



PRELIMINARY

**NLT Technologies**

# **TFT COLOR LCD MODULE**

**NL192108BC18-06F**

**40cm (15.6 Type)**

**FHD**

**eDP interface**

**PRELIMINARY DATA SHEET**



**DOD-PP-2375 (1st edition)**

**All information is subject to change without notice.  
Please confirm the sales representative before starting  
to design your system.**

### INTRODUCTION

The Copyright to this document belongs to NLT Technologies, Ltd. (hereinafter called "NLT"). No part of this document will be used, reproduced or copied without prior written consent of NLT.

NLT does and will not assume any liability for infringement of patents, copyrights or other intellectual property rights of any third party arising out of or in connection with application of the products described herein except for that directly attributable to mechanisms and workmanship thereof. No license, express or implied, is granted under any patent, copyright or other intellectual property right of NLT.

Some electronic products would fail or malfunction at a certain rate. In spite of every effort to enhance reliability of products by NLT, the possibility of failures and malfunction might not be avoided entirely. To prevent the risks of damage to death, human bodily injury or other property arising out thereof or in connection therewith, each customer is required to take sufficient measures in its safety designs and plans including, but not limited to, redundant system, fire-containment and anti-failure.

The products are classified into three grades: "**Standard**", "**Special**", and "**Specific**".

Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The **Standard**: Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.

Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

The **Special**: Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.

Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

The **Specific**: Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.

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.

## CONTENTS

|                                                        |           |
|--------------------------------------------------------|-----------|
| <b>INTRODUCTION .....</b>                              | <b>2</b>  |
| <b>1. OUTLINE .....</b>                                | <b>4</b>  |
| 1.1 STRUCTURE AND PRINCIPLE .....                      | 4         |
| 1.2 APPLICATION .....                                  | 4         |
| 1.3 FEATURES .....                                     | 4         |
| <b>2. GENERAL SPECIFICATIONS .....</b>                 | <b>5</b>  |
| <b>3. BLOCK DIAGRAM .....</b>                          | <b>6</b>  |
| <b>4. DETAILED SPECIFICATIONS .....</b>                | <b>8</b>  |
| 4.1 MECHANICAL SPECIFICATIONS .....                    | 8         |
| 4.2 ABSOLUTE MAXIMUM RATINGS .....                     | 8         |
| 4.3 ELECTRICAL CHARACTERISTICS .....                   | 9         |
| 4.3.1 LCD panel signal processing board .....          | 9         |
| 4.3.2 Backlight .....                                  | 9         |
| 4.3.3 Fuse .....                                       | 9         |
| 4.4 POWER SUPPLY VOLTAGE SEQUENCE .....                | 10        |
| 4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS ..... | 11        |
| 4.5.1 LCD panel signal processing board .....          | 11        |
| 4.5.2 Backlight .....                                  | 12        |
| 4.5.3 Positions of socket .....                        | 12        |
| 4.6 DISPLAY COLORS AND INPUT DATA SIGNALS .....        | 13        |
| 4.7 INPUT DATA SIGNALS AND DISPLAY POSITIONS .....     | 14        |
| 4.8 eDP SIGNAL TIMING SPECIFICATIONS .....             | 15        |
| 4.8.1 Display Port main link signal .....              | 15        |
| 4.8.2 Display Port HPD signal .....                    | 15        |
| 4.8.3 Display port AUX signal .....                    | 15        |
| 4.9 INPUT SIGNAL TIMINGS .....                         | 16        |
| 4.9.1 Outline of input signal timings .....            | 16        |
| 4.9.2 Timing characteristics .....                     | 17        |
| 4.9.3 Input signal timing chart .....                  | 17        |
| 4.10 OPTICS .....                                      | 18        |
| 4.10.1 Optical characteristics .....                   | 18        |
| 4.10.2 Definition of contrast ratio .....              | 19        |
| 4.10.3 Definition of luminance uniformity .....        | 19        |
| 4.10.4 Definition of response times .....              | 19        |
| 4.10.5 Definition of viewing angles .....              | 19        |
| <b>5. ESTIMATED LUMINANCE LIFETIME .....</b>           | <b>20</b> |
| <b>6. RELIABILITY TESTS .....</b>                      | <b>21</b> |
| <b>7. PRECAUTIONS .....</b>                            | <b>22</b> |
| 7.1 MEANING OF CAUTION SIGNS .....                     | 22        |
| 7.2 CAUTIONS .....                                     | 22        |
| 7.3 ATTENTIONS .....                                   | 22        |
| 7.3.1 Handling of the product .....                    | 22        |
| 7.3.2 Environment .....                                | 23        |
| 7.3.3 Characteristics .....                            | 23        |
| 7.3.4 Others .....                                     | 23        |
| <b>8. OUTLINE DRAWINGS .....</b>                       | <b>24</b> |
| 8.1 FRONT VIEW .....                                   | 24        |
| 8.2 REAR VIEW .....                                    | 25        |
| <b>REVISION HISTORY .....</b>                          | <b>26</b> |

### 1. OUTLINE

#### 1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL192108BC18-06F 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

