

PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL6448AC33-97D

26cm (10.4 Type)

VGA

CMOS interface

PRELIMINARY DATA SHEET

DOD-PP-1597 (1st edition)

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starting to design your system.**

INTRODUCTION

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Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The Standard: Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.

Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

The Special: Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.

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

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

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

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

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL6448AC33-97D 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

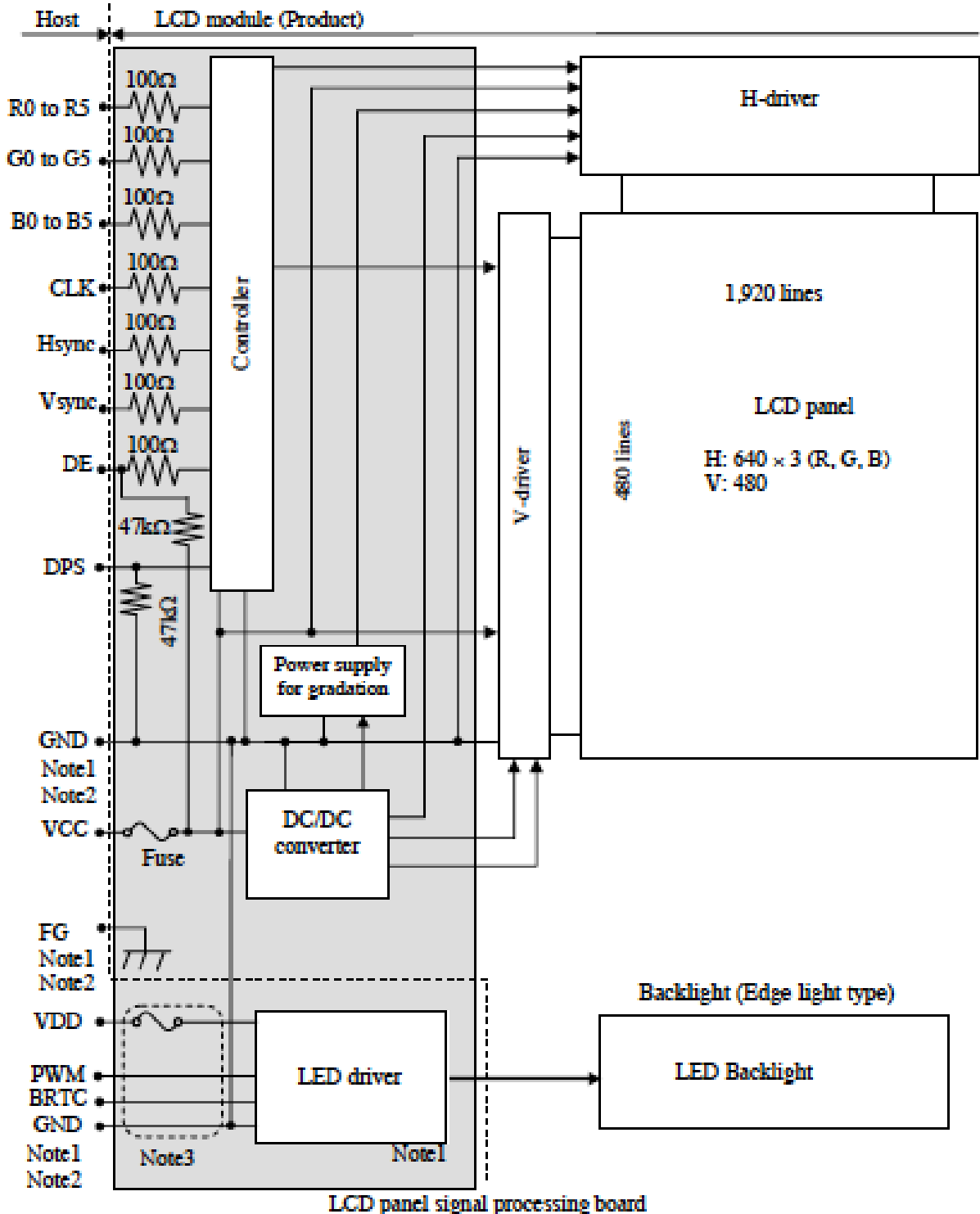
1.3 FEATURES

- Long life LED backlight type
- High contrast
- LED driver circuit Built-in
- 6-bit digital RGB signals
- DE (Data enable) function
- Reversible-scan direction
- Replaceable lamp for backlight

2. GENERAL SPECIFICATIONS

<i>Display area</i>	211.2 (H) × 158.4 (V) mm
<i>Diagonal size of display</i>	26cm (10.4 inches)
<i>Drive system</i>	a-Si TFT active matrix
<i>Display color</i>	262,144 colors
<i>Pixel</i>	640 (H) × 480 (V) pixels
<i>Pixel arrangement</i>	RGB (Red dot, Green dot, Blue dot) vertical stripe
<i>Dot pitch</i>	0.11 (H) × 0.33 (V) mm
<i>Pixel pitch</i>	0.33 (H) × 0.33 (V) mm
<i>Module size</i>	246.5 (W) × 179.4 (H) × 9.5 (D) mm (typ.)
<i>Weight</i>	TBD g (typ.)
<i>Contrast ratio</i>	(900:1) (typ.)
<i>Viewing angle</i>	At the contrast ratio $\geq 10:1$ <ul style="list-style-type: none"> • Horizontal: Right side 70° (typ.), Left side 70° (typ.) • Vertical: Up side 40° (typ.), Down side 70° (typ.)
<i>Designed viewing direction</i>	At DPS= Low or Open: Normal scan <ul style="list-style-type: none"> • Viewing direction without image reversal: Up side (12 o'clock) • Viewing direction with contrast peak: Down side 5° to 10° (6 o'clock) • Viewing angle with optimum grayscale ($\gamma \approx 2.2$): Normal axis (perpendicular)
<i>Polarizer surface</i>	Antiglare
<i>Polarizer pencil-hardness</i>	3H (min.) [by JIS K5600]
<i>Color gamut</i>	At LC D panel center 40% (typ.) [against NTSC color space]
<i>Response time</i>	$T_{on}+T_{off}$ (10% \leftrightarrow 90%) TBD ms (typ.)
<i>Luminance</i>	At the maximum luminance control 300cd/m ² (typ.)
<i>Signal system</i>	6-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE), Horizontal synchronous signal (Hsync), Vertical synchronous signal (Vsync)
<i>Power supply voltage</i>	LCD panel signal processing board: 3.3V or 5.0V LED Driver board: 12V
<i>Backlight</i>	LED backlight type built in LED Driver Circuit (Replaceable part • Lamp holder set: Type No. 104LHS201)
<i>Power consumption</i>	At the maximum luminance control, Checkered flag pattern. TBD W (typ.)

3. BLOCK DIAGRAM



Note1: Relations between GND (Signal ground and LED Driver Ground) and FG (Frame ground) in the LCD module are as follows.

