BOLYMIN

SPECIFICATIONS FOR LCD MODULE

MODEL NO.
BO1602DGPHBH369$
VER.06

RoHS COMPLIANT

FOR MESSRS:

_____

ON DATE OF:

_____

APPROVED BY:

_____

History of Version

Version	Contents	Date	Note
01	**NEW VERSION**	**2011/08/01**	**SPEC.**
02	**Add Handling Instruction** **Update Absolute Maximum Ratings, Electrical Characteristics, Quality Assurance , Reliability** **Modify Drawing**	**2012/10/23**	**Page 5、7、13 15、16**
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04	**Modify Handling Instruction**	**2013/02/19**	**Page 6**
05	**Modify Handling Instruction、Quality Assurance、 Reliability**	**2013/07/12**	**Page 6、14~16**
06	**Modify Handling Precaution、Absolute Maximum Rating 、Electrical Characteristics、Optical Characteristics、 Quality Assurance and Reliability**	**2015/07/13**	**Page 5~8 13~15**

C O N T E N T S

1. Numbering System

B	O	1602	D	G	P	H	B	H	369$
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 B=English/European/Japanese
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 xxx=to be assigned on datasheet 369=New design B/L	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℃±10℃ 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℃ 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℃±10℃.
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 ℃) 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℃) 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℃ 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: $\leqq$ 50%

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

Display function at room temperature: Normal

Appearance: Normal

3. General Specification

(1) Mechanical Dimension

Item	Dimension	Unit
Number of Characters	16characters x 2 Lines	—
Module dimension (L x W x H)	47.15 x 48.65 x 3.8(Max)	mm
View area	38.2 x 17.0	mm
Dot size	0.34 x 0.5	mm
Dot pitch	0.38 x 0.58	mm
Character size (L x W)	1.86 x 4.56	mm

(2) Controller IC: **ST7032i controller**

4. Absolute Maximum Ratings

4.1 Electrical Absolute Maximum Ratings

(VSS=0V, Ta=25℃)

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage For Logic	Vdd-Vss	-0.3	-	6.0	V
Supply Voltage For LCD	Vo-Vss	7.0-Vss	-	-0.3+Vss	V
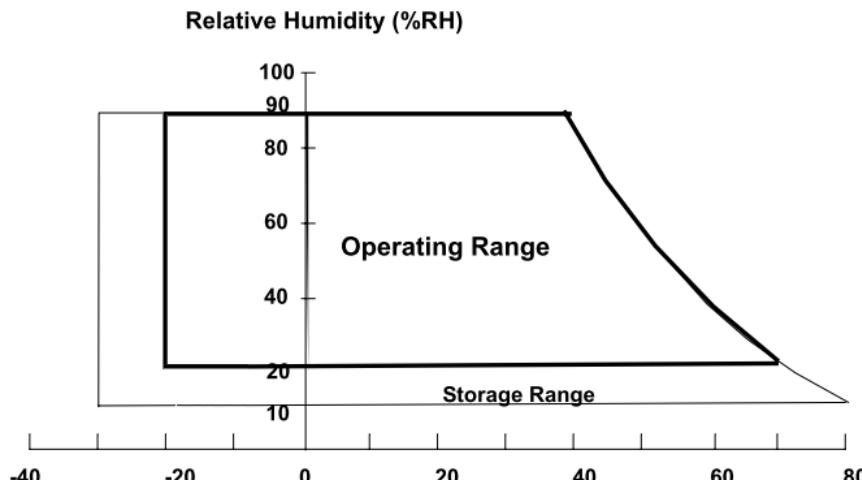
4.2 Environmental Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Operating Temperature	TOP	-20	70	℃	(1)
Storage Temperature	TST	-30	80	℃	(1)、(2)

Note (1)

  (a) 90 %RH Max. (Ta <= 40 ℃).

  (b) Wet-bulb temperature should be 39 ℃ Max. (Ta > 40 ℃).

  (c) No condensation.

Note (2) The temperature of panel surface should be -20 ℃ min. and 70 ℃ max.

5. Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	Vdd-Vss	—	2.7	—	4.5	V
Supply Voltage For LCD	Vo-Vss	Ta=25℃	4.5	4.8	5.1	V
Input High Volt.	V_{IH}	—	1.9	—	Vdd	V
Input Low Volt.	V_{IL}	—	-0.3	—	0.8	V
Output High Volt.	V_{OH}	—	0.75*Vdd	—	—	V
Output Low Volt.	V_{OL}	—	—	—	0.8	V
Supply Current	Idd	Vdd=3.3V	—	1	—	mA
LCM Surface Luminance Ta=25℃	L	I_{LED}=30mA Display all OFF	70	105	—	cd/m²
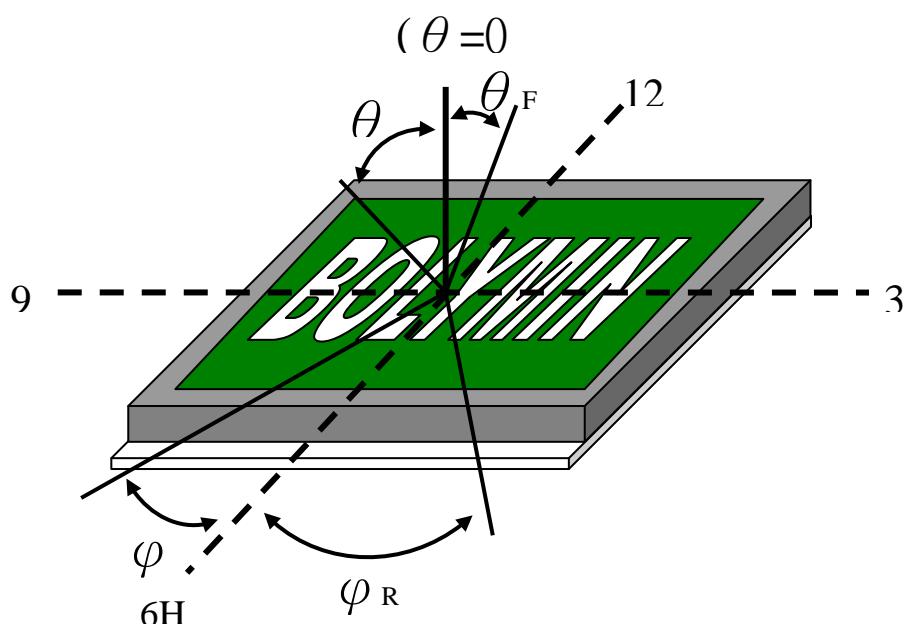
※Optimum LCD driving voltage value, referring to above mentioned range, is changed due to

