PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NL160120AC27-40

54cm (21.3Type)
UXGA
LVDS Interface (2 port)

PRELIMINARY DATA SHEET

DOD-PP-1993 (1st edition)

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

INTRODUCTION

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The products are classified into three grades: **"Standard"**, **"Special"**, and **"Specific"**.
Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

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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.

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Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

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Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL160120AC27-40 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.

Grayscale data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array.

1.2 APPLICATION

- Color monitor system

1.3 FEATURES

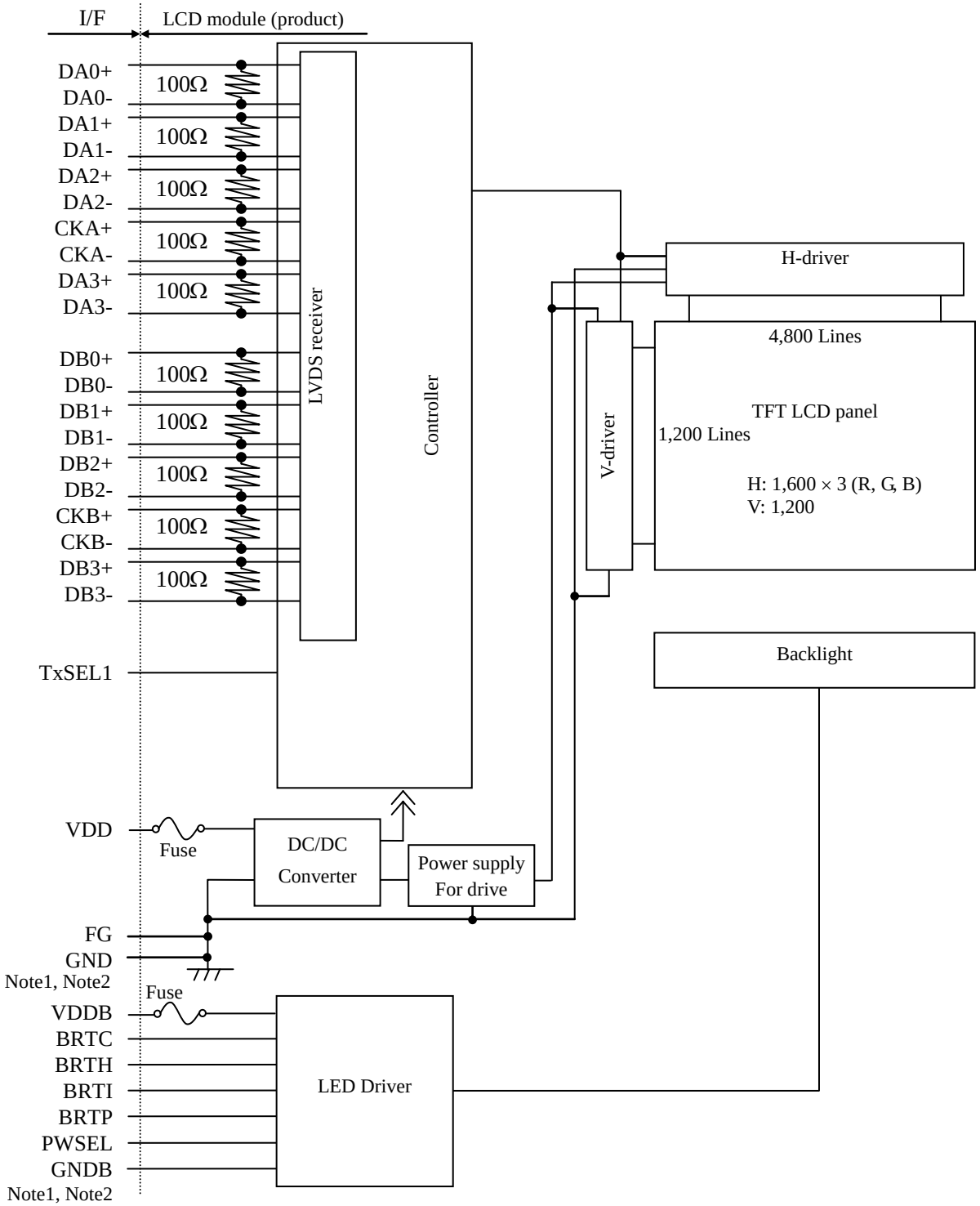
- Ultra-wide viewing angle (Super Fine TFT (SFT))
- High luminance
- High contrast
- High resolution
- Low reflection
- Wide color gamut
- 256 gray scale in each R, G, B sub-pixel (8-bit), 16,777,216 colors
- LVDS interface
- Selectable LVDS data input map
- Small foot print
- Long life LED backlight with an LED driver
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

2. GENERAL SPECIFICATIONS

Display area	432.0 (H) × 324.0 (V) mm
Diagonal size of display	54cm (21.3 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Pixel	1,600 (H) × 1,200 (V) pixels (1 pixel consists of 3 sub-pixels (RGB).)
Pixel arrangement	RGB vertical stripe
Sub-pixel pitch	0.090 (H) × 0.270 (V) mm
Pixel pitch	0.270 (H) × 0.270 (V) mm
Module size	457.0 (W) × 350.0 (H) × 21.5 (D) mm (typ.)
Weight	(2,800)g (typ.)
Contrast ratio	1,400:1 (typ.)
Viewing angle	*At the contrast ratio ≥ 10:1* • Horizontal: Right side 88° (typ.), Left side 88° (typ.) • Vertical: Up side 88° (typ.), Down side 88° (typ.)
Designed viewing direction	Viewing angle with optimum grayscale (γ≒DICOM): Normal axis (perpendicular) Note1
Polarizer surface	Antiglare
Polarizer pencil-hardness	2H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 72 % (typ.)[against NTSC color space]
Response time	*Ton+Toff (10%←→90%)* (40)ms (typ.)
Luminance	*At the maximum luminance control* 900cd/m^2 (typ.)
Signal system	2 ports LVDS interface [RGB 8-bit signals, Data enable signal (DE), Dot clock (CLK)]
Power supply voltage	LCD panel signal processing board: 12.0V LED driver: 12.0V
Backlight	LED backlight with LED driver
Power consumption	*At checkered flag pattern, the maximum luminance control* (56)W (typ.)

Note1: When the product luminance is 450cd/m^2, the gamma characteristic is designed to γ≒DICOM.

3. BLOCK DIAGRAM



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

GND- FG	Connected
GND- GNDB	Not connected
FG- GNDB	Not connected

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

Note3 Each pair of the LVDS signal has a 100Ω terminating resistance between D+ and D-.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	457.0 ±0.5 (W) × 350.0 ±0.5 (H) × 21.5 (typ., D) 23.0 (max. D)	Note1, Note2	mm
Display area	432.0 (H) × 324.0 (V)	Note2	mm
Weight	(2,800) (typ.), (2,980) (max.)		g

Note1: Excluding warpage of the cover for circuit board.
Note2: See "**8**. **OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter			Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board		VDD	-0.3 to +14.0	V	Ta= 25°C
	LED driver		VDDB	-0.3 to +15.0	V	
Input voltage for signals	LCD panel signal processing board Note1		Vi	-0.3 to +3.45	V	VDD= 12.0V
	LED driver board	BRTI signal	VBI	-0.3 to +1.5	V	VDDB= 12.0V
		BRTP signal	VBP	-0.3 to +5.5	V	
		BRTC signal	VBC	-0.3 to +5.5	V	
		PWSEL signal	VBS	-0.3 to +5.5	V	
Storage temperature		Note6	Tst	-20 to +60	°C	-
Operating temperature Note6		Front surface	TopF	0 to +60	°C	Note2
		Rear surface	TopR	0 to +60	°C	Note3
Relative humidity Note4, Note6			RH	≤ 95	%	Ta ≤ 40°C
				≤ 85	%	40°C < Ta ≤ 50°C
				≤ 70	%	50°C < Ta ≤ 55°C
Absolute humidity Note4, Note6			AH	≤ 73 Note5	g/m^3	Ta > 55°C
Operating altitude			-	≤ 5,100	m	0°C ≤ Ta ≤ 55°C
Storage altitude			-	≤ 13,600	m	-20°C ≤ Ta ≤ 60°C

Note1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-
Note2: Measured at LCD panel surface (including self-heat)
Note3: Measured at LCD module's rear shield surface (including self-heat)
Note4: No condensation
Note5: Water amount at Ta= 55°C and RH= 70%
Note6: The image quality may cause degradation in case of rapid change humidity and temperature.

