

TFT COLOR LCD MODULE

NL8060BC31-28D

30.8cm (12.1 Type)

SVGA

LVDS interface (1port)

DATA SHEET 

DOD-PD-0823 (5th edition)

**This DATA SHEET is updated document from
DOD-PD-0727(4).**

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL8060BC31-28D 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. PC, signal generator, etc.) are modulated into best form for active matrix system by a signal processing circuit, and sent to the driver LSIs which drive the individual TFT arrays.

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

1.2 APPLICATION

- For industrial use

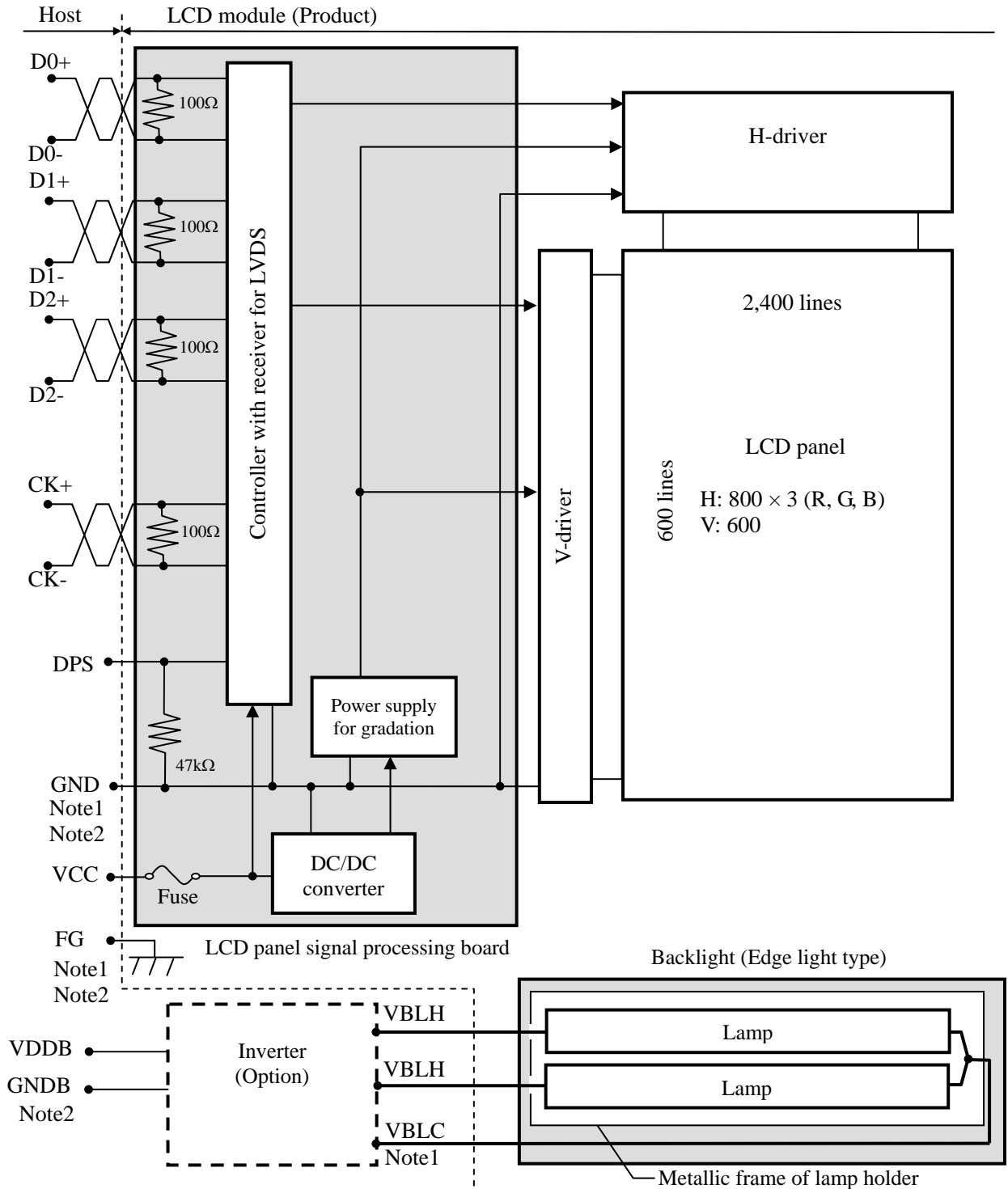
1.3 FEATURES

- High luminance
- High contrast
- Wide viewing angle
- Wide temperature range
- LVDS interface
- Reversible-scan direction
- Edge light type (without inverter)
- Replaceable lamp for backlight
- Acquisition product for UL60950-1 1st Edition/CSA C22.2 No.60950-1-03 (File number: E170632)

2. GENERAL SPECIFICATIONS

| | |
|-----------------------------------|--|
| <i>Display area</i> | 246.0 (H) × 184.5 (V) mm |
| <i>Diagonal size of display</i> | 30.8 cm (12.1 inches) |
| <i>Drive system</i> | a-Si TFT active matrix |
| <i>Display color</i> | 262,144 colors |
| <i>Pixel</i> | 800 (H) × 600 (V) pixels |
| <i>Pixel arrangement</i> | RGB (Red dot, Green dot, Blue dot) vertical stripe |
| <i>Dot pitch</i> | 0.1025 (H) × 0.3075 (V) mm |
| <i>Pixel pitch</i> | 0.3075 (H) × 0.3075 (V) mm |
| <i>Module size</i> | 280.0 (W) × 210.0 (H) × 13.0 (D) mm (typ.) |
| <i>Weight</i> | 730 g (typ.) |
| <i>Contrast ratio</i> | 600:1 (typ.) |
| <i>Viewing angle</i> | At the contrast ratio ≥10:1 <ul style="list-style-type: none"> • Horizontal: Right side 70° (typ.), Left side 70° (typ.) • Vertical: Up side 45° (typ.), Down side 55° (typ.) |
| <i>Designed viewing direction</i> | At DPS= Low or open: normal scan <ul style="list-style-type: none"> • Viewing direction without image reversal: up side (12 o'clock) • Viewing direction with contrast peak: down side (6 o'clock) • Viewing angle with optimum grayscale (γ=2.2): normal axis |
| <i>Polarizer surface</i> | Antiglare |
| <i>Polarizer pencil-hardness</i> | 3H (min.) [by JIS K5400] |
| <i>Color gamut</i> | At LCD panel center 40 % (typ.) [against NTSC color space] |
| <i>Response time</i> | Ton+Toff (10%←→90%) 33 ms (typ.) |
| <i>Luminance</i> | At IBL= 5.0mArms / lamp 350 cd/m ² (typ.) |
| <i>Signal system</i> | LVDS 1port (Receiver: THC63LVDF84B, THine Electronics Inc. or equivalent) 6bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE) |
| <i>Power supply voltage</i> | LCD panel signal processing board: 3.3V |
| <i>Backlight</i> | Edge light type: 2 cold cathode fluorescent lamps (Replaceable part) <ul style="list-style-type: none"> • Lamp holder set: Type No. 121LHS18 (Recommended inverter (Option)) <ul style="list-style-type: none"> • Inverter: Type No. 121PW181 |
| <i>Power consumption</i> | At IBL=5.0mArms / lamp and checkered flag pattern 6.4 W (typ.) (Power dissipation of the inverter is not included.) |

