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Datasheet

NEC/NLT

Product Specification

Color TFT-LCD Module

NEC

TFT COLOR LCD MODULE

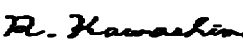
Type: NL10276AC30-04L
38cm (15 Type), XGA

SPECIFICATIONS
(Second Edition)

PRELIMINARY

This document is preliminary. All information in this document is subject to change without prior notice.

NEC Corporation
NEC Electron Devices
Display Device Operations Unit
Color LCD Division
Application Engineering Department

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1. DESCRIPTION

NL10276AC30-04L 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. NL10276AC30-04L has a built-in backlight with an inverter.
The 38cm(15 Type) diagonal display area contains 1024×768 pixels and can display 262144 colors simultaneously.

2. FEATURES

- TMDS interface (SiI851, Silicon Image, Inc.)
- Wide viewing angle (with Retardation Film)
- Expansion functions
- Corresponding to DDC2B
- High luminance and Low reflection
- High contrast
- Luminance control (variable steps and two steps)
- Incorporated edge type backlight
- Replaceable lamp holders
- Replaceable inverter
- Approved by UL1950 Third Edition (File No. E170632) and CSA-C22.2 No.950-95 (File No. E170632)

3. APPLICATION

PC monitor

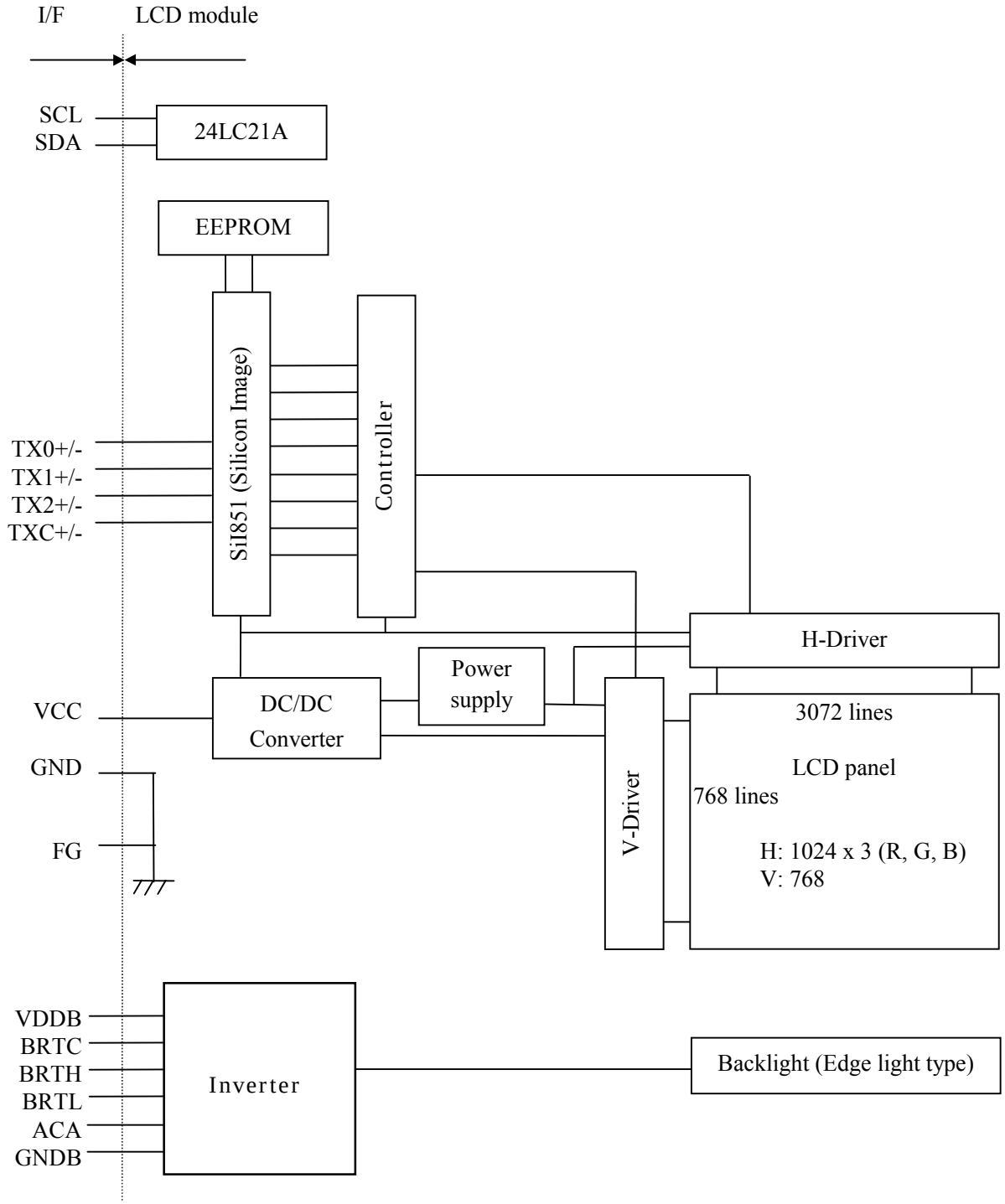
4. STRUCTURE AND FUNCTIONS

A color TFT (thin film transistor) LCD module is comprised of a TFT liquid crystal panel structure, LSIs for driving the TFT array, and a backlight assembly. Sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate creates the TFT panel structure. And the driver LSIs are connected to the panel, 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.
Acting as an Electro-optical switch, each TFT cell regulates light transmission from the backlight assembly when activated by the data source. By regulating the amount of light passing through the array of red, green, and blue dots, color images are created with clarity.

5. OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	304.128 (H)×228.096 (V)mm
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	1024×768
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.297 (H)×0.297 (V)mm
Module size	350.0 (H)×265.0 (V)×20.0 Typ. (D) mm
Weight	1350 g (Typ.)
Contrast ratio	200:1 (Typ.)
Viewing angle (more than the contrast ratio of 10:1)	・Horizontal: 60 ° (Typ., left side, right side) ・Vertical: 40 ° (Typ., up side), 50 ° (Typ., down side)
Designed viewing direction	・Wider viewing angle without image reversal: up side ・Wider viewing angle with contrast ratio: down side 5° (Typ.) ・Optimum grayscale (γ =2.2): perpendicular
Polarizer Pencil-hardness	3 H (Min., at JIS K5400)
Color gamut	40 % (Typ., At center, To NTSC)
Response time	15 ms (Typ.), white to black (100%→10%)
Luminance	200 cd/m^2 (Typ.)
Signal system	TMDS interface (1port) (SiI851, Silicon Image, Inc.)
Supply voltage	12V (Logic, LCD driving) , 12V (Backlight)
Backlight	Edge light type: Two cold cathode fluorescent lamps with inverter 【Replaceable parts】 ・Lamp holder: type No.150LHS11 ・Inverter: type No.141PW201
Power consumption	13.1 W (Typ., Checker flag pattern, at 200 cd/m^2 Typ.)

6. BLOCK DIAGRAM



Note1: GND is signal ground for logic and LCD driving. GND is connected to FG (frame ground) in the LCD module and neither GND nor FG are connected to GNDB (backlight ground). These grounds should be connected to system ground in customer equipment.

7. GENERAL SPECIFICATIONS

Items	Specifications	Unit
Module size	350.0±0.6 (H) × 265.0±0.6 (V) × 20.5 Max. (D)	mm
Display area	304.128 (H) × 228.096 (V) [Diagonal display area: 38cm (Type 15.0)]	mm
Number of pixels	1024 (H) × 768 (V)	pixel
Dot pitch	0.099 (H) × 0.297 (V)	mm
Pixel pitch	0.297 (H) × 0.297 (V)	mm
Pixel arrangement	RGB (red, green, blue) vertical stripe	—
Display colors	262,144 (RGB, 6bit)	color
Weight	1350(Typ.), 1500(Max.)	g

8. ABSOLUTE MAXIMUM RATINGS

Parameters	Symbols	Ratings	Unit	Remarks
Supply voltage	VCC	-0.3 to +14	V	Ta = 25℃
	VDDB	-0.3 to +14	V	
Logic input voltage	Vi	-0.3 to VCC+0.3	V	Ta = 25℃ VDDB=12V
Logic input voltage (backlight-logic signal)	ViBL1	-0.3 to +5.5	V	
Logic input voltage (backlight-BRTL signal)	ViBL2	-0.3 to +1.5	V	
Storage temperature	Tst	-20 to +60	℃	—
Operating temperature	Top	0 to +50	℃	Module surface Note 1
Relative humidity (RH) Note 2		≤ 95	%	Ta≤40℃
		≤ 85	%	40℃＜Ta≤50℃
Absolute humidity Note 2		Absolute humidity shall not exceed Ta=50℃, Relative humidity =85% level.	g/m^3	Ta＞50℃

