

SPECIFICATIONS FOR LCD MODULE

MODEL NO.
BO12864LFPHH\$
VER.03



Customer :

APPROVED BY:

Date:

/ /

Distributor:

APPROVED BY:

Date:

/ /

APPROVED BY	CHECKED BY	COMPOSED BY
R&D Manager 	R&D Engineer 	FAE 

BOLYMIN, INC.

5F, No. 38, Keya Rd., Daya Dist., Central Taiwan Science Park, Taichung City, 42881, Taiwan.

Web Site:<http://www.bolymin.com.tw> TEL:+886-4-25658689 FAX:+886-4-25658698

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1. Numbering System

	<u>B</u>	<u>O</u>	<u>12864</u>	<u>L</u>	<u>F</u>	<u>P</u>	<u>H</u>	:	<u>H</u>	<u>\$</u>
	0	1	2	3	4	5	6	7	8	9
0	Brand			Bolymin						
1	Module Type			C= character type G= graphic type P= TAB/TCP type				O= COG type F= COF type L=PLED/OLED		
2	Format			2002=20 characters, 2 lines 12232= 122 x 32 dots						
3	Version No.			A type						
4	LCD Color			G=STN/gray Y=STN/yellow-green C=color STN K=DFSTN				B=STN/blue F=FSTN T=TN		
5	LCD Type			R=positive/reflective P=positive/transflective				M=positive/transmissive N=negative/transmissive		
6	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 S=LED edge/RGW		
7	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		
8	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		
9	Special Code			3=3.3 volt logic power supply n=negative voltage for LCD c=cable/connector				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°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°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 64	dots
Module dimension (L x W x H)	62.8 x 83.5x 5.3 (MAX)	mm
View area	57.6 x 36.7	mm
Active area	53.73 x 31.97	mm
Dot size	0.39 x 0.47	mm
Dot pitch	0.42 x 0.50	mm

(2) Controller IC: ST7567-G4B-1 controller

4. Absolute Maximum Ratings

4.1 Electrical Absolute Maximum Ratings

(VSS=0V, Ta=25°C)

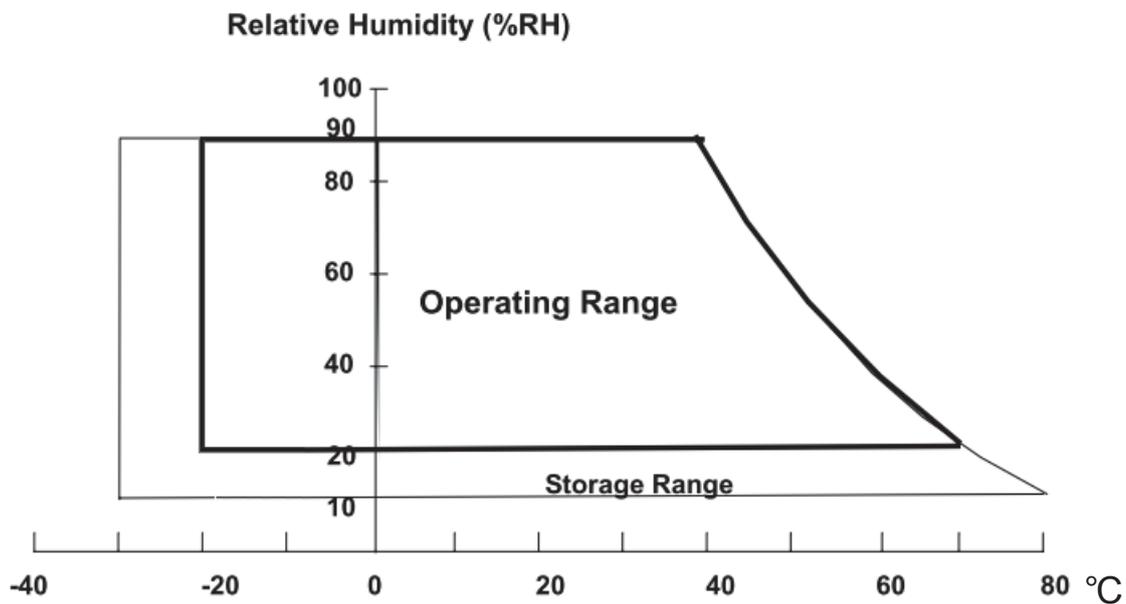
Item	Symbol	Min	Max	Unit
Supply Voltage	VDD	-0.3	3.6	V
Supply Voltage (LCD Driver)	V0-XV0	-0.3	16.0	V
Input Voltage	VI	-0.3	VDD+0.3	V

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

(VSS=0V, Ta=25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	VDD-VSS	—	3.0	3.3	3.4	V
Supply Voltage For LCD	V0-XV0	—	8.5	8.8	9.1	V
Input High Volt.	VIH	—	0.7VDD	—	VDD	V
Input Low Volt.	VIL	—	VSS	—	0.3VDD	V
Output High Volt.	VOH	—	0.8VDD	—	VDD	V
Output Low Volt.	VOL	—	VSS	—	0.2VDD	V
Supply Current	IDD	VDD=3.3V	—	1.0	2.0	mA
LCM Surface Luminance	L	I _{LED} =60 mA Display all OFF	70	105	—	cd/m ²

