NEC

TFT COLOR LCD MODULE

Type: NL10276BC28-24F
36cm (14.1 Type), XGA
LVDS interface (1 port)

SPECIFICATIONS

(First Edition)

PRELIMINARY

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

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CONTENTS

1. DESCRIPTION

The NL10276BC28-24F is a TFT (thin film transistor) active-matrix color liquid crystal display (LCD) comprising an amorphous silicon TFT attached to each signal electrode, a driving circuit, and a backlight. NL10276BC28-24F has a built-in backlight.
The 36cm(14.1 Type) diagonal display area contains 1024 × 768 pixels and can display 262,144 colors simultaneously.

2. FEATURES

- Expanded screen size without increasing the frame area
- LVDS interface (adapted SN75LVDS88B, TEXAS INSTRUMENTS. as a receiver core with timing controller)
- High luminance (Typ. 160 cd/m^2 at IL= 6.0mArms)
- Supply voltage: 3.3V
- Incorporated edge-type backlight (One lamp, inverter-less)
- Approved by UL1950 (File No.E170632) Third Edition and CSA-C22.2 No.950-95 (File No.E170632)

3. APPLICATION

- Engineering work station, Desk–top type of PCs
- Monitors

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. After the driver LSIs are connected to the panel, the backlight assembly is attached to the back side 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 address 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)

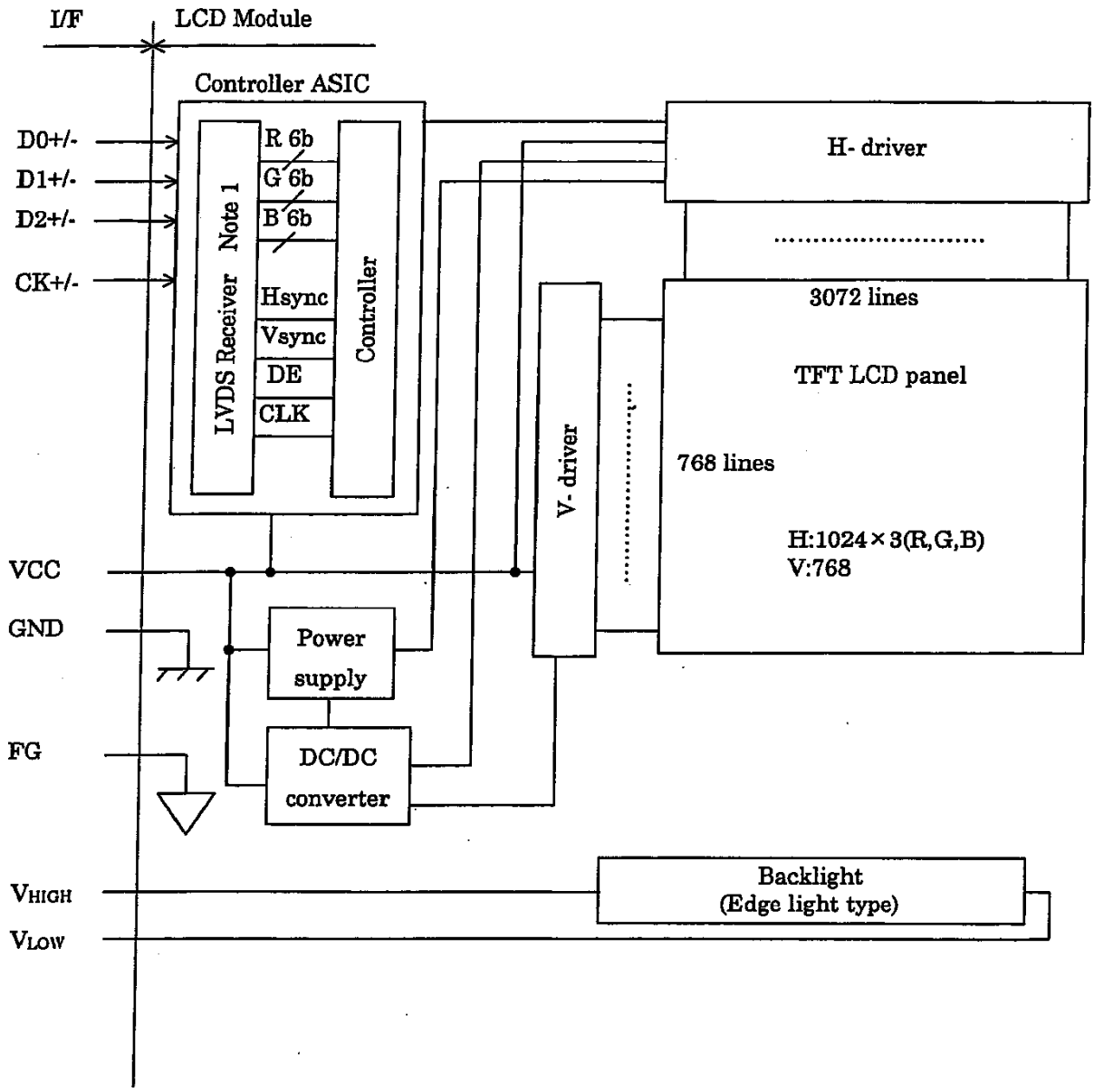
Display area	285.696 (H) × 214.272 (V) mm
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	1024 × 768
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.279 (H) × 0.279 (V) mm
Module size	298.5 (H) × 226.5 (V) × 6.0 (D) mm Max.
Weight	540 g (Typ.)
Contrast ratio	250:1 (Typ.)

Viewing angle (more than the contrast ratio of 10:1)
- Horizontal: 40° (Typ. , left side, right side)
- Vertical: 20° (Typ. , up side), 40° (Typ., down side)

Designed viewing direction
- Optimum grayscale (γ =TBD): 5° (down side, 6 o'clock)
- Best contrast angle: down side

Pencil hardness	3 H (Min., JIS K5400)
Color gamut	40 % (Typ., At center, To NTSC)
Response time	15 ms (Max.), white to black (100%→10%)
Luminance	160 cd/m^2 (Typ. at IL= 6.0mArms)
Signal system	LVDS interface (Receiver:SN75LVDS88B, TEXAS INSTRUMENTS.) RGB 6-bit signals, Synchronous signals (Hsync, Vsync), Data enable signal (DE) and dot clock (CLK) encoded with SN75LVDS84A (TEXAS INSTRUMENTS.) are preferable.
Supply voltage	3.3 V (Typ.)
Backlight	Edge light type: One cold cathode fluorescent lamp in a holder, Inverter-less
Power consumption	5.2 W (Typ. at 160 cd/m^2)

6. BLOCK DIAGRAM



Note 1: SN75LVDS88B (TEXAS INSTRUMENTS.)
Remark 1: GND is connected to the FG (Frame ground) in the LCD module.

