PiTek

Product Specification

1.63" COLOR AMOLED MODULE

MODEL NAME: PA320320A

< □ >Preliminary Specification
< >Final Specification

Record of Revision

Version	Revise Date	Page	Content
0.0	Mar. 5, 2014		First Draft
1.0	Mar.18,2014	17 21 22 23	Revise H. Specifications_Optical characteristics Add I. Reliability test items_Vibration test Add J.packing Revise K.2D/3D drawing;
2.0	Apr.16,2014	7 11 14, 15 16 24	Add Idle power consumption & revise panel power Revise TE description Revise Initial Code for display optimization B500=0x05 -> 0x03; B501=0x05 -> 0x03; B502=0x05 -> 0x03 BA00=0x13 -> 0x03; BA01=0x13 -> 0x03; BA02=0x13 -> 0x03 BE00=0x22 -> 0x32 Revise CF description Revise K. 2D drawing

Contents

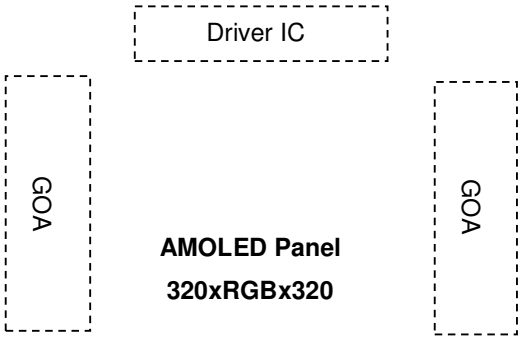
A. General Specification 4
1. Physical Specifications 4
2. Module Block Diagram 4
3. Panel Scan direction 4
B. Electrical Specifications 5
1. Main FPC Pin assignment — AMOLED Panel Input/Output Signal Interface 5
2. Absolute maximum ratings 6
C. Electrical Characteristics 7
1. DC Operating Conditions 7
2. Display Current Consumption 7
D. AC Characteristics 8
1. MIPI Interface Characteristics 8
2. Display RESET Timing Characteristics 10
3. TE Timing Characteristics 11
E. Recommended Operating Sequence 12
1. Display Power on / off Sequence 12
2. Display Initial code 13
F. Brightness Control 16
G. Application Circuit 17
H. Specifications 18
I. Reliability Test Items 22
J. Packing 23
K. Outline Demension (Tentative) 24

A. General Specification

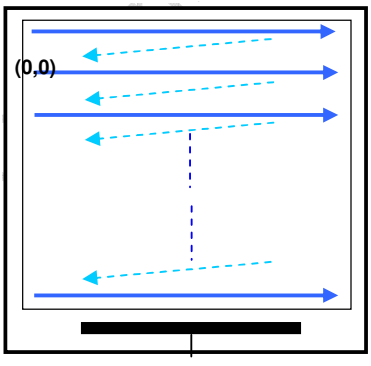
1. Physical Specifications

	Item	Description	Remark
1	Screen Size (inch)	1.63”	
2	Display Mode	AMOLED	
3	Display Resolution (dot)	320xRGBx320	
4	Active Area (mm*mm)	29.28 (H)×29.28(V)	
5	Display Color (M)	16.7	
6	Brightness (nits)	300	
7	Interface	MIPI DSI	
8	Outline Dimension (mm*mm*mm)	32.08 (H) × 36.48(V) × 0.7(T)	cell+foam

2. Module Block Diagram



3. Panel Scan direction



Driver IC Side

B. Electrical Specifications

1. Main FPC Pin assignment — AMOLED Panel Input/Output Signal Interface

Recommended connector: AXE520127 (Panasonic)

FPC	Pin_name	I/O	Description
1	**ELVSS**	P	AMOLED power Negative
2	**ELVSS**	P	AMOLED power Negative
3	**ELVSS**	P	AMOLED power Negative
4	**VDD**	P	Power supply for analog
5	**IOVDD**	P	Power supply for Interface system excep MIPI interface
6	**GND**	P	GND
7	**TE**	O	Vsync(vertical sync)signal output from panel to avoid tearing effect
8	**MTP**	I	MTP(need to indicate to connect GND or NC)
9	**RESX**	I	Device reset signal (0 : Enable ; 1: Disable)
10	**SWIRE**	O	SWIRE signal for PWR IC control
11	**ELVDD**	P	AMOLED power positive
12	**ELVDD**	P	AMOLED power positive
13	**ELVDD**	P	AMOLED power positive
14	**GND**	P	GND
15	**DSI_D0N**	I/O	MIPI data negative signal
16	**DSI_D0P**	I/O	MIPI data positive signal
17	**GND**	P	GND
18	**DSI_CLKN**	I	MIPI strobe negative signal
19	**DSI_CLKP**	I	MIPI strobe postive signal
20	**GND**	P	GND

Note: I = input ; O = output ; P = Power ; I/O = input / Output

2. Absolute maximum ratings

Item	Symbol	Min.	Max.	Unit	Remark
Digital Power supply	IOVDD	-0.3	5.5	V	
Analog Power supply	VDD	-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. Also, if the module operates with the absolute maximum ratings for a long time, the reliability may drop.

