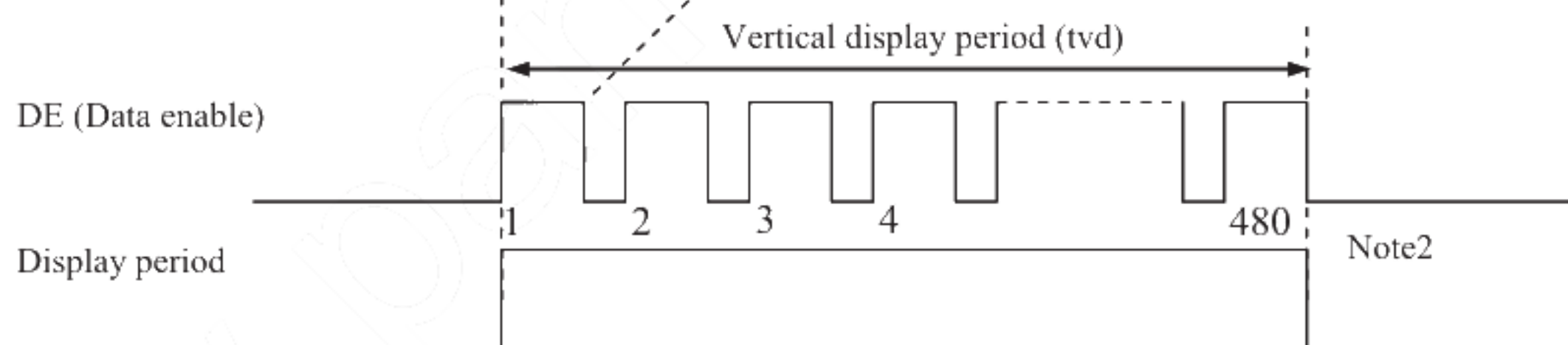
- Horizontal signal

Note1



- Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.

Note2: See "4.8.3 Input signal timing chart" for the pulse number.

## 4.8.2 Timing characteristics

(Note1, Note2)

| Parameter                             |                         |                | Symbol | min.   | typ.   | max.   | Unit | Remarks        |
|---------------------------------------|-------------------------|----------------|--------|--------|--------|--------|------|----------------|
| CLK                                   | Frequency               |                | 1/tc   | 24.8   | 25.2   | 34.2   | MHz  | 39.68ns (typ.) |
|                                       | Duty ratio              |                | tcd    | 0.4    | 0.5    | 0.6    | -    | -              |
| DATA<br>(R0-R5)<br>(G0-G5)<br>(B0-B5) | CLK-DATA                | Setup time     | tds    | 8      | -      | -      | ns   | -              |
|                                       |                         | Hold time      | tdh    | 8      | -      | -      | ns   | -              |
| DE                                    | Horizontal              | Cycle          | th     | 29.240 | 31.746 | 32.258 | μs   | 31.5kHz (typ.) |
|                                       |                         |                |        | 800    | 800    | 1,000  | CLK  |                |
|                                       |                         | Display period | thd    | 640    |        |        | CLK  | -              |
|                                       | Vertical<br>(One frame) | Cycle          | tv     | 15.351 | 16.667 | 16.935 | ms   | 60.0Hz (typ.)  |
|                                       |                         |                |        | 516    | 525    | 570    | H    |                |
|                                       |                         | Display period | tvd    | 480    |        |        | H    | -              |
|                                       | CLK-DE                  | Setup time     | tdes   | 8      | -      | -      | ns   | -              |
|                                       |                         | Hold time      | tdeh   | 8      | -      | -      | ns   |                |

