PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL10276BC16-06D

21cm (8.4 Type)
XGA
LVDS interface (1 port)

PRELIMINARY DATA SHEET
DOD-PP-1682 (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.

PRELIMINARY

NLT Technologies, Ltd.

NL10276BC16-06D

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL10276BC16-06D 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

- Ultra-wide viewing angle (Super Fine TFT (SFT))
- Wide color gamut
- High luminance
- High contrast
- LVDS interface
- Selectable 8bit or 6bit digital signals for data of RGB
- Selectable LVDS data input map
- Reversible-scan direction
- LED backlight type
- Replaceable lamp for backlight
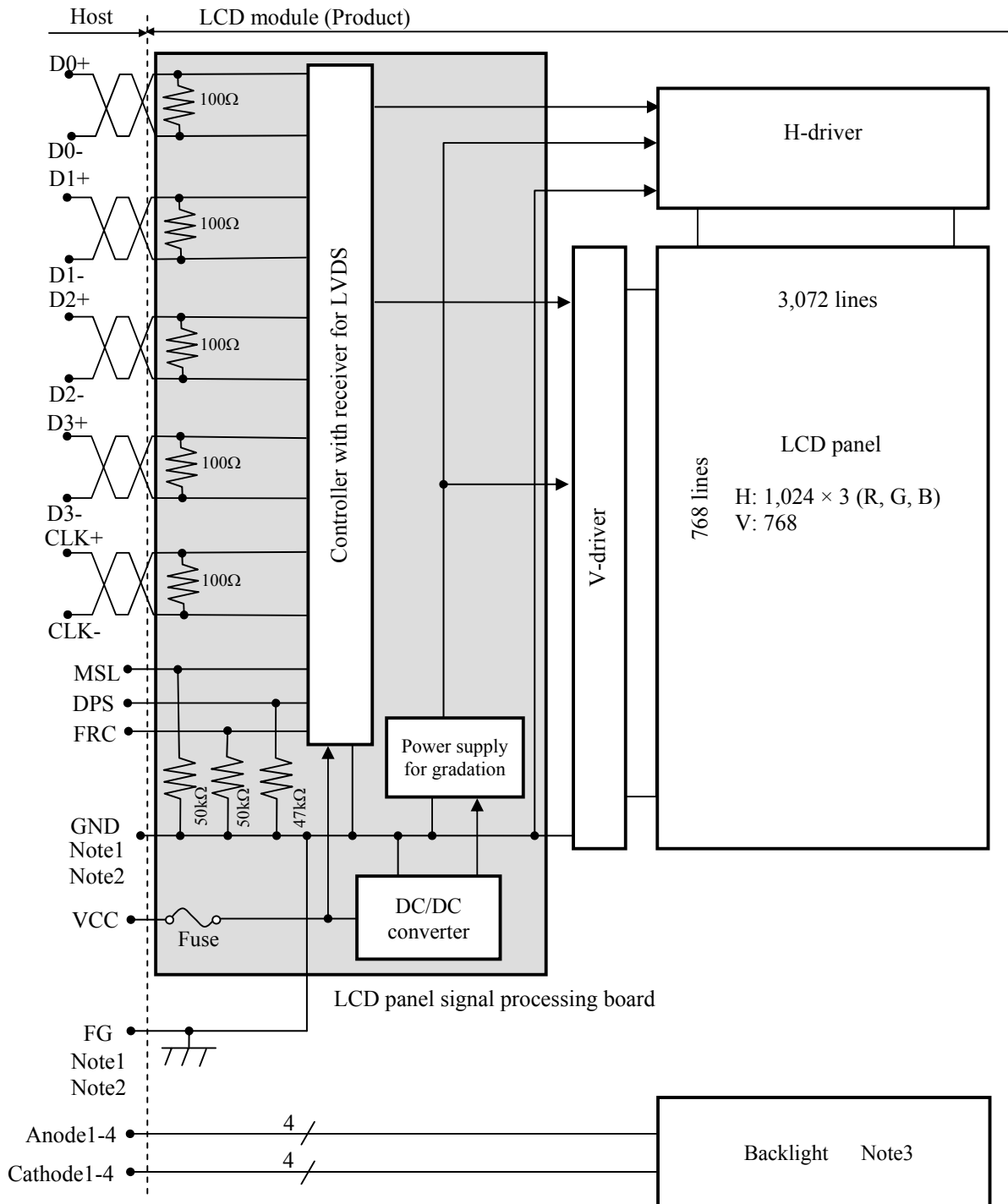- Compliant with the European RoHS directive (2011/65/EU)

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2. GENERAL SPECIFICATIONS

Display area	170.496 (H) × 127.872 (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	1,024 (H) × 768 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.0555 (H) × 0.1665 (V) mm
Pixel pitch	0.1665 (H) × 0.1665 (V) mm
Module size	200.0 (W) × 152.0 (H) × 8.2 (D) mm (typ.)
Weight	TBD g (typ.)
Contrast ratio	(600):1 (typ.)
Viewing angle	*At the contrast ratio ≥ 10:1* • Horizontal: Right side 88° (typ.), Left side 88° (typ.) • Vertical: Up side 88° (typ.), Down side 88° (typ.)
Designed viewing direction	• Viewing angle with optimum grayscale (γ= 2.2): Normal axis (perpendicular)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 72% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→90%)* TBD ms (typ.)
Luminance	*At IL= 50mA/One circuit* (400) cd/m^2 (typ.)
Signal system	LVDS 1port (Receiver: THC63LVDF84B, THine Electronics Inc. or equivalent) [8bit/6bit 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 type: Replaceable part • Lamp holder set: Type No. TBD Recommended LED driver board (Option) • LED driver board: Type No. 104PW03F • Corresponding wiring harness: Type No. 121CBL02
Power consumption	*At IL= 50 mA/One circuit, Checkered flag pattern* TBD (Less than 6W) (typ.)

3. BLOCK DIAGRAM

Note1: Relations between GND (Signal ground), GNDB (LED driver ground) and FG (Frame ground) in the LCD module are as follow.

