



## CUSTOMER APPROVAL SHEET

<b>Company Name</b>	
<b>MODEL</b>	A021AE01 V0
<b>CUSTOMER APPROVED</b>	

- APPROVAL FOR SPECIFICATIONS ONLY (Spec. Ver. 0.7)
- APPROVAL FOR SPECIFICATIONS AND ES SAMPLE (Spec. Ver. 0.7)
- APPROVAL FOR SPECIFICATIONS AND CS SAMPLE (Spec. Ver. 0.7)
- CUSTOMER REMARK :

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# Product Specification

## 2.1" EPD MODULE

**Model Name :** A021AE01 V0

<b>Planned Lifetime:</b>	From 2009/Jul. To 2011/Jul.
<b>Phase-out Control:</b>	From 2011/Mar. To 2011/Jul.
<b>EOL Schedule:</b>	2011/Jul.

- < ◆ > Preliminary Specification
- < > Final Specification

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

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Record of Revision

Version	Revise Date	Page	Content
0.0	2009/06/29	All	First Draft.
0.1	2009/07/17	25	DC-DC circuit is tentative version.
0.2	2009/09/04	3	Add module weight spec
		4 & 5	Modify module drawing. (VCOM Pad from 2 x 2mm to 2.2 x 2.5mm)
		20	Modify LUT.
0.3	2009/09/09	20 & 21	Add one LUT & CR spec for low temperature.
0.4	2009/09/28	8	Modify power consumption & max operation temperature.
		17 & 18	Modify power on/off sequence
		19	Update LUT & Contrast
		24	Update application circuit.
0.5	2009/09/30	2	Update Spec contents
		7	Modify absolute maximum operation temperature
		19	Update contrast
0.6	2009/10/07	6	Modify Recommended connector.(FH12-10S-0.5SH)
		8	Modify min supply voltage from 2.0V to 3.0V.
0.7	2009/10/14	24	Modify the direction of diode. (D1)

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## A. General Information

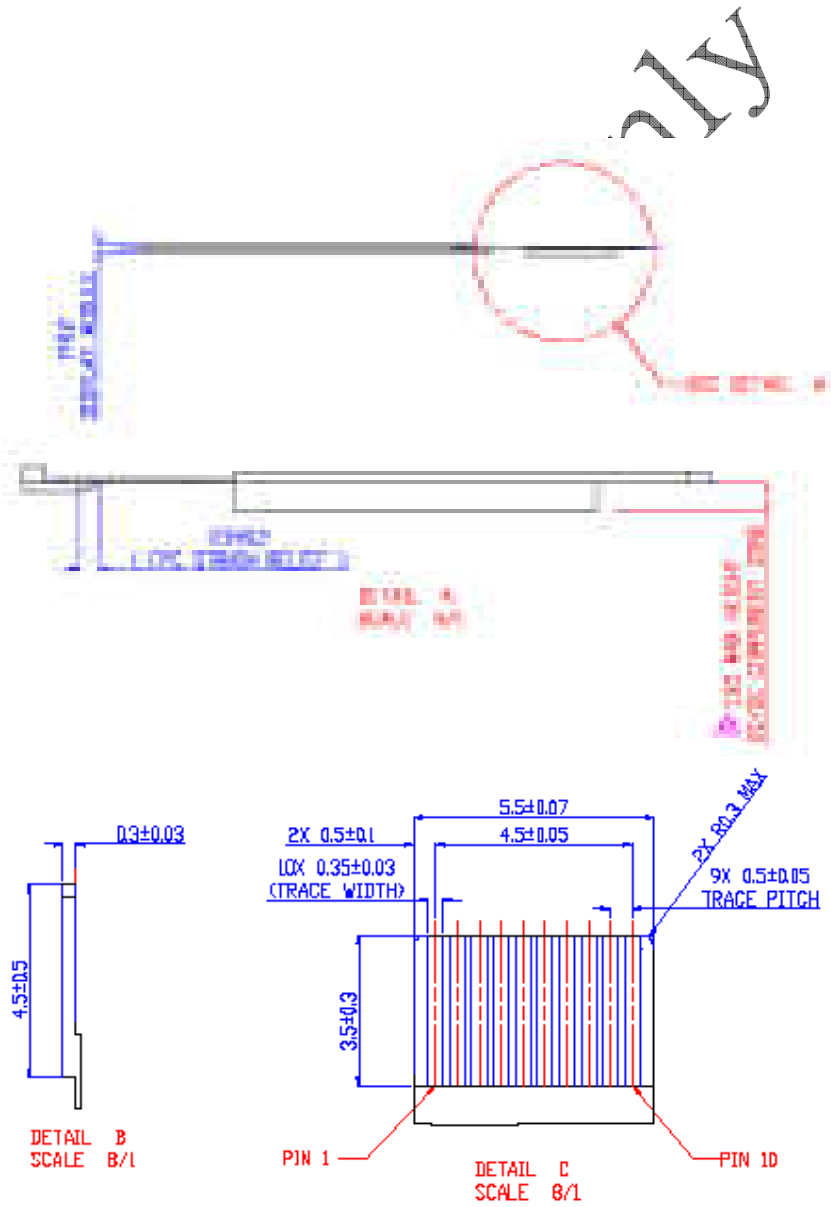
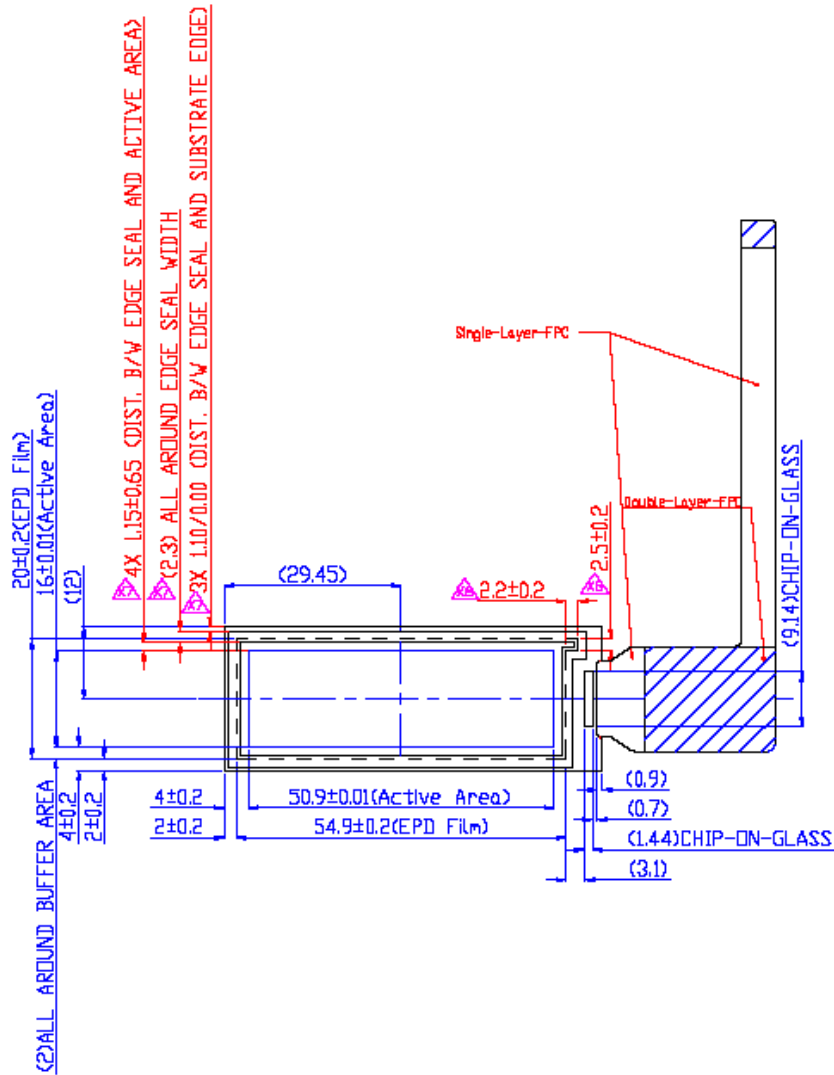
This product is for Electric Shelf Label application.

