



# SPECIFICATION FOR TFT LCD MODULE

CUSTOMER : \_\_\_\_\_

CUSTOMER MODULE : \_\_\_\_\_

HL MODEL :           HG005WS003          

Preliminary Specification

Final Specification

Customer Confirmation column:

Approved by : \_\_\_\_\_ Dept. : \_\_\_\_\_ Data : \_\_\_\_\_

Please return one of the copies of the specification with your signature to us within two weeks after you receive this document. If it is not returned, we will assume that you agree to the entire contents of this specification document.

Designed by	Checked by	Approved by



## REVISION RECORD

REV.	REVISION DESCRIPTION	REV. DATE	REMARK
X01	INITIAL RELEASE	2019. 04. 30	



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## **1. SCOPE**

## **2. WARRANTY**

## **3. FEATURES**

- Small molecular organic light emitting diode.
- Color : White
- Panel matrix : 48x88
- Driver IC : CH1115
- Excellent quick response time.
- Extremely thin thickness for best mechanism design : 1.227 mm
- High contrast : 10,000:1
- Wide viewing angle : 160°
- I<sup>2</sup>C interface.
- Strong environmental resistance.
- Wide range of operating temperature : -40 to 70 °C.
- Anti-glare polarizer.



## 4. MECHANICAL DATA

NO	ITEM	SPECIFICATION	UNIT
1	Dot Matrix	48 (W) x 88 (H)	dot
2	Dot Size	0.108 (W) x 0.108 (H)	mm <sup>2</sup>
3	Dot Pitch	0.128 (W) x 0.128 (H)	mm <sup>2</sup>
4	Aperture Rate	71	%
5	Active Area	6.124 (W) x 11.244 (H)	mm <sup>2</sup>
6	Panel Size	8.928 (W) x 17.1 (H)	mm <sup>2</sup>
7*	Panel Thickness	1.02 ± 0.1	mm
8	Module Size	9 (W) x 27.6 (H) x 1.227 (D)	mm <sup>3</sup>
9	Diagonal A/A size	0.5	inch
10	Module Weight	TBD	gram

\* Panel thickness includes substrate glass, cover glass and UV glue thickness.



## 5. MAXIMUM RATINGS

ITEM	MIN	MAX	UNIT	Condition	Remark
Supply Voltage ( $V_{DD1}$ )	-0.3	3.6	V	Ta = 25°C	IC maximum rating
Supply Voltage ( $V_{DD2}$ )	-0.3	4.8	V	Ta = 25°C	IC maximum rating
Supply Voltage ( $V_{PP}$ )	8	14.5	V	Ta = 25°C	IC maximum rating
Operating Temp.	-40	70	°C	-	-
Storage Temp	-40	85	°C	-	Note (2)

Note:

- (1) Maximum ratings are those values beyond which damages to the OLED module may occur. The OLED functional operation should be restricted to the limits in the section 6. Electrical Characteristics tables.
- (2) The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.

## 6. ELECTRICAL CHARACTERISTICS

### **6.1 D.C ELECTRICAL CHARACTERISTICS**

SYMBOL	PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
$V_{DD1}$	Logic Supply Voltage	Ta = 25°C	1.65	1.8	3.5	V
$V_{DD2}$	Charge Pump Regulator Supply Voltage	Ta = 25°C	3.3	-	4.75	V
$V_{PP}$	Operating Voltage (for OLED panel) (Charge Pump)	Ta = 25°C	7.0	7.4	-	V
$V_{OH}$	High Logic Output Level	$I_{OH} = -0.5mA$	$0.8 * V_{DD1}$	-	$V_{DD1}$	V
$V_{OL}$	Low Logic Output Level	$I_{OL} = 0.5mA$	$V_{SS}$	-	$0.2 * V_{DD1}$	V
$V_{IH}$	High Logic Input Level	-	$0.8 * V_{DD1}$	-	$V_{DD1}$	V
$V_{IL}$	Low Logic Input Level	-	$V_{SS}$	-	$0.2 * V_{DD1}$	V



## 6.2 ELECTRO-OPTICAL CHARACTERISTICS

### PANEL ELECTRICAL SPECIFICATIONS

PARAMETER	MIN	TYP.	MAX	UNITS	COMMENTS
Normal mode current (IDD2) (Charge Pump)	-	13	14	mA	All pixels on (1)
	-	4	5	mA	20% pixels on (1)
Standby mode current (IDD2) (Charge Pump)	-	1	2	mA	Standby mode 10% pixels on (2)
IDD1 sleep mode current	-	-	5	uA	Sleep mode Current (3)
IDD2 sleep mode current (Charge Pump)	-	-	5	uA	Sleep mode Current (3)
Normal Luminance (Charge Pump)	170	200	-	cd/m <sup>2</sup>	Display Average
Standby Luminance (Charge Pump)	-	45	-	cd/m <sup>2</sup>	Display Average
CIE <sub>x</sub> (White)	0.23	0.27	0.31		x, y (CIE 1931)
CIE <sub>y</sub> (White)	0.265	0.305	0.345		
Dark Room Contrast	10,000:1				
Viewing Angle	160			degree	
Response Time		10		μs	

(1) Normal mode condition : (Charge Pump)

- V<sub>DD2</sub> = 3.3V
- Contrast setting : 0x39
- Frame rate : 105Hz
- Duty setting : 1/48

(2) Standby mode condition : (Charge Pump)

- V<sub>DD2</sub> = 3.3V
- Contrast setting : 0x00
- Frame rate : 105Hz
- Duty setting : 1/48

(3) Sleep mode condition :

When send 0xae command OLED display off and memory data will be maintained.

(4) Wake up condition :

When send 0xaf command OLED will be turned on.



## 7. LIFETIME SPECIFICATION

ITEM	MIN	UNIT	Condition	Remark
Life Time	10,000	Hrs	200 cd/m <sup>2</sup> , alternating checkerboard	(Charge pump) Note (1)

Note:

(A) Under  $V_{DD2} = 3.3V$  (Charge Pump),  $T_a = 25^{\circ}C$ , 50% RH.

(B) Life time is defined the amount of time when the luminance has decayed to less than 50% of the initial measured luminance.

(1) Setting of 200 cd/m<sup>2</sup> : (Charge Pump)

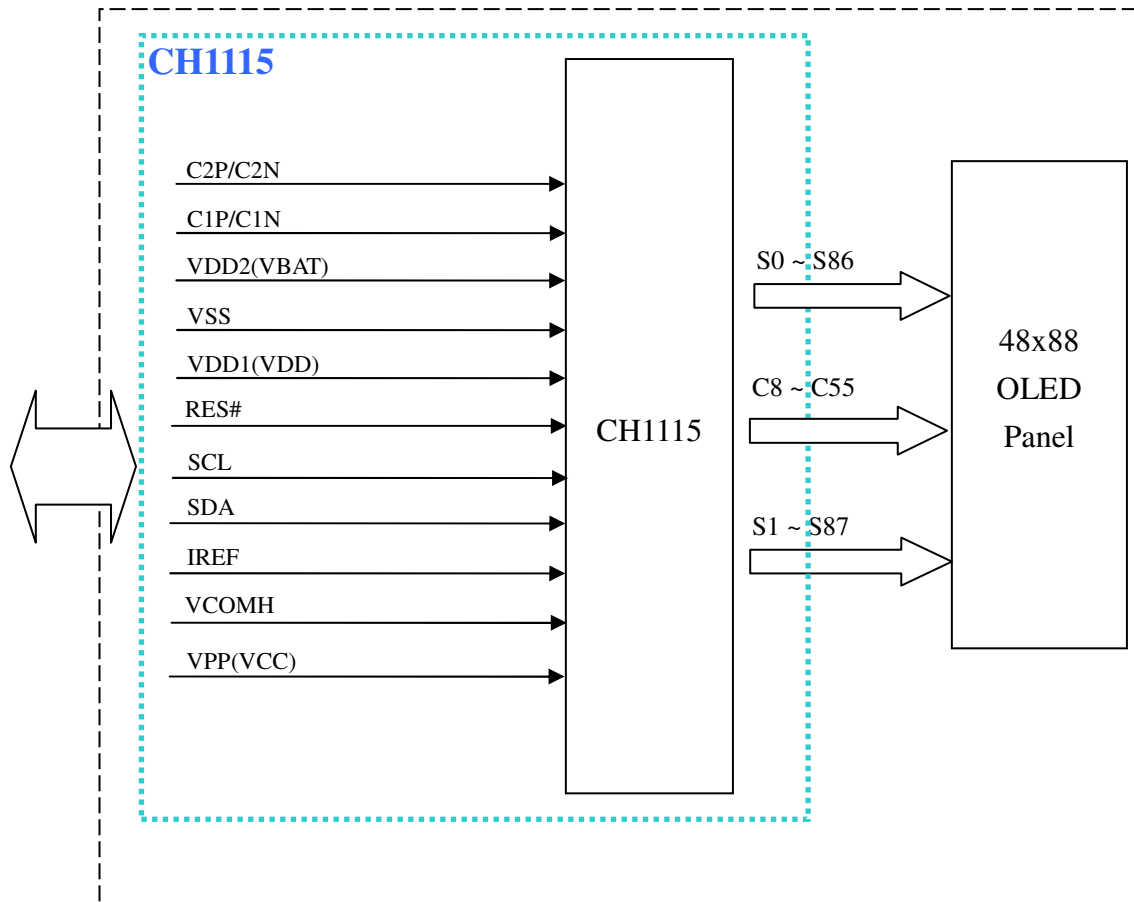
- Contrast setting : 0x39
- Frame rate : 105Hz
- Duty setting : 1/48