Note1: Measure at the display area (including self heat)
Note2: No condensation

9. ELECTRICAL CHARACTERISTICS

(1) Logic/ LCD driving Ta = 25℃

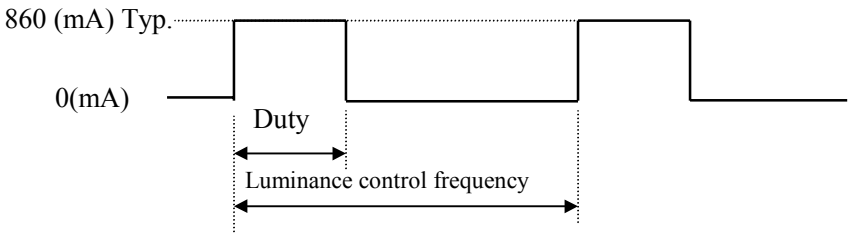
Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VCC	11.4	12.0	12.6	V	—
Ripple voltage	VRP	—	—	100	mV	for VCC
Input voltage Note1	VI	—	0.5	—	V	RT=500Ω
Terminating resistor	RT	—	500	—	Ω	—
Supply current	ICC	—	230 Note2	400 Note3	mA	VCC=12.0V

Note1: Terminal control resistor (R_{EXT_RES}) of TMDS receiver is 500Ω (settlement).
Note2: Checker flag pattern (in EIAJ ED-2522)
Note3: Theoretical maximum current pattern

(2) Backlight

Ta = 25℃

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VDDB	10.8	12.0	13.2	V	Backlight power supply
Logic input "L" voltage	ViL1	0	—	0.6	V	for BRTP
Logic input "H" voltage	ViH1	4.5	—	5.25	V	
Logic input "L" voltage	ViL2	0	—	0.8	V	for BRTC, ACA, BRTL, PWSEL
Logic input "H" voltage	ViH2	2.2	—	5.25	V	
Logic input "L" current	IiL1	-1.0	—	—	mA	for BRTP
Logic input "H" current	IiH1	—	—	10	mA	
Logic input "L" current	IiL2	-1.0	—	—	mA	for BRTC, ACA, BRTL, PWSEL
Logic input "H" current	IiH2	—	—	0.8	mA	
Supply current	IDDB	—	860	1000	mA	VDDB=12.0V (at Max. luminance)



Maximum luminance control : 100%
Minimum luminance control : 20%
Luminance control frequency : 243 to 297 Hz 270Hz(Typ.)

Please see **11.INTERFACE PIN CONNECTIONS** (4) Luminance control.

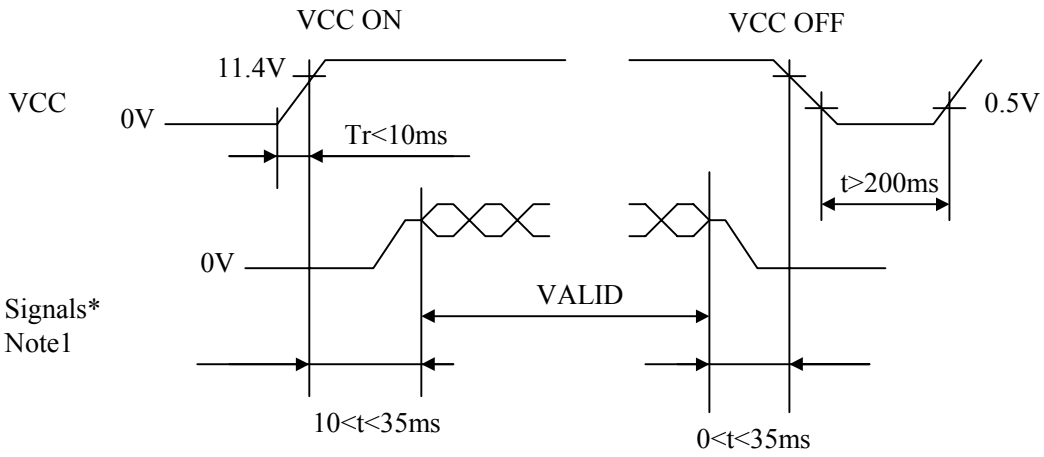
(3)Fuse

This LCD module uses fuses as follows.

Supply voltage	Part No.	Supplier	Ratings	Remarks
VCC	ICP-S1.2	ROHM	50V/1.2A	-
VDDB	①R433002 ②R429002	LITTLE FUSE	63V/2A	① or ② is used.

Remark: Before the power is designed, fuses should be considered. The power capacity should be used more than 2.0 times of fuses rating. When the power capacity is less than 2.0 times of fuses rating, the module must be evaluated enough from safety point of view.

10. SUPPLY VOLTAGE SEQUENCE



* Signals: Hsync, Vsync, DE, CLK, R0 to R5, G0 to G5, B0 to B5

Note1: The values of signals are in terminal of resistor 100 Ω.

Remark1: Logic signals (synchronous signals and control signals) should be "0" voltage (V), when VCC is not input. If input voltage to signal lines is higher than 0.3 V, the internal circuit will be damaged.

Remark2: When the power supply voltage (VCC) fluctuates less than 11.4V, the LCD module may not be worked by the protection circuit.

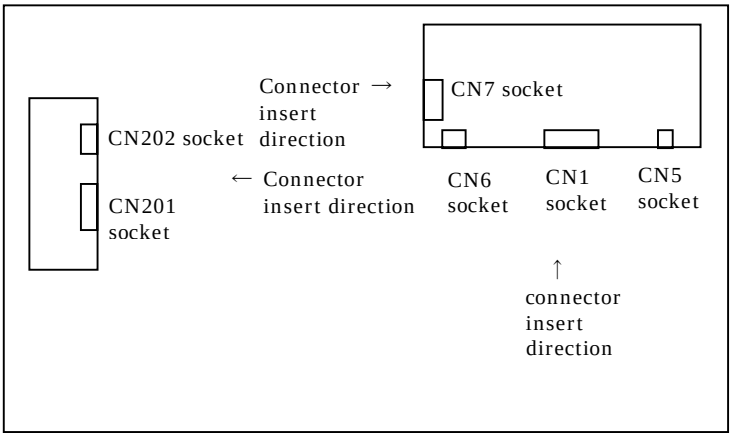
Remark3: Turn on the backlight should be controlled while logic signals are supplied. The backlight power supply (VDDB) is not related to the power supply sequence. However, unstable data will be displayed when the backlight power is turned ON with no logic signals.

Remark4: 12V for backlight should be started up within 80ms, otherwise, the protection circuit makes the backlight turn off.

11. INTERFACE PIN CONNECTIONS

(1)Connector locations

Rear view



Remark1: Same terminal of CN201 and CN202 use either one.
Remark2: CN5 should be opened.

(2) Interface connector for signals and power

CN1 socket: FI-XD7S-HF
Adaptable plug: FI-XD7H, FI-XD7M
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbols	I/O	Descriptions
1	RX2+	Input	TMDS differential data input R (+) Note1
2	RX2-	Input	TMDS differential data input R (-) Note1
3	GND	—	GND for logic and LCD driving
4	RX1+	Input	TMDS differential data input G (+) Note1
5	RX1-	Input	TMDS differential data input G (-) Note1
6	GND	—	GND for logic and LCD driving
7	RX0+	Input	TMDS differential data input B (+) Note1
8	RX0-	Input	TMDS differential data input B (-) Note1
9	GND	—	GND for logic and LCD driving
10	RXC+	Input	TMDS differential clock input (+) Note1
11	RXC-	Input	TMDS differential clock input (-) Note1
12	GND	—	GND for logic and LCD driving
13	N.C.	—	Non-connection, Keep the terminal open.
14	N.C.	—	Non-connection, Keep the terminal open.
15	GND	—	GND for logic and LCD driving
16	SENS	Output	Connection detective signal
17	+5V_DC	Input	+5V power supply (DDC power supply)
18	GND	—	GND for logic and LCD driving
19	SDA	Input/ Output	Data for DDC
20	SCL	Input	Clock for DDC

Note1: Use 50Ω twist pair wires for the cable.
Remark1: Do not keep pins free (except 13 and 14) to avoid noise issue.

CN1 socket: Figure from socket view

1	2	・・・・・	19	20

CN6 socket: IL-Z-8PL-SMTY
Adaptable plug: IL-Z-8S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbols	I/O	Descriptions
1	BRTH	Input	Luminance control signal, Please see (4) Luminance control.
2	BRTL		
3	GNDB	—	Backlight ground
4	GNDB		
5	GND	—	GND for logic and LCD driving
6	VDDB	Input	Power supply for backlight +12V±5%
7	VDDB		
8	VCC	Input	Power supply for LCD driving +12V±5%

CN6 socket: Figure from socket view

8 7 .....3 2 1

CN7 socket: IL-Z-11PL-SMTY
Adaptable plug: IL-Z-11S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbols	I/O	Descriptions
1	N.C.	—	Non-connection, Keep the terminal open.
2	BRTL	Output	Luminance control signal, Connect to CN201 Pin No.10 or CN202 Pin No.6
3	BRTH	Output	Luminance control signal, Connect to CN201 Pin No.9 or CN202 Pin No.5
4	BRTC	Output	Backlight ON/OFF control signal “H”: DE signal is input to SiI851 chip. “L”: DE signal is no input to SiI851 chip. Connect to Pin No.8 of CN201 or Pin No.4 of CN202
5	N.C.	—	Non-connection, Keep the terminal open.
6	GNDB	—	Ground for backlight, Connect to GNDB of CN201 or CN202.
7	GNDB		
8	GNDB		
9	VDDB	Output	12V_DC, Connect to VDDB of CN201
10	VDDB		
11	VDDB		

CN7 socket: Figure from socket view

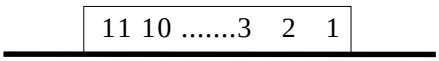
11 10 .....3 2 1

Remark1: Do not keep pins free (except 1 and 5 of CN7) to avoid noise issue.

