

**BOLYMIN**

**SPECIFICATIONS FOR  
LCD MODULE**

**MODEL NO.  
BO12864JFPHH20i\$  
VER.01**



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	2018/03/19	SPEC.

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# 1. Numbering System

<u>B</u>	<u>O</u>	<u>12864</u>	<u>J</u>	<u>F</u>	<u>P</u>	<u>H</u>	:	<u>H</u>	<u>20i\$</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 20i= SPI interface	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 64	dots
Module dimension (L x W x H)	89.7 x 148.7 x 6.0 LED B/L	mm
View area	69.0 x 36.5	mm
Active area	63.97 x 31.97	mm
Dot size	0.47 x 0.47	mm
Dot pitch	0.5 x 0.5	mm

#### (2) Controller IC: ST7565P controller

### 4. Absolute Maximum Ratings

#### 4.1 Electrical Absolute Maximum Ratings

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

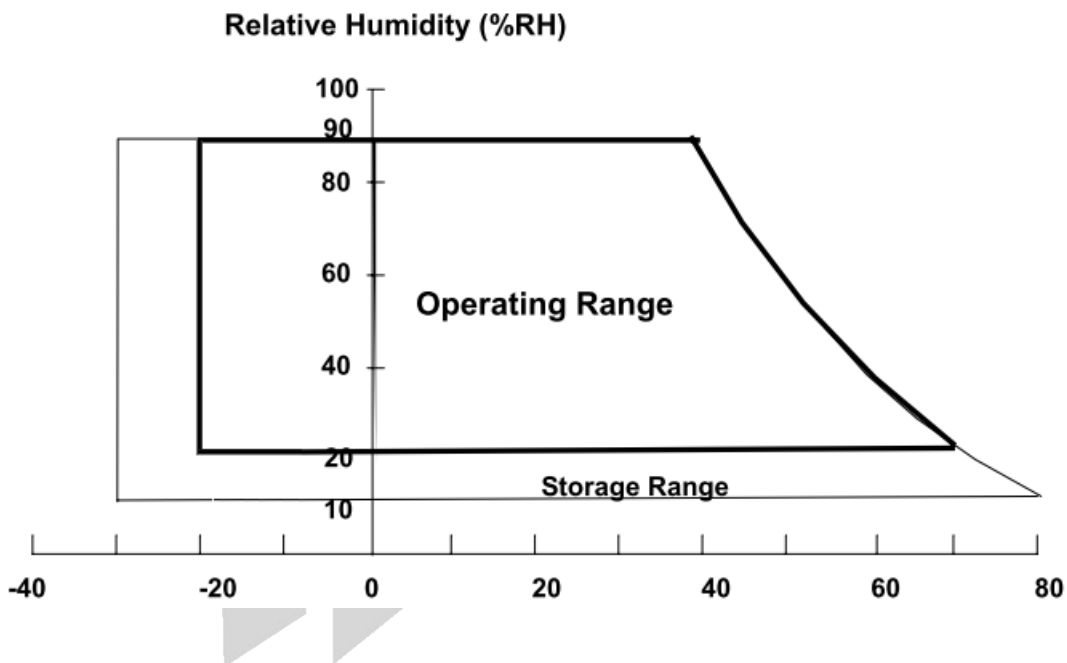
Item	Symbol	Min	Typ	Max	Unit
Supply Voltage For Logic	V <sub>dd</sub> -V <sub>ss</sub>	1.8	-	3.3	V
Supply Voltage For LCD	V <sub>o</sub> -V <sub>ss</sub>	3.0	-	12	V

