First Edition
Jun 18, 2003

LCD Module Technical Specification

Final Revision

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Type No. **T-51513D104JU-FW-A-AC**

Approved by (Quality Assurance Division)

Checked by (ACI Engineering Division)

Prepared by (Module Administration Group)

1. OVERVIEW

T-51513D104JU-FW-A-AC is 10.4" color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, and backlight unit.

By applying 6 bit digital data 640 × 480, 260K-color images are displayed on the 10.4" diagonal screen. Input power voltage is single 3.3 / 5.0V for LCD driving. Both 3.3V-CMOS and 5.0V-CMOS level voltage are acceptable for logic input voltage.

Inverter for backlight is not included in this module. General specifications are summarized in the following table:

ITEM	SPECIFICATION
Display Area (mm)	211.2(H) × 158.4 (V) (10.39-inch diagonal)
Number of Dots	640 × 3 (H) × 480 (V)
Pixel Pitch (mm)	0.33 (H) × 0.33 (V)
Color Pixel Arrangement	RGB vertical stripe
Display Mode	normally white
Number of Color	260K
Wide Viewing Angle Technology	Optical compensation film
Optimum Viewing Angle(Contrast ratio)	12 o'clock
Brightness (cd/m^2)	380
Module Size (mm)	243.0 (W) × 181.6 (H) × 12.2 (D)
Module Mass (g)	540
Backlight Unit	CCFL, 2-tubes, edge-light, replaceable
Surface Treatment	Anti-glare and hard-coating 3H

Sign"( )" is preliminary value. Characteristic value without any note is typical value.

The LCD product described in this specification is designed and manufactured for the standard use in OA equipment and consumer products, such as computers, communication equipment, industrial robots, AV equipment and so on.
Do not use the LCD product for the equipment that require the extreme high level of reliability, such as aerospace applications, submarine cables, nuclear power control systems and medical or other equipment for life support.
OPTREX assumes no responsibility for any damage resulting from the use of the LCD product in disregard of the conditions and handling precautions in this specification.
If customers intend to use the LCD product for the above items or other no standard items, please contact our sales persons in advance.

2. ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT
Power Supply Voltage for LCD	VCC	-0.3	6.5	V
Logic Input Voltage	VI	0	6.5	V
Lamp Voltage	VL	0	(2000)	Vrms
Lamp Current	IL	0	(10.0)	mArms
Lamp Frequency	FL	(30)	(80)	kHz
Operation Temperature Note 1,2)	T_{op}	0	(60)	°C
Storage Temperature Note 2)	T_{stg}	-20	(70)	°C

[Note]

1) Display panel surface

2) Top,Tstg ≤ 40°C : 90%RH max. without condensation

Top,Tstg > 40°C : Absolute humidity shall be less than the value of 90%RH at 40°C without condensation

3. ELECTRICAL CHARACTERISTICS

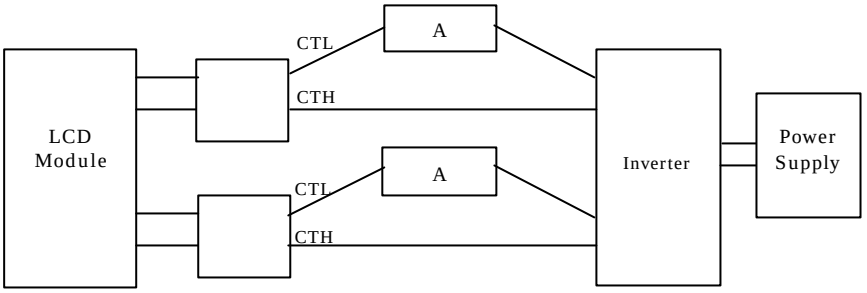
(1) TFT- LCD Ambient Temperature : Ta = 25°C

ITEM		SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
Power Supply Voltage for LCD	3.3V powered	VCC	3.0	3.3	3.6	V	A)
	5.0V powered	VCC	4.75	5.0	5.25	V	A)
Power Supply Current for LCD	3.3V powered	ICC	-	300	400	mA	VCC=3.3V B)
	5.0V powered	ICC	-	200	280	mA	VCC=5.0V B)
Permissive Input Ripple Voltage		VRP	-	-	100	mVp-p	VCC = +3.3V/5.0V
Logic Input Voltage	High	VIH	2.0	-	5.25	V	
	Low	VIL	0	-	0.8	V	

(2) Backlight Ta=25°C

ITEM		SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
Lamp Voltage		VL	--	480	--	Vrms	IL=6.0mArms
Lamp Current		IL	3.0	6.0	7.0	mArms	*1)
Lamp Frequency		FL	40	--	80	kHz	*2),*5)
Starting Lamp Voltage	Ta=25°C	VS	930	--	--	Vrms	
	Ta=0°C		1170	--	--	Vrms	
Lamp Life Time		LT	50000	--	--	h	*3),*4) IL=6.0mArms

*1) Lamp Current measurement method (The current meter is inserted in low voltage line.)



