

NEC

NEC Corporation
NEC Electron Devices
Display Device Operations Unit
Color LCD Division
2nd Engineering Department

TFT COLOR LCD MODULE

Type No. NL6448BC26-01

21cm(8.4type),VGA

SPECIFICATIONS
(Second edition)

PRELIMINARY

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INTRODUCTION

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Anti-radioactive design is not implemented in this product.

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1. DESCRIPTION

NL6448BC26-01 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. NL6448BC26-01 has a built-in backlight. The backlight includes long-life-lamps and its lamps are replaceable with a holder.

The 21cm(8.4 Type) diagonal display area contains 640×480 pixels and can display 262,144 colors simultaneously

NL6448BC26-01 is suitable for industrial application use because of the wide viewing angle and the high luminance. Also, the viewing direction is selectable either upper or lower side by changing scan direction.

2. FEATURES

- Wide viewing angle(with Retardation film)
- Wide temperature range(storage:-20 to +70°C,operation:0 to +60°C)
- Antiglare polarizer surface
- High luminance (400cd/m^2 typ. :saturated value,at room temp.)
- Edge type backlight with two long-life-time lamps(Inverter less)
- Reversible scan direction(with DPS pin)
- 6-bit digital RGB signals (CMOS level)
- Data enable(DE) function(Auto recognition)
- Lamp holder replaceable(Type No.TBD)
- Recommended inverter(Type No.: 65PWB31)

3. APPLICATIONS

- Industrial PCs
- Display terminals for control system
- Monitors for process controller

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 backside of the panel.

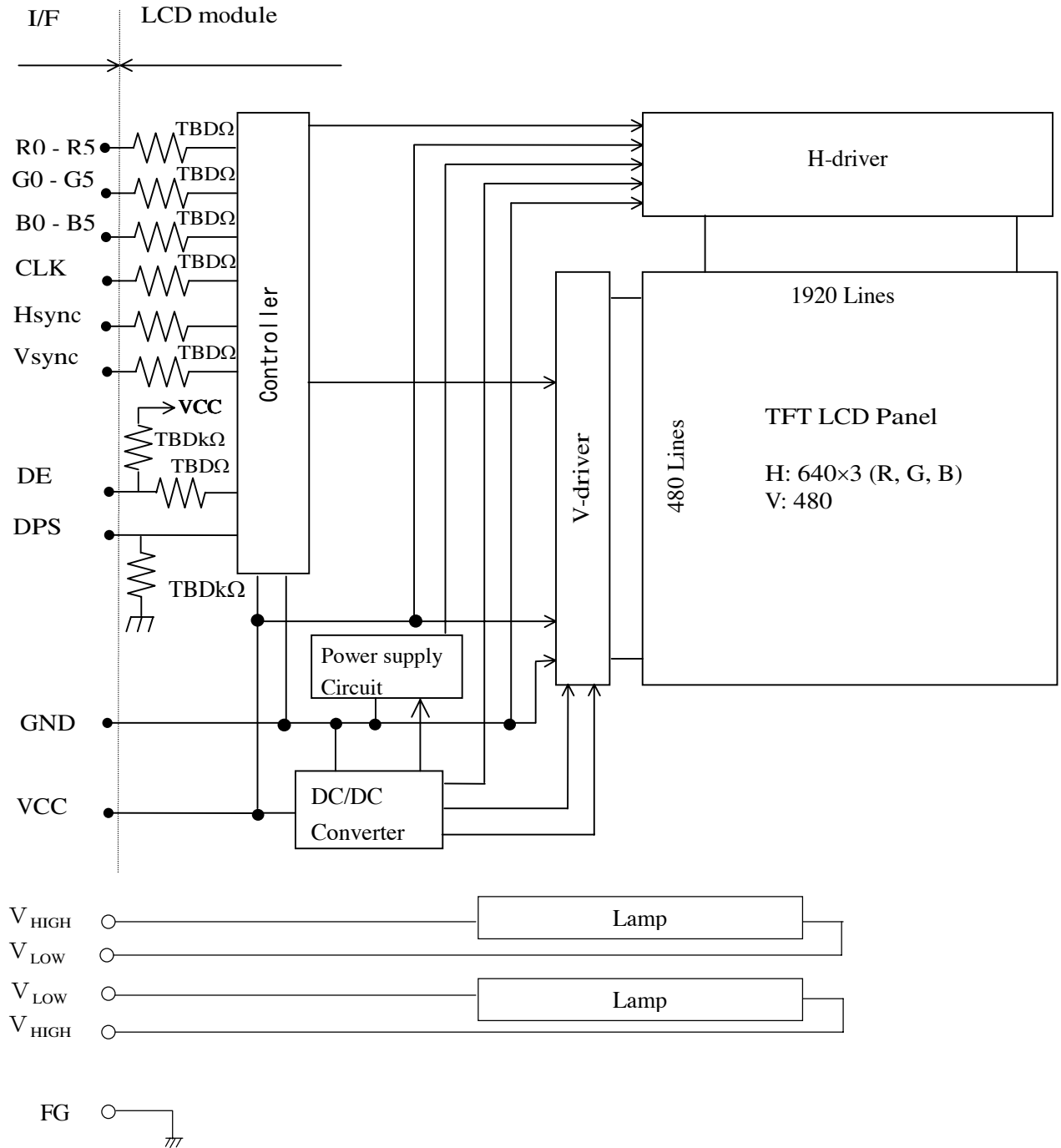
RGB(red,green,blue) data signals from a source system is modulated into a form suitable for active matrix addressing by the onboard signal processor and sent to the driver LSIs which in turn addresses the individual TFT cells.

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.

5. OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	170.88(H)×128.16(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	0.267 (H)×0.267 (V)mm
Module size	200.0(H)×152.0(V)×12.0(D)mm (Typ.)
Recommendation inverter size	105.0(H)×25.0(V)×8.0(D)mm(Max.)
Weight	400g (typ., Design target)
Contrast ratio	300:1 (typ.)
Viewing angle (more than the contrast ratio of 10:1)	Horizontal: 60° (Typ. left side, right side) Vertical : 40° (Typ. up side), 60° (Typ. down side)
Designed viewing direction	Wider viewing angle without image reversal : Upper side(12 o'clock, normal scan) Wider viewing angle with contrast ratio : Lower side(6 o'clock, normal scan)
Polarizer pencil-hardness	TBD(at JIS K5400)
Color gamut	43% typ. (at center, to NTSC)
Response time	TBD ms typ. ("white" to "black")
Luminance	400cd/m ² (Typ.)
Signal system	RGB 6-bit digitals, Synchronous signals(Hsync, Vsync), Dot clock(CLK) DE
Supply voltage	3.3V [5.0V](Logic, LCD driving)
Backlight	Edge light type : Two cold cathode fluorescent lamps Replaceable lamp holder: type No. TBD
Power consumption	TBD[w] typ.(3.3V, 5.0mA rms)

BLOCK DIAGRAM



note1 : GND is not connected to FG(Frame Ground)in the LCD module.

7. SPECIFICATIONS

7.1. GENERAL SPECIFICATIONS

Item	Specifications	Unit
Module size	200.0±0.5 (H) × 152.0±0.5 (V) × TBD(D)Max.	mm
Display area	170.88 (H) × 128.16 (V)	mm
Number of pixels	640×3 (H) × 480 (V)	pixel
Dot pitch	0.089 (H) × 0.267 (V)	mm
Pixel pitch	0.267 (H) × 0.267 (V)	mm
Pixel arrangement	RGB (Red,Green,Blue) vertical stripe	-
Display colors	262144	color
Weight	TBD Max.	g

7.2. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings	Unit	Remarks
Supply voltage	VCC	-0.3 to +6.5	V	Ta=25°C LCD Module
Input voltage	VI	-0.3 to Vcc+0.3	V	
Supply voltage	VDDDB	0 to +6.5	V	Ta=25°C
Lamp voltage	VL	1800	Vrms	Ta=25°C
Storage temp.	T _{st}	-20 to +70	°C	-
Operation temp.	T _{op}	0 to +60	°C	module surface note 1
Relative humidity(RH) note 2		≤ 95% relative humidity	%	Ta ≤ 40°C
		≤ 85% relative humidity	%	40 < Ta ≤ 50°C
Absolute humidity note 2		Absolute humidity shall not exceed Ta=50°C,85% relative humidity level.	g/m ³	Ta > 50°C

note 1 : Measured at the display area(including self heat)

note 2 : No condensation

7.3. ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	VCC	3.0 (4.75)	3.3 (5.0)	3.6 (5.25)	V	VCC=3.3V (VCC=5.0V)
Logic input "L" voltage	VIL	0	-	VCC×0.3	V	-
Logic input "H" voltage	VIH	VCC×0.7	-	VCC	V	
Supply current	ICC	-	270 TBD note 1	TBD TBD	mA	VCC=3.3V VCC=5.0V

note 1 : Checker flag pattern (in EIAJ ED-2522)

(2)Backlight

Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Lamp current	IL	2.0	5.0	5.5	mArms	with one lamp
Lamp voltage	VL	–	(440)	–	Vrms	–
Lamp turn on voltage	VS	–	–	TBD	Vrms	Ta=25°C
		–	–	TBD	Vrms	Ta= 0°C
Oscillator frequency	Ft	50	54	58	KHz	note 1

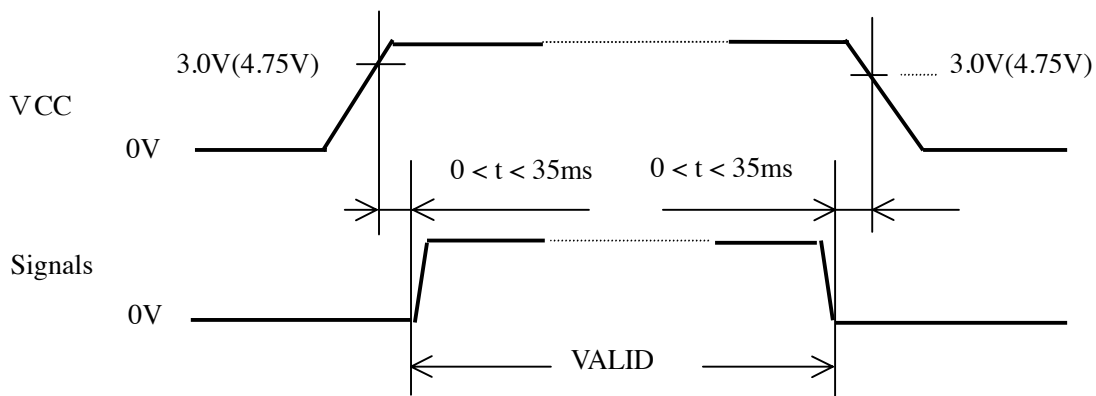
note 1:Recommended value of "Ft"

Ft is within the specification.

$$F_t = (2n-1)/4t_h$$

t_h :Hsync period
 n :a natural number

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

7.4. SUPPLY VOLTAGE SEQUENCE

Signals:CLK,Hsync,Vsync,DE,RO-R5,G0-G5,B0-B5,DPS

note 1 The supply voltage for input signals should be the same as VCC.

note 2 Apply VH 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, please keep whole signals(Hsync, Vsync, CLK, DE, RO-R5, G0-G5, B0-B5, DPS) low level or high impedance.

note 4 Wrong power sequence is not may damaged to the module.

note 5 The signal must not be down during operation. Even if signal could recover,LCD module may not be operated correctly or the display may have unevenness. In case of signal down, VCC should be turned off and then turn VCC and signals on as above sequence.

