First Edition
May 20, 2002
Final Revision
******

LCD Module Technical Specification

OPTREX **T-51513D104U-FW-A-AB**

Tentative

Checked by (Quality Assurance Div.)

Checked by (Design Engineering Div.)

Prepared by (Production Div.)

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Revision History

Rev.	Date	Page	Comment

1. OVERVIEW

T-51513-D104U-FW-A-AB 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	260 K
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)	530
Backlight Unit	CCFL, 2-tubes, replaceable
Surface Treatment	Anti-glare and hard-coating 3H

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	--	80	kHz
Operation Temperature *1)	T_{op}	0	50	°C
Storage Temperature *1)	T_{stg}	-20	60	°C

[Note]

*1) 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	3.3 V powered	VCC	3.0	3.3	3.6	V	A), D)
	5.0 V powered	VCC	4.75	5.0	5.25	V	A), D)
Power Supply Current for LCD	3.3 V powered	ICC	-	220	380	mA	VCC=3.3 V B)
	5.0 V powered	ICC	-	150	280	mA	VCC=5.0 V B)
Permissive Input Ripple Voltage		VRP	-	-	100	mVp-p	VCC=+3.3 V/5.0 V
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	--	580	--	Vrms	IL=6.0mAr
Lamp Current		IL	3.0	6.0	7.0	mArms	*1)
Lamp Frequency		FL	40	--	80	kHz	*2)
Starting Lamp Voltage	Ta=25°C	VS	810	--	--	Vrms	
	Ta=0°C		1000	--	--	Vrms	
Lamp Life Time	IL=3.0mArms	LT	50000	50000	--	h	*3),*4)
	IL=6.0mArms		40000	50000	--	h	
	IL=7.0mArms		30000	40000	--	h	

*1) Lamp Current measurement method (The current meter is inserted in low voltage line.)
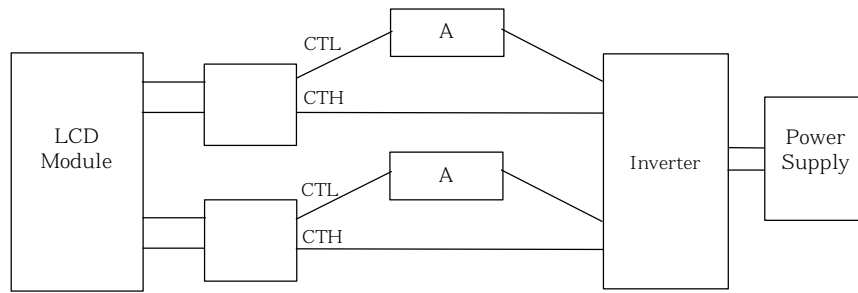
*2) Lamp frequency of inverter may produce interference with horizontal synchronous frequency, and this may cause horizontal beat on the display. Therefore, please adjust lamp frequency, and keep inverter as far from module as possible or use electronic shielding between inverter and module to avoid the interference.
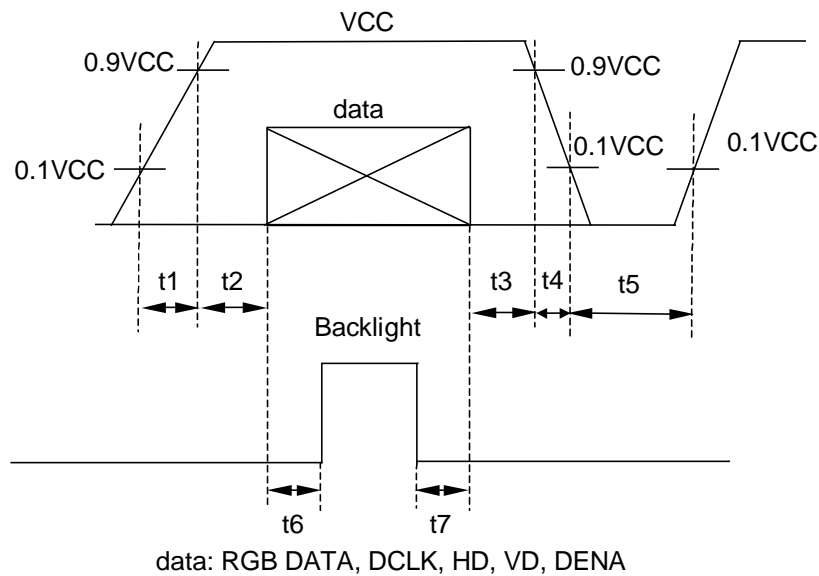
*3) Lamp life time is defined as the time either when the brightness becomes 50% of the initial value, or when the starting lamp voltage does not meet the value specified in this table.

