RAYSTAR

SPECIFICATION

OLED SPECIFICATION

Model No:

REX012864UYPP3N00000

CUSTOMER:

APPROVED BY	
PCB VERSION	
DATE	

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■**APPROVAL FOR SPECIFICATIONS AND SAMPLE**

1. Revision History

VERSION	DATE	REVISED PAGE NO.	Note
0	2018/02/08		First release
A	2018/10/30		Modify VSL pin of the 3.1 Application recommendations. Add 6.3 Application Note for RAM mapping
B	2018/11/27		Modify Static electricity test Content of Test
C	2019/07/11		Modify Application recommendations
D	2019/09/02		Modify Precautions in use of OLED Modules
E	2019/10/04		Add 6.4 Command Table

Contents

1.General Specification

The Features is described as follow:

- Dot Matrix: 128 x 64
- Module dimension: 73.0 x 41.86 x 2.01 mm
- Active Area: 61.41 x 30.69 mm
- Pixel Size: 0.45 x 0.45 mm
- Pixel Pitch: 0.48 x 0.48 mm
- Display Mode: Passive Matrix
- Display Color: Monochrome (Yellow)
- Drive Duty: 1/64 Duty
- Interface: 8-bits 6800 and 8080 parallel, 4-line SPI, I2C
- IC: SSD1357
- Size: 2.7 inch

2.Module Classification information

1	2	3	4	5	6	7	8	9	10	11	12	13	14
R	E	X	012864	U	Y	P	P	3	N	0	0	0	00

1	Brand：Raystar Optronics Inc.			
2	E：OLED			
3	Display Type	C：COB Character	G：COB Graphic	
		X：COG	H：COG + FR	
		P：COG + FR + PCB	T：TAB	
		A：COG + PCB		
4	Dot Matrix： 128*64			
5	Series			
6	Emitting Color	A：Amber	R：Red	C：Full Color
		B：Blue	W：White	
		G：Green	Y：Yellow	
		S：Sky Blue	X：Dual Color	
7	Polarizer	P：With Polarizer; N: Without Polarizer A：Anti-glare Polarizer		
8	Display Mode	P：Passive Matrix ; N：Active Matrix		
9	Driver Voltage	3：3.0~3.3V ； 5：5.0V		
10	Touch Panel	N：Without touch panel; T: With touch panel		
11	Product type	0：Standard 1：Daylight Readable 2：Transparent OLED (TOLED) 3：Flexible OLED (FOLED) 4：OLED Lighting		
12	Inspection Grade	0：Standard 2：B grade C：Automotive grade Y：Consumer grade		
13	Option	0：Default ; F：ZIF FPC ; H：Hot bar FPC; D：Demo Kit		
14	Serial No.	Serial number(00~ZZ)		

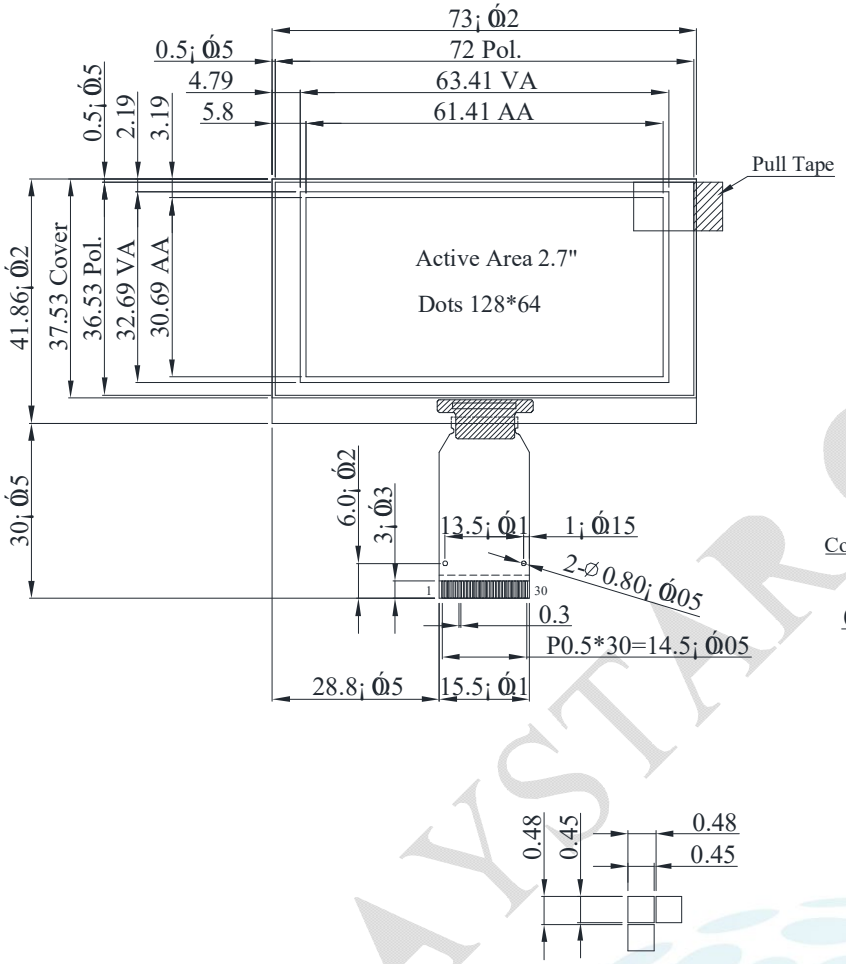
3.Interface Pin Function

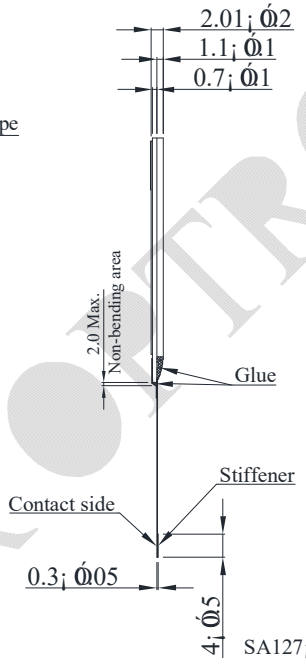
No.	Symbol	Function
1	NC(GND)	No connection.
2	VSS	Ground of Logic Circuit. This is a ground pin. It also acts as a reference for the logic pins. It must be connected to external ground.
3	VCC	Power supply for panel driving voltage. This is also the most positive power voltage supply pin.
4	VCOMH	Voltage Output High Level for COM Signal. This pin is the input pin for the voltage output high level for COM signals. A tantalum capacitor should be connected between this pin and VSS.
5	VLSS	Ground of Analog Circuit These are the analog ground pins. They should be connected to VSS externally.
6~13	D7~D0	These pins are bi-directional data bus connecting to the MCU data bus. Unused pins are recommended to tie LOW. When serial interface mode is selected, D0 will be the serial clock input: SCLK; D1 will be the serial data input: SDIN and D2 should be kept NC. When I2C mode is selected, D2, D1 should be tied together and serve as SDAout, SDAin in application and D0 is the serial clock input, SCL.
14	E/RD#	This pin is MCU interface input. When 6800 interface mode is selected, this pin will be used as the Enable (E) signal. Read/write operation is initiated when this pin is pulled HIGH and the chip is selected. When 8080 interface mode is selected, this pin receives the Read (RD#) signal. Read operation is initiated when this pin is pulled LOW and the chip is selected. When serial or I2C interface is selected, this pin must be connected to VSS.
15	R/W#	This pin is read / write control input pin connecting to the MCU interface. When 6800 interface mode is selected, this pin will be used as Read/Write (R/W#) selection input. Read mode will be carried out when this pin is pulled HIGH and write mode when LOW. When 8080 interface mode is selected, this pin will be the Write (WR#) input. Data write operation is initiated when this pin is pulled LOW and the chip is selected. When serial or I2C interface is selected, this pin must be connected to VSS.

