PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NL192108AC18-02D

40cm (15.6 Type)
FHD
LVDS interface (2port)

PRELIMINARY DATA SHEET

DOD-PP-2162 (1st edition)

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"**.
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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.

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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.

The **Specific:** Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.
Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

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

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL192108AC18-02D is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

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

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

1.2 APPLICATION

- For industrial use

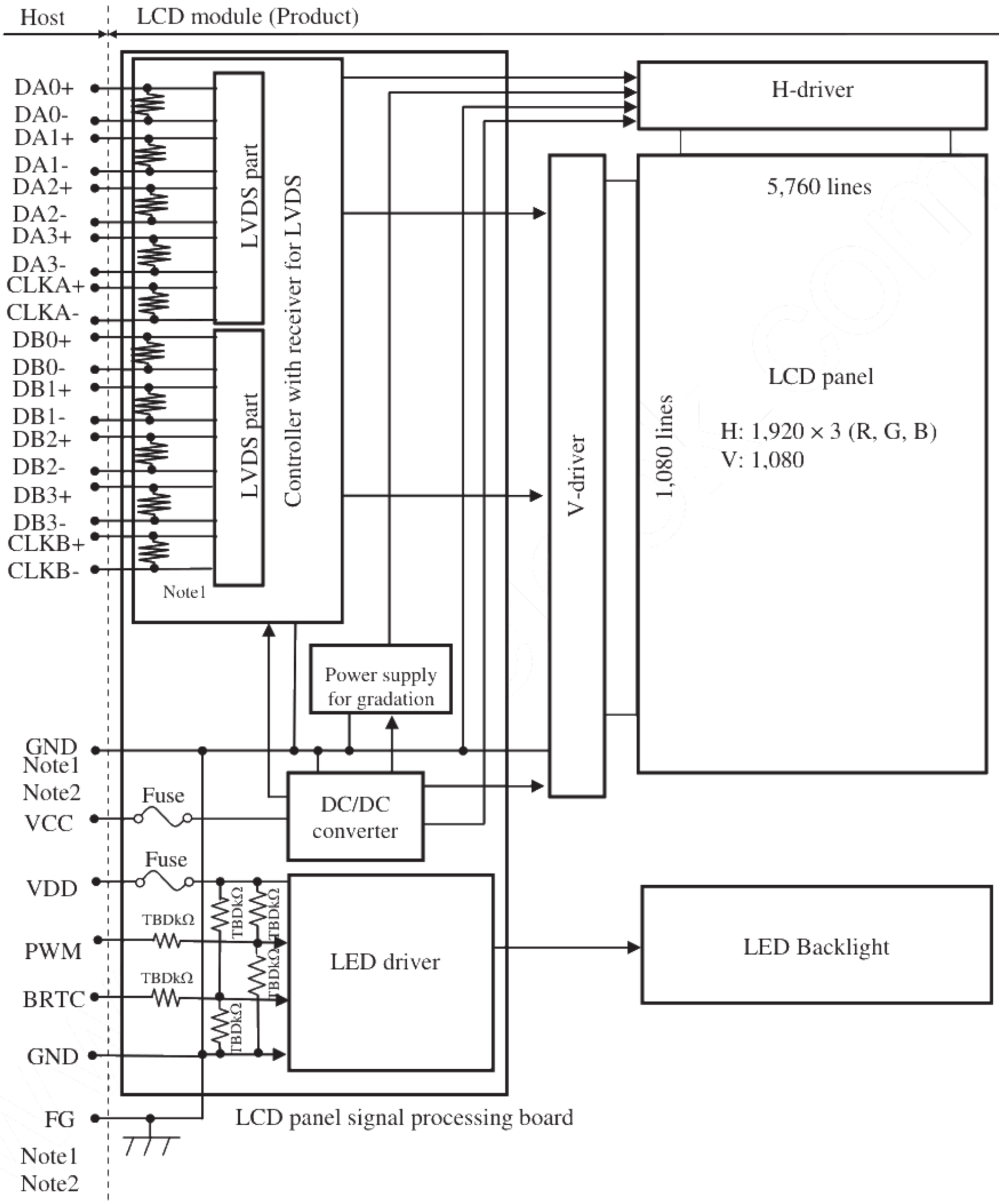
1.3 FEATURES

- Ultra Wide viewing angle (Super Fine TFT (SFT))
- High contrast
- Wide color gamut
- Wide temperature range
- LVDS interface
- 8-bit digital signals for data of RGB
- Narrow frame
- LED backlight built in LED driver
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

2. GENERAL SPECIFICATIONS

Display area	344.16 (H) × 193.59 (V) mm
Diagonal size of display	40cm (15.6 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Pixel	1920 (H) × 1080 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.05975 (H) × 0.17925 (V) mm
Pixel pitch	0.17925 (H) × 0.17925 (V) mm
Module size	363.8 (W) × 215.9 (H) × (6.3) (D) mm (typ.)
Weight	(610) g (typ.)
Contrast ratio	750:1 (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 ($\gamma \fallingdotseq$ 2.2): Normal axis (perpendicular)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 72% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→ 90%)* TBD ms (typ.)
Luminance	*At the maximum luminance control* 400 cd/m^2 (typ.)
Signal system	LVDS 2-port [8-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE)]
Power supply voltage	LCD panel signal processing board: 3.3V LED driver: 12.0V
Backlight	LED backlight built in LED driver
Power consumption	*At the maximum luminance control, Checkered flag pattern* TBD W (typ.)

3. BLOCK DIAGRAM



Note1: Relation between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module is as follows.

GND- FG	Connected

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

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	363.8 ± 0.5 (W) × 215.9 ± 0.5 (H) × (6.3) (D)	Note1	mm
Display area	344.16 (H) × 193.59 (V)	Note1	mm
Weight	(610) (typ.), TBD (max.)		g

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

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board	VCC	TBD	V	-
	LED driver	VDD	TBD		
Input voltage for signals	Display signals Note1	VD	TBD	V	
	Function signal for LED driver	PWM	TBD	V	
		BRTC	TBD	V	
Storage temperature		Tst	-20 to +70	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note2
	Rear surface	TopR	-20 to +70	°C	Note3
Relative humidity Note4		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 Note4		AH	≤ 70 Note5	g/m^3	Ta = 70°C

Note1: DA0+/-, DA1+/-, DA2+/-, DA3+/- ,CLKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CLKB+/-
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= 70°C and RH= 36%