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

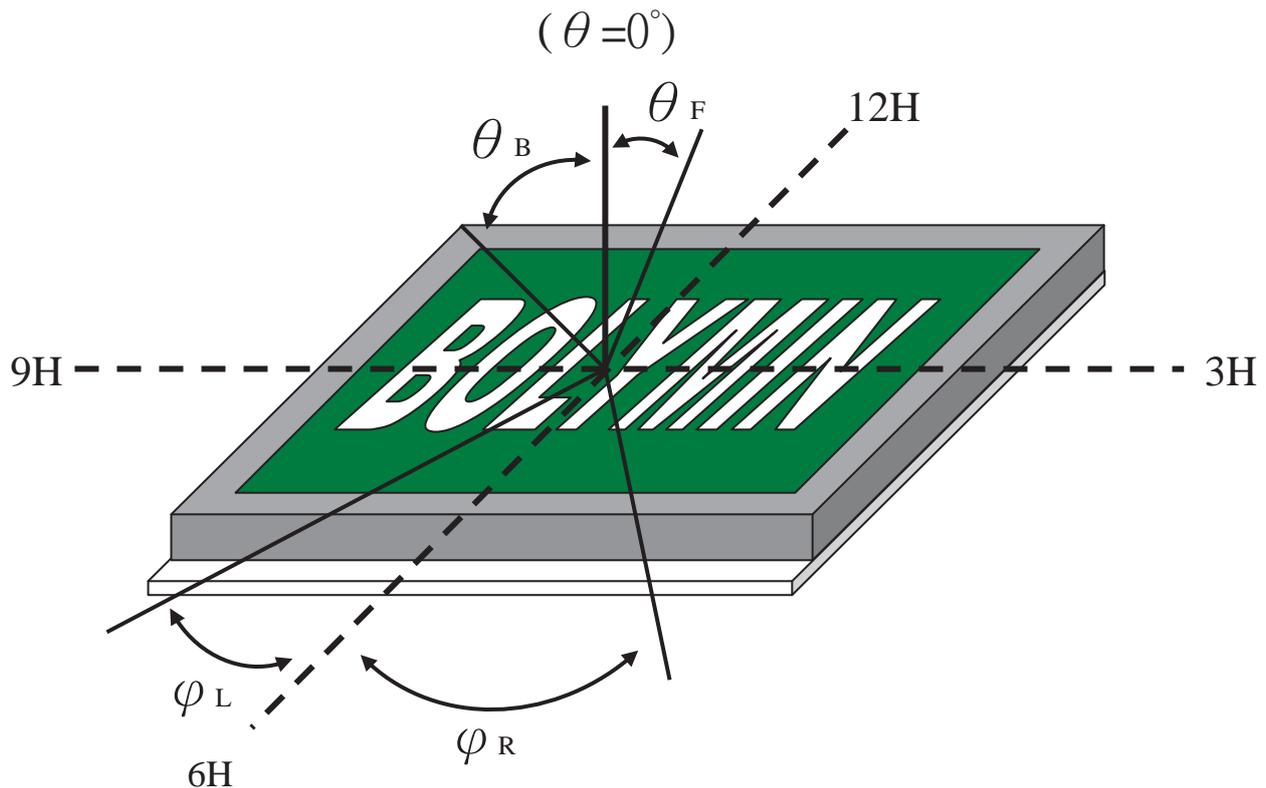
Duty ratio=1/65, Bias ratio=1/9, Measured in Dots ON-state.