different batch of LCD glass.
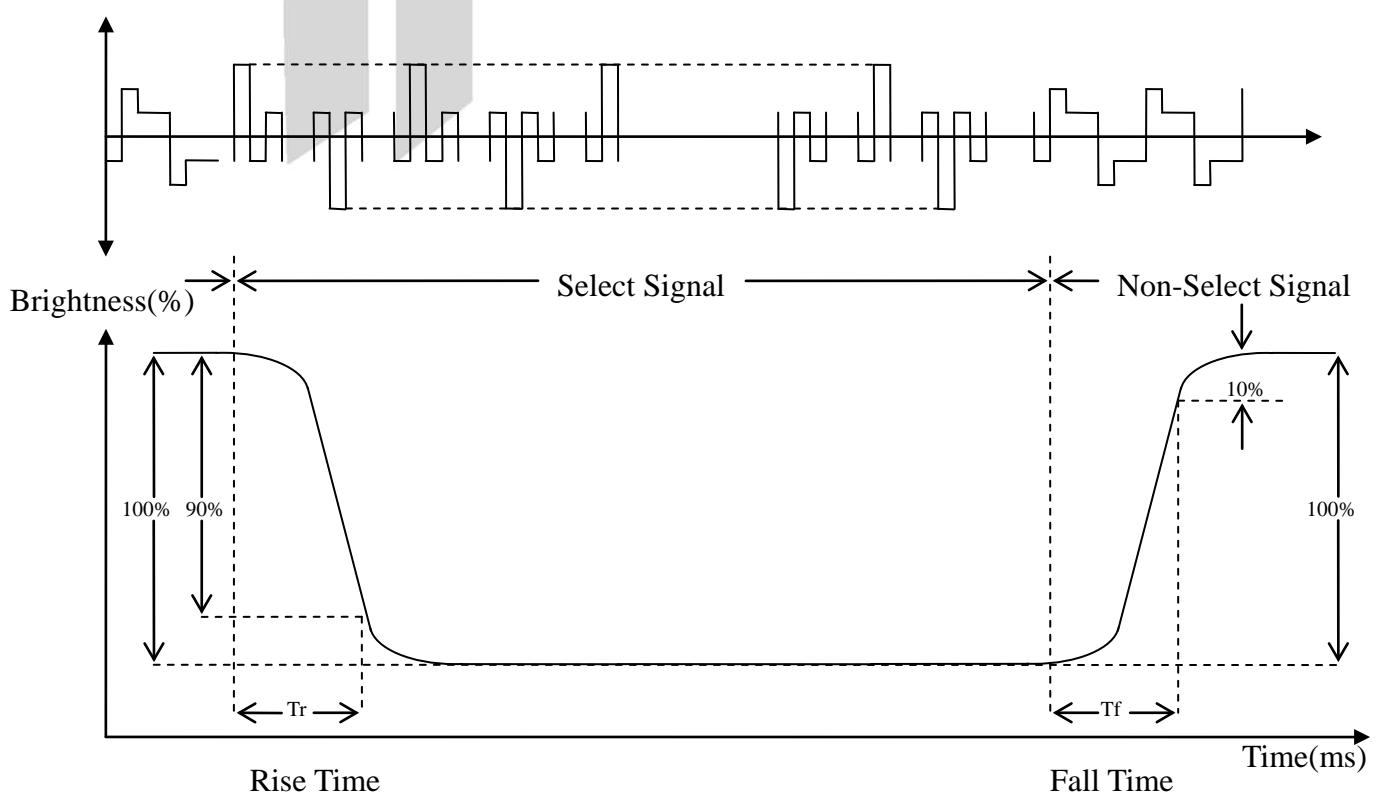