PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NLB150XG01L-01

38cm (15.0 Type)
XGA
LVDS interface (1port)

PRELIMINARY DATA SHEET

DOD-PP-1443 (6th edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-1411(5)

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

Document Number: DOD-PP-1443 (6th edition)
Published date: June 2012 CP(N)

INTRODUCTION

NLT does and will not assume any liability for infringement of patents, copyrights or other intellectual property rights of any third party arising out of or in connection with application of the products described herein except for that directly attributable to mechanisms and workmanship thereof. No license, express or implied, is granted under any patent, copyright or other intellectual property right of NLT.

Some electronic products would fail or malfunction at a certain rate. In spite of every effort to enhance reliability of products by NLT, the possibility of failures and malfunction might not be avoided entirely. To prevent the risks of damage to death, human bodily injury or other property arising out thereof or in connection therewith, each customer is required to take sufficient measures in its safety designs and plans including, but not limited to, redundant system, fire-containment and anti-failure.

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

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NLB150XG01L-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 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 APPLICATION

- For industrial use

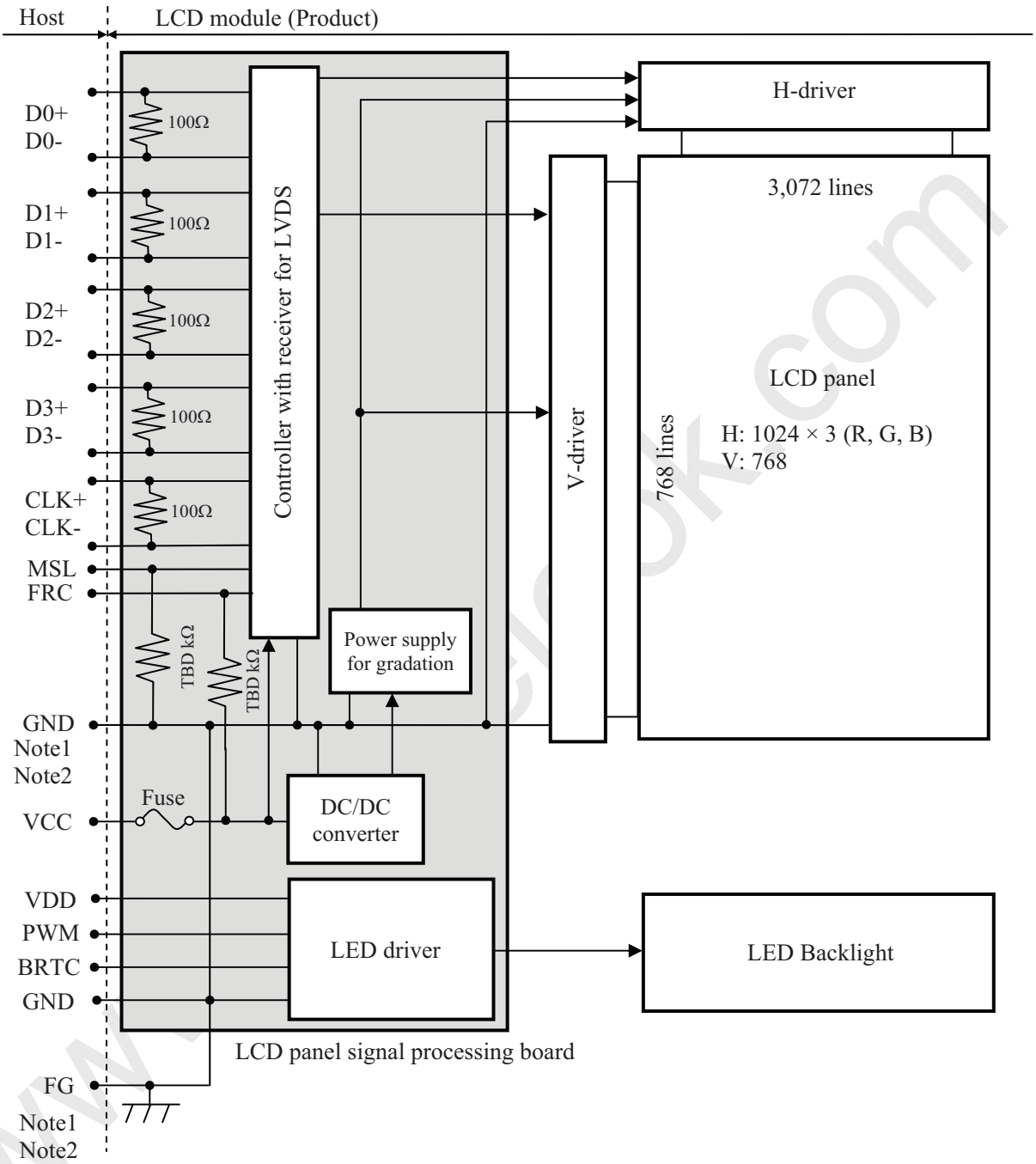
1.3 FEATURES

- High Contrast
- LED backlight type
- LED driver Built-in
- LVDS interface
- Replaceable lamp holder for backlight

2. GENERAL SPECIFICATIONS

Display area	304.128 (H) × 228.096 (V) mm
Diagonal size of display	38.0cm (15.0 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors (At 6 bit + FRC)
Pixel	1024 (H) × 768 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.099 (H) × 0.297 (V) mm
Pixel pitch	0.297 (H) × 0.297 (V) mm
Module size	326.5 mm (W) (typ.) × 253.5 mm (H) (typ.) × 11.8 (D) mm (typ.)
Weight	1,000 g (typ.)
Contrast ratio	600:1 (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.)
Polarizer surface	Anti glare
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%)* 8ms (typ.)
Luminance	*At the maximum luminance control* 400 cd/m^2 (typ.)
Signal system	LVDS 1port
Power supply voltage	LCD panel: 3.3V LED backlight: 12V
Backlight	LED backlight type Replaceable part • Lamp holder set: Type No. TBD
Power consumption	*At the maximum luminance control, Gray pattern* ≤ 12 W (typ.)

3. BLOCK DIAGRAM



Note1: Relations between GND (Signal ground and LED driver 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.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	326.5 ± 0.5 (W) × 253.5 ± 0.5 (H) × 11.8 ± 0.3 (D) Note1	mm
Display area	304.128 (H) × 228.096 (V) Note1	mm
Weight	1,000 (typ.), TBD (max.)	g

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

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks	
Power supply voltage	LCD panel	VCC	-0.3 to +4.0	V	Ta= 25°C	
	LED driver	VDD	-0.3 to +33.0			
Input voltage for signals	Display signals Note1	VD	-0.3 to +1.98	V		6
	Function signals Note2	VF	-0.3 to VCC			6
	Function signal for LED driver	PWM	-0.3 to +5.5	V		
		BRTC	-0.3 to +5.5	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	
Absolute humidity Note5		AH	≤ 70	g/m^3	Ta > +50°C	

Note1: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-
Note2: 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.

