PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL10276AC30-42C

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

PRELIMINARY DATA SHEET

DOD-PP-1508 (5th edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-1450(4)

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

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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.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL10276AC30-42C 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

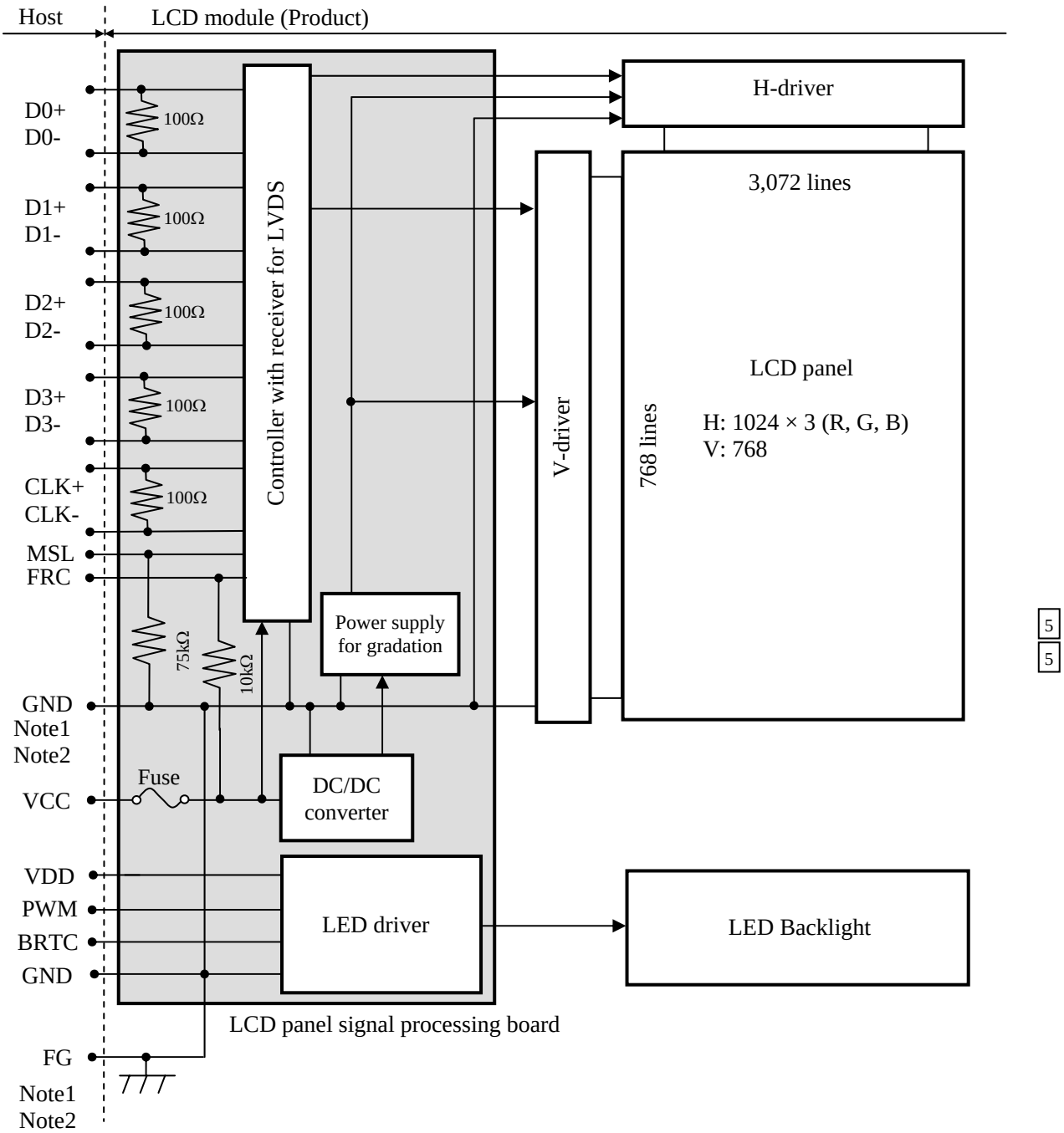
1.3 FEATURES

- Adoption of T-EVT (Transmissive-Enhanced View TFT) Technology 5
- High luminance
- High contrast
- Low reflection
- LED backlight type
- LED driver Built-in
- LVDS interface
- Replaceable lamp holder for backlight
- Selectable 8bit or 6bit digital signals for data of RGB 5
- Fast response time 5
- Small foot print 5
- Selectable LVDS input map 5
- Long life LED backlight type 5
- Wide viewing angle 5

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.)	5
Weight	1,050 g (typ.)	5
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	Clear + Antireflection (AR)	
Polarizer pencil-hardness	2H (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* 600 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. 150LHS202)	5
Power consumption	*At the maximum luminance control, Checkered flag pattern* 11.9 W (typ.)	5

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	1,050 (typ.), 1,100 (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	
	Function signals Note2	VF	-0.3 to VCC		
	Function signal for LED driver	PWM	-0.3 to +5.5	V	
		BRTC	-0.3 to +5.5	V	
Incident light intensity		II	150,000	lx	Note3
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note4
	Rear surface	TopR	-20 to +70	°C	Note5
Relative humidity Note6		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40°C < Ta ≤ 50°C
			≤ 55	%	50°C < Ta ≤ 60°C
			≤ 36	%	60°C < Ta ≤ 70°C
Absolute humidity Note6		AH	≤ 70 Note7	g/m^3	Ta > 70°C

Note1: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-
Note2: MSL and FRC
Note3: If the product surface (polarizer) is exposed to an ultraviolet ray, the polarizer may discolor (Surface treatment may be damaged.). Use a filter to protect the polarizer from the ultraviolet ray.
Note4: Measured at LCD panel surface (including self-heat)
Note5: Measured at LCD module's rear shield surface (including self-heat)
Note6: No condensation.
Note7: 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	-	400 Note1	840 Note2	mA	at VCC= 3.3V	5
Permissible ripple voltage		VRPC	-	-	300	mVp-p	for VCC	
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 and FRC signals	High	VFH	1.65	-	VCC	V	-	
	Low	VFL	0	-	0.40	V		5
Input current for MSL and FRC signals	High	IFH	-	-	10	μA	-	
	Low	IFL	-10	-	-	μA		5

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	-	880	1,210 Note2	mA	At the maximum luminance control.	5
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD Note3	
Input voltage for PWM signal	High	VDFH1	1.2	-	5.5	V	-	
	Low	VDFL1	-	-	0.35	V		5
Input voltage for BRTC signal	High	VDFH2	1.5	-	5.5	V	-	
	Low	VDFL2	0	-	0.8	V		5
PWM frequency		f_{PWM}	200	-	1k	Hz	Note4, Note5	
PWM duty ratio		DRpwm	1	-	100	%	Note6, Note7	5
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.

$$f_{PWM} = \frac{2n-1}{4} \times fv$$

$$(n = \text{integer}, fv = \text{frame frequency of LCD module})$$

Note5: Depending on the frequency used, so noise may appear on the screen, please conduct a thorough evaluation.

