

**26 cm (10.4 inches), 640 × 480 pixels, 262,144 colors,
Incorporated two-lamp/Edge-light type backlight
Wide viewing angle**

DESCRIPTION

NL6448AC33-24 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. NL6448AC33-24 has a built-in backlight. Backlight includes long-life-lamps and the lamps are replaceable.

The 26 cm (10.4 inches) diagonal display area contains 640 × 480 pixels and can display 262,144 colors simultaneously.

NL6448AC33-24 is suitable for factory automation use, because the viewing angle is ultra wide and the luminance is high.

FEATURES

- Ultra wide viewing angle
- High luminance (190 cd/m², TYP.)
- Low reflection
- 6-bit digital RGB interface
- Data enable (DE) function
- Incorporated edge type backlight with long-life-lamps (Two lamps, with inverter)
- Lamp holder replaceable (Type No.: 104LHS-17L)
- Reversible scan direction
- Approved to UL1950 2nd edition and CSA-C22.2 No.950-93 (File No.: E170632)

APPLICATIONS

- Display terminals for control system
- Monitors for process controller
- Personal computers (PC), Word processor



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

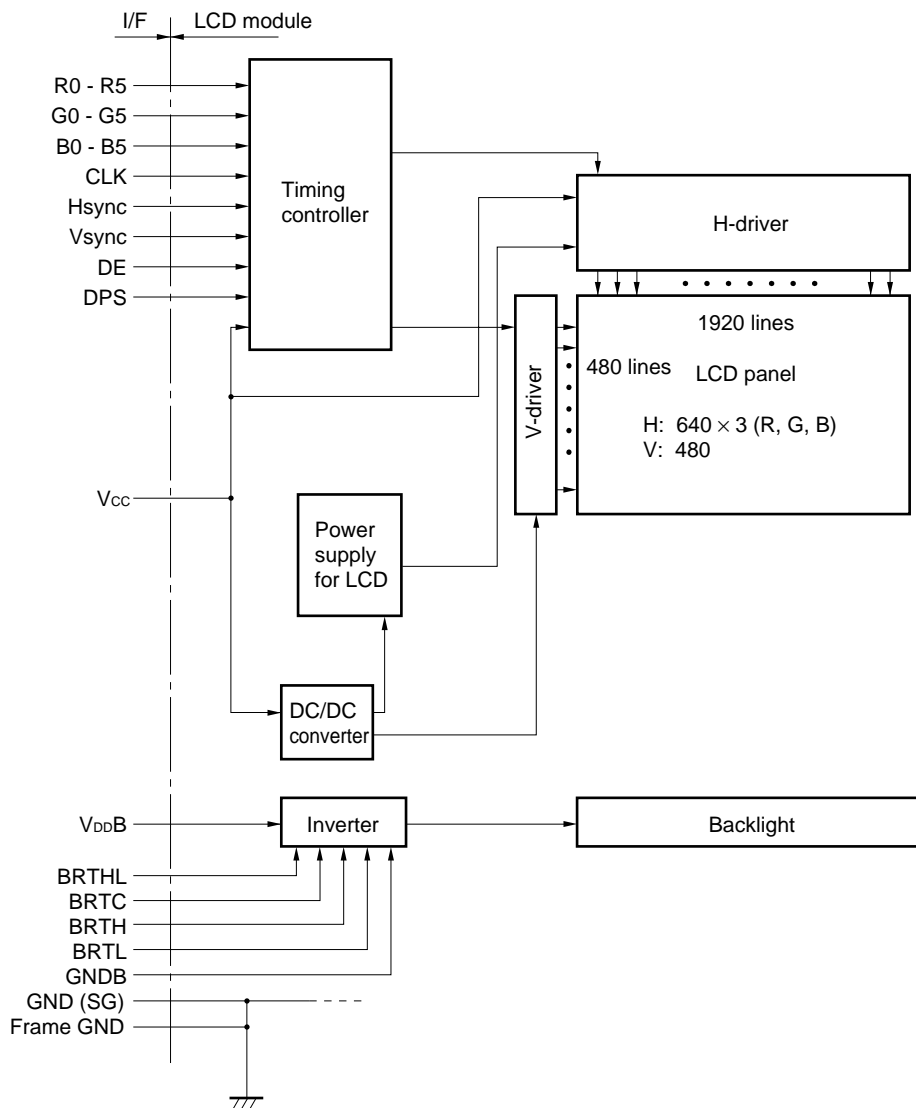
STRUCTURE AND FUNCTIONS

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



Remark Frame is not connected to GNDB.

OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	211.2 (H) × 158.4 (V) mm
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	640 × 480 pixels
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.33 (H) × 0.33 (V) mm
Module size	243.0 (H) × 185.1 (V) × 10.7 TYP. (D) mm
Inverter size	25.0 (H) × 105.0 (V) × 10.2 MAX. (D) mm
Weight	485 g (TYP.) + 15 g (TYP., inverter)
Contrast ratio	150 : 1 (TYP.)
Viewing angle (more than the contrast ratio of 10 : 1)	Horizontal : 80° (TYP., left side, right side) Vertical : 80° (TYP., left side, right side)
Designed viewing direction	Optimum grayscale ($\gamma = 2.2$): perpendicular
Color gamut	45% (TYP., center, to NTSC)
Response time	50 ms (TYP.), white to black
Luminance	190 cd/m ² (TYP., lamp current: 5.0 mA (per one lamp))
Signal system	6-bit digital signals for each of RGB primary colors, synchronous signals (Hsync, Vsync), dot clock (CLK), DE signal
Supply voltages	3.3 V [5.0 V], 12.0 V
Backlight	Edge light type, two cold cathode fluorescent lamp
Power consumption	7.1 W (TYP., 3.3 V, 12.0 V)