## 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.

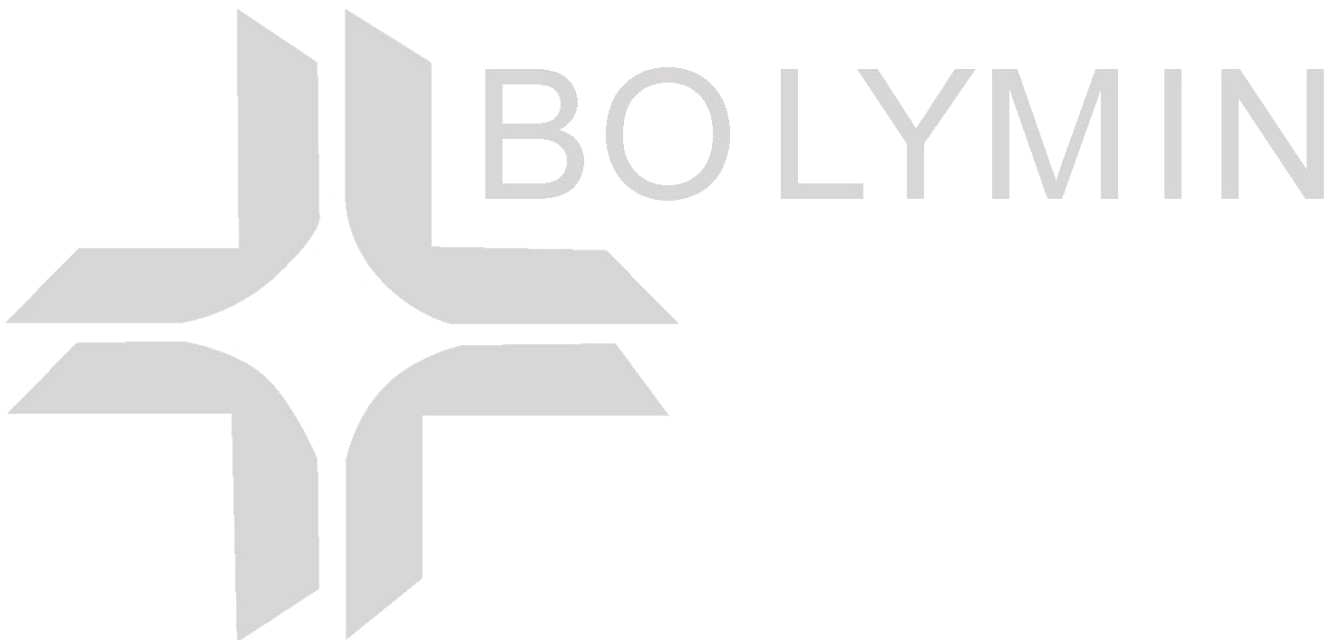




## 5. Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	Vdd-Vss	—	2.7	—	3.3	V
Supply Voltage For LCD	Vo-Vss	Ta=25°C	9.2	9.45	9.70	V
Input High Volt.	V <sub>IH</sub>	—	0.8*Vdd	—	Vdd	V
Input Low Volt.	V <sub>IL</sub>	—	Vss	—	0.2*Vdd	V
Output High Volt.	V <sub>OH</sub>	—	0.8*Vdd	—	Vdd	V
Output Low Volt.	V <sub>OL</sub>	—	Vss	—	0.2*Vdd	V
Supply Current	I <sub>dd</sub>	Vdd=3.3V	—	—	3.0	mA
LCM Surface Luminance Ta=25°C	L	I <sub>LED</sub> =90mA Display all OFF	90	135	—	cd/m <sup>2</sup>