GND - FG	Connected

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

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Note3: Backlight in detail

Backlight

Anode 1

Cathode 1

Anode 2

Cathode 2

Anode 3

Cathode 3

Anode 4

Cathode 4
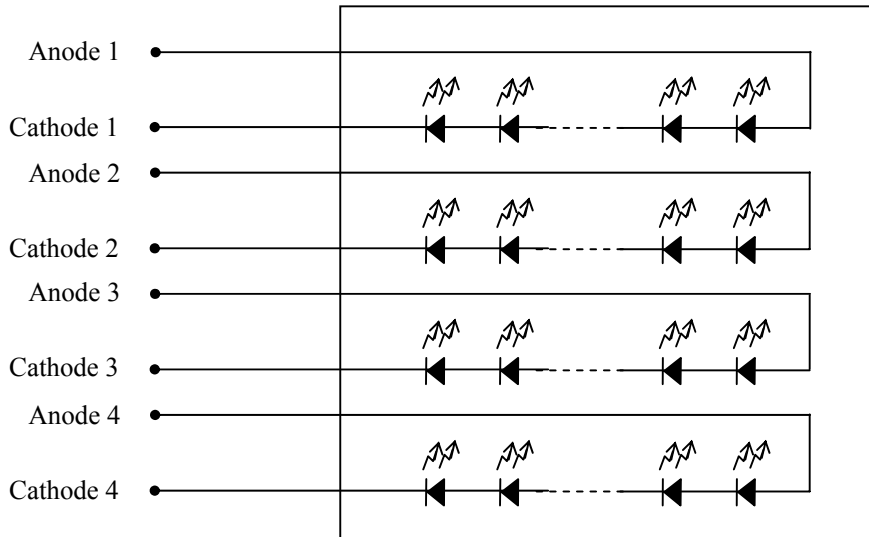
4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	200.0 ± 0.5 (W) × 152.0 ± 0.5 (H) × 8.2 ± 0.5 (D)	Note1	mm
Display area	170.496 (H) × 127.872 (V)	Note1	mm
Weight	TBD (typ.)		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 +4.0	V	
Input voltage for signals	Display signals Note1	VD	-0.3 to VCC+0.3	V	-
	Function signals Note2	VF			
Backlight	Forward current	IL	60	mA	per one circuit
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	(-10 to +70)	°C	Note3
	Rear surface	TopR	(-10 to +70)	°C	Note4
Relative humidity Note5		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40°C < Ta ≤ 50°C
			≤ 55	%	50°C < Ta ≤ 60°C
			≤ 36	%	60°C < Ta ≤ 70°C
Absolute humidity Note5		AH	≤ 70 Note6	g/m^3	Ta > 70°C

Note1: Display signals are D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-.
Note2: Function signals are DPS, FRC and MSL.
Note3: Measured at center of LCD panel surface (including self-heat)
Note4: Measured at center of LCD module's rear shield surface (including self-heat)
Note5: No condensation
Note6: Water amount at Ta= 70°C and RH= 36%

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	-	TBD Note1	TBD 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, FRC and MSL signals	High	VFH	0.7VCC	-	VCC	V	CMOS level
	Low	VFL	0	-	0.3VCC	V	
Input current for FRC and MSL signals	High	IFH	-	-	300	μA	-
	Low	IFL	-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 Backlight lamp

(Ta= 25°C, Note1, Note2, Note3)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward current	IL	-	50.0	55.0	mA	-
Forward Voltage	VL	(18.6)	(21.0)	(23.8)	V	Ta= +25°C at IL= 50mA /One circuit
		(17.1)	-	-		Ta= +80°C at IL= 50mA /One circuit
		-	-	(26.2)		Ta= -30°C at IL= 50mA /One circuit
		-	-	(26.4)		Ta= -30°C at IL= 55mA /One circuit

Note1: Please drive the backlight 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 4 circuits. It is recommended that the current value difference among the circuits be less than 5%.

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

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16162AB	KAMAYA ELECTRIC Co., Ltd.	1.6A	3.2A	Note1
			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
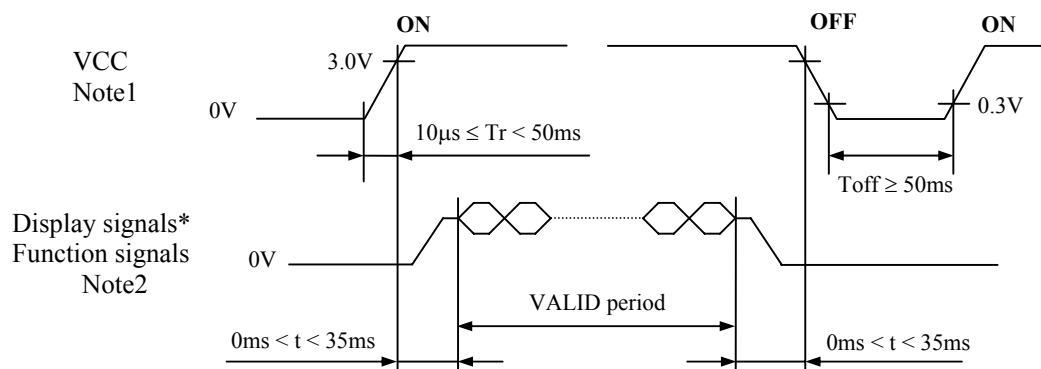
* These signals should be measured at the terminal of 100Ω resistance.

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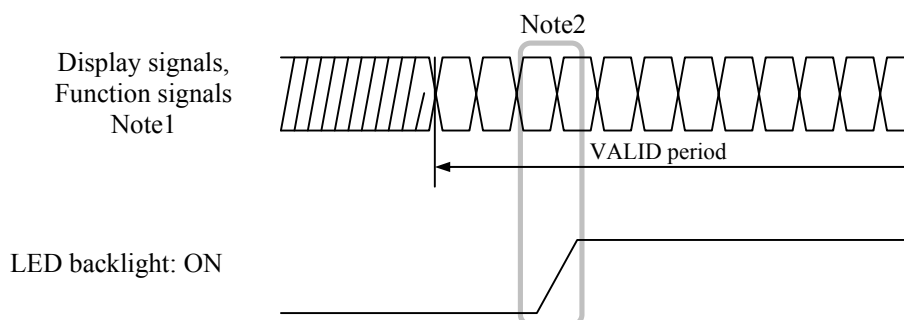
Note1: These are the display and function signals for LCD panel signal processing board.
Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

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: 8bit		Input data signal: 6bit	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: 16,777,216 colors		Low or Open: 262,144 colors	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	High	Low	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 GND and VCC 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 board

CN2 plug (LCD module side):   SM08B-SRSS-TB   (J.S.T. Mfg. Co., Ltd.)
Adaptable socket: 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	A4	Anode4	-
8	K4	Cathode4	-

