NEC

TFT COLOR LCD MODULE

NL6448AC33-18

26 cm (10.4 inches), 640 × 480 pixels, 262144 colors, incorporated two-lamp/edge-light type backlight

DESCRIPTION

NL6448AC33-18 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. NL6448AC33-18 has a built-in backlight. Backlight includes long life CCFLs and the tubes are replaceable.

The 26 cm diagonal display area contains 640 × 480 pixels and can display 262144 colors simultaneously.

NL6448AC33-18 is suitable for factory automation use, because luminance is higher, and viewing direction is selectable by switching display scan direction.

FEATURES

- Backlight tube replaceable (refer to the tube replace manual for NL6448AC33-18)
- High luminance (200 cd/m^2 TYP.)
- Display up side/down side reverse function (user set up)
- Low reflection
- 6-bit digital RGB signals
- 3.3 V operation (5.0 V available)
- Incorporated edge type backlight (Two lamps, with inverter, bright/dark selectable)
- Data enable function (DE/Fixed mode select: user set up)
- Smooth polarizer surface (No antiglare treatment)

APPLICATIONS

- Personal computers (PC) for factory automation
- Display terminals for control system
- Monitors for process controller

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

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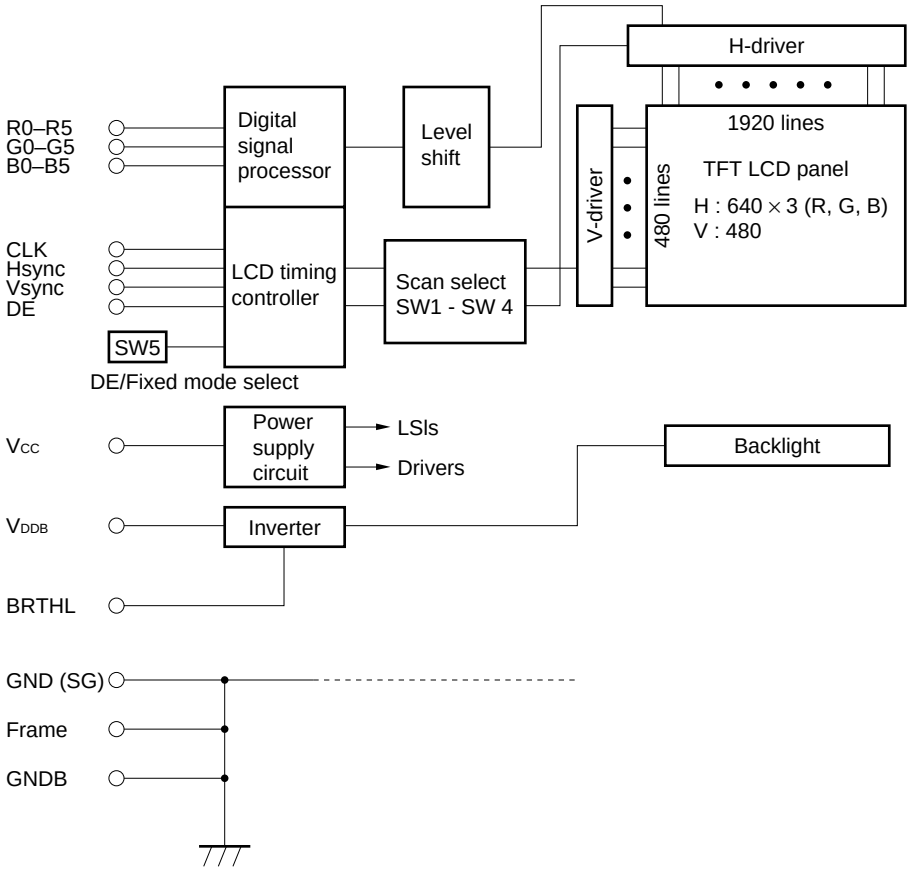
STRUCTURE AND FUNCTIONS

A TFT color LCD module comprises a TFT LCD panel, LSIs for driving liquid crystal, and the backlight. The TFT LCD panel is composed of a TFT array glass substrate superimposed on a color filter glass substrate with liquid crystal filled in the narrow gap between two substrates. The backlight apparatus is located on the backside of the LCD panel.

RGB (Red, Green, Blue) data signals are sent to LCD panel drivers after modulation into suitable forms for active matrix addressing through signal processor.

Each of the liquid crystal cells acts as an electro-optical switch that controls the light transmission from the backlight by a signal applied to a signal electrode through the TFT switch.

BLOCK DIAGRAM



OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	211.2 (H) × 158.4 (V) mm
Drive system	a-Si TFT active matrix
Display colors	262144 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) × 11.0 max. (D) mm
Weight	470 g (typ.) + 15 g (typ., inverter)
Contrast ratio	150:1 (typ.)
Viewing angle (more than the contrast ratio of 10:1)	
	Horizontal : 45° (typ. left side, right side)
	Vertical : 30° (typ. up side), 20° (typ. down side)
Designed viewing direction	• Wider viewing angle with contrast ratio
	: up side (12 o'clock, normal scan)
	: down side (6 o'clock, reverse scan)
	• Wider viewing angle without image reversal
	: down side (6 o'clock, normal scan)
	: up side (12 o'clock, reverse scan)
	• Optimum grayscale (γ = 2.2): perpendicular
Color gamut	43 % (typ. center, to NTSC)
Response time	40 ms (max.), "white" to "black"
Luminance	200 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 V
Backlight	Edge light type, two cold cathode fluorescent lamp
Power consumption	6.8 W (typ. at 3.3 V, 12.0 V)