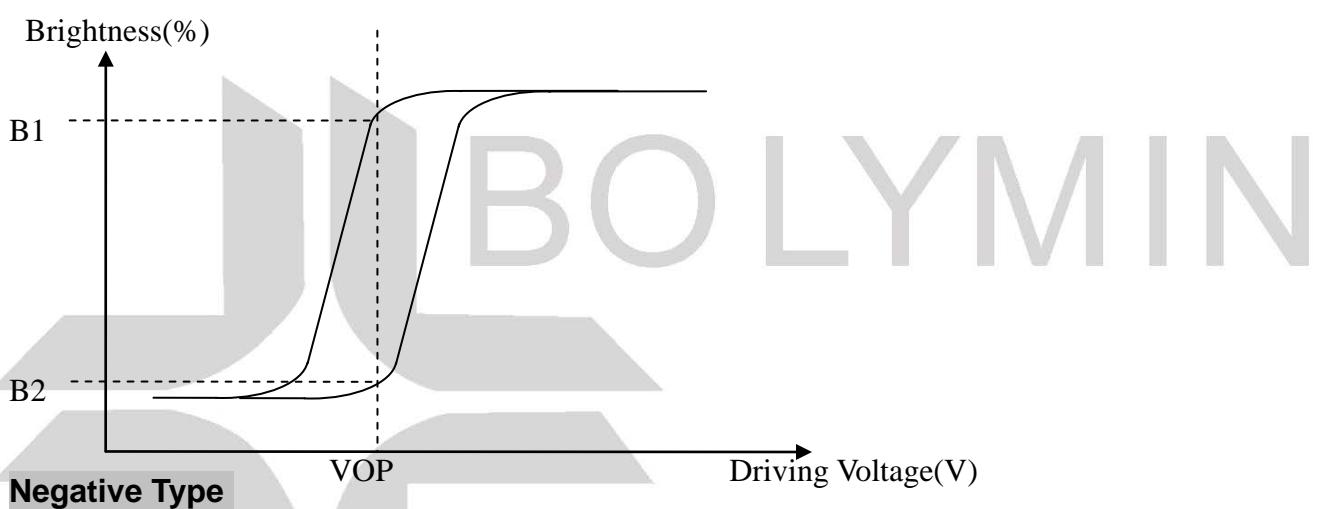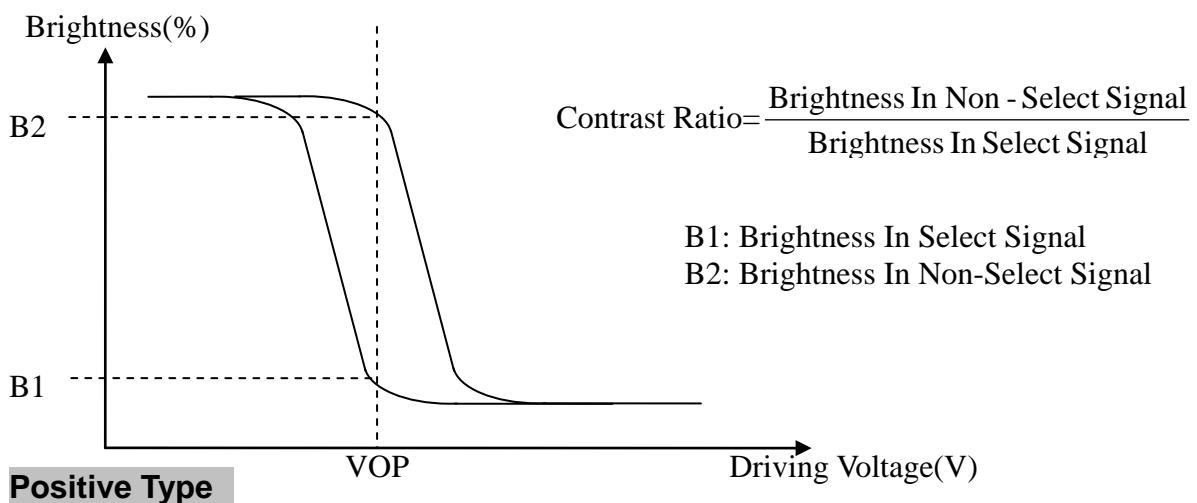
6.Optical Characteristics