C. Electrical Characteristics

1. DC Operating Conditions

Item		Symbol	Min.	Typ.	Max.	Unit	Remark
Digital Power supply		IOVDD	1.65	1.8	1.95	V	Note1
Analog Power supply		VDD	2.8	3.0	3.1	V	Note1
ELVDD power supply		ELVDD	4.57	4.60	4.63	V	Note1,2
ELVSS power supply		ELVSS	-3.35	-3.40	-3.45	V	Note1
Input Signal Voltage	H Level	V_{IH}	0.8*IOVDD	-	IOVDD	V	Note1
	L Level	V_{IL}	0	-	0.2*IOVDD	V	
Output Signal Voltage	H Level	V_{OH}	0.8*IOVDD	-	IOVDD	V	Note1
	L Level	V_{OL}	0	-	0.2*IOVDD	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.

Note 2 : TPS65631W Positive output voltage = 4.6V ± 0.8% at -40℃ ≦ Ta ≦ +85 ℃

2. Display Current Consumption

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Panel Power		P_{NL}	ELVDD:4.6V ELVSS:-3.4V	--	--	138.4	mW	Note1,2,
		I_{NL}		--	--	17.3	mA	Note1,2,
IC	**Normal**	P_{VDD}	VDD : 3.0V	--	25.2	39.3	mW	Note2,
		I_{VDD}		--	8.4	13.1	mA	Note2,
		P_{IOVDD}	IOVDD :1.8V	--	18.0	19.8	uW	Note2,
		I_{IOVDD}		--	10.0	11.0	uA	Note2,
	Idle	P_{VDD}	VDD : 3.0V	--	12.0	15.3	mW	Note3,
		I_{VDD}		--	4.0	5.1	mA	Note3,
		P_{IOVDD}	IOVDD :1.8V	--	18.0	19.8	uW	Note3,
		I_{IOVDD}		--	10.0	11.0	uA	Note3,

Note 1: Based on L255 (300nits) full white pattern

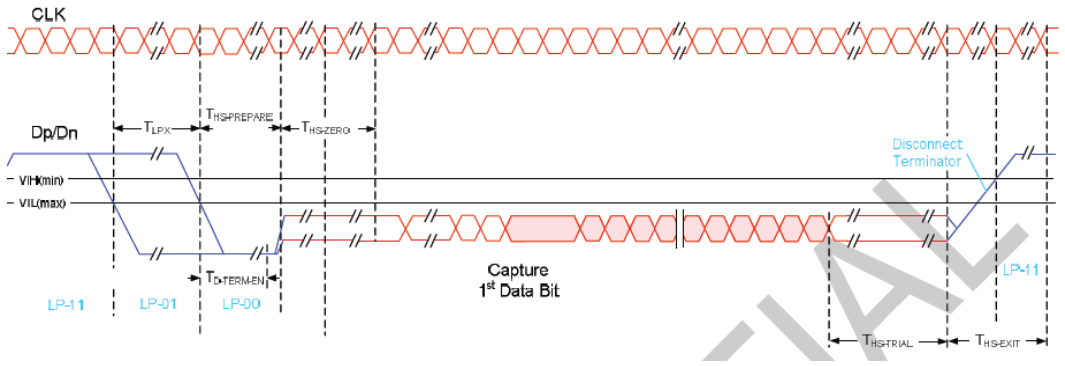
Note 2: Testing in MIPI-DSI frame rate 60Hz CMD mode.

Note 3: Testing in MIPI-DSI frame rate 30Hz CMD mode.