Note6: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than 5μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal. 5

Note7: Regardless of the PWM frequency, both PWM duty cycle and PWM pulse width must be always more than the minimum values. 5

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
VDD	12.0V	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

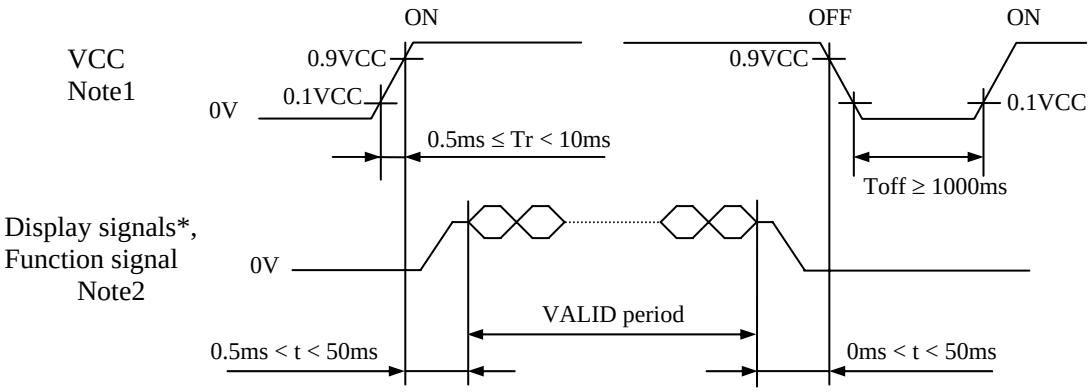
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 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

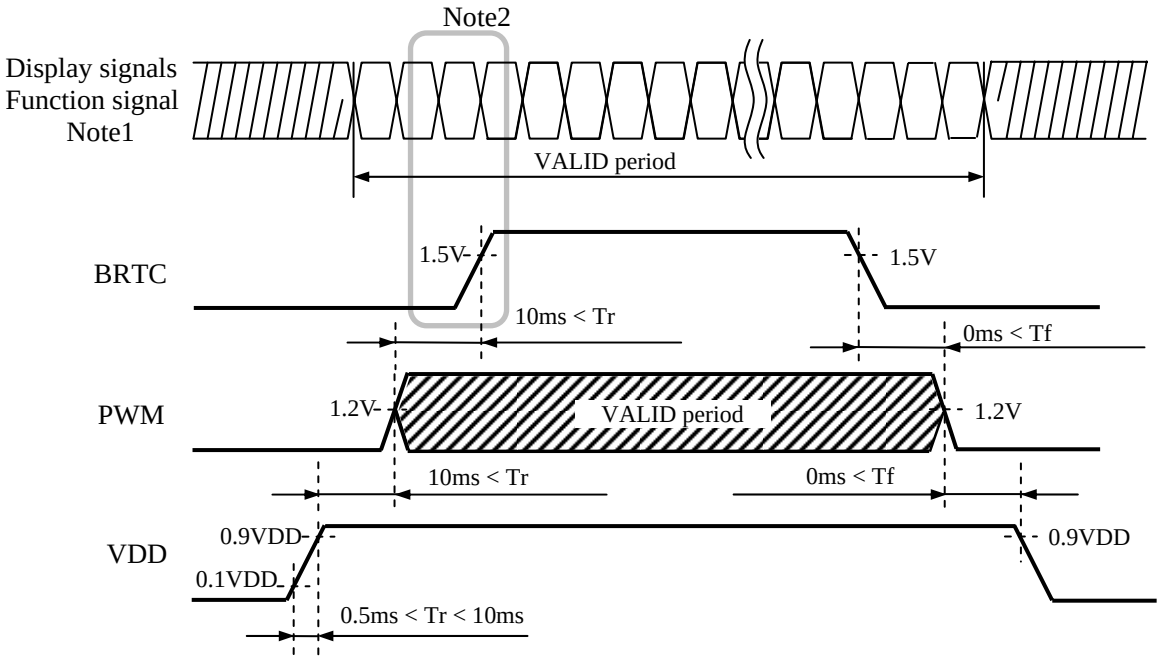


* These signals should be measured at the terminal of 100Ω resistance.

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, FRC) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage. 5
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 5



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**".

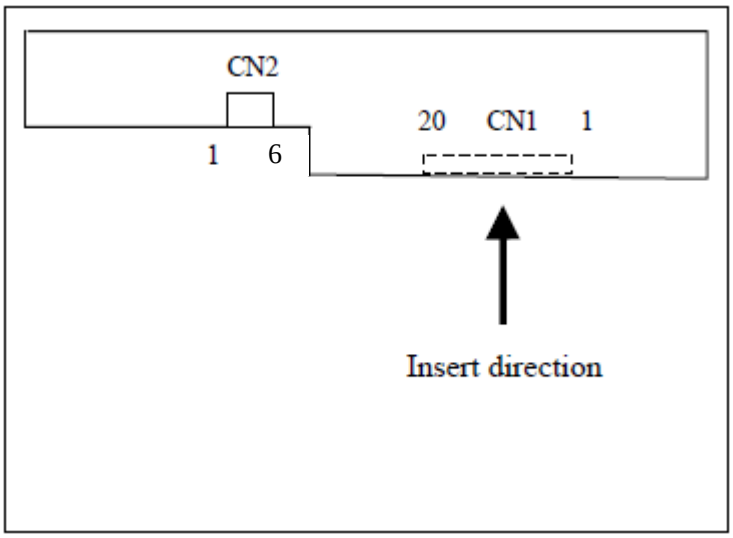
4.5.2 Backlight lamp

CN2 socket (LCD module side): MSB24038P6 (STM) or equivalent.
Adaptable plug: P24038P6 (STM) or equivalent.

