

PRODUCT SPECIFICATION **FOR LCD MODULE**

Revision: 1.0

Model No: LS015I02-S-V1

Module Type: COG+FPC+B/L

APPROVED SIGNATURE

- ☒ Approved Product Specification only
- ☐ Approved Product Specification and Samples

<u>Prepared By</u>	<u>Checked By</u>	<u>Approved By</u>

Records of Revision

Rev.	Date	Page	Revise	Prepared by
V1.0	2025.06.19	-	First issue	Wang Jing

Table of Contents	Page
1. Product Features	4
1.1 Introduction	4
1.2 General Features	4
2. Mechanical Specification	4
2.1 General Specification	4
2.2 Outline Dimension (Counter Drawing)	5
3. Interface Assignment	6
4. TFT Electrical Specification	7
4.1 Absolute Maximum Ratings	7
4.2 Typical Operation Conditions	7
4.2.1 DC Characteristics	7
4.2.2 AC Characteristics	8
4.2.3 Power ON/OFF Sequence	10
4.2.4 Backlight Specification	10
5. Optical Characteristics(T=25℃)	12
6. Quality Specifications	14
6.1 Condition for product appearance inspection	14
6.2 Function Inspection	15
6.3 TFT - LCD Pixel Inspection	15
6.4 TFT Module Dot And Line Inspection	16
6.5 TFT +PCAP Module Dot And Line Inspection	17
6.6 Module Cosmetic Criteria	17
7. Reliability Test	18
8. PRECAUTIONS	19
8.1 Handling	19
8.1.1	19
8.1.2	19
8.1.3	19
8.1.4	19
8.2 Storage	19
8.2.1	19
8.2.2	19
8.2.3	19
8.3 Safety	19
9. Limited Warranty	19
9.1 RETURNING LCM UNDER WARRANTY – TERMS AND CONDITIONS	19
9.1.1	19
9.1.2	19
10. Package	20

1. Product Features

1.1 Introduction

This is a color active matrix Thin Film Transistor(TFT) Liquid Crystal Display(LCD) that uses TFT as a switching device,without CTP.This model is composed of a 1.5 inch transmissive type TFT-LCD panel . The resolution of the panel is 360(RGB)*360 pixels.

1.2 General Features

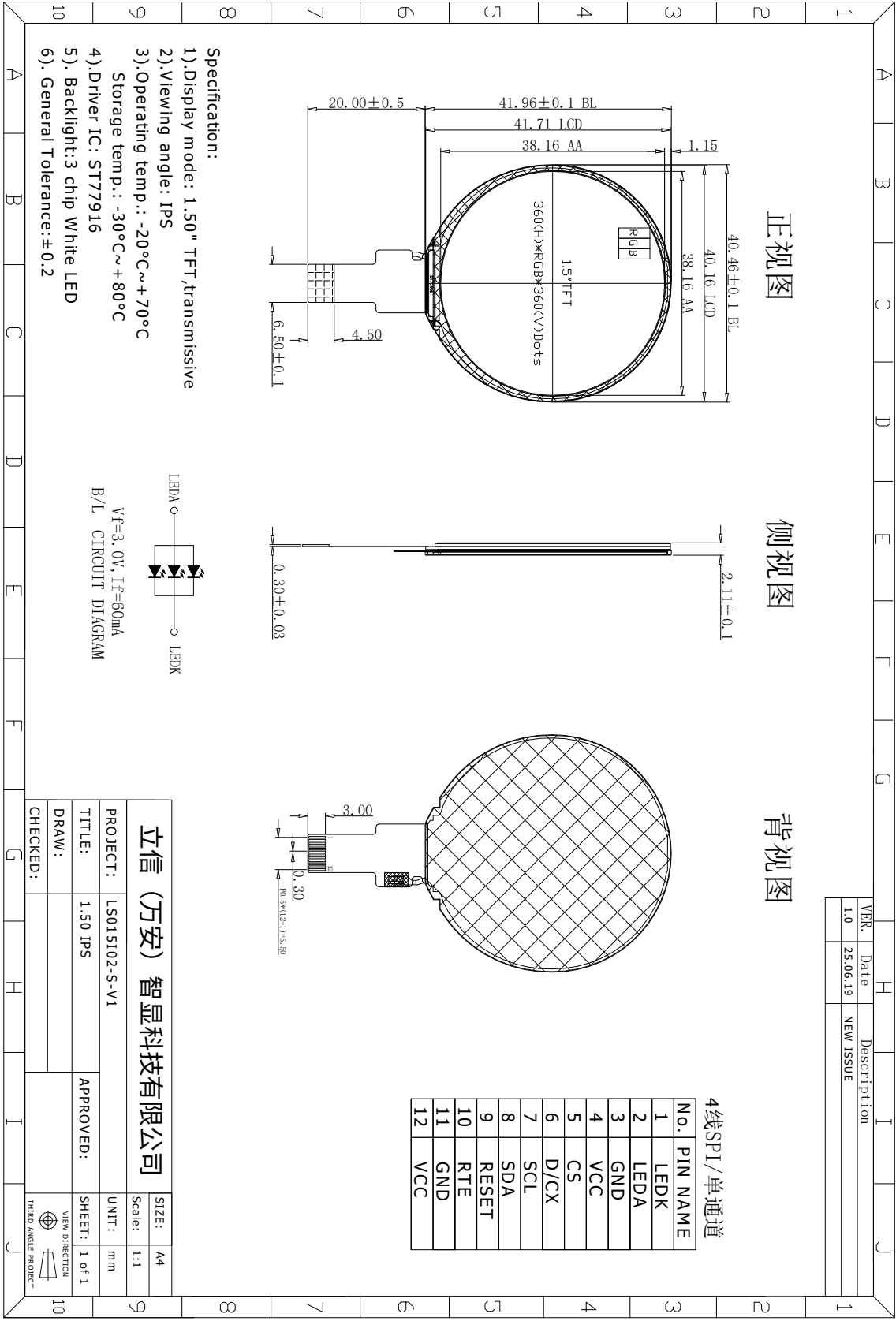
Parameter	Value	Unit
LCD Size	1.5	inch
Panel Type	IPS TFT	-
Resolution	360(RGB)*360	pixel
Display Mode	Normally Black, Transmissive	-
Display Colors	262K	-
Best Viewing Direction(eyes)	All O'clock	-
Contrast Ratio	1000(Typ.)	-
Luminance of LCD Surface	350(Typ.)	cd/m2
Driver IC	ST77916	-
Light source	3 White LED's	-
Interface	SPI-4W	-
Weight	TBD	g
Operating Temperature	-20°C~+70°C	°C
Storage Temperature	-30°C~+80°C	°C
POL	Up:0 DOWN:90	°

