NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL6448BC20-08E

16.6cm (6.5 Type)
VGA

DATA SHEET

DOD-PD- 0395 (9th edition)

This DATA SHEET is updated document from DOD-M-1249(8).

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INTRODUCTION

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Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Military systems, aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems (medical equipment, etc.) and any other equipment

The quality grade of this product is ***"Standard"*** unless otherwise specified in this document. If customers intend to use this product for applications other than those specified for ***"Standard"*** quality grade, they should contact NEC sales representative in advance.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL6448BC20-08E 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 APPLICATION

- Industrial PC
- Display terminal for control system

1.3 FEATURES

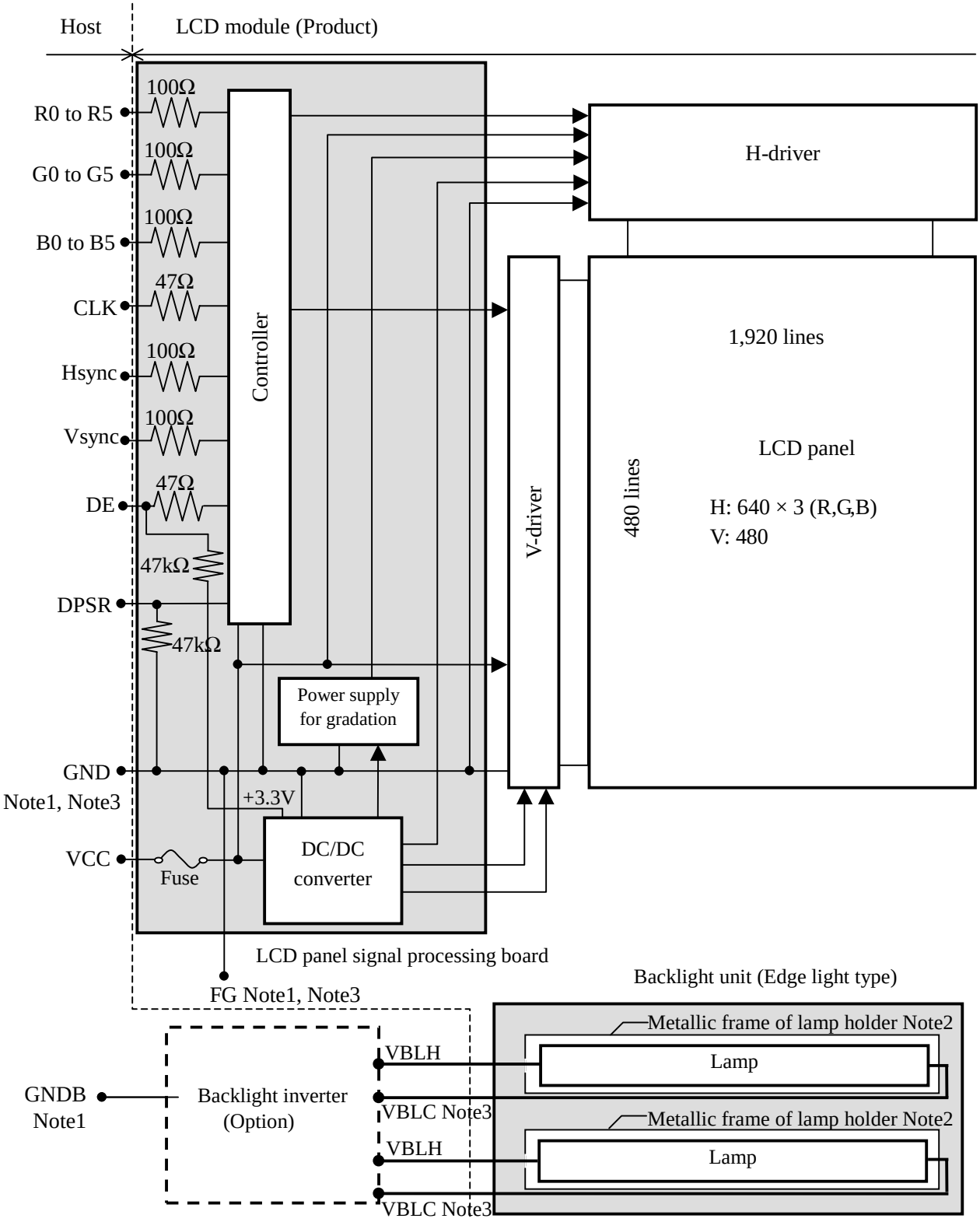
- High luminance
- Wide viewing angle
- Low reflection
- 6-bit digital RGB signals
- Reversible-scan direction
- Edge light type (Without inverter)
- Replaceable lamp for backlight unit
- Acquisition product for UL1950 3rd edition/CSA C22.2 No.950-95(File number:E170632)
- Comparison table of NL6448BC20-08E and NL6448BC20-08

Item	NL6448BC20-08E	NL6448BC20-08
Haze	16%	12%

2. GENERAL SPECIFICATIONS

Display area	132.5 (H) × 99.4 (V) mm (typ.)
Diagonal size of display	16.6 cm (6.5 inches)
Drive system	a-Si TFT active matrix
Display color	262,144 colors
Pixel	640 (H) × 480 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.0690 (H) × 0.2070 (V) mm
Pixel pitch	0.2070 (H) × 0.2070 (V) mm
Module size	178.8 (W) × 126.8 (H) × 11.0 (D) mm (typ.)
Weight	240 g (typ.)
Contrast ratio	250:1 (typ.)
Viewing angle	*At the contrast ratio ≥ 10:1* • Horizontal: Right side 50° (typ.), Left side 50° (typ.) • Vertical: Up side 35° (typ.), Down side 45° (typ.) ☆
Designed viewing direction	*At DPSR: 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) • Viewing angle with optimum grayscale (γ=2.2): normal axis
Polarizer surface	Antiglare treatment
Polarizer pencil-hardness	2H (min.) [by JIS K5400]
Color gamut	*At LCD panel center* 42 % (typ.) [against NTSC color space]
Response time	*Ton (90%→10%)* 13 ms (typ.) ☆
Luminance	*At IBL= 5.0mArms / lamp* 300 cd/m^2 (typ.)
Signal system	6-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 or 5.0V
Backlight	Edge light type: 2 cold cathode fluorescent lamps (Replaceable parts • Lamp holder set: Type No. 65LHS04) (Recommended inverter (Option) • Inverter: Type No. 65PWB31)
Power consumption	*At IBL= 5.0mArms / lamp and checkered flag pattern* 5.0 W (typ., Power dissipation of the inverter does not include.) ☆

3. BLOCK DIAGRAM



Note1: GND and GNDB must be connected to customer equipment's ground, and it is recommended that these grounds are connected together in customer equipment. ☆

Note2: The metallic frame of lamp holder is not connected to VBLC (Lamp low voltage terminal) and FG.

