

OEL Display Application Note

Product Development Section

January 22, 2010



What is OEL Display?

- OEL Display
 - Organic ElectroLuminescence Display
- OELD
 - Organic ElectroLuminescence Display
- **OLED**
 - Organic Light Emitting Diode
- OED
 - Organic Electroemissive Device



Outline

- Module Introduction
 - Driver IC Package
 - Assembly
 - Driver & Controller Selection
 - Peripheral Circuit
- Tips
 - Power up/down Sequence
 - Start on
 - Flicker Issue
 - Shadow Line Issue
 - Screen Saver
 - Power Saving



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TCP (*Tape Carrier Package*)

- TAB (*Tape Automatic Bonding*)
- Longer Development Duration
- Compact Mechanical Size
 - Specified Bending Area Design
- Capable Assembly Method
 - Soldering
 - Hot Bar
 - Connector
 - Either Only & Not Applicable on the Same Module
- *Most Popular Design in the Early Stage of OLED Application*



COF (Chip on Film)

- TAB / Surface Mount Technology
- Passive Components Integrated Application
- Compact Mechanical Size
 - Flexible Bending Area Design
- Capable Assembly Method
 - Hot Bar
 - Connector
 - Either Only & Not Applicable on the Same Module
- *Most Popular Design in Full Color Application*



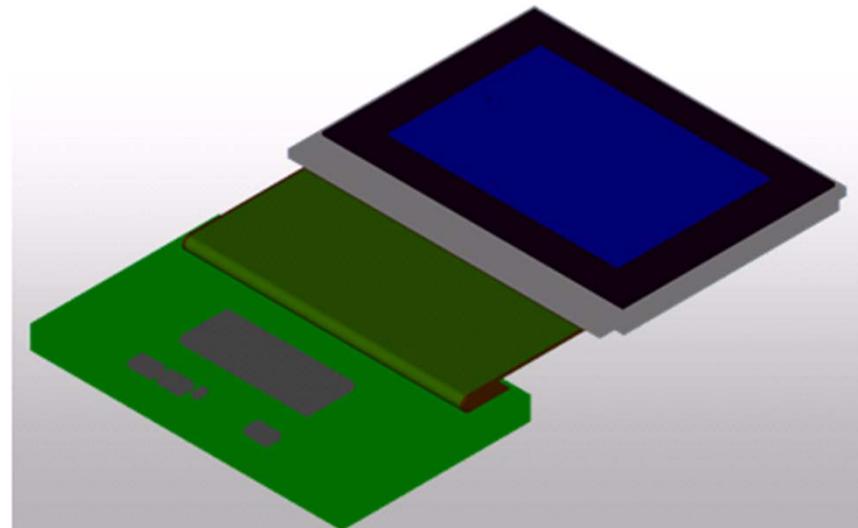
COG (Chip on Glass)

- More Flexible Delivery Schedule
- Smaller Mechanical Size
- Capable Assembly Method
 - Soldering
 - Hot Bar
 - Connector
 - Either Only & Not Applicable on the Same Module
- ***Most Popular Design of OLED Application***



COB (Chip on Board)

- Shorter Development Duration
- Larger Mechanical Size
- Capable Assembly Method
 - Soldering
 - Connector
 - Either Only & Not Applicable on the Same Module
- ***Limited OLED Driver IC Selection***