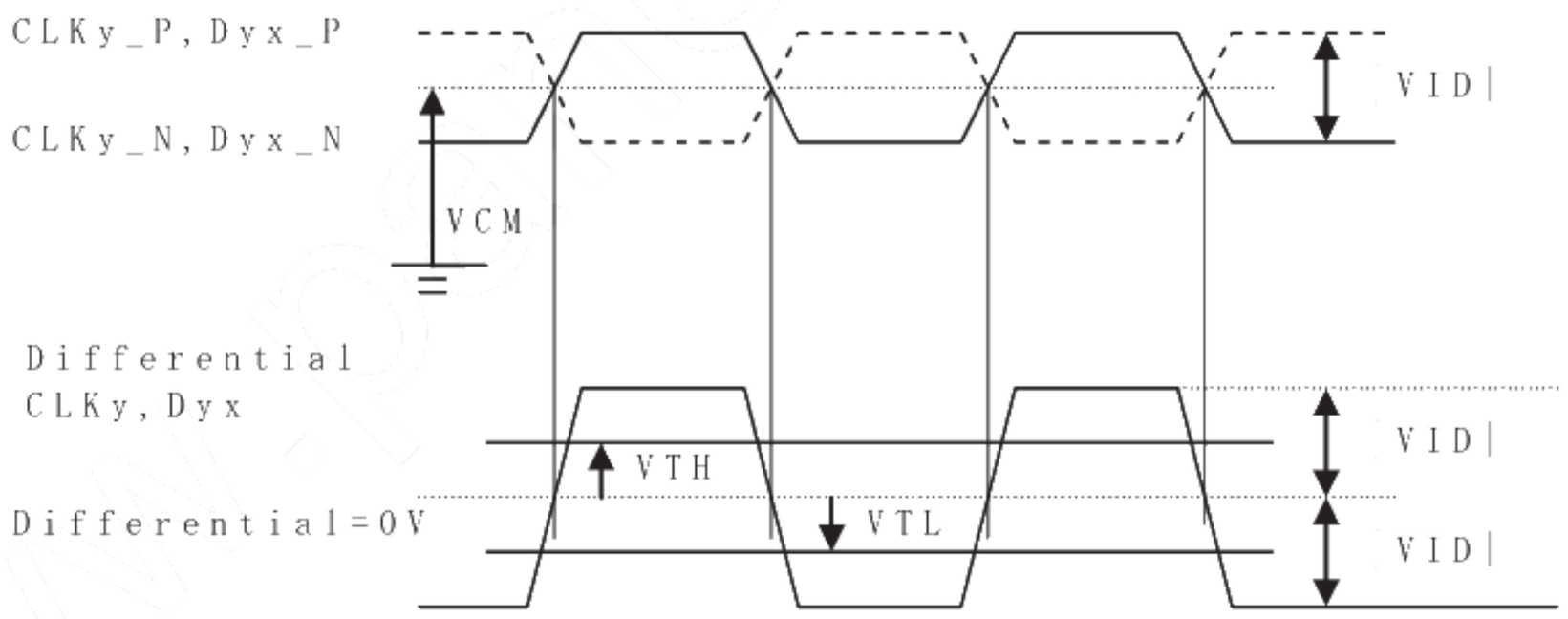
4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VCC	3.0	3.3	3.6	V	-
Power supply current		ICC	-	TBD Note1	TBD Note2	mA	at VCC= 3.3V
Permissible ripple voltage		VRPC	-	-	100	mVp-p	for VCC
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2V Note3, Note4
	Low	VTL	-100	-	-	mV	
Input Differential Voltage		|VID|	100	400	600	mV	-
Differential Input Common Mode Voltage		VCM	0.7	1.2	1.6	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 receiver
Note4: DC characteristics (LVDS receiver part)



CLKy_P, CLKy_N: y = A,B
Dyx_P, Dyx_N: y = A,B x = 0,1,2,3
|VID| = |**_P-**_N|
VCM = (**_P+**_N)/2
P: +, N: -
**: CLKy or Dxy

4.3.2 LED driver

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	Note1
Power supply current Note2		IDD	-	TBD	TBD Note3	mA	at VDD= 12.0V Note4
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD
Input voltage for PWM signal	High	VDFH1	(2.0)	-	(5.0)	V	-
	Low	VDFL1	0	-	(0.8)	V	
Input voltage for BRTC signal	High	VDFH2	(2.0)	-	(5.0)	V	-
	Low	VDFL2	0	-	(0.8)	V	
PWM frequency		f_{PWM}	200	-	1k	Hz	Note5, Note6
PWM duty ratio		DR_{PWM}	(1)	-	100	%	Note7, Note8
PWM pulse width		tPWH	(20)	-	-	μs	

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.

Note2: 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.

Note3: This value excludes peak current such as overshoot current.

Note4: At the maximum luminance control.

Note5: A recommended f_{PWM} value is as follows.

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

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

Note6: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note7: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than (20)μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

Note8: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

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	≤ 100	mVp-p
VDD	12.0V	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

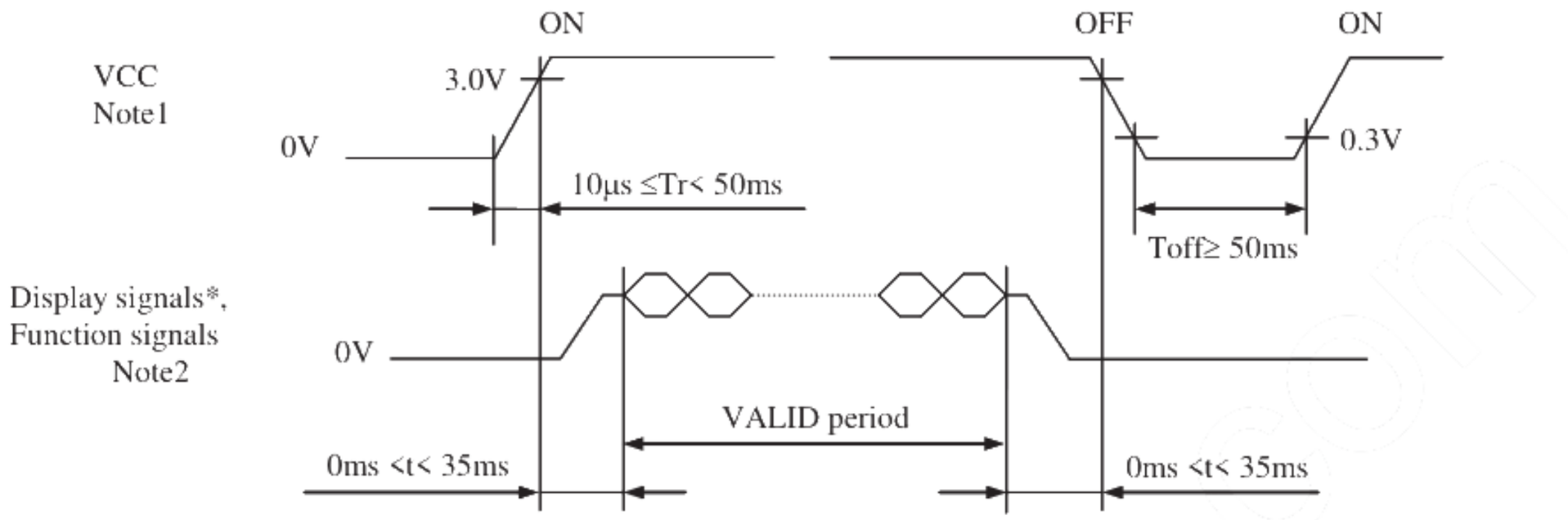
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	TBD	TBD	TBDA TBDV	TBDA	Note1
VDD	TBD	TBD	TBDA TBDV	TBDA	

