

**DM-OLEDR14-679**

1.4" 454 X 454 Round 16.7M OLED - MIPI,SPI

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## 1 Scope

This Specification defines AMOLED manufactured by Shanghai Top Display Optoelectronics Limited, from here on refer as TDO. In the case of any unspecified item, it may require both TDO and the party designs this module into its product to work out a solution.

## 2 Features

### 2.1 Product Applications

Smart Watch(On-cell)

### 2.2 Product Features

- 1) Display color: 16.7M (RGB x 8bits)
- 2) Display format: 1.4"(454RGBx454)
- 3) Pixel arrangement: Real RGB arrangement
- 4) Interface: MIPI/SPI
- 5) Driver IC: ICNA3310 TP IC:ZTW523

## 3 Maximum Rating

Parameter	Symbol	Spec			Unit	Note
		Min.	Typ.	Max.		
Analog/boost power voltage	VCI	-0.3	-	5.5	V	-
I/O voltage	VDDIO	-0.3	-	5.5	V	-
Operating temperature	Top	-20	-	60	°C	-
Storage temperature	Tstg	-30	-	70	°C	-

## 4 Mechanical Specifications

Item	Specification	unit
Panel outline	38.46(V) x 38.62(W) x 0.78(T)	mm
LTPS Glass outline	38.46(V) x 38.62(W)	mm
Encapsulation Glass outline	φ38.62	mm
Number of dots	454(W) x RGB x 454(H)	dots
Active area	φ35.41	mm
Diagonal size	1.39	inch
Pixel pitch	78 x 78	μm
Glass thickness	0.3 (up) + 0.2 (under)	mm

(LTPS/encapsulation glass)		
Weight	TBD	g

## 5 Electrical Specifications

### 5.1 Electrical Characteristics

#### 5.1.1 Power Characteristic:

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
AMOLED Power positive	ELVDD	4.55	4.6	4.65	V	-
AMOLED power Negative	ELVSS	-2.45	-2.4	-2.35	V	Ref
Digital Power supply	VDDIO	1.65	1.8	1.95	V	Ref
Analog Power supply	VCI	3.2	3.3	3.4	V	Ref

#### 1) Normal Mode

**Power Supply:** IOVCC=1.8V VCI=3.3V

**Frame Frequency:**  $F_{\text{frame}}=60\text{HZ}$  @ 25degC, Brightness 400 nits, Command Mode,

Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
100% Pixel On 400nits	IELVDD /ELVSS	-			mA	Ref
	IVCI	-	6	7.2	mA	Ref
	IVDDIO	-			mA	Ref

#### 2) Idle Mode

**Power Supply:** IOVCC=1.8V VCI=2.8V

**Frame Frequency:**  $F_{\text{frame}}=15\text{HZ}$  @ 25degC, Brightness:30nits, OPR:10%,Command Mode

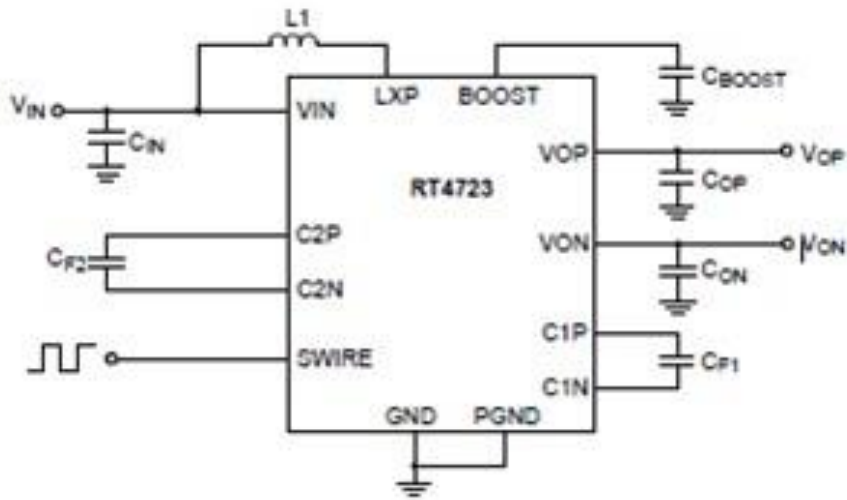
Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
10% Pixel On 30 nits	IELVDD /ELVSS	-	-	-	mA	Supplied by Driver IC
	IVCI	-	3	3.6	mA	Ref
	IVDDIO	-	1.2	1.5	mA	Ref

