PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NLB150XG02L-01BA

38cm (15.0 Type)
XGA
LVDS interface (1port)

PRELIMINARY DATA SHEET

DOD-PP-2100 (2nd edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-2027(1)

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INTRODUCTION

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Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

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Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

The **Specific:** Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.
Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NLB150XG02L-01BA 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, touch panel (T/P) and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

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

1.2 APPLICATION

- For industrial use

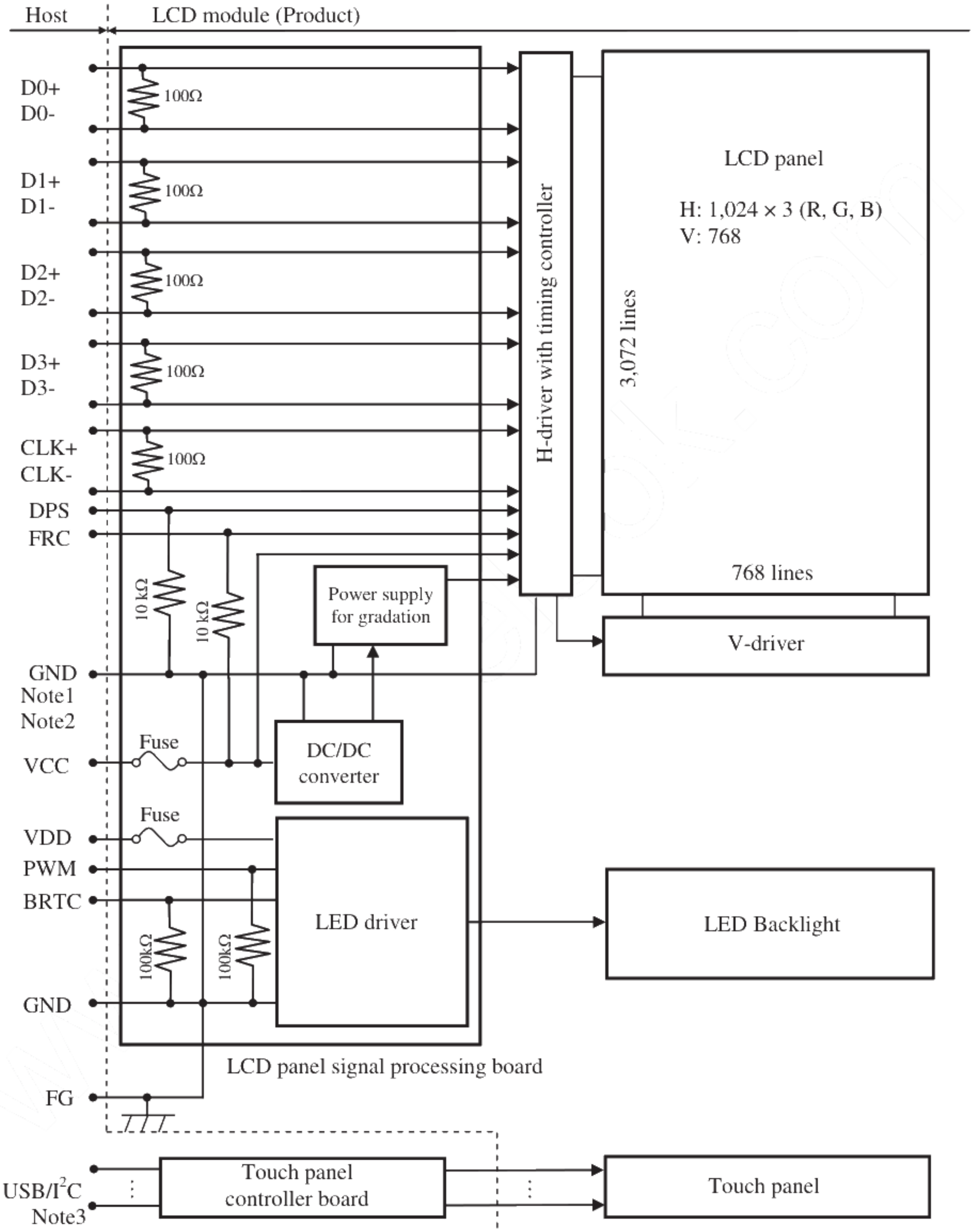
1.3 FEATURES

- Projected capacitive touch panel (PCAP T/P) attached
- Touch panel having cover glass
- High luminance
- High contrast
- Wide viewing angle
- Fast response time
- LVDS interface
- Reversible-scan direction
- Selectable 8-bit or 6-bit digital signals for data of RGB
- Small foot print
- LED backlight built in LED driver
- Replaceable lamp holder for backlight
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

2. GENERAL SPECIFICATIONS

Display area	304.128 (H) × 228.096 (V) mm
Diagonal size of display	38.0cm (15.0 inches)
Drive system	a-Si TFT active matrix
Display color	16,194,277 colors (At 8-bit input, FRC terminal= Low) 262,144 colors (At 6-bit input, FRC terminal= High or Open)
Pixel	1,024 (H) × 768 (V) pixels
Pixel arrangement	BGR (Blue dot, Green dot, Red dot) vertical stripe
Dot pitch	0.099 (H) × 0.297 (V) mm
Pixel pitch	0.297 (H) × 0.297 (V) mm
Module size (Including Touch Panel)	326.5 (W) × 253.5 (H) × (13.4) (D) mm (typ.)
Weight	(1,210) g (typ.)
Contrast ratio	600:1 (typ.)
Viewing angle	*At the contrast ratio ≥10:1* • Horizontal: Right side 80° (typ.), Left side 80° (typ.) • Vertical: Up side 80° (typ.), Down side 80° (typ.)
Designed viewing direction	*At DPS= Low or Open: Normal scan* • Viewing direction without image reversal: Up side (12 o'clock) • Viewing direction with contrast peak: Down side (6 o'clock) • Viewing angle with optimum grayscale (γ≒2.2): Normal axis (perpendicular)
Touch panel type	Projected capacitive (Recommended T/P controller board (Option) • T/P controller board: PTPW04/05)
Touch panel surface	Bare glass
Touch panel pencil-hardness	6H (min.) [by JIS K5600]
Touch panel cover glass	• Thickness: 0.7mm glass
Touch panel bonding method	Perimeter-bonding (with air gap)
Color gamut	*At LCD panel center* 60% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→90%)* 8ms (typ.)
Luminance	*At the maximum luminance control* (350)cd/m^2 (typ.)
Signal system	LVDS 1port
Power supply voltage	LCD panel signal processing board: 3.3V LED driver: 12.0V
Backlight	LED backlight built in LED driver (Replaceable part • Lamp holder set: 150LHS204)
Power consumption	*At the maximum luminance control, Checkered flag pattern* *Driving with the recommended T/P controller board, The number of touch= 10* (7.6)W (typ.)

3. BLOCK DIAGRAM



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

GND- FG	Connected

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

Note3: Refer to the specifications of T/P controller board.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size (Including Touch Panel)	326.5 ± 0.5 (W) × 253.5 ± 0.5 (H) × (13.4) (D)	Note1	mm
Display area	304.128 (H) × 228.096 (V)	Note1	mm
Weight	(1,210) (typ.), (1,330) (max.)		g

Note1: See "**8. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

(Note1)

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board	VCC	(-0.3 to +3.96)	V	Ta= 25°C
	LED driver	VDD	(-0.3 to +15.0)		
Input voltage for signals	Display signals Note2	VD	(-0.5 to 3.96)	V	
	Function signals Note3	VF	(-0.5 to 3.96)		
	Function signal for LED driver	PWM	-0.3 to +5.5	V	
		BRTC	-0.3 to +5.5	V	
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note4
	Rear surface	TopR	-20 to +70	°C	Note5
Relative humidity Note6		RH	≤ 90	%	Ta ≤ 40°C
			≤ 80	%	40°C < Ta ≤ 50°C
Absolute humidity Note6		AH	≤ 66 Note7	g/m^3	Ta > 50°C

Note1: Regarding the driving of T/P, refer to the specifications of T/P controller board.
Note2: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-
Note3: DPS and FRC
Note4: Measured at LCD T/P surface (including self-heat)
Note5: Measured at LCD module's rear shield surface (including self-heat)
Note6: No condensation
Note7: Water amount at Ta= 50°C and RH= 80%

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks	
Power supply voltage		VCC	3.0	3.3	3.6	V	-	
Power supply current		ICC	-	(400) Note1	(780) Note2	mA	at VCC= 3.3V	2
Permissible ripple voltage		VRP	-	-	300	mVp-p	for VCC	
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.25V Note3	
	Low	VTL	-100	-	-	mV		
Terminating resistance		RT	-	100	-	Ω	-	
Input voltage for DPS signal	High	VFH1	0.7VCC	-	VCC	V	-	2
	Low	VFL1	0	-	0.3VCC	V		
Input voltage for FRC signal	High	VFH2	0.7VCC	-	VCC	V		
	Low	VFL2	0	-	0.3VCC	V		
Input current for DPS signal	High	IFH1	-	-	500	µA	-	2
	Low	IFL1	-500	-	-	µA		
Input current for FRC signal	High	IFH2	-	-	500	µA		
	Low	IFL2	-500	-	-	µA		

Note1: Checkered flag pattern [by EIAJ ED-2522]
Note2: Pattern for maximum current
Note3: Common mode voltage for LVDS receiver

4.3.2 LED driver

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	Note1
Power supply current		IDD	-	(480)	(650) Note2	mA	At the maximum luminance control
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD Note3
Input voltage for PWM signal	High	VDFH1	1.3	-	5.5	V	-
	Low	VDFL1	-	-	0.5	V	
Input voltage for BRTC signal	High	VDFH2	1.3	-	5.5	V	-
	Low	VDFL2	0	-	0.5	V	
PWM frequency		f_{PWM}	200	-	20k	Hz	Note4, Note5
PWM duty ratio		DR_{PWM}	1	-	100	%	Note6, Note7
PWM pulse width		tPWH	5	-	-	μs	

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.

Note2: This value excludes peak current such as overshoot current.

Note3: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.

Note4: A recommended f_{PWM} value is as follows.

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

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

Note5: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note6: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than 5μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

Note7: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

4.3.3 Power supply voltage ripple

This product works if the ripple voltage levels are over the permissible values as the following 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	3.3V	≤ 300	mVp-p
VDD	12.0V	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	Note1
VDD	FCC16202AB	KAMAYA ELECTRIC Co., Ltd.	2.0A 36V	4.0A	

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

4.4 TOUCH PANEL SPECIFICATION

(Ta= 25°C, Note1)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Accuracy	Center	Acrc	-	-	1.5	mm	Note2
	Border	Acrb	-	-	2.5		
Number of touch		NUM	1	-	16	Point	-
Minimum distance for dual touch	Horizontal	Tdist H	13.5			mm	Note3
	Vertical	Tdist V	15.5				
Scan speed	Active	Sspd A	-	100	-	Hz	-
	Idle	Sspd I	-	30	-		
Resolution	Horizontal	-	-	-	4,096	-	Note4
	Vertical	-	-	-	4,096	-	
Response area	Horizontal	-	-	306.124	-	mm	Note5
	Vertical	-	-	230.092	-		

