PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NLB104SV01L-01

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

PRELIMINARY DATA SHEET
DOD-PP-2093 (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.

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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 NLB104SV01L-01 is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

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

- 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
- Built in LED driver
- Replaceable lamp for backlight
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

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	243.0 (W) × 185.1 (H) × 10.5 (D) mm (typ.)
Weight	430g (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)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At, LCD panel center* 40% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10% ←→ 90%)* 18ms (typ.)
Luminance	*At the maximum luminance control* (400)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: 104LHS203
Power consumption	*At the maximum luminance control, Checkered flag pattern* (4.7)W (typ.)

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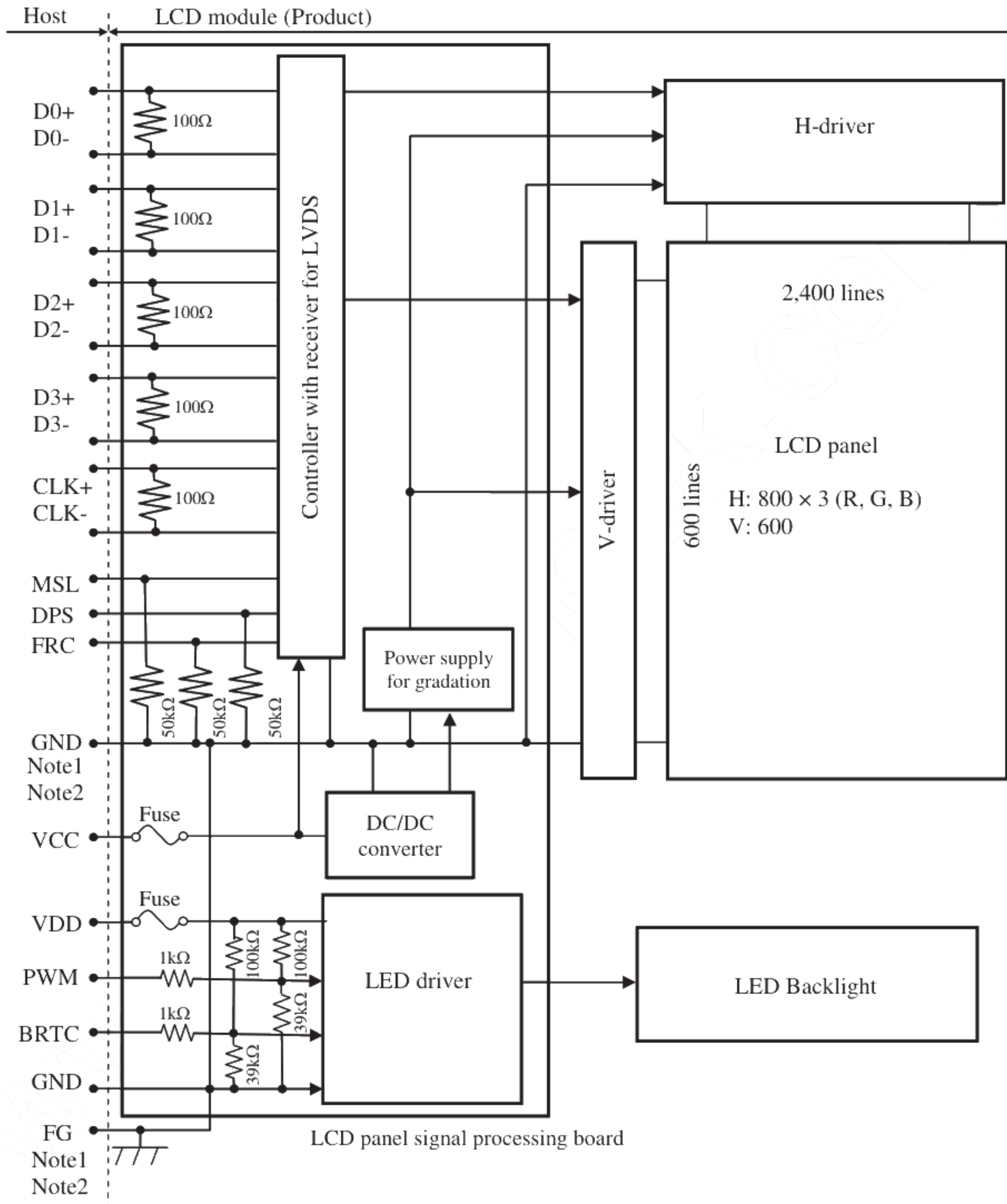
Note1: Relation between GND (Signal ground) and FG (Frame ground) in the LCD module is as follows.

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.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	243.0 ± 0.5 (W) $\times$ 185.1 ± 0.5 (H) $\times$ 10.5 ± 0.5 (D)	Note1	mm
Display area	211.2 (H) $\times$ 158.4 (V)	Note1	mm
Weight	430 (typ.), 465 (max.)		g

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

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board	VCC	-0.3 to +3.96	V	
	LED driver	VDD	-0.3 to +15.0		
Input voltage for signals	Display signals Note1	VD	-0.3 to VCC+0.3	V	Ta= 25°C
	Function signals Note2	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	-20 to +70	°C	Note3
	Rear surface	TopR	-20 to +70	°C	Note4
Relative humidity Note5		RH	≤ 90	%	Ta ≤ 40°C
			≤ 80	%	40°C < Ta ≤ 50°C
Absolute humidity Note5		AH	≤ 66 Note6	g/m^3	Ta > 50°C

Note1: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-.
Note2: DPS, FRC and MSL
Note3: Measured at LCD panel surface (including self-heat)
Note4: Measured at LCD module's rear shield surface (including self-heat)
Note5: No condensation
Note6: 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	-	320 Note1	480 Note2	mA	at VCC= 3.3V
Permissible ripple voltage		VRP	-	-	100	mVp-p	for VCC
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2V Note3
	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 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 Note2		IDD	-	(300)	(370) Note3	mA	At the maximum luminance control
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD
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	Note4, Note5
PWM duty ratio		DR_{PWM}	1	-	100	%	Note6, Note7
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. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.

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

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 1μs. 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	≤ 100	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	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 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board
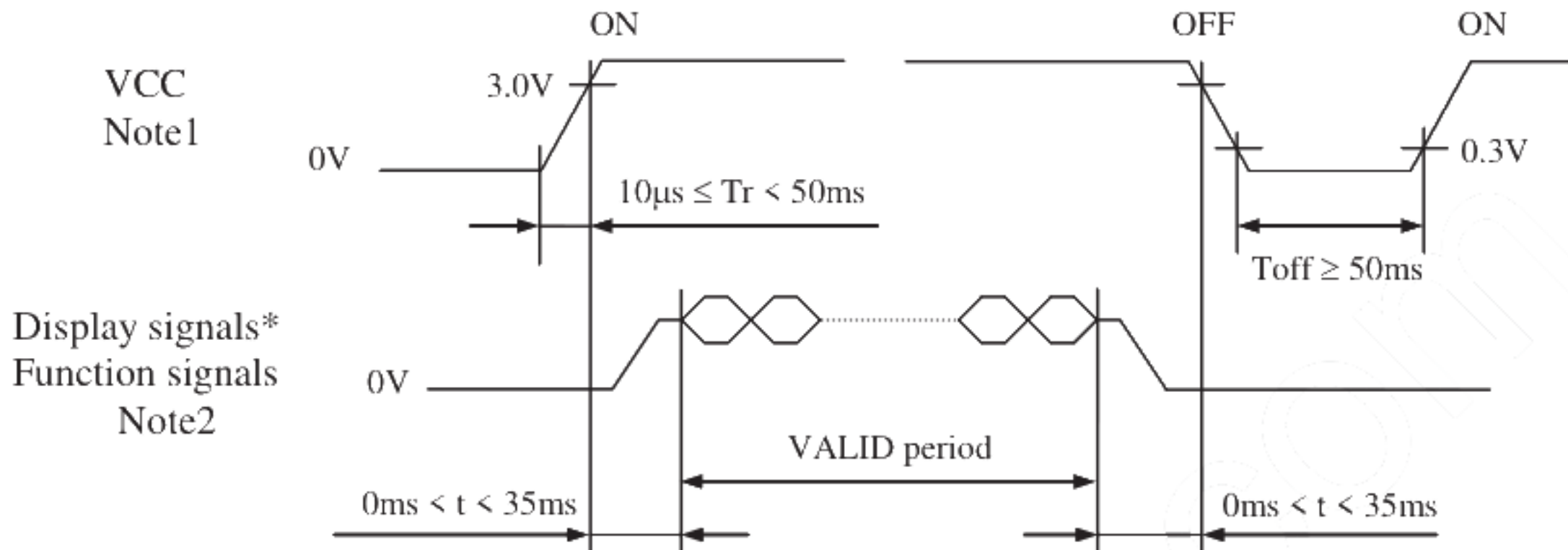
* These signals should be measured at the terminal of 100Ω resistance.

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.

