DISPLAY MODULE

SPECIFICATION

Module Size: **5.99” 1440 x 2880**

Spec Part No:

Date : **2020-03-22**

Version: **D**

Huawei Technologies Co., Ltd.

Revision History

Version	Revise Date	Page	Content	Prepared by
Preliminary	2016-11-30	ALL	First release	Liu Jun
A	2020-02-21	6 24 48 49 51, 61	Delete PCD in D-IC feature Add Project ID in 7.1.1 Update G/B color coordinate, NTSC ratio Update color temperature, and gamma spec Add lifetime calculation formula	Liu Jun
B	2020-08-19	4 5 5 6 10 20 29 30 49 52 65 67 69	Update Force touch and Hover Modify module dimension information Modify FPC BTB connect mothod Modify 2D barcode and project ID Update pin assignment Update DC Characteristics Update Force and Hover requirement Update CG spec Update Optical performance Update UD Optical Fingerprint transmittance request Update Module drawing Update Module Unit Reliability Test Spec Add EMI spec first version	Shenmenghu
C	2020-01-14	5 5 5 6 13 14 23 27 33 51 52 66 68 68 69	Add luminance (5 min aging) Storage temperature -30~80 Add weight 24.95+/-2.95 g Add panel & IC power consumption Update Schematic Circuit Diagram Update Timing Characteristics Update Power Consumption Update TP spec Update CG spec Update Color Coordinate， Luminance decrease ratio ，color shift ，Delta E，OLED lifetime, Short time image sticking Cancle Polarization direction Update Mechanical drawing Update Incoming Inspection Requirement Update Module Unit Reliability Test Update EMI spec version	Liwenjie Shenmenghu
D	2020-02-06	53	Update Color temperature	Shenmenghu

		53	Update ΔE under different gray level and different brightness level	

Table of Contents

1 General Specification

1.1 Features

1.1.1 Touch Feature

Hardware feature	Requirement	Software feature	Requirement
Anti-Finger	√	Glove function	√
Al-Si cover glass	√	Wake up by touch	√
Na-Ca cover glass		Force touch function	√
BTB connect	√	Waterproof function	√
Same Color between ink and Display panel active area(for black lens)	√	Hover function	√
RoHS and REACH environmental criterion.	√	Proximity function	

1.1.2 Display Feature

-- AMOLED Display type
--MIPI-DSI 4 lanes
--BTB Connection
--This product accords with RoHS and REACH environmental criterion.

1.2 Application

Display/TP terminals for Cellular Phone

1.3 General Specification

No	Item	Specification	Unit	Remark
1	Display Size	5.99”	Inch	
2	ITO Techology Type	LTPS		

3	Display mode		AMOLED		
4	Resolution		1440 x 2880		
5	Color Depth		16.7M		
6	Viewing Direction		All direction		
7	Contrast Ratio		90000:1(TYP)		CPK>1.33
8	Luminance (with lens)		Normal mode: 405 min / 450 typ / 495 max (5 min aging) HBM mode:600nits	cd/m^2	CPK>1.33 (without HBM)
9	Module Size	Display Panel (with Touch)	70.24(W)×139.78(H)×0.425(T) (flat, w/o cushion tape, thickness only for reference)	mm	Note 1.1
		OCA	0.125	mm	Note 1.1
		Cover Lens (3D)	71.28(W)*150.06(H)*0.55(T)	mm	Note 1.1
		Display Panel &Cover lens (3D)	71.28(W)*150.06(H)*1.26(T)	mm	Note 1.1
10	Display Panel Max. Thickness		Max 0.525, Typ:0.425±0.1	mm	Note 1.1
11	Panel Active Area		68.04x136.08 (UnCurved)	mm	Note 1.1
12	Pixel Size		47.25x47.25	um	
13	Pixel Pitch		47.25	um	
14	Pixel Aspect Ratio		1:1		
15	Light Source		OLED		
16	Interface		MIPI-DSI 4 lanes (typ 1Gbps/lane)		
17	Operation Temperature		-20~+70	degC	
18	Storage Temperature		-30~+80	degC	
19	Weight		26+/-3	Gram	
20	Pixel Per inch		538	PPI	
21	Environmental Protection Requirement		RoHS & REACH must be executed		
22	Connection method		Main: 14241007		
			TP: 14241009		
23	Panel gate scan direction		Gate only support scan from IC opposite side to IC side		Note 1.2
24	Diagonal Stripes&Morie		Invisible		Note 1.4
25	Profile of any surface		≤0.12mm@ Four corner For detailed, refer 2D drawing		Note 1.3
26	Polarizer Type		Hard coating: 3H, Glare		

27	Sunglass Readability	Non Sunglass Circularly type Polarizer solution		
28	FPC EMI shielding	need		Refer drawing
29	Protection Film Antistatic Film	Antistatic Film ESD<1000V		Refer drawing
30	Support 2D bar code	All must use uppercase character Protection film handle 1pcs Storage in TP IC Position refer 2D drawing		Note 1.6
31	Resistance value between the FPC ground and the Cu sheet	Less than 10 ohm Contact size large than 20 mm^2		
32	TP project ID	Storage in TP IC		
33	TP Color	Storage in DDIC		
34	TP IC need Underfill glue	Follow HW criteria		Note 1.7
35	Panel power consumption(white pattern 450nit)	1550Typ/2042 Max	mW	W/O IC power comsumption
36	IC power consumption(color pattern POCB Off/On)	299.7 Typ /344.65 Max(POCB Off) 335.7 Typ / 386.05 Max (POCB On)	mW	

No	Driver IC feature	Support	Remark
1	HBM (High brightness mode) Function Brightness and gamma tuning is integrated	√	
2	ACL(Automatic current limitation) function	√	
3	Gamma Correction, White correction function, RGB Separate γ Correction Function	√	
4	Scaling up function	√	HD720
5	Err flag detection	√	
6	MIPI Checksum	√	
7	Command mode	√	
8	Video mode	√	
9	Driver IC RAM (size)	√	1/3 RAM
10	Color Enhancement	√	
11	Contrast Enhancement	√	

12	CRC (Gamut mapping)	√	
13	White Balance adjustment	√	
14	Sharpness function	√	
15	Support VESA standard 1/3 compression	√	DSC1.1
16	AMOLED/TP module port of provisional TLP technical requirements	√	Note 1.5
17	MURA compensation IP	√	
18	Internal EL voltage generation for low power mode	√	

Note 1.1

Please Refer to the mechanical drawing.

Note 1.2

Some GOP panel can not support gate bidirectional scanning, or even some gate bidirectional scanning GOP panel are abnormal working when the gate scanning direction set to be reversed**.**

Note 1.3

Warpage inspected by 3D coordinate scanning/ measuring system to analyze surface warpage and precision gauge is applied for module thickness measurement. Display panel is placed on flat stage to get 9 points warpage measured by 3D scanning system.
Test Method: Nikon VMR-3020- optical.

Note 1.4

Viewing distance: 300mm±50mm.

Viewing angle: θ_L <45 °, θ_R <45 °, ψ_T<45 °, ψ_B<45 °.

The viewing angle Refer to **Note 8.3.**

The inspection condition refers to 10.2 《General Inspection Criteria for the TP-LCD Integrated Module of Huawei Device V6.0》

Note 1.5

LCD/TP module port of provisional TLP technical requirements:

ESD requirement on the LCD/TP terminals in BTB connector: In TLP test with 100 ns pulse width, 10 ns rising edge, ESD ceritia for TLP test: TLP failure current of terminal must be higher than 4 A, or the terminal's withstand voltage (TLP source voltage) must be higher than 500V.

Note 1.6

There would be 2 potential places to add 2D code for tracking during assembly:

1. CG protection film, 2D barcode only, size 12*12 mm;
2. Storage in the IC NVM or OTP.

For 2D code rule, please follow the below criteria, total 39 characters.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
huawei part number								Vendor	Module Information								Glass Information							
								Vendor	Equipment line	Year	Month	Day	Serial number				Glass Factory	Year	Month	Day	Glass ID			
2	3	0	2	0~9	0~9	0~9	0~9	A~Z	1~Z W/O I、O	1~9	1~C	1~X W/O	0001~ZZZZ				1~Z W/O I、O	1~9	1~C	1~X W/O I、O	0001~ZZZZ W/O I、O			
2	3	0	2	0	4	6	7	Huawei appoint	Module equipment Information	Module Production Date			Module Production number				Glass Production Place	Glass Production Date			Glass Glass ID			

26	27	28	29	30	31	32	33	34	35	36	37	38	39
LED IC batch Informatio			ouch IC batch Informatic			Cushion			MTP	TBD	TBD	TBD	标识位
Year	Month	Day	Year	Month	Day	Vendor	Model	Thickness	code version				标识位
1~9	1~C	1~X W/O	1~9	1~C	1~X W/O								C
IC batch Information			IC batch Information										

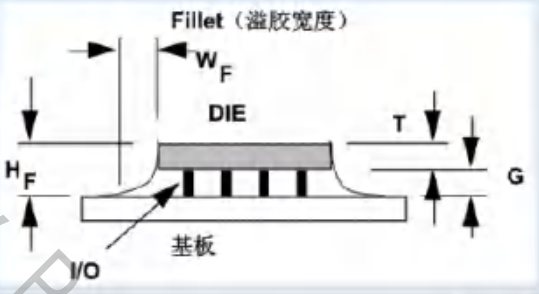
Note 1.7

Adding underfill glue around TP IC.

The water absorption test mehod refers to ASTM 570 Standard Test Method for Water Absorption of Plastics.

TP-IC 点胶相关技术规格要求 TP-IC Underfill Specification Requirements			
项目 Item	规格要求 Specification Requirement	是否必须 If necessary or not	检测频次 inspection
Underfill 吸湿率 Underfill Water Absorption	<1%@85℃，85%RH，500H	必须 Must	
Underfill Tg 点 Underfill glass transition temperature (Tg)	71℃	必须 Must	
Underfill 来料管内气泡数 Bubble Number in the Underfill Material Tube	0	必须 Must	全检 All Detection
Underfill 回温方式 Underfill Thawed Method	自然回温，禁止加热回温 Naturally Thaw, DO NOT Heat.	必须 Must	
点胶路径 Underfill Coating Route	I 字形点胶 I Font	推荐 recommended	
点胶前 FPCA 烘烤 FPCA Baking Before Underfill Coating	15min，150℃	必须 Must	
点胶前 FPCA 预热 FPC Pre-heat Before Underfill Coating	温度设定按照胶水 SPEC 要求 Set Temperature Acording to Underfill Material Specification	必须 Must	

Underfill 空洞 Cavity Number After Underfill Coating	**测试方法 Inspection Method:** 磨切片。 Slices. **允收标准 Acceptance Standard:** 1）不允许有贯穿两个及以上焊球的空洞或裂纹； There is no Cavity or Crack through two or more Solder Balls. 2）孤立空洞的数量≤3 个。 Isolated Cavity number <= 3.	必须 Must	样品:3pcs/lot/编码 Trial-produce: 3 pcs/lot 量产:3pcs/week/编码 Mass Production: 3 pcs/week
Underfill 与锡膏中 flux 兼容性 Compatibility between Underfill and Flux	**测试方法 Inspection Method:** 点胶后平磨，使用 0.1mm 针头穿刺。 Slice and Puncture with a 0.1 mm Needle. **允收标准 Acceptance Standard:** 无拉丝、粘稠和液态现象。 There is no Filiform, Ropy or Liquid Phenomenon.	必须 Must	材料选型后第一次样品必须测试，更换材料必须复测 Must Test Again, Once Material is Altered.
UF 固化度 Underfill Degree of Cure	**测试方法 Inspection Method:** 称取未固化的 underfill 胶和固化后的 underfil 分别 15mg 左右，放入 DSC 中，升温范围为 50℃至 260℃，升温速率 10℃/min，N2 气气氛，观察 underfill 胶的固化起始温度、峰值温度、终了温度，以及其固化焓。 The degree of cure is Measured Usmg a Differential Scanning Calorimetry (DSC) Thermal Analysis Apparatus. 固化度=（未固化胶水的固化焓-固化后胶水的固化焓）/未固化胶水的固化焓*100%。 %Cure (Degree of Cure) = [DHuncured-DHcured]/[DHuncured]*100%. In this relationship,DHuncured represents the heat of cure of the uncured underfill material and DHcured is that of the partially cured resin.If no heat of cure is observed,then the value of %Cure is 100% and it is assumed that the underfill is completely cured. **允收标准 Acceptance Standard:** 固化度大于 99% Degree of Cure > 99%.	必须 Must	样品:3pcs/lot/编码 Trial-produce: 3 pcs/lot 量产:3pcs/week/编码 Mass Production: 3 pcs/week
TP-IC 焊接后锡渣残留 Tin Slag Residual	**测试方法 Inspection Method:** 平磨切片后显微镜观察 Slice and Watch by a Microscope **允收标准 Acceptance Standard:** 不允许有锡渣 DO NOT have Tin Slag.	必须 Must	样品:3pcs/lot/编码 Trial-produce: 3 pcs/lot 量产:3pcs/week/编码 Mass Production: 3 pcs/week

固化后 fillet 高度 Fillet Height	测试方法 Inspection Method: 切片后测量尺寸 Slice and Measure its size. 允收标准 Acceptance Standard: 四周高度必须超过除去焊球外的芯片 1/2 厚度位置，即 Hf>G+1/2T，参考下图: Edge Height must be more than the Height of Solder Ball and half Chip as Shown Below, that is, Hf>G+1/2T.  	必须 Must	样品:3pcs/lot/编码 Trial-produce: 3 pcs/lot 量产:3pcs/week/编码 Mass Production: 3 pcs/week
固化后 fillet 外观 Fillet Appearance	测试方法 Inspection Method: 50x 显微镜外观观察 Watch by a 50x Microscope. 允收标准 Acceptance Standard: 无孔隙 No Hole or Crack.	必须 Must	样品:3pcs/lot/编码 Trial-produce: 3 pcs/lot 量产:3pcs/week/编码 Mass Production: 3 pcs/week
去 flux 及残留物 Clean Flux and Residua	SMT 后喷淋清洗 Spray Clean after SMT	推荐 Recommended	
加压固化 Curing through Pressurization	加压固化 Curing through Pressurization.	推荐 Recommended	
返修 Reworking	FPC SMT 禁止返修 DO NOT Reworking.	必须 Must	

2 Pin Assignments

2.1 Display Pin Assignments

No.	Pin	I/O	Description
1	ELVSS	I	P-IC (Typ: -2.4V)
3		I	

5		I	
7	GND	I	Ground
9	ELVDD	I	P-IC (Typ: 4.6V)
11		I	
13		I	
15	GND	I	Ground
17	DDVDH	I	P-IC (Typ: 6.7V)
19	VDDIO	I	ID flag
21	VPP	I	D-IC writing Power
23	ERR_FG	O	Error flag pin
25	TE	O	Tearing effect signal
27	RESET	I	D-IC Reset
29	VDDI	I	D-IC Logic (Typ: 1.8V)
31	HSYNC	I/O	TP synchronization
33	VPNL	I	Analog Power(Typ: 3.0V)

No.	Pin	I/O	Description
2	D3N	I	MIPI
4	D3P	I	
6	GND	I	
8	D0N	I/O	
10	D0P	I/O	
12	GND	I	
14	CKN	I	
16	CKP	I	
18	GND	I	
20	D1N	I	
22	D1P	I	
24	GND	I	
26	D2N	I	
28	D2P	I	
30	GND	I	
32	GPO0	O	Connect P-IC EN3 Pin
34	GPO1	O	Connect P-IC CTRL Pin

2.2 Touch Pin Assignments

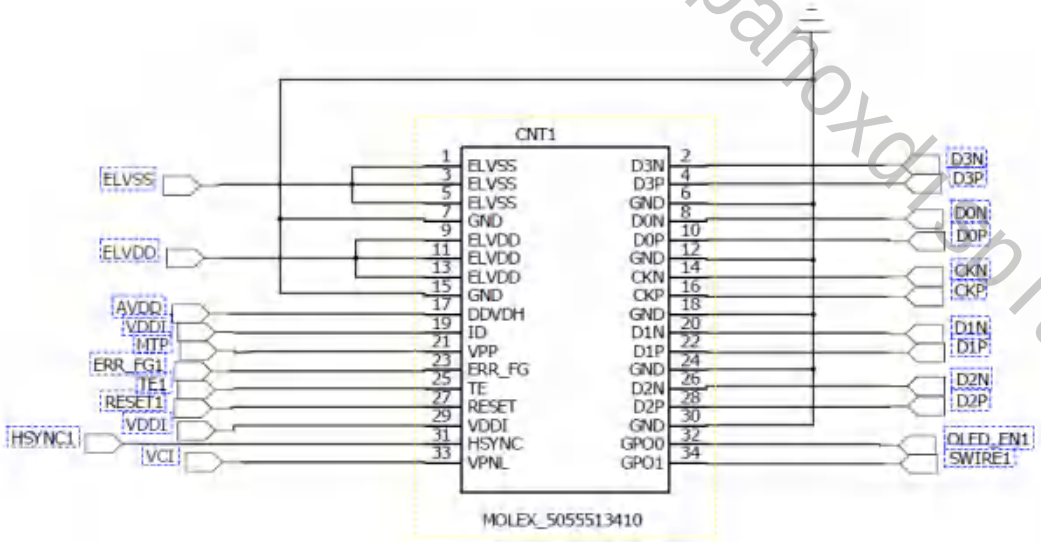
NO.	Pin	NO.	Pin
1	GND	2	GPIO_00
3	TP_VCI(3.3V)	4	GPIO_01
5	TP_VDD(1.8V)	6	VPP/TS_IN_N
7	GND	8	RST/RESET_N
9	GND	10	SPI_CSK/HOST_SCK
11	INT_Standby	12	FP_1V8
13	TP_RST	14	SPI_MISO/HOST_MISO
15	TP_INT	16	SPI_MOSI/HOST_MOSI
17	I2C_SCL	18	INT/HOST_DRDY
19	I2C_SDA	20	SPI_CS/HOST_SSN
21	HSYNC	22	VDD
23	GND	24	GND

Note ID:

This pin definition needs confirm with hardware engineer before Display panel FPC fixed.