3. BLOCK DIAGRAM



Note1: Connections between GND (Signal ground), FG (Frame ground) and VBLC (Lamp low voltage terminal) in the LCD module

| | |
|------------|---------------|
| GND - FG | Not connected |
| GND - VBLC | Not connected |
| FG - VBLC | Not connected |

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

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

| Parameter | Specification | Unit |
|--------------|--|------|
| Module size | 280.0 ± 0.5 (W) × 210.0 ± 0.5 (H) × 13.0 (typ., D) 13.7 (max., D) Note1 | mm |
| Display area | 246.0 (H) × 184.5 (V) Note1 | mm |
| Weight | 730 (typ.), 760 (max.) | g |

Note1: See "7. 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 |
| | Lamp voltage | VBLH | 1,800 | Vrms | |
| Input voltage for signals | Display signals Note1 | VD | -0.3 to VCC+0.3 | V | |
| | Function signal Note2 | VF | | | |
| Storage temperature | | Tst | -20 to +80 | °C | - |
| Operating temperature | Front surface | TopF | -10 to +70 | °C | Note3 |
| | Rear surface | TopR | -10 to +70 | °C | Note4 |
| Relative humidity Note5 | | RH | ≤ 95 | % | Ta ≤ 40°C |
| | | | ≤ 85 | % | 40 < Ta ≤ 50°C |
| Absolute humidity Note5 | | AH | ≤ 70 Note6 | g/m ³ | Ta > 50°C |

Note1: Display signals are D0+/-, D1+/-, D2+/- and CK+/-.

Note2: Function signal is DPS.

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

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

Note5: No condensation

Note6: Water amount at Ta = 50°C and RH = 85%

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 | - | 200 Note1 | 410 Note2 | mA | at VCC = 3.3V | |
| Permissible ripple voltage | VRP | - | - | 100 | mVp-p | for VCC | |
| Differential input threshold voltage for LVDS receiver | High | VTH | - | - | +100 | mV | at VCM=1.2V Note3 |
| | Low | VTL | -100 | - | - | mV | |
| Terminating resistance | RT | - | 100 | - | Ω | - | |
| Input voltage for DPS signal | High | VFH | 2.0 | - | VCC | V | - |
| | Low | VFL | 0 | - | 0.8 | V | |

Note1: Checkered flag pattern [by EIAJ ED-2522]

Note2: Pattern for maximum current

Note3: Common mode voltage for LVDS receiver

4.3.2 Backlight lamp

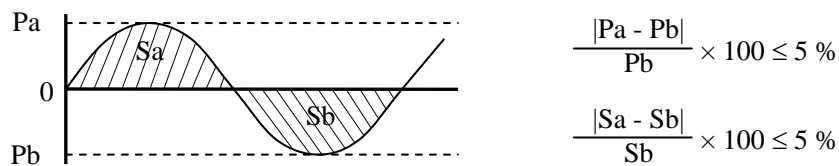
(Ta=25°C, Note1)

| Parameter | Symbol | min. | typ. | max. | Unit | Remarks |
|----------------------------|--------|-------|------|------|-------|--|
| Lamp current | IBL | 2.0 | 5.0 | 5.5 | mArms | at IBL=5.0mArms: 350cd/m ² Note3, Note4 |
| Lamp voltage | VBLH | - | 570 | - | Vrms | Note2, Note3 |
| Lamp starting voltage | VS | 970 | - | - | Vrms | Ta = 25°C Note2, Note3 |
| | | 1,410 | - | - | Vrms | Ta = -10°C Note2, Note3 |
| Lamp oscillation frequency | FO | 58 | 63 | 68 | kHz | Note5 |

Note1: This product consists of 2 backlight lamps, and these specifications are for each lamp.

Note2: The lamp voltage cycle between lamps should be kept on a same phase. "VS" and "VBLH" are the voltage value between low voltage side (Cold) and high voltage side (Hot).

Note3: The asymmetric ratio of working waveform for lamps (Power supply voltage peak ratio, power supply current peak ratio and waveform space ratio) should be less than 5 % (See the following figure.). If the waveform is asymmetric, DC (Direct current) element apply into the lamp. In this case, a lamp lifetime may be shortened, because a distribution of a lamp enclosure substance inclines toward one side between low voltage terminal (Cold terminal) and high voltage terminal (Hot terminal). When designing the inverter, evaluate asymmetric of lamp working waveform sufficiently.



Pa: Supply voltage/current peak for positive, Pb: Supply voltage/current peak for negative
Sa: Waveform space for positive part, Sb: Waveform space for negative part.

Note4: This product consists of 2 lamps. 2 lamps are contained in the 1 lamp holder, and both lamps are connected to 1 low voltage cable. Recommendation lamp current is 5.0mArms typical for each lamp, and sum of 2 lamps is 10mArms typical. The lamp current should be measured by high-frequency current meter at the low voltage terminal.

Note5: In case "FO" is not the recommended value, beat noise may display on the screen, because of interference between "FO" and "1/th". Recommended value of "FO" is as following

$$FO = \frac{1}{4} \times \frac{1}{th} \times (2n-1)$$

th: Horizontal cycle (See "4.9.2 Timing characteristics".)
n: Natural number (1, 2, 3)

Note6: Method of lamp cable installation may invite fluctuation of lamp current and voltage or asymmetric of lamp working waveform. When designing method of lamp cable installation, evaluate the fluctuation of lamp current, voltage and working waveform sufficiently.

4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

| Power supply voltage | | Ripple voltage (Measure at input terminal of power supply) | Note1 | Unit |
|----------------------|------|---|-------|-------|
| VCC | 3.3V | ≤ 100 | | mVp-p |

Note1: The permissible ripple voltage includes spike noise.