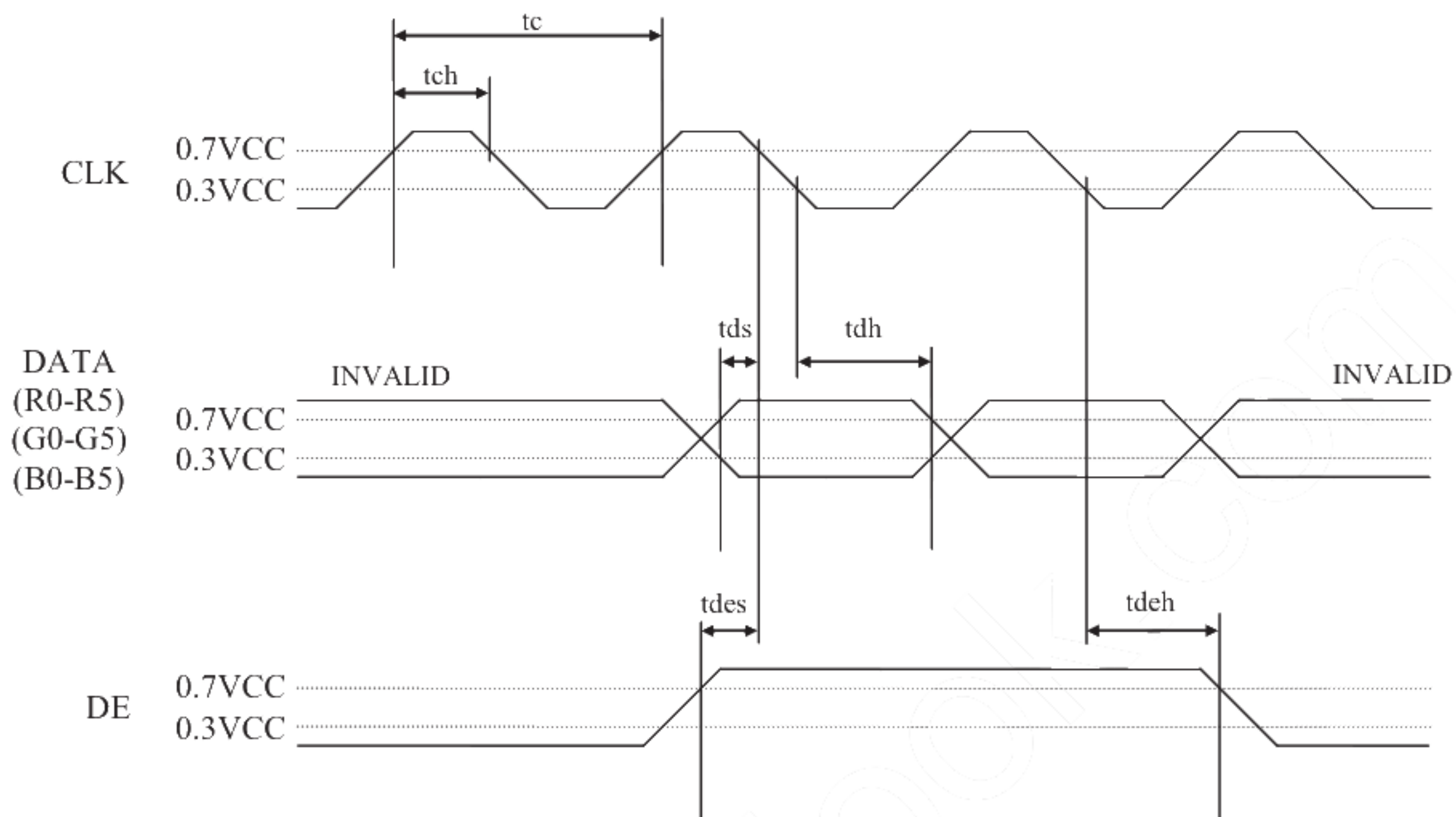
Note1: Definition of parameters is as follows.

tc= 1CLK, tcd= tch/tc, th= 1H

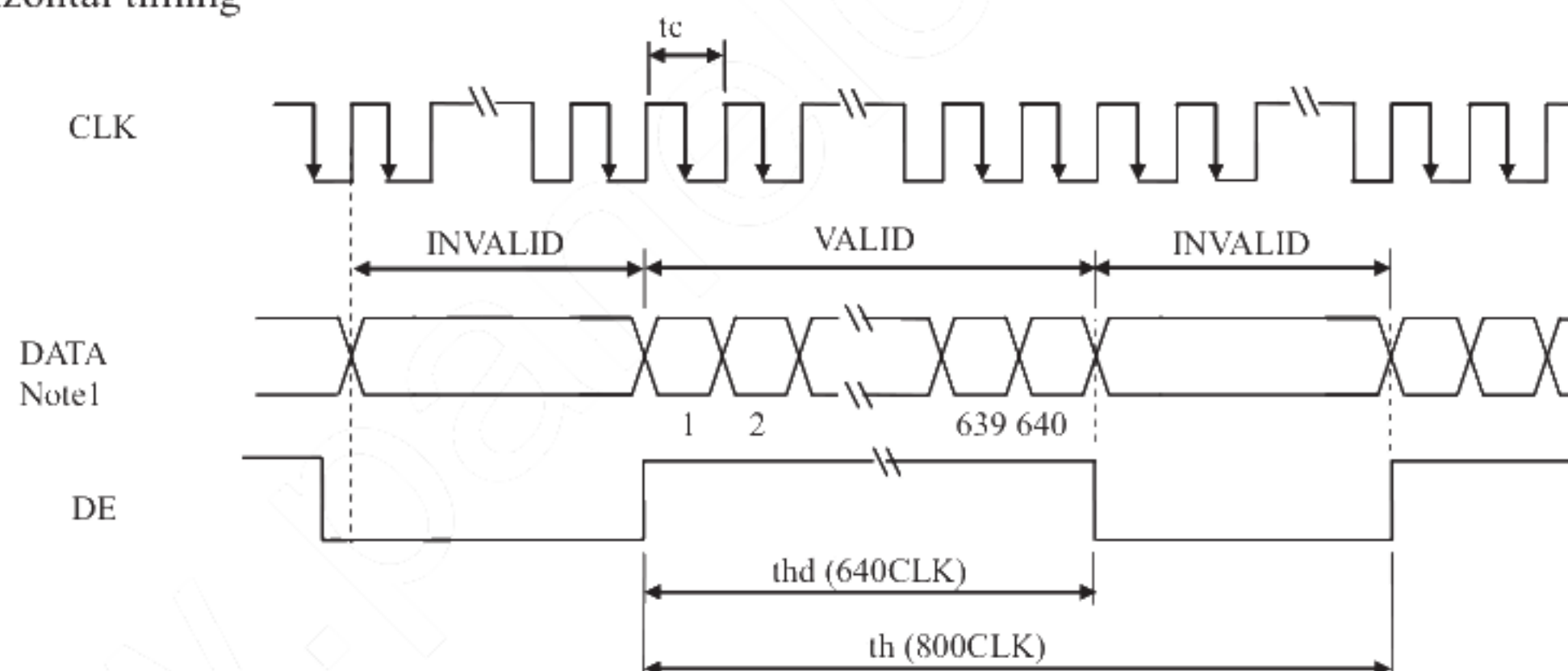
Note2: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).



