Date: 2020/10/13

Specifications for Approval

Model name : JMD0.96G REV:A

ENG	QA	APPROVAL
Andy	Leo	Duke

Customer Approval	☐ **Accept** ☐ **Reject** **Comment:** **Approved by:**

REVISION RECORD

Revision	Revision Date	Page	Contents
A	20201013		Initial Release and Issue Full Specification

1. FEATURES

The features of LCD are as follows

* Display mode : Passive Matrix
* Color : Monochrome (White)
* Display Format : 128Dots × 64Dots
* IC : SSD1315
* Interface Input Data : IIC
* Driving Method : 1/65 Duty,

2. MECHANICAL SPECIFICATIONS

Item	Specification	Unit
Module Size	26.0(W) X26.0(H) X2.62(T)	mm
Viewing Area	22.74(W) X 11.86(H)	mm
Effective Display Area	21.74(W) X 10.86(H)	mm
Number of Dots	128 X 64 Dots	-
Dot Size	0.17(W) X 0.17(H)	mm
Dot Pitch	0.15(W) X 0.15(H)	mm

3. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage for Logic	V_{DD}	-0.3	4	V	1, 2
Supply Voltage for Display	V_{CC}	0	16.5	V	1, 2
Supply Voltage for DC/DC	*V_{BAT}*	*-0.3*	*4.5*	*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 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. "Optics & Electrical Characteristics". If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.

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

Note 4: V_{CC} = 9.0V, T_a = 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.

4.Optics & Electrical Characteristics

4.1 Optics Characteristics

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Brightness (V_{CC} Supplied Externally)	L_{br}	Note 5	90	-	-	cd/m²
Brightness (V_{CC} Generated by Internal DC/DC)	*L_{br}*	*Note 6*	*80*	*100*	-	*cd/m²*
C.I.E. (White)	(x) (y)	C.I.E. 1931	0.25 0.27	0.29 0.31	0.33 0.35	
Dark Room Contrast	CR		-	2000:1	-	
Viewing Angle			-	Free	-	degree

* Optical measurement taken at VDD = 2.8V, VCC = 9V & *7.25V*. Software configuration follows Section 4.4 Initialization.

4.2 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)	8.5	9.0	9.5	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)*	*7.0*	-	*7.5*	*V*
High Level Input	V_{IH}	I_{OUT} = 100μA, 3.3MHz	0.8×V_{DD}	-	V_{DD}	V
Low Level Input	V_{IL}	I_{OUT} = 100μA, 3.3MHz	0	-	0.2×V_{DD}	V
High Level Output	V_{OH}	I_{OUT} = 100μA, 3.3MHz	0.9×V_{DD}	-	V_{DD}	V
Low Level Output	V_{OL}	I_{OUT} = 100μA, 3.3MHz	0	-	0.1×V_{DD}	V
Operating Current for V_{DD}	I_{DD}		-	160	220	μA
Operating Current for V_{CC} (V_{CC} Supplied Externally)	I_{CC}	Note 7	-	9	15	mA
Operating Current for V_{BAT} (V_{CC} Generated by Internal DC/DC)	*I_{BAT}*	*Note 8*	-	*25.0*	*32.0*	*mA*
Sleep Mode Current for V_{DD}	$I_{DD, SLEEP}$		-	-	10	μA
Sleep Mode Current for V_{CC}	$I_{CC, SLEEP}$		-	-	10	μA

Note 5 & *6*: Brightness (Lbr) and Supply Voltage for Display (VCC) are subject to the change of the panel characteristics and the customer's request.