*2) Lamp frequency of inverter may produce interference with horizontal synchronous frequency, and this may cause horizontal beat on the display. Therefore, please adjust lamp frequency, and keep inverter as far from module as possible or use electronic shielding between inverter and module to avoid the interference.

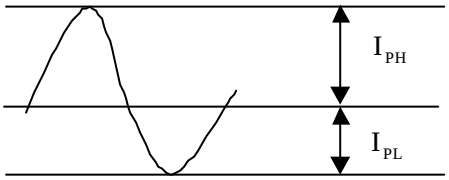
*3) Lamp life time is defined as the time either when the brightness becomes 50% of the initial value, or when the starting lamp voltage does not meet the value specified in this table.

*4) The life time of the backlight depends on the ambient temperature. The life time will decrease under low/high temperature.

*5) Please use the inverter which has symmetrical current wave form as follows,

The degree of unbalance: less than 10%

The ratio of wave height: less than $\sqrt{2} \pm 10\%$



I_{PH}: High side peak

I_{PL}: Low side peak

The degree of unbalance = $|I_{PH} - I_{PL}| / Irms \times 100(\%)$

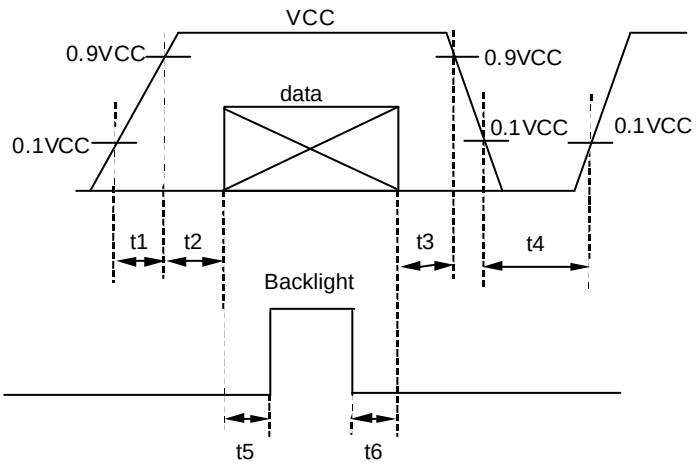
The ratio of wave height = I_{PH}(or I_{PL}) / Irms

CURRENT WAVE FORM

[Note]

A) Power and signals sequence:

t1 ≤ 10 ms	400 ms ≤ t4
0 < t2 ≤ 50 ms	200 ms ≤ t5
0 < t3 ≤ 50 ms	0 ≤ t6



data: RGB DATA, DCLK, HD, VD, DENA

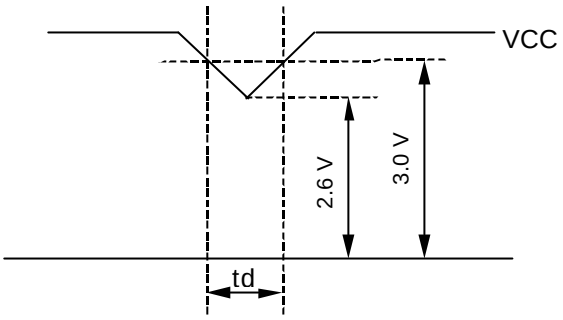
VCC-dip conditions:

(a) 3.3 V powered

1) When 2.6 V ≤ VCC < 3.0 V, td ≤ 10 ms

2) When VCC < 2.6 V

VCC-dip conditions should also follow the power and signals sequence.

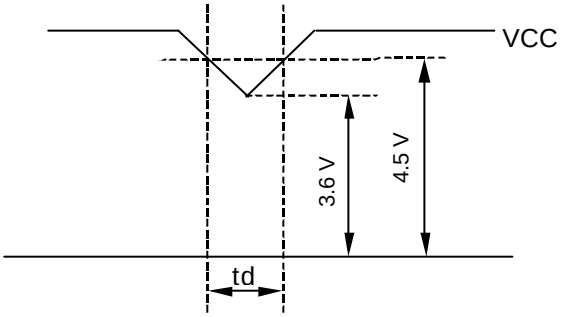


(b) 5.0V powered

1) When 3.6 V ≤ VCC < 4.5 V, td ≤ 10 ms

2) When VCC < 3.6 V

VCC-dip conditions should also follow the power and signals sequence.