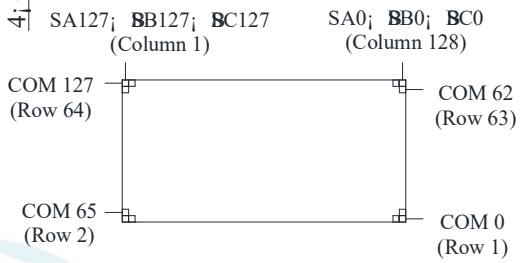
<table>
<tr><td>16
17</td><td>BS1
BS2</td><td>Communicating Protocol Select.
These pins are MCU interface selection input. See the following table:
<table>
<tr><td></td><td>BS1</td><td>BS2</td></tr>
<tr><td>I2C</td><td>1</td><td>0</td></tr>
<tr><td>4-wire Serial</td><td>0</td><td>0</td></tr>
<tr><td>8-bit 8080 Parallel</td><td>1</td><td>1</td></tr>
<tr><td>8-bit 6800 Parallel</td><td>0</td><td>1</td></tr>
</table></td></tr>
<tr><td>18</td><td>D/C#</td><td>This pin is Data/Command control pin connecting to the MCU.
When the pin is pulled HIGH, the data at D[7:0] will be interpreted as data.
When the pin is pulled LOW, the data at D[7:0] will be transferred to a command register.
In I2C mode, this pin acts as SA0 for slave address selection.
When 3-wire serial interface is selected, this pin must be connected to VSS.</td></tr>
<tr><td>19</td><td>CS#</td><td>Chip Select
This pin is the chip select input. The chip is enabled for MCU communication only
when CS# is pulled low.</td></tr>
<tr><td>20</td><td>RES#</td><td>This pin is reset signal input.
When the pin is pulled LOW, initialization of the chip is executed.
Keep this pin pull HIGH during normal operation.</td></tr>
<tr><td>21</td><td>FR</td><td>Frame Frequency Triggering Signal
This pin will send out a signal that could be used to identify the driver status.
Nothing should be connected to this pin. It should be left open individually.</td></tr>
<tr><td>22</td><td>IREF</td><td>This pin is the segment output current reference pin.
IREF is supplied externally.</td></tr>
<tr><td>23</td><td>N.C.</td><td>Reserved Pin
The N.C. pin between function pins is reserved for compatible and flexible design.</td></tr>
<tr><td>24</td><td>VDD</td><td>Power Supply for I/O Pin.
This pin is a power supply pin of I/O buffer. It should be connected to VCI or external source. All I/O signal should have VIH reference to VDDIO. When I/O signal pins (BS0~BS1, D0~D7, control signals…) pull high, they should be connected to VDDIO.</td></tr>
<tr><td>25</td><td>VP</td><td>Power Supply for Core Logic Circuit
This is a voltage supply pin. It can be supplied externally (within the range of 2.4~2.6V) or regulated internally from VCI. A capacitor should be connected between this pin & VSS under all circumstances.</td></tr>
<tr><td>26</td><td>VDD</td><td>Power Supply for Operation.
This is a voltage supply pin. It must be connected to external source & always be equal to or higher than VDD & VDDIO.</td></tr>
</table>

27	VSL	Voltage Output Low Level for SEG Signal This is segment voltage reference pin. When external VSL is not used, this pin should be left open. When external VSL is used, this pin should connect with resistor and diode to ground.
28	VLSS	Ground of Analog Circuit These are the analog ground pins. They should be connected to VSS externally.
29	VCC	Power Supply for OEL Panel These are the most positive voltage supply pin of the chip. They must be connected to external source.
30	NC(GND)	No connection

4.Contour Drawing & Block Diagram



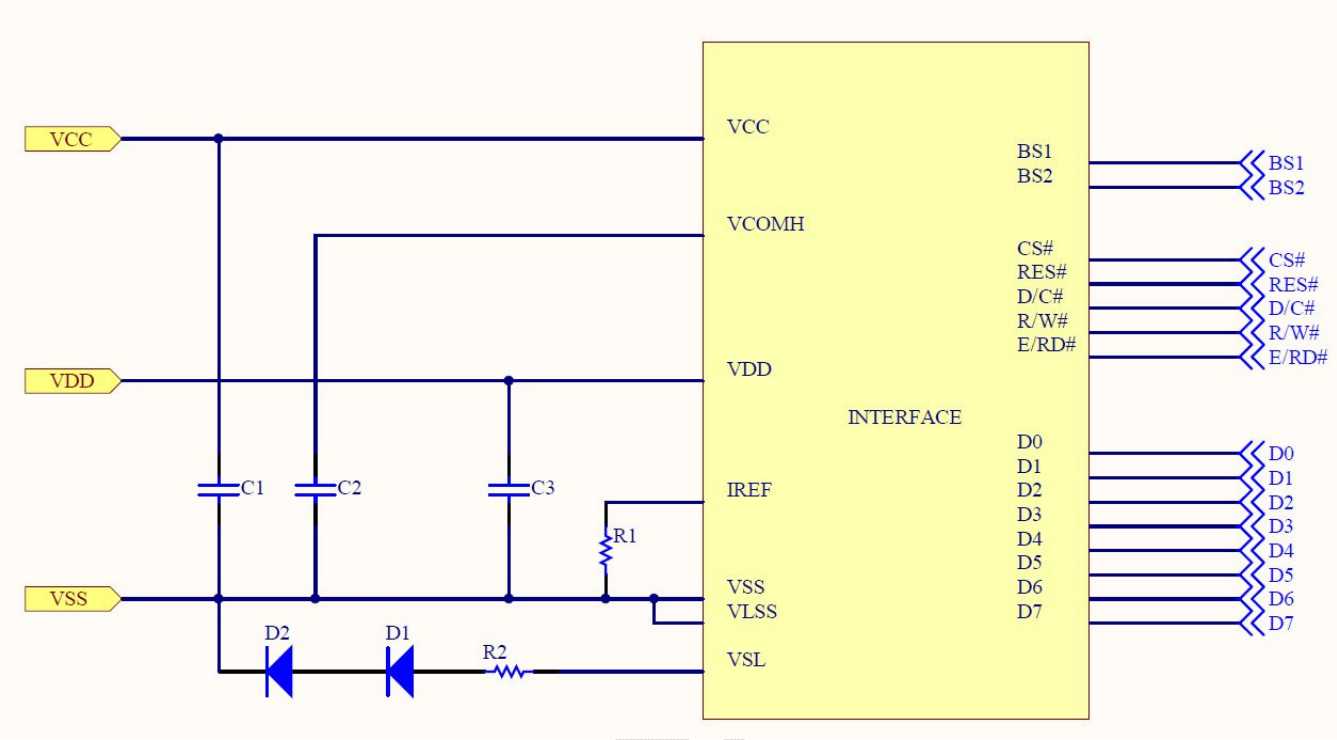




PIN NO.	SYMBOL
1	NC(GND)
2	VSS
3	VCC
4	VCOMH
5	VLSS
6	D7
7	D6
8	D5
9	D4
10	D3
11	D2
12	D1
13	D0
14	E/RD#
15	R/W#
16	BS1
17	BS2
18	DC#
19	CS#
20	RES#
21	FR
22	IREF
23	NC
24	VDD
25	VP
26	VDD
27	VSL
28	VLSS
29	VCC
30	NC(GND)

The non-specified tolerance of dimension is ¡ Ó.3mm.