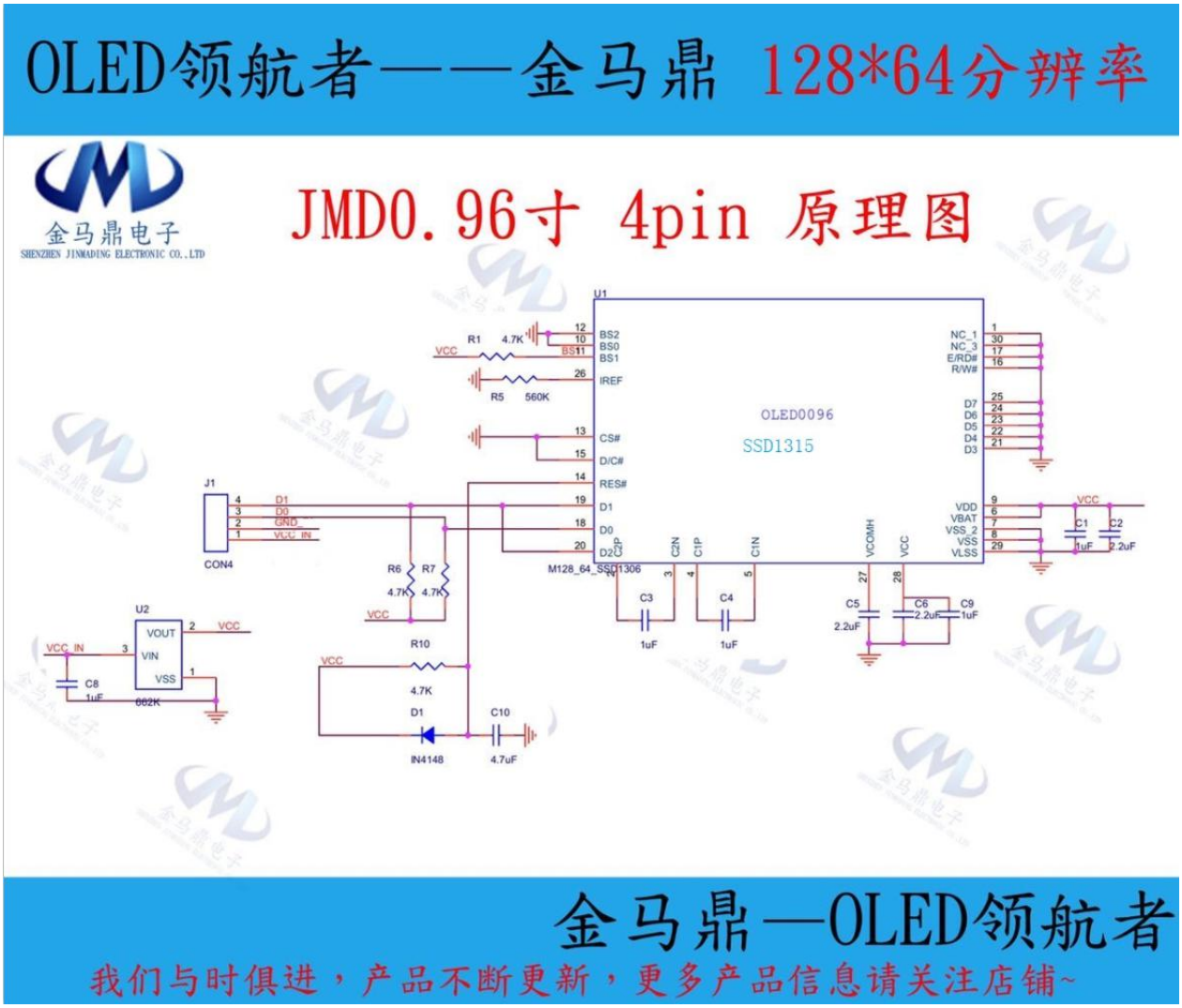
Note 7: VDD = 2.8V, VCC = 9V, 100% Display Area Turn on.

Note 8: VDD = 2.8V, VCC = 7.25V, 100% Display Area Turn on.

* Software configuration follows Section 4.4 Initialization.

5. Interface Pin Function

Pin NO.	Symbol	I / O	Functions
1	VCC	Power Supply	Power supply
2	GND	Power Supply	Ground
3	SCL	I	Spi interface clock line
4	SDA	I	Spi interface data line



6. Functional Specification

6.1 Commands

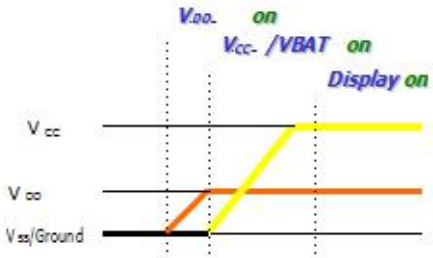
Refer to the Technical Manual for the SSD1315

6.1 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.

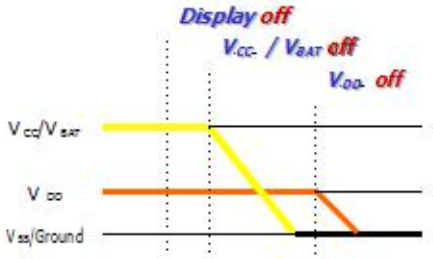
6.1.1 Power up Sequence:

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



6.1.2 Power down Sequence:

8. Send Display off command
9. Power down V_{CC} / V_{BAT}
10. Delay 100ms
    (When V_{CC} / V_{BAT} is reach 0 and panel is completely discharges)
11. 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.

