PHOENIX DISPLAY
INTERNATIONAL, INC.

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SPECIFICATION FOR LCD MODULE

CUSTOMER	
PART NUMBER	PDIAT497HAK-01
DESCRIPTION	4.97" HD(720x1280) AMOLED
VERSION	4.0
ISSUE DATE	

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Reversion History			
Reversion. No	**Date**	**Contents**	**Remark**
01	2017-03-01	First Version	
02	2017-06-20	RA 更新、ESD 注释更新、环境保护项目更新	
03	2017-09-06	更新机构尺寸 panel outline	
04	2017-10-12	CIE range 修正、震动测试项目修正	

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1 Scope

This Specification defines AMOLED manufactured by A-TOPS ELECTRONICSCO.,LTD In the case of any unspecified item, it may require both A-TOPS and the party designs this module into its product to work out a solution.

2 Features

2.1 Product Applications

Mobile phone

2.2 Product Features

1) Display color：16.7M (RGB x 8bits)
2) Display format：4.97”HD (720RGBx1280)
3) Pixel arrangement：Real RGB arrangement
4) Interface：MIPI 4 lanes

3 Mechanical Specifications

Item	Specification	unit	Note
Panel Dimension outline	64.12 × 116.72 × 0.823	mm	*
LTPS Glass outline	64.12 × 116.72	mm	
Encapsulation Glass outline	64.12 × 113.72	mm	
Number of dots	720(W) x RGB x 1280(H)	dots	
Active area	61.884 × 110.016	mm	
Diagonal size	4.97	inch	
Pixel pitch	28.65 × 85.95	μm	
Glass thickness （LTPS/encapsulation glass）	0.2 / 0.3	mm	
Weight	TBD	g	

*Note: Refer to 9 Outline Dimension Drawing

4 Maximum Rating

Parameter	Symbol	Spec			Unit	Note
		Min.	Typ.	Max.		
Analog/boost power voltage	VCI	-0.3	-	5.5	V	-
VCI I/O voltage	VCI_IF	-0.3	-	5.5	V	-
I/O voltage	VDDI	-0.3	-	5.5	V	-
VSP voltage	VSP	-0.3	-	6.6	V	-
VPP(OTP power)	VPP	-	-	8.25	V	-
Operating temperature	Top	-20		60	℃	
Storage temperature	Tstg	-30		70	℃	
TP_Power Voltage	TSP_AVDD	-0.3		4.2	V	

5 Electrical Specifications

5.1 Electrical Characteristics

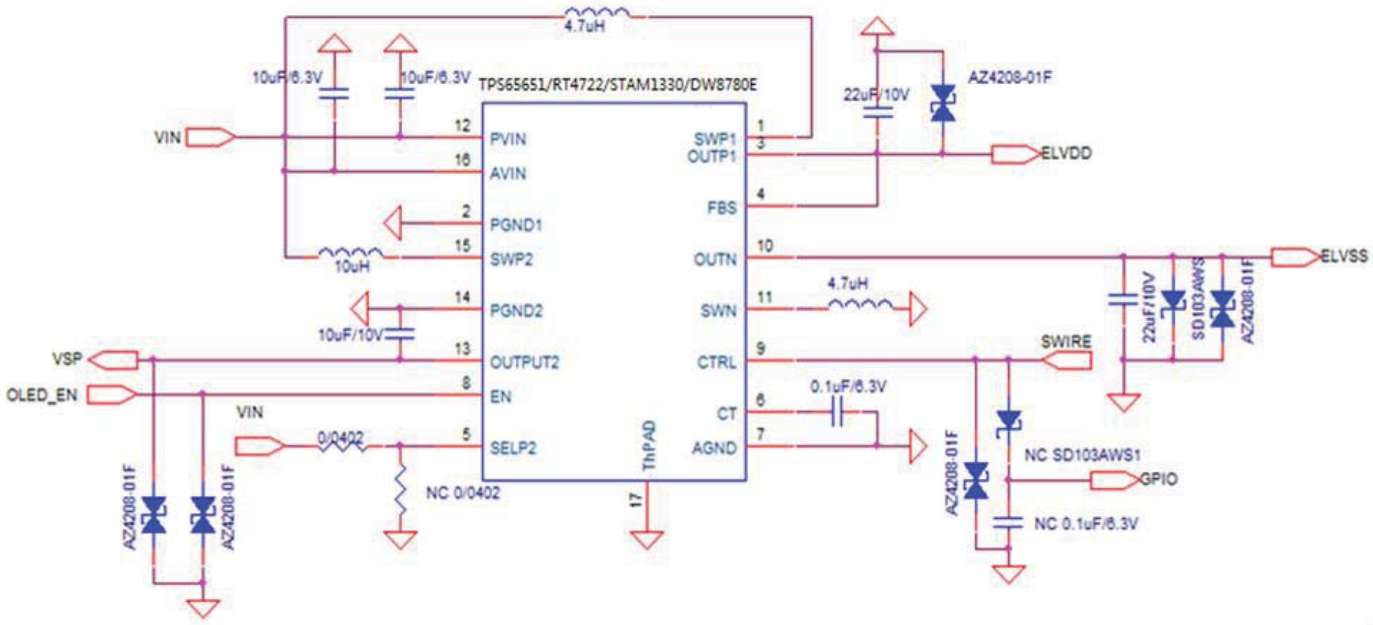
5.1.1 Power Characteristic :

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
AMOLED Power positive	ELVDD		4.6		V	
AMOLED power Negative	ELVSS		-2.5		V	Ref
Gamma Voltage	VSP		6.4	-	V	Ref
Digital Power supply	VDDI	1.65	1.8	3.3	V	Ref
Analog Power supply	VCI	2.5	3.3	4.8	V	Ref
TP Power Supply voltage	TSP_AVDD	2.6	2.8	3.6	v	

Mode	Symbol	Condition	Min.	Typ.	Max.	Unit
350 nits @Gray 255	$I_{ELVDD/ELVSS}$	VELVDD=4.6V VELVSS=-2.5V VCI=3.3V VDDIO=1.8V VSP=6.4V	-	160	190	mA
	I_{VCI}		-	1.5	2	mA
	I_{VDDIO}		-	15	20	mA
	I_{VSP}		-	10	13	mA

5.1.2 Power supply circuit application (Reference only)：

Power IC recommend: TI: TPS65651, ST: STAM1330, Silicon Mitus: SM3301, Richtek: RT4722



