

LCD Module Technical Specification

First Edition
Mar 7, 2005

Final Revision

Type No. **T-51512D121J-FW-A-AC**

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1. APPLICATION

This specification applies to color TFT-LCD module, T-51512D121J-FW-A-AC.

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OPTREX classifies the usage of the TFT-LCD module as follows. Please confirm the usage before using the product.

(1) Standard Usage

Computers, office equipment, factory automation equipment, test and measurement equipment, communications, transportation equipment(automobiles, ships, trains, etc.), provided, however, that operation is not influenced by TFT-LCD directly.

(2) Special Usage

Medical equipment, safety equipment, transportation equipment, provided, however, that TFT-LCD is necessary to its operation.

(3) Specific Usage

Cockpit Equipment, military systems, aerospace equipment, nuclear reactor control systems, life support systems and any other equipment. OPTREX should make a contract that stipulate apportionment of responsibilities between OPTREX and our customer.

The product specified in this document is designed for "Standard Usage" unless otherwise specified in this document. If customers intend to use the product for applications other than those specified for "Standard Usage", they should contact OPTREX sales representative in advance.

OPTREX has been making continuous effort to improve the reliability of its products. Customers should implement sufficient reliability design of their application equipments such as redundant system design, fail-safe functions, anti-failure features.

OPTREX assumes no responsibility for any damage resulting from the use of the product that does not comply with the instructions and the precautions specified in this document.

Please contact and consult a OPTREX sales representative for any questions regarding this product.

2. OVERVIEW

T-51512D121J-FW-A-AC 12.1" 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, 800 × 600, 260 K-color images are displayed on the 12.1" diagonal screen. Input power voltage is single 3.3V or 5.0V for LCD driving.

The type of data and control signals are digital and transmitted via CMOS interface per typ. 40MHz clock cycle.

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

ITEM	SPECIFICATION
Display Area (mm)	246.0(H) × 184.5(V) (12.106-inch diagonal)
Number of Dots	800 × 3 (H) × 600 (V)
Pixel Pitch (mm)	0.3075 (H) × 0.3075 (V)
Color Pixel Arrangement	RGB vertical stripe
Display Mode	Normally white TN
Number of Color	260 K
Brightness (cd/m ²)	400
Wide Viewing Angle Technology	Optical compensation Film
Viewing Angle(CR≥10)	-65~65°(H) -75~45°(V)
Surface Treatment	Antireflection and hard-coating 2H
Electrical Interface	CMOS
Optimum Viewing Angle(Contrast ratio)	6 o'clock
Module Size (mm)	280.0 (W) × 210.0 (H) × 12.0 (D)
Module Mass (g)	720
Backlight Unit	CCFL, 2-tubes, edge-light, replaceable

Characteristic value without any note is typical value.

3. ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX	UNIT
Power Supply Voltage for LCD	VCC	0	6.0	V
Logic Input Voltage	VI	-0.3	6.5	V
Lamp Voltage	VL	0	2000	Vrms
Lamp Current	IL	0	18	mArms
Lamp Frequency	FL	--	80	kHz
Operation Temperature(Panel) <small>Note 1,2)</small>	T _{op} (Panel)	-20	70	°C
Operation Temperature(Ambient) <small>Note 2)</small>	T _{op} (Ambient)	-20	70	°C
Storage Temperature <small>Note 2)</small>	T _{stg}	-20	80	°C

[Note]

1) Measured at the center of active area and at the center of panel back 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.

4. ELECTRICAL CHARACTERISTICS

(1) TFT-LCD

Ambient temperature: Ta = 25

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks	
Power Supply Voltage for LCD	3.3V powered	VCC	3.0	3.3	3.6	V	*1)
	5.0V powered	VCC	4.75	5.0	5.25	V	*1)
Power Supply Current for LCD	3.3V powered	ICC	--	340	500	mA	*2)
	5.0V powered	ICC	--	220	340	mA	*2)
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	

*1) Power and signals sequence:

$$t1 \leq 10 \text{ ms}$$

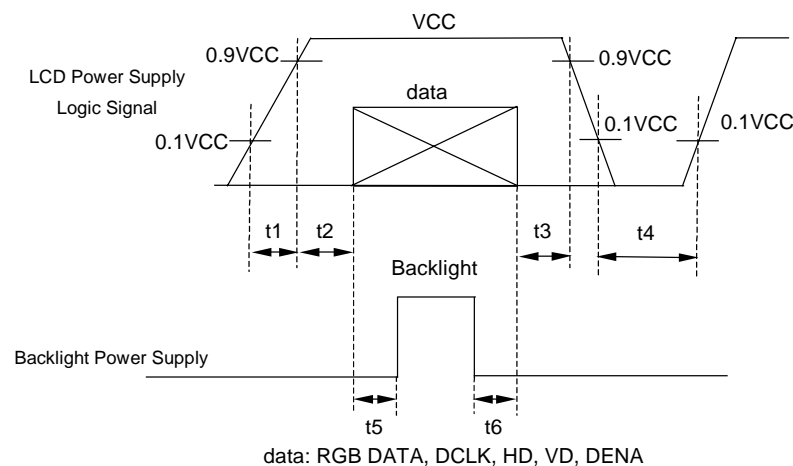
$$400 \text{ ms} \leq t4$$

$$0 < t2 \leq 50 \text{ ms}$$

$$200 \text{ ms} \leq t5$$

$$0 < t3 \leq 50 \text{ ms}$$

$$0 \leq t6$$

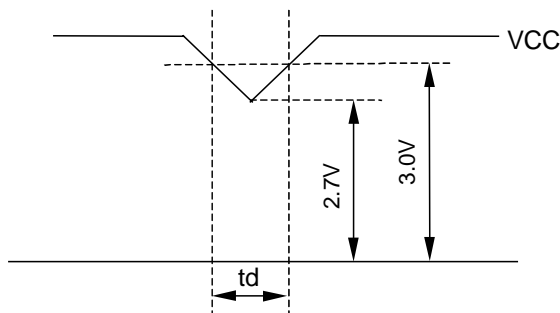


VCC-dip conditions:

(a) 3.3 V powered

- 1) When $2.7\text{ V} \leq VCC < 3.0\text{ V}$, $t_d \leq 10\text{ ms}$
- 2) When $VCC < 2.7\text{ V}$

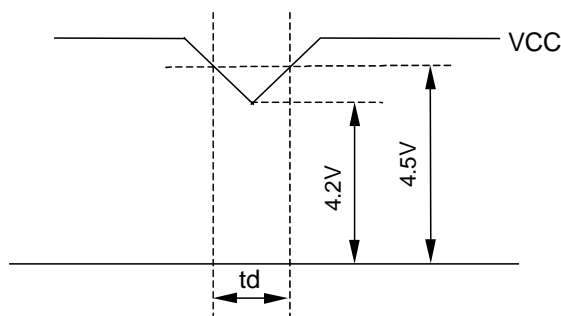
VCC-dip conditions should also follow the power and signals sequence.



(b) 5.0V powered

- 1) When $4.2\text{ V} \leq VCC < 4.5\text{ V}$, $t_d \leq 10\text{ ms}$
- 2) When $VCC < 4.2\text{ V}$

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



B) Typical current condition:

64-gray-bar pattern

600 line mode

$VCC = +3.3\text{ V} / 5.0\text{ V}$, $f_H=37.9\text{kHz}$, $f_V=60.3\text{Hz}$, $f_{CLK}= 40\text{MHz}$

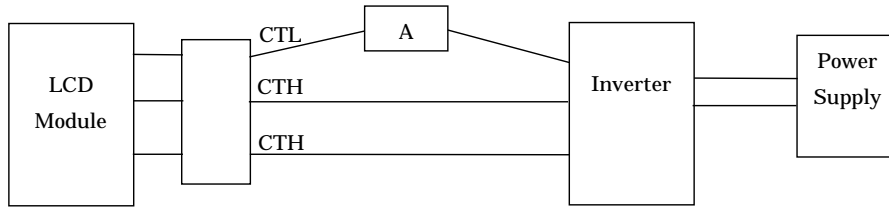
(2) Backlight

$T_a = 25$

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
Lamp Voltage	VL	--	540	--	Vrms	IL = 12.0 mArms
Lamp Current	IL	6.0	12.0	13.0	mArms	*1), *5)
Lamp Frequency	FL	30	--	60	kHz	*2)
Starting Lamp Voltage	VS	1000	--	--	Vrms	$T_a = 25^\circ\text{C}$
		1200	--	--		$T_a = 0^\circ\text{C}$
		1290	--	--		$T_a = -20^\circ\text{C}$
Lamp Life Time	LT	50,000	--	--	h	*3),*4)IL = 12.0 mArms, Continuous operation

[Note]

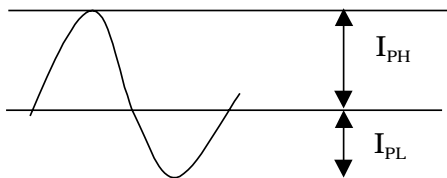
1) Lamp Current measurement method (The current meter is inserted in low voltage line.)



- 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

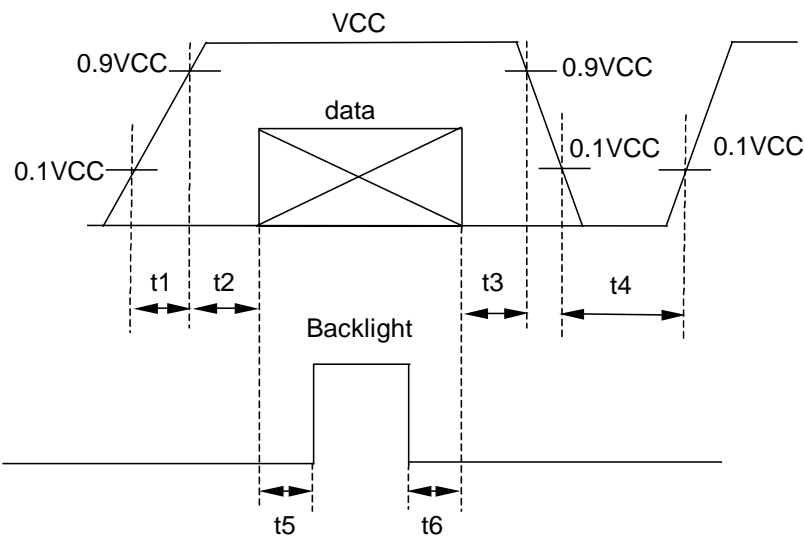
I_{PL} : Low side peak

The degree of unbalance = $|I_{PH} - I_{PL}| / I_{rms} \times 100(\%)$
 The ratio of wave height = $I_{PH}(\text{or } I_{PL}) / I_{rms}$