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

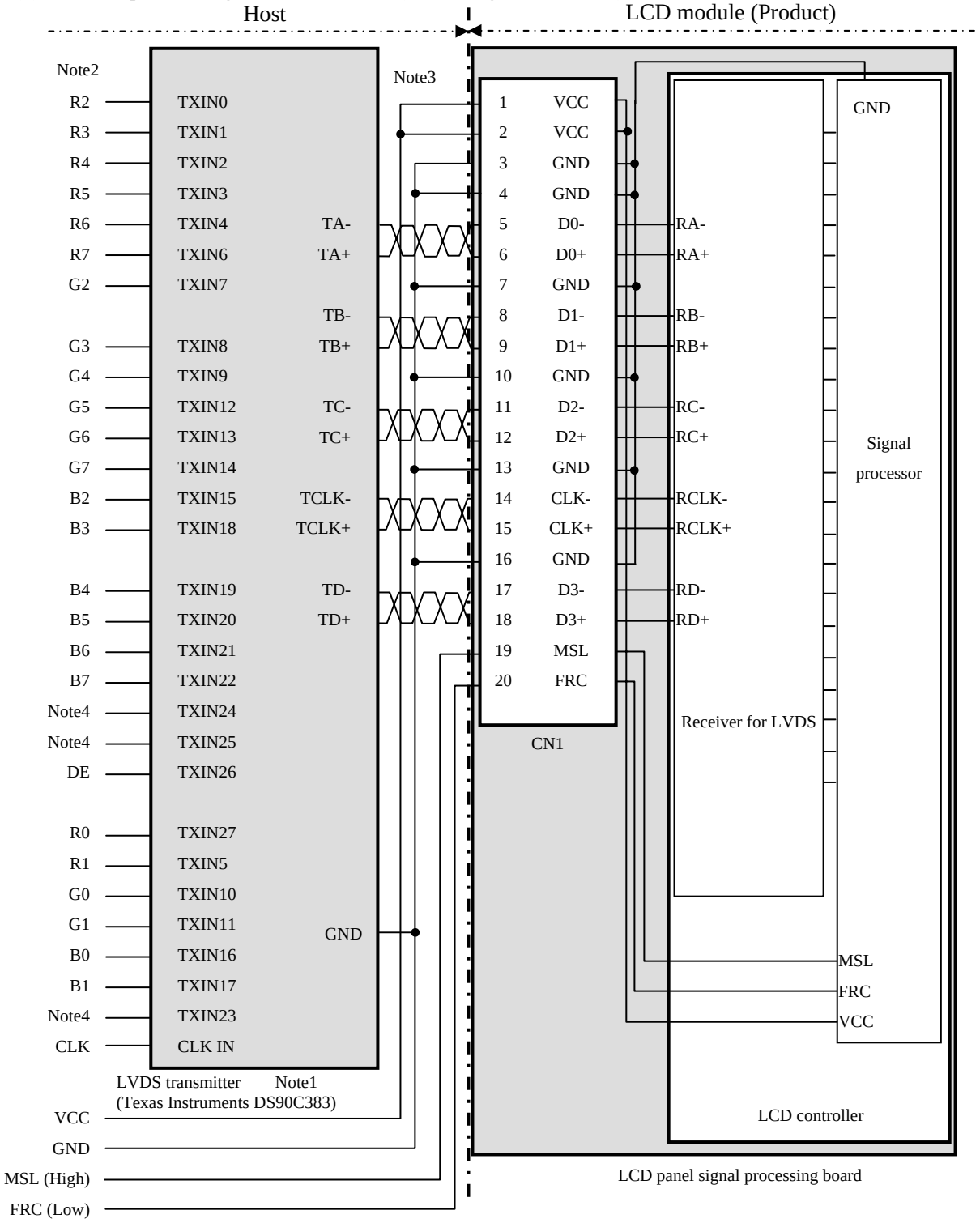
4.5.3 Positions of plug and socket

Rear side



4.5.4 Connection between receiver and transmitter for LVDS

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



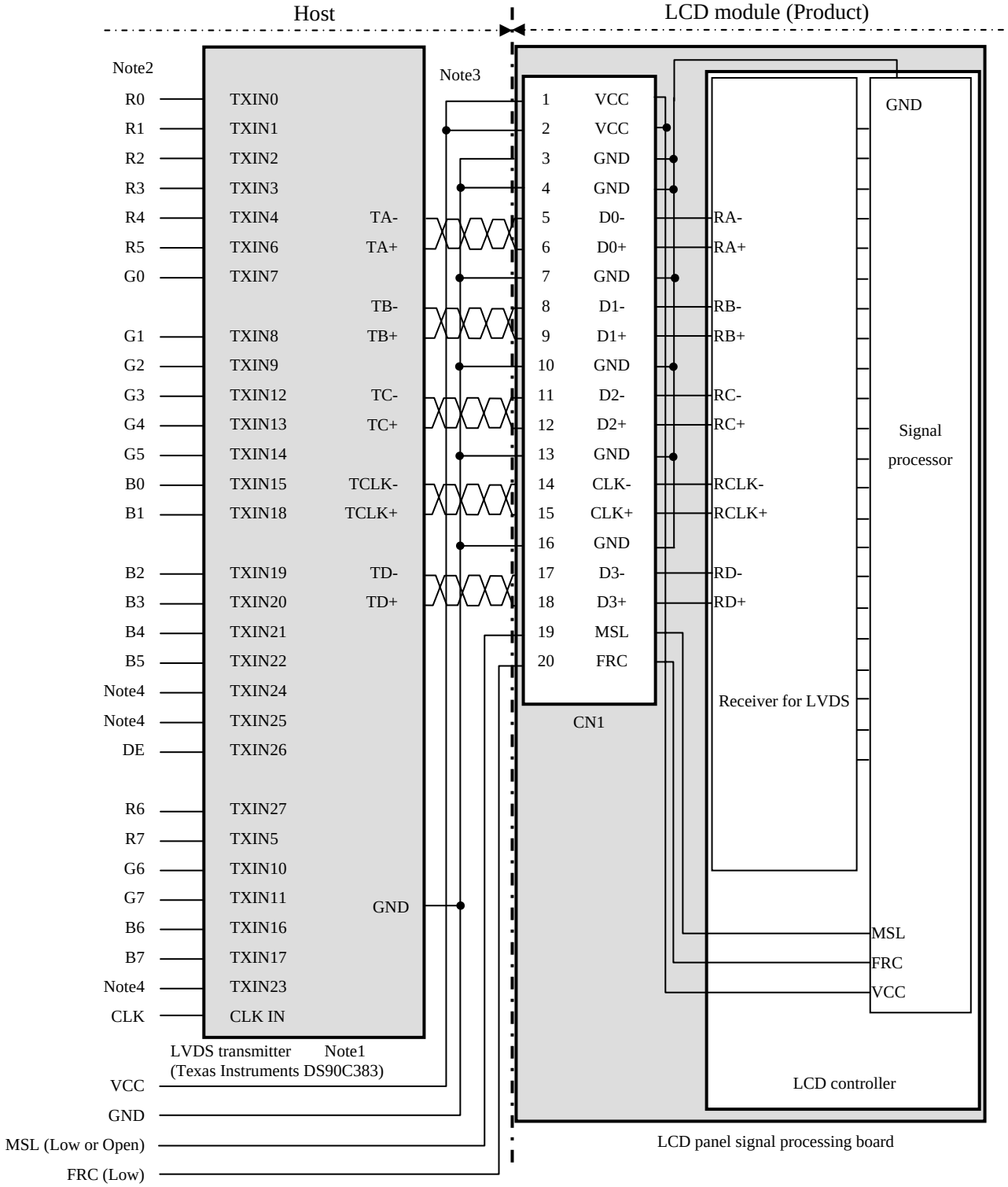
Note1: Recommended transmitter. See the data sheet for DS90C383 (Texas Instruments).

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.

