PRELIMINARY

# NLT Technologies

# TFT COLOR LCD MODULE

# NL192108AC21-04

## 47cm (18.5 Type)
## FHD
## LVDS interface (2port)

# PRELIMINARY DATA SHEET

**DOD-PP-2434** (2nd edition)

**This PRELIMINARY DATA SHEET is updated document from DOD-PP-2288(1)**

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

# INTRODUCTION

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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.

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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.

## CONTENTS

**1. OUTLINE**

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL192108AC21-04 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))
- High contrast
- Wide color gamut
- Wide temperature range
- LVDS interface
- 8-bit digital signals for data of RGB
- Narrow frame
- LED backlight built in LED driver
- UL60950-1/CSA C22.2 No.60950-1-03 will be acquired for this product when starting mass production.
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

## 2. GENERAL SPECIFICATIONS

| | | |
|---|---|---|
| *Display area* | 408.96 (H) × 230.04 (V) mm | |
| *Diagonal size of display* | 47cm (18.5 inches) | |
| *Drive system* | a-Si TFT active matrix | |
| *Display color* | 16,777,216 colors | |
| *Pixel* | 1,920 (H) × 1,080 (V) pixels | |
| *Pixel arrangement* | RGB (Red dot, Green dot, Blue dot) vertical stripe | |
| *Dot pitch* | 0.071(H) × 0.213 (V) mm | |
| *Pixel pitch* | 0.213 (H) × 0.213 (V) mm | |
| *Module size* | 430.4 (W) × 254.6 (H) × (13.5) (D) mm (typ.) | |
| *Weight* | (1,550) g (typ.) | 2 |
| *Contrast ratio* | (1,000:1) (typ.) (typ.) | 2 |
| *Viewing angle* | At the contrast ratio ≥10:1 <br> • Horizontal: Right side 88° (typ.), Left side 88° (typ.) <br> • Vertical: Up side 88° (typ.), Down side 88° (typ.) | |
| *Designed viewing direction* | Viewing angle with optimum grayscale ($\gamma$≒ 2.2): Normal axis <br> (perpendicular) | |
| *Polarizer surface* | Antiglare | |
| *Polarizer pencil-hardness* | 3H (min.) [by JIS K5600] | |
| *Color gamut* | At LCD panel center <br> 72% (typ.) [against NTSC color space] | |
| *Response time* | Ton+Toff (10%←→90%) <br> 25 ms (typ.) | 2 |
| *Luminance* | At the maximum luminance control <br> 400 cd/m$^2$ (typ.) | 2 |
| *Signal system* | LVDS interface (2 port) <br> [8-bit digital signals for data of RGB colors, Dot clock (CLK), <br> Data enable (DE)] | |
| *Power supply voltage* | LCD panel signal processing board: 5.0V <br> LED driver: 12.0V | |
| *Backlight* | LED backlight built in LED driver | |
| *Power consumption* | At the maximum luminance control, Checkered flag pattern <br> (15.3) W (typ.) | 2 |

## 3. BLOCK DIAGRAM
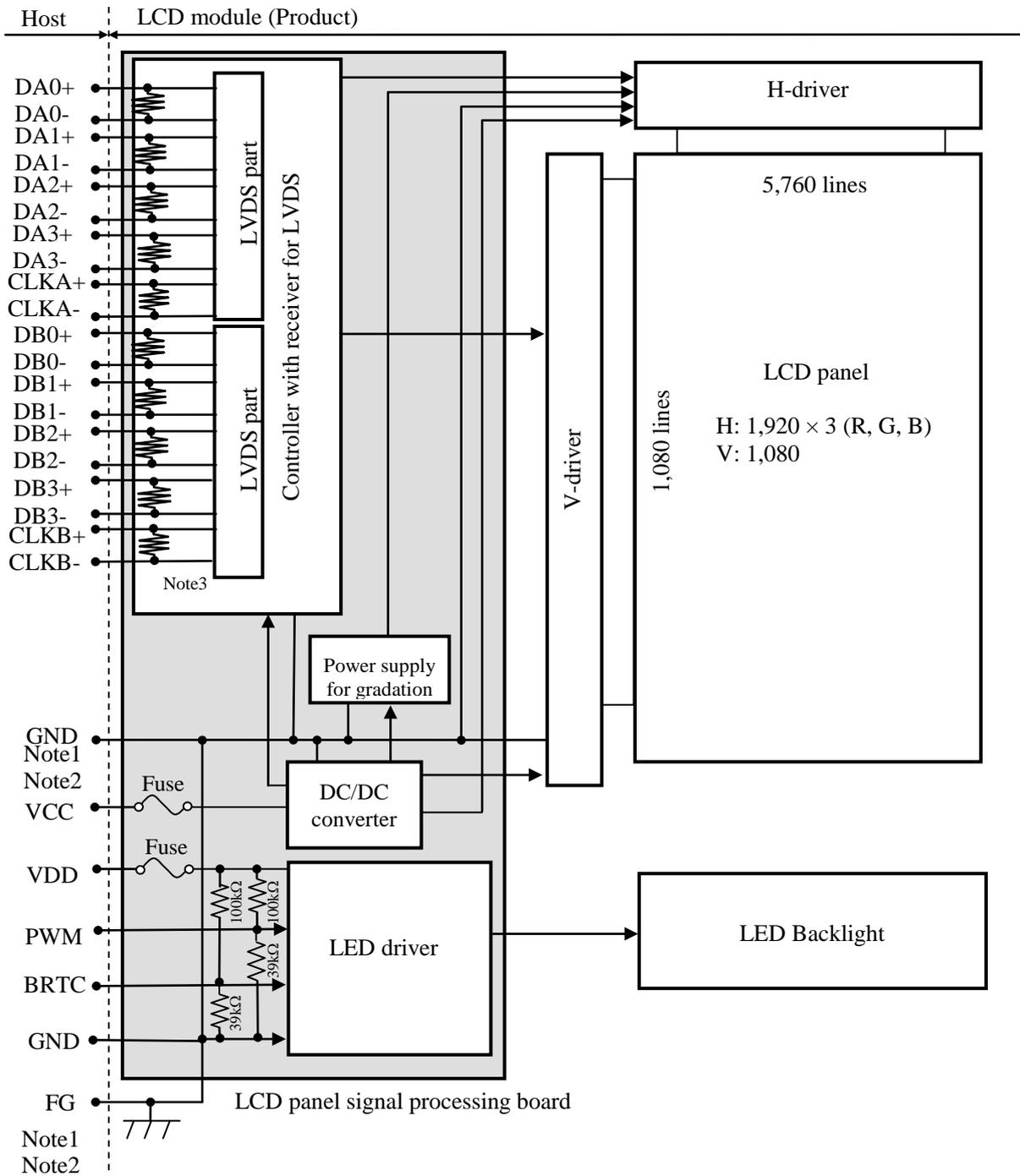


Note1: Relation between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module is as follows.

| 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.

Note3: Each pair of the LVDS signal has a 100Ω terminating resistance.