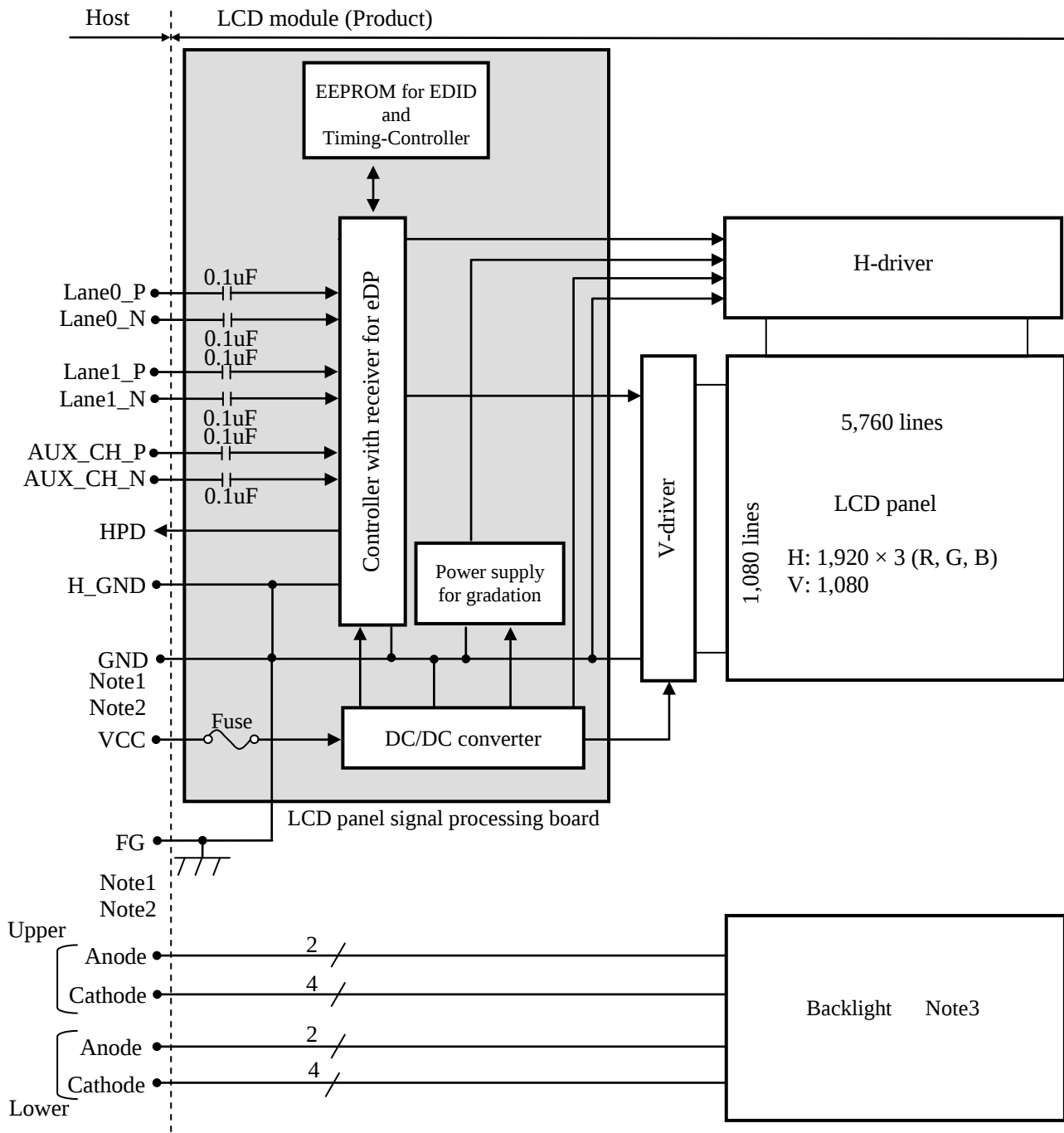
#### 1.3 FEATURES

- Ultra wide viewing angle (Super Fine TFT (SFT))
- Ultra high luminance
- High contrast
- Wide color gamut
- Wide temperature range
- eDP interface
- Narrow frame
- LED backlight
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

## 2. GENERAL SPECIFICATIONS

|                                   |                                                                                                                                                                                                             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Display area</b>               | 344.16 (H) × 193.59 (V) mm                                                                                                                                                                                  |
| <b>Diagonal size of display</b>   | 40cm (15.6 inches)                                                                                                                                                                                          |
| <b>Drive system</b>               | a-Si TFT active matrix                                                                                                                                                                                      |
| <b>Display color</b>              | 16,777,216 colors                                                                                                                                                                                           |
| <b>Pixel</b>                      | 1,920 (H) × 1,080 (V) pixels                                                                                                                                                                                |
| <b>Pixel arrangement</b>          | RGB (Red dot, Green dot, Blue dot) vertical stripe                                                                                                                                                          |
| <b>Dot pitch</b>                  | 0.05975 (H) × 0.17925 (V) mm                                                                                                                                                                                |
| <b>Pixel pitch</b>                | 0.17925 (H) × 0.17925 (V) mm                                                                                                                                                                                |
| <b>Module size</b>                | 363.8 (W) × 215.9 (H) × 15.7 D mm (typ.)                                                                                                                                                                    |
| <b>Weight</b>                     | (1,300) g (typ.)                                                                                                                                                                                            |
| <b>Contrast ratio</b>             | 750:1 (typ.)                                                                                                                                                                                                |
| <b>Viewing angle</b>              | At the contrast ratio $\geq 10:1$ <ul style="list-style-type: none"> <li>• Horizontal: Right side 88° (typ.), Left side 88° (typ.)</li> <li>• Vertical: Up side 88° (typ.), Down side 88° (typ.)</li> </ul> |
| <b>Designed viewing direction</b> | • Viewing angle with optimum grayscale ( $\gamma \approx 2.2$ ): Normal axis (perpendicular)                                                                                                                |
| <b>Polarizer surface</b>          | Antiglare                                                                                                                                                                                                   |
| <b>Polarizer pencil-hardness</b>  | 3H (min.) [by JIS K5600]                                                                                                                                                                                    |
| <b>Color gamut</b>                | At LCD panel center<br>40% (typ.) [against NTSC color space]                                                                                                                                                |
| <b>Response time</b>              | $T_{on} + T_{off}$ (10% $\leftrightarrow$ 90%)<br>30ms (typ.)                                                                                                                                               |
| <b>Luminance</b>                  | At $IL = (65) \text{mA/One circuit}$<br>1,500cd/m <sup>2</sup> (typ.)                                                                                                                                       |
| <b>Signal system</b>              | eDP 2lanes, 2.7Gbps<br>[8-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE)]                                                                                                    |
| <b>Power supply voltage</b>       | LCD panel signal processing board: 3.3V                                                                                                                                                                     |
| <b>Backlight</b>                  | LED backlight                                                                                                                                                                                               |
| <b>Power consumption</b>          | At $IL = (65) \text{mA/One circuit}$ , Checkered flag pattern<br>(24.4)W (typ.)                                                                                                                             |

### 3. BLOCK DIAGRAM

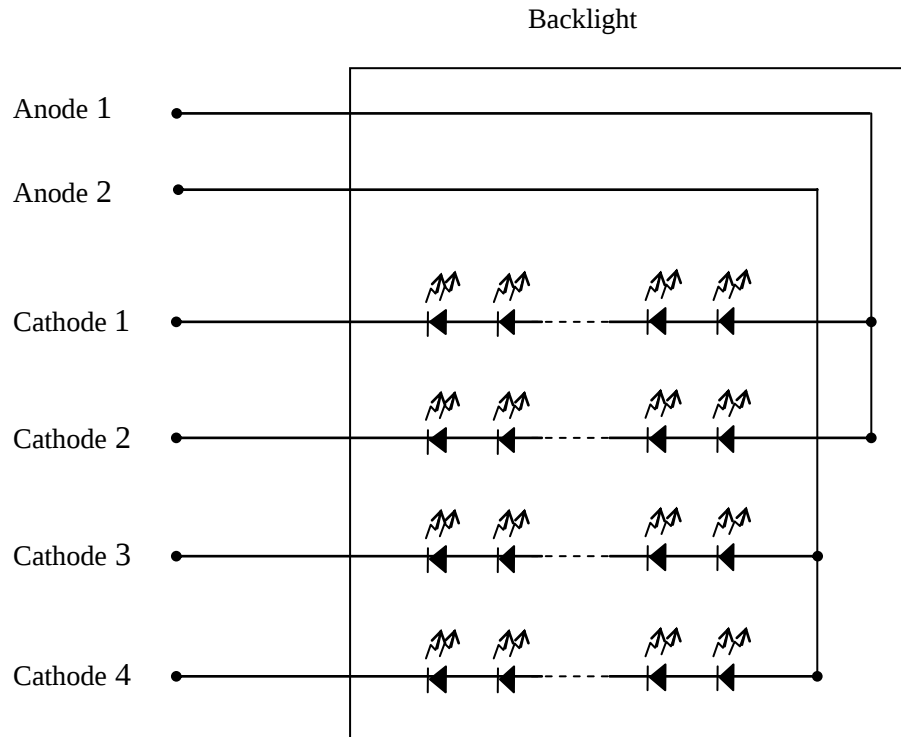


Note1: Relations between H\_GND (High Speed Ground), GND (Signal ground) and FG (Frame ground) in the LCD module are as follows.

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

Note2: H\_GND, 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.

Note3: Backlight in detail



This figure is a common view of both upper and lower.

