NEC

TFT COLOR LCD MODULE

NL6448AC63-01

51.0cm (20.1 Type)
VGA

DATA SHEET

(3rd edition)

All information is subject to change without notice.

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INTRODUCTION

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Anti-radioactive design is not implemented in this product.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

NL6448AC63-01 module 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 unit.

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 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 APPLICATIONS

- Multimedia monitor
- TV monitor
- Display terminal for control system

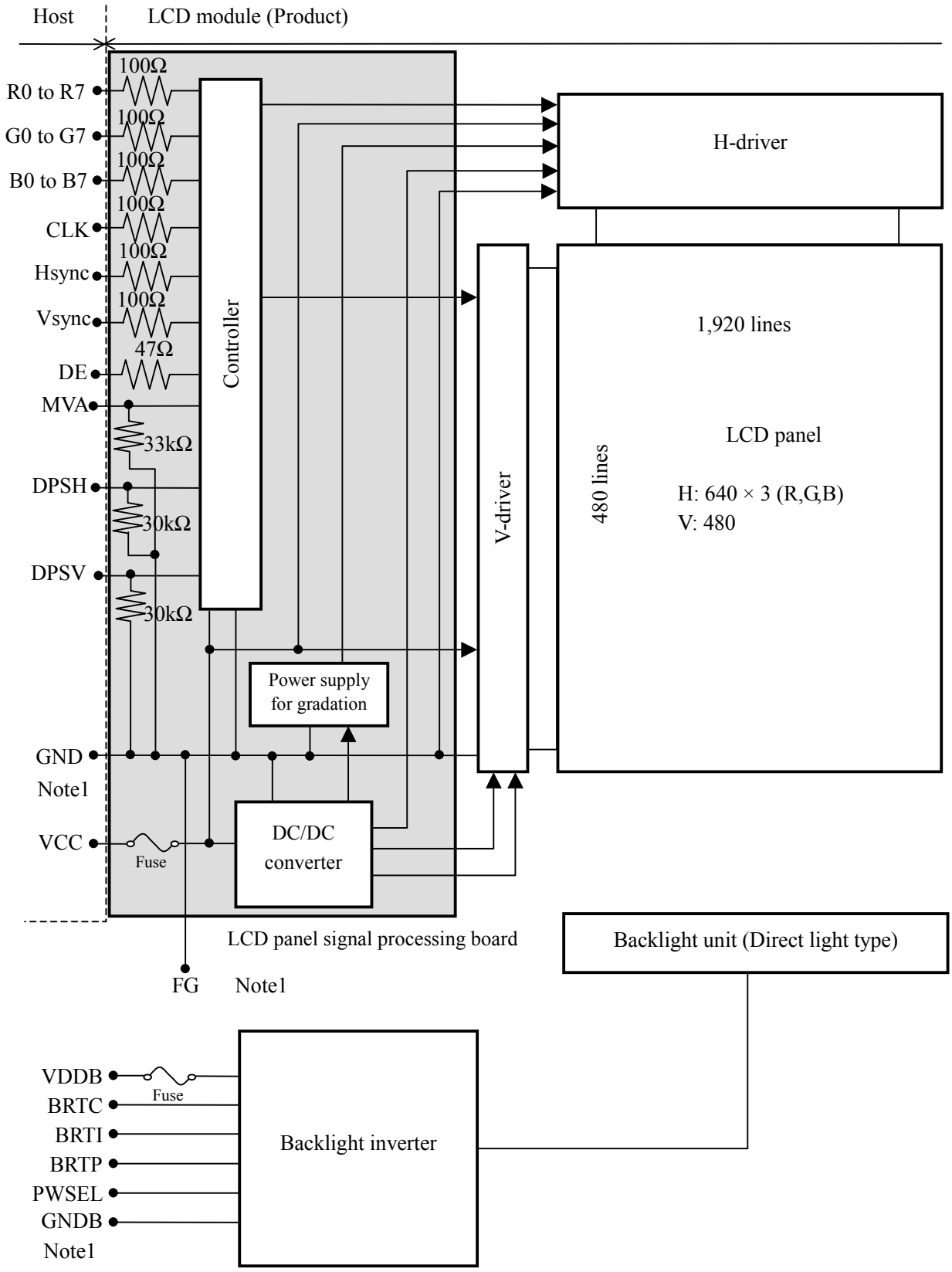
1.3 FEATURES

- High luminance
- Wide viewing angle
- High contrast
- Low reflection
- 8-bit digital RGB signals
- Select function of best viewing angle
- Reversible-scan direction
- Direct light type
- Replaceable backlight unit and inverter

2. GENERAL SPECIFICATIONS

Display area	408.0 (W) × 306.0 (H) mm (typ.)
Diagonal size of display	51.0 cm (20.1 inches)
Drive system	a-Si TFT active matrix
Display color	16,194,277 colors
Pixel	640 (H) × 480 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.2125 (W) × 0.6375 (H) mm
Pixel pitch	0.6375 (W) × 0.6375 (H) mm
Module size	448.0 (W) × 348.0 (H) × 33.2 (D) mm (typ.)
Weight	1,900 g (typ.)
Contrast ratio	400:1 (typ.)
Viewing angle	*At the contrast ratio 10:1* • Horizontal: Left side 65° (typ.), Right side 65° (typ.) • Vertical: Up side 55° (typ.), Down side 50° (typ.)
Designed viewing direction	*At DPSH: normal scan and DPSV: normal scan* • Viewing direction without image reversal: up side (12 o'clock) • Viewing direction with contrast peak: down side 5° to 10° (6 o'clock) *At MVA: Low or Open* • Viewing angle with optimum grayscale (γ=2.2): normal axis
Polarizer surface	Antiglare treatment
Polarizer pencil-hardness	3H (min.) [by JIS K5400]
Color gamut	*At LCD panel center* 57 % (typ.) [against NTSC color space]
Response time	4 ms (typ.)
Luminance	500 cd/m^2 (typ.)
Signal system	8-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE), Horizontal synchronous signal (Hsync), Vertical synchronous signal (Vsync)
Power supply voltage	LCD panel signal processing board: 3.3V Backlight inverter: 12.0V
Backlight	Direct light type: 12 cold cathode fluorescent lamps Replaceable parts • Backlight unit: type No. 201LHS04 • Inverter: type No. 201PW051
Power consumption	*At maximum luminance and checkered flag pattern* 47 W (typ.)

3. BLOCK DIAGRAM



Note 1: GND is connected to FG (Frame ground). GNDB is not connected to FG. GND and GNDB should be connected together in customer equipment.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	448.0 ± 1.0 (W) × 348.0 ± 1.0 (H) × 33.2 ± 1.0 (D) Note1	mm
Display area	408.0 ± 0.5 (W) × 306.0 ± 0.5 (H) Note1	mm
Weight	1,900 (typ.), 2,060 (max.)	g

Note1: See "**7. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal board	VCC	-0.3 to +6.5	V	Ta = 25°C
	Backlight inverter	VDDB	-0.3 to +14	V	
Input voltage for signals	Display signals Note1	VD	-0.3 to VCC+0.3	V	
	Function signals Note2	VF	-0.3 to VCC+0.3	V	
	BRTI signal	VBI	-0.3 to +1.5	V	Ta = 25°C VDDB = 12.0V
	BRTP signal	VBP	-0.3 to +5.5	V	
	BRTC signal	VBC	-0.3 to +5.5	V	
	PWSEL signal	VBS	-0.3 to +5.5	V	
Storage temperature		Tst	-20 to +60	°C	-
Operating temperature	Front surface	TopF	0 to +55	°C	
	Rear surface	TopR	0 to +55	°C	
Relative humidity Note3		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40 < Ta ≤ 50°C
			≤ 70	%	50 < Ta ≤ 55°C
Absolute humidity Note3		AH	≤ 78 Note4	g/m^3	Ta > 55°C