Note3: Connection between GND, FG (Frame ground) and VBLC in the LCD module

GND - FG	Connected
GND - VBLC	Not connected
FG - VBLC	Not connected

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	178.8 ± 0.5 (W) × 126.8 ± 0.5 (H) × 11.0 ± 0.5 (D)	Note1	mm
Display area	132.5 (H) × 99.4 (V)	Note1	mm ☆
Weight	240 (typ.), 260 (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
	Lamp		VBLH	2,000	Vrms	
Input voltage for signals	Display signals Note1		VD	-0.3 to VCC+0.3	V	
	Function signal Note2		VF	-0.3 to VCC+0.3	V	
Storage temperature			Tst	-25 to +70	°C	-
Operating temperature		Front surface	TopF	0 to +60	°C	-
		Rear surface	TopR	0 to +60	°C	
Relative humidity Note3			RH	≤ 95	%	Ta ≤ 40°C
				≤ 85	%	40 < Ta ≤ 50°C
				≤ 70	%	50 < Ta ≤ 55°C
				≤ 60	%	55 < Ta ≤ 60°C
Absolute humidity Note3			AH	≤ 78 Note4	g/m^3	Ta > 60°C

Note1: Display signals are CLK, Hsync, Vsync, DE and DATA (R0 to R5, G0 to G5, B0 to B5).
Note2: Function signal is DPSR.
Note3: No condensation
Note4: Ta = 60°C, RH = 60%

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	at VCC = 3.3V
			4.7	5.0	5.3	V	at VCC = 5.0V
Power supply current		ICC	-	320 Note1	600	mA	at VCC = 3.3V
			-	200 Note1	450	mA	at VCC = 5.0V
Logic input voltage for display signals	Low	VDLL	0	-	0.99	V	CMOS level Note2
	High	VDLH	2.31	-	VCC	V	
Input voltage for DPSR signal	Low	VFDL	0	-	0.99	V	
	High	VFDH	2.31	-	VCC	V	

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

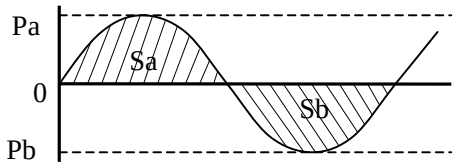
Note2: Input signal voltage is judged with CMOS level on the basis of internal generated voltage.

4.3.2 Working for backlight lamp

Parameter	Symbol	Ta	min.	typ.	max.	Unit	Remarks
Lamp starting voltage	VS	0°C	720	-	-	Vrms	Note1
		25°C	590	-	-	Vrms	
Lamp voltage	VBLH	25°C	-	400	-	Vrms	Note1, Note2
Lamp current	IBL	25°C	2.0	5.0	6.0	mArms	Note2
Lamp oscillation frequency	FO	25°C	50	54	58	kHz	Note3

Note1: The power supply 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).

Note2: 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).



$$\frac{|Pa - Pb|}{Pb} \times 100 \leq 5\ \%$$

$$\frac{|Sa - Sb|}{Sb} \times 100 \leq 5\ \%$$

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

Note3: 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.

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

th: Horizontal cycle (See "**4.9.2 Timing characteristics**".)

n: Natural number (1, 2, 3 ·····)

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 Note1 (Measure at input terminal of power supply)	Unit
VCC	3.3 V	≤ 100	mVp-p
	5.0 V	≤ 100	mVp-p

Note1: The permissible ripple voltage includes spike noise.

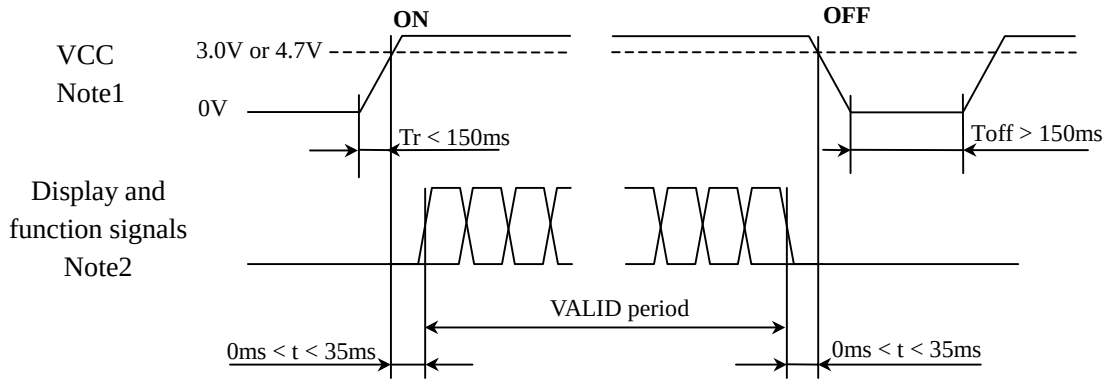
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	KAB2402202	Matsuo Electric Co., Ltd.	2.0A 24V	4.0A	Note1

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

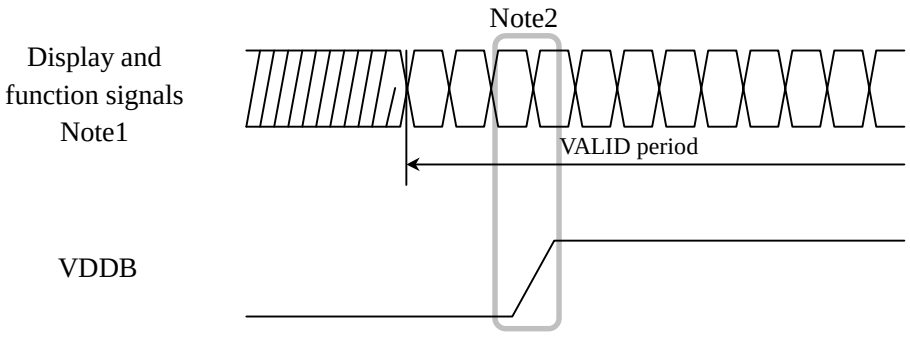
4.4.1 Sequence for LCD panel signal processing board



Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V in "VCC = 3.3V" or 4.7V in "VCC = 5.0V", a protection circuit may work, and then this product may not work.