B) Typical current condition:

64- gray- bar-pattern

480 line mode

VCC = + 3.3 / 5.0 V, f_H=31.5kHz, f_V=60Hz, f_{CLK}= 25MHz

4. INTERFACE PIN CONNECTION

CN 1(INTERFACE SIGNAL)

Used connector: DF9B-31P-1V(Hirose)

Corresponding connector: DF9-31S-1V(Hirose)

Pin No.	Symbol	Function
1	GND	
2	DCLK	Clock signal for sampling catch data signal
3	HD	Horizontal sync signal
4	VD	Vertical sync signal
5	GND	
6	R0	Red data signal(LSB)
7	R1	Red data signal
8	R2	Red data signal
9	R3	Red data signal
10	R4	Red data signal
11	R5	Red data signal(MSB)
12	GND	
13	G0	Green data signal(LSB)
14	G1	Green data signal
15	G2	Green data signal
16	G3	Green data signal
17	G4	Green data signal
18	G5	Green data signal(MSB)
19	GND	
20	B0	Blue data signal(LSB)
21	B1	Blue data signal
22	B2	Blue data signal
23	B3	Blue data signal
24	B4	Blue data signal
25	B5	Blue data signal(MSB)
26	GND	
27	DENA	Data enable signal(to settle the viewing area)
28	VCC	3.3 / 5.0 V Power Supply
29	VCC	3.3 / 5.0 V Power Supply
30	TEST	This pin should be open. Test signal output for only internal test use.
31	SC	Scan direction Control.(GND or Open:Normal, High:Reverse)

*1) The shielding case is connected with GND

*2) See; Timing Chart(P9)

CN 2 , CN 3 (BACKLIGHT)

Backlight-side connector: BHR-02(8.0)VS-1N(JST)

Inverter-side connector: SM02(8.0)B-BHS(JST)

Pin No.	Symbol	Function
1	CTH	VBLH（High Voltage）
3	CTL	VBLL（Low Voltage）

[Note] VBLH-VBLL=VL

5. INTERFACE TIMING

(1) Timing Specifications

ITEM		SYMBOL	MIN.	TYP.	MAX.	UNIT
DCLK *1) *4)	Frequency	f_{CLK}	--	25	29	MHz
	Period	t_{CLK}	34.5	40	--	ns
	Low Width	t_{WCL}	12	--	--	ns
	High Width	t_{WCH}	12	--	--	ns
DATA *1) (R,G,B,DENA HD, VD)	Set up time	t_{DS}	5	--	--	ns
	Hold time	t_{DH}	5	--	--	ns
DENA *3)	Horizontal Active Time	t_{HA}	640	640	640	t_{CLK}
	Horizontal Front Porch	t_{HFP}	10	16	--	t_{CLK}
	Horizontal Back Porch	t_{HBP}	2	138	--	t_{CLK}
	Vertical Active Time	t_{VA}	480	480	480	t_H
	Vertical Front Porch	t_{VFP}	1	13	--	t_H
	Vertical Back Porch	t_{VBP}	2	33	--	t_H
HD *2)*4)	Frequency	f_H	27	31.5	38	kHz
	Period	t_H	26.3	31.7	37.0	µs
	Low Width	t_{WHL}	5	96	--	t_{CLK}
VD *2)	Frequency	f_V	55	60	70	Hz
	Period	t_V	14.3	16.7	18.2	ms
	Low Width	t_{WVL}	3	--	--	t_H

[Note]

*1) DATA is latched at fall edge of DCLK in this specification.

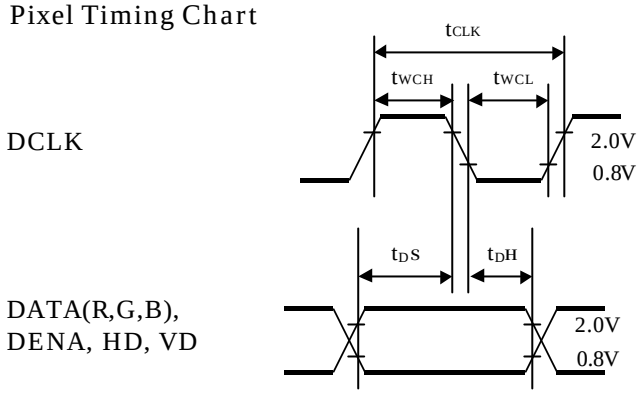
*2) Polarities of HD and VD are negative in this specification.

*3) DENA (Data Enable) should always be positive polarity as shown in the timing specification.

