Thin-Film-Transistor LCD Module
Model: GTTY43SP7F1R0

Acceptance

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Approved and Checked by

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S G 2007		S G 2007	S G 2007

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Product Specification

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Revise Records

Rev.	Date	Contents	Written	Approved
A	2007/06/26	Preliminary Specification	Kevin Lin	Garry Chen
A.1	2007/07/23	To revised basic display color and gray scale	Kevin Lin	
		To revised AC timing	Kevin Lin	

Special Notes

Note1.	
Note2.	
Note3.	
Note4.	
Note5.	

Contents

1   General Description and Features

GTTY43SP7F1R0 is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit and a touch screen panel (TSP). The resolution of a 4.3" contains 480RGBx272 dots and can display up to 16.7M colors. The following table described the features of GTTY43SP7F1R0.
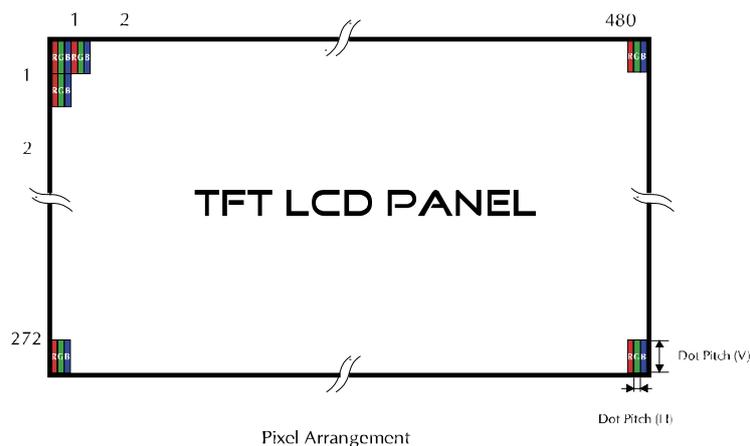
1.1   Features
- Transmissive and back-light with seven LEDs are available.
- TN (Twisted Nematic) mode.
- Line inversion mode with stripe type.
- Using the Touch Screen Panel (Film to Glass).
- 24bit RGB Interface

1.2   Applications
- Display terminals for PMP (Portable Multimedia Player) application products.

1.3   LCD Module

Item	Specification	Unit
Screen Size	4.3 inches	Diagonal
Display Resolution	480 x RGB x 272	Dot
Dot Pitch	0.198 (H) x 0.198 (V)	mm
Active Area	95.040 (H) x 53.856 (V)	mm
Outline Dimension	105.5 (W) x 67.2 (H) x 5.05 (D)	mm
Display Mode	Normally white/Transmissive	--
Pixel Arrangement	RGB-Stripe	--
Surface Treatment	Anti-glare (AG)	--
Display Color	16.7M	--
Viewing Direction	6 o'clock	--
Input Interface	Digital 24-bits parallel RGB	--
Color Gamut (NTSC%)	NTSC 50%	--

Pixel Arrangement

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2 Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	--	105.5	--	mm	--
	Vertical (V)	--	67.20	--	mm	(1)
	Thickness (T)	--	5.05	--	mm	(1)
Weight		--	N/A	--	g	--

Note (1) Not include FPC.
　　　　Refer to the Dimensional Outlines for further information.
　　(2) Back-light & touch panel unit are included.

3 Absolute Maximum Ratings

3.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

$(Ta=25\pm2°C, V_{SS}=GND=0)$

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T_{STG}	-20	70	°C	(1)
Operating temperature (Ambient temperature)	T_{OPR}	-10	60	°C	(1), (2)

Note (1) 90 % RH Max. (60 °C ≥ Ta)

　　　　Absolute humidity shall be less than 90 % RH (Ta > 60 °C) No condensation.

Note (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character.

3.2 Electrical Absolute Rating

3.2.1 TFT-LCD Module

(Ta=25±2°C, V_{SS}=GND=0)

Item	Symbol	Value		Unit	Condition
		Min.	Max.		
Logic power supply	V_{DD}	-0.3	6.0	V	
Driver power supply	AV_{DD}	-0.3	6.0	V	
Logic input voltage	V_{I1}	-0.3	V_{DD}+0.3	V	
Driver input voltage	V_{I2}	-0.3	AV_{DD} +0.3	V	
Logic output voltage	V_{O1}	-0.3	V_{DD}+0.3	V	
Driver output voltage	V_{O2}	-0.3	AV_{DD} +0.3	V	

Note :

1. Temp. ≤ 60°C, 90% RH MAX.
2. Temp. > 60°C , absolute humidity shall be less than 90% RH at 60°C

3.2.2 Back-Light Unit

(Ta=25±2°C)

Item	Symbol	Min.	Max.	Unit	Note
Current	I_f	--	20	mA	(1)

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded. Functional operation should be restricted to the conditions described under normal operating conditions.

4 Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).
Measuring equipment: BM-5A

(Ta=25±2°C , Vcc = V_{CI}=3.3V, $I_{f=}$20mA)

Item		Symbol	Condition	Min	Type	Max	Unit	Note
Brightness		--	--	200	250	--	cd/m^2	(1),(2)
Response time		T_R	θ=0°	--	15	20	ms	(1),(2)
		T_F		--	35	50	ms	
Contrast ratio		CR	At optimized viewing angle	200	250	--	--	(1)
Color Chromaticity	Red	R_X	θ=0° Normal Viewing Angle	0.585	0.615	0.645	--	(1)
		R_Y		0.314	0.344	0.374		
	Green	G_X		0.277	0.307	0.337	--	
		G_Y		0.532	0.562	0.592		
	Blue	B_X		0.103	0.133	0.163	--	
		B_Y		0.120	0.150	0.180		
	White	Wx		0.279	0.309	0.339	--	
		Wy		0.320	0.350	0.380		
Viewing Angle (6H)	Hor.	θ_R	CR≥10	55	65	--	Degree	(1)
		θ_L		55	65	--		
	Ver.	ϕ_H		40	50	--		
		ϕ_L		55	65	--		