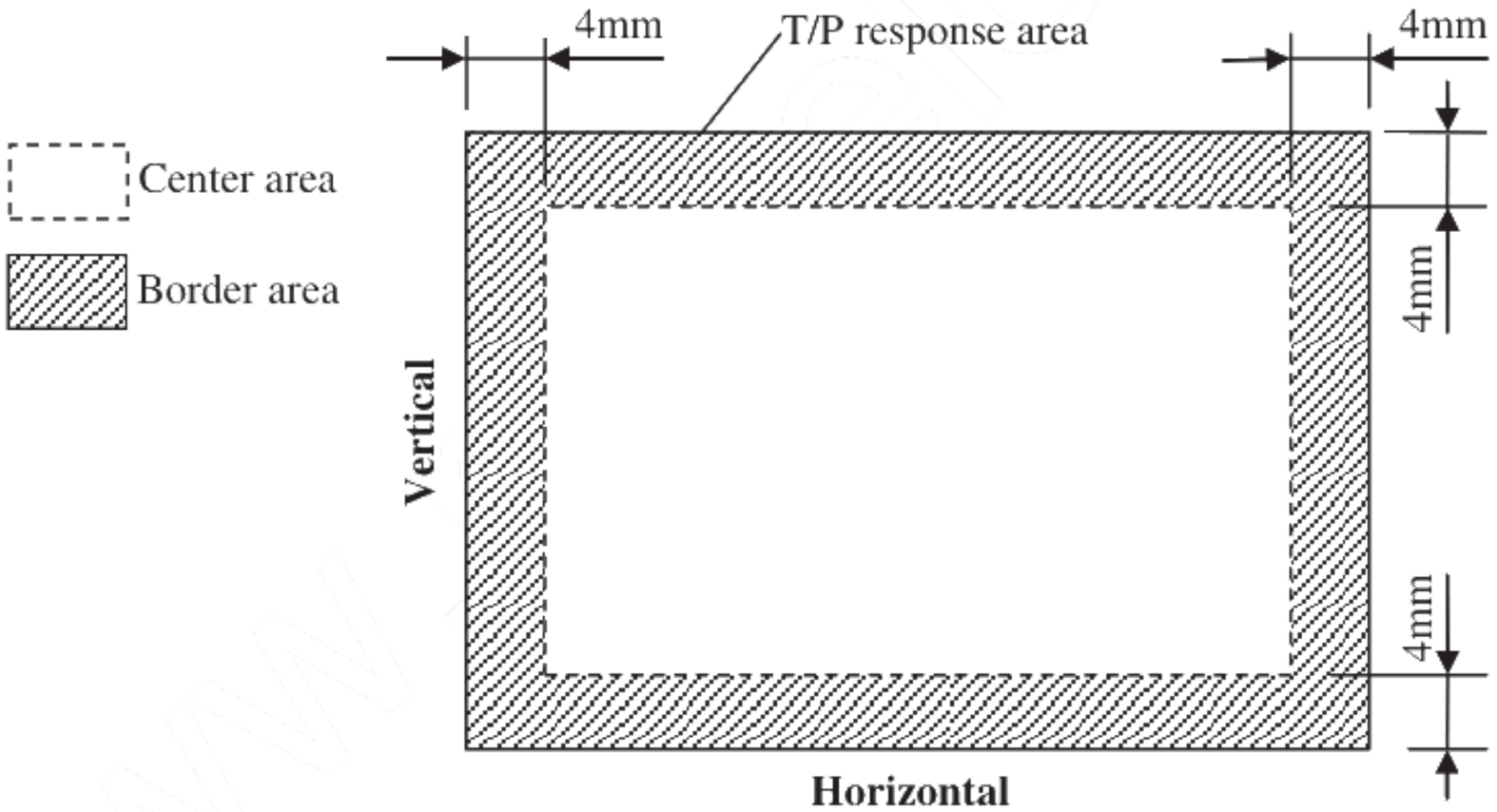
Note1: If a customer uses a recommended touch panel controller board, specifications of the touch panel controller board are given priority over the specifications in this table.

Note2: Definition of accuracy

Accuracy shows a difference between an ideal position and an actual position.

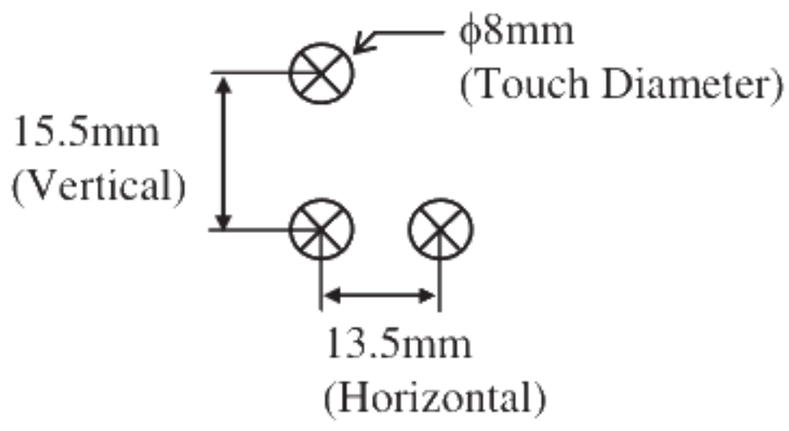
Acrc: Accuracy at center area

Acrb: Accuracy at border area



Input method is ϕ8mm conductive stylus.

Note3: Minimum distance for dual touch

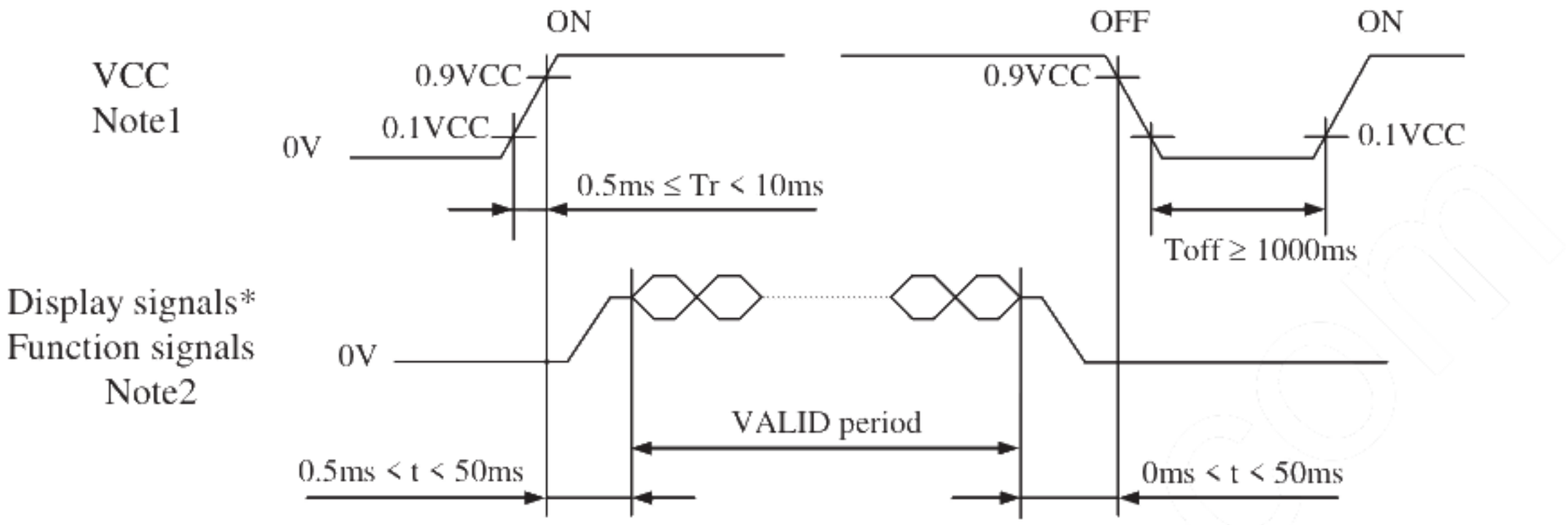


Note4: When using the recommended T/P controller board

Note5: The center point of the T/P response area and the center point of the display area are arranged at the same position.

4.5 POWER SUPPLY VOLTAGE SEQUENCE

4.5.1 LCD panel signal processing board

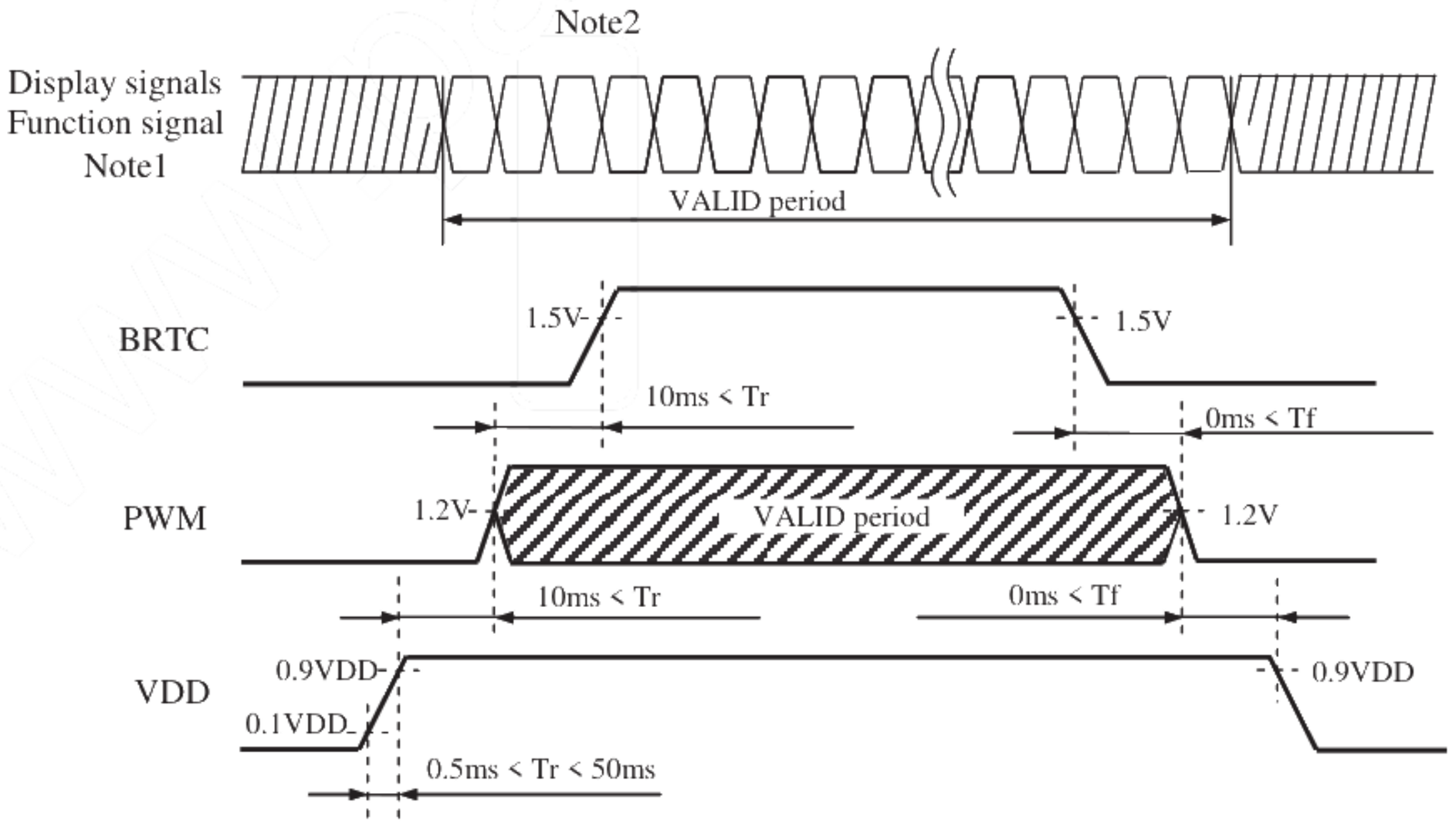


* These signals should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-) and function signals (DPS and FRC) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.
If some of display 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 a customer stops the display and function signals, VCC also must be shut down.

4.5.2 LED driver



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

Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

4.6 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.6.1 LCD panel signal processing board

CN1 socket (LCD module side): 185083-20121 (P-TWO ELECTRIC TECHNOLOGY CO., LTD.)
Adaptable plug: DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbol	Signal	Input data signal: 8-bit	Input data signal: 6-bit	Remarks
1	VCC	Power supply	Power supply		Note2
2	VCC				
3	GND	Ground	Ground		Note2
4	DPS	Selection of scan direction	High: Reverse scan Low or Open: Normal scan		Note3
5	D0-	Pixel data	R0-R5, G0		Note1
6	D0+				
7	GND	Ground	Ground		Note2
8	D1-	Pixel data	G1-G5, B0-B1		Note1
9	D1+				
10	GND	Ground	Ground		Note2
11	D2-	Pixel data	B2-B5, DE		Note1
12	D2+				
13	GND	Ground	Ground		Note2
14	CLK-	Pixel clock	Pixel clock		Note1
15	CLK+				
16	GND	Ground	Ground		Note2
17	D3- / GND	Pixel data / Ground	R6-R7 G6-G7 B6-B7	Ground	Note1
18	D3+ / GND				
19	N. C.	Non connection	-		Keep this pin Open
20	FRC	Selection of the number of colors	Low	High or Open	-

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note2: All GND and VCC terminals should be used without any non-connected lines.
Note3: See "**4.9 SCANNING DIRECTIONS**".

