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CUSTOMER APPROVAL SHEET

Company Name

MODEL **H139BLN01.0**

CUSTOMER **Title :**

APPROVED **Name :**

☐ **APPROVAL FOR SPECIFICATIONS ONLY (Spec. Ver.____)**

☐ **APPROVAL FOR SPECIFICATIONS AND ES SAMPLE (Spec. Ver.____)**

☐ **APPROVAL FOR SPECIFICATIONS AND CS SAMPLE (Spec. Ver.____)**

☐ **CUSTOMER REMARK :**

Product Specification

1.39" AMOLED

MODEL NAME: H139BLN01.0

AUO Product P/N: 95.01H73.000

< ◆ >Preliminary Specification
< >Final Specification

Note: The content of this specification is subject to change.

Record of Revision

Version	Revise Date	Page	Content
0.0	May 26, 2015		First Draft

Contents

A. General Specification

1. Physical Specifications

No.	Item	Specification	Unit	Remark
1	Display Size	1.4	Inch	
2	ITO Technology Type	LTPS		
3	Display Type	AMOLED		
4	Resolution	400RGB*400		
5	Color Depth	16.7M		
6	Viewing Direction	All direction		Note 1
7	Contrast Ratio	10000:1		Min
8	Luminance	350cd/m2	cd/m^2	Typ
9	Panel Size	40.5(H)+38.6(W)+0.7(T)	mm	Note 1
10	Panel Maximum Thickness	0.8	mm	Note 1
11	Panel Active Area	¢ 35.4	mm	Diameter
12	Pixel Size	88.5*88.5	μm	
13	Pixel Pitch	88.5	μm	
14	Pixel Aspect Ratio	1 : 1		
15	Driver IC	Recommended by supplier		
16	Driver IC RAM Size	Full RAM		
17	Light Source	OLED		
18	Interface	MIPI		
19	Operation Temperature	-20~70	degC	
20	Storage Temperature	-30~80	degC	
21	Weight	2.15	Gram	±15%
22	Pixel Per inch	286	PPI	
23	Environmental Protection Requirement	RoHS & REACH must be executed		
24	Connection method	MOLEX ：5042482410		Part No.
25	Gamma Correction	R/G/B separation		
26	Polarizer Type	Hard coat treating	3H	
		Glare		
27	Panel gate scan direction	W/O		Note 2
28	Warpage	Front side warpage value < 0.1mm Rear side warpage value(w/o foam) < 0.1mm		Note 3

Note1:Please Refer to the mechanical drawing.

Note2: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.

Note3: Warpage inspected by 3D coordinate scanning/ measuring system to analyze surface warpage and precision gauge is applied for module thickness measurement. OLED is placed on flat stage to get 4 points warpage measured by 3D scanning system or gauge.(4 points position is defined same as Uniformity in note 9)
Test Method: Nikon VMR-3020- optical or other useful method.

2. FPC Pin Assignment

Main FPC Pin assignment — AMOLED Panel Input/Output Signal Interfac
FPCA recommended connector: 504248-2410,Molex
Main board recommended connector: 504208-2410,Molex

Pin No.	Symbol	I/O	Function	Remark
1	GND	Power	Ground	
2	XRES	I	Device reset signal (0 : enable ; 1 : Disable)	
3	DSI_D0N	I/O	MIPI negative data signal	
4	SWIRE	O	SWIRE signal for PWR IC control	
5	DSI_D0P	I/O	MIPI positive data signal	
6	NC	-	Floating	
7	GND	Power	Ground	
8	TE	I	Vsync (vertical sync) signal output from panel to avoid tearing effect	
9	DSI_CLKN	I	MIPI negative clock signal	
10	GND	Power	Ground	
11	DSI_CLKP	I	MIPI positive clock signal	
12	GND	Power	Ground	
13	GND	Power	Ground	
14	GND	Power	Ground	
15	VDDIO	Power	Power supply for interface system excep MIPI interface	
16	VCI	Power	Driver analog power supply	
17	GND	Power	Ground	
18	GND	Power	Ground	
19	ELVSS	Power	AMOLED negative power supply	
20	ELVDD	Power	AMOLED positive power supply	
21	ELVSS	Power	AMOLED negative power supply	
22	ELVDD	Power	AMOLED positive power supply	
23	ELVSS	Power	AMOLED negative power supply	
24	ELVDD	Power	AMOLED positive power supply	

Note: I = input ; O = output ; P = Power ; I/O = input / Output; NC= No Connection

3. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Remark
Digital Power Supply	VDDIO	-0.3	5.5	V	
Analog Power Supply	VCI	-0.3	5.5	V	
ELVDD power Supply	ELVDD	-	5.0	V	
ELVSS power Supply	ELVSS	-5.0	-	V	

Note : If the module exceeds the absolute maximum ratings, it may be damaged permanently.

B. DC Characteristics

1. Display DC Characteristics

Item		Symbol	Min.	Typ.	Max.	Unit	Remark
Digital Power Supply		VDDIO	1.65	1.8	1.95	V	Note1
Analog Power Supply		VCI	2.7	2.8	2.9	V	Note1
ELVDD power Supply		ELVDD	4.55	4.60	4.65	V	Note1
ELVSS power Supply		ELVSS	-2.35	-2.40	-2.45	V	Note1
Input Signal Voltage	H Level	V_{IH}	0.8* VDDIO	-	VDDIO	V	Note1
	L Level	V_{IL}	0	-	0.2* VDDIO	V	
Output Signal Voltage	H Level	V_{OH}	0.8* VDDIO	-	VDDIO	V	Note1
	L Level	V_{OL}	0	-	0.2* VDDIO	V	Note1

Note 1: The operation is guaranteed under the recommended operating conditions only. The operation is not guaranteed if a quick voltage change occurs during the operation. To prevent the noise, a bypass capacitor must be inserted into the line closed to the power pin.

2. Display Current Consumption

Power Supply: IOVCC=1.8V VCI=2.8V

Frame Frequency: Fframe >=60HZ @ 25degC, Brightness 350 nits

Display Mode	Item	Symbol	Spec	
			Typ	Max
			Current(mA)	Current(mA)
100% Pixel On (Normal mode)	Current of IOVDD	Idd	2.2	2.5
	Current of VCI	Ici	4.2	4.6
	Current of ELVSS	Iess	21	23.4
50% Pixel On (Normal mode)	Current of IOVDD	Idd	2.2	2.5
	Current of VCI	Ici	4.4	4.9
	Current of ELVSS	Iess	10.5	11.7
All Pixel Off (Normal mode)	Current of IOVDD	Idd	2.2	2.5
	Current of VCI	Ici	4.6	5.3
	Current of ELVSS	Iess	0.0	0.0
All Pixel Off (Standby mode)	Current of IOVDD	Idd	--	0.0
	Current of VCI	Ici	--	<2uA
	Current of ELVSS	Iess	--	0.0

Power Supply: IOVCC=1.8V VCI=2.8V

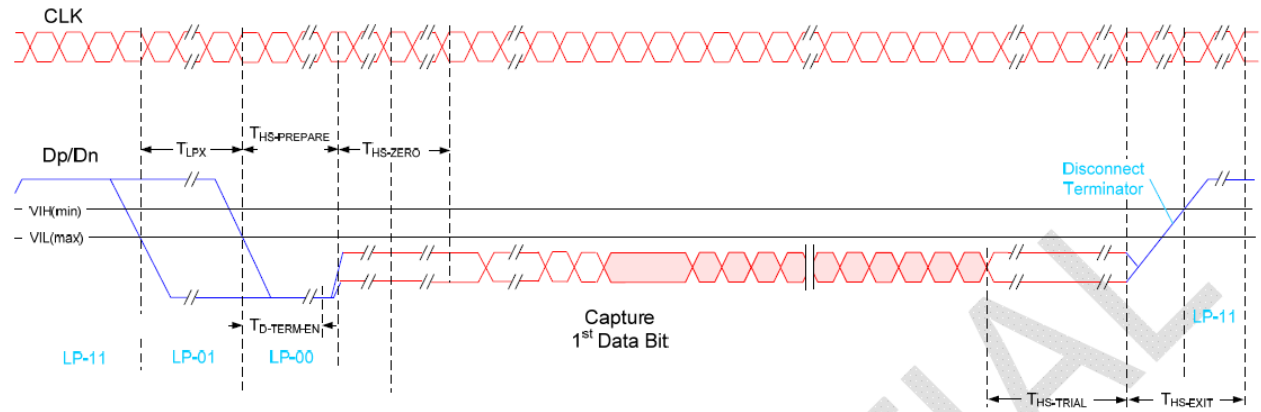
Frame Frequency: Fframe =15HZ @ 25degC, Brightness 20 nits

