



PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NL8060AC21-21KD

21cm (8.4 Type)

SVGA

LVDS interface (1port)

PRELIMINARY DATA SHEET

DOD-PP-2298 (1st edition)

**All information is subject to change without notice.
Please confirm the sales representative before
starting to design your system.**

INTRODUCTION

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The products are classified into three grades: "**Standard**", "**Special**", and "**Specific**".

Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The **Standard**: Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.

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.

The **Special**: Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.

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 NL8060AC21-21KD 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

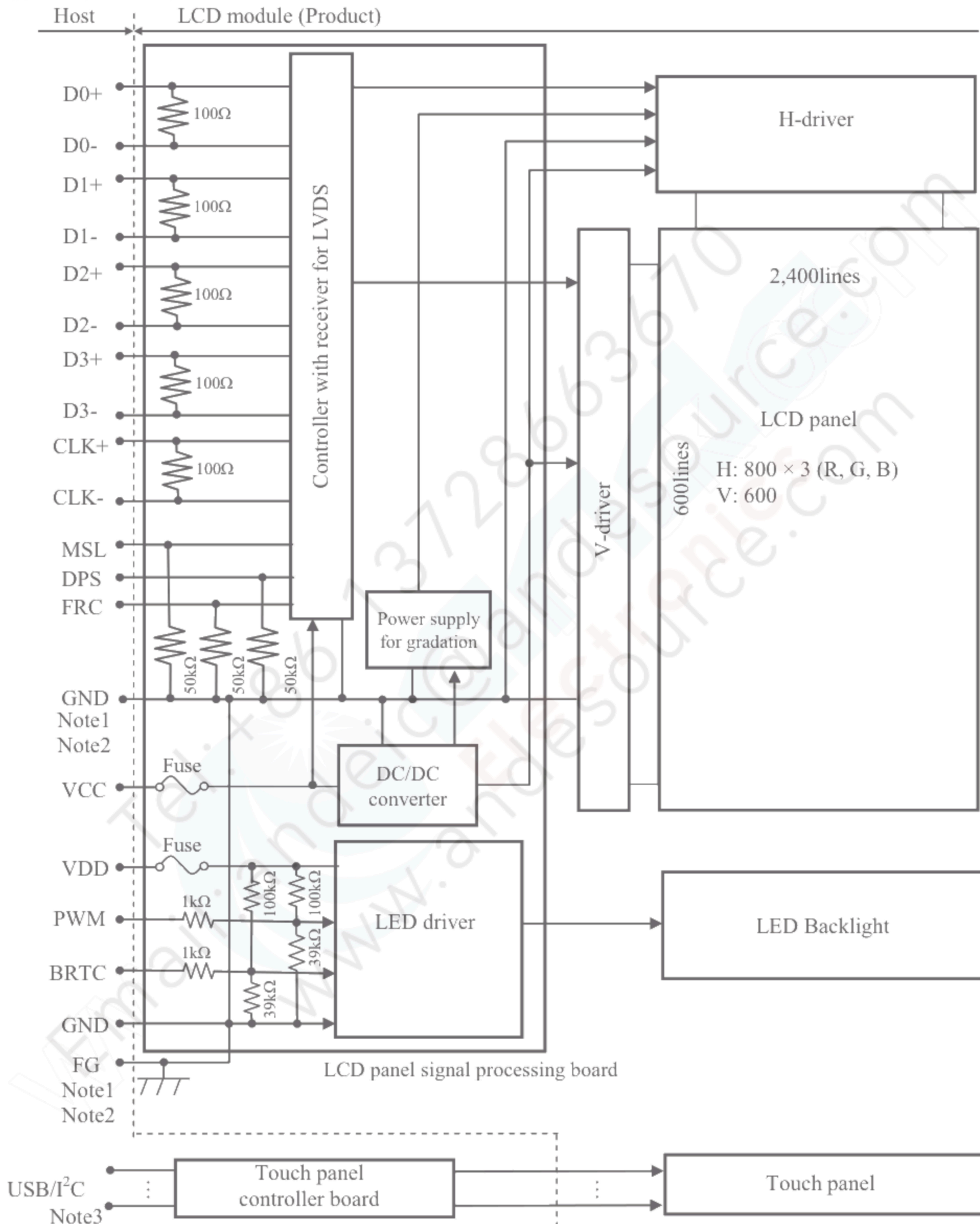
1.3 FEATURES

- Projected capacitive touch panel (PCAP T/P) attached
- Wet & Glove Technology (PCAP Generation 2)
- Touch panel having cover glass
- High luminance
- High contrast
- ColorXcell technology (Color Enhancement)
- Wide viewing angle
- Wide temperature range
- LVDS interface
- Reversible-scan direction
- Selectable 8-bit or 6-bit digital signals for data of RGB
- Replaceable lamp for backlight
- Long life LED backlight built in LED driver
- UL60950-1/CSA C22.2 No.60950-1-03 will be acquired for this product when starting mass production.
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

2. GENERAL SPECIFICATIONS

Display area	170.4 (H) × 127.8 (V) mm
Diagonal size of display	21cm (8.4 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors (At 8-bit input, FRC terminal= High) 262,144 colors (At 6-bit input, FRC terminal= Low or Open)
Pixel	800 (H) × 600 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.071 (H) × 0.213 (V) mm
Pixel pitch	0.213 (H) × 0.213 (V) mm
Module size (Including Touch panel)	200.0 (W) × 152.0 (H) × 10.2 (D) mm (typ.)
Weight	TBD g (typ.)
Contrast ratio	800: 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 ($\gamma \approx 2.2$): Normal axis (perpendicular)
Touch panel type	Projected capacitive Recommended Touch panel controller board (Option) • Touch panel controller board: PTPW10/11
Touch panel surface	Antiglare + AFP(Anti-finger print)
Touch panel pencil-hardness	2H (min.) [by JIS K5600]
Touch panel cover glass	Thickness:0.7mm glass
Touch panel bonding method	Optical-bonding
Color gamut	At, LCD panel center 40% (typ.) [against NTSC color space]
Response time	$T_{on} + T_{off}$ (10% ← → 90%) 18ms (typ.)
Luminance	At the maximum luminance control (380)cd/m ² (typ.)
Signal system	LVDS 1port (Receiver: THC63LVDF84B, Thine Electronics Inc. or equivalent) [8-bit/6-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE)]
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: 84LHS201
Power consumption	At the maximum luminance control, Checkered flag pattern Driving with the recommended T/P controller board, The number of touch= 10 TBD W (typ.)

3. BLOCK DIAGRAM



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

GND- FG	Connected
---------	-----------

Note2: GND and FG must 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)	200.0 ± 0.5 (W) $\times$ 152.0 ± 0.5 (H) $\times$ 10.2 ± 0.7 (D) Note1	mm
Display area	170.4 (H) $\times$ 127.8 (V) Note1	mm
Weight	TBD (typ.), TBD (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	-0.3 to VCC+0.3	V	
	Function signals Note3	VF			
	Function signal for LED driver	PWM	-0.3 to +5.5	V	
		BRTC	-0.3 to +VDD+0.1	V	
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	-30 to +80	°C	Note4
	Rear surface	TopR	-30 to +80	°C	Note5
Relative humidity Note6		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40°C < Ta ≤ 50°C
			≤ 55	%	50°C < Ta ≤ 60°C
			≤ 36	%	60°C < Ta ≤ 70°C
			≤ 24	%	70°C < Ta ≤ 80°C
Absolute humidity Note6		AH	≤ 70 Note7	g/m³	Ta= 80°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, FRC and MSL

Note4: Measured at 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 = 80°C and RH = 24%

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	-	300 Note1	425 Note2	mA	at VCC= 3.3V
Permissible ripple voltage		VRP	-	-	100	mVp-p	for VCC Note3, Note4, Note5
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2V Note6
	Low	VTL	-100	-	-	mV	
Terminating resistance		RT	-	100	-	Ω	-
Input voltage for DPS signal	High	VFH1	0.7VCC	-	VCC	V	CMOS level
	Low	VFL1	0	-	0.3VCC	V	
Input voltage for FRC signal	High	VFH2	0.7VCC	-	VCC	V	
	Low	VFL2	0	-	0.3VCC	V	
Input voltage for MSL signal	High	VFH3	0.7VCC	-	VCC	V	
	Low	VFL3	0	-	0.3VCC	V	
Input current for DPS signal	High	IFH1	-	-	300	μ A	-
	Low	IFL1	-300	-	-	μ A	
Input current for FRC signal	High	IFH2	-	-	300	μ A	
	Low	IFL2	-300	-	-	μ A	
Input current for MSL signal	High	IFH3	-	-	300	μ A	
	Low	IFL3	-300	-	-	μ A	

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

Note2: Pattern for maximum current

Note3: This product works if the ripple voltage levels are over the permissible values, but there might be noise on the display image.

Note4: The permissible ripple voltage includes spike noise.

Note5: The load variation influence does not include.

Note6: 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 Note2		IDD	-	195	240 Note3	mA	Note4
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD Note5, Note6, Note7
Input voltage for PWM signal	High	VDFH1	2.0	-	5.3	V	-
	Low	VDFL1	-	-	0.8	V	
Input voltage for BRTC signal	High	VDFH2	2.0	-	VDD	V	-
	Low	VDFL2	-	-	0.8	V	
PWM frequency		f _{PWM}	100	-	10k	Hz	Note8, Note9
PWM duty ratio		DR _{PWM}	1	-	100	%	Note10
PWM pulse width		tPWH	1	-	-	μs	

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

Note2: 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

Note3: This value excludes peak current such as overshoot current.

Note4: At the maximum luminance control.

Note5: This product works if the ripple voltage levels are over the permissible values, but there might be noise on the display image.

Note6: The permissible ripple voltage includes spike noise.

Note7: The load variation influence does not include.

Note8: A recommended f_{PWM} value is as follows.

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

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

Note9: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note10: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than 1μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

4.3.3 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC CO.,LTD	1.5A	3.0A	Note1
			36V		
VDD	FCC16152AB	KAMAYA ELECTRIC CO.,LTD	1.5A	3.0A	
			36V		

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 SPECIFICATIONS

(Ta= 25°C, Note1)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Accuracy	Center	Acrc	-	-	(1.5)	mm	Note2
	Boarder	Acrb	-	-	(2.5)	mm	
Number of touch		NUM	1	-	16	Point	-
Minimum distance for dual touch	Horizontal	Tdist H	12.0			mm	Note3
	Vertical	Tdist V	12.0				
Scan speed	Active	Sspd A	-	(100)	-	Hz	-
	Idle	Sspd I	-	(30)	-	Hz	-
Resolution	Horizontal	-	-	-	4,096	-	Note4
	Vertical	-	-	-	4,096	-	
Response area	Horizontal	-	-	172.856	-	mm	Note5
	Vertical	-	-	130.144	-		

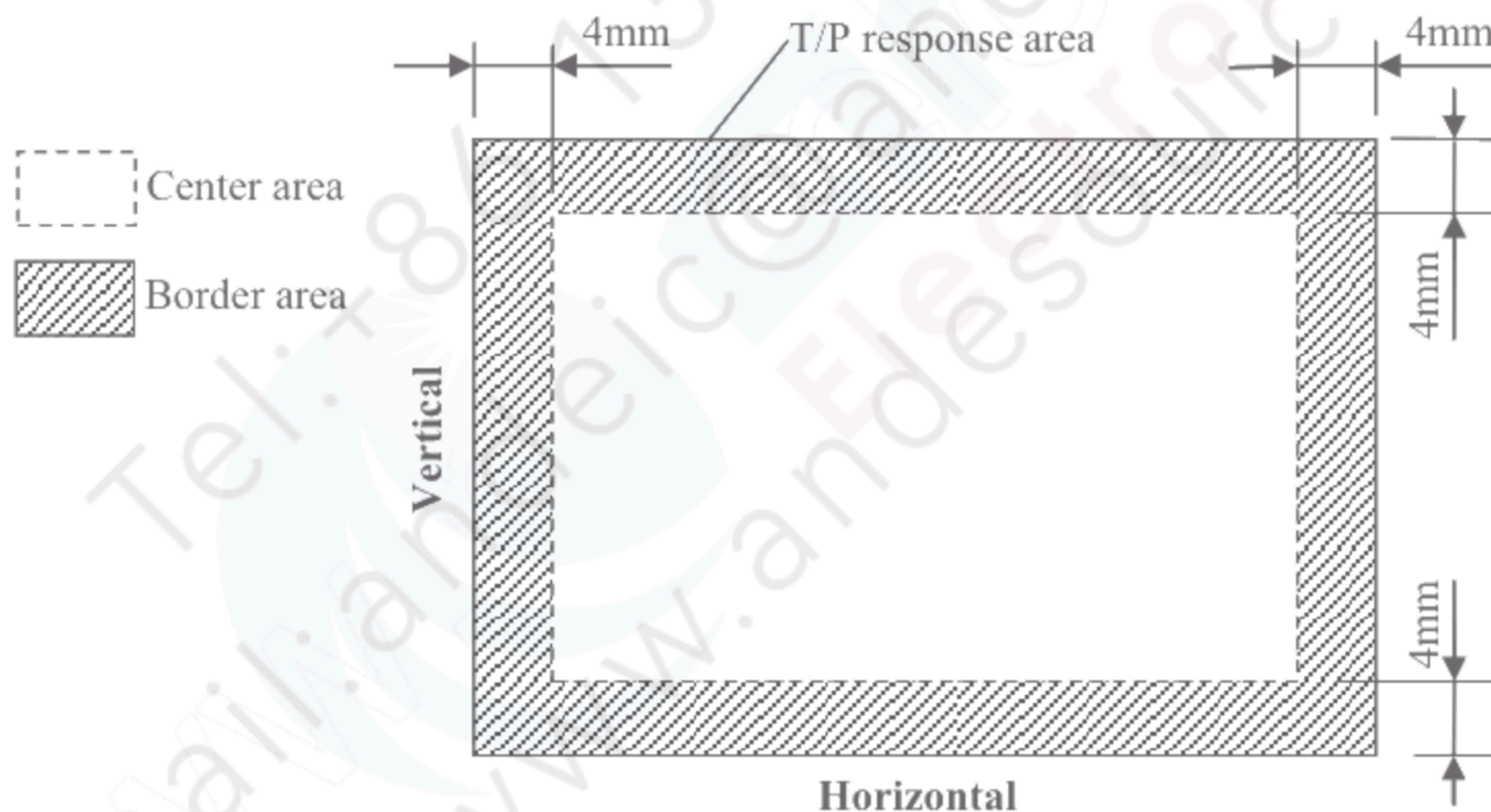
Note1: If a customer uses a recommended T/P controller board, specifications of the T/P controller board are given priority over the specifications in this table.