Note1: Display signals are CLK, Hsync, Vsync, DE and DATA (R0 to R7, G0 to G7, B0 to B7).
Note2: Function signals are DPSH, DPSV and MVA.
Note3: No condensation
Note4: Ta = 55°C, RH = 70%

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 Driving for 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	-	395 Note1	660	mA	VCC = 3.3V
Logic input voltage for display signals	Low	VDLL	0	-	0.3Vcc	V	CMOS level
	High	VDLH	0.7Vcc	-	Vcc	V	
Input voltage for DPSH or DPSV signals	Low	VFDL	0	-	0.3Vcc	V	
	High	VFDH	0.7Vcc	-	Vcc	V	
Input voltage for MVA signal	Low	VFML	0	-	0.3Vcc	V	
	High	VFMH	0.7Vcc	-	Vcc	V	

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

4.3.2 Driving for backlight inverter

(Ta = 25°C)

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Power supply voltage			VDDB	10.8	12.0	13.2	V	-
Power supply current			IDDB	-	3,800	-	mA	at maximum luminance, VDDB = 12.0V Note1
Input voltage for control system signals	BRTI signal		VBI	0	-	1.2	V	-
	BRTP signal	Low	VBPL	0	-	0.8	V	
		High	VBPH	2.0	-	5.0	V	
	BRTC signal	Low	VBCL	0	-	0.8	V	
		High	VBCH	2.0	-	5.0	V	
	PWSEL signal	Low	VBSL	0	-	0.8	V	
		High	VBSH	2.0	-	5.0	V	
Input current for control system signals	BRTI signal		IBI	-130	-	-	μA	
	BRTP signal	Low	IBPL	-1,580	-	-	μA	
		High	IBPH	-	-	3,500	μA	
	BRTC signal	Low	IBCL	-610	-	-	μA	
		High	IBCH	-	-	440	μA	
	PWSEL signal	Low	IBSL	-610	-	-	μA	
		High	IBSH	-	-	440	μA	

Note1: The power supply lines (VDDB and GNDB) occurs large ripple voltage (See "4.3.3 Power supply voltage ripple".) while luminance control. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor (5,000 to 6,000μF) between the power source lines (VDDB and GNDB) to reduce the noise, if the noise occurred in the circuit.

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.

Parameter	Power supply voltage	Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VCC	3.3 V	≤ 100	mVp-p
VDDB	12.0 V	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

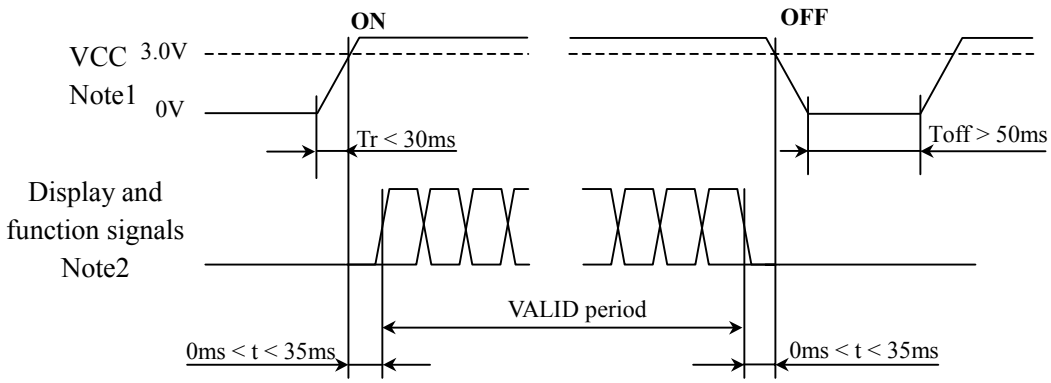
4.3.4 Fuses

Fusing line	Fuse		Rating	Fusing current Note1
	Type	Supplier		
VCC	TF16N2.50TE	KOA Corporation	2.5 A 32 V	5.0 A
VDDB	R451007	Littel Fuse Inc.	7.0 A 125 V	14.0 A

Note1: The power supply capacity should be more than the fusing current. If the power supply capacity is less than the fusing current, the fuse may not blow for a short time, and then nasty smell, smoking and so on may occur.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 Sequence for LCD panel signal processing board

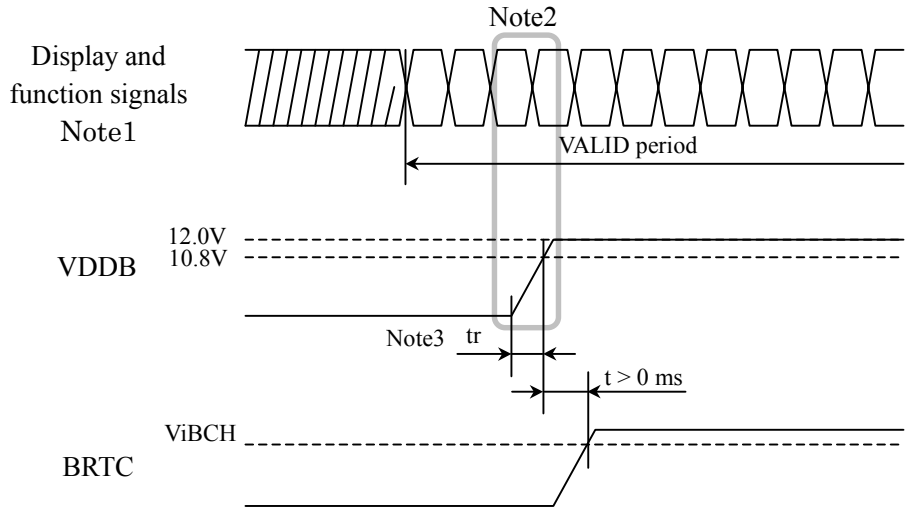


Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V, a protection circuit may work, and then this product may not work.

Note2: Display (CLK, Hsync, Vsync, DE, R0 to R7, G0 to G7, B0 to B7) and function (DPSH, DPSV, MVA) signals 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 Sequence for backlight inverter



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

Note2: The backlight power voltage (VDDB) should be inputted within the valid period of display and function signals, in order to avoid unstable data display.

Note3: The tr should be less than 800ms when BRTC terminal [Socket: CN202, Pin No.: 4] (See "4.5.2 Backlight inverter".) is Open.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

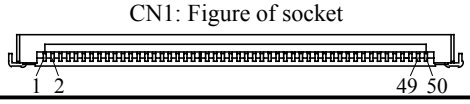
4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): FH12-50S-0.5SH (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GND	Ground	-
2	GND	Ground	
3	R7	Red data (MSB)	Most significant bit
4	R6	Red data	-
5	R5	Red data	
6	R4	Red data	
7	GND	Ground	
8	R3	Red data	
9	R2	Red data	
10	R1	Red data	
11	R0	Red data (LSB)	Least significant bit
12	GND	Ground	-
13	G7	Green data (MSB)	Most significant bit
14	G6	Green data	-
15	G5	Green data	
16	G4	Green data	
17	GND	Ground	
18	G3	Green data	
19	G2	Green data	
20	G1	Green data	
21	G0	Green data (LSB)	Least significant bit
22	GND	Ground	-
23	B7	Blue data (MSB)	Most significant bit
24	B6	Blue data	-
25	B5	Blue data	
26	B4	Blue data	
27	GND	Ground	
28	B3	Blue data	
29	B2	Blue data	
30	B1	Blue data	
31	B0	Blue data (LSB)	Least significant bit
32	GND	Ground	-
33	DE	Data enable	DE mode: Data enable signal, Fixed mode: High
34	Hsync	Horizontal sync.	-
35	GND	Ground	
36	Vsync	Vertical sync.	
37	GND	Ground	
38	CLK	Dot clock	
39	GND	Ground	
40	MVA	Select of best viewing angle	Normal axis (0°): Low or Open, Down side (-10°): High
41	DPSH	Select of scan direction (Horizontal)	Normal scan: Low or Open, Reverse scan: High
42	DPSV	Select of scan direction (Vertical)	Note1
43	VCC	Power supply	-
44	VCC	Power supply	
45	VCC	Power supply	
46	VCC	Power supply	
47	VCC	Power supply	
48	GND	Ground	
49	GND	Ground	
50	GND	Ground	

Note1: See "4.9 SCANNING DIRECTIONS".

