

Product Specification

Product Name: LSC028I07-M-V1

Customer			
Approved by Customer		Approved Date	

Designed By	Check By	Approved By	
		R&D	QA

Records of Revision

Date	Rev.	Description	Page	Author
2023-10-30	A0	Initial Released		

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1 General Description

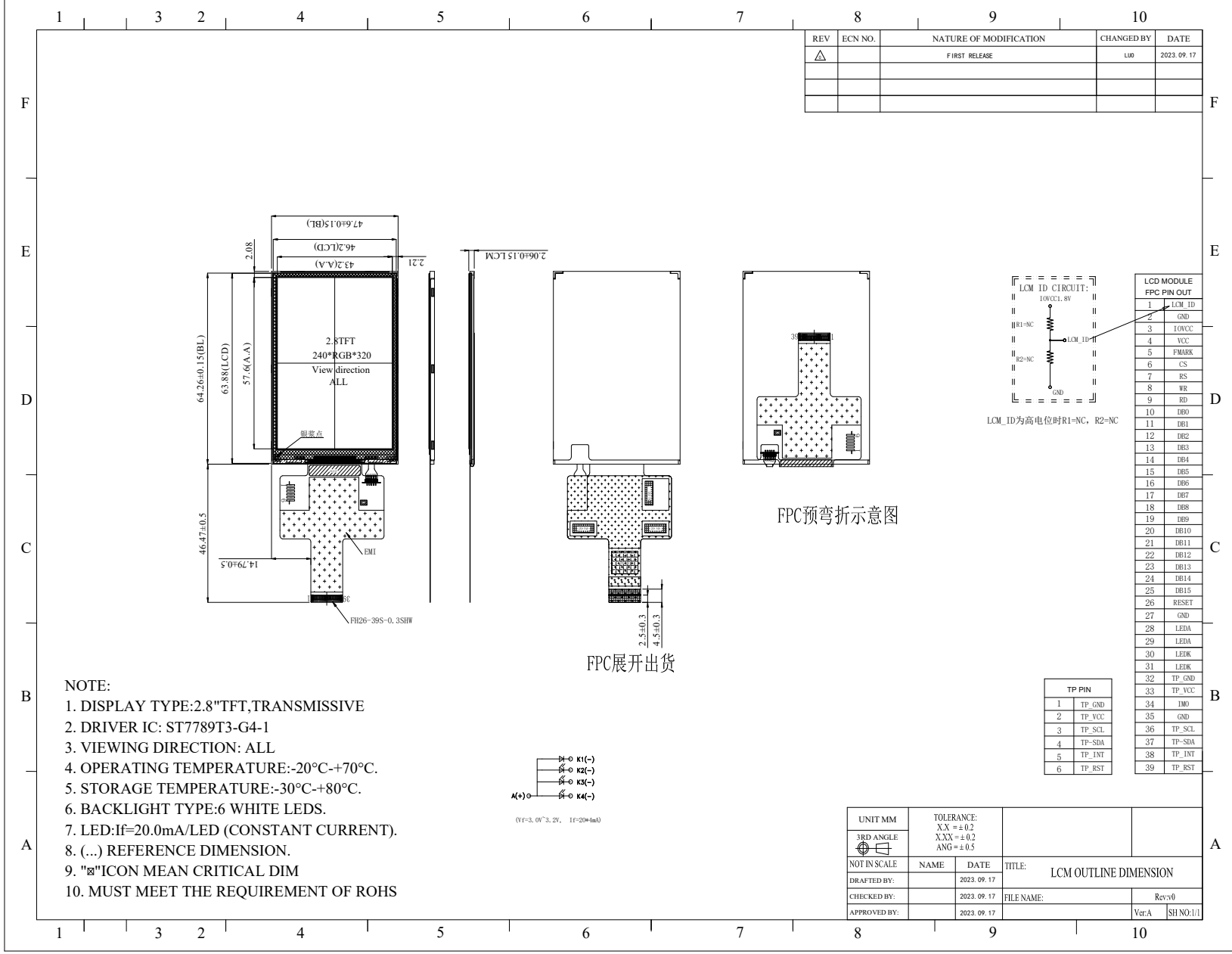
This display module is a transfective type color active matrix TFT(Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This module is composed of a TFT LCD module, a driver circuit, and a back-light unit. The resolution of a 2.8" contains 240(RGB)x320 dots and can display up to 262K colors.