7.5. INTERFACE PIN CONNECTIONS

(1) Interface signals, power supply

CN1 socket : DF9C-31P-1V(HIROSE ELECTRIC CO.,LTD.)

Adaptable plug : DF9-31S-1V(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

Pin No.	Symbol	Function
17	G4	Green data
18	G5	Green data (MSB)
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 signal
28	VCC	Power supply
29	VCC	Power supply
30	N.C.	Non connection
31	DPS	Scan direction select

LSB:Least Significant Bit

MSB:Most Significant Bit

note 1) VCC : All VCC terminals should be connected to 3.3V or 5.0V.

note 2) DE : DE/Fixed mode select is as follows.

Data enable signal = DE mode

"VCC" or "OPEN" = Fixed mode

note 3) DPS : can change scan at horizontal direction(normal scan and reverse scan).

"GND" or "OPEN" = normal scan

"VCC" = reverse scan

See 7-8 DISPLAY POSITION about another way for reversible scan.

note 4) GND is not connected to the frame of the LCD module.

(2) Backlight

CN2 : BHR-03VS-1

Adaptable socket : SM03(4.0)B-BHS-TB

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

Pin No.	Symbol	Function
1	CFL Hot	High voltage terminal
2	N.C	No Connection
3	CFL Cold	Low voltage terminal

Remark: CFL Cold should be close to Grand potential.

7.6. 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 gray scale	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 gray scale	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 gray scale	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										

Remark : Colors are developed in combination with 6 bit signals (64 steps in gray scale) of each primary red, green, and blue color. This process can result in up to 262144 (64×64×64) colors.