CN1: Figure of socket

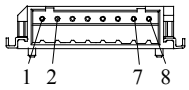


4.5.2 Backlight inverter

CN201 socket: DF3-8P-2H (Hirose Electric Co., Ltd.)
Adaptable plug: DF3-8S-2S (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GNDB	Backlight ground	-
2	GNDB	Backlight ground	
3	GNDB	Backlight ground	
4	GNDB	Backlight ground	
5	VDDB	Power supply	
6	VDDB	Power supply	
7	VDDB	Power supply	
8	VDDB	Power supply	

CN201: Figure of socket

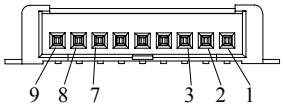


CN202 socket: IL-Z-9PL-SMTY (Japan Aviation Electronics Industry Limited)
Adaptable plug: IL-Z-9S-S125C3 (Japan Aviation Electronics Industry Limited)

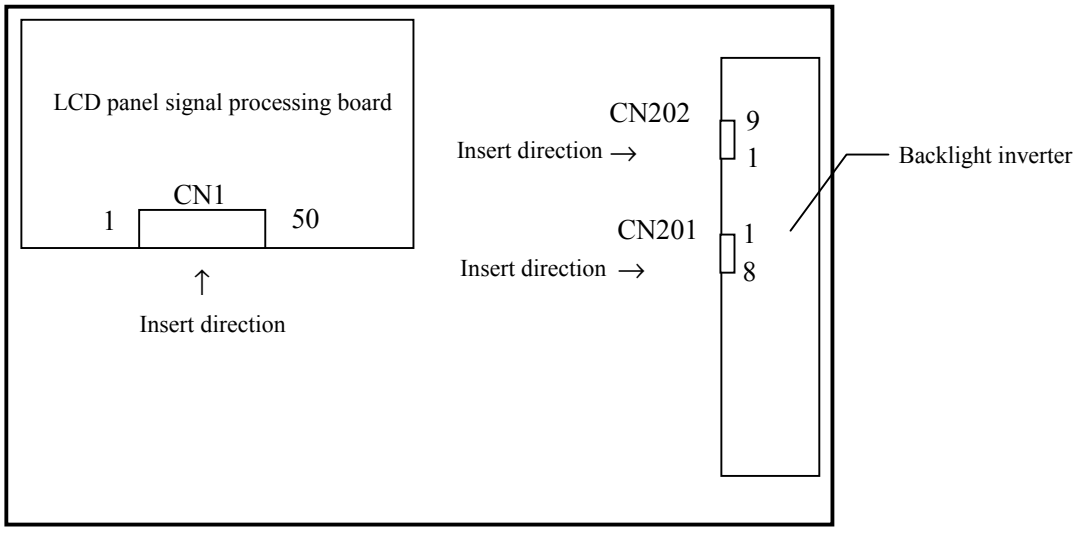
Pin No.	Symbol	Signal	Remarks
1	GNDB	Backlight ground	-
2	GNDB	Backlight ground	
3	N.C.	Non-connection	
4	BRTC	Backlight ON/OFF signal	ON: High or Open, OFF: Low
5	GNDB	Backlight ground	-
6	BRTI	Luminance control by resistor/voltage control method	Note1
7	BRTP	PWM signal	
8	GNDB	Backlight ground	-
9	PWSEL	Select signal of luminance control method	Note1

Note1: See "4.6.1 Luminance control methods".

CN202: Figure of socket



4.5.3 Positions of sockets

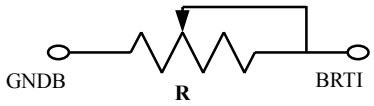


4.6 LUMINANCE CONTROLS

4.6.1 Luminance control methods

<table>
<tr><th>Method</th><th>Adjustment and luminance ratio</th><th>PWSEL signal</th><th>BRTP signal</th></tr>
<tr><td>Resistor control

Note1</td><td>• Adjustment

The variable resistor (R) for luminance control should be 10kΩ ±5%, B curve, 1/10W. Minimum point of the resistor is the minimum luminance. Also maximum point of the resistor is the maximum luminance.
 

• Luminance ratio Note3
<table><tr><th>Resistance</th><th>Luminance ratio</th></tr><tr><td>0 kΩ</td><td>30% (Minimum)</td></tr><tr><td>10 kΩ</td><td>100% (Maximum)</td></tr></table></td><td rowspan="2">High or Open</td><td rowspan="2">Open</td></tr>
<tr><td>Voltage control

Note1</td><td>• Adjustment

This control method can carry out continuation adjustment of luminance, if it is adjusted within the rated voltage for BRTI signal (VBI).
• Luminance ratio Note3
<table><tr><th>BRTI Voltage (VBI)</th><th>Luminance ratio</th></tr><tr><td>0V</td><td>30% (Minimum)</td></tr><tr><td>1.0V</td><td>100% (Maximum)</td></tr></table></td></tr>
<tr><td>Pulse width modulation
Note1
Note2</td><td>• Adjustment

Pulse width modulation (PWM) method works, when PWSEL signal is Low and PWM signal (BRTP signal) is inputted into BRTP terminal. The luminance is controlled by duty ratio of BRTP signal.
• Luminance ratio Note3
<table><tr><th>Duty ratio Note4</th><th>Luminance ratio</th></tr><tr><td>0.3</td><td>30% (Minimum)</td></tr><tr><td>1.0</td><td>100% (Maximum)</td></tr></table></td><td>Low</td><td>PWM signal</td></tr>
</table>

Note1: In case of the resistor control method and the voltage control method, noises may appear on the display image depending on the input signals timing for LCD panel signal processing board.

Use PWM method, if interference noises appear on the display image!

Note2: In case BRTC signal is High or Open, the inverter will stop work when BRTP signal is fixed to Low. In this case, backlight will not turn on, even if BRTP signal is inputted again. This is not out of order. Backlight inverter will start to work when power is supplied again.

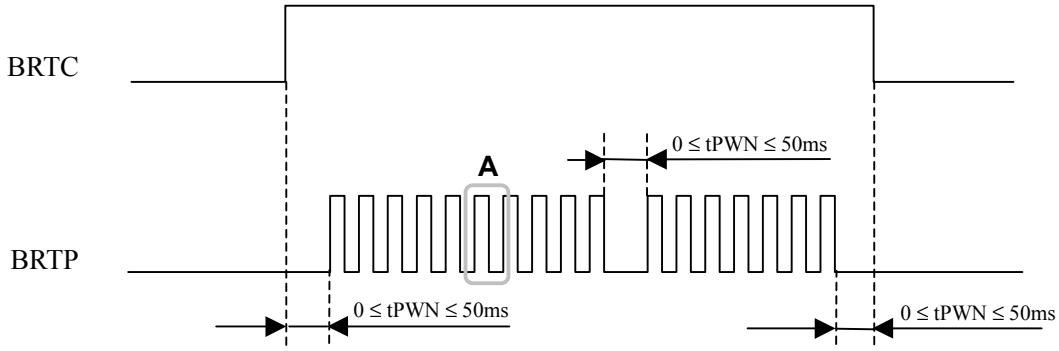
Note3: These data are the target values.

Note4: See "4.6.2 Detail of PWM timing".