Note2: Definition of accuracy

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

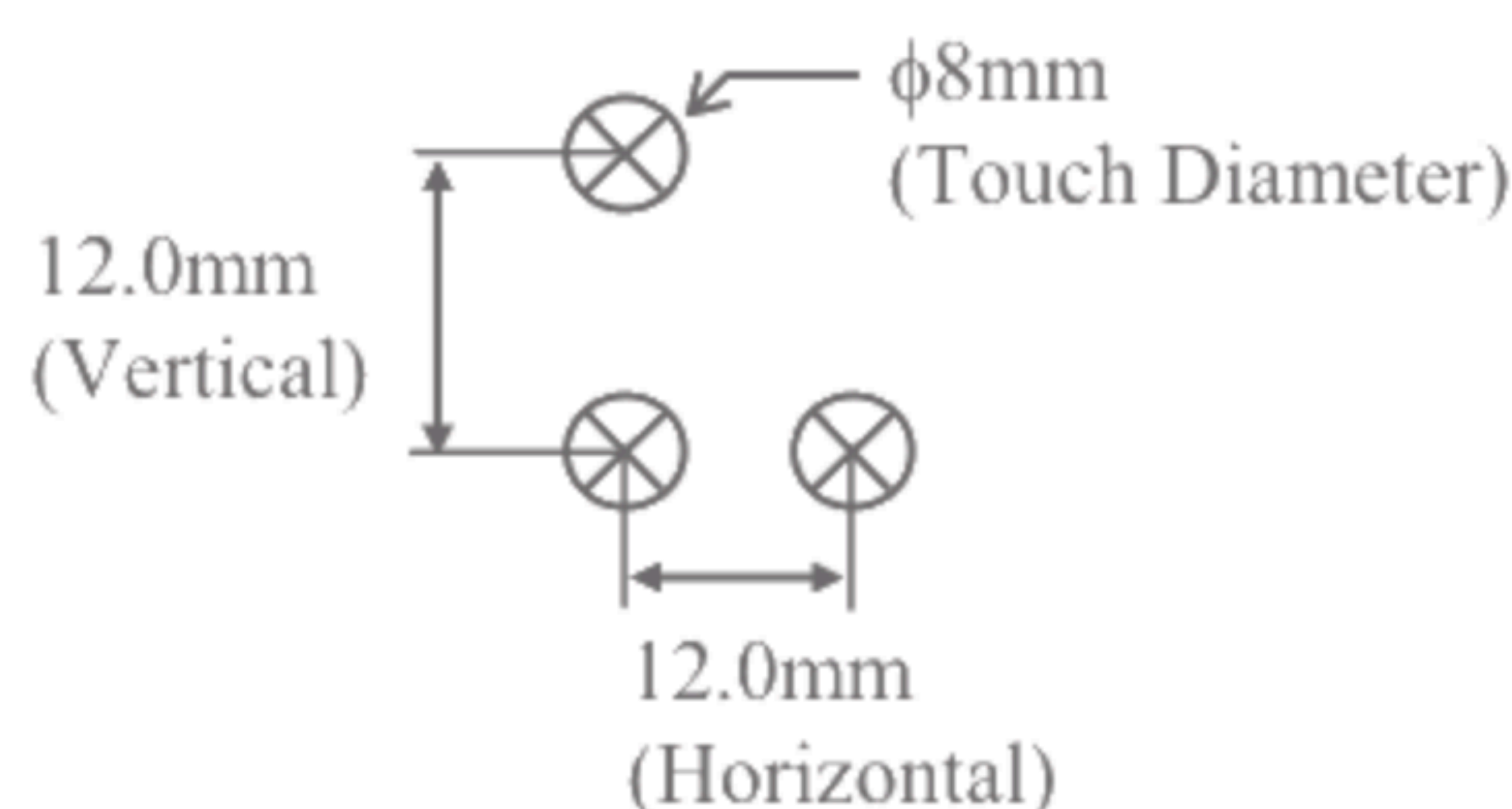
Acrc: Accuracy at center area

Acrb: Accuracy at boarder area



Input method is $\phi 8\text{mm}$ conductive stylus.

Note3: Minimum distance for dual touch

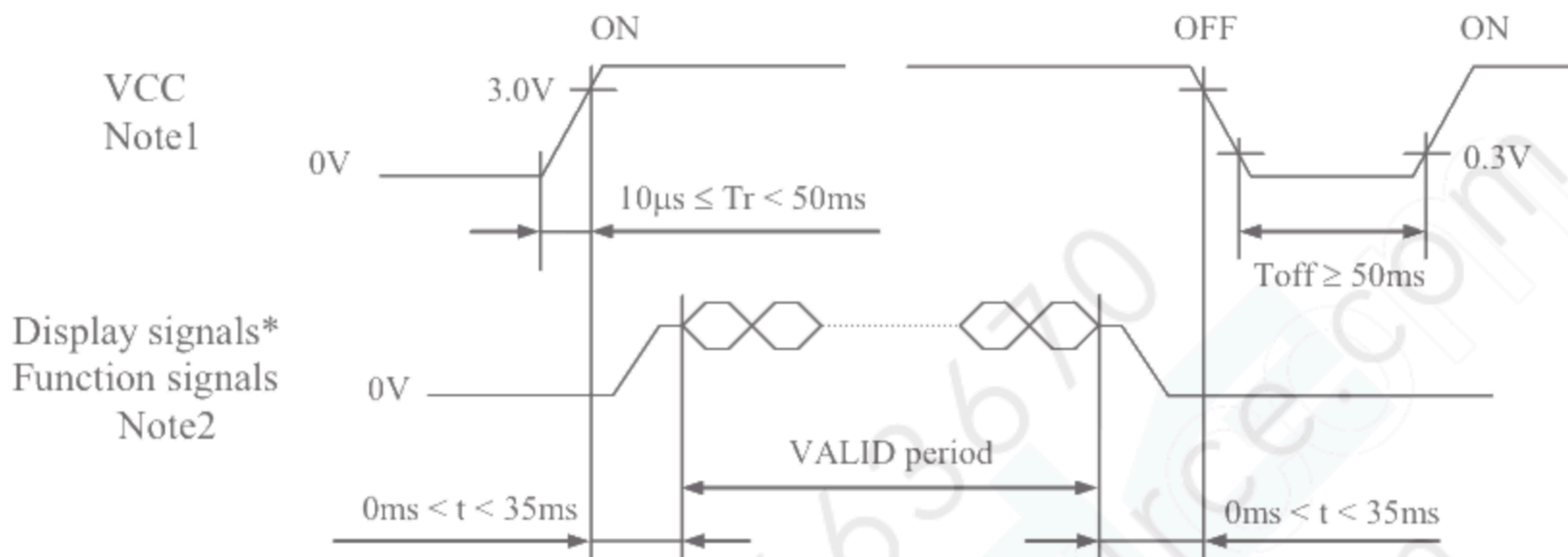


Note4: When using the recommended T/P controller board

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



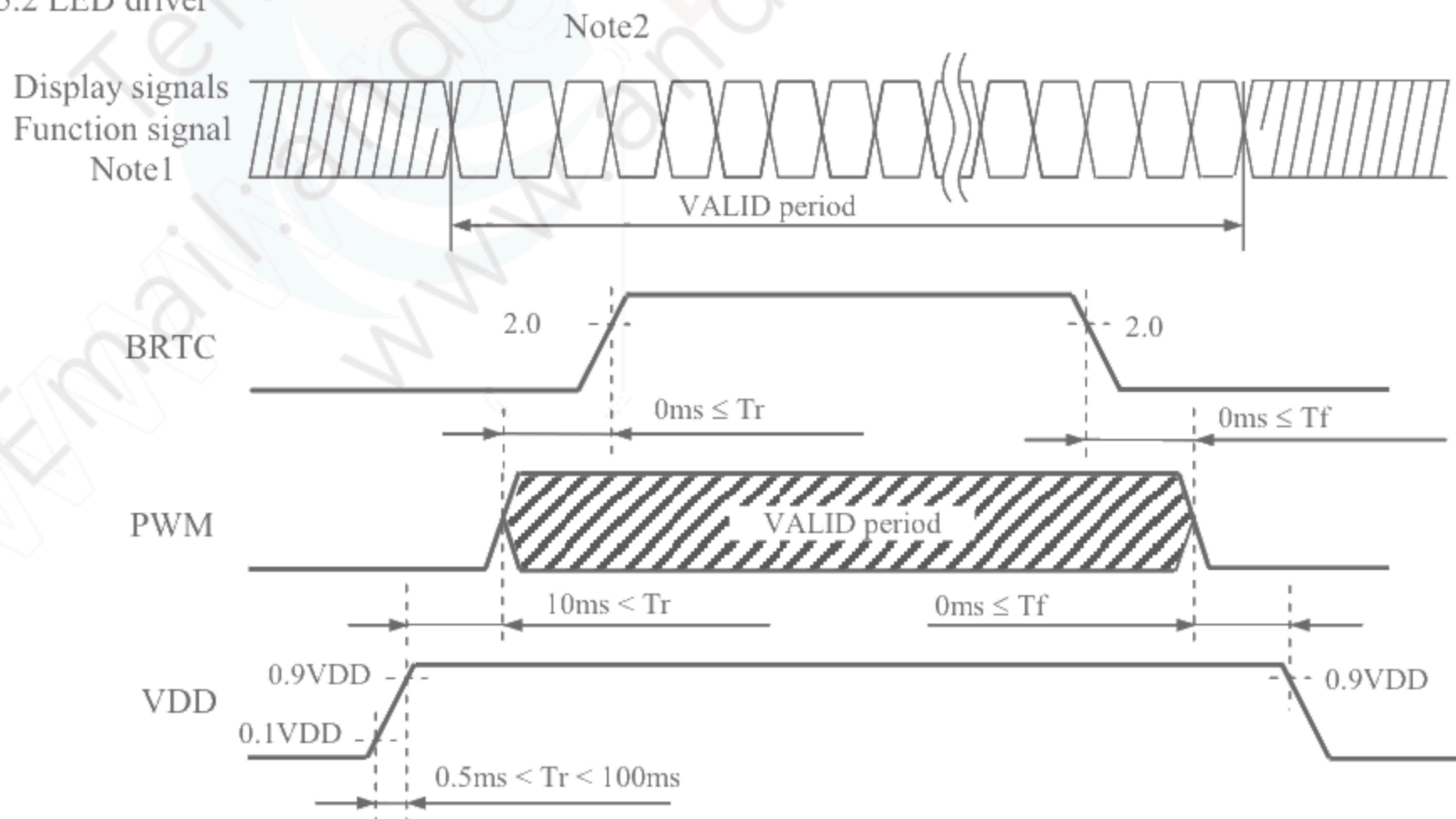
* These signals should be measured at the terminal of 100Ω resistance.

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, FRC and MSL) 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): FI-SE20P-HFE (Japan Aviation Electronics Industry Limited (JAE))

Adaptable plug: FI-S20S (Japan Aviation Electronics Industry Limited (JAE))

Pin No.		Symbol	Signal	Input data signal: 8-bit		Input data signal: 6-bit	Remarks
				MAP A	MAP B		
1	A	D3+	Pixel data	R0-R1,G0-G1,B0-B1	R6-R7,G6-G7,B6-B7	-	Note1 Note2
	B	GND	Ground	-		Ground	Note3
2	A	D3-	Pixel data	R0-R1,G0-G1,B0-B1	R6-R7,G6-G7,B6-B7	-	Note1 Note2
	B	GND	Ground	-		Ground	Note3
3	DPS	Selection of scan direction	High : Low or Open :	Reverse scan Normal scan			Note4
4	FRC	Selection of the number of colors	High			Low or Open	Note1 Note5
5	GND	Ground	Ground				Note3
6	CLK+	Pixel clock	Pixel clock				Note2
7	CLK-						
8	GND	Ground	Ground				Note3
9	D2+	Pixel data	B4-B7,DE	B2-B5,DE			Note2
10	D2-						
11	GND	Ground	Ground				Note3
12	D1+	Pixel data	G3-G7,B2-B3	G1-G5,B0-B1			Note2
13	D1-						
14	GND	Ground	Ground				Note3
15	D0+	Pixel data	R2-R7,G2	R0-R5,G0			Note2
16	D0-						
17	GND	Ground	Ground				Note3
18	MSL	Selection of LVDS input map	Low or Open	High		Low or Open	Note5
19	VCC	Power supply	Power supply				Note3
20	VCC						

Note1: See "4.7 DISPLAY COLORS AND INPUT DATA SIGNALS".

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: All GND and VCC terminals should be used without any non-connected lines.

Note4: See "4.9 SCANNING DIRECTIONS".

Note5: See "4.6.5 Connection between receiver and transmitter for LVDS".