7.7. INPUT SIGNAL TIMINGS

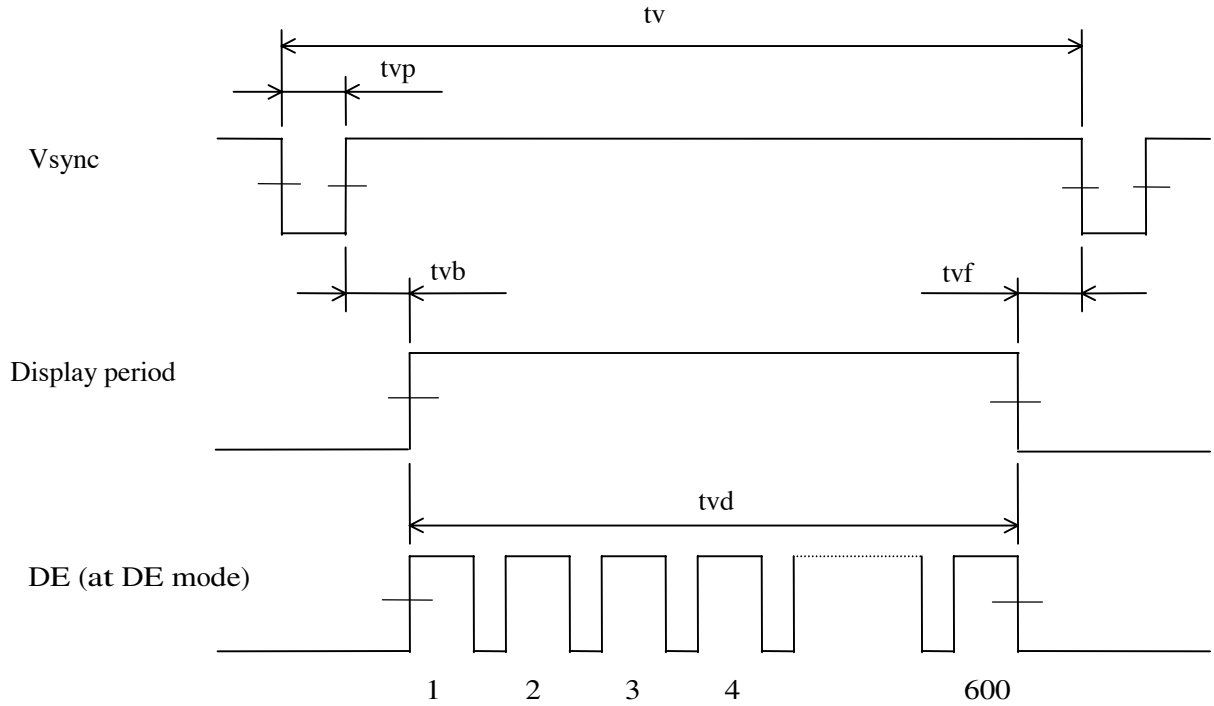
(1)Input signal specifications

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
DCLK	Frequency	1/tc	21.0	25.175	29.0	MHz	39.722ns (typ.)
	Duty	tch/tc	0.4	0.5	0.6	—	—
	Rise, fall	trf	—	—	10	ns	—
Hsync	Period	th	30.0	31.778	33.6	μ s	31.468KHz (typ.)
			—	800	—	CLK	
	Display period	thd	640			CLK	—
	Front-porch	thf	—	16	—	CLK	Fixed mode
			0	16	—	CLK	DE mode
	Pulse width	thp *	—	96	—	CLK	Fixed mode
			10	96	127	CLK	DE mode
	Back-porch	thb *	—	48	—	CLK	Fixed mode
			5	48	509	CLK	DE mode
	*) thp + thb		144			CLK	Fixed mode
			15	144	—	CLK	DE mode
	CLK-Hsync timing	thch	10	—	—	ns	—
	Hsync-CLK timing	thcs	8	—	—	ns	—
Hsync-Vsync timing	tvhh	1	—	—	CLK	—	
Vsync-Hsync timing	tvhs	15	—	—	ns	—	
Rise, fall	thrf	—	—	10	ns	—	
Vsync	Period	tv	16.1	16.683	17.2	ms	59.94Hz (typ.)
			—	525	—	H	
	Display period	tvd	480			H	—
	Front-porch	tvf	—	1	—	H	Fixed mode
			1	1	—	H	DE mode
	Pulse width	tvp **	2	2	23	H	Fixed mode
			2	2	—	H	DE mode
	Back-porch	tvb **	—	31	—	H	Fixed mode
			4	31	—	H	DE mode
**) tvp + tvb		—			H	Fixed mode	
		6			33	—	H
Rise, fall	tvrf	—	—	10	ns	—	
DATA R0-R5 G0-G5 B0-B5	DATA-CLK(Set up)	tds	8	—	—	ns	—
	CLK-DATA (Hold)	tdh	12	—	—	ns	
	Rise, Fall	tdrf	—	—	10	ns	
D E	DE-CLK timing	tes	8	—	—	ns	DE mode
	CLK-DE timing	the	12	—	—	ns	
	Rise, fall	terf	—	—	10	ns	

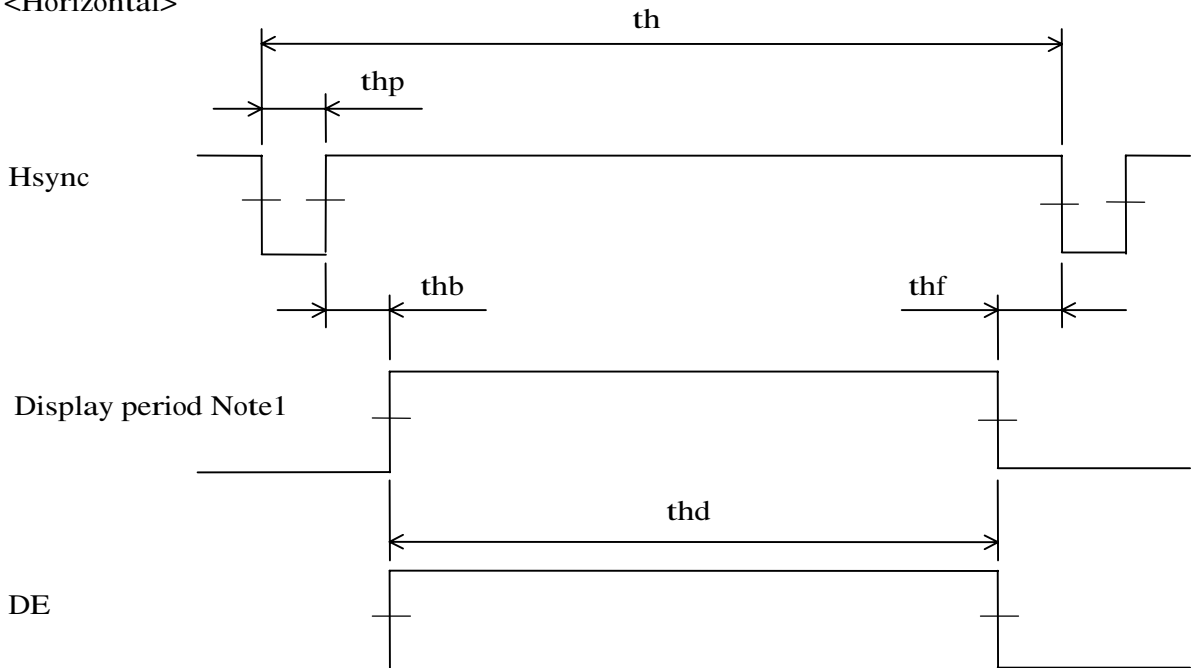
Remark : All paramerers should be kept within the specified range.