4.6.2 LED driver

CN2 socket (LCD module side): MSB24038P5 (STM)
Adaptable plug: P24038P5 (STM) or 51146-0500 (Molex)

Pin No.	Symbol	Signal	Remarks
1	N. C.	Non connection	Keep this pin Open.
2	PWM	Luminance control	PWM Dimming
3	BRTC	Backlight ON/OFF control	High: ON / Low or Open: OFF
4	GND	Ground	-
5	VDD	Power supply	-

2

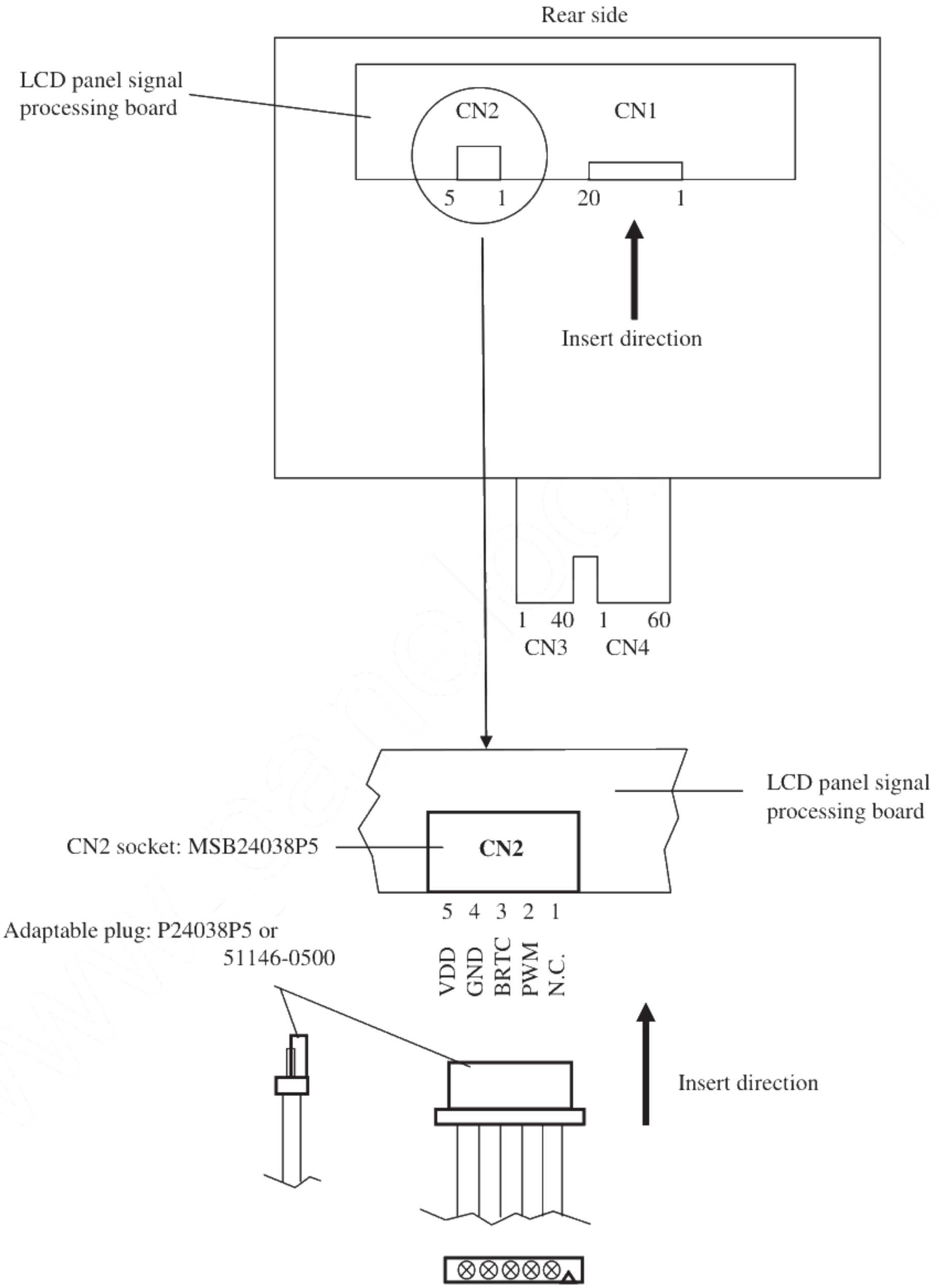
4.6.3 Touch panel

Connect CN3 and CN4 to the sockets of the T/P controller board.

CN3: FPC (40 pins)
Adaptable socket: FH28-40S-0.5SH(05) (Hirose Electric Co., Ltd.(HRS))

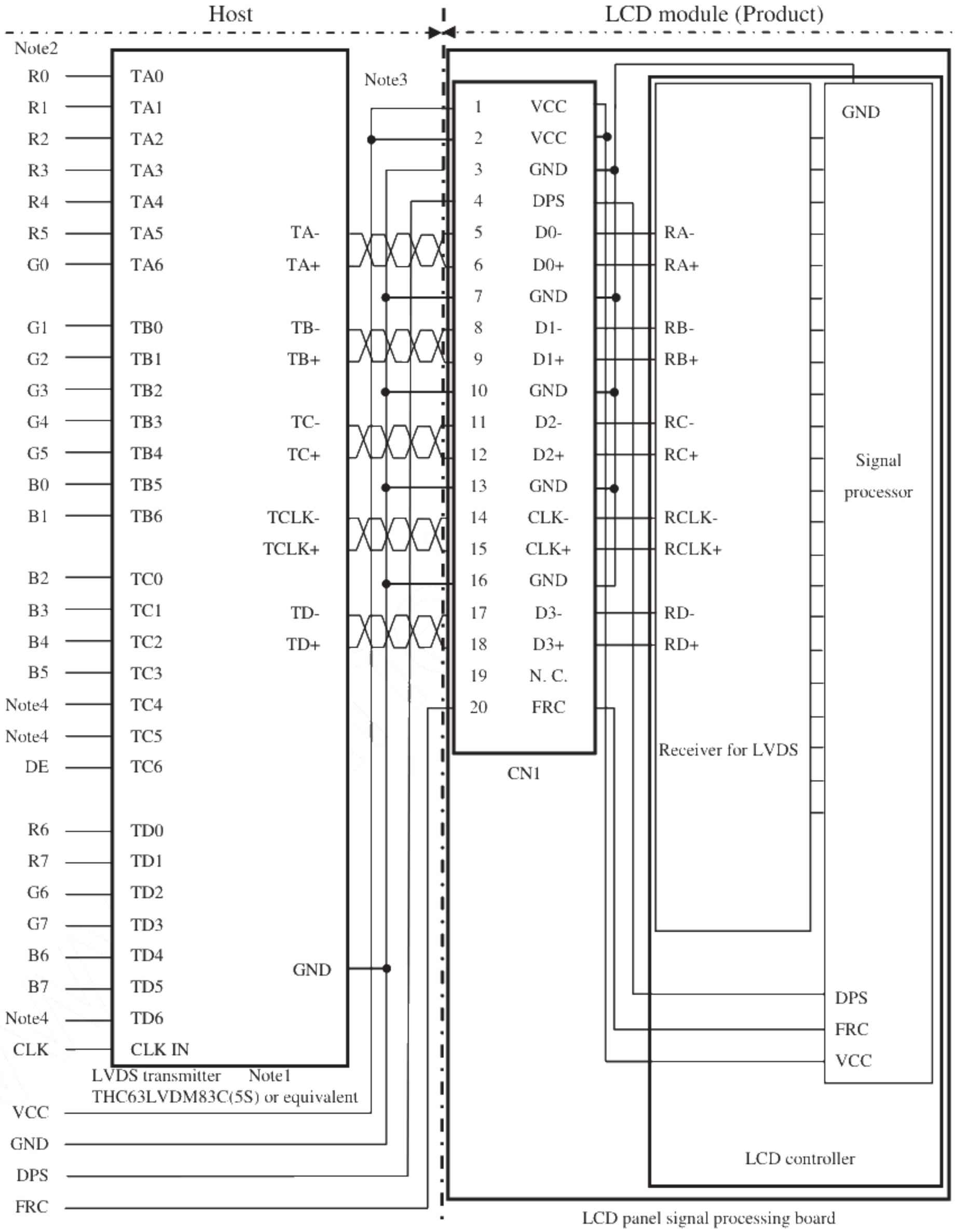
CN4: FPC (60 pins)
Adaptable socket: FH28-60S-0.5SH(05) (Hirose Electric Co., Ltd.(HRS))

4.6.4 Positions of socket



4.6.5 Connection between receiver and transmitter for LVDS

(1) LVDS Input data signal: 8-bit (FRC: Low)



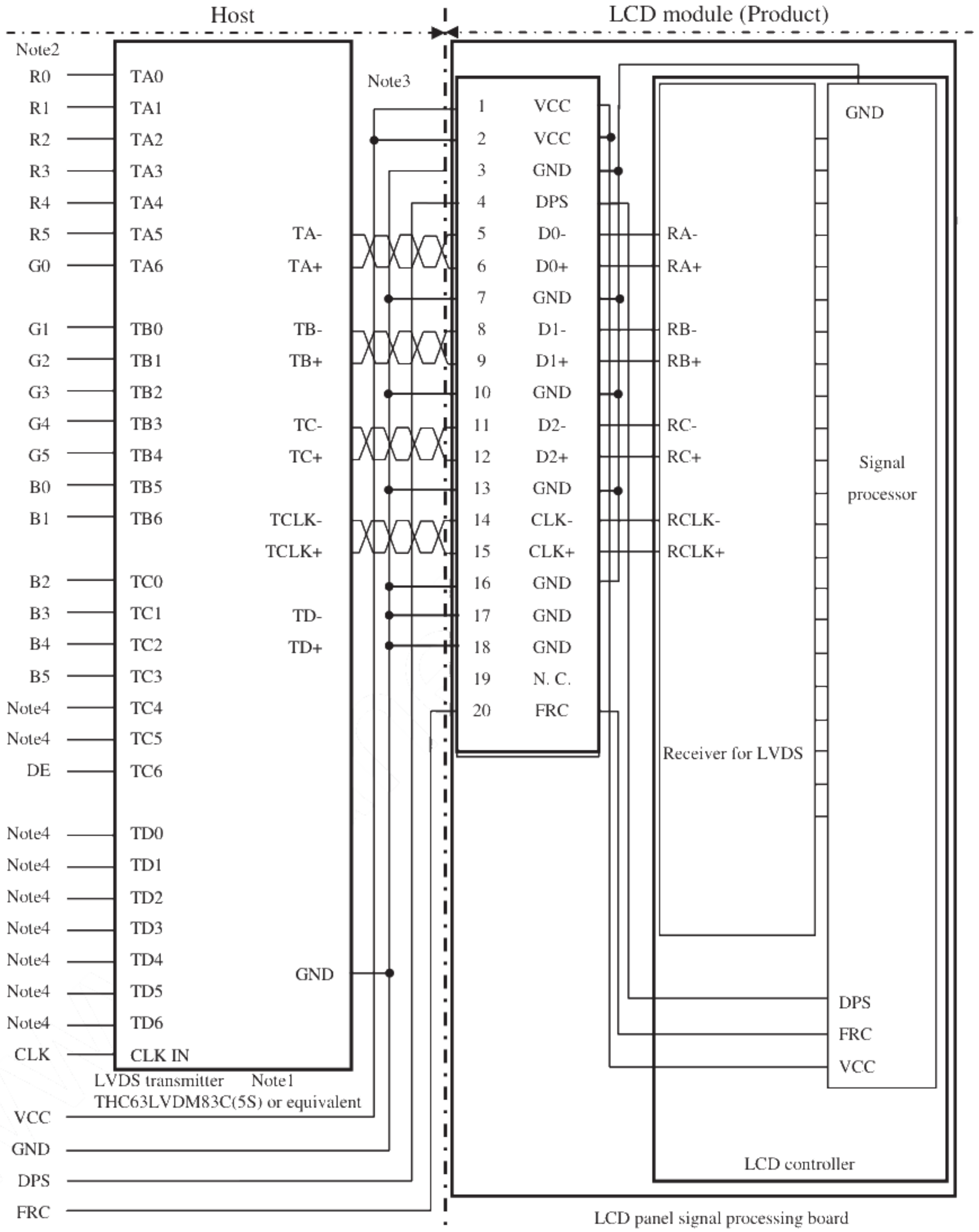
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent.

Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R7, G7, B7

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

Note4: Input signals to TC4, TC5 and TD6 are not used inside the product, but do not keep them open to avoid noise problem.

(2) LVDS Input data signal: 6-bit (FRC: High or Open)



Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent.