Display Mode	Item	Symbol	Spec	
			Typ	Max
			Current(mA)	Current(mA)
10% Pixel On (Idle mode)	Current of IOVDD	Idd	1.2	1.3
	Current of VCI	Ici	2.4	2.7
	Current of ELVSS	Iess	0	0

C. AC Characteristics

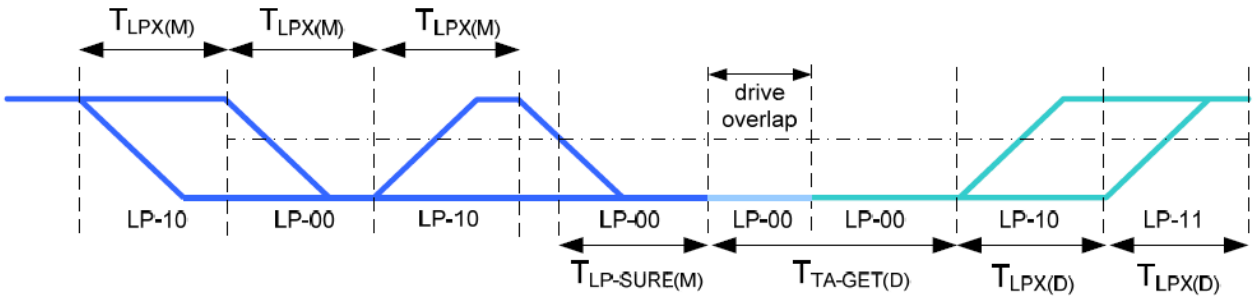
1. MIPI Interface Characteristics

HS Data Transmission Burst

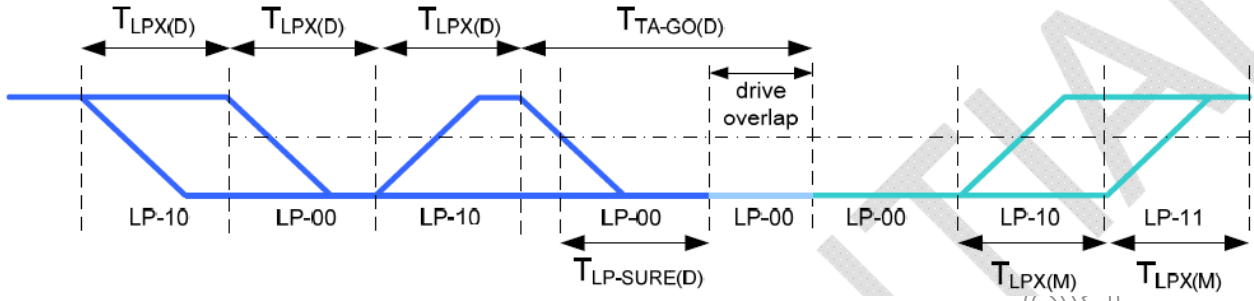


HS clock transmission

Turnaround Procedure



Bus turnaround (BAT) from MPU to display module timing



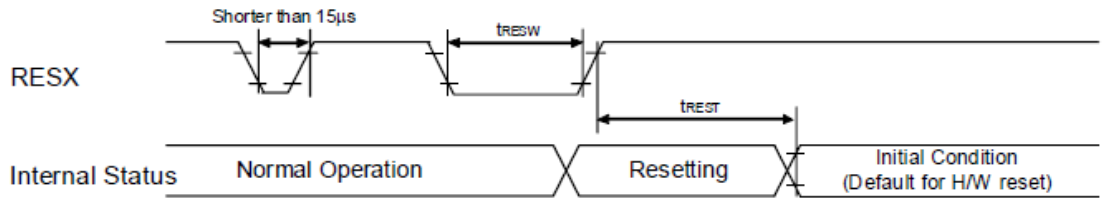
Timing Parameters

Symbol	Description	Min	Typ	Max	Unit
$T_{CLK-POST}$	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			ns
$T_{CLK-TRAIL}$	Time that the transmitter drives the HS-0 state after the last payload clock bit of a HS transmission burst.	60			ns
$T_{HS-EXIT}$	Time that the transmitter drives LP-11 following a HS burst.	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 $V_{IL,MAX}$.	Time for Dn to reach $V_{TERM-EN}$		38	ns
$T_{CLK-PREPARE}$	Time that the transmitter drives the Clock Lane LP-00 Line state immediately before the HS-0 Line state starting the HS transmission.	38		95	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			UI
$T_{CLK-PREPARE} + T_{CLK-ZERO}$	$T_{CLK-PREPARE}$ + time that the transmitter drives the HS-0 state prior to starting the Clock.	300			ns
$T_{D-TERM-EN}$	Time for the Data Lane receiver to enable the HS line termination, starting from the time point when Dn crosses $V_{IL,MAX}$.	Time for Dn to Reach $V_{TERM-EN}$		35 ns +4*UI	
$T_{HS-PREPARE}$	Time that the transmitter drives the Data Lane LP-00 Line state immediately before	40ns + 4*UI		85 ns + 6*UI	ns

	the HS-0 Line state starting the HS transmission				
$T_{HS-PREPARE}$ + $T_{HS-ZERO}$	$T_{HS-PREPARE}$ + time that the transmitter drives the HS-0 state prior to transmitting the Sync sequence.	145ns + 10*UI			ns
$T_{HS-TRAIL}$	Time that the transmitter drives the flipped differential state after last payload data bit of a HS transmission burst	60ns + 4*UI			ns
$T_{LPX(M)}$	Transmitted length of any Low-Power state period of MCU to display module	50		150	ns
$T_{TA-SURE(M)}$	Time that the display module waits after the LP-10 state before transmitting the Bridge state (LP-00) during a Link Turnaround.	$T_{LPX(M)}$		$2*T_{LPX(M)}$	ns
$T_{LPX(D)}$	Transmitted length of any Low-Power state period of display module to MCU	50		150	ns
$T_{TA-GET(D)}$	Time that the display module drives the Bridge state (LP-00) after accepting control during a Link Turnaround.		$5*T_{LPX(D)}$		ns
$T_{TA-GO(D)}$	Time that the display module drives the Bridge state (LP-00) before releasing control during a Link Turnaround.		$4*T_{LPX(D)}$		ns
$T_{TA-SURE(D)}$	Time that the MPU waits after the LP-10 state before transmitting the Bridge state (LP-00) during a Link Turnaround.	$T_{LPX(D)}$		$2*T_{LPX(D)}$	ns

2. Display RESET Timing Characteristics

Reset input timing



Timing Parameters

Symbol	Parameter	Related Pins	MIN	TYP	MAX	Note	Unit
t_{RESW}	*1) Reset low pulse width	RESX	10	-	-	-	µs
t_{REST}	*2) Reset complete time	-	-	-	5	When reset applied during Sleep in mode	ms
		-		-	120	When reset applied during Sleep out mode	ms

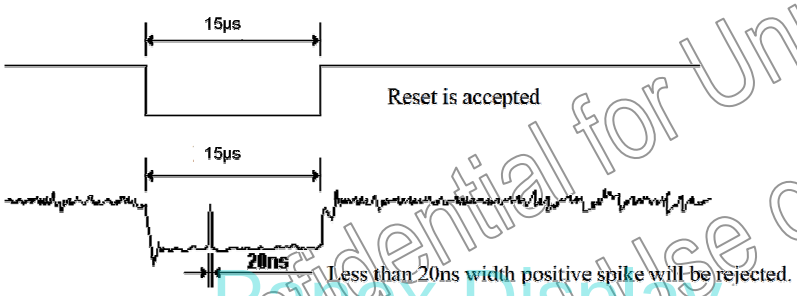
Note 1. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below.

