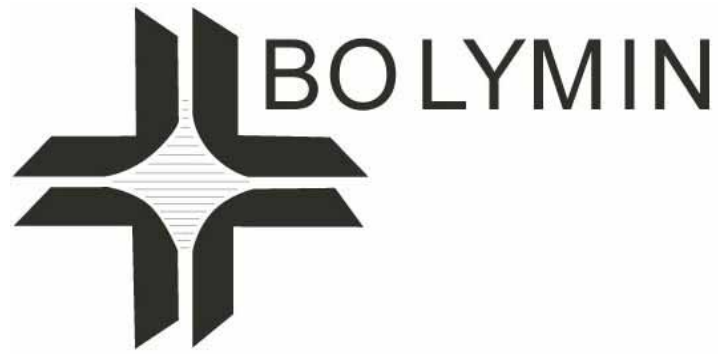




SPECIFICATIONS FOR LCD MODULE

MODEL NO.
BO1602D series
VER.04



FOR MESSRS:

ON DATE OF:

APPROVED BY:

BOLYMIN, INC.
13F-1, 20, TA-LONG RD., TAICHUNG CITY 403, TAIWAN, R.O.C.
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History of Version

Version	Contents	Date	Note
01	NEW VERSION	2007/10/22	SPEC.
02	ADD RESET TIMMING ADD ICON RAM MAP ADD VO VOLTAGE FOLLOWER VALUE CALCULATION	2007/12/21	
03	ADD LED DRAWING	2008/05/30	
04	MODIFY BACKLIGHT INFORMATION	2008/07/01	

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1. Numbering System
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11. Font table
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13. Drawing

1. Numbering System

<u>B</u>	<u>O</u>	<u>1602</u>	<u>D</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</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	1602=16 characters, 2 lines	
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 D=OLED/blue+yellow A=OLED/blue+yellow+green
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 volt logic power supply n=negative voltage for LCD c=cable/connector xxx=to be assigned on datasheet	t=temperature compensation for LCD p=touch panel \$=RoHS

2. General Specification

(1) Mechanical Dimension

Item	Dimension	Unit
Number of Characters	16characters x 2 Lines	-
Module dimension (L x W x H)	41.2 x 27.5 x 2.1 (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

(3) Temperature Range

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

3. Absolute Maximum Ratings

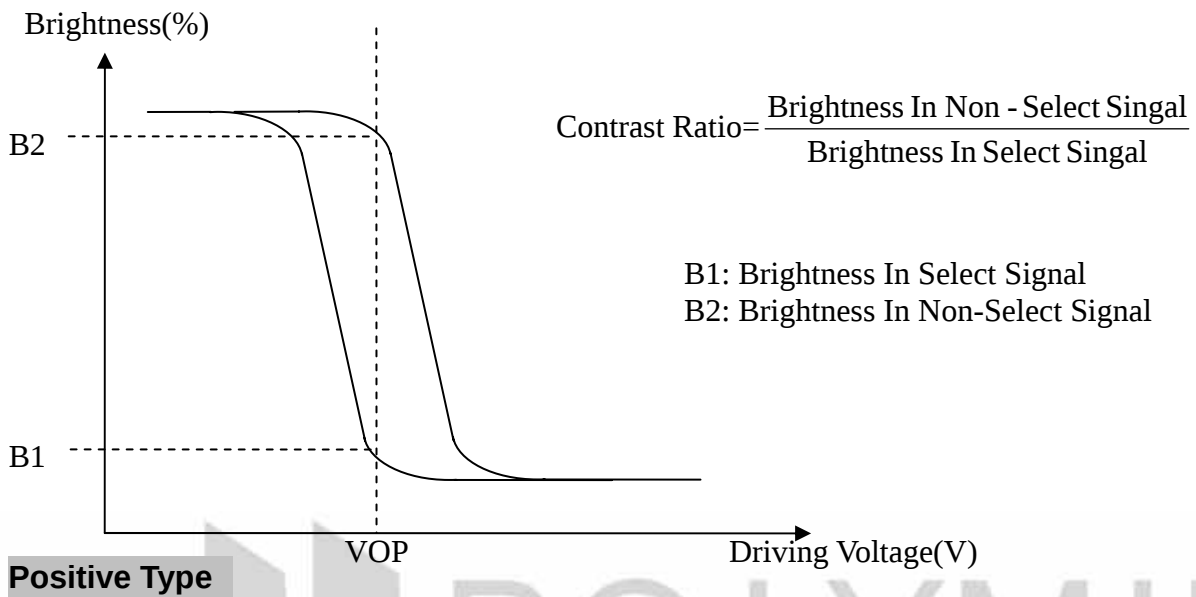
(Vss=0V, Ta=25 °C)