(3) Connector for backlight unit
CN201 socket: IL-Z-11PL1-SMTY
Adaptable plug: IL-Z-11S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbols	I/O	Descriptions
1	VDDB	Input	Power supply for backlight +12V±5%
2	VDDB		
3	VDDB		
4	GNDB	—	Ground for backlight
5	GNDB		
6	GNDB		
7	ACA	Input	Luminance control signal "H" or "Open" : Normal luminance 100% "L" : Low luminance (1/2 of normal luminance)
8	BRTC	Input	Backlight ON/OFF control signal "H" or "Open" : Backlight ON "L" : Backlight OFF
9	BRTH	Input	Luminance control signal, Please see (4) Luminance control.
10	BRTL		
11	N.C.	—	Non-connection, Keep the terminal open.

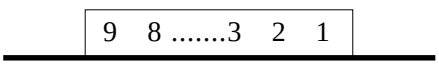
CN201 socket: Figure from socket view



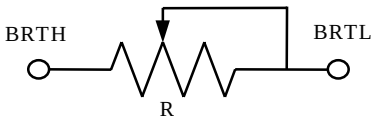
CN202 socket: IL-Z-9PL1-SMTY
Adaptable plug: IL-Z-9S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbols	I/O	Descriptions
1	GNDB	—	Ground for backlight
2	GNDB		
3	ACA	Input	Luminance control signal "H" or "Open" : Normal luminance 100% "L" : Low luminance (1/2 of normal luminance)
4	BRTC	Input	Backlight ON/OFF control signal "H" or "Open" : Backlight ON "L" : Backlight OFF
5	BRTH	Input	Luminance control signal, Please see (4) Luminance control.
6	BRTL		
7	BRTP		
8	GNDB	—	Ground for backlight
9	PWSEL	Input	Select signal of PWM luminance control function Please see (4) Luminance control.

CN202 socket: Figure from socket view



(4) Luminance control

Form	PWM	Voltage	Variable resistor
How to adjust	PWSEL="L"	PWSEL="H" or "Open" and BRTP="OPEN"	
	See **OUTSIDE CONTROL FOR LUMINANCE**	BRTH should be fixed to 0V to control luminance by voltage. The range of input voltage between BRTL and GNDB is as follows. Maximum luminance: 1V(100%) Minimum luminance: 0V(30%)	The variable resistor for luminance control should be 10 kΩ type, and zero point of the resistor corresponds to the minimum of luminance.  ACA=H Maximum luminance: R=10 kΩ(100%) Minimum luminance : R= 0 Ω(30%) Mating variable resistor: 10 kΩ B curve, 1/10W

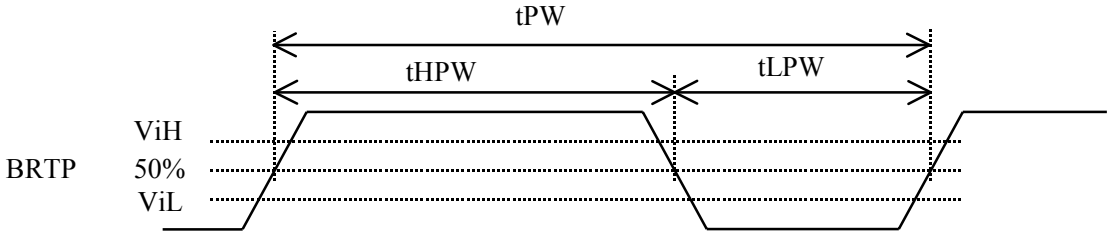
[OUTSIDE CONTROL FOR LUMINANCE]

Outside control is valid, when PWSEL="L" and input signal for BRTP. Luminance can be controlled by the duty value of input signal for BRTP.

Duty=100%: luminance is maximum.

Duty=20%: luminance is minimum.

BRTC must not fix on "L" in the condition of PWSEL= "L" and BRTC ="H" or "Open". Otherwise, the inverter stops. In this case, even if BRTP pulse is input again, the backlight will not turn on. Please input power supply to the inverter again.



Parameters	Symbols	Min.	Typ.	Max.	Units	Remarks
Frequency	1/tPW	185	—	340	Hz	Note1
"L" period	tLPW	—	—	50	ms	Note2
Pulse-width	tHPW/tPW	20	—	100	%	Duty=100%: Luminance is maximum. Duty=20%: Luminance is minimum.
Luminance	Lu	30	—	100	%	—
Input voltage	ViL	—	—	0.6	V	—
	ViH	4.5	—	—	V	—

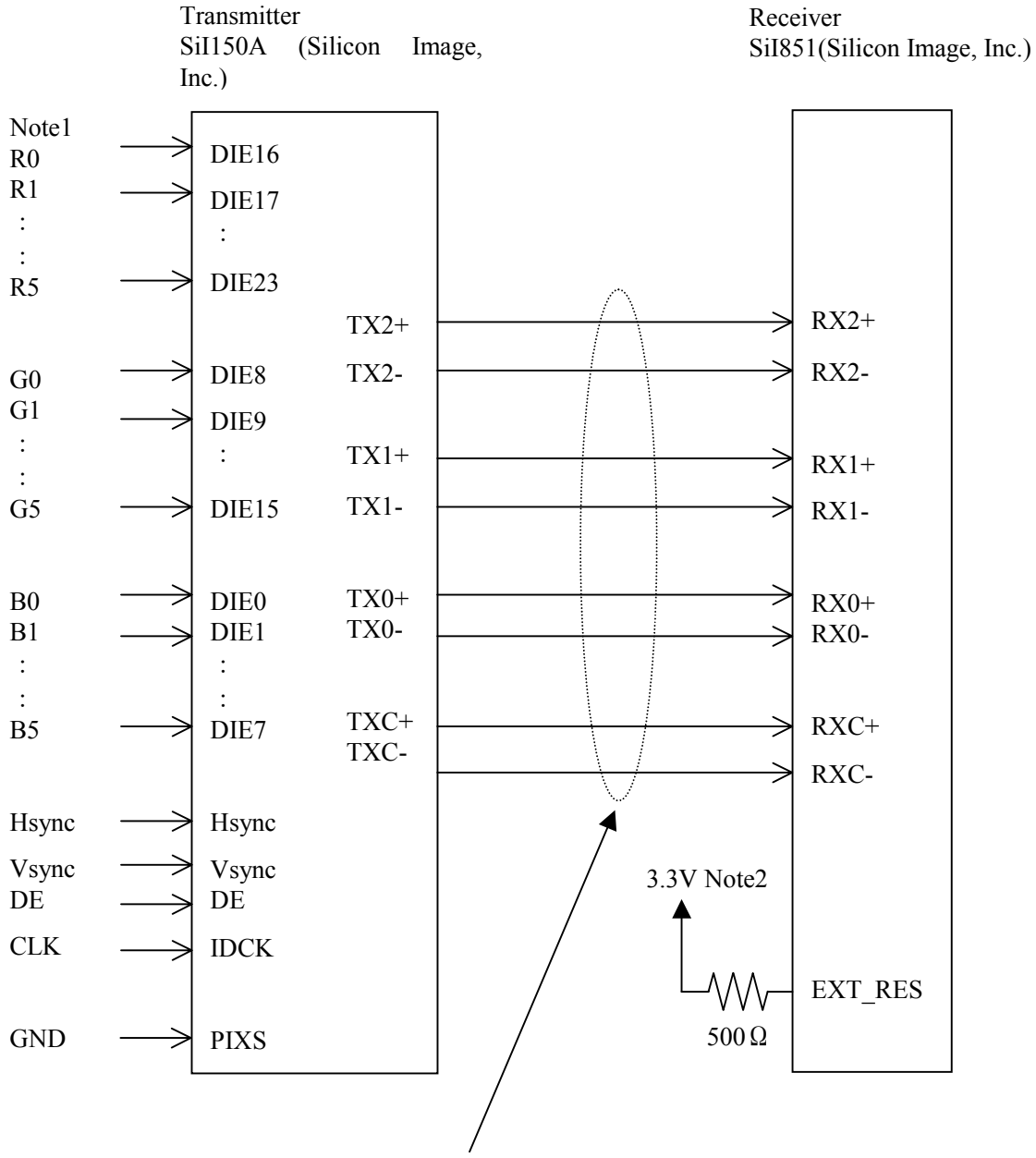
Note1: Regarding set up for frequency, refer to the below method.

Set up frequency = Vsync frequency × (n+0.25) or (n+0.75)

Adopt the frequency evaluating the display quality, because the display will be disturbed depend on frequency.

Note2: The backlight is turned off with safety circuit, when "L" period of BRTP signal is input more than 50 ms.