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	-	400 Note1	(780) Note2	mA	at VCC= 3.3V	6
Permissible ripple voltage		VRPC	-	-	300	mVp-p	for VCC	6
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 MSL signals	High	VFH	1.65	-	VCC	V	-	
	Low	VFL	0	-	0.40	V		6
Input current for MSL signal	High	IFH	-	-	10	µA	-	
	Low	IFL	-10	-	-	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

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	12.6	V	Note1
Power supply current		IDD	-	610	≤ 833 Note2	mA	At the maximum luminance control. Note2
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD
Input voltage for PWM signal	High	VDFH1	1.2	-	-	V	-
	Low	VDFL1	-	-	0.4	V	
Input voltage for BRTC signal	High	VDFH2	1.5	-	-	V	-
	Low	VDFL2	0	-	0.8	V	
PWM frequency		f_{PWM}	200	-	20k	Hz	Note4, Note5
PWM pulse width		tPWH	5	-	-	μs	-

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.
Note2: This value excludes peak current such as overshoot current.
Note3: 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.
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, so noise may appear on the screen, please conduct a thorough evaluation.

4.3.3 Power supply voltage ripple

This product works, even 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	6
VDD	12.0V	≤ 200	mVp-p	6

Note1: The permissible ripple voltage includes spike noise.

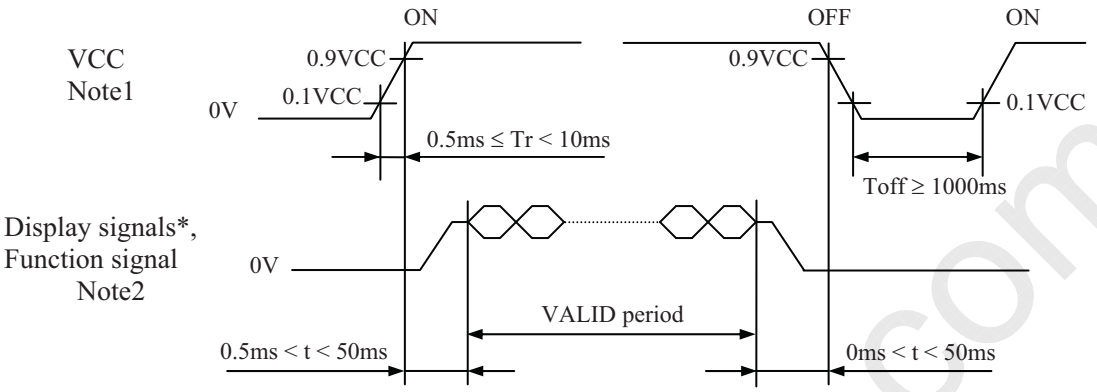
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	Note1
VDD	FCC16202AB	KAMAYA ELECTRIC Co., Ltd.	2.0A 36V	4.0A	

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

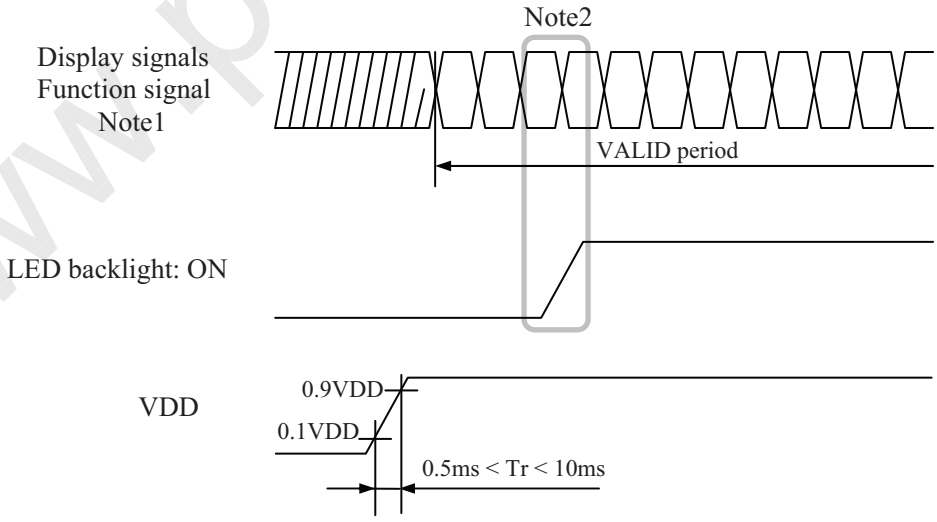


* These signals should be measured at the terminal of 100Ω resistance.

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 signal (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): 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: 8bit		Input data signal: 6bit	Remarks
			MAP A	MAP B		
1	VCC	Power supply	Power supply			Note2
2	VCC					
3	GND	Ground	Ground			Note2
4	GND					
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	MSL	Selection of LVDS Input data map	High	Low or Open	High	Note3, Note4
20	FRC	Selection of the number of colors	Low		High or Open	-

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**".

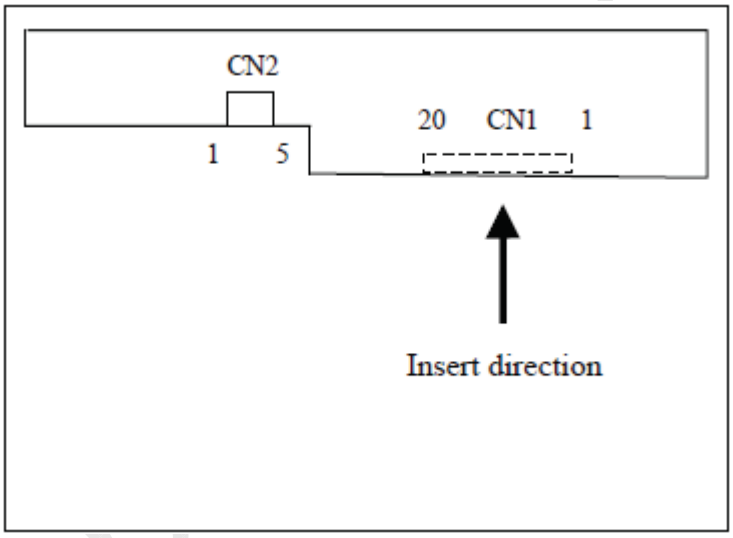
4.5.2 Backlight lamp

CN2 socket (LCD module side): MSB24038P5 (Produced by STM) or equivalent.
Adaptable plug: P24038P5 (Produced by STM)

Pin No.	Symbol	Signal	Remarks	
1	VDD	Power supply	-	6
2	GND	Ground	-	
3	BRTC	Back light ON/OFF control	High- On / Low- Off	6
4	PWM	Luminance control	PWM Dimming	
5	N. C.	Non connection	Keep this pin Open.	

