NEC

TFT COLOR LCD MODULE

NL6448BC26-03

21.4cm (8.4 Type)
VGA

DATA SHEET

(1st edition)

All information is subject to change without notice.
Please confirm the delivery specification before starting to design your system.

INTRODUCTION

While NEC Corporation has been making continuous effort to enhance the reliability of its products, the possibility of failures cannot be eliminated entirely. To minimize risks of damage to property or injury to person arising from a failure in an NEC product, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.

NEC products are classified into the following three quality grades:

"Standard", "Special", "Specific"

The ***"Specific"*** quality grade applies only to applications developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a product depend on its quality grade, as indicated below. Customers must check the quality grade of each application before using it in a particular application.

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 Corporation sales representative in advance.

Anti-radioactive design is not implemented in this product.

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CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

NL6448BC26-03 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

- Display terminal for control system
- Industrial PC

1.3 FEATURES

- High luminance
- Wide viewing angle
- 6-bit digital RGB signals
- Reversible-scan direction
- Edge light type
- Replaceable lamp for backlight (Inverter less)
- Suitable for setting in the portrait position (See **"4.7.2 Setting the LCD module in the portrait position (vertical)"**.

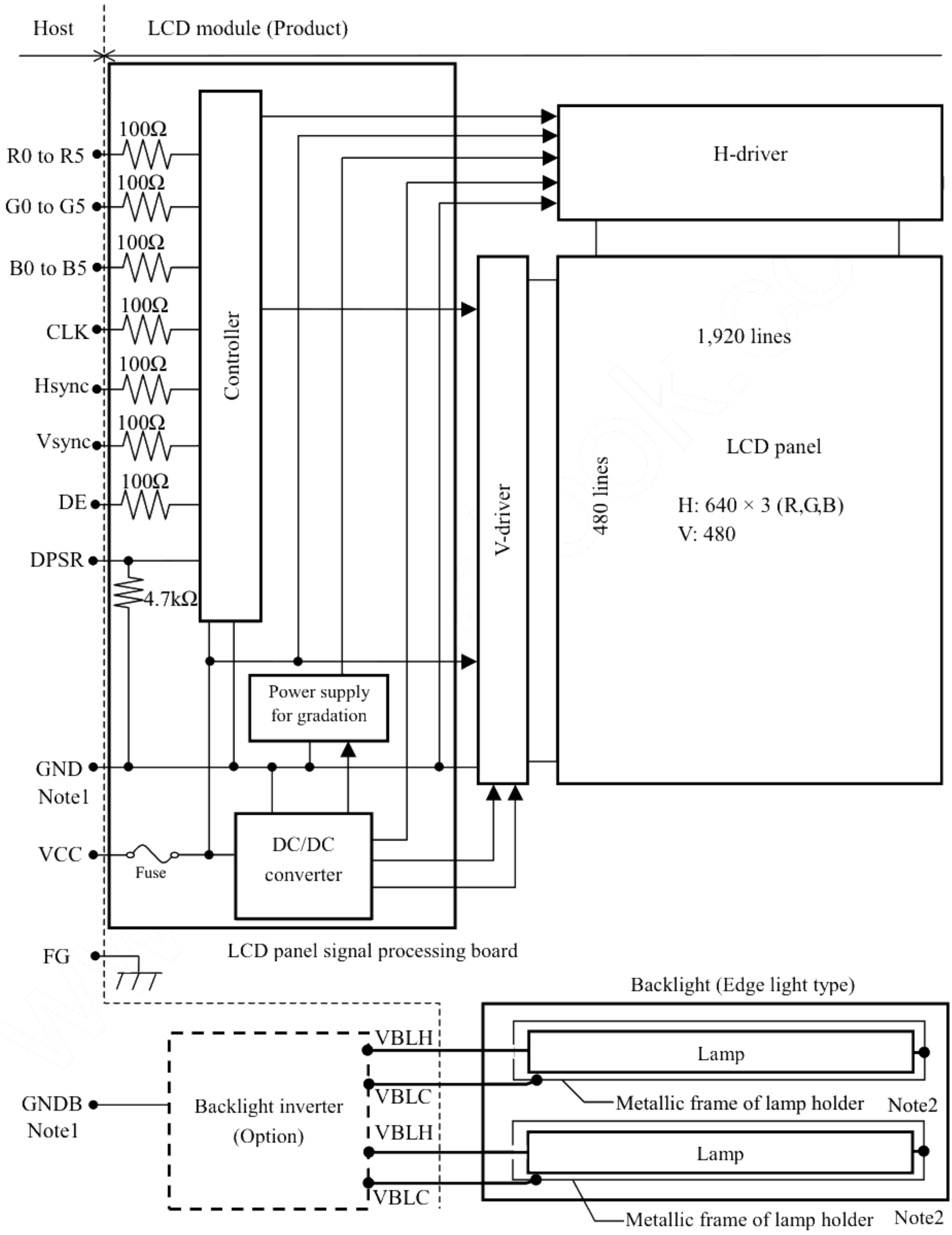
Comparison table of NL6448BC26-03 and NL6448BC26-01

Item		NL6448BC26-03	NL6448BC26-01
Viewing angle	Horizontal	Right side 40°, Left side 70°	Right side 55°, Left side 55°
	Vertical	Up side 55°, Down side 55°	Up side 40°, Down side 70°

2. GENERAL SPECIFICATIONS

Display area	170.9 (W) × 128.2 (H) mm (typ.)
Diagonal size of display	21.4 cm (8.4 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	0.0890 (W) × 0.2670 (H) mm
Pixel pitch	0.2670 (W) × 0.2670 (H) mm
Module size	200.0 (W) × 152.0 (H) × 12.0 (D) mm (typ.)
Weight	375 g (typ.)
Contrast ratio	500:1 (typ.)
Viewing angle	*At the contrast ratio 10:1* • Horizontal: Right side 40° (typ.), Left side 70° (typ.) • Vertical: Up side 55° (typ.), Down side 55° (typ.)
Designed viewing direction	*At DPSR= Low or open: normal scan* • Viewing direction without image reversal: right side (3 o'clock) • Viewing direction with contrast peak: left side 5° to 10° (9 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* 40 % (typ.) [against NTSC color space]
Response time	*Ton (white 90%→ black 10%)* 10 ms (typ.)
Luminance	*At 5.0mArms / lamp* 450 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. 84LHS01) (Recommended inverter (Option) • Inverter: Type No. 65PWB31)
Power consumption	*At maximum luminance and checkered flag pattern* 4.6 W (typ.)

3. BLOCK DIAGRAM



Note1: GND, FG (Frame ground) and GNDB (Backlight inverter ground) should be connected together in customer equipment.

Note2: The metallic frame of lamp holder is connected to VBLC (Lamp low voltage terminal).

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

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

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	200.0 ± 0.5 (W) × 152.0 ± 0.5 (H) × 12.0 ± 0.7 (D)	Note1	mm
Display area	170.9 (W) × 128.2 (H)	Note1	mm
Weight	375 (typ.), 400 (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	High voltage side (Hot) Note1	VBLH	1,800	Vrms	
		Low voltage side (Cold) Note2	VBLC	42.4	Vrms	
Input voltage for signals	Display signals Note3		VD	-0.3 to VCC+0.3	V	
	Function signals Note4		VF	-0.3 to VCC+0.3	V	
Storage temperature			Tst	-20 to +70	°C	-
Operating temperature	Front surface		TopF	0 to +60	°C	
	Rear surface center		TopR	0 to +65	°C	
Relative humidity Note5			RH	≤ 95	%	Ta ≤ 40°C
				≤ 85	%	40 < Ta ≤ 50°C
				≤ 70	%	50 < Ta ≤ 55°C
				≤ 60	%	55 < Ta ≤ 60°C
Absolute humidity Note5			AH	≤ 78 Note6	g/m^3	Ta > 60°C

Note1: "VBLH" is the voltage value between low voltage terminal (Cold) and high voltage terminal (Hot).

Note2: "VBLC" is the voltage value between backlight inverter ground (GNDB) and low voltage terminal (Cold).

Note3: Display signals are CLK, Hsync, Vsync, DE and DATA (R0 to R5, G0 to G5, B0 to B5).

Note4: Function signal is DPSR.

