OSD DISPLAYS

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Customer:	
Model Number:	OSD9616P2477-21
Specification Number:	
Date:	2/12/2014
Version:	D.0

For Customer's Acceptance

Approved by	Comments

Approved by	Reviewed by	Prepared by

CONTENT

REVISION RECORD

REV.	REVISION DESCRIPTION	REV. DATE	REMARK
D01	Initial release.	2014-02-12	

1 Overview

OSD9616P2477-21 is a monochrome OLED display module with 96×16 dot matrix. The characteristics of this display module are high brightness, self-emission, high contrast ratio, slim/thin outline, wide viewing angle, wide temperature range, and low power consumption.

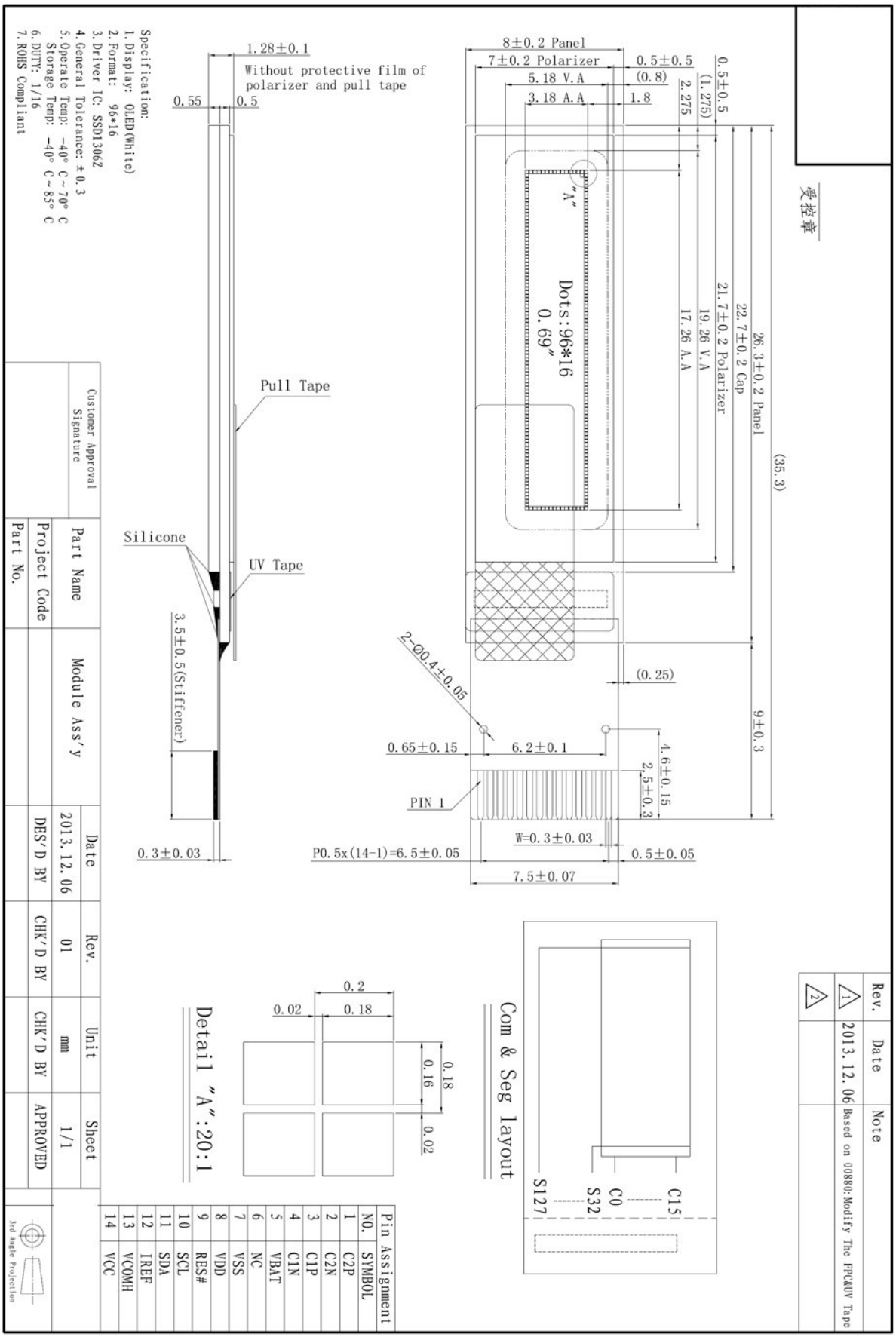
2 Features

- Display Color: White
- Dot Matrix:96×16
- Driver IC: SSD1306Z
- Interface: I^2C
- Wide range of operating temperature: -40℃ to 70℃

3 Mechanical Data

NO.	ITEM	SPECIFICATION	UNIT
1	Dot Matrix	96(W)×16(H)	-
2	Dot Size	0.16(W)×0.18 (H)	mm^2
3	Dot Pitch	0.18(W)×0.20 (H)	mm^2
4	Aperture Rate	80	%
5	Active Area	17.26(W)×3.18 (H)	mm^2
6	Panel Size	26.3(W)×8(H)×1.05(T)	mm^3
7	Module Size	35.3(W)×8(H)×1.28 (T)	mm^3
8	Diagonal A/A Size	0.69	inch
9	Module Weight	0.49±10%	gram