Note : (1) Measuring surrounding : dark room

(2) 5min. warm-up time

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a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".
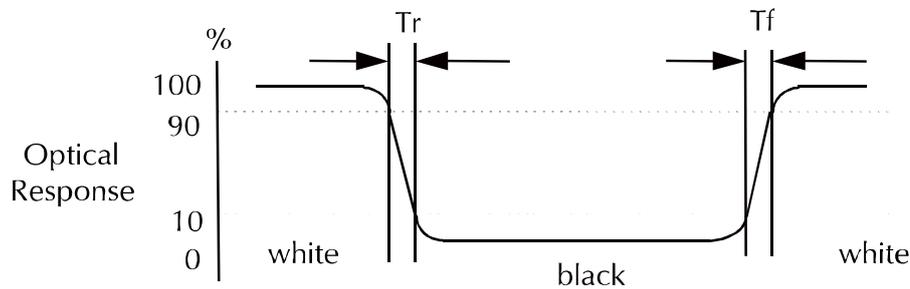
c. Definition of contrast ratio:

$$\text{Contrast Ratio (CR)} = \frac{\text{Brightness measured when LCD is at "white state"}}{\text{Brightness measured when LCD is at "black state"}}$$
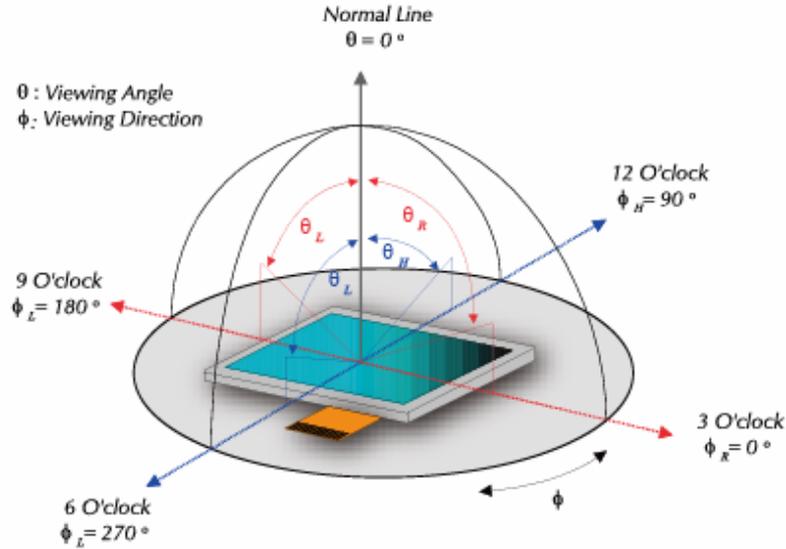
d. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

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e. View Angle

f. Definition of Luminance of White: Luminance of white at the center points

| Light Source of Back-Light Unit	LED Type

g. Definition of White Uniformity

$$\text{White Uniformity} = \frac{\text{Min. luminance of white among 5-points}}{\text{Max. luminance of white among 5-points}}$$

h. The definition of Color Gamut -Color Chromaticity CIE 1931
   Color coordinate of white & red, green, blue at center point.
   Color Gamut : NTSC(%) = (RGB Triangle Area / NTSC Triangle Area) x 100

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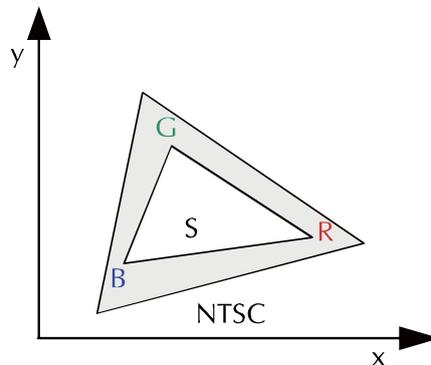
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5 Electrical Characteristics

5.1 TFT-LCD Module

(Ta=25±2°C,DVSS=AVSS=0V)

Item	Symbol	Value			Unit	Condition
		Min.	Typ.	Max.		
Logic power supply	V_{DD}	2.25	3.3	3.6	V	
Driver power supply	AV_{DD}	4.8	5.0	5.2	V	
Input high voltage	V_{IH}	0.7x V_{DD}	--	V_{DD}	V	
Input low voltage	V_{IL}	0	--	0.3xV_{DD}	V	
Driver output voltage	V_O	0.2	--	AV_{DD}-0.2	V	
Gamma voltage	V_N	0.2	--	AV_{DD}-0.2	V	
Clock frequency	f_{CLK}	--	9	15	MHz	

5.2 Power ON/OFF sequence

This LCM has a power ON/OFF sequence control function. When DISP pin is pulled. "H", blank data is outputted for 10-frames first, from the falling edge of the following VSYNC signal. Similarly, when DISP is pulled "L", 10-frames of blank data will be outputted from the falling edge of the following VSYNC, too. The blank data would be gray level 0 for normally black LC (NBW="H"), and be gray level 255 for normally white LC (NBW="L").
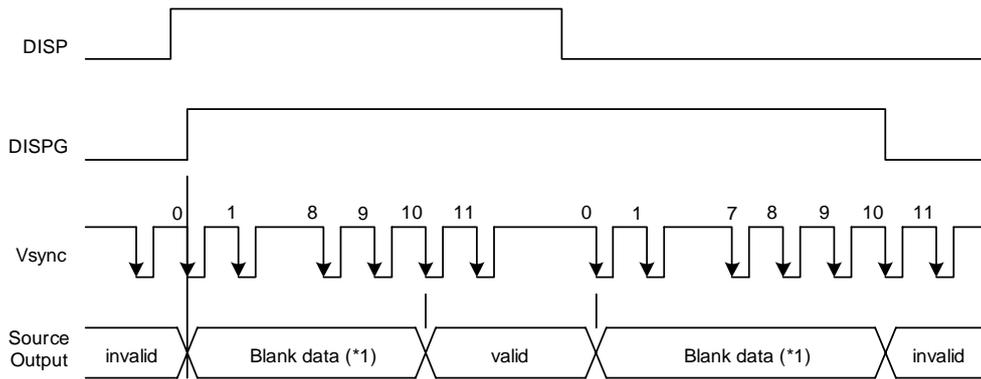
This LCM is internally initialized by the global reset signal, RESETB. The reset input must be held for at least 1ms after power is stable.