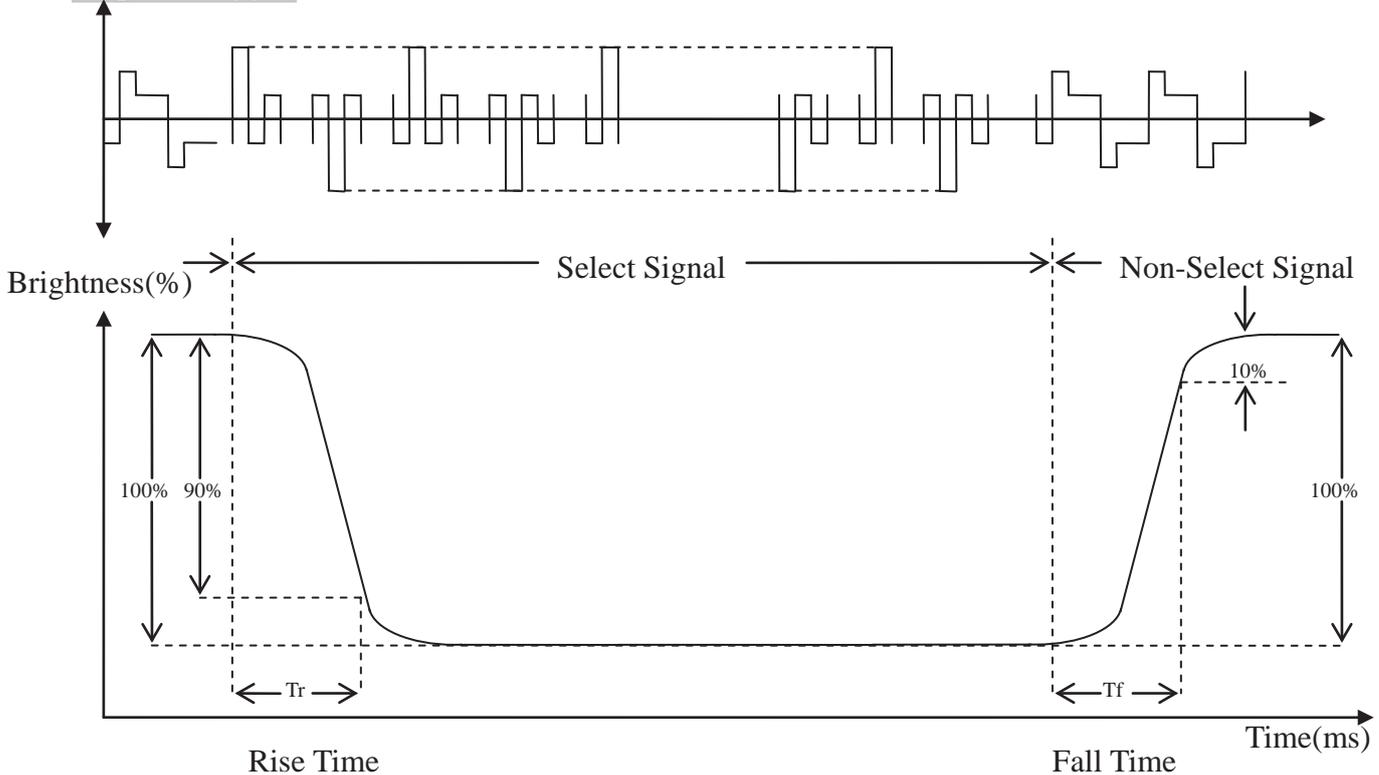
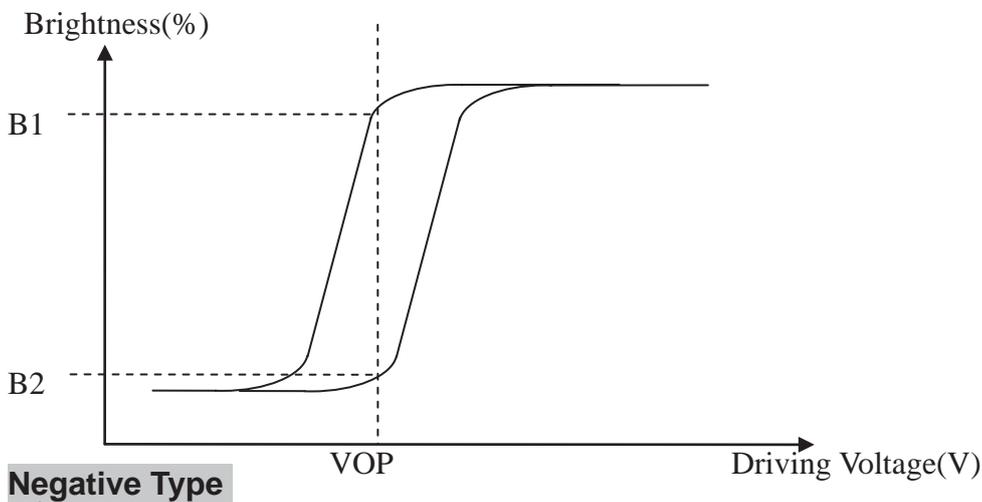
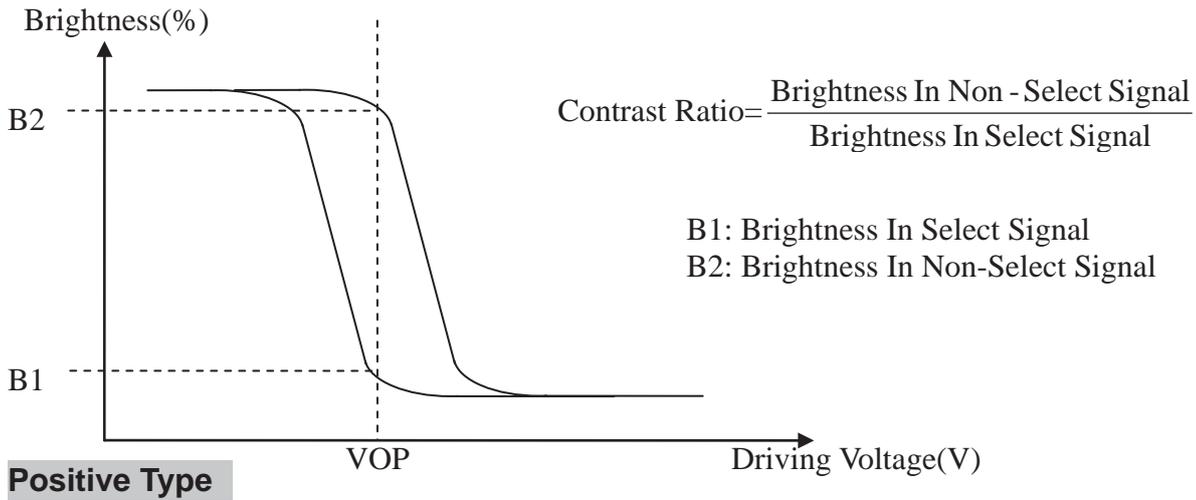
6. Optical Characteristics

a. FSTN

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

Item	Symbol	Min.	Typ.	Max.	Unit
View Angle ($\text{CR} \geq 2$)	θ_F	-	25	-	deg
	θ_B	-	32	-	deg
	φ_L	-	35	-	deg
	φ_R	-	35	-	deg
Contrast Ratio	CR	2	3	-	-
Response Time 25°C	T rise	-	200	300	ms
	T fall	-	250	400	ms



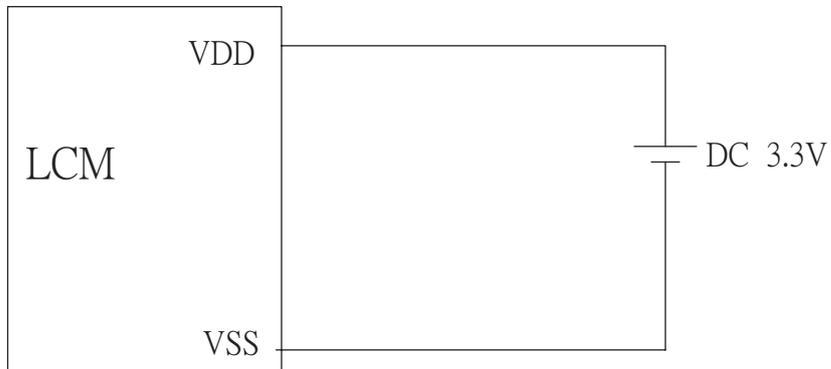


7.Interface Pin Function

7.1 Pin Description

Pin No.	Symbol	Level	Description
1	NC	-	Not used.
2	NC	-	Not used.
3	CSB	H/L	Chip select input pin. Interface access is enabled when CSB is "L". When CSB is non-active (CSB="H"), D[7:0] pins are high impedance.
4	RSTB	H/L	Hardware reset input pin. When RSTB is "L", internal initialization is executed and the internal registers will be initialized.
5	A0	H/L	It determines whether the access is related to data or command. A0="H" : Indicates that signals on D[7:0] are display data. A0="L" : Indicates that signals on D[7:0] are command.
6	SCL	H/L	SCL : Serial clock input.
7	SDA	H/L	SDA : Serial data input.
8	VDD	Power	Power supply.
9	VSS	Power	Power supply.
10	V0	O	V0 is the LCD driving voltage for common circuits at negative frame.
11	XV0	O	XV0 is the LCD driving voltage for common circuits at positive frame.
12	VG	O	VG is the LCD driving voltage for segment circuits.
13	NC	-	Not used.
14	NC	-	Not used.
15	LEDA	Power	Backlight anode.
16	LEDK	Power	Backlight cathode.