4.5.3 Positions of plug and socket
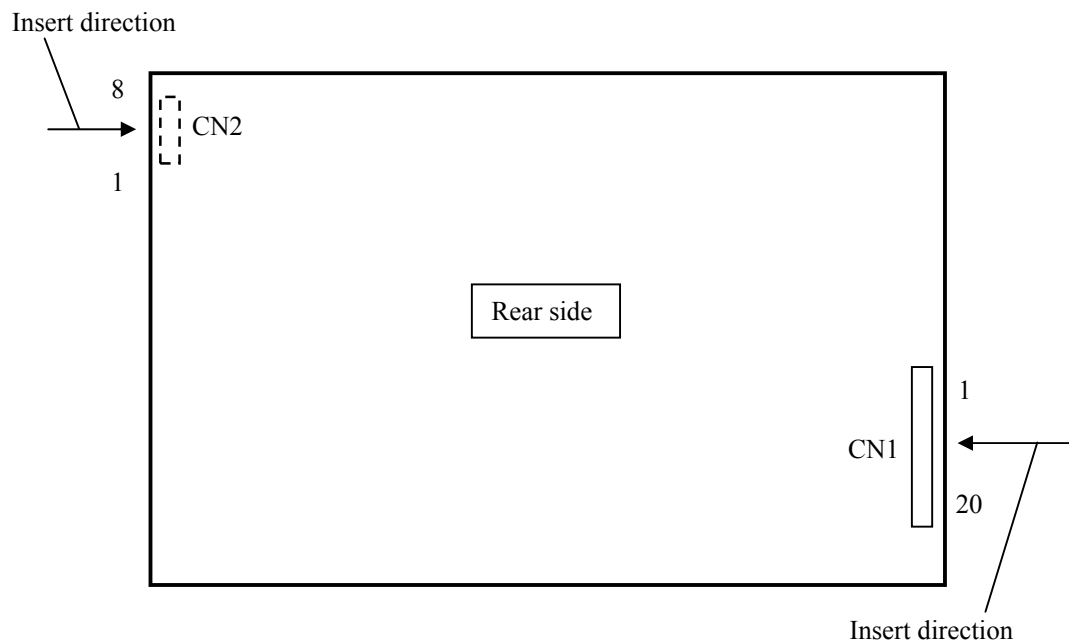
4.5.4 Connection between receiver and transmitter for LVDS

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

Host | LCD module (Product)

Host			
Note2		Note3	
R2	TA0		
R3	TA1	TD+	
R4	TA2	TD-	
R5	TA3		
R6	TA4		
R7	TA5		
G2	TA6		
G3	TB0	TCLK+	
G4	TB1	TCLK-	
G5	TB2		
G6	TB3	TC+	
G7	TB4	TC-	
B2	TB5		
B3	TB6	TB+	
		TB-	
B4	TC0		
B5	TC1	TA+	
B6	TC2	TA-	
B7	TC3		
Note4	TC4		
Note4	TC5		
DE	TC6		
R0	TD0		
R1	TD1		
G0	TD2		
G1	TD3		
B0	TD4	GND	
B1	TD5		
Note4	TD6		
CLK	CLK IN		

LVDS transmitter
THC63LVDM83D or equivalent
Note1

VCC
GND
DPS
FRC
MSL

CN1
1 D3+
2 D3-
3 DPS
4 FRC
5 GND
6 CLK+
7 CLK-
8 GND
9 D2+
10 D2-
11 GND
12 D1+
13 D1-
14 GND
15 D0+
16 D0-
17 GND
18 MSL
19 VCC
20 VCC

RD+
RD-
GND

RCLK+
RCLK-

RC+
RC-

RB+
RB-

RA+
RA-

Receiver for LVDS

Equivalent of
THC63LVDF84B

Signal
processor

DPS
FRC
MSL
VCC

LCD controller

LCD panel signal processing board

Note1: Recommended transmitter THC63LVDM83D (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 TC4, TC5 and TD6 open to avoid noise problem.

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

Host		LCD module (Product)

Note2

R0	TA0			
R1	TA1	TD+		Note3
R2	TA2	TD-		

Host side signals:
R0 — TA0
R1 — TA1   TD+
R2 — TA2   TD-
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

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

LVDS transmitter
THC63LVDM83D or equivalent
Note1

VCC
GND
DPS
FRC
MSL

CN1 connector:
1 — D3+
2 — D3-
3 — DPS
4 — FRC
5 — GND
6 — CLK+
7 — CLK-
8 — GND
9 — D2+
10 — D2-
11 — GND
12 — D1+
13 — D1-
14 — GND
15 — D0+
16 — D0-
17 — GND
18 — MSL
19 — VCC
20 — VCC

