

PRODUCT SPECIFICATION

MODEL No. HD15MOF1

[1.5" 128x128 MONO PMOLED Module]

CUSTOMER'S APPROVAL	
SIGNATURE	DATE

Hyundai Display (HK) Co., Limited

Date : 20-May-2020

Version : A.0

Issue Date	Designed By : Engineering Dept.			Confirmed By : QA Dept.	
	Prepared	Checked	Approved	Checked	Approved
20-May-2020					

This specification is subject to change without notice. Consult "Hyundai Display" before ordering.

[RECORD OF REVISIONS]

Rev. No.	DATE	PAGE	DESCRIPTION
A.0	2020.05.20	-	FIRST RELEASE

[TABLE OF CONTENTS]

1. Application -----	4
2. Construction and outline -----	4
3. Mechanical specifications -----	4
4. Absolute maximum ratings -----	5
5. Electrical characteristics -----	6
6. Optical characteristics -----	9
7. Interface signals -----	11
8. Input timing characteristics -----	13
9. Lot number identification -----	18
10. Reliability test conditions -----	19
11. Outline drawing -----	20
12. Packaging specification -----	21
13. Incoming inspection standards -----	22
14. Warranty -----	23
15. Precautions for use -----	23

1. APPLICATION

This document defines the specification of “HD15MOF1”(ROHS Compliant).
This model has been specifically designed for use only in digital wearable electronic devices such as smart watch, smart band and healthy tracker, etc.

2. CONSTRUCTION AND OUTLINE

Display type : PMOLED display

Backlight system : None

3. MECHNICAL SPECIFICATIONS

Item	Specification	Unit	Note
Display type	1.5" PMOLED display	-	-
Dot format	128(W) x 128(H)	dot	(1)
Viewing direction	All	O'clock	(2)
Contrast ratio	2000 (Min.)	-	-
Luminance	80 (Typ.)	cd/m ²	-
Outline dimensions	33.80(W) x 36.50(H) x 2.05(T)	mm	(3)
Viewing area	26.86(W) x 26.86(H)	mm	-
Active area	28.86(W) x 28.86(H)	mm	-
Pixel pitch	0.21 x 0.21	μm	-
Driver IC	SSD1327ZB/Solomon	-	-
Interface type	SPI/I ² C/6800,8080 MCU	-	-
Display colors	Monochrome (White), 16 Gray scale	-	-
Surface treatment	Anti glare	-	-
Weight	TBD	g	-

* Note (1) : Resolution

* Note (2) : IC pad in the down.

* Note (3) : Projection not include, please refer to outline drawing for details.

4. ABSOLUTE MAXIMUM RATINGS

4-1. Electrical absolute maximum ratings

(Ta=25°C)

Item	Symbol	Min	Max	Unit
Supply vol. for operation	VCI	- 0.3	+4.0	V ₍₁₎₍₂₎
Supply vol. for logic	VDD	- 0.5	+2.75	V ₍₁₎₍₂₎
Supply vol. for display	VCC	- 0.5	+19.0	V ₍₁₎₍₂₎

* Note (1) : Even if the absolute maximum rating of one of the above parameters is exceeded only for short while, the quality of the product may be degraded. Therefore, be sure to use the product within the range of the absolute maximum ratings.

* Note (2) : “VSS=0V”

4-2. Environmental absolute maximum ratings

Item	Symbol	Min	Max	Unit
Operating temperature (1)	T _{OP}	- 40	+ 80	°C
Storage temperature (2)	T _{ST}	- 40	+ 85 ⁽⁶⁾	°C
Operating humidity (3)	H _{OP}	10	(4)	%RH
Storage humidity (3)	H _{ST}	10	(4)	%RH
Vibration (with Packing)	-	(5)	(5)	-

* Note (1) : Under operating temperature of -40 to +70 deg the OLED module can be operated without permanent damage. Some reversible optical artifacts may occur at very low and very high temperatures. To be evaluated by customer.

* Note (2) : Please follow the condition which is written on 4-2. Environmental absolute maximum ratings.

Temp. ≤ 60°C, 90%RH

Temp. > 60°C, Absolute humidity shall be less than 65%RH

Even within operating temperature range, environmental usage shall be within spec.

* Note (3) Non-condensing.

* Note (4) Please refer and hold by the following spec which is mentioned in the specification

Temp. ≤ 60°C, 90%RH Max.

Temp. > 60°C, Absolute humidity shall be less than 65%RH.

Even though it is wide temp range, it is not accepted to use under the environment which is over the spec.

* Note (5)

Frequency	10 ~ 55 Hz	X.Y.Z : 0.5 Hrs / each direction
Amplitude of vibration	1.5 mm	
Interval	12 minutes	

*Note (6) The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.

5. ELECTRICAL CHARACTERISTICS

5-1. DC characteristics

(Ta=25°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Supply voltage for logic	VCI	2.8	3.0	3.3	V	-
Supply voltage for display	VCC	14.0	14.5	15.0	V	-
High level input voltage	VIH	0.8*VCI	-	VCI	V	-
Low level input voltage	VIL	0	-	0.2*VCI	V	-
High level output voltage	VOH ⁽¹⁾	0.9*VCI	-	VCI	V	-
Low level output voltage	VOL ⁽¹⁾	0	-	0.1*VCI	V	