Note5: No condensation

Note6: 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	for 3V system
			4.7	5.0	5.3	V	for 5V system
Power supply current		ICC	-	140 Note1	400	mA	VCC = 3.3V
			-	105 Note1	-	mA	VCC = 5.0V
Logic input voltage for display signals	Low	VDLL	0	-	0.3Vcc	V	CMOS level
	High	VDLH	0.7Vcc	-	Vcc	V	
Input voltage for DPSR signal	Low	VFDL	0	-	0.3Vcc	V	
	High	VFDH	0.7Vcc	-	Vcc	V	

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

4.3.2 Working for backlight lamp

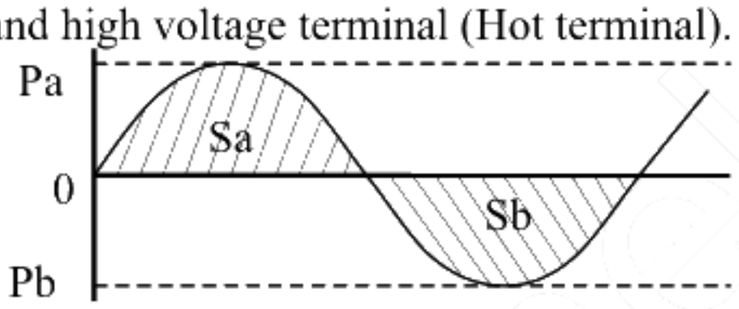
(Note1)

Parameter	Symbol	Ta	Min.	Typ.	Max.	Unit	Remarks
Lamp starting voltage	VS	0°C	900	-	-	Vrms	Note2
		25°C	700	-	-	Vrms	
Lamp voltage	VBLH	25°C	-	410	-	Vrms	Note2,Note3
Lamp current	IBL	25°C	3.0	5.0	5.5	mArms	Note3
Oscillation frequency	FO	25°C	50	54	58	kHz	Note4

Note1: This product's backlight consists of 2 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).



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

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

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

Note4: 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 synchronous cycle (See "**4.8 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD**".)

n: Natural number (1, 2, 3 ·····)

Note5: Method of lamp cable installation may invite fluctuation of lamp current and voltage or asymmetric of lamp working waveform. When design the backlight inverter, evaluate the fluctuation of lamp current and voltage or asymmetric of lamp 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.

Parameter	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.

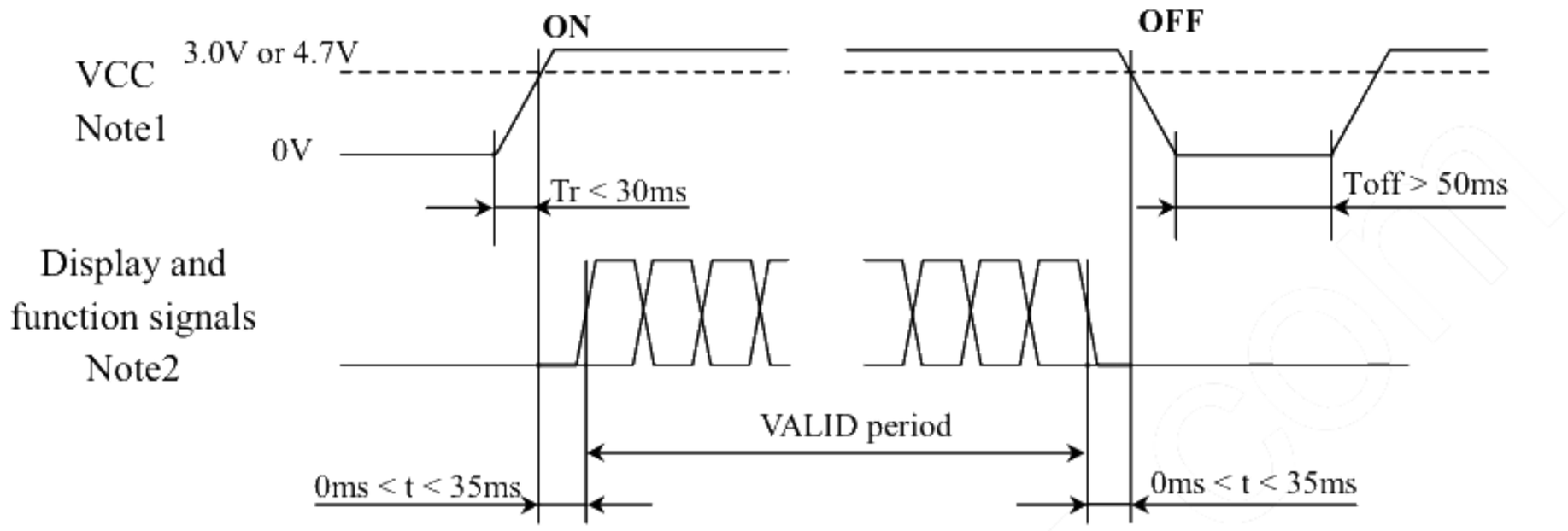
4.3.4 Fuse

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

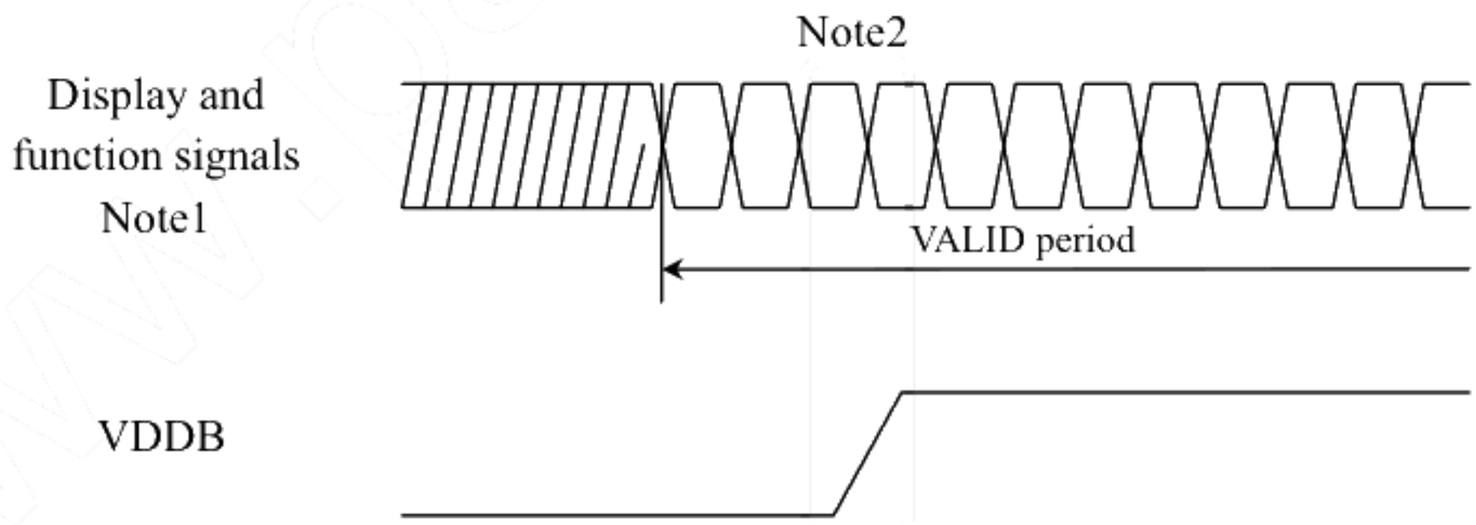


Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V in "VCC = 3.3V" or 4.7V in "VCC = 5.0V", a protection circuit may work, and then this product may not work.

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

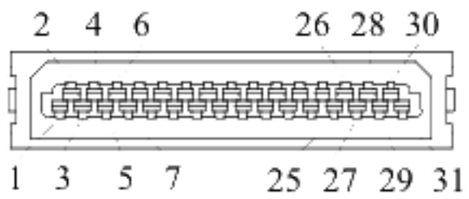
4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): DF9-31P-1V (Hirose Electric Co., Ltd.)
Adaptable plug: DF9-31S-1V (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GND	Ground	-
2	CLK	Dot clock	
3	Hsync	Horizontal synchronous	
4	Vsync	Vertical synchronous	
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	Select of DE / Fixed mode	DE mode: Data enable signal, Fixed mode: Open
28	VCC	Power supply	-
29	VCC	Power supply	
30	NC	Non connection	
31	DPSR	Select of scan direction	Normal scan: Low or Open, Reverse scan: High Note1

Note1: See "**4.7 DISPLAY POSITIONS AND SCANNING DIRECTIONS**".