## 4. DETAILED SPECIFICATIONS

## 4.1 MECHANICAL SPECIFICATIONS

| Parameter    | Specification                                                                      | Unit |
|--------------|------------------------------------------------------------------------------------|------|
| Module size  | $363.8 \pm 0.5$ (W) $\times$ $215.9 \pm 0.5$ (H) $\times$ $15.7 \pm 0.5$ (D) Note1 | mm   |
| Display area | $344.16$ (H) $\times$ $193.59$ (V) Note1                                           | mm   |
| Weight       | (1,300) (typ.), TBD (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 +4.0)     | V                | Ta= 25°C                                             |
| Input voltage for signals  | Display signals                   | VD     | (-0.3 to +3.6)     | V                |                                                      |
| Backlight                  | Forward current                   | IL     | 75                 | mA               | per one circuit<br>Ta = 25°C                         |
| Storage temperature        |                                   | Tst    | (-40) to (+85)     | °C               | -                                                    |
| Operating temperature      | Front surface                     | TopF   | (-30) to (+85)     | °C               | Note1                                                |
|                            | Rear surface                      | TopR   | (-30) to (+85)     | °C               | Note2                                                |
| Relative humidity<br>Note3 |                                   | RH     | $\leq 95$          | %                | Ta $\leq 40^\circ\text{C}$                           |
|                            |                                   |        | $\leq 85$          | %                | $40^\circ\text{C} < \text{Ta} \leq 50^\circ\text{C}$ |
|                            |                                   |        | $\leq 55$          | %                | $50^\circ\text{C} < \text{Ta} \leq 60^\circ\text{C}$ |
|                            |                                   |        | $\leq 36$          | %                | $60^\circ\text{C} < \text{Ta} \leq 70^\circ\text{C}$ |
|                            |                                   |        | $\leq 24$          | %                | $70^\circ\text{C} < \text{Ta} \leq 80^\circ\text{C}$ |
|                            |                                   |        | $\leq 20$          | %                | $80^\circ\text{C} < \text{Ta} \leq 85^\circ\text{C}$ |
| Absolute humidity<br>Note3 |                                   | AH     | $\leq 70$<br>Note4 | g/m <sup>3</sup> | Ta= 85°C                                             |

Note1: Measured at LCD panel surface (including self-heat)

Note2: Measured at LCD module's rear shield surface (including self-heat)

Note3: No condensation

Note4: Water amount at Ta= 85°C and RH= 20%

## 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    | -    | 580<br>Note1 | 1000<br>Note2 | mA    | at VCC= 3.3V                      |
| Permissible ripple voltage | VRPC   | -    | -            | 100           | mVp-p | for VCC<br>Note3, Note4,<br>Note5 |

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 Backlight

(Ta= 25°C, Note1, Note2, Note3)

| Parameter       | Symbol | min.   | typ.   | max.   | Unit | Remarks                                    |
|-----------------|--------|--------|--------|--------|------|--------------------------------------------|
| Forward current | IL     | -      | (65)   | (70)   | mA   | -                                          |
| Forward Voltage | VL     | (38.8) | (43.7) | (48.6) | V    | Ta= +25°C<br>at IL= (65)mA<br>/One circuit |
|                 |        | (36.4) | -      | -      |      | Ta= +85°C<br>at IL= (65)mA<br>/One circuit |
|                 |        | -      | -      | (51.5) |      | Ta= -30°C<br>at IL= (65)mA<br>/One circuit |
|                 |        | -      | -      | (52.1) |      | Ta= -30°C<br>at IL= (70)mA<br>/One circuit |

Note1: Please drive the backlight with constant current.

Note2: The above specifications are for one LED circuit of the backlight.

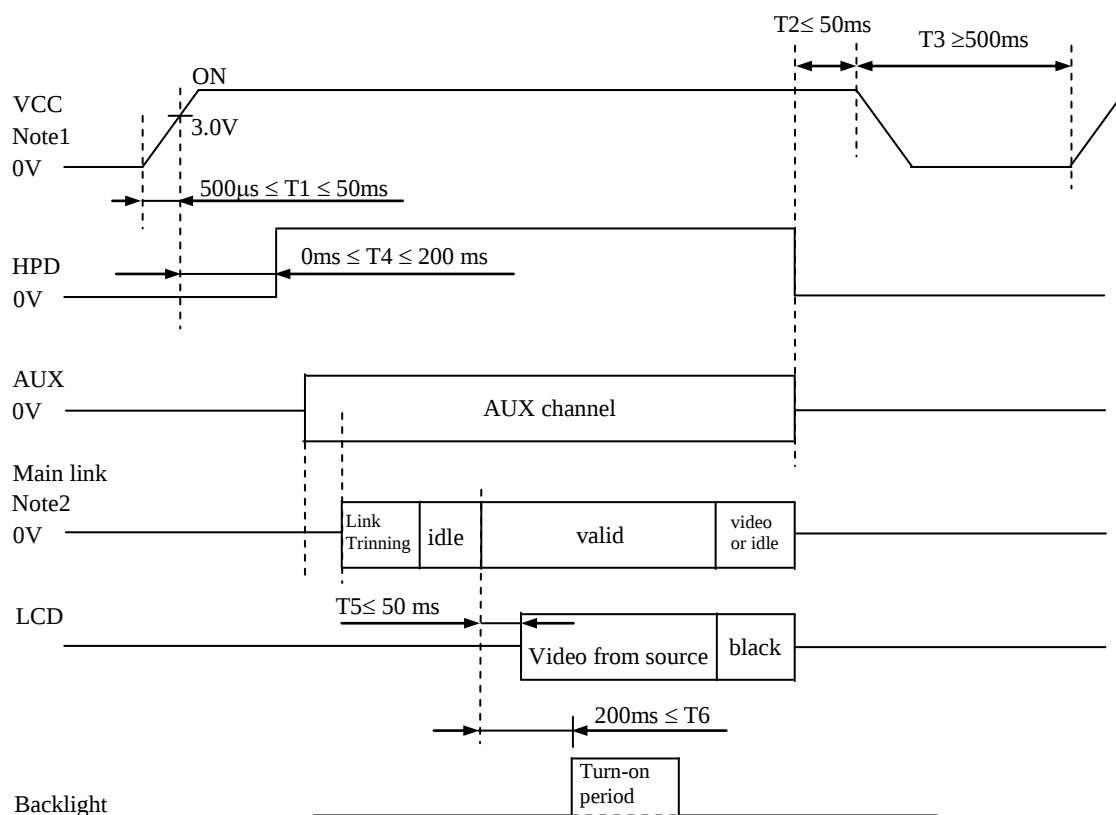
Note3: The luminance uniformity may be changed depending on the current variation between 4 circuits. It is recommended that the current value difference among the circuits be less than 5%.

## 4.3.3 Fuse

| Parameter | Fuse       |                             | Rating | Fusing current | Remarks |
|-----------|------------|-----------------------------|--------|----------------|---------|
|           | Type       | Supplier                    |        |                |         |
| VCC       | FCC16202AB | KAMAYA ELECTRIC<br>CO., LTD | 2.0A   | TBD            | Note1   |
|           |            |                             | 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



Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (Lane0\_P/N, Lane1\_P/N) must be set to Low or High-impedance, except the VCC ON period (See above sequence diagram), in order to avoid the circuitry damage.

