TIANMA ☆

TFT COLOR LCD MODULE

NL6448AC18-11D

14cm (5.7 Type)
VGA
LVDS interface (1port)

DATA SHEET

DOD-PP-2839 (2nd edition)

This DATA SHEET is updated document from DOD-PP-2443(1)

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

INTRODUCTION

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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 NL6448AC18-11D 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

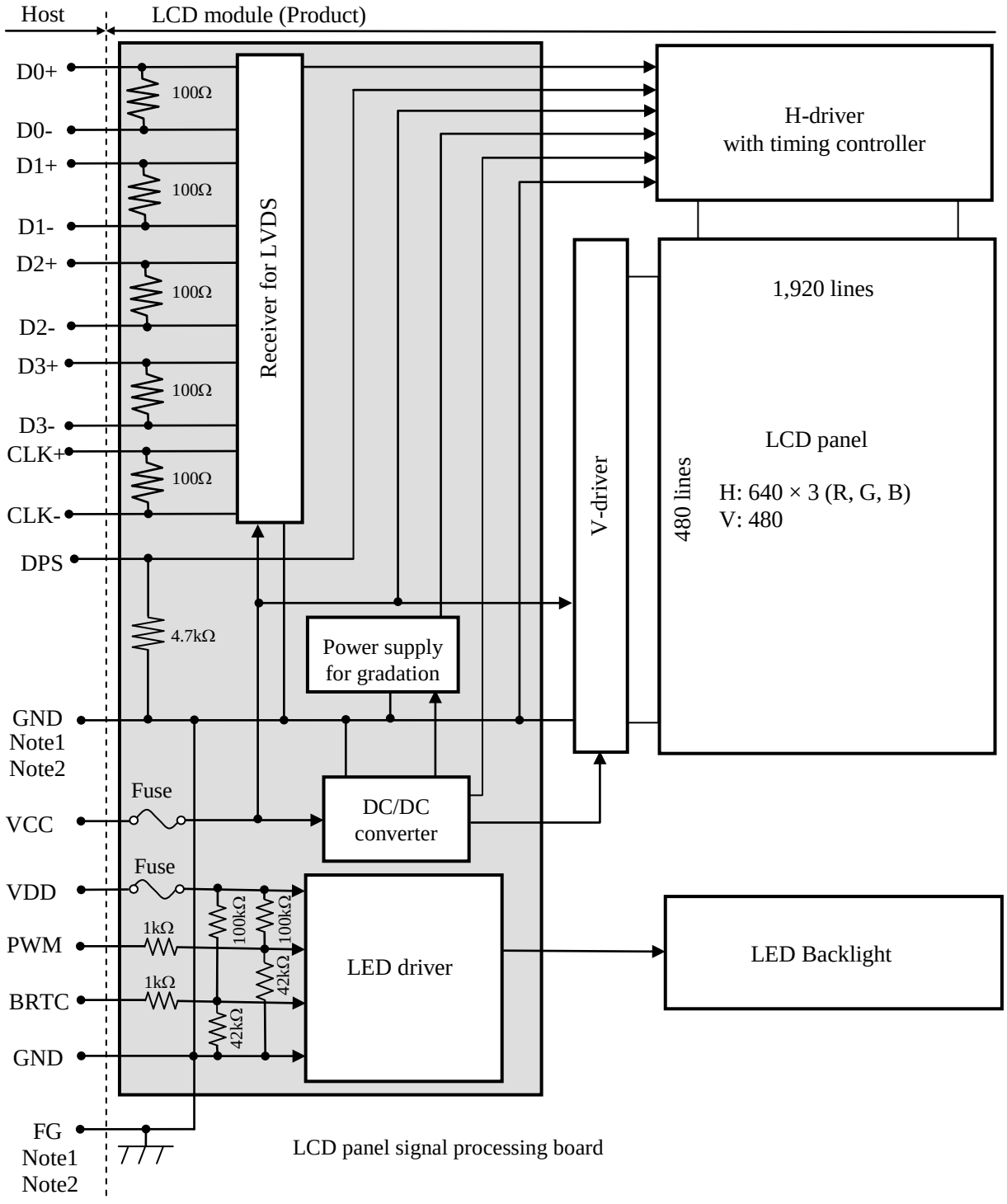
1.3 FEATURES

- Wide viewing angle ☆
- Wide temperature range ☆
- Reversible-scan direction ☆
- LVDS interface
- Long life LED backlight built in LED driver ☆
- Acquisition product for UL60950-1/CSA-C22.2 No.60950-1-03 (File number: E170632)
- Compliant with the European RoHS directive (2011/65/EU)

2. GENERAL SPECIFICATIONS

Display area	115.2 (H) × 86.4 (V) mm
Diagonal size of display	14cm (5.7 inches)
Drive system	a-Si TFT active matrix
Display color	16,194,277 colors
Pixel	640 (H) × 480 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.06 (H) × 0.18 (V) mm
Pixel pitch	0.18 (H) × 0.18 (V) mm
Module size	144.0 (W) × 104.6 (H) × 12.3 (D) mm (typ.)
Weight	150 g (typ.)
Contrast ratio	900:1 (typ.)
Viewing angle	*At the contrast ratio ≥ 10:1* • Horizontal: Right side 80° (typ.), Left side 80° (typ.) • Vertical: Up side 80° (typ.), Down side 80° (typ.)
Designed viewing direction	*At DPS= Low or Open: Normal scan* • Viewing direction without image reversal: Down side (6 o'clock) • Viewing direction with contrast peak: Up side (12 o'clock) • Viewing angle with optimum grayscale (γ≒ 2.2): Normal axis (perpendicular)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 50% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→ 90%)* 18ms (typ.)
Luminance	*At the maximum luminance control* 550cd/m^2 (typ.)
Signal system	LVDS interface (1port) 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* 2.4 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	144.0 ± 0.5 (W) × 104.6 ± 0.5 (H) × 12.3± 0.5 (D) Note1	mm
Display area	115.2 (H) × 86.4(V) Note1	mm
Weight	150 (typ.), 165 (max.)	g

