First Edition
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Final Revision
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LCD Module Technical Specification

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

Approved by (Quality Assurance Division)

Checked by (ACI Engineering Division)

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1. APPLICATION

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

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(1) Standard Usage

Computers, office equipment, factory automation equipment, test and measurement equipment, communications

(2) Special Usage

Transportation equipment(automobiles, ships, trains, etc.), medical equipment, safety equipment

(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.

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2. OVERVIEW

T-51512D121J-FW-A-AC is 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. Both 3.3 V-CMOS and 5.0 V-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)	246.0 × 184.5 (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
Number of Color	260 K
Optimum Viewing Angle(Contrast ratio)	6 o'clock
Brightness (cd/m^2)	400
Module Size (mm)	280.0 (W) × 210.0 (H) × 12.0 (D)
Module Mass (g)	720
Backlight Unit	CCFL, 2-tubes, edge-light, replaceable
Surface Treatment	Antireflection and hard-coating 2H

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	6.5	V
Lamp Voltage	VL	0	2000	Vrms
Lamp Current	IL	0	18	mArms
Lamp Frequency	FL	--	80	kHz
Operation Temperature(Panel) Note 1,2)	$T_{op(Panel)}$	0	60	°C
Operation Temperature(Ambient) Note 2)	$T_{op(Ambient)}$	0	60	°C
Storage Temperature Note 2)	T_{stg}	-20	70	°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	A)
	5.0V powered	VCC	4.75	5.0	5.25	V	A)
Power Supply Current for LCD	3.3V powered	ICC	--	340	500	mA	VCC = 3.3 V B)
	5.0V powered	ICC	--	220	340	mA	VCC = 5.0 V 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	

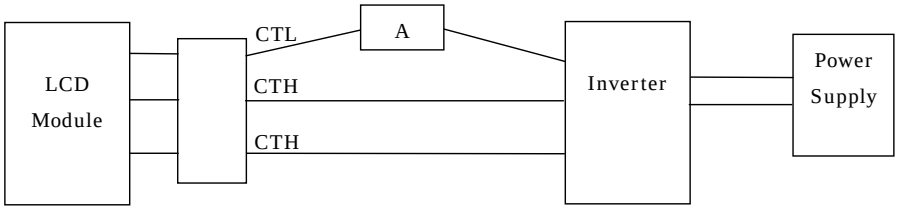
(2) Backlight

Ta = 25℃

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	Note 1), 5)
Lamp Frequency	FL	30	--	60	kHz	Note 2)
Starting Lamp Voltage	VS	1000	--	--	Vrms	Ta = 25°C Note 3)
		1200	--	--		Ta = 0°C Note 3)
Lamp Life Time	LT	50,000	--	--	h	IL = 12.0 mArms, Continuous operation Note 3),4)

[Note]

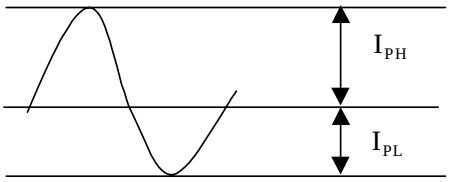
1) Lamp Current measurement method (The current meter is inserted in low voltage line.)



