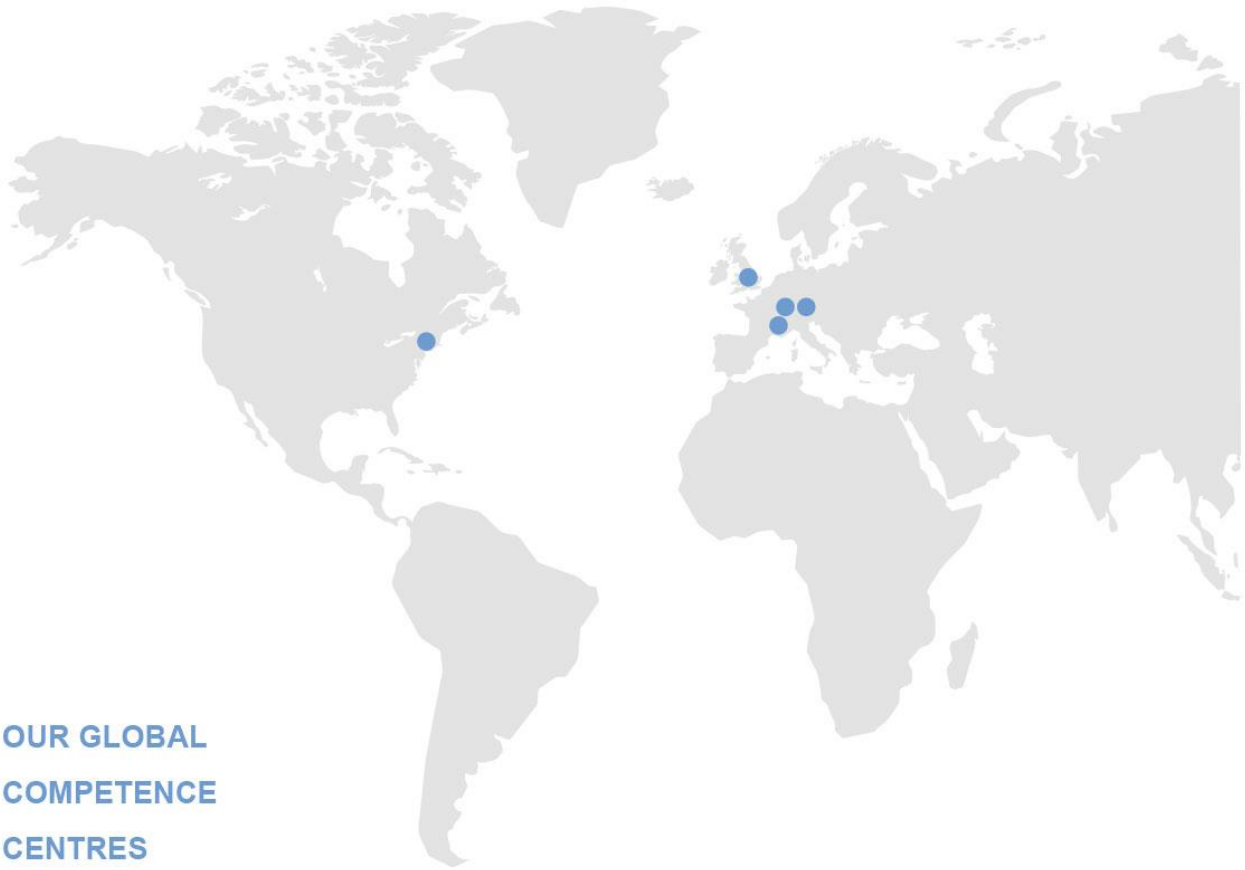
FORTEC
ELEKTRONIK AG



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APOLLO DISPLAY TECHNOLOGIES

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Datasheet

Tianma

NL8060BC26-35BA

10.4" TFT Display

NL-60-052

TFT COLOR LCD MODULE

NL8060BC26-35BA

26cm (10.4 Type)
SVGA
LVDS interface (1port)

DATA SHEET

DOD-PP-3141 (4th edition)

This DATA SHEET is updated document from DOD-PP-2988(3).

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 TMJ 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.

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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.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL8060BC26-35BA 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

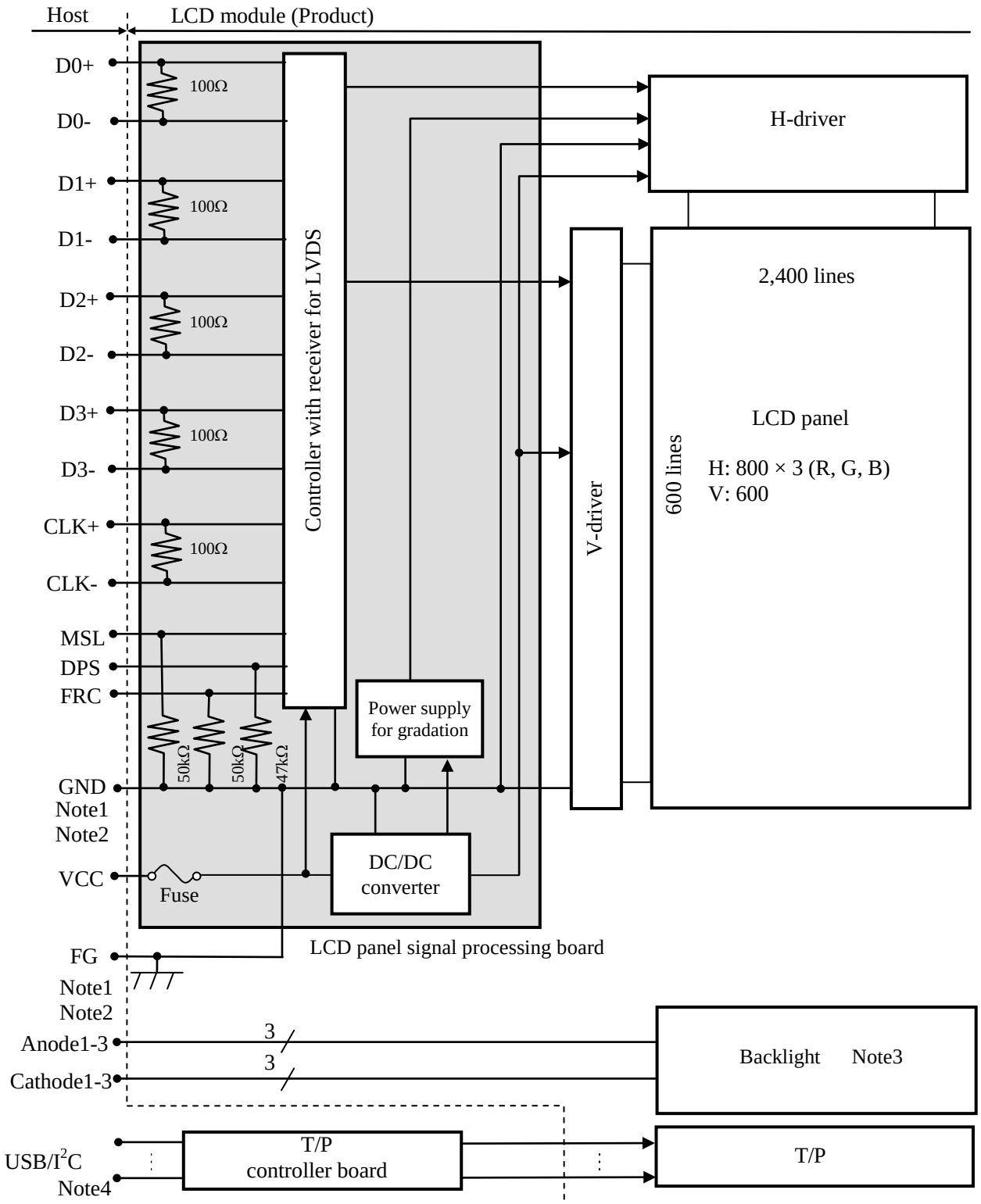
1.3 FEATURES

- Projected capacitive touch panel (PCAP T/P) attached
- PCAP Generation 2 ☆
- T/P 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
- Long life LED backlight
- Replaceable lamp for backlight
- Acquisition product for UL60950-1/CSA C22.2 No.60950-1-03 (File number: E170632)
- Compliance with the European RoHS directive (2011/65/EU) and Delegated Directive (2015/863/EU, Amending Annex II of 2011/65/EU) ☆

