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Product Specification

Model Name: ML-FG548-ST002

Description: 5.48" (1920 x 1080) AMOLED

Doc. Version: 1.0

Customer:

Customer Part No:

Approved for Preliminary Specification

Approved for Final Specification

Approved for Final Specification & Sample

Prepared	Checked	Approved

Customer's Approval

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1.Scope

This specification defines AMOLED display manufactured by Guangdong MOLI display technology CO.,LTD. In the event that there occurs any doubt, discrepancy, and unspecified term in this specification therein, the party may request to other party to cooperatively discuss to find mutual satisfactory solution.

2.Features

2.1 Product Applications

Industrial,Consumer...

2.2 Product Features

2.2.1	Display Color	16.7M
2.2.2	Display Format	5.48" FHD (1080x1920)
2.2.3	Pixel Arrangement	Rendering
2.2.4	Interface	MIPI 4 lanes
2.2.5	Driver IC	Oleadvision OT8202
2.2.6	Module Type	FOG

3.Maximum Ratings

Parameter	Symbol	Spec			Unit	Note
		Min.	Typ.	Max.		
Analog/Boost Power Voltage	VCI	-0.3	-	5.5	V	
I/O Voltage	VDDIO	-0.3	-	5.5	V	
VSP Voltage	VSP	-0.3	-	6.6	V	
VPP(OTP power)	VPP	-	-	8.64	V	
Operation Temperature	TSTG	-30		+80	°C	
Storage Temperature	TSTG	-30		+85	°C	

4.Mechanical Specifications

Item	Specification	Unit
Dimension Outline	70.36 x 127.344 x 1.76	mm
Resolution	1920 x 1080	dots
Active Area	121.344 x 68.256	mm

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Diagonal Size	5.48"	inch
Pixel Pitch	63.2 x 94.8	μm
Panel Thickness (AI Bracket/Cushion Tapel/LTPS/Encap/Pol)	1/0.135 / 0.2 / 0.3 / 0.125	mm
Weight	TBD	g

5. Electrical Specifications

5.1 Electrical Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Note
AMOLED Power Positive	ELVDD	-	4.6	5	V	-
AMOLED Power Negative	ELVSS	-5	-3.2	-	V	Normal
AMOLED Power Negative	ELVSS	-5	-3.2	-	V	HBM
Digital Power Supply	VDDIO	1.65	1.8	3.6	V	Ref
Analog Power Supply	VCI	2.5	3	3.6	V	Ref

Frame Frequency : Frame =60HZ @ 25degC,Video Mode

Mode	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
500 nits @Gray 255	VELVDD/ VELVSS	VELVDD=4.6V VELVSS=-3.2V	-	280	400	mA	
	VCI	VCI=3.3V	-			mA	
	VSP	VDDIO=1.8V AVDD=7.6V	-			mA	
	VDDIO		-			mA	

Frame Frequency : Frame =60HZ @ 25degC,Video Mode

Mode	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
HBM 700 nits @Gray 255	VELVDD/ VELVSS	VELVDD=4.6V VELVSS=-3.2V	-	400	500	mA	
	VCI	VCI=3.3V	-			mA	
	VSP	VDDIO=1.8V AVDD=7.6V	-			mA	
	VDDIO		-			mA	

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5.1.2 Input Voltage Ripple :

Item	Symbol	Max.	Unit	Note
AMOLED Power Positive	ELVDD	200	mV	0.1/us
AMOLED Power Negative	ELVSS	200	mV	0.1/us
Gamma Voltage	AVDD	200	mV	ref
Digital Power Supply	VDDIO	30	mV	ref
Analog Power Supply	VCI	30	mV	ref

5.1.3 Reference MIPI Setting :

Mode	Active	BPD	SPW	FPD	Total	Unit	Note
Vertical	1920	16	4	8	1948	H-sync	-
Horizontal	1080	34	4	26	1144	P-clk	-
PLL_CLK	Vtotal*Htotal*fps*24bit/4lane					Hz	-

Note: V total=V active +VBPD+ VSPW +VFPD , H total=H active +HBPD+ HBPD +HFPD
HSPW (horizontal sync pulse width) , HBPD (horizontal back porch)
HFPD (horizontal front porch) , VSPW (vertical sync pulse width)
VBPD (vertical back porch) , VFPD (vertical front porch) , fps (frame per second)