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 $\sqrt{2}$ ±10%



I_{PH}: High side peak

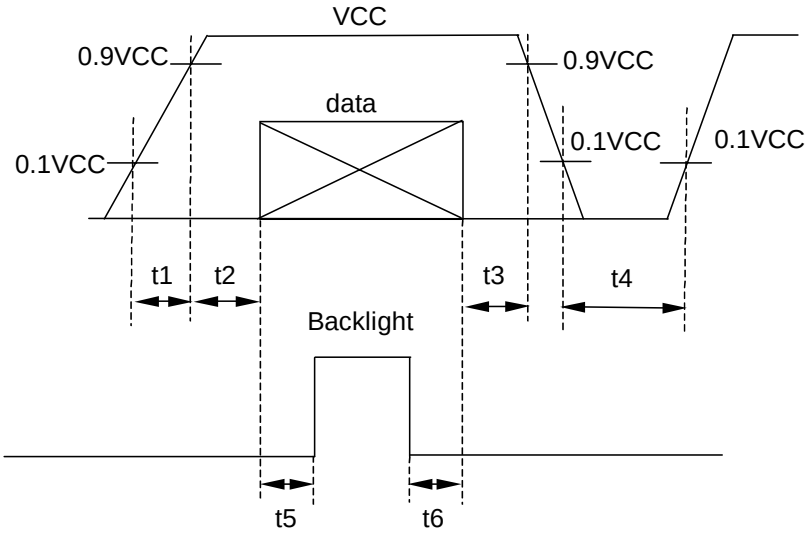
I_{PL}: Low side peak

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

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

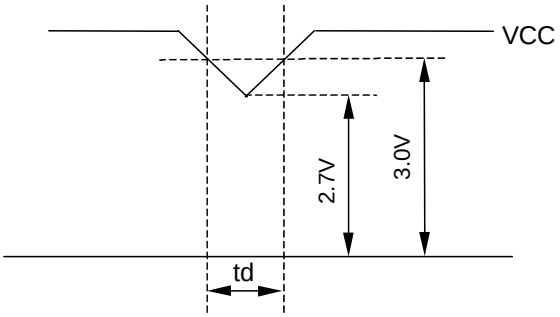
VCC-dip conditions:

(a) 3.3 V powered

1) When 2.7 V ≤ VCC < 3.0 V, td ≤ 10 ms

2) When VCC < 2.7 V

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

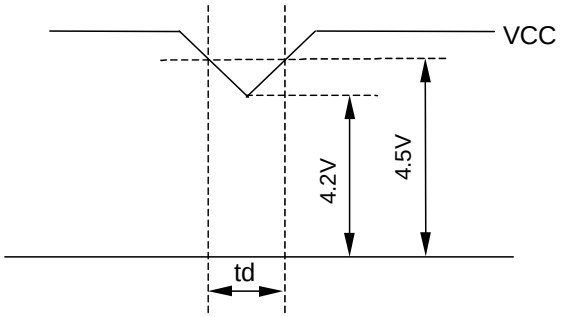


(b) 5.0V powered

1) When 4.2 V ≤ VCC < 4.5 V, td ≤ 10 ms

2) When VCC < 4.2 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 V / 5.0 V, f_H=37.9kHz, f_V=60.3Hz, f_{CLK}= 40MHz

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.(GND 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)

VBLH - VBLL = VL

6. INTERFACE TIMING

(1) Timing Specifications

VCC = 3.3/5.0 V, Ta = 25℃

ITEM		SYMBOL	MIN	TYP	MAX	UNIT
DCLK *1,4)	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 *1) (R,G,B,DENA, HD, VD)	Set up time	t_{DS}	4	--	--	ns
	Hold time	t_{DH}	4	--	--	ns
DENA*3)	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*2,4)	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*2)	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.

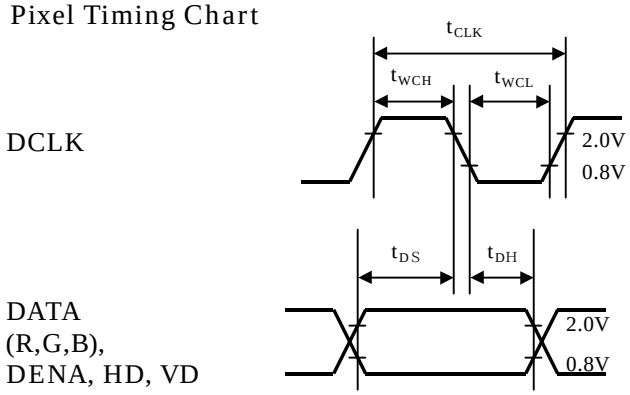
*2) Polarities of HD and VD are negative in this specification.