4 Mechanical Drawing

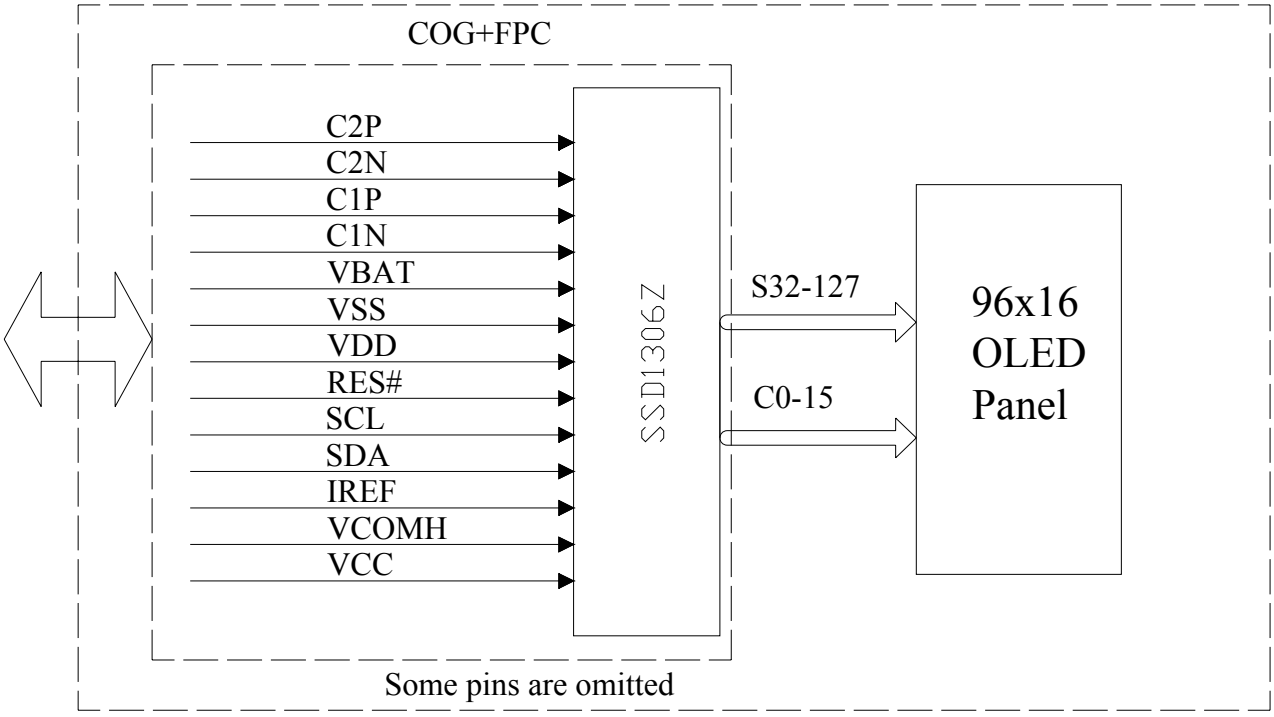


5 Module Interface

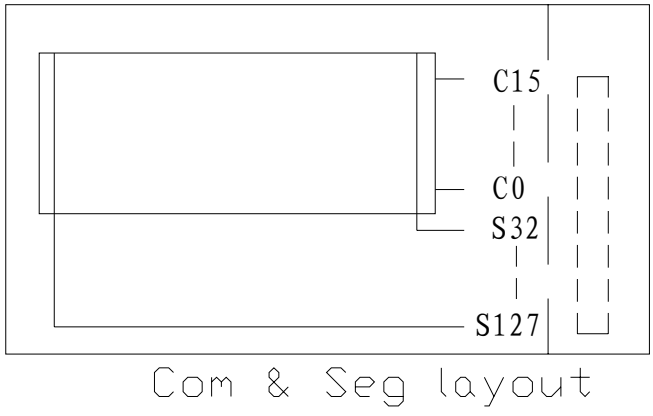
<table>
<tr><th>PIN NO.</th><th>PIN NAME</th><th>DESCRIPTION</th></tr>
<tr><td>1</td><td>C2P</td><td rowspan="2">C1P/C1N – Pin for charge pump capacitor; Connect to each other with a capacitor.</td></tr>
<tr><td>2</td><td>C2N</td></tr>
<tr><td>3</td><td>C1P</td><td rowspan="2">C2P/C2N – Pin for charge pump capacitor; Connect to each other with a capacitor.</td></tr>
<tr><td>4</td><td>C1N</td></tr>
<tr><td>5</td><td>VBAT</td><td>Power supply for charge pump regulator circuit.
<table>
<tr><td>Status</td><td>VBAT</td><td>VDD</td><td>VCC</td></tr>
<tr><td>Enable charge pump</td><td>Connect to external VBAT source</td><td>Connect to external VDD source</td><td>A capacitor should be connected between this pin and VSS</td></tr>
<tr><td>Disable charge pump</td><td>Keep float or connect to VDD</td><td>Connect to external VDD source</td><td>Connect to external VCC source</td></tr>
</table></td></tr>
<tr><td>6</td><td>NC</td><td>This is dummy pin.</td></tr>
<tr><td>7</td><td>VSS</td><td>This is a ground pin.</td></tr>
<tr><td>8</td><td>VDD</td><td>Power supply pin for core logic operation.</td></tr>
<tr><td>9</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 HIGH (i.e. connect to VDD) during normal operation.</td></tr>
<tr><td>10</td><td>SCL</td><td>I^2C serial clock pin.</td></tr>
<tr><td>11</td><td>SDA</td><td>I^2C serial data pin.</td></tr>
<tr><td>12</td><td>IREF</td><td>This is segment output current reference pin.
A resistor should be connected between this pin and VSS to maintain the IREF current at 12.5 uA.</td></tr>
<tr><td>13</td><td>VCOMH</td><td>The pin for COM signal deselected voltage level.
A capacitor should be connected between this pin and VSS.</td></tr>
<tr><td>14</td><td>VCC</td><td>Power supply for panel driving voltage. This is also the most positive power voltage supply pin. When charge pump is enabled, a capacitor should be connected between this pin and VSS.</td></tr>
</table>

6 Function Block Diagram

6.1 Function Block Diagram



6.2 Panel Layout Diagram



7 Absolute Maximum Ratings

ITEM	SYMBOL	MIN	MAX	UNIT	REMARK
Logic supply voltage	VDD	-0.3	4	V	IC maximum rating
Charge Pump supply voltage	VBAT	-0.3	5	V	IC maximum rating
OLED Operating voltage	VCC	0	16	V	IC maximum rating
Operating Temp.	Top	-40	70	℃	-
Storage Temp	Tstg	-40	85	℃	-

Note (1): All of the voltages are on the basis of "VSS = 0V".

Note (2): Permanent breakage of module may occur if the module is used beyond the maximum rating. The module can be normal operated under the conditions according to Section 8 "Electrical Characteristics". Malfunctioning of the module may occur and the reliability of the module may deteriorate if the module is used beyond the conditions.

