SPECIFICATIONS FOR
LCD MODULE

MODEL NO.
BO9864B series
VER01

FOR MESSRS:

_____

ON DATE OF:

_____

APPROVED BY:

_____

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

History of Version

Version	Contents	Date	Note
01	NEW VERSION	2007/09/20	SPEC.

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1. Numbering System

	B	O	9864	B	-	-	-	-	-	xxx
	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
2	Format	2002=20 characters, 4 lines 12232= 122 x 32 dots	
3	Version No.	A type	
4	LCD Color	G=STN/gray Y=STN/yellow-green C=color STN	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=LEDedge/yellow-green F=RGB Q=LED edge/red A=LED edge/amber	D=LED edge/blue E=EL/white B=EL/blue C=CCFL/white Y=LED Bottom/yellow O=LED array/orangr K=LED edge/green
7	CGRAM Font (applied only on character type)	J=English/Japanese Font E=English/European Font	C=English/Cyrillic Font H=English/Hebrew 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 xxx=to be assigned on datasheet	t=temperature compensation for LCD p=touch panel

2. General Specification

(1) Mechanical Dimension

Item	Standard Value	Unit
Number of dots	98 × 64	dots
Module Size (W x H x T)	34.0 x 34.0 x 1.65max-No B/L	mm
View area	31.0(W) × 22.5(H)	mm
Dot size	0.26W) × 0.31(H)	mm
Dot pitch	0.28(W) × 0.33(H)	mm

(2) Controller IC: ST7548i Controller

(3) Temperature Range

	Normal	Wide
Operating	0 ~+50℃	-20 ~ +70℃
Storage	-10 ~ +60℃	-40 ~ +85℃

3. Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage For Logic	V_{DD}-V_{SS}	2.4	3.0	3.3	V
Supply Voltage For LCD	V_{LCD}	0	—	13.5	V
Input Voltage	V_I	-0.3	—	V_{DD}+0.3	V
Operating Temperature	T_{OP}	-20	—	+70	℃
Storage Temperature	T_{STG}	-30	—	+85	℃

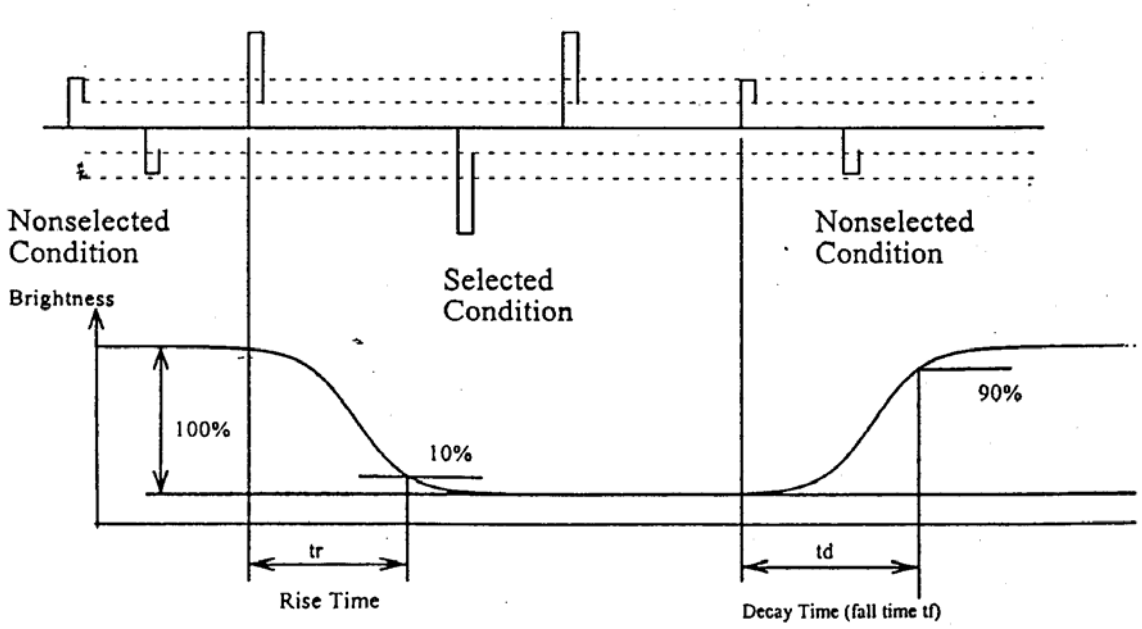
4. Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
----- Electronic Characteristics -----							
Logic Circuit Supply Voltage	V_{DD}-V_{SS}	--	2.4	3.0	3.3	V	
LCD Driving Voltage	V_{LCD}	-20 °C	--	12.2	--	V	* It should be defined by real design.
		25 °C	--	**11.9**	--		
		+70 °C	--	11.2	--		
Input Voltage	V_{IH}	--	0.7 V_{DD}	--	V_{DD}	V	
	V_{IL}	--	0	--	0.3 V_{DD}	V	
Logic Supply Current	I_{DD}	V_{DD} = 3V	--	0.2	--	mA	
----- Optical Characteristics -----							
Contrast	CR	-20 °C	--	1.7*	--		Note 1 * It should be defined by real design.
		25 °C	--	8*	--		
		70 °C	--	4.6*	--		
Rise Time	tr	-20 °C	--	2100*	--	ms	Note 2 * It should be defined by real design.
		25 °C	--	150*	--		
		70 °C	--	50*	--		
Fall Time	tf	-20 °C	--	5500*	--	ms	
		25 °C	--	250*	--		
		70 °C	--	65*	--		
Viewing Angle Range	θ f	25°C & CR≥2	--	40	--	Deg.	Note 3
	θ b		--	30	--		
	θ l		--	35	--		
	θ r		--	35	--		
Frame Frequency	fF	25°C	--	64	--	Hz	

