Display Elektronik GmbH

DATA SHEET

OLED-MODULE

DEP 20402–Y

Product Specification **Ver.: 16**

18.05.2023

Revision History

VERSION	DATE	Note
0	29.07.2014	First Release
1	08.12.2015	Modify Lifetime
2	01.06.2016	Modify Static Electricity Test
3	12.09.2017	Modify Reliability Test Conditions
4	27.11.2018	Modify Static Electricity Test Contest of Test
5	02.09.2019	Modify Precautions
6	18.12.2019	Modify Reliability Test
7	06.02.2020	Modify Inspection Specification
8	28.08.2020	Modify Drawing & Thickness & Absolute Maximum
9	18.11.2020	Modify Ratings & Electrical Characteristics & Reliability Test Condition, Add Init-Code
10	04.02.2021	Modify Brightness, Precautions, Optical Characteristics
11	25.02.2021	Modify Precautions
12	06.08.2021	Modify Application Recommendations, Init-Code Add I2C Bus Data Format Modify Electrical Chracteristics Modify Optical Characteristics
13	06.05.2022	Add Not for Absolute Maximum Ratings
14	04.10.2022	Modify Reliability Test and Measurement Conditions
15	27.04.2023	Modify Lifetime Note
16	18.05.2023	Modify Inspection Criteria

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1. General Specification

The Features is described as follow:

- Module Dimension: 84.50 x 27.5 x 2.17 mm
- View Area: 72.42 x 22.82mm
- Active Area: 70.42 x 20.82 mm
- Number of Characters: 20 characters x 4 Lines
- Dot Size: 0.57 x 0.57 mm
- Dot Pitch: 0.60 x 0.60 mm
- Character Size: 2.97 x 4.77 mm
- Character Pitch: 3.55 x 5.35 mm
- Duty: 1/32
- Emitting Color: OLED , Yellow
- IC: SSD1311
- Interface: 6800, 8080, SPI, I2C
- Size: 2,89”

2. Interface Pin Function

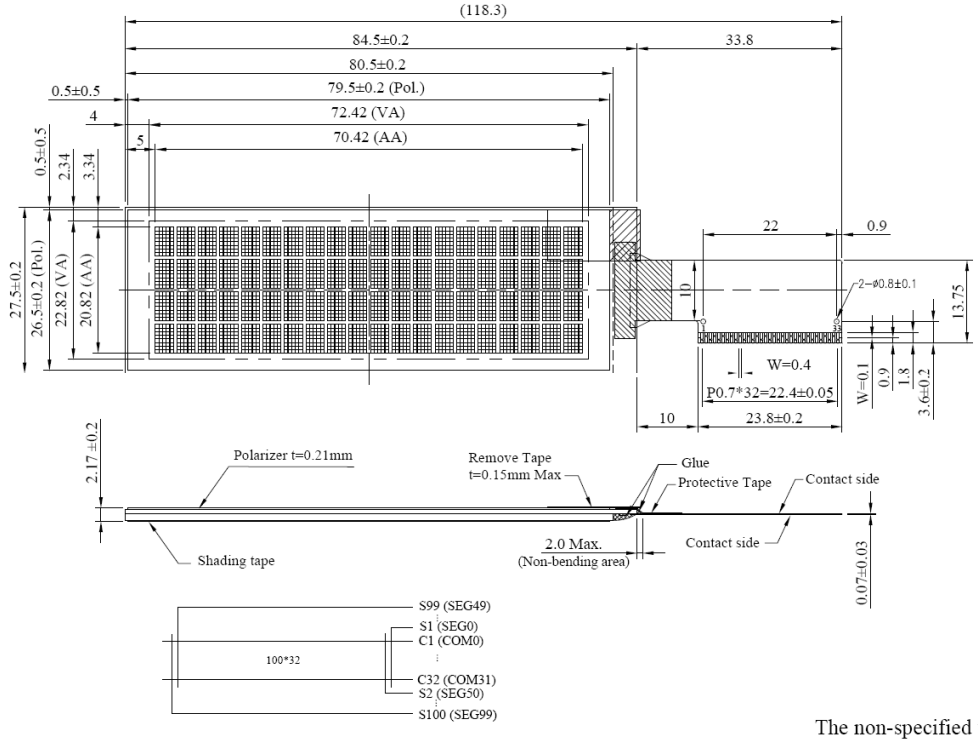
<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin Type</th><th>Description</th></tr>
<tr><td>1</td><td>NC</td><td>-</td><td>No connection</td></tr>
<tr><td>2</td><td>VSL</td><td>P</td><td>This is segment voltage (output low level) reference pin.
When external VSL is not used, this pin should be left open.
When external VSL is used, connect with resistor and diode to ground (details depend on application).</td></tr>
<tr><td>3</td><td>VSS</td><td>P</td><td>Ground pin. It must be connected to external ground.</td></tr>
<tr><td>4</td><td>REGVDD</td><td>I</td><td>Internal VDD regulator selection pin in 5V I/O application mode.
When this pin is pulled HIGH, internal VDD regulator is enabled (5V I/O application).
When this pin is pulled LOW, internal VDD regulator is disabled (Low voltage I/O application).</td></tr>
<tr><td>5</td><td>SHLC</td><td>I</td><td>This pin is used to determine the Common output scanning direction.
COM scan direction
<table>
<tr><th>SHLC</th><th>COM scan direction</th></tr>
<tr><td>1</td><td>COM0 to COM31 (Normal)</td></tr>
<tr><td>0</td><td>COM31 to COM0 (Reverse)</td></tr>
</table>
Note
(1) 0 is connected to VSS
(2) 1 is connected to VDDIO</td></tr>
<tr><td>6</td><td>SHLS</td><td>I</td><td>This pin is used to change the mapping between the display data column address and the Segment driver.
SEG scan direction
<table>
<tr><th>SHLS</th><th>SEG direction</th></tr>
<tr><td>1</td><td>SEG0 to SEG99 (Normal)</td></tr>
<tr><td>0</td><td>SEG99 to SEG0 (Reverse)</td></tr>
</table>
Note
(1) 0 is connected to VSS
(2) 1 is connected to VDDIO</td></tr>
<tr><td>7</td><td>VDD</td><td>P</td><td>Power supply for core logic operation.
VDD can be supplied externally or regulated internally.
In LV IO application (internal VDD is disabled), this is a power input pin.
In 5V IO application (internal VDD is enabled), VDD is regulated internally from VDDIO.
A capacitor should be connected between VDD and VSS under all circumstances.</td></tr>
<tr><td>8</td><td>VDDIO</td><td>P</td><td>Low voltage power supply and power supply for interface logic level in both Low Voltage I/O and 5V I/O application. It should match with the MCU interface voltage level and must be connected to external source.</td></tr>
</table>