2. Mechanical Specification

2.1 General Specification

Parameter		Specifications	Unit
CG/TP Outline dimensions		/	mm
LCM Outline dimensions		40.46(W) *41.96(H)*2.11(D)	mm
Color TFT	CG/TP view area	/	mm
	LCD active area	38.16(W) * 38.16(H)	mm
	Display format	360(RGB) x 360	pixel
	Color configuration	RGB Vertical stripe	-
	Dot pitch	0.106x0.106	mm
Cell Weight		/	g

2.2 Outline Dimension (Counter Drawing)



3. Interface Assignment

Pin NO.	Symbol	Description
1	LEDK	Backlight Cathode
2	LEDA	Backlight Anode
3	GND	Power ground
4	VCC	Power Supply for Analog 2.8-3.3V
5	CS	Chip selection pin. Low enable.
6	DCX	Serves as command or parameter select in parallel.1=data,0=command
7	SCL	Serial clock signal
8	SDA	Serial data input/output signal
9	RESET	This signal will reset the device and must be applied to properly initialize the chip
10	TE	Tearing effect output pin
11	GND	Power ground
12	VCC	Power Supply for Analog 2.8-3.3V

4. TFT Electrical Specification

4.1 Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Analog Voltage	VCC	-0.3	+4.6	V	-
Digital Voltage	IOVCC	-	-	V	-
Operation Temperature	T _{op}	-20	70	°C	-
Storage Temperature	T _{ST}	-30	80	°C	-

Note 1: The absolute maximum rating of this product are not allowed to be exceeded at any times. Should a module be used with any of the absolute maximum ratings exceeded, the characteristics of the module may not be recovered, or in an extreme case, the module may be permanently destroyed.

4.2 Typical Operation Conditions

4.2.1 DC Characteristics

Item	Symbol	Min	Typ	Max	Unit	Note
Analog Voltage	VCC	2.5	-	3.6	V	-
Digital Voltage	IOVCC	-	-	-	V	-
Input logic high voltage	V _{IH}	0.7VCC	-	VCC	V	-
Input logic low voltage	V _{IL}	0	-	0.3VCC	V	-
Output logic high voltage	V _{OH}	0.8VCC	-	-	V	-
Output logic low voltage	V _{OL}	0	-	0.2VCC	V	-

