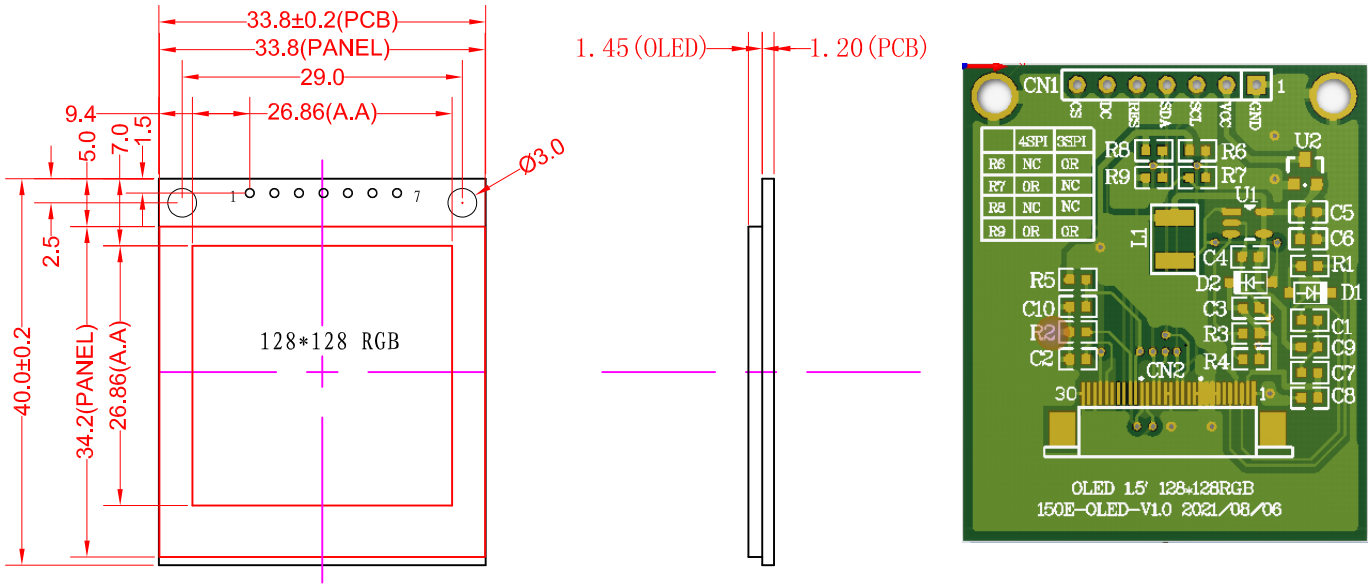
1.Functions & Features

Display Mode	AM OLED
	Color: RGB
Display Format	Graphic 128*128 Dot matrix
Input Data	4-SPI Interface
Viewing Direction	All
Driver IC	SSD1351

2.Mechanical Specifications

Item	Specifications	Unit
Dimensional outline	33.8*40.0*3.8(MAX)	mm
Resolution	128(H)*128(V)	dots
LCD Active area	26.855(H)x26.864(V)	mm
Pixel size	0.185x0.194	mm