4.4.2 LED driver
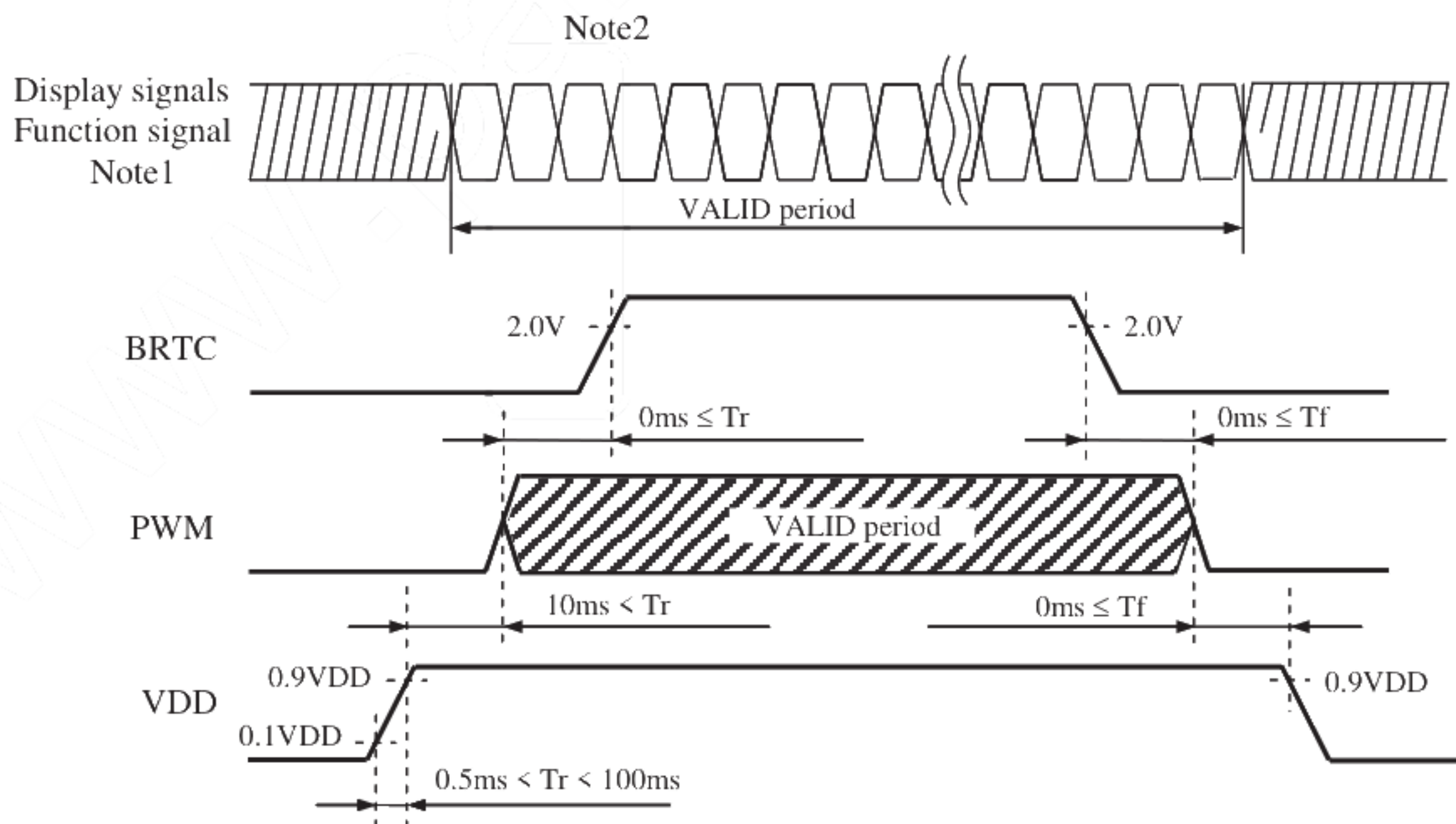
Note1: These are the display and function signals for LCD panel signal processing board.
Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 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 "**4.6 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 VCC and GND terminals should be used without any non-connected lines.
Note4:　See "**4.8 SCANNING DIRECTIONS**".
Note5:　See "**4.5.4 Connection between receiver and transmitter for LVDS**".

4.5.2 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	PWM Dimming High or Open: 100% (Max. Luminance)

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

4.5.3 Positions of plug and socket

Rear side

Insert direction   Insert direction

1 ↓ 6   1 ↓ 20

CN2   CN1
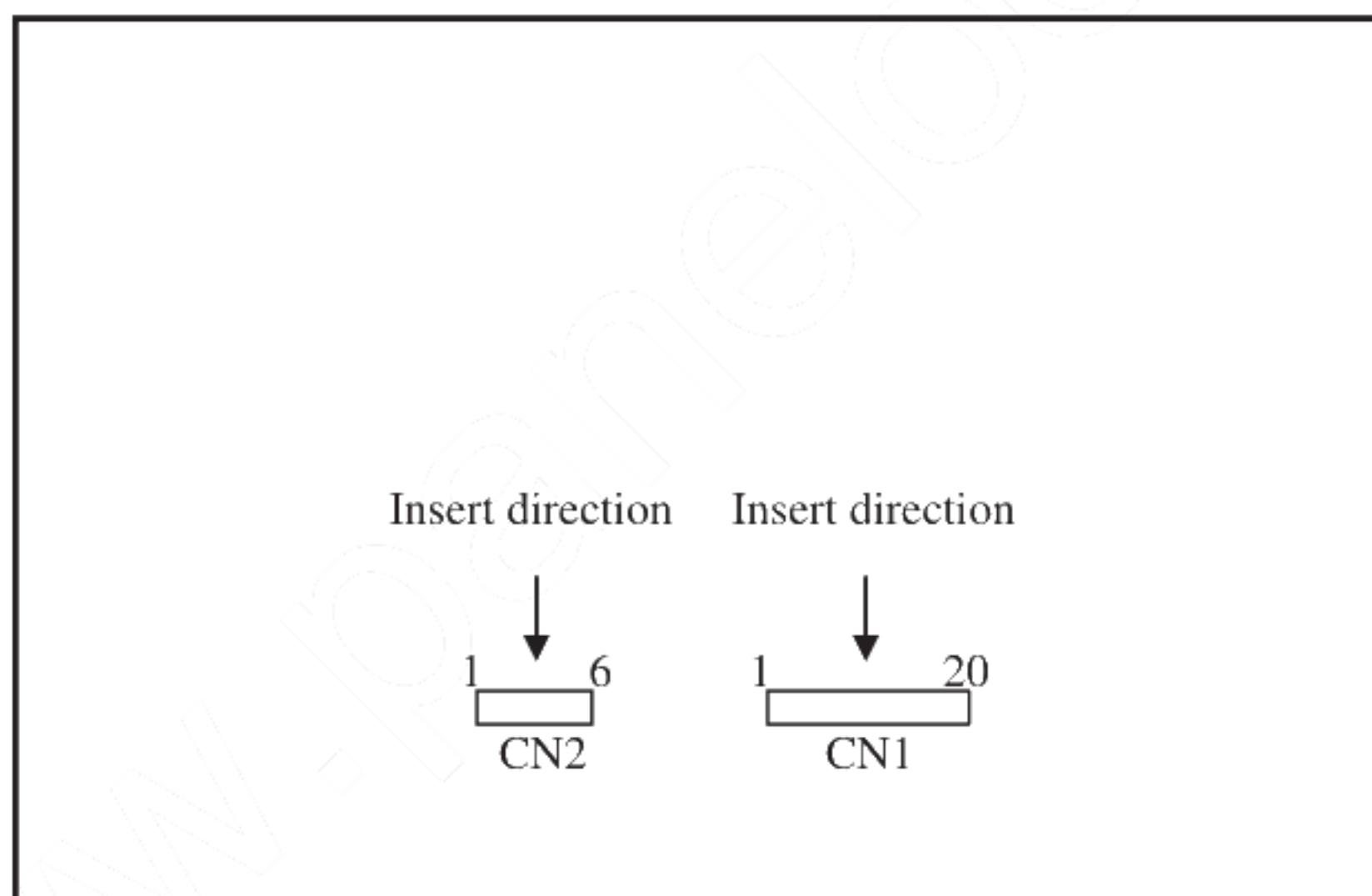
4.5.4 Connection between receiver and transmitter for LVDS