a. STN   (Ta=25℃)

Item	Symbol	Min.	Typ.	Max.	Unit
View Angle (CR>=2)	θ_F	-	30	-	deg
	θ_B	-	35	-	deg
	φ_L	-	38	-	deg
	φ_R	-	40	-	deg
Contrast Ratio	CR	2	3	-	-
Response Time 25℃	T rise	-	200	350	ms
	T fall	-	200	400	ms

Brightness(%)

B2

B1

VOP   Driving Voltage(V)

Positive Type

$$\text{Contrast Ratio} = \frac{\text{Brightness In Non - Select Signal}}{\text{Brightness In Select Signal}}$$

B1: Brightness In Select Signal
B2: Brightness In Non-Select Signal

Brightness(%)

B1

B2

VOP   Driving Voltage(V)

Negative Type

Brightness(%)

Select Signal   Non-Select Signal

100% 90%   10%

100%

Tr   Tf

Rise Time   Fall Time   Time(ms)
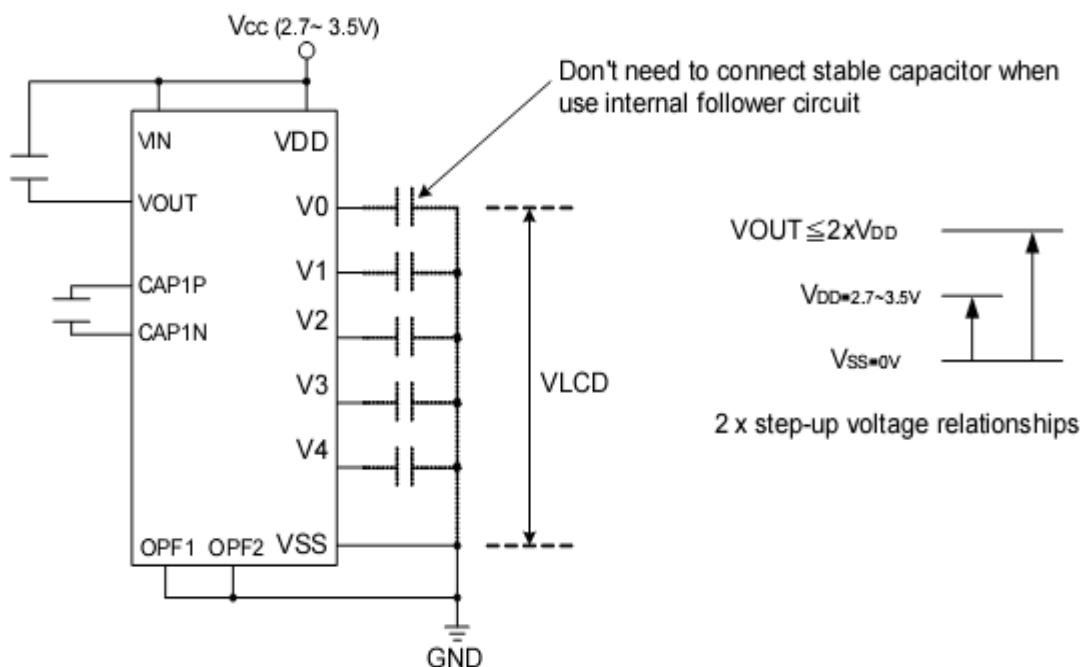
7.Interface Pin Function
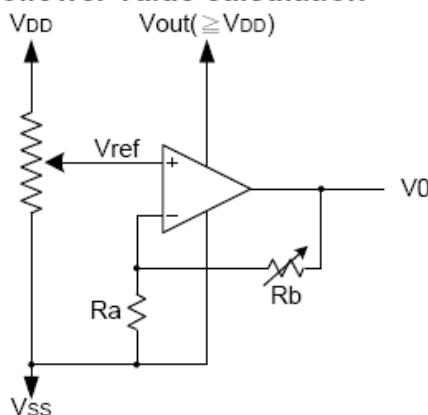
Pin No.	Symbol	Level	Function
1	RST	H/L	Reset signal
2	SCL	H/L	Serial Clock Input
3	SDA	H/L	Serial Data Input/Output
4	VSS	-	Power supply GND
5	VDD	-	Power supply for logic (+3.3V)
6	CAP+	-	Voltage booster circuit
7	CAP-	-	External capacitor about 0.1u~4.7uf
8	VOUT	-	LCD driver voltage

8. Power supply for LCD Module And Block Diagram

● **When built-in booster and voltage followers are used(OPF1=0,OPF2=0)**

V0 voltage follower value calculation
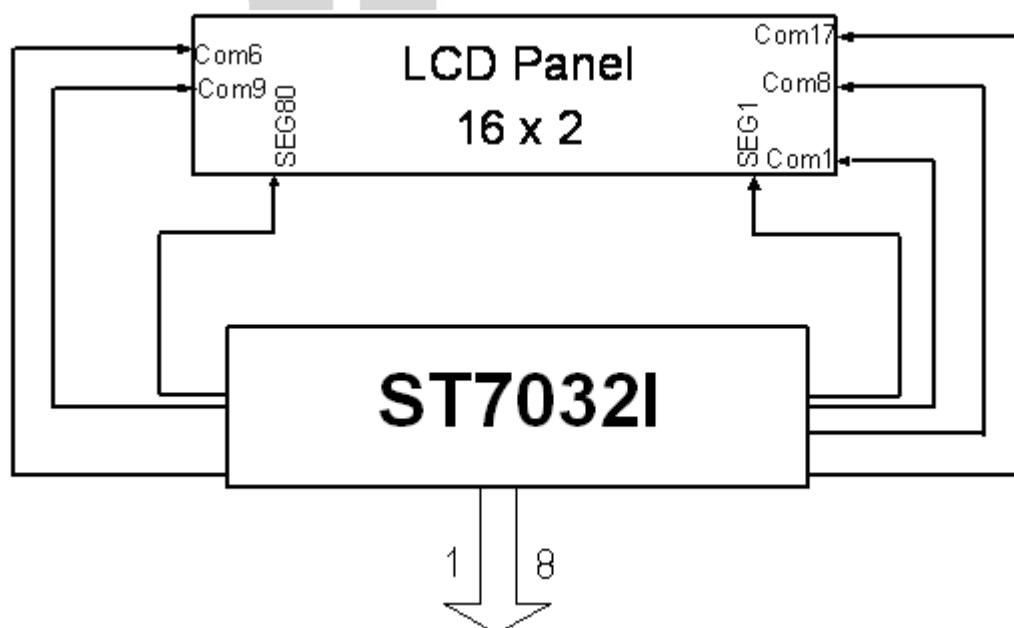
$$V0 = \left(1 + \frac{Rb}{Ra}\right) * Vref$$

$$\text{While } Vref = V_{DD} * \left(\frac{\alpha + 36}{100}\right)$$

C5	C4	C3	C2	C1	C0	α
0	0	0	0	0	0	0
0	0	0	0	0	1	1
0	0	0	0	1	0	2
.						.
.						.
1	1	1	1	0	1	61
1	1	1	1	1	0	62
1	1	1	1	1	1	63