Note2: Display (CLK, Hsync, Vsync, DE, R0 to R5, G0 to G5, B0 to B5) and function (DPSR) 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 (Option)



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

Note2: The backlight inverter 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

CN31 socket (LCD module side) : DF9B-31P-1V (2∗) (Hirose Electric Co., Ltd.) ☆
Adaptable plug : DF9-31S-1V (2∗) (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GND	Ground	-
2	CLK	Dot clock	
3	Hsync	Horizontal synchronous signal	
4	Vsync	Vertical synchronous signal	
5	GND	Ground	
6	R0	Red data (LSB)	Least significant bit
7	R1	Red data	-
8	R2	Red data	
9	R3	Red data	
10	R4	Red data	
11	R5	Red data (MSB)	Most significant bit
12	GND	Ground	-
13	G0	Green data (LSB)	Least significant bit
14	G1	Green data	-
15	G2	Green data	
16	G3	Green data	
17	G4	Green data	
18	G5	Green data (MSB)	Most significant bit
19	GND	Ground	-
20	B0	Blue data (LSB)	Least significant bit
21	B1	Blue data	-
22	B2	Blue data	
23	B3	Blue data	
24	B4	Blue data	
25	B5	Blue data (MSB)	Most significant bit
26	GND	Ground	-
27	DE	Selection of DE / Fixed mode	Data enable signal: DE mode VCC or Open: Fixed mode ☆
28	VCC	Power supply	-
29	VCC	Power supply	
30	N.C.	Non connection	
31	DPSR	Selection of scan direction	Low or Open: Normal scan High: Reverse scan Note1

Note1: See "**4.8 SCANNING DIRECTIONS**".

4.5.2 Backlight lamp

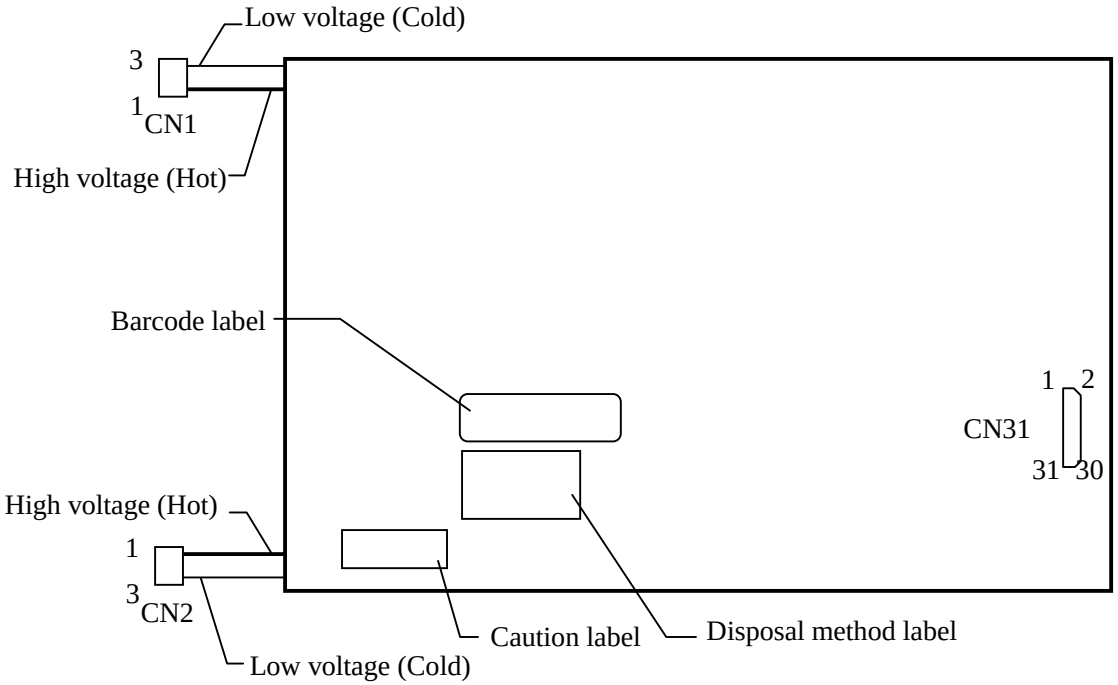
CN1 plug : BHR-03VS-1 (J.S.T Mfg. Co., Ltd.)
Adaptable socket : SM03 (4.0) B-BHS-TB (J.S.T Mfg. Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	VBLH	High voltage (Hot)	-
2	N.C.	Non connection	
3	VBLC	Low voltage (Cold)	

CN2 plug : BHR-03VS-1 (J.S.T Mfg. Co., Ltd.)
Adaptable socket : SM03 (4.0) B-BHS-TB (J.S.T Mfg. Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	VBLH	High voltage (Hot)	-
2	N.C.	Non connection	
3	VBLC	Low voltage (Cold)	

4.5.3 Positions of a socket and plugs



4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 262,144 colors in 64 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)																	
		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 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 scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑				:						:						:		
	↓				:						:						:		
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue 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 figure of "**4.8 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(1, 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)

4.8 SCANNING DIRECTIONS

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

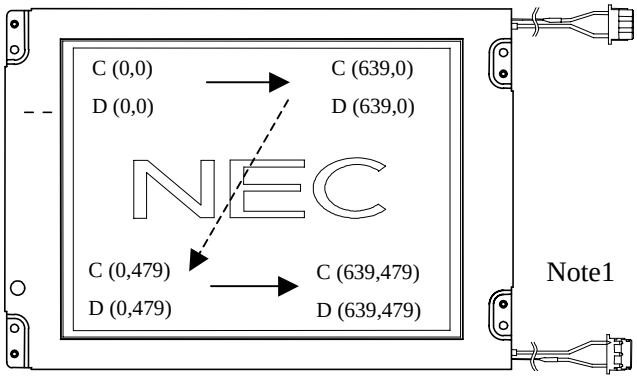


Figure 1. Normal scan (DPSR: Low or Open)