## 4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

## 4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): 20455-040E (IPEX)

Adaptable plug: 20453-240T-11 (IPEX, Plug Set)

20454-240T (IPEX, HOUSING) or equivalent

| Pin | Signal Name | Description                                        | Remarks |
|-----|-------------|----------------------------------------------------|---------|
| 1   | N.C.        | Keep this pin Open.                                | -       |
| 2   | N.C.        |                                                    |         |
| 3   | N.C.        |                                                    |         |
| 4   | N.C.        |                                                    |         |
| 5   | N.C.        |                                                    |         |
| 6   | N.C.        |                                                    |         |
| 7   | N.C.        |                                                    |         |
| 8   | H_GND       | High Speed Ground                                  | Note1   |
| 9   | Lane1_N     | Complement Signal Link Lane 1                      | -       |
| 10  | Lane1_P     | True Signal Link Lane 1                            | -       |
| 11  | H_GND       | High Speed Ground                                  | Note1   |
| 12  | Lane0_N     | Complement Signal Link Lane 0                      | -       |
| 13  | Lane0_P     | True Signal Link Lane 0                            | -       |
| 14  | H_GND       | High Speed Ground                                  | Note1   |
| 15  | AUX_CH_P    | True Signal Auxiliary Channel                      | -       |
| 16  | AUX_CH_N    | Complement Signal Auxiliary Channel                | -       |
| 17  | H_GND       | High Speed Ground                                  | Note1   |
| 18  | VCC         | Power supply for LCD panel signal processing board | Note1   |
| 19  | VCC         |                                                    |         |
| 20  | VCC         |                                                    |         |
| 21  | VCC         |                                                    |         |
| 22  | RSVD        | Keep this pin Open.                                | -       |
| 23  | GND         | Ground                                             | Note1   |
| 24  | GND         |                                                    |         |
| 25  | GND         |                                                    |         |
| 26  | GND         |                                                    |         |
| 27  | HPD         | HPD Signal Pin                                     | -       |
| 28  | N.C.        | Keep this pin Open.                                | -       |
| 29  | N.C.        |                                                    |         |
| 30  | N.C.        |                                                    |         |
| 31  | N.C.        |                                                    |         |
| 32  | N.C.        |                                                    |         |
| 33  | N.C.        |                                                    |         |
| 34  | N.C.        |                                                    |         |
| 35  | N.C.        |                                                    |         |
| 36  | N.C.        |                                                    |         |
| 37  | N.C.        |                                                    |         |
| 38  | N.C.        |                                                    |         |
| 39  | N.C.        |                                                    |         |
| 40  | N.C.        |                                                    |         |

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

### 4.5.2 Backlight

CN2 socket (LCD module side): BM06B-SHJS-TB (HF) (J.S.T. Mfg. Co., Ltd.)

Adaptable plug: SHJP-06V-S (HF) (J.S.T. Mfg. Co., Ltd.)

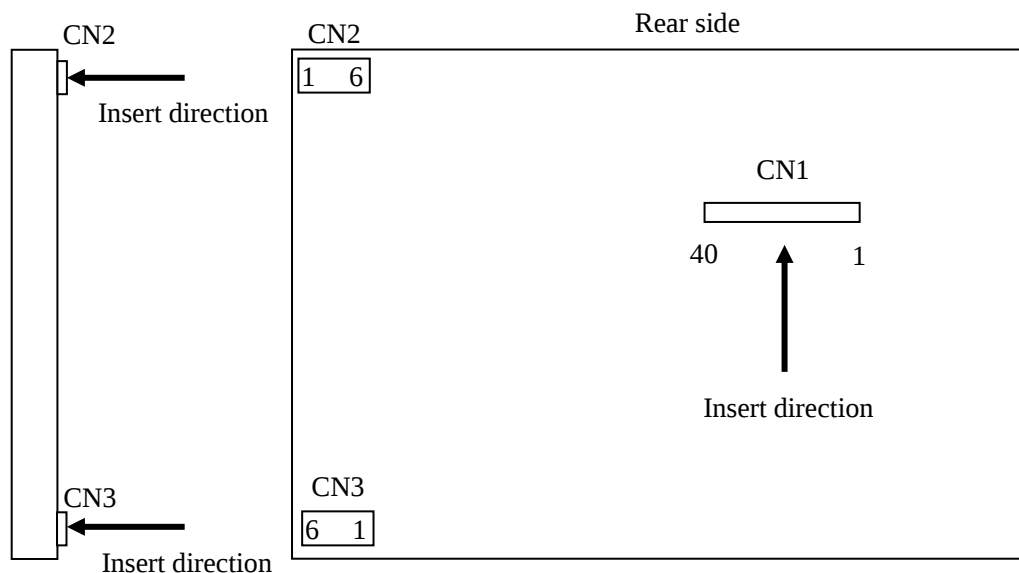
| Pin No. | Symbol | Signal    | Remarks |
|---------|--------|-----------|---------|
| 1       | A1     | Anode 1   | -       |
| 2       | A2     | Anode 2   | -       |
| 3       | K1     | Cathode 1 | -       |
| 4       | K2     | Cathode 2 | -       |
| 5       | K3     | Cathode 3 | -       |
| 6       | K4     | Cathode 4 | -       |

CN3 socket (LCD module side): BM06B-SHJS-TB (HF) (J.S.T. Mfg. Co., Ltd.)

Adaptable plug: SHJP-06V-S (HF) (J.S.T. Mfg. Co., Ltd.)

| Pin No. | Symbol | Signal    | Remarks |
|---------|--------|-----------|---------|
| 1       | K4     | Cathode 4 | -       |
| 2       | K3     | Cathode 3 | -       |
| 3       | K2     | Cathode 4 | -       |
| 4       | K1     | Cathode 1 | -       |
| 5       | A2     | Anode 2   | -       |
| 6       | A1     | Anode 1   | -       |

### 4.5.3 Positions of socket

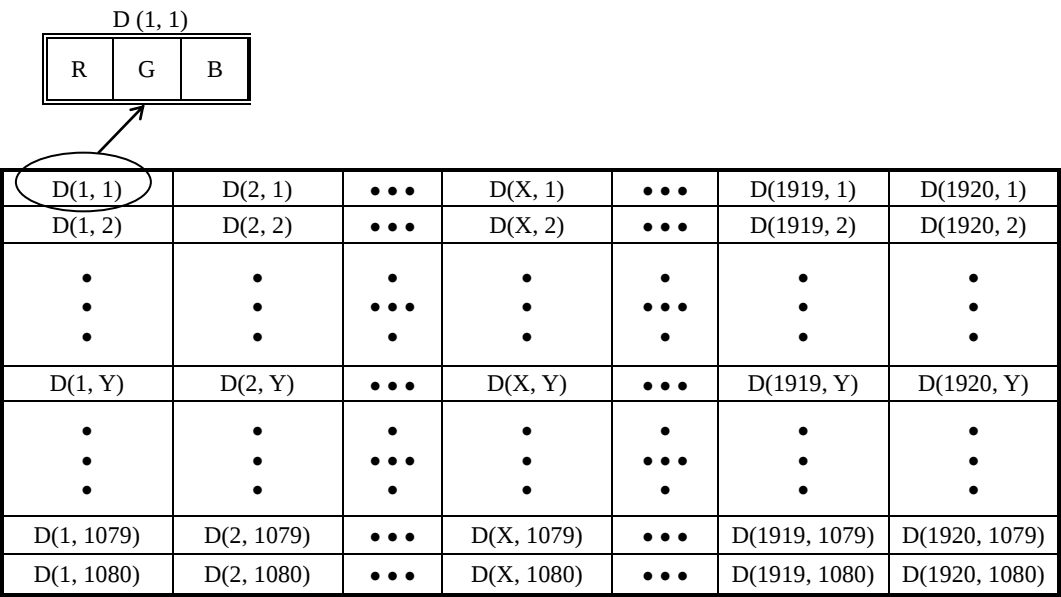


### 4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display equivalent of 16,777,216 colors with 256 gray scales.  
Also the relation between display colors and input data signals is as follows.