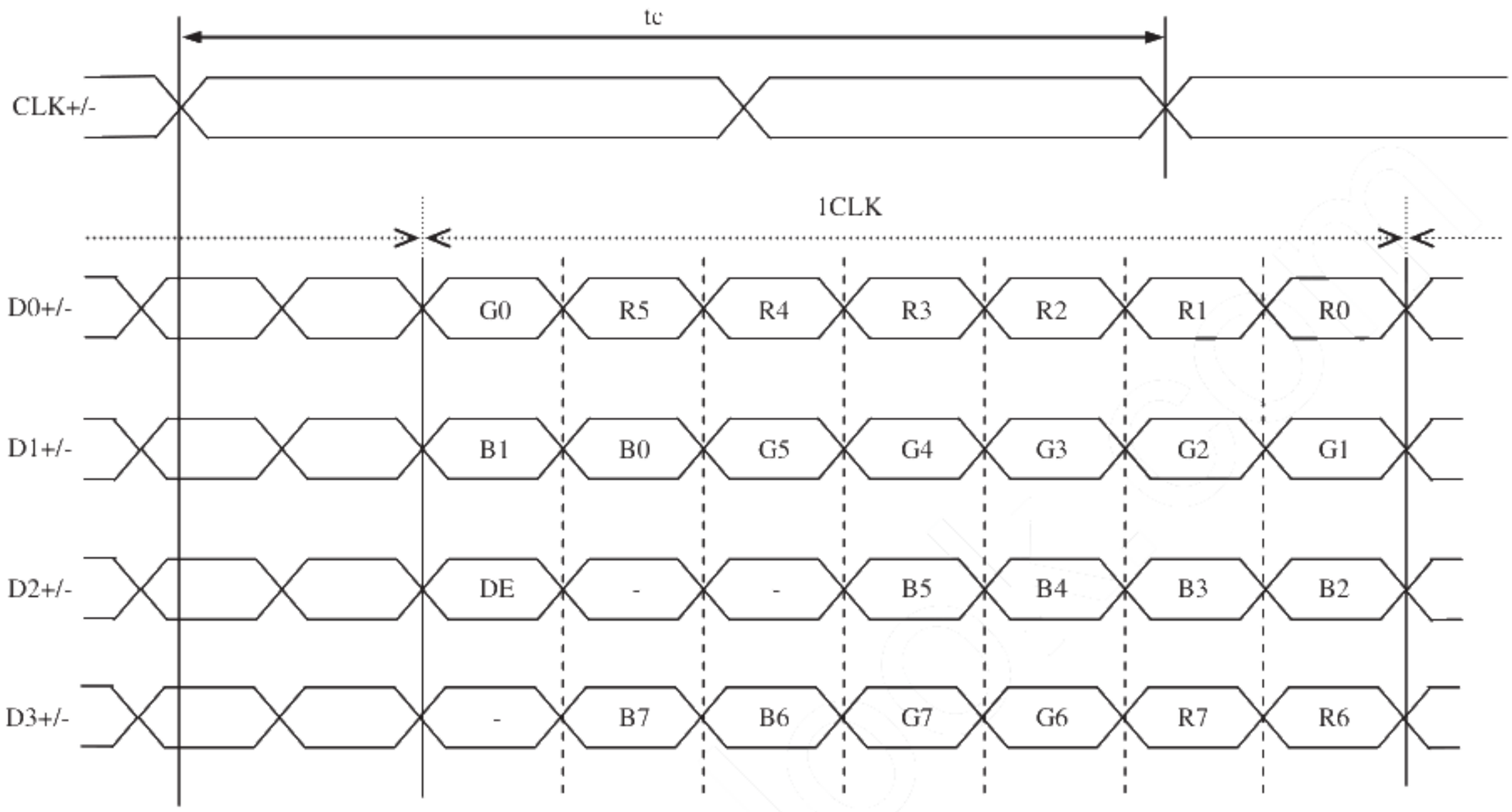
Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R5, G5, B5

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

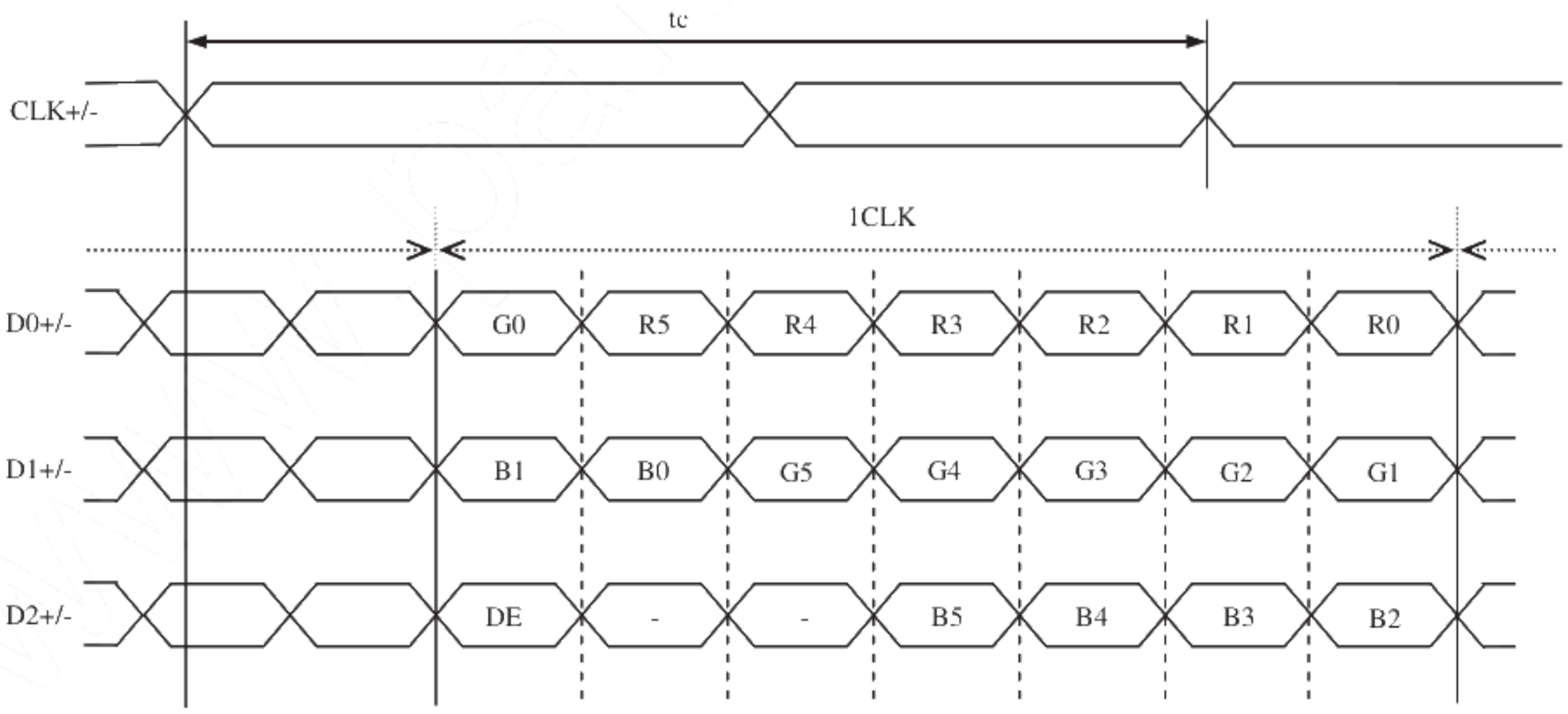
Note4: Input signals to TC4, TC5 and TD0-6 are not used inside the product, but do not keep them open to avoid noise problem.

4.6.6 Input data mapping

(1) LVDS Input data signal: 8-bit



(2) LVDS Input data signal: 6-bit



4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

4.7.1 Combinations of input data signals and FRC signal

This product can display 16,194,277 colors with 253 gray scales and 262,144 colors with 64 gray scales by combination of input data signals and FRC signal. See the following table.

Combination	Input data signals	CN1- Pin No.17 and 18	FRC terminal	Display colors	Remarks
①	8-bit	D3+/-	Low	16,194,277	Note1
②	6-bit	GND	High or Open	262,144	Note2

Note1: See "**4.7.2 16,194,277 colors**".
Note2: See "**4.7.3 262,144 colors**".

4.7.2 16,194,277 colors

This product can display 16,194,277 colors with 253 gray scales by combination ①.
(See "**4.7.1 Combinations of input data signals and FRC signal**".)
Also the relation between display colors and input data signals is as follows.

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 gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑					:							:									:			
	↓					:							:									:			
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑					:							:									:			
	↓					:							:									:			
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑					:							:									:			
	↓					:							:									:			
	bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

4.7.3 262,144 colors

This product can display 262,144 colors with 64 gray scales by combination ②.
(See "**4.7.1 Combinations of input data signals and FRC signal**".)
Also the relation between display colors and input data signals is as follows.

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

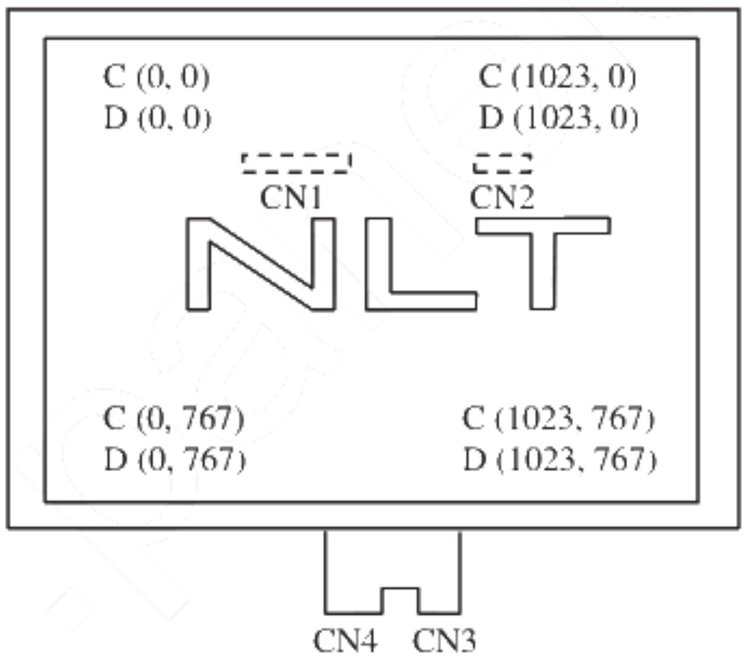
4.8 DISPLAY POSITIONS

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

C (0, 0)						
B	G	R				
C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(1022, 0)	C(1023, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(1022, 1)	C(1023, 1)
•	•	•	•	•	•	•
•	•	• • •	•	• • •	•	• • •
•	•	•	•	•	•	•
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(1022, Y)	C(1023, Y)
•	•	•	•	•	•	•
•	•	• • •	•	• • •	•	•
•	•	•	•	•	•	•
C(0, 766)	C(1, 766)	• • •	C(X, 766)	• • •	C(1022, 766)	C(1023, 766)
C(0, 767)	C(1, 767)	• • •	C(X, 767)	• • •	C(1022, 767)	C(1023, 767)

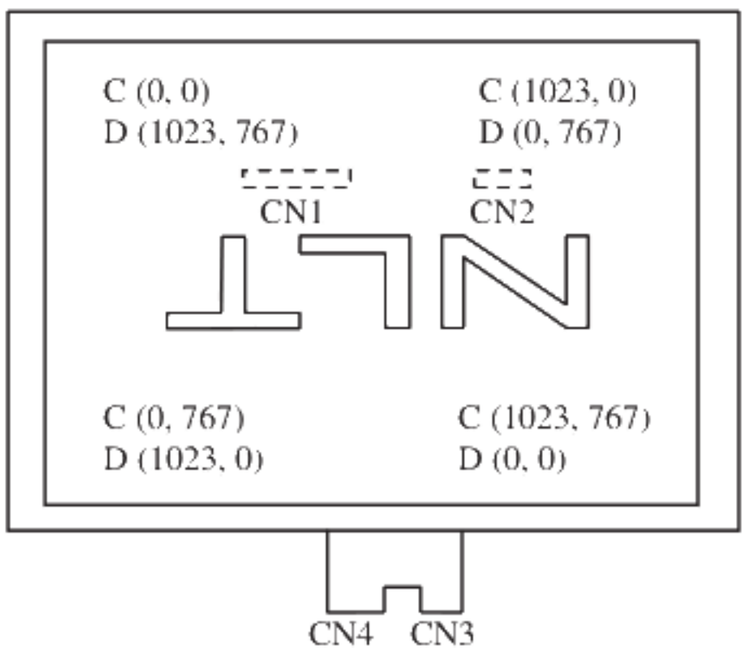
4.9 SCANNING DIRECTIONS

The following figures are seen from a front view.