CN1: Figure of socket



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

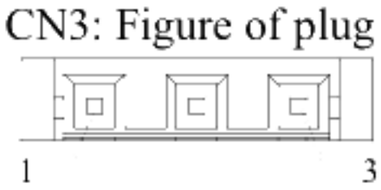
Pin No.	Symbol	Signal	Remarks
1	VBLH	High voltage (Hot)	-
2	N.C.	Non connection	
3	VBLC	Low voltage (Cold)	

CN2: Figure of plug

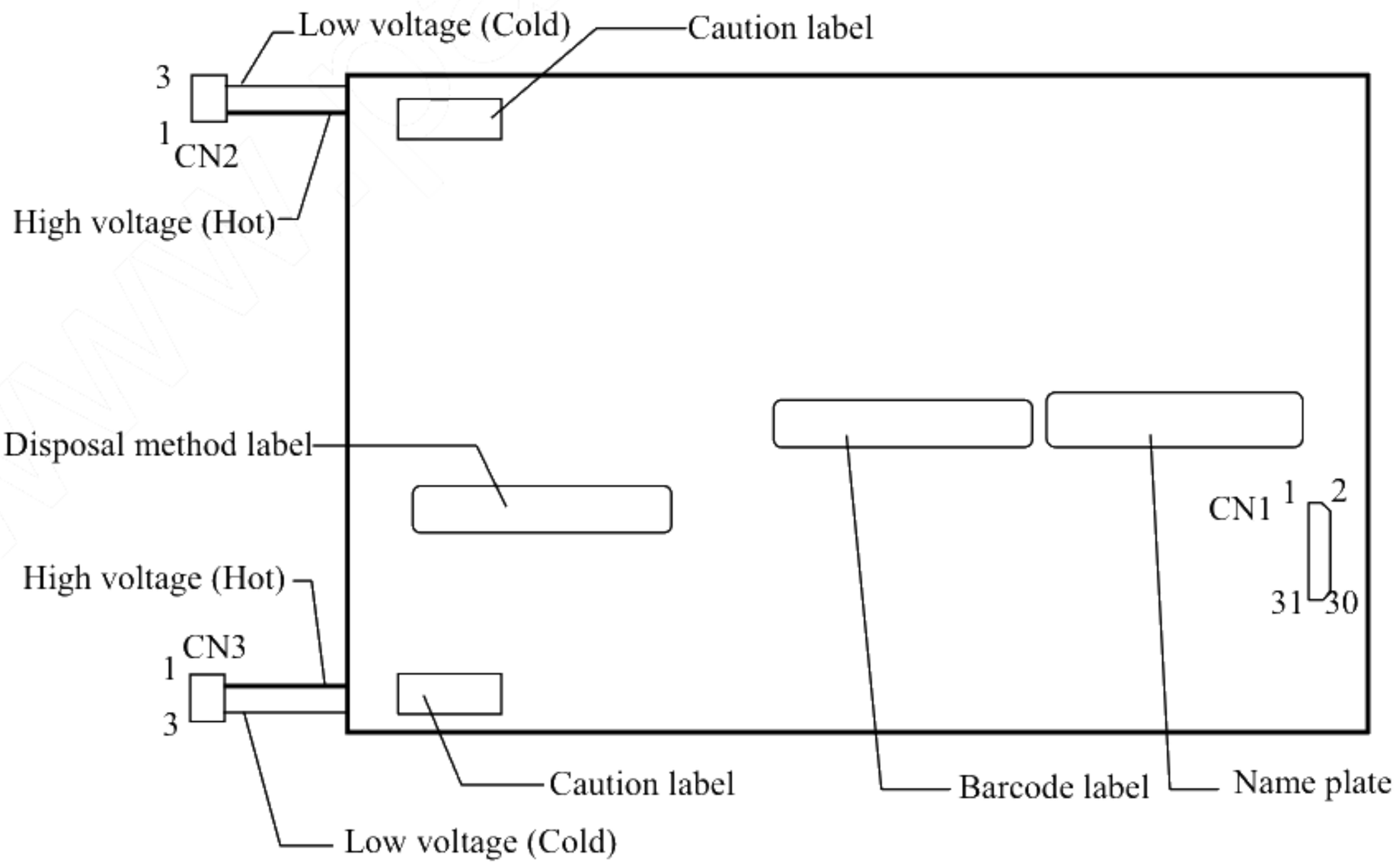
CN3 plug: BHR-03VS-1 (J.S.T Mfg. Co., Ltd.)
Adaptable socket: SM03 (4.0) B-BHS-TB (J.S.T Mfg. Co., Ltd.)

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

CN3: Figure of plug



4.5.3 Positions of plugs and a socket



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 AND SCANNING DIRECTIONS

4.7.1 Setting the LCD module in the landscape position (horizontal)

(1) Display positions

The following table is the coordinates per pixel (See figure of "**(2) 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)

(2) Scanning directions

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

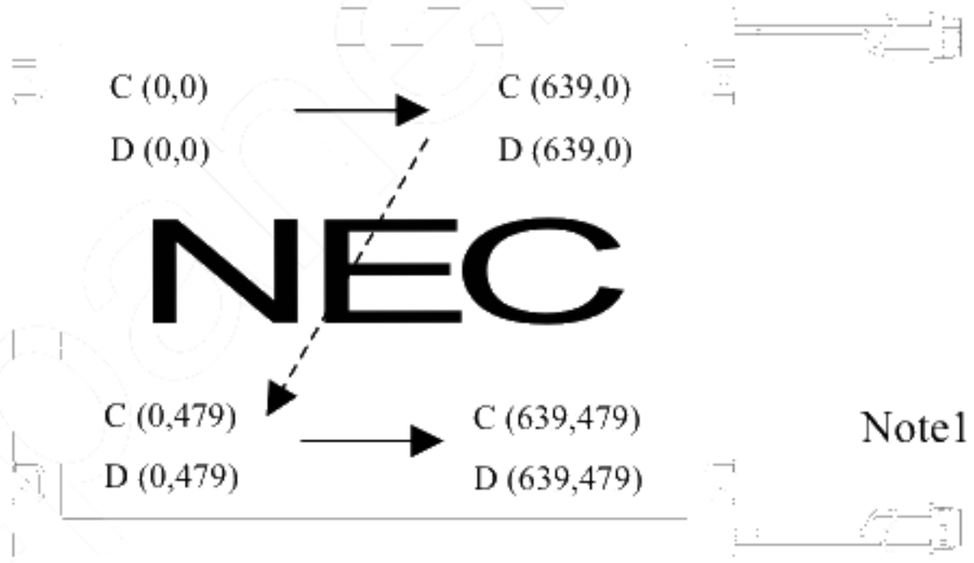


Figure 1. Normal scan (DPSR: Low or Open)

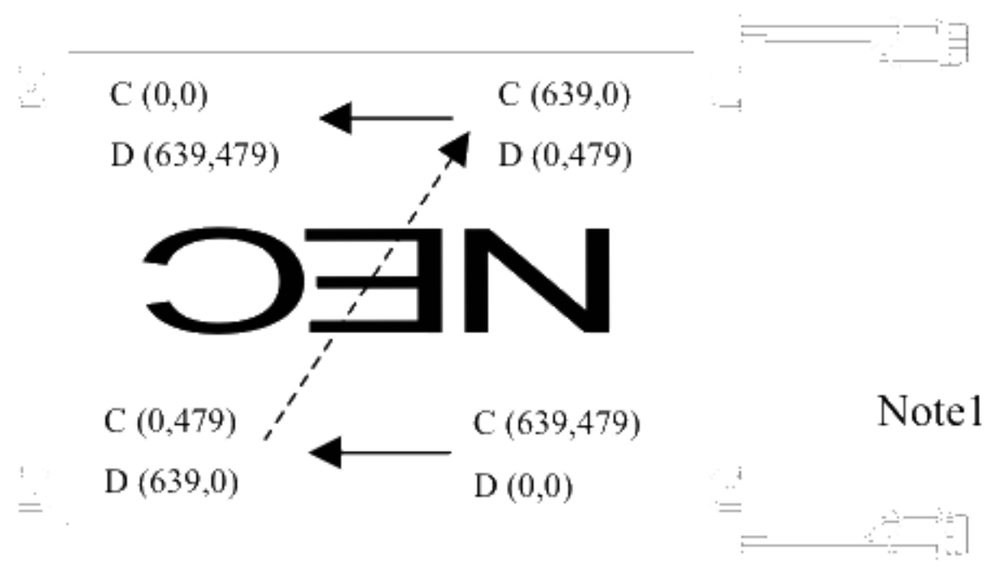


Figure 2. Reverse scan (DPSR: High)

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

C (X, Y): The coordinates of the display position (See "**(1) DISPLAY POSITIONS**".)