4.2.2 AC Characteristics

4.2.2.1 Display Serial Interface Timing Characteristics (4-line SPI system):

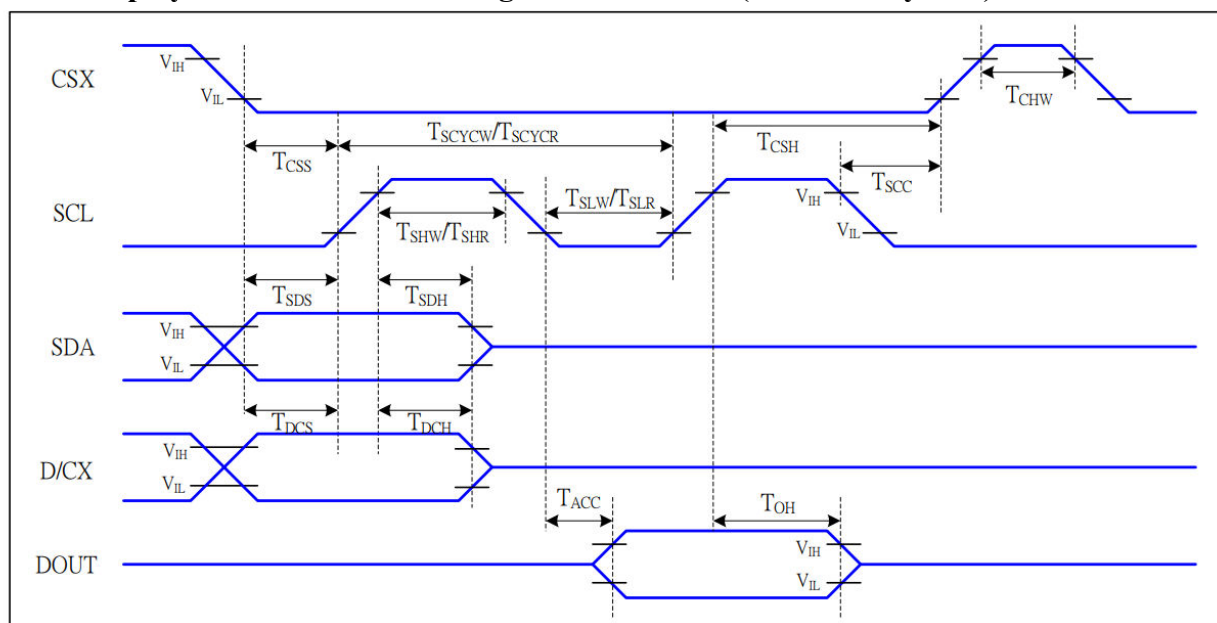


Figure 5 4-line serial Interface Timing Characteristics

$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.65$ to $3.3V$, $GND=RGND=0V$, $T_a=25^{\circ}C$

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (Write)	16		ns	-write command & data ram
	T_{SHW}	SCL "H" pulse width (Write)	7		ns	
	T_{SLW}	SCL "L" pulse width (Write)	7		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	-read command & data ram
	T_{SHR}	SCL "H" pulse width (Read)	60		ns	
	T_{SLR}	SCL "L" pulse width (Read)	60		ns	
D/CX	T_{DCS}	D/CX setup time	7		ns	
	T_{DCH}	D/CX hold time	7		ns	
SDA (DIN)	T_{SDS}	Data setup time	7		ns	
	T_{SDH}	Data hold time	7		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum $CL=30pF$
	T_{OH}	Output disable time	15	50	ns	For minimum $CL=8pF$

4.2.2.2 Reset Timing

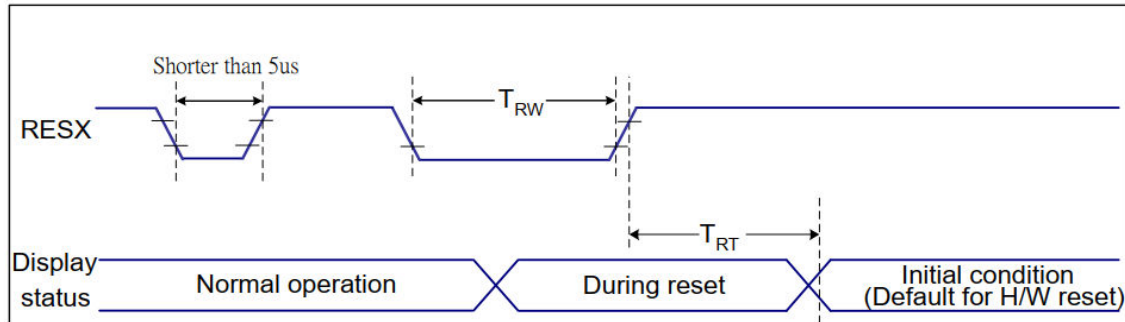


Figure 8 Reset Timing

VDDI=1.65 to 3.3V, VDD=2.65 to 3.3V, GND=RGND=0V, Ta=25°C

Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
			-	120 (Note 1, 6, 7)	ms

Table 9 Reset Characteristics

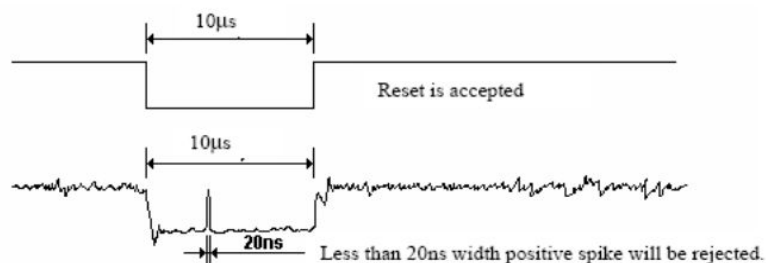
Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (trt) within 5 ms after a rising edge of RESX.
2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.

4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec

4.2.3 Power ON/OFF Sequence

VDDI and VDD can be applied in any order.

VDD and VDDI can be power down in any order.

During power off, if LCD is in the Sleep Out mode, VDD and VDDI must be powered down minimum 120msec after RESX has been released.

During power off, if LCD is in the Sleep In mode, VDDI or VCI can be powered down minimum 0msec after RESX has been released.

CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

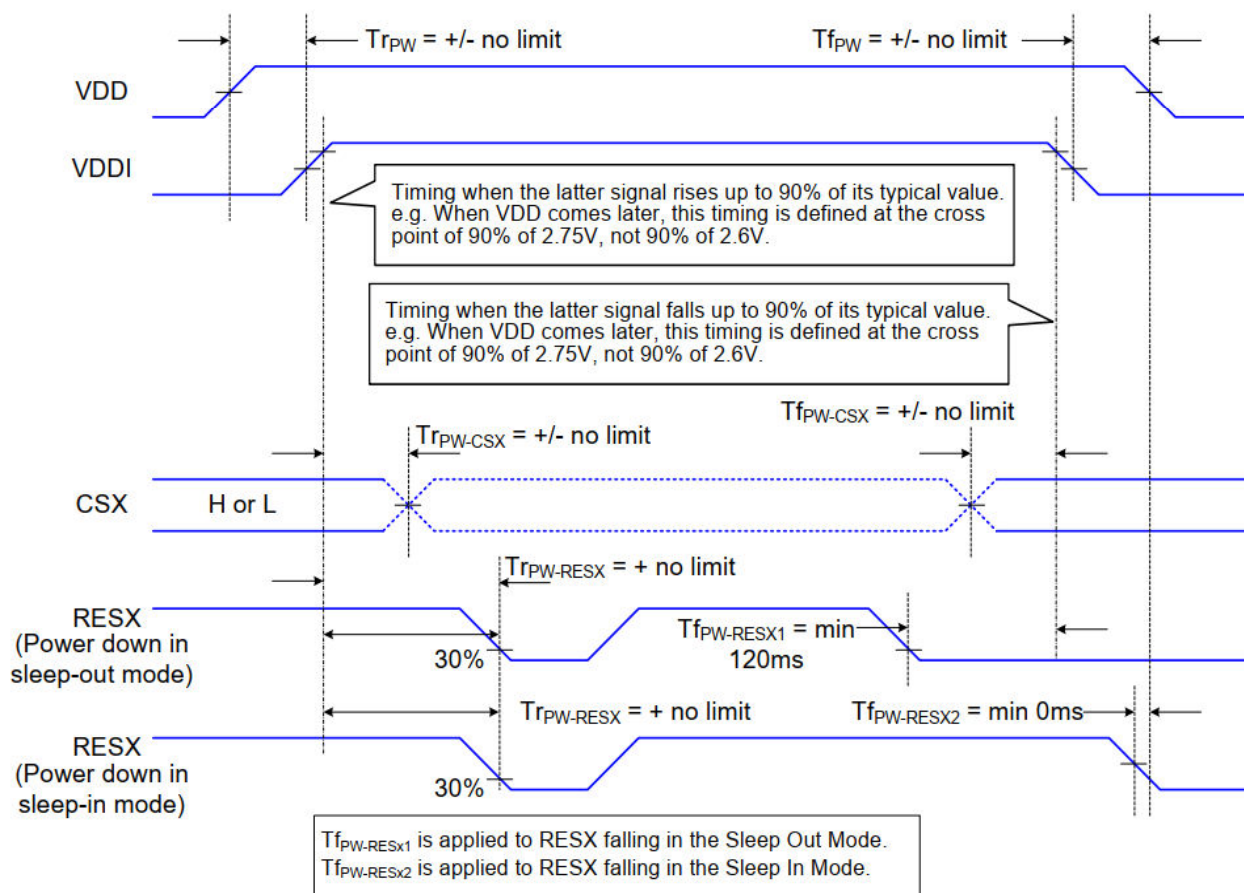
Note 1: There will be no damage to the display module if the power sequences are not met.

Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.

Note 3: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out command. Also between receiving Sleep In command and Power Off Sequence.

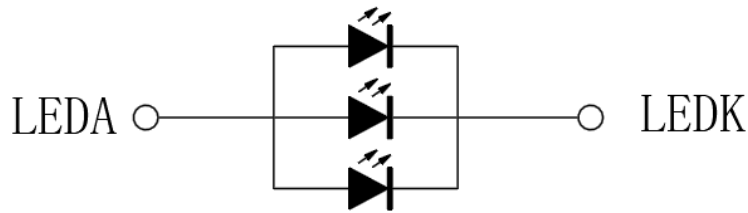
Note 4: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not guaranteed.

The power on/off sequence is illustrated below



4.2.4 Backlight Specification

4.2.4.1 Backlight Circuit



$V_f = 3.0V$, $I_f = 60mA$
B/L CIRCUIT DIAGRAM

4.2.4.2 Absolute Ratings

Parameter	Symbol	Specifications	Unit
Power Dissipation	P_d	225	mW
Forward Current(Single Chip)	I_{fm}	25	mA
Reverse Voltage(Single Chip)	V_r	5	V

4.2.4.3 Electrical Characteristics

Item	Symbol	Min	Typ	Max	Unit	Conditions	Note
Voltage for backlight	V_L	2.9	3.0	3.1	V	$I_F = 60mA$	Note 1
Current for backlight(Single Chip)	I_L	-	20	-	mA	Constant	-
Luminance(with LCD)	L	350	400	-	Cd/m ²	$I_L = 20mA$	-
LED life time	-	20000	-	-	Hr	-	Note 2

Note 1: The LED Supply Voltage is defined by the number of LED at $T_a = 25^\circ C$ and $I_L = 20mA$.