8. Power supply for LCD Module



9. Backlight information

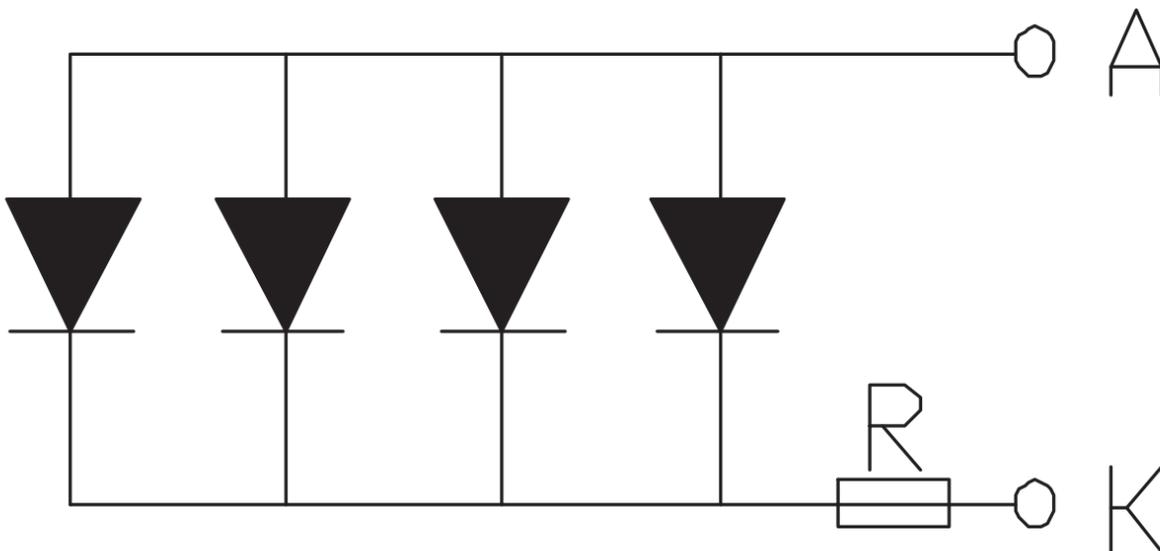
9.1 LED edge/white

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I _{LED}	—	60	—	mA	V=3.3V
Supply Voltage	V	3.0	3.3	3.5	V	I _{LED} =60mA
Reverse Current	I _R	—	—	40	uA	—
CIE Chromaticity Diagram	X	0.25	—	0.31	nm	I _{LED} =60mA
	Y	0.26	—	0.32		
Color	White					

*Measured at the bare LED back-light unit

9.2 Backlight Circuit Diagram

LED SMD 1x4 =4 DIES



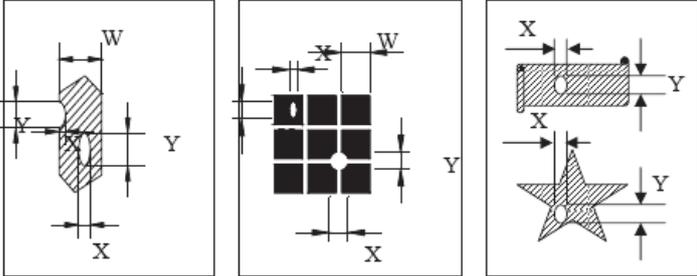
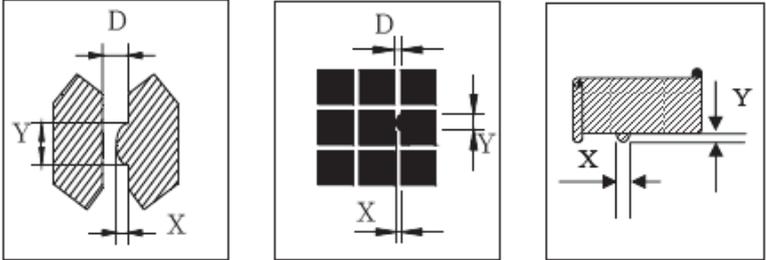
10. Quality Assurance

