NEC

TFT COLOR LCD MODULE

NL10276BC28-05D

36 cm (14.1 inches), 1024 × 768 pixels, 262,144 colors, LVDS Interface, High luminance

DESCRIPTION

NL10276BC28-05D 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. NL10276BC28-05D has a built-in backlight and no inverters.

The 36 cm (14.1 inches) diagonal display area contains 1024 × 768 pixels and can display 262,144 colors simultaneously.

FEATURES

- High luminance
- Low reflection
- LVDS interface (Equivalent to THC63LVDF64A of Thine Electronics, Inc.)
- 6-bit digital RGB signals
- Incorporated edge type backlight (two lamps) and lamp holder replaceable

APPLICATIONS

- PC monitors

The information in this document is subject to change without notice.

Please confirm with the delivery specification before starting to design the system.

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. The TFT panel structure is created by sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate. After 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 is 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.

BLOCK DIAGRAM
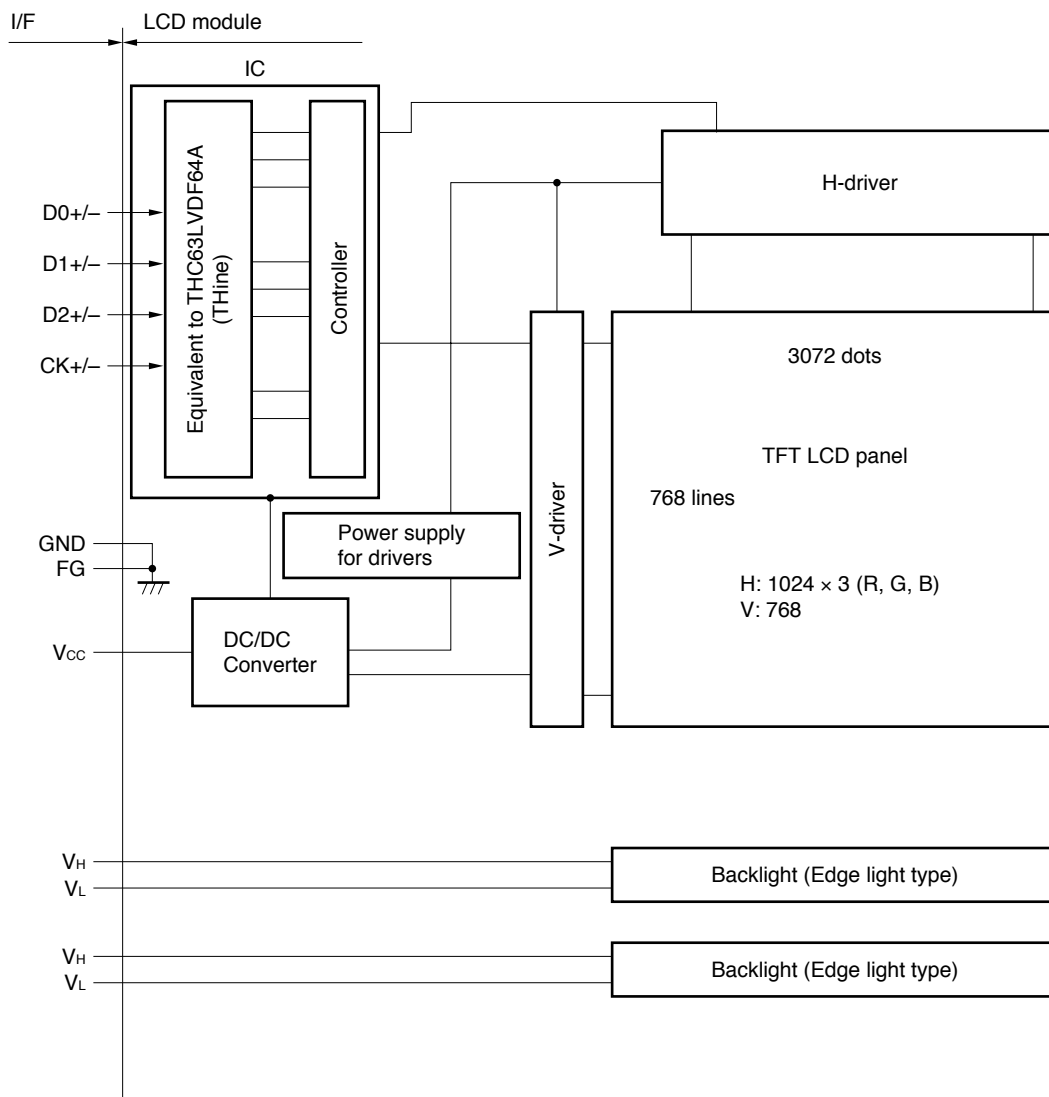
Note GND is connected to FG (Frame Ground) inside the LCD module.