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

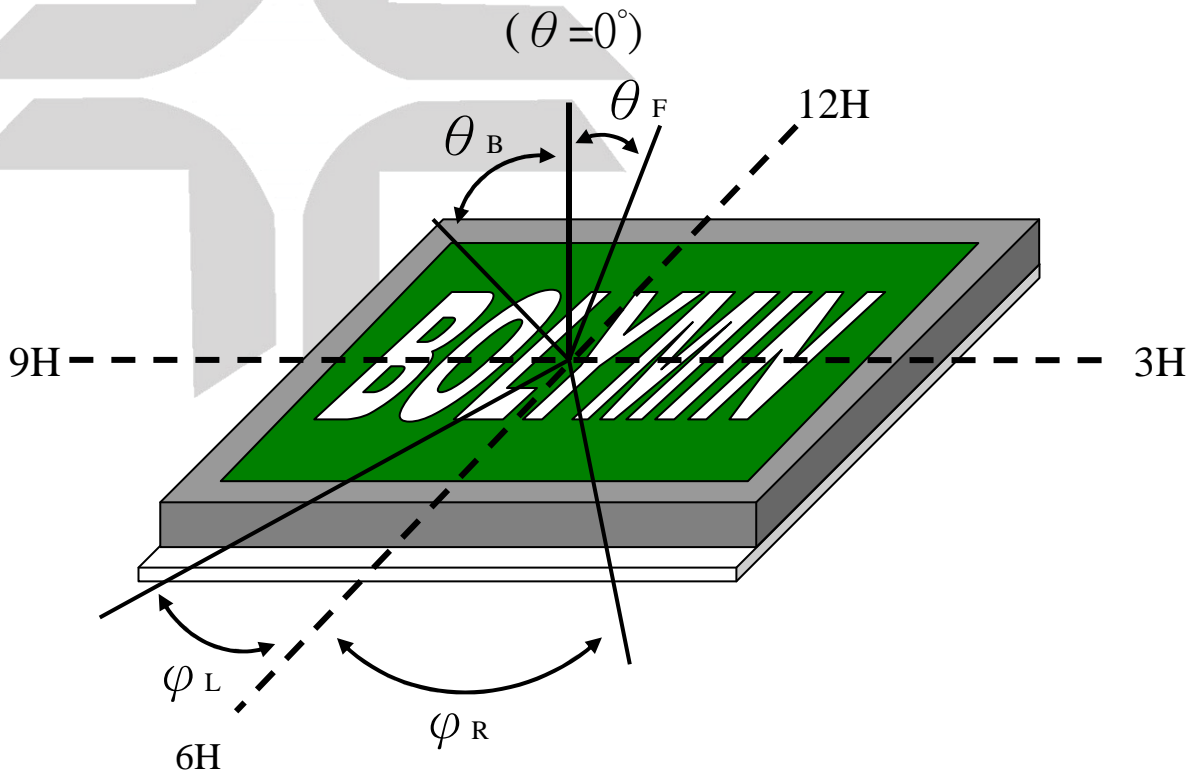


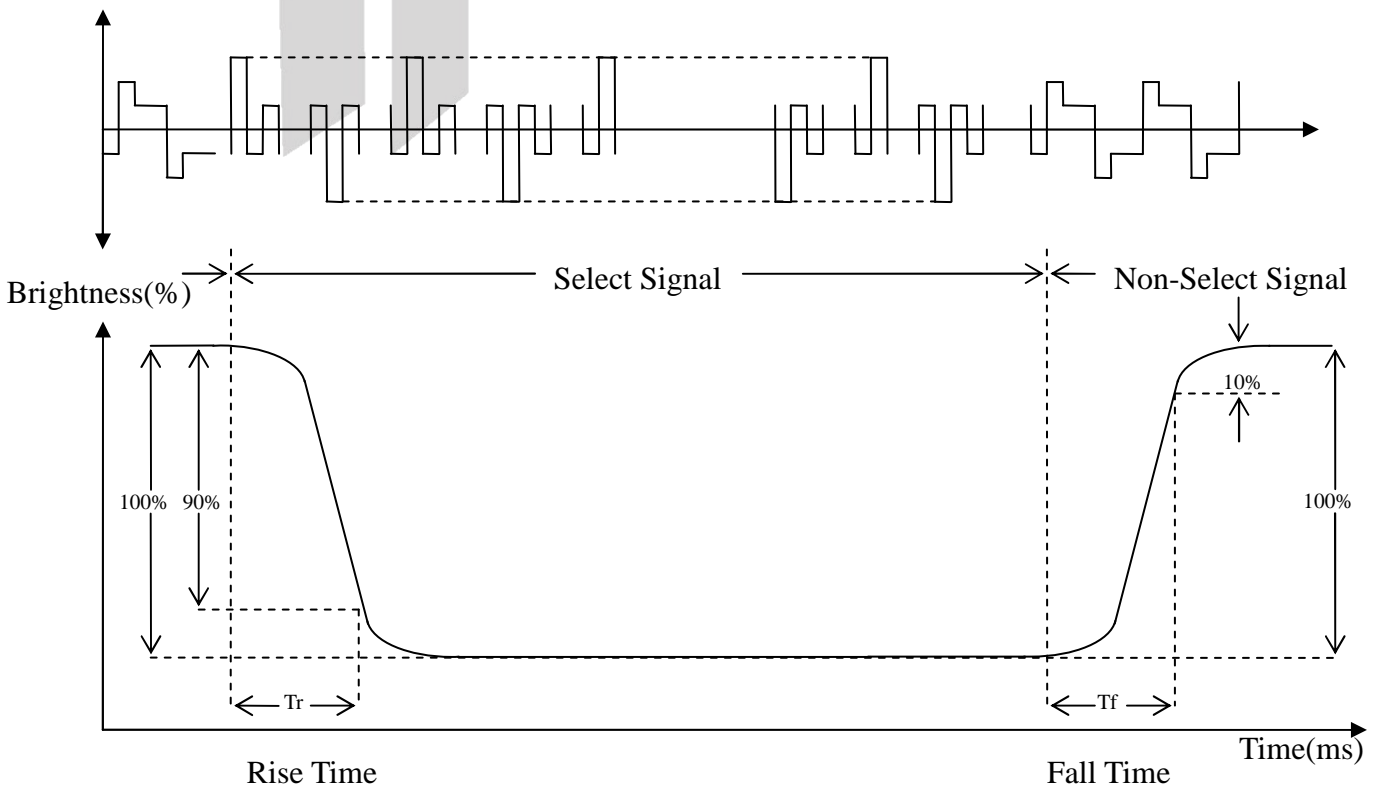
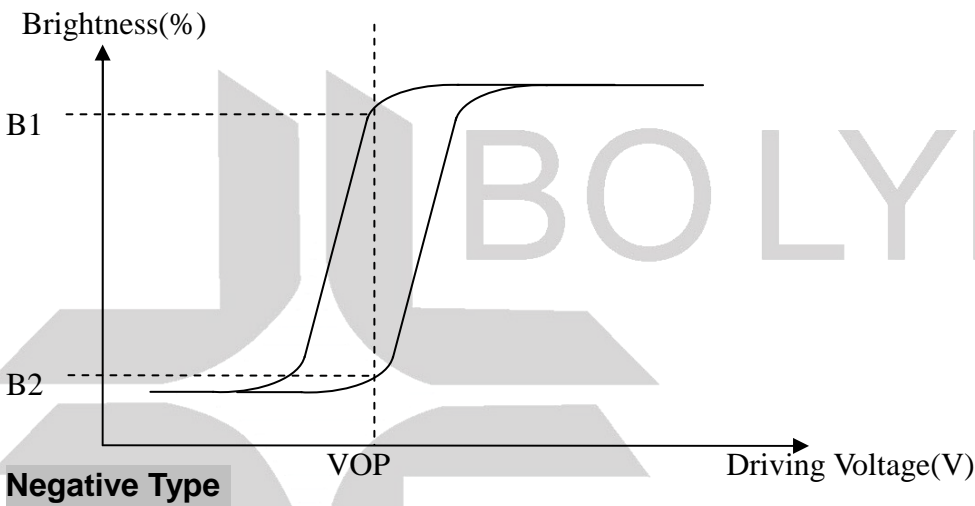
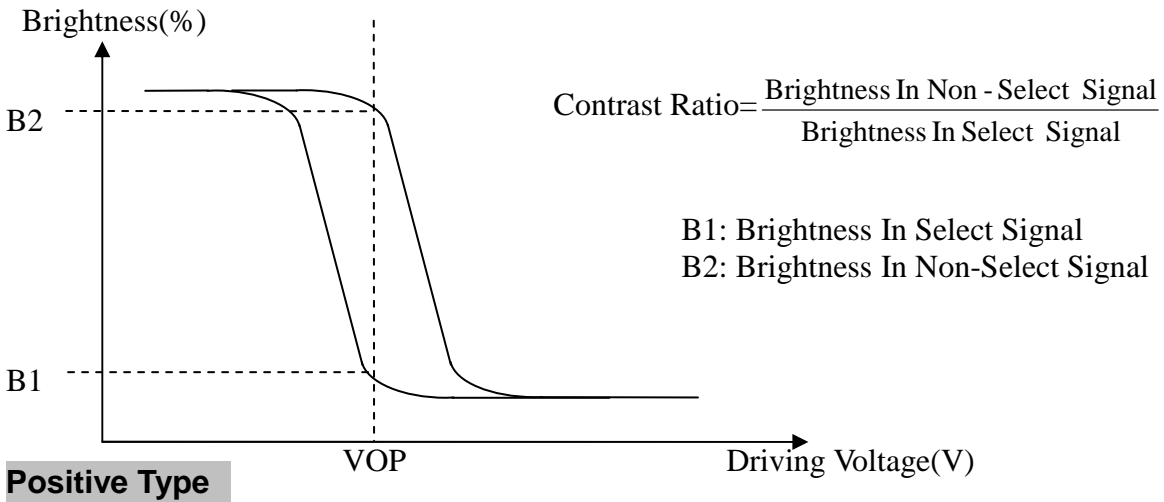
## 6. Optical Characteristics

a. FSTN

(Ta=25°C)