RESX Pulse	Action
Shorter than 5µs	Invalid Reset
Longer than 15µs	Valid Reset
Between 5µs and 15µs	Reset Initialigation Precedure

Note 2. During the resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode) and then return to Default condition for H/W reset.

Note 3. During Reset Complete Time, data in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 5ms after a rising edge of RESX.

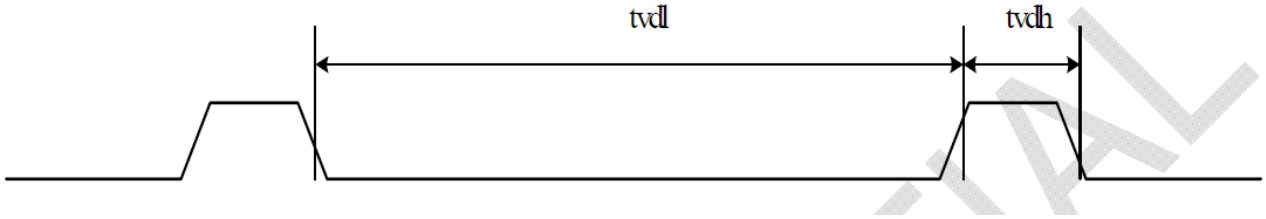
Note 4. Spike Rejection also applies during a valid reset pulse as shown below:



Note 5. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

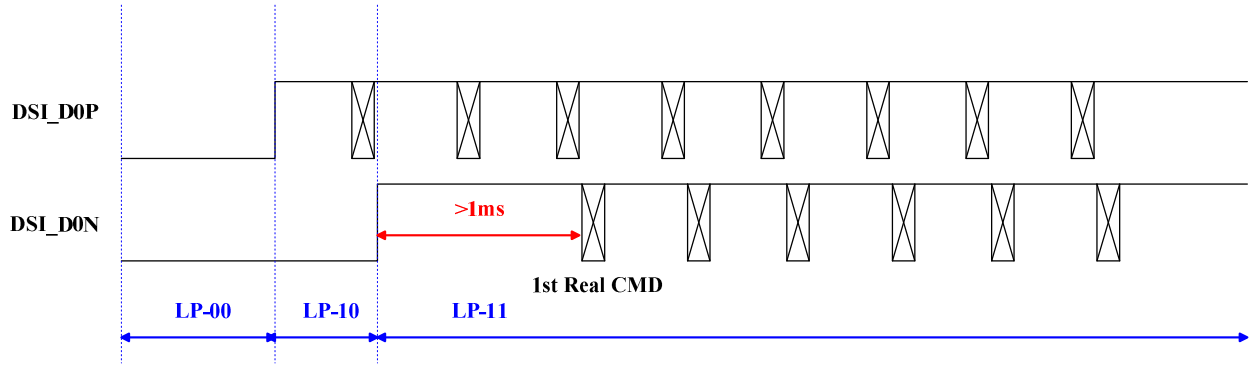
TE Timing Characteristics

Mode 1, the tearing effect output signal consist of V-sync information only:



tvdh = The display is not updated from the frame memory
tvdl = The display is updated from the frame memory

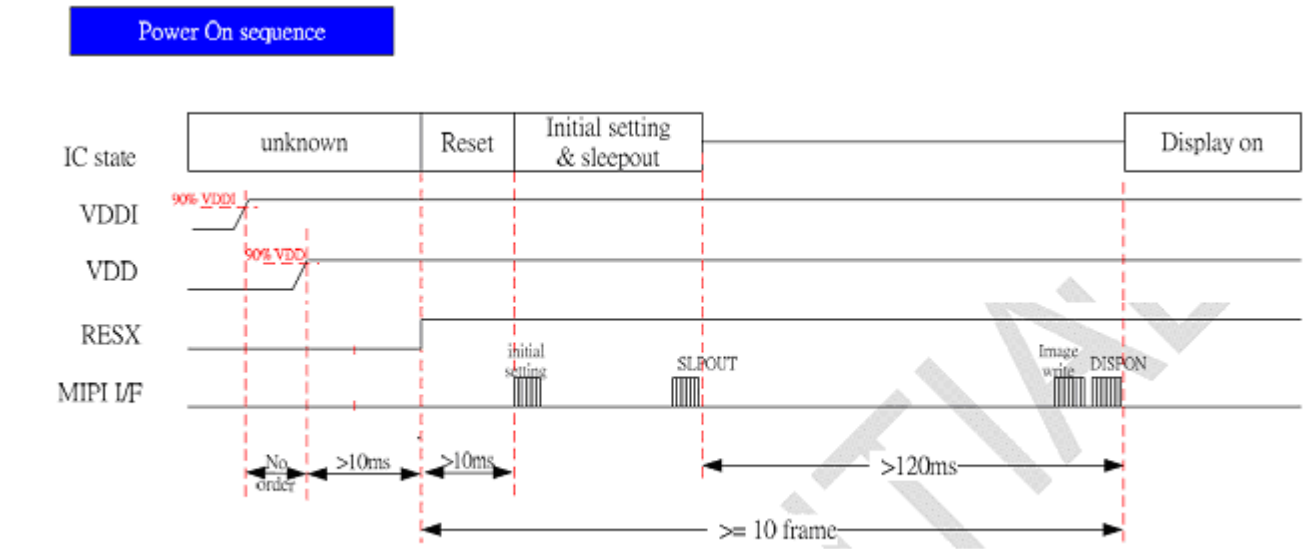
MIPI Initial CMD Flow



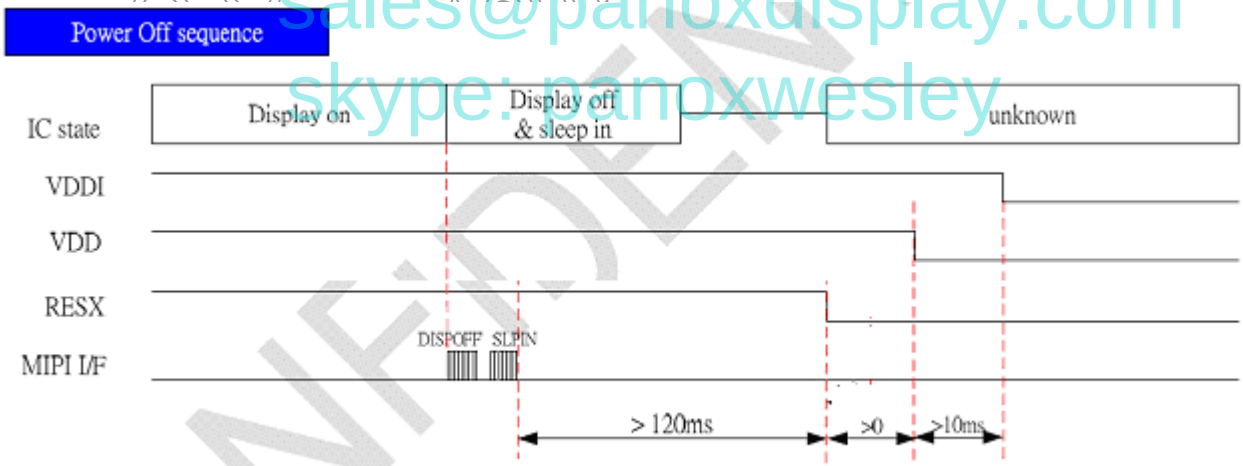
Operating Sequence

Display Power on/off Sequence

Power on sequence



Power off sequence



Display Initial Setting

Recommended Power on Initial Sequence								
Step	Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
					MIPI	Others		
1	Turn on V_{CI}							VCI=2.8V
2	Turn on V_{DDIO}							VDDIO=1.8V
3	Delay	no limit						
4	REST pin low	20us						
5	REST pin high							
6	Delay	5 ms						
7			W	0x15	FE	FE00	07	
8			W	0x15	07	07A0	4F	
9			W	0x15	FE	FE00	0A	
10			W	0x15	1C	1CD0	1B	
11			W	0x15	FE	FE00	00	
12			W	0x15	35	3500	00	
13	Sleep out		W	0x05	11	1100	00	
14	Turn on peripheral packet			0x32				Video Turn On
15	Delay	300 ms						
16	Display on		W	0x05	29	2900	00	