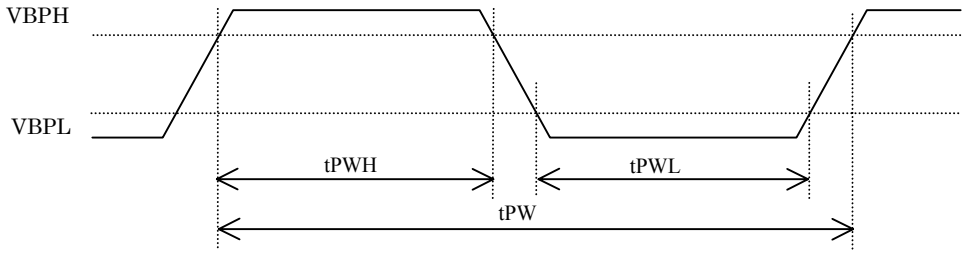
4.6.2 Detail of PWM timing

(1) Timing diagrams

• Outline chart



• Detail of **A** part



(2) Each parameter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Luminance control frequency	FL	202	280	290	Hz	Note1, Note2
Duty ratio	DL	0.3	-	1.0	-	Note1, Note3
Non signal period	tPWN	0	-	50	ms	Note4

Note1: Definition of parameters is as follows.

$$FL = \frac{1}{tPW},\ DL = \frac{tPWH}{tPW}$$

Note2: See the following formula for luminance control frequency.

Luminance control frequency = tv × (n+0.25) [or (n + 0.75)]

n = 1, 2, 3 · · · · · ·

tv: See "4.10.4 Timing characteristics".

The interference noise of luminance control frequency and input signal frequency for LCD panel signal processing board may appear on a display. Set up luminance control frequency so that the interference noise does not appear!

Note3: See "4.6.1 Luminance control methods".

Note4: If tPWN is more than 50ms, the backlight will be turned off by a protection circuit for inverter.

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 16,194,277 colors in 256 scale. 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)																									
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	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	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 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 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 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

4.8 DISPLAY POSITIONS

The following table is the coordinates per pixel (See figure of "4.9 SCANNING DIRECTIONS".).

C(0, 0)	C(1, 0)	•••	C(X, 0)	•••	C(638, 0)	C(639, 0)
C(0, 1)	C(1, 1)	•••	C(X, 1)	•••	C(638, 1)	C(639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, Y)	C(1, Y)	•••	C(X, Y)	•••	C(638, Y)	C(639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, 478)	C(0,478)	•••	C(X,478)	•••	C(638,478)	C(639,478)
C(0,479)	C(1,479)	•••	C(X,479)	•••	C(638,479)	C(639,479)

4.9 SCANNING DIRECTIONS

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

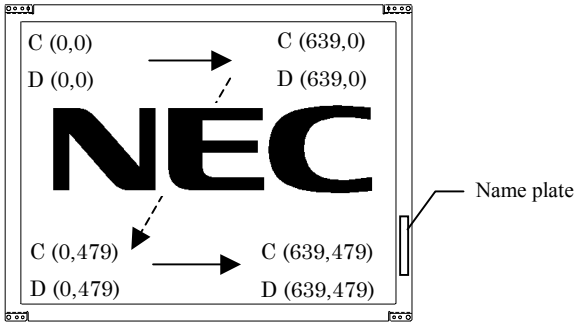


Figure 1. DPSH: Normal scan, DPSV: Normal scan

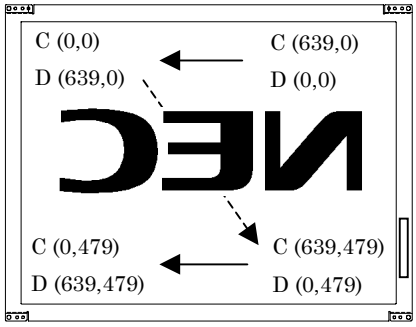


Figure 2. DPSH: Reverse scan, DPSV: Normal scan

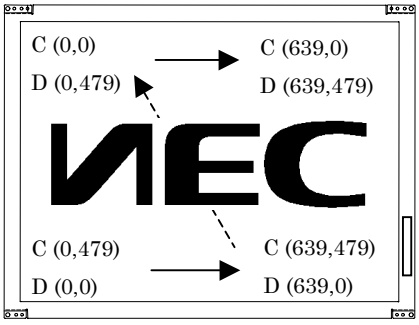


Figure 3. DPSH: Normal scan, DPSV: Reverse scan

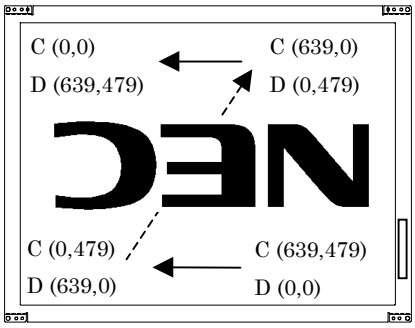


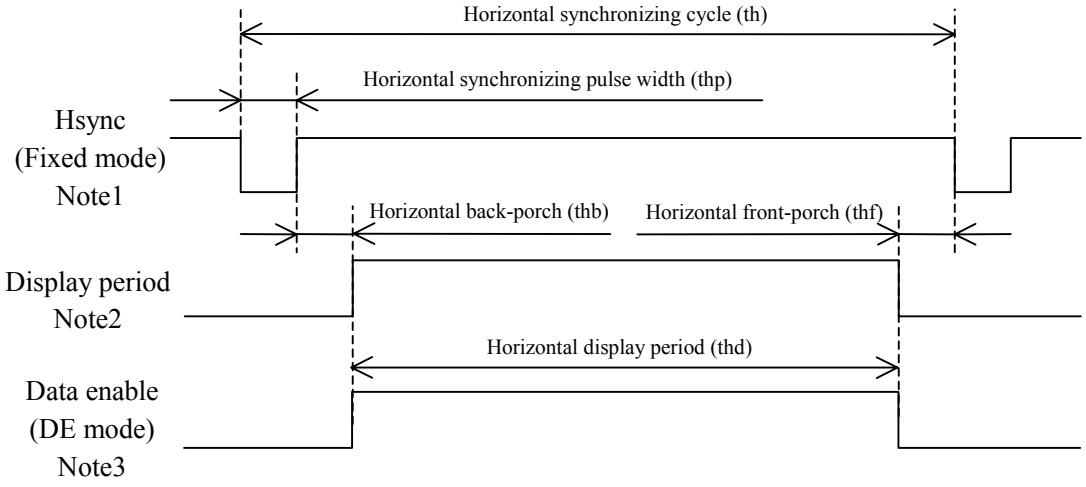
Figure 4. DPSH: Reverse scan, DPSV: Reverse scan

Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "4.8 DISPLAY POSITIONS".)
D (X, Y): The data number of input signal for LCD panel signal processing board
Note2: Normal scan: Low or Open, Reverse scan: High

4.10 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD

4.10.1 Outline of input signal timings

- Horizontal signal

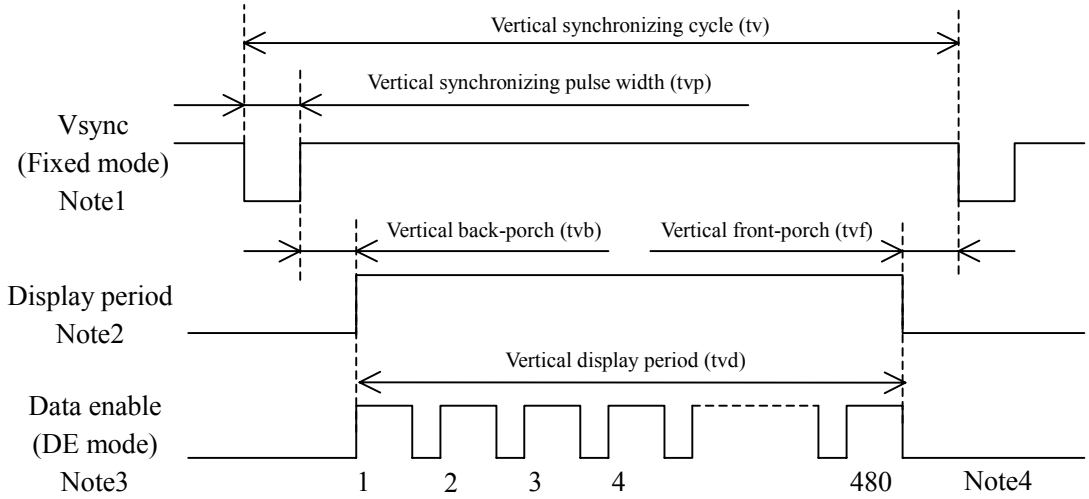


Note1: Fixed mode cannot be used while working of DE mode.