GENERAL SPECIFICATIONS

Item	Specification	Unit
Module size	243.0 ± 0.5 (H) × 185.1 ± 0.5 (V) × 11.2 MAX. (D)	mm
Inverter size	25.0 ± 0.5 (H) × 105.0 ^{+0.7} _{-0.3} (V) × 10.2 MAX. (D)	mm
Display area	211.2 (H) × 158.4 (V)	mm
Number of dots	640 × 3 (H) × 480 (V)	dot
Number of pixels	640 (H) × 480 (V)	pixel
Dot pitch	0.11 (H) × 0.33 (V)	mm
Pixel pitch	0.33 (H) × 0.33 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) vertical stripe	—
Display colors	262,144	color
Weight	Module: 490 (MAX.) + Inverter: 20 (MAX.)	g

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Remarks	
Supply voltage	V _{CC}	-0.3 to 6.5	V	T _a = 25°C V _i - V _{CC} < 3.0	
Input voltage	V _i	-0.3 to 6.5	V		
Storage temp.	T _{ST}	-20 to 60	°C		
Operating temp.	T _{OP}	0 to 50	°C	Module surface ^{Note}	
Humidity	—	≤ 95% relative humidity	—	T _a ≤ 40°C	No condensation
	—	≤ 85% relative humidity	—	40 < T _a ≤ 50°C	
	—	Absolute humidity shall not exceed T _a = 50°C, 85% relative humidity level.	—	T _a > 50°C	

Note Measured at the display area

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

T_a = 25°C

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply voltage	V _{CC}	3.0 (4.75)	3.3 (5.0)	3.6 (5.25)	V	V _{CC} = 3.3 V (V _{CC} = 5.0 V)
Logic input Low voltage	V _{IL}	0	—	V _{CC} × 0.3	V	
Logic input High voltage	V _{IH}	V _{CC} × 0.7	—	V _{CC}	V	
Supply current	I _{CC}	— —	400 ^{Note} (300)	600 (400)	mA	V _{CC} = 3.3 V (V _{CC} = 5.0 V)

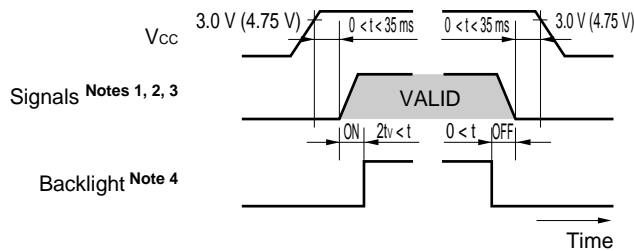
Note Checkered flag pattern (in EIAJ ED-2522)

(2) Backlight

T_a = 25°C

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply voltage	V _{DDB}	11.4	12.0	12.6	V	
Supply current	I _{DDB}	—	480	550	mA	190 cd/m ²

SUPPLY VOLTAGE SEQUENCE



- Notes**
1. Signals: CLK, Hsync, Vsync, DE, DATA (R0-R5, G0-G5, B0-B5)
 2. The supply voltage for input signals should be the same as V_{CC}.
 3. Apply V_{DDB} 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, please keep whole signals low level or high impedance.

INTERFACE AND PIN CONNECTION

(1) Interface signals, power supply

Module side connector

Mating connector

CN1 ... DF9C-31P-1V

DF9-31S-1V, DF9M-31S-1R or IL-310-T31S-VF

Supplier: HIROSE ELECTRIC CO., LTD., Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Function
1	GND	Ground (SG) ^{Note 2}
2	CLK	Dot clock
3	Hsync	Horizontal sync.
4	Vsync	Vertical sync.
5	GND	Ground (SG) ^{Note 2}
6	R0	Red data (LSB)
7	R1	Red data
8	R2	Red data
9	R3	Red data
10	R4	Red data
11	R5	Red data (MSB)
12	GND	Ground (SG) ^{Note 2}
13	G0	Green data (LSB)
14	G1	Green data
15	G2	Green data
16	G3	Green data
17	G4	Green data
18	G5	Green data (MSB)

Pin No.	Symbol	Function
19	GND	Ground (SG) ^{Note 2}
20	B0	Blue data (LSB)
21	B1	Blue data
22	B2	Blue data
23	B3	Blue data
24	B4	Blue data
25	B5	Blue data (MSB)
26	GND	Ground (SG) ^{Note 2}
27	DE	Data enable ^{Note 3}
28	V _{CC}	Power supply ^{Note 1}
29	V _{CC}	Power supply ^{Note 1}
30	N. C.	Non-connection ^{Note 4}
31	DPS	Scan direction select ^{Note 5}

LSB : Least Significant Bit

MSB : Most Significant Bit

Notes 1. V_{CC}: All V_{CC} terminals should be connected to 3.3V or 5.0 V.

2. GND is not connected to the frame of LCD module.

3. Input DE signal when LCD is operated.

4. N. C. should be open.

5. DPS can change scan direction (normal scan and reverse scan.)

DPS = Low or open : normal scan

DPS = High : reverse scan

See **INPUT SIGNAL TIMING** (4) Display position of input data about another way for reversible scan.

When DPS is high, reverse scan is selected even if SW1 is set at normal scan.

