First Edition
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LCD Module Technical Specification

Final Revision
******

Type No.　**T-51866D121J-FW-A-AA**

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CONTENTS

1. APPLICATION

This specification applies to color TFT-LCD module, T-51866D121J-FW-A-AA.

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(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.

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

2. OVERVIEW

T-51866D121J-FW-A-AA 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 or 8 bit digital data, 800 × 600, 260 K-color or 16.1 M-color images are displayed on the 12.1" diagonal screen. Input power voltage is 3.3V for LCD driving.
The type of data and control signals are digital and transmitted via LVDS 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 whiteTN
Number of Color	260 K(6 bit/color), 16.1 M(8 bit/color)
Brightness (cd/m²)	350
Wide Viewing Angle Technology	Optical Compensation Film
Viewing Angle (CR ≥ 10)	-65~65° (H) -75~45° (V)
Surface Treatment	Antiglare and hard-coating 3H
Electrical Interface	LVDS(6 bit/8 bit)
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	4.0	V
Logic Input Voltage		VI	-0.3	VCC+0.3	V
Lamp Voltage		VL	0	2000	Vrms
Lamp Current		IL	0	18	mArms
Lamp Frequency		FL	--	80	kHz
Operation Temperature(Panel) Note 1,2)		$T_{op(Panel)}$	-20	70	°C
Operation Temperature(Ambient) Note 2)		$T_{op(Ambient)}$	-20	70	°C
Storage Temperature Note 2)		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 $\leq$ 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 Voltages for LCD	VCC	3.0	3.3	3.6	V	*1)
Power Supply Currents for LCD	ICC	--	300	450	mA	VCC = 3.3 V *2)
Permissive Input Ripple Voltage	VRP	--	--	100	mVp-p	VCC = 3.3V

*1) Power and signals sequence:

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

data: RGB DATA, DCLK, HD, VD, DENA
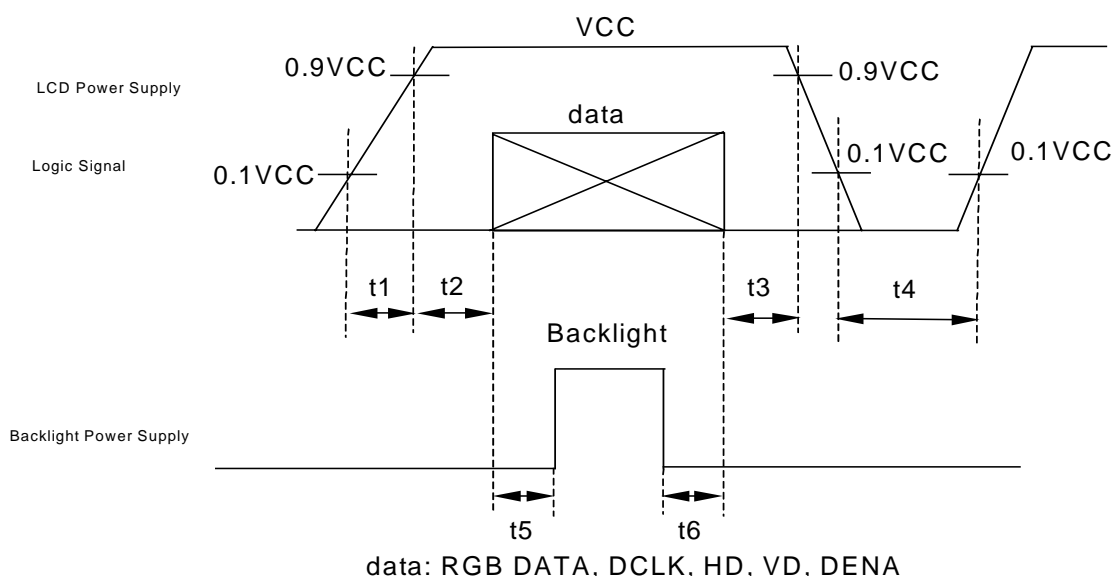
VCC-dip conditions:
  1) When 2.7 V $\leq$ VCC < 3.0 V, td $\leq$ 10 ms
  2) When VCC < 2.7 V
  VCC-dip conditions should also follow the power and signals sequence.
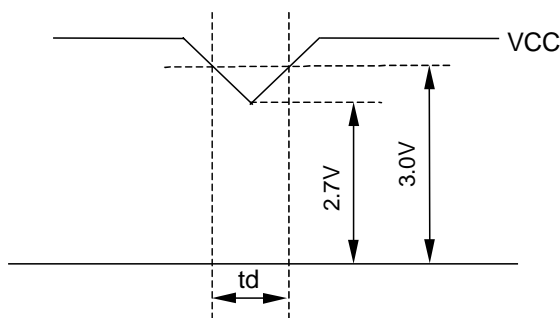
*2) Typical current condition:
  64-gray-bar pattern
  600 line mode
  VCC = +3.3 V , f_H=37.9kHz, f_V=60.3Hz, f_{CLK}= 40MHz

(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	* 1), *5)
Lamp Frequency	FL	30	--	60	kHz	* 2)
Starting Lamp Voltage	VS	1000	--	--	Vrms	Ta = 25°
		1200	--	--		Ta = 0°C
		1290	--	--		Ta = -20°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.
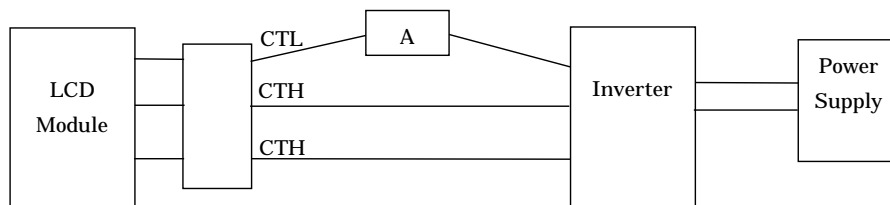
3) Lamp life time is defined as the time either when the brightness becomes 50% of the initial value, or when the starting lamp voltage does not meet the value specified in this table.
4) The life time of the backlight depends on the ambient temperature. The life time will decrease under low/high temperature.