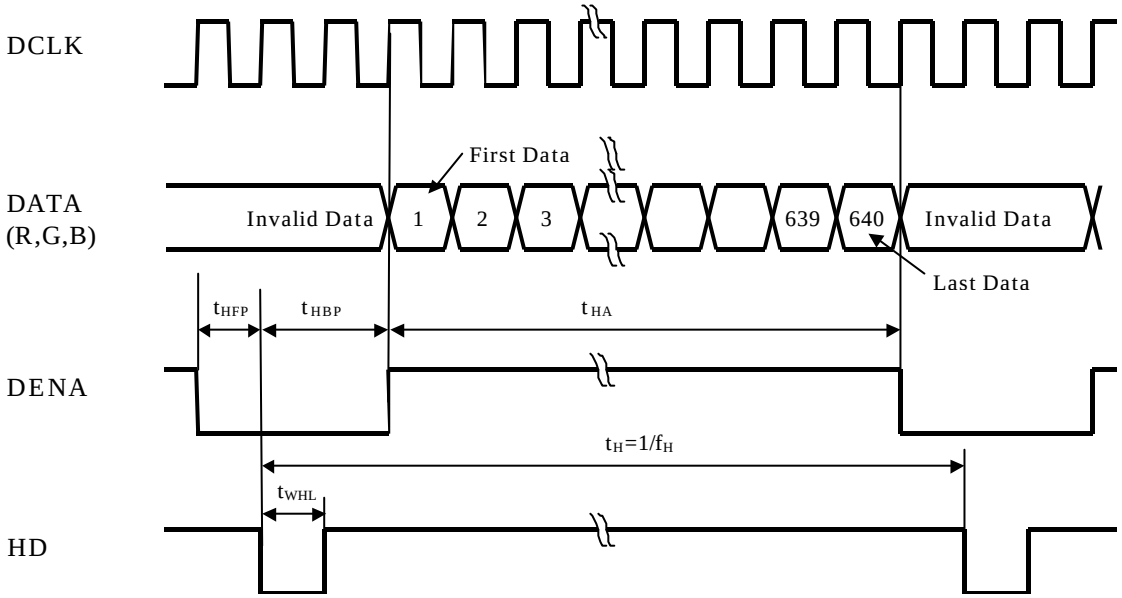
*4) DCLK should appear during all invalid period, and HD should appear during invalid period of frame cycle.

(2) Timing Chart

a. Pixel Timing Chart

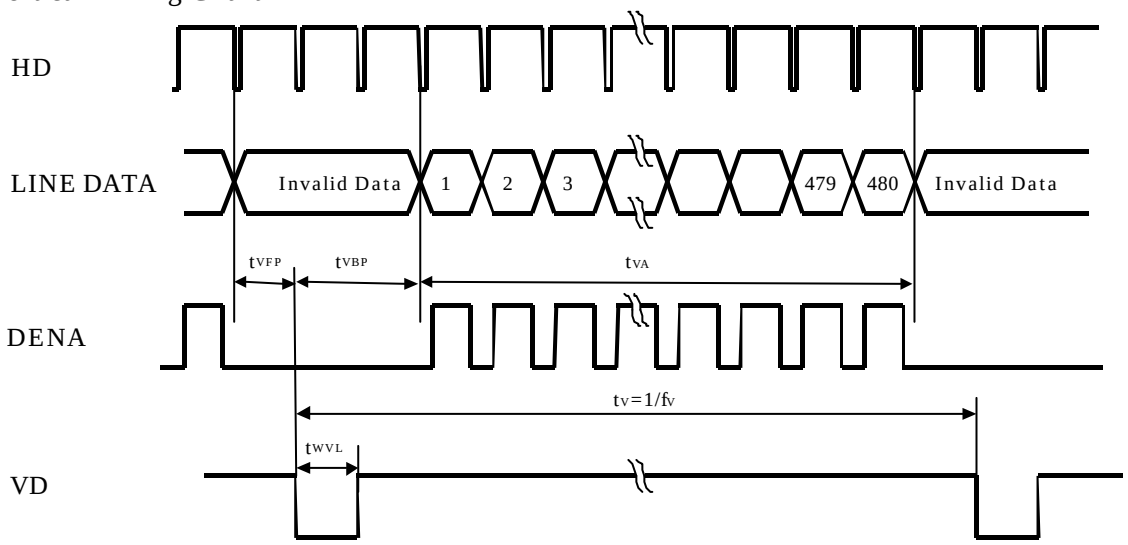


b. Horizontal Timing Chart



(3) Color Data Assignment

c. Vertical Timing Chart



COLOR	INPUT DATA	R DATA						G DATA						B DATA					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
		MSB					LSB	MSB					LSB	MSB					LSB
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	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	RED(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	RED(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	GREEN(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	GREEN(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BLUE(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	BLUE(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

[Note]

