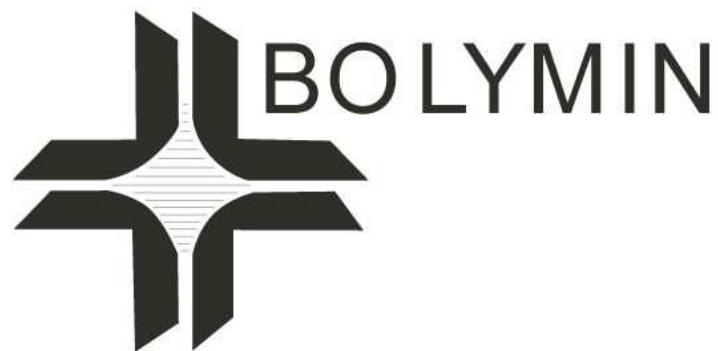




SPECIFICATIONS FOR LCD MODULE

MODEL NO.
BG12864A series
VER.04



FOR MESSRS:

ON DATE OF:

APPROVED BY:

BOLYMIN, INC.

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History of Version

Version	Contents	Date	Note
01	NEW VERSION	2003/3/21	SPEC.
02	To modify Thought hole dim.	2005/02/21	
03	MODIFY BACKLIGHT INFORMATION	2008/02/23	
04	Add Handling Instruction Update Electrical Characteristics、Quality Assurance and Reliability Modify Backlight Information	2013/01/07	

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2. Handling Instruction
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1. Numbering System

<u>B</u>	<u>G</u>	<u>12864</u>	<u>A</u>	-	-	-	-	-	<u>xxx</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 PLED/yellow-green C=color STN,OLED/RGB	B=STN/blue,OLED/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 A=LED edge/amber
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 volt logic power supply n=negative voltage for LCD c=cable/connector 207d=AVANT IC	t=temperature compensation for LCD p=touch panel \$=RoHS

2. Handling Instruction

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 on the surface of display area.
- 2.1.2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. 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 and never scrub hard.
- 2.1.3. Store the panel or module in a dark place where the temperature is $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and the humidity is below 60% RH.
- 2.1.4. Keep LCD panels away from direct sunlight, also avoid them in high-temperature & high humidity environment for a long period.
- 2.1.5. Do not input any signal before power is turned on.
- 2.1.6. 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.
- 2.1.7. To control temperature and time of soldering is $320 \pm 10^{\circ}\text{C}$ and 3-5 sec.
- 2.1.8. EL manufactured from the organic film, and easily affected by temperature, humidity and other environmental impact. Long-term placement in a place will cause low quality of the case. Therefore, unpack the cartons and start the production with the LCM within three months after the reception of them.

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 is inductive to static, a relative humidity of 50-60% is recommended.

2.3 Operation Precautions:

- 2.3.1. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, 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. Driving voltage should be kept within specified range; excess voltage will shorten display life.
- 2.3.3. An electrochemical reaction due to direct current causes LCD deterioration, Avoid the use of -Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them.

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.

2.6 MTBF

- 2.6.1 .By specific test condition, MTBF based on 30 °C normal operation temperature is 50,000hours. Estimator of L(10) is 5,268 hours. Remark: L(10) means accumulative defect rate equals 10% at the time of L(10).

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:

Loss of brightness at specific measured point: $\leq 50\%$

Loss of brightness at specific measured point: $\leq 20\%$

Display function at room temperature: Normal

Appearance: Normal

3.General Specification

(1) Mechanical Dimension

Item	Standard Value	Unit
Number of dots	128×64	dots
Module dimension (L*W*H)	93.0*70.0*13.1(Max)-LED array/edge B/L 93.0*70.0*9.2(Max)- E/L or No B/L	mm
View area	72(W)×40(H)	mm
Active area	66.52(W)×33.24(H)	mm
Dot size	0.48(W)×0.48(H)	mm
Dot pitch	0.52(W)×0.52(H)	mm

(2) Controller IC: NT7107/NT7108 or equivalent

(3) Temperature Range

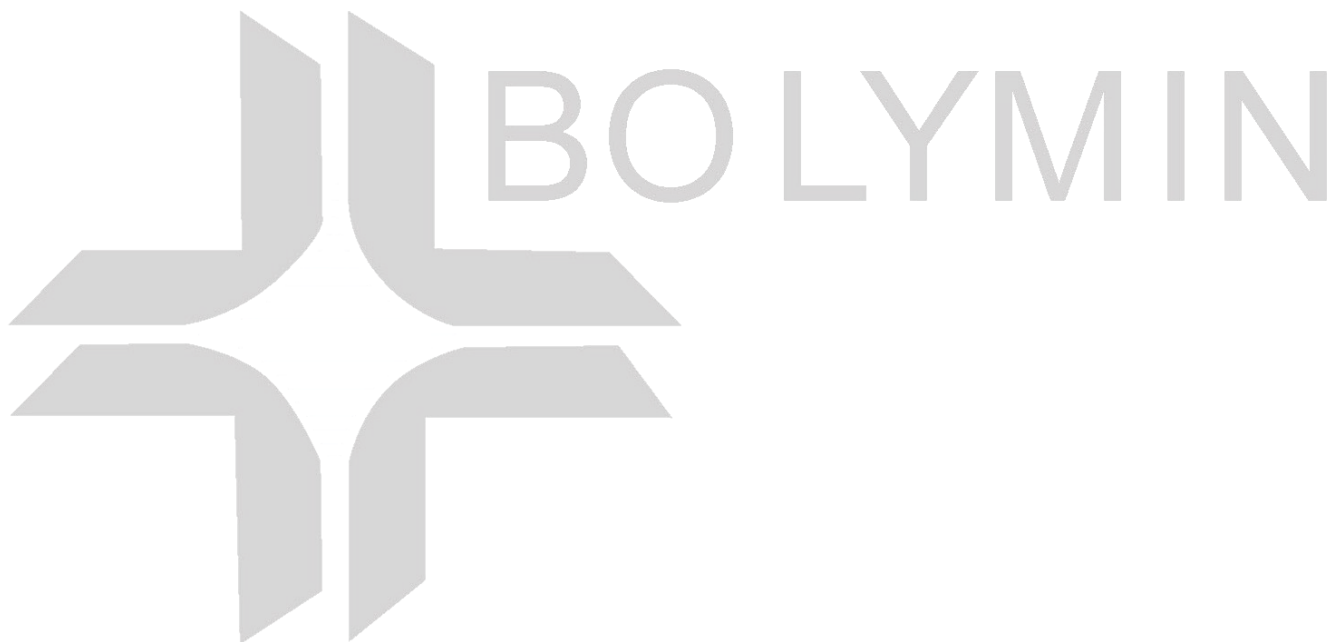
	Normal	Wide
Operating	0 ~ +50℃	-20 ~ +70℃
Storage	-10 ~ +60℃	-30 ~ +80℃

4.Absolute Maximum Rating

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T _{OP}	-20	—	+70	℃
Storage Temperature	T _{ST}	-30	—	+80	℃
Input Voltage	V _I	0	—	V _{CC}	V
Supply Voltage For Logic	V _{CC}	0	—	6.7	V
Supply Voltage For LCD	V _{CC} -V _{LCD}	0	—	16.7	V
Supply Voltage For LCD	V _{OUT}	—	—	-5	V

5. Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage For Logic	$V_{DD}-V_{SS}$	—	4.5	5.0	5.5	V
Supply Voltage For LCD	$V_{DD}-V_0$	$T_a=25^{\circ}\text{C}$	—	8.8	—	V
Input High Vol	V_{IH}	—	$0.7V_{DD}$	—	V_{DD}	V
Input Low Vol	V_{IL}	—	0	—	$0.3V_{DD}$	V
Output High Vol	V_{OH}	—	2.4	—	—	V
Output Low Vol.	V_{OL}	—	—	—	0.4	V
Supply Current	I_{DD}	—	—	18.0	—	mA



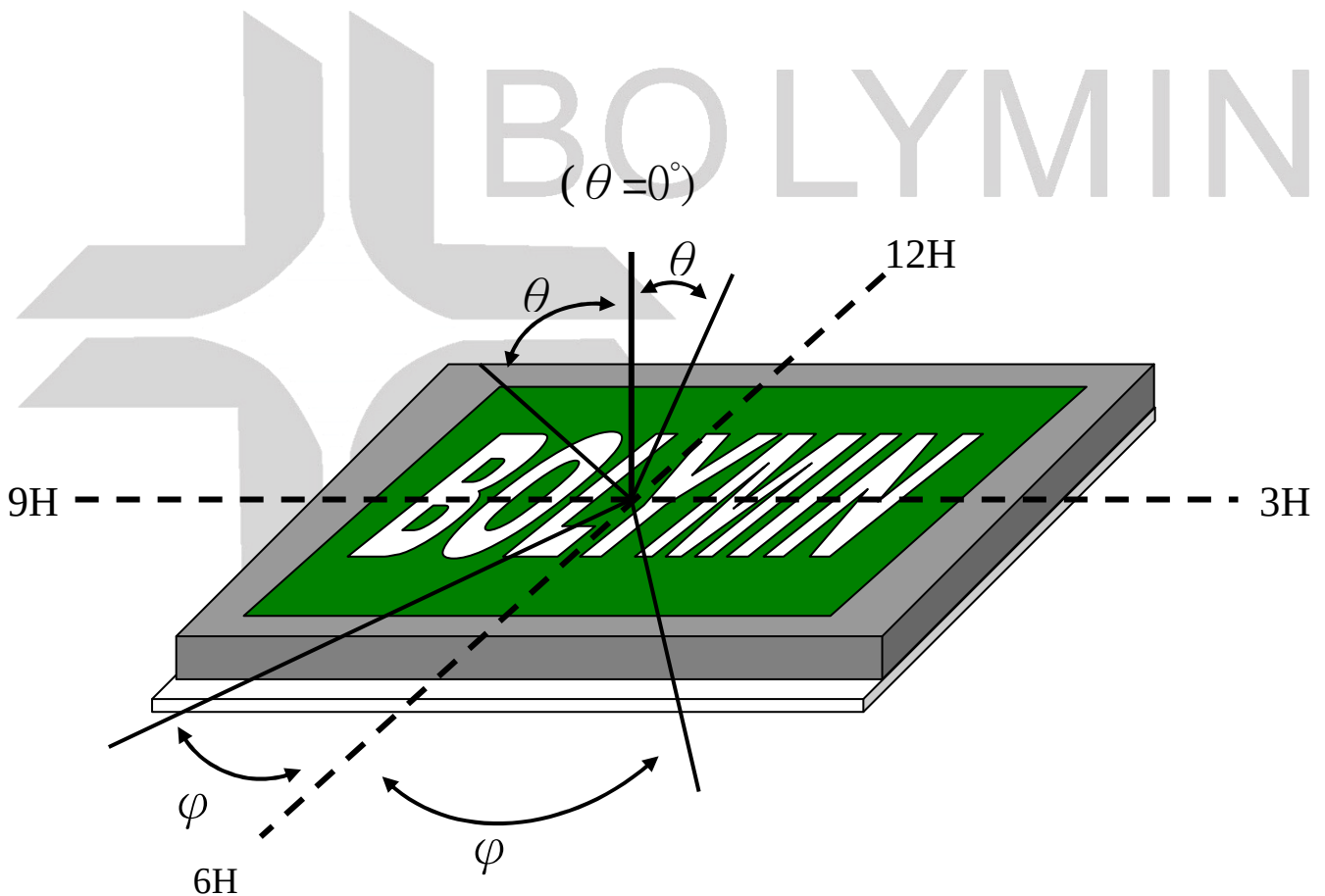
6. Optical Characteristics

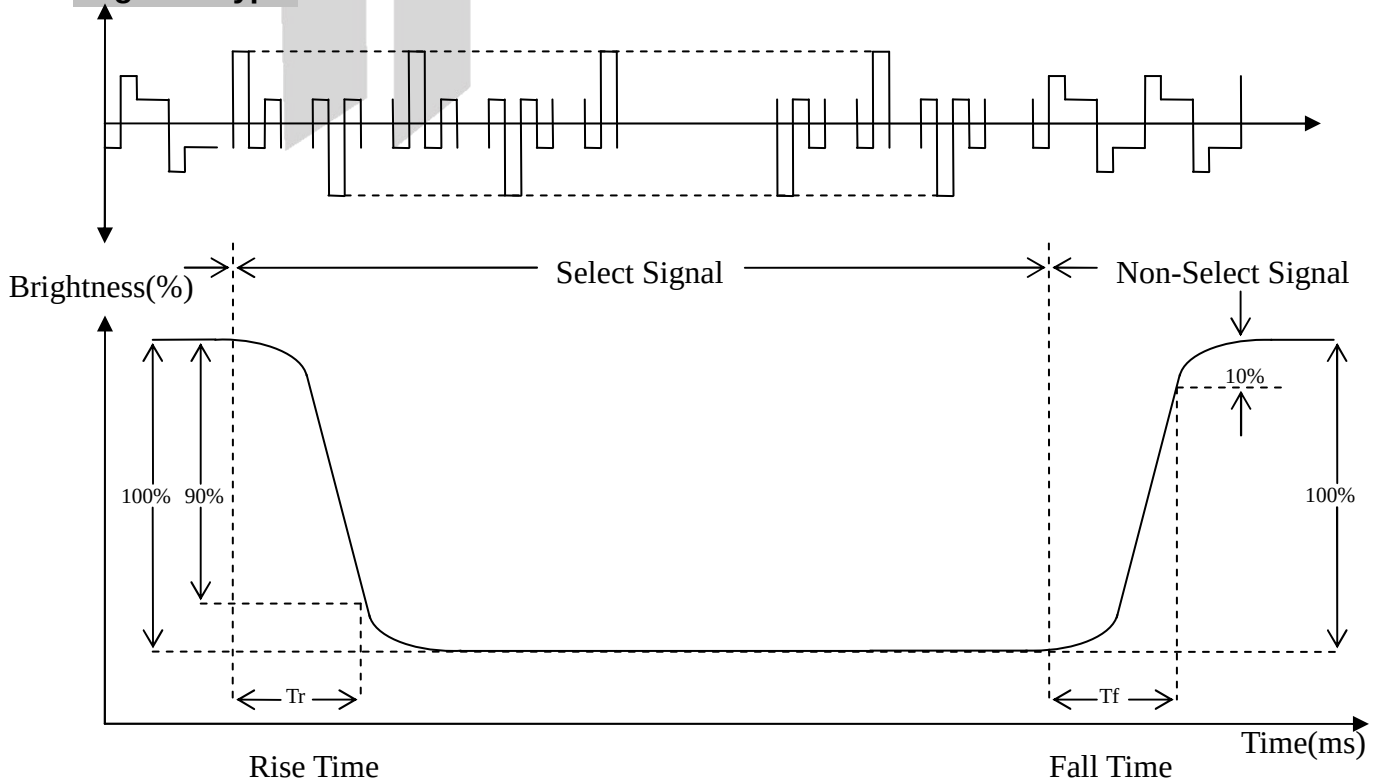
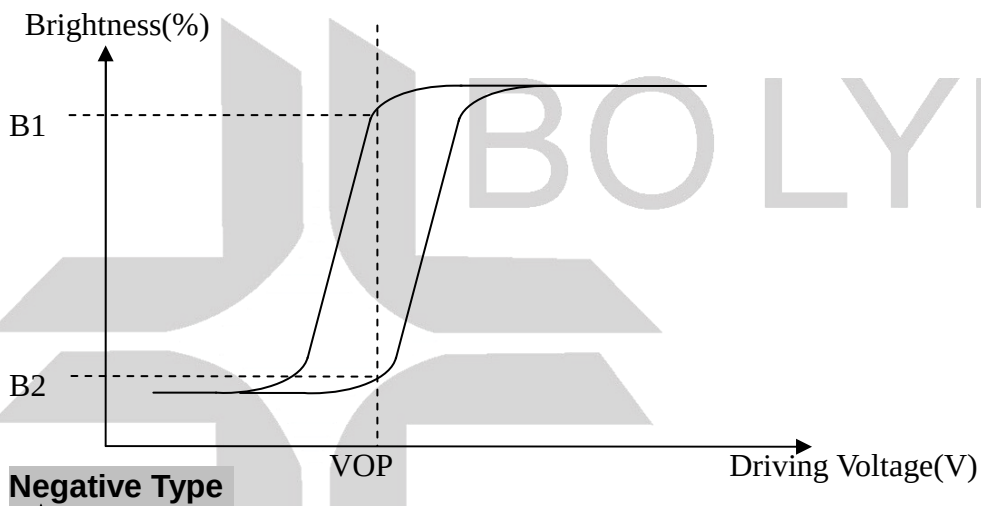
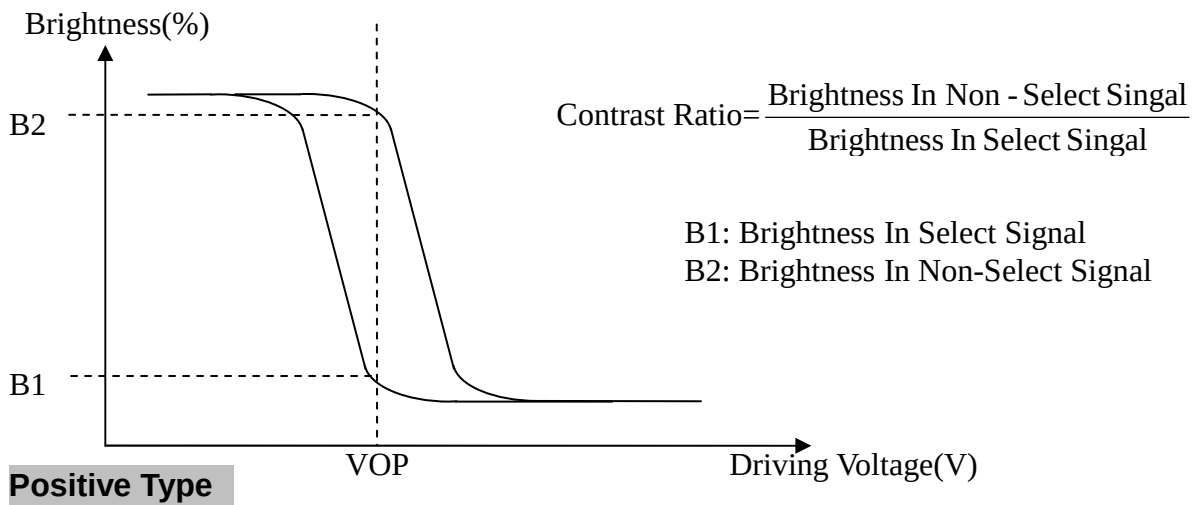
a. STN

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
View Angle	$(V) \theta$	$CR \geq 2$	10	-	45	deg
	$(H) \varphi$	$CR \geq 2$	-30	-	30	deg
Contrast Ratio	CR	-	-	3	-	-
Response Time 25°C	T rise	-	-	200	350	ms
	T fall	-	-	250	400	ms

b.FSTN

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