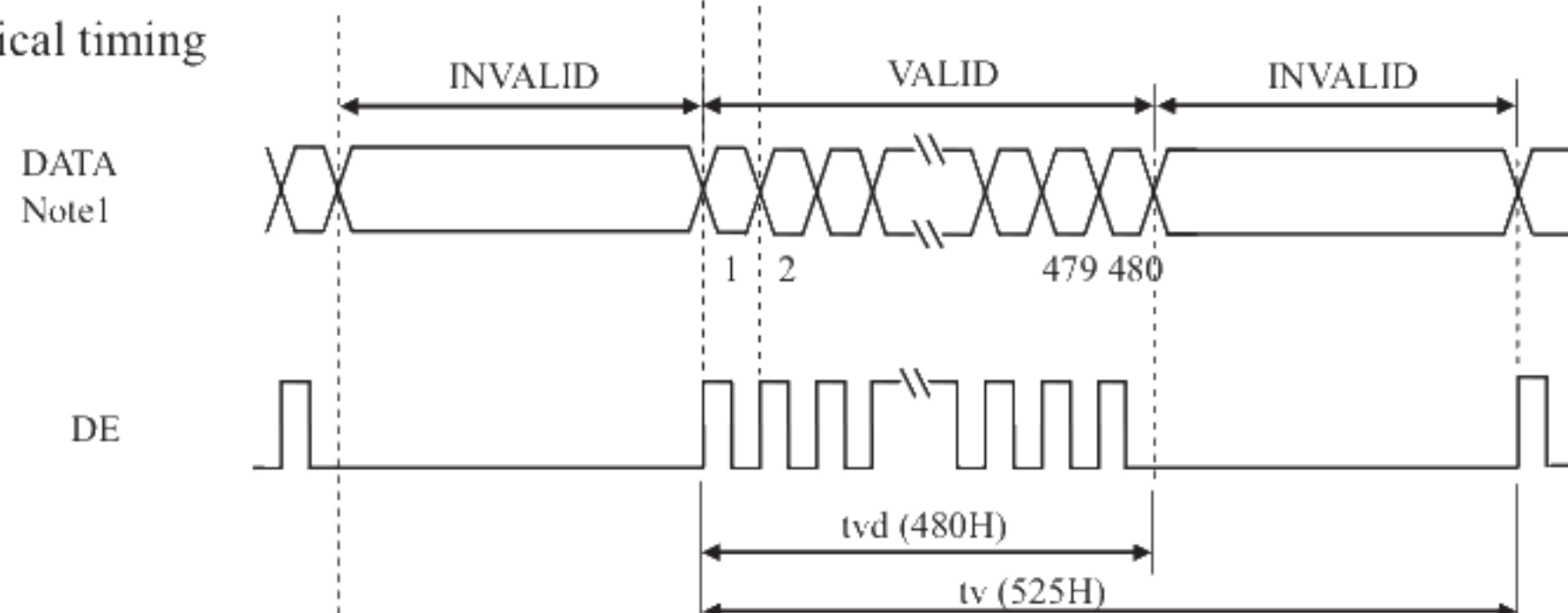
### 4.8.3 Input signal timing chart



#### Horizontal timing



#### Vertical timing



Note1: DATA = R0-R5, G0-G5, B0-B5

## 4.9 OPTICS

### 4.9.1 Optical characteristics

(Note1, Note2)

| Parameter            |       | Condition   | Symbol     | min.  | typ.  | max.  | Unit              | Measuring instrument | Remarks |   |
|----------------------|-------|---|------------|-------|-------|-------|-------------------|----------------------|---------|---|
| Luminance            |       | White at center<br>$\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$                     | L          | 640   | 800   | -     | cd/m <sup>2</sup> | BM-5A or equivalent  | -       | ☆ |
| Contrast ratio       |       | White/Black at center<br>$\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$               | CR         | 500   | 900   | -     | -                 | BM-5A or equivalent  | Note3   | ☆ |
| Luminance uniformity |       | White<br>$\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$                               | LU         | -     | 1.25  | 1.4   | -                 | BM-5A or equivalent  | Note4   | ☆ |
| Chromaticity         | White | x coordinate  | Wx         | 0.263 | 0.313 | 0.363 | -                 | SR-3 or equivalent   | Note5   | ☆ |
|                      |       | y coordinate  | Wy         | 0.279 | 0.329 | 0.379 | -                 |                      |         |   |
|                      | Red   | x coordinate  | Rx         | -     | 0.605 | -     | -                 |                      |         |   |
|                      |       | y coordinate  | Ry         | -     | 0.348 | -     | -                 |                      |         |   |
|                      | Green | x coordinate  | Gx         | -     | 0.328 | -     | -                 |                      |         |   |
|                      |       | y coordinate  | Gy         | -     | 0.576 | -     | -                 |                      |         |   |
|                      | Blue  | x coordinate  | Bx         | -     | 0.144 | -     | -                 |                      |         |   |
|                      |       | y coordinate  | By         | -     | 0.120 | -     | -                 |                      |         |   |
| Color gamut          |       | $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$<br>at center, against NTSC color space | C          | 45    | 50    | -     | %                 |                      |         |   |
| Response time        |       | White to Black  | Ton        | -     | 3     | 5     | ms                | BM-5A or equivalent  | Note6   | ☆ |
|                      |       | Black to White  | Toff       | -     | 15    | 21    | ms                |                      | Note7   |   |
| Viewing angle        | Right | $\theta U=0^{\circ}, \theta D=0^{\circ}, CR \geq 10$  | $\theta R$ | 70    | 80    | -     | °                 | EZ Contrast          | Note8   |   |
|                      | Left  | $\theta U=0^{\circ}, \theta D=0^{\circ}, CR \geq 10$  | $\theta L$ | 70    | 80    | -     | °                 |                      |         |   |
|                      | Up    | $\theta R=0^{\circ}, \theta L=0^{\circ}, CR \geq 10$  | $\theta U$ | 70    | 80    | -     | °                 |                      |         |   |
|                      | Down  | $\theta R=0^{\circ}, \theta L=0^{\circ}, CR \geq 10$  | $\theta D$ | 70    | 80    | -     | °                 |                      |         |   |