2 Module Parameter

Features	Details	Unit
Display Size(Diagonal)	2.8	inch
LCD type	α -Si TFT	-
Display Mode	IPS / Transfective / Normally Black	-
Resolution	240RGB x320	-
View Direction	All	Best image
Module Outline	47.6(H) ×64.26(V)×2.06(T) (Note 1)	mm
Active Area	43.2(H)×57.6(V)	mm
TP/CG outline	--	mm
Display Colors	262K	-
Interface	8080MCU 8/16 bit	-
Driver IC	ST7789T3	-
Operating Temperature	-20~70	°C
Storage Temperature	-30~80	°C
Life Time	13	Months
Weight	TBD	g

Note 1: Excluding hooks, posts , FPC/FPC tail etc.

3 Mechanical Drawings



4 Module Interface

NO	SYMBOL	FUNCTION
1	LCM_ID	Harewaer ID pin.
2	GND	Ground.
3	IOVCC	Power Supply for I/O System.
4	VCC	Power Supply for Analog, Digital System and Booster Circuit.
5	FMARK	Tearing effect signal is used to synchronize MCU to frame memory writing. If not used, please let this pin open.
6	CS	Chip selection pin.Low enable.
7	RS	Display data/command selection pin in parallel interface.
8	WR	Write enable in MCU parallel interface.
9	RD	Read enable in 8080 MCU parallel interface.
10-25	DB0~DB15	DB[15:0] are used as MCU parallel interface data bus.
26	RESET	This signal will reset the device and it must be applied to properly initialize the chip. Signal is active low.
27	GND	Power Ground
28~29	LEDA	LED Aathode
30~31	LEDK	LED Cathode
32	TP_GND	Ground.
33	TP_VCC	Power Supply for TP, VDD=2.7V~3.6V.
34	IM0	The MCU interface mode select. 0: 80-8bit parallel I/F 1: 80-16bit parallel I/F
35	GND	Ground.
36	TP_SCL	I ² C clock signal of Touch Panel.
37	TP_SDA	I ² C data signal of Touch Panel.
38	TP_INT	Interrupt signal to main processor of Touch Panel.
39	TP_RST	System reset of Touch Panel.

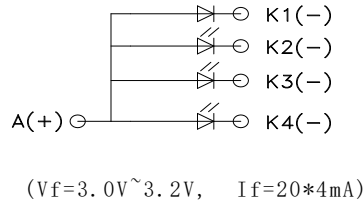
5 Application Circuit

Motherboard LCM Interface recommended circuit

more details about recommended circuit can be found the end of this article.

Backlight recommended circuit

Motherboard driver backlight is need constant current circuit:



Note: constant current circuit for every LED, and though LED lamp current is less than 20mA. Recommend between 3mA and 20 mA for every LED. If the range is exceeded, dim lights will appear and the lifespan will be affected.

6 Absolute Maximum Ratings

VSS=0V, Ta=25°C

Item		Symbol	Min.	Max.	Unit
Analog Supply Voltage	Display IC	VCI	-0.3	+4.6	V
	Touch IC	TP_VCC	-	-	V
Logic Supply Voltage	Display IC	IOVCC	-0.3	+4.6	V
Logic Output Voltage	Display IC	Vout	-0.3	IOVCDD+0.5	V
	Touch IC		-	-	V

7 Electrical Specification

DC Characteristics

Item		Symbol	Min.	Typ.	Max.	Unit
Analog Supply Voltage	Display IC	VCI	2.5	2.8	3.3	V
		AVDD	-	-	-	V
		AVEE	-	-	-	V
	Touch IC	TP_VCC	2.5	2.8	3.3	V
Logic Supply Voltage	Display IC	IOVDD	1.65	2.8	3.3	V
Logic Low input voltage		V _{IL}	VSS	-	0.3IOVCC	V
Logic High input voltage		V _{IH}	0.7IOVCC	-	IOVCC	V
Logic Low output voltage		V _{OL}	GND	-	0.2IOVCC	V
Logic High output voltage		V _{OH}	0.8IOVCC	-	IOVCC	V
Current Consumption Of display	Normal display	Ivdd	-	TBD	-	mA
	Standby mode	Ivdd	-	TBD	-	uA
Current Consumption Of Touch	Dynamic Mode	Ivdd	-	TBD	-	mA
	Standby mode	Ivdd	-	TBD	-	uA
Frame Frequency		f _{FR}	-	60	-	Hz

8 AC Characteristics

Please refer to IC datasheet.