2. GENERAL SPECIFICATIONS

Display area	211.2 (H) × 158.4 (V) mm
Diagonal size of display	26cm (10.4 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	0.088 (H) × 0.264 (V) mm
Pixel pitch	0.264 (H) × 0.264 (V) mm
Module size (Including T/P)	243.0 (W) × 185.1 (H) × 11.9 (D) mm (typ.)
Weight	600 g (typ.)
Contrast ratio	900:1 (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 ($\gamma \fallingdotseq$ 2.2): Normal axis (perpendicular)
Color gamut	*At LCD panel center* 40 % (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→90%)* 18 ms (typ.)
Luminance	*At IL= 50mA/One circuit* 350 cd/m^2 (typ.)
T/P type	Projected capacitive (Recommended T/P controller board (Option) • T/P controller board: PTPW16/17)
T/P surface	Bare glass
T/P pencil-hardness	6H (min.) [by JIS K5600]
T/P cover glass	Thickness: 0.7mm glass
T/P bonding method	Perimeter-bonding (with air gap)
Signal system	LVDS interface (1 port) (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
Backlight	LED backlight: (Replaceable part • Lamp holder set: 104LHS56) (Recommended LED driver board (Option) • LED driver board: 104PW03F • Corresponding wiring harness: 121CBL02)
Power consumption	*At IL= 50mA/One circuit, Checkered flag pattern,* *Driving with the recommended T/P controller board, The number of touch= 10* 3.8W (typ.)

3. BLOCK DIAGRAM

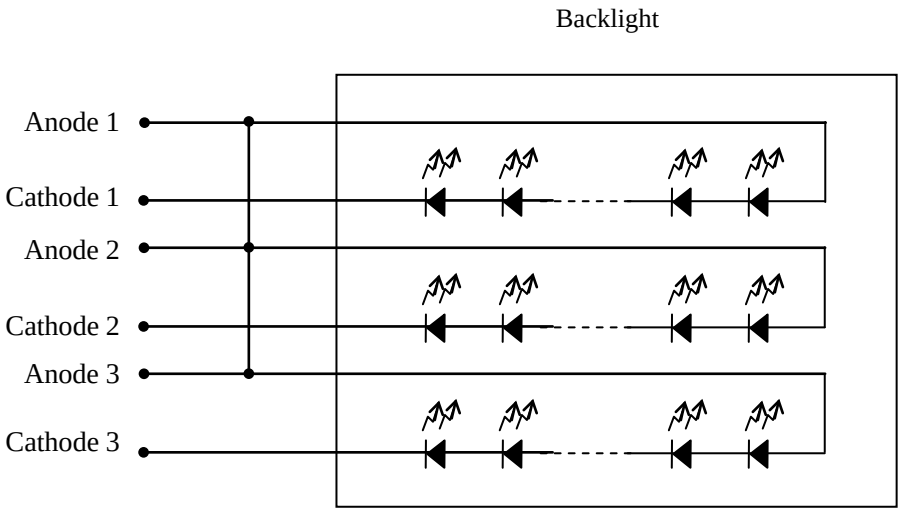


Note1: Relation between GND (Signal ground) and FG (Frame ground) in the LCD module is as follows.

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: Backlight in detail



Note4: Refer to the specifications of T/P controller board.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size (Including T/P)	243.0 ± 0.5 (W) × 185.1 ± 0.5 (H) × 11.9 ± 0.6 (D)	Note1	mm
Display area	211.2 (H) × 158.4 (V)	Note1	mm
Weight	600 (typ.), 640 (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 +4.0	V	Ta= 25°C
Input voltage for signals	Display signals Note2	VD	-0.3 to VCC +0.3	V	
	Function signals Note3	VF			
Backlight	Forward current	IL	60	mA	per one circuit Ta= 25°C
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/m^3	Ta= 80°C

Note1: Regarding the driving of T/P, refer to the specifications of T/P controller board.
Note2: D0+/-, D1+/-, D2+/-, D3+/-, CLK+/-
Note3: DPS, FRC, 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	-	250 Note1	370 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	μA	-
	Low	IFL1	-300	-	-	μA	
Input current for FRC signal	High	IFH2	-	-	300	μA	
	Low	IFL2	-300	-	-	μA	
Input current for MSL signal	High	IFH3	-	-	300	μA	
	Low	IFL3	-300	-	-	μA	

Note1: Checkered flag pattern [by IEC61747-6]
Note2: Pattern for maximum current
Note3: This product works even 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 Backlight

(Ta= 25°C, Note1, Note2, Note3)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward current	IL	-	50.0	55.0	mA	-
Forward voltage	VL	15.9	18.0	20.4	V	Ta= +25°C at IL= 50mA/One circuit
		14.2	-	-		Ta= +80°C at IL= 50mA/One circuit
		-	-	22.4		Ta= -30°C at IL= 50mA/One circuit
		-	-	22.6		Ta= -30°C at IL= 55mA/One circuit

Note1: Please drive with constant current.

Note2: The above specifications are for one LED circuit of the backlight.

Note3: The Luminance uniformity may be changed depending on the current variation between 3 circuits. It is recommended that the current value difference among the circuits to be less than 5%.

4.3.3 Fuse

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

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	-	-	213.192	-	mm	Note5
	Vertical	-	-	160.396	-		

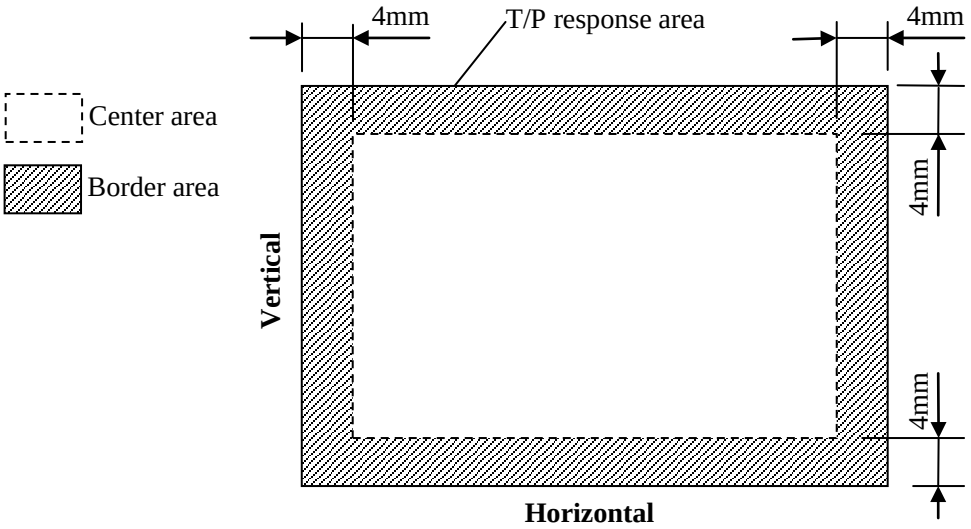
Note1: If a customer uses a recommended T/P controller board, specifications of the T/P controller board are given priority over the specifications in this table.

Note2: Definition of accuracy

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

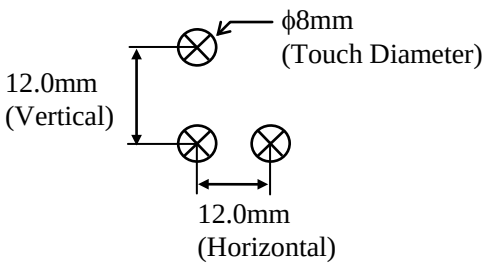
Acrc: Accuracy at center area

Acrb: Accuracy at border area



Input method is ϕ8mm conductive stylus.