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

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter			Symbol	Rating	Unit	Remarks	
Power supply voltage	LCD panel signal processing board		VCC	-0.3 to +5.0	V	Ta = 25°C	
	LED driver		VDD	-0.3 to +15.0			
Input voltage for signals	LCD panel signal processing board	Display signals Note1	VD	-0.3 to VCC+0.3	V		
		Function signals Note2	VF				
	LED driver		PWM	-0.3 to +5.5	V		
			BRTC	-0.3 to +VDD+0.1	V		
Storage temperature			Tst	-30 to +85	°C	-	☆
Operating temperature		Front surface	TopF	-30 to +85	°C	Note3	☆
		Rear surface	TopR	-30 to +85	°C	Note4	☆
Relative humidity Note5			RH	≤ 95	%	Ta ≤ 40°C	
				≤ 85	%	40°C < Ta ≤ 50°C	
				≤ 55	%	50°C < Ta ≤ 60°C	
				≤ 36	%	60°C < Ta ≤ 70°C	
				≤ 24	%	70°C < Ta ≤ 80°C	
				≤ 20	%	80°C < Ta ≤ 85°C	☆
Absolute humidity Note5			AH	≤ 70 Note6	g/m^3	Ta= 85°C	☆

Note1: D0+/-, D1+/-, D2+/-, D3+/-, CLK+/-
Note2: DPS
Note3: Measured at LCD panel surface (including self-heat)
Note4: Measured at LCD module's rear shield surface (including self-heat)
Note5: No condensation
Note6: Water amount at Ta= 85°C and RH= 20% ☆

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C, Note1)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VCC	3.0	3.3	3.6	V	-
Power supply current		ICC	-	180 Note2	270 Note3	mA	at VCC= 3.3V
Permissible ripple voltage		VRPC	-	-	100	mVp-p	for VCC Note4, Note5, Note6
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2 V Note7
	Low	VTL	-100	-	-		
Terminating resistance		RT	-	100	-	Ω	-
Input voltage for DPS signal	High	VFH	0.7VCC	-	VCC	V	CMOS level
	Low	VFL	0	-	0.3VCC		
Input current for DPS signal	High	IFH	-	-	800	μA	-
	Low	IFL	-800	-	-		

Note1: When designing of the power supply, take the measures for the prevention of surge voltage. ☆
Note2: Checkered flag pattern [by IEC 61747-6]
Note3: Pattern for maximum current
Note4: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.
Note5: The permissible ripple voltage includes spike noise.
Note6: The load variation influence does not include.
Note7: Common mode voltage for LVDS receiver

4.3.2 LED driver

(Ta= 25°C, Note1) ☆

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	-
Power supply current		IDD	-	150	190 Note2	mA	at VDDB= 12.0V, at the maximum luminance control ☆
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD Note3, Note4, Note5
Input voltage for PWM signal	High	VDFH1	2.0	-	5.3	V	Note6
	Low	VDFL1	-	-	0.8	V	
Input voltage for BRTC signal	High	VDFH2	2.0	-	VDD	V	
	Low	VDFL2	-	-	0.8	V	
Input current for PWM signal	High	IDFH1	-	-	300	μA	Note6
	Low	IDFL1	-300	-	-	μA	
Input current for BRTC signal	High	IDFH2	-	-	500	μA	
	Low	IDFL2	-500	-	-	μA	
PWM frequency		f_{PWM}	200	-	10k	Hz	Note7, Note8
PWM duty ratio		DR_{PWM}	1	-	100	%	Note9, Note10
PWM pulse width		tPWH	1	-	-	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: This product works even if the ripple voltage levels are over the permissible values, but there might be noise on the display image.
Note4: The permissible ripple voltage includes spike noise.
Note5: 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.
Note6: See "**3. BLOCK DIAGRAM**".
Note7: A recommended f_{PWM} value is as follows.

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

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

Note8: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.
Note9: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than minimum value. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.
Note10: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

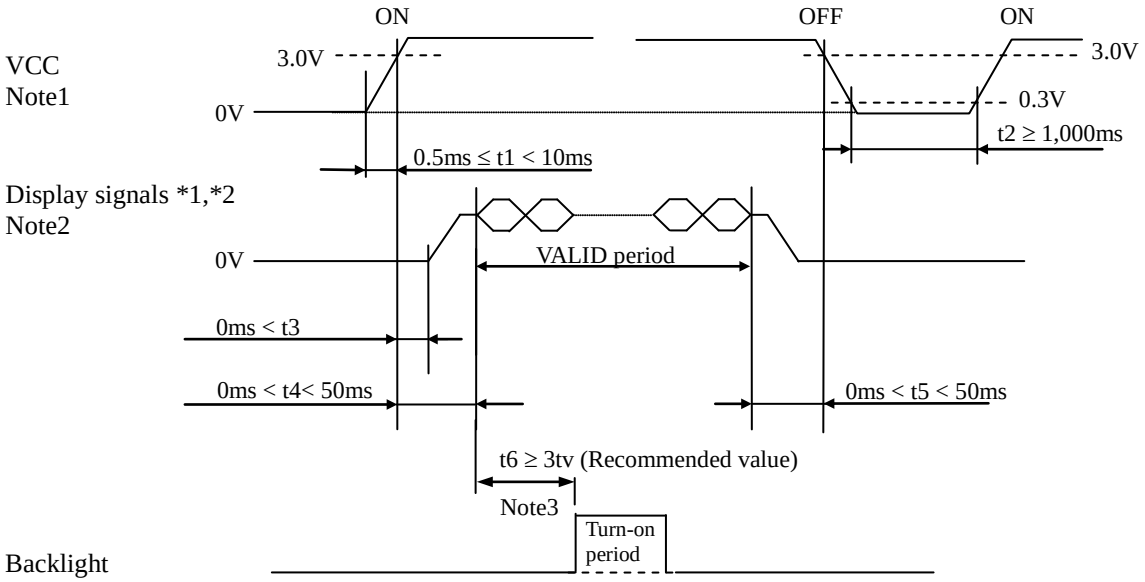
4.3.3 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC CO.,LTD	1.5A 36V	3.0A	Note1
VDD	FCC16152AB	KAMAYA ELECTRIC CO.,LTD	1.5A 36V	3.0A	