Note 2: The "LED life time" is defined as the module brightness decrease to 50% original brightness at $T_a = 25^\circ C$ and $I_L = 20mA$. The LED lifetime could be decreased if operating I_L is larger than 20mA.

5. Optical Characteristics(T=25°C)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Contrast Ratio		CR	$\theta=0^{\circ}$, $\phi=0^{\circ}$	800	1000	-	-	Note1
Surface Luminance		L	$\theta=0^{\circ}$, $\phi=0^{\circ}$	300	350	-	Cd/m2	Note2
Luminance Uniformity		U _L	$\theta=0^{\circ}$, $\phi=0^{\circ}$	75	80	-	%	Note3
Response Time		T _r +T _f	$\theta=0^{\circ}$, $\phi=0^{\circ}$	-	35	40	ms	Note4
Color Chromaticity (CIE1931)	Red	R _x	I _L =20mA $\theta=0^{\circ}$, $\phi=0^{\circ}$	-0.03	0.622	+0.03	-	Note5
		R _y			0.338			
	Green	G _x			0.312			
		G _y			0.588			
	Blue	B _x			0.145			
		B _y			0.132			
	White	W _x			0.290			
		W _y			0.320			
Color Gamut		NTSC	CIE1931	60	65	-	%	Note5
Viewing Angle	$\phi=90^{\circ}$	θ_T	Cr $\geq$ 10	80	85	-	Degree	Note6
	$\phi=270^{\circ}$	θ_B		80	85	-	Degree	
	$\phi=180^{\circ}$	θ_L		80	85	-	Degree	
	$\phi=0^{\circ}$	θ_R		80	85	-	Degree	

Note1. Definition of contrast ratio

Contrast ratio(Cr) is defined mathematically by the following formula.

For more information see FIG.2.

Contrast ratio= $\frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$

Measured at the center area of the LCD

Note2. Definition of surface luminance

Surface luminance is the luminance with all pixels displaying white.

For more information see FIG.2.

L_v = Average Surface Luminance with all white pixels($P_1, P_2, P_3, \dots, P_n$)

Note3. Definition of luminance uniformity

The luminance uniformity in surface luminance is determined by measuring luminance at each test position 1 through n, and then dividing the maximum luminance of n points luminance by minimum luminance of n points luminance. For more information see FIG.2.

$Y_u = \frac{\text{Minimum surface luminance with all white pixels (P1,P2,P3,.....,Pn)}}{\text{Maximum surface luminance with all white pixels (P1,P2,P3,.....,Pn)}}$

Note4. Definition of response time

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (T_{ON}) is the time between photo detector output intensity changed from 90% to 10%.

And fall time (T_{OFF}) is the time between photo detector output intensity changed from 10% to 90%.

For additional information see FIG1.

Note5. Definition of color chromaticity (CIE1931)

CIE (x,y) chromaticity, The x,y value is determined by screen active area center position P5. For more information see FIG.2.

Note6. Definition of viewing angle

Viewing angle is the angle at which the contrast ratio is greater than 10. angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface.

For more information see FIG.3.

For viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope or DMS series Instruments or compatible. For contrast ratio, Surface Luminance, Luminance uniformity and CIE, the testing data is base on TOPCON's BM-5or BM-7 photo detector or compatible.

Note: For TFT module, Gray scale reverse occurs in the direction of panel viewing angle.

FIG.1. The definition of response Time

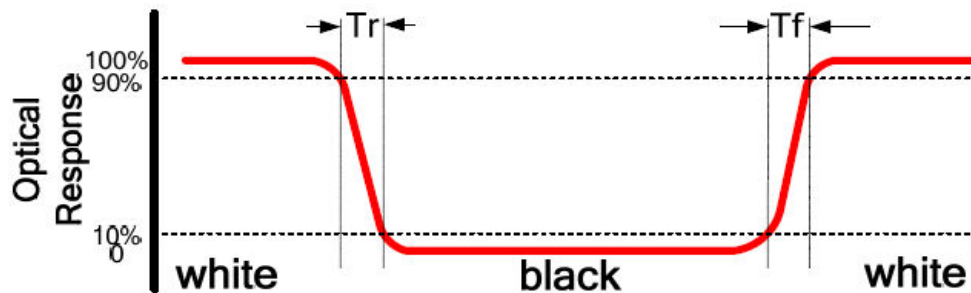


FIG.2. Measuring method for contrast ratio, surface luminance, luminance uniformity, CIE (x,y) chromaticity

Size : $S \leq 5"$ (see Figure a)

A : 5 mm B : 5 mm

H,V : Active area

Light spot size $\varnothing=5\text{mm}$ (BM-5) or $\varnothing=7.7\text{mm}$ (BM-7) 50cm distance or compatible distance from the LCD surface to detector lens.

test spot position : see Figure a.

measurement instrument : TOPCON's luminance meter BM-5 or BM-7 or compatible (see Figure c).