4.3 ELECTRICAL CHARACTERISTICS

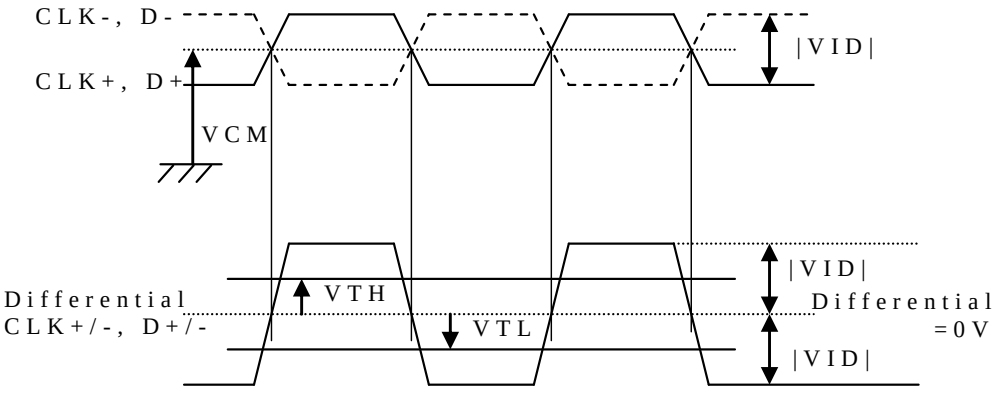
4.3.1 LCD panel signal processing board

(1) DC characteristics

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	-
Power supply current		IDD	-	(500) Note1	(700) Note2	mA	at VDD= 12.0V
Permissible ripple voltage		VRP	-	-	100	mVp-p	for VDD
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2V Note3, Note4
	Low	VTL	-100	-	-	mV	
Input Differential Voltage		|VID|	100	-	600	mV	-
Differential Input Common Mode Voltage		VCM	1.0	1.2	1.4	V	-
Terminating resistance		RT	-	100	-	Ω	-

Note1: Checkered flag pattern (by EIAJ ED-2522)
Note2: Pattern for maximum current
Note3: Common mode voltage for LVDS driver
Note4: DC characteristics (LVDS receiver part)

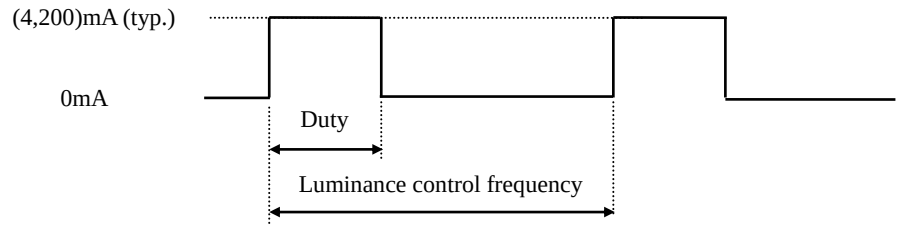


4.3.2 LED driver

(Ta= 25°C)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage			VDDB	11.4	12.0	12.6	V	-
Power supply current			IDDB	-	(4,200)	(5,800)	mA	VDDB= 12.0V, At the maximum luminance control
Input voltage for signals	BRTI signal		VBI	0	-	1.0	V	-
	BRTP signal	High	VBPH	2.0	-	5.25	V	
		Low	VBPL	0	-	0.8	V	
	BRTC signal	High	VBCH	2.0	-	5.25	V	
		Low	VBCL	0	-	0.8	V	
	PWSEL signal	High	VBSH	2.0	-	5.25	V	
		Low	VBSL	0	-	0.8	V	
Input current for signals	BRTI signal		IBI	(-200)	-	(-100)	μA	
	BRTP signal	High	IBPH	-	-	(1,000)	μA	
		Low	IBPL	(-600)	-	-	μA	
	BRTC signal	High	IBCH	-	-	(300)	μA	
		Low	IBCL	(-300)	-	-	μA	
	PWSEL signal	High	IPSH	-	-	(1,000)	μA	
		Low	IPSL	(-600)	-	-	μA	

4.3.3 Current wave for LED driver



Duty: At the maximum luminance control 100% to at the minimum luminance control 1%.
Luminance control frequency: 270Hz (typ.)

Note1: Luminance control frequency indicate the input pulse frequency, when select the external pulse control. See "**4.6.2 Detail of BRTP timing**".

Note2: The power supply lines (VDDB and GNDB) have large ripple voltage during luminance control. See "**4.3.4 Power supply voltage ripple** ".
There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on.

4.3.4 Power supply voltage ripple

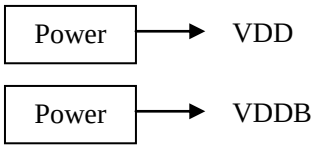
This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

Power supply voltage		Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VDD	12.0V	≤ 100	mVp-p
VDDB	12.0V	≤ 200	mVp-p

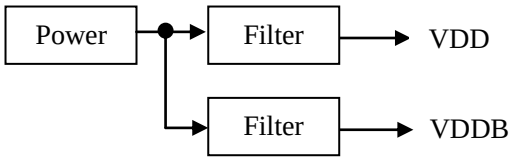
Note1: The permissible ripple voltage includes spike noise.

Example of the power supply connection

a) Separate the power supply



b) Put in the filter



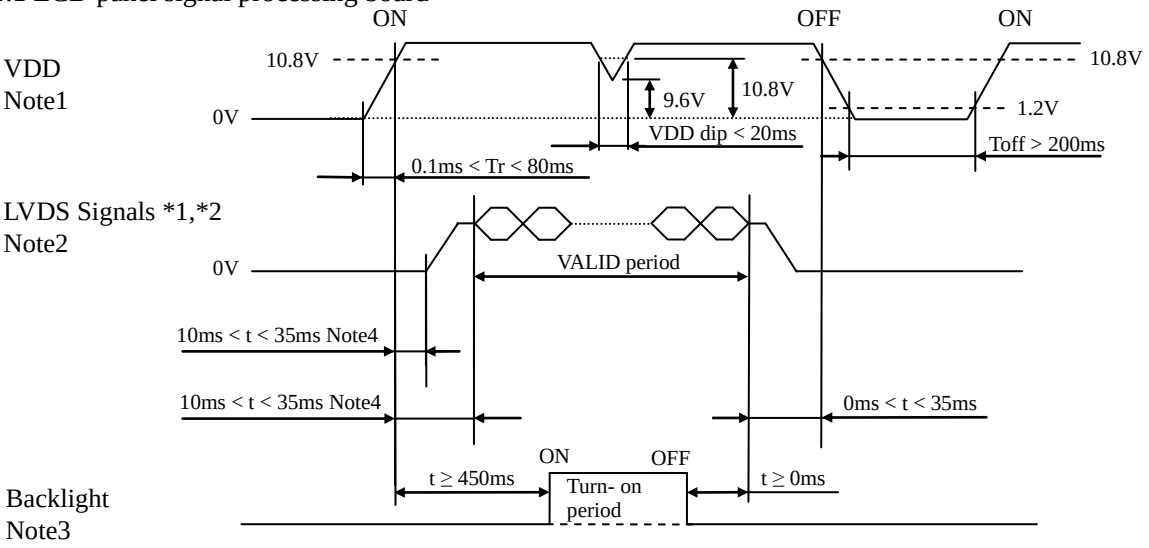
4.3.5 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VDD	TBD	TBD	TBD A	TBD A, TBD seconds maximum	Note1
			TBD V		
VDDB	TBD	TBD	TBD A	TBD A, TBD seconds maximum	
			TBD V		

Note1: The power supply capacity should 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



*1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/- and CKB+/-

*2: LVDS signals should be measured at the terminal of 100 Ω resistance.