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 signal processing board



*1 D0+/-, D1+/-, D2+/-, D3+/-, CLK+/-

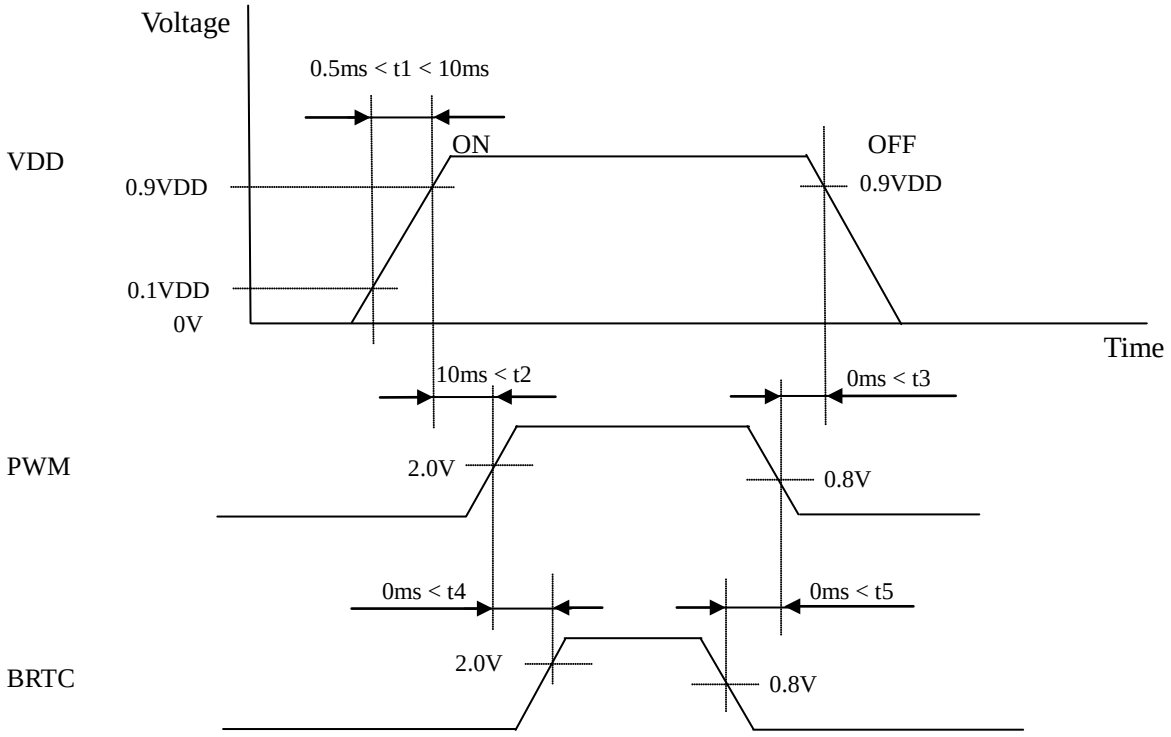
*2 These signals should be measured at the terminal of 100Ω resistance.

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

Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-) and function signals (DPS) 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.

Note3: In order to avoid unstable data display, the backlight is recommended to turn on within the valid of display and function signals.
Recommended value: t6 ≥ 3tv
(tv is vertical cycle (Please refer to 4.9.2 Timing characteristics.))

4.4.2 LED driver



Note1: 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): FI-SE20P-HFE (Japan Aviation Electronics Industry Limited (JAE))
Adaptable plug: FI-S20S (Japan Aviation Electronics Industry Limited (JAE))

Pin No.	Symbol	Signal	Remarks
1	D3+	Pixel data (R6-R7,G6-G7,B6-B7)	Note2, Note4
2	D3-		
3	DPS	Selection of scan direction	High : Reverse scan Low or Open : Normal scan Note3
4	N.C.	-	Keep this pin Open.
5	GND	Ground	Note1
6	CLK+	Pixel clock	Note2
7	CLK-		
8	GND	Ground	Note1
9	D2+	Pixel data (B2-B5,DE)	Note2, Note4
10	D2-		
11	GND	Ground	Note1
12	D1+	Pixel data (G1-G5,B0-B1)	Note2, Note4
13	D1-		
14	GND	Ground	Note1
15	D0+	Pixel data (R0-R5,G0)	Note2, Note4
16	D0-		
17	GND	Ground	Note1
18	GND		
19	VCC	Power supply	Note1
20	VCC		

Note1: All GND and VCC terminals should be used without any non-connected lines.
Note2: See "**4.6 DISPLAY COLORS AND INPUT DATA SIGNALS**".
Note3: See "**4.8 SCANNING DIRECTIONS**".
Note4: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

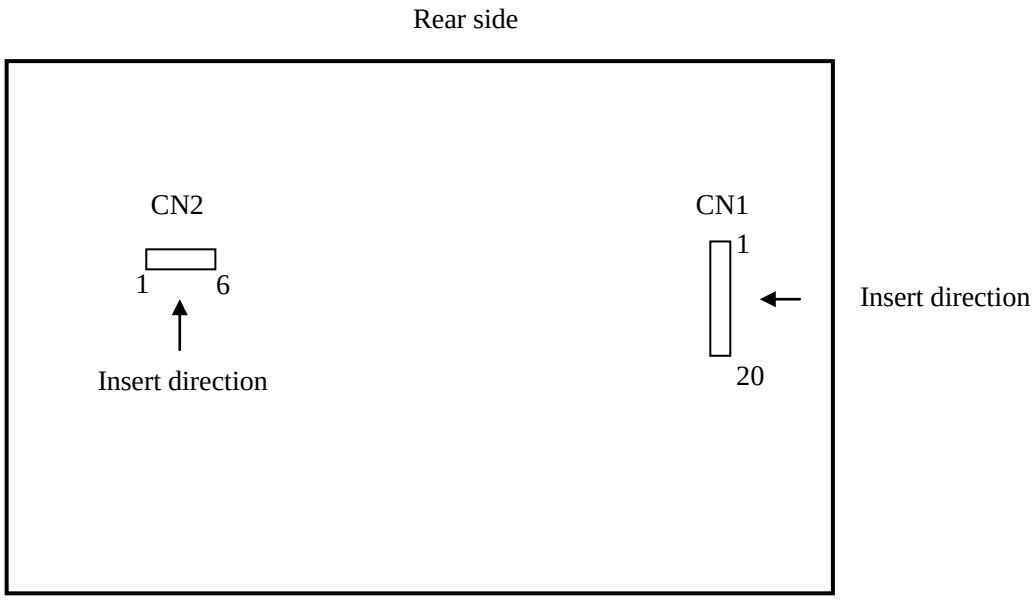
4.5.2 LED driver

CN2 socket (LCD module side): SM06B-SRSS-TB(LF)(SN) (JST Co. Ltd)
Adaptable plug: SHR-06V-S-B (JST Co. Ltd)