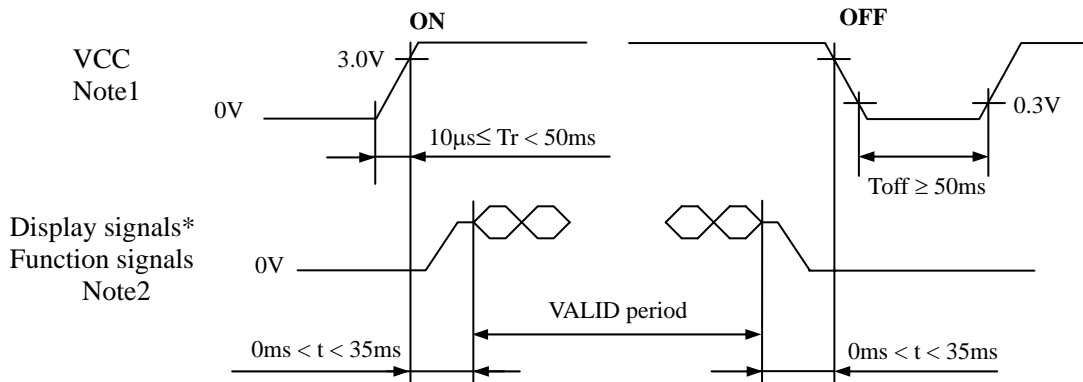
4.3.4 Fuse

| Parameter | Fuse | | Rating | Fusing current | Remarks |
|-----------|------------|-----------------------------|--------|----------------|---------|
| | Type | Supplier | | | |
| VCC | FCC16202AB | KAMAYA ELECTRIC Co., Ltd | 2.0A | 4.0A | Note1 |
| | | | 32V | | |

Note1: The power supply capacity should 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



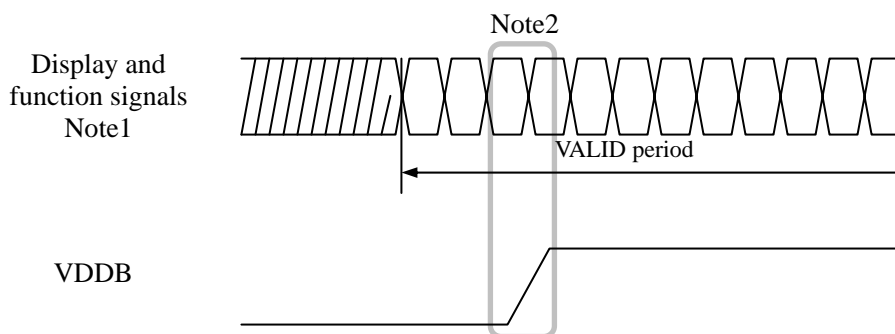
* These signals should be measured at the terminal of 100Ω resistance.

Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V, a protection circuit may work, and then this product may not work.

Note2: Display signals (D0+/-, D1+/-, D2+/- and CK+/-) and function signal (DPS) must be Low or High-impedance, exclude the VALID period (See above sequence diagram), in order to avoid that internal circuits is damaged.

If some of display and function 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 customer stops the display and function signals, they should be cut VCC.

4.4.2 Inverter (Option)



Note1: These are the display and function signals for LCD panel signal processing board.

Note2: The inverter power supply voltage (VDDB) should be inputted 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): FI-SE20P-HFE (Japan Aviation Electronics Industry Limited (JAE)) ☆
 Adaptable plug: FI-S20S (Japan Aviation Electronics Industry Limited (JAE))

| Pin No. | Symbol | Signal | Remarks |
|---------|--------|-----------------------------|---|
| 1 | GND | Ground | Note1 |
| 2 | GND | | |
| 3 | DPS | Selection of scan direction | High: Reverse scan Low or Open: Normal scan Note2 |
| 4 | GND | Ground | Note1 |
| 5 | GND | | |
| 6 | CK+ | Pixel clock | Note3 |
| 7 | CK- | | |
| 8 | GND | Ground | Note1 |
| 9 | D2+ | Pixel data | Note3 |
| 10 | D2- | | |
| 11 | GND | Ground | Note1 |
| 12 | D1+ | Pixel data | Note3 |
| 13 | D1- | | |
| 14 | GND | Ground | Note1 |
| 15 | D0+ | Pixel data | Note3 |
| 16 | D0- | | |
| 17 | GND | Ground | Note1 |
| 18 | GND | | |
| 19 | VCC | Power supply | Note1 |
| 20 | VCC | | |

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

Note2: See "4.8 SCANNING DIRECTIONS".

Note3: Twist pair wires with 100Ω (Characteristic impedance) should be connected between LCD panel signal processing board and LVDS transmitter.

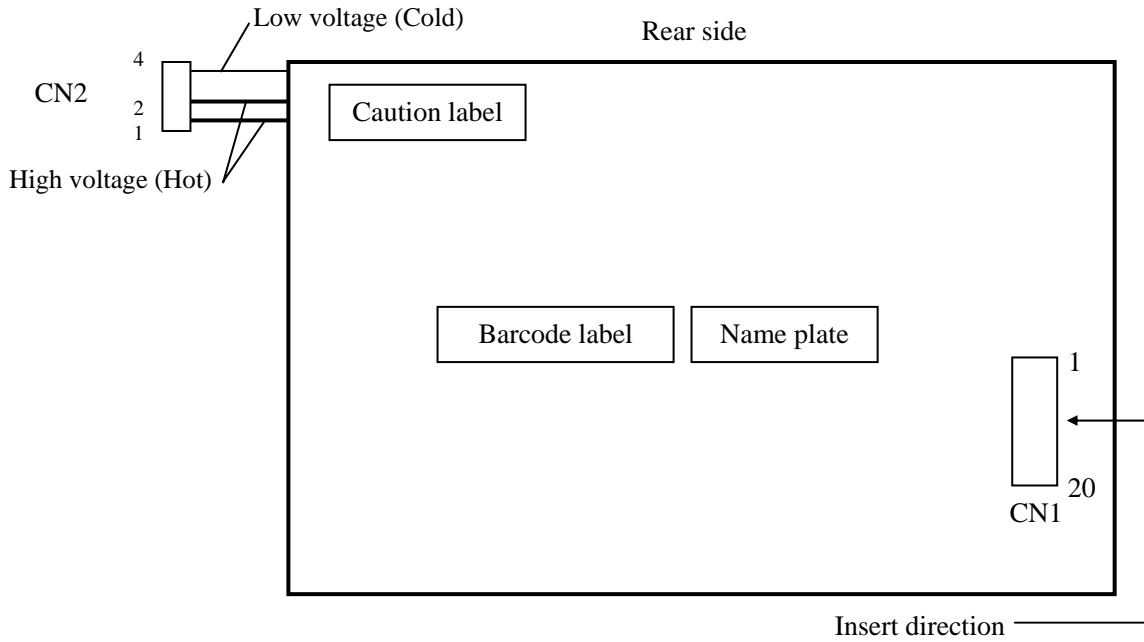
4.5.2 Backlight lamp

Attention: VBLH and VBLC must be connected correctly. If customer connects wrongly, customer will be hurt and the module will be broken.