Rab2	Rab1	Rab0	1+Rb/Ra
0	0	0	1
0	0	1	1.25
0	1	0	1.5
0	1	1	1.8
1	0	0	2
1	0	1	2.5
1	1	0	3
1	1	1	3.75

Block Diagram

9. Backlight information

9.1 Specification

(1) LED edge / white
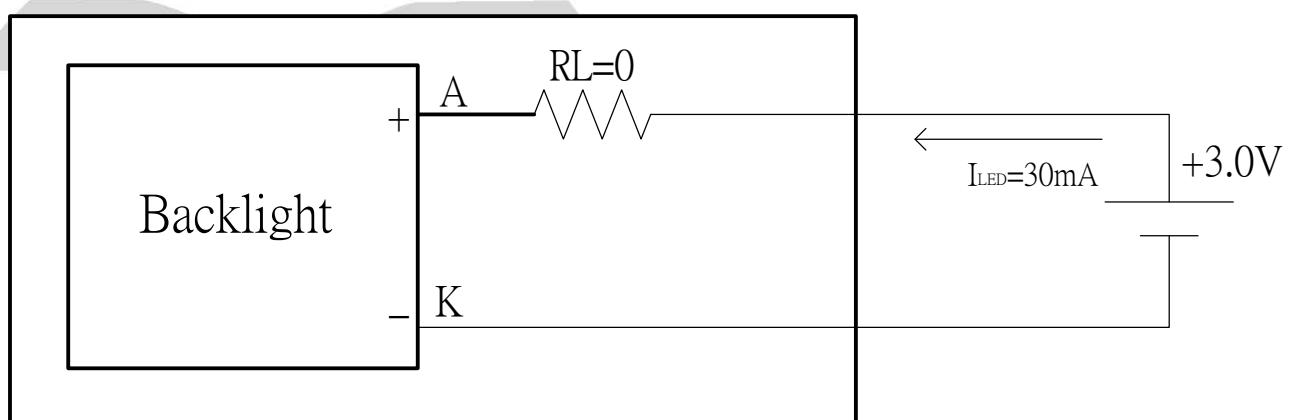
Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	ILED	—	30	—	mA	V=3.0V
Supply Voltage	V	2.8	3.0	3.4	V	ILED=30mA
Reverse Voltage	VR	—	—	5	V	
CIE	X	0.26	—	0.32		ILED=30mA
	Y	0.26	—	0.32		
Color	White					

9.2 Backlight driving methods

a.LED B/L drive from A、K

a.1 edge /white

LCM
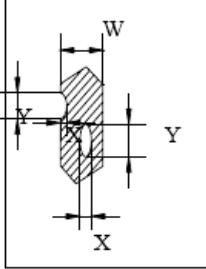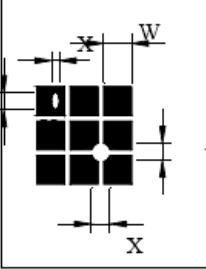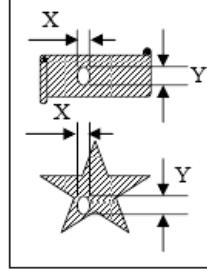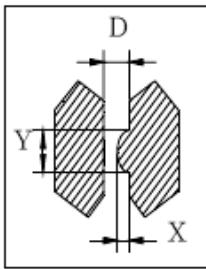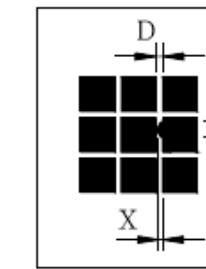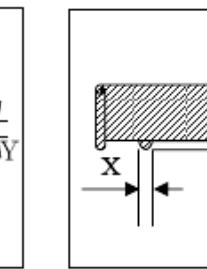
10. Quality Assurance
10.1 Inspection conditions

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
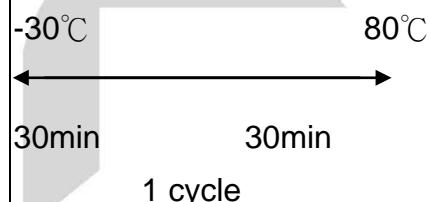
NO.	Parameter	Criteria			
1	Black or White spots (Particle)	Zone \ Dimension	Acceptable Number	Class Of Defects	Acceptable Level
		D≦0.10	Disregard	Minor	2.5
		0.10<D≦0.2	4		
		0.2<D≦0.3	2		
		0.3<D	0		

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.

NO.	Parameter	Zone		Acceptable Number	Class Of Defects	Acceptable Level
		X(mm)	Y(mm)			
2	Scratch, Substances	—	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)	Zone \ Dimension	Acceptable Number	Class Of Defects	Acceptable Level
		D≦0.2	Disregard	Minor	2.5
		0.2＜D≦0.5	3		
		0.5＜D	0		

Total defects shall not excess 3/module.
Defect that is located at outside of AA and doesn't affect function is ignored.
Bobble is sawn only under reflection light is disregarded.

4	Displaying Pattern				

1. Incomplete or broken line is not allowed.
2. Pinholes

Dimension Φ(mm)	Criteria	Class Of Defects	Acceptable Level
Φ＜0.1	Disregard	Minor	2.5
0.1＜Φ≦0.2	2		
0.2＜Φ≦0.25	1		
0.25＜Φ	0		

$Ø=(X+Y)/2$

3. Deformation

Dimension Φ(mm)	Criteria	Class Of Defects	Acceptable Level
Φ＜0.15	Disregard	Minor	2.5
Φ≦0.25 and X≦1/2D	3		
Φ＞0.25and X＞1/2D	0		

D：間距 $Ø=(X+Y)/2$

Other Inspection standard reference Bolymin standard.