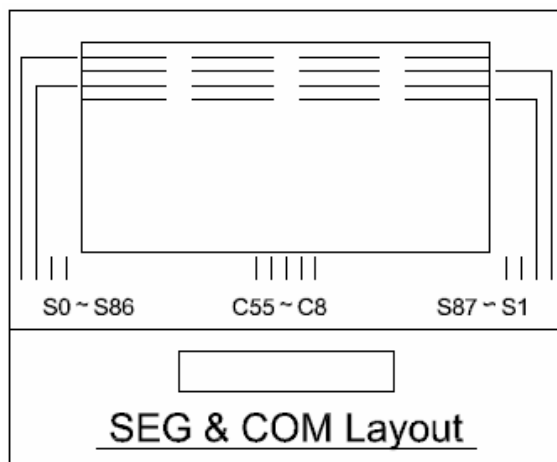


## 8. INTERFACE

### 8.1 FUNCTION BLOCK DIAGRAM



### 8.2 PANEL LAYOUT DIAGRAM





## 8.3 PIN ASSIGNMENTS

PIN NO.	PIN NAME	DESCRIPTION	Setting at each interface		
			8080 parallel	SPI	IIC
1	C2P	C2N/C2P – Pin for charge pump capacitor; Connect to each other with a capacitor.			
2	C2N				
3	C1P	C1N/C1P – Pin for charge pump capacitor; Connect to each other with a capacitor.			
4	C1N				
5	VDD2 (VBAT)	Power supply for charge pump regulator circuit.			
6	NC	No connection.			
7	VSS	Ground pin.			
8	VDD1 (VDD)	Power supply pin for core logic operation.			
9	RES#	This pin is reset signal input.	NA	NA	RES#
10	SCL	When the I <sup>2</sup> C interface is selected, then D0 serves as the serial clock input pad (SCL) and D1 serves as the serial data input pad (SDA). At this time, D2 to D7 are set to high impedance.	NA	NA	SCL
11	SDA		NA	NA	SDA
12	IREF	This pin is the segment output current reference pin. A resistor should be connected between this pin and VSS.			
13	VCOMH	COM signal deselected voltage level. A capacitor should be connected between this pin and VSS.			
14	VPP (VCC)	Power supply for panel driving voltage.			

### Note

(1) Low is connected to VSS.

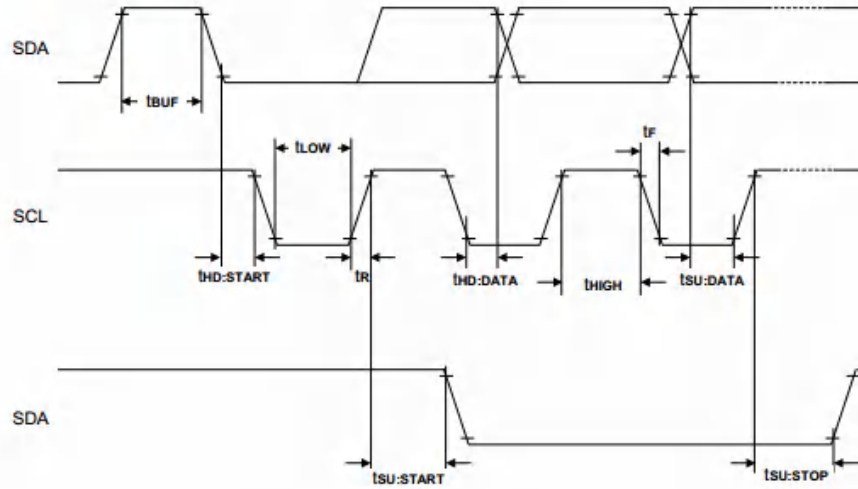
(2) High is connected to VDD1(VDD).





## 8.5 INTERFACE TIMING CHART

I<sup>2</sup>C interface characteristics



(VDD1 = 1.65 - 3.5V, TA = +25°C)

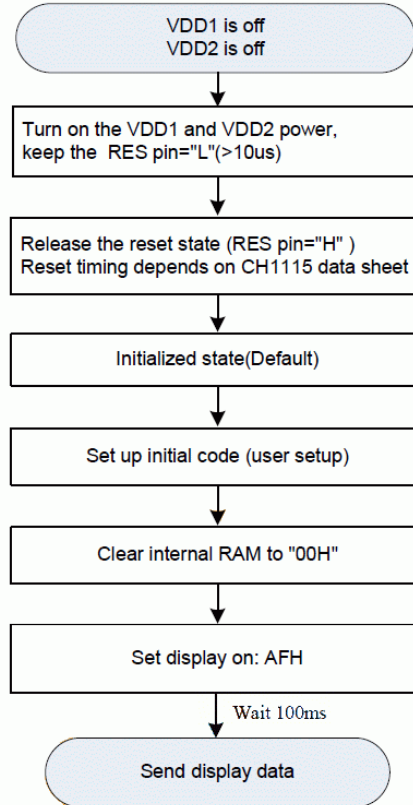
Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
f <sub>SCL</sub>	SCL clock frequency	DC	-	400	kHz	
T <sub>LOW</sub>	SCL clock Low pulse width	1.3	-	-	uS	
T <sub>HIGH</sub>	SCL clock H pulse width	0.6	-	-	uS	
T <sub>SU:DATA</sub>	data setup time	100	-	-	nS	
T <sub>HD:DATA</sub>	data hold time	0	-	0.9	uS	
T <sub>R</sub>	SCL · SDA rise time	20+0.1Cb	-	300	nS	
T <sub>F</sub>	SCL · SDA fall time	20+0.1Cb	-	300	nS	
C <sub>b</sub>	Capacity load on each bus line	-	-	400	pF	
T <sub>SU:START</sub>	Setup time for re-START	0.6	-	-	uS	
T <sub>HD:START</sub>	START Hold time	0.6	-	-	uS	
T <sub>SU:STOP</sub>	Setup time for STOP	0.6	-	-	uS	
T <sub>BUF</sub>	Bus free times between STOP and START condition	1.3	-	-	uS	



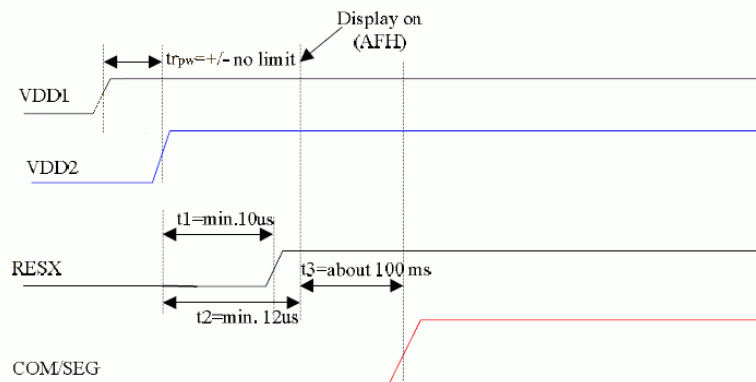
## 9. POWER ON / OFF SEQUENCE & APPLICATION CIRCUIT

### 9.1 POWER ON / OFF SEQUENCE

Built-in DC-DC pump power is being used immediately after turning on the power:

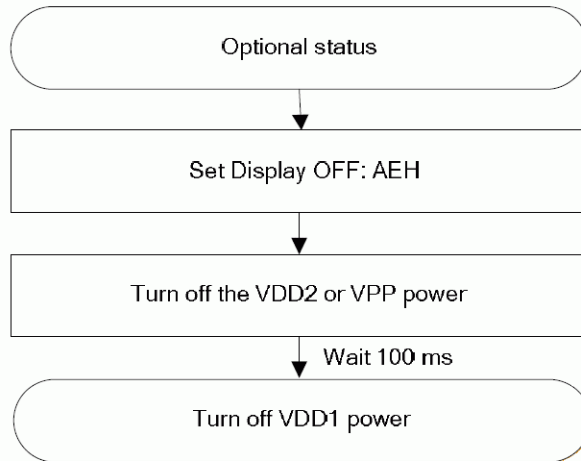


Power on sequence:





## Power Off

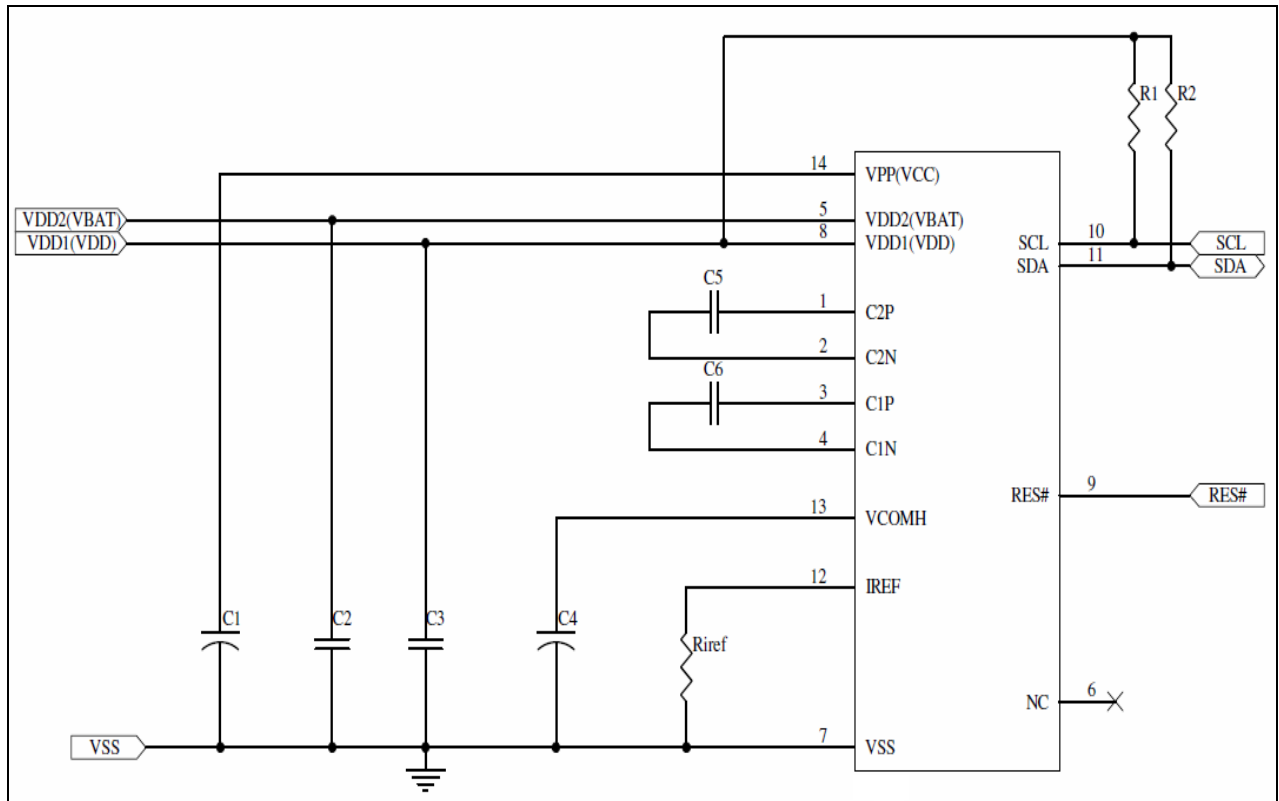


## Power off sequence:





## 9.2 APPLICATION CIRCUIT (Charge Pump)



### Recommended components :

C1 : 4.7uF/16V(0805)

C2 、 C3 、 C5 、 C6 : 1uF/6.3V(0603)

C4 : 4.7uF/25V(Tantalum type) or VISHAY (572D475X0025A2T)

Riref : 620K ohm 1%(0603)

R1 、 R2 : 10K ohm (0603)

**This circuit is for I<sup>2</sup>C interface.**

## 9.3 COMMAND TABLE

Refer to CH1115 IC Spec.



## **10. RELIABILITY TEST CONDITIONS**

No.	Items	Specification	Quantity
1	High temp. (Non-operation)	85 °C, 240hrs	5
2	High temp. (Operation)	70 °C, 120hrs	5
3	Low temp. (Operation)	-40°C, 120hrs	5
4	High temp. / High humidity (Operation)	65 °C, 90%RH, 120hrs	5
5	Thermal shock (Non-operation)	-40 °C ~85 °C (-40 °C /30min; transit /3min; 85 °C /30min; transit /3min) 1cycle: 66min, 100 cycles	5
6	Vibration	Frequency : 5~50HZ, 0.5G Scan rate : 1 oct/min Time : 2 hrs/axis Test axis : X, Y, Z	1 Carton
7	Drop	Height: 120cm Sequence : 1 angle 、 3 edges and 6 faces Cycles: 1	1 Carton
8	ESD (Non-operation)	Air discharge model, ±8kV, 10 times	5

### **Test and measurement conditions**

1. All measurements shall not be started until the specimens attain to temperature stability.
2. The degradation of Polarizer are ignored for item 1, 4 & 5.

### **Evaluation criteria**

1. The function test is OK.
2. No observable defects.
3. Luminance: > 50% of initial value.
4. Current consumption: within  $\pm 50\%$  of initial value.





## 11. EXTERNAL DIMENSION

General	Tolerance	Material	Approval
Length (mm)	Tolerance(mm)	W.Y.H.	
0 ~ 8	±0.1		
8 ~ 25	±0.2		
25 ~ 50	±0.3	20210922	

**Specification**

1. Display: OLED(White)
2. Dot Matrix: 48(c)x88(s)
3. Dot Size: 0.108x0.108mm
4. Dot Pitch: 0.128x0.128mm
5. Aperture Rate: 71%
6. Active Area: 6.124x11.244mm
7. IC: CH1115

PROJECT CODE	REVISION
HG005W0003	1
PART NAME	Sheet
OLED Module	1
PARTS DES.	1

**Pin Assignment**

NO.	SYMBOL
1	C2P
2	C2N
3	C1P
4	C1N
5	VDD2(VBA)
6	NC
7	VSS
8	VDD1(VDI)
9	RES#
10	SCL
11	SDA
12	IREF
13	VCOMH
14	VPP/VCC

**SEG & COM Layout**

REV	DATE	DESCRIPTION
1	20210922	The first version



**12. PACKING SPECIFICATION**

TBD



## 13. OUTGOING INSPECTION PROVISION

### 1. 抽樣方法 / SAMPLING METHOD

- (1) MIL-STD-1916 / 驗證水準 level III / 正常檢驗 / 單次樣品檢驗  
MIL-STD-1916 / inspection level III / normal inspection / single sample inspection
- (2) 主要缺陷 Level III ; 次要缺陷 Level II  
Major Level III ; Minor Level II

MIL-STD-1916 樣本代字對照表							
批量	驗證水準 (VL)						
	VII	VI	V	IV	III	II	I
2 ~ 170	A	A	A	A	A	A	A
171 ~ 288	A	A	A	A	A	A	B
289 ~ 544	A	A	A	A	A	B	C
545 ~ 960	A	A	A	A	B	C	D
961 ~ 1632	A	A	A	B	C	D	E
1633 ~ 3072	A	A	B	C	D	E	E
3073 ~ 5440	A	B	C	D	E	E	E
5441 ~ 9216	B	C	D	E	E	E	E
9217 ~ 17408	C	D	E	E	E	E	E
17409 ~ 30720	D	E	E	E	E	E	E
≥ 30721	E	E	E	E	E	E	E

樣本代字 (CL)	驗證水準(VL)							
	T	VII	VI	V	IV	III	II	I
	樣本大小							
A	3072	1280	512	192	80	32	12	5
B	4096	1536	640	256	96	40	16	6
C	5120	2048	768	320	128	48	20	8
D	6144	2560	1024	384	160	64	24	10
E	8192	3072	1280	512	192	80	32	12



## 2. 檢驗條件 / INSPECTION CONDITION

檢查和測量在下列條件下進行的，除非另有規定。

The inspection and measurement are performed under the following conditions, unless otherwise specified.

