PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL13676BC25-03F

39.5cm (15.6 Type)
WXGA (1366×768)
LVDS Interface (1port)

2

PRELIMINARY DATA SHEET

DOD-PP-1897 (2nd edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-1849(1)

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.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL13676BC25-03F 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 circuit, 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 APPLICATIONS

- For industrial use

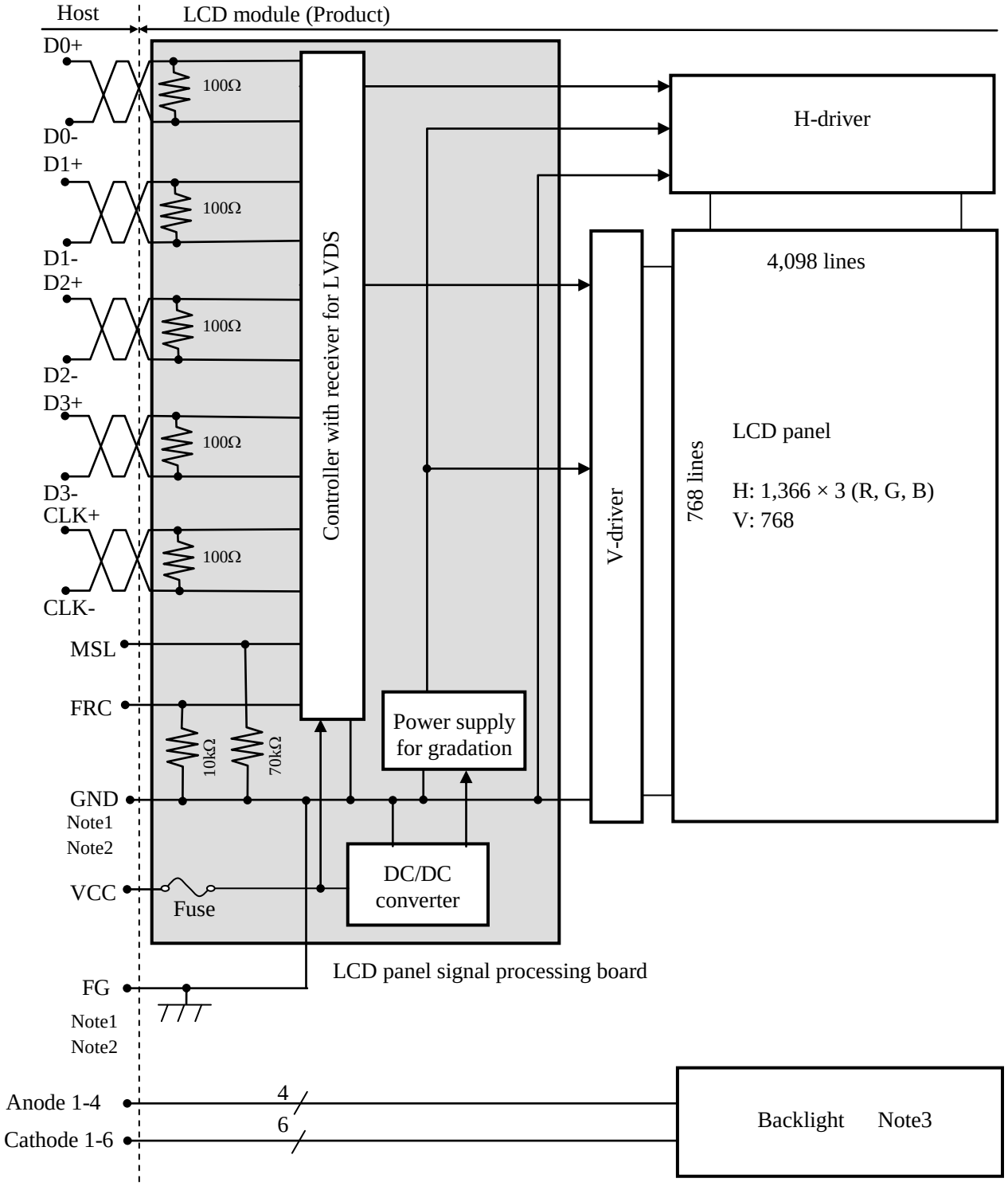
1.3 FEATURES

- High luminance
- High contrast
- LED backlight
- LVDS interface
- Selectable 8bit or 6bit digital signals for data of RGB

2. GENERAL SPECIFICATIONS

Display area	344.232 (H) × 193.536 (V) mm	
Diagonal size of display	39.5cm (15.6 inches)	
Drive system	a-Si TFT active matrix	
Display color	16,777,216 colors (At 8-bit input, FRC terminal= Low or Open) 262,144 colors (At 6-bit input, FRC terminal= High)	
Pixel	1,366 (H) × 768 (V) pixels	
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe	
Dot pitch	0.084 (H) × 0.252 (V) mm	
Pixel pitch	0.252 (H) × 0.252 (V) mm	
Module size	363.8 (W) × 215.9 (H) × 12.65 (D) mm (typ.)	
Weight	1,070 g (typ.)	2
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	• Viewing direction without image reversal: Up side (12 o'clock) • Viewing direction with contrast peak: Down side (6 o'clock) • Viewing angle with optimum grayscale (γ≒ 2.2): Normal axis (perpendicular)	
Polarizer surface	Antiglare	
Polarizer pencil-hardness	3H (min.) [by JIS K5600]	
Color gamut	*At LCD panel center* 60% (typ.) [against NTSC color space]	
Response time	*Ton+Toff (10%←→ 90%)* 18ms (typ.)	2
Luminance	*At IL= 90 mA/One circuit* 1,100cd/m^2 (typ.)	2
Signal system	LVDS 1port	
Power supply voltage	LCD panel signal processing board: 3.3V	
Backlight	LED backlight:	
Power consumption	*At IL= 90 mA/One circuit, Checkered flag pattern* 16.2 W (typ.)	2