(1) Input data signal: 8-bit, MAP A (MSL: Low or Open, FRC: High)
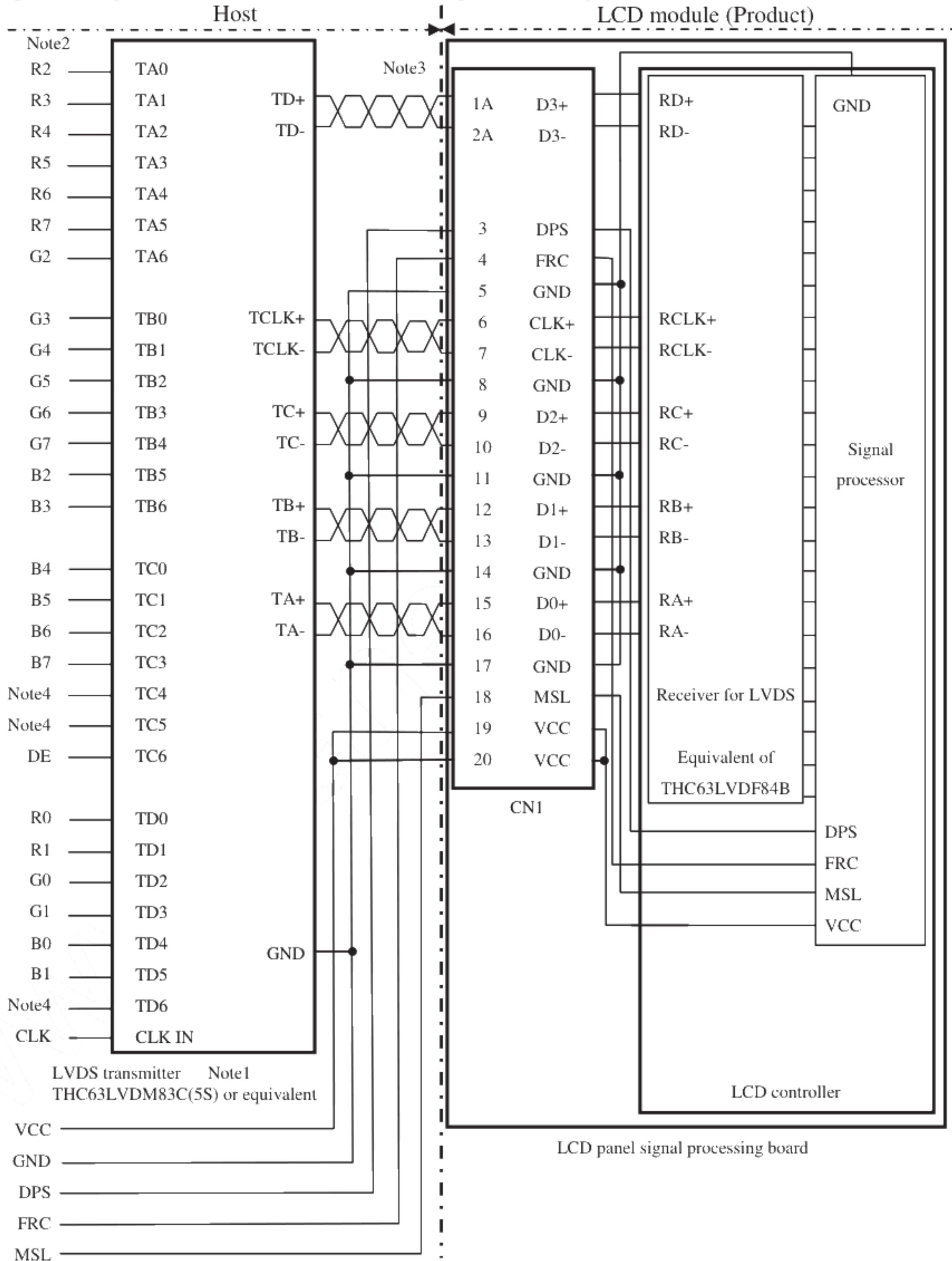
Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent

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)

Host | LCD module (Product)

Note2
R0 — TA0
R1 — TA1 — TD+ — 1A — D3+ — RD+ — GND
R2 — TA2 — TD- — 2A — D3- — RD-
R3 — TA3
R4 — TA4
R5 — TA5 — 3 — DPS
G0 — TA6 — 4 — FRC
5 — GND
G1 — TB0 — TCLK+ — 6 — CLK+ — RCLK+
G2 — TB1 — TCLK- — 7 — CLK- — RCLK-
G3 — TB2 — 8 — GND
G4 — TB3 — TC+ — 9 — D2+ — RC+
G5 — TB4 — TC- — 10 — D2- — RC-
B0 — TB5 — 11 — GND — Signal processor
B1 — TB6 — TB+ — 12 — D1+ — RB+
— TB- — 13 — D1- — RB-
B2 — TC0 — 14 — GND
B3 — TC1 — TA+ — 15 — D0+ — RA+
B4 — TC2 — TA- — 16 — D0- — RA-
B5 — TC3 — 17 — GND
Note4 — TC4 — 18 — MSL — Receiver for LVDS
Note4 — TC5 — 19 — VCC
DE — TC6 — 20 — VCC — Equivalent of THC63LVDF84B

CN1

R6 — TD0 — DPS
R7 — TD1 — FRC
G6 — TD2 — MSL
G7 — TD3 — VCC
B6 — TD4 — GND
B7 — TD5
Note4 — TD6
CLK — CLK IN

LVDS transmitter   Note1
THC63LVDM83C(5S) or equivalent

LCD controller

LCD panel signal processing board

VCC
GND
DPS
FRC
MSL

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)

Host | LCD module (Product)

Note2
R0 — TA0
R1 — TA1
R2 — TA2
R3 — TA3
R4 — TA4
R5 — TA5
G0 — TA6

G1 — TB0   TCLK+
G2 — TB1   TCLK-
G3 — TB2
G4 — TB3   TC+
G5 — TB4   TC-
B0 — TB5
B1 — TB6   TB+
            TB-

B2 — TC0
B3 — TC1   TA+
B4 — TC2   TA-
B5 — TC3
Note4 — TC4
Note4 — TC5
DE — TC6

Note4 — TD0
Note4 — TD1
Note4 — TD2
Note4 — TD3
Note4 — TD4   GND
Note4 — TD5
Note4 — TD6
CLK — CLK IN

Note3

1B GND
2B GND
3   DPS
4   FRC
5   GND
6   CLK+   RCLK+
7   CLK-   RCLK-
8   GND
9   D2+   RC+
10 D2-   RC-
11 GND
12 D1+   RB+
13 D1-   RB-
14 GND
15 D0+   RA+
16 D0-   RA-
17 GND
18 MSL
19 VCC
20 VCC

CN1

GND

Signal
processor

Receiver for LVDS

Equivalent of
THC63LVDF84B

DPS
FRC
MSL
VCC

LCD controller

LVDS transmitter   Note1
THC63LVDM83C(5S) or equivalent

VCC
GND
DPS
FRC
MSL

LCD panel signal processing board

Note1: Recommended transmitter: THC63LVDM83C(5S) (THine Electronics Inc.) or equivalent
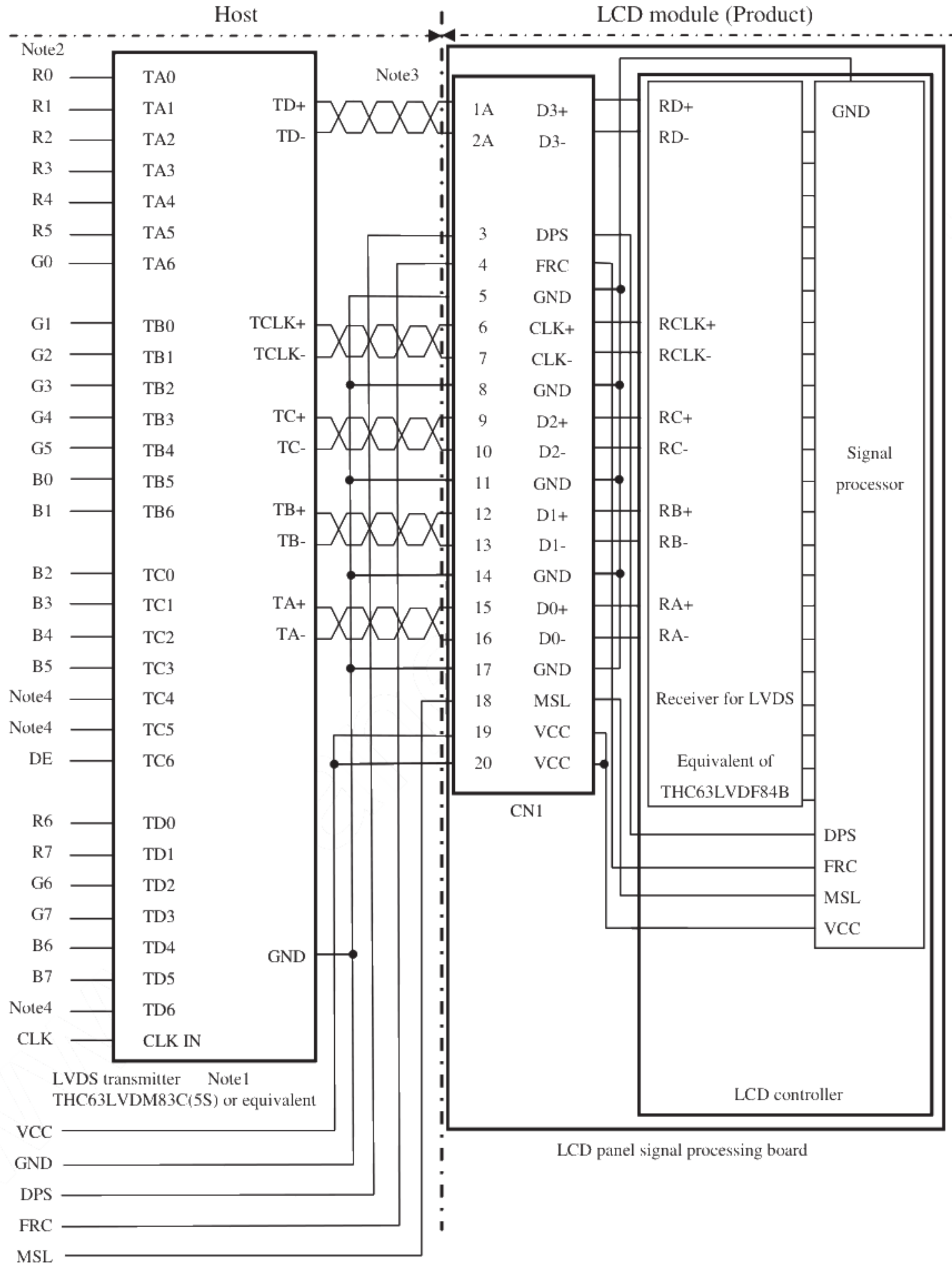Note2: LSB (Least Significant Bit) – R0, G0, B0   MSB (Most Significant Bit) – R5, G5, B5
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
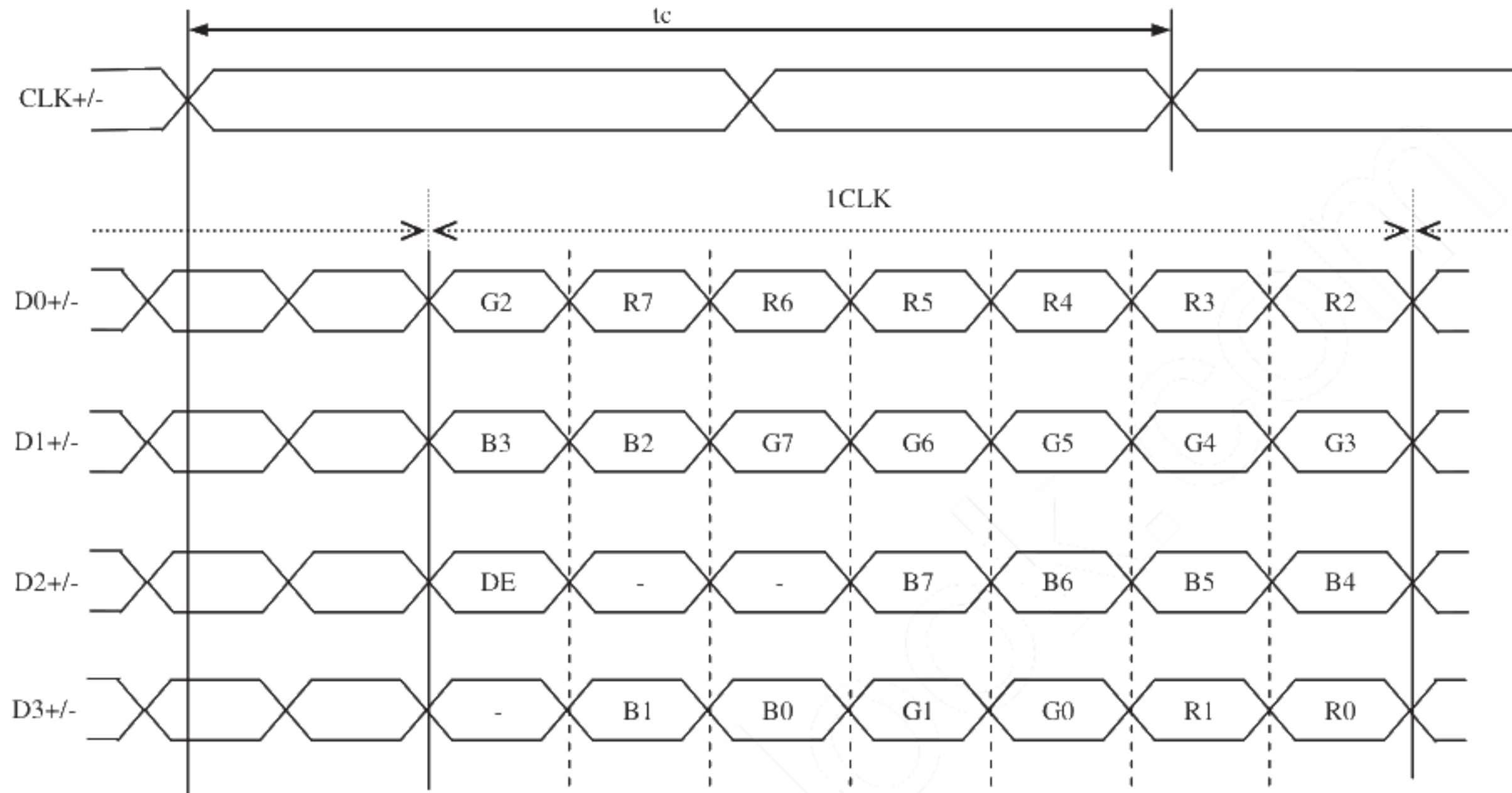Note4: Input signals to TC4, TC5 and TD0-6 are not used inside the product, but do not keep them open to avoid noise problem.