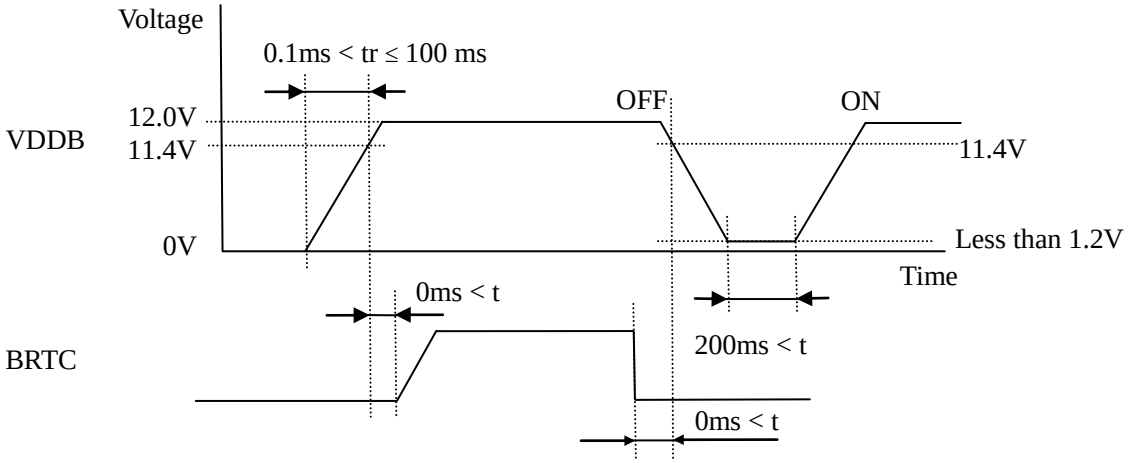
Note1: If there is a voltage variation (voltage drop) at the rising edge of VDD below 10.8V, there is a possibility that a product does not work due to a protection circuit.

Note2: LVDS signals 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 signals 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, VDD also must be shut down.

Note3: The backlight should be turned on within the turn-on period, in order to avoid unstable data display.

Note4: After turning VDD on, terminal voltages on LVDS input terminals (*1) will rise. This is caused by initial operation of the product.

4.4.2 LED driver



Note1: If tr is more than 100 ms, the backlight will be turned off by a protection circuit for LED driver.

Note2: When VDDB is 0V or BRTC is Low, PWSEL must be set to Low or Open.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

(1) CN1

CN1 socket (LCD module side): DF19G-30P-1H (56) (HIROSE ELECTRIC Co,.Ltd.)
Adaptable plug: DF19-30S-1C (HIROSE ELECTRIC Co,.Ltd.)

Pin No.	Symbol	Signal	Remarks
1	DA0-	Pixel data A0	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1
2	DA0+		
3	DA1-	Pixel data A1	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1
4	DA1+		
5	DA2-	Pixel data A2	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1
6	DA2+		
7	GND	Ground	Signal groud Note2
8	CKA-	Pixel clock	Odd pixel clock input (LVDS DIFFERENTIAL DATA) Note1
9	CKA+		
10	DA3-	Pixel data A3	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1
11	DA3+		
12	DB0-	Pixel data B0	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1
13	DB0+		
14	GND	Ground	Signal groud Note2
15	DB1-	Pixel data B1	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1
16	DB1+		
17	GND	Ground	Signal groud Note2
18	DB2-	Pixel data B2	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1
19	DB2+		
20	CKB-	Pixel clock	Even pixel clock input (LVDS DIFFERENTIAL DATA) Note1
21	CKB+		
22	DB3-	Pixel data B3	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1
23	DB3+		
24	GND	Ground	Signal groud Note2
25	N.C.	N.C.	N.C.
26	TxSEL1	Select LVDS data input map	Note3, Note4 (TxSEL1: Open → A; Low → B)
27	GND	Ground	Signal groud Note2
28	VDD	Power supply	12.0V Note2
29	VDD		
30	VDD		

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note2: All GND terminals should be used without any non-connected lines.
Note3: This terminal is pulled-up in the product.
Note4: See "**4.7 LVDS data input map**.

4.5.2 LED driver

CN201 socket (LCD module side): DF3Z-10P-2H (2∗) (HIROSE ELECTRIC Co,.Ltd.)
Adaptable plug: DF3-10S-2C (HIROSE ELECTRIC Co,.Ltd.)

Pin No.	Symbol	Function	Description
1	GNDB	LED driver ground	Note1
2	GNDB		
3	GNDB		
4	GNDB		
5	GNDB		
6	VDDB	Power supply	Note1
7	VDDB		
8	VDDB		
9	VDDB		
10	VDDB		

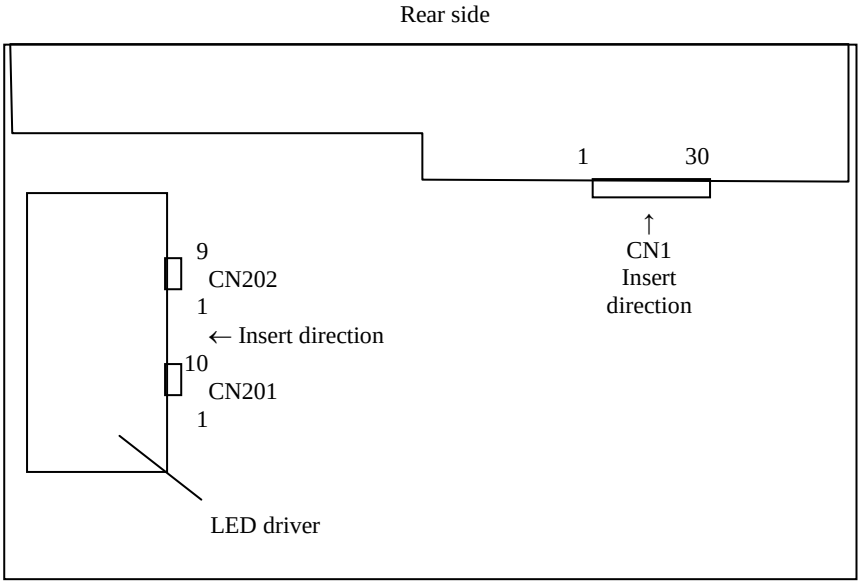
Note1: All VDDB and GNDB terminals should be used without any non-connected lines.

CN202 socket (LCD module side): 53261-0971 (molex)
Adaptable plug: 51021-0900 (molex)

Pin No.	Symbol	Function	Description
1	PWSEL	Selection of luminance control signal method	Note2, Note3
2	GNDB	LED driver ground	Note1
3	BRTP	BRTP signal	Note2
4	BRTI	Luminance control terminal	Note2
5	BRTH		
6	BRTC	Backlight ON/OFF control signal	High or Open: Backlight ON Low Backlight OFF
7	N.C.	-	Keep this pin Open.
8	GNDB	LED driver ground	Note1
9	GNDB		

Note1: All GNDB terminals should be used without any non-connected lines.
Note2: See "**4.6 LUMINANCE CONTROL** ".
Note3: When VDDB is 0V or BRTC is Low, PWSEL must be set to Low or Open.

4.5.3 Positions of socket

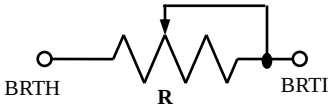


4.6 LUMINANCE CONTROL

4.6.1 Luminance control methods

<table>
<tr><th>Method</th><th>Adjustment and luminance ratio</th><th>PWSEL terminal</th><th>BRTP terminal</th></tr>
<tr><td>Variable resistor control

Note1</td><td>• Adjustment

The variable resistor (R) for luminance control should be 10kΩ ±5%, 1/10W. Minimum point of the resistance is the minimum luminance and maximum point of the resistance is the maximum luminance.
The resistor (R) must be connected between BRTH-BRTI terminals.
 