6.2 Reset Circuit

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

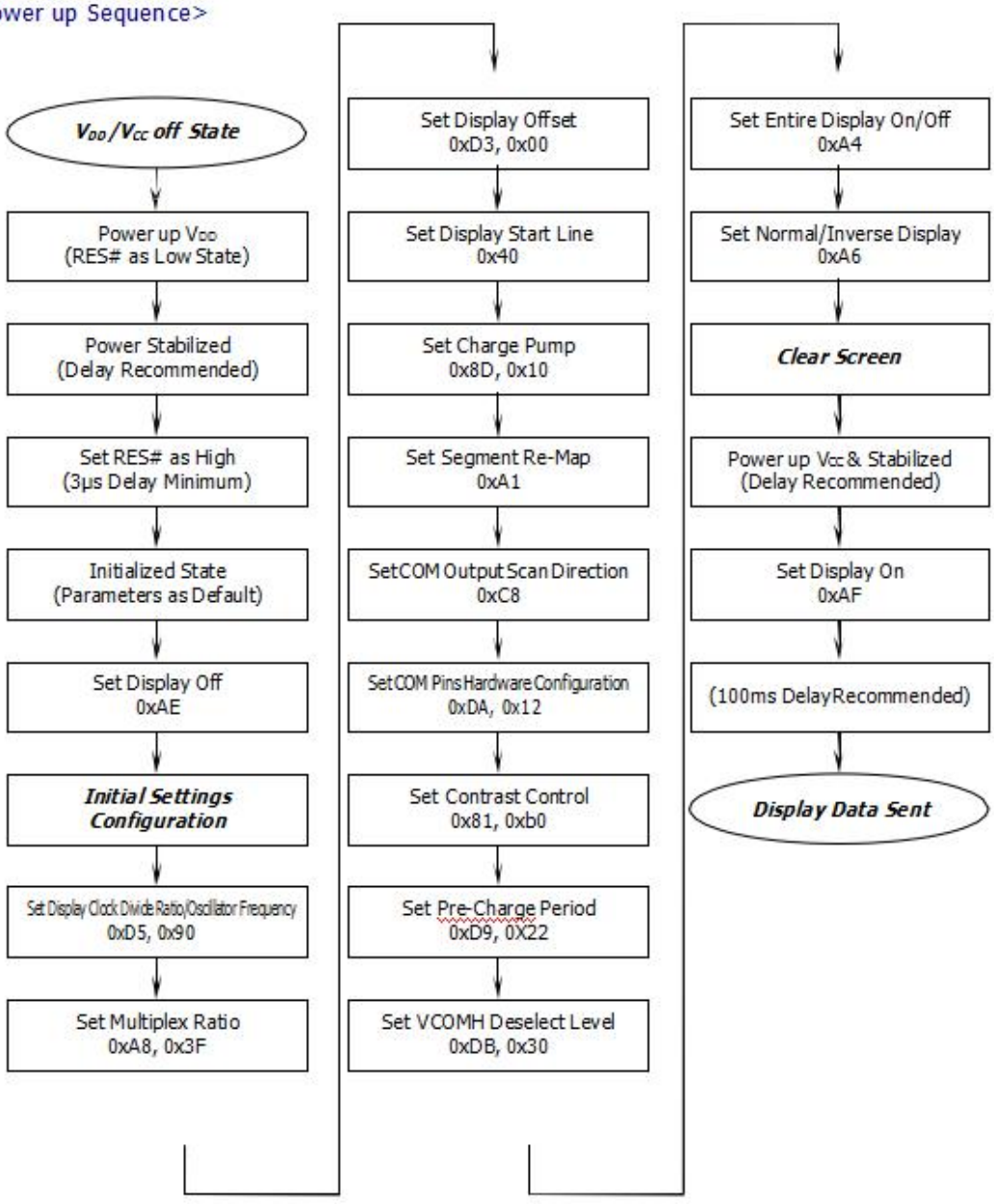
1. Display is OFF
2. 128×64 Display Mode
3. Normal segment and display data column and row address mapping (SEG0 mapped to column address 00h and COM0 mapped to row address 00h)
4. Shift register data clear in serial interface
5. Display start line is set at display RAM address 0
6. Column address counter 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)

6.2Actual Application Example

Command usage and explanation of an actual example

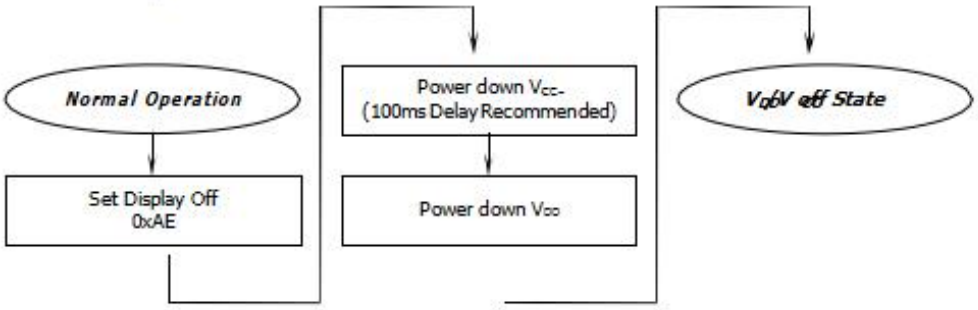
6.1.2V_{CC} Supplied Externally

<Power up Sequence>

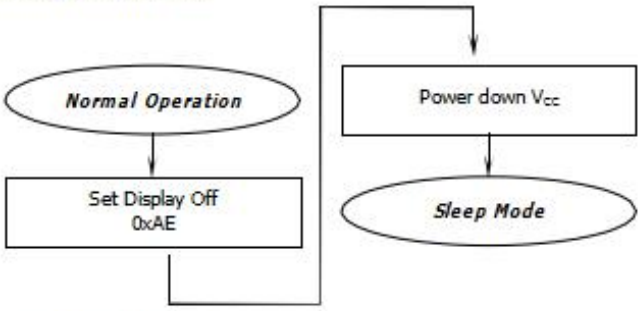


If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.