9 Command Table

Please refer to IC datasheet.

10 Recommended Setting and Initialization Flow for Reference

Please refer to attached file.

11 Optical Specifications

11.1 Optical Specifications

Ta=25°C, VDD=2.8V (Transmissive)

	Item		Symbol	Condition	Specification			Unit
					Min.	Typ.	Max.	
	Luminance on surface(I_f =80mA)		L_V	$\theta_X=\theta_Y=0^\circ$	-	120	-	cd/m ²
	Contrast ratio		CR		50	80	-	-
	Response time		$T_{R+} \ T_F$		-	-	30	ms
	Chromaticity Transmissive	Red	X_R	-	0.3903	0.4206	0.4503	-
			Y_R		0.2686	0.2989	0.3288	-
		Green	X_G		0.3026	0.3324	0.3522	-
			Y_G		0.4235	0.4533	0.4231	-
		Blue	X_B		0.1514	0.1816	0.2115	-
			Y_B		0.1195	0.1495	0.1794	-
		White	X_W		0.2666	0.2962	0.3260	-
			Y_W		0.2724	0.3012	0.3312	-
	Viewing Angle	Horiz ontal	θ_{X+}	Center $CR\geq 2$	25	-	-	Deg.
			θ_{X-}		30	-	-	
		Vertic al	θ_{Y+}		30	-	-	
			θ_{Y-}		30	-	-	
	NTSC		-	-	15	20	-	%

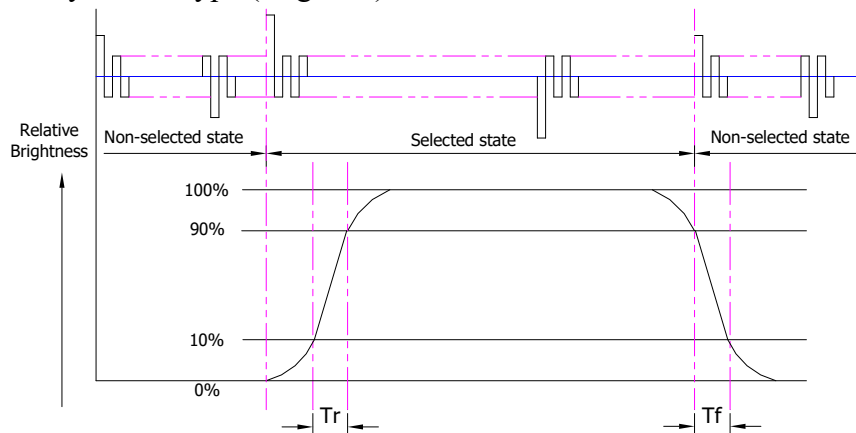
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Ta=25°C, VDD=2.8V (Reflective)

	Item		Symbol	Condition	Specification			Unit
					Min.	Typ.	Max.	
	Contrast ratio		CR		5	7	-	-
	Response time		T_{R+} T_F		-	-	TBD	ms
	Viewing Angle	Horiz ontal	θ_{X+}	Center CR $\geq$ 2	50	-	-	Deg.
			θ_{X-}		50	-	-	
		Vertic al	θ_{Y+}		50	-	-	
			θ_{Y-}		50	-	-	
	NTSC		-	-	12	16	-	%
	Reflective (SCE)		T	-	4.7	6.4	-	%

11.2 Definition of Response Time

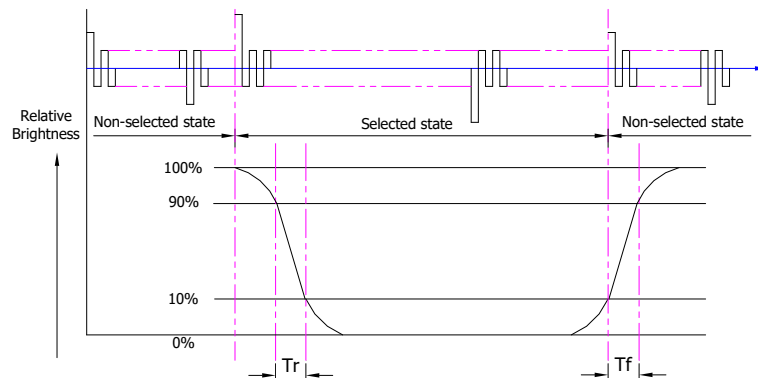
11.2.1 Normally Black Type (Negative)



T_r is the time it takes to change from non-selected state with relative luminance 10% to selected state with relative luminance 90%;

T_f is the time it takes to change from selected state with relative luminance 90% to non-selected state with relative luminance 10%.