(2) Inverter

- Inverter side connector 1 Mating connector 1
CN1 ... LZ-5P-SL-SMT LZ-5S-SC3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Function	Pin No.	Symbol	Function
1	V _{DB} B	Power supply	4	GNDB	Backlight ground
2	V _{DB} B	Power supply	5	BRTHL	Luminance select ^{Note}
3	GNDB	Backlight ground			

Note High luminance (100%): BRTHL = High or open
Low luminance (60%): BRTHL = GND

- Inverter side connector 2 Mating connector 2
CN3 ... IL-Z-3PL-SMTY IL-Z-3S-S125C3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Function
1	BRTC	Backlight ON/OFF signal ^{Note 1}
2	BRTH	Luminance control input ^{Note 2}
3	BRTL	Luminance control input ^{Note 2}

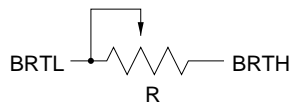
Notes 1. TTL level

Backlight ON : BRTC = High or open

Backlight OFF : BRTC = Low

2. <1> A way of luminance control by a variable resistor

This way works when BRTHL (No.5 pin) of CN3 is opened.



- Mating variable resistor : 10 kΩ ±5%
- Minimum luminance (50%) : R = 0 Ω
- Maximum luminance (100%): R = 10 kΩ

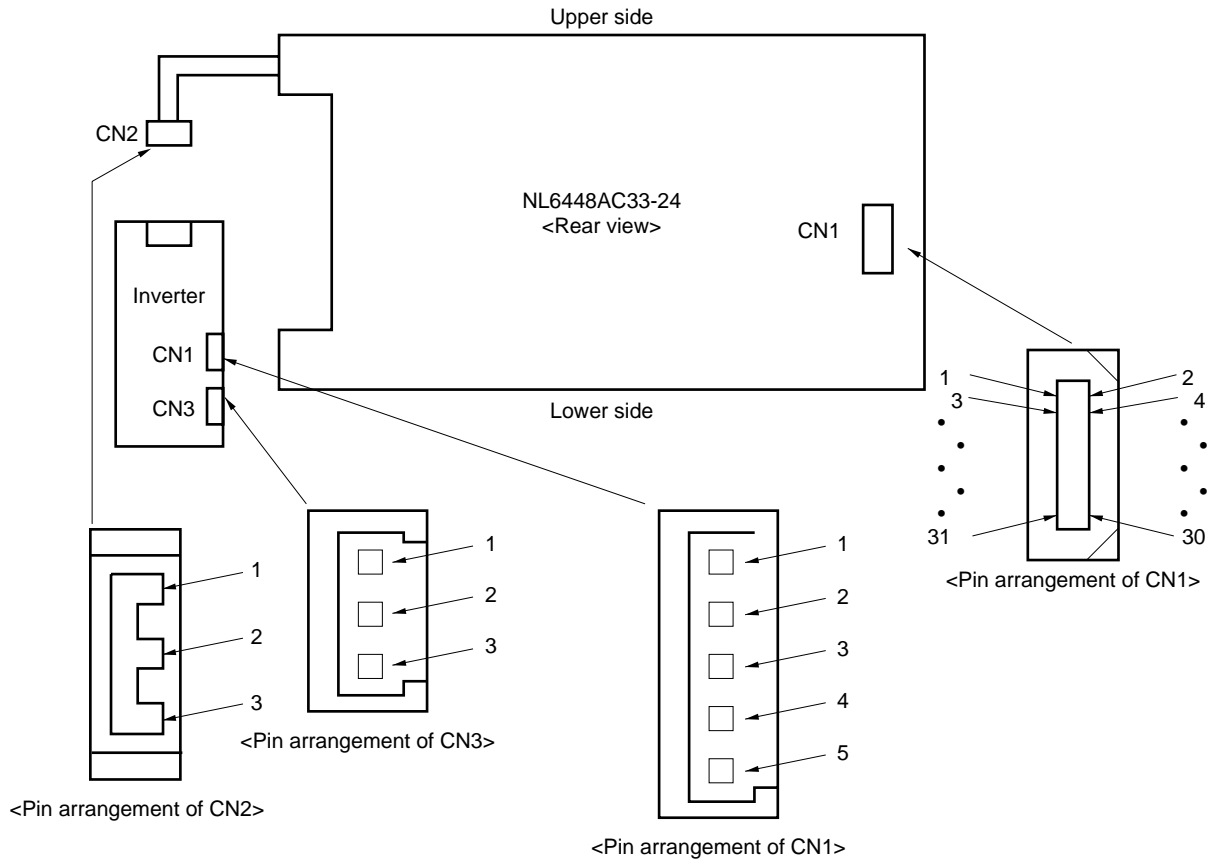
<2> A way of luminance control by a voltage

This way works when BRTHL and BRTL are opened. The range of input voltage between BRTH and GNDB is as follows.

Minimum luminance (50%) : 2.5 V

Maximum luminance (100%): ≤ 1.2 V

<Connector location>



Note 1. CN2 is not connected each other at shipment. It should be connected, when LCD is operated.

(3) Pin function

Symbol	In/Out	Logic	Description
R0-R5 G0-G5 B0-B5	In	Positive	Data for R, G and B
Vsync	In	Negative	Vertical synchronous signal
Hsync	In	Negative	Horizontal synchronous signal
CLK	In	Negative	Dot clock input Data is valid at negative edge of CLK signal
DE	In	Positive	Data enable signal Data during DE is "H" is valid on the screen
MVA	In	-	Signal to select the best viewing angle of $\gamma = 2.2$ MVA = High or open : 0° MVA = Low : 10° (up side)
DPS	In	Positive	Signal to select the scan direction DPS = Low or open : normal scan DPS = High : reverse scan
Vcc	In	-	Power supply for logic and LCD drivers
VbbB	In	-	Power supply for backlight (12.0 V)
GND	-	-	Ground for logic
GNDB	-	-	Ground for backlight

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	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
		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 TIMING