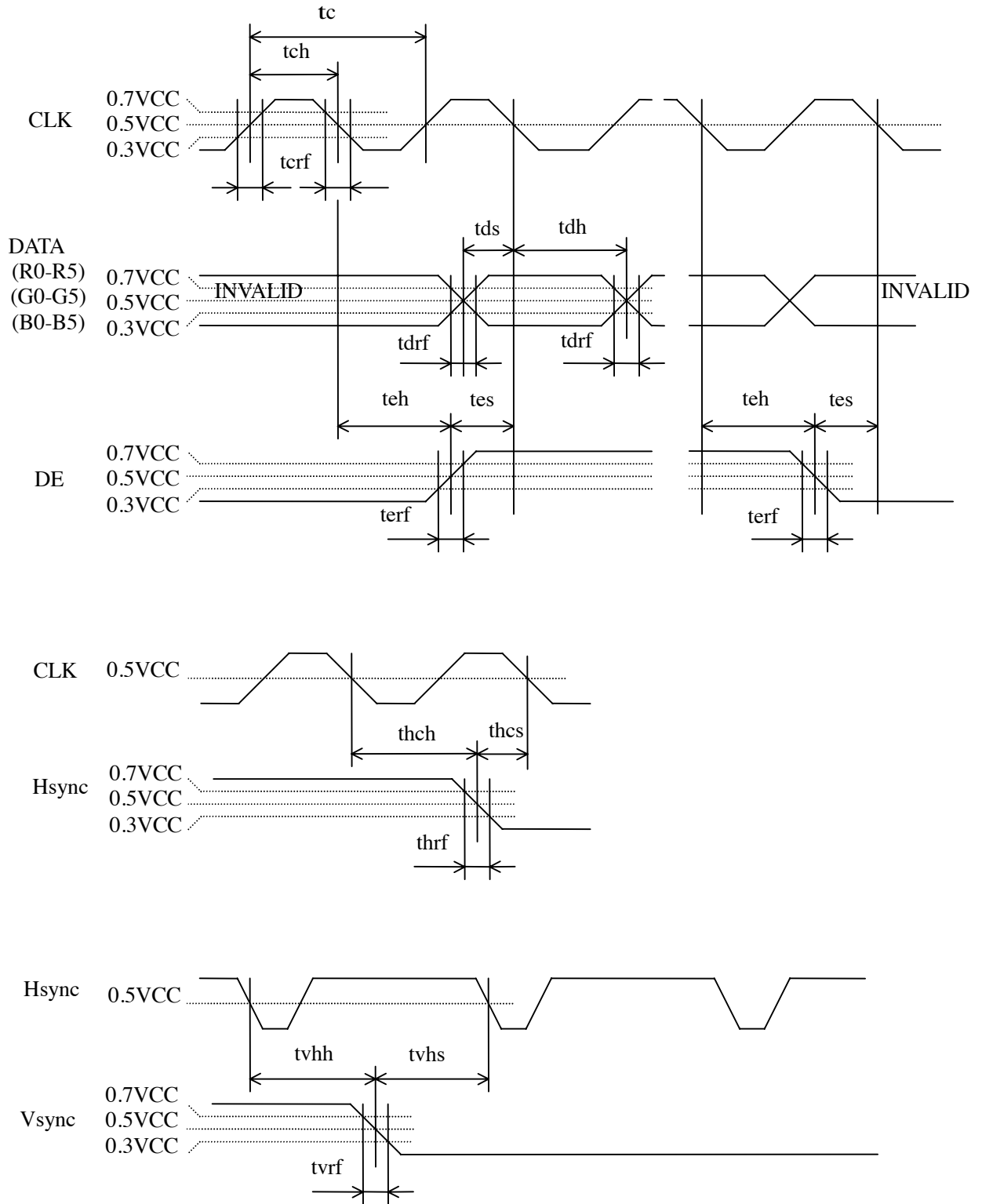
(2)Definition of input signal timing

<Vertical>



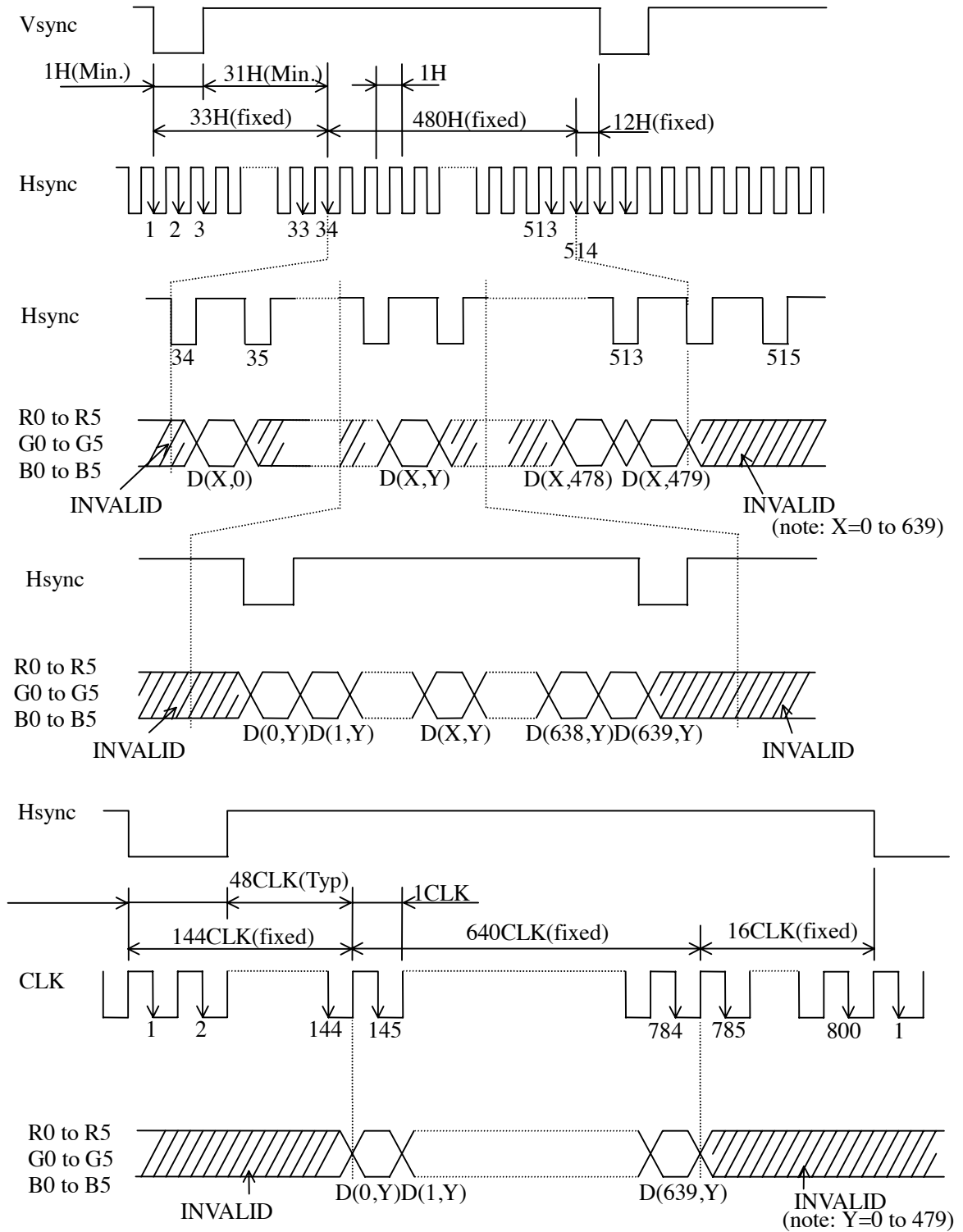
<Horizontal>



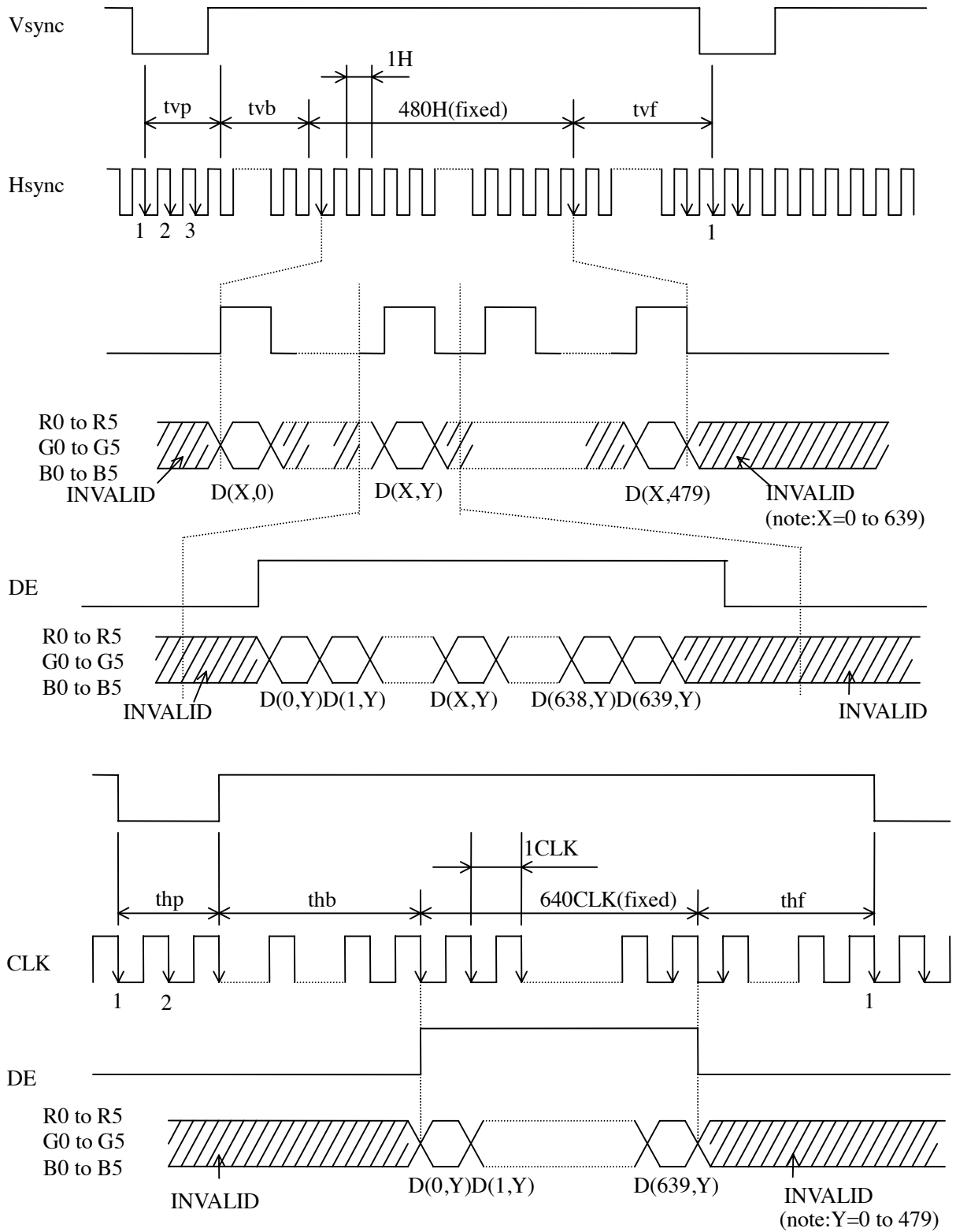


(3)Input signal timing chart

(a) Fixed mode



(b) DE mode



7.8. DISPLAY POSITIONS