GND - FG	Not connected
----------	---------------

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

Note3: See "4.3.5 Equivalent circuit at input part"

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	246.5 ± 0.5 (W) × 179.4 ± 0.5 (H) × 9.5 ± 0.5 (D) Note1	mm
Display area	211.2 (H) × 158.4 (V) Note1	mm
Weight	TBD (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	-0.3 to +6.5	V	Ta = 25°C	
	LED backlight	VDD	-0.3 to +28	V		
Input voltage for signals	Display signals Note1	VD	-0.3 to VCC+0.3	V		
	Function signal Note2	VF		V		
	Function signal for LED driver	PWM	-0.3 to +5.5	V		
BRTC		-0.3 to +5.5	V			
Storage temperature		Tst	-30 to +80	°C		-
Operating temperature	Front surface	TopF	-20 to +70	°C		Note3
	Rear surface	TopR	-20 to +70	°C	Note4	
Relative humidity Note5		RH	≤ 95	%	Ta ≤ 40°C	
			≤ 85	%	40 < Ta ≤ 50°C	
			≤ 55	%	50 < Ta ≤ 60°C	
			≤ 36	%	60 < Ta ≤ 70°C	
Absolute humidity Note5		AH	≤ 70 Note6	g/m ³	Ta = 70°C	

Note1: CLK, Hsync, Vsync, DE, DATA (R0 to R5, G0 to G5, B0 to B5)

Note2: DPS

Note3: Measured at center of LCD panel surface (including self-heat)

Note4: Measured at center of LCD module's rear shield surface (including self-heat)

Note5: No condensation

Note6: 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	at VCC = 3.3V	
		4.5	5.0	5.5	V	at VCC = 5.0V	
Power supply current	ICC	-	TBD Note1	TBD Note2	mA	at VCC = 3.3V	
		-	TBD Note1	TBD Note2	mA	at VCC = 5.0V	
Permissible ripple voltage	VRPC	-	-	100	mVp-p	for VCC	
Logic input voltage for display signals	High	VDH	0.7VCC	-	VCC	V	CMOS level
	Low	VDL	0	-	0.3VCC	V	
Input voltage for DPS signal	High	VPH	0.7VCC	-	VCC	V	
	Low	VPL	0	-	0.3VCC	V	

Note1: Checkered flag pattern [by EIAJ ED-2522]

Note2: Pattern for maximum current

4.3.2 Backlight

(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	IDD	-	TBD	≤ TBD	mA	At the maximum luminance control. Note3	
Permissible ripple voltage	VRPD	-	-	200	mVp-p	for VDD	
Input voltage for PWM signals	High	VDPH1	(2.1)	-	(5.5)	V	-
	Low	VDPL1	-	-	(0.15)	V	
Input voltage for BRTC signals	High	VDPH2	(2.1)	-	(5.5)	V	-
	Low	VDPL2	0	-	(0.8)	V	
PWM frequency	f _{PWM}	(200)	-	(1k)	Hz	Note4, Note5	
PWM duty ratio	DR _{PWM}	10	-	100	%	Note6	
PWM pulse width	t _{PWH}	TBD	-	-	μs	Note7	

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

Note2: This value excludes peak current such as overshoot current.

Note3: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.

Note4: A recommended f_{PWM} value is as follows.

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

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

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

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

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

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 (Measure at input terminal of power supply)	Note1	Unit
VCC	3.3V	≤ 100		mVp-p
	5.0V	≤ 100		mVp-p
VDD	12.0V	≤ 200		mVp-p

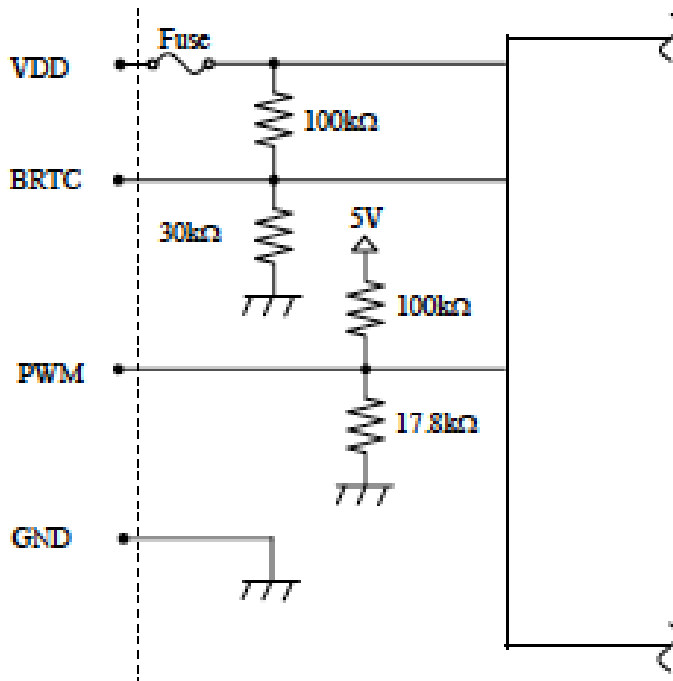
Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

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

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.