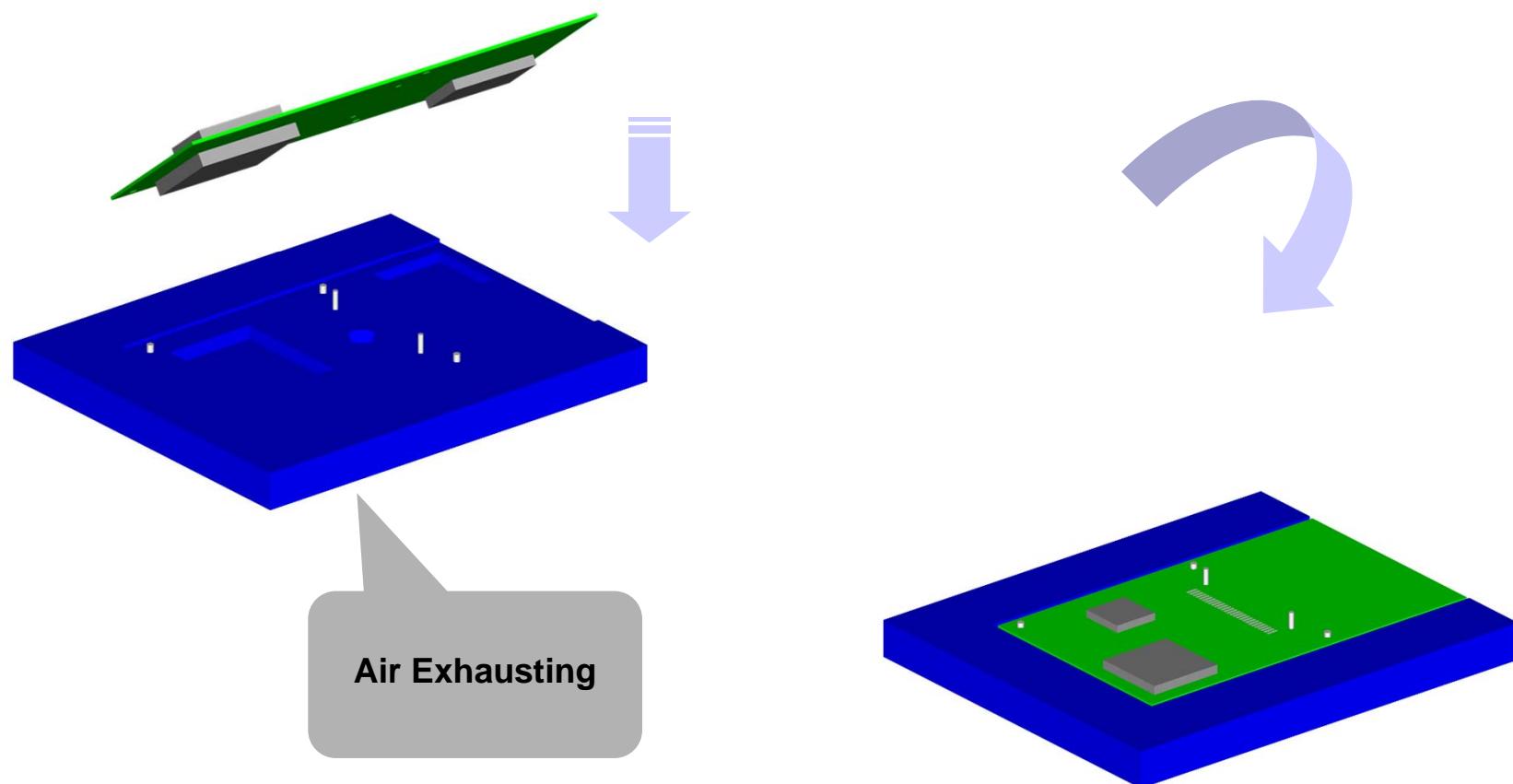


Outline

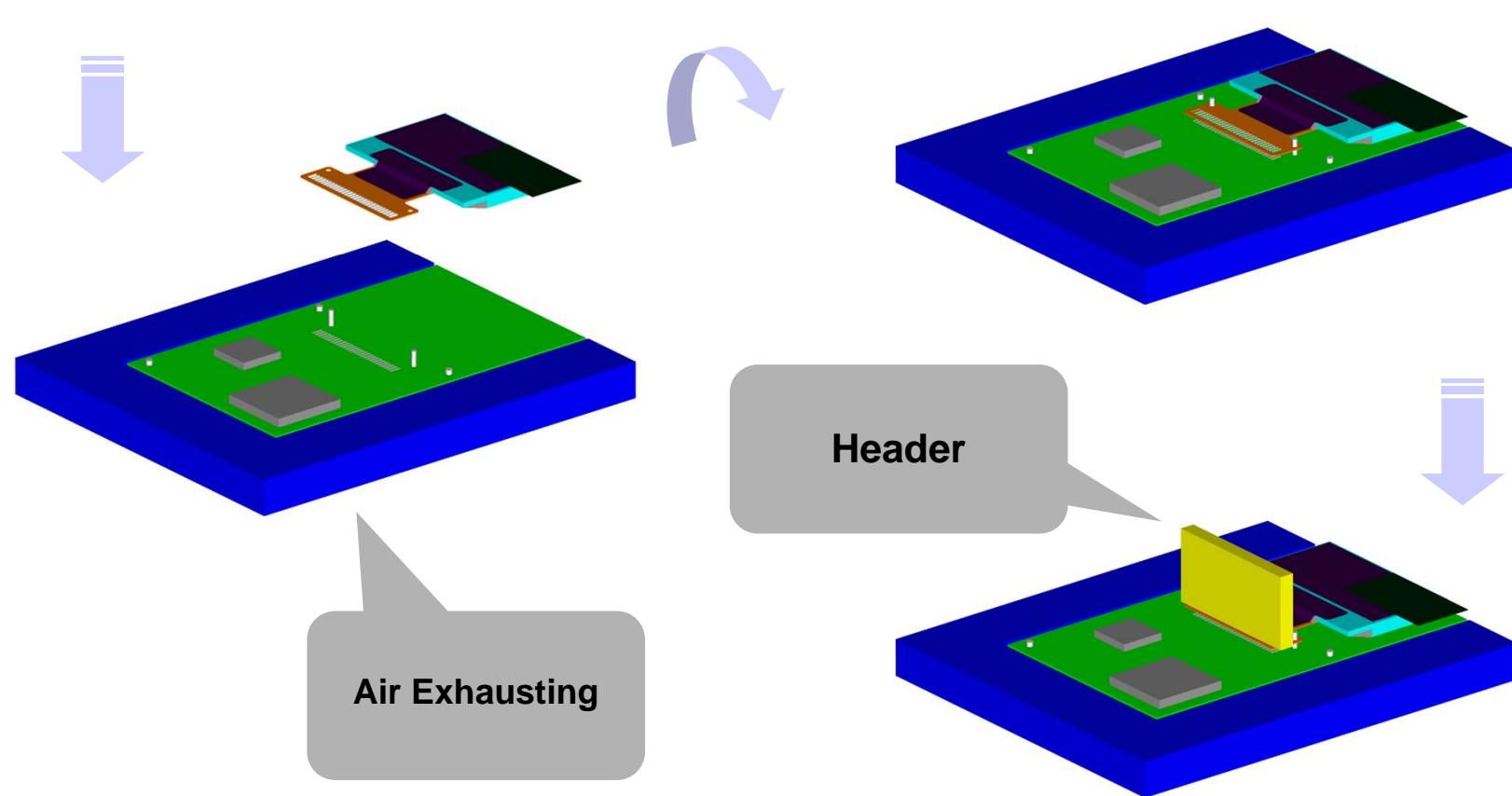
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Hot Bar Assembly (1)



