

# SPECIFICATIONS FOR LCD MODULE

MODEL NO.  
BO128128CFPHH\$  
VER.04



FOR MESSRS:

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ON DATE OF:

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APPROVED BY:

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## History of Version

Version	Contents	Date	Note
01	NEW VERSION	2008/05/20	SPEC.
02	Add Handling Instruction Update Electrical Characteristics、Quality Assurance and Reliability Modify Backlight Information、Drawing	2012/12/26	Page 5、8、13 14、16、 17
03	Modify Handling Instruction	2013/02/06	Page 6
04	Modify Handling Precaution、Absolute Maximum Rating 、Electrical Characteristics、Optical Characteristics、 Quality Assurance and Reliability	2016/05/23	Page 5~10 15~17

## CONTENTS

1. Numbering System
2. Handling Precaution
3. General Specification
4. Absolute Maximum Rating
5. Electrical Characteristics
6. Optical Characteristics
7. Interface Pin Function
8. Power supply for LCD Module
9. Backlight information
10. Quality Assurance
11. Reliability
12. Appendix (Drawing , ST7528 controller data)
  - 12-1 Drawing
  - 12-2 ST7528 controller data
    - 12-2.1 Instruction table
    - 12-2.2 Timing characteristics
    - 12-2.3 Initializing by Instruction

## 1. Numbering System

<u>B</u>	<u>O</u>	<u>128128</u>	<u>C</u>	<u>F</u>	<u>P</u>	<u>H</u>	<u>-</u>	<u>H</u>	<u>\$</u>
0	1	2	3	4	5	6	7	8	9

<b>0</b>	Brand	Bolymin	
<b>1</b>	Module Type	C= character type G= graphic type P= TAB/TCP type	O= COG type F= COF type L=PLED/OLED
<b>2</b>	Format	2002=20 characters, 2 lines 12232= 122 x 32 dots	
<b>3</b>	Version No.	A type	
<b>4</b>	LCD Color	G=STN/gray Y=STN/yellow-green PLED/yellow-green C=color STN,OLED/RGB	B=STN/blue,OLED/blue F=FSTN T=TN
<b>5</b>	LCD Type	R=positive/reflective P=positive/transflective	M=positive/transmissive N=negative/transmissive
<b>6</b>	Backlight type/color	L=LED array/ yellow-green H=LED edge/white R=LED array/red G=LED edge/yellow-green F=RGB array I=RGB edge Q=LED edge/red N=No backlight	D=LED edge/blue E=EL/white B=EL/blue C=CCFL/white Y=LED Bottom/yellow O=LED array/orange K=LED edge/green A=LED edge/amber
<b>7</b>	CGRAM Font (applied only on character type)	J=English/Japanese Font E=English/European Font G=Chinese(simple) F=Chinese(traditional)	C=English/Cyrillic Font H=English/Hebrew Font A=English/Arabic Font
<b>8</b>	View Angle/ Operating Temperature	B=Bottom/Normal Temperature H=Bottom/Wide Temperature U=Bottom/Ultra wide Temperature	T=Top/Normal Temperature W=Top/Wide Temperature C=9H/Normal Temperature E=Top/ultra wide temperature
<b>9</b>	Special Code	3=3.3 volt logic power supply n=negative voltage for LCD c=cable/connector xxx=to be assigned on datasheet	t=temperature compensation for LCD p=touch panel \$=RoHS

## 2. Handling Precaution

### 2.1 Precaution in use of LCD Module

- 2.1.1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure and/or sharp tools on the surface of display area.
- 2.1.2. The polarizer placed on the display surface is easily scratched and damaged. Extreme care should be taken when handling it. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol, ethyl alcohol, do not use water, ketone or aromatics to clear display surface, and never scrub it hard.
- 2.1.3. Keep LCD panels away from direct sunlight. The storage environment should be dust-free, clean, dry, temperature is  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$  and the humidity is below 55% RH.
- 2.1.4. Do not input any signal before power is turned on.
- 2.1.5. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
- 2.1.6. It's important to control soldering temperature and time. RoHS compliant materials might need higher temperature and time, but try to keep temperature under  $350^{\circ}\text{C}$  and time in 3-5 sec.
- 2.1.7. EL is manufactured from the organic film, and is easily affected by temperature, humidity and other environmental impact. Long time storage might cause low quality of the case. Therefore, please start production in 3 months after reception of the LCM. If in any case, long time storage over 3 months is necessary, please keep EL in vacuum package or at least in humidity  $< 35\%$  RH, and temperature  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ .  
Note: 2.1.7. is applied to EL backlight only.

### 2.2 Static Electricity Precautions:

- 2.2.1. The LCD module contains a C-MOS LSI. People who operate the LCM should wear ESD protection equipment to prevent ESD hurt on products.
- 2.2.2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
- 2.2.3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
- 2.2.4. The modules should be kept in anti-static bags or trays for storage.
- 2.2.5. Only properly grounded soldering irons should be used.
- 2.2.6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
- 2.2.7. The normal static prevention measures should be observed for work clothes and working benches.
- 2.2.8. Since dry air(almost low RH) is inductive to static, a humidity of 50-60% RH is recommended in assembly line.

### 2.3 Operation Precautions:

- 2.3.1. DC voltage applied on LCM causes electrochemical reactions, which will deteriorate the display over time. The applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
- 2.3.2. LCD driving voltage should be kept within specified range; excess voltage will shorten display life, while less voltage may not turn on LCM.
- 2.3.3. LCM response time will be extremely delayed in low operating temperature(such as  $-20^{\circ}\text{C}$ ) than in room operating temperature. Therefore, higher LCD driving voltage is required in low operating temperature; On the other hand, in high operating temperature (such as  $+70^{\circ}\text{C}$ ) LCD shows dark background color, therefore lower LCD driving voltage is required. Be sure to use the specified LCD driving voltage in different operating temperature.

## 2.4 Safety:

- 2.4.1 If the LCD panel breaks, be careful not to get the liquid crystal to touch your skin.  
If the liquid crystal touches your skin or clothes, please wash it off immediately by using soap and water.

## 2.5 WARRANTY POLICY

**Bolymin .Will provide one-year warranty for the products only if under specification operating conditions.**

**If there are functional defects found during the period of warranty, the defective products would be replaced on a one-to-one basis.**

**Bolymin would not be responsible for any direct/indirect liabilities consequential to any parties.**

## 2.6 MTBF

- 2.6.1 .By specific test condition, MTBF based on 30°C normal operation temperature is 50,000hours.