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 $\sqrt{2} \pm 10\%$
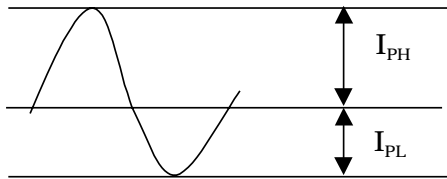
I_{PH}: High side peak

I_{PL}: Low side peak

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

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

CURRENT WAVE FORM

5. INTERFACE PIN CONNECTION

(1) CN 1(Interface Signal)

Used connector: FI-SEB20P-HF

Corresponding connector: FI-S20S[for discrete Wire], FI-SE20M[for SMT]

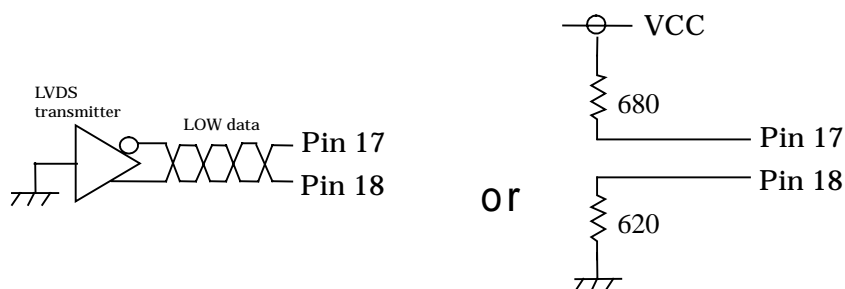| Pin No.	Symbol	Function(ISP 6 bit compatibility mode)		Function(ISP 8 bit compatibility mode)
		6 bit input	8 bit input	
1	VCC	+3.3 V Power supply		←
2	VCC	+3.3 V Power supply		←
3	GND	GND		←
4	GND	GND		←
5	Link 0-	R0, R1, R2, R3, R4, R5, G0	R2, R3, R4, R5, R6, R7, G2	R0, R1, R2, R3, R4, R5, G0
6	Link 0+	R0, R1, R2, R3, R4, R5, G0	R2, R3, R4, R5, R6, R7, G2	R0, R1, R2, R3, R4, R5, G0
7	GND	GND		←
8	Link 1-	G1, G2, G3, G4, G5, B0, B1	G3, G4, G5, G6, G7, B2, B3	G1, G2, G3, G4, G5, B0, B1
9	Link 1+	G1, G2, G3, G4, G5, B0, B1	G3, G4, G5, G6, G7, B2, B3	G1, G2, G3, G4, G5, B0, B1
10	GND	GND		←
11	Link 2-	B2, B3, B4, B5, HD, VD, DENA	B4, B5, B6, B7, HD, VD, DENA	B2, B3, B4, B5, HD, VD, DENA
12	Link 2+	B2, B3, B4, B5, HD, VD, DENA	B4, B5, B6, B7, HD, VD, DENA	B2, B3, B4, B5, HD, VD, DENA
13	GND	GND		←
14	CLKIN-	Clock -		←
15	CLKIN+	Clock +		←
16	GND	GND		←
17	Link3-	See: *2)	R0, R1, G0, G1, B0, B1	R6, R7, G6, G7, B6, B7
18	Link3+	See: *2)	R0, R1, G0, G1, B0, B1	R6, R7, G6, G7, B6, B7
19	MODE	Low=ISP 6 bit compatibility mode		High=ISP 8 bit compatibility mode
20	SC	Scan direction control. (Low : Normal , High : Reverse)		←

*1) The shielding case is connected with GND
*2) Recommended wiring of Pin 17,18 (6 bit input)

(2) 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

(3) ISP data mapping

a. ISP 6 bit compatibility mode(6 bit input)

			G0	R5	R4	R3	R2	R1	R0	
CLKIN+/-										
Link0+/-			G0	R5	R4	R3	R2	R1	R0	
Link1+/-			B1	B0	G5	G4	G3	G2	G1	
Link2+/-			DENA	VD	HD	B5	B4	B3	B2	

