TOL091G-12832X-2 Series

OLED Graphic Module

User Manual

Attention:
A. Some specifications of IC are not listed in this manual. Please refer to the IC manual for more details.
B. The drawing of a related touch panel, schematic drawing, and demo code are available as separate documents upon request.
C. Please pay close attention to “Precautions” in this manual. Placement of an order with TVI Electronics indicates Buyer's agreement with these criterions.

REV	DESCRIPTION	RELEASE DATE
1.0	PRELIMINARY RELEASE	31 JUL 2014

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CONTENTS

1. BASIC SPECIFICATIONS

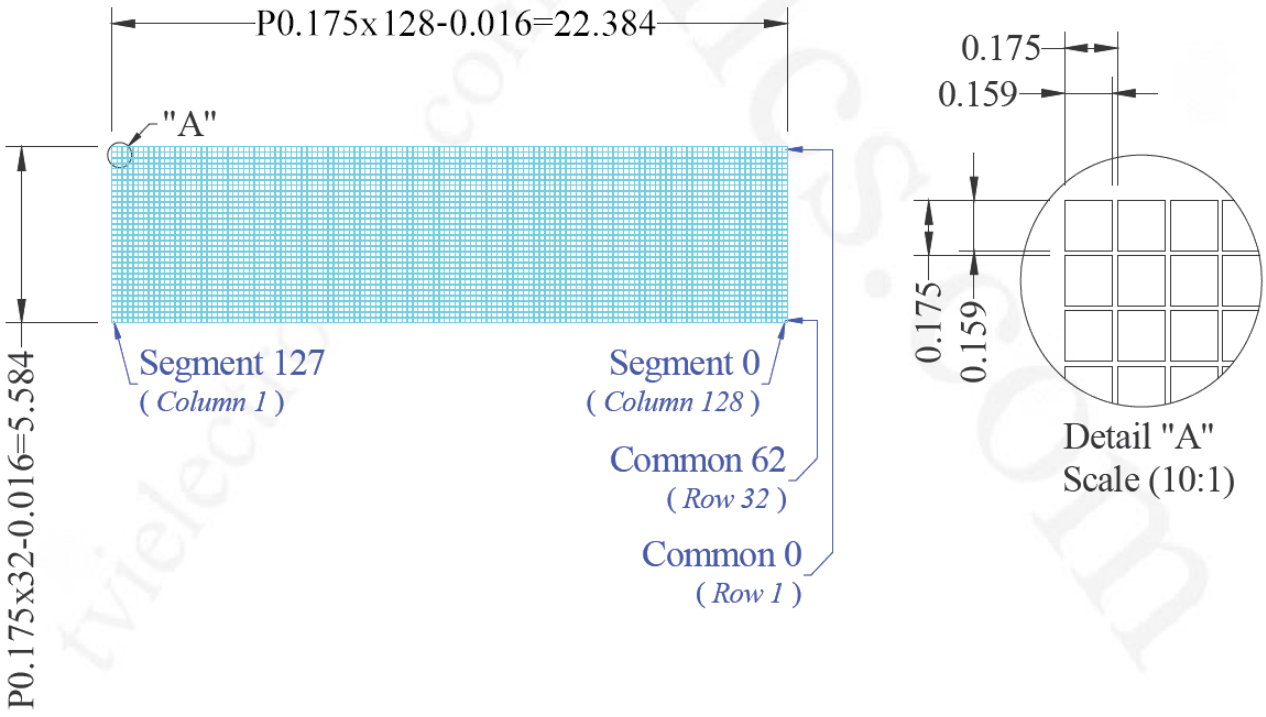
1.1. Display Specifications

1) Display Mode: Passive Matrix
2) Display Color: Monochrome (Blue or White)
3) Drive Duty: 1/32 Duty

1.2. Mechanical Specifications

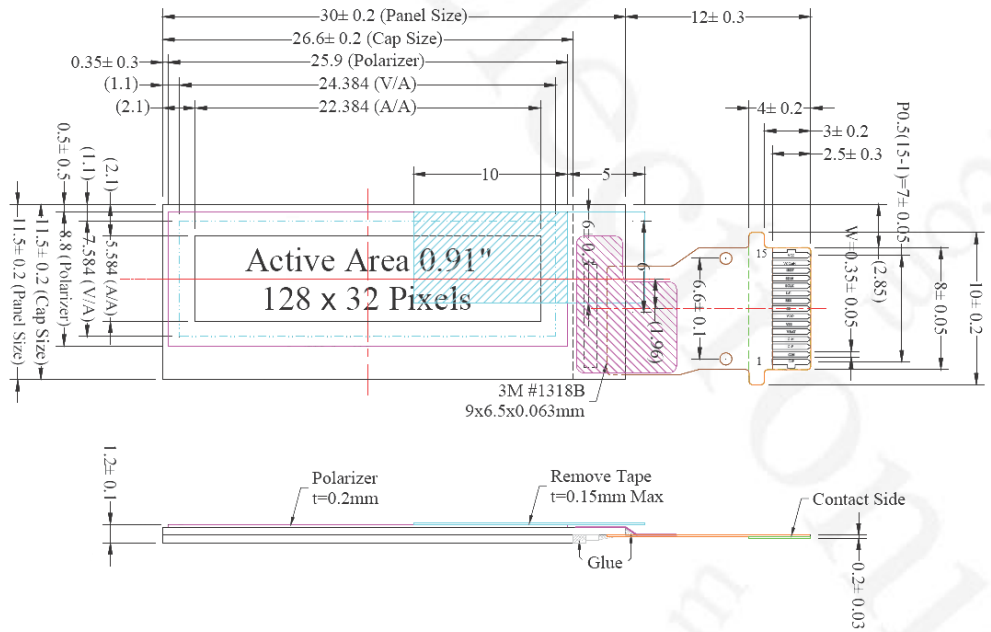
1) Outline Drawing: According to the annexed outline drawing
2) Number of Pixels: 128 x 32
3) Panel Size: 30.00 (W) × 11.50 (H) × 1.20 (D) (mm)
4) Active Area: 22.384 (W) x 5.584 (H) (mm)
5) Pixel Pitch: 0.175 × 0.175 (mm)
6) Pixel Size: 0.159 × 0.159 (mm)
7) Weight: TBD

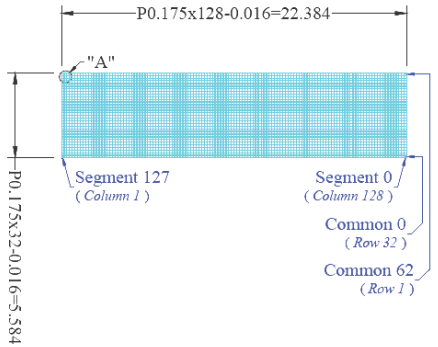
1.3. Active Area / Memory Mapping & Pixel Construction

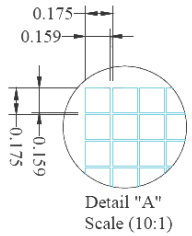


1.4. Mechanical Drawing

Item	Date	Remark
A	20140617	Original Drawing







Pin	Symbol
1	C2P
2	C2N
3	C1P
4	C1N
5	VBAT
6	VSS
7	VDD
8	CS
9	RES
10	D/C
11	SCLK
12	SDIN
13	IREF
14	VCOMH
15	VCC

Notes:

1. Color: Blue/White
2. Driver IC: SSD1306
3. Interface: 4 -wire SPI
4. General Tolerance: ± 0.30

TVI Electronics, LLC							Drawing Number		Rev.
									A
Unless Otherwise Specified		Title	TOL091G-12832X-2 Series				Material		
Unit	mm						Soda Lime / Polyimide		
General Roughness									
Tolerance			Drawn	E.E.	Panel / E.	P.M.			
Dimension	± 0.3	By					Scale	Sheet	Size
Angle	± 1	Date	20140617				1:1	1 of 1	A3

1.5. Pin Definition

No.	Symbol	I/O	Function
Power Supply			
7	VDD	P	*Power Supply for Logic* This is a voltage supply pin. It must be connected to external source.
6	VSS	P	*Ground of OEL System* This is a ground pin. It also acts as a reference for the logic pins. It must be connected to external ground.
15	VCC	P	*Power Supply for OEL Panel* This is the most positive voltage supply pin of the chip. A stabilization capacitor should be connected between this pin and V_{SS} when the converter is used. It must be connected to external source when the converter is not used.
Driver			
13	IREF	I	*Current Reference for Brightness Adjustment* This pin is segment current reference pin. A resistor should be connected between this pin and V_{SS}. Set the current at 12.5µA maximum.
14	VCOMH	O	*Voltage Output High Level for COM Signal* This pin is the input pin for the voltage output high level for COM signals. A capacitor should be connected between this pin and V_{SS}.
DC/DC Converter			
5	VBAT	P	*Power Supply for DC/DC Converter Circuit* This is the power supply pin for the internal buffer of the DC/DC voltage converter. It must be connected to external source when the converter is used. It should be connected to V_{DD} when the converter is not used.
3 / 4 1 / 2	C1P / C1N C2P / C2N	I	*Positive Terminal of the Flying Inverting Capacitor* *Negative Terminal of the Flying Boost Capacitor* The charge-pump capacitors are required between the terminals. They must be floated when the converter is not used.
Interface			
9	RES#	I	*Power Reset for Controller and Driver* This pin is reset signal input. When the pin is low, initialization of the chip is executed.
11	SCLK	I	*Serial Clock Input Signal* The transmission if information in the bus is following a clock signal. Each transmission of data bit is taken place during a single clock period of this pin.
12	SDIN	I/O	*Serial Data Input Signal* This pin acts as a communication channel. The input data through SDIN is latched at the rising edge of SCLK in the sequence of MSB

			first and converted to 8-bit parallel data and handled at the rising edge of last serial clock. SDIN is identified to display data or command by D/C bit data at the rising of first SCLK.
8	CS	I	*Chip Select* This pin is the chip select input. The chip is enabled for MCU communication only when CS# is pulled low.
10	D/C	I	*Data/Command Control* When the pin is pulled high and serial interface mode is selected, the data at SDIN is treated as data. When it is pulled low, the data at SDIN will be transferred to the command register.