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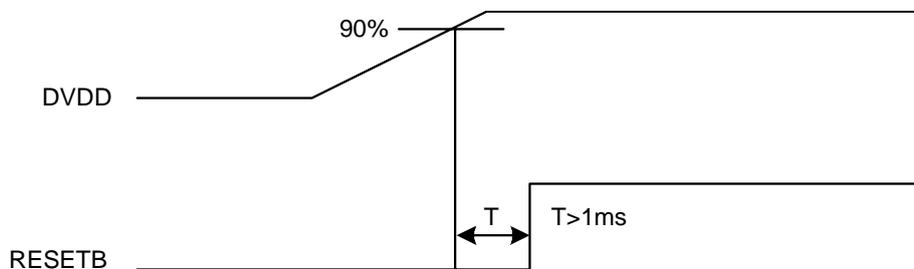
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5.3   Backlight Unit

The back-light system is an edge-lighting type with **seven** white LED (Light Emitting Diode)s.

(Ta=25±2°C)

Item	Symbol	Value			Unit	Condition
		Min.	Typ.	Max.		
Power Consumption	P_{LED}	-	735	-	mW	
LED Current	If	-	20	-	mA	

Note (1) Seven LEDs serial type.

(2) Where If = 20mA, V_B =23.8V= P_{LED} / If

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6   Touch Screen Panel Specifications

6.1   Touch Screen Panel Specifications

6.1.1 Electrical Characteristics

Item	Min.	Typ.	Max.	Unit	Note
Linearity	-1.5	-	1.5	%	Analog X and Y directions
Terminal resistance	200	-	700	Ω	X (Glass side)
	200	-	900	Ω	Y (Film side)
Insulation resistance	20	-	-	$M\Omega$	DC 25V
Voltage	-	5.0	7.0	V	DC
Chattering	-	-	10	ms	100kΩ pull-up
Transparency	-	82	-	%	Non-glare

Caution (1) : Do not operate it with a thing except a polyacetal pen (tip R0.8mm or less) or a finger,

especially those with hard or sharp tips such as a ball point pen or a mechanical pencil.

6.1.2 Mechanical & Reliability Characteristics

Item	Min.	Typ.	Max.	Unit	Note
Activation force	-		80	g	(1)
Durability-surface scratching	Write 100,000	-	-	characters	(2)
Durability-surface pitting	1,000,000	-	-	touches	(3)
Surface hardness	3	-	-	H	JIS K5400,ASTM D3363

Note (1) Stylus pen Input : R0.8mm polyacetal pen or Finger

Note (2) Measurement for Surface area - Scratch 100,000 times straight line on the Film with a stylus change every 20,000times
- Force : 150gf
- Speed : 100mm/sec
- Stylus : R0.8 polyacetal tip

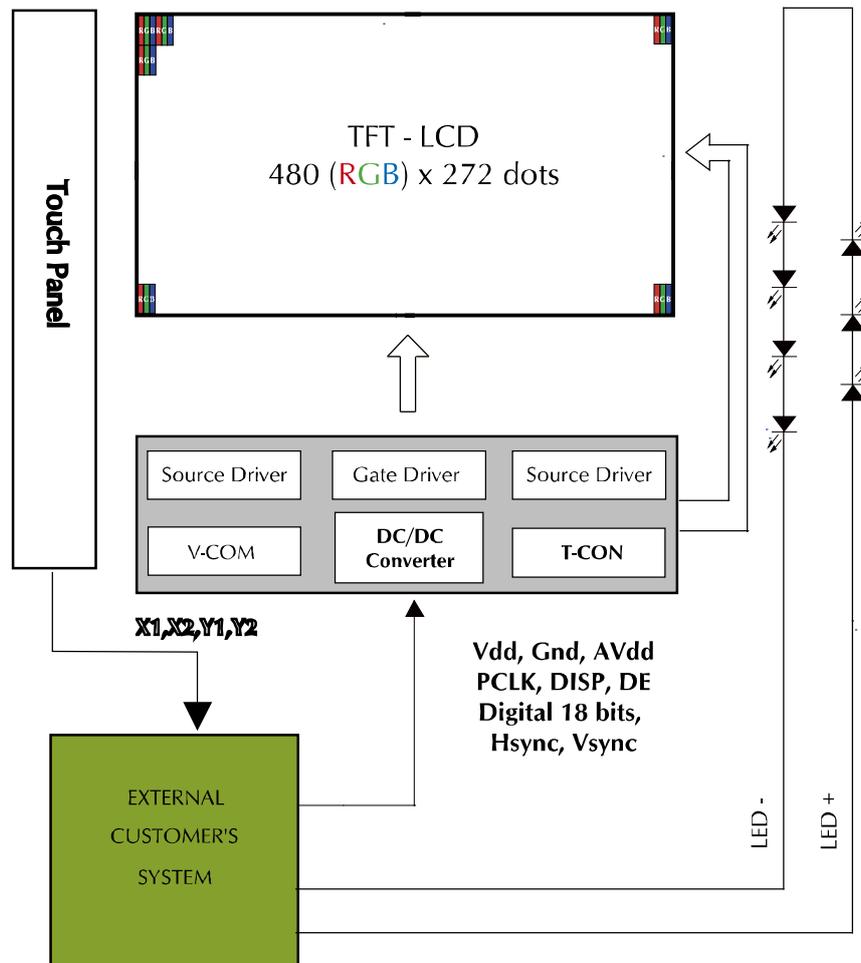Note (2) Pit 1,000,000 times on the Film with a R8.0 silicon rubber.
- Force : Force : 250gf
- Speed : 3times/sec

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7   Block Diagram

7.1   TFT-LCD Module (Interface System Structure) with Back Light Unit

7.2   Touch Panel (TSP)

Pin No.	Symbol	Function	Remark
1	X2	Touch Panel Left Side	--
2	Y2	Touch Panel Bottom Side	--
3	X1	Touch Panel Right Side	--
4	Y1	Touch Panel Top Side	--