Item	Symbol	Min.	Typ.	Max.	Unit
View Angle (CR>=2)	$\theta_F$	-	25	-	deg
	$\theta_B$	-	28	-	deg
	$\varphi_L$	-	26	-	deg
	$\varphi_R$	-	25	-	deg
Contrast Ratio	CR	-	5	-	-
Response Time 25°C	T rise	-	200	400	ms
	T fall	-	250	400	ms





## 7.Interface Pin Function

Pin No.	Symbol	I/O	Description
1	/CS1B	I	This is the chip select signal. When /CS1B="L", then the chip select becomes active, and data/command I/O is enabled.
2	/RES	I	When /RES is set to "L", the setting are initialized.
3	A0	I	This is connect to the least significant bit of the normal MPU address bus, and it determines whether the data bits are data or command.
4	WR(R/W)	I	The data bus are latched at the rising edge of the WR signal.
5	RD(E)	I	This is the enable clock input terminal of the 6800 Series MPU.
6~13	DB0~DB7	I/O	This is an 8-bit bi-directional data bus. In serial interface (SPI mode) DB7: Serial data input (SI); D6: Serial clock input (SCL). D0 to D5 should be connected to VDD or floating.
14	VDD	P	Power supply.
15	VSS	P	Ground.
16	VOUT	O	DC/DC voltage converter. Connect a capacitor between this terminal and VSS or VDD.
17	CAP3P	O	DC/DC voltage converter.
18	CAP1N	O	DC/DC voltage converter.
19	CAP1P	O	DC/DC voltage converter.
20	CAP2P	O	DC/DC voltage converter.
21	CAP2N	O	DC/DC voltage converter.
22~26	V4~V0	P	This is a multi-level power supply for the liquid crystal drive.
27	VR	I	Output voltage regulator terminal. Provides the voltage between VSS and V0 through a resistive voltage divider.
28	C86	I	H: 6800 series MPU; L:8080 series MPU
29	P/S	I	This is the parallel data input/serial data input switch terminal.
30	NC	-	No connection.

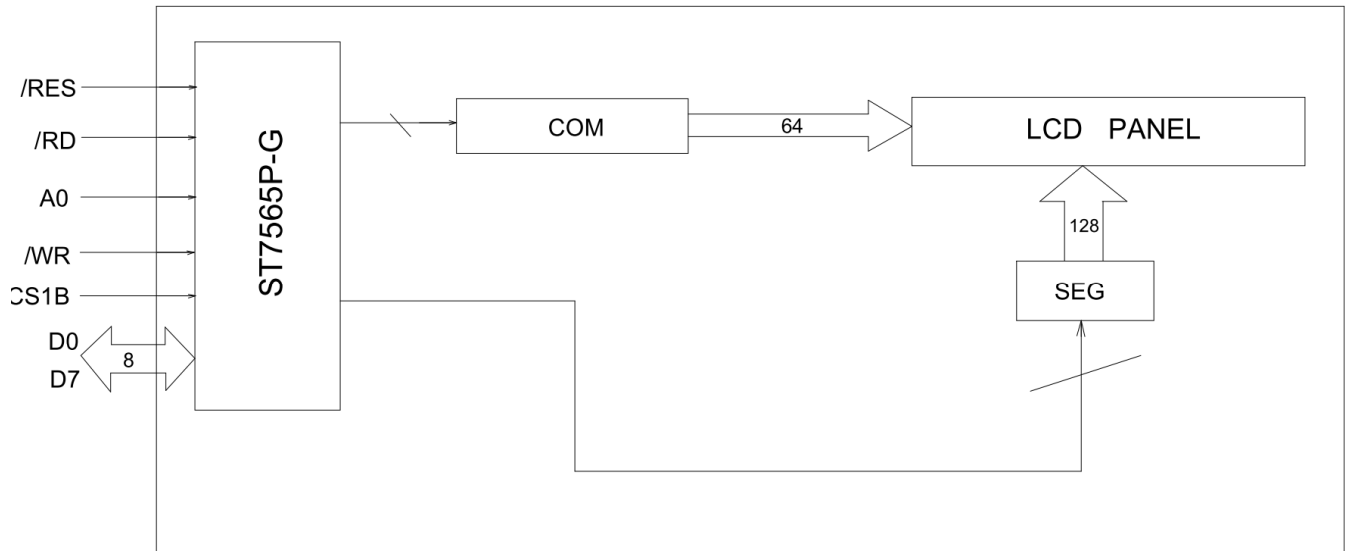
**Note: Fix P/S to "VSS" for Serial Peripheral Interface (SPI mode).**

