



TFT COLOR LCD MODULE

NL6448AC33-A1D

26cm (10.4 Type)

VGA

DATA SHEET

DOD-PP-3102 (2nd edition)

**This DATA SHEET is updated document from
DOD-PP-2590(1)**

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Please confirm the sales representative before
starting to design your system.**

INTRODUCTION

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

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

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

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL6448AC33-A1D 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

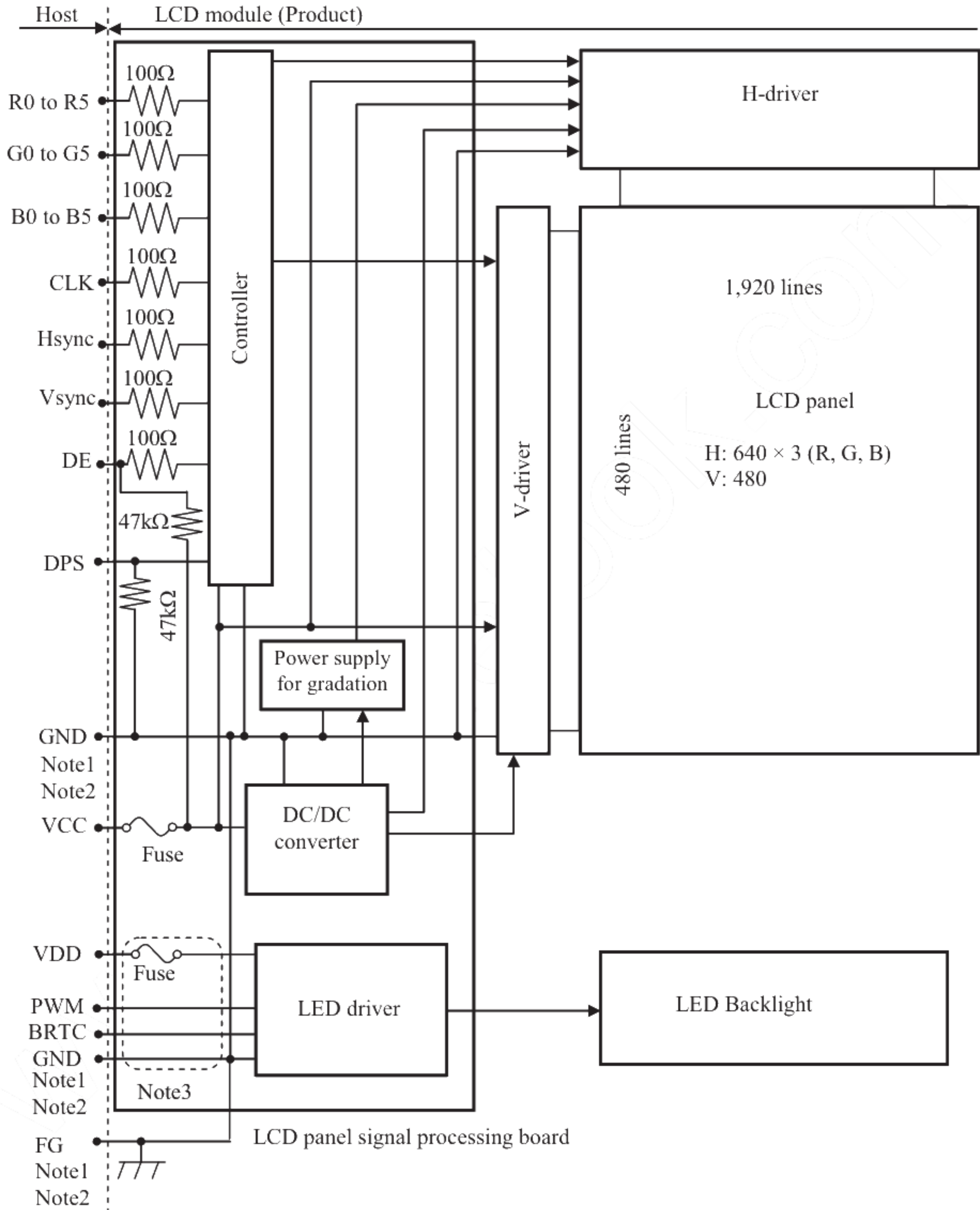
- Wide temperature range
- 6-bit digital RGB signals
- Reversible-scan direction
- DE (Data enable) function
- Long life LED backlight built in LED driver
- Acquisition product for UL60950-1/CSA-C22.2 No.60950-1-03 (File number: E170632)
- Compliant with the European RoHS directive (2011/65/EU)

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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>	227.3 (W) × 177.5 (H) × 9.3(D) mm (typ.)
<i>Weight</i>	380g (typ.)
<i>Contrast ratio</i>	900:1 (typ.)
<i>Viewing angle</i>	<p><i>At the contrast ratio ≥ 10:1</i></p> <ul style="list-style-type: none"> • Horizontal: Right side 80° (typ.), Left side 80° (typ.) • Vertical: Up side 80° (typ.), Down side 80° (typ.)
<i>Designed viewing direction</i>	<p><i>At DPS= Low or Open: Normal scan</i></p> <ul style="list-style-type: none"> • Viewing direction without image reversal: Up side (12 o'clock) • Viewing direction with contrast peak: Down side (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>	<p><i>At LCD panel center</i></p> <p>40% (typ.) [against NTSC color space]</p>
<i>Response time</i>	<p><i>Ton+Toff (10%←→90%)</i></p> <p>18ms (typ.)</p>
<i>Luminance</i>	<p><i>At the maximum luminance control</i></p> <p>370cd/m² (typ.)</p>
<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: 12.0V
<i>Backlight</i>	LED backlight built in LED driver
<i>Power consumption</i>	<p><i>At the maximum luminance control, Checkered flag pattern.</i></p> <p>3.3W (typ.)</p>

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.

Note3: See "4.3.4 Equivalent circuit at input part"

4. DETAILED SPECIFICATIONS
4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	227.3 ± 0.5 (W) × 177.5 ± 0.5 (H) × 9.3 ± 0.5 (D) Note1	mm
Display area	211.2 (H) × 158.4 (V) Note1	mm
Weight	380 (typ.), 420 (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 driver	VDD	-0.3 to +15.0	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	-30 to +80	°C		Note3
	Rear surface	TopR	-30 to +80	°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	
Absolute humidity Note5		AH	≤ 70 Note6	g/m ³	Ta= 80°C	

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

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= 80°C and RH= 24%

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	at VCC= 3.3V
		4.5	5.0	5.5	V	at VCC= 5.0V
Power supply current	ICC	-	230 Note2	300 Note3	mA	at VCC= 3.3V
		-	150 Note2	200 Note3	mA	at VCC= 5.0V
Permissible ripple voltage	VRPC	-	-	100	mVp-p	for VCC Note4, Note5, Note6
Logic input voltage for display signals	High	VDH	0.7VCC	-	VCC	V CMOS level
	Low	VDL	0	-	0.3VCC	
Input voltage for DPS signal	High	VFH	0.7VCC	-	VCC	
	Low	VFL	0	-	0.3VCC	
Input current for DPS signal	High	IFH	-	-	300	μA -
	Low	IFL	-300	-	-	

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.

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	-	210	240 Note2	mA	at VDD = 12.0V, at the maximum luminance control	
Permissible ripple voltage	VRP	-	-	200	mVp-p	for VDD Note3, Note4, Note5	
Input voltage for function signals	PWM	High	VDFH1	2.1	-	5.5	V
		Low	VDFL1	0	-	0.15	V
	BRTC	High	VDFH2	2.1	-	5.5	V
		Low	VDFL2	0	-	0.8	V
Input current for function signals	PWM	High	IDFH1	-	-	300	μA
		Low	IDFL1	-300	-	-	μA
	BRTC	High	IDFH2	-	-	300	μA
		Low	IDFL2	-300	-	-	μA
PWM frequency	f _{PWM}	200	-	1k	Hz	Note7, Note8	
PWM duty ratio	DR _{PWM}	10	-	100	%	Note9, Note10, Note11	
PWM pulse width	tPWH	100	-	-	μs	Note10, Note11	

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 “4.3.4 Equivalent circuit at input part”

Note7: A recommended f_{PWM} value is as follows.

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

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

Note8: Depending on the frequency used, some noise may appear on the screen, please conduct a thorough evaluation.

Note9:

$$DR_{PWM} = \frac{tPWH}{tPW}$$

tPWH: PWM pulse width, tPW: PWM dimming cycle (= 1/fPWM)

Note10: While the BRTC signal is high, do not set the tPWH(PWM pulse width) is less than the minimum value. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.