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

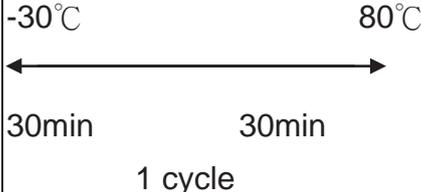
NO.	Parameter	Criteria				
1	Black or White spots (Particle)	Zone		Acceptable Number	Class Of Defects	Acceptable Level
		Dimension				
		$D \leq 0.10$		Disregard	Minor	2.5
		$0.10 < D \leq 0.2$		4		
		$0.2 < D \leq 0.3$		2		
$0.3 < D$		0				
$D = (\text{Long} + \text{Short}) / 2$ Total defects should 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)			
		—	$0.05 \geq W$	Disregard	Minor	2.5
		$4.0 \geq L$	$0.05 \geq W$	4		
		$3.0 \geq L$	$0.1 \geq W$	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" data-bbox="416 226 1171 517"> <thead> <tr> <th>Zone Dimension</th> <th>Acceptable Number</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td>$D \leq 0.2$</td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td>$0.2 < D \leq 0.5$</td> <td>3</td> </tr> <tr> <td>$0.5 < D$</td> <td>0</td> </tr> </tbody> </table> <p data-bbox="416 524 1366 667">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>	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														
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																											
4	Displaying Pattern	<p data-bbox="416 707 1038 775">1. Incomplete or broken line is not allowed. 2. Pinholes</p> <table border="1" data-bbox="459 779 1278 1025"> <thead> <tr> <th>Dimension Φ(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td>$\Phi < 0.1$</td> <td>Disregard</td> <td rowspan="4">Minor</td> <td rowspan="4">2.5</td> </tr> <tr> <td>$0.1 < \Phi \leq 0.2$</td> <td>2</td> </tr> <tr> <td>$0.2 < \Phi \leq 0.25$</td> <td>1</td> </tr> <tr> <td>$0.25 < \Phi$</td> <td>0</td> </tr> </tbody> </table> <div data-bbox="469 1032 1166 1308">  <p data-bbox="756 1317 879 1346" style="text-align: center;">$\emptyset = (X+Y)/2$</p> </div> <p data-bbox="416 1384 639 1413">3. Deformation</p> <table border="1" data-bbox="459 1417 1342 1621"> <thead> <tr> <th>Dimension Φ(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td>$\Phi < 0.15$</td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td>$\Phi \leq 0.25$ and $X \leq 1/2D$</td> <td>3</td> </tr> <tr> <td>$\Phi > 0.25$ and $X > 1/2D$</td> <td>0</td> </tr> </tbody> </table> <div data-bbox="469 1630 1235 1890">  <p data-bbox="501 1910 603 1939">D : 間距</p> <p data-bbox="794 1910 927 1939" style="text-align: center;">$\emptyset = (X+Y)/2$</p> </div>	Dimension Φ (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 Φ (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 Φ (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																											
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$\Phi > 0.25$ and $X > 1/2D$	0																											

Other Inspection standard reference Bolymin standard.