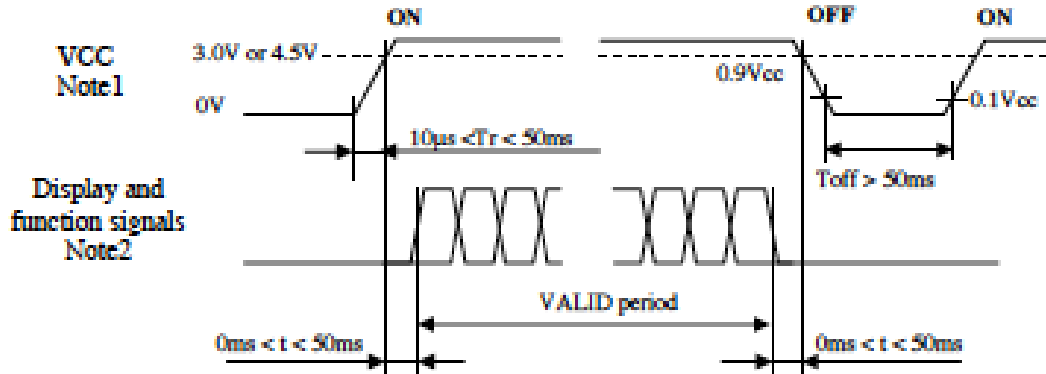
4.3.5 Equivalent circuit at input part



LED driver circuit

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board



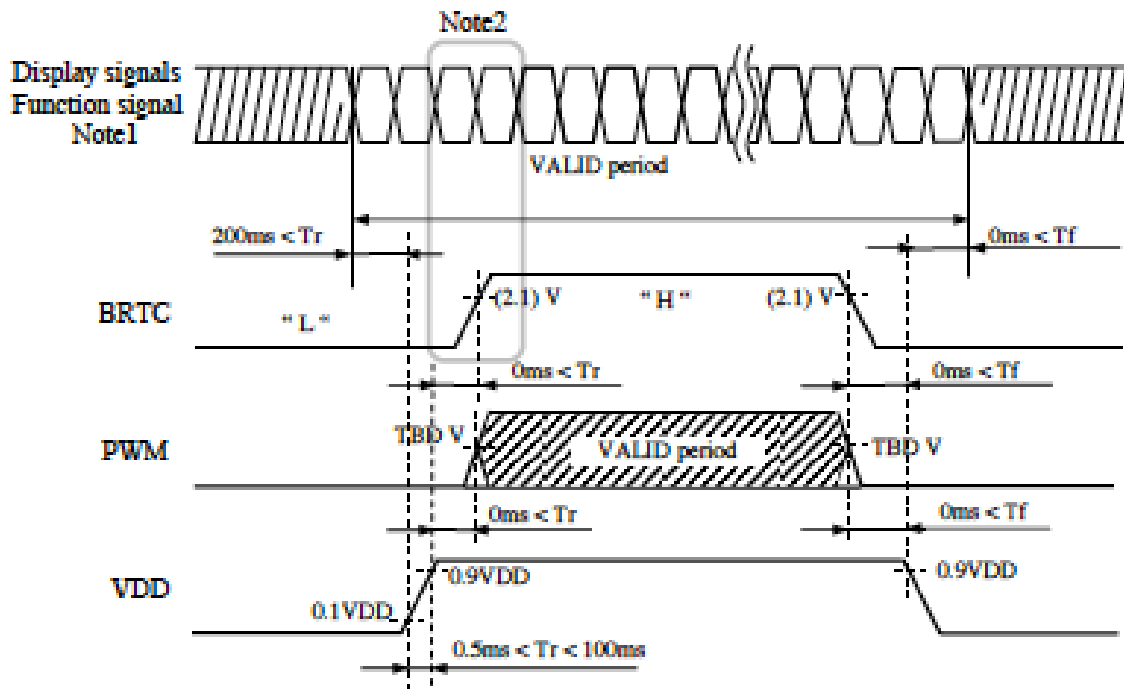
* These signal should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V in "VCC 3.3V " or 4.5V in "VCC = 5.0V ", there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (CLK, Hsync, Vsync, DE, DATA (R0 to R5, G0 to G5, B0 to B5)) and function signal (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.

4.4.2 LED driver board



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

Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): DF9C-31P-1V (2*) (Hirose Electric Co., Ltd. (HRS))

Adaptable plug: DF9-31S-1V (2*), DF9-31S-1V (3*) (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbol	Signal	Remarks
1	GND	Ground	Note1
2	CLK	Dot clock	-
3	Hsync	Horizontal synchronous signal	
4	Vsync	Vertical synchronous signal	
5	GND	Ground	
6	R0	Red data (LSB)	Least significant bit
7	R1	Red data	-
8	R2	Red data	
9	R3	Red data	
10	R4	Red data	
11	R5	Red data (MSB)	Most significant bit
12	GND	Ground	Note1
13	G0	Green data (LSB)	Least significant bit
14	G1	Green data	-
15	G2	Green data	
16	G3	Green data	
17	G4	Green data	
18	G5	Green data (MSB)	Most significant bit
19	GND	Ground	Note1
20	B0	Blue data (LSB)	Least significant bit
21	B1	Blue data	-
22	B2	Blue data	
23	B3	Blue data	
24	B4	Blue data	
25	B5	Blue data (MSB)	Most significant bit
26	GND	Ground	Note1
27	DE	Selection of DE / Fixed mode	High or Open: Fixed mode Data enable signal: DE mode
28	VCC	Power supply	Note1
29	VCC	Power supply	
30	N.C.	-	Keep this pin Open.
31	DPS	Selection of scan direction	High: Reverse scan Low or Open: Normal scan Note2

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

Note2: See "4.8 SCANNING DIRECTIONS".

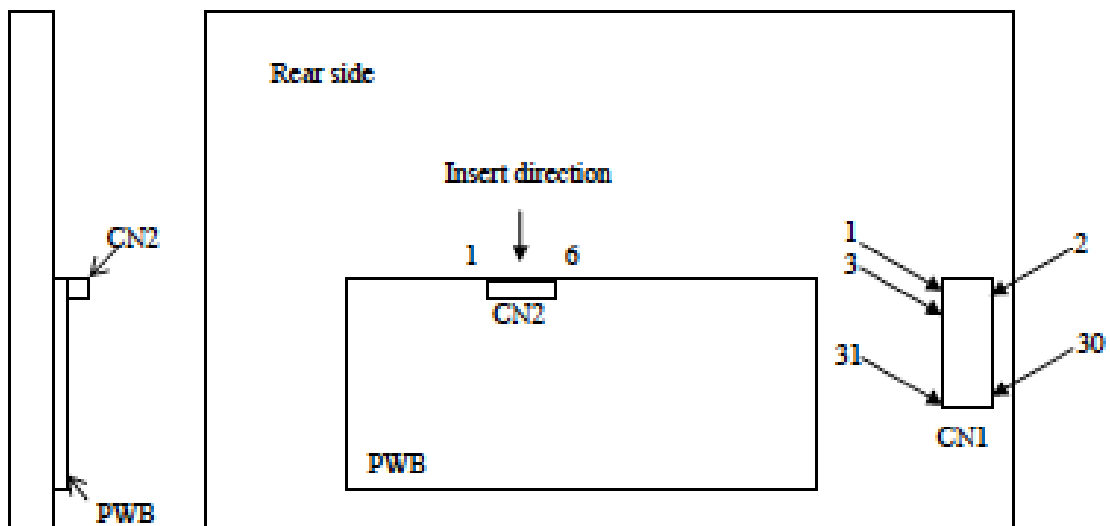
4.5.2 LED driver board

CN2 socket (LCD module side): FI-S6P-HFE (Japan Aviation Electronics Industry Limited (JAE))
 Adaptable plug: FI-S6S (Japan Aviation Electronics Industry Limited (JAE))

Pin No.	Symbol	Signal	Remarks
1	VDD	Power supply	Note 1
2	VDD	Power supply	
3	GND	Ground	
4	GND	Ground	
5	BRTC	Backlight on/off control	High or open: On Low: Off (3.3V or 5V)
6	PWM	Luminance control	PWM Dimming (3.3V or 5V)

Note 1: All VDD and GND terminals should be used without any non-connected lines.

4.5.3 Positions of a socket



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4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display 262,144 colors with 64 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)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑				:														
	↓				:														
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑				:														
	↓				:														
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	
Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	↑				:														
	↓				:														
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	
Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel (See "4.8 SCANNING DIRECTIONS").

$C(0, 0)$													
<table border="1" style="border-collapse: collapse; width: 100%; text-align: center;"> <tr> <td style="padding: 2px 10px;">R</td> <td style="padding: 2px 10px;">G</td> <td style="padding: 2px 10px;">B</td> <td colspan="4"></td> </tr> </table>							R	G	B				
R	G	B											
$C(0, 0)$	$C(1, 0)$...	$C(X, 0)$...	$C(638, 0)$	$C(639, 0)$							
$C(0, 1)$	$C(1, 1)$...	$C(X, 1)$...	$C(638, 1)$	$C(639, 1)$							
⋮	⋮	⋮	⋮	⋮	⋮	⋮							
$C(0, Y)$	$C(1, Y)$...	$C(X, Y)$...	$C(638, Y)$	$C(639, Y)$							
⋮	⋮	⋮	⋮	⋮	⋮	⋮							
$C(0, 478)$	$C(1, 478)$...	$C(X, 478)$...	$C(638, 478)$	$C(639, 478)$							
$C(0, 479)$	$C(1, 479)$...	$C(X, 479)$...	$C(638, 479)$	$C(639, 479)$							

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.