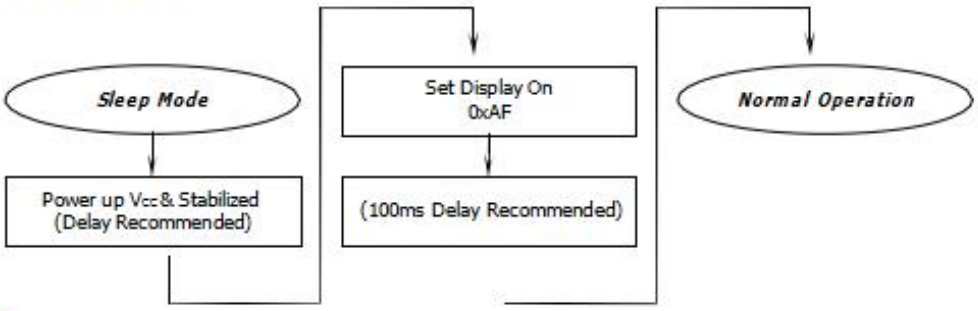
<Power down Sequence>



<Entering Sleep Mode>



<Exiting Sleep Mode>



External setting

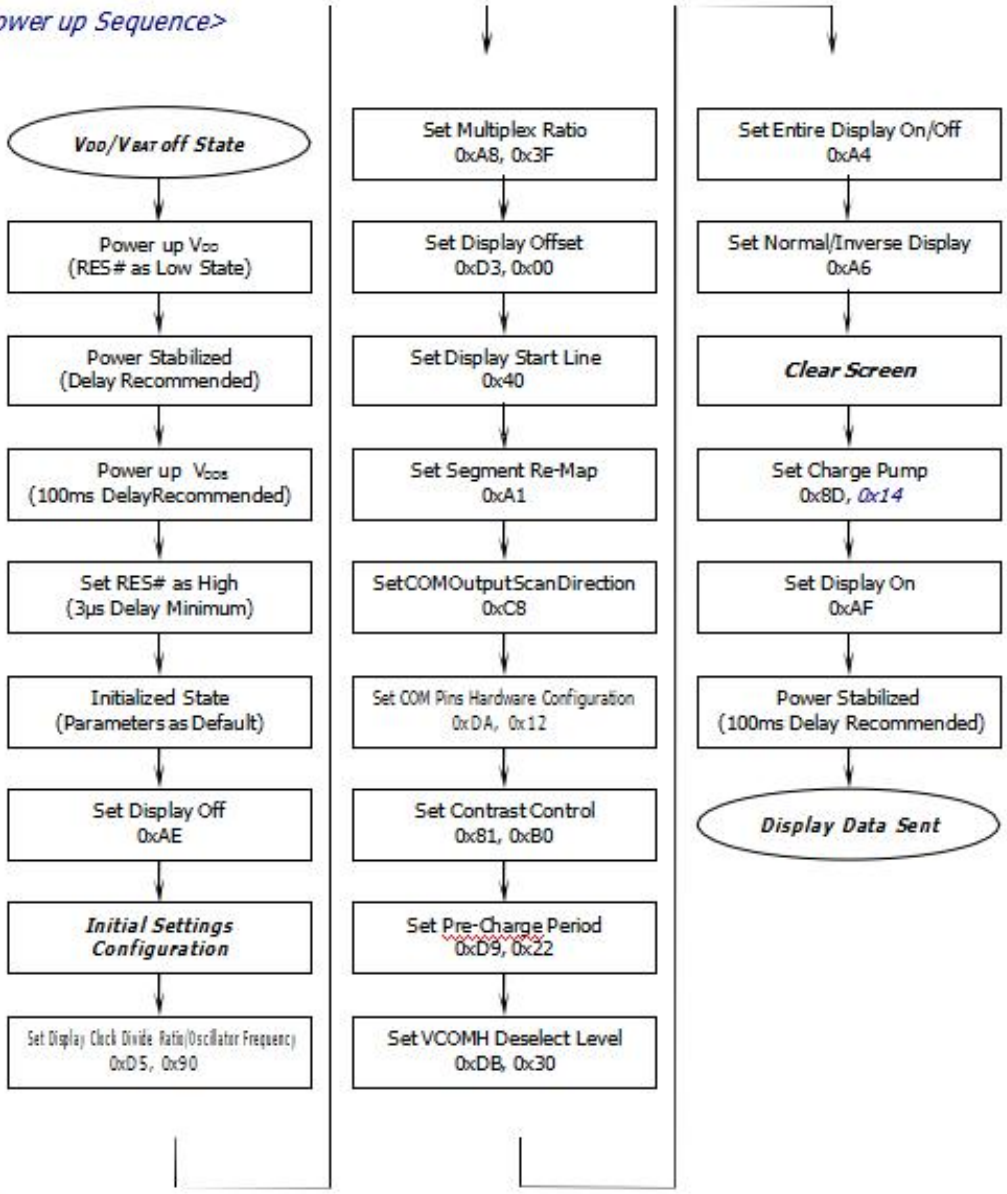
```
{
    RES=1;
    delay(1000);
    RES=0;
    delay(1000);
    RES=1;
    delay(1000);

write_i(0xAE);      /*display off*/

write_i(0x00);      /*set lower column address*/
write_i(0x10);      /*set higher column address*/

write_i(0x40);      /*set display start line*/

write_i(0xB0);      /*set page address*/
```

```
        write_i(0x81);      /*contract control*/
        write_i(0xb0);      /*128*/

        write_i(0xA1);      /*set segment remap*/

        write_i(0xA4);

        write_i(0xA6);      /*normal / reverse*/

        write_i(0xA8);      /*multiplex ratio*/
        write_i(0x3F);      /*duty = 1/64*/

        write_i(0xC8);      /*Com scan direction*/

        write_i(0xD3);      /*set display offset*/
        write_i(0x00);

        write_i(0xD5);      /*set osc division*/
        write_i(0x90);

        write_i(0xD9);      /*set pre-charge period*/
        write_i(0x22);

        write_i(0xDA);      /*set COM pins*/
        write_i(0x12);

         write_i(0xdb);      /*set vcomh*/
        write_i(0x30);

         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)
```