### 2.6.2 Test Condition:

2.6.2.1 Supply Voltage for LCM: Typical Vdd

2.6.2.2 CC (Constant Current) mode and typical current is applied for LED.

2.6.2.3 Run-Patterns: by Bolymin's test program that has defined patterns and cyclic period.

2.6.2.4 Humidity: 60%RH

### 2.6.3 Test Criteria:

Attenuation of average brightness:  $\leq 50\%$

Increasing of current consumption for LCM/Backlight:  $\leq 20\%$

Display function at room temperature: Normal

Appearance: Normal

### 3. General Specification

#### (1) Mechanical Dimension

Item	Dimension	Unit
Number of Dots	128 x 128	dots
Module dimension (L x W x H)	38.5 x 95.7 x 4(MAX)	mm
View area	30.5 x 32.0	mm
Active area	27.25 x 29.81	mm
Dot size	0.199x 0.219	mm
Dot pitch	0.213 x 0.233	mm

#### (2) Controller IC: ST7528 controller

### 4. Absolute Maximum Ratings

#### 4.1 Electrical Absolute Maximum Ratings

(V<sub>SS</sub>=0V, T<sub>a</sub>=25°C)

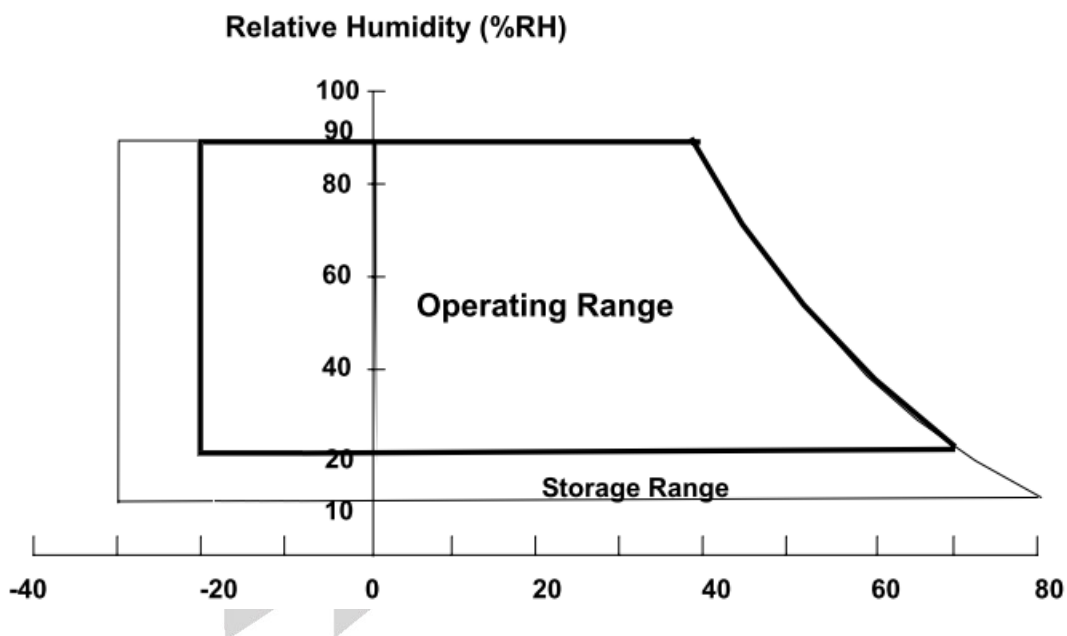
Item	Symbol	Min	Typ	Max	Unit
Supply Voltage For Logic	V <sub>DD</sub> -V <sub>SS</sub>	1.8	-	3.3	V
Supply Voltage For LCD	V <sub>O</sub> -V <sub>SS</sub>	-	+11	-	V

## 4.2 Environmental Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Operating Temperature	TOP	-20	70	°C	(1)
Storage Temperature	TST	-30	80	°C	(1)

Note (1)

- (a) 90 %RH Max. ( $T_a \leq 40$  °C).
- (b) Wet-bulb temperature should be 39 °C Max. ( $T_a > 40$  °C).
- (c) No condensation.





## 5. Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	Vdd-Vss	—	3.0	3.3	3.6	V
Supply Voltage For LCD	Vo-Vss	Ta=25°C	13.4	13.7	14.0	V
Input High Volt.	VIH	—	1.8	—	Vdd	V
Input Low Volt.	VIL	—	0	—	0.8	V
Output High Volt.	VOH	—	0.7*Vdd	—	Vdd	V
Output Low Volt.	VOL	—	Vss	—	0.3*Vss	V
Supply Current	Idd	Vdd=3.3V	—	0.5	—	mA
LCM Surface Luminance Ta=25°C	L	I <sub>LED</sub> =30mA Display all OFF	35	52	—	cd/m <sup>2</sup>

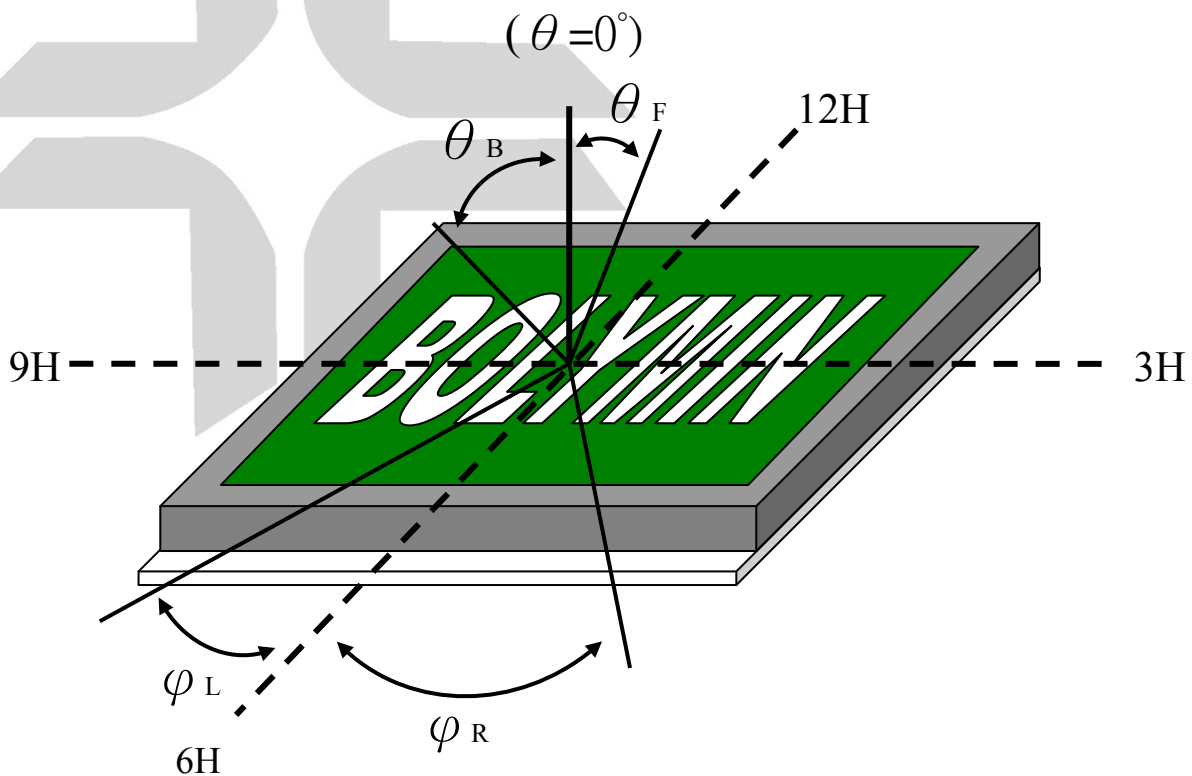
※Optimum LCD driving voltage value, referring to above mentioned range, is changed due to different batch of LCD glass.