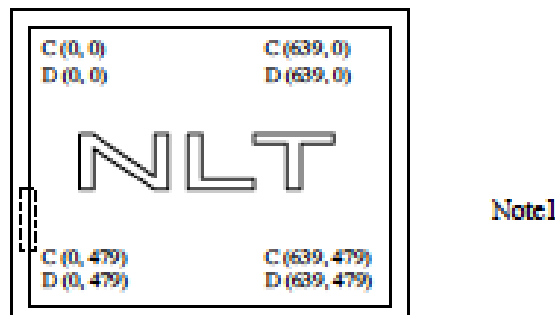


Figure1. Normal scan (DPS: Low or Open)

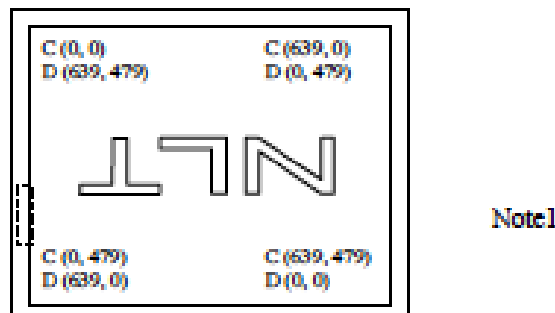


Figure2. Reverse scan (DPS: High)

Note1: Meaning of C (X, Y) and D (X, Y)

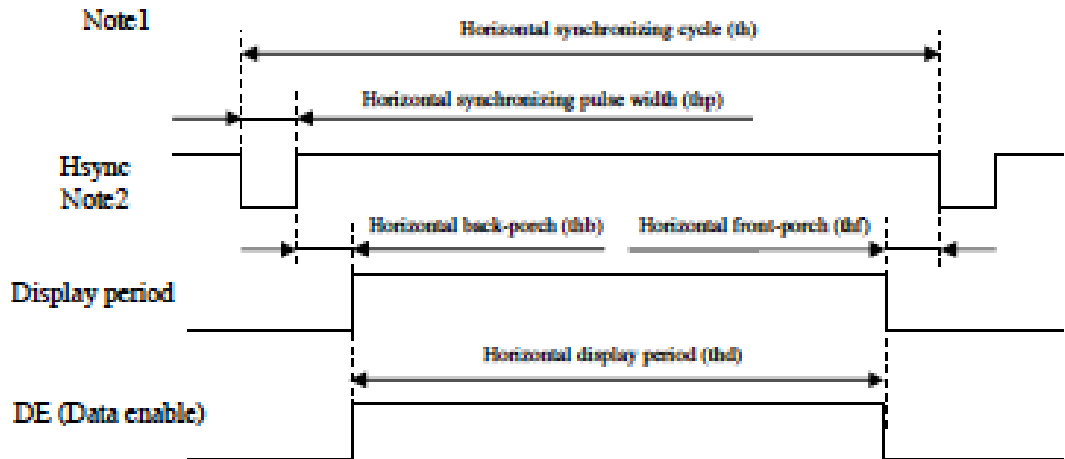
C (X, Y): The coordinates of the display position (See "4.7 DISPLAY POSITIONS".)

D (X, Y): The data number of input signal for LCD panel signal processing board

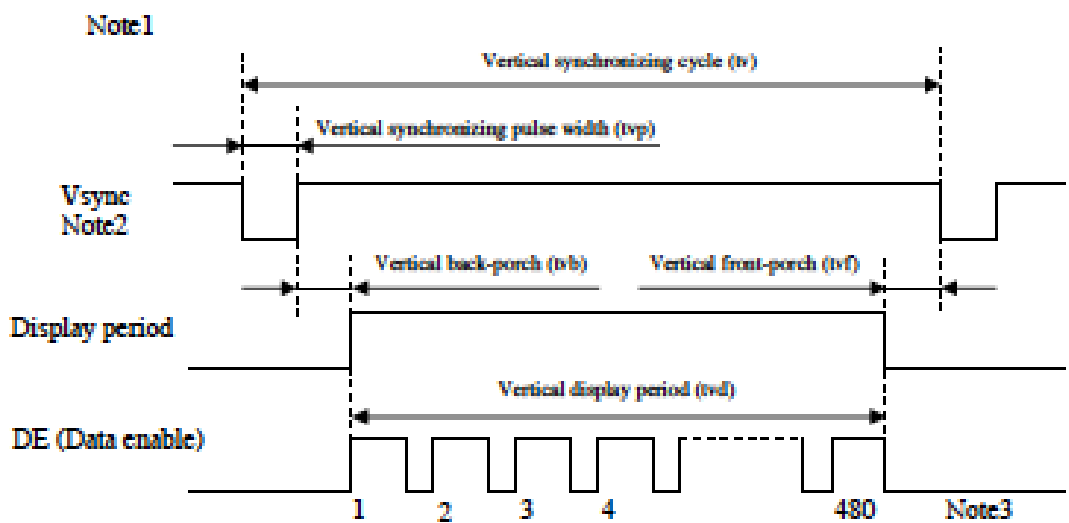
4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

- Horizontal signal



- Vertical signal



Note1: This diagram indicates virtual signal for set up to timing.

Note2: Fixed mode cannot be used while working of DE mode.

Note3: See "4.9.3 Input signal timing chart" for the pulse number.

4.9.2 Timing characteristics

(a) Fixed mode

(Note1)

Parameter		Symbol	min.	typ	max.	Unit	Remarks	
CLK	Frequency	1/te	21.0	25.175	29.0	MHz	39.72 ns (typ.)	
	Duty	ted	0.4	0.5	0.6	-	-	
	Rise time, Fall time	tcrf	-	-	10	ns	-	
DATA (R0-R5) (G0-G5) (B0-B5)	CLK-DATA	Setup time	tds	3	-	-	ns	-
		Hold time	tdh	5	-	-	ns	
	Rise time, Fall time	tdrf	-	-	10	ns		
Hsync	Cycle	th	30.0	31.778	33.6	µs	31.468 kHz (typ.)	
			800			CLK	-	
	Display period	thd	640			CLK		
	Front-porch	thf	16			CLK		
	Pulse width	thp	10	96	-	CLK		
	Back-porch	thb	-	48	134	CLK		
	Total of pulse width and back-porch	thp + thb	144			CLK		Note2
	CLK- Hsync	Setup time	ths	3	-	-	ns	-
		Hold time	thh	5	-	-	ns	
	Rise time, Fall time	thrf	-	-	10	ns		
Vsync	Cycle	tv	16.1	16.683	17.2	ms	59.94 Hz (typ.)	
			525			H	-	
	Display period	tvd	480			H		
	Front-porch	tvf	12			H		
	Pulse width	tvp	1	2	-	H		
	Back-porch	tvb	-	31	32	H		
	Total of pulse width and back-porch	tvp + tvb	33			H		Note2
	Hsync-Vsync	Setup time	tvhs	3	-	-	ns	-
		Hold time	tvhh	5	-	-	ns	
	Rise time, Fall time	tvrf	-	-	10	ns		

Note1: Definition of parameters is as follows.

te = 1CLK, ted = tch/te, th = 1H

Note2: Keep tvp + tvb and thp + thb within the table. If it is out of specification, display position will be shifted to right/left side or up/down.

PRELIMINARY

NLT Technologies, Ltd.