3 Schematic Circuit Diagram

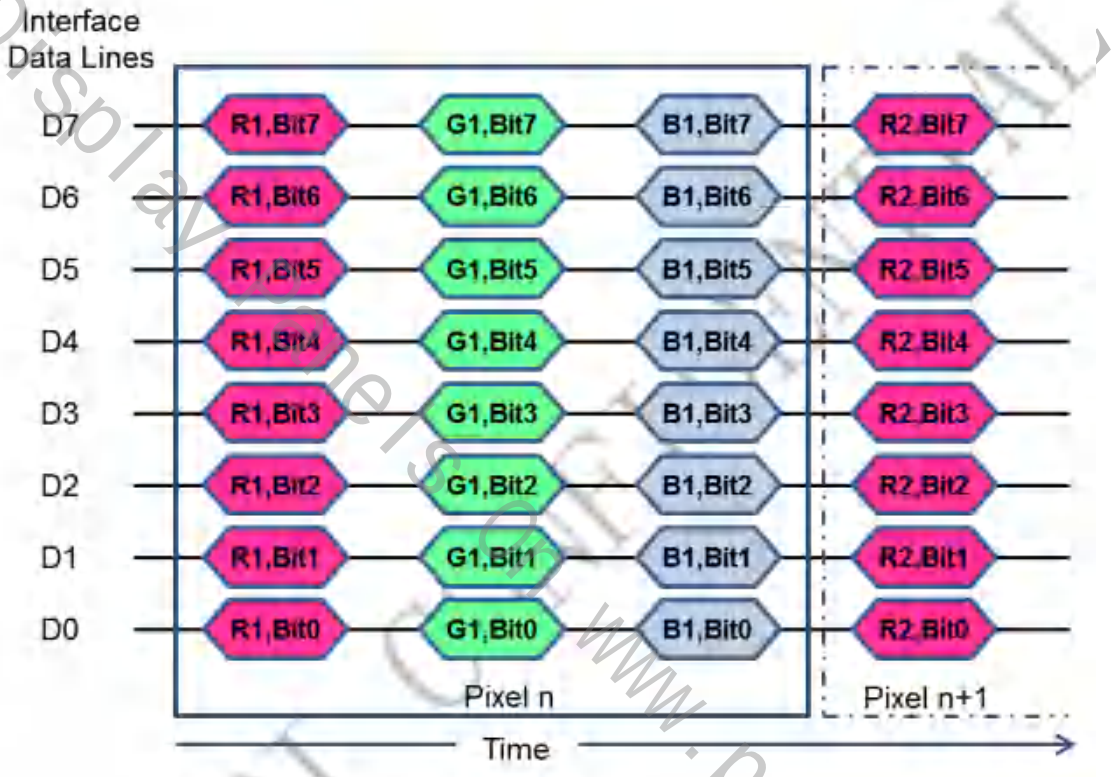
3.1 MIPI-DSI 4 lanes Reference Circuit



4 Register & Pixel Data Format

4.1 MIPI-DSI 4 lanes Data Format

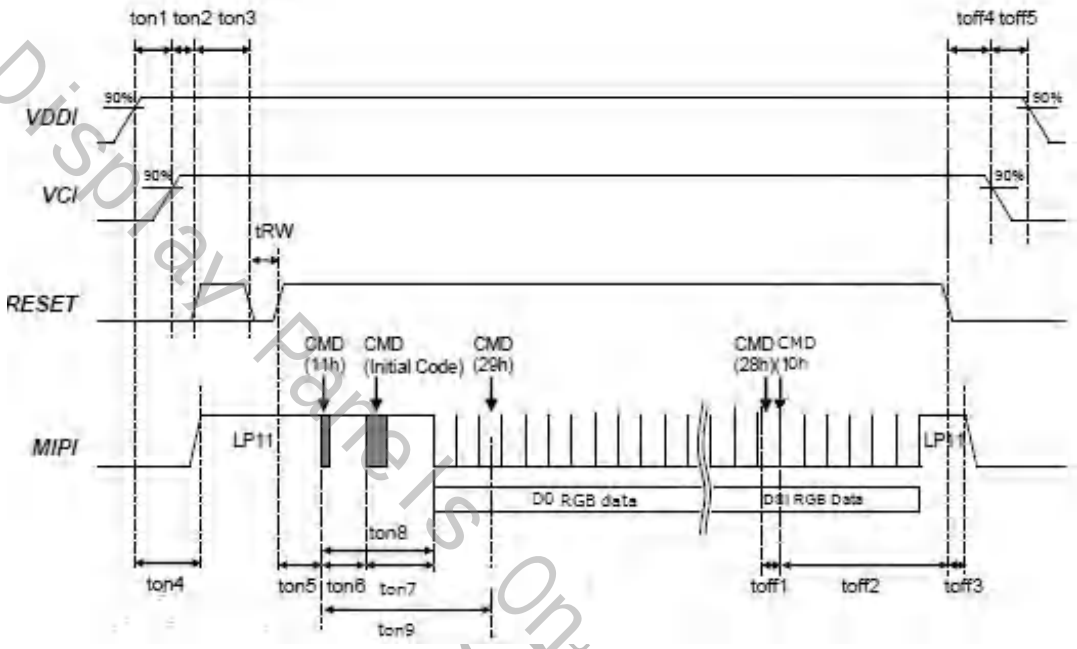
Reference data format.



Twenty-four Bits per pixel Format to Byte Mapping

5 Timing Characteristics

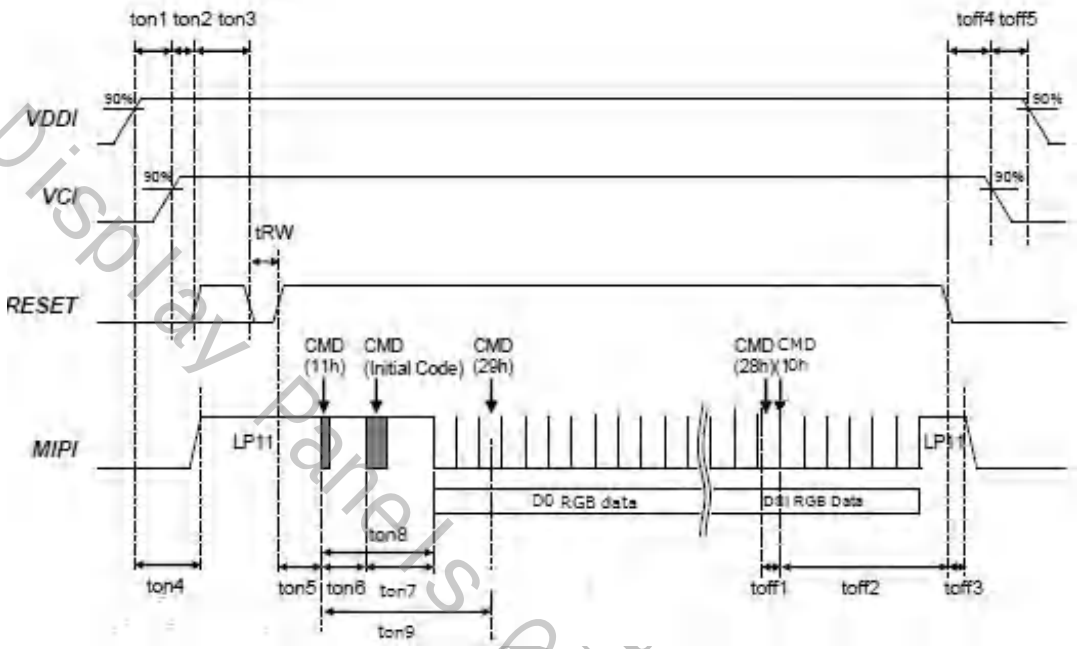
5.1 Power on/off Sequence



Parameter	Min.	Typ.	Max.	Unit
Ton1	0			ms
Ton2	1			ms
Ton3	9			ms
Ton4	1		Ton1+ Ton2	ms
Ton5	20			ms
Ton6	10			ms
Ton7	20			ms
Ton8	30		100	ms
Ton9	0			ms
tRW	0.02		1	ms
Toff1	0			ms
Toff2	150			ms
Toff3	0			ms
Toff4	0			ms
Toff5	0			ms

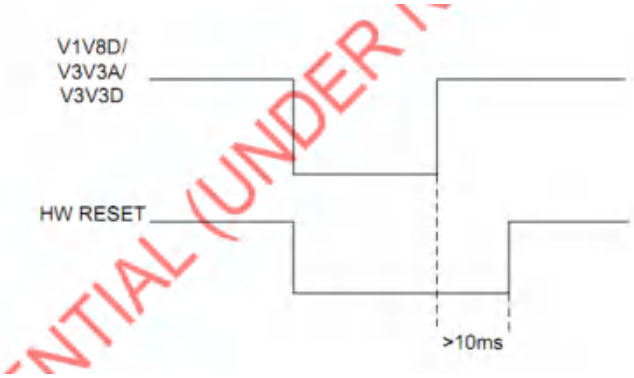
5.2 Reset Timing Sequence Requirement

Display panel reset timing:



Parameter	Min.	Typ.	Max.	Unit
Ton1	0			ms
Ton2	1			ms
Ton3	9			ms
Ton4	1		Ton1+ Ton2	ms
Ton5	20			ms
Ton6	10			ms
Ton7	20			ms
Ton8	30		100	ms
Ton9	0			ms

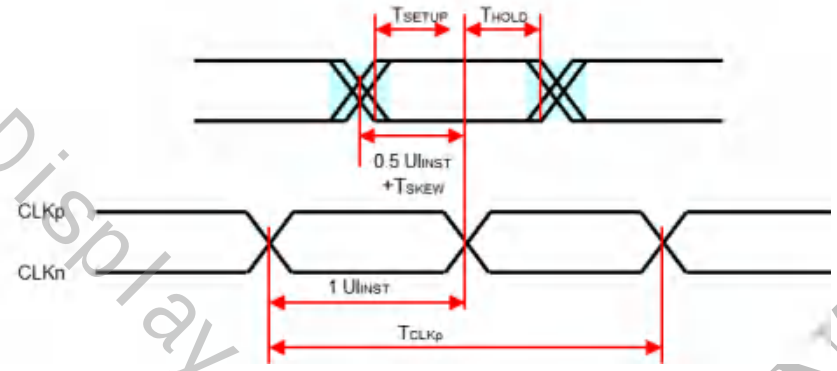
TP reset timing:



5.3 MIPI-DSI 4 lanes Interface Characteristics

5.3.1 High speed mode

High Speed Data Transmission: Data-Clock Timing



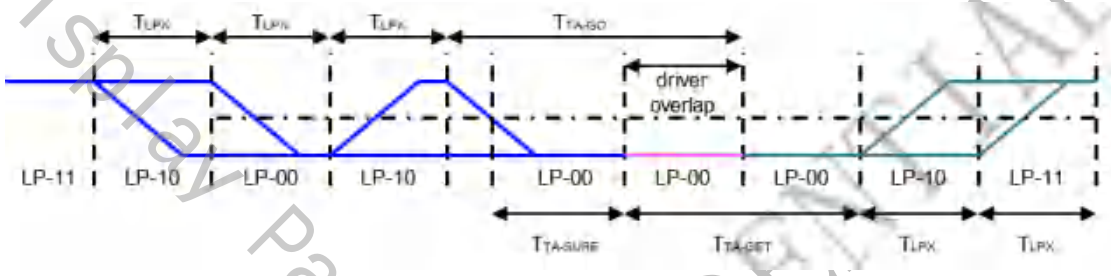
Parameter	Symbol	Min	Typ	Max	Units	Notes
UI instantaneous	UIINST	1		12.5	ns	1,2,10
Data to Clock Skew [measured at transmitter]	TSKEW[TX]	-0.15		0.15	UIINST	3
		-0.2		0.2	UIINST	4
Data to Clock Setup Time [measured at receiver]	TSETUP[RX]	0.15		0.15	UIINST	5
		0.2		0.2	UIINST	6
Data to Clock Hold Time [measured at receiver]	THOLD[RX]	0.15		0.15	UIINST	5
		0.2		0.2	UIINST	6
20% - 80% rise time and fall time	tR / tF	100			ps	9
				0.3	UIINST	7
				0.35	UIINST	8

Note:

1. This value corresponds to a minimum 80 MHz data rate.
2. The minimum UI shall not be violated for any single bit period, i.e. ,any DDR half cycle within a data burst.
3. Total silicon and package delay budget of 0.3* UIINST when D-PHY is supporting maximum data rate = 1Gbps.
4. Total silicon and package delay budget of 0.4* UIINST when D-PHY is supporting maximum data rate > 1Gbps.
5. Total setup and hole window for receiver of 0.3* UIINST when D-PHY is supporting maximum data rate = 1Gbps.
6. Total setup and hole window for receiver of 0.4* UIINST when D-PHY is supporting maximum data rate > 1Gbps.
7. Applicable when operating at HS bit rates ≤ 1 Gbps (UI ≥ 1 ns).
8. Applicable when operating at HS bit rates > 1 Gbps (UI < 1 ns).
9. Applicable for all HS bit rates. However, to avoid excessive radiation, bit rates ≤ 1 Gbps (UI ≥ 1 ns), should not use values below 150 ps.
1. For MIPI speed limitation:
   [1] Per lane bandwidth is 1Gbps.
   [2] Total Bit Rate: 4Gbps for 8-8-8; 3Gbps for 6-6-6; and 2.67Gbps for5-6-5.

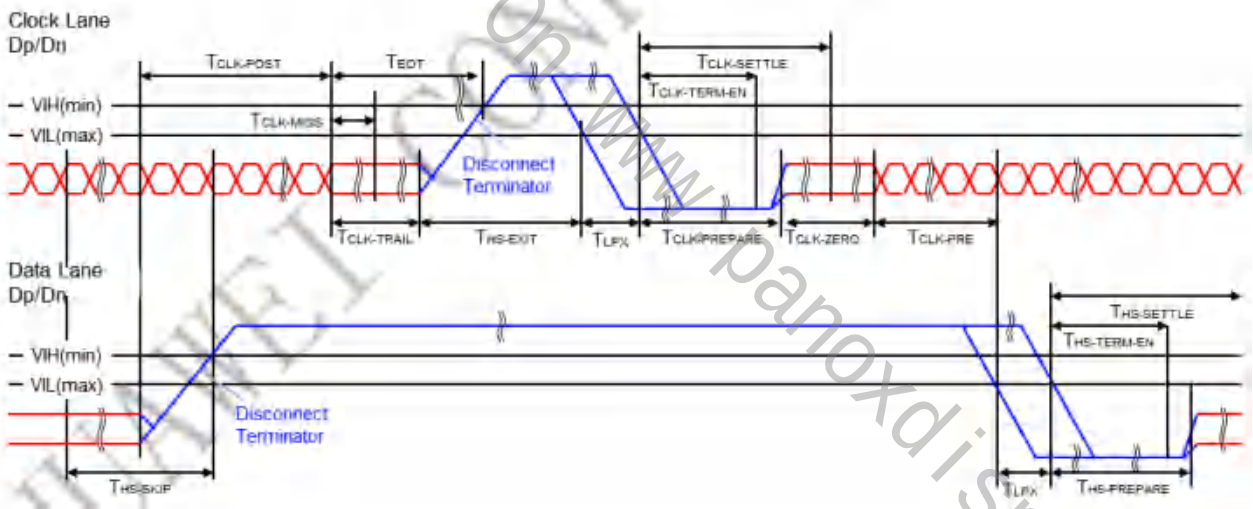
5.3.2 Low power mode

Parameter	Symbol	Min	Typ	Max	Unit
Length of any Low-Power state period : Master side	T_{LPX}	50		75	ns
Length of any Low-Power state period : Slave side	T_{LPX}	50		75	ns
Ratio of TLPX(MASTER)/TLPX(SLAVE) between Master and Slave side	Ratio T_{LPX}	2/3		3/2	
Time-out before new TX side start driving	$T_{TA-SURE}$	T_{LPX}		$2T_{LPX}$	ns
Time to drive LP-00 by new TX	T_{TA-GET}		$5T_{LPX}$		ns
Time to drive LP-00 after Turnaround Request	T_{TA-GO}		$4T_{LPX}$		ns



5.3.3 Switching Clock lane

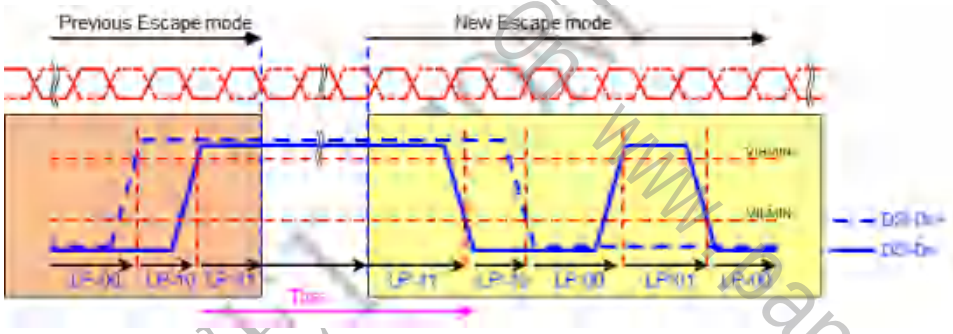
Switching the Clock Lane between Clock Transmission and Low-Power Mode