11.2.2 Normally White Type (Positive)



T_r is the time it takes to change from non-selected state with relative luminance 90% to selected state with relative luminance 10%;

T_f is the time it takes to change from selected state with relative luminance 10% to non-selected state with relative luminance 90%;

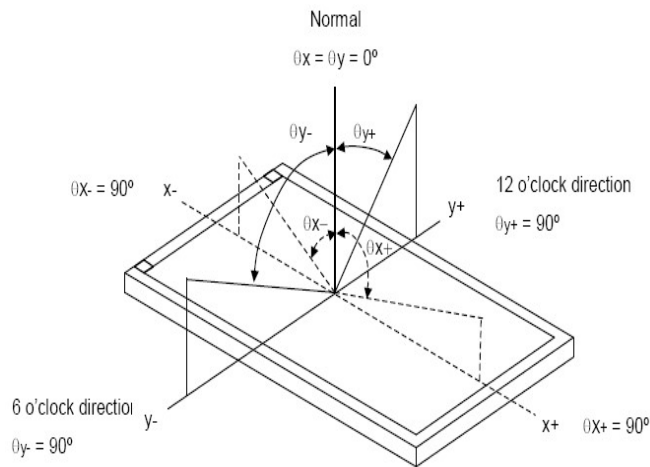
11.3 Definition of Contrast Ratio

Contrast is measured perpendicular to display surface in reflective and transmissive mode. The measurement condition is:

Measuring Equipment	BM-7 or EQUI
Measuring Point Diameter	3mm/1mm
Measuring Point Location	Active Area centre point
Test pattern	A: All Pixels white
	B: All Pixel black
Contrast setting	Maximum

Definitions: CR (Contrast) = Luminance of White Pixel / Luminance of Black Pixel

11.4 Definition of Viewing Angles



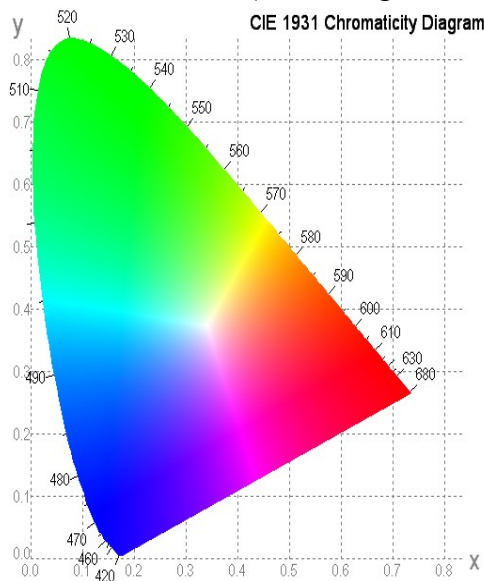
Measuring machine: LCD-5100 or EQUI

11.5 Definition of Color Appearance

R,G,B and W are defined by (x, y) on the IE chromaticity diagram

NTSC=area of RGB triangle/area of NTSC triangleX100%

Measuring picture: Red, Green, Blue and White (Measuring machine: BM-7)



11.6 Definition of Surface Luminance, Uniformity and Transmittance

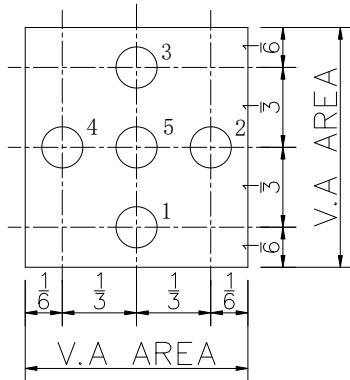
Using the transmissive mode measurement approach, measure the white screen luminance of the display panel and backlight.