• Luminance ratio Note3
<table><tr><th>Resistance</th><th>Luminance ratio</th></tr><tr><td>0Ω</td><td>(5)% (typ.)</td></tr><tr><td>10kΩ</td><td>100%</td></tr></table></td><td rowspan="2">High or Open</td><td rowspan="2">Open</td></tr>
<tr><td>Voltage control

Note1</td><td>• Adjustment

Voltage control method works, when BRTH terminal is 0V and VBI voltage is input between BRTI-BRTH terminals. This control method can carry out continuation adjustment of luminance.
Luminance is the maximum when BRTI terminal is Open

• Luminance ratio Note3
<table><tr><th>BRTI Voltage (VBI)</th><th>Luminance ratio</th></tr><tr><td>0V</td><td>(5)% (typ.)</td></tr><tr><td>1.0V</td><td>100%</td></tr></table></td></tr>
<tr><td>Pulse width modulation

Note1
Note2
Note4</td><td>• Adjustment

Pulse width modulation (PWM) method works, when PWSEL terminal is Low and PWM signal (BRTP signal) is input into BRTP terminal. The luminance is controlled by duty ratio of BRTP signal.

• Luminance ratio Note3
<table><tr><th>Duty ratio</th><th>Luminance ratio</th></tr><tr><td>0.01</td><td>1% (typ.)
(At frequency: 325 Hz)</td></tr><tr><td>1.0</td><td>100%</td></tr></table></td><td>Low</td><td>BRTP signal</td></tr>
</table>

Note1: In case of the variable resistor control method and the voltage control method, noises may appear on the display image depending on the input signals timing for LCD panel signal processing board.
Use PWM method, if interference noises appear on the display image!

Note2: The LED driver board will stop working, if the Low period of BRTP signal is more than 50ms while BRTC signal is High or Open. Then the backlight will not turn on anymore, even if BRTP signal is input again. This is not out of order. The LED driver board will start to work when power is supplied again.

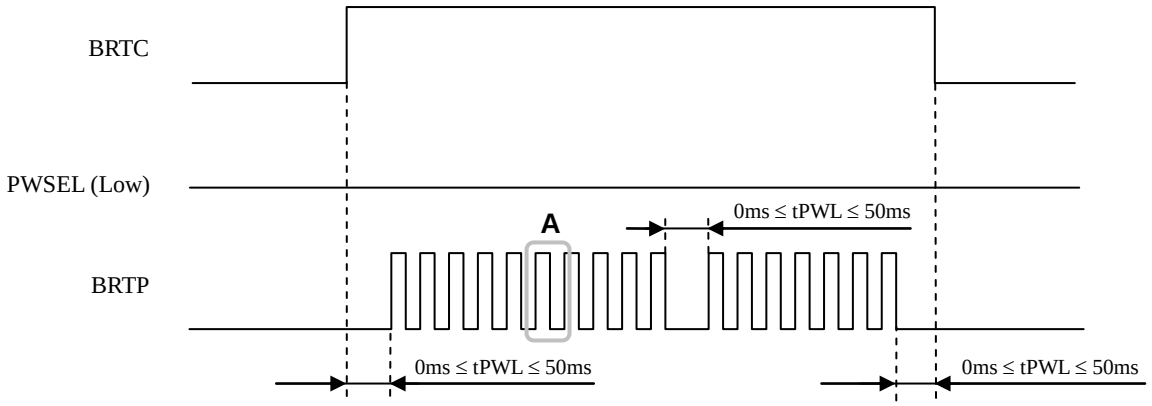
Note3: These data are the target values.

Note4: See "**4.6.2 Detail of BRTP timing**".

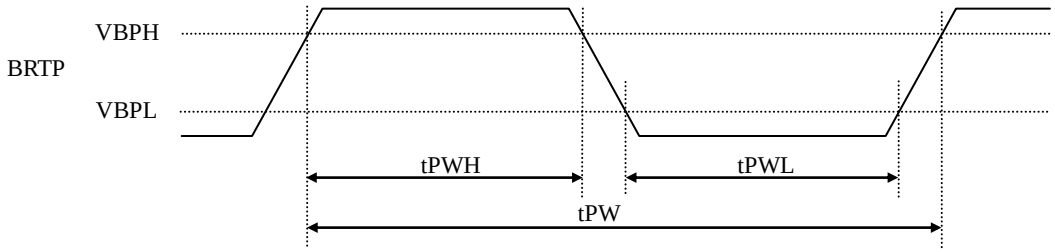
4.6.2 Detail of BRTP timing

(1) Timing diagrams

• Outline chart



• Outline chart



(2) Each parameter

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
PWM frequency	f_{PWM}	185	-	1k	Hz	Note1,2,3
PWM duty ratio	DR_{PWM}	1	-	100	%	Note4,5
PWM pulse width	tPWH	30	-	-	μs	Note1,4,5

Note1: Definition of parameters is as follows.

$$f_{PWM} = \frac{1}{tPW} \quad , DR_{PWM} = \frac{tPWH}{tPW}$$

Note2: A recommended f_{PWM} value is as follows.

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

(n= integer, fv= frame frequency of LCD module)

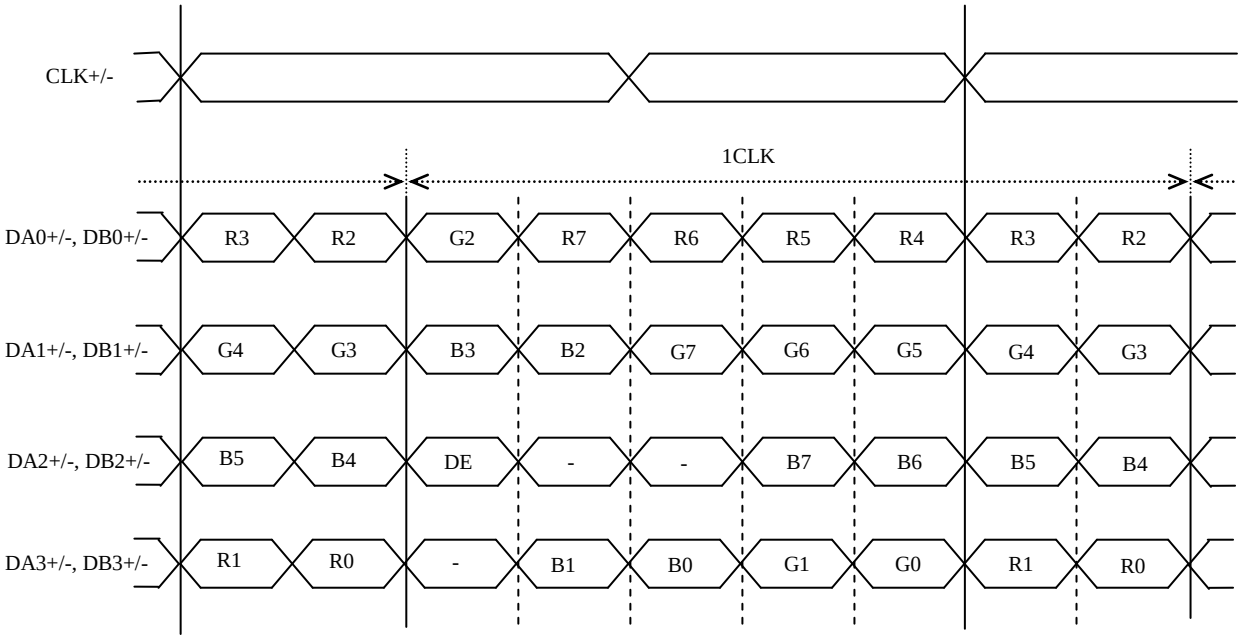
Note3: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note4: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than 30μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