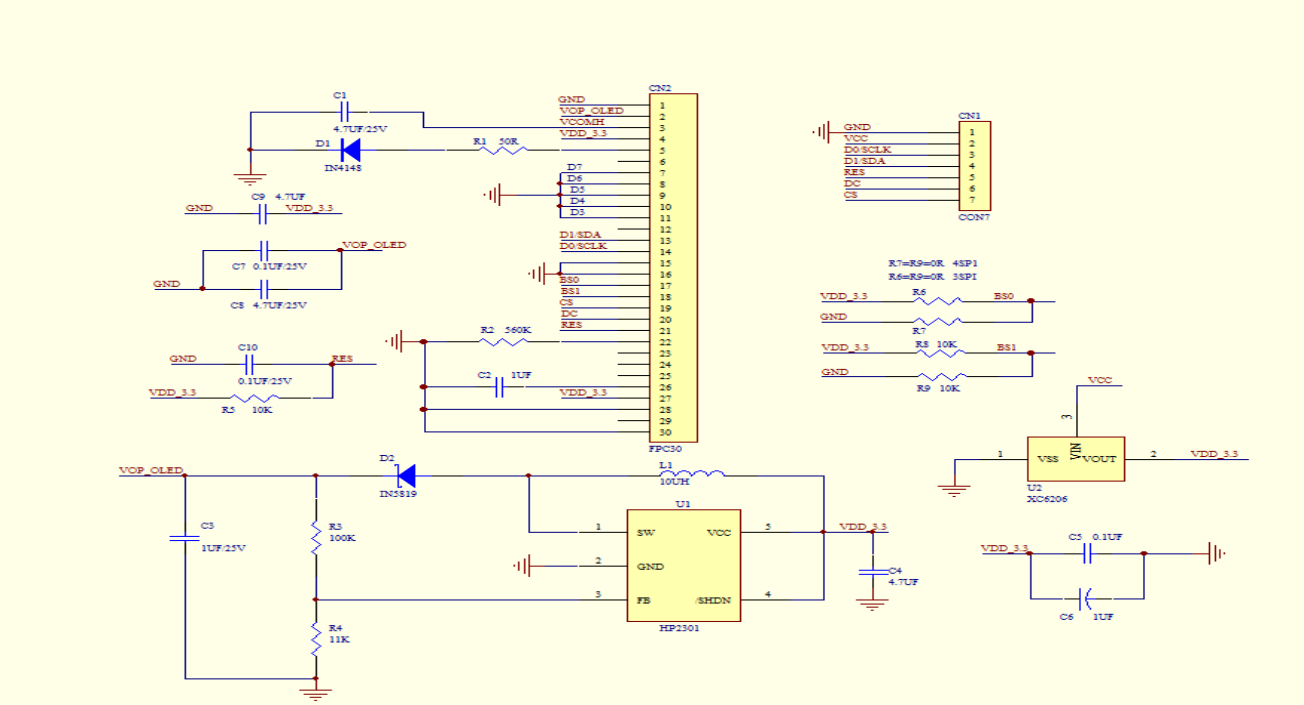
3.External Dimensions



4.Pin Description

Pin	Symbol	I/O	
1	GND	P	Ground(-)
2	VCC	P	Power supply pin(+)
3	SCL	I	Serial Clock
4	SDA	I	Serial Data
5	RES	I	Reset
6	D/C	I	Command and Data Select
7	CS	I	Chip Select

5.Schematic diagram(for reference only)



6.Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage for Display	VCC	3	5	V	
Supply Voltage for Logic	SCL/SDA/RES/DC/CS	1.65	3.3	V	
Operating Temperature	T_{OP}	-40	70	°C	
Storage Temperature	T_{STG}	-40	85	°C	
Life Time(100 cd/m2)		13,000	-	hour	1(1)
Life Time(80 cd/m2)		16,000	-	hour	1(2)

Note:

(A)Under Vcc = 15V, Ta = 25°C, 50% RH.

(B)Life time is defined the amount of time when the luminance has decayed to less than 50% of the initial measured luminance.

(1) Setting of 100 cd/m2 :

- Contrast setting : 0x5f
- Frame rate : 105Hz
- Duty setting : 1/96

(2) Setting of 80 cd/m2 :

- Contrast setting : 0x4f
- Frame rate : 105Hz
- Duty setting : 1/96

7.Electrical Characteristics

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage for Operation	V_{CI}		2.4	2.8	3.5	V
Supply Voltage for Logic	V_{DD}		2.4	2.5	2.6	V
Supply Voltage for I/O Pins	V_{DDIO}		1.65	1.8	V_{CI}	V
Supply Voltage for Display	V_{CC}	Note 3	12.5	13	13.5	V
High Level Input	V_{IH}		$0.8\times V_{DDIO}$	-	V_{DDIO}	V
Low Level Input	V_{IL}		0	-	$0.2\times V_{DDIO}$	V
High Level Output	V_{OH}	I_{out} = 100μA, 3.3MHz	$0.9\times V_{DDIO}$	-	V_{DDIO}	V
Low Level Output	V_{OL}	I_{out} = 100μA, 3.3MHz	0	-	$0.1\times V_{DDIO}$	V
Operating Current for V_{CI}	I_{CI}		-	240	300	μA
Operating Current for V_{CC}	I_{CC}	Note 4	-	23.2	29.0	mA
		Note 5	-	33.4	41.8	mA
Sleep Mode Current for V_{CI}	$I_{CI, SLEEP}$		-	1	5	μA
Sleep Mode Current for V_{CC}	$I_{CC, SLEEP}$		-	1	5	μA

Note 3: 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 4: V_{CI} = 2.8V, V_{CC} = 13V, 50% Display Area Turn on.
Note 5: V_{CI} = 2.8V, V_{CC} = 13V, 100% Display Area Turn on.

* Software configuration follows Section 4.4 Initialization.