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	NOTES
Supply Voltage (Logic)	V_{DD}	-0.3	4	V	1, 2
Supply Voltage (Display)	V_{CC}	0	16	V	1, 2
Supply Voltage (DC/DC)	V_{BAT}	-0.3	4.3	V	1, 2
Operating Temperature	T_{OP}	-40	85	℃	-
Storage Temperature	T_{STG}	-40	85	℃	3
Life Time (120 cd/m^2)		10,000	-	hour	4
Life Time (80 cd/m^2)		30,000	-	hour	4
Life Time (60 cd/m^2)		50,000	-	hour	4

Note 1: All of the above voltages are on the basis of "V_{SS} = 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 3. "Optical & Electrical Characteristics". If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.

Note 3: The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80℃.

Note 4: V_{CC} = 8.0V, Ta = 25°C, 50% Checkerboard.

*Software configuration follows Section 4.4 Initialization.

*End of lifetime is specified as 50% of initial brightness reached. The average operating lifetime at room temperature is estimated by the accelerated operation at high temperature conditions.

3. OPTICAL & ELECTRICAL CHARACTERISTICS

3.1. Optical Characteristics

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN.	TYP.	MAX	UNIT
Brightness (V_{CC} Supplied Externally)	L_{BR}	Note 5	150	-	-	cd/m^2
Brightness (V_{CC} Generated by Internal DC/DC)	L_{BR}	Note 6	150	180	-	cd/m^2
C.I.E. (Blue)	(x) (y)	C.I.E. 1931	0.12 0.22	0.16 0.26	0.20 0.30	
Dark Room Contrast	CR		-	2000:1	-	
View Angle			-	Free	-	degree

* Optical measurement taken at V_{DD} = 2.8V, V_{CC} = 8V.
Software configuration follows Section 4.4. Initialization.

3.2. DC Characteristics

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN.	TYP.	MAX	UNIT
Supply Voltage for Logic	V_{DD}	-	1.65	2.8	3.3	V
Supply Voltage for Display (Supplied Externally)	V_{CC}	Note 5 (Internal DC/DC Disable)	7	7.25	7.5	V
Supply Voltage for DC/DC	V_{BAT}	Internal DC/DC Enable	3.5	-	4.2	V
Supply Voltage for Display (Generated by Internal DC/DC)	V_{CC}	Note 6 (Internal DC/DC Enable)	6.4	-	9	V
High Level Input	V_{IH}	I_{OUT} = 100µA, 3.3MHz	0.8xV_{DD}	-	V_{DD}	V
Low Level Input	V_{IL}	I_{OUT} = 100µA, 3.3MHz	0	-	0.2xV_{DD}	V
High Level Output	V_{OH}	I_{OUT} = 100µA, 3.3MHz	0.9xV_{DD}	-	V_{DD}	V
Low Level Output	V_{OL}	I_{OUT} = 100µA, 3.3MHz	0	-	0.1xV_{DD}	V
Operating Current for V_{DD}	I_{DD}	-	-	180	300	µA
Operating Current for V_{CC} (V_{CC} Supplied Externally)	I_{CC}	Note 7	-	10	16	mA
Operating Current for V_{BAT} (V_{CC} Generated by Internal DC/DC)	I_{BAT}	Note 8	-	23.0	29.0	mA
Sleep Mode Current for V_{DD}	$I_{DD, SLEEP}$	-	-	1	5	µA
Sleep Mode Current for V_{CC}	$I_{CC, SLEEP}$	-	-	2	10	µA

Note 5 & 6: Brightness (L_{BR}) and Supply Voltage for Display (V_{CC}) are subject to the change of the panel characteristics and the customer's request.

Note 7: V_{DD} = 2.8V, V_{CC} = 7.25V, 100% Display Area Turn on.

Note 8: V_{DD} = 2.8V, V_{CC} = 7.25V, 100% Display Area Turn on.

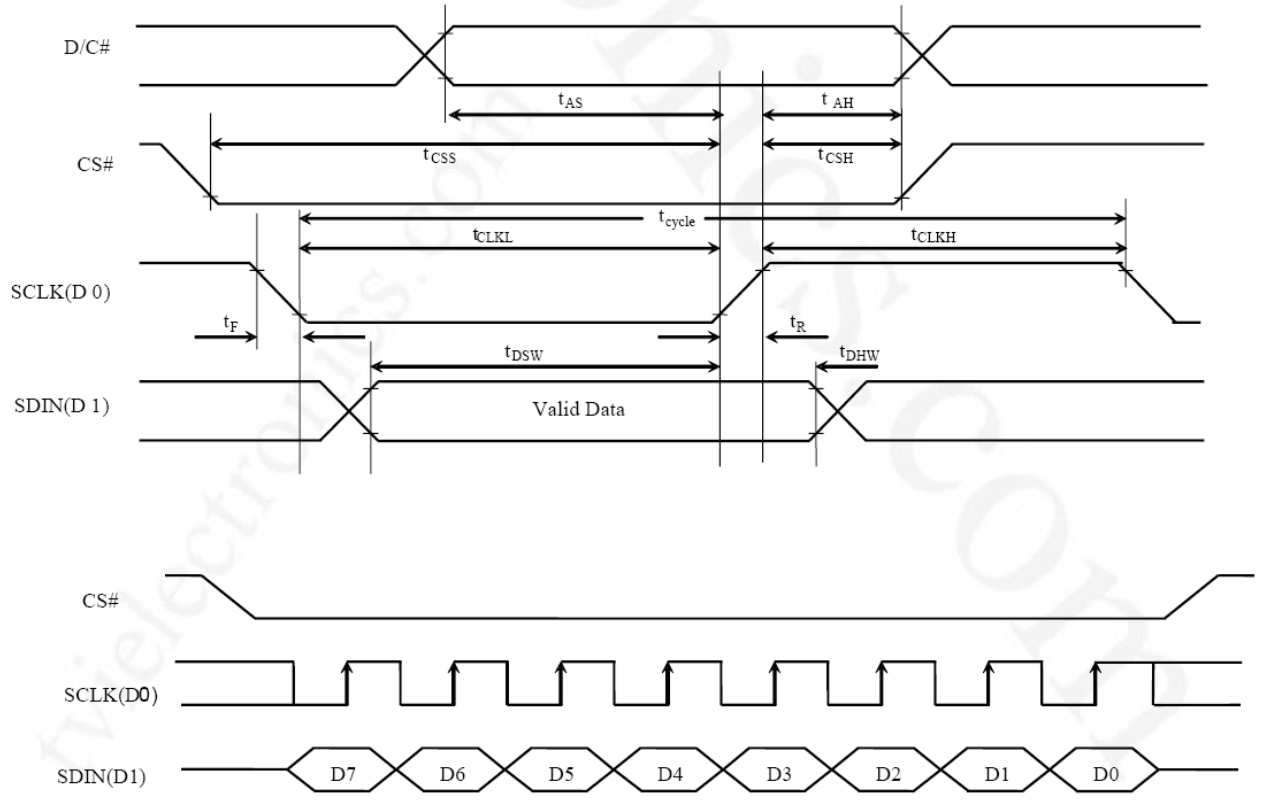
* Software configuration follows Section 4.4. Initialization.

3.3. AC Characteristics

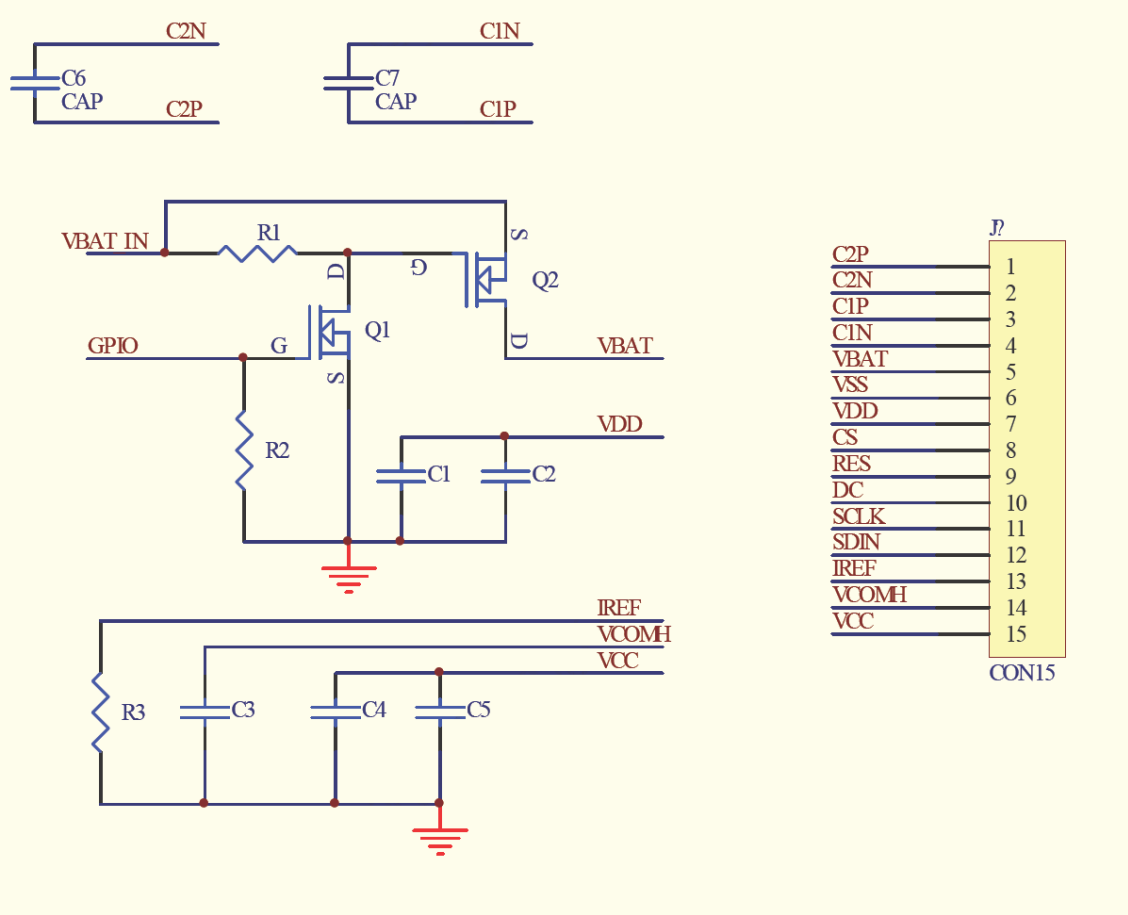
3.3.1. Serial Interface Timing Characteristics: (4-wire SPI)