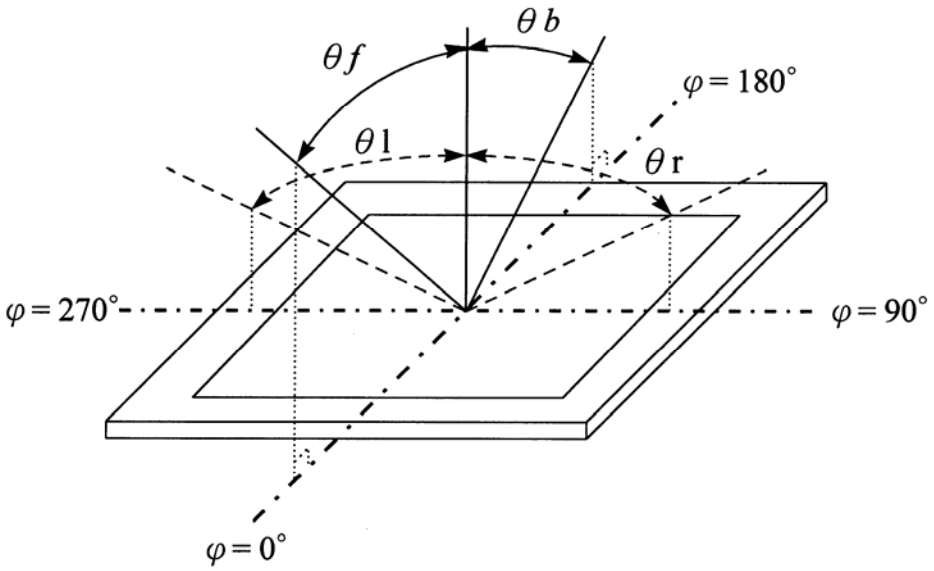
(NOTE 1) Contrast ratio :

CR = (Brightness in OFF state) / (Brightness in ON state)

(NOTE 2) Response time :



(NOTE 3) Viewing angle



5. Interface Pin Function

No.	Symbol	Function
1	V_{LCD}	LCD power supply
2	V_{SS1}	Logic ground 0V
3	V_{SS2}	Logic ground 0V
4	SCL	I^2C-bus Serial clock signal input
5	SDA	I^2C-bus data lines
6	RES	This signal is used to rest the device. This signal is active Low.
7	V_{DD2}	Positive power supply
8	V_{DD1}	Positive power supply