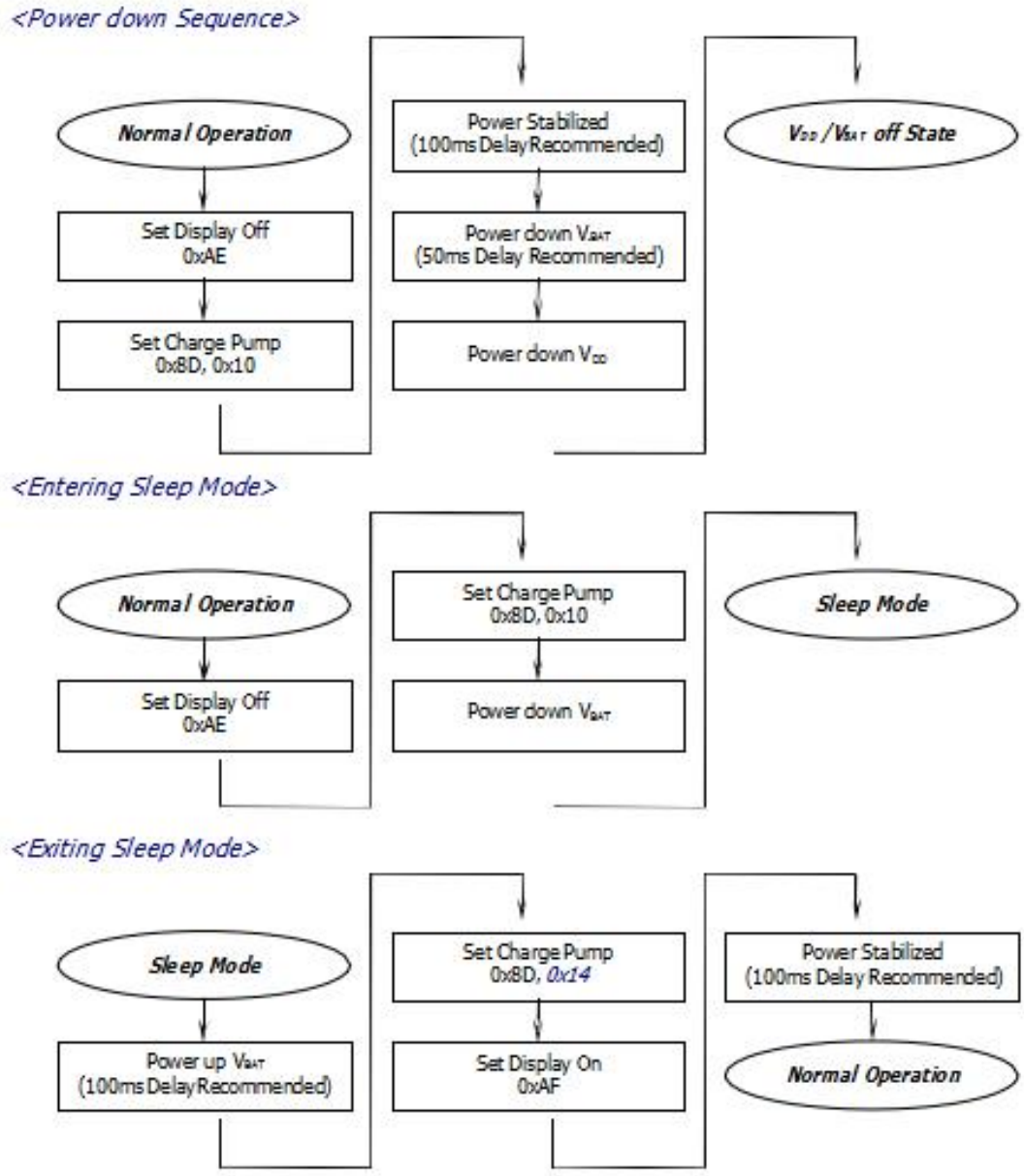
```
        {
           SDA=1;
         }
        else
         {
            SDA=0;
         }

        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--;
    }
}
```

6.1.2Vcc Generated by Internal DC/DCCircuit

<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.



