DENSITRON® DISPLAYS

OLED DISPLAY MODULE

Product Specification

CUSTOMER	Standard	
PRODUCT NUMBER	DD-9616BE-2A	
CUSTOMER APPROVAL		Date

INTERNAL APPROVALS		
Product Mgr	Doc. Control	Electr. Eng
Bazile Peter	**Bazile Peter**	**Luo Luo**
Date: 22/12/09	Date: 22/12/09	Date: 22/12/09

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REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
A	22 December 09			First Issue	

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1 MAIN FEATURES

ITEM	CONTENTS
Display Format	96 x 16 Dots
Overall Dimensions(W*H*T)	29.10×9.20× 1.60 mm
Active Area(W*H)	21.104 × 3.504 mm
Viewing Area(W*H)	23.104 x 5.504 mm
Display Mode	Passive Matrix
Display Colour	Blue Colour
Driving Method	1 / 16 duty
Driver IC	SSD1306
Operating temperature	-30℃ ~ +70℃
Storage temperature	-40℃ ~ +80℃

2 MECHANICAL SPECIFICATION

2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	96 x 16	Dots
Overall Dimensions	29.10×9.20× 1.60	mm
Viewing Area	23.104 x 5.504	mm
Active Area	21.104 × 3.504	mm
Dot Size	0.204 × 0.204	mm
Dot Pitch	0.22 × 0.22	mm
Weight	0.89	g
IC Controller/Driver	SSD1306	

(Reference Mechnical Design)

Notes:

1. Color: Light Blue
2. Driver IC: SSD1306
3. FPC Number: UT-0206-P01
4. Interface: I2C
5. General Tolerance: ±0.30
6. The total thickness (1.70 Max) is without polarizer protective film & remove tape.
   The actual assembled total thickness with above materials should be 1.95 Max.
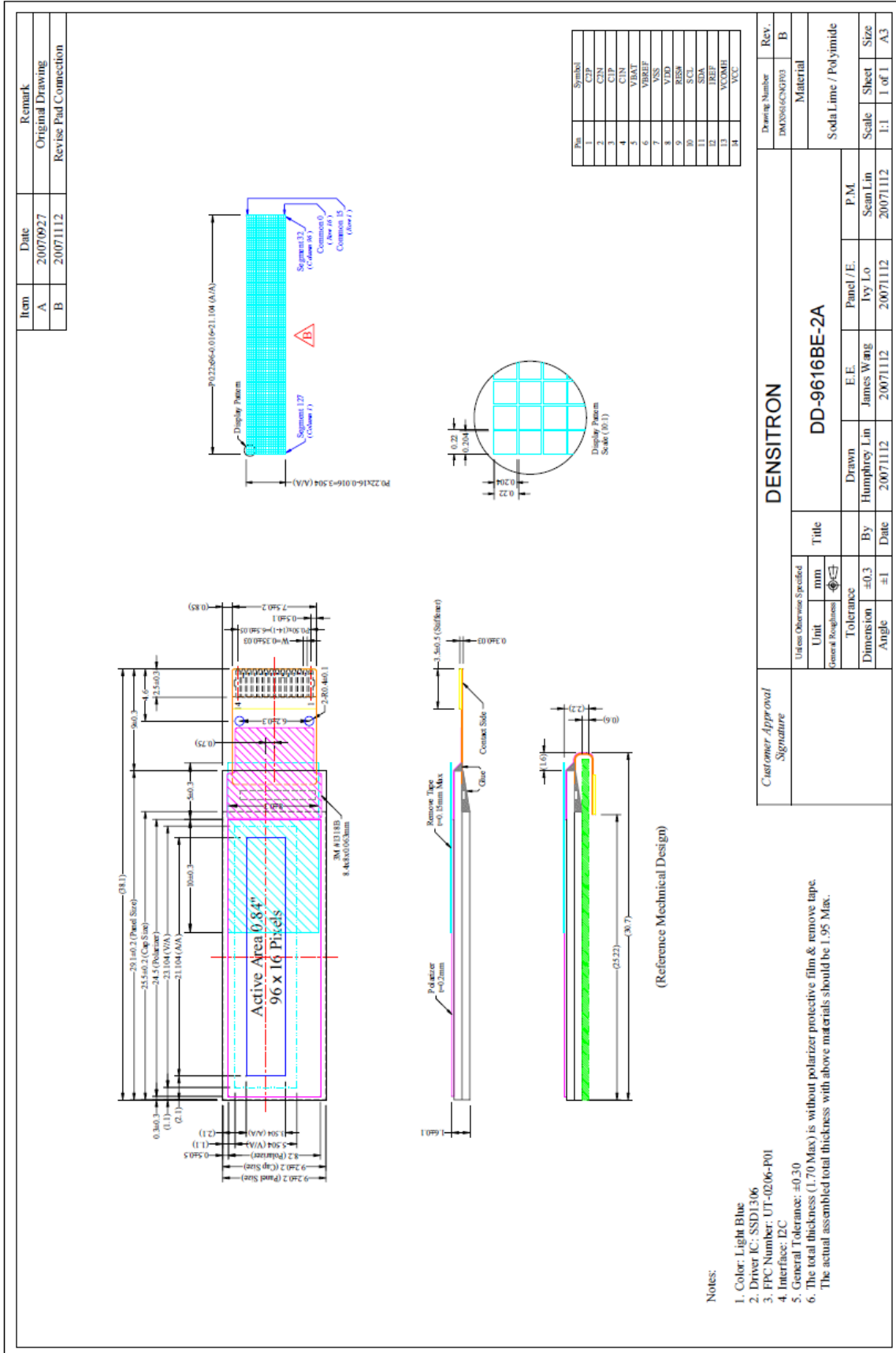
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3 ELECTRICAL SPECIFICATION