### 4. DETAILED SPECIFICATIONS

#### 4.1 MECHANICAL SPECIFICATIONS

| Parameter | Specification | | Unit |
|---|---|---|---|
| Module size | 430.4 ± 0.5 (W) × 254.6 ± 0.5 (H) × (13.5) (D) | Note1 | mm |
| Display area | 408.96 (H) × 230.04 | Note1 | mm |
| Weight | (1,550) (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 | -0.3to +6.5 | V | |
| | LED driver | VDD | -0.3to +15.0 | | |
| Input voltage for signals | Display signals Note1 | VD | -0.3to +4.0 | V | Ta= 25°C |
| | Function signal for LED driver | PWM | -0.3to +5.5 | | |
| | | BRTC | -0.3to +5.5 | | |
| Storage temperature | | Tst | -20 to +80 | °C | - |
| Operating temperature | Front surface | TopF | -20 to +70 | °C | Note2 |
| | Rear surface | TopR | -20 to +70 | °C | Note3 |
| Relative humidity Note4 | | RH | ≤ 95 | % | Ta ≤ 40°C |
| | | | ≤ 85 | % | 40°C < Ta ≤ 50°C |
| | | | ≤ 55 | % | 50°C < Ta ≤ 60°C |
| | | | ≤ 36 | % | 60°C < Ta ≤ 70°C |
| Absolute humidity Note4 | | AH | ≤ 70 Note5 | g/m$^3$ | Ta > 70°C |

Note1: DA0+/-, DA1+/-, DA2+/-, DA3+/- ,CLKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CLKB+/-
Note2: Measured at LCD panel surface (including self-heat)
Note3: Measured at LCD module's rear shield surface (including self-heat)
Note4: No condensation
Note5: Water amount at Ta= 70°C and RH= 36%

### 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 | 4.5 | 5.0 | 5.5 | V | - | 2 |
| Power supply current | | ICC | - | (420) Note1 | (760) Note2 | mA | at VCC= 5.0V | 2 |
| Permissible ripple voltage | | VRPC | - | - | 100 | mVp-p | for VCC Note3, Note4, Note5 | |
| Differential input threshold voltage | High | VTH | - | - | +100 | mV | at VCM= 1.2V Note6, Note7 | |
| | Low | VTL | -100 | - | - | mV | | |
| Input Differential Voltage | | |VID| | 100 | 400 | 600 | mV | - | |
| Differential Input Common Mode Voltage | | VCM | 0.7 | 1.2 | 1.6 | V | - | |
| Terminating resistance | | RT | - | 100 | - | Ω | - | |

Note1: Checkered flag pattern [by IEC 61747-6]    2
Note2: Pattern for maximum current
Note3: This product works 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.
Note6: Common mode voltage for LVDS receiver
Note7: DC characteristics (LVDS receiver part)
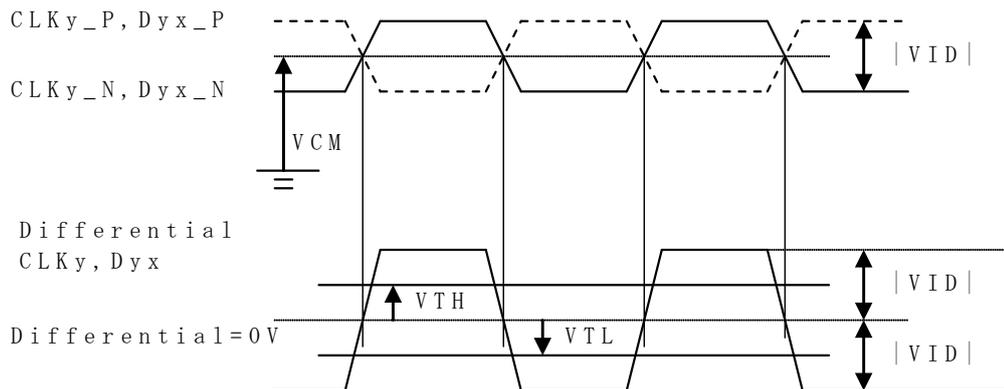


CLKy_P, CLKy_N: y = A,B
Dyx_P, Dyx_N: y = A,B    x = 0,1,2,3
|VID| = |**_P-**_N|
VCM = (**_P+**_N)/2
P: +, N: -
**: CLKy or Dxy

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 | - | (1,100) | (1,350) Note3 | mA | at VDD= 12.0V Note4 | 2 |
| Permissible ripple voltage | | VRPD | - | - | 200 | mVp-p | for VDD Note2, Note5, Note6 | |
| Input voltage for PWM signal | High | VDFH1 | (2.0) | - | (5.0) | V | | 2 |
| | Low | VDFL1 | 0 | - | (0.4) | V | | |
| Input voltage for BRTC signal | High | VDFH2 | (2.0) | - | (5.0) | V | | |
| | Low | VDFL2 | 0 | - | (0.8) | V | Note7 | |
| Input current for PWM signal | High | IDFH1 | - | - | (300) | μA | | 2 |
| | Low | IDFL1 | (-300) | - | - | μA | | |
| Input current for BRTC signal | High | IDFH2 | - | - | (300) | μA | | 2 |
| | High | IDFL2 | (-300) | - | - | μA | | |
| PWM frequency | | f$_{PWM}$ | 200 | - | 1k | Hz | Note8, Note9 | |
| PWM duty ratio | | DR$_{PWM}$ | 1 | - | 100 | % | Note10, Note11 | 2 |
| PWM pulse width | | tPWH | 5 | - | - | μs | | 2 |

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 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$_{PWM}$ value is as follows.

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

$(n = integer, fv = frame frequency of LCD module)$

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

2

| Parameter | Fuse | | Rating | Fusing current | Remarks |
|-----------|------|---|--------|----------------|---------|
| | Type | Supplier | | | |
| VCC | (FCC16202AB) | KAMAYA ELECTRIC CO.,LTD | (2.0A) | (4.0)A (5) seconds | Note1 |
| | | | (36.0V) | | |
| VDD | (FCC16202AB) | KAMAYA ELECTRIC CO.,LTD | (2.0A) | (4.0)A (5) seconds | |
| | | | (36.0V) | | |

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



2
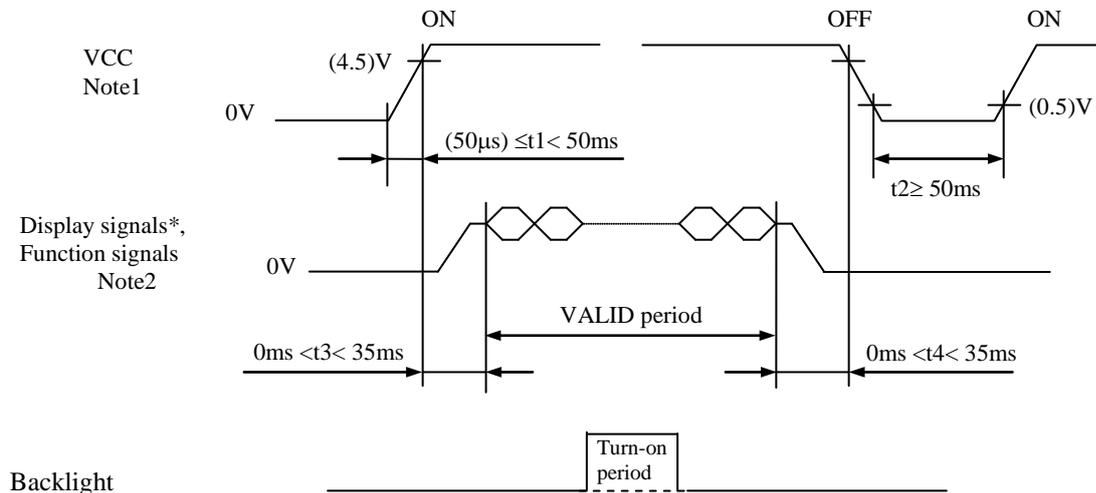
2

2

\* These signals should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below (4.5) V, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (DA0+/-, DA1+/-, DA2+/-, DA3+/-,CLKA+/-,DB0+/-, DB1+/-, DB2+/-, DB3+/- and CLKB+/-) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.

If some of display signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display signals, VCC also must be shut down.