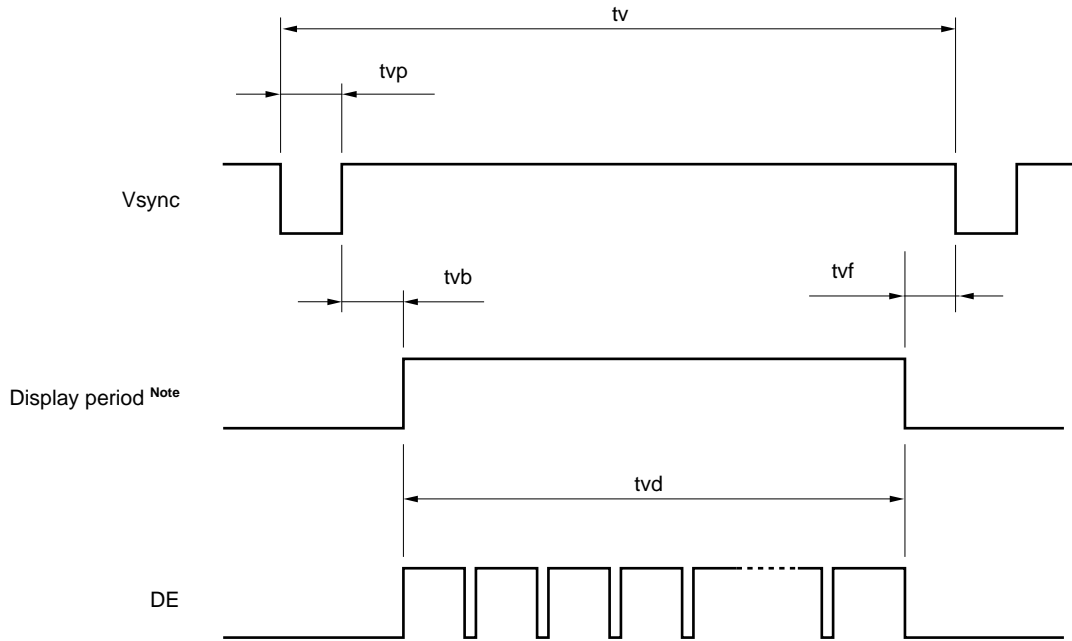
(1) Input signal specifications (DE mode)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Remarks
CLK	Frequency	1/tc	21.0	25.175	29.0	MHz	39.72 ns (TYP.)
	Duty	tch/tc	0.4	0.5	0.6	—	
	Rise, fall	tcrf	—	—	10	ns	
Hsync	Period	th	30.0	31.778	33.6	μs	31.468 kHz (TYP.)
			—	800	—	CLK	
	Display period	thd	640			CLK	
	Front-porch	thf	2	16	—	CLK	
	Pulse width	thp	10	96	—	CLK	
	Back-porch	thb	4	48	—	CLK	
	thp + thb		14	144	—	CLK	
	CLK-Hsync timing	thch	12	—	—	ns	
	Hsync-CLK timing	thcs	8	—	—	ns	
	Hsync-Vsync timing	tvh	1	—	—	CLK	
	Vsync-Hsync timing	tvs	30	—	—	ns	
	Rise, fall	thrf	—	—	10	ns	
Vsync	Period	tv	16.1	16.683	17.2	ms	59.94 Hz (TYP.)
			—	525	—	H	
	Display period	tvd	480			H	
	Front-porch	tvf	1	12	—	H	
	Pulse width	tvp	1	2	—	H	
	Back-porch	tvb	4	31	—	H	
	tvp + tvb		5	33	—	H	
	Rise, fall	tvrf	—	—	10	ns	
DATA (R0-R5 G0-G5 B0-B5)	CLK-DATA timing	tds	8	—	—	ns	
	DATA-CLK timing	tdh	12	—	—	ns	
	Rise, fall	tdrf	—	—	10	ns	
DE	DE-CLK timing	tes	8	—	—	ns	
	CLK-DE timing	teh	12	—	—	ns	
	Rise, fall	terf	—	—	10	ns	

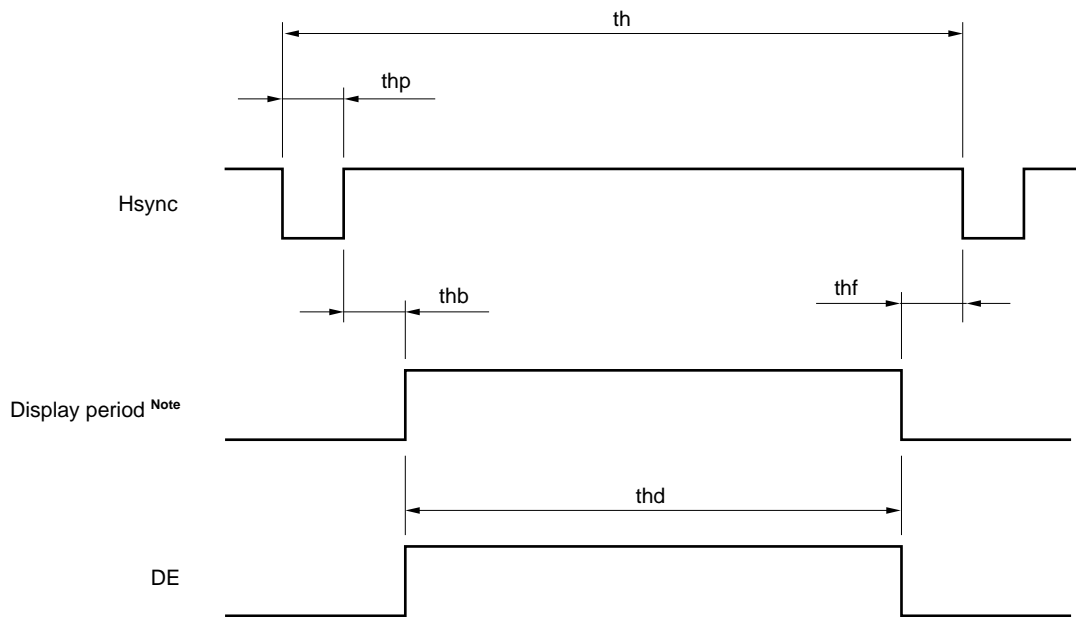
Caution All of parameters should be kept in the specified range.