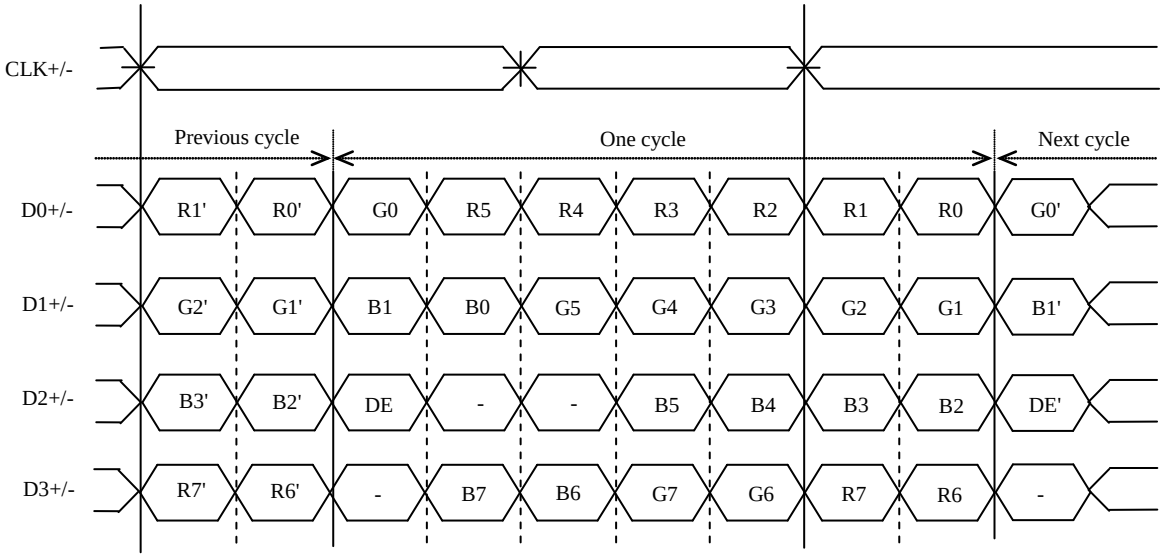
Pin No.	Symbol	Function	Remarks
1	VDD	Power supply	Note1
2	VDD	Power supply	
3	GND	Ground	
4	GND	Ground	
5	PWM	Luminance control	PWM Dimming Open: Max. Luminance
6	BRTC	Backlight ON/OFF control	High or Open: Backlight ON Low: Backlight OFF

Note1: All VDD and GND terminals should be used without any non-connected lines. ☆

4.5.3 Positions of socket



4.5.4 Input data mapping



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.

4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display 16,194,277 colors with 253 gray scales. Also the relation between display colors and input data signals is as follows.

(Note1)

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	x	x
	Red	1	1	1	1	1	1	x	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	x	x	0	0	0	0	0	0	0	0	1	1	1	1	1	1	x	x
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	x	x	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	x	x	1	1	1	1	1	1	x	x
	Yellow	1	1	1	1	1	1	x	x	1	1	1	1	1	1	x	x	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	x	x	1	1	1	1	1	1	x	x	1	1	1	1	1	1	x	x
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	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	x	x	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	0	1	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	x	x	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	0	1	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	x	x

Note1: X means 0 or 1.

4.7 DISPLAY POSITIONS

D (1, 1)

R	G	B

D(1, 1)	D(2, 1)	· · ·	D(X, 1)	· · ·	D(639, 1)	D(640, 1)
D(1, 2)	D(2, 2)	· · ·	D(X, 2)	· · ·	D(639, 2)	D(640, 2)
. . .	. . .	. . .	. . .	. . .	. . .	. . .
D(1, Y)	D(2, Y)	· · ·	D(X, Y)	· · ·	D(639, Y)	D(640, Y)
. . .	. . .	. . .	. . .	. . .	. . .	. . .
D(1, 479)	D(2, 479)	· · ·	D(X, 479)	· · ·	D(639, 479)	D(640, 479)
D(1, 480)	D(2, 480)	· · ·	D(X, 480)	· · ·	D(639, 480)	D(640, 480)

Note1: See "**4.8 SCANNING DIRECTIONS**".

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.

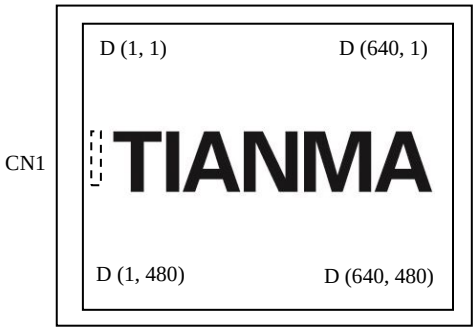


Figure1. Normal scan (DPS: Low or Open)

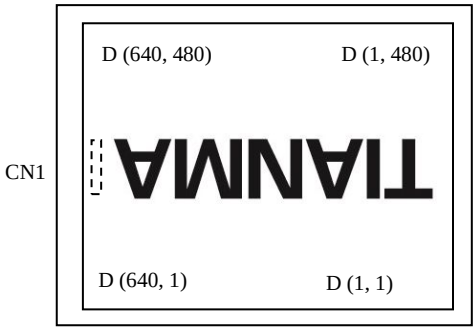


Figure2. Reverse scan (DPS:High)