Note2: This diagram indicates virtual signal for set up to timing.

Note3: Customer should be inputted synchronized signals (Hsync, Vsync) in addition to DE signal to this product, when it is worked in DE mode. Synchronized signals are used for DE/Fixed mode detection.

- Vertical signal



Note1: Fixed mode cannot be used while working of DE mode.

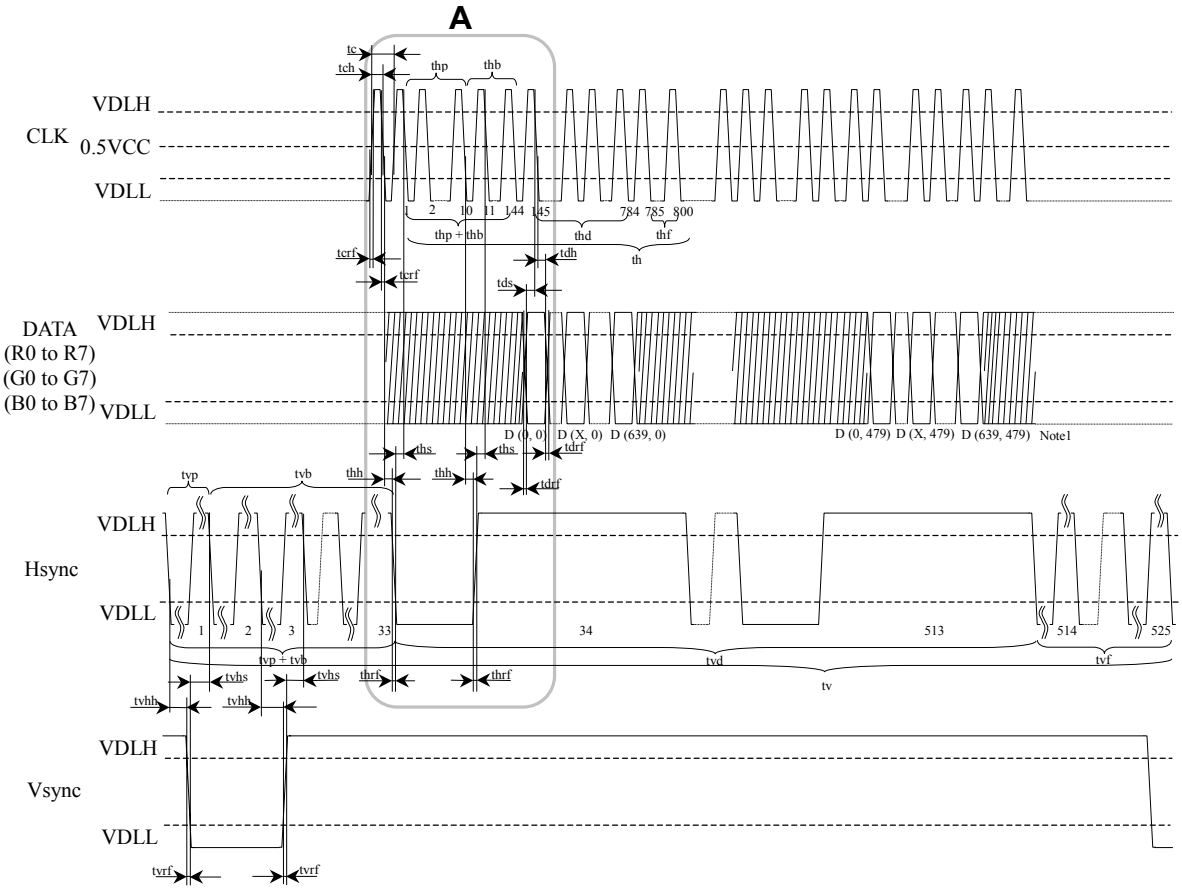
Note2: This diagram indicates virtual signal for set up to timing.

Note3: Customer should be inputted synchronized signals (Hsync, Vsync) in addition to DE signal to this product, when it is worked in DE mode. Synchronized signals are used for DE/Fixed mode detection.

Note4: See "4.10.2 Detailed input signal timing chart for fixed mode" and "4.10.3 Detailed input signal timing chart for DE mode" for numeration of pulse.

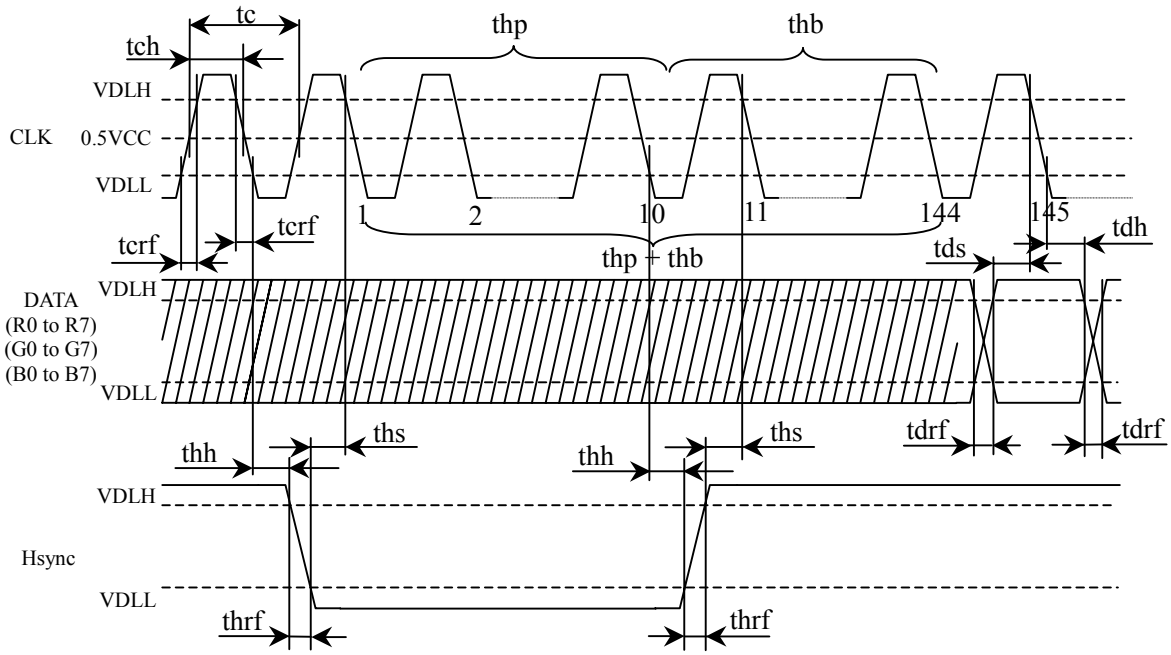
4.10.2 Detailed input signal timing chart for fixed mode

• Outline chart



Note1: X is data number from 1 to 638. See "4.9 SCANNING DIRECTIONS".