Note1

Figure1. Normal scan (DPS: Low or Open)



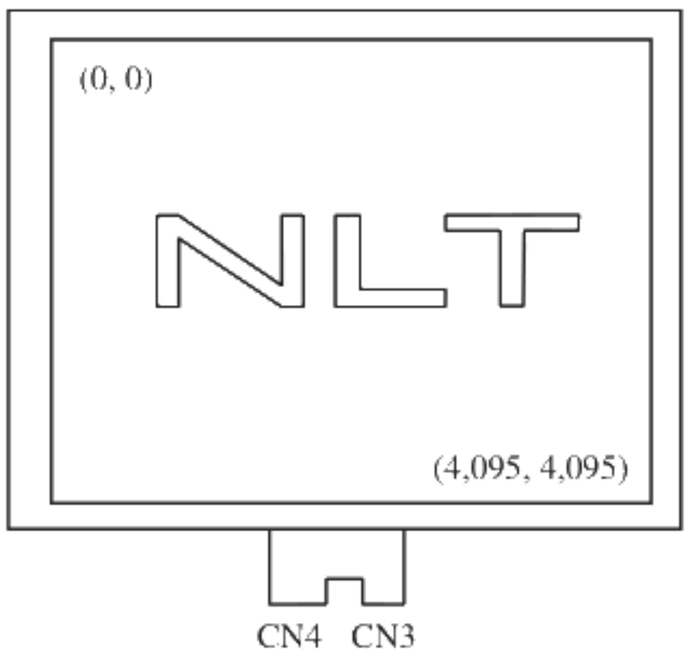
Note1

Figure2. Reverse scan (DPS: High)

Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "**4.8 DISPLAY POSITIONS**".)
D (X, Y): The data number of input signal for LCD panel signal processing board

4.10 TOUCH PANEL POSITIONS

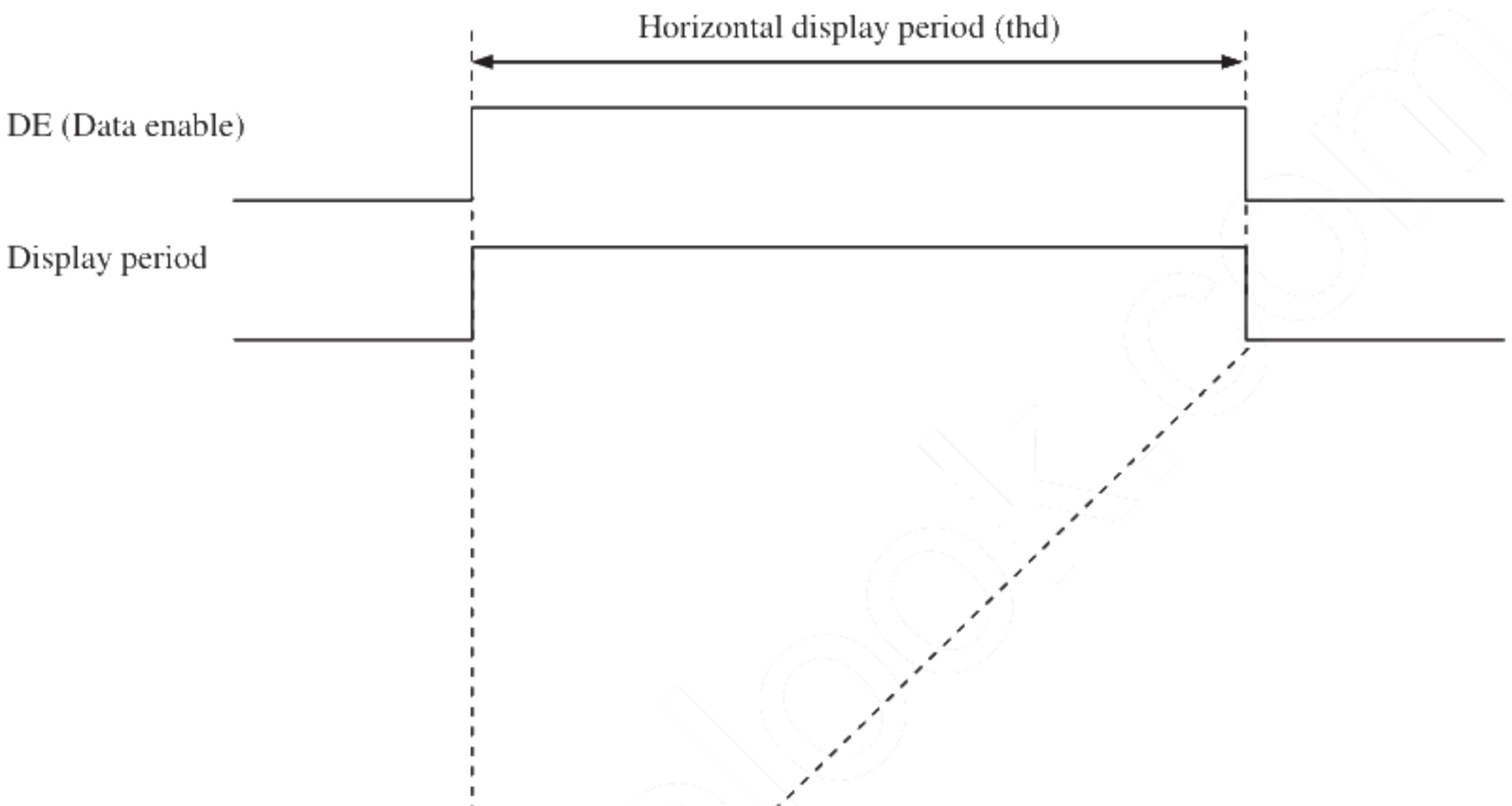
The following figure is the coordinates of the T/P from the front view.



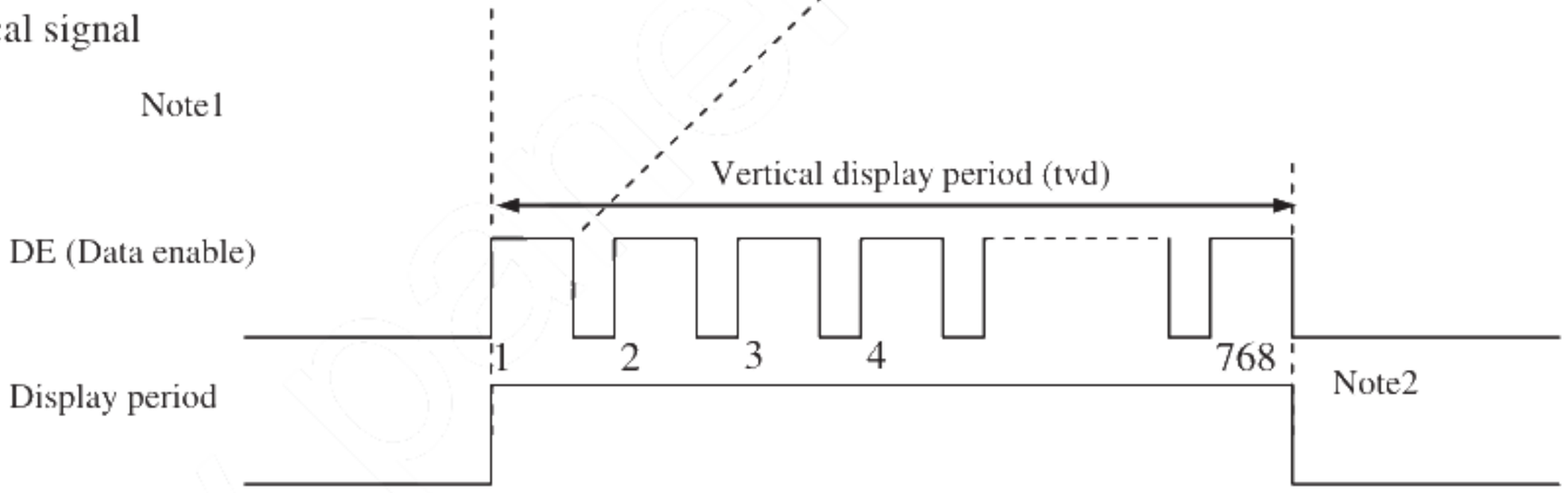
4.11 INPUT SIGNAL TIMINGS

4.11.1 Outline of input signal timings

• Horizontal signal



• Vertical signal



Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.11.3 Input signal timing chart**" for the pulse number.

4.11.2 Timing characteristics

(Note1, Note2, Note3)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	52.0	65.0	71.0	MHz	15.385ns (typ.)
	Duty ratio		-	-			-	-
	Rise time, Fall time		-				ns	
DATA	CLK-DATA	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	16.542	20.676	26.88	μs	48.363kHz (typ.)
				1,114	1,344	1,400	CLK	
		Display period	thd	1024			CLK	-
	Vertical (One frame)	Cycle	tv	13.34	16.666	20.0	ms	60.0Hz (typ.)
				780	806	845	H	
		Display period	tvd	768			H	-
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

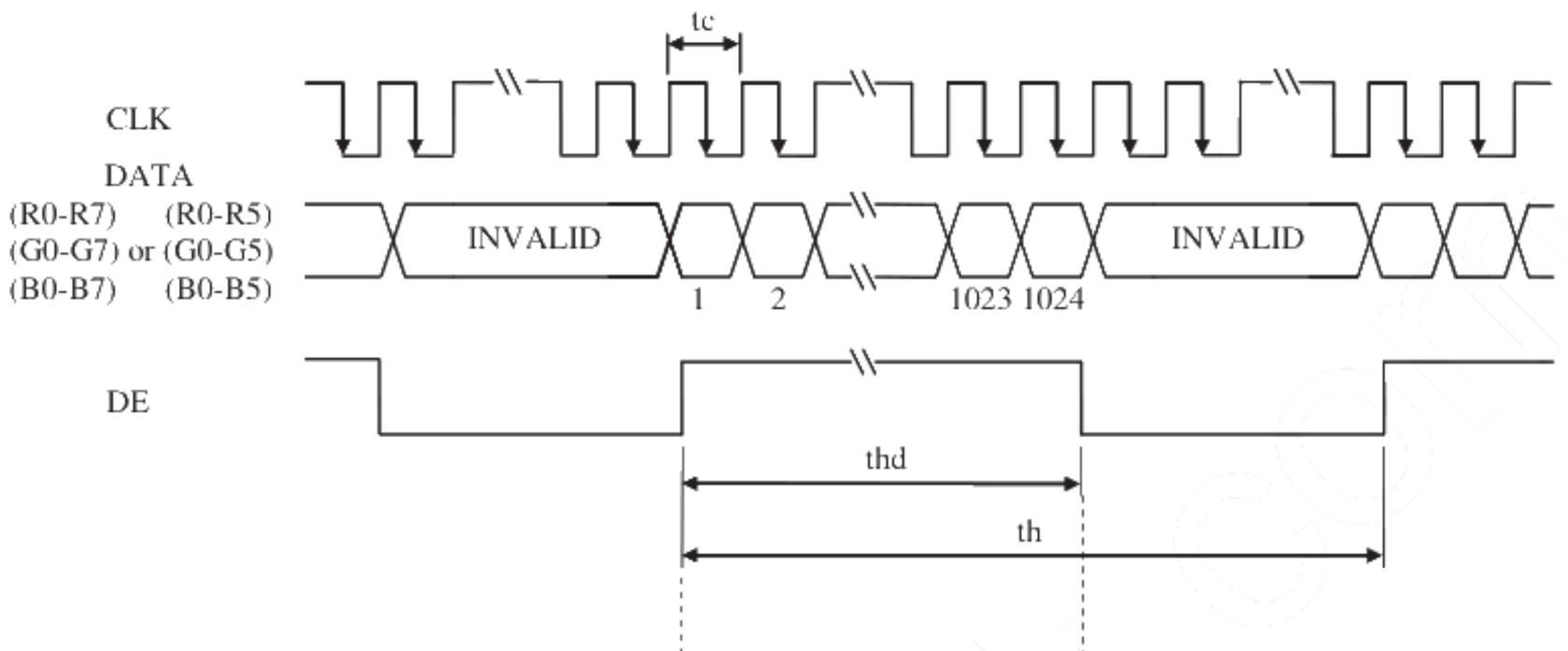
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

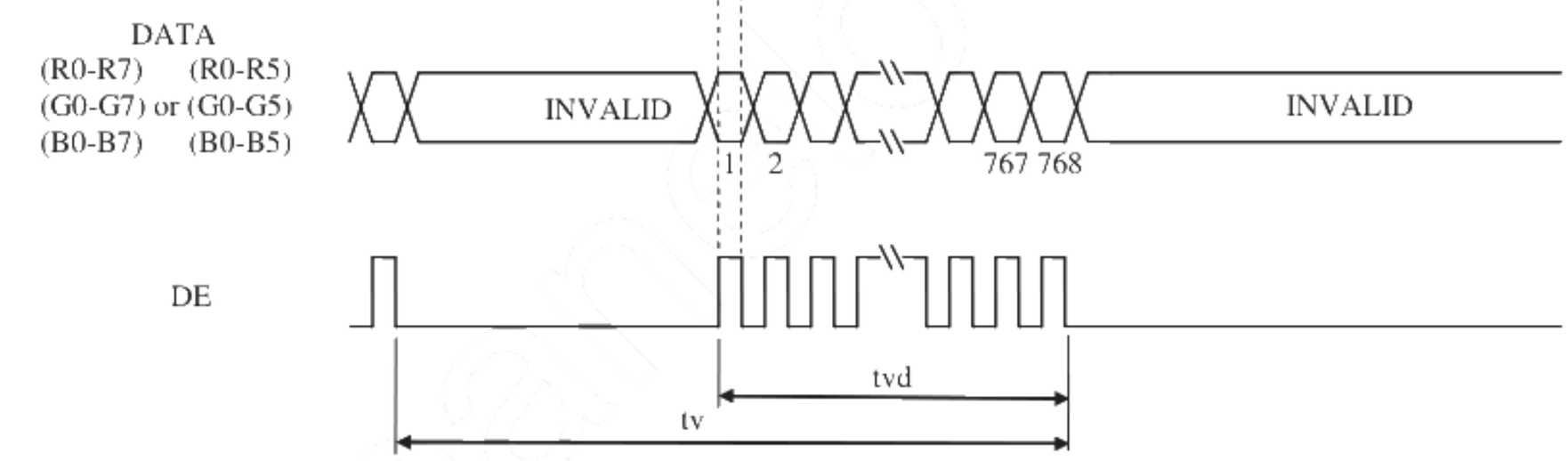
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.11.3 Input signal timing chart