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

[Note]

A) Power and signals sequence:

$t1 \leq 10$ ms 400 ms $\leq t5$
$0 < t2 \leq 50$ ms 200 ms $\leq t6$
$0 < t3 \leq 50$ ms $0 \leq t7$
$0 < t4 \leq 50$ ms

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

VCC-dip conditions:

        (a) 3.3 V powered

                1) When 2.4 V ≤ VCC < 3.0 V, td ≤ 10 ms

                2) When VCC < 2.4 V

                    VCC-dip conditions should also follow the power and signals sequence.
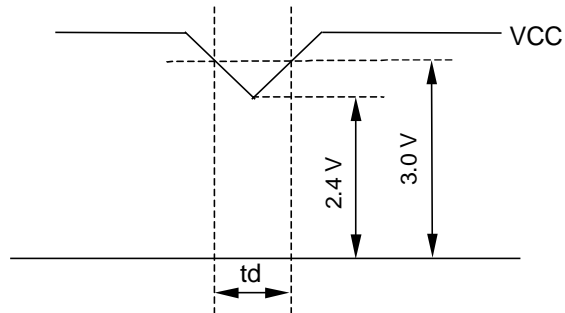
        (b) 5.0 V powered

                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.
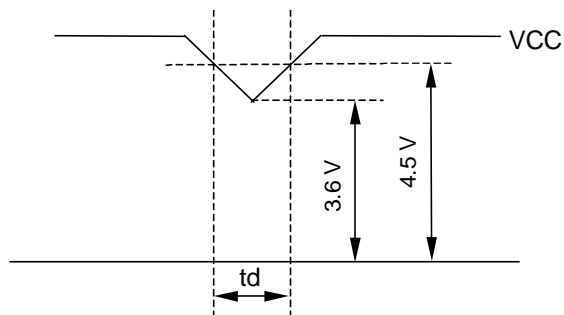
B) Typical current condition:

        64- gray- bar-pattern

        480 line mode

        VCC = + 3.3 / 5.0 V, f_H=31.6kHz, f_V=60Hz, f_{CLK}= 25MHz

4. INTERFACE PIN CONNECTION

CN 1(INTERFACE SIGNAL)

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

Corresponding connector: DF9B-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	144	--	t_{CLK}
	Vertical Active Time	t_{VA}	480	480	480	t_{H}
	Vertical Front Porch	t_{VFP}	1	12	--	t_{H}
	Vertical Back Porch	t_{VBP}	2	33	--	t_{H}
HD *2)*4)	Frequency	f_{H}	27	31.6	38	kHz
	Period	t_{H}	26.3	31.6	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.
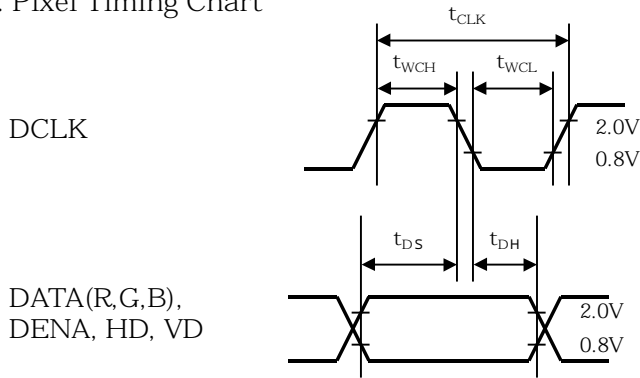
*2) Polarities of HD and VD are negative in this specification.

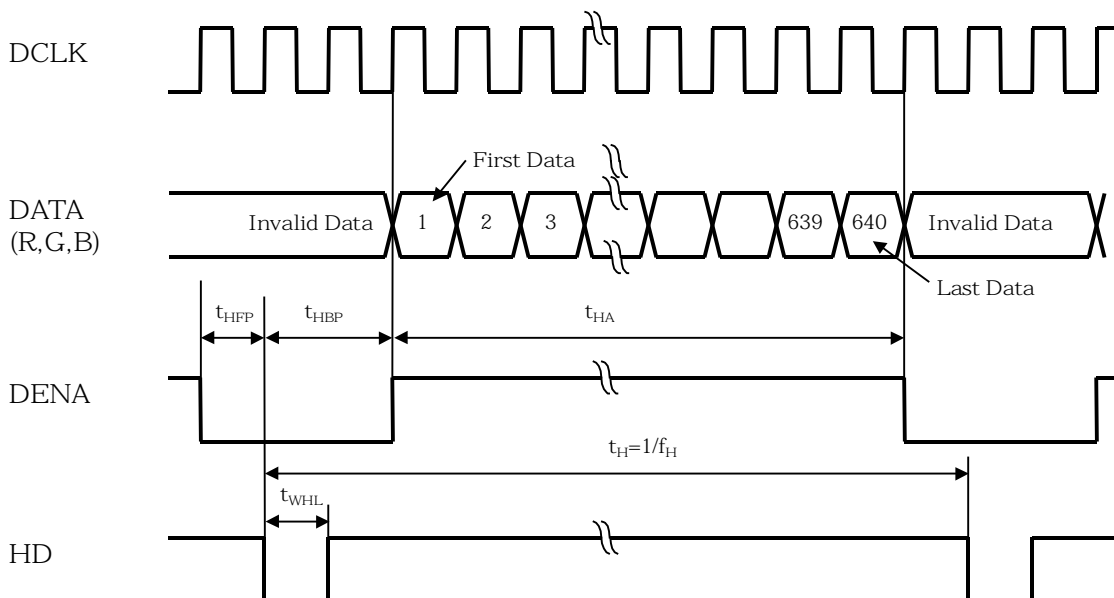*3) DENA (Data Enable) should always be positive polarity as shown in the timing specification.