12. METHOD OF CONNECTION FOR SiI150A



Note1: These signals should be kept in the specified range of **15. INPUT SIGNAL TIMINGS**.
Note2: LCD internal voltage

13. DISPLAY COLORS vs INPUT DATA SIGNALS

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 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	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 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	1	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 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	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
		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

Note1: Colors are developed in combination with 6-bit signals (64 steps in grayscale) of each primary red, green, and blue color. This process can result in up to 262,144 (64×64×64) colors.

14. EXPANSION FUNCTIONS

Expansion mode is a function to expand screen. For example, VGA signal has 640×480 pixels. But, if the display data can expanded to 1.6 times vertically and horizontally, VGA screen image can be displayed fully on the screen of XGA resolution.

This LCD module has the function that expands vertical direction as shown in 7.9 (1). And expanding horizontal direction is possible by setting input CLK frequency equivalent to the magnification. It is necessary to make this CLK outside of this LCD module.

Please adopt this mode after evaluating display quality, because the appearance in expansion mode is happened to be relatively bad in some cases.

The followings show display magnifications for each mode.

Input display	Number of pixels	Magnification	
		Vertical	Horizontal
XGA	1024×768	1	1
SVGA	800×600	1.28	1.28
VGA	640×480	1.6	1.6

15. INPUT SIGNAL TIMINGS

(1) Input signal specifications for LCD controller

XGA mode

	Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	—	65.0 15.385	—	MHz ns	—
	Rise, fall	tcrf	Note1			ns	—
	Duty	tch/tc				—	
Hsync	Period	th	—	20.676 1344	—	μs CLK	48.363kHz (Typ.)
	Display period	thd	—	1024	—	CLK	—
	Front-porch	thf	—	24	—	CLK	—
	Pulse width	thp *	—	136	—	CLK	—
	Back-porch	thb *	—	160	—	CLK	—
	* thp + thb		—	296	—	CLK	—
	Hsync-CLK timing	ths	Note1			ns	—
	CLK-Hsync timing	thh				ns	—
	DE-CLK timing	tes				ns	—
	CLK-DE timing	teh				ns	—
	Rise, fall	thrf				ns	—
Vsync	Period	tv	—	16.666 806	—	ms H	60.004Hz (Typ.)
	Display period	tvd	—	768	—	H	—
	Front-porch	tvf	—	3	—	H	—
	Pulse width	tvp *	—	6	—	H	—
	Back-porch	tvb *	—	29	—	H	—
	* tvp + tvb		—	35	—	H	—
	Vsync-Hsync timing	tvs	Note 1			CLK	—
	Hsync-Vsync timing	tvh				CLK	—
	Rise, fall	tvrf				ns	—
DATA	DATA-CLK (Set up)	tds				ns	—
	CLK-DATA (Hold)	tdh				ns	—

SVGA mode

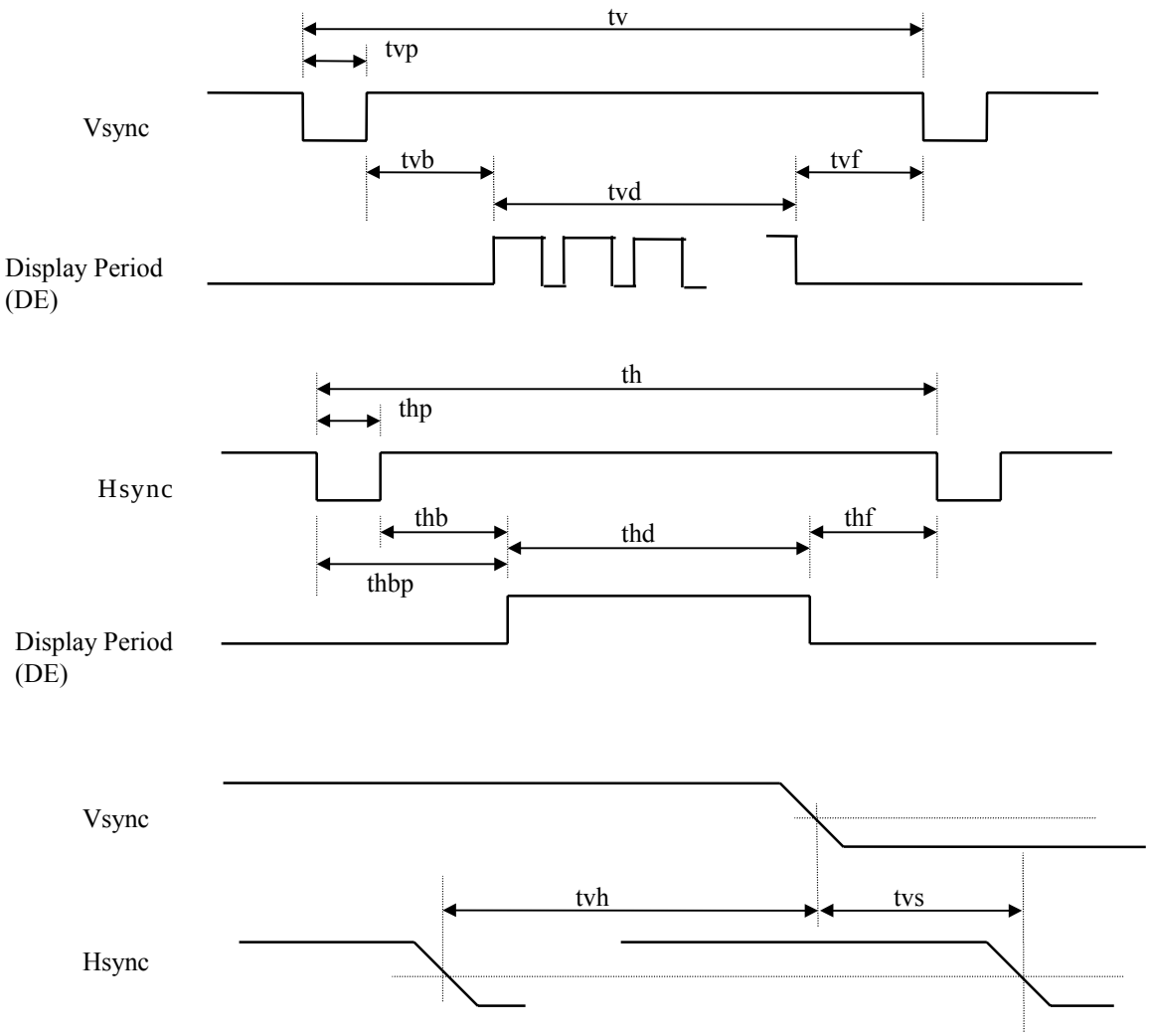
	Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	—	40.0 25.0	—	MHz	—
	Rise, fall	tcrf	Note 1			ns	—
	Duty	tch/tc				—	
Hsync	Period	th	—	26.399	—	μ s	37.897kHz (Typ.)
				1058		CLK	
	Display period	thd	—	800	—	CLK	—
	Front-porch	thf	—	40	—	CLK	—
	Pulse width	thp *	—	128	—	CLK	—
	Back-porch	thb *	—	88	—	CLK	—
	* thp + thb		—	216	—	CLK	—
	Hsync-CLK timing	ths	Note 1			ns	—
	CLK-Hsync timing	thh				ns	—
	DE-CLK timing	tes				ns	—
	CLK-DE timing	teh				ns	—
	Rise, fall	thrf				ns	—
Vsync	Period	tv	—	16.579 628	—	ms H	60.317Hz (Typ.)
	Display period	tvd	—	600	—	H	—
	Front-porch	tvf	—	1	—	H	—
	Pulse width	tvp *	—	4	—	H	—
	Back-porch	tvb *	—	23	—	H	—
	* tvp + tvb		—	27	—	H	—
	Vsync-Hsync timing	tvs	Note 1			CLK	—
	Hsync-Vsync timing	tvh				CLK	—
	Rise, fall	tvrf				ns	—
DATA	DATA-CLK (Set up)	tds				ns	—
	CLK-DATA (Hold)	tdh				ns	—