8 Input Terminal Pin Assignment

8.1 CN1 Pin Assignment (LCD)

Pin No.	Symbol	I/O	Function	Remark
1	GND	I	Ground	
2	GND	I	Ground	
3	V_{DD}	I	Logic power supply	
4	V_{DD}	I	Logic power supply	
5	R0	I	Red Data Bit 0	
6	R1	I	Red Data Bit 1	
7	R2	I	Red Data Bit 2	
8	R3	I	Red Data Bit 3	
9	R4	I	Red Data Bit 4	
10	R5	I	Red Data Bit 5	
11	R6	I	Red Data Bit 6	
12	R7	I	Red Data Bit 7	
13	G0	I	Green Data Bit 0	
14	G1	I	Green Data Bit 1	
15	G2	I	Green Data Bit 2	
16	G3	I	Green Data Bit 3	
17	G4	I	Green Data Bit 4	
18	G5	I	Green Data Bit 5	
19	G6	I	Green Data Bit 6	
20	G7	I	Green Data Bit 7	
21	B0	I	Blue Data Bit 0	
22	B1	I	Blue Data Bit 1	
23	B2	I	Blue Data Bit 2	
24	B3	I	Blue Data Bit 3	
25	B4	I	Blue Data Bit 4	
26	B5	I	Blue Data Bit 5	
27	B6	I	Blue Data Bit 6	
28	B7	I	Blue Data Bit 7	
29	GND	I	Ground	
30	P_{CLK}	I	Dot Data Clock	
31	DISP	I	Display on/off mode control.	
32	H_{SYNC}	I	Horizontal Sync Input	
33	V_{SYNC}	I	Vertical Sync Input	

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34	DEN	I	Data Enable Input	
35	AV$_{DD}$	I	Driver power supply	
36	AV$_{DD}$	I	Driver power supply	
37	R/L	--	Horizontal display mode select signal L: Normal H: Left / Right reverse mode	Note
38	U/D	--	Vertical display mode select signal H: Normal L: Up / Down reverse mode	Note
39	GND	I	Ground	
40	GND	I	Ground	

Note 5 - 2, 3
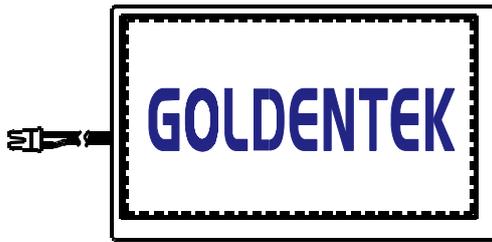
R/L = L, U/D = H

R/L = H, U/D = H

R/L = L, U/D = L

R/L = H, U/D = L

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9   Basic Display Color and Gray Scale

		Color & Gray Scale	Data Signal																										
			R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
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(0)	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(0)	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(0)	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		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(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(127)	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
		Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Red(255)	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		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
		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(127)	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
		Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
		Green(255)	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		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
		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(127)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
		Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
		Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

0 : Low level voltage, 1 :High level voltage

Each basic color can be displayed in 256 gray scales from 8 bit data signals. With the combination of total 24 bit data signals, the 16,777,216-color display can be achieved on the screen.

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10 AC Timing

10.1 AC Timing Characteristics

(T$_A$ =25ºC, VDD=3.3V, DVSS= 0V)

PARAMETER	Symbol	Min.	Typ.	Max.	Unit
Clock cycle	Dclk	--	10.89	15	MHz
Horizontal Signal					
Horizontal cycle	Th	--	550	--	CLK
Horizontal display period	Thd	--	480	--	CLK
Horizontal front porch	Thf	--	42	--	CLK
Horizontal pulse width	Thp	--	10	--	CLK
Horizontal back porch	Thb	--	18	--	CLK
Vertical Signal					
Vertical cycle	Tv	--	330	--	H
Vertical display period	Tvd	--	272	--	H
Vertical front porch	Tvf	--	54	--	H
Vertical pulse width	Tvp	--	2	--	H
Vertical back porch	Tvb	--	2	--	H