CURRENT WAVE FORM

A) Power and signals sequence:

- $t1 \leq 10 \text{ ms}$ $400 \text{ ms} \leq t4$
- $0 < t2 \leq 50 \text{ ms}$ $200 \text{ ms} \leq t5$
- $0 < t3 \leq 50 \text{ ms}$ $0 \leq t6$



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

5. INTERFACE PIN CONNECTION

CN 1(INTERFACE SIGNAL)

Used connector: DF9B-41P-1V(Hirose)

Corresponding connector: DF9B-41S-1V(Hirose)

Pin No.	Symbol	Function
1	GND	Signal ground
2	DCLK	Clock signal for sampling catch data signal
3	GND	Signal ground
4	HD	Horizontal sync signal
5	VD	Vertical sync signal
6	GND	Signal ground
7	GND	Signal ground
8	GND	Signal ground
9	R0	RED data signal(LSB)
10	R1	RED data signal
11	R2	RED data signal
12	GND	Signal ground
13	R3	RED data signal
14	R4	RED data signal
15	R5	RED data signal(MSB)
16	GND	Signal ground
17	GND	Signal ground
18	GND	Signal ground
19	G0	GREEN data signal(LSB)
20	G1	GREEN data signal
21	G2	GREEN data signal
22	GND	Signal ground
23	G3	GREEN data signal
24	G4	GREEN data signal
25	G5	GREEN data signal(MSB)
26	GND	Signal ground
27	GND	Signal ground
28	GND	Signal ground
29	B0	BLUE data signal (LSB)
30	B1	Blue data signal
31	B2	BLUE data signal
32	GND	Signal ground
33	B3	BLUE data signal
34	B4	BLUE data signal
35	B5	BLUE data signal(MSB)
36	GND	Signal ground
37	DENA	Data enable signal(to settle the viewing area)
38	NC	
39	VCC	+3.3 / 5.0 V Power supply
40	VCC	+3.3 / 5.0 V Power supply
41	SC	Scan direction control.(Low or Open:Normal, High:Reverse)

*)The shielding case is connected with GND.

CN 2(BACKLIGHT)

Backlight-side connector: BHR-04VS-1 (JST)

Inverter-side connector: SM04(4.0)B-BHS-1(JST)

Pin No.	Symbol	Function
1, 2	CTH	VBLH (High voltage)
4	CTL	VBLL (Low voltage)

[Note]VBLH - VBLL = VL

6. INTERFACE TIMING

(1) Timing Specifications

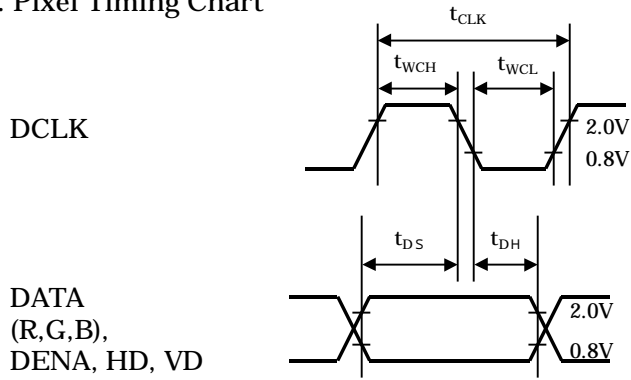
ITEM		SYMBOL	MIN	TYP	MAX	UNIT
DCLK	Frequency	f _{CLK}	35	--	40	MHz
	Period	t _{CLK}	25	--	28.6	ns
	Low Width	t _{WCL}	10	--	--	ns
	High Width	t _{WCH}	10	--	--	ns
DATA (R,G,B,DENA, HD, VD)	Set up time	t _{DS}	4	--	--	ns
	Hold time	t _{DH}	4	--	--	ns
DENA	Horizontal Active Time	t _{HA}	800	800	800	t _{CLK}
	Horizontal Front Porch	t _{HFP}	0	--	--	t _{CLK}
	Horizontal Back Porch	t _{HBP}	10	--	--	t _{CLK}
	Vertical Active Time	t _{VA}	600	600	600	t _H
	Vertical Front Porch	t _{VFP}	1	--	--	t _H
	Vertical Back Porch	t _{VBP}	2	--	--	t _H
HD	Frequency	f _H	35.2	37.9	39.2	kHz
	Period	t _H	25.5	26.4	28.4	μs
	Low Width	t _{WHL}	5	--	--	t _{CLK}
VD	Frequency	f _V	55	60.3	64.2	Hz
	Period	t _V	15.6	16.6	18.2	ms
	Low Width	t _{WVL}	1	--	--	t _H

[Note]