4.4.2 LED driver
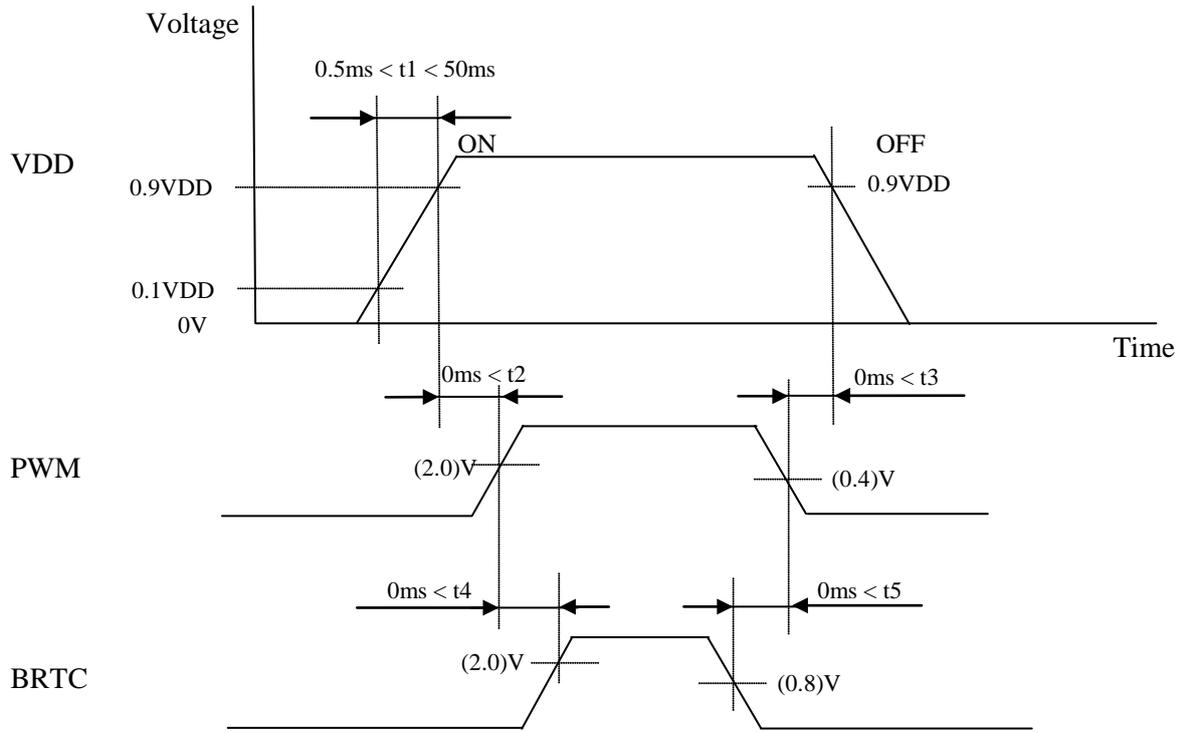


Note1: The LED driver should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

### 4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

#### 4.5.1 LCD panel signal processing board

CN1 socket (LCD module side):  MDF76KBW-30S-1H(55) or MDF76TW-30S-1H(55) or
MDF76GW-30S-1H(55) (HIROSE ELECTRIC Co., Ltd.)
Adaptable plug:  MDF76-30P-1C (HIROSE ELECTRIC Co., Ltd.)

| Pin No. | Symbol | Signal | Remarks |
|---------|--------|--------|---------|
| 1 | DA0- | Odd pixel data 0 | Note1 |
| 2 | DA0+ | | |
| 3 | DA1- | Odd pixel data 1 | Note1 |
| 4 | DA1+ | | |
| 5 | DA2- | Odd pixel data 2 | Note1 |
| 6 | DA2+ | | |
| 7 | GND | Ground | Note2 |
| 8 | CLKA- | Odd pixel clock | Note1 |
| 9 | CLKA+ | | |
| 10 | DA3- | Odd pixel data 3 | Note1 |
| 11 | DA3+ | | |
| 12 | DB0- | Even pixel data 0 | Note1 |
| 13 | DB0+ | | |
| 14 | GND | Ground | Note2 |
| 15 | DB1- | Even pixel data 1 | Note1 |
| 16 | DB1+ | | |
| 17 | GND | Ground | Note2 |
| 18 | DB2- | Even pixel data 2 | Note1 |
| 19 | DB2+ | | |
| 20 | CLKB- | Even pixel clock | Note1 |
| 21 | CLKB+ | | |
| 22 | DB3- | Even pixel data 3 | Note1 |
| 23 | DB3+ | | |
| 24 | GND | Ground | Note2 |
| 25 | GND | Ground | Note2 |
| 26 | GND | Ground | Note2 |
| 27 | GND | Ground | Note2 |
| 28 | VCC | Power supply | Note2 |
| 29 | | | |
| 30 | | | |

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note2: All GND and VCC terminals should be used without any non-connected lines.

PRELIMINARY

4.5.2 LED driver

CN2 socket (LCD module side):    DF19L-14P-1H(54) or DF19G-14P-1H(54) or DF19K-14P-1H(54)   2
                                        (HIROSE ELECTRIC Co., Ltd.)
Adaptable plug:                      DF19-14S-1C (HIROSE ELECTRIC Co., Ltd.)

| Pin No. | Symbol | Function | Description |
|---------|--------|----------|-------------|
| 1 | VDD | Power supply | Note1 |
| 2 | VDD | | |
| 3 | VDD | | |
| 4 | VDD | | |
| 5 | VDD | | |
| 6 | GND | LED driver ground | Note1 |
| 7 | GND | | |
| 8 | GND | | |
| 9 | GND | | |
| 10 | GND | | |
| 11 | RSVD | Keep this pin open. | - |
| 12 | BRTC | Backlight ON/OFF control | High or Open: Backlight ON<br>Low: Backlight OFF |
| 13 | PWM | Luminance control | PWM dimming |
| 14 | GND | LED driver ground | Note1 |

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

4.5.3 Positions of socket

Rear side

Signal processing board

CN2        CN1

1   14   1      30

Insert direction

### 4.5.4 Input data mapping

2

| | | Previous cycle | | One cycle | | | | | | | | Next cycle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DA0+/-<br>DB0+/- | | RA1'<br>RB1' | RA0'<br>RB0' | GA0<br>GB0 | RA5<br>RB5 | RA4<br>RB4 | RA3<br>RB3 | RA2<br>RB2 | RA1<br>RB1 | RA0<br>RB0 | GA0'<br>GB0' | |
| DA1+/-<br>DB1+/- | | GA2'<br>GB2' | GA1'<br>GB1' | BA1<br>BB1 | BA0<br>BB0 | GA5<br>GB5 | GA4<br>GB4 | GA3<br>GB3 | GA2<br>GB2 | GA1<br>GB1 | BA1'<br>BB1' | |
| DA2+/-<br>DB2+/- | | BA3'<br>BB3' | BA2'<br>BB2' | DE | - | - | BA5<br>BB5 | BA4<br>BB4 | BA3<br>BB3 | BA2<br>BB2 | DE' | |
| DA3+/-<br>DB3+/- | | RA7'<br>RB7' | RA6'<br>RB6' | - | BA7<br>BB7 | BA6<br>BB6 | GA7<br>GB7 | GA6<br>GB6 | RA7<br>RB7 | RA6<br>RB6 | - | |

CLKA+/-
CLKB+/-

Note1: LSB (Least Significant Bit) – R0, G0, B0    MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