(2) Definition of input signal timing

<Vertical>

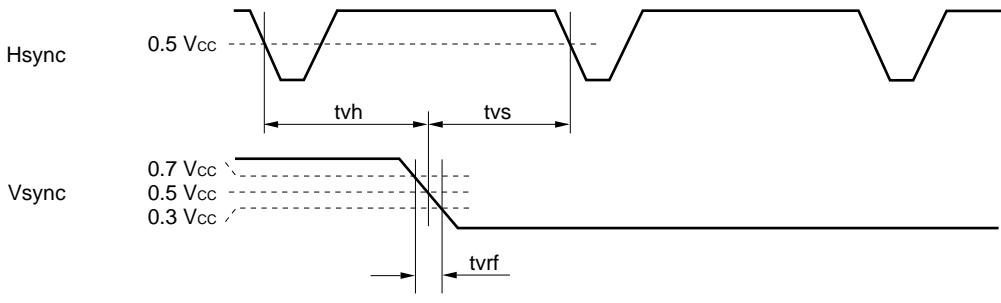
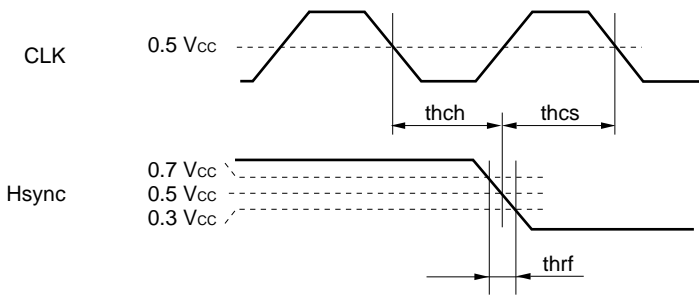
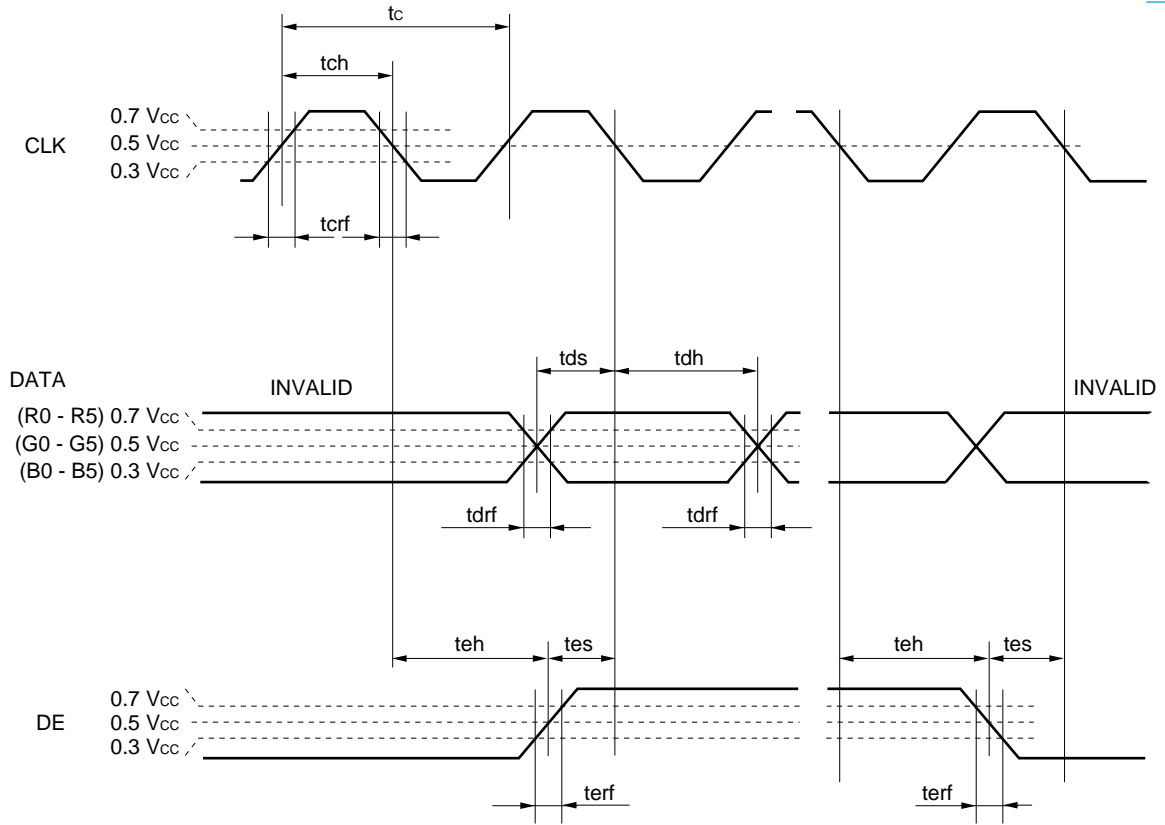