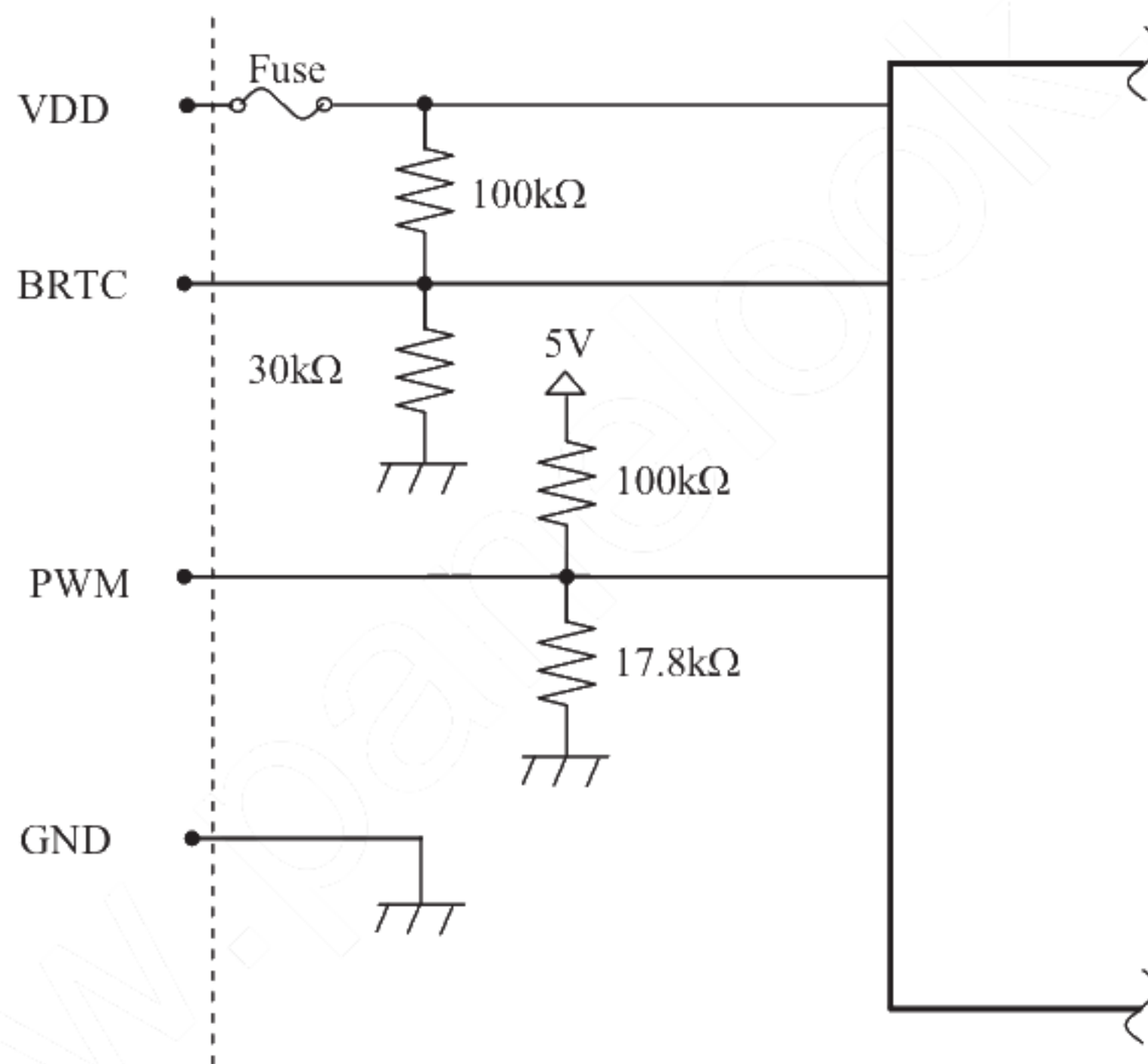
Note11: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum value.

4.3.3 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A	3.0A 5 seconds maximum	Note1
			36V		
VDD	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A	3.0A 5 seconds maximum	
			36V		

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.

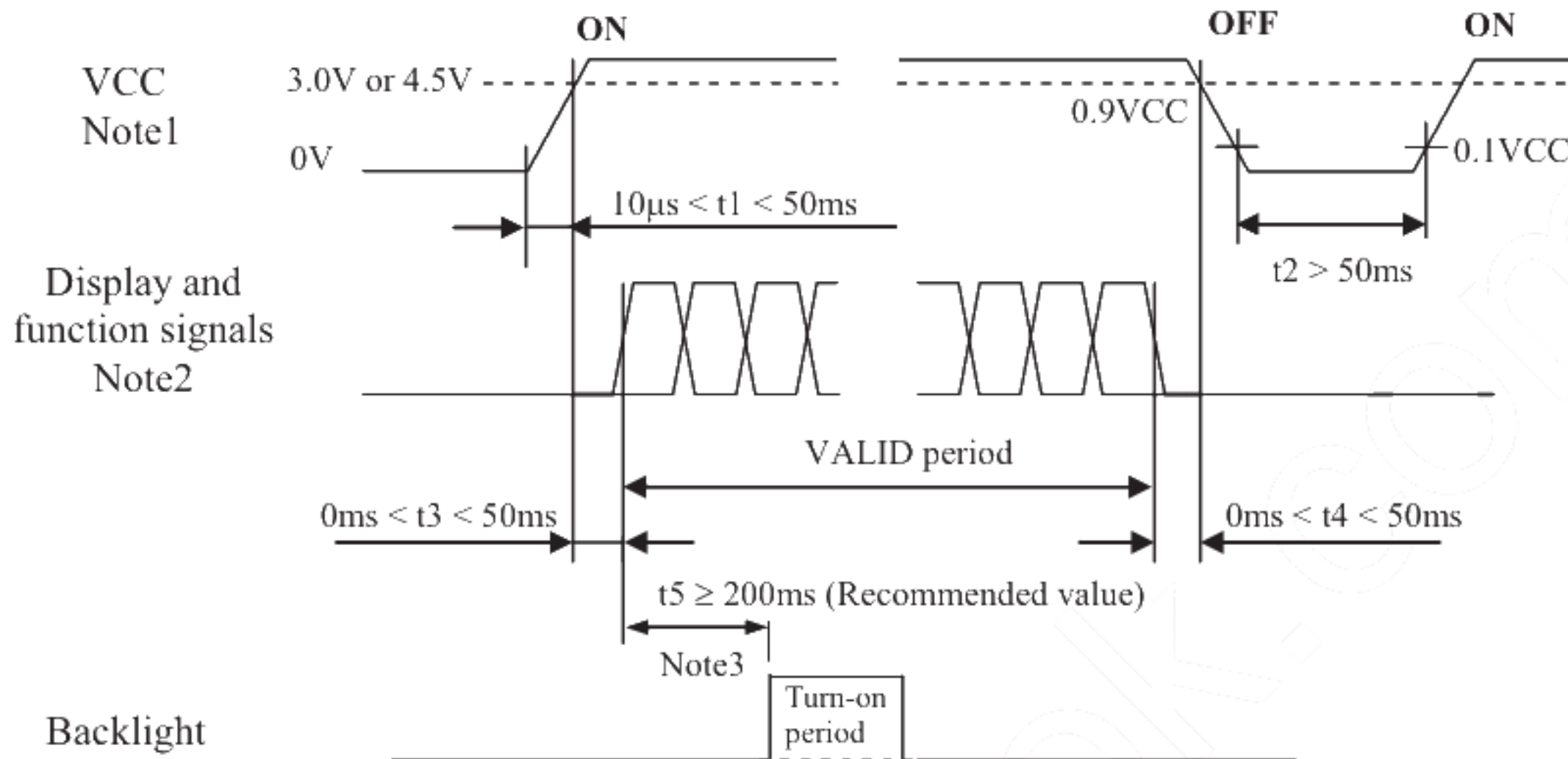
4.3.4 Equivalent circuit at input part



LED driver circuit

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board



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.

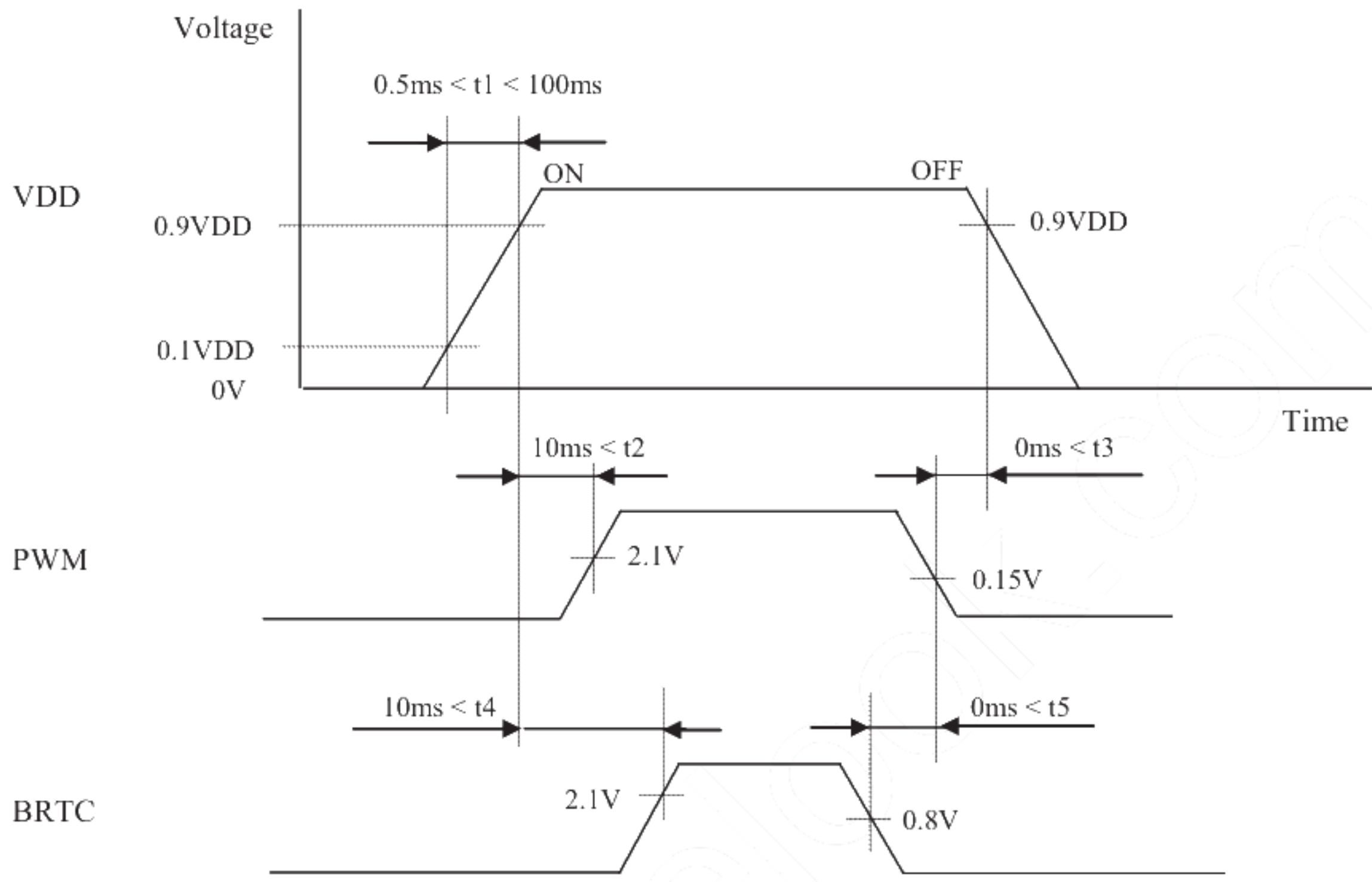
Note2: Display signals (CLK, Hsync, Vsync, DE, DATA (R0 to R5, G0 to G5, B0 to B5)) and function signal (DPS) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.