Horizontal timing



Vertical timing



4.12 OPTICS

4.12.1 Optical characteristics

(Note1, Note2)

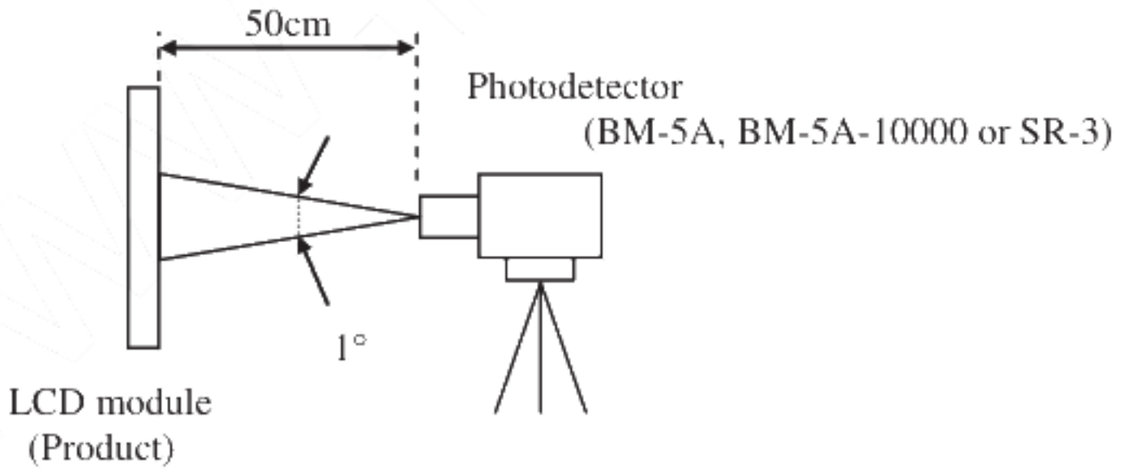
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	(230)	(350)	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	400	600	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	1.33	-	BM-5A	Note4
Chromaticity	White	**x** coordinate	Wx	0.263	0.313	0.363	-	SR-3	Note5
		y coordinate	Wy	0.279	0.329	0.379	-		
	Red	**x** coordinate	Rx	-	(0.615)	-	-		
		y coordinate	Ry	-	(0.337)	-	-		
	Green	**x** coordinate	Gx	-	(0.334)	-	-		
		y coordinate	Gy	-	(0.608)	-	-		
	Blue	**x** coordinate	Bx	-	(0.157)	-	-		
		y coordinate	By	-	(0.080)	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	55	60	-	%		
Response time		White to Black	Ton	-	3	5	ms	BM-5A -10000	Note6 Note7
		Black to White	Toff	-	5	8	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	80	-	°	EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	80	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	80	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	80	-	°		

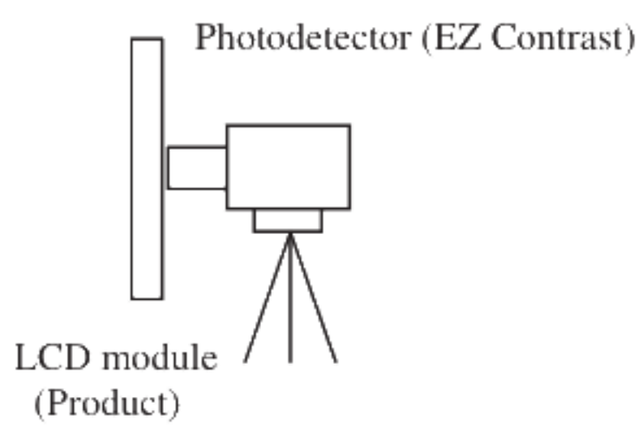
Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 3.3V, VDD= 12.0V, PWM duty ratio: 100%,
Display mode: XGA, Horizontal cycle= 1/48.363kHz, Vertical cycle= 1/60.0Hz,
DPS= Low or Open: Normal scan, FRC=Low (8-bit mode)

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





Note3: See "**4.12.2 Definition of contrast ratio**".

Note4: See "**4.12.3 Definition of luminance uniformity**".

Note5: These coordinates are found on CIE 1931 chromaticity diagram.

Note6: Product surface temperature: TopF= 29 °C

Note7: See "**4.12.4 Definition of response times**".

Note8: See "**4.12.5 Definition of viewing angles**".

4.12.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

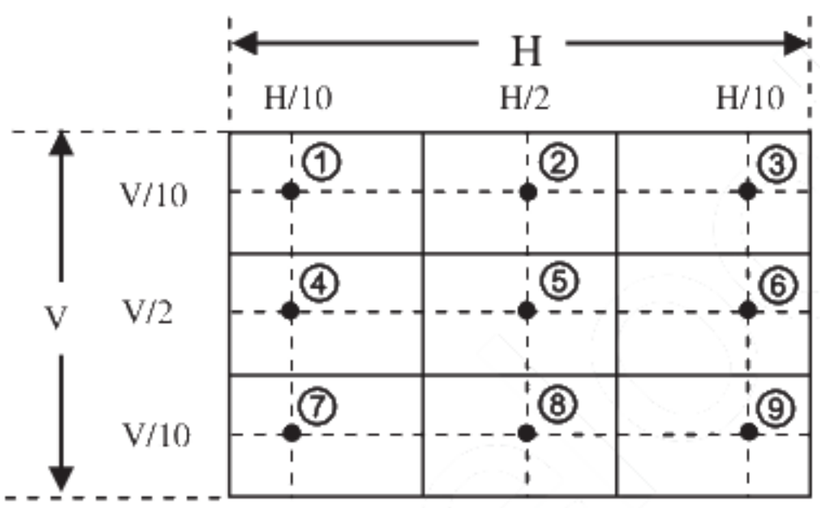
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.12.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

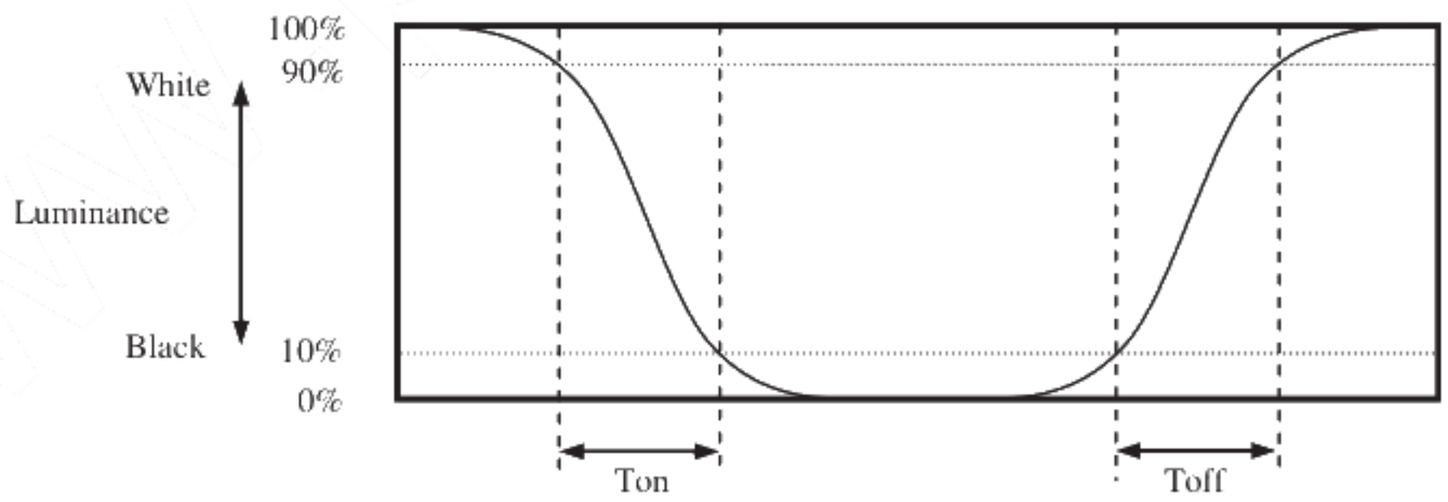
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑨}}{\text{Minimum luminance from ① to ⑨}}$$

The luminance is measured at near the 9 points shown below.

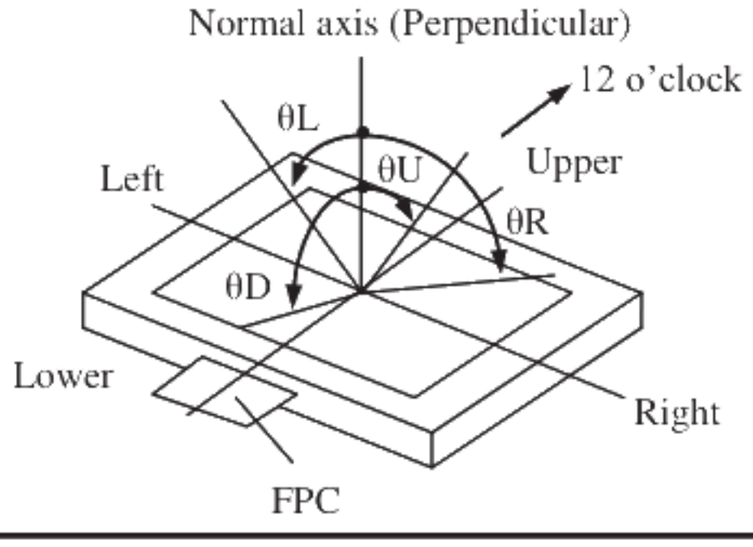


4.12.4 Definition of response times

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



4.12.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio: 100%	50,000	h

Note1: Life time expectancy is mean time to half-luminance.

Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.

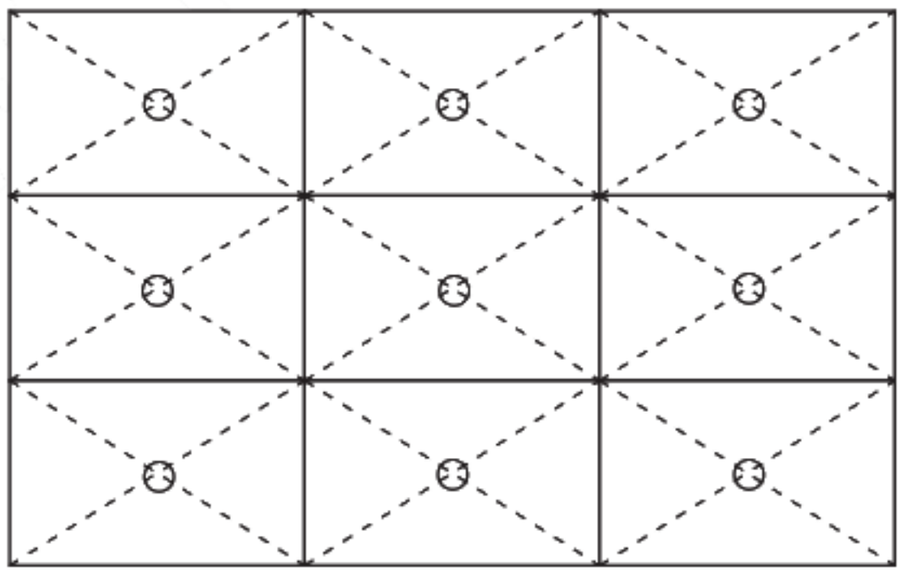
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① 50 ± 2°C, RH= 80%, 300hours ② Display data is black.	No display malfunctions	
High temperature (Operation)	① 70 ± 3°C, 300hours ② Display data is black.		
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.		
ESD (Operation)	Contact Discharge ① 150pF, 330Ω, ±8kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval Air Discharge ① 150pF, 330Ω, ±15kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval		
Vibration (Non operation)	① 5 to 100Hz, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 50 times each directions	No display malfunctions No physical damages	
Mechanical shock (Non operation)	① 294m/s^2, 11ms ② ±X, ±Y, ±Z directions ③ 3 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.



7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**

⚠	This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.

✋	This sign has the meaning that a customer will be injured if the customer practices wrong operations.