<table>
<tr><td>9</td><td>BS0</td><td rowspan="3">I</td><td rowspan="3">MCU bus interface selection pins. Select appropriate logic setting as described in the following table. BS2, BS1 and BS0 are pin select.
Bus Interface selection
<table><tr><td>BS[2:0]</td><td>Interface</td></tr><tr><td>000</td><td>Serial Interface</td></tr><tr><td>001</td><td>Invalid</td></tr><tr><td>010</td><td>I²C</td></tr><tr><td>011</td><td>Invalid</td></tr><tr><td>100</td><td>8-bit 6800 parallel</td></tr><tr><td>101</td><td>4-bit 6800 parallel</td></tr><tr><td>110</td><td>8-bit 8080 parallel</td></tr><tr><td>111</td><td>4-bit 8080 parallel</td></tr></table>Note
(1) 0 is connected to VSS
(2) 1 is connected to VDDIO</td></tr>
<tr><td>10</td><td>BS1</td></tr>
<tr><td>11</td><td>BS2</td></tr>
<tr><td>12</td><td>GPIO</td><td>I/O</td><td>It is a GPIO pin. Details refer to OLED command DCh.</td></tr>
<tr><td>13</td><td>CS#</td><td>I</td><td>This pin is the chip select input connecting to the MCU.
The chip is enabled for MCU communication only when CS# is pulled LOW (active LOW).
In I2C mode, this pin must be connected to VSS.</td></tr>
<tr><td>14</td><td>RES#</td><td>I</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>15</td><td>D/C#</td><td>I</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 serial interface is selected, this pin must be connected to VSS.</td></tr>
<tr><td>16</td><td>R/W#(WR#)</td><td>I</td><td>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.</td></tr>
</table>

<table>
<tr><td>17</td><td>E(RD#)</td><td>I</td><td>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.</td></tr>
<tr><td>18</td><td>D0</td><td rowspan="8">I/O</td><td rowspan="8">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: SID and D2 will be the serial data output: SOD.
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.</td></tr>
<tr><td>19</td><td>D1</td></tr>
<tr><td>20</td><td>D2</td></tr>
<tr><td>21</td><td>D3</td></tr>
<tr><td>22</td><td>D4</td></tr>
<tr><td>23</td><td>D5</td></tr>
<tr><td>24</td><td>D6</td></tr>
<tr><td>25</td><td>D7</td></tr>
<tr><td>26</td><td>IREF</td><td>I</td><td>This pin is the segment output current reference pin.
IREF is supplied externally.
A resistor should be connected between this pin and VSS to maintain current of around 15uA.</td></tr>
<tr><td>27</td><td>ROM0</td><td rowspan="2">I</td><td rowspan="2">These pins are used to select Character ROM; select appropriate logic setting as described in the following table.
ROM1 and ROM0 are pin select as shown in below table:
Character ROM selection
<table><tr><td>ROM1</td><td>ROM0</td><td>ROM</td></tr><tr><td>0</td><td>0</td><td>A</td></tr><tr><td>0</td><td>1</td><td>B</td></tr><tr><td>1</td><td>0</td><td>C</td></tr><tr><td>1</td><td>1</td><td>S/W selectable (3)</td></tr></table>Note
(1) 0 is connected to VSS
(2) 1 is connected to VDDIO</td></tr>
<tr><td>28</td><td>ROM1</td></tr>
<tr><td>29</td><td>OPR0</td><td rowspan="2">I</td><td rowspan="2">This pin is used to select the character number of character generator.
Character RAM selection
<table><tr><td>OPR1</td><td>OPR0</td><td>CGROM</td><td>CGRAM</td></tr><tr><td>1</td><td>1</td><td>256</td><td>0</td></tr><tr><td>0</td><td>1</td><td>248</td><td>8</td></tr><tr><td>1</td><td>0</td><td>250</td><td>6</td></tr><tr><td>0</td><td>0</td><td>240</td><td>8</td></tr></table>Note
(1) 0 is connected to VSS
(2) 1 is connected to VDDIO</td></tr>
<tr><td>30</td><td>OPR1</td></tr>
</table>

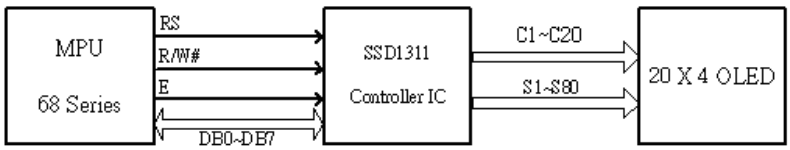
31	VCOMH	P	COM signal deselected voltage level. A capacitor should be connected between this pin and VSS. No external power supply is allowed to connect to this pin.
32	VCC	P	Power supply for panel driving voltage. This is also the most positive power voltage supply pin. It is supplied by external high voltage source.
33	NC	-	No connection

3. Counter Drawing & Block Diagram



PIN	SYMBOL	PIN	SYMBOL
1	NC	18	D0
2	VSL	19	D1
3	VSS	20	D2
4	REGVDD	21	D3
5	SHLC	22	D4
6	SHLS	23	D5
7	VDD	24	D6
8	VDDIO	25	D7
9	BS0	26	IREF
10	BS1	27	ROM0
11	BS2	28	ROM1
12	GPIO	29	OPR0
13	CS#	30	OPR1
14	RES#	31	VCOMH
15	D/C#	32	VCC
16	R/W#(WR#)	33	NC
17	E(RD#)		