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.

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: $t_5 \geq 200ms$

4.4.2 LED driver



4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS
4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): FH63F-40S-0.5H (Hirose Electric Co., Ltd. (HRS))

Adaptable plug: 0.5mm pitch, Bottom Contact Type

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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
32 - 40	N. C.	-	Keep this pin Open.

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

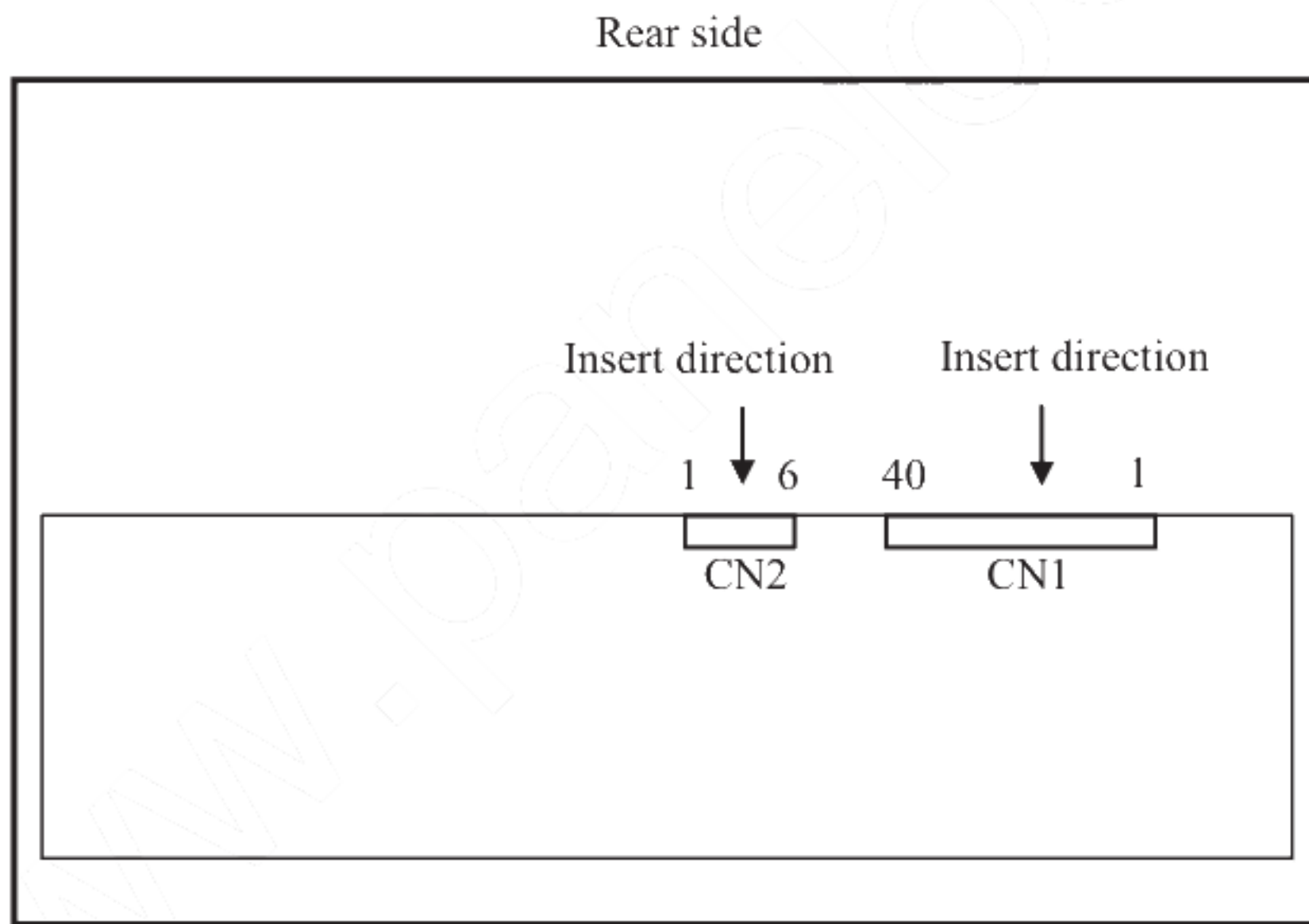
CN2 socket (LCD module side): FI-S6P-HFE (Japan Aviation Electronics Industry Limited (JAE))
 Adaptable plug: FI-S6S (Japan Aviation Electronics Industry Limited (JAE))

Pin No.	Symbol	Signal	Remarks
1	VDD	Power supply	Note1
2	VDD	Power supply	
3	GND	Ground	
4	GND	Ground	
5	BRTC	Backlight ON/OFF control	High or Open: ON Low: OFF
6	PWM	Luminance control	PWM dimming Note2

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

Note2: Please do not leave the PWM terminal Open.

4.5.3 Positions of socket

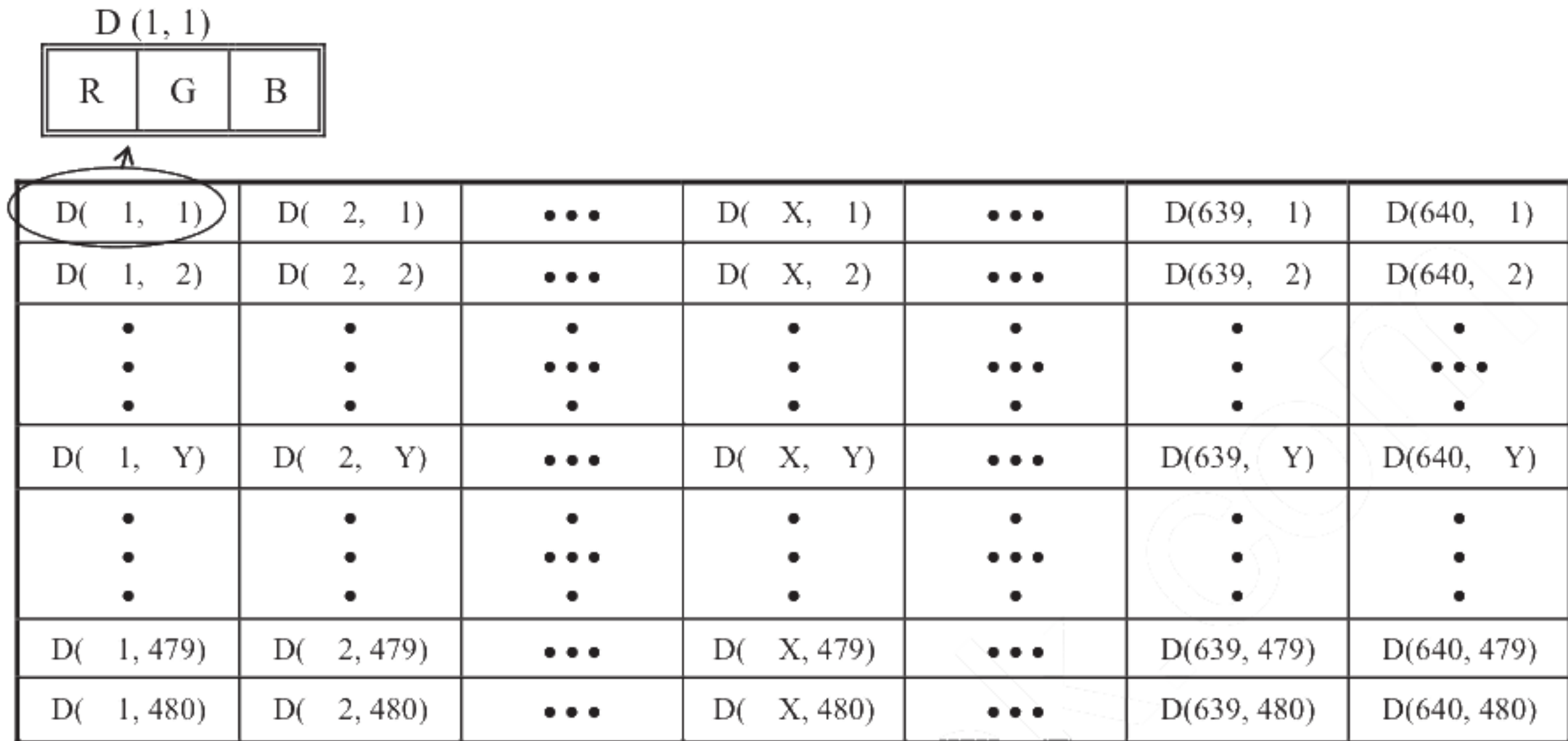


4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

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
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	1	0	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
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	1	0
	↑				:														
	↓				:														
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	↑				:														
	↓				:														
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