OUTLINE OF CHARACTERISTICS (at room temperature)

Items	Description
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 pixels
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.279 (H) × 0.279 (V) mm
Module size	330.0 (H) × 255.0 (V) × 17.3 typ. (D) mm
Weight	1150 g (typ.)
Contrast ratio	150 : 1 (typ.)
Viewing angle (more than the contrast ratio of 10 : 1)	• Horizontal: 50° (typ., left side, right side) • Vertical : 20° (typ., up side). 35° (typ., down side)
Designed viewing direction	• Best contrast angle: down side 5° • Wider viewing angle without image reversal : up side (12 o'clock) • Optimum grayscale (r = 2.2): perpendicular
Color gamut	40 % (typ., at center, to NTSC)
Response time	11 ms (typ.), "white 100 %" to "Black 10%"
Luminance	200 cd/m^2 (typ., at I_L = 6.1 mArms/lamp)
Signal system	RGB 6-bit signals, Synchronous signals (Hsync, Vsync), Dot clock (CLK) LVDS interface (Equivalent to THC63LVDF64A, Thine Electronics, Inc.)
Supply voltage	5 V (Logic, LCD driving)
Backlight	Edge light type: Two cold cathode fluorescent lamps in a holder • Lamp holder: type No.141 LHS08
Power consumption	9.5 W (typ., at I_L = 6.1 mArms/lamp)

GENERAL SPECIFICATIONS

Items	Description	Unit
Module size	330 ± 0.5 (H) × 255.0 ± 0.5 (V) × 18.5 max. (D)	mm
Display area	285.696 (H) × 214.272 (V) [Diagonal display area: 36 cm (14.1 inches)]	mm
Number of pixels	1024 × 3 (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)	color
Weight	1150 (typ.), 1300 (max.)	g

ABSOLUTE MAXIMUM RATINGS

Parameters	Symbol	Rating	Unit	Remarks
Supply voltage	V_{CC}	−0.3 to +6.0	V	T_a = 25°C
Logic input voltage	V_i	−0.3 to V_{CC} + 0.3	V	
Lamp voltage	V_L	2000	Vrms	
Storage temp.	T_{ST}	−20 to +60	°C	–
Operating temp.	T_{OP}	0 to +50	°C	Module surface **Note 1**
Relative Humidity (RH)	**Note 2**	≤ 95%	%	T_a ≤ 40°C
		≤ 85%	%	40 < T_a ≤ 50°C
Absolute humidity	**Note 2**	Absolute humidity shall not exceed T_a = 50°C, 85% relative humidity level.	g/m^3	T_a > 50°C

Notes **1.** Measured at the panel surface (including selfheat)

       2. No condensation

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

Ta = 25°C

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V_{CC}	4.75	5.0	5.25	V	–
Ripple voltage	V_{RP}	–	–	100	mV	for V_{CC}
Differential input "L" Threshold voltage	V_{TL}	–100	–	–	mV	VCM = 1.2 V VCM: Common mode voltage in LVDS driver
Differential input "H" Threshold voltage	V_{TH}	–	–	+100	mV	
Differential input voltage	V_i	0	–	2.4	V	R_T = 100 Ω
Common mode voltage	V_{CM}	1.125	1.25	1.375	V	R_T = 100 Ω
Terminating resistor	R_T	–	100	–	Ω	–
Supply current	I_{CC}	– –	270 **Note**	600	mA	V_{CC} = 5.0 V

Notes 1. Checker flag pattern (in EIAJ ED-2522)
2. Theoretical maximum current pattern

(2) Backlight

Ta = 25°C

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Lamp current	I_L	3.0	6.1	6.5	mArms	–
Lamp voltage	V_L	–	650	–	Vrms	I_L = 6.1 mArms
Lamp turn on voltage **Note 1**	V_S	1050	–	–	Vrms	Ta = 25°C
		1550	–	–	Vrms	Ta = 0°C
Oscillator frequency	Ft	53	–	67	KHz	**Note 2**

Notes 1. When VS is less than Min. value. lamps might be not turned on.
2. Recommended value of "Ft".
   - Ft is within the specification.
   - Ft = ¼ th × (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.

SUPPLY VOLTAGE SEQUENCE
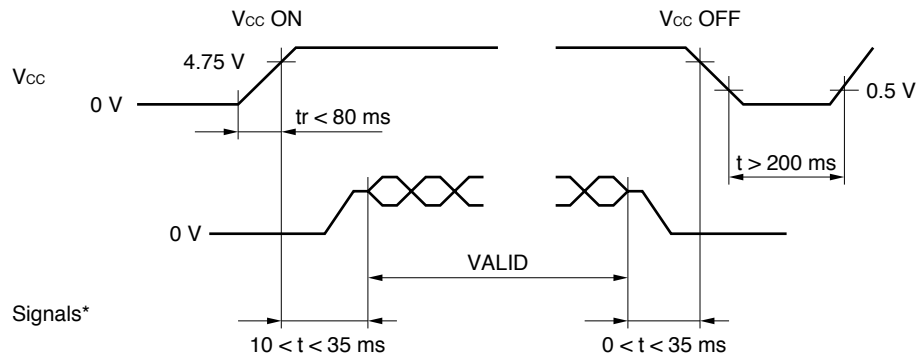
*   The termination of the signal line is connected to resistance 100 Ω.

Notes **1.** Logic signals (synchronous signals and control signals) must be "0" voltage (V), when Vcc is not applied. If input voltage to signal lines is higher than 0.3 V, the internal circuit will be damaged.

2. The supply voltage for input signals should be the same as Vcc.

3. 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.