3. BLOCK DIAGRAM

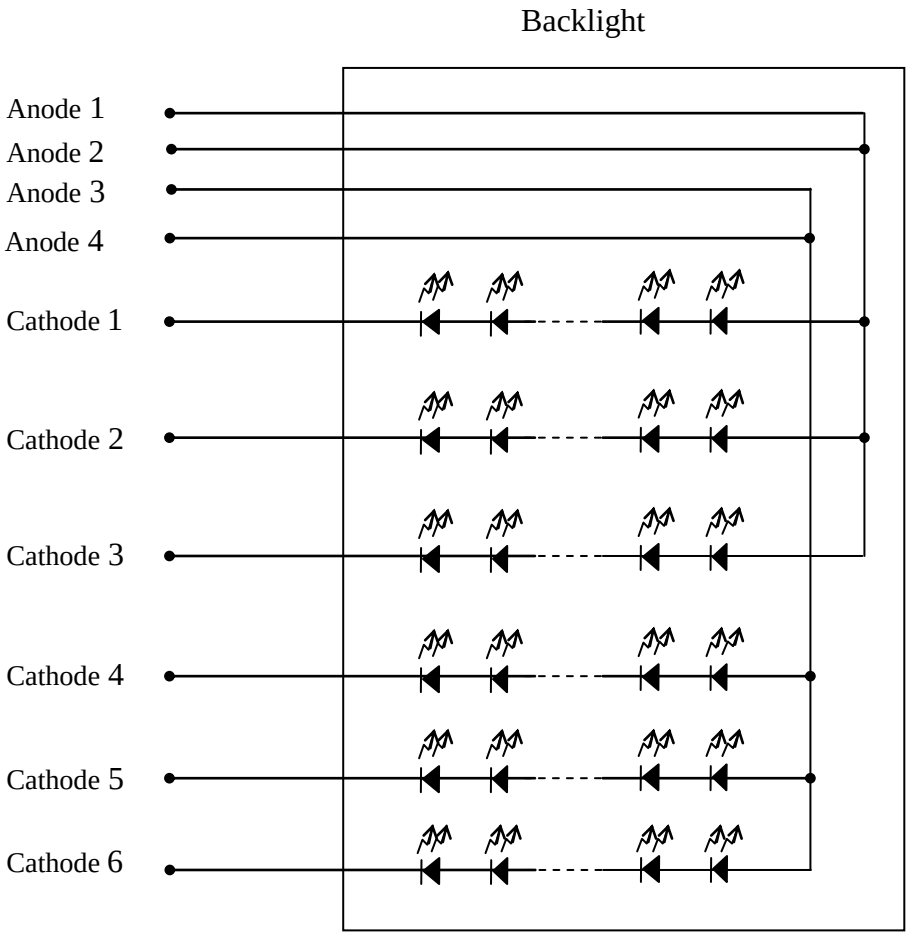


Note1: Relations between GND (Signal ground) and FG (Frame ground) in the LCD module are as follows.

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.

Note3: Backlight in detail



4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	363.8 ± 0.5 (W) × 215.9 ± 0.5 (H) × 12.65 ± 0.5 (D)	Note1	mm
Display area	344.232 (H) × 193.536 (V)	Note1	mm
Weight	1,070 (typ.), 1,170 (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 +4.0	V	Ta= 25°C
Input voltage for signals	Display signals Note1	VD	-0.3 to 1.98	V	
	Function signals Note2	VF	-0.3 to +4.0		
Backlight	Forward current	IL	100	mA	per one circuit
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	≤ 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: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-
Note2: 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= 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	-	480 Note1	800 Note2	mA	at VCC= 3.3V	2
Permissible ripple voltage		VRP	-	-	300	mVp-p	for VCC	2
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.25V Note3	
	Low	VTL	-100	-	-	mV		
Terminating resistance		RT	-	100	-	Ω	-	
Input voltage for FRC and MSL signals	High	VFH	2.25	-	VCC	V	-	
	Low	VFL	0	-	0.40	V		
Input current for FRC and MSL signals	High	IFH	-	-	500	μA	-	
	Low	IFL	0	-	-	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	-	90.0	95.0	mA	-	2
Forward Voltage	VL	24.4	27.1	29.8	V	Ta= +25°C at IL= 90 mA /One circuit	2
		23.2	-	-		Ta= +70°C at IL= 90 mA /One circuit	2
		-	-	31.4		Ta= -20°C at IL= 90 mA /One circuit	2
		-	-	31.5		Ta= -20°C at IL= 95 mA /One circuit	2

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 6 circuits. It is recommended that the current value difference amongst 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	≤ 300	mVp-p	2

Note1: The permissible ripple voltage includes spike noise.

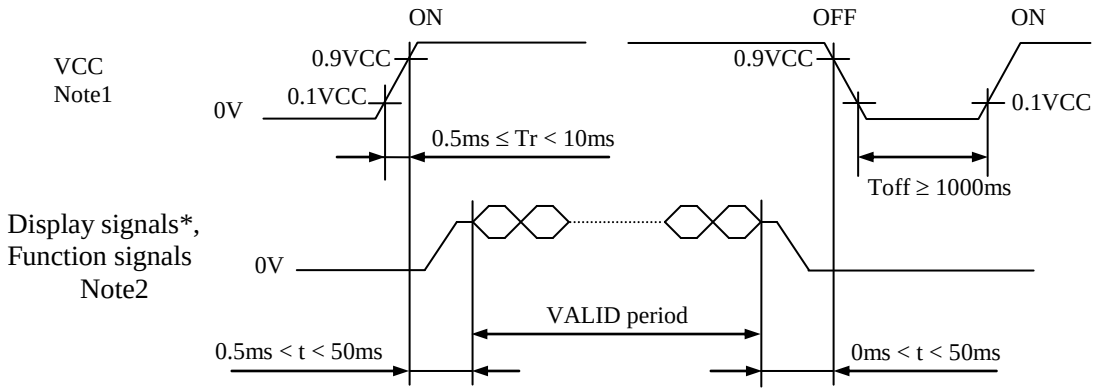
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks	
	Type	Supplier				
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	Note1	2

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

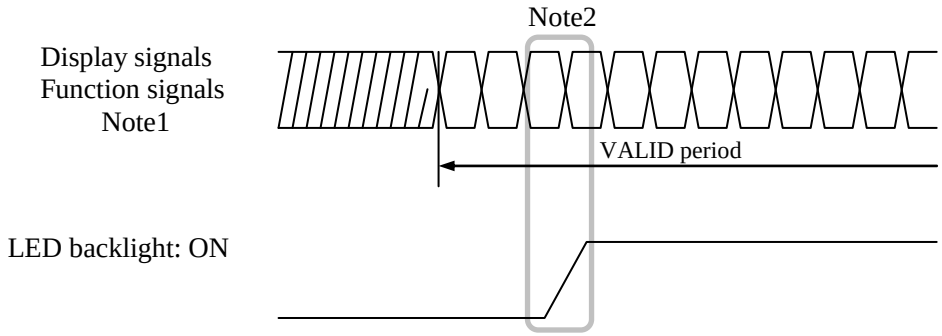


* These signals should be measured at the terminal of 100Ω resistance.

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

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

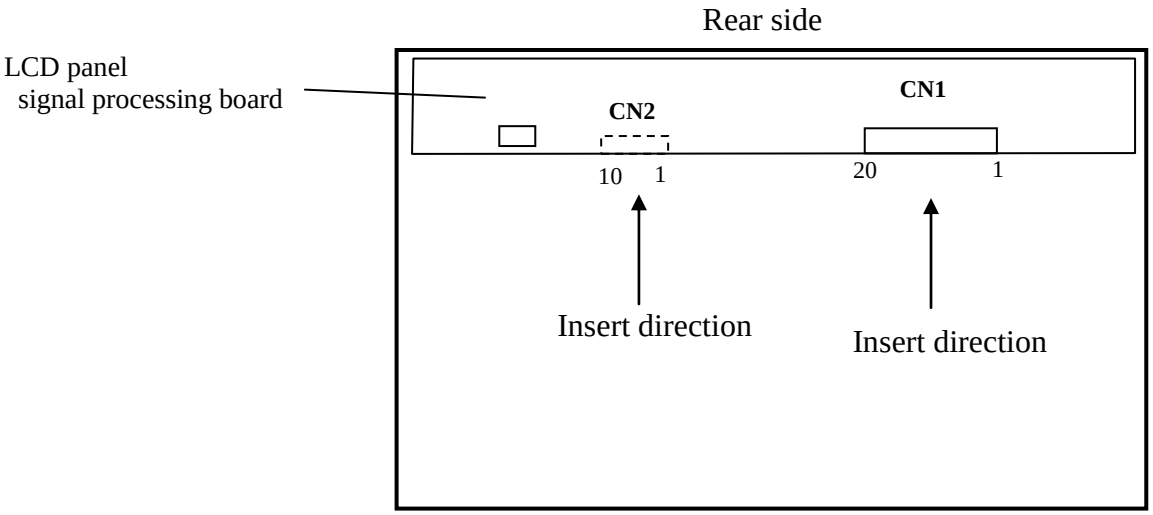
Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note2: All GND and VCC terminals should be used without any non-connected lines.
Note3: See "**4.5.4 Connection between receiver and transmitter for LVDS**".
Note4: See "**4.6 DISPLAY COLORS AND INPUT DATA SIGNALS**".