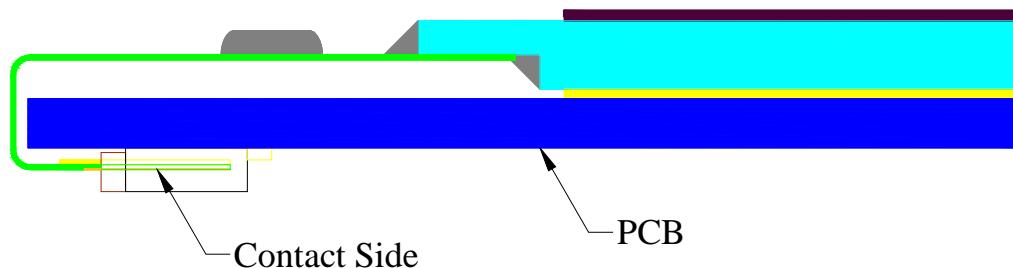
Hot Bar Assembly (2)



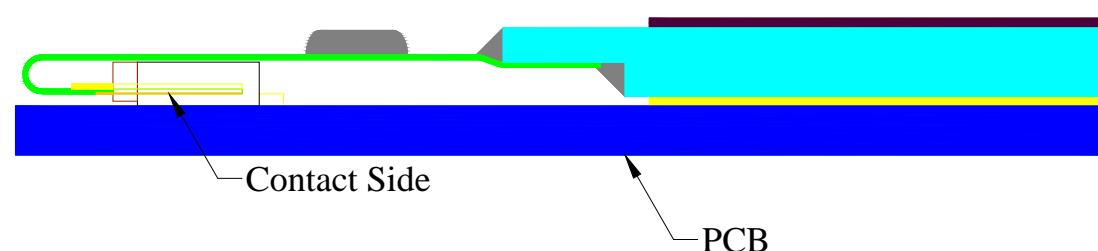
Connector Selection

(Depending on the Mechanical Design)

- Top Contact Type



- Bottom Contact Type



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Driver & Controller Selection

- Required Function
 - Compatible Instruction with LCD Driver
 - It will shorten the development schedule.
 - Power Saving Mode
 - Flexible Brightness & Contrast Control
 - Partial Display
 - Integration of Screen Saver
- Integration
 - Combo Chip
(Common & Segment Driver, Controller, SRAM...)
 - Embedded DC/DC Converter



Interface (Parallel)

■ Parallel

- 6-/8-/9-/12-/16-/18-bit + Control Lines

	Data Lines	Control Lines
Pin Description	Data Bus (6, * 8, 9, 12, * 16, 18 bits)	Chip Select Data/Command Select Read/Write Select Read/Write Enable



Interface (Serial)

■ Serial

- I²C, 3-wire Serial, 3-/4-wire SPI, 3-wire Nokia

	* I ² C	3-wire Serial	3-wire SPI	* 4-wire SPI	3-wire Nokia
Data/Command Control	No	No	No	Yes	No
Chip Enable	NO	Yes	Yes	Yes	Yes
Serial Clock	Yes	Yes	Yes	Yes	Yes
Serial Data Packets	8 bits	9 bits	8 bits	8 bits	9 bits
Serial Output Data Packets	8 bits	8 bits	8 bits	8 bits	7 bits