6. Backlight Information

(1) EL /White(blue)

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Voltage	Vrms	--	110 (AC)		V	
Frequency	HZ	--	400		Hz	
Brightness*(Mea su-re on LCD)	cd/m^2	5	10		cd/m 2	110Vrms 400Hz
CIE Chromaticity Diagram	X	--	0.2901white 0.182 blue		--	
	Y	--	0.3608 white 0.46 blue		--	
Current Dissipation	mA/cm^2	--	1.33		mA	

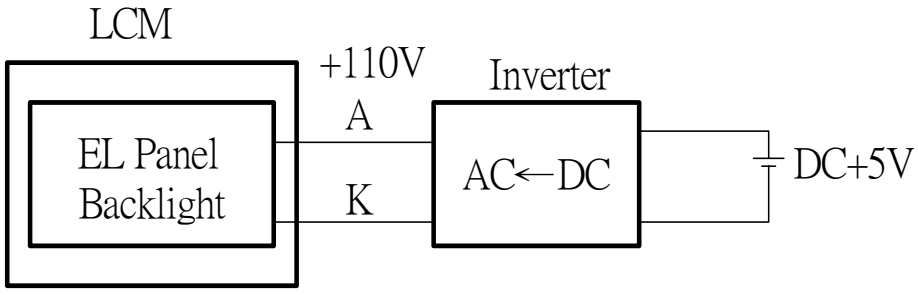
Power Dissipation	mW/cm^2	--	26.29		mW	
Color	White(Blue)					

(2) LED edge/white

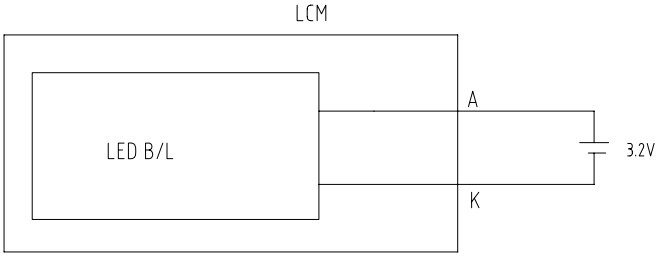
Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Supply Current	ILED	—	20	25	mA	V=3.2V
Supply Voltage	V	—	3.2	3.4	V	
Reverse Voltage	VR	—	—	5	V	
Luminous Intensity	IV	15	—	—	cd/m^2	ILED=20mA
Life Time		—	15000	—	Hr.	V≦3.2V
Color	White					

6.2 Backlight driving methods

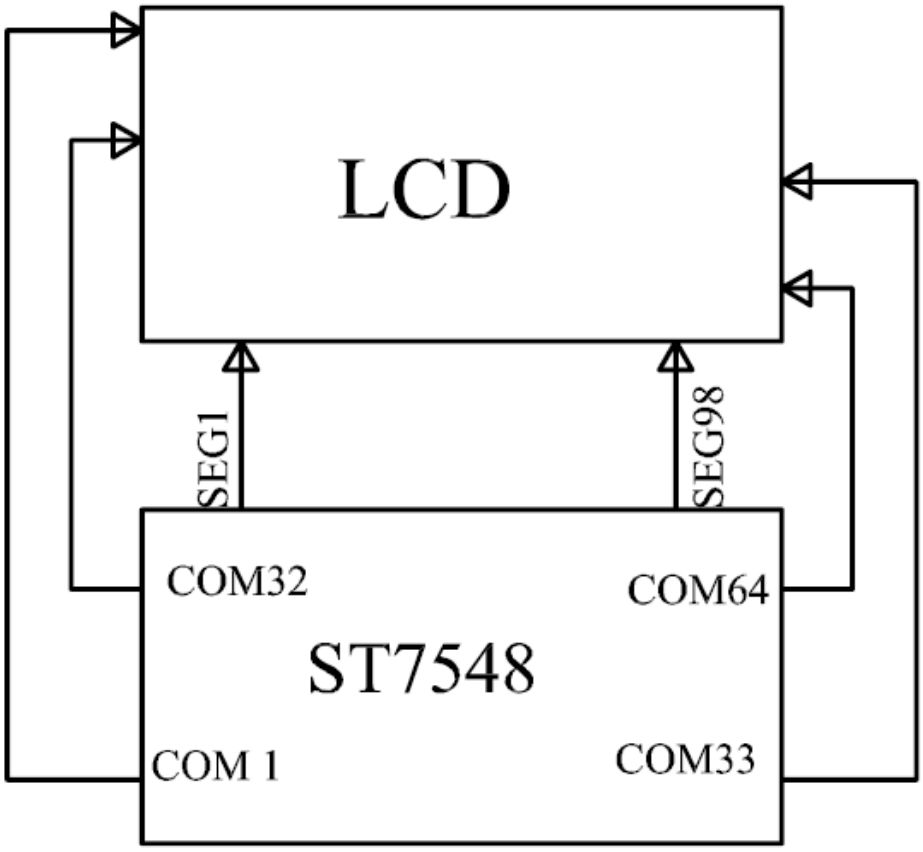
E/L B/L driven from PINS of EL backlight directly