Recommended Power off Mode Sequence								
Step	Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
					MIPI	Others		
1	Display Off		W	0x05	28	2800	00	
2	Sleep in		W	0x05	10	1000	00	
3	delay	120ms						
4	Power off							

Idle mode Flow

(1) Normal to Idle

Recommended Idle Initial Sequence								
Step	Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
					MIPI	Others		
1	Enter Idle mode		W	0x05	39	3900	00	Idle mode 15HZ

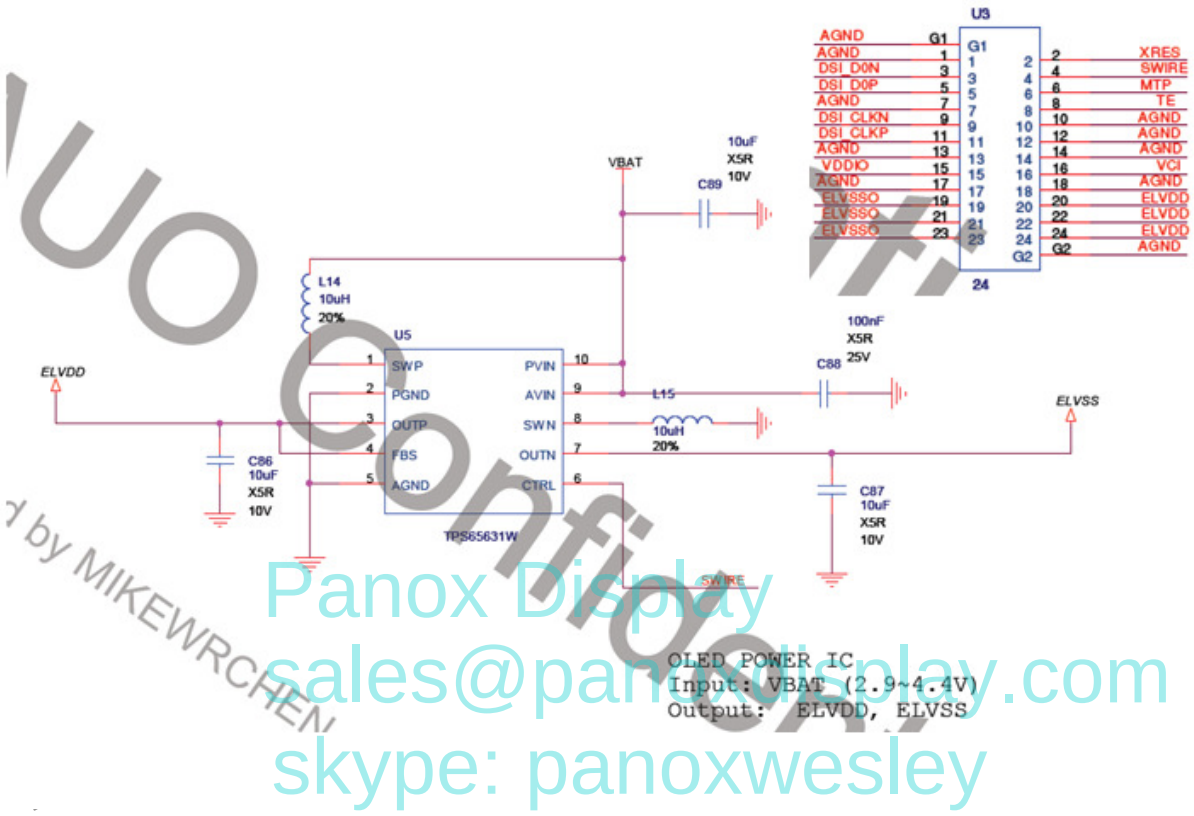
(2) Idle to Normal

Recommended Power on Initial Sequence								
Step	Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
					MIPI	Others		
1	Idle mode Off		W	0x05	38	3800	00	Normal mode 60HZ

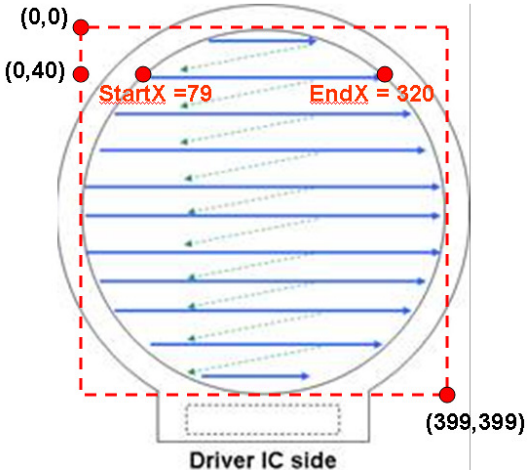
Brightness Control

Recommended Brightness Control							
Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
				MIPI	Others		
Brightness control		W	0x05	51	5100	Value	Value form 0~255(FF)

D. Power IC Application Circuit



E. Display Scan Direction & Coordinate



Panel Start Point = (0 , 0)

Panel End Point = (399 , 399)

Each Line = (Start x , y) ~~ (End x , y)

Coordinate

Y	start_X	end_X	Total	Y	start_X	end_X	Total	Y	start_X	end_X	Total
0	187	212	26	30	94	305	212	60	57	342	286
1	176	223	48	31	92	307	216	61	56	343	288
2	169	230	62	32	91	308	218	62	55	344	290
3	163	236	74	33	89	310	222	63	54	345	292
4	158	241	84	34	88	311	224	64	53	346	294
5	154	245	92	35	86	313	228	65	52	347	296
6	150	249	100	36	85	314	230	66	51	348	298
7	146	253	108	37	84	315	232	67	50	349	300
8	143	256	114	38	82	317	236	68	49	350	302
9	139	260	122	39	81	318	238	69	49	350	302
10	136	263	128	40	79	320	242	70	48	351	304
11	133	266	134	41	78	321	244	71	47	352	306
12	131	268	138	42	77	322	246	72	46	353	308
13	128	271	144	43	76	323	248	73	45	354	310
14	125	274	150	44	74	325	252	74	44	355	312
15	123	276	154	45	73	326	254	75	44	355	312
16	121	278	158	46	72	327	256	76	43	356	314
17	118	281	164	47	71	328	258	77	42	357	316
18	116	283	168	48	70	329	260	78	41	358	318
19	114	285	172	49	68	331	264	79	40	359	320
20	112	287	176	50	67	332	266	80	40	359	320
21	110	289	180	51	66	333	268	81	39	360	322
22	108	291	184	52	65	334	270	82	38	361	324
23	106	293	188	53	64	335	272	83	38	361	324
24	104	295	192	54	63	336	274	84	37	362	326
25	102	297	196	55	62	337	276	85	36	363	328
26	101	298	198	56	61	338	278	86	35	364	330
27	99	300	202	57	60	339	280	87	35	364	330
28	97	302	206	58	59	340	282	88	34	365	332
29	96	303	208	59	58	341	284	89	33	366	334