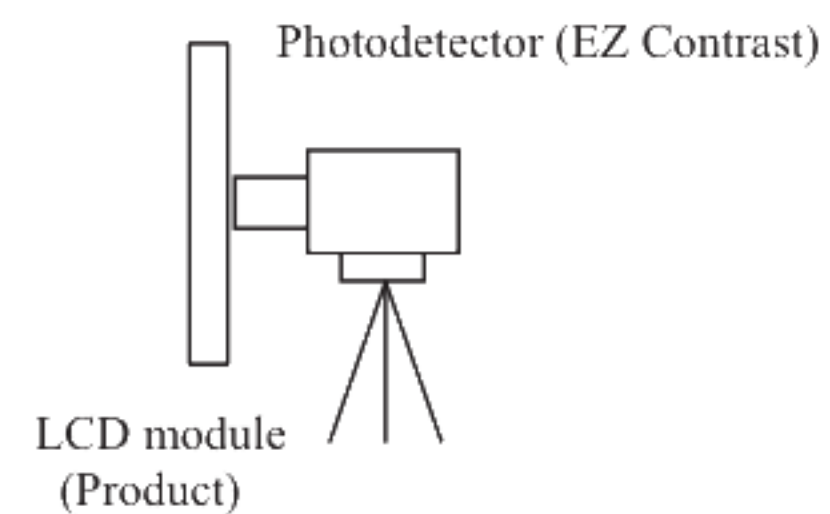
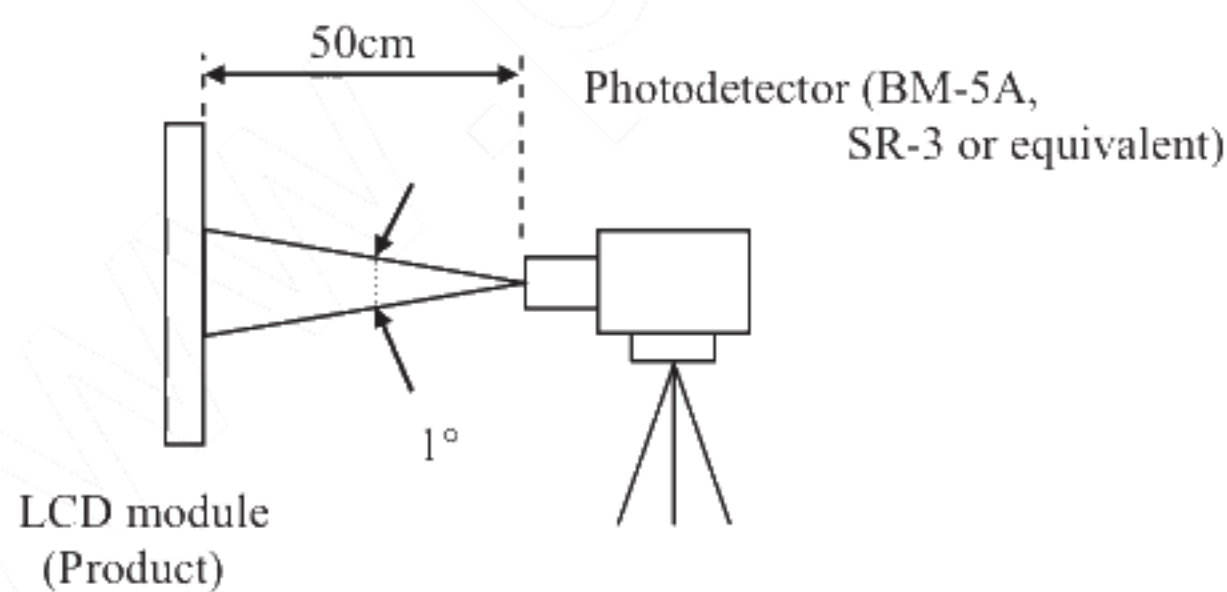
Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 3.3V, VDD= 12.0V, PWM duty ratio: 100%,

Display mode: VGA, Horizontal cycle= 1/31.5kHz, Vertical cycle= 1/60.0Hz,

Optical characteristics are measured at luminance saturation 20minutes after the product works, in the dark room. Also measurement methods are as follows.



Note3: See "4.9.2 Definition of contrast ratio".

Note4: See "4.9.3 Definition of luminance uniformity".

Note5: These coordinates are found on CIE 1931 chromaticity diagram.

Note6: Product surface temperature: TopF= 28°C

Note7: See "4.9.4 Definition of response times".

Note8: See "4.9.5 Definition of viewing angles".