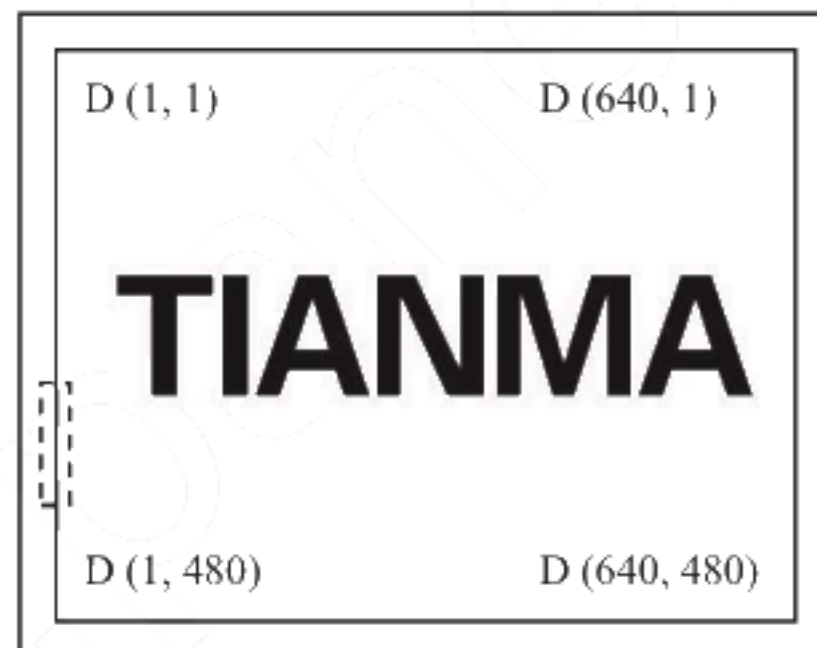
4.7 DISPLAY POSITIONS



Note1: See "4.8 SCANNING DIRECTIONS".

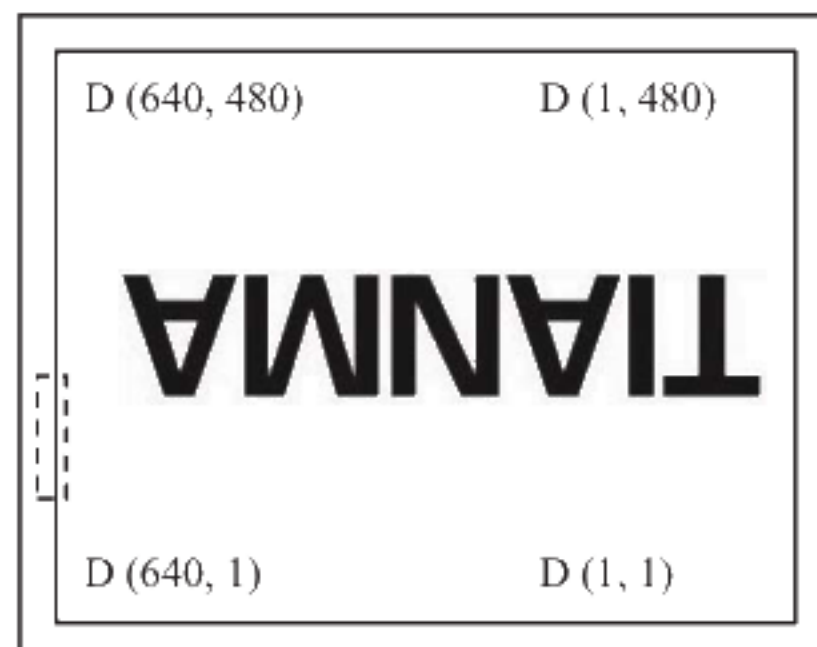
4.8 SCANNING DIRECTIONS

The following figures are seen from a front view.



Note1

Figure1. Normal scan (DPS: Low or Open)



Note1

Figure2. Reverse scan (DPS: High)

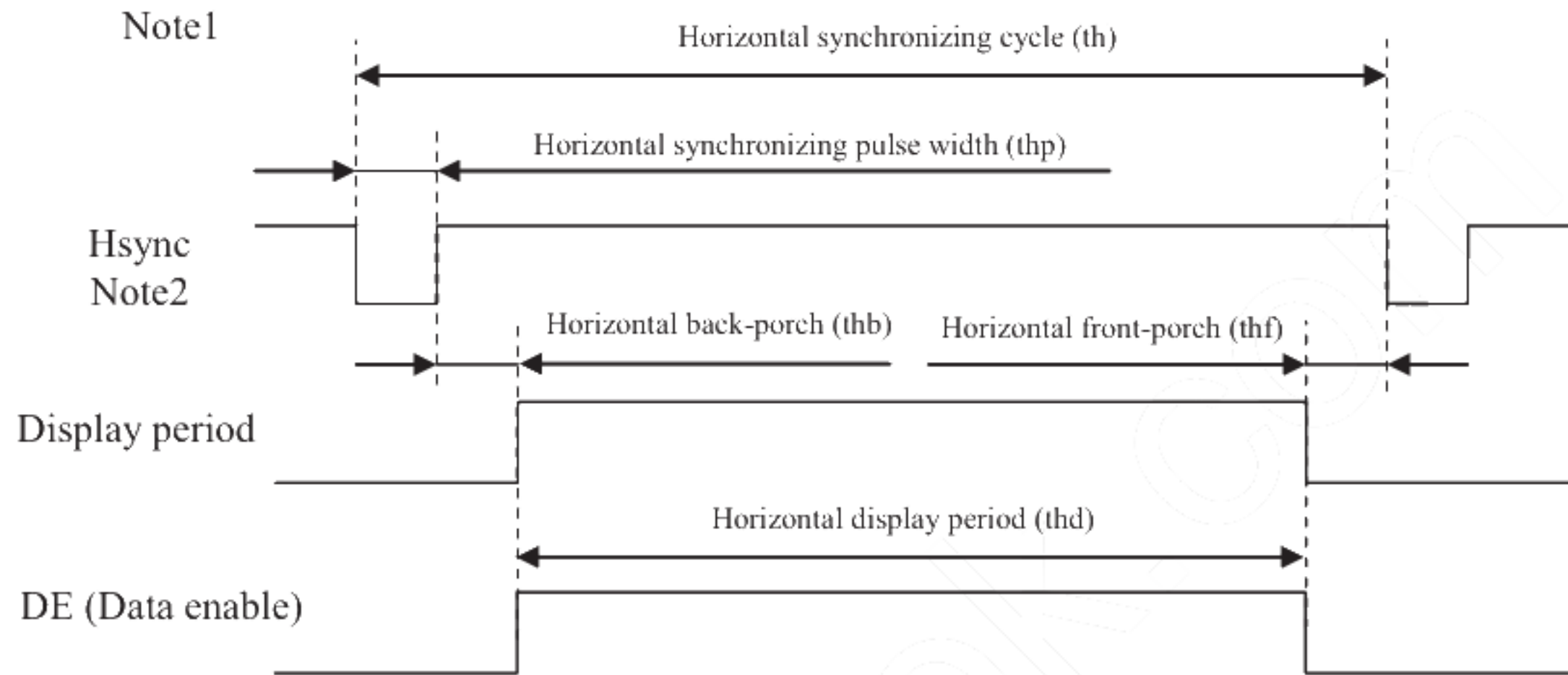
Note1: Meaning of D (X, Y)

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

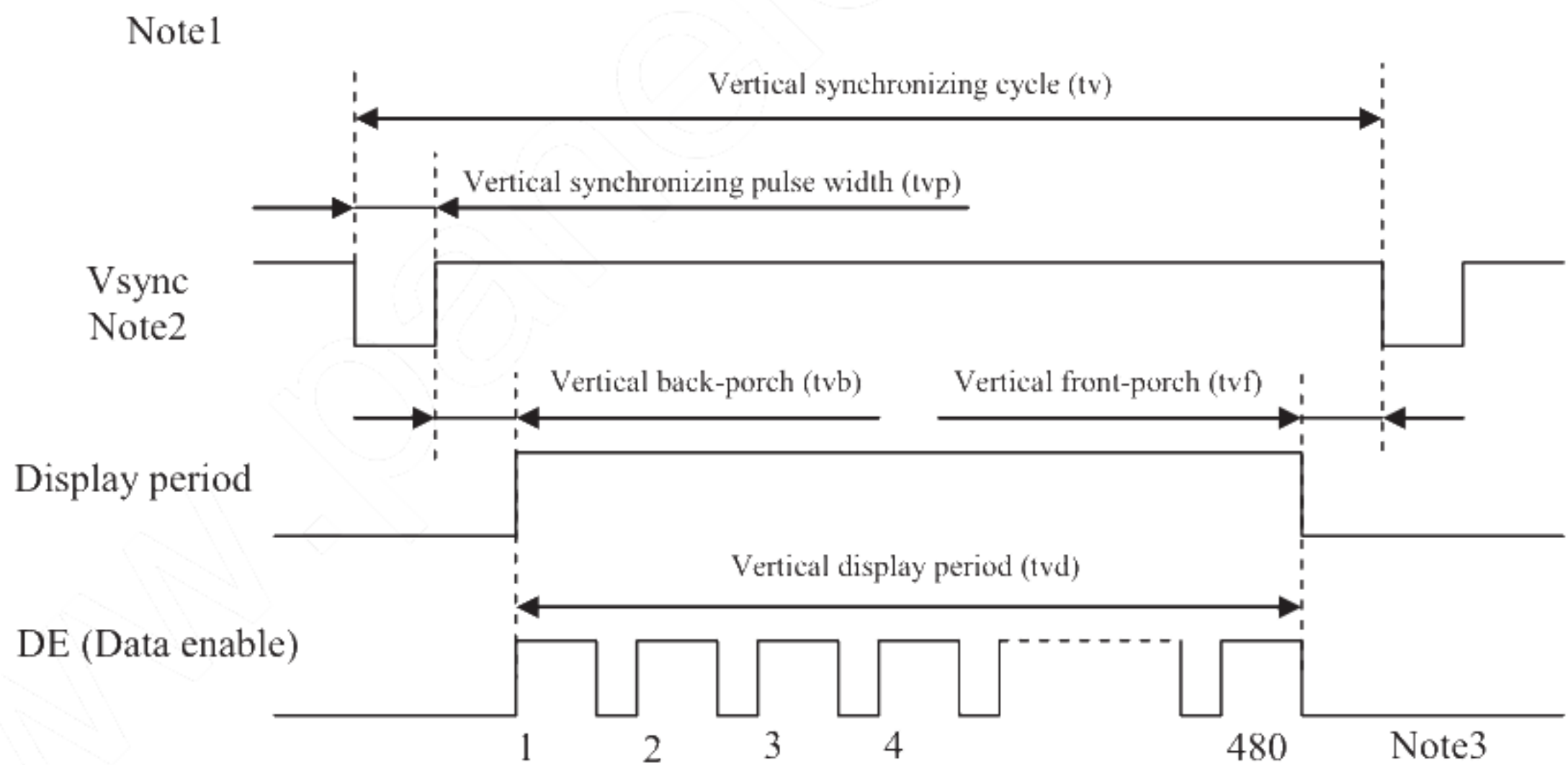
4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