**In SPI mode, D0 to D5 must be fixed to "H" or floating.**

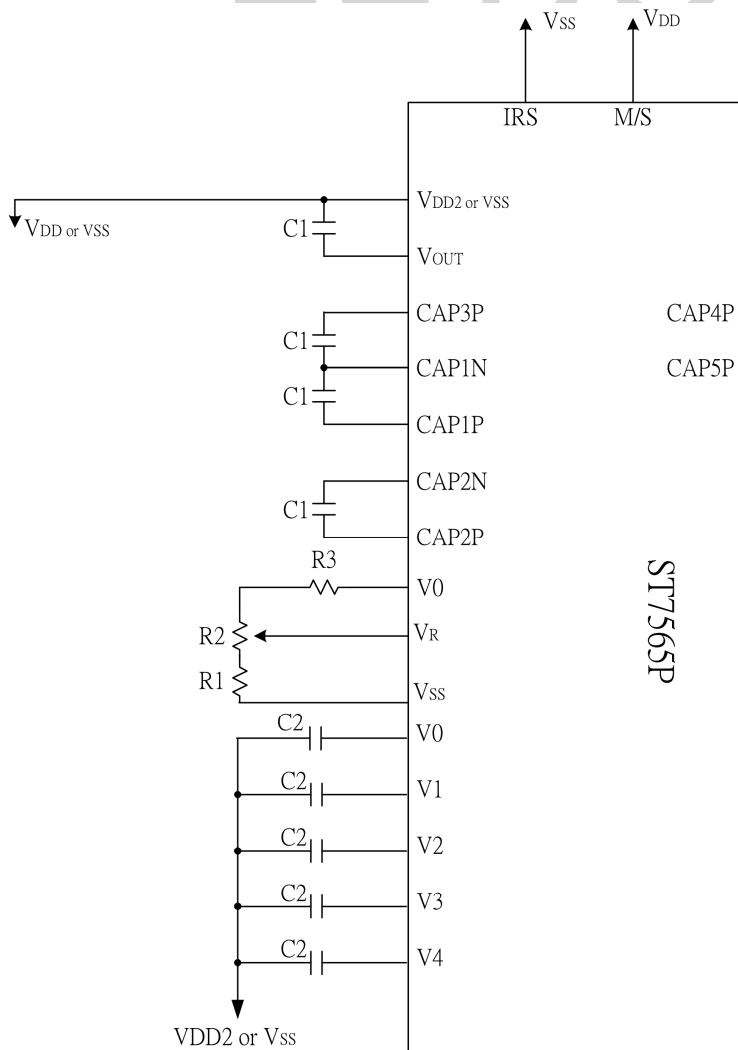
**RD (E) and WR (R/W) are fixed to either "H" or "L".**

**The serial access mode does NOT support read operation.**

## 8. BLOCK DIAGRAM and RECOMMEND CIRCUIT



When the voltage regulator internal resistor is not used.  
(Example where  $V_{DD2} = V_{DD}$ , with 4x step-up)



## 9. Backlight information

### 1 Specification

#### (1) edge LED/white

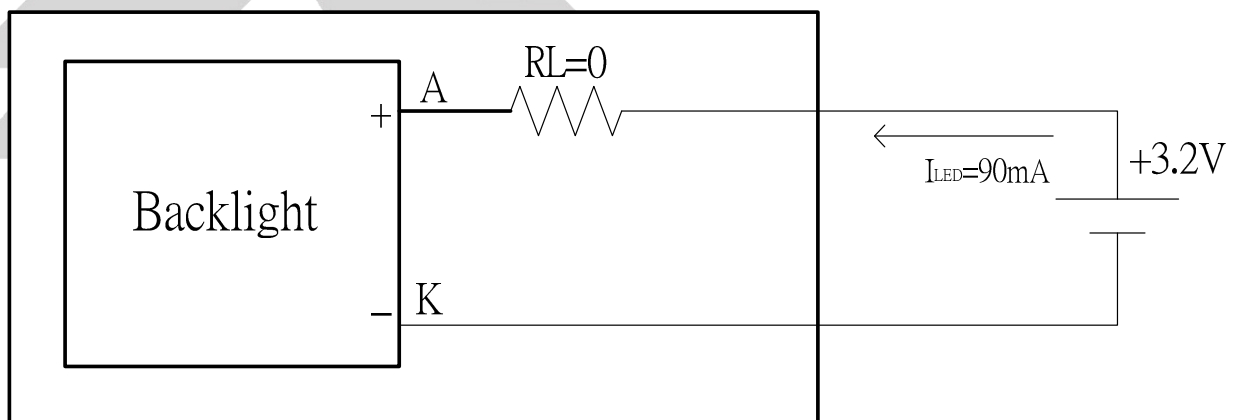
Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I <sub>LED</sub>	—	90		mA	V=3.2V
Supply Voltage	V	3.0	3.2	3.4	V	I <sub>LED</sub> =90mA
Reverse Voltage	V <sub>R</sub>	—	—	5	V	
CIE	X	0.26		0.32		I <sub>LED</sub> =90mA
	Y	0.26		0.32		
Color	White					

### 9.2 Backlight driving methods

#### a.LED B/L driven from A.K pin directly

##### a.1 edge LED/white

LCM



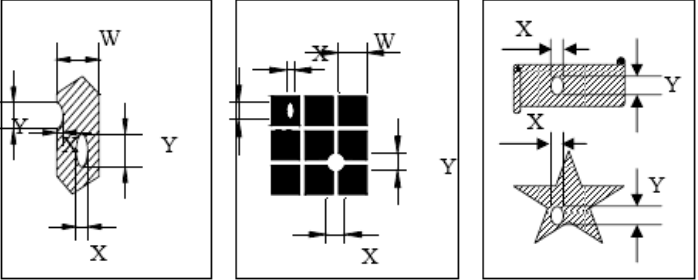
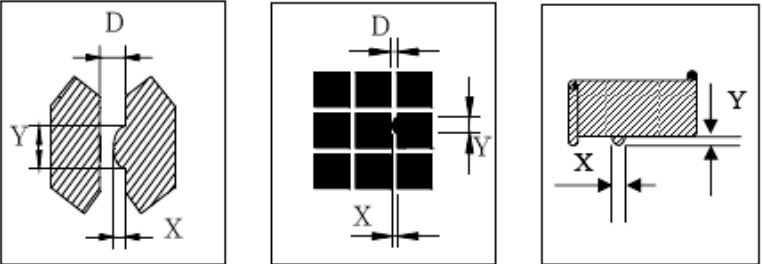
## 10. Quality Assurance