Note3: Minimum distance for dual touch

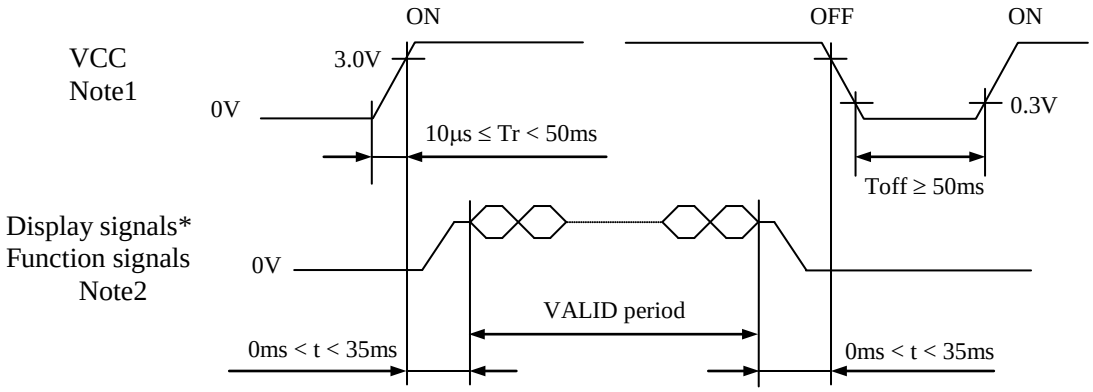


Note4: When using the recommended T/P controller board

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

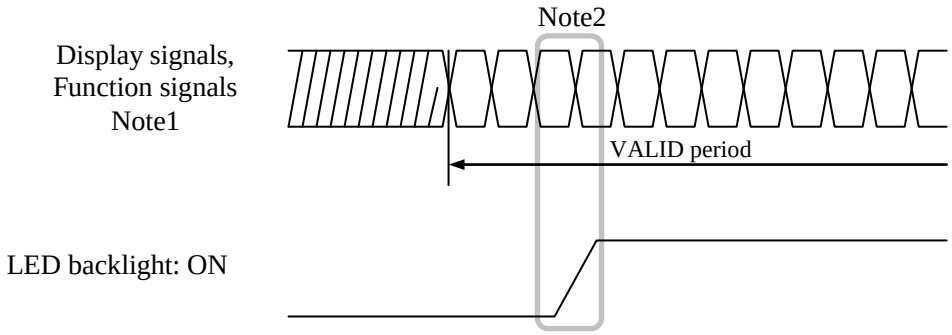


* These signals should be measured at the terminal of 100Ω resistance.

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, 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 : Reverse scan Low or Open : 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 Backlight

CN2 socket (LCD module side): SM08B-SRSS-TB (J.S.T. Mfg. Co., Ltd.)
Adaptable plug: SHR-08V-S, SHR-08V-S-B (J.S.T. Mfg. Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	A1	Anode1	-
2	K1	Cathode1	-
3	A2	Anode2	-
4	K2	Cathode2	-
5	A3	Anode3	-
6	K3	Cathode3	-
7	N. C.	-	Keep this pin Open.
8	N. C.	-	Keep this pin Open.

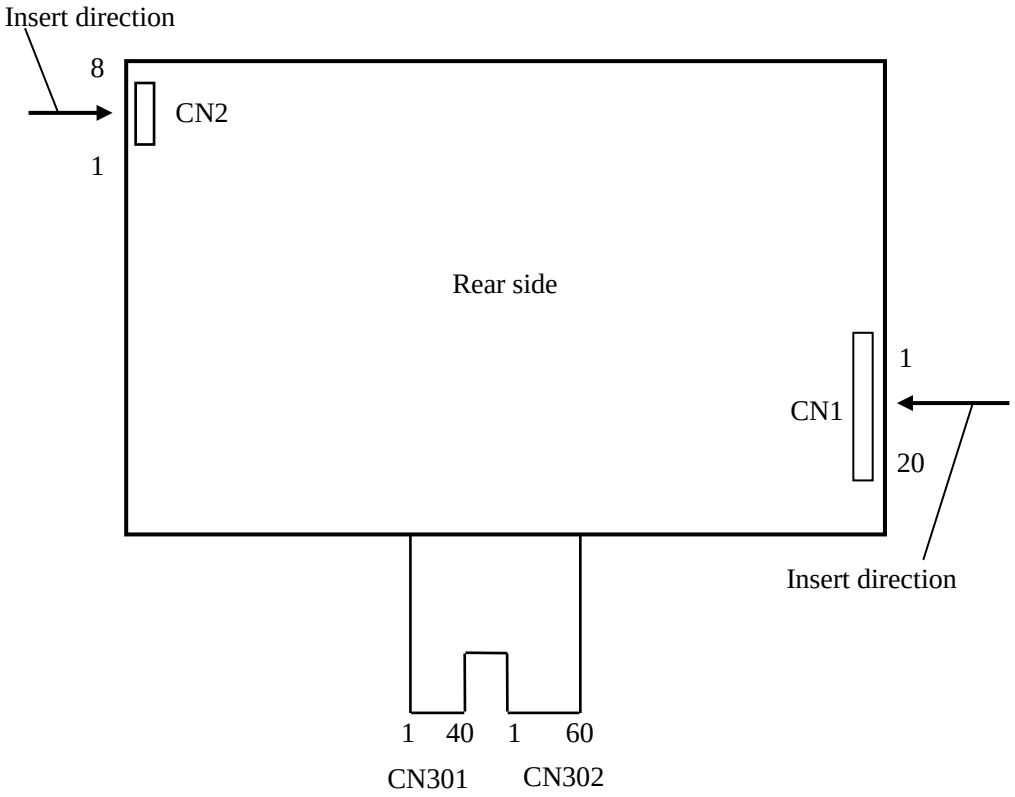
4.6.3 Touch panel

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))

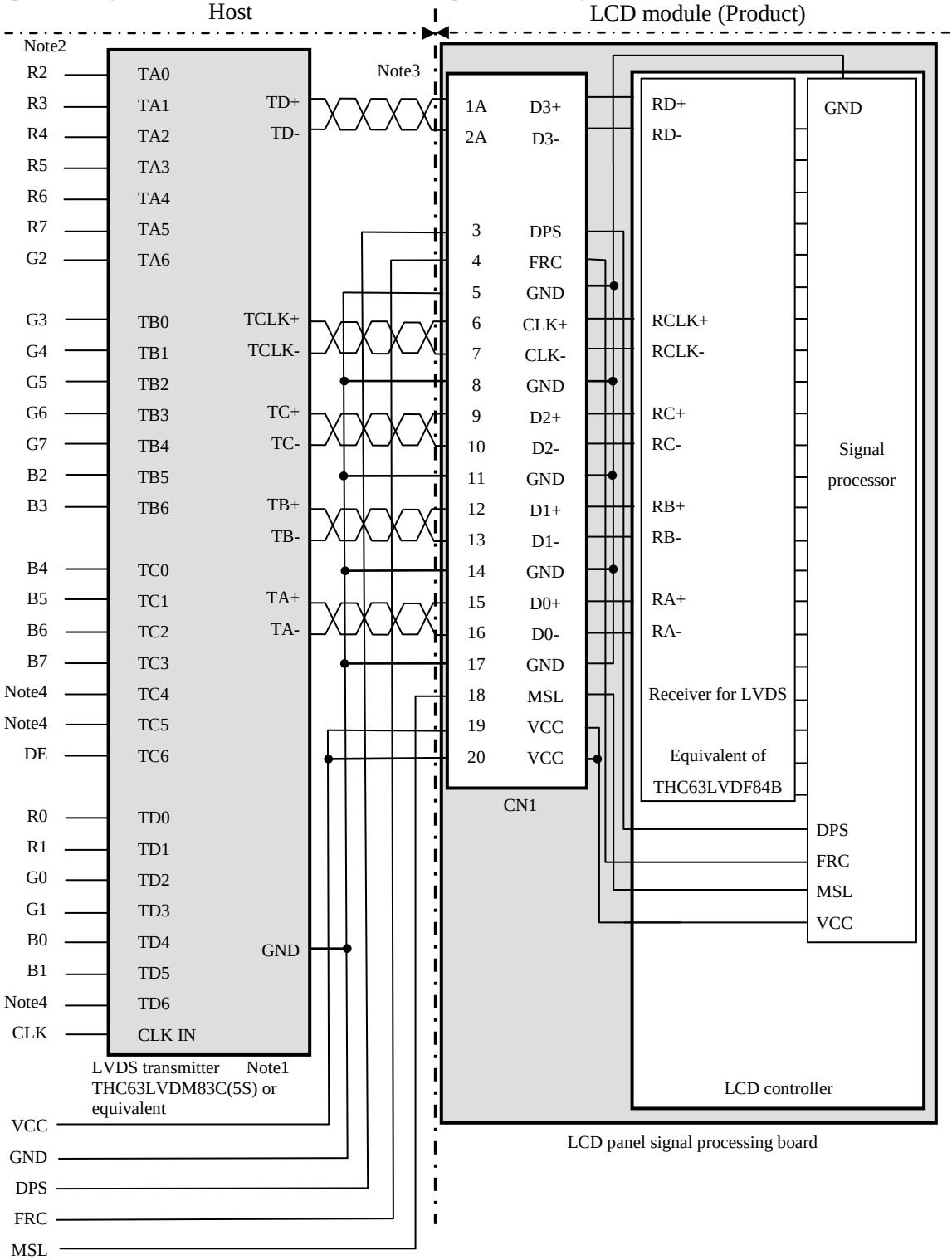
CN302: FPC (60 pins)
Adaptable socket: FH28-60S-0.5SH(05) (Hirose Electric Co., Ltd.(HRS))