#### 3) Deep Standby Mode

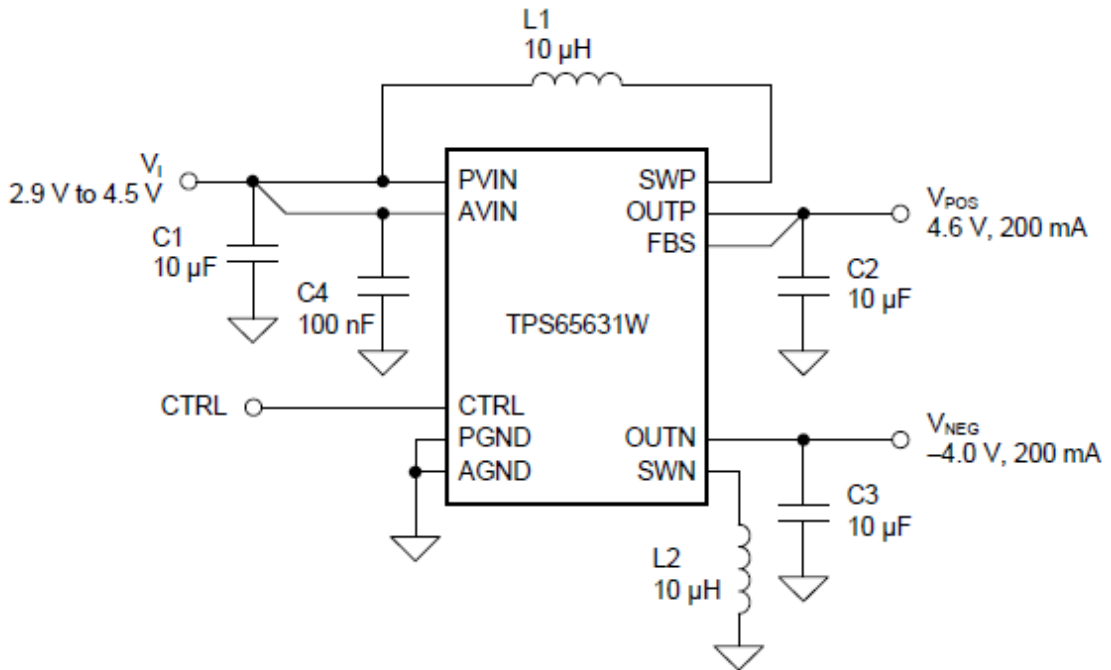
Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
Deep Standby	IVCI	-	-	15	uA	-
	IVDDIO	-	-	4	uA	-
	Power Consumption	-	-	<50	uW	Ref

5.1.2 Power supply circuit application (This is for reference only):

1) RT4723



2) TPS65631W



## 5.2 I/O Connection and Block Diagrams

### 5.2.1 Main FPC Bonding PAD Define

Pin No.	Symbol	I/O	Function Description
1	ELVSS	Power	AMOLED power Negative
2	ELVDD	Power	AMOLED power Positive
3	ELVSS	Power	AMOLED power Negative
4	ELVDD	Power	AMOLED power Positive
5	ELVSS	Power	AMOLED power Negative
6	ELVDD	Power	AMOLED power Positive
7	NC(OTP)	--	--
8	GND	Power	The power ground
9	SWIRE	O	Swire protocol setting pin of Power IC
10	MIPI_D0N	I/O	MIPI DSI data0-
11	VDDIO	Power	Driver IC digital I/O supply
12	MIPI_D0P	I/O	MIPI DSI data0+
13	VCI	Power	Driver IC analog supply
14	GND	Power	The power ground
15	TE	O	Tear effect output
16	MIPI_CLKN	I/O	MIPI DSI clock-
17	RST	I	OLED Device reset signal (0:enable;1:Disable)
18	MIPI_CLKP	I/O	MIPI DSI clock+
19	GND	Power	The power ground
20	GND	Power	The power ground
21	SPI_CSX	I	SPI interface
22	SPI_SCL	I	SPI interface
23	SPI_SDI	I	SPI interface
24	SPI_DCX	I	SPI interface
25	SPI_SDO	I	SPI interface
26	SAS	--	The power ground
27	GND	Power	The power ground
28	GND	Power	The power ground
29	NFC1	Power	NFC
30	NFC2	Power	NFC