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board

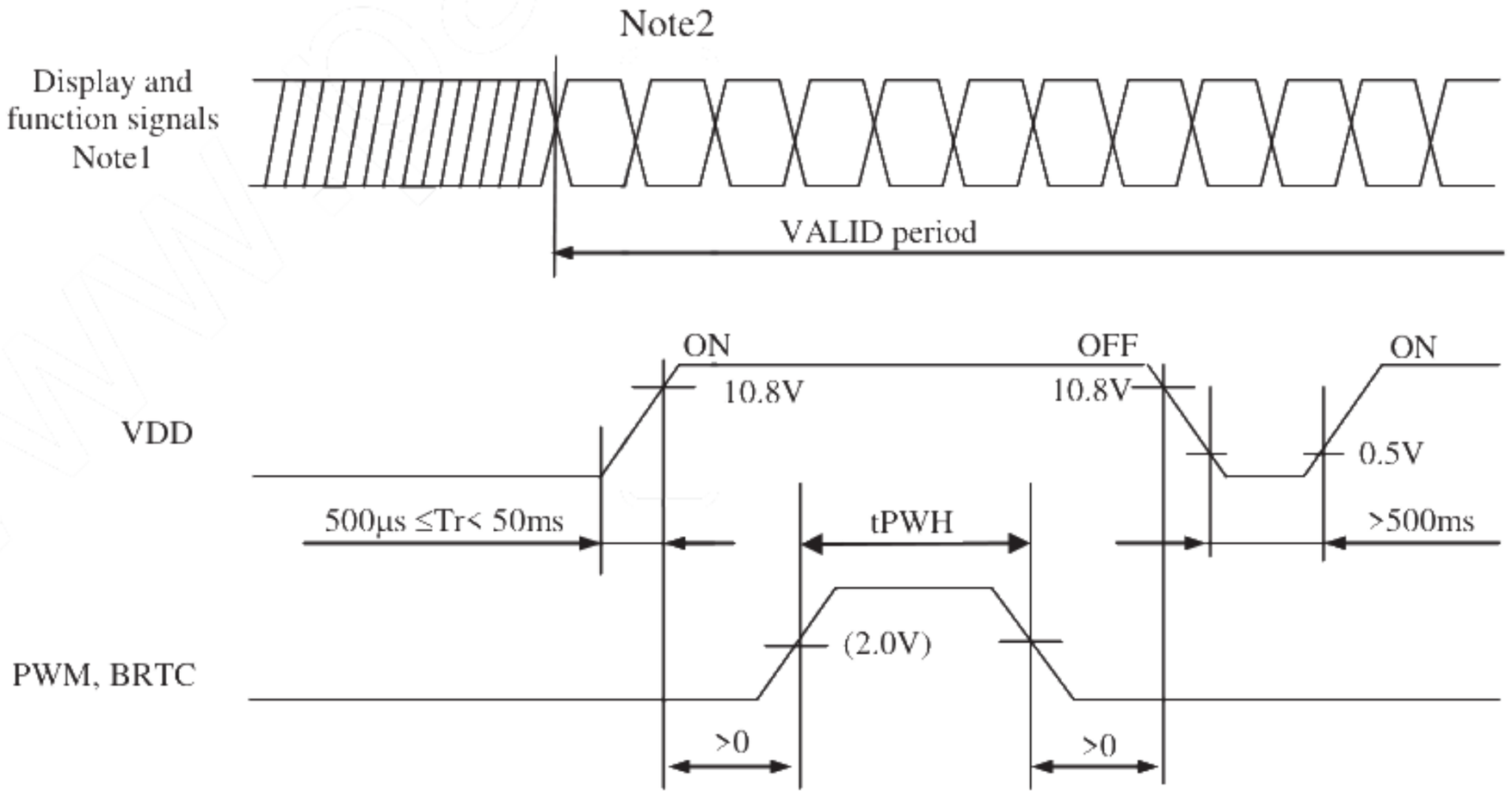


* These signals should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (DA0+/-, DA1+/-, DA2+/-, DA3+/-,CLKA+/-,DB0+/-, DB1+/-, DB2+/-, DB3+/- and CLKB+/-) and must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.
If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VCC also must be shut down.

4.4.2 LED driver



Note1: These are the display and function signals for LCD panel.

Note2: The LED driver 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): MDF76KBW-30S-1H(55) (HIROSE ELECTRIC Co., Ltd.)
Adaptable plug: MDF76-30P-1C (HIROSE ELECTRIC Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	DA0-	Odd pixel data 0	Note1
2	DA0+		
3	DA1-	Odd pixel data 1	Note1
4	DA1+		
5	DA2-	Odd pixel data 2	Note1
6	DA2+		
7	GND	Ground	Note2
8	CLKA-	Odd pixel clock	Note1
9	CLKA+		
10	DA3-	Odd pixel data 3	Note1
11	DA3+		
12	DB0-	Even pixel data 0	Note1
13	DB0+		
14	GND	Ground	Note2
15	DB1-	Even pixel data 1	Note1
16	DB1+		
17	GND	Ground	Note2
18	DB2-	Even pixel data 2	Note1
19	DB2+		
20	CLKB-	Even pixel clock	Note1
21	CLKB+		
22	DB3-	Even pixel data 3	Note1
23	DB3+		
24	GND	Ground	Note2
25	GND	Ground	Note2
26	GND	Ground	Note2
27	GND	Ground	Note2
28	VCC	Power supply	Note2
29			
30			

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.

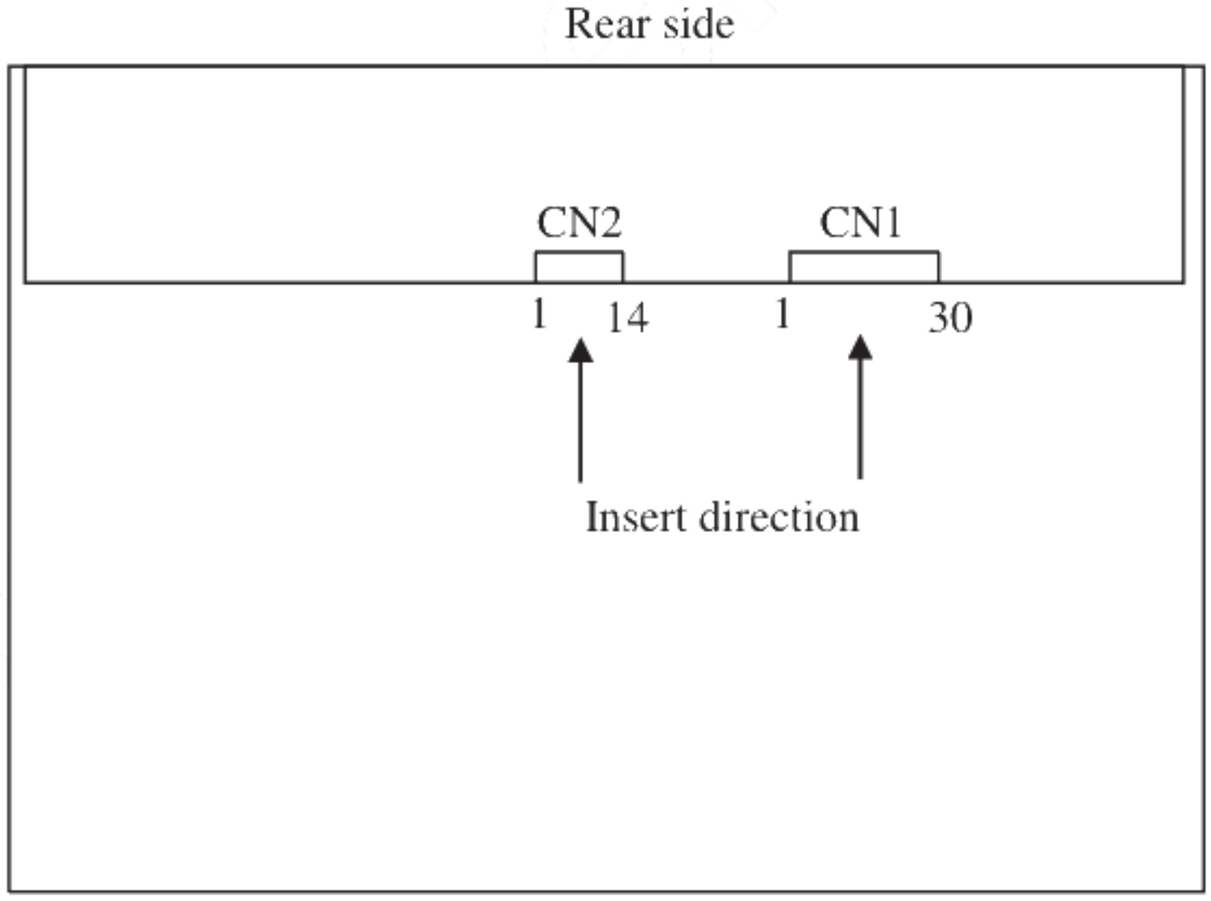
4.5.2 LED driver

CN2 socket (LCD module side): DF19L-14P-1H(54)(HIROSE ELECTRIC Co., Ltd.)
Adaptable plug: DF19-14S-1C (HIROSE ELECTRIC Co., Ltd.)