*Note (1) : Iout=100uA

5-2. OLED panel electrical characteristics

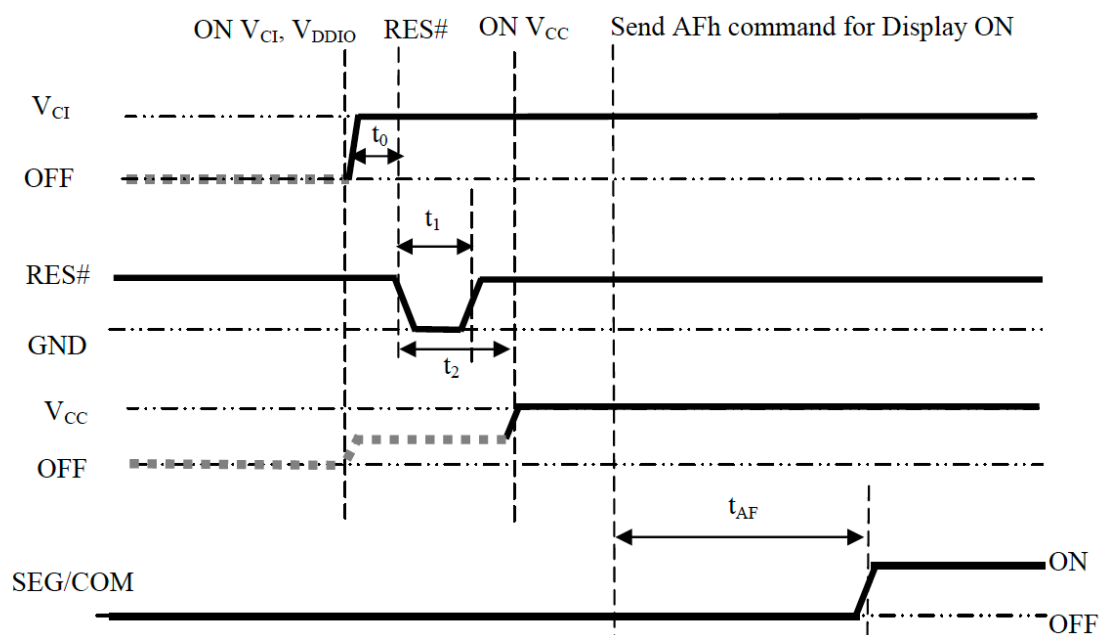
(Ta=25°C)

Item	Min.	Typ.	Max.	Unit	Note
Normal mode current consumption (ICC)	-	24.0	33.0	mA	(1)

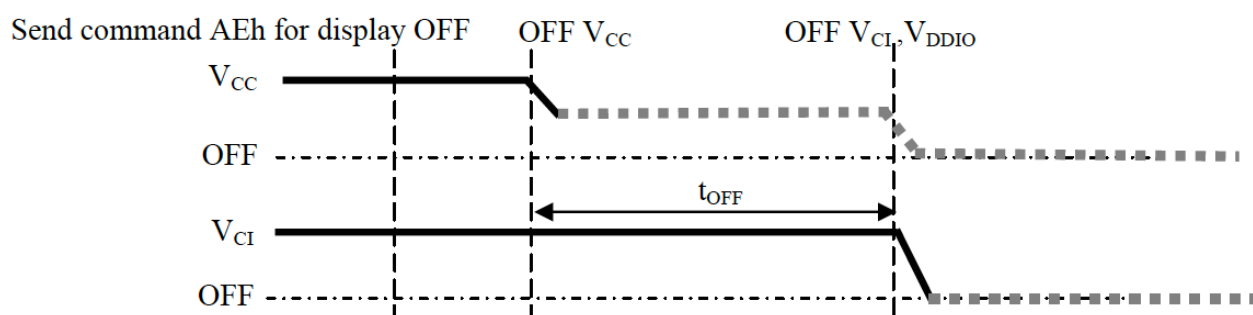
*Note (1) : VCC=14.5V

5-3. Power ON/OFF sequence

(1) Power on sequence



(2) Power off sequence



5-4. Initialization code

```
void Initial_ic(void){

    write_command(0x15);    //Set Column Address
    write_command(0x00);    //Start Column Address
    write_command(0x3F);    //End Column Address

    write_command(0x75);    //Set Row Address
    write_command(0x00);    //Start Row Address
    write_command(0x7F);    //End Row Address

    write_command(0x81);    //Set Contrast Control
    write_command(0x9b);    //Contrast Level

    write_command(0xA0);    //Set Re-map
    write_command(0x51);    //Default Setting

    write_command(0xA1);    //Set Display Start Line
    write_command(0x00);

    write_command(0xA2);    //Set Display Offset
    write_command(0x00);

    write_command(0xA4);    //Set Display Mode

    write_command(0xA8);    //Set Multiplex Ratio
    write_command(0x7F);    //Multiplex

    write_command(0xAB);    //Set Function SelectionA
    write_command(0x01);

    write_command(0xB1);    //Set Phase Length
    write_command(0xf1);

    write_command(0xB3);    //Set Display Clock Divide Ratio/Oscillator Frequency
    write_command(0x00);

    write_command(0xBC);    //Set Precharge Voltage
    write_command(0x07);

    write_command(0xBE);    //Set VCOMH Voltage
    write_command(0x07);

    write_command(0xB6);    //Set Second Pre-charge period
    write_command(0x0F);

    write_command(0xD5);    //Set Function selection B
    write_command(0x62);

    write_command(0xAF);    //Set Display On
}
```