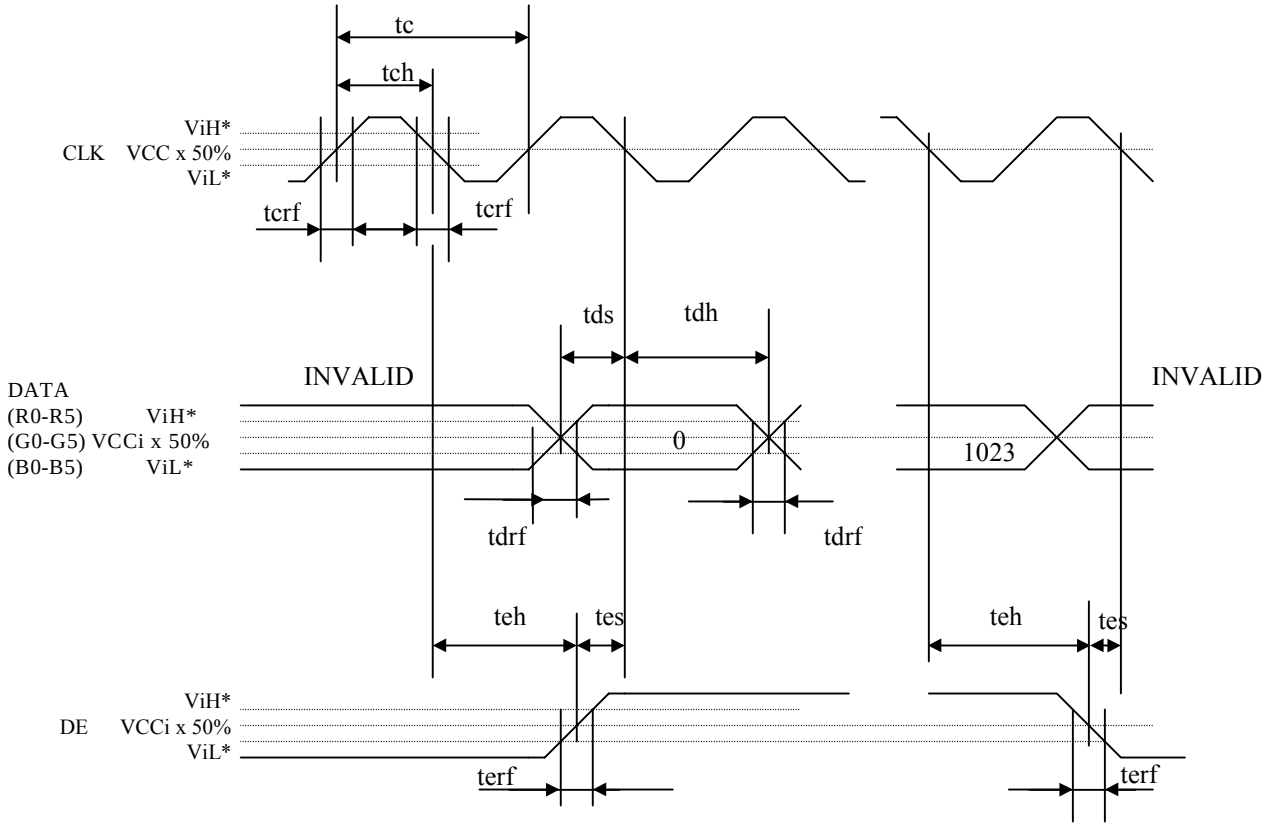
VGA mode

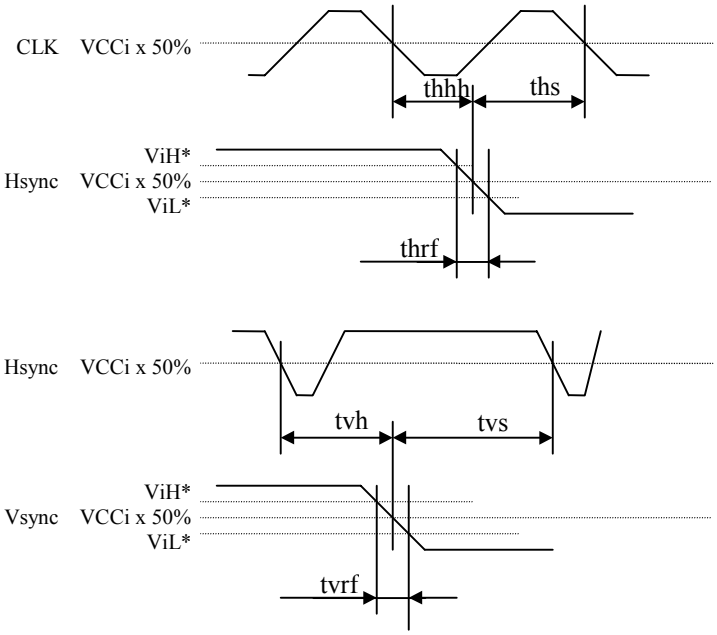
	Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	—	25.175 39.721	—	MHz	—
	Rise, fall	tcrf	Note1			ns	—
	Duty	tch/tc				—	—
Hsync	Period	th	—	31.777 800	—	μ s CLK	31.469kHz (Typ.)
	Display period	thd	—	640	—	CLK	—
	Front-porch	thf	—	16	—	CLK	—
	Pulse width	thp *	—	96	—	CLK	—
	Back-porch	thb *	—	48	—	CLK	—
	* thp + thb		—	144	—	CLK	—
	Hsync-CLK timing	ths	Note1			ns	—
	CLK-Hsync timing	thh				ns	—
	DE-CLK timing	tes				ns	—
	CLK-DE timing	teh				ns	—
	Rise, fall	thrf				ns	—
Vsync	Period	tv	—	16.683	—	ms	59.940Hz (Typ.)
			—	525	—	H	
	Display period	tvd	—	480	—	H	—
	Front-porch	tvf	—	10	—	H	—
	Pulse width	tvp *	—	2	—	H	—
	Back-porch	tvb *	—	33	—	H	—
	* tvp + tvb		—	35	—	H	—
	Vsync-Hsync timing	tvs	Note1			CLK	—
	Hsync-Vsync timing	tvh				CLK	—
	Rise, fall	tvrf				ns	—
DATA	DATA-CLK (Set up)	tds				ns	—
	CLK-DATA (Hold)	tdh				ns	—

Remark1: These values are in the timing standard of SiI150A.
Timing standard prescribes in the input of TMDS transmitter.
The product equivalent to SiI150A (Silicon Image, Inc.) is recommended to the input of LVDS transmitter.

(2) Input signals timing chart for LCD

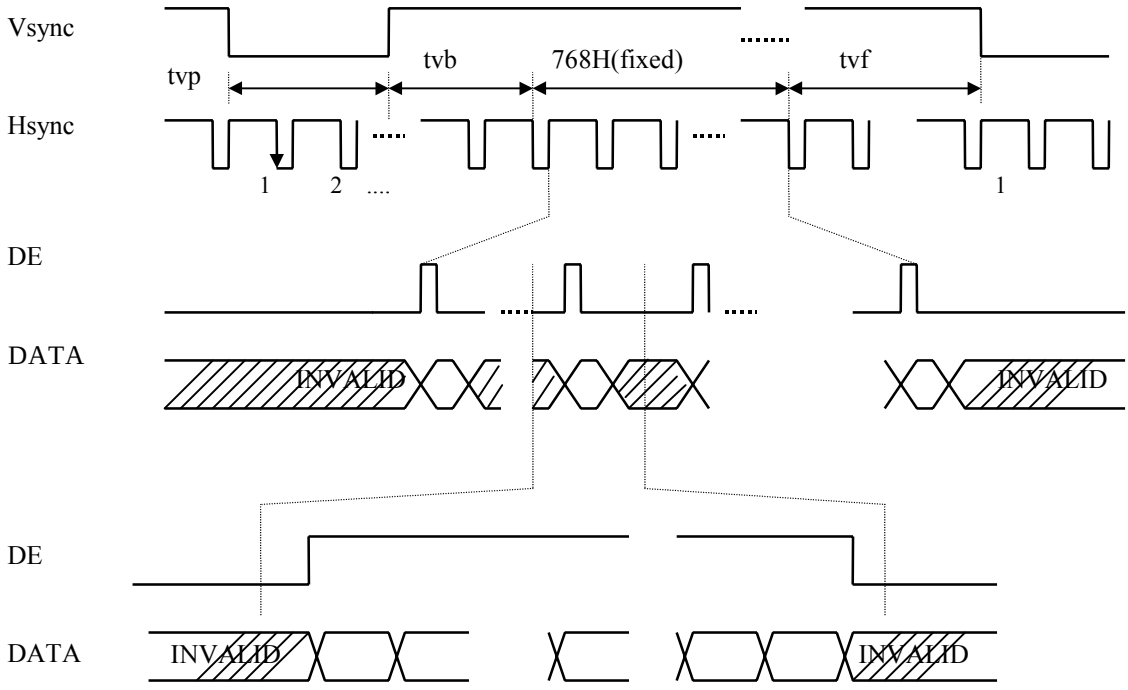


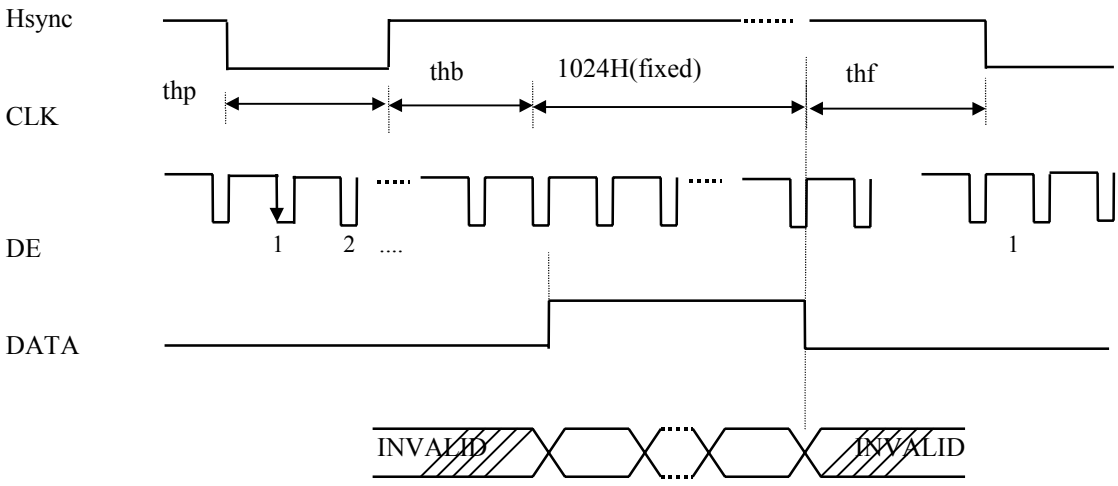




ViH = VCCi×0.7(Min.)
ViL = VCCi×0.3(Max.)
VCCi = 3.3V (LCD internal voltage)