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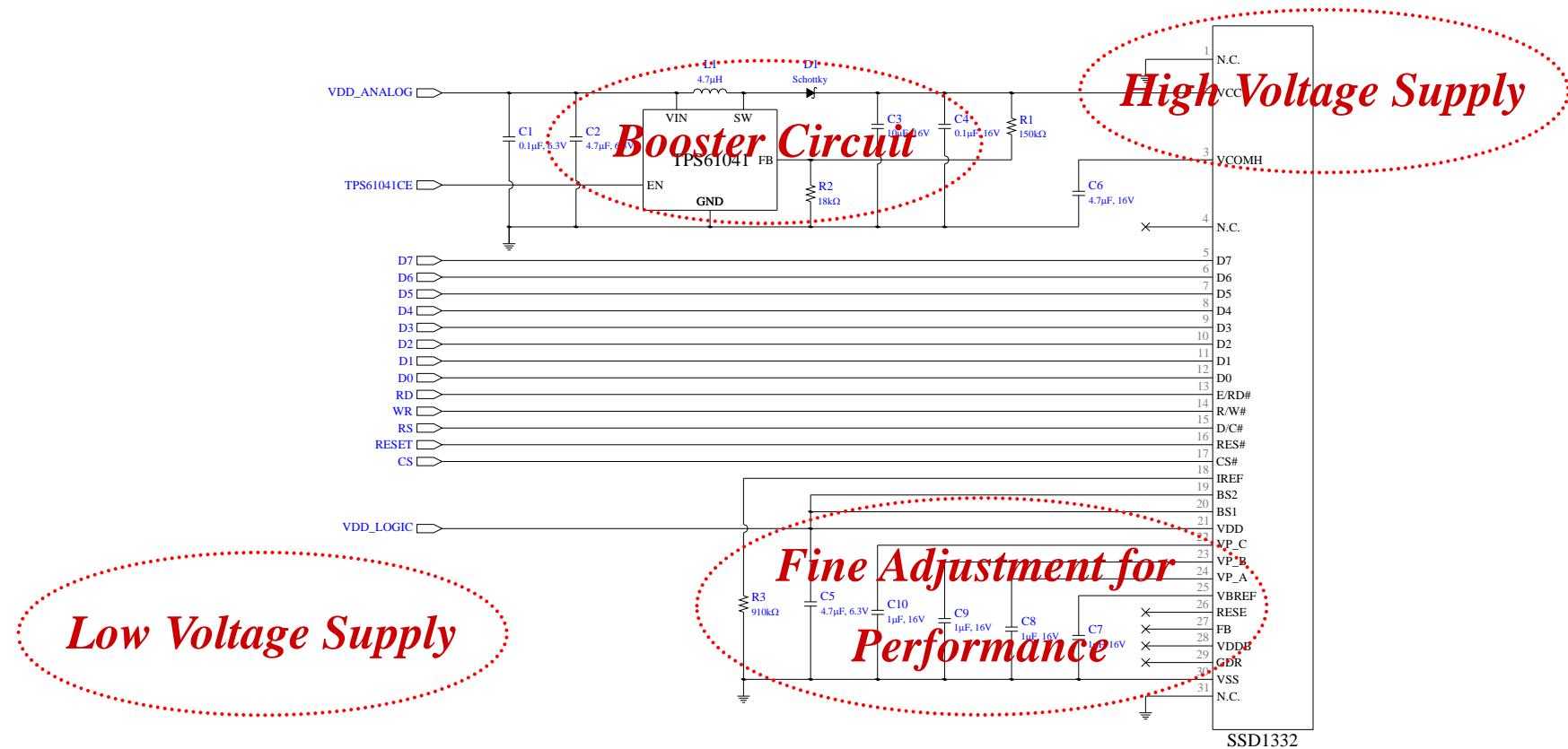


Peripheral Circuit

- Power Supply (*2 More Sources Required*)
 - Low Voltage for Driver IC Operation
 - *2.4~3.5V Normally...*
 - Separated $V_{I/O}/V_{Core}$ Source, if necessary...
 - Separated Logic/Analog Source, if necessary...
 - High Voltage for Brightness Control
 - Depended on the Requested Luminance...
- Peripheral Circuit
 - Driver IC Reference Voltage & Current Setting Circuit
 - Booster Circuit
- Components (*12~16 pieces Required Basically*)



Reference Typical Circuit



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Purpose

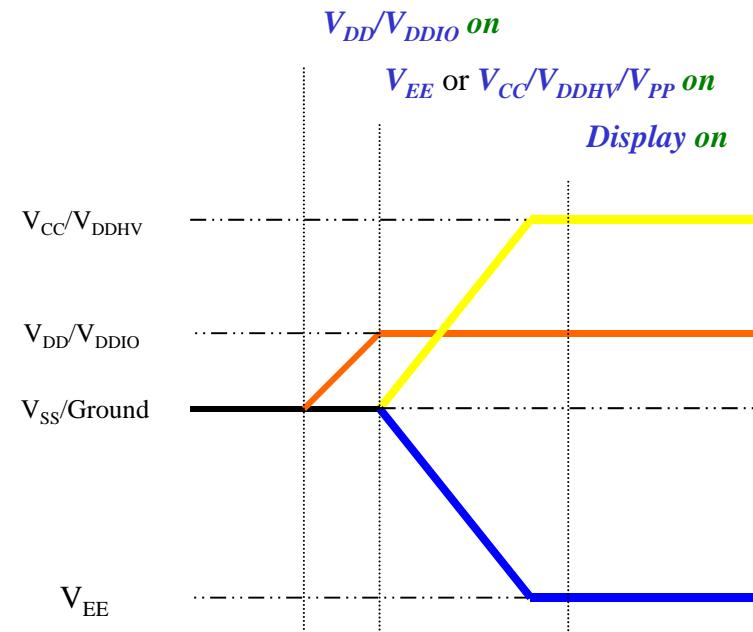
- Prevent the Unexpected Phenomenon Shown on the Screen When the Panel Turning *on/off*
- Protect OLED Panel to Prevent the High Luminance Line Appearing