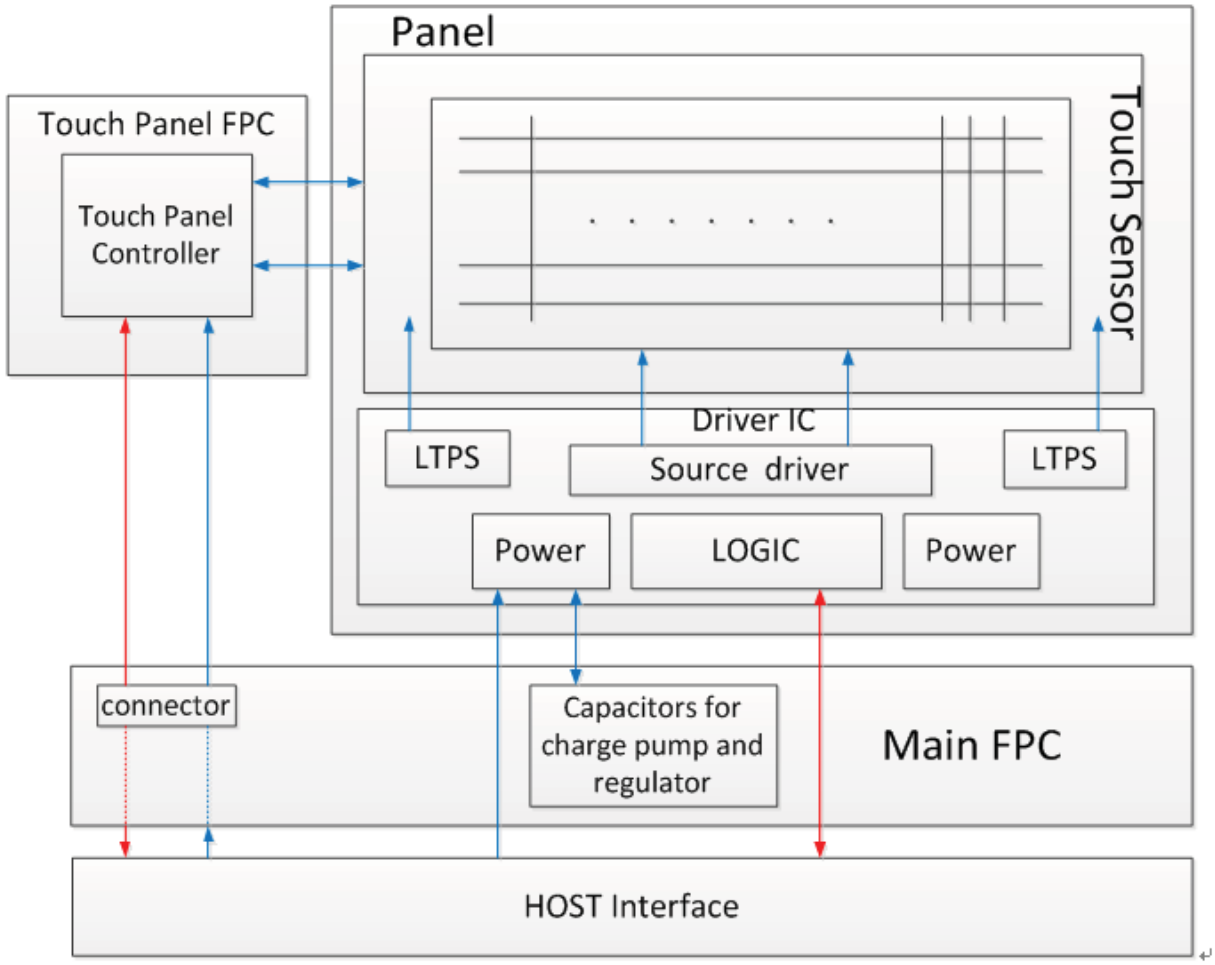
5.2 I/O Connection and Block Diagrams

5.2.1 Main I/O Connection

NO.	Symbol	I/O	Description
1	VPP	Power	Power supply for OTP Leave the pin to open when not in use.
2	GND	Power	The power ground
3	SWIRE	O	Enable ELVDD and ELVSS of DC/DC IC
4	D3N	I	MIPI DSI data3-
5	OLED_EN	O	Enable VSP(VLIN) for DC/DC IC
6	D3P	I	MIPI DSI data3+
7	PCD	O	Panel Crack Detection output pad, open it if not use
8	GND	Power	The power ground
9	ERR_FG	O	MIPI error flag monitor，open it if not use
10	D0N	I	MIPI DSI data0-
11	RSTB	I	Display RESET. Active low.
12	D0P	I	MIPI DSI data0+
13	VDDI	I	Digital power for Driver IC
14	GND	Power	The power ground
15	VSP	I	Charge pumping Power for Driver IC

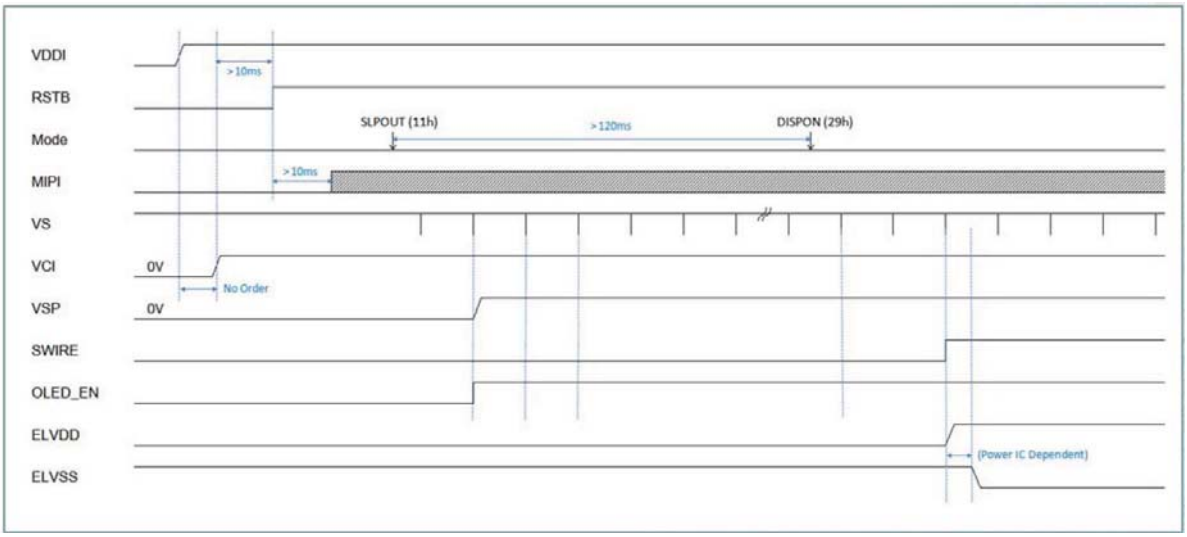
16	CKN	I	MIPI DSI Clock-
17	VCI	I	Analog power for Driver IC
18	CKP	I	MIPI DSI Clock+
19	TSP_ATTN	I	State change interrupt for TSP
20	GND	Power	The power ground
21	TSP_SDA	I/O	Serial interface Data for TSP
22	D1N	I	MIPI DSI data1-
23	TSP_SCL	I/O	Serial interface Clock for TSP
24	D1P	I	MIPI DSI data1+
25	TSP_RESET	I	Active low，RESET the Touch IC
26	GND	Power	The power ground
27	NC	-	No connection
28	D2N	I	MIPI DSI data2-
29	TSP_AVDD	I	Analog Power for TSP
30	D2P	I	MIPI DSI data2+
31	ID0	O	Connect to Mainboard ID0,default High
32	GND	Power	The power ground
33	ID1	O	Connect to Mainboard ID1,default Low
34	NC	-	No connection
35	ELVDD	Power	AMOLED power Positive
36	ELVSS	Power	AMOLED power Negative
37	ELVDD	Power	AMOLED power Positive
38	ELVSS	Power	AMOLED power Negative
39	ELVDD	Power	AMOLED power Positive
40	ELVSS	Power	AMOLED power Negative