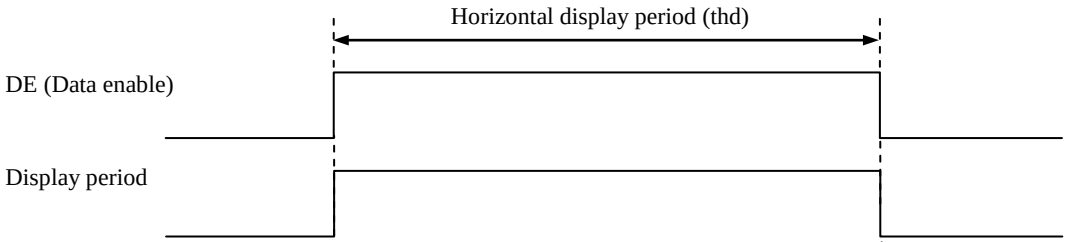
Note1: Meaning of D (X, Y)
D (X, Y):Input data signals for LCD panel signal processing board

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

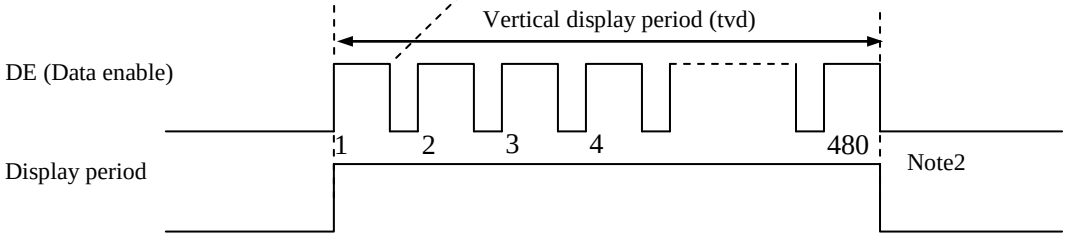
- Horizontal signal

Note1



- Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

4.9.2 Timing characteristics

(Note1, Note2, Note3)

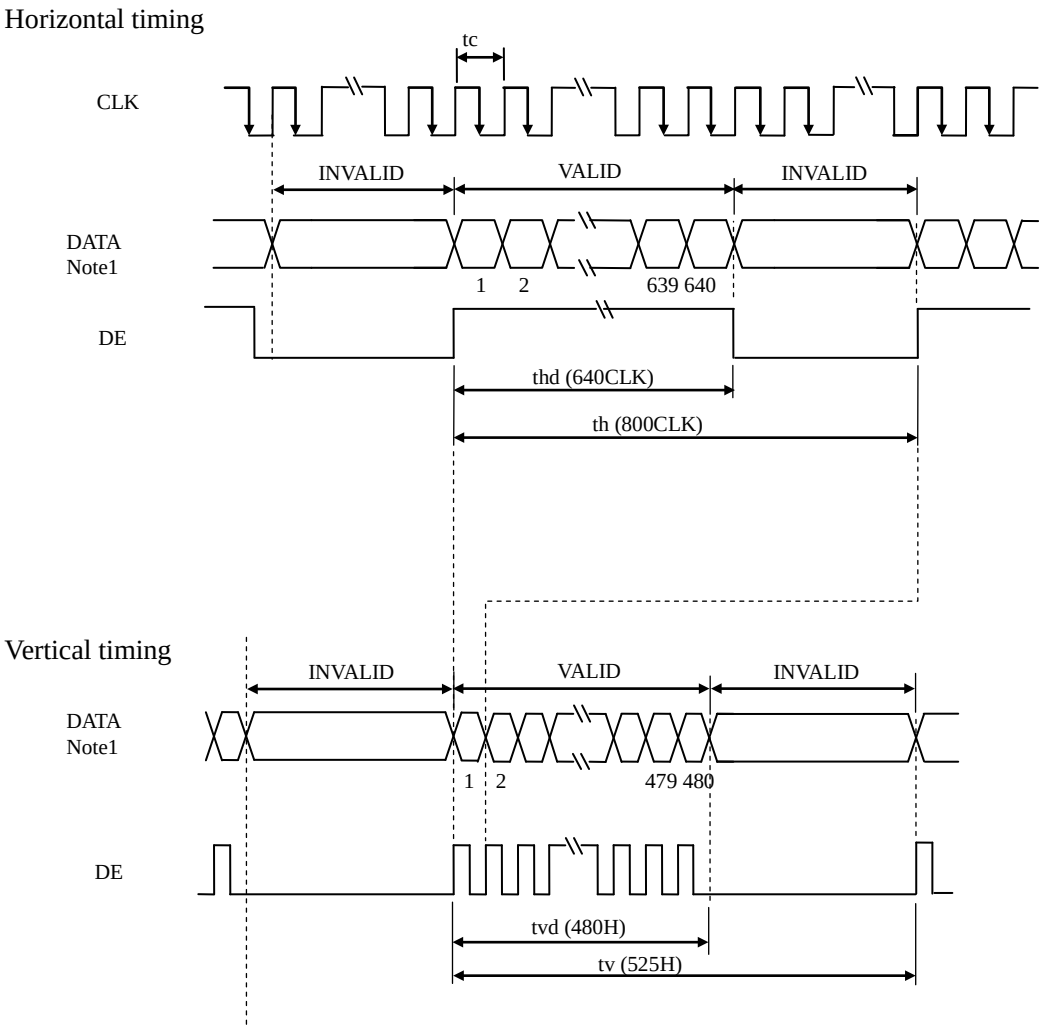
Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	24.8	25.2	34.2	MHz	39.68ns (typ.)
	Duty ratio		-	-			-	-
DATA (R0-R7) (G0-G7) (B0-B7)	CLK-DATA	Setup time	-	-			ns	-
		Hold time	-				ns	
DE	Horizontal	Cycle	th	29.240	31.746	32.258	μs	31.5 kHz (typ.)
				800	800	1,000	CLK	
		Display period	thd	640			CLK	-
	Vertical (One frame)	Cycle	tv	15.351	16.667	16.935	ms	60.0 Hz (typ.)
				516	525	570	H	
		Display period	tvd	480			H	-
	CLK-DE	Setup time	-	-			ns	-
		Hold 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).