Internal setting（Charge pump）

```
{
    RES=1;
    delay(1000);
    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(0x40);      /*set display start line*/

        write_i(0xB0);      /*set page address*/

        write_i(0x81);      /*contract control*/
        write_i(0xb0);      /*128*/

        write_i(0xA1);      /*set segment remap*/

        write_i(0xA4);

        write_i(0xA6);      /*normal / reverse*/

        write_i(0xA8);      /*multiplex ratio*/
        write_i(0x3F);      /*duty = 1/64*/

        write_i(0xC8);      /*Com scan direction*/

        write_i(0xD3);      /*set display offset*/
        write_i(0x00);

        write_i(0xD5);      /*set osc division*/
        write_i(0x90);

        write_i(0xD9);      /*set pre-charge period*/
        write_i(0x22);

        write_i(0xDA);      /*set COM pins*/
        write_i(0x12);

         write_i(0xdb);      /*set vcomh*/
        write_i(0x30);

         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)
```

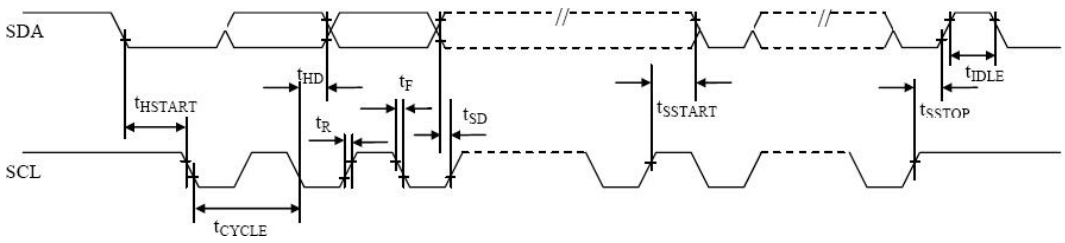
```
{
  unsigned char   m,da;
  unsigned int j;
     DC=1;
     CS=0;
     da=dat;
  for(j=0;j<8;j++)
    {
      m=da;
      SCL=0;
      m=m&0x80;
      if(m==0x80)
        {
           SDA=1;
        }
       else
        {
            SDA=0;
        }

       da=da<<1;
       SCL=1;
     }
  CS=1;
```

```
}


void delay(unsigned int i)
{
    while(i>0)
    {
    i--;
    }
}
```

7.TIMING CHARACTERISTICS (Continued)

I²C Interface Timing Characteristics:

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



8. QUALITY SPECIFICATION (Continued)

8-3. Sampling Plan and Acceptance

1. Sampling Plan

MIL - STD - 105E (||) ordinary single inspection is used.

2. Acceptance

Major defect: AQL = 0.25%

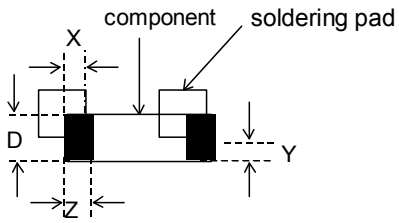
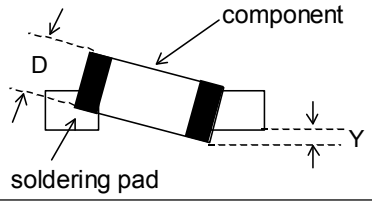
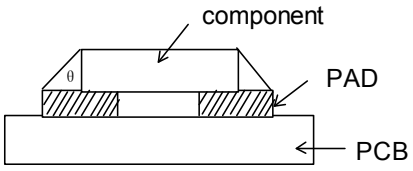
Minor defect: AQL = 0.65%

8-4. Criteria

1. COB

Defect	Inspection Item	Inspection Standards	
Major	PCB copper flakes peeling off	Any copper flake in viewing Area should be greater than 1.0mm^2	Reject
Major	Height of coating epoxy	Exceed the dimension of drawing	Reject
Major	Void or hole of coating epoxy	Expose bonding wire or IC	Reject
Major	PCB cutting defect	Exceed the dimension of drawing	Reject

2. SMT

Defect	Inspection Item	Inspection Standards	
Minor	Component marking not readable		Reject
Minor	Component height	Exceed the dimension Of drawing	Reject
Major	Component solder defect (missing , extra, wrong component or wrong orientation		Reject
Minor	Component position shift 	X < 3/4Z Y > 1/3D	Reject Reject
Minor	Component tilt 	Y > 1/3D	Reject
Minor	Insufficient solder 	$\theta \leq 20^{\circ}$	Reject