3.1 ABSOLUTE MAXIMUM RATINGS

VSS = 0 V, Ta = 25 °C

Item	Symbol	Min	Max	Unit	Note
Supply Voltage for Operation	V_{DD}	-0.3	4	V	Note 1, 2
Supply Voltage for Display	V_{CC}	0	15	V	
Operating Temperature	Top	-30	70	°C	
Storage Temperature	Tstg	-40	80	°C	
Static Electricity	Be sure that you are grounded when handling displays.				

Note 1: All the above voltages are on the basis of "VSS=0V".
Note 2: When this module is used beyond above absolute maximum ratings, permanent damage to the module may occur. Also for normal operations it's desirable to use this module under the conditions according to Section 3.2 "Electrical Characteristics" and section 4 "optical characteristic. If this module is used beyond these conditions the module may malfunction and the reliability could deteriorate.

3.2 ELECTRICAL CHARACTERISTICS

3.2.1 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	V_{CC}	Note 3	7.0	7.25	7.5	V
Supply Voltage for DC/DC	V_{BAT}	Internal DC/DC	3.3	-	4.2	V
High Level Input	V_{IH}	-	$0.8 \times V_{DD}$	-	V_{DD}	V
Low Level Input	V_{IL}	-	0	-	$0.2 \times V_{DD}$	V
High Level Output	V_{OH}	Iout=100µA,3.3 MHz	$0.9 \times V_{DD}$	-	V_{DD}	V
Low Level Output	V_{OL}	Iout=100µA,3.3 MHz	0	-	$0.1 \times V_{DD}$	V
Operating Current for VDD	I_{DD}	Note 4 Note 5	-	180	300	µA
Operating Current for VBAT(VCC Generated by Internal DC/DC)	I_{BAT}	Note 4	-	7.5	9.4	mA
		Note 5	-	12.6	15.8	mA
Sleep Mode Current for VCI	$I_{DD, SLEEP}$	-	-	1	5	µA
Sleep Mode Current for VCC	$I_{CC, SLEEP}$	-	-	1	5	µA

Note 3 Brightness (L_{br}) and Supply Voltage for Display (V_{CC}) is subject to the change of the panel characteristics and the customer's request.
Note 4 V_{DD}= 2.8V, V_{CC} = 7.25V, 50% Display area turned on.
Note 5 V_{DD} = 2.8V, V_{CC} = 7.25V, 100% Display area turned on