4.1 Application recommendations



Recommended components:
C1, C2：2.2uF/25V/0603
C3：1.0uF/16V/0603
R2：20 ohm
D1,D2：1N4148

Bus Interface selection: (Must be set the BS[2:1], refer to item 3)
8-bits 6800 and 8080 parallel, 4-line SPI, I2C

Voltage at IREF = VCC – 2V. For VCC = 9V, IREF = 10uA:
R1 = (Voltage at IREF - VSS) / IREF
= (9-2) / 10u
≅ 700K ohm

Note:
The values are recommended value for 7.Optical Characteristics. Select appropriate value against module application.

5.Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage for Logic	VDD	-0.3	4.0	V	1,2
Supply Voltage for Display	VCC	0	15.0	V	1,2
Operating Temperature	TOP	-40	+80	°C	-
Storage Temperature	TSTG	-40	+85	°C	-

Note 1: All the above voltages are on the basis of “VSS = 0V”.

Note 2: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur. Also, for normal operations, it is desirable to use this module under the conditions according to Section 6.“Optics & Electrical Characteristics”. If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.

6.Electrical Characteristics

6.1 DC Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage for Logic	VDD	–	2.8	3.0	3.3	V
Supply Voltage for Display	VCC	–	8.5	9.0	9.5	V
High Level Input	VIH	–	0.8×VDD	–	–	V
Low Level Input	VIL	–	–	–	0.2×VDD	V
High Level Output	VOH	–	0.9×VDD	–	–	V
Low Level Output	VOL	–	–	–	0.1×VDD	V
50% Check Board operating Current		VCC =9.0V	–	31.5	47.5	mA

6.2 Initial code

```
void Initial_SSD1357(){

                write_command(0xfd);
                write_data(0x12);

                write_command(0xae);

                write_command(0xa0);
                write_data(0x12);               //A[7:6] Set Color Depth,
                write_data(0x10);               //10b: Enable Dual-COM

                write_command(0xa1);
                write_data(0x00);

                write_command(0xa2);
                write_data(0x00);

                write_command(0xa6);

                write_command(0xb1);
                write_data(0xFF);

                write_command(0xb3);            //Oscillator Frequency
                write_data(0x20);               //105Hz

                write_command(0xb6);
                write_data(0x0f);

                write_command(0xb9);

                write_command(0xbb);
                write_data(0x1f);

                write_command(0xbe);            //Set VCOMH
                write_data(0x07);               //0.86*VCC

                write_command(0xc1);            //Contrast Current
                write_data(0xcf);               //Blue contrast set
                write_data(0xcf);               //Green contrast set
                write_data(0xcf);               //Red contrast se

                write_command(0xca);            //Set MUX Ratio
                write_data(0x7f);               //128 Duty

                write_command(0xaf);            //Display on

}
```

6.3 Application Note for RAM mapping

Data bus to RAM mapping under different input mode

Write data		Data bus							
Depth	Input order	D7	D6	D5	D4	D3	D2	D1	D0
Mono	-	0xFF / 0x00							
16Gray Scale	1st	X	X	D3	D2	D1	D0	X	X
	2nd	X	X	D3	D2	D1	D0	X	X
	3rd	X	X	D3	D2	D1	D0	X	X

Example code

(A) Mono

```
write_command(0xa0);
write_data(0x12);        //A[7:6] Set Color Depth,
                         //00b: mono
                         //10b: 16 Gray Scale
write_data(0x10);        //0x10: Enable Dual-COM ; 0x00 : Disable
write_command(0x15);     //Column
write_data(0x00);
write_data(0x7F);
write_command(0x75);     //Row
write_data(0x00);
write_data(0x3F);
write_command(0x5C);
for(y=0;y<64;y++)
{    for(x=0;x<128;x++)
      {   write_data(0xFF);      // or write_data(0x00);
}      }
```

(B)16 Gray Scale

```
write_command(0xA0);
write_data(0x92);        //A[7:6] Set Color Depth,
                         //00b: mono
                         //10b: 16 Graycale
write_data(0x10);        //0x10: Enable Dual-COM ; 0x00 : Disable
write_command(0x15);     //Column
write_data(0x00);
write_data(0x7F);
write_command(0x75);     //Row
write_data(0x00);
write_data(0x3F);
write_command(0x5C);
for(y=0x00;y<0x40;y++)
{    for(x=0;x<64;x=x+4)   //16 G.S.
     {      for(z=0;z<8;z++)
               {    write_data(x);
                    write_data(x);
                    write_data(x);
}     }        }
```

6.4 Command Table

(D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	15	0	0	0	1	0	1	0	1	Set Column Address	A[6:0]: Start Address. [reset=0] B[6:0]: End Address. [reset=127] Range from 0 to 127
1	A[6:0]	*	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[6:0]	*	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	75	0	1	1	1	0	1	0	1	Set Row Address	A[6:0]: Start Address. [reset=0] B[6:0]: End Address. [reset=127] Range from 0 to 127
1	A[6:0]	*	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[6:0]	*	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	5C	0	1	0	1	1	1	0	0	Write RAM Command	Enable MCU to write Data into RAM
0	5D	0	1	0	1	1	1	0	1	Read RAM Command	Enable MCU to read Data from RAM
0	A0	1	0	1	0	0	0	0	0	Set Re-map / Color Depth (Display RAM to Panel)	A[0]=0b, Horizontal address increment [reset] A[0]=1b, Vertical address increment A[1]=0b, Column address 0 is mapped to SEG0 [reset] A[1]=1b, Column address 127 is mapped to SEG0 A[2]=0b, Color sequence: A → B → C [reset] A[2]=1b, Color sequence is swapped: C → B → A A[3]=0b, Reserved [reset] A[3]=1b, Reserved A[4]=0b, Scan from COM0 to COM[N –1] [reset] A[4]=1b, Scan from COM[N-1] to COM0. Where N is the Multiplex ratio. A[5]=0b, Disable COM Split Odd Even A[5]=1b, Enable COM Split Odd Even [reset] A[7:6] Set Color Depth, 00b: 256color 01b: 65k color [reset] 10b: 262k color 11b Pseudo 262k color, 16-bit format 2 Refer to Product Preview Table 6-6 for details
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[7:0]	0	0	0	0	0	0	0	0		

Fundamental Command Table											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**	**Command**	**Description**
0 1	A1 A[6:0]	1 *	0 A_6	1 A_5	0 A_4	0 A_3	0 A_2	0 A_1	1 A_0	Set Display Start Line	Set vertical scroll by RAM from 0~127. [reset=00h]
0 1	A2 A[6:0]	1 *	0 A_6	1 A_5	0 A_4	0 A_3	0 A_2	1 A_1	0 A_0	Set Display Offset	Set vertical scroll by Row from 0-127. [reset=00h]
0	A4~A7	1	0	1	0	0	1	X_1	X_0	Set Display Mode	A4h: All OFF A5h: All ON (All pixels have GS63) A6h : Reset to normal display [reset] A7h: Inverse Display (GS0 -> GS63, GS1 -> GS62, ...)
0	AE~AF	1	0	1	0	1	1	1	X_0	Set Sleep mode ON/OFF	AEh = Sleep mode On (Display OFF) AFh = Sleep mode OFF (Display ON)
0 1	B1 A[7:0]	1 A_7	0 A_6	1 A_5	1 A_4	0 A_3	0 A_2	0 A_1	1 A_0	Set Reset (Phase 1) / Pre-charge (Phase 2) period	A[3:0] Phase 1 period of 2~30 DCLK(s) clocks [reset=0100b] A[3:0]: 0 invalid 1 = 2 DCLKs 2 = 4 DCLKs : 15 = 30DCLKs A[7:4] Phase 2 period of 2~30 DCLK(s) clocks [reset=1000b] A[7:4]: 0 invalid 1 = 2 DCLKs 2 = 4 DCLKs : 15 =30DCLKs Note (1) 0 DCLK is invalid in phase 1 & phase 2