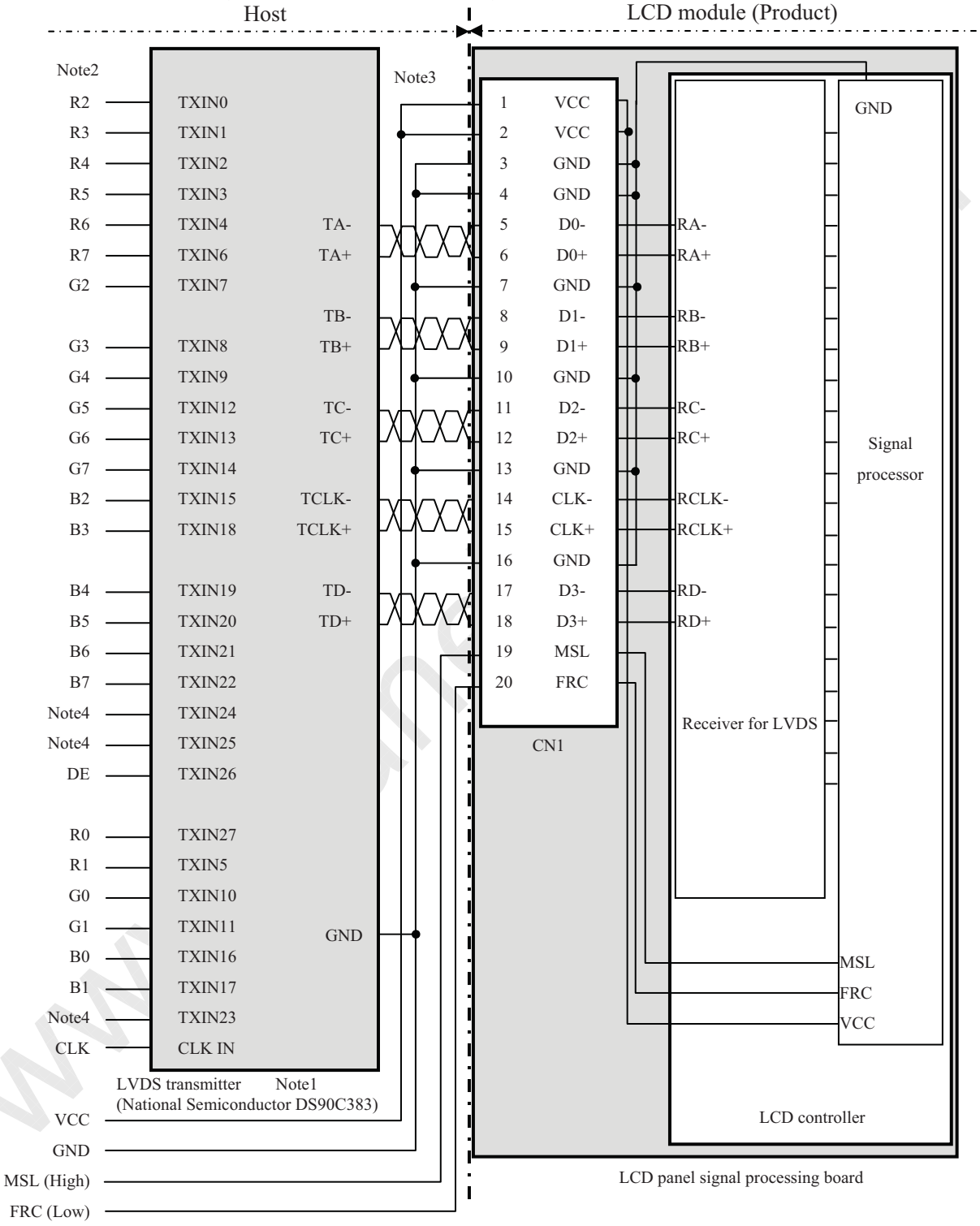
4.5.3 Positions of plug and socket

Rear side



4.5.4 Connection between receiver and transmitter for LVDS

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



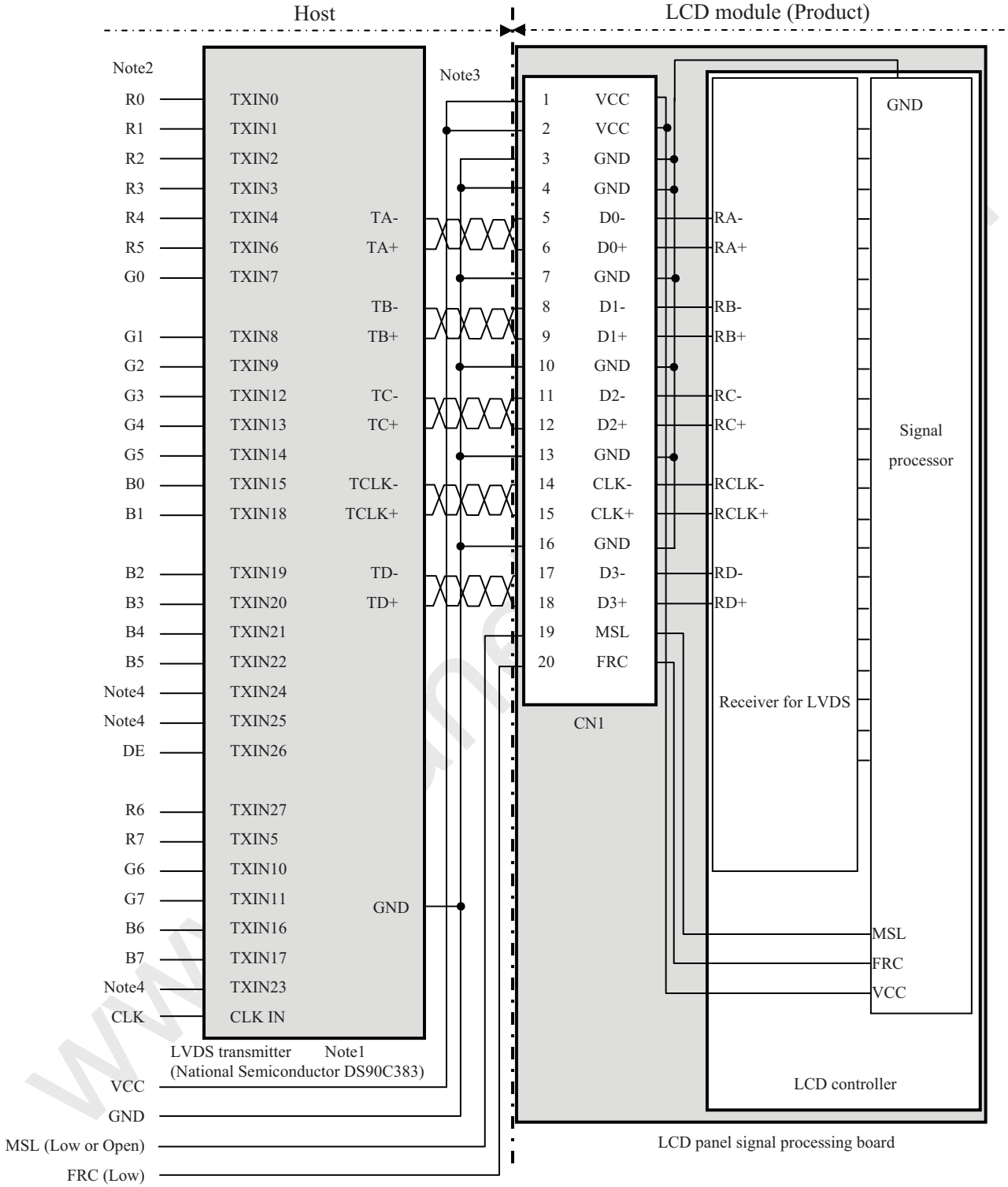
Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).

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.