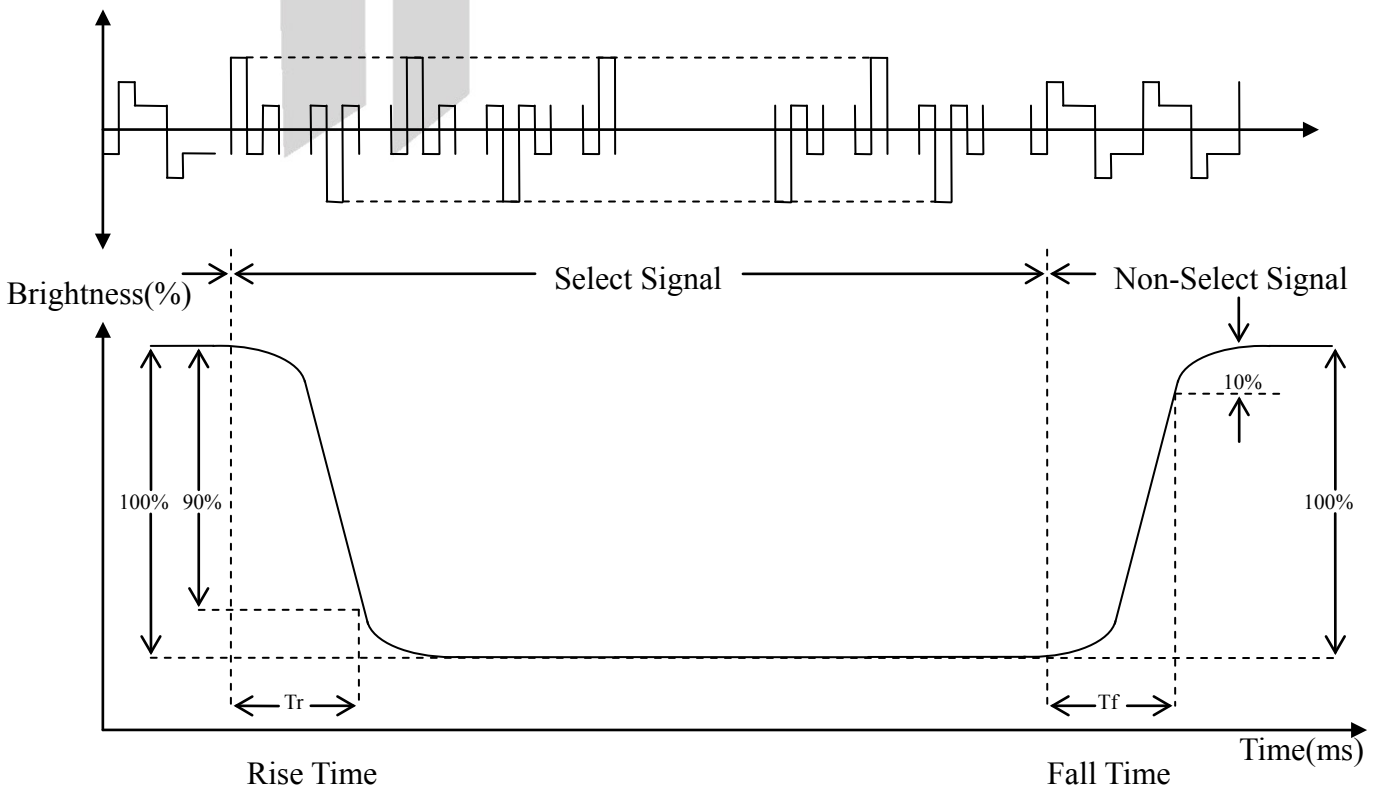
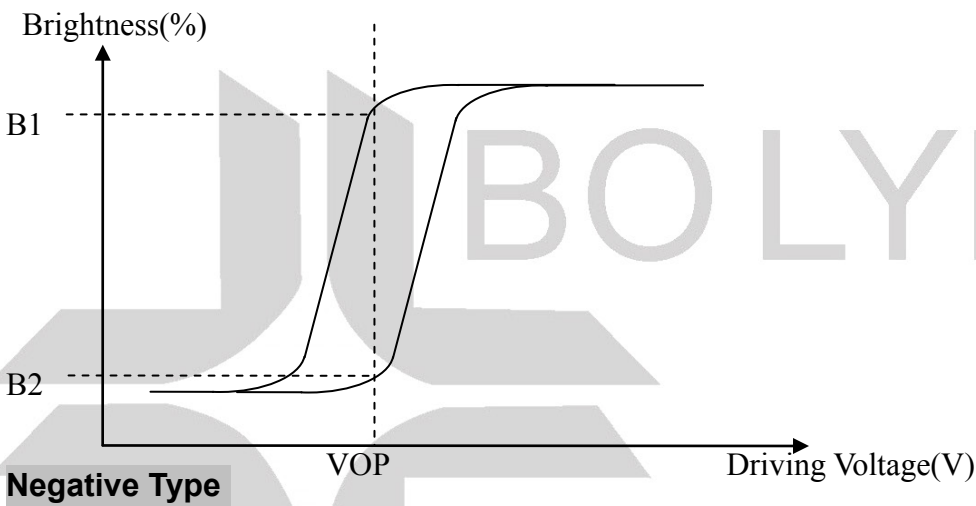
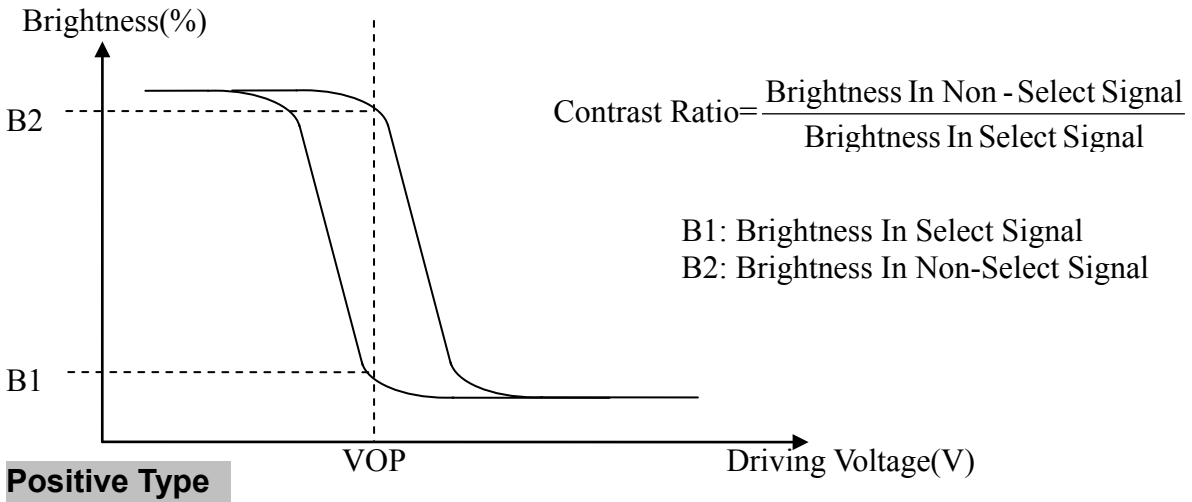
## 6. Optical Characteristics

a. FSTN

( $T_a=25^{\circ}\text{C}$ )