11. Reliability

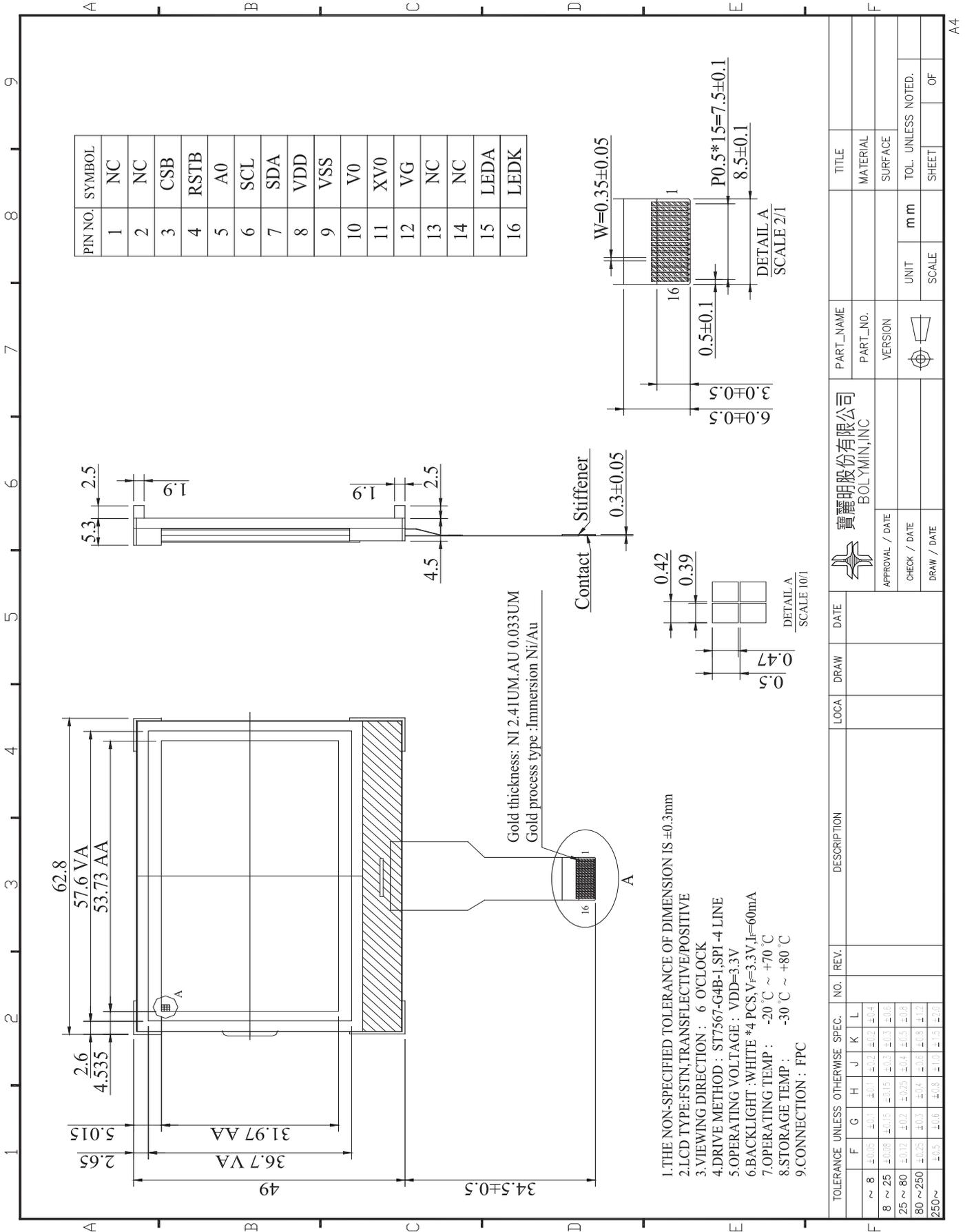
■ Content of Reliability Test

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 15 minutes	—

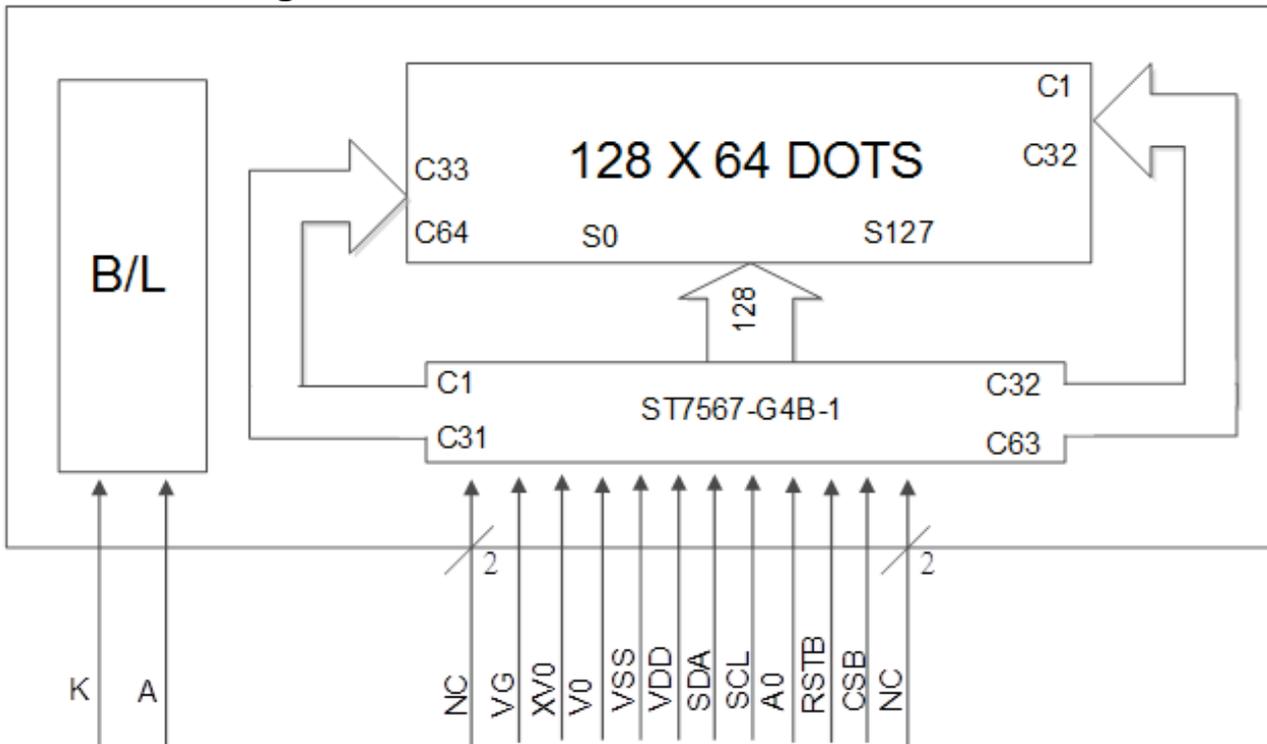
※Assess after placing at normal temperature and humidity for 4 hour ◦ No abnormalities in functions and appearance ◦