Item	Symbol	Min	Max	Unit
Supply Voltage (Logic)	Vdd-Vss	2.7	3.5	V
Supply Voltage (LCD driver)	Vlcd	3	7.0	V
Input Voltage	VI	-0.3	Vdd+0.3	V
Normal Type	TOP	0	+50	
	TSTG	-10	+60	
Wide Temperature Type	Top	-20	+70	
	Tstg	-30	+80	

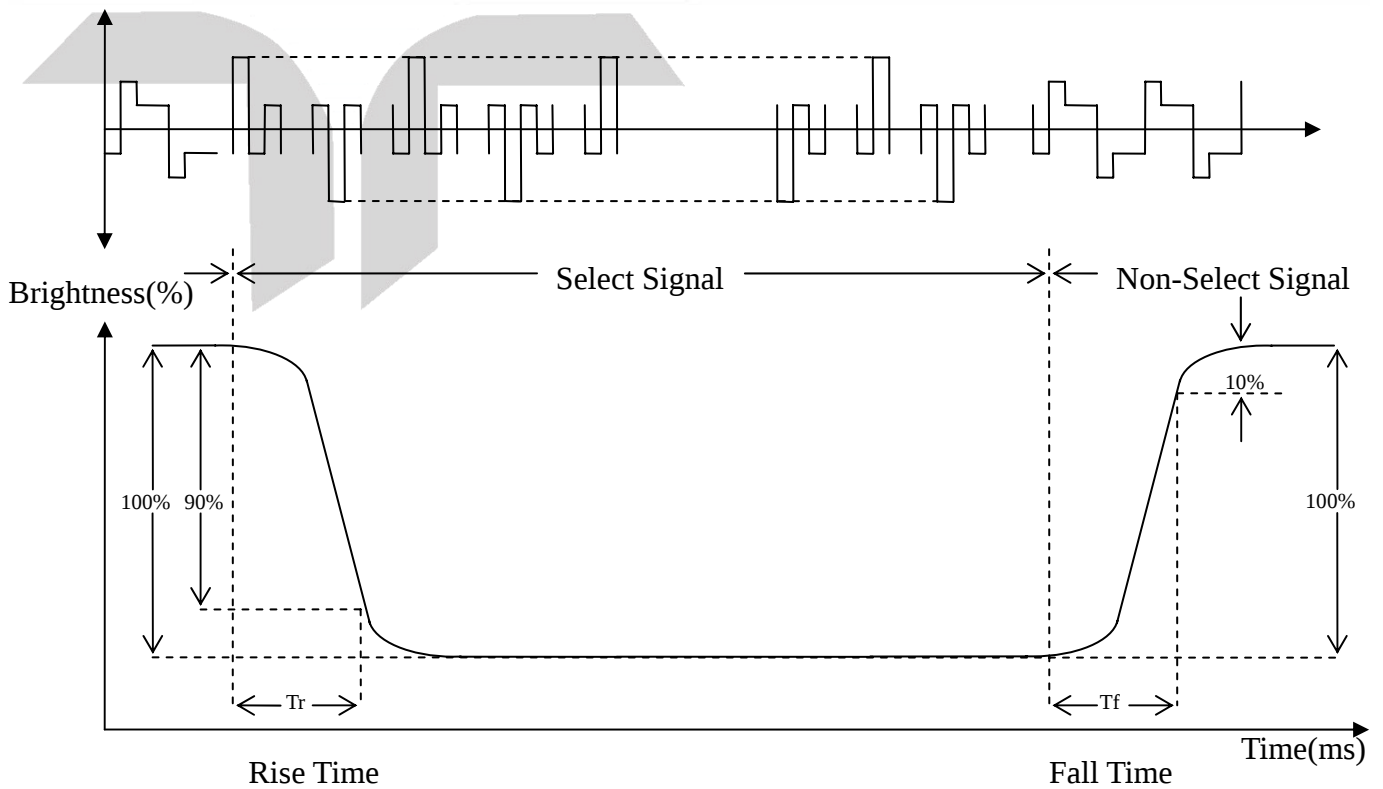
4. Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
----- Electronic Characteristics -----							
Logic Circuit Supply Voltage	Vdd-Vss	--	2.7	3.3	3.5	V	
LCD driving voltage (STN)	Vlcd	-20 °C	--		--	V	-20 ~ 70 °C for Extended Temp. typ
		0 °C	--	--	--		
		25 °C	--	4.8	--		
		50 °C	--	--	--		
		70 °C	--		--		
Input Voltage	VIH	--	2.1	--	Vdd	V	
	VIL	--	0	--	0.9	V	
Logic Supply Current	Idd	Vdd=3.0V	--	1	--	mA	
----- Optical Characteristics (STN)-----							
Contrast	CR	STN type		8			Note 1
Rise Time	tr	25°C	--	150	300	ms	Note 2
Fall Time	tf	25°C	--	150	300	ms	
Viewing Angle Range	θ f	25°C & CR≥3	--	40	--	Deg.	Note 3
	θ b		--	35	--		
	θ l		--	35	--		
	θ r		--	35	--		
Frame Frequency	fF	25°C	--	64	--	Hz	