Item	Symbol	Min.	Typ.	Max.	Unit
View Angle (CR $\geq$ 2)	$\theta_F$	-	30	-	deg
	$\theta_B$	-	35	-	deg
	$\varphi_L$	-	30	-	deg
	$\varphi_R$	-	30	-	deg
Contrast Ratio	CR	-	5	-	-
Response Time 25 $^{\circ}\text{C}$	T rise	-	200	400	ms
	T fall	-	250	400	ms





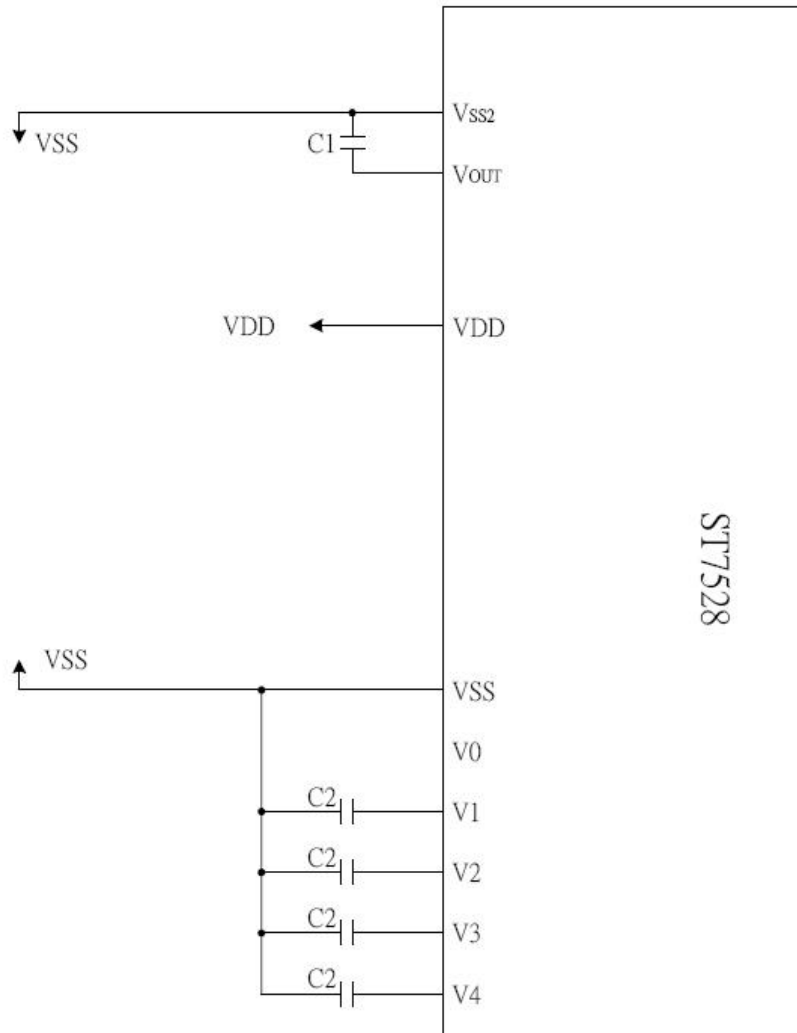
## 7.Interface Pin Function

Pin No.	Symbol	Level	Description
1	NC	-	No connection
2	V0	-	LCD driver voltage $V0 \geq V1 \geq V2 \geq V3 \geq V4 \geq VSS$
3	V1	-	
4	V2	-	
5	V3	-	
6	V4	-	
7	VOUT	-	LCD driver voltage
8	VSS	-	Ground
9	VDD	-	Power supply (+3.3V)
10	SID	H/L	Serial Data Input
11	SCLK	H/L	Serial Clock Input
12	A0	H/L	H=Data L=Instruction
13	/RESET	L	Reset : L=Enable H=Disable
14	/CSB	L	L=chip selected H=chip unselected

## 8. Power supply for LCD Module

\* Bias Power Save circuit

When we set the Instruction of Bias Power Save, the bias also could be working, and the IC current consumption will be lower about 100uA to 200uA



MIN

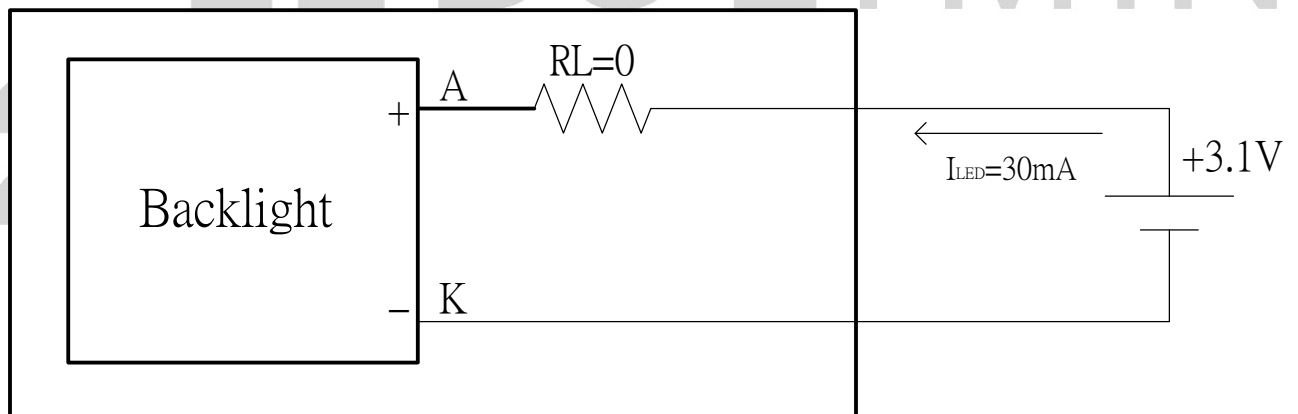
**C1= 1u F ~ 4.7u F, C2 = 0.1u F ~ 1u F (suggestion value: C1=1uF, C2=0.1uF)**

## 9. Backlight information

### 9.1. edge LED/white

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I <sub>LED</sub>	—	30		mA	V=3.1V
Supply Voltage	V	2.9	3.1	3.3	V	I <sub>LED</sub> =30mA
Reverse Voltage	V <sub>R</sub>	—	—	5	V	
CIE	X	0.27	—	0.32		I <sub>LED</sub> =30mA
	Y	0.28	—	0.33		
Color	White					