6. OPTICAL CHARACTERISTICS

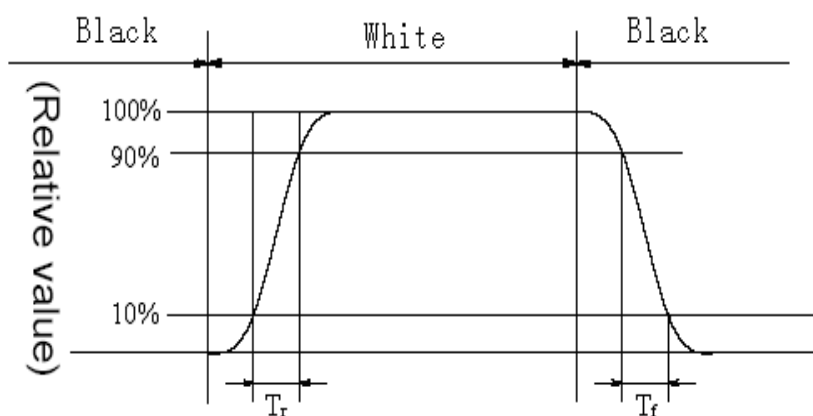
(VDD=3.3V, Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Response time ⁽²⁾	T_r	$\Theta=\Phi=0^\circ$	-	10	-	us
	T_f					
Viewing angle range ⁽³⁾	$\Theta_{T(12)}$	CR $\geq$ 10	75	80	-	deg
	$\Theta_{B(6)}$		75	80	-	
	$\phi_{R(3)}$		75	80	-	
	$\phi_{L(9)}$		75	80	-	
Contrast ratio ⁽¹⁾	CR	$\Theta=\Phi=0^\circ$	-	2000	-	-
Brightness ⁽⁴⁾	L	$\Theta=\Phi=0^\circ$	60	80	-	cd/m ²
Luminance uniformity	U_L	$\Theta=\Phi=0^\circ$	80	-	-	%
Operating life time ⁽⁵⁾	Top	L=80cd/m ²	20000	-	-	Hrs
Color Chromaticity (CIE1931)	White	Normal $\Theta=\Phi=0^\circ$	0.23	0.28	0.33	-
			0.27	0.32	0.37	

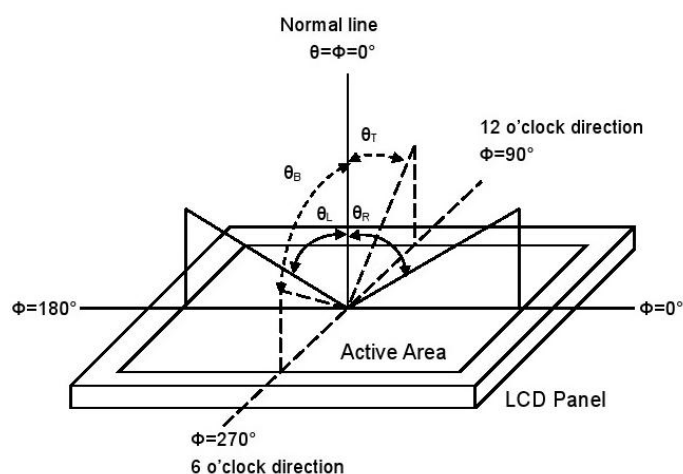
* Note (1) : Definition of contrast ratio (Dark room contrast)

$$\text{Contrast Ratio (CR)} = \frac{\text{Luminance When OLED is at "White" state}}{\text{Luminance When OLED is at "Black" state}}$$

* Note (2) : Definition of response time



* Note (3) : Definition of viewing angle



* Note (4)(5) : Under $VCC=14.5V$, $T_a=25^\circ C$, 50% RH

Life time is defined the amount of time when the luminance has decayed to less than 50% of the initial measured luminance. Screen saving mode will extend OLED life time.

Item	Min.	Unit	Condition	Remarks
Life Time	20,000	Hrs	80cd/m ² , 50% checkerboard	

7. INTERFACE SIGNALS

Mating connector HIROSE “FH19C-24S-0.5SH”

No.	Symbol	Description	Remarks
1	VSS	Ground pin. It must be connected to external ground.	
2	VCC	Power supply for panel driving voltage. This is also the most positive power voltage supply pin. It is supplied by external high voltage source.	
3	VCOMH	Common signal deselected voltage level. A capacitor should be connected between this pin and VSS. No external power supply is allowed to connect to this pin	
4	VCI	Low voltage power supply and power supply for interface logic level. It should match with the MCU interface voltage level and must be connected to external source. VCI must always set to be equivalent to or higher than VDD.	
5	VDD	Power supply for core logic operation.	
6	BS1	MCU bus interface selection pins. ⁽¹⁾	
7	BS2		
8	VSS	Ground pin. It must be connected to external ground.	
9	IREF	This is segment output current reference pin.	
10	CS	This pin is the chip select input connecting to the MCU. The chip is enabled for MCU communication only when CS is pulled LOW. (active LOW)	
11	RES	This is reset signal input pin. When the pin is pulled low, initialization of the chip is executed. Keep this pin pull HIGH during normal operation.	
12	D/C	This pin is data/command control pin connecting to the MCU. ⁽²⁾	
13	W/R	This pin is read/write control pin connecting to the MCU interface. ⁽³⁾	
14	RD	This pin is MCU interface pin. ⁽⁴⁾	
15~22	D0~D7	These pins are bi-directional data bus connecting to the MCU data bus. ⁽⁵⁾	
23	VCC	Power supply for panel driving voltage. This is also the most positive power voltage supply pin. It is supplied by external high voltage source.	
24	VSS	Ground pin. It must be connected to external ground.	

* Note (1) : BUS interface selection

BS[2:1]	Interface
00	4 line SPI
01	I ² C
11	8-bit 8080 parallel
10	8-bit 6800 parallel

(a) "0" is connected to "VSS" (b) "1" is connected to "VCI"

* Note (2) : When the pin is pulled HIGH, the data at D[7:0] will be interpreted as data.
When the pin is pulled LOW, the data at D[7:0] will be transferred to a command register.

In I²C mode, this pin acts as SA0 for slave address selection.

When 3 wire serial interface is selected, this pin must be connected to VSS.

* Note (3) : When 6800 interface mode selected, this pin will be used as READ/WRITE selection Input. Read mode will be carried out when this pin pulled HIGH and write mode when LOW.

When 8080 interface mode selected, this pin will be the WRITE input. Data write operation is initiated when this pin is pulled LOW and the chip is selected.