Pin No.	Symbol	Function	Description
1	VDD	Power supply	Note1
2	VDD		
3	VDD		
4	VDD		
5	VDD		
6	GND	LED driver ground	Note1
7	GND		
8	GND		
9	GND		
10	GND		
11	RSVD	Keep this pin open.	-
12	BRTC	Backlight ON/OFF control	High or Open: Backlight ON Low: Backlight OFF
13	PWM	Luminance control	PWM dimming
14	GND	LED driver ground	Note1

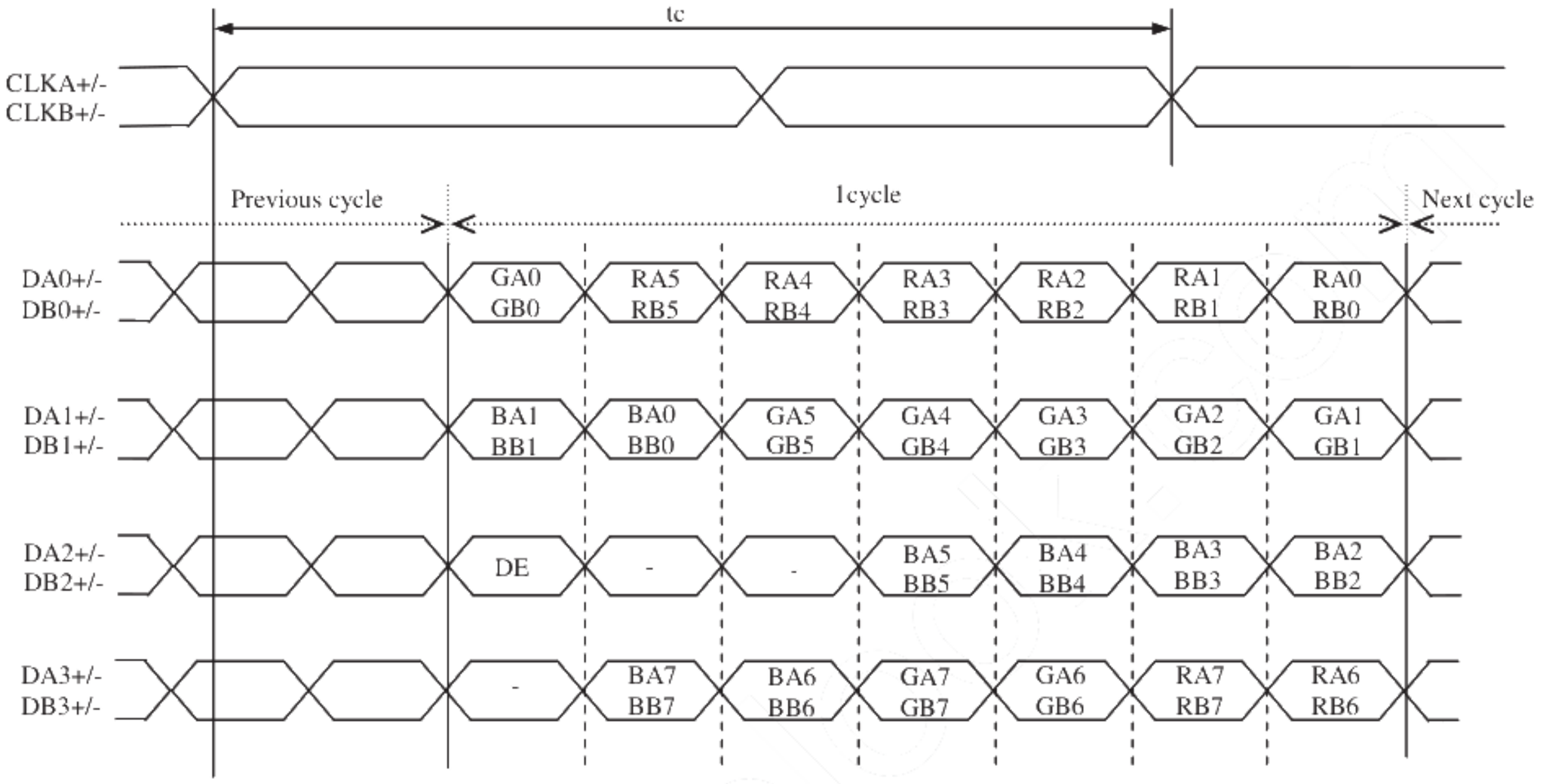
Note1: All VDDB and GNDB terminals should be used without any non-connected lines.

4.5.3 Positions of socket



4.5.4 Input data mapping

(1) Input data signal



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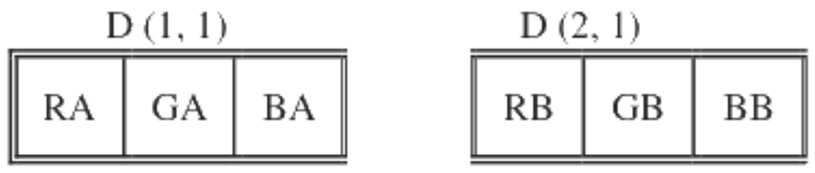
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display equivalent of 16,777,216 colors with 256 gray scales .Also the relation between display colors and input data signals is as follows.

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

4.7 INPUT DATA SIGNALS AND DISPLAY POSITIONS



~~D(1, 1)~~	~~D(2, 1)~~	• • •	D(959, 1)	D(960, 1)	• • •	D(1919, 1)	D(1920, 1)
D(1, 2)	D(2, 2)	• • •	D(959, 2)	D(960, 2)	• • •	D(1919, 2)	D(1920, 2)
• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
D(1, Y)	D(2, Y)	• • •	D(959, Y)	D(960, Y)	• • •	D(1919, Y)	D(1920, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
D(1, 1079)	D(2, 1079)	• • •	D(959, 1079)	D(960, 1079)	• • •	D(1919, 1079)	D(1920, 1079)
D(1, 1080)	D(2, 1080)	• • •	D(959, 1080)	D(960, 1080)	• • •	D(1919, 1080)	D(1920, 1080)