NL6448AC33-97D

(b) DE mode

(Note1, Note2, Note3)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks	
CLK	Frequency	1/te	21.0	25.175	29.0	MHz	39.72 ns (typ.)	
	Duty	ted	0.4	0.5	0.6	-	-	
	CLK high period	tch	7	-	-	ns		
	CLK low period	tel	7	-	-	ns		
	Rise time, Fall time	trf	-	-	10	ns		
DATA (R0-R5) (G0-G5) (B0-B5)	CLK-DATA	Setup time	tds	3	-	-	ns	-
		Hold time	tdh	5	-	-	ns	
	Rise time, Fall time	trf	-	-	10	ns		
DE	Horizontal	Cycle	th	30.0	31.778	33.6	μs	31.468 kHz (typ.)
		Display period	thd	-	800	-	CLK	-
	Vertical (One frame)	Cycle	tv	16.1	16.683	17.2	ms	59.94 Hz (typ.)
		Display period	tvd	-	525	-	H	-
	CLK-DE	Setup time	tdes	3	-	-	ns	-
		Hold time	tdeh	5	-	-	ns	
		Rise time, Fall time	trf	-	-	10	ns	

Note1: Definition of parameters is as follows.

te = 1CLK, ted = tch/te, th = 1H

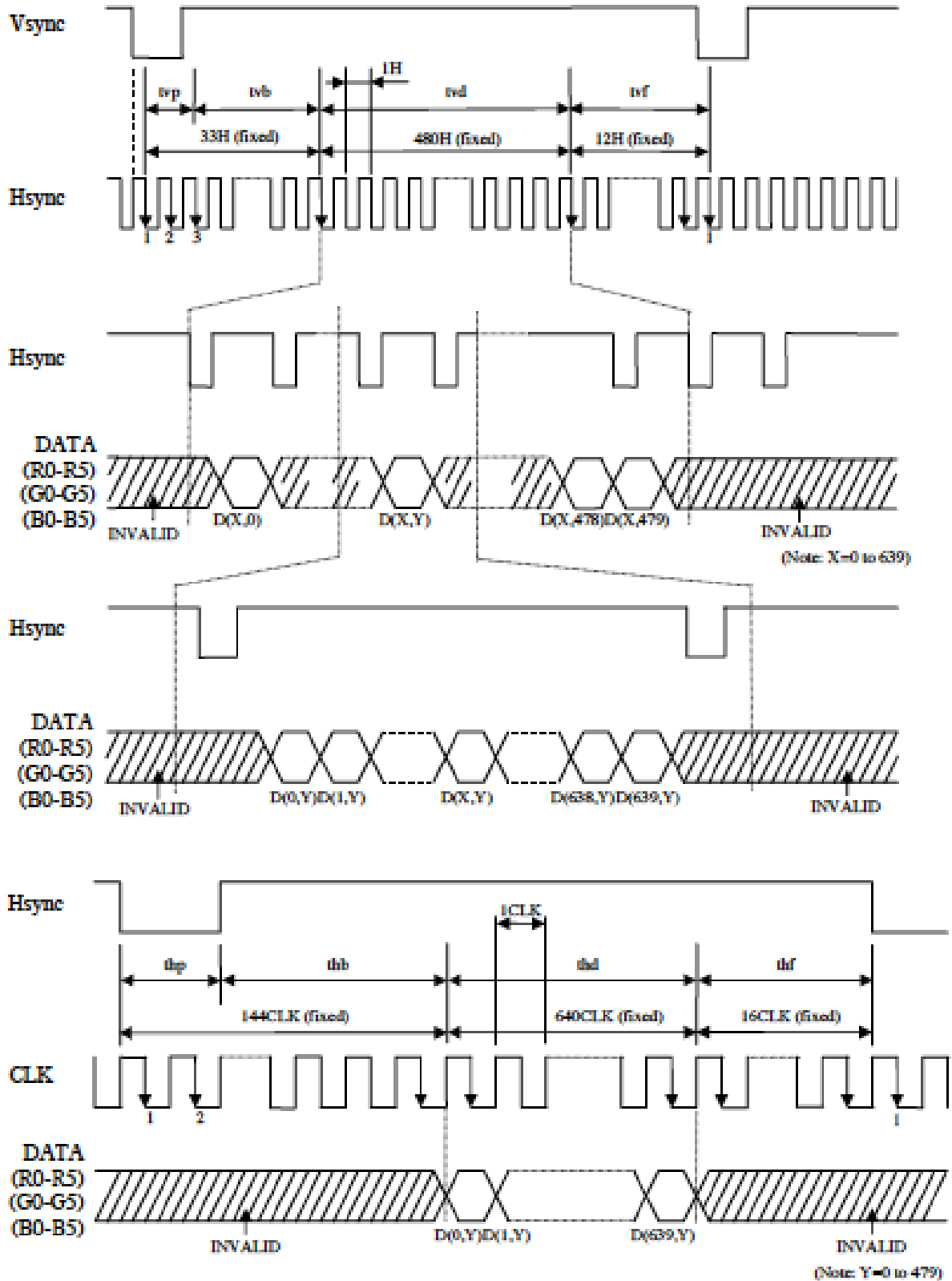
Note2: Hsync signal (Pin No.3 of CN1) and Vsync signal (Pin No.4 of CN1) are not used inside the product at DE mode.

Do not keep pin open to avoid noise problem.