#### 4.9.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

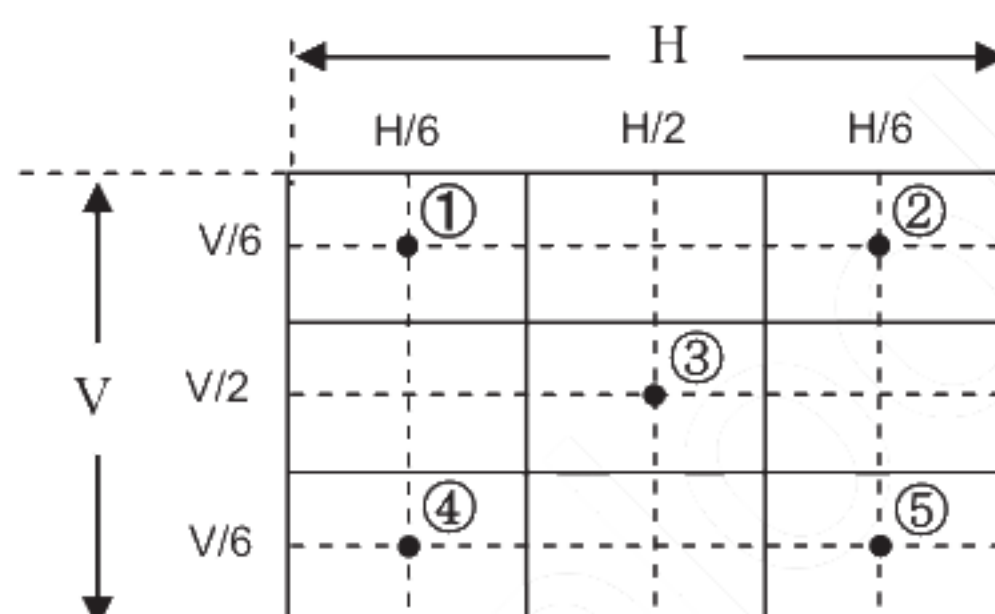
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

#### 4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

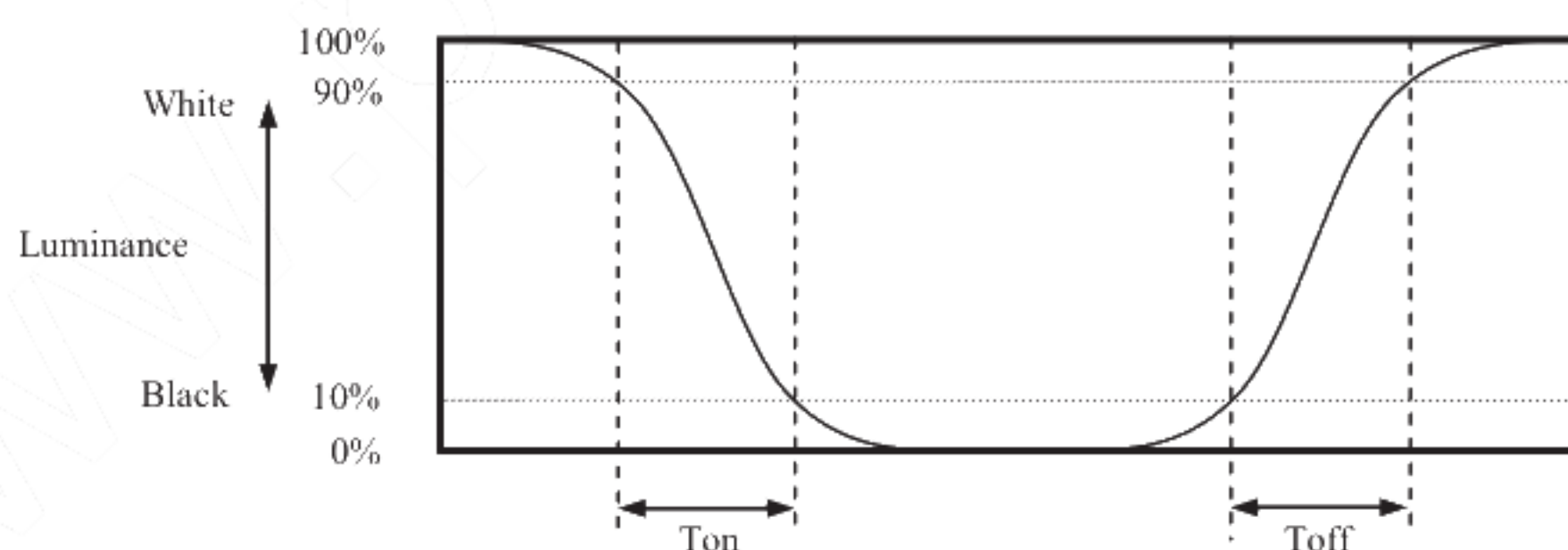
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

The luminance is measured at near the 5 points shown below.