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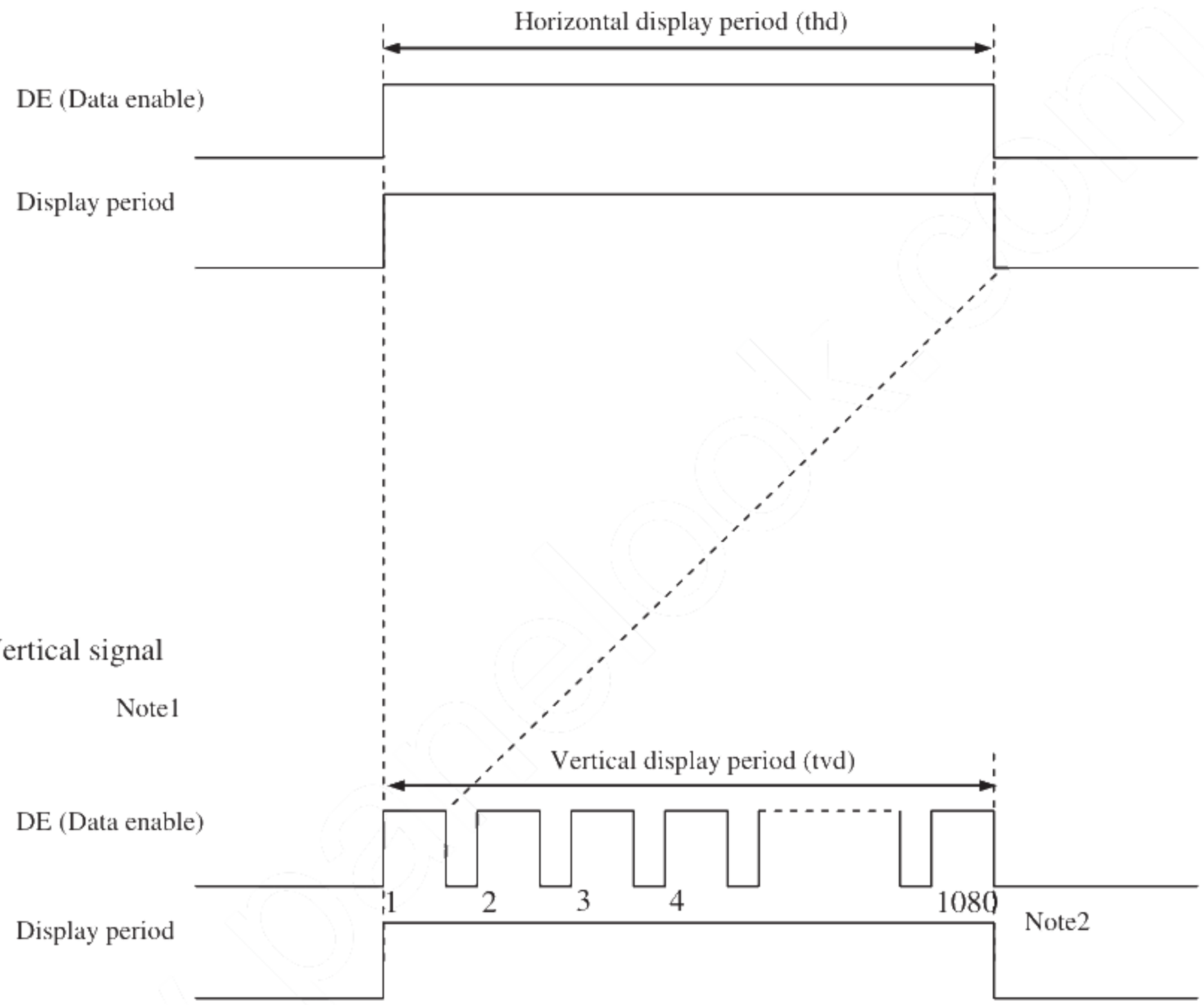
4.8 INPUT SIGNAL TIMINGS

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	(65.0)	74.175	(81.5)	MHz	13.48ns (typ.)
	Duty ratio		-	-			-	-
	Rise time, Fall time		-				ns	
DATA	CLK-DATA	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	(13.19)	14.83	(16.53)	µs	67.43 kHz (typ.)
				(1,075)	1,100	-	CLK	
		Display period	thd	960			CLK	-
	Vertical (One frame)	Cycle	tv	(15.39)	16.68	(18.18)	ms	59.94 Hz (typ.)
				(1,100)	1,125	-	H	
		Display period	tvd	1,080			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).

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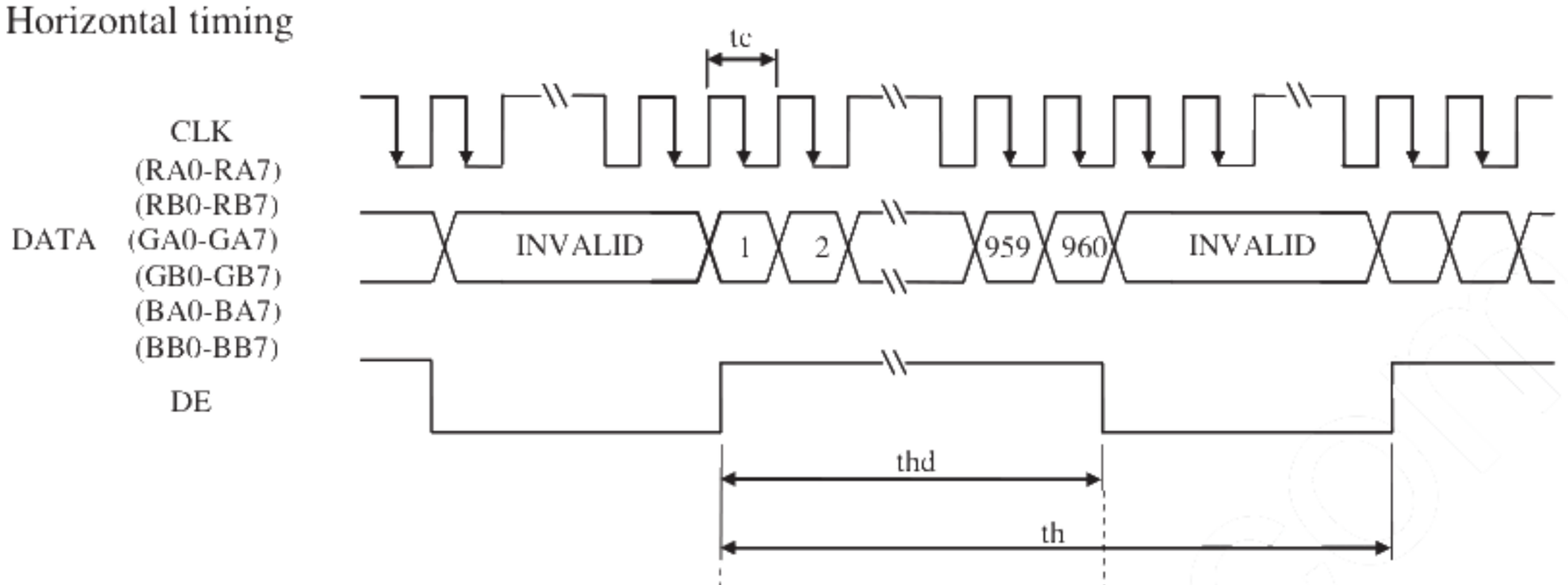
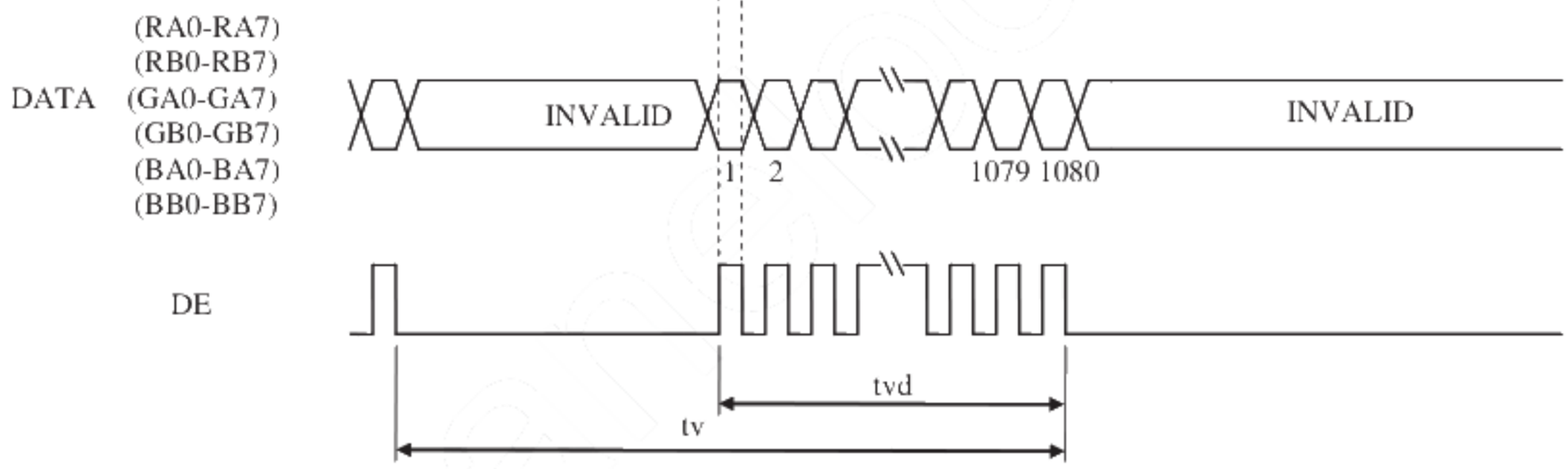
4.8.3 Input signal timing char