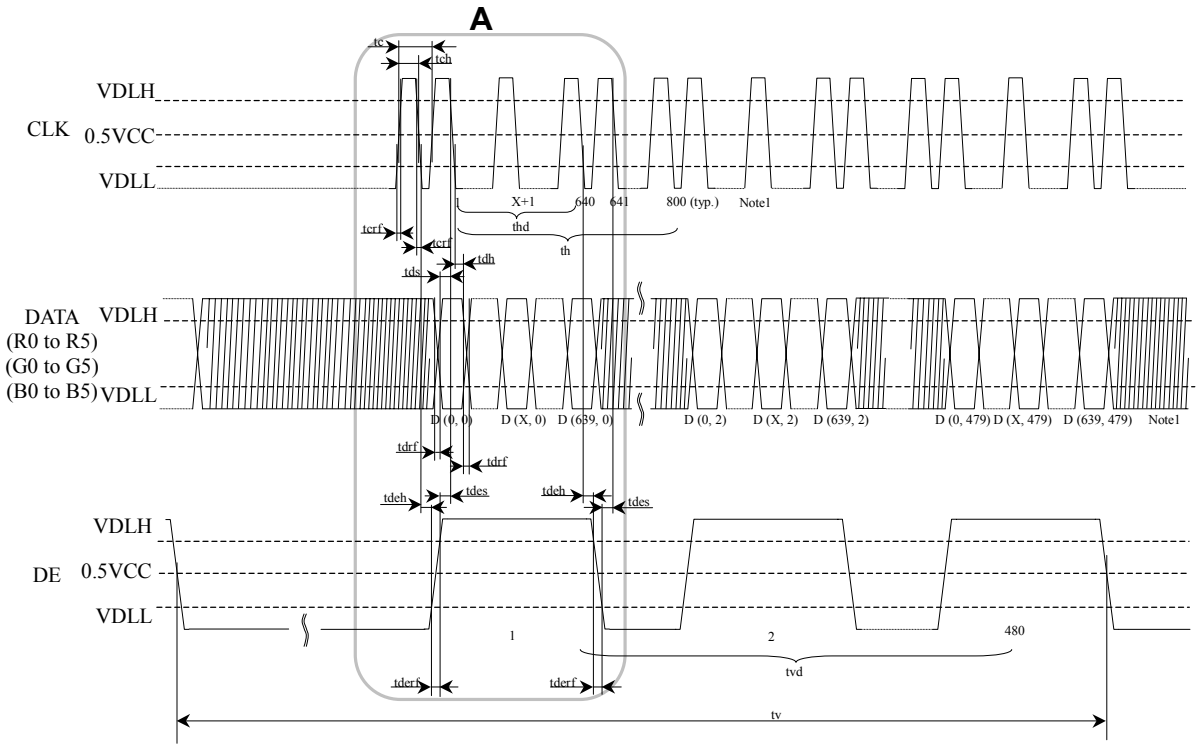
• Detail of **A** part



4.10.3 Detailed input signal timing chart for DE mode

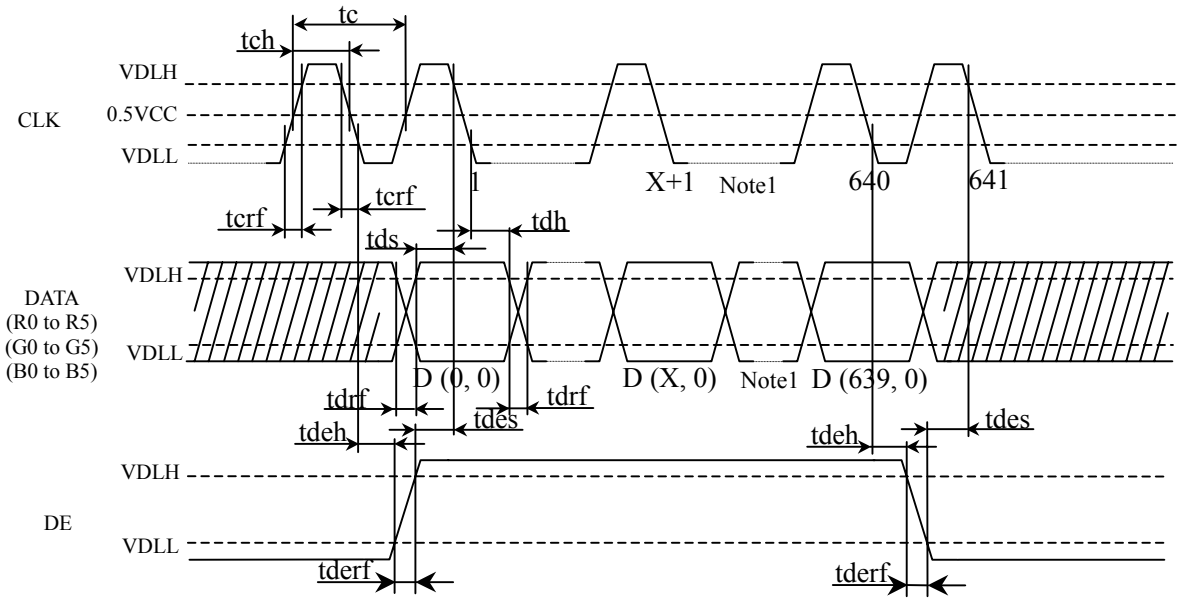
Customer should be inputted synchronized signals (See "4.10.2 Detailed input signal timing chart for fixed mode".) in addition to DE signal to this product, when it is worked in DE mode. Synchronized signals are used for DE/Fixed mode detection.

• Outline chart



Note1: X is data number from 1 to 638. See "4.9 SCANNING DIRECTIONS".

• Detail of **A** part



Note1: X is data number from 1 to 638. See "4.9 SCANNING DIRECTIONS".

4.10.4 Timing characteristics

• Common to DE mode and fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency		tcf	21.0	25.2	29.0	MHz	39.7 ns (typ.) Note1
	Duty		tcd	0.4	-	0.6	-	Note1
	Rise time, Fall time		tcrf	-	-	10	ns	-
DATA	CLK-DATA	Setup time	tds	8	-	-	ns	
		Hold time	tdh	12	-	-	ns	
	Rise time, Fall time		tdrf	-	-	10	ns	

Note1: Definition of parameters is as follows.

tcf = 1/tc, tcd = tch/tc = tch×tcd

• Fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Hsync	Cycle		th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				800			CLK	Note1
	Display period		thd	640			CLK	
	Front-porch		thf	16			CLK	
	Pulse width		thp	10	96	-	CLK	
	Back-porch		thb	-	48	134	CLK	
	Total of pulse width and back-porch		thp + thb	144			CLK	Note1, Note2
	CLK- Hsync	Setup time	ths	8	-	-	ns	-
		Hold time	thh	12	-	-	ns	
	Rise time, Fall time		thrf	-	-	10	ns	
Vsync	Cycle		tv	16.1	16.7	17.2	ms	59.9 Hz (typ.)
				525			H	Note1
	Display period		tvd	480			H	
	Front-porch		tvf	12			H	
	Pulse width		tvp	1	-	2	H	
	Back-porch		tvb	31	-	32	H	
	Total of pulse width and back-porch		tvp + tvb	33			H	Note1, Note2
	Vsync-Hsync	Setup time	tvhs	1	-	-	CLK	Note1
		Hold time	tvhh	30	-	-	ns	-
	Rise time, Fall time		tvrf	-	-	10	ns	

Note1: Definition of parameters is as follows.

tc = 1CLK, th = 1H

Note2: Keep tvp + tvb and thp + thb within the table. If it is out of specification, display position will be shifted to right/left side or up/down.

• DE mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
DE Note1	Horizontal	Cycle	th	-	800	-	CLK	Note2
		Display period	thd	640			CLK	
	Vertical (One frame)	Cycle	tv	-	525	-	H	
		Display period	tvd	480			H	
	CLK-DE	Setup time	tdes	8	-	-	ns	-
		Hold time	tdeh	12	-	-	ns	
	Rise time, Fall time		tderf	-	-	10	ns	

Note1: Customer should be inputted synchronized signals (See fixed mode in "4.10.4 Timing characteristics".) in addition to DE signal to this product, when it is worked in DE mode. Synchronized signals are used for DE/Fixed mode detection.