Note5: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

4.7 LVDS data input map.

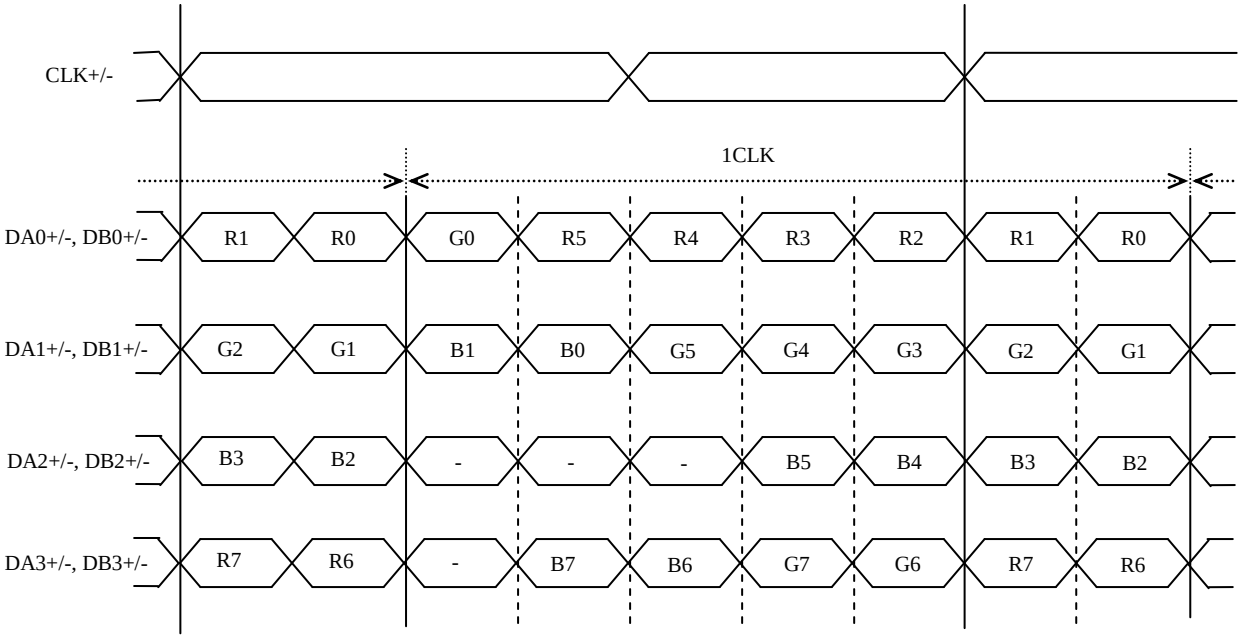
4.7.1 Mode A



Note1: LSB (Least Significant Bit) – R0, G0, B0
MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

4.7.2 Mode B



Note1: LSB (Least Significant Bit) – R0, G0, B0
MSB (Most Significant Bit) – R7, G7, B7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

4.8 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 16,777,216 colors in 256 gray scales in each RGB sub-pixel. Also the relation between display colors and input data signals is as the following table.

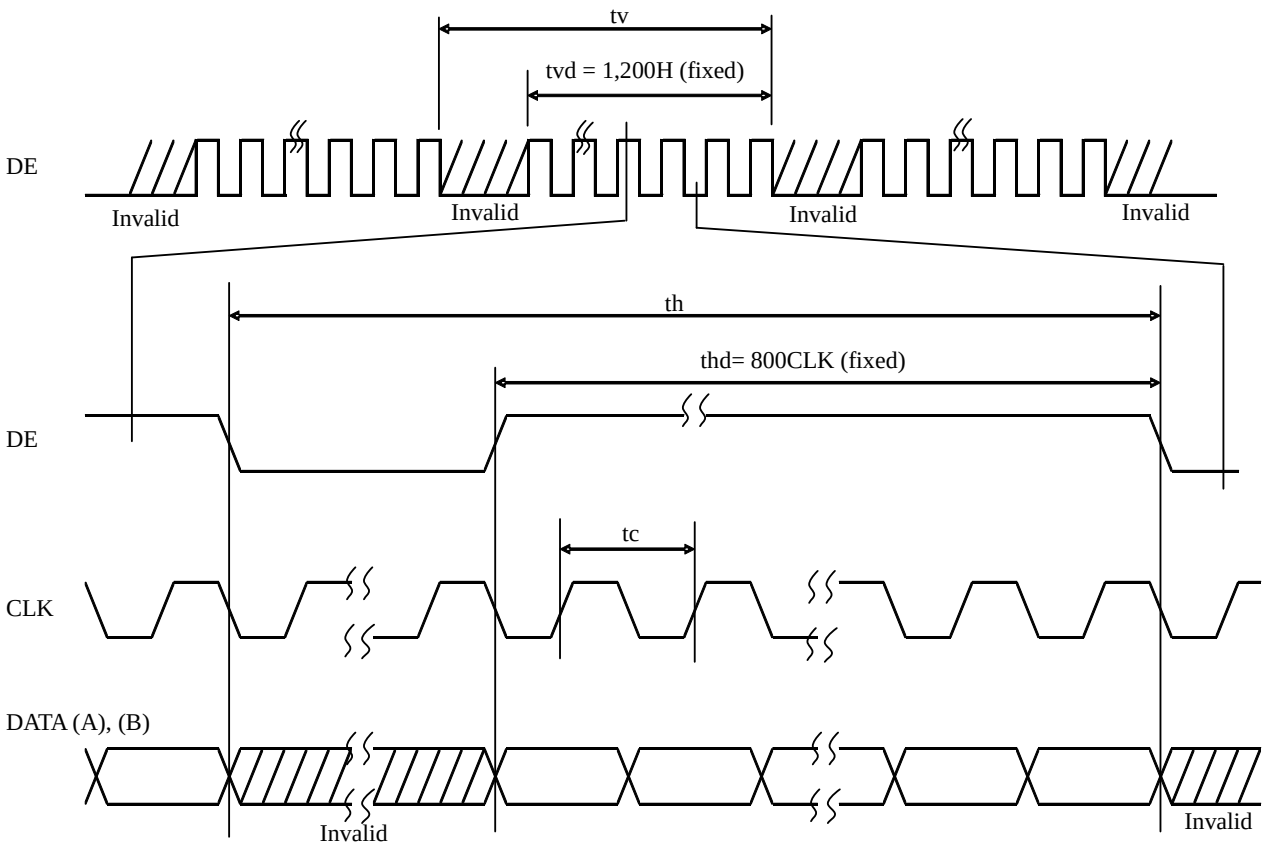
Display colors		Data signal (0: Low level, 1: High level)																									
		RA7	RA6	RA5	RA4	RA3	RA2	RA1	RA0	GA7	GA6	GA5	GA4	GA3	GA2	GA1	GA0	BA7	BA6	BA5	BA4	BA3	BA2	BA1	BA0
		RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	GB7	GB6	GB5	GB4	GB3	GB2	GB1	GB0	BB7	BB6	BB5	BB4	BB3	BB2	BB1	BB0
Basic Colors	Black	0	0	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