View Angle	(V) θ	$CR \geq 3$	10		60	deg
	(H) φ	$CR \geq 3$	-45		45	deg
Contrast Ratio	CR	—		5		—
Response Time 25°C	T rise	—		200	400	ms
	T fall	—		250	400	ms



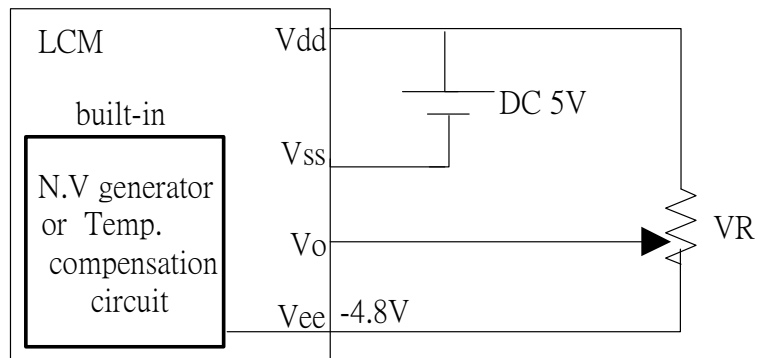


7.Interface Pin Function

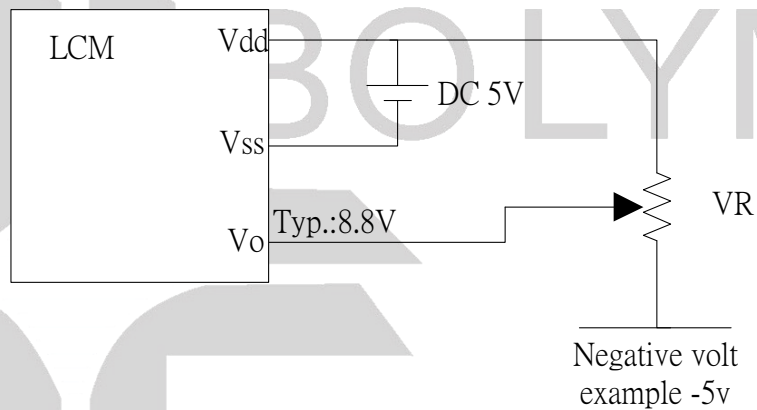
Pin No.	Symbol	Level	Description
1	Vss	0V	Ground
2	Vdd	5.0V	Supply voltage for logic
3	V _O	(Variable)	Operating voltage for LCD
4	D/I	H/L	H: Data , L: Instruction
5	R/W	H/L	H: Read(MPU←Module) , L :Write(MPU→Module)
6	E	H	Enable signal
7	DB0	H/L	Data bus line
8	DB1	H/L	Data bus line
9	DB2	H/L	Data bus line
10	DB3	H/L	Data bus line
11	DB4	H/L	Data bus line
12	DB5	H/L	Data bus line
13	DB6	H/L	Data bus line
14	DB7	H/L	Data bus line
15	CS1	L	Chip Select for IC1
16	CS2	L	Chip Select for IC2
17	/RST	L	Reset signal
18	Vee		Negative Voltage output -4.8V
19	A	—	Power supply for B/L (+)
20	K	—	Power supply for B/L (GND)