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

4.7.2 Setting the LCD module in the portrait position (vertical)

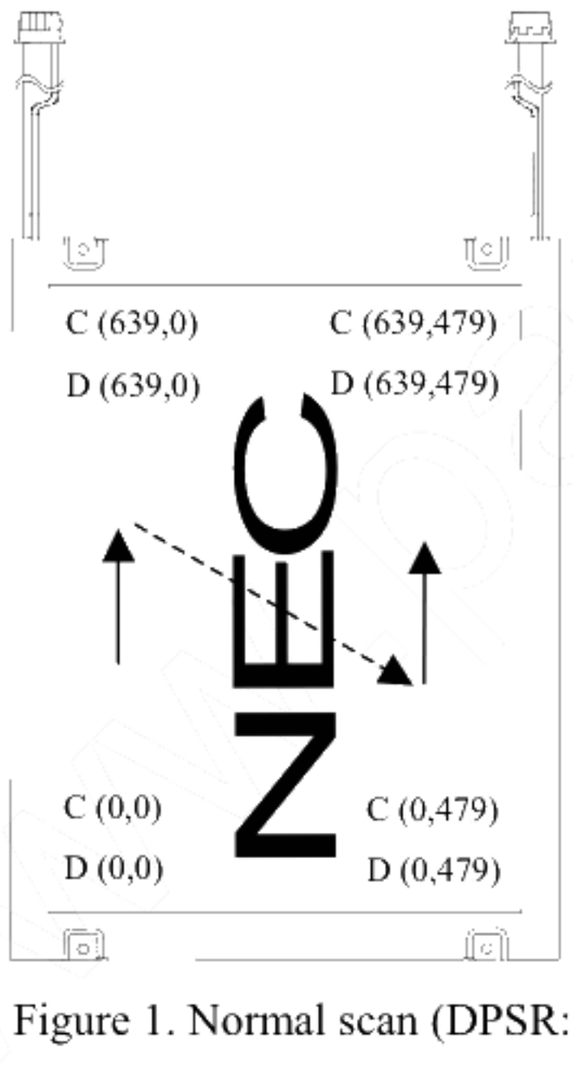
(1) Display positions

The following table is the coordinates per pixel (See figure of "**(2) Scanning directions**".).

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

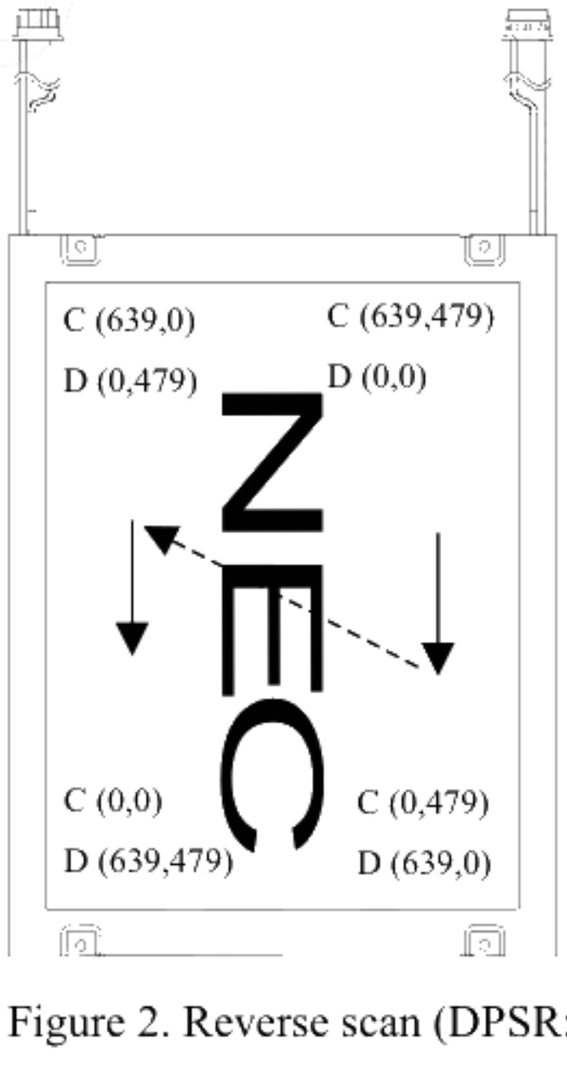
(2) Scanning directions

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



Note1

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



Note1

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 "**(1) DISPLAY POSITIONS**".)

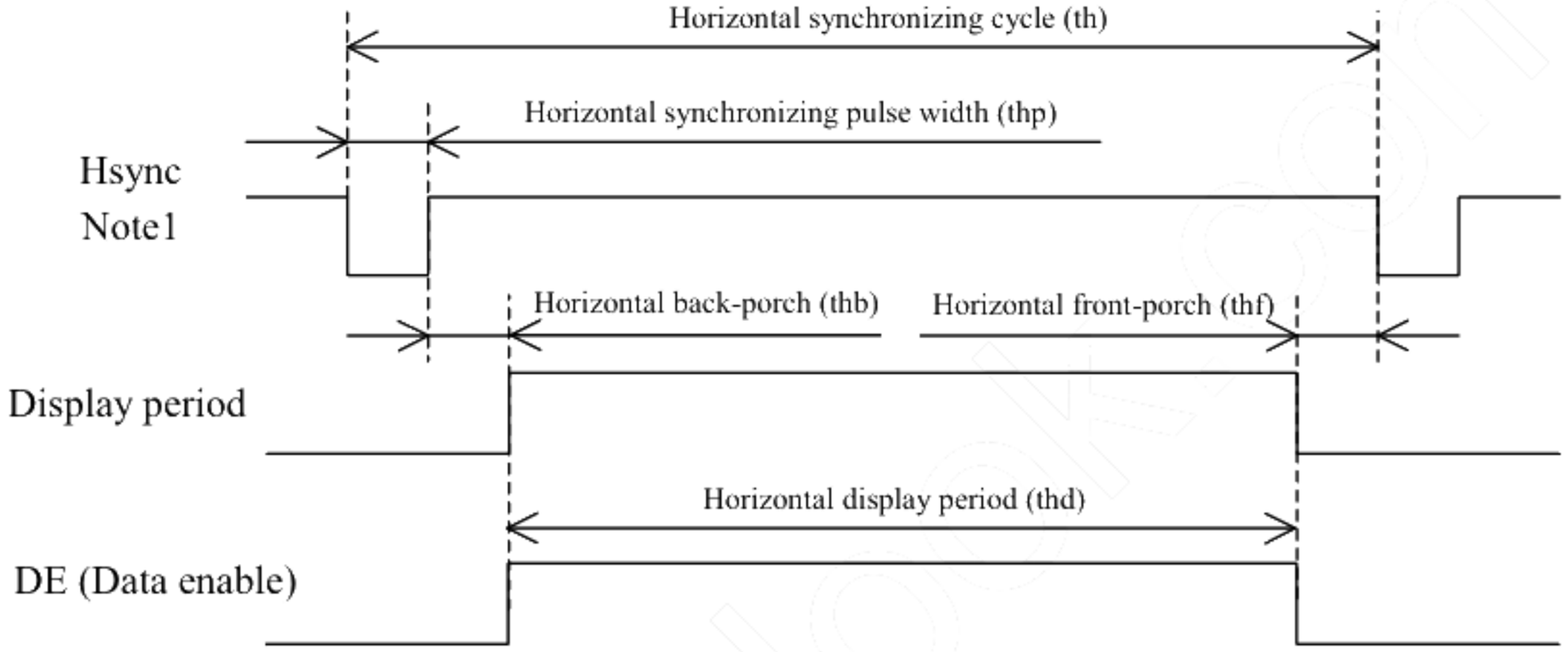
D (X, Y): The data number of input signal for LCD panel signal processing board

4.8 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD

4.8.1 Outline of input signal timings

This diagram indicates virtual signal for set up to timing.