* Note (4) : When 6800 interface mode is selected, this pin will be used as the Enable(E) signal. Read/Write operation is initiated when this pin is pulled HIGH and the chip is selected.
When 8080 interface mode is selected, this pin receives the READ (RD) signal. Read operation is initiated when this pin is pulled LOW and the chip is selected.
When serial or I²C interface is selected, this pin must be connected to VSS.

* Note (5) : Unused pins are recommended to tie LOW.

When serial interface mode is selected,

D0 will be the serial clock input : SCLK,

D1 will be the serial data input : SDIN,

D2 should be kept NC.

When I²C interface mode is selected,

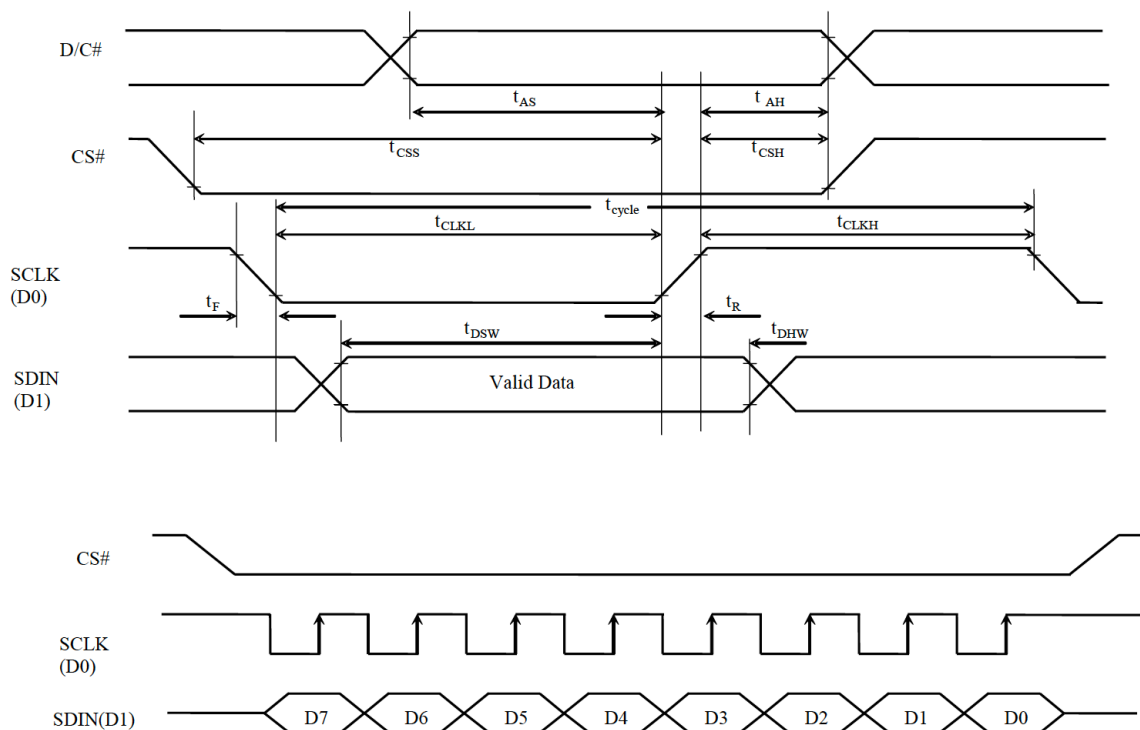
D2,D1 should be tied together and serve as SDAout, SDAin in application

D0 is the serial clock input : SCL.

8. INPUT TIMING CHARACTERISTICS

8-1. AC Characteristics

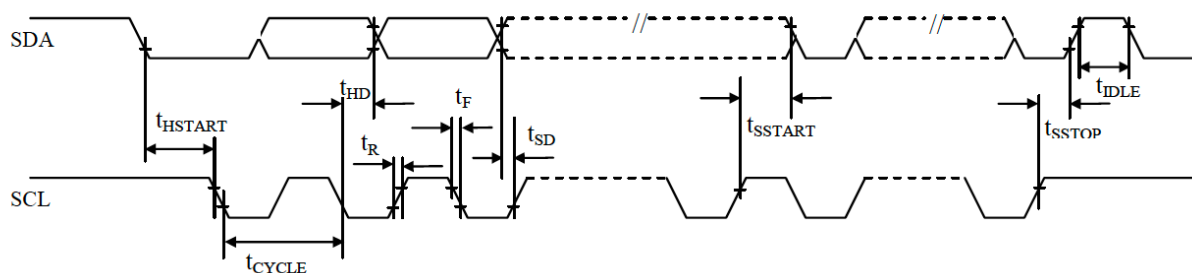
(1) 4 Wire serial interface timing characteristics



(VCI-VSS=1.65V~3.5V, Ta=25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	100	-	-	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

