NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL128102AC31-02

51cm (20.1 Type)
SXGA

DATA SHEET

DOD-PD-0228 (1st edition)

This DATA SHEET is updated document from DOD-M-0310(2).

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

INTRODUCTION

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Specific: Military systems, aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems (medical equipment, etc.) and any other equipment

The quality grade of this product is "***Standard***" unless otherwise specified in this document. If customers intend to use this product for applications other than those specified for "***Standard***" quality grade, they should contact NEC sales representative in advance.

CONTENTS

1. OUTLINE

NL128102AC31-02 is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) comprising amorphous silicon TFT attached to each signal electrode, a driving circuit and a backlight with an inverter.

This product has a 51cm (20.1 inches) display area by a diagonal, and contains 1280×1024 pixels in it. Also it can display 16,777,216 colors.

2. FEATURES

- Ultra-wide viewing angle (with lateral electric field)
- Low reflection
- LVDS interface
- High luminance
- Wide color gamut
- Incorporated direct type backlight (twelve lamps in backlight unit with an inverter)
- Replaceable backlight unit (part No.: 201LHS02)
- Replaceable inverter (part No.: 201PW021)
- Acquisition product for UL1950 3rd edition/CSA C22.2 No.950-95 (File number: E170632)

3. APPLICATION

- EWS monitors
- Monitors for CAD system

4. PRINCIPLE AND STRUCTURE

A color TFT (thin film transistor) LCD module is composed of a TFT liquid crystal panel structure, LSIs for driving the TFT array, and a backlight assembly. The TFT liquid crystal panel structure is injected liquid crystal material into the narrow gap between a TFT array glass substrate and a color filter glass substrate. Also, LCD module is connected the driver LSIs with a TFT liquid crystal panel structure, and then the backlight assembly is attached to the backside of the panel.

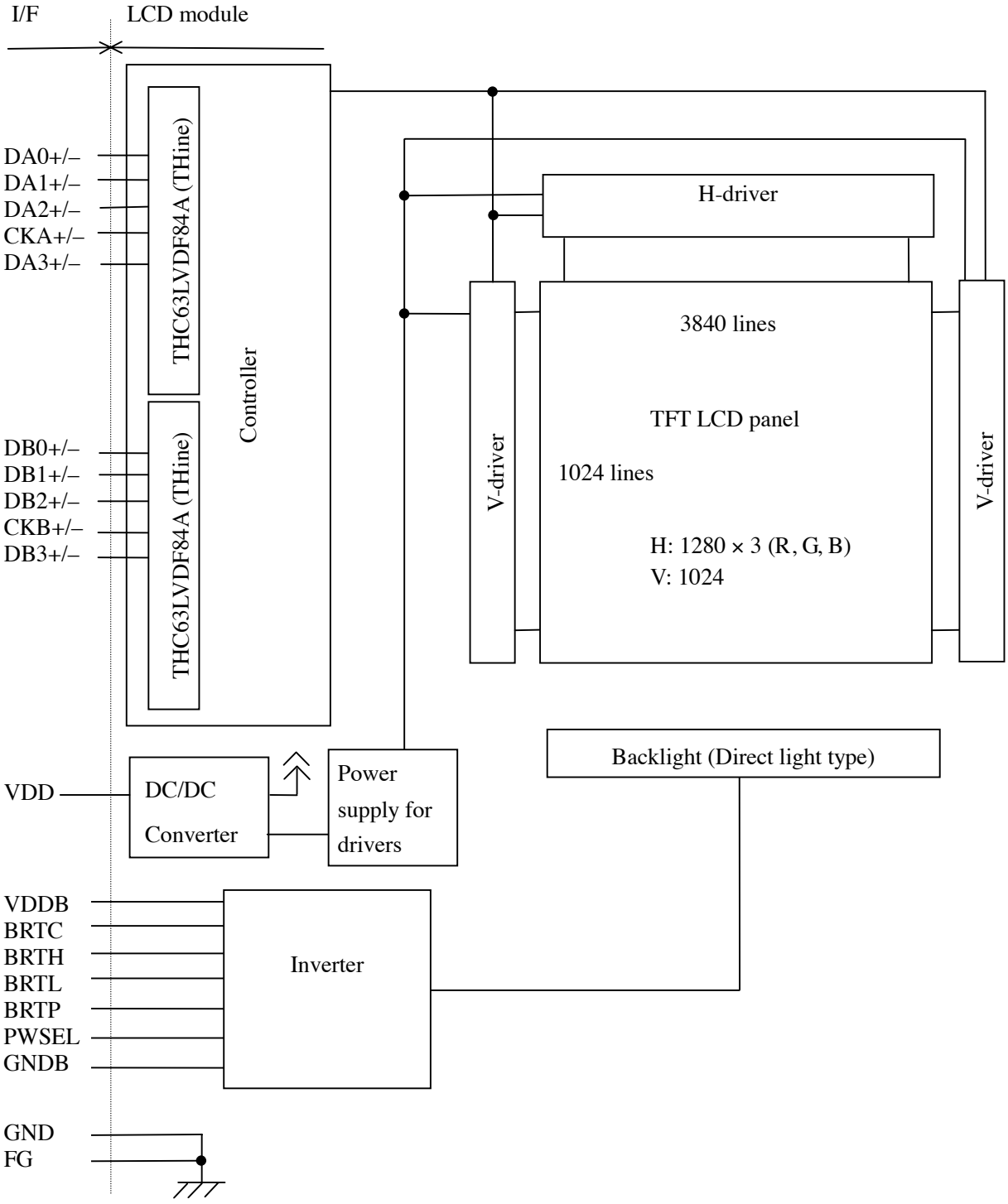
RGB (red, green, blue) data signals from a source system are modulated into a form suitable for active matrix addressing by the onboard signal processor and sent to the driver LSIs which in turn addresses the individual TFT cells.

Working as an electro-optical switch, each TFT cell regulates transmitted light from the backlight assembly when worked by the data source. Color images are created by regulating the amount of transmitted light through the array of red, green, and blue dots

5. GENERAL SPECIFICATIONS

Display area	399.36 (W) × 319.49 (H) mm (typ.)
Diagonal size of display	51 cm (20.1 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Pixel	1280 (H) × 1024 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.104 (W) × 0.312 (H) mm
Pixel pitch	0.312 (W) × 0.312 (H) mm
Module size	470.0 (W) × 382.0 (H) × 42.5 (D) mm (max.)
Weight	2,320 g (typ.)
Contrast ratio	300:1 (typ.)
Viewing angle	*At the contrast ratio 10:1* • Horizontal: Right side 85° (typ.), Left side 85° (typ.) • Vertical: Up side 85° (typ.), Down side 85° (typ.)
Designed viewing direction	Viewing angle with optimum grayscale (γ=2.2): normal axis
Polarizer pencil-hardness	3H (min.) [by JIS K5400]
Color gamut	*At LCD panel center* 60 % (typ.) [against NTSC color space]
Response time	*Ton (black 10% → white 90%)* 30 ms (typ.)
Luminance	250 cd/m^2 (typ.)
Signal system	2 ports LVDS interface (THC63LVDF84A×2pcs, Thine Electronics, Inc.) RGB 8-bit signals, Synchronous signals (Hsync, Vsync), Data enable signal (DE) THC63LVDF83A (THine Electronics, Inc.) are preferable.
Power supply voltage	12V (Logic, LCD driving), 12V (Backlight)
Backlight	Direct light type: 12 cold cathode fluorescent lamps with an inverter (Replaceable parts • Backlight unit: Type No. 201LHS02 • Inverter: Type No.: 201PW021)
Power consumption	45.7 W (Typ.) (at maximum luminance)

6. BLOCK DIAGRAM



Note1: Connections between GND (Signal ground), FG (Frame ground) and GNDB (Inverter ground) in the LCD module

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 are connected together in customer equipment.