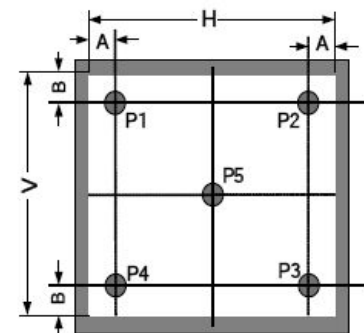


Figure a

Size : $5" < S \leq 12.3"$ (see Figure b)

H,V : Active area

Light spot size $\varnothing=5\text{mm}$ (BM-5) or $\varnothing=7.7\text{mm}$ (BM-7) 50cm distance or compatible distance from the LCD surface to detector lens.

test spot position : see Figure b.

measurement instrument : TOPCON's luminance meter BM-5 or BM-7 or compatible (see Figure c).

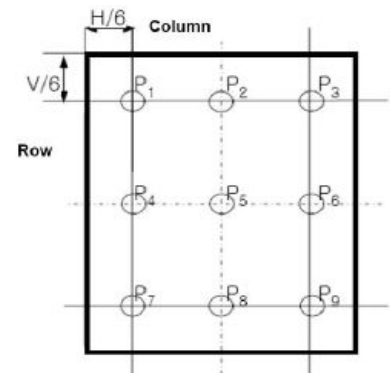


Figure b

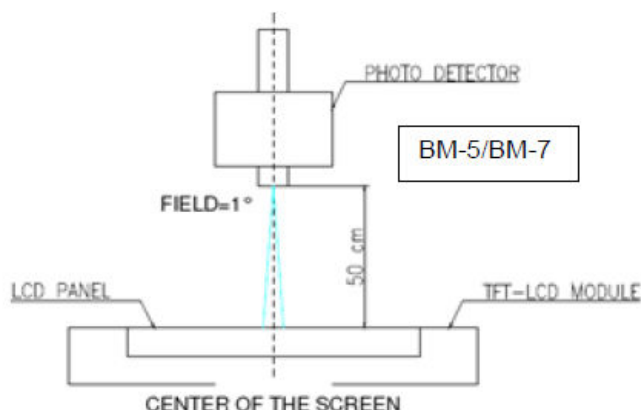
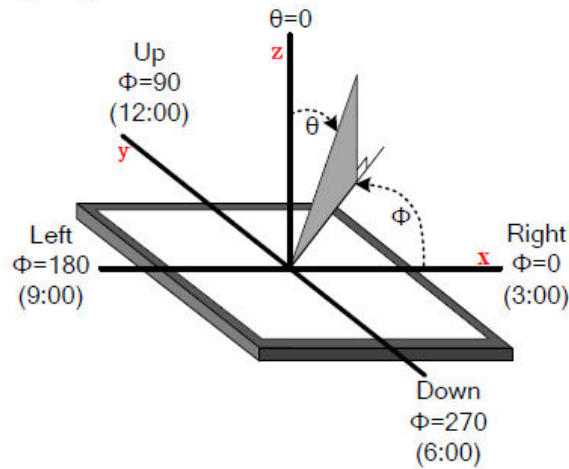


Figure c

FIG.3. The definition of viewing angle



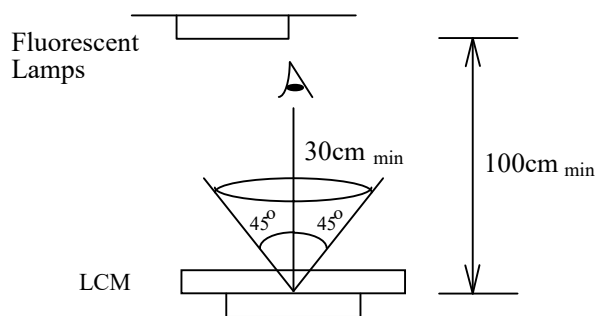
6. Quality Specifications

6.1 Condition for product appearance inspection

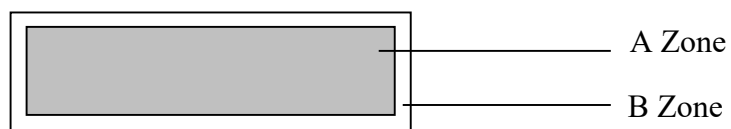
Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps.

Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.



Definition of zone:



A Zone: Active display area (minimum viewing area).

B Zone: Non-active display area (outside viewing area).

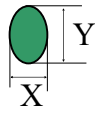
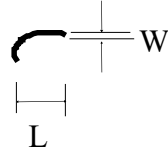
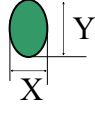
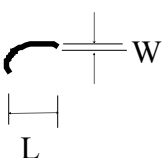
6.2 Function Inspection

Inspecting items	Inspecting criterion	Classification of defects
All functional defects	No display Display abnormally Missing vertical, horizontal segment Short circuit Back-light no lighting or abnormal lighting, and abnormally lighting. Obvious striation Current consumption exceeds limit	Major
Missing	Missing component	
Outline dimension	Referred to counter drawing	

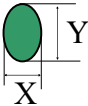
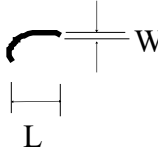
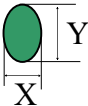
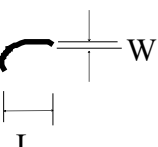
6.3 TFT - LCD Pixel Inspection