8 Electrical Characteristics

8.1 DC Electrical Characteristics

ITEM	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Logic Supply Voltage	VDD	22±3°C, 55±15%R.H	1.65	3.0	3.3	V
OLED Driver Supply Voltage (Generated by Internal DC/DC)	VCC	22±3°C, 55±15%R.H	7.0	7.25	7.5	V
Charge Pump Regulator Supply Voltage	VBAT	22±3°C, 55±15%R.H	3.3	3.7	4.2	V
OLED Driver Supply Voltage (Supply Externally)	VCC	22±3°C, 55±15%R.H	9.5	10	10.5	V
High-level Input Voltage	V_{IH}	-	0.8×VDD	-	-	V
Low-level Input Voltage	V_{IL}	-	-	-	0.2×VDD	V
High-level Output Voltage	V_{OH}	-	0.9×VDD	-	-	V
Low-level Output Voltage	V_{OL}	-	-	-	0.1×VDD	V

Note : The VCC input must be kept in a stable value; ripple and noise are not allowed.

8.2 Electro-optical Characteristics

ITEM	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Normal Mode Brightness	L_{br}	All pixels ON (1)	100	150	-	cd/m^2
ICC,Sleep mode Current	ICC,SLEEP	VDD = 1.65V~3.3V, VCC = 7V~15V Display OFF, No panel attached	-	-	20	uA
IDD,Sleep mode Current	IDD,SLEEP	VDD = 1.65V~3.3V, VCC = 7V~15V Display OFF, No panel attached	-	-	20	uA
Normal Mode Power Consumption	Pt	All pixels On(1)	-	31.45	38.85	mW
C.I.E(White)	(x)	x,y(CIE1931)	0.25	0.29	0.33	-
	(y)		0.29	0.33	0.37	-
Dark Room Contrast	CR	-	≥2000:1	-	-	-
Response Time	-	-	-	10	-	μs
View Angle	-	-	≥160	-	-	Degree

Note(1): Normal Mode test conditions are as follows:

- Contrast setting : 0x56
- Frame rate : 101 Hz
- Duty setting : 1/16

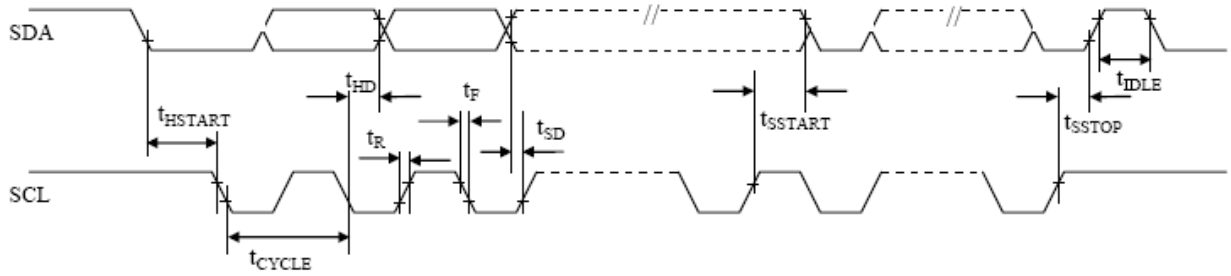
8.3 AC Electrical Characteristics

I²C Interface Timing Characteristics

(VDD - VSS = 1.65V to 3.3V, TA = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	2.5	-	-	us
t_{HSTART}	Start condition Hold Time	0.6	-	-	us
t_{HD}	Data Hold Time (for "SDA_{OUT}" pin)	0	-	-	ns
	Data Hold Time (for "SDA_{IN}" pin)	300	-	-	ns
t_{SD}	Data Setup Time	100	-	-	ns
t_{SSTART}	Start condition Setup Time (Only relevant for a repeated Start condition)	0.6	-	-	us
t_{SSTOP}	Stop condition Setup Time	0.6	-	-	us
t_R	Rise Time for data and clock pin	-	-	300	ns
t_F	Fall Time for data and clock pin	-	-	300	ns
t_{IDLE}	Idle Time before a new transmission can start	1.3	-	-	us