Receiver for LVDS signals:
RD+
RD-
RCLK+
RCLK-
RC+
RC-
RB+
RB-
RA+
RA-

Receiver for LVDS
Equivalent of
THC63LVDF84B

GND

Signal
processor

LCD controller

DPS
FRC
MSL
VCC

LCD panel signal processing board

Note1: Recommended transmitter THC63LVDM83D (THine Electronics Inc.) or equivalent
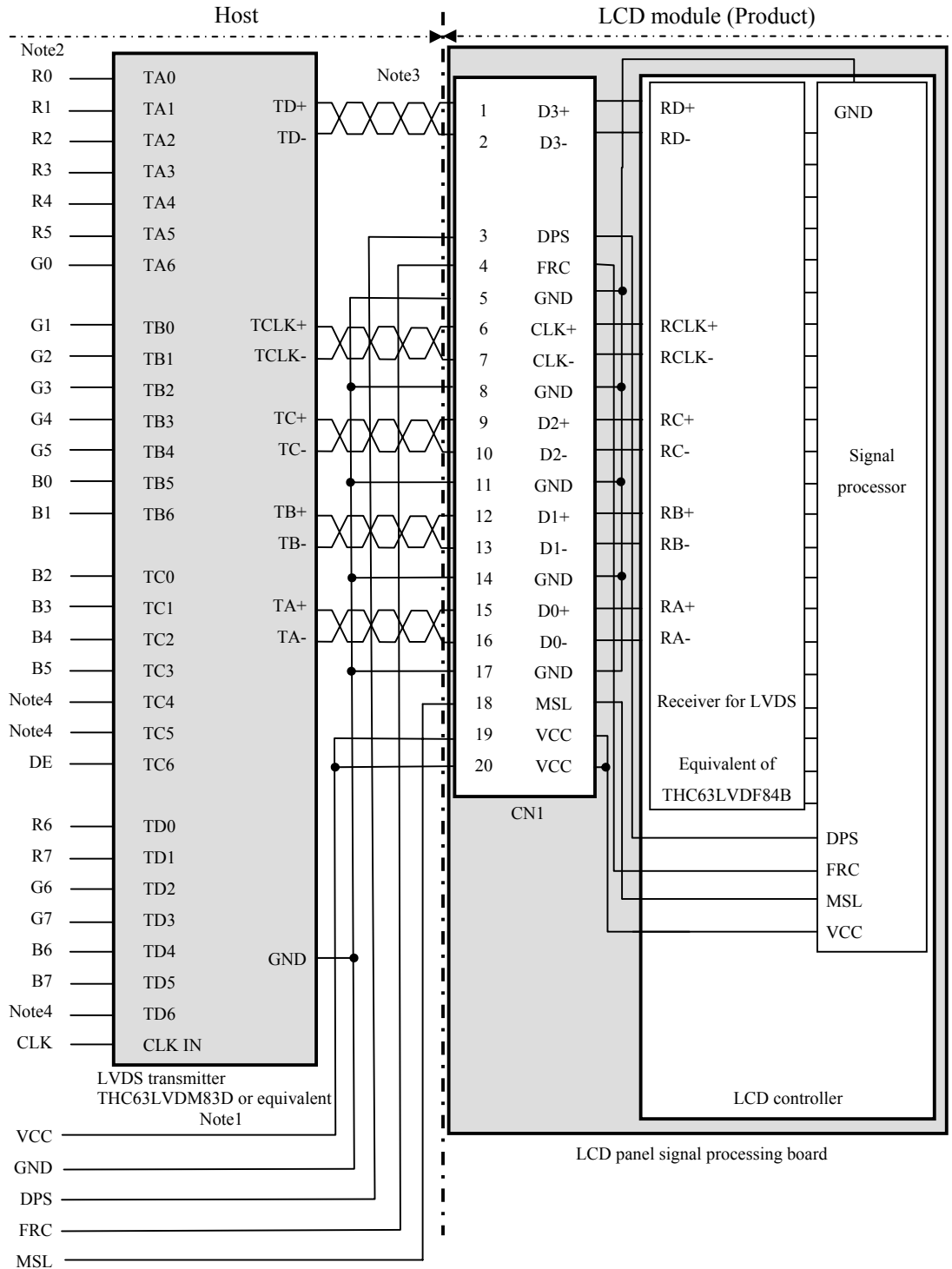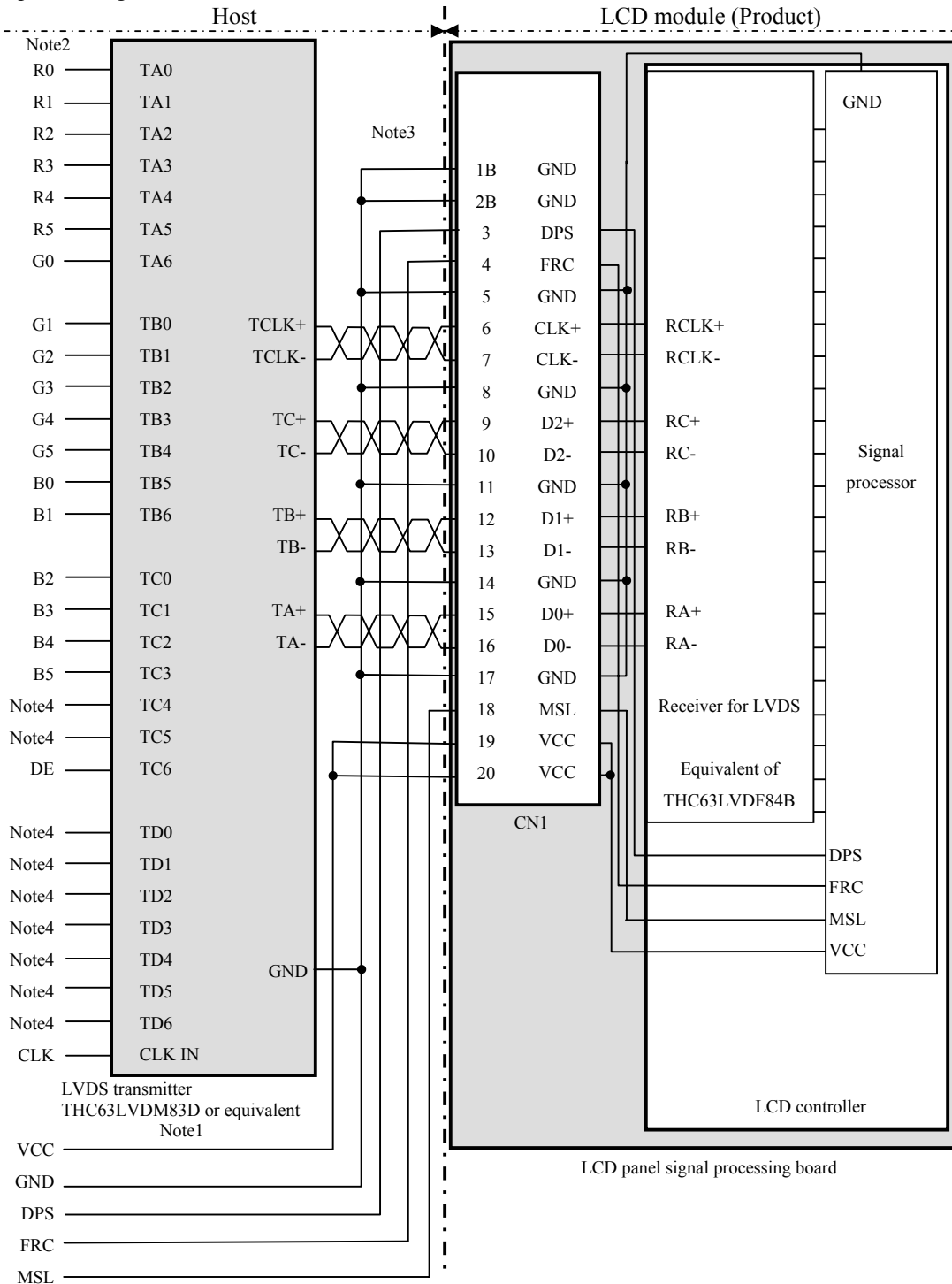Note2: LSB (Least Significant Bit) - R0, G0, B0   MSB (Most Significant Bit) - R7, G7, B7
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note4: Input signals to TC4, TC5 and TD6 are not used inside the product, but do not keep TC4, TC5 and TD6 open to avoid noise problem.

(3) Input data signal: 6bit

Host | LCD module (Product)

Note2

Host			CN1		LCD

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
Note4 — TD5 — GND
Note4 — TD6
CLK — CLK IN