7. DETAILED SPECIFICATIONS

7.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	470.0 ± 1.0 (W) × 382.0 ± 1.0 (H) × 42.5 (Max.) (D)	Note1	mm
Display area	399.36 (W) × 319.49 (H)	Note1	mm
Weight	2,320 (typ.), 2,430 (max.)		g

Note1: See "**16. OUTLINE DRAWINGS**".

7.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage		VDD	-0.3 to +14.0	V	Ta = 25°C
		VDDB	-0.3 to +14.0	V	
LVDS input voltage (LCD)		Vi	-0.3 to +3.6	V	Ta = 25°C VDD = 12V
Logic input voltage (BRTP)		ViB1	-0.3 to +5.5	V	Ta = 25°C VDDB = 12V
Logic input voltage (BRTC, PWSEL)		ViB2	-0.3 to +5.5	V	
BRTL input voltage (BRTL)		ViB3	-0.3 to +1.5	V	
Storage temperature		Tst	-20 to +60	°C	-
Operating temperature	Front surface	TopF	0 to +55	°C	Note1
	Rear surface	TopR	≤ 65	°C	Note2
Relative humidity Note3		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40 < Ta ≤ 50°C
			≤ 70	%	50 < Ta ≤ 55°C
Absolute humidity Note3		AH	≤ 73 Note4	g/m^3	Ta > 55°C

Note1: Measured at center of LCD panel surface (including self-heat)

Note2: Measured at center of LCD module's rear shield surface (including self-heat)

Note3: No condensation

Note4: Ta = 55°C, RH = 70%

7.3 ELECTRICAL CHARACTERISTICS

(1) Controller / LCD driving Ta = 25°C

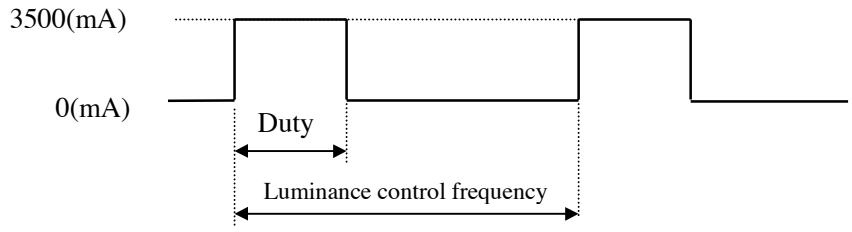
Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VDD	11.4	12.0	12.6	V	-
Ripple voltage	VRP	-	-	100	mV	for VDD
Differential input "L" Threshold voltage	VTL	-100	-	-	mV	VCM=1.2V VCM: Common mode voltage in LVDS driver
Differential input "H" Threshold voltage	VTH	-	-	+100	mV	
Input voltage width	VI	0	-	2.4	V	-
Terminating resistor	RT	-	100	-	Ω	-
Supply current	IDD	-	310 Note 1	1000 Note 2	mA	VDD=12.0V

Note 1: Checker flag pattern (in EIAJ ED-2522)
Note 2: Theoretical maximum current pattern

(2) Backlight Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VDDB	10.8	12.0	13.2	V	backlight power supply
Logic input "L" level 1	ViBL1	0	-	0.8	V	for BRTP
Logic input "H" level 1	ViBH1	2	-	5	V	
Logic input "L" level 2	ViBL2	0	-	0.8	V	for BRTC, PWSEL
Logic input "H" level 2	ViBH2	2	-	5	V	
Logic input "L" current 1	IiBL1	-1.6	-	-	mA	for BRTP
Logic input "H" current 1	IiBH1	-	-	3.5	mA	
Logic input "L" current 2	IiBL2	-610	-	-	μA	for BRTC, PWSEL
Logic input "H" current 2	IiBH2	-	-	440	μA	
BRTL input current	IiB3	-130	-	-	μA	for BRTL
Supply current	IDDB	-	3500	4200	mA	VDDB=12.0V (at Max. luminance)

(3) Inverter current wave



Maximum luminance control: 100%

Minimum luminance control: 20%

Luminance control frequency: 262 to 290 Hz, 276Hz (Typ.)

Note 1: The power supply lines (VDDB and GNDB) have large ripple voltage while dimming. There is the possibility that the ripple voltage produces an acoustic noise and signal wave noise in a system circuit (e.g. audio circuit). If the noise occurred in a circuit system, put an aluminum electrolytic capacitor (5,000 to 6,000μF) between the power source lines (VDDB and GNDB), and the capacitor will be able to reduce the noise.

Note2: Luminance control frequency indicate the input pulse frequency, when select the external pulse control. See '9.INTERFACE PIN CONECTIONS AND FUNCTIONS, (4) External pulse control for luminance'.

(4) Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VDD	CCP2E40	KOA Corporation	1.6 A 72 V	4.0A	Note1
VDDB	R451007	Littelfuse Inc.	7.0 A 125 V	14.0A	Note1

Note1: The power supply capacity should be more than the fusing current. If the power supply capacity is less than the fusing current, the fuse may not blow for a short time, and then nasty smell, smoking and so on may occur.

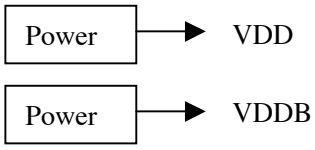
(5) Ripple of supply voltage

Supply voltage	VDD (for logic and LCD driver)	VDDB (for backlight)
Acceptable level Note1	≤ 100mVp-p	≤ 200mVp-p

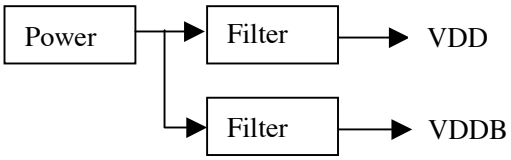
Note1: The acceptable level of ripple voltage includes spike noise.