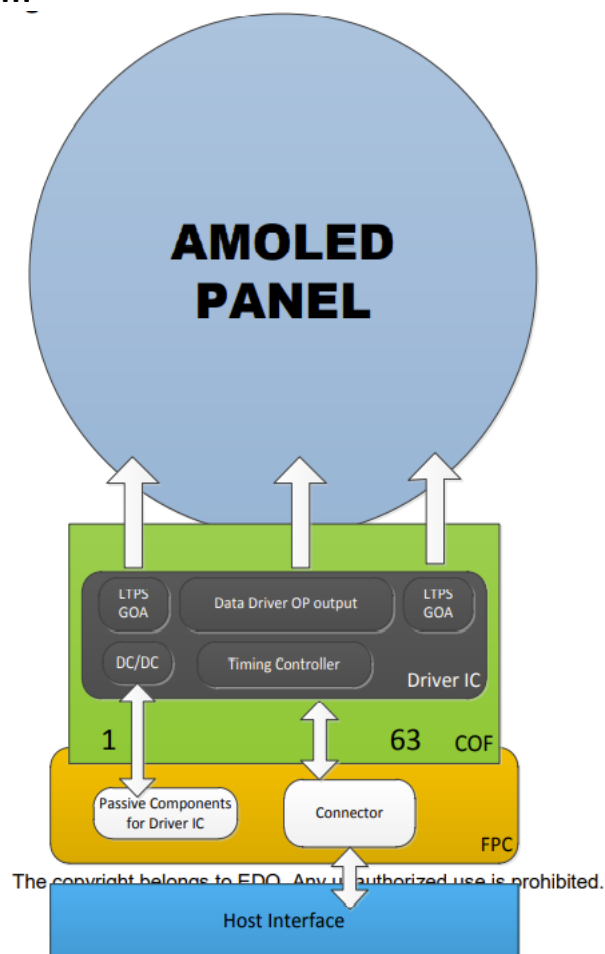
### 5.2.2 TP FPC Bonding PAD Define

Pin No.	Symbol	I/O	Function Description	When not use
1	GND	-	GND	
2	GND	-	GND	
3	RESET	I/O	Interrupt	
4	VDD	Power	Power	
5	INT	I	IIC interface	
6	SCL	I	IIC interface	
7	VDDIO	I/O	IIC interface	
8	SDA	Power	Power	
9	GND	-	GND	
10	GND	-	GND	