7. GENERAL SPECIFICATIONS

Items	Specifications	Unit
Module size	298.5±0.5 (H) × 226.5±0.5 (V) × 6.0 (D) Max.	mm
Display area	285.696 (H) × 214.272 (V) 【 Diagonal display area: 36cm (Type: 14.1) 】	mm
Number of pixels	1024 (H) × 768 (V)	pixel
Dot pitch	0.093 (H) × 0.279 (V)	mm
Pixel pitch	0.279 (H) × 0.279 (V)	mm
Pixel arrangement	RGB (red, green, blue) vertical stripe	—
Display colors	262,144 (RGB 6-bit each)	color
Weight	570 (Max.)	g

8. ABSOLUTE MAXIMUM RATINGS

Parameters	Symbols	Ratings	Unit	Remarks
Supply voltage	VCC	-0.3 to +4.0	V	Ta = 25℃
Logic input voltage	VI	-0.3 to VCC+0.3	V	
Lamp voltage	VL	2000	Vrms	
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℃, RH= 85%.	g/m³	Ta>50℃

Note 1: Measured at the display area (Including self-heat)
Note 2: No condensation

9. ELECTRICAL CHARACTERISTICS

(1) Logic/ LCD driving

Ta = 25℃

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VCC	3.0	3.3	3.6	V	—
Ripple voltage	VRP	—	—	100	mV	for VCC
LVDS signal input "L" voltage	VTL	-100	—	—	mV	VCM=1.2V VCM: Common mode voltage in LVDS driver
LVDS signal input "H" voltage	VTH	—	—	+100	mV	
Terminating resistor	RT	—	100	—	Ω	—
Supply current	ICC	—	320 Note 1	650 Note 2	mA	VCC= 3.3V

Note 1: Checker flag pattern (in EIAJ ED-2522)
Note 2: 2H1V Checker flag pattern

(2) Backlight

Ta = 25℃

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Lamp current	IL	2.0	6.0	6.0	mArms	IL=6.0 mArms 160 cd/m^2 Note1
Lamp voltage	VL	—	690	—	Vrms	IL=6.0 mArms
Lamp turn on voltage	VS	1300	—	—	Vrms	Ta=0℃ Note1
		900	—	—		Ta=25℃ Note1
Oscillator frequency	Ft	50	60	—	kHz	Note2

Note1: When IL and VS are less than Min. value, lamps might be not turned on it.

Note2: Recommended value of "Ft"

・Ft is within the specification.

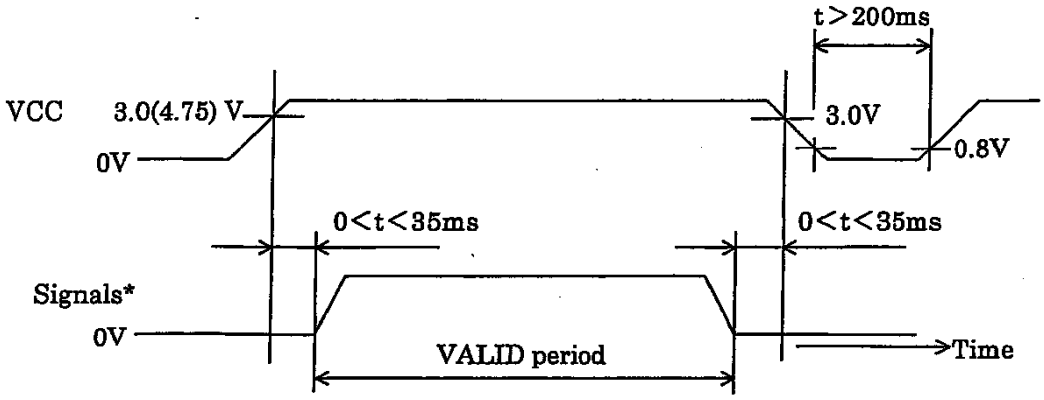
$$\cdot Ft = \frac{1}{4th} \times (2n-1)$$

th: Hsync period

n: a natural number (1,2,3,・・・・)

If Ft is out of the recommended value, interference between Ft frequency and Hsync frequency may cause beat on the display.

10. POWER SUPPLY SEQUENCE



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

Note 1: The supply voltage for input signals should be the same as VCC.
Note 2: Turn on the backlight within the LCD operation period. When the backlight turns on before LCD operation or the LCD operation turns off before the backlight turns off, the display may momentarily become white.
Note 3: When the power is off, keep whole signals (CLK, Hsync, Vsync, DE, R0-R5, G0-G5, and B0-B5) low level or high impedance.
Note 4: Wrong power sequence may damage the module.
Note 5: The signals should not be down during operation. Even if the signals could recover, the LCD module can not be operated correctly or the display may have un-uniformity. In case the signals is down, VCC should be turned off, and then turn VCC and the signals on with above sequence.

11. INTERFACE PIN CONNECTIONS

(1) Interface connector for signals and power

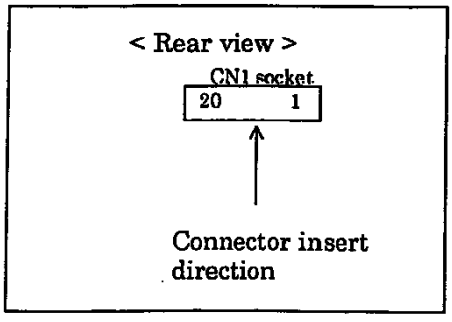
Part No.: FI-SEB20P-HF10
Adaptable plug: FI-SE20S
Supplier: Japan Aviation Electronics Industry Limited (JAE)

CN1 socket

Pin No.	Symbols	Signal type	Functions
1	VCC	Power supply	Supply +3.3V ±0.3V
2	VCC		
3	GND	Ground	Note 1
4	GND		
5	D0-	Pixel data etc.	LVDS differential data input Note 2
6	D0+		
7	GND	Ground	Note 1
8	D1-	Pixel data etc.	LVDS differential data input Note 2
9	D1+		
10	GND	Ground	Note 1
11	D2-	Pixel data etc.	LVDS differential data input Note 2
12	D2+		
13	GND	Ground	Note 1
14	CK-	Pixel clock	CLK for pixel data f=65MHz (Typ.) (LVDS level) Note 2
15	CK+		
16	GND	Ground	Note 1
17	N.C.	Non-connection	–
18	N.C.		
19	GND	Ground	Note 1
20	GND		

Note 1: GND for logic and LCD driving. GND is not connected to FG (Frame Ground) in the module. These grounds should be connected in customer equipment.
Note 2: Use 100Ω twist pair wires for the cable.
Remark: Do not keep pins free (except 17 and 18) to avoid noise issue.