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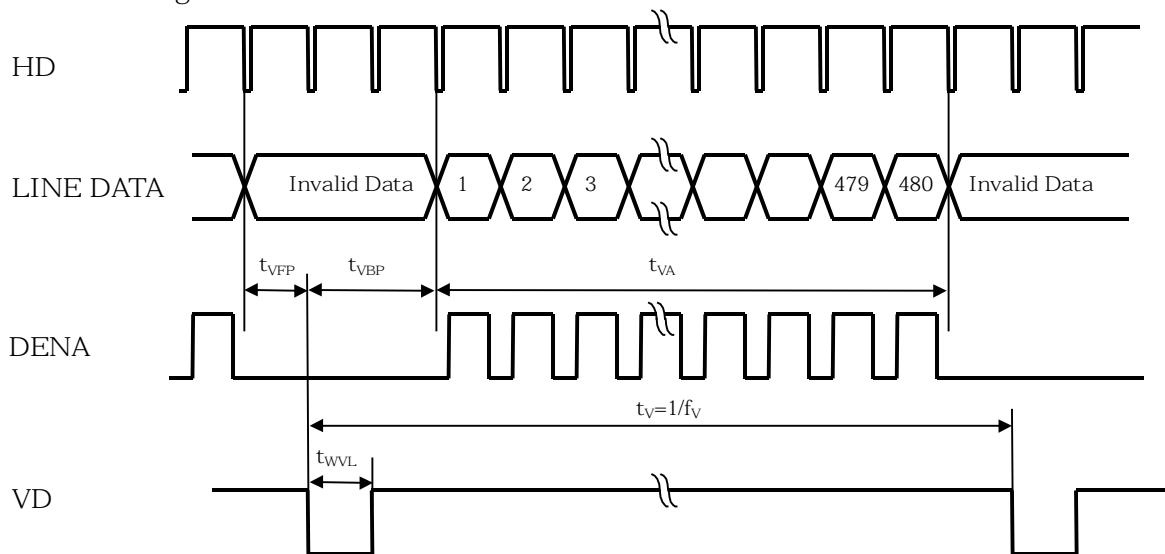
(2) Timing Chart

a. Pixel Timing Chart

DCLK

t_{CLK}

t_{WCH} t_{WCL}

2.0V
0.8V

DATA(R,G,B),
DENA, HD, VD

t_D t_D

2.0V
0.8V

b. Horizontal Timing Chart

DCLK

DATA
(R,G,B)