8. Power supply for LCD Module and LCD operating voltage adjustment

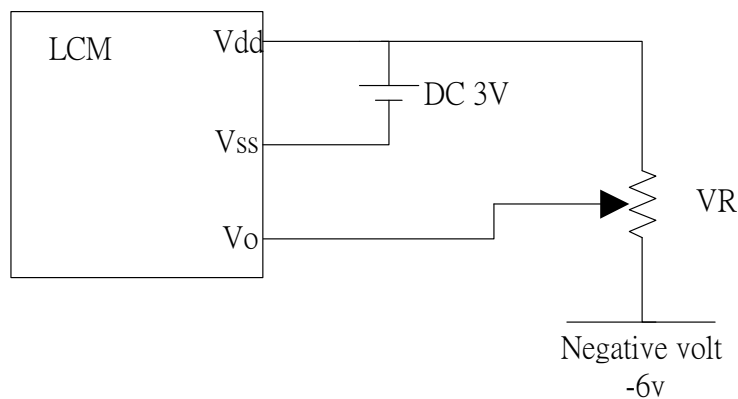
* LCM operating on " DC 5V " input with built-in negative voltage



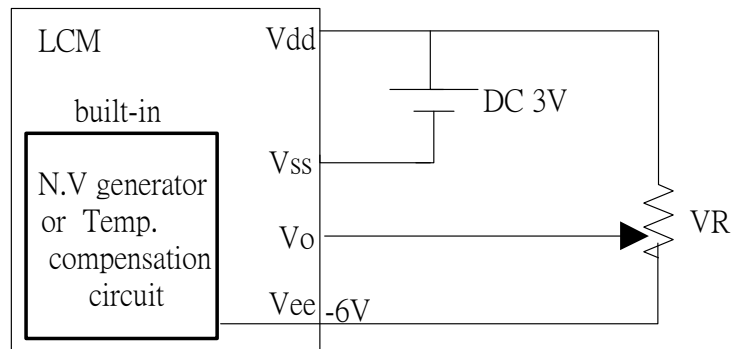
* (Option) LCM operating on " DC 5V " input with external negative voltage



* (Option) LCM operating on " DC 3V " input with external negative voltage



* (Option) LCM operating on " DC 3V " input with built-in negative voltage



9.Backlight information

(1) LED array / yellow-green

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I _{LED}	—	330	—	mA	V=4.1V
Supply Voltage	V	4.0	4.1	4.4	V	I _{LED} =330mA
Reverse Voltage	V _R	—	—	5	V	
Luminous Intensity	I _V	220	280	—	cd/m ²	I _{LED} =330mA
Wave Length	λ _p	568	—	573	nm	I _{LED} =330mA
Color	Yellow Green					

(2)LED edge/ White

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I _{LED}	—	60	—	mA	V=3.7V
Supply Voltage	V	3.4	3.7	4.0	V	I _{LED} =60mA
Reverse Voltage	V _R	—	—	5	V	—
Luminous Intensity	I _V	590	730	—	cd/m ²	I _{LED} =60mA
CIE	X	0.27	—	0.32		I _{LED} =60mA
	Y	0.27	—	0.32		
Color	White					

(3) EL white / blue

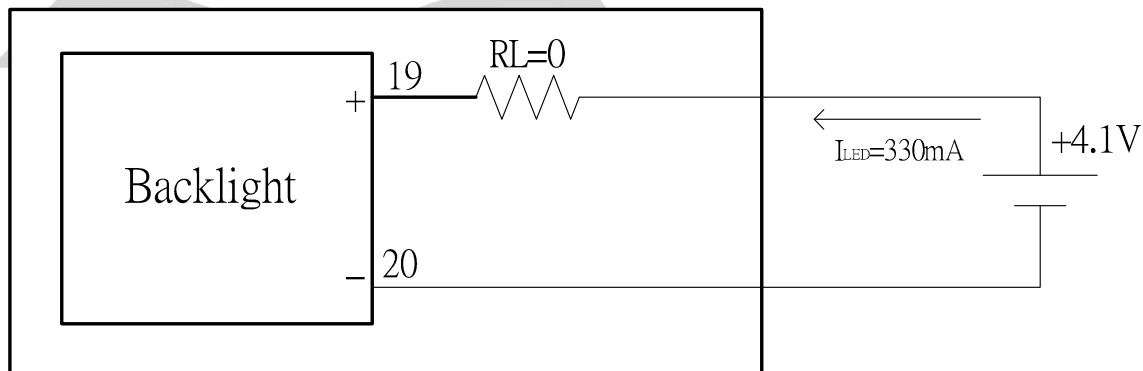
Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Voltage	Vrms	--	110 (AC)		--	
Frequency	HZ	--	400		--	
Brightness*	cd/m2	48	50		--	110Vrms 400Hz
CIE Chromaticity Diagram	X	--	0.3019(white)		--	
			0.330 (blue)		--	
	Y	--	0.3929(white)		--	
			0.365 (blue)		--	
Current Dissipation	mA/cm2	--	3.63		--	
Power Dissipation	mW/cm2	--	71.71		--	
Life time			5000	hrs		
Color	Blue , white					

(2) Backlight driving methods

a. LED B/L drive from pin19 (LED+) pin20 (LED-)

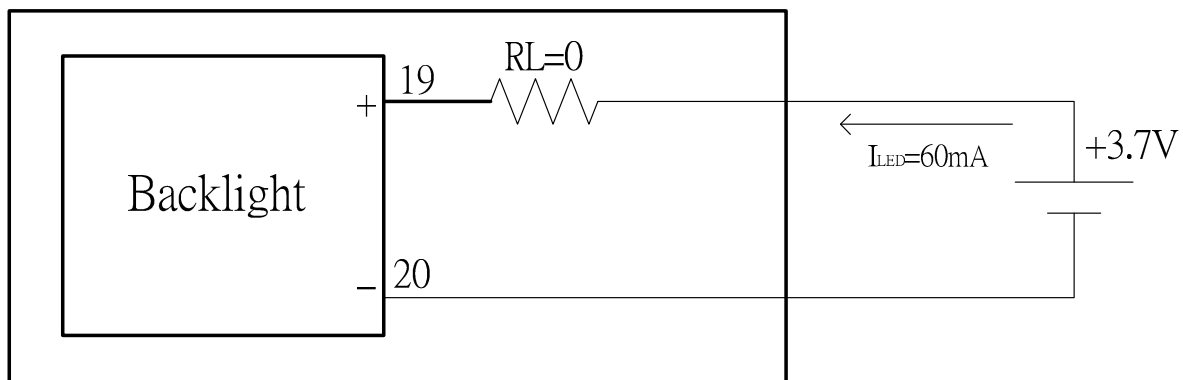
a.1 array (yellow-green)