12. Drawing & Block Diagram

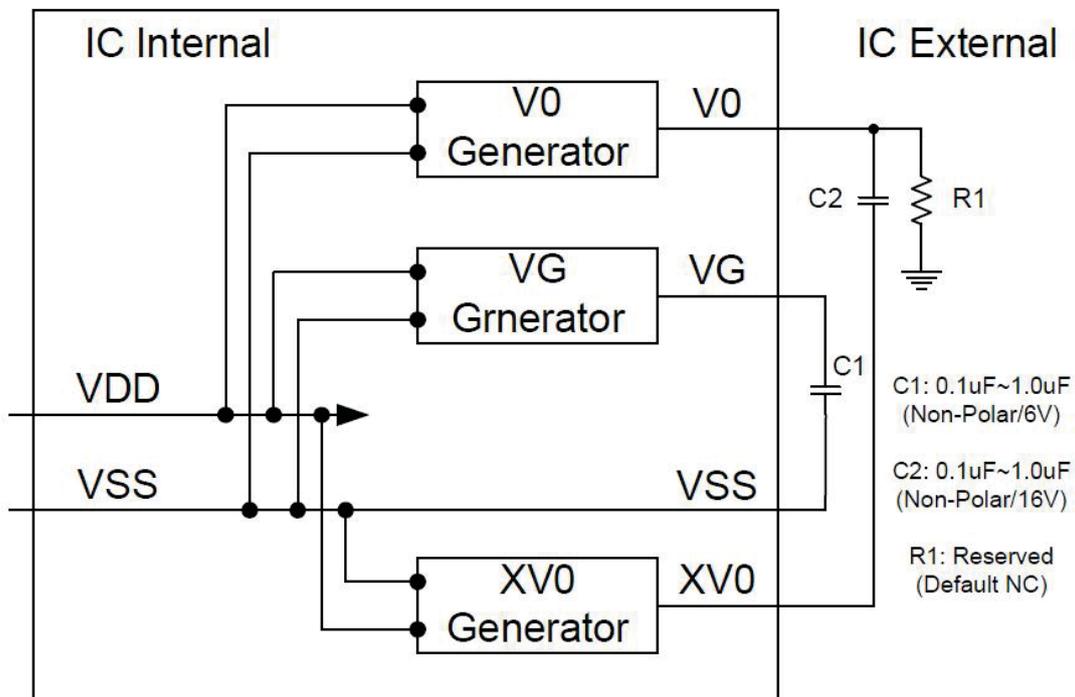
12.1 LCM Drawing



12.2 Block Diagram



12.3.1 External components recommended



13. Instruction Table & Timing Characteristics

13.1 Instruction Table

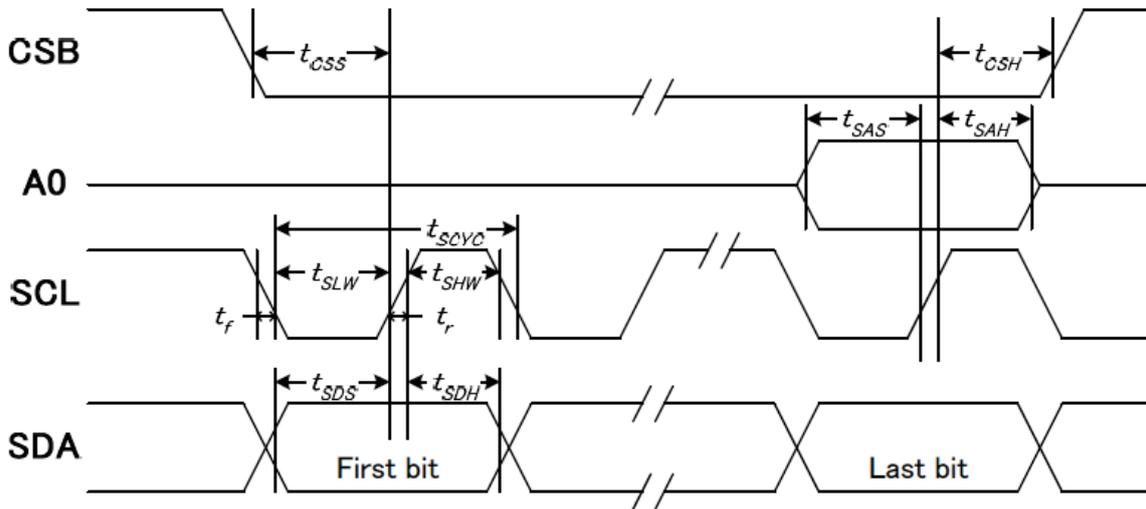
INSTRUCTION	A0	R/W (RWR)	COMMAND BYTE								DESCRIPTION
			D7	D6	D5	D4	D3	D2	D1	D0	
(1) Display ON/OFF	0	0	1	0	1	0	1	1	1	D	D=1, display ON D=0, display OFF
(2) Set Start Line	0	0	0	1	S5	S4	S3	S2	S1	S0	Set display start line
(3) Set Page Address	0	0	1	0	1	1	Y3	Y2	Y1	Y0	Set page address
(4) Set Column Address	0	0	0	0	0	1	X7	X6	X5	X4	Set column address (MSB)
	0	0	0	0	0	0	X3	X2	X1	X0	Set column address (LSB)
(5) Read Status	0	1	0	MX	D	RST	0	0	0	0	Read IC Status
(6) Write Data	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write display data to RAM
(7) Read Data	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read display data from RAM
(8) SEG Direction	0	0	1	0	1	0	0	0	0	MX	Set scan direction of SEG MX=1, reverse direction MX=0, normal direction
(9) Inverse Display	0	0	1	0	1	0	0	1	1	INV	INV =1, inverse display INV =0, normal display
(10) All Pixel ON	0	0	1	0	1	0	0	1	0	AP	AP=1, set all pixel ON AP=0, normal display
(11) Bias Select	0	0	1	0	1	0	0	0	1	BS	Select bias setting 0=1/9; 1=1/7 (at 1/65 duty)
(12) Read-modify-Write	0	0	1	1	1	0	0	0	0	0	Column address increment: Read:+0 , Write:+1
(13) END	0	0	1	1	1	0	1	1	1	0	Exit Read-modify-Write mode
(14) RESET	0	0	1	1	1	0	0	0	1	0	Software reset
(15) COM Direction	0	0	1	1	0	0	MY	-	-	-	Set output direction of COM MY=1, reverse direction MY=0, normal direction
(16) Power Control	0	0	0	0	1	0	1	VB	VR	VF	Control built-in power circuit ON/OFF
(17) Regulation Ratio	0	0	0	0	1	0	0	RR2	RR1	RR0	Select regulation resistor ratio
(18) Set EV	0	0	1	0	0	0	0	0	0	1	Double command!! Set electronic volume (EV) level
	0	0	0	0	EV5	EV4	EV3	EV2	EV1	EV0	
(19) Set Booster	0	0	1	1	1	1	1	0	0	0	Double command!! Set booster level: BL=0: 4X BL=1: 5X
	0	0	0	0	0	0	0	0	0	BL	
(20) Power Save	0	0	Compound Command								Display OFF + All Pixel ON
(21) NOP	0	0	1	1	1	0	0	0	1	1	No operation
(22) Test	0	0	1	1	1	1	1	1	1	-	Do NOT use. Reserved for testing.

Note:

1. "--" = Disabled bit. It can be either logic 0 or 1.
2. For detail description of instruction. Please refer to ST7567 datasheet.

13.2 4-Lines Serial Interface Timing

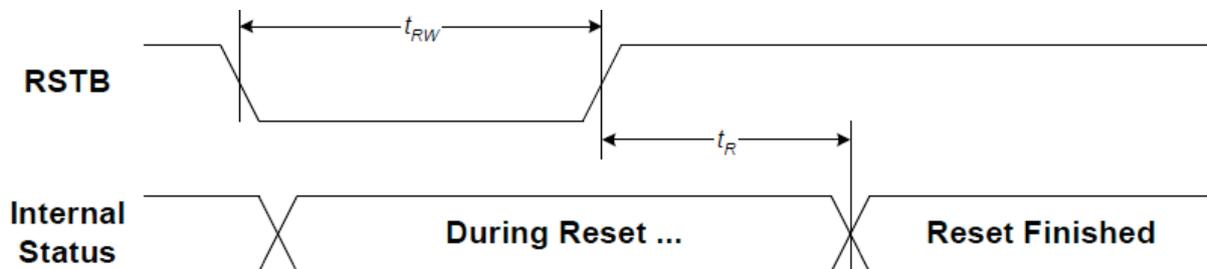
13.2.1 . Timing characteristics



(VDD = 3.3V , Ta =25°C)