First Data

Invalid Data | 1 | 2 | 3 | ... | 639 | 640 | Invalid Data

Last Data

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

DENA

$t_H = 1/f_H$

t_{WHL}

HD

c. Vertical Timing Chart

HD

LINE DATA

Invalid Data | 1 | 2 | 3 | ... | 479 | 480 | Invalid Data

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

DENA

$t_V = 1/f_V$

t_{WVL}

VD

(3) Color Data Assignment

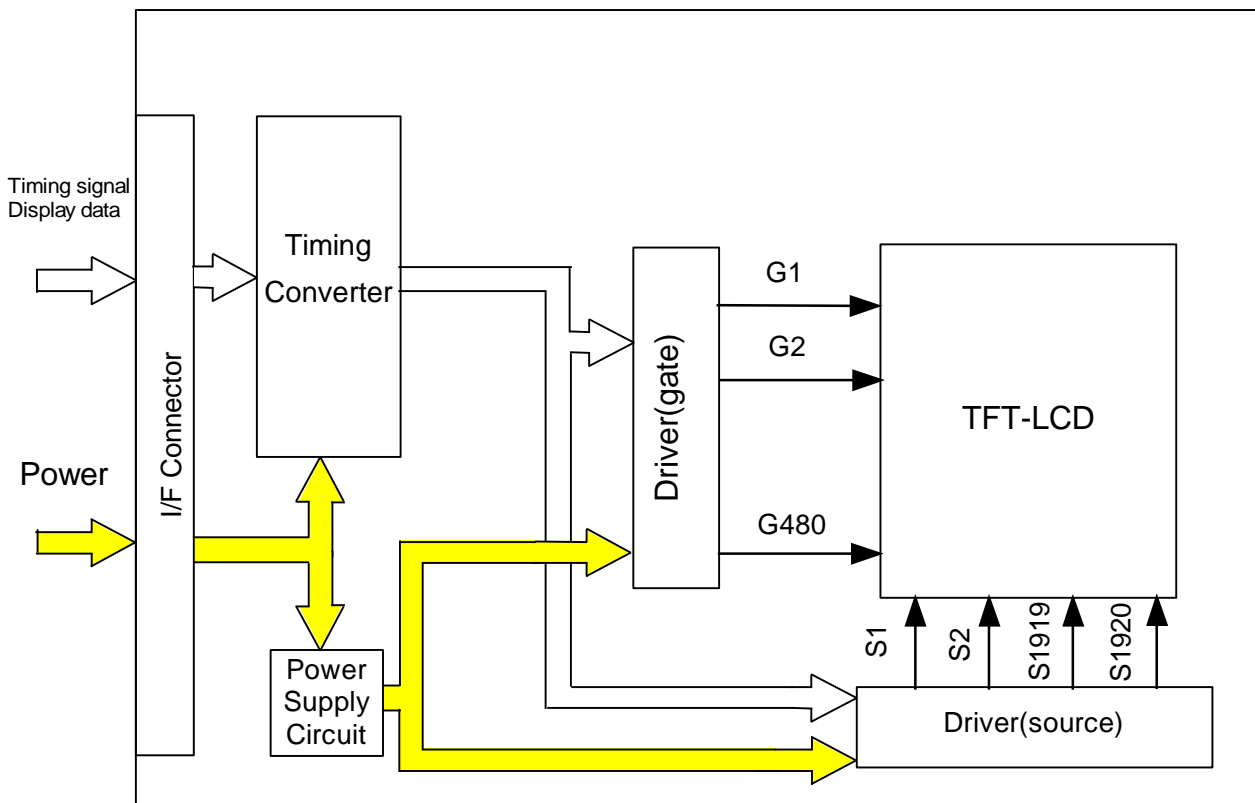| COLOR	INPUT DATA	R DATA						G DATA						B DATA					
		R5 MSB	R4	R3	R2	R1	R0 LSB	G5 MSB	G4	G3	G2	G1	G0 LSB	B5 MSB	B4	B3	B2	B1	B0 LSB
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE(63)	0	0	0	0	0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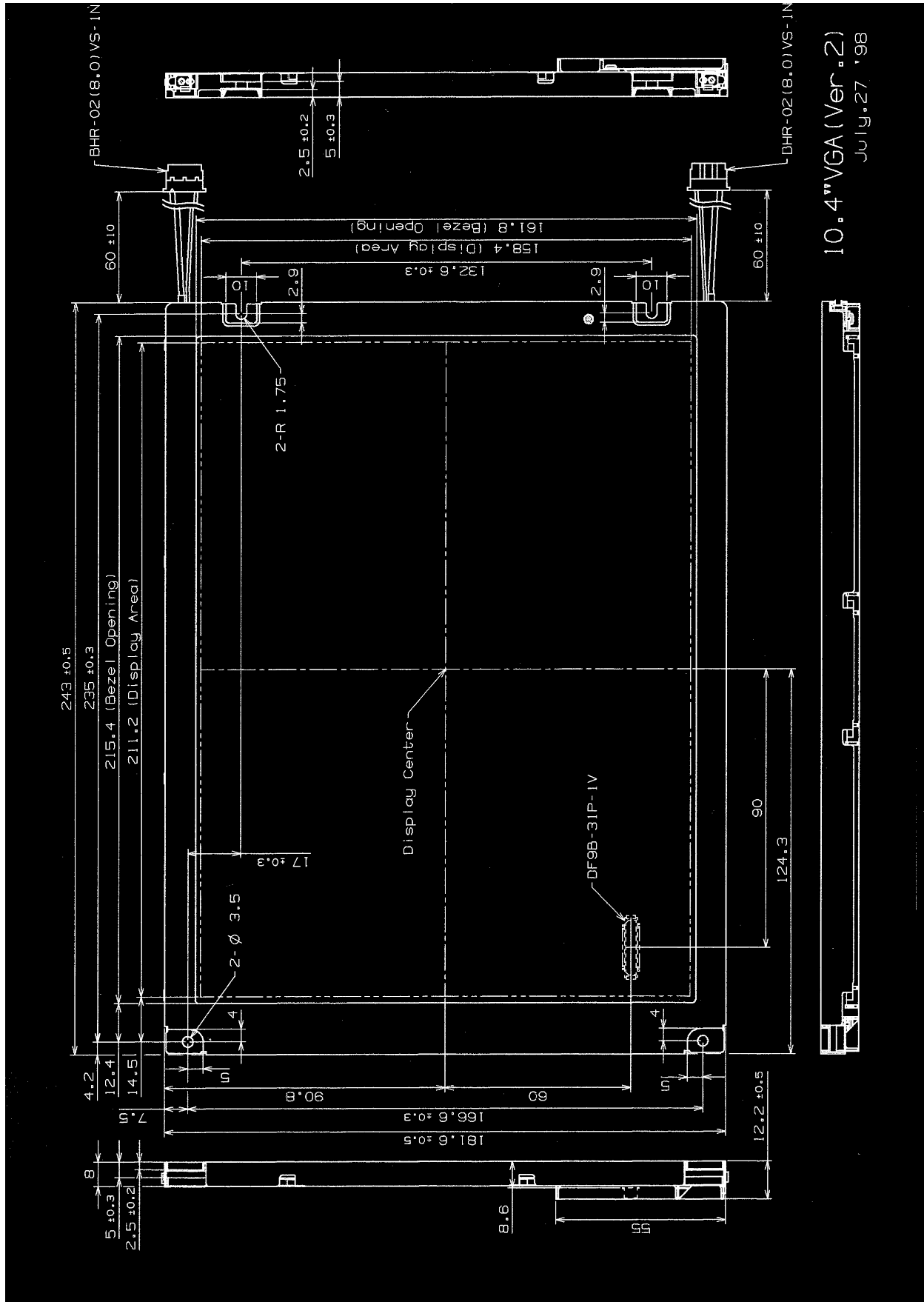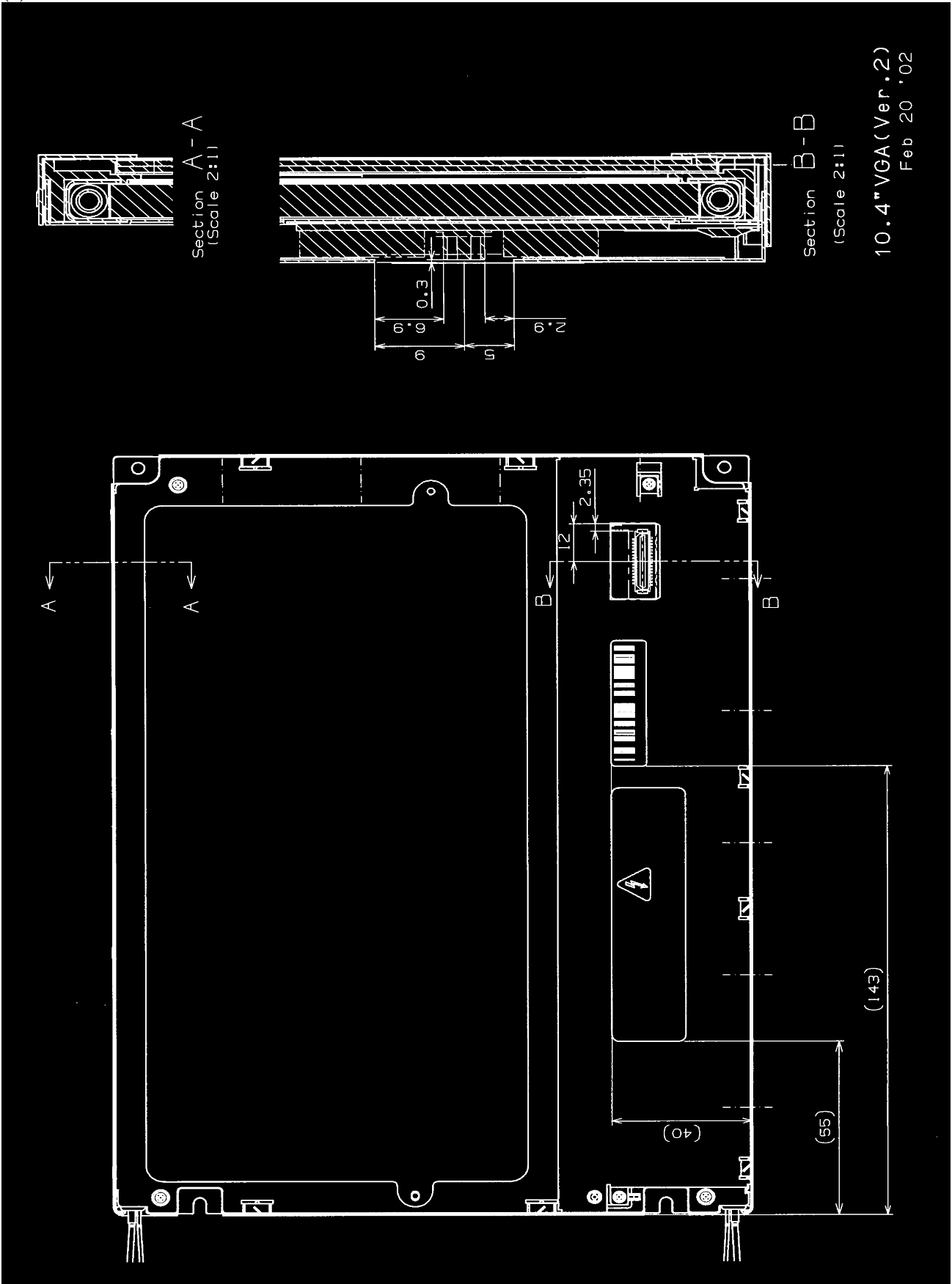
2) Data