I²C Interface Timing Characteristics

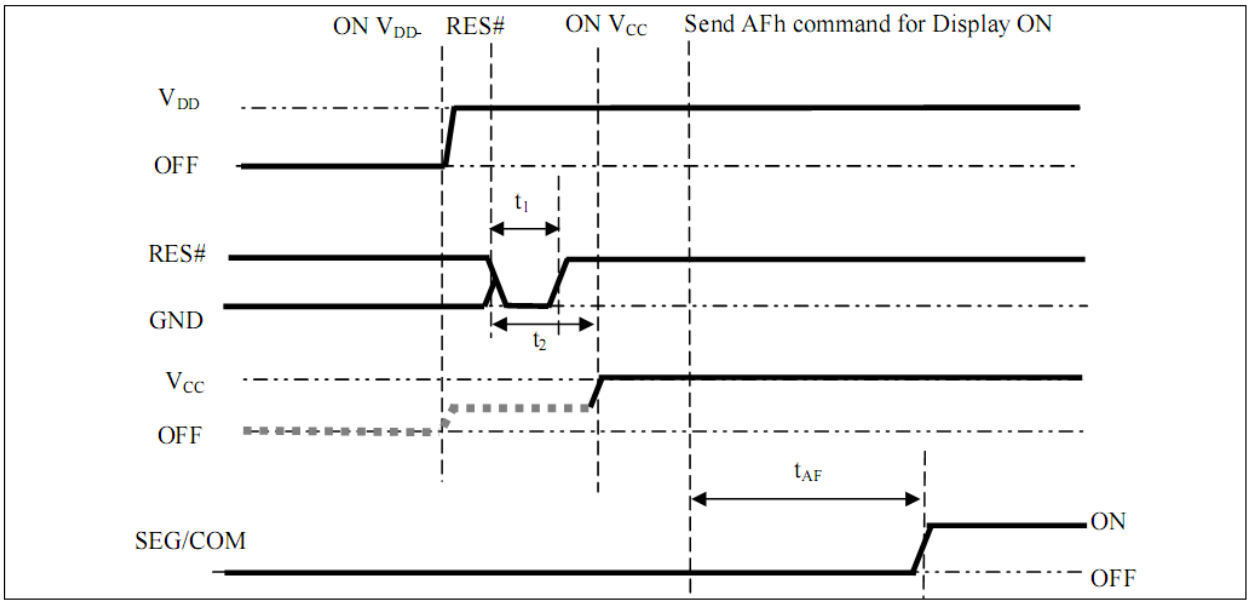


9 Functional Specification and Application Circuit

9.1 Power ON and Power OFF Sequence with External VCC

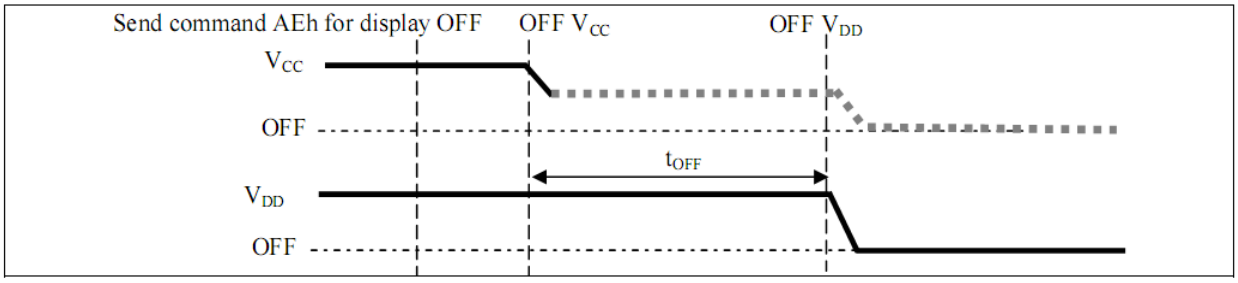
Power ON Sequence:

1. Power ON VDD
2. After VDD become stable, set RES# pin LOW (logic low) for at least 3us (t_1)[4] and then HIGH (logic high).
3. After set RES# pin LOW (logic low), wait for at least 3us (t_2). Then Power ON VCC[1].
4. After VCC become stable, send command AFh for display ON. SEG/COM will be ON after 100ms(t_{AF}).



Power OFF Sequence:

1. Send command AEh for display OFF.
2. Power OFF VCC[1],[2],[3].
3. Power OFF VDD after t_{OFF}. [5] (Typical t_{OFF}=100ms)



Note:

(1)Since an ESD protection circuit is connected between VDD and VCC, VCC becomes lower than VDD whenever VDD is ON and VCC is OFF as shown in the dotted line of VCC in above figures.

(2) VCC should be kept float (disable) when it is OFF.

(3) Power Pins(VDD, VCC) can never be pulled to ground under any circumstance.

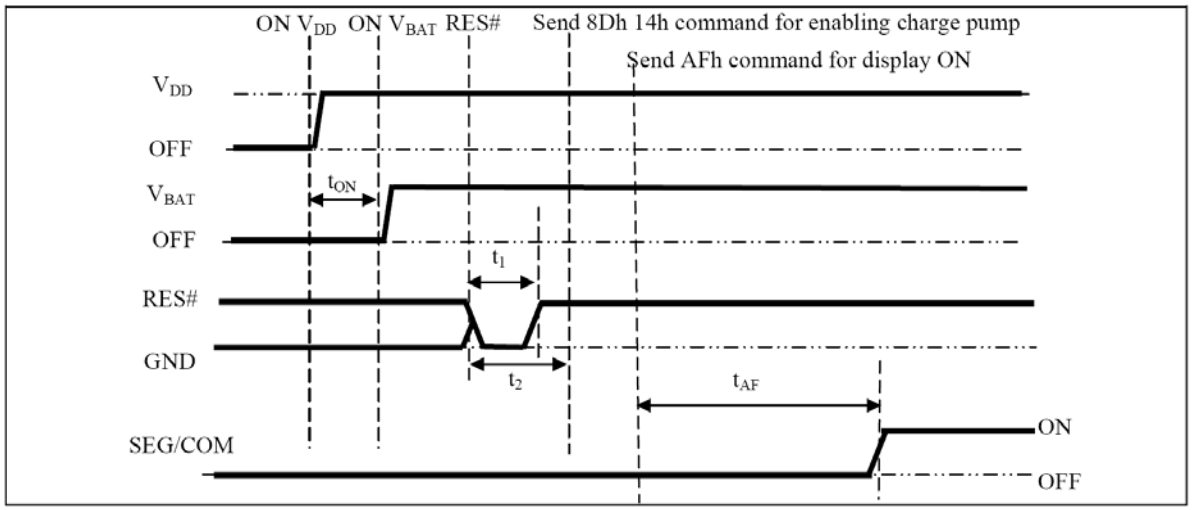
(4) The register values are reset after t1.

(5) VDD should not be Power OFF before VCC Power OFF

9.2 Power ON and Power OFF Sequence with Charge Pump Application

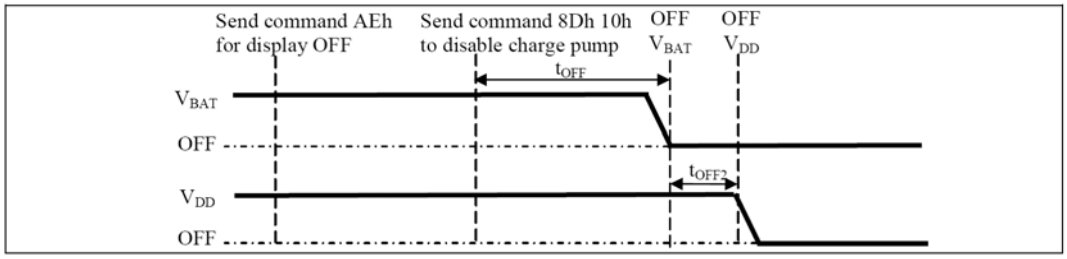
Power ON Sequence:

1. Power ON VDD
2. Wait for t_{ON}. Power ON VBAT.[(1), (2)] (where Minimum t_{ON} = 0ms)
3. After VBAT become stable, set RES# pin LOW (logic low) for at least 3us (t1) [(3)] and then HIGH (logic high).
4. After set RES# pin LOW (logic low), wait for at least 3us (t2). Then input commands with below sequence:
   a. 8Dh 14h for enabling charge pump
   b. AFh for display ON
5. SEG/COM will be ON after 100ms (tAF).



Power OFF Sequence:

1. Send command AEh for display OFF.
2. Send command 8Dh 10h to disable charge pump.
3. Power OFF VBAT after tOFF. (1), (2) (Typical tOFF =100ms)
4. Power OFF VDD after tOFF2. (where Minimum tOFF2 = 0ms (4), Typical tOFF2=5ms)



Note:

(1) VBAT should be kept float (i.e. disable) when it is OFF.