溫度 / Temperature:  $25\pm 5^{\circ}\text{C}$

濕度 / Humidity:  $50\pm 10\%\text{R.H.}$

壓力 / Pressure: 860~1060hPa (mbar)

檢驗員拿的面板和眼睛之間的距離 / Distance between the panel and eyes of the inspector  $\geq 30\text{cm}$



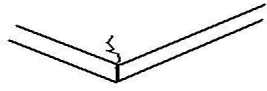
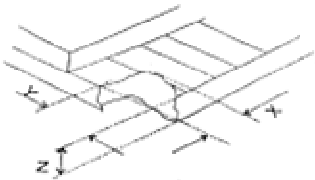
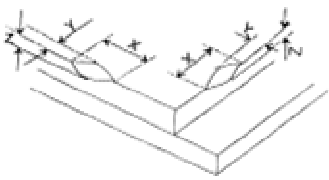
## 3. 品質檢驗規格 / SPECIFICATION FOR QUALITY CHECK

### 3.1 缺陷分類 / DEFECT CLASSIFICATION

嚴重度 Severity	檢驗項目 Inspection Item	缺陷 Defect	備註 Remark
主要缺陷 Major Defect	1. 面板 Panel	(1) 無顯示 Non-displaying	
		(2) 線缺陷 Line defects	
		(3) 故障 Malfunction	
	2. 軟板 Film	(1) 軟板尺寸超規 Film dimension out of specification	不能組裝 Can not be assembled
		3. 尺寸 Dimension	(1) 外形尺寸超規 Outline dimension out of specification
次要缺陷 Minor Defect	1. 面板 Panel	(1) 玻璃刮傷 Glass scratch	外觀缺陷 Appearance defect
		(2) 玻璃切割異常 Glass cutting NG	
		(3) 玻璃崩邊、崩角 Glass chip	
	2. 偏光板 Polarizer	(1) 偏光板刮傷 Polarizer scratch	
		(2) 表面汙漬 Stains on surface	
		(3) 偏光板氣泡 Polarizer bubbles	
	3. 顯示 Displaying	(1) 暗點、亮點、髒污 Dim spot·Bright spot·dust	
	4. 軟板 Film	(1) 損傷 Damage	
(2) 異物 Foreign material			



## 3.2 出貨規格 / OUTGOING SPECIFICATION

項目 Item	描述 Description	標準 Criterion	允收 水準 AQL															
I. 面板 Panel	1. 玻璃刮傷 Glass scratch	<table border="1"> <thead> <tr> <th>寬 / Width (mm) W</th> <th>長 / Length (mm) L</th> <th>容許個數 number of pieces permitted</th> </tr> </thead> <tbody> <tr> <td><math>W \leq 0.03</math></td> <td>忽略 Ignore</td> <td>忽略 Ignore</td> </tr> <tr> <td><math>0.03 &lt; W \leq 0.05</math></td> <td><math>L \leq 1</math></td> <td>1</td> </tr> <tr> <td><math>0.05 &lt; W</math></td> <td>-----</td> <td>無 None</td> </tr> <tr> <td>顯示區外 beyond A.A.</td> <td>-----</td> <td>忽略 Ignore</td> </tr> </tbody> </table>	寬 / Width (mm) W	長 / Length (mm) L	容許個數 number of pieces permitted	$W \leq 0.03$	忽略 Ignore	忽略 Ignore	$0.03 < W \leq 0.05$	$L \leq 1$	1	$0.05 < W$	-----	無 None	顯示區外 beyond A.A.	-----	忽略 Ignore	次要 Minor
	寬 / Width (mm) W	長 / Length (mm) L	容許個數 number of pieces permitted															
	$W \leq 0.03$	忽略 Ignore	忽略 Ignore															
$0.03 < W \leq 0.05$	$L \leq 1$	1																
$0.05 < W$	-----	無 None																
顯示區外 beyond A.A.	-----	忽略 Ignore																
2. 玻璃破損 Glass crack	<p>(1) 裂紋 / Crack 擴展裂紋是不能接受的。 Propagation crack is not acceptable.</p> 	主要 Major																
3. 玻璃崩邊、崩角 Glass chip	<p>(1) 崩角 / Chip on corner</p>  <p>(2) 崩邊 / Chip on edge</p> 	次要 Minor																



項目 Item	描述 Description	標準 Criterion	允收 水準 AQL																
I. 面板 Panel	3. 玻璃崩邊、崩角 Glass chip	<table border="1"> <thead> <tr> <th>崩角 Chip on corner</th> <th>Size (mm)</th> <th>崩邊 Chip on edge</th> <th>Size (m )</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>≤1.5</td> <td>X</td> <td>≤3.0</td> </tr> <tr> <td>Y</td> <td>≤2.0</td> <td>Y</td> <td>≤1.0</td> </tr> <tr> <td>Z</td> <td>≤t</td> <td>Z</td> <td>≤t</td> </tr> </tbody> </table> <p>備註 / Note:            1. t = 玻璃厚度            t = glass thickness            2. 崩邊或崩角延伸到 ITO 導線是不能接受的。            Chip on the corner extending into the ITO contact is not acceptable.</p>	崩角 Chip on corner	Size (mm)	崩邊 Chip on edge	Size (m )	X	≤1.5	X	≤3.0	Y	≤2.0	Y	≤1.0	Z	≤t	Z	≤t	次要 Minor
	崩角 Chip on corner	Size (mm)	崩邊 Chip on edge	Size (m )															
X	≤1.5	X	≤3.0																
Y	≤2.0	Y	≤1.0																
Z	≤t	Z	≤t																
	4. 尺寸 Dimension	請參閱圖紙的規範。 Refer to the drawing of the spec	主要 Major																
II. 偏光板 Polarizer	1. 刮傷 Scratch	點狀按照“項目 II-3 偏光板氣泡”的標準。 Spot type in accordance with the criteria of “Item II-3. Polarizer bubble”. 線狀按照“項目 I-1 玻璃刮傷”的標準。 Line type in accordance with the criteria of “Item I-1. Glass scratch”.	次要 Minor																
	2. 表面汙漬 Stains on surface	表面汙漬無法用軟布或類似的清潔物輕輕擦拭 去除。 Stains cannot be removed even when wiped lightly with a soft cloth or similar cleaning.	次要 Minor																
	3. 偏光板氣泡 Polarizer bubble	<p style="text-align: right;">(mm)</p> <table border="1"> <thead> <tr> <th>尺寸 Size</th> <th>容許個數 number of pieces permitted</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.2</math></td> <td>忽略 Ignore</td> </tr> <tr> <td><math>0.2 &lt; \Phi \leq 0.5</math></td> <td>2</td> </tr> <tr> <td><math>0.5 &lt; \Phi</math></td> <td>0</td> </tr> <tr> <td>顯示區外 beyond A.A.</td> <td>忽略 Ignore</td> </tr> </tbody> </table>	尺寸 Size	容許個數 number of pieces permitted	$\Phi \leq 0.2$	忽略 Ignore	$0.2 < \Phi \leq 0.5$	2	$0.5 < \Phi$	0	顯示區外 beyond A.A.	忽略 Ignore	次要 Minor						
尺寸 Size	容許個數 number of pieces permitted																		
$\Phi \leq 0.2$	忽略 Ignore																		
$0.2 < \Phi \leq 0.5$	2																		
$0.5 < \Phi$	0																		
顯示區外 beyond A.A.	忽略 Ignore																		



項目 Item	描述 Description	標準 Criterion	允收 水準 AQL											
III. 顯示 Displaying	1. 耗電 Power consumption	該模組的工作電流消耗不應超出產品規格書的規範。 The module operating current consumption should not go beyond the standard indicated in Product Specification	主要 Major											
	2. 像素尺寸 Pixel size	顯示像素的尺寸的公差應規格的±25%之內。 The tolerance of display pixel dimension should be within ±25% of specification.	次要 Minor											
	3. 顏色 Color	依據產品規格。 Refer to the product specification.	主要 Major											
	4. 亮度 Luminance	依據產品規格。 Refer to the product specification.	主要 Major											
	5. 暗點、亮點、 髒污 Dimming spot、Lighting spot、Dust	1. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>平均直徑 Average diameter D:(mm)</th> <th>容許個數 number of pieces permitted</th> </tr> </thead> <tbody> <tr> <td><math>D \leq 0.1</math></td> <td>忽略 Ignore</td> </tr> <tr> <td><math>0.1 &lt; D \leq 0.15</math></td> <td>1</td> </tr> <tr> <td><math>0.15 &lt; D \leq 0.2</math></td> <td>1</td> </tr> <tr> <td><math>0.2 &lt; D</math></td> <td>0</td> </tr> <tr> <td>顯示區外 beyond A.A.</td> <td>忽略 Ignore</td> </tr> </tbody> </table> <p>D=(長邊直徑 + 短邊直徑)/2 D=(long diameter + short diameter)/2 像素暗點是不允許。 Pixel off is not allowed.</p>	平均直徑 Average diameter D:(mm)	容許個數 number of pieces permitted	$D \leq 0.1$	忽略 Ignore	$0.1 < D \leq 0.15$	1	$0.15 < D \leq 0.2$	1	$0.2 < D$	0	顯示區外 beyond A.A.	忽略 Ignore
平均直徑 Average diameter D:(mm)	容許個數 number of pieces permitted													
$D \leq 0.1$	忽略 Ignore													
$0.1 < D \leq 0.15$	1													
$0.15 < D \leq 0.2$	1													
$0.2 < D$	0													
顯示區外 beyond A.A.	忽略 Ignore													





項目 Item	描述 Description	標準 Criterion	允收 水準 AQL		
III. 顯示 Displaying	5. 暗點、亮點、 髒污 Dimming spot、Lighting spot、Dust	2.	次要 Minor		
		寬 width(mm) W		長 length(mm) L	容許個數 number of pieces permitted
		$W \leq 0.03$		忽略 Ignore	忽略 Ignore
		$0.03 < W \leq 0.05$		$L \leq 1$	3
		$0.05 < W$		-----	無 None
顯示區外 beyond A.A.	-----	忽略 Ignore			
IV. 軟板 Film	1. 尺寸 Dimension	軟板尺寸超規。 Film dimension out of Spec.	主要 Major		
	2. 損傷 Damage	破損；深刮傷；深摺痕；深壓痕或其他損害是不能接受的。 Crack; deep scratch; deep fold; deep pressure mark or other damage is not acceptable.	次要 Minor		
	3. 異物 Foreign material	導電異物附著在導線，軟板和玻璃之間的異物是不能接受的。 Conductive foreign material sticking to the leads, foreign material between film and glass are not acceptable.	次要 Minor		



## **14. APPENDIXES**

### **APPENDIX 1: DEFINITIONS**

#### **A. DEFINITION OF CHROMATICITY COORDINATE**

The chromaticity coordinate is defined as the coordinate value on the CIE 1931 color chart for R, G, B, W.