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	B3	1	0	1	1	0	0	1	1	Front Clock Divider (DivSet)/ Oscillator Frequency	A[3:0] [reset=0000b], divide by DIVSET where A[3:0] → DIVSET: 0000 divide by 1; 0001 divide by 2; 0010 divide by 4; 0011 divide by 8; 0100 divide by 16; 0101 divide by 32; 0110 divide by 64; 0111 divide by 128; 1000 divide by 256; >=1001 invalid A[7:4] Oscillator frequency, frequency increases as level increases [reset=0010b]
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	B6	1	0	1	1	0	1	0	0	Set Second Pre-charge Period	A[3:0] Set Second Pre-charge Period 0000b invalid 0001b 1 DCLKS 0010b 2 DCLKS .... 1000 8 DCLKS [reset] .... 1111 15 DCLKS
1	A[3:0]	0	0	0	0	A_3	A_2	A_1	A_0		
0	B8	1	0	1	1	1	0	0	0	Master Look Up Table for Gray Scale Pulse width (Color A,B,C)	The next 63 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d). A1[7:0]: Gamma Setting for GS1, A2[7:0]: Gamma Setting for GS2, : A62[7:0]: Gamma Setting for GS62, A63[7:0]: Gamma Setting for GS63 **Note** (1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS62 < Setting of GS63 (2) GS0 does not has pre-charge and current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. (4) When command B8h is input only, color A, B, C will follow the master LUT. (5) When command BCh is input, it selects individual LUT for color A, GS1~31A; When command BDh is input, it selects individual LUT for color C, GS1~31C (6) To select individual LUT for color B, A and C, command B8h should be input before command BCh and BDh,
1	A1[7:0]	$A1_7$	$A1_6$	$A1_5$	$A1_4$	$A1_3$	$A1_2$	$A1_1$	$A1_0$		
1	A2[7:0]	$A2_7$	$A2_6$	$A2_5$	$A2_4$	$A2_3$	$A2_2$	$A2_1$	$A2_0$		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	A62[7:0]	$A62_7$	$A62_6$	$A62_5$	$A62_4$	$A62_3$	$A62_2$	$A62_1$	$A62_0$		
1	A63[7:0]	$A63_7$	$A63_6$	$A63_5$	$A63_4$	$A63_3$	$A63_2$	$A63_1$	$A63_0$		

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	B9	1	0	1	1	1	0	0	1	Use Built-in Linear LUT [reset= linear]	Reset to default Look Up Table: Color A: GS1A = 0 DCLK; GS2A = 4 DCLK; GS3A = 8 DCLK; ...; GS31A = 120 DCLK Color B: GS1B = 0 DCLK; GS2B = 2 DCLK; GS3B = 4 DCLK; ...; GS62B = 122 DCLK; GS63B = 124 DCLK Color C: GS1C = 0 DCLK; GS2C = 4 DCLK; GS3C = 8 DCLK; ...; GS31C = 120 DCLK
0 1	BB A[4:0]	1 0	0 0	1 0	1 A_4	1 A_3	0 A_2	1 A_1	1 A_0	Set Pre-charge voltage	Set pre-charge voltage level.[reset = 11110b] A[4:0] / Hex code / pre-charge voltage: 00000 / 00h / 0.10 x V_{CC} : / : / : 11110 / 1Eh / 0.50 x V_{CC} [reset] 11111 / 1Fh / 0.5133 x V_{CC} **Note** (1)Pre-charge voltage level must be smaller than COM deselect voltage level
0 1 1 1 1 1 1	BC A1[7:0] A2[7:0] . . . A30[7:0] A31[7:0]	1 $A1_7$ $A2_7$ . . . $A30_7$ $A31_7$	0 $A1_6$ $A2_6$ . . . $A30_6$ $A31_6$	1 $A1_5$ $A2_5$ . . . $A30_5$ $A31_5$	1 $A1_4$ $A2_4$ . . . $A30_4$ $A31_4$	1 $A1_3$ $A2_3$ . . . $A30_3$ $A31_3$	1 $A1_2$ $A2_2$ . . . $A30_2$ $A31_2$	0 $A1_1$ $A2_1$ . . . $A30_1$ $A31_1$	0 $A1_0$ $A2_0$ . . . $A30_0$ $A31_0$	Individual Look Up Table for Gray Scale Pulse width (Color A)	The next 31 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) for color A. A1[7:0]: Gamma Setting for GS1A, A2[7:0]: Gamma Setting for GS2A, : A62[7:0]: Gamma Setting for GS30A, A63[7:0]: Gamma Setting for GS31A **Note** (1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS30 < Setting of GS31 (2) GS0 does not has pre-charge and current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. (4) When command B8h is input, it selects one LUT for color A, B and C. i.e. GS1~31A, GS1~63B and GS1~31C are updated. (5) Command B8h should be input before command BCh and BDh to select individual LUT for color B, A and C.

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	BD	1	0	1	1	1	1	0	1	Individual Look Up Table for Gray Scale Pulse width (Color C)	The next 31 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) for color C. A1[7:0]: Gamma Setting for GS1C, A2[7:0]: Gamma Setting for GS2C, : A62[7:0]: Gamma Setting for GS30C, A63[7:0]: Gamma Setting for GS31C **Note** (1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS30 < Setting of GS31 (2) GS0 does not has pre-charge and current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. (4) When command B8h is input, it selects one LUT for color A, B and C. i.e. GS1~31A, GS1~63B and GS1~31C are updated. (5) Command B8h should be input before command BCh and BDh to select individual LUT for color B, A and C.
1	A1[7:0]	$A1_7$	$A1_6$	$A1_5$	$A1_4$	$A1_3$	$A1_2$	$A1_1$	$A1_0$		
1	A2[7:0]	$A2_7$	$A2_6$	$A2_5$	$A2_4$	$A2_3$	$A2_2$	$A2_1$	$A2_0$		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	A30[7:0]	$A30_7$	$A30_6$	$A30_5$	$A30_4$	$A30_3$	$A30_2$	$A30_1$	$A30_0$		
1	A31[7:0]	$A31_7$	$A31_6$	$A31_5$	$A31_4$	$A31_3$	$A31_2$	$A31_1$	$A31_0$		
0	BE	1	0	1	1	1	1	1	0	Set V_{COMH} Voltage	Set COM deselect voltage level [reset = 05h] A[2:0] / Hex code / V_{COMH} 000 / 00h / 0.72 x V_{CC} : / : / : 101 / 05h / 0.82 x V_{CC} [reset] : / : / : 111 / 07h / 0.86 x V_{CC}
1	A[2:0]	0	0	0	0	0	A_2	A_1	A_0		
0	C1	1	1	0	0	0	0	0	1	Set Contrast Current for Color A,B,C	A[7:0] Contrast Value Color A [reset=7Fh] B[7:0] Contrast Value Color B [reset=7Fh] C[7:0] Contrast Value Color C [reset=7Fh]
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[7:0]	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
1	C[7:0]	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
0	C7	1	1	0	0	0	1	1	1	Master Contrast Current Control	A[3:0] : 0000b reduce output currents for all colors to 1/16 0001b reduce output currents for all colors to 2/16 .... 1110b reduce output currents for all colors to 15/16 1111b no change [reset]
1	A[3:0]	*	*	*	*	A_3	A_2	A_1	A_0		
0	CA	1	1	0	0	1	0	1	0	Set MUX Ratio	A[6:0] MUX ratio 4MUX ~ 128MUX, [reset=127], (Range from 3 to 127)
1	A[6:0]	0	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	E3	1	1	1	0	0	0	1	1	NOP	Command for No Operation