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

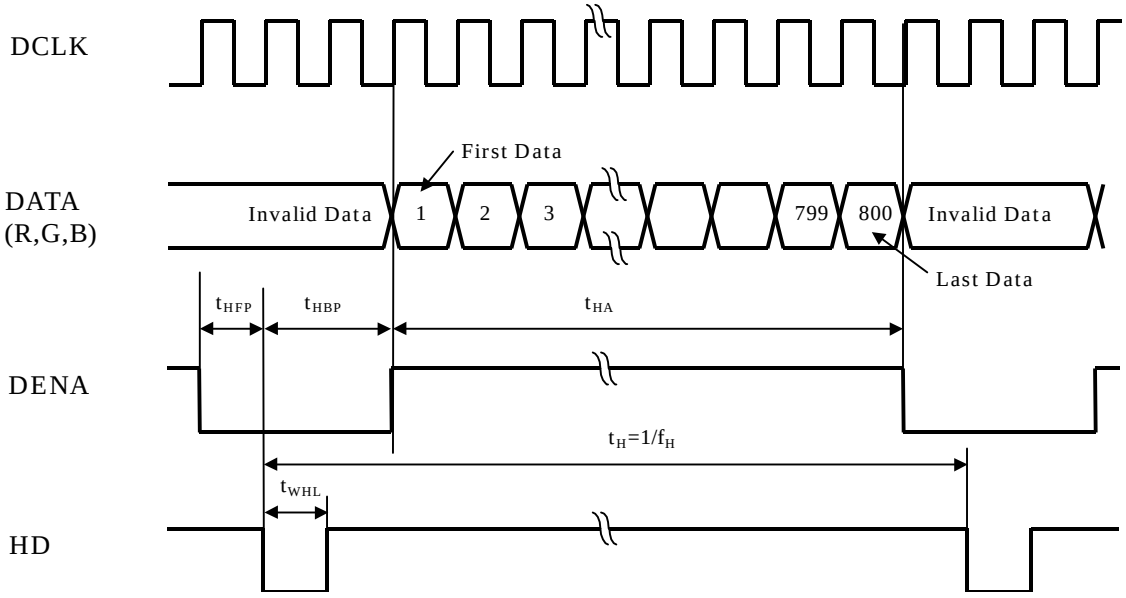
*4) DCLK should appear during all invalid period, and HD should appear during invalid period of frame cycle.