4.5.2 Backlight lamp

CN2 plug (LCD module side): SM10B-SHLS-TF(LF)(SN) (J.S.T. Mfg. Co., Ltd.)
Adaptable socket: SHLP-10V-S-B (J.S.T. Mfg. Co., Ltd.)

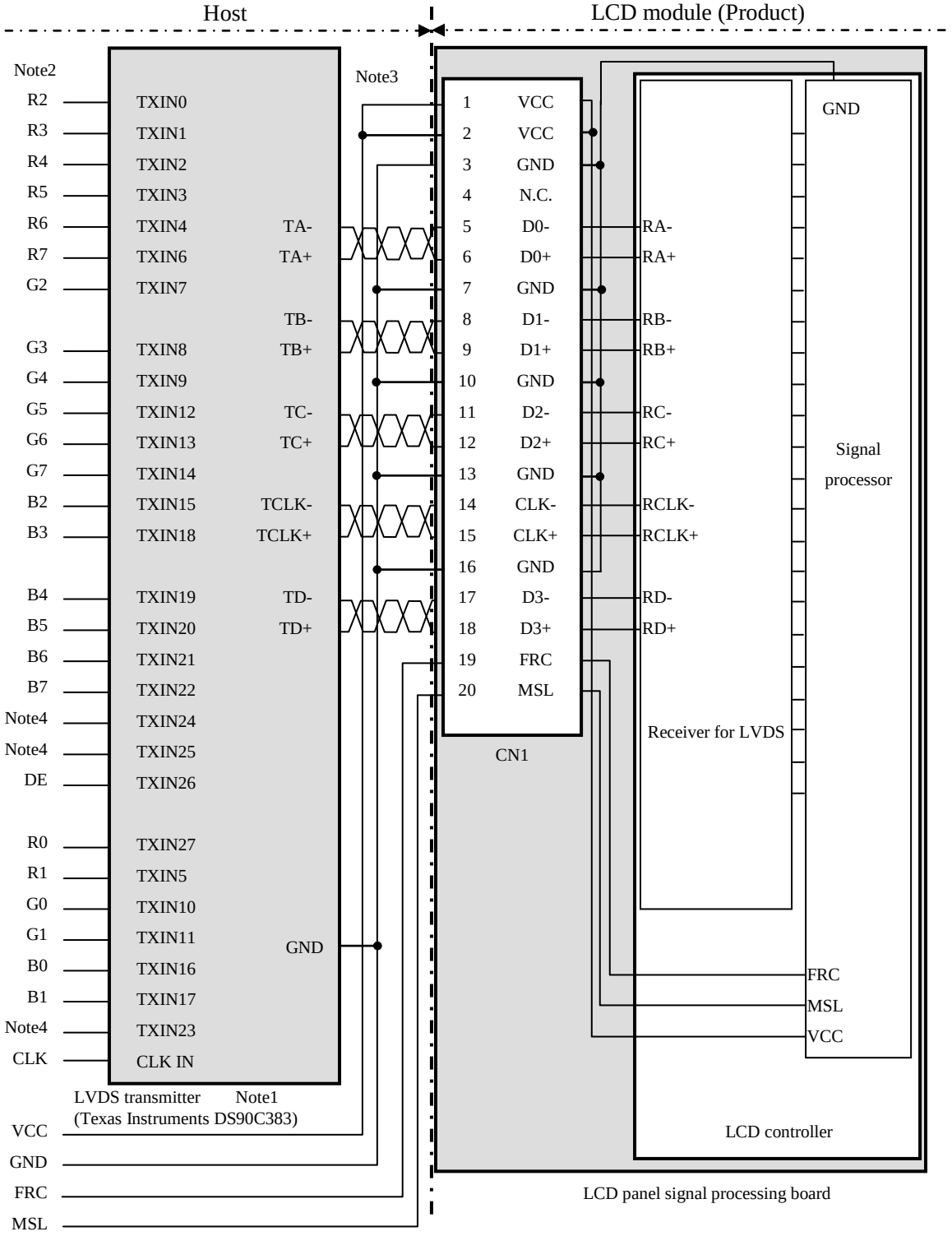
Pin No.	Symbol	Signal	Remarks
1	A1	Anode1	-
2	A2	Anode2	-
3	A3	Anode3	-
4	A4	Anode4	-
5	K1	Cathode1	-
6	K2	Cathode2	-
7	K3	Cathode3	-
8	K4	Cathode4	-
9	K5	Cathode5	-
10	K6	Cathode6	-

4.5.3 Position of plug and socket



4.5.4 Connection between receiver and transmitter for LVDS

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



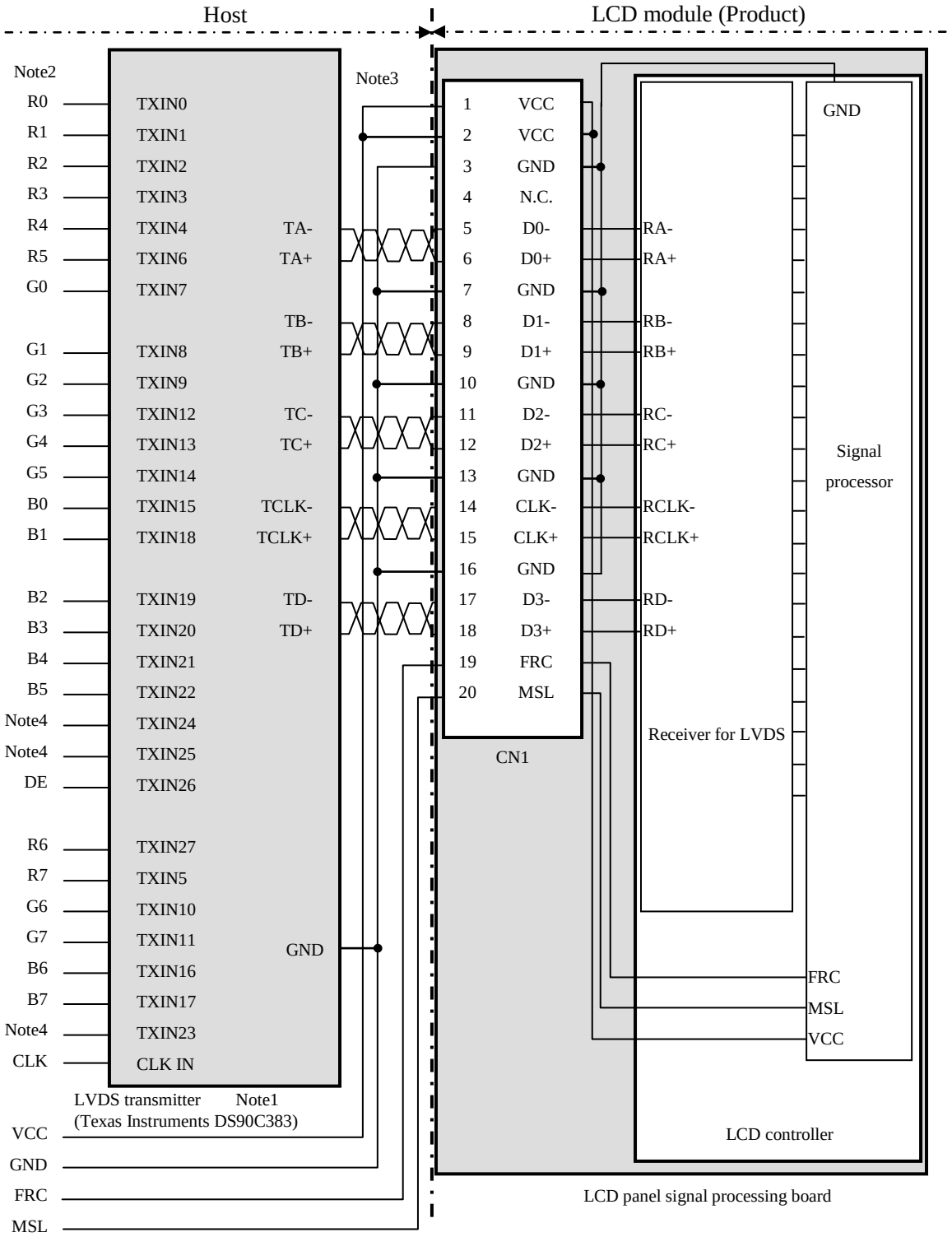
Note1: Recommended transmitter DS90C383 (Texas Instruments)