Power up Sequence

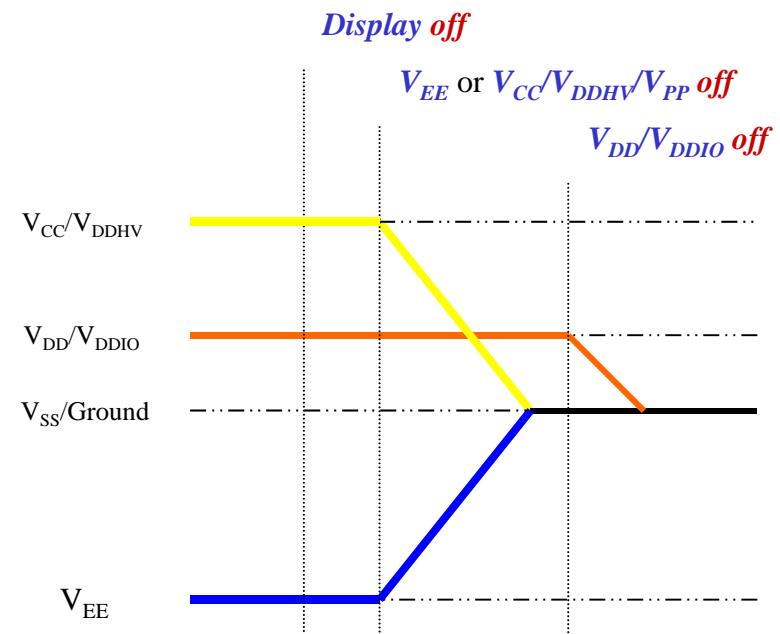
- Power up V_{DD}/V_{DDIO}
- Send **Display off** command
- Initialization
- Clear Screen
- Power up V_{EE} or $V_{CC}/V_{DDHV}/V_{PP}$
- Delay 100ms (when V_{EE} or $V_{CC}/V_{DDHV}/V_{PP}$ is stable)
- Send **Display on** command

- High/Negative Voltage
 - V_{EE}
 - Used on Specified Driver ICs
 - $V_{CC}/V_{DDHV}/V_{PP}$
 - Used for Most Driver ICs Application



Power down Sequence

- Send *Display off* command
- Power down V_{EE} or $V_{CC}/V_{DDHV}/V_{PP}$
- Delay 100ms (when V_{EE} or $V_{CC}/V_{DDHV}/V_{PP}$ is reach 0 & panel is completely discharges)
- Power down V_{DD}/V_{DDIO}
- High/Negative Voltage
 - V_{EE}
 - Used on Specified Drive ICs
 - $V_{CC}/V_{DDHV}/V_{PP}$
 - Used for Most Driver ICs Application



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How to Start

- Check the Pin Connection
- Write Two Instructions to Check the Communication
 - Entire Display on (*All Pixels on*)
 - Display on (*Screen on*)



Abnormal (Monochrome/Full Color)



Correct



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Phenomenon

- A High Luminance Line Rapidly Shown on the OLED Display Module Randomly
 - Caused by Unsuitable Coding
 - Caused by Low Refresh Frequency



Recommendation

- Separate Initial Code & Refresh Code by Different Subroutine
- Make Sure No “Reset” Command Recalled in Main Program to Prevent the Registers Switched Rapidly then Cause the *Flicker* Appeared
- Set Higher Refresh Frequency on Acceptable Power Consumption



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Purpose & Recommendation

- Prevent the Shadow Line (*Cross Talk/Banking*) Appear
- Prevent to use *White* as Background Color



Poor

Good

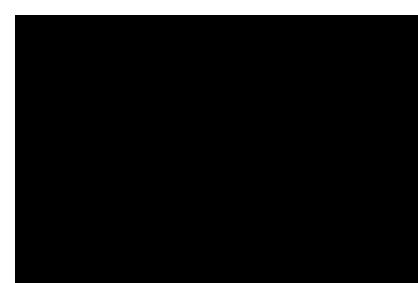


Recommended Pattern Design

- Design the Text with Gray Scales (*Gray Scale/Full Color*)
- Design the Icons by Gray Scales (*Gray Scale/Full Color*)
- Drop Down the Brightness to Mitigate the Phenomenon



Poor



Good



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Purpose

- Prevent the Image Sticking (*Burn-in/Ghost*)
- Power Saving



What is the Image Sticking...???