5.1.4 I/O Pin Define

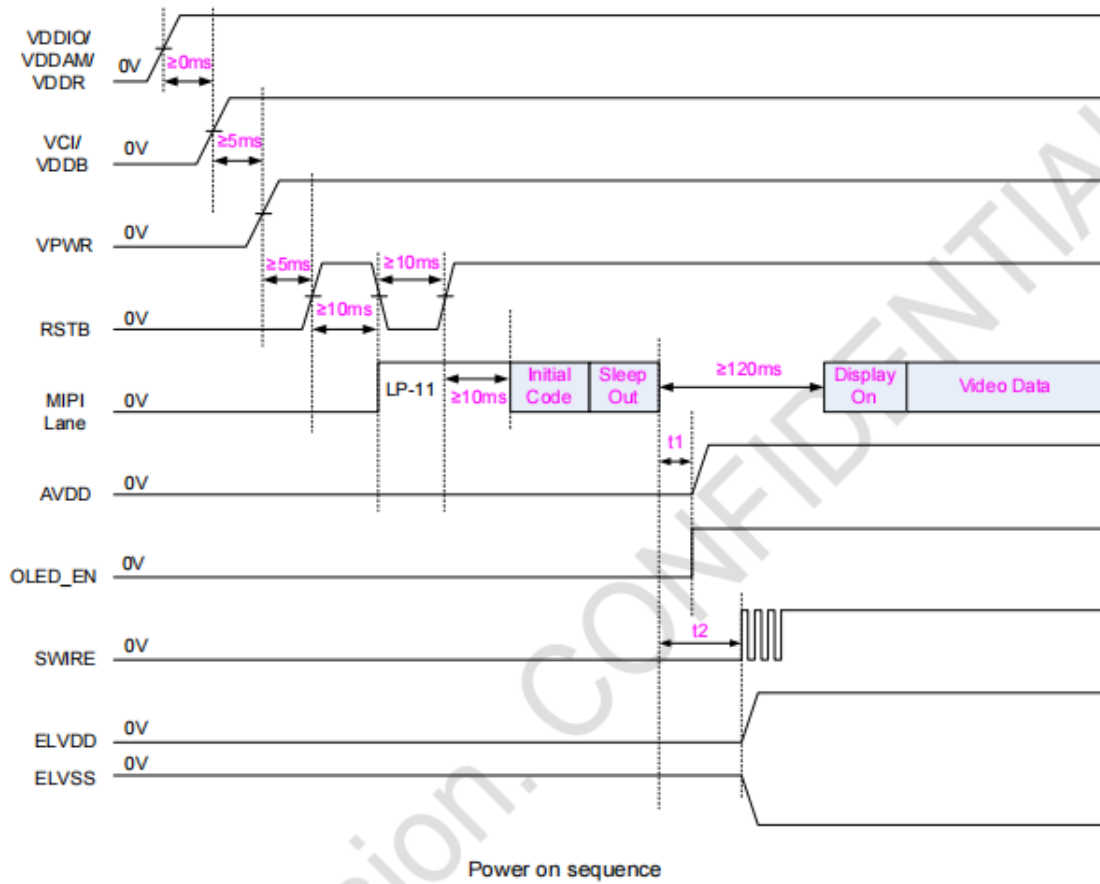
No.	Pin Name	Description
1	GND	Ground
2	NC	NC
3	NC	NC
4	NC	NC
5	NC	NC
6	NC	NC
7	NC	NC
8	GND	Ground
9	MIPI_DSI_D3_P	MIPI Data Lane3 Positive
10	MIPI_DSI_D3_N	MIPI Data Lane3 Negative
11	GND	Ground
12	MIPI_DSI_D0_P	MIPI Data Lane0 Positive
13	MIPI_DSI_D0_N	MIPI Data Lane0 Negative