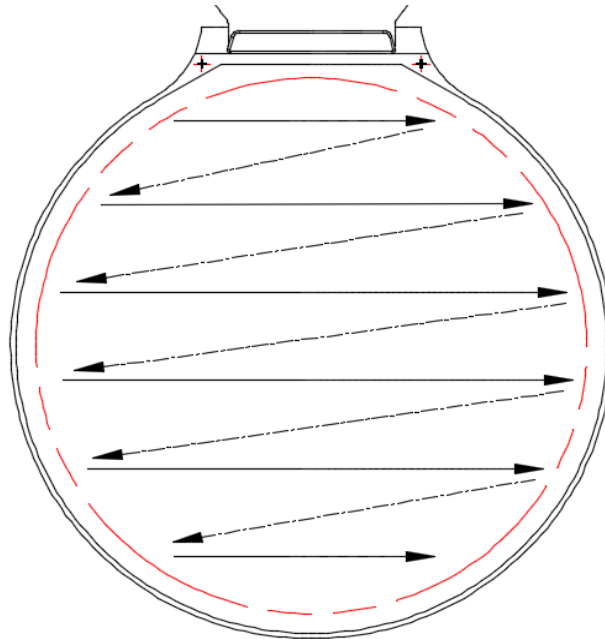
### 5.3 Initial CODE

TBD

### 5.4 System Block Diagram

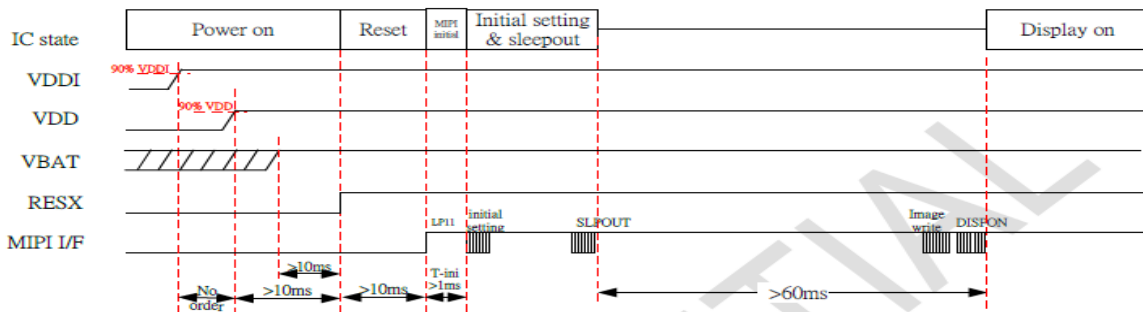


### 5.4.1 Graphic memory writing direction

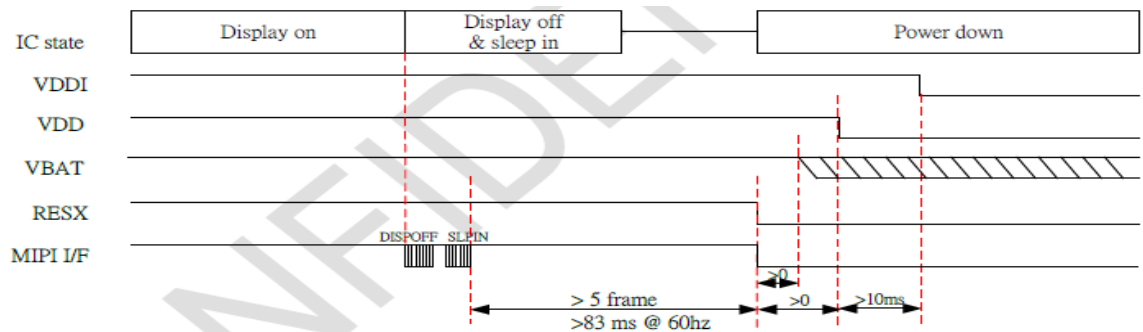


## 5.5 Recommended Operating Sequence

### 5.5.1 Power on sequence



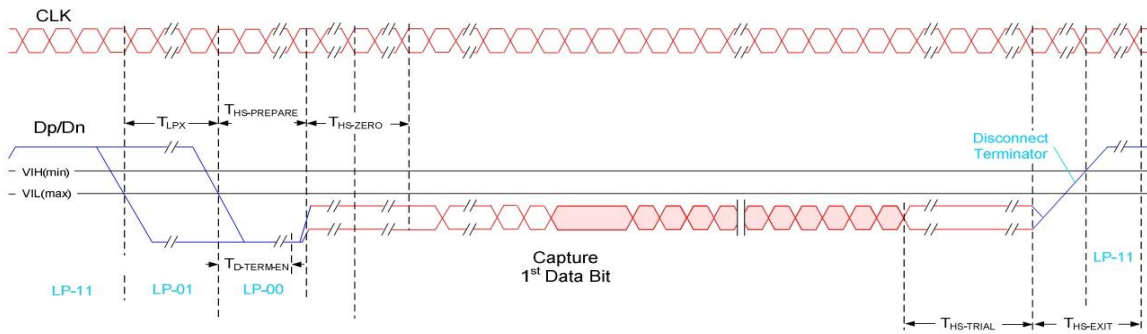
### 5.5.2 Power off sequence



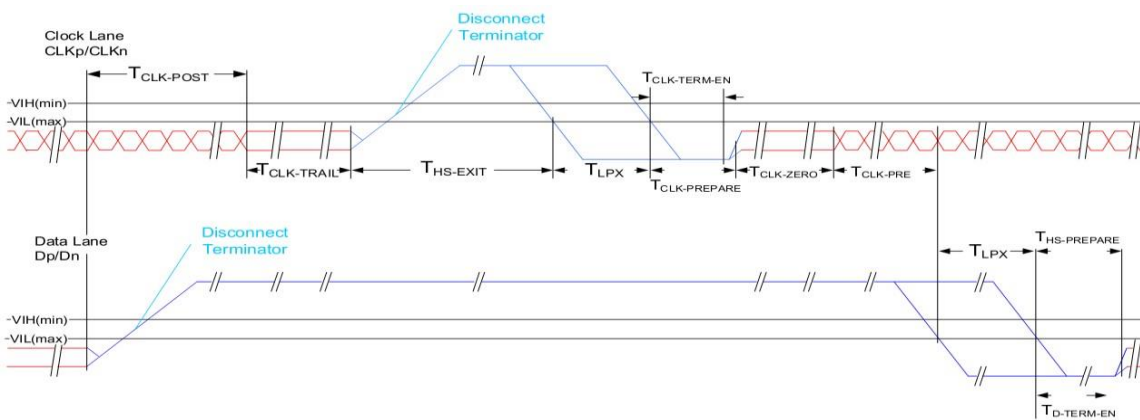


## 5.6 AC Characteristics (MIPI)

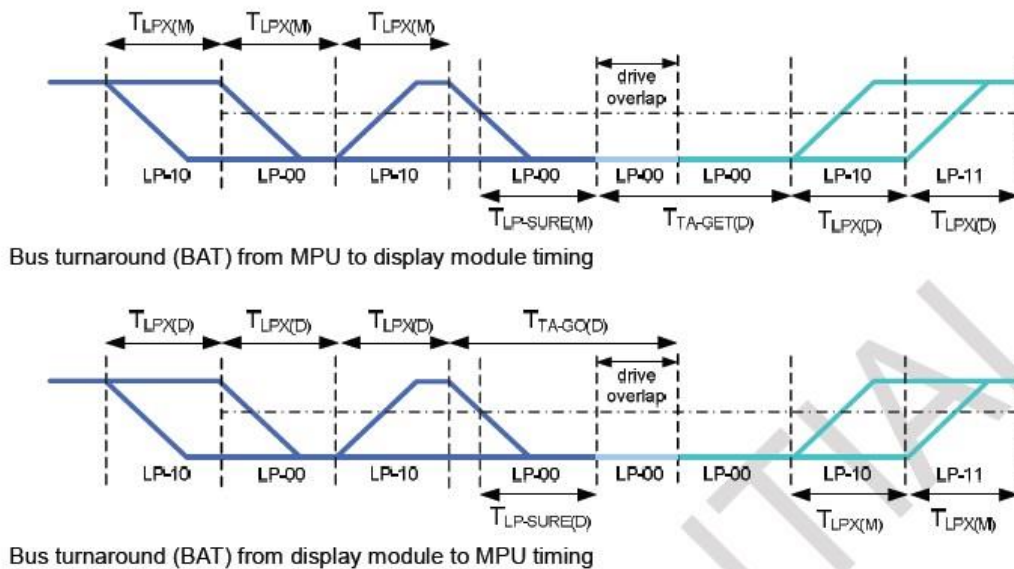
### 5.6.1 HS Data Transmission Burst



### 5.6.2 HS Clock Transmission



### 5.6.3 Turnaround Procedure



## 5.6.4 Timing Parameters

Symbol	Description	Min	Typ	Max	Unit
TREOT	30%-85% rise time and fall time	-	-	35	ns
TCLK-MISS	Timeout for receiver to detect absence of Clock transitions and disable the Clock Lane HS-RX.	-	-	60	ns
TCLK-POST*1	Time that the transmitter continues to send HS clock after the last associated Data Lane has transitioned to LP Mode. Interval is defined as the period from the end of THS-TRAIL to the beginning of TCLK-TRAIL.	$60\text{ns} + 52 \cdot \text{UI}$ (For DCS)	-	-	ns
TCLK-PRE	Time that the HS clock shall be driven by the transmitter prior to any associated Data Lane beginning the transition from LP to HS mode.	8	-	-	ns
TCLK-SETTLE	Time interval during which the HS receiver shall ignore any Clock Lane HS transitions, starting from the beginning of TCLK-PRE.	95	-	300	ns
TCLK-TERM-EN	Time for the Clock Lane receiver to enable the HS line termination, starting from the time point when Dn crosses VIL,MAX.			38	ns
THS-SETTLE	Time interval during which the HS receiver shall ignore any Data Lane HS transitions,	$85\text{ ns} + 6 \cdot \text{UI}$		$145\text{ ns} + 10 \cdot \text{UI}$	ns

	starting from the beginning of THSPREPARE.				
TEOT	Time from start of THS-TRAIL or TCLK-TRAIL period to start of LP-11 state	-	-	105ns+48*UI	ns
THS-EXIT(1)	time to drive LP-11 after HS burst	100	-	-	ns
THS-PREPARE	Time to drive LP-00 to prepare for HS transmission	40ns + 4*UI	-	85ns+6*UI	ns
THS-PREPARE + THS-ZERO	THS-PREPARE + Time to drive HS-0 before the Sync sequence	145ns + 10*UI	-	-	ns