Example of the power supply connection

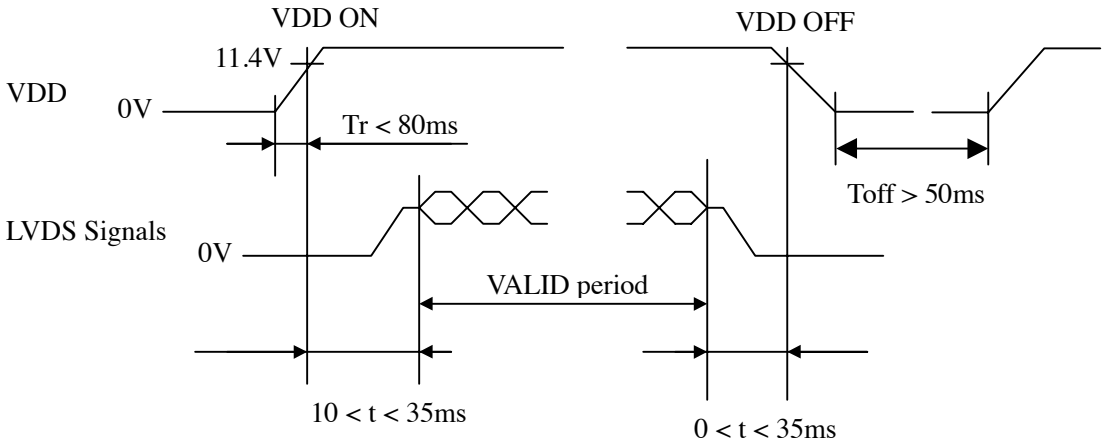
a) Separate the power supply

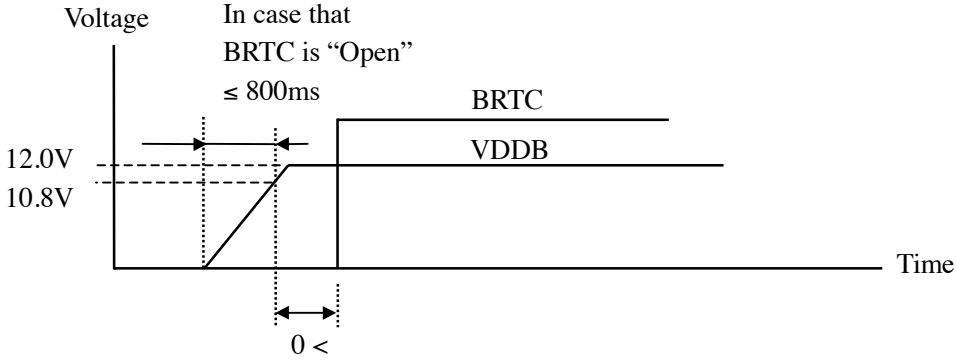


b) Put in the filter



8. SUPPLY VOLTAGE SEQUENCE





Note1: LVDS signals should be measured at the terminal of 100Ω resistor.

Note2: When turn on the LCD module, if VDD voltage falls down during the rising period up to 11.4V, the LCD module may not start to work because of the protection circuit.

Note3: Backlight ON/OFF (BRTC signal) should be controlled, while LVDS signals are supplied. The backlight power supply (VDDB) is not related to the power supply sequence. However, unstable data may be displayed when the backlight power is turned ON/OFF during no LVDS signals.

Note4: Rising time of backlihght power supply (12V) should be less the 800ms, otherwise, the protection circuit will work, and backlight will be turned off.

Note5: When "L" period of BRTP is more than 50 ms, the backlight will be turned off by safety circuit.

Note6: PWSEL must not be "H" while VDD is 0V or BRTC is "L".

9. INTERFACE PIN CONNECTIONS AND FUNCTIONS

(1) Interface connector for signal and power

CN1 socket: 53780-2010
Adaptable plug: 51146-2000
Supplier: Molex Incorporated.

Pin No.	Symbol	Function	Description	
1	N.C.	Non-connection	Keep the terminal open	
2	N.C.			
3	GND	Ground	Connect to system ground	Note 1
4	GND			
5	DA0-	Odd pixel Data0	LVDS differential signal	Note 2
6	DA0+			
7	GND	Ground	Connect to system ground	Note 1
8	DA1-	Odd pixel Data1	LVDS differential signal	Note 2
9	DA1+			
10	GND	Ground	Connect to system ground	Note 1
11	DA2-	Odd pixel Data2	LVDS differential signal	Note 2
12	DA2+			
13	GND	Ground	Connect to system ground	Note 1
14	CKA-	Odd pixel Clock	LVDS differential signal	Note 2
15	CKA+			
16	GND	Ground	Connect to system ground	Note 1
17	DA3-	Odd pixel Data3	LVDS differential signal	Note 2
18	DA3+			
19	GND	Ground	Connect to system ground	Note 1
20	N.C.	Non-connection	Keep the terminal open	

Note1: GND is signal ground for Controller. GND is connected to FG (Frame Ground) in the LCD module. Neither GND nor FG is connected to GNDB (Backlight Ground). These grounds should be connected to system ground in customer equipment.

Note2: Use 100Ω twist pair wires for the cable.

Note3: Do not keep pins free (except 1,2 and 20) to avoid noise problem.

CN1: Figure of socket

CN2 socket: 53780-3010
Adaptable plug: 51146-3000
Supplier: Molex Incorporated.

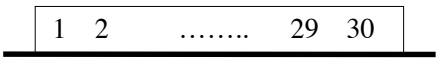
Pin No.	Symbol	Function	Description	
1	N.C.	Non-connection	Keep the terminal open	
2	N.C.			
3	GND	Ground	Connect to system ground	Note 1
4	GND			
5	DB0-	Even Pixel Data0	LVDS differential signal	Note 2
6	DB0+			
7	GND	Ground	Connect to system ground	Note 1
8	DB1-	Even Pixel Data1	LVDS differential signal	Note 2
9	DB1+			
10	GND	Ground	Connect to system ground	Note 1
11	DB2-	Even Pixel Data2	LVDS differential signal	Note 2
12	DB2+			
13	GND	Ground	Connect to system ground	Note 1
14	CKB-	Even Pixel Clock	LVDS differential signal	Note 2
15	CKB+			
16	GND	Ground	Connect to system ground	Note 1
17	DB3-	Even Pixel Data3	LVDS differential signal	Note 2
18	DB3+			
19	GND	Ground	Connect to system ground	Note 1
20	Reserved	Reserved	Keep the terminal open	
21	Reserved			
22	Reserved			
23	Reserved			
24	GND	Ground	Connect to system ground	Note 1
25	GND			
26	GND			
27	N.C.	Non-connection	Keep the terminal open	
28	VDD	+12V Power Supply	12V±5%	
29	VDD			
30	VDD			

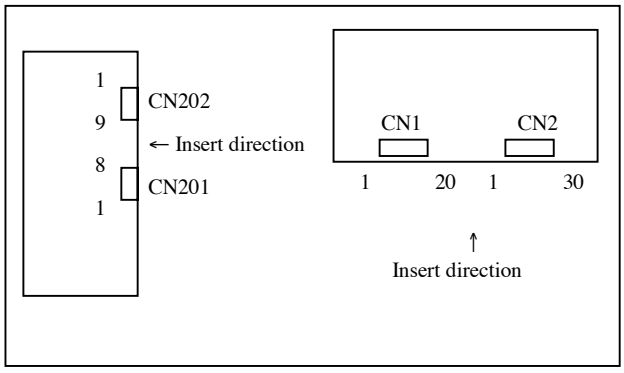
Note1: GND is signal ground for Controller. GND is connected to FG (Frame Ground) in the LCD module. Neither GND nor FG is connected to GNDB (Backlight Ground). These grounds should be connected to system ground in customer equipment.

Note2: Use 100Ω twist pair wires for the cable.

Note3: Do not keep pins free (except 1,2,20-23 and 27) to avoid noise problem.

CN2: Figure of socket





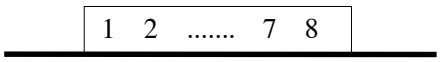
(2) Connector for backlight unit

CN201 socket: DF3-8P-2H(2∗)
Adaptable plug: DF3-8S-2C(2∗)
Supplier: HIROSE ELECTRIC CO,. LTD.

Pin No.	Symbol	Function	Description
1	GNDB	Ground for backlight	Note 1
2	GNDB		
3	GNDB		
4	GNDB		
5	VDDB	12V power supply	+12V±10%
6	VDDB		
7	VDDB		
8	VDDB		

Note1: GNDB should be connected to system ground in customer equipment.
Note2: Do not keep pins free to avoid noise problem.

CN201: Figure of socket

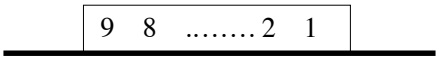


CN202 socket: IL-Z-9PL1-SMTY
Adaptable plug: IL-Z-9S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

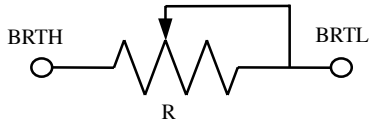
Pin No.	Symbol	Function	Description
1	GNDB	Ground for backlight	Note 1
2	GNDB		
3	N.C.	Non-connection	Keep the terminal open
4	BRTC	Backlight ON/OFF control signal	“H” or “Open”: Backlight on “L”: Backlight off
5	BRTH	Luminance control signal	-
6	BRTL	Luminance control signal	
7	BRTP	Luminance control signal	-
8	GNDB	Ground for backlight	Note 1
9	PWSEL	Luminance control select signal	-

Note1: GNDB should be connected to system ground in customer equipment.
Note2: Do not keep pins free (except 3 and 4) to avoid noise problem.