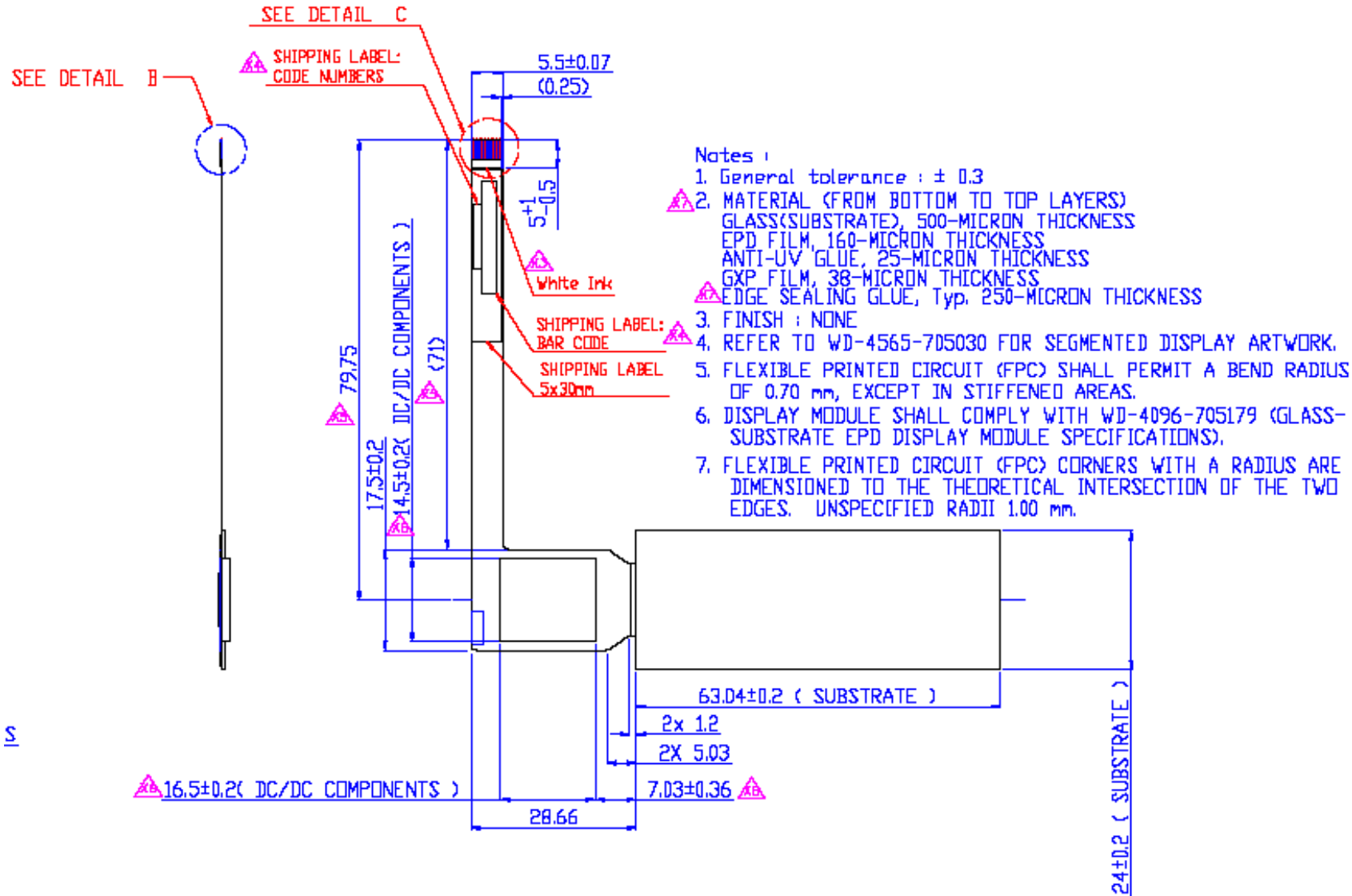
NO.	Item	Unit	Specification	Remark
1	Screen Size	inch	2.1 (Diagonal)	
2	Display Resolution	dot	Segment Type	
3	Overall Dimension	mm	63.04(H) × 24(V) × 1(T)	Note
4	Active Area	mm	50.9(H)×16(V)	
5	Depth	--	1bit	
6	Weight	g	2.9	

Note 1: Not include FPC. Refer next page to get further information.