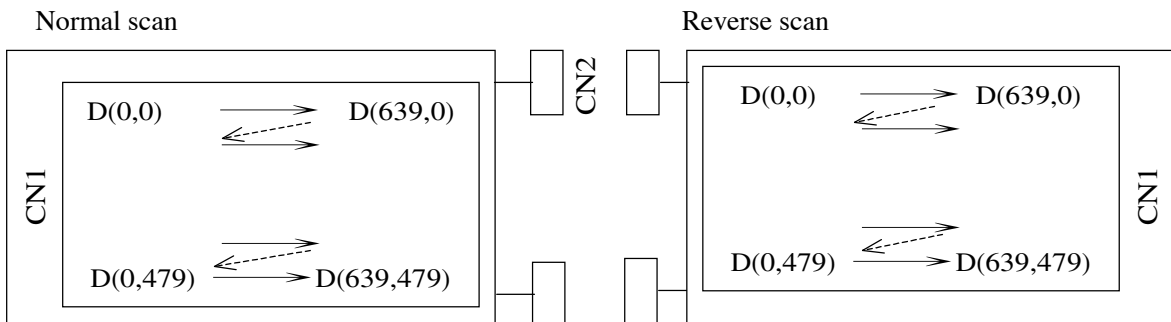
Noermal scan(DPS="Low" or "Open")

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 san(DPS="High")

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:Below drawings show relations between the scan direction and viewing direction.