### 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				
		$D \leq 0.10$		Disregard	Minor	2.5
		$0.10 < D \leq 0.2$		4		
		$0.2 < D \leq 0.3$		2		
$0.3 < D$		0				
<p><math>D = (\text{Long} + \text{Short}) / 2</math>            Total defects should not exceed 5/module            Defect that is located at outside of AA and doesn't affect function is ignored.</p>						
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				
<p>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.</p>						

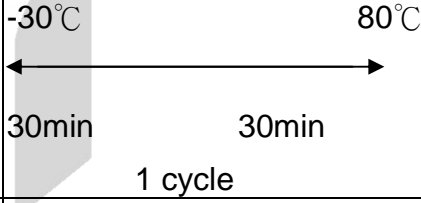
3	Air Bubbles ( between glass & polarizer)	<table border="1"> <tr> <th>Zone Dimension</th> <th>Acceptable Number</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> <tr> <td><math>D \leq 0.2</math></td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td><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> </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														
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																											
		<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"> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> <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> </table>  <p style="text-align: center;"><math>\phi = (X+Y)/2</math></p> <p>3. Deformation</p> <table border="1"> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> <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> </table>  <p style="text-align: center;"><math>D</math> : 間距      <math>\phi = (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																											
$0.2 < \Phi \leq 0.25$	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																											

Other Inspection standard reference Bolymin standard.



## 11. Reliability

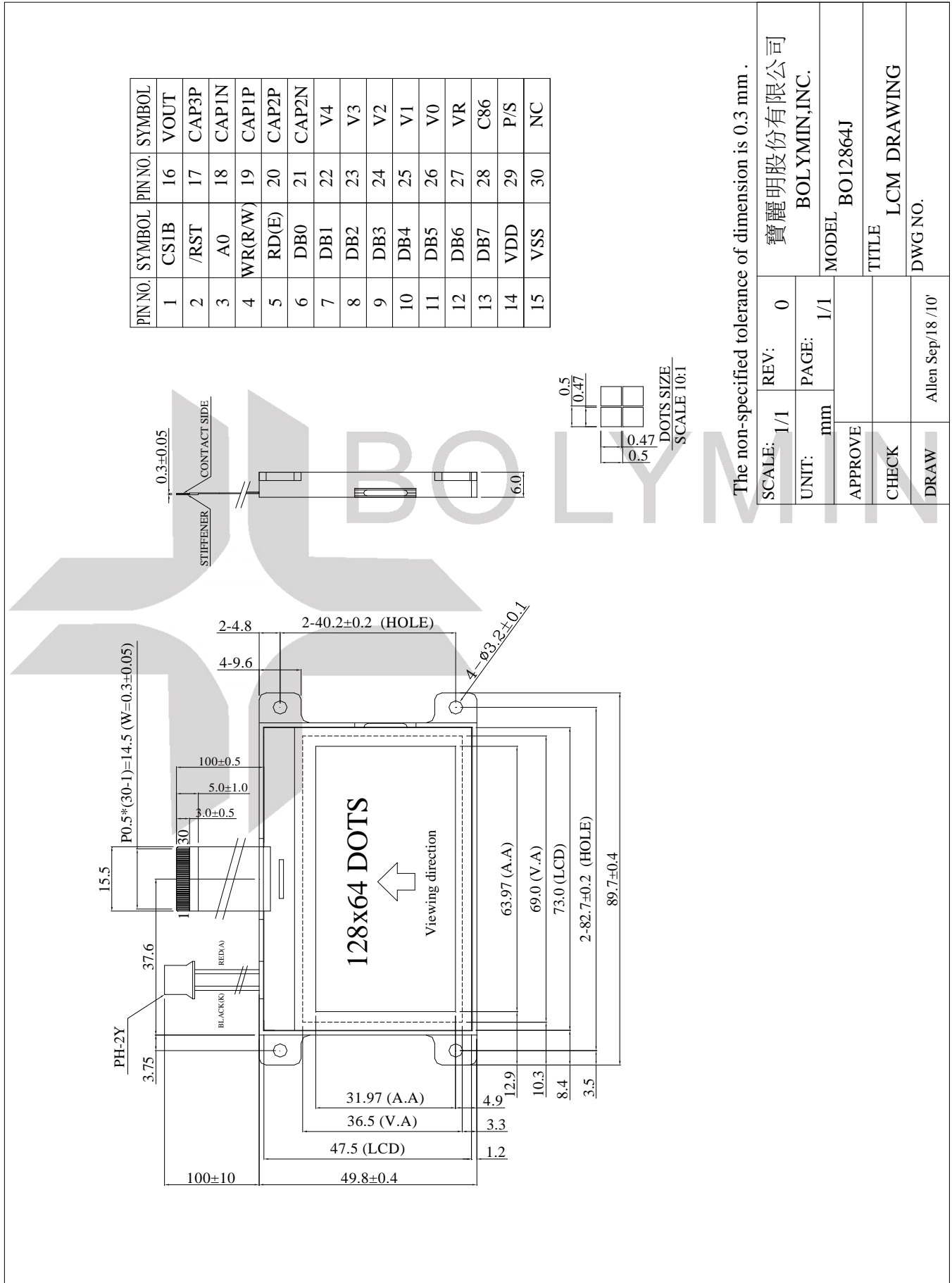
### ■Content of Reliability Test

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)	<p>Endurance test applying the low and high temperature cycle.</p> 	-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 , ST7565P controller data)