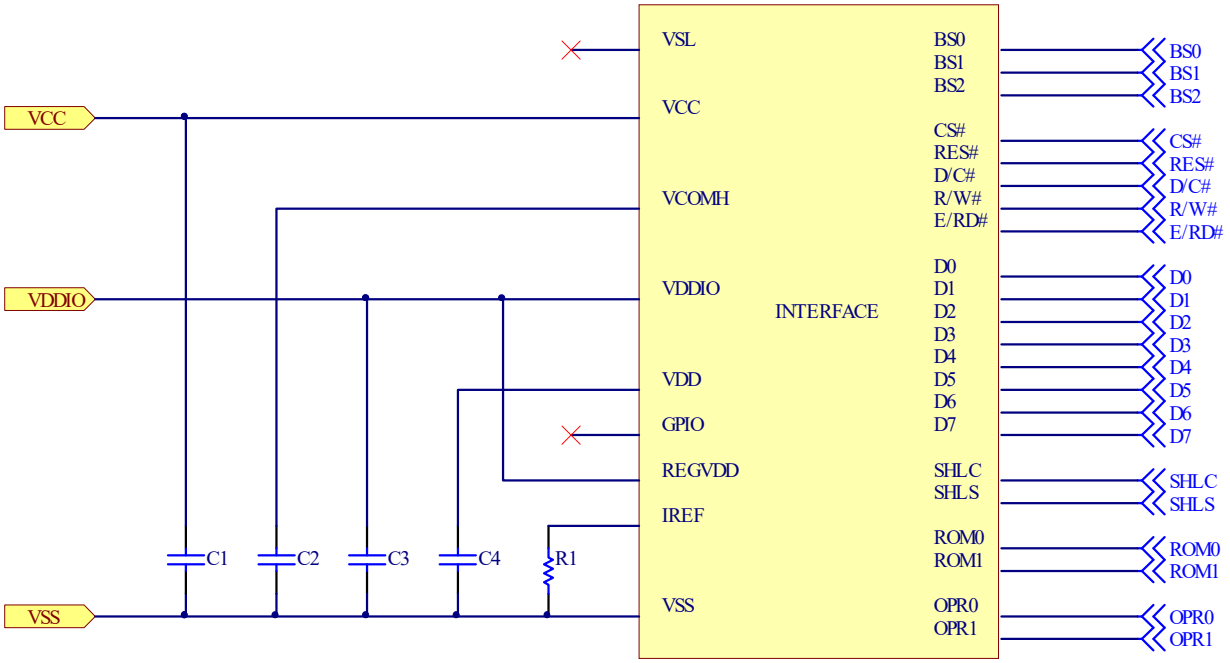
The non-specified tolerance of dimension is ±0.3mm.



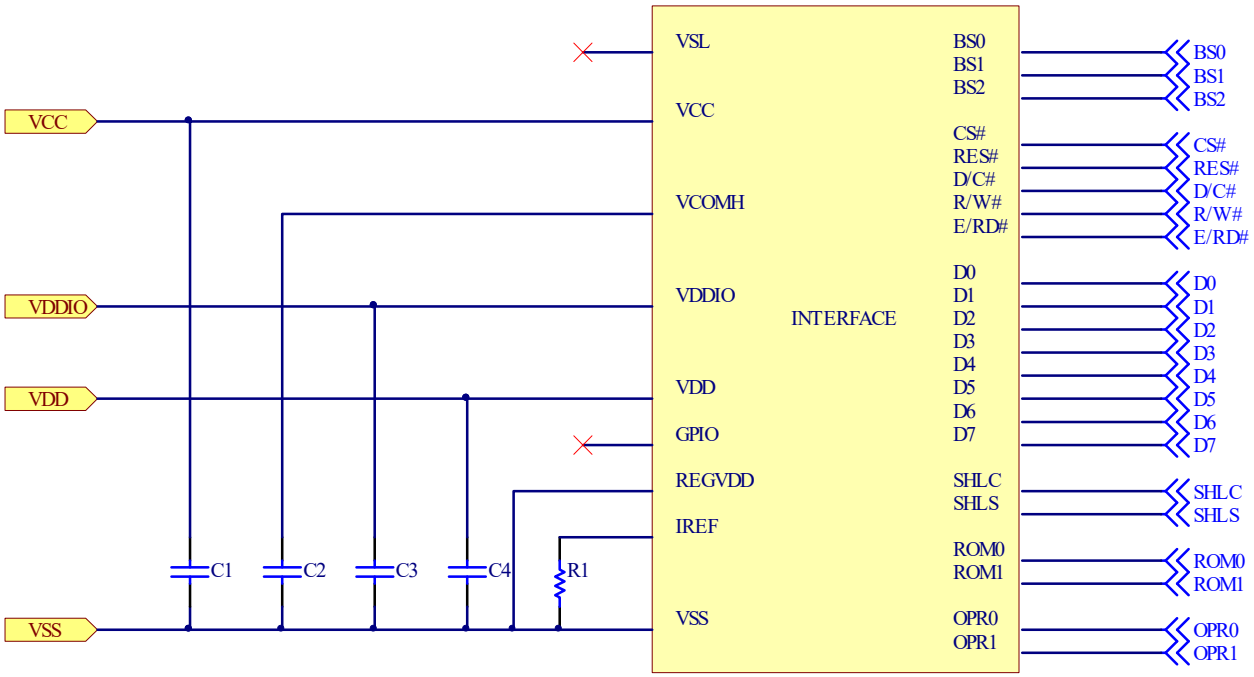
Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DD RAM Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13
DD RAM Address	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	30	31	32	33
DD RAM Address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53
DD RAM Address	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F	70	71	72	73

3.1 Application Recommendations

I/O Application (5 Volt):



Low Voltage I/O Application:



C1, C2: 4.7uF (1)
C3, C4: 1.0uF (1) Place close to IC VDDIO / VDD and VSS pins on PCB

Bus Interface Selection: (Must be set the BS[2:0], refer to item 3)
8-bits 6800 and 8080 parallel, 4-bits 6800 and 8080 parallel, SPI, I2C

Voltage at IREF = VCC – 4.5V. For VCC = 10V, IREF = 15uA:

R1 = (Voltage at IREF - VSS) / IREF

= (10-4.5)V / 15uA

≧ 365KΩ(2)

Pin Name	Low Voltage I/O Application	5V I/O Application
REGVDD	LOW, disable 5V I/O regulator	HIGH, enable 5V I/O regulator
VDD	2.4 - VDDIO	NC with stabilizing capacitor It is internally regulated
VDDIO	2.4V – 3.3V	4.4V - 5.3V

Note:

(1) The capacitor value is recommended value. Select appropriate value against module application.

(2) Minimum value. When OLED product application, then R1 must be greater than the calculated value.

4. Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Notes
Supply Voltage For Logic	VDD	-0.3	VDDIO	V	-
Power Supply for I/O pins	VDDIO	-0.3	6	V	-
Operating Voltage	VCC	0	16	V	-
Operating Temperature	TOP	-40	+80	°C	-
Storage Temperature	TST	-40	+85	°C	-

Notes:

- All the above voltages are on the basis of “VSS = 0V”.
- 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 ‘’Electrical Characteristics’’. If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.
- The absolute limit temperature was verified according to the test conditions of reliability test (See section 9. Reliability) , and module was met all criteria.
- The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.

5. Electrical Characteristics

5.1 DC Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	VDD	Low Voltage I/O	2.4	3.0	3.3	V
		5V I/O (VDD as output)	-	-	-	V
Power supply for I/O pins	VDDIO	Low Voltage I/O	2.4	3.0	3.3	V
		5V I/O	4.4	5.0	5.3	V
Operating Voltage	VCC	-	8.0	10.0	10.5	V
			8.0	12.0	12.5	V
Input High Volt.	VIH	-	0.8xVDDIO	-	-	V
Input Low Volt.	VIL	-	-	-	0.2xVDDIO	V
Output High Volt.	VOH	IOH=-0.5mA	0.9xVDDIO	-	-	V
Output Low Volt.	VOL	IOL=0.5mA	-	-	0.1xVDDIO	V
50% Check Board Operating Current	ICC	VCC=10V	-	19	29	mA
		VCC=12V	-	23	35	mA

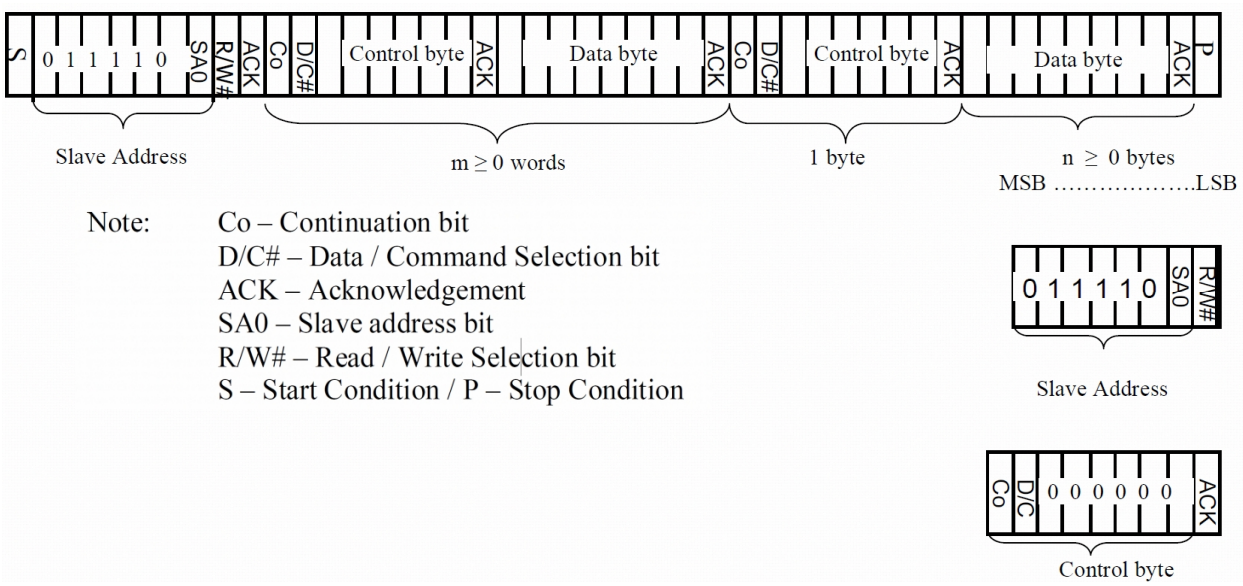
Notes: The VCC (VPP) value can be adjusted according to the demand brightness. When VCC (VPP) is lowered, the brightness decreases or when VCC (VPP) is increased, the brightness increases. The VCC (VPP) value is set within the recommended range.
The lifetime of OLED is directly related to the set brightness, and lower brightness helps to improve the lifetime.

5.1 Initial Code

```
void Initial_SSD1311(){

    WriteCmd(0x08);         //Display off

    WriteCmd(0x2A);         //Function Set //RE =1,SD=0,IS = 0

    WriteCmd(0x71);         //Function Selection A
    WriteData(0x4C);        //Internal VDD Regulator ON for 5V I/O Application
    //WriteData(0x00);      //Internal VDD Regulator OFF for Low Voltage I/O Application

    WriteCmd(0x72);         //Function Selection B
    WriteData(0x00);        //Select Font table

    WriteCmd(0x79);         // OLED command set is enabled

    WriteCmd(0x81);          //Set Contrast
    WriteCmd(0x75)

    WriteCmd(0xD5);          //Set display clock divide Ratio
    WriteCmd(0x80);          //≈105Hz

    WriteCmd(0xD9);          //Set phase Length
    WriteCmd(0x78);

    WriteCmd(0xDA);          //Set SEG pin Hardware Config.
    WriteCmd(0x10);          //Default value

    WriteCmd(0xDB);          //Set VcomH Deselect Level
    WriteCmd(0x20);

    WriteCmd(0xDC);          // Function Selection C
    WriteCmd(0x03);          // Internal VSL

    WriteCmd(0x78);         //SD=0,OLED command set is disabled

    WriteCmd(0x06);         // Entry Mode Set(RE=1) BDC=1,BDS=0

    WriteCmd(0x09);         // Extended function Set
                            //3-line or 4-line display mode

    WriteCmd(0x28);         //Function Set //Extended command Set ending
                            //RE = 0,SD=0,IS = 0
    WriteCmd(0x02);         //Return home

    WriteCmd(0x06);         //entry mode Set

    WriteCmd(0x01);         //clear display

    WriteCmd(0x0C);         //display on
}
```

Note 1: This Initial Code is for reference only. Please make the best adjustment with the OLED module.
Note 2: Command: Set Contrast Control (0x81) , This command sets the Contrast Setting of the display. The chip has 255 contrast steps from 01h to FFh. The segment output current increases as the contrast step value increases. The segment current increases, the OLED brightness increases.

I2C-bus data format



(a)I2C address bit (SA0)
The slave address is following the start condition for recognition use. The slave address is either “b0111100” or “b0111101” by changing the SA0 to LOW or HIGH (D/C pin acts as SA0).

(b)“R/W#” bit is used to determine the operation mode of the I2C-bus interface. R/W#=1, it is in read mode. R/W#=0, it is in write mode.