4.5.5 Input data mapping

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

CLK+/-				tc			
				1CLK			
D0+/-	G2	R7	R6	R5	R4	R3	R2
D1+/-	B3	B2	G7	G6	G5	G4	G3
D2+/-	DE	-	-	B7	B6	B5	B4
D3+/-	-	B1	B0	G1	G0	R1	R0

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

CLK+/-				tc			
				1CLK			
D0+/-	G0	R5	R4	R3	R2	R1	R0
D1+/-	B1	B0	G5	G4	G3	G2	G1
D2+/-	DE	-	-	B5	B4	B3	B2
D3+/-	-	B7	B6	G7	G6	R7	R6

PRELIMINARY
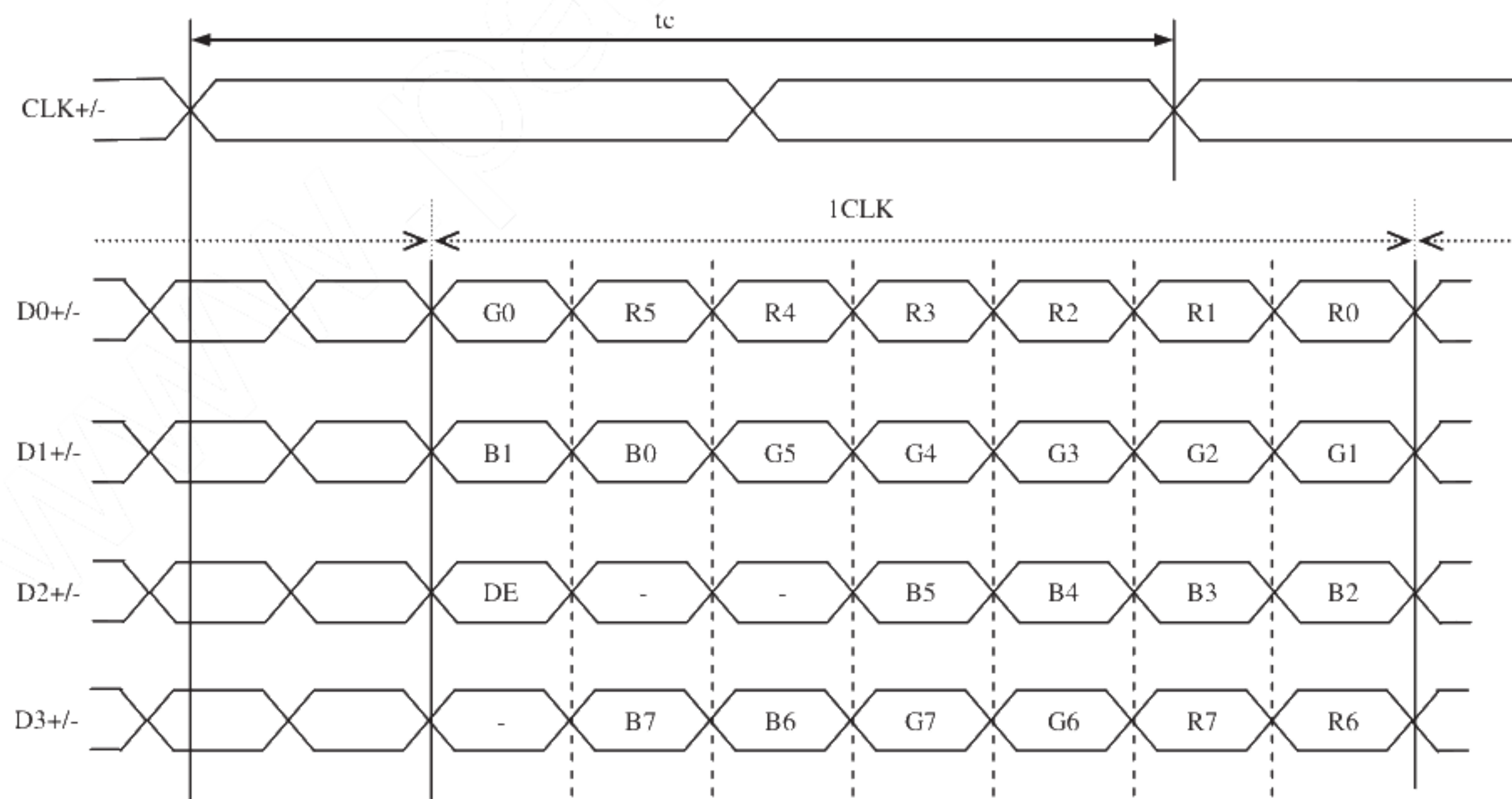
(3) Input data signal: 6-bit
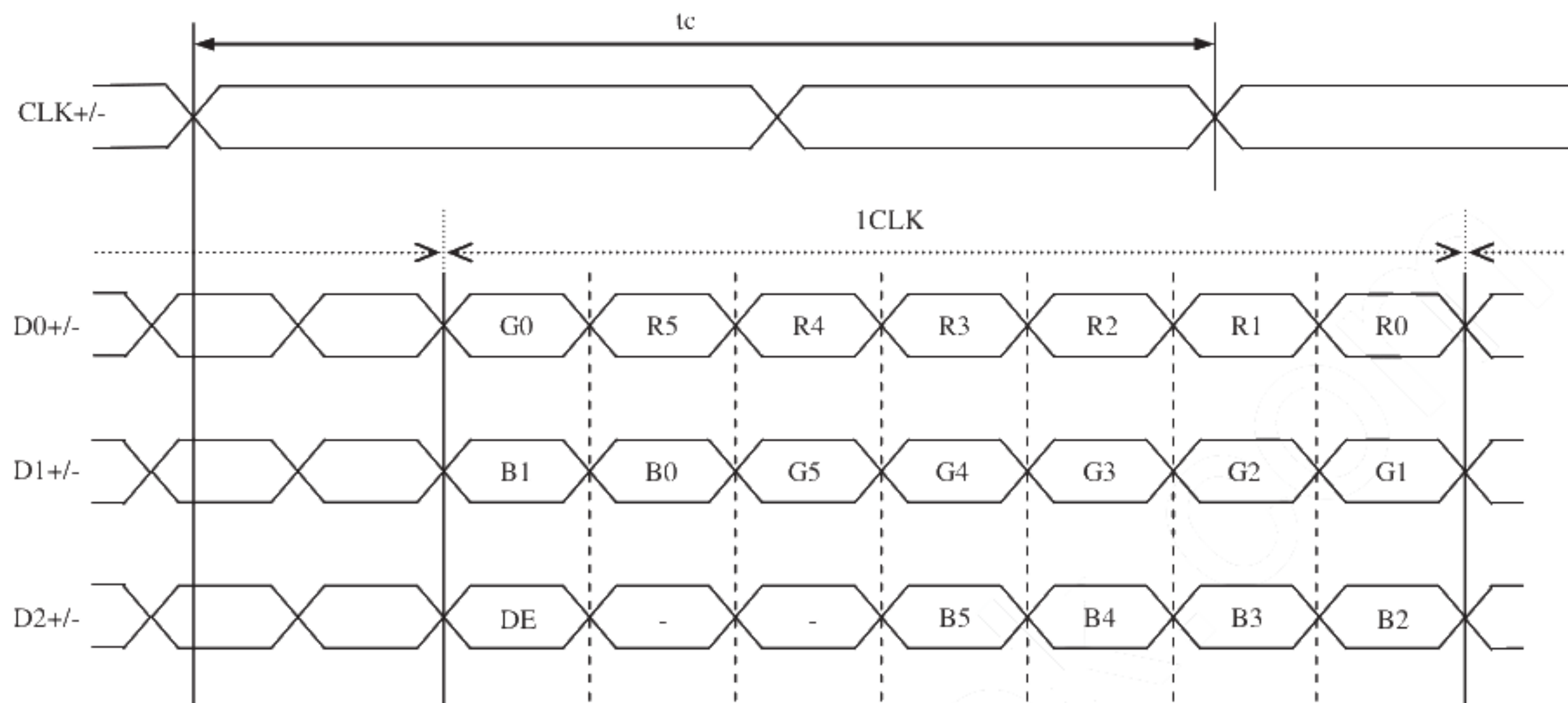
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