Note3

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

CN1

RCLK+
RCLK-
RC+
RC-
RB+
RB-
RA+
RA-

Receiver for LVDS

Equivalent of
THC63LVDF84B

GND

Signal
processor

DPS
FRC
MSL
VCC

LCD controller

LVDS transmitter
THC63LVDM83D or equivalent
Note1

VCC —
GND —
DPS —
FRC —
MSL —

LCD panel signal processing board

Note1: Recommended transmitter: THC63LVDM83D (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.
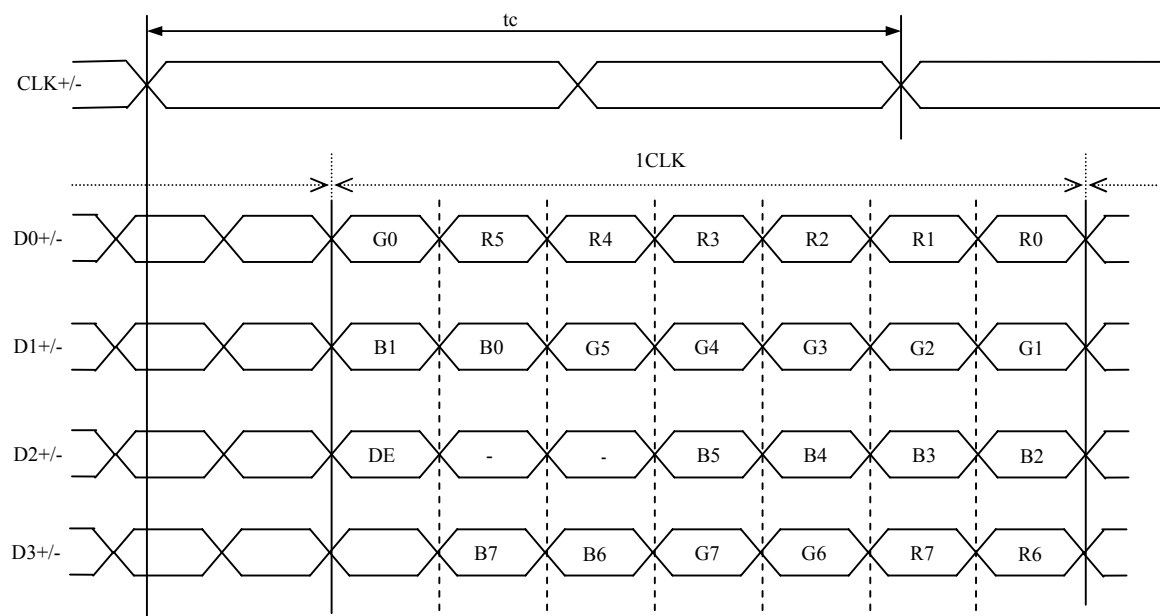Note4: Input signals to TC4, TC5 and TD0-6 are not used inside the product, but do not keep TC4, TC5 and TD0-6 open to avoid noise problem.

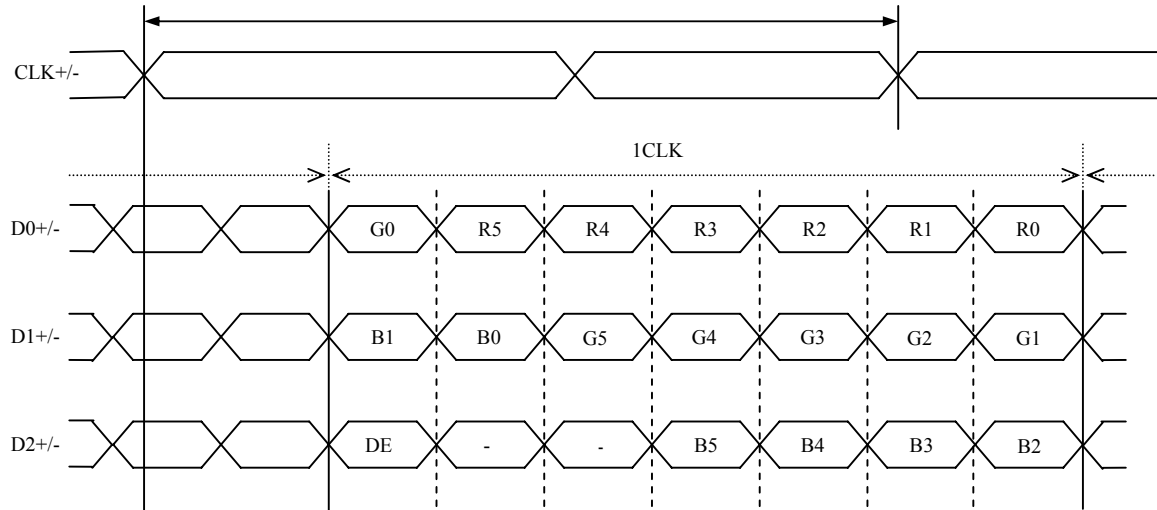4.5.5 Input data mapping

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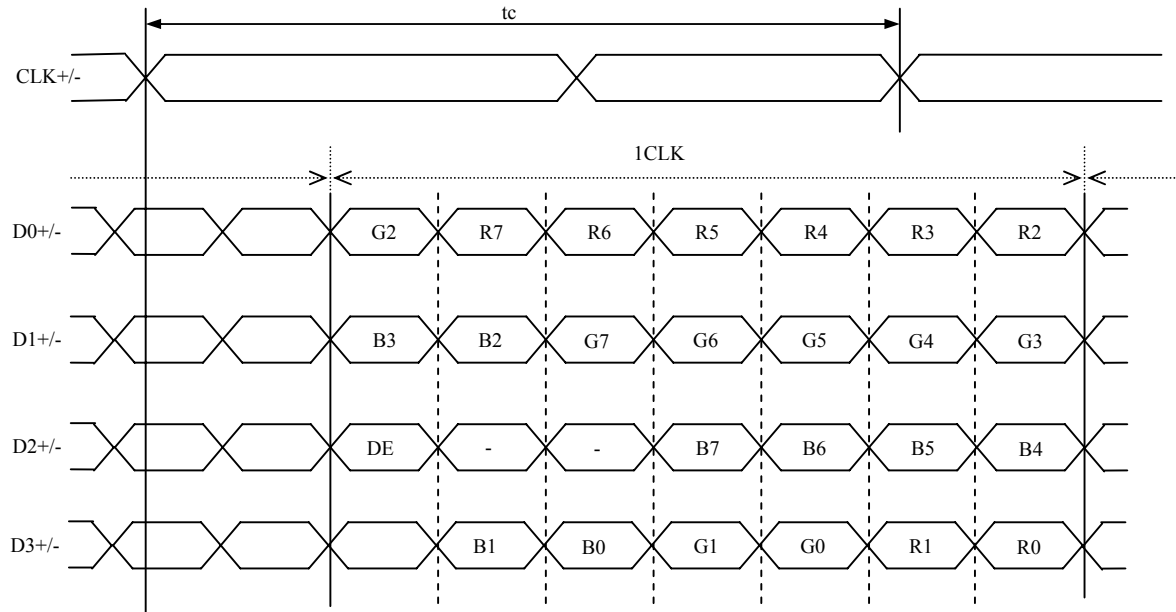
(2) Input data signal: 8bit , MAP B

(3) Input data signal: 6bit

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	16,777,216	Note1
②	8 bit	MAP B	D3+/-	High	High	16,777,216	Note1
③	6 bit	-	GND	Low or Open	Low	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		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

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

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.
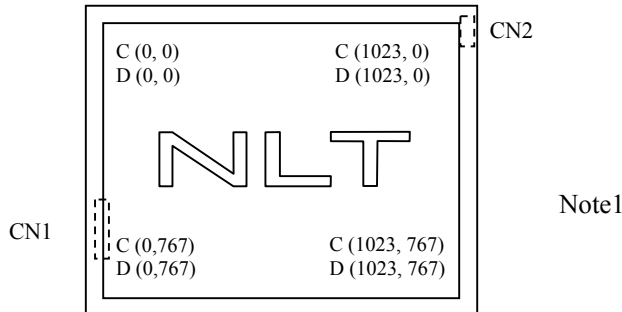
Figure1. Normal scan (DPS: Low or Open)
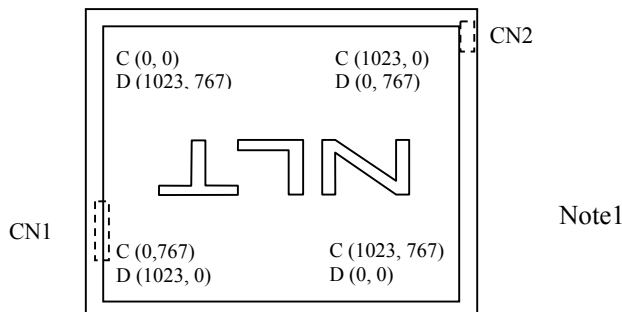
Figure2. Reverse scan (DPS: High)