5.2.2 Display Module Block Diagram

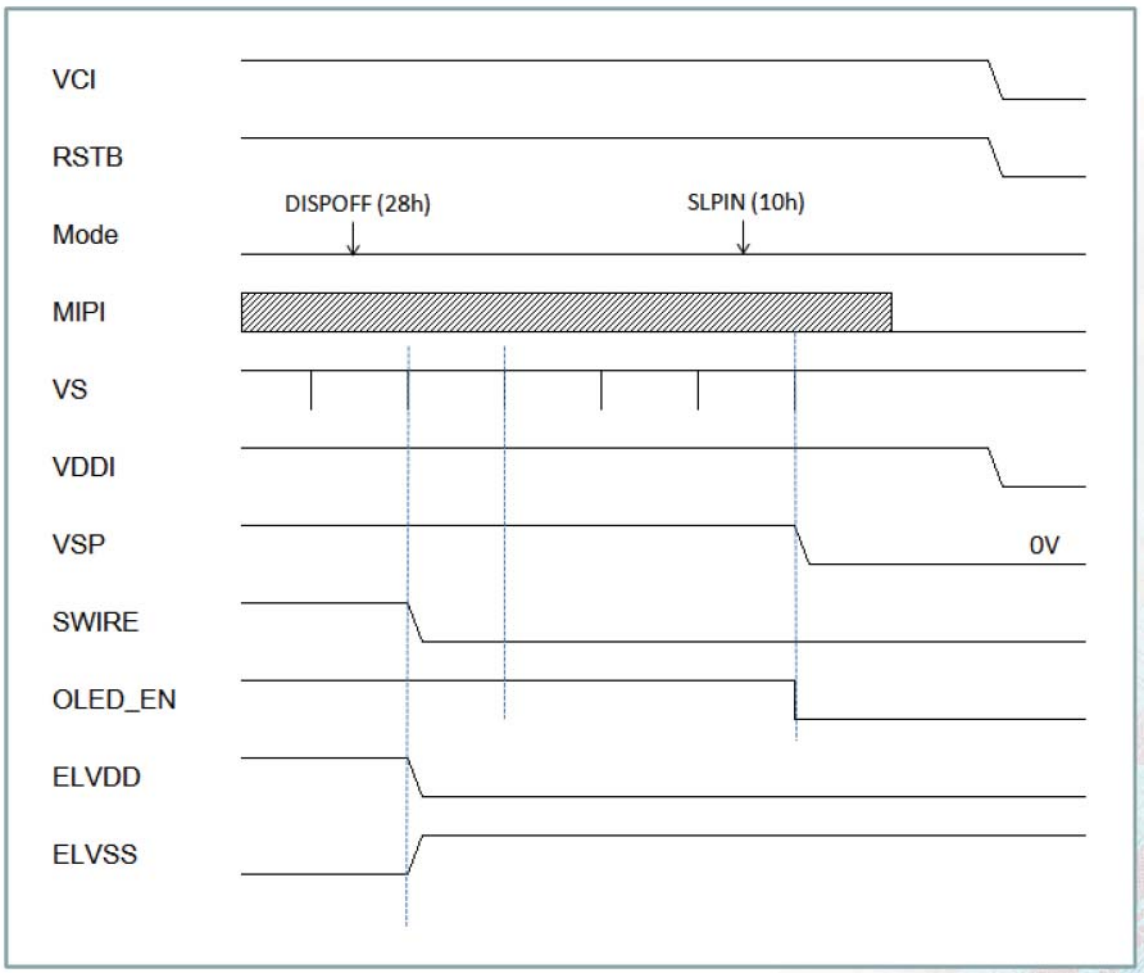


5.3 Recommended Operating Sequence

5.3.1 Power on sequence

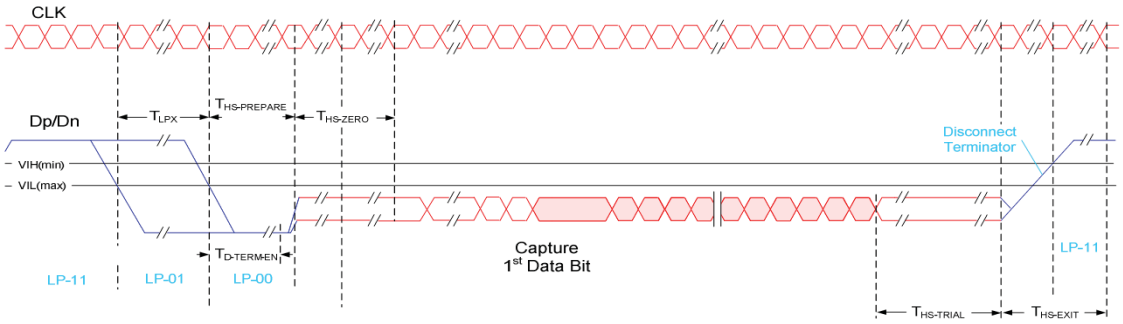


5.3.2 Power off sequence

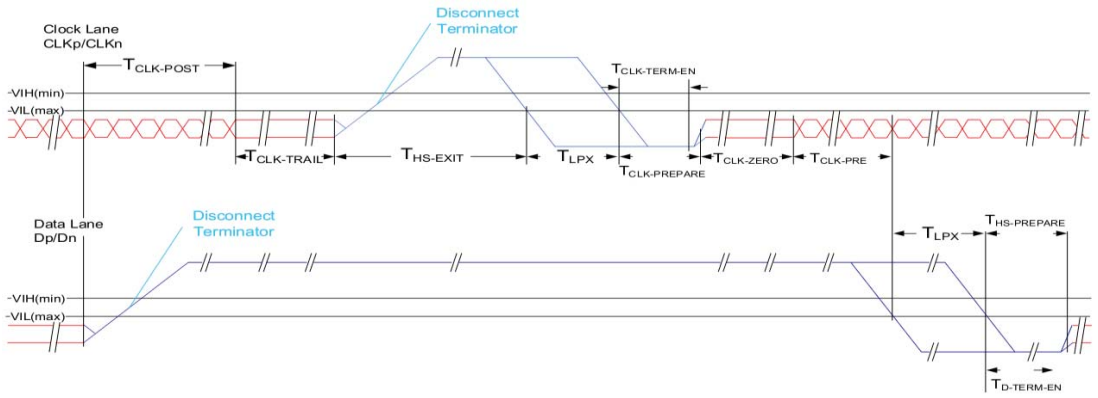


5.4 AC Characteristics (MIPI)

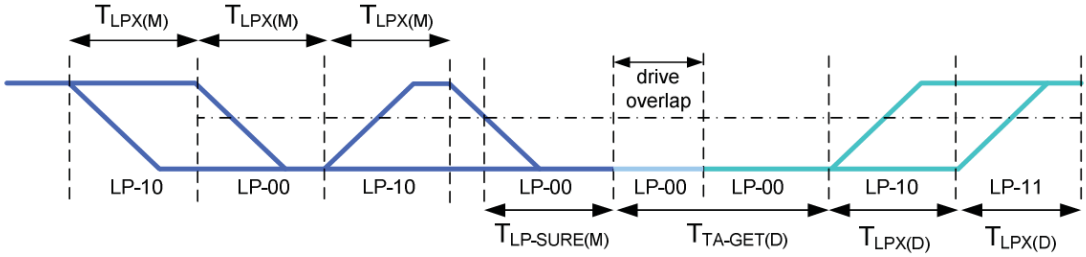
5.5.1 HS Data Transmission Burst



5.5.2 HS Clock Transmission



5.5.3 Turnaround Procedure



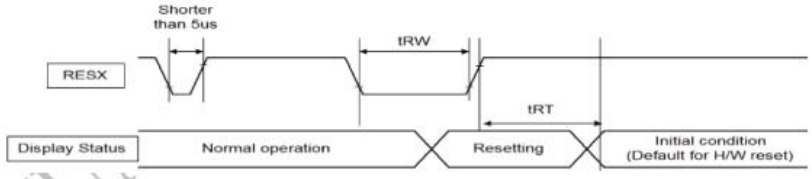
5.5.4 Timing Parameters

Symbol	Description	Min	Typ	Max	Unit
T_{REOT}	30%-85% rise time and fall time	-	-	35	ns
$T_{CLK-MISS}$	Timeout for receiver to detect absence of Clock transitions and disable the Clock Lane HS-RX.	-	-	60	ns
$T_{CLK-POST}$*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 $T_{HS-TRAIL}$ to the beginning of $T_{CLK-TRAIL}$.	60ns + 52*UI (For DCS)	-	-	ns
$T_{CLK-PRE}$	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
$T_{CLK-SETTLE}$	Time interval during which the HS receiver shall ignore any Clock Lane HS transitions, starting from the beginning of $T_{CLK-PRE}$.	95	-	300	ns
$T_{CLK-TERM-EN}$	Time for the Clock Lane receiver to enable the HS line termination, starting from the time point when Dn crosses VIL, MAX.	Time for Dn to reach VTERM-EN		38	ns