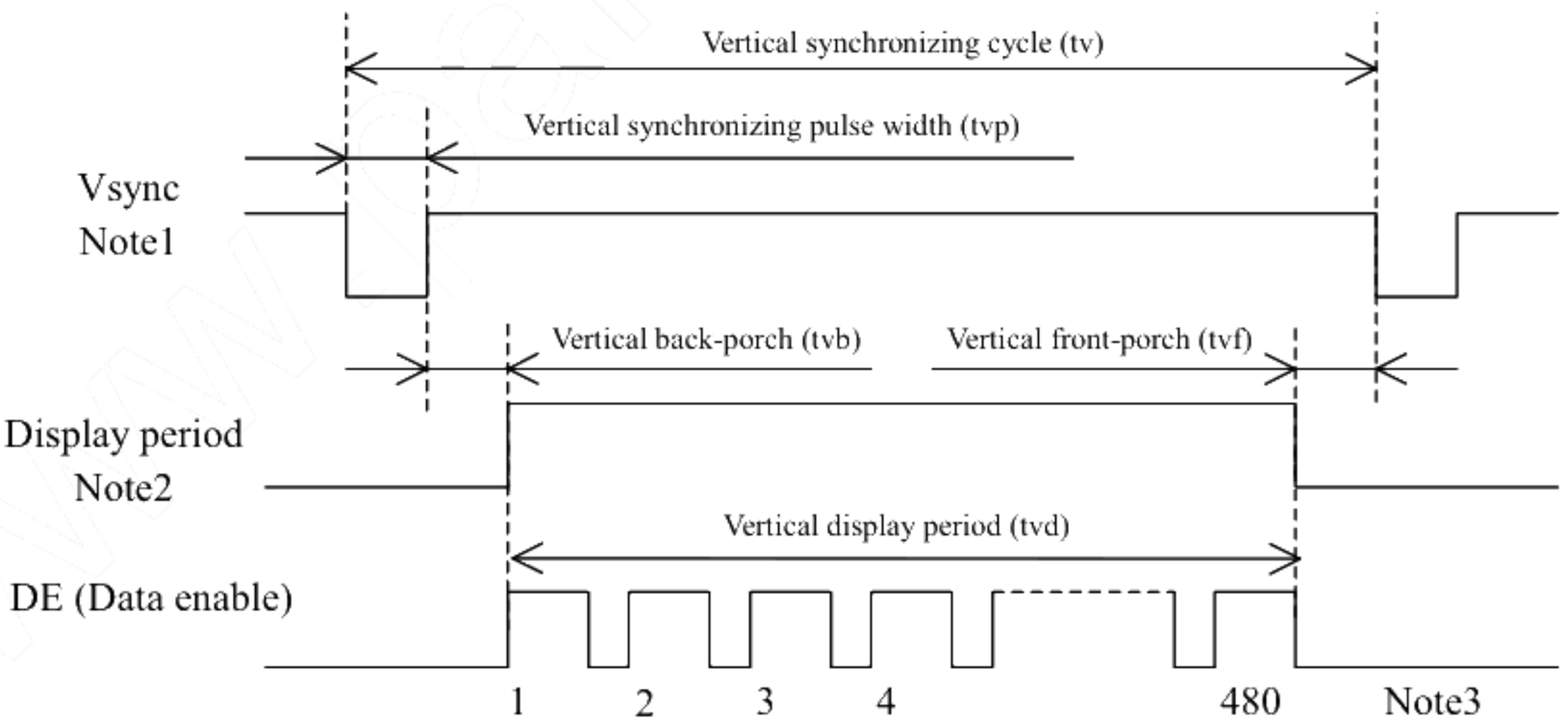
- Horizontal signal



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

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

- 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: See "**4.8.3 Input signal timing chart**" for numeration of pulse.

4.8.2 Timing characteristics

(a) 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	
Hsync	Cycle		th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				800			CLK	Note2
	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	Note2, Note3
	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	Note2
	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	Note2, Note3
	Hsync- Vsync		thv	1	-	-	CLK	Note2
	Vsync-Hsync		tvs	15	-	-	ns	-
	Rise time, Fall time		tvrf	-	-	10	ns	

Note1: Definition of parameters is as follows.

tcf = 1/tc, tcd = tch/tc = tch×tcd

Note2: Definition of parameters is as follows.

tc = 1CLK, th = 1H

Note3: 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.

(b) 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	
Hsync	Cycle		th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				-	800	-	CLK	Note2
	Display period		thd	640			CLK	
	Front-porch		thf	2	16	-	CLK	
	Pulse width		thp	10	96	-	CLK	
	Back-porch		thb	4	48	-	CLK	
	Total of pulse width and back-porch		thp + thb	14	144	-	CLK	Note2, Note3
	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	Note2
	Display period		tvd	480			H	
	Front-porch		tvf	0	12	-	H	
	Pulse width		tvp	1	2	-	H	
	Back-porch		tvb	4	31	-	H	
	Total of pulse width and back-porch		tvp + tvb	5	33	-	H	Note2, Note3
	Hsync- Vsync		thv	1	-	-	CLK	Note2
	Vsync-Hsync		tvs	30	-	-	ns	-
	Rise time, Fall time		tvrf	-	-	10	ns	
DE	Horizontal	Cycle	th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				-	800	-	CLK	Note2
		Display period	thd	640			CLK	
	Vertical (One frame)	Cycle	tv	16.1	16.7	17.2	ms	59.9 Hz (typ.)
				-	525	-	H	Note2
		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: Definition of parameters is as follows.

tcf = 1/tc, tcd = tch/tc = tch×tcd

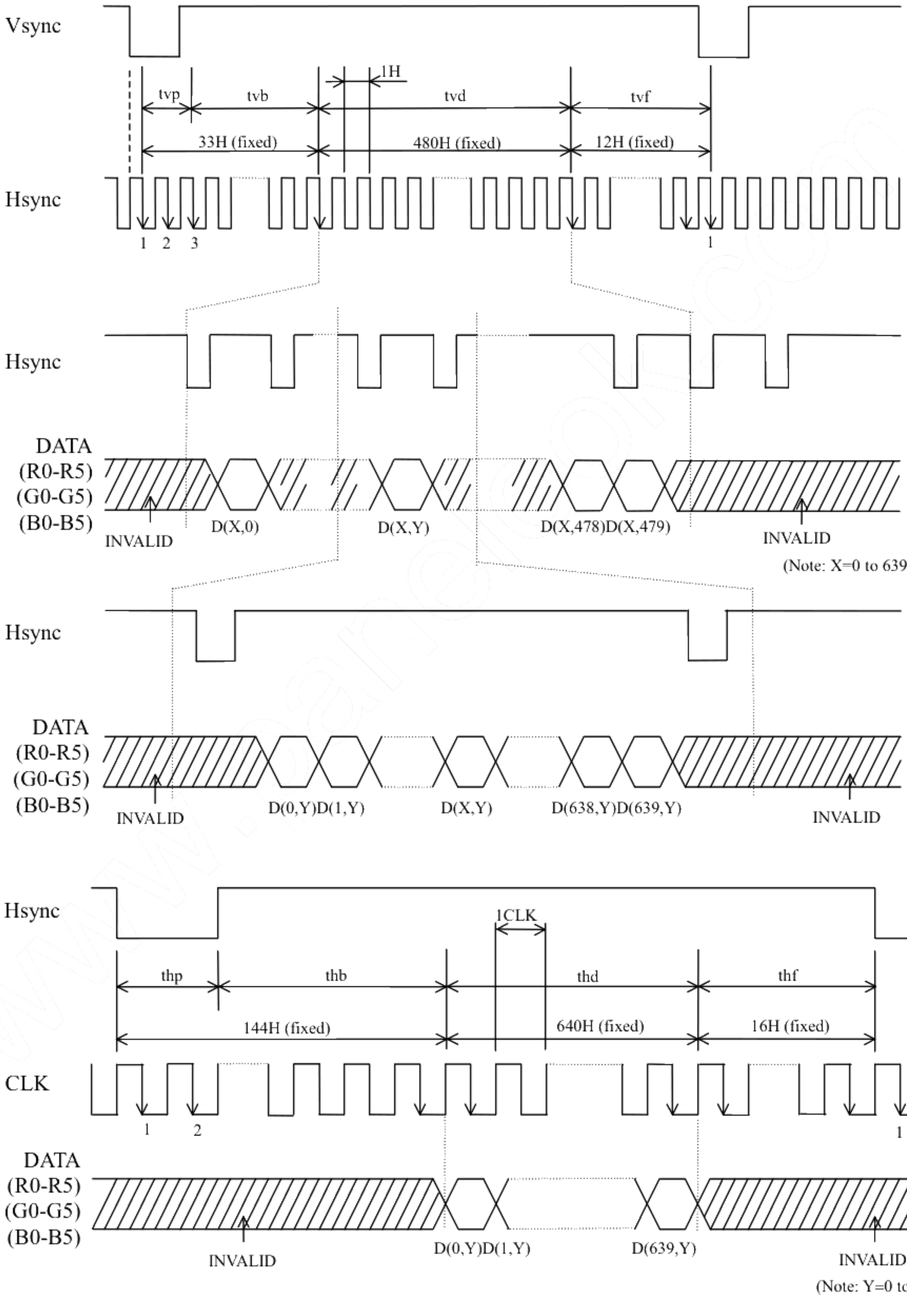
Note2: Definition of parameters is as follows.