8.OPTICAL CHARACTERISTICS

Ta=25°C note 1

Parameter	Symbol	condition	Min.	Typ.	Max.	Unit	Remark
Luminance	Lvmax	Note 3	(320)	400	—	cd/m ²	Note 2
Contrast ratio	CR	Note 3	TBD	300	—	—	Note 4
Brightness uniformity	—	max./min.	—	1.25	1.4	—	Note 7

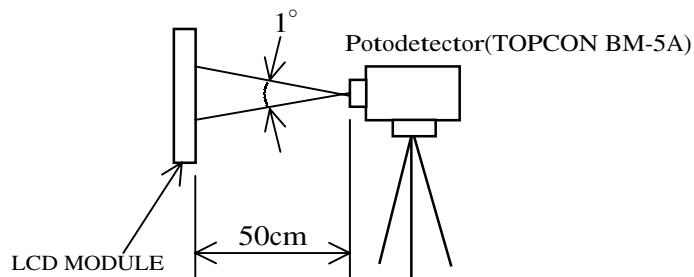
Reference data

Ta=25°C note 1

Parameter	Symbol	condition	Min.	Typ.	Max.	Unit	Remark	
Color gamut	C	at center,to NTSC	TBD	43	—	%	—	
Viewing angle range	Horizontal	θ_{x+}	CR>10, $\theta_{y} = \pm 0^{\circ}$	TBD	60	—	deg.	Note 5
		θ_{x-}		TBD	60	—		
	Vertical	θ_{y+}	CR>10, $\theta_{x} = \pm 0^{\circ}$	TBD	40	—		
		θ_{y-}		TBD	60	—		
Chromaticity coordinate	White	W_x	note 3	—	TBD	—	—	—
		W_y		—	TBD	—		
Response time	ton	white to black	—	TBD	TBD	ms	Note 6	
	toff	black to white	—	TBD	TBD			

Note 1) VCC = 3.3V, IL=5.0mA, at normal scan.

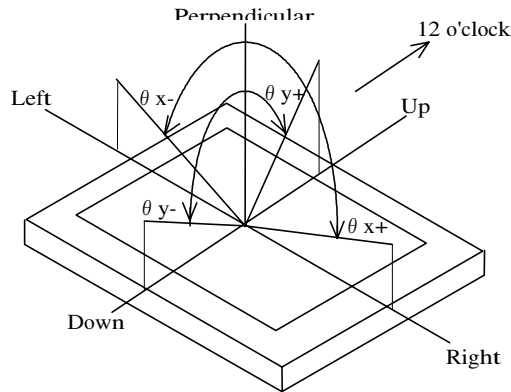
Note 2) The luminance is measured after 20 minute from the module works, with all pixels in "white".
 Typical value is measured after luminance saturation.
 The luminance is measured in dark room

Note 3) Viewing angle is $\theta_{x} = \pm 0^{\circ}$, $\theta_{y} = \pm 0^{\circ}$. at center.

Note 4) The contrast ratio is calculated by using the following formula.

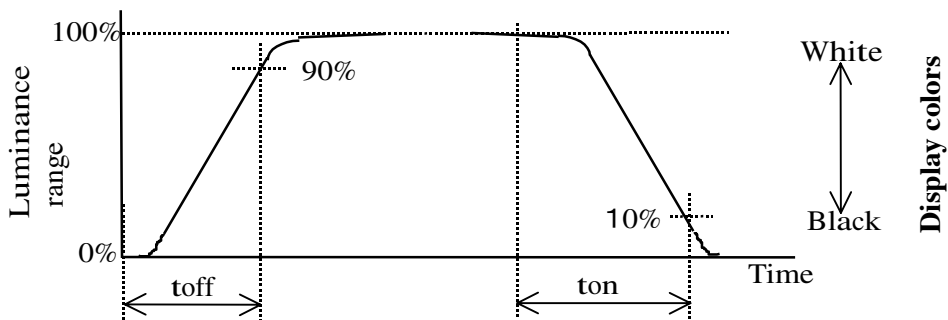
$$\text{Contrast ratio(CR)} = \frac{\text{Luminance with all pixels in "white"}}{\text{Luminance with all pixels in "black"}}$$

Note 5) Definitions of viewing angle are as follows.



Note 6) Definition of response time is as follows.

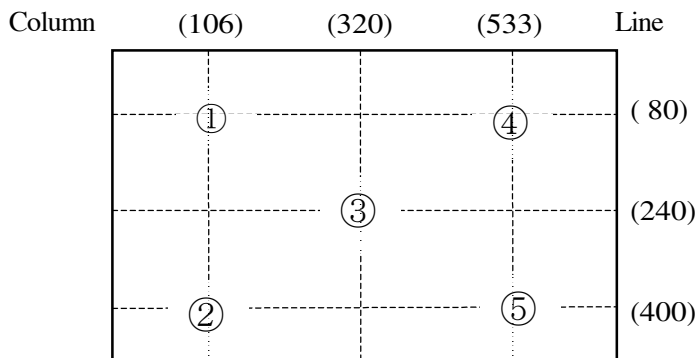
Photo detector output signal is measured when the luminance changes “black” to “white” (“white” to “black”). Response time is the time between 0% and 90% (100% and 10%) of the photodetector output amplitude.



Note 7) The luminance uniformity is calculated by using following formula.