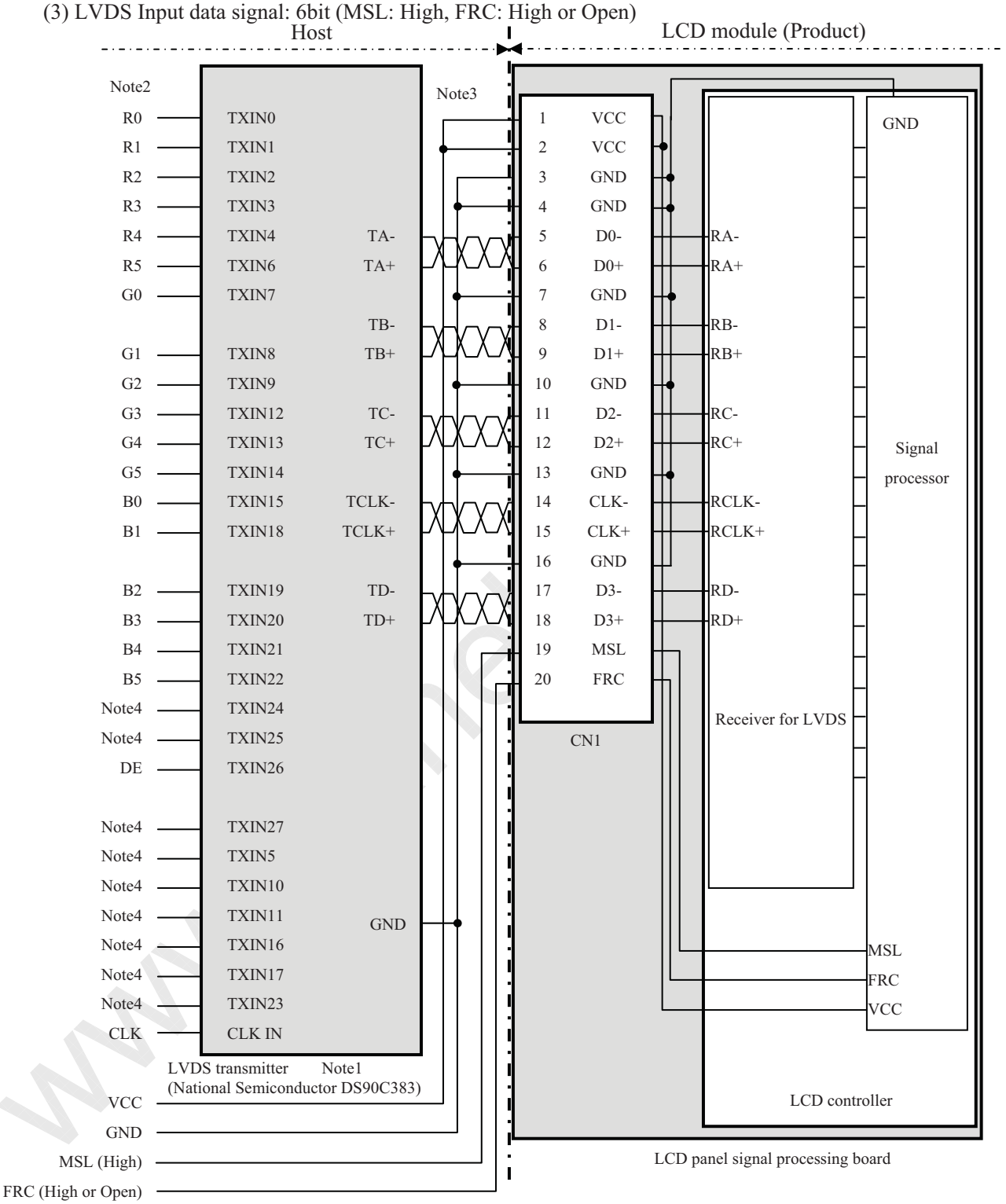
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

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



Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).
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 TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

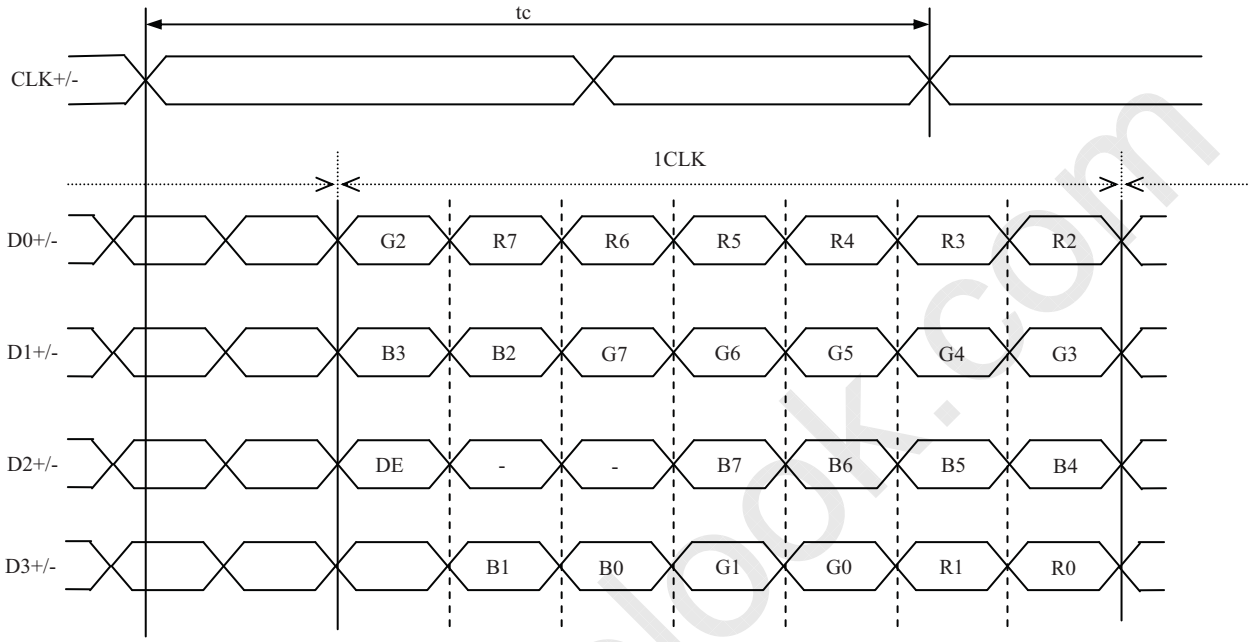
(3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open)



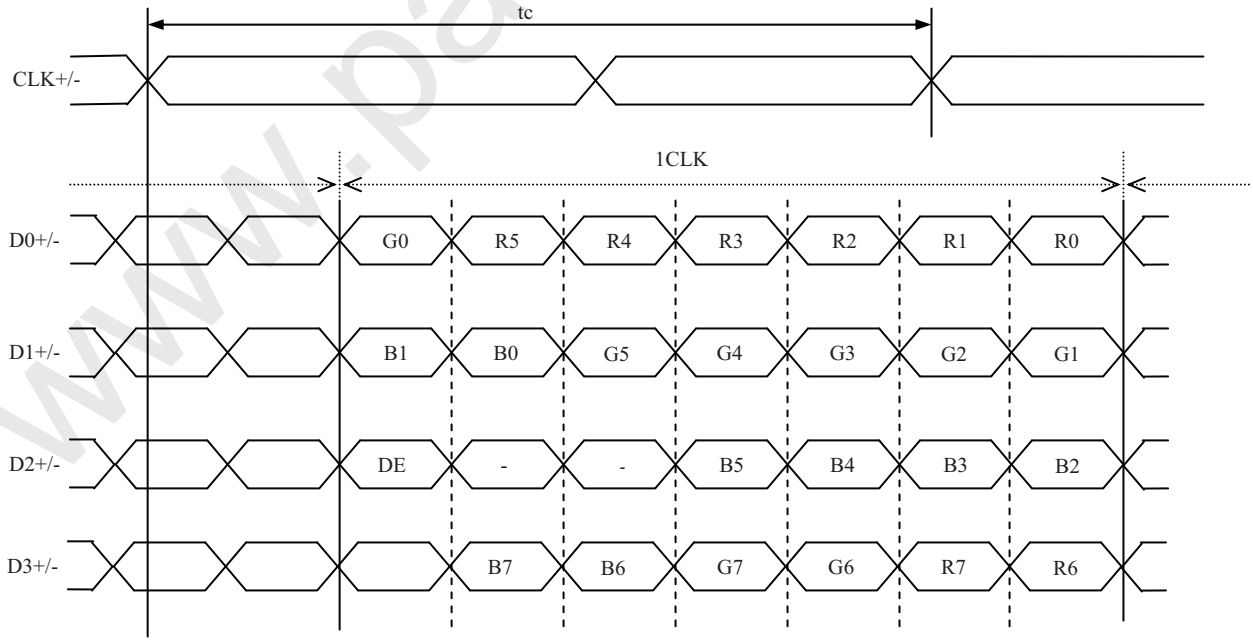
Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).
Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R5, G5, B5
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS 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 TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 open to avoid noise problem.