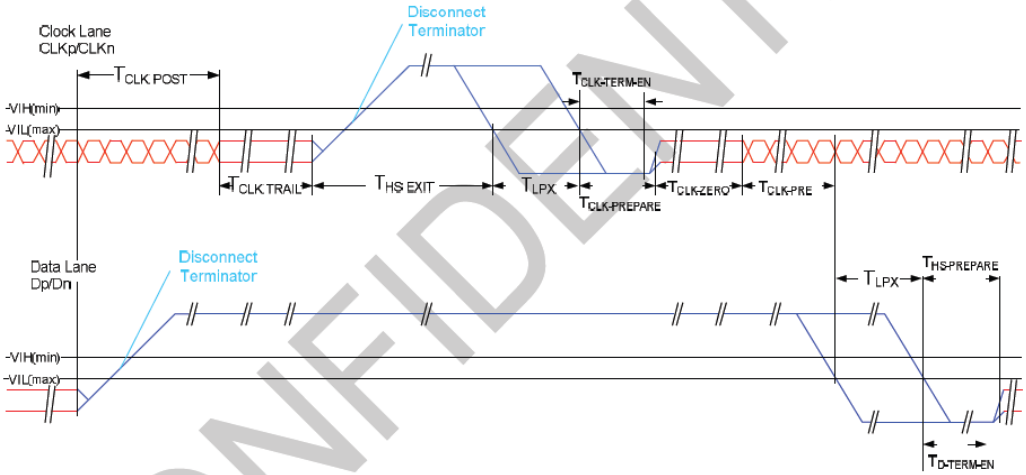
D. AC Characteristics

1. MIPI Interface Characteristics

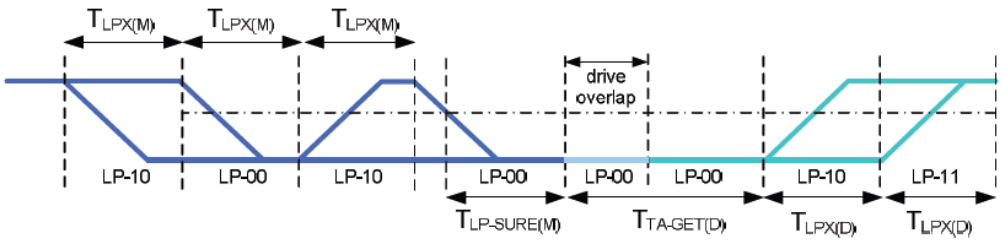
HS Data Transmission Burst



HS clock transmission



Turnaround Procedure



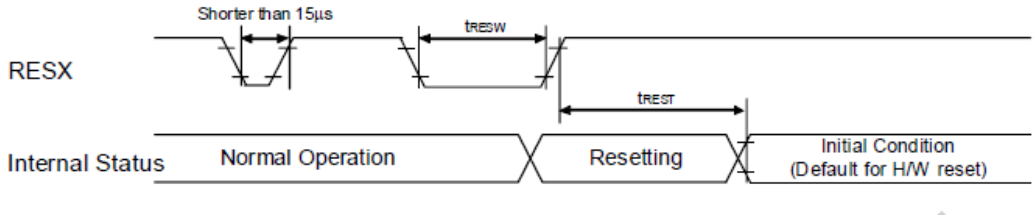
Timing Parameters

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 the HS-0 Line state starting the HS transmission	40ns + 4*UI		60 ns + 6*UI	ns
$T_{HS-PREPARE}$ + $T_{HS-ZERO}$	$T_{HS-PREPARE}$ + 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	96*UI			ns
$T_{LPX(M)}$	Transmitted length of any Low-Power state	100		150	ns

	period of MCU to display module				
$T_{TA-SURE(M)}$	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



IOVDD=1.65 to 1.95V, VDD=2.8 to 3.1V, AGND=DGND=0V, Ta=-40 to 85□

Timing Parameters

Symbol	Parameter	Related Pins	MIN	TYP	MAX	Note	Unit
t_{RESW}	*1) Reset low pulse width	RESX	15	-	-	-	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.

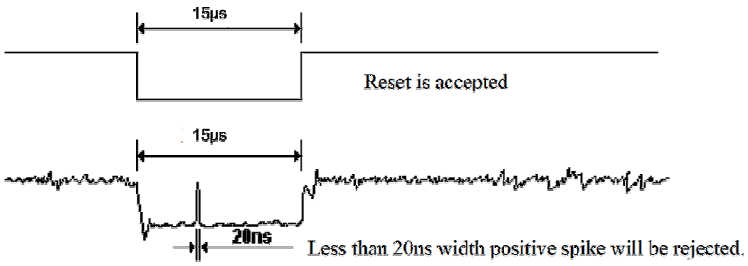
RESX Pulse	Action
Shorter than 5µs	Reset Rejected
Longer than 15µs	Reset
Between 5µs and 15µs	Reset starts (It depends on voltage and temperature condition.)

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.

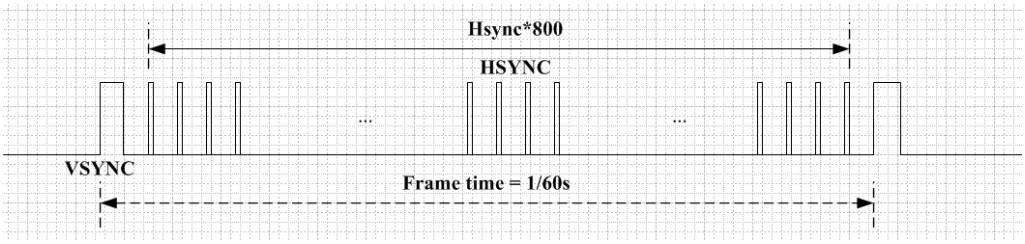
Note 3. During Reset Complete Time, data in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 5ms after a rising edge of RESX.

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.