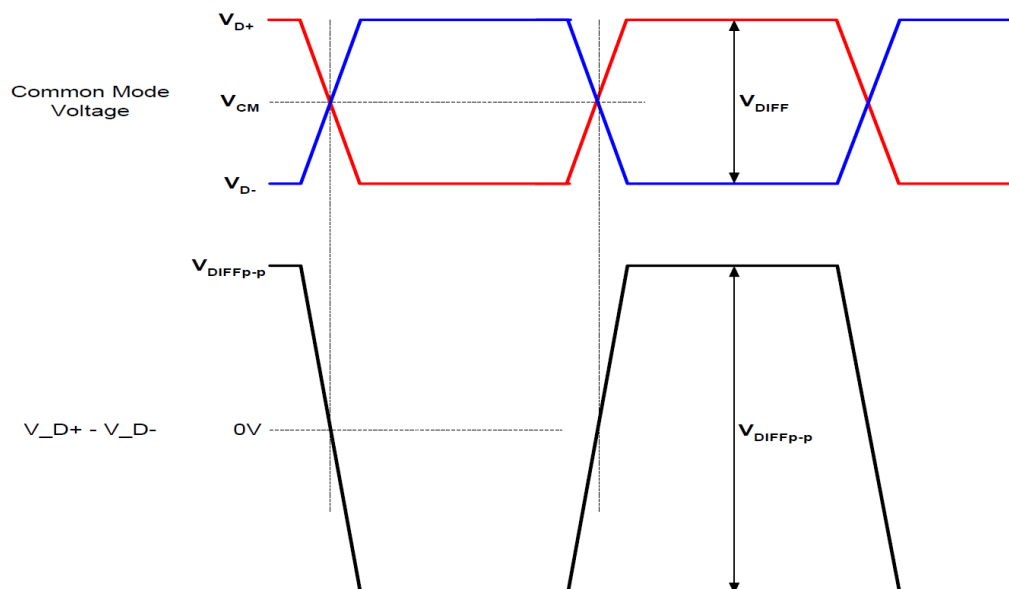
| Display colors   |         | Input color data |    |    |    |    |    |    |    |       |    |    |    |    |    |    |    |
|------------------|---------|------------------|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|
|                  |         | Red              |    |    |    |    |    |    |    | Green |    |    |    |    |    |    |    |
|                  |         | R7               | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7    | G6 | G5 | G4 | G3 | G2 | G1 | G0 |
| Basic Colors     | Black   | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | Blue    | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | Red     | 1                | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | Magenta | 1                | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | Green   | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                  | Cyan    | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                  | Yellow  | 1                | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                  | White   | 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  |
|                  | dark    | 0                | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | ↑       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | ↓       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | bright  | 1                | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 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  |
|                  | dark    | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
|                  | ↑       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | ↓       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | bright  | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 1  |
| 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  | 1  |
|                  | dark    | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | ↑       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | ↓       |                  |    |    | :  | :  |    |    |    |       |    | :  | :  |    |    |    |    |
|                  | bright  | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Blue gray scale  |         | 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  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                  | Blue    | 0                | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

4.7 INPUT DATA SIGNALS AND DISPLAY POSITIONS



### 4.8 eDP SIGNAL TIMING SPECIFICATIONS

#### 4.8.1 Display Port main link signal



| Parameter                               | Symbol        | min. | typ. | max.  | Unit | Remarks |
|-----------------------------------------|---------------|------|------|-------|------|---------|
| Differential peak-to-peak Input voltage | $V_{DIFFp-p}$ | 100  | -    | 1,320 | mV   | -       |
| Rx input DC common Mode Voltage         | $V_{CM}$      | -    | 0    | -     | V    | -       |
| Jitter tracking bandwidth               | -             | 10   | -    | -     | MHz  | -       |
| Link clock down spreading               | -             | -    | 0.5  | -     | %    | -       |

#### 4.8.2 Display Port HPD signal

| Description     | Symbol | min. | typ. | max. | Unit | Remarks          |
|-----------------|--------|------|------|------|------|------------------|
| Hot Plug detect | HPD    | 2.0  | -    | 2.5  | V    | I/O type: LVTTTL |

#### 4.8.3 Display port AUX signal

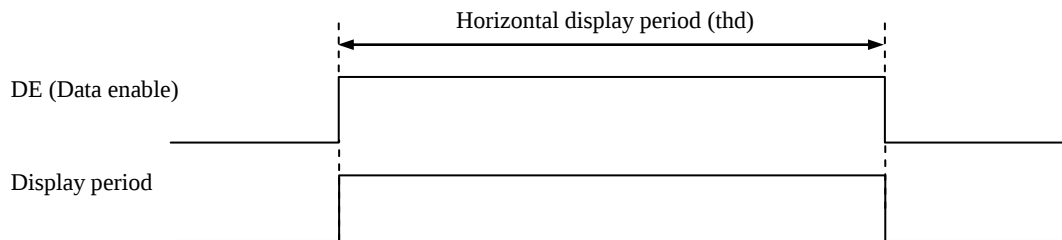
| Description                                          | Symbol | min. | typ. | max. | Unit     | Remarks |
|------------------------------------------------------|--------|------|------|------|----------|---------|
| AUX differential peak-to-peak voltage When driving   | -      | 0.4  | -    | 1    | V        | -       |
| AUX differential peak-to-peak voltage When receiving | -      | 0.25 | -    | 1.36 | V        | -       |
| AUX common-mode voltage When transmitting            | -      | -    | 0.15 | -    | V        | -       |
| AUX common-mode voltage When receiving               | -      | -    | GND  | -    | V        | -       |
| AUX differential termination resistance              | -      | 80   | 100  | 120  | $\Omega$ | -       |
| Unit interval                                        | -      | 0.4  | 0.5  | 0.6  | $\mu s$  | -       |
| Cycle-to-cycle jitter time                           | -      | -    | -    | 0.04 | UI       | -       |

### 4.9 INPUT SIGNAL TIMINGS

#### 4.9.1 Outline of input signal timings

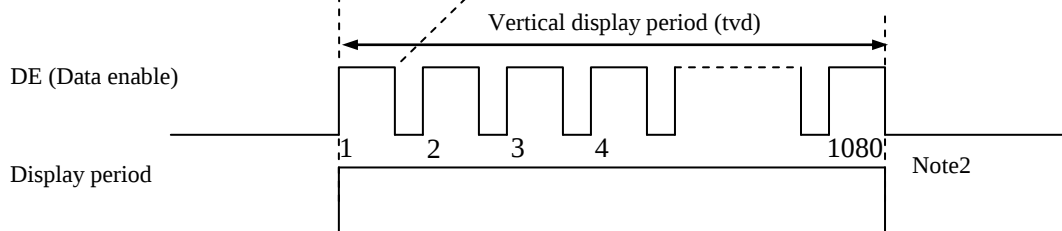
- Horizontal signal

Note1



- Vertical signal

Note1



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

Note2: See "4.9.3 Input signal timing chart" for the pulse number.