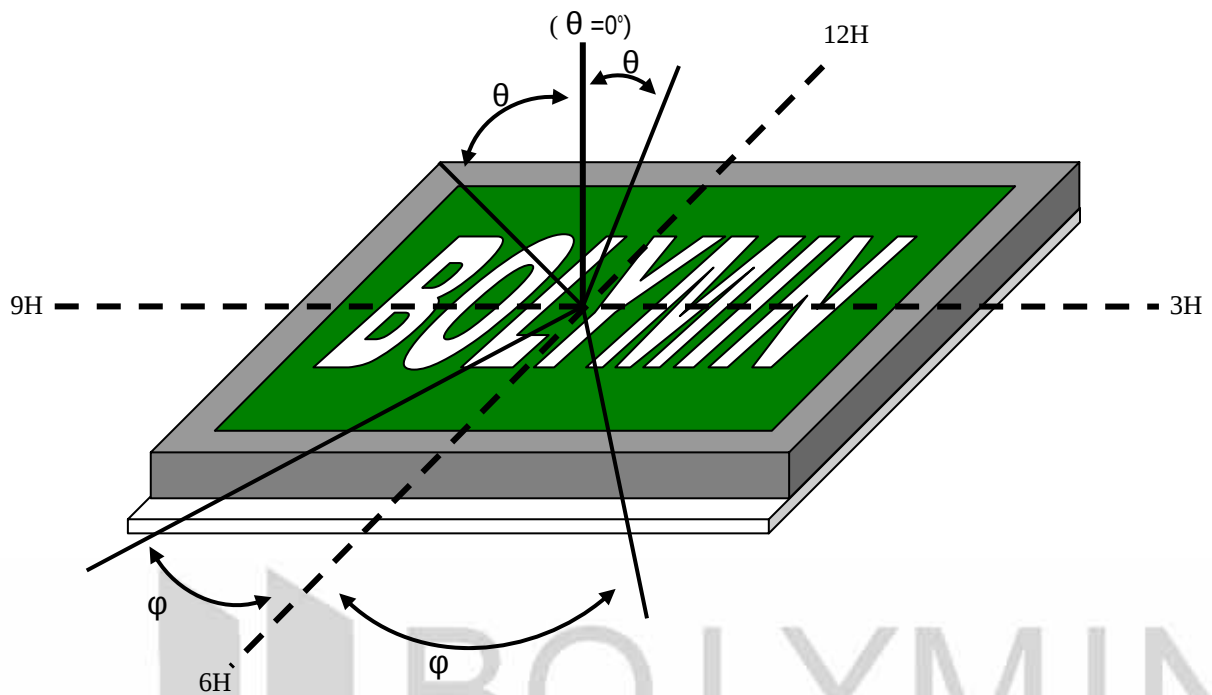
(Note 1) Contrast ratio :