1CLK
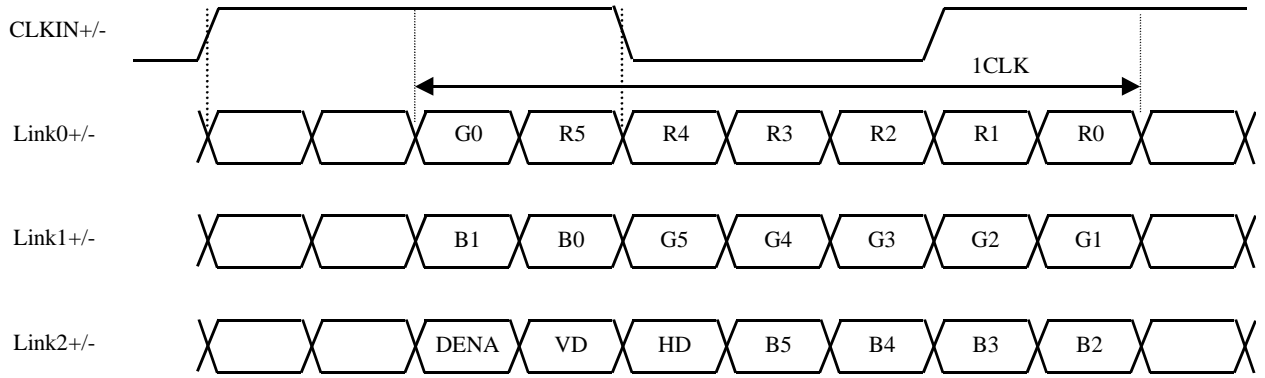
b. ISP 6 bit compatibility mode(8 bit input)

CLKIN+/-

1CLK

Link0+/-	G2	R7	R6	R5	R4	R3	R2
Link1+/-	B3	B2	G7	G6	G5	G4	G3
Link2+/-	DENA	VD	HD	B7	B6	B5	B4
Link3+/-	B1	B0	G1	G0	R1	R0	

c. ISP 8 bit compatibility mode

CLKIN+/-

1CLK

Link0+/-	G0	R5	R4	R3	R2	R1	R0
Link1+/-	B1	B0	G5	G4	G3	G2	G1
Link2+/-	DENA	VD	HD	B5	B4	B3	B2
Link3+/-	B7	B6	G7	G6	R7	R6	
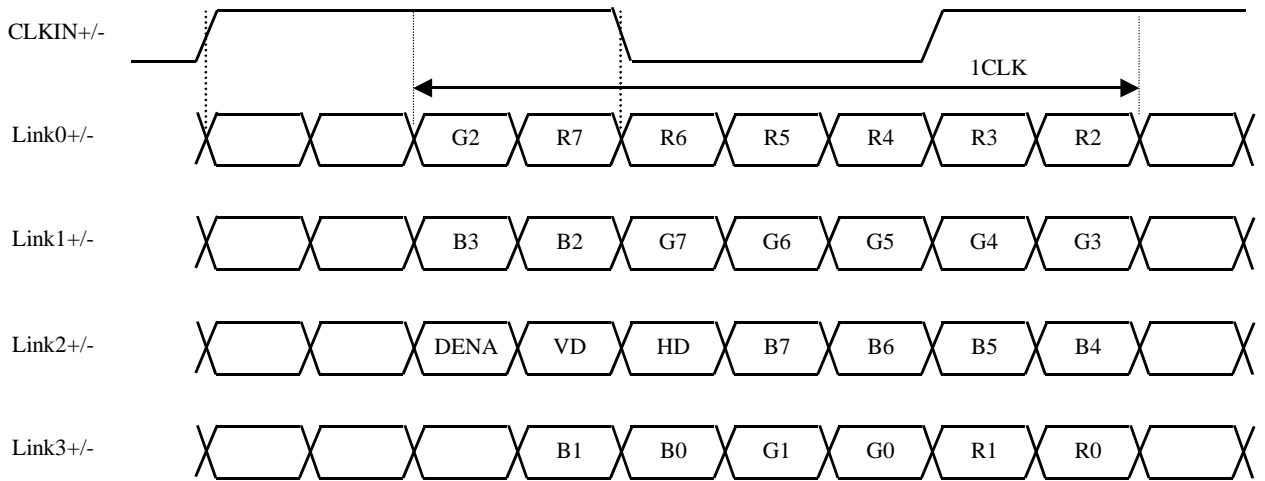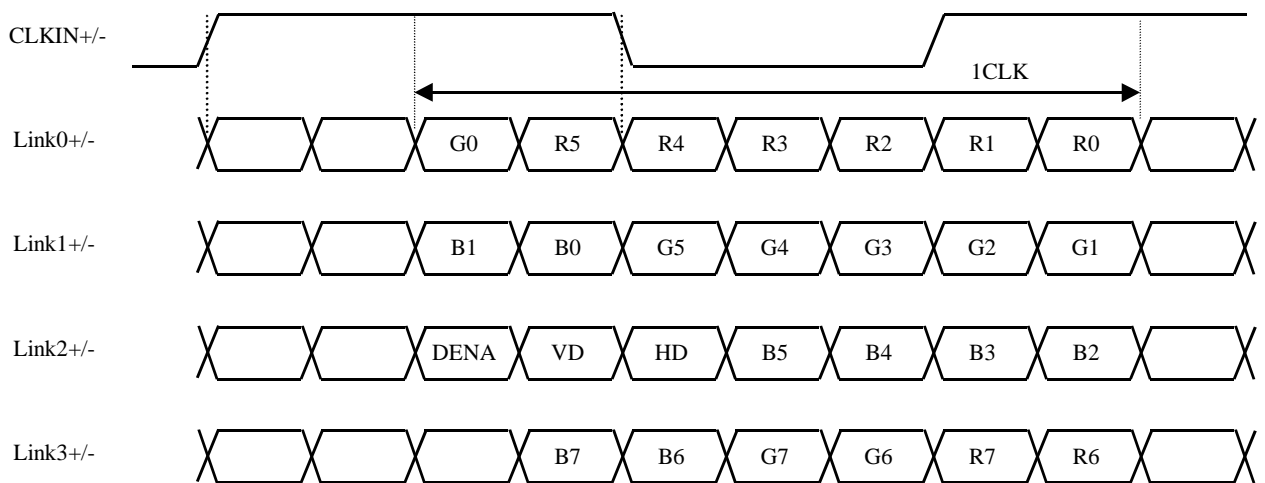
6. INTERFACE TIMING