### 4.9.2 Timing characteristics

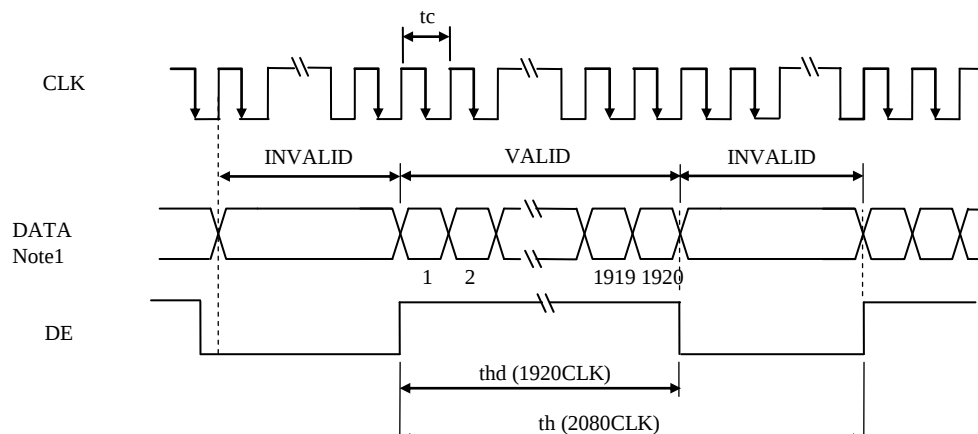
(Note1)

| Parameter |                         | Symbol         | min.  | typ.  | max.  | Unit   | Remarks          |
|-----------|-------------------------|----------------|-------|-------|-------|--------|------------------|
| CLK       | Frequency               | 1/tc           | 111.0 | 138.5 | 166.5 | MHz    | 7.22ns (typ.)    |
|           | Duty ratio              | -              | -     |       |       | -      | -                |
|           | Rise time, Fall time    | -              |       |       |       | ns     |                  |
| DE        | Horizontal              | Cycle          | th    | -     | 15.02 | -      | 66.59 kHz (typ.) |
|           |                         |                |       | 2,040 | 2,080 | 2,280  | CLK              |
|           |                         | Display period | thd   | 1,920 |       |        | CLK              |
|           | Vertical<br>(One frame) | Cycle          | tv    | -     | 16.70 | -      | 59.88Hz (typ.)   |
|           |                         |                |       | 1,111 | 1,112 | 1,212- | H                |
|           |                         | Display period | tvd   | 1,080 |       |        | H                |

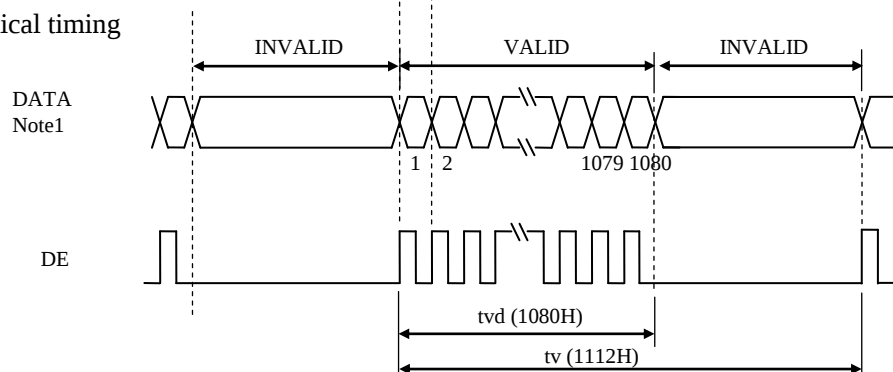
Note1: Definition of parameters is as follows.  
tc= 1CLK, th= 1H

### 4.9.3 Input signal timing chart

#### Horizontal timing



#### Vertical timing



Note1: DATA=R0-R7, G0-G7, B0-B7

### 4.10 OPTICS

#### 4.10.1 Optical characteristics

(Note1, Note2)

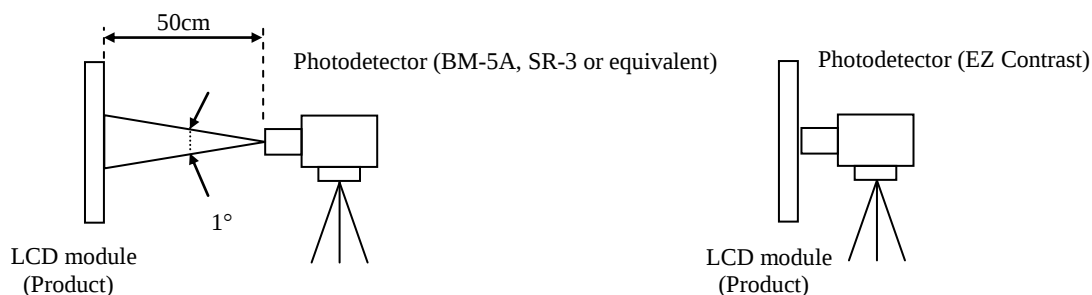
| (Note1, Note2)       |       |                                                                       |        |       |       |       |                   |                      |         |
|----------------------|-------|-----------------------------------------------------------------------|--------|-------|-------|-------|-------------------|----------------------|---------|
| Parameter            |       | Condition                                                             | Symbol | min.  | typ.  | max.  | Unit              | Measuring instrument | Remarks |
| Luminance            |       | White at center<br>θR= 0°, θL= 0°, θU= 0°, θD= 0°                     | L      | 1,200 | 1,500 | -     | cd/m <sup>2</sup> | BM-5A or equivalent  | -       |
| Contrast ratio       |       | White/Black at center<br>θR= 0°, θL= 0°, θU= 0°, θD= 0°               | CR     | (500) | 750   | -     | -                 | BM-5A or equivalent  | Note3   |
| Luminance uniformity |       | White<br>θR= 0°, θL= 0°, θU= 0°, θD= 0°                               | 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     | -     | 0.565 | -     | -                 |                      |         |
|                      |       | y coordinate                                                          | Ry     | -     | 0.345 | -     | -                 |                      |         |
|                      | Green | x coordinate                                                          | Gx     | -     | 0.340 | -     | -                 |                      |         |
|                      |       | y coordinate                                                          | Gy     | -     | 0.530 | -     | -                 |                      |         |
|                      | Blue  | x coordinate                                                          | Bx     | -     | 0.150 | -     | -                 |                      |         |
|                      |       | y coordinate                                                          | By     | -     | 0.105 | -     | -                 |                      |         |
| Color gamut          |       | θR= 0°, θL= 0°, θU= 0°, θD= 0°<br>at center, against NTSC color space | C      | (35)  | 40    | -     | %                 |                      |         |
| Response time        |       | Black to White                                                        | Ton    | -     | 15    | TBD   | ms                | BM-5A or equivalent  | Note6   |
|                      |       | White to Black                                                        | Toff   | -     | 15    | TBD   | ms                |                      | Note7   |
| Viewing angle        | Right | θU= 0°, θD= 0°, CR≥ 10                                                | θR     | 70    | 88    | -     | °                 | EZ Contrast          | Note8   |
|                      | Left  | θU= 0°, θD= 0°, CR≥ 10                                                | θL     | 70    | 88    | -     | °                 |                      |         |
|                      | Up    | θR= 0°, θL= 0°, CR≥ 10                                                | θU     | 70    | 88    | -     | °                 |                      |         |
|                      | Down  | θR= 0°, θL= 0°, CR≥ 10                                                | θD     | 70    | 88    | -     | °                 |                      |         |

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 3.3V, IL= (65) mA/One Circuit, Display mode: FHD,  
Horizontal cycle= 1/66.59kHz, Vertical cycle= 1/59.88Hz

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



Note3: See "4.10.2 Definition of contrast ratio".