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

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

- Horizontal signal

  Note1
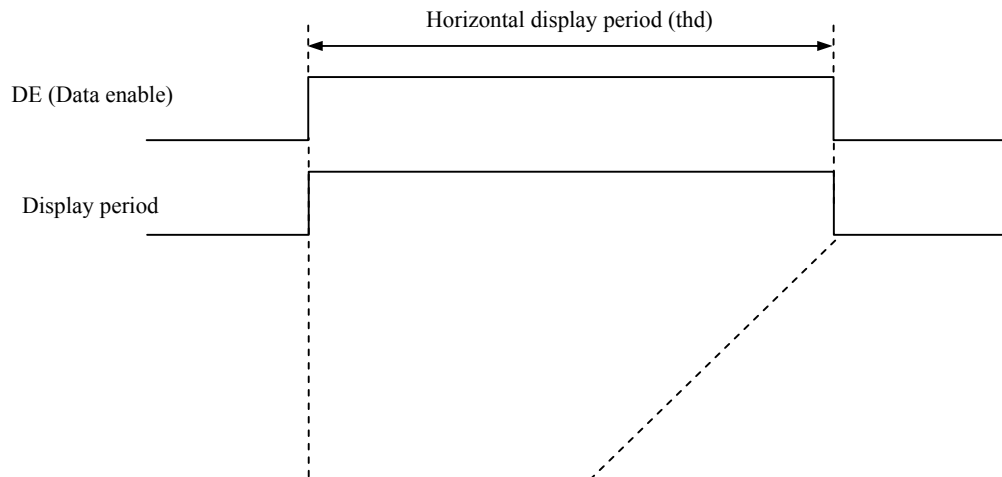
- Vertical signal

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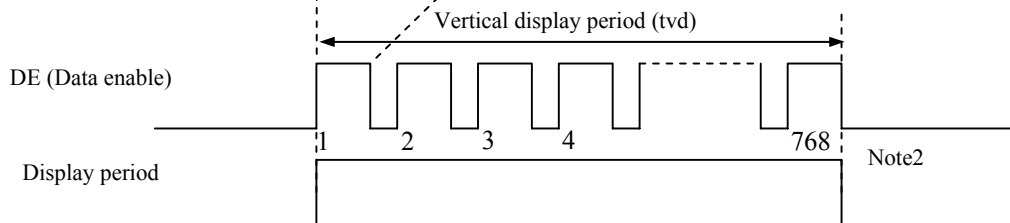
Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

4.9.2 Timing characteristics

(Note1, Note2, Note3)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	60.0	65.0	68.0	MHz	15.385 ns (typ.)
	Duty		-		-		-	-
	Rise time, Fall time		-				ns	
DATA	CLK-DATA	Setup time	-				ns	-
		Hold time	-		-		ns	
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	19.67	20.676	22.4	μs	48.363 kHz (typ.)
				-	1,344	-	CLK	
		Display period	thd		1,024		CLK	
	Vertical (One frame)	Cycle	tv	13.3	16.666	18.5	ms	60.0 Hz (typ.)
				780	806	-	H	
		Display period	tvd		768		H	
	CLK-DE	Setup time	-				ns	-
		Hold time	-		-		ns	
	Rise time, Fall time		-				ns	

Note1: Definition of parameters is as follows.
      tc= 1CLK, th= 1H
Note2: See the data sheet of LVDS transmitter.
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.9.3 Input signal timing chart

Horizontal timing
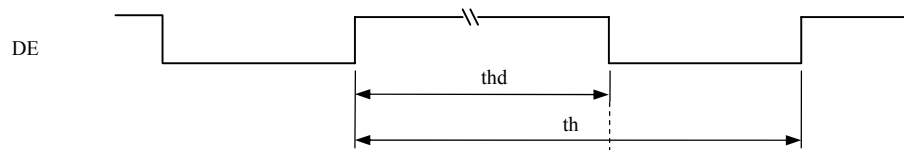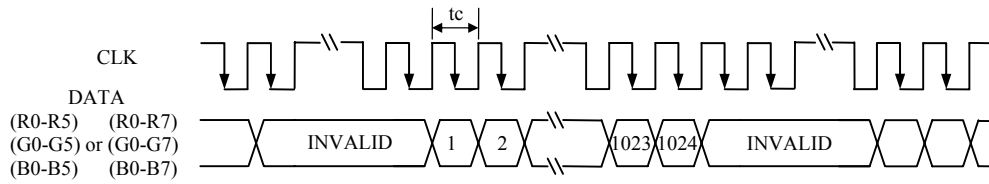
Vertical timing
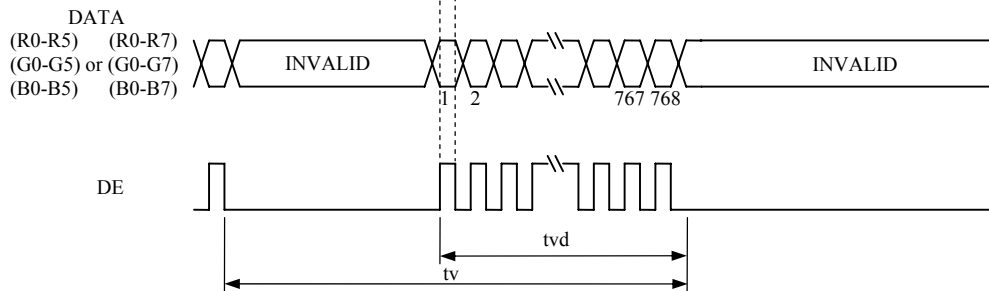
4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	TBD	(400)	-	cd/m²	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	TBD	(600)	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	TBD	TBD	-	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	-	TBD	-	-		
		y coordinate	Ry	-	TBD	-	-		
	Green	x coordinate	Gx	-	TBD	-	-		
		y coordinate	Gy	-	TBD	-	-		
	Blue	x coordinate	Bx	-	TBD	-	-		
		y coordinate	By	-	TBD	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	TBD	72	-	%		
Response time		White to Black	Ton	-	TBD	TBD	ms	BM-5A-10000	Note6 Note7
		Black to White	Toff	-	TBD	TBD	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	88	-	°	EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	88	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	88	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	88	-	°		

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.3V, IL= 50mA/One Circuit, Display mode: XGA, Horizontal cycle= 1/48.363kHz, Vertical cycle= 1/60.0Hz, DPS= Low or Open, FRC= High