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.

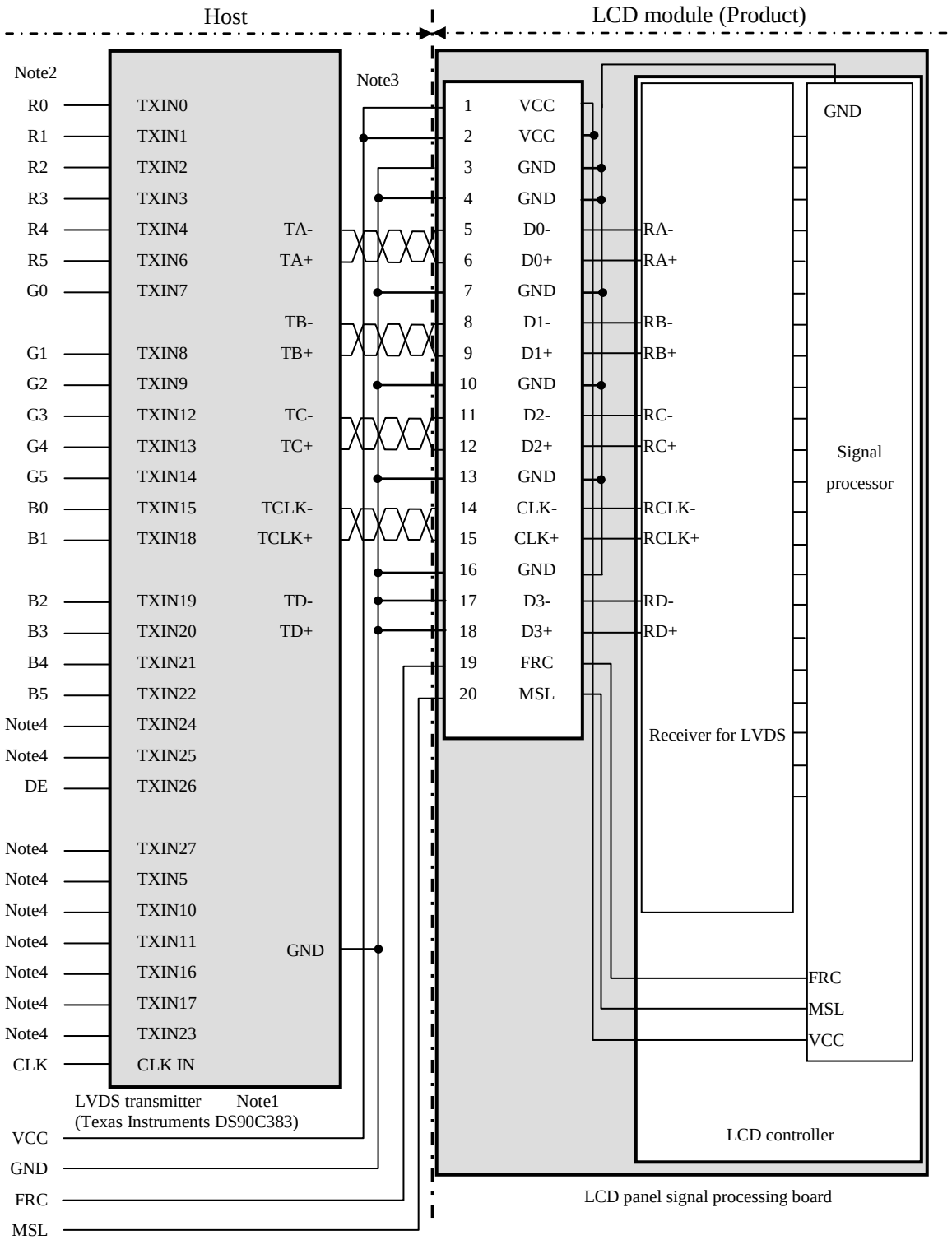
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep them open to avoid noise problem.

(2) Input data signal: 8-bit, MAP B (MSL: Low or Open, FRC: Low or Open)



Note1: Recommended transmitter DS90C383 (Texas Instruments).
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 TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep them open to avoid noise problem.

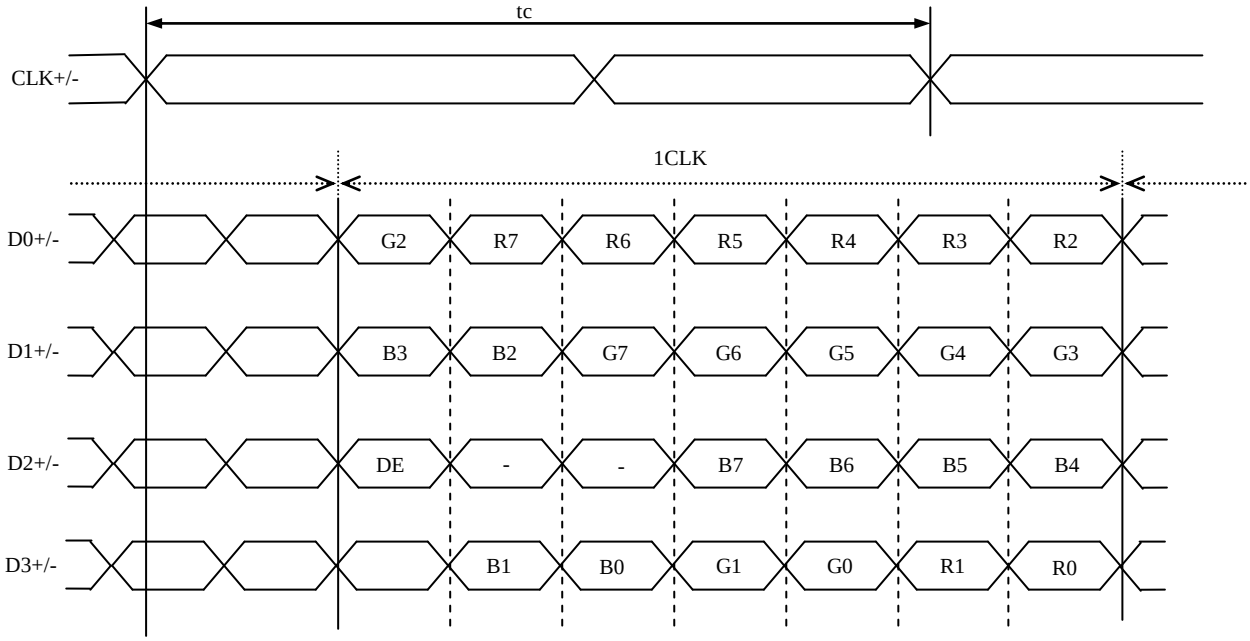
(3) Input data signal: 6-bit (MSL: High, FRC: High)