DE

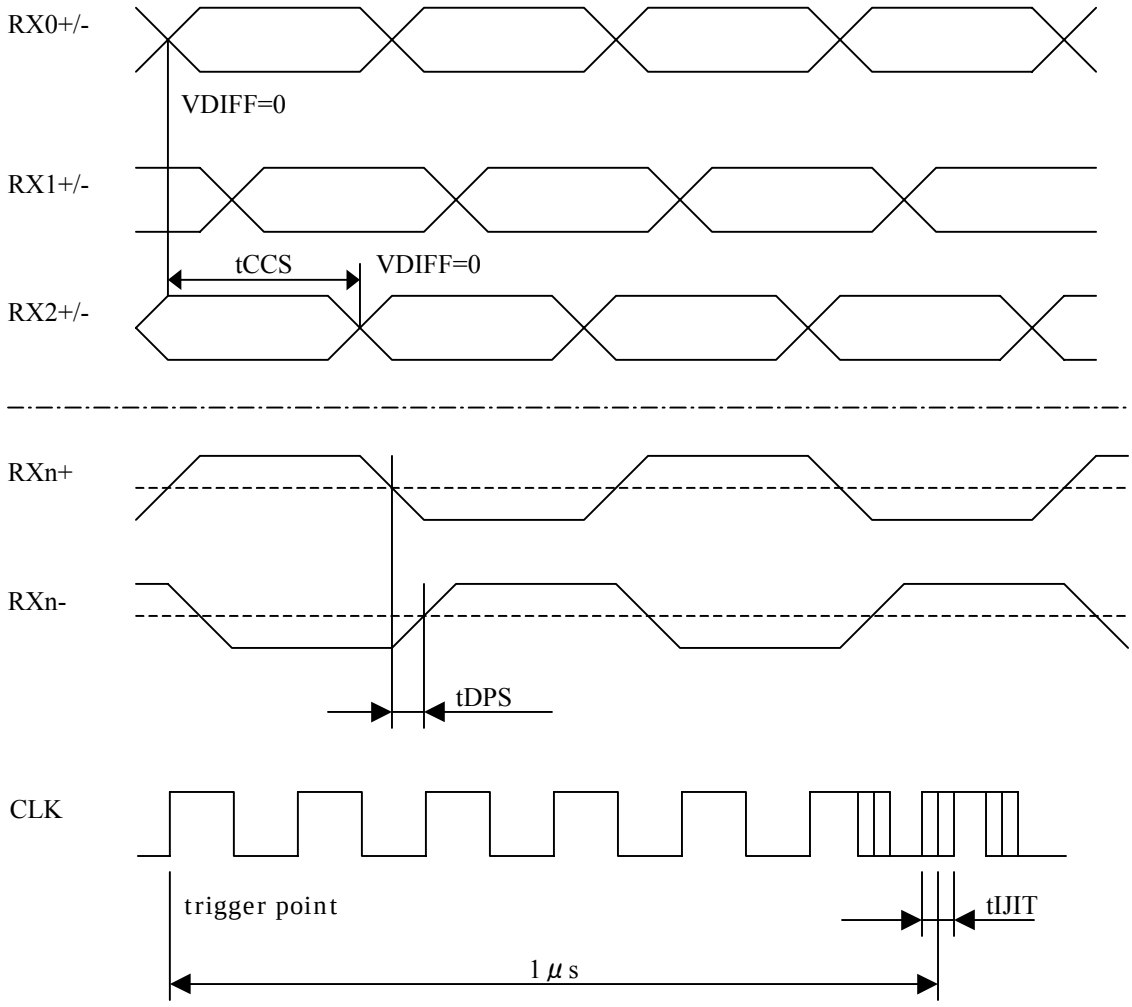

Vsync
tvp
tvb
768H(fixed)
tvf
Hsync
1
2
....
1
DE
DATA
INVALID
INVALID
DE
DATA
INVALID
INVALID


Hsync
thp
thb
1024H(fixed)
thf
CLK
1
2
....
1
DE
DATA
INVALID
INVALID

(3)For LVDS receiver

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Intra-pair (+ to -) differential input skew	tDPS	—	—	360	ps	112MHz,1pixel/clock
Channel to channel differential input skew	tCCS	—	—	6	ns	112MHz,1pixel/clock
Input clock jitter	tIJIT	—	—	270	ps	112MHz,1pixel/clock

Input timings



(4) Display position of input data

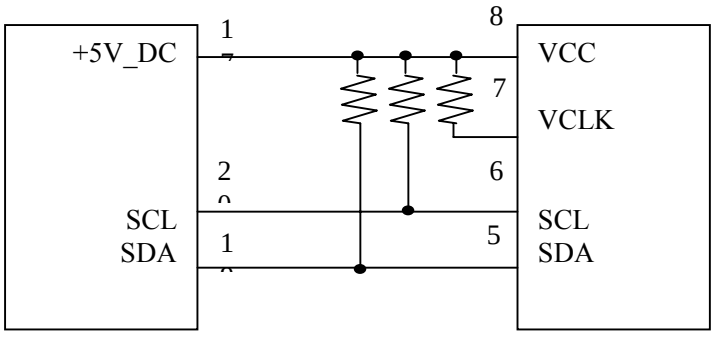
D(0, 0)	D(1, 0)	•••	D(X, 0)	•••	D(1023, 0)
D(0, 1)	D(1, 1)	•••	D(X, 1)	•••	D(1023, 1)
• • •	• • •	• ••• •	• • •	• ••• •	• • •
D(0, Y)	D(1, Y)	•••	D(X, Y)	•••	D(1023, Y)
• • •	• • •	• ••• •	• • •	• ••• •	• • •
D(0,767)	D(1,767)	•••	D(X,767)	•••	D(1023,767)

16. DDC FUNCTION

This function is corresponding to VESA DDC™ and EDID™ (Structure Version 1).
Follow the specifications of the IC when you write a data. (VCLK is fixed on "H")
Write appropriate data into necessary addresses in advance before using this function.
The input equivalent circuit diagram is as follow.

EDID: Extended Display Identification Data

<Internal circuit diagram>



Product: Microchip Technology Inc.
24LC21A
or equivalent

17. OPTICAL CHARACTERISTICS

(Ta= 25 ℃, VCC= 12V, VDDB=12V, Note1)

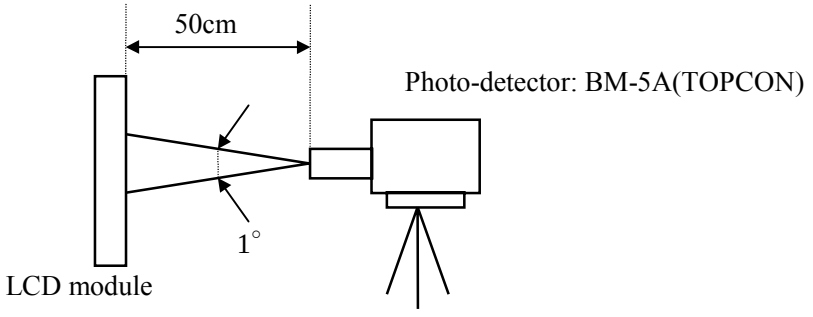
Parameters	Symbols	Conditions	Min.	Typ.	Max.	Units	Remarks
Contrast ratio	CR	Note 3	80	200	-	-	Note 2
Luminance	Lumax	Note 3	150	200	-	cd/m^2	-
Luminance uniformity	-	Max. / Min., Note 3	-	-	1.3	-	Note 6

Reference data

(Ta= 25 ℃, VCC= 12V, VDDB=12V, Note1)

Parameters		Symbols	Conditions		Min.	Typ.	Max.	Units	Remarks
Contrast ratio		CR	Best contrast angle θ x= ±0°, θ y= -5°		-	450	-	-	Note 2
Color gamut		C	To NTSC		35	40	-	%	Note 3
Chromaticity Coordinates		W	White (x, y)		-	0.30, 0.31	-	-	-
		R	Red (x, y)		-	0.58, 0.33	-	-	
		G	Green (x, y)		-	0.33, 0.52	-	-	
		B	Blue (x, y)		-	0.15, 0.11	-	-	
Viewing Angle Range (CR>10)	Horizontal	θ x+	CR>10, θ y = ±0°		50	60	-	deg.	Note 4
		θ x-			50	60	-	deg.	
	Vertical	θ y+	CR>10, θ x = ±0°		30	40	-	deg.	
		θ y-			35	50	-	deg.	
Viewing Angle Range (CR>5)	Horizontal	θ x+	CR>5, θ y = ±0°		-	80	-	deg.	
		θ x-			-	80	-	deg.	
	Vertical	θ y+	CR>5, θ x = ±0°		-	60	-	deg.	
		θ y-			-	65	-	deg.	
Response time (Module front surface temperature=T.B.D.)		Ton	White to black	100%→10%	-	15	40	ms	Note 5
				90%→10%	-	T.B.D.	-		
		Toff	Black to white	0%→90%	-	40	80		
				10%→90%	-	T.B.D.	-		
Luminannce control range		ACA=H	Maximum luminannce:100%		-	30-100	-	-	%
		ACA=L			-	60-100	-	-	