4.9.3 Input signal timing chart

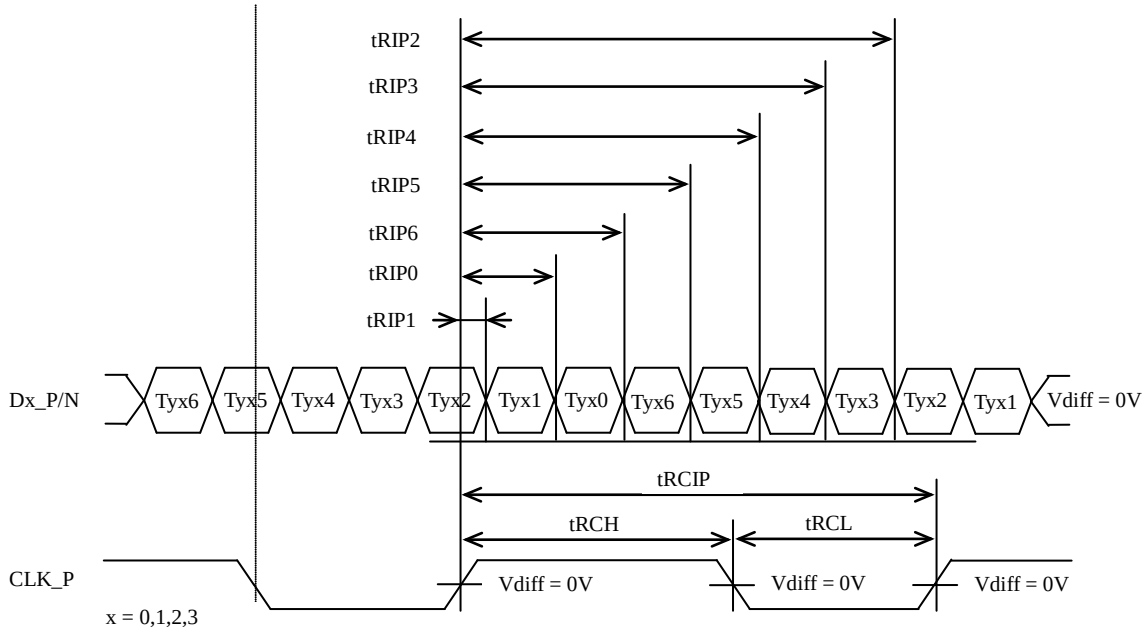


Note1: DATA = R0-R7, G0-G7, B0-B7

4.10 LVDS Rx AC SPEC

Symbol	Parameter	min.	typ.	max.	Units
t_{RCIP}	CKy_+ Period	29.24	-	40.32	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	-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

☆



4.11 OPTICS

4.11.1 Optical characteristics

(Note1, Note2)

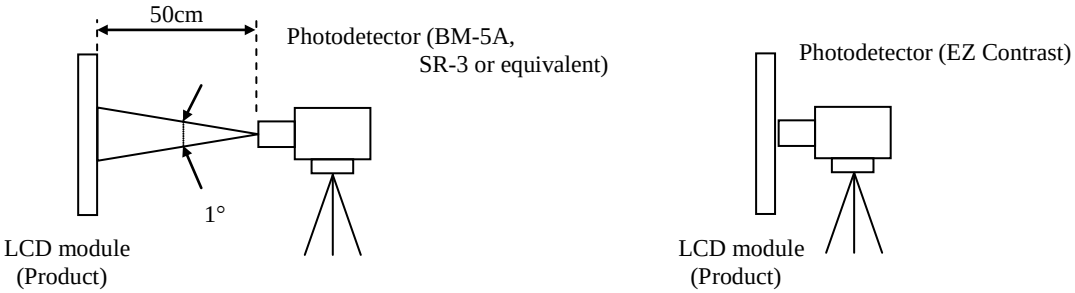
Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°,θU= 0°,θD= 0°	L	400	550	-	cd/m^2	BM-5A or equivalent	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°,θU= 0°,θD= 0°	CR	500	900	-	-	BM-5A or equivalent	Note3
Luminance uniformity		White θR= 0°, θL= 0°,θU= 0°,θD= 0°	LU	-	1.25	1.4	-	BM-5A or equivalent	Note4
Chromaticity	White	**x** coordinate	Wx	0.263	0.313	0.363	-	SR-3 or equivalent	Note5
		y coordinate	Wy	0.279	0.329	0.379	-		
	Red	**x** coordinate	Rx	-	0.605	-	-		
		y coordinate	Ry	-	0.348	-	-		
	Green	**x** coordinate	Gx	-	0.328	-	-		
		y coordinate	Gy	-	0.576	-	-		
	Blue	**x** coordinate	Bx	-	0.144	-	-		
		y coordinate	By	-	0.120	-	-		
Color gamut		θR= 0°, θL= 0°,θU= 0°,θD= 0° at center, against NTSC color space	C	45	50	-	%		
Response time		White to Black	Ton	-	3	5	ms	BM-5A or equivalent	Note6 Note7
		Black to White	Toff	-	15	21	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	80	-	°	EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	80	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	80	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	80	-	°		

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta = 25°C, VCC = 3.3V, VDD = 12.0V, PWM duty ratio: 100%,
Display mode: VGA, Horizontal cycle = 1/31.5kHz, Vertical cycle = 1/60.0Hz,
DPS= Low or Open: Normal scan

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



Note3: See "**4.11.2 Definition of contrast ratio**".

Note4: See "**4.11.3 Definition of luminance uniformity**".

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

Note6: Product surface temperature: TopF= 28°C

Note7: See "**4.11.4 Definition of response times**".

Note8: See "**4.11.5 Definition of viewing angles**".