SYMBOL	DESCRIPTION	MIN.	MAX	UNIT
t_{cycle}	Clock Cycle Time	500	-	ns
t_{AS}	Address Setup Time	300	-	ns
t_{AH}	Address Hold Time	300	-	ns
t_{CSS}	Chip Select Setup Time	240	-	ns
t_{CSH}	Chip Select Hold Time	120	-	ns
t_{DSW}	Write Data Setup Time	300	-	ns
t_{DHW}	Write Data Hold Time	300	-	ns
t_{CLKL}	Clock Low Time	200	-	ns
t_{CLKH}	Clock High Time	200	-	ns
t_R	Rise Time	-	30	ns
t_F	Fall Time	-	30	ns

* (V_{DD} - V_{SS} = 1.65V to 3.3V, Ta = 25°C)



3.3.2. 4 wire SPI Interface with Internal Charge Pump



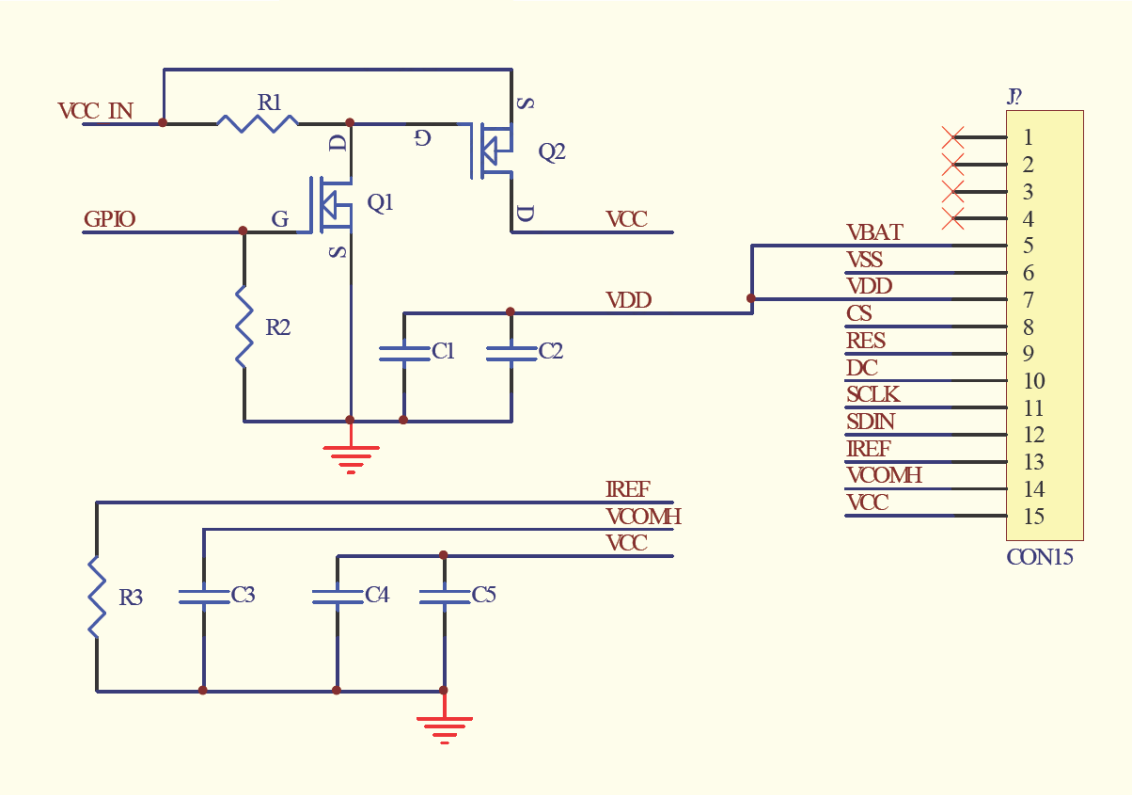
Recommended Components:

C1:	0.1μF / 6.3V, X5R
C2:	4.7μF / 6.3V, X5R
C3:	2.2μF/ 16V, X7R
C4:	4.7μF / 16V, X7R
C5:	0.1μF / 16V, X7R
C6,C7:	1μF / 16V, X7R
R3:	560KΩ, R3 = (Voltage at IREF - VSS) / IREF
R2, R1:	47kΩ
Q1:	FDN338P
Q2:	FDN335N

Notes:

VDD:	1.65~3.3V, it should be equal to MPU I/O voltage.
VBAT_in:	3.5~4.2V

3.3.3. 4 wire SPI Interface with External VCC



Recommended Components:

C1:	0.1μF / 6.3V, X5R
C2:	4.7μF / 6.3V, X5R
C3:	2.2μF/ 16V, X7R
C4:	4.7μF / 16V, X7R
C5:	0.1μF / 16V, X7R
R3:	560KΩ, R3 = (Voltage at IREF - VSS) / IREF
R2, R1:	47kΩ
Q1:	FDN338P
Q2:	FDN335N

Notes:

VDD:	1.65~3.3V, it should be equal to MPU I/O voltage.
VCC_in:	7~7.5V

4. FUNCTIONAL SPECIFICATIONS

4.1. Commands

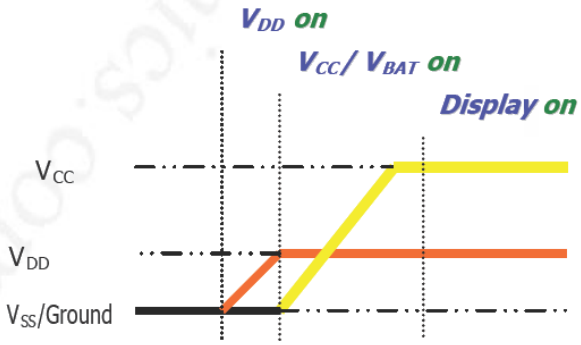
Refer to the Technical Manual for the SSD1306Z.

4.2. Power Down and Power Up Sequence

To protect OEL panel and extend the panel life time, the driver IC power up/down routine should include a delay period between high voltage and low voltage power sources during turn on/off. It gives the OEL panel enough time to complete the action of charge and discharge before/after the operation.

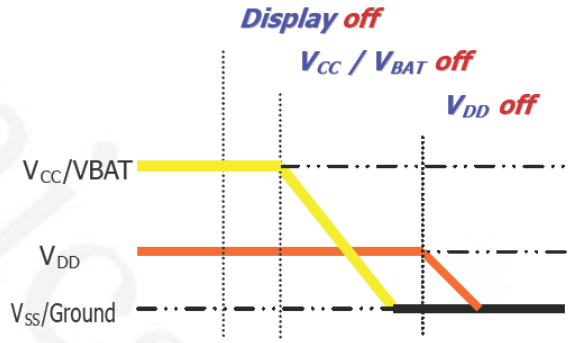
4.2.1. Power Up Sequence

1. Power up V_{DD}
2. Send Display off command
3. Initialization
4. Clear Screen
5. Power up V_{CC} / V_{BAT}
6. Delay 100ms
   (When V_{CC} is stable)
7. Send Display on command



4.2.2. Power Down Sequence

1. Send Display off command
2. Power down V_{CC} / V_{BAT}
3. Delay 100ms
   (When V_{CC} / V_{BAT} reaches 0 and panel is completely discharged)
4. Power down V_{DD}



Note 13:

1) Since an ESD protection circuit is connected between V_{DD} and V_{CC} inside the driver IC, V_{CC} becomes lower than V_{DD} whenever V_{DD} is ON and V_{CC} is OFF.
2) V_{CC} / V_{BAT} should be kept float (disable) when it is OFF.
3) Power Pins (V_{DD}, V_{CC}, V_{BAT}) can never be pulled to ground under any circumstance.
4) V_{DD} should not be power down before V_{CC} / V_{BAT} power down.

4.3. Reset Circuit

When RES# input is low, the chip is initialized with the following status:

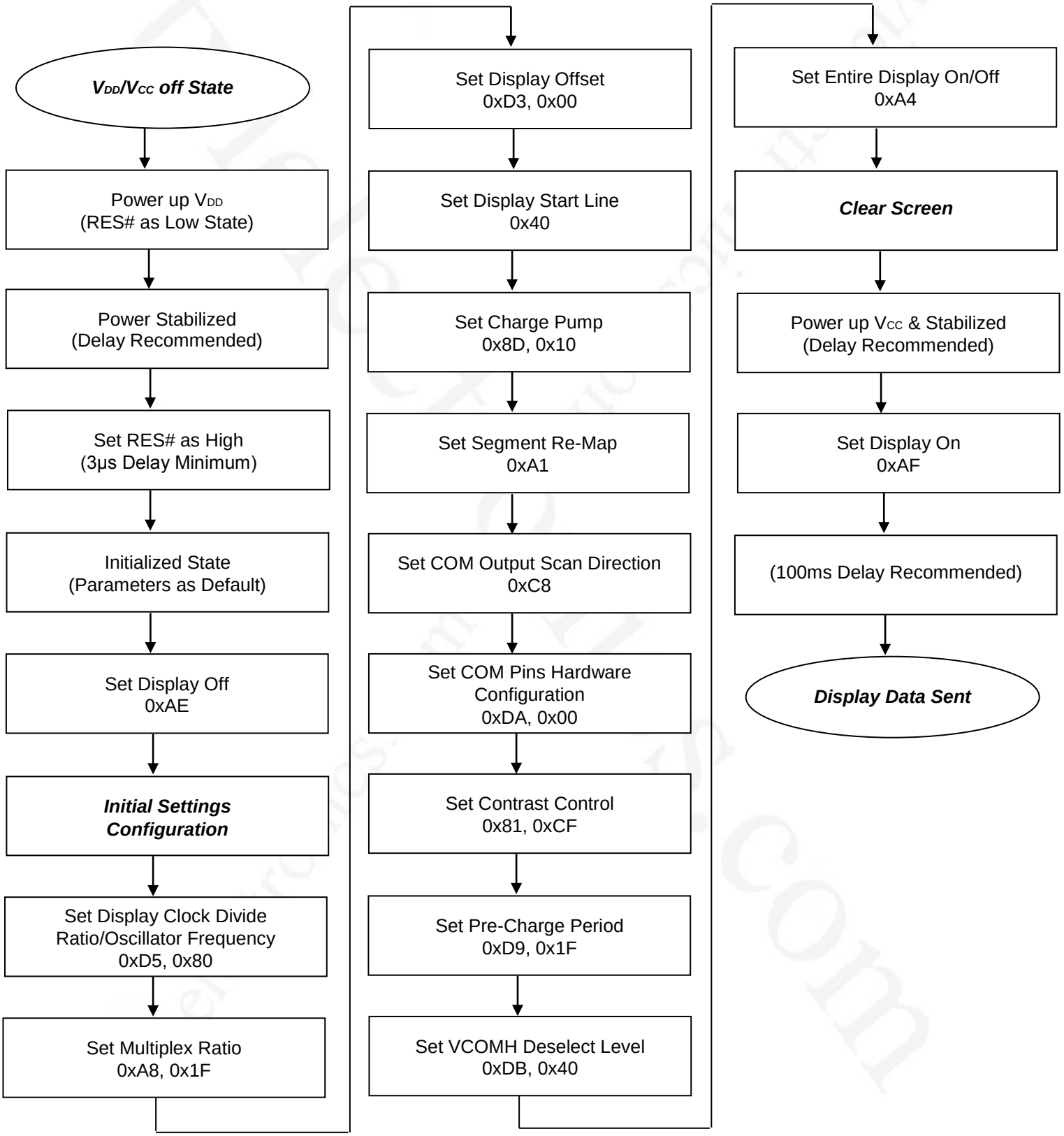
1. Display is OFF
2. 128x64 Display Mode
3. Normal segment and display data column and row address mapping (SEG0 mapped to column address 00h and COM0 mapped to row address 00h).
4. Shift register data clear in serial interface.
5. Display start line is set at display RAM address 0.
6. Column address counter is set at 0.
7. Normal scan direction of the COM outputs.
8. Contrast control register is set at 7Fh.
9. Normal display mode (Equivalent to A4h command).