1) Definition of gray scale

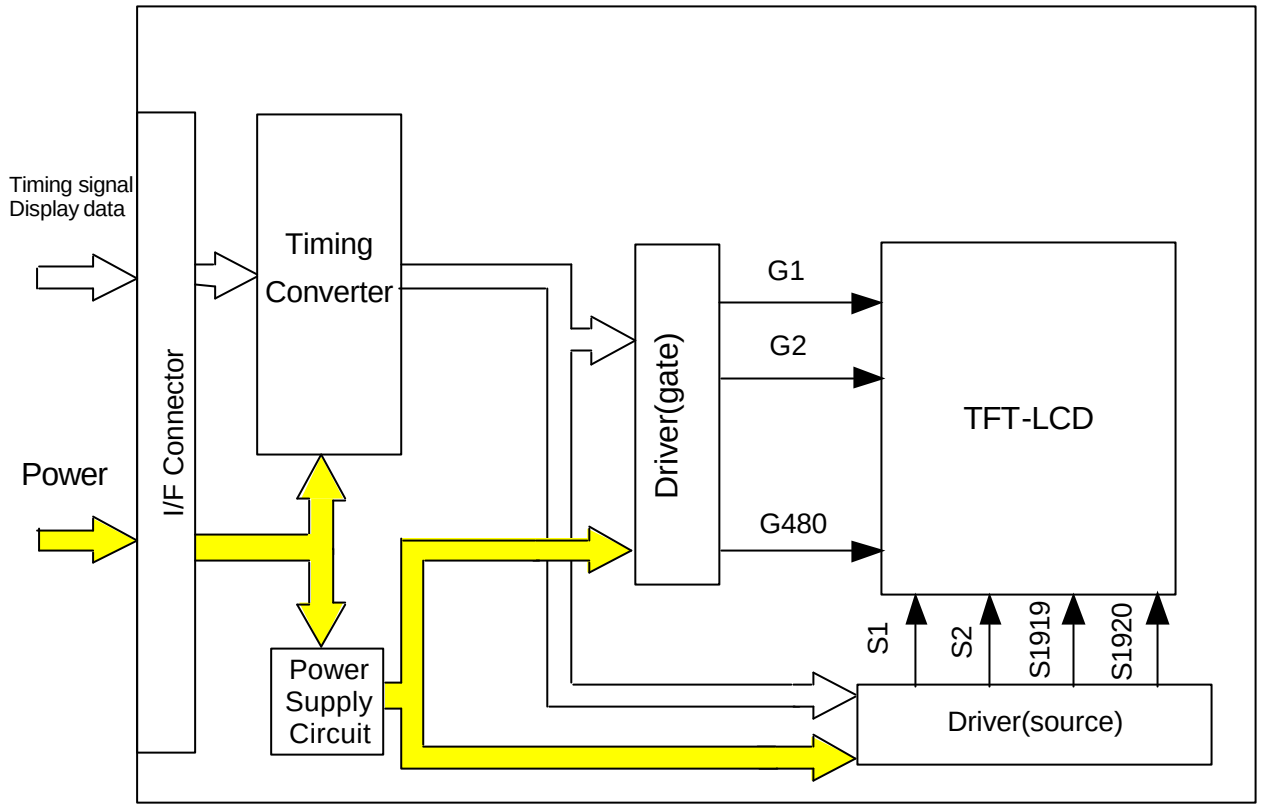
Color (n) --- n indicates gray scale level.

Higher n means brighter level.