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10.2 AC Timing Diagram
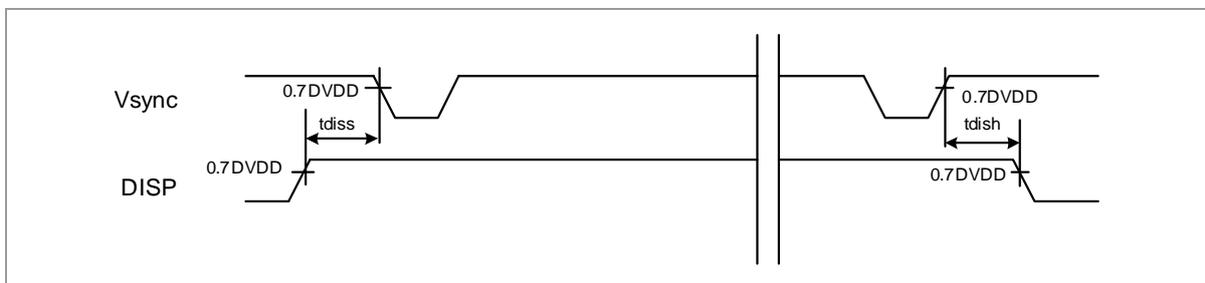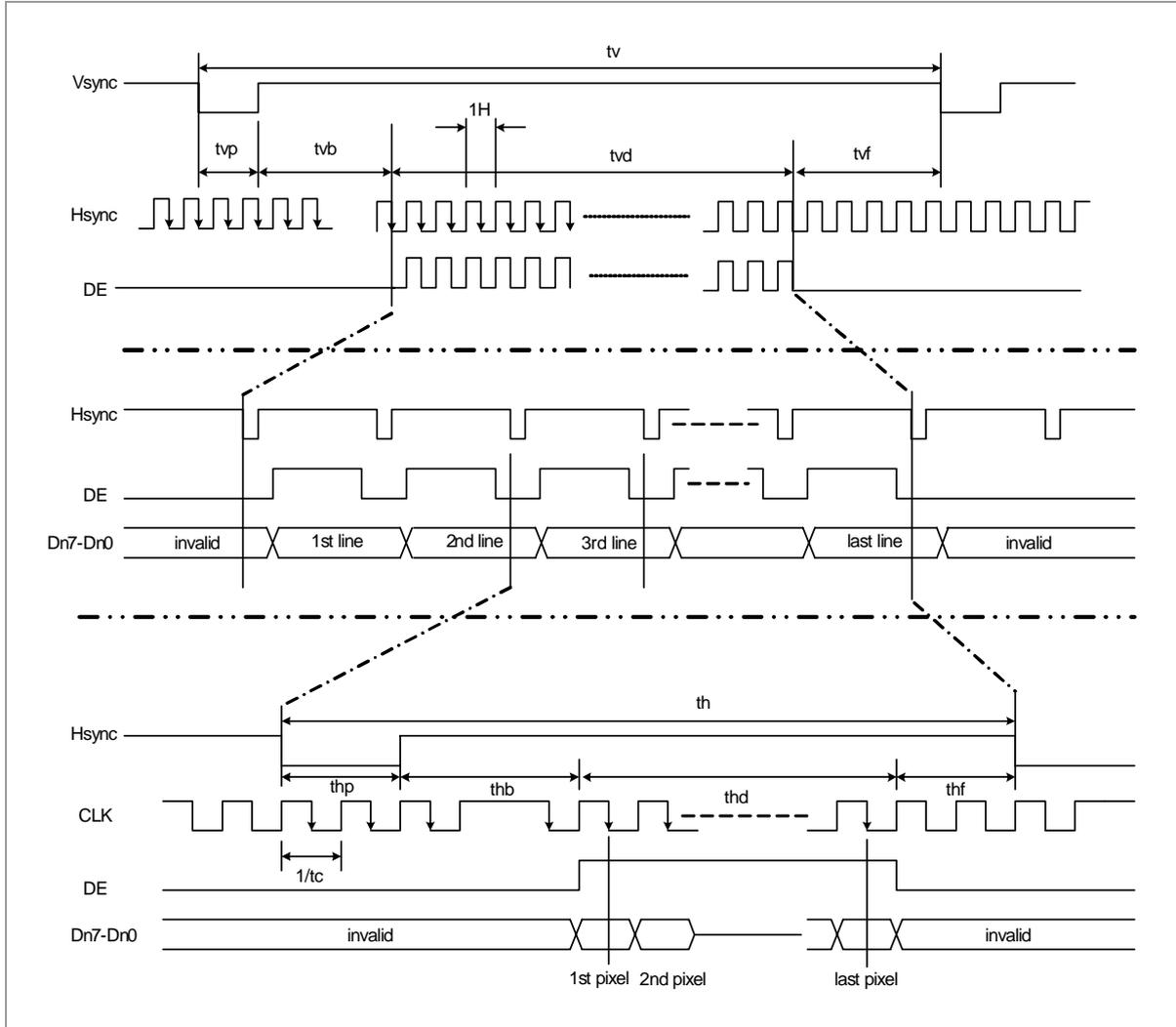
11 Quality Standard for LCD

11.1 Objective

This specification book is the standard for LCD module general inspection. And also this book will be refer to customer approval specification.

11.2 Scope

This specification book is applicable to general LCD module. If supplier has any doubt or requirement, then it can be discussed.

11.2.1 Acceptable Quality Level

INSPECTION	SAMPLING PROCEDURES	A.Q.L
Major	MIL-STD-105E Inspection Level II Normal Inspection, Single sample inspection	1
Minor	MIL-STD-105E Inspection Level II Normal Inspection, Single sample inspection	1.5

Major defect :

A major defect is a defect that could result in failure or extremely reduction on the usability of the product for its intended purpose.

Minor defect :

A minor defect is one that does not materially reduce the usability of the product for its intended purple or is a departure from established standards giving no significant bearing on the effective use or operation of the unit.

11.2.2 Inspection Conditions

11.2.2.1 The environmental conditions for inspection shall be as follows
- Room Temperature : 25±10°C
- Humidity Temperature : 45±20%RH

11.2.3 The external visual inspection
- The inspection shall be performed by using 40Watts fluorescent lamp for illumination and the distance between LCD and eyes of the inspector shall be 30cm or more.

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11.2.4 Inspection Item

Pinhole, Bright spot, Black spot, White spot, Black line, White Line, Foreign particle, Bubble	The color of a small area is different from the remainder. The phenomenon dose not change with voltage.
Contrast variation	The color of a small area is different from the remainder. The phenomenon change with voltage.
Glass defect	Glass crack, Chip
Operating	Function, Contrast, Uniformity, Components