7.2 CAUTIONS

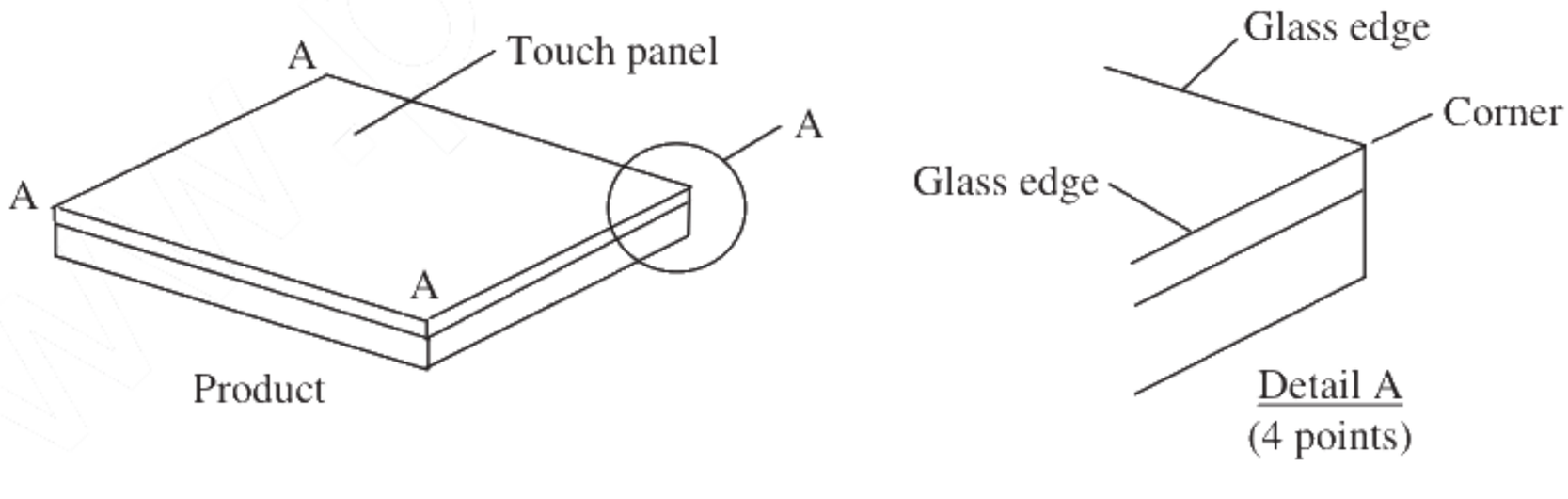
✋

- *** Be taken care when handling the T/P. There is a danger of injury, because the T/P has the glass edge and corner which are sharp.**
- *** Do not shock and press the LCD panel, T/P and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than 294m/s^2 and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N (ϕ16mm jig))**

7.3 ATTENTIONS ⚠

7.3.1 Handling of the product

① Use gloves or fingerstalls and do not touch glass edge of T/P when handling it, because it has sharp glass edge.



② Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
③ Do not hook or pull FPC in order to avoid any damage.
④ When the product is put on the table temporarily, display surface must be placed downward.
⑤ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
⑥ The torque for product mounting screws must never exceed 0.392 N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 4.5 mm.
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). Bends or twist described above and undue stress to any portion may cause display mura.

⑧ Do not hit or rub the surface of T/P with hard materials, because it is easily scratched.
⑨ When cleaning the T/P surface, wipe it with a soft dry cloth.
⑩ Do not press or rub on the sensitive product surface.
⑪ Do not push or pull the interface connectors while the product is working.
⑫ When handling the product, use of an original protection sheet on the product surface is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the T/P surface.
⑬ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.
⑭ When tuning on the power of the T/P do not touch T/P surface with any conductive materials such as finger and so on. It may cause malfunction of the T/P.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
③ Do not operate in high magnetic field. If not, circuit boards may be broken.
④ This product is not designed as radiation hardened.

7.3.3 Characteristics

The following items are neither defects nor failures.

① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
⑤ Optical characteristics may be changed depending on input signal timings.
⑥ If the product is subjected to direct sunlight for a long time, T/P transmission may be degraded.

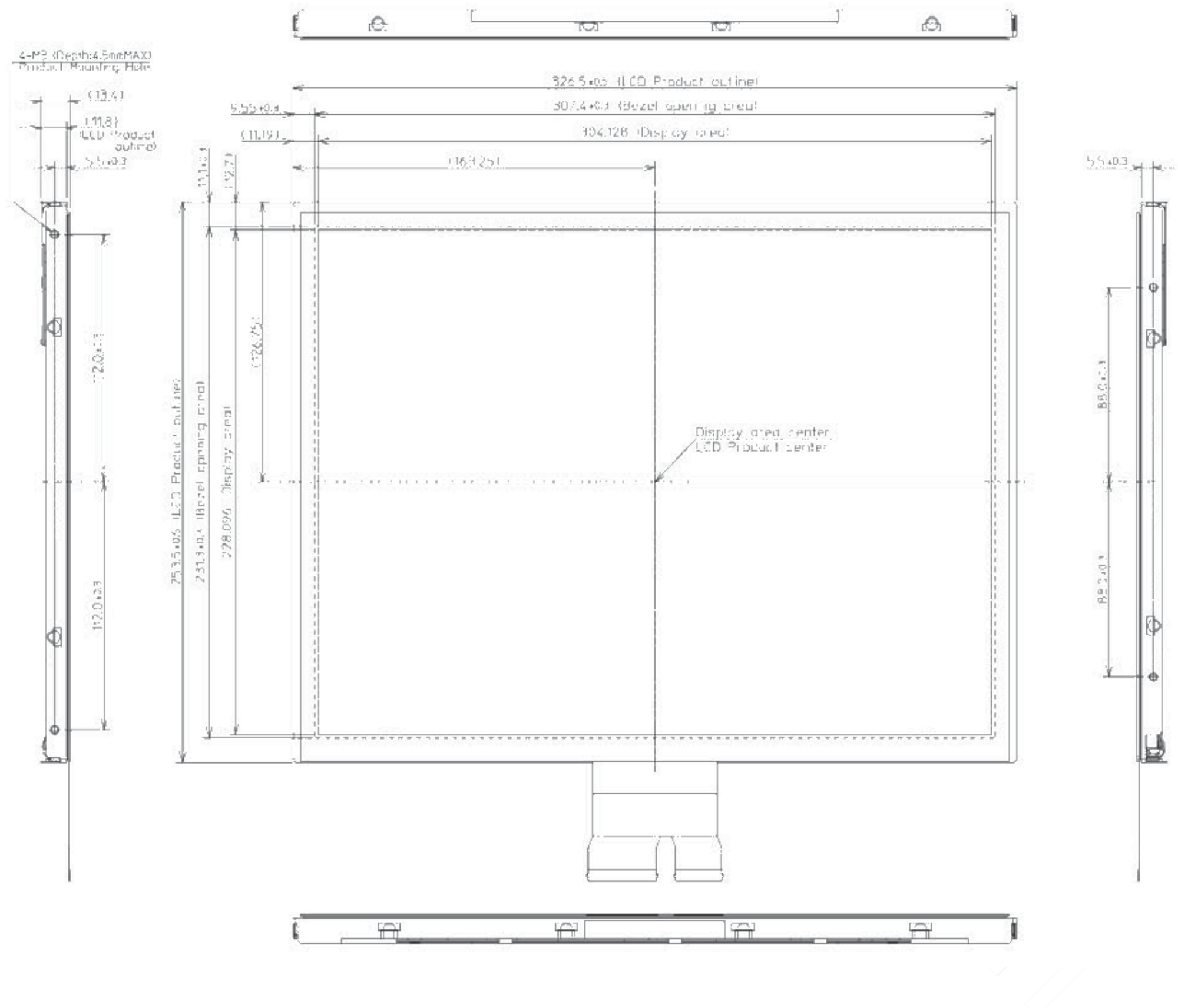
7.3.4 Others

① All GND, VCC and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing lamp holder set.
④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.