4. When the power is off, keep whole signals low level or high impedance.

NEC

INTERFACE AND CONNECTOR PIN ASSIGNMENT

(1) Interface connector for signal and power

CN1

Part No.	: FI-SE20P-HF
Adaptable socket	: FI-SE20M
Supplier	: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Signal type	Function
1	GND	Ground	**Note 1**
2	GND		
3	NC	Non-connection	–
4	NC		
5	GND	Ground	**Note**
6	CK+	Pixel clock	CLK for pixel data f = 65 MHz (typ.) (LVDS level)
7	CK–		
8	GND	Ground	**Note**
9	D2+	Pixel data	LVDS differential data input
10	D2–		
11	GND	Ground	**Note**
12	D1+	Pixel data	LVDS differential data input
13	D1–		
14	GND	Ground	**Note**
15	D0+–	Pixel data	LVDS differential data input
16	D0–		
17	GND	Ground	**Note**
18	GND		
19	Vcc	+5.0 V power supply	Supply +5.0 V ±5%
20	Vcc		

Note GND is signal ground for logic and LCD driving. GND is connected to FG (frame ground) inside the module.

Remark Connect all pins (except 3, 4) to avoid noise issue.
Use 100 Ω twist pair wires for the cable.

CN1: Figure from socket view
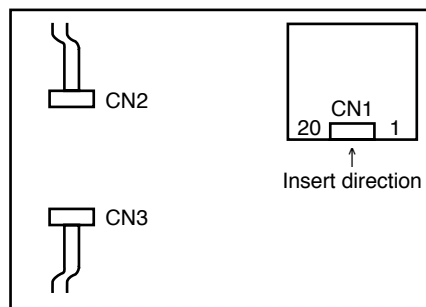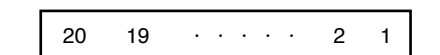
(2) Connector for backlight unit

CN2, 3

Part No.   : BHR-03VS-1

Adaptable socket: SM02 (8.0)B-BHS-TB

Supplier   : J.S.T. TRADING COMPANY, LTD.

Pin No.	Symbol	Function
1	V_L	Low voltage terminal (The cable color is gray.)
2	NC	Non-connection
3	V_H	High voltage terminal (The cable color is white.)

Note V_H and V_L must be connected correctly. If you make a mistake to connect, you will get hurt and the module will break.

METHOD OF CONNECTIONS FOR THC63LVDF63A
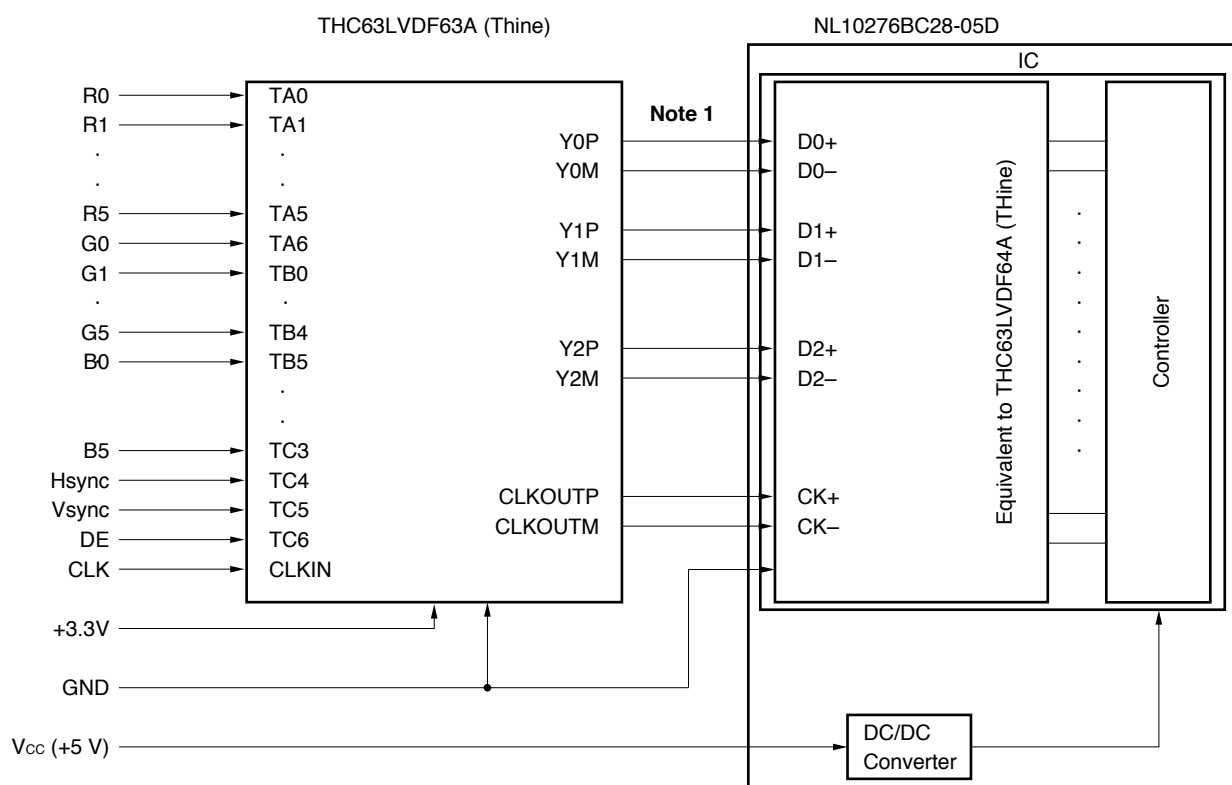
Notes 1. 100 Ω twist pair.