4.11.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

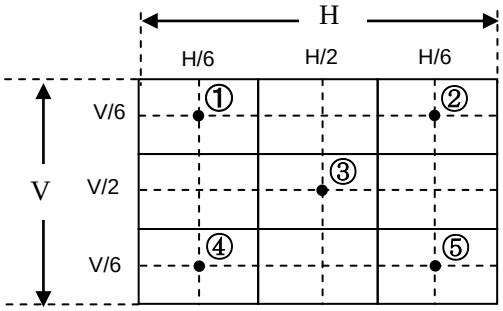
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.11.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

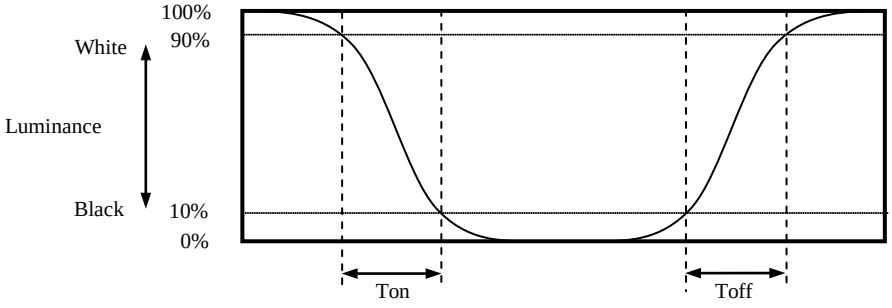
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

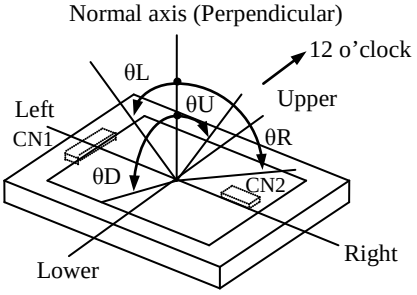


4.11.4 Definition of response times

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.).



4.11.5 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	☆
	85°C (Temperature of LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio: 100%	40,000		☆

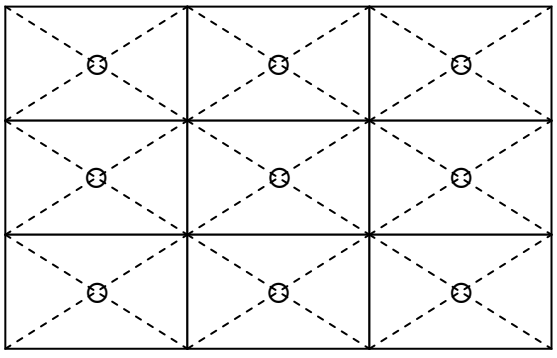
Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment,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

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature (Operation)	① +85 ± 3°C, 240 hours ② Display data is black.	No display malfunctions (The polarizer discoloration is allowed. But no peeling the polarizer off is recognized.)
Heat cycle (Operation)	① -30 ± 3°C…1 hour +85 ± 3°C…1 hour ② 50 cycles, 4 hours/cycle ③ Display data is black.	
Thermal shock (Non operation)	① -30 ± 3°C…30 minutes +85 ± 3°C…30 minutes ② 100cycles, 1 hour/cycle ③ Temperature transition time is within 5 minutes.	
High temperature and humidity (Operation)	① +60 ± 2°C, RH= 90%, 240 hours ② Display data is black.	No display malfunctions
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note2 ③ 10 times each place at 1 sec interval	
Dust (Operation)	① Sample dust: No. 15 (by JIS-Z8901) ② 15 seconds stir ③ 8 times repeat at 1 hour interval	
Vibration (Non operation)	① 5 to 100Hz, 19.6m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 120 times each direction	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 539m/s^2, 11ms ② ±X, ±Y, ±Z directions ③ 5 times each direction	

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 539m/s^2 and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N (ϕ16mm jig))**

7.3 ATTENTIONS 

7.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.
③ When the product is put on the table temporarily, display surface must be placed downward.
④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
⑤ The torque for product mounting screws must never exceed 0.200 N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 3.5 mm.
⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
⑦ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
⑧ Do not push or pull the interface connectors while the product is working.
⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
⑩ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
③ Do not operate in high magnetic field. If not, circuit boards may be broken.
④ This product is not designed as radiation hardened.

7.3.3 Characteristics

The following items are neither defects nor failures.

① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
⑤ Optical characteristics may be changed depending on input signal timings.

7.3.4 Others

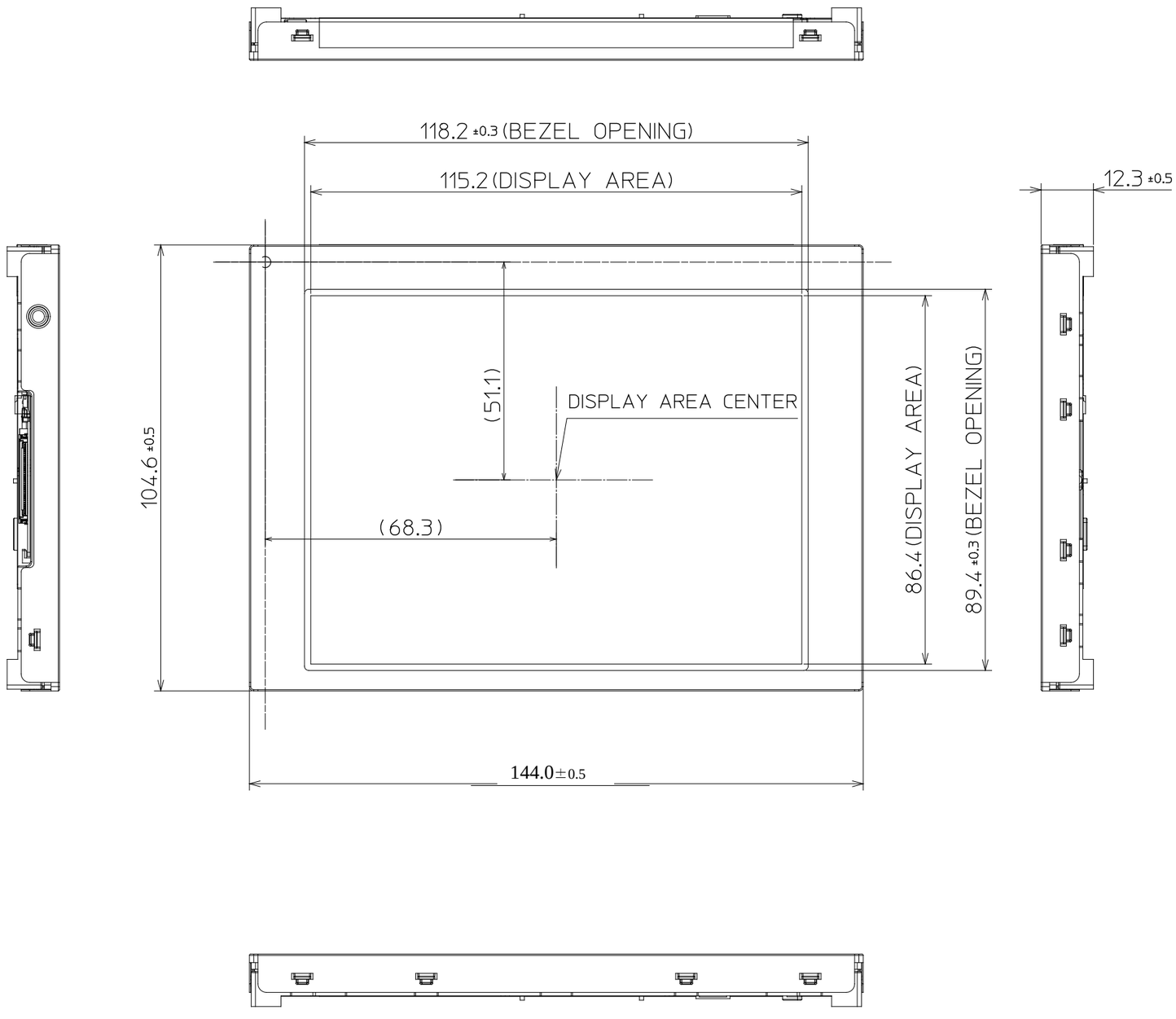
① All GND, VCC and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to TMJ.
④ Pay attention not to enter foreign materials inside of the product, when using tapping screws.
⑤ The information of China RoHS (Ⅱ) six hazardous substances or elements in this product is as follows.