$T_{HS-SETTLE}$	Time interval during which the HS receiver shall ignore any Data Lane HS transitions, starting from the beginning of $T_{HSPREPARE}$.	85 ns + 6*UI		145 ns + 10*UI	ns
T_{EOT}	Time from start of $T_{HS-TRAIL}$ or $T_{CLK-TRAIL}$ period to start of LP-11 state	-	-	105ns +48*UI	ns
$T_{HS-EXIT}$(1)	time to drive LP-11 after HS burst	100	-	-	ns
$T_{HS-PREPARE}$	Time to drive LP-00 to prepare for HS transmission	40ns + 4*UI	-	85ns +6*UI	ns
$T_{HS-PREPARE}$ + $T_{HS-ZERO}$	$T_{HS-PREPARE}$ + Time to drive HS-0 before the Sync sequence	145ns + 10*UI	-	-	ns

$T_{HS-SKIP}$	Time-out at RX to ignore transition period of EoT	40	-	55ns +4*UI	ns
$T_{HS-TRAIL}$	Time to drive flipped differential state after last payload data bit of a HS transmission burst	60 + 4*UI	-	-	ns
T_{LPX}	Length of any Low-Power state period	50	-	-	ns
Ratio T_{LPX}	Ratio of $T_{LPX(MASTER)}/T_{LPS(SLAVE)}$ between Master and Slave side	2/3	-	3/2	ns
T_{TA-GET}	Time to drive LP-00 by new TX	5*TLPX	5*TLPX	5*TLPX	ns
T_{TA-GO}	Time to drive LP-00 after Turnaround Request	4*TLPX	4*TLPX	4*TLPX	ns
$T_{TA-SURE}$	Time-out before new TX side starts driving	TLPX	-	2*TLPX	ns

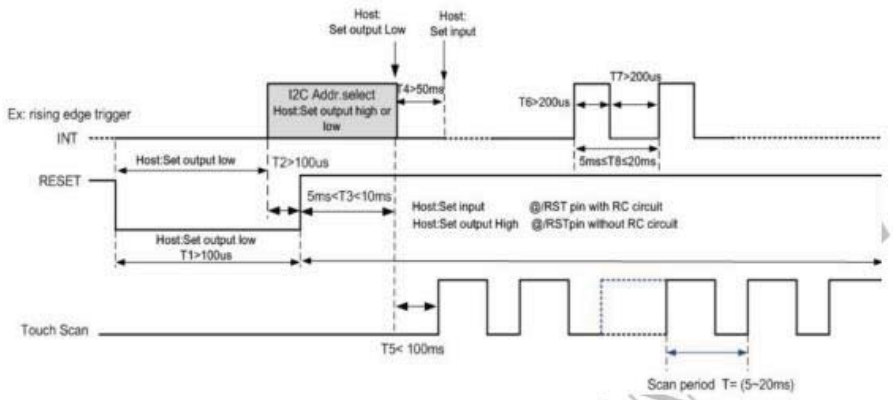
5.5.5 Reset Timing Sequence Requirement

Display panel reset timing:



Signal	Symbol	Parameter	Min	Max	Unit
Resx(Reset)	tRW	Reset pulse duration	10	-	us
	tRT	Reset cancel(Sleep in mode)		5	ms
	tRT	Reset cancel(Sleep out mode)		120	ms

TP reset timing:



Signal	Symbol	Parameter	Min	Max	Unit
TSP_RESET	T1	TSP_Reset pulse duration	100	-	us

6 Touch Interface Definition

NO.	Symbol	Description
1	GND	TSP Ground
2	Test Point	NC
3	TSP_SDA	Serial interface Data for TSP
4	TSP_SCL	Serial interface Clock for TSP
5	GND	TSP Ground
6	TSP_AVDD	Analog Power for TSP, TYP 2.8V
7	TSP_AVDD	Analog Power for TSP, TYP 2.8V
8	NC	Not Connect
9	NC	Not Connect
10	NC	Not Connect
11	GND	TSP Ground
12	TSP_ATTN	State change interrupt for TSP
13	TSP_RESET	Active low, Reset the Driver IC
14	Test Point	NC
15	GND	TSP Ground

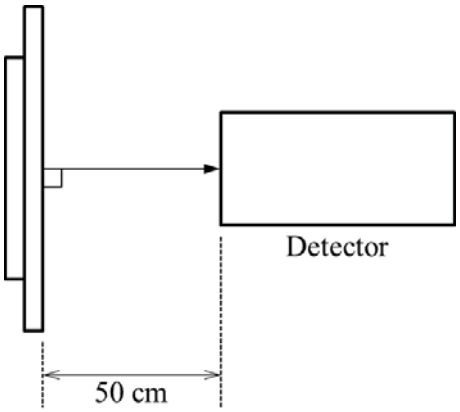
7 Electro-Optical Specification

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit	Remark
Brightness			Full White	315	350	385	cd/m2	Note 1
Brightness Uniformity				75	85	-	%	Note 2
Contrast Ratio		CR		10000	20000			Based on CA-310 Note 3
CIE Chromaticity	White	u’	Normal to surface (CIE 1976)	0.181	0.196	0.211	-	Ref.
		v’		0.441	0.456	0.471	-	Ref.
	Red	u’		0.447	0.477	0.510	-	Ref.
		v’		0.519	0.528	0.537	-	Ref.
	Green	u’		0.062	0.070	0.100	-	Ref.
		v’		0.571	0.578	0.585	-	Ref.
	Blue	u’		0.137	0.159	0.185	-	Ref.
		v’		0.123	0.146	0.203	-	Ref.
Color Gamut			vs. NTSC	95	110	-	%	
Color Temperature			Full White Normal to surface	6724	7524	8324	K	

Viewing angle	Left	θL	CR≥10	75	80	-	Deg.	Note 4
	Right	θR		75	80		Deg.	Note 4
	Top	ϕT		75	80		Deg.	Note 4
	Bottom	ϕB		75	80		Deg.	Note 4
Color Shift			White @ 30 degree			6	JNCD	Note 5
Flicker						-30	dB	Note 6
Cross Talk						1.7	%	Note 7
Gamma			At brightness 350nit	2.0	2.2	2.4		
Polarization Direction			PdF		135		Deg.	Note 8
OLED Life Time			With a Full-white image, lighting on with brightness of 350 nits for 120 hrs.	T94>=120h				
Response time						2	ms	Note 9

Note 1: Luminance Measurement

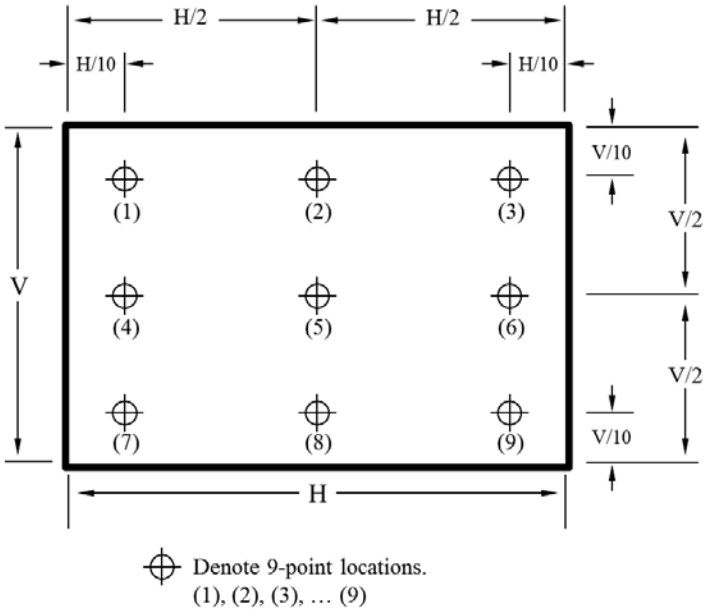
- Environmental conditions: Temp. 25℃±3℃, 65±20%RH, Dark Room.
- The data are measured after OLEDs are lighted on for more than 5 minutes and displays are fully white. The brightness is the average value of 9 measured spots. Measurement equipment: CS2000 or similar equipment. (Field of view: 1 deg., Distance: 50 cm)



Note 2: Brightness Uniformity

- Environmental conditions: Temp. 25℃±3℃, 65±20%RH, Dark Room.