### 9.2 Backlight Driver From A K LCM



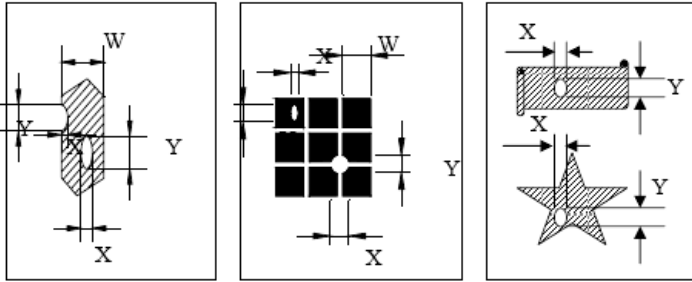
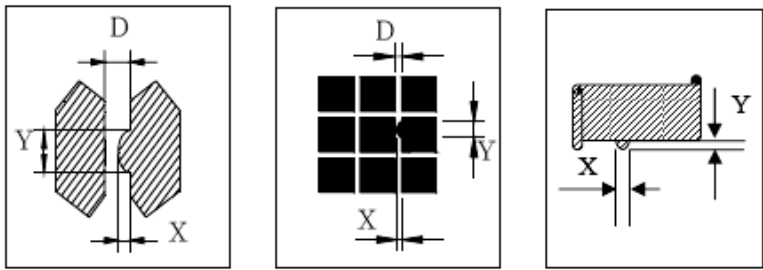
## 10. Quality Assurance

### 10.1 Inspection conditions

1. The LCD shall be inspected under 20~40W white fluorescent light.
2. Checking Direction shall be in the 40 degree from perpendicular line of specimen surface.
3. Checker shall see over 30 cm.
4. Inspect about 5 seconds for each side.
5. Defect that is located at outside of VA and doesn't affect function is ignored.

### 10.2 Inspection Parameters

NO.	Parameter	Criteria				
1	Black or White spots (Particle)	Zone		Acceptable Number	Class Of Defects	Acceptable Level
		Dimension				
		D ≤ 0.10		Disregard	Minor	2.5
		0.10 < D ≤ 0.2		4		
		0.2 < D ≤ 0.3		2		
0.3 < D		0				
D=(Long + Short)/2 Total defects should not exceed 5/module Defect that is located at outside of AA and doesn't affect function is ignored.						
2	Scratch, Substances	Zone		Acceptable Number	Class Of Defects	Acceptable Level
		X(mm)	Y(mm)			
		—	0.05 ≥ W	Disregard	Minor	2.5
		4.0 ≥ L	0.05 ≥ W	4		
		3.0 ≥ L	0.1 ≥ W	2		
—	0.1 < W	0				
X: Length    Y: Width Total defects should not exceed 5/module Defect that is located at outside of AA and doesn't affect function is ignored.						

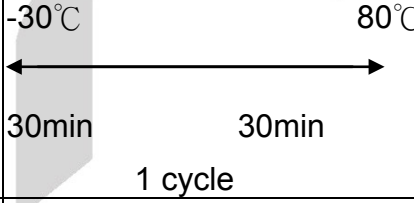
3	Air Bubbles ( between glass & polarizer)	<table border="1"> <thead> <tr> <th>Zone Dimension</th> <th>Acceptable Number</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>D \leq 0.2</math></td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td><math>0.2 &lt; D \leq 0.5</math></td> <td>3</td> </tr> <tr> <td><math>0.5 &lt; D</math></td> <td>0</td> </tr> </tbody> </table>	Zone Dimension	Acceptable Number	Class Of Defects	Acceptable Level	$D \leq 0.2$	Disregard	Minor	2.5	$0.2 < D \leq 0.5$	3	$0.5 < D$	0														
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$0.2 < D \leq 0.5$	3																											
$0.5 < D$	0																											
<p>Total defects shall not excess 3/module. Defect that is located at outside of AA and doesn't affect function is ignored. Bobbie is sawn only under reflection light is disregarded.</p>																												
4	Displaying Pattern	<p>1. Incomplete or broken line is not allowed. 2. Pinholes</p> <table border="1"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.1</math></td> <td>Disregard</td> <td rowspan="4">Minor</td> <td rowspan="4">2.5</td> </tr> <tr> <td><math>0.1 &lt; \Phi \leq 0.2</math></td> <td>2</td> </tr> <tr> <td><math>0.2 &lt; \Phi \leq 0.25</math></td> <td>1</td> </tr> <tr> <td><math>0.25 &lt; \Phi</math></td> <td>0</td> </tr> </tbody> </table>  <p style="text-align: center;"><math>\emptyset = (X+Y)/2</math></p> <p>3. Deformation</p> <table border="1"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.15</math></td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td><math>\Phi \leq 0.25</math> and <math>X \leq 1/2D</math></td> <td>3</td> </tr> <tr> <td><math>\Phi &gt; 0.25</math> and <math>X &gt; 1/2D</math></td> <td>0</td> </tr> </tbody> </table>  <p style="text-align: center;"><math>D</math> : 間距 <math>\emptyset = (X+Y)/2</math></p>	Dimension $\Phi$ (mm)	Criteria	Class Of Defects	Acceptable Level	$\Phi < 0.1$	Disregard	Minor	2.5	$0.1 < \Phi \leq 0.2$	2	$0.2 < \Phi \leq 0.25$	1	$0.25 < \Phi$	0	Dimension $\Phi$ (mm)	Criteria	Class Of Defects	Acceptable Level	$\Phi < 0.15$	Disregard	Minor	2.5	$\Phi \leq 0.25$ and $X \leq 1/2D$	3	$\Phi > 0.25$ and $X > 1/2D$	0
Dimension $\Phi$ (mm)	Criteria	Class Of Defects	Acceptable Level																									
$\Phi < 0.1$	Disregard	Minor	2.5																									
$0.1 < \Phi \leq 0.2$	2																											
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$\Phi > 0.25$ and $X > 1/2D$	0																											

Other Inspection standard reference Bolymin standard.