THS-SKIP	Time-out at RX to ignore transition period of EoT	40	-	55ns+4*UI	ns
THS-TRAIL	Time to drive flipped differential state after last payload data bit of a HS transmission burst	60 + 4*UI	-	-	ns
TLPX	Length of any Low-Power state period	50	-	-	ns
Ratio TLPX	Ratio of TLPX(MASTER)/TLPX(SLAVE) between Master and Slave side	2/3	-	3/2	ns
TTA-GET	Time to drive LP-00 by new TX	5*TLPX	5*TLPX	5*TLPX	ns
TTA-GO	Time to drive LP-00 after Turnaround Request	4*TLPX	4*TLPX	4*TLPX	ns
TTA-SURE	Time-out before new TX side starts driving	TLPX	-	2*TLPX	ns

### 5.6.5 Timing requirements for RESETB

When RESETB of the reset pin equals to Low, it will be in the condition of reset.

When it is in the condition of reset, it will make the device recover the initial set.

However, in order to avoid the reset noise cause reset, there is a mechanism to judge about whether the reset is needed or not.

The closed interval of Low can be shown as the following.

**(Test condition: VDDIO=1.65V~3.6V, VSS=0V, TA=-20°C~+70°C)**

Parameter	Symbol	Conditions	Spec			Unit
			Min.	Typ.	Max.	
Reset low pulse width	Trst	-	20	-	-	$\mu\text{s}$

Table: Reset timing

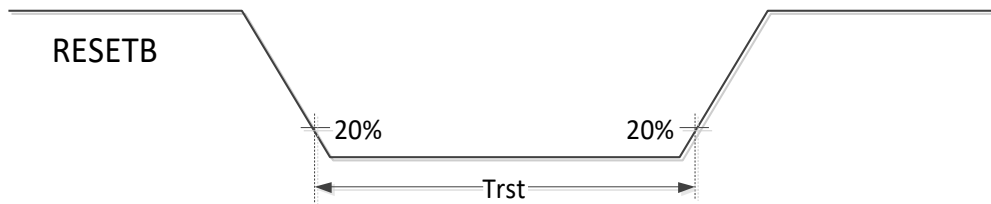


Figure: Reset timing

## 6 Electro-Optical Specification

Test condition: IOVCC=1.8V , VCI=2.8V , Ta=25°C

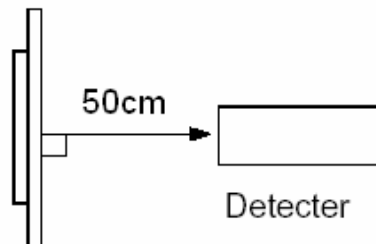
Item	Symbol	Condition	Value			Unit	Note	
			Min	Typ	Max			
Luminance		$\theta=0^\circ$	350	400	450	cd/m <sup>2</sup>	Note 1	
Uniformity		$\Phi=0^\circ$	85	-	-	%	Note 2	
Viewing Angle	Left	$\theta_L$	$Cr \geq 200$	80	85	-	Deg.	Note 3
	Right	$\theta_R$		80	85	-		
	Top	$\psi_T$		80	85	-		
	Bottom	$\psi_B$		80	85	-		
Contrast Ratio	CR	$\theta=0^\circ$	10000	100000	-	-	Note 4	
Response Time	Tr+Tf	$\Phi=0^\circ$	-	2	3	ms	Note 5	
Color Coordinate of CIE1931	Red	X	$\theta=0^\circ$ $\Phi=0^\circ$	0.666	0.686	0.706	-	-
		Y		0.293	0.313	0.333		
	Green	X		0.215	0.235	0.255		
		Y		0.700	0.720	0.740		
	Blue	X		0.123	0.143	0.163		
		Y		0.024	0.044	0.064		
	White	X		0.28	0.30	0.32		
		Y		0.29	0.31	0.33		
NTSC Ratio	NTSC	DCI-P3	97	100	-	%	-	
Flicker	-	-	-	-	-30	dB	-	
Gamma	-	-	1.9	2.2	2.5		Note 6	
Crosstalk	$\Delta CT$	-	-	-	1.1		Note 7	