Horizontal timing

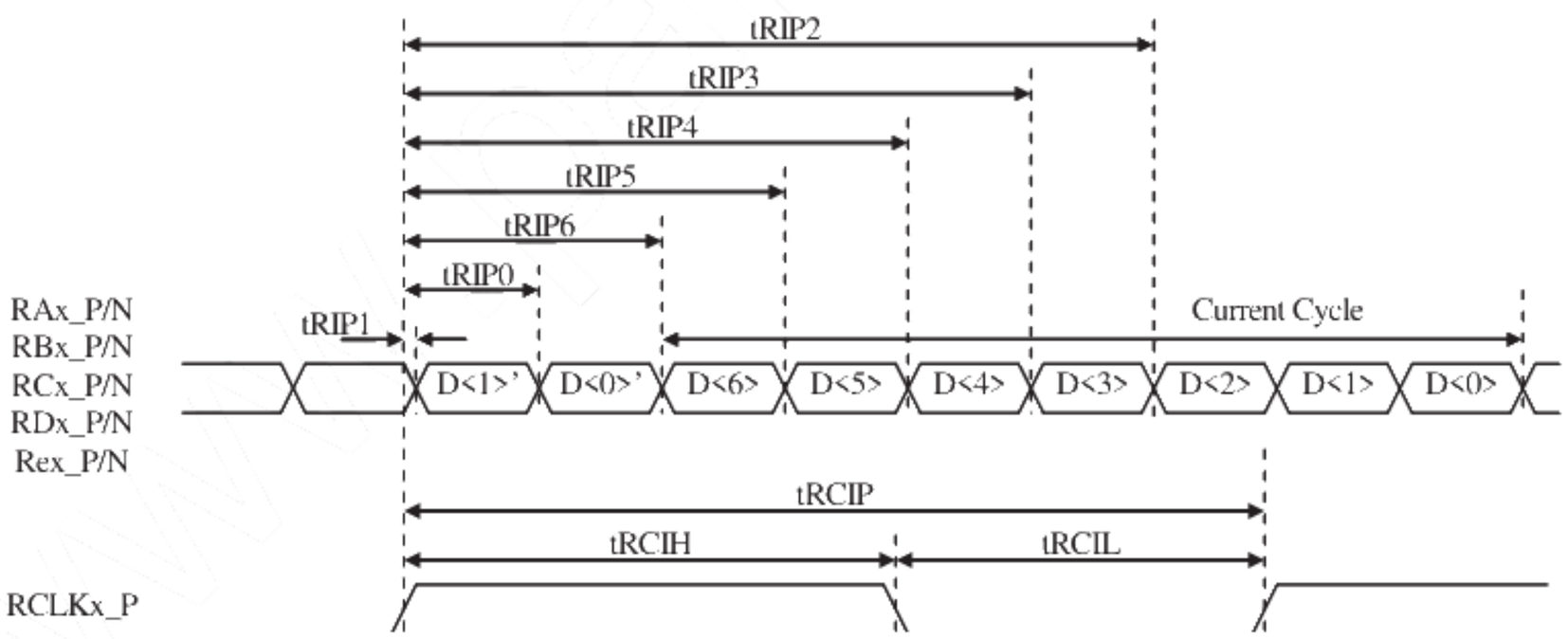


Vertical timing



4.9 LVDS Rx AC SPEC

Symbol	Parameter	min.	typ.	max.	Units
t_{RCIP}	CKy_+ Period	12.27	-	15.38	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= 75MHz	(-0.4)	-	(0.4)	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



4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

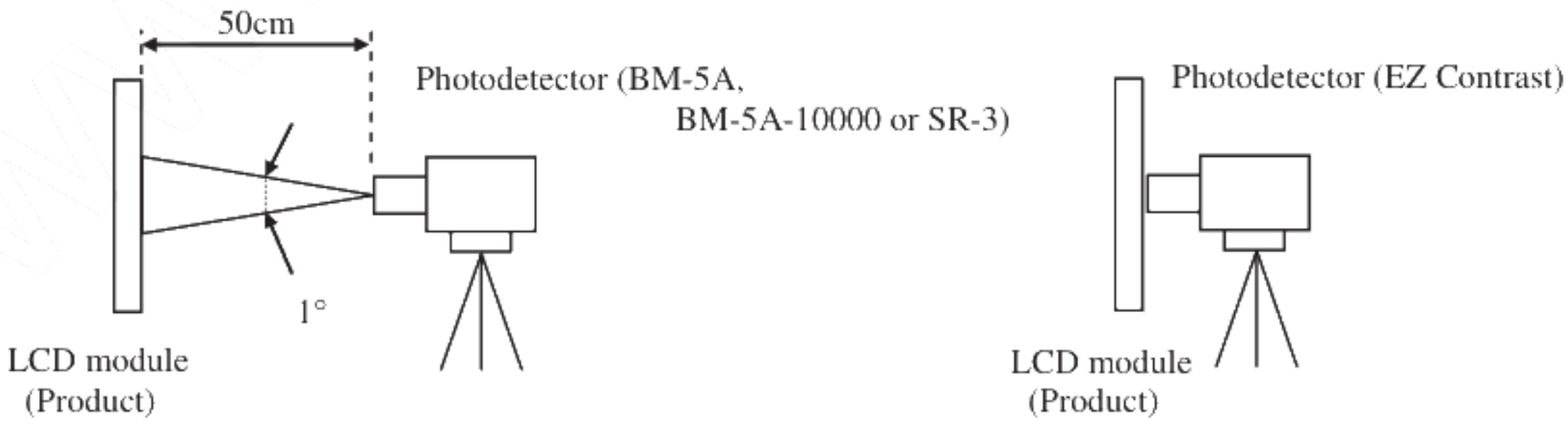
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	(280)	400	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	(500)	750	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	1.4	-	BM-5A	Note4
Chromaticity	White	**x** coordinate	Wx	0.263	0.313	0.363	-	SR-3	Note5
		y coordinate	Wy	0.279	0.329	0.379	-		
	Red	**x** coordinate	Rx	-	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	65	72	-	%		
Response time		Black to White	Ton	-	TBD	TBD	ms	BM-5A -10000	Note6 Note7
		White to Black	Toff	-	TBD	TBD	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	88	-	°	EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	88	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	88	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	88	-	°		

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 3.3V, VDD=12.0V, PWM duty ratio: 100%,
Display mode: FHD, Horizontal cycle= 1/66.6kHz, 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 "**4.10.2 Definition of contrast ratio**".

Note4: See "**4.10.3 Definition of luminance uniformity**".

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

Note6: Product surface temperature: TopF= TBD°C

Note7: See "**4.10.4 Definition of response times**".