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## B. Outline Dimension





## C. Electrical Specifications

### 1. Pin Assignment

Recommended connector : FH12-10S-0.5SH.

Pin No.	Symbol	I/O	Description	Remark
1	VDD	I	Power input	
2	RST_N	I	Reset pin.	
3	GND	I	Ground.	
4	SDA	I/O	Serial interface.	
5	GND	I	Ground.	
6	SCL	I	Serial interface.	
7	GND	I	Ground.	
8	DUMMY	NC	Not connect	
9	CSB	I	Serial interface.	
10	BUSY_N	O	Busy signal output.	

I: Input pin ; I/O input/output ; O:output pin

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## 2. Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit	Remark
Power voltage	VDD	GND=0	-0.3	+5.0	V	
Storage temperature	Tstg	-	-25	70	°C	Panel Surface temperature
Operating	Topa	-	0	70	°C	Panel Surface temperature

Note: Maximum ratings are those values beyond which damages to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics chapter.

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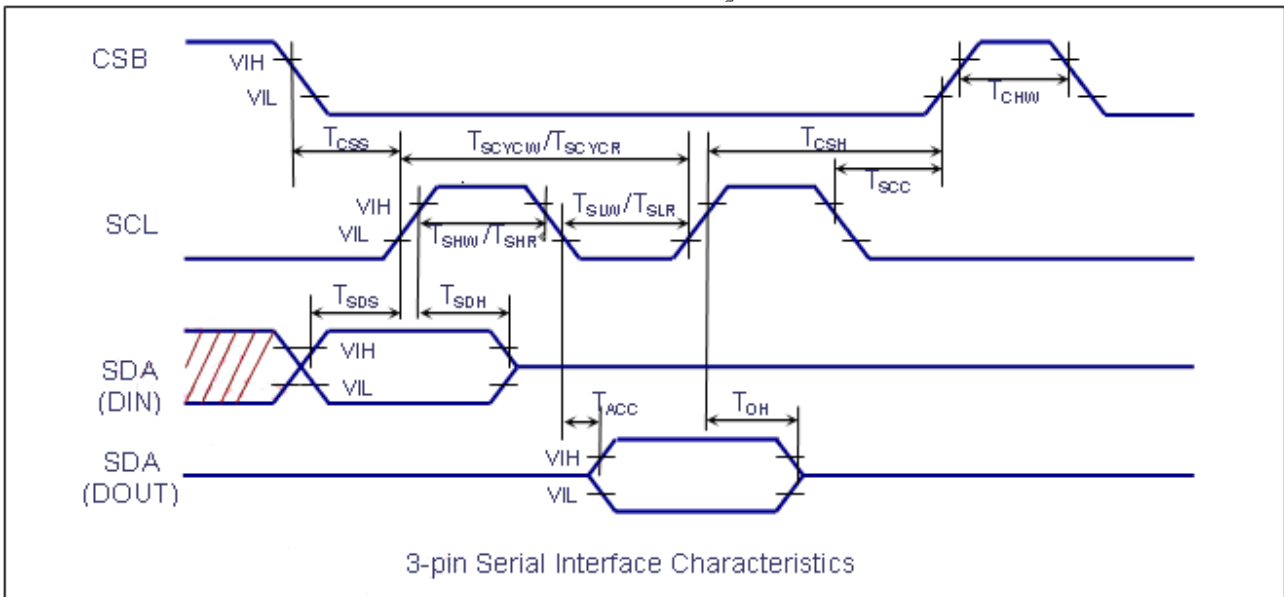
## D. Electrical DC Characteristics

Item	Symbol	Condition	Min.	Typical	Max.	Unit	Remark
Supply Voltage	VDD		3.0	3.3	3.6	V	
Low Level Input Voltage	Vil	Digital input pins	GND	-	0.3xVDD	V	
High Level Input Voltage	Vih	Digital input pins	0.7xVDD	-	VDD	V	
High Level Output Voltage	Voh	Digital output pins; $I_{OH} = 400\mu A$	VDD-0.4	-	-	V	
Low Level Output Voltage	Vol	Digital output pins; $I_{OL} = -400\mu A$	GND	-	GND+0.4	V	
Operating temperature	T <sub>op</sub>		0	-	65	°C	
Operation Power Dissipation			--	10	15	mW	Note
Standby Power Dissipation			--	--	3.3	$\mu A$	

Note: Operation power dissipation condition: VDD = 3.3V, Frame Rate = 8.5 Hz.