4.9 INPUT SIGNAL TIMINGS

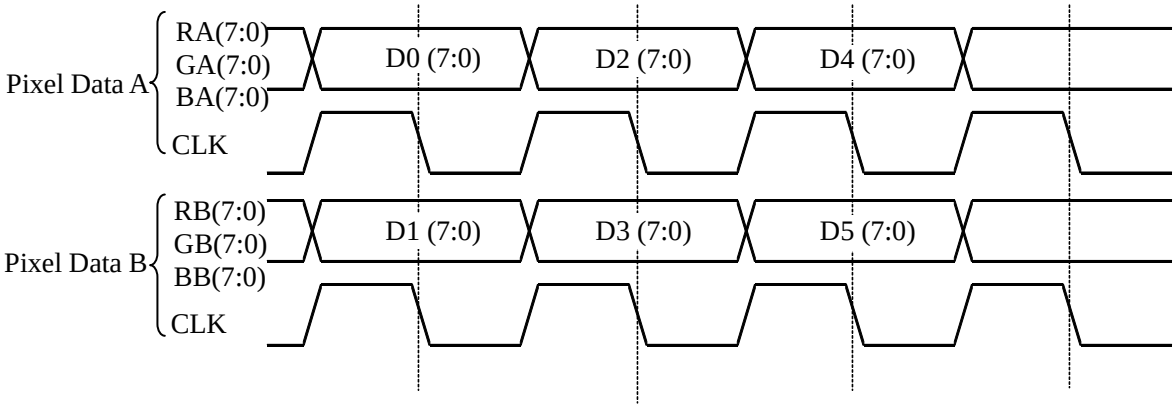
4.9.1 Timing characteristics

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/ tc	60.0	64.5	65.0	MHz	15.50ns (typ.)
	Pulse width	tc	15.38	15.5	-	ns	
Horizontal	Cycle	th	13.1	13.3	19.2	μs	-
			848	860	1,156	CLK	
	Display period	thd	800			CLK	-
Vertical	Cycle	1/tv	59	60	61	Hz	-
		tv	1,206	1,250	-	H	
	Display period	tvd	1,200			H	-

4.9.2 Input signal timing chart

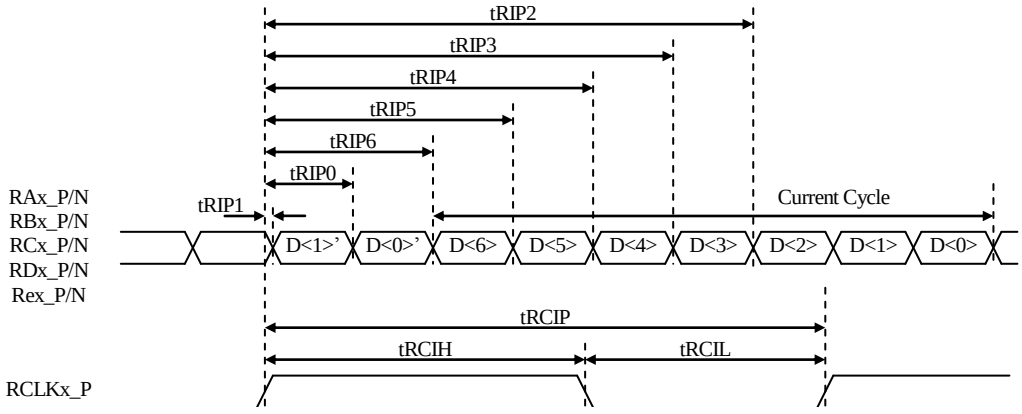


4.10 LVDS DATA TARANSMISSION METHOD



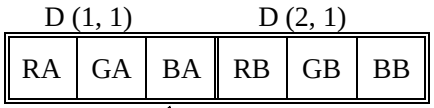
4.11 LVDS Rx AC SPEC

Symbol	Parameter	min.	typ.	max.	Units
t_{RCIP}	CKy_+ Period	15.385	-	16.667	ns
t_{RCIH}	CKy_+ High pulse width	-	$\frac{4}{7}t_{RCIP}$	-	ns
t_{RCIL}	CKy_+ Low pulse width	-	$\frac{3}{7}t_{RCIP}$	-	ns
t_{RMG}	Receiver Data Input Margin CLK= 65MHz	-0.65	-	0.65	ns
t_{RIP1}	Input Data Position0	$-\lvert t_{RMG}\rvert$	0.0	$+\lvert t_{RMG}\rvert$	ns
t_{RIP0}	Input Data Position1	$\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$\frac{t_{RCIP}}{7}$	$\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns
t_{RIP6}	Input Data Position2	$2\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$2\frac{t_{RCIP}}{7}$	$2\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns
t_{RIP5}	Input Data Position3	$3\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$3\frac{t_{RCIP}}{7}$	$3\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns
t_{RIP4}	Input Data Position4	$4\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$4\frac{t_{RCIP}}{7}$	$4\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns
t_{RIP3}	Input Data Position5	$5\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$5\frac{t_{RCIP}}{7}$	$5\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns
t_{RIP2}	Input Data Position6	$6\frac{t_{RCIP}}{7}-\lvert t_{RMG}\rvert$	$6\frac{t_{RCIP}}{7}$	$6\frac{t_{RCIP}}{7}+\lvert t_{RMG}\rvert$	ns



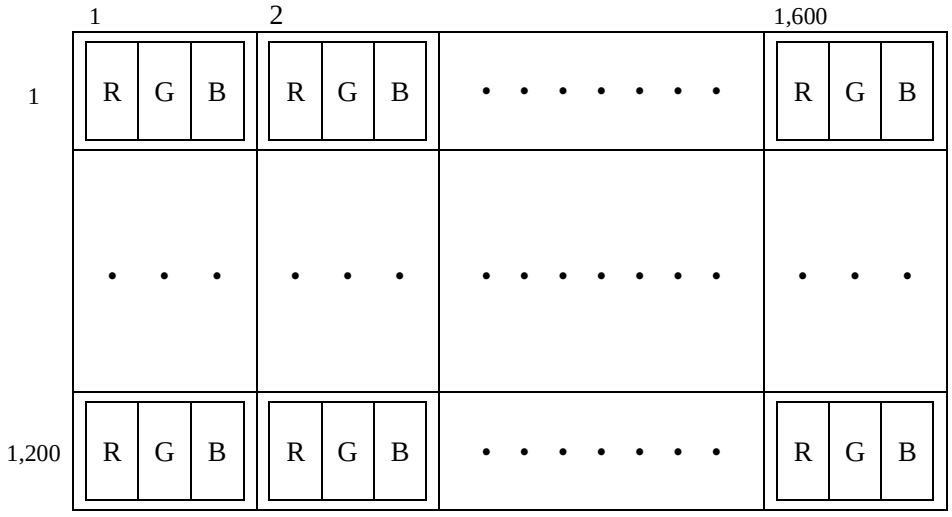
4.12 DISPLAY POSITIONS

Odd pixel: RA= R data, GA= G data, BA= B data
Even pixel: RB= R data, GB= G data, BB= B data



D(1, 1)	D (2, 1)	• • •	D (X, 1)	• • •	D (1599, 1)	D (1600, 1)
D (1, 2)	D (2, 2)	• • •	D (X, 2)	• • •	D (1599, 2)	D (1600, 2)
• • •	• • •	• • • •	• • •	• • • •	• • •	• • • •
D (1, Y)	D (2, Y)	• • •	D (X, Y)	• • •	D (1599, Y)	D (1600, Y)
• • •	• • •	• • • •	• • •	• • • •	• • •	• • •
D (1, 1199)	D (2, 1199)	• • •	D (X, 1199)	• • •	D (1599, 1199)	D (1600, 1199)
D (1, 1200)	D (2, 1200)	• • •	D (X, 1200)	• • •	D (1599, 1200)	D (1600, 1200)