tc = 1CLK, th = 1H

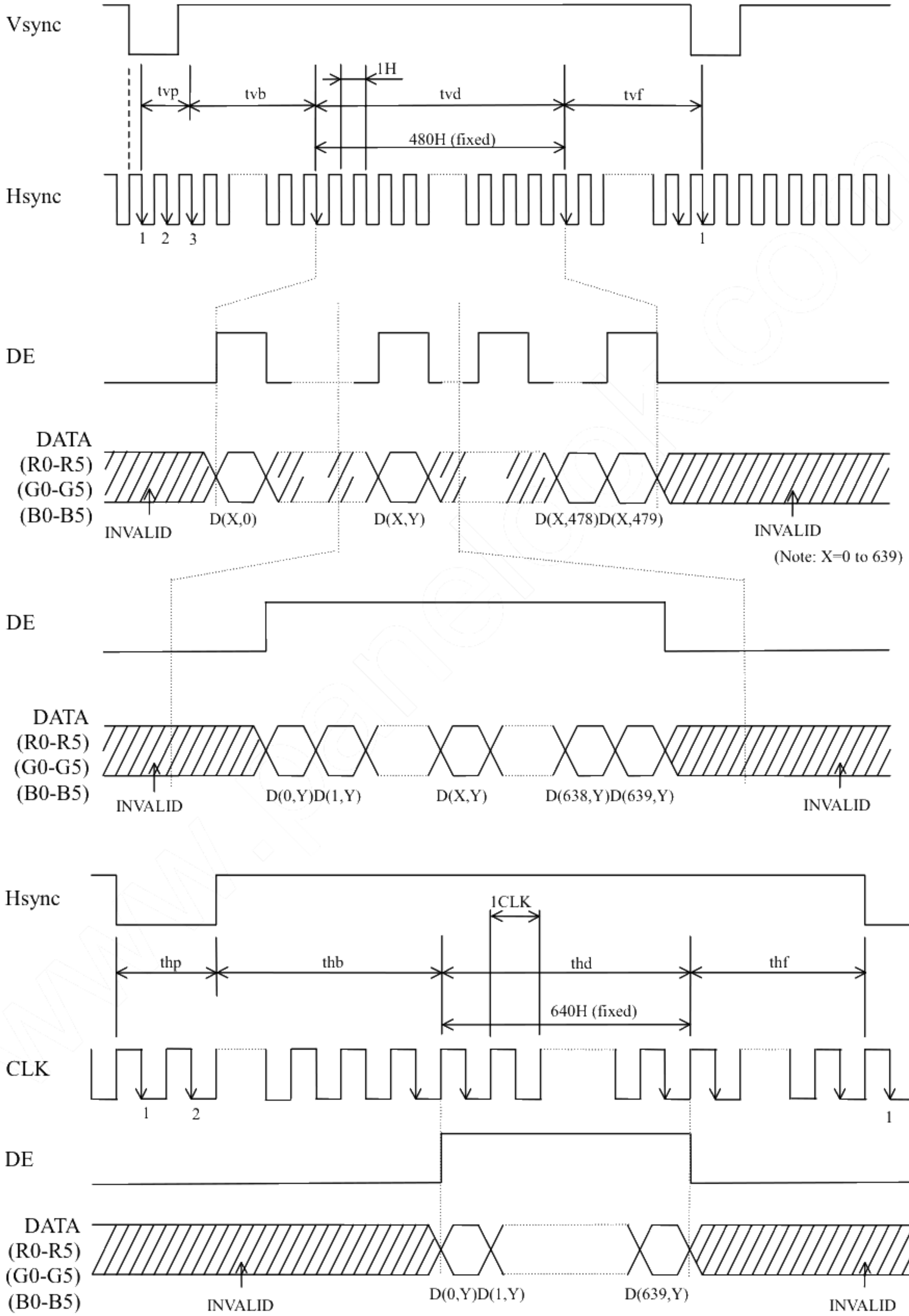
Note3: Keep tvp + tvb and thp + thb within the table. If it is out of specification, display position will be shifted to right/left side or up/down.

4.8.3 Input signal timing chart

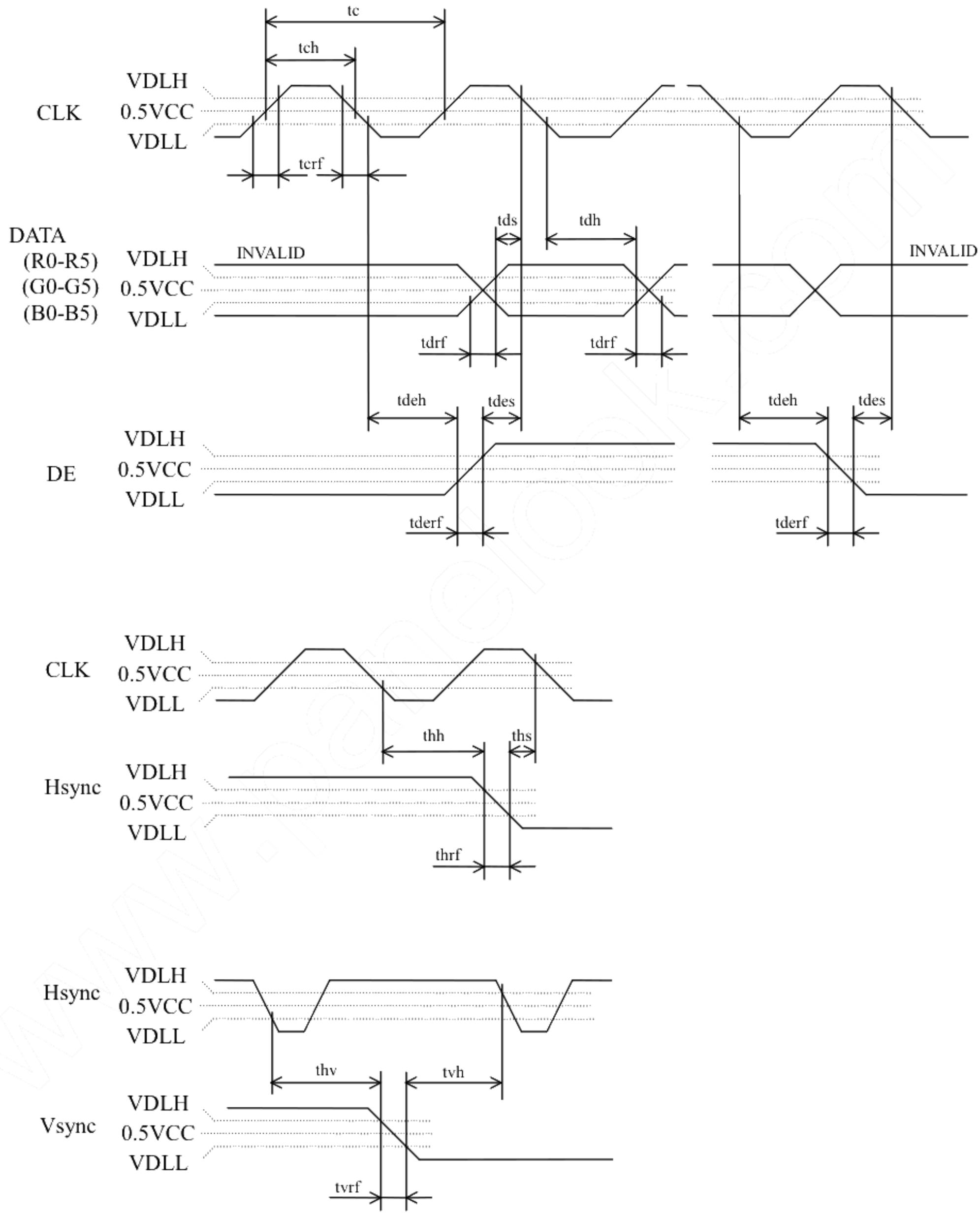
(a) Fixed mode



(b) DE mode


Vsync
1H
tvp
tvb
tvd
tvf
480H (fixed)
Hsync
1 2 3
1
DE
DATA
(R0-R5)
(G0-G5)
(B0-B5)
INVALID
D(X,0)
D(X,Y)
D(X,478)D(X,479)
INVALID
(Note: X=0 to 639)
DE
DATA
(R0-R5)
(G0-G5)
(B0-B5)
INVALID
D(0,Y)D(1,Y)
D(X,Y)
D(638,Y)D(639,Y)
INVALID
Hsync
1CLK
thp
thb
thd
thf
640H (fixed)
CLK
1 2
1
DE
DATA
(R0-R5)
(G0-G5)
(B0-B5)
INVALID
D(0,Y)D(1,Y)
D(639,Y)
INVALID
(Note: Y=0 to 479)

(c) Common


tc
tch
CLK
VDLH
0.5VCC
VDLL
tcrf
tds
tdh
DATA
(R0-R5)
(G0-G5)
(B0-B5)
VDLH
0.5VCC
VDLL
INVALID
INVALID
tdrf
tdrf
tdeh
tdes
tdeh
tdes
DE
VDLH
0.5VCC
VDLL
tderf
tderf
CLK
VDLH
0.5VCC
VDLL
thh
ths
Hsync
VDLH
0.5VCC
VDLL
thrf
Hsync
VDLH
0.5VCC
VDLL
thv
tvh
Vsync
VDLH
0.5VCC
VDLL
tvrf