4.4. Actual Application Example

Command usage and explanation of an actual example

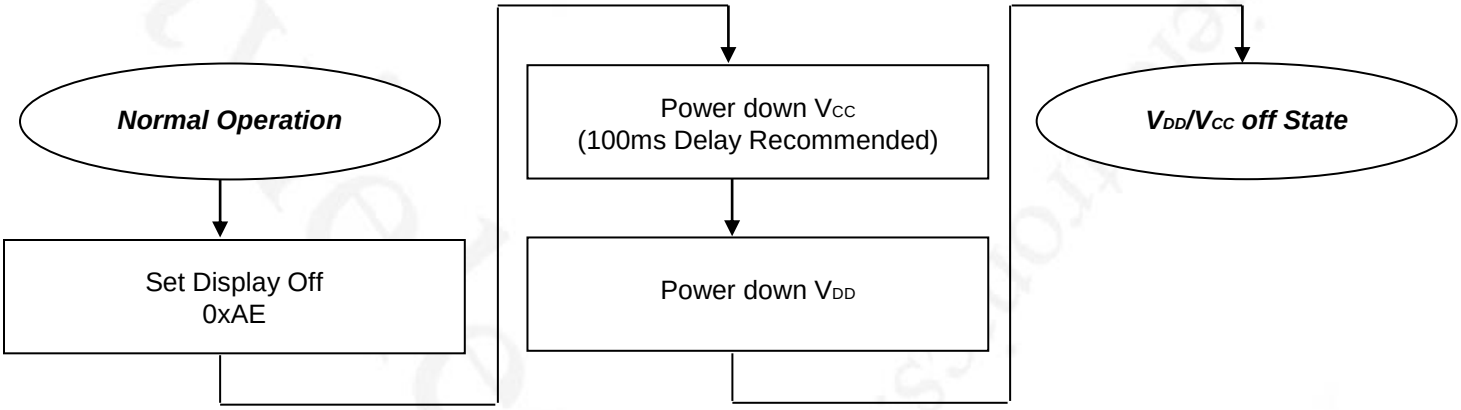
4.4.1. V_{CC} Supplied Externally

<Power up Sequence >

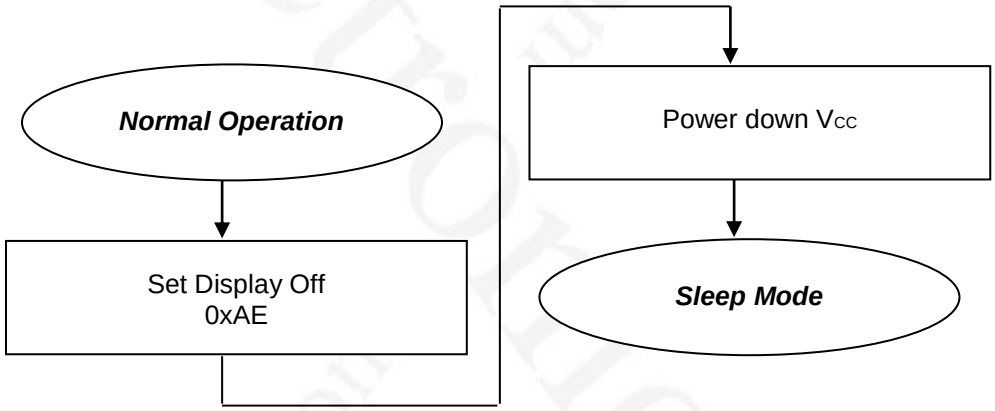


If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.

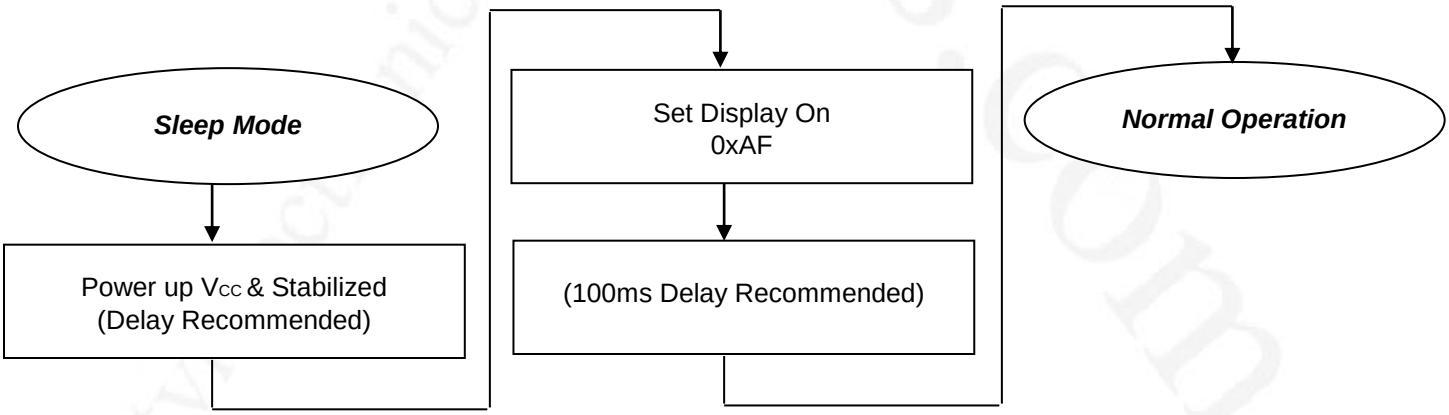
<Power down Sequence>



<Entering Sleep Mode>



<Exiting Sleep Mode>



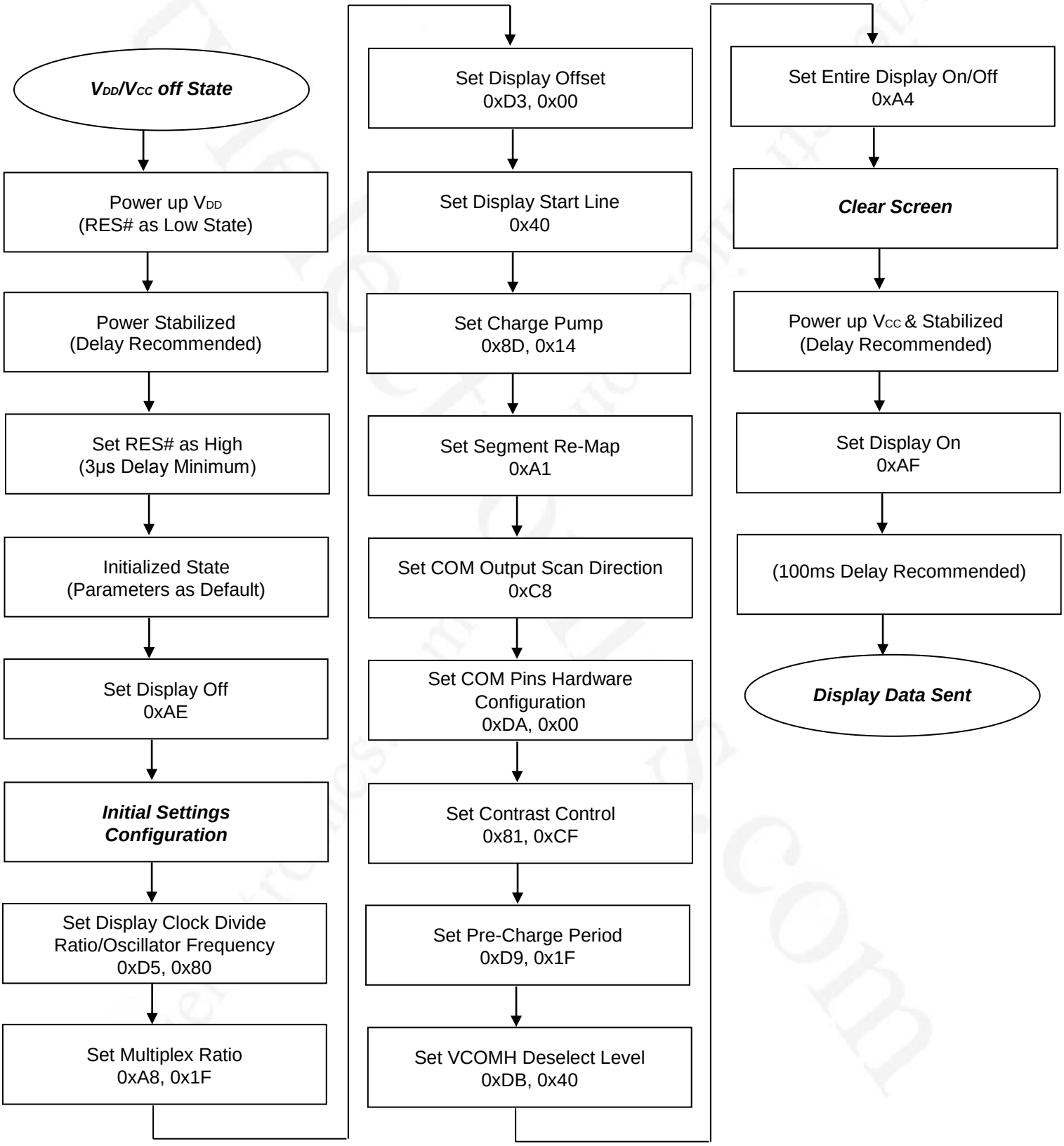
External setting

```
void SSD1306()
{
        RES=0;
        delay(1000);
        RES=1;
        delay(1000);
                write_i(0xAE); /*display off*/
                write_i(0x00);  /*set lower column address*/
                write_i(0x10);  /*set higher column address*/
                write_i(0x00);  /*set display start line*/
                write_i(0xB0);  /*set page address*/
                write_i(0x81);  /*contract control*/
                write_i(0xCF); /*128*/
                write_i(0xA1);  /*set segment remap*/
                write_i(0xA6);  /*normal / reverse*/
                write_i(0xA8);  /*multiplex ratio*/
                write_i(0x1F);  /*duty = 1/32*/
                write_i(0xC8);  /*Com scan direction*/
                write_i(0xD3);  /*set display offset*/
                write_i(0x00);
                write_i(0xD5);  /*set osc division*/
                write_i(0x80);
                write_i(0xD9);  /*set pre-charge period*/
                write_i(0x1f);
                write_i(0xDA);          /*set COM pins*/
                write_i(0x00);
                write_i(0xdb);  /*set vcomh*/
                write_i(0x40);
                write_i(0x8d);  /*set charge pump enable*/
                write_i(0x10);
                write_i(0xAF);  /*display ON*/
}

void write_i(unsigned char ins)
{
        unsigned char m,da;
        unsigned int j;
                DC=0;
                CS=0;
                da=ins;
        for(j=0;j<8;j++)
              {
                  m=da;
                  SCL=0;
                  m=m&0x80;
                  if(m==0x80)
                    {
```

```
                    SDA=1;
                }
            else
                {
                    SDA=0;
                }
                 da=da<<1;
                 SCL=1;
            }
        CS=1;
}

void write_d(unsigned char dat)
{
        unsigned char m,da;
        unsigned int j;
            DC=1;
            CS=0;
            da=dat;
        for(j=0;j<8;j++)
            {
                m=da;
                SCL=0;
                m=m&0x80;
                if(m==0x80)
                {
                    SDA=1;
                }
            else
                {
                    SDA=0;
                }
                 da=da<<1;
                 SCL=1;
            }
        CS=1;
}
void delay(unsigned int i)
{
        while(i>0)
        {
            i--;
        }
}
```