*Show Still Image
for Long Duration*



Display New Image



Phenomenon



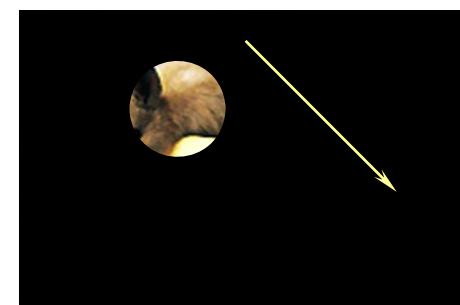
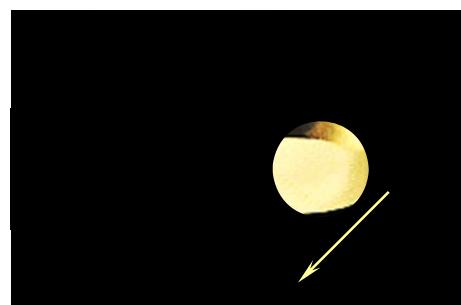
Vertical/Horizontal Scrolling

Display area scrolls gradually.



Block Move

Display box moves like billiard play.



Fade in/out

Display brightness changes gradually.



Fade Box

Display area changes in box shape gradually.



Fade Mask

Display area narrows down vertical/horizontal gradually.



Fade Scroll

Display area shifts up/down/left/right gradually.



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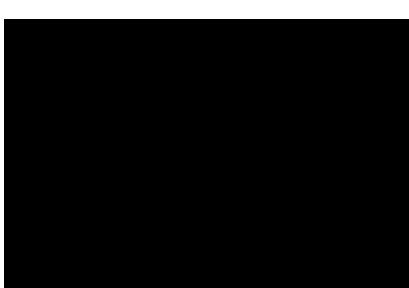


Recommended Pattern Design (1)

- The power consumption of OLED display depends on the lighted up pixels. Fewer lighted up pixels will have lower power consumption.



Poor

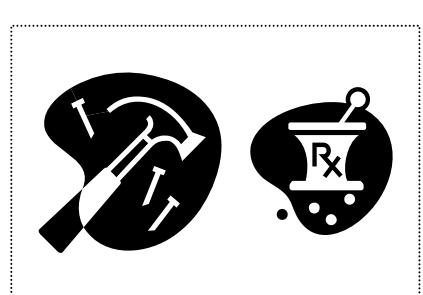


Good

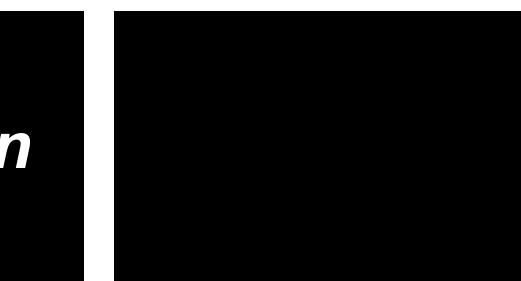


Recommended Pattern Design (2)