Note8: See "**4.10.5 Definition of viewing angles**".

4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

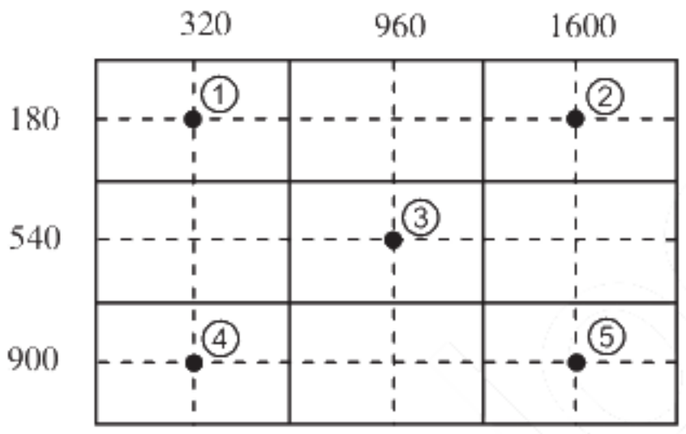
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

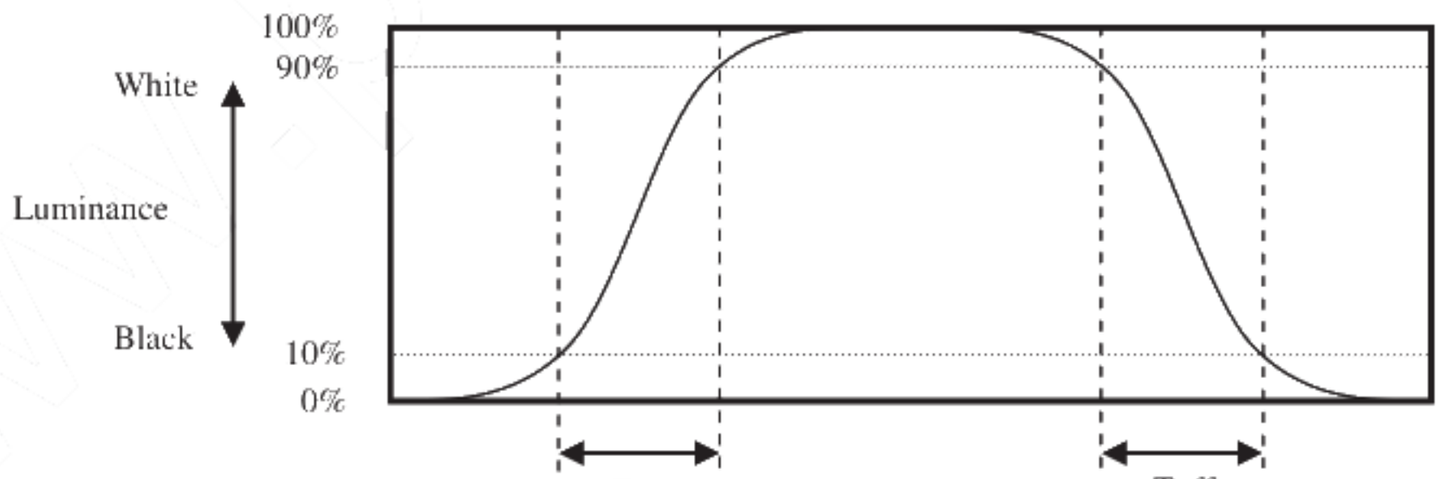
$$\text{Luminance uniformity (LU)} = \frac{\text{Minimum luminance from ① to ⑤}}{\text{Maximum luminance from ① to ⑤}} \quad [\%]$$

The luminance is measured at near the 5 points shown below.

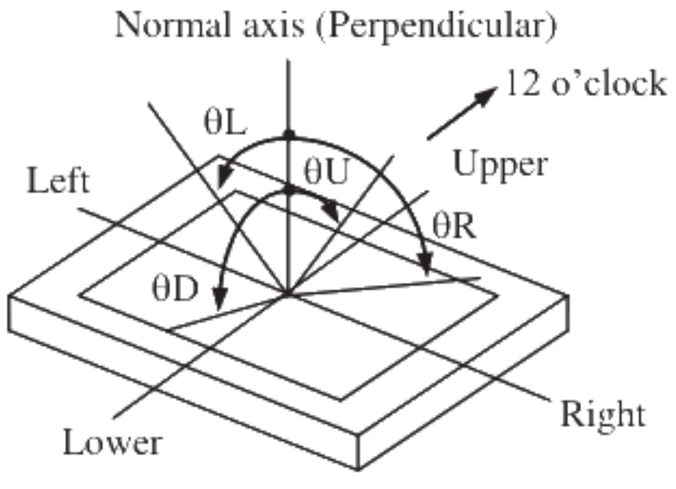


4.10.4 Definition of response times

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.).



4.10.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

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

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

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio:100%	50,000	h
	TBD °C (Temperature at LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio:100%	TBD	

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.

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6. RELIABILITY TESTS

TBD

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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.

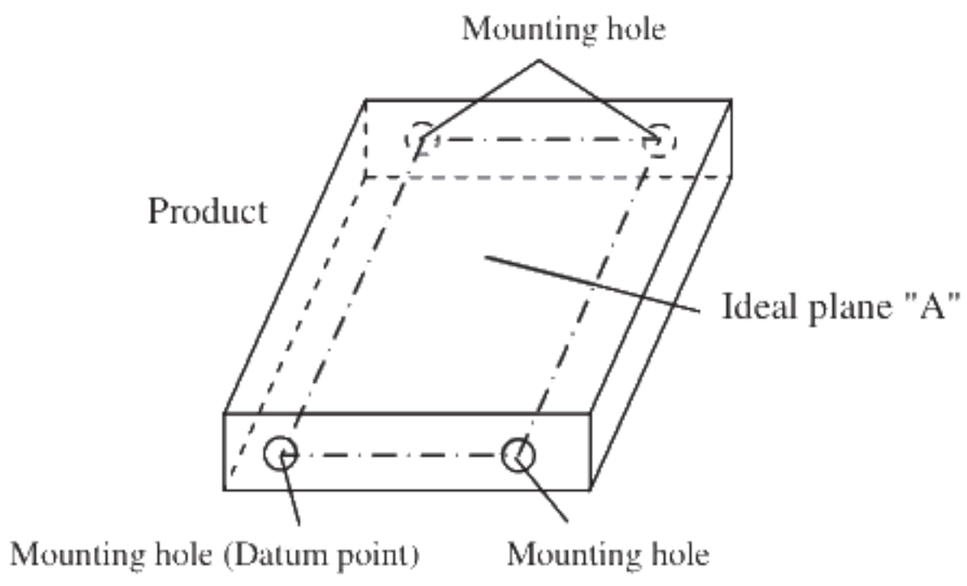
7.2 CAUTIONS

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

7.3 ATTENTIONS

7.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
② When the product is put on the table temporarily, display surface must be placed downward.
③ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
④ The torque for product mounting screws must never exceed 0.23N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be (≤ 2.0mm).
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.
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.



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.