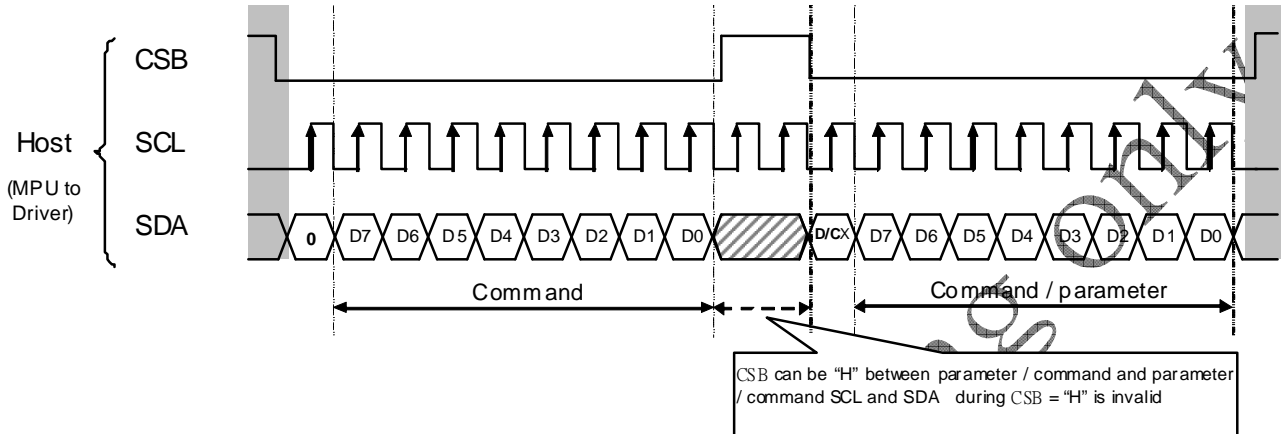
### E. Electrical AC Characteristics

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
CSB	$t_{CSS}$	Chip select setup time	60			ns
	$t_{CSH}$	Chip select hold time	65			ns
	$t_{SCC}$	Chip select setup time	20			ns
	$t_{CHW}$	Chip select setup time	40			ns
SCL	$t_{SCYCW}$	Serial clock cycle (Write)	100			ns
	$T_{SHW}$	SCL "H" pulse width (Write)	35			ns
	$t_{SLW}$	SCL "L" pulse width (Write)	35			ns
	$t_{SCYCR}$	Serial clock cycle (Read)	150			ns
	$T_{SHR}$	SCL "H" pulse width (Read)	60			ns
	$t_{SLR}$	SCL "L" pulse width (Read)	60			ns
SDA (DIN) (DOUT)	$t_{SDS}$	Data setup time	30			ns
	$t_{SDH}$	Data hold time	30			ns
	$t_{ACC}$	Access time	10			ns
	$t_{OH}$	Output disable time	15			ns



FO

### 1.SPI format



## 2. Register definition

### 2.1. R02H (POF): Power OFF Command

R02H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
POF	W	0	0	0	0	0	0	0	1	0	(02H)

Description	-The command define as follows: After power off command, driver will power off base on power off sequence. After power off command, BUSY_N signal will become "0".
Restriction	- This command only active when BUSY_N = "1".

### 2.2. R04H (PON): Power ON Command

R04H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
PON	W	0	0	0	0	0	0	1	0	0	(04H)

Description	-The command define as follows: After power on command, driver will power on base on power on sequence. After power on command and all power sequence are ready, then BUSY_N signal will become "1".
Restriction	User can send this command in any time. It doesn't have restriction of BUSY_N.

### 2.3. R10H (DTM): Data Start transmission Register

R10H												
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)	
DTM	W	0	0	0	0	1	0	0	0	0	(10H)	
1 <sup>st</sup> Parameter	W	1	Pixel1	Pixel2	Pixel3	Pixel4	Pixel5	Pixel6	Pixel7	Pixel8	00h	
2 <sup>nd</sup> Parameter	W	1	Pixel9	Pixel10	Pixel11	Pixel12	Pixel13	Pixel14	Pixel15	Pixel16	00h	
⋮		1									00h	
M <sup>th</sup> Parameter	W	1	Pixel(N-7)	Pixel(N-6)	Pixel(N-5)	Pixel(N-4)	Pixel(N-3)	Pixel(N-2)	Pixel(N-1)	PixelN	00h	

Description	-The command define as follows: The register is indicates that user start to transmit data. While complete data transmission, user must send command 11H(DSP). Then chip will start to send data/VCOM for panel.
Restriction	- This command only active when BUSY_N = "1".

## 2.4. R11H (DSP): Data Stop Command

R11H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
DSP	W	0	0	0	0	1	0	0	0	1	(11H)
1 <sup>st</sup> Parameter	R	1	data_flag	-	-	-	-	-	-	-	

Description	-The command define as follows: While finished the data transmission, user must send this command for driver and read data_flag information. 1 <sup>st</sup> Parameter:					
	<table border="1"> <thead> <tr> <th>Bit7</th> <th>Data flag of receiving user data.</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Driver didn't receive all the data.</td> </tr> <tr> <td>1</td> <td>Driver has already received all the one frame data.</td> </tr> </tbody> </table>	Bit7	Data flag of receiving user data.	0	Driver didn't receive all the data.	1
Bit7	Data flag of receiving user data.					
0	Driver didn't receive all the data.					
1	Driver has already received all the one frame data.					
Restriction	- This command only active when BUSY_N = "1". After data start (10h) and data stop (11h) command, BUSY_N signal will become "0".					

## 2.5. R20H (LUTC): LUT for VCOM Register

R20H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
LUTC	W	0	0	0	1	0	0	0	0	0	(20H)
1 <sup>st</sup> Parameter	W	1	0	1	0	0	1	1	1	1	4Fh
2 <sup>nd</sup> Parameter	W	1	1	0	0	0	1	1	1	1	8Fh
3 <sup>rd</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
4 <sup>th</sup> Parameter	W	1	0	1	0	0	1	1	1	1	8Fh
5 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
6 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
7 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
8 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
9 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
10 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
11 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
12 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
13 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
14 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
15 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h

Description	-The command define as follows: This register is set for VCOM LUT.
Restriction	- This command only active when BUSY_N = "1".

## 2.6. R21H (LUTW): LUT for White Register

R21H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
LUTW	W	0	0	0	1	0	0	0	0	1	(21H)
1 <sup>st</sup> Parameter	W	1	1	0	0	0	1	1	1	1	8Fh
2 <sup>nd</sup> Parameter	W	1	0	1	0	0	1	1	1	1	4Fh
3 <sup>rd</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
4 <sup>th</sup> Parameter	W	1	0	1	0	0	1	1	1	1	4Fh
5 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
6 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
7 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
8 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
9 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
10 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
11 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
12 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
13 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
14 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
15 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h

Description	-The command define as follows: This register is set for White data LUT.
Restriction	- This command only active when BUSY_N = "1"

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## 2.7. R22H (LUTB): LUT for Black Register

R22H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
LUTB	W	0	0	0	1	0	0	0	1	0	(22H)
1 <sup>st</sup> Parameter	W	1	0	1	0	0	1	1	1	1	4Fh
2 <sup>nd</sup> Parameter	W	1	0	1	0	0	1	1	1	1	4Fh
3 <sup>rd</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
4 <sup>th</sup> Parameter	W	1	1	0	0	0	1	1	1	1	8Fh
5 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
6 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	1	01h
7 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
8 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
9 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
10 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
11 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
12 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
13 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
14 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h
15 <sup>th</sup> Parameter	W	1	0	0	0	0	0	0	0	0	00h

Description	-The command define as follows: This register is set for Black data LUT.
Restriction	- This command only active when BUSY_N = "1".