4.6.2 LED driver

CN2 socket (LCD module side): FI-S6P-HFE (Japan Aviation Electronics Industry Limited (JAE))
 Adaptable plug: FI-S6S (Japan Aviation Electronics Industry Limited (JAE))

Pin No.	Symbol	Function	Remarks
1	VDD	Power supply	Note1
2	VDD	Power supply	
3	GND	Ground	
4	GND	Ground	
5	BRTC	Backlight ON/OFF control	High or Open: Backlight ON Low: Backlight OFF
6	PWM	Luminance control terminal by PWM Dimming	High or Open: 100% (Max. Luminance)

Note1: All GND and VDD terminals must be connected to appropriate terminals.

4.6.3 Touch panel

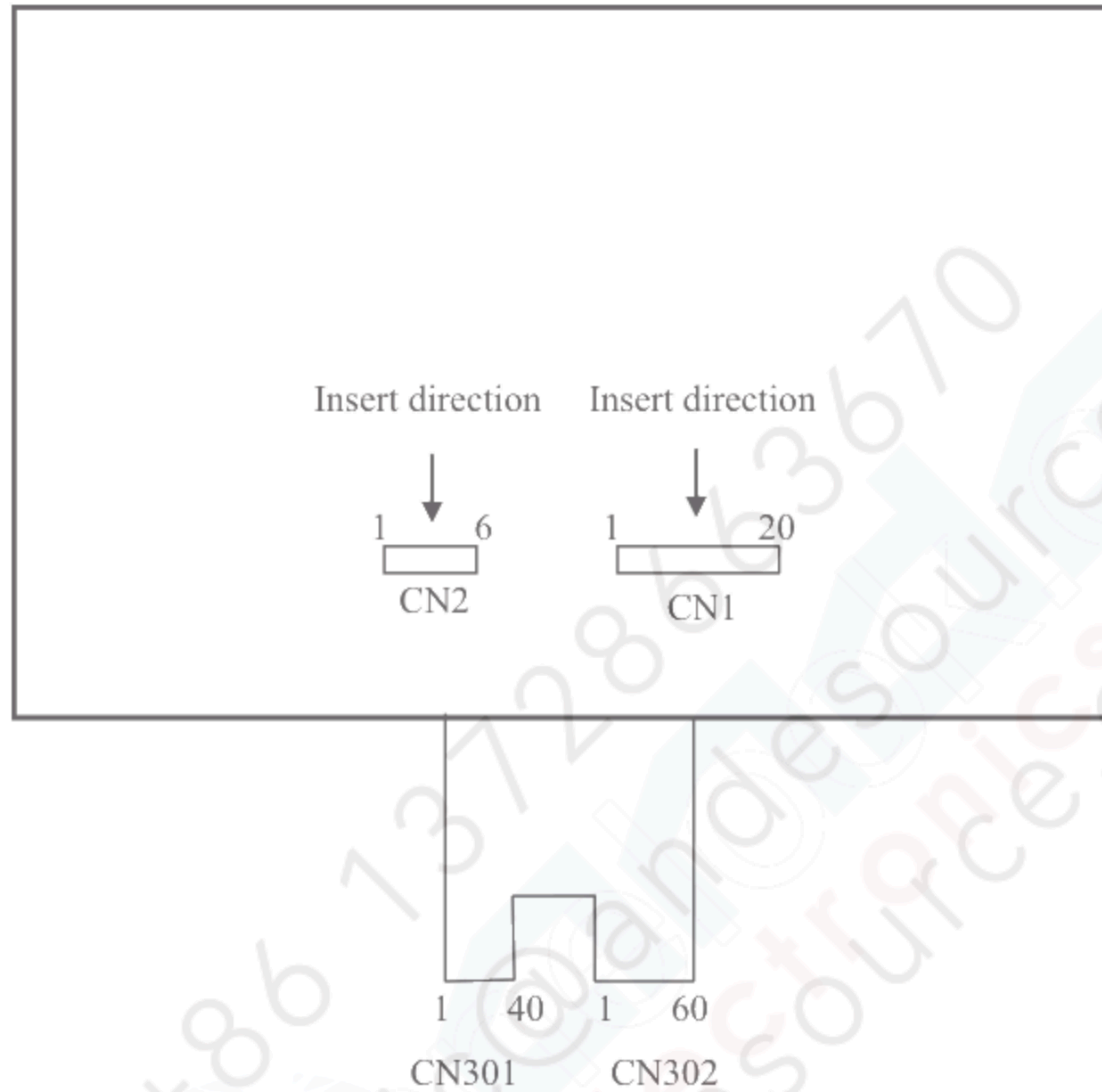
Connect CN301 and CN302 to the sockets of the T/P controller board.

CN301: FPC (40 pins)
 Adaptable socket: FH28-40S-0.5SH(05) (Hirose Electric Co., Ltd.(HRS))

CN302: FPC (60 pins)
 Adaptable socket: FH28-60S-0.5SH(05) (Hirose Electric Co., Ltd.(HRS))

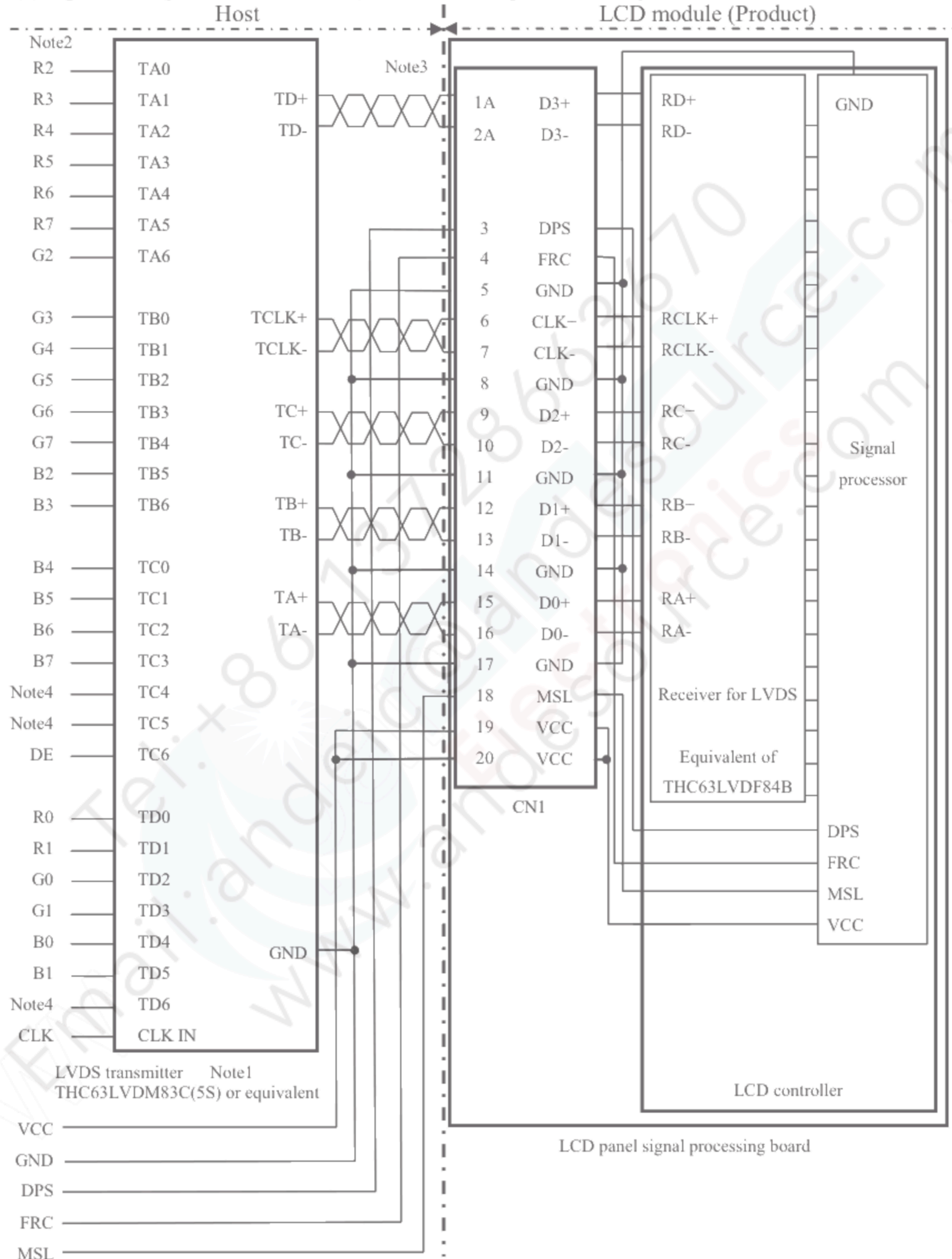
4.6.4 Positions of plug and socket

Rear side



4.6.5 Connection between receiver and transmitter for LVDS

(1) Input data signal: 8-bit, MAP A (MSL: Low or Open, FRC: High)



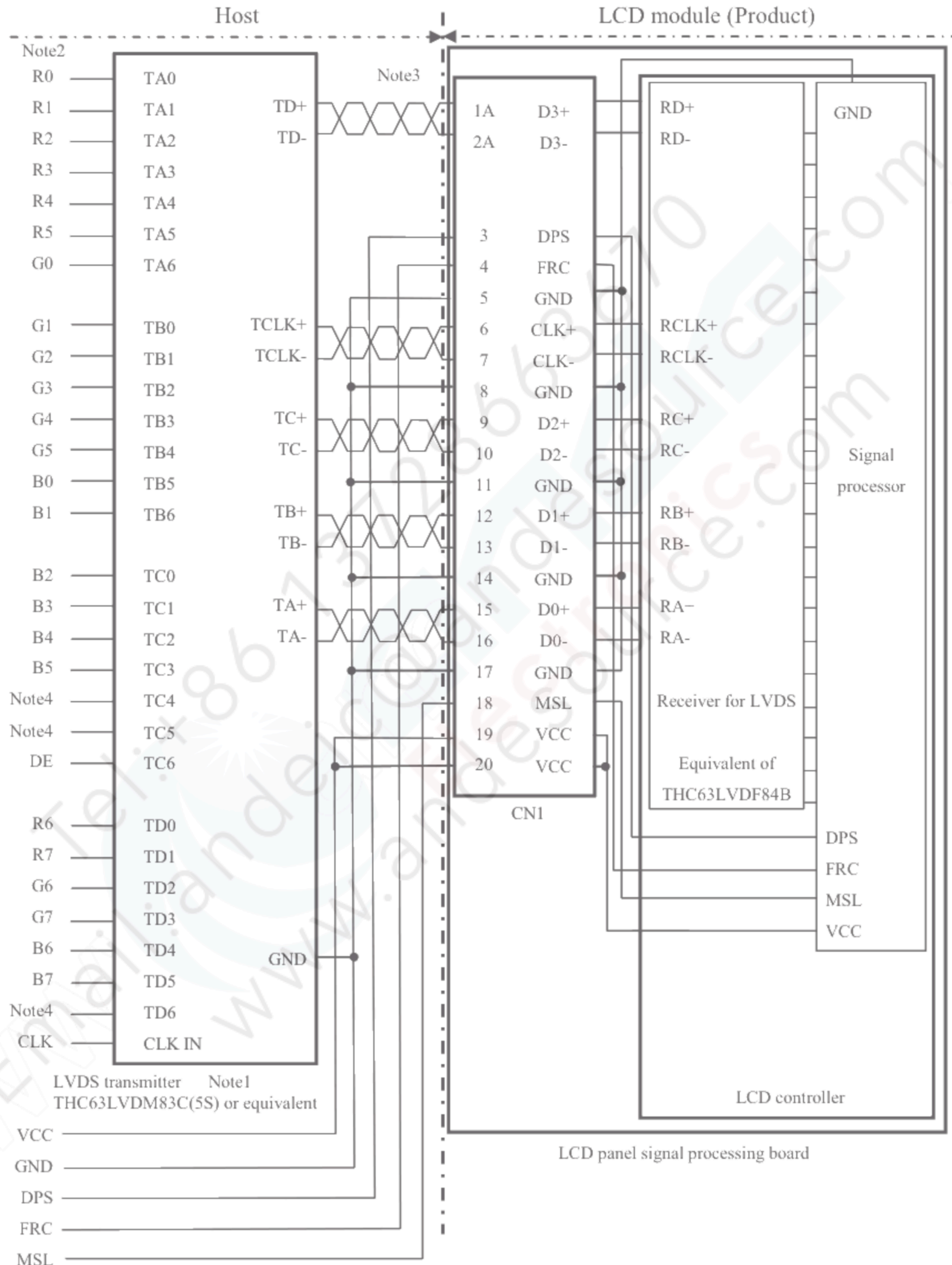
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent

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) Input data signal: 8-bit, MAP B (MSL: High, FRC: High)