2. These signals should be kept in the specified range of **INPUT SIGNAL TIMINGS**.

3. V_{CCi} = 3.3 V (LCD internal voltage)

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 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.

INPUT SIGNAL TIMINGS

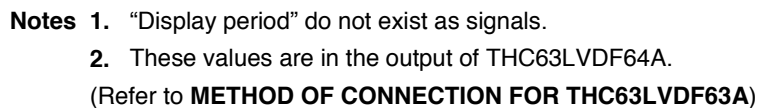(1) Input signal specifications for LCD controller

	Parameter	Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/tc	60.0	65.0	68.0	MHz	–
			–	15.385	–	ns	
	Rise, fall	tcrf	**Note**			ns	–
	Duty	tch/tc				–	–
Hsync	Period	th	16.0	20.676	–	μs	48.363 kHz (typ.)
			110	1344	1780	CLK	
	Display period	thd	–	1024	–	CLK	–
	Front-porch	thf	0	–	–	CLK	–
	Pulse width	thp*	12	–	–	CLK	–
	Back-Porch	thb	2	–	–	CLK	–
	*thp + thb		86	–	–	CLK	–
	Hsync-CLK timing	ths	**Note**			ns	–
	CLK-Hsync timing	thh				ns	–
	DE-CLK timing	tcs				ns	–
	CLK-DE timing	tch				ns	–
	Rise, fall	thrf, terf				ns	–
Vsync	Period	tv	–	16.666	–	ms	60.004 Hz (typ.)
			–	806	–	H	
	Display period	tvd		768		H	–
	Front-porch	tvf	1	–	–	H	–
	Pulse width	tvp*	1	3	36	H	–
	Back-porch	tvb*	1	–	36	H	–
	*tvp + tvb		3	–	38	H	–
	Vsync-Hsync timing	tvs	10	–	–	ns	**Note**
	Hsync-Vsync timing	tvh	1	–	–	CLK	**Note**
	Rise, fall	tvrf	–	–	10	ns	**Note**
DATA	DATA-CLK (set up)	tds	1	–	–	ns	**Note**
	CLK-DATA (Hold)	tdh	2	–	–	ns	**Note**
DE	DE-CLK timing	tes	1	–	–	ns	–
	CLK-DE timing	teh	2	–	–	ns	
	Rise, fall	terf	–	–	10	ns	

Note These values are in the timing regulation of THC63LVDF64A (THine).

The product equivalent to THC63LVDF63A (THine) is recommended to the input of LVDS transmitter.

The Timing regulation prescribes in the input of the LVDS transmitter.

(2) Definition of input signal timing for LCD controller

<Vertical>

<Horizontal>

Notes 1. "Display period" do not exist as signals.

2. These values are in the output of THC63LVDF64A.

(Refer to **METHOD OF CONNECTION FOR THC63LVDF63A**)

(3) Input signal timing chart

tc

tch

CLK V$_{cci}$ × 50 % V$_{IH}$ V$_{IL}$

tcrf

tds tdh

DATA
(R0 - R5)
(G0 - G5) V$_{cci}$ × 50 % V$_{IH}$ V$_{IL}$
(B0 - B5)

INVALID

INVALID

tdrf tdrf

teh tes teh tes

DE V$_{cci}$ × 50 % V$_{IH}$ V$_{IL}$

terf terf

CLK V$_{cci}$ × 50 %

thh ths

Hsync V$_{IH}$ V$_{cci}$ × 50 % V$_{IL}$

thrf

Hsync V$_{cci}$ × 50 %

tvh tvs

Vsync V$_{cci}$ × 50 % V$_{IH}$ V$_{IL}$

tvrf

Note V$_{IH}$, V$_{IL}$: Refer to LVDS transmitter specifications.