4.6.4 Positions of plug and socket



4.6.5 Connection between receiver and transmitter for LVDS

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



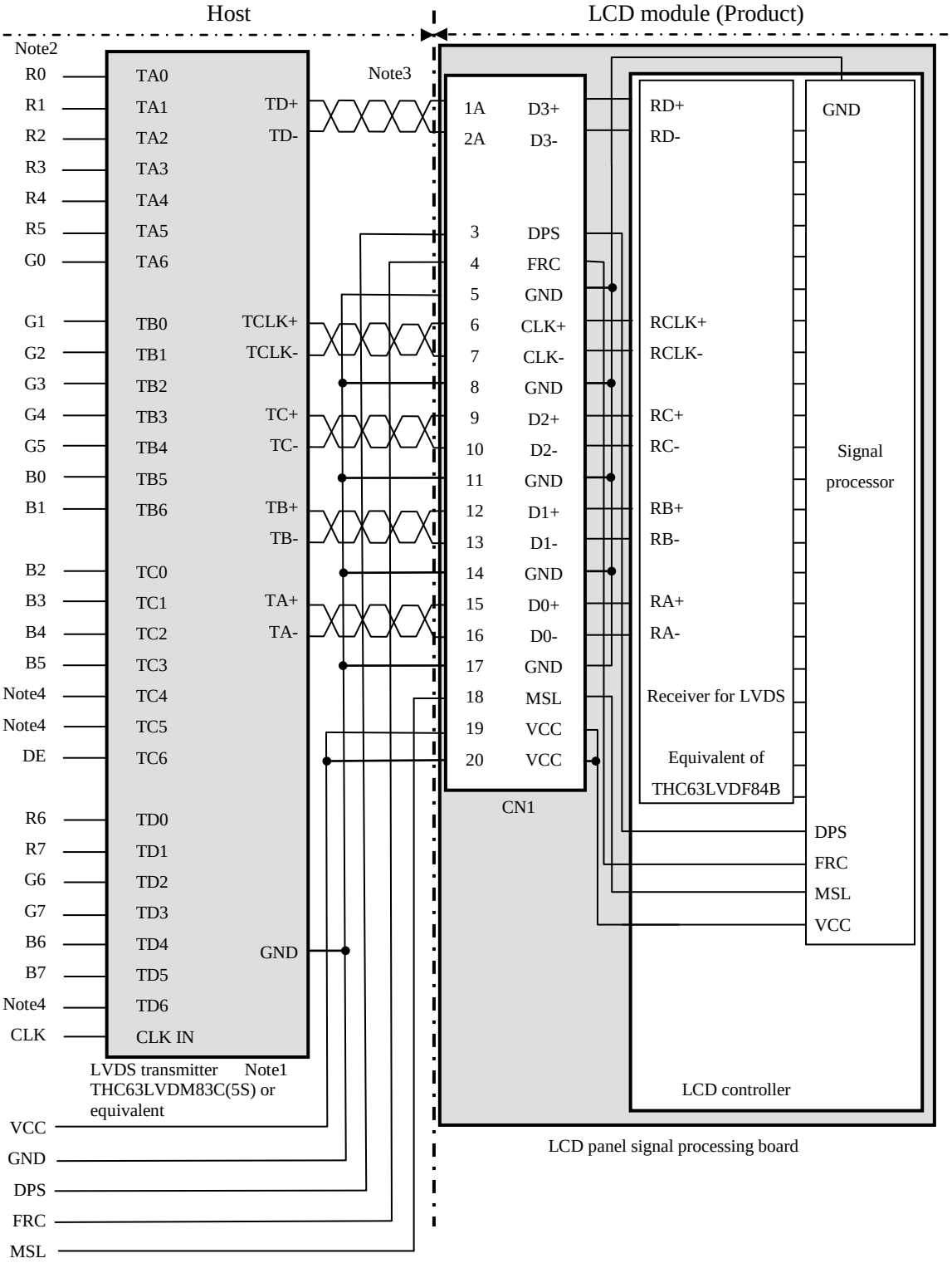
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent

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)



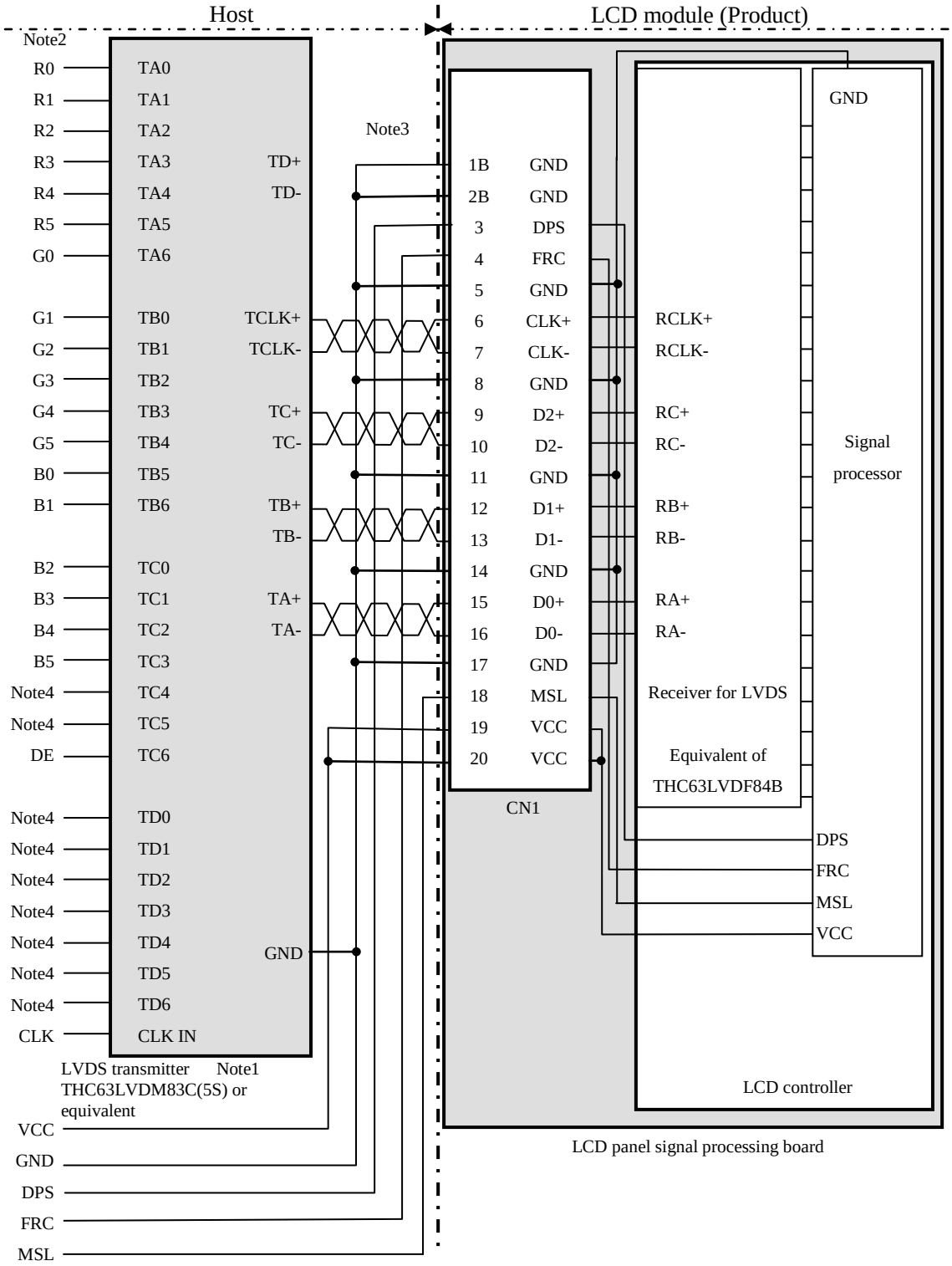
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent

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

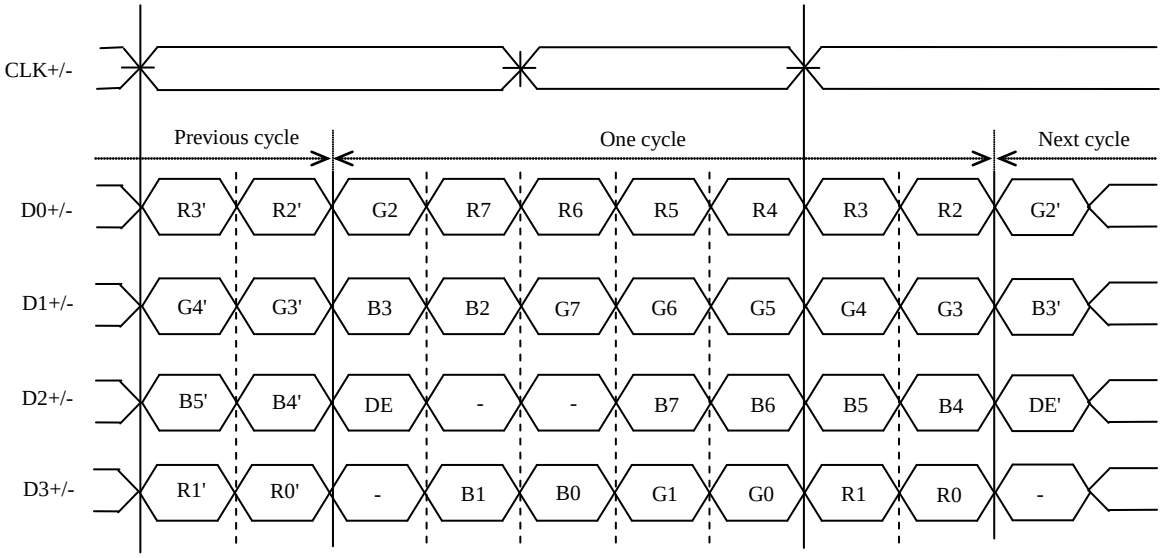
Note2: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R5, G5, B5

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.

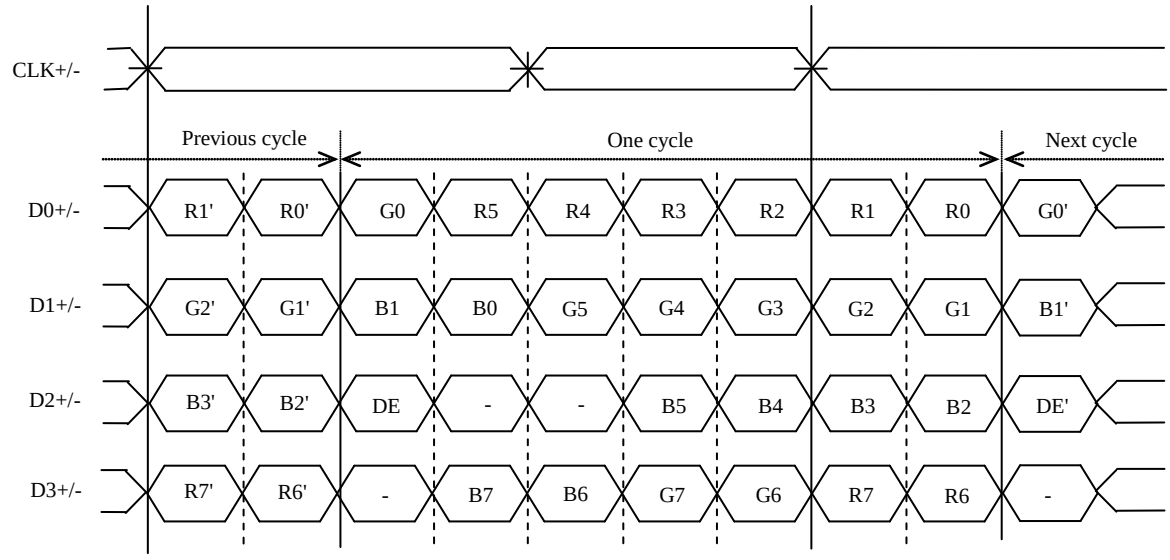
4.6.6 Input data mapping

(1) Input data signal: 8-bit, MAP A



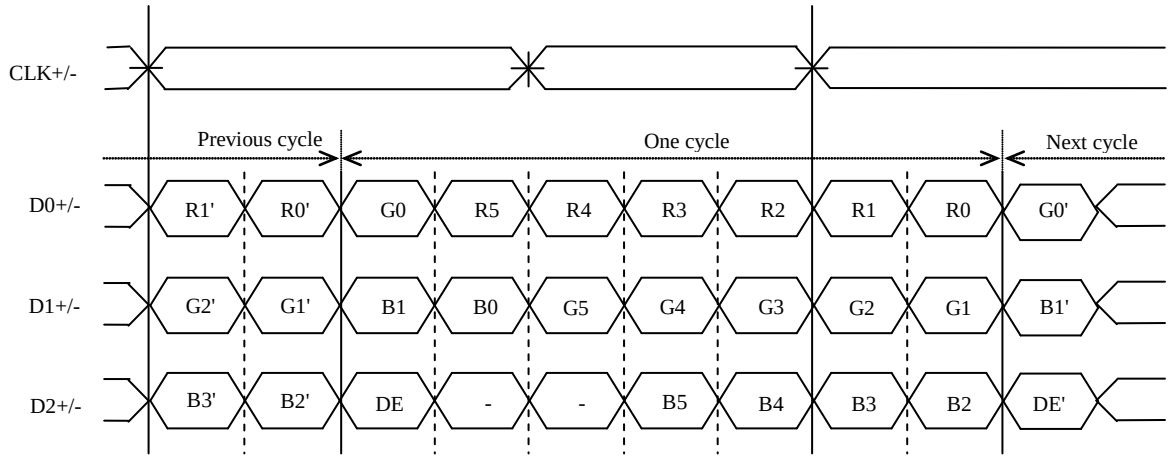
Note1: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R7, G7, B7
Note2: Twist pair wires with 100Ω(Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

(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.

(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.

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

4.7.1 Combinations of input data signals, FRC and MSL signals

This product can display equivalent of 16,777,216 colors and 262,144 colors by combination of input data signals, FRC and MSL signals. 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 signals**".)
Also the relation between display colors and input data signals is as follows.

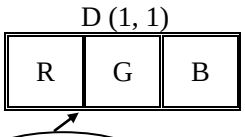
Display colors		Data signal (0: Low level, 1: High level)																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	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 ③.
(See "**4.7.1 Combinations of input data signals, FRC and MSL signals**".)
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



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.