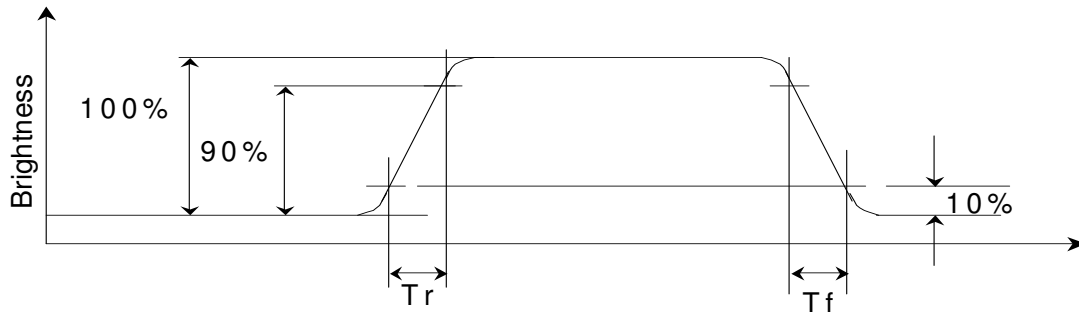
#### **B. DEFINITION OF CONTRAST RATIO**

The contrast ratio is defined as the following formula:

$$\text{Contrast Ratio} = \frac{\text{Luminance of all pixels on measurement}}{\text{Luminance of all pixels off measurement}}$$

#### **C. DEFINITION OF RESPONSE TIME**

The definition of turn-on response time  $T_r$  is the time interval between a pixel reaching 10% of steady state luminance and 90% of steady state luminance. The definition of turn-off response time  $T_f$  is the time interval between a pixel reaching 90% of steady state luminance and 10% of steady state luminance. It is shown in Figure 2.



**Figure 2 Response time**



## D. DEFINITION OF VIEWING ANGLE

The viewing angle is defined as Figure 3. Horizontal and vertical (H & V) angles are determined for viewing directions where luminance varies by 50% of the perpendicular value.

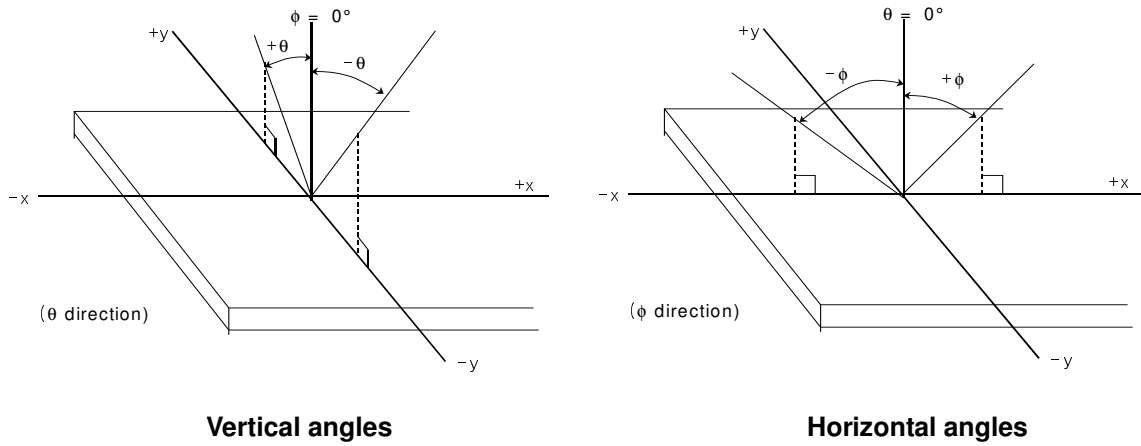


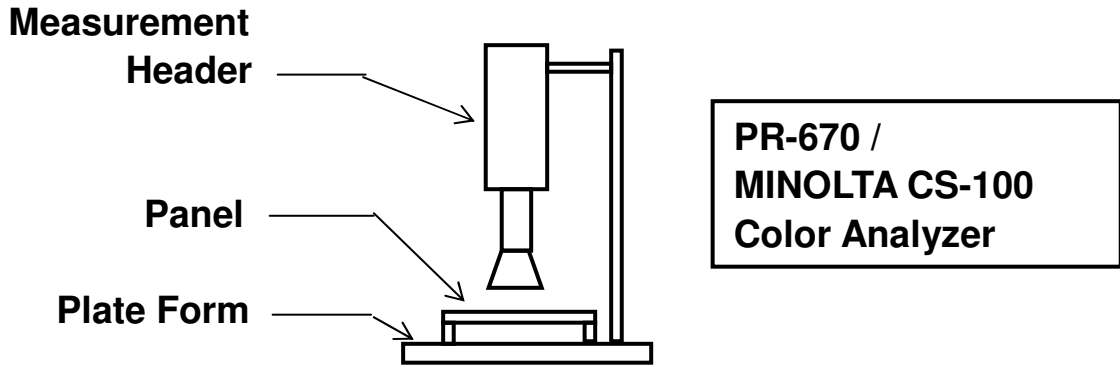
Figure 3 Viewing Angle



**APPENDIX 2: MEASUREMENT APPARATUS**

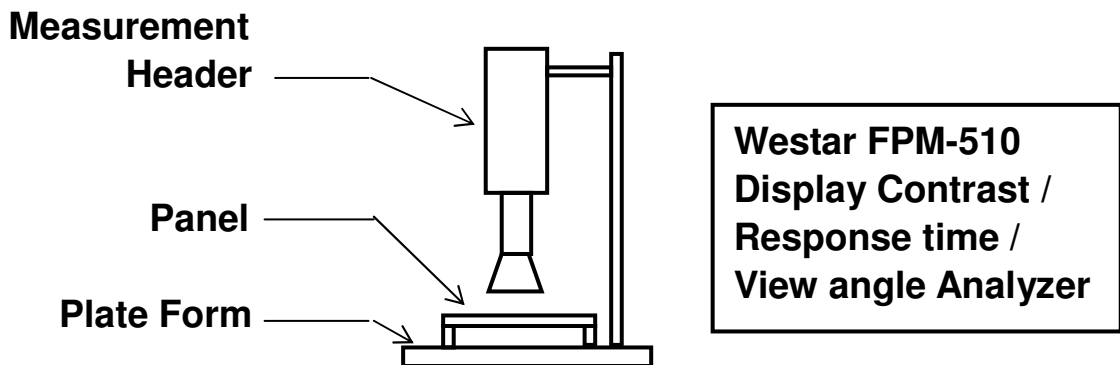
**A. LUMINANCE/COLOR COORDINATE**

PHOTO RESEARCH PR-670, MINOLTA CS-100



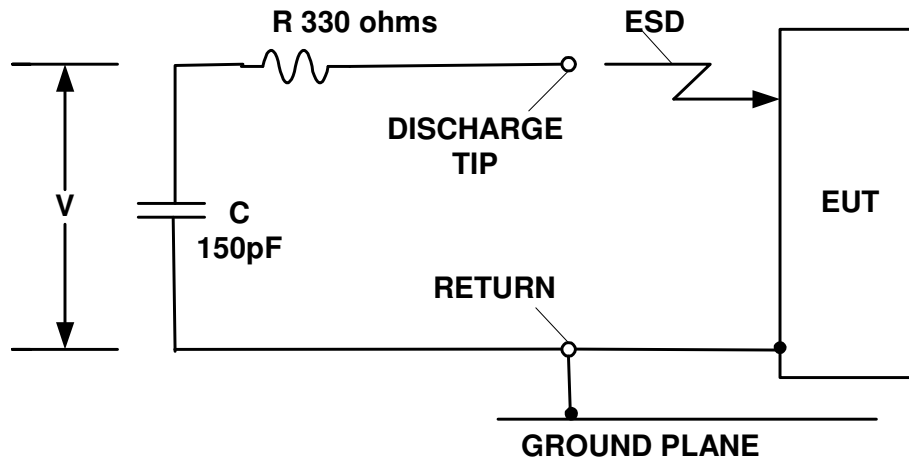
**B. CONTRAST / RESPONSE TIME / VIEWING ANGLE**