3.3 INTERFACE PIN ASSIGNMENT

No.	Symbol	I/O	Function
1	C2P	I	
2	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 floating when the converter is not used.
3	C1P	I	
4	C1N	I	
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 VDD source when the converter is used. It should be floating to VDD when the converter is not used.
6	VBREF	P	Voltage Reference for DC/DC Converter Circuit This pin is the internal voltage reference of booster circuit. A stabilization capacitor should be connected to VSS
7	VSS	P	Ground of Logic Circuit This is a ground pin. It acts as a reference for the logic pins. The OEL driving voltages and the analogue circuits. It must be connected to external ground.
8	VDD	P	Power Supply for Logic This is a voltage supply pin. It must be connected to external source
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.
10	SCL	I	I2C Bus Clock Signal The transmission if information in the I2C bus is following a clock signal. Each transmission of data bit is taken place during a single clock period of this pin
11	SDA	I/O	I2C Bus Data Signal This pin acts as a communication channel between the transmitter and the receiver.
12	IREF	I	Current Reference for Brightness Adjustment This pin is segment current reference pin. A resistor should be connected between this pin and VSS. Set the current lower than 12.5µA.
13	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 VSS.
14	VCC	P	Power Supply for OEL Panel This is the most positive voltage supply pin of the chip. It must be connected to external source.