LVDS transmitter input signal

(1) Timing Specifications

ITEM		SYMBOL	MIN	TYP	MAX	UNIT
DCLK	Frequency	f_{CLK}	35	--	40	MHz
	Period	t_{CLK}	25	--	28.6	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) Polarities of HD and VD are negative in this specification.
2) DENA (Data Enable) should always be positive polarity as shown in the timing specification.
3) DCLK should appear during all invalid period, and HD should appear during invalid period of frame cycle.
4) LVDS timing follows the timing specifications of LVDS receiver IC: THC63LVDF84B(Thine).
5) $t_{HFP} + t_{HBP} \geq 20 \, t_{CLK}$

(2) Timing Chart) Timing Chart

a. Horizontal Timing Chart

DCLK

DATA (R,G,B)

First Data — Invalid Data | 1 | 2 | 3 | ... | 799 | 800 | Invalid Data — Last Data

t_{HFP} t_{HBP} t_{HA}

DENA

$t_H = 1/f_H$

t_{WHL}

HD

b. Vertical Timing Chart

HD

LINE DATA

Invalid Data | 1 | 2 | 3 | ... | 599 | 600 | Invalid Data

t_{VFP} t_{VBP} t_{VA}

DENA

$t_V = 1/f_V$

t_{WVL}

VD
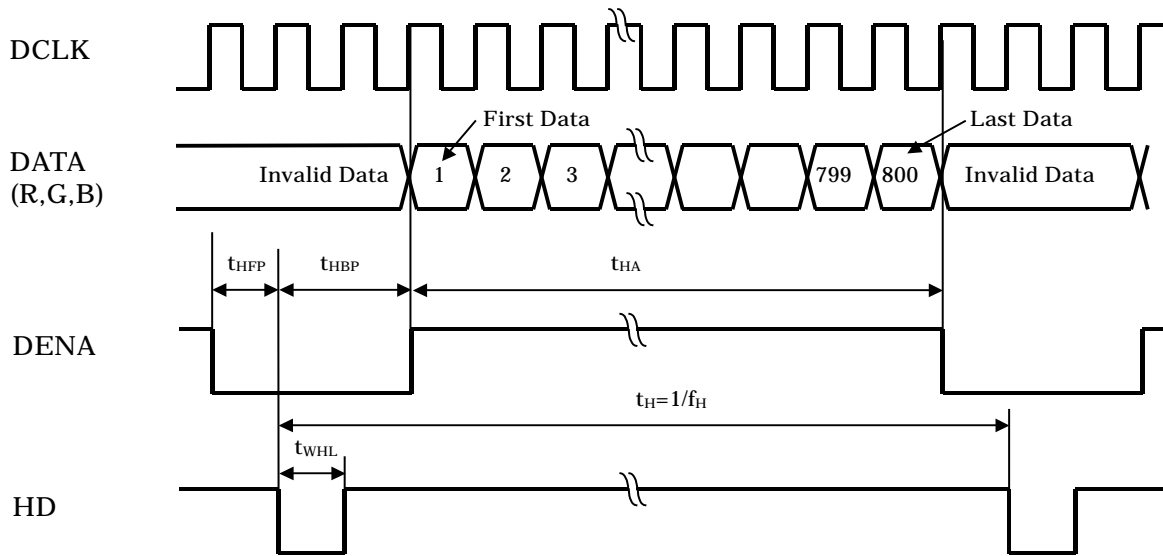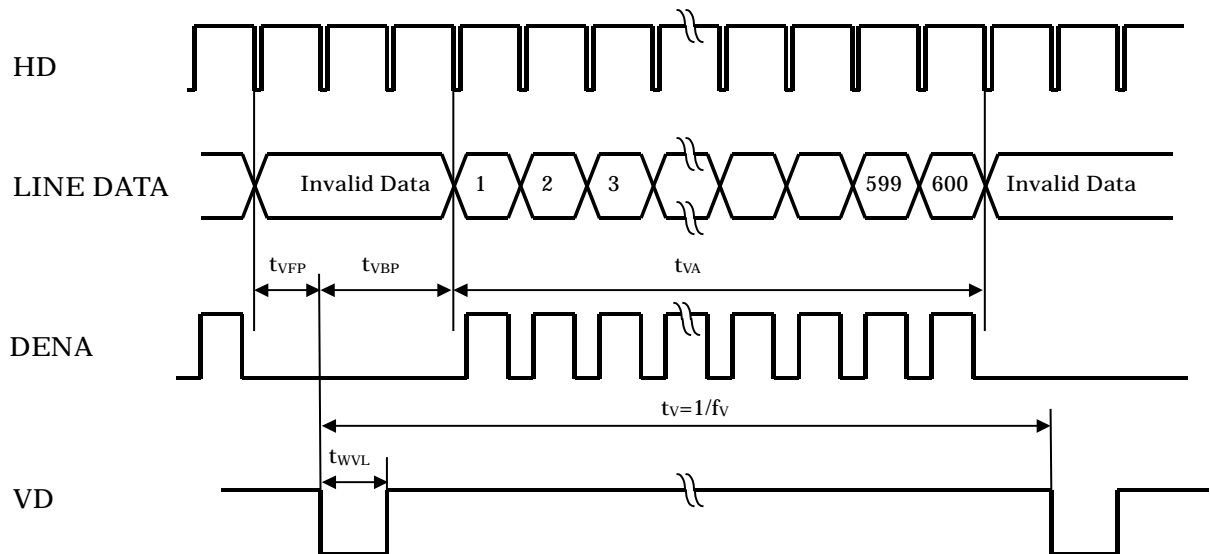
(3) Color Data Assignment