Y	start_X	end_X	Total	Y	start_X	end_X	Total	Y	start_X	end_X	Total
90	33	366	334	120	17	382	366	150	6	393	388
91	32	367	336	121	16	383	368	151	6	393	388
92	31	368	338	122	16	383	368	152	6	393	388
93	31	368	338	123	15	384	370	153	6	393	388
94	30	369	340	124	15	384	370	154	5	394	390
95	30	369	340	125	14	385	372	155	5	394	390
96	29	370	342	126	14	385	372	156	5	394	390
97	28	371	344	127	14	385	372	157	5	394	390
98	28	371	344	128	13	386	374	158	4	395	392
99	27	372	346	129	13	386	374	159	4	395	392
100	27	372	346	130	13	386	374	160	4	395	392
101	26	373	348	131	12	387	376	161	4	395	392
102	25	374	350	132	12	387	376	162	4	395	392
103	25	374	350	133	11	388	378	163	3	396	394
104	24	375	352	134	11	388	378	164	3	396	394
105	24	375	352	135	11	388	378	165	3	396	394
106	23	376	354	136	10	389	380	166	3	396	394
107	23	376	354	137	10	389	380	167	3	396	394
108	22	377	356	138	10	389	380	168	3	396	394
109	22	377	356	139	9	390	382	169	2	397	396
110	21	378	358	140	9	390	382	170	2	397	396
111	21	378	358	141	9	390	382	171	2	397	396
112	20	379	360	142	9	390	382	172	2	397	396
113	20	379	360	143	8	391	384	173	2	397	396
114	19	380	362	144	8	391	384	174	2	397	396
115	19	380	362	145	8	391	384	175	2	397	396
116	18	381	364	146	7	392	386	176	1	398	398
117	18	381	364	147	7	392	386	177	1	398	398
118	17	382	366	148	7	392	386	178	1	398	398
119	17	382	366	149	7	392	386	179	1	398	398

Y	start_X	end_X	Total	Y	start_X	end_X	Total	Y	start_X	end_X	Total
180	1	398	398	210	0	399	400	240	4	395	392
181	1	398	398	211	0	399	400	241	4	395	392
182	1	398	398	212	0	399	400	242	5	394	390
183	1	398	398	213	1	398	398	243	5	394	390
184	1	398	398	214	1	398	398	244	5	394	390
185	1	398	398	215	1	398	398	245	5	394	390
186	1	398	398	216	1	398	398	246	6	393	388
187	0	399	400	217	1	398	398	247	6	393	388
188	0	399	400	218	1	398	398	248	6	393	388
189	0	399	400	219	1	398	398	249	6	393	388
190	0	399	400	220	1	398	398	250	7	392	386
191	0	399	400	221	1	398	398	251	7	392	386
192	0	399	400	222	1	398	398	252	7	392	386
193	0	399	400	223	1	398	398	253	7	392	386
194	0	399	400	224	2	397	396	254	8	391	384
195	0	399	400	225	2	397	396	255	8	391	384
196	0	399	400	226	2	397	396	256	8	391	384
197	0	399	400	227	2	397	396	257	9	390	382
198	0	399	400	228	2	397	396	258	9	390	382
199	0	399	400	229	2	397	396	259	9	390	382
200	0	399	400	230	2	397	396	260	9	390	382
201	0	399	400	231	3	396	394	261	10	389	380
202	0	399	400	232	3	396	394	262	10	389	380
203	0	399	400	233	3	396	394	263	10	389	380
204	0	399	400	234	3	396	394	264	11	388	378
205	0	399	400	235	3	396	394	265	11	388	378
206	0	399	400	236	3	396	394	266	11	388	378
207	0	399	400	237	4	395	392	267	12	387	376
208	0	399	400	238	4	395	392	268	12	387	376
209	0	399	400	239	4	395	392	269	13	386	374

Y	start_X	end_X	Total	Y	start_X	end_X	Total	Y	start_X	end_X	Total
270	13	386	374	300	27	372	346	330	49	350	302
271	13	386	374	301	28	371	344	331	49	350	302
272	14	385	372	302	28	371	344	332	50	349	300
273	14	385	372	303	29	370	342	333	51	348	298
274	14	385	372	304	30	369	340	334	52	347	296
275	15	384	370	305	30	369	340	335	53	346	294
276	15	384	370	306	31	368	338	336	54	345	292
277	16	383	368	307	31	368	338	337	55	344	290
278	16	383	368	308	32	367	336	338	56	343	288
279	17	382	366	309	33	366	334	339	57	342	286
280	17	382	366	310	33	366	334	340	58	341	284
281	17	382	366	311	34	365	332	341	59	340	282
282	18	381	364	312	35	364	330	342	60	339	280
283	18	381	364	313	35	364	330	343	61	338	278
284	19	380	362	314	36	363	328	344	62	337	276
285	19	380	362	315	37	362	326	345	63	336	274
286	20	379	360	316	38	361	324	346	64	335	272
287	20	379	360	317	38	361	324	347	65	334	270
288	21	378	358	318	39	360	322	348	66	333	268
289	21	378	358	319	40	359	320	349	67	332	266
290	22	377	356	320	40	359	320	350	68	331	264
291	22	377	356	321	41	358	318	351	70	329	260
292	23	376	354	322	42	357	316	352	71	328	258
293	23	376	354	323	43	356	314	353	72	327	256
294	24	375	352	324	44	355	312	354	73	326	254
295	24	375	352	325	44	355	312	355	74	325	252
296	25	374	350	326	45	354	310	356	76	323	248
297	25	374	350	327	46	353	308	357	77	322	246
298	26	373	348	328	47	352	306	358	78	321	244
299	27	372	346	329	48	351	304	359	79	320	242

Y	start_X	end_X	Total	Y	start_X	end_X	Total	Y	start_X	end_X	Total
360	81	318	238	390	139	260	122				
361	82	317	236	391	143	256	114				
362	84	315	232	392	146	253	108				
363	85	314	230	393	150	249	100				
364	86	313	228	394	154	245	92				
365	88	311	224	395	158	241	84				
366	89	310	222	396	163	236	74				
367	91	308	218	397	169	230	62				
368	92	307	216	398	176	223	48				
369	94	305	212	399	187	212	26				
370	96	303	208								
371	97	302	206								
372	99	300	202								
373	101	298	198								
374	102	297	196								
375	104	295	192								
376	106	293	188								
377	108	291	184								
378	110	289	180								
379	112	287	176								
380	114	285	172								
381	116	283	168								
382	118	281	164								
383	121	278	158								
384	123	276	154								
385	125	274	150								
386	128	271	144								
387	131	268	138								
388	133	266	134								
389	136	263	128								

F. Optical Specifications

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

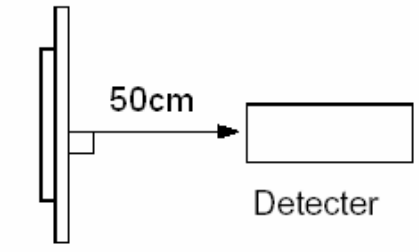
Item		Symbol	Condition	AUO Spec			Unit	Note
				Min	Typ	Max		
luminance		Bp	θ=0° □=0°	300	350	--	cd/m2	CPK>1.33 Note1
Uniformity		△Bp		85	--	--	%	Note2
Viewing Angle	Left	θ_L	Cr≥10	80	--	--	deg	Note 3
	Right	θ_R		80	--	--		
	Top	ψ_T		80	--	--		
	Bottom	ψ_B		80	--	--		
Contrast Ratio		Cr	θ=0° □=0°	10000		--	-	Note 4
Response Time		Tr		--	2	3	ms	Note 5
		Tf		--	2	3	ms	
		Tgray		-	2	3	ms	
Color Coordinate of CIE1931	Red	x	θ=0° □=0°	0.645	0.675	0.705	-	Note 6
		y		0.295	0.325	0.355		
	Green	x		0.186	0.236	0.286		
		y		0.661	0.711	0.761		
	Blue	x		0.09	0.13	0.17		
		y		0.025	0.065	0.105		
	White	x		0.28	0.3	0.32		
		y		0.29	0.31	0.33		
NTSC Ratio		NTSC	CIE1931		100	--	%	Note 7
Color temperature		CT			7500		K	
Flicker		amount	-	-	--	-30	dB	Note 8
Gamma		-	-	1.9	2.2	2.5		Note 9
Crosstalk		△CT	-	-	--	1.1		Note 10
Reflectance		Rf	@550nm	--	TBD	--	%	Note 11
Polarization direction of front polarizer		PdF		--	135	--	deg	Note 12
Luminance decrease ratio of full white			θL=30°		35	40	%	Note 13
			θR=30°		35	40	%	
			ψT=30°		35	40	%	
			ψB=30°		35	40	%	
Color shift			θL=30°	---	3	4	JNCD	Note 14
			θR=30°	---	3	4	JNCD	