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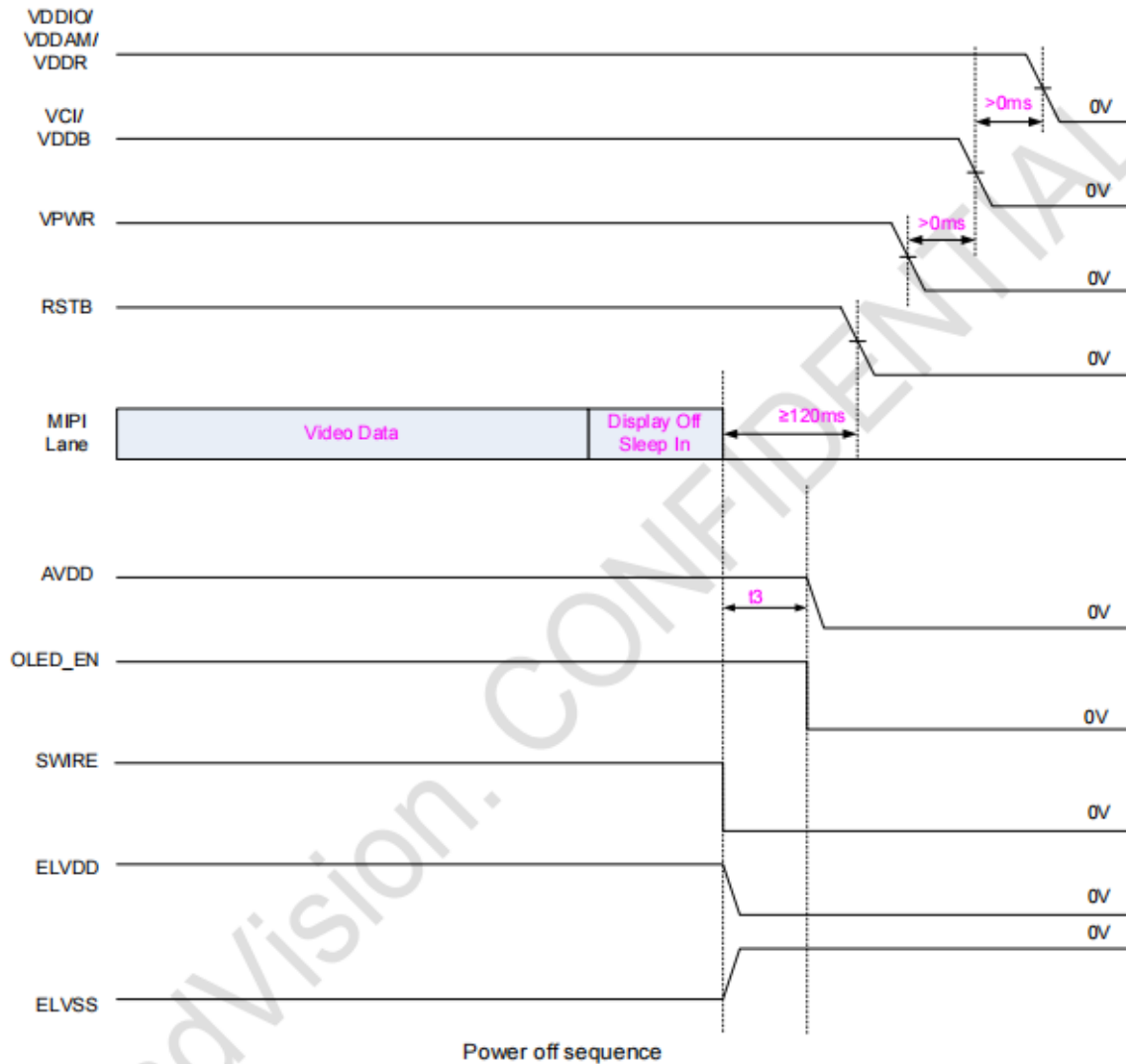
14	GND	Ground
15	MIPI_DSI_CLK_P	MIPI Clock Lane Positive
16	MIPI_DSI_CLK_N	MIPI Clock Lane Negative
17	GND	Ground
18	MIPI_DSI_D1_P	MIPI Data Lane1 Positive
19	MIPI_DSI_D1_N	MIPI Data Lane1 Negative
20	GND	Ground
21	MIPI_DSI_D2_P	MIPI Data Lane2 Positive
22	MIPI_DSI_D2_N	MIPI Data Lane2 Negative
23	GND	Ground
24	RESET	Reset SD IC. This signal is active low.
25	TE	Pad for TE
26	SWIRE	Enable Vpos(ELVDD) and Vneg(ELVSS) for DC/DC IC
27	AVDD_EN	Power IC enable control pin
28	ERR_FG	Error Flag
29	PCD	Panel Crack Detection pin.
30	IOVCC	Digital circuit I/O power supply
31	VCI	Power supply for Analog circuit.
32	AVDD	AMOLED Charge pumping Power for Driver IC
33	AVDD	AMOLED Charge pumping Power for Driver IC
34	ELVSS	Negative power supply for EL
35	ELVSS	Negative power supply for EL
36	ELVSS	Negative power supply for EL
37	ELVDD	Positive power supply for EL
38	ELVDD	Positive power supply for EL
39	ELVDD	Positive power supply for EL
40	GND	Ground

5.2 Recommended Operating Sequence

5.2.1 Power on Sequence



5.2.2 Power Off Sequence



5.2.3 Timing Requirements for RESETB

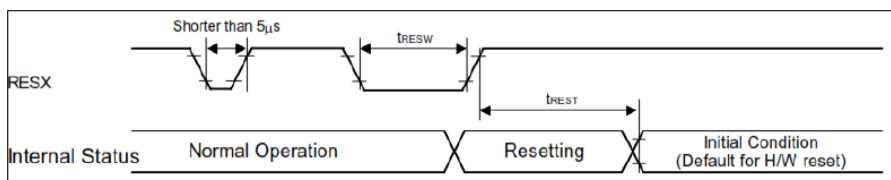


Figure 8-6-1 Reset Function

Symbol	Parameter	Related Pins	Min.	Typ.	Max.	Note	Unit
t_{RESW}	*1) Reset low pulse width	RESX	10	-	-	-	us
t_{REST}	*2) Reset complete time				5	When reset applied during sleep in mode	ms
					120	When reset applied during Sleep out mode	ms

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6. Electro-Optical Specification

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note	
Brightness		Normal (White Mode)	450	500	550	cd/m ²	(1)	
		HBM	630	700	770	cd/m ²		
Brightness Uniformity		L255	75	-	-	%	(2)	
Contrast Ratio	CR	Normal to Surface	100000	-	-	-	(3)	
Color of CIE Coordinate	White	x	Normal $\Theta=\Phi=0^\circ$	0.275	0.295	0.315	-	Reference Data, Actual Typ. Data Needs Measurements
		y		0.285	0.305	0.325	-	
	Red	x		0.66	0.69	0.72	-	
		y		0.28	0.31	0.34	-	
	Green	x		0.195	0.235	0.275	-	
		y		0.68	0.72	0.76	-	
	Blue	x		0.113	0.143	0.173	-	
		y		0.014	0.044	0.074	-	
Color Shift		@30 Degree	-	-	6	JNCD	(4)	
Color Gamut		DCI-P3	90	109	-	%		
Viewing Angle		U/D/L/R CR \geq 10	80	-	-	°		
Gamma		V(Gray)=48,72,104,132,164,192,224,255	2.0	2.2	2.4	-		
Response Time		@25°C	-	-	2	ms	(5)	
Flicker		Normal $\Theta=\Phi=0^\circ$	-	-	-30	dB	(6)	
Image Residue		20*20 Checker Stress 3min, Switch to Gray 128, Should Disappear	-	-	18	S	(7)	
Crosstalk		4% Black or White window, 127 Gray scale	-	-	2	%	(8)	
OLED Life Time		LT50 @ 25°C	-	-	-	Hrs		
		LT80 @ 25°C	-	-	-	Hrs		