Parameter	Symbol	Min	Typ	Max	Units
Time that the transmitter shall continue sending HS clock after the last associated Data Lane has transitioned to LP mode (RM=0)	$T_{CLK-POST}$	60+112UI			ns
Time that the transmitter shall continue sending HS clock after the last associated Data Lane has transitioned to LP mode (RM=1) Note: Due to this value need to correspond with a minimum 80 MHz data rate	$T_{CLK-POST}$	60+312UI			ns
Time that the transmitter shall continue sending HS clock after the last associated Data Lane has transitioned to LP mode (RM=1) Note: Due to this value need to correspond with a minimum 500 MHz data rate	$T_{CLK-POST}$	60+252UI			ns
Detection time that the clock has stopped toggling	$T_{CLK-MISS}$			60	ns
Time to drive LP-00 to prepare for HS clock transmission	$T_{CLK-PREPARE}$	38		95	ns
Minimum lead HS-0 drive period before starting Clock	$T_{CLK-PREPARE}$ +$T_{CLK-ZERO}$	300			ns
Time to enable Clock Lane receiver line termination measured from when Dn cross VIL,MAX	$T_{HS-TERM-EN}$			38	ns
Minimum time that the HS clock must be set prior to any associated date lane beginning the transmission from LP to HS mode	$T_{CLK-PRE}$	8			UI
Time to drive HS differential state after last payload clock bit of a HS transmission burst	$T_{CLK-TRAIL}$	60			ns

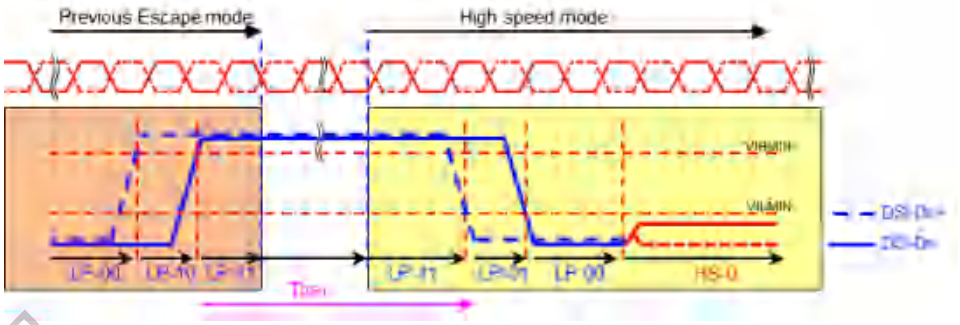
5.3.4 Timing request between data transmission

(1) Timing between LP – LP command



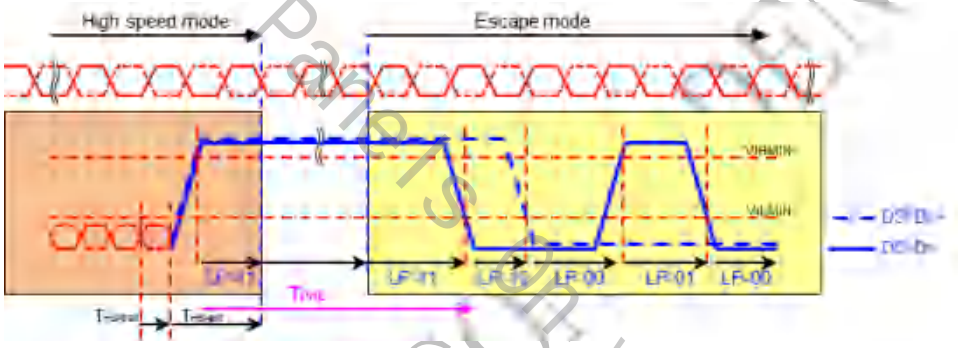
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the new Escape Mode Entry	T_{DEE}	**100**			**ns**

(2) Timing between LP – HS command



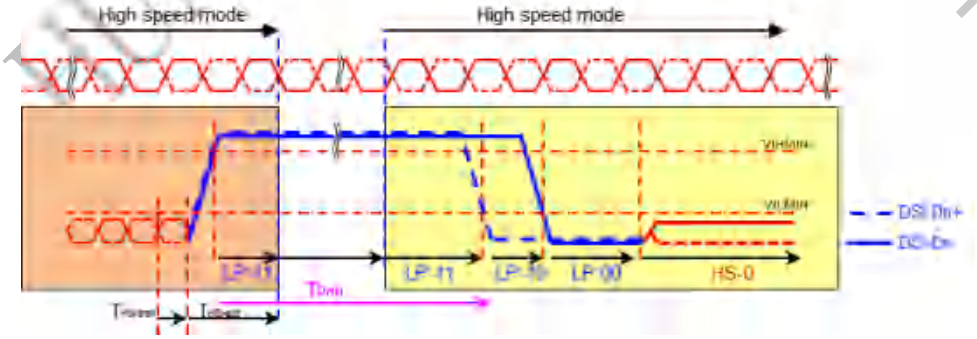
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the Entering High Speed Mode	T_{DEH}	Max(100,32UI)			ns

(3)Timing between HS – LP command



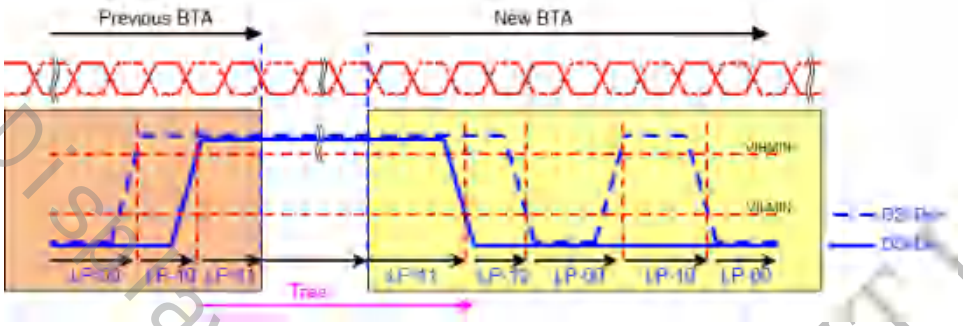
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the Escape Mode Entry	T_{DHE}	Max(100,32UI)			ns

(4)Timing between HS –HS command



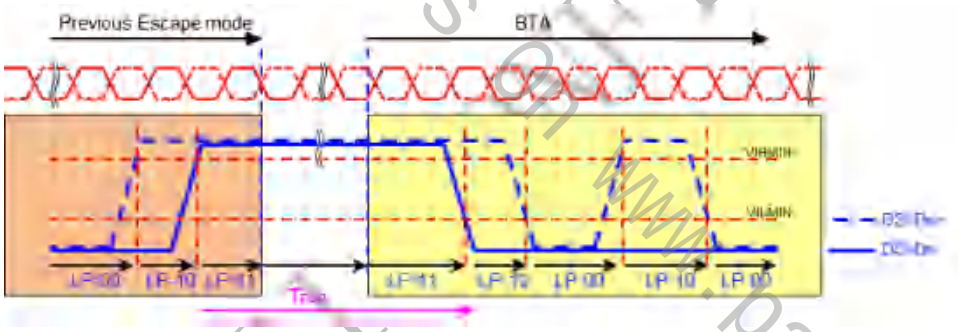
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the Entering High Speed Mode	T_{EHS}	Max(100,32UI)			ns

(5)Timing between BTA – BTA command



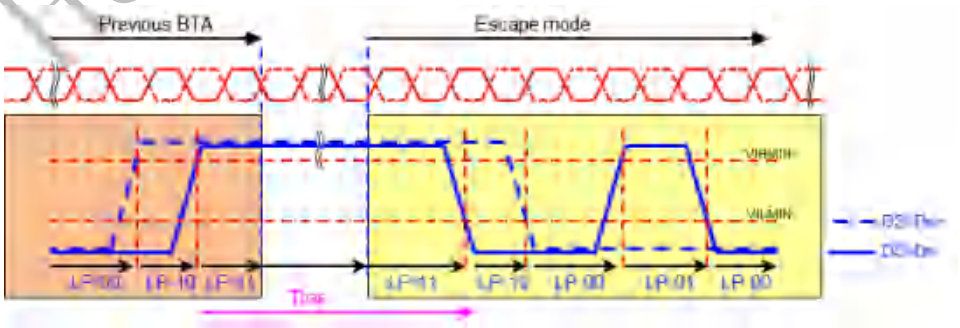
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the new BTA	T_{BSB}	100			ns

(6)Timing between LP– BTA command



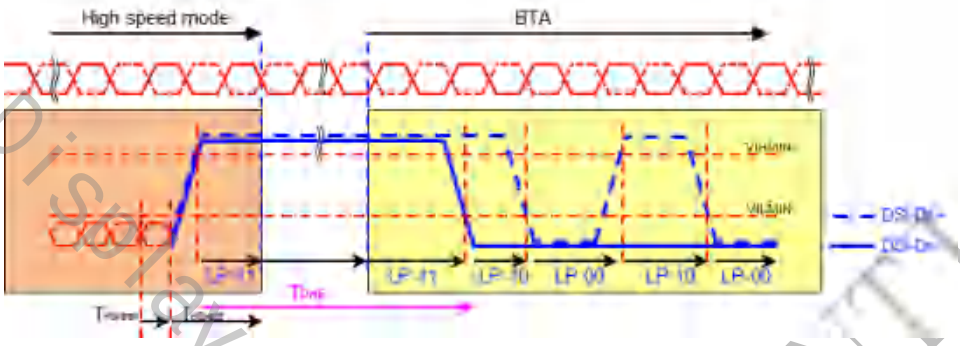
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the BTA	T_{DEB}	100			ns

(7)Timing between BTA – LP command



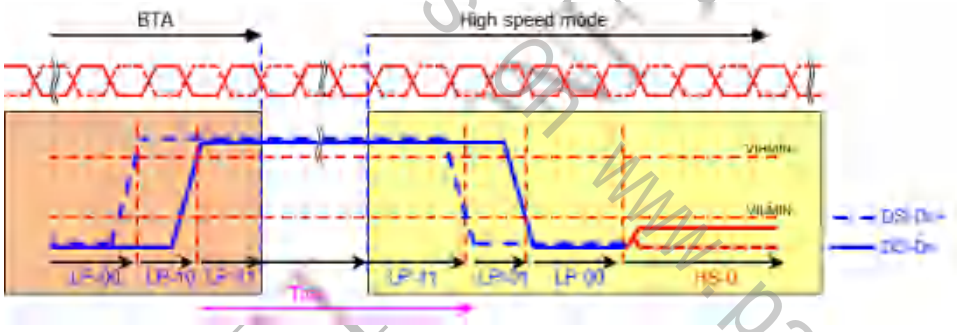
Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the Escape Mode Entry	T_{DSE}	100			ns

(8)Timing between HS – BTA command



Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the BTA	T_{DHB}	Max(100,32UI)			ns

(9)Timing between BTA – HS command



Parameter	Symbol	Min	Typ	Max	Units
LP-11 delay to a start of the Entering High Speed Mode	T_{DSH}	Max(100,32UI)			ns

6 Electrical Specifications

6.1 DC Characteristics Requirements

Item	Symbol	Values			Unit	Remark
		Min	Typ	max		
TP Power supply	TSP_3.3V	2.7	3.3	3.6	V	

TP I/O Supply Voltage	TSP_1.8V	1.65	1.8	1.95	V	
DDIC Power supply	VCI_3.3V	2.7	3	3.3	V	Note 5
DDIC I/O Supply Voltage	VDD_1.8V	1.65	1.8	1.95	V	
DDIC Charge pumping Power	VLIN1	5	6.7	7.7	V	
EL supply voltage	ELVDD	-	4.6	-	V	DC/DC output
EL supply voltage	ELVSS		-2.4	-	V	Controlled by DDIC
Input High Voltage	V_{IH}		-	460	mV	MIPI HS
Input Low Voltage	V_{IL}	-40	-	-	mV	MIPI HS
Input High Voltage	V_{IH}	880	-	-	mV	MIPI LP
Input Low Voltage	V_{IL}	0	-	550	mV	MIPI LP
Output High Voltage	V_{OH}	1100	1200	1300	mV	MIPI LP
Output Low Voltage	V_{OL}	-50	-	50	mV	MIPI LP
Frame Frequency	fFRAME	59	60	61	Hz	Command mode

6.2 Power Consumption of Display Panel and Touch panel

For Display panel

Condition: @ room temperature(25℃), ACL off, still white pattern with luminance 450 cd/m^2,

Power Supply: TSP_3.3V =3.3V, TSP_1.8V =1.8V, VCI_3.3V =3.3V, VDD_1.8V =1.8V, VLIN1=7.0V

Frame Frequency: f_{FRAME}=60HZ @ 25℃

Display Mode	Item	Symbol	Value		Unit	Remark
			Typ	Max		
Display White	Current of VDD_1.8V	$I_{VDD\_1.8V}$	26	34.32	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	29	38.28	mA	
	Current of ELVDD	I_{ELVDD}	221	291.72	mA	
	Current of ELVSS	I_{ELVSS}	221	291.72	mA	
Display Black	Current of VDD_1.8V	$I_{VDD\_1.8V}$	25	33	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	25	33	mA	

	Current of ELVDD	I_{ELVDD}	0	1	mA	
	Current of ELVSS	I_{ELVSS}	0	1	mA	
Display Red	Current of VDD_1.8V	$I_{VDD\_1.8V}$	29	38.28	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	45	59.4	mA	
	Current of ELVDD	I_{ELVDD}	82	108.24	mA	
	Current of ELVSS	I_{ELVSS}	82	108.24	mA	
Display Green	Current of VDD_1.8V	$I_{VDD\_1.8V}$	28	36.96	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	26	34.32	mA	
	Current of ELVDD	I_{ELVDD}	70	92.4	mA	
	Current of ELVSS	I_{ELVSS}	70	92.4	mA	
Display Blue	Current of VDD_1.8V	$I_{VDD\_1.8V}$	29	38.28	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	48	63.36	mA	
	Current of ELVDD	I_{ELVDD}	130	171.6	mA	
	Current of ELVSS	I_{ELVSS}	130	171.6	mA	
Display color pattern	Current of VDD_1.8V	$I_{VDD\_1.8V}$	48	59	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	32	40	mA	
	Current of ELVDD	I_{ELVDD}	68	89.76	mA	
	Current of ELVSS	I_{ELVSS}	68	89.76	mA	
Sleep Mode	Current of VDD_1.8V	$I_{VDD\_1.8V}$	2.8	8	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	80	300	uA	
	Current of VLIN1	I_{VLIN1}	0	0.00	mA	
	Current of ELVDD	I_{ELVDD}	0	0.00	mA	
	Current of ELVSS	I_{ELVSS}	0	0.00	mA	

Sleep Mode : LP00_ULPM,RAM data are not kept.

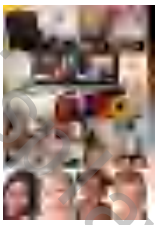
For Display panel with HBM mode

Condition: @ room temperature(25℃), ACL off, still white pattern with luminance 600 cd/m^2,

Power Supply: TSP_3.3V =3.3V, TSP_1.8V =1.8V, VCI_3.3V =3.3V, VDD_1.8V =1.8V, VLIN1=7.0V

Frame Frequency: f_{FRAME}=60HZ @ 25℃

Display Mode	Item	Symbol	Value		Unit	Remark
			Typ	Max		

Display White	Current of VDD_1.8V	$I_{VDD\_1.8V}$	27	35.64	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	28	36.96	mA	
	Current of ELVDD	I_{ELVDD}	275	363	mA	
	Current of ELVSS	I_{ELVSS}	275	363	mA	
Display Black	Current of VDD_1.8V	$I_{VDD\_1.8V}$	25	33	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	24	31.68	mA	
	Current of ELVDD	I_{ELVDD}	0	1	mA	
	Current of ELVSS	I_{ELVSS}	0	1	mA	
Display Red	Current of VDD_1.8V	$I_{VDD\_1.8V}$	29	38.28	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	45	59.4	mA	
	Current of ELVDD	I_{ELVDD}	110	145.2	mA	
	Current of ELVSS	I_{ELVSS}	110	145.2	mA	
Display Green	Current of VDD_1.8V	$I_{VDD\_1.8V}$	28	36.96	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	25	33	mA	
	Current of ELVDD	I_{ELVDD}	105	138.6	mA	
	Current of ELVSS	I_{ELVSS}	105	138.6	mA	
Display Blue	Current of VDD_1.8V	$I_{VDD\_1.8V}$	28	36.96	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	50	66	mA	
	Current of ELVDD	I_{ELVDD}	178	234.96	mA	
	Current of ELVSS	I_{ELVSS}	178	234.96	mA	
Display color pattern	Current of VDD_1.8V	$I_{VDD\_1.8V}$	46	60.72	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	0.13	0.2	mA	
	Current of VLIN1	I_{VLIN1}	30	39.6	mA	
	Current of ELVDD	I_{ELVDD}	90	118.8	mA	
	Current of ELVSS	I_{ELVSS}	90	118.8	mA	
Sleep Mode	Current of VDD_1.8V	$I_{VDD\_1.8V}$	2.8	8	mA	
	Current of VCI_3.3V	$I_{VCI\_3.3V}$	80	300	uA	
	Current of VLIN1	I_{VLIN1}	0	0	mA	
	Current of ELVDD	I_{ELVDD}	0	0	mA	
	Current of ELVSS	I_{ELVSS}	0	0	mA	

For TP (Fix a full black pattern and then test):

Power Supply: TSP_3.3V =3.3V, TSP_1.8V =1.8V, VCI_3.3V =3.3V, VDD_1.8V =1.8V, VLIN1=7.0V

Report Rate: 80Hz @ Display panel Frame Frequency = 60Hz

Work Mode	Item	Symbol	Value		Unit	Remark
			Typ	Max		
Sleep Mode	Current of TSP_1.8V	$I_{TSP\_1.8V}$	10 uA	20 uA	uA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	10 uA	20 uA	uA	
Idle Mode	Current of TSP_1.8V	$I_{TSP\_1.8V}$	350 uA	500 uA	uA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	1 mA	2 mA	mA	
No finger	Current of TSP_1.8V	$I_{TSP\_1.8V}$	7 mA	10 mA	mA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	14 mA	20 mA	mA	
1 Finger	Current of TSP_1.8V	$I_{TSP\_1.8V}$	8 mA	11 mA	mA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	14 mA	20 mA	mA	
5 Finger	Current of TSP_1.8V	$I_{TSP\_1.8V}$	9 mA	12 mA	mA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	14 mA	20 mA	mA	
10 Finger	Current of TSP_1.8V	$I_{TSP\_1.8V}$	10 uA	20 uA	uA	
	Current of TSP_3.3V	$I_{TSP\_3.3V}$	10 uA	20 uA	uA	