4.9 OPTICS

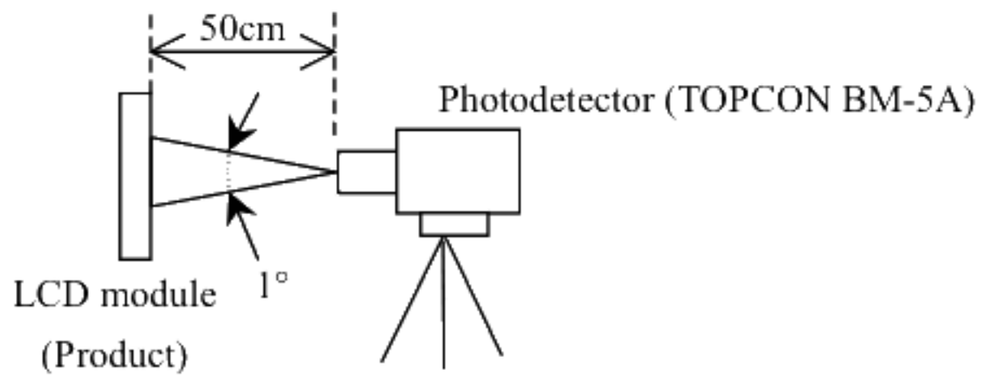
4.9.1 Optical characteristics

Parameter Note1		Condition	Symbol	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio		White/Black at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	CR	200	500	-	-	Note2
Luminance		White at center θR = 0°, θL = 0°, θU = 0°, θD = 0°	L	360	450	-	cd/m^2	-
Luminance uniformity		-	LU	-	-	1.40	-	Note3
Chromaticity	White	**x** coordinate	Wx	-	0.305	-	-	Note4
		y coordinate	Wy	-	0.340	-	-	
	Red	**x** coordinate	Rx	-	0.562	-	-	
		y coordinate	Ry	-	0.334	-	-	
	Green	**x** coordinate	Gx	-	0.320	-	-	
		y coordinate	Gy	-	0.537	-	-	
	Blue	**x** coordinate	Bx	-	0.156	-	-	
		y coordinate	By	-	0.157	-	-	
Color gamut		θR = 0°, θL = 0°, θU = 0°, θD = 0° at center, against NTSC color space	C	35	40	-	%	
Response time		White to black	Ton	-	10	20	ms	Note5 Note6
		Black to white	Toff	-	25	50	ms	
Viewing angle	Right	θU = 0°, θD = 0°, CR = 10	θR	-	40	-	°	Note7
	Left	θU = 0°, θD = 0°, CR = 10	θL	-	70	-	°	
	Up	θR = 0°, θL = 0°, CR = 10	θU	-	55	-	°	
	Down	θR = 0°, θL = 0°, CR = 10	θD	-	55	-	°	

Note1: Measurement conditions are as follows.

Ta = 25°C, VCC = 3.3V, 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 "**4.9.2 Definition of contrast ratio**".

Note3: See "**4.9.3 Definition of luminance uniformity**".

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

Note5: Product surface temperature: TopF = 25°C

Note6: See "**4.9.4 Definition of response times**".

Note7: See "**4.9.5 Definition of viewing angles**".

4.9.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

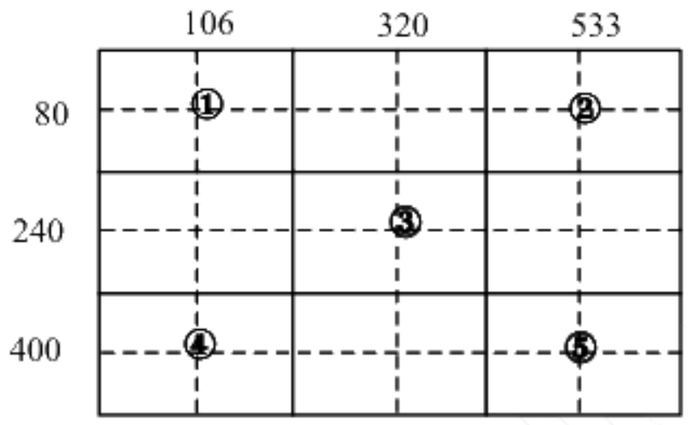
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

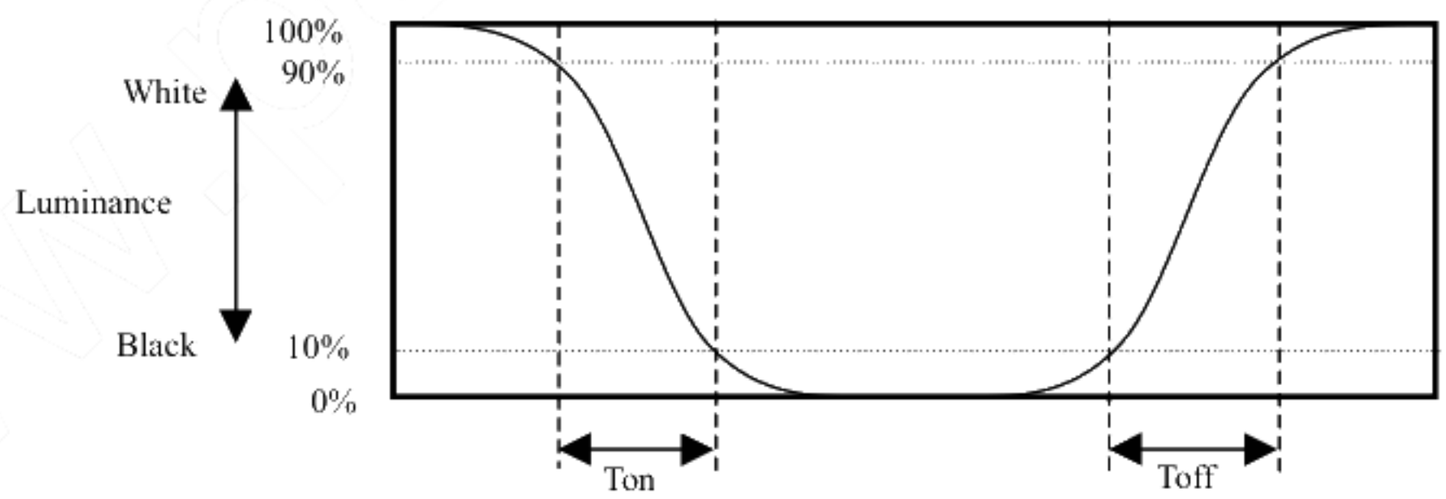
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

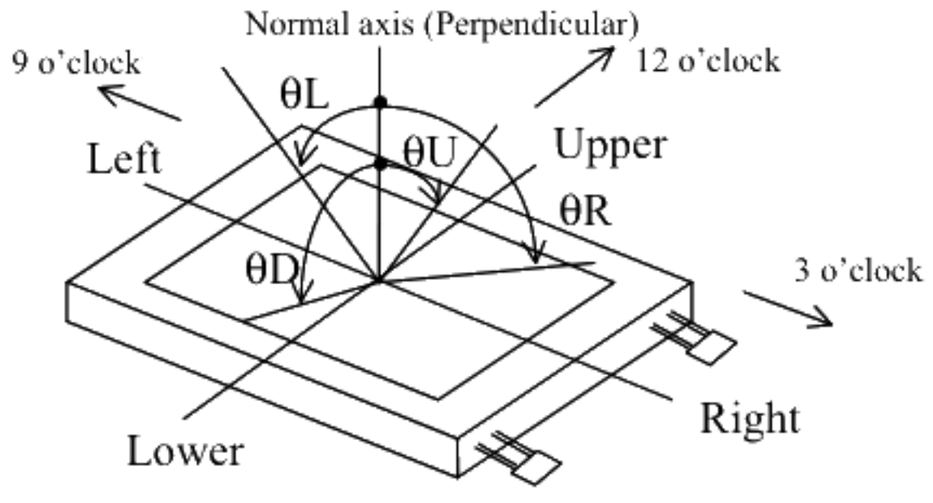


4.9.4 Definition of response times

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.).



4.9.5 Definition of viewing angles

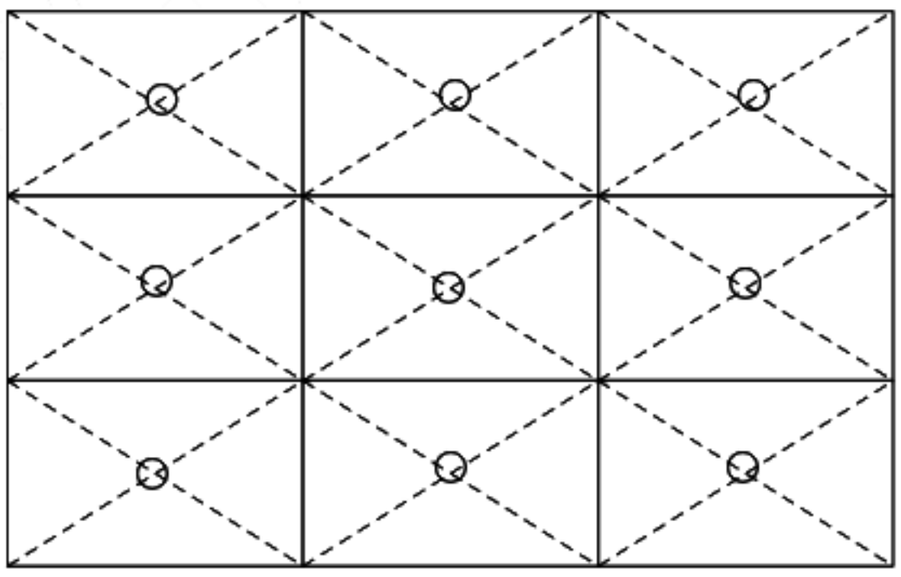


5. RELIABILITY TESTS

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 ± 2°C, 240hours ② Display data is black.	
Heat cycle (Operation)	① 0 ± 3°C…1hour 60 ± 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 Note1 No physical damages
Mechanical shock (Non operation)	① 539m/ 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

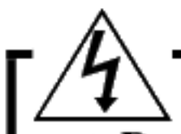
6.1 MEANING OF CAUTION SIGNS

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 the lamp cables while turn on. Customer will be in danger of an electric 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! There is a danger of breaking, because they are made of glass. (Shock: To be not greater 539m/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 lamp 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 0.16N·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.