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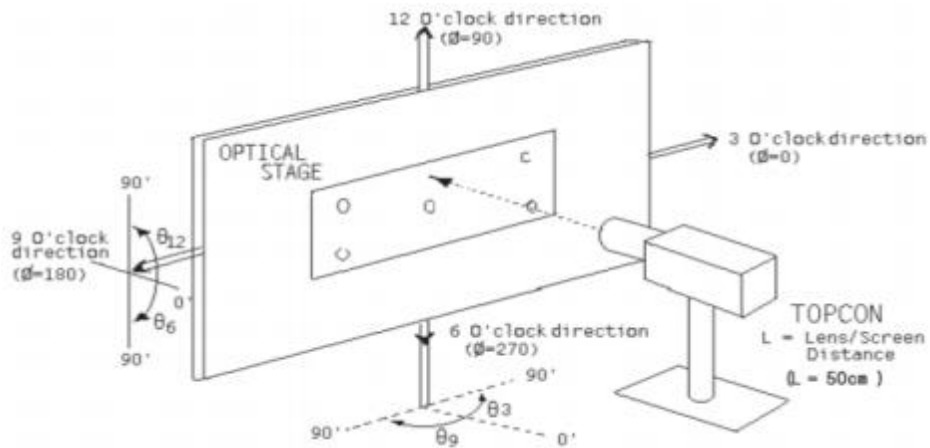
Note 1: Brightness

Environmental conditions: Temp.25°C±3°C, 65±20%RH, Dark Room. Distance of OLED display center to measuring machine is 50cm.

Test 5pcs manually;

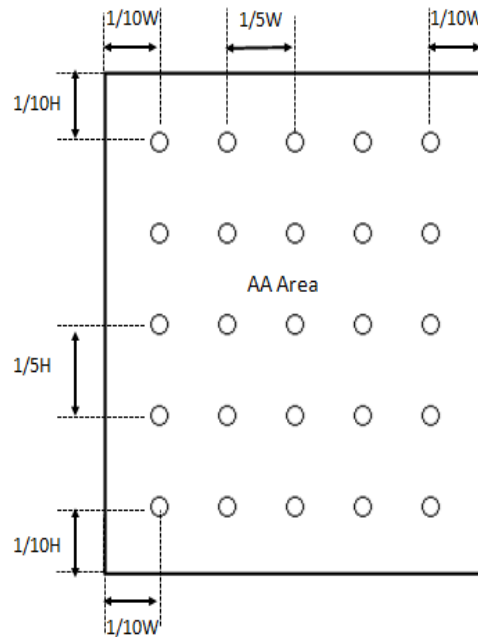
Equipment: CS2000A

Method: Turn the machine around direction, and measure the brightness of the middle of the panel.



Note 2: Brightness Uniformity

Measure 25 points of Display Brightness, Brightness Uniformity=Lmin/LMax×100%

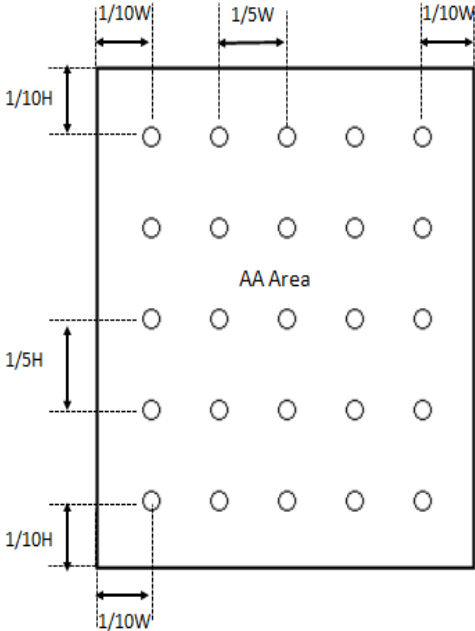


Note 3: Contrast Ratio

Environmental conditions : Temp.25°C±3°C, 65±20%RH, Dark Room.
 C.R=LW/LB
 LW: full white brightness of display center P0;
 LB: full black brightness of display center P0.