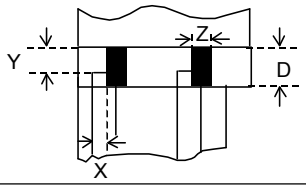
8. QUALITY SECIFICATION (Continued)

8-4. Criteria (Continued)

3. Metal (Plastic) Frame

Defect	Inspection Item	Inspection Standards		
Major	Crack / breakage	Anywhere		Reject
Minor	Frame Scratch	W	L	Acceptable of Scratch
		w<0.03mm	Any	Ignore
		0.03mm≤w<0.05mm	L≤5.0mm	2
		0.05mm≤w<0.1mm	L≤3.0mm	1
		w≥0.1mm	Any	0
		Note: 1. Above criteria applicable to scratch lines with distance greater than 5mm. 2. Scratch on the back side of frame (not visible) can be ignored.		
Minor	Frame Dent, Prick $\Phi = \frac{L+W}{2}$			Acceptable of Dents / Pricks
		$\Phi \leq 1.0$mm		2
		$1.0 < \Phi \leq 1.5$mm		1
		$1.5\text{mm} > \Phi$		0
		Note: 1. Above criteria applicable to any two dents / pricks with distance greater than 5mm 2. Dent / prick on the back side of frame (not visible) can be ignored		
Minor	Frame Deformation	Exceed the dimension of drawing		
Minor	Metal Frame Oxidation	Any rust		

4. Flexible Film Connector (FFC)

Defect	Inspection Item		Inspection Standards	
Minor	Tilted soldering		Within the angle ±3°	Acceptable
Minor	Uneven solder joint /bump			Reject
Minor	Hole	$\Phi = \frac{L+W}{2}$	Expose the conductive line	Reject
			Φ > 1.0mm	Reject
Minor	Position shift 		Y > 1/3D	Reject
			X > 1/2Z	Reject

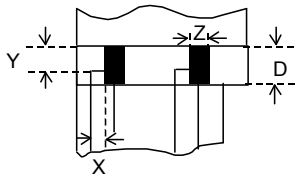
8. QUALITY SPECIFICATION (Continued)

8-4. Criteria (Continued)

5. Screw

Defect	Inspection Item	Inspection Standards	
Major	Screw missing/loosen		Reject
Minor	Screw oxidation	Any rust	Reject
Minor	Screw deformation	Difficult to accept screw driver	Reject

6. Heat seal 、TCP 、FPC

Defect	Inspection Item	Inspection Standards	
Major	Scratch expose conductive layer		Reject
Minor	HS Hole $\Phi = \frac{L+W}{2}$	Φ> 0.2mm	Reject
Major	Adhesion strength	Less than the specification	Reject
Minor	Position shift 	Y > 1/3D	Reject
		X > 1/2Z	Reject
Major	Conductive line break		Reject

7. LED Backing Protective Film and Others

Defect	Inspection Item	Inspection Standards	
Minor	LED dirty, prick	Acceptable number of units	
		$\Phi \leq$0.10mm	Ignore
		0.10<$\Phi \leq$0.15mm	2
		0.15<$\Phi \leq$0.2mm	1
		Φ>0.2mm	0
		The distance between any two spots should be $\geq$10mm Any spot/dot/void outside of viewing area is acceptable	
Minor	Protective film tilt	Not fully cover LCD	Reject
Major	COG coating	Not fully cover ITO circuit	Reject

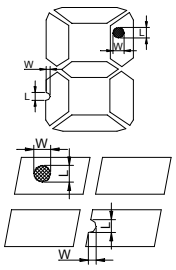
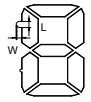
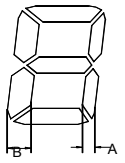
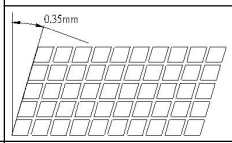
8. Electric Inspection

Defect	Inspection Item	Inspection Standards	
Major	Short		Reject
Major	Open		Reject

8. QUALITY SPECIFICATION (Continued)

8-4. Criteria (Continued)