## 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.

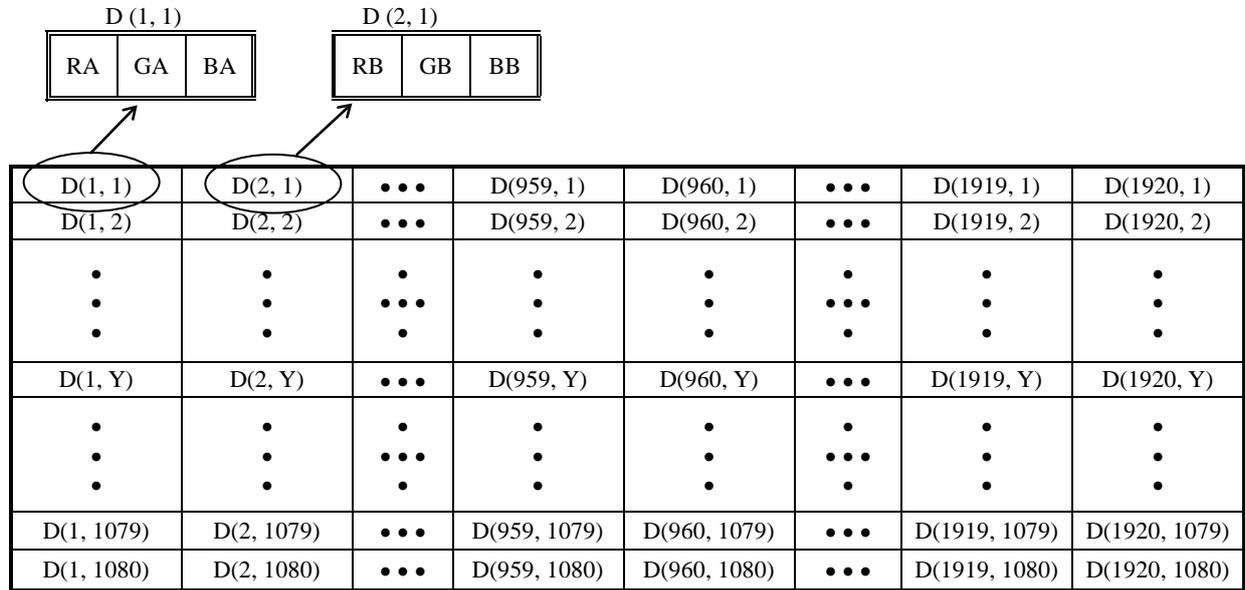| Display colors | | Data signal (0: Low level, 1: High level) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RA7 RB7 | RA6 RB6 | RA5 RB5 | RA4 RB4 | RA3 RB3 | RA2 RB2 | RA1 RB1 | RA0 RB0 | GA7 GB7 | GA6 GB6 | GA5 GB5 | GA4 GB4 | GA3 GB3 | GA2 GB2 | GA1 GB1 | GA0 GB0 | BA7 BB7 | BA6 BB6 | BA5 BB5 | BA4 BB4 | BA3 BB3 | BA2 BB2 | BA1 BB1 | BA0 BB0 |
| Basic Colors | 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 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | White | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Red 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 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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 | 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 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green 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 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | : | : | | | | | | | | : | : | | | | | | | : | : | | |
| | ↓ | | | | : | : | | | | | | | | : | : | | | | | | | : | : | | |
| | bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Blue 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 | 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 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | ↑ | | | | : | : | | | | | | | | : | : | | | | | | | : | : | | |
| | ↓ | | | | : | : | | | | | | | | : | : | | | | | | | : | : | | |
| | bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## 4.7 INPUT DATA SIGNALS AND DISPLAY POSITIONS

D (1, 1)

| RA | GA | BA |
|----|----|----|

D (2, 1)

| RB | GB | BB |
|----|----|----|

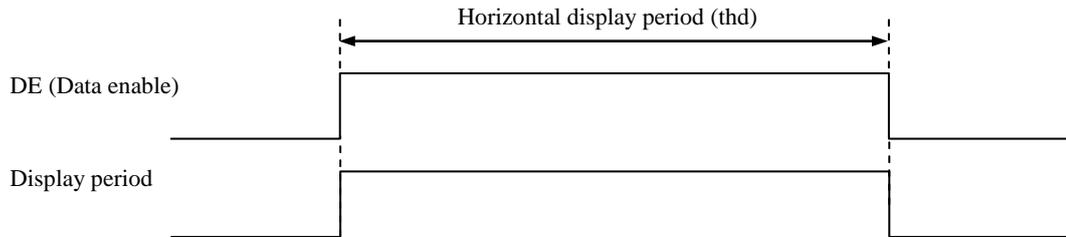| D(1, 1) | D(2, 1) | • • • | D(959, 1) | D(960, 1) | • • • | D(1919, 1) | D(1920, 1) |
|---------|---------|-------|-----------|-----------|-------|------------|------------|
| D(1, 2) | D(2, 2) | • • • | D(959, 2) | D(960, 2) | • • • | D(1919, 2) | D(1920, 2) |
| • • • | • • • | • • • | • • • | • • • | • • • | • • • | • • • |
| D(1, Y) | D(2, Y) | • • • | D(959, Y) | D(960, Y) | • • • | D(1919, Y) | D(1920, Y) |
| • • • | • • • | • • • | • • • | • • • | • • • | • • • | • • • |
| D(1, 1079) | D(2, 1079) | • • • | D(959, 1079) | D(960, 1079) | • • • | D(1919, 1079) | D(1920, 1079) |
| D(1, 1080) | D(2, 1080) | • • • | D(959, 1080) | D(960, 1080) | • • • | D(1919, 1080) | D(1920, 1080) |

4.8 INPUT SIGNAL TIMINGS
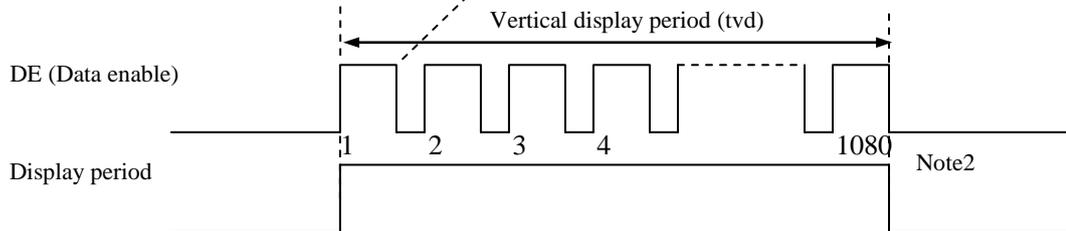
4.8.1 Outline of input signal timings

· 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, Note3)

| Parameter | | | Symbol | min. | typ. | max. | Unit | Remarks | |
|---|---|---|---|---|---|---|---|---|---|
| CLK | Frequency | | 1/tc | 65.0 | 74.175 | 81.5 | MHz | 13.48ns (typ.) | 2 |
| | Duty ratio | | - | | - | | - | - | |
| | Rise time, Fall time | | - | | | | ns | | |
| DATA | CLK-DATA | Setup time | - | | | | ns | - | |
| | | Hold time | - | | - | | ns | | |
| | Rise time, Fall time | | - | | | | ns | | |
| DE | Horizontal | Cycle | th | 13.19 | 14.83 | 16.53 | μs | 67.43kHz (typ.) | 2 |
| | | | | 1,075 | 1,100 | - | CLK | | |
| | | Display period | thd | | 960 | | CLK | - | |
| | Vertical (One frame) | Cycle | tv | 15.39 | 16.68 | 18.18 | ms | 59.94Hz (typ.) | 2 |
| | | | | 1,100 | 1,125 | - | H | | |
| | | Display period | tvd | | 1,080 | | H | - | |
| | CLK-DE | Setup time | - | | | | ns | - | |
| | | Hold time | - | | - | | ns | | |
| | Rise time, Fall time | | - | | | | ns | | |