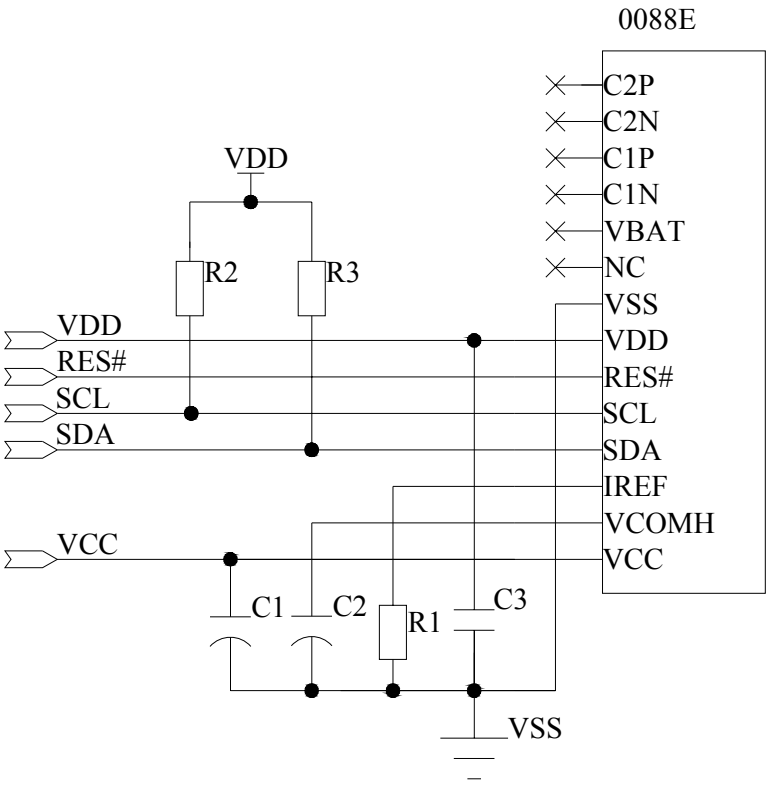
(2) Power Pins (VDD , VBAT) can never be pulled to ground under any circumstance.

(3) The register values are reset after t1.

(4) VDD should not be Power OFF before VBAT Power OFF

9.3 Application Circuit

(1).The configuration for I² C interface mode, external VCC is shown in the following diagram



Pin connected to MCU interface: SCL,SDA,RES#

Slave Address：0x78

Under external VCC Mode, the Charge Pump Setting(ADh) must be set as follow:

8Dh: Charge Pump Setting

10h: Disable Charge Pump

Recommended components

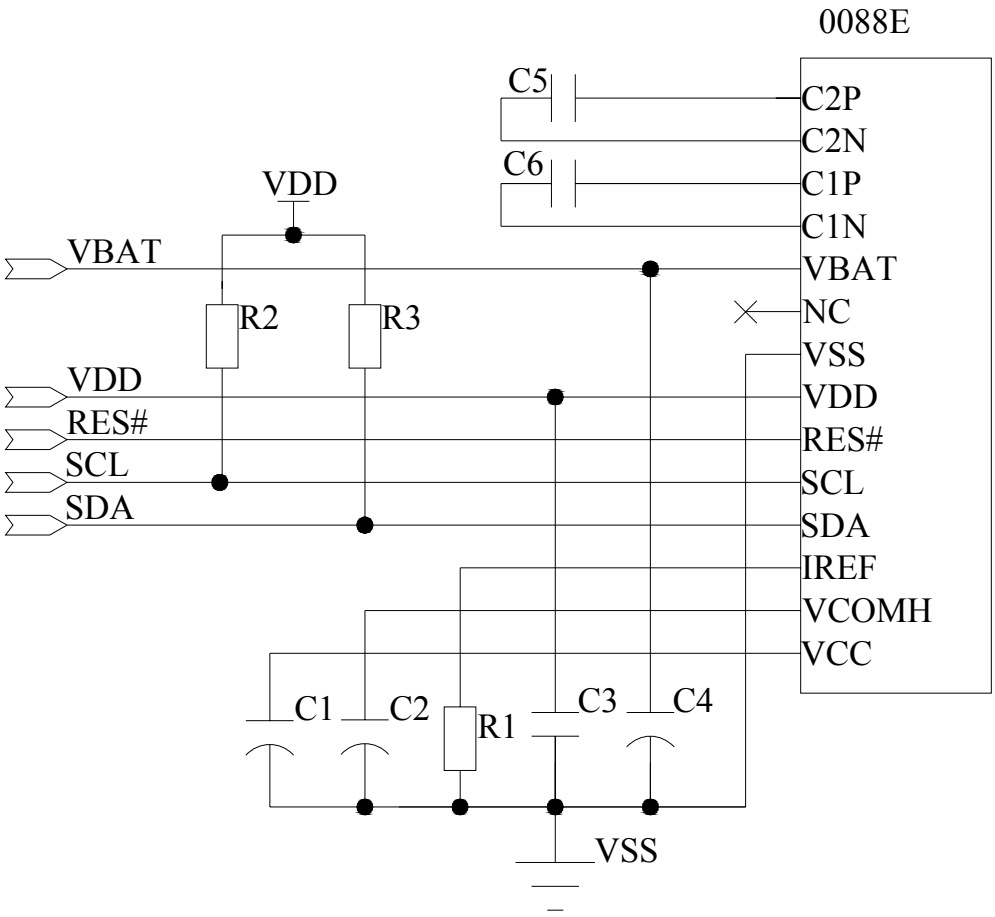
C3 : 0.1uF-0603-X7R±10%.RoHS

C1,C2 : 4.7μF/25V.RoHS (Tantalum Capacitors)

R1: 0603 1/10W +/-5% 390K ohm.RoHS

R2,R3: 0603 1/10W +/-5% 10K ohm.RoHS

(2).The configuration for I² C interface mode, Internal Charge Pump is shown in the following diagram



Pin connected to MCU interface: SCL,SDA,RES#

Slave Address：0x78

Under Internal DC/DC Mode, the Charge Pump Setting(ADh) must be set as follow:

8Dh: Charge Pump Setting

14h: Enable Charge Pump

Recommended components

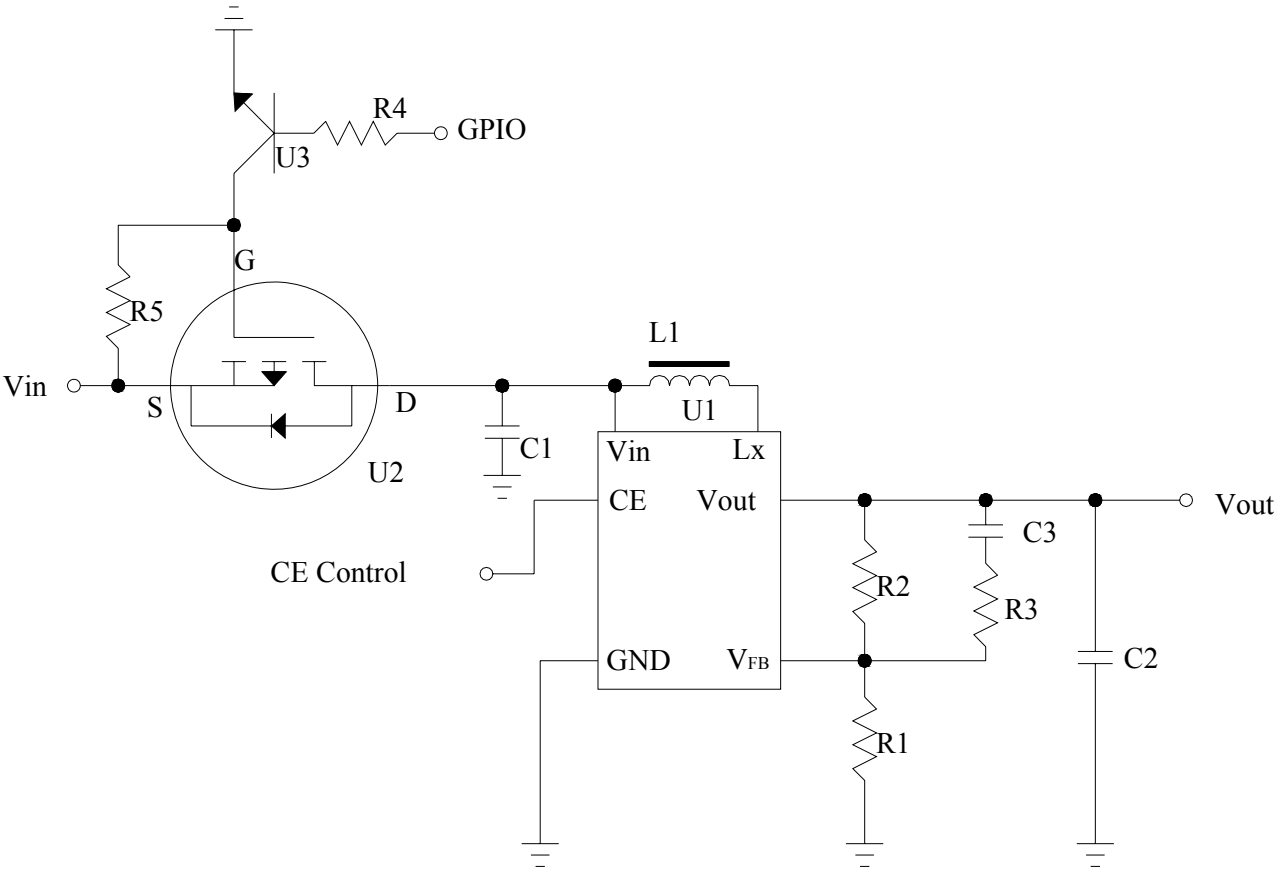
C4,C1,C2: 4.7μF/16V.RoHS (Tantalum Capacitors)

C5,C6,C3: 1uF-0603-X7R±10%.RoHS

R1: 0603 1/10W +/-5% 820K ohm.RoHS

R2,R3: 0603 1/10W +/-5% 10K ohm.RoHS

9.4 External DC-DC application circuit



Recommend component

The C1	: 1 uF-0603-X7R±10%.RoHS
The C2	: 1 uF-0603-X7R±10%.RoHS
The C3	: 220pF-0603-X7R±10%.RoHS
The R1	: 0603 1/10W +/-5% 10Kohm.RoHS
The R2	: 0603 1/10W +/-5% 91Kohm.RoHS
The R3	: 0603 1/10W +/-5% 2Kohm.RoHS
The R4	: 0603 1/10W +/-5% 1Kohm.RoHS
The R5	: 0603 1/10W +/-5% 10Kohm.RoHS
The L1	: 22uH
The U1	: R1200
The U2	: FDN338P
The U3	: 8050

9.5 Display Control Instruction

Refer to SSD1306Z IC Specification.

9.6 Recommended Software Initialization

In order to ensure the reliability and stability of the module, the module must initialized use the following code, Malfunctioning of the module may occur and the reliability of the module may deteriorate if the module is used beyond the initialize code.

```
void init_program()
{
    Write_Command(0xAE);          //Display OFF (sleep mode)
    Write_Command(0xD5);          //Set Display Clock Divide Ratio/Oscillator Frequency
    Write_Command(0x52);          //320kHz //101hz        52
    Write_Command(0xA8);          //Set Multiplex Ratio
    Write_Command(0x0f);          //16
    Write_Command(0xD3);          //Set Display Offset
    Write_Command(0x00);
    Write_Command(0x40);          //Set Display Start Line
    Write_Command(0x8D);          //Set Display Offset
    Write_Command(0x14);          //VCC Generated by Internal DC/DC circuit
    Write_Command(0xA0);          //Set Segment Re-map
    Write_Command(0xC0);          //Set COM Output Scan Direction
    Write_Command(0xDA);          //Set COM Pins Hardware Configuration
    Write_Command(0x02);
    Write_Command(0x81);          //Set Contrast Control
    Write_Command(0x56);
    Write_Command(0xD9);          //Set Pre-charge Period
    Write_Command(0xf1);          //VCC Supplied Externallyt
    Write_Command(0xDB);          //Set VCOMH Deselect Level
    Write_Command(0x20);          //0x3C
    Write_Command(0xA4);          //Output follows RAM content
    Write_Command(0xA6);          //Set Normal Display
    clear_screen();
    Write_Command(0xAF);          //Set Display ON (normal mode)}
```

11 Reliability

11.1 Reliability Test

NO.	ITEM	CONDITION	QUANTITY
1	High Temperature (Non-operation)	85℃,240hrs	4
2	Low Temperature (Non-operation)	-40℃,240hrs	4
3	High Temperature (Operation)	70℃,240hrs	4
4	Low Temperature (Operation)	-40℃,240hrs	4
5	High Temperature / High Humidity (Operation)	60℃,90%RH,240hrs	4
6	Thermal shock (Non-operation)	-40℃~85℃(-40℃/30min;transit/3min;85℃/30min;transit/3min) 1cycle: 66min,30cycles	4
7	Vibration	Frequency: 5~50Hz,0.5G Scan rate: 1 oct/min Time: 2 hrs/axis Test axis: X,Y, Z	1 Carton
8	Drop	Height: 100 cm Sequence: 1 angle, 3 edges and 6 faces	1 Carton

Test and measurement conditions

1. All measurements shall not be started until the specimens attain to temperature stability, the stable time is at least 15 minutes.
2. The degradation of polarizer is ignored for item 5.
3. The tolerance of temperature is ±3℃, and the tolerance of relative humidity is ±5%.