GENERAL SPECIFICATIONS

Item	Specification	Unit
Module size	243.0 ± 0.5 (H) × 185.1 ± 0.5 (V) × 11.0 max. (D)	mm
Invertor size	25.0 ± 0.5 (H) × $100^{+0.7}_{-0.3}$ (V) × 10.2 max. (D)	mm
Display area	211.2 (H) × 158.4 (V)	mm
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	262144	color
Weight	Module: 480 (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
Input voltage	V_I	–0.3 to 6.5	V	$V_I - V_{CC} < 3.0$	
Storage temp.	T_{ST}	–20 to 60	˚C		
Operating temp.	T_{OP}	0 to 50	˚C	Module surface*	
Humidity		≤ 95 % relative humidity		$T_a \leq 40$ ˚C	No condensation
		≤ 85 % relative humidity		$40 < T_a \leq 50$ ˚C	
		Absolute humidity shall not exceed T_a = 50 ˚C, 85 % relative humidity level		$T_a > 50$ ˚C	

***** 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 “L” voltage	V_{IL}	0	–	$V_{CC} \times 0.3$	V	CMOS level
Logic input “H” voltage	V_{IH}	$V_{CC} \times 0.7$	–	V_{CC}	V	
Supply current	I_{CC}	– –	*1 300 *1 (200)	*2 400 *2 (300)	mA mA	V_{CC} = 3.3 V (V_{CC} = 5.0 V)

***1.** Checker flag pattern (in EIAJ ED-2522)

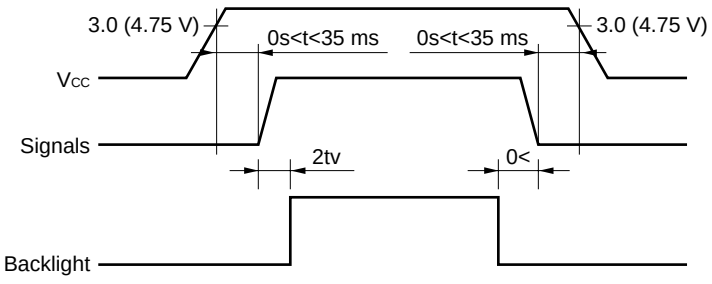
***2.** Theoretical maximum current pattern

(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	–	mA	200cd/m^2

SUPPLY VOLTAGE SEQUENCE



*1 The supply voltage for input signals should be same as V_{CC}.

*2 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.

*3 When the power is off, please keep whole signals (Hsync, Vsync, CLK, data) low level or high impedance.

INTERFACE PIN CONNECTION

(1) Interface signals, power supply

Module side connector — Mating connector

CN1 ··· DF9C-31P-1V (No. 1 to 31) — DF9-31S-1V or DF9M-31S-1R

Supplier: HIROSE ELECTRIC CO., LTD.

Pin No.	Symbol	Function
1	GND	Ground
2	CLK	Dot clock
3	Hsync	Horizontal sync.
4	Vsync	Vertical sync.
5	GND	Ground
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
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
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
27	DE	Data enable
28	V_{CC}	Power supply
29	V_{CC}	Power supply
30	N. C.	Non-connection
31	N. C.	Non-connection

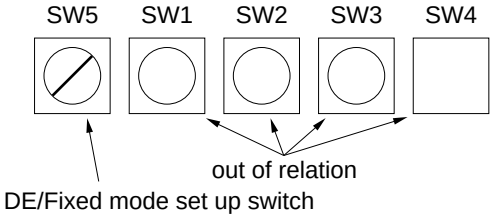
LSB : Least Significant Bit

MSB : Most Significant Bit

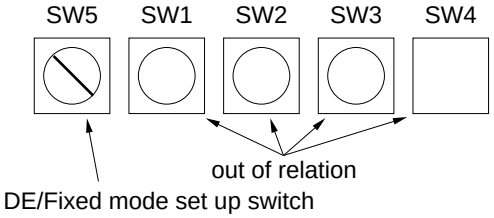
Notes 1. V_{CC}: All V_{CC} terminals should be connected to 3.3 V or 5.0 V.

2. DE/Fixed mode select is set by SW5 on the rear side.

• DE mode (factory set)



• Fixed mode



(2) Backlight

Inverter side connector — Mating connector

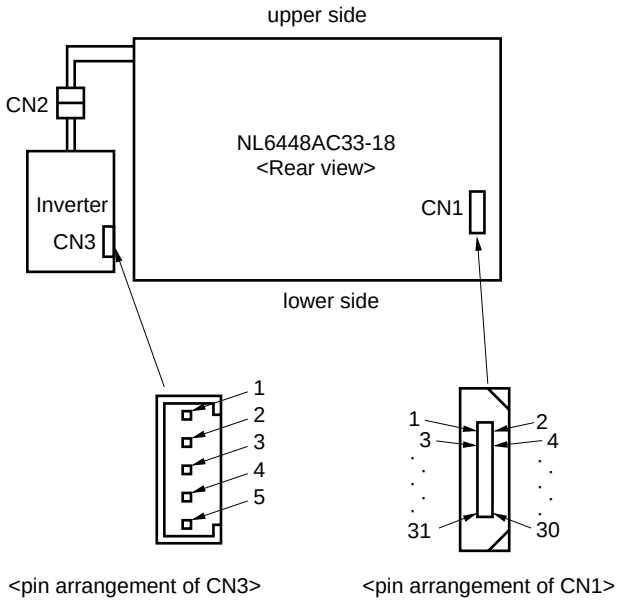
CN2 ··· LZ-5P-SL-SMT — LZ-5S-SC3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Function
1	V_{DDB}	Backlight power supply
2	V_{DDB}	Backlight power supply
3	GNDB	Backlight ground
4	GNDB	Backlight ground
5	BRTHL	Backlight luminance select *1

Note 1. High luminance (100 %) : High level or open
Low luminance (60 %, TYP.) : Low level

<Connector location>



<pin arrangement of CN3> <pin arrangement of CN1>

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

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 262144 ($64 \times 64 \times 64$) colors.