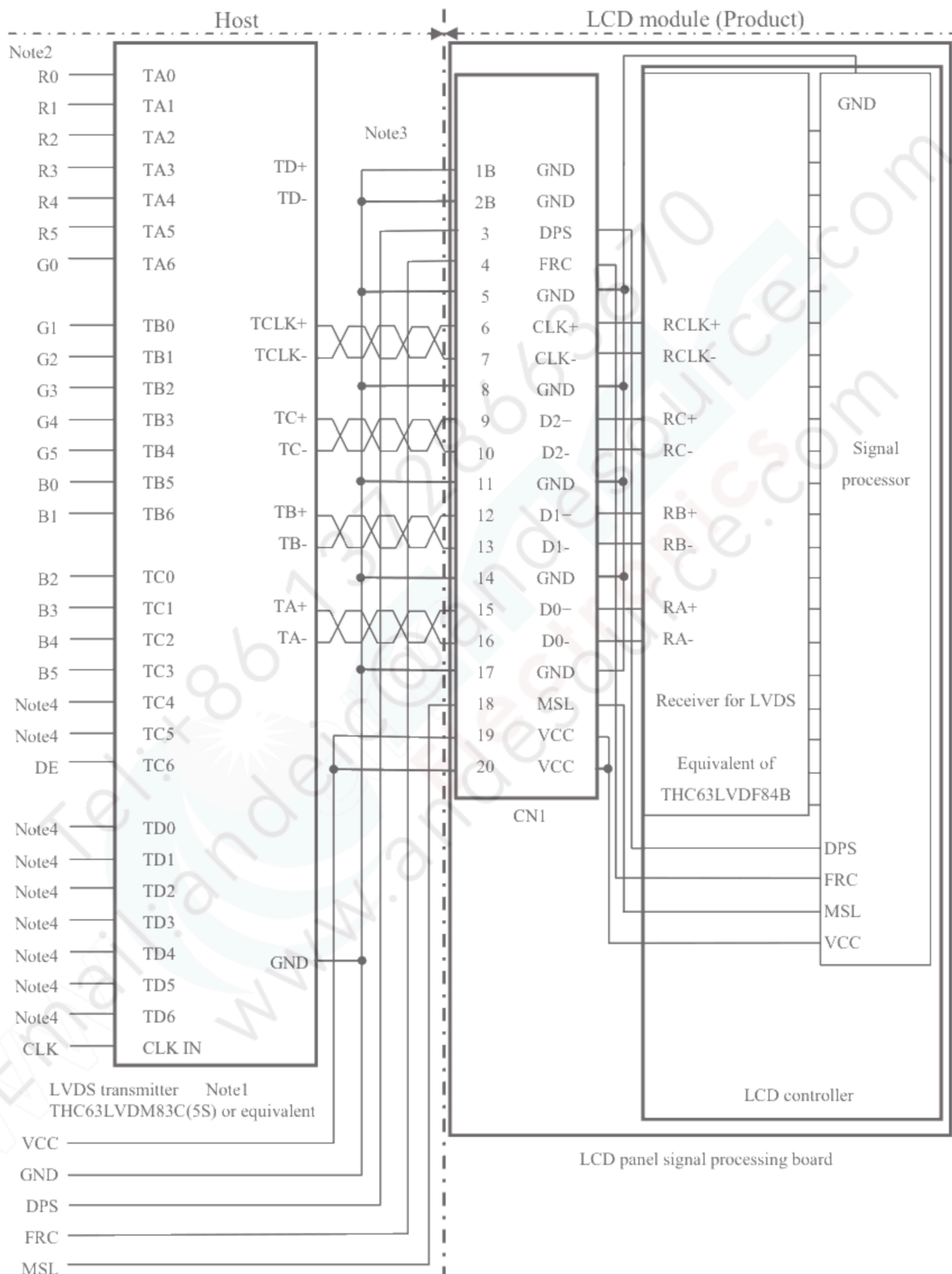
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent

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.

(3) Input data signal: 6-bit (MSL: Low or Open, FRC: Low or Open)



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

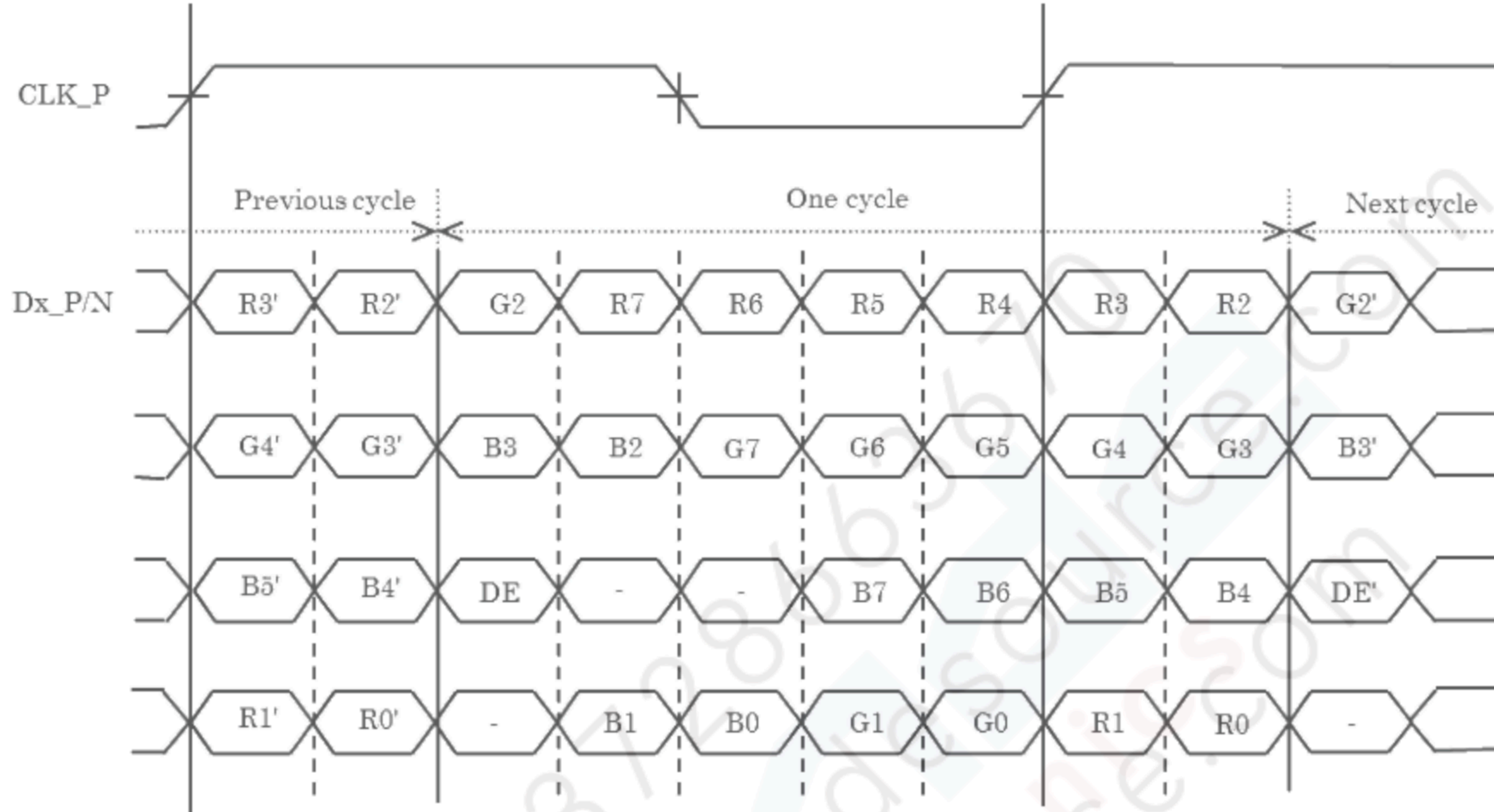
Note2: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R5, G5, B5

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) Input data signal: 8-bit, MAP A

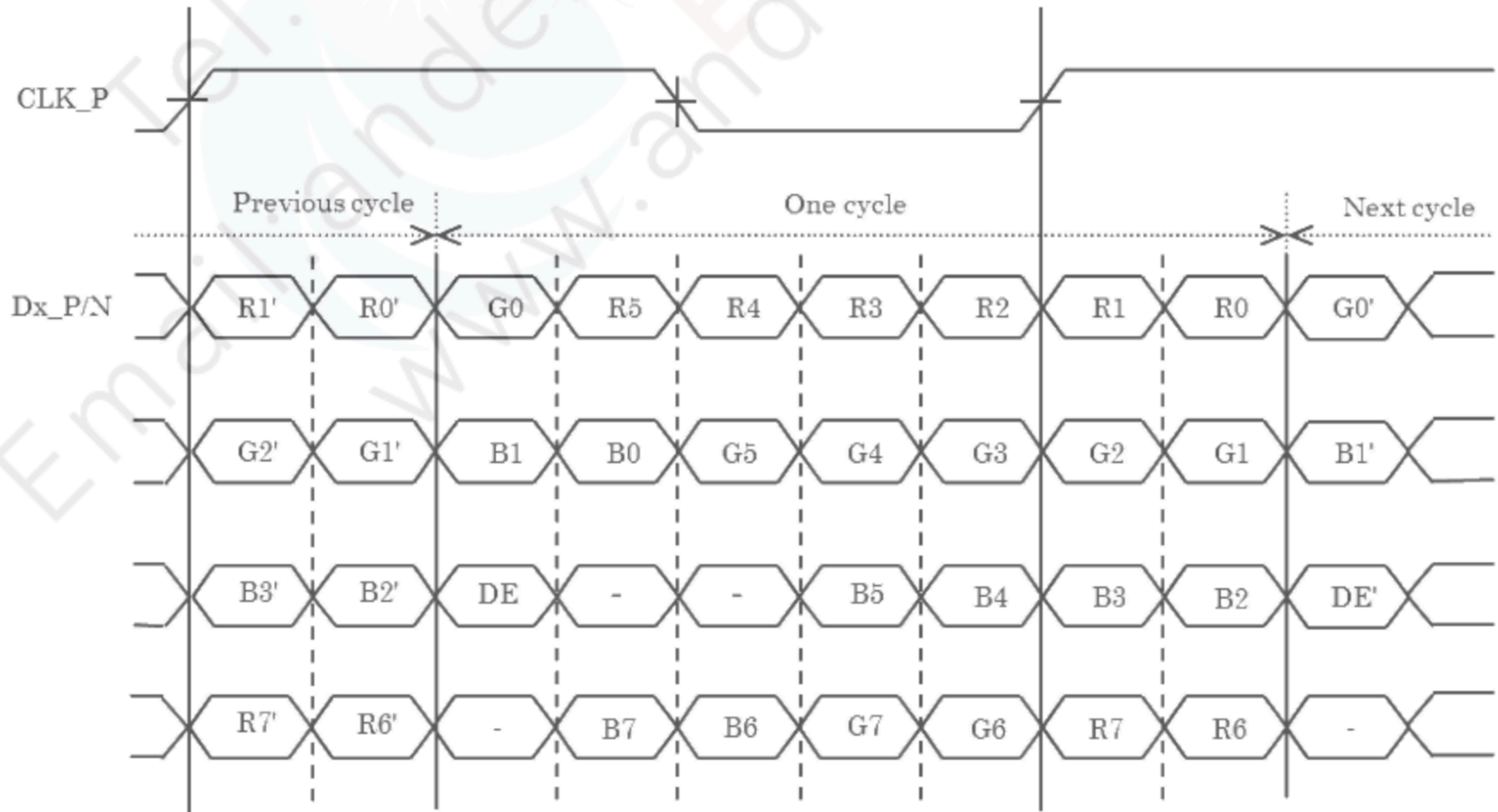


Note1: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: Dx_P/N: x = 0,1,2,3 (P: +, N: -)

(2) Input data signal: 8-bit, MAP B

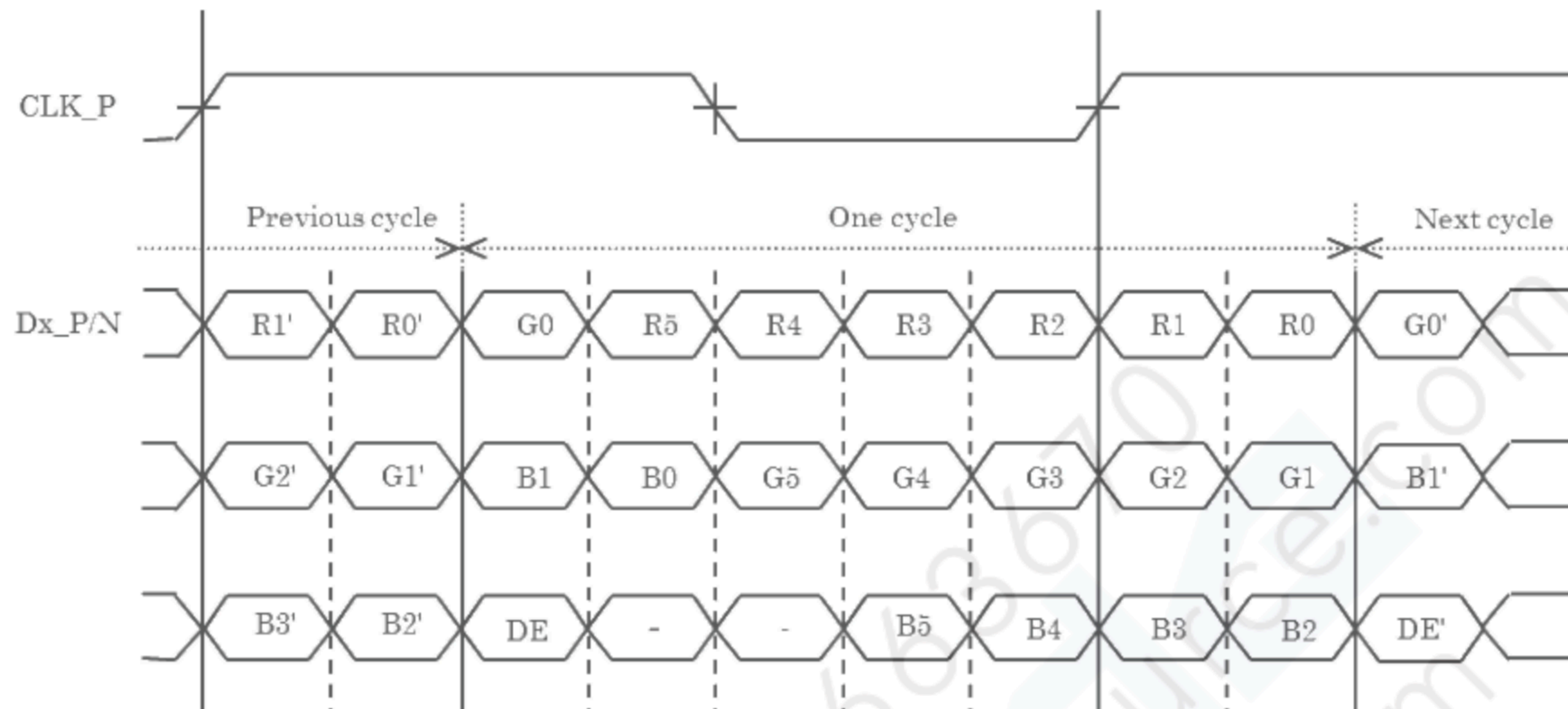


Note1: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: Dx_P/N: x = 0,1,2,3 (P: +, N: -)

(3) Input data signal: 6-bit



Note1: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R5, G5, B5

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: Dx_P/N: x = 0,1,2 (P: +, N: –)

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

4.7.1 Combinations of input data signals, FRC and MSL signal

This product can display equivalent of 16,777,216 colors and 262,144 colors by combination of input data signals, FRC and MSL signal. See the following table.