CN202: Figure of socket



(3) Luminance control

Control method	Function and adjustment	PWSEL	BRTP signal
PWM	Luminance controlled by BRTP signal. See "(4) External pulse control for luminance".	"L"	Input
Variable resistor Note1	The variable resistor for luminance control should be 10kΩ type, and zero point of the resistor corresponds to the minimum of luminance.  Max. luminance (100%): R=10kΩ Min. luminance (30%): R=0Ω Mating variable resistor: 10kΩ ±5%,B curve, 1/10W	"H" or "OPEN"	"OPEN"
Voltage Note1	BRTH should be fixed to 0V, and input to BRTL as follows. Max. Luminance (100%): 1V(Typ.) Min. Luminance (30%): 0V		

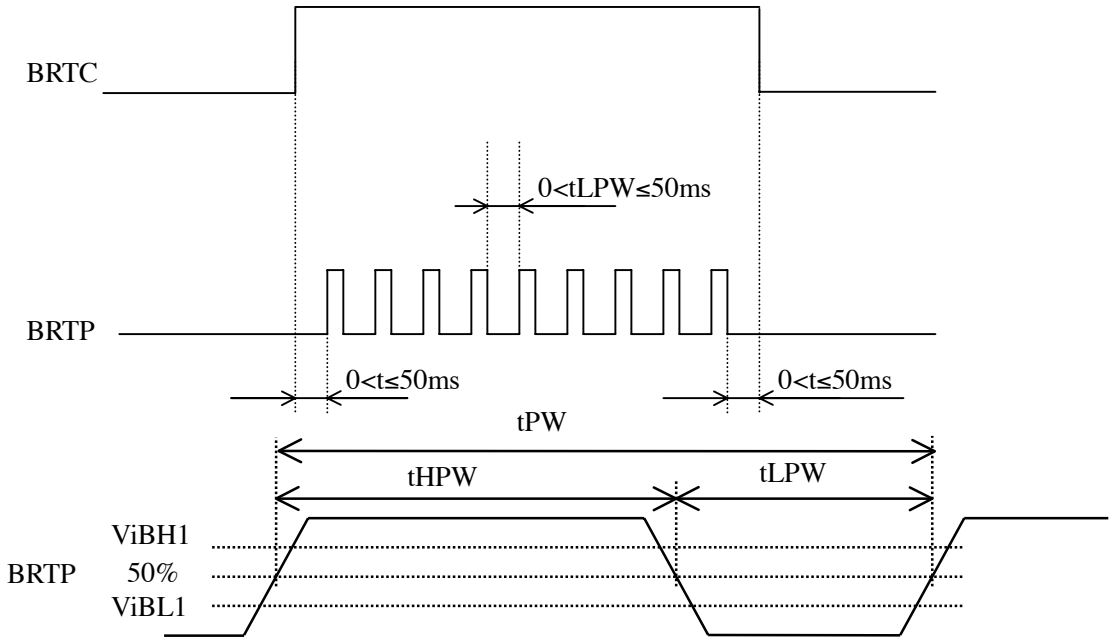
Note1: Luminance control may be overlap noises on the display image depending on input signal timing. In this case, keep off the interference between input signal and backlight driving signal, by PWM method.

(4) External pulse control for luminance

Luminance control with external pulse is valid, when PWSWL is "L" and external pulse signal is inputted to BRTP. This luminance control is controlled by duty ratio, and luminance is as follows.

Duty ratio=100%: Max. luminance

Duty ratio=20%: Min. luminance



Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Frequency	1/tPW	185	-	325	Hz	Note1
“L” period	tLPW	-	-	50	ms	Note2
Pulse-width	tHPW/tPW	20	-	100	%	Note3
Luminance ratio	-	-	30 to 100	-	%	-
Input voltage	ViBL1	0	-	0.8	V	-
	ViBH1	2.0	-	5.0	V	-

Note1: See the following formula for luminance control frequency.

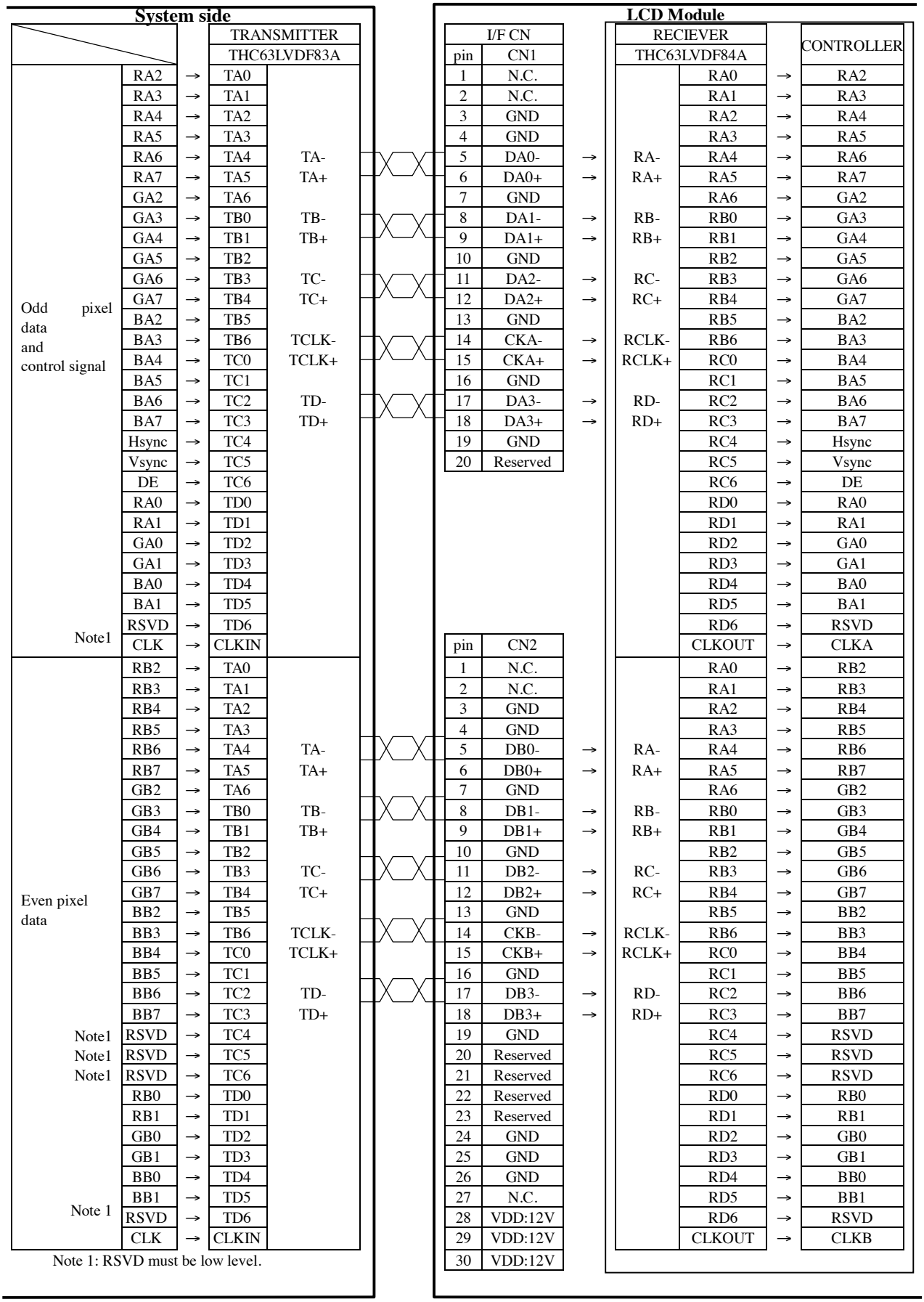
Luminance control frequency = Vsync frequency × (n+0.25) [or (n + 0.75)]

Note2: In case tLPW is out of 50ms, backlight will turn off by its protection circuits.