INPUT SIGNAL TIMING

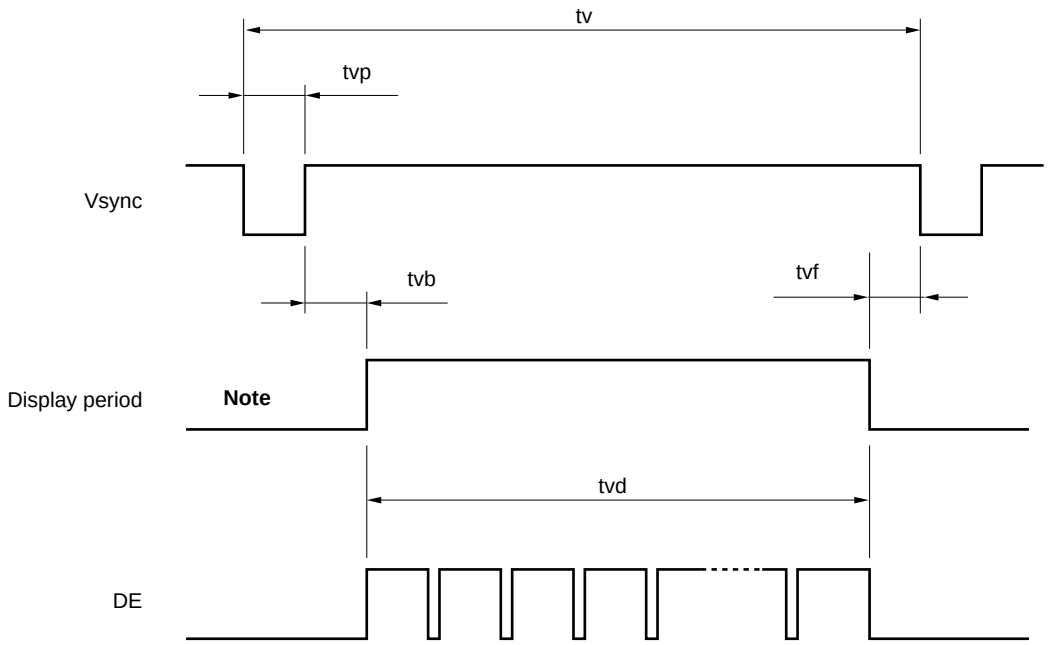
(1) Input signal specifications

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	21.0	25.175	29.0	MHz	39.722 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	31.469 kHz (Typ.)
			–	800	–	CLK	
	Display period	thd	640			CLK	–
	Front-porch	thf	16			CLK	Fixed timing mode
			2	16	–	CLK	DE mode
	Pulse width	thp*	10	96	–	CLK	Fixed timing mode
			10	96	–	CLK	DE mode
	Back-porch	thb*	4	48	–	CLK	Fixed timing mode
			4	48	–	CLK	DE mode
	thp + thb*		144			CLK	Fixed timing mode
			14	144	–	CLK	DE mode
	CLK-Hsync timing	thch	12	–	–	ns	–
	Hsync-CLK timing	thcs	8	–	–	ns	–
	Hsync-Vsync timing	tvh	1	–	–	CLK	1CLK = 39.722 ns (Typ.)
	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	12			H	Fixed timing mode
			1	12	–	H	DE mode
	Pulse width	tvp*	1	2	–	H	Fixed timing mode
			1	2	–	H	DE mode
	Back-porch	tvb*	4	31	–	H	Fixed timing mode
			4	31	–	H	DE mode
	tvp + tvb*		33			H	Fixed timing mode
			5	33	–	H	DE mode
	Rise, fall		–	–	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	DE mode
	CLK-DE timing	teh	12	–	–	ns	
	Rise, fall	terf	–	–	10	ns	

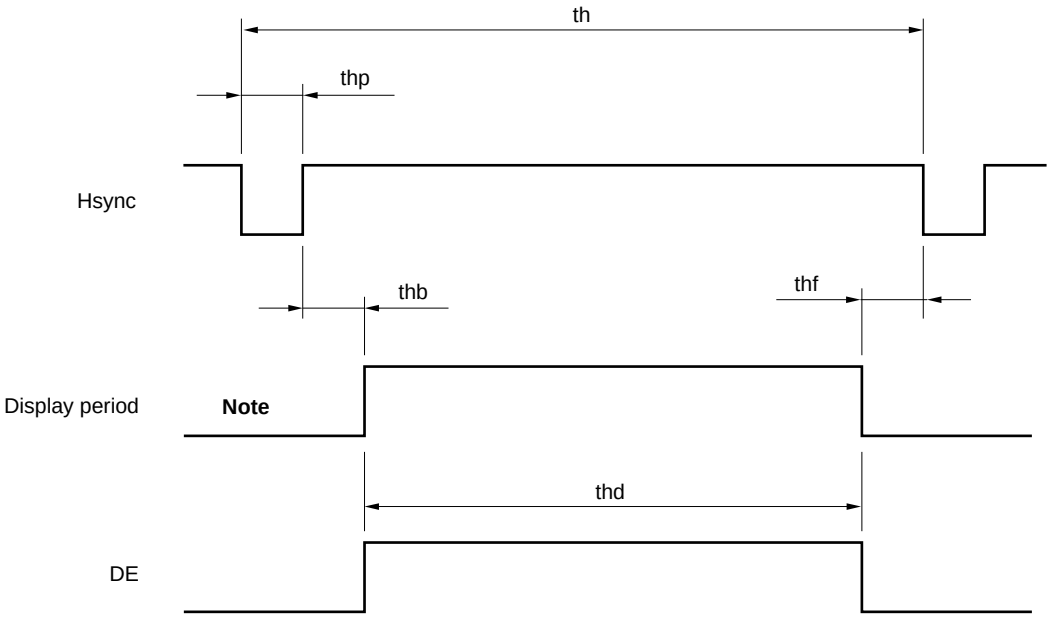
All of parameters should be kept in the specified range.