11.6.1 Surface Luminance: $LV = \text{average (LP1:LP5)}$

11.6.2 Uniformity = $\text{Minimal (LP1:LP5) / Maximal (LP1:LP5) * 100\%}$

11.6.3 Transmittance = $LV \text{ on LCD} / LV \text{ on Backlight} * 100\%$

Note :Measuring machine:BM-7



12 Quality Assurance

12.1 Purpose

This standard for Quality Assurance assures the quality of LCD module products supplied to customer by RRJ-DISPLAY display.

12.2 Agreement Items

RRJ-DISPLAY and customer shall negotiate if the following situation occurs:

12.2.1 Discrepancies between RRJ-DISPLAY's QA standards and customer's QA standards.

12.2.2 Additional requirement to be added in product specification.

12.2.3 Any other special problem.

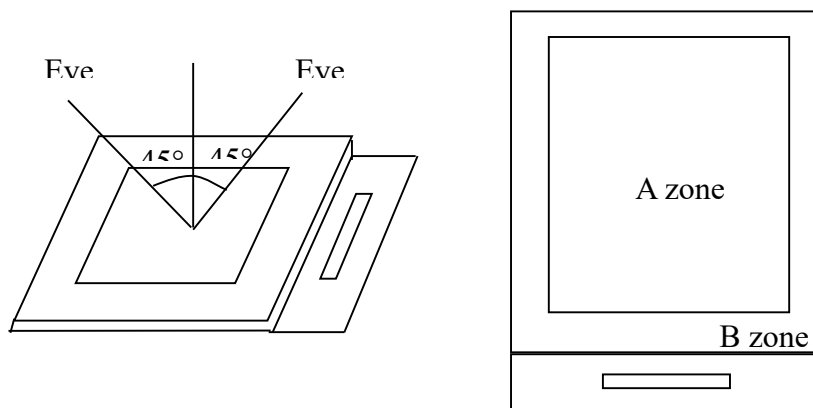
12.3 Standard of the Product Visual Inspection

12.3.1 Appearance inspection:

12.3.1.1 The inspection must be under illumination about 1000 – 1500 lx, and the distance of view must be at $30\text{cm} \pm 2\text{cm}$.

12.3.1.2 The viewing angle should be 45° from the vertical line without reflection light or follows customer's viewing angle specifications.

12.3.1.3 Definition of area: A Zone: Active Area, B Zone: Viewing Area.



12.3.2 Basic principle: A set of sample to indicate the limit of acceptable quality level must be discussed by both RRJ-DISPLAY and customer when there is any dispute happened.

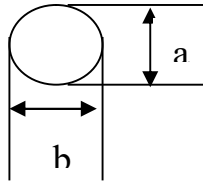
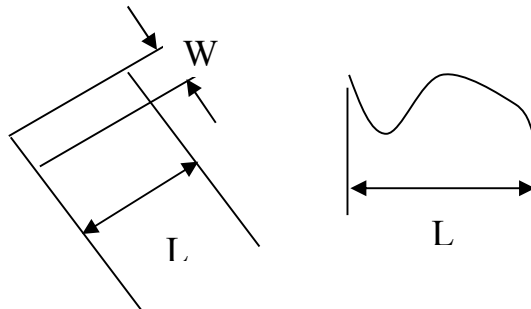
12.4 Inspection Specification

Sampling plan according to GB/T2828.1-2012/ISO 2859-1: 1999 and ANSI/ASQC

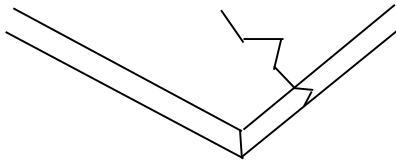
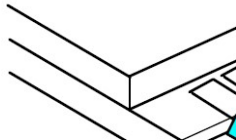
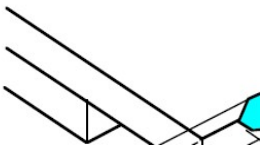
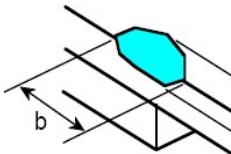
Z1.4-1993,normal level 2 and based on:

Major defect: AQL 0.4

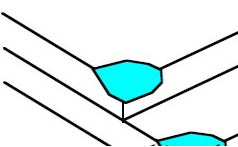
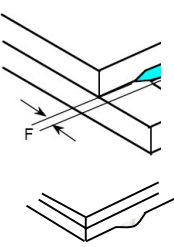
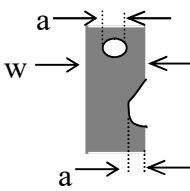
Minor defect: AQL 1.0