8.Optics Characteristic

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Brightness (White)	L_{br}	With Polarizer (Note 3)	70	90	-	cd/m^2
C.I.E. (White)	(x) (y)	With Polarizer	0.26 0.29	0.30 0.33	0.34 0.37	
C.I.E. (Red)	(x) (y)	With Polarizer	0.60 0.30	0.64 0.34	0.68 0.38	
C.I.E. (Green)	(x) (y)	With Polarizer	0.27 0.58	0.31 0.62	0.35 0.66	
C.I.E. (Blue)	(x) (y)	With Polarizer	0.10 0.12	0.14 0.16	0.18 0.20	
Dark Room Contrast	CR		-	>2000:1	-	
View Angle			>160	-	-	degree

* Optical measurement taken at V_{CI} = 2.8V, V_{CC} = 13V.

9.Timing Characteristics(4-SPI)

The 4-wire serial interface consists of serial clock: SCLK, serial data: SDIN, D/C#, CS#. In 4-wire SPI mode, R/W# (WR#) acts as SCLK, D0 acts as SDIN. For the unused data pins, D1 should be left open. The pins from D2 to D17and E can be connected to an external ground.

Control pins of 4-wire Serial interface

Function	E	CS#	D/C#
Write command	Tie LOW	L	L
Write data	Tie LOW	L	H

Note

(1) H stands for HIGH in signal

(2) L stands for LOW in signal

SDIN is shifted into an 8-bit shift register on every rising edge of SCLK in the order of D7, D6, ... D0. D/C# is sampled on every eighth clock and the data byte in the shift register is written to the Graphic Display Data RAM (GDDRAM) or command register in the same clock.

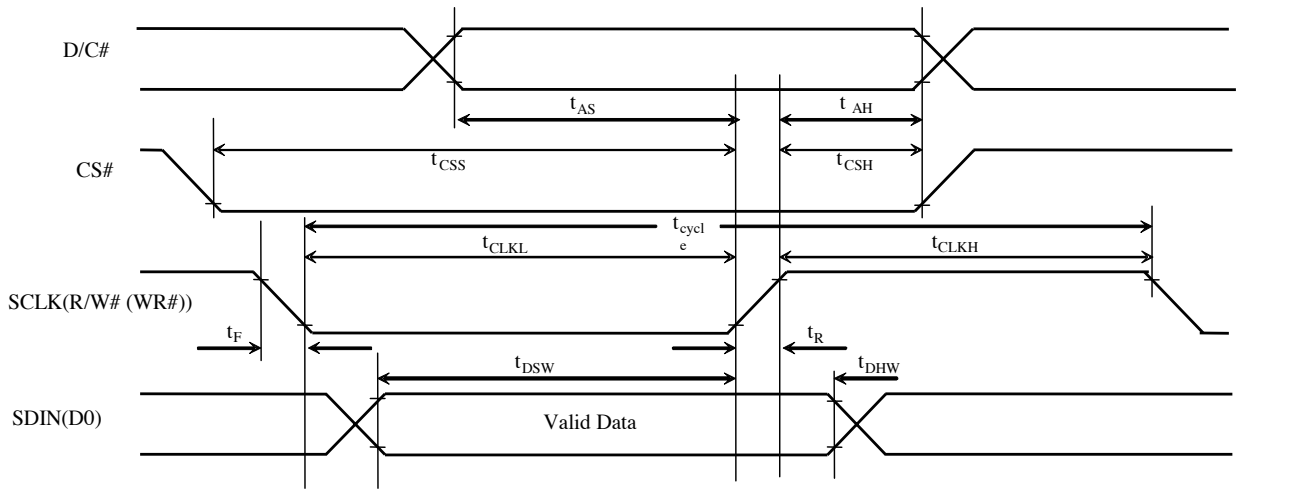
Under serial mode, only write operations are allowed.

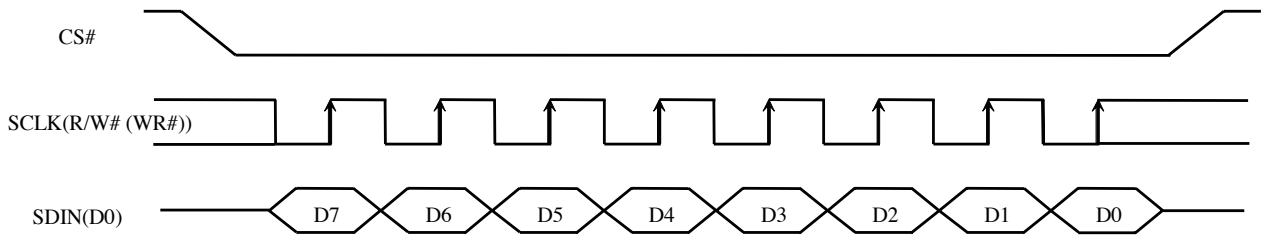
Serial Interface Timing Characteristics (4-wire SPI)