7 Touch Panel Specification

7.1 Touch Performance

7.1.1 IC Specifications

NO.	Item	Specification	Description	Remark
1	Project ID	Write project ID as Huawei requirements	1, Huawei can only read it, and can not write it forever 2, The ninth byte increased by 1 if sensor or circuit changed and can not use one TP FW	

			compatible for them.	
2	I2C Communication to Host	Yes (IC support)	Speed: ≥400KHZ	
3	SPI Communication to Host	NA	Speed: ≥12MHz 4 mode	Note 7.1
4	Main Oscillator Frequency	≥50MHz (IC support)		
5	Main Oscillator Frequency Shift	NA	1, (Max – Min)/Max 2, between -20℃~60℃	
6	Auxiliary Oscillator Frequency	≥32KHz Low power clock is 32KHz		
7	Auxiliary Oscillator Frequency Shift	The frequency shift on this oscillator is not critical for touch application (IC support)	1, (Max – Min)/Max 2, between -20℃~60℃	
8	Memory Size	≥48K Byte (IC support)		
9	For Huawei size	≥4K Byte (IC support)		
10	RAM Size	Data RAM 64KB Frame RAM 64KB		
11	Boot Loader Work Time	≤40ms (IC support)		
12	Initialization Work Time	≤60ms (IC support)		
13	Power on work time	≤50ms (IC support)	The time from TP IC reset to it can receive host command	
14	Maximum Sensing Frequency	≥500KHz (IC support)	Tx Sensing Frequency	
15	Minimum Sensing Frequency	≤50KHz (IC support)		
16	Sensing Frequency resolution	≤5KHz (IC support)		
17	Sensing process sound noise level	≤-85dB (IC support)		
18	Software Update	Must support (IC support)	1, IC support FW update again if powered off during updating	

			FW 2, Can not affect the other information	
19	SNR	refer the item20~item30 below to see the specific demand	1,Use ø10mm copper touch TP on 9 points, and each point get 100 times data to calculate it. 2, Different specification in different condition,	Note 7.2
20	Display White SNR	≥50:1	Display White	Note 7.2
21	Display Black SNR	≥50:1	Display Black	Note 7.2
22	Display 1 Dot inversion SNR	≥15:1	Display 1 Dot inversion	Note 7.2
23	Display 2 Dot inversion SNR	≥40:1	Display 2 Dot inversion	Note 7.2
24	Display Line inversion SNR	≥40:1	Display Line inversion	Note 7.2
25	Display Column inversion SNR	≥40:1	Display Column inversion	Note 7.2
26	Display Frame inversion SNR	≥25:1	Display Frame inversion	Note 7.2
27	Power Supply Ripple interference SNR	≥40:1	1, Display Black; 2, TP_VCI，Supplied by LDO; 3, Power Supply Ripple is 100mV.	Note 7.2
28	Noise interference SNR	≥5:1	1, Display Black; 2, Input wave: 1V Sine Wave; 3, TP sensing and noise frequency: both fixed at 400KHz.	Note 7.3
29	Touch Resolution	≥OLED Resolution	The Coordinate should be report one by one pixel	
30	Sensor Configure	electrode data changes one by one	1, use ø10mm copper move from the top-left to bottom-right and from top-right to bottom left,	
31	Capacitance Calibration and Save	Need	1,must calibrate and save in factory 2, driver can calibrate the IC automatically	

32	Calibration and Save time	<1S (IC support)	Calibration must be done in 1S	

7.1.2 Touch Sensor Specifications:

Item	Item	Specification	Description	Remark
1	Middle Pitch	≤4.5mm	Be suitable for TX and RX	
2	Left and Right Edge pitch	Usually half a sensor pitch. ~2mm	Edge Width is 10mm (for example≤2mm)	For Edge
3	Max ITO Resistance	Long: ≤20KΩ Short: ≤15KΩ	1, The Maximum ITO resistance 2, Long ITO and Short ITO has different spec	
4	Capacitance Sensitivity	≥10% Diff Rate≤10%	delta value/raw data*100%	Note 7.4
5	Raw Capacitance Uniformity	≤30%	the raw capacitance value between different area should be similar, (Max-Min)/(Max raw data)	Note 7.5
6	Signal Uniformity at different position	Diff Rate≤10%	Use ø10mm copper touch on screen, the uniformity of capacitance delta value in the whole screen	Note 7.6
7	Signal Uniformity at Different sensing frequency	Shift Rate ≤10%	Separately fix TP sensing frequency at 300KHz and 400KHz and judge if their raw data difference is in the spec or not	Note 7.7
8	Touch in the VA area	Interference Rate ≤ 3%	Use ø10mm copper touch in the VA area, the interference in other area.	Note 7.8
9	Touch out of the VA area	Interference Rate ≤ 3%	out of the VA area use ø10mm copper touch, the interference in the TP VA area;	Note 7.9

7.1.3Basic Specifications

No.	Item	Specification	Description	Remark
1	Communication Protocol to Host	I2C		

2	I2C Address		0x92		
3	Touch Origination Dot		Left up		
4	Finger		10		
5	Report Rate		100HZ		
6	Respond Time(100HZ)		Active： 15ms(Avg)/20ms(Max)		
7	Power consumption	Active model	<50mW		
		standby mode	<10mW		
		Sleep model	<120uW		
8	Point Sensitivity		≤Φ4mm	Report Percent=100% (Both center area and edge area)	Note 7.11
9	Accuracy(Φ7mm)		Edge area<1.2mm Center area<0.8mm		Note 7.12
10	Precision(Φ7mm)		Edge area <0.30mm Center area <0.20mm		Note 7.13
11	Jitter (Φ7mm)		Edge area <0.30mm Center area <0.20mm		Note 7.14
12	Move Sensitivity		≤Φ3mm		Note 7.15
13	Linearity (Φ7mm)		Edge area <1.2mm Center area <0.8mm		Note 7.16
14	Adjacent Finger		Finger Distance <10mm	Center to Center	Note 7.17
15	Palm & Face		Ø30mm		Note 7.18
16	Water Proof		Drop Test	1.No ghost finger reported to host 2.No sensitivity reduce when water wiped off	Note 7.19
			Water Spray Test	1.No ghost finger, 2.No fault ID 3.No sensitivity reduce when water wiped off	
			Bathroom Test		
17	Move with low speed (2mm/s)- Handwork		NO fault ID, especial missing point near edge area		

18	Fast drawing(5 fingers)-Handwork	NO fault ID report to host interface	Touch Panel must detect touch ID fast and exactly	
19	Fast Tap (5 fingers)-Handwork	NO fault ID report to host interface		

7.1.4 Glove Requirement

No.	Item	Specification	Description	Remark
1	Finger (Glove mode)	≥2 (IC support)		
2	Thickness of actual glove	≤4mm (IC support)	Suitable for all the glove, especial for standard glove	Note 7.20
3	Report Rate	>60HZ (IC support)		
4	Switch Time (finger mode to glove mode)	1S (IC support)	Suitable for all the glove.	Note 7.21
5	Low Temperature	(-10℃,-20℃) (IC support)	Handset can response exactly (No ghost finger, No missing finger, etc)	Note 7.22
6	Point Sensitivity	≤Φ9mm (IC support)	Reported Percent 100%	Note 7.23
7	Linearity /Accuracy (Φ9mm)	Edge area <2.5mm Center area <1.5mm (IC support)	Test condition：base on 9mm copper size which connect surface use 0.05mm OCA adhesive with 5mm isolation material which Conductivity 3.7-4.2	

7.1.5 Force touch and Hover Requirement

No.	Item	Specification	Description	Remark
1	Force touch area	Single point	Force touch not whole AA area, just UD Fingerprint area	
2	Forch touch sensor	Support 11*18mm for 2 sensor	This sensor will be made by HW, through UD Fingerprint	

		18*4.65mm per sensor	FPC to TP FPC	
3	Force IC Cp support	Support Total Cp≥ 200pf	The Cp is the total capacitance between force sensor and ground	
		Support Delta C≤ 1%@100g	The delta C between without any pressure and with 100g pressure	
4	Force IC support	SNR≥10:1 (IC Support)	Base on 100g pressure	
5	Force support	100g-500g force, 100 steps (IC Support)		
6	Hover height	≥12mm (IC Support)	By Φ7mm copper finger	
7	Hover response time	≤35ms (IC Support)		
8	Hover power consumption	≤20mW (IC Support)		

7.2 Cover Lens Specifications

NO.	Item	Specification	Remark
1	Lens color	Black	Refer to limited sample
2	Lens figure	3D	Confirm in MD drawing
3	Outline Dimension	71.28(W)*150.06(L)*2.69(H)	Width and length: tolerance: ±0.1mm; height: tolerance: ±0.15mm;
4	Cover lens View Area	68.70(W)*137.08(L)	Tolerance: ±0.1mm
5	Lens Thickness	0.55	Tolerance:±0.05mm
6	Lens strength	CS≥680Mpa DOL≥8um CSK: ≥65 Mpa DOC: ≥95 um CT≤95Mpa	
7	Proximity sensor hole (IR hole)	Semi-Transparent blue purple	Refer to limited sample
		≥75% @850nm	Scinco VMS-1S

		4% ~10% @ 550nm	Scinco VMS-1S
8	Logo artwork	Mirror sliver	Refer drawing, if no logo, please ignore it.
9	Touch key		Refer drawing, if N.A., please ignore it.
10	LED (Black lens)	ϕ=0.8±0.1mm Transmission rate: Black: 2-8% @550 nm	Huawei ID confirms hiding effect in visual.
11	RGB Hole (Black lens)	ϕ=2.6mm Transmission rate: Black: 4-8%@550nm	Huawei ID confirms hiding effect in visual.
12	Camera hole (Black lens)	1. Transparent ≥91% 2.PV:≤1.3λ (λ=632.8nm)	Fizeau optical test interferometer
13	OD (optical density) of cover lens Ink area	≥5.0	X-rite 341
14	Ink adhesive （cross cut）	1.cross cut ≥4B on normal atmospheric temperature; 2.Pencil hardness≥2H on normal atmospheric temperature; 3.cross cut ≥3B After 80℃ *30min hot water test;	1.Pencil hardness test by Mitsubishi and 750gf force ; 2.Hot water test condition: 80℃ *30min, keep 2Hours on normal atmospheric temperature then test cross cut; 3.test sample 5pcs
15	Anti-Finger	AF coating method	PVD
		Test 5 sample’s Water contact angle ＞110°(CG top side)	1.Rubber eraser 5000times，Testing distance 40mm，40cycles/min 2.Force=1000g Test area=2×2cm The type of rubber eraser MUNBANGSAWOO 3.The coating must not be broken off after friction；
		Rubber eraser test, Test 3 points in the test distance and Water contact angle after test>100°	
		Dynamic friction test: ≤ 0.03(tolerance+0.01/-0.01)	Load is 200 g , medium of test is printing paper and the dynamic friction test must less than 0.03
16	Surface energy	Dyne value≥32	After alcohol wiping(Module)

7.3 TP Sensor/FPC Specifications

NO.	Item	Specification	Remark
1	Structure	on -cell (Film)	
2	Pitch(A)	A≤4.5mm	Be suitable for TX and RX
3	Full capacitive limited Range	Avg +/- 6sigma	4500~5500 (IC CM Ref.)
4	Difference check of Base Line between each points	T(x) - T(x+1) < 390 fF R(x) - R(x+1) <390 fF (replaced to Cx Gap inspection)	
5	Noise limited Range	-10≦X≦10 (replaced to Jitter inspection)	
6	Connector type /No.	BTB/ 14241009	
7	Quantity of valid ACF grain	More than 5 grains/each bonding pad	
8	Sealing compound on Bonding area and touch IC	Needed	
9	Obvious ITO etching pattern	Can not see	Inspection condition refers to General Inspection Criteria for the TP-LCD Integrated Module of Huawei Device V6.0
10	The OCA/OCR thickness of TP &Display panel	OCA 0.15	
11	Other details	Ref to ID/MD drawing	
12	Report Rate	60Hz/120Hz both support	1, can change automatically by FW itself; 2, can select by software command

~~7.4 Cover Lens Optical Specifications~~

~~NO.~~	~~Item~~	~~Specification~~	~~Remark~~

~~1~~	~~Transmittance~~	~~≥90%~~	~~CG unit not module~~
~~2~~	~~Haze~~	~~≤0.5~~	
~~3~~	~~Reflection~~	~~≤8.6~~	
~~4~~	~~Chromaticity a *~~	~~-1.0 ≤a * ≤1.0~~	
	~~Chromaticity b *~~	~~0 ≤b * ≤1~~	

7.5 Touch Interface Definition

The following information interface definition for this project, you need to clearly define Pin, pin early in the project is important to define clearly
Note: PIN order to see the drawings MD.

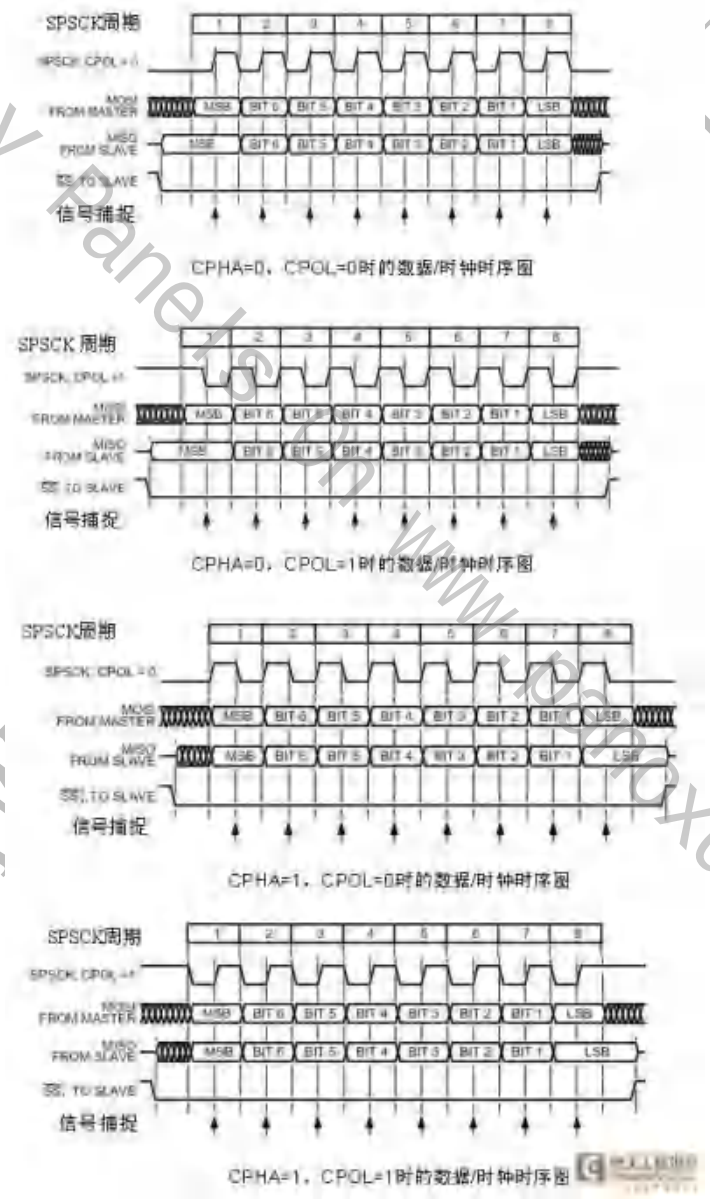
NO.	Pin	NO.	Pin
1	GND	2	GPIO_00
3	TP_VCI(3.3V)	4	GPIO_01
5	TP_VDD(1.8V)	6	VPP/TS_IN_N
7	GND	8	RST/RESET_N
9	GND	10	SPI_CSK/HOST_SCK
11	INT_Standby	12	FP_1V8
13	TP_RST	14	SPI_MISO/HOST_MISO
15	TP_INT	16	SPI_MOSI/HOST_MOSI
17	I2C_SCL	18	INT/HOST_DRDY
19	I2C_SDA	20	SPI_CS/HOST_SSN
21	HSYNC	22	VDD
23	GND	24	GND

7.6 TP Test jig Specifications

No.	Item	Specification	Description	Remark
1	Voltage	The voltage of TP test jig Must keep same as huawei phone level side	AVDD+/-3%	Ref to phone side
2	Test side	Require TP screen on the top side ,and Display panel		Ref to TP IC

		side hang in the air; Add calibration on TPLCD test side;		
3	Test operation	Don’t touch the TP screen when TP function test or Capacitive adjust		Ref to TP IC

Note 7.1 SPI work mode



Note 7.2 SNR test

IC support is possible for red markings, but SET Touch performance is

implemented by IC Firmware and guaranteed only at Set level. Therefore, at the Module level, it is replaced with the result of consulted Moudle check item, not actual measurement data. (No. : 20~28, 30)

SNR is signal to noise ratio, it determined TP performance, is the most important primal factor.

SNR test is also useful for **"Signal Uniformity at Different Sensing Frequency"** test.

- Test Condition: Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;
- Measurement equipment: Arm of robot with **10mm diameter** copper, the copper is connected to the GND,
- Test location: Test touch panel with 3*3 points , see note **Definition of signal test points**;
- Test procedure:
  - No copper touch on the screen;
  - 100 frames of raw diff data were read, for each test point, the average value is calculated: **Noise(AVG)** = AVG(RawDiffData100), which is noise baseline of this test point;
  - Use copper touch on the screen;
  - 100 frames of raw diff data were read, for each test point, the average value is calculated: **Signal(AVG)** = AVG(MAX(RawDiffData100));
  - The Signal of this test point is calculated, **Signal = Signal(AVG) - Noise(AVG)**
  - the noise of each test point were calculated, Noise(RMS)=root square deviation of this test point=SQRT(VARP(MAX(RawDiffData100));
  - For test point, **SNR** = Signal / Noise(RMS);
  - For the whole touch screen, **SNR** = min(**SNR** from point 1 to point 9);
  - Totally test 3 samples, **SNR of the product** = min(SNR of sample 1, SNR of sample 2, SNR of sample 3).