CN1 socket: Figure from socket view



(2) Connector for backlight unit

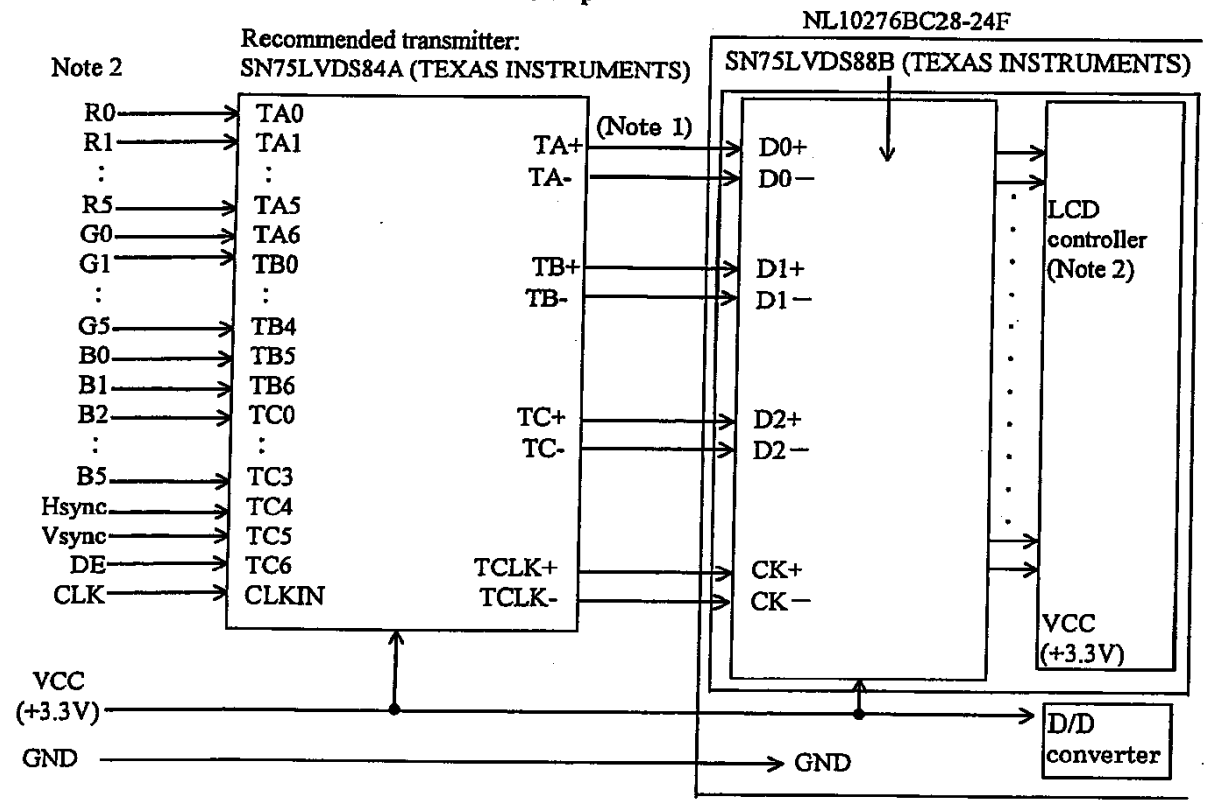
Part No.: BHTR-02VS-1
Adaptable socket: BHTMR-02VS
Supplier: J.S.T. TRADING Company, Ltd.

CN2

Pin No.	Symbols	Functions
1	V_{HIGH}	High voltage terminal
2	V_{LOW}	Low voltage terminal

Note1: V_{HIGH} and V_{LOW} must be connected correctly. If you connect wrongly, you will get hurt and the module will be broken.

12. METHOD OF CONNECTION FOR LVDS chip



Note 1: 100Ω twist pair
Note 2: These signals should be kept in the specified range of 14. INPUT SIGNAL TIMINGS.

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

Note 1: 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. INPUT SIGNAL TIMINGS

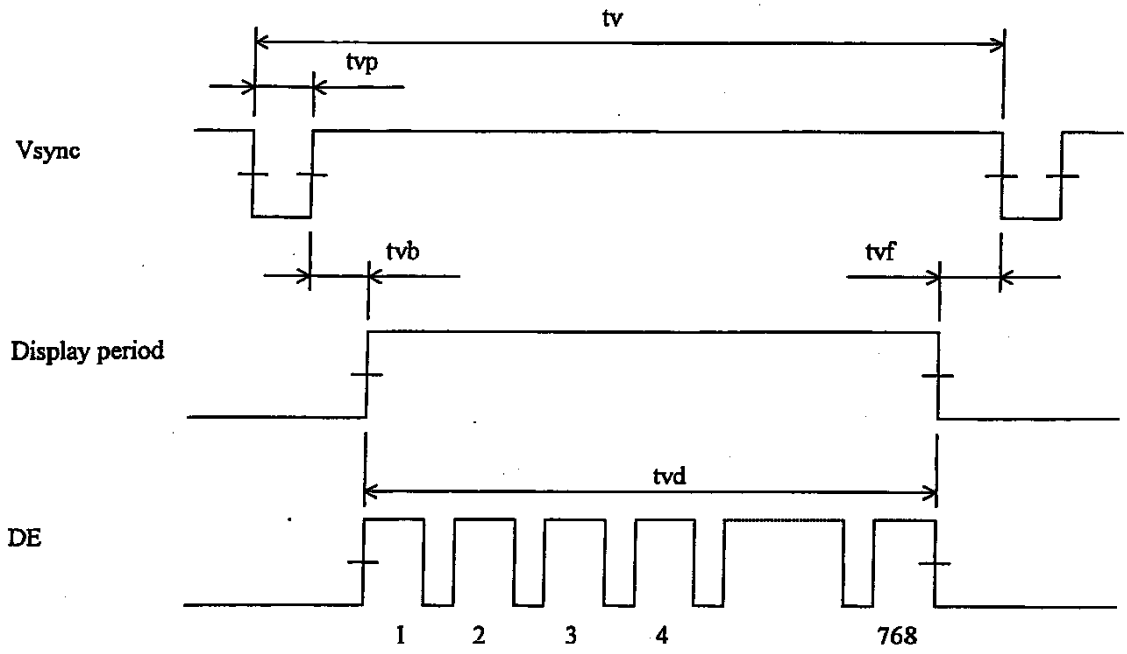
(1) Input signal specifications for LCD controller

	Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	60.0	65.0	68.0	MHz	15.384ns (Typ.)
	Duty	tch/tc	Note1			—	—
	Rise, fall	tcrf				ns	
Hsync	Period	th		20.676		μs	48.363kHz (Typ.)
				1344		CLK	
	Display period	thd		1024		CLK	—
	Front-porch	thf *	1	40	—	CLK	—
	Pulse width	thp *	2	208	—	CLK	—
	Back-porch	thb *	1	72	—	CLK	—
	* thf + thp + thb		81	320	1023	CLK	—
	Hsync-CLK timing	ths	Note1			ns	—
	CLK-Hsync timing	thh				ns	
	Rise, fall	thrf				ns	
Vsync	Period	tv		16.666		ms	60.004Hz (Typ.)
				806		H	
	Display period	tvd		768		H	—
	Front-porch	tvf *	1	3	—	H	—
	Pulse width	tvp *	2	—	—	H	—
	Back-porch	tvb *	1	33	—	H	—
	* tvf + tvp + tvb		4	38	—	H	—
	Vsync-Hsync timing	tvs	Note1			ns	—
	Hsync-Vsync timing	tvh				CLK	
	Rise, fall	tvrf				ns	
DATA	DATA-CLK (Set up)	tds				ns	
	CLK-DATA (Hold)	tdh				ns	
DE	DE-CLK timing	tes				ns	
	CLK-DE timing	teh				ns	
	Rise, fall	terf				ns	

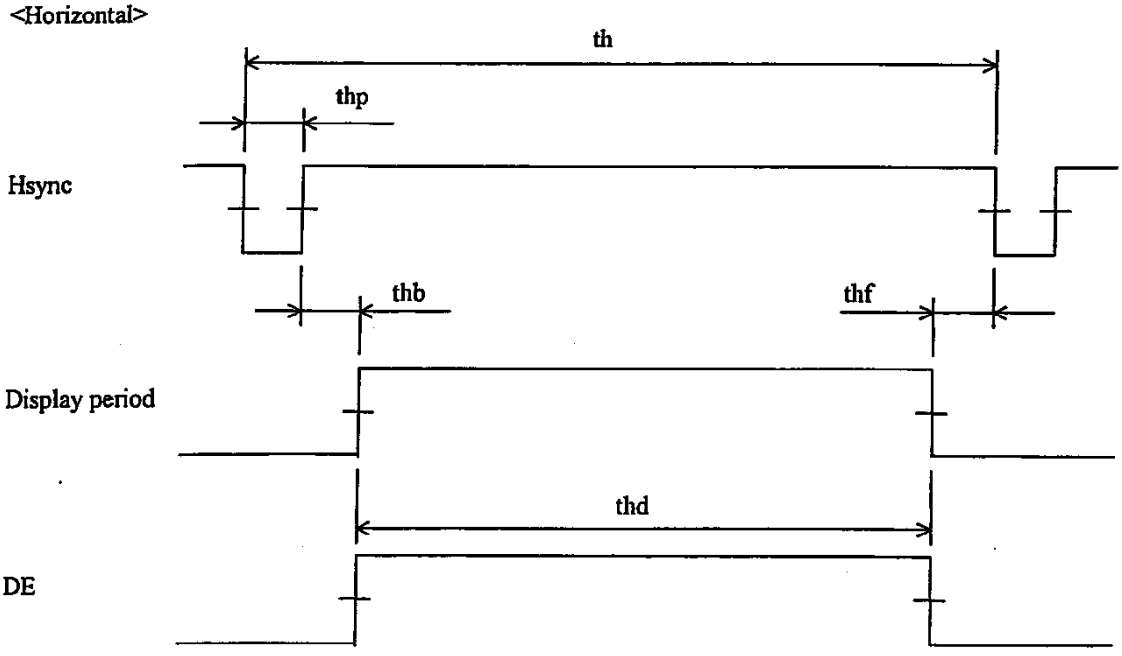
Note 1: These values are specified at the inputs of SN75LVDS88B (TEXAS INSTRUMENTS).
(Refer to **12. METHOD OF CONNECTION FOR LVDS chip**)