4.5.5 Input data mapping

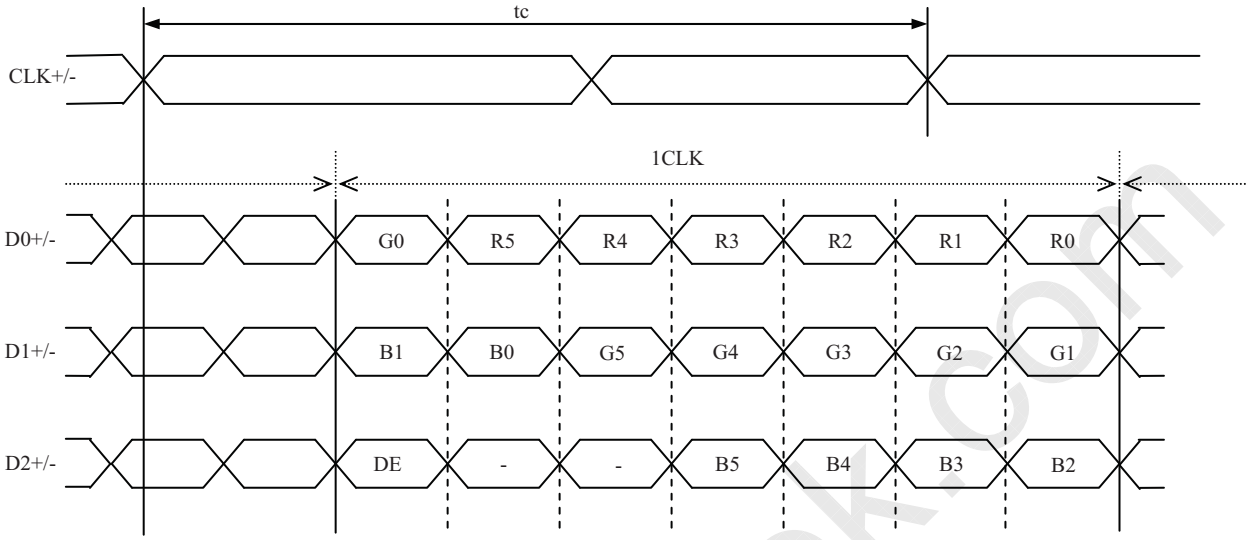
(1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low)



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



(3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open)



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	High	16,777,216	Note1
②	8 bit	MAP B	D3+/-	Low	Low or Open	16,777,216	Note1
③	6 bit	-	GND	High or Open	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 equivalent of 16,777,216 colors in 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 the following table.

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

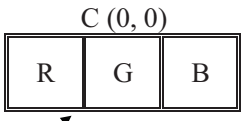
4.6.3 262,144 colors

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.

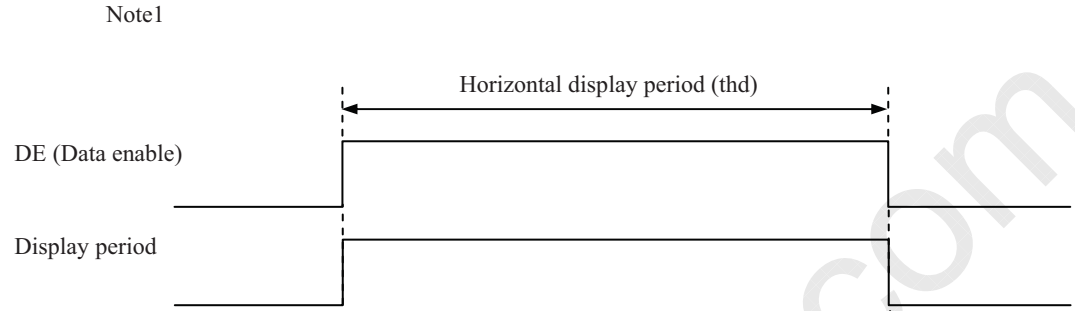


C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(1022, 0)	C(1023, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(1022, 1)	C(1023, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(1022, Y)	C(1023, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 766)	C(1, 766)	• • •	C(X, 766)	• • •	C(1022,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

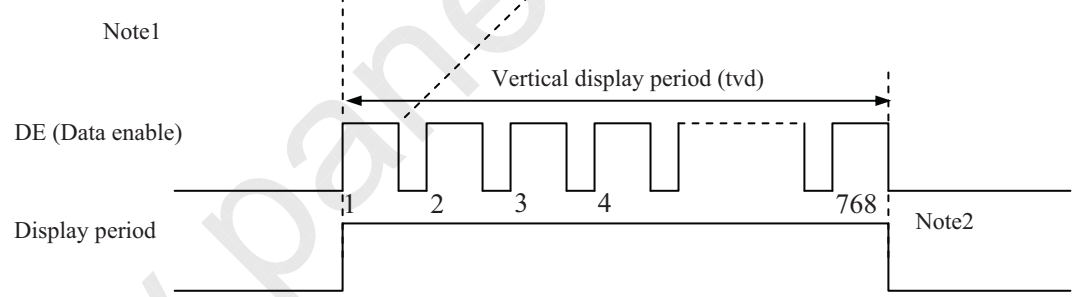
4.8 INPUT SIGNAL TIMINGS

4.8.1 Outline of input signal timings

- Horizontal signal



- Vertical signal



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	50.0	65.0	81.25	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	16.542	20.676	26.88	µs	48.363 kHz (typ.)
				1,100	1,344	1,800	CLK	
		Display period	thd	1024			CLK	-
	Vertical (One frame)	Cycle	tv	13.34	16.666	20.0	ms	60.0 Hz (typ.)
				780	806	1,334	H	
		Display period	tvd	768			H	
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

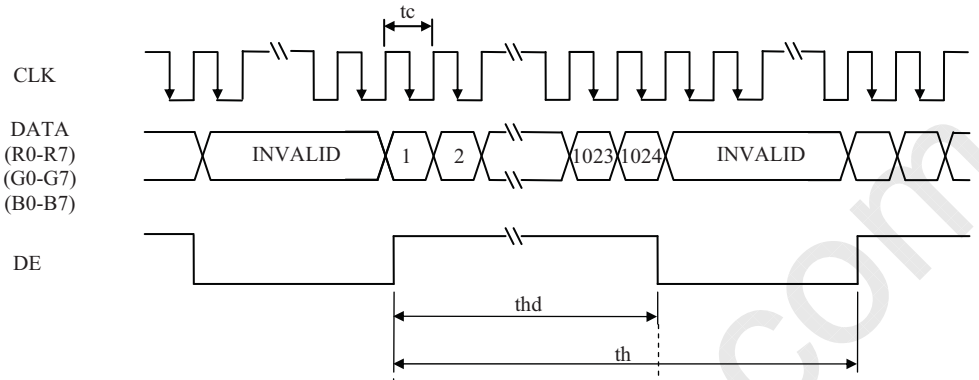
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