<Horizontal>

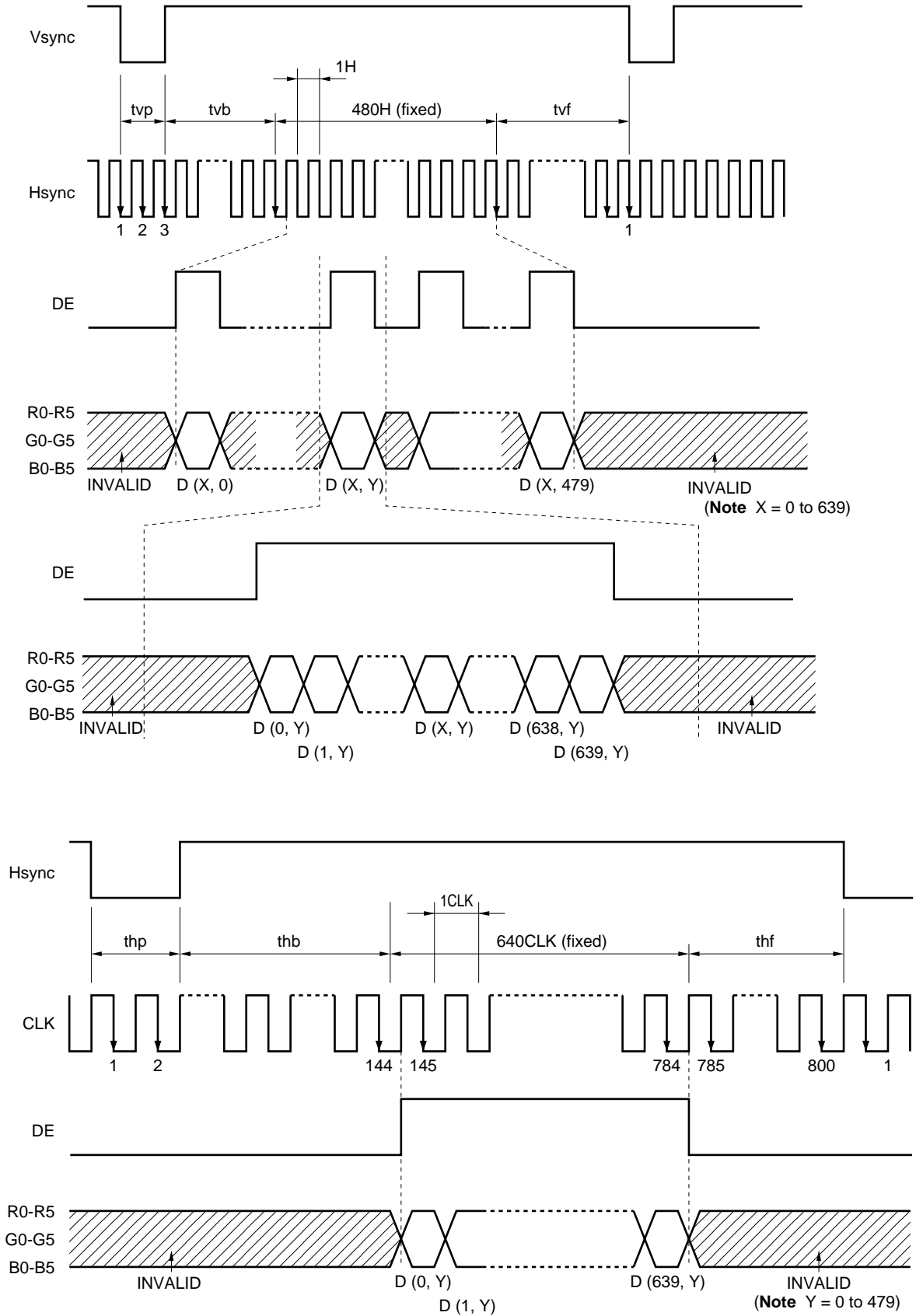


Note These do not exist as signals.

Remark Set the total of $thp + thb$ and $tvp + tvb$ as the table of input signal timing, otherwise display position is shifted to right or left side, or to up or down side.



(3) Input signal timing chart



(4) Display position of input data

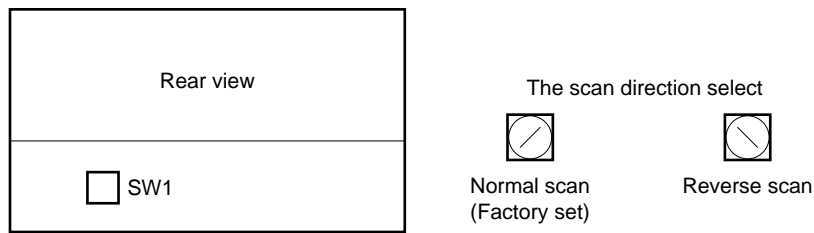
Normal scan (factory set)

D (0, 0)	D (1, 0)	---	D (X, 0)	---	D (638, 0)	D (639, 0)
D (0, 1)	D (1, 1)	---	D (X, 1)	---	D (638, 1)	D (639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (0, Y)	D (1, Y)	---	D (X, Y)	---	D (638, Y)	D (639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (0, 478)	D (1, 478)	---	D (X, 478)	---	D (638, 478)	D (639, 478)
D (0, 479)	D (1, 479)	---	D (X, 479)	---	D (638, 479)	D (639, 479)