(2) Definition of input signals timing for LCD controller

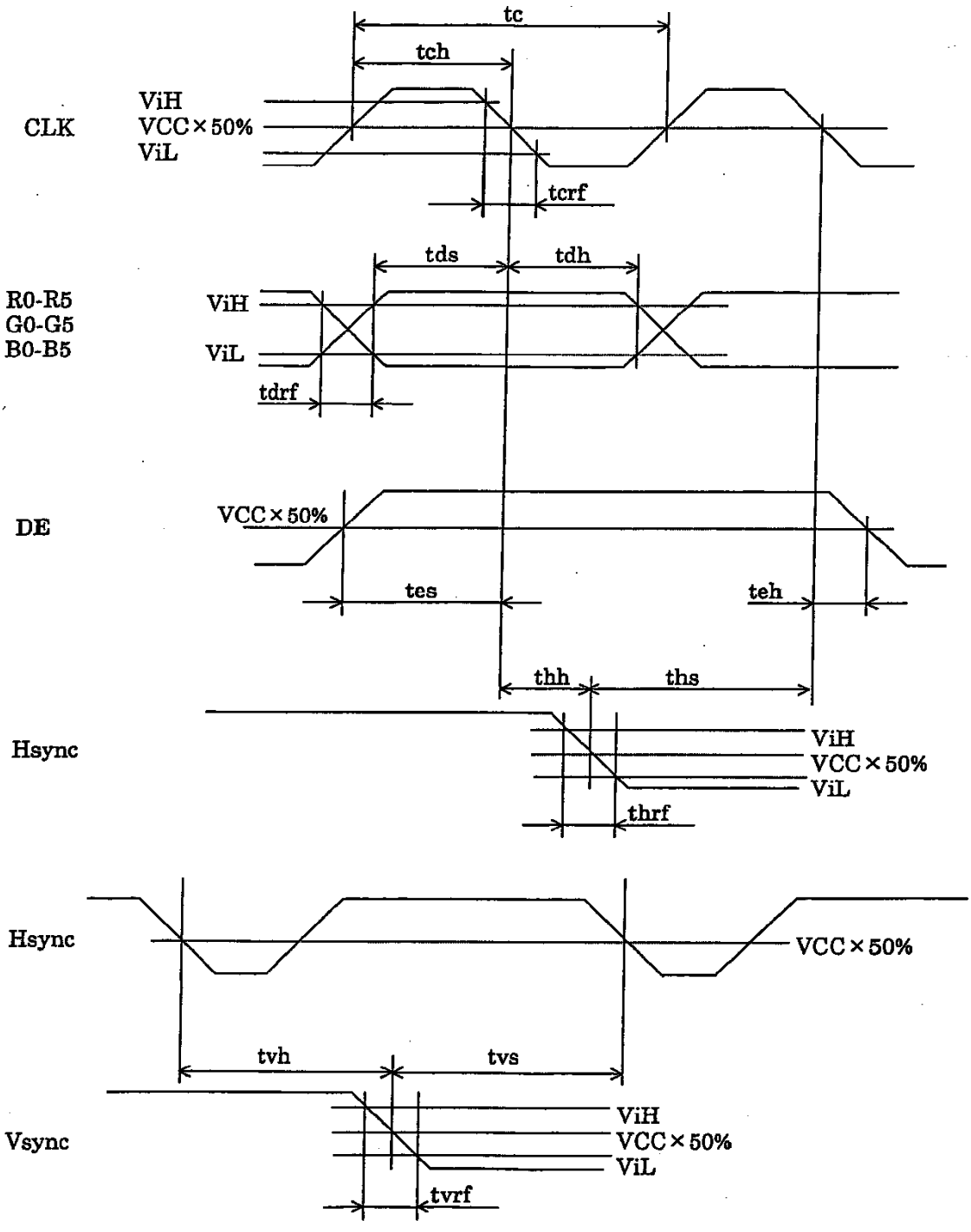
<Vertical>



<Horizontal>

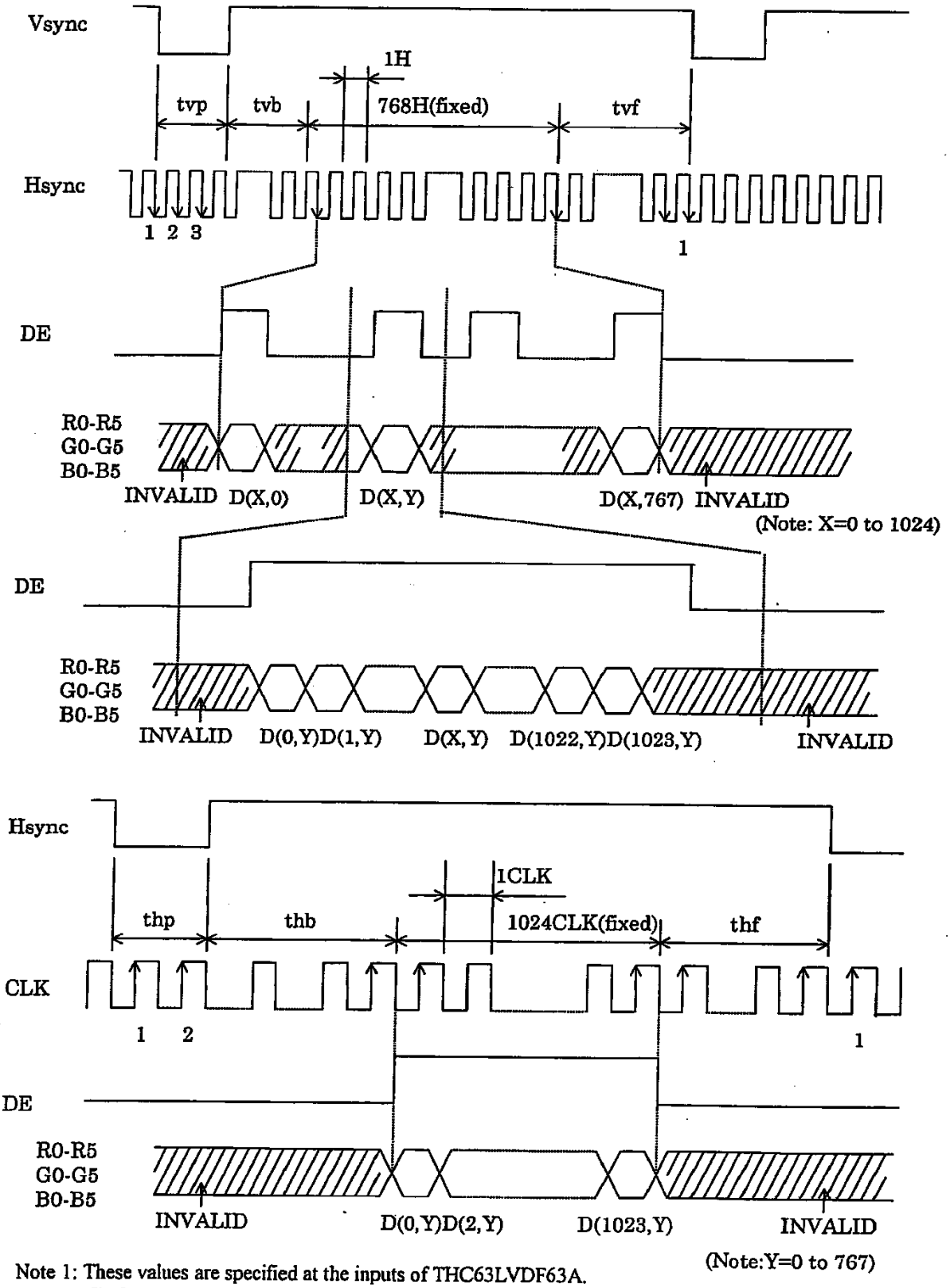


Note 1: "Display period" do not exist as signals.
Note 2: These values are specified at the inputs of SN75LVDS88B.
(Refer to **12. METHOD OF CONNECTION FOR LVDS chip**)



ViH = VCC×0.7(Min.)
ViL = VCC×0.3(Max.)

(3) Input signals timing chart for LCD



Note 1: These values are specified at the inputs of THC63LVDF63A.
(Refer to **12. METHOD OF CONNECTION FOR LVDS chip**).

(4) Display positions 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)

15. FOR LVDS RECEIVER

(1) Input signal specifications (It is prescribed in the part CN1 input)