Items	Judgment striation		
	$S \leq 5.0\text{inch}$	$5.0 < S \leq 7.0\text{inch}$	$7.0 < S \leq 12.1\text{inch}$
Bad dot-bright dot(R、G、B)	1	2	3
Two adjacent bright point	0	1	2
Three or more adjacent bright point	0	0	0
Total points for bad dot-bright dot	1	3	5
Bad dot-dark dot	2	4	5
Two adjacent dot-dark	1	2	3
Three or more adjacent dot-dark	0	1	1
Total points for bad dot-dark	3	7	9

6.4 TFT Module Dot And Line Inspection

Item	Judgment criterion				Figure	
	LCD Size	S≤5.0 inch	5.0<S≤7.0 inch	7.0<S≤12.1 inch		
Dot inspection	D≤0.1		allowed	allowed	allowed	 D=(X+Y)/2
	0.1<D≤0.2		2	allowed	allowed	
	0.2<D≤0.3		1	3	6	
	0.3<D≤0.5		0	0	6	
	D>0.5		0	0	0	
	The distance between two defect dot:DS≥5mm					
Line inspection	L(mm)	W(mm)	Judgment criterion			
	disregard	W≤0.05	allowed	allowed	allowed	
	L≤5	0.05<W≤0.1	1	3	5	
	L>5	W>0.1	0	0	0	
Concave point and air bubble for polarizer	LCD size(mm)		Judgment criterion			 D=(X+Y)/2
	D≤0.3		allowed	allowed	allowed	
	0.3<D≤1.0		3	4	5	
	1.0<D≤1.5		1	2	3	
	D>1.5		0	0	0	
Fold mark、 linear scar for polarizer	L(mm)	W(mm)	Judgment criterion			
	disregard	W≤0.05	allowed	allowed	allowed	
	1<L≤5	0.05<W≤0.2	3	4	5	
	L>5	W>0.2	0	0	0	

6.5 TFT +PCAP Module Dot And Line Inspection

Item	Judgment criterion				Figure	
	TFT Module Size	S≤5.0 inch	5.0<S≤7.0 inch	7.0<S≤12.1 inch		
Dot inspection	D≤0.1		allowed	allowed	allowed	 D=(X+Y)/2
	0.1<D≤0.2		3	allowed	allowed	
	0.2<D≤0.3		2	8	9	
	0.3<D≤0.5		0	0	6	
	D>0.5		0	0	0	
	The distance between two defect dot:DS≥5mm					
Line inspection	L(mm)	W(mm)	Judgment criterion			
	disregard	W≤0.05	allowed	allowed	allowed	
	L≤5	0.05<W≤0.1	2	7	8	
	L>5	W>0.1	0	0	0	
	The distance between two defect dot:DS≥20mm					
Concave point and air bubble for polarizer	LCD size(mm)		Judgment criterion			 D=(X+Y)/2
	D≤0.3		allowed	allowed	allowed	
	0.3<D≤1.0		4	6	7	
	1.0<D≤1.5		5	4	5	
	D>1.5		0	0	0	
Fold mark、linear scar for polarize	L(mm)	W(mm)	Judgment criterion			
	disregard	W≤0.05	allowed	allowed	allowed	
	1<L≤5	0.05<W≤0.2	3	4	5	
	L>5	W>0.2	0	0	0	

6.6 Module Cosmetic Criteria

Item	Judgment Criterion
Difference in Spec	None allowed
Pattern peeling	No substrate pattern peeling and floating
Soldering defects	No soldering missing No soldering bridge No cold soldering
Stain	No stain to spoil cosmetic badly
Plate discoloring	No plate fading, rusting and discoloring
Newton ring	Referring to limited sample
Mura	Invisible with 5%ND, allowed
Light leaks	Referring to limited sample

7. Reliability Test

Test Item	Conditions		Criteria
	Temperature	Time (hrs)	
High temp. Storage	+80°C	48	/
High temp. Operating	+70°C	48	/
Low temp. Storage	-30°C	48	/
Low temp. Operating	-20°C	48	/
High Temperature & High Humidity Operation	60°C/ 90%RH	48	/
Thermal shock , Storage	-20°C ← 25°C → +70°C (30 min ← 3 min → 30min)	20cycles	/

Note1: In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product only guarantees operation, but don't guarantee all of the cosmetic specification.

Note2: Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

8. PRECAUTIONS

8.1 Handling

8.1.1 Polarizer Cleaning, Petroleum ether (or N-hexane) is recommended for cleaning the front/rear polarizers and reflectors, acetone, toluene and ethanol are not allowed to avoid damaging the surface.

8.1.2 Body grounding, must wear Anti-ESD wrist strap while pick up LCDs.

8.1.3 FPC Soldering, less than 300°C/3S, solder must be grounding on grounding bench.

8.1.4 If use electric Screwdriver to do assembly, screwdriver must be grounding.

8.2 Storage

8.2.1 Keep in a sealed polyethylene bag.

8.2.2 Keep in a dark place.

8.2.3 Keep in temperature between 0 °C and 35 °C.

NOT allowed at 70 °C for more than 160 Hours, or at -20 °C for more than 48 Hrs.