Note1: Definition of parameters is as follows.
     tc= 1CLK, th= 1H
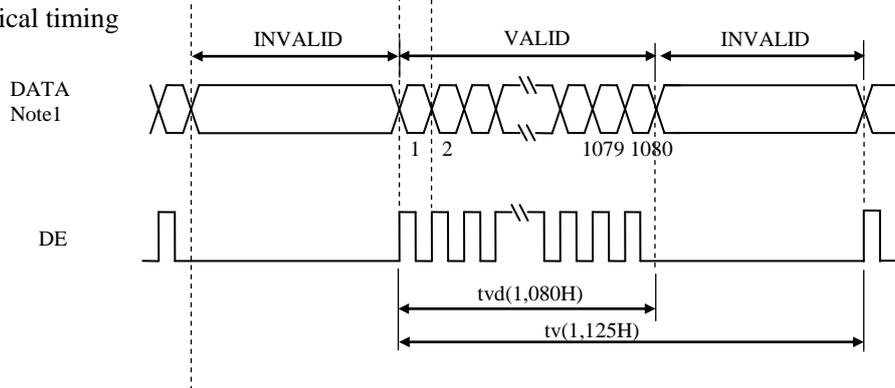Note2: See the data sheet of LVDS transmitter.
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.8.3 Input signal timing char

Horizontal timing
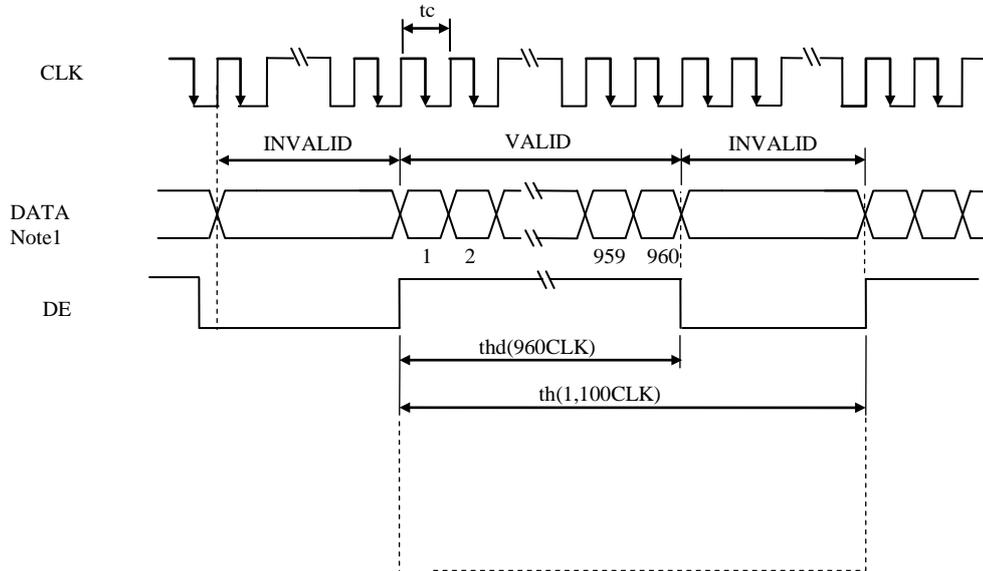


Vertical timing



Note1: DATA (A) = RA0-RA7, GA0-GA7, BA0-BA7
DATA (B) = RB0-RB7, GB0-GB7, BB0-BB7

# PRELIMINARY

### 4.9 LVDS Rx AC SPEC

| Symbol | Parameter | min. | typ. | max. | Units | |
|--------|-----------|------|------|------|-------|---|
| $t_{RCIP}$ | CKy_+ Period | 12.27 | - | 15.38 | ns | 2 |
| $t_{RCIH}$ | CKy_+ High pulse width | - | $\frac{4}{7}t_{RCIP}$ | - | ns | |
| $t_{RCIL}$ | CKy_+ Low pulse width | - | $\frac{3}{7}t_{RCIP}$ | - | ns | |
| $t_{RMG}$ | Receiver Data Input Margin CLK= 75MHz | (-0.4) | - | (0.4) | ns | |
| $t_{RIP1}$ | Input Data Position0 | $-|t_{RMG}|$ | 0.0 | $+|t_{RMG}|$ | ns | |
| $t_{RIP0}$ | Input Data Position1 | $\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $\frac{t_{RCIP}}{7}$ | $\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
| $t_{RIP6}$ | Input Data Position2 | $2\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $2\frac{t_{RCIP}}{7}$ | $2\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
| $t_{RIP5}$ | Input Data Position3 | $3\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $3\frac{t_{RCIP}}{7}$ | $3\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
| $t_{RIP4}$ | Input Data Position4 | $4\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $4\frac{t_{RCIP}}{7}$ | $4\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
| $t_{RIP3}$ | Input Data Position5 | $5\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $5\frac{t_{RCIP}}{7}$ | $5\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
| $t_{RIP2}$ | Input Data Position6 | $6\frac{t_{RCIP}}{7}-|t_{RMG}|$ | $6\frac{t_{RCIP}}{7}$ | $6\frac{t_{RCIP}}{7}+|t_{RMG}|$ | ns | |
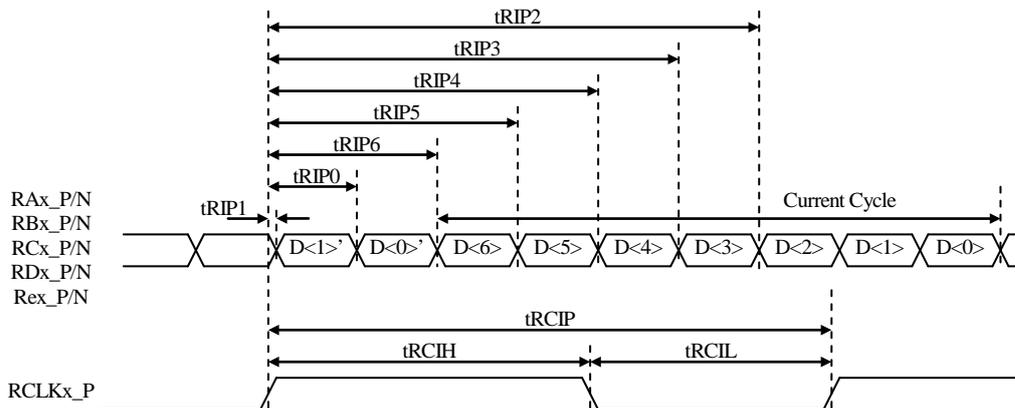
## 4.10 OPTICS

### 4.10.1 Optical characteristics

(Note1, Note2)

| Parameter | | Condition | Symbol | min. | typ. | max. | Unit | Measuring instrument | Remarks | |
|---|---|---|---|---|---|---|---|---|---|---|
| Luminance | | White at center $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$ | L | 280 | 400 | - | cd/m$^2$ | BM-5A or equivalent | - | 2 |
| Contrast ratio | | White/Black at center $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$ | CR | (600) | (1,000) | - | - | BM-5A or equivalent | Note3 | 2 |
| Luminance uniformity | | White $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$ | 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 | 2 |
| | | **y** coordinate | Wy | 0.279 | 0.329 | 0.379 | - | | | |
| | Red | **x** coordinate | Rx | - | (0.630) | - | - | | | |
| | | **y** coordinate | Ry | - | (0.335) | - | - | | | |
| | Green | **x** coordinate | Gx | - | (0.290) | - | - | | | |
| | | **y** coordinate | Gy | - | (0.620) | - | - | | | |
| | Blue | **x** coordinate | Bx | - | (0.155) | - | - | | | |
| | | **y** coordinate | By | - | (0.065) | - | - | | | |
| Color gamut | | $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$ at center, against NTSC color space | C | 65 | 72 | - | % | | | |
| Response time | | Black to White | Ton | - | 12 | 20 | ms | BM-5A or equivalent | Note6 | 2 |
| | | White to Black | Toff | - | 13 | 20 | ms | | Note7 | |
| Viewing angle | Right | $\theta U= 0°, \theta D= 0°, CR \geq 10$ | $\theta R$ | 70 | 88 | - | ° | EZ Contrast | Note8 | |
| | Left | $\theta U= 0°, \theta D= 0°, CR \geq 10$ | $\theta L$ | 70 | 88 | - | ° | | | |
| | Up | $\theta R= 0°, \theta L= 0°, CR \geq 10$ | $\theta U$ | 70 | 88 | - | ° | | | |
| | Down | $\theta R= 0°, \theta L= 0°, CR \geq 10$ | $\theta D$ | 70 | 88 | - | ° | | | |