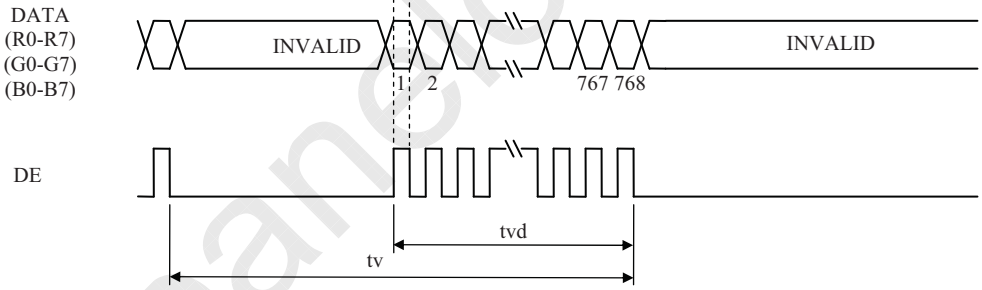
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.8.3 Input signal timing chart

Horizontal timing



Vertical timing



4.9 OPTICS

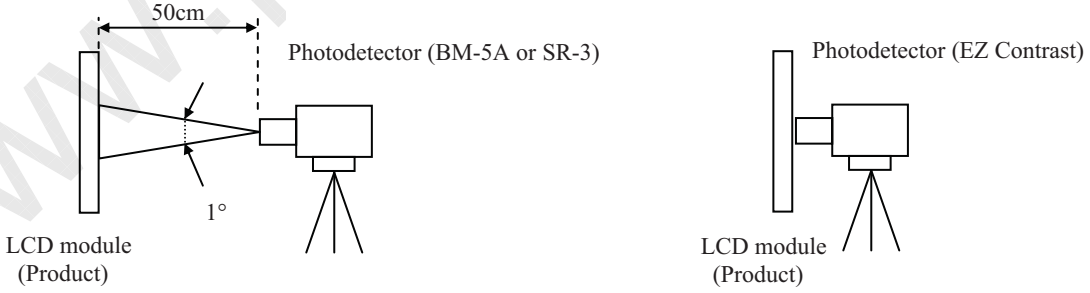
4.9.1 Optical characteristics

(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	280	400	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	400	600	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	(1.33)	-	BM-5A	Note4
Chromaticity	White	**x** coordinate	Wx	TBD	0.313	TBD	-	SR-3	Note5
		y coordinate	Wy	TBD	0.329	TBD	-		
	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	-	60	-	%		
Response time		White to Black	Ton	-	3	TBD	ms	BM-5A	Note6 Note7
		Black to White	Toff	-	5	TBD	ms		
		Ton + Toff	-	-	8	TBD	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	-	80	-	°	BM-5A or EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	-	80	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	-	80	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	-	80	-	°		

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.3V, VDD=12.0V, PWM: Duty 100%,
Display mode: XGA, Horizontal cycle= 1/48.363kHz, Vertical cycle= 1/60.0Hz,

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= TBD °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.

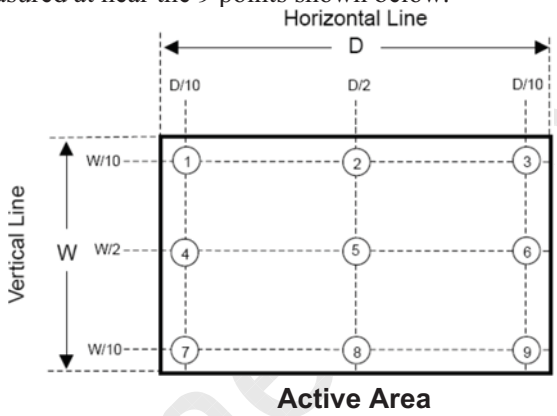
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

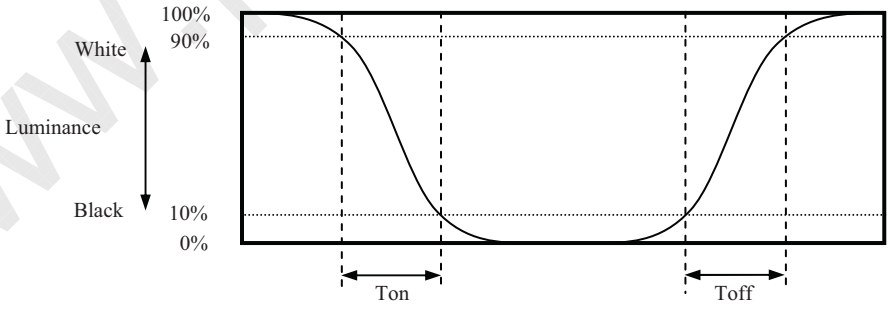
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑨}}{\text{Minimum luminance from ① to ⑨}}$$

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

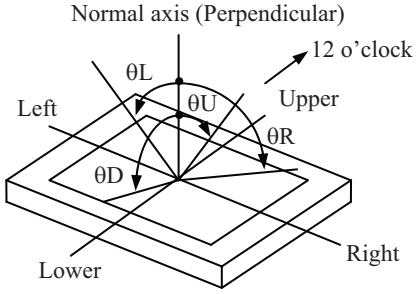


4.9.4 Definition of response times

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, PWM Duty: 100%	50,000	h

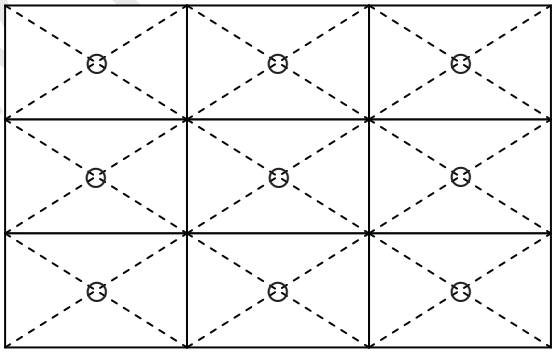
Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature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

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① 50 ± 2°C, RH= 80%, 300hours ② Display data is black.	No display malfunctions
High temperature (Operation)	① 70 ± 3°C, 300hours ② Display data is black.	
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.	
ESD (Operation)	Contact Discharge ① 150pF, 330Ω, ±8kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval Air Discharge ① 150pF, 330Ω, ±15kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec 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	
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.**

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 0.34N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ TBD mm.
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 panel surface, wipe it with a soft dry cloth.
⑦ Do not push or pull the interface connectors while the product is working. 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.
⑧ 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.