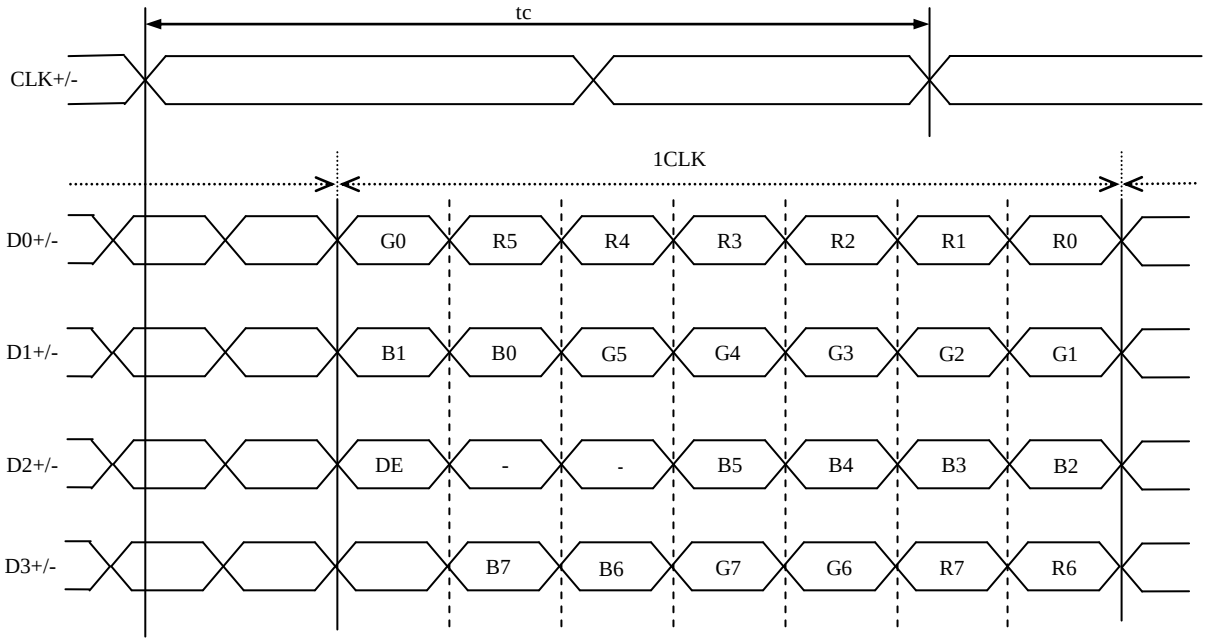
Note1: Recommended transmitter DS90C383 (Texas Instruments).
Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R5, G5, B5
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note4: Input signals to TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 are not used inside the product, but do not keep them open to avoid noise problem.

4.5.5 Input data mapping

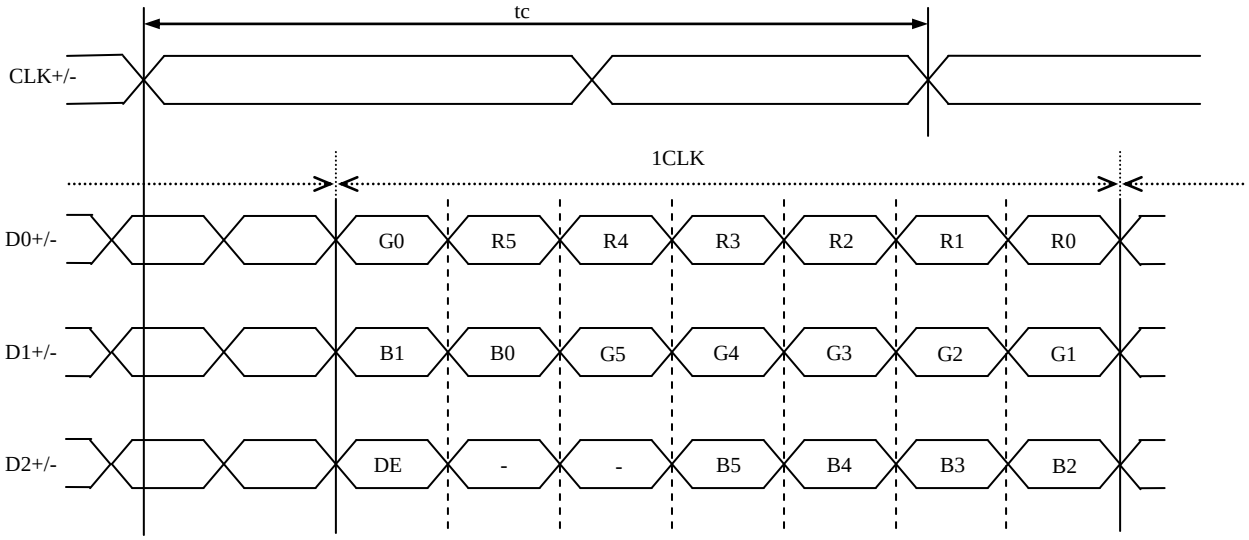
(1) Input data signal: 8-bit, MAP A



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



(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.17 and 18	FRC terminal	MSL terminal	Display colors	Remarks
①	8-bit	MAP A	D3+/-	Low or Open	High	16,777,216	Note1
②	8-bit	MAP B	D3+/-	Low or Open	Low or Open	16,777,216	Note1
③	6-bit	-	GND	High	High	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

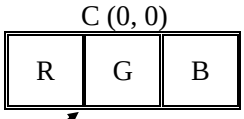
4.6.3 262,144 colors

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)																	
		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

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel.