(Note 2) Response time :



(Note 3) Viewing angle

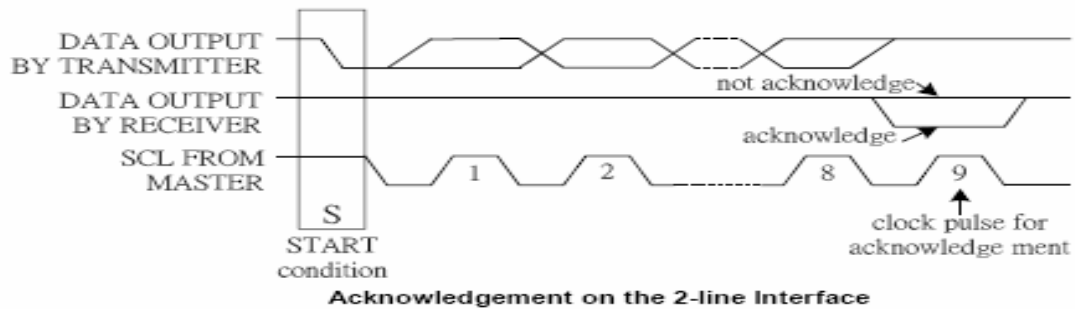
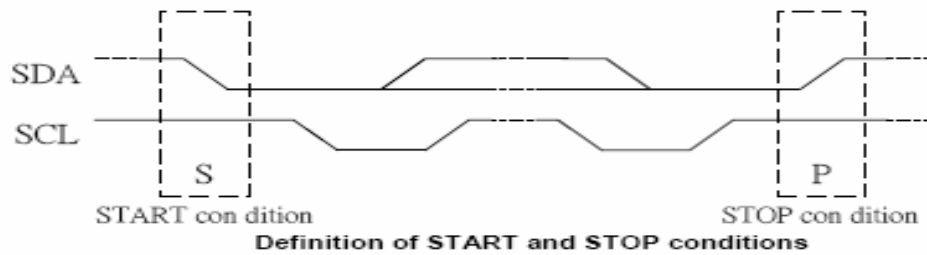


5. Interface Pin Function

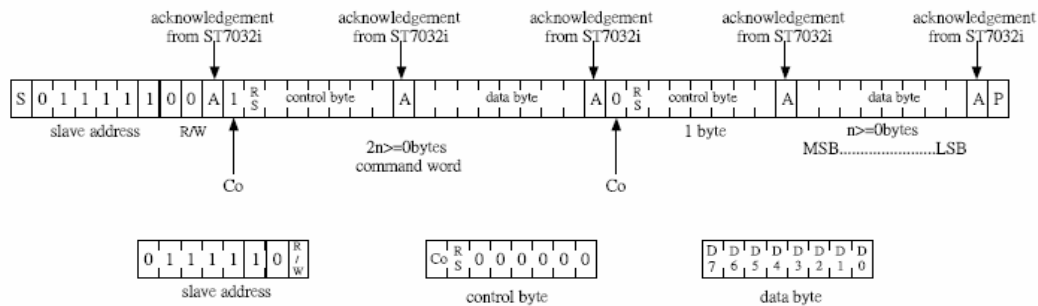
Pin No.	Symbol	Level	Function
1	RST	H/L	Reset signal
2	SCL	H/L	Serial Clock Input
3	SDA	H/L	Serial Data Input/Output
4	VSS	-	Power supply GND
5	VDD	-	Power supply for logic (+3.3V)
6	CAP+	-	Voltage booster circuit
7	CAP-	-	External capacitor about 0.1u~4.7uf
8	VOUT	-	LCD driver voltage