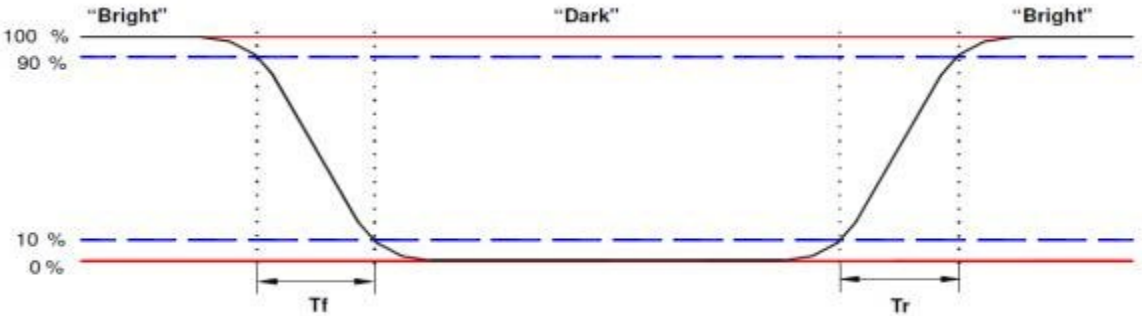
Note 4: Color Uniformity

Calculate the max $\Delta u' v'$ value between two random point of 25 point · Calculate all the test point (ui, vi) compare to the center of active area point(uj, vj), $d_{uv} = \text{sqrt} ((u_i - u_j)^2 + (v_i - v_j)^2)$



Note 5: Response Time

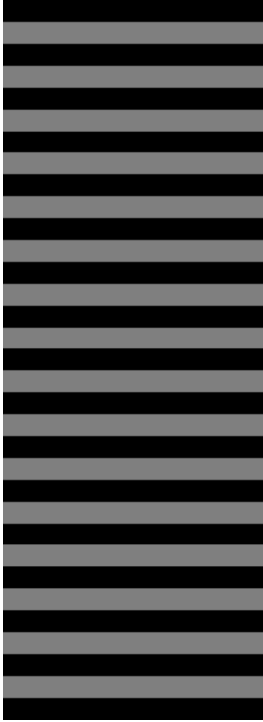
Response time=Pixel turn on and turn off time (White<=>Black).
 It is measuring transition time from 10% to 90% of luminance with single frame pattern.



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Note 6: Flicker

Suggested Instruments: **Konica Minolta CA-310 or similar instrument**



Flicker Pattern: one line black one line Gray 128 and so on....

The flicker level is defined by Fast Fourier Transformation (FTT) as follows:

$$Flicker = 20 \log_{10} \left(2 \frac{f_{FFTC}(n)}{f_{FFTC}(0)} \right) + FS(Hz) \quad (dB)$$

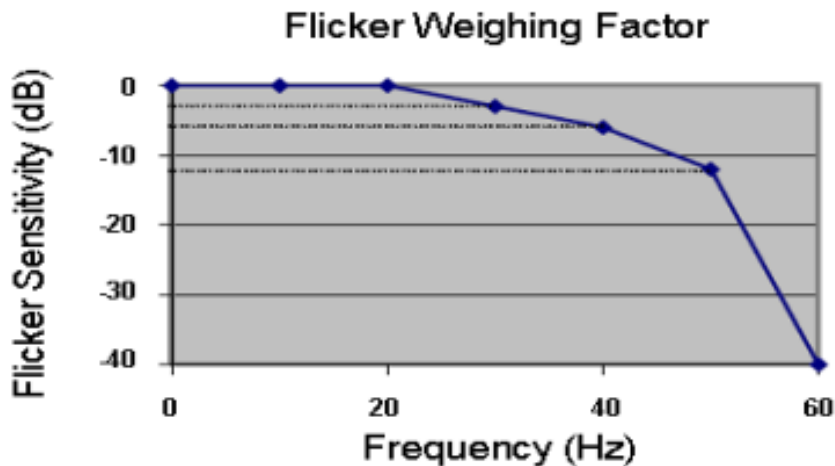
Where

$f_{FFTC}(n)$ is the n-th FFT coefficient.

$f_{FFTC}(0)$ is the 0-th FFT coefficient which is DC component.

$FS(Hz)$ is the flicker sensitivity as a function of frequency.

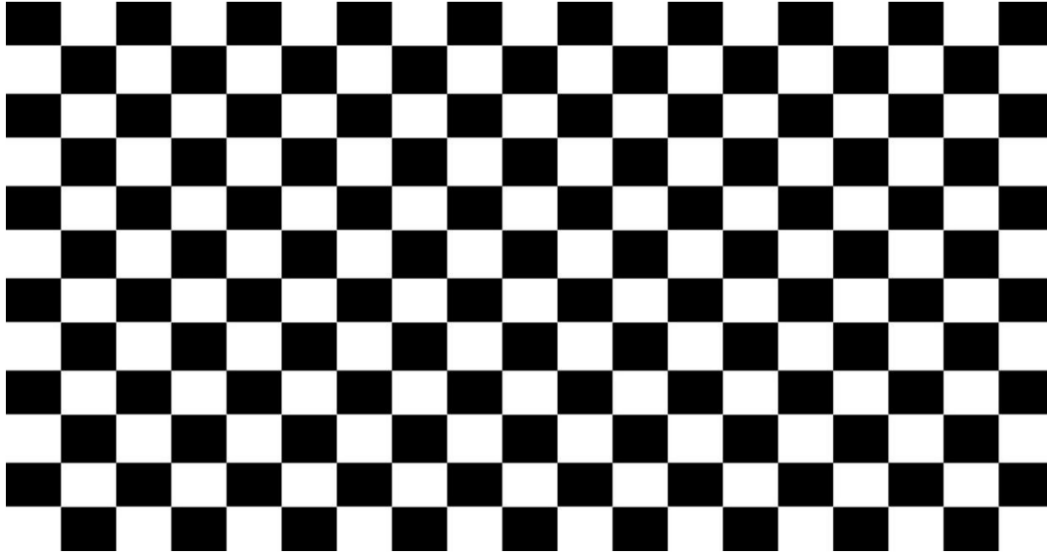
The peak flicker level shall be reported based on the calculation using above formula in which $FS(Hz)$ is determined by the flicker weighing factor shown below.