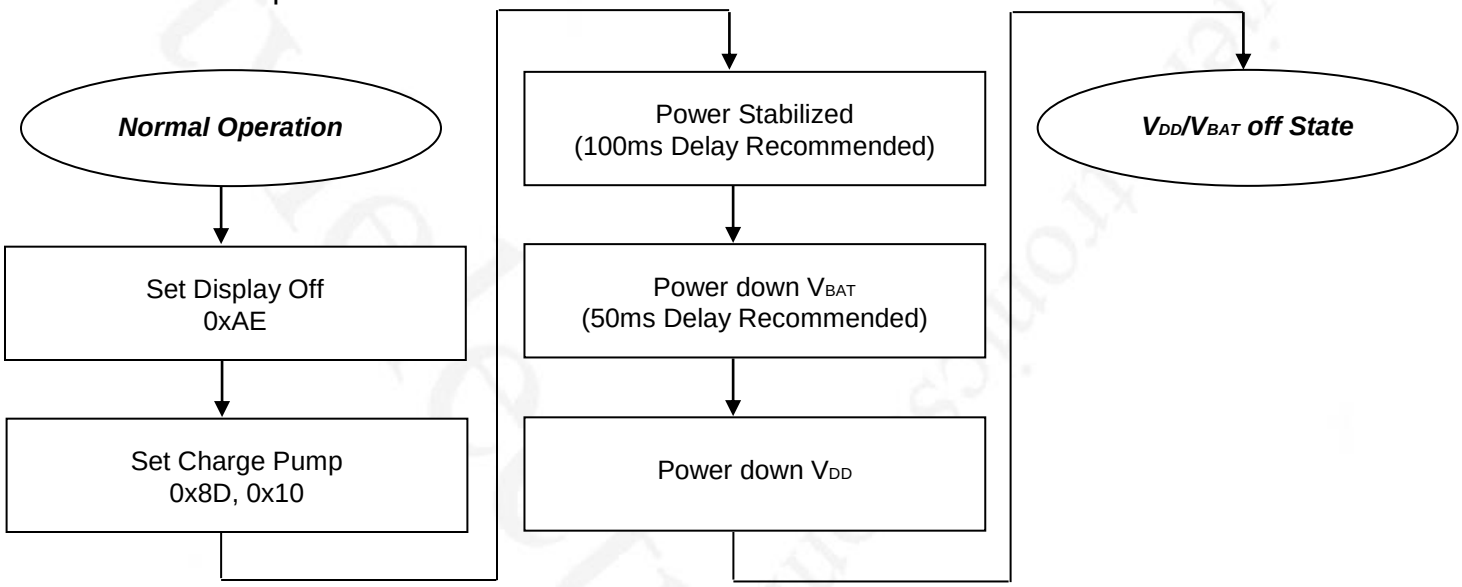
4.4.2. V_{CC} Generated by Internal DC/DC Circuit

<Power up Sequence >

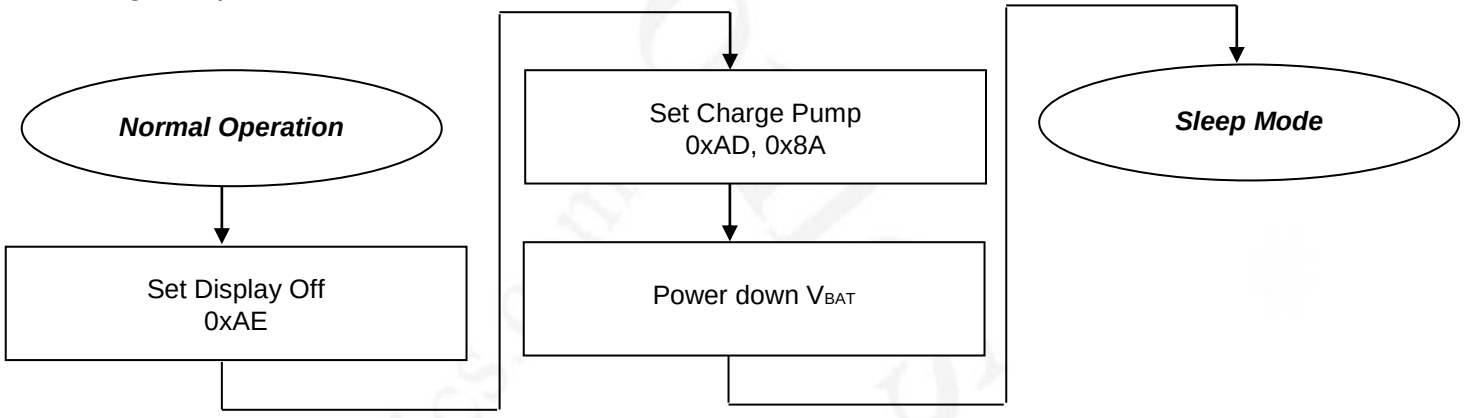


If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.