Optical characteristics are measured at luminance saturation 20minutes after the product works in the dark room. Also measurement methods are as follows.
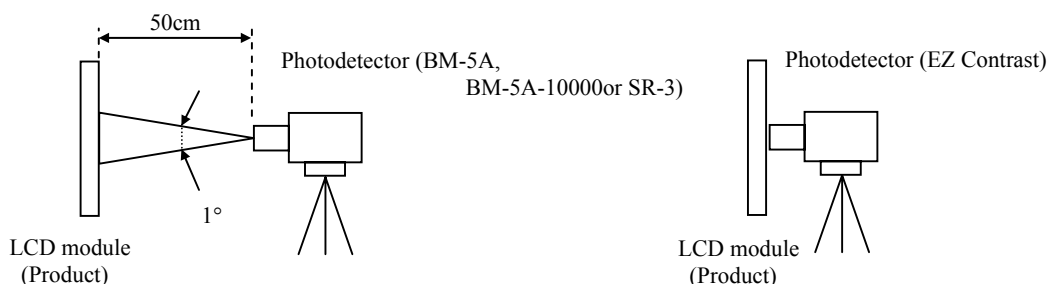
Note3: See "**4.10.2 Definition of contrast ratio**".
Note4: See "**4.10.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= TBD °C
Note7: See "**4.10.4 Definition of response times**".
Note8: See "**4.10.5 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.
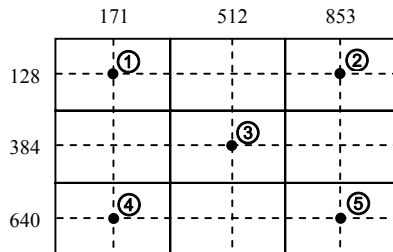
4.10.4 Definition of response times

Response time is measured, the luminance changes from " black " to " white ", or " white " to " black " on the same screen point, by photo-detector. Ton is the time it takes the luminance change from 10% up to 90%. Also Toff is the time it takes the luminance change from 90% down to 10% (See the following diagram.).
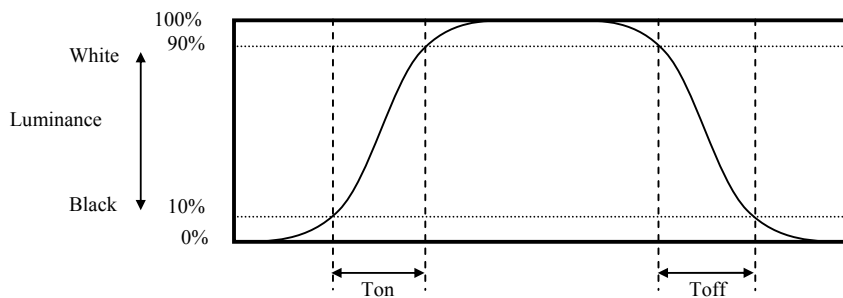
4.10.5 Definition of viewing angles
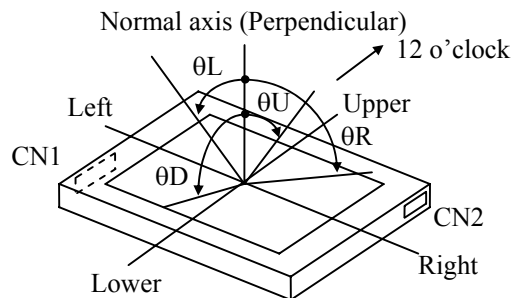
5. ESTIMATED LUMINANCE LIFETIME

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, IL= 50mA/One circuit	70,000	h
	70°C (Surface temperature at screen) Continuous operation, IL= 50mA/One circuit	60,000	h

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

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① 60 ± 2°C, RH = 90%, 240hours ② Display data is white.	No display malfunctions
Heat cycle (Operation)	① -20 ± 3°C…1hour 　70 ± 3°C…1hour ② 50cycles, 4hours/cycle ③ Display data is white.	No display malfunctions
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 　80 ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.	No display malfunctions
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 9 places on a panel surface　　Note2 ③ 10 times each points at 1 sec interval	No display malfunctions
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
Vibration (Non operation)	① 5 to 100Hz, 19.6m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 120 times each directions	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 539m/ s^2, 11ms ② ±X, ±Y, ±Z directions ③ 5 times each directions	No display malfunctions No physical damages

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.
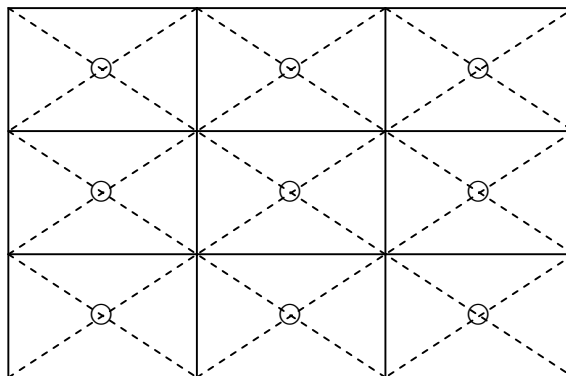
7. PRECAUTIONS

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

⚠

∗ **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 TBD N·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 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 The interference noise between input signal frequency for this product's signal processing board and luminance control frequency of the LED driver board may appear on a display. Set up luminance control frequency of the LED driver board so that the interference noise does not appear.

7.3.4 Others

① All GND, VCC, GNDB and VDDB terminals should be used without any non-connected lines.

② Do not disassemble a product or adjust variable resistors.

③ The LCD module by itself or integrated into end product should be packed and transported with display in the vertical position. Otherwise the display characteristics may be degraded.

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.