2

8. OUTLINE DRAWINGS

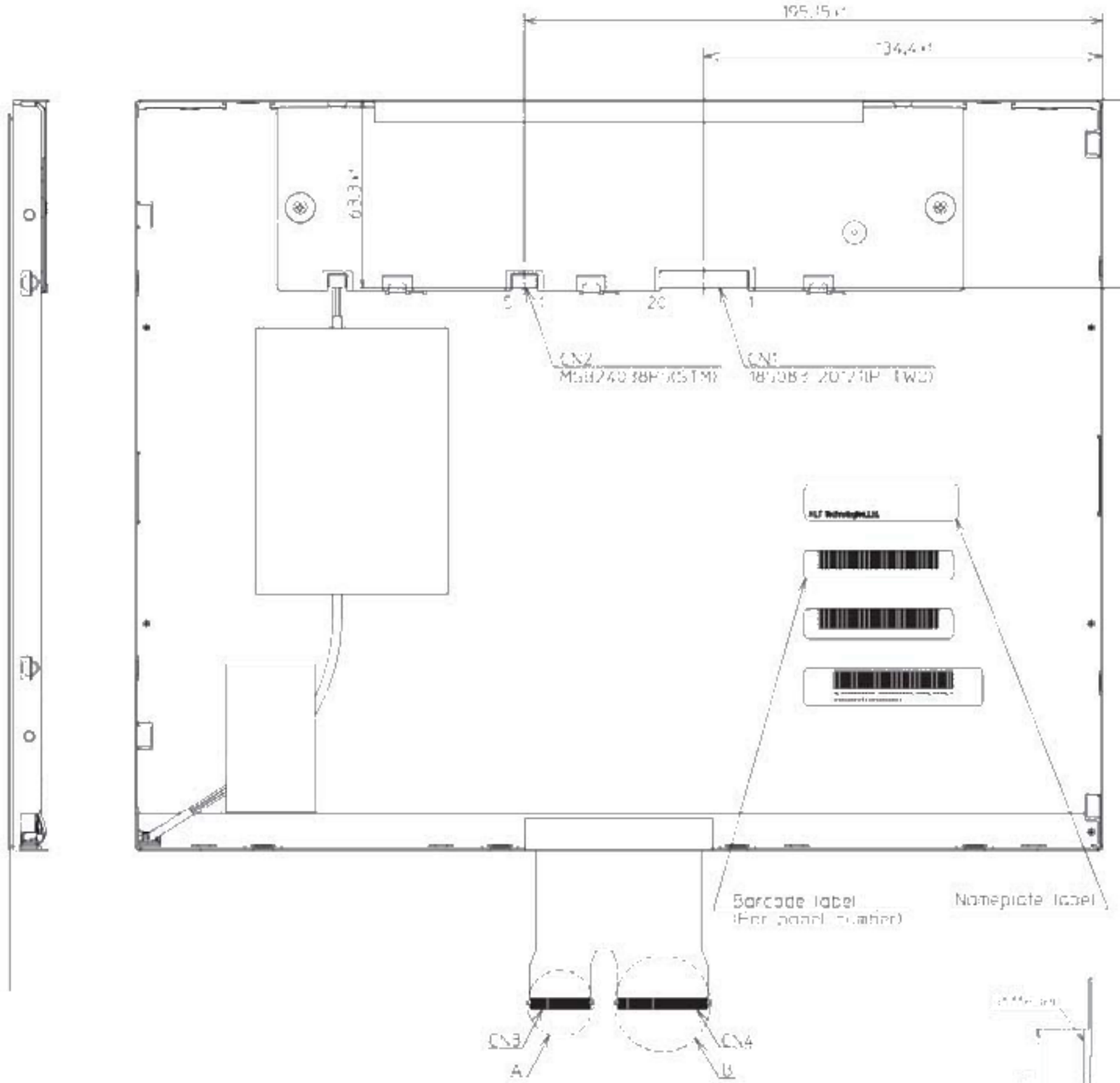
8.1 FRONT VIEW

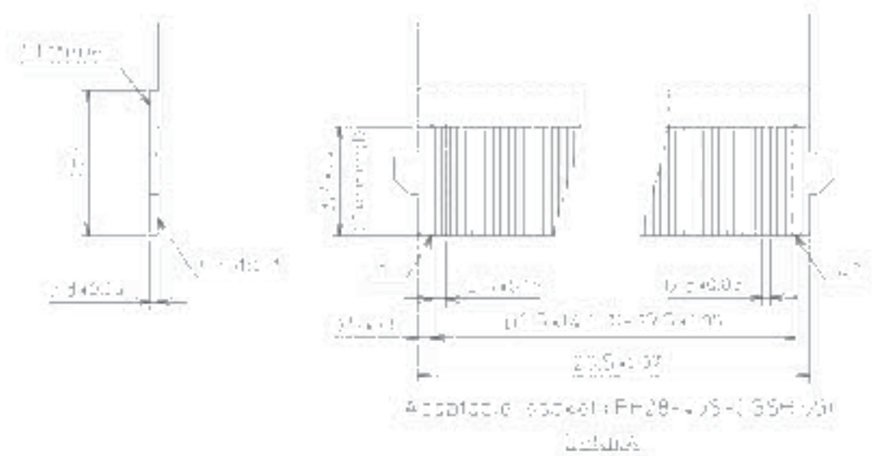


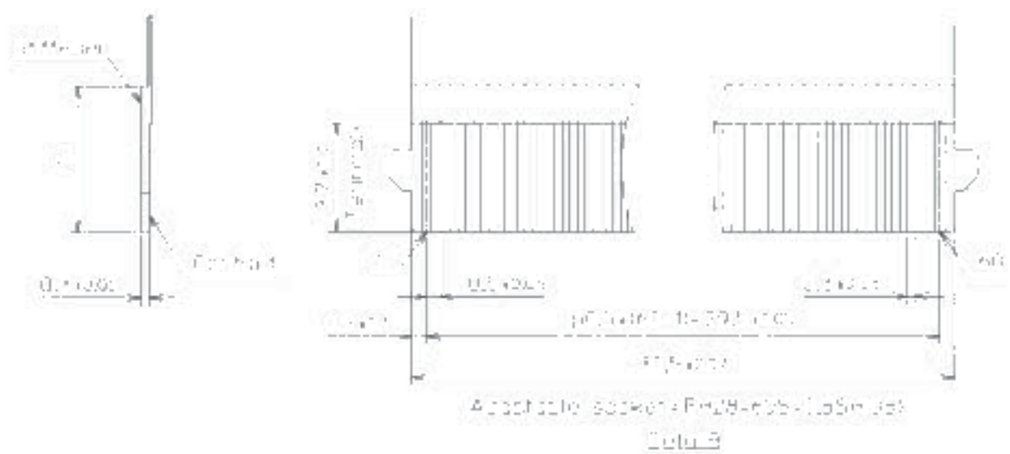
Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.392N·m. And the length of product mounting screws must be ≤ 4.5 mm.

Unit: mm

8.2 REAR VIEW



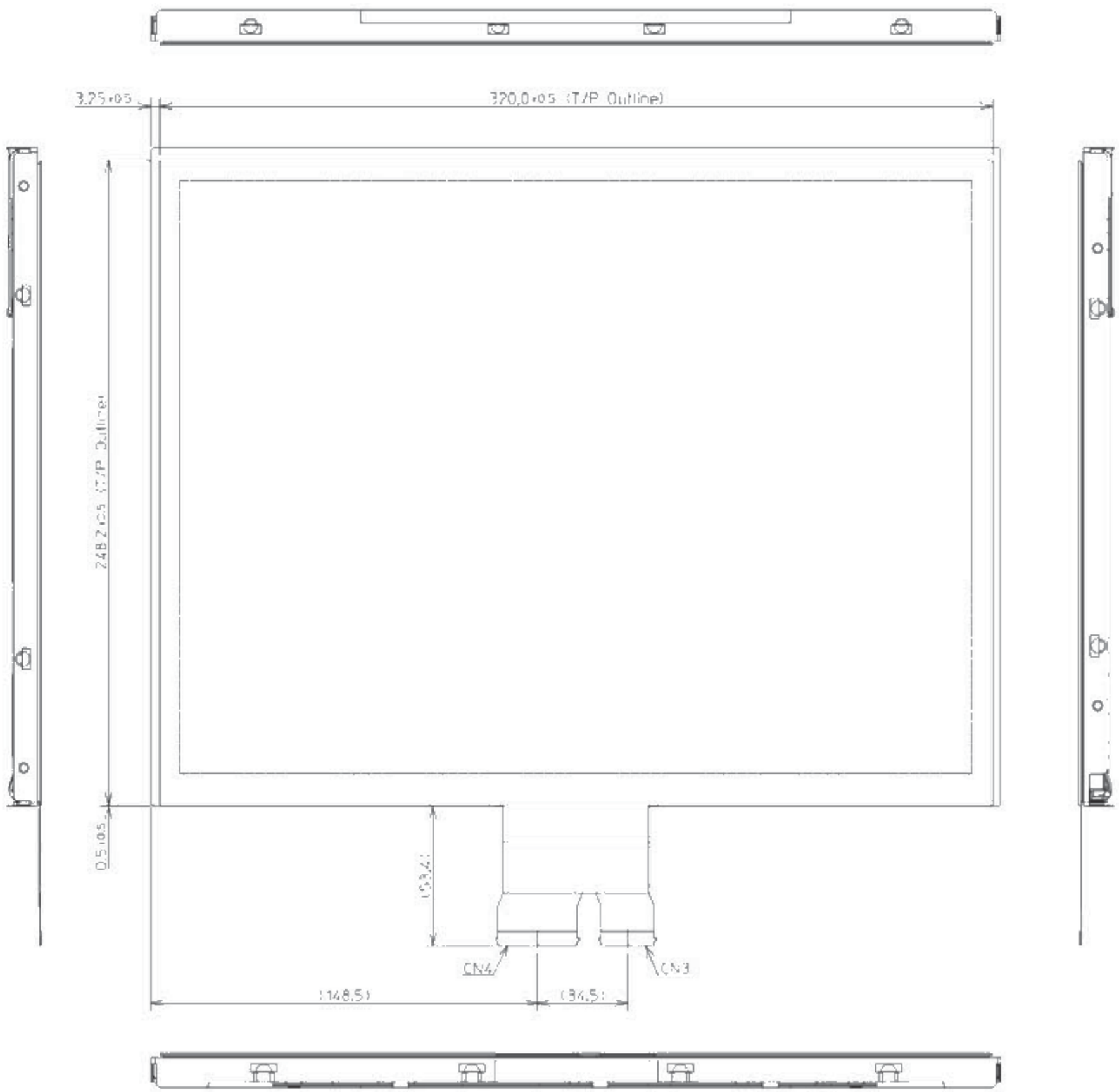




Unit: mm

Note1: The values in parentheses are for reference.

8.3 TOUCH PANEL



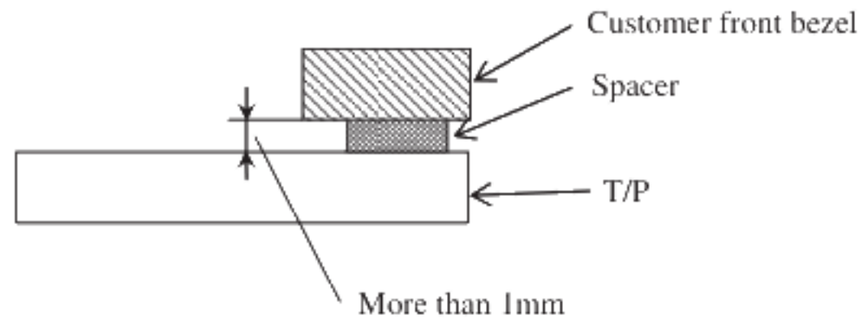
Note1: The values in parentheses are for reference.

INSTALL GUIDANCE

1. Bezel mounting

If a customer put a front bezel on the T/P, please take care the following items.

- Use a front bezel made from an insulative material such as plastic and so on.
- If a customer use a front bezel made from a conductive material, please always keep a distance more than 1mm between the front bezel and the T/P. Otherwise, the bezel will lower T/P sensitivity or cause unstable touch action.



2. FPC handling

- Do not fold the FPC. If the FPC is folded, disconnection of a wiring pattern may be caused. In case of bending FPC, the minimum radius of curvature must be 1.0mm or more.
- Do not bend the FPC at the reinforced area (A).

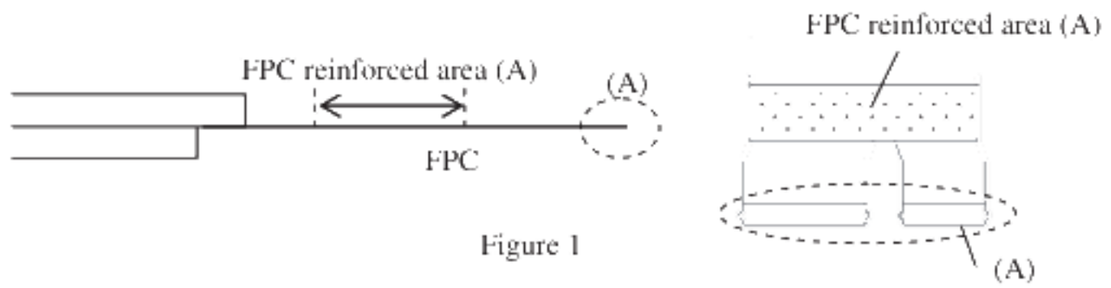


Figure 1

・Bending direction

To avoid any mechanical damage to the base part of the FPC, please always bend the FPC at the outer side of the LCD module in the direction of the arrow in Figure 2.

・Allowable number of bending

30 times

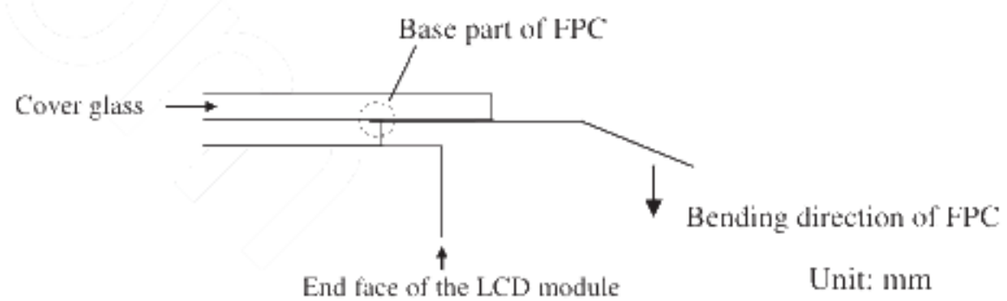


Figure 2

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-PP -2027	Dec. 11, 2014	**Revision contents** New issue **Writer** *Approved by* R. KAWASHIMA *Checked by* ——— *Prepared by* E. YOSHIMURA
2nd edition	DOD-PP -2100	Apr. 13, 2015	**Revision contents** P5 General specifications • Module size: (13.9) (D)mm (typ.) → (13.4) (D)mm (typ.) • Weight: TBD g (typ.) → (1,210) g (typ.) • Contrast ratio: TBD:1 (typ.) → 600:1 (typ.) • Power consumption: TBD W (typ.) → (7.6) W (typ.) P6 Block diagram • PWM-GND, BRTC-GND: 100kΩ (addition) P7 Detailed specifications • Weight: TBD (typ., max.) g → (1,210) (typ.), (1,330) (max.) g • Module size: (13.9) (D)mm → (13.4) (D)mm P8 Electrical characteristics - LCD panel processing board • Power supply current: TBD (typ., max.) mA → (400) (typ.), (780) (max.) mA • Input voltage for DPS and FRC signal (Expressions were changed.) • Input current for DPS and FRC signal (Expressions were changed.) • Input current for DPS - IFH1,2: TBD (max.) μA → 500(max.) μA - IFL1,2: TBD (min.) μA → 500(min.) μA P9 LED driver • Power supply voltage: 12.6 (max.) V → 13.2 (max.) V • Power supply current: TBD (typ., max) mA → (480) (typ.), (650) (max.) mA P13 LED driver • BRTC - Remarks: Low: OFF → Low or Open: OFF P26 Optics - Optical characteristics • Luminance: TBD (min.) cd/m^2 → (230) (min.) cd/m^2 • Contrast ratio: TBD (min., typ.) → 400 (min.), 600 (typ.) • Chromaticity- Rx: TBD (typ.) → (0.615) (typ.) - Ry: TBD (typ.) → (0.337) (typ.) - Gx: TBD (typ.) → (0.334) (typ.) - Gy: TBD (typ.) → (0.608) (typ.) - Bx: TBD (typ.) → (0.157) (typ.) - By: TBD (typ.) → (0.080) (typ.) • Note6: TopF=TBD°C → TopF= 29 °C P31 Attentions - Handling of the product • ⑭ (addition) P32 Attentions - Others • ④: ...the product to NLT. → ...the product to NLT for reparing and so on. P33-35 Outline drawings • Tape (2point) (addition) P33 Outline - Front view • (13.9) mm → (13.4) mm

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
2nd edition	DOD-PP -2100	Apr. 13, 2015	**Revision contents** P34 Outline - Rear view • Barrier shape (change) • Tape size (change) • 63.3±1 mm (addition) • Label (position change, addition) • Note1 (change) P35 Outline drawings - Touch panel • (3.25) mm → 3.25±0.5 mm • (0.5) mm → 0.5±0.5 mm • Install guidance → 2 FPC handling (Revised) **Signature of writer** *Approved by* R. Kawashima R. KAWASHIMA *Checked by* _____ *Prepared by* E. Yoshimura E. YOSHIMURA