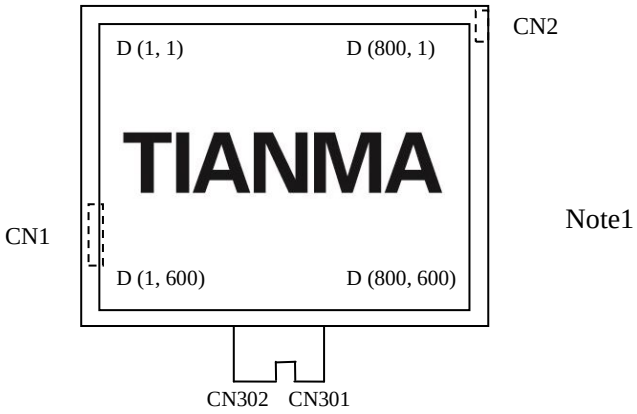


Figure1. Normal scan (DPS: Low or Open)

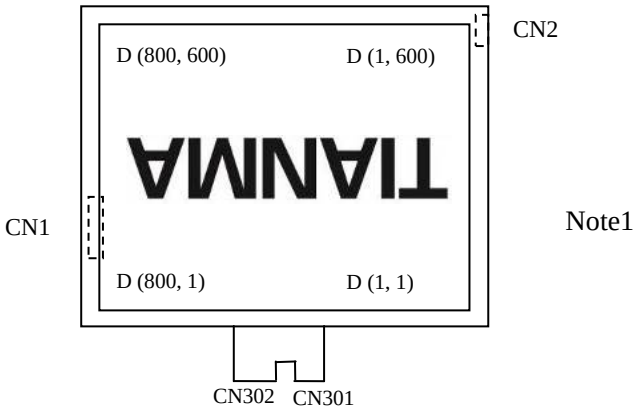
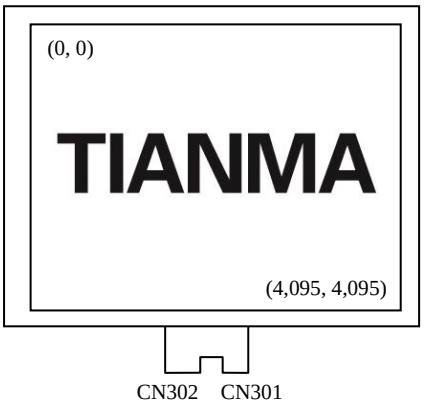


Figure2. Reverse scan (DPS: High)

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.

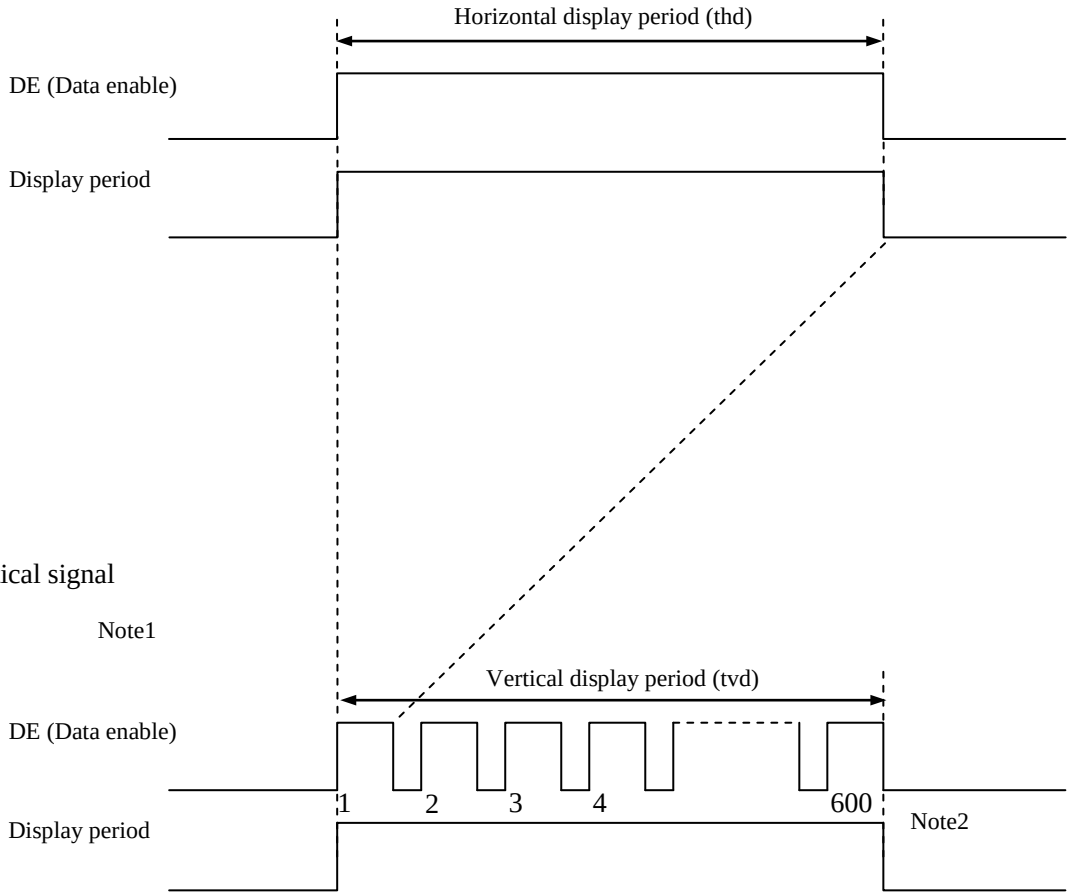


4.11 INPUT SIGNAL TIMINGS

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

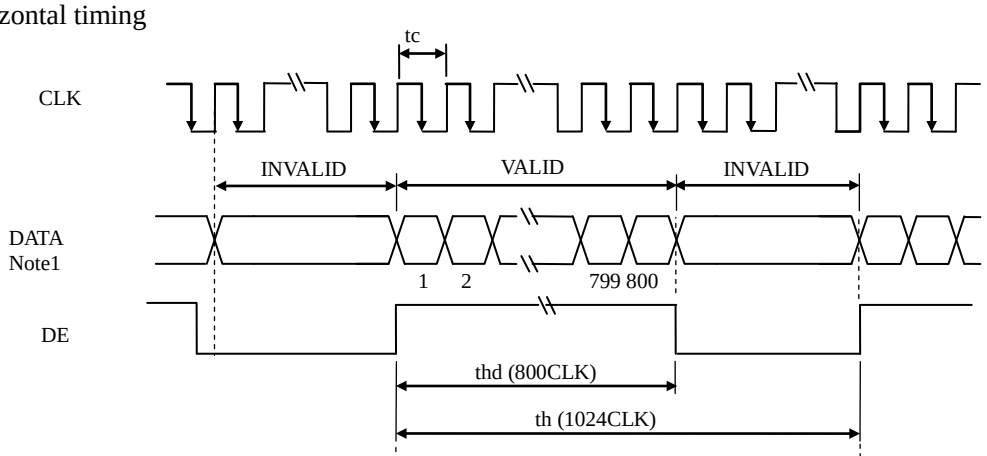
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

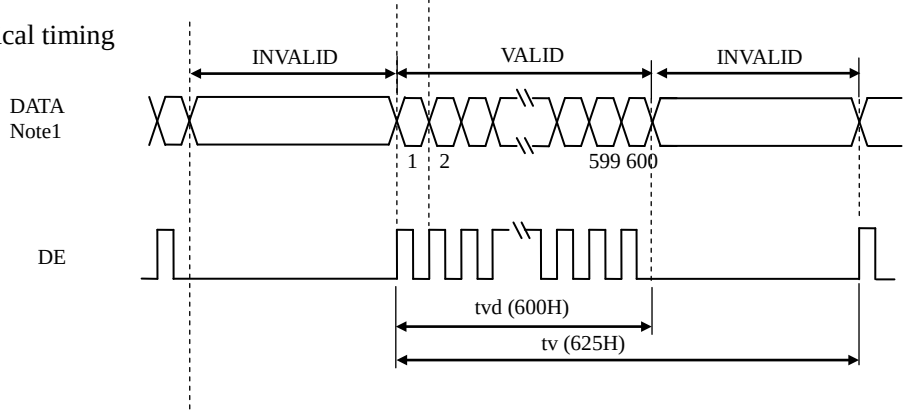
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

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)

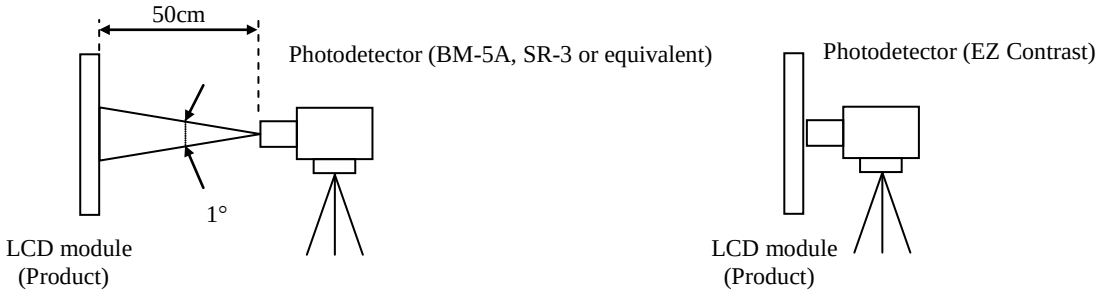
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	200	350	-	cd/m^2	BM-5A or equivalent	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	500	900	-	-	BM-5A or equivalent	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	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	-	0.559	-			
		y coordinate	Ry	-	0.342	-			
	Green	**x** coordinate	Gx	-	0.355	-			
		y coordinate	Gy	-	0.548	-			
	Blue	**x** coordinate	Bx	-	0.156	-			
		y coordinate	By	-	0.125	-			
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	-	3	5	ms	BM-5A or equivalent	Note6 Note7
		Black to White	Toff	-	15	21	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, IL= 50mA/One circuit, 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= 31 °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.