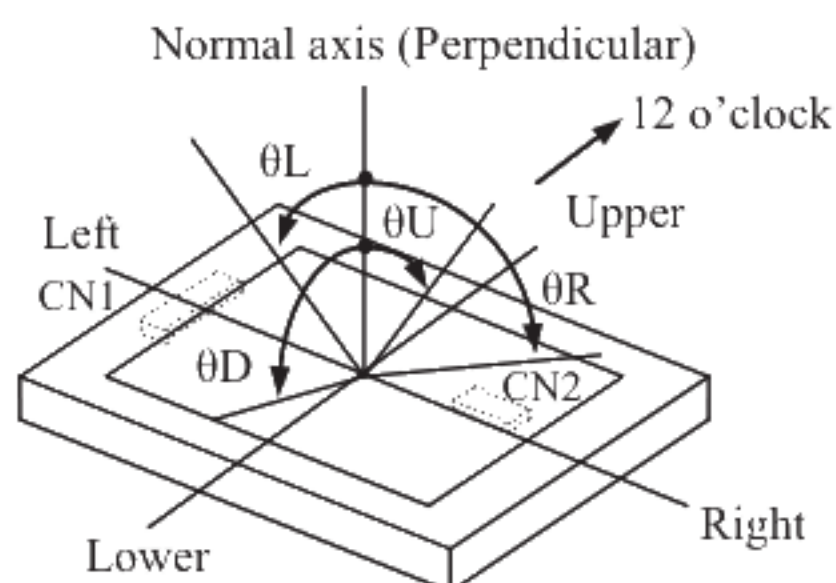


#### 4.9.4 Definition of response times

Response time is measured at the time when the luminance changes from "white" to "black", or "black" to "white" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 90% down to 10%. Also Toff is the time when the luminance changes from 10% up to 90% (See the following diagram.).



#### 4.9.5 Definition of viewing angles



## 5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

**This lifetime is the estimated value, and is not guarantee value.**

| Condition                |  | Estimated luminance lifetime<br>(Life time expectancy)<br>Note1, Note2, Note3 | Unit |
|--------------------------|--|---|------|
| LED elementary substance | 25°C (Ambient temperature of the product)<br>Continuous operation, PWM duty ratio: 100%                          | 50,000  | h    |
|                          | 80°C (Temperature at LCD panel surface<br>and rear shield surface)<br>Continuous operation, PWM duty ratio: 100% | 30,000  |      |

Note1: Life time expectancy is mean time to half-luminance.

Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.

Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.



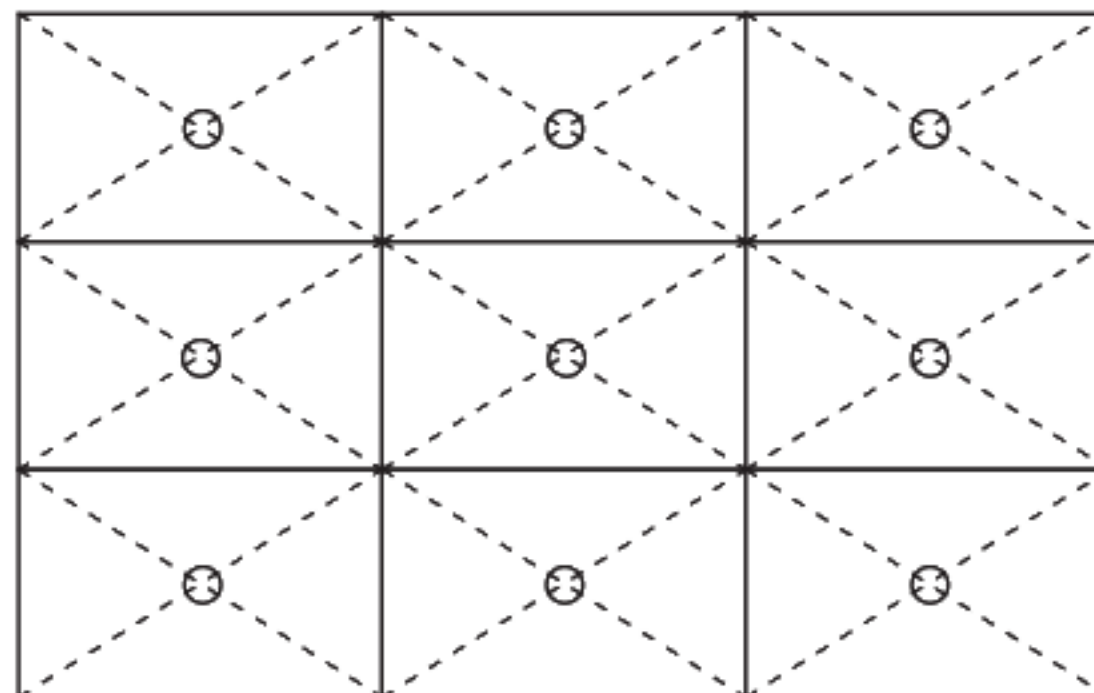


## 6. RELIABILITY TESTS

| Test item                                    | Condition   | Judgment                                       | Note1 |
|--|---|--|-------|
| High temperature and humidity<br>(Operation) | ① $60 \pm 2^{\circ}\text{C}$ , RH= 90%, 240hours<br>② Display data is black.  | No display malfunctions                        |       |
| High temperature<br>(Operation)              | ① $80 \pm 3^{\circ}\text{C}$ , 240hours<br>② Display data is black.   |  |       |
| Heat cycle<br>(Operation)                    | ① $-30 \pm 3^{\circ}\text{C}$ ...1hour<br>$80 \pm 3^{\circ}\text{C}$ ...1hour<br>② 50cycles, 4 hours/cycle<br>③ Display data is black.                                  |  |       |
| Thermal shock<br>(Non operation)             | ① $-30 \pm 3^{\circ}\text{C}$ ...30minutes<br>$80 \pm 3^{\circ}\text{C}$ ...30minutes<br>② 100cycles, 1hour/cycle<br>③ Temperature transition time is within 5 minutes. |  |       |
| ESD<br>(Operation)                           | ① 150pF, 150Ω, $\pm 10\text{kV}$<br>② 9 places on a panel surface Note2<br>③ 10 times each place at 1 sec interval  |  |       |
| Dust<br>(Operation)                          | ① Sample dust: No. 15 (by JIS-Z8901)<br>② 15 seconds stir<br>③ 8 times repeat at 1 hour interval  | No display malfunctions<br>No physical damages | ☆     |
| Vibration<br>(Non operation)                 | ① 5 to 200Hz, $66.6\text{m/s}^2$<br>② 1 minute/cycle<br>③ X, Y, Z directions<br>④ X, Y: 120 times each direction<br>Z: 240 times  |  |       |
| Mechanical shock<br>(Non operation)          | ① $539\text{m/s}^2$ , 11ms<br>② $\pm\text{X}$ , $\pm\text{Y}$ , $\pm\text{Z}$ directions<br>③ 5 times each direction  |  |       |