No.	Item	Criteria (Unit: mm)																
01	Black / White spot Foreign material (Round type) Pinholes Stain Particles inside cell. (Minor defect)	 $\varphi = (a + b) / 2$	<table><tr><th>Size \ Area</th><th>Acc. Qty</th></tr><tr><td>$\varphi \leq 0.10$</td><td>Ignore</td></tr><tr><td>$0.10 < \varphi \leq 0.2$</td><td>2</td></tr><tr><td>$0.20 < \varphi$</td><td>0</td></tr><tr><td>Total</td><td>2 (no include $\varphi \leq 0.10$)</td></tr></table>	Size \ Area	Acc. Qty	$\varphi \leq 0.10$	Ignore	$0.10 < \varphi \leq 0.2$	2	$0.20 < \varphi$	0	Total	2 (no include $\varphi \leq 0.10$)					
		Size \ Area	Acc. Qty															
$\varphi \leq 0.10$	Ignore																	
$0.10 < \varphi \leq 0.2$	2																	
$0.20 < \varphi$	0																	
Total	2 (no include $\varphi \leq 0.10$)																	
		Distance between 2 defects should more than 5mm apart.																
02	Black and White line Scratch Foreign material (Line type) (Minor defect)		<table><tr><th>Length</th><th>Width</th><th>Acc. Qty</th></tr><tr><td>/</td><td>$W \leq 0.03$</td><td>Ignore</td></tr><tr><td>$L \leq 5$</td><td>$0.03 < W \leq 0.05$</td><td>2</td></tr><tr><td>$L > 5$</td><td>$0.05 < W$</td><td>0</td></tr><tr><td colspan="2">Total</td><td>2</td></tr></table>	Length	Width	Acc. Qty	/	$W \leq 0.03$	Ignore	$L \leq 5$	$0.03 < W \leq 0.05$	2	$L > 5$	$0.05 < W$	0	Total		2
		Length	Width	Acc. Qty														
/	$W \leq 0.03$	Ignore																
$L \leq 5$	$0.03 < W \leq 0.05$	2																
$L > 5$	$0.05 < W$	0																
Total		2																
		Distance between 2 defects should more than 5mm apart. Scratches not viewable through the back of the display are acceptable.																

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No.	Item	Criteria (Unit: mm)										
03	Glass Crack (Minor defect)	 LCD with extensible crack line is unacceptable(When press the cracked LCD area, the line will expand, we define it is extensible crack line)										
04	Glass Chipping Pad Area: (Minor defect)	 <table><tr><th>Length and Width</th><th>Acc. Qty</th></tr><tr><td>$c < 5.0, b < 0.4$</td><td>Ignore</td></tr></table>	Length and Width	Acc. Qty	$c < 5.0, b < 0.4$	Ignore						
Length and Width	Acc. Qty											
$c < 5.0, b < 0.4$	Ignore											
05	Glass Chipping Rear of Pad Area: (Minor defect)	 <table><tr><th>Length and Width</th><th>Acc. Qty</th></tr><tr><td>$c > 3.0, b < 1.0$</td><td>1</td></tr><tr><td>$c < 3.0, b < 1.0$</td><td>2</td></tr><tr><td>$c < 3.0, b < 0.5$</td><td>4</td></tr><tr><td colspan="2">$a < \text{Glass Thickness}$</td></tr></table>	Length and Width	Acc. Qty	$c > 3.0, b < 1.0$	1	$c < 3.0, b < 1.0$	2	$c < 3.0, b < 0.5$	4	$a < \text{Glass Thickness}$	
Length and Width	Acc. Qty											
$c > 3.0, b < 1.0$	1											
$c < 3.0, b < 1.0$	2											
$c < 3.0, b < 0.5$	4											
$a < \text{Glass Thickness}$												
06	Glass Chipping Except Pad Area: (Minor defect)	 <table><tr><th>Length and Width</th><th>Acc. Qty</th></tr><tr><td>$c \leq 0.6, b < 5.0$</td><td>Ignore</td></tr><tr><td colspan="2">$a < \text{Glass Thickness}$</td></tr></table>	Length and Width	Acc. Qty	$c \leq 0.6, b < 5.0$	Ignore	$a < \text{Glass Thickness}$					
Length and Width	Acc. Qty											
$c \leq 0.6, b < 5.0$	Ignore											
$a < \text{Glass Thickness}$												