• Horizontal signal



• 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/tc	21.0	25.175	29.0	MHz	39.72ns (typ.)	
	Duty ratio	tcd	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	31.468kHz (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	
	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	59.94Hz (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	
	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.

$$tc = 1CLK, tcd = tch/tc, th = 1H$$

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.

(b) DE mode

(Note1, Note2, Note3)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks	
CLK	Frequency	1/tc	21.0	25.175	29.0	MHz	39.72ns (typ.)	
	Duty ratio	tcd	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		
DE	Horizontal	Cycle	th	30.0	31.778	33.6	μs	31.468kHz (typ.)
				-	800	-	CLK	
	Vertical (One frame)	Cycle	tv	16.1	16.683	17.2	ms	59.94Hz (typ.)
				-	525	-	H	
	CLK-DE	Setup time	tdes	3	-	-	ns	-
		Hold time	tdeh	5	-	-	ns	
	Rise time, Fall time	tderf	-	-	10	ns		

Note1: Definition of parameters is as follows.

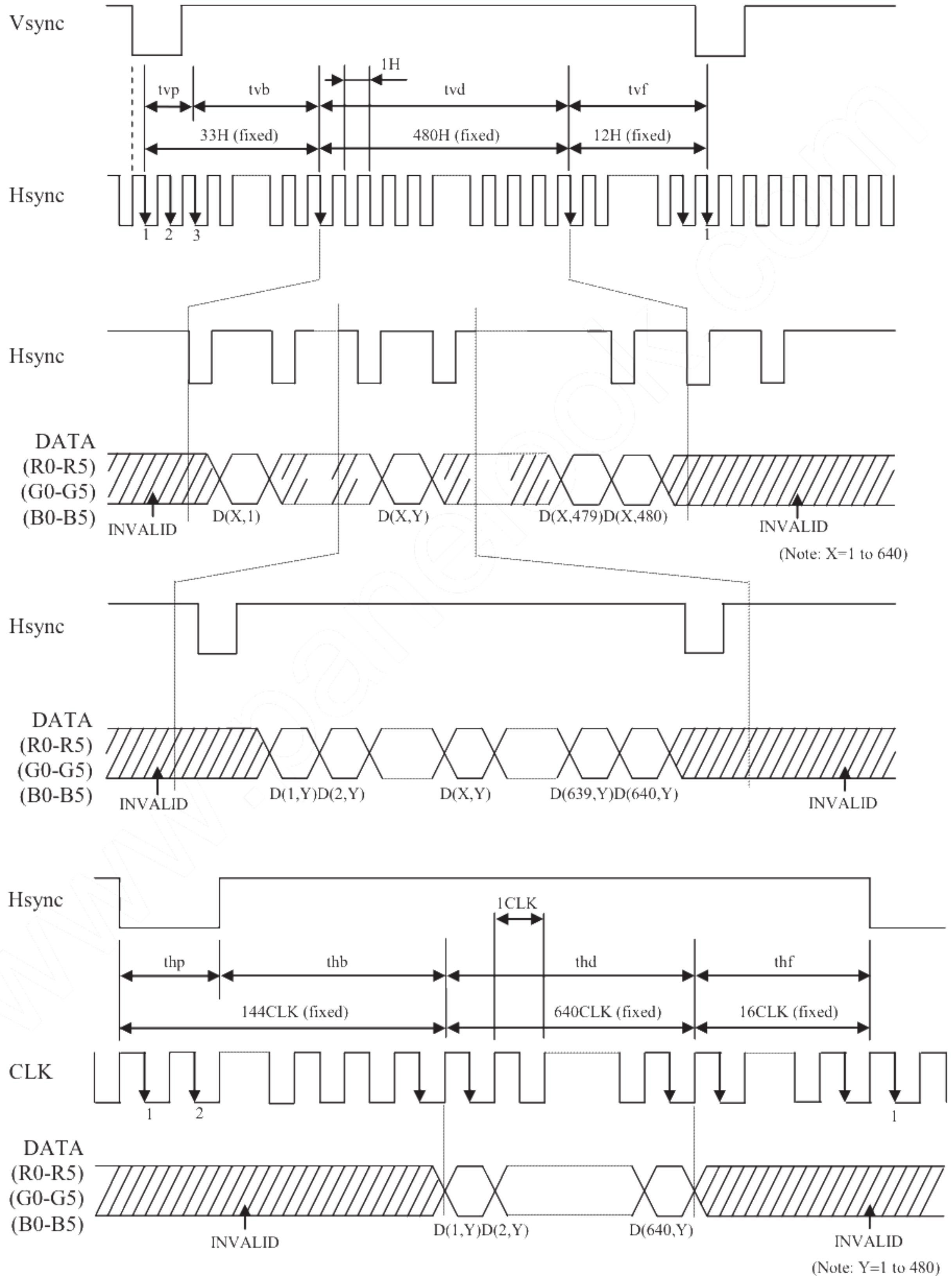
tc = 1CLK, tcd = tch/tc, th = 1H

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 these pins open to avoid noise problem.