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.



## 7. PRECAUTIONS

### 7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**



This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.



This sign has the meaning that a customer will be injured if the customer practices wrong operations.

### 7.2 CAUTIONS



**\* Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than  $539\text{m/s}^2$  and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N ( $\phi 16\text{mm}$  jig))**

### 7.3 ATTENTIONS



#### 7.3.1 Handling of the product

- ① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
- ② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.
- ③ When the product is put on the table temporarily, display surface must be placed downward.
- ④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
- ⑤ The torque for product mounting screws must never exceed 0.200N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be  $\leq 3.5\text{mm}$ .
- ⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
- ⑦ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
- ⑧ Do not push or pull the interface connectors while the product is working.
- ⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
- ⑩ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.





## 7.3.2 Environment

- ① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
- ② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
- ③ Do not operate in high magnetic field. If not, circuit boards may be broken.
- ④ This product is not designed as radiation hardened.

## 7.3.3 Characteristics

**The following items are neither defects nor failures.**

- ① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
- ② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
- ③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
- ④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
- ⑤ Optical characteristics may be changed depending on input signal timings.

## 7.3.4 Others

- ① All GND, VCC and VDD terminals should be used without any non-connected lines.
- ② Do not disassemble a product or adjust variable resistors.
- ③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT.
- ④ Pay attention not to enter foreign materials inside of the product, when using tapping screws.
- ⑤ The information of China RoHS (II) six hazardous substances or elements in this product is as follows.

| China RoHS (II) six hazardous substances or elements |              |              |                             |                                |                                       |
|--|--------------|--------------|-----------------------------|--------------------------------|---------------------------------------|
| Lead (Pb)  | Mercury (Hg) | Cadmium (Cd) | Hexavalent Chromium (Cr VI) | Polybrominated Biphenyls (PBB) | Polybrominated Biphenyl Ethers (PBDE) |
| ×  | ○            | ○            | ○                           | ○                              | ○                                     |

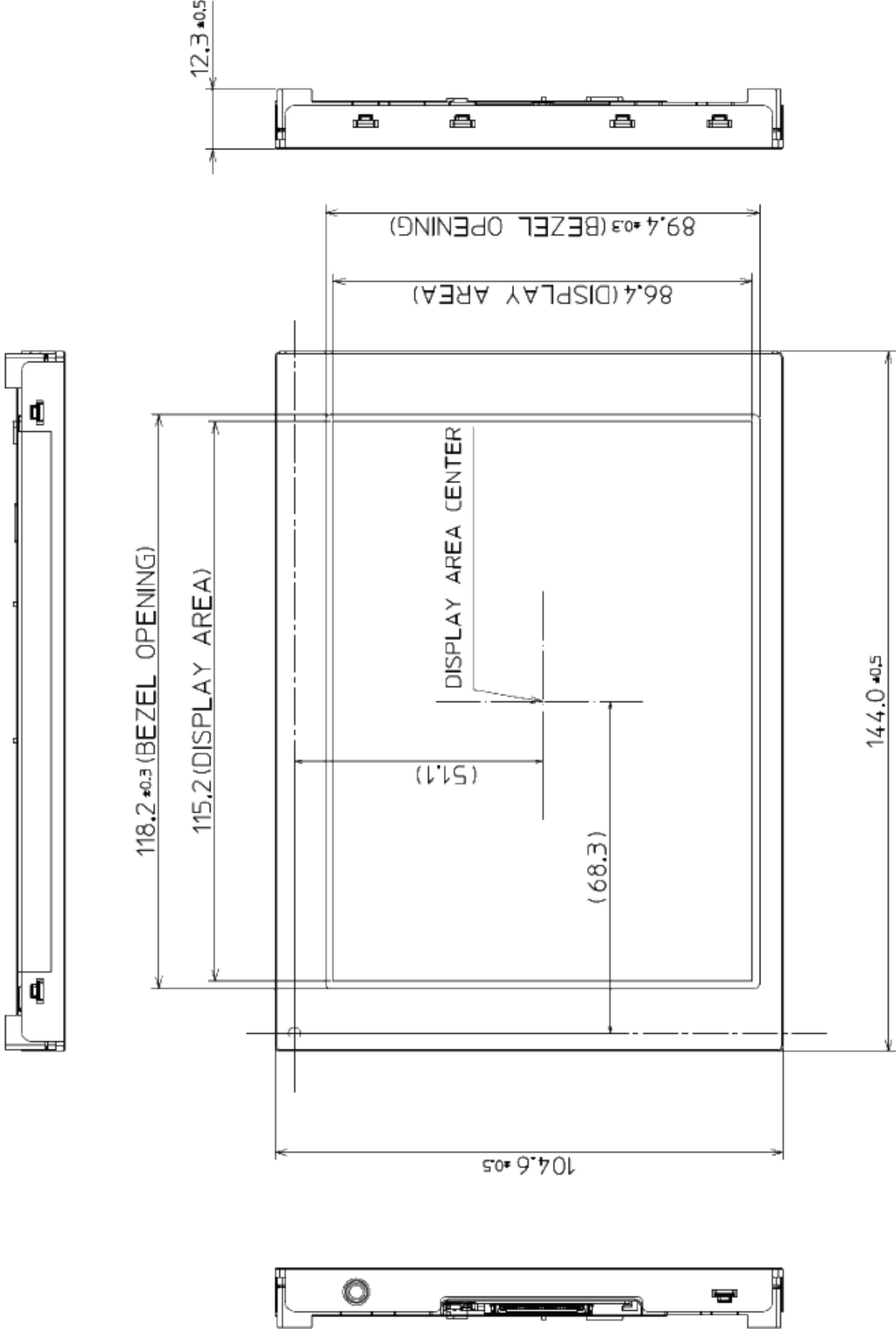
Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of GB/T26572-2011 standard regulation.