### 12.1 Drawing



## 12.2 ST7565P controller data

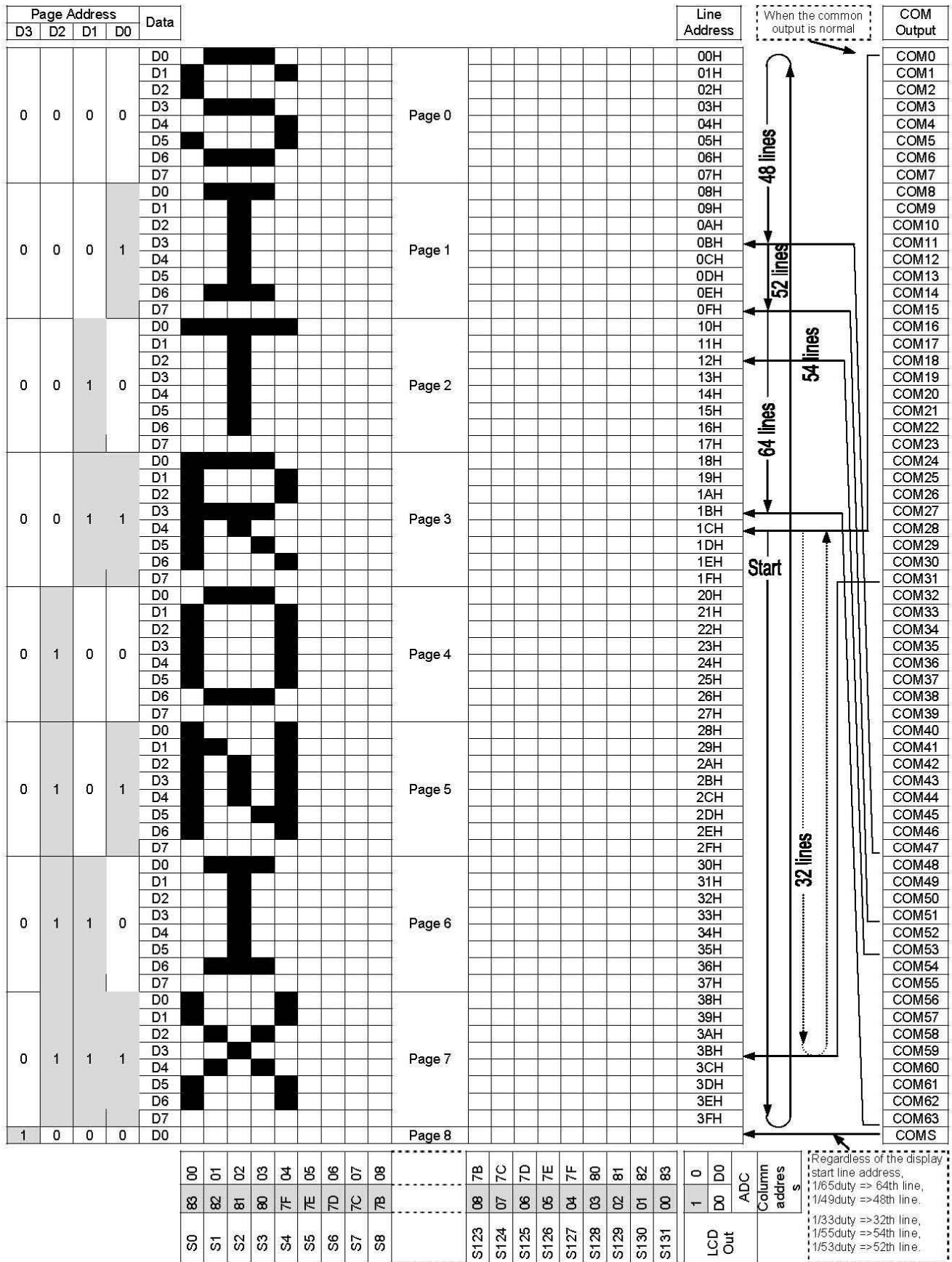
### 12.2.1. Instruction table

**Table 16: Table of ST7565P Commands**

(Note) \*: disabled data

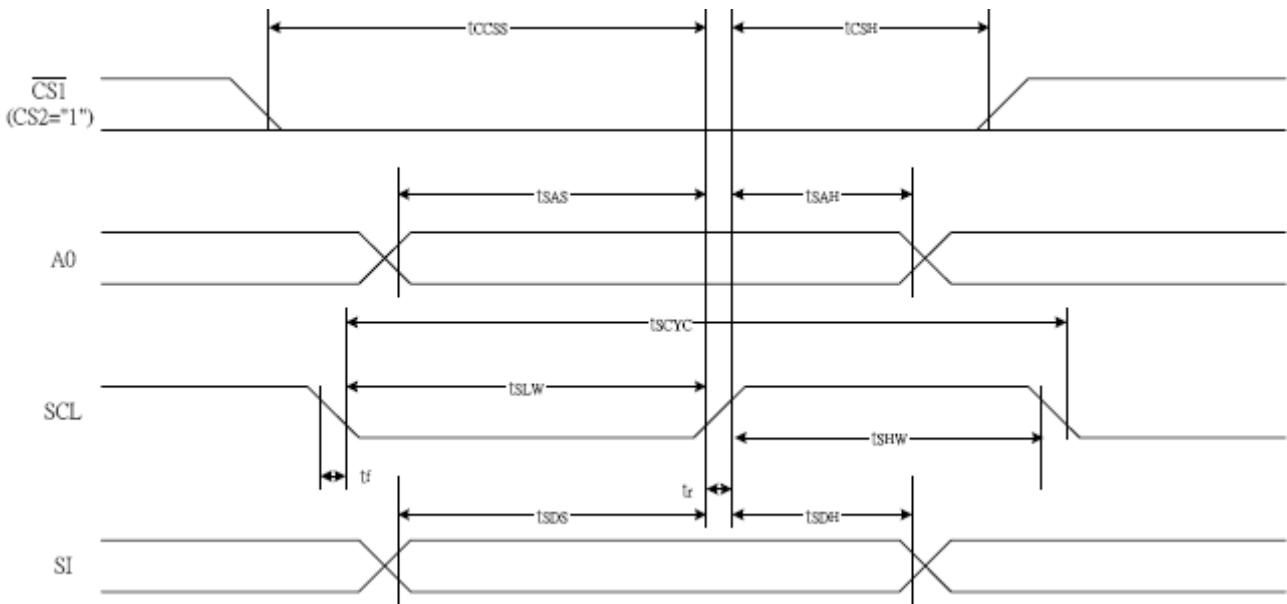
Command	Command Code										Function	
	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1		D0
(1) Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0	LCD display ON/OFF 0: OFF, 1: ON
(2) Display start line set	0	1	0	0	1	Display start address					Sets the display RAM display start line address	
(3) Page address set	0	1	0	1	0	1	Page address				Sets the display RAM page address	
(4) Column address set upper bit	0	1	0	0	0	0	1	Most significant column address				Sets the most significant 4 bits of the display RAM column address. Sets the least significant 4 bits of the display RAM column address.
Column address set lower bit	0	1	0	0	0	0	0	Least significant column address				
(5) Status read	0	0	1	Status			0	0	0	0	0	Reads the status data
(6) Display data write	1	1	0	Write data							Writes to the display RAM	
(7) Display data read	1	0	1	Read data							Reads from the display RAM	
(8) ADC select	0	1	0	1	0	1	0	0	0	0	0	Sets the display RAM address SEG output correspondence 0: normal, 1: reverse
(9) Display normal/reverse	0	1	0	1	0	1	0	0	1	1	0	Sets the LCD display normal/reverse 0: normal, 1: reverse
(10) Display all points ON/OFF	0	1	0	1	0	1	0	0	1	0	0	Display all points 0: normal display 1: all points ON
(11) LCD bias set	0	1	0	1	0	1	0	0	0	1	0	Sets the LCD drive voltage bias ratio 0: 1/9 bias, 1: 1/7 bias (ST7565P)
(12) Read/modify/write	0	1	0	1	1	1	0	0	0	0	0	Column address increment At write: +1 At read: 0
(13) End	0	1	0	1	1	1	0	1	1	1	0	Clear read/modify/write