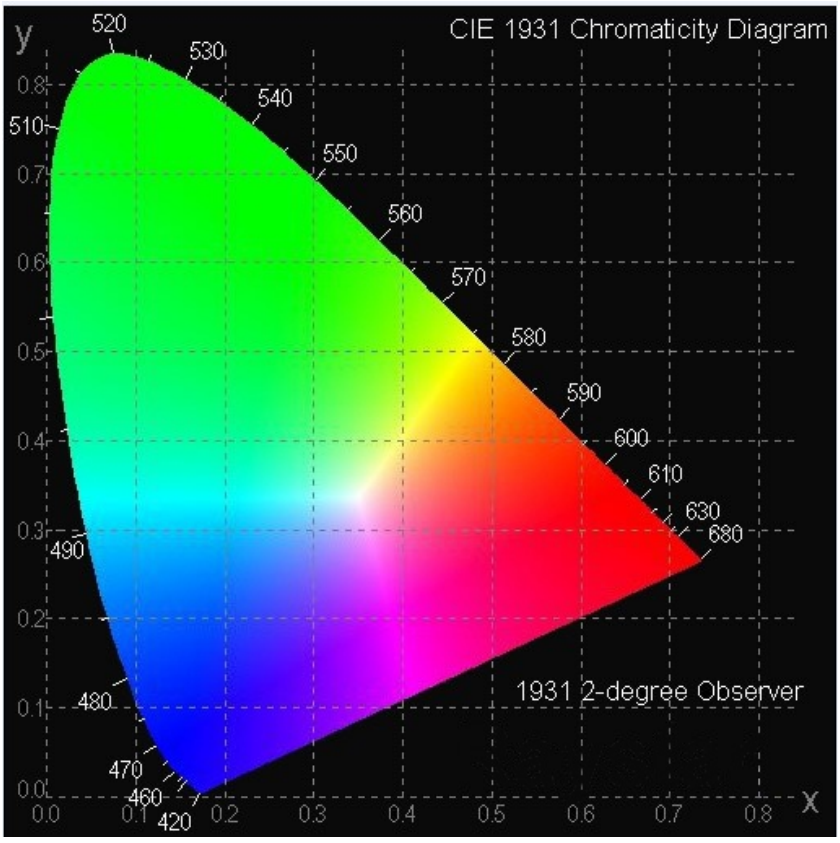
(c)After the transmission of the slave address, either the control byte or the data byte may be sent across the SDA. A control byte mainly consists of Co and D/C# bits following by six “0”’s.

a. If the Co bit is set as logic “0”, the transmission of the following information will contain data bytes only.
b. The D/C# bit determines the next data byte is acted as a command or a data. If the D/C# bit is set to logic “0”, it defines the following data byte as a command. If the D/C# bit is set to logic “1”, it defines the following data byte as a data which will be stored at the GDDRAM. The GDDRAM column address pointer will be increased by one automatically after each data write.

6. Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V)θ	-	160	-	-	deg
	(H)φ	-	160	-	-	deg
Contrast Ratio	CR	Dark	10,000:1	-	-	-
Response Time	T rise	-	-	10	-	μs
	T fall	-	-	10	-	μs
Display with 50% check Board Brightness(1)		VCC=10V	100	150	-	cd/m2
		VCC=12V	120	170	-	cd/m2
CIEx(Yellow)		(CIE1931)	0.45	0.47	0.49	-
CIEy(Yellow)		(CIE1931)	0.48	0.50	0.52	-

Note 1: The brightness value is based on the setting of VCC (VPP)equal to the Typical value.



7. OLED Lifetime

ITEM	Conditions	Min	Typ	Remark
Operating Life Time	Ta=25°C / Initial 50% checkerboard brightness 100cd/ m^2	50,000 Hrs	-	Note

Note:

- Lifetime is defined the amount of time when the luminance has decayed to <50% of the minimal brightness.
- 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.
- Screen saving mode will extend OLED lifetime.
- Lifetime is not guaranteed one but expected lifetime in normal condition.

8. 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	...ance 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°C±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
4. No Condensation.

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.

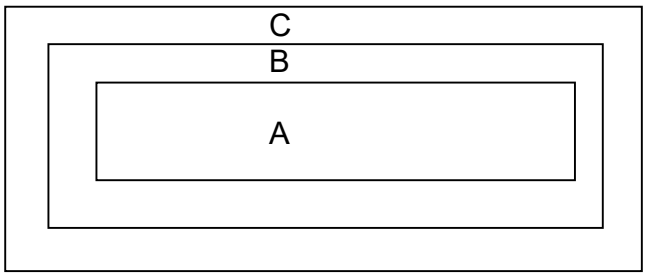
9. Inspection Specification

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:

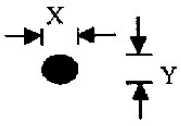


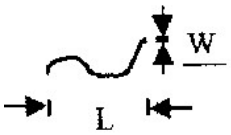
Zone A: Active Area
Zone B: Viewing Area except Zone A
Zone C: Outside Viewing Area
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble of quality and assembly to customer`s product.

Inspection Methods

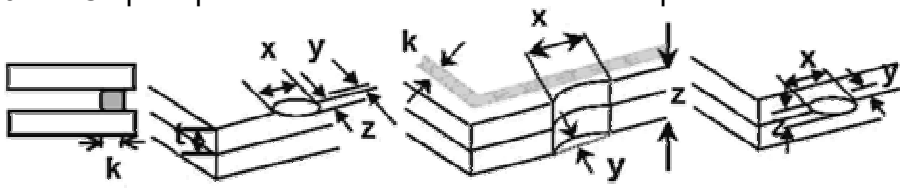
1 The general inspection: Under fluorescent light illumination: 750~1500 Lux, about 30cm viewing distance, within 45º viewing angle, under 25±5°C.
2 The luminance and color coordinate inspection : By SR-3 or BM-7 or the equal equipments, in the dark room, under 25°C±5°C.