Combination	Input data signals	Input Data mapping	CN1- Pin No.1 and 2	FRC terminal	MSL terminal	Display colors	Remarks
①	8-bit	MAP A	D3+/-	High	Low or Open	16,777,216	Note1
②	8-bit	MAP B	D3+/-	High	High	16,777,216	Note1
③	6-bit	-	GND	Low or Open	Low or Open	262,144	Note2

Note1: See "4.7.2 16,777,216 colors".

Note2: See "4.7.3 262,144 colors".

4.7.2 16,777,216 colors

This product can display equivalent of 16,777,216 colors with 256 gray scales by combination ① or ②.
(See "4.7.1 Combinations of input data signals, FRC and MSL 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	
	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
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
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	1	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	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
Blue		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 ③.

(See "4.7.1 Combinations of input data signals, FRC and MSL 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	1	0	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	

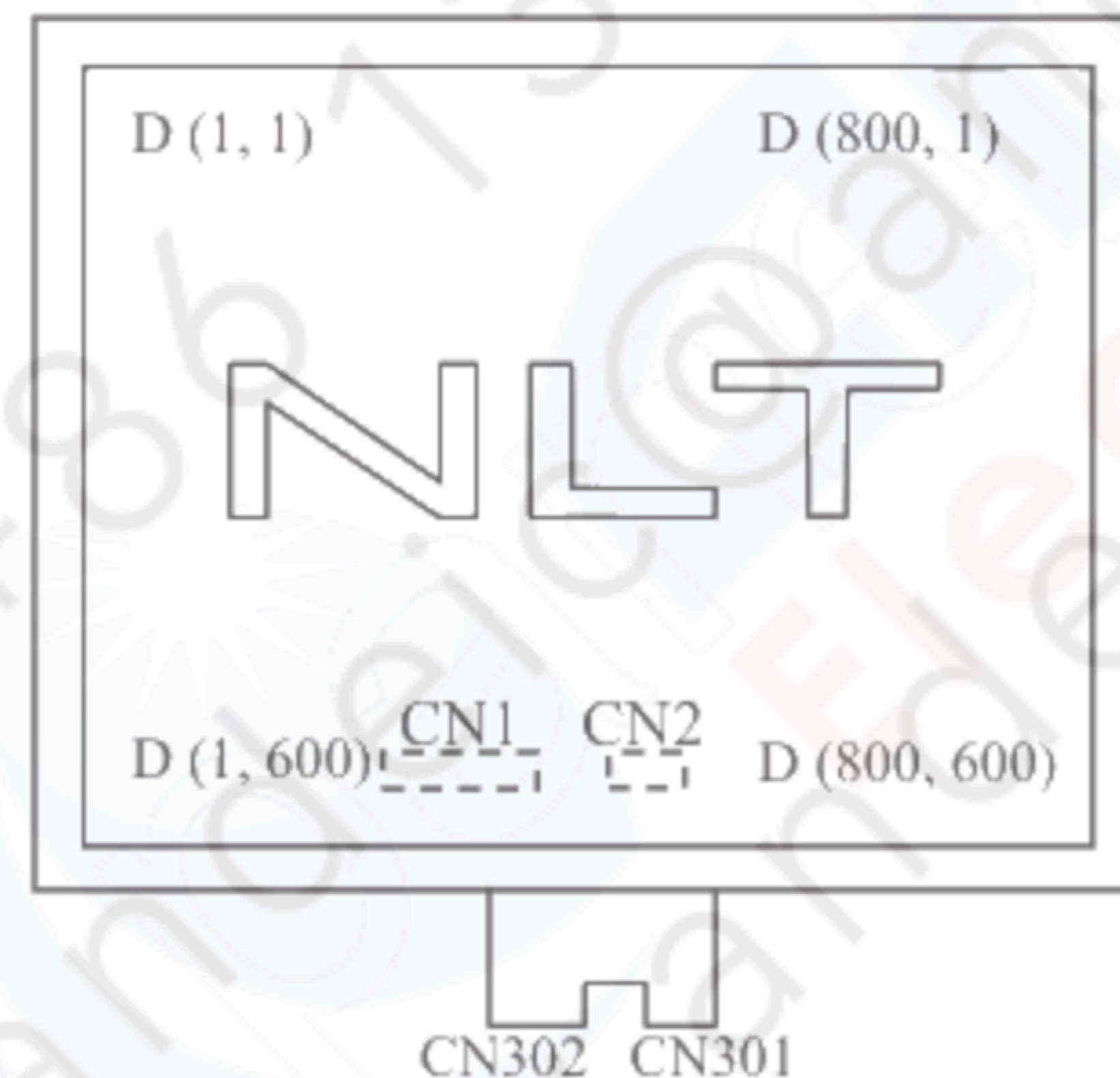
4.8 DISPLAY POSITIONS

D (1, 1)						
R	G	B				
D(1, 1)	D(2, 1)	• • •	D(X, 1)	• • •	D(799, 1)	D(800, 1)
D(1, 2)	D(2, 2)	• • •	D(X, 2)	• • •	D(799, 2)	D(800, 2)
•	•	•	•	•	•	•
•	•	•	•	•	•	•
•	•	•	•	•	•	•
D(1, Y)	D(2, Y)	• • •	D(X, Y)	• • •	D(799, Y)	D(800, Y)
•	•	•	•	•	•	•
•	•	•	•	•	•	•
•	•	•	•	•	•	•
D(1, 599)	D(2, 599)	• • •	D(X, 599)	• • •	D(799, 599)	D(800, 599)
D(1, 600)	D(2, 600)	• • •	D(X, 600)	• • •	D(799, 600)	D(800, 600)

Note1: See "4.9 SCANNING DIRECTIONS".

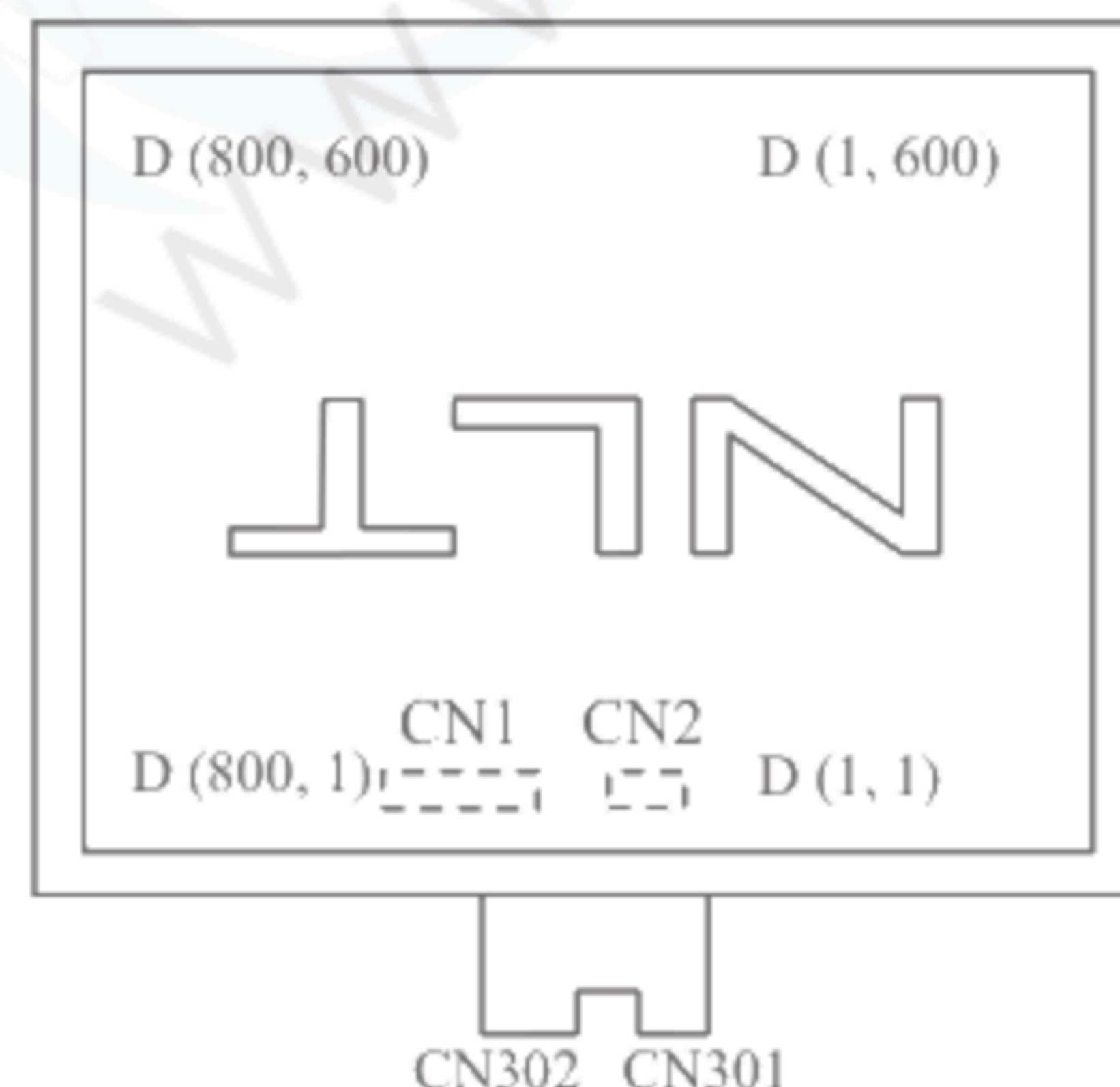
4.9 SCANNING DIRECTIONS

The following figures are seen from a front view.



Note1

Figure1. Normal scan (DPS: Low or Open)



Note1

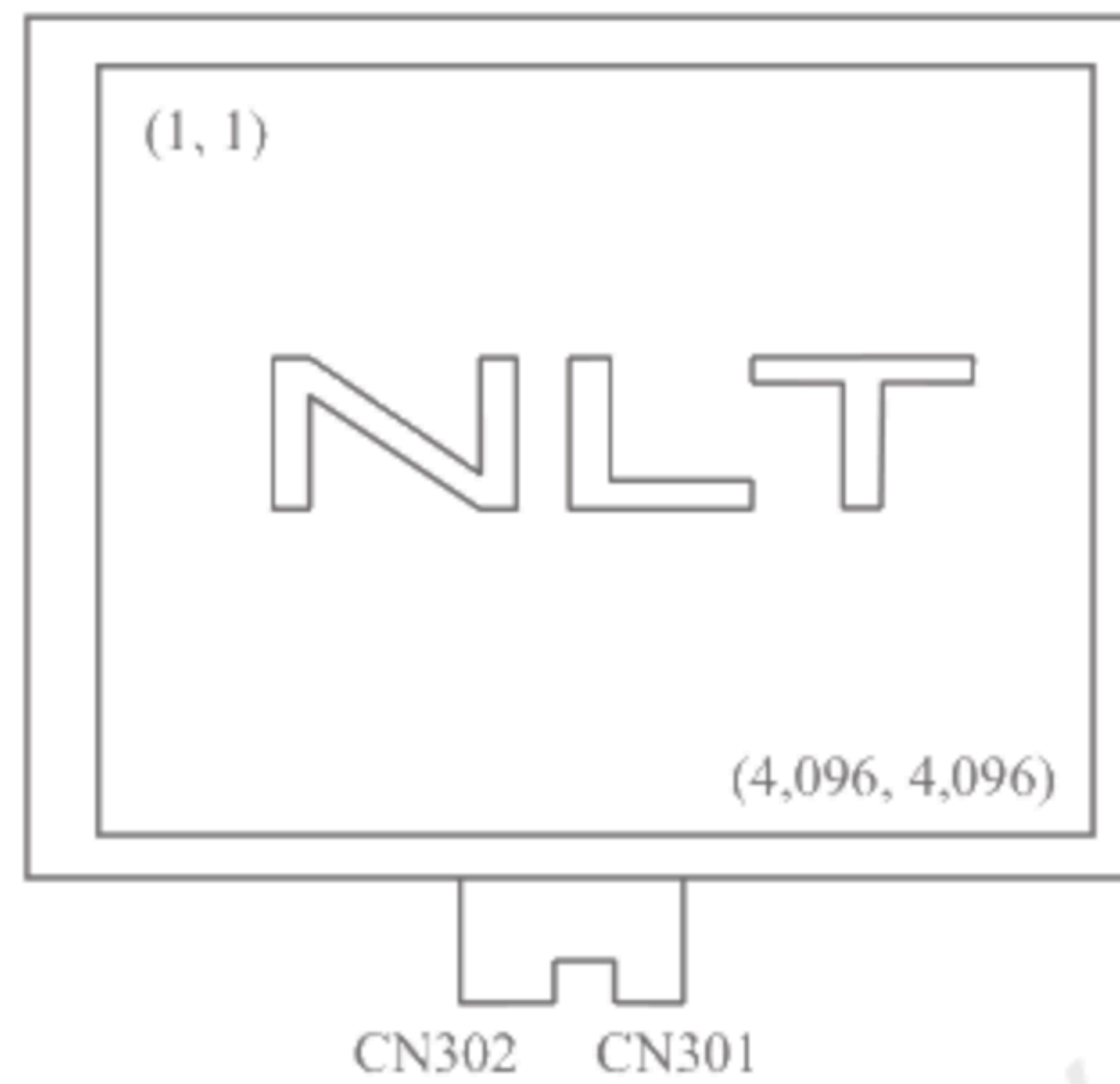
Figure2. Reverse scan (DPS: High)