Reverse scan

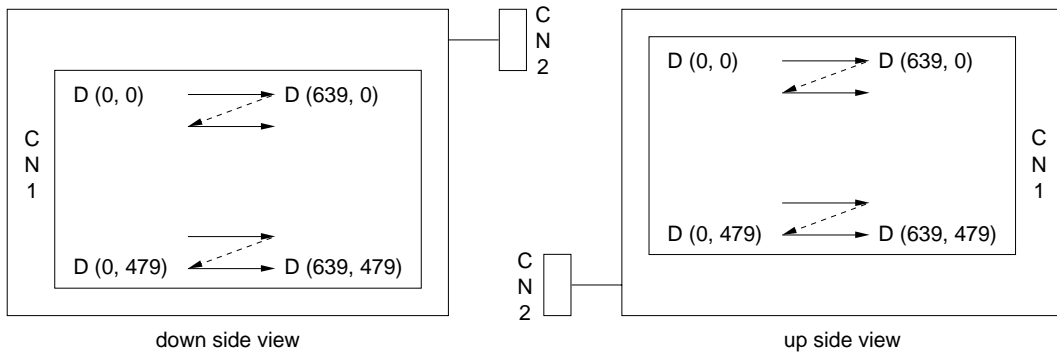
D (639, 479)	D (638, 479)	---	D (X, 479)	---	D (1, 479)	D (0, 479)
D (639, 478)	D (638, 478)	---	D (X, 478)	---	D (1, 478)	D (0, 478)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (639, Y)	D (638, Y)	---	D (X, Y)	---	D (1, Y)	D (0, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (639, 1)	D (638, 1)	---	D (X, 1)	---	D (1, 1)	D (0, 1)
D (639, 0)	D (638, 0)	---	D (X, 0)	---	D (1, 0)	D (0, 0)

Remarks 1. The scan direction is set up by the switch (SW1) on the rear side.



See (1) Interface signals, power supply (Note 5) about another way for reversible scan.
When DPS is High, reverse scan is selected even if SW1 is set at normal scan.

2. Below drawings shows relation between the scan direction and viewing direction.



OPTICAL CHARACTERISTICS

T_a = 25 ± 5°C, at center (θ_X = ±0°, θ_Y = ±0°), V_{cc} = 3.3 V (I_L = 5.0 mArms)

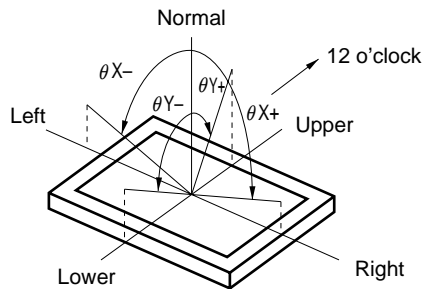
Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	
Luminance	LVMAX	θ _X = ±0°, θ _Y = ±0°, at center	150	190	–	cd/m ²	
Contrast ratio	CR	θ _X = ±0°, θ _Y = ±0°, at center	80	150	–	–	
Viewing angle range	Horizontal	θ _{X+}	CR > 10, θ _Y = ±0°	70	80	–	deg.
		θ _{X-}	CR > 10, θ _Y = ±0°	70	80	–	deg.
	Vertical	θ _{Y+}	CR > 10, θ _X = ±0°	70	80	–	deg.
		θ _{Y-}	CR > 10, θ _X = ±0°	70	80	–	deg.
Color gamut	C	at center, to NTSC	40	45	–	%	
Response time	tpd	Black to white	–	50	70	ms	
Brightness uniformity	–	Maximum luminance	–	1.25	1.4	–	
		Minimum luminance	–	–	–	–	

Remarks 1. The contrast ratio is calculated by using the following formula.

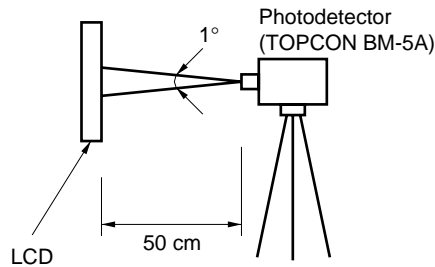
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance with all pixels in white}}{\text{Luminance with all pixels in black}}$$

The Luminance is measured in darkroom.

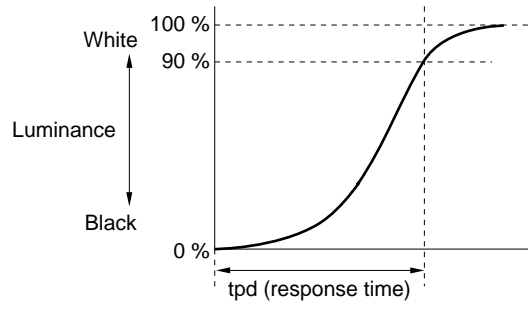
2. Definitions of viewing angle are as follows.



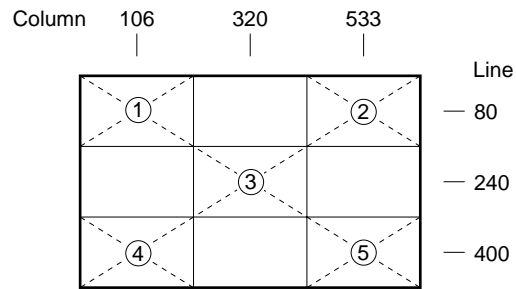
3. The luminance is measured after 20 minutes from the module works, with all pixels in white. Typical value is measured after luminance saturation.



4. Definition of response time is as follows.



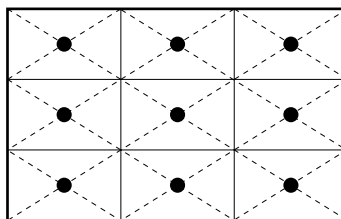
5. The luminance is measured at near the five points shown below.