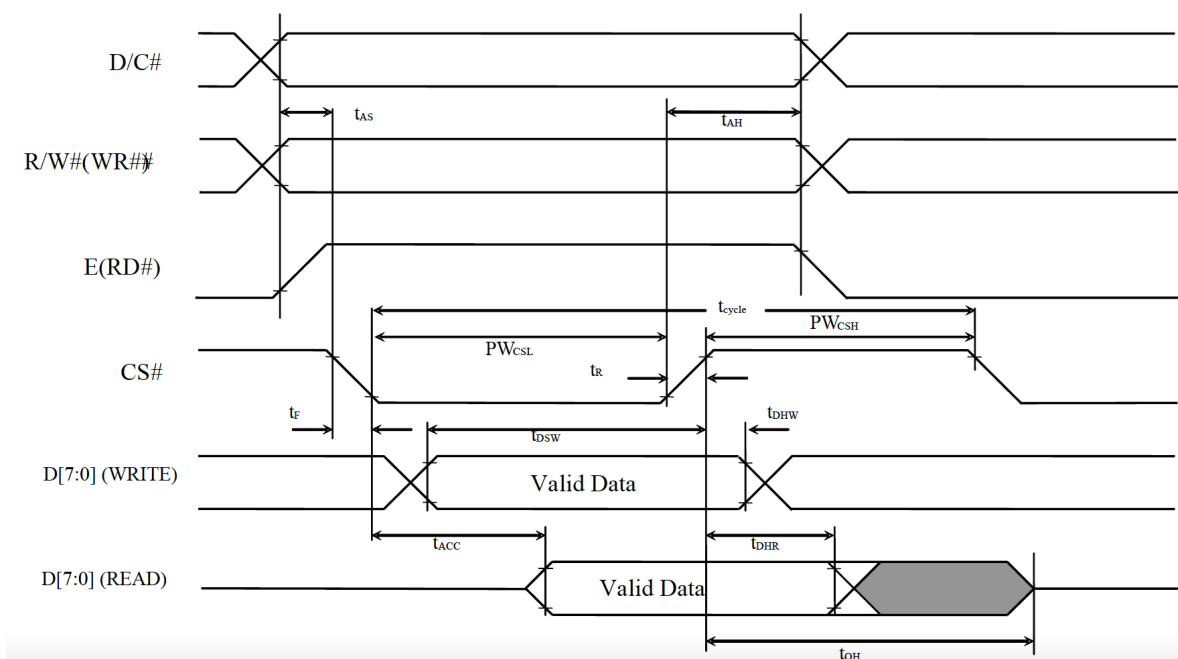
(2) I²C interface timing characteristics



(V_{CI}-V_{SS}=1.65V~3.5V, T_a=25°C)

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

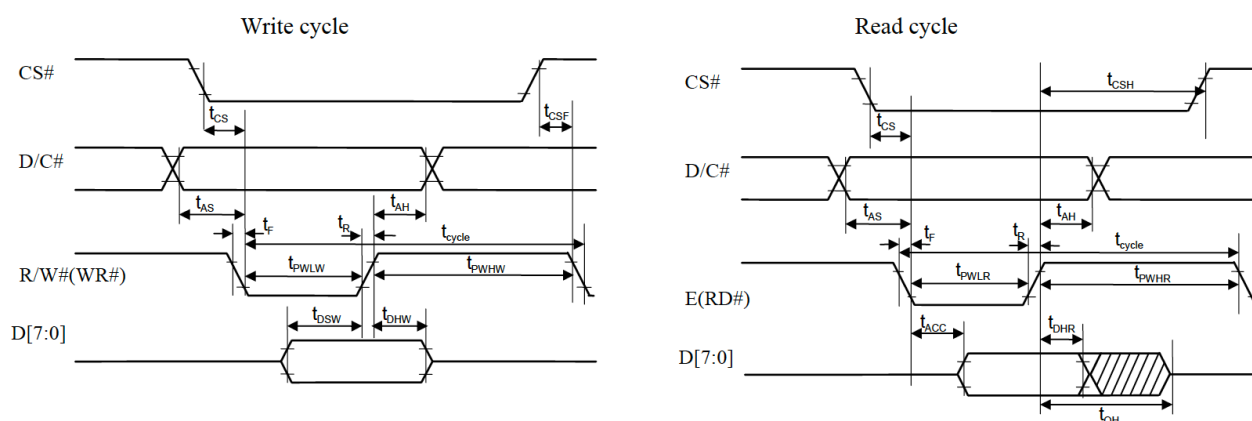
(3) 6800 Series MCU parallel interface timing characteristics



(VCI-VSS=1.65V~3.5V, Ta=25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	300	-	-	ns
t_{AS}	Address Setup Time	10	-	-	ns
t_{AH}	Address Hold Time	0	-	-	ns
t_{DSW}	Write Data Setup Time	40	-	-	ns
t_{DHW}	Write Data Hold Time	7	-	-	ns
t_{DHR}	Read Data Hold Time	20	-	-	ns
t_{OH}	Output Disable Time	-	-	70	ns
t_{ACC}	Access Time	-	-	140	ns
PW_{CSL}	Chip Select Low Pulse Width (read) Chip Select Low Pulse Width (write)	120 60	-	-	ns
PW_{CSH}	Chip Select High Pulse Width (read) Chip Select High Pulse Width (write)	60 60	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns

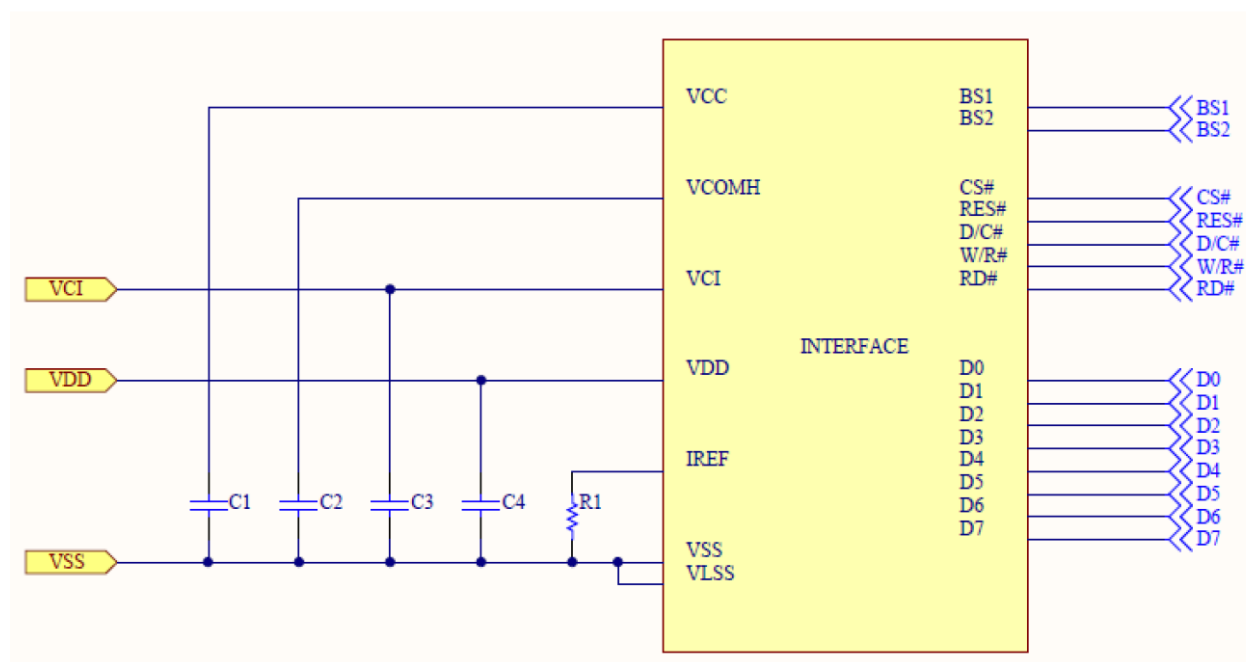
(4) 8080 Series MCU parallel interface timing characteristics