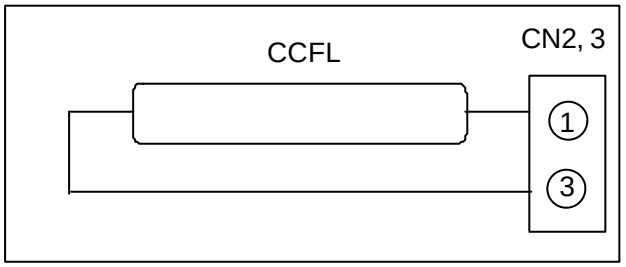
2) Data

1:High, 0: Low

6. BLOCK DIAGRAM

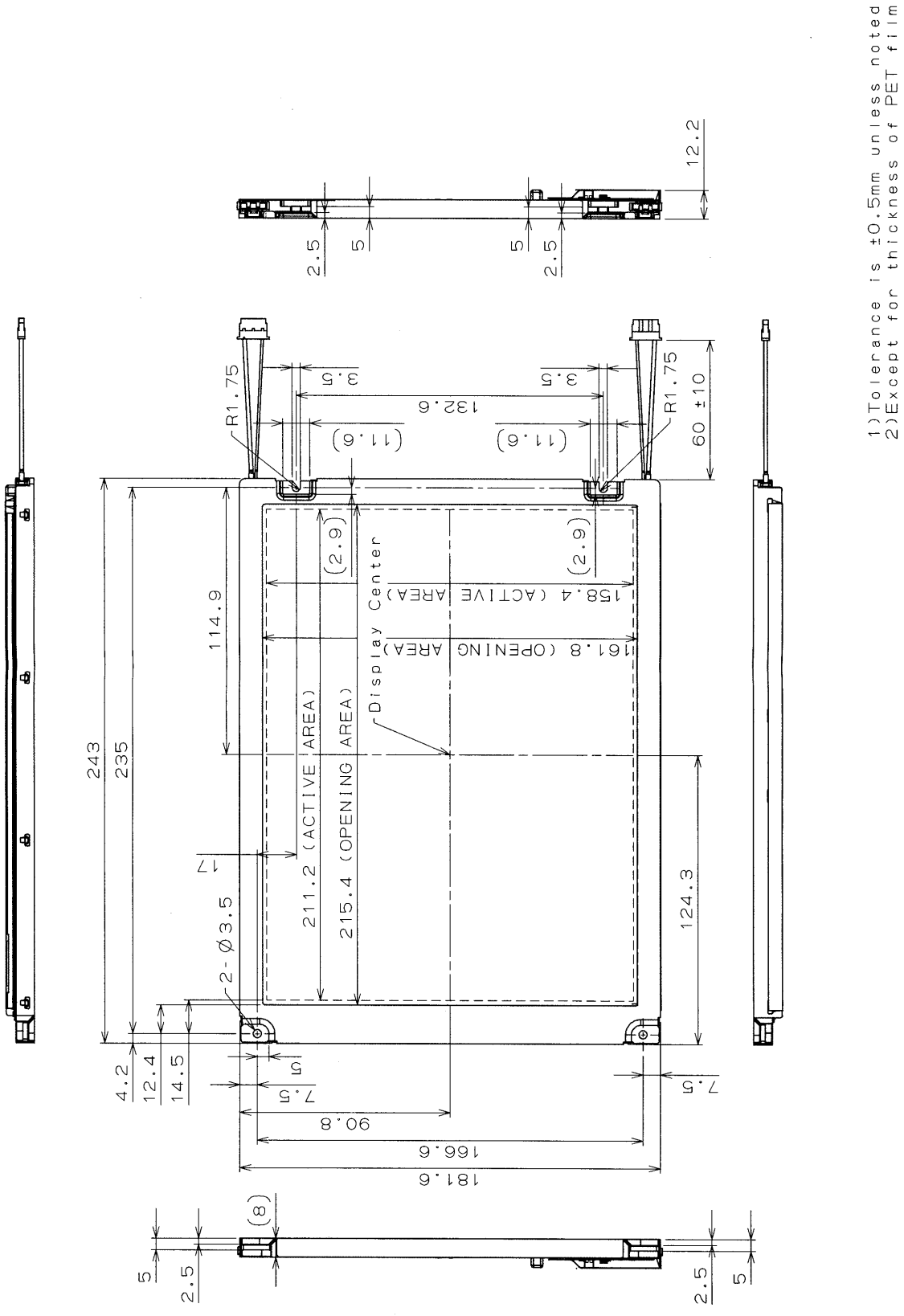


BACKLIGHT



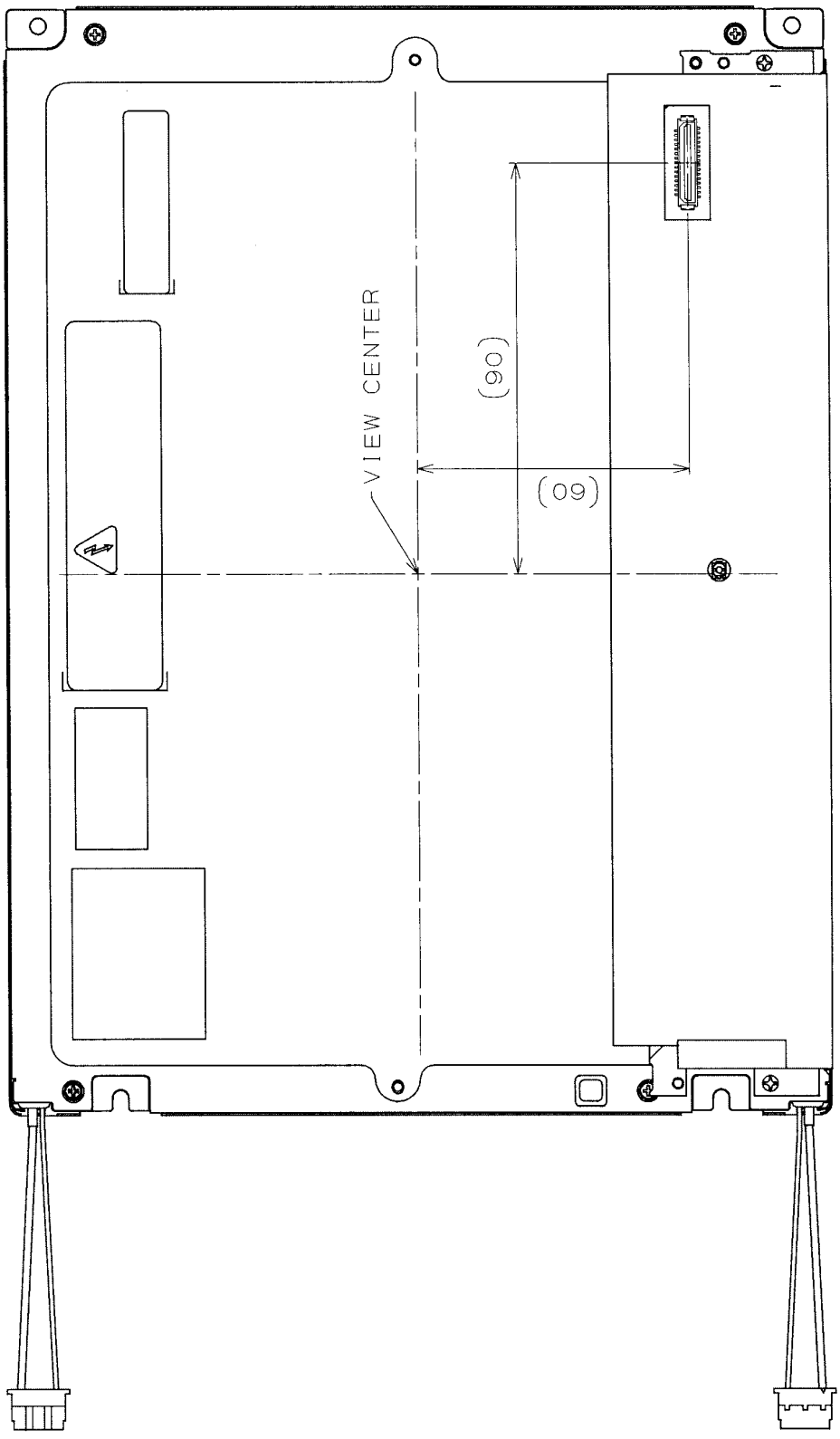
7. MECHANICAL SPECIFICATIONS

(1) Front Side



(Unit:mm)

(2) Rear Side



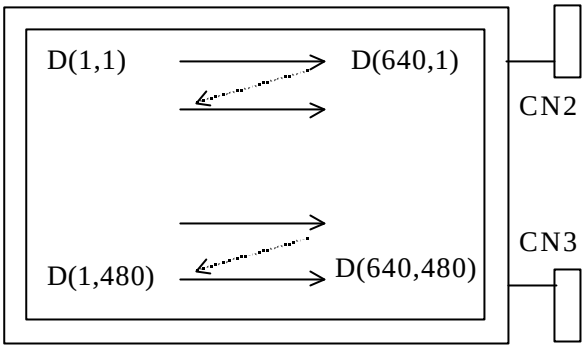
(Unit:mm)
Tolerance is ±0.5mm unless noted
Except for thickness of PET film

[Note]

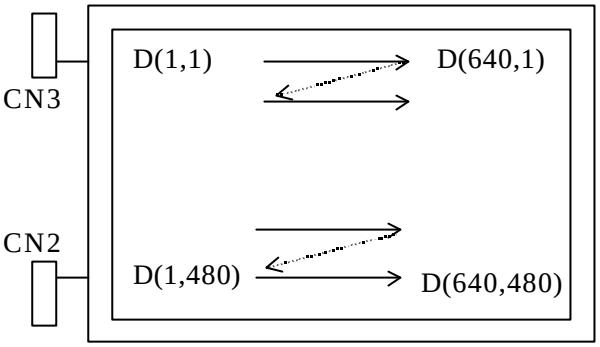
We recommend you referring to the detailed drawing for your design.
Please contact our company sales representative when you need the detailed drawing.

(3) Scanning direction

SC：GND or Open



SC : High



8. OPTICAL CHARACTERISTICS

Ta=25°C, VCC=3.3 / 5.0 V, Input Signals: Typ. Values shown in Section 5

ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	Remarks
Contrast Ratio		CR	θ = ϕ = 0°	350	500	--	--	*1)*3)
Luminance		Lw	θ = ϕ = 0°	300	380	--	cd/m^2	*2)*3)
Response Time		tr	θ = ϕ = 0°	--	10	--	ms	*3)*4)
		tf	θ = ϕ = 0°	--	30	--	ms	*3)*4)
Viewing Angle	Horizontal	ϕ	CR ≥ 10	--	-60~60	--	°	*3)
	Vertical	θ		--	-45~55	--	°	*3)
Image Sticking		tis	2 h	--	--	2	s	*5)
Color Coordinates	Red	Rx	θ = ϕ = 0°	0.555	0.585	0.615	--	*3)
		Ry		0.304	0.334	0.364		
	Green	Gx		0.300	0.330	0.360		
		Gy		0.506	0.536	0.566		
	Blue	Bx		0.138	0.168	0.198		
		By		0.143	0.173	0.203		
	White	Wx		0.300	0.330	0.360		
		Wy		0.312	0.342	0.372		