6.Timing Characteristics

6.1 I2C INTERFACE



Write mode



2-line Interface protocol

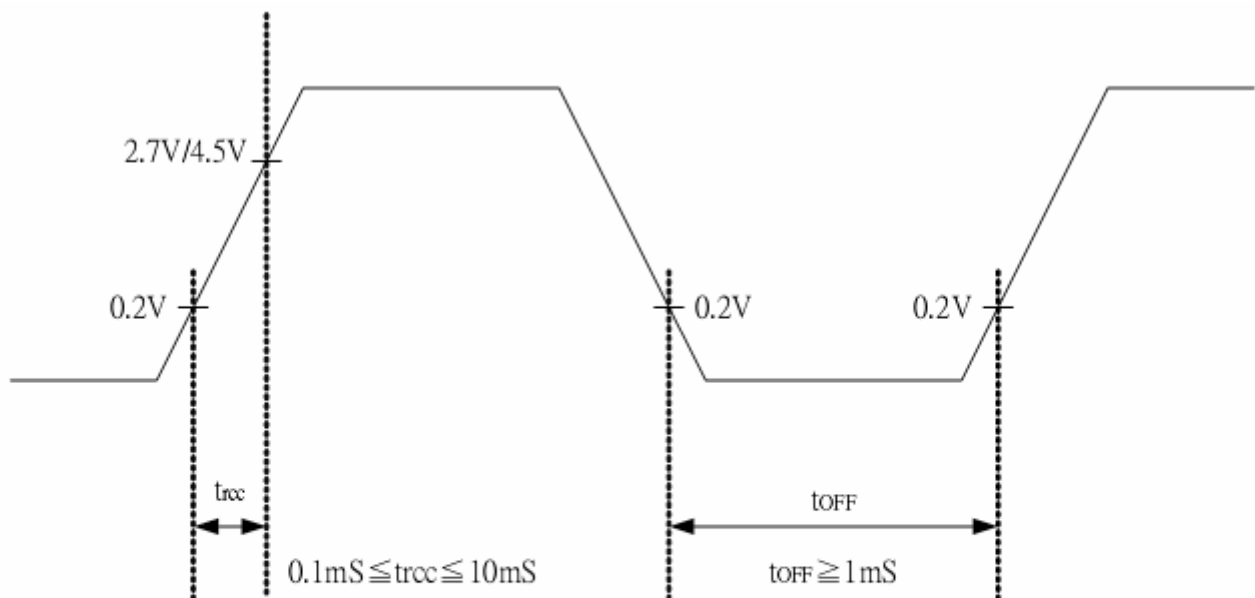
Co	0	Last control byte to be sent. Only a stream of data bytes is allowed to follow. This stream may only be terminated by a STOP condition.
	1	Another control byte will follow the data byte unless a STOP condition is received.

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.