a. 6 bit input

COLOR		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

INPUT DATA — R DATA / G DATA / B DATA

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

b. 8 bit input

COLOR		R DATA								G DATA								B DATA							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	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	0	0	0	0	0	0
	RED(252)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(252)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	BLUE(252)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	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	1	1	1	1	1	1
RED	RED(1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(252)	1	1	1	1	1	1	1	1	0	0	0	0	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	0	0	0	0	1	0	0	0	0	0	0	0	0
	GREEN(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	GREEN(252)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	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	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	0	0	0	0	0	0	1	0
	BLUE(252)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

[Note]

    *1) Definition of gray scale

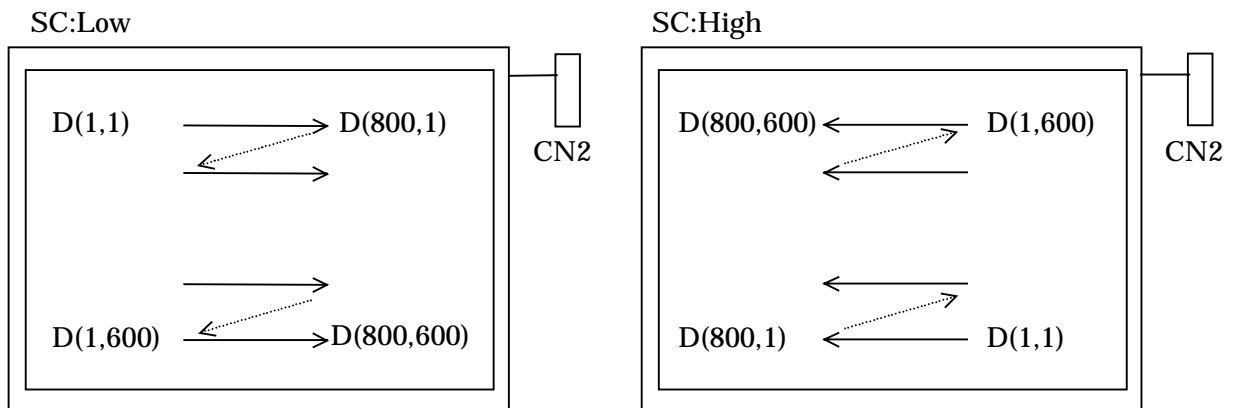   Color (n) --- n indicates gray scale level.

           Higher n means brighter level.

    *2) Data
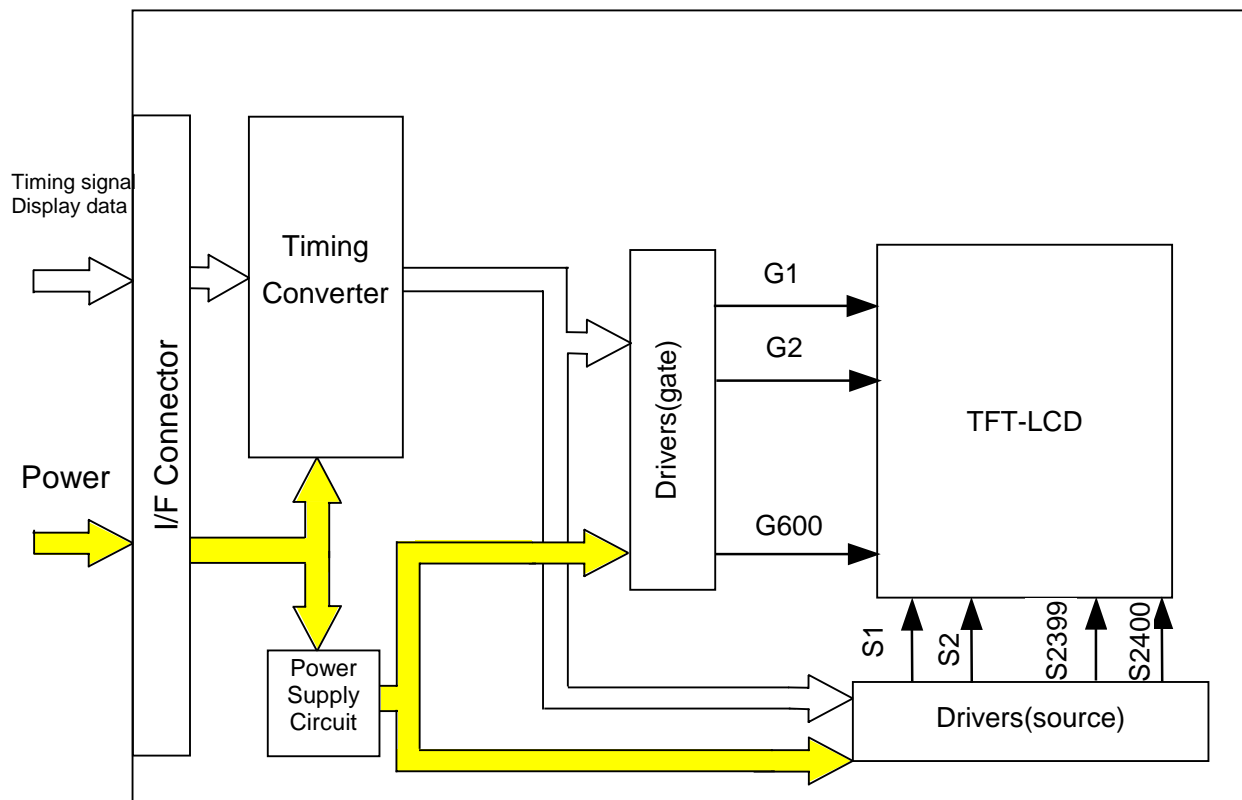
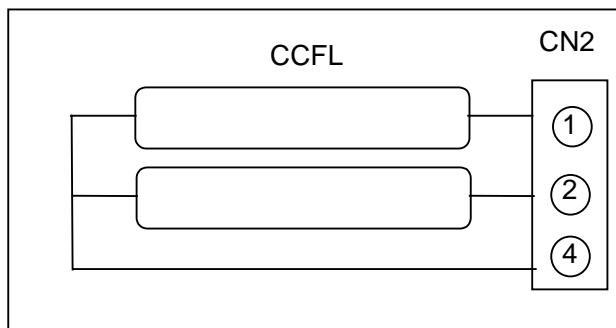   1:High,   0: Low