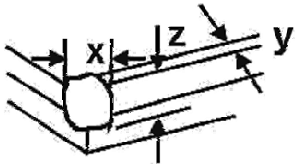
NO	Item	Criterion	AQL
01	Electrical Testing	1.1 Missing vertical, horizontal segment, segment contrast defect. 1.2 Missing character , dot or icon. 1.3 Display malfunction. 1.4 No function or no display. 1.5 Current consumption exceeds product specifications. 1.6 OLED viewing angle defect. 1.7 Mixed 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

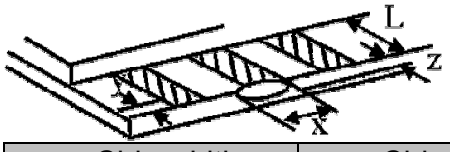
<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td rowspan="2">03</td><td>OLED black spots, white spots, contamination
(non-display)</td><td>3.1 Round type :
As following drawing
Φ=(x + y) / 2
 

<table>
<tr><th>SIZE</th><th>Acceptable QTY</th><th>Zone</th></tr>
<tr><td>Φ≦0.10</td><td>ignore</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)
 

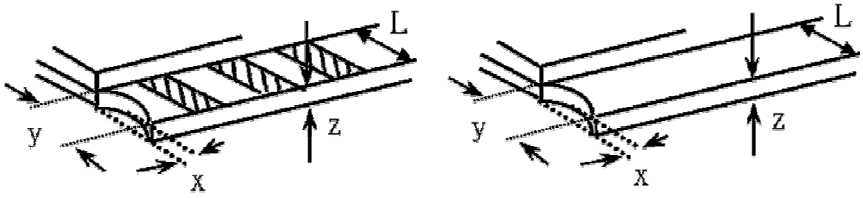
<table>
<tr><th>Length</th><th>Width</th><th>Acceptable Q TY</th><th>Zone</th></tr>
<tr><td>---</td><td>W≦0.02</td><td>ignore</td><td>A+B</td></tr>
<tr><td>L≦3.0</td><td>0.02 < W≦0.03</td><td rowspan="2">2</td><td>A+B</td></tr>
<tr><td>L≦2.5</td><td>0.03 < W≦0.05</td><td>A+B</td></tr>
<tr><td>---</td><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 /Dent</td><td>4.1 If bubbles are visible, judge using black spot specifications, not easy to find, must check in specify direction.
4.2 The polarizer dent follows this specification.
<table>
<tr><th>Size Φ</th><th>Acceptable Q TY</th><th>Zone</th></tr>
<tr><td>Φ≦0.20</td><td>ignore</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 colspan="2">Follow NO.3 OLED black spots, white spots, contamination.</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:
 

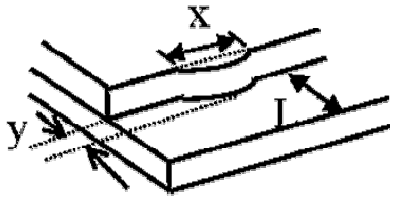
<table>
<tr><th>z: Chip thickness</th><th>y: Chip width</th><th>x: Chip length</th></tr>
<tr><td>Z≦1/2t</td><td>Not over viewing area</td><td>x≦1/8a</td></tr>
<tr><td>1/2t < z≦2t</td><td>Not exceed 1/3k</td><td>x≦1/8a</td></tr>
</table>
⊙If there are 2 or more chips, x is total length of each chip.</td>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

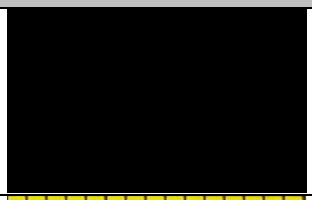
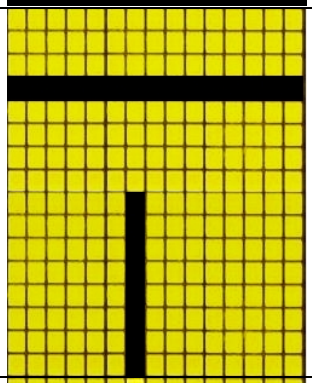
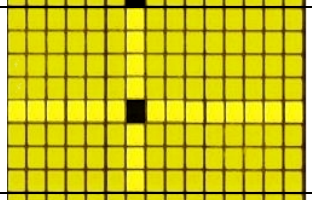
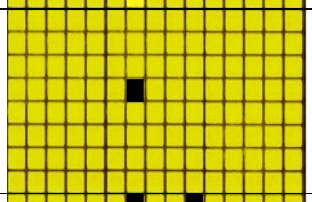
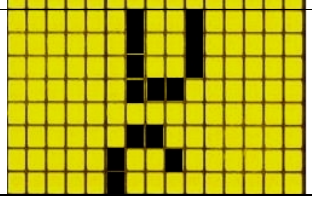
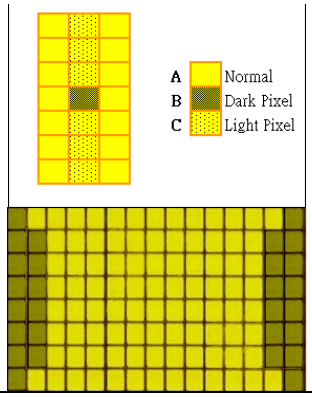
6.2.3 Substrate protuberance and internal crack.
 

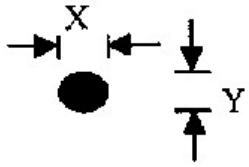
<table>
<tr><th>y: width</th><th>x: length</th></tr>
<tr><td>y≦1/3L</td><td>x ≦ a</td></tr>
</table></td><td>2.5</td></tr>
<tr><td>07</td><td>Cracked glass</td><td>The OLED with extensive crack is not acceptable.</td><td>2.5</td></tr>
<tr><td>08</td><td>Backlight elements</td><td>8.1 Illumination source 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

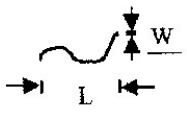
0.65</td></tr>
<tr><td>09</td><td>Bezel</td><td>9.1 Bezel may not have rust, be deformed or have fingerprints, stains or other contamination.
9.2 Bezel must comply with job specifications.</td><td>2.5