Fundamental Command Table											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**	**Command**	**Description**
0	FD	1	1	1	1	1	1	0	1	Set Command Lock	A[7:0]: MCU protection status [reset = 12h] A[7:0] = 12h, Unlock OLED driver IC MCU interface from entering command [reset] A[7:0] = 16h, Lock OLED driver IC MCU interface from entering command **Note** (1) The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command.
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		

Note

(1) "*" stands for "Don't care".

Graphic Acceleration Command List

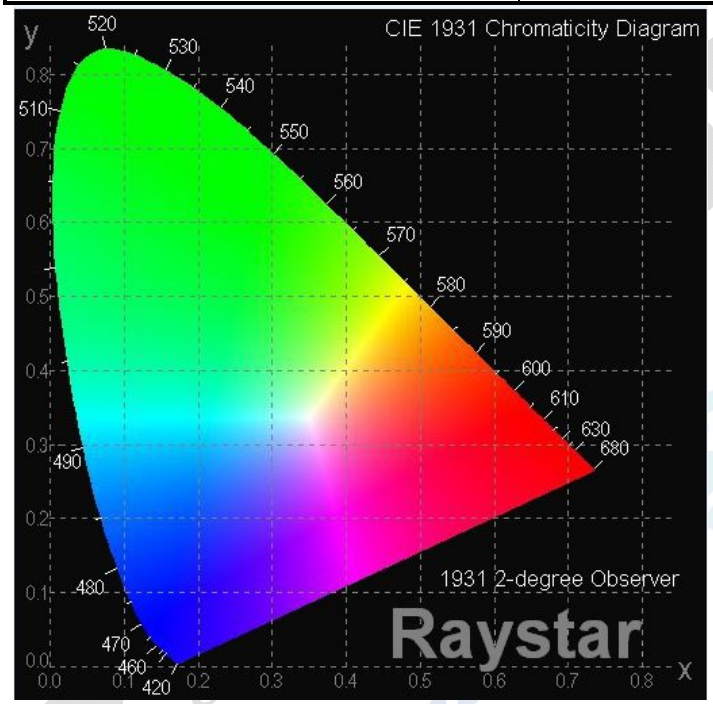
Set (GAC) (D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

Graphic acceleration command											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D2**	**D0**	**Command**	**Description**
0	96	1	0	0	1	0	1	1	0	Horizontal Scroll	A[7:0] = 00000000b No scrolling A[7:0] = 00000001b to 00111111b Scroll towards SEG127 with 1 column offset A[7:0] = 01000000b to 11111111b Scroll towards SEG0 with 1 column offset B[6:0] : start row address C[7:0] : end row address D[6:0] : Reserved (reset=00h) E[1:0] : scrolling time interval 00b Invalid 01b normal 10b slow 11b slowest **Note** Operates during display ON.
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[6:0]	0	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
1	C[7:0]	0	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
1	D[6:0]	0	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
1	E[1:0]	0	0	0	0	0	0	E_1	E_0		
0	9E	1	0	0	1	1	1	1	0	Stop Moving	Stop horizontal scroll **Note** After sending 9Eh command to stop the scrolling action, the ram data needs to be rewritten
0	9F	1	0	0	1	1	1	1	1	Start Moving	Start horizontal scroll

Note
(2) "*" stands for "Don't care".

7.Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V)θ	—	160	—	—	deg
	(H)φ	—	160	—	—	deg
Contrast Ratio	CR	Dark	2000:1	—	—	—
Response Time	T rise	—	—	10	—	μs
	T fall	—	—	10	—	μs
Display with 50% check Board Brightness			60	80	—	cd/m2
CIEx(Yellow)		(CIE1931)	0.45	0.47	0.49	—
CIEy(Yellow)		(CIE1931)	0.48	0.50	0.52	—



8.OLED Lifetime

ITEM	Conditions	Min	Typ	Remark
Operating Life Time	Ta=25°C / Initial 50% check board brightness Typical Value	50,000 Hrs	-	Note

Notes:
1. Life time is defined the amount of time when the luminance has decayed to <50% of the initial value.
2. This analysis method uses life data obtained under accelerated conditions to extrapolate an estimated probability density function (*pdf*) for the product under normal use conditions.
3. Screen saving mode will extend OLED lifetime.

9.Reliability

Content of Reliability Test

Environmental Test			
Test Item	**Content of Test**	**Test Condition**	**Applicable Standard**
High Temperature storage	Endurance test applying the high storage temperature for a long time.	85°C 240hrs	___
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-40°C 240hrs	___
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	80°C 240hrs	___
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-40°C 240hrs	___
High Temperature/ Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time.	60°C,90%RH 240hrs	___
High Temperature/ Humidity Operation	Endurance test applying the high temperature and high humidity Operation for a long time.	60°C,90%RH 120hrs	___
Temperature Cycle	Endurance test applying the low and high temperature cycle. -40°C 25°C 80°C 30min 5min 30min 1 cycle	-40°C /80°C 30 cycles	___
Mechanical Test			
Vibration test	Endurance test applying the vibration during transportation and using.	Frequency:10~55Hz amplitude:1.5mm Time:0.5hrs/axis Test axis:X,Y,Z	___
Others			
Static electricity test	Endurance test applying the electric stress to the finished product housing.	Air Discharge model ±4kv,10 times	___

*** Supply voltage for OLED system =Operating voltage at 25°C

Test and measurement conditions

1. All measurements shall not be started until the specimens attain to temperature stability. After the completion of the described reliability test, the samples were left at room temperature for 2 hrs prior to conducting the failure test at 23±5°C; 55±15% RH.
2. All-pixels-on is used as operation test pattern.
3. The degradation of Polarizer are ignored for High Temperature storage, High Temperature/ Humidity Storage, Temperature Cycle

Evaluation criteria

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

APPENDIX:

RESIDUE IMAGE

Because the pixels are lighted in different time, the luminance of active pixels may reduce or differ from inactive pixels. Therefore, the residue image will occur. To avoid the residue image, every pixel needs to be lighted up uniformly.

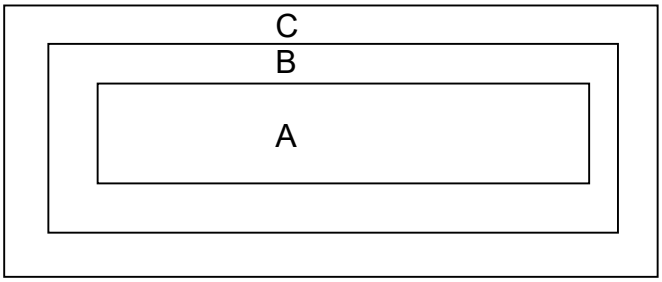
10.Inspection specification

Inspection Standard:

MIL-STD-105E table normal inspection single sample level II.