11.Reliability
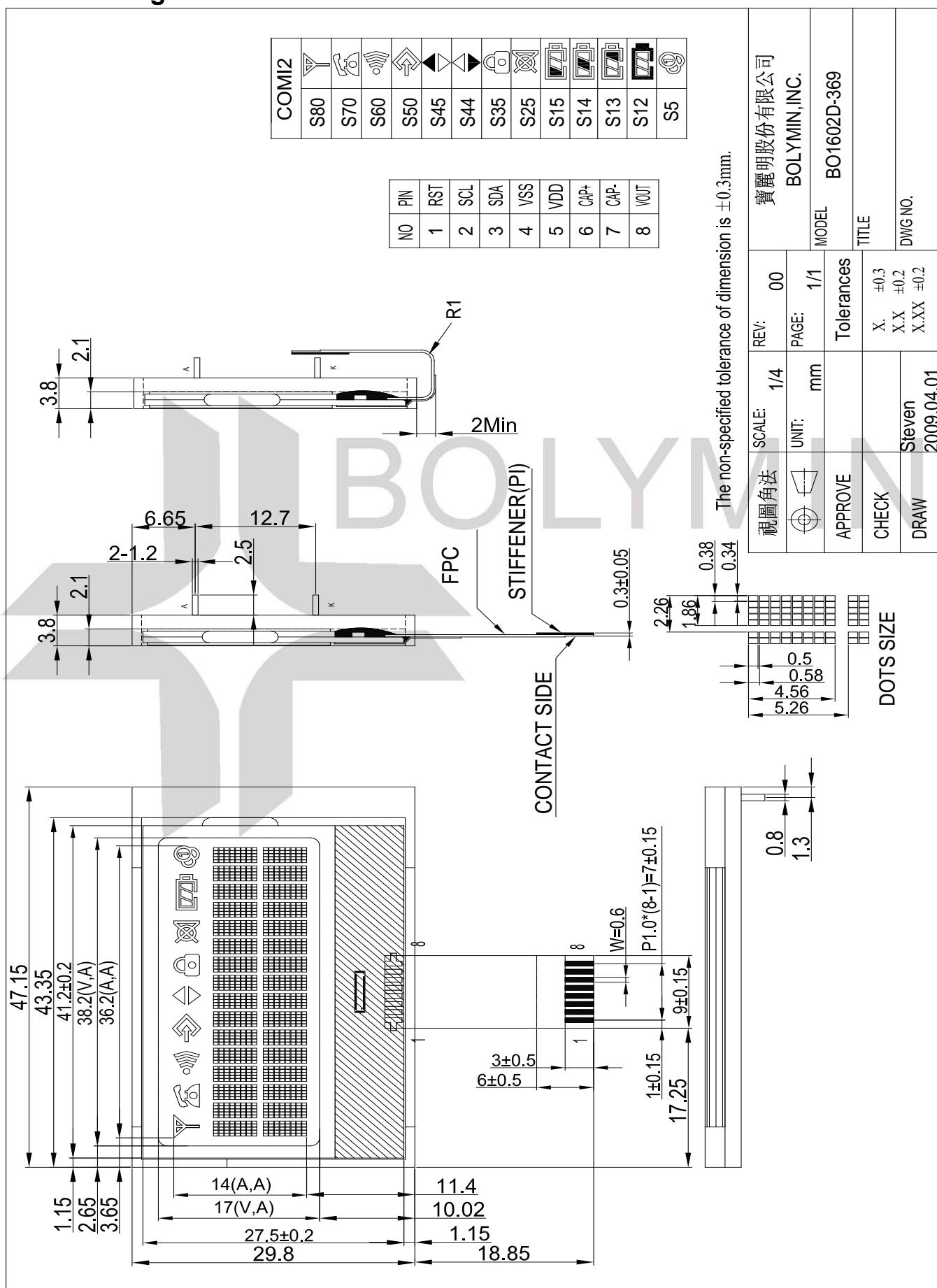
■Content of Reliability Test

	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℃ 96 hrs	――
2	Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30℃ 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℃ 96 hrs	――
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 96 hrs	――
5	Humidity Test	Endurance test applying the high humidity storage for a long time.	40℃,90%RH 96hrs	――
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	――

※Assess after placing at normal temperature and humidity for 4 hour。No abnormalities in

functions and appearance。

12.Appendix (Drawing , ST7032I controller data)
12.1 Drawing

12.2 ST7032I　controller data
12.2.1. Instruction table

Instruction	Instruction Code										Description	Instruction Execution Time		
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		OSC= 380KHz	OSC= 540kHz	OSC= 700KHz
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM. and set DDRAM address to "00H" from AC	1.08 ms	0.76 ms	0.59 ms
Return Home	0	0	0	0	0	0	0	0	1	x	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.08 ms	0.76 ms	0.59 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	26.3 us	18.5 us	14.3 us
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=1:entire display on C=1:cursor on B=1:cursor position on	26.3 us	18.5 us	14.3 us
Function Set	0	0	0	0	1	DL	N	DH	*0	IS	DL: interface data is 8/4 bits N: number of line is 2/1 DH: double height font IS: instruction table select	26.3 us	18.5 us	14.3 us
Set DDRAM address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	26.3 us	18.5 us	14.3 us
Read Busy flag and address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0	0	0
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 us	18.5 us	14.3 us
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 us	18.5 us	14.3 us