(2) Timing Chart

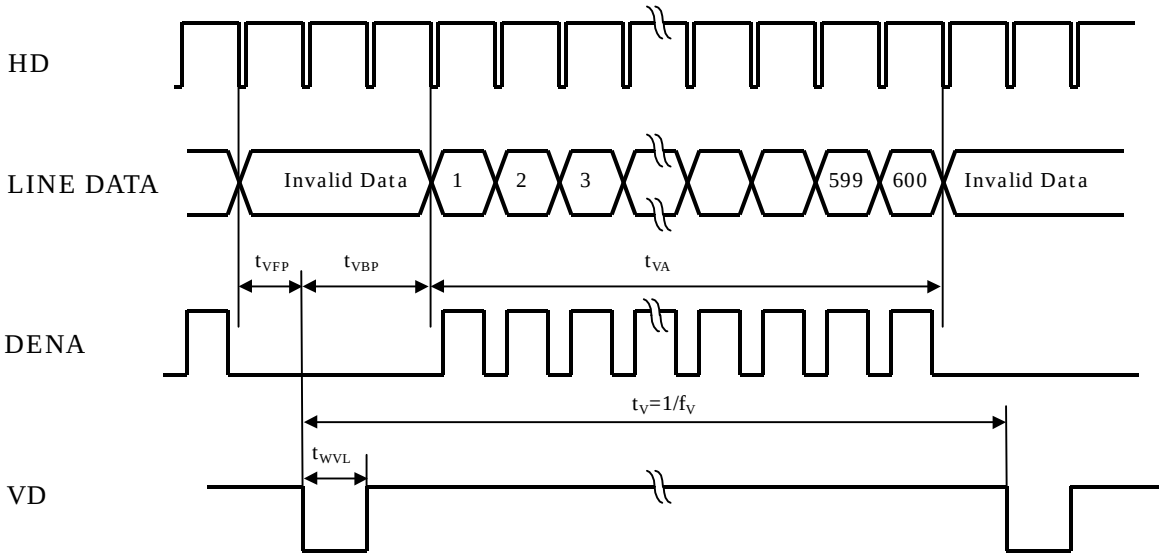
a. Pixel Timing Chart



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

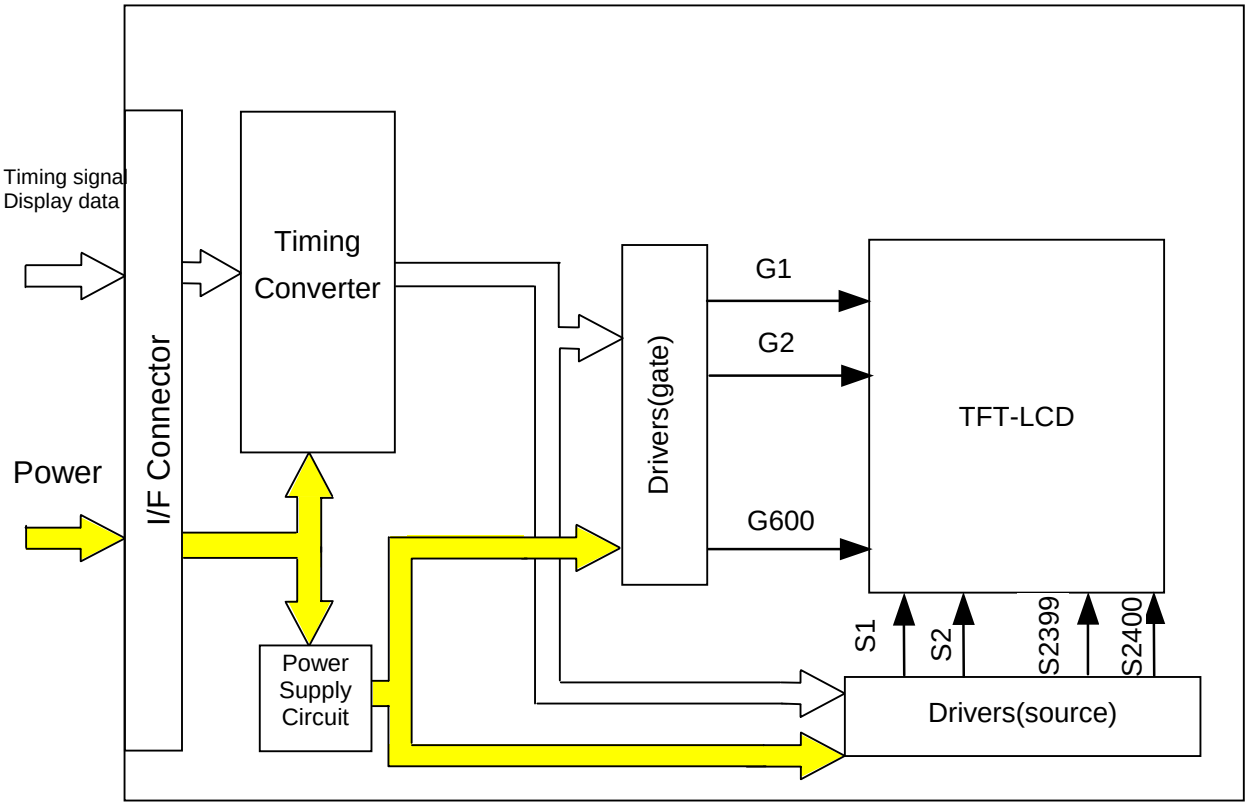
Color (n) --- n indicates gray scale level.

Higher n means brighter level.