Note2: Definition of parameters is as follows.

tc = 1CLK, th = 1H

4.11 OPTICS

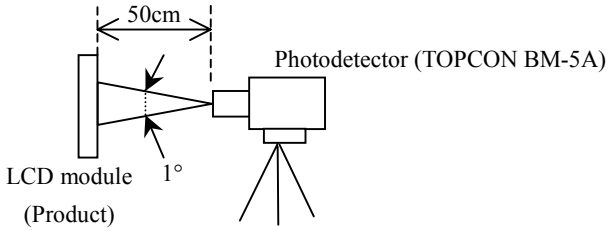
4.11.1 Optical characteristics

Parameter Note1		Condition	Symbol	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio		White/Black at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	CR	300	400	-	-	Note2
Luminance		White at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	L	400	500	-	cd/m^2	-
Luminance uniformity		-	LU	-	1.25	1.40	-	Note3
Chromaticity	White	**x** coordinate	Wx	-	0.275	-	-	Note4
		y coordinate	Wy	-	0.280	-	-	
	Red	**x** coordinate	Rx	-	0.628	-	-	
		y coordinate	Ry	-	0.336	-	-	
	Green	**x** coordinate	Gx	-	0.307	-	-	
		y coordinate	Gy	-	0.547	-	-	
	Blue	**x** coordinate	Bx	-	0.142	-	-	
		y coordinate	By	-	0.073	-	-	
Color gamut		θR = 0°, θL = 0°, θU = 0°, θD = 0° at center, against NTSC color space	C	-	57	-	%	
Response time		White to black	Ton	-	4	10	ms	Note5 Note6
		Black to white	Toff	-	28	40	ms	
Viewing angle	Right	θU = 0°, θD = 0°, CR = 10	θR	-	65	-	°	Note7
	Left	θU = 0°, θD = 0°, CR = 10	θL	-	65	-	°	
	Up	θR = 0°, θL = 0°, CR = 10	θU	-	55	-	°	
	Down	θR = 0°, θL = 0°, CR = 10	θD	-	50	-	°	

Note1: Measurement conditions are as follows.

Ta = 25°C, VCC = 3.3V, VDDB = 12.0V, DPSH = Low, DPSV = Low, MVA = Low

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.



Note2: See "4.11.2 Definition of contrast ratio".

Note3: See "4.11.3 Definition of luminance uniformity".

Note4: These coordinates are found on CIE 1931 chromaticity diagram.

Note5: Product surface temperature: TopF = 25°C

Note6: See "4.11.4 Definition of response times".

Note7: See "4.11.5 Definition of viewing angles".

4.11.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

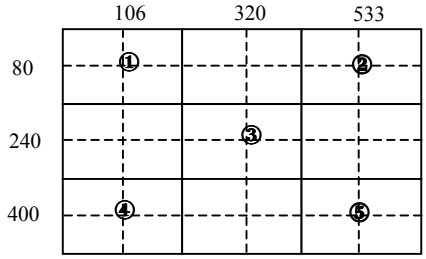
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.11.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

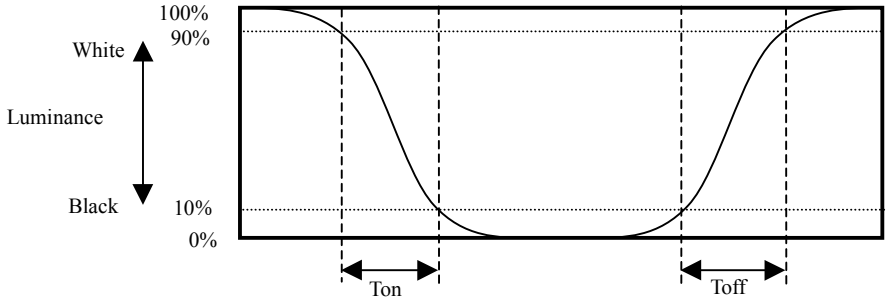
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

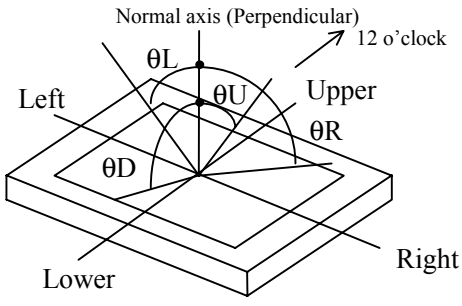


4.11.4 Definition of response times

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.).



4.11.5 Definition of viewing angles

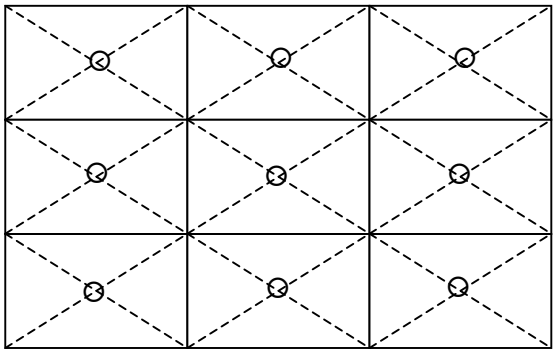


5. RELIABILITY TESTS

Test item	Condition	Judgement
High temperature and humidity (Operation)	① 60 ± 2°C, RH = 60%, 240hours ② Display data is black.	No display malfunctions Note1
Heat cycle (Operation)	① 0 ± 3°C…1hour 55 ± 3°C…1hour ② 50cycles, 4hours/cycle ③ Display data is black.	
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 30minutes/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, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z direction ④ 10 times each directions	No display malfunctions Note1 No physical damages
Mechanical shock (Non operation)	① 294m/ s^2, 11ms ② X, Y, Z direction ③ 3 times each directions	

Note1: Display functions are checked under the same conditions as product inspection.

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", after understanding this contents!**

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 HIGH VOLTAGE PART of the inverter while turned on! Danger of an electrical shock.

∗ Pay attention to burn injury for the working backlight! It may be over 35°C from ambient temperature.

∗ Do not shock and press the LCD panel and the backlight! Danger of breaking, because they are made of glass. (Shock: To be not greater 294m/s^2 and to be not greater 11ms, Pressure: To be not greater 19.6N)

6.3 ATTENTIONS

6.3.1 Handling of the product

① Take hold of both ends without touch the circuit board 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 cables nor pull connection cables such as flexible cable and so on, for fear of 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 such as earth band, ionic shower and so on, when customer deals with the product, because products may be damaged by electrostatic.

⑤ The torque for mounting screws must never exceed 0.39N·m. Higher torque values might result in distortion of the bezel.

⑥ Do not press or rub on the sensitive display surface. If customer clean on the panel surface, NEC Corporation recommends using the cloth with ethanolic liquid such as screen cleaner for LCD.

⑦ Do not push-pull the interface connectors while the product is working, because wrong power sequence may break down the product.

6.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in antistatic pouch in room temperature, because of avoidance for dusts and sunlight, if customer stores the product.
② Do not operate in high magnetic field. Circuit boards may be broken down by it.
③ Use an original protection sheet on the product surface (polarizer). Adhesive type protection sheet should be avoided, because it may change color or properties of the polarizer.

6.3.3 Characteristics

The following items are neither defects nor failures.