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No.	Item	Criteria (Unit: mm)								
07	Glass Corner Chipping: (Minor defect) 	<table><tr><th>Length and Width</th><th>Acc. Qty</th></tr><tr><td>$c < 2.0, b < 1.5$</td><td>Ignore</td></tr><tr><td>$c < 1.5, b < 2$</td><td>Ignore</td></tr><tr><td colspan="2">$a < \text{Glass Thickness}$</td></tr></table>	Length and Width	Acc. Qty	$c < 2.0, b < 1.5$	Ignore	$c < 1.5, b < 2$	Ignore	$a < \text{Glass Thickness}$	
Length and Width	Acc. Qty									
$c < 2.0, b < 1.5$	Ignore									
$c < 1.5, b < 2$	Ignore									
$a < \text{Glass Thickness}$										
08	Glass Burr: (Minor defect) 	Glass burr don't affect assemble and module dimension. <table><tr><th>Length</th><th>Acc. Qty</th></tr><tr><td>$F < 0.5$</td><td>Ignore</td></tr></table>	Length	Acc. Qty	$F < 0.5$	Ignore				
Length	Acc. Qty									
$F < 0.5$	Ignore									
09	FPC Defect: (Minor defect) 	9.1 Dent, pinhole width $a < w/2$. (w: circuitry width.) 9.2 Open circuit is unacceptable. 9.3 No oxidation, contamination and distortion.								
10	Screen deformation 	Test for insertion of plug gauge at highest warping point: (0.96-3.1inches does not contain 3.1) $H \leq 0.25\text{MM}$ The client has special requirements, according to drawing								
11	Bubble on Polarizer (Minor defect)	<table><tr><th>Diameter</th><th>Acc. Qty</th></tr><tr><td>$\varphi \leq 0.1$</td><td>Ignore</td></tr><tr><td>$0.10 < \varphi \leq 0.20$</td><td>2</td></tr><tr><td>$0.20 < \varphi$</td><td>None</td></tr></table>	Diameter	Acc. Qty	$\varphi \leq 0.1$	Ignore	$0.10 < \varphi \leq 0.20$	2	$0.20 < \varphi$	None
Diameter	Acc. Qty									
$\varphi \leq 0.1$	Ignore									
$0.10 < \varphi \leq 0.20$	2									
$0.20 < \varphi$	None									

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No.	Item	Criteria (Unit: mm)	
12	Dent on Polarizer (Minor defect)		Diameter
			Acc. Qty
		$\varphi \leq 0.10$	Ignore
		$0.10 < \varphi \leq 0.20$	2
		$0.2 < \varphi$	None
13	Bezel	13.1 No rust, distortion on the Bezel. 13.2 No visible fingerprints, stains or other contamination.	
14	Touch Panel	D: Diameter W: width L: length 14.1 Spot: $D \leq 0.20$ is acceptable $0.20 < D \leq 0.3$, acceptable QTY, 3 2dots are acceptable and the distance between defects should more than 5mm. $D > 0.3$ is unacceptable 14.2 Dent: $D > 0.30$ is unacceptable 14.3 Scratch: $W \leq 0.03$, $L \leq 10$ is acceptable, $0.03 < W \leq 0.10$, $L \leq 10$, acceptable QTY, 3 Distance between 2 defects should more than 5 mm. $W > 0.10$ is unacceptable.	
15	PCB	15.1 No distortion or contamination on PCB terminals. 15.2 All components on PCB must same as documented on the BOM/component layout. 15.3 Follow IPC-A-600F.	
16	Soldering	Follow IPC-A-610C standard	

No.	Item	Criteria (Unit: mm)
17	Electrical Defect (Major defect)	The below defects must be rejected. 17.1 Missing vertical / horizontal segment, 17.2 Abnormal Display. 17.3 No function or no display. 17.4 Current exceeds product specifications. 17.5 LCD viewing angle defect. 17.6 No Backlight. 17.7 Dark Backlight. 17.8 Touch Panel no function. 17.9 Dark Dot –one Allowed. 17.10 Bright Dot – one Allowed. Remark: 1. A pixel defect is acceptable if one color is none functional and causes a bright dot. The display may have one case where one color is out and cause a dark dot. 2. Bright dot caused by scratch and foreign object accords to item1.
18	Leak	Yellow light,OK; White light,According to the limit sample
19	Mura	5% ND not visible, or reference limit samples

Remark: Visual and cosmetic defects are rejectable only if these fall within the LCD viewing area.