1:High, 0: Low

6. BLOCK DIAGLAM

Timing signal
Display data

Power

I/F Connector

Timing Converter

Power Supply Circuit

Driver(gate)

G1

G2

G480

TFT-LCD

S1   S2   S1919   S1920

Driver(source)

BACKLIGHT

CCFL

CN2, 3

①

③

7. MECHANICAL SPECIFICATIONS
(1) Front Side

Tolerance is ±0.5mm unless noted.
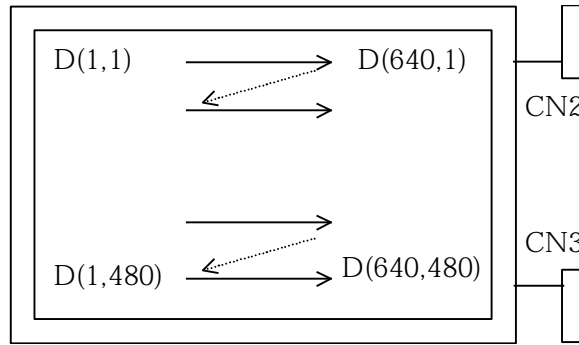
(2) Rear Side

10.4"VGA(Ver.2)
Feb 20 '02

Section A-A
(Scale 2:1)

Section B-B
(Scale 2:1)

0.3

6.9

9

2.9

5

2.35

2

(143)

(40)

(55)

Tolerance is ±0.5mm unless noted

[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　High

D(1,1) → D(640,1)

CN2

D(1,480) → D(640,480)

CN3

SC : GND or Open

CN3

D(1,1) → D(640,1)

CN2

D(1,480) → D(640,480)
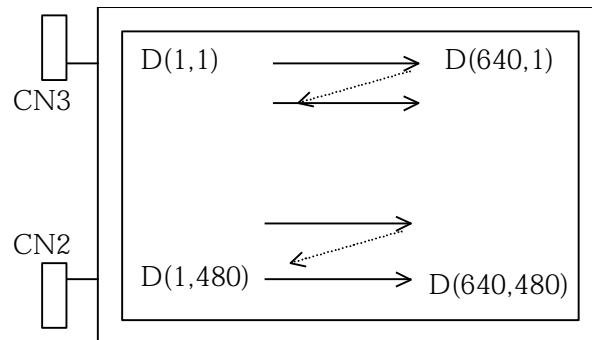
8. OPTICAL CHARACTERISTICS

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°	150	300	--	--	*1)*3)
Luminance		Lw	θ = φ = 0°	300	380	--	cd/m^2	*2)*3)
Response Time		tr	θ = φ = 0°	--	15	--	ms	*3)*4)
		tf	θ = φ = 0°	--	35	--	ms	*3)*4)
Viewing Angle	Horizontal	φ	CR ≥ 10	--	-60~60	--	°	*3)
	Vertical	θ		--	-45~55	--	°	*3)
Color Coordinates	Red	Rx	θ = φ = 0°	0.54	0.57	0.60	--	*3)
		Ry		0.30	0.33	0.36		
	Green	Gx		0.30	0.33	0.36		
		Gy		0.49	0.52	0.55		
	Blue	Bx		0.14	0.17	0.20		
		By		0.15	0.18	0.21		
	White	Wx		0.29	0.32	0.35		
		Wy		0.31	0.34	0.37		

[Note]
 These items are measured using BM-5A(TOPCON) or LCD-7000(Otsuka Electronic) under the dark room condition (no ambient light).
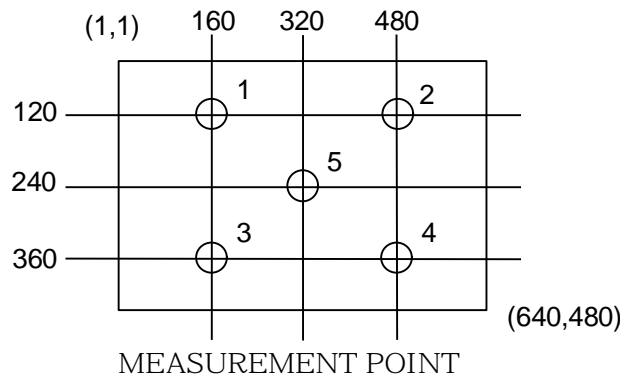
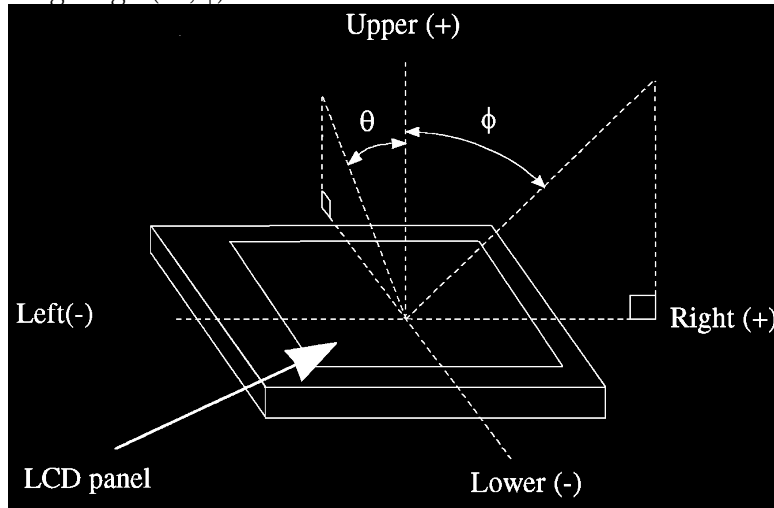 Condition: IL=6.0mArms, FL=55 kHz