*Note * : this bit is for test command , and must always set to "0"*

Instruction table 0(IS=0)														
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	x	x	S/C and R/L: Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	26.3 us	18.5 us	14.3 us
Set CGRAM	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	26.3 us	18.5 us	14.3 us
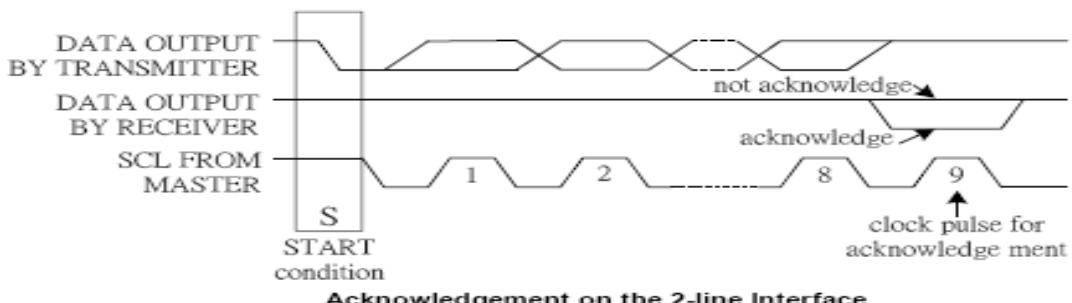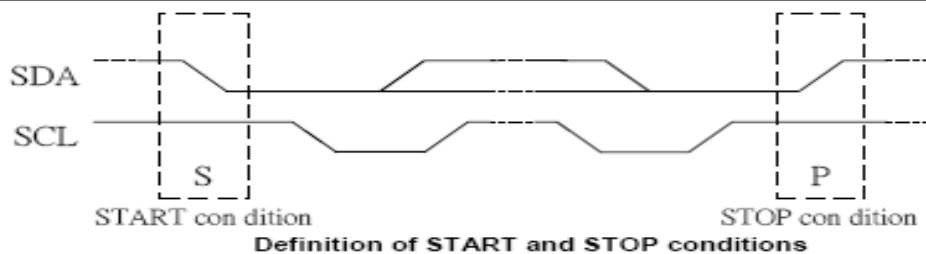
Instruction table 1(IS=1)														
Internal OSC frequency	0	0	0	0	0	1	BS	F2	F1	F0	BS=1:1/4 bias BS=0:1/5 bias F2~0: adjust internal OSC frequency for FR frequency.	26.3 us	18.5 us	14.3 us
Set ICON address	0	0	0	1	0	0	AC3	AC2	AC1	AC0	Set ICON address in address counter.	26.3 us	18.5 us	14.3 us
Power/ICON control/Contrast set	0	0	0	1	0	1	Ion	Bon	C5	C4	Ion: ICON display on/off Bon: set booster circuit on/off C5,C4: Contrast set for internal follower mode.	26.3 us	18.5 us	14.3 us
Follower control	0	0	0	1	1	0	Fon	Rab 2	Rab 1	Rab 0	Fon: set follower circuit on/off Rab2~0: select follower amplified ratio.	26.3 us	18.5 us	14.3 us
Contrast set	0	0	0	1	1	1	C3	C2	C1	C0	Contrast set for internal follower mode.	26.3 us	18.5 us	14.3 us

12.2.2 . Font table

12.2.3 . Timing characteristics
I2C INTERFACE

Definition of START and STOP conditions

Acknowledgement on the 2-line Interface

2-line Interface protocol
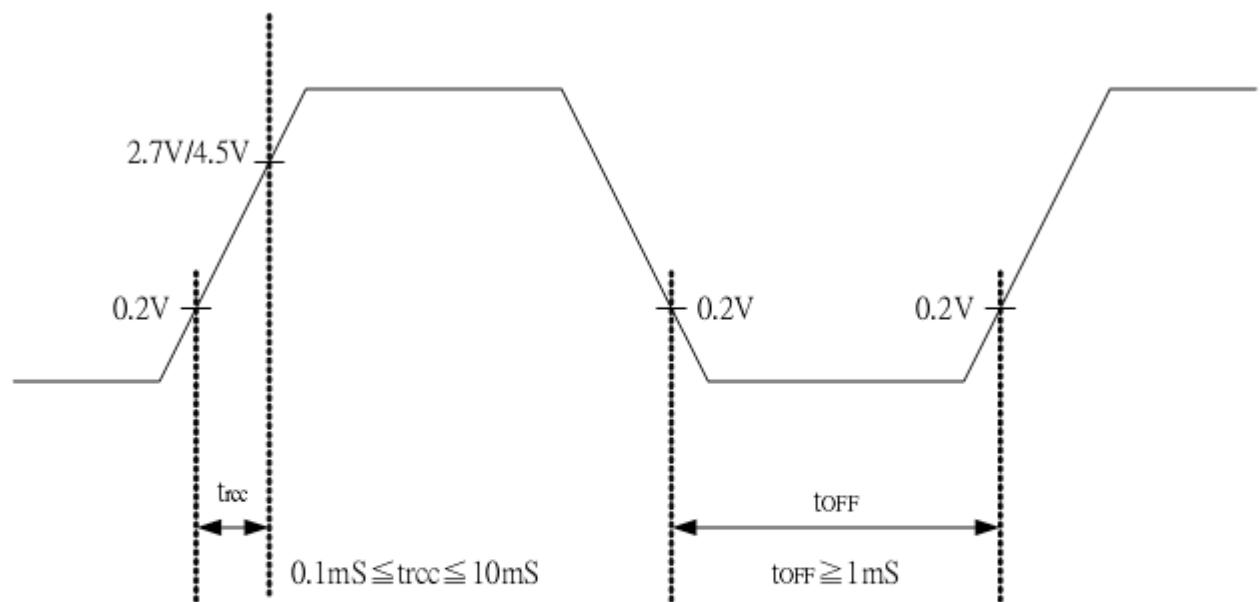
| Co | 0 | Last control byte to be sent. Only a stream of data bytes is allowed to follow. This stream may only be terminated by a STOP condition. |
| | 1 | Another control byte will follow the data byte unless a STOP condition is received. |