WESTAR CORPORATION FPM-510





C. ESD ON AIR DISCHARGE MODE



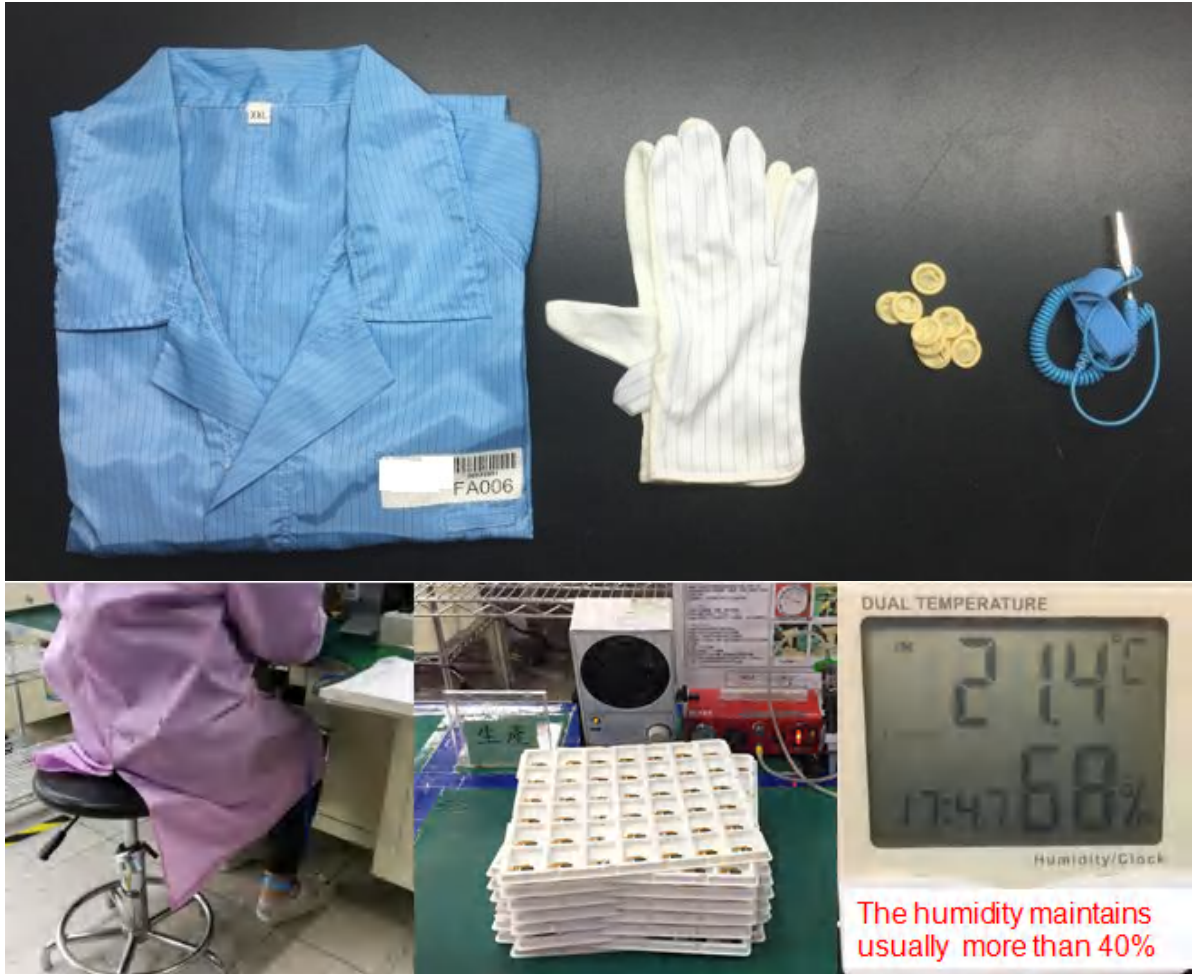


## APPENDIX 3: PRECAUTIONS FOR USING THE OLED MODULE

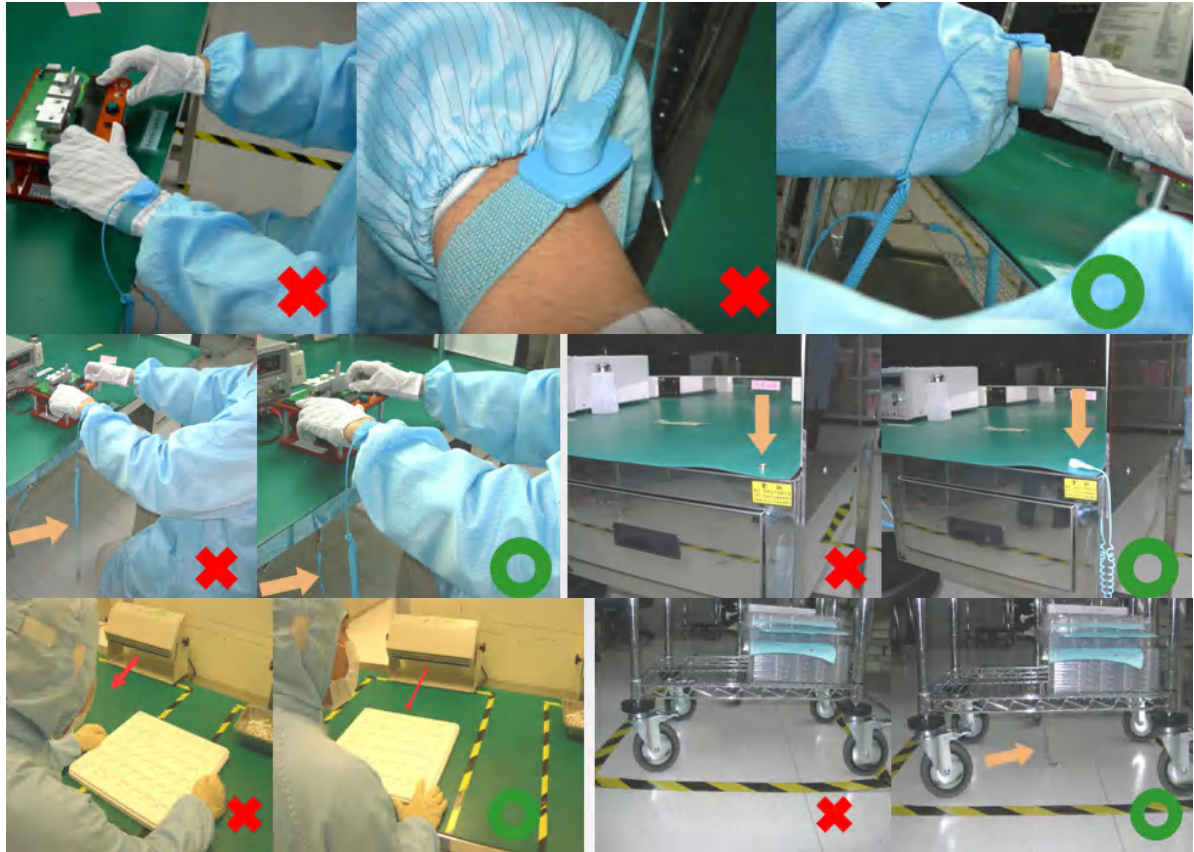
### *Precautions for Handling*

1. When handling the module, wear powder-free anti static rubber finger cots/ anti-static clothing, anti-static gloves ,antistatic wrist strap and anti-static shoes