		ψT=30°	--	3	4	JNCD	
		ψB=30°	--	3	4	JNCD	
OLED lifetime	0.95*(TYP brightness)	At 25℃,with white color pattern	150	-		hrs	Tentative
Image sticking		With 8*8 black-white chess board test image, lighting on with maximum luminance for 12H	Light off or gray display for 3 minutes, normal performance after the test, without image sticking.				Tentative

Note 1: Luminance measurement

The test condition is at 25℃ and measured on the surface of OLED module.

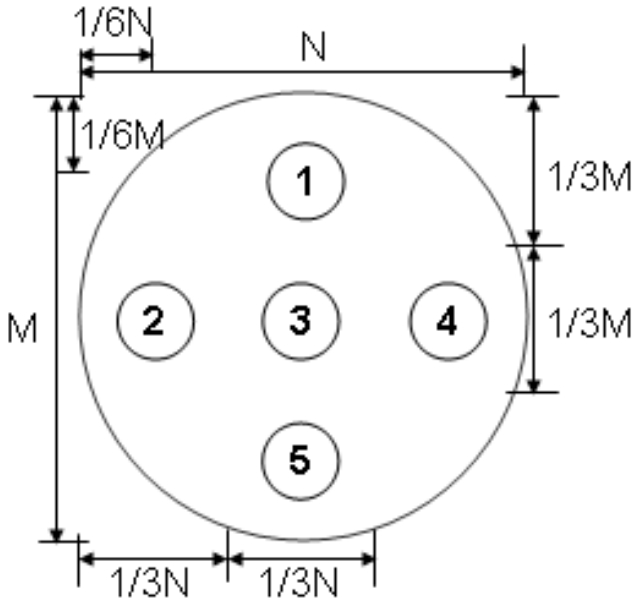
- The data are measured after OLEDs are lighted on for more than 5 minutes and displays are fully white. The brightness is the average value of 5 measured spots. Measurement equipment CS2000 or similar equipments (Field of view:1deg,Distance:50cm)
- Measuring surroundings: Dark room.
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.
- Measured value at the center point of panel must be after more than 5 minutes while backlight turning on.



Note 2: Uniformity

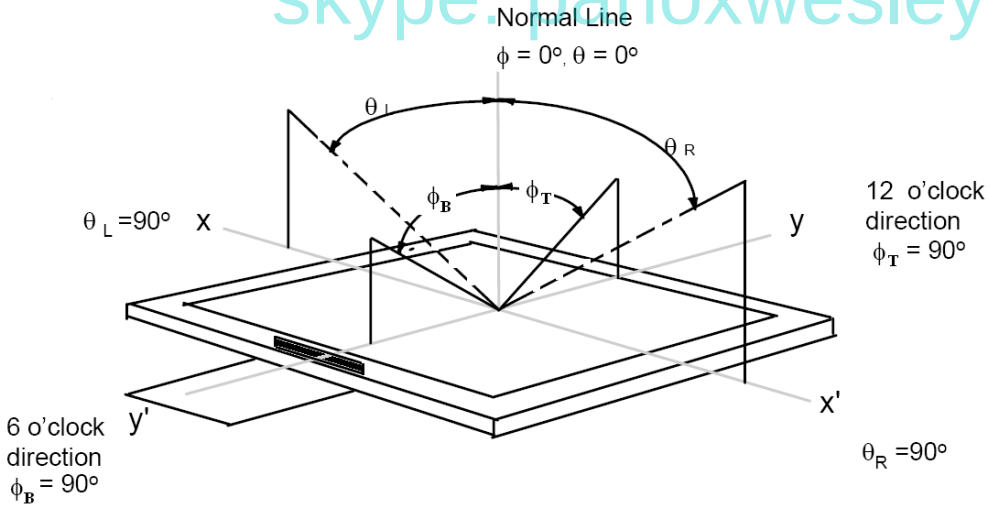
- The test condition is at 25℃ and measured on the surface of display module.
- Measurement equipment: CS2000 or similar equipments.
- The luminance uniformity is calculated by using following formula:
- △Bp = Bp (Min.) / Bp (Max.)×100 (%)

- Bp (Max.) = Maximum brightness in 5 measured spots
- Bp (Min.) = Minimum brightness in 5 measured spots.



Note 3: **The definition of Viewing Angle**

Refer to the graph below marked by *ê* and *Ô*



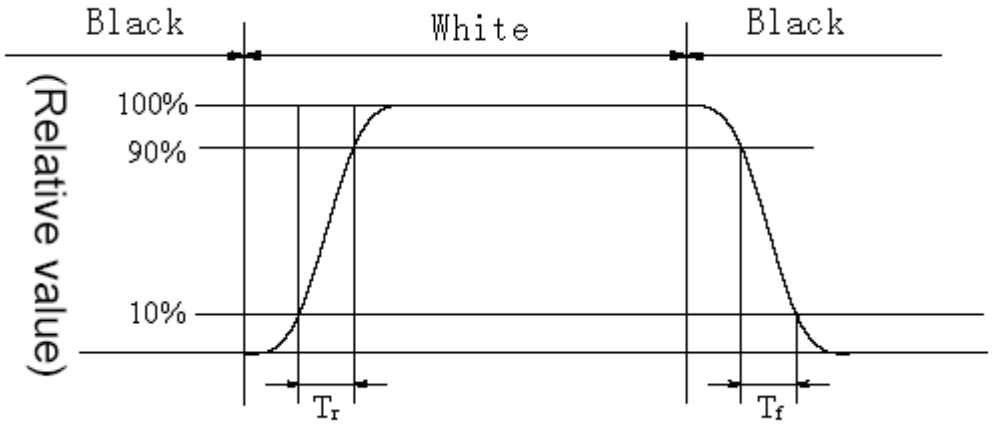
Note 4: **The definition of Contrast Ratio** (Test OLED using CS2000 or similar equipments):

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

(Contrast Ratio is measured in optimum common electrode voltage)

Note 5: **Definition of Response time.** (Test OLED 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: DMS501 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:

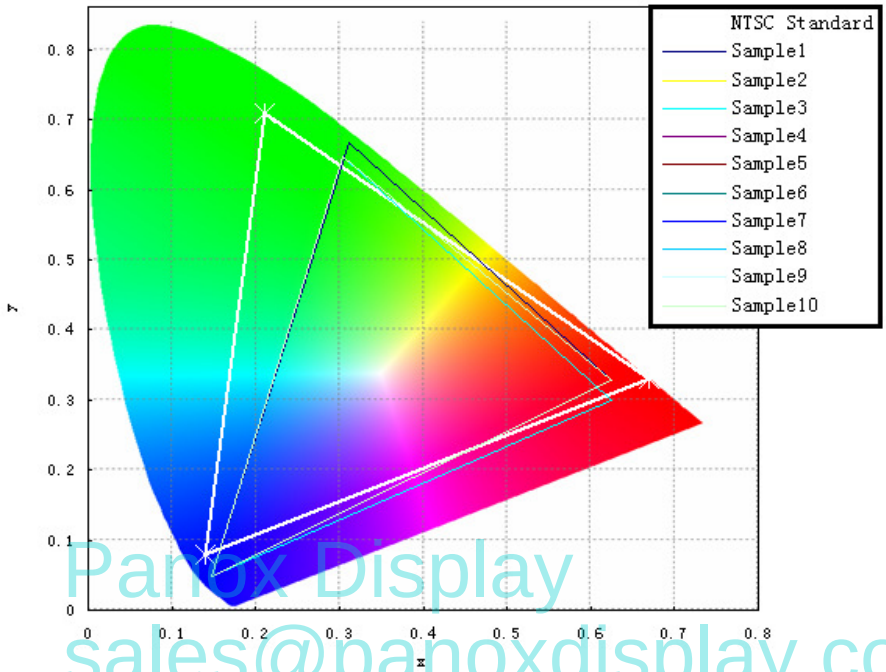
	L0	L1	L2	L3	L4	L5	L6	L7
L0	■							
L1		■						
L2			■					
L3				■				
L4					■			
L5						■		
L6							■	
L7								■

Note 6: Color Coordinates of CIE 1931

- The test condition is at 25℃ and measured on the surface of display module.
- Measurement equipment: CS2000 or similar equipments.
- The Color Coordinate (CIE 1931) is the measurement of the center of the display shown in below figure.

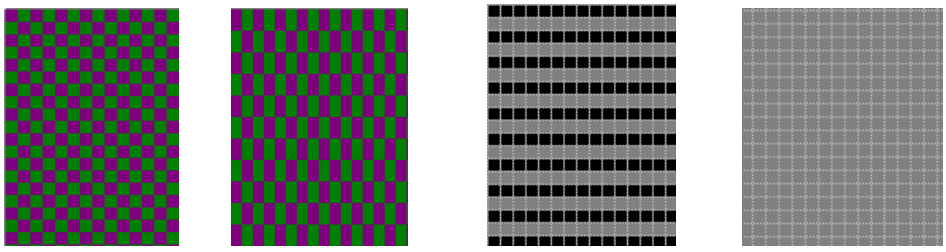
Note 7: **Definition of Color of CIE Coordinate and NTSC Ratio.**

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



Note 8: 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)



1 Dot Inversion 2 Dot inversion Line Inversion Frame Inversion

The point should be marked is, for line and frame inversion, the background of Flicker Test Pattern- “gray “ are defined as middle gray scale .For example, RGB 24bit “gray” 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

For Dot inversion, the RGB data for first pixel is (127, 0, 127), the RGB data for the second pixel is (0, 127, 0).

- Frame Frequency Requirement before test： The OLED must be tuned to more than 65HZ before measurement .

- Measurement Point: the center of display active area.
- Conversion of Flicker ratio:

  Flicker[dB] = 10xlog[Px/P0]

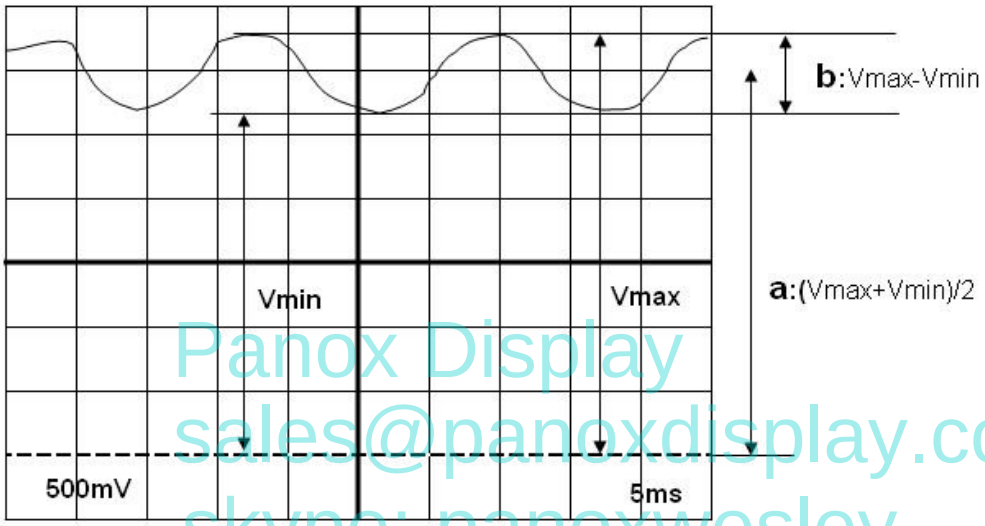
  Where

  Px: Maximum power spectrum of AC component after passing through integrator

  P0:Power spectrum of DC component after passing through integrator

  AC component=b (Refer to below diagram)

  DC component=a (Refer to below diagram)



Note 9: gamma curve control

- For gamma curve control, HUAWEI's request as below:

- 1,the whole curve's tolerance must control within +/-0.3, HUAWEI will test the gray scale below:

  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

Note 10: 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:

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

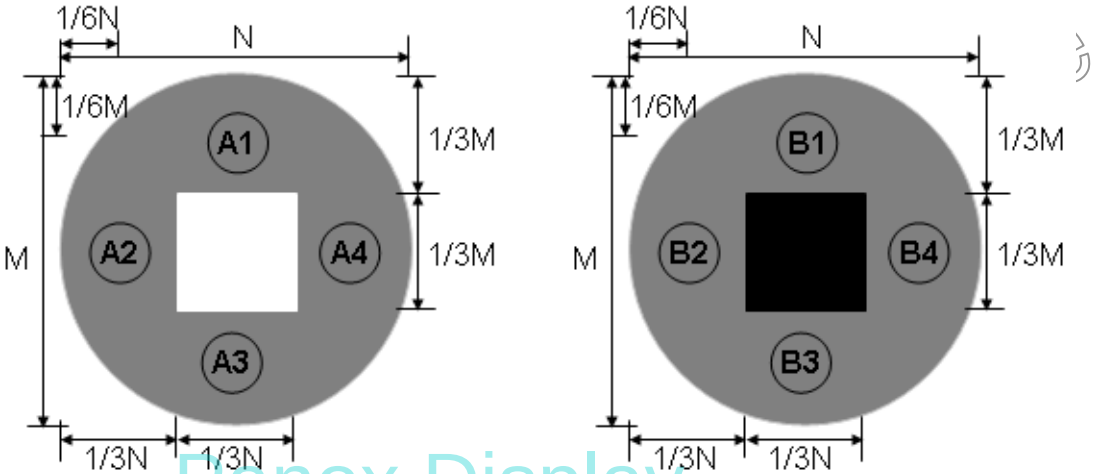
- △Bpn = Bpn (gray) / Bpn (white)

  Which n means the dot No. In the Cross-talk Test Pattern ;

Bpn (gray) means the brightness of the No.n spots in Cross-talk Test Pattern;

Bpn (white) means the brightness of the No.n spots in Full white Test Pattern;

- △Bp (Max.) = Maximum value in △Bp1~△Bp4.
- △Bp (Min.) = Minimum value in △Bp1~△Bp4.
- △CT=△Bp (Max.)/ △Bp(Min.).
- △CT must be less than 1.10