## 11. Reliability

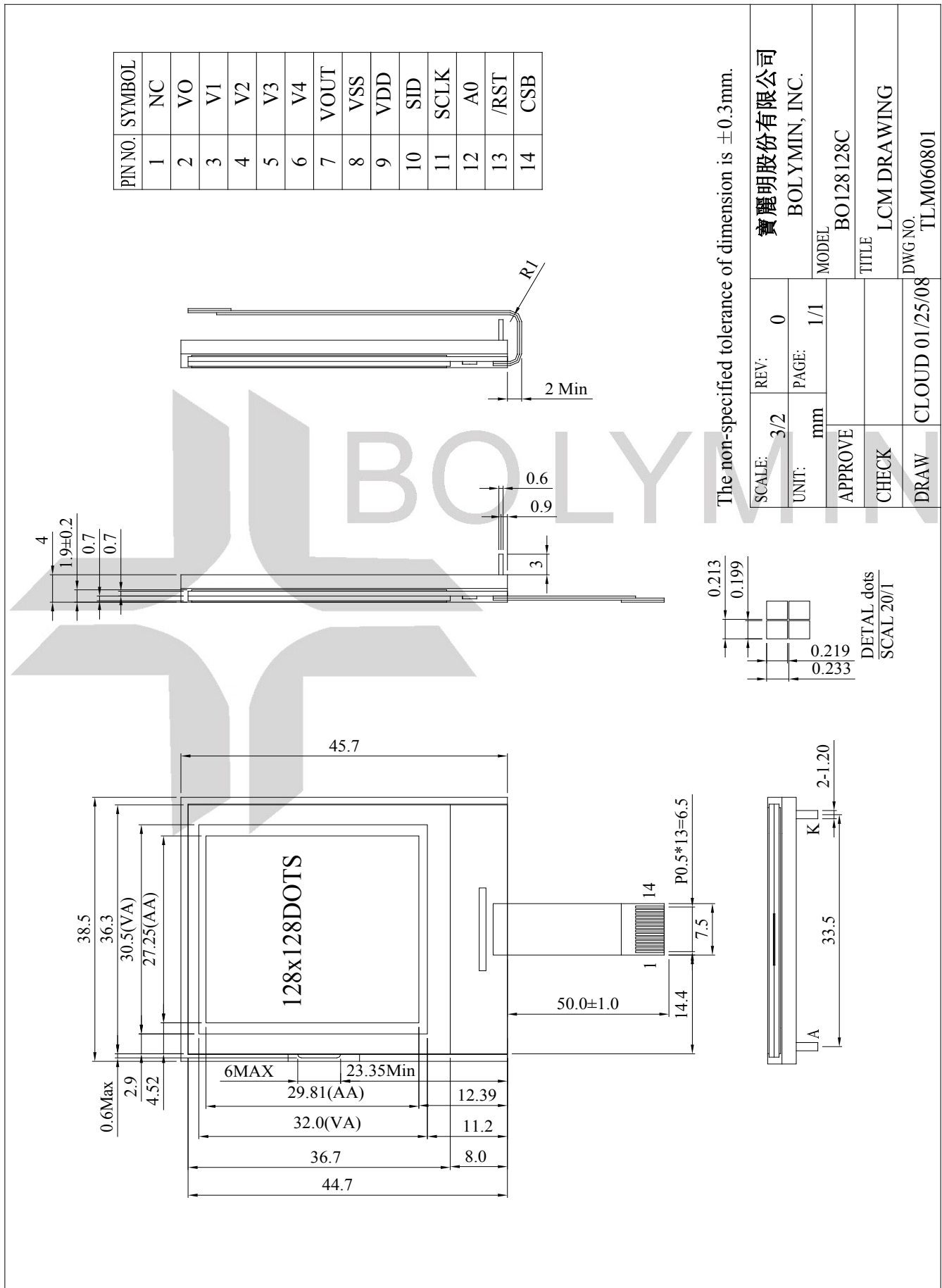
### ■ Content of Reliability Test

Environmental Test				
No	Test Item	Content of Test	Test Condition	Applicable Standard
1	High Temperature storage	Endurance test applying the high storage temperature for a long time.	80°C 96 hrs	—
2	Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30°C 96 hrs	—
3	High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70°C 96 hrs	—
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20°C 96 hrs	—
5	Humidity Test	Endurance test applying the high humidity storage for a long time.	40°C, 90%RH 96hrs	—
6	Temperature cycle (Non-operation)	Endurance test applying the low and high temperature cycle. 	-30°C/80°C 10 cycles	—
7	Vibration test	Endurance test applying the vibration during transportation and using.	Total Fixed Amplitude: 1.5mm Vibration Frequency : 10~55Hz One cycle 60 seconds to 3 direction of X,Y,Z for each 15minutes	—

※Assess after placing at normal temperature and humidity for 4 hour ◦ No abnormalities in functions and appearance ◦