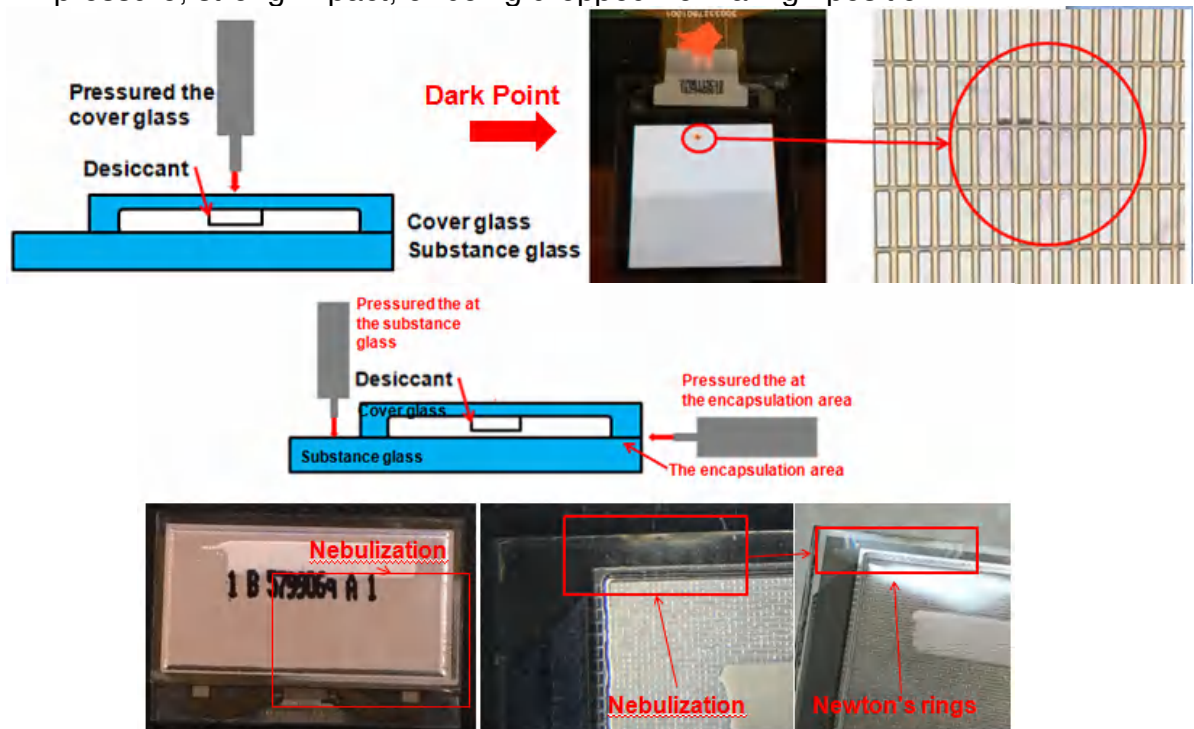
The environment should dispose the static elimination blower, anti-static pad, anti-static chair, and anti-static floor. The humidity maintains usually more than 40%



2. The OLED module is an electronic component and is subject to damage caused by Electro Static Discharge (ESD). And hence normal ESD precautions must be taken when handling it. Also, appropriate ESD protective environment must be administered and maintained in the production line. When handling and assembling the panel, wear an antistatic wrist strap with the alligator clip attached to the ground to prevent ESD damage on the panel. Antistatic wrist strap should touch human body directly instead of gloves. (See below photos).



3. The OLED module is consisted of glass and film, and it should avoid pressure, strong impact, or being dropped from a high position.



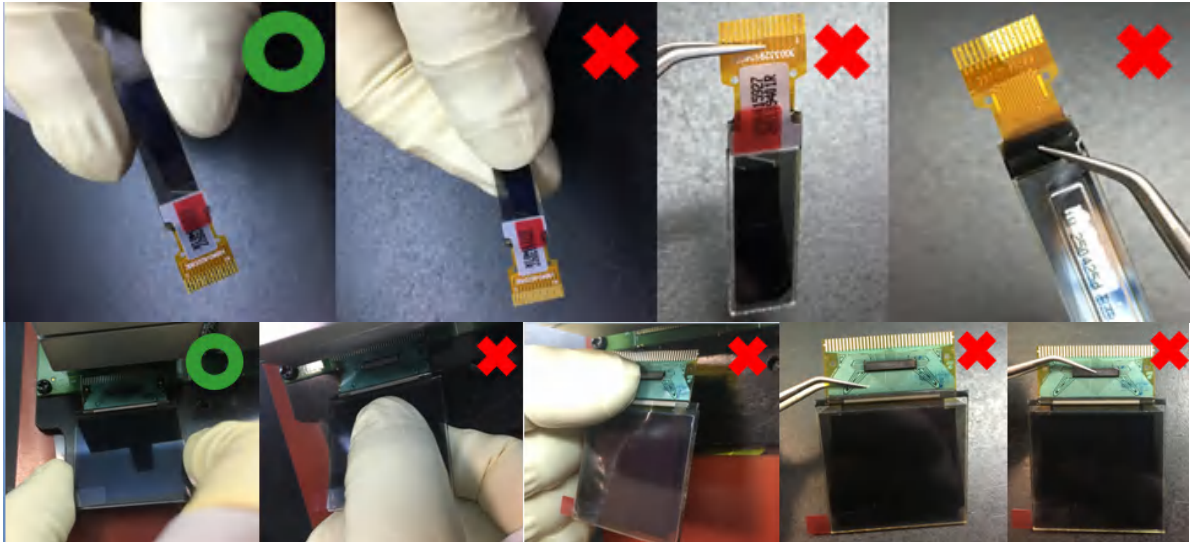


4. Take out the panel one by one from the holding trays for assembly, and never put the panel on top of another one to avoid the scratch.



5. Avoid jerk and excessive bend on TAB/FPC/COF, and be careful not to let foreign matter or bezel damage the film.

6. When handling and assembling the module (panel + IC), grab the panel, not the TAB/FPC/COF.



7. Use the tweezers to open the clicks on the connector of PCB before the insertion of FPC/COF, and click them back in. Once the FPC/COF sits properly in the connector, use the tweezers to avoid the damages.



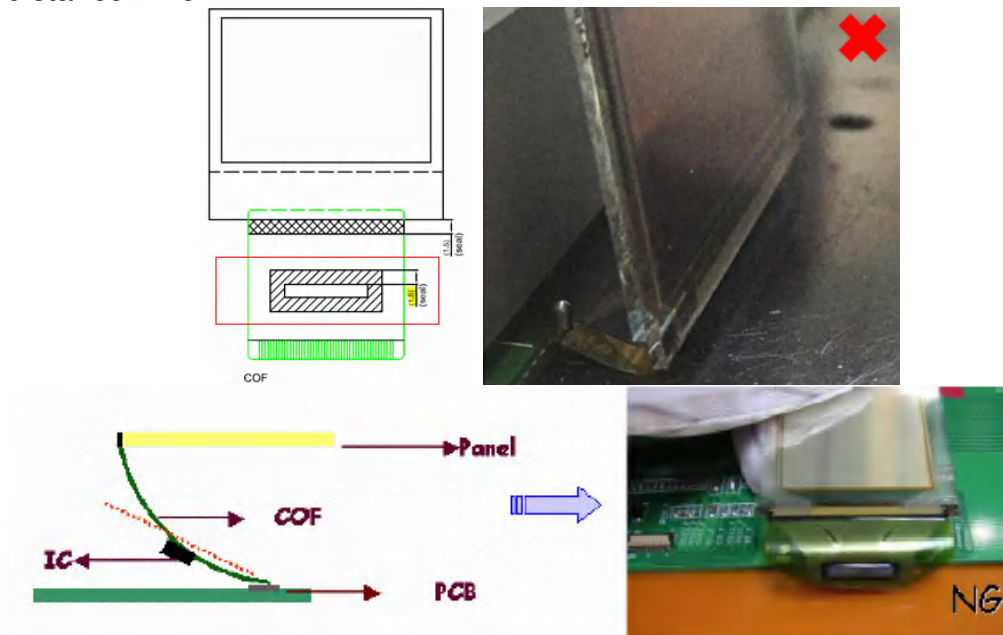




8. Please do not bend the film near the substrate glass. It could cause film peeling and TAB/FPC/COF damage. For TAB, It should bend the slit area as actual OLED it is. For FPC or COF, it is suggested to follow below pictures for instruction (distance between substrate glass and bending area  $>1.5\text{mm}$ ;  $R>0.5\text{mm}$ ).



9. Avoid bending the film at IC bonding area. It could damage the IC ILB bonding. It should avoid bending the IC seal area. Please keep the bending distance  $>1.5\text{mm}$ .

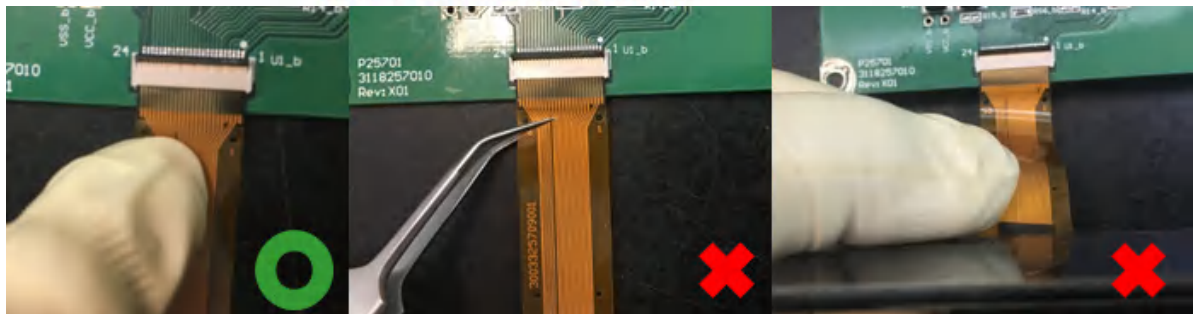




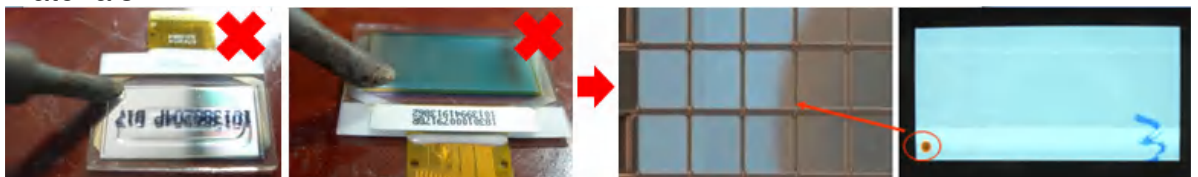
Use finger to insert COF /FPC into the connector when assembling the panel.  
Please refer to the photo.