(V_{DD} - V_{SS} = 2.4 to 2.6V, V_{DDIO}=1.65V, V_{CI} = 2.8V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	50	-	-	ns
t_{AS}	Address Setup Time	15	-	-	ns
t_{AH}	Address Hold Time	15	-	-	ns
t_{CSS}	Chip Select Setup Time	20	-	-	ns
t_{CSH}	Chip Select Hold Time	10	-	-	ns
t_{DSW}	Write Data Setup Time	15	-	-	ns
t_{DHW}	Write Data Hold Time	15	-	-	ns
t_{CLKL}	Clock Low Time	20	-	-	ns
t_{CLKH}	Clock High Time	20	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns

Figure 13-3 : Serial interface characteristics (4-wire SPI)





10.Commands

Refer to the Technical Manual for the SSD1351

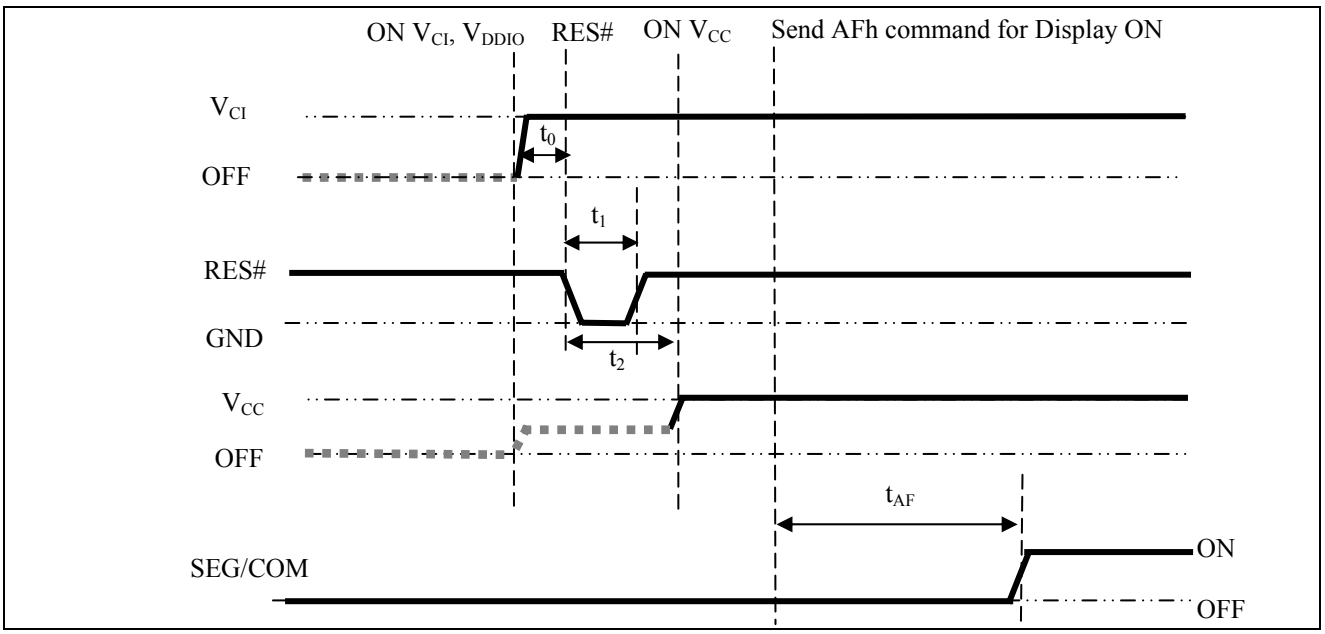
11.Power ON an OFF Sequence

The following figures illustrate the recommended power ON and power OFF sequence of SSD1327 (assume internal V_{DD} is used).

Power ON sequence:

1. Power ON $V_{CI.}$
2. After V_{CI} becomes stable, set wait time at least 1ms (t_0) for internal V_{DD} become stable. Then set RES# pin LOW (logic low) for at least 100us (t_1) [4] and then HIGH (logic high).
3. After set RES# pin LOW (logic low), wait for at least 100us (t_2). Then Power ON $V_{CC.}$[1]
4. After V_{CC} become stable, send command AFh for display ON. SEG/COM will be ON after 200ms (t_{AF}).