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

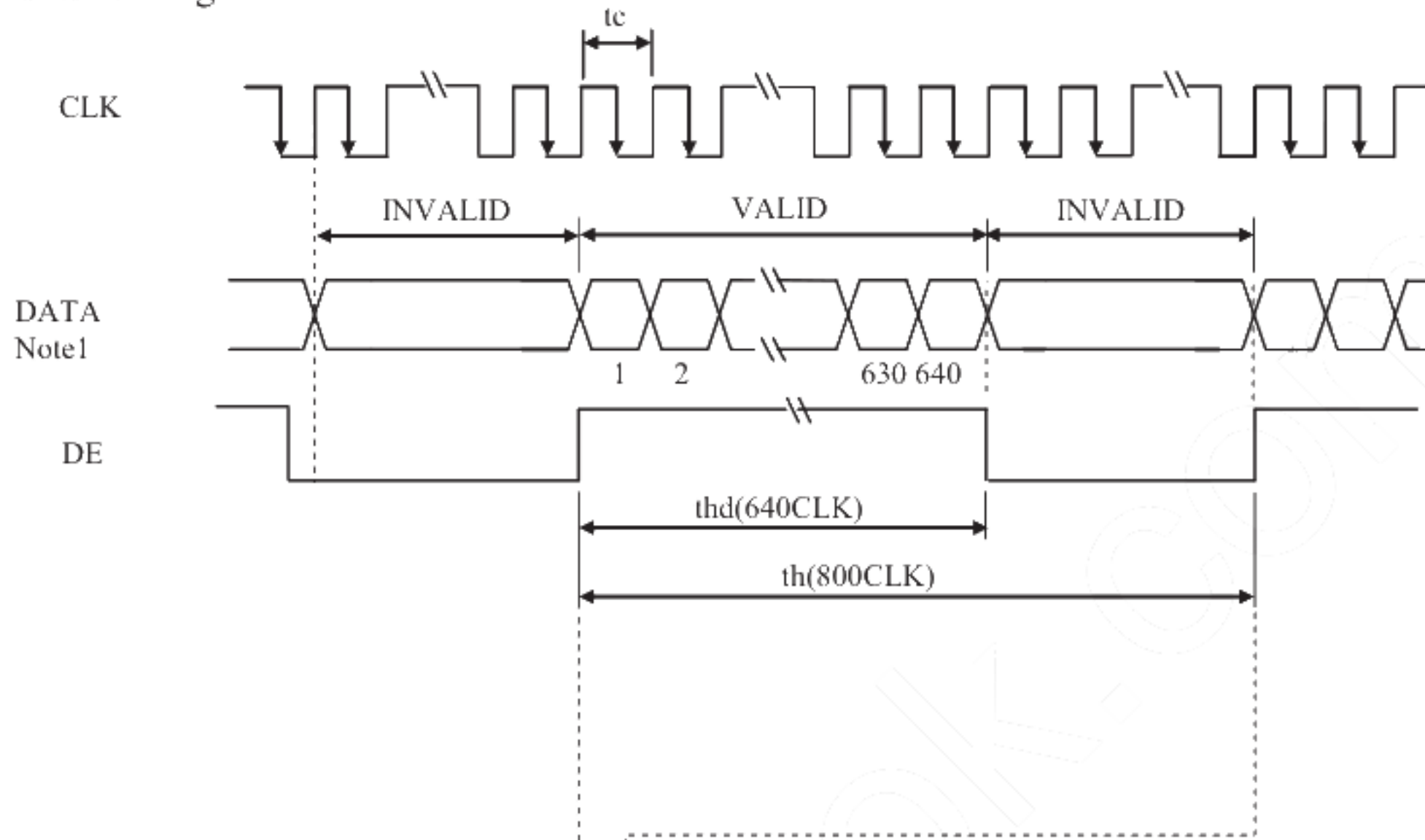
4.9.3 Input signal timing chart

(a) Fixed mode

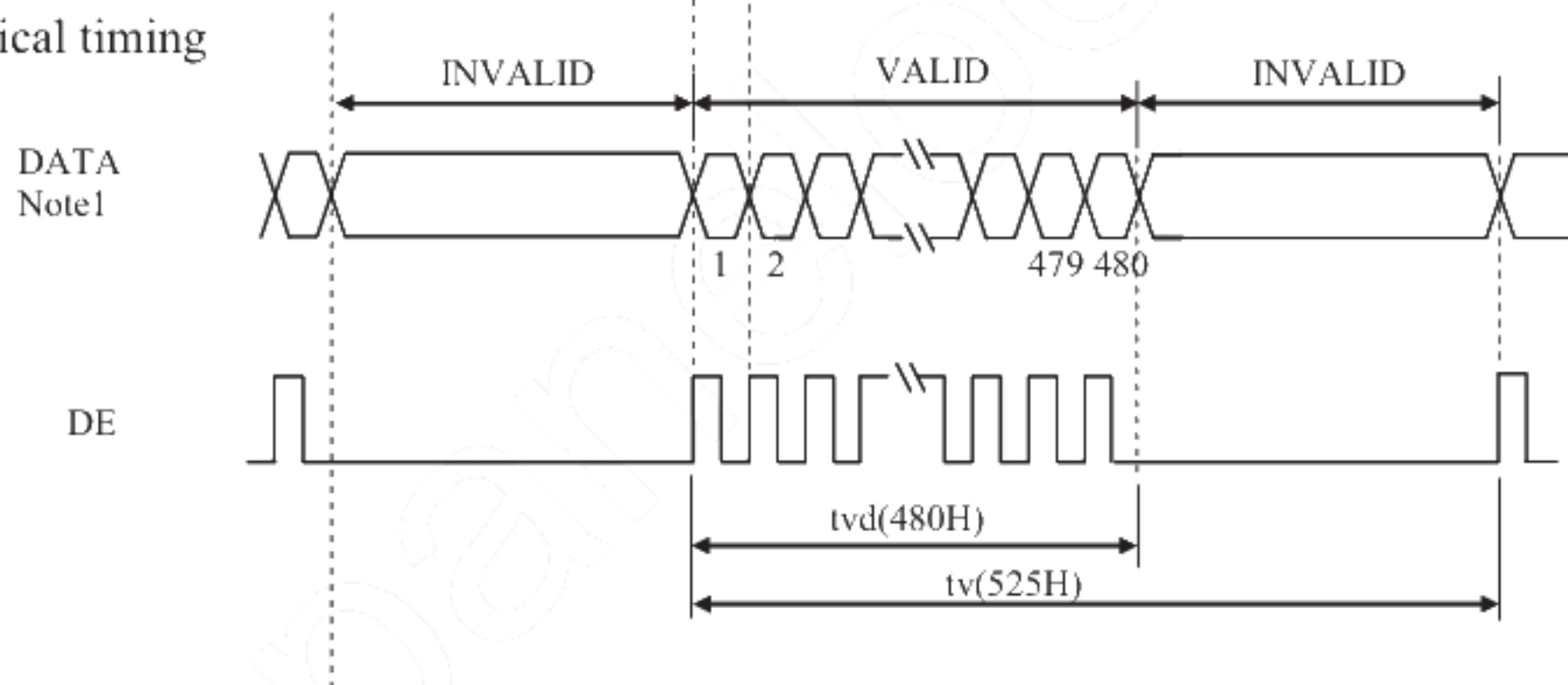


(b) DE mode

Horizontal timing

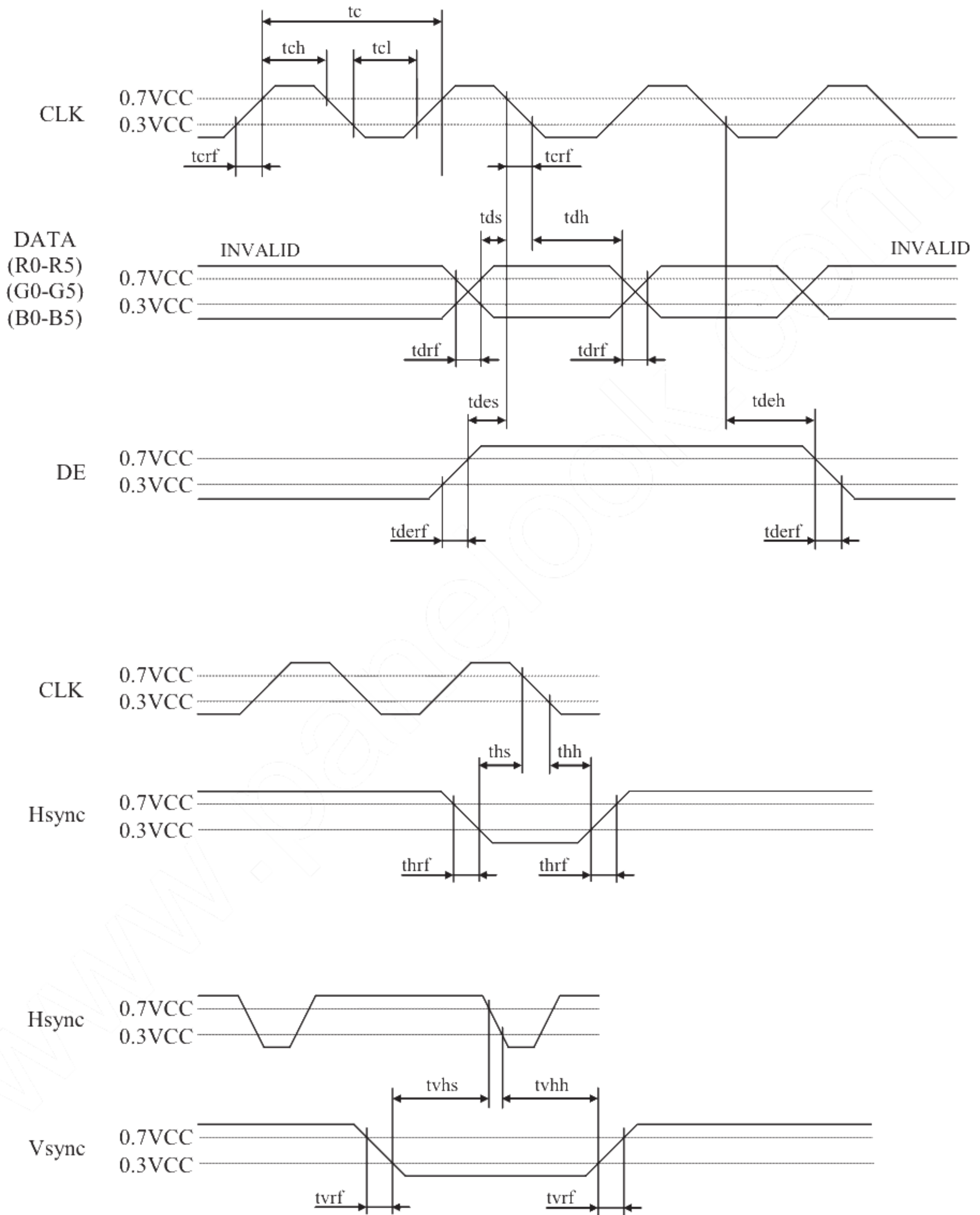


Vertical timing



Note1: DATA = R0-R5, G0-G5, B0-B5

(c) Common item of Fixed mode and DE mode



4.10 OPTICS

4.10.1 Optical characteristics

(Note1, Note2)

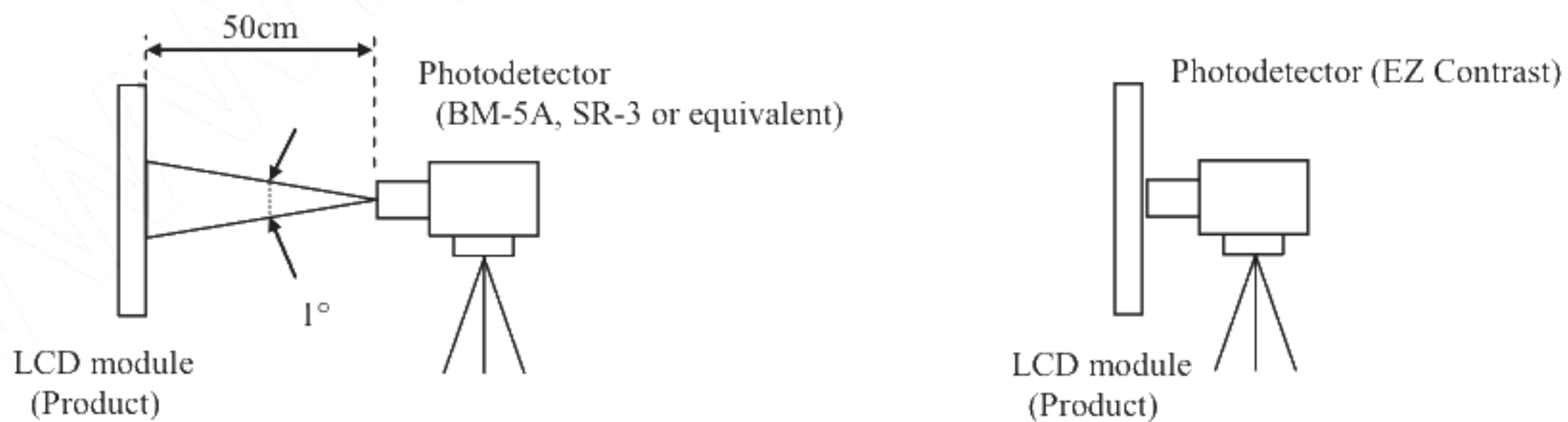
Parameter	Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks	
Luminance	White at center $\theta R=0^\circ, \theta L=0^\circ, \theta U=0^\circ, \theta D=0^\circ$	L	240	370	-	cd/m ²	BM-5A or equivalent	-	
Contrast ratio	White/Black at center $\theta R=0^\circ, \theta L=0^\circ, \theta U=0^\circ, \theta D=0^\circ$	CR	500	900	-	-	BM-5A or equivalent	Note3	
Luminance uniformity	White $\theta R=0^\circ, \theta L=0^\circ, \theta U=0^\circ, \theta D=0^\circ$	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	-	0.568	-	-		
		y coordinate	Ry	-	0.347	-	-		
	Green	x coordinate	Gx	-	0.345	-	-		
		y coordinate	Gy	-	0.565	-	-		
Blue	x coordinate	Bx	-	0.162	-	-			
	y coordinate	By	-	0.145	-	-			
Color gamut	$\theta R=0^\circ, \theta L=0^\circ, \theta U=0^\circ, \theta D=0^\circ$ at center, against NTSC color space	C	35	40	-	%			
Response time	White to Black	Ton	-	3	5	ms	BM-5A or equivalent	Note6	
	Black to White	Toff	-	15	21	ms		Note7	
Viewing angle	Right	$\theta U=0^\circ, \theta D=0^\circ, CR \geq 10$	θR	70	80	-	EZ Contrast	Note8	
	Left	$\theta U=0^\circ, \theta D=0^\circ, CR \geq 10$	θL	70	80	-			
	Up	$\theta R=0^\circ, \theta L=0^\circ, CR \geq 10$	θU	70	80	-			
	Down	$\theta R=0^\circ, \theta L=0^\circ, CR \geq 10$	θD	70	80	-			