LED B/L driven from PINS of LED backlight directly



7. Block Diagram

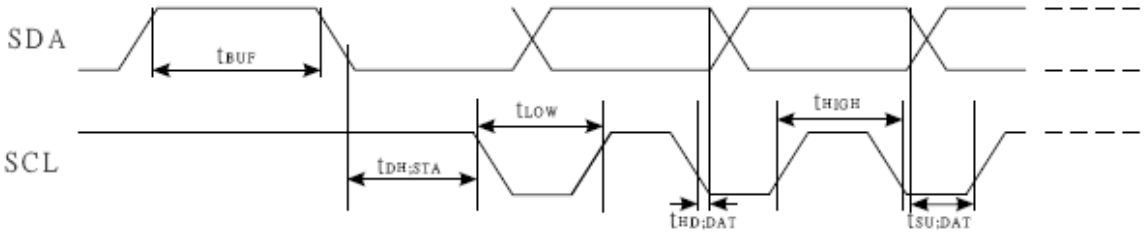


Display Configuration
Setting :

MX=1 MY=0

8. Timing Characteristics

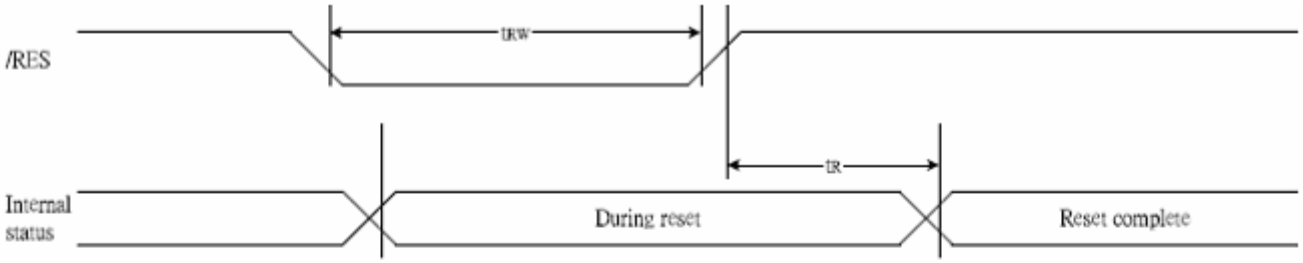
8.1 Serial Interface(I2C interface)



(V_{DD}=3.3V,Ta=25℃)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
SCL clock frequency	SCL	FSCLK		-	400	kHZ
SCL clock low period	SCL	TLOW		1.3	-	us
SCL clock high period	SCL	THIGH		0.6	-	us
Data set-up time	SI	TSU;Data		100	-	ns
Data hold time	SI	THD;Data		0	0.9	us
SCL,SDA rise time	SCL	TR		20+0.1Cb	300	ns
SCL,SDA fall time	SCL	TF		20+0.1Cb	300	ns
Capacitive load represented by each bus line		Cb		-	400	pF
Setup time for a repeated START condition	SI	TSU;SUA		0.6	-	us
Start condition hold time	SI	THD;STA		0.6	-	us
Setup time for STOP condition		TSU;STO		0.6	-	us
Tolerable spike width on bus		TSW		-	50	ns
BUS free time between a STOP and START condition	SCL	TBUF		1.3		us