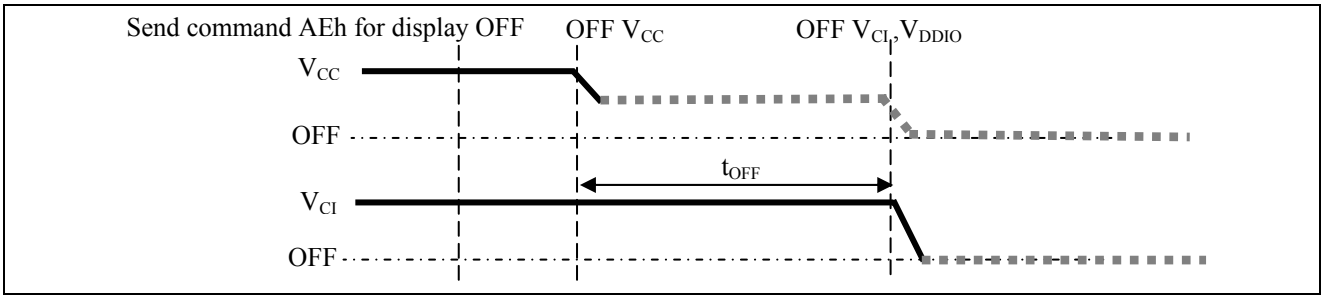
Figure 8-17 : The Power ON sequence.



Power OFF sequence:

1. Send command AEh for display OFF.
2. Power OFF $V_{CC.}$[1], [2], [3]
3. Wait for t_{OFF}. Power OFF $V_{CI.}$ (where Minimum t_{OFF}=0ms [5], Typical t_{OFF}=100ms)

Figure 8-18 : The Power OFF sequence



Note:

[1] Since an ESD protection circuit is connected between V_{CI} and V_{CC}, V_{CC} becomes lower than V_{CI} whenever V_{CI} is ON and V_{CC} is OFF as shown in the dotted line of V_{CC} in Figure 8-17 and Figure 8-18.

[2] V_{CC} should be kept float (disable) when it is OFF.

[3] Power pins (V_{CI}, V_{CC}) can never be pulled to ground under any circumstance.

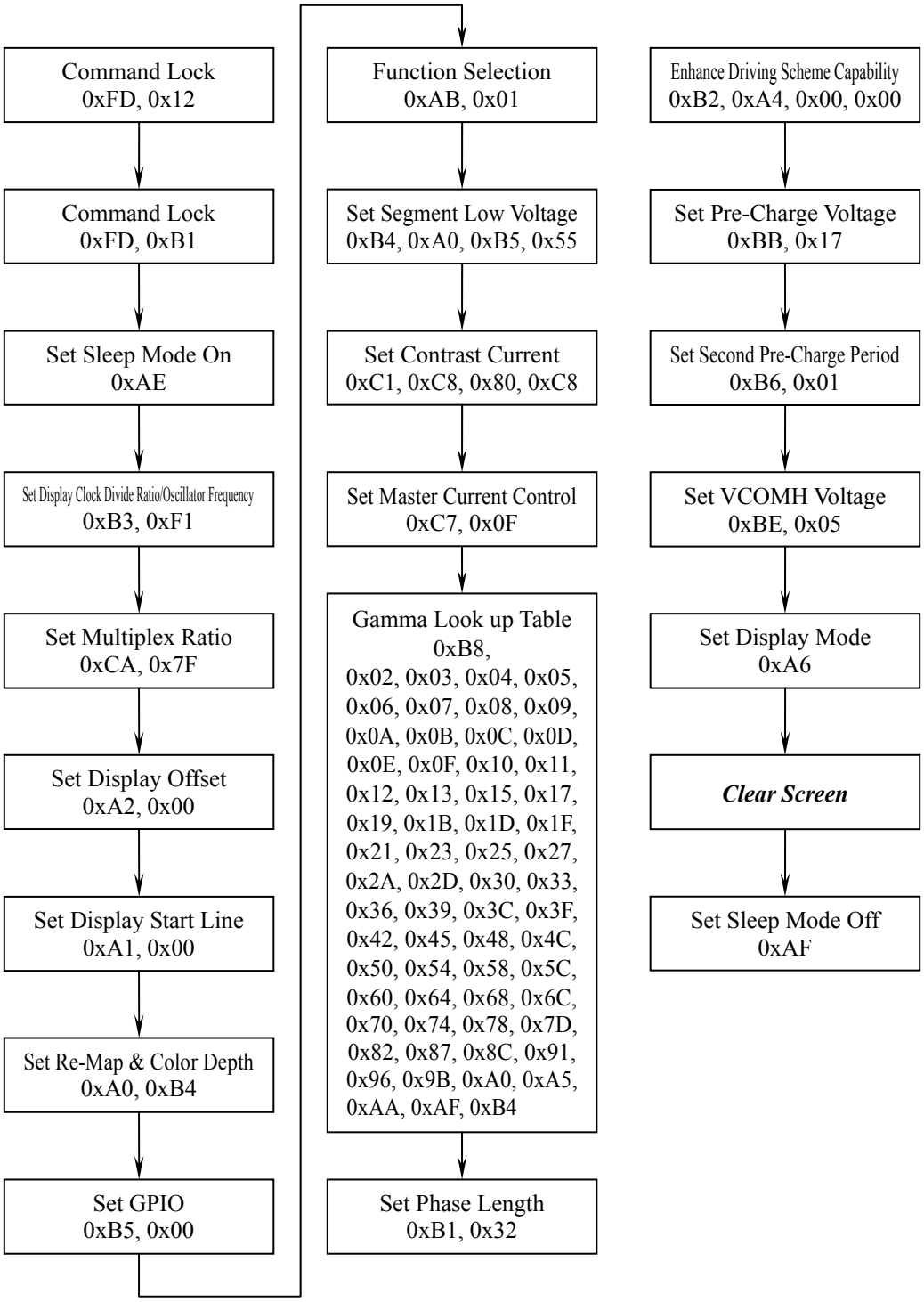
[4] The register values are reset after t_1.