Definition

1 Major defect : The defect that greatly affect the usability of product.
2 Minor defect : The other defects, such as cosmetic defects, etc.
Definition of inspection zone:

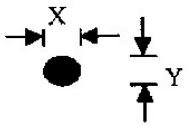


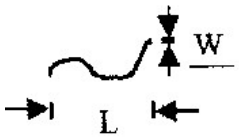
Zone A: Active Area
Zone B: Viewing Area except Zone A
Zone C: Outside Viewing Area
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble of quality and assembly to customer`s product.

Inspection Methods

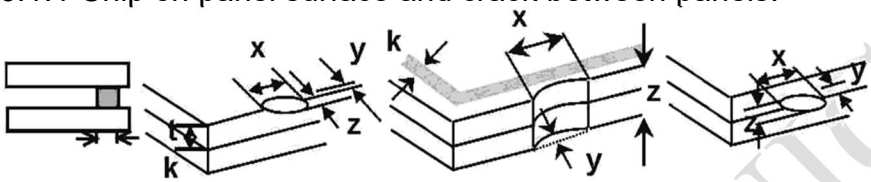
1 The general inspection : Under fluorescent light illumination: 750~1500 Lux, about 30cm viewing distance, within 45º viewing angle, under 25±5°C.
2 The luminance and color coordinate inspection : By SR-3 or BM-7 or the equal equipments, in the dark room, under 25±5°C.

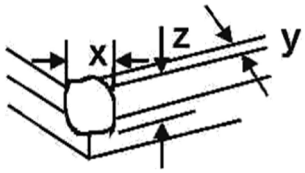
NO	Item	Criterion	AQL
01	Electrical Testing	1.1 Missing vertical, horizontal segment, segment contrast defect. 1.2 Missing character , dot or icon. 1.3 Display malfunction. 1.4 No function or no display. 1.5 Current consumption exceeds product specifications. 1.6 OLED viewing angle defect. 1.7 Mixed product types. 1.8 Contrast defect.	0.65
02	Black or white spots on OLED (display only)	2.1 White and black spots on display • 0.25mm, no more than three white or black spots present. 2.2 Densely spaced: No more than two spots or lines within 3mm.	2.5

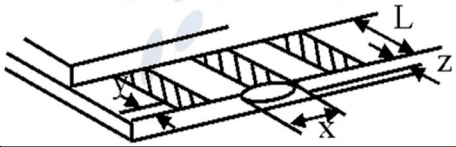
<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td rowspan="2">03</td><td>OLED black spots, white spots, contamination
(non-display)</td><td>3.1 Round type :
As following drawing
Φ=(x + y) / 2
 

<table>
<tr><th>SIZE</th><th>Acceptable QTY</th><th>Zone</th></tr>
<tr><td>Φ≦0.10</td><td>Accept no dense</td><td>A+ B,</td></tr>
<tr><td>0.10＜Φ≦0.20</td><td>2</td><td>A+ B</td></tr>
<tr><td>0.20＜Φ≦0.25</td><td>1</td><td>A+ B</td></tr>
<tr><td>0.25＜Φ</td><td>0</td><td>A+ B</td></tr>
</table></td><td>2.5</td></tr>
<tr><td>3.2 Line type : (As following drawing)
 

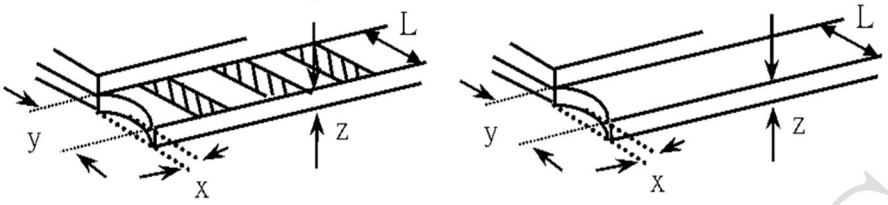
<table>
<tr><th>Length</th><th>Width</th><th>Acceptable Q TY</th><th>Zone</th></tr>
<tr><td>---</td><td>W≦0.02</td><td>Accept no dense</td><td>A+B</td></tr>
<tr><td>L≦3.0</td><td>0.02＜W≦0.03</td><td rowspan="2">2</td><td>A+B</td></tr>
<tr><td>L≦2.5</td><td>0.03＜W≦0.05</td><td>A+B</td></tr>
<tr><td>---</td><td>0.05＜W</td><td>As round type</td><td></td></tr>
</table></td><td>2.5</td></tr>
<tr><td>04</td><td>Polarizer bubbles</td><td>If bubbles are visible, judge using black spot specifications, not easy to find, must check in specify direction.
<table>
<tr><th>Size Φ</th><th>Acceptable Q TY</th><th>Zone</th></tr>
<tr><td>Φ≦0.20</td><td>Accept no dense</td><td>A+B</td></tr>
<tr><td>0.20＜Φ≦0.50</td><td>3</td><td>A+B</td></tr>
<tr><td>0.50＜Φ≦1.00</td><td>2</td><td>A+B</td></tr>
<tr><td>1.00＜Φ</td><td>0</td><td>A+B</td></tr>
<tr><td>Total Q TY</td><td>3</td><td></td></tr>
</table></td><td>2.5</td></tr>
<tr><td>05</td><td>Scratches</td><td>Follow NO.3 OLED black spots, white spots, contamination.</td><td></td></tr>
</table>

<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td rowspan="3">06</td><td rowspan="2">Chipped glass</td><td>Symbols Define:
x: Chip length y: Chip width z: Chip thickness
k: Seal width t: Glass thickness a: OLED side length
L: Electrode pad length:
6.1 General glass chip :
6.1.1 Chip on panel surface and crack between panels:
 

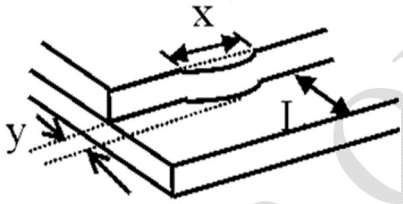
<table><tr><th>z: Chip thickness</th><th>y: Chip width</th><th>x: Chip length</th></tr><tr><td>Z≦1/2t</td><td>Not over viewing area</td><td>x≦1/8a</td></tr><tr><td>1/2t＜z≦2t</td><td>Not exceed 1/3k</td><td>x≦1/8a</td></tr></table>⊙If there are 2 or more chips, x is total length of each chip.</td><td>2.5</td></tr>
<tr><td>6.1.2 Corner crack:
 

<table><tr><th>z: Chip thickness</th><th>y: Chip width</th><th>x: Chip length</th></tr><tr><td>Z≦1/2t</td><td>Not over viewing area</td><td>x≦1/8a</td></tr><tr><td>1/2t＜z≦2t</td><td>Not exceed 1/3k</td><td>x≦1/8a</td></tr></table>⊙If there are 2 or more chips, x is the total length of each chip.</td><td>2.5</td></tr>
<tr><td>Glass crack</td><td>Symbols :
x: Chip length y: Chip width z: Chip thickness
k: Seal width t: Glass thickness a: OLED side length
L: Electrode pad length
6.2 Protrusion over terminal :
6.2.1 Chip on electrode pad :
 

<table><tr><th>y: Chip width</th><th>x: Chip length</th><th>z: Chip thickness</th></tr><tr><td>y≦0.5mm</td><td>x≦1/8a</td><td>0 ＜ z ≦ t</td></tr></table></td><td>2.5</td></tr>
</table>