Note 7.3 Noise interference SNR

Noise interference SNR test method is similar to SNR, it is used to judge the TP IC noise immunity, especially the common mode noise immunity.

- Test Condition : Handset is on the insulated table, TP and test device GND is connected together, and TP sensing frequency is **fixed at 300KHz**;
- Measurement equipment: Arm of robot with 10mm diameter copper, the copper is not connected to GND, but connected to a signal generator with **1Vpp-300KHz sine wave** signal.
- Test procedure: the same method with SNR, please refer Note **SNR test**;

Accuracy & Precision for stylus

- The test method is same as finger test method, and definition of test points for Stylus by Note 18,and Arm of robot with 1.5mm diameter copper.

Move Sensitivity &Linearity for stylus

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot
- Test procedure: Draw 8 line with 30mm/s from 1.5mm to 4mm diameter copper
- The Precision is calculated by using following formula:

  Reported percent= Reported number (1.5 to 4 mm)/ Reported number (7mm)*100%

Standard: No missing point.

Note 7.4 Capacitance Sensitivity

Based on Touch IC CM refence Delta, Module guarantees module inspection (No.4~9)

Capacitance Sensitivity is used to test the capacitance value change rate after touch screen is touched.

- Test Condition: Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;
- Measurement equipment: Arm of robot with **10mm diameter** copper, the copper is connected to the GND,
- Test location: Test touch panel with 3*3 points , see **Definition of signal test points**;
- Test procedure:
  - Before the copper is pressed on the touch screen, read TP IC raw data for 100 frames and get a frame of average raw data as Original Raw;
  - After the copper pressed on the touch screen, read TP IC raw data and noise data for 100 frames;
  - Get each frame’s maximum noise data as the “Signal”, calculate their average value Signal(AVG) = AVG(Signal(100));
  - Get the signal same position’s Original Raw as Signal Raw;
  - For test point, **Capacitance sensitivity** = Signal(AVG) / Signal Raw *100%;
  - For the whole touch screen, **Capacitance sensitivity** = min(**Capacitance sensitivity** from point 1 to point 9)
  - **Diff Rate** = (MAX-MIN) / MAX * 100%;.

Note 7.5 Capacitance Uniformity

Capacitance Uniformity demand raw capacitance value between different area should be similar, it means all the mutual/self capacitance value should be similar, and the ITO resistance should be small enough

- Test Condition: Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;
- Test procedure:
  - Nothing touch the screen, read TP IC raw data;
  - Get the maximum and minimum raw data, then get the **diff rate** = (MAX-MIN) / MAX*100%;
  - Test 100 times and get the maximum **diff rate** from these value as the **Max diff rate**:

Note 7.6 Signal Uniformity at different position

When use the same copper touch on different area, because of the Resistance and Capacitance(RC) is not the same, TP IC will get different signal value, if these value’s diff is too large, TP sensitivity will be not the same in the whole screen, this test is used to make sure TP sensitivity uniformity.

- Test Condition : Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;
- Measurement equipment: Arm of robot with **10mm diameter** copper, the copper is connected to the GND,
- Test location: Test touch panel with 3*3 points , see note **Definition of signal test points**;
- Test procedure:
  - First use the copper pressed on the touch screen;
  - Read a frame of capacitance raw diff data, take the maximum raw diff data as the “Signal”;
  - Totally 100 frames of “Signal” data were read.
  - For each test point, Signal(AVG) = AVG(Signal(100));
  - **MAX** = max(Signal from point 1 to point 9);
  - **MIN** = min(Signal from point 1 to point 9);
  - **Diff Rate** = (MAX-MIN) / MAX * 100%.

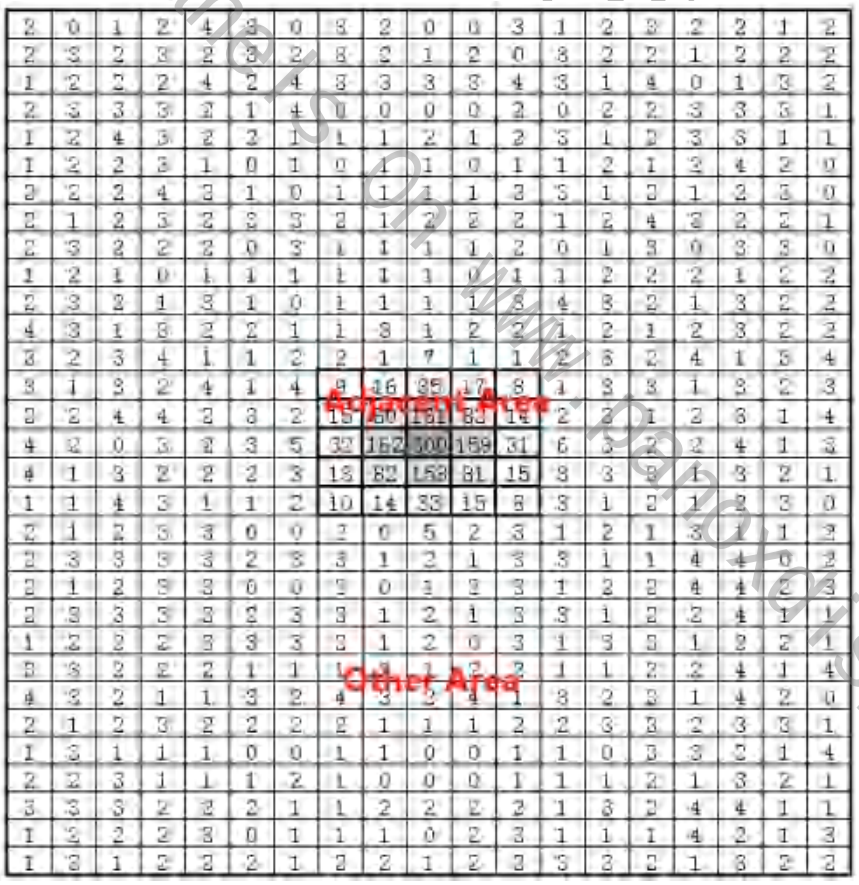
Note 7.7 Signal Uniformity at Different Sensing Frequency

- Test Condition : Handset is on the insulated table;
- Test location: Test touch panel with 3*3 points , see note **Definition of signal test points**;
- Test procedure:
  - Nothing touch the screen, read TP IC raw data;
  - TP sensing frequency is **fixed at 300KHz**;
  - Get 100 frames of TP raw data, and then get each electrode’s average capacitance value: **Raw1(AVG)** = AVG(Raw(100));
  - TP sensing frequency is **fixed at 200KHz**;
  - Get another 100 frames of TP raw data, and then get each electrode’s average capacitance value: **Raw2(AVG)** = AVG(Raw(100));
  - Use **Raw1(AVG)** and **Raw2(AVG)** to get each electrode’s absolute capacitance differ, and select the maximum differ value as **Max Diff**;
  - Refer **Display Black SNR** test, take its “Signal” as **Signal**;
  - **Shift Rate** = **Max Diff** / **Signal** * 100%;

Note 7.8 The Interference of Touch in the VA Area

- Test Condition: Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;

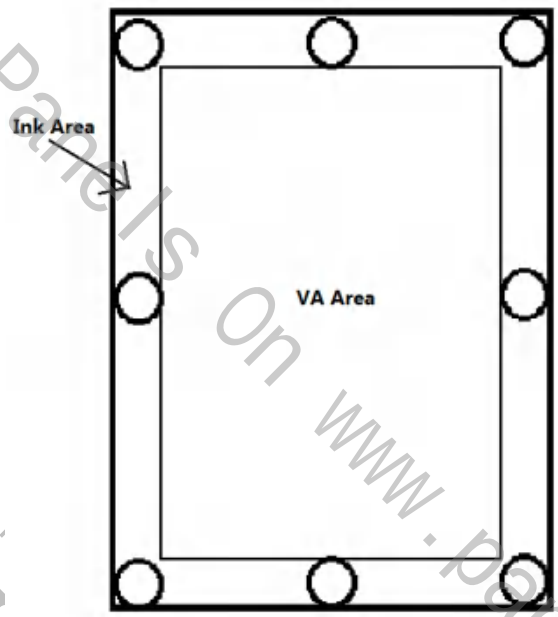
- Measurement equipment: Arm of robot with **10mm diameter** copper, the copper is connected to the GND,
- Test location: Test touch panel with 3*3 points , see **Definition of signal test points**;
- Test procedure:
  - Use copper touch on the screen;
  - Get a frame of capacitance data, from the screen select the maximum noise data as the **Signal**;
  - The electrodes which with Signal electrode’s distance **less than 3 pitch** are belong to **Adjacent Area,** and the others are belong to **Other Area**;
  - Get the maximum absolute noise data from the **Other Area** and take it as **Interference Noise**;
  - **Interference Rate** = **Interference Noise / Signal** * 100%;
  - Totally 100 frames of data are read and 100 **Interference Rate** are got;
  - For each test point, **Interference Rate**(AVG) = AVG(**Interference Rate** (100));
  - For the whole touch screen, **Interference Rate** = Max(**Interference Rate** from point 1 to point 9)



Note 7.9 The Interference of Touch out the VA Area

- Test Condition: Handset is on the insulated table, and TP sensing frequency is fixed between **300KHz~500KHz**;

- Measurement equipment: Arm of robot with **10mm diameter** copper, the copper is connected to the GND,
- Test location: Test touch panel with 8 points , see the picture below;
- Test procedure:
  - Use copper touch on the screen Ink Area;
  - Get a frame of capacitance data, from the screen select the maximum noise data as the **Interference Noise**;
  - Get 100 frames of TP capacitance data, and then get **Interference Noise(AVG)** = AVG(Interference Noise(100));
  - Refer **Display Black SNR** test, take its Signal(AVG) as **Signal**;
  - **Interference Rate** = **Interference Noise(AVG) / Signal** * 100%;
  - For the whole touch screen, **Interference Rate** = Max(**Interference Rate** from point 1 to point 8)



Note 7.10 Point Sensitivity

Point sensitivity is determined by the minimum size finger that touch panel can detect .When the minimum size finger touch on the surface of touch, the touch can report to host exactly.

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot with 5mm diameter copper.
- Test procedure: Test touch panel with 7*9 points , each point 10 times (Refer Test Matrix of Note 7.24)
- The point sensitivity is calculated by using following formula:
  Report Rate(Center point)= Reported points/350*100%
  Report Rate (Edge point) = Reported points/280*100%

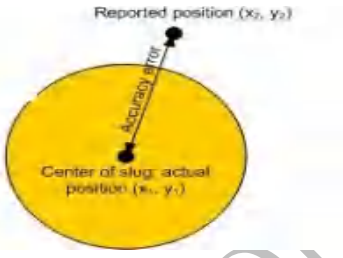
Note 7.11 Accuracy

IC support is possible for No. : 8~19, but SET Touch performance is implemented by

IC Firmware and guaranteed only at Set level. Therefore, at the Module level, it is replaced with the result of consulted Module inspection limit spec, not actual measurement data.

Accuracy is determined by a comparison of the actual copper position and the reported position when the copper touch on the surface of touch.

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot with 6mm diameter copper.
- Test procedure: Test touch panel with 7*9 points , each point 10 times(Refer Test Matrix of Note 7.24)
- The Accuracy is calculated by using following formula:



Accuracy **Definition**

1: Calculate every distance from reported position to actual position (Each point contains 10 reported position dates)

Accuracy Error = square root [(xi – x0)2 + (yi – y0)2] (i-1,2…10)

2: Select maximum accuracy error as the final accuracy of the point

Accuracy point j= max (error 1,error 2,……error 10)

3: Select maximum Accuracy as the accuracy of the point (Result must be divided for center point and edge point)

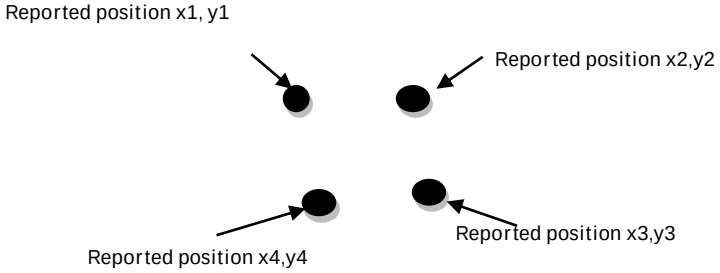
Center point: Accuracy = max (point 29,point ,……point 63)

Edge point: Accuracy = max (point 1, point 2,……,point 28)

Note 7.12 Precision

Precision is defined as the discrete of reported positions with ideal positions when a conductive copper tap the touch many times.

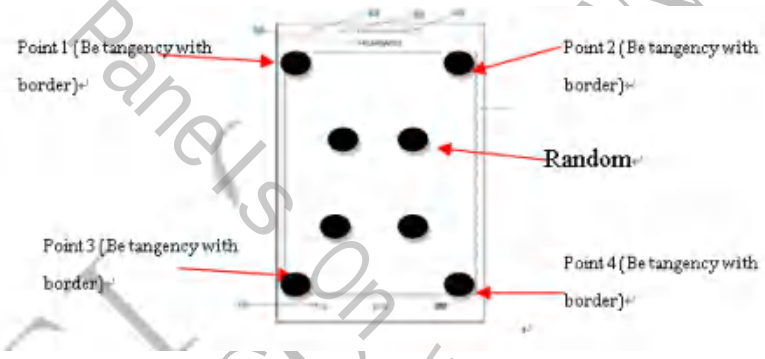
- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot with 6mm diameter copper.
- Test procedure: Test touch panel with 7*9 points , each point 10 times (Refer Test Matrix of Note 7.24)
- The Precision is calculated by using following formula:



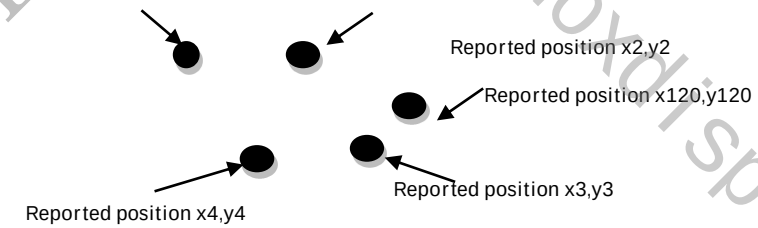
1.Point 1 Precision X=mean square error（x1， x2 ， x3，x4 ， x5…x10）
2.Point 1 Precision Y=mean square error（y1， y2 ， y3，y4 ， y5…..y10）
3.All precision of the TP= MAX（Point 1 Precision X，Point 1 Precision Y，Point 2 Precision X，Point 2 Precision Y ……）
Select the maximum value as our test result
Center area(Center points): Precision= max (Precision 29 Precision 30 ,……Precision 63)
Edge area(Center points): precision = max (Precision 1, Precision 2 ,……Precision 28)

Note 7.13 Jitter

Jitter is defined as the deltas of reported positions when a conductive copper is in stationary contact with the sensor cover lens. A total of hundred sequential samples are collected with each stationary contact of the Copper with the sensor cover lens.



- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot with 6mm diameter copper.
- Test procedure: Test 8 points in the touch for 1s
- The Precision is calculated by using following formula:

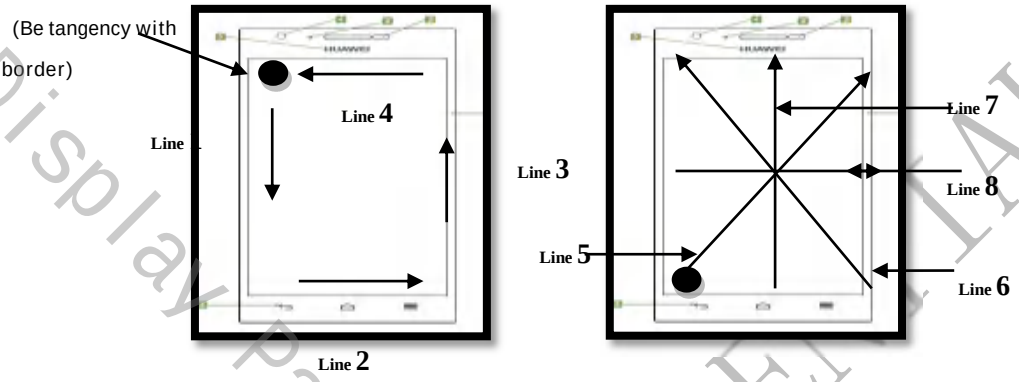


Then we will get the result like below (Take point 1 as the example)
1: calculate distance from each reported position to the rest of points
Distance Error = square root [(xi – Xj)2 + (yi – yj)2] (i=1,2….120,j=1,2…120)
2. Select the maximum distance error from one to each one
jitter 1= max(error 1,error 2….error 120)
3. Repeat 1to 2 for the other 7 point as the jitter value
4: select the maximum value as our test result
Center area: jitter= max (jitter 5 ,jitter 6,……jitter 8)

Edge area: jitter = max (jitter 1, jitter 2 ,……jitter 4)

Note 7.14 Move Sensitivity

Move sensitivity is determined by the minimum size finger that touch panel can detect .When the minimum size finger draw on the surface of touch, the touch can report to host exactly.



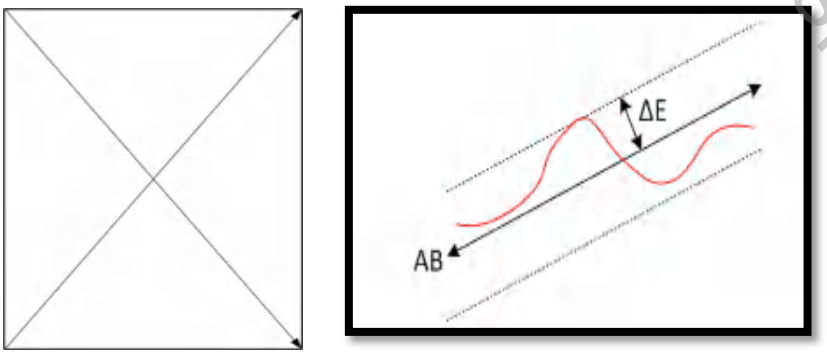
Move sensitivity test

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot
- Test procedure: Draw 8 line with 30mm/s by 4mm copper and 9mm copper
- The Precision is calculated by using following formula:
  Reported percent= Reported number (4mm)/ Reported number (9mm)*100%
  Standard: No missing point.