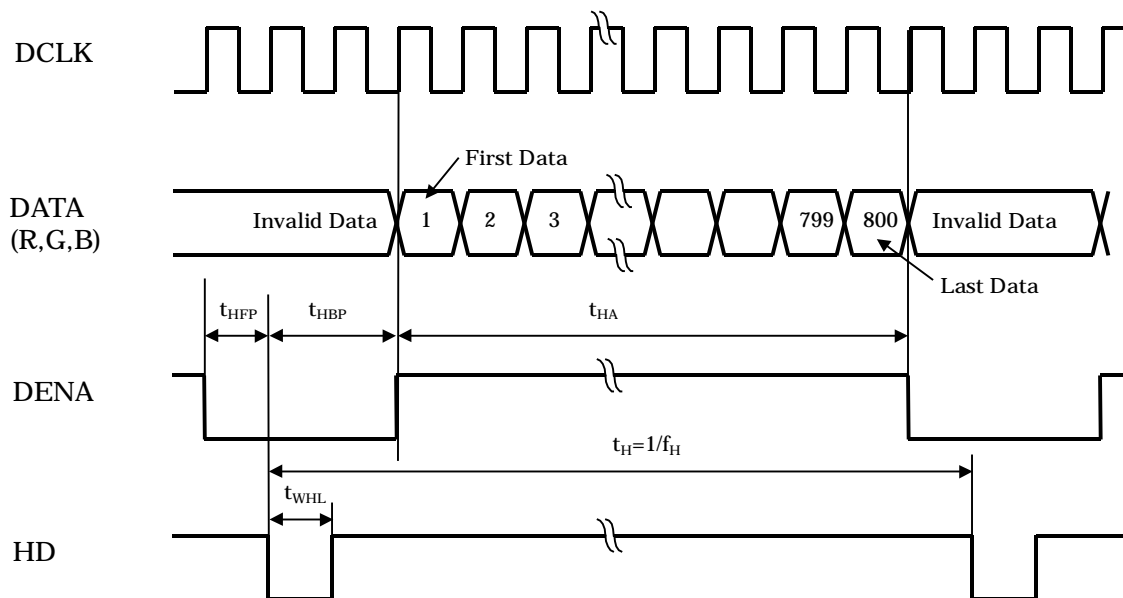
- 1) DATA is latched at fall edge of DCLK in this specification.
- 2) Polarities of HD and VD are negative in this specification.
- 3) DENA (Data Enable) should always be positive polarity as shown in the timing specification.
- 4) DCLK should appear during all invalid period, and HD should appear during invalid period of frame cycle.
- 5) t_{HFP} + t_{HBP} ≥ 20 t_{CLK}

(2) Timing Chart

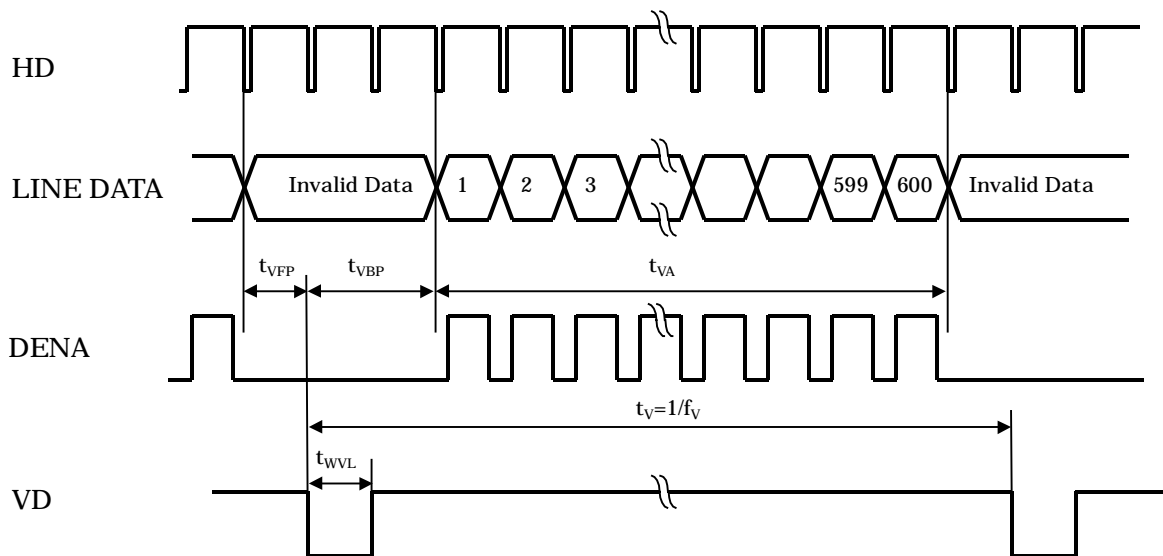
a. Pixel Timing Chart



b. Horizontal Timing Chart



c. Vertical Timing Chart



(3) Color Data Assignment

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(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(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(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

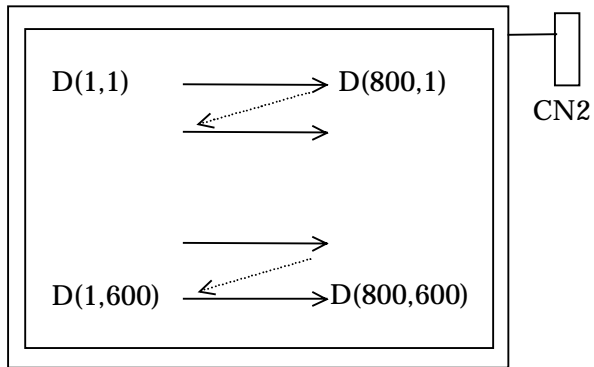
[Note]