Note4: See "4.10.3 Definition of luminance uniformity".

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

Note6: Product surface temperature: TopF= TBD°C

Note7: See "4.10.4 Definition of response times".

Note8: See "4.10.5 Definition of viewing angles".

### 4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

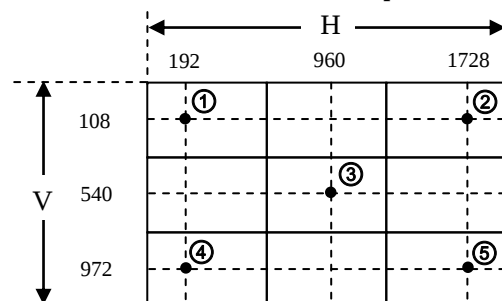
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

### 4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

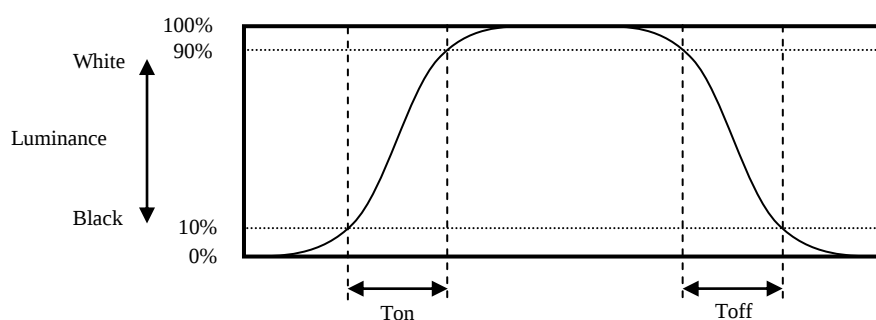
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

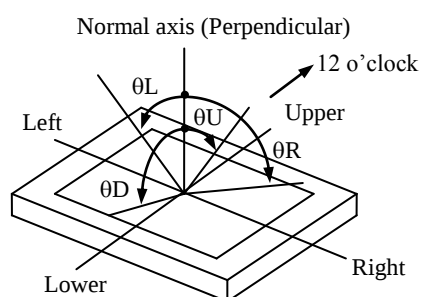


### 4.10.4 Definition of response times

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



### 4.10.5 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, IL= (65)mA/One<br>circuit                            | 50,000                                                                        | h    |
|                          | TBD °C (Temperature of LCD panel surface<br>and rear shield surface)<br>Continuous operation, IL= (65)mA/One<br>circuit | TBD                                                                           |      |

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.

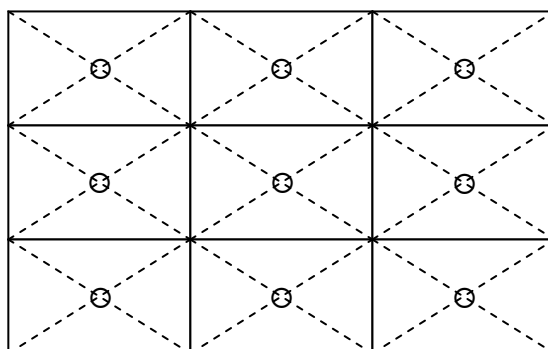
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

### 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 white.                                                                                            | No display malfunctions                        |       |
| High temperature<br>(Operation)              | ① $+85 \pm 3^{\circ}\text{C}$ , 240hours<br>② Display data is white.                                                                                                     |                                                |       |
| Heat cycle<br>(Operation)                    | ① $-30 \pm 3^{\circ}\text{C}$ ...1hour<br>$+85 \pm 3^{\circ}\text{C}$ ...1hour<br>② 50cycles, 4 hours/cycle<br>③ Display data is white.                                  |                                                |       |
| Thermal shock<br>(Non operation)             | ① $-40 \pm 3^{\circ}\text{C}$ ...30minutes<br>$+85 \pm 3^{\circ}\text{C}$ ...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                                                                         |                                                |       |
| Vibration<br>(Non operation)                 | ① 5 to 100Hz, $11.76\text{m/s}^2$<br>② 1 minute/cycle<br>③ X, Y, Z directions<br>④ 50 times each direction                                                               | No display malfunctions<br>No physical damages |       |
| Mechanical shock<br>(Non operation)          | ① $294\text{m/s}^2$ , 11ms<br>② $\pm\text{X}$ , $\pm\text{Y}$ , $\pm\text{Z}$ directions<br>③ 3 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 "10.2 CAUTIONS" and "10.3 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



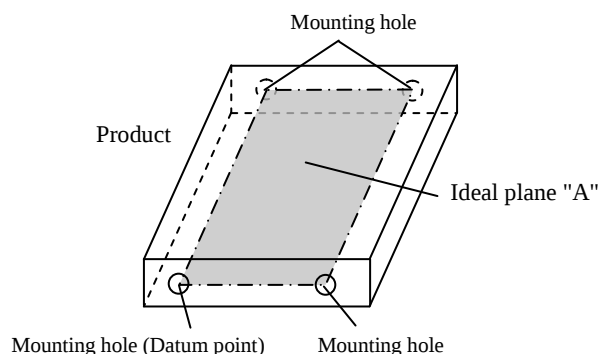
**\* Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than  $294\text{m/s}^2$  and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N ( $\phi 16\text{mm}$  jig))**

#### 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 When the product is put on the table temporarily, display surface must be placed downward.
- ③ 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.
- ④ The torque for product mounting screws must never exceed  $0.34\text{N}\cdot\text{m}$ . Higher torque might result in distortion of the bezel. And the length of product mounting screws must be  $\leq 2.8\text{mm}$ .
- ⑤ 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.  
Recommended installing method: Ideal plane "A" is defined by one mounting hole (datum point) and other mounting holes. The ideal plane "A" should be the same plane within  $\pm 0.3\text{ mm}$ .



- ⑥ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
- ⑦ Do not push or pull the interface connectors while the product is working. 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.
- ⑧ 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.**