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Serial clock period	SCLK	tSCYC		50	—	ns
SCLK "H" pulse width		tSHW		25	—	
SCLK "L" pulse width		tSLW		25	—	
Address setup time	A0	tSAS		20	—	
Address hold time		tSAH		10	—	
Data setup time	SDA	tSDS		20	—	
Data hold time		tSDH		10	—	
CSB-SCLK time	CSB	tCSS		20	—	
CSB-SCLK time		tCSH		40	—	

13.2.2 Reset Timing

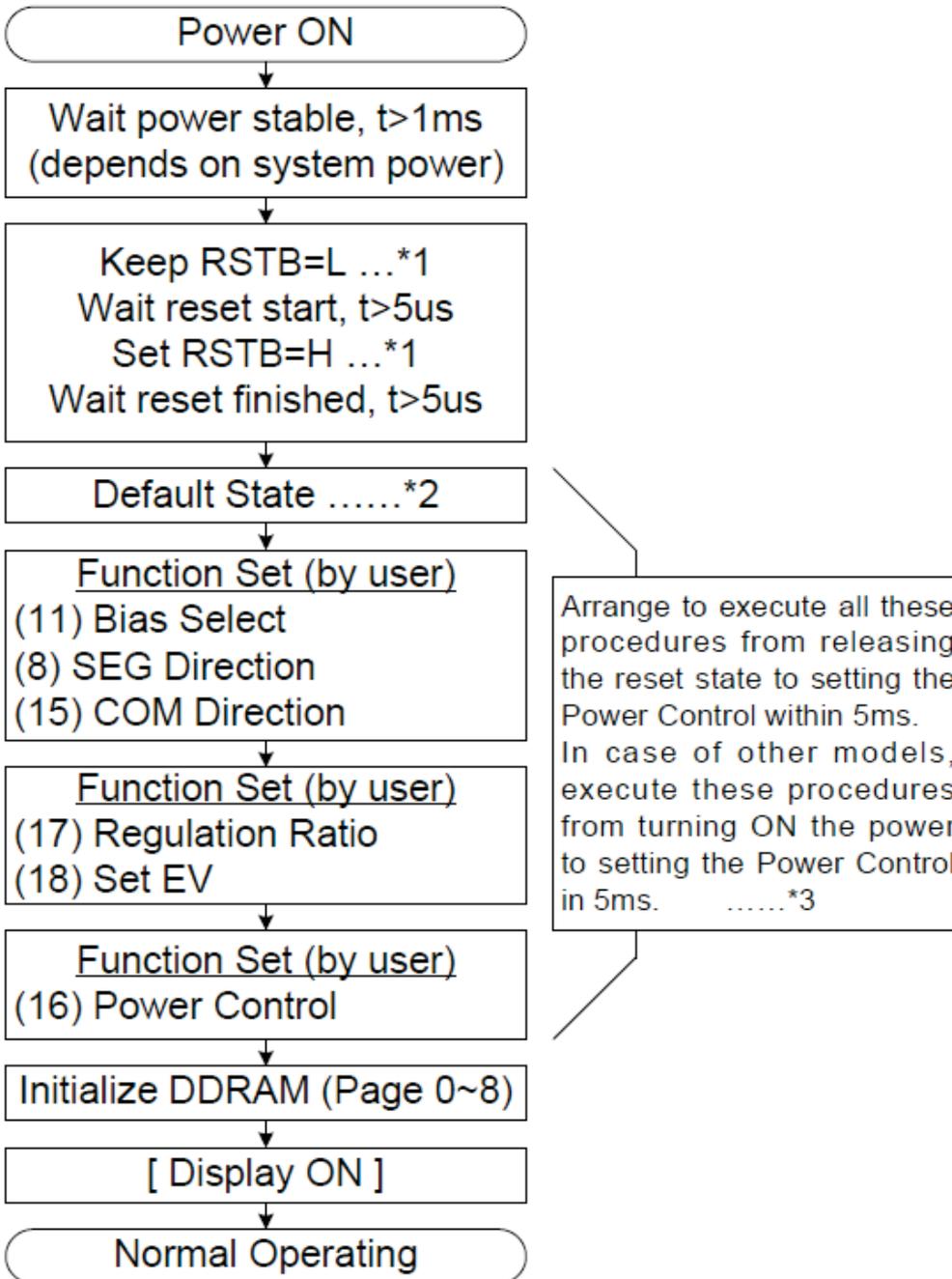


(VDD = 3.3V , Ta =25°C)

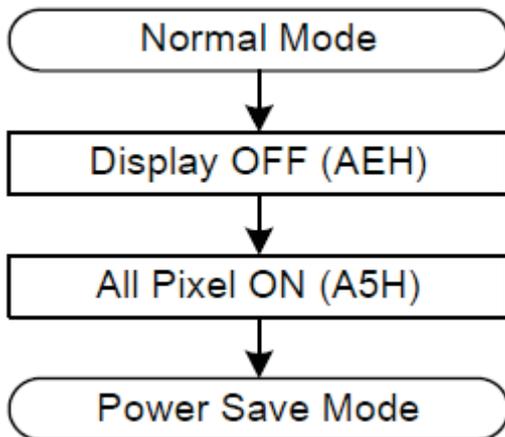
Item	Symbol	Condition	Min.	Max.	Unit
Reset time	tR		—	1.0	us
Reset "L" pulse width	tRW		1.0	—	

13.3 Recommended Setting

13.3.1 Referential Initial Flow



13.3.2 ENTERING THE POWER SAVE MODE



13.3.3 EXITING THE POWER SAVE MODE