(4) DE
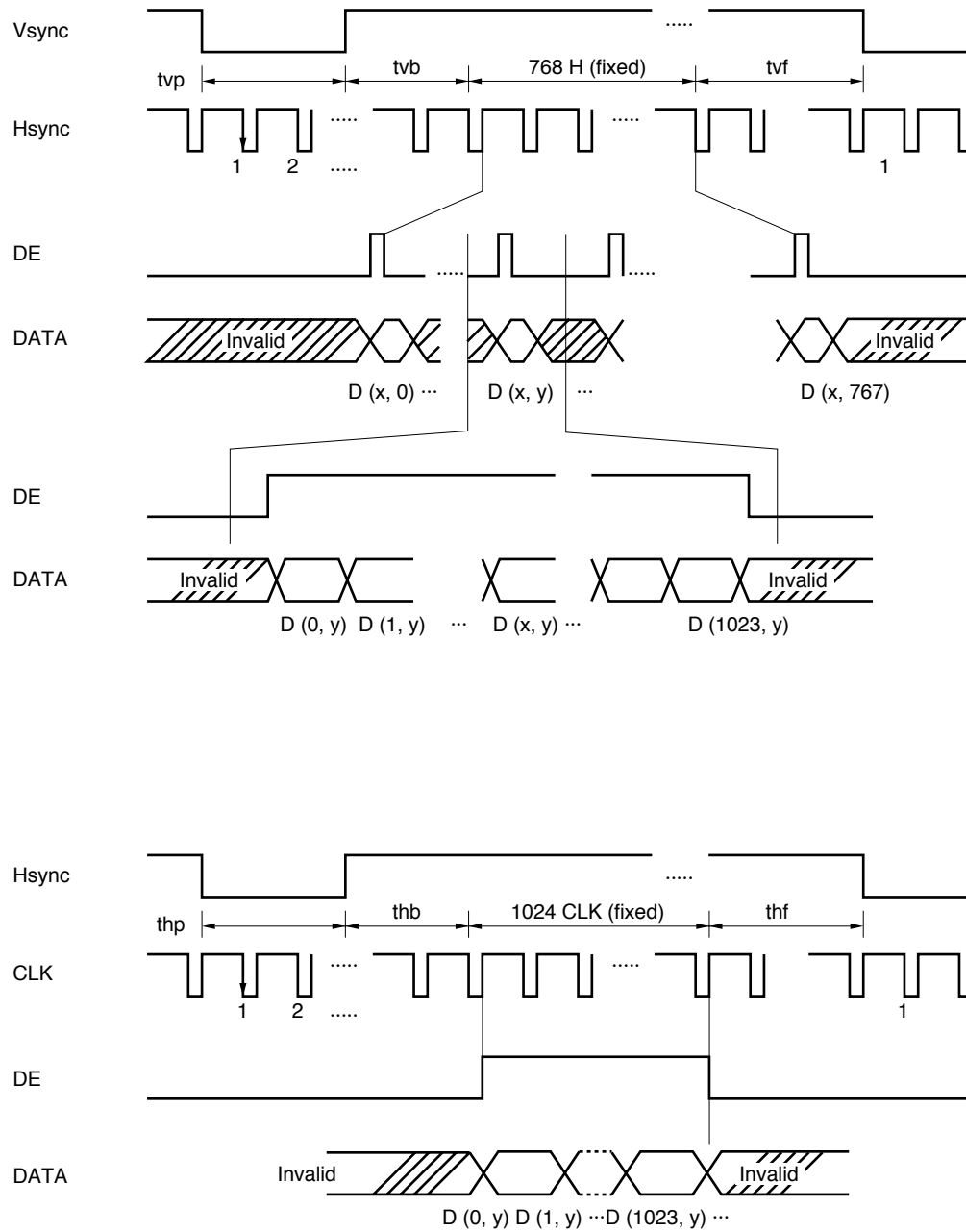
Vsync

tvp | tvb | 768 H (fixed) | tvf

Hsync

1   2   1

DE

DATA Invalid

D (x, 0) ···   D (x, y) ···   D (x, 767)

DE

DATA Invalid   Invalid

D (0, y) D (1, y)   ···   D (x, y) ···   D (1023, y)

Hsync

thp | thb | 1024 CLK (fixed) | thf

CLK

1   2   1

DE

DATA Invalid   Invalid

D (0, y) D (1, y) ···D (1023, y) ···

Note These values are in the output of THC63LVDF64A.
(Refer to **METHOD OF CONNECTION FOR THC63LVDF63A**).

(5) Display position of input data

D (0, 0)	D (1, 0)	---	D (X, 0)	---	D (1022, 0)	D (1023, 0)
D (0, 1)	D (1, 1)	---	D (X, 1)	---	D (1022, 1)	D (1023, 1)
┆	┆	-┼-	┆	-┼-	┆	┆
D (0, Y)	D (1, Y)	---	D (X, Y)	---	D (1022, Y)	D (1023, Y)
┆	┆	-┼-	┆	-┼-	┆	┆
D (0, 766)	D (1, 766)	---	D (X, 766)	---	D (1022, 766)	D (1023, 766)
D (0, 767)	D (1, 767)	---	D (X, 767)	---	D (1022, 767)	D (1023, 767)

FOR LVDS RECEIVER

(1) Input signal specifications

Parameter	Symbol	Min	Typ.	Max.	Unit	Remarks
CLK Frequency	TRCP	14.71	T	16.66	ns	T = 15.38 ns
Bit0 position	TRIP1	−0.5	0	+0.5	ns	
Bit1 position	TRIP0	T/7-0.5	T/7	T/7+0.5	ns	
Bit2 position	TRIP6	2T/7-0.5	2T/7	2T/7+0.5	ns	
Bit3 position	TRIP5	3T/7-0.5	3T/7	3T/7+0.5	ns	
Bit4 position	TRIP4	4T/7-0.5	4T/7	4T/7+0.5	ns	
Bit5 position	TRIP3	5T/7-0.5	5T/7	5T/7+0.5	ns	
Bit6 position	TRIP2	6T/7-0.5	6T/7	6T/7+0.5	ns	