- Measurement equipment: CS2000 or similar equipment.
- The brightness uniformity is calculated by using following formula:
  Brightness uniformity = Bri.(Min.) / Bri.(Max.) × 100%
  Bri.(Min.) = Minimum brightness measured in 9 measuring spots.
  Bri.(Max.) = Maximum brightness measured in 9 measuring spots.
- Illustration of 9 measuring spots as follows



Note 3: Contrast Ratio

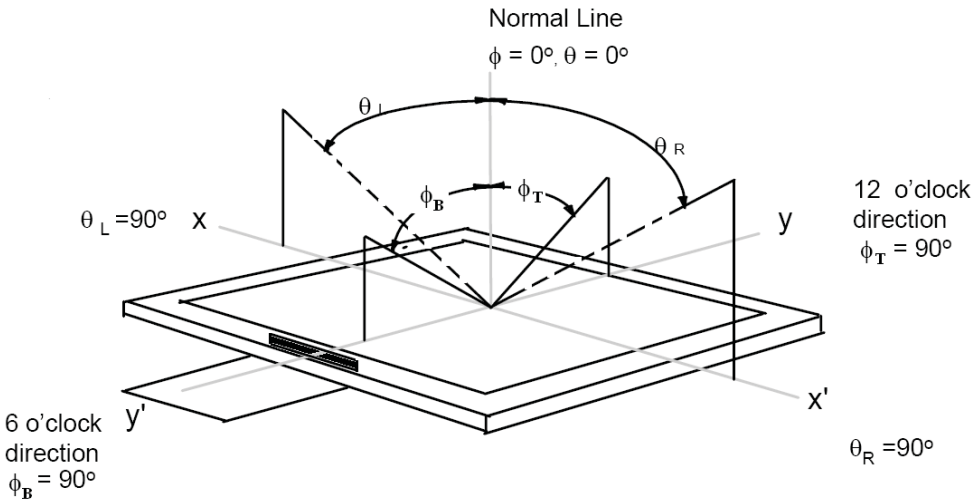
Dark Room C.R=L_W/L_B

L_W: Full white brightness of display center P0;

L_B : Full black brightness of display center P0.

Note 4: Viewing Angle

Refer to the figure below marked by θ and ϕ.



Note 5: Color Shift JNCD

- For JNCD measure, fix on white pattern, on the condition θ = 0°, ϕ= 0°, a color coordinate (u'_1, v'_1) can be obtained and another color coordinate (u'_2, v'_2) can be obtained on θ_L=30°.
- Delta u'v' = square root ((u'_2-u'_1)^2+(v'_2-v'_1)^2), and JNCD stands for "Just Noticeable Color Difference". For the (u', v') color space 1 JNCD = 0.004 Delta u'v', For example, color shift less than 2 JNCD means Delta u'v' < 0.008.

Note 6: Flicker

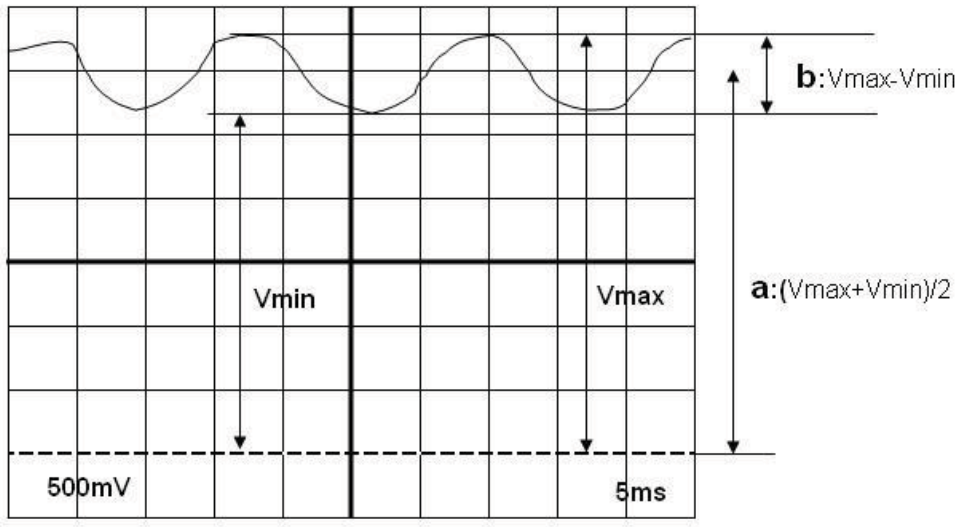
- Measurement equipment: CA-210 or similar equipment.
- Measuring temperature: Ta = 25 °C.
- Test method: JEITA method.
- Test pattern: Refer to below (Test pattern should be full-fill of display screen).
- The point should be marked is, the background of Flicker test pattern – "gray" is defined as middle gray scale. For example, RGB 24 bit "gray" is defined as below:

R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

- Frame frequency requirement before test: The display panel must be tuned to

more than 60 Hz before measurement.

- If the intensity level of the display changes as Figure below, it is considered that AC component (b) overlaps on the DC component (a). With the contrast method, the ratio of AC component to DC component is defined as the flicker amount.
- AC component (b) is defined as V_{max} - V_{min} and DC component (a) as (V_{max} + V_{min})/2, and the flicker amount is calculated by the following formula:
  Flicker amount = AC component / DC component = b/a
  = (V_{max} - V_{min}) / [(V_{max} + V_{min})/2] × 100%



Note 7: Crosstalk

- Measurement equipment: CS2000 or similar equipment.
- The background of crosstalk test pattern “gray” is defined as middle gray scale. For example, RGB 24 bit “gray” is defined as below”

R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

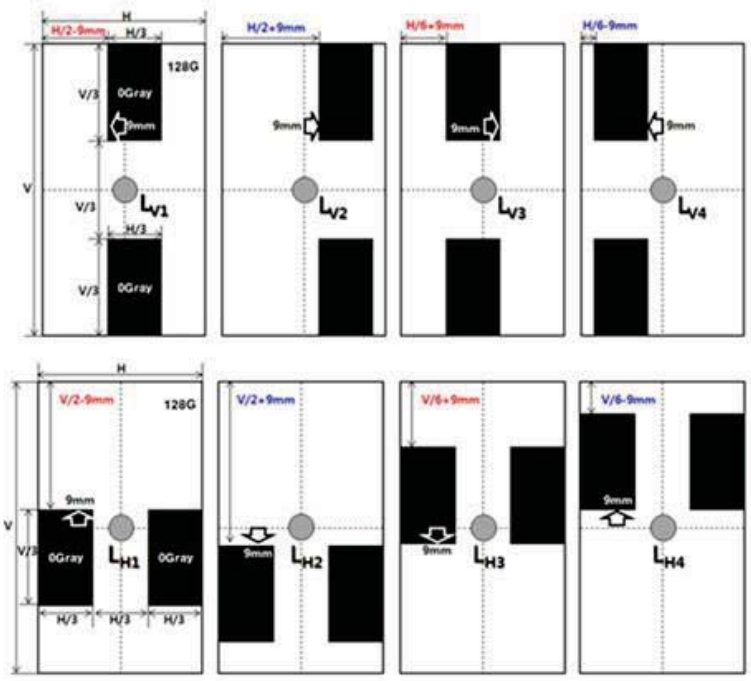
- Test pattern follows the picture below, the background is middle gray and with two black rectangle parts, each one is 1/9 of the AA size.
- Calculate the crosstalk (V) and crosstalk (H) with the formula below:

$$Crosstalk\ (V) = \max\left(\left|\frac{L_{V1} - L_{V2}}{L_{V2}}\right| \times 100, \left|\frac{L_{V3} - L_{V4}}{L_{V4}}\right| \times 100\right)$$

$$Crosstalk\ (H) = \max\left(\left|\frac{L_{H1} - L_{H2}}{L_{H2}}\right| \times 100, \left|\frac{L_{H3} - L_{H4}}{L_{H4}}\right| \times 100\right)$$