4.6.1 Combinations of input data signals, FRC and MSL signal

This product can display 16,777,216 colors equivalent with 256 gray scales and 262,144 colors with 64 gray scales 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 "**4.6.2 16,777,216 colors**".
Note2: See "**4.6.3 262,144 colors**".

4.6.2 16,777,216 colors

This product can display 16,777,216 colors equivalent with 256 gray scales by combination ① or ②.
(See "**4.6.1 Combinations of input data signals, FRC and MSL signal**".)
Also the relation between display colors and input data signals is as follows.

Display colors		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

Data signal (0: Low level, 1: High level)

4.6.3 262,144 colors

This product can display 262,144 colors with 64 gray scales by combination ③.
(See "**4.6.1 Combinations of input data signals, FRC and MSL signal**".)
Also the relation between display colors and input data signals is as follows.

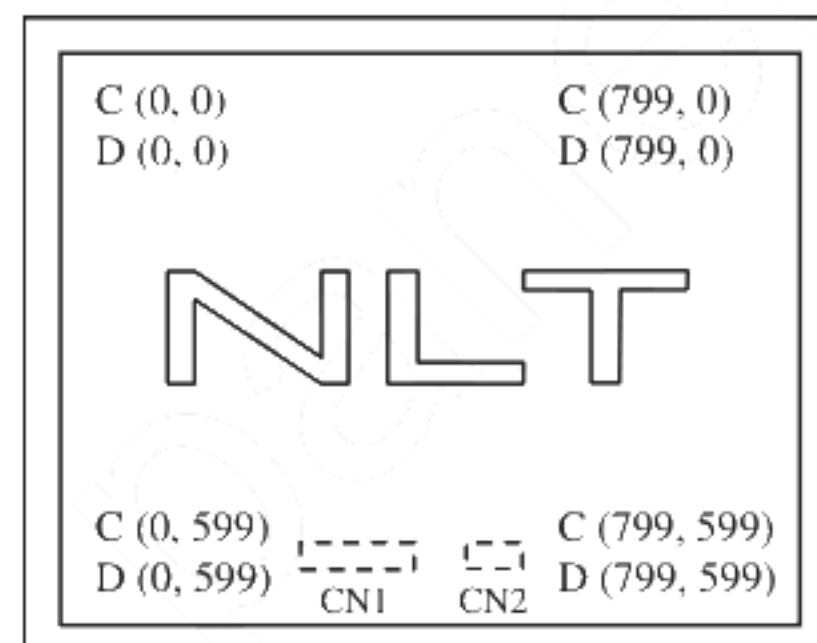| Display colors		Data signal (0: Low level, 1: High level)																	
		R 5	R 4	R 3	R 2	R 1	R 0	G 5	G 4	G 3	G 2	G 1	G 0	B 5	B 4	B 3	B 2	B 1	B 0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	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

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel (See **"4.8 SCANNING DIRECTIONS"**.).

C (0, 0)

| R | G | B |

C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(798, 0)	C(799, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(798, 1)	C(799, 1)
•	•	•	•	•	•	•
•	•	• • •	•	• • •	•	• • •
•	•	•	•	•	•	•
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(798, Y)	C(799, Y)
•	•	•	•	•	•	•
•	•	• • •	•	• • •	•	•
•	•	•	•	•	•	•
C(0, 598)	C(1, 598)	• • •	C(X, 598)	• • •	C(798, 598)	C(799, 598)
C(0, 599)	C(1, 599)	• • •	C(X, 599)	• • •	C(798, 599)	C(799, 599)

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.

C (0, 0)   C (799, 0)
D (0, 0)   D (799, 0)

NLT

C (0, 599)   C (799, 599)
D (0, 599)   CN1   CN2   D (799, 599)

Note1

Figure1. Normal scan (DPS: Low or Open)

C (0, 0)   C (799, 0)
D (799, 599)   D (0, 599)

NLT

C (0, 599)   C (799, 599)
D (799, 0)   CN1   CN2   D (0, 0)
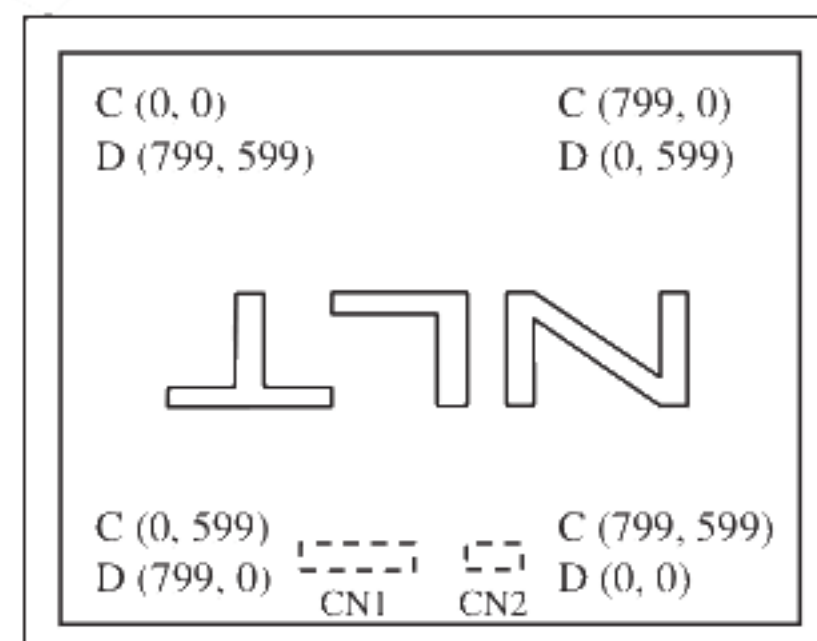
Note1

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 "**4.7 DISPLAY POSITIONS**".)
       D (X, Y): The data number of input signal for LCD panel signal processing board