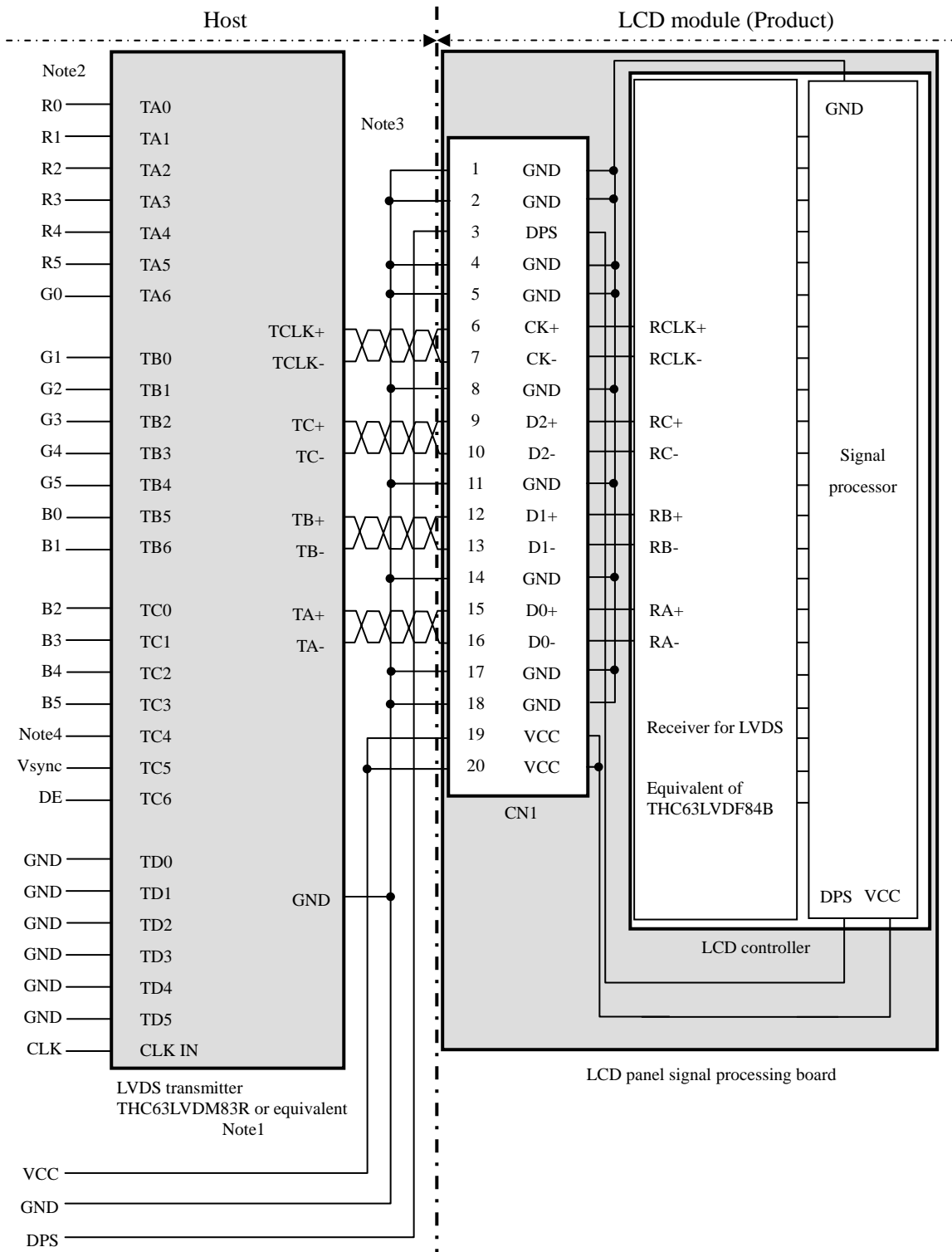
CN2 plug: BHR-04VS-1 (J.S.T Mfg. Co., Ltd.)
 Adaptable socket: SM03 (7-D1) B-BHS-1-TB (LF) (SN),
 SM03 (7-D1) B-BHS-1-TB (J.S.T Mfg. Co., Ltd.)

| Pin No. | Symbol | Signal | Remarks |
|---------|--------|--------------------|---------------------|
| 1 | VBLH | High voltage (Hot) | Cable color: Pink |
| 2 | VBLH | High voltage (Hot) | Cable color: Pink |
| 3 | N. C. | - | Keep this pin Open. |
| 4 | VBLC | Low voltage (Cold) | Cable color: White |

4.5.3 Positions of plug and socket



4.5.4 Connection between receiver and transmitter for LVDS



- Note1: Recommended transmitter THC63LVDM83R (THine Electronics Inc.) or equivalent
- Note2: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R5, G5, B5
- Note3: Twist pair wires with 100Ω (Characteristic impedance) should be connected between LCD panel signal processing board and LVDS transmitter.
- Note4: Input signal to TC4 is not used inside the product, but do not keep TC4 open to avoid noise problem.

4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 262,144 colors in 64 gray scales. Also the relation between display colors and input data signals is as the following table.

| Display colors | | Data signal (0: Low level, 1: High level) | | | | | | | | | | | | | | | | | |
|------------------|---------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | | R5 | R4 | R3 | R2 | R1 | R0 | G5 | G4 | G3 | G2 | G1 | G0 | B5 | B4 | B3 | B2 | B1 | B0 |
| Basic colors | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | White | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Red gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | dark | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | : | | | | | : | | | | | | : | | | |
| | ↓ | | | | : | | | | | : | | | | | | : | | | |
| bright | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Green gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | : | | | | | : | | | | | | : | | | |
| | ↓ | | | | : | | | | | : | | | | | | : | | | |
| bright | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Blue gray scale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | ↑ | | | | : | | | | | : | | | | | | : | | | |
| | ↓ | | | | : | | | | | : | | | | | | : | | | |
| bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | |
| Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | |

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel (See "4.8 SCANNING DIRECTIONS").

| | | | | | | |
|------------|------------|-----|------------|-----|-------------|-------------|
| C (0, 0) | | | | | | |
| R | G | B | | | | |
| C(0, 0) | C(1, 0) | ... | C(X, 0) | ... | C(798, 0) | C(799, 0) |
| C(0, 1) | C(1, 1) | ... | C(X, 1) | ... | C(798, 1) | C(799, 1) |
| . | . | . | . | . | . | . |
| . | . | ... | . | ... | . | ... |
| . | . | . | . | . | . | . |
| C(0, Y) | C(1, Y) | ... | C(X, Y) | ... | C(798, Y) | C(799, Y) |
| . | . | . | . | . | . | . |
| . | . | ... | . | ... | . | . |
| . | . | . | . | . | . | . |
| C(0, 598) | C(1, 589) | ... | C(X, 598) | ... | C(798, 598) | C(799, 598) |
| C(0, 599) | C(1, 599) | ... | C(X, 599) | ... | C(798, 599) | C(799, 599) |

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view. Also the arrow shows the direction of scan.