Note1: Optical characteristics are measured after 20 minutes from the module works, with all pixels in " white ".Typical value is measured after luminance saturation. The luminance is measured in dark room.
Input signal timing: 15.Input signal timings (1) XGA mode, Typ. value

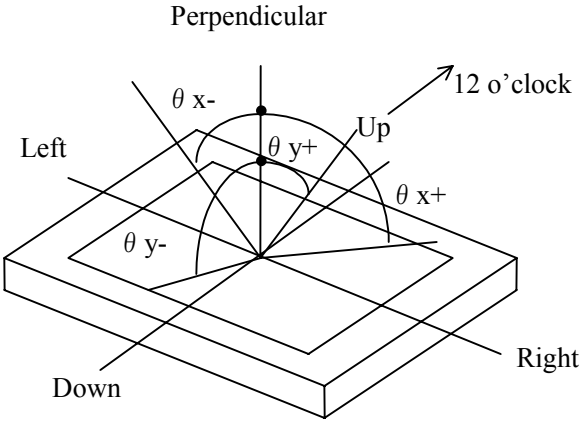


Note2: The contrast ratio is calculated by using the following formula.

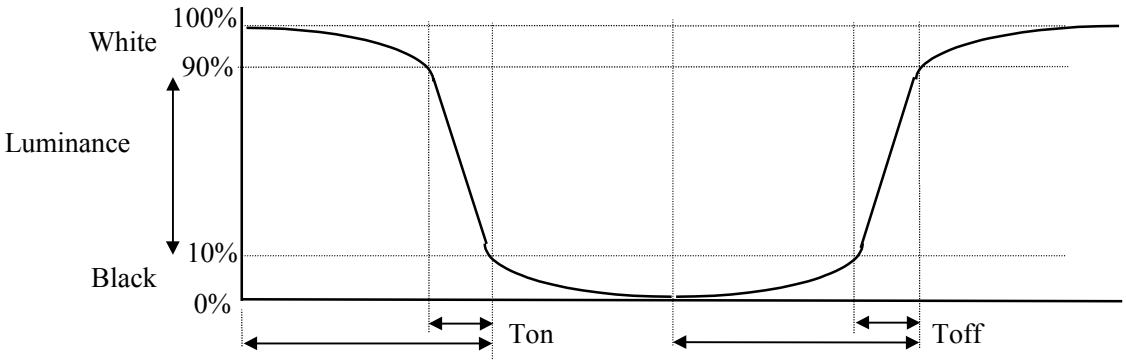
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance with all pixels in white}}{\text{Luminance with all pixels in black}}$$

Note3: Viewing angle is θ x = ±0°, θ y = ±0° and at center.

Note4: Definitions of viewing angle are as follows



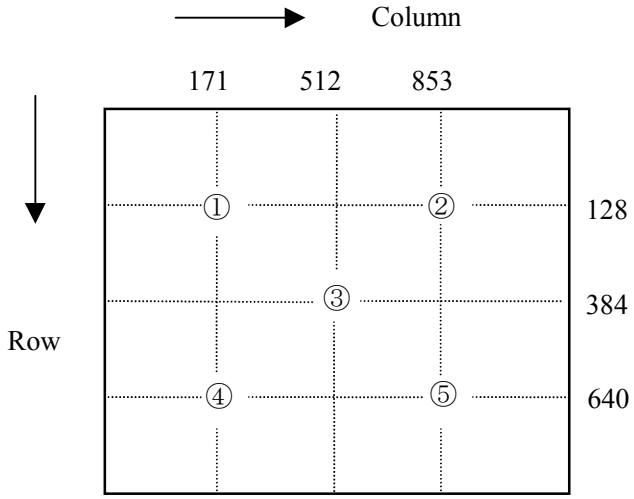
Note 6: Definitions of response time are as follows.
Photo-detector output signal is measured when the luminance changes "white" to "black" or "black" to "white". Response time is the time between 10% and 100% of the photo-detector output amplitude.



Note7: Luminance uniformity is calculated by using the following formula.

$$\text{Luminance uniformity} = \frac{\text{Maximum luminance}}{\text{Minimum luminance}}$$

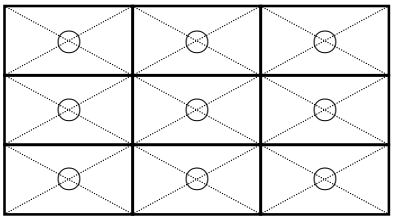
The luminance is measured at near the five points shown below.



18. RELIABILITY TEST

Test items	Test conditions	Judgment
High temperature/humidity operation	50±2℃, RH=85% 240 hours, Display data is black.	*1
Heat cycle (operation)	① 0℃±3℃・・・1 hour 55℃±3℃・・・1 hour ② 50 cycles , 4 hours/cycle ③ Display data is black.	*1
Thermal shock (non-operation)	① -20℃±3℃・・・30 minutes 60℃±3℃・・・30 minutes ② 100 cycles ③ Temperature transition time is within 5 minutes.	*1
Vibration (non-operation)	① 5-100Hz, 19.6m/s^2, 1 minute/cycle, X,Y,Z direction ② 50 times each direction	*1, *2
Mechanical shock (non-operation)	① 294m/s^2, 11ms X,Y,Z direction ② 3 times each direction	*1, *2
ESD (operation)	150pF, 150Ω, ±10kV 9 places on a panel *3 10 times each place at one-second intervals	*1
Dust (operation)	15 kinds of dust (JIS-Z 8901) Hourly 15 seconds stir, 8 times repeat	*1

*1: Display function is checked by the same condition as LCD module out-going inspection.
*2: Physical damage
*3: Discharge points are shown in the figure.



19. ESTIMATED LIFE-TIME OF THE BARE LAMP

Note 1,3

	Bare lamp
Conditions	Luminance Maximum Room temp.（25±2℃）, Continuous operation
Estimated value (MTTF)	40,000h (IL=6.0mArms) Note 2
Criteria	Half value luminance (compared with initial value.)

Note1: The life-time is estimated value (reference).
Note2: This estimated value is based on the test results with a bare lamp operation. The MTTF for the module may be different from these values, because of the influence of ambient and clamshell conditions.
Note3: The life-time becomes short if the module is operated under the low temperature environment.
Note4: This module consists of two lamps. Even though one of the lamps goes off, all the lamps may go off.

20. GENERAL CAUTIONS

Because the following statements are very important, please be sure you understand their contents completely.

CAUTION	This figure is a warning that you will get hurt and/or the module will be damaged if you make a mistake in operation.

	This figure is a warning that you will get an electric shock if you make a mistake in operation.
	This figure is a warning that you will get hurt if you make a mistake in operation.

CAUTIONS

	Do not touch an inverter on which there is a caution label is stuck while the LCD module is in operation, because of dangerous high voltage.

(1) Caution when taking out the module

① Pick up the pouch only, when removing the module from a carrier box.

(2) Cautions for handling the module

① As the electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges. Peel protection sheet out from the LCD panel surface as slowly as possible.

② As the LCD panel and backlight element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.

③ As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.

④ Do not pull the interface connectors in or out while the LCD module is operating.

⑤ Put the module display side down on a flat horizontal plane.

⑥ Handle connectors and cables with care.

⑦ When the module is operating, do not lose CLK, Hsync, or Vsync signal. If any one or more of these signals is lost, the LCD panel would be damaged.

⑧ The torque for mounting screws should never exceed 0.392 N·m.

⑨ Don't push or rub the surface of LCD module please.
If you do, the scratches or the marks like rubbing marks may be left on the surface of the module.

⑩ Do not give the stress too much on interface connectors. The module may become function deficiency by a contact defective and damages. Pay attention to handling at the time of matching connector connection and in the connection condition.

⑪ Do not put front side (display surface side) of the module on a desk or a table for a long time, because the display may become un-uniformity.

(3) Cautions regarding atmosphere

① Dew-drop atmosphere must be avoided.
② Do not store and/or operate the LCD module in a high-temperature and/or high-humidity atmosphere. Storage in an anti-static pouch and under the room temperature atmosphere is recommended.
③ This module uses cold cathode fluorescent lamps. Therefore the lifetime of lamps is shortened if the module is operated under the low temperature environment.
④ Do not operate the LCD module in high magnetic field.

(4) Cautions about the module characteristics

① Do not apply any fixed pattern data for a long time to the LCD module. It may cause image sticking. Use screen savers if the display pattern is fixed.
② This module has the lends sheet which may cause the variation of the color hue in the different viewing angles. The ununiformity may appear on the screen under the high temperature operation.
③ The light vertical stripe may be observed depending on the display pattern. This is not defects or malfunctions.
④ The noise from the inverter circuit may observed in the luminance control mode. This is not defects or malfunctions.