- 1) Definition of gray scale
 Color (n) --- n indicates gray scale level.
 Higher n means brighter level.
- 2) Data
 1:High, 0: Low

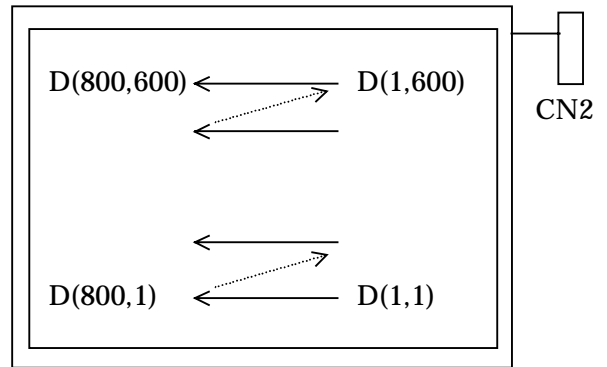
(4) Display Position and Scan Direction

D(X,Y) shows the data number of input signal for LCD panel signal processing PCB.

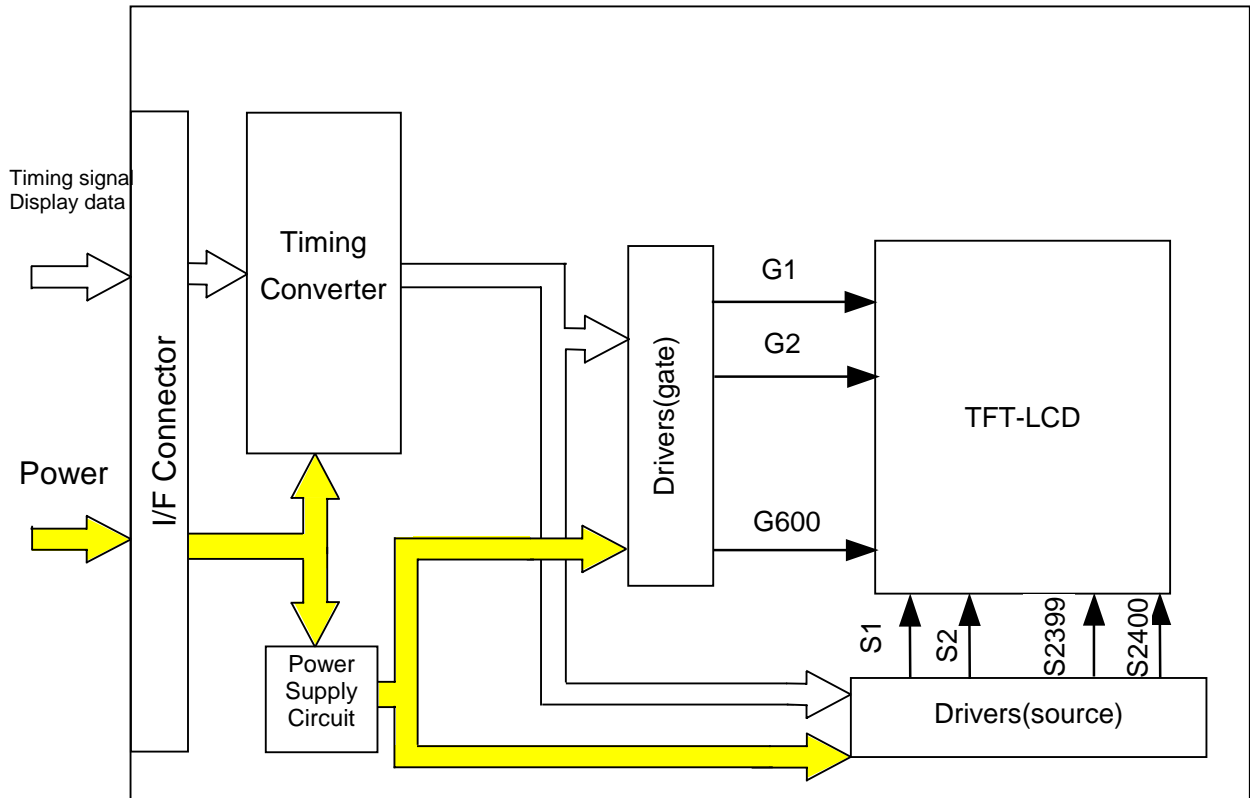
SC:Low or Open



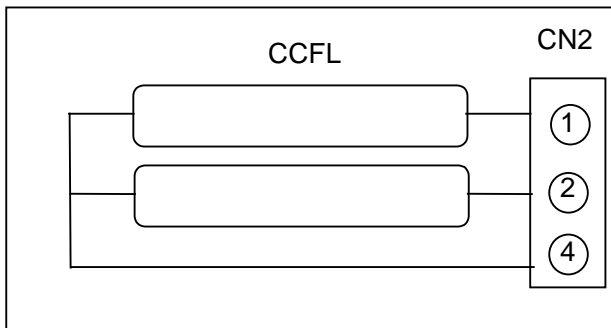
SC:High



7. BLOCK DIAGRAM

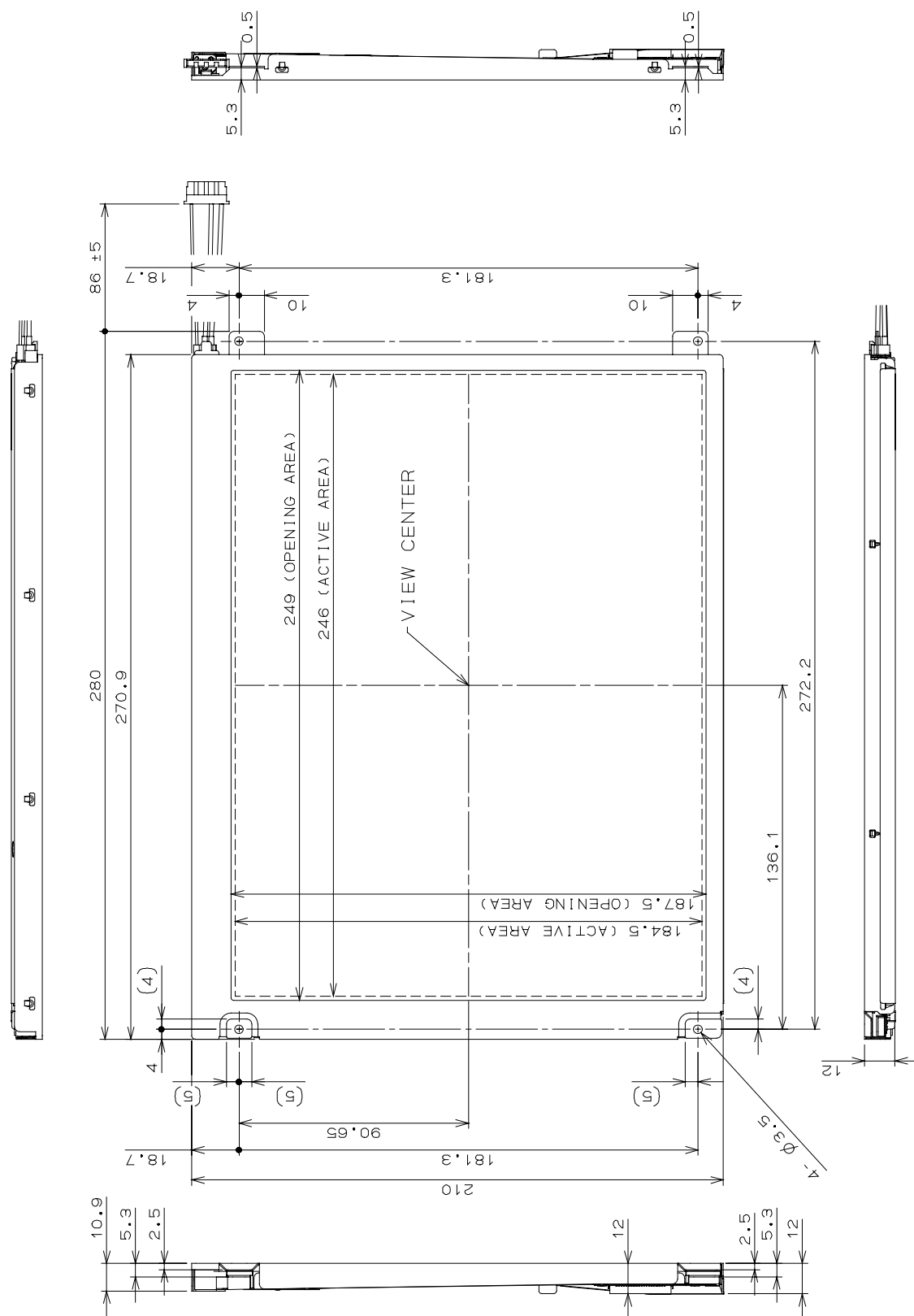


BACKLIGHT



8. MECHANICAL SPECIFICATIONS

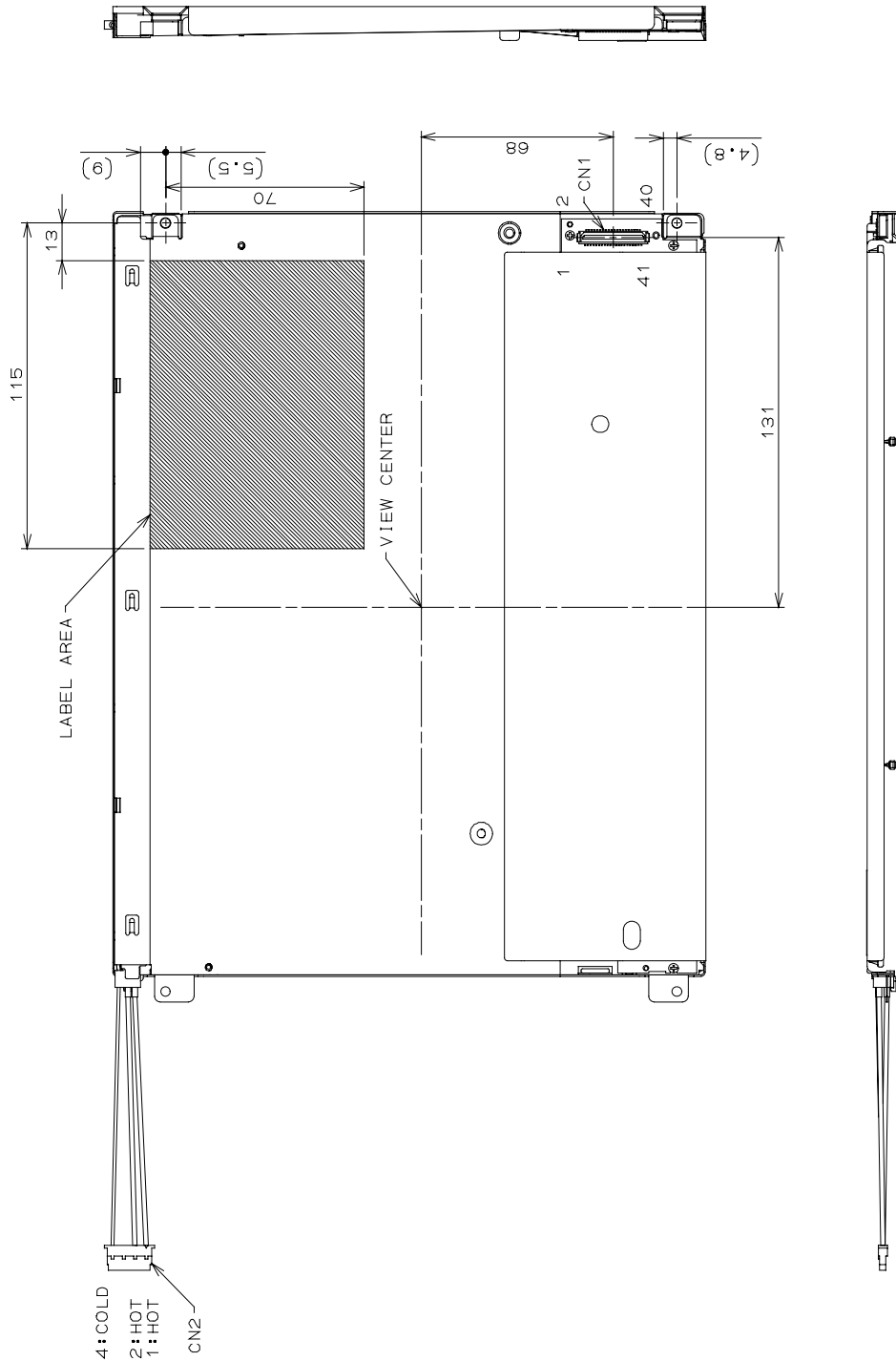
(1) Front Side



UNDEFINED TOLERANCES TO BE $\pm 0.5\text{mm}$.
EXCEPT FOR THICKNESS OF PET FILM.