Note 7.15 Linearity

Linearity is defined as the difference between reported finger positions versus the least square fitted line as the finger moves linearly across a specified trajectory of the Display panel area.

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot
- Test procedure: Draw 8 line with 30mm/s by 6mm copper (Trochoid refer Note 7.16)
- The Precision is calculated by using following formula:



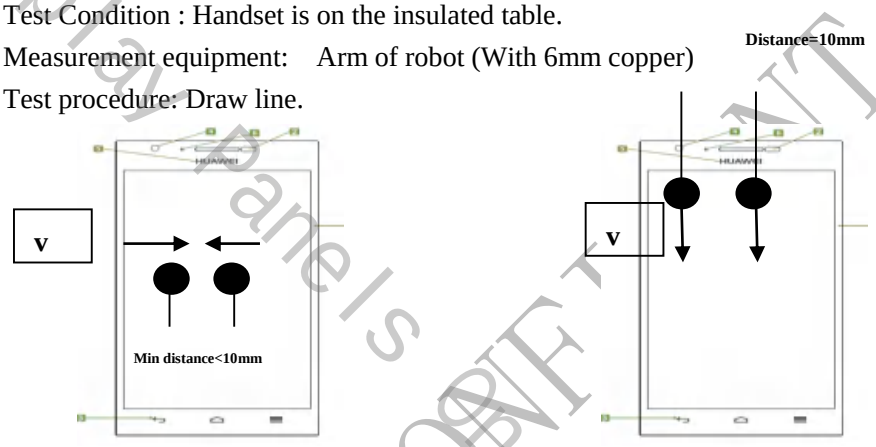
Linearity definition

1.Calculate the max △E for each line (Refer the figure above)
Linearity center= max (Linearity 5, Linearity 6, Linearity 7, Linearity 8)
Linearity edge=max (Linearity 1, Linearity 2, Linearity 3, Linearity 4)

Note 7.16 Adjacent Finger

Finger separation is defined as the minimum physical distance between two fingers on the sensor required for the fingers to be detected as two individual fingers. Any two fingers on the sensor must be separated by at least the finger separation distance in order to be detected correctly. Requirement : finger distance<10mm (center to center) That means when We use 2 finger to play game or other operation by keep distance with 10mm ,our handset will detected ID correctly.

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot (With 6mm copper)
- Test procedure: Draw line.



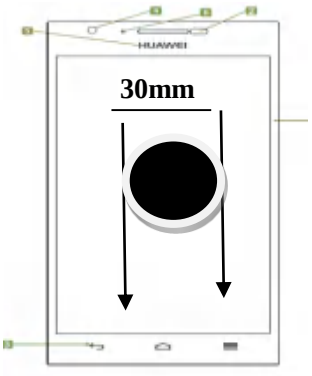
Adjacent Test

Standard: Observe the reported point by eyes

Note 7.17 Palm & Face

Palm & Face is defined as large area Immunity. When large area such as human face touch on the surface of touch , the touch can detect it exactly and doesn’t report position.

- Test Condition : Handset is on the insulated table.
- Measurement equipment: Arm of robot
- Test procedure: Test procedure: Put 30mm copper on the touch for 20s then tap 20 times



Palm Test

Standard: Observe the reported point by eyes

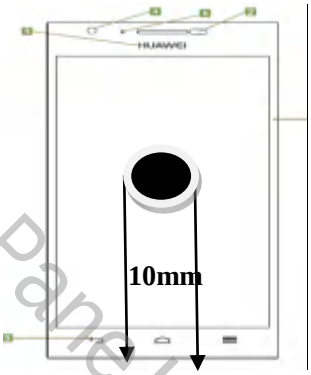
Note 7.18 Water Proof

The presence of moisture on the surface of touch can affect touch performance. Performance will vary based on the amount of moisture and its properties. In the test we will define the basic requirement in the document.

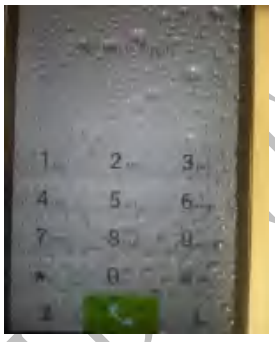
Method:

Drop: Size **：** ø10 mm diameter drop,4 drops

Spray size: 3ml once



Water Dorp



Water Spray Test

Procedure**:**

Test 1-drop test:

Step 1**:** Make 4 drops water on the surface of touch, each drop with 10mm diameter.

Step 2: Test the area (without water area) handwork, and test it again after wiped off water

Step 3: Observe whether the water area report ghost finger

Test 2-Spray test:

Step 1: Spray the water on the surface of touch for 3ml.

Step 2: Keep the water on the surface of touch for 60 seconds.

Step 3: Wipe off the water then test the function

Step 4: Observe whether the water area report ghost finger

Note 7.19 Type of Glove

(* Refer below comments of the thickness and material to select the glove for testing)

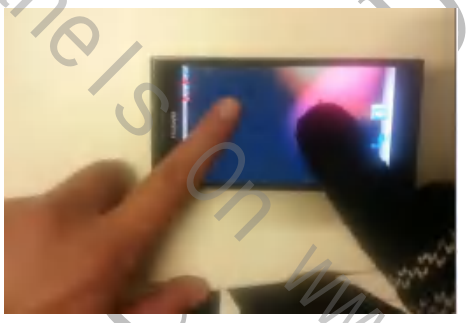
Glove is the particular function for this project .Our customer can use handset outdoor .In the test, we will test the function at different scene. Here we list standard glove of HUAWEI.

Glove	Thickness	Material	Purpose
Standard glove 1	3mm (middle finger) 4.2mm (forefinger)	3mm-cotton&downy 4.2mm- rubber& cotton & downy	Keep hand warm
Standard glove 2	3.5mm (middle finger)	Cotton & downy	
Standard glove 3	3mm (middle finger)	Outer :Special water spoof Material Inner: cotton	

Note 7.20 Switch Time (Finger mode switch to glove mode)

This handset have different mode such as finger mode and glove mode. Normally, customer will use handset by finger, but in winter. Customer will use handset by glove .In this test ,we will test switch time between different mode.

- Test Condition : Normal temperature and handset on the insulated table.
- Measurement equipment: Handwork



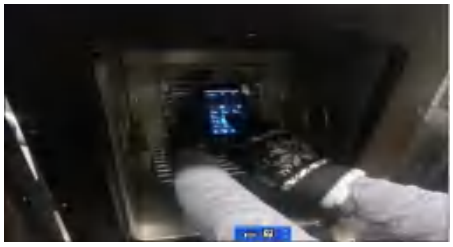
Switch Time Test

Test procedure:

1. Draw line on the handset for 10S
2. Stop drawing the wait for 2s
3. Draw line with glove for 2s
4. Retest step 1 to step 3 for 3 times
5. Replace glove and then retest step 1 to step 4.

Standard: In SPEC time , the finger report to host(The finger display on the screen)

Note 7.21 Low Temperature(-10℃,-20℃)



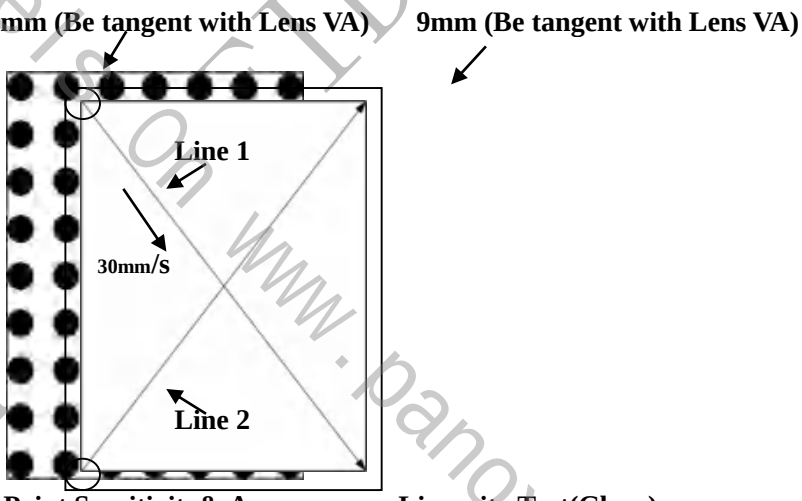
- Test Condition : -10℃, -20℃
- Measurement equipment: Handwork in the box

- Test procedure: keep handset in -10℃ environment for 5 minutes Then operate handset in the .Test method is as follow.
- 1.Keep handset in -10℃ environment for 5 minutes
- 1.Power on the handset
- 2. Lock off handset
- 3.Dial number 131234567890 and call out
- 4.Tap Contacts list , search somebody and call out
- 5. Tap message , search somebody and review it.
- 6.Slide screen in the main menu and set display brightness as the maximal
- 7.Select a picture, then zoom in and zoom out for 3 time.
- 8.Rework step 1 to step 7 for 3 times
- 9. Rework step 1 to step 8 for by another glove
- 10.Rework step 1 to step 9 for -20℃

Standard:

Handset can response exactly (No ghost finger, No missing finger, etc)

Note 7.22 Glove test



Test copper **Point Sensitivity& Accuracy** **Linearity Test(Glove)**

- Measurement: Arm of robot
- Test procedure:

1. Sensitivity & Accuracy follow as finger test (See Note 7.24 Test Matrix only replace the copper to 9mm with crylic)

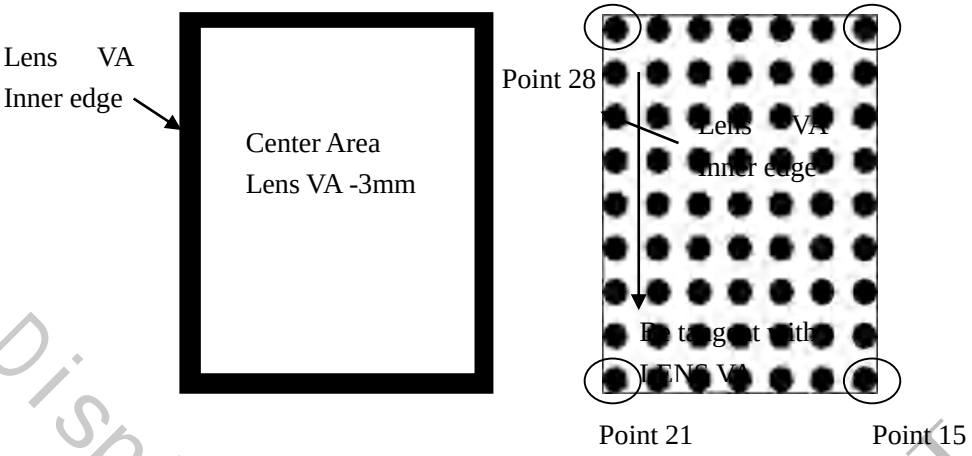
2. Linearity is tested as Linearity Test above

- The Sensitivity & Accuracy is calculated follow finger mode.
- The Linearity is calculated follow finger mode.(For glove mode , only test 2 lines)

Note 7.23 Definition of test points.

Point 1

Point 7



Area Definition **Test Matrix(7*9)**

- Center area :Lens VA inner 3mm (See Area Definition)
- Edge area. the other area of Lens VA (See Area Definition)
- Center area and edge area will be used to calculate the different spec such as Move Sensitivity, Linearity and so on
- Center point: All the point except center points (See Test Matrix above)
- Edge point: Named point 1 to point 28 (See Test Matrix above)
- Test Matrix: 7*9 points (Each corner is tangent with Lens VA, then divide the other area evenly.).Test matrix will be used in Point Sensitivity, Accuracy, Precision, etc.

8 Optical Specifications

Test condition：

TSP_3.3V =3.3V, TSP_1.8V =1.8V, VCI_3.3V =3.3V, VDD_1.8V =1.8V, Ta=25℃

Item		Symbol	Condition	Value			Unit	Note
				Min	Typ	Max		
Luminance (Normal mode with lens)		Bp	θ=0° Φ=0°	405	450	495	cd/m²	CPK≥1.33 Note 8.1
Luminance (HBM mode with lens)		Bp		540	600	660	cd/m²	Note 8.1
Minimal Luminance (white 255 pattern with lens)		Bp		1.8	2	2.2	cd/m²	
Uniformity		△Bp		75	85	-	%	Note 8.2
Maximum Brightness of Black Pattern		Bblk*		-	-	0.005	cd/m²	Based on CS2000 Note 8.1
Contrast Ratio		Cr	θ=0° Φ=0°	81000	90000	-	-	Based on CS2000 Note 8.4
Response Time		Ton-off		-	-	1	ms	Note 8.5
Color Coordinate of CIE1931	Red	x	θ=0° Φ=0°	0.654	0.679	0.704	-	Note 8.6 Color gamut covers both DCI-P3 & Adobe RGB
		y		0.295	0.319	0.345		
	Green	x		0.210	0.260	0.310		
		y		0.655	0.705	0.755		
	Blue	x		0.120	0.140	0.160		
		y		0.029	0.049	0.069		
	White	x		0.2788	0.2988	0.3188		
		y		0.2956	0.3156	0.3356		

NTSC Ratio	NTSC	CIE1976	100	117		%	Note 8.7
Color Temperature	CT		6702	7502	8302	K	
~~Flicker~~	~~amount~~	~~-~~		~~-~~	~~-30~~	~~dB~~	~~Note 8.8~~
Gamma	Full brightness (450nit)		2.0	2.2	2.4		Note 8.13 Meet △E Spec. &keep the detail in dark area
Crosstalk	∆ CT	-			1.5%		Note 8.9
Reflectance （with lens）	Rf	for visible wavelengths	-	Avg.5.5	6	%	Note 8.11
Color uniformity	∆ u’v’-A		-	-	0.013	-	Note 8.12
	∆ u’v’-B		-	-	0.004	-	
~~Delta E~~	~~∆ E~~	~~White point under different brightness~~	~~0~~	~~2.3~~	~~3~~	~~-~~	~~Note 8.13~~
Delta E	∆ E	Tracking of CIExy for Gray 48~255 levels under brightness 5-30nit	0	4	6	-	Note 8.13
		Tracking of CIExy for Gray 48~255 levels under brightness 31-449nit	0	2	5		

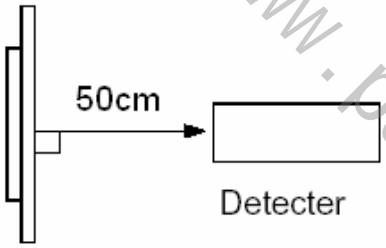
		Tracking of CIExy for Gray 48~255 levels under brightness 450nit	0	1.5	2.5		
Luminance decrease ratio		θL=30°	---	---	35	%	Note 8.15
		θR=30°	---	---	35	%	
		ψT=30°	---	---	35	%	
		ψB=30°	---	---	35	%	
Color shift		θL=30°	---	---	4.5	JNC	Note 8.17 Refer limit sample
		θR=30°	---	---	4.5	JNC	
		ψT=30°	---	---	4.5	JNC	
		ψB=30°	---	---	4.5	JNC	
		θL=45°	---	---	5.2	JNC	
		θR=45°	---	---	5.2	JNC	
		ψT=45°	---	---	5.2	JNC	
		ψB=45°	---	---	5.2	JNC	
		θL=60°	---	---	---	JNC	
		θR=60°	---	---	---	JNC	
		ψT=60°	---	---	---	JNC	
		ψB=60°	---	---	---	JNC	
OLED lifetime		At 25℃,with white color pattern for 240hrs	Lc (B10) >= 95% $Lc = \frac{L_{W\_240hr}}{L_{W\_0hr}} + (1 - \frac{L_{B\_240hr}}{L_{B\_0hr}})$ Lw (Brightness of W area) LB (Brightness of B area)			-	Note 8.18
~~Long time Image sticking~~		~~With a test image, lighting on with typical brightness of normal mode for 240 hrs~~	~~Lc (ave) >= 95%~~ ~~$Lc = \frac{L_{W\_240hr}}{L_{W\_0hr}} + (1 - \frac{L_{B\_240hr}}{L_{B\_0hr}})$~~ ~~Lw (Brightness of W area)~~ ~~LB (Brightness of B area)~~			-	~~Note 8.19~~

Short time image sticking		Light on a Black&White pattern for 10sec and then change to 48Gray pattern to measure 60pcs data			30/3JND	sec	Note 8.20

Bblk* : Reference value.

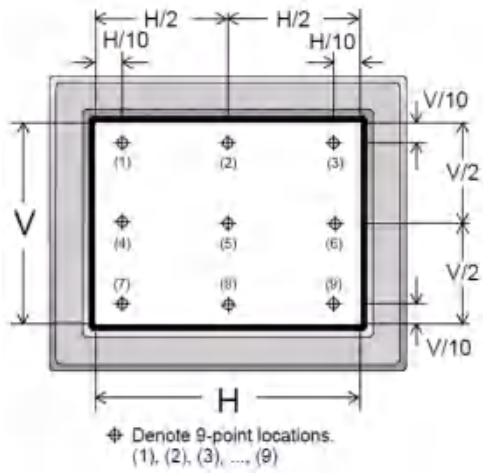
Note 8.1 Luminance measurement

- The test condition is at 25℃ and measured on the surface of Display panel module.
- 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 equipments (Field of view:1deg,Distance:50cm)
- Measuring surroundings: Dark room.
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.
- Measured value at the center point of Display panel must be after more than 5 minutes while turning on.
- This is target spec, The provider must do the best to achieve the target.
- If the providers can’t reach the target, the base line is the brightness of the center point must meet the brightness Requirement.