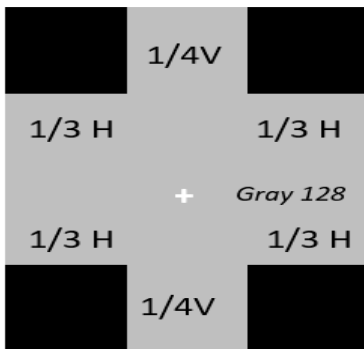
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Note7 Image Residue

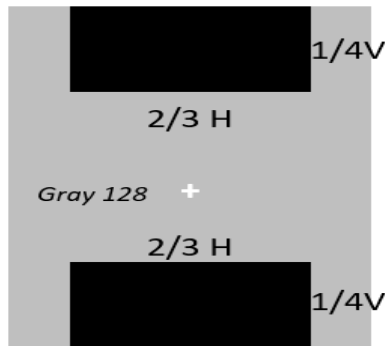
20*20 Checker Stress 3min,Switch to Gray 128,Should Disappear Within 18s.



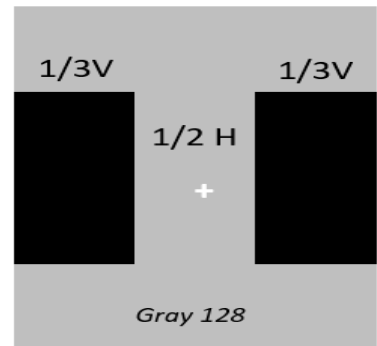
Note 8: Crosstalk



REF



VINF



HINF

$$\text{Vertical Crosstalk} = \frac{\text{Luminance at REF} - \text{Luminance at VINF}}{\text{Luminance at REF}} \times 100\%$$

$$\text{Horizontal Crosstalk} = \frac{\text{Luminance at REF} - \text{Luminance at HINF}}{\text{Luminance at REF}} \times 100\%$$

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7. Reliability

7.1 Environmental Reliability Test

No	Item	Condition	Quantity	Note
1	Low Temp. Operation	-30±2°C/ 240H	5 pcs	
2	Low Temp. Storage	-40±2°C/ 240H	5 pcs	
3	High Temp. Operation	80±2°C/ 240H	5 pcs	
4	High Temp. Storage	80°C±2°C/ 240H	5 pcs	
5	High Temp. / High Humidity Operation	65°C, 90% RH, 240hrs	5 pcs	
6	Thermal Shock, Display Off	-30°C(30min) ~ +80°C(30min), 30 cycle,	5 pcs	
7	ALT(Component Level)	"65 °C, 90% RH" + Thermal Shock" -40°C ~ +80 °C" , 5loops	5 pcs	Figure.1 Figure.2
8	Salt Spray	3 cycles, each cycle including two stages : 1).2 hours salt mist test : (15~35°C) (5±1) %Nacl 2).22 hours store : (40±2°C) ,90%~95 %RH Requirements: The touch panel has no cracks, discoloration, bubbles, or other abnormalities, and the function is OK.	5 pcs	