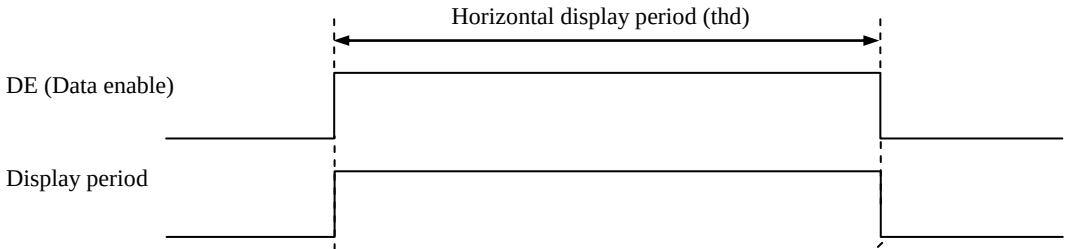
C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(1364, 0)	C(1365, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(1364, 1)	C(1365, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(1364, Y)	C(1365, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 766)	C(1, 766)	• • •	C(X, 766)	• • •	C(1364, 766)	C(1365, 766)
C(0, 767)	C(1, 767)	• • •	C(X, 767)	• • •	C(1364, 767)	C(1365, 767)

4.8 INPUT SIGNAL TIMINGS

4.8.1 Outline of input signal timings

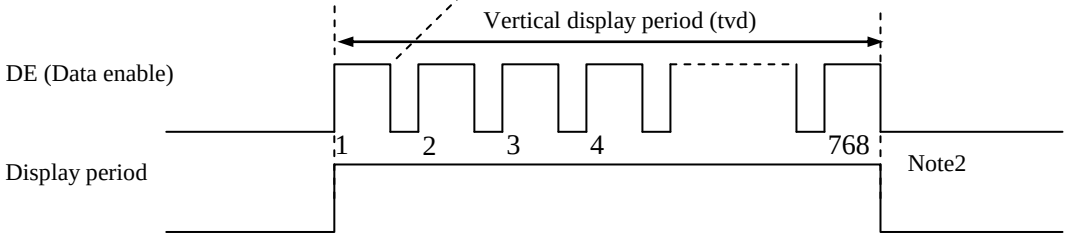
- Horizontal signal

Note1



- Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.8.3 Input signal timing chart**" for the pulse number.

4.8.2 Timing characteristics

(Note1, Note2, Note3)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	71.0	75.4	79.8	MHz	13.263ns (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	16.542	20.678	26.88	μs	48.360kHz (typ.)
				1,446	1,560	1,936	CLK	
		Display period	thd	1,366			CLK	
	Vertical (One frame)	Cycle	tv	14.29	16.67	20.00	ms	60.0Hz (typ.)
				778	806	-	H	
		Display period	tvd	768			H	
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

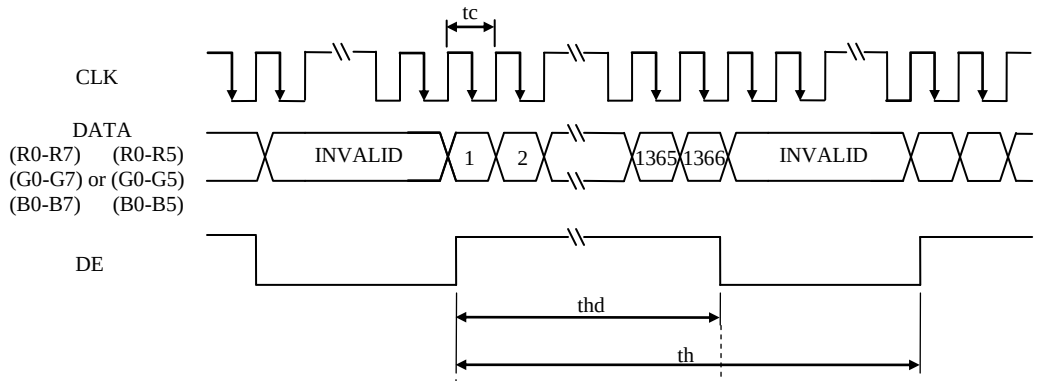
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

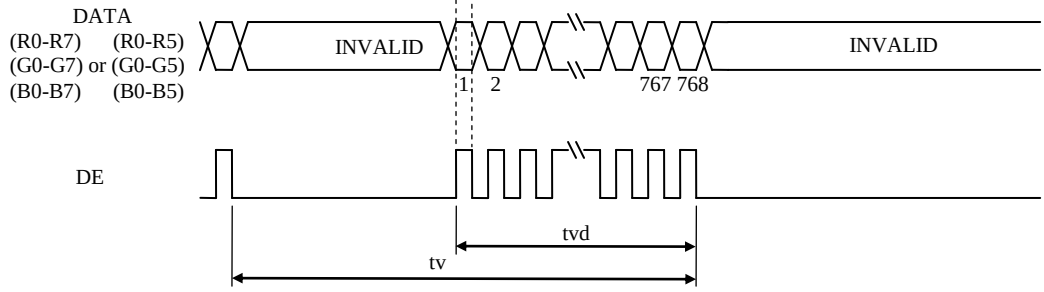
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.8.3 Input signal timing chart

Horizontal timing



Vertical timing



4.9 OPTICS

4.9.1 Optical characteristics

(Note1, Note2)

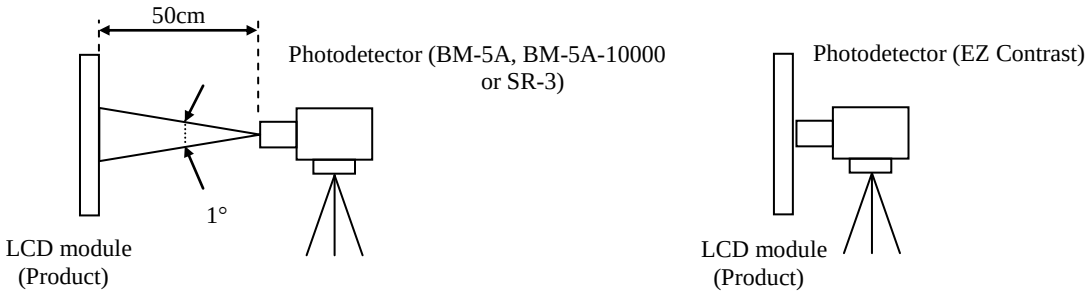
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	800	1,100	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	540	900	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 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	-	0.631	-	-		
		y coordinate	Ry	-	0.357	-	-		
	Green	**x** coordinate	Gx	-	0.344	-	-		
		y coordinate	Gy	-	0.608	-	-		
	Blue	**x** coordinate	Bx	-	0.153	-	-		
		y coordinate	By	-	0.089	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	55	60	-	%		
Response time		White to Black	Ton	-	3	5	ms	BM-5A -10000	Note6 Note7
		Black to White	Toff	-	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= 90mA/One circuit, Display mode: WXGA,
Horizontal cycle= 1/48.360kHz, Vertical cycle= 1/60.0Hz, FRC= Low (8-bit MODE)

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



Note3: See "**4.9.2 Definition of contrast ratio**".

Note4: See "**4.9.3 Definition of luminance uniformity**".

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

Note6: Product surface temperature: TopF= 35°C

Note7: See "**4.9.4 Definition of response times**".

Note8: See "**4.9.5 Definition of viewing angles**".