**COF: Use both thumbs**

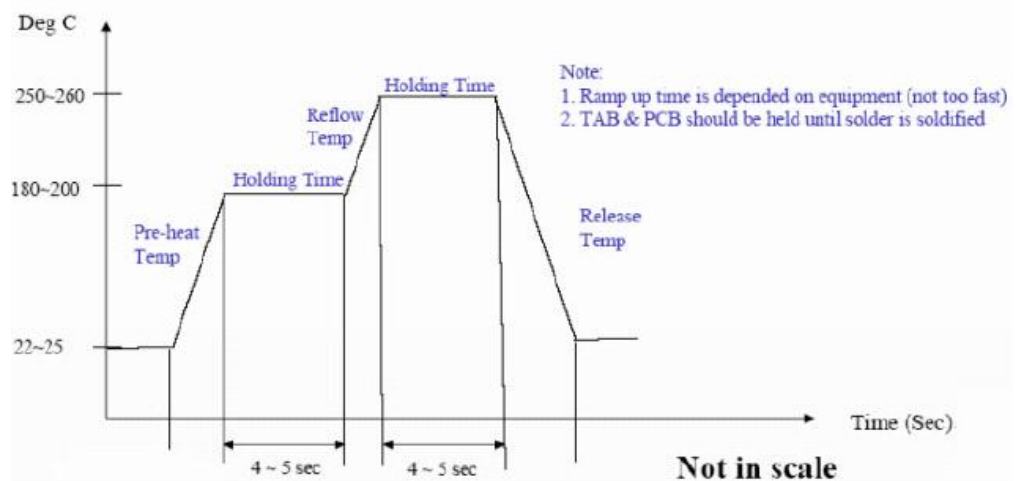


10. Do not wipe the pin of film and polarizer with the dry or hard materials that will damage the surface. When cleaning the display surface, use the soft cloth with solvent, IPA or alcohol, to clean.
11. Protection film is applied to the surface of OLED panel to avoid the scratch. Please remove the protective film before assembling it. If the OLED panel has been stored for a long time, the residue adhesive material of the protective film may remain on the display surface after remove the protective film. Please use the soft cloth with solvent, IPA or alcohol, to clean.
12. When hand or hot-bar soldering TAB/FPC onto PCB, make sure the temperature and timing profiles to meet the requirements of soldering specification (the specification depends on the application or optimized by customer) to prevent the damage of IC pins by inappropriate soldering, and also avoid the high temperature to damage the Organic light-emitting materials.





13. Solder residues arise from soldering process have to be cleaned up thoroughly before the module assembly.
14. Use the voltage and current settings listed in the specification to do the function test after the module assembly.
15. Suggestion for soldering process:
  - i. TAB Lead- free soldering hot bar process
    1. Use pulse heated bonding tool equipment
    2. Material: Sn/Ag/Cu lead-free solder paste with typical 25um thickness on PCB pad. The TAB pin size and shape may be different, please base on the production line to adjust the thickness of PCB pad and temperature.S
    3. Bonding Force:--4kg per centimeter square as the starting point.
    4. Suggested bonding tool temperature & time profile is as below for reference. Since there are differences in TAB soldering pins, soldering technicians' skills, mechanism...etc., the soldering conditions must be adequately tuned.



- ii. TAB Lead- free soldering wire process
  - In case of manual soldering (Lead- free solder wire)
    1. Solder wire contact iron directly:  $280\pm 5^{\circ}\text{C}$  at 3-5secs
    2. Solder wire contact TAB lead directly (near iron but not contact):  $380\pm 5^{\circ}\text{C}$ , 3-5secs
    3. Since there are differences in TAB soldering pins, soldering technicians' skills, mechanism...etc., the soldering conditions must be adequately tuned.
- iii. High temperature will result in rapid heat conduction to IC and might cause damage to IC, so please keep the temperature below  $380^{\circ}\text{C}$ . Also, avoid damaging the polyimide and solder resist which might take place at high temperatures. Refold cycles base on the de-soldering status, if the plating of pin was damaged, it can not be used again.



## Precautions for Electrical

### 1. Residual Image (Image Sticking)

The OLED is a self-emissive device. As with other self-emissive device or displays consisting of self-emissive pixels, when a static image frozen for a long period of time is changed to another one with all-pixels-on background, residual image or image sticking is noticed by the human eye. Image sticking is due to the luminance difference or contrast between the pixels that were previously turned on and the pixels that are newly turned on. Image sticking depends on the luminance decay curve of the display. The slower the decay, the less prominent the image sticking is. It is strongly recommended that the user employ the following four strategies to minimize image sticking.

1. Employ image scrolling or animation to even out the lit-on time of each and every pixel on the display, also could use sleeping mode for reduced the residual image and extend the power capacity.
2. Minimize the use of all-pixels-on or full white background in their application because when the panel is turned on full white, the image sticking from previously shown patterns is the most revealing. Black background is the best for power savings, greatest visibility, eye appealing, and dazzling displays.
3. Avoid displaying the characters or menu with high brightness level in a fix position for a long time or repeatedly. If necessary, using the auto fadeout technology.
4. If a static logo is used in the reliability test, change the pattern into its inverse (i.e., turn off the while pixels and turn on the previously unlit pixels) and freeze the inverse pattern as long as the original logo is used, so every pixel on the panel can be lit on for about the same time to minimize image sticking, caused by the differential turn-on time between the original and its reverse patterns.





## Scrolling example

Frame1

Frame2

Frame3

Frame4

Frame5

Example: setup and start

```
comm_out2(0x26); // scrolling setup
comm_out2(0x08); // scrolling numbers/step
comm_out2(0x00); // start page
comm_out2(0x00); // scrolling step/frame
comm_out2(0x08); // end page
comm_out2(0x2F); // start
```

Example: stop

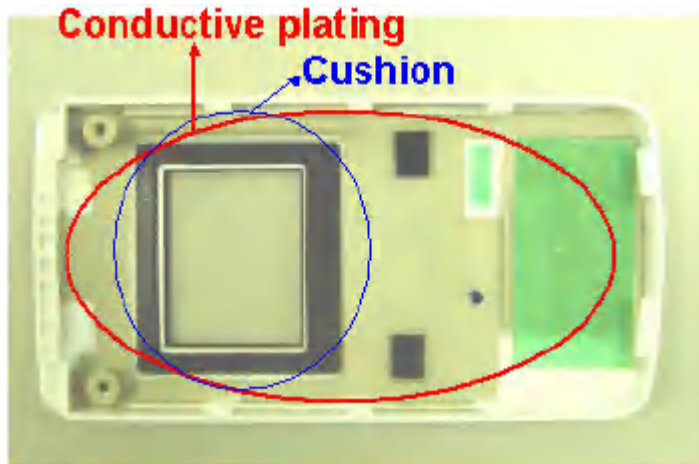
```
comm_out2(0x2E); //stop
```



## *Precautions for Mechanical*

### **1. Cushion or Buffer tape on the cover glass**

It is strongly recommended to have a cushion or buffer tape to apply on the panel backside and front side when assembling OLED panel into module to protect it from damage due to excessive extraneous forces.



It is recommended that a plating conductive layer be used in the housing for EMI/EMC protection. And, the enough space should be reserved for the IC placement if the IC thickness is thicker than the TAB film when customer design the PCB.

### **2. Avoid excessive bending of film when handling or designing the panel into the product**

The bending of TAB/COF/FPC has to follow the precautions indicated in the specification, extra bending or excessive extraneous forces should be avoided to minimize the chances of film damage. If bending the film is necessary, please bend the designated bending area only. Please refer to items 8 and 9 of Precautions for Handling for more information.



## *Precautions for Storage and Reliability Test*

### **1. Storage**

Store the packed cartons or packages at  $25^{\circ}\text{C}\pm 5^{\circ}\text{C}$ ,  $55\%\pm 10\%\text{RH}$ . Do not store the OLED module under direct sunlight or UV light. For best panel performance, unpack the cartons and start the production of the panels within six months after the reception of them.