LCM

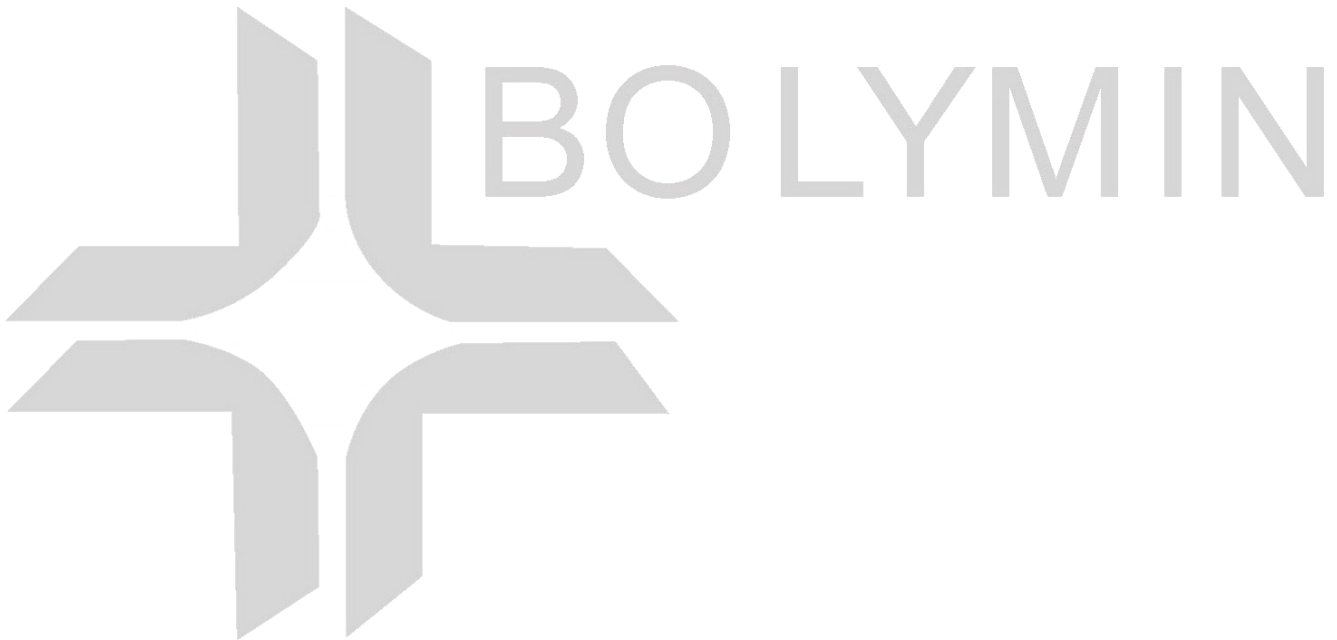
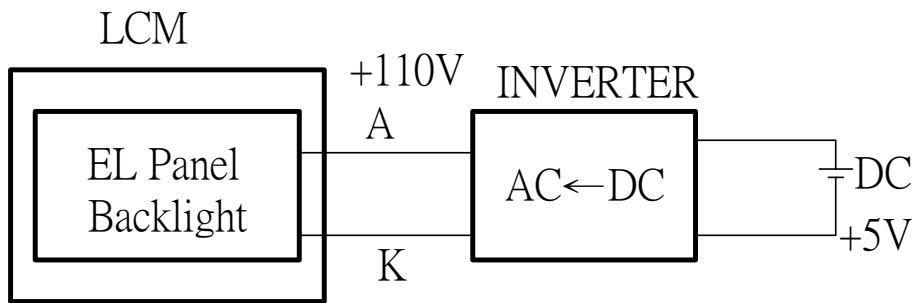


a.2 edge/ White

LCM



b. E/L B/L driven from A.K cable directly



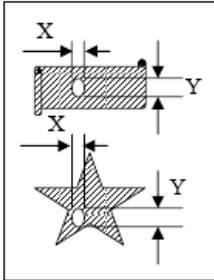
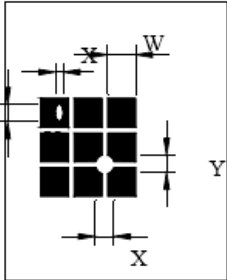
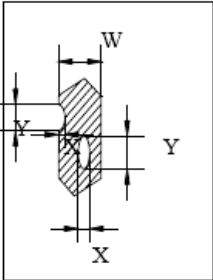
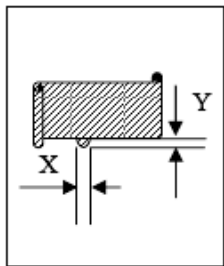
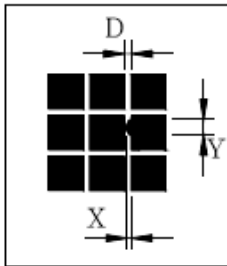
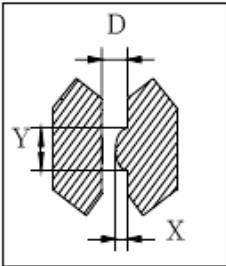
10 Quality Assurance

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.