[5] V_{CI} should not be Power OFF before V_{CC} Power OFF.

12.Actual Application Example

Command usage and explanation of an actual example

<Initialization>



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

13.Reliability & Inspection Standards

13.1 Test Condition

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.

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 23±5°C; 55±15% RH.

13.2 Outgoing Quality Control Specifications

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:	≥ 50cm
Distance between the Panel & Eyes of the Inspector:	≥ 30cm

Finger glove (or finger cover) must be worn by the inspector.

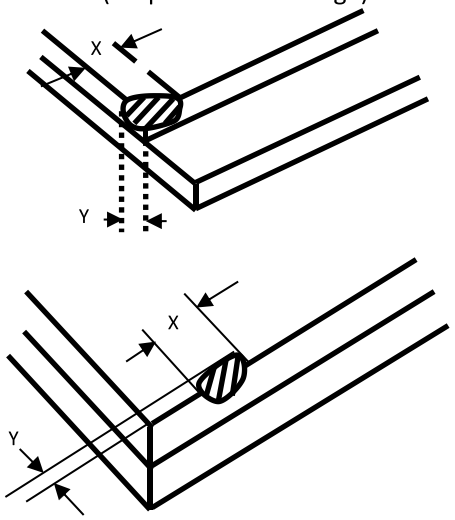
Inspection table or jig must be anti-electrostatic.

13.3 AQL(Acceptable Quality Level)

AQL of major and minor defect.

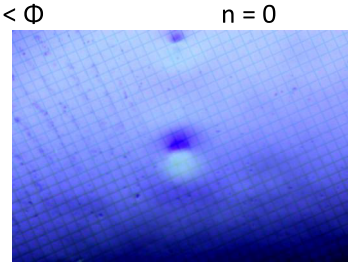
	MAJOR DEFECT	MINOR DEFECT
AQL	0.65	1.0

Cosmetic Check (Display Off) in Non-Active Area

Check Item	Classification	Criteria
Panel General Chipping	Minor	X > 6 mm (Along with Edge) Y > 1 mm (Perpendicular to edge) 

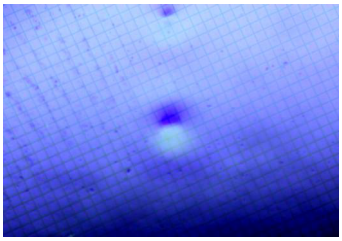
Cosmetic Check (Display Off) in Active Area

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

Check Item	Classification	Criteria
Any Dirt & Scratch on Polarizer's Protective Film	Acceptable	Ignore for not Affect the Polarizer
Scratches, Fiber, Line-Shape Defect (On Polarizer)	Minor	W ≤ 0.1 Ignore W > 0.1 L ≤ 2 n ≤ 1 L > 2 n = 0
Dirt, Black Spot, Foreign Material, (On Polarizer)	Minor	Φ ≤ 0.1 Ignore 0.1 < Φ ≤ 0.25 n ≤ 1 0.25 < Φ n = 0
Dent, Bubbles, White spot (Any Transparent Spot on Polarizer)	Minor	Φ ≤ 0.5 ➔ Ignore if no Influence on Display 0.5 < Φ n = 0 
Fingerprint, Flow Mark (On Polarizer)	Minor	Not Allowable