[Note]

These items are measured using CS1000(MINOLTA) for color coordinates, EZContrast(ELDIM) for viewing angle and CS1000 or BM-5A(TOPCON) for others under the dark room condition (no ambient light) after more than 30 minutes from turning on the lamp unless noted.

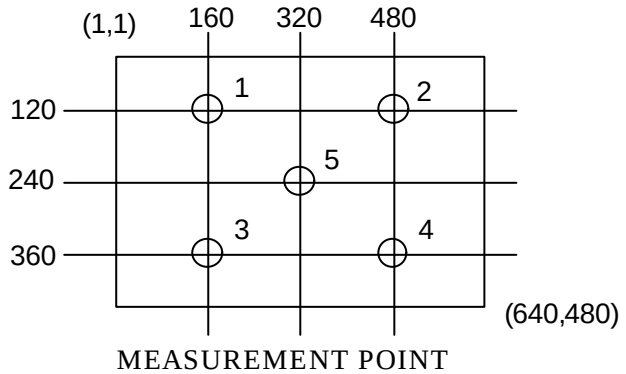
Condition: IL = 6.0 mArms, FL=55kHz

*1) Definition of Contrast Ratio

CR=ON(White) Luminance / OFF(Black) Luminance: average of 5 points shown in a figure below

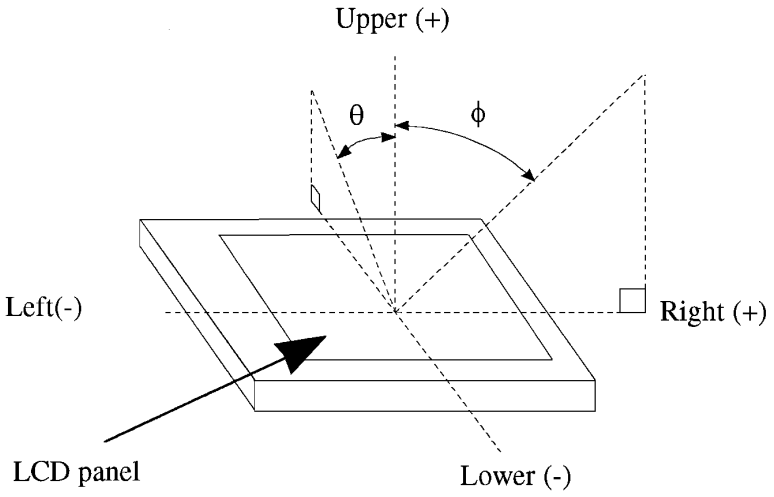
*2) Definition of Luminance

Lw= ON (White) Luminance: average of 5 points shown in a figure below

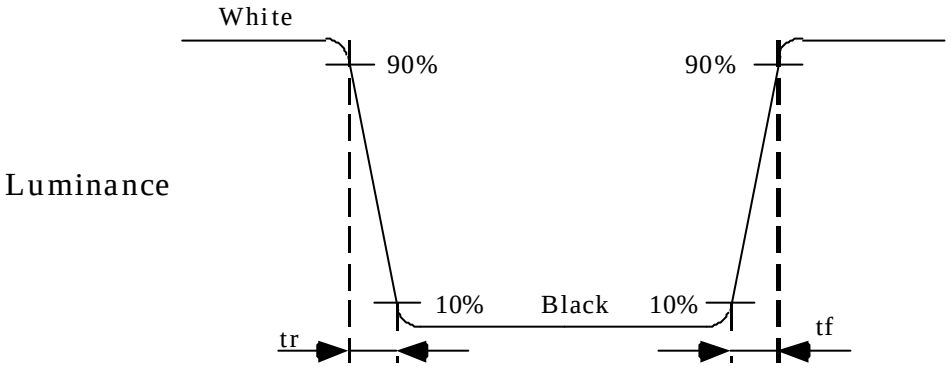


MEASUREMENT POINT

*3) Definition of Viewing Angle(θ , ϕ)



*4) Definition of Response Time



*5) Image Sticking

Continuously display the test pattern shown in the figure below for two-hours. Then display a completely white screen. The previous image shall not persist more than two seconds at 25°C.

TEST PATTERN FOR IMAGE STICKING TEST