(VCI-VSS=1.65V~3.5V, Ta=25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	300	-	-	ns
t_{AS}	Address Setup Time	10	-	-	ns
t_{AH}	Address Hold Time	0	-	-	ns
t_{DSW}	Write Data Setup Time	40	-	-	ns
t_{DHW}	Write Data Hold Time	7	-	-	ns
t_{DHR}	Read Data Hold Time	20	-	-	ns
t_{OH}	Output Disable Time	-	-	70	ns
t_{ACC}	Access Time	-	-	140	ns
t_{PWLW}	Read Low Time	150	-	-	ns
t_{PWLW}	Write Low Time	60	-	-	ns
t_{PWHW}	Read High Time	60	-	-	ns
t_{PWHW}	Write High Time	60	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns
t_{CS}	Chip select setup time	0	-	-	ns
t_{CSH}	Chip select hold time to read signal	0	-	-	ns
t_{CSF}	Chip select hold time	20	-	-	ns

8-2. Application circuit (for reference only)



* Recommended components :

C1, C2 : 4.7uF/25V (0805)

C3, C4 : 1uF/16V (0603)

Bus interface selection : Must be set the BS[2:1]
4 wire SPI, I²C, 8 bits 6800 & 8080 MCU parallel

Voltage at IREF=VCC-3V. For VCC=15V, IREF=10uA

$R1 = (\text{Voltage at IREF} - VSS) / IREF$

$= (15-3)V / 10\mu A = 1.2M\Omega$

9. LOT NUMBER IDENTIFICATION

9-1. Product label position

The product QR code shall be indicated on the back of the each OLED module.
Please refer the outline drawing for details.

9-2. Product lot number format



HD15MOF1 -XXXX-XX-X
(1)(2)(3) (4) (5)

1. Label size : 7.0mm(W) x 7.0mm (H) x 0.1mm (T)

2. No.1 ~ No. 5 : above indicate

(1) Year code (2) Month code (3) Date (4) Version number (5) Internal code

Year	2020	2021	2022	2023	2024	2025
Code	0	1	2	3	4	5

Month	JAN.	FEB.	MAR.	APR.	MAY.	JUN.
Code	1	2	3	4	5	6

Month	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Code	7	8	9	X	Y	Z

10. RELIABILITY TEST CONDITIONS

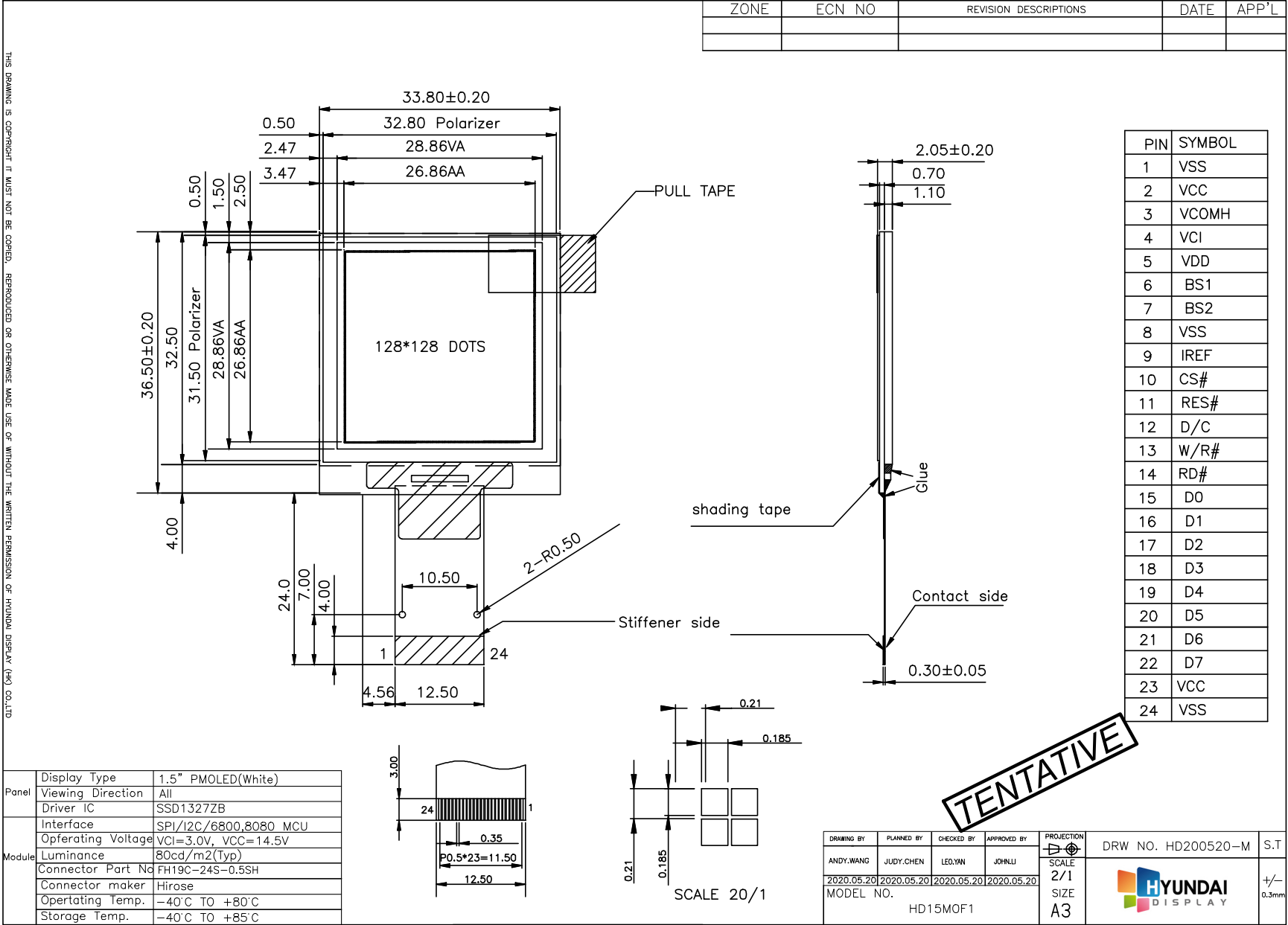
Test item	Test condition	Test time	Remark
High temp. Storage	+85°C	120 Hours	-
Low temp. Storage	-40°C	120 Hours	-
High temp. Operating	+80°C	120 Hours	-
Low temp. Operating	-40°C	120 Hours	-
High temp. humidity atmosphere	+60°C, 90%	120 Hours	with Pure water (Resistance >10MΩ)
Temp cycle. Storage	-40°C 0.5H +80°C 0.5H	10 Cycles	-
Dropping test	Height 70 Cm	X.Y.Z / 1 time	with Ctn.Box
Vibration test	-	-	(Page.5)
ESD	AIR : ±8KV, 150pF, 330Ω	2 times/item	Air : 10mm