(4) Display Position and Scan Direction

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

SC:Low

D(1,1) ——————→ D(800,1)

D(1,600) ——————→ D(800,600)

CN2

SC:High

D(800,600) ←——————→ D(1,600)
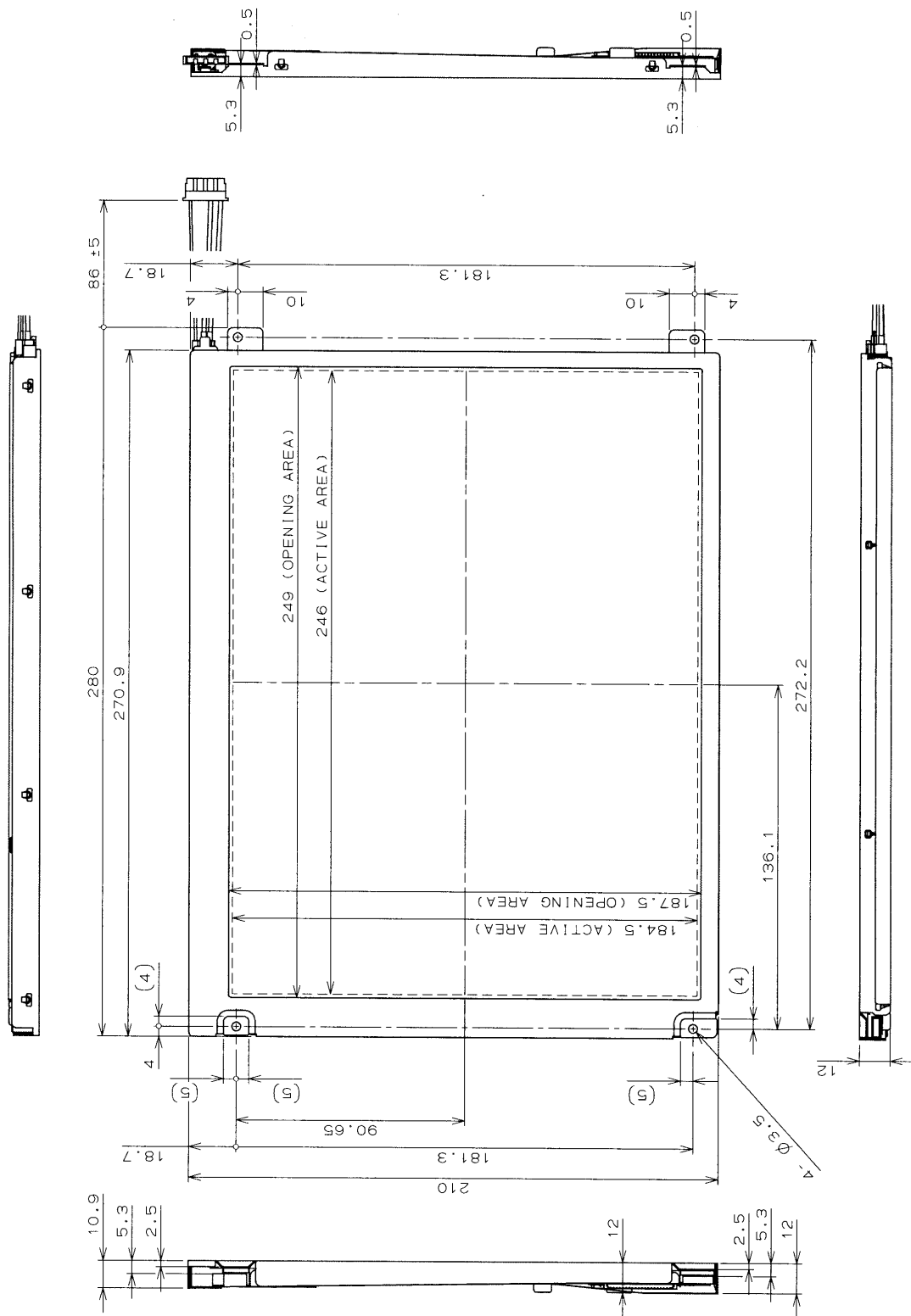
D(800,1) ←—————— D(1,1)
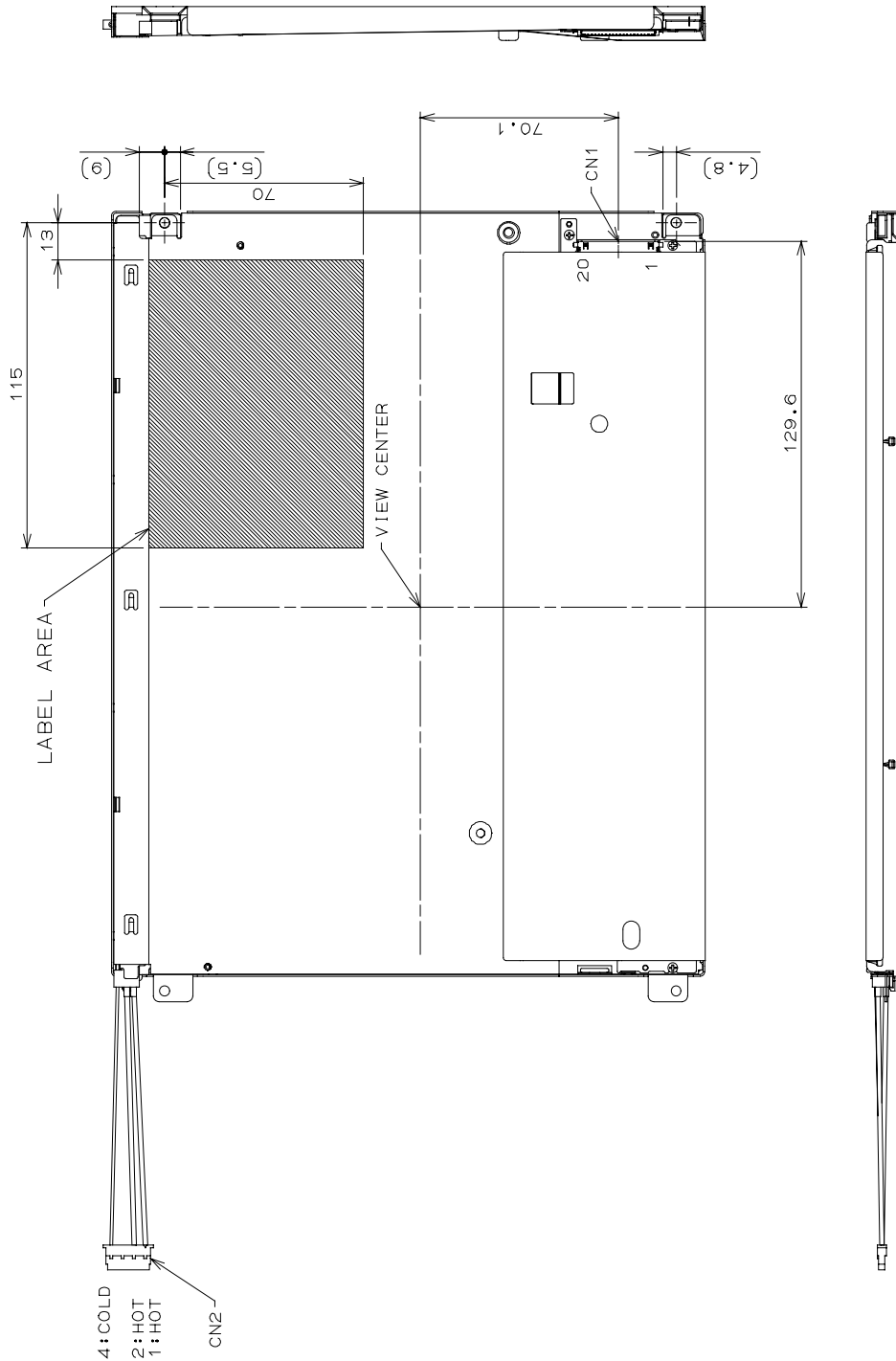
CN2