×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of GB/T26572-2011 standard regulation.



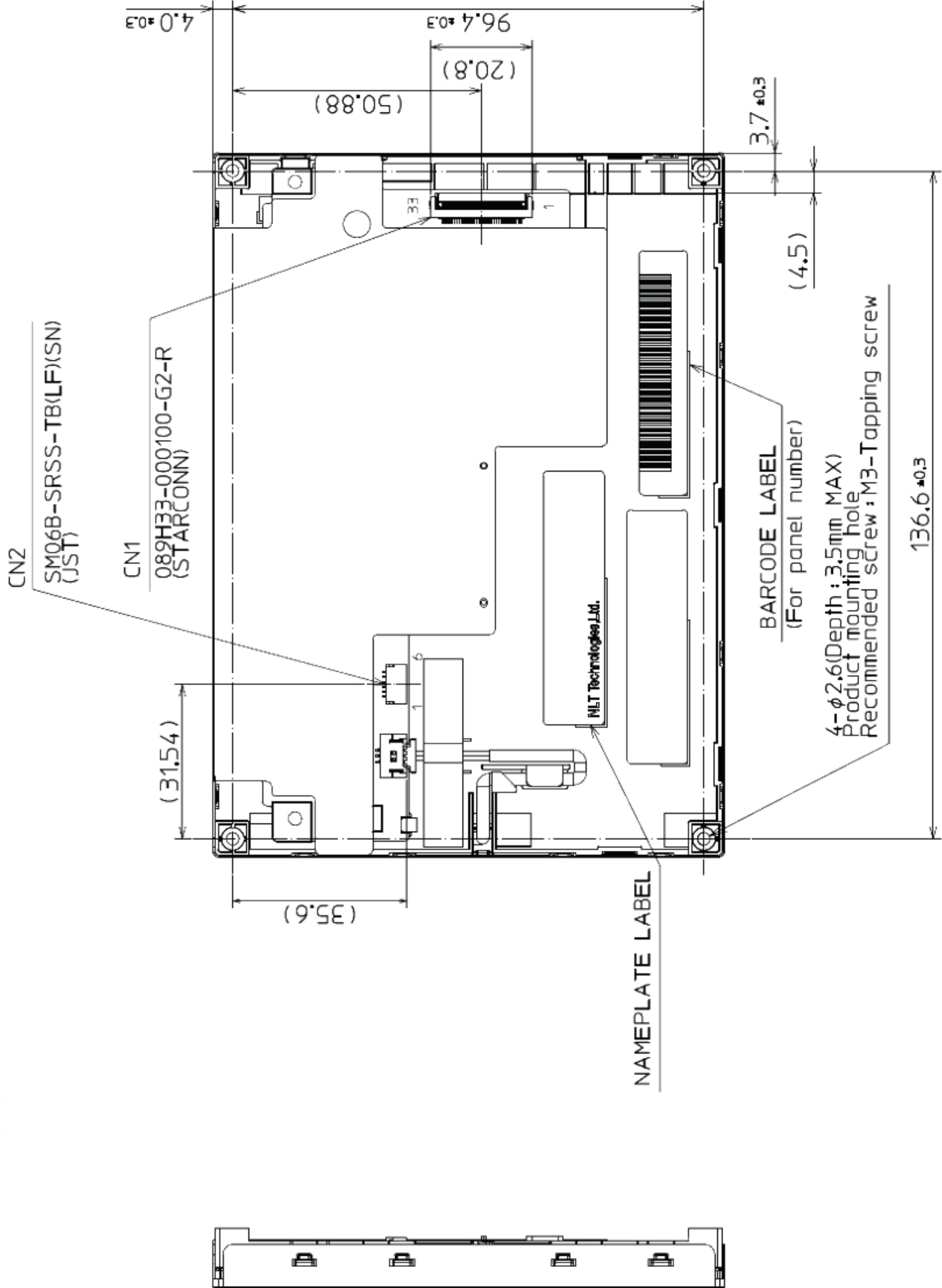
8. OUTLINE DRAWINGS

8.1 FRONT VIEW



Note! : The values in parentheses are for reference.

8.2 REAR VIEW



Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.200N·m. And the length of product mounting screws must be ≤ 3.5mm.

Unit: mm