- For *Monochrome/Area Color* Model
 - Prevent to Show Inverse Images



Poor

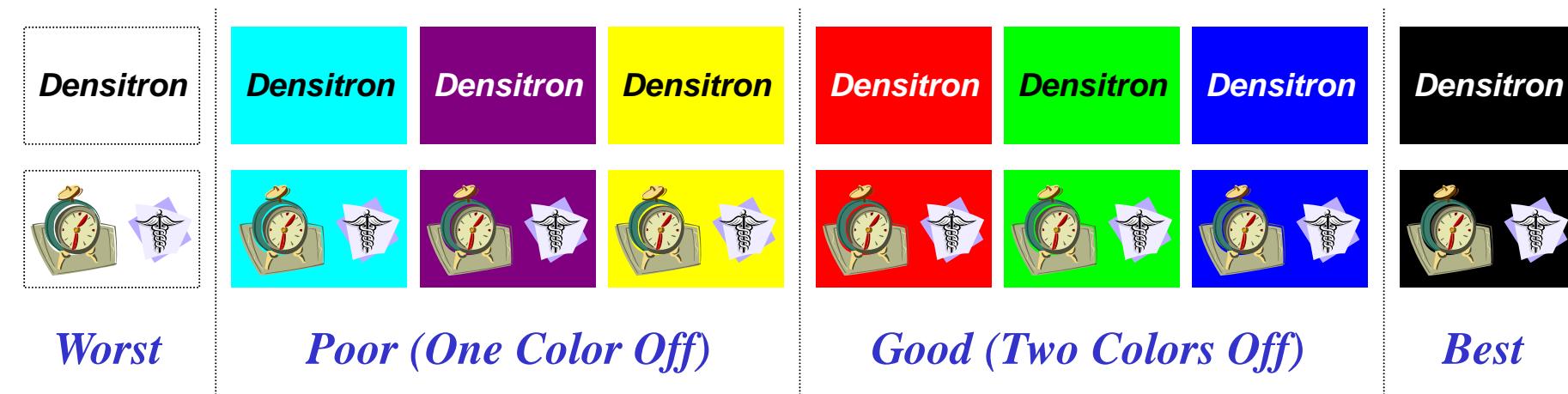


Good



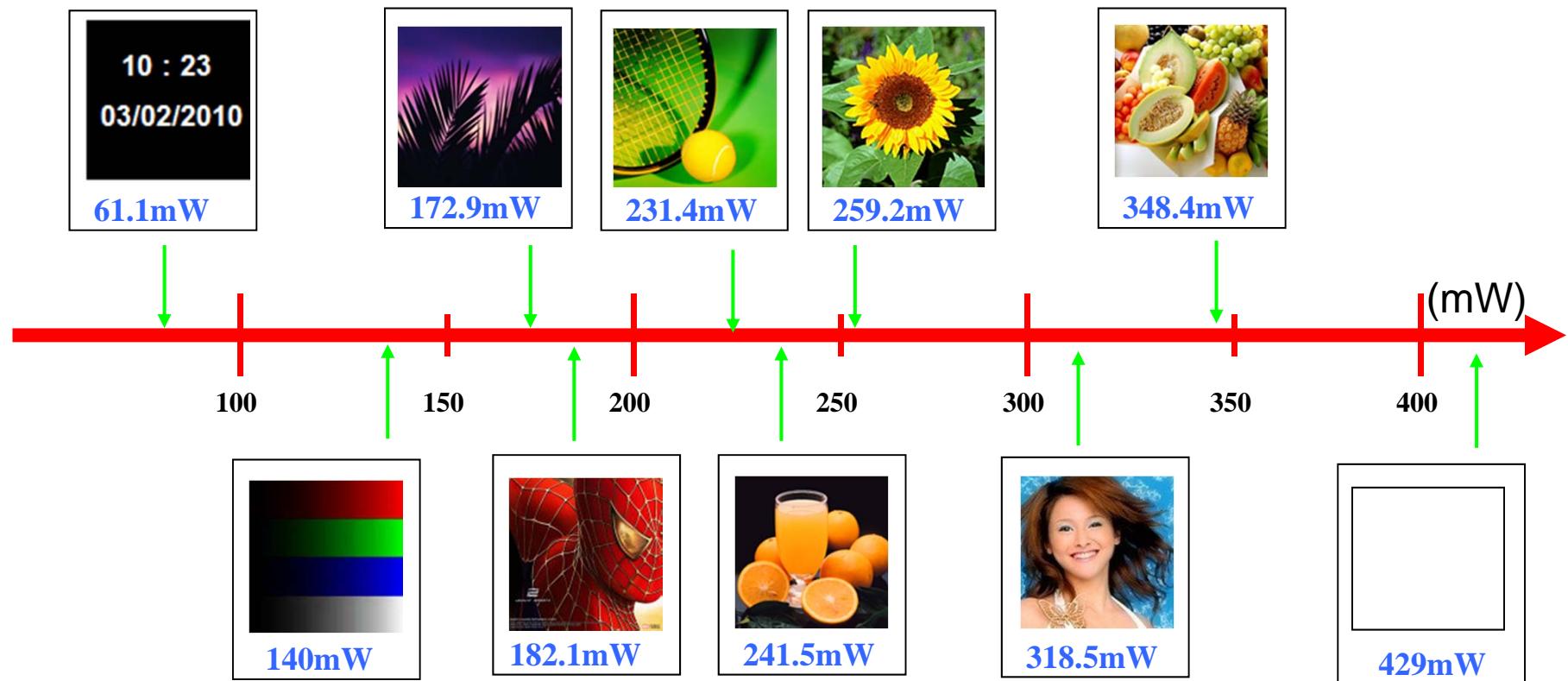
Recommended Pattern Design (3)

- For *Full Color* Model
 - Use the *Black/Red/Green/Blue* or the *Cyan/Purple/Yellow* Instead of the *White* as Background



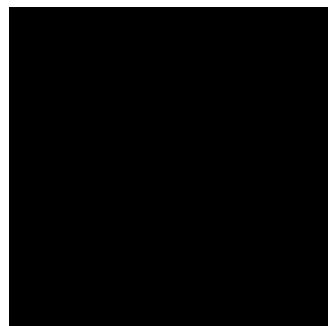
Power Consumption Compassion

1.5" 128RGB×128 (Full White 150nits@13V)



Standby Mode

- *Screen off or Lower Brightness Setting*
 - Lower Power Consumption
 - Longer Life Time
- *Higher Brightness Setting* only if Necessary
 - Under Sunlight



Or

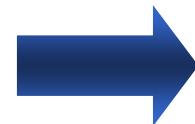


Or



Complete Power Saving Procedure (1)