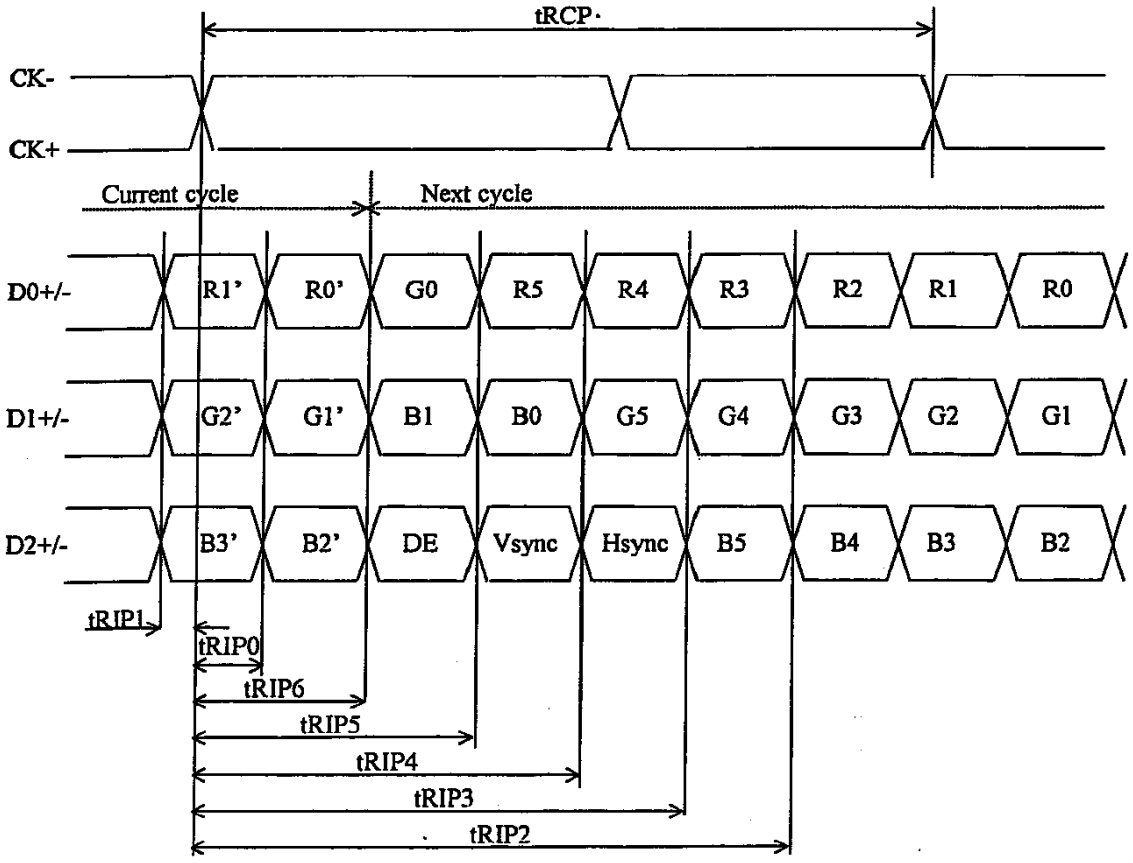
Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
CLK Frequency	tRCP	14.71	15.38	16.66	ns	—
Bit0 position	tRIP1	—	0	—	ns	—
Bit1 position	tRIP0	—	T/7	—	ns	—
Bit2 position	tRIP6	—	2T/7	—	ns	—
Bit3 position	tRIP5	—	3T/7	—	ns	—
Bit4 position	tRIP4	—	4T/7	—	ns	—
Bit5 position	tRIP3	—	5T/7	—	ns	—
Bit6 position	tRIP2	—	6T/7	—	ns	—
	SKRM	490	—	—	ps	—

Note 1: See the specifications of LVDS manufactures for detailed design.
In case that CLK jitter value between current cycle and next cycle is big, skew time of the next cycle decreases with the value of the jitter.

CLK jitter + LVDS output skew + cable skew ≦ 500ps

e. q. LVDS output skew: ±200ps
Cable skew: ±100ps
} acceptable CLK jitter ±200ps (500-(200+100) = 200ps)

(2) Input signals timing chart



16. OPTICAL CHARACTERISTICS

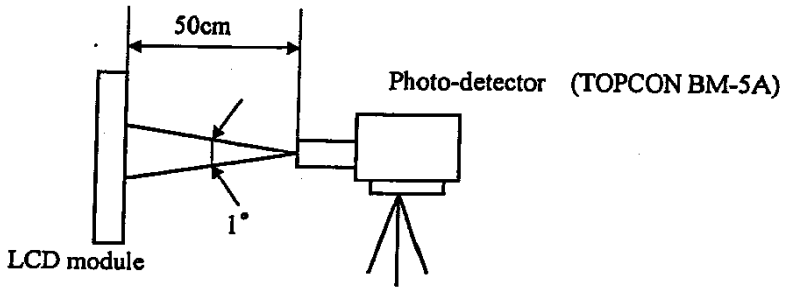
(Ta = 25±5℃, VCC = 3.3V, IL = 6.0 mArms, Note 1)

Items	Symbols	Conditions	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio	CR	θR=0°, θL=0°, θU=0°, θD=0° White/Black, at center	80	250	—	—	Note 2
Luminance	Lvmax	White, at center	135	160	—	cd/m^2	—
Luminance uniformity	—	White	—	—	TBD	—	Note 3

Reference data

Items	Symbols	Conditions	Min.	Typ.	Max.	Unit	Remarks
Best contrast ratio	CR	θR=0°, θL=0°, θU=0°, θD=5°	—	300	—	—	Note 2
Viewing angle range (CR > 10)	θ x+	CR > 10, θU=0°, θD=0° White/Black, at center	30	40	—	deg.	Note 4
	θ x-		30	40	—	deg.	
	θ y+	CR > 10, θR=0°, θL=0° White/Black, at center	10	20	—	deg.	
	θ y-		30	40	—	deg.	
Viewing angle range (CR > 5)	θ x+	CR > 5, θU=0°, θD=0° White/Black, at center	—	50	—	deg.	
	θ x-		—	50	—	deg.	
	θ y+	CR > 5, θR=0°, θL=0° White/Black, at center	—	25	—	deg.	
	θ y-		—	50	—	deg.	
Color gamut	C	θR=0°, θL=0°, θU=0°, θD=0° at center, to NTSC	35	40	—	%	—
Response time	Ton	White to Black (100%→10%)	—	15	40	ms	Note 5
		White to Black (90%→10%)	—	TBD	TBD		
	Toff	Black to White (0%→90%)	—	TBD	TBD	ms	
		Black to White (10%→90%)	—	TBD	TBD		

Note 1: Optical characteristics are measured after 20 minutes from the module works.
The typical value is measured after luminance saturation, more than one hour after burn-in.
Optical characteristics are measured in dark room.



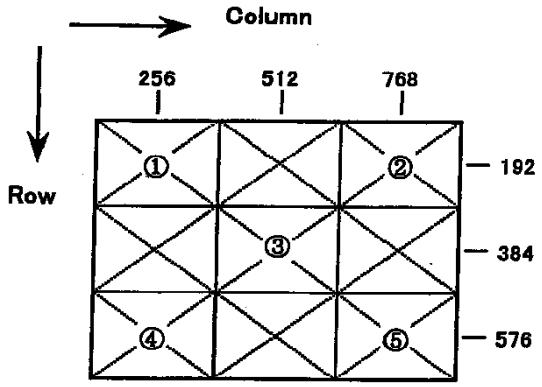
Note 2: The contrast ratio is calculated by using the following formula.