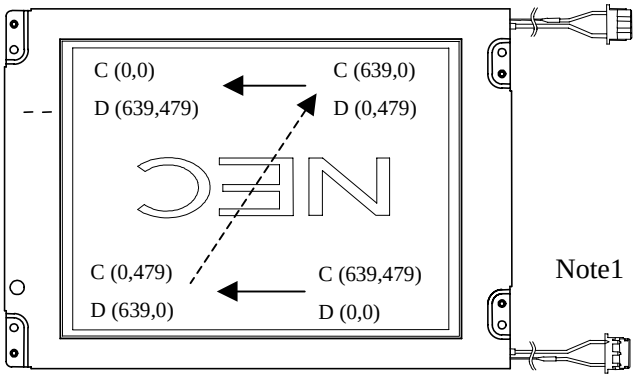


Figure 2. Reverse scan (DPSR: High)

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

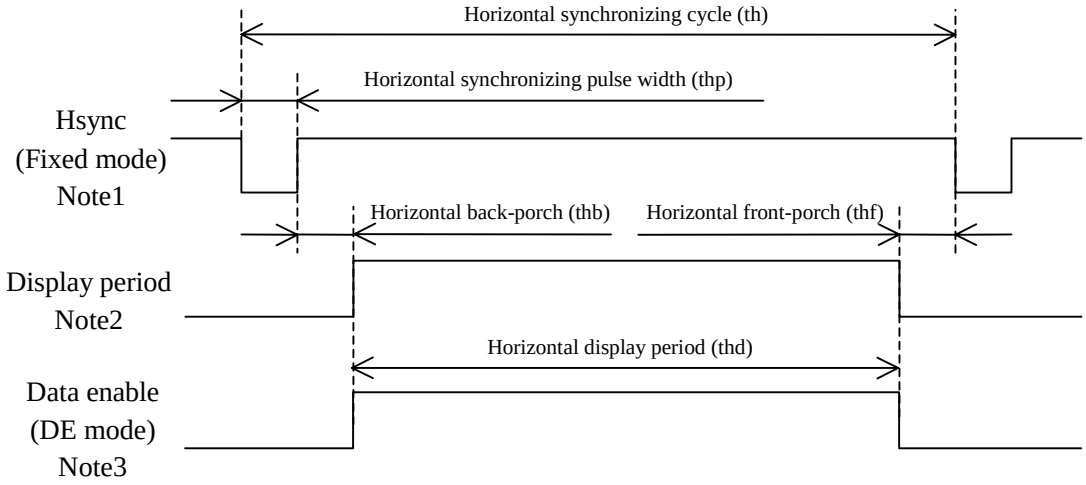
C (X, Y): The coordinates of the display position (See "**4.7 DISPLAY POSITIONS**".)

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

4.9 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD

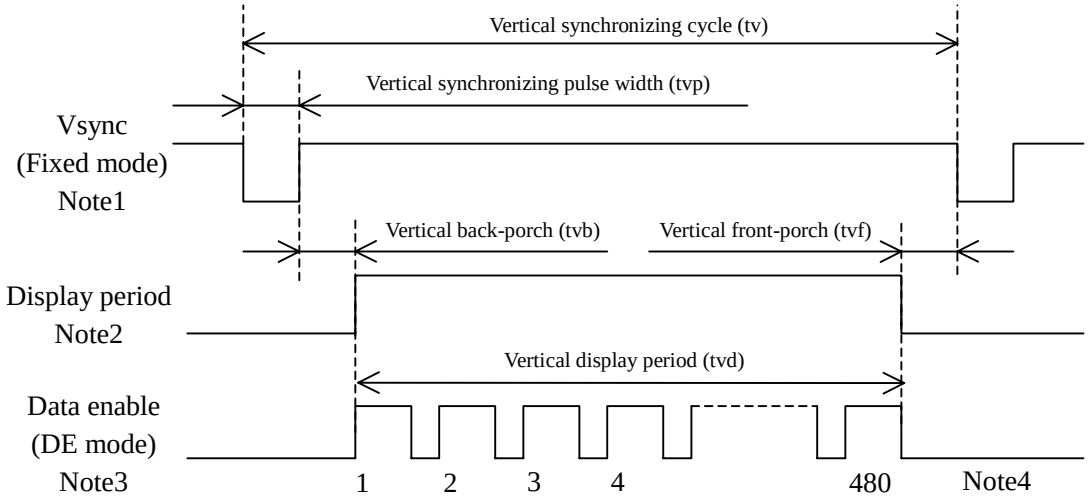
4.9.1 Outline of input signal timings

• 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.