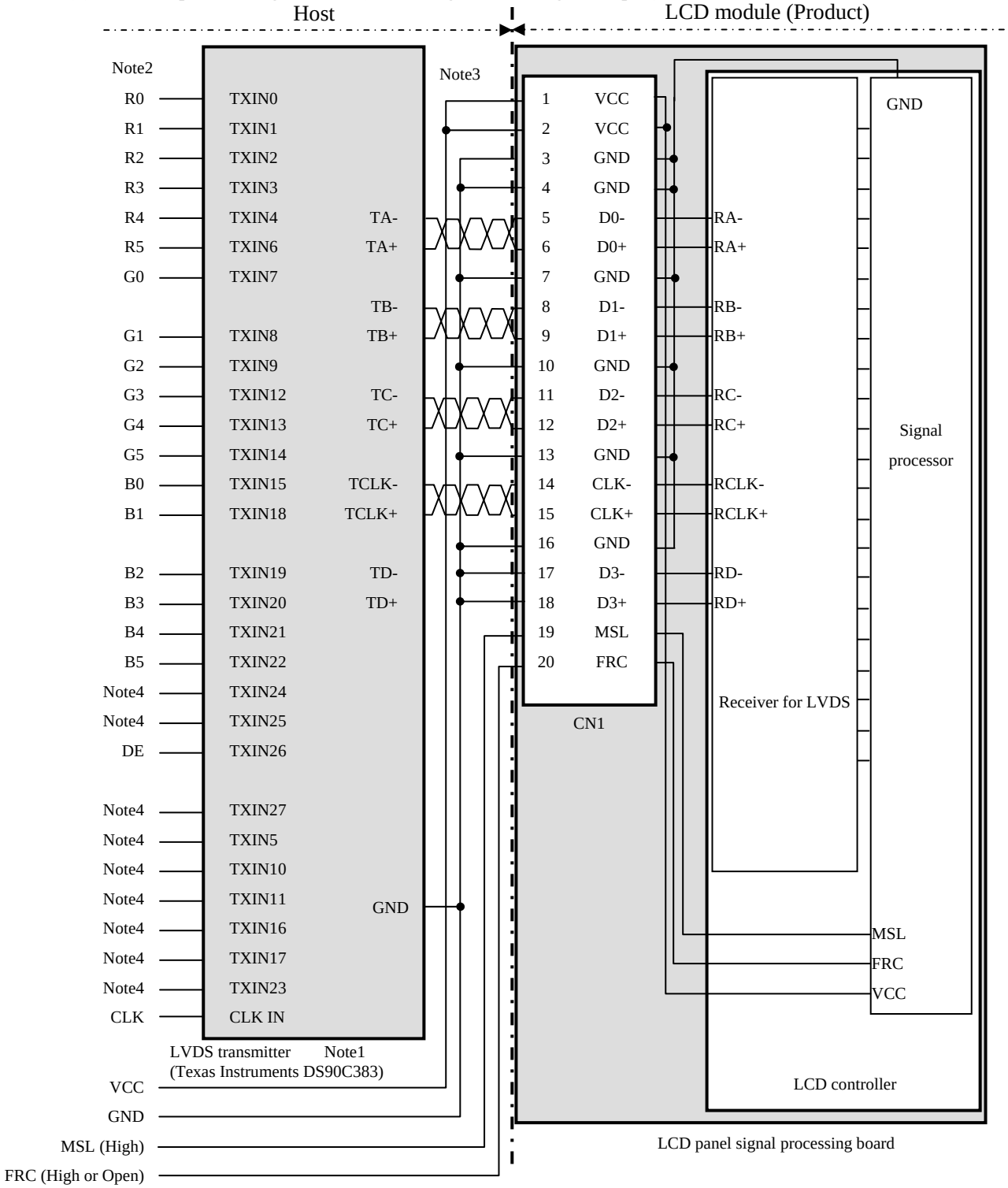
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

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



Note1: Recommended transmitter. See the data sheet for DS90C383 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 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 (Texas Instruments).

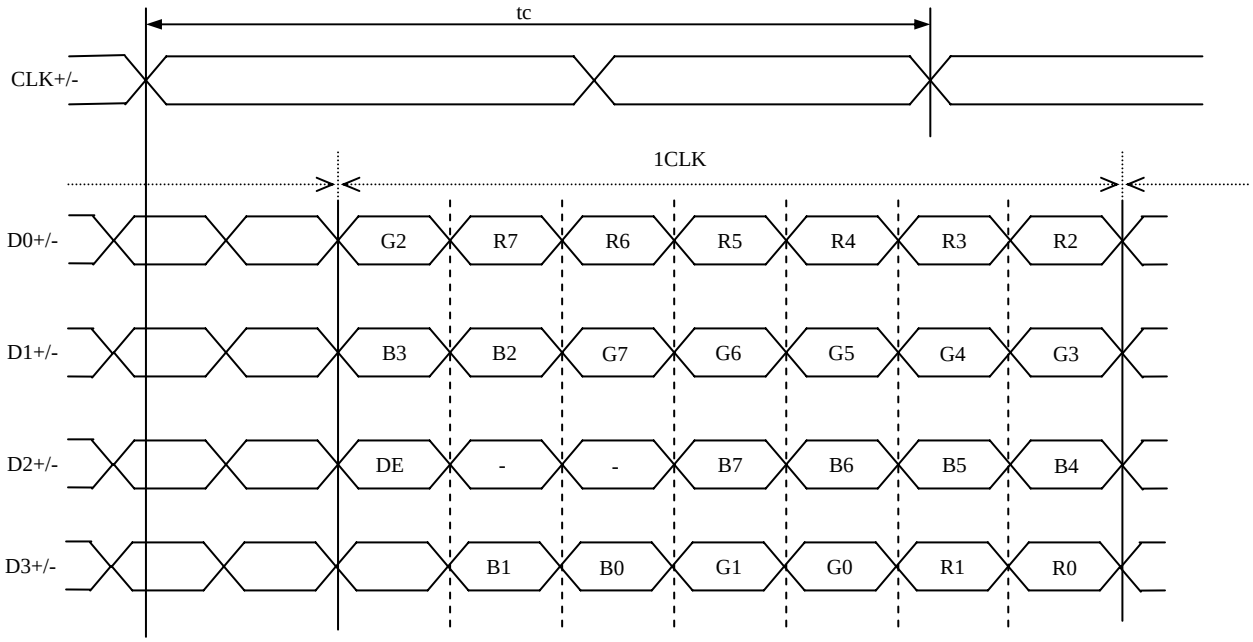
Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R5, G5, B5

Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

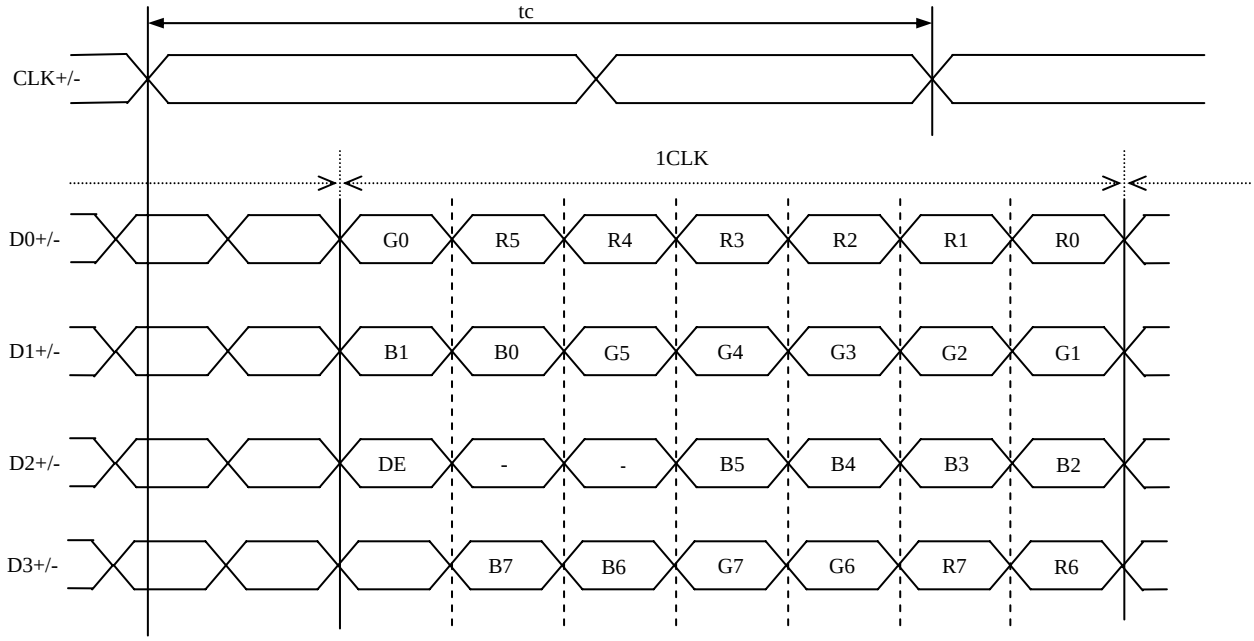
Note4: Input signals to TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 are not used inside the product, but do not keep TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 open to avoid noise problem.