10.2 Inspection Parameters

NO.	Parameter	Criteria																								
1	Black or White spots	<table><tr><th colspan="2">Zone Dimension</th><th>Acceptable Number</th><th>Class Of Defects</th><th>Acceptable Level</th></tr><tr><td colspan="2">D≤0.10</td><td>Disregard</td><td rowspan="4">Minor</td><td rowspan="4">0.65</td></tr><tr><td colspan="2">0.10<D≤0.2</td><td>4</td></tr><tr><td colspan="2">0.2<D≤0.3</td><td>2</td></tr><tr><td colspan="2">0.3<D</td><td>0</td></tr></table>				Zone Dimension		Acceptable Number	Class Of Defects	Acceptable Level	D≤0.10		Disregard	Minor	0.65	0.10<D≤0.2		4	0.2<D≤0.3		2	0.3<D		0		
		Zone Dimension		Acceptable Number	Class Of Defects	Acceptable Level																				
		D≤0.10		Disregard	Minor	0.65																				
		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	<table><tr><th colspan="2">Zone</th><th rowspan="2">Acceptable Number</th><th rowspan="2">Class Of Defects</th><th rowspan="2">Acceptable Level</th></tr><tr><th>X(mm)</th><th>Y(mm)</th></tr><tr><td>—</td><td>0.05≥W</td><td>Disregard</td><td rowspan="4">Minor</td><td rowspan="4">0.65</td></tr><tr><td>4.0≥L</td><td>0.05≥W</td><td>4</td></tr><tr><td>3.0≥L</td><td>0.1≥W</td><td>2</td></tr><tr><td>—</td><td>0.1<W</td><td>0</td></tr></table>				Zone		Acceptable Number	Class Of Defects	Acceptable Level	X(mm)	Y(mm)	—	0.05≥W	Disregard	Minor	0.65	4.0≥L	0.05≥W	4	3.0≥L	0.1≥W	2	—	0.1<W	0
		Zone		Acceptable Number	Class Of Defects	Acceptable Level																				
		X(mm)	Y(mm)																							
		—	0.05≥W	Disregard	Minor	0.65																				
		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><tr><th>Zone Dimension</th><th>Acceptable Number</th><th>Class Of Defects</th><th>Acceptable Level</th></tr><tr><td>$D \leq 0.2$</td><td>Disregard</td><td rowspan="3">Minor</td><td rowspan="3">0.65</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></table> 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.	Zone Dimension	Acceptable Number	Class Of Defects	Acceptable Level	$D \leq 0.2$	Disregard	Minor	0.65	$0.2 < D \leq 0.5$	3	$0.5 < D$	0														
Zone Dimension	Acceptable Number	Class Of Defects	Acceptable Level																									
$D \leq 0.2$	Disregard	Minor	0.65																									
$0.2 < D \leq 0.5$	3																											
$0.5 < D$	0																											
4	Displaying Pattern	1. Incomplete or broken line is not allowed. 2. Pinholes <table><tr><th>Dimension Φ(mm)</th><th>Criteria</th><th>Class Of Defects</th><th>Acceptable Level</th></tr><tr><td>$\Phi < 0.1$</td><td>Disregard</td><td rowspan="4">Minor</td><td rowspan="4">0.65</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></table>  $\varnothing = (X+Y)/2$ 3. Deformation <table><tr><th>Dimension Φ(mm)</th><th>Criteria</th><th>Class Of Defects</th><th>Acceptable Level</th></tr><tr><td>$\Phi < 0.15$</td><td>Disregard</td><td rowspan="3">Minor</td><td rowspan="3">0.65</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></table>  D : 間距 $\varnothing = (X+Y)/2$	Dimension Φ (mm)	Criteria	Class Of Defects	Acceptable Level	$\Phi < 0.1$	Disregard	Minor	0.65	$0.1 < \Phi \leq 0.2$	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	0.65	$\Phi \leq 0.25$ 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	0.65																									
$0.1 < \Phi \leq 0.2$	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	0.65																									
$\Phi \leq 0.25$ and $X \leq 1/2D$	3																											
$\Phi > 0.25$ and $X > 1/2D$	0																											

Other Inspection standard reference Bolymin standard.

11. Reliability

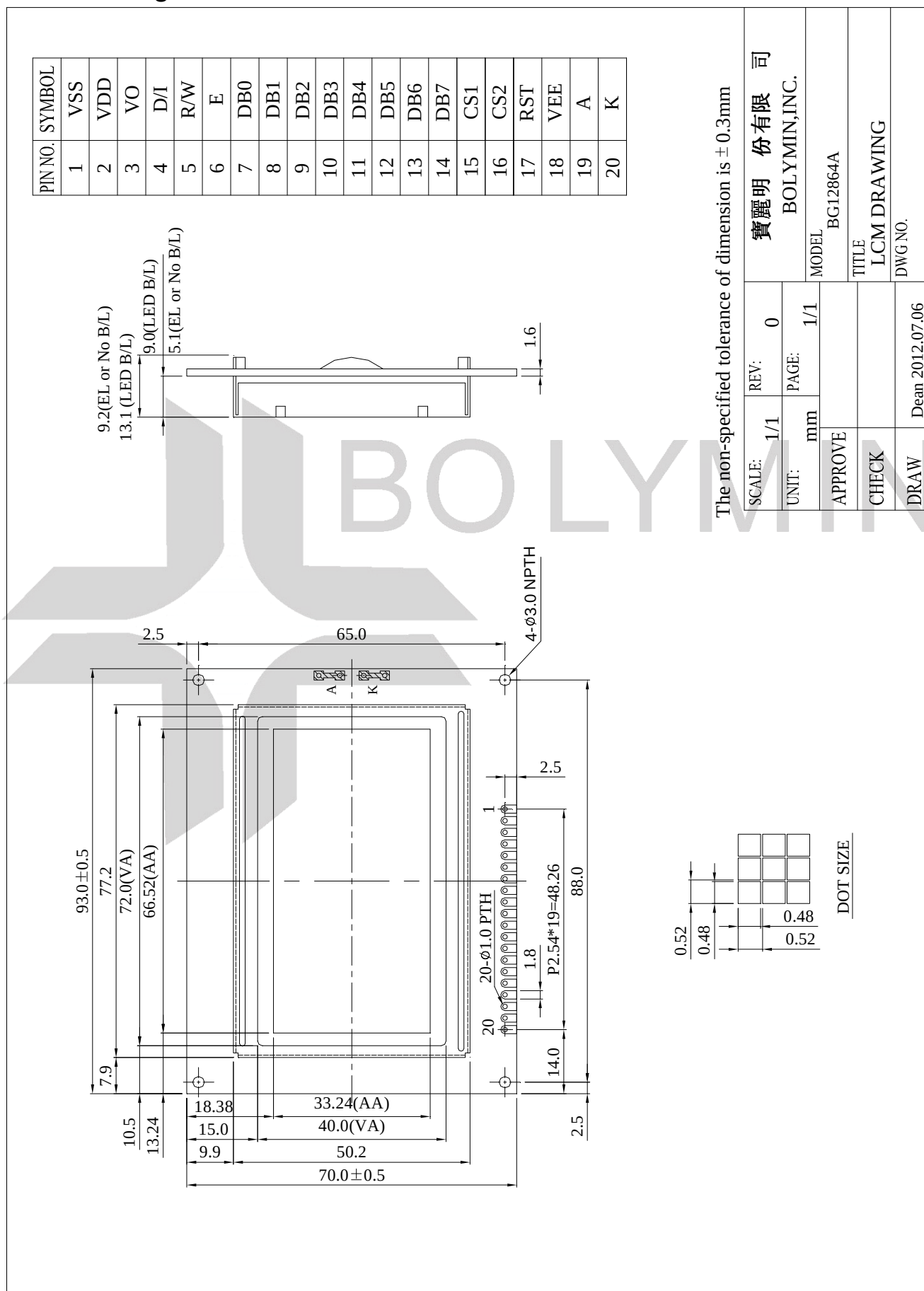
■ Content of Reliability Test

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℃ 168 hrs	—
2	Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30℃ 168 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℃ 168 hrs	—
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 168 hrs	—
5	Humidity Test	Endurance test applying the high humidity storage for a long time.	40℃, 90%RH 168 hrs	—
6	Temperature cycle (Non-operation)	Endurance test applying the low and high temperature cycle. -30℃ 80℃ ←—————→ 30min 30min 1 cycle	-30℃ / 80℃ 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	—

***Supply voltage for logic system=5V. Supply voltage for LCD system =Operating voltage at 25℃

12.Appendix (Drawing , IC controller data)

12.1 Drawing



DRAW	Dean 2012.07.06
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12.2 IC controller data

12.2.1 Display Control Instruction

The display control instructions control the internal state of the NT7108. Instruction is received from MPU to NT7108 for the display control. The following table shows various instructions.