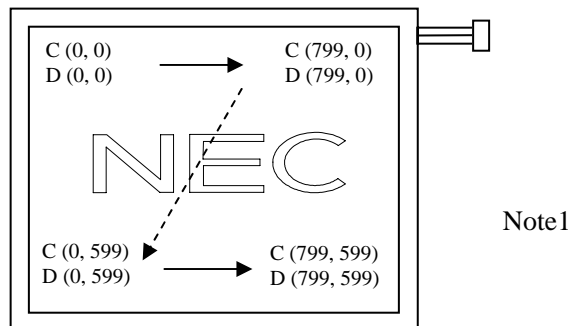


Figure1. Normal scan (DPS: Low or Open)

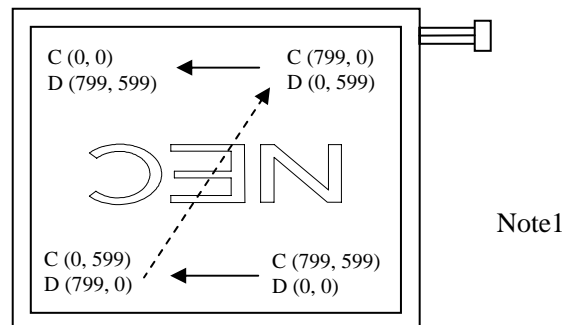


Figure2. Reverse scan (DPS: High)

Note1: Meaning of C (X, Y) and D (X, Y)

C (X, Y): The coordinates of the display position (See "4.7 DISPLAY POSITIONS".)

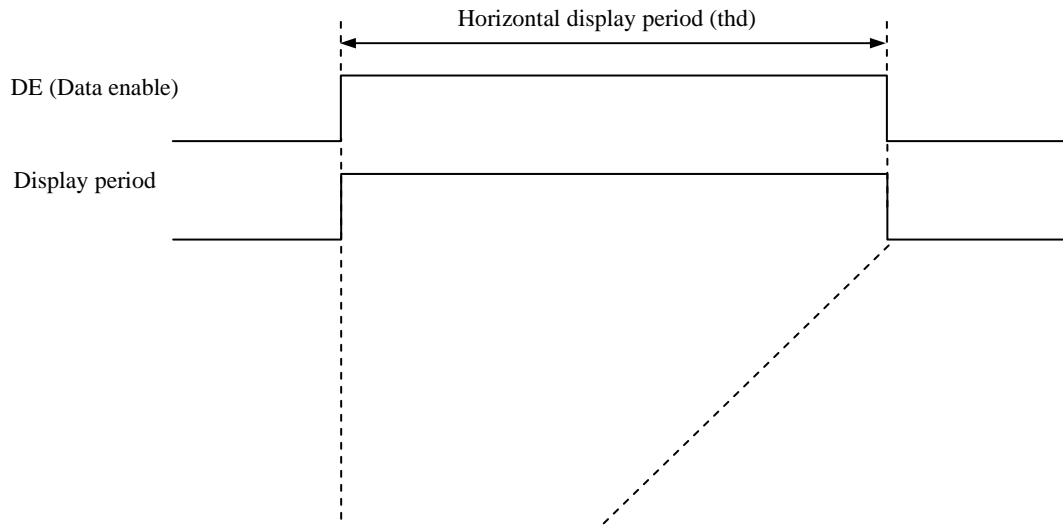
D (X, Y): The data number of input signal for LCD panel signal processing board

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

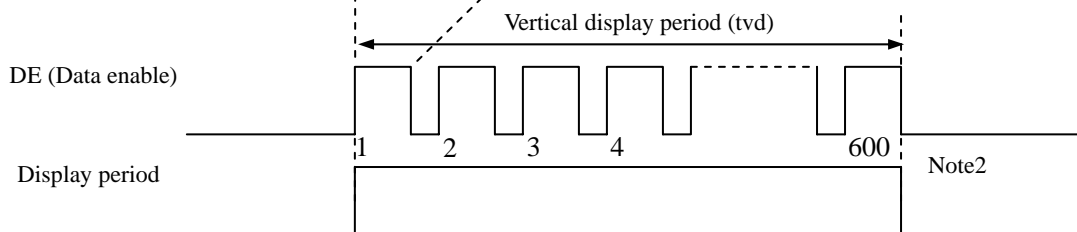
• Horizontal signal

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 numeration of pulse.

4.9.2 Timing characteristics

| Parameter | | Symbol | min. | typ. | max. | Unit | Remarks | |
|----------------------|----------------------|----------------|------|--------|--------|------|------------------|---|
| CLK | Frequency | 1/tc | 34.0 | 38.362 | 40.0 | MHz | 26.067 ns (typ.) | |
| | Duty | - | - | | | - | Note2 | |
| | Rise time, Fall time | - | | | | ns | | |
| DATA | CLK-DATA | Setup time | - | | | ns | Note2 | |
| | | Hold time | | | | ns | | |
| | Rise time, Fall time | - | | | | ns | | |
| Vsync | Pulse width | | 1 | 2 | - | H | - | |
| | Vsync-DE timing | Setup time | 1 | - | - | CLK | | |
| | | Hold time | 1 | - | - | CLK | | |
| DE | Horizontal | Cycle | th | 24.0 | 26.693 | 30.1 | μs | 37.463 kHz (typ.) Note1, Note2, Note3 |
| | | | thd | 829 | 1,024 | - | CLK | |
| | | Display period | thd | 800 | | | CLK | |
| | Vertical (One frame) | Cycle | tv | 16.1 | 16.683 | 17.2 | ms | 59.94 Hz (typ.) Note1 |
| | | | tvd | 603 | 625 | - | H | |
| | CLK-DE | Setup time | - | - | | | ns | Note2 |
| | | Hold time | - | | | | ns | |
| Rise time, Fall time | | - | ns | | | | | |

Note1: Definition of parameters is as follows.

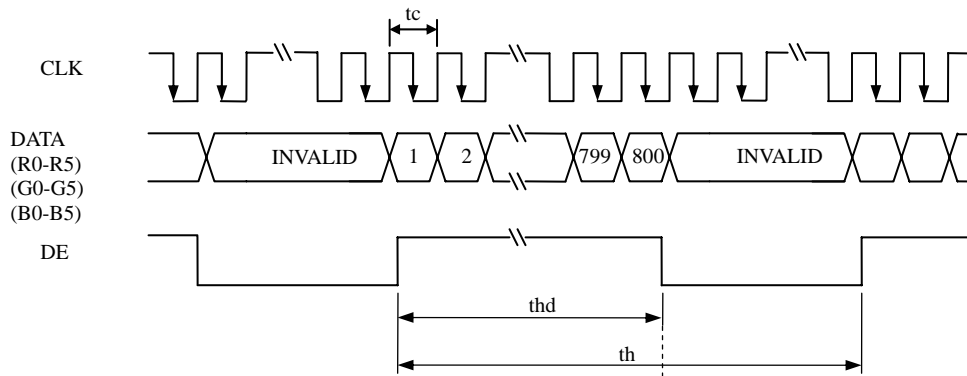
$$tc = 1CLK, th = 1H$$

Note2: See the data sheet of LVDS transmitter.