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
    Ta= 25°C, VCC= 5.0V, VDD=12.0V, PWM duty ratio: 100%,
    Display mode: FHD, Horizontal cycle= 1/67.43kHz, Vertical cycle= 1/59.94Hz

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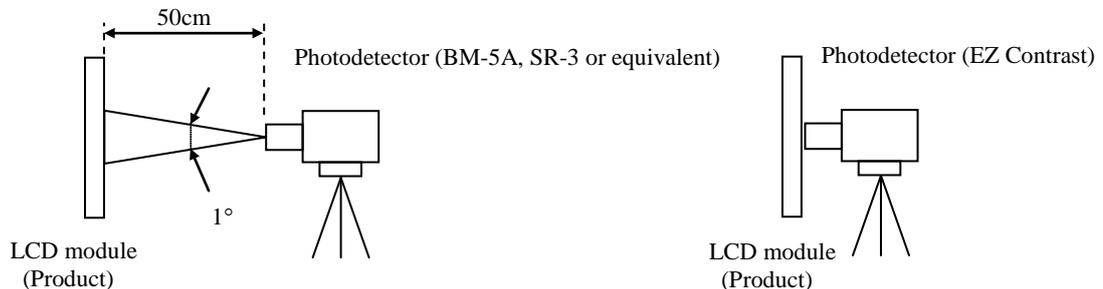


Note3: See "**4.10.2 Definition of contrast ratio**".
Note4: See "**4.10.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= TBD°C
Note7: See "**4.10.4 Definition of response times**".
Note8: See "**4.10.5 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.
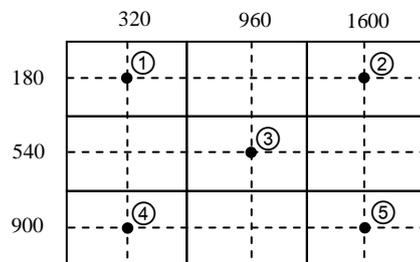


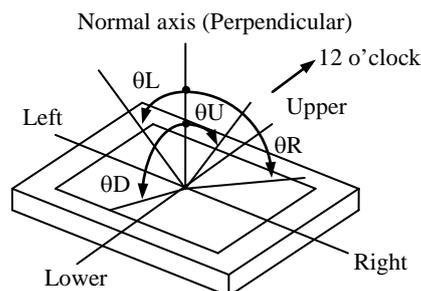4.10.4 Definition of response times

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.).
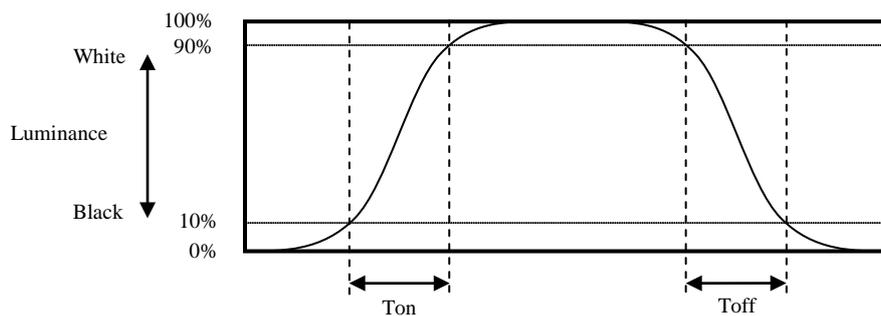


4.10.5 Definition of viewing angles

## 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 (Life time expectancy) Note1, Note2, Note3 | Unit |
|---|---|---|---|
| LED elementary substance | 25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio:100% | 50,000 | h |
| | 70 °C (Temperature of LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio:100% | 30,000 | |

2

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.

# PRELIMINARY

## NLT Technologies

## 6. RELIABILITY TESTS

| Test item | Condition | Judgment      Note1 | |
|---|---|---|---|
| High temperature and humidity (Operation) | ① (+60) ± 2°C, RH= (90%), 240hours<br>② Display data is white. | | |
| High temperature (Operation) | ① +70 ± 3°C, 240hours<br>② Display data is white. | No display malfunctions | 2 |
| Heat Cycle (Operation) | ①-20±3℃…1hour<br>   70±3℃…1hour<br>② 50cycles, 4hours/cycle<br>③ Display data is White. | | |
| Thermal shock (Non operation) | ① -20 ± 3°C…30minutes<br>   +80 ± 3°C…30minutes<br>② 100cycles, 1hour/cycle<br>③ Temperature transition time is within 5 minutes. | | |
| ESD (Operation) | ① 150pF, 150Ω, ±10kV<br>② 9 places on a panel surface         Note2<br>③ 10 times each point at 1 sec interval | | |
| Dust (Operation) | ① Sample dust: No. 15 (by JIS-Z8901)<br>② 15 seconds stir<br>③ 8 times repeat at 1 hour interval | | |
| Vibration (Non operation) | ① 5 to 100Hz, 11.76m/s$^2$<br>② 1 minute/cycle<br>③ X, Y, Z directions<br>④ 10 times each direction | No display malfunctions<br>No physical damages | 2 |
| Mechanical shock (Non operation) | ① 294m/ s$^2$, 11ms<br>② ±X, ±Y, ±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.
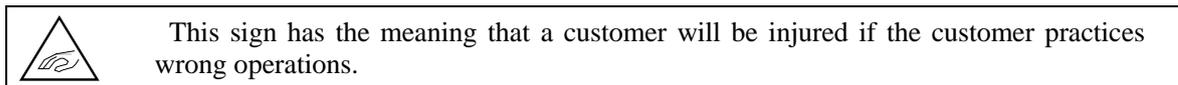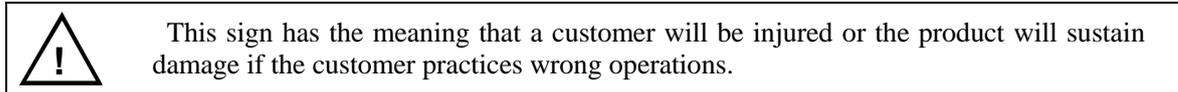
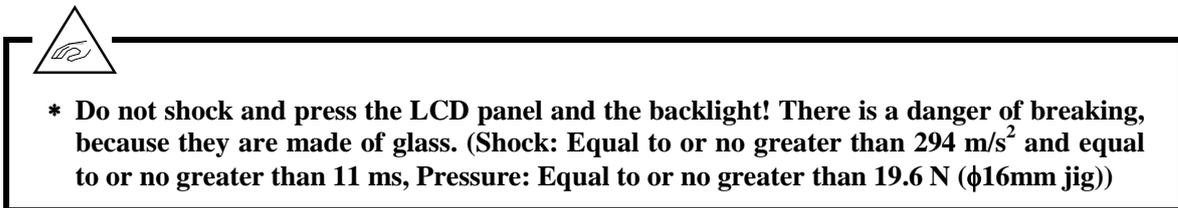Note2: See the following figure for discharge points.
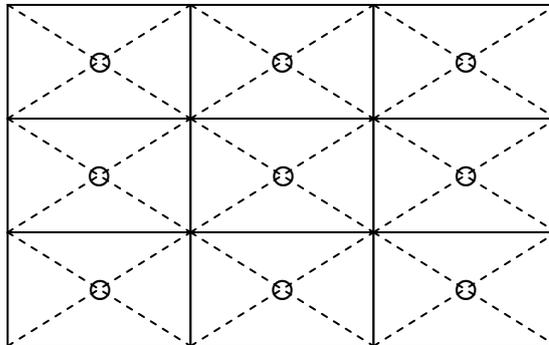
**7. PRECAUTIONS**