11.2.5 Definition of the Area
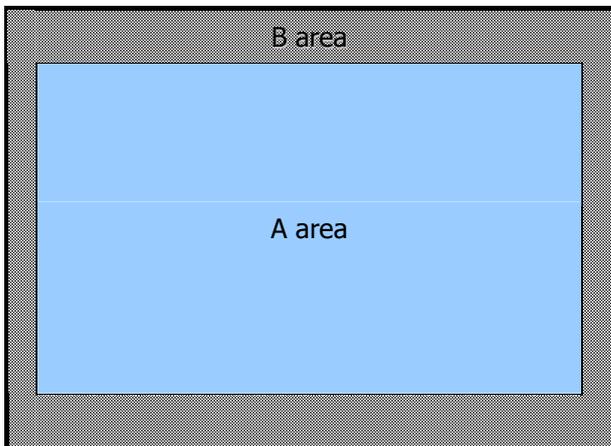
B area

A area

A area: Viewing Area

B area: Out of Viewing Area

11.3 Inspection specification

11.3.1 Non-operating inspection specification

Class of defects	No.	Inspection Item	Criteria of defects			Acceptable Q'ty	
						Zone A	Zone B
Major	1	Circuits	1. Circuit short			0	0
			2. Circuit open				
Minor	2	(Black spot, White spot, Bright spot, Foreign particle) $\phi = (a+b)/2$	A	$\phi \le 0.1$		*	Ignore
			B	$0.1 < \phi < 0.2$		3	
			C	$0.2 \le \phi < 0.3$		1	
			D	$0.3 \le \phi$		0	
			Total defect point (B,C)			3	
			* Reject when 5 or more spots are gathered within 5mm circle.				
	3	(Black line, White line)	A	$W \le 0.02$	-	*	Ignore
			B	$0.02 < W \le 0.05$	$L \le 5$	2	
			C	$0.05 < W \le 0.1$	$L \le 3$	2	
			D	$0.1 < W$	-	0	
			Total defect point (B,C)			3	
			* Reject when 5 or more spots are gathered within 5mm circle.				
	4	(Contrast variation) $\phi = (a+b)/2$	A	$\phi \le 0.3$		Ignore	Ignore
			B	$0.3 < \phi \le 0.4$		2	
			C	$0.4 < \phi \le 0.5$		1	
			D	$0.5 < \phi$		0	
			Total defect point (B,C)			3	
	5	(Pattern deformity) $\phi = (a+b)/2$	1. Pin hole				Ignore
			A	$\phi \le 0.15$		Ignore	
			B	$0.15 < \phi \le 0.2$		2 (*)	
				$0.2 < \phi$		0	
			* Two pin hole shall not formed in the single dot				
			2. Excess, void				Ignore
			A	$a \le 0.2$ and $b \le 0.2$		Ignore	
			B	$0.2 < a$ or $0.2 < b$		0	

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Minor	6	Dot defect	A	Bright dot	0	Ignore	
			B	Dark dot	1		
			* This inspection item does not apply to B/W LCD				
	7	Bubble between Polarizer and panel	A	$\phi \leq 0.3$	Ignore	Ignore	
			B	$0.3 < \phi \leq 0.5$	2		
			C	$0.5 < \phi$	0		
	8	Polarizer scratch and particle	Circular: Same as inspection item No.2			Ignore	
			Linear: Same as inspection item No.3				
	9	Polarizer Dent	A	$\phi \leq 0.2$	Ignore	Ignore	
			B	$0.2 < \phi \leq 0.3$	2		
			C	$0.3 < \phi \leq 0.4$	1		
			D	$0.4 < \phi$	0		
			Total defect point (B,C)		3		
	10	Bubble in the Cell	Any size		0	0	
	11	Dirt on polarizer	Dirt which can be wiped easily should be accepted.				
	12	Protection film	The protection film should not be stripped up to viewing area and the peeled off angle should not exceed 20 degrees.				
	13	Polarizer shift	1. Shifting in position should not exceed the glass outline dimension. 2. Incomplete covering of the viewing area due to shifting is not allowed. 3. Shifting in position should be within the tolerance (refer to module dimensional drawing)				
	14	Silicon	1. Silicon must cover all circuits. 2. Silicon thickness should be within specification (refer to module dimensional drawing)				
	15	Tape	1. Location: refer to specification. 2. Insufficient adhesive.				
Major	16	TCP, FPC defect	Film or Pattern should not have crack.				
	17	Components	Missing components not allowed.				

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Class of defects	No.	Inspection Item	Criteria of defects
Major	18	(Progressive crack)	Reject any progressive crack.
Minor	19	(The front lead terminals)	$a \leq t$ $b \leq 1$ $c \leq 7.0$ * Glass crack should not cover alignment mark
	20	(The rear of lead terminals)	$a \leq t$ $b \leq 1$ $c \leq 7.0$
	21	(Short glass side)	$a \leq t$ $c \leq 7.0$ $b <$ Inner border line of the each
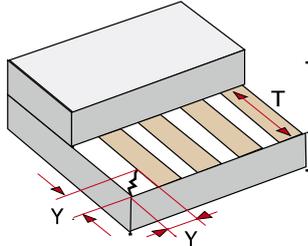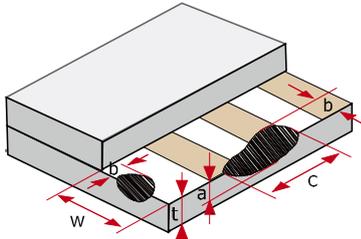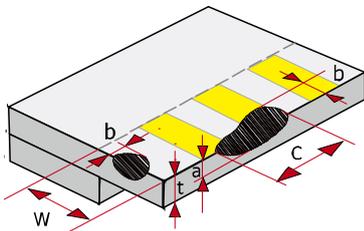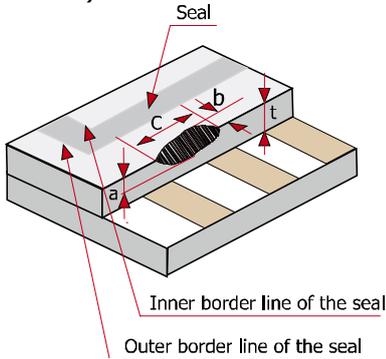
Class of defects	No.	Inspection Item	Criteria of defects
Major	22	(Progressive crack)	Reject any progressive crack.
	23	(Corner)	$a \leq t$ $b \leq 3.0$ $c \leq 3.0$ * Glass crack should not cover patterns used for recognition and assembly, alignment mark and patterns.
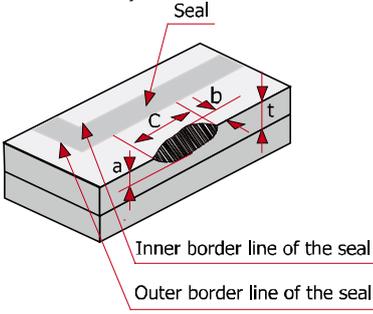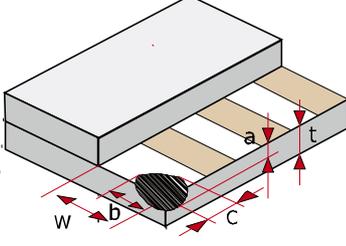
* Condition of item 2~9

1. Distance between defects must be more than 10mm with light on, more than 15mm with light off.
2. Total acceptable defect number
   - Defects with light on : 6 points
   - Defects with light off : 4 points
   - Total defect point : 6 points
3. Regarding the defect distance and total acceptable defect number, above 2-A, 3-A should be neglected.