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.

11.2 Lifetime

End of lifetime is specified as 50% of initial brightness and the test pattern at operating condition is 50% alternating checkerboard.

ITEM	MIN	MAX	UNIT	CONDITION
Operation Life Time	10,000	-	hrs	150 cd/m^2, 50% alternating checkerboard, 22±3°C, 55±15% RH

11.3 Failure Check Standard

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 22±3°C; 55±15% RH.

13 Outgoing Quality Control Specifications

13.1 Sampling Method

(1) GB/T 2828.1-2003/ISO2859-1：1999, inspection level Ⅱ, normal inspection, single sample inspection

(2) AQL: Major 0.65; Minor 1.0

13.2 Inspection Conditions

The environmental conditions for test and measurement are performed as follows.

Temperature: 22±3°C

Humidity: 55±15%R.H

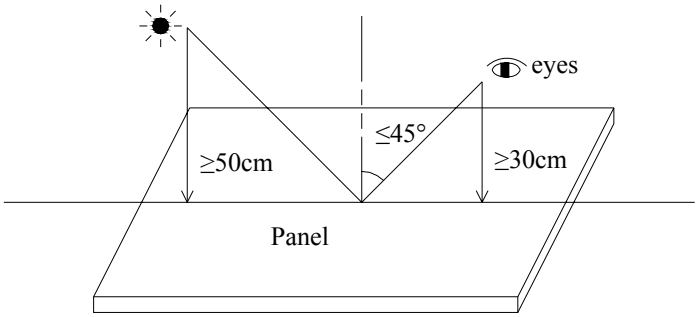
Fluorescent Lamp: 30W

Distance between the Panel & Lamp: ≥50cm

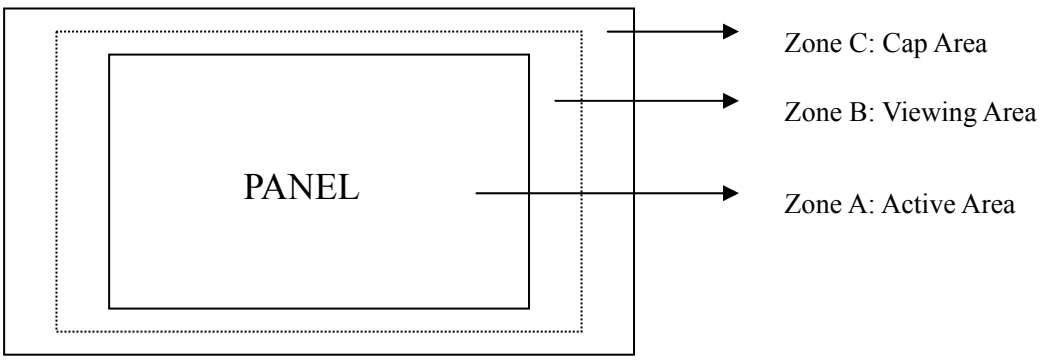
Distance between the Panel & Eyes: ≥30cm

Viewing angle from the vertical in each direction: ≤45°

(See the sketch below)

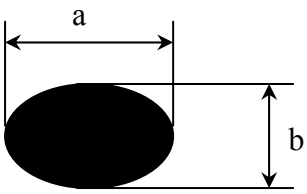


13.3 Quality Assurance Zones

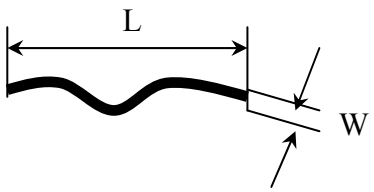


13.4 Inspection Standard

Definition of Φ&L&W (Unit: mm)

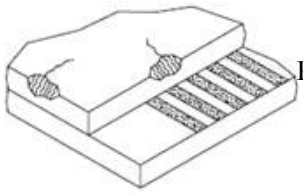
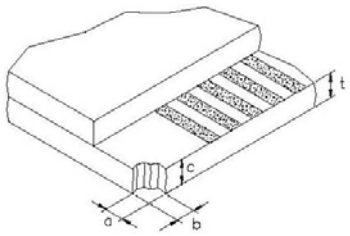
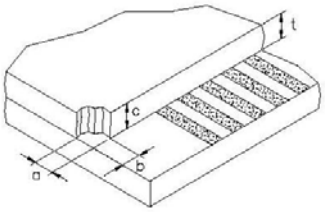
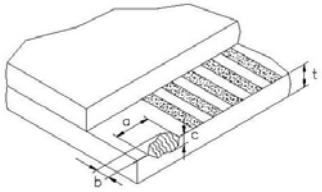
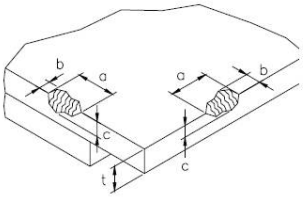
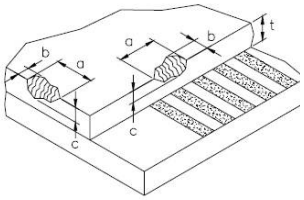