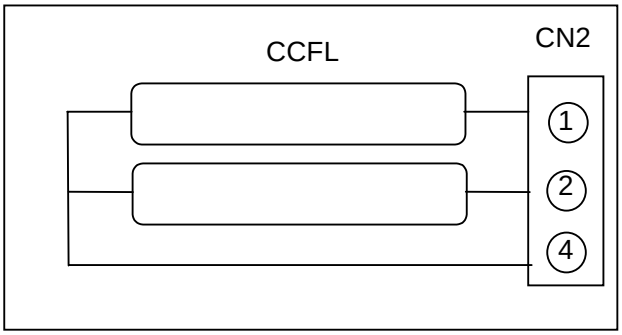
2) Data

1:High, 0: Low

7. BLOCK DIAGRAM

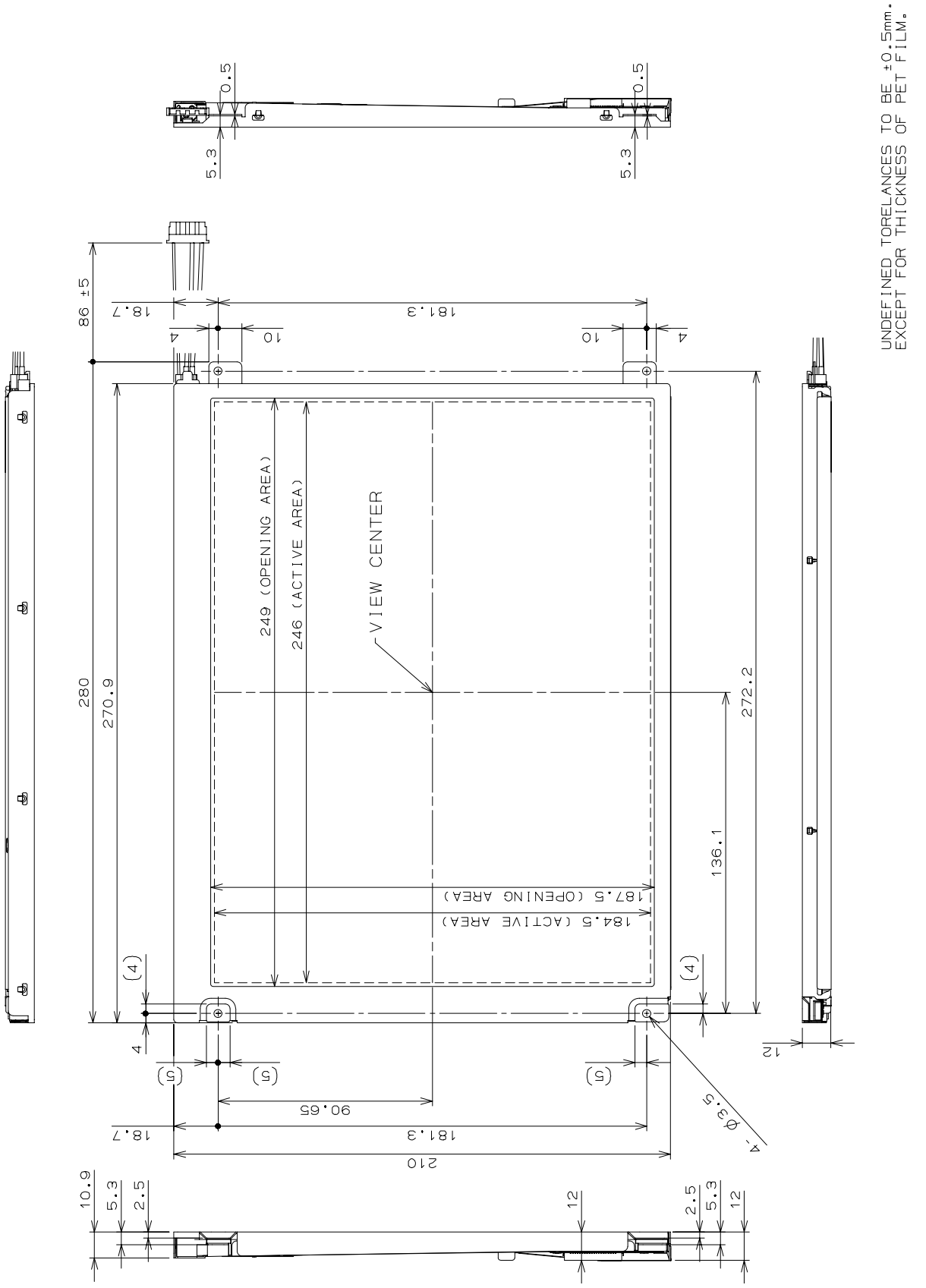


BACKLIGHT



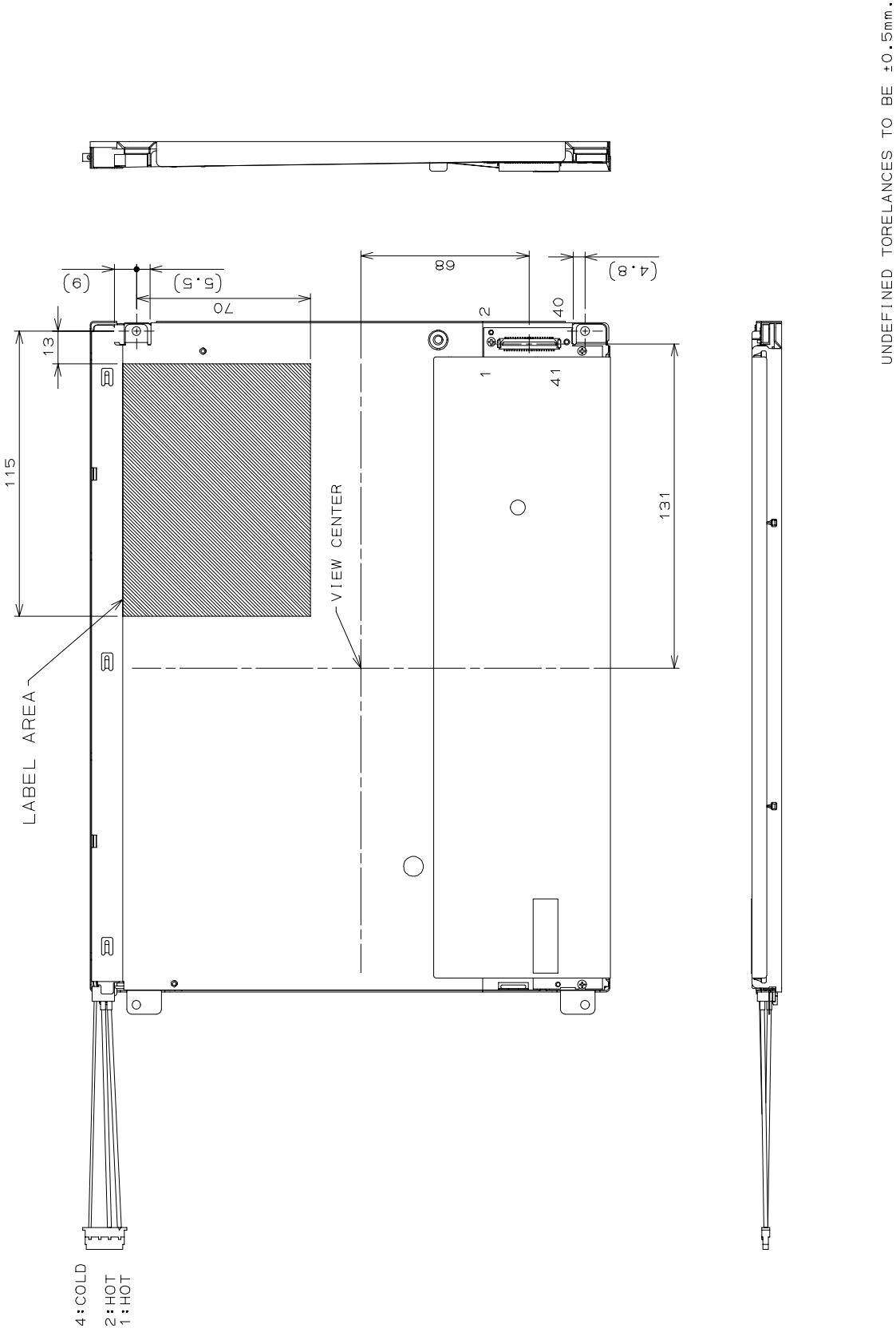
8. MECHANICAL SPECIFICATIONS

(1) Front Side



(Unit: mm)

(2) Rear Side



(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	θ = ϕ = 0°	350	500	--	--	*1)*3)
Luminance		Lw	θ = ϕ = 0°	250	400	--	cd/m²	*2)*3)
Luminance Uniformity		ΔLw	θ = ϕ = 0°	--	--	30	%	*2)*3)
Response Time		tr	θ = ϕ = 0°	--	10	--	ms	*3)*4)
		tf	θ = ϕ = 0°	--	30	--	ms	*3)*4)
Viewing	Horizontal	ϕ	CR ≥ 10	-50~50	-65~65	--	°	*3)
Angle	Vertical	θ		-40~30	-75~45	--	°	*3)
Image sticking		tis	2 h	--	--	2	s	*5)
Color Coordinates	Red	Rx	θ = ϕ = 0°	0.556	0.586	0.616	--	*3)
		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