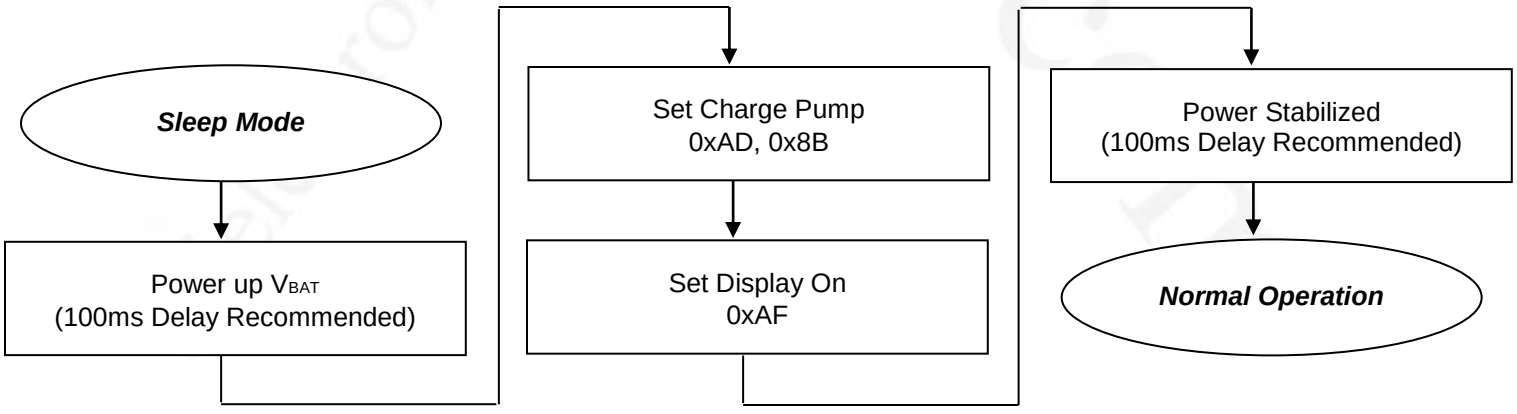
<Power down Sequence>



<Entering Sleep Mode>



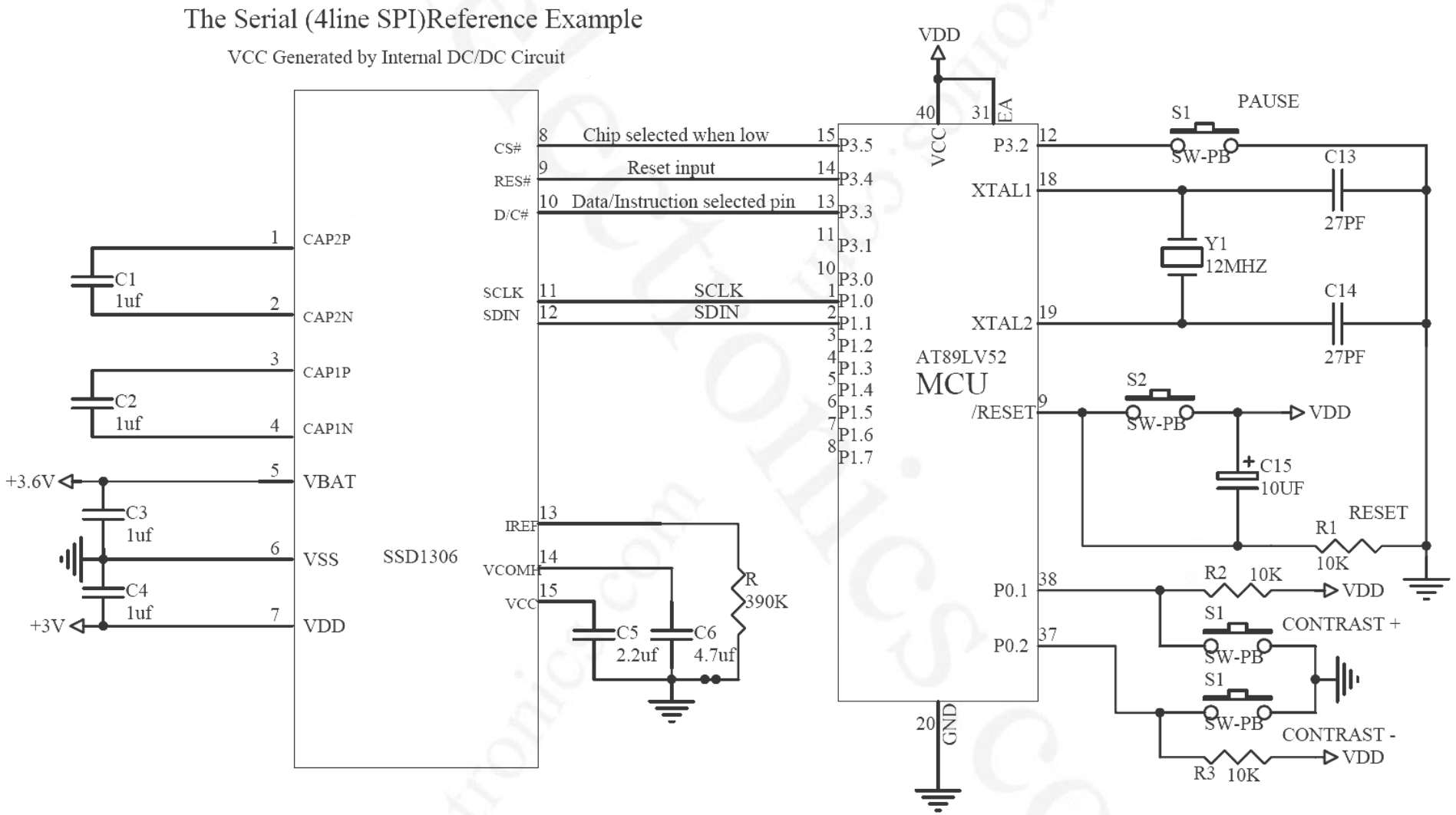
<Exiting Sleep Mode>



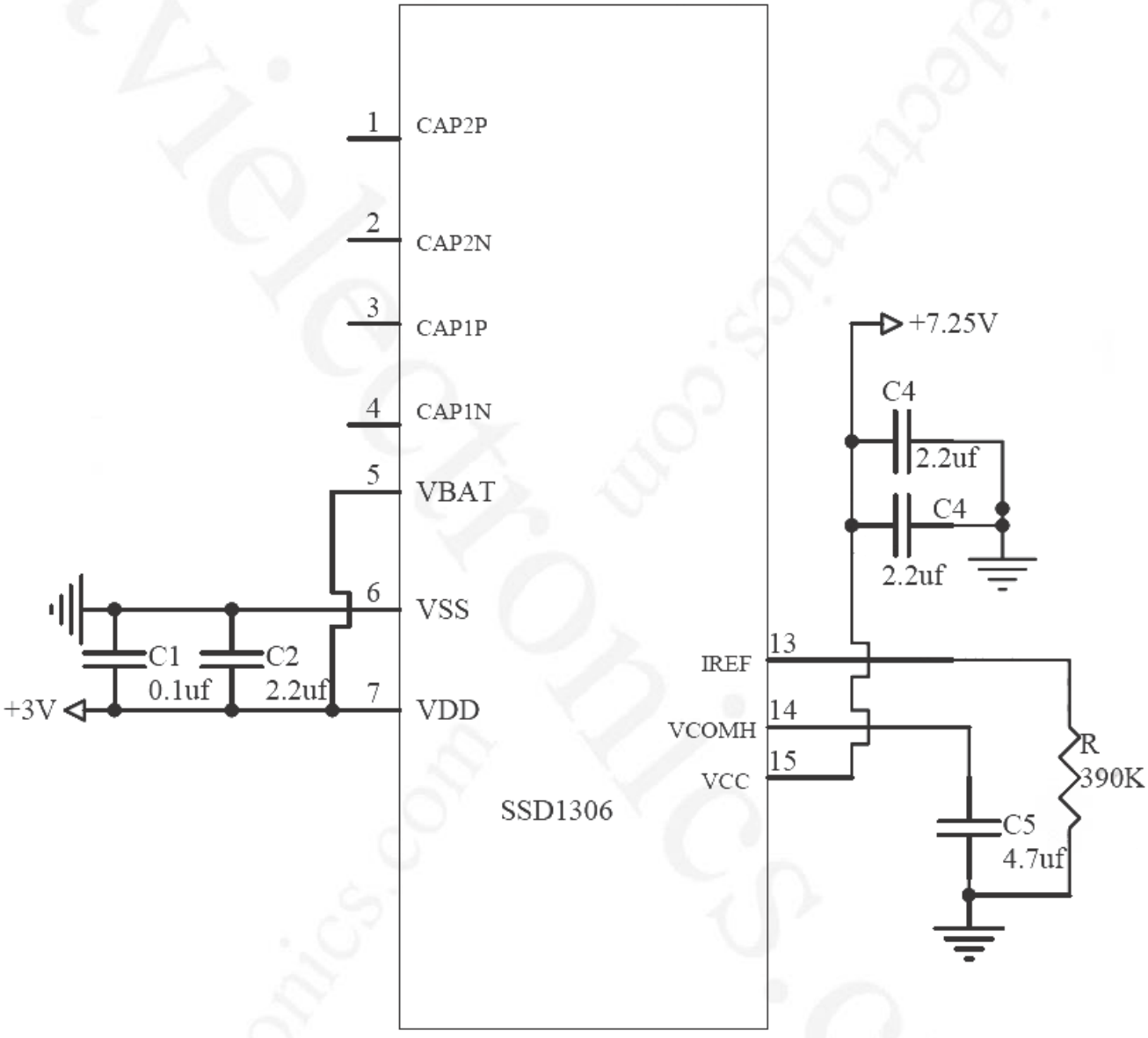
```
Internal setting（Charge pump）
void SSD1306()
{
        RES=0;
        delay(1000);
        RES=1;
        delay(1000);

                write_i(0xAE); /*display off*/
                write_i(0x00);  /*set lower column address*/
                write_i(0x10);  /*set higher column address*/
                write_i(0x00);  /*set display start line*/
                write_i(0xB0);  /*set page address*/
                write_i(0x81);  /*contract control*/
                write_i(0xCF); /*128*/
                write_i(0xA1);  /*set segment remap*/
                write_i(0xA6);  /*normal / reverse*/
                write_i(0xA8);  /*multiplex ratio*/
                write_i(0x1F);  /*duty = 1/32*/
                write_i(0xC8);  /*Com scan direction*/
                write_i(0xD3);  /*set display offset*/
                write_i(0x00);
                write_i(0xD5);  /*set osc division*/
                write_i(0x80);
                write_i(0xD9);  /*set pre-charge period*/
                write_i(0x1f);
                write_i(0xDA);          /*set COM pins*/
                write_i(0x00);
                write_i(0xdb);  /*set vcomh*/
                write_i(0x40);
                write_i(0x8d);  /*set charge pump enable*/
                write_i(0x14);
                write_i(0xAF);  /*display ON*/
}

void write_i(unsigned char ins)
{
        unsigned char m,da;
        unsigned int j;
                DC=0;
                CS=0;
                da=ins;
        for(j=0;j<8;j++)
              {
                    m=da;
                    SCL=0;
                    m=m&0x80;
                    if(m==0x80)
                      {
```

```
                    SDA=1;
                  }
                else
                  {
                    SDA=0;
                  }
                   da=da<<1;
                   SCL=1;
            }
        CS=1;
}

void write_d(unsigned char dat)
{
        unsigned char m,da;
        unsigned int j;
                DC=1;
                CS=0;
                da=dat;
        for(j=0;j<8;j++)
                {
                        m=da;
                        SCL=0;
                        m=m&0x80;
                        if(m==0x80)
                          {
                            SDA=1;
                          }
                        else
                          {
                            SDA=0;
                          }
                           da=da<<1;
                           SCL=1;
                }
        CS=1;
}
void delay(unsigned int i)
{
        while(i>0)
        {
                i--;
        }
}
```

5. INTERFACING TO AT89LV52 MCU



VCC Supplied Externally(Don't use internal DC/DC Circuit)



6. RELIABILITY

6.1. Contents of Reliability Tests

ITEM	CONDITIONS	CRITERIA
High Temperature Operation	70°C, 240 hrs	The operational functions work.
Low Temperature Operation	-40°C, 240 hrs	
High Temperature Storage	85°C, 240 hrs	
Low Temperature Storage	-40°C, 240 hrs	
High Temperature/Humidity Operation	60°C, 90% RH, 120 hrs	
Thermal Shock	-40°C ⇔ 85°C, 24 cycles 60 mins dwell	

* The samples used for the above tests do not include polarizer.
* No moisture condensation is observed during tests.

6.2. Failure Check Standard

After the completion of the described reliability test, the samples were left at room temperature for 2hrs. prior to conducting the failure test at 23±5°C, 55±15% RH.

7. OUTGOING QUALITY CONTROL SPECIFICATIONS

7.1. Environment Required

Customer's test & measurement are required to be conducted under the following conditions:

Temperature:	23 ± 5°C
Humidity:	55 ± 15% RH
Fluorescent Lamp:	30W
Distance between the Panel & Lamp:	≥50 cm
Distance between the Panel & Eyes of the Inspector:	≥30 cm

Finger glove (or finger cover) must be worn by the inspector.
Inspection table or jig must be anti-electrostatic.