 *1) Definition of Contrast Ratio
       CR=ON (White) Luminance / OFF(Black) Luminance: average of 5 points
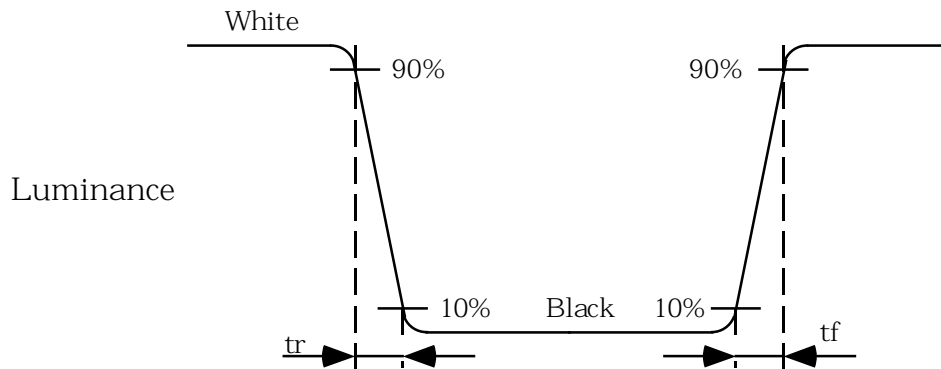
 *2) Definition of Luminance
       Lw= ON (White) Luminance: average of 5 points

MEASUREMENT POINT

*3) Definition of Viewing Angle(θ, ϕ)

*4) Definition of Response Time

9. RELIABILITY TEST CONDITION

(1) Temperature and Humidity

TEST ITEM	CONDITIONS
HIGH TEMPERATURE HIGH HUMIDITY OPERATION	40°C, 90%RH, 240 h
HIGH TEMPERATURE STORAGE	60°C, 96 h
LOW TEMPERATURE STORAGE	-20°C, 96 h
THERMAL SHOCK(NON-OPERATION)	BETWEEN -20°C (1h) and 60°C(1h), 5 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 axis 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 to 5Hz in each of three mutually perpendicular axis(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, obvious non-uniformity, or line defects.

10. INSPECTION STANDARDS

Inspection condition is as follows:
      Viewing distance is approximately 35cm.
      Viewing angle is normal to the LCD panel.
      Ambient temperature is approximately 25°C
   Ambient light is from 300 to 500 lx.
Bright Dot is defined as follows:
      Visible through 5% transmission ND filter under the condition that black image(color 0) is
      on the display.

DEFFECT TYPE		LIMIT
POLARIZER	SCRATCH	0.01 mm ≤ W ≤ 0.05 mm, L ≤ 10 mm, N ≤ 2
	DENT, BUBBLE	D ≤ 0.5 mm, N ≤ 2
DOT DEFECT	BRIGHT DOT	N ≤ 5
	DARK DOT	N ≤ 5
	TOTAL DOT	N ≤ 8

	TWO ADJACENT DOT
	  BRIGHT DOT
	  DARK DOT
		≤ 2 PAIRS
		≤ 2 PAIRS

	THREE OR MORE ADJACENT DOT	NOT ALLOWED

	DISTANCE BETWEEN DEFECTS
	  DEFECTS
	  DARK DOT
		≥ 15 mm
		≥ 15 mm

LINE DEFECT		NOT ALLOWED

  *1) W: width,   L: length,   D: diameter,   N: number
  *2) DEFINITION OF ADJACENT

R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B

    ■ Defective Dot
    ■ Adjacent Dots
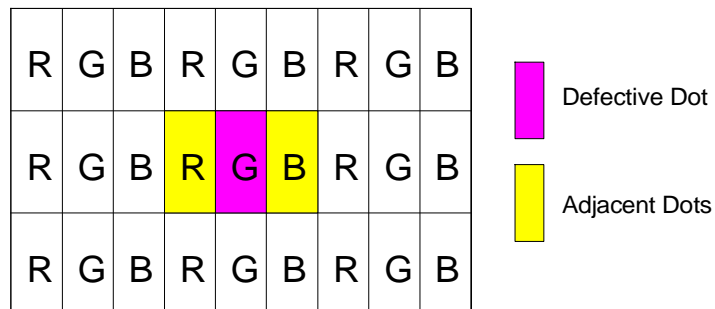
   The defects that are not defined above and considered to be problem shall be reviewed and discussed by both parties.