### Note 1: Luminance measurement

The test condition is measured on the surface of AMOLED module at 25°C.

- Measurement equipment CS2000 or similar equipment (Field of view:1deg,Distance:50cm)

- Measuring surroundings: Dark room.
- Measuring temperature:  $T_a=25^\circ\text{C}$ .
- Adjust operating voltage to get optimum contrast at the center of the display.



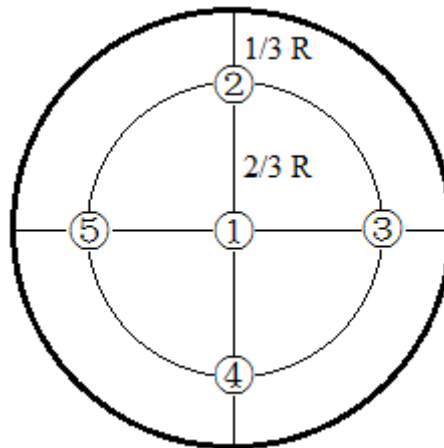
### Note 2: Uniformity

The luminance uniformity is calculated by using following formula:

$$\Delta B_p = B_p (\text{Min.}) / B_p (\text{Max.}) \times 100 (\%)$$

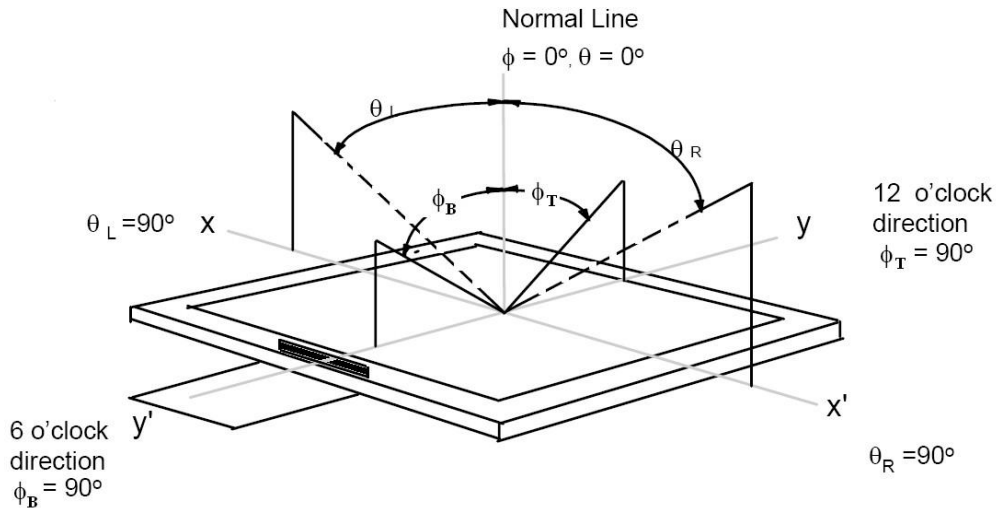
$B_p (\text{Max.})$  = Maximum brightness in 5 measured spots

$B_p (\text{Min.})$  = Minimum brightness in 5 measured spots.



### Note 3: The definition of Viewing Angle

Refer to the graph below marked by  $\vartheta$  and  $\phi$

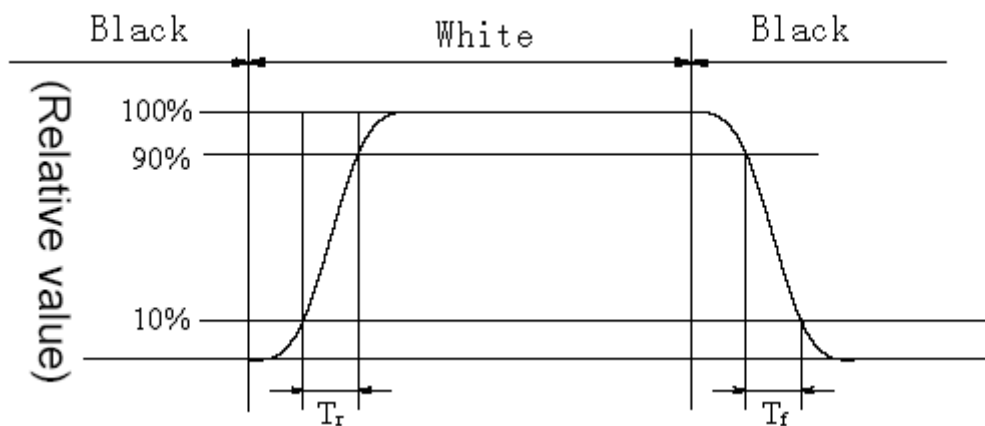


**Note 4: The definition of Contrast Ratio:**

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

**Note 5: Definition of Response time.**

The output signals of photo detector are measured when the input signals are changed from "black" to "white" (Voltage falling time) and from "white" to "black" (Voltage rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes. Refer to figure as below.