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.	2.5
		10.2 COB seal surface may not have pinholes through to the IC.	2.5
		10.3 The height of the COB should not exceed the height indicated in the assembly diagram.	0.65
		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.	2.5
		10.5 No oxidation or contamination PCB terminals.	2.5
		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.	0.65
		10.7 The jumper on the PCB should conform to the product characteristic chart.	0.65
		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
11	Soldering	11.1 No un-melted solder paste may be present on the PCB.	2.5
		11.2 No cold solder joints, missing solder connections, oxidation or icicle.	2.5
		11.3 No residue or solder balls on PCB.	2.5
		11.4 No short circuits in components on PCB.	0.65
12	General appearance	12.1 No oxidation, contamination, curves or, bends on interface Pin (OLB) of TCP.	2.5
		12.2 No cracks on interface pin (OLB) of TCP.	0.65
		12.3 No contamination, solder residue or solder balls on product.	2.5
		12.4 The IC on the TCP may not be damaged, circuits.	2.5
		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.	2.5
		12.6 The residual rosin or tin oil of soldering (component or chip component) is not burned into brown or black color.	2.5
		12.7 Sealant on top of the ITO circuit has not hardened.	2.5
		12.8 Pin type must match type in specification sheet.	0.65
		12.9 OLED pin loose or missing pins.	0.65
		12.10 Product packaging must the same as specified on packaging specification sheet.	0.65
		12.11 Product dimension and structure must conform to product specification sheet.	0.65

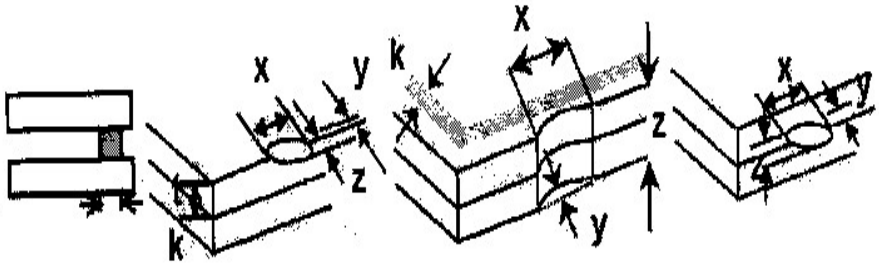
Check Item	Classification	Criteria
No Display	Major	
Missing Line	Major	
Pixel Short	Major	
Dark Pixel	Major	
Wrong Display	Major	
Un-uniform B/A x 100% < 70% A/C x 100% < 70%	Major	

<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td>01</td><td>Electrical Testing</td><td>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.</td><td>0.65</td></tr>
<tr><td>02</td><td>Black or white spots on OLED (display only)</td><td>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.</td><td>2.5</td></tr>
<tr><td>03</td><td>OLED black spots, white spots, contamination (non-display)</td><td>3.1 Round type : As following drawing
Φ=(x + y) / 2
 

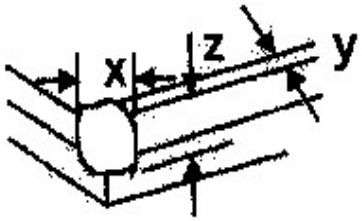
<table>
<tr><th>SIZE</th><th>Acceptable Q TY</th></tr>
<tr><td>Φ≦0.10</td><td>Accept no dense</td></tr>
<tr><td>0.10 < Φ≦0.20</td><td>2</td></tr>
<tr><td>0.20 < Φ≦0.25</td><td>1</td></tr>
<tr><td>0.25 < Φ</td><td>0</td></tr>
</table></td><td>2.5</td></tr>
<tr><td></td><td></td><td>3.2 Line type : (As following drawing)
 

<table>
<tr><th>Length</th><th>Width</th><th>Acceptable Q TY</th></tr>
<tr><td>---</td><td>W≦0.02</td><td>Accept no dense</td></tr>
<tr><td>L≦3.0</td><td>0.02 < W≦0.03</td><td rowspan="2">2</td></tr>
<tr><td>L≦2.5</td><td>0.03 < W≦0.05</td></tr>
<tr><td>---</td><td>0.05 < W</td><td>As round type</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></tr>
<tr><td>Φ≦0.20</td><td>Accept no dense</td></tr>
<tr><td>0.20 < Φ≦0.50</td><td>3</td></tr>
<tr><td>0.50 < Φ≦1.00</td><td>2</td></tr>
<tr><td>1.00 < Φ</td><td>0</td></tr>
<tr><td>Total Q TY</td><td>3</td></tr>
</table></td><td>2.5</td></tr>
</table>

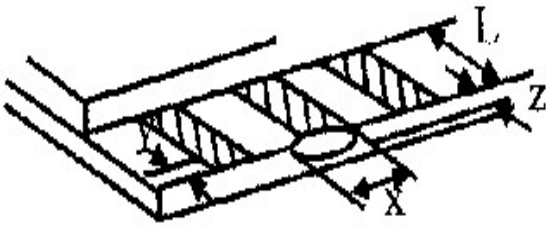
<table>
<tr><th>NO</th><th>Item</th><th>Criterion</th><th>AQL</th></tr>
<tr><td>05</td><td>Scratches</td><td>Follow NO.3 OLED black spots, white spots, contamination</td><td></td></tr>
<tr><td>06</td><td>Chipped glass</td><td>Symbols Define:
x: Chip length y: Chip width z: Chip thickness
k: Seal width t: Glass thickness a: OLED side length
L: Electrode pad length:

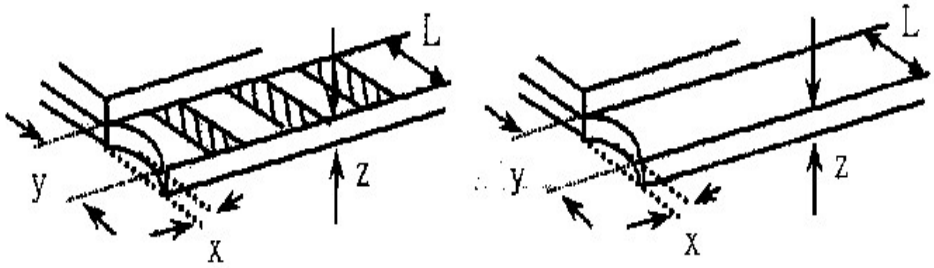
6.1 General glass chip :
6.1.1 Chip on panel surface and crack between panels:
 

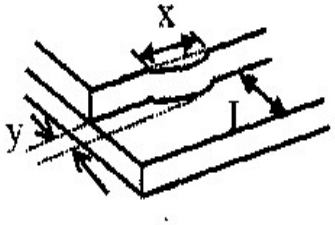
<table><tr><th>z: Chip thickness</th><th>y: Chip width</th><th>x: Chip length</th></tr><tr><td>Z≦1/2t</td><td>Not over viewing area</td><td>x≦1/8a</td></tr><tr><td>1/2t < z≦2t</td><td>Not exceed 1/3k</td><td>x≦1/8a</td></tr></table>⊙If there are 2 or more chips, x is total length of each chip.