6.2 RESET TIMMING

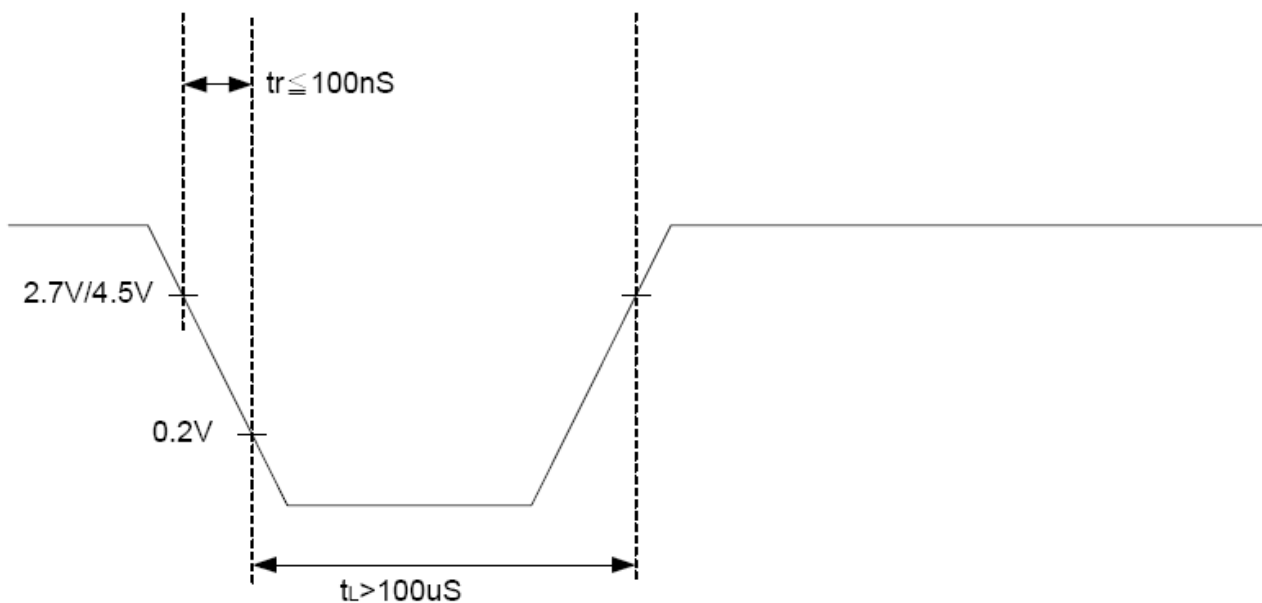
6.2.1 Internal Power Supply Reset



Notes:

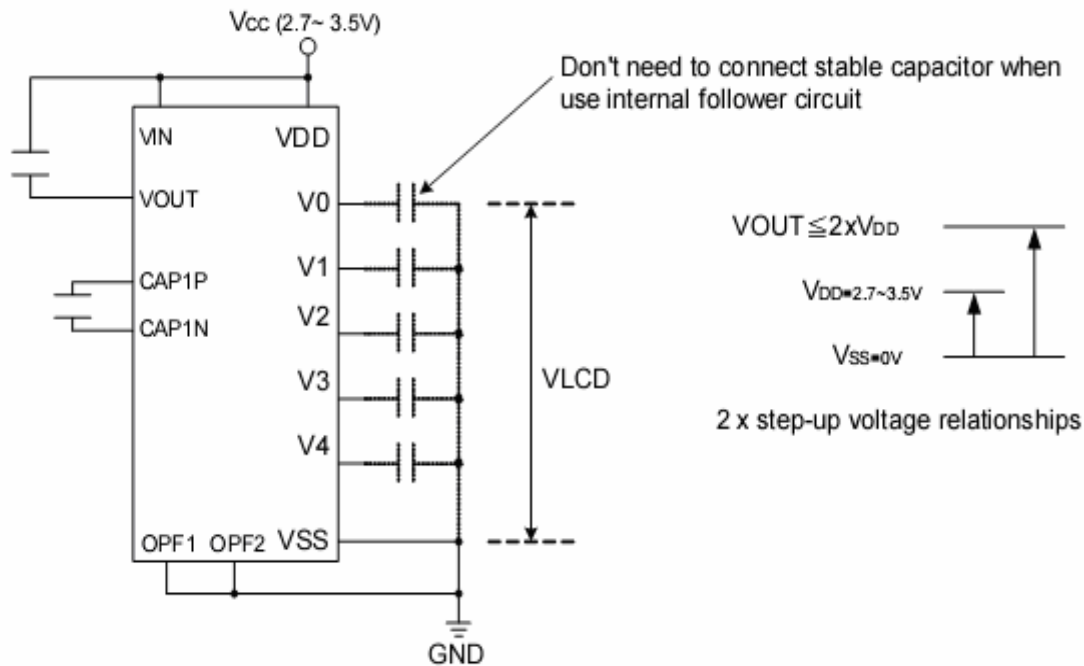
- t_{off} compensates for the power oscillation period caused by momentary power supply oscillations.
- Specified at 4.5V for 5V operation, and at 2.7V for 3V operation.
- If 2.7V/4.5V is not reached during 3V/5V operation, internal reset circuit will not operate normally.