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 5.0V, VDD= 12.0V, PWM duty ratio: 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= 28°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.

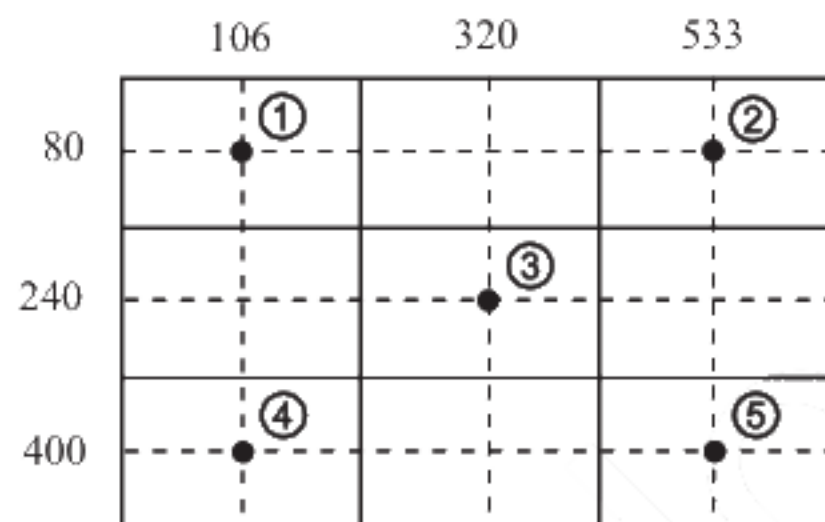
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

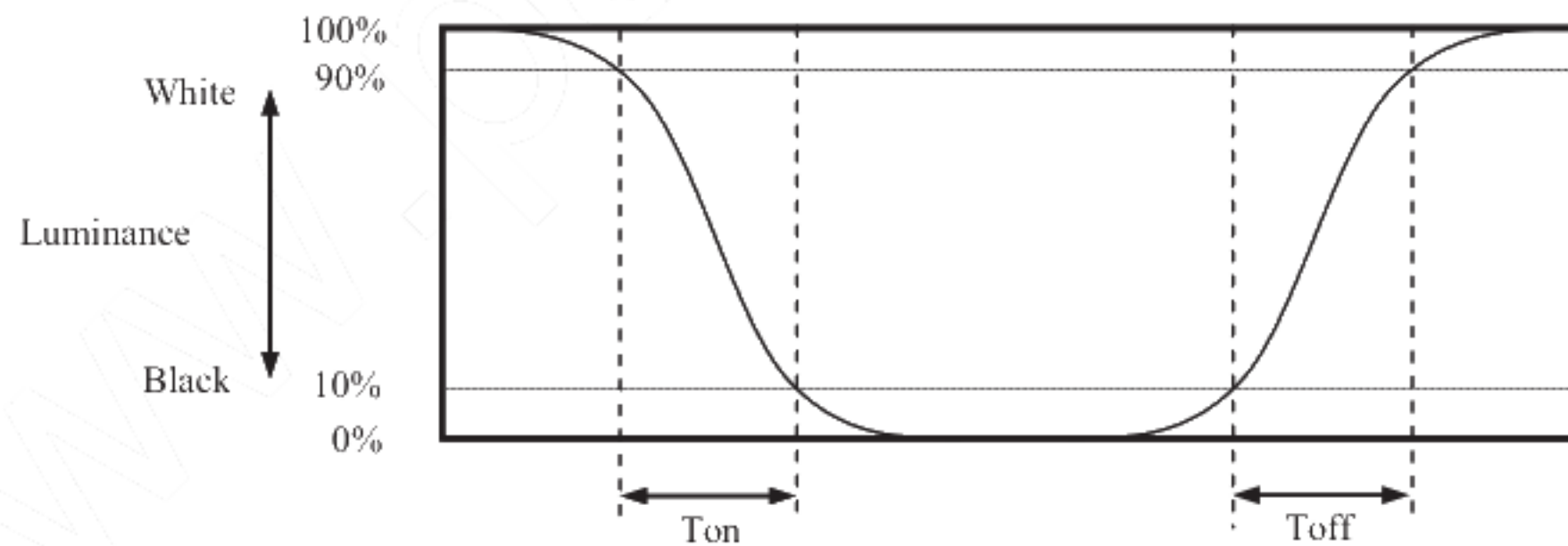
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

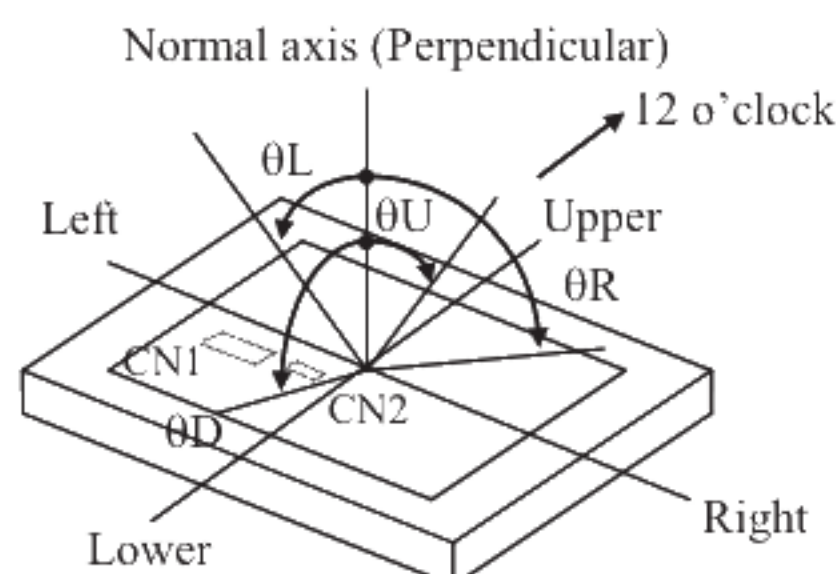


4.10.4 Definition of response times

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 ratio: 100%	100,000	h
	80°C (Temperature at LCD panel surface and rear shield surface) Continuous operation, PWM duty ratio: 100%	50,000	

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

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

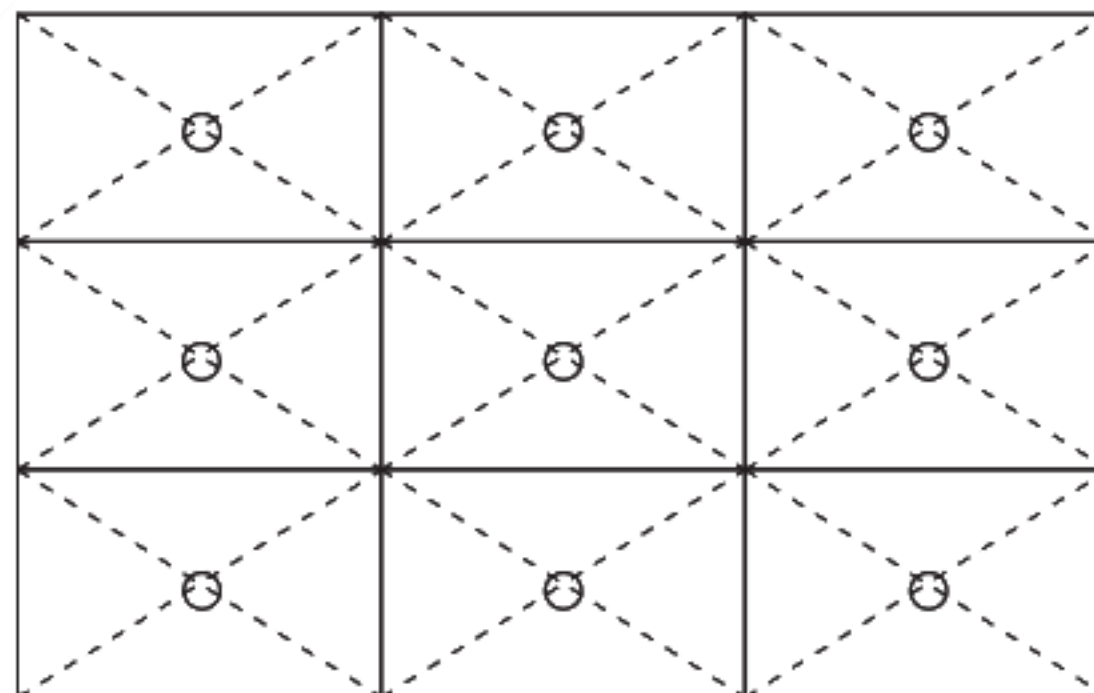
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① 60 ± 2°C, RH = 90%, 240hours ② Display data is black.	No display malfunctions	
High temperature (Operation)	① 80 ± 3°C, 240hours ② Display data is black.		
Heat cycle (Operation)	① -30 ± 3°C...1hour 80 ± 3°C...1hour ② 50cycles, 4hours/cycle ③ Display data is black.		
Thermal shock (Non operation)	① -30 ± 3°C...30minutes 80 ± 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 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, 19.60m/s ² ② 1 minute/cycle ③ X, Y, Z directions ④ 120 times each direction		
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