(Unit: mm)

(2) Rear Side



UNDEFINED TOLERANCES TO BE $\pm 0.5\text{mm}$.
EXCEPT FOR THICKNESS OF PET FILM.

CN1:DF9B-41P-1V(HIROSE)
CN2:BHR-04VS-1(JST)

(Unit:mm)

[Note]

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

9. OPTICAL CHARACTERISTICS

Ta=25°C, VCC=3.3V / 5.0V, Input Signals: Typ. Values shown in Section 6

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT	Remarks	
Contrast Ratio	CR	$\theta = \phi = 0^\circ$	350	500	--	--	*1)*2)*6)	
Luminance	Lw	$\theta = \phi = 0^\circ$	250	400	--	cd/m ²	*1)*3)*6)	
Luminance Uniformity	ΔLw	$\theta = \phi = 0^\circ$	--	--	30	%	*1)*4)*6)	
Response Time	tr	$\theta = \phi = 0^\circ$	--	10	--	ms	*1)*5)*6)	
	tf	$\theta = \phi = 0^\circ$	--	30	--	ms	*1)*5)*6)	
Viewing Angle	Horizontal	ϕ	CR ≥ 10	-50~50	-65~65	--	°	*1)*6)
	Vertical			θ	-40~30	-75~45	--	°
	Horizontal	ϕ	CR ≥ 5	-65~65	-80~80	--	°	*1)*6)
				Vertical	θ	-50~40	-80~55	--
Image sticking	tis	2 h	--	--	2	s	*7)	
Color Coordinates	Red	Rx	$\theta = \phi = 0^\circ$	0.556	0.586	0.616	--	*1)*6)
		Ry		0.310	0.340	0.370		
	Green	Gx		0.300	0.330	0.360		
		Gy		0.525	0.555	0.585		
	Blue	Bx		0.138	0.168	0.198		
		By		0.167	0.197	0.227		
	White	Wx		0.302	0.332	0.362		
		Wy		0.337	0.367	0.397		

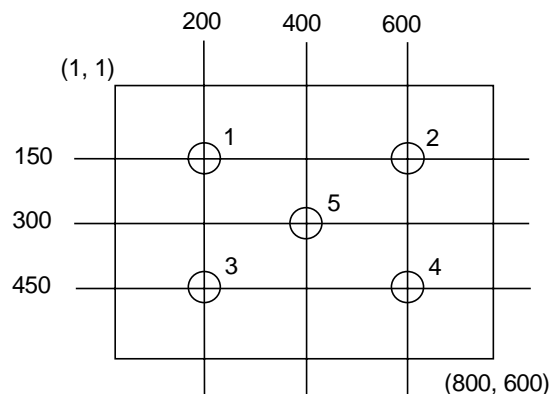
[Note]