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>
</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>
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 :


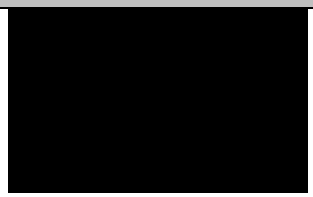
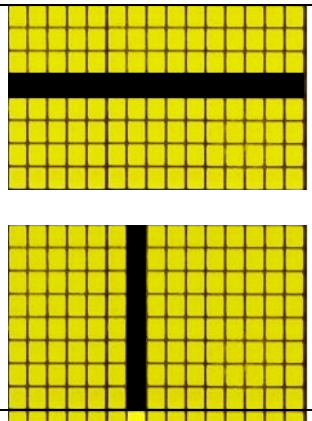
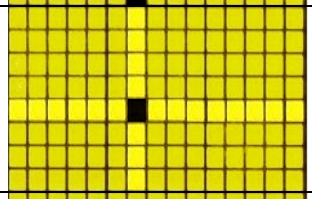
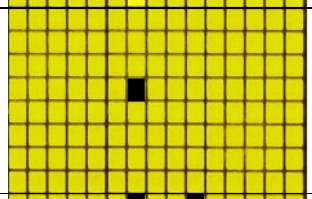
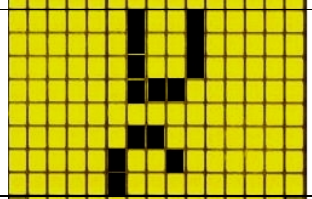
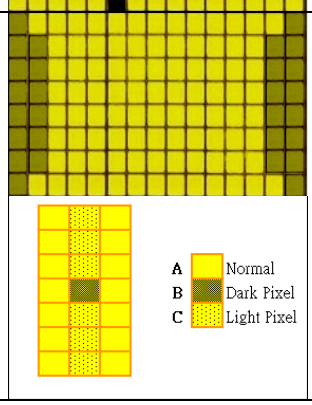
<table>
<tr><th>y: Chip width</th><th>x: Chip length</th><th>z: Chip thickness</th></tr>
<tr><td>y≦0.5mm</td><td>x≦1/8a</td><td>0 < z ≦ t</td></tr>
</table>
6.2.2 Non-conductive portion:


<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>
</table>

NO	Item	Criterion	AQL
07	Cracked glass	The OLED with extensive crack is not acceptable.	2.5
08	Backlight elements	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.	0.65 2.5 0.65
09	Bezel	9.1 Bezel may not have rust, be deformed or have fingerprints, stains or other contamination. 9.2 Bezel must comply with job specifications.	2.5 0.65
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

NO	Item	Criterion	AQL
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	

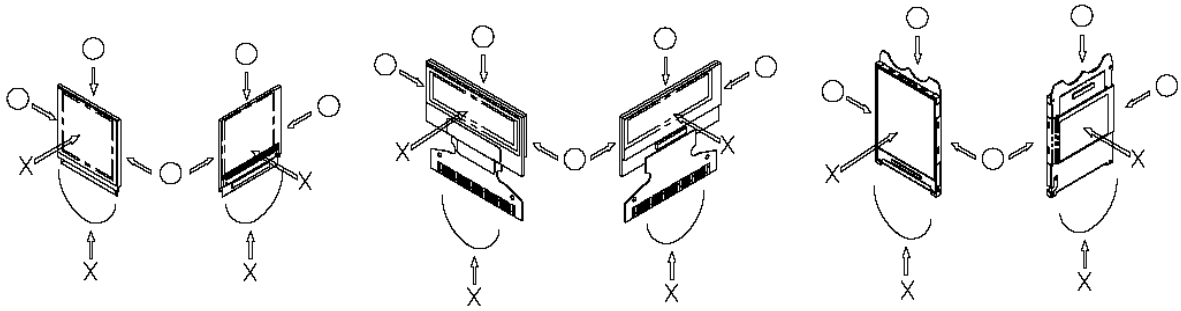
10. Precautions in use of OLED Modules

(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°C~350°C, less than 5 seconds.
(9) Display Elektronik 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, Display Elektronik has the right to modify the version.)
(10) Display Elektronik has the right to upgrade or modify the product function.
(11) For COG & COF structure OLED products, customers should reserve VCC (VPP) adjustment function or software update function when designing OLED supporting circuit. (The progress of OLED light-emitting materials will increase the conversion efficiency and the brightness. The brightness can be adjusted if necessary)..

10.1. 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.

10.2. 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. And, also, place in the temperature 25°C±5°C and Humidity below 65% RH.(We recommend you to store these modules in the packaged state when they were shipped from Display Elektronik. 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.

10.3. 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.

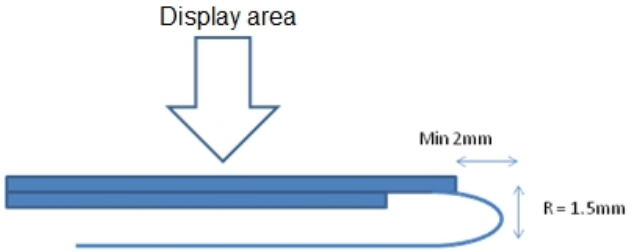
(3) We recommend you to install excess current preventive unit (fuses, etc.) to the power circuit (VDD / VCC). (Recommend value: 0.5A)

(4) Pay sufficient attention to avoid occurrence of mutual noise interference with the nearby devices.

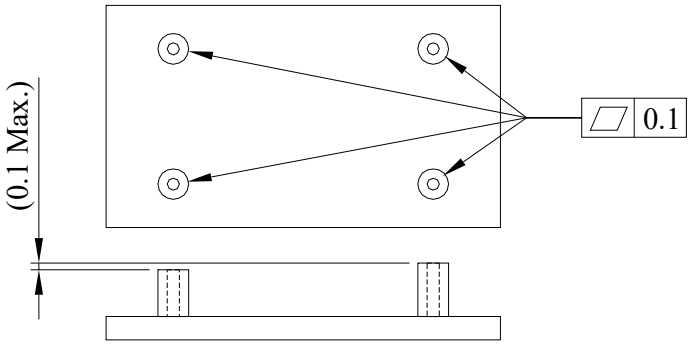
(5) As for EMI, take necessary measures on the equipment side basically.

(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.



(13) Please heat up a little the tape sticking on the components when removing it; otherwise the components might be damaged.

10.4. 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.