## 2.8. R30H (PLL): PLL control Register

R30H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
PLL	W	0	0	0	1	1	0	0	0	0	(30H)
1 <sup>st</sup> Parameter	W	1	-	-	M[2]	M[1]	M[0]	N[2]	N[1]	N[0]	0CH

Description	-The command define as follows: The command will decide PLL clock frequency.
Restriction	- This command only active when BUSY_N = "1".

\*Note: Please set M=1 and N=4, the frame rate is 8.5Hz.



## 2.9. R41H (TSE): Temperature Sensor Enable Register

R41H											
Inst / Para	R/W	D/CX	D7	D6	D5	D4	D3	D2	D1	D0	(Code)
TSC	W	0	0	1	0	0	0	0	0	1	(41H)
1 <sup>st</sup> Parameter	W	1	-	-	-	-	-	-	-	TSE	01h

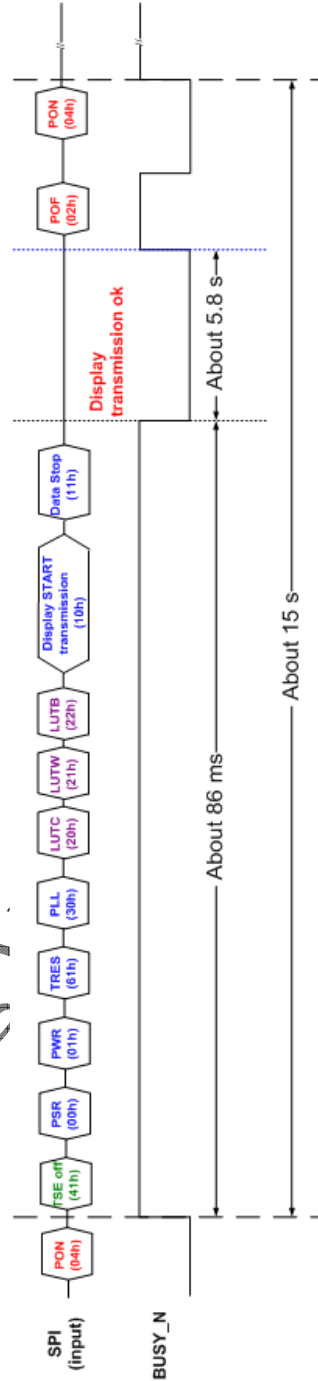
\*NOTE: "-" Don't care, can be set to VDD or GND level

Description	<p>-The command define as follows: This command indicates the driver IC temperature sensor enable function. When TSE="1", if driver start to update display, driver will get temperature sensor value and send I<sup>2</sup>C to external EEPROM for updating LUT data before display.</p> <p>When TSE="0", if driver start to update display, it will not get temperature sensor value and will not send I<sup>2</sup>C to external EEPROM. Driver will update display base on LUT registers (20h, 21h, 22h).</p> <p>1<sup>st</sup> Parameter:</p> <table border="1" data-bbox="379 882 735 958"> <thead> <tr> <th>Bit0</th> <th>TSE</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Disable.</td> </tr> <tr> <td>1</td> <td>Enable. <b>(Default)</b></td> </tr> </tbody> </table>	Bit0	TSE	0	Disable.	1	Enable. <b>(Default)</b>
Bit0	TSE						
0	Disable.						
1	Enable. <b>(Default)</b>						
Restriction	-- This command only active when BUSY_N = "1".						

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### 3.Data transimssion wavefor

Fig. 1. Temperature sensor disable (Register:41H,TSE=0)



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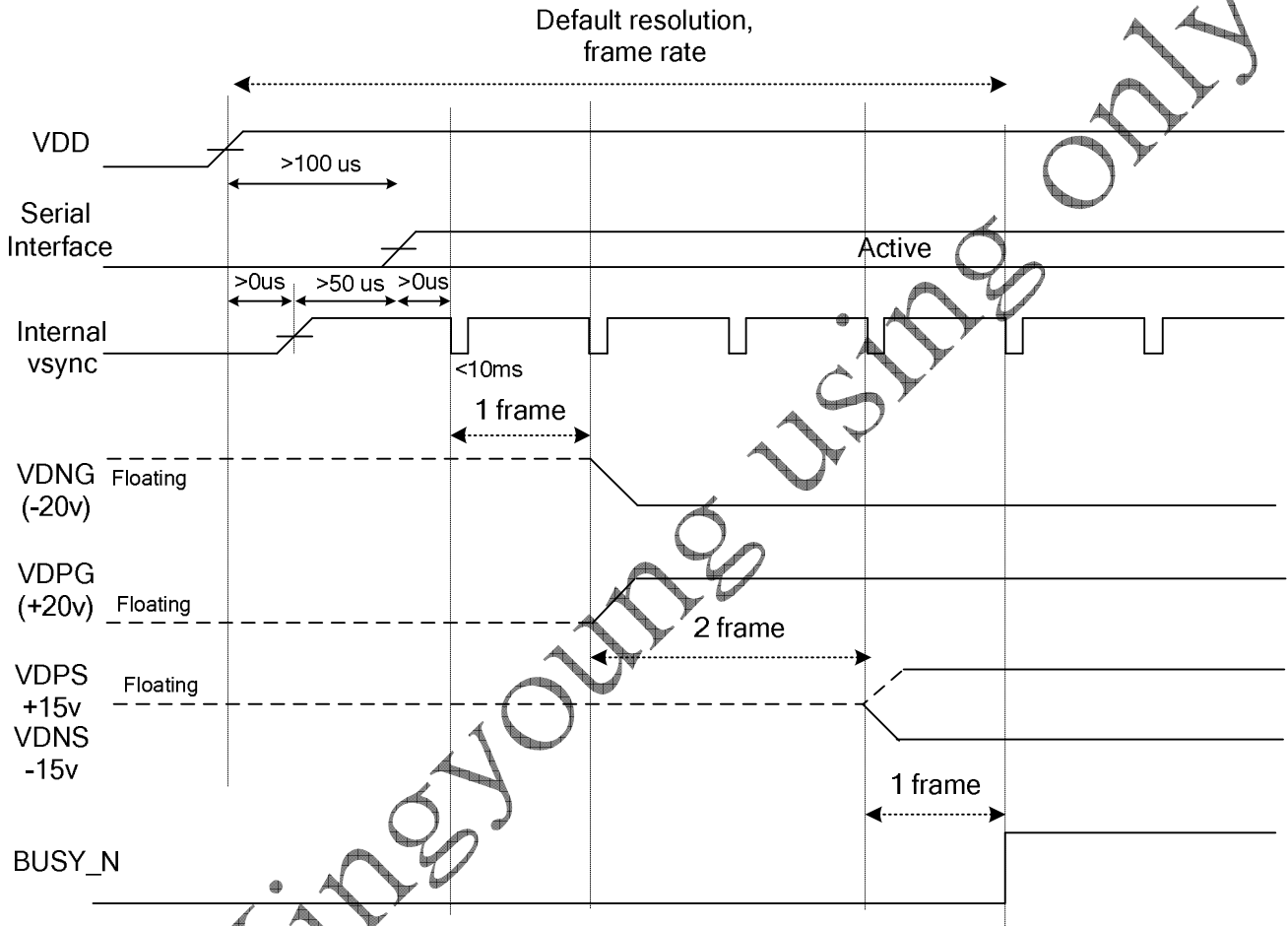
Using Only