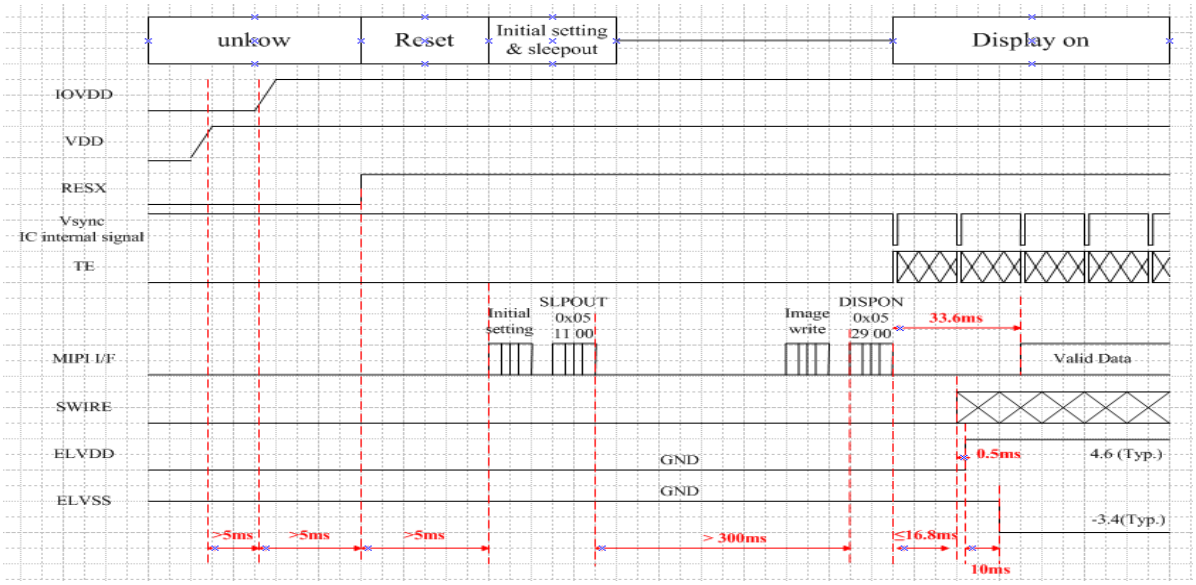
3. TE Timing Characteristics



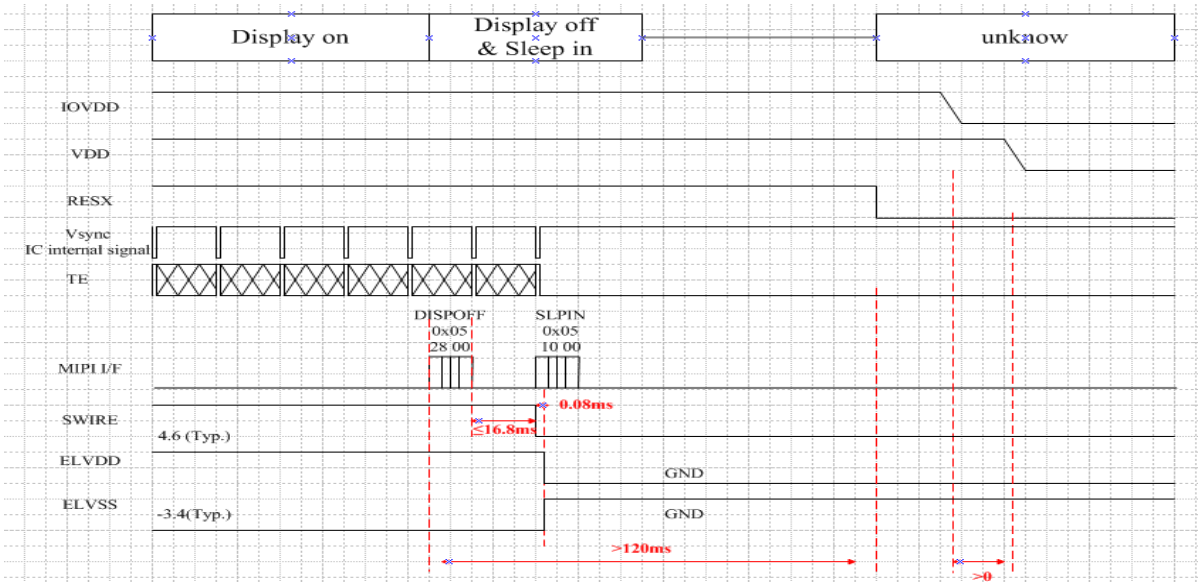
E. Recommended Operating Sequence

1. Display Power on / off Sequence

Power on sequence



Power off sequence



2. Display Initial code

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_{vDD}							VDD=2.8V~3.1V
2	Turn on V_{IOVDD}							IOVDD=1.8V
3	Delay	no limit						
4	REST pin low	20us						
5 6	REST pin high Delay	5 ms						
7			W	0x39	F0	F000	55	
8			W			F001	AA	
9			W			F002	52	
10			W			F003	08	
11			W			F004	00	
12			W	0x39	BD	BD00	01	
13			W			BD01	90	
14			W			BD02	14	
15			W			BD03	14	
16			W			BD04	00	
12			W	0x39	BE	BE00	01	
13			W			BE01	90	
14			W			BE02	14	
15			W			BE03	14	
16			W			BE04	01	
12			W	0x39	BF	BF00	01	
13			W			BF01	90	
14			W			BF02	14	
15			W			BF03	14	
16			W			BF04	00	
12			W	0x39	BB	BB00	07	
13			W			BB01	07	
14			W			BB02	07	
17			W	0x39	C7	C700	40	
18			W	0x39	F0	F000	55	
19			W			F001	AA	
20			W			F002	52	
21			W			F003	08	

22			W			F004	02	
23			W	0x39	FE	FE00	08	
24			W			FE01	50	
25			W	0x39	C3	C300	F2	
26			W			C301	95	
27			W			C302	04	
28			W	0x15	CA	CA00	04	
29			W	0x39	F0	F000	55	
30			W			F001	AA	
31			W			F002	52	
32			W			F003	08	
33			W			F004	01	
34			W	0x39	B0	B000	03	
35			W			B001	03	
36			W			B002	03	
37			W	0x39	B1	B100	05	
38			W			B101	05	
39			W			B102	05	
40			W	0x39	B2	B200	01	
41			W			B201	01	
42			W			B202	01	
43			W	0x39	B4	B400	07	
44			W			B401	07	
45			W			B402	07	
46			W	0x39	B5	B500	03	
47			W			B501	03	
48			W			B502	03	
49			W	0x39	B6	B600	53	
50			W			B601	53	
51			W			B602	53	
52			W	0x39	B7	B700	33	
53			W			B701	33	
54			W			B702	33	
55			W	0x39	B8	B800	23	
56			W			B801	23	
57			W			B802	23	
58			W	0x39	B9	B900	03	
59			W			B901	03	
60			W			B902	03	