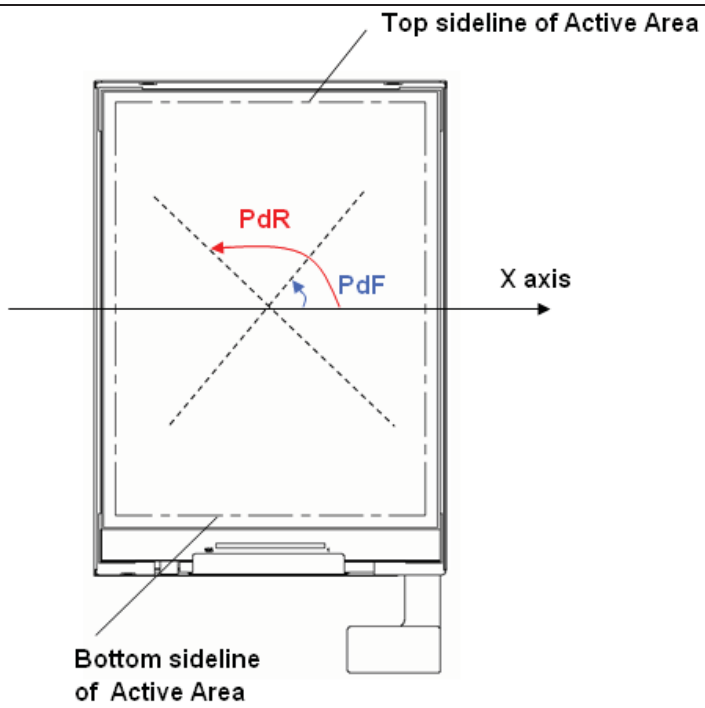
- The final crosstalk value is the maximum one between Crosstalk (V) and Crosstalk (H).

Pattern : 2/9 area is Black Box , (Background: 128gray)



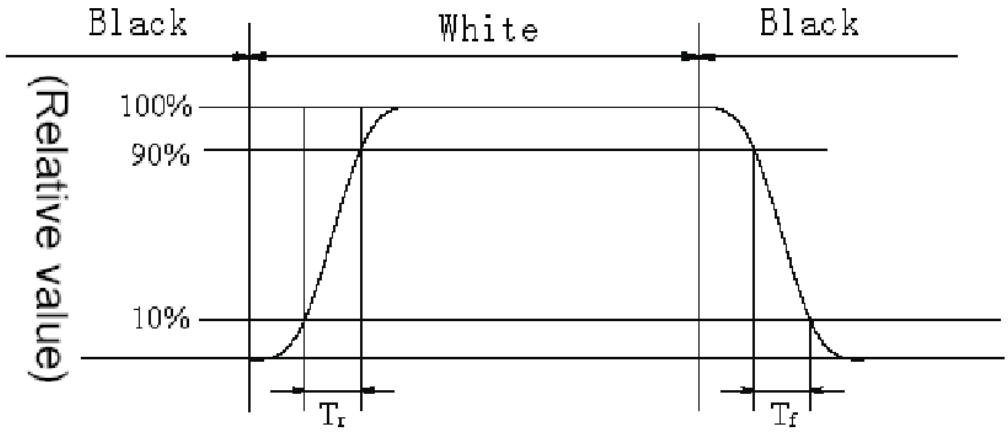
Note 8: Polarization Direction Definition

- Viewing direction is normal user viewing direction which is vertical to the display surface.
- The X axis is defined as parallel to Top and Bottom sidelines of the Active Area.
- PdF which is marked in blue arrow in the figure below is polarization degree.
- The polarization degree parameter is indicated in range of 0 deg. to 180 deg. according to above definition.



Note 9: Definition of Response Time

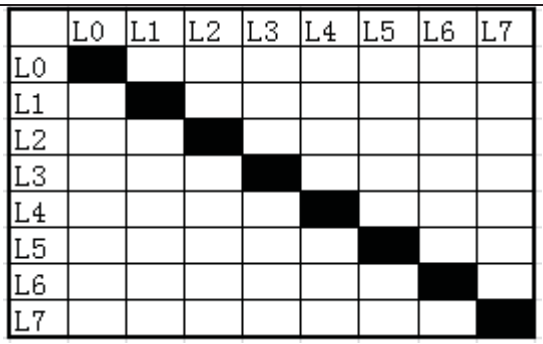
The output signals of photo detector are measured when the input signals are changed from “black” to “white” (voltage falling time) and from “white” to “black” (voltage rising time), respectively. The response time is defined as the time interval between 10% and 90% of the amplitudes, as shown in the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



- Response time of gray to gray

  Measurement equipment: CS2000 or similar equipment.

  Test method: 8 grays L0 to L7 are defined, the gray level of which are 0, 36, 73, 109, 146, 182, 219, and 255. The output signals of photo detector are measured when the input signals are changed from “Lx” to “Ly”, [x, y] = [0, 7]. The response time is defined as the time interval between 10% and 90% of the amplitudes. The result of the test can be noted as below:



8 Reliability

8.1 Environmental Test

No	Item	Conditions	Note
1	High Temperature Storage 5pcs	60℃ / 128 hours	Base on FOG or Full-MDL
2	Low Temperature Storage 5pcs	-40℃/128hours	Base on FOG or Full-MDL
3	High Temperature Operation 5pcs	70℃ / 128 hours	Base on FOG or Full-MDL
4	High Temperature and Humidity Operation 5pcs	60℃ / 90% RH 128 hours	Base on FOG or Full-MDL
5	Low Temperature Operation 5pcs	-20℃ / 128 hours	Base on FOG or Full-MDL
6	Thermal Shock Storage 5pcs	-40℃ ~ 85℃ 30min, change time < 5min, 30 cycles	Base on FOG or Full-MDL
7	Air discharge 5pcs	±8 KV,150PF/330Ω 5 Points (1 Center / 4 Corners), Each 2 times	Base on Full-MDL Note 10
8	Contact discharge 5pcs	±4 KV, 150PF/330Ω 5 Points (1 Center / 4 Corners) Each 2 times	Base on Full-MDL Note 10