9. Inspection Specification of LCD

Defect	Inspect Item		Inspection Standards				
Minor	Linear Defect	∗ Glass Scratch ∗ Polarizer Scratch ∗ Fiber and Linear material	W	W≤0.03		0.03<W≤0.05	W>0.05
			L	L<5		L<3	Any
			ACC. NO.	1		1	Reject
			Note	L is the length and W is the width of the defect			
Minor	Black Spot and Polarizer Pricked	∗ Foreign material between glass and polarizer or glass and glass ∗ Polarizer hole or protuberance by external force	Φ	Φ≤0.1	0.1<Φ≤0.15	0.15<Φ≤0.2	Φ>0.2
			ACC. NO.	3EA /1PC	2	1	0
			Note	Φ is the average diameter of the defect. Distance between two defects > 10mm.			
Minor	White Spot and Bubble in polarizer	∗ Unobvious transparant foreign material between glass and glass or glass and polarizer ∗ Air protuberance between polarizer and glass	Φ	Φ≤0.1	0.1<Φ≤0.15	0.15<Φ≤0.2	Φ>0.2
			ACC. NO.	3EA / 1PC	2	1	0
			Note	Φ is the average diameter of the defect. Distance between two defects > 10mm.			
Minor	Segment Defect		Φ	Φ≤0.10	0.10<Φ≤0.20		Φ>0.2
			ACC. NO.	3EA /1PC	2		0
			Note	W is more than 1/2 segment width			Reject
				$\Phi = \frac{L + W}{2}$ Distance between two defect is 10mm			
Minor	Protuberant Segment	 Φ = (L + W) / 2	Φ	Φ≤0.10	0.10<Φ≤0.20		Φ>0.2
			W	Glue	W≤1/2 Seg , W≤0.2		Ignore
			ACC. NO.	3EA /1PC	2		0
Minor	Assembly Mis-alignment		1. Segment				
			B	B≤0.4mm	0.4<B≤1.0mm		B>1.0mm
			B-A	B-A<1/2B	B-A<0.2		B-A<0.25
			Judge	Acceptable	Acceptable		Acceptable
			2. Dot Matrix				
			Deformation>0.35mm				Reject
Minor	Stain on LCD Panel Surface		Accept when stains can be wiped lightly with a soft cloth or a similar one. Otherwise, judged according to the above items: “Black spot” and “White Spot”				

9. RELIABILITY

NO.	Item	Condition	Criterion
1	High Temperature Operating	70℃, 240Hrs	No defect in cosmetic and operational function allowable. Total current Consumption should be below double of initial value.
2	Low Temperature Operating	-40℃, 240Hrs	
3	High Humidity	40℃, 90%RH, 240Hrs	
4	High Temperature Storage	85℃, 240Hrs	
5	Low Temperature Storage	-40℃, 240Hrs	
6	Vibration	Random wave 10 ~ 100Hz Acceleration: 2g 2 Hrs per direction(X,Y,Z)	
7	Thermal Shock	-10℃ to 25℃ to 60℃ (60Min) (5Min) (60Min) 16Cycles	
8	ESD Testing	Contract Discharge Voltage: +1 ~ 5kV and –1 ~ –5kV	There will be discharged ten times at every discharging voltage cycle. The voltage gap is 1kV.
		Air Discharge Voltage: +1 ~ 8kV and –1 ~ -8kV	

Note: 1) Above conditions are suitable for XUDING standard products.

2) For restrict products, the test conditions listed as above must be revised.

10. HANDLING PRECAUTION

(1) Mounting Method

The panel of the LCD Module consists of two thin glass plates with polarizers which easily get damaged since the Module is fixed by utilizing fitting holes in the printed circuit board. Extreme care should be taken when handling the LCD Modules.

(2) Caution of LCD handling & cleaning

When cleaning the display surface, use soft cloth with solvent (recommended below) and wipe lightly.

- Isopropyl alcohol
- Ethyl alcohol
- Trichlorotrifloroethane

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent:

- Water
- Ketone
- Aromatics

(3) Caution against static charge

The LCD Module use C-MOS LSI drivers, so we recommend that you connect any unused input terminal to VDD or VSS, do not input any signals before power is turned on. And ground your body, Work/assembly table. And assembly equipment to protect against static electricity.

(4) Packaging

- Modules use LCD elements, and must be treated as such. Avoid intense shock and falls from a height.
- To prevent modules from degradation. Do not operate or store them exposed directly to sunshine or high temperature/humidity.

(5) Caution for operation

- It is indispensable to drive LCD's within the specified voltage limit since the higher voltage than the limit shorten LCD life. An electrochemical reaction due to direct current causes LCD deterioration, Avoid the use of direct current drive.

10. HANDLING PRECAUTION (Continued)

- Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them.

However those phenomena do not mean malfunction or out of order with LCD's. Which will come back in the specified operating temperature range.

- If the display area is pushed hard during operation, some font will be abnormally displayed but it resumes normal condition after turning off once.
- A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit.

Usage under the relative condition of 60 C, 90%RH or less is required.

(6) Storage

In the case of storing for a long period of time (for instance ,for years) for the purpose or replacement use, The following ways are recommended.

- Storage in a polyethylene bag with sealed so as not to enter fresh air outside in it, And with no desiccant.
- Placing in a dark place where neither exposure to direct sunlight nor light is. Keeping temperature in the specified storage temperature range.
- Storing with no touch on polarizer surface by the anything else. (It is recommended to store them as they have been contained in the inner container at the time of delivery)

(7) Safety

- It is recommendable to crash damaged or unnecessary LCD into pieces and wash off liquid crystal by using solvents such as acetone and ethanol.

Which should be burned up later.

- When any liquid crystal leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water.

11. OUTLINE DIMENTION