Note1: Meaning of D (X, Y)

D (X, Y): Input data signals 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

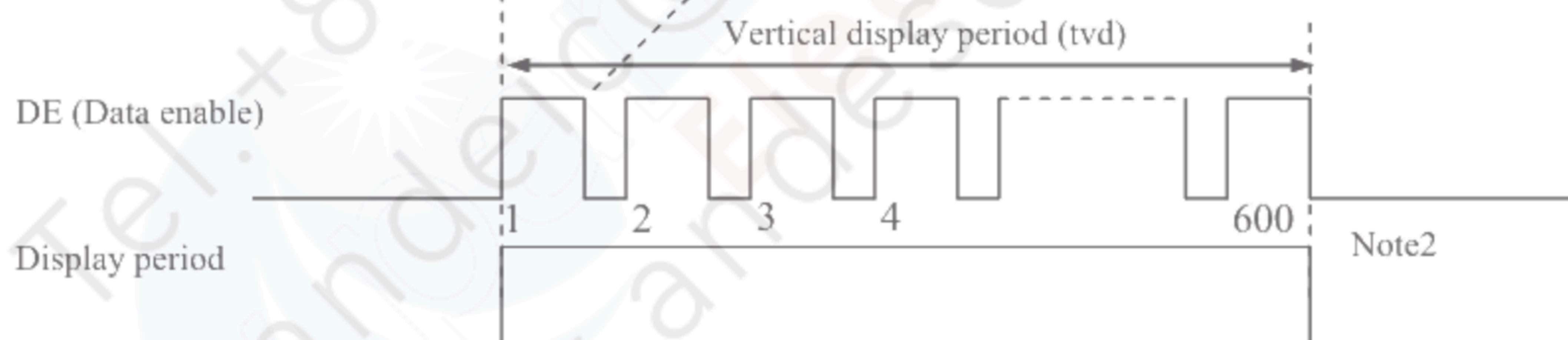
• Horizontal signal

Note1



• Vertical signal

Note1



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	34.0	38.362	42.0	MHz	26.067ns (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	24.0	26.693	30.1	μs	37.463kHz (typ.)
				-	1,024	-	CLK	
		Display period		thd	800			CLK
	Vertical (One frame)	Cycle	tv	16.1	16.683	17.2	ms	59.94Hz (typ.)
				-	625	-	H	
		Display period		tvd	600			H
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

Note1: Definition of parameters is as follows.

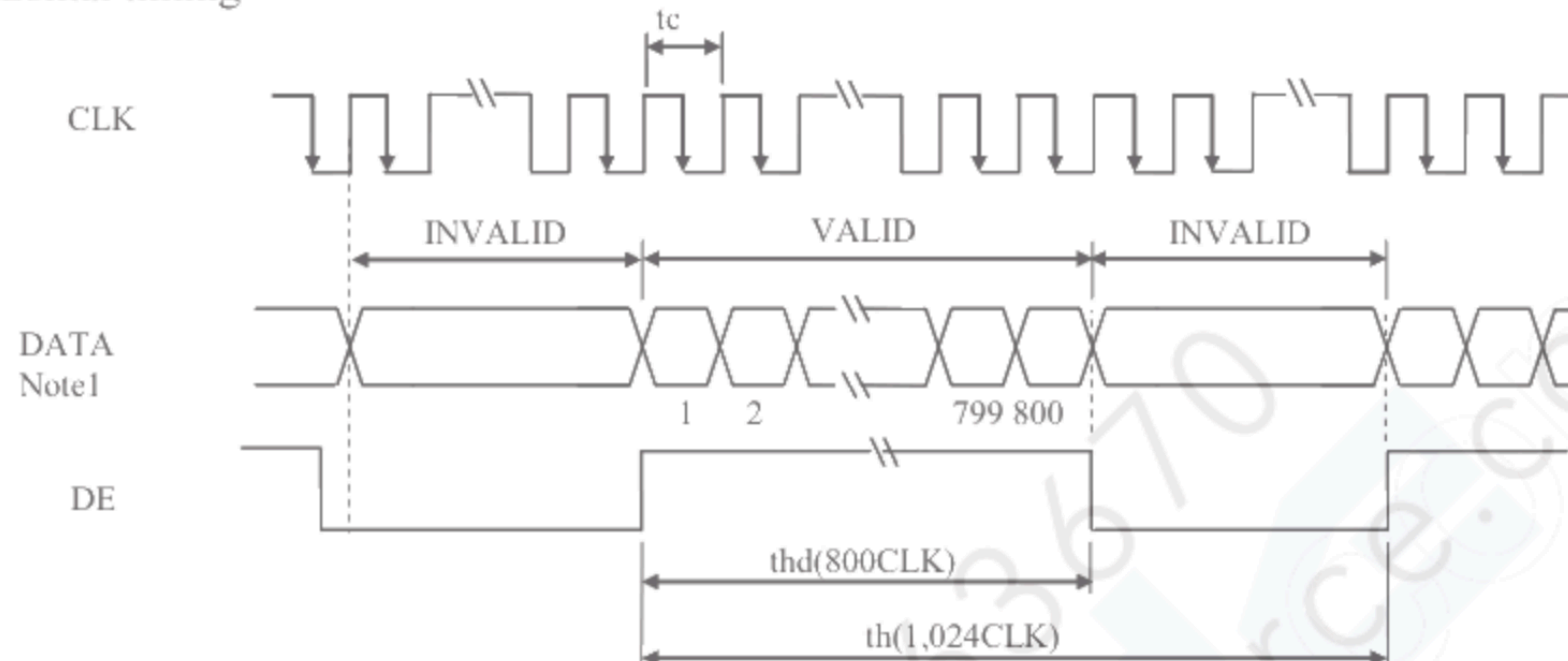
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

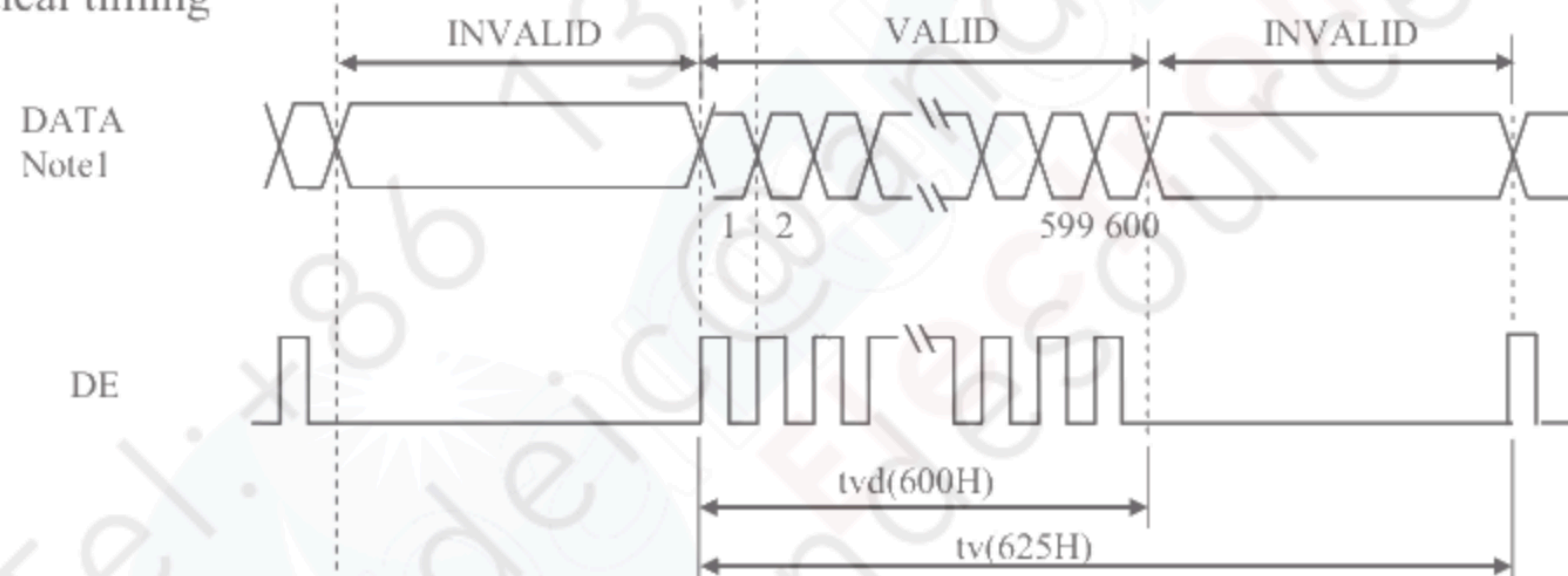
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.11.3 Input signal timing chart

Horizontal timing



Vertical timing



Note1: DATA = R0-R7, G0-G7, B0-B7 or R0-R5, G0-G5, B0-B5

4.12 OPTICS

4.12.1 Optical characteristics

(Note1, Note2)

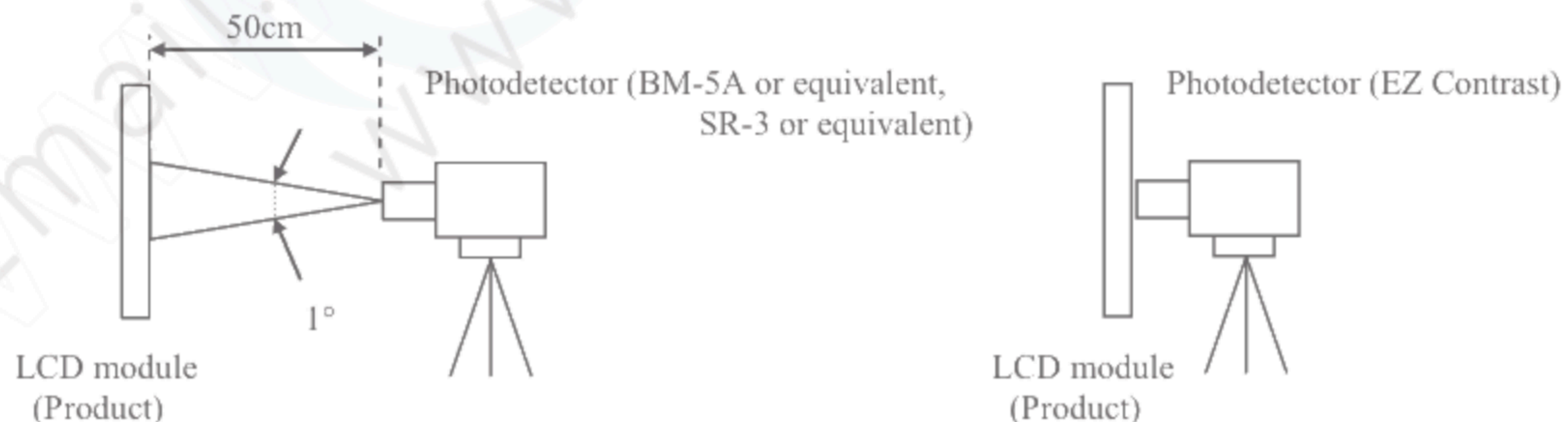
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	L	TBD	(380)	-	cd/m ²	BM-5A or equivalent	-
Contrast ratio		White/Black at center $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	CR	500	800	-	-	BM-5A or equivalent	Note3
Luminance uniformity		White $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	LU	-	1.25	1.4	-	BM-5A or equivalent	Note4
Chromaticity	White	x coordinate	Wx	0.263	0.313	0.363	-	SR-3 or equivalent	Note5
		y coordinate	Wy	0.279	0.329	0.379	-		
	Red	x coordinate	Rx	-	0.583	-	-		
		y coordinate	Ry	-	0.357	-	-		
	Green	x coordinate	Gx	-	0.366	-	-		
		y coordinate	Gy	-	0.559	-	-		
	Blue	x coordinate	Bx	-	0.159	-	-		
		y coordinate	By	-	0.137	-	-		
Color gamut		$\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$ at center, against NTSC color space	C	35	40	-	%		
Response time		White to Black	Ton	-	3	5	ms	BM-5A or equivalent	Note6
		Black to White	Toff	-	15	21	ms		Note7
Viewing angle	Right	$\theta U=0^{\circ}, \theta D=0^{\circ}, CR \geq 10$	θR	70	80	-	$^{\circ}$	EZ Contrast	Note8
	Left	$\theta U=0^{\circ}, \theta D=0^{\circ}, CR \geq 10$	θL	70	80	-	$^{\circ}$		
	Up	$\theta R=0^{\circ}, \theta L=0^{\circ}, CR \geq 10$	θU	70	80	-	$^{\circ}$		
	Down	$\theta R=0^{\circ}, \theta L=0^{\circ}, CR \geq 10$	θD	70	80	-	$^{\circ}$		

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: SVGA,
Horizontal cycle= 1/37.463kHz, Vertical cycle= 1/59.94Hz, DPS= Low or Open: Normal scan

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= 27°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.