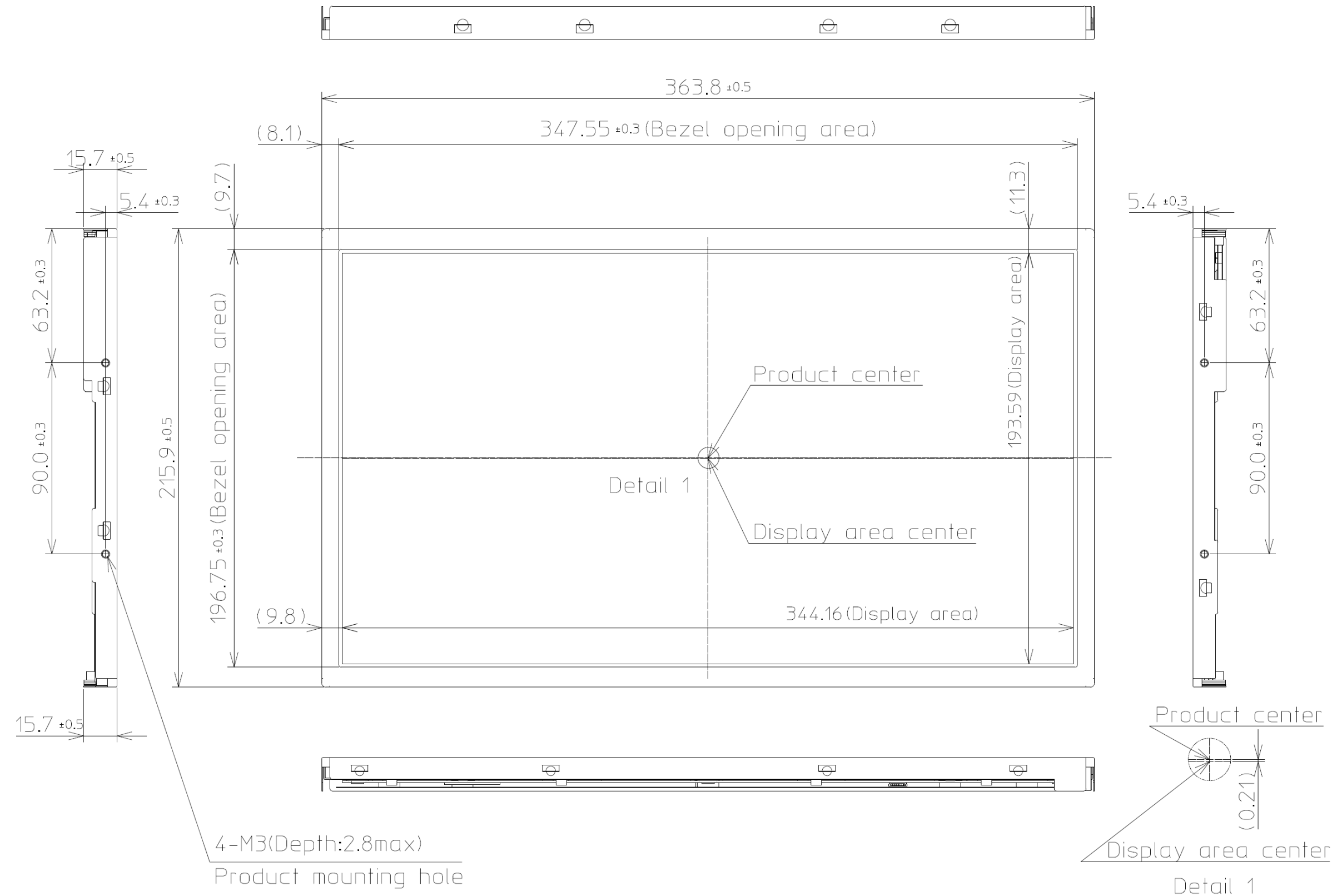
- ① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough 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, H\_GND and VCC 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.

8. OUTLINE DRAWINGS

8.1 FRONT VIEW

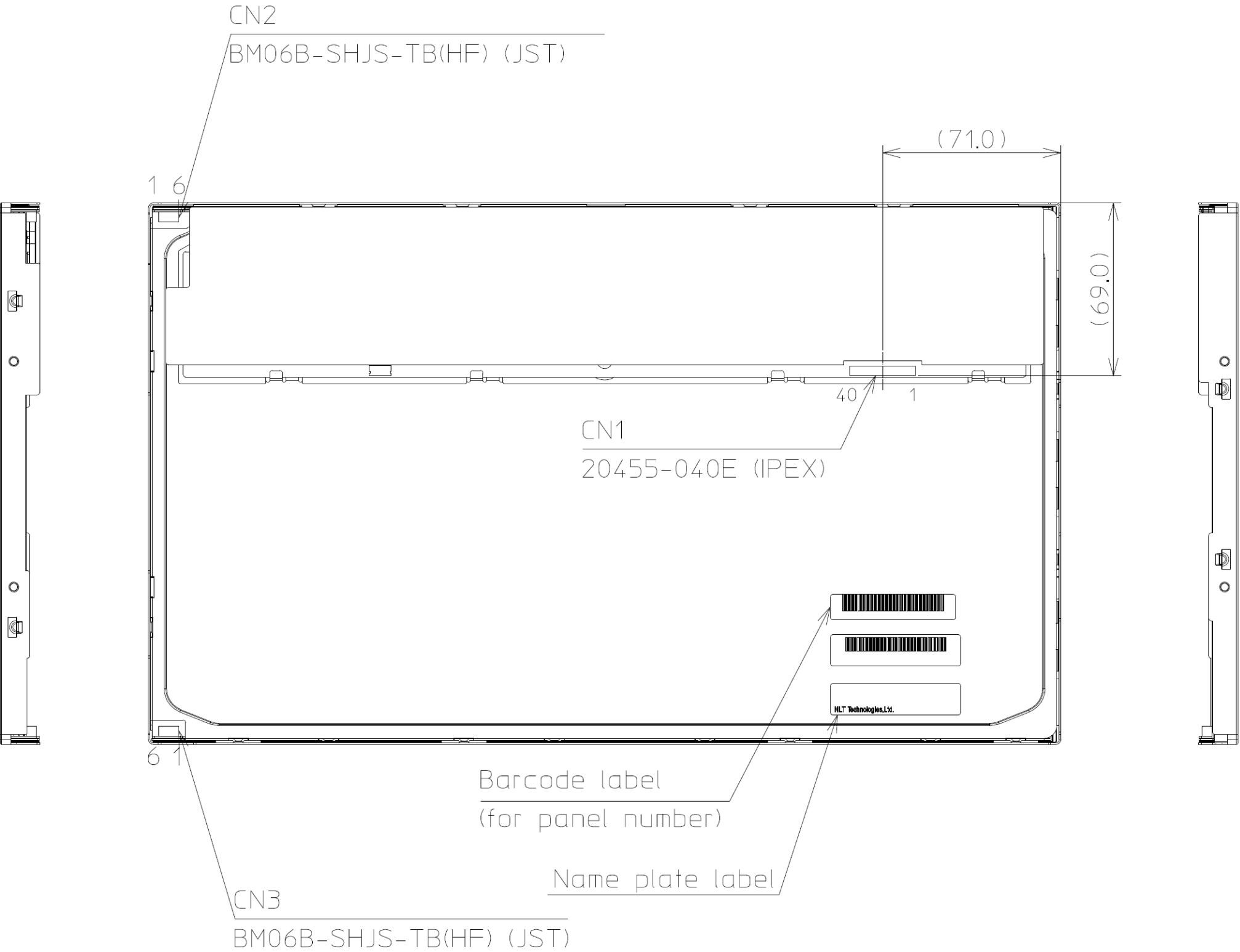


Unit: mm

Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.34N·m. And the length of product mounting screws must be ≤ 2.8mm.

8.2 REAR VIEW



Note1: The values in parentheses are for reference.

Unit: mm

## REVISION HISTORY

*The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.*

| Edition     | Document number | Prepared date | Revision contents and signature                                                                                                                                                                                                                                                                                                                    |
|-------------|-----------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1st edition | DOD-PP-2375     | Oct. 17, 2016 | <b>Revision contents</b><br><br>New issue<br><br><b>Signature of writer</b><br><div> <div>Approved by</div> <div><i>R. Kawashima</i></div> <div>R. KAWASHIMA</div> </div> <div> <div>Checked by</div> <div><i>T. Ogawa</i></div> <div>T. OGAWA</div> </div> <div> <div>Prepared by</div> <div><i>y. Urasaki</i></div> <div>Y. URASAKI</div> </div> |
|             |                 |               |                                                                                                                                                                                                                                                                                                                                                    |