3.4 BLOCK DIAGRAM
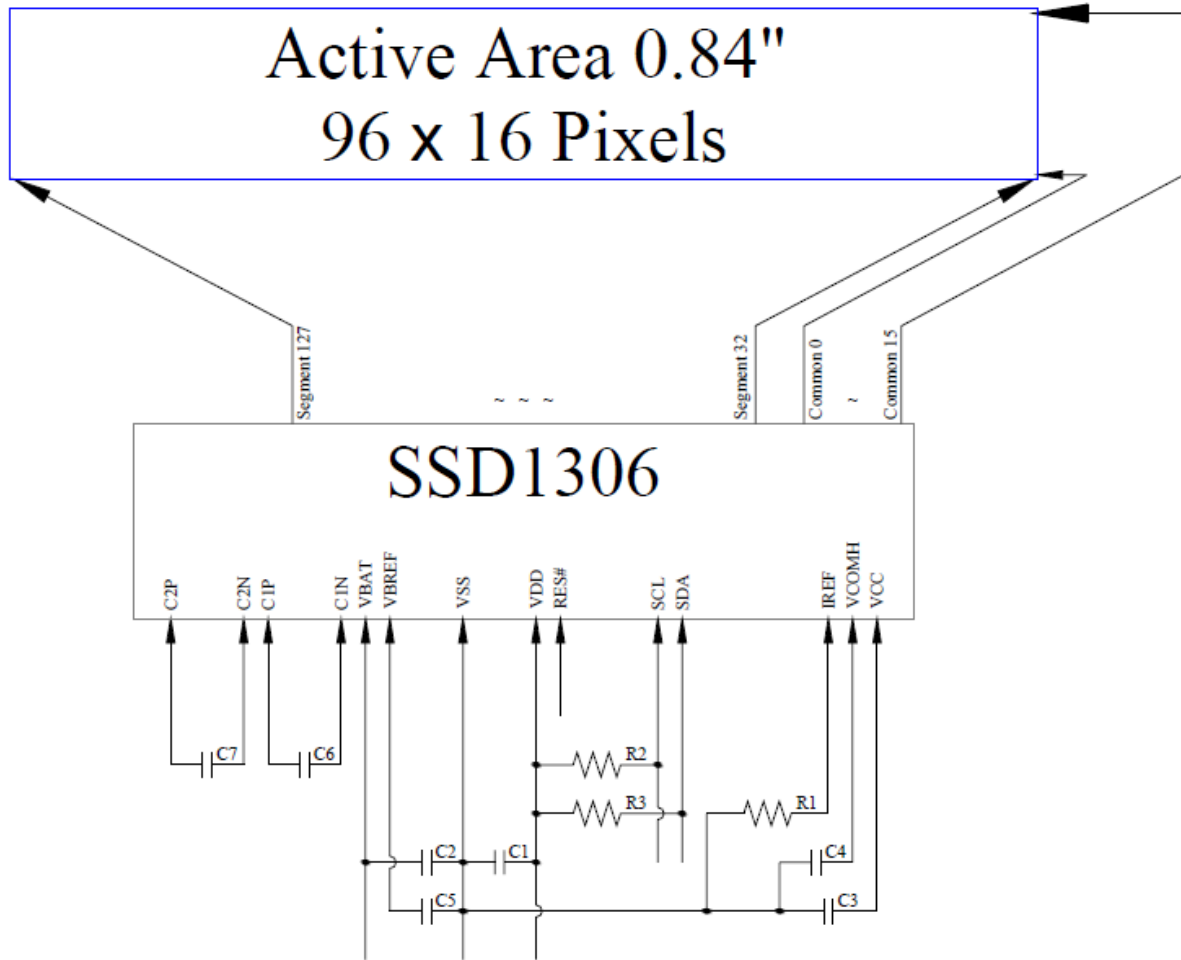
Pins connected to MCU interface: RES#, SCL and SDA

C1, C3, C6, C7:	1µF
C3, C4:	2.2µF
C5:	22 n F
R1:	820kΩ, R1 = (Voltage at IREF – VSS) / IREF
R2, R3:	2KΩ

3.5 AC CHARACTERISTICS

Characteristics	Symbol	Min	Max	Unit
Clock Cycle Time	t_{cycle}	2.5	-	us
Start Condition Hold Time	t_{HSTART}	0.6	-	us
Data Hold Time (for "SDA$_{OUT}$" Pin)	t_{HD}	0	-	ns
Data Hold Time (for "SDA$_{IN}$" Pin)		300		
Data Setup Time	t_{SD}	100	-	ns
Start Condition Setup Time (Only relevant for a repeated Start condition)	t_{SSTART}	0.6	-	us
Stop Condition Setup Time	t_{SSTOP}	0.6	-	us
Rise Time for Data and Clock Pin	t_R	-	300	ns
Fall Time for Data and Clock Pin	t_F	-	300	ns
Idle Time before a New Transmission can Start	t_{IDLE}	1.3		us

(VDD – VSS = 2.8V, Ta = 25°C)
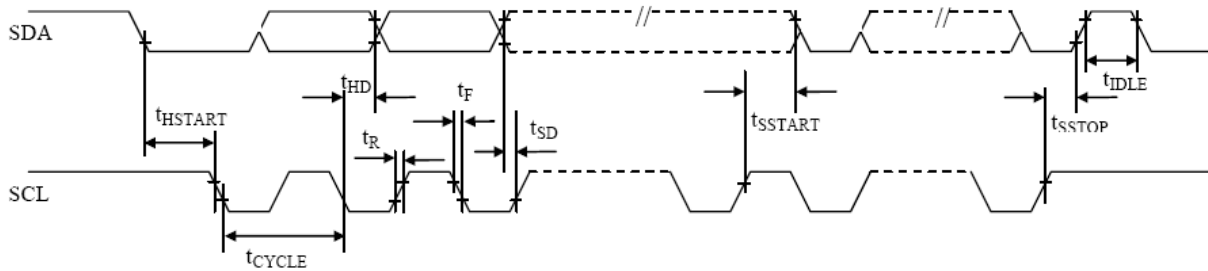
4 OPTICAL SPECIFICATION

4.1 OPTICAL CHARACTERISTICS

Characteristics	Symbol	Condition	Min	Typ	Max	Unit
Brightness	L_{br}	With Polarizer	100	120	-	cd/m^2
C.I.E.(White)	(X)	Without Polarizer	0.12	0.16	0.20	-
	(Y)		0.22	0.26	0.30	
Dark Room Contrast	CR		-	>2000:1	-	-
Viewing Angle			>160	-	-	degree

Optical measurement taken at V_{DD} = 2.8V, V_{CC} = 9V & 7.25V
Software configuration follows Section 5.4 Initialization.

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5 FUNCTIONAL SPECIFICATION

5.1 COMMANDS

Please refer to the Technical Manual for the SSD1306

5.2 POWER UP/DOWN SEQUENCE

To protect panel and extend the panel lifetime, 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 panel enough time to complete the action of charge and discharge before/after the operation.