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 ^{Note 1} (operation)	<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 ^{Note 1} (non-operation)	<1> -20°C ± 3°C ... 30 minutes 60°C ± 3°C ... 30 minutes <2> 100 cycles <3> Temperature transition time within 5 minutes
Vibration ^{Notes 1, 2} (non-operation)	<1> 5 - 100 Hz, 2G 1 minute/cycle X, Y, Z direction <2> 120 times each direction
Mechanical shock ^{Notes 1, 2} (non-operation)	<1> 55 G, 11 ms X, Y, Z direction <2> 5 times each direction
ESD ^{Notes 1, 3} (operation)	150 pF, 150 Ω, ±10 kV 8 places on a panel 10 times each place at one-second intervals
Dust ^{Note 1} (operation)	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 sentence are very important. Please understand these contents as follows.

	CAUTION This figure is a mark that you will get hurt and/or the module will have damages when you make a mistake to operate.
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	This figure is a mark that you will get an electric shock when you make a mistake to operate.
	This figure is a mark that you will get hurt when you make a mistake to operate




	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.
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(1) Caution when taking out the module

- a) Pick the pouch only, in taking out 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 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 to mounting screw should never exceed 0.294 N·m (3 kgf·cm).

(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 electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
- c) This module uses cold cathod fluorescent lamp. Therefore, the life time of lamp becomes short conspicuously at low temperature.
- 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 LCD module. It may cause image sticking. Please use screen savers if the display pattern is fixed more than one hour.

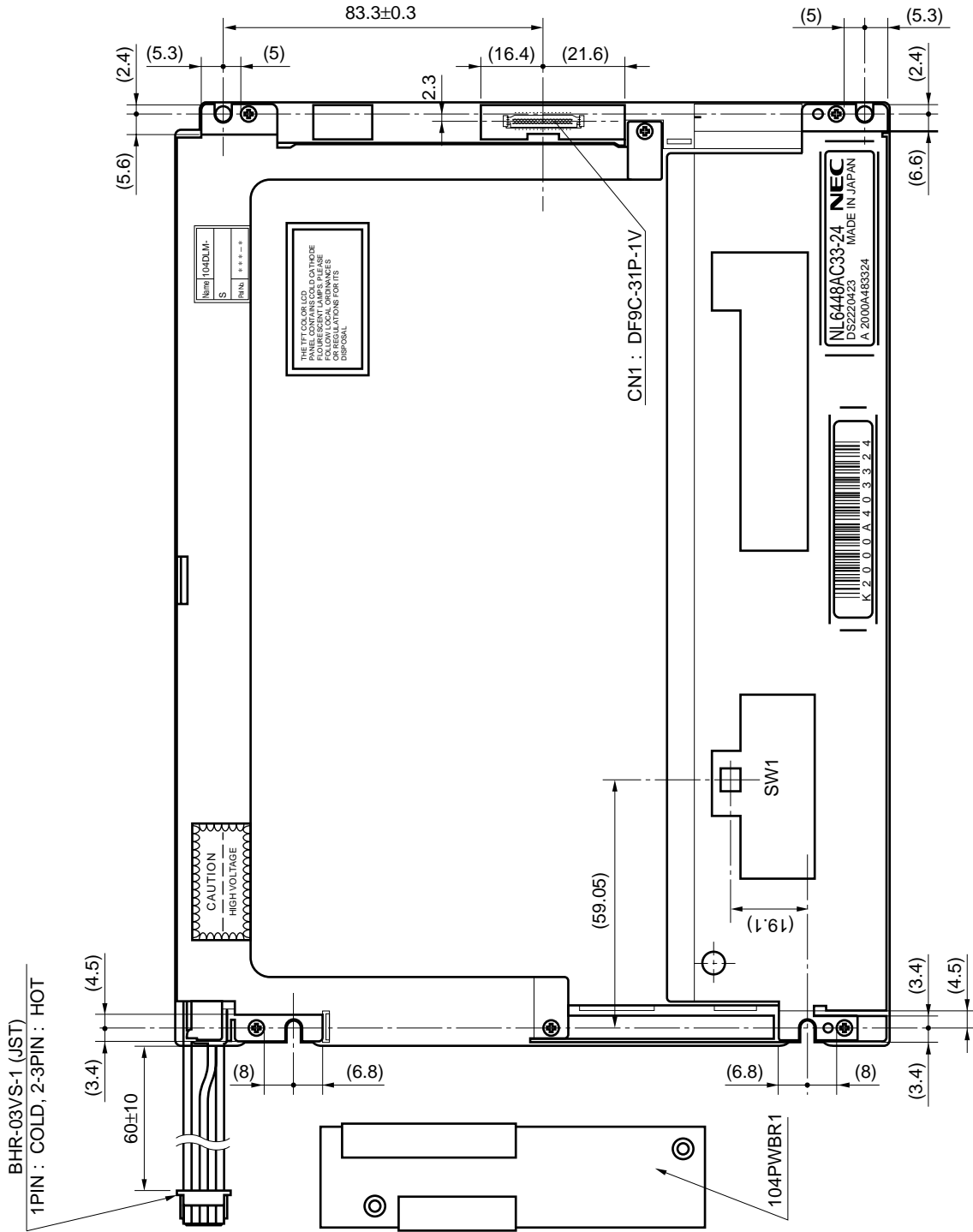
(5) Other cautions

- a) Do not disassemble and/or reassemble LCD module.
- b) Do not readjust variable resistors etc.
- c) When returning the module for repair or etc, please pack the module not to be broken. We recommend to the original shipping packages.

Liquid Crystal Display has the following specific characteristics. There are not defects or malfunctions.

- The display condition of LCD module may be affected by the ambient temperature.
- The LCD module uses cold cathode tube for backlighting. Optical characteristics, like luminance or uniformity, will change during time.
- Uneven brightness and/or small spots may be noticed depending on different display patterns.

OUTLINE DRAWING: Rear View (Unit: mm)



[MEMO]

[MEMO]

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Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.



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