Note 10:Class C will be executed unless otherwise specified :

	Class	Performance
ESD Criterion	A	All functions perform as designed during and after exposure to interference
	B	Temporary degradation or less of performance which is self-recoverable
	C	Degradation or less of performance which requires operator intervention or system reset to recover
	D	Degradation or less of function which is not recoverable

8.2 Mechanical

No	Item	Main spec	Note
1	4PB	>80MPa	
2	Drop Test	Note11	Package
3	Sinusoidal Vibration Test	Note12	Package

Note 11 Drop Test

试验前根据包装件重量从表 1 中选择对应的跌落高度进行跌落试验。

对包装件进行 1 个角、3 条棱和 6 个面的跌落试验，具体角、棱和面跌落对象及跌落顺序表 1。

重量 M（Kg）	跌落高度（mm）	试验次数
M < 10	1000	每个指定的面、角和棱各跌落 1 次
10≤M < 15	1000	
15≤M < 20	800	
20≤M < 30	600	
30≤M < 40	500	
40≤M < 50	400	
50≤M < 100	300	

表 1　自由跌落试验参数表

试验顺序	跌落对象	确定跌落对象方法
1	1＃角	最薄弱的一个底角；不能确定的话，选择角 2-3-5
2	1＃棱	构成最薄弱底角的三条棱之中最短的一条棱

3	2＃棱	构成最薄弱底角的三条棱之中倒数第二短的一条棱
4	3＃棱	构成最薄弱底角的三条棱之中最长的一条棱
5	1＃面	包装件外表面中面积最小的一个
6	2＃面	与 1＃面正对的面
7	3＃面	包装件外表面中面积中等的一个
8	4＃面	与 3＃面正对的面
9	5＃面	包装件外表面中面积最大的一个
10	6＃面	与 5＃面正对的面

表 2　自由跌落试验顺序表

测试适用范围：外箱，最少数量 1PCS 外箱。包装内顶层和底层 Tray 盘必须装满良品，中间 Tray 盘可以装不良品配重。

合格判据

1）中箱允许不影响运输保护的破损（破损长度<5cm），允许适当的变形。不允许机能上的损伤

2）包装的缓冲材料应无变形、允许小量的不可恢复的压痕、折痕和破裂。(破损长度<3cm)，但需要记录失效现象并拍照。

3）Tray　盘不可以有开裂、折痕和不开恢复变形问题。

4）试验后顶层和底层样品机械功能和电气功能正常，机械强度满足华为单体规格书机械可靠性测试要求。

Note 12 Vibration Test

试验时按照表 3、表 4 的参数进行试验设置：

试验顺序	试验轴向	试验时间（min）	备注①
1	Z 轴向	30	面 3 放置工作台上，装夹方式是压紧
2	Y 轴向	30	面 4 放置工作台上，装

			夹方式是压紧
3	X 轴向	30	面 6 放置工作台上 ,装夹方式是压紧

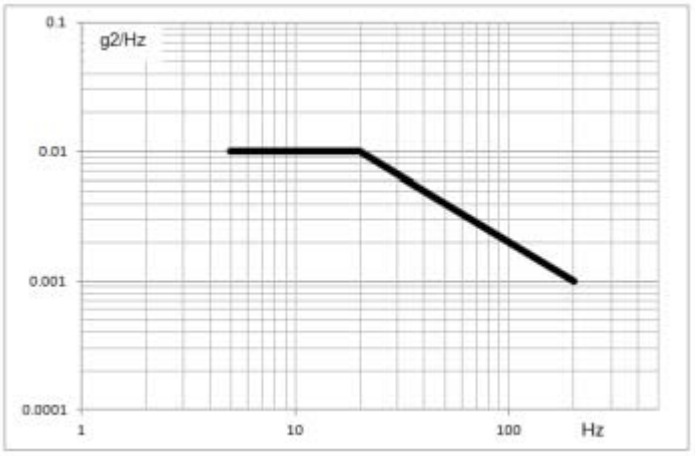
表 3　随机振动试验参数表

若产品有明确的放置面，则要求放置面始终放在振台面上。即 Y 轴向和 X 轴向测试放在振动台的水平滑台上。

频率（HZ）	PSD（功率谱密度，g2/Hz）
5	0.01
20	0.01
200	0.001
均方根加速度（Grms）	0.781

表 4　随机振动断点设置表

根据上表设置的随机振动频谱曲线（PSD VS Hz）应符合下图：



测试适用范围：外箱，最少数量 1PCS　外箱。包装内顶层和底层 Tray 盘必须装满良品，中间 Tray 盘可以装不良品配重。

合格判据

1）中箱允许不影响运输保护的破损（破损长度<5cm），允许适当的变形。不允许机能上的损伤

2）包装的缓冲材料应无变形、允许小量的不可恢复的压痕、折痕和破裂。(破损长度<3cm)，但需要记录失效现

象并拍照。

3) Tray　盘不可以有开裂、折痕和不开恢复变形问题。

4) 试验后顶层和低层样品机械功能和电气功能正常，机械强度满足华为单体规格书机械可靠性测试要求。

8.3 Environmental protection

Item	Main spec	Note
有害物质管控	参考附件《有害物质管控标准书》	IS-110

9 Handling Precautions

9.1 When cleaning ITO pad, avoid using hard and abrasive material or corrosive solution

9.2 Keep module away from direct sunlight or fluorescent light, and keep it at room temperature and humidity

9.3 Strong impact & pressure on module and packing is prohibited

9.4 Following normal power on/off sequence is necessary for preventing abnormal display or permanent damage to display

9.5 Optimal contrast ratio under ideal voltage is AMOLED module’s characteristic, hence it is recommended a voltage control function available.

9.6 Image sticking may occur if an image displays for an extended period of time

9.7 When interfered by system’s overall mechanical design, an abnormal display may occur

9.8 After considering emitting energy, you should plan your design to satisfy EMI standards.

9.9 Host side should place a surge-prevent circuit at power trace (ie: VCI, Vddi) to protect AMOLED module.

10 Outline Dimension Drawing

10.1 Module Outline