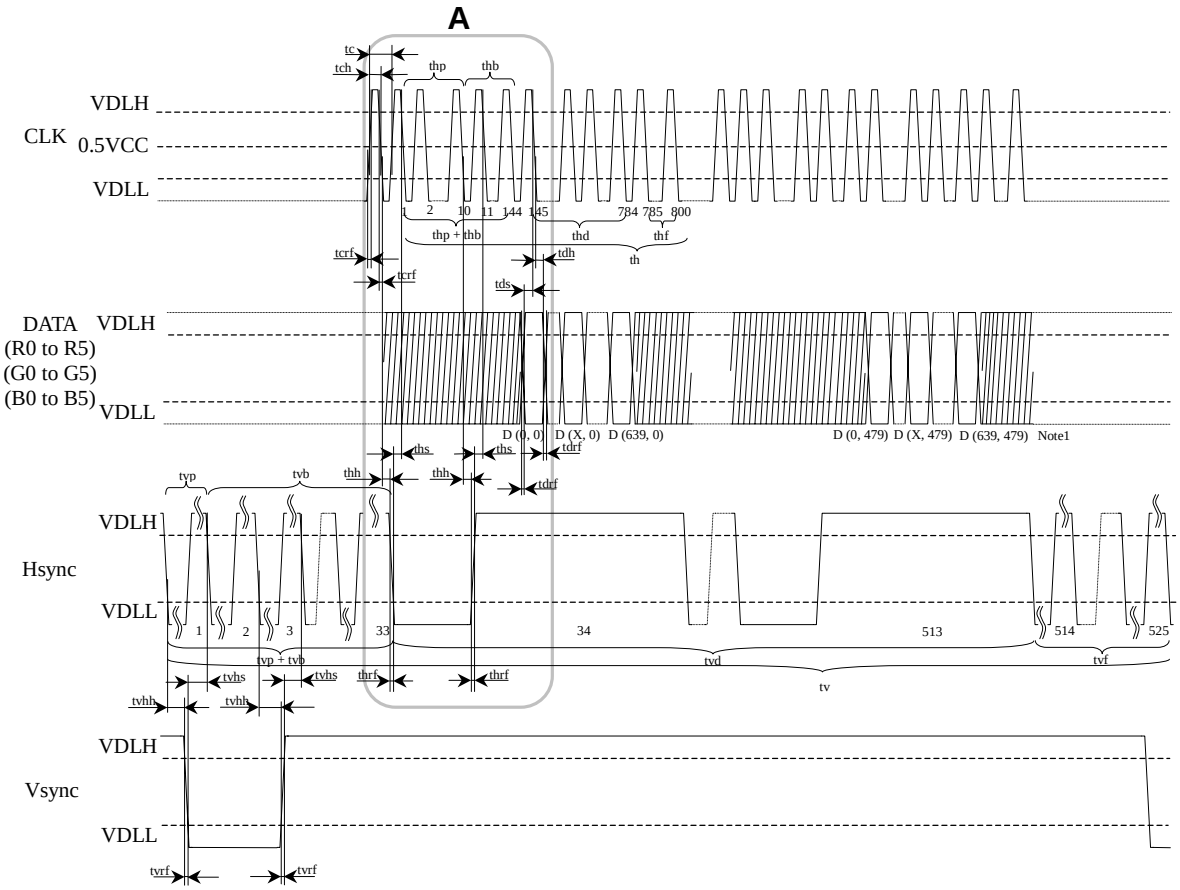
• Vertical signal



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 **"4.9.2 Detailed input signal timing chart for fixed mode"** and **"4.9.3 Detailed input signal timing chart for DE mode"** for numeration of pulse.

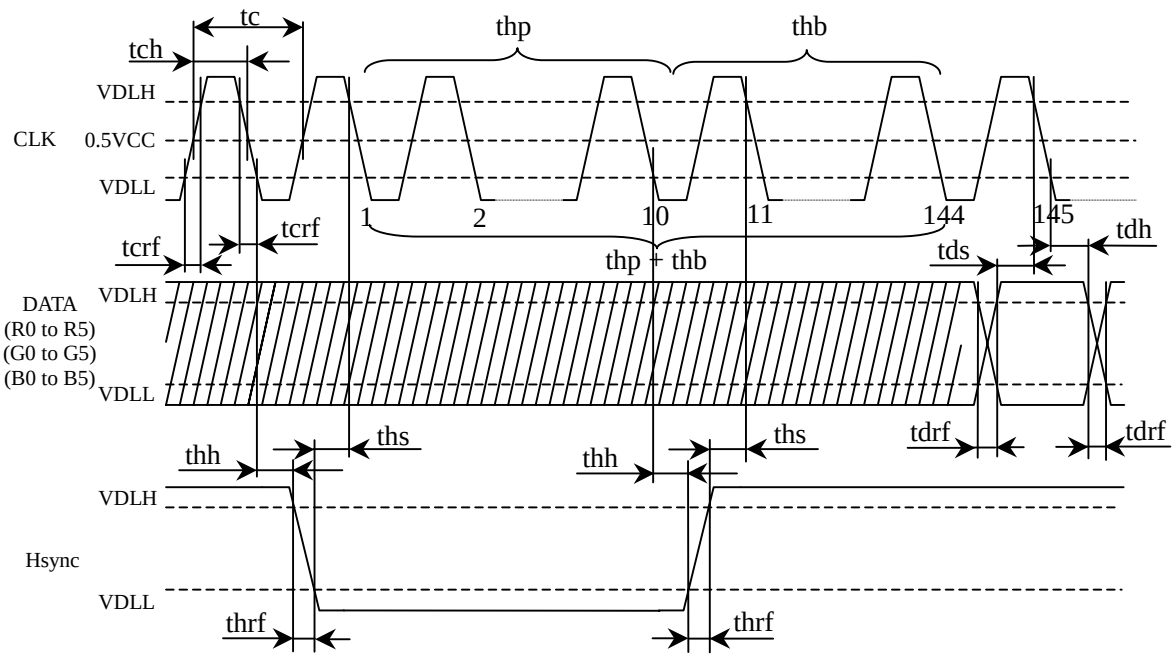
4.9.2 Detailed input signal timing chart for fixed mode

- Outline chart



Note1: X is data number from 1 to 638. See **"4.8 SCANNING DIRECTIONS"**.