Note3: Max. Luminance at 100%

Attention: External pulse control for luminance may be disturbed the display image when set up frequency is interfered with internal signal frequency.

10. METHOD OF CONNECTION FOR THC63LVDF83A



Note 1: RSVD must be low level.

11. DISPLAY COLORS vs. INPUT DATA SIGNALS

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 grayscale	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 grayscale	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 grayscale	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

Note: The combination of 8-bit signals (256-grayscale level) results in equivalent to 16,777,216 colors.

12. INPUT SIGNAL TIMINGS

(1) Input signal specifications

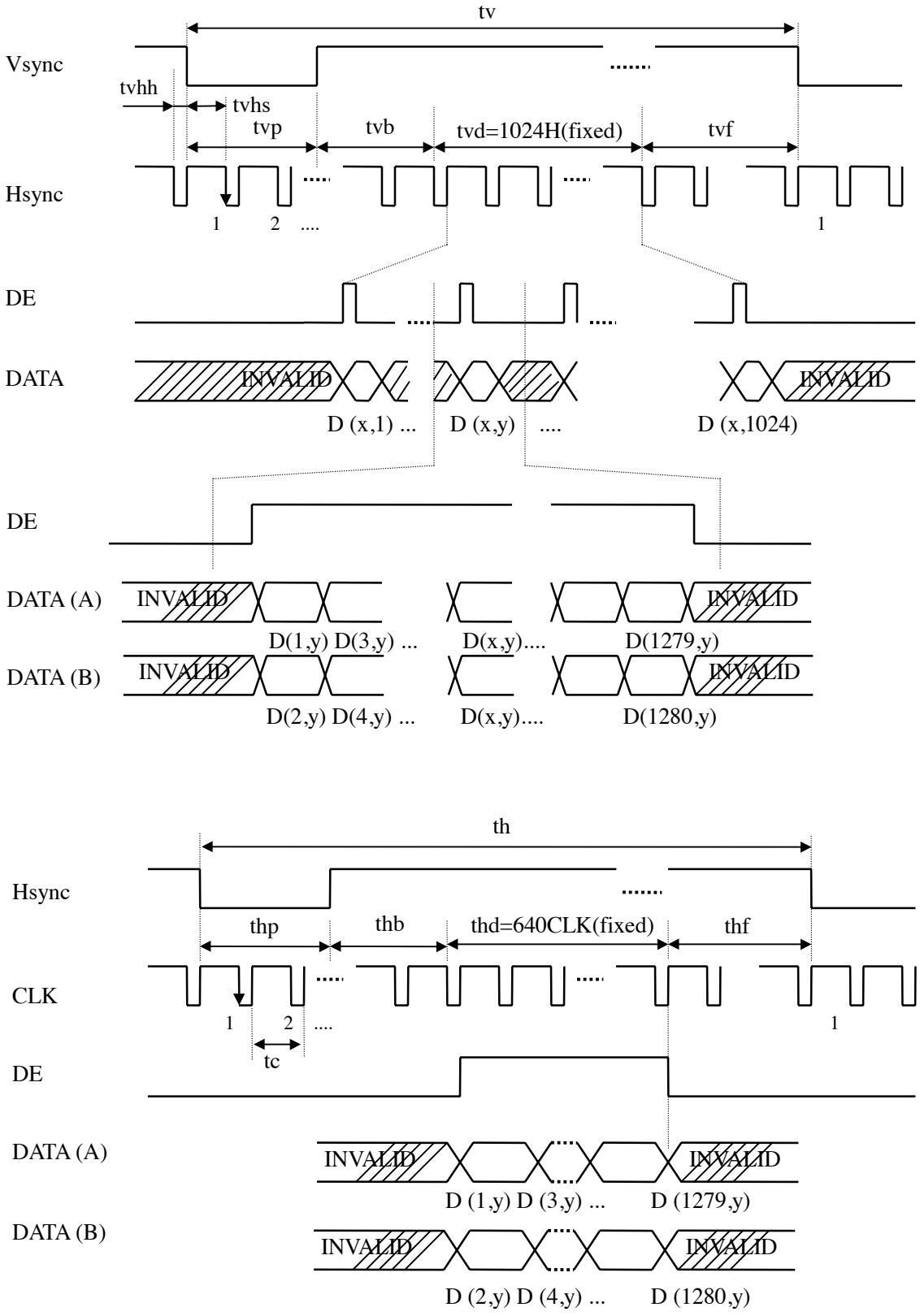
	Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	Vf=75Hz	1/ tc	65.0 -	67.5 14.815	70.0 -	MHz ns	-
		Vf=60Hz		51.5 -	54.0 18.52	56.5 -	MHz ns	
	Duty		tc / tcl	Note 1			-	-
	Rise, fall		tcrf				ns	-
Hsync	Period	Vf=75Hz	th	12.3 750	12.504 844	- -	µs CLK	Typ=80.0kHz Note2,3
		Vf=60Hz		12.3 750	15.630 844	- -	µs CLK	Typ=64.0kHz
	Display period		thd	640			CLK	-
	Front-porch		thf	-	-	-	CLK	-
	Pulse width	Vf=75Hz	thp *	-	72	-	CLK	-
		Vf=60Hz		-	56	-	CLK	
	Back-porch		thb *	-	124	-	CLK	-
	* thp + thb			110	-	-	CLK	-
	CLK-Hsync set-up		ths	Note1			ns	-
	CLK-Hsync hold		thh				ns	-
	Raise,fall		thrf				ns	-
Vsync	Period	Vf=75Hz	tv	- 1028	13.329 1066	- -	ms H	Typ=75.0Hz
		Vf=60Hz		- 1028	16.661 1066	- -	ms H	Typ=60.0Hz
	Display period		tvd	1024			H	-
	Front-porch		tvf *	-	1	-	H	-
	Pulse width		tvp *	-	3	-	H	-
	Back-porch		tvb *	-	38	-	H	-
	* tvp + tvb +tvf			4	-	-	H	-
	Hsync-Vsync set-up		thvs	1	-	-	CLK	-
	Hsync-Vsync hold		thvh	1	-	-	CLK	-
	CLK-Vsync set-up		tvs	Note1			ns	-
	CLK-Vsync hold		tvh				ns	-
	Raise,fall		tvrf				ns	-
DE	CLK-DE set-up		tdes	Note1			ns	-
	CLK-DE hold		tdeh				ns	-
	Raise,fall		tderf				ns	-
DATA	CLK-DATA set-up		tds	Note1			ns	-
	CLK-DATA hold		tdh				ns	-
	Rise, fall		tdrf				ns	-

Note1: Timing specifications are defined by the input signals of LVDS transmitter.
THC63LVDF83A (THine) or equivalent products are recommended for LVDS transmitter.