Φ=(a+b)/2



Ⅰ. Appearance Defects

<table>
<tr><th>NO.</th><th>ITEM</th><th>CRITERIA</th><th>CLASSIFICATION</th></tr>
<tr><td>1</td><td>Polarizer Black or White spot, Dirty spot, Foreign matter, Dent on the polarizer</td><td>
<table>
<tr><td rowspan="2">Average Diameter (mm)</td><td colspan="2">Acceptable Number</td></tr>
<tr><td>Zone A,B</td><td>Zone C</td></tr>
<tr><td>Φ≤0.15</td><td>Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.15<Φ≤0.30</td><td>3</td></tr>
<tr><td>Φ>0.30</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>2</td><td>Scratch/line on the glass/Polarizer</td><td>
<table>
<tr><td rowspan="2">Width (mm)</td><td rowspan="2">Length (mm)</td><td colspan="2">Acceptable Number</td></tr>
<tr><td>Zone A,B</td><td>Zone C</td></tr>
<tr><td>W≤0.03</td><td>---</td><td>Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.03<W≤0.08</td><td>L≤5.0</td><td>3</td></tr>
<tr><td>W>0.08</td><td>---</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>3</td><td>Polarizer Bubble</td><td>
<table>
<tr><td rowspan="2">Average Diameter (mm)</td><td colspan="2">Acceptable Number</td></tr>
<tr><td>Zone A,B</td><td>Zone C</td></tr>
<tr><td>Φ>0.5</td><td>0</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.2<Φ≤0.5</td><td>3</td></tr>
<tr><td>Φ≤0.2</td><td>Ignore</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>4</td><td>Any Dirt & Scratch on Polarizer’s Protective Film</td><td>Ignore for not affect the polarizer.</td><td>Minor</td></tr>
<tr><td>5</td><td>Any Dirt on Cap Glass</td><td>
<table>
<tr><td>Average Diameter (mm)</td><td>Acceptable Number</td></tr>
<tr><td>Φ≤0.5</td><td>Ignore</td></tr>
<tr><td>0.5<Φ≤1.0</td><td>3</td></tr>
<tr><td>Φ>1.0</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
</table>

6	Glass Crack	 Propagation crack is not acceptable.	Major
7	Corner Chip	 t= Glass thickness Accept a≤2.0mm or b≤2.0mm, c≤t	Minor
8	Corner Chip on Cap Glass	 t= Glass thickness Accept a≤1.5mm or b≤1.5mm, c≤t	Minor
9	Chip on Contact Pad	 t= Glass thickness Accept a≤3.0mm or b≤0.8mm, c≤t (on the contact pin) a≤3.0mm or b≤1.5mm, c≤t (outside of the contact pin)	Minor
10	Chip on Face of Display	 t= Glass thickness Accept a≤1.5mm or b≤1.5mm, c≤t	Minor
11	Chip on Cap Glass	 t= Glass thickness Accept a≤3.0mm or b≤3.0mm, c≤t/2 a≤1.5mm or b≤1.5mm, t/2≤c≤t	Minor
12	Stain on Surface	Stain removable by soft cloth or air blow is acceptable.	Minor
13	TCP/FPC Damage	(1) Crack, deep scratch, deep hole and deep pressure mark on the TCP/FPC are not acceptable. (2) Terminal lead twisted or broken is not allowable. (3) Copper exposed is not allowed by naked eye inspection.	Minor
14	Dimension Unconformity	Checking by mechanical drawing.	Major

Ⅱ. Displaying Defects

<table>
<tr><th>NO.</th><th>ITEM</th><th>CRITERIA</th><th>CLASSIFICATION</th></tr>
<tr><td>1</td><td>Black/White spot
Dirty spot
Foreign matter</td><td>
<table>
<tr><td rowspan="2">Average Diameter (mm)</td><td colspan="2">Pieces Permitted</td></tr>
<tr><td>Zone A,B</td><td>Zone C</td></tr>
<tr><td>Φ≤0.10</td><td>Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.10<Φ≤0.20</td><td>3</td></tr>
<tr><td>Φ>0.20</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>2</td><td>No Display</td><td>Not allowable.</td><td>Major</td></tr>
<tr><td>3</td><td>Irregular Display</td><td>Not allowable.</td><td>Major</td></tr>
<tr><td>4</td><td>Missing Line
(row or column)</td><td>Not allowable.</td><td>Major</td></tr>
<tr><td>5</td><td>Short</td><td>Not allowable.</td><td>Major</td></tr>
<tr><td>6</td><td>Flicker</td><td>Not allowable.</td><td>Major</td></tr>
<tr><td>7</td><td>Abnormal Color</td><td>Refer to the SPEC.</td><td>Major</td></tr>
<tr><td>8</td><td>Luminance NG</td><td>Refer to the SPEC.</td><td>Major</td></tr>
<tr><td>9</td><td>Over Current</td><td>Refer to the SPEC.</td><td>Major</td></tr>
</table>

14 Precautions for operation and Storage

14.1 Precautions for Operation

(1) Since OLED panel is made of glass, do not apply any mechanical shock or impact or excessive force to it when installing the OLED module. Any strong mechanical impact due to falling dropping etc. may cause damage (breakage or cracking).

(2) The polarizer on the OLED surface is made of soft material and is easily scratched. Please take most care when handing. When the surface of the polarizer of OLED Module is contaminated, please wipe it off gently by using moisten soft cloth with isopropyl alcohol, do not use water, ketone or aromatics. If there is saliva or water on the OLED surface, please wipe it off immediately.

(3) When handling OLED module, please be sure that the body and the tools are properly grounded. And do not touch I/O pins with bare hands or contaminate I/O pins, it will cause disconnection or defective insulation of terminals.

(4) Do not attempt to disassemble or process the OLED module.

(5) OLED module should be used under recommended operating conditions shown in the specification. Since the higher voltage leads to the shorter lifetime, be sure to use the specified operating voltage.

(6) Foggy dew, moisture condensation or water droplets deposited on surface and contact terminals will cause polarizer stain or damage, the deteriorated display quality and electrochemical reaction then leads to shorter life time and permanent damage to the module probably. Please pay attention to the environmental temperature and humidity.

(7) An afterimage is created by the difference in brightness between unused dot and the fixed dot, according to the decrease of brightness of the emitting time. Therefore, to avoid having an afterimage, the full set should be thoroughly used instead of using a fixed dot. When the fixed dot emits, an afterimage can be created.

(8) Flicker could be come out at full on display. And it disappears when frame frequency increase, but brightness decreases too.

14.2 Soldering

(1) Soldering should be performed only on the I/O terminals.

(2) Use soldering irons with proper grounding and no leakage.

(3) Iron: no higher than 300℃ and 3~4 sec during soldering.

14.3 Precautions for Storage

(1) Please store OLED module in a dark place. Avoid exposure to sunlight, the light of fluorescent lamp or any ultraviolet ray.

(2) Keep the environment temperature between 10℃ and 35℃ and the relative humidity less than 60%. Avoid high temperature and high humidity.

(3) Keep the OLED modules stored in the container when shipped from supplier before using them is recommended.

(4) Do not leave any article on the OLED module surface for an extended period of time.

14.4 Warranty period

OSD warrants for a period of 12 months from the shipping date when stored or used under normal condition.