RS	R/W	Operation
L	L	Instruction Write operation (MPU writes Instruction code into IR)
H	L	Data Write operation (MPU writes data into DR)

## Various kinds of operations according to RS and R/W bits.
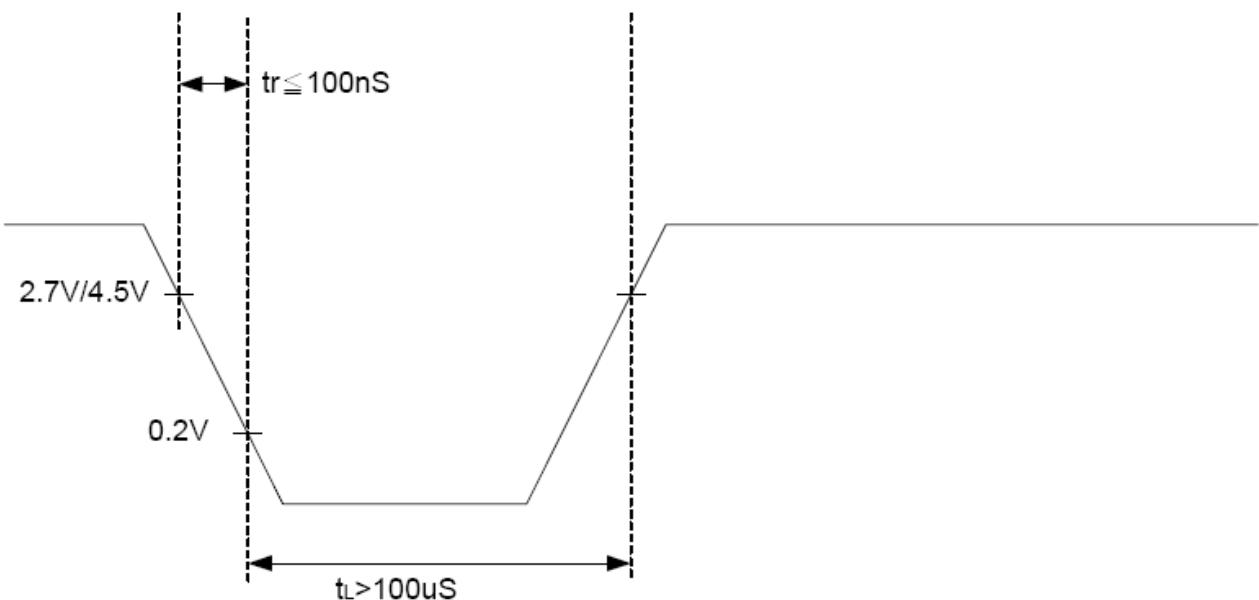
RESET TIMMING
Internal Power Supply Reset

2.7V/4.5V

0.2V   0.2V   0.2V

trcc   tOFF

$0.1mS \leqq trcc \leqq 10mS$ $tOFF \geqq 1mS$

Notes:
- tOFF compensates for the power oscillation period caused by momentary power supply oscillations.
- Specified at 4.5V for 5V operation,and at 2.7V for 3V operation.
- If 2.7V/4.5V is not reached during 3V/5V operation, internal reset circuit will not operate normally.

Hardware Reset (XRESET)

$tr \leqq 100nS$

2.7V/4.5V

0.2V

$t_L > 100uS$

12.2.4 . ICON RAM MAP

ICON address	ICON RAM bits							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	-	-	-	S80	S79	S78	S77	S76
01H	-	-	-	S75	S74	S73	S72	S71
02H	-	-	-	S70	S69	S68	S67	S66
03H	-	-	-	S65	S64	S63	S62	S61
04H	-	-	-	S60	S59	S58	S57	S56
05H	-	-	-	S55	S54	S53	S52	S51
06H	-	-	-	S50	S49	S48	S47	S46
07H	-	-	-	S45	S44	S43	S42	S41
08H	-	-	-	S40	S39	S38	S37	S36
09H	-	-	-	S35	S34	S33	S32	S31
0AH	-	-	-	S30	S29	S28	S27	S26
0BH	-	-	-	S25	S24	S23	S22	S21
0CH	-	-	-	S20	S19	S18	S17	S16
0DH	-	-	-	S15	S14	S13	S12	S11
0EH	-	-	-	S10	S9	S8	S7	S6
0FH	-	-	-	S5	S4	S3	S2	S1

ICON RAM map