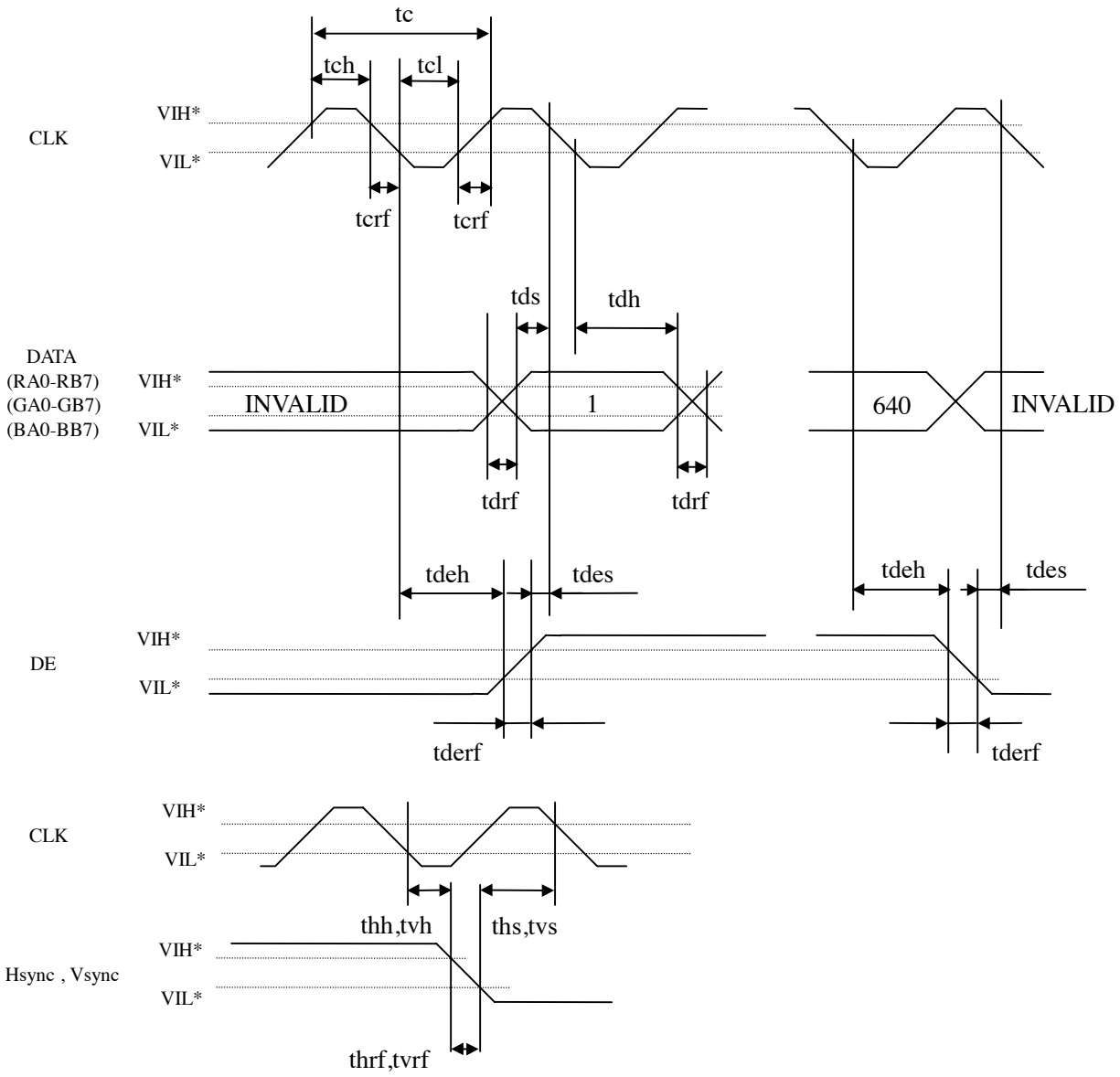
Note2: Both of "time" and "CLK number" of the "th" must keep the Minimum value of specification.

Note3: During operation, fluctuation of Hsync period must not exceed ±1 CLK. Otherwise function errors will occur in LCD module.
e.g.: Acceptable fluctuation range is 799-801 CLK, when the Hsync period is 800 CLK.

(2) Input signals timing chart for LCD



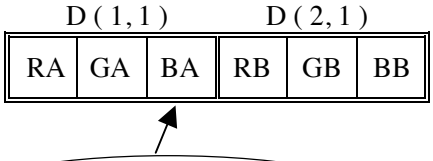
Note1: DATA (A): RA0-RA7, GA0-GA7, BA0-BA7
DATA (B): RB0-RBA7, GB0-GB7, BB0-BB7



* See the specifications of LVDS manufactures for detailed design.

(3) Display positions of input data

Odd Pixel: RA= R DATA Even Pixel : RB=R DATA
Odd Pixel: GA= G DATA Even Pixel : GB=G DATA
Odd Pixel: BA= B DATA Even Pixel : BB=B DATA



D(1, 1)	D(2,1)	•••	D(1280,1)
D(1,2)	D(2, 2)	•••	D(1280,2)
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
D(1,1024)	D(2,1024)	•••	D(1280,1024)

13. OPTICS

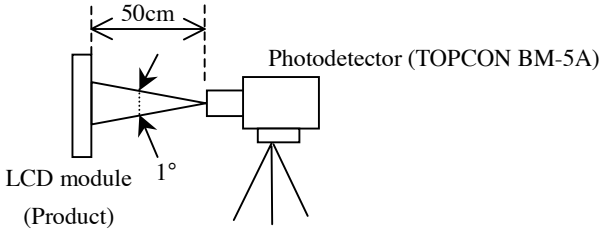
13.1 Optical characteristics

(Note1, Note2)

Parameter		Condition		Symbol	Min.	Typ.	Max.	Unit	Remarks
Luminance		White at center θR = 0°, θL = 0°, θU = 0°, θD = 0°		L	200	250	-	cd/m^2	-
Contrast ratio		White/Black at center θR = 0°, θL = 0°, θU = 0°, θD = 0°		CR	200	300	-	-	Note3
Luminance uniformity		-		LU	-	1.1	1.3	-	Note4
Chromaticity	White	**x** coordinate		Wx	**-**	0.300	-	**-**	Note5
		y coordinate		Wy	**-**	0.315	-	**-**	
	Red	**x** coordinate		Rx	**-**	0.615	**-**	**-**	
		y coordinate		Ry	**-**	0.340	**-**	**-**	
	Green	**x** coordinate		Gx	**-**	0.312	**-**	**-**	
		y coordinate		Gy	**-**	0.585	**-**	**-**	
	Blue	**x** coordinate		Bx	**-**	0.143	**-**	**-**	
		y coordinate		By	**-**	0.093	**-**	**-**	
Color gamut		θR = 0°, θL = 0°, θU = 0°, θD = 0° at center, against NTSC color space		C	50	60	-	%	
Response time		Black to White	(0% → 90%)	Ton	-	35	85	ms	Note6 Note7
			(10% → 90%)		-	30	-	ms	
		White to Black	(100% → 10%)	Toff	-	25	55	ms	
			(90% → 10%)		-	23	-	ms	
Viewing angle	Right	θU = 0°, θD = 0°, CR = 10		θR	70	85	-	°	Note8
	Left	θU = 0°, θD = 0°, CR = 10		θL	70	85	-	°	
	Up	θR = 0°, θL = 0°, CR = 10		θU	70	85	-	°	
	Down	θR = 0°, θL = 0°, CR = 10		θD	70	85	-	°	

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
Ta=25°C, VDD=12V, VDDB=12V

Optical characteristics are measured at luminance saturation after 20minutes from working the product, in the dark room. Also measurement method for luminance is as follows.