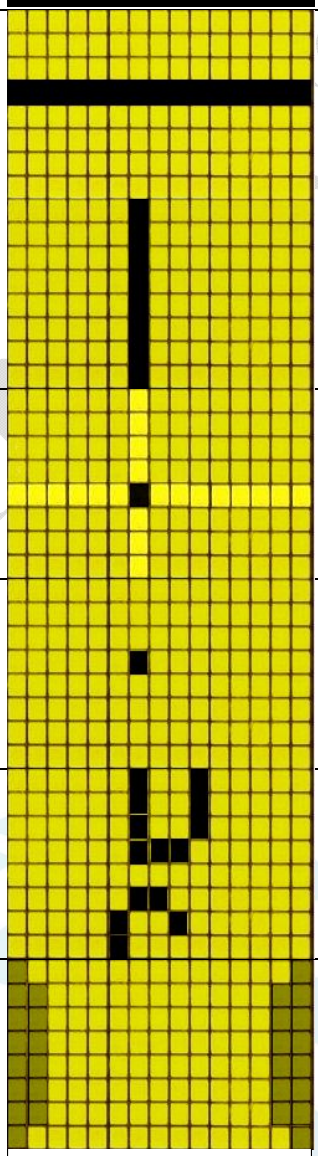
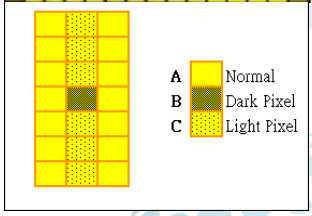
<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td>06</td><td>Glass crack</td><td>6.2.2 Non-conductive portion:
 

<table>
<tr><th>y: Chip width</th><th>x: Chip length</th><th>z: Chip thickness</th></tr>
<tr><td>y≦ L</td><td>x≦1/8a</td><td>0 ＜ z ≦ t</td></tr>
</table>
⊙If the chipped area touches the ITO terminal, over 2/3 of the ITO must remain and be inspected according to electrode terminal specifications.
⊙If the product will be heat sealed by the customer, the alignment mark not be damaged.

6.2.3 Substrate protuberance and internal crack.
 

<table>
<tr><th>y: width</th><th>x: length</th></tr>
<tr><td>y≦1/3L</td><td>x ≦ a</td></tr>
</table></td><td>2.5</td></tr>
<tr><td>07</td><td>Cracked glass</td><td>The OLED with extensive crack is not acceptable.</td><td>2.5</td></tr>
<tr><td>08</td><td>Backlight elements</td><td>8.1 Illumination source flickers when lit.
8.2 Spots or scratched that appear when lit must be judged. Using OLED spot, lines and contamination standards.
8.3 Backlight doesn’t light or color wrong.</td><td>0.65
2.5
0.65</td></tr>
<tr><td>09</td><td>Bezel</td><td>9.1 Bezel may not have rust, be deformed or have fingerprints, stains or other contamination.
9.2 Bezel must comply with job specifications.</td><td>2.5
0.65</td></tr>
</table>

NO	Item	Criterion	AQL
10	PCB , COB	10.1 COB seal may not have pinholes larger than 0.2mm or contamination. 10.2 COB seal surface may not have pinholes through to the IC. 10.3 The height of the COB should not exceed the height indicated in the assembly diagram. 10.4 There may not be more than 2mm of sealant outside the seal area on the PCB. And there should be no more than three places. 10.5 No oxidation or contamination PCB terminals. 10.6 Parts on PCB must be the same as on the production characteristic chart. There should be no wrong parts, missing parts or excess parts. 10.7 The jumper on the PCB should conform to the product characteristic chart. 10.8 If solder gets on bezel tab pads, OLED pad, zebra pad or screw hold pad, make sure it is smoothed down.	2.5 2.5 0.65 2.5 2.5 0.65 0.65 2.5
11	Soldering	11.1 No un-melted solder paste may be present on the PCB. 11.2 No cold solder joints, missing solder connections, oxidation or icicle. 11.3 No residue or solder balls on PCB. 11.4 No short circuits in components on PCB.	2.5 2.5 2.5 0.65
12	General appearance	12.1 No oxidation, contamination, curves or, bends on interface Pin (OLB) of TCP. 12.2 No cracks on interface pin (OLB) of TCP. 12.3 No contamination, solder residue or solder balls on product. 12.4 The IC on the TCP may not be damaged, circuits. 12.5 The uppermost edge of the protective strip on the interface pin must be present or look as if it cause the interface pin to sever. 12.6 The residual rosin or tin oil of soldering (component or chip component) is not burned into brown or black color. 12.7 Sealant on top of the ITO circuit has not hardened. 12.8 Pin type must match type in specification sheet. 12.9 OLED pin loose or missing pins. 12.10 Product packaging must the same as specified on packaging specification sheet. 12.11 Product dimension and structure must conform to product specification sheet.	2.5 0.65 2.5 2.5 2.5 2.5 2.5 0.65 0.65 0.65 0.65

Check Item	Classification	Criteria
No Display	Major	
Missing Line	Major	
Pixel Short	Major	
Darker Short	Major	
Wrong Display	Major	
Un-uniform B/A x 100% < 70% A/C x 100% < 70%	Major	

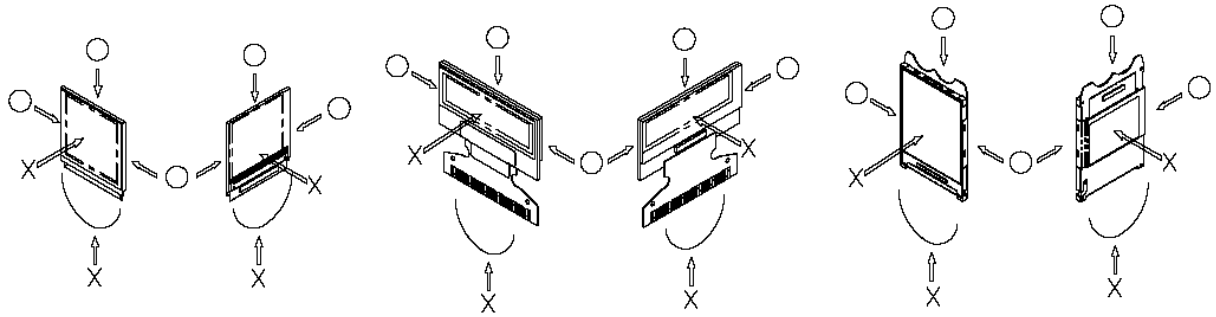
11.Precautions in use of OLED Modules

(1) Avoid applying excessive shocks to module or making any alterations or modifications to it.
(2) Don't make extra holes on the printed circuit board, change the components or modify its shape of OLED display module.
(3) Don't disassemble the OLED display module.
(4) Do not apply input signals while the logic power is off.
(5) Don't operate it above the absolute maximum rating.
(6) Don't drop, bend or twist OLED display module.
(7) Soldering: only to the I/O terminals.
(8) Hot-Bar FPC soldering condition: 280~350C, less than 5 seconds.
(9) Raystar has the right to change the passive components (Resistors, capacitors and other passive components will have different appearance and color caused by the different supplier.) and change the PCB Rev. (In order to satisfy the supplying stability, management optimization and the best product performance...etc, under the premise of not affecting the electrical characteristics and external dimensions, Raystar have the right to modify the version.)
(10) Raystar has the right to upgrade or modify the product function.