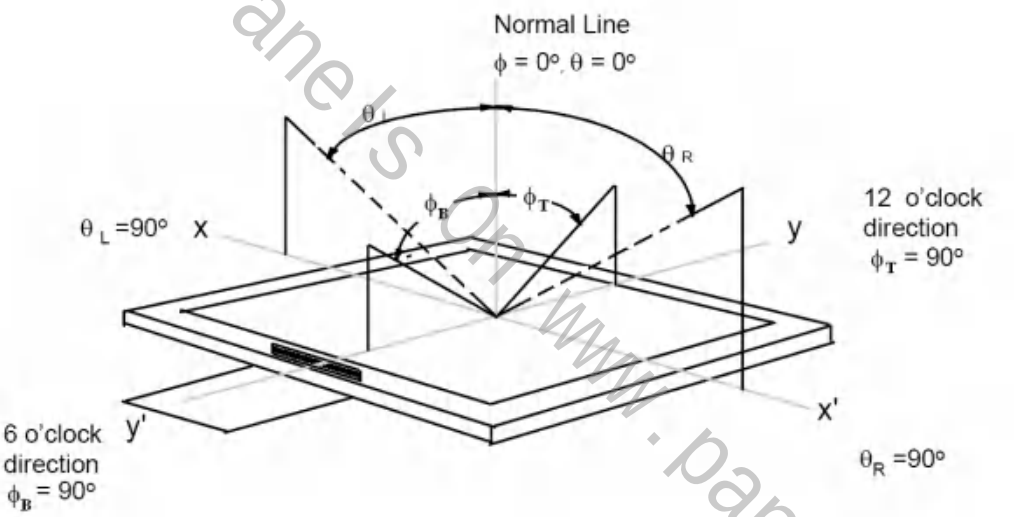
Note 8.2 Uniformity

- The test condition is at 25℃ and measured on the surface of Display panel module.
- Measurement equipment: CS2000 or similar equipments.
- The luminance uniformity is calculated by using following formula:
  △Bp = Bp (Min.) / Bp (Max.)×100 (%)
  Bp (Max.) = Maximum brightness in 9 measured spots
  Bp (Min.) = Minimum brightness in 9 measured spots.



Note 8.3 The definition of Viewing Angle

Refer to the graph below marked by θ and Φ



Note 8.4 The definition of Contrast Ratio (Test Display panel using CS2000 or similar equipments):

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

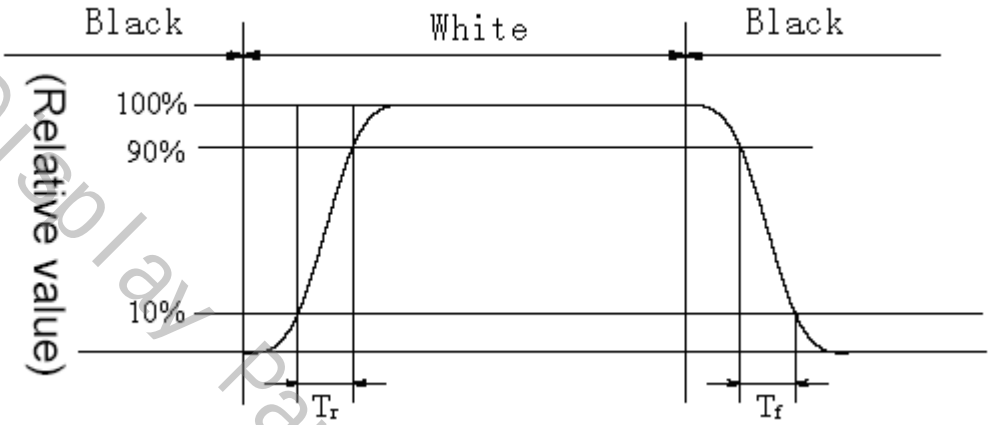
(Contrast Ratio is measured in optimum common electrode voltage)

This is target spec, The provider must do the best to achieve the target. If the providers can't reach the target, Both side will review after 1st sample

Note 8.5 Definition of Response time. (Test Display panel using DMS501 or similar

equipments.):

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.



Response time of gray to gray:

Measurement equipment: CS2000 or similar equipments.

Test method :we define 8 grays L0-L7, the grays of L0-L7 were defined as:0,36,73, 109, 146, 182, 219, 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 the 10% and 90% of amplitudes. The result of the test can be noted as below:

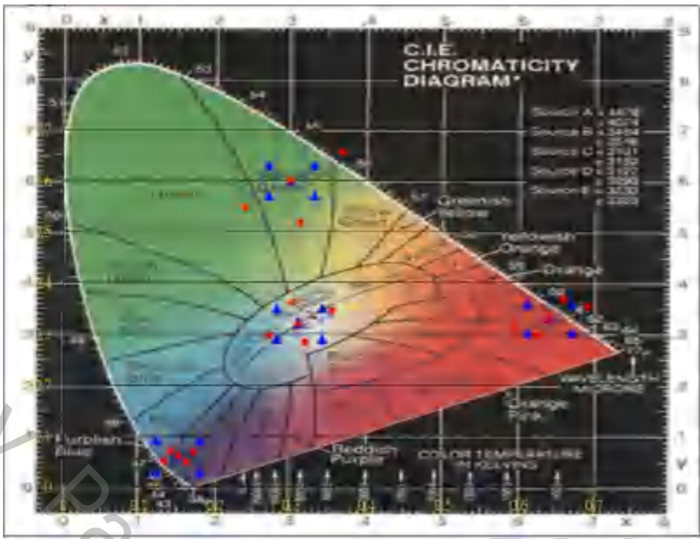
	L0	L1	L2	L3	L4	L5	L6	L7
L0	■							
L1		■						
L2			■					
L3				■				
L4					■			
L5						■		
L6							■	
L7								■

Note 8.6 Color Coordinates of CIE 1931/CIE1976

- The test condition is at 25℃ and measured on the surface of Display panel module.
- Measurement equipment: CS2000 or similar equipments.
- The Color Coordinate (CIE 1931/CIE1976) measure the center of active area of the module.

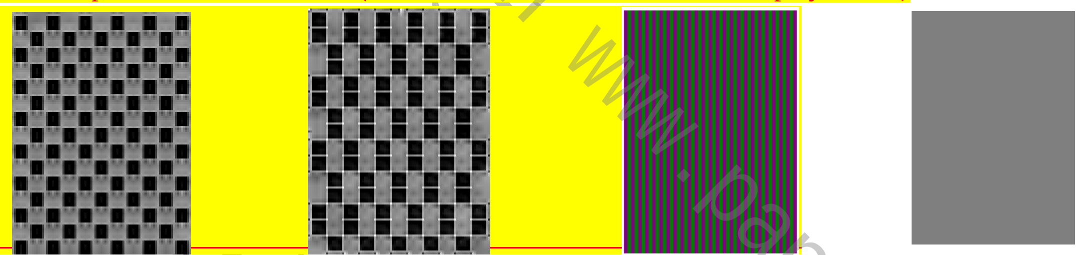
Note 8.7 Definition of Color of CIE Coordinate and NTSC Ratio.

$$S = \frac{\text{area of RGB triangle}}{\text{area of NTSC triangle}} \times 100\%$$



~~**Note 8.8 Flicker**~~

- ~~Measurement equipment :CA-210 or similar equipments.~~
- ~~Measuring temperature: Ta=25℃.~~
- ~~Test method: JEITA method~~
- ~~Test pattern : Refer to below(Test Pattern should be full-fill of display screen)~~



~~For Dot Inversion　　For 2H1V Inversion　　1 column inversion　　Frame inversion~~

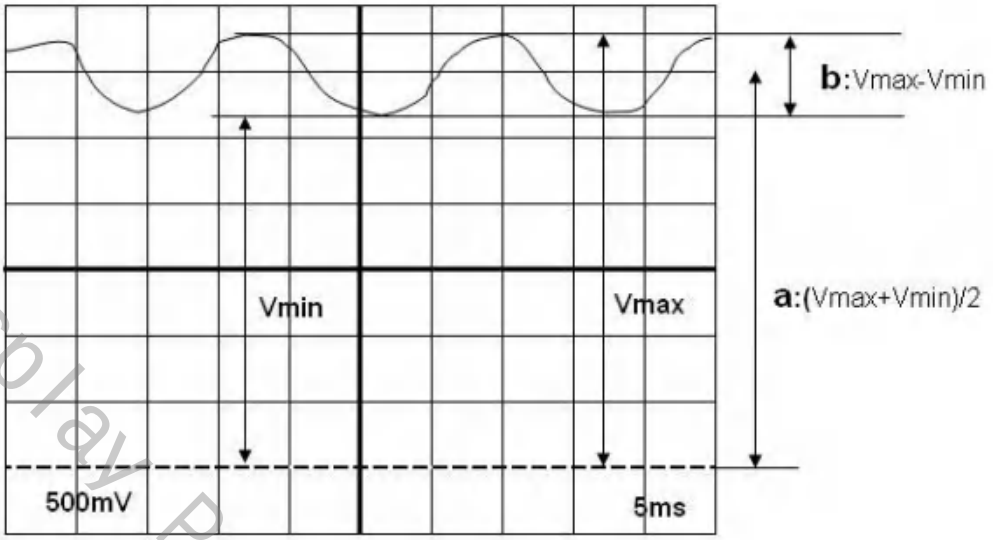
~~The point should be marked is, the background of Flicker Test Pattern "gray " are defined as middle gray scale .For example, RGB 24bit "gray" defined as below:~~

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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 60HZ before measurement .~~
- ~~If the intensity level of the display changes as Fig 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 (a) is defined as Vmax – Vmin and DC component (b) as (Vmax + Vmin)/2, and the flicker amount is calculated by the following formula.~~

~~Flicker amount = AC component / DC component=b/a~~

~~= (Vmax - Vmin)/{(Vmax + vmin)/2}×100%~~



Note 8.9 Crosstalk

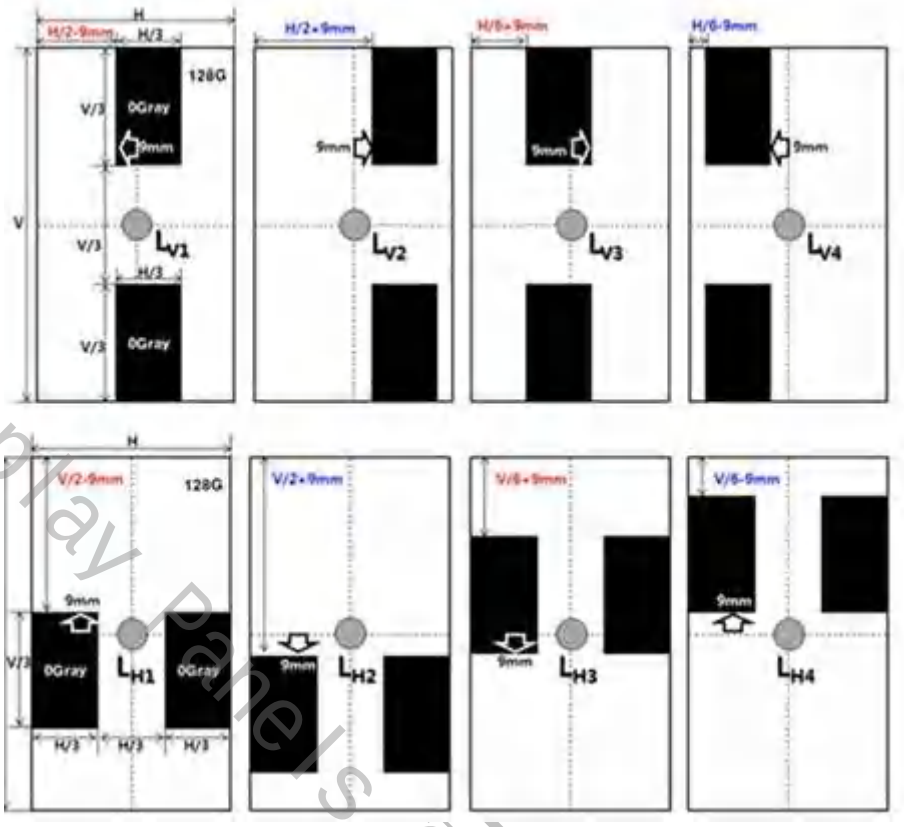
- There should be no visible cross-talk in normal direction of the display when the two ”Cross-talk Test Patterns ” below are loaded.
- Measurement equipment: CS2000 or similar equipments
- The point should be marked is, the background of Cross-talk Test Pattern-“gray “ are defined as middle gray scale . For example, RGB 24bit “gray” defined as below:

- Test pattern follow below picture, 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 test formula below:

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

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

- Then use the max value between Crosstalk(V) and Crosstalk(H) as the final crosstalk.



Cross-talk Test Pattern

Note 8.10 Gamma curve control

For gamma curve control, HUAWEI’s request as below:

1. Calibration the test instrument. Set the screen size parameters, and measure the center point.
2. HUAWEI will test the gray scale below, if possible also can use the patterns of gray 0 to 255 to test:

   for example:

   0, 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, 247, 255

   Or

   0, 1, 2, 3, … , 252, 253, 254,255. Total 256pcs patterns.
3. Output the measure data. Data number normalization and draw the chart.
4. The whole screen should be complied with the gamma curve of gamma 2.2 or 2.5, it means +/-0.3 error is allowed. But if there are special requirements for the special project, its required specifications can be used as a standard value, please refer the project spec.

Note 8.11 Reflectance Ratio

- Measurement equipment : X-rite SP64
- Measurement parameter：Reflectance Ratio @**400nm~700nm**
- Measurement theory：The reflection ratio should be tested by collimated light method, testing light should be in the middle of AA area and perpendicular to display

panel. The inspection condition refers to **"终端 TP 与 LCD 一体化模组可靠性试验技术规范 V5.1"(Validation Technical Specification for TP-LCD Integrated Modules V5.1)**

Note 8.12 Color uniformity

- Measurement Conditions

Recommended measuring equipment for color is ICPMI16 Colorimeter or similar CCD type equipment.

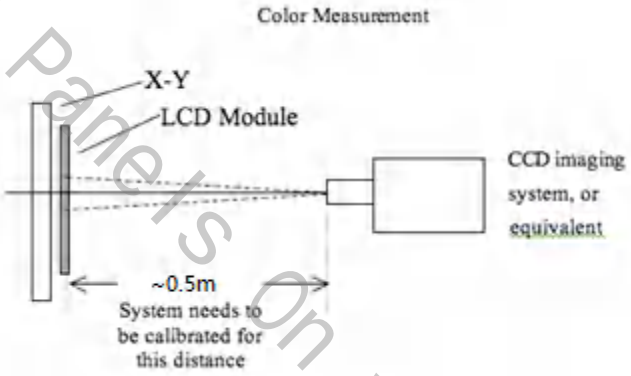
The optical characteristics are determined after the unit has been 'ON' and stable at the following conditions:

Maximum brightness

Dark environment

Ambient temperature at 25℃ ±2℃

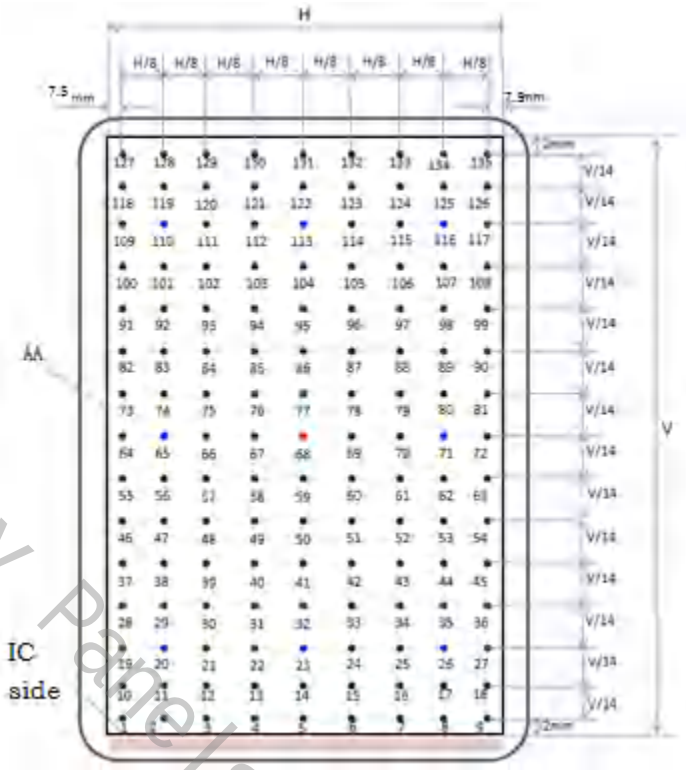
- Optical measurement system



- Total 135 measure points should set as shown in the following figures. The CIE 1967 Standards shall be used.
- The color difference is calculated by using following formula:

Max（△u'v'-A）（the max △u'v' value between two random point of 135 point）

Max（△u'v'-B）（the max △u'v' value between two adjacent point in column and row of 135 point）

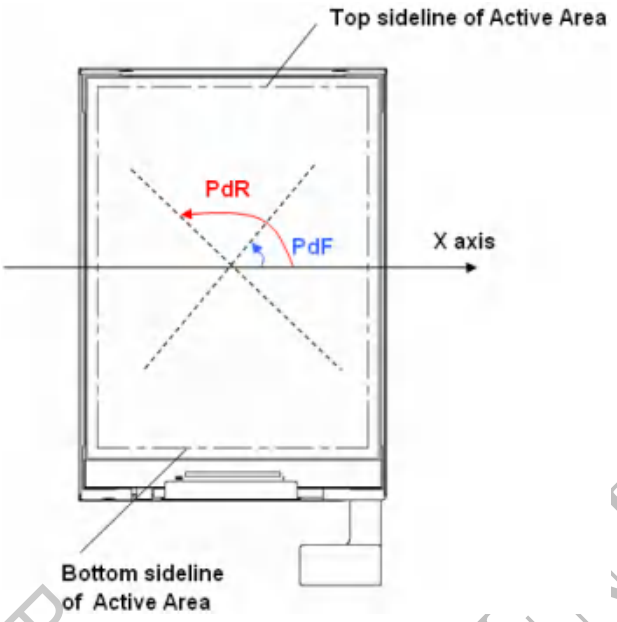


Note 8.13 Definition of Delta E

- Measure a CIExy Y values for a set of ramp colors from 0 to 255 levels;
- The ramp colors include grayscale, red, green and blue;
- Calculate 1976 CIELAB Lightness Difference (ΔL^*) between a color and its adjacent ones;
- Calculate 1976 CIELAB Color Difference (ΔE^*_{ab}) between them;
- Calculate (ΔE^*_{ab}^2- ΔL^*^2)^0.5 for each color and take a max value across the ramp colors;
- Repeat the above steps for 5 dimming levels (100%, 75%, 50%, 25%, and the lowest);