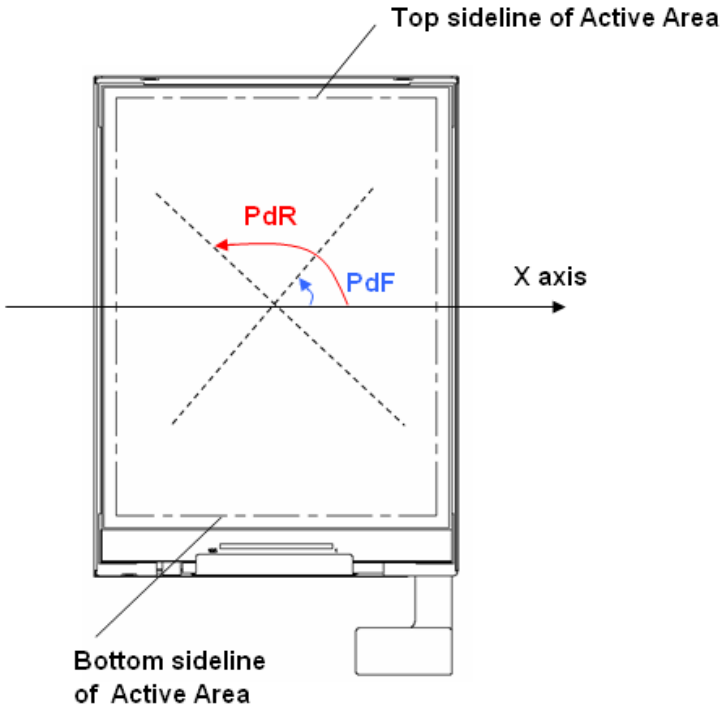
Cross-talk Test Pattern

Note 11:Reflectance Ratio

- Measurement equipment : X-rite SP64
- Measurement parameter : Reflectance Ratio @550nm

Note 12: 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
- The polarization degree parameter must be indicated in range of 0deg to 180deg according to above definition



Absorption axis Definition

Note 13: Definition of Luminance decrease ratio

- Refer to the graph of note 9.
- Test pattern : Full White
- The luminance decrease ratio is calculated by using following formula:

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

Note14: 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 onθL=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.

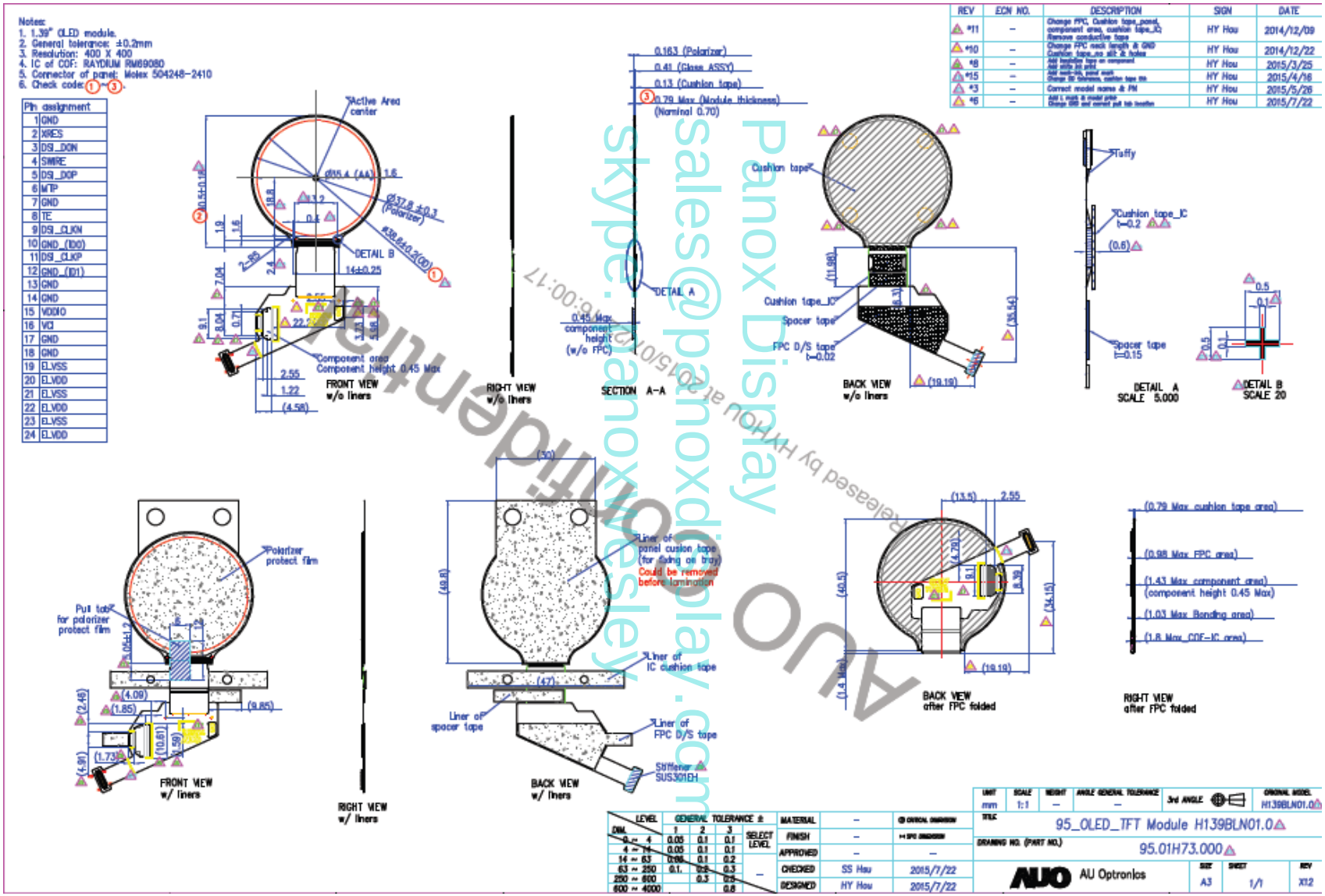
  This Requirement is from our customer and we have test some of our phone display and the result is OK.

G. Reliability Test Items

Category	No.	Test items	Conditions		Remark
Reliability (Environment)	1	High Temp. Operation	Ta= 70ºC	240 hrs	Reliability (Environment)
	2	High Temp. Storage	Ta= 80 ºC	240 hrs	
	3	Low Temp. Operation	Ta= -20 ºC	240 hrs	
	4	Low Temp. Storage	Ta= -30 ºC	240 hrs	
	5	High Temp./Humi. Operation	Ta= 60 ºC. 90% RH	240 hrs	
	6	Thermal Shock	-40 ºC ~80 ºC, Dwell for 30 min. 100 cycles.		Non-operation

H. Packing

I. Outline Demension



J. Precaution

Please pay attention to the following items when you use the OLED Modules(Panel):

1. Do not twist or bend the module(panel) and prevent the unsuitable external force for display during assembly.
2. Adopt measures for good heat radiation. Be sure to use the module(panel) with in the specified temperature.
3. Avoid dust or oil mist during assembly.
4. Follow the correct power sequence while operating. Do not apply the invalid signal, otherwise, it will cause improper shut down and damage the module(panel).
5. Less EMI: it will be more safety and less noise.
6. Please operate module(panel) in suitable temperature. The response time & brightness will drift by different temperature.
7. Avoid to display the fixed pattern (exclude the white pattern) in a long period, otherwise, it will cause image sticking.
8. Please be sure to turn-off the power when connecting or disconnecting the circuit.
9. Polarizer scratches easily, please handle it carefully.
10. Display surface never likes dirt or stains.
11. A dew drop may lead to destruction. Please wipe off any moisture before using module(panel).
12. Sudden temperature changes cause condensation, and it will cause polarizer damaged.
13. High temperature and humidity may degrade performance. Please do not expose the module(panel) to the direct sunlight and so on.
14. Acetic acid or chlorine compounds are not friends with AMOLED display module(panel).
15. Static electricity will damage the module(panel), please do not touch the module(panel) without any grounded device.
16. Please avoid any static electricity damage (ESD) during producing and operating.
17. Do not disassemble and reassemble the module(panel) by self.
18. Be careful do not touch the rear side directly.
19. No strong vibration or shock. It will cause module(panel) broken.
20. Storage the modules(panel) in suitable environment with regular packing.
21. Be careful of injury from a broken display module(panel).
22. Please avoid the pressure adding to the surface (front or rear side) of modules(panel), because it will cause the display non-uniformity or other function issue.