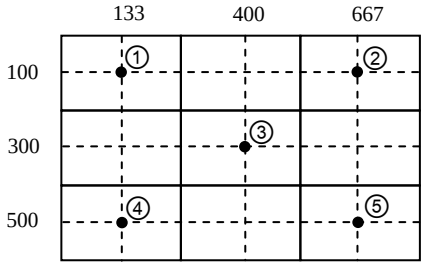
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.12.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

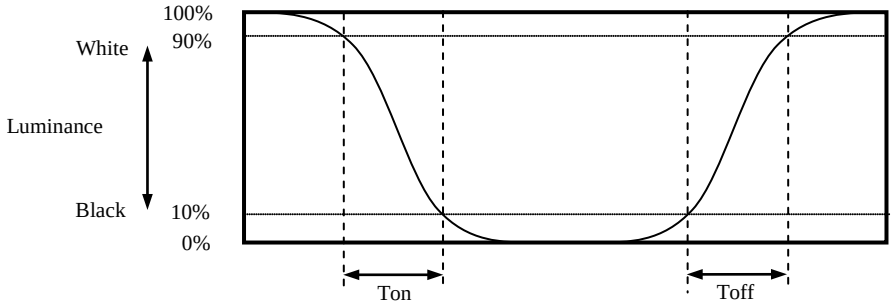
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

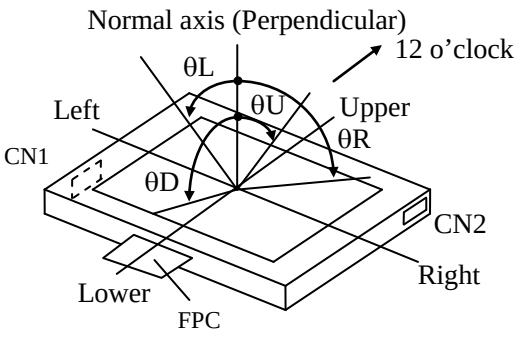


4.12.4 Definition of response times

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, IL= 50mA/One circuit	70,000	h
	80°C (Temperature of T/P surface and rear shield surface) Continuous operation, IL= 50mA/One circuit	60,000	

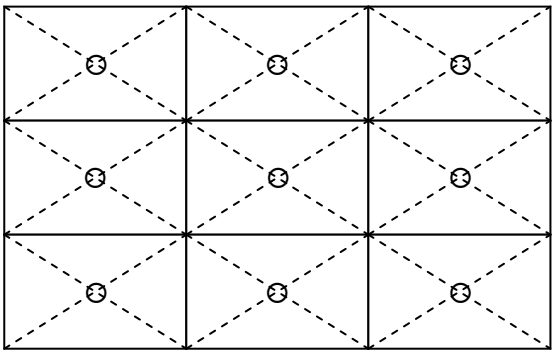
Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① +60 ± 2°C, RH= 90%, 240hours ② Display data is black.	No display malfunctions
High temperature (Operation)	① +80 ± 3°C, 240hours ② Display data is black.	
Heat cycle (Operation)	① -30 ± 3°C…1hour +80 ± 3°C…1hour ② 50cycles, 4 hours/cycle ③ Display data is black.	
Thermal shock (Non operation)	① -30 ± 3°C…30minutes +80 ± 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 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	
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	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 539m/ s^2, 11ms ② ±X, ±Y, ±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.

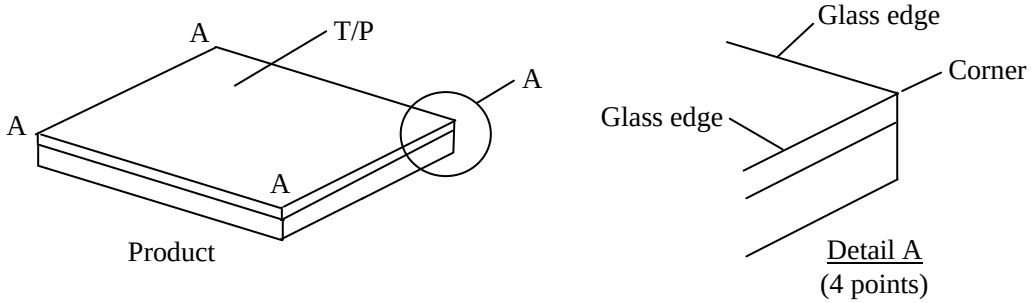
7.2 CAUTIONS

- **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 (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 0.294N·m. Higher torque might result in distortion of the bezel.
⑦ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). 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 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 polarizing 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 polarizing 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

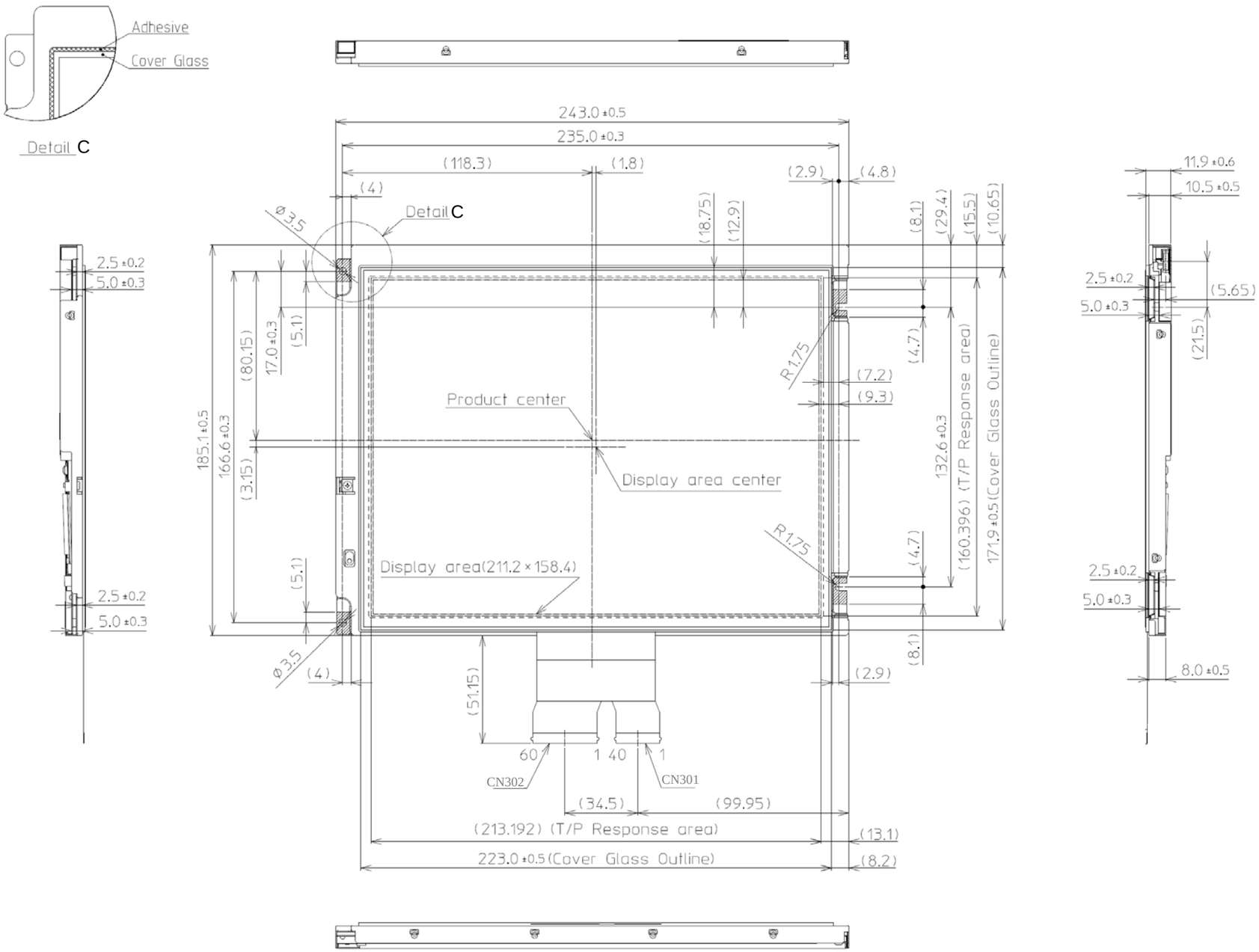
① All VCC and GND terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing lamp holder set.
④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to TMJ 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.
⑥ The information of China RoHS (Ⅱ) six hazardous substances or elements in this product is as follows.