(2) Definition of input signal timing

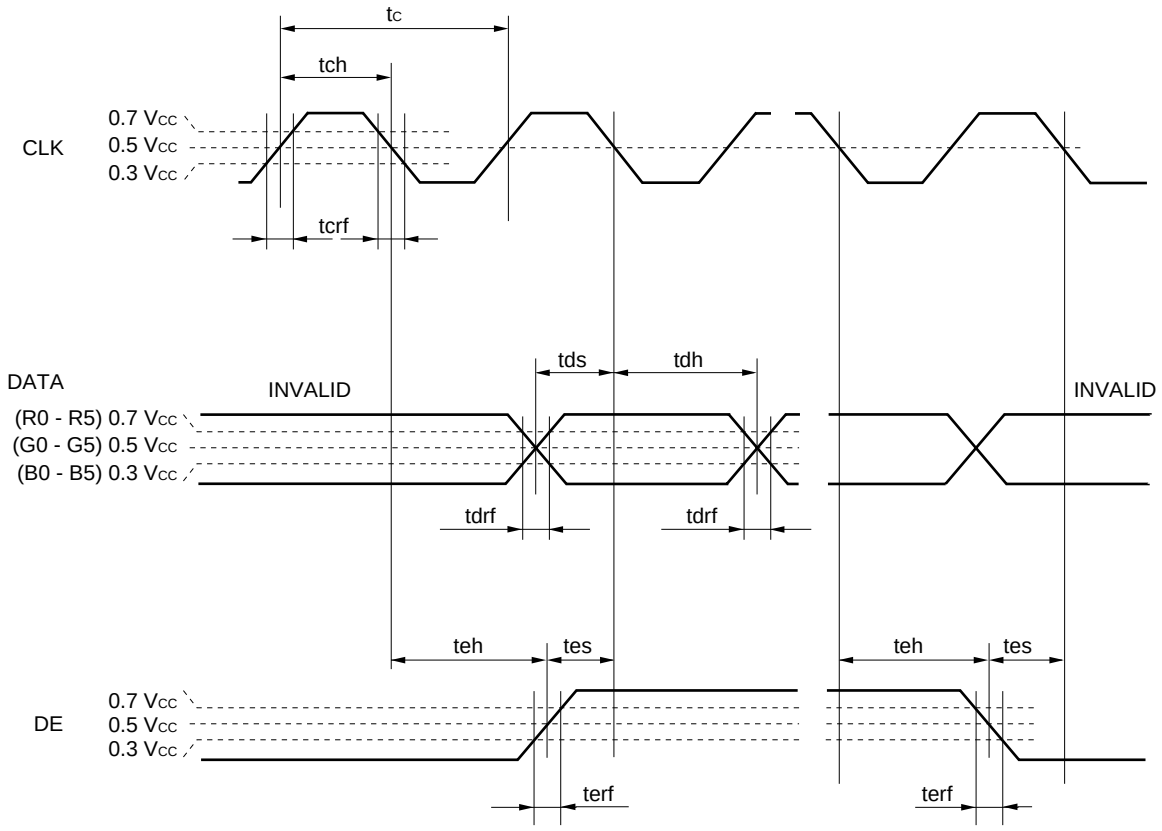
<Vertical>

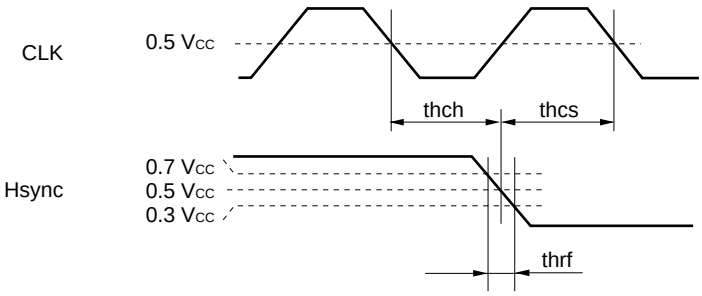


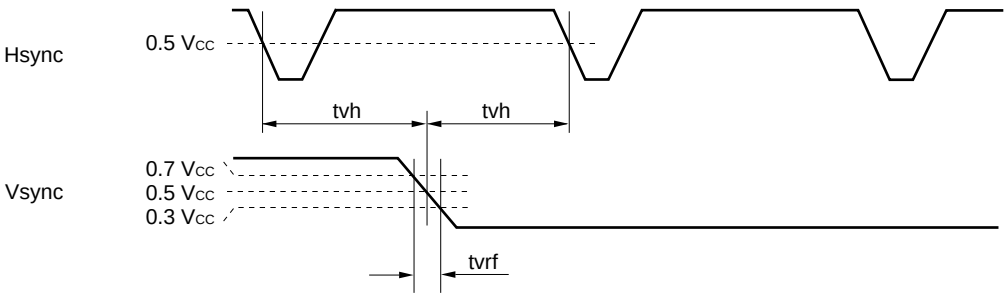
<Horizontal>



Note These do not exist as signals.