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "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 294 m/s$^2$ and equal to or no greater than 11 ms, Pressure: Equal to or no greater than 19.6 N (ϕ16mm jig))** ▢2 ▢2

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 or pull FPC 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 0.735N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ (4.5)mm.
⑥ The product must be installed 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) ▢2 and other mounting holes. The ideal plane "A" should be the same plane within ±0.3 mm.
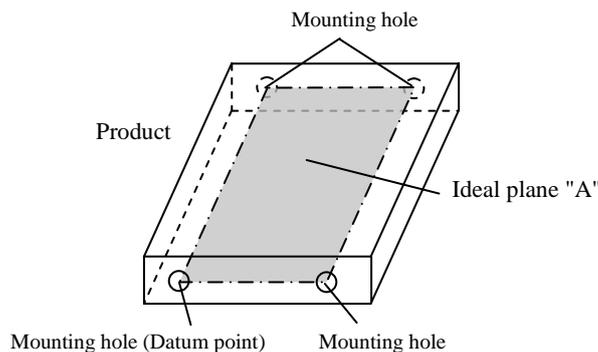
⑦ Do not press or rub on the sensitive product surface.

⑧ When cleaning the T/P surface, wipe it with a soft dry cloth.

⑨ Do not push or pull the interface connectors while the product is working.

⑩ 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.

⑪ 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.

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# PRELIMINARY

## 8. OUTLINE DRAWINGS

### 8.1 FRONT VIEW



430.4 ±0.5

413.4 ±0.5 (Bezel opening area)

(13.5)

8.5 ±0.5

6.0 ±0.5

10.3 ±0.5

(12.28)

6.0 ±0.5

73.3 ±0.5

77.3 ±0.5

254.6 ±0.5

234.0 ±0.5 (Bezel opening area)

230.04 (Display area)

108.0 ±0.5

100.0 ±0.5

LCD product center
Display area center

(10.72)

408.96 (Display area)

10.4 ±0.5

4-M3 (Depth: (4.5)max)
Product mounting hole
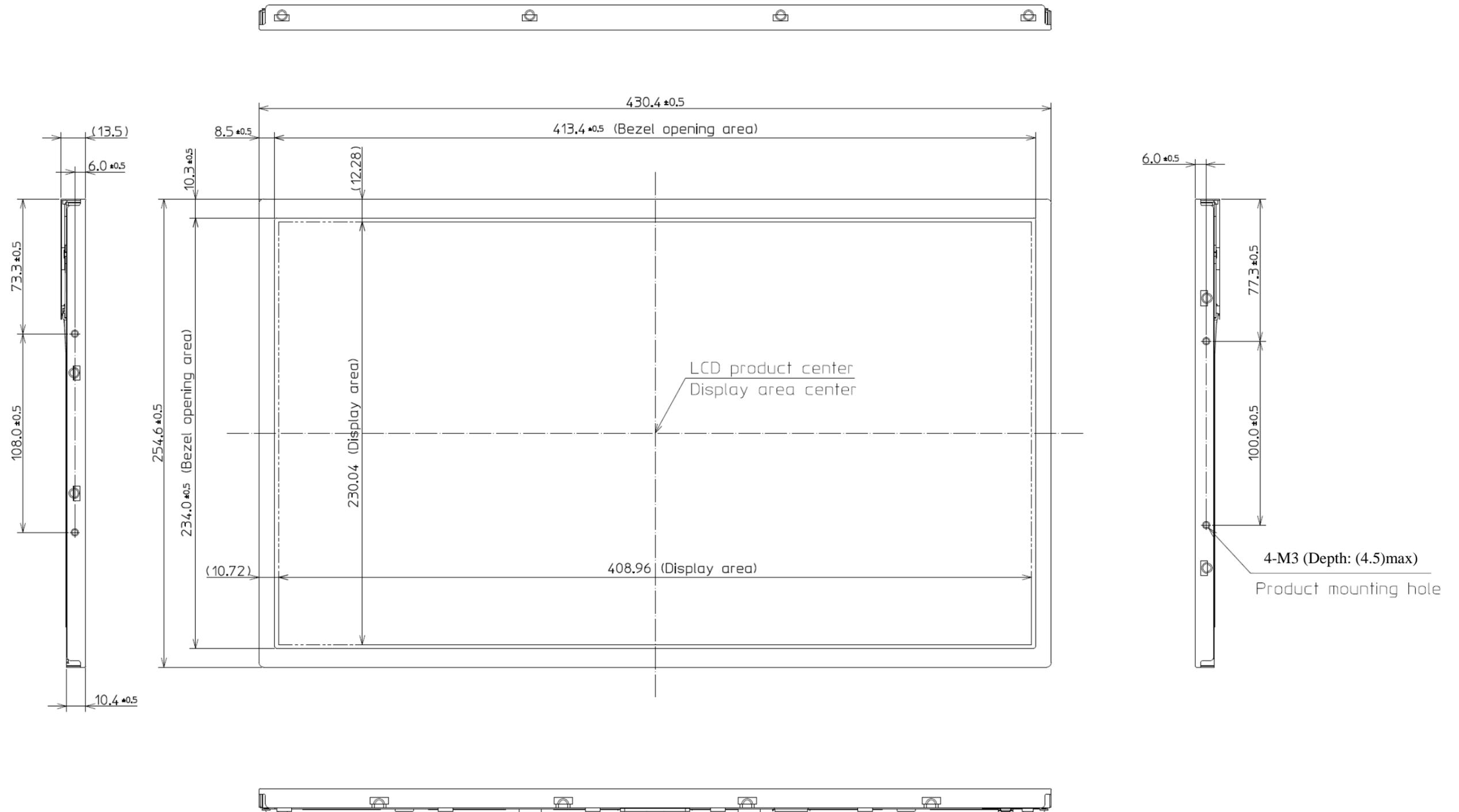
Note1:  The values in parentheses are for reference.
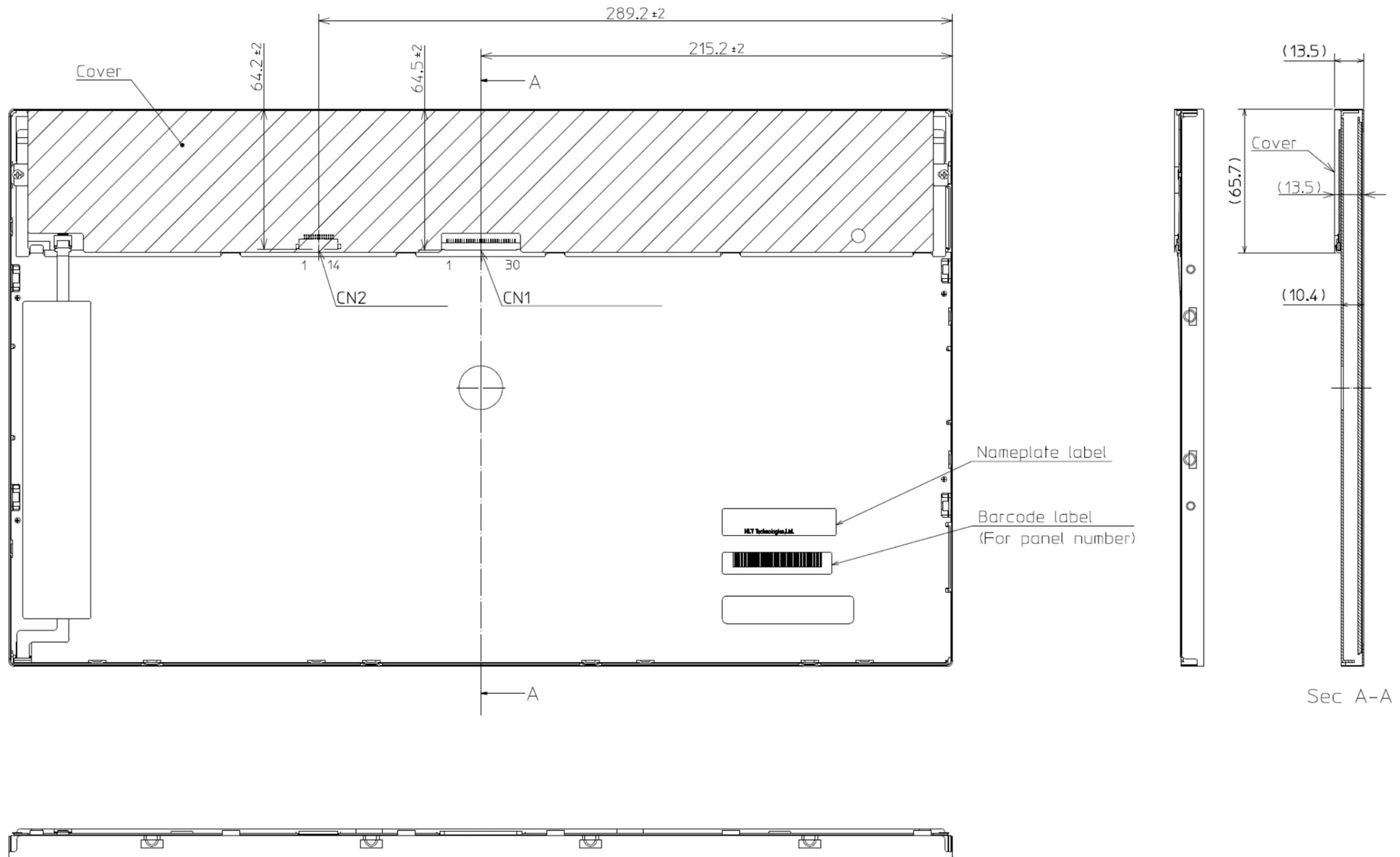Note2:  The torque for product mounting screws must never exceed 0.735N·m. And the length of product mounting screws must be ≤ (4.5)mm.