- Drop Down the Brightness after System Idle for few Seconds



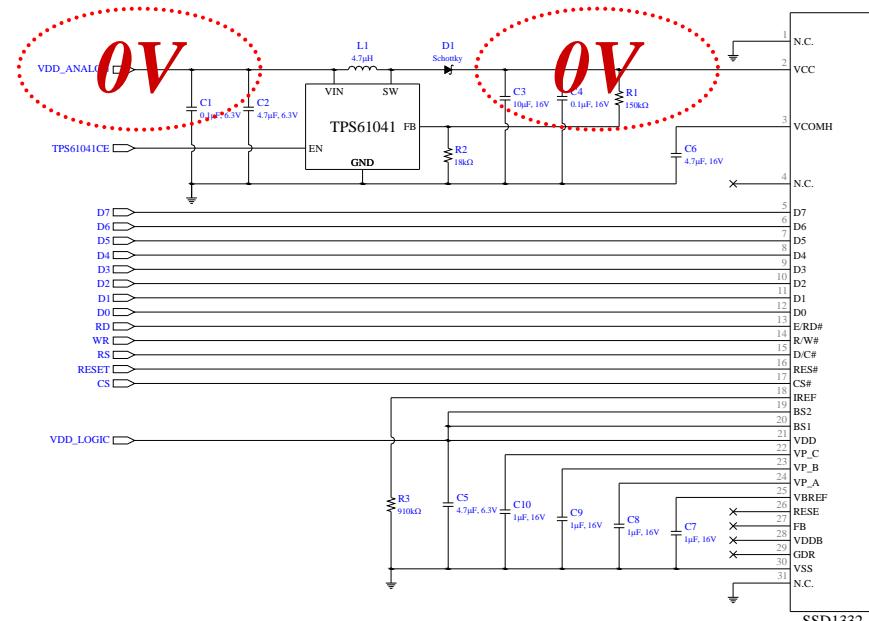
Complete Power Saving Procedure (2)

- Run Screen Saver Only for Necessary Information & with Lower Luminance after System Idle for few Seconds



Complete Power Saving Procedure (3)

- Turn off the Screen after Operation for few Seconds
 - *To Isolate the VDD_ANALOG & Make Sure the High Voltage Source as 0V for Standby/Shutdown Mode*



OLED vs Other Technology
Advantages



Comparison of OLED to Other Display

Condition	PMOLED (MCF)	a-TFT	CSTN
Resolution	128RGBx128	128RGBx128	128RGBx128
Size (inch)	1.5	1.5	1.5
Thickness (mm)	1.43 mm	3.5 mm	3.5 mm
Brightness	140cd/m ²	140cd/m ²	140cd/m ²
View Angle	> 160	>75 (Cr>10,BL ON)	< 90
Contrast	>1000	>100	15 (1.5 ~ 35)
NTSC (%)	82	38	22
Response Time (ms)	10 μ s	22.97 ms ($T_r + T_f$)	200 ms
Power consumption	416 mW (Full White)	150mW	175mW
Uniformity	>90	>80	>80
Life Time	▲	50000H	50000H

- OLED power consumption depends on displayed contents
- LCD consumes almost constant power
- Typical Average Power of OLED is only 30% of Full White State



More Display Comparison

Best: ○ , Good: ● , Middle: ▲, Bad: x

	CRT	PDP	LCD	OLED
Thickness & Weight	x	▲	○	○
Response Time	●	●	x	○
Viewing Angle	○	○	x	○
Cost	○	x	▲	●
Color	○	●	▲	○
Power Consumption	x	x	●	○

OLED

=

CRT: Cost, Color, Viewing angle, Response time

+

LCD: Thickness & Weight, Power Consumption



Cell Phone Panel Display Comparison

Technology	Strengths	Weaknesses	Application
STN-LCD	Less Power Consumption/ Lower Price	Slower Motion Picture Respond Time	Middle to Lower Scale Cell Phone Usage
TFT	Matured Technology	Higher Power Consumption, Higher Cost Compares to STN	Higher to Middle Level Cell Phone Application
LTPS	Fine Resolution	Low Yield Rate, High Production Cost	High Level Cell Phone Usage
OLED	Thin /Light in Weight /Less Power needed /Faster Response Time	Good Yield Rate, Lower Manufacturing Cost, Brightness	Higher to Middle Level Cell Phone Application



Response Time



Moving Picture Performance
(10 us by PMOLED)

Moving Picture Performance
(50 ms by a-Si TFT LCDM)



Brightness & Contrast



OLED

STN

OLED adds values to your design. It is visible and eye catching. Helps to sell!



TN vs OLED



Good Visual Performance



Comparison Table * example ~2.7"

Feature	Unit	OLED	STN LCD	VFD
Resolution	-	128 * 64	128 * 64	128 * 64
Active Area	inch	2.7	2.4	2.5
	mm	61.4 * 30.7	55.0 * 27.5	57.5 * 28.7
Panel Size	mm	73 * 42	75 * 53	103 * 53
Pixel Pitch	mm	0.48 * 0.48	0.45 * 0.45	0.43 * 0.43
Pixel Size	mm	0.45 * 0.45	0.33 * 0.33	0.39 * 0.39
Module Thickness	mm	2.0 	8.9	22.2
Weight	g	12.4 	35	85
Brightness	nits	100	100	500 
Power Consumption	mW	795 (all pixel turn on) 	500 (LED-B/L)	2500
	mW	350 (1/3 pixel turn on) 	550 (EL-B/L)	-
Max. Generate Volt. on circuit	V	15 (DC, OLED) 	10 (DC, STN, LED-B/L)	64 (DC, Filament)
	V	-	110 (AC 60Hz, EL-B/L)	-



Thanks for Your Attention!!!

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