4.5.5 Input data mapping

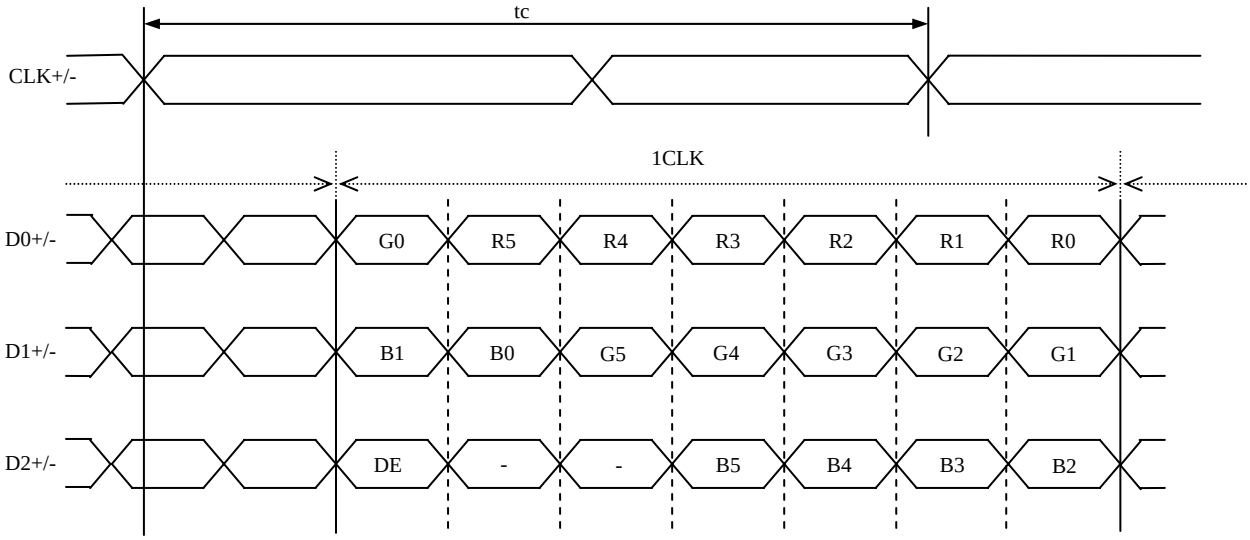
(1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low)



(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

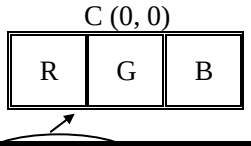
4.6.3 262,144 colors

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.



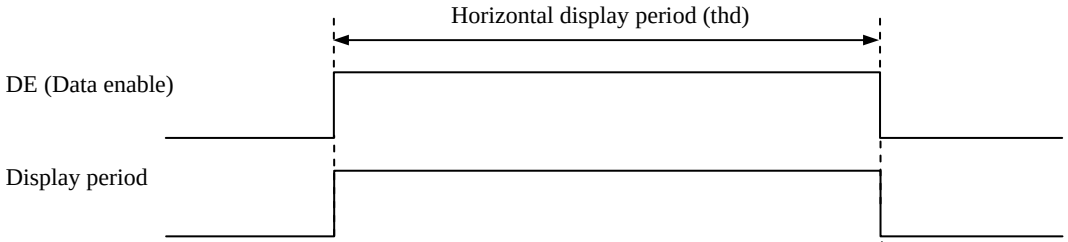
C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(1022, 0)	C(1023, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(1022, 1)	C(1023, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(1022, Y)	C(1023, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 766)	C(1, 766)	• • •	C(X, 766)	• • •	C(1022,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

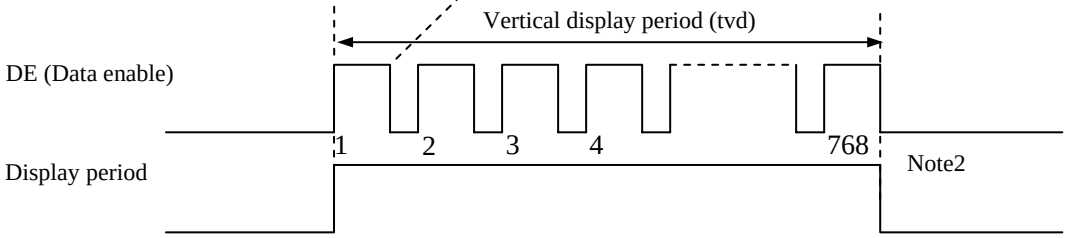
- Horizontal signal

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	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	

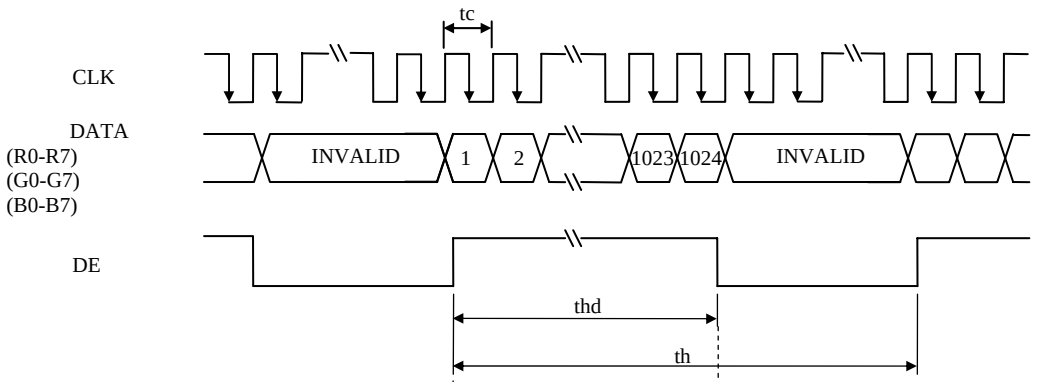
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

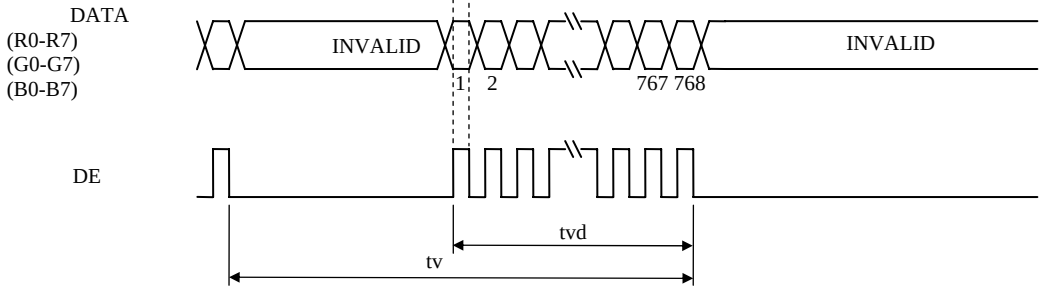
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.8.3 Input signal timing chart

Horizontal timing



Vertical timing



4.9 OPTICS

4.9.1 Optical characteristics

(Note1, Note2)