Note3: See "**13.2 Definition of contrast ratio**".
Note4: See "**13.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF = 29°C
Note7: See "**13.4 Definition of response times**".
Note8: See "**13.5 Definition of viewing angles**".

13.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

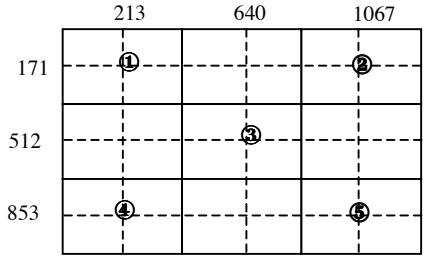
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

13.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

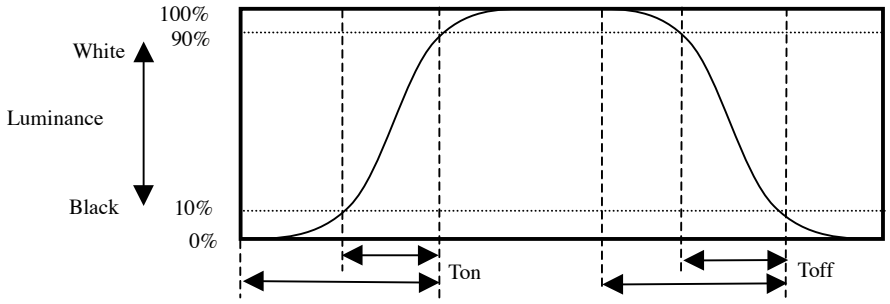
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

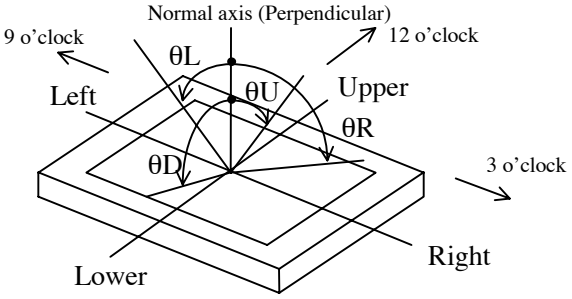


13.4 Definition of response times

Response time is measured, the luminance changes from "black" to "white", or "white" to "black" on the same screen point, by photo-detector. Ton is the time it takes the luminance change from 0% up to 90% and 10% up to 90%. Also Toff is the time it takes the luminance change from 100% down to 10% and 90% down to 10% (See the following diagram.).



13.5 Definition of viewing angles

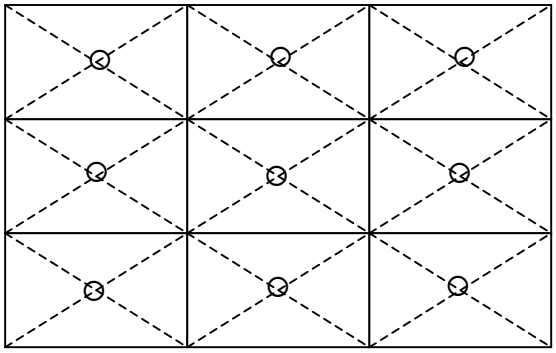


14. RELIABILITY TESTS

Test item	Condition	Judgement
High temperature and humidity (Operation)	① 60 ± 2°C, RH = 60%, 240hours ② Display data is white.	No display malfunctions Note1
Heat cycle (Operation)	① 0 ± 3°C…1hour 55 ± 3°C…1hour ② 50cycles, 4hours/cycle ③ Display data is white.	
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.	
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note2 ③ 10 times each places 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, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z direction ④ 10 times each directions	No display malfunctions No physical damages Note1
Mechanical shock (Non operation)	① 294m/ s^2, 11ms ② ±X, ±Y, ±Z direction ③ 3 times each directions	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.



15. PRECAUTIONS

15.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "15.2 CAUTIONS" and "15.3 ATTENTIONS", after understanding this contents!**

This sign has the meaning that customer will be injured by himself or the product will sustain a damage, if customer has wrong operations.

This sign has the meaning that customer will get an electrical shock, if customer has wrong operations.

This sign has the meaning that customer will be injured by himself, if customer has wrong operations.

15.2 CAUTIONS

∗ Do not touch the working backlight and inverter. Customer will be in danger of an electric shock.

∗ Do not touch the working backlight. Customer will be in danger of burn injury.
∗ Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: To be not greater 294m/s^2 and to be not greater 11ms, Pressure: To be not greater 19.6 N)

15.3 ATTENTIONS 

15.3.1 Handling of the product

① Take hold of both ends without touch the circuit board when customer pulls out products (LCD modules) from inner packing box. If customer touches it, products may be broken down or out of adjustment, because of stress to mounting parts.
② Do not hook cables nor pull connection cables such as lamp cable and so on, for fear of damage.
③ If customer puts down the product temporarily, the product puts on flat subsoil as a display side turns down.
④ Take the measures of electrostatic discharge such as earth band, ionic shower and so on, when customer deals with the product, because products may be damaged by electrostatic.
⑤ The torque for mounting screws must never exceed 0.392N·m. Higher torque values might result in distortion of the bezel.
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) except mounting hole portion.
Bends or twist described above and undue stress to any portion except mounting hole portion may cause display un-uniformity.

⑦ Do not press or rub on the sensitive display surface. If customer clean on the panel surface, NEC recommends using the cloth with ethanolic liquid such as screen cleaner for LCD.
⑧ Do not push-pull the interface connectors while the product is working, because wrong power sequence may break down the product.

15.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in antistatic pouch in room temperature, because of avoidance for dusts and sunlight, if customer stores the product.
② In order to prevent dew condensation occurring by temperature difference, the product packing box must be opened after leave under the environment of an unpacking room temperature enough. Because a situation of dew condensation occurring is changed by the environmental temperature and humidity, evaluate the leaving time sufficiently. (Recommendation leaving time: 6 hour or more with packing state)
③ Do not operate in high magnetic field. Circuit boards may be broken down by it.
④ This product is not designed as radiation hardened.
⑤ Use an original protection sheet on the product surface (polarizer). Adhesive type protection sheet should be avoided, because it may change color or properties of the polarizer.

15.3.3 Characteristics

The following items are neither defects nor failures.