5.2.1 POWER UP SEQUENCE

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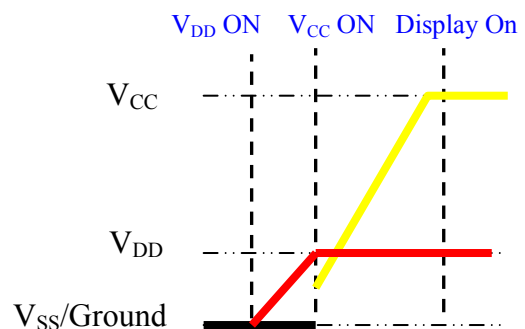
5.2.2 POWER DOWN SEQUENCE

1. Send Display off command
2. Power down V_{CC}
3. Delay 100ms
   (When V_{CC} is reach 0 and panel is completely discharges)
4. Power down V_{DDIO}
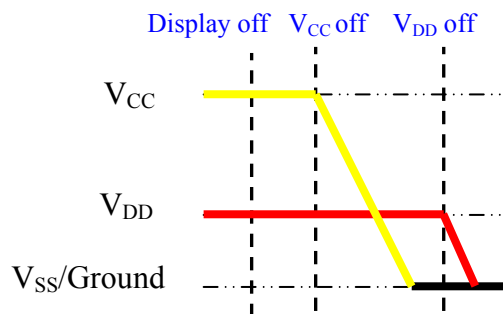
5.3 RESET CIRCUIT

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)

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5.4 ACTUAL APPLICATION EXAMPLE

Command usage and explanation of an actual example

<Initialization>

Set Display Off 0xAE	Set Low Power Display Mode 0xD8, 0x05	Set VCOMH Deselect Level 0xDB, 0x20
Set Display Clock Divide Ratio/Oscillator Frequency 0xD5, 0x80	Set Segment Re-Map 0xA1	Set Entire Display On/Off 0xA4
Set Multiplex Ratio 0xA8, 0x0F	Set COM Output Scan Direction 0xC8	Set Normal/Inverse Display 0xA6
Set Display Offset 0xD3, 0x00	Set COM Pins Hardware Configuration 0xDA, 0x02	Clear Screen
Set Display Start Line 0x40	Set Contrast Control 0x81, 0xAF	Set Display On 0xAF
Set Charge Pump 0x8D, 0x14	Set Pre-Charge Period 0xD9, 0xF1	

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6 PACKAGING AND LABELLING SPECIFICATION
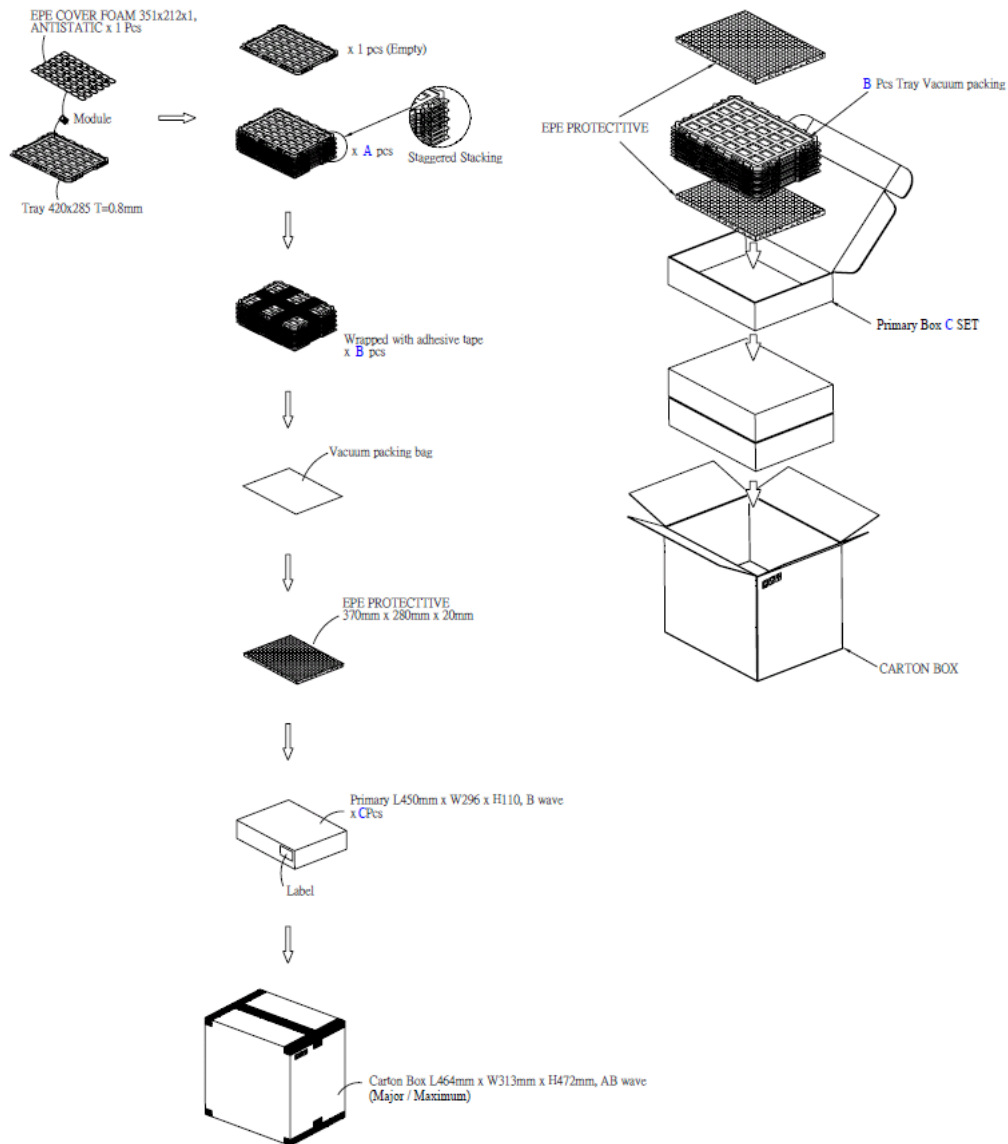
Item		Quantity	
Holding Trays	(A)	15	per Primary Box
Total Trays	(B)	16	per Primary Box (Including 1 Empty Tray)
Primary Box	(C)	1~4	per Carton (4 as Major / Maximum)