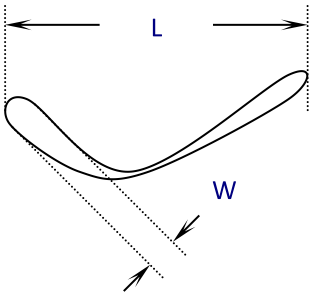
Cosmetic Check (Display Off) in Active Area

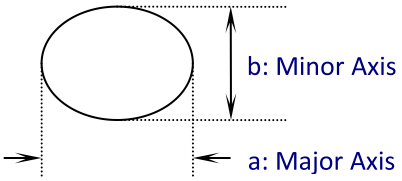
It is recommended to execute in clear room environment (class 10k) if actual in necessary.

Check Item	Classification	Criteria
Any Dirt & Scratch on Polarizer's Protective Film	Acceptable	Ignore for not Affect the Polarizer
Scratches, Fiber, Line-Shape Defect (On Polarizer)	Minor	W ≤ 0.1 Ignore W > 0.1 L ≤ 2 n ≤ 1 L > 2 n = 0
Dirt, Black Spot, Foreign Material, (On Polarizer)	Minor	Φ ≤ 0.1 Ignore 0.1 < Φ ≤ 0.25 n ≤ 1 0.25 < Φ n = 0
Dent, Bubbles, White spot (Any Transparent Spot on Polarizer)	Minor	Φ ≤ 0.5 ➔ Ignore if no Influence on Display 0.5 < Φ n = 0 
Fingerprint, Flow Mark (On Polarizer)	Minor	Not Allowable

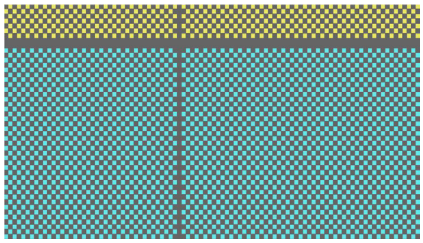
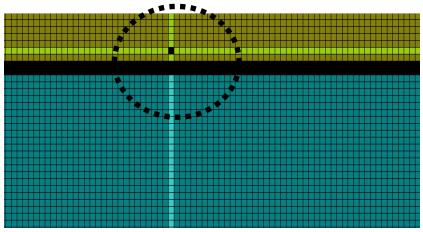
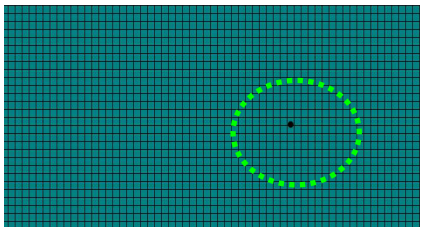
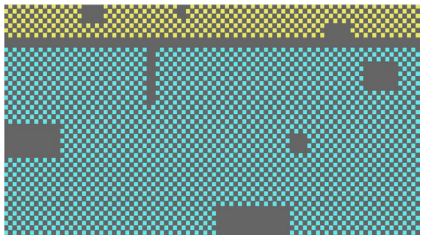
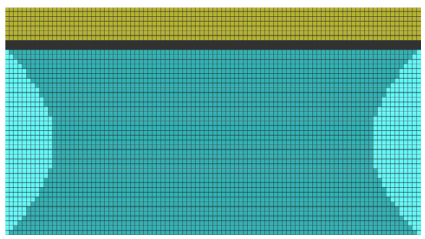
* Protective film should not be tear off when cosmetic check.

** Definition of W & L & Φ (Unit: mm): Φ = (a + b) / 2





Pattern Check (Display On) in Active Area

Check Item	Classification	Criteria
No Display	Major	
Missing Line	Major	
Pixel Short	Major	
Darker Pixel	Major	
Wrong Display	Major	
Un-uniform	Major	