ALT 2019 Mini-loop TH/TC Chamber Profile

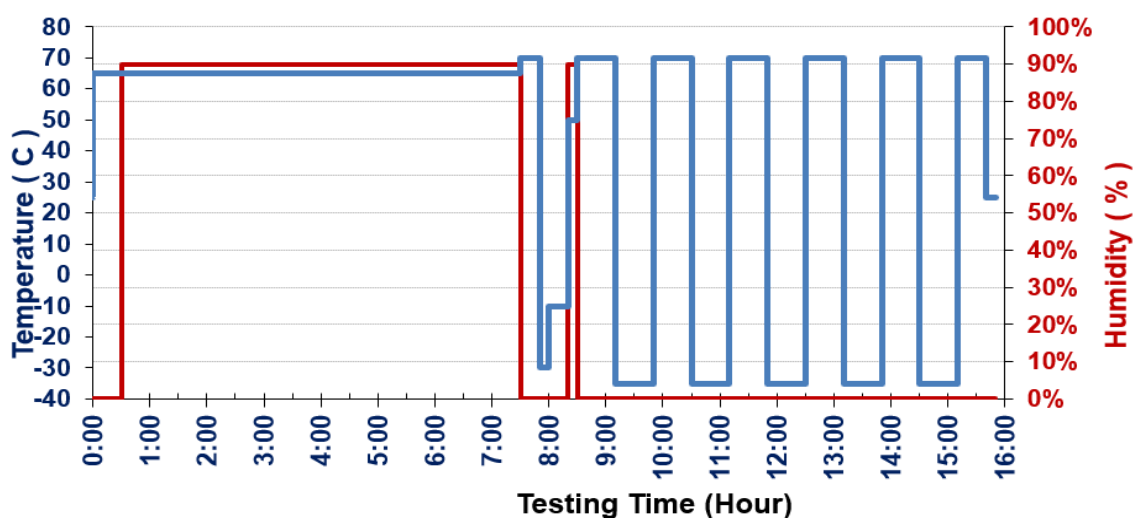


Figure.1

Interval	Temperature	Humidity	Temperature	Humidity	Next	# of	Elapsed	Comments	
Intvl #	Time	(Chn. 1)	(Chn. 2)	(Chn. 1)	(Chn. 2)	Interval	Loops	Time	
1	0:00:01	25	0	65	0	2	0	0	<div style="text-align: center;"> <p>Pre-heat to prevent condensing environment Temperature Humidity</p> <p>↓</p> <p>Dry out</p> <p>↓</p> <p>Condensation Cycle</p> <p>↓</p> <p>Temperature Cycle/Shock</p> <p>↓</p> <p>Dry out</p> <p>↓</p> </div>
2	0:30:00	65	0	65	0	3	0	0:30	
3	0:00:01	65	90	65	90	4	0	0:30	
4	7:00:00	65	90	65	90	5	0	7:30	
5	0:00:01	70	0	70	0	6	0	7:30	
6	0:20:00	70	0	70	0	7	0	7:50	
7	0:00:01	-30	0	-30	0	8	0	7:50	
8	0:10:00	-30	0	-30	0	9	0	8:00	
9	0:00:01	-10	0	-10	0	10	0	8:00	
10	0:20:00	-10	0	-10	0	11	0	8:20	
11	0:00:01	50	90	50	90	12	0	8:20	
12	0:10:00	50	90	50	90	13	0	8:30	
13	0:00:01	70	0	70	0	14	0	8:30	
14	0:40:00	70	0	70	0	15	0	9:10	
15	0:00:01	-35	0	-35	0	16	0	9:10	
16	0:40:00	-35	0	-35	0	13	5	15:50	
17	0:00:01	70	0	70	0	18	0	15:50	
18	0:30:00	70	0	70	0	19	0	16:20	
19	0:00:01	25	0	25	0	20	0	16:20	
20	0:10:00	25	0	25	0	1	999	16:30	

Figure.2

7.2 ESD_Test

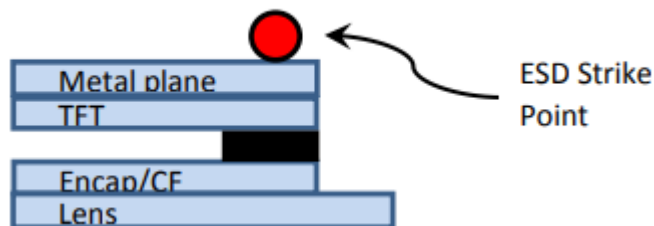
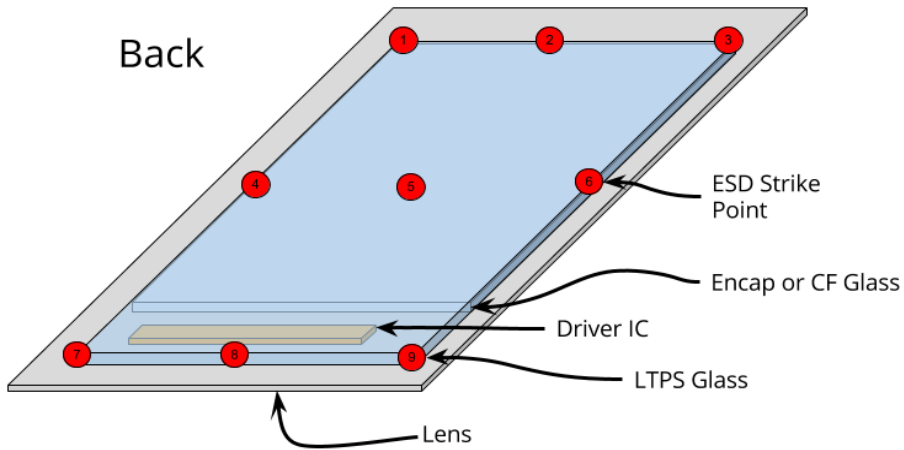
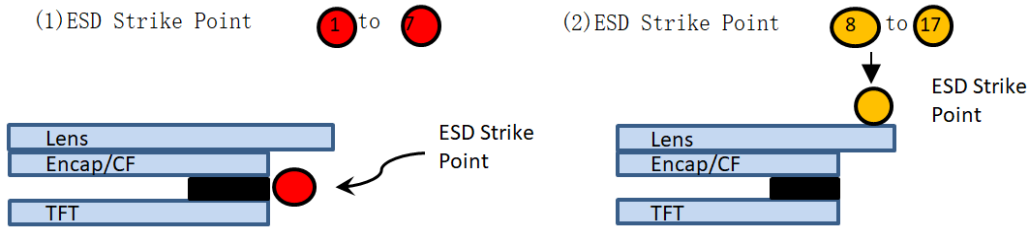
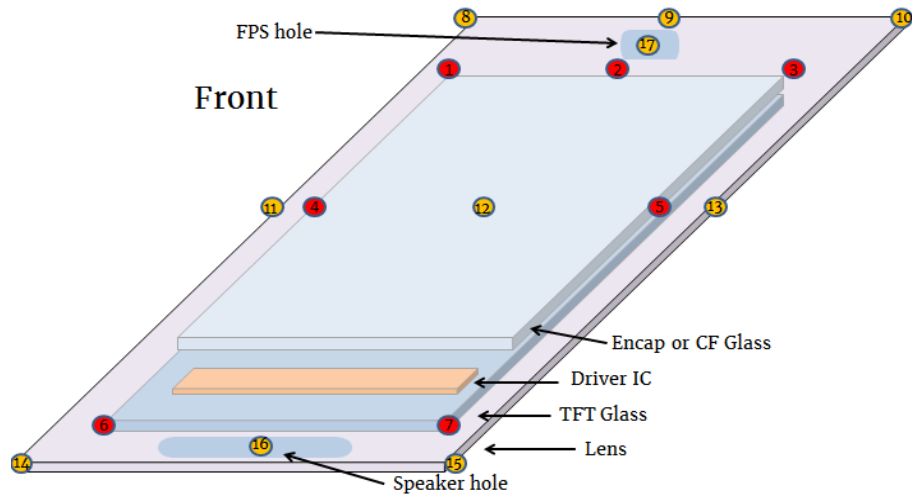
Sample Quantity: 5 pieces Display screen/touch panel/display screen touch component