6.2.2 Hardware Reset (XRESET)

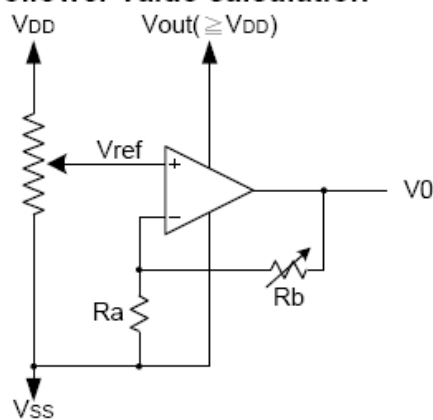


7. Power Supply

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



V0 voltage follower value calculation



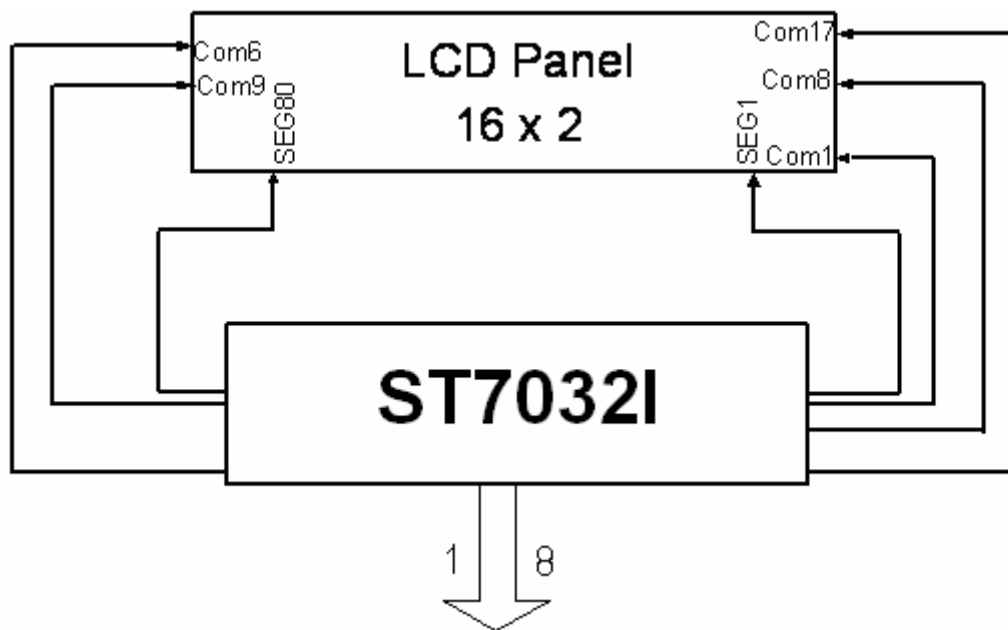
$$V_0 = \left(1 + \frac{R_b}{R_a}\right) \times V_{ref}$$

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

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	$1 + R_b/R_a$
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

8. Block Diagram



9. Backlight Information

9.1 Specification

(1) LED edge / yellow-green B/L

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	I _{LED}	—	20	-	mA	V=4.2V
Supply Voltage	V	-	4.2	4.3	V	
Reverse Voltage	V _R	-	-	5	V	
Luminous Intensity	I _V	-	-	-	cd/ m ²	I _{LED} =20mA
Wave Length	λ _p		572		nm	I _{LED} =20mA
Life Time		-	50000	-	Hr.	V 4.2V
Color			Yellow Green			

10. Commands

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
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
Function Set	0	0	0	0	1	DL	N	x	x	x	DL: interface data is 8/4 bits N: number of line is 2/1	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
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)	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)	26.3 us	18.5 us	14.3 us

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

11. Font table

b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0001	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0010	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0011	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0100	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0101	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0110	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
0111	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1000	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1001	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1010	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1011	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1100	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1101	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1110	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı
1111	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı	ı