(5) Other cautions

① Do not disassemble and/or reassemble the LCD module.
② Do not readjust variable resistors nor switches in the module.
③ When returning the module for repair, etc., please pack the module properly to avoid any damages. NEC recommends using original shipping packages.

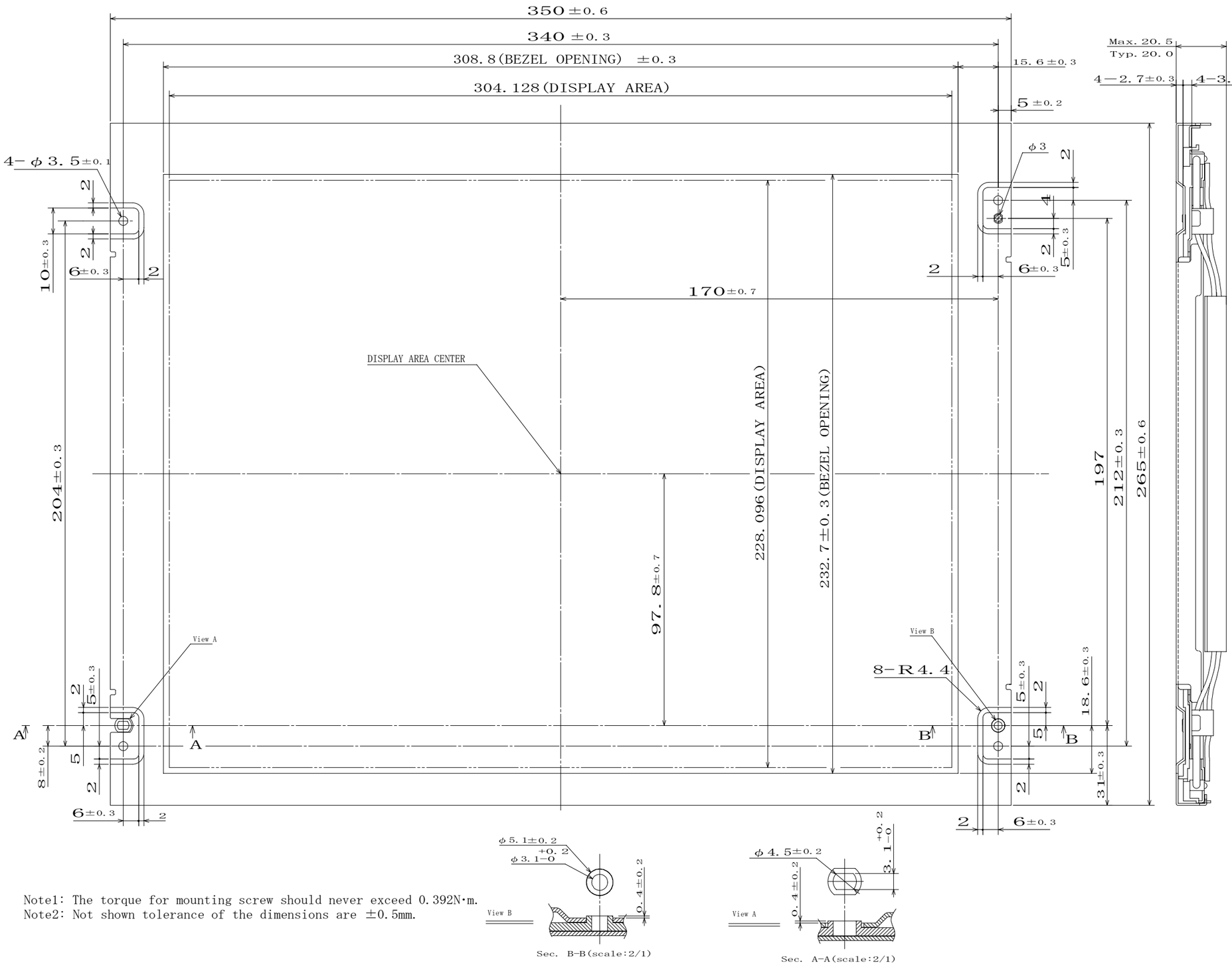
The liquid crystal display has the following specific characteristics. These are not defects or malfunctions.

The optical characteristics of this module may be affected by the ambient temperature.
This module has cold cathode tube for backlight. Optical characteristics, like luminance or uniformity, will be changed by the progress in time.

Uneven brightness and/or small spots may be observed depending on different display patterns.

21.OUTLINE DRAWINGS (Unit:mm)

21.1.FRONT VIEW

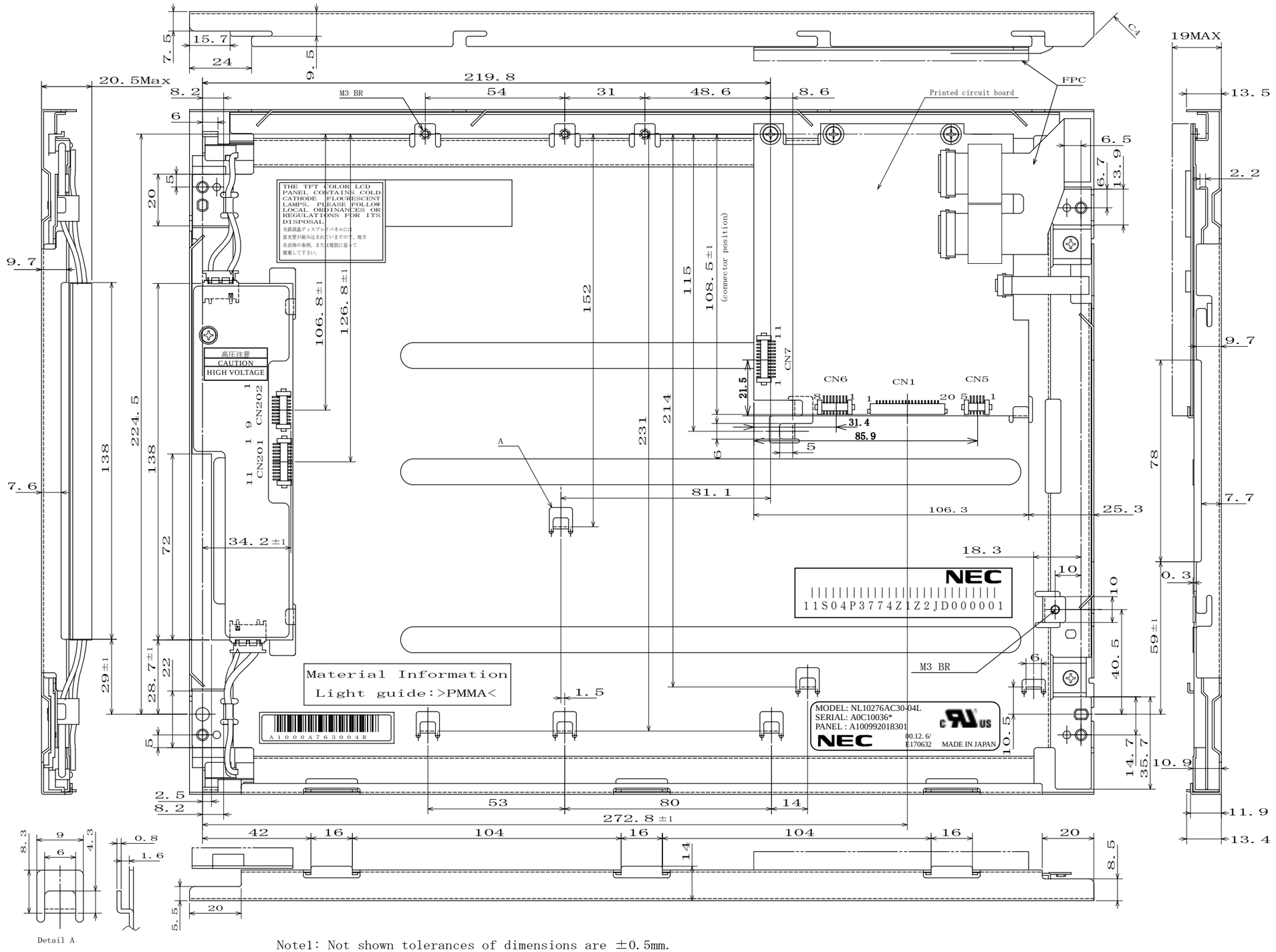


Sec. B-B(scale:2/1)

Sec. A-A(scale:2/1)

Note1: The torque for mounting screw should never exceed 0.392N·m.
Note2: Not shown tolerance of the dimensions are ±0.5mm.

21.2.REAR VIEW



Note1: Not shown tolerances of dimensions are ±0.5mm.

Rev.	prepared date	Revision contents	Approved	Checked	Prepared	Issued date
1	Nov. 29, 2000	DOD-H-8111(abstract)	A.Okamoto	T.kusanagi	N.Kano	—
2	Dec. 7, 2000	DOD-H-8237(all spec)				—