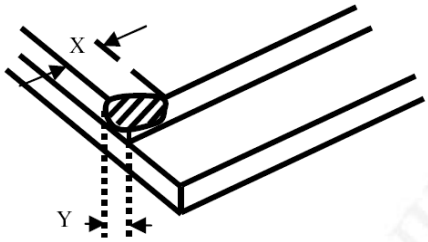
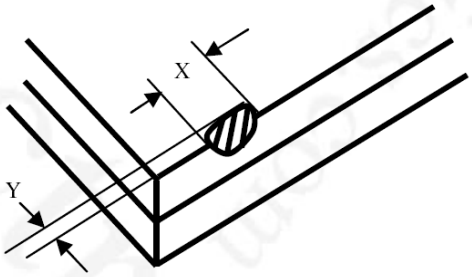
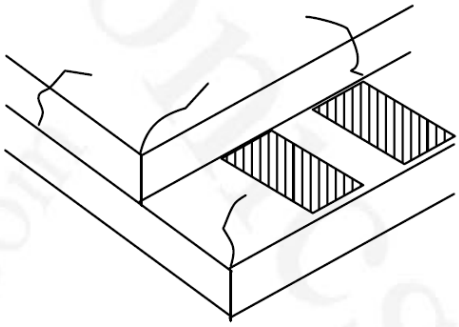
7.2. Sampling Plan

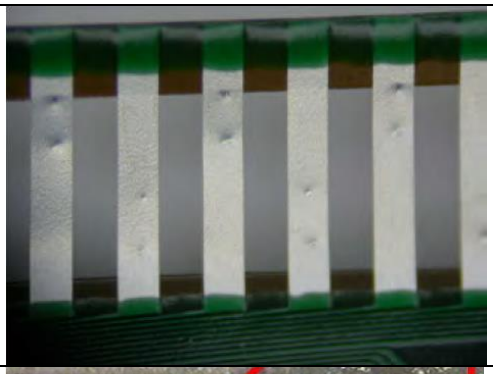
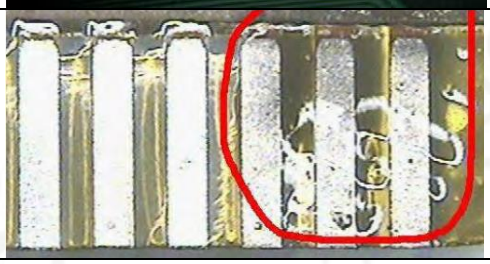
Level II, Normal Inspection, Single Sampling, MIL-STD-105E.

7.3. Criteria & Acceptable Quality Level (AQL)

PARTITION	AQL	DEFINITION
Major	0.65	Defects in Pattern Check (Display On)
Minor	1.0	Defects in Cosmetic Check (Display Off)

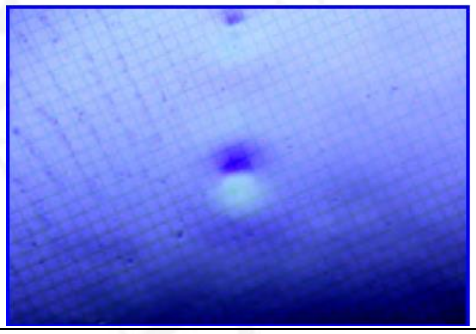
7.3.1. Cosmetic Check (Display Off) in Non-Active Area

CHECK ITEM	JUDGMENT CRITERIA	CLASSIFICATION
Panel General Chipping	X > 6 mm (Along with Edge) Y > 1 mm (Perpendicular to edge)  	Minor
Panel Crack	Any crack is not allowable. 	Minor
Cupper Exposed (Even Pin or Film)	Not Allowable by Naked Eye Inspection	Minor
Film or Trace Damage		Minor

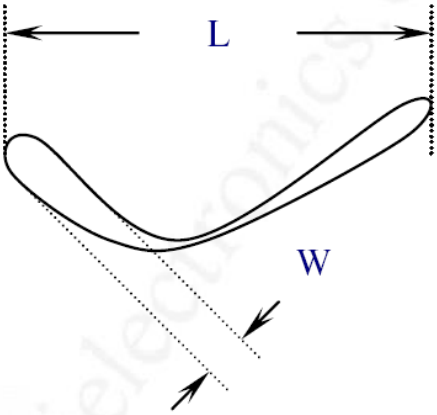
Terminal Lead Prober Mark		Acceptable
Glue or Contamination on Pin (Couldn't Be Removed by Alcohol)		Minor
Ink Marking on Back Side of panel (Exclude on Film)	Ignore for Any	Acceptable

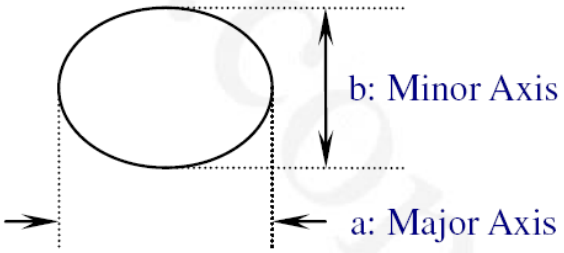
7.3.2. Cosmetic Check (Display Off) in Active Area

It is recommended to execute in clear room environment (class 10k) if actual in necessary.

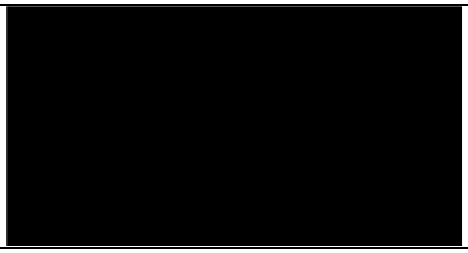
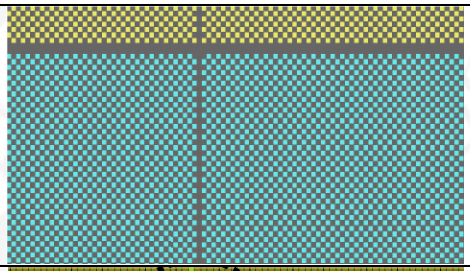
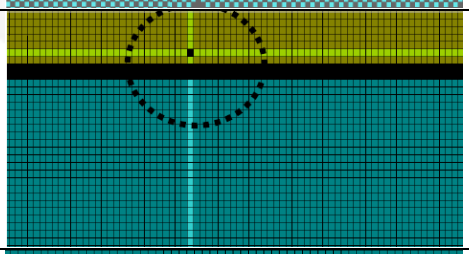
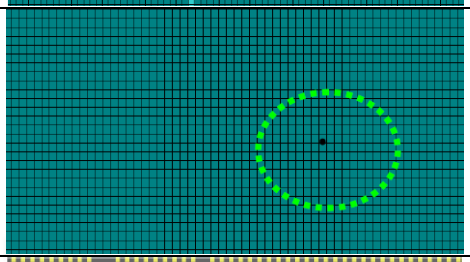
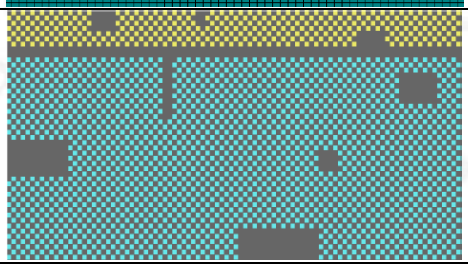
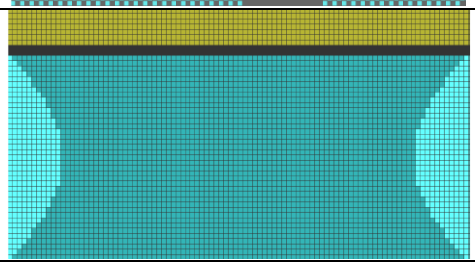
CHECK ITEM	JUDGMENT CRITERIA	CLASSIFICATION
Any Dirt & Scratch on Polarizer's Protective Film	Ignore for not affect the polarizer	Acceptable
Scratches, Fiber, Line-Shape Defect (On Polarizer)	W ≤ 0.1 Ignore W > 0.1, L ≤ 2 n ≤ 1 L > 2 n = 0	Minor
Dirt, Black Spot, Foreign Material (On Polarizer)	Φ ≤ 0.1 Ignore 0.1 < Φ ≤ 0.25 n ≤ 1 0.25 < Φ n = 0	Minor
Dent, Bubbles, White Spot (Any Transparent Spot on Polarizer)	Φ ≤ 0.5 ➔ Ignore if no influence on display. 0.5 < Φ n = 0 	Minor
Fingerprint, Flow Mark (On Polarizer)	Not Allowable	Minor

* Protective film should not be torn off during cosmetic check.
** Definition of W & L & Φ (Unit: mm): Φ = (a + b) / 2