14.Precautions

14.1 Handing precautions

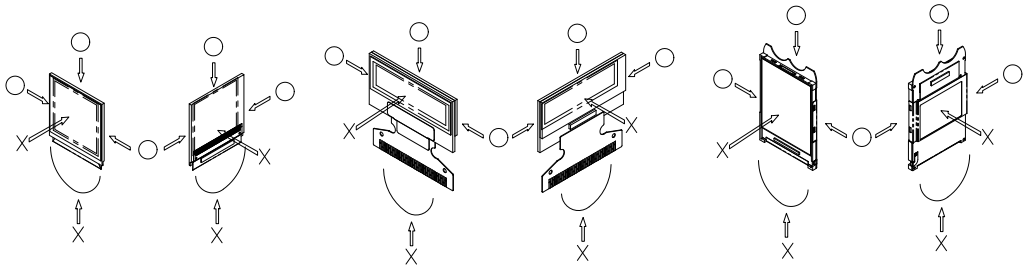
1) Since the display panel is being made of glass, do not apply mechanical impacts such us dropping from a high position.
2) If the display panel is broken by some accident and the internal organic substance leaks out, be careful not to inhale nor lick the organic substance.
3) If pressure is applied to the display surface or its neighborhood of the OEL display module, the cell structure may be damaged and be careful not to apply pressure to these sections.
4) The polarizer covering the surface of the OEL display module is soft and easily scratched. Please be careful when handling the OEL display module.
5) When the surface of the polarizer of the OEL display module has soil, clean the surface. It takes advantage of 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) Hold OEL display module very carefully when placing OEL display module into the system housing. Do not apply excessive stress or pressure to OEL 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.



7) Do not apply stress to the driver IC and the surrounding molded sections.
8) Do not disassemble nor modify the OEL display module.

9) Do not apply input signals while the logic power is off.
10) Pay sufficient attention to the working environments when handing OEL display modules to prevent occurrence of element breakage accidents by static electricity.
    * Be sure to make human body grounding when handling OEL 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 OEL display module. Be careful since static electricity may be generated when exfoliating the protective film.
11) 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 OEL 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).
12) If electric current is applied when the OEL display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful to avoid the above.

14.2 Designing precautions

1) The absolute maximum ratings are the ratings which cannot be exceeded for OEL display module, and if these values are exceeded, panel damage may be happen.
2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the V_{IL} and V_{IH} specifications and, at the same time, 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 (V_{DD}). (Recommend 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: SSD1322

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

15.The Appendix

SSD1351_Initial code

```
void OLED_Init(void)
{
 OLED_RES_Clr();
 delay_ms(200);
 OLED_RES_Set();
LCD_WR_REG(0xFD);
LCD_WR_DATA8(0x12);
LCD_WR_REG(0xFD);
LCD_WR_DATA8(0xB1);
LCD_WR_REG(0xAE);
LCD_WR_REG(0xB3);
LCD_WR_DATA8(0xF1);
LCD_WR_REG(0xCA);
LCD_WR_DATA8(0x7F);
LCD_WR_REG(0xA2);
LCD_WR_DATA8(0x00);
LCD_WR_REG(0xA1);
LCD_WR_DATA8(0x00);
LCD_WR_REG(0xA0);
LCD_WR_DATA8(0x74);
LCD_WR_DATA8(0xB5);
LCD_WR_DATA8(0x55);
LCD_WR_REG(0xB5);
LCD_WR_DATA8(0x00);
LCD_WR_REG(0xAB);
LCD_WR_DATA8(0x01);
LCD_WR_REG(0xB4);
LCD_WR_DATA8(0xA0);
 LCD_WR_REG(0xC1);
LCD_WR_DATA8(0xC8);
LCD_WR_DATA8(0x80);
LCD_WR_DATA8(0xC8);
LCD_WR_REG(0xC7);
LCD_WR_DATA8(0x0F);
Set_Gray_Scale_Table();
LCD_WR_REG(0xB1);
LCD_WR_DATA8(0x32);
LCD_WR_REG(0xBB);
LCD_WR_DATA8(0x17);
LCD_WR_REG(0xB2);
LCD_WR_DATA8(0xA4);
LCD_WR_DATA8(0x00);
LCD_WR_DATA8(0x00);
 LCD_WR_REG(0xB6);
 LCD_WR_DATA8(0x01);
 LCD_WR_REG(0xBE);
 LCD_WR_DATA8(0x05);
 LCD_WR_REG(0xA6);
 LCD_WR_REG(0xAF);
 }
```

16.Code Rule

QT 150E C C30 PG01 S7 V10

QT------Company
150-----Panel size(1.5 inch)
E--------Serial No.(A-Z)
C--------Display color: W-white B-blue G-green R-red Y-yellow C-Color
C---------FPC type H---Welded C---ZIF
30--------FPC numbers of OLED Panel (30PIN)
PG01----Reserved Code
S7----------Interface mode & pin numbers S7--SIP7PIN P--Parallel IX--I2C XPINS
V10------Product Ver. V10

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