61			W	0x39	BA	BA00	03	
62			W			BA01	03	
63			W			BA02	03	
64			W	0x39	BE	BE00	32	
65			W			BE01	30	
66			W			BE02	70	
70			W	0x39	CF	CF00	FF	
71			W			CF01	D4	
72			W			CF02	95	
73			W			CF03	EF	
74			W			CF04	4F	
75			W			CF05	00	
67			W			CF06	04	
67			W	0x15	35	3500	01	
68			W	0x15	36	3600	00	
69			W	0x15	C0	C000	20	
70			W	0x39	C2	C200	17	
71			W			C201	17	
72			W			C202	17	
73			W			C203	17	
74			W			C204	17	
75			W			C205	0B	
76	Turn on peripheral packet			0x32				Video Turn On
77	Sleep out (SLPOUT)		W	0x05	11	1100	00	
78	Delay	300 ms						
79	Display on (DISPON)		W	0x05	29	2900	00	

Recommended Power off Mode Sequence

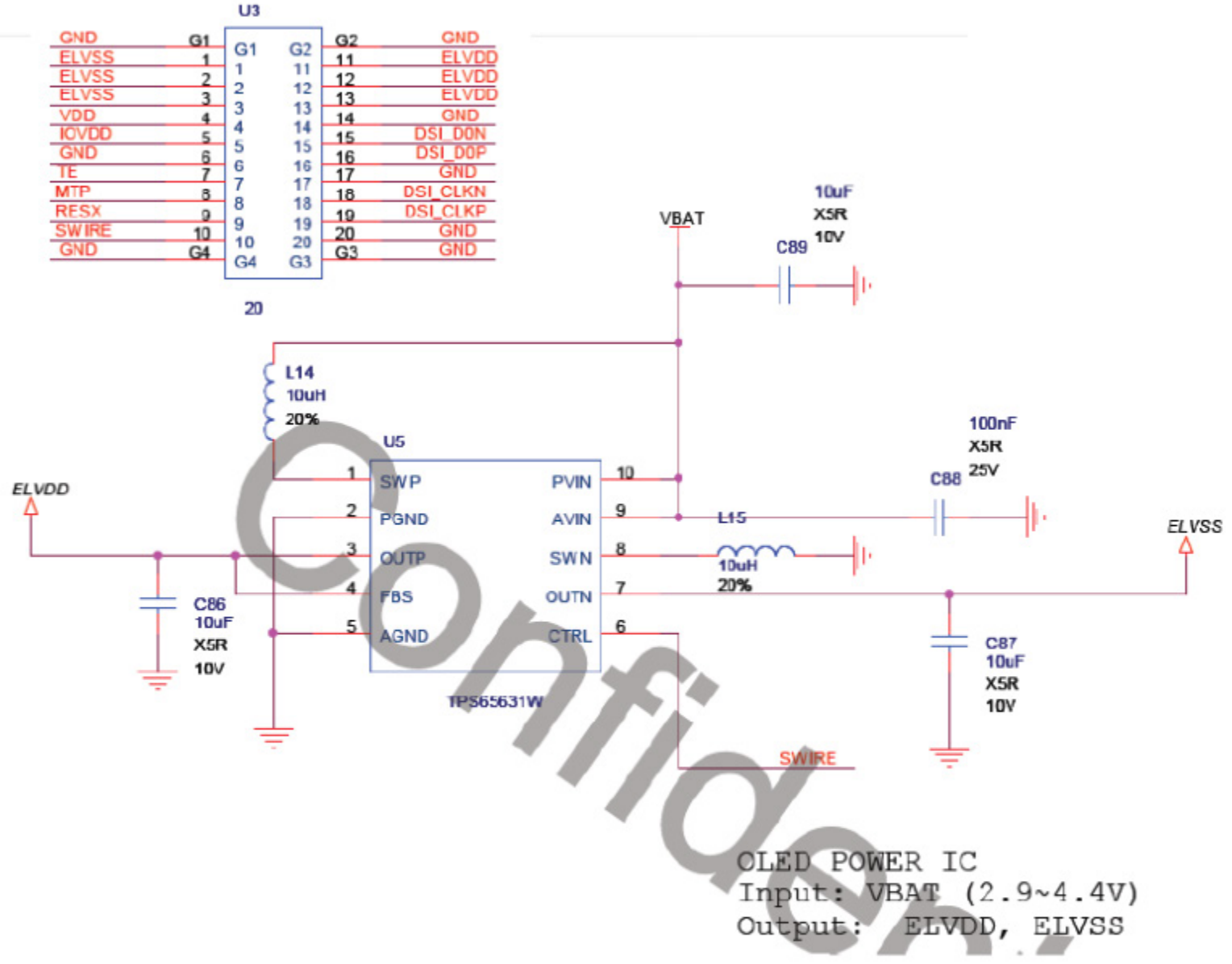
Step	Instruction/Parameters	Delay time	R/W	MIPI Data Type	Address		Data hex.	Description
					MIPI	Others		
1	Display off (DISPOFF)		W	0x05	28	2800	00	
2	Sleep in (SLPIN)		W	0x05	10	1000	00	
3	delay	120ms						
4	Power off							

F. Brightness Control

Recommended Power on Initial Sequence							
Step	Delay time	R/W	MIPI Data Type	Address MIPI	Address Others	Data hex.	Description
1		W	0x39	F0	F000	55	
2		W			F001	AA	
3		W			F002	52	
4		W			F003	08	
5		W			F004	01	
6		W	0x39	CF	CF00	FF	CF00 control Max Brightness
7		W			CF01	D4	
8		W			CF02	95	
9		W			CF03	EF	
10		W			CF04	4F	
11		W			CF05	00	
12		W			CF06	04	