11.1. Handling Precautions

(1) Since the display panel is being made of glass, do not apply mechanical impacts such as dropping from a high position.
(2) If the display panel is broken by some accident and the internal organic substance leaks out, be careful not to inhale nor lick the organic substance.
(3) If pressure is applied to the display surface or its neighborhood of the OLED display module, the cell structure may be damaged. So, be careful not to apply pressure to these sections.
(4) The polarizer covering the surface of the OLED display module is soft and easily scratched.
(5) When the surface of the polarizer of the OLED display module has soil, clean the surface. It takes advantage by using following adhesion tape.
* Scotch Mending Tape No. 810 or an equivalent
Never try to breathe upon the soiled surface nor wipe the surface using cloth containing solvent such as ethyl alcohol, since the surface of the polarizer will become cloudy.
Also, pay attention that the following liquid and solvent may spoil the polarizer:
* Water
* Ketone
* Aromatic Solvents
(6) Protection film is being applied to the surface of the display panel and removes the protection film before assembling it. At this time, if the OLED display module has been stored for a long period of time, residue adhesive material of the protection film may remain on the surface of the display panel after removed of the film. In such case, remove the residue material by the method introduced in the above Section 5.
(7) Do not touch the following sections whenever possible while handling the OLED display modules.
* Pins and electrodes
* Pattern layouts such as the TCP & FPC
(8) Hold OLED display module very carefully when placing OLED display module into the

System housing. Do not apply excessive stress or pressure to OLED display module. And, do not over bend the film with electrode pattern layouts. These stresses will influence the display performance. Also, secure sufficient rigidity for the outer cases.



(9) Do not apply stress to the LSI chips and the surrounding molded sections.
(10) Pay sufficient attention to the working environments when handing OLED display modules to prevent occurrence of element breakage accidents by static electricity.
* Be sure to make human body grounding when handling OLED display modules.
* Be sure to ground tools to use or assembly such as soldering irons.
* To suppress generation of static electricity, avoid carrying out assembly work under dry environments.
* Protective film is being applied to the surface of the display panel of the OLED display module. Be careful since static electricity may be generated when exfoliating the protective film.

11.2. Storage Precautions

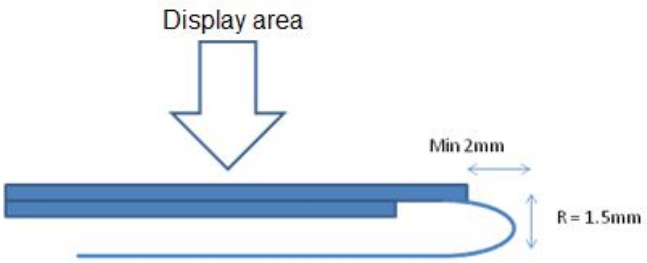
(1) When storing OLED display modules, put them in static electricity preventive bags to avoid be directly exposed to sun or lights of fluorescent lamps. (We recommend you to store these modules in the packaged state when they were shipped from Raystar. At that time, be careful not to let water drops adhere to the packages or bags.)

(2) When the OLED display module is being dewed or when it is placed under high temperature or high humidity environments, the electrodes may be corroded if electric current is applied. Please store it in clean environment.

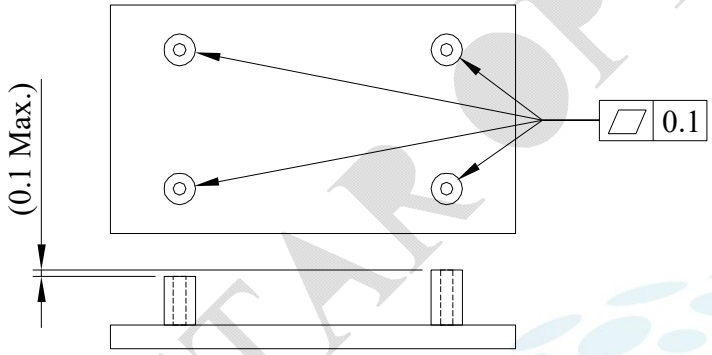
11.3. Designing Precautions

(1) The absolute maximum ratings are the ratings which cannot be exceeded for OLED display module, and if these values are exceeded, OLED display module may be damaged.
(2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the VIL and VIH specification and to make the signal line cable as short as possible.
(3) We recommend you to install excess current preventive unit (fuses, etc.) to the power circuit (VDD / VCC). (Recommend value: 0.5A)
(4) Pay sufficient attention to avoid occurrence of mutual noise interference with the nearby devices.
(5) As for EMI, take necessary measures on the equipment side basically.
(6) If the power supplied to the OLED display module is forcibly shut down by such errors as taking out the main battery while the OLED display panel is in operation, we cannot guarantee the quality of this OLED display module.
* Connection (contact) to any other potential than the above may lead to rupture of the IC.

(7) If this OLED driver is exposed to light, malfunctioning may occur and semiconductor elements may change their characteristics.
(8) The internal status may be changed, if excessive external noise enters into the module. Therefore, it is necessary to take appropriate measures to suppress noise generation or to protect module from influences of noise on the system design.
(9) We recommend you to make periodical refreshment of the operation statuses (re-setting of the commands and re-transference of the display data) to cope with catastrophic noise.
(10) It's pretty common to use "Screen Saver" to extend the lifetime and Don't use the same image for long time in real application. When an OLED display module is operated for a long of time with fixed pattern, an afterimage or slight contrast deviation may occur.
(11) The limitation of FPC and Film bending.



(12) The module should be fixed balanced into the housing, or the module may be twisted.



11.4. Precautions when disposing of the OLED display modules

(1) Request the qualified companies to handle industrial wastes when disposing of the OLED display modules. Or, when burning them, be sure to observe the environmental and hygienic laws and regulations.

Module Sample Estimate Feedback Sheet		
Module Number： _____		
1、Panel Specification：		
1. Panel Type：	□ Pass	□NG ,_____
2. Numbers of Pixel：	□ Pass	□NG ,_____
3. View Area：	□ Pass	□NG ,_____
4. Active Area：	□ Pass	□NG ,_____
5.Emitting Color：	□ Pass	□NG ,_____
6.Uniformity：	□Pass	□NG ,_____
7.Operating Temperature：	□ Pass	□NG ,_____
8.Storage Temperature：	□ Pass	□NG ,_____
9.Others：_____		
2、Mechanical Specification：		
1. PCB Size：	□Pass	□NG ,_____
2.Frame Size：	□Pass	□NG ,_____
3.Materal of Frame：	□Pass	□NG ,_____
4.Connector Position：	□Pass	□NG ,_____
5.Fix Hole Position：	□Pass	□NG ,_____
6. Thickness of PCB：	□Pass	□NG ,_____
7. Height of Frame to PCB：	□Pass	□NG ,_____
8.Height of Module：	□Pass	□NG ,_____
9.Others：	□Pass	□NG ,_____
3、Relative Hole Size：		
1.Pitch of Connector：	□Pass	□NG ,_____
2.Hole size of Connector：	□Pass	□NG ,_____
3.Mounting Hole size：	□Pass	□NG ,_____
4.Mounting Hole Type：	□Pass	□NG ,_____
5.Others：	□Pass	□NG ,_____

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Module Number：_____		
4、Electronic Characteristics of Module：		
1.Input Voltage：	□Pass	□NG ,_____
2.Supply Current：	□Pass	□NG ,_____
3.Driving Voltage for OLED：	□Pass	□NG ,_____
4.Contrast for OLED：	□Pass	□NG ,_____
5.Negative Voltage Output：	□Pass	□NG ,_____
6.Interface Function：	□Pass	□NG ,_____
7.ESD test：	□Pass	□NG ,_____
8.Others：	□Pass	□NG ,_____

5、Summary：

Sales signature：_____

Customer Signature：_____ **Date**： / /