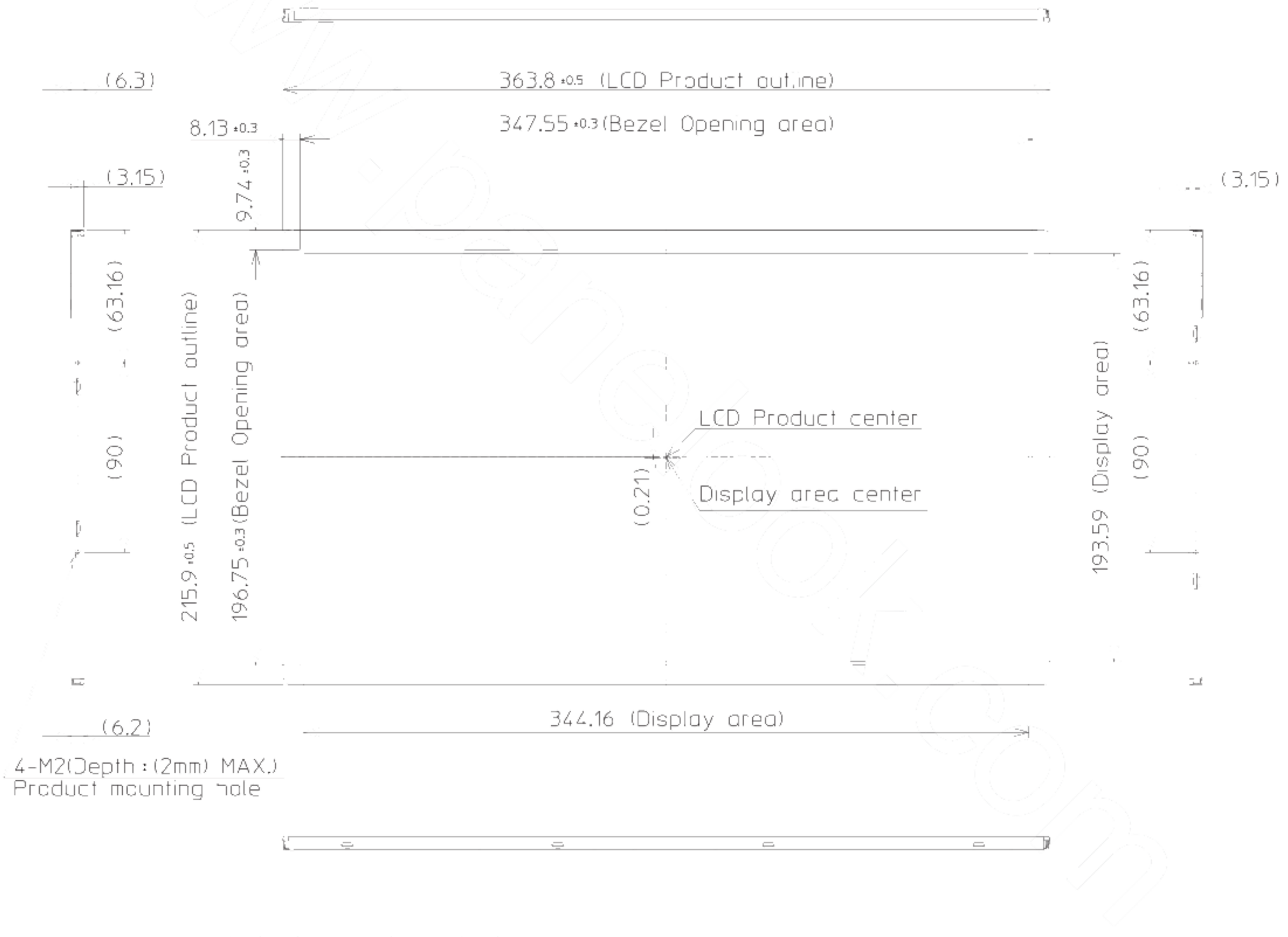
① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough 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 Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT.

8. OUTLINE DRAWINGS

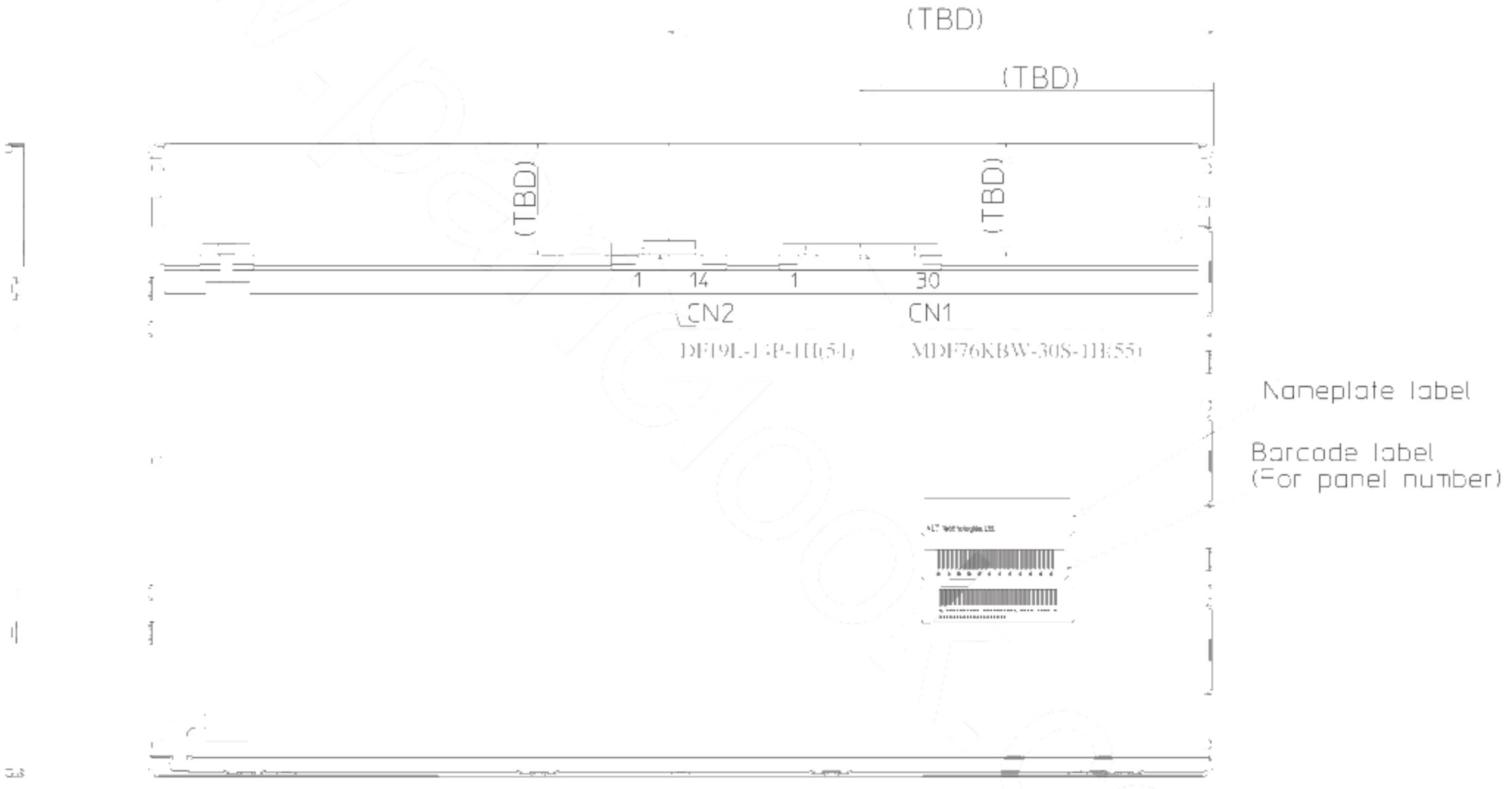
8.1 FRONT VIEW



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.23N·m. And the length of product mounting screws must be (≤ 2.0)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 0.23N-m. And the length of product mounting screws must be (≤ 2.0mm).

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-2162	Aug. 18, 2015	**Revision contents** New issue **Signature of writer** *Approved by* R. KAWASHIMA *Checked by* *Prepared by* E. YOSHIMURA

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