8.3 Safety

If liquid crystal leak out of a damaged glass cell, **DO NOT** put it in your mouth or touch eyes, if the liquid crystal touch your skin or clothes, please wash it off immediately using soap and water.

9. Limited Warranty

Unless otherwise agreed between HM and customer, HM will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with HM acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects over specs must be returned to HM within 30 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of HM limited to repair and/or replacement on the terms set forth above. HM shall not be responsible for any subsequent or consequential events.

9.1 RETURNING LCM UNDER WARRANTY – TERMS AND CONDITIONS

9.1.1 No warranty can be granted if the precautions stated above have been disregarded.

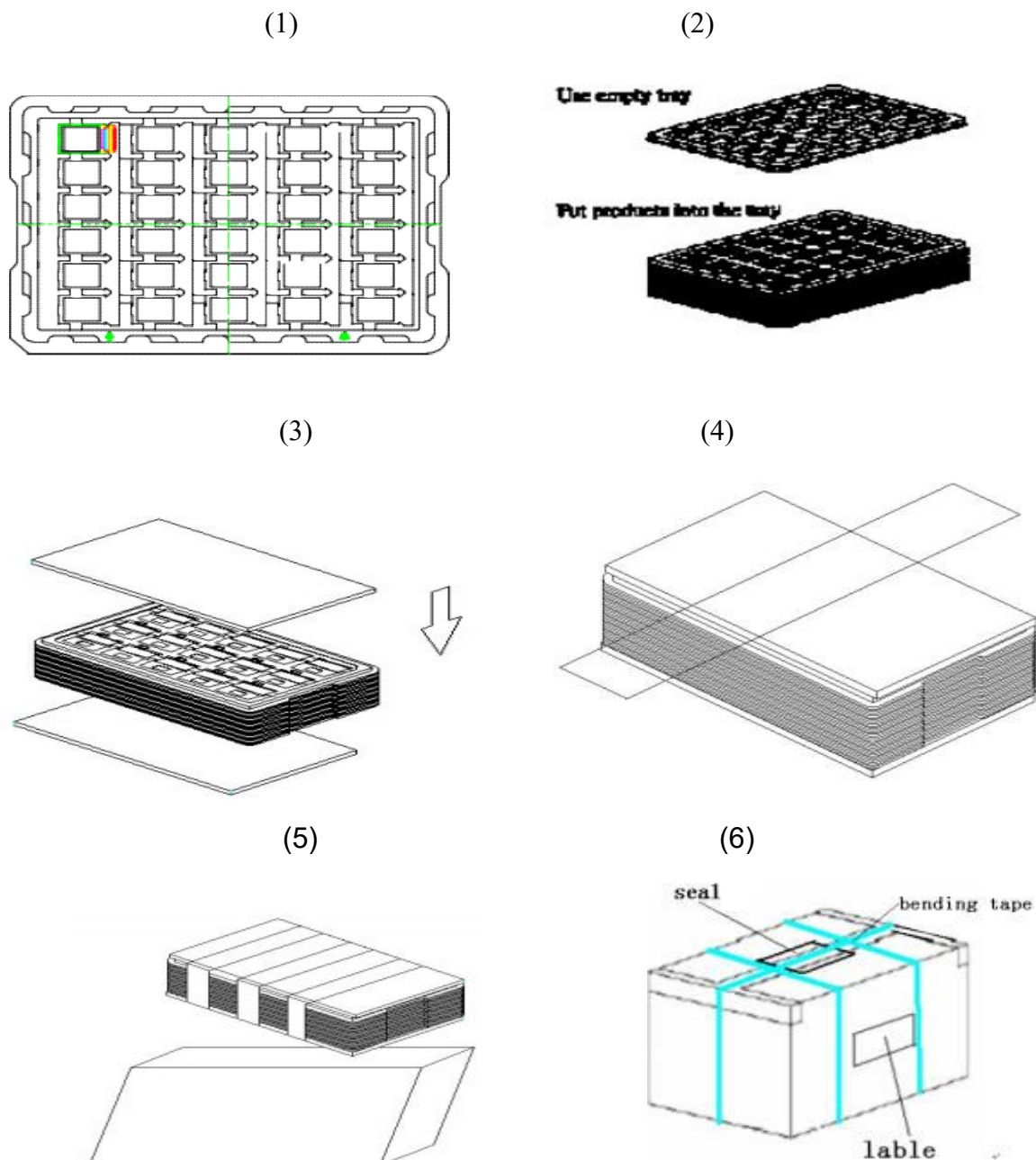
The typical examples of violations are :

- Broken LCD glass.
- Circuit modified in any way, including addition of components.

9.1.2 Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB's eyelet, conductors and terminals.

10. Package

Packing Method



1. Put module into tray cavity:
2. Tray stacking
3. Put 1 cardboard under the tray stack and 1 cardboard above:
4. Fix the cardboard to the tray stack with adhesive tape:
5. Put the tray stack into carton.
6. Carton sealing with adhesive tape.

- END -