*Condition of item 19 ~ 23

1. Total acceptable defect number: 4

Class of defects	No.	Inspection Item	Criteria of defects
Major	1	No display	--
	2	Abnormal operation	--
	3	Contrast defect	Judge according to module specification. Establish boundary sample if required.
	4	Viewing angle defect	Judge according to module specification. Establish boundary sample if required.
	5	Excess power consumption	Judge according to module specification.
	6	Back-light, LED defect	1. No lit-on 2. Different color 3. Low brightness
	7	Speaker, Vibrator defect	1. No operation 2. Abnormal operation
Minor	8	Cross-talk defect	No noticeable crosstalk. Establish boundary sample if required.
	9	Uneven brightness	No noticeable unevenness allowed. Establish boundary sample if required.
	10	Uneven color	No noticeable unevenness allowed. Establish boundary sample if required.
	11	Spot, Pinhole, Foreign particle, Line	Same as in Chapter 7.1

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12 Reliability Condition for LCD

12.1 LCD Reliability Test

12.1.1 Reliability Test Condition

No.	TFT	Item	Condition	Test time	Note
1	V	High temp. operating	60°C	240 Hrs	--
2	V	Low temp. operating	-10°C	240 Hrs	--
3	V	High temp. storage	70°C	240 Hrs	--
4	V	Low temp. storage	-20°C	240 Hrs	--
5	V	High Temp / High Humidity Storage	T = 60°C /90%. For (But no condensation dew)	24 Hrs	--
6	V	High Temp/ High Humidity Operating	T = 40°C /90% For (But no condensation dew)	240 Hrs	--
7	V	Thermal Shock	-20 ~ 70°C, 50 cycle	1 Hrs	--

12.1.2 Operating Test Pattern

No.	Items	Test Pattern
1	Test Pattern in Driving Condition	1. Full Red 2. Full Green 3. Full Blue 4. Gradation (horizontal) 5. Gradation (vertical) 6. Character (111111) 7. Full White 8. Full Black 9. Black Line (horizontal) 10. Black Line (vertical) 11. Mosaic (1X1) The Test Pattern is changed 1sec. The same Pattern are repeated.
2	Black Square	Black Window and White Background

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12.1.3 Test Method

The method of visual inspection is equal to the appearance standard. Evaluation and assessment made two hours after return to room temperature (25 ± 5°C). The LCDs subjected to the test must not have dew condensation.
The test pattern is gray scale and the operating voltage sweep from Vth to Vsat variable.
The non-uniformity and other appearance are checked in LCD.

12.1.4 Result Evaluation Criteria

There should be no change which might affect the practical display function when the dis playquality test is conducted under normal operating condition.

12.1.5 Life time

Life time expectancy of LCD Panel is approximately 50,000 hours under the room environ ment
Definition on the termination of life time is deterioration of contrast ratio by one fifth against initial value.

12.1.6 Basic rule for Reliability test

* Place all the samples under room temperature & humidity for 24 hours after reliability st ressing.
* Room environment means 25+/-10°C, 45+/-20%RH.
* There should be no condensation during the test.
* One LCD module shall be used for one test item only and once.

12.1.7 Judgment Criteria for reliability test No. 1-2

* Contrast (or Brightness) ratio variation is within 50% of the initial value.
* No abnormal function
* No extreme decay on appearance

12.1.8 Life time

Main Display (LCD module) : Life time expectancy of LCD Panel is approximately 50,000 hours under the room environment. Definition on the termination of life time is deterioration of contrast ratio by one fifth against initial value. (25±10°C, 45±20%RH).

Life time shall be defined as one of below cases;
* When the contrast ratio for Main display reaches 30% of initial condition and the brightness (or luminance with polarizer) for sub display reaches 50% of initial condition.
* When the appearance degradation appears.

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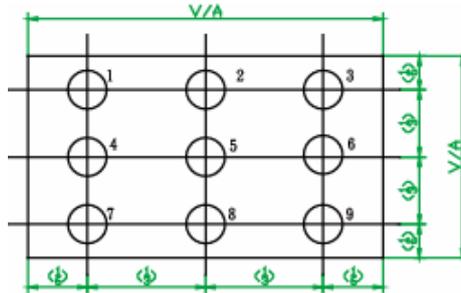**13 Inspection Quality Standard for LED Backlight**

13.1 Features

13.1.1 External dimension (H*W*T) : NIL

13.1.2 Effective Lighting area (H*W) : NIL

13.2 Absolute Maximum Rating & Operating Temperature

Item	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	20	mA
Operating Temperature	T_{opr}	-10 to 60	^oC

13.3 Optical characteristic

13.3.1 Measurement Apparatus : BM-7F made by TOPCON

13.3.2 Measurement Distance : 500 mm

13.3.3 Measurement Environment : 22^oC, 50%RH (in the dark room under 2 lux of luminance)

13.3.4 Field Angle : 1°

13.3.5 Measurement Point B/L

13.4 Luminance

Item	Unit	Measurement Condition	Specification		
			Min	Typ	Max
Min (P1 ~ P9)	cd/m^2	TBD	3850	4100	--
9 Point Uniformity	%	$\dfrac{Min \ (P1 \sim P9)}{Max \ (P1 \sim P9)} \times 100$	80	85	--

13.5 Chromaticity

Color coordination			
X	0.265	0.290	0.315
Y	0.255	0.280	0.305

13.6 Reliability test

Test Item		Condition	Specification
Storage Test	High Temp	70±2°C /240hrs	a,b,c,d,f
	Low Temp	-20±2°C /240hrs	
	High Temp & Humid	50±2°C /90%RH/240hrs	
	Thermal Shock	12cycles (each 60min for 70°C /-20°C)	
Operation Test	Temp Cycle	3cycles at +60°C (90min)/-10°C (90min), Transient time=1°C /min	a,b,c,d,e

    a.   Non-Lighting and unstable lighting should not be happened.

    b.   The luminance should be kept over 50% of the initial luminance.

    c.   The difference of uniformity before and after the test should be within ±0.25 compared to initial value.

    d.   The difference of chromaticity before and after the test should be within ±0.02 compared to initial chromaticity.

    e.   The operation test should be done at typical LED current. After measurement, let the sample at 25±5 °C, 65±20%RH for 24 hrs and it should be re-measured within 2 hrs.

    f.   The non-operation test should be measured within 2hrs after completing the test.
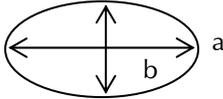
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13.7 Visual inspection

Should be checked at 22±2°C, 50±5%RH, 300-500 lux, 300mm distance, within 80 degree viewing angle in 4 directions, at typical LED current.