Unit: mm

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-2288 | Feb. 23, 2016 | **Revision contents**<br><br>New issue<br><br>**Writer**<br>*Approved by*     *Checked by*     *Prepared by*<br>R. KAWASHIMA     ————     T. OGAWA |
| 2nd edition | DOD-PP-2434 | Sep. 27, 2016 | **Revision contents**<br><br>P5 General specifications<br>• Weight: TBD g (typ.) → (1,550) g (typ.)<br>• Contrast ratio: (700:1) (typ.) → (1,000:1) (typ.)<br>• Response time: TBD ms (typ.) → 25 ms (typ.)<br>• Luminance: (400) cd/m$^2$ (typ.) → 400 cd/m$^2$ (typ.)<br>• Power consumption: TBD W (typ.) → (15.3)W (typ.)<br>P6 Block diagram<br>• PWM - VDD, BRTC - VDD: TBD kΩ → 100kΩ<br>• PWM - GND, BRTC - GND: TBD kΩ → 39kΩ<br>• PWM - LED driver, BRTC - LED driver: (elimination)<br>P7 Detailed specifications – Mechanical specification<br>• Weight: TBD g (typ.) → (1,550) g (typ.)<br>P7 Detailed specifications - Absolute maximum ratings<br>• Power supply voltage -LCD panel signal processing board: TBD V → -0.3 to + 6.5 V<br>              - LED driver: TBD V → -0.3 to +15.0 V<br>• Input voltage for signals -Display signals: TBD V → -0.3 to +4.0 V<br>         - Function signal for LED driver - PWM, BRTC: TBD V → -0.3 to +5.5 V<br>P8 Electrical characteristics - LCD panel signal processing board<br>• Power supply voltage: (4.5)V (min.), (5.5)V (max.) → 4.5V (min.), 5.5V (max.)<br>• Power supply current: TBD mA (typ., max.) → (420)mA (typ.), (760)mA (max.)<br>• Note1: EIAJ ED-2522 → IEC 61747-6<br>P9 Electrical characteristics - LED driver<br>• Power supply current: TBD mA (typ., max.) → (1,100)mA (typ.), (1,350)mA (max.)<br>• Input voltage for PWM signal- VDFL1: (0.8) (max.) V → (0.4) (max.) V<br>• Input current for PWM signal (addition)<br>• Input current for BRTC signal (addition)<br>• PWM duty ratio: TBD % (min.) → 1% (min.)<br>• PWM pulse width: TBDμs (min.) →5μs (min.)<br>• Note7 (addition)<br>P10 Fuse (Specified)<br>P10 Power supply voltage sequence - LCD panel signal processing board<br>  • (4.0)V → (4.5)V<br>  • Backlight (addition)<br>P11 Power supply voltage sequence - LED driver (Revised)<br>P13 Connections and functions for interface pins - LED driver<br>• CN2 socket: DF19G-30P-1H(54), DF19K-30P-1H(54)<br>                       → DF19G-14P-1H(54), DF19K-14P-1H(54)<br>P14 Input data mapping (Revised) |

## REVISION HISTORY

| Edition | Document number | Prepared date | Revision contents and signature |
|---|---|---|---|
| 2nd edition | DOD-PP-2434 | Sep. 27, 2016 | **Revision contents**<br><br>P18 Input signal timing – Timing characteristics<br> • CLK- Frequency: (65.0) (min.), (81.5) (max.) MHz → 65.0 (min.), 81.5 (max.) MHz<br> • DE- Horizontal- Cycle: (13.19) (min.), (16.53) (max.) μs → 13.19 (min.), 16.53 (max.) μs<br>        (1,075) (min.) CLK → 1,075 (min.) CLK<br> • DE- Vertical- Cycle: (15.39) (min.), (18.18) (max.) ms → 15.39 (min.), 18.18 (max.) ms<br>        (1,100) (min.) H → 1,100 (min.) H<br>P20 LVDS Rx AC SPEC<br> • CKy_+ Period: (12.27) (min.), (15.38) (max.) ns → 12.27 (min.), 15.38 (max.) ns<br>P21 Optics - Optical characteristics<br> • Luminance: TBD (min.), (400) (typ.) cd/m$^2$ → 280(min.), 400 cd/m$^2$ (typ.) cd/m$^2$<br> • Contrast ratio: TBD (min.), (700) (typ.) → (600) (min.), (1,000) (typ.)<br> • Chromaticity - Rx: TBD (typ.) → (0.630) (typ.)<br>            - Ry: TBD (typ.) → (0.335) (typ.)<br>            - Gx: TBD (typ.) → (0.290) (typ.)<br>            - Gy: TBD (typ.) → (0.620) (typ.)<br>            - Bx: TBD (typ.) → (0.155) (typ.)<br>            - By: TBD (typ.) → (0.065) (typ.)<br> • Response time - Ton: TBD (typ., max.) ms → 12 (typ.), 20 (max.) ms<br>              - Toff: TBD (typ., max.) ms → 13 (typ.), 20 (max.) ms<br>P23 Estimated luminance lifetime<br> • LED elementary substance: TBD °C, TBD h → 70°C, 30,000 h<br>P24 Reliability test<br> • High temperature: ① 300hours → 240hours<br> • Vibration: ④50times → 10times<br>P25 Cautions<br> • TBD m/s$^2$ → 294 m/s$^2$<br> • TBD ms → 11 ms<br>P25 Attentions - Handling of the product<br> • ⑥: Recommended installing method (addition)<br>P26 Attentions - Others<br> • ③: for repairing and so on (elimination)<br><br><br>**Signature of writer**<br><br>*Approved by*     *Checked by*     *Prepared by*<br>R. KAWASHIMA        T. OGAWA |
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