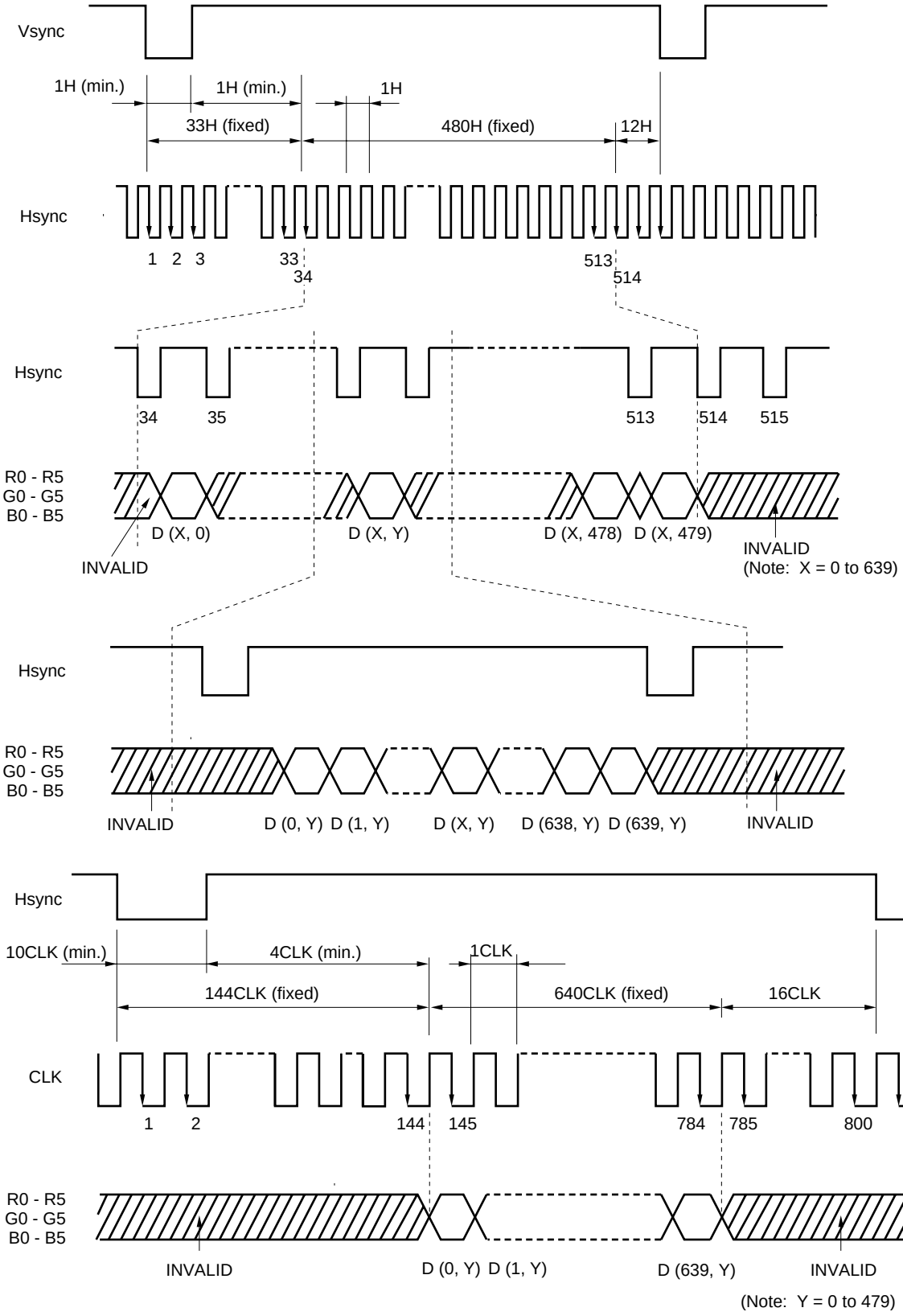

tc
tch
CLK
0.7 Vcc
0.5 Vcc
0.3 Vcc
tcrf
DATA
INVALID
INVALID
tds
tdh
(R0 - R5) 0.7 Vcc
(G0 - G5) 0.5 Vcc
(B0 - B5) 0.3 Vcc
tdrf
tdrf
teh
tes
teh
tes
DE
0.7 Vcc
0.5 Vcc
0.3 Vcc
terf
terf