12. ICON RAM MAP

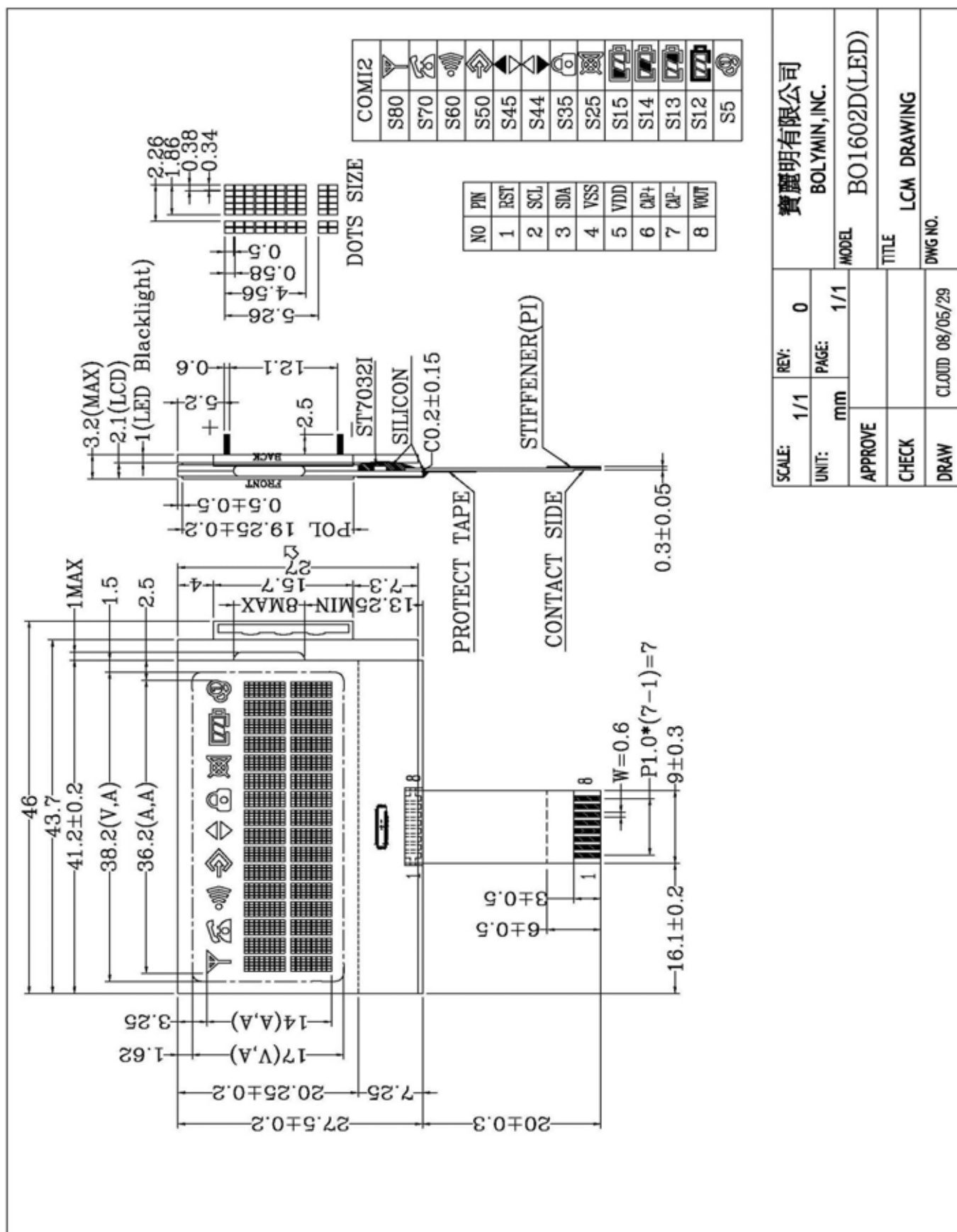
ICON address	ICON RAM bits							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	-	-	-	S80	S79	S78	S77	S76
01H	-	-	-	S75	S74	S73	S72	S71
02H	-	-	-	S70	S69	S68	S67	S66
03H	-	-	-	S65	S64	S63	S62	S61
04H	-	-	-	S60	S59	S58	S57	S56
05H	-	-	-	S55	S54	S53	S52	S51
06H	-	-	-	S50	S49	S48	S47	S46
07H	-	-	-	S45	S44	S43	S42	S41
08H	-	-	-	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



13. Drawing

13.1 LCD+ Backlight Drawing



13.2 LCD Drawing