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

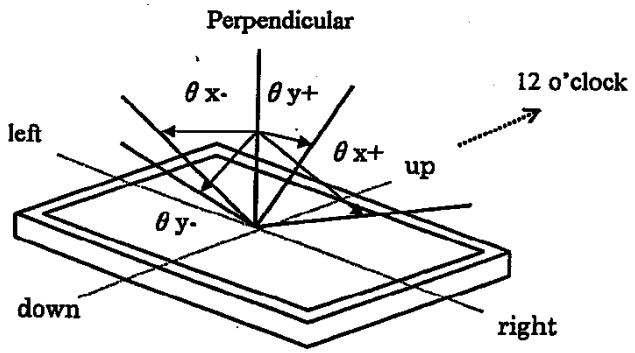
Note 3: Luminance uniformity is calculated by using the following formula.

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

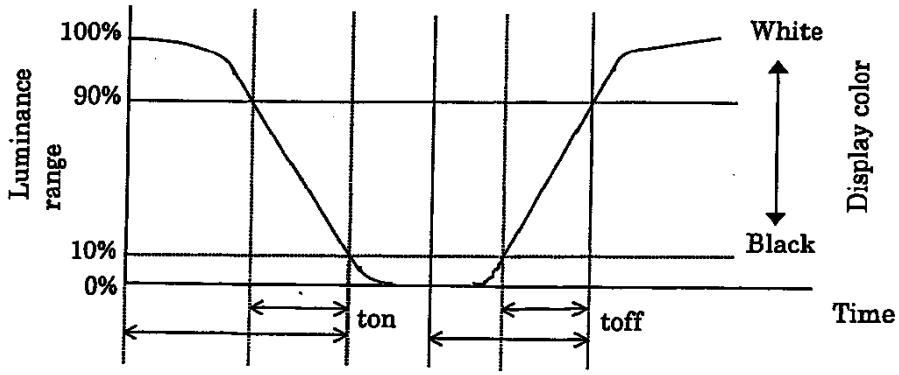
The luminance is measured at near the five points shown below.



Note 4: Definitions of viewing angle are as follows.



Note 5: Definition of response time is as follows.
Photo-detector output signal is measured when the luminance changes "white" to "black".



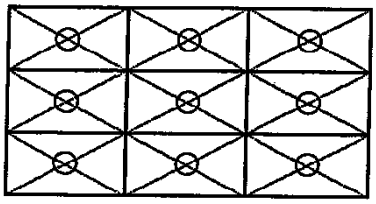
17. RELIABILITY TEST

Test items	Test conditions	Judgment
High temperature/humidity operation	50±2℃, RH= 85% 240 hours, Display data is white.	*1
Heat cycle (operation)	① 0℃±3℃···1 hour +55℃±3℃···1 hour ② 50 cycles , 4 hours/cycle ③ Display data is white.	*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 (2G) 1 minute/cycle, X,Y,Z direction ② 120 times each direction	*1, *2
Mechanical shock (non-operation)	① 490m/s^2 (50G), 11ms X,Y,Z direction ② 5 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.



18. EXPECTED LIFE-TIME OF THE BARE LAMP

Note 1,3

	Bare lamp
Condition	IL=6mArms/lamp Room temp. (25±2℃) , Continuous operation
Expected value (MTTF)	10,000 h Note 2
Criteria	Half value luminance (compared with initial value.)

Note 1: The life-time is expected value (reference).

Note 2: This expected 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.

Note 3: The life-time becomes short if the module is operated under the low temperature environment.

19. GENERAL CAUTIONS

Because the following figures and 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 hurt if you make a mistake in operation.

⚠ CAUTIONS

(1) A caution when taking out the module

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

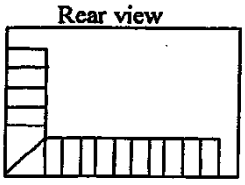
⑦ When the module is operating, do not lose CLK, Hsync, or Vsync signal. If any one or more of these signals is lost, the LCD panel would be damaged.

⑧ The torque for mounting screws should never exceed 0.2 N·m (2.0 kgf·cm).

⑨ The LCD module should be mounted in strong body such as magnesium alloy. If the press or twist are added to the module, the display may have un-uniformity image. When the module is mounted to customer chassis, please evaluate the display condition carefully.

⑩ Be careful not to touch the sheet at handling because only a thin transparency seat is put on the printed circuit board.

Rear view



← A thin transparency sheet on the printed circuit board.

⑪ Do not any stress to the interface connector.

(3) Cautions regarding atmosphere

① Dew drop atmosphere must be avoided.

② Do not store and/or operate the LCD module in high-temperature and/or high humidity atmosphere. Storage in an Electro-conductive polymer-packing pouch and in a relatively low-temperature atmosphere is recommended.

③ This module uses cold cathode fluorescent lamp. The lifetime of the lamps is shortened conspicuously at low temperatures.

④ Do not operate the LCD module in high magnetic field.

(4) Caution about the module characteristics

① Do not apply any fixed pattern to the LCD module at product aging. Applying a fixed pattern for a long time may cause image sticking.

(5) Other cautions

① Do not disassemble and/or reassemble the LCD module.

② Do not readjust variable resistors nor switches etc.