CLK
0.5 Vcc
thch
thcs
Hsync
0.7 Vcc
0.5 Vcc
0.3 Vcc
thrf

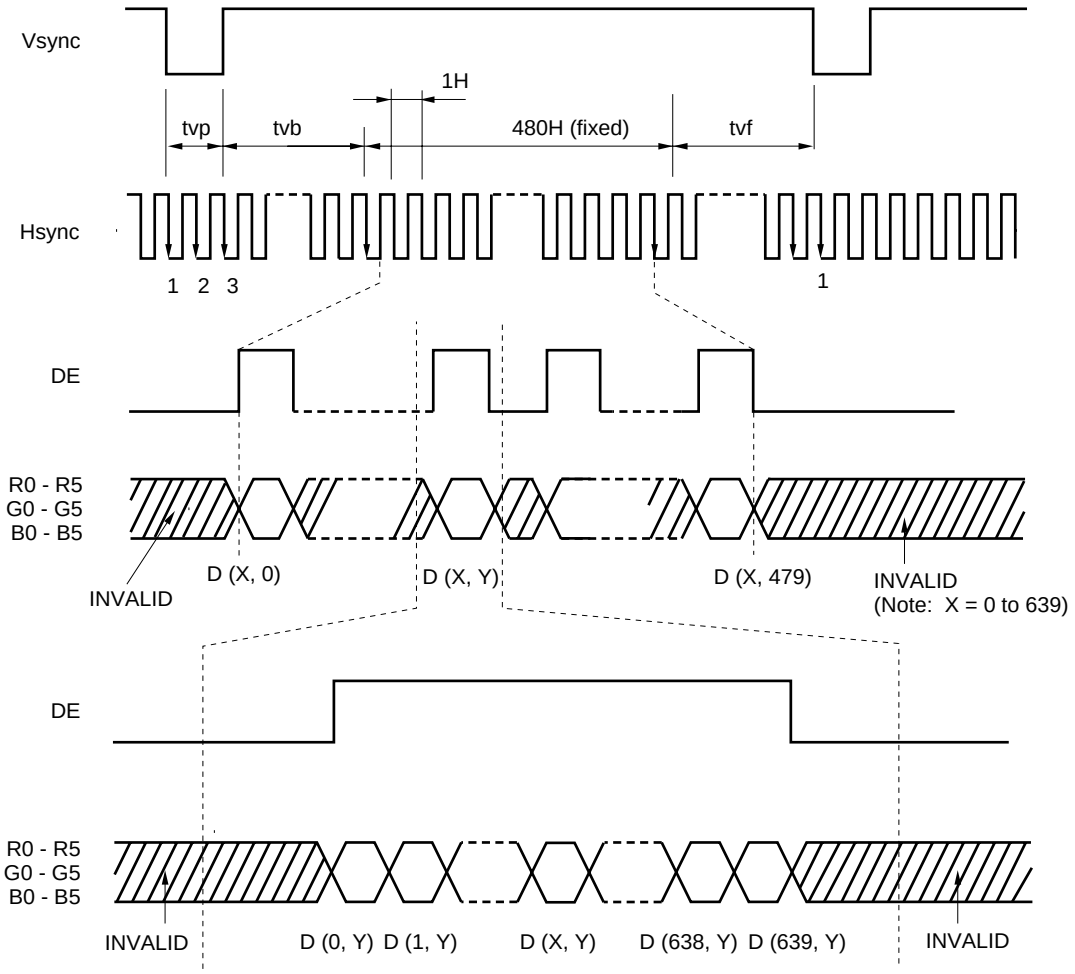

Hsync
0.5 Vcc
tvh
tvh
Vsync
0.7 Vcc
0.5 Vcc
0.3 Vcc
tvrf

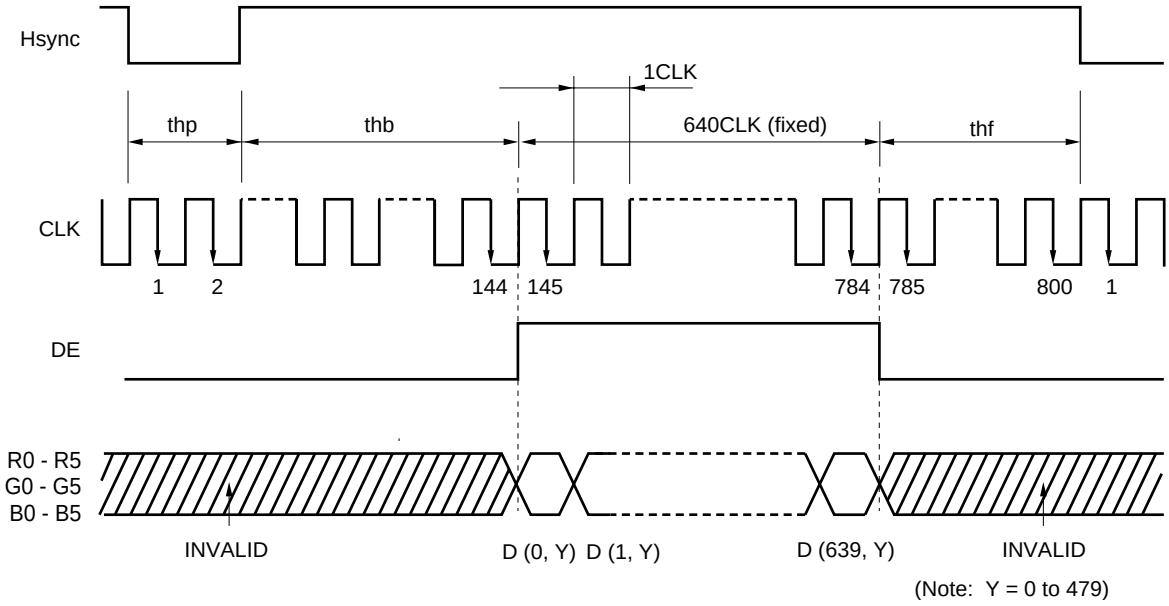
(3) Input signal timing chart

a) Fixed timing mode



b) DE mode


Vsync
1H
tvp
tvb
480H (fixed)
tvf
Hsync
1 2 3
1
DE
R0 - R5
G0 - G5
B0 - B5
INVALID
D (X, 0)
D (X, Y)
D (X, 479)
INVALID
(Note: X = 0 to 639)
DE
R0 - R5
G0 - G5
B0 - B5
INVALID
D (0, Y) D (1, Y)
D (X, Y)
D (638, Y) D (639, Y)
INVALID


Hsync
1CLK
thp
thb
640CLK (fixed)
thf
CLK
1
2
144
145
784
785
800
1
DE
R0 - R5
G0 - G5
B0 - B5
INVALID
D (0, Y) D (1, Y)
D (639, Y)
INVALID
(Note: Y = 0 to 479)

(4) Display position of input data

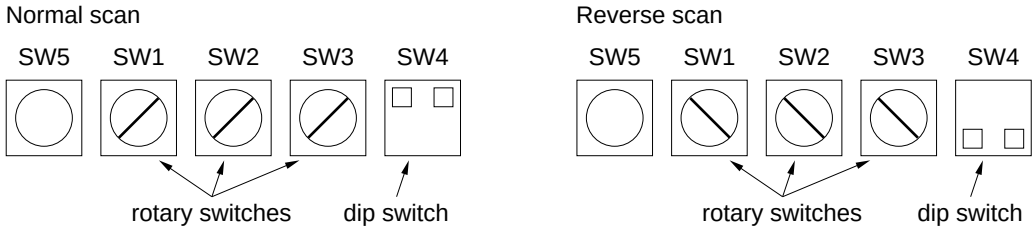
Normal scan (factory set)