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

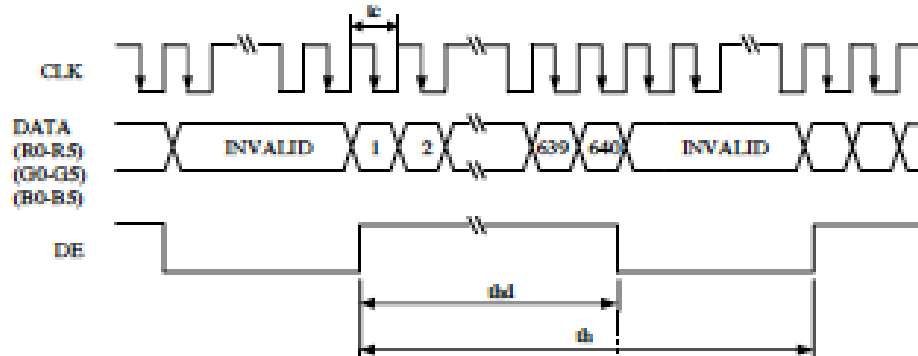
4.9.3 Input signal timing chart

(a) Fixed mode

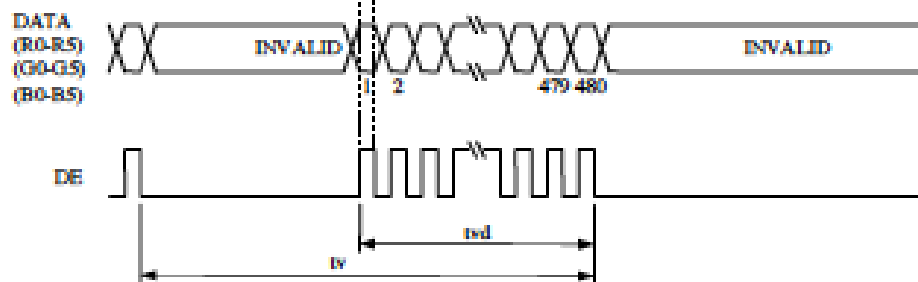


(b) DE mode

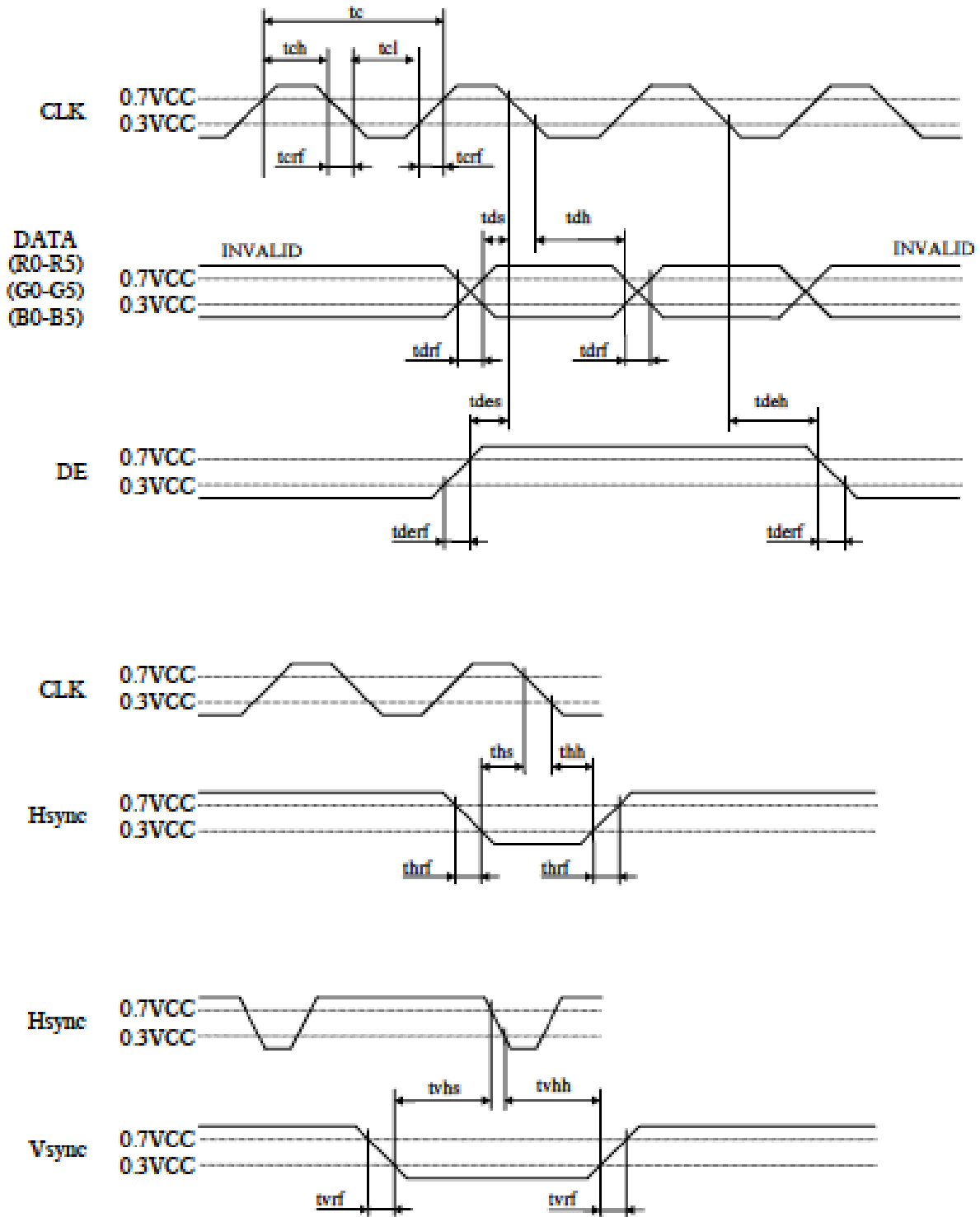
Horizontal timing



Vertical timing



(c) Common item of Fixed mode and DE mode



4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

Parameter	Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks	
Luminance	White at center 6R= 0°, 6L= 0°, 6U= 0°, 6D= 0°	L	TBD	(300)	-	cd/m ²	BM-5A	PWM=11	
Contrast ratio	White/Black at center 6R= 0°, 6L= 0°, 6U= 0°, 6D= 0°	CR	(500)	(900)	-	-	BM-5A	Note3	
Luminance uniformity	White 6R= 0°, 6L= 0°, 6U= 0°, 6D= 0°	LU	-	1.25	1.4	-	BM-5A	Note4	
Chromaticity	White	x coordinate	Wx	-	0.313	-	-	SR-3	Note5
		y coordinate	Wy	-	0.329	-	-		
	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	6R= 0°, 6L= 0°, 6U= 0°, 6D= 0° at center, against NTSC color space	C	35	40	-	%			
Response time	White to Black	Ton	-	TBD	TBD	ms	BM-5A	Note6	
	Black to White	Toff	-	TBD	TBD	ms	-10000	Note7	
Viewing angle	Right	6U= 0°, 6D= 0°, CR≥ 10	6R	TBD	70	-	EZ Contrast	Note8	
	Left	6U= 0°, 6D= 0°, CR≥ 10	6L	TBD	70	-			
	Up	6R= 0°, 6L= 0°, CR≥ 10	6U	TBD	40	-			
	Down	6R= 0°, 6L= 0°, CR≥ 10	6D	TBD	70	-			

Note1: These are initial characteristics.

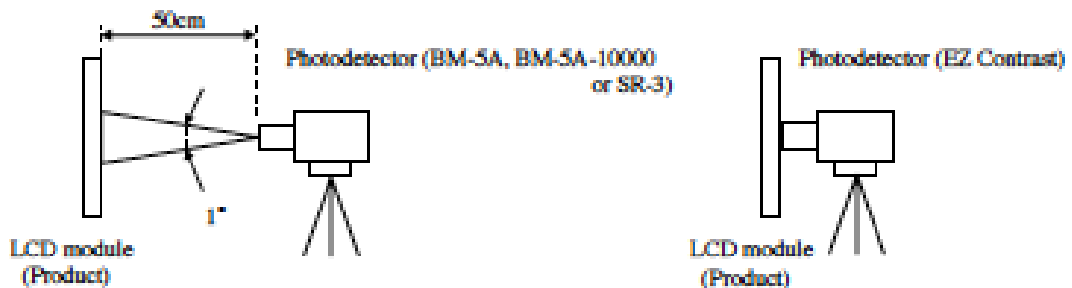
Note2: Measurement conditions are as follows.

Ta=25°C, VOC=5.0V, VDD= 12.0V, PWM: Duty 100%

Display mode: VGA, Horizontal cycle = 1/31.468kHz, Vertical cycle = 1/59.94Hz,

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 "4.10.2 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.