4.13 PIXEL ARRANGNMENT



4.14 OPTICS

4.14.1 Optical characteristics

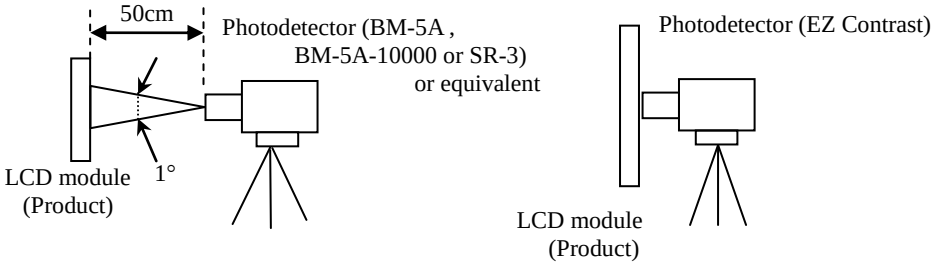
(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	670	900	-	cd/m^2	BM-5A or SR-3	Note3
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	1,000	1,400	-	-	BM-5A or SR-3	Note3 Note5
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	80	-	-	%	BM-5A or SR-3	Note4 Note6
Chromaticity	White	**x** coordinate	Wx	0.269	0.299	0.329	-	SR-3	Note3 Note7
		y coordinate	Wy	0.285	0.315	0.345	-		
	Red	**x** coordinate	Rx	-	0.65	-	-		
		y coordinate	Ry	-	0.33	-	-		
	Green	**x** coordinate	Gx	-	0.29	-	-		
		y coordinate	Gy	-	0.60	-	-		
	Blue	**x** coordinate	Bx	-	0.15	-	-		
		y coordinate	By	-	0.07	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	65	72	-	%	SR-3	Note3
Response time		Black to White	Ton	-	(20)	(30)	ms	BM-5A -10000	Note8 Note9
		White to Black	Toff	-	(20)	(30)	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	88	-	°	EZ Contrast	Note3 Note10
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	88	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	88	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	88	-	°		

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.
Ta= 25°C, VDD= 12.0V, VDDB= 12.0V, PWM duty ratio: 100%, Display mode: UXGA, Horizontal cycle= 1/75.19 kHz, 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: Product surface temperature TopF= 32°C,TopR= 43°C (at the maximum luminance control)

Note4: Product surface temperature TopF= 30°C,TopR= 38°C (at the product luminance 450cd/m^2)
LU is measured under the condition of temperature differences in the display area are less than 10°C.

Note5: See "**4.14.2 Definition of contrast ratio**".

Note6: See "**4.14.3 Definition of luminance uniformity**".

Note7: These coordinates are found on CIE 1931 chromaticity diagram.

Note8: See "**4.14.4 Definition of response times**".

Note9: Product surface temperature TopF= 35°C

Note10: See "**4.14.5 Definition of viewing angles**".

4.14.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

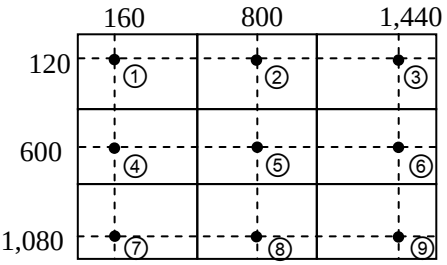
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.14.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

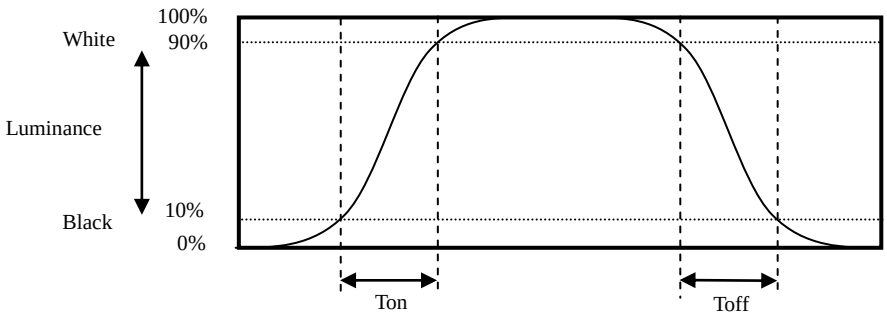
$$\text{Luminance uniformity (LU)} = \frac{\text{Minimum luminance from ① to ⑨}}{\text{Maximum luminance from ① to ⑨}}$$

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

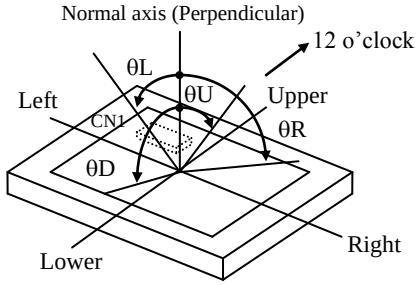


4.14.4 Definition of response times

Response time is measured at the time when the luminance changes from "black" to "white", or "white" to "black" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 10% up to 90%. Also Toff is the time when the luminance changes from 90% down to 10% (See the following diagram.).



4.14.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

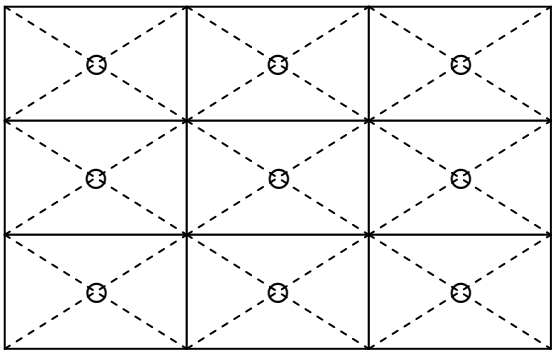
Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio: 100%	70,000	h
	60°C (Temperature of the product front or rear panel) Continuous operation, PWM duty ratio: 100%	60,000	

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

6. RELIABILITY TESTS

Test item		Condition	Judgment Note1
High temperature and humidity (Operation)		① 60 ± 2°C, RH= 60%, 240hours ② Display data is white. Note2	No display malfunctions
Heat cycle (Operation)		① 0 ± 3°C 1hour 60 ± 3°C 1hour ② 50cycles, 4hours/cycle ③ Display data is white. Note2	
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.	
Vibration (Non operation)		① 5 to 100Hz, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 10 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	
ESD (Operation)		① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note3 ③ 10 times each places at 1 sec interval	No display malfunctions
Low pressure	Non-operation	① 15 kPa (Equivalent to altitude 13,600m) ② -20°C±3°C 24 hours ③ +60°C±3°C 24 hours	No display malfunctions
	Operation	① 53.3kPa (Equivalent to altitude 5,100m) ② 0°C±3°C 24 hours ③ +55°C±3°C 24 hours Note2	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.
Note2: Luminance: 450cd/m^2 at luminance control.
Note3: 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.

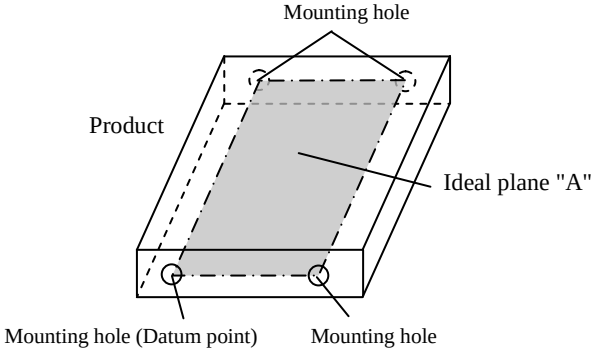
7.2 CAUTIONS

- **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 19.6N (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 or 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 0.735N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 5.0mm.
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.
Recommended installing method: Ideal plane "A" is defined by one mounting hole (datum point) and other mounting holes. The ideal plane "A" should be the same plane within ±0.3 mm.



⑦ Do not press or rub on the sensitive product surface. When cleaning the product 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.