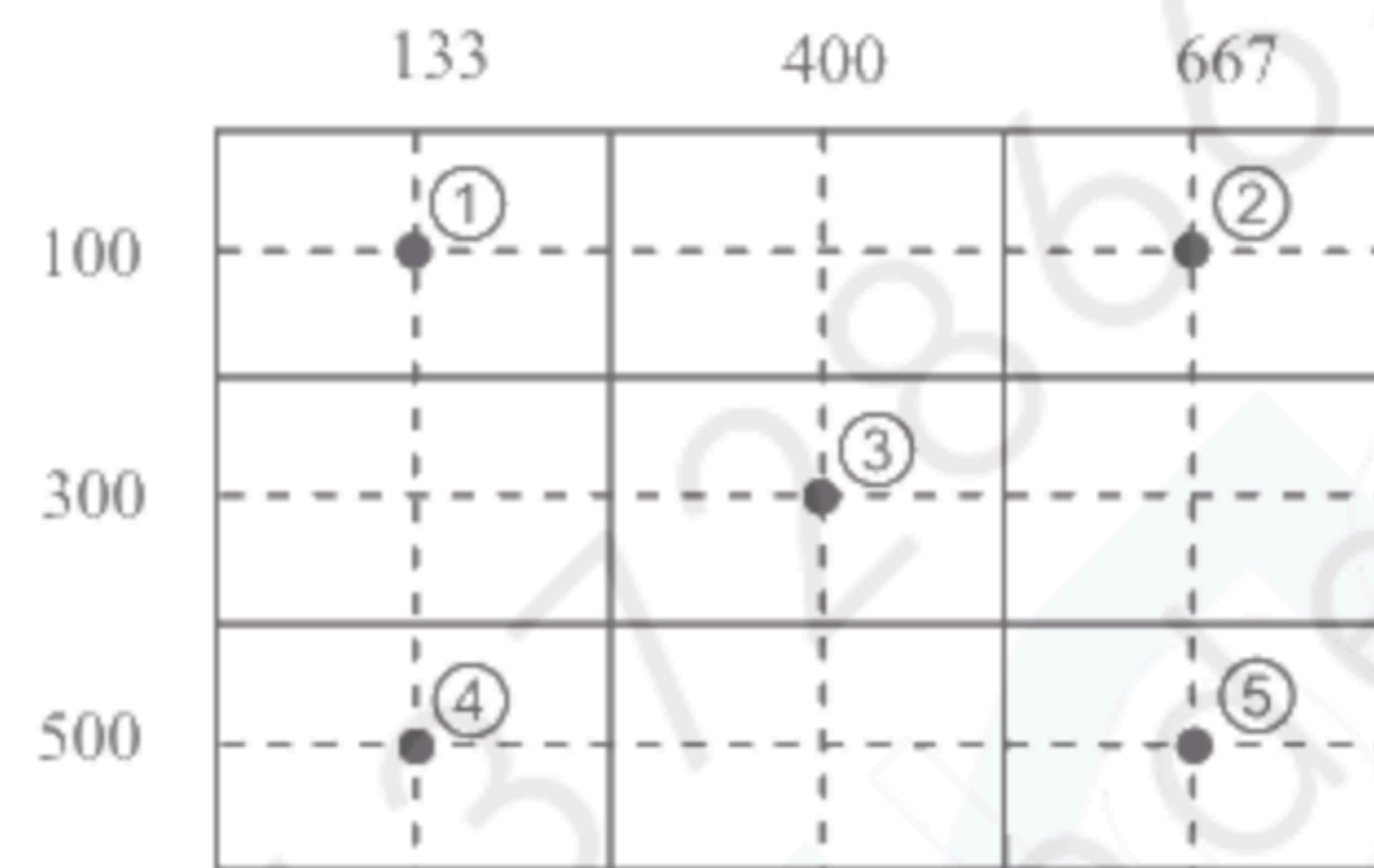
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.12.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

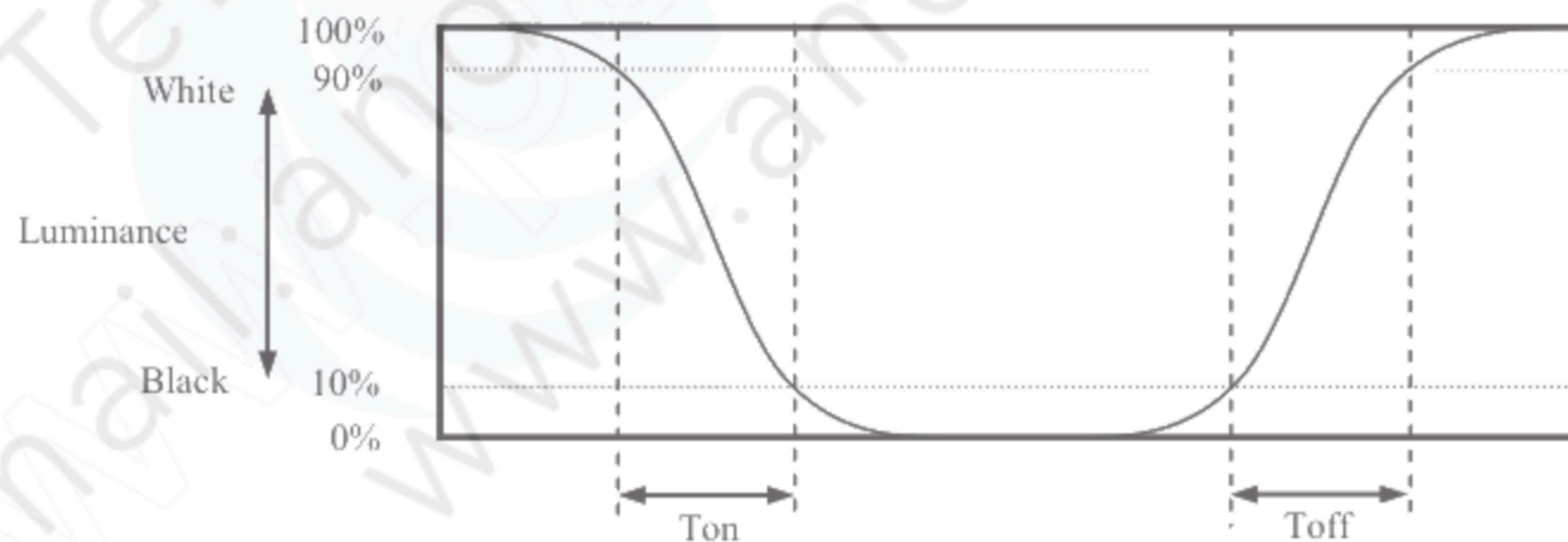
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

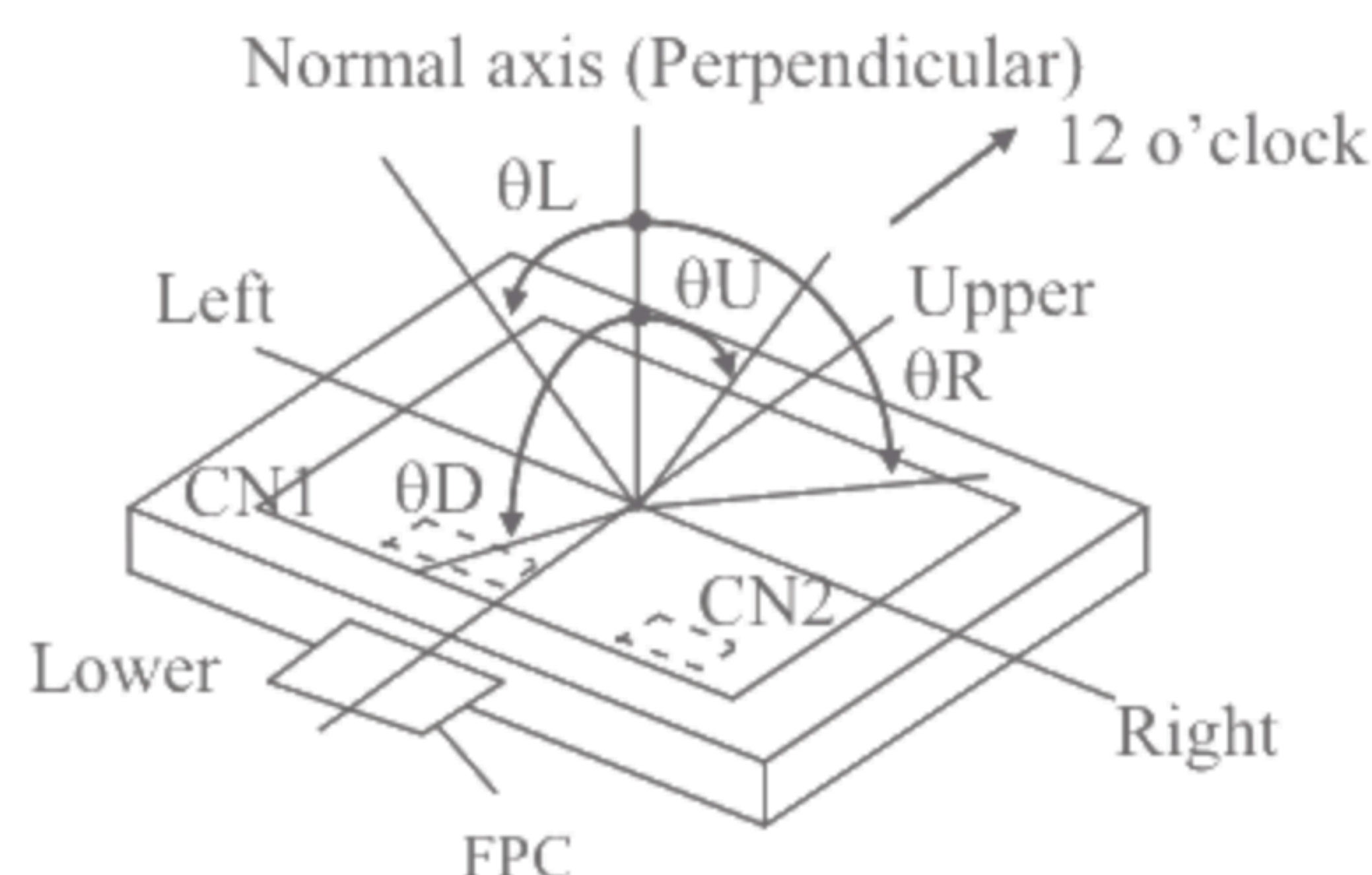


4.12.4 Definition of response times

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%	100,000	h
	80°C (Temperature of T/P surface and rear shield surface) Continuous operation, PWM duty ratio: 100%	70,000	h

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

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

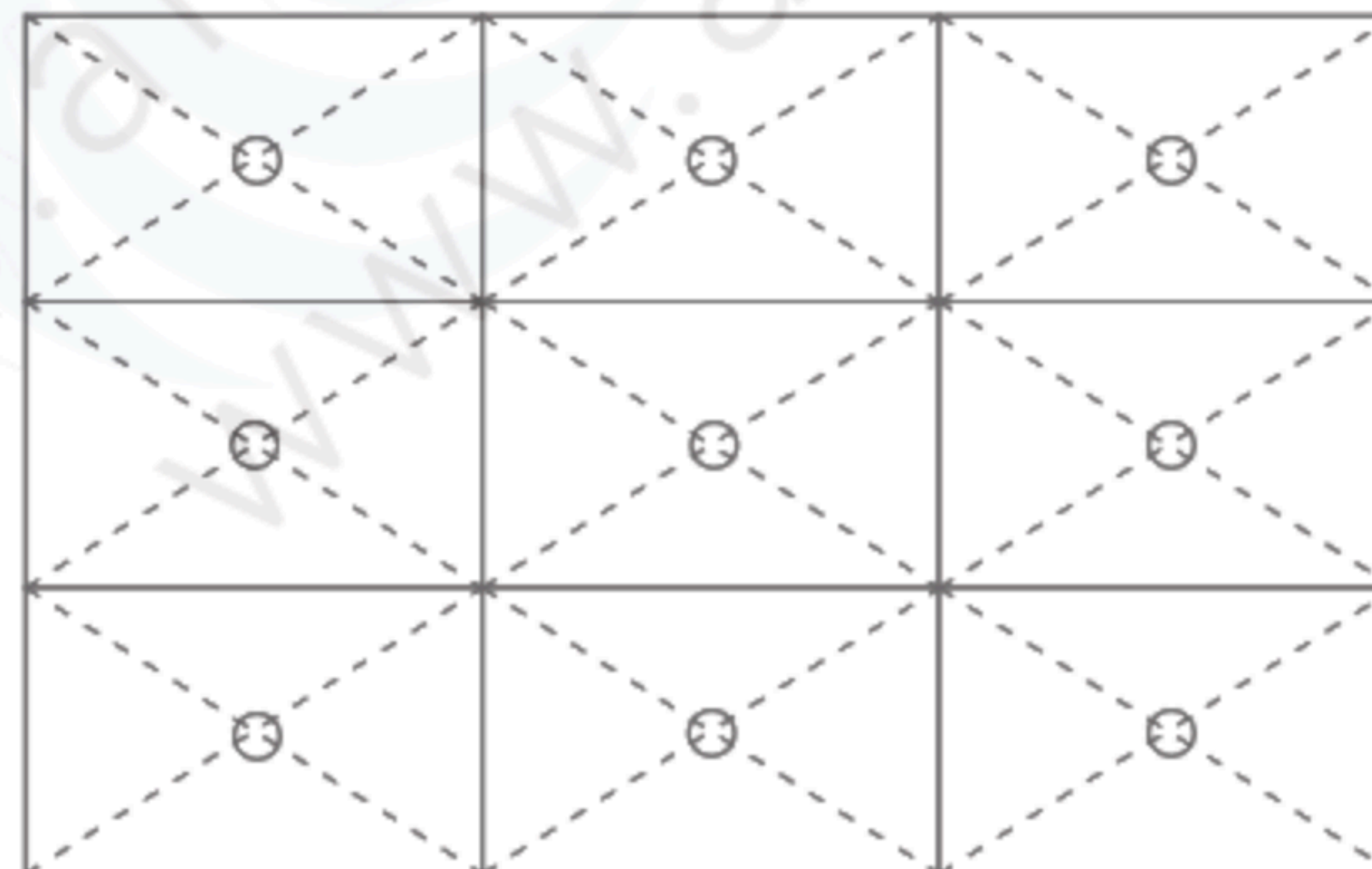
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① $60 \pm 2^{\circ}\text{C}$, RH= 90%, 240hours ② Display data is black.	No display malfunctions	
High temperature (Operation)	① $80 \pm 3^{\circ}\text{C}$, 240hours ② Display data is black.		
Heat cycle (Operation)	① $-30 \pm 3^{\circ}\text{C}$ 1hour $80 \pm 3^{\circ}\text{C}$ 1hour ② 50cycles, 4 hours/cycle ③ Display data is black.		
Thermal shock (Non operation)	① $-30 \pm 3^{\circ}\text{C}$ 30minutes $80 \pm 3^{\circ}\text{C}$ 30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.		
ESD (Operation)	① 150pF, 150Ω, $\pm 10\text{kV}$ ② 9 places on a panel surface ③ 10 times each place 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	No display malfunctions No physical damages	
Vibration (Non operation)	① 5 to 100Hz, 19.6m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 120 times each direction		
Mechanical shock (Non operation)	① 539m/s^2 , 11ms ② $\pm X$, $\pm Y$, $\pm Z$ directions ③ 5 times each direction		