(14) Reset	0	1	0	1	1	1	0	0	0	1	0	Internal reset
(15) Common output mode select	0	1	0	1	1	0	0	0	*	*	*	Select COM output scan direction 0: normal direction 1: reverse direction
(16) Power control set	0	1	0	0	0	1	0	1	Operating mode		Select internal power supply operating mode	
(17) V <sub>0</sub> voltage regulator internal resistor ratio set	0	1	0	0	0	1	0	0	Resistor ratio		Select internal resistor ratio(R <sub>b</sub> /R <sub>a</sub> ) mode	
(18) Electronic volume mode set Electronic volume register set	0	1	0	1	0	0	0	0	0	0	1	Set the V <sub>0</sub> output voltage electronic volume register
(20) Booster ratio set	0	1	0	1	1	1	1	1	0	0	0	select booster ratio 00: 2x,3x,4x 01: 5x 11: 6x
(21) Power saver												Display OFF and display all points ON compound command
(22) NOP	0	1	0	1	1	1	0	0	0	1	1	Command for non-operation
(23) Test	0	1	0	1	1	1	1	*	*	*	*	Command for IC test. Do not use this command

### 12.2.2 . Line Address circuit



### 12.2.3 . Timing characteristics

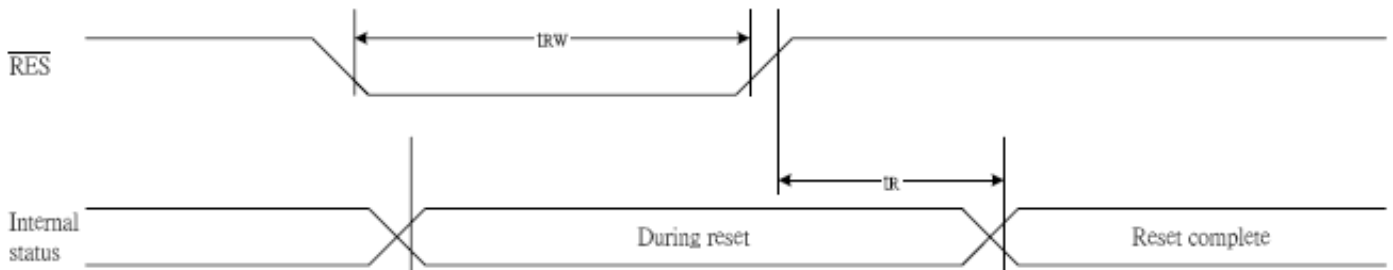
#### The Serial Interface (SPI mode)



(V<sub>DD</sub> = 3.3V, T<sub>a</sub> = 25°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	T <sub>scyc</sub>		50	—	ns
SCL "H" pulse width		T <sub>shw</sub>		25	—	
SCL "L" pulse width		T <sub>slw</sub>		25	—	
Address setup time	A0	T <sub>sas</sub>		20	—	
Address hold time		T <sub>sah</sub>		10	—	
Data setup time	SI	T <sub>sds</sub>		20	—	
Data hold time		T <sub>sdh</sub>		10	—	
CS-SCL time	CS	T <sub>css</sub>		20	—	
CS-SCL time		T <sub>csh</sub>		40	—	

#### Reset Timing



(V<sub>DD</sub> = 3.3V, T<sub>a</sub> = -40 to 85°C)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tr		—	—	0.5	us
Reset "L" pulse width	/RES	trw		0.5	—	—	us