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6.1 LABELLING & MARKING

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DENSITRON
DD-9616BE-2A
TW YY MM
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# 7 QUALITY ASSURANCE SPECIFICATION

7.1 CONFORMITY

The performance, function and reliability of the shipped products conform to the Product Specification.

7.2 DELIVERY ASSURANCE

7.2.1 DELIVERY INSPECTION STANDARDS

IPC-AA610, class 2 electronic assembly's standard

7.2.2 Zone definition

A Active

B Outside Active
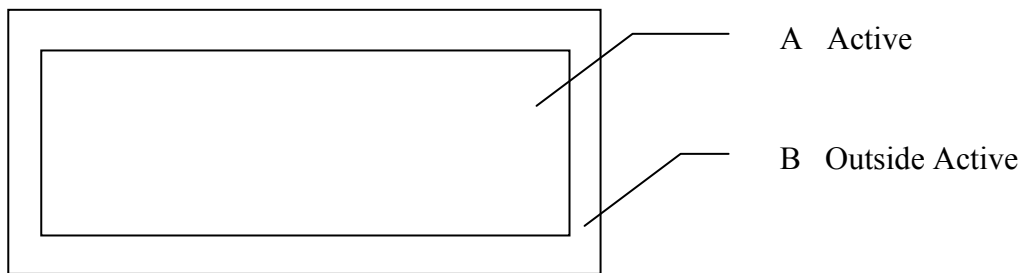
7.2.3 Visual inspection

Test and measurement to be conducted under following conditions
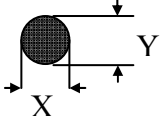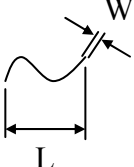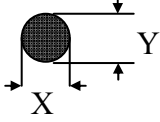
Temperature:	23±5
Humidity:	55±15%RH
Fluorescent lamp:	30 W
Distance between the Panel & Eyes of the Inspector:	30cm
Distance between the Panel & the lamp:	50cm
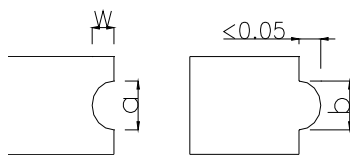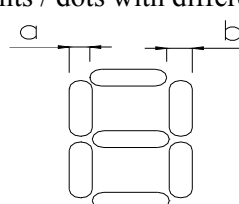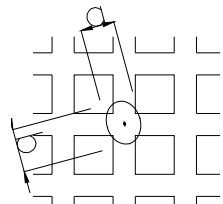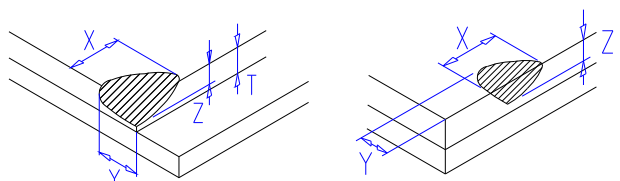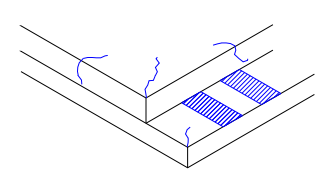
7.2.4 Standard of appearance inspection