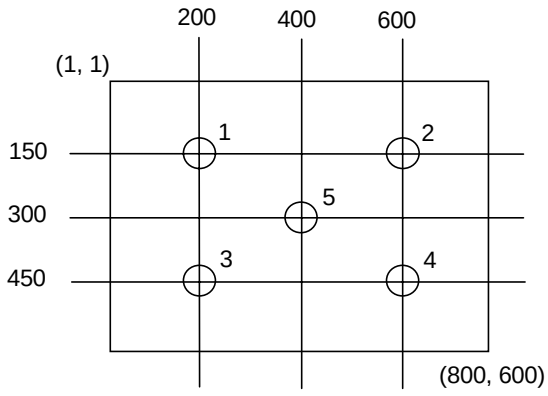
*1) Definition of Contrast Ratio

CR=ON (White) Luminance / OFF(Black) Luminance: measurement point 5 (center point) shown in a figure below

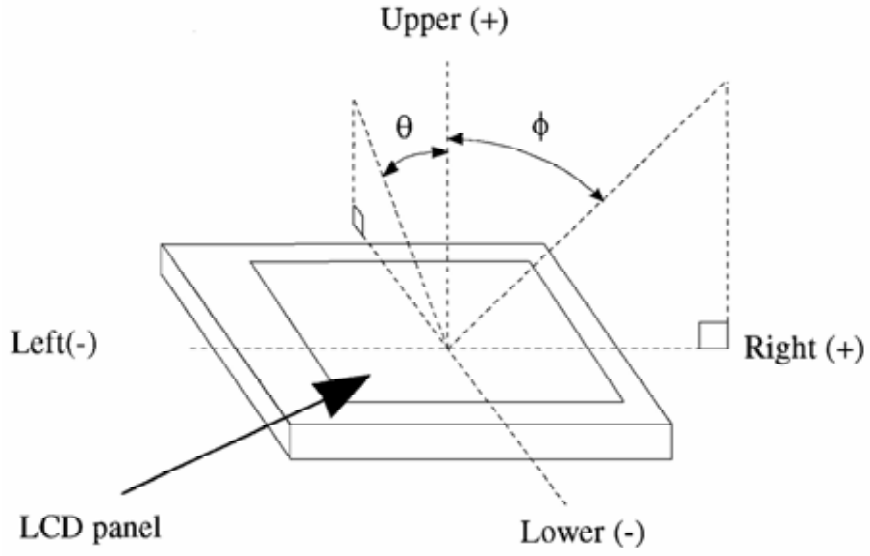
*2) Definition of Luminance and Luminance Uniformity

Lw= ON (White) Luminance: measurement point 5 (center point) shown in a figure below

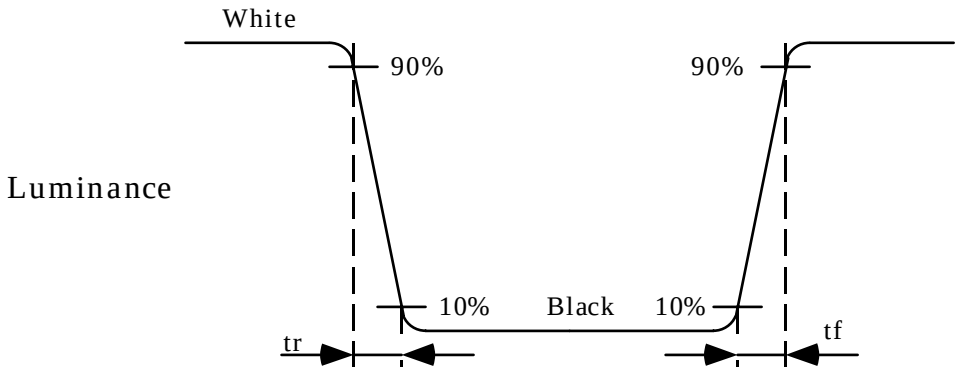
ΔLw=[Lw(MAX)/Lw(MIN)-1] × 100



*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