(2) Input signal timing chart
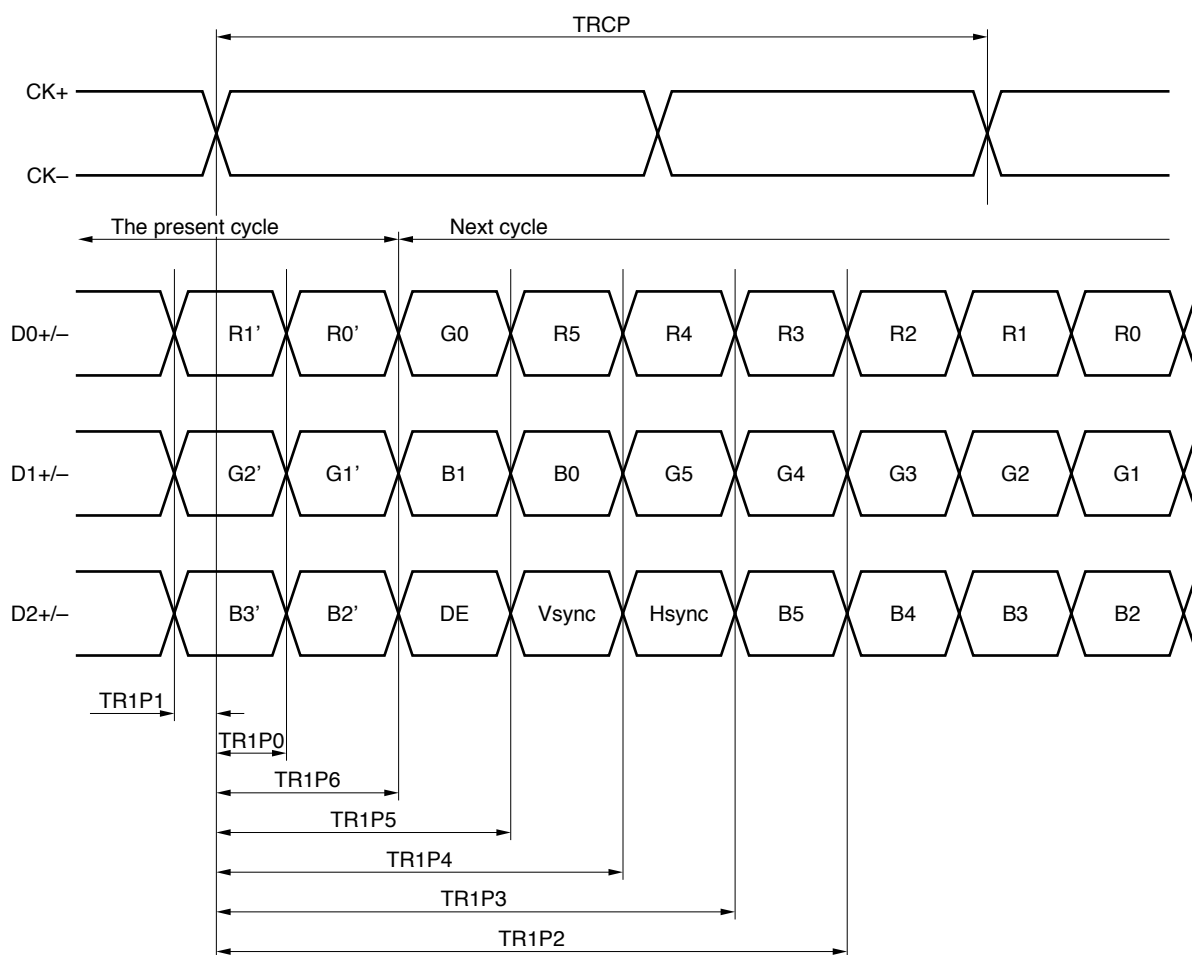
OPTICAL CHARACTERISTICS

$(T_a = 25°C, \text{Note } 1, 2)$

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Remark
Contrast ratio	CR	at center	80	150	–	–	**Note 3**
Luminance	Lumax	"White", at center	150	200	–	cd/m^2	–
Luminance uniformity	–	Maximum/Minimum	–	–	1.30	–	**Note 4**

Reference data

$(T_a = 25°C, V_{CC} = 5 \text{ V}, V_{DD}B = 12 \text{ V})$

Parameter		Symbol	Condition	MIN.	TYP.	MAX.	Unit	Remark
Contrast ratio		CR	Best contrast angle, $\theta X = \pm0°$, $\theta Y = -5°$, at center	–	300	–	–	**Note 3**
Color gamut		C	To NTSC, at center	35	40	–	%	**Note 2**
Viewing angle range	Horizontal	$\theta X+$	CR > 10, $\theta Y = \pm0°$	40	50	–	deg.	**Note 5**
		$\theta X-$	CR > 10, $\theta Y = \pm0°$	40	50	–	deg.	
	Vertical	$\theta Y+$	CR > 10, $\theta X = \pm0°$	15	20	–	deg.	
		$\theta Y-$	CR > 10, $\theta X = \pm0°$	25	35	–	deg.	
Response time		ton	White to black	–	11	25	ms	**Note 6**
		toff	Black to white	–	40	80		

Notes 1. The luminance is measured after 20 minutes from the module works, with all pixels in white. Typical value is measured after luminance saturation.
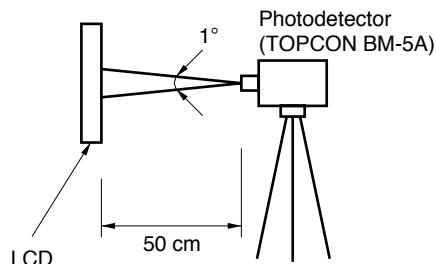
2. Viewing angle is $\theta x = \pm0°$, $\theta y = \pm0°$

3. The contrast ratio is calculated by using the following formula.

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

The Luminance is measured in darkroom.