## F. Power On/Off Characteristics

### 1. Recommended Power On/off Sequence

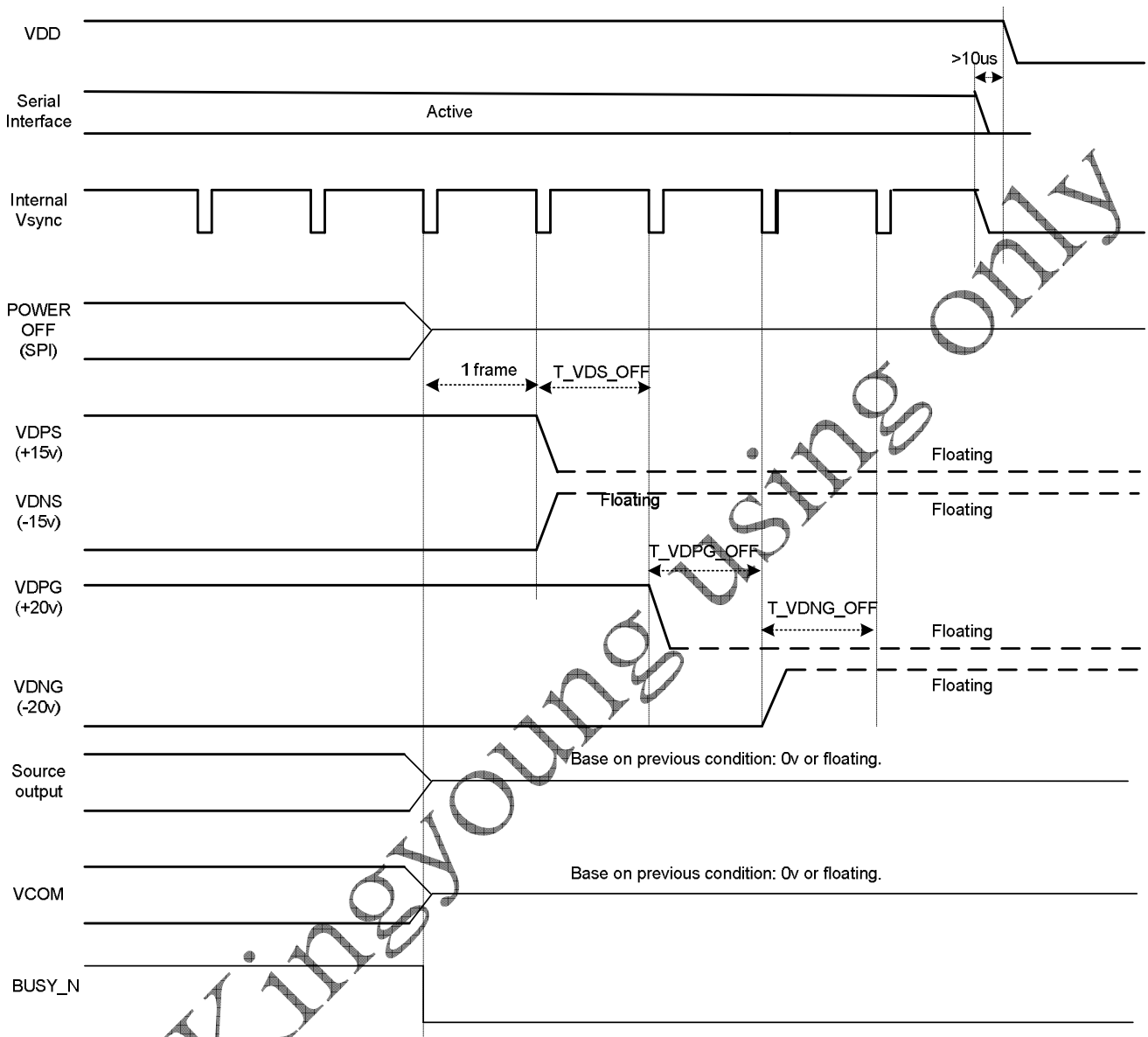
The suggested power on/off sequence is below:

#### Power on sequence:



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**Power off sequence:**



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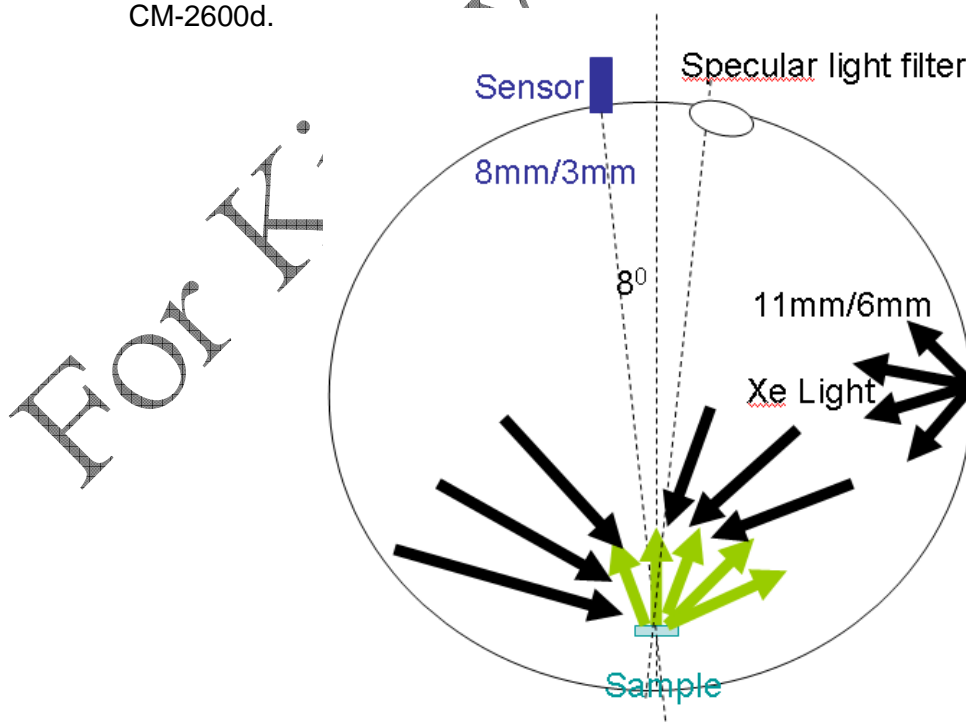
## G. Optical Specification

All optical specification is measured under typical condition (Note 2)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Remark
Flashing LUT	LUT	5 Year Lifetime	<5 °C	--	17.5	--	Sec	Note 7
			5~25 °C	--	4.5	--	Sec	
			25~65 °C	--	1.8	--	Sec	
Non-Flashing LUT	LUT	5 Year Lifetime	0 ~ 15 °C	--	7.5	--	Sec	Note 7
			15 ~ 25 °C	--	3	--	Sec	
			25~65 °C	--	1.2	--	Sec	
Reflectance	R	White		22	25	--	%	Note1, 4
Contrast Ratio	CR	At optimized viewing angle	<5 °C	6	--	--		Note1, 5 & Flashing LUT
			5~25 °C	8	--	--		
			25~65 °C	8	--	--		
			0 ~ 5 °C	4	--	--	Note1, 5 & Non-Flashing LUT	
			15~25 °C	7	--	--		
			25~65 °C	8	--	--		

Note 1. Ambient temperature =25°C

Note 2. Reflectance and contrast ratio are measured by KONICA MINOLTA spectrophotometer CM-2600d.



Note 3. Definition of response time:

The response time is defined as the time from image load to full updated display.

Note 4. Definition of Reflectance:

The Reflectance is expressed as:

$$R = \text{Reflectance Factor}_{\text{white board}} \times (L_{\text{center}} / L_{\text{white board}})$$

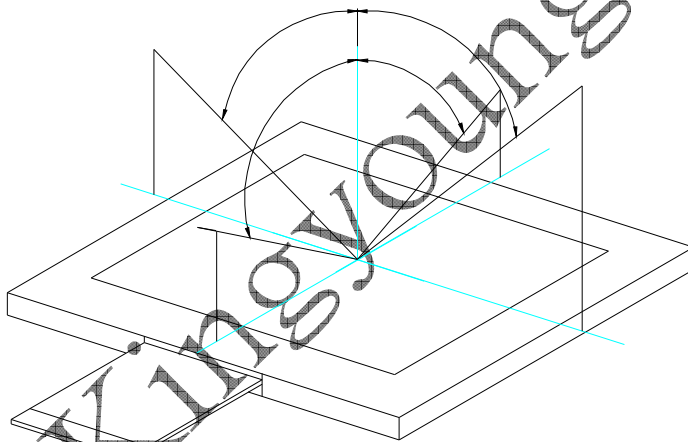
$L_{\text{center}}$  is the luminance measured at center in a white area.  $L_{\text{white board}}$  is the luminance of a standard white board.

Note 5. Definition of contrast ratio:

The contrast ratio (CR) is the ratio between the reflectance in a full white area (Rl) and reflectance in a dark area (Rd).

$$\text{Contrast ratio (CR)} = \frac{Rl}{Rd}$$

Note 6. Definition of viewing angle,  $\theta$ , Refer to figure as below.



## H. Reliability Test Items

No.	Test items	Conditions		Remark
1	High-Temperature Operation	Ta = 65°C	240Hrs	
2	Low-Temperature Operation	Ta = 0°C	240Hrs	
3	High-Temperature Storage	Ta = +70°C	240Hrs	
4	Low-Temperature Storage	Ta = -20°C	240Hrs	
5	High-Temperature, High-Humidity Operation	Ta = +40°C, RH = 90%	240Hrs	Operation
6	High-Temperature, High-Humidity Storage	Ta = +50°C, RH = 80%	240Hrs	
7	Heat Shock	1 Cycle : [-30°C 30min] > [+50°C 30min] : 100 cycles		Non-operation
8	Electrostatic Discharge	+/- 2 KV		Non-operation

Note 1. Ta: Ambient Temperature.

Note 2. In the standard conditions, there is not display function NG issue occurred. All the cosmetic specification is judged before the reliability stress.

Note 3. All the cosmetic specification is judged before the reliability stress.

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## 2. Module/Panel Label Information

The module/panel (collectively called as the "Product") will be attached with a label of Shipping Number which represents the identification of the Product at a specific location. Refer to the Product outline drawing for detailed location and size of the label. The label is composed of a 22-digit serial number and printed with code 39/128 with the following definition:

ABCDEFGHIJKLMNOPQRSTUV

- For internal system usage and production serial numbers.
- AUO Module or Panel factory code, represents the final production factory to complete the Product
- Product version code, ranging from 0~9 or A~Z (for Version after 9)
- Week Code, the production week when the product is finished at its production process

## 3. Carton Label Information

The packing carton will be attached with a carton label where packing Q'ty, AUO Model Name, AUO Part Number, Customer Part Number (Optional) and a series of Carton Number in 13 or 14 digits are printed. The Carton Number is appearing in the following format:

ABC-DEFG-HIJK-LMN

- DEFG appear after first "-" represents the packing date of the carton
- Date from 01 to 31
- Month, ranging from 1~9, A~C. A for Oct, B for Nov and C for Dec.
- A.D. year, ranging from 1~9 and 0. The single digit code represents the last number of the year