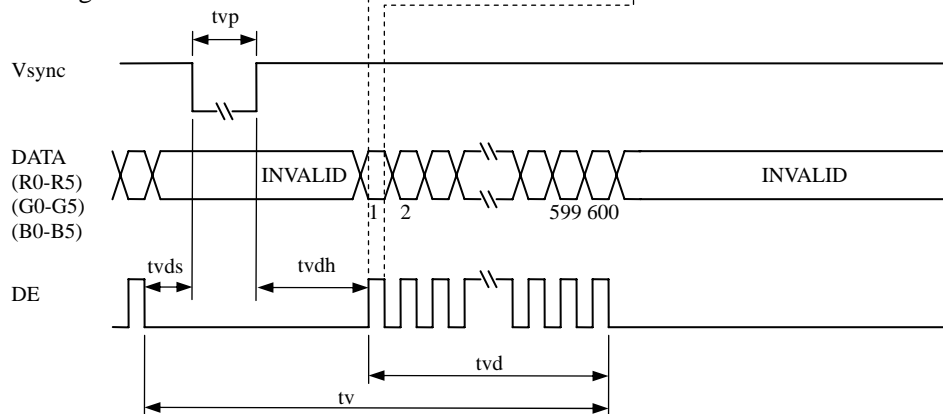
Note3: "th" must keep the fluctuation within ± 1 CLK, because of avoidance of image sticking.

4.9.3 Input signal timing chart

Horizontal timing



Vertical timing



4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

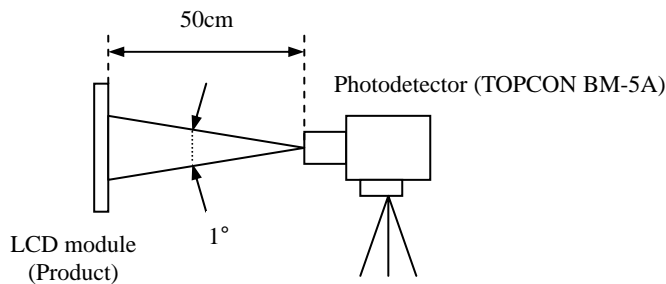
| Parameter | Condition | Symbol | min. | typ. | max. | Unit | Remarks | |
|----------------------|---|--|------------|-------|-------|-------------------|---------|-------|
| Luminance | White at center $\theta R = 0^\circ, \theta L = 0^\circ, \theta U = 0^\circ, \theta D = 0^\circ$ | L | 250 | 350 | - | cd/m ² | - | |
| Contrast ratio | White/Black at center $\theta R = 0^\circ, \theta L = 0^\circ, \theta U = 0^\circ, \theta D = 0^\circ$ | CR | 300 | 600 | - | - | Note3 | |
| Luminance uniformity | White $\theta R = 0^\circ, \theta L = 0^\circ, \theta U = 0^\circ, \theta D = 0^\circ$ | LU | - | 1.25 | 1.40 | - | Note4 | |
| Chromaticity | White | x coordinate | Wx | 0.283 | 0.313 | 0.343 | - | Note5 |
| | | y coordinate | Wy | 0.299 | 0.329 | 0.359 | - | |
| | Red | x coordinate | Rx | - | 0.586 | - | - | |
| | | y coordinate | Ry | - | 0.345 | - | - | |
| | Green | x coordinate | Gx | - | 0.327 | - | - | |
| | | y coordinate | Gy | - | 0.518 | - | - | |
| Blue | x coordinate | Bx | - | 0.156 | - | - | | |
| | y coordinate | By | - | 0.145 | - | - | | |
| Color gamut | $\theta R = 0^\circ, \theta L = 0^\circ, \theta U = 0^\circ, \theta D = 0^\circ$ at center, against NTSC color space | C | 35 | 40 | - | % | | |
| Response time | White to Black | Ton | - | 8 | 10 | ms | Note6 | |
| | Black to White | Toff | - | 25 | 30 | ms | Note7 | |
| Viewing angle | Right | $\theta U = 0^\circ, \theta D = 0^\circ, CR \geq 10$ | θR | 60 | 70 | - | ° | Note8 |
| | Left | $\theta U = 0^\circ, \theta D = 0^\circ, CR \geq 10$ | θL | 60 | 70 | - | ° | |
| | Up | $\theta R = 0^\circ, \theta L = 0^\circ, CR \geq 10$ | θU | 35 | 45 | - | ° | |
| | Down | $\theta R = 0^\circ, \theta L = 0^\circ, CR \geq 10$ | θD | 45 | 55 | - | ° | |

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta=25°C, VCC=3.3V, IBL= 5.0mArms/lamp, Display mode: SVGA, Horizontal cycle = 1/37.463kHz, Vertical cycle = 1/59.94Hz, DPS= Low or Open: Normal scan

Optical characteristics are measured at luminance saturation after 20minutes from working the product, in the dark room. Also measurement method for luminance is 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 = 28°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.

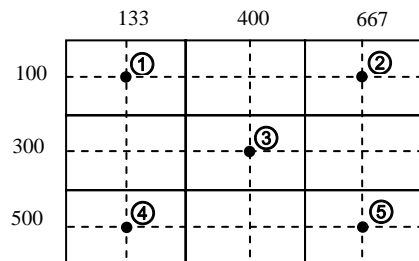
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

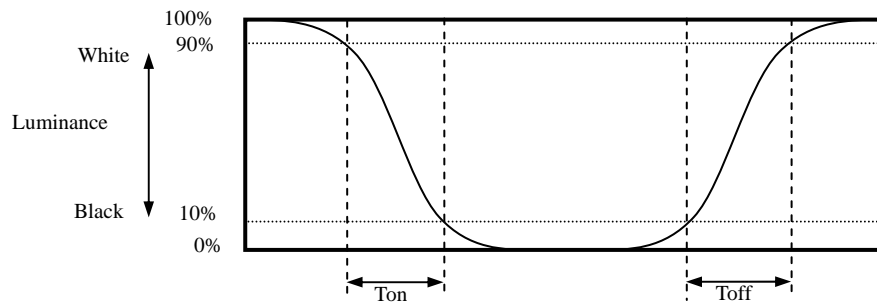
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