4. Luminance uniformity is calculated using following formula.

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

Column　171　512　853
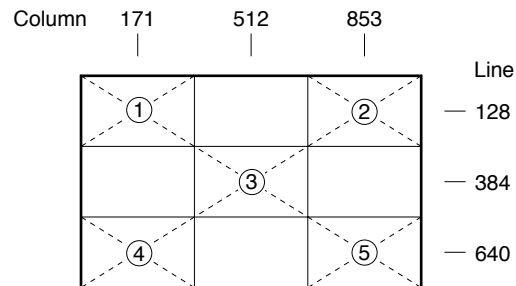
5. Definitions of viewing angle are as follows.
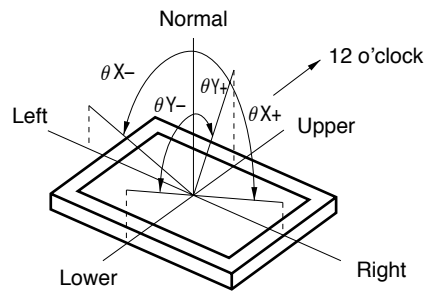
6. Definition of response time is as follows.
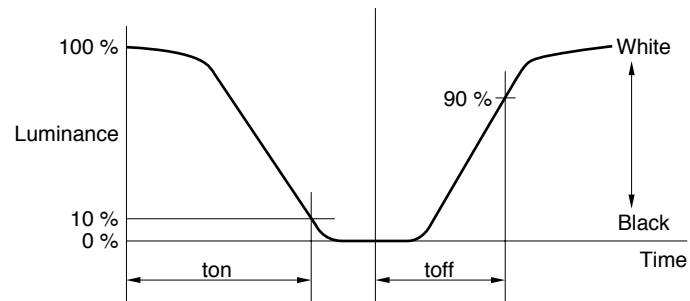
RELIABILITY TEST

Test item	Test condition
High temperature/humidity operation **Note 1**	50 ± 2°C, 85% relative humidity 240 hours Display data is black.
Heat cycle (operation) **Note 1**	<1> 0°C ± 3°C ··· 1 hour 55°C ± 3°C ··· 1 hour <2> 50 cycles, 4 hours/cycle <3> Display data is black.
Thermal shock (non-operation) **Note 1**	<1> −20°C ± 3°C ··· 30 minutes 60°C ± 3°C ··· 30 minutes <2> 100 cycles <3> Temperature transition time within 5 minutes

Vibration (non-operation) **Notes 1, 2**	<1> 5 - 100 Hz, 19.6 m/s^2 (2G)
	      1 minute/cycle
	      X, Y, Z direction
	<2> 50 times each direction

Mechanical shock (non-operation) **Notes 1, 2**	<1> 294 m/s^2 (30 G), 11 ms X, Y, Z direction <2> 3 times each direction
ESD (operation) **Notes 1, 3**	150 pF, 150 Ω, ±10 kV 9 places on a panel 10 times each place at one-second intervals
Dust (operation) **Note 1**	15 kinds of dust (JIS Z 8901) Hourly 15 seconds stir, 8 times repeat

Notes 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.
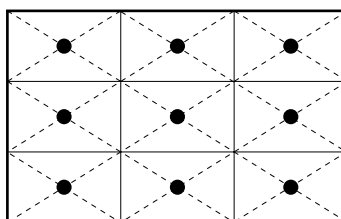
GENERAL CAUTIONS

Next figures and sentences are very important. Please understand these contents as follows.

⚠ CAUTION	This mark indicates that you will get hurt and/or the module will have damages when you make a mistake to operate.

⚡	This mark indicates that you will get an electric shock when you make a mistake to operate.
⚠	This mark indicates that you will get hurt when you make a mistake to operate

⚠ CAUTION

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

(1) Caution when taking out the module
   a)   Pick the pouch only, when taking out the module from a carrier box.

(2) Cautions for handling the module
   a)   As the electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges.
   b)   ⚠ As the LCD panel and backlight element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
   c)   As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
   d)   Do not pull the interface connectors in or out while the LCD module is operating.
   e)   Put the module display side down on a flat horizontal plane.
   f)   Handle connectors and cables with care.
   g)   When the module is operating, do not lose CLK, Hsync or Vsync signal. If any one of these signals is lost, the LCD panel would be damaged.
   h)   The torque for mounting screw should never exceed 0.392 N·m (4 kgf·cm).
   i)   Don't push or rub the surface of LCD modules.
        If you do it, the scratches or the rubbing marks may be left on the surface of the modules.