7. BLOCK DIAGRAM

BACKLIGHT

8. MECHANICAL SPECIFICATIONS

(1) Front Side

UNDEFINED TORELANCES TO BE ±0.5mm.
EXCEPT FOR THICKNESS OF PET FILM.

(Unit: mm)

(2) Rear Side

UNDEFINED TORELANCES TO BE ±0.5mm.
EXCEPT FOR THICKNESS OF PET FILM.

70.1

CN1

(4.8)

(9)

(5.5)

70

13

115

129.6

VIEW CENTER

LABEL AREA

20

1

4:COLD
2:HOT
1:HOT

CN2

CN1:FI-SEB20P-HF (JAE)
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, Input Signals: Typ. Values shown in Section 6

| ITEM		SYMBOL	CONDITION	MIN	TYP	MAX	UNIT	Remarks
Contrast Ratio		CR	$\theta = \phi = 0°$	350	500	--	--	*1)*2)*6)
Luminance		Lw	$\theta = \phi = 0°$	250	350	--	cd/m²	*1)*3)*6)
Luminance Uniformity		ΔLw	$\theta = \phi = 0°$	--	--	30	%	*1)*4)*6)
Response Time		tr	$\theta = \phi = 0°$	--	10	--	ms	*1)*5)*6)
		tf	$\theta = \phi = 0°$	--	30	--	ms	*1)*5)*6)
Viewing Angle	Horizontal	ϕ	CR $\geq$ 10	-50~50	-65~65	--	°	*1)*6)
	Vertical	θ		-40~30	-75~45	--	°	*1)*6)
	Horizontal	ϕ	CR $\geq$ 5	-65~65	-80~80	--	°	*1)*6)
	Vertical	θ		-50~40	-80~55	--	°	*1)*6)
Image sticking		tis	2 h	--	--	2	s	*7)
Color Coordinates	Red	Rx	$\theta = \phi = 0°$	0.551	0.581	0.611	--	*1)*6)
		Ry		0.305	0.335	0.365		
	Green	Gx		0.298	0.328	0.358		
		Gy		0.518	0.548	0.578		
	Blue	Bx		0.135	0.165	0.195		
		By		0.155	0.185	0.215		
	White	Wx		0.283	0.313	0.343		
		Wy		0.299	0.329	0.359		