4.9.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

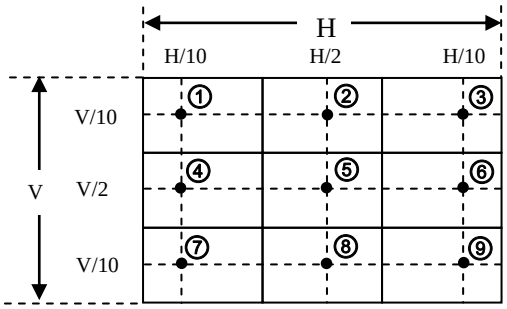
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

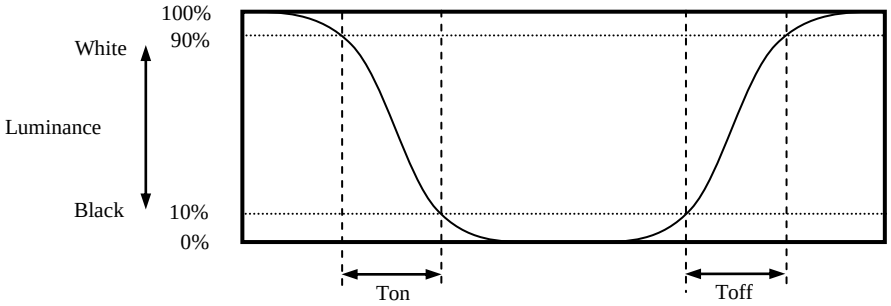
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑨}}{\text{Minimum luminance from ① to ⑨}}$$

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

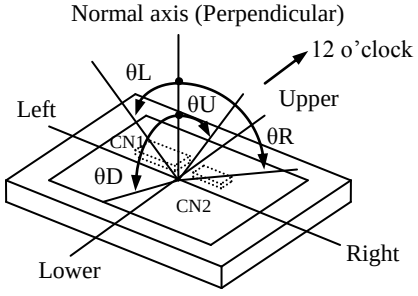


4.9.4 Definition of response times

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.).



4.9.5 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= 90mA/One circuit	70,000	h
	70°C (Temperature at LCD panel surface and rear shield surface) Continuous operation, IL= 90mA/One circuit	60,000	

2

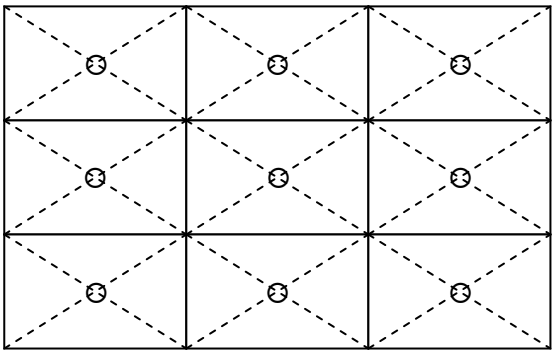
Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature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

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① 60 ± 2°C, RH= 90%, 240hours ② Display data is black.	No display malfunctions
High temperature (Operation)	① 70 ± 3°C, 240hours ② Display data is black.	
Heat cycle (Operation)	① -20 ± 3°C…1hour 70 ± 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 places 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, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 50 times each directions	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 294m/s^2, 11ms ② ±X, ±Y, ±Z directions ③ 3 times each directions	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.



7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

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

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

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

7.2 CAUTIONS

- **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 294m/s^2 and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N (ϕ16mm jig))**

7.3 ATTENTIONS

7.3.1 Handling of the product

① 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 Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.
③ When the product is put on the table temporarily, display surface must be placed downward.
④ 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.
⑤ The torque for product mounting screws must never exceed 0.343N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 2.8mm.
⑥ 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.
⑦ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
⑧ Do not push or pull the interface connectors while the product is working.
⑨ 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.
⑩ 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.

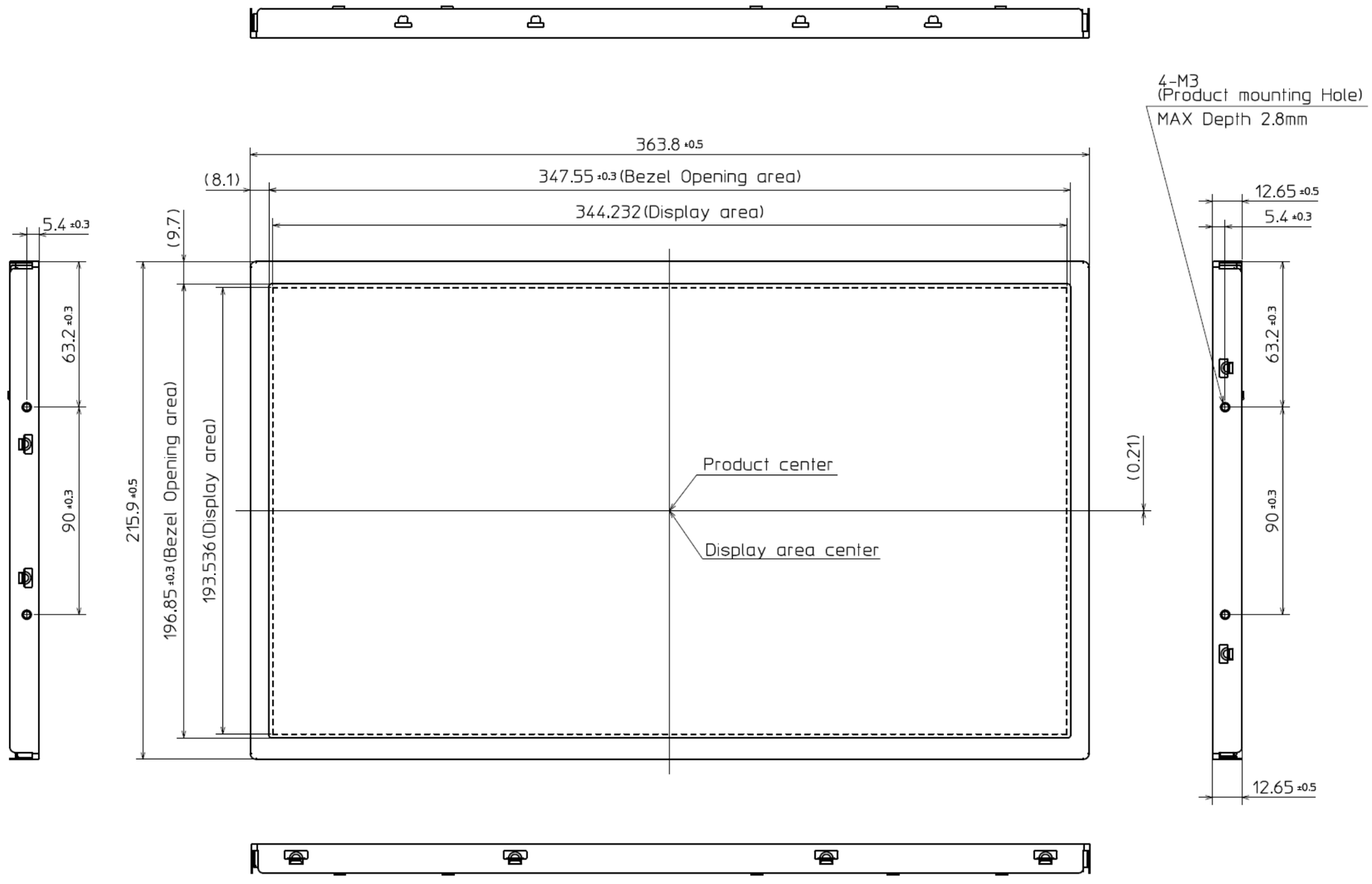
① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough 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 and GND terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT. 2