(3) Cautions for the atmosphere
   a)   Dew drop atmosphere should be avoided.
   b)   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.
   c)   This module uses cold cathod fluorescent lamp. Therefore, the life time of lamp becomes short if the module is operated under the low temperature environment.
   d)   Do not operate the LCD module in a high magnetic field.

(4) Caution for the module characteristics

    a) Do not apply fixed pattern data signal for a long time to the module. It may cause image sticking. Please use screen savers if the display pattern is fixed for a long time.

    b) This module has the retardation film 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.

    c) The light vertical stripe may be observed depending on the display pattern. This is neither defects nor malfunctions.

    d) The noise from the inverter circuit may be observed in the luminance control mode. This is neither defects nor malfunctions.

(5) Other cautions

    a) Do not disassemble and/or reassemble LCD module.

    b) Do not readjust variable resistors or switches in the module.

    c) When returning the module for repair etc., please pack the module properly to avoid any damages. We recommend using the original shipping packages.

Liquid Crystal Display has the following specific characteristics. There are neither defects nor 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.

OUTLINE DRAWING: Front View (Unit: mm)
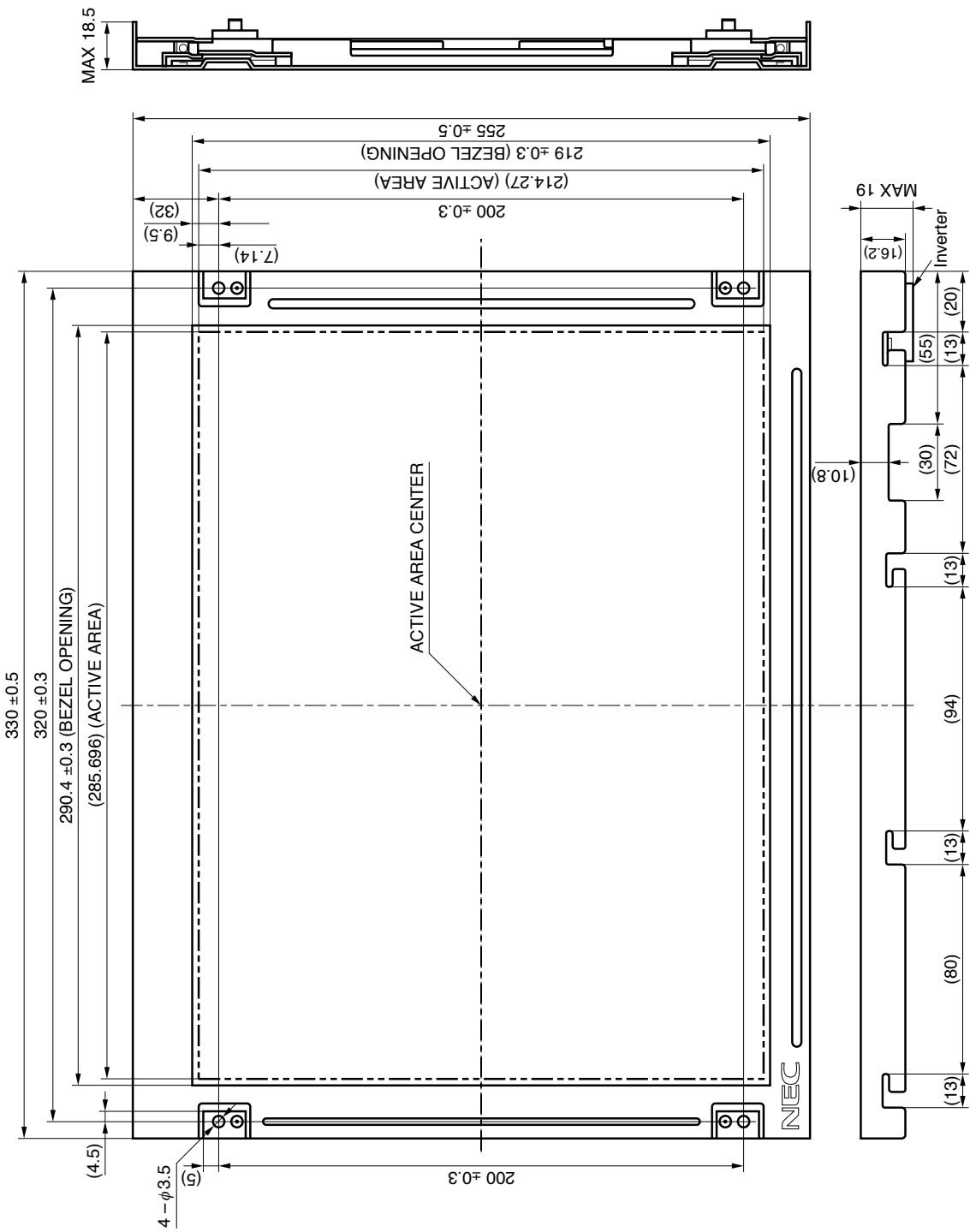
Notes 1. Not shown tolerance of the dimensions are ±0.5 mm.
2. The torque to mounting screw should never exceed 0.392 N·m (4 Kgf·cm).

OUTLINE DRAWING: Rear View (Unit: mm)

MEMO