8.2 Reset Timing



(VDD = 3.3V , Ta = –40 to 85°C)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR		—	—	1	us
Reset "L" pulse width	RESB	tRW		1	—	—	us

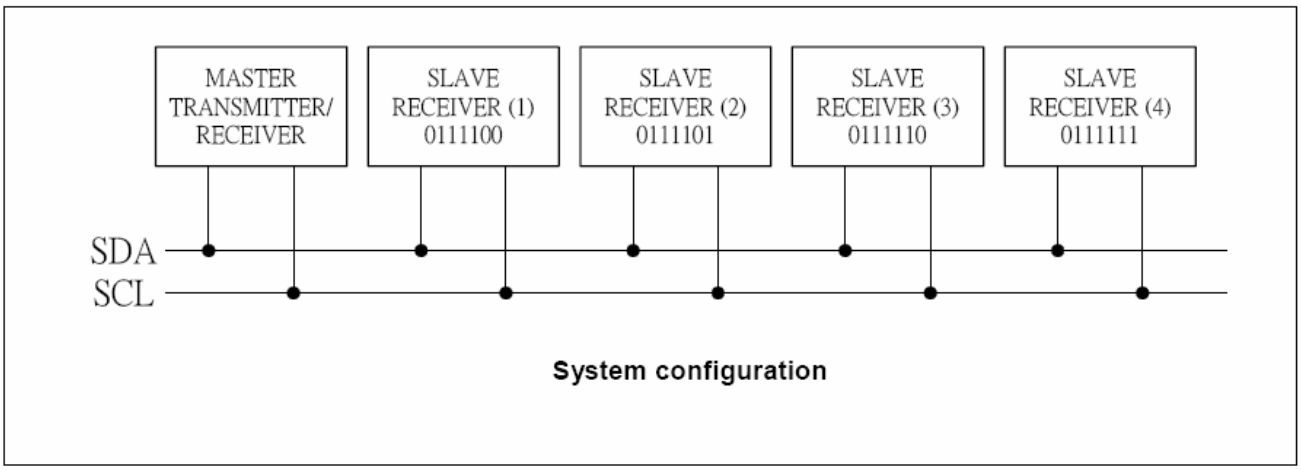
(VDD = 2.7V , Ta = –40 to 85°C)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR		—	—	2.0	us
Reset "L" pulse width	RESB	tRW		2.0	—	—	us