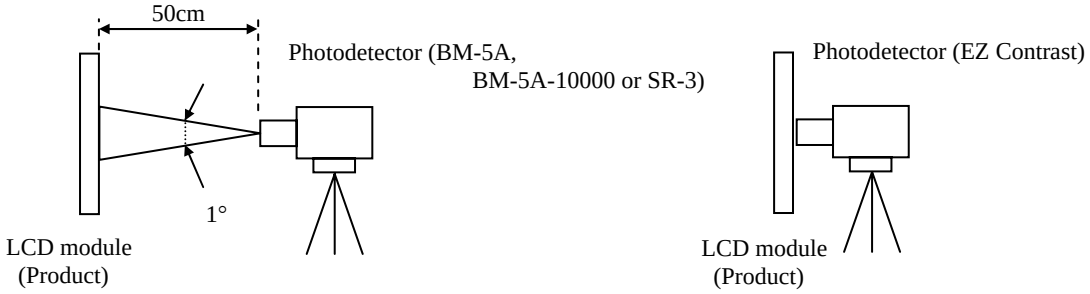
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks	
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	450	600	-	cd/m^2	BM-5A	-	5
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	400	600	-	-	BM-5A	Note3	
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	1.33	-	BM-5A	Note4	5
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)	-	-			5
	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	-	%			5
Response time		White to Black	Ton	-	3	5	ms	BM-5A -10000	Note6 Note7	5
		Black to White	Toff	-	5	8	ms			
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	80	-	°	BM-5A or EZ Contrast	Note8	
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	80	-	°			5
	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, VDD= 12.0V, PWM: Duty 100%,
Display mode: XGA, Horizontal cycle= 1/48.363kHz, Vertical cycle= 1/60.0Hz,
FRC=Low (8bit mode) 5

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= 30°C 5

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.

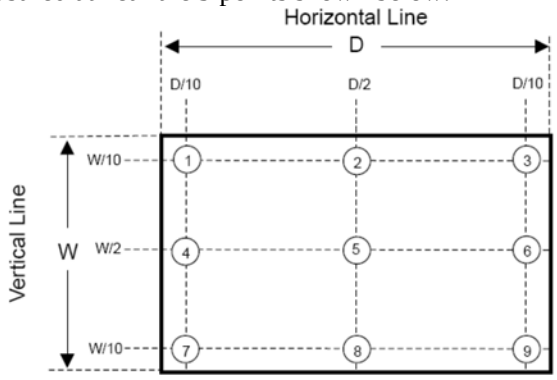
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

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

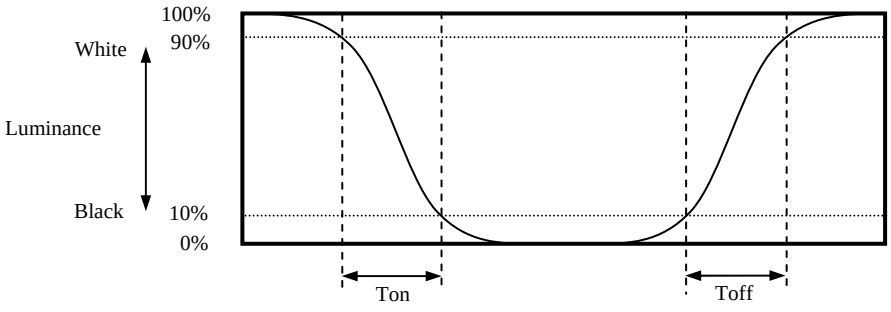
The luminance is measured at near the 9 points shown below.



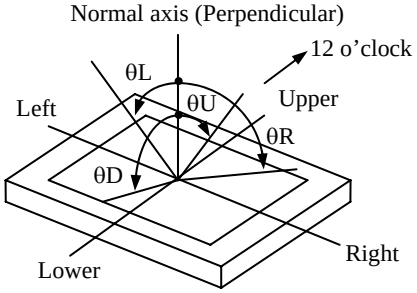
Display Area

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%	70,000	h

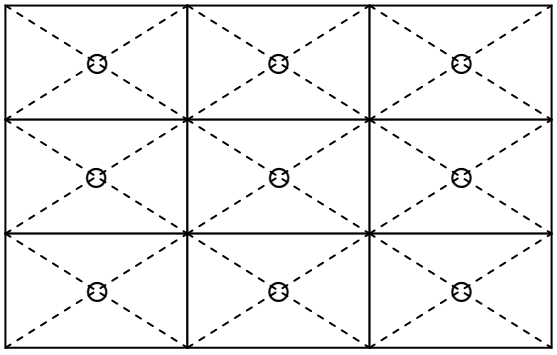
Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature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

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① 60 ± 2°C, RH= 90%, 240hours ② Display data is black.	No display malfunctions	5
High temperature (Operation)	① 70 ± 3°C, 240hours ② Display data is black.		5
Heat cycle (Operation)	① -20 ± 3°C…1hour 70 ± 3°C…1hour ② 50cycles, 4 hours/cycle ③ Display data is Black.		5
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.		5
ESD (Operation)	① 150pF, 150Ω, ±15kV ② 9 places on a panel surface Note2 ③ 10 times each places at 1 sec interval		5
Dust (Operation)	① Sample dust: No. 15 (by JIS-Z8901) ② 15 seconds stir ③ 8 times repeat at 1 hour interval		5
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. (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))** 5

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 0.392N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 4.5mm. 5
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.
⑥ The product gives AR (antireflection) coating of the polarizer surface. Though AR (antireflection) coating actualizes the low reflection with the multilayer structure, the color of reflection may differ among products and the color change of reflection may occur in the same product by fluctuation of AR (antireflection) coating.