**Note 6: Gamma curve**

The whole curve's tolerance must control within +/-0.3, test the gray scale below:  
 8, 16, 25, 33, 41, 49, 58, 66, 74, 82, 90, 99, 107, 115, 123, 132, 140, 148, 156, 165, 173, 181, 189, 197, 206, 214, 222, 230, 239, 255

**Note 7: Crosstalk**

There should be no visible cross-talk in normal direction of the display when the two

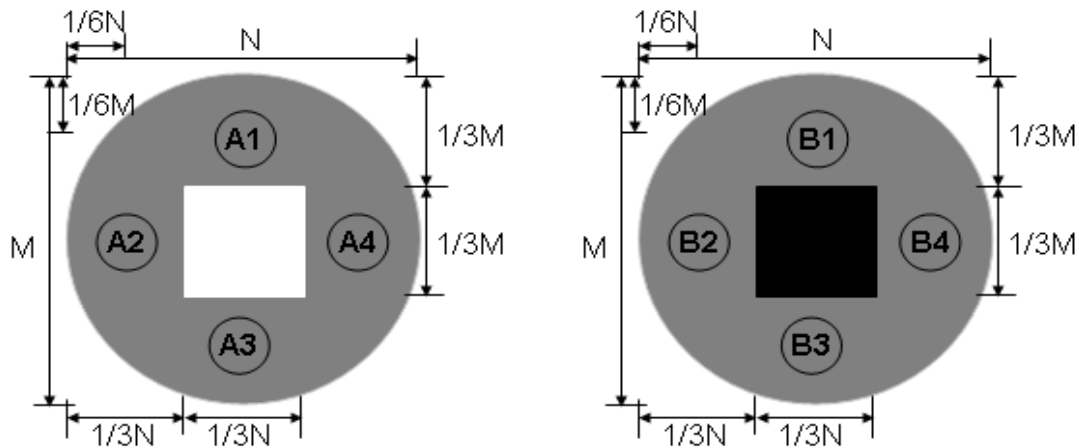
“Cross-talk Test Patterns” below are loaded.

$\Delta Bp$  (Max.) = Maximum value in  $\Delta Bp1 \sim \Delta Bp4$ .

$\Delta Bp$  (Min.) = Minimum value in  $\Delta Bp1 \sim \Delta Bp4$ .

$\Delta CT = \Delta Bp(\text{Max.}) / \Delta Bp(\text{Min.})$ .

$\Delta CT$  must be less than 1.10



**Cross-talk Test Pattern**

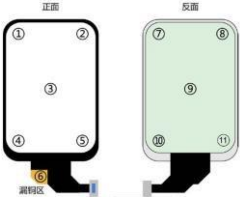
## 7 Reliability

### 7.1 Environmental Test

Item	Main spec	No. of failures / No. of examinations	Note
High Temperature Operation	70°C / 240hours	0/5	
Low Temperature Operation	-20°C / 240hours	0/5	
High Temperature Storage	80°C / 240hours	0/5	
Low Temperature Storage	-40°C / 240hours	0/5	
High Temperature Humidity Operation	60°C / 90%RH 240hours	0/5	
Thermal Shock	-40°C ~ 80°C 0.5hr, 100 cycles	0/5	

Lifetime	T95 > 240hrs	0/5	
Image sticking	6*6 棋盘格 12hrs 切 127 灰阶 3min 内 ND04 不可见	0/5	

## 7.2 Electrical Test

Item(Display)	Main spec	No. of failures / No. of examinations	Note
Air Discharge	±4kV , 150pF/330Ω ( B class ) ±6KV,150pF/330Ω ( except IC,C class )	0/5	5Points ( 正面 1、2、4、5、6; 反面 7、8、9、10、11 ) , Each 2times. No degradation of OLED performance after this test. 
Contact Discharge	±4kV, 150pF/330Ω ( C class )	0/5	B class: Sample 在实施静电放电时, 画面有横线, 闪烁, 画异, 无显等异常, 但在不实施静电放电时回复正常显示。 C class: Sample 在实施静电放电时, 画面有横线, 闪烁, 画异, 无显等异常, 且在不实施静电放电时不能恢复, 但信号 Reset 后能恢复正常显示。