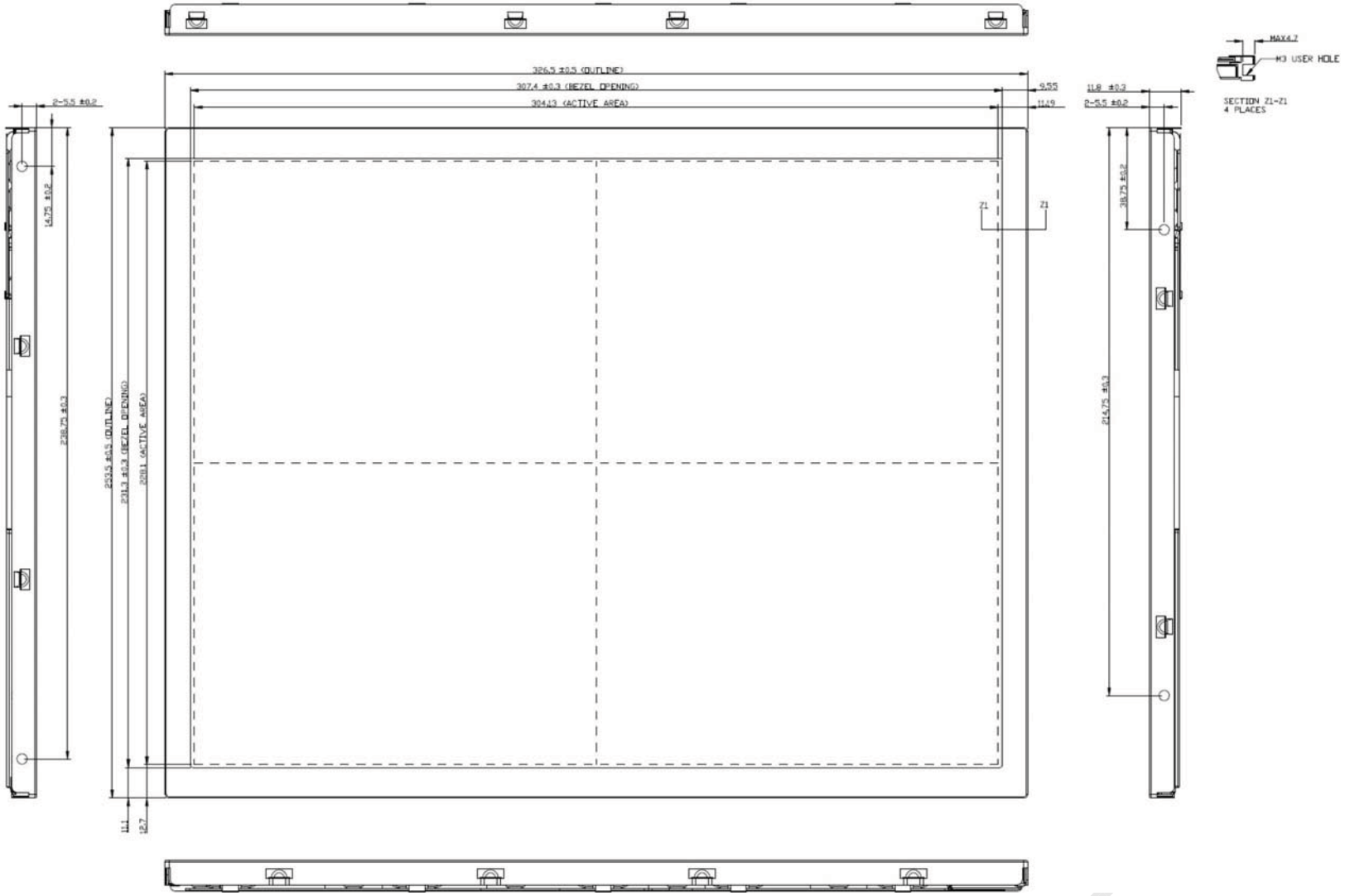
① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough 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 GND, VCC and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing lamp holder set.
④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.

8. OUTLINE DRAWINGS

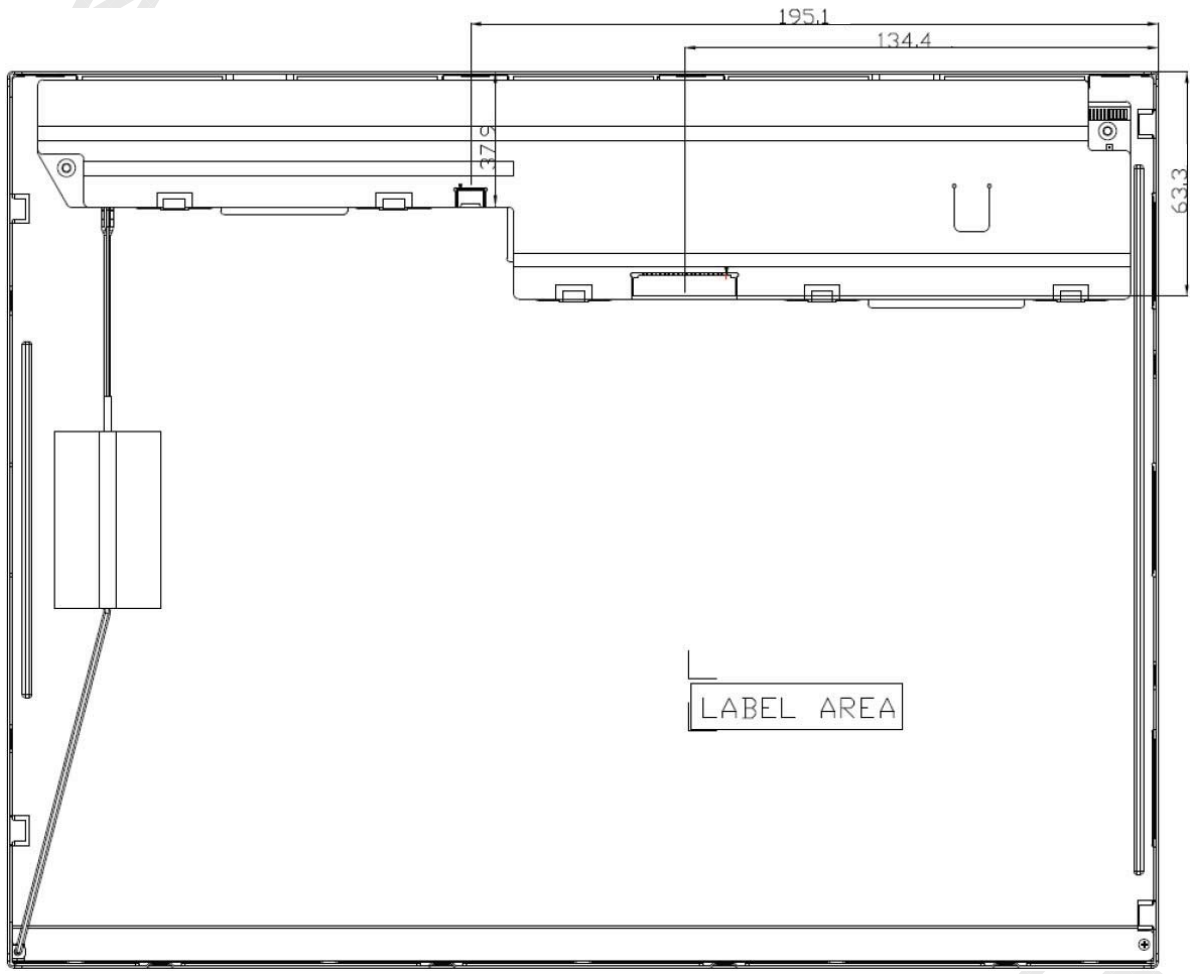
8.1 FRONT VIEW



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.34N·m. And the length of product mounting screws must be ≤ TBD mm.

Unit: mm

8.2 REAR VIEW



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.34N·m. And the length of product mounting screws must be ≤ TBD mm.