Address MIPI	Address Others	Data hex.	Gray Level
CF	CF00	00	L0
⋮	⋮	⋮	⋮
CF	CF00	80	L128
⋮	⋮	⋮	⋮
CF	CF00	FF	L255

G. Application Circuit



OLED POWER IC
Input: VBAT (2.9~4.4V)
Output: ELVDD, ELVSS

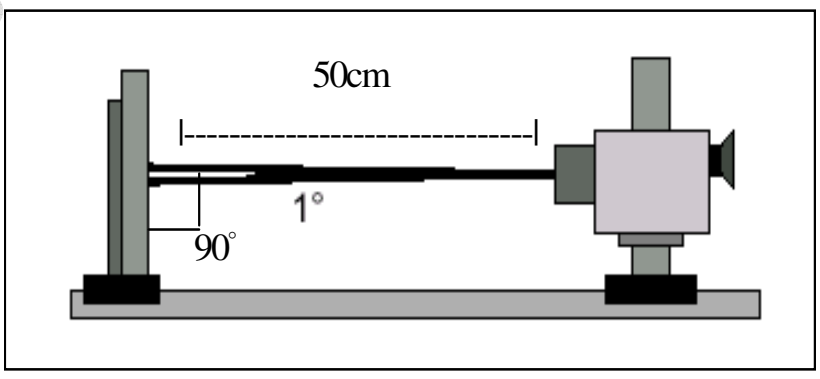
H. Specifications

Item		Abbr.	Min.	Typ.	Max.	Unit	Remark
Optical Characteristic (w/o Cover Lens)		Brightness	270	300	330	nits	Note 3
		Wx	0.275	0.305	0.335		
		Wy	0.290	0.320	0.350		
Contrast ratio		@25deg	10000	--	--		Note 4
Brightness Uniformity		300nits	75%	--	--		Note 5
Viewing angle CR>1600		Top	80°	--	--	deg	Note 6
		Bottom	80°	--	--	deg	
		Left	80°	--	--	deg	
		Right	80°	--	--	deg	
Color	Red	CIE1931 x	0.645	0.675	0.705	Red	Note 7
	Red	CIE1931 y	0.295	0.325	0.355	Red	
	Green	CIE1931 x	0.186	0.236	0.286	Green	
	Green	CIE1931 y	0.661	0.711	0.761	Green	
	Blue	CIE1931 x	0.090	0.130	0.170	Blue	
	Blue	CIE1931 y	0.025	0.065	0.105	Blue	
NTSC		CIE x , y	90	100	--	%	
Life time	T50	25℃	--	50K	--	hr	Note 8
Crosstalk	300nits	Vertical	--	--	5.0	%	Note 9
Flicker			--	--	-30	db	Note 10
Optical Switching Time		+25℃B/W(Tr+Tf)/2	--	--	1	ms	Note 11
Gamma		γ	2.0	2.2	2.4		

Note 1: Ambient temperature =25 ºC±2 ºC

Note 2: To be measured in the dark room.

Note 3: The brightness measurement shall be done at the center of the display with a full white image. The brightness shall meet the following spec, at 100% check.

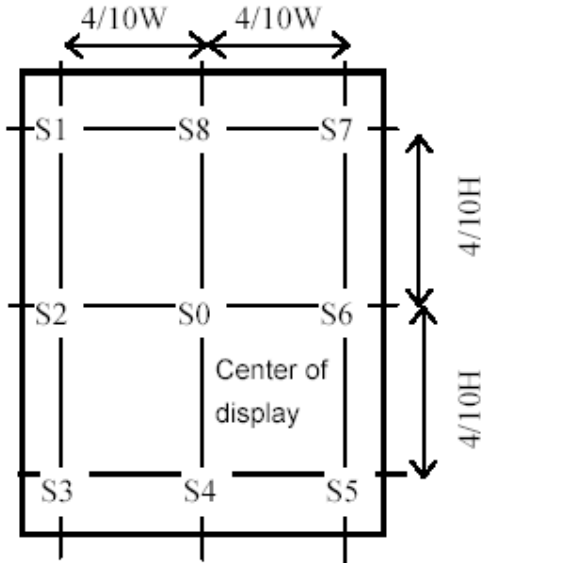


Note 4: Definition of contrast ratio:

Contrast ratio is calculated with the following formula:

$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output when OLED is at “White” state}}{\text{Photo detector output when OLED is at “Black}}$$

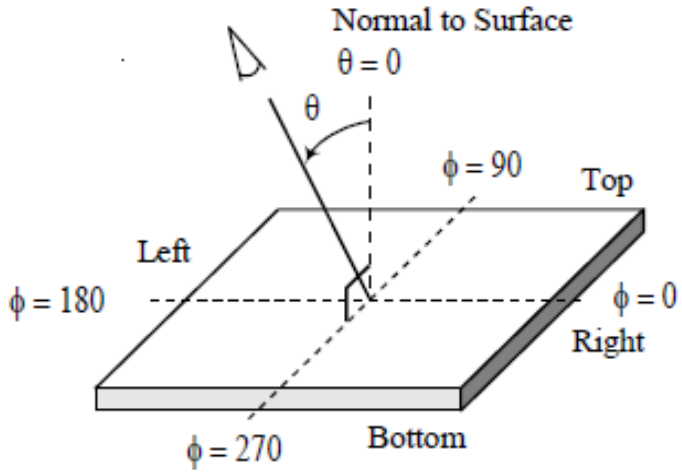
Note 5: Uniformity. Refer to figure as below



$$\text{Luminance uniformity} = \frac{\text{Minimum value from S0 to S8}}{\text{Maximum value from S0 to S8}} \times 100(\%)$$