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


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



9. 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.
---	----------------	--


	This figure is a mark that you will get hurt when you mark a mistake to operate
---	---



(1) Caution when taking the module

- ① Pick the pouch only, when taking on 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 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 of these signals is lost, the LCD panel would be damaged.
- ⑧ The torque to mounting screw should never exceed 0.294 N·m (3 Kgf·cm).
- 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 to interface connectors. The module may become function and an the connection condition.

(3) Caution 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 high humidity atmosphere.
Storage in a anti-static pouch and under the room temperature atmosphere is recommended.
- ③ This module uses cold cathode fluorescent lamps. Therefore, the life time of lamps becomes short if the module is operated under the low temperature environment.
- ④ Do not operate the LCD module in a high magnetic field.

(4) Caution for the module characteristics

- ① Do not apply any fixed patterns data for a long time to the LCD module. It may cause image sticking. Please use screen savers if the display pattern is fixed for a long time.
- ② 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.
- ③ The light vertical stripe may be observed depending on the display pattern. This is not a defect or normal function.
- ④ The noise from the inverter circuit may be observed in the luminance control mode. This is not a defect or normal function.

(5) Other cautions

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

Liquid Crystal Display has the following specific characteristics. These are not defects or normal functions.

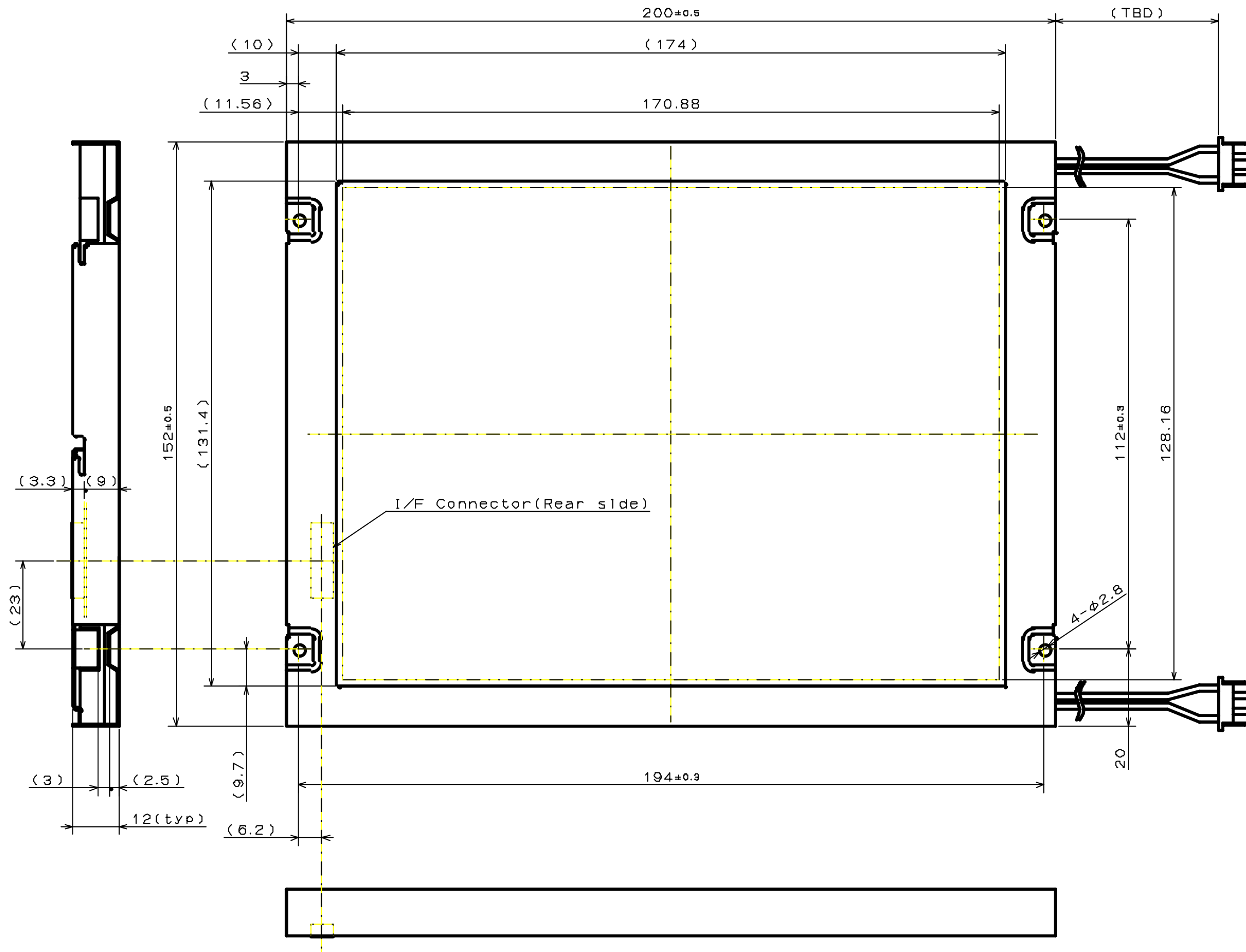
The ambient temperature may affect the optical characteristics of the module.

This module has a 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.




10. OUTLINE DRAWINGS

10.1. FRONT SIDE (Unit in mm)



10.2. REAR SIDE (Unit in mm)

Intentionally Blank

Revision History			DOD-N-0205	23/23
Rev.	Prepared date	Revision Contents and approval	Signature of writer	
1	May 11, 2001	DOD-N-0163	Approved by H.Moriyama Checked by T.Kusanagi Prepared by A.Kumano	
2	June 7, 2001	DOD-N-0205 • Module size TBD → 12.0(D)mm (Typ.) • Outline drawings Front side is all revised.	Approved by H.Moriyama  <hr/> Checked by T.Kusanagi  <hr/> Prepared by A.Kumano  <hr/>	