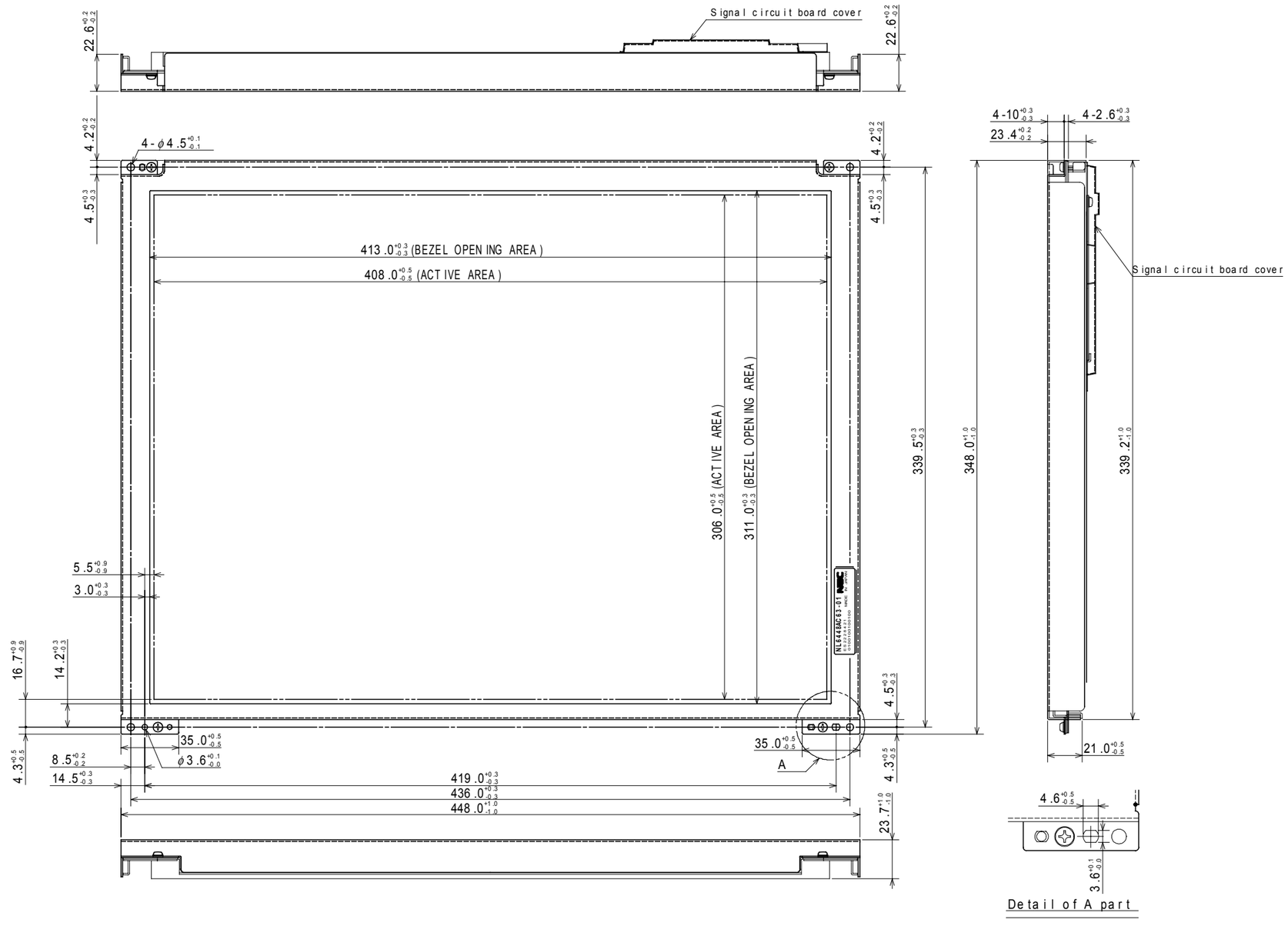
① Response time, luminance and color may be changed by ambient temperature.
② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating 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 unit.
⑥ The luminance may be changed by voltage variation (voltage drop), even if power source applies recommended voltage to backlight inverter.
⑦ Optical characteristics may be changed by input signal timings.

6.3.4 Other

① All GND, GNDB, VCC and VDDB terminals should be used without a non-connected line.
② Do not disassemble a product or adjust volume without permission of NEC Corporation.
③ See "REPLACEMENT MANUAL FOR BACKLIGHT", if customer would like to replace backlight lamps.
④ Pay attention not to insert waste materials inside of products, if customer uses screwnails.

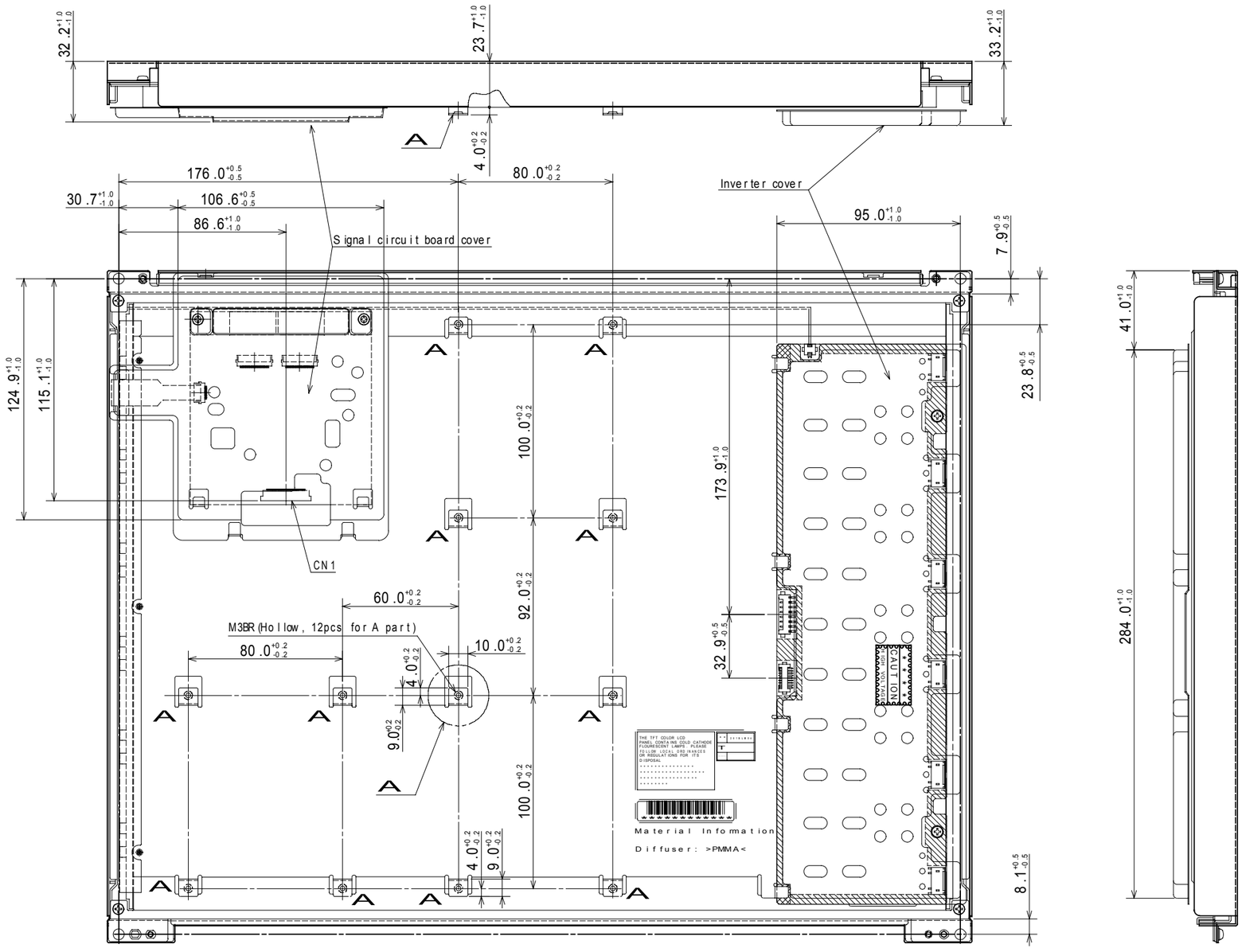
7. OUTLINE DRAWINGS

7.1 FRONT VIEW



Unit: mm

7.2 REAR VIEW



Unit: mm