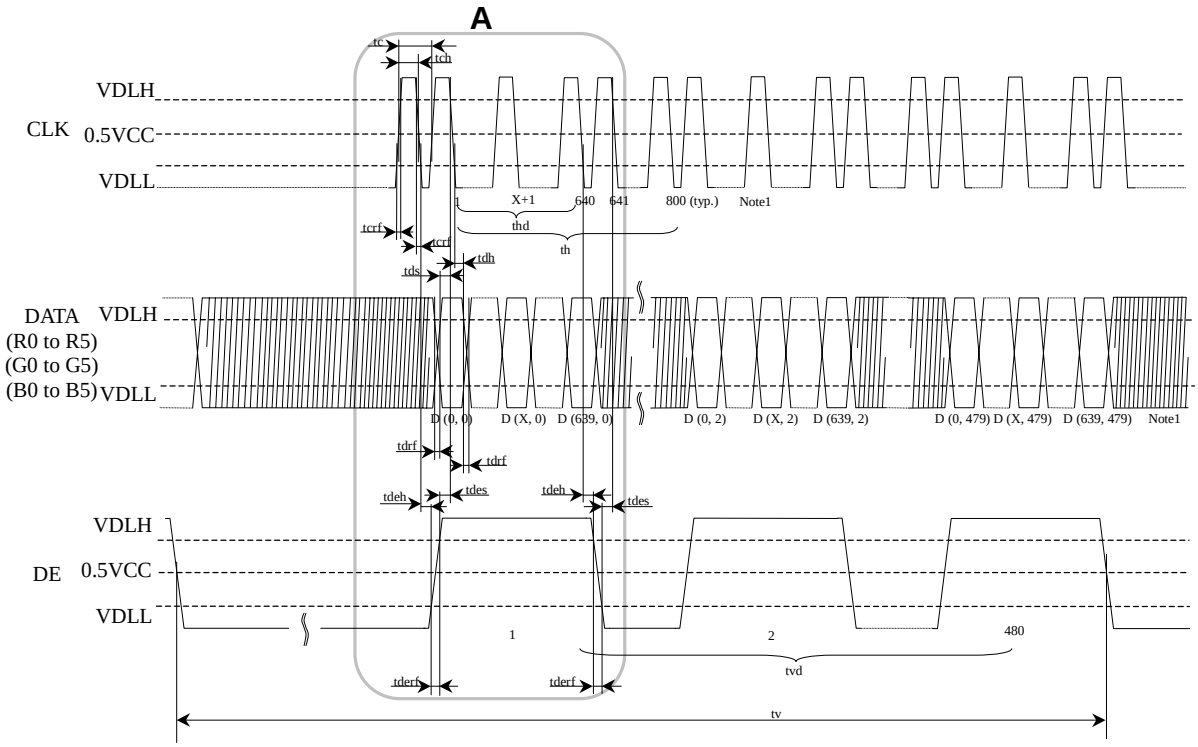
- Detail of **A** part



4.9.3 Detailed input signal timing chart for DE mode

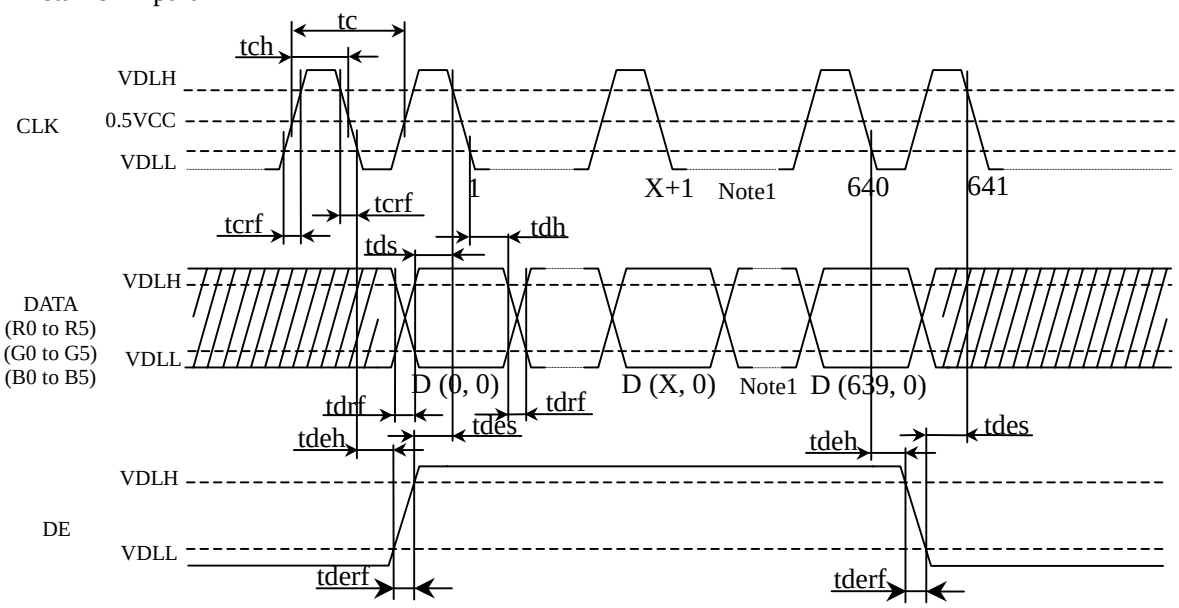
Customer should be inputted synchronized signals (See **"4.9.2 Detailed input signal timing chart for fixed mode"**.) in addition to DE signal to this product, when it is worked in DE mode. Synchronized signals are used for DE/Fixed mode detection.

• Outline chart



Note1: X is data number from 1 to 638. See **"4.8 SCANNING DIRECTIONS"**.

• Detail of **A** part



Note1: X is data number from 1 to 638. See **"4.8 SCANNING DIRECTIONS"**.

4.9.4 Timing characteristics

- Common to fixed mode and DE 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	30	-	-	ns	Note1
		Hold time	tvhh	1	-	-	CLK	-
	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 **"4.9.4 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

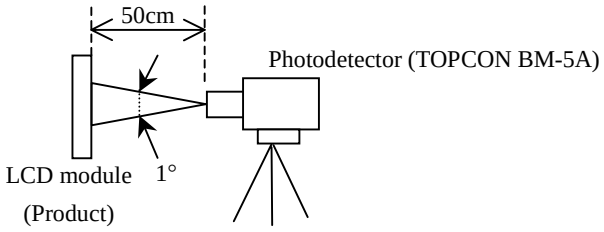
4.10 OPTICS

4.10.1 Optical characteristics

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Remarks
Contrast ratio		White/Black at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	CR	150	250	-	-	Note2
Luminance		White at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	L	250	300	-	cd/m^2	-
Luminance uniformity		-	LU	-	1.25	-	-	Note3
Chromaticity	White	**x** coordinate	Wx	0.315	0.345	0.375	-	Note4
		y coordinate	Wy	0.317	0.347	0.377	-	
	Red	**x** coordinate	Rx	-	0.609	-	-	
		y coordinate	Ry	-	0.335	-	-	
	Green	**x** coordinate	Gx	-	0.326	-	-	
		y coordinate	Gy	-	0.548	-	-	
	Blue	**x** coordinate	Bx	-	0.151	-	-	
		y coordinate	By	-	0.147	-	-	
Color gamut		θR = 0°, θL = 0°, θU = 0°, θD = 0° at center, against NTSC color space	C	-	42	-	%	
Response time		White to Black	Ton	-	13	40	ms	Note5 Note6
		Black to White	Toff	-	36	90	ms	
Viewing angle	Right	θU = 0°, θD = 0°, CR ≥ 10	θR	-	50	-	°	Note7 ☆
	Left	θU = 0°, θD = 0°, CR ≥ 10	θL	-	50	-	°	
	Up	θR = 0°, θL = 0°, CR ≥ 10	θU	-	35	-	°	
	Down	θR = 0°, θL = 0°, CR ≥ 10	θD	-	45	-	°	

Note1: Measurement conditions are as follows.
Ta = 25°C, VCC = 5.0V, IBL = 5.0mArms/lamp

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 "**4.10.2 Definition of contrast ratio**".
Note3: See "**4.10.3 Definition of luminance uniformity**".
Note4: These coordinates are found on CIE 1931 chromaticity diagram.
Note5: Product surface temperature: TopF = 25°C
Note6: See "**4.10.4 Definition of response times**".
Note7: 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.