Note 6: Definition of viewing angle :

The optical performance is specified as the driver IC located at =270°□



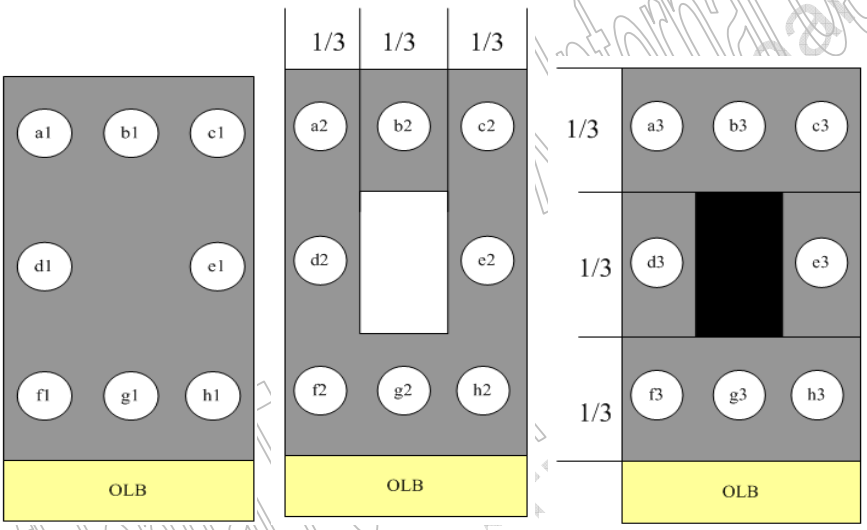
Note 7: The color chromaticity should be based on sample performance because new OLED material should be verified later.

Note 8: Time to 50% Luminance 25°C 30 Loading

Life Time (Typ) : 250 cd/m2 10K hrs , Life Time :170 cd/m2 20K hrs , Life Time :140 cd/m2 30K hrs

Life Time (Typ) : 125 cd/m2 40K hrs . Life Time :100 cd/m2 50K hrs ,

Note 9: Cross-talk



$$CrossTalk\_White = \left\{ \begin{array}{l} 1-\left(\frac{b2}{a2}\div\frac{b1}{a1}\right)\times 100\%, 1-\left(\frac{b2}{c2}\div\frac{b1}{c1}\right)\times 100\%, \\ 1-\left(\frac{d2}{a2}\div\frac{d1}{a1}\right)\times 100\%, 1-\left(\frac{d2}{f2}\div\frac{d1}{f1}\right)\times 100\%, \\ 1-\left(\frac{e2}{c2}\div\frac{e1}{c1}\right)\times 100\%, 1-\left(\frac{e2}{h2}\div\frac{e1}{h1}\right)\times 100\%, \\ 1-\left(\frac{g2}{f2}\div\frac{g1}{f1}\right)\times 100\%, 1-\left(\frac{g2}{h2}\div\frac{g1}{h1}\right)\times 100\% \end{array} \right\}$$

$$CrossTalk\_Black = \left\{ \begin{array}{l} 1-\left(\frac{b3}{a3}\div\frac{b1}{a1}\right)\times 100\%, 1-\left(\frac{b3}{c3}\div\frac{b1}{c1}\right)\times 100\%, \\ 1-\left(\frac{d3}{a3}\div\frac{d1}{a1}\right)\times 100\%, 1-\left(\frac{d3}{f3}\div\frac{d1}{f1}\right)\times 100\%, \\ 1-\left(\frac{e3}{c3}\div\frac{e1}{c1}\right)\times 100\%, 1-\left(\frac{e3}{h3}\div\frac{e1}{h1}\right)\times 100\%, \\ 1-\left(\frac{g3}{f3}\div\frac{g1}{f1}\right)\times 100\%, 1-\left(\frac{g3}{h3}\div\frac{g1}{h1}\right)\times 100\% \end{array} \right\}$$

$$CrossTalk = MAX\{CrossTalk\_White, CrossTalk\_Black\}$$

Note 10: Flicker

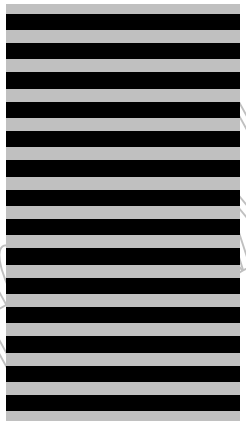
The flicker level is defined using Fast Fourier Transformation (FTT) as follows:

$$Flic\ker = 20\log_{10}\left(2\frac{f_{FFTC}(n)}{f_{FFTC}(0)}\right) + FS(Hz) \quad \text{(dB)}$$

where fFFTC(n) is the nth FFT coefficient, and fFFTC(0) is the 0th FFT coefficient which is DC component. FS(Hz) is the flicker sensitivity as a function of frequency.