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

- Horizontal signal

  Note1
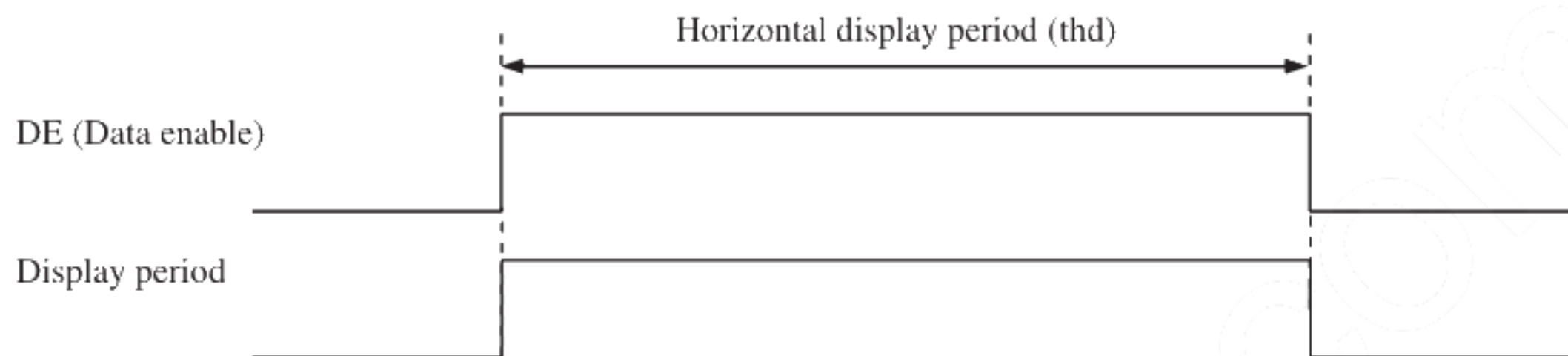
- Vertical signal

  Note1
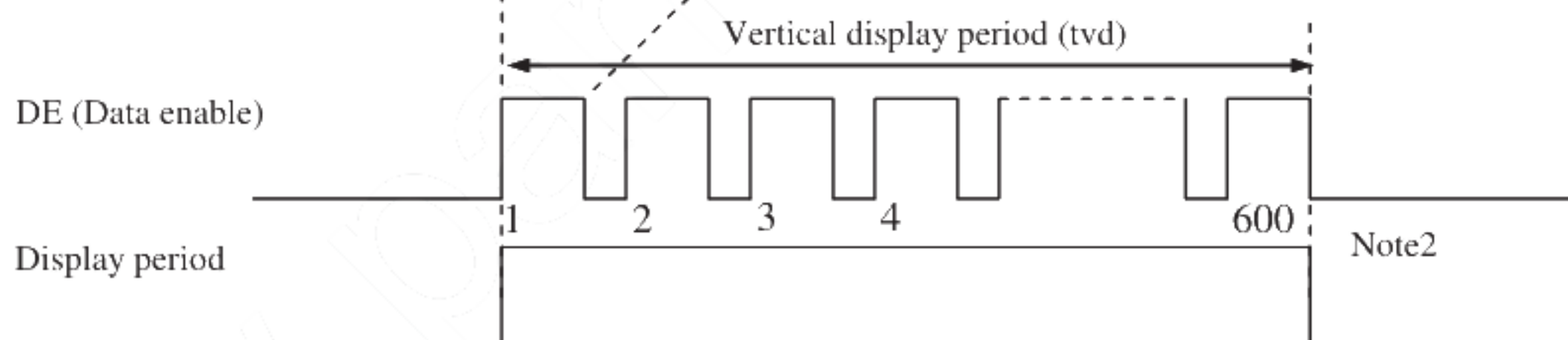
Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

4.9.2 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).

4.9.3 Input signal timing chart

Horizontal timing
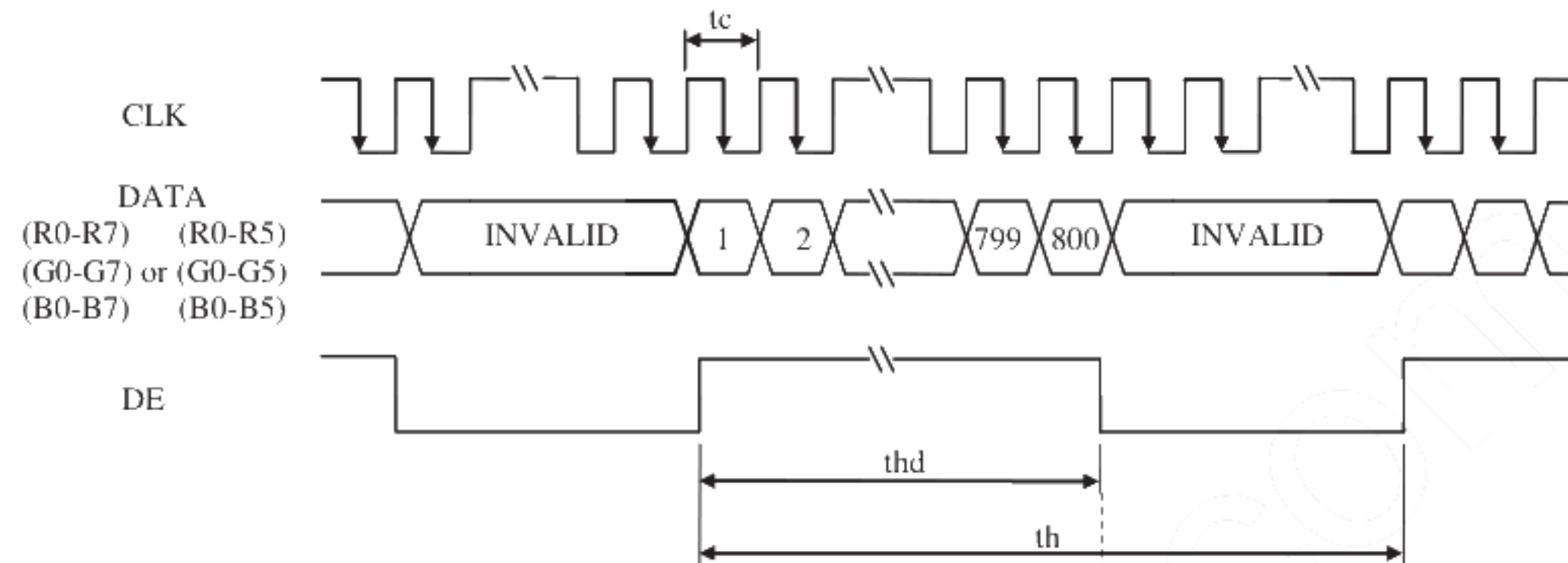
Vertical timing
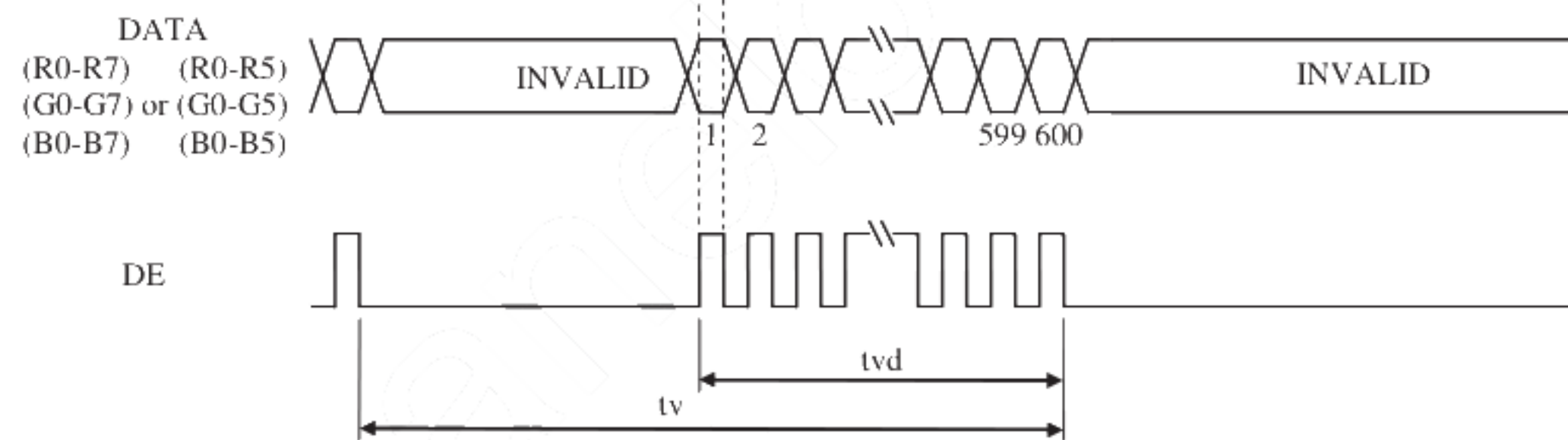
4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$	L	(240)	(400)	-	cd/m²	BM-5A	-
Contrast ratio		White/Black at center $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$	CR	500	900	-	-	BM-5A	Note3
Luminance uniformity		White $\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$	LU	-	1.25	1.4	-	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	-	0.585	-	-		
		y coordinate	Ry	-	0.350	-	-		
	Green	x coordinate	Gx	-	0.358	-	-		
		y coordinate	Gy	-	0.553	-	-		
	Blue	x coordinate	Bx	-	0.158	-	-		
		y coordinate	By	-	0.140	-	-		
Color gamut		$\theta R= 0°, \theta L= 0°, \theta U= 0°, \theta D= 0°$ at center, against NTSC color space	C	35	40	-	%		
Response time		White to Black	Ton	-	3	5	ms	BM-5A -10000	Note6
		Black to White	Toff	-	15	21	ms		Note7
Viewing angle	Right	$\theta U= 0°, \theta D= 0°, CR\geq 10$	θR	70	80	-	°	EZ Contrast	Note8
	Left	$\theta U= 0°, \theta D= 0°, CR\geq 10$	θL	70	80	-	°		
	Up	$\theta R= 0°, \theta L= 0°, CR\geq 10$	θU	70	80	-	°		
	Down	$\theta R= 0°, \theta L= 0°, CR\geq 10$	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: 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.
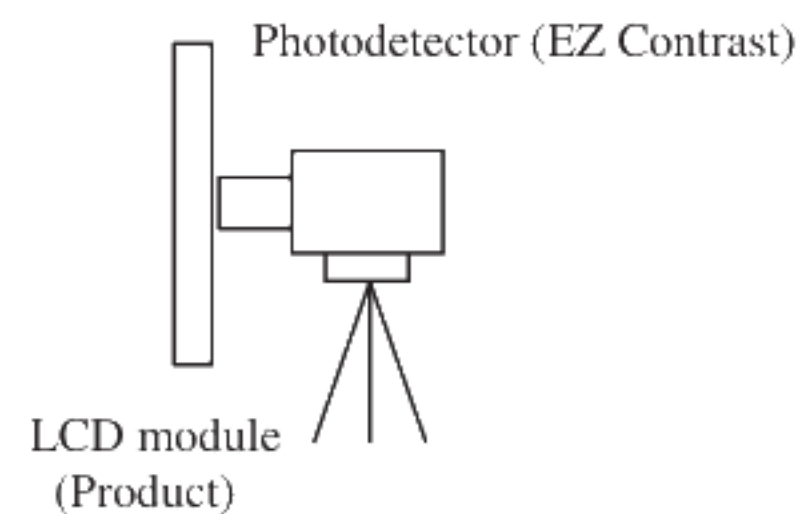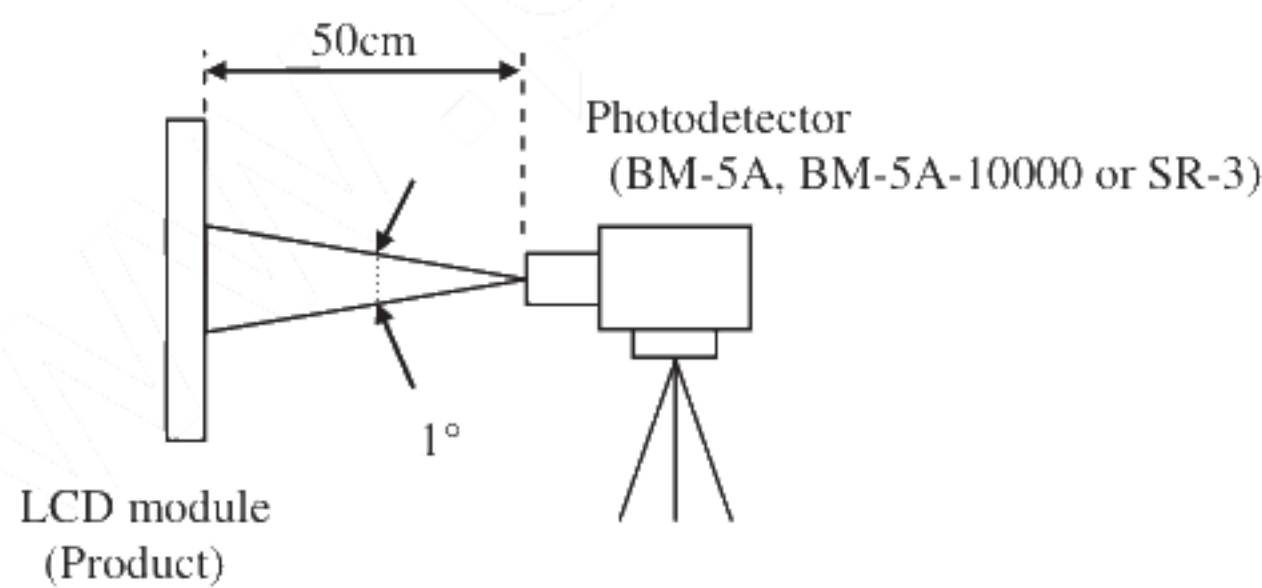
Note3: See "**4.10.2 Definition of contrast ratio**".
Note4: See "**4.10.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= 28°C
Note7: See "**4.10.4 Definition of response times**".
Note8: See "**4.10.5 Definition of viewing angles**".