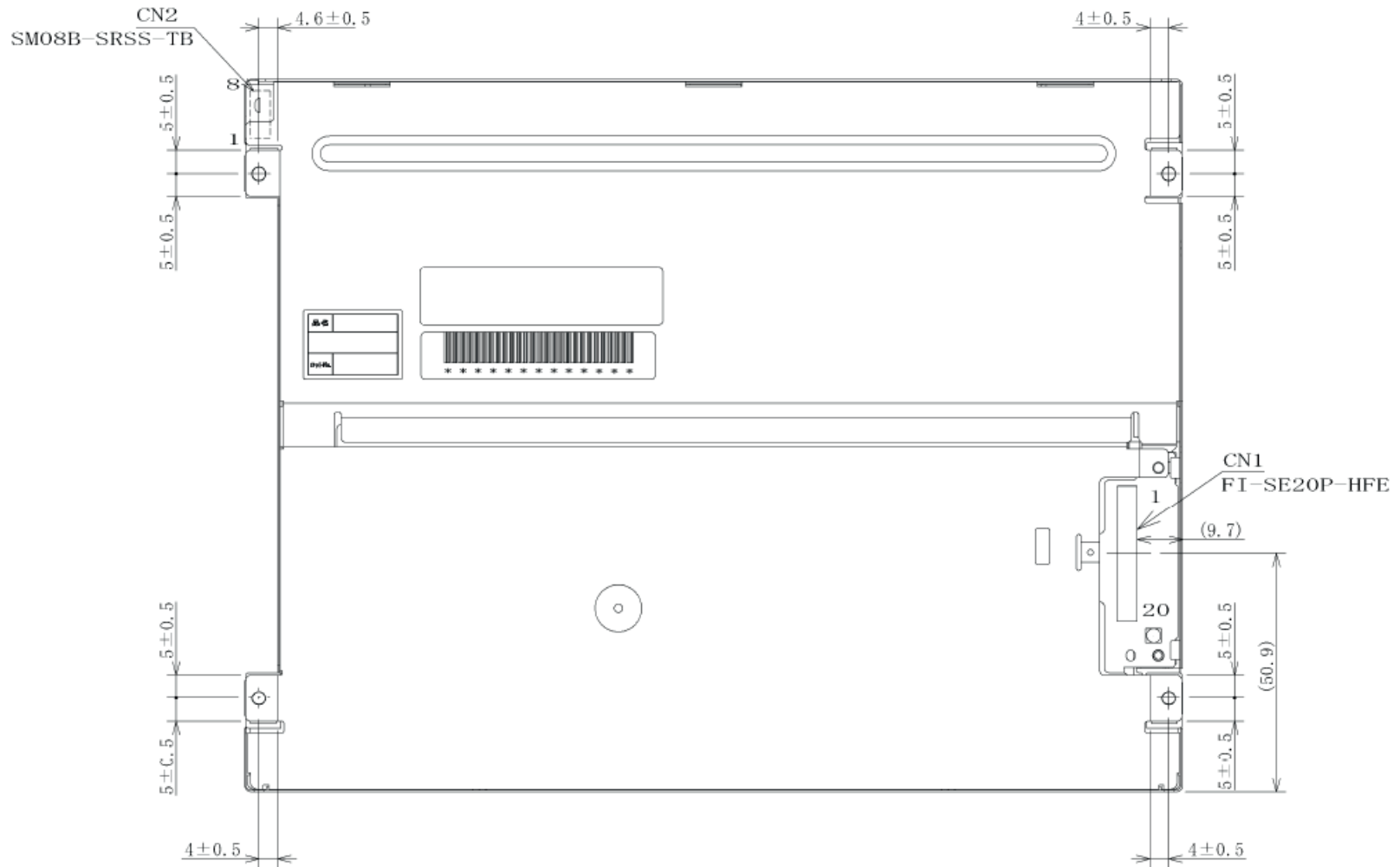## 8. OUTLINE DRAWINGS

8.1 FRONT VIEW
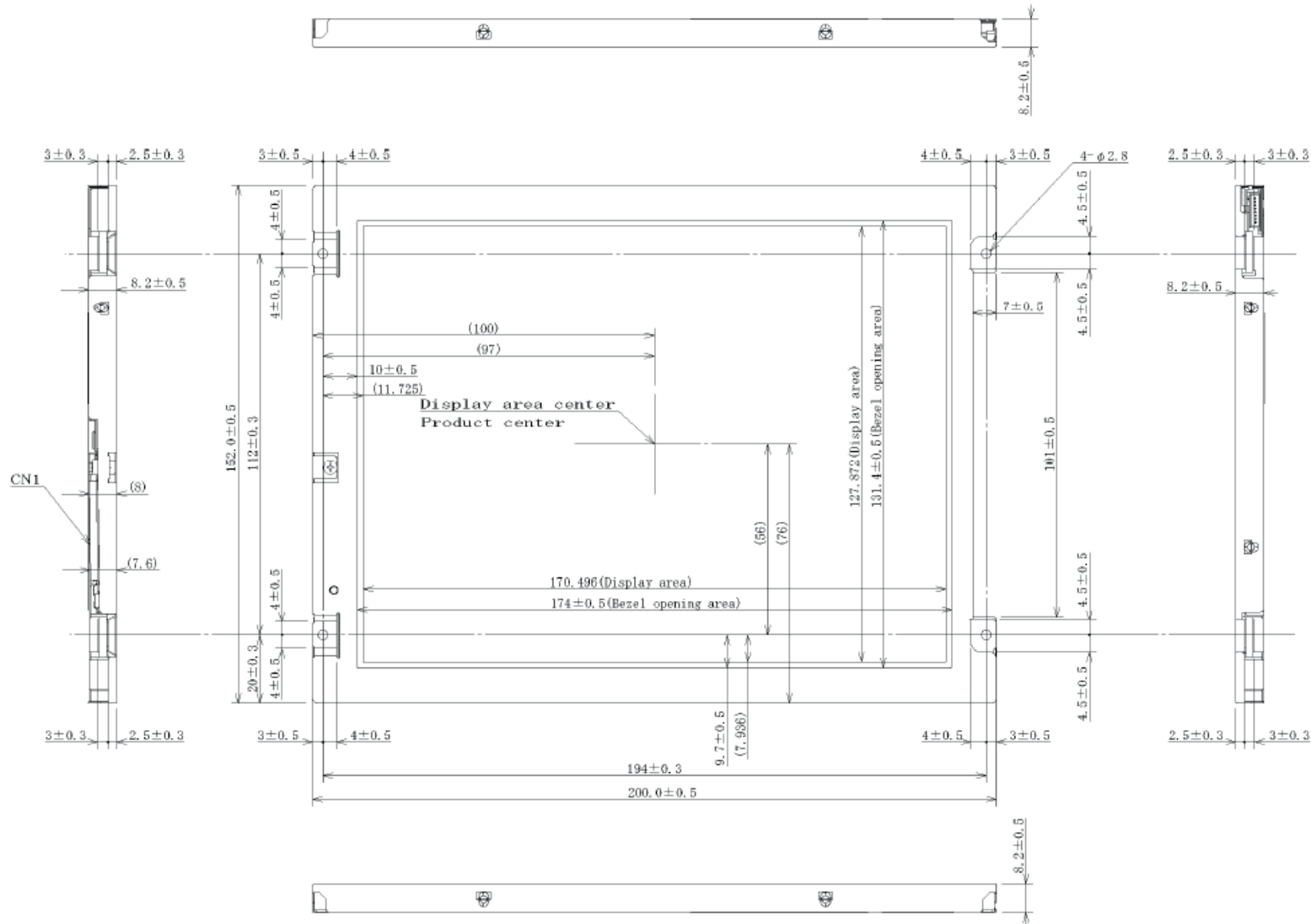
Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed TBD N·m.
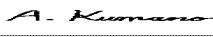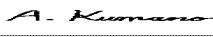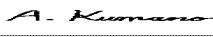
Unit: mm

8.2 REAR VIEW

CN2
SM08B−SRSS−TB

CN1
FI−SE20P−HFE

Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed TBD N·m.

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-1682	June 10, 2013	**Revision contents** New issue **Signature of writer** *Approved by* *Checked by* *Prepared by* R. KAWASHIMA A. KUMANO