12.5 Classification of Defects

Visual defects (Except no / wrong label) are treated as minor defect and electrical defect is major.

12.6 Identification/marketing criteria

Any unit with illegible / wrong /double or no marking/ label shall be rejected.

12.7 Packing

12.7.1 There should be no damage of the outside carton box, each packaging box should has label in the correct location per packing drawing requirement.

12.7.2 All direct package materials shall offer ESD protection.

13 Reliability Specification

Item	Condition	Cycle Time	Quantity	Remark
Constant Temp. and Constant Humidity Operation Test	+40 ± 3°C, 90 ± 3%RH	240hrs	--	*1
High Temp. Storage Test	+80 ± 3°C	240hrs	--	
Low Temp. Storage Test	-30 ± 3°C	240hrs	--	
High Temp. Operation Test	+70 ± 3°C	240hrs	--	
Low Temp. Operation Test	-20 ± 3°C	240hrs	--	
Thermal Shock Test	-20 ± 3°C (30min) +70 ± 3°C (30min)	10cycles	--	
ESD Test(end product)	150pF, 330Ω, ±2KV, Contact	10times	--	*2, *3
	150pF, 330Ω, ±6KV, Air			
Vibration Test (for packaging)	Frequency: 10Hz to 55Hz to 10Hz, Swing: 1.5mm, time : X, Y, Z each 2H.	6hrs	One inner carton	*4

Note 1. For humidity test, DI water should be used.

Inspection Standard: Inspect after 1-2hrs storage at room temperature, the sample shall be free from the following defects:

- Air bubble in the LCD
- Seal Leakage
- Non-display
- Missing Segment
- Glass Crack
- IDD is greater than twice initial value.
- Others as per QA Inspection Criteria

Note 2. No defect is allowed after testing

The End Product ESD value is only indicative and depends on customer ESD protection design for the whole system.

Note 3. ESD should be applied to LCD glass panel, not other areas (such as on IC and so on) IDD should be within twice initial value.

In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judged as a good part.

Note 4. Only upon request.

14 Precautions and Warranty

14.1 Safety

14.1.1 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.

14.1.2 Since the liquid crystal cells are made of glass, do not apply strong impact on them. Handle with care.

14.2 Handling

14.2.1 Reverse and use within ratings in order to keep performance and prevent damage.

14.2.2 Do not wipe the polarizer with dry cloth, as it might cause scratch. If the surface of the LCD needs to be cleaned, wipe it swiftly with cotton or other soft cloth soaked with petroleum IPA, do not use other chemicals.

14.3 Operation

14.3.1 Do not drive LCD with DC voltage

14.3.2 Response time will increase below lower temperature

14.3.3 Display may change color with different temperature

14.3.4 Mechanical disturbance during operation, such as pressing on the display area, may cause the segments to appear “fractured”.

14.4 Static Electricity

14.4.1 CMOS LSIs are equipped in this unit, so care must be taken to avoid the electro-static charge, by ground human body, etc.

14.4.2 The normal static prevention measures should be observed for work clothes and benches.

14.4.3 The module should be kept into anti-static bags or other containers resistant to static for storage.

14.5 Limited Warranty

14.5.1 Unless otherwise agreed between RRJ-DISPLAY and customer, RRJ-DISPLAY will replace or repair any of its LCD and LCM which RRJ-DISPLAY found to be defective electrically and visually when inspected in accordance with RRJ-DISPLAY Quality Standards, for a period of one year from date of shipment.

14.5.2 The warranty liability of RRJ-DISPLAY is limited to repair and/or replacement. RRJ-DISPLAY will not be responsible for any consequential loss.

14.5.3 If possible, we suggest you use up all modules in six months. If the module storage time over twelve months, we suggest that recheck it before the module be used.

15 Packaging

TBD

16 Prior Consult Matter

1. For RRJ-DISPLAY standard products, we keep the right to change material, process for improving the product property without prior notice to our customer.

2. For OEM products, if any changes are needed which may affect the product property, we will consult with our customer in advance.

3. If you have special requirement about reliability condition, please let us know before you start the test on our samples.

17 LCM Interface recommended circuit

TBD