4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

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

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

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

The luminance is measured at near the 5 points shown below.
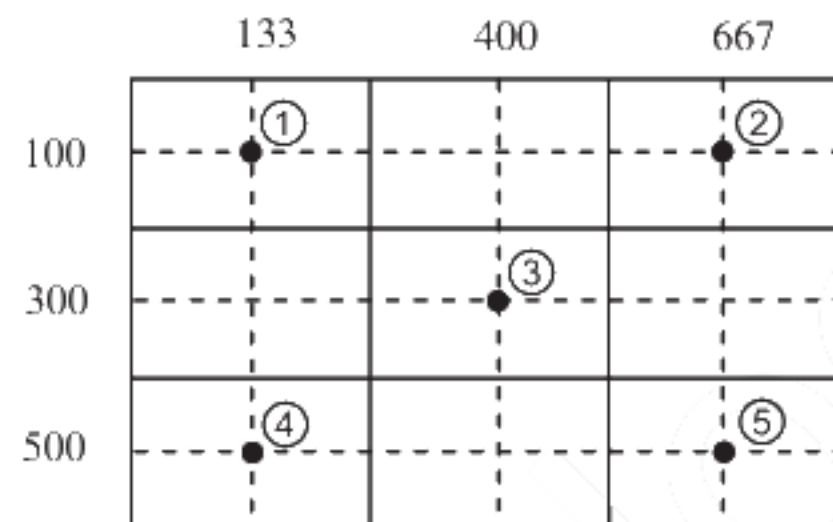
4.10.4 Definition of response times

Response time is measured 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.).
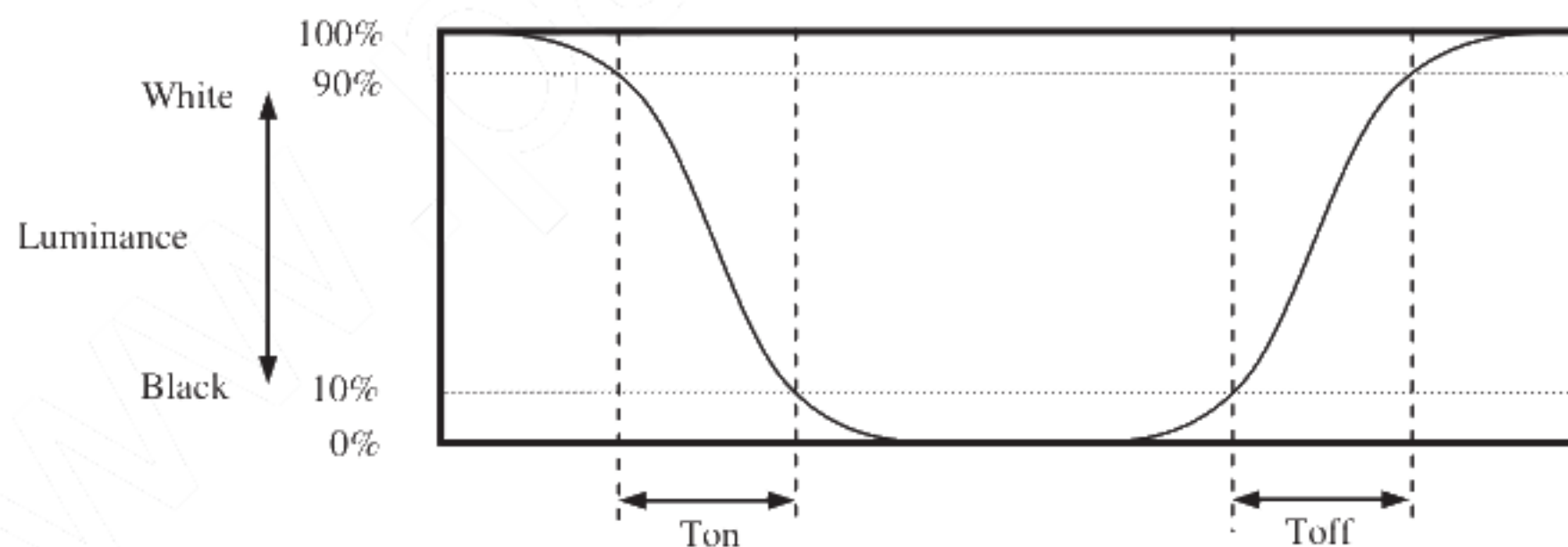
4.10.5 Definition of viewing angles
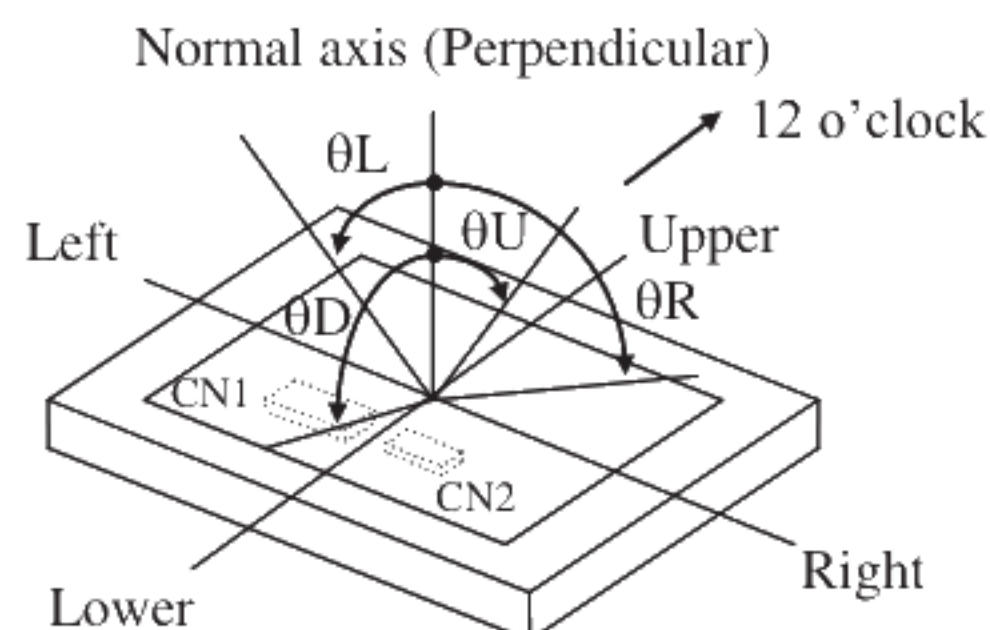
5. ESTIMATED LUMINANCE LIFETIME

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
	TBD°C (Temperature at LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio: 100%	TBD	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

TBD

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

⚠

* **Do not shock and press the LCD panel 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 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.