8. OUTLINE DRAWINGS

8.1 FRONT VIEW

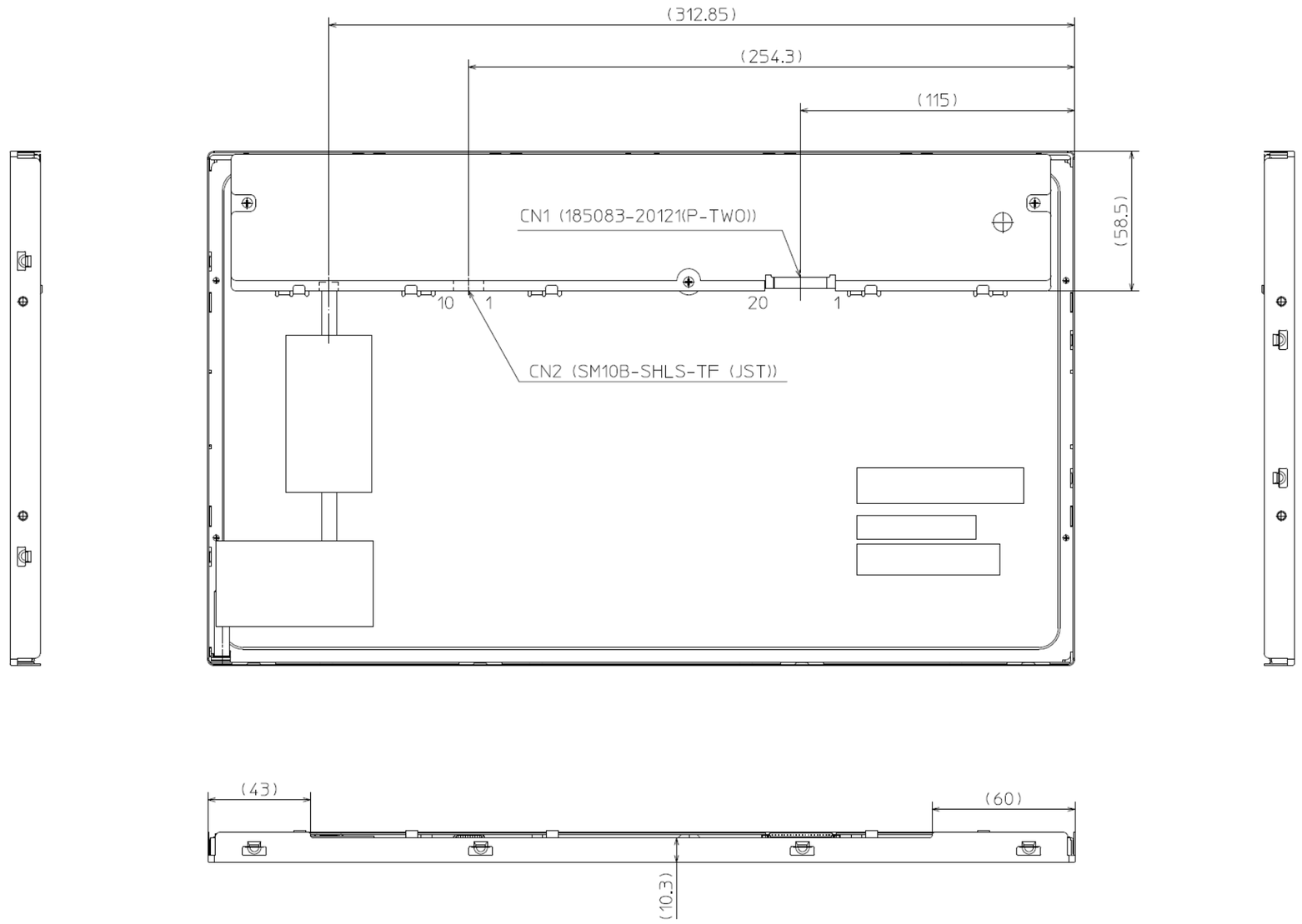


Unit: mm

Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.343 N·m. The length of product mounting screws from surface of plate must be ≤ 2.8mm.
Note3: Module depth excludes projection such as hook, and so on.

8.2 REAR VIEW

2



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.343 N·m. The length of product mounting screws from surface of plate must be ≤ 2.8mm.
Note3: Module depth excludes projection such as hook, and so on.

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-1849	Feb. 21, 2014	**Revision contents** New issue **Writer** *Approved by* R. KAWASHIMA *Checked by* ——— *Prepared by* T. OGAWA
2nd edition	DOD-PP-1897	May 23, 2014	**Revision contents** P1 WXGA → WXGA (1366×768) P5 General specifications • Weight: TBD g (typ.) → 1,070 g (typ.) • Response time: (18) ms (typ.) → 18 ms (typ.) • Luminance: IL = (90) mA → IL = 90 mA • Power consumption: IL = (90) mA, (16.3) W (typ.) → IL = 90 mA, 16.2 W (typ.) P8 Mechanical specifications • Weight: TBD g (typ., max.) → 1,070, 1,170 g (typ., max.) P8 Absolute maximum ratings • Backlight - Forward current: TBD mA → 100 mA • Storage temperature: (-30 to +80) °C → -30 to +80 °C P9 LCD panel signal processing board • Power supply current: (480), (800) mA (typ., max.) → 480, 800 mA (typ., max.) • Permissible ripple voltage: (300) mVp-p (max.) → 300 mVp-p (max.) P10 Backlight lamp • Forward current: (90), (95) mA (typ., max.) → 90.0, 95.0 mA (typ., max.) • Forward voltage: Ta=+25°C at IL= (90) mA, TBD (min.), (27.2) (typ.), (31.5) (max.) V → Ta=+25°C at IL= 90 mA, 24.4 (min.), 27.1 (typ.), 29.8 (max.) V : Ta=+70°C at IL= (90) mA, (23.5) (min.) V → Ta=+70°C at IL= 90 mA, 23.2 (min.) V : Ta=-20°C at IL= (90) mA, TBD (max.) V → Ta=-20°C at IL= 90 mA, 31.4 (max.) V - Ta=-20°C at IL= 95mA: (31.4) (max.) V → 31.5 (max.) V P10 Power supply voltage ripple • Ripple voltage: (300) mVp-p → 300 mVp-p P10 Fuse (specified) P25 Optics - Optical characteristics • Luminance: TBD cd/m^2 (min.) → 800 cd/m^2 (min.) • Response time - Ton: (3), (5) ms (typ., max.) → 3, 5 ms (typ., max.) - Toff: (15), (21) ms (typ., max.) → 15, 21 ms (typ., max.) • Viewing angle - θR: (70) ° (min.) → 70 ° (min.) - θL: (70) ° (min.) → 70 ° (min.) - θU: (70), (80) ° (min., typ.) → 70 , 80 ° (min., typ.) - θD: (70) ° (min.) → 70 ° (min.) • Note2: IL=(90) mA → IL=90 mA • Note6: TopF= TBD °C →TopF= 35 °C P27 Estimated luminance lifetime • LED elementary substance - 25 °C: IL=(90)mA, (60,000) h → IL=90mA, 70,000 h - 70 °C: IL=(90)mA, TBD h → IL=90mA, 60,000 h P30 Others • ③: ... for repairing and so on (elimination)

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
2nd edition	DOD-PP-1897	May 23, 2014	**Revision contents** P32 Outline drawings - Rearview • Tape size and position (change and elimination) • Label (addition) • Bottom view (addition) **Signature of writer** *Approved by* R. KAWASHIMA *Checked by* *Prepared by* E. YOSHIMURA