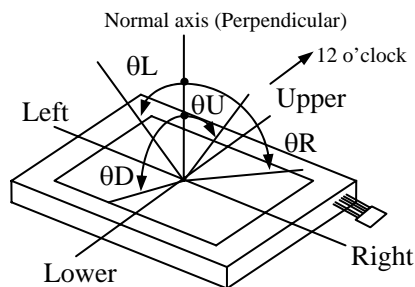


4.10.4 Definition of response times

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



4.10.5 Definition of viewing angles

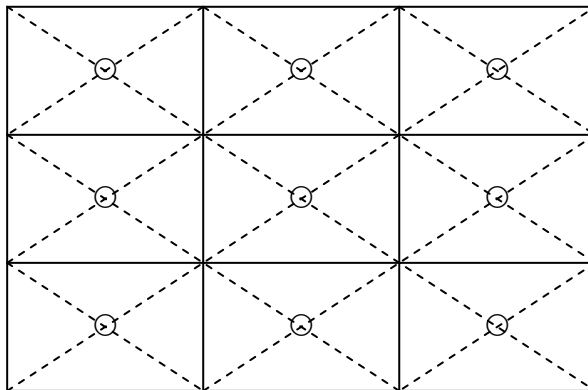


5. RELIABILITY TESTS

| Test item | Condition | Judgement |
|---|---|---|
| High temperature and humidity (Operation) | ① 60 ± 2°C, RH = 90%, 240hours ② Display data is black. | No display malfunctions Note1 |
| High temperature (Operation) | ① 70 ± 2°C, 240hours ② Display data is black. | |
| Heat cycle (Operation) | ① -10 ± 3°C...1hour 70 ± 3°C...1hour ② 50cycles, 4hours/cycle ③ Display data is black. | |
| Thermal shock (Non operation) | ① -20 ± 3°C...30minutes 80 ± 3°C...30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes. | |
| ESD (Operation) | ① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note2 ③ 10 times each places at 1 sec interval | |
| Dust (Operation) | ① Sample dust: No. 15 (by JIS-Z8901)) ② 15 seconds stir ③ 8 times repeat at 1 hour interval | |
| Vibration (Non operation) | ① 5 to 100Hz, 19.6m/s ² ② 1 minute/cycle ③ X, Y, Z direction ④ 120 times each directions | No display malfunctions No physical damages Note1 |
| Mechanical shock (Non operation) | ① 539m/ s ² , 11ms ② ±X, ±Y, ±Z direction ③ 5 times each directions | |

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.





6. PRECAUTIONS

6.1 MEANING OF CAUTION SIGNS


The following caution signs have very important meaning. **Be sure to read "6.2 CAUTIONS" and "6.3 ATTENTIONS", after understanding these contents!**


| | |
|---|--|
|  | This sign has the meaning that customer will be injured by himself or the product will sustain a damage, if customer has wrong operations. |
|---|--|

| | |
|---|---|
|  | This sign has the meaning that customer will get an electrical shock, if customer has wrong operations. |
|---|---|

| | |
|---|---|
|  | This sign has the meaning that customer will be injured by himself, if customer has wrong operations. |
|---|---|

6.2 CAUTIONS

| | |
|---|---|
|  | * Do not touch the working backlight. Customer will be in danger of an electric shock. |
|---|---|

| | |
|---|---|
|  | * Do not touch the working backlight. Customer will be in danger of burn injury. * Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: To be not greater 539m/s² and to be not greater 11ms, Pressure: To be not greater 19.6 N) |
|---|---|

6.3 ATTENTIONS 

6.3.1 Handling of the product

- ① Take hold of both ends without touch the circuit board cover when customer pulls out products (LCD modules) from inner packing box. If customer touches it, products may be broken down or out of adjustment, because of stress to mounting parts.
- ② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid damage.
- ③ If customer puts down the product temporarily, the product puts on flat subsoil as a display side turns down.
- ④ Take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because products may be damaged by electrostatic when customer handles the product.
- ⑤ The torque for mounting screws must never exceed 0.294N·m. Higher torque values might result in distortion of the bezel.
- ⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area) except mounting hole portion.
Bends or twist described above and undue stress to any portion except mounting hole portion may cause display un-uniformity.
- ⑦ Do not press or rub on the sensitive display surface. If customer clean on the panel surface, NEC recommends using the cloth with ethanolic liquid such as screen cleaner for LCD.

- ⑧ Do not push nor pull the interface connectors while the product is working.
- ⑨ Do not bend or unbend the lamp cable at the near part of the lamp holding rubber, to avoid the damage for high voltage side of the lamp. This damage may cause a lamp breaking and abnormal operation of high voltage circuit.
- ⑩ If the lamp cable is attached on the metal part of the LCD module directly, a leak high frequency current to the metal part may occur, then the brightness may decrease or the lamp may not light.
- ⑪ When not connecting FG of the LCD module to the customer's equipment ground, inverter noise may create a beat frequency that will cause video noise on the LCD screen.
- ⑫ When customer handles 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 properties of the polarizer.

6.3.2 Environment

- ① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box and antistatic pouch in room temperature to avoid for dusts and sunlight, when customer stores the product.
- ② In order to prevent dew condensation occurring by temperature difference, the product packing box should be opened after being left under the environment of an unpacking room enough. Because a situation of dew condensation occurring is changed by the environmental temperature and humidity. Evaluate the leaving time sufficiently. (Recommendation leaving time: 6 hour or more with packing state)
- ③ Do not operate in high magnetic field. Circuit boards may be broken down by it.
- ④ This product is not designed as radiation hardened.

6.3.3 Characteristics

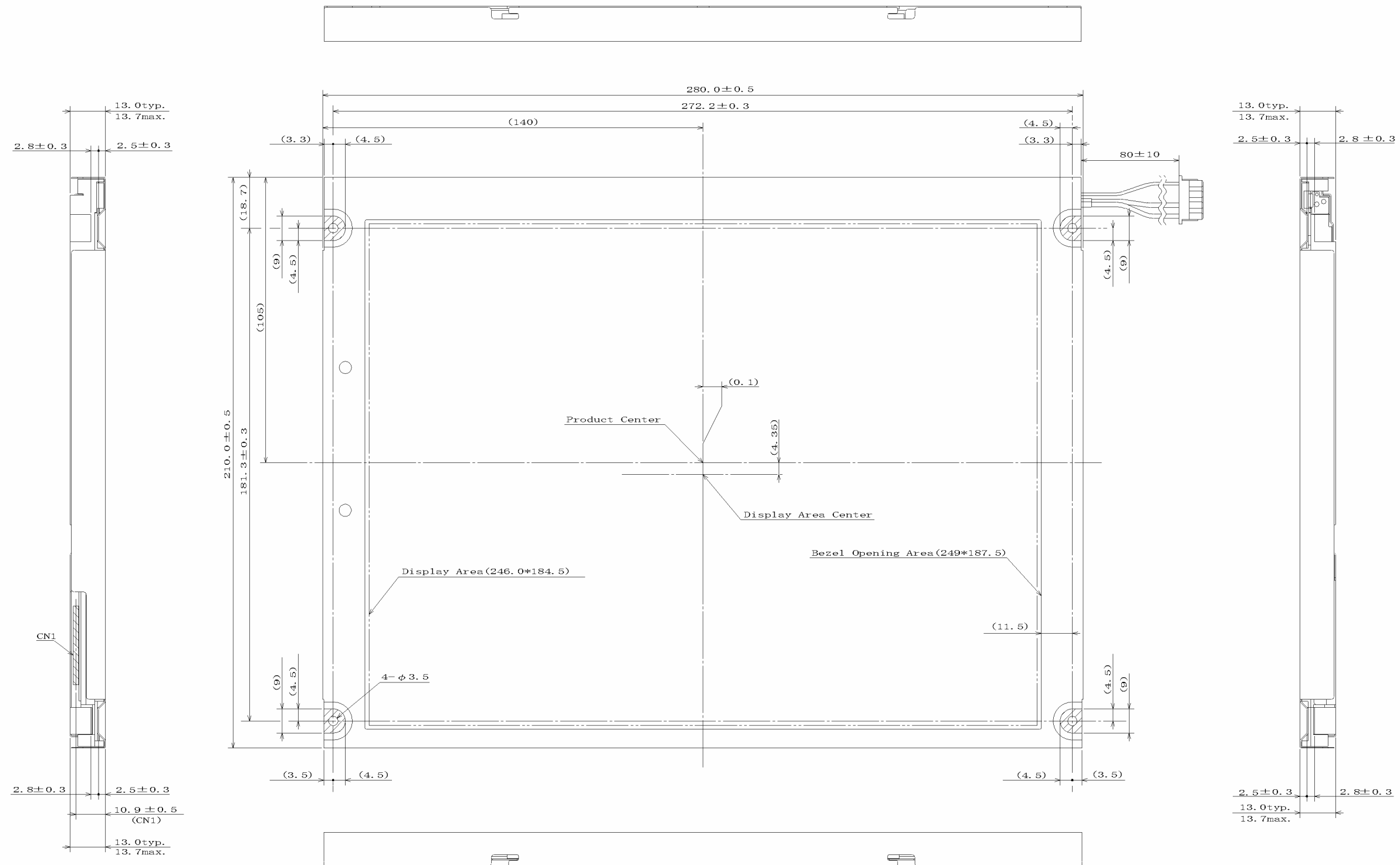
The following items are neither defects nor failures.