Note 8.14 Polarization Direction Definition

- Viewing direction is normal user viewing direction which is vertical to the display surface
- The polarizer which is closer to viewer is defined as Front Polarizer
- ~~The polarizer which is on the rear side of viewer is defined as Rear Polarizer~~
- The X axis is defined as parallel line to top&bottom sidelines of the Active Area
- PdF which is marked in blue arrow is polarization degree of Front polarizer
- ~~PdB which is marked in red arrow is polarization degree of Back polarizer~~
- The polarization degree parameter must be indicated in range of 0deg to 180deg according to above definition



Polarization Definition

Note 8.15 Definition of Luminance decrease ratio

- Refer to the graph of note 8.3.
- Test pattern : Full White
- The luminance decrease ratio is calculated by using following formula:

$$\text{Luminance decrease Ratio} = 1 - \frac{\text{Luminance test at } \theta_L/\theta_R/\psi_T/\psi_B = 30°}{\text{Luminance test at } \theta_L/\theta_R/\psi_T/\psi_B = 0°}$$

Note 8.16 Definition of Contrast decrease ratio

- Refer to the graph of note 8.3.
- Using contrast test method.
- The contrast decrease ratio is calculated by using following formula:

$$\text{Contrast decrease Ratio} = 1 - \frac{\text{Contrast test at } \theta_L/\theta_R/\psi_T/\psi_B = 30°}{\text{Contrast test at } \theta_L/\theta_R/\psi_T/\psi_B = 0°}$$

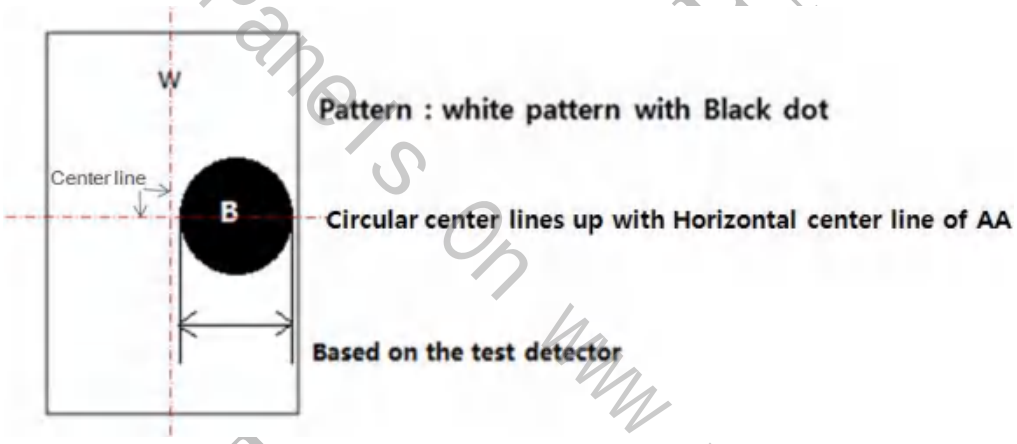
Note 8.17 Color Shift JNCD

- For JNCD measure:
- Fix on one pattern like white pattern,
- On the condition θ =0 F=0°, we can get the color coordinate (u1', v1') and on θ L=30° we can get another color coordinate (u2', v2')
- Delta = Square Root((u2' - u1')^2 + (v2' - v1')^2)
- JNCD stands for "Just Noticeable Color Difference"
- For the (u', v') color space JNCD=0.0040.
- 2JNCD means Delta u’v’<0.0080

- For color shift we need to measure white/red/green/blue pattern.
- This Requirement is from our customer and we have test some of our phone display and the result is OK.

Note 8.18 OLED lifetime

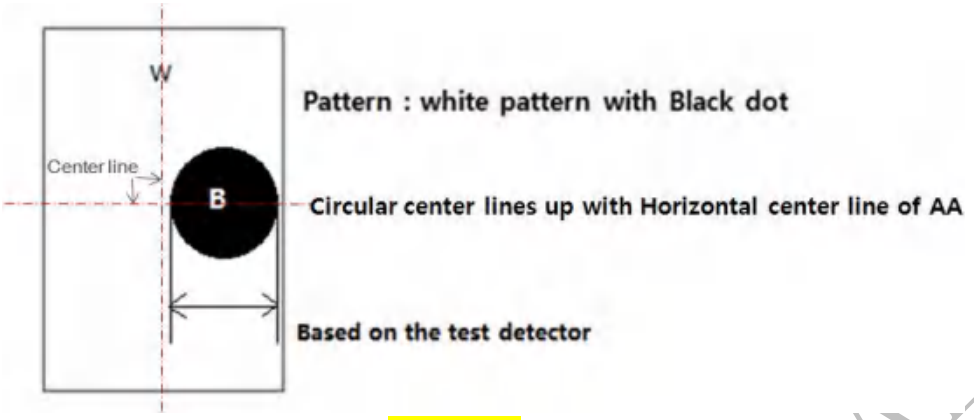
- Test samples 30pcs;
- At room temperature(25℃), light the module with typical value brightness, display a white pattern, which with a black dot, the dot size based on the test equipment’s detector.
- Warmming Up for 30 minutes to maintain stable screen and then starting test.
- To record the brightness of W area and B area every 24 hours.
- Test 240 hours or more (Thr) to collect the raw data;
- **$Lc = \frac{L\_W\_Thr}{L\_W\_0hr} + (1 - \frac{L\_B\_Thr}{L\_B\_0hr})$, Lc is OLED luminance decay ratio.**
- Then use the raw data and the special formula to calculate and estimate the lifetime.
- When Lc is 50%, the lifetime must pass the specification.



Lifetime test pattern

~~**Note 8.19 OLED Long time image sticking**~~

- ~~Test samples 30pcs;~~
- ~~At room temperature(25℃), light the module with typical value brightness, display a white pattern, which with a black dot, the dot size based on the test equipment’s detector.~~
- ~~Initial & afer testing 30min aging~~
- ~~Keep working 240 hours;~~
- ~~Then change to an full white pattern, measure the brightness data of W area and B area;~~
- ~~The test data must pass the specification.~~
- ~~Lc(ave) ≥ 95%, $Lc = \frac{L\_W\_240hr}{L\_W\_0hr} + (1 - \frac{L\_B\_240hr}{L\_B\_0hr})$~~



~~Test pattern~~

Note 8.20 OLED short time image sticking

- Test samples 5pcs;
- Light on a 48 gray pattern;

48 Gray pattern

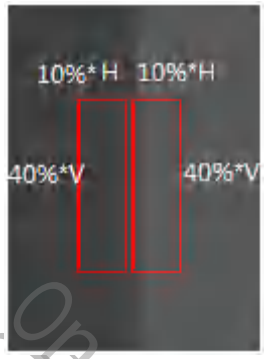
- Change to a Black &White pattern, and light on this pattern for 10 seconds;

Black &White pattern

- Then change the pattern back to 48 gray;

48 Gray pattern

- At same time start to use CCD measures the luminance, the CCD exposure time is 0.3sec;
- Measure 60 times and each interval step is 1 sec;
- Capture the useful luminance data as below pattern:



Useful data area

- Calculate the contrast as below method:

$$X = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

Calculate method

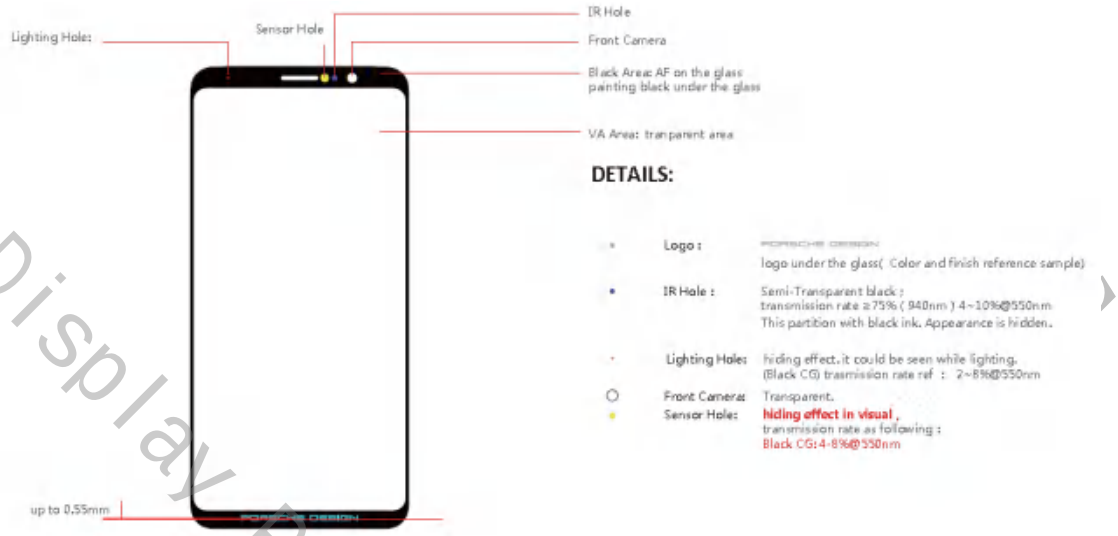
- Record the time which satisfy the x value less than 3(JND);
- This time value must within the module spec.

9 Mechanical Drawing

9.1 Lens ID drawing

Drawing name	Version	MD Engineer	Change content	Update date
DP049-CG-VN2 -171128-Final	Ver.A	Huanglu		20171128

（refer drawing “DP049-CG-VN2 -171128-Final”）

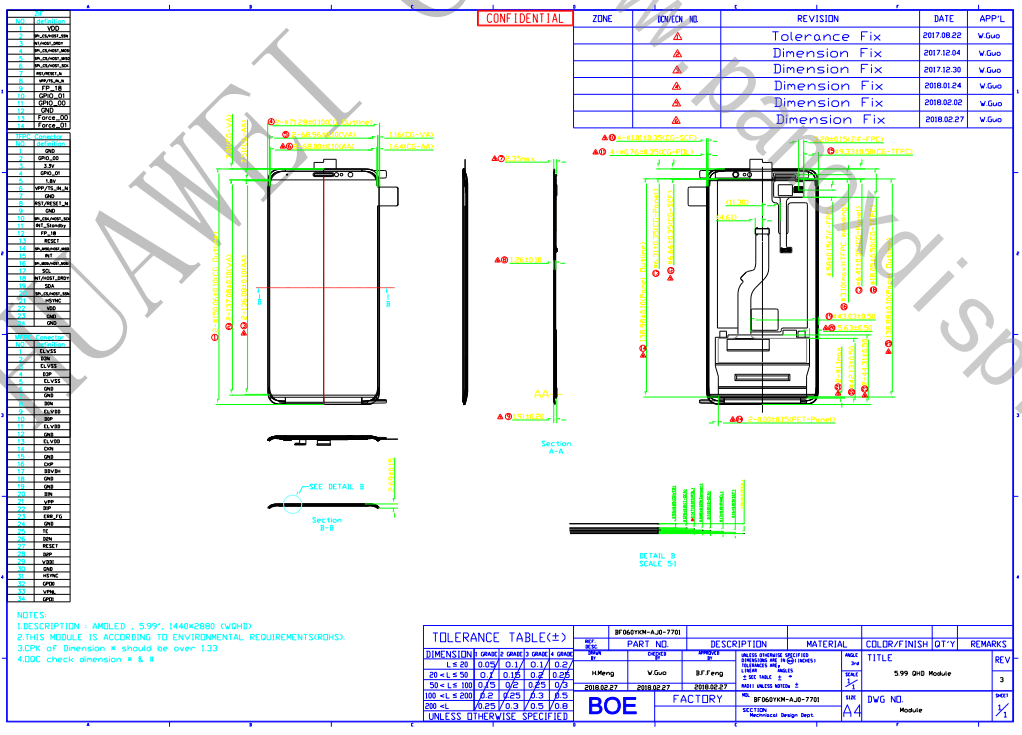


Note: All the color and process effect must follow ID drawing!

9.2 Module Drawing

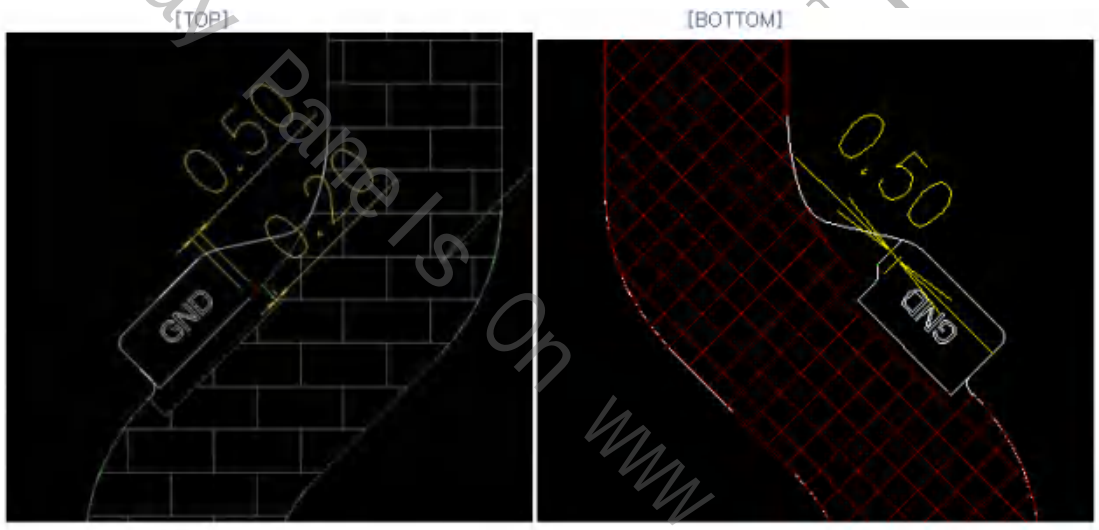
Drawing name	Version	MD Engineer	Change content	Update date
23020467	MP	Huangting		20180117

（refer drawing “23020467”）



Note:

1. The mipi layout must be kept equal length both in pair and between pairs. Huawei's layout guideline requires the length difference less than 20mil for lines in one pair and less than 40mil for lines between pairs. And the resistance of all MIPI lines is 100±10Ω.
2. Note: All structural dimensions must follow MD drawing!
3. **The FPC bonding area and components area are all need water proof, except the 50 pin BTB.**
4. **The module needs Anti-Electrostatic protect films on both surface and rear side of the lens to prevent surface crack.**
5. **Dimension in ( ),CPK should meet 1.33.**
6. ~~**TP FPC peeling height should be within 1mm, Cushion peeling should be within 0.5mm.**~~
7. **TSP cover source line ESD area to prevent HTHH bright line.**
8. **In MP, MFPC GDN area outline need running change, 2Ddrawing is attached.**



10 Reliability Requirement

10.1 General Reliability Requirement

Refer to “Device Dispaly & Touch Panel Materials Packing Techniques and Reliability Specifications V3.0"
Refer to “终端显示和触摸屏来料包装工艺及可靠性规范 V3.0”

10.2 Incoming Inspection Requirement

Refer to “终端 显示屏幕和触摸屏一体化来料通用检验标准V6.0” *

Refer to 《General Inspection Criteria for the TP-LCD Integrated Module of Huawei Device V6.0》*

Refer to "终端显示和触摸屏来料包装工艺及可靠性规范 V3.0"
Refer to "Display Touch Panel Materials Packing Techniques and Reliability Specifications V3.0"

Refer to "Device Display Test Criterion V1.0 " for pattern test.
Refer to "终端 显示器件测试规范 V1.0",定义来料检验画面

Refer to"终端来料包装及标识工艺规范-V3.4"

Note 10.2.1: Pixel Dark dot refers to limit samples(3ea 3P, 1ea 4P)Or follow the IIS paticle spec

10.3 Module Unit Reliability Test

~~**Refer to "终端 手机 显示屏单体测试技术规范 V8.3"**~~
~~**(Validation Technical Specification for Mobile Phone Display V8.3)**~~

Refer to "终端 TP 与 LCD 一体化模组可靠性试验技术规范 V5.1" **
(Validation Technical Specification for TP-LCD Integrated Modules V5.1) **

Note 10.3.1 ： AMOLED cannot guarantee 85℃/85%/240hr & Combined test(HTHH(60℃90%)+Thermal shock(-40℃~80℃)(The Temperature range -30~+80, refer to the General Specification) & HAST

10.4 EMI Specifications

Item			Specification	Remark
	General	MIPI	Support dynamic HS Clock rate	
	Charge Pump	OSC	Adjustable charge pump frequency within 20kHz~40kHz,stepsize＜10kHz	
	Gate Driver	Gate	Driving strength control	Vendor provides data
		Source	Driving strength control	Vendor provides data

	Source Driver		Provide option to switch off Source Hi-Z between line	
			there should be no Gamma switching action on source analog part, and the function should be achieved in digital part	only for OLED
			Provide option to switch off Source Hi-Z at Touch sensing time	
RFI for COF	General	COF design	Covered by single-sided EMI tape or conductive fabric, including the bending area.	
			GND area in COF for EMI tape or conductive fabric	
			TDDIC is not recommended for COF LCM because TDDIC with COF has worse anti-RF performance than discrete TP IC	
	Gate Driver	Gate	the least driving ability of each line should be less than 10 uA	
		MUX	the least driving ability of each line should be less than 10 uA	
	Source Driver	Signal Edge	there should be no rising\falling edge within 100ns on the source waveform. All the functions that will lead to those edges should be closed.(test condition: add a parallel resistor of 1kΩ on source)	
		Source	the least driving ability of each line should be less than 1 uA	
Anti-RF		Sensitive signals, like SPI、I2C、PWM、MIPI	all the RF-sensitive trace should be routed with two followed GND traces.	Vendor provides the traces