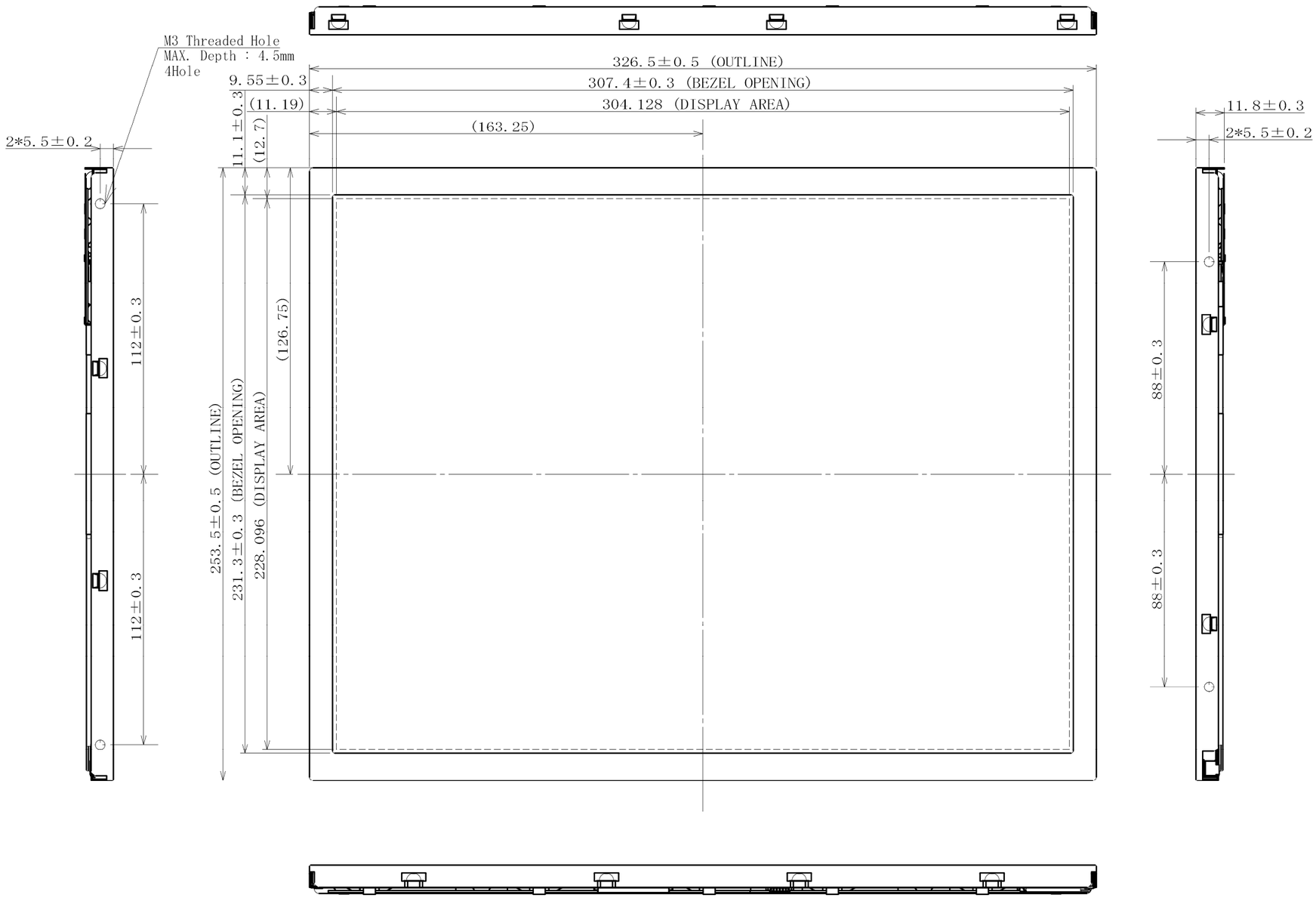
7.3.4 Others

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

5



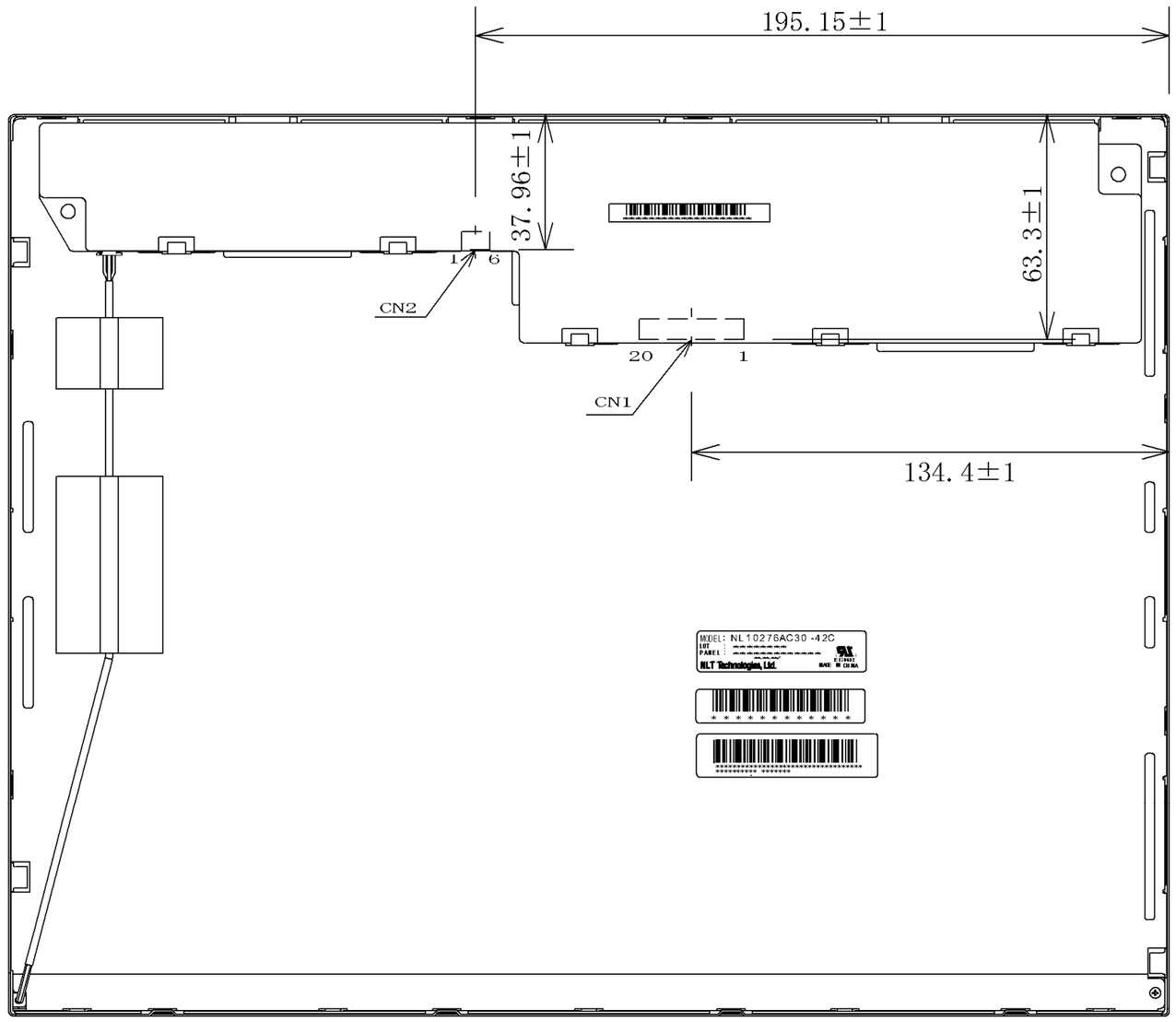
Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.392N·m. And the length of product mounting screws must be ≤ 4.5 mm.

Unit: mm

5

8.2 REAR VIEW

5



Note1: The torque for product mounting screws must never exceed 0.392N·m. And the length of product mounting screws must be ≤ 4.5 mm.

Unit: mm

5

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-1395	Apr. 4, 2012	**Revision contents** New issue **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* E. YOSHIMURA
2nd edition	DOD-PP-1413	May 10, 2012	**Revision contents** P8 LCD panel signal processing board • Input current for MSL signal: High: 10 (max.) μA → (50) (max.) μA P9 Electrical characteristics • Fuse : VCC/VDD: TBD → specified P10 Power supply voltage sequence • LED driver board: VDD (addition) P11,12 Connections and functions for interface pins • LCD panel signal processing board • CN1- Adaptable plug: P240420 (Produced by STM) → DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS)) • Backlight lamp • CN2 plug → CN2 socket (correction) **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* E. YOSHIMURA
3rd edition	DOD-PP-1436	June 4, 2012	**Revision contents** P12 Connections and functions for interface pins • Backlight lamp (revised) • CN2 • socket: MSB24038P5 (Produced by STM) or equivalent. → MSB24038P6 (STM) or equivalent. • Adaptable plug: P24038P5 (Produced by STM) → P24038P5 (STM) or equivalent. • Pin No.1- Signal: Power supply (12V) → Power supply • Pin No.2: GND, Ground → VDD, Power supply • Pin No.3: BRTC, Back light ON/OFF control, 5V-On / 0V-Off → GND, Ground, - • Pin No.4: PWM, Luminance control, PWM Dimming → GND, Ground, - • Pin No.5: N. C., Non connection, Keep this pin Open. → BRTC, Back light ON/OFF control, High - On / Low - Off • Pin No.6: PWM, Luminance control, PWM Dimming (addition) • Positions of plug and socket • Rear side- CN2: 1 to 5 → 1 to 6 **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* A. KUMANO