* Note :

- (1) Each test item uses a test OLED only once. The tested OLED is not used in any other tests.
The samples must be free from any defect before test.
- (2) The OLED is tested in circumstances in which there is no condensation.
- (3) The reliability test is not an out-going inspection.
- (4) The result of the reliability test is for your reference purpose only.
The reliability test is conducted only to examine the OLED's capability.
- (5) ESD : "GND" of display module is connected, GND of test system ground.
- (6) Inspection after 24 hours storage at room temperature, the samples should be free from below defects.
 - air bubble in the OLED, seal leak, non-display, missing segments, glass crack
 - surface damage
 - The electric characteristics requirements shall be satisfied.
 - Luminance : >50% of initial value
 - Current consumption : within ±50% of initial value
- (7) Failure judgment criterion : Basic specification of Electrical, Mechanical, Optical characteristics.
- (8) The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.

11. OUTLINE DRAWING

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12. PACKAGING SPECIFICATIONS

12-1. Packing materials

	Part name	Materials
1	Master carton	Corrugate cardboard
2	Inner box	Corrugate cardboard
3	Tray for packing	Anti-static polystyrene
4	OPP tape	Polypropylene
5	Bar-code label	Anti-static polyethylene

12-2. Packing outline dimensions

TBD

12-3. Packaging quantities

TBD

12-4. Packaging weight

TBD

13. INCOMING INSPECTION STANDARDS

13-1. GENERAL

- (1) Customer identified anomalies not defined within inspection standard shall be reviewed by Hyundai Display, and an additional standard shall be determined by mutual consent.
- (2) This inspection standard about the image quality shall be applied to any defect within the active area and shall not be applicable to outside of the area.
- (3) Inspection conditions
 - Luminance : 500 Lux min.
 - Inspection distance : 300 mm.
 - Temperature : $25 \pm 5^{\circ}\text{C}$
 - Direction : Directly above, incline degree 30°
- (4) Check level : MIL-STD-105D Level II
 - Major non-conformance : AQL 0.65 %,
 - Minor non-conformance : AQL 1.0 %

13-2. DEFINITION OF INSPECTION ITEM

(1) Dot defect

Bright dot defect	The dot is constantly “on” when power applied to the OLED, even when all “Black” data sent to the screen. Inspection tool : 5% Transparency neutral density filter. Count dot : If the dot is visible through the filter. Don’t count dot : If the dot is not visible through the filter. <table><tr><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td></tr><tr><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td></tr><tr><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td><td>R</td><td>G</td><td>B</td></tr></table>	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B																				
R	G	B	R	G	B	R	G	B																				
R	G	B	R	G	B	R	G	B																				
Black dot defect	The dot is constantly “off” when power applied to the OLED, even when all “White” data sent to the screen.																											

Adjacent dot

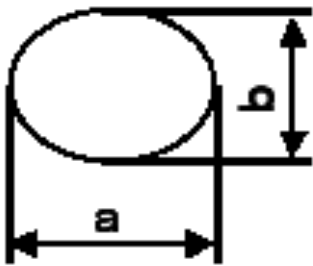
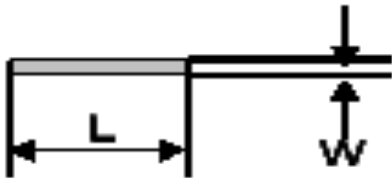
Adjacent dot defect is defined as two or more bright dot defect or black dot defect.

R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B
R	G	B	R	G	B	R	G	B

(2) External inspection

Bubble, Scratch, Foreign particle (Polarizer, Cell, Backlight....)	Visible operating (all pixels "Black" or "White") and non operating.
Appearance inspection	Does not satisfy the value at the spec.