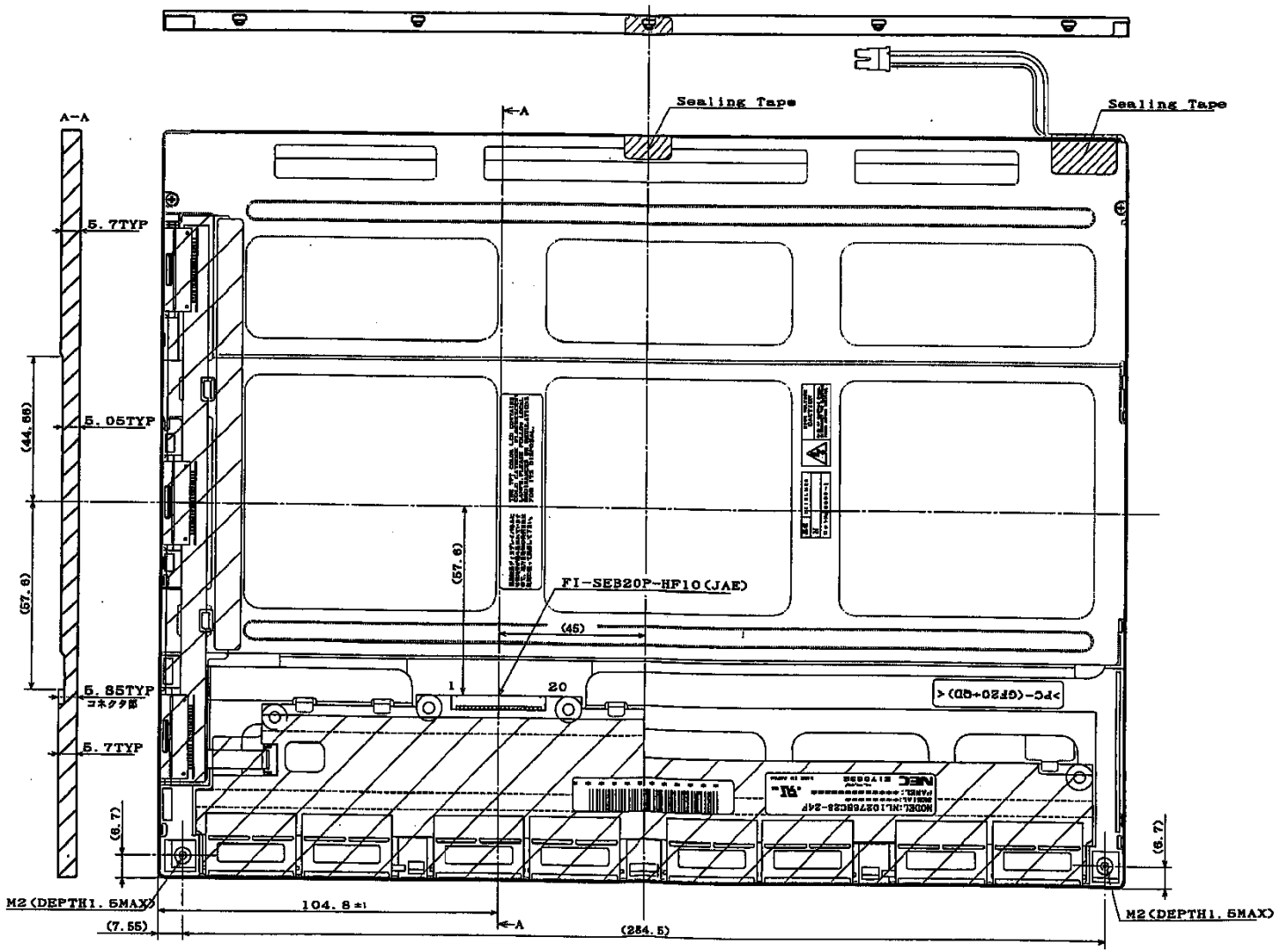
③ When returning the module for repair etc., pack the module so it will not be broken. We recommend using the original shipping packages.

The liquid crystal display has the following specific characteristics. These are neither defects nor malfunctions.

The ambient temperature may affect the display condition of the LCD module.
The LCD module uses cold cathode tube for backlight. Optical characteristics, like luminance or uniformity, will change over time.

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

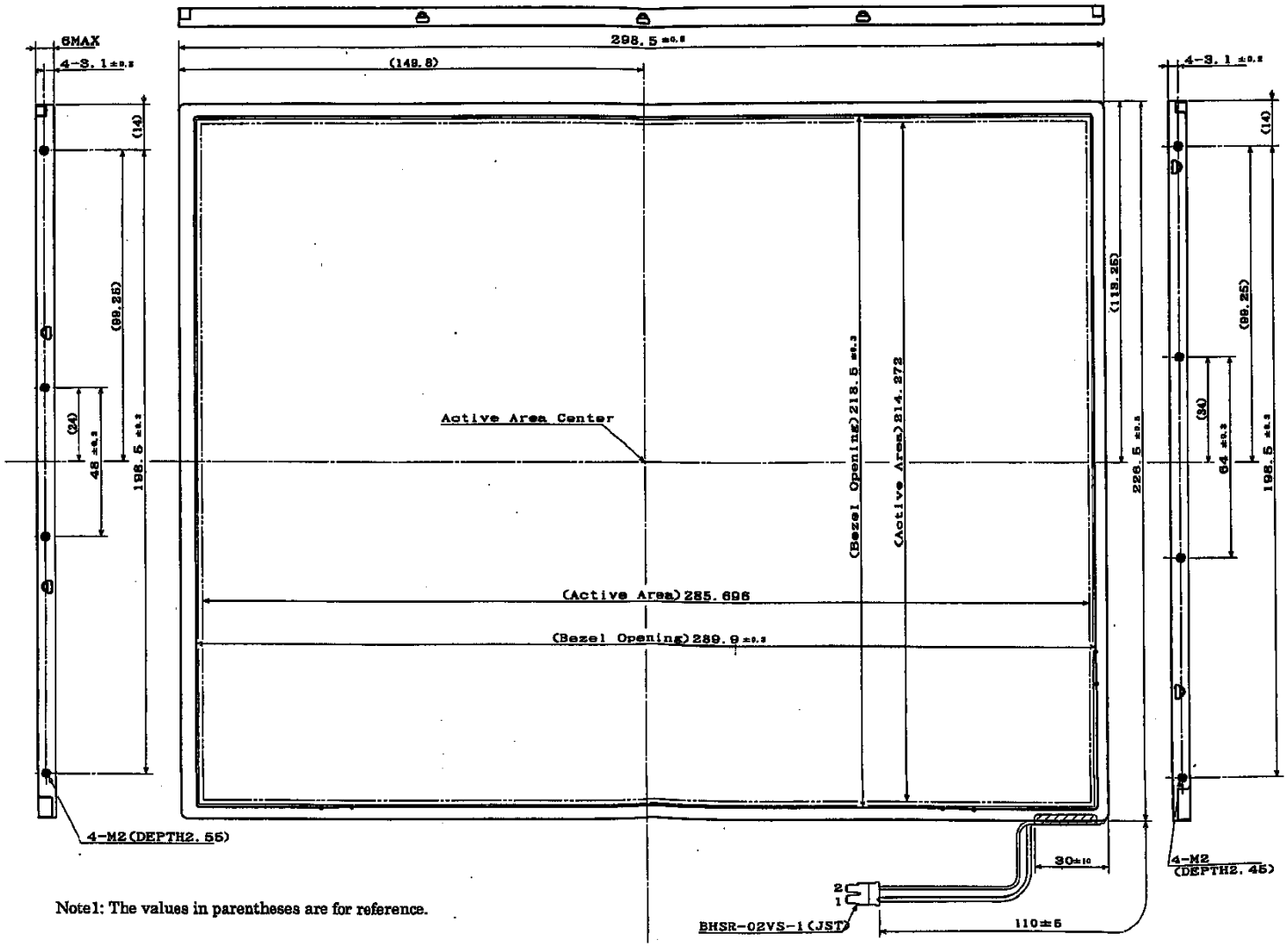
20.2. Rear view



Note1: The values in parentheses are for reference.

20. OUTLINE DRAWINGS (Unit : mm)

20. 1. Front view



Note1: The values in parentheses are for reference.

Revision History

Rev.	prepared date	Revision contents	Approved	Checked	Prepared	Issued date
1	Nov. 6, 2000	Reliability and QC department R:_____ QA:_____ Planning Department _____ Product Engineering Department _____ Application Engineering Department _____	T. Kusanagi		N. Kano	