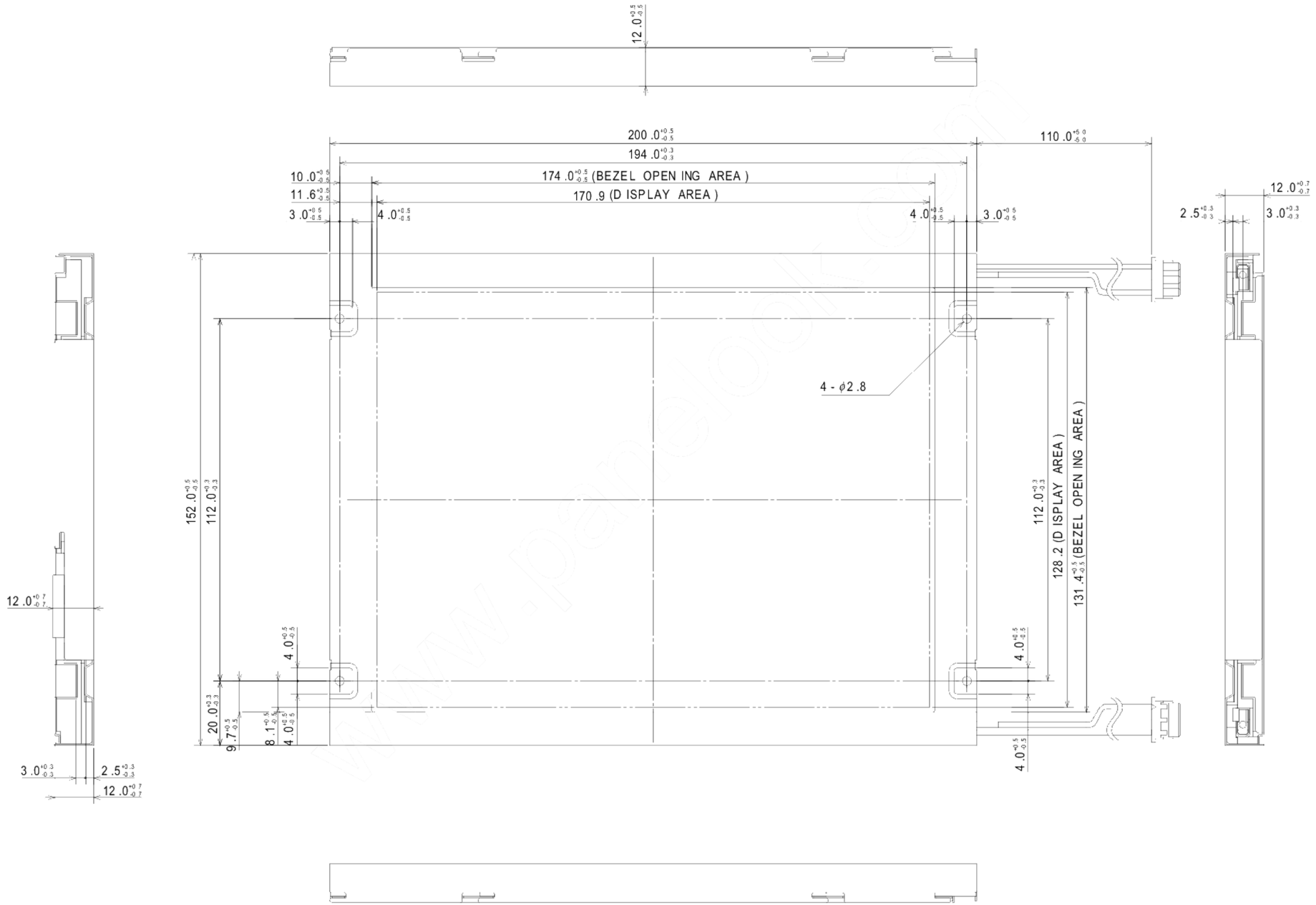
① Response time, luminance and color may be changed by ambient temperature.
② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating 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 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 Corporation.
③ See "REPLACEMENT MANUAL FOR LAMP HOLDER", 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 Corporation for repair and so on.

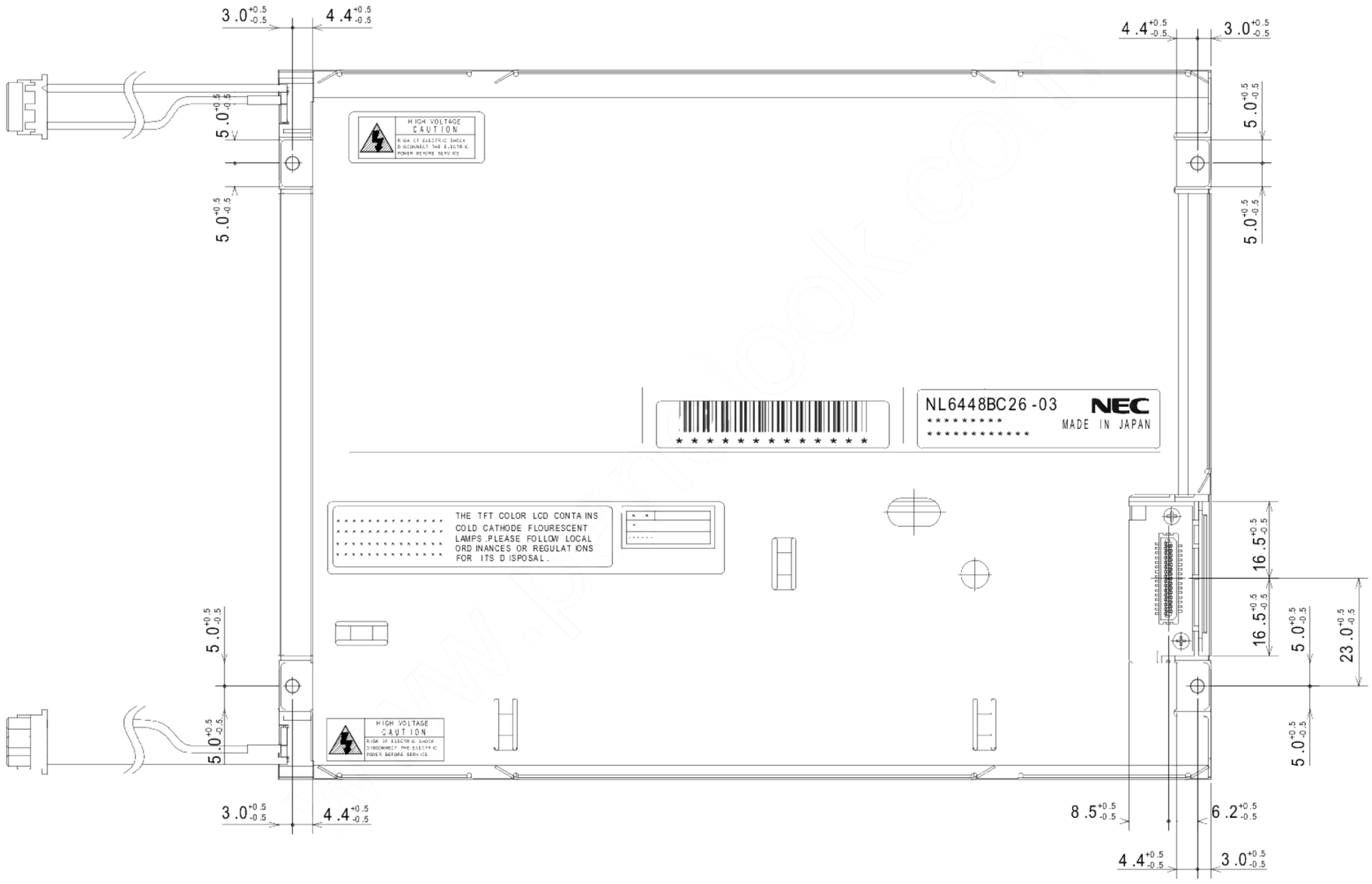
7. OUTLINE DRAWINGS

7.1 FRONT VIEW



Unit: mm

7.2 REAR VIEW



Unit: mm