(3) Definition of size

Definition of circle size	Definition of linear size
 $\phi = (a+b) / 2$	

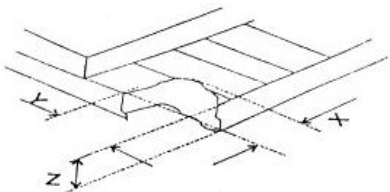
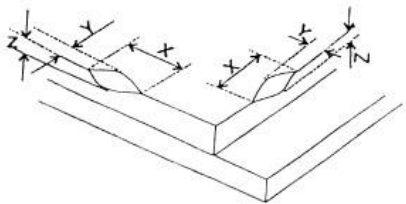
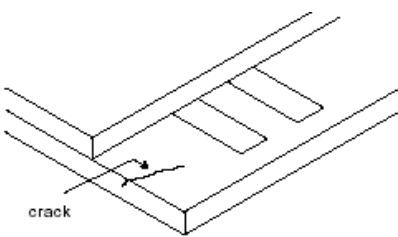
13-3. INSPECTION STANDARD

(1) Major non-conformance

Item		Inspection standard	Judgment
1	No display	No display is not allowed.	Major
2	White display	White display is not allowed.	
3	Line defect	Line defect is not allowed.	
4	Abnormal display	Abnormal display is not allowed.	
5	Out of dimension	Out of dimension is not allowed.	
6	Short	Not allowed	

(2) Minor non-conformance

Item		Inspection standard				Judgment	
1	Black/White dot	(unit : mm)				Minor	
		Area Size	Acceptable number				
			Active area	Non A/A			
		$\phi \leq 0.2$	Ignore	Ignore			
		$0.2 < \phi \leq 0.25$	2				
		$0.25 < \phi \leq 0.3$	1				
		$0.3 < \phi$	0				
		Distant between dot to dot : $\geq 10\text{mm}$					
2	Scratch, Bubble, Linear, Foreign particle	(unit : mm)					
		Size		Acceptable number			
		Length	Width	A/A	Non A/A		
		Ignore	$W \leq 0.03$	Ignore	Ignore		
		$L \leq 5.0$	$0.03 < W \leq 0.1$	2			
		$L \leq 5.0$		1			
		$L > 3.0$	$W > 0.1$	0			
		Distant between line to line : $\geq 10\text{mm}$					
		3	Polarizer position	Polarizer must cover display area.			

4	Chipping on ITO/Touch panel	 $X \leq 3.0\text{mm}$, $Y \leq \text{ITO Length}$, $Z \leq \text{glass thickness}$	Minor
5	Chipping on ITO edge	 $X \leq 2.0\text{mm}$, $Y < \text{Frame edge}$ $Z \leq \text{glass thickness}$	
6	ITO/Touch panel crack	 Not allowed ITO or Touch Panel crack	
7	Logo color and pattern	Follow customer's limit samples	
8	Other defects	Follow product specification and customer's limit samples	

14. WARRANTY

14-1. Incoming inspection

Please inspect the OLED within one month after your receipt.

14-2. Production warranty

Hyundai Display warrants its OLED's for a period of 12 months from the ship date. Hyundai Display shall, by mutual agreement, replace or re-work defective OLED's that are shown to be Hyundai Display's responsibility.

15. PRECAUTIONS FOR USE

15-1. Installation of the OLED

- (1) A transparent protection plate shall be added to protect the OLED and its polarizer.
- (2) The OLED shall be installed so that there is no pressure on the LSI chips.
- (3) Since this product is made of glass, occurrence level of in-plane unevenness by the external stress is different compared to other product. So there is a possibility that in-plane unevenness will be occurred by over twist, strain giving by attaching to OLED, and over pressure to touch panel.
Please be careful of stress when designing the housing.
- (4) A transparent protection sheet is attached to the polarizer. Please remove the protection film slowly before use, paying attention to static electricity.

15-2. Static electricity

- (1) Since CMOS ICs are mounted directly onto the OLED glass, protection from static electricity is required.
- (2) Workers should use body grounding. Operator should wear ground straps.

15-3. OLED operation

The OLED shall be operated within the limits specified. Operation at values outside of these limits may shorten life, and/or harm display images.

15-4. Storage

- (1) The OLED shall be stored within the temperature and humidity limits specified.
Store in a dark area, and protect the OLED from direct sunlight or fluorescent light. Keep the temperature $25\pm5^{\circ}\text{C}$ at less than 60% humidity.
- (2) Always store the OLED so that it is free from external pressure onto it.

15-5. Usage

- (1) DO NOT store in a high humidity environment for extended periods.
Polarizer degradation bubbles, and/or peeling off of the polarizer may result.
- (2) The front polarizer is easily scratched or damaged. Prevent touching it with any hard material, and from being pushed or rubbed.
- (3) The OLED screen may be cleaned by wiping the screen surface with a soft cloth or cotton pad.
- (4) Water may cause damage or discoloration of the polarizer.
Clean condensation or moisture from any source immediately.
- (5) Always keep the OLED free from condensation during testing. Condensation may permanently spot or stain the polarizer.
- (6) Do not disassemble OLED because it will result in damage.
- (7) This Hyundai Display's OLED has been specifically designed for use in general electronic devices, but not for use in a special environment such as usage in an active gas.
Hence, when the OLED is supposed to be used in a special environment, evaluate the OLED thoroughly before hand and do not expose the OLED to chemicals such as an active gas.
- (8) Please do not use solid-base image pattern for long hours because a temporary afterimage may appear. We recommend using screen saver etc. in cases where a solid-base image pattern must be used.
- (9) Be careful not to let the fluid go into your eyes and mouth when the OLED is broken. In the case the fluid touches your body, rinse it off right away with water and soap.