## 12.Appendix (Drawing , ST7528 controller data)

### 12.1 Drawing



## 12.2 ST7528 controller data

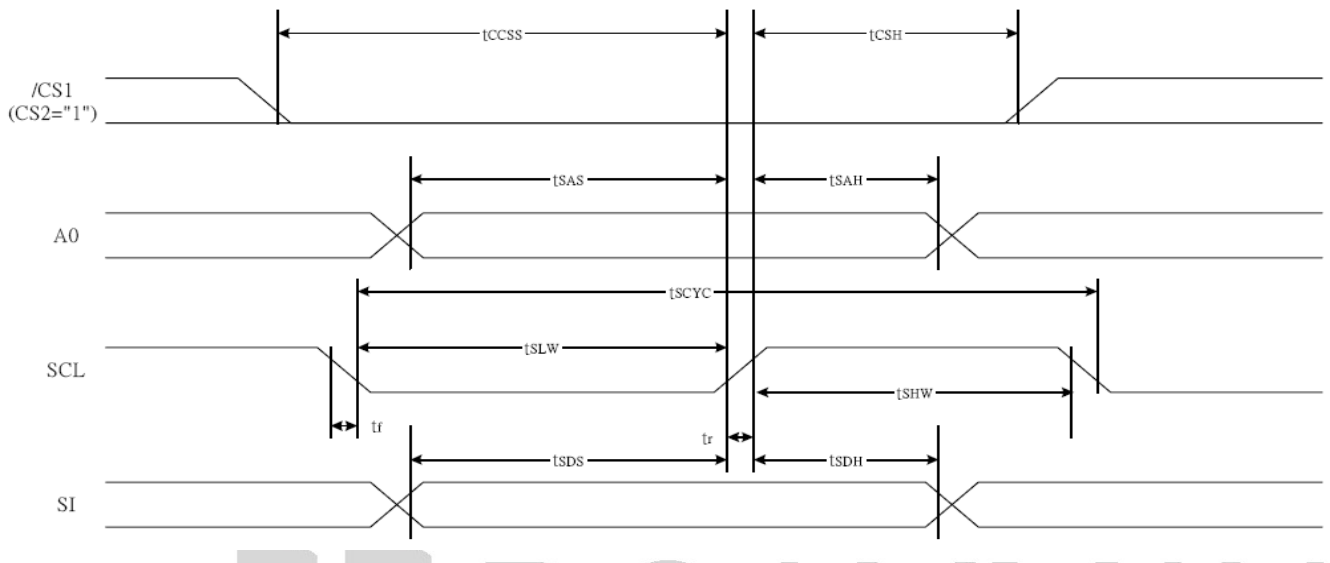
### 12.2.1. Instruction table

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
<b>EXT=0 or 1</b>											
Mode Set	0	0	0	0	1	1	1	0	0	0	2-byte instruction to set Mode and FR( Frame frequency control) BE( Booster efficiency control)
	0	0	FR3	FR2	FR1	FR0	0	BE	x'	EXT	
<b>EXT=0</b>											
Read display data	1	1	Read data								Read data into DDRAM
Write display data	1	0	Write data								Write data into DDRAM
Read status	0	1	BUSY	ON	RES	MF2	MF1	MF0	DS1	DS0	Read the internal status
ICON control register ON/OFF	0	0	1	0	1	0	0	0	1	ICON	ICON=0: ICON disable(default) ICON=1: ICON enable & set the page address to 16
Set page address	0	0	1	0	1	1	P3	P2	P1	P0	Set page address
Set column address MSB	0	0	0	0	0	1	Y9	Y8	Y7	Y6	Set column address MSB
Set column address LSB	0	0	0	0	0	0	Y5	Y4	Y3	Y2	Set column address LSB
Set modify-read	0	0	1	1	1	0	0	0	0	0	Set modify-read mode
Reset modify-read	0	0	1	1	1	0	1	1	1	0	release modify-read mode
Display ON/OFF	0	0	1	0	1	0	1	1	1	D	D=0: Display OFF D=1: Display ON
Set initial display line register	0	0	0	1	0	0	0	0	x'	x'	2-byte instruction to specify the initial display line to realize vertical scrolling
	0	0	x'	S6	S5	S4	S3	S2	S1	S0	
Set initial COM0 register	0	0	0	1	0	0	0	1	x'	x'	2-byte instruction to specify the initial COM0 to realize window scrolling
	0	0	x'	C6	C5	C4	C3	C2	C1	C0	
Select partial display line	0	0	0	1	0	0	1	0	x'	x'	2-byte instruction to set partial display duty ratio
	0	0	D7	D6	D5	D4	D3	D2	D1	D0	
Set N-line inversion	0	0	0	1	0	0	1	1	x'	x'	2-byte instruction to set N-line inversion register
	0	0	x'	x'	x'	N4	N3	N2	N1	N0	
Release N-line inversion	0	0	1	1	1	0	0	1	0	0	Release N-line inversion mode
Reverse display ON/OFF	0	0	1	0	1	0	0	1	1	REV	REV=0: normal display REV=1: reverse display
Entire display ON/OFF	0	0	1	0	1	0	0	1	0	EON	EON=0: normal display EON=1: entire display ON

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
<b>Ext=0</b>											
Power control	0	0	0	0	1	0	1	VC	VR	VF	Control power circuit operation
Select DC-DC step-up	0	0	0	1	1	0	0	1	DC1	DC0	Select the step-up of internal voltage converter
Select regulator register	0	0	0	0	1	0	0	R2	R1	R0	Select the internal resistance ratio of the regulator resistor
Select electronic volumn register	0	0	1	0	0	0	0	0	0	1	2-byte instruction to specify the reference voltage
	0	0	x'	x'	EV5	EV4	EV3	EV2	EV1	EV0	
Select LCD bias	0	0	0	1	0	1	0	B2	B1	B0	Select LCD bias
Set Bias Power Save Mode	0	0	1	1	1	1	0	0	1	1	Bias Power save Save the Bias current consumption
	0	0	0	0	0	0	0	0	0	0	
Release Bias Power Save Mode	0	0	1	1	1	1	0	0	1	1	Bias Power save release set the Bias power to normal
	0	0	0	0	0	0	0	1	0	0	
SHL select	0	0	1	1	0	0	SHL	x'	x'	x'	COM bi-directional selection SHL=0: normal direction SHL=1: reverse direction
ADC select	0	0	1	0	1	0	0	0	0	ADC	SEG bi-direction selection ADC=0: normal direction ADC=1: reverse direction
Oscillator on start	0	0	1	0	1	0	1	0	1	1	Start the built-in oscillator
Set power save mode	0	0	1	0	1	0	1	0	0	P	P=0: normal mode P=1: sleep mode
Release power save mode	0	0	1	1	1	0	0	0	0	1	release power save mode
Reset	0	0	1	1	1	0	0	0	1	0	initial the internal function
Set data direction & display data length(DDL)	x'	x'	1	1	1	0	1	0	0	0	2-byte instruction to specify the number of data bytes. (SPI mode)
	x'	x'	D7	D6	D5	D4	D3	D2	D1	D0	
Select FRC and PWM mode	0	0	1	0	0	1	0	FRC	PWM1	PWM0	FRC(1:3FRC, 0:4FRC) PWM1 PWM0 0 0 45PWM 0 1 45 PWM 1 0 60PWM 1 1 ---
NOP	0	0	1	1	1	0	0	0	1	1	<u>No operation</u>
Test Instruction	0	0	1	1	1	1	x'	x'	x'	x'	<u>Don't use this instruction</u>

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
<b>EXT=1</b>											
Set white mode and 1 <sup>st</sup> frame,	0	0	1	0	0	0	0	0	0	0	Set white mode and 1st frame
set pulse width	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 2 <sup>nd</sup> frame,	0	0	1	0	0	0	0	0	0	1	Set white mode and 2nd frame
set pulse width	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 3 <sup>rd</sup> frame,	0	0	1	0	0	0	0	0	1	0	Set white mode and 3rd frame
set pulse width	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 4 <sup>th</sup> frame,	0	0	1	0	0	0	0	0	1	1	Set white mode and 4th frame
set pulse width	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set gray level 1 mode	0	0	84H~87H (4 bytes)								Set gray level1
Set gray level 2 mode	0	0	88H~8BH (4 bytes)								Set gray level2
Set gray level 3 mode	0	0	8CH~8FH (4bytes)								Set gray level3
Set gray level 4 mode	0	0	90H~93H (4bytes)								Set gray level4
Set gray level 5 mode	0	0	94H~97H (4bytes)								Set gray level5
Set gray level 6 mode	0	0	98H~9BH (4 bytes)								Set gray level6
Set gray level 7 mode	0	0	9CH~9FH (4 bytes)								Set gray level7
Set gray level 8 mode	0	0	A0H~A3H (4 bytes)								Set gray level8
Set gray level 9 mode	0	0	A4H~A7H (4 bytes)								Set gray level9
Set gray level 10 mode	0	0	A8H~ABH (4 bytes)								Set gray level10
Set gray level 11mode	0	0	ACH~AFH (4 bytes)								Set gray level11
Set gray level 12 mode	0	0	B0H~B3H (4 bytes)								Set gray level12
Set gray level 13 mode	0	0	B4H~B7H (4 bytes)								Set gray level13
Set gray level 14 mode	0	0	B8H~BBH (4 bytes)								Set gray level14
Set Dark mode and 1st frame,	0	0	1	0	1	1	1	1	0	0	Set Dark mode and 1st frame, set pulse width
set pulse width	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 2nd frame,	0	0	1	0	1	1	1	1	0	1	Set Dark mode and 2nd frame, set pulse width
set pulse width	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 3rd frame,	0	0	1	0	1	1	1	1	1	0	Set Dark mode and 3rd frame, set pulse width
set pulse width	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 4th frame,	0	0	1	0	1	1	1	1	1	1	Set Dark mode and 4th frame, set pulse width
set pulse width	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	

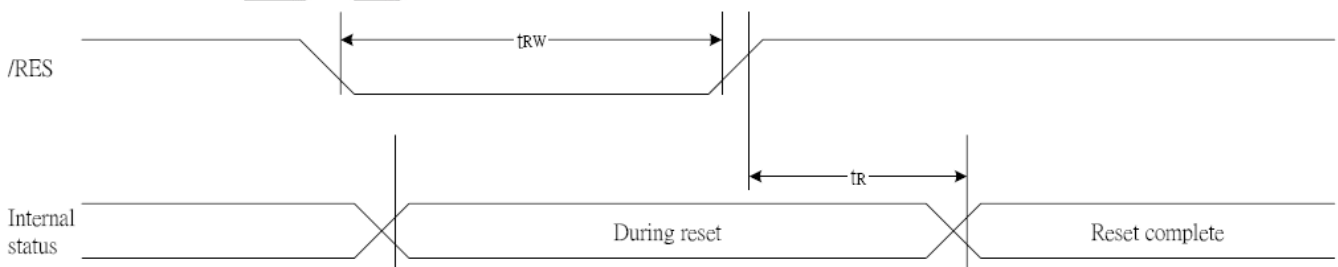
## 12.2.2 . Timing characteristics Serial Interface (4-line interface)