Strike Location	Display status	ESD Test	RC network	Limit		Number of Strikes
				Contact	Air	
Front On Display	Display On	IEC 61000-4-2	330Ω/150pF	±4 kV	±8 kV	5 per location
Ground On Metal Plane	Display On	IEC 61000-4-2	330Ω/150pF	±4 kV	±8 kV	5 per location
Front, Back Reset, Power, Ground On Display Flex	Display Off	HBM	1.5kΩ/100pF	±2.5 kV	n/a	5 per location
Front On Touch	Display On	IEC 61000-4-2	330Ω/150pF	±8 kV	±15 kV	10 per location
Reset, Power, Ground On Touch Flex	Display Off	HBM	1.5kΩ/100pF	±2 kV	n/a	5 per location

Test Method:

- 1) Confirm that the temperature and humidity of the laboratory meet the IEC61000-4-2 standard, and record the actual temperature and humidity in a table.
- 2) Select appropriate RC components according to the table and conduct tests. Except for Front on touch, each point is tested 10 times and discharged after each test. For other points, each point is tested 5 times and discharged after each test.

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9 Packing Specification(TBD)

10 The Control of Hazardous Substances

The Control of Hazardous substances refer to ML document
(Standard document for the Control of Hazardous substances) , The Last Version

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11 Precaution

Please pay attention to the following items when you use the AMOLED Modules(Panel):

- 1.Do not twist or bend the module(panel) and prevent the unsuitable external force for display during assembly.
- 2.Adopt measures for good heat radiation. Be sure to use the module(panel) with in the specified temperature.
- 3.Avoid dust or oil mist during assembly.
- 4.Follow the correct power sequence while operating. Do not apply the invalid signal, otherwise, it will cause improper shut down and damage the module(panel).
- 5.Less EMI: it will be more safety and less noise.
- 6.Please operate module(panel) in suitable temperature. The response time & brightness will drift by different temperature.
- 7.Avoid to display the fixed pattern (exclude the white pattern) in a long period, otherwise, it will cause image sticking.
- 8.Please be sure to turn-off the power when connecting or disconnecting the circuit.
- 9.Polarizer scratches easily, please handle it carefully.
- 10.Display surface never likes dirt or stains.
- 11.A dew drop may lead to destruction. Please wipe off any moisture before using module(panel).
- 12.Sudden temperature changes cause condensation, and it will cause polarizer damaged.
- 13.High temperature and humidity may degrade performance. Please do not expose the module(panel) to the direct sunlight and so on.
- 14.Acetic acid or chlorine compounds are not friends with AMOLED display module(panel).
- 15.Static electricity will damage the module(panel), please do not touch the module(panel) without any grounded device.
- 16.Please avoid any static electricity damage (ESD) during producing and operating.
- 17.Do not disassemble and reassemble the module(panel) by self. 18.Be careful do not touch the rear side directly.
- 19.No strong vibration or shock. It will cause module(panel) broken.
- 20.Storage the modules(panel) in suitable environment with regular packing. 21.Be careful of injury from a broken display module(panel).
- 22.Please avoid the pressure adding to the surface (front or rear side) of modules(panel), because it will cause the display non-uniformity or other function issue.
- 23.Touch code is decided by (1) cover lens type, (2) lens lamination parameters, and (3) customers' hardware/software setting. Please be noted if above factors was changed, MOLI need new samples to re-adjusted touch code.
- 24.Please take some protective action at the interface between rear side of panel and system hardware.
- 25.Please avoid any reflection material to cause the light radiated from rear side or broadside of panel.
- 26.Please NOTICE to keep the flatness between system board and AMOLED display, it will be much safer during the module drop test.

12 Warranty

MOLI warrants that products delivered in accordance with this specification (or order) will comply with the agreed specifications for a period of twelve (12) months from the date of shipment (the "Warranty Period"). If a product is found to be defective or does not meet specifications during the warranty period, MOLI is obliged to repair or replace the product free of charge, provided that the product is stored at an ambient temperature of 25°C±5°C and a relative humidity of 45% to 75%. Do not store in original packaging exposed to sunlight or fluorescent lighting. Use under the conditions specified in the book.