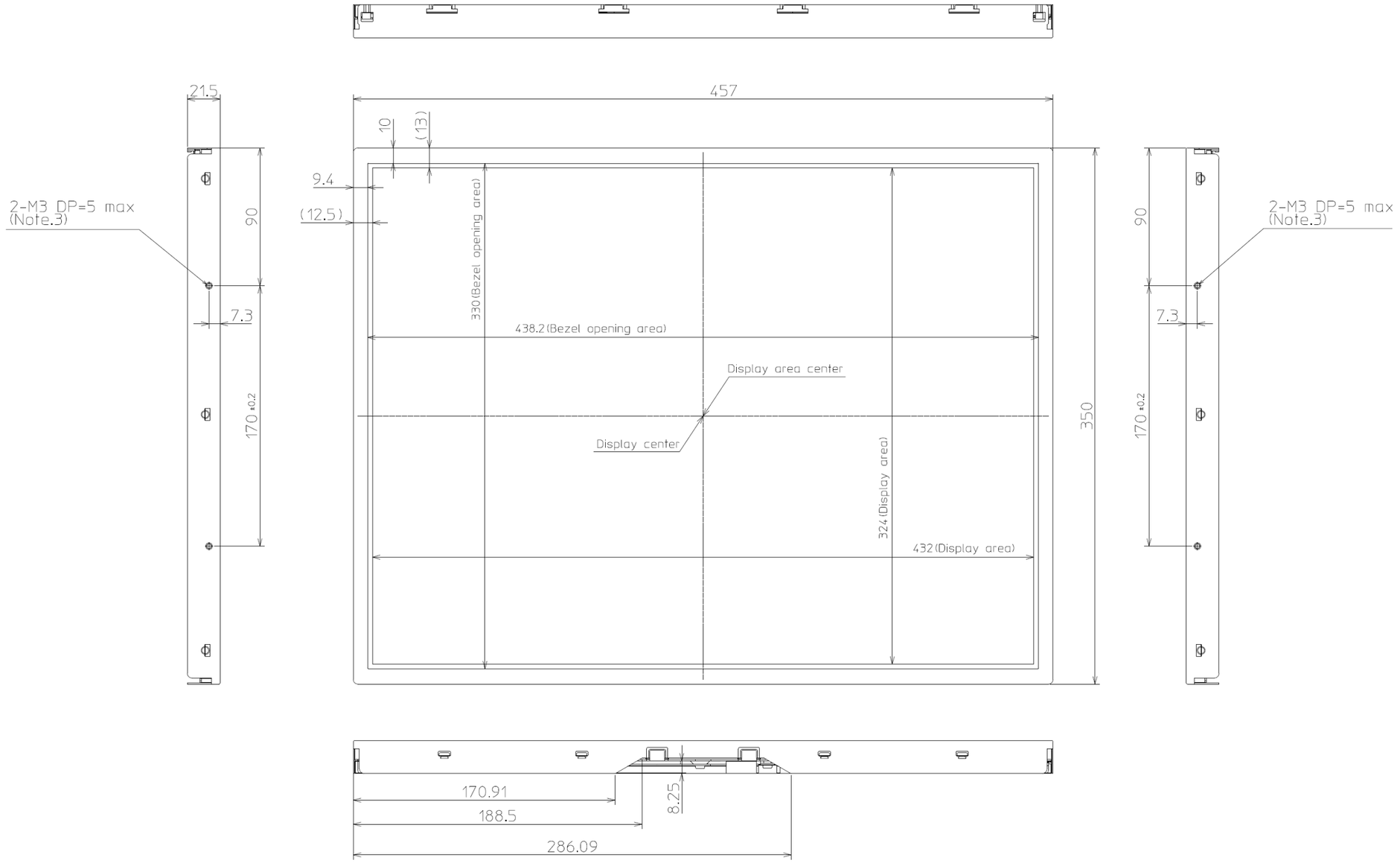
① Response time, luminance and color may be changed by ambient temperature.
② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed 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, GNDB, VDD and VDDB 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.
④ The LCD module by itself or integrated into end product should be packed and transported with display in the vertical position. Otherwise the display characteristics may be degraded.

8. OUTLINE DRAWINGS

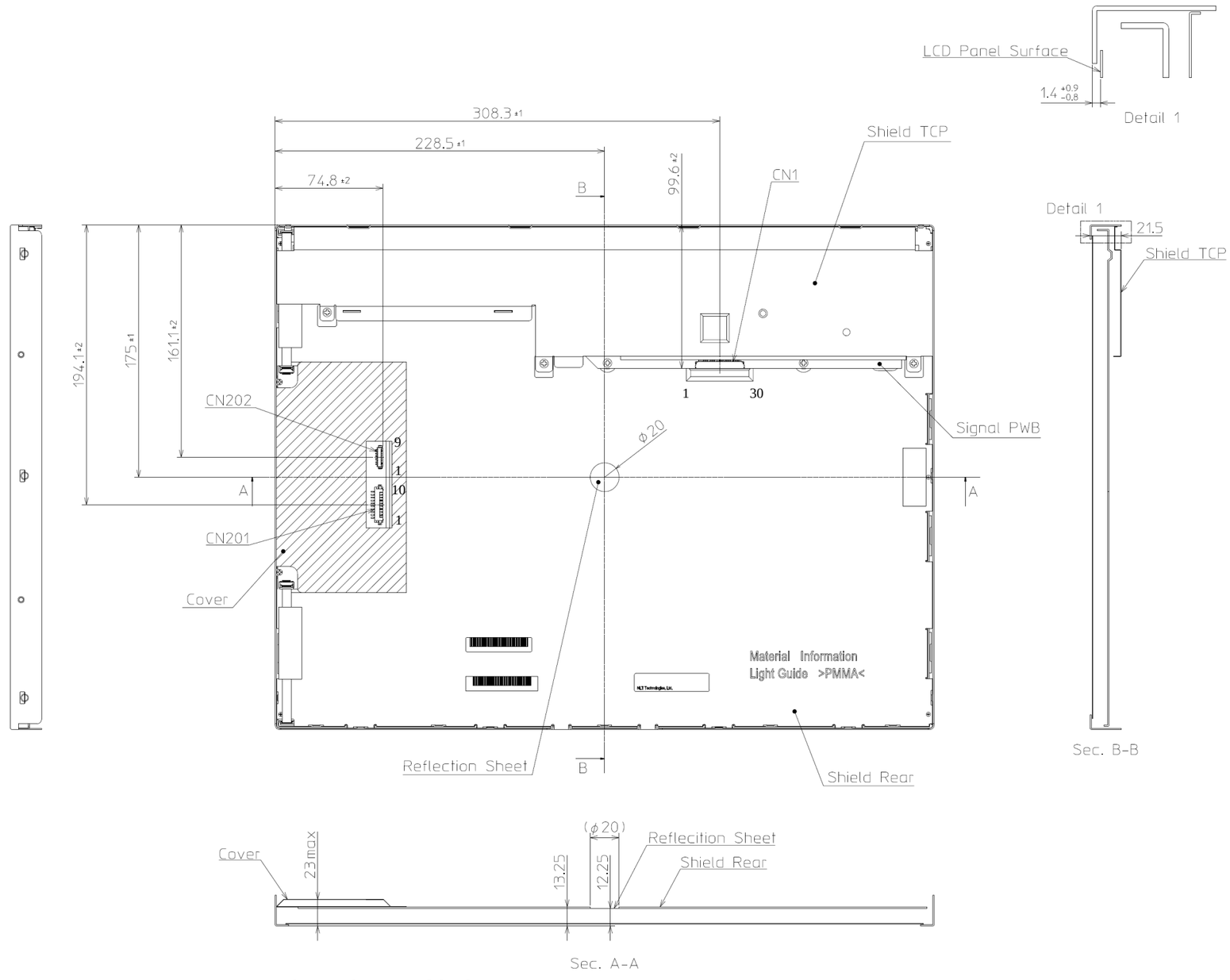
8.1 FRONT VIEW



Note1: Not shown tolerances of the dimensions are ±0.5mm.
Note2: The torque for product mounting screws must never exceed 0.735N·m.
Note3: The length of product mounting screws from surface of plate must be ≤ 5.0mm.
Note4: The values in parentheses are for reference.

Unit: mm

8.2 REAR VIEW



Note1: Not shown tolerances of the dimensions are ±0.5mm.
Note2: The torque for product mounting screws must never exceed 0.735N·m.
Note3: The length of product mounting screws from surface of plate must be ≤ 5.0mm.
Note4: The values in parentheses are for reference.

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-1993	Oct. 15, 2014	**Revision contents** New issue **Signature of writer** *Approved by* R. KAWASHIMA *Checked by* *Prepared by* E. YOSHIMURA