11. HANDLING PRECAUTIONS FOR TFT-LCD MODULE

Please pay attention to the followings in handling TFT-LCD products;

(1) ASSEMBLY PRECAUTION

a. Please use the mounting hole on the module in installing and do not bending or wrenching LCD in assembling. And please do not drop, bend or twist LCD module in handling.

b. Please design display housing in accordance with the following guide lines.

   (a) Housing case must be designed carefully so as not to put stresses on LCD all sides and not to wrench module. The stresses may cause non-uniformity even if there is no non-uniformity statically.

   (b) Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.

   (c) When some parts, such as, FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is, especially, to be reconsidered when the additional parts are implemented for EMI countermeasure.

   (d) Design the inverter location and connector position carefully so as not to give stress to lamp cable, or not to interface the LCD module by the lamp cable.

   (e) Keep sufficient clearance between LCD module and the others parts, such as inverter and speaker so as not to interface the LCD module. Approximately 1.0mm of the clearance in the design is recommended.

c. Please do not push or scratch LCD panel surface with anything hard. And do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)

d. Please do not press any parts on the rear side such as source TCP, gate TCP, control circuit board and FPCs during handling LCD module. If pressing rear part is unavoidable, handle the LCD module with care not to damage them.

e. Please wipe off LCD panel surface with absorbent cotton or soft cloth in case of it being soiled.

f. Please wipe off drops of adhesives like saliva and water on LCD panel surface immediately. They might damage to cause panel surface variation and color change.

g. Please do not take a LCD module to pieces and reconstruct it. Resolving and reconstructing modules may cause them not to work well.

h. Please do not touch metal frames with bare hands and soiled gloves. A color change of the metal frames can happen during a long preservation of soiled LCD modules.

i. Please pay attention to handling lead wire of backlight so that it is not tugged in connecting

with inverter.

j. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.

k. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.

(2) OPERATING PRECAUTIONS

a. Please be sure to turn off the power supply before connecting and disconnecting signal input cable.

b. Please do not change variable resistance settings in LCD module. They are adjusted to the most suitable value. If they are changed, it might happen LCD does not satisfy the characteristics specification.

c. LCD backlight takes longer time to become stable of radiation characteristics in low temperature than in room temperature.

d. A condensation might happen on the surface and inside of LCD module in case of sudden change of ambient temperature.

e. Please pay attention not to display the same pattern for very long time. Image might stick on LCD. Even if image sticking happens, it may disappear as the operation time proceeds.

f. Please obey the same safe instructions as ones being prepared for ordinary electronic products.

(3) PRECAUTIONS WITH ELECTROSTATICS

a. This LCD module use CMOS-IC on circuit board and TFT-LCD panel, and so it is easy to be affected by electrostatics. Please be careful with electrostatics by the way of your body connecting to the ground and so on.

b. Please remove protection film very slowly from the surface of LCD module to prevent from electrostatics occurrence.

(4) STORAGE PRECAUTIONS

a. Please do not leave the LCDs in the environment of high humidity and high temperature such as 60°C90%RH.

b. Please do not leave the LCDs in the environment of low temperature; below -20°C.

(5) SAFETY PRECAUTIONS

a. When you waste damaged or unnecessary LCDs, it is recommended to crush LCDs into pieces

and wash them off with solvents such as acetone and ethanol, which should later be burned.

b. If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

c. Be sure to turn off the power supply when inserting or disconnecting the cable.

d. Inverter should be designed carefully so as not to keep working in case of detecting over current or open circuit on the lamp.

(6) OTHERS

a. A strong incident light into LCD panel might cause display characteristics changing inferior because of polarizer film, color filter, and other materials becoming inferior. Please do not expose LCD module direct sunlight and strong UV rays.

b. Please pay attention to a panel side of LCD module not to contact with other materials in preserving it alone.

c. For the packaging box, please pay attention to the followings;

(a) Packaging box and inner case for LCD are designed to protect the LCDs from the damage or scratching during transportation. Please do not open except picking LCDs up from the box.

(b) Please do not pile them up more than 5 boxes. (They are not designed so.) And please do not turn over.

(c) Please handle packaging box with care not to give them sudden shock and vibrations. And also please do not throw them up.

(d) Packaging box and inner case for LCDs are made of cardboard. So please pay attention not to get them wet. (Such like keeping them in high humidity or wet place can occur getting them wet.)