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-1450	June 25, 2012	**Revision contents** P5 General specifications • Power consumption: ≤ TBD W (typ.) → ≤ 12.2 W (typ.) 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 V P8, 9 Electrical characteristics • LCD panel signal processing board • Power supply current: TBD (typ., max.) mA → 400 (typ.), (780) (max.) mA • Permissible ripple voltage: 100 (max.) mVp-p → 300 (max.) mVp-p • Input voltage for MSL signals (VFL): 0.78 (max.) V → 0.40 (max.) V • Backlight • Power supply current: TBD(typ.), ≤ TBD(max.) mA → 900(typ.), ≤ (1200)(max.) mA • Power supply voltage ripple • Ripple voltage- VCC: ≤ 100 mVp-p → ≤ 300 mVp-p - VDD: TBD mVp-p → ≤ 200 mVp-p P24 Optical characteristics • Response time- Ton + Toff (elimination) **Writer** *Approved by* T. OGAWA *Checked by* *Prepared by* A. KUMANO
5th edition	DOD-PP-1508	Nov. 9, 2012	**Revision contents** P4 FEATURES • ST-NLT (Super-Transmissive Natural Light TFT) → T-EVT (Transmissive-Enhanced View TFT) Technology • Selectable 8bit or 6bit digital signals for data of RGB • Fast response time • Small foot print • Selectable LVDS input map • Long life LED backlight type • Wide viewing angle P5 GENERAL SPECIFICATIONS • Module size: TBD (D) mm (typ.) → 11.8 (D) mm (typ.) • Weight: TBD → 1,050 g (typ.) • Backlight: Lamp holder set: Type No. TBD → Type No. 150LHS202 • Power consumption: Gray pattern → Checkered flag pattern (correction) ≤12.2 W (typ.) → 11.9 W (typ.) P6 BLOCK DIAGRAM • MSL - GND: TBD kΩ → 75kΩ • FRC - VCC: TBD kΩ → 10kΩ P7 MECHANICAL SPECIFICATIONS • Module size: TBD (D) mm → 11.8± 0.3 (D) mm • Weight: 1,000 (typ.), TBD (max.) g → 1,050 (typ.), 1,100 (max.) g P7 ABSOLUTE MAXIMUM RATING • Relative humidity: ≤ 90 %, Ta ≤ +40°C → ≤ 95 %, Ta ≤ 40°C ≤ 85 %, 40°C < Ta ≤ 50°C ≤ 55 %, 50°C < Ta ≤ 60°C ≤ 36 %, 60°C < Ta ≤ 70°C • Absolute humidity: Remarks - Ta > +50°C →Ta > 70°C • Note2: FRC (addition) • Note7: Water amount at Ta= 70°C and RH= 36% (addition)

REVISION HISTORY

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5th edition	DOD-PP-1508	Nov. 9, 2012	**Revision contents** P8 LCD panel signal processing board • Power supply current: (780) (max.) mA →840 (max.) mA • Input voltage for MSL signals → Input voltage for MSL and FRC signals • Input current for MSL signal →Input current for MSL and FRC signals • Input current for MSL and FRC signals - High: (50) (max.) μA → 10 (max.) μA P8, 9 Backlight • Power supply current: 900 (typ.), ≤ (1,200) (max.) mA → 880 (typ.), 1,210 (max.) mA • Input voltage for PWM signal - High: - (max.) V → 5.5 (max.) V - Low: 0.4 (max.) V → 0.35 (max.) V • Input voltage for BRTC signal - High: - (max.) V → 5.5 (max.) V • PWM frequency: 20k (max.) Hz → 1k (max.) Hz • PWM duty ratio (addition) • Note6, 7 (addition) P10 LCD panel • Note2: function signal (MSL) → function signal (MSL, FRC) P10 LED driver board (Revised) • BRTC, PWMsignals figure (addition) • VDD off (addition) P13-15 Connection between receiver and transmitter for LVDS • DS90C383 (National Semiconductor) → DS90C383 (Texas Instruments) P15 LVDS Input data signal: 6bit (MSL: High, FRC: High or Open) • LCD module (Product) Pin17: TD-, Pin18: TD+ → Pin17, Pin18: GND P24 Optical characteristics • Luminance: TBD (min.) cd/m^2 → 450 (min.) cd/m^2 • Luminance uniformity: (1.33) (max.) → 1.33 (max.) • Chromaticity - Wx: TBD (min., max.) → 0.263 (min.), 0.363(max.) - Wy: TBD (min., max.) → 0.279 (min.), 0.379(max.) - Rx: TBD (typ.) → (0.631) (typ.) - Ry: TBD (typ.) → (0.357) (typ.) - Gx: TBD (typ.) → (0.344) (typ.) - Gy: TBD (typ.) → (0.608) (typ.) - Bx: TBD (typ.) → (0.153) (typ.) - By: TBD (typ.) → (0.089) (typ.) • Color gamut: - (min.) % → 55 (min.) % • Response time - Ton: TBD (max.) ms → 5 (max.) ms - Toff: TBD (max.) ms → 8 (max.) ms - Measuring instrument: BM-5A → BM-5A-10000 • Viewing angle - (θR, θL, θU, θD): - ° (min.) → 70 ° (min.) • Note2: FRC=Low (8bit mode) (addition) • Note6: TopF=TBD °C → TopF=30 °C P27 RELIABILITY TESTS • High temperature and humidity: ① 50 ± 2°C, RH= 80%, 300hours → ① 60 ± 2°C, RH= 90%, 240hours • High temperature: ① 300hours → ① 240hours • Heat cycle (addition) • Thermal shock: ① -20 ± 3°C, 60 ± 3°C → ① -30 ± °C, 80 ± 3°C • ESD: ① 330 Ω, ±8kV → ① 150 Ω, ±15kV ③ 25times → ③ 10times Air Discharge (elimination) • Dust (addition) P28 CAUTIONS • (Shock:… 11ms, Presure: …)) (addition)

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5th edition	DOD-PP-1508	Nov. 9, 2012	**Revision contents** P28 ATTENTIONS • ④ ...0.34N·m..., …≤ TBDmm…→...0.392N·m..., ≤ 4.5mm… P30 OUTLINE DRAWINGS - FRONT VIEW • 304.13 (ACTIVE AREA) → 304.128 (DISPLAY AREA) • (163.25) (addition) • 2-5.5±0.2, TBD → 2*5.5±0.2 • M3 Threaded Hole (addition) • Z1-Z1 (elimination) • Section Z1-Z1 (elimination) • 11.1 → 11.1±0.3 • 12.7 → (12.7) • 9.55 → 9.55±0.3 • 11.19 → (11.19) • 14.75±0.2 (elimination) • 38.75±0.2 (elimination) • 112±0.3 (2points) (addition) • 88±0.3 (2points) (addition) • 238.75±0.3 (elimination) • 214.75±0.3 (elimination) • 228.1 (ACTIVE AREA) → 228.096 (DISPLAY AREA) • (126.75) (addition) • Note1: ...0.34N·m..., …≤ TBDmm…→...0.392N·m..., ≤ 4.5mm… P31 OUTLINE DRAWINGS - REAR VIEW • 195.1 → 195.15±1 • 134.4 → 134.4±1 • 37.9 → 37.96±1 • 63.3 → 63.3±1 • CN1, CN2, Pin No. (addition) • Label (4 points) (addition) • Note1 (elimination) • Note2:...0.34N·m..., …≤ TBDmm…→ Note1...0.392N·m..., ≤ 4.5mm… **Signature of writer** *Approved by* K. Fujimoto — K. FUJIMOTO *Checked by* — *Prepared by* E. Yoshimura — E. YOSHIMURA