## 7.3 Mechanical Test

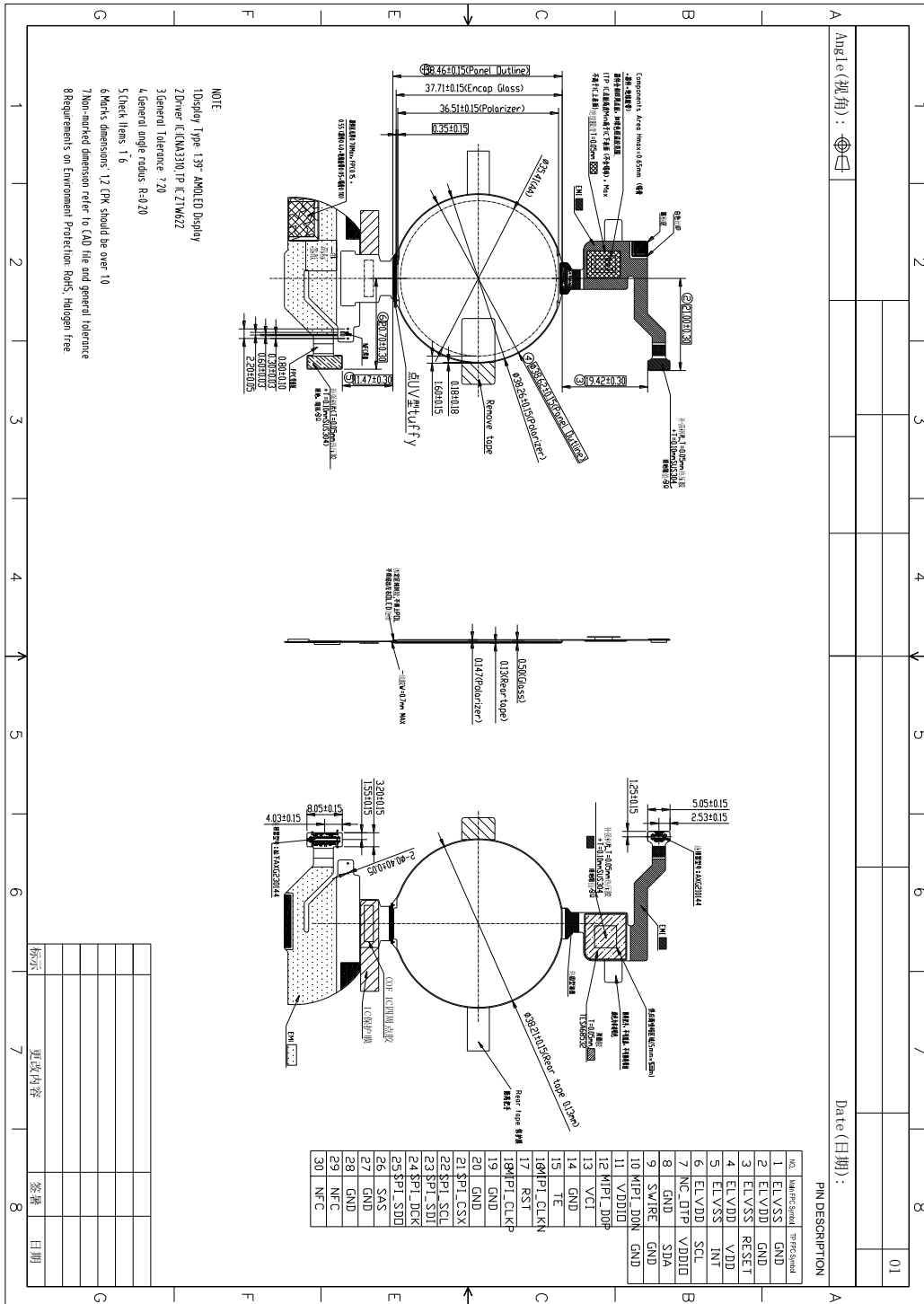
Item	Main spec	Note
Drop Test	Drop the packing from 75cm height, 1times for 6-faces, 3-edges and 1-corner	Package
Vibration-proof test	2g, f=10->55->10Hz apply in each of X, Y, and Z direction for 30 min	Package



## 8 Handling Precautions

1. When cleaning ITO pad, avoid using hard and abrasive material or corrosive solution
2. Keep module away from direct sunlight or fluorescent light, and keep it at room temperature and humidity
3. Strong impact & pressure on module and packing is prohibited
4. Following normal power on/off sequence is necessary for preventing abnormal display or permanent damage to display
5. Optimal contrast ratio under ideal voltage is AMOLED module's characteristic, hence it is recommended a voltage control function available
6. Image sticking may occur if an image displays for an extended period of time
7. When interfered by system's overall mechanical design, an abnormal display may occur
8. After considering emitting energy, you should plan your design to satisfy EMI standards.
9. Host side should place a surge-prevent circuit at power trace (ie: VCI, Vddi) to protect AMOLED module.

### 9 Outline Dimension Drawing



### 10 The Control of Hazardous substances

The Control of Hazardous substances refer to TDO document 《有害物质管控标准书》(Standard document for the Control of Hazardous substances ) TDO-IS-110, the latest version.