Instruction	D/I	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Function
Display ON/OFF	0	0	0	0	1	1	1	1	1	0/1	Controls the display on or off. Internal status and display RAM data are not affected. 0:OFF, 1:ON
Set Address	0	0	0	1	Y address (0~63)						Sets the Y address in the Y address counter.
Set Page (X address)	0	0	1	0	1	1	1	Page (0 ~7)			Sets the X address at the X address register.
Display Start Line	0	0	1	1	Display start line(0~63)						Indicates the display data RAM displayed at the top of the screen.
Status Read	0	1	B U S Y	0	O N/ O F F	R E S E T	0	0	0	0	Read status. BUSY 0:Ready 1:In operation ON/OFF 0:Display ON 1:Display OFF RESET 0:Normal 1:Reset
Write Display Data	1	0	Display Data								Writes data (DB0:7) into display data RAM. After writing instruction, Y address is increased by 1 automatically.
Read Display Data	1	1	Display Data								Reads data (DB0:7) from display data RAM to the data bus.

Detailed Explanation

Display On/Off

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	1	1	1	D

The display data appears when D is 1 and disappears when D is 0. Though the data is not on the screen with D = 0, it remains in the display data RAM. Therefore, you can make it appear by changing D = 0 into D = 1.

Display Start Line

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	A	A	A	A	A	A

Z address AAAAAA (binary) of the display data RAM is set in the display start line register and displayed at the top of the screen. Figure 2. shows examples of display (1/64 duty cycle) when the start line = 0-3. When the display duty cycle is 1/64 or more (ex. 1/32, 1/24 etc.), the data of total line number of LCD screen, from the line specified by display start line instruction, is displayed.

Set Page (X Address)

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	1	1	A	A	A

X address AAA (binary) of the display data RAM is set in the X address register. After that, writing or reading to or from MPU is executed in this specified page until the next page is set. See Figure 1.

Set Y Address

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	A	A	A	A	A	A

Y address AAAAAA (binary) of the display data RAM is set in the Y address counter. After that, Y address counter is increased by 1 every time the data is written or read to or from MPU.

Status Read

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	Busy	0	On/Off	RESET	0	0	0	0

•Busy

When busy is 1, the LSI is executing internal operations. No instruction are accepted while busy is 1, so you should make sure that busy is 0 before writing the next instruction.

•ON/OFF

Shows the liquid crystal display condition: on condition or off condition.

When on/off is 1, the display is in off condition.

When on/off is 0, the display is in on condition.

•RESET

RESET = 1 shows that the system system is being initialized. In this condition, no instructions except status read can be accepted.

RESET = 0 shows that initializing has system is in the usual operation condition.

Write Display Data

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	D	D	D	D	D	D	D	D

Writes 8-bit data DDDDDDDD (binary) into the display data RAM. The Y address is increased by 1 automatically.

Read Display Data

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	D	D	D	D	1	D	D	D

Reads out 8-bit data DDDDDDDD (binary) from the display data RAM. Then Y address is increased by 1 automatically.

One dummy read is necessary right after the address setting. For details, refer to the explanation of output register in “Function of Each Block”.

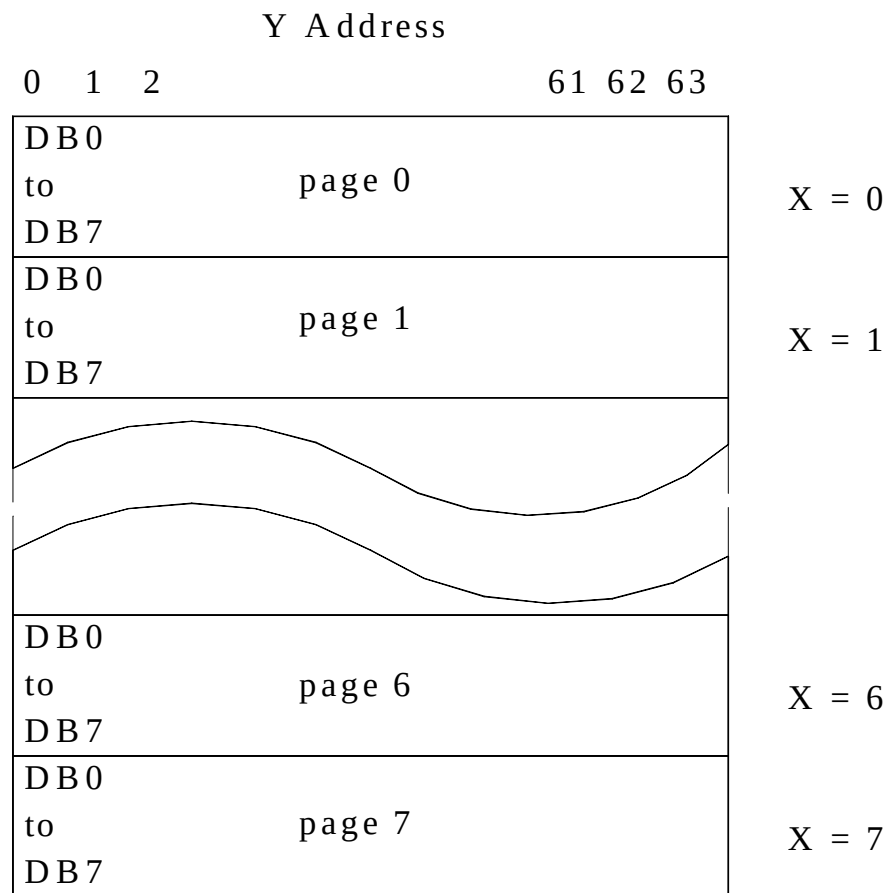
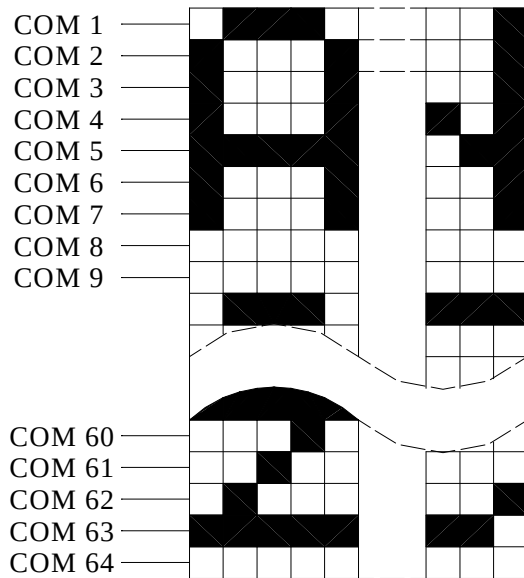
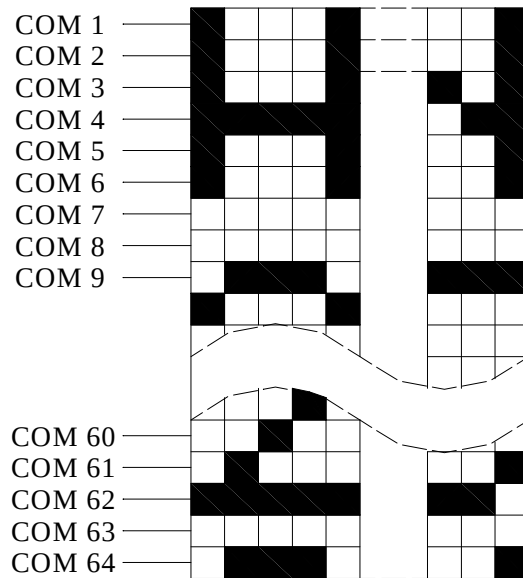