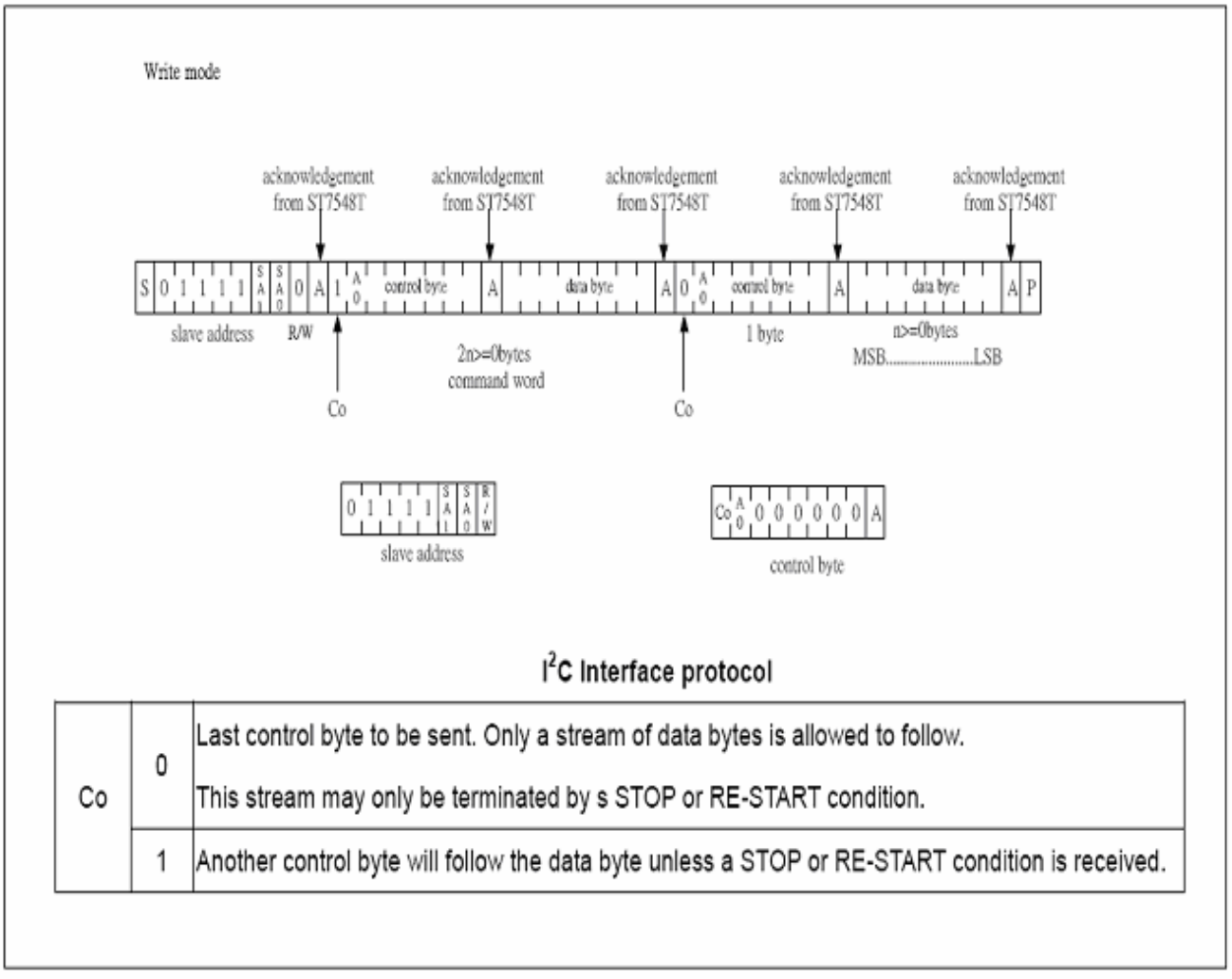
(VDD = 1.8V , Ta = –40 to 85°C)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR		—	—	3.0	us
Reset "L" pulse width	RESB	tRW		3.0	—	—	us

9.I2C Interface Protocol



System configuration



I^2C 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 s STOP or RE-START condition.
	1	Another control byte will follow the data byte unless a STOP or RE-START condition is received.

10.Instruction Table

INSTRUCTION	A0	WR (R/W)	COMMAND BYTE								DESCRIPTION
			D7	D6	D5	D4	D3	D2	D1	D0	
H=0 or 1											
NOP	0	0	0	0	0	0	0	0	0	0	No operation
Reserved	0	0	0	0	0	0	0	0	0	1	Do not use
Function set	0	0	0	0	1	MX	MY	PD	V	H	Power-down; entry mode;
Read status byte	0	1	PD	0	0	D	E	MX	MY	DO	Read status byte
Write data	1	0	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Write data to RAM