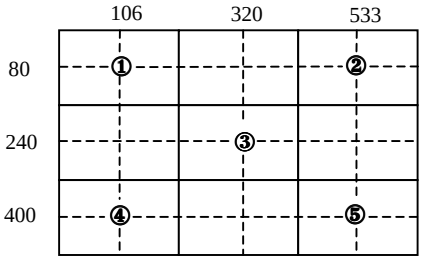
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

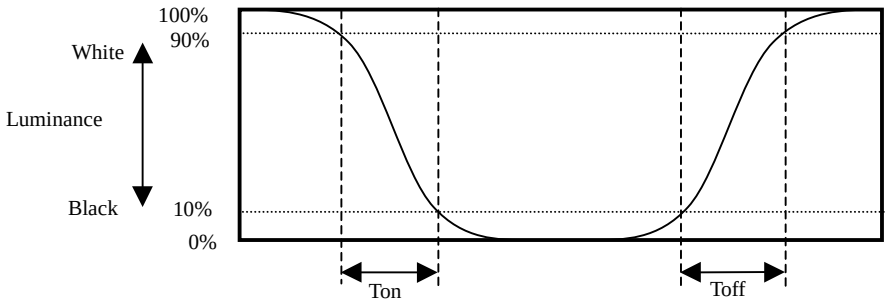
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

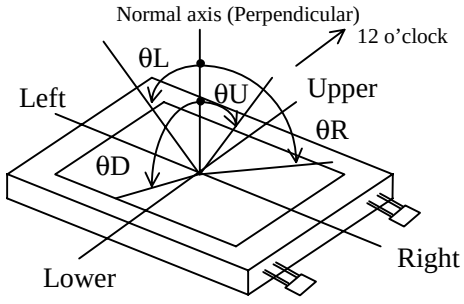


4.10.4 Definition of response times

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

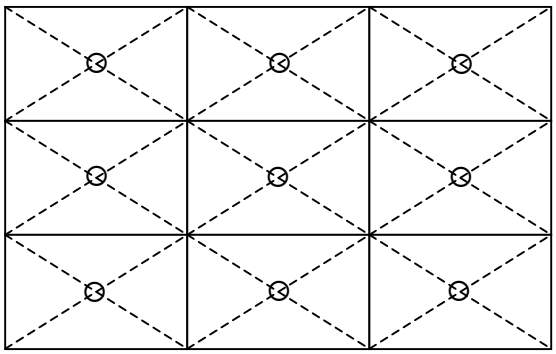


5. RELIABILITY TESTS

Test item	Condition	Judgement
High temperature and humidity (Operation)	① 50 ± 2°C, RH = 85%, 240hours ② Display data is black.	No display malfunctions Note1
High temperature (Operation)	① 60 ± 3°C, 240hours ② Display data is black.	
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 70 ± 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 490m/ 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 this contents!**

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

6.2 CAUTIONS

- **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 490m/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 When customer connects an adaptable plug to CN31 socket, put the product on flat subsoil and so on, in order to prevent the product from bending.
④ If customer puts down the product temporarily, the product puts on flat subsoil as a display side turns down.
⑤ 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.
⑥ The torque for mounting screws must never exceed 0.29N·m. Higher torque values might result in distortion of the bezel.
⑦ 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.
⑧ 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.
⑨ Do not push-pull the interface connectors while the product is working, because wrong power sequence may break down the product.
⑩ 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.
⑪ When installing the lamp cable, do not attach the lamp cable on the metal part of the LCD module directly. This may cause leakage high frequency current to the metal part, then the brightness may decrease or the lamp may not light. ☆

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 In order to prevent dew condensation occurring by temperature difference, the product packing box must be opened after leave under the environment of an unpacking room temperature 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.
⑤ 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.

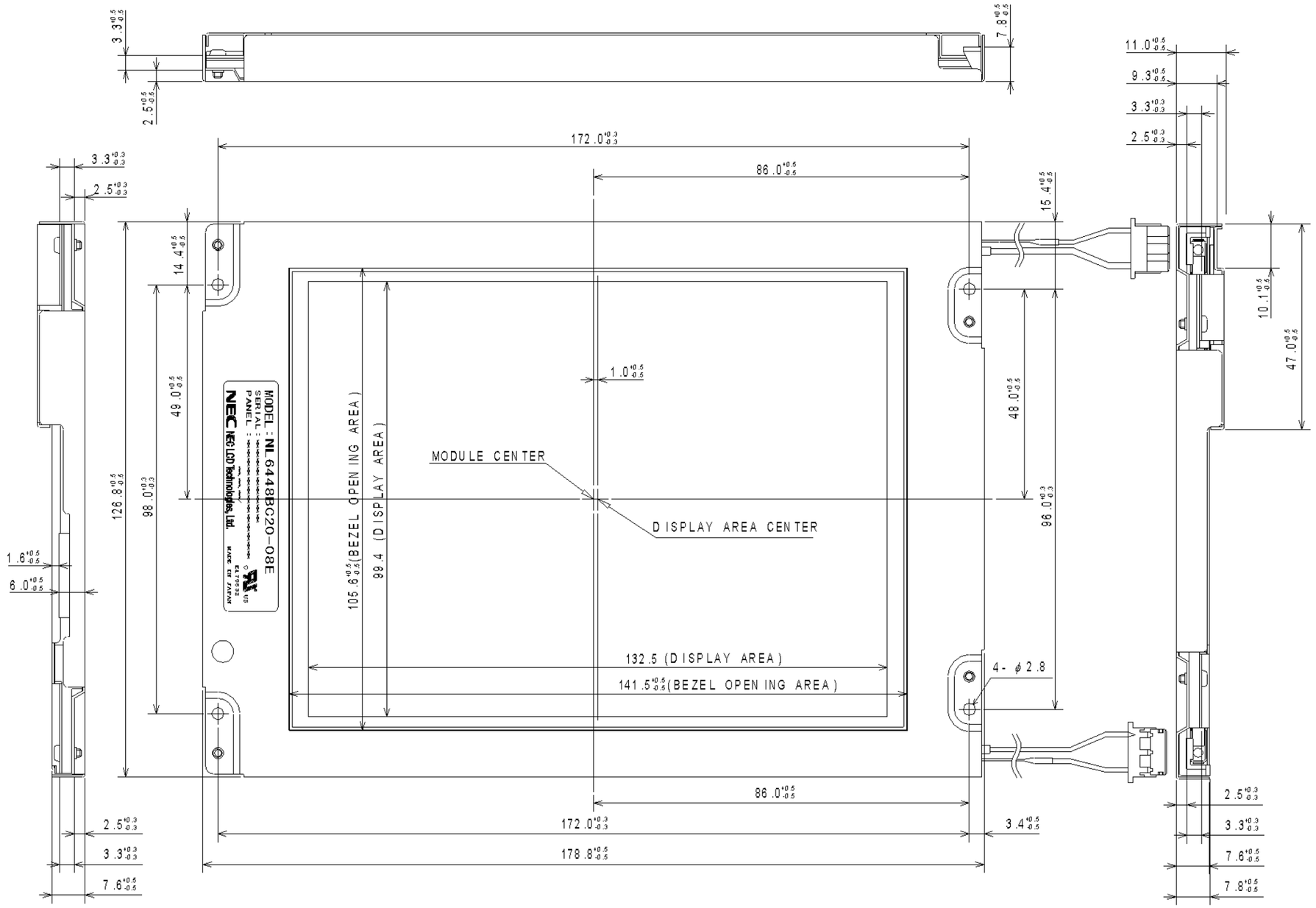
① Response time, luminance and color may be changed by ambient temperature.
② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating 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 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 backlight inverter may appear on a display. Set up luminance control frequency of backlight inverter so that the interference noise does not appear.