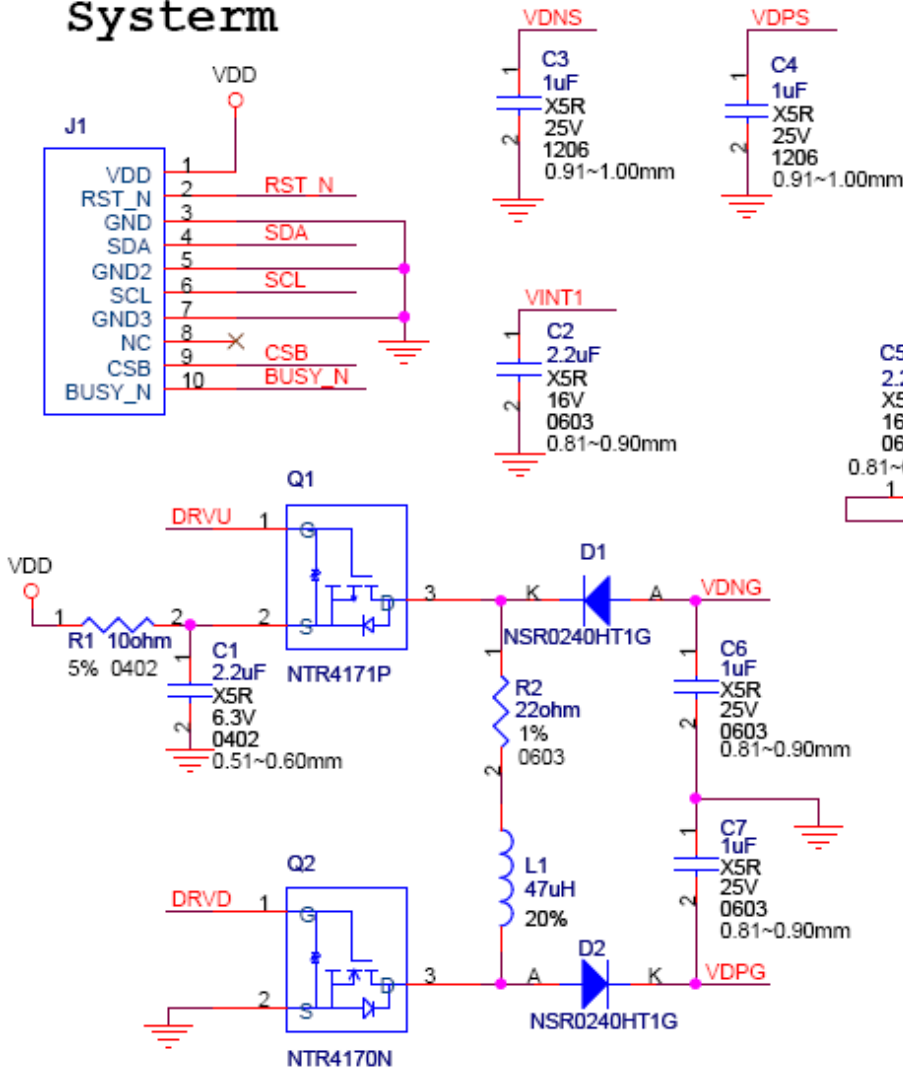
Refer to the drawing of packing format for the location and size of the carton label.

FOR KINGSYC

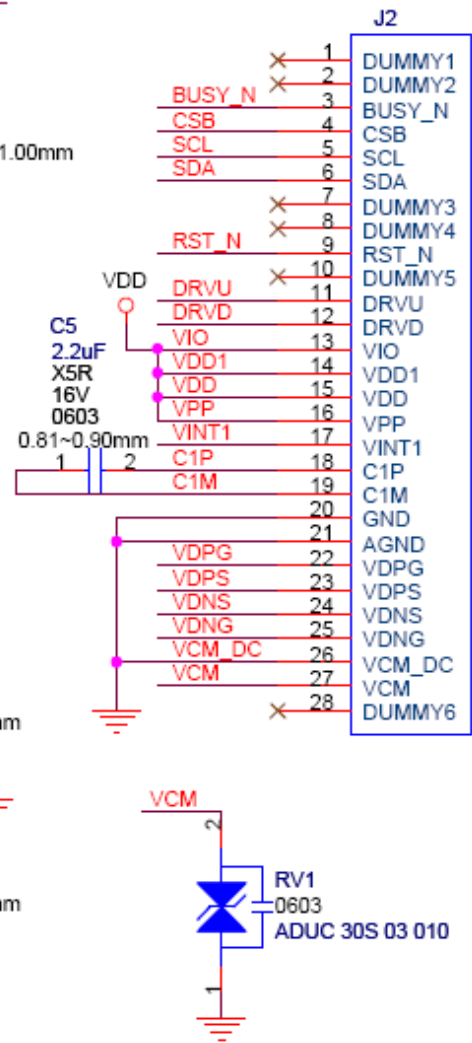
## J. Application Note

### 1. Application Circuit

#### System



#### Panel bonding



FOR X

## K. Precautions

1. Do not twist or bend the module and prevent the unsuitable external force for display module during assembly.
2. Adopt measures for good heat radiation. Be sure to use the module within 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.
5. Less EMI: it will be more safety and less noise.
6. Please operate module in suitable temperature. The response time & brightness will drift by different temperature.
7. Be sure to turn off the power when connecting or disconnecting the circuit.
8. Display surface never likes dirt or stains.
9. A dewdrop may lead to destruction. Please wipe off any moisture before using module.
10. High temperature and humidity may degrade performance. Please do not expose the module to the direct sunlight and so on.
11. Acetic acid or chlorine compounds are not friends with display module.
12. Static electricity will damage the module, please do not touch the module without any grounded device.
13. Do not disassemble and reassemble the module by self.
14. Be careful do not touch the rear side directly.
15. No strong vibration or shock. It will cause module broken.
16. Storage the modules in suitable environment with regular packing.
17. Be careful of injury from a broken display module.
18. Please avoid the pressure adding to the surface (front or rear side) of modules, because it will cause the display non-uniformity or other function issue.