China RoHS (Ⅱ) six hazardous substances or elements					
Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenys (PBB)	Polybrominated Biphenyl Ethers (PBDE)
×	○	○	○	○	○

Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of GB/T26572-2011 standard regulation.
×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of GB/T26572-2011 standard regulation.

8. OUTLINE DRAWINGS

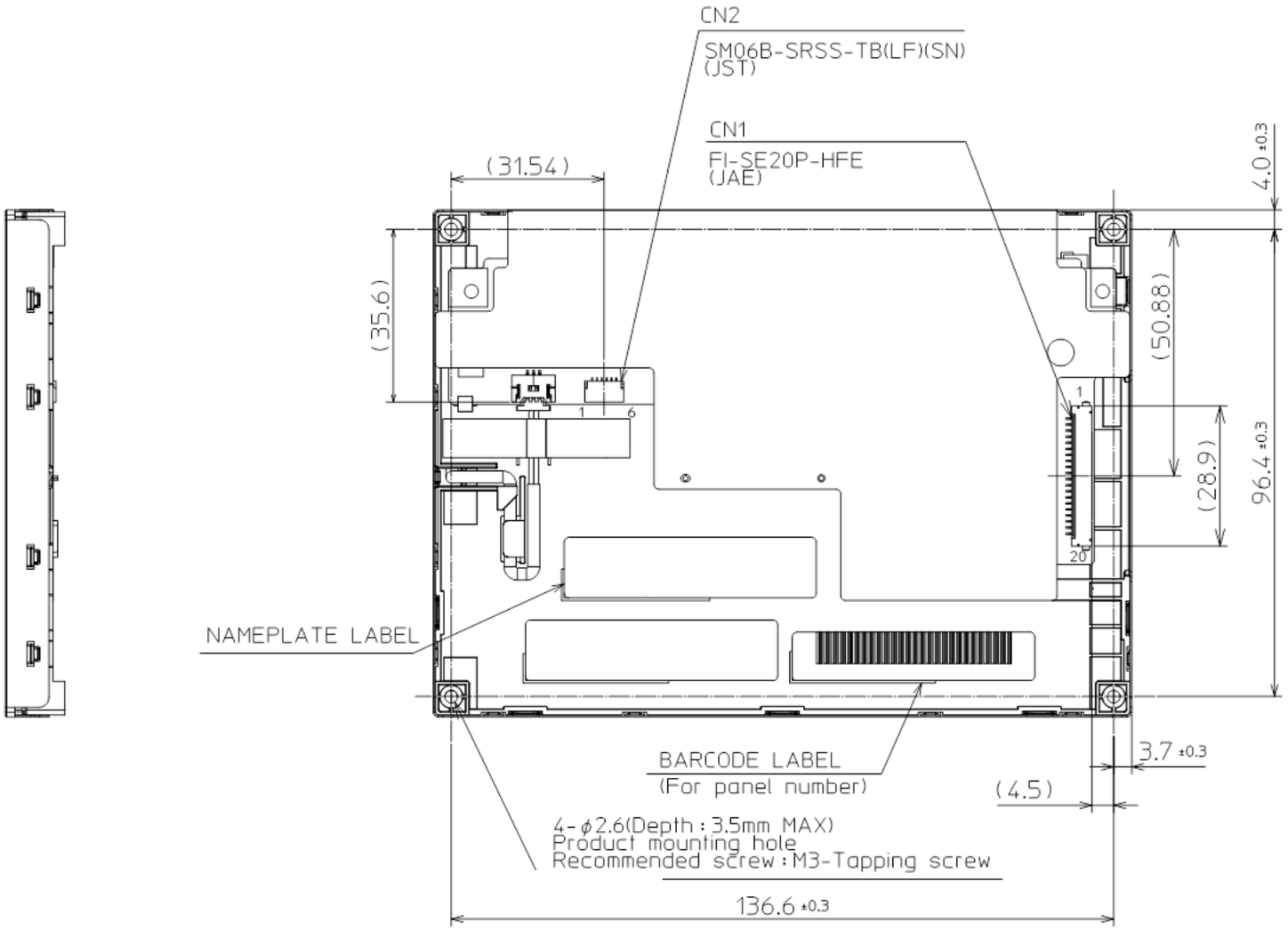
8.1 FRONT VIEW



Unit: mm

Note1: The values in parentheses are for reference.

8.2 REAR VIEW



Unit: mm

Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.200 N·m. And the length of product mounting screws must be ≤ 3.5 mm.