② When the product is put on the table temporarily, display surface must be placed downward.

③ 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.

④ The torque for product mounting screws must never exceed 0.294N·m. Higher torque might result in distortion of the bezel.

⑤ 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.

⑥ Do not press or rub on the sensitive product surface. When cleaning the product surface, wipe it with a soft dry cloth.

⑦ Do not push or pull the interface connectors while the product is working.

⑧ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.

⑨ 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.

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
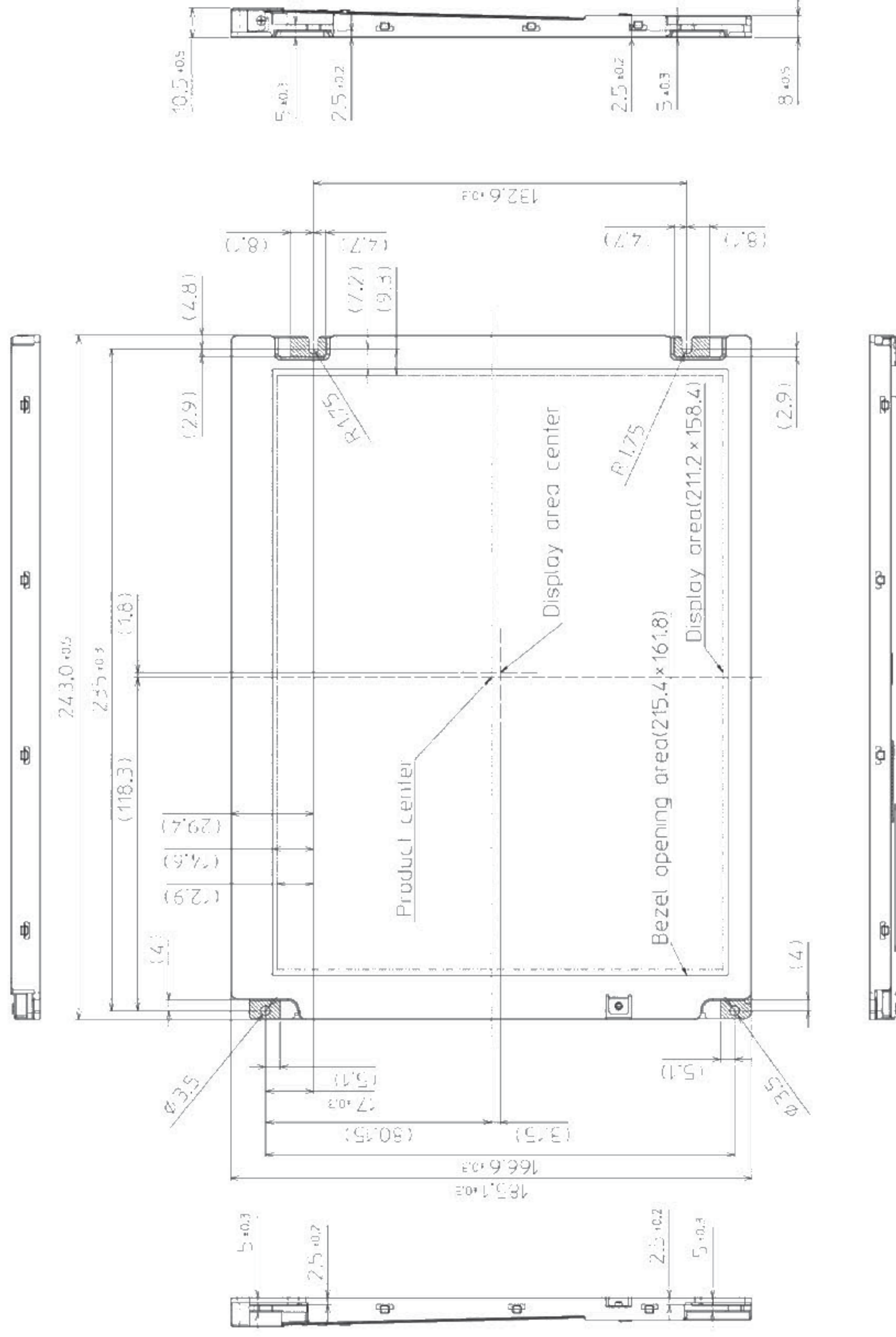
The following items are neither defects nor failures.

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.

7.3.4 Others

① All VCC, VDD 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.

PRELIMINARY

8. OUTLINE DRAWINGS

8.1 FRONT VIEW

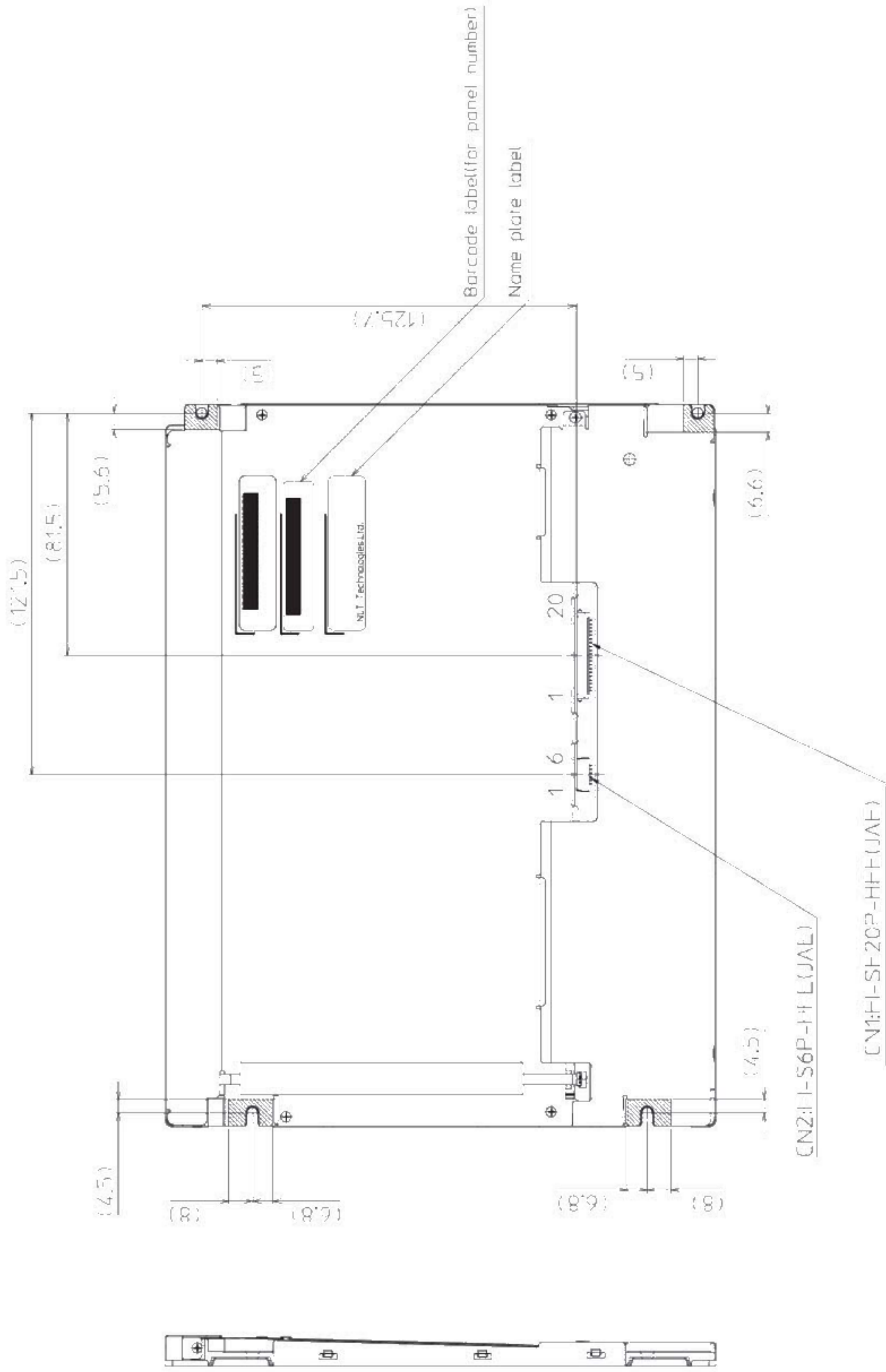Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.294N·m.
Note3: ▨ Mounting hole portions (4 pieces)

Unit: mm

PRELIMINARY DATA SHEET DOD-PP-2093 (1st edition)

PRELIMINARY

8.2 REAR VIEW

Barcode label(for panel number)
Name plate label

NLT Technologies,Ltd.

CN1:FI-SE20P-HFE(JAE)

CN2:FI-S6P-HFE(JAE)

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

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-2093	Apr. 9, 2015	**Revision contents** New issue **Signature of writer** *Approved by*　　　*Checked by*　　　*Prepared by* R. KAWASHIMA　　　—————　　　E. YOSHIMURA