6.3.4 Other

① All GND, backlight inverter ground (GNDB), VCC and backlight inverter power supply voltage (VDDB) terminals should be used without a non-connected line.
② Do not disassemble a product or adjust volume without permission of NEC.
③ See "REPLACEMENT MANUAL FOR LAMPHOLDER", 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, because of avoidance of some damages during transportation, when customer returns it to NEC for repair and so on.

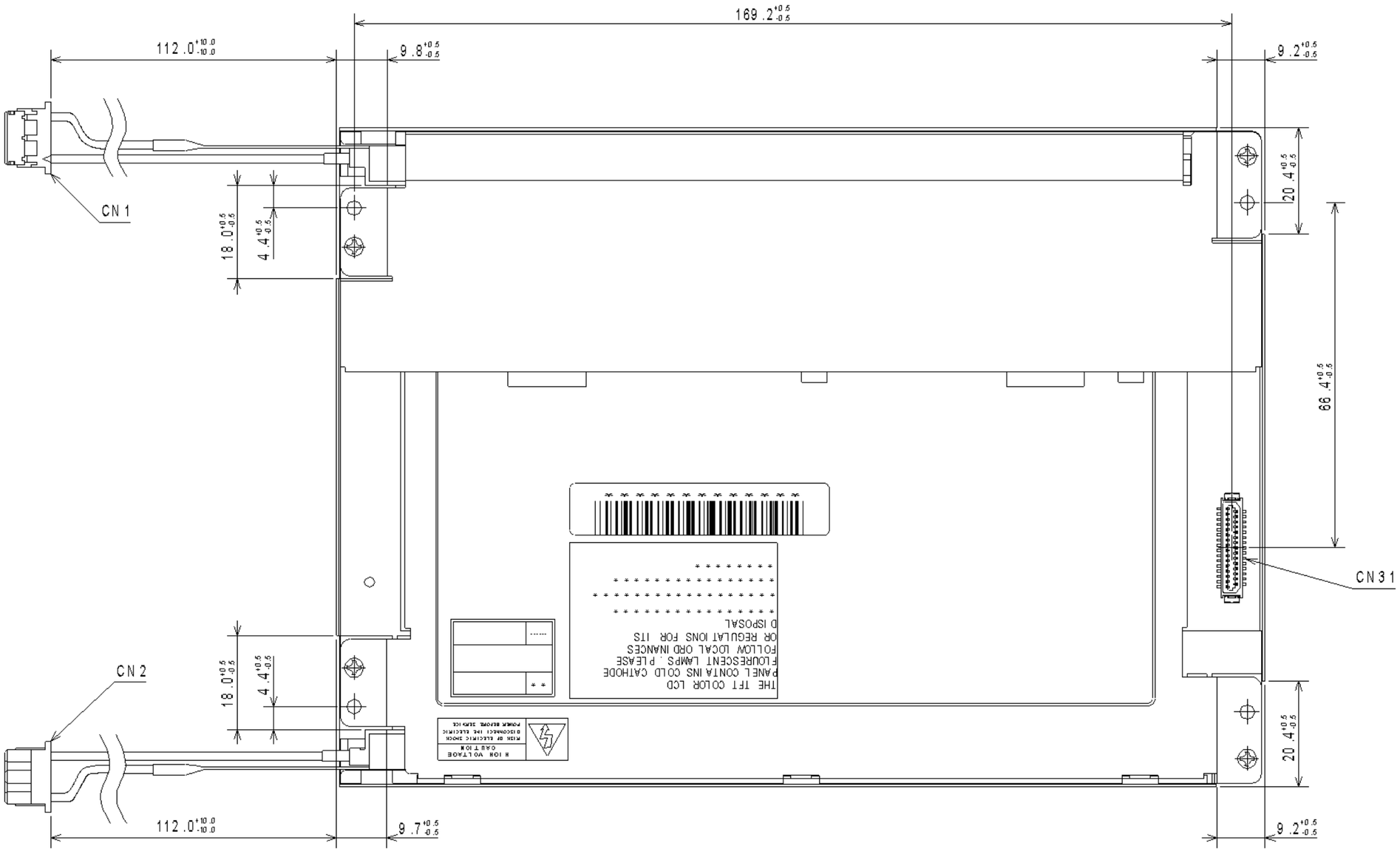
7. OUTLINE DRAWINGS

7.1 FRONT VIEW



Unit: mm

7.2 REAR VIEW



Unit: mm