Units: mm

Class	Item	Criteria	
Minor	Packing & Label	Outside & inside package	Presence of product no., lot no., quantity
Critical		Product must not be mixed with others and quantity must not be different from that indicated on the label	
Major	Dimension	Product dimensions must be according to specification and drawing	
Major	Electrical	Product electrical characteristics must be according to specification	
Critical	OLED Display	Missing lines, short circuits or wrong patterns on OLED display are not allowed	
Minor	Black spot, white spot, dust	Round type: as per following drawing $\varnothing = (X+Y)/2$ Line type: as per following drawing Total acceptable quantity: 3	
Minor	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1	
Minor	Polariser bubble	$\varnothing = (X+Y)/2$	

Round type — Acceptable quantity:

Size	Zone A	Zone B
$\varnothing < 0.1$	Any number	
$0.1 < \varnothing < 0.2$	3	Any number
$0.2 < \varnothing < 0.25$	1	
$0.25 < \varnothing$	0	

Line type — Acceptable quantity:

Length	Width	Zone A	Zone B
- -	$W \leq 0.05$	Any number	
$L \leq 2.0$	$W \leq 0.1$	3	Any number
$L > 2.0$		0	

Polariser bubble — Acceptable quantity:

Size	Zone A	Zone B
$\varnothing < 0.5$	Any number	Any number
$\varnothing > 0.5$	0	
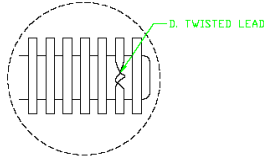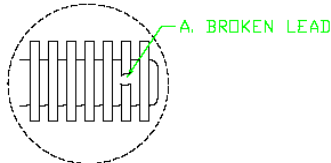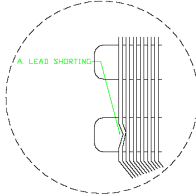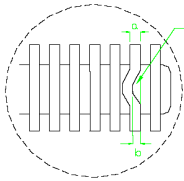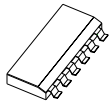
Class	Item	Criteria
Minor	Segment deformation	1b. Pin hole on dot matrix display **Acceptable quantity** | Size	
---	---
a,b<0.1	Any number
(a+b)/2≤0.1	Any number
0.5<∅<1.0	3 | Total acceptable quantity: 7 2. Segments / dots with different width **Acceptable** | a≥b	a/b≤4/3
---	---
a<b	a/b>4/3 | 3. Alignment layer defect ∅ = (a+b)/2 **Acceptable quantity** | Size	
---	---
∅≤0.4	Any number
0.4<∅≤1.0	5
1.0<∅≤1.5	3
1.5<∅≤2.0	2	 Total acceptable quantity: 7
Minor	Panel Chipping	X ≤ 1/6 Panel length Y ≤ 1 Z ≤ T
Minor	Panel Cracking	Cracks not allowed
Minor	Cupper exposed (pin or film)	Not allowed if visible by eye inspection
Minor	Film or Trace Damage	Not allowed if affect electrical function

Class	Item	Criteria			
Minor	Contact Lead Twist	Not allowed			
Minor	Contact Lead Broken	Not allowed			
Minor	Contact Lead Bent	Not allowed if bent lead causes short circuit			
		Not allowed if bent lead extends horizontally more than 50% of its width			
Minor	Colour uniformity	Level of sample for approval set as limit sample			
Major	PCB	No unmelted solder paste should be present on PCB			
Critical		Cold solder joints, missing solder connections, or oxidation are not allowed			
Minor		No residue or solder balls on PCB are allowed			
Critical		Short circuits on components are not allowed			
Minor	Tray particles			Size	Quantity
			On tray	$\varnothing<0.2$	Any number
				$\varnothing>0.25$	4
			On display	$\varnothing\geq0.25$	2
				L = 3	1

7.3 DEALING WITH CUSTOMER COMPLAINTS

7.3.1 Non-conforming analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.
After accepting it, Densitron should complete the analysis in two weeks from receiving the sample.
If the analysis cannot be completed on time, Densitron must inform the purchaser.