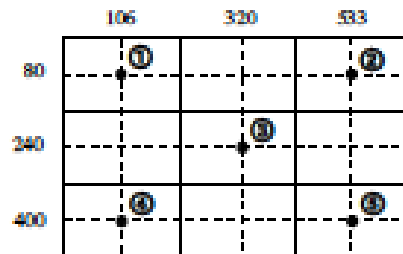
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

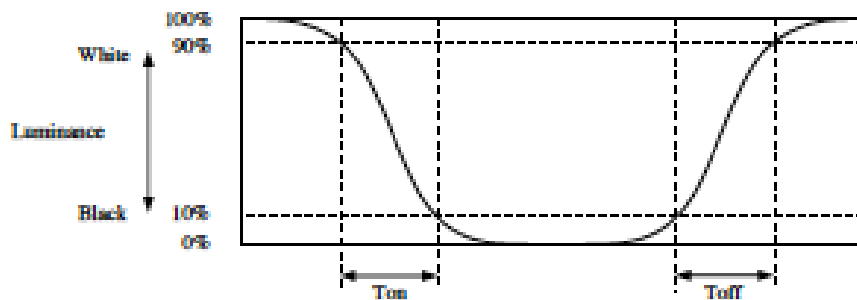
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

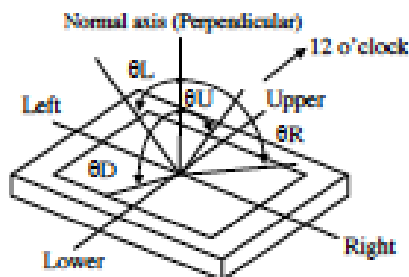


4.10.4 Definition of response times

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.)



4.10.5 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: 100%	100,000	h
	70°C (Ambient temperature of the product) Continuous operation, PWM Duty: 100%	70,000	

Note1: Life time expectancy is mean time to half-luminance.

Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.

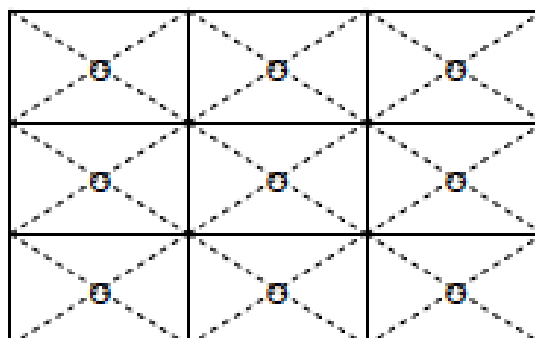
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① $60 \pm 2^{\circ}\text{C}$, RH = 90%, 240hours ② Display data is black.	No display malfunctions	
High temperature (Operation)	① $70 \pm 3^{\circ}\text{C}$, 240hours ② Display data is black.		
Heat cycle (Operation)	① $-20 \pm 3^{\circ}\text{C}$...1hour $70 \pm 3^{\circ}\text{C}$...1hour ② 50cycles, 4hours/cycle ③ Display data is black.		
Thermal shock (Non operation)	① $-30 \pm 3^{\circ}\text{C}$...30minutes $80 \pm 3^{\circ}\text{C}$...30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.		
ESD (Operation)	① 150pF, 150 Ω , $\pm 10\text{kV}$ 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, 19.60m/s ² ② 1 minute/cycle ③ X, Y, Z directions ④ 120 times each directions		
Mechanical shock (Non operation)	① 539m/s ² , 11ms ② X, Y, Z directions ③ 5 times each directions		

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

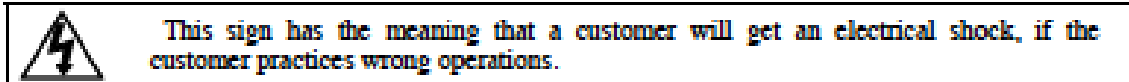
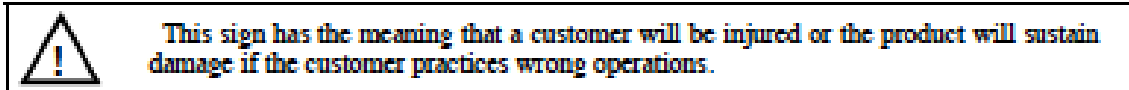
Note2: See the following figure for discharge points.



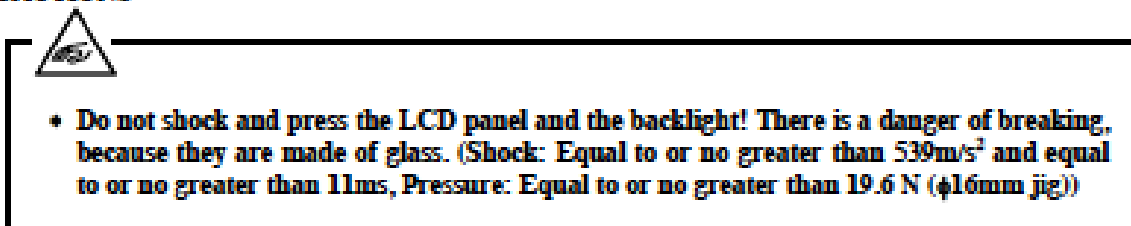
7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!



7.2 CAUTIONS



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 $0.294\text{N}\cdot\text{m}$. Higher torque might result in distortion of the bezel.
- ⑤ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
- ⑥ Do not press or rub on the sensitive product surface. When cleaning the product 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.

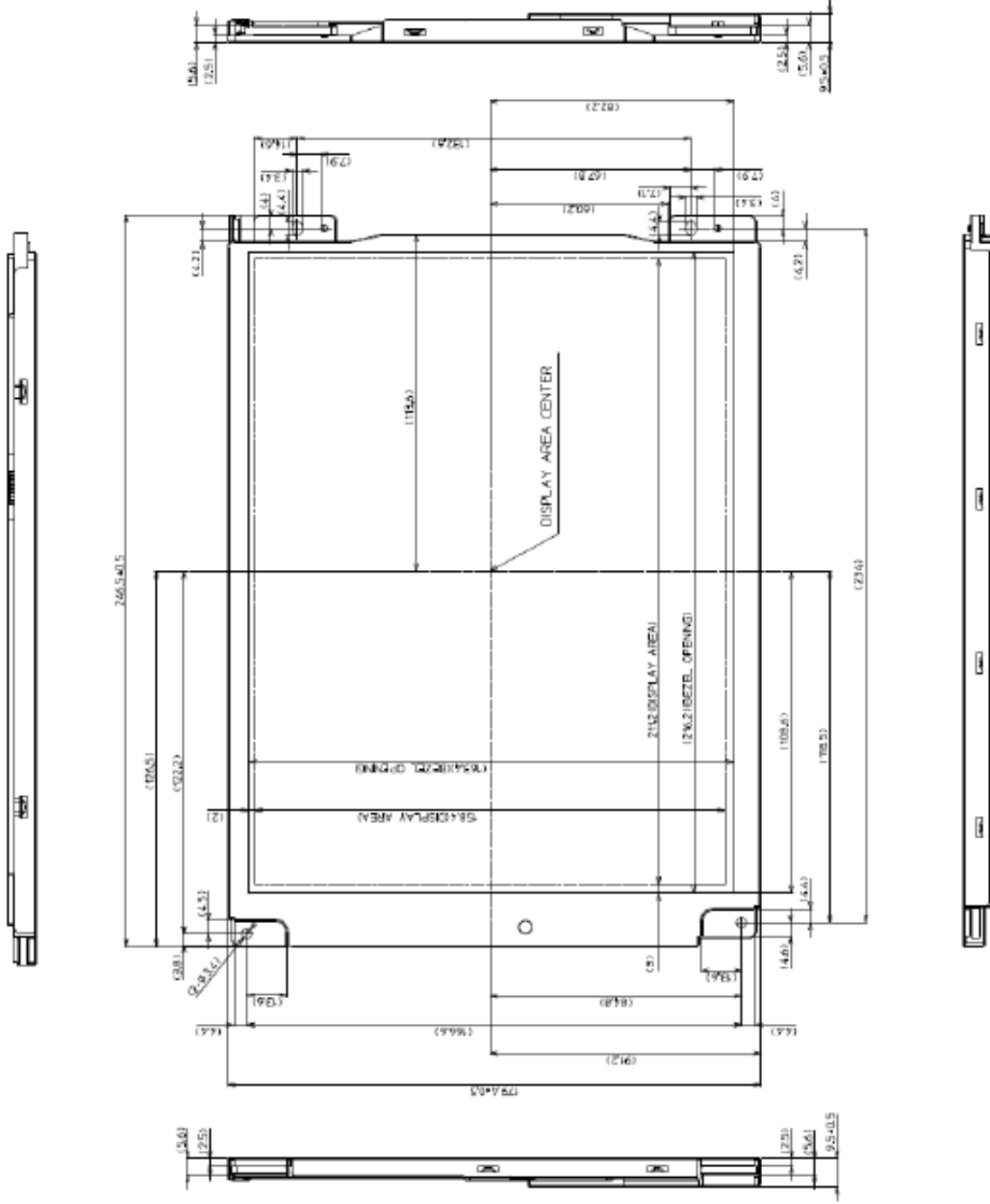
- ① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough 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 and VCC terminals should be used without any non-connected lines.
- ② Do not disassemble a product or adjust variable resistors.
- ③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing backlight lamps.
- ④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.