13.7.1 Outside of effective lighting area

Item	Condition	Specification
Particle	Non-Operation	Cannot be shown easily.
Non-lighting, Unstable lighting	Operation	None
Contamination and defects of mold frame	Non-Operation	None

13.7.2 Inside of effective lighting area

Item	Condition	Specification
Black spot, Particle	Operation	$D < 0.10$: OK (not within 15mm) $0.10 \leq D < 0.20$: 2EA OK (not within 15mm) $D \geq 0.20$: NG $D = (a+b)/2$
Bright spot, Bright Line, Dim spot Scratch, Newton Ring	Operation	Should not be shown on the glass panel after panel ass'y
Stain	Operation	Should not be shown on the glass panel after panel ass'y

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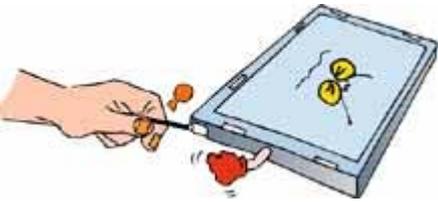|		Rev. No.	Issued Date.	Page.
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14 Precautions

14.1 Operation

Burn-in sometimes happens when the same character was displayed at along time. Therefore, to prevent Burn-in, it is recommended to set up a Screen-saver function.
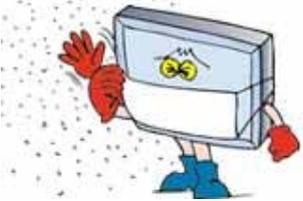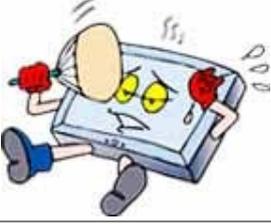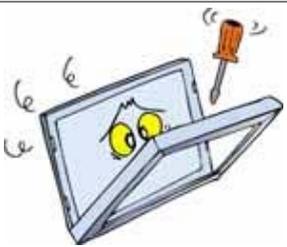
14.2 Safety

The liquid crystal in the LCD is poisonous, DO NOT put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

14.3 Handling

	a. The LCD module shall be installed flat, without twisting or bending. b. COF or FPC has narrow pattern width, so easily become open circuit by external force. DO NOT apply pressure to COF or FPC especially in bending area.
	c. To avoid damage in appearance or malfunction, DO NOT subject the module to mechanical shock or to excessive force on its surface.
	d. The polarizer attached to the display is very easy to damage, handle it with care to avoid scratching.
	e. To avoid contamination on the display surface, DO NOT touch the display surface with bare hands. f. Provide a space so that the LCD module does not come into contact with other components.

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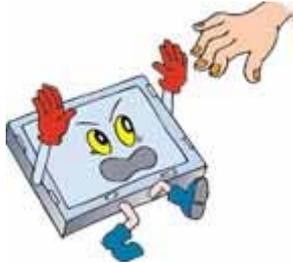|		Rev. No.	Issued Date.	Page.
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	g. To protect the LCD panel from external pressure, put covering glass (acrylic board or similar board) to keep appropriate space between them.
	h. Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
	i. Property of semiconductor devices may be affected when they are exposed to light possibly resulting in malfunctioning of the ICs. To prevent such malfunctioning of the ICs, your design and mounting layout done are so that the IC is not exposed to light in actual use.
	j. Strong light exposure causes degradation of color filter. It may not recover
	k. DO NOT contact with water to avoid Metal corrosion. l. When it is not in use, the screen must be turned off or the pattern must be frequently changed by a screen saver. If it displays the same pattern for a long period of time, brightness down/image sticking may develop due to the LCD structure.
	m.Never disassemble LCD product under any circumstances. If unqualified operators or users assemble the product after disassembling it, it may not function or its operation may be seriously affected.

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14.4 Static electricity

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge.

	a. The LCD module shall be installed flat, without twisting or bending. Ground soldering iron tips, tools and testers when they operate. b. Ground your body when handling the products. c. DO NOT apply voltage to the input terminal without applying power supply. d. DO NOT apply voltage that exceeds the absolute maximum rating. e. Store the products in an anti-electrostatic container. f. Peel off protect tape, attached to polarizer, slowly to minimize ESD damage.

14.5 Storage

	Store the products in a dark place at +5 ∼ +25 degree C, low humidity (50%RH or less). DO NOT store the products in an atmosphere containing organic solvents or corrosive gases.

14.6 Cleaning

	a. DO NOT wipe the polarizer with dry cloth, as it might cause scratch. b. Wipe the polarizer with a soft cloth soaked with petroleum IPA, other chemical might damage.

14.7 Waste

	When dispose of LCD module, manage it at the production waste according to the relevant laws and regulations.

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15 Warranty

This product has been manufactured to your company's specifications as a part for use in your company's general electronic products. It is guaranteed to perform according to delivery specifications. For any other use apart from general electronic equipment, we cannot take responsibility if the product is used in medical devices, nuclear power control equipment, aerospace equipment, fire and security systems, or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required. If the product is to be used in any of the above applications, we will need to enter into a separate product liability agreement.

1   We cannot accept responsibility for any defect, which may arise from additional manufacturing of the product (including disassembly and reassembly), after product delivery.

2   We cannot accept responsibility for any defect, which may arise after the application of strong external force to the product.

3   We cannot accept responsibility for any defect, which may arise due to the application of static electricity after the product has passed your company's acceptance inspection procedures.

4   We cannot accept responsibility for industrial property, which may arise through the use of your product, with exception to those issues relating directly to the structure or method of manufacturing of our product. SGD-origin longer than one year from SGD production.

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16 Dimensional Outlines