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



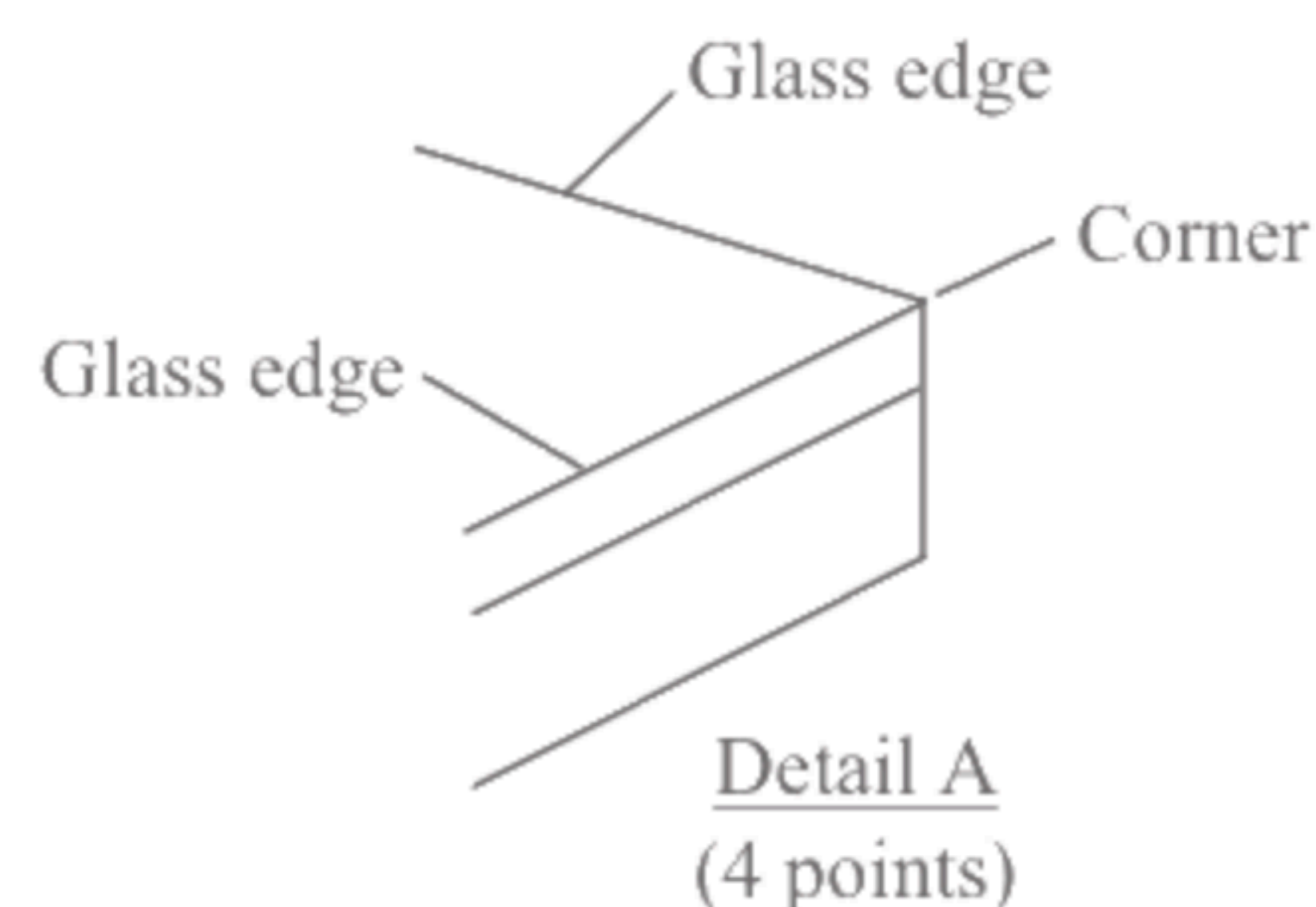
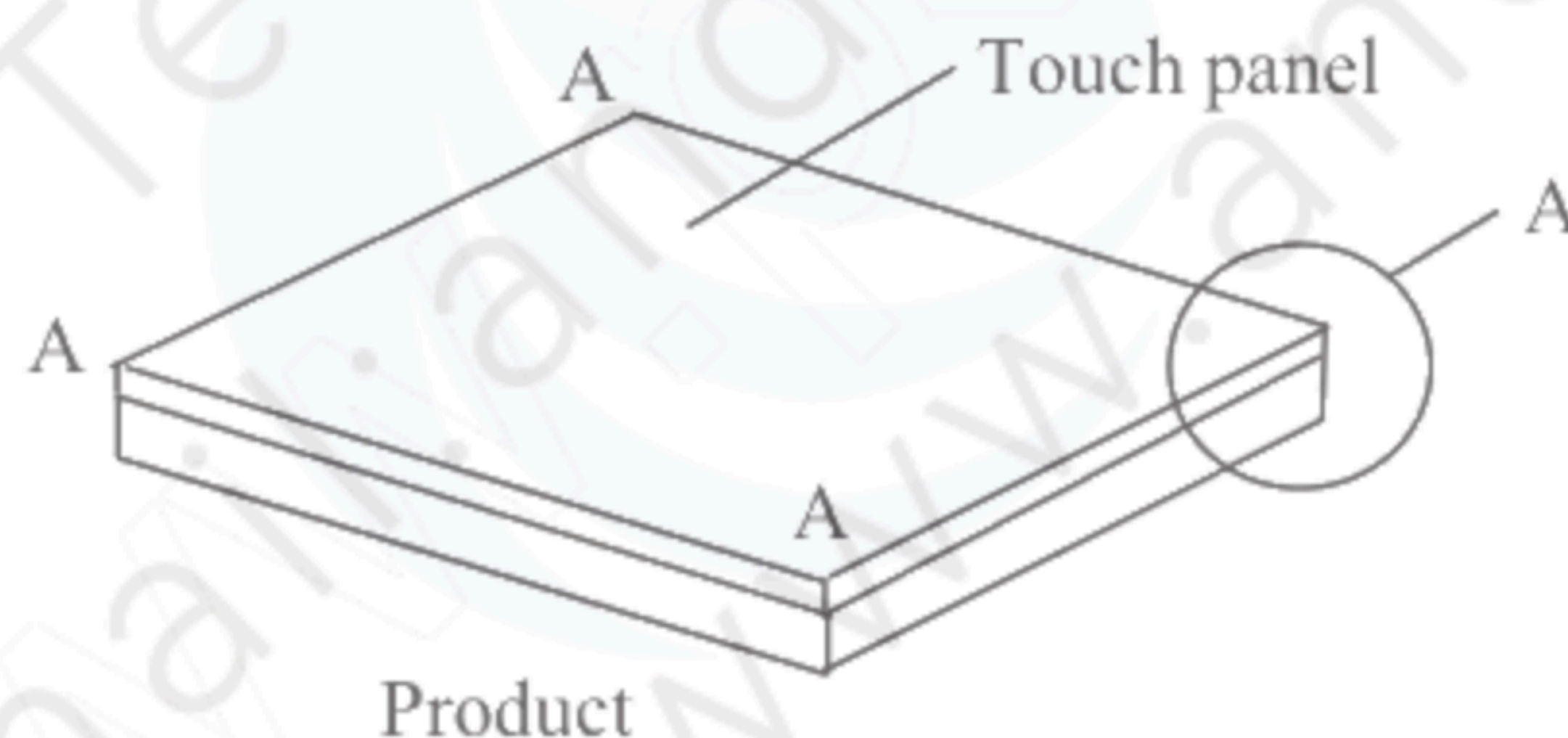
- * **Be taken care when handling the T/P. There is a danger of injury, because the T/P has the glass edge and corner which are sharp.**
- * **Do not shock and press the LCD panel, T/P and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than 539m/s^2 and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N ($\phi 16\text{mm}$ 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 $0.294\text{N}\cdot\text{m}$. Higher torque might result in distortion of the bezel.
- ⑦ Do not hit or rub the surface of T/P with hard materials, because it is easily scratched.

- ⑧ 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.
- ⑨ Do not press or rub on the sensitive product surface.
- ⑩ When cleaning the T/P surface, wipe it with a soft dry cloth.
- ⑪ Do not push or pull the interface connectors while the product is working.
- ⑫ 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.
- ⑬ When turning 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 T/P has polarizing characteristic. And the polarizer characteristics differ among products. Therefore, when seeing the displays through the other polarizing material (for example polarizing sunglasses), some displays can not be seen and some displays look different color darker because of polarizer characteristic mismatching between T/P and the other polarizing material.
- ⑦ If the product is subjected to direct sunlight for a long time, T/P transmission may be degraded.

7.3.4 Others

- ① All VCC and GND 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.
- ⑤ T/P operational performance (the number of touch, touch sensitivity and so on) may vary depending on usage environments (screen wet condition, thickness of using glove and so on). Please adjust parameters of a T/P controller as needed.



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



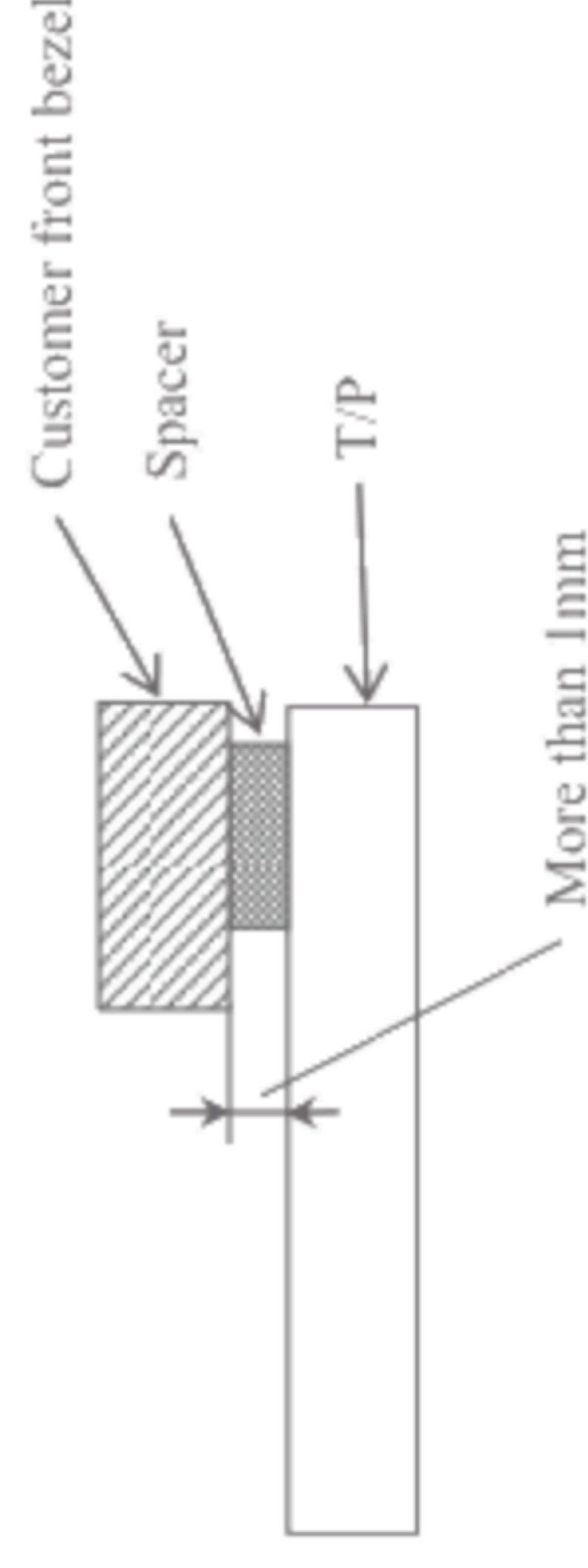
Note2: The torque for product mounting screws must never exceed 0.294N·m.

Unit: mm

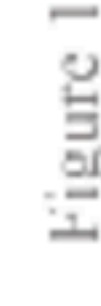
If a customer put a front bezel on the T/P, please take care the following items.

- 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.



- 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).



- 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.

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Unit: mm

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

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-2298	Feb. 29, 2016	Revision contents New issue Signature of writer <i>Approved by</i>  <u>R. KAWASHIMA</u> <i>Checked by</i>  <u>E. YOSHIMURA</u> <i>Prepared by</i>  <u>E. YOSHIMURA</u>