8. OUTLINE DRAWINGS

8.1 FRONT VIEW

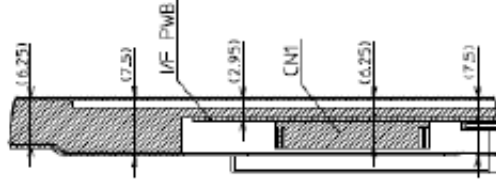
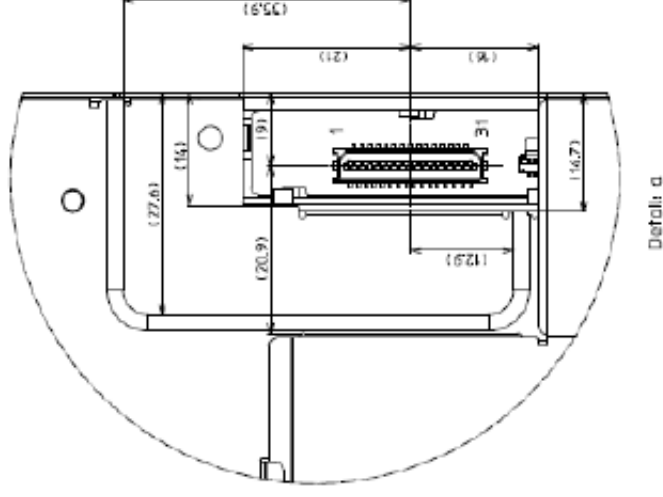
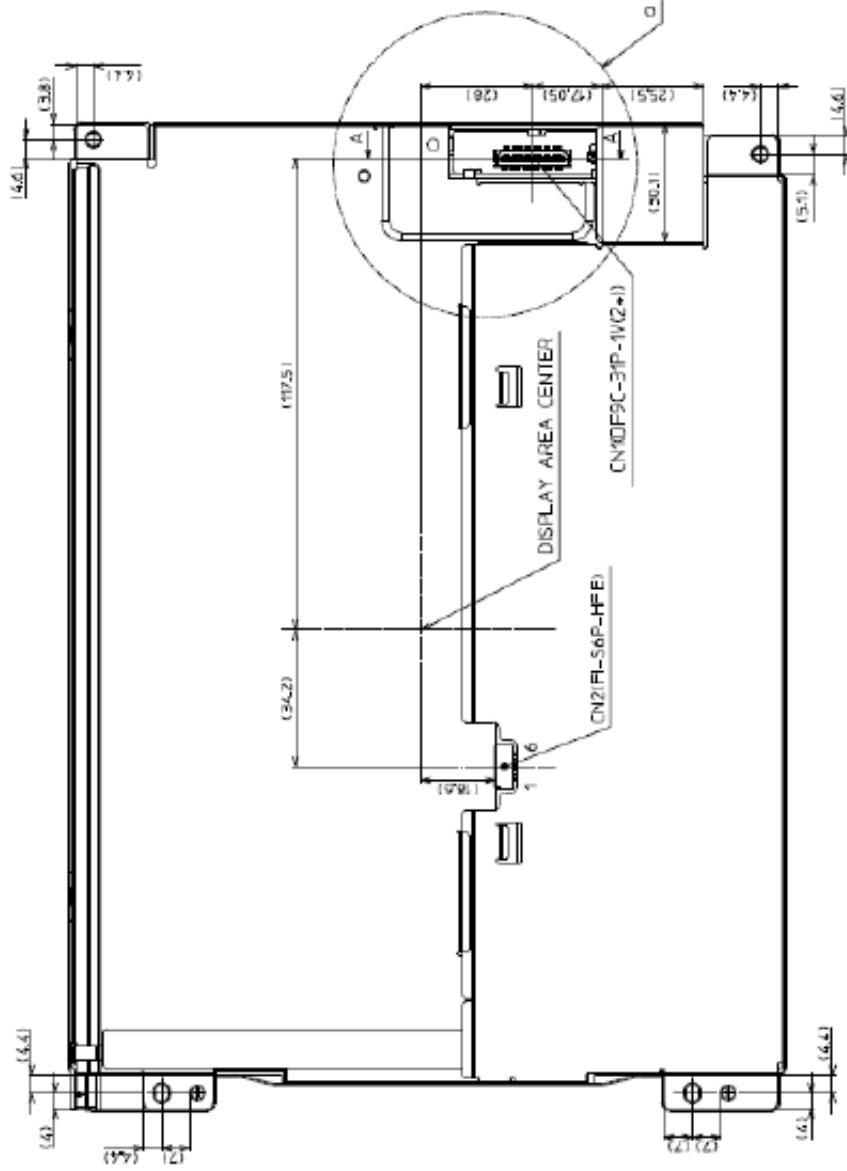


Note 1: The values in parentheses are for reference.

Note 2: The torque for product mounting screws must never exceed 0.294N-m.

Unit: mm

8.2 REAR VIEW





Section: A-A

Unit: mm

Note 1: The values in parentheses are for reference.
 Note 2: The torque for product mounting screws must never exceed 0.294N.m.

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	DGD-PP-1597	Mar. 11, 2013	<p>Revision contents</p> <p>New issue</p> <p>Signature of writer <i>Approved by</i>  <hr style="width: 100%;"/> K. FUJIMOTO</p> <p style="text-align: center;"><i>Checked by</i> <hr style="width: 100%;"/></p> <p style="text-align: right;"><i>Prepared by</i>  <hr style="width: 100%;"/> E. YOSHIMURA</p>