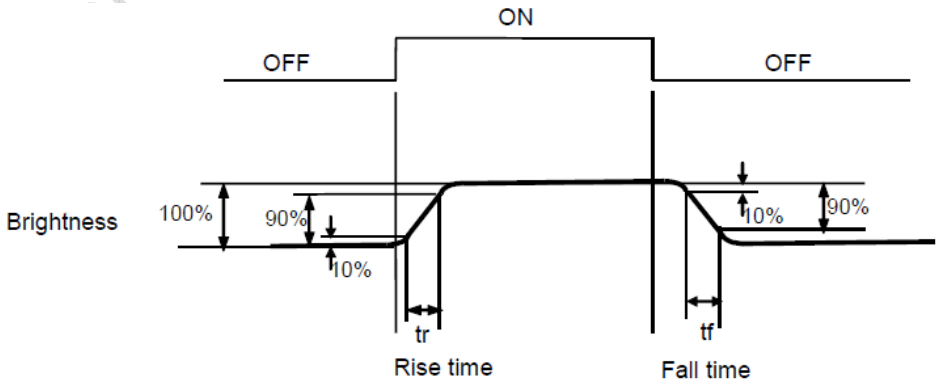
The flicker level shall be measured with the test pattern in below.

The gray leves of test pattern is 128.



Note 11: Optical Switching Time:

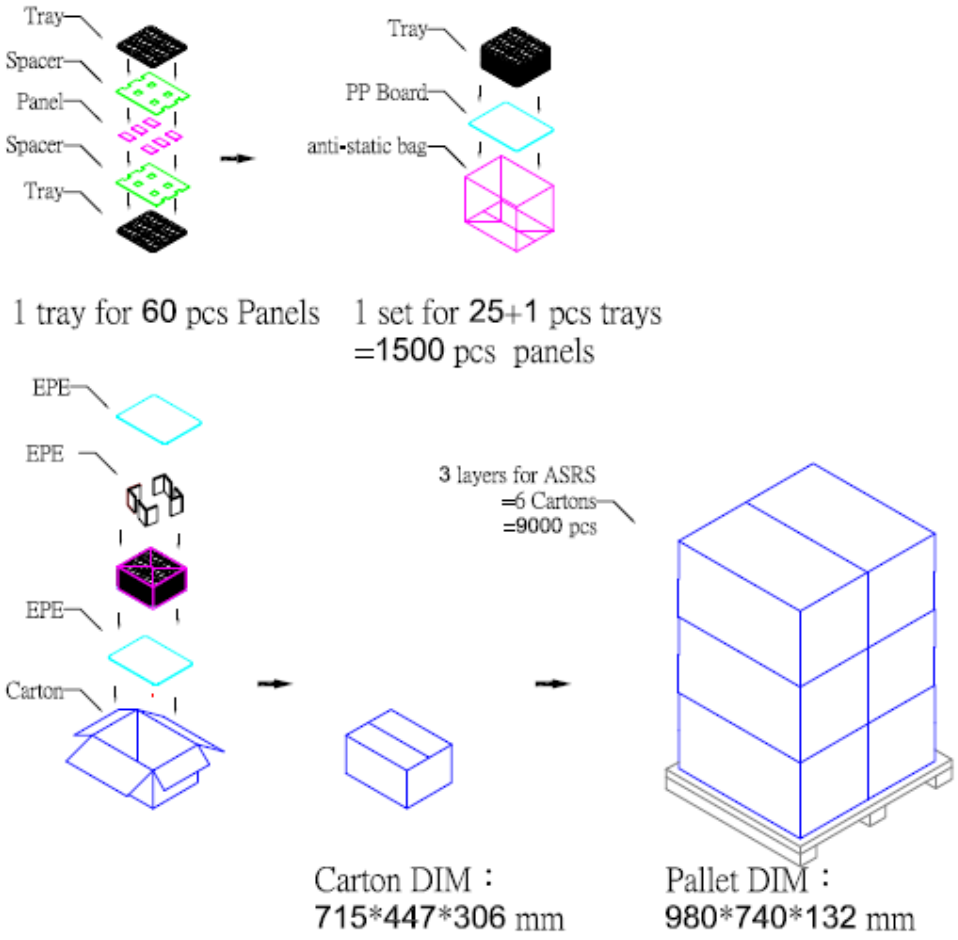
The optical switching time measurements should be performed at driven BLACK and driven WHITE at typ. brightness setting by the driving techniques specified. The luminance should be measured with the emitting display and the detector at θ=0°and ψ=90°. The rise time tr is the time between a 10% optically response of the display and a 90% optically response of the display. The fall time tf is the time between a 10% optically response of the display and a 90% optically response to the display. The response time is defined as the average of the rise time and the fall time.



I. Reliability Test Items

Category	No.	Test items	Conditions	Remark
Reliability (Environment)	1	High Temp. Operation	Ta= 80ºC 168hrs	Ta: Ambient temperature.
	2	High Temp. Storage	Ta= 80 ºC 168h	Non-operation
	3	Low Temp. Operation	Ta= -40 ºC 168hrs	
	4	Low Temp. Storage	Ta= -40 ºC 168hr	Non-operation
	5	High Temp./Humi. Operation	Ta= 40 ºC. 95% RH 168hrs	
	6	Thermal Shock	-40 ºC ~80 ºC, Dwell for 30 min. 30 cycl	Non-operation
	7	Vibration test	Random 1.5G,10~200Hz,30min/axis	Non-operation

J. Packing



K. Outline Demension (Tentative)