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 = 12.0 mArms, FL=55kHz

*1) Measurement Point

Contrast Ratio, Luminance, Response Time, Viewing Angle, Color Coordinates: Display Center
Luminance Uniformity: point 1~5 shown in a figure below



*2) Definition of Contrast Ratio

CR=ON (White) Luminance / OFF(Black) Luminance

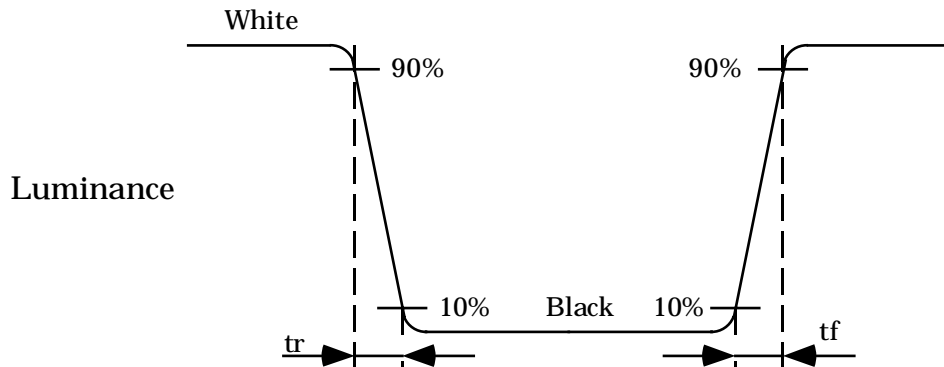
*3) Definition of Luminance

Lw= ON (White) Luminance

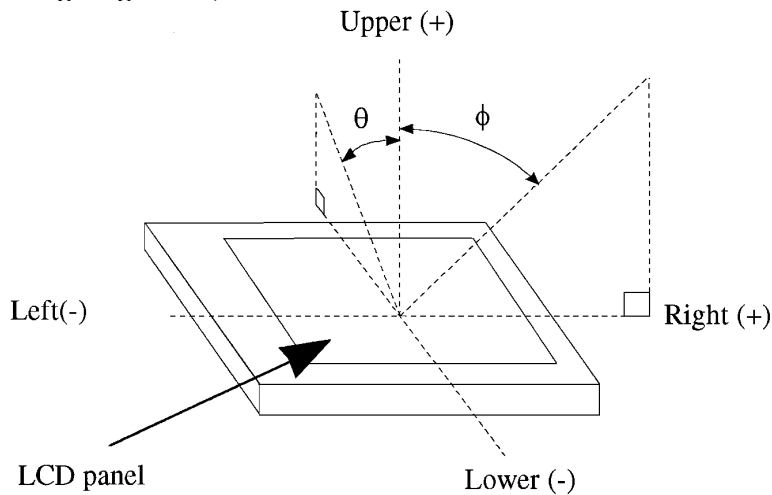
*4) Definition of Luminance Uniformity

$$\Delta L_w = [L_w(\text{MAX})/L_w(\text{MIN}) - 1] \times 100$$

*5) Definition of Response Time



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

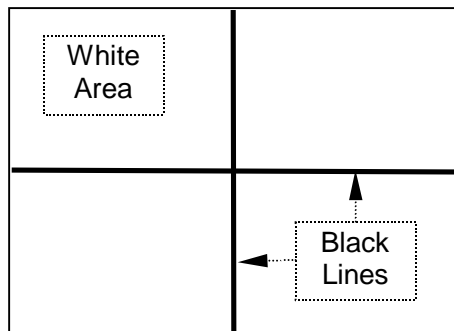


*7) Image sticking:

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.

Cols 398-402

Rows 298-302



TEST PATTERN FOR IMAGE STICKING TEST

10. RELIABILITY TEST CONDITION

(1) Temperature and Humidity

TEST ITEM	CONDITIONS
HIGH TEMPERATURE HIGH HUMIDITY OPERATION	40°C, 90%RH, 240 h (No condensation)
HIGH TEMPERATURE STORAGE	80°C, 240h
LOW TEMPERATURE STORAGE	-20°C, 240 h
THERMAL SHOCK	BETWEEN -20°C (1h) and 80°C(1h), 100 CYCLES

(2) Shock & Vibration

ITEM	CONDITIONS
SHOCK (NON-OPERATION)	Shock level: 1470m/s ² (150G) Waveform: half sinusoidal wave, 2ms Number of shocks: one shock input in each direction of three mutually perpendicular axes for a total of six shock inputs
VIBRATION (NON-OPERATION)	Vibration level: 9.8m/s ² (1.0G) Waveform: sinusoidal Frequency range: 5 to 500Hz Frequency sweep rate: 0.5 octave /min Duration: one sweep from 5 to 500 Hz in each of three mutually perpendicular axis(each x,y,z axis: 1 hour, total 3 hours)

(3) Judgment standard

The judgment of the above tests should be made as follow:

Pass: Normal display image, no damage of the display function. (ex. no line defect)

Partial transformation of the module parts should be ignored.

Fail: No display image, damage of the display function. (ex. line defect)