- ① Response time, luminance and color may be changed by ambient temperature.
- ② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
- ③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating time, and especially low temperature, because the LCD has cold cathode fluorescent lamps.
- ④ 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.
- ⑤ The display color may be changed by viewing angle because of the use of condenser sheet in the backlight.
- ⑥ Optical characteristics may be changed by input signal timings.
- ⑦ The interference noise of input signal frequency for this product's signal processing board and luminance control frequency of customer's inverter may appear on a display. Set up luminance control frequency of inverter so that the interference noise does not appear.

6.3.4 Other

- ① All VCC and GND terminals should be used without any non-connected lines.
- ② Do not disassemble a product or adjust variable resistors without permission of NEC.
- ③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", if customer would like to replace backlight lamps.
- ④ Pay attention not to insert waste materials inside of products, if customer uses screwnails.
- ⑤ Pack the product with original shipping package, in order to avoid any damages during transportation, when customer returns it to NEC for repair and so on.

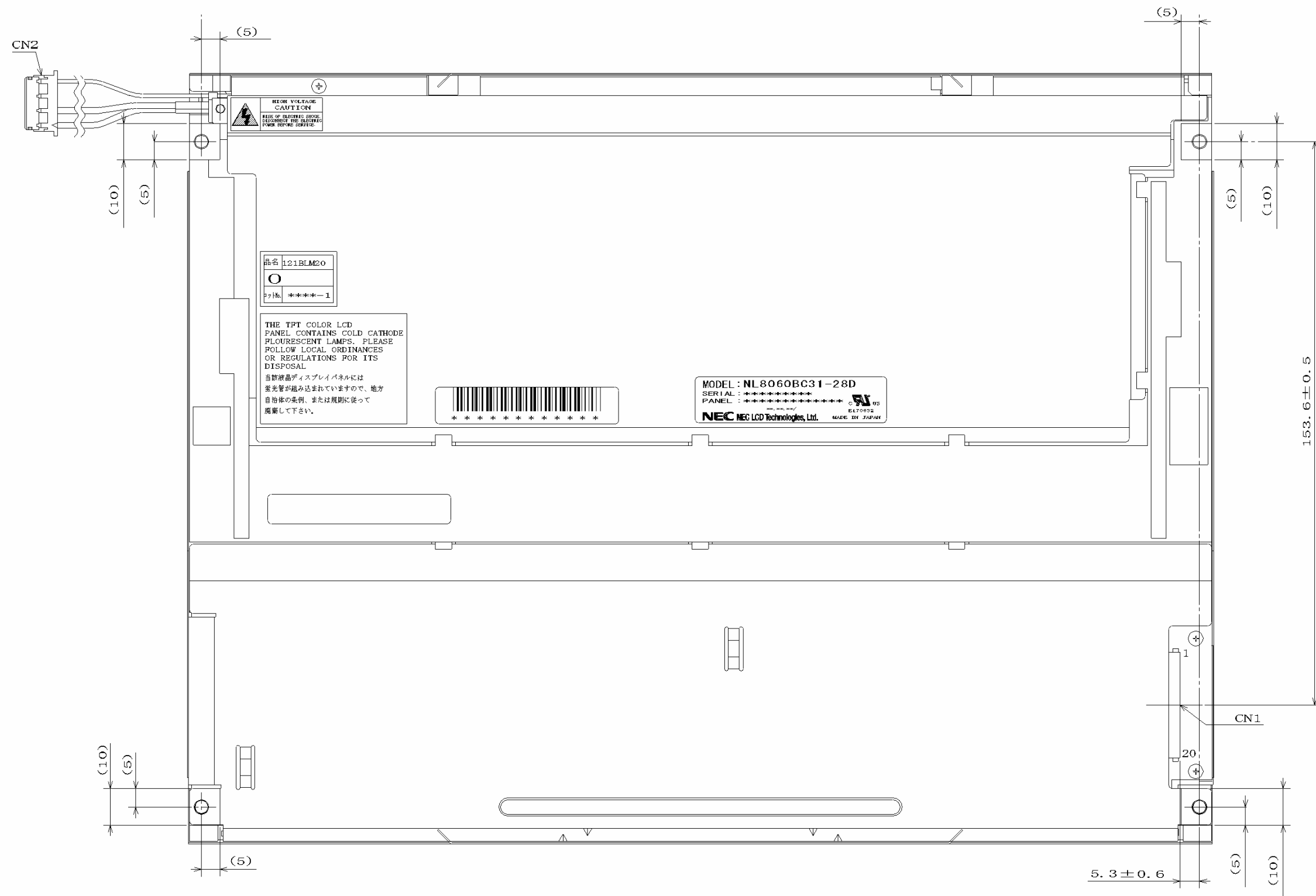
7. OUTLINE DRAWINGS
7.1 FRONT VIEW



- Note1: The values in parentheses are for reference.
 Note2: The torque for mounting screws must never exceed 0.294N·m.
 Note3:  Mounting hole portions (4 pieces)

Unit: mm

7.2 REAR VIEW



Note1: The values in parentheses are for reference.

Note2: The torque for mounting screws must never exceed 0.294N·m.

Unit: mm