[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: DisplayCenter
　　　Luminance Uniformity: point 1~5 shown in a figure below
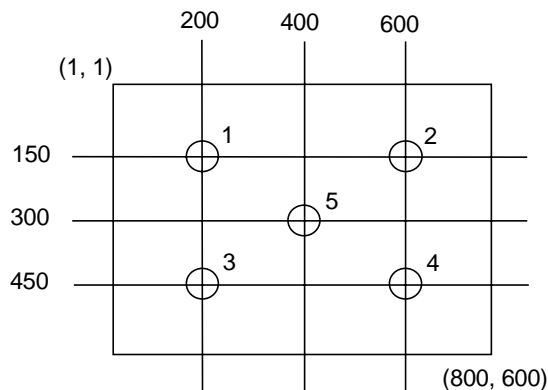
*2) Definition of Contrast Ratio
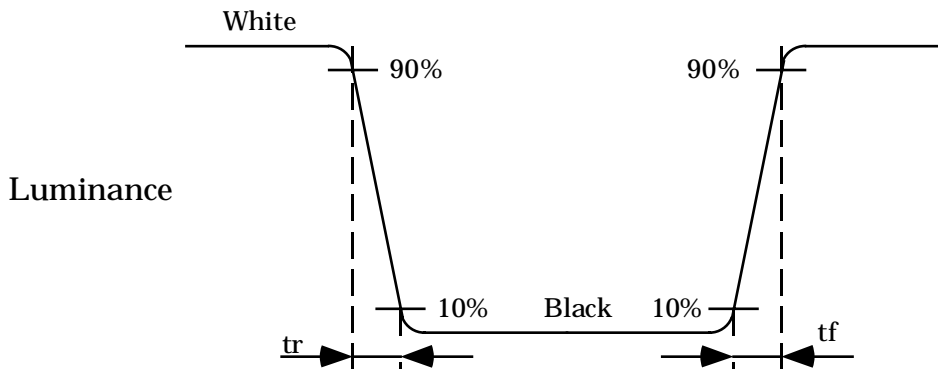
　　　CR=ON (White) Luminance / OFF(Black) Luminance
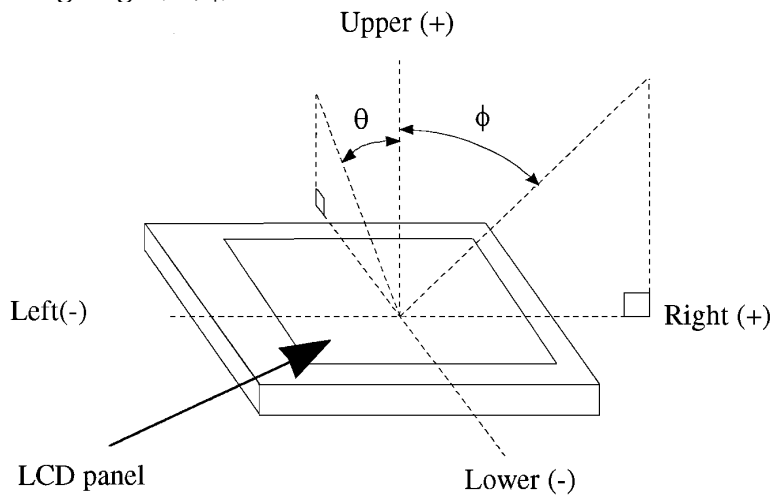
*3) Definition of Luminance

　　　Lw= ON (White) Luminance

*4) Definition of Luminance Uniformity

$$\Delta Lw = [Lw(MAX)/Lw(MIN)-1] \times 100$$

*5) Definition of Response Time

White

Luminance
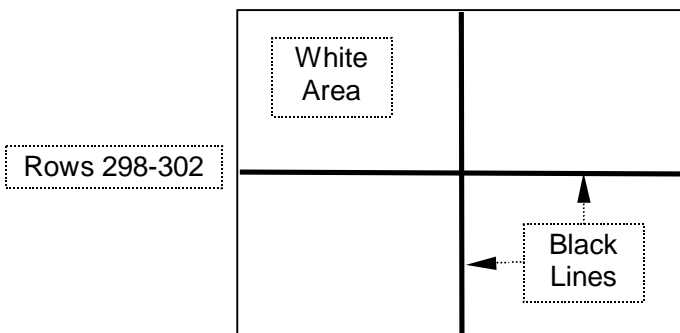
90%   90%

10%   Black   10%

tr   tf

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

Upper (+)

θ   φ

Left(-)   Right (+)

LCD panel   Lower (-)

*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

White
Area

Rows 298-302

Black
Lines

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, 240 h
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/s² (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/s² (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 with no obvious non-uniformity and no line defect.

Partial transformation of the module parts should be ignored.

Fail: No display image, or line defects.