( $V_{DD}=3.3V, T_a=-30\sim 85^{\circ}C$ )

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	tSCYC		50	—	ns
SCL "H" pulse width		tSHW		25	—	
SCL "L" pulse width		tSLW		25	—	
Address setup time	A0	tSAS		20	—	
Address hold time		tSAH		10	—	
Data setup time	SI	tSDS		20	—	
Data hold time		tSDH		10	—	
CS-SCL time	CSB	tCSS		20	—	
CS-SCL time		tCSH		40	—	

### Reset Timing

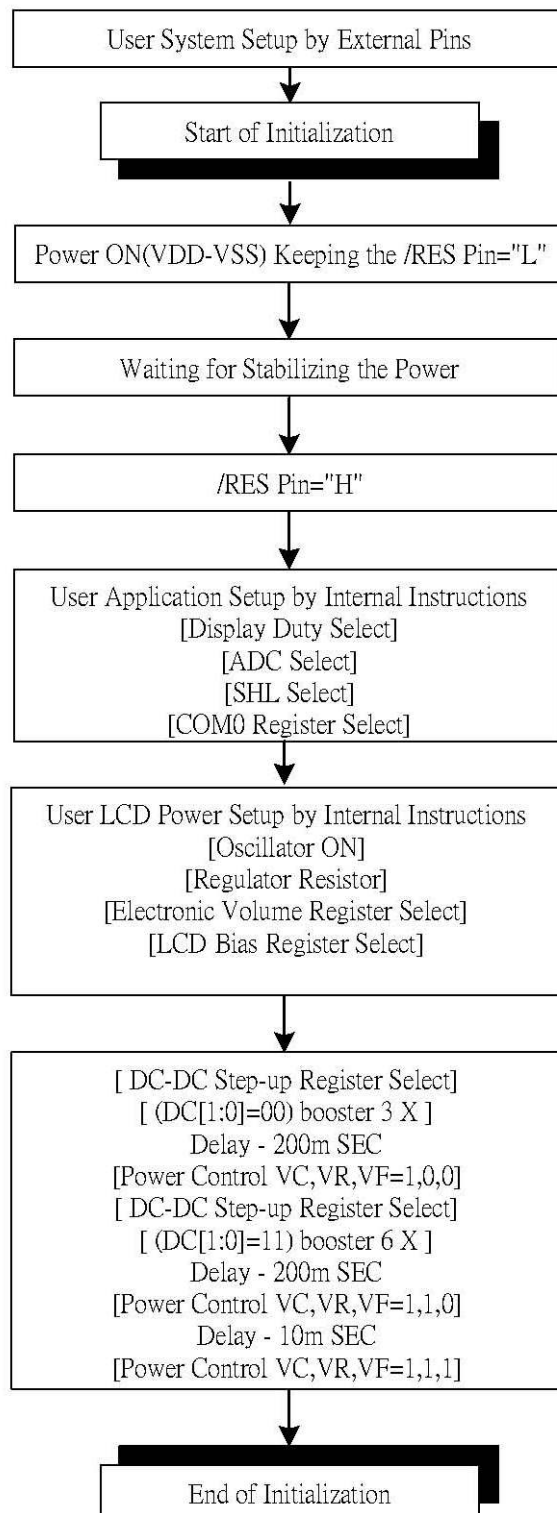


( $V_{DD} = 3.3V, T_a = -30 \text{ to } 85^{\circ}C$ )

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR		—	—	1	us
Reset "L" pulse width	RESB	tRW		1	—	—	us

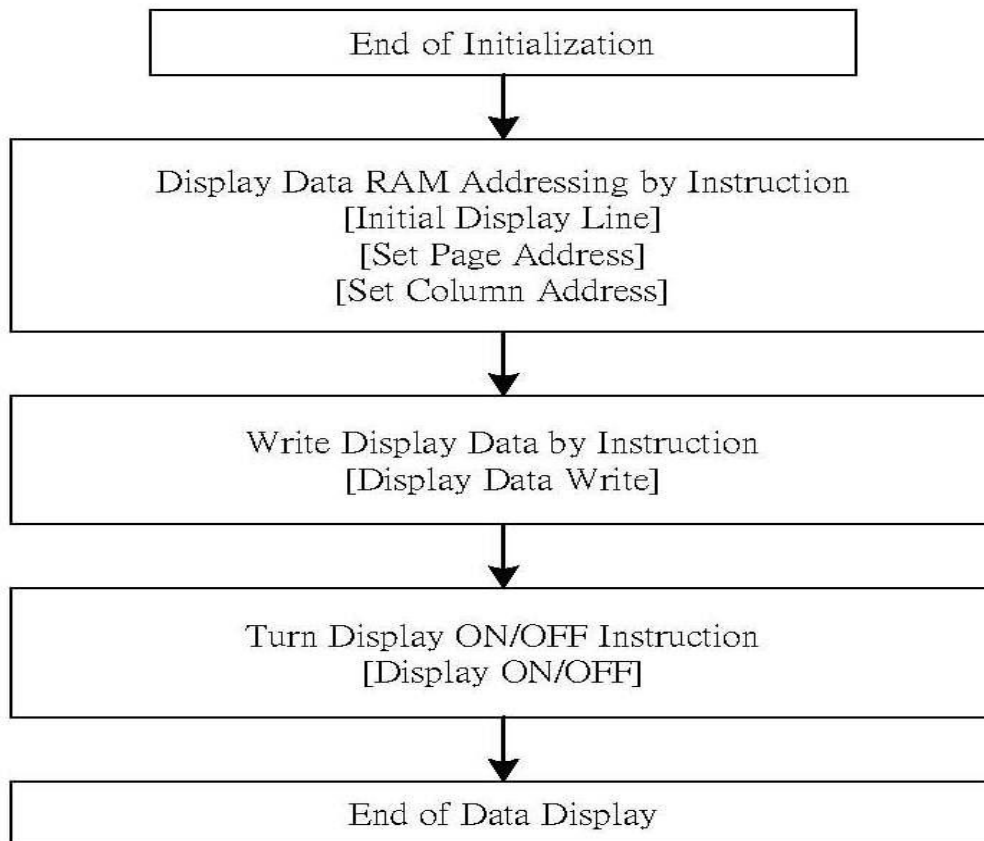
### 12.2.3 . Initializing by Instruction

#### Referential Instruction Setup Flow: Initializing with the built-in Power Supply Circuits



IN

## Referential Instruction Setup Flow: Data Displaying



## Referential Instruction Setup Flow: Power OFF