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

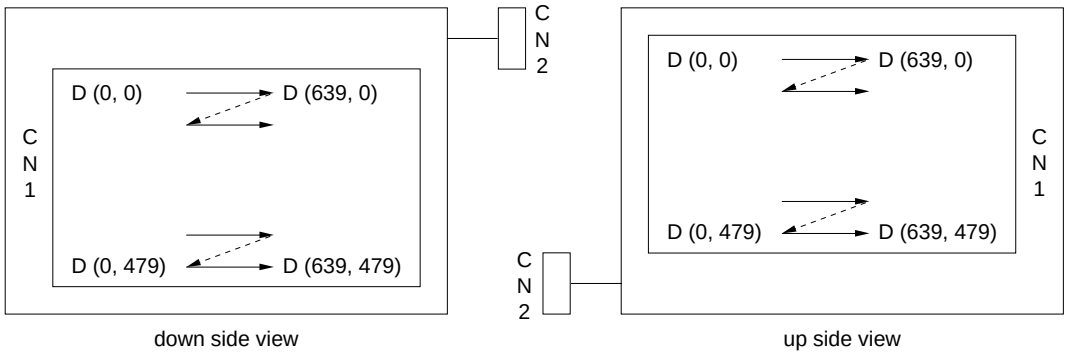
D (639, 479)	D (638, 479)	- - -	D (X, 479)	- - -	D (1, 479)	D (0, 479)
D (639, 478)	D (638, 478)	- - -	D (X, 478)	- - -	D (1, 478)	D (0, 478)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (639, Y)	D (638, Y)	- - -	D (X, Y)	- - -	D (1, Y)	D (0, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D (639, 1)	D (638, 1)	- - -	D (X, 1)	- - -	D (1, 1)	D (0, 1)
D (639, 0)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

Note 1. The scan direction is set up by switches on the rear side.



*SW5 is not related for setting up the scan direction.

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



GENERAL CAUTION

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

(2) Cautions for handling the module
   1) As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
   2) As the LCD panel and back-light 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) The torque to mounting screw should never exceed 0.294 N·m (3 Kgf·cm).

(3) Cautions for the operation
   1) When the module is operating, do not lose CLK, Hsync or Vsync signals. If any one of these signals is lost, the LCD panel would be damaged.
   2) Obey the supply voltage sequence. If wrong sequence is applied, the module would be damaged.

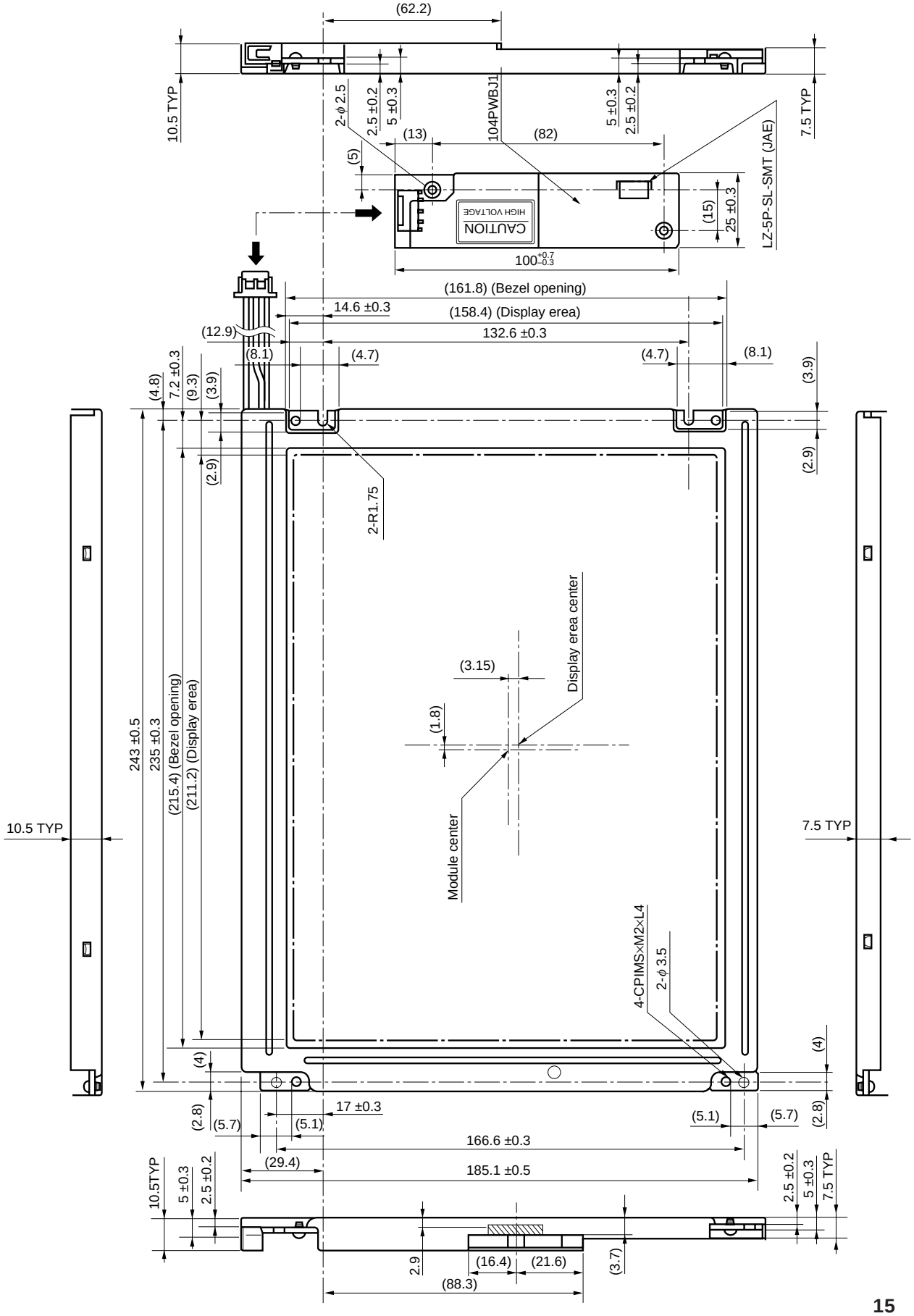
(4) Cautions for the atmosphere
   1) Dew drop atmosphere should be avoided.
   2) Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
   3) This module uses cold cathode fluorescent lamps. Therfore, the life time of lamps becomes short conspicuously at low temperature.