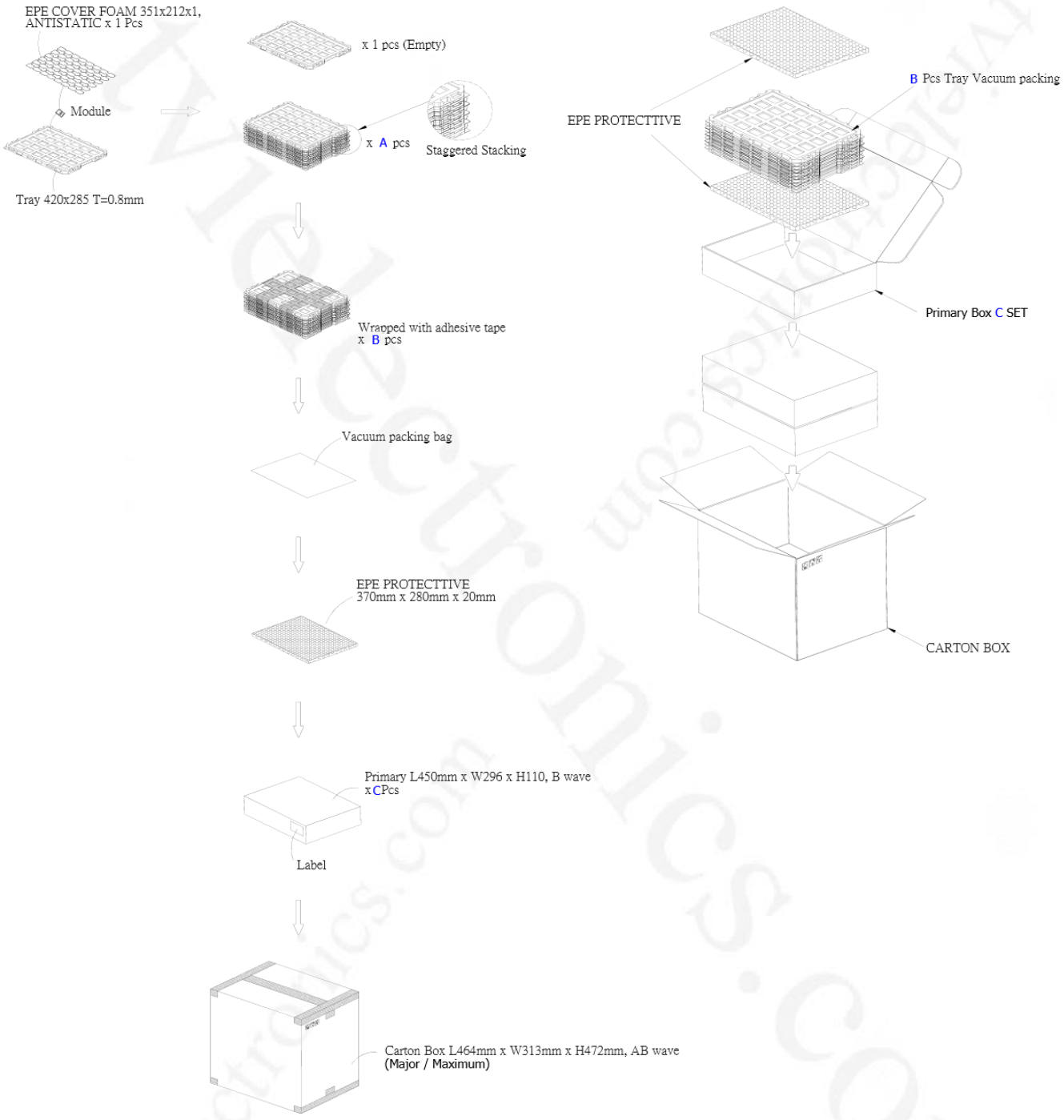




7.3.3. Pattern Check (Display On) in Active Area

CHECK ITEM	JUDGMENT CRITERIA	CLASSIFICATION
No Display		Major
Flicker	Not Allowable	Major
Missing Line		Major
Pixel Short		Major
Darker Pixel		Major
Wrong Display		Major
Un-uniform		Major

8. PACKAGING SPECIFICATIONS

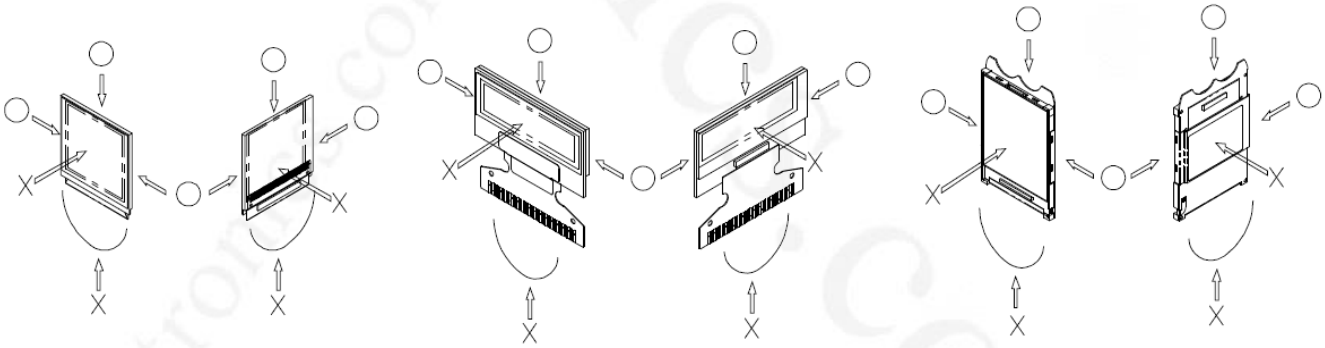


ITEM		QUANTITY	
Module		810	per Primary Box
Holding Trays	(A)	15	per Primary Box
Total Trays	(B)	16	per Primary Box (Including 1 Empty Tray)
Primary Box	(C)	1~4	per Carton (4 as Major / Maximum)

9. PRECAUTIONS RELATING PRODUCT USAGE

9.1. Handling Precautions

1) The display panel used in OEL display module is made of glass. Avoid any strong mechanical shock, such us dropping from a high position. Should the glass break, handle it with care.
2) Do not ingest the internal organic substance should the display panel break and fluid leak out. Should hands or clothing come in contact with display panel fluid, wash it off immediately with soap and water.
3) If pressure is applied to the display surface or its neighborhood of the OEL display module, the cell structure may become damaged. Be careful not to apply pressure to these sections.
4) The polarizer adhering to the surface of the OEL display module is made of a soft material and can be easily scratched. Protect against scratching it.
5) When the surface of the polarizer of the OEL display module becomes soiled, clean the surface by using the 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, note that the following liquids and solvents may spoil the polarizer:
   * Water
   * Ketone
   * Aromatic Solvents
6) Hold OEL display module very carefully when placing it into the system housing. Do not apply excessive stress or pressure to OEL display module. Do not over bend the film with electrode pattern layouts, since this will affect the display performance. Also, secure sufficient rigidity for the outer cases.



7) Do not apply stress to the LSI chips and the surrounding molded sections.
8) Do not disassemble nor modify the OEL display module.
9) If the logic circuit power is off, do not apply the input signals.
10) To prevent destruction of the elements by static electricity, be careful to maintain an optimum working environment.
    - Be sure to ground your body when handling the OEL display module.

- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The OEL display module is coated with a film to protect the display surface. Exercise care when peeling off this protective film, since this operation can generate static electricity.

11) If OEL display module surface becomes contaminated, breathe on it and gently wipe it off with a soft dry cloth. If it is heavily contaminated, remove the residue material by the method mentioned in the Section 5) above.
12) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets, moisture condensation, or a current flow in a high-humidity environment.

9.2. Storage Precautions

When the OEL display module alone must be stored for long periods of time:

1) Do not stack up OEL display modules, since they can be damaged by components on neighboring modules.
2) Do not place heavy objects on top of the product. This could cause glass breakage.
3) Protect the modules from high/low temperatures and humidity, whenever possible.
4) Keep the modules out of direct sunlight or direct exposure to ultraviolet rays.
5) Protect the modules from excessive external forces.
6) Prevent moisture build-up upon the module and observe the environmental constraints for storage temperature.

9.3. Design Precautions

1) Identify and observe absolute maximum ratings for OEL display module at all times. Note that there is some variation between models.
2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the VIL and VIH specifications and at the same time, minimize the cable length between OEL display module and host MPU.
3) We recommend installing an overcurrent protector circuit (fuse, etc.) to the power circuit (VDD), since the module is not provided with this protective feature (Recommended value: 0.5A).
4) Pay sufficient attention to avoid occurrence of mutual noise interference with the neighboring devices.
5) As for EMI, take necessary measures on the equipment side basically.
6) When fastening the OEL display module, fasten the external plastic housing section.
7) If power supply to the OEL display module is forcibly shut down by such errors as taking out the main battery while the OEL display panel is in operation, we cannot guarantee the quality of this OEL display module.

8) The electric potential to be connected to the rear face of the IC chip should be as follows: SSD1306.

   * Connection (contact) to any other than the above potential may lead to rupture of the IC.

9.4. Proper Disposing of OEL

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

9.5. Other Precautions

1) If OEL display module has been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
2) To minimize the performance degradation of the OEL display modules resulting from destruction caused by static electricity etc., exercise care to avoid touching the following sections when handling the modules:
   - Pattern layouts, such as the FPC.
   - Pins and electrodes.
3) With this OEL display module, the OEL driver is being exposed. Generally speaking, semiconductor elements change their characteristics when light is radiated according to the principle of the solar battery. Consequently, if this OEL driver is exposed to light, malfunctioning may occur.
   * Design the product and installation method so that the OEL driver may be shielded from light in actual usage.
   * Design the product and installation method so that the OEL driver may be shielded from light during the inspection processes.
4) Although this OEL display module stores the operation state data by the commands and the indication data, when excessive external noise, etc. enters into the module, the internal status may be changed. Therefore, it is necessary to take appropriate measures to suppress noise generation or to protect from influences of noise on the system design.
5) We recommend to construct the software to make periodical refreshment of the operation statuses (re-setting of the commands and re-transferring the display data) to cope with catastrophic noise.

10. LIMITED WARRANTY

TVI Electronics warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TVI Electronics' standard warranty.
All TVI Electronics products have been manufactured to your company's or your own specifications as a part for use in your company's or own general electronic products. It is guaranteed to perform according to delivery specifications.

We cannot take responsibility for any other use apart from general electronic equipment, if the product is used in medical devices, nuclear power control equipment, aerospace equipment, fire and security systems, or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required.

Customers are responsible for their products and applications using TVI Electronics components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

Following conditions are not covered by the warranty and are subject to change.

1) Any malfunctions and damages during transportation and transfer by user.
2) Any malfunctions and damages caused by static electricity, electrostatic discharge (ESD) or application of incorrect voltage after the product has passed your company's acceptance inspection procedures.
3) Any malfunctions and damages caused by a natural disaster or a fire.
4) Any malfunctions and damages caused by the failure of the associated equipment.
5) Any malfunctions and damages caused by an application of strong external force or mechanical stress to the product.
6) Any malfunctions and damages caused by an additional manufacturing of the product (including disassembly and reassembly), remodeling or repairing by the user or unauthorized personnel after product delivery.
7) If the product is glued onto the equipment and then uninstalled.
8) Any malfunctions and damages caused by an improper installation (including an incidental or consequential damages), usage and handling against the specifications and notes.
9) Custom products are not eligible for Warranty Replacement.

11. RETURN POLICY

Unless agreed between TVI Electronics and the customer, TVI Electronics will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with TVI Electronics LCD acceptance standards (copies available upon request) for a period of one year from date of shipment. Cosmetic/visual defects must be returned to TVI Electronics within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of TVI Electronics

limited to repair and/or replacement on the terms set forth above. TVI Electronics will not be responsible for any subsequent or consequential events.

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are:

1) Broken LCD glass
2) PCB eyelet damaged or modified
3) PCB conductors damaged
4) Circuit modified in any way, including addition of components
5) PCB tampered by grinding, engraving or painting varnish
6) Soldering to or modifying the bezel in any manner

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failure or defect. Any connectors or cables installed by the customer must be removed completely without damaging the PCB eyelets, conductors and terminals.