7.3.2 Handling of non-conforming displays

If any non-conforming displays are found during customer acceptance inspection which Densitron is clearly responsible for, return them to Densitron.
Both Densitron and customer should analyse the reason and discuss the handling of non-conforming displays when the reason is not clear.
Equally, both sides should discuss and come to agreement for issues pertaining to modification of Densitron quality assurance standard.

8 RELIABILITY SPECIFICATION

8.1 RELIABILITY TESTS

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	70°C±2, 240 hours	The operational functions work
Low Temperature Operation	-30°C±2, 240 hours	
High Temperature Storage	80°C±2, 240 hours	
Low Temperature Storage	-40°C±2, 240 hours	
High Temperature & High Humidity Storage(Operation)	60°C±2, 90%RH, 120 hours	
Thermal Shock	-40°C to 85°C, 24 cycles 1 Hour	

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

8.1.1 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 teat at 23±5 °C;55±15% RH

8.2 LIFE TIME

Item	Description
1	Function, performance, appearance, etc. shall be free from remarkable deterioration more than 10,000 hours under ordinary operating conditions of room temperature (25±10 °C), normal humidity (50% RH), and in area not exposed to direct sunlight. Storage Life time is 20,000 hr under room temperature (25±10 °C), normal humidity (50% RH)
2	End of lifetime is specified as 50% of initial brightness.

8.3 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 23±5°C; 55±15% RH.

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9 PRECAUTIONS

9.1 Handling

Safety
If the panel breaks, be careful not to get the organic substance in your mouth or in your eyes.
If the organic substance touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design
Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.
Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during OLED cleaning
Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotriflorothane.
Do not wipe the display surface with dry or hard materials that will damage the polariser surface.
Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge
As the display uses C-MOS LSI drivers, connect any unused input terminal to V_{DD} or V_{SS}. Do not input any signals before power is turned on.
Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging
Displays use OLED elements, and must be treated as such. Avoid strong shock and drop from a height.
To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation
It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life.

Other Precautions
When a display module is operated for a long of time with fixed pattern may remain as an after image or slight contrast deviation may occur.
Nonetheless, if the operation is interrupted and left unused for a while, normal state can be restored.
Also, there will be no problem in the reliability of the module.

Storage
Store the display in a dark place where the temperature is 25°C ± 10°C and the humidity below 50%RH.
Store the display in a clean environment, free from dust, organic solvents and corrosive gases.
Do not crash, shake or jolt the display (including accessories).

9.2 STORAGE

When storing OEL display modules, put them in static electricity preventive bags avoiding exposure to direct sun light nor to lights of fluorescent lamps, etc. and, also, avoiding high temperature and high humidity environments or low temperature (less than 0°C) environments. (We recommend you to store these modules in the packaged state when they were shipped from Factory.)
At that time, be careful not to let water drops adhere to the packages or bags nor let dewing occur with them.

 If electric current is applied when water drops are adhering to the surface of the OEL display module, 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 about the above.

9.3 DESIGNING

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.

To prevent occurrence of malfunctioning by noise: pay attention to satisfy the VIL and VIH specifications and, at the same time, to make the signal line cable as short as possible.

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

Pay sufficient attention to avoid occurrence of mutual noise interference with the neighbouring devices.

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

When fastening the OEL display module, fasten the external plastic housingsection.

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.

The electric potential to be connected to the rear face of the IC chip should be as follows: SSD1351
* Connection (contact) to any other potential than the above may lead to rupture of the IC.

9.4 Disposing

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

When an OEL display module is operated for a long of time with fixed pattern may remain as an after image or slight contrast deviation may occur. Nonetheless, if the operation is interrupted and left unused for a while, normal state can be restored. Also, there will be no problem in the reliability of the module.

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To protect OEL display modules from performance drops by static electricity rapture, etc., do not touch the following sections whenever possible while handling the OEL display modules.
* Pins and electrodes
* Pattern layouts such as the COF

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.

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. It therefore is necessary to take appropriate measures to suppress noise generation or to protect from influences of noise on the system design.

We recommend you to construct its software to make periodical refreshment of the operation statuses (re-setting of the commands and re-transference of the display data) to cope with catastrophic noise.

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