(5) Cautions for the module characteristics
   1) Do not apply fixed pattern data signal to the LCD module at product aging. Applying fixed pattern for a long time may cause image sticking.

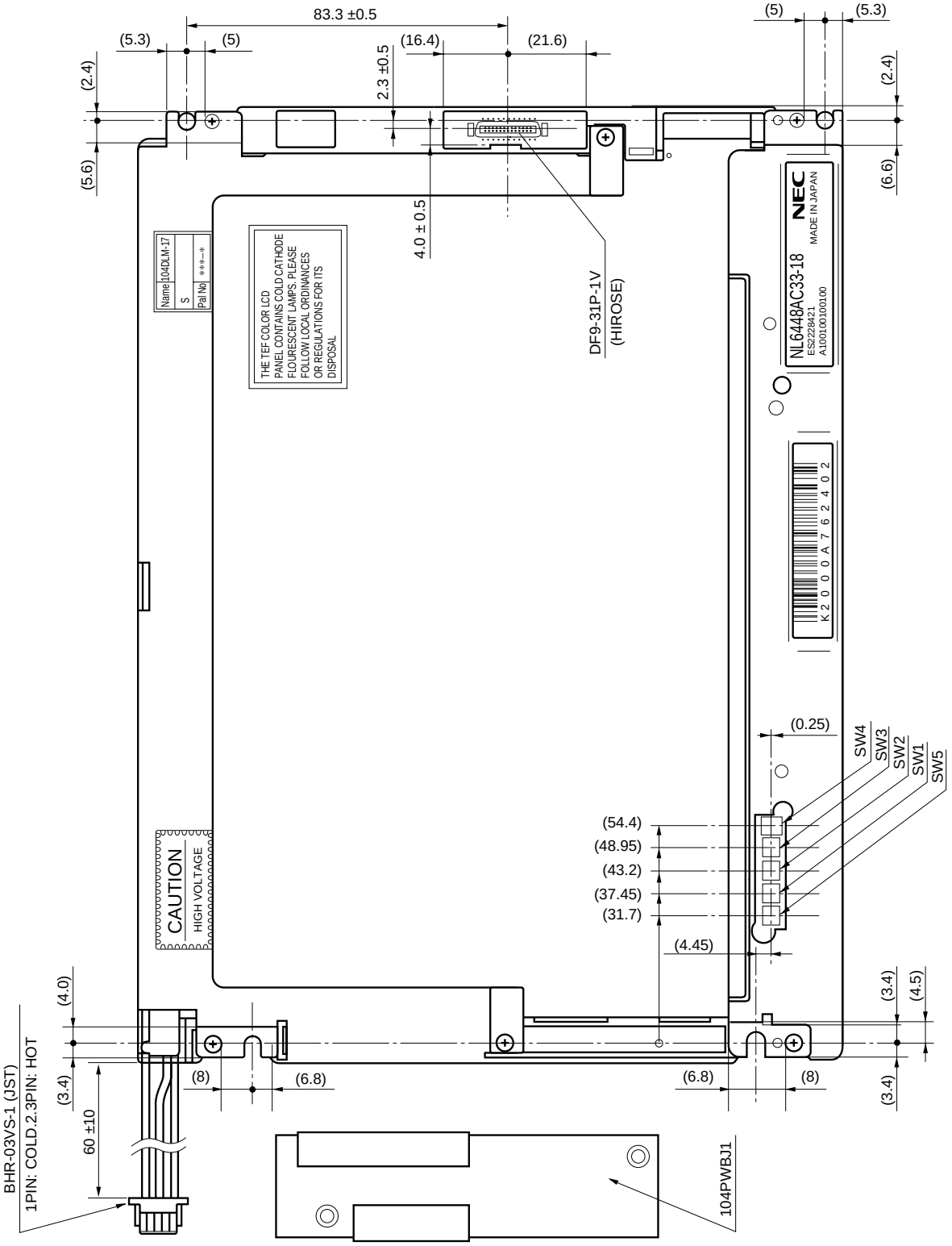
(6) Other cautions
   1) Do not disassemble and/or re-assemble LCD module. (except for backlight lamp)
   2) Do not re-adjust variable resistor or switch etc. (except for scan select switches)
   3) When returning the module for repair or etc., please pack the module not to be broken.
      We recommend to use the original shipping packages.
   4) Turn off the power supply to avoid electrical shock while backlight lamp is replaced, and refer to the backlight replace manual.

Liquid Crystal Display has the following specific characteristics. These are not defects or malfunctions.
The display condition of LCD module may be affected by the ambient temperature.
The LCD module uses cold cathode tubes 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: Front View (Unit in mm)



OUTLINE DRAWING: Rear View (Unit in mm)



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