China RoHS (Ⅱ) six hazardous substances or elements					
Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenys (PBB)	Polybrominated Biphenyl Ethers (PBDE)
×	○	○	○	○	○

Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of GB/T26572-2011 standard regulation.
×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of GB/T26572-2011 standard regulation.

8. OUTLINE DRAWINGS

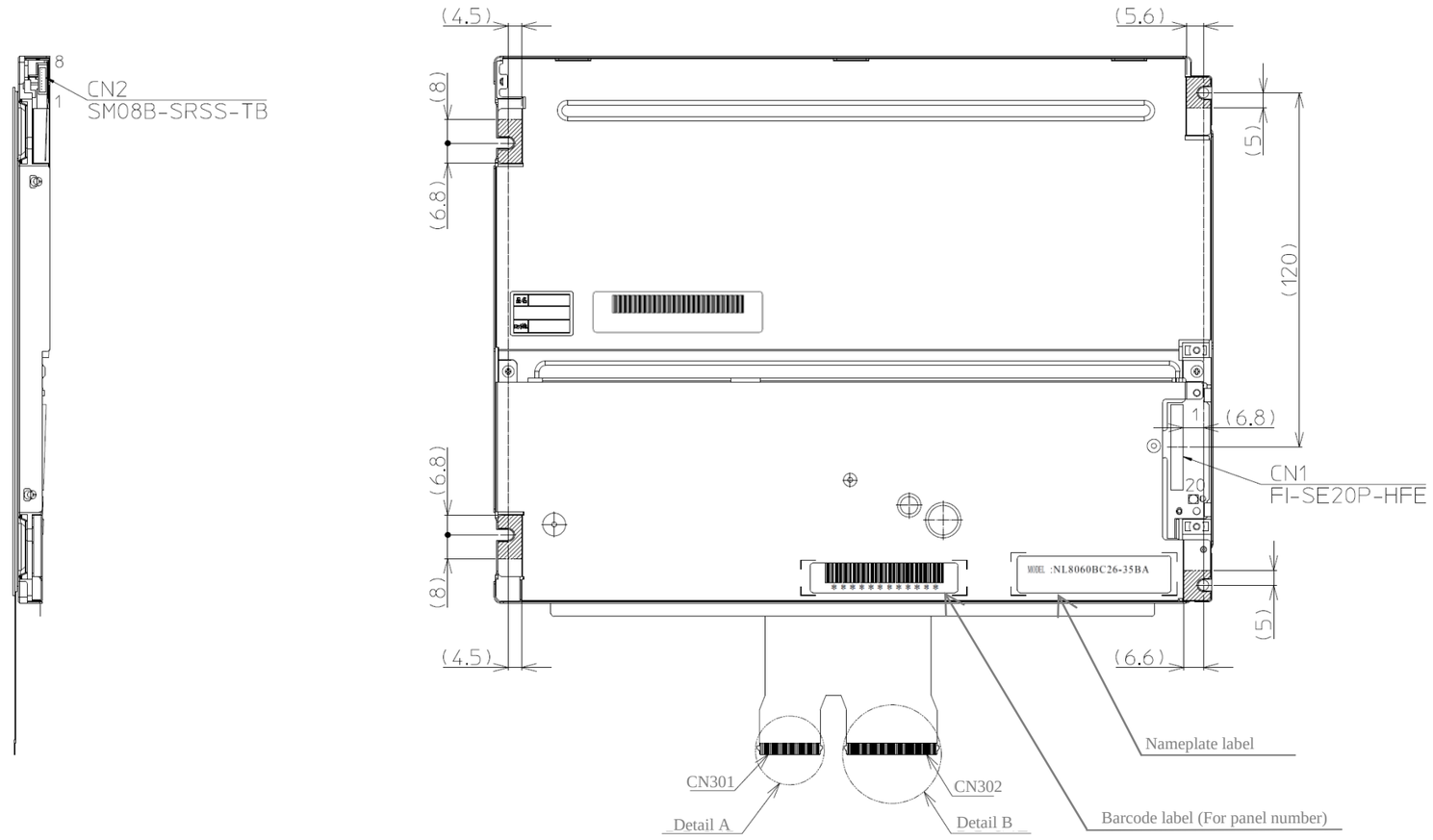
8.1 FRONT VIEW

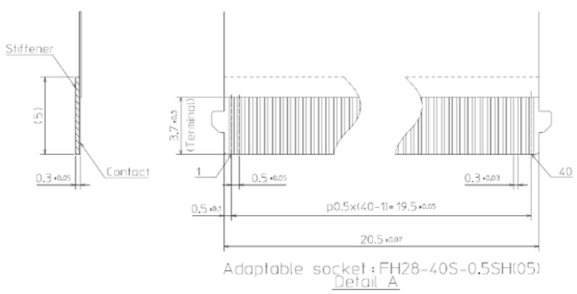


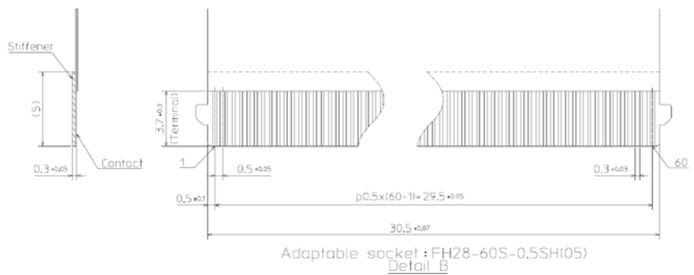
Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.294N·m.
Note3: ▨ Mounting hole portions (4 pieces)

Unit: mm

8.2 REAR VIEW







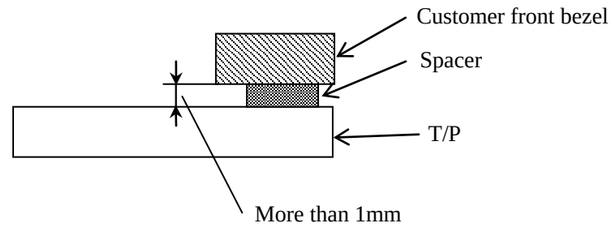
Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.294N·m.
Note3: ▨ Mounting hole portions (4 pieces)

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).

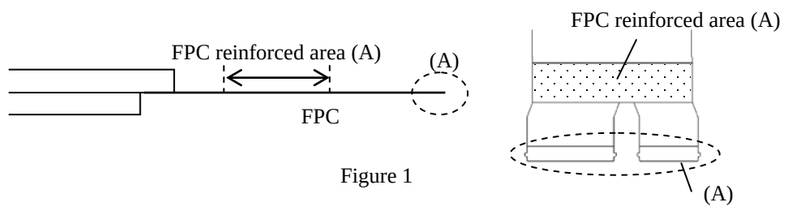


Figure 1

・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

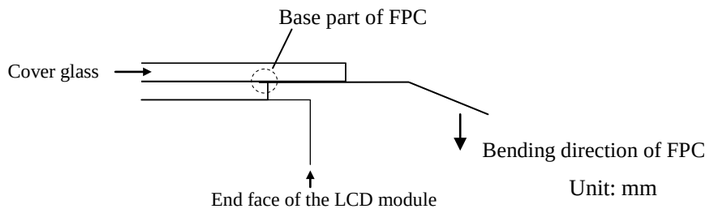


Figure 2

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