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-MD -1227	Nov. 16, 2011	**Revision contents** New issue **Writer** *Approved by* T. KANATSU *Checked by* _____ *Prepared by* H. SUZUKI
2nd edition	DOD-MD -1242	Jan. 12, 2012	**Revision contents** P5 GENERAL SPECIFICATIONS • Contrast ratio: 700:1 (typ.) → 600:1 (typ.) • Luminance: 350 cd/m^2 (typ.) → 400 cd/m^2 (typ.) P7 ABSOLUTE MAXIMUM RATINGS • Storage temperature: -10 to +70°C → -30 to +80°C • Operating temperature- Front / Rear : 0 to +60°C → -20 to +70°C P21 Optical characteristics • Luminance: 350 (typ.) (cd/m^2) → 400 (typ.) (cd/m^2) • Contrast ratio: 700 (typ.) → 600 (typ.) P24 RELIABILITY TESTS (addition) **Writer** *Approved by* T. KANATSU *Checked by* _____ *Prepared by* H. SUZUKI
3rd edition	DOD-MD A-0591	Feb. 9, 2012	**Revision contents** Change product name: NL10276AC30-XX → NLB150XG01L-01 P19 Timing characteristics • CLK Frequency: 60.0(min.), 68.0(max.) → 50.0(min.), 81.25(max.) • DE Horizontal Cycle: 19.67(min.), 22.4(max.) → 16.542(min.), 26.88(max.) • DE Vertical Cycle: 13.3(min.), 18.5(max.) → 13.34(min.), 20.0(max.) **Writer** *Approved by* T. KANATSU *Checked by* _____ *Prepared by* H. SUZUKI
4th edition	DOD-PP-1391	March 14, 2012	**Revision contents** P2 INTRODUCTION – Quality grade (Revised) P4 Structure and principle: NL10276AC30-XX → NLB150XG01L-01 P5 General specifications • Weight: TBD → 1,000 g (typ.) • Polarizer pencil-hardness (addition) P6 Block diagram: FRC (addition) P7 Mechanical specifications • Weight: TBD g → 1,000 (typ.), TBD (max.) g P7 Absolute maximum ratings • Power supply voltage- LED driver: TBD V → -0.3 to +33.0 V • Input voltage for signals- Function signal for LED driver • PWM: TBD V → -0.3 to +5.5 V • BRTC: TBD V → -0.3 to +5.5 V

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-1391	March 14, 2012	**Revision contents** P8 LCD panel signal processing board • Power supply current: TBD (typ.), ≤ 606 (max.) mA → 400 (typ.), TBD (max.) mA • Input voltage for MSL signals • High: TBD (min.), TBD (max.) V → 1.65 (min.), VCC (max.) V • Low: TBD (max.) → 0.78 (max.) V • Input current for MSL signal • High: TBD (max.) µA → 10 (max.) µA • Low: TBD (min.) µA → -10 (min.) µA • Note2:All Gray pattern → Pattern for maximum current P9 Backlight • Power supply voltage: TBD (min.), TBD (max.) V → 10.8 (min.), 12.6 (max.) V • Power supply current: TBD (typ.) mA → 610 (typ.) mA • Permissible ripple voltage: TBD (max.) mVp-p → 200 (max.) mVp-p • Input voltage for PWM signal • High: TBD (min.) V → 1.2 (min.) V • Low: TBD (max.) V → 0.4 (max.) V • Input voltage for BRTC signal • High: TBD (min., max.) V → 1.5 (min.), - (max.) V • Low: TBD (max.) V → 0.8 (max.) V • PWM frequency: 100(min), 200(typ.), 10K (max.) Hz → 200 (min), -(typ.), 20k (max.) Hz • PWM pulse width: TBD (min) µs → 5 (min) µs P10 LED driver board (addition) P11 LCD panel signal processing board (revised) • CN1 socket: Pin No.19: GND → MSL Pin No.20: MSL → FRC • Note4 (additio) P13-15 Connection between receiver and transmitter for LVDS • (1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low) (Title is changed) • Figure (revised) • Note4: TC4, TC5 and TD6 → TXIN23, TXIN24 and TXIN25 • (2) LVDS Input data signal: 8bit, MAP B (MSL: Low or Open, FRC: Low) (Title is changed) • Figure (revised) • Note4: TC4, TC5 and TD6 → TXIN23, TXIN24 and TXIN25 • (3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open) (addition) P16-17 Input data mapping • (1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low) (Title is changed) • (2) LVDS Input data signal: 8bit, MAP B (MSL: Low or Open, FRC: Low) (Title is changed) • (3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open) (addition) P17 Display colors and input signals • Combinations of input data signals, FRC and MSL signal (addition) P18 16,777,216 colors • by combination ① or ②, (See "4.6.1 Combinations of input data signals, FRC and MSL signal".) (addition) P19 262,144 colors (addition) P22 Timing characteristics • DE- Horizontal- Cycle: - (min., max.) CLK → 1,100 (min.), 1,800 (max.) CLK • DE- Vertical- Cycle: - (max.) H → 1,334 (max.) H P24 Optical characteristics • Viewing angle- Remarks: EZ Contrast (addition) • Note2: 30minutes → 20minutes P30 Outline drawings • front view (revised) • Bezel opening: 230.3 ± 0.3 → 231.3 ± 0.3, 307.3 ± 0.3 → 307.4 ± 0.3 • 14.75 → 14.75 ± 0.2, 238.75 → 238.75 ± 0.3, 2-5.5 → 2-5.5 ± 0.2 • 11.8 → 11.8 ± 0.3, 38.75 → 38.75 ± 0.2, 2-5.5 → 2-5.5 ± 0.2 • 214.75 → 214.75 ± 0.3, 11.6 → 11.1, 9.6 → 9.55 • Section ZI- ZI (addition)

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-1391	March 13, 2012	**Revision contents** **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* T. OGAWA
5th edition	DOD-PP-1411	Apr. 24, 2012	**Revision contents** P9 Electrical characteristics • Fuse • VCC- Type: TBD → FCC16152AB - Supplier: TBD → KAMAYA ELECTRIC Co., Ltd. - Rating: TBD A, TBD V → 1.5A, 36V - Fusing current: TBD A → 3.0A • VDD- Type: TBD → FCC16202AB - Supplier: TBD → KAMAYA ELECTRIC Co., Ltd. - Rating: TBD A, TBD V → 2.0A, 36V - Fusing current: TBD A → 4.0A P10 Power supply voltage sequence • LED driver board: VDD (Figure is addition) P11,12 Connections and functions for interface pins • LCD panel signal processing board • Adaptable plug: DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS)) (addition) • Backlight lamp • CN2 plug → CN2 socket, Adaptable socket → Adaptable plug (correction) • Adaptable plug: P24038P5 (Produced by STM) (addition) **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* A. KUMANO
6th edition	DOD-PP-1443	June 8, 2012	**Revision contents** P7 Absolute Maximum Ratings • Input voltage for signals- Display signals(VD): -0.3 to +3.3 V → -0.3 to +1.98 V - Function signals(VF): -0.3 to +3.3 V → -0.3 to VCC P8 Electrical Characteristics • LCD panel signal processing board • Power supply current(ICC): TBD (max.) mA → (780) (max.) mA • Permissible ripple voltage(VRPC): 100 (max.) mVp-p → 300 (max.) mVp-p • Input voltage for MSL signals- Low(VFL): 0.78 (max.) V → 0.40 (max.) V P9 Power supply voltage ripple • VCC- Ripple voltage: ≤ 100 mVp-p → ≤ 300 mVp-p • VDD- Ripple voltage: TBD mVp-p → ≤ 200 mVp-p P12 Backlight lamp • CN2- Pin No.1- Signal: Power supply (12V) → Power supply - Pin No.3- Remarks: 5V-On / 0V-Off → High- On / Low- Off **Signature of writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* A. KUMANO