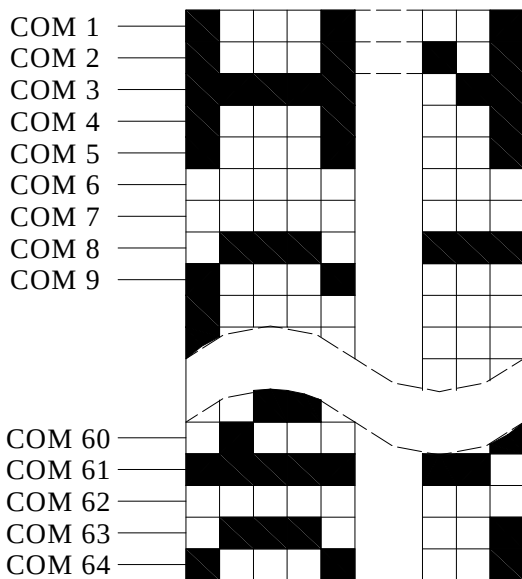
Figure 1



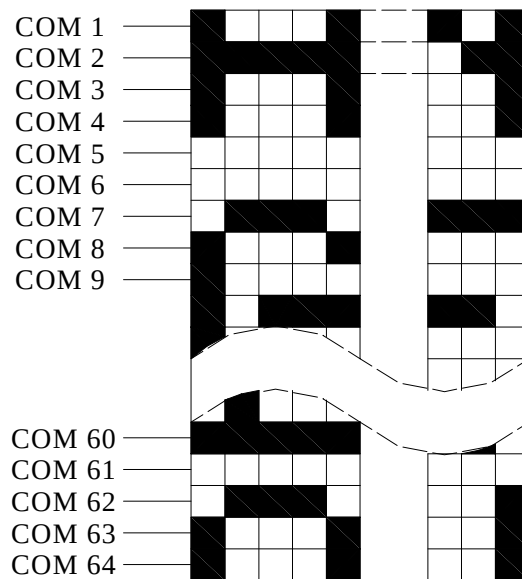
Start line = 0



Start line = 1



Start line = 3

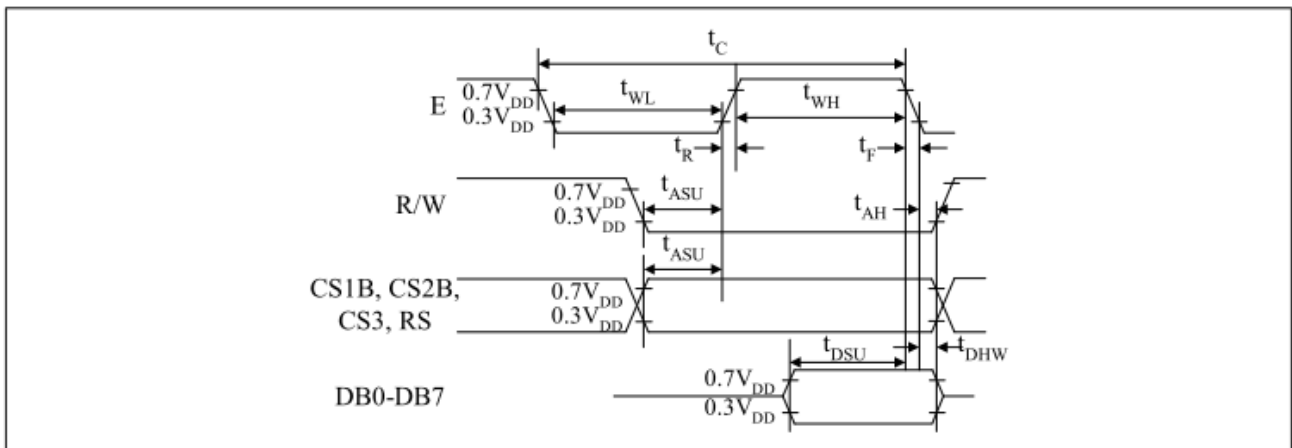


Start line = 4

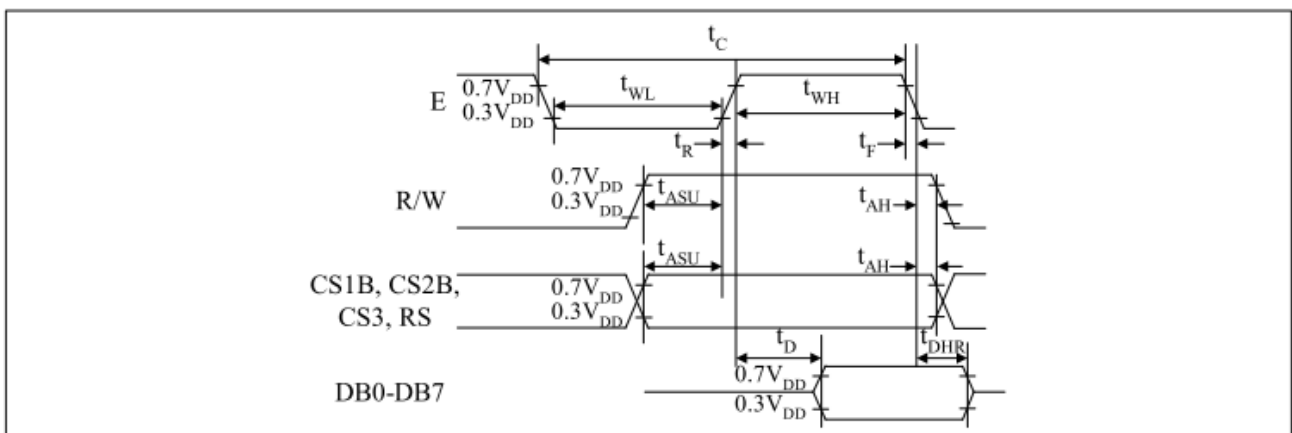
Figure 2

12.2.2 Timing characteristics

Characteristic	Symbol	Min	Type	Max	Unit
E cycle	t_C	1000	-	-	ns
E high level width	t_{WH}	450	-	-	
E low level width	t_{WL}	450	-	-	
E rise time	t_R	-	-	25	
E fall time	t_F	-	-	25	
Address set-up time	t_{ASU}	140	-	-	
Address hold time	t_{AH}	10	-	-	
Data set-up time	t_{DSU}	200	-	-	
Data delay time	t_D	-	-	320	
Data hold time (write)	t_{DHW}	10	-	-	
Data hold time (read)	t_{DHR}	20	-	-	



MPU Write Timing



MPU Read Timing