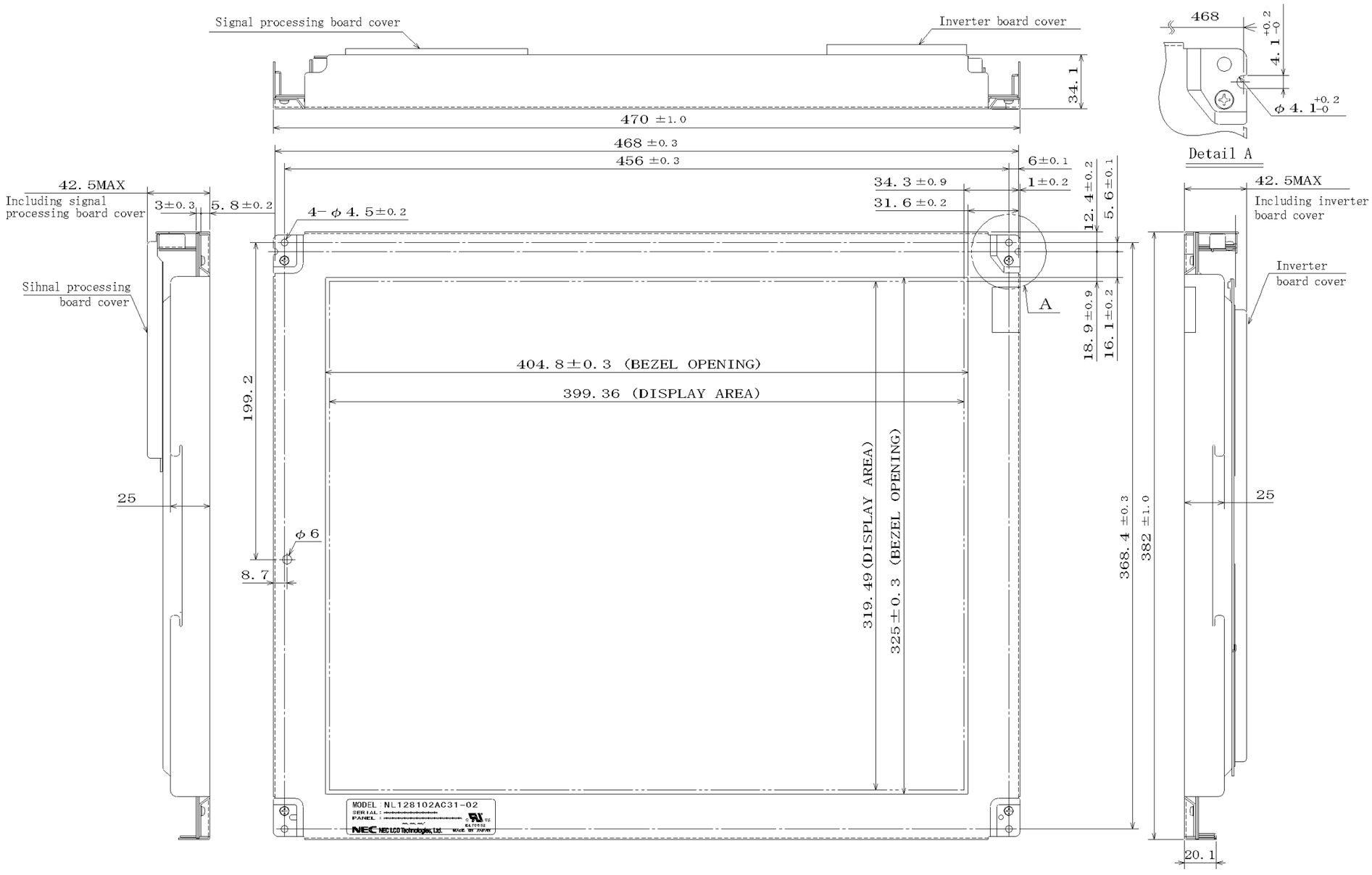
① Response time, luminance and color may be changed by ambient temperature.
② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating time, and especially low temperature, because the LCD has cold cathode fluorescent lamps.
④ 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.
⑤ The display color may be changed by viewing angle because of the use of condenser sheet in the backlight.
⑥ Optical characteristics may be changed by input signal timings.

15.3.4 Other

① All GND, GNDB, VDD and VDDB terminals should be used without a non-connected line.
② Do not disassemble a product or adjust volume without permission of NEC.
③ See "REPLACEMENT MANUAL FOR BACKLIGHT UNIT", if customer would like to replace backlight lamps.
④ Pay attention not to insert waste materials inside of products, if customer uses screwnails.
⑤ Pack the product with original shipping package, because of avoidance of some damages during transportation, when customer returns it to NEC for repair and so on.
⑤ The LCD module by itself or integrated into end product should be packed and transported with display in the vertically position. Otherwise the display characteristics may be impaired.

16. OUTLINE DRAWINGS

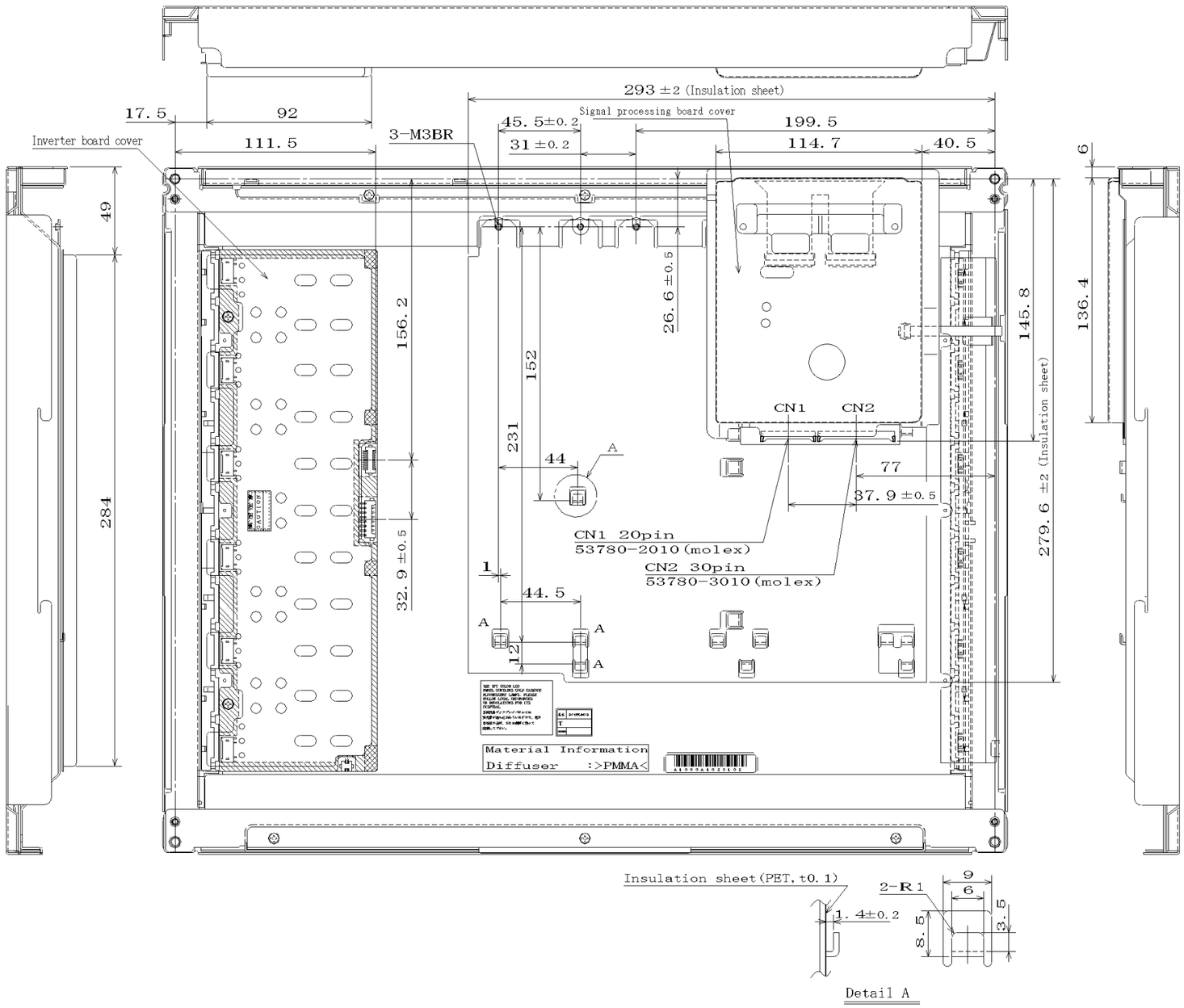
16.1 FRONT VIEW



Note1: Not shown tolerances of the dimensions are ±0.5mm.
Note2: The torque for mounting screws must never exceed 0.392N·m.

Unit: mm

16.2 REAR VIEW



Note1: Not shown tolerances of the dimensions are ±0.5mm.
Note2: The torque for mounting screws must never exceed 0.392N·m.

Unit: mm