	<p>* 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/s² and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6 N (φ16mm jig))</p>
--	---

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 0.294N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 3.0mm.
- ⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
- ⑦ Do not press or rub on the sensitive product surface. When cleaning the product surface, wipe it with a soft dry cloth.
- ⑧ Do not push or pull the interface connectors while the product is working. ☆
- ⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer. ☆
- ⑩ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

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

7.3.3 Characteristics

The following items are neither defects nor failures.

- ① 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.
- ⑥ The interference noise between input signal frequency for this product's signal processing board and luminance control frequency of backlight driving circuit may appear on a display. Set up luminance control frequency of backlight driving circuit so that the interference noise does not appear.

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 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 TMJ.
- ⑤ The information of China RoHS (II) six hazardous substances or elements in this product is as follows.

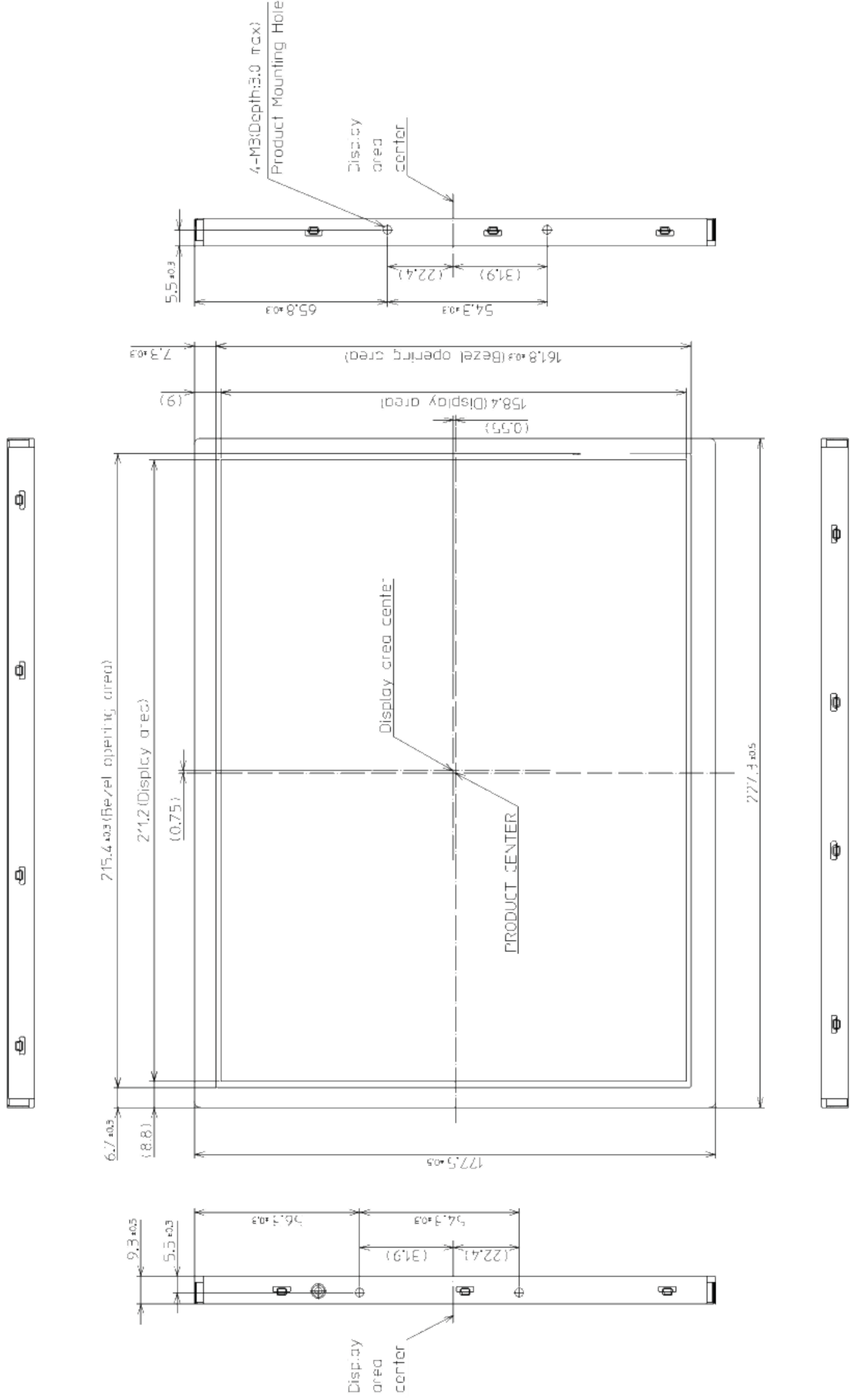
China RoHS (II) six hazardous substances or elements					
Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenyls (PBB)	Polybrominated Biphenyl Ethers (PBDE)
×	○	○	○	○	○

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

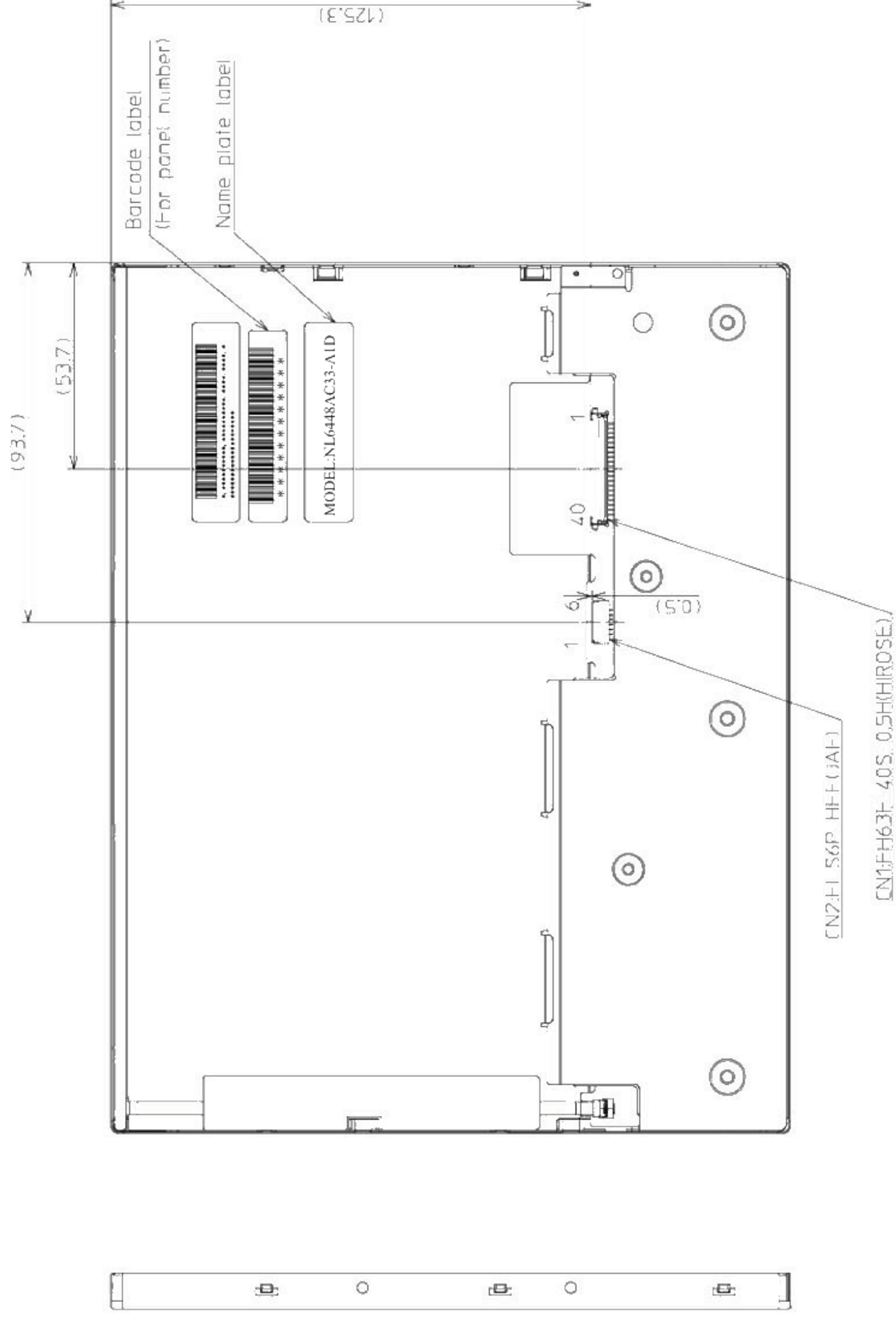


Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.294N.m. And the length of product mounting screws must be ≤ 3.0mm.

Unit: mm

8.2 REAR VIEW



Unit: mm