INSTRUCTION	A0	WR (R/W)	COMMAND BYTE								DESCRIPTION
			D7	D6	D5	D4	D3	D2	D1	D0	
H=0											
Reserved	0	0	0	0	0	0	0	0	1	X	Do not use
Set V0 range	0	0	0	0	0	0	0	1	0	PRS	V0 range L/H select
Display control	0	0	0	0	0	0	1	D	0	E	Sets display configuration
Reserved	0	0	0	0	0	1	0	0	X	X	Do not use
Set Y address of RAM	0	0	0	1	0	0	Y_3	Y_2	Y_1	Y_0	Sets Y address of RAM $0 \leq Y \leq 9$
Set X address of RAM	0	0	1	X_6	X_5	X_4	X_3	X_2	X_1	X_0	Sets X address of RAM $0 \leq X \leq 101$
H=1											
Reserved	0	0	0	0	0	0	0	0	1	X	Do not use
Display configuration	0	0	0	0	0	0	1	DO	X	X	Set data order
Bias system	0	0	0	0	0	1	0	BS_2	BS_1	BS_0	Sets bias system (BSx)
Reserved	0	0	0	1	X	X	X	X	X	X	Do not use(reserved for test)
Set V0 voltage (Set V_{OP})	0	0	1	V_{OP6}	V_{OP5}	V_{OP4}	V_{OP3}	V_{OP2}	V_{OP1}	V_{OP0}	Write V0 (V_{OP}) voltage to register

11.Instruction Description

H=”0” or “1”

Function Set

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	1	MX	MY	PD	V	H

Flag	Description
MX	SEG bi-direction selection MY=0:normal direction (SEG0->SEG101) MY=1:reverse direction (SEG101->SEG0)
MY	COM bi-direction selection See Pad Center Coordinates at page 3~10 when using this register
PD	All LCD outputs at VSS (display off), bias generator and V0 generator off, VOUT can be disconnected, oscillator off (external clock possible), RAM contents not cleared; RAM data can be written. PD=0:chip is active PD=1:chip is in power down mode
V	When V = 0, the horizontal addressing is selected. When V = 1, the vertical addressing is selected.
H	When H = 0 the commands ‘display control’, ‘set Y address’ and ‘set X address’ can be performed, when H = 1 the others can be executed. The commands ‘write data’ and ‘function set’ can be executed in both cases. H=0:use basic instruction set H=1:use extended instruction set

Read status byte

Indicates the internal status of the ST7548T

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	1	PD	0	0	D	E	MX	MY	DO

Flag			
PD	PD=0:chip is active PD=1:chip is in power down mode		
D,E	D	E	The bits D and E select the display mode.
	0	0	Display blank
	0	1	All display segments on
	1	0	Normal mode
	1	1	Inverse video mode
DO	DO=0:MSB is on top DO=1:LSB is on top		

Write data

8-bit data of Display Data from the microprocessor can be written to the RAM location specified by the column address and page address. The column address is increased by 1 automatically so that the microprocessor can continuously write data to the addressed page. During auto-increment, the column address wraps to 0 after the last column is written.

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
1	0	Write data							

H= “0”

Set V0 range

V0 range L/H select

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	1	0	PRS

PRS=0: V0 programming range LOW

PRS=1: V0 programming range HIGH

Display Control

This bits D and E selects the display mode.

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	1	D	0	E

Flag	Description		
D,E	D	E	The bits D and E select the display mode.
	0	0	Display blank
	1	0	Normal display
	0	1	All display segments on
	1	1	Inverse video mode

Set Y address of RAM

Y [3:0] defines the Y address vector address of the display RAM.

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	1	0	0	Y_3	Y_2	Y_1	Y_0

Y_3	Y_2	Y_1	Y_0	CONTENT	ALLOWED X-RANGE
0	0	0	0	Page0 (display RAM)	0 to 101
0	0	0	1	Page1 (display RAM)	0 to 101
0	0	1	0	Page2 (display RAM)	0 to 101
0	0	1	1	Page3 (display RAM)	0 to 101
0	1	0	0	Page4 (display RAM)	0 to 101
0	1	0	1	Page5 (display RAM)	0 to 101
0	1	1	0	Page6 (display RAM)	0 to 101
0	1	1	1	Page7 (display RAM)	0 to 101
1	0	0	0	Page8 (display RAM)	0 to 101
1	0	0	1	Page9 (display RAM)	0 to 101

Set X address of RAM

The X address points to the columns. The range of X is 0…101.

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	X_6	X_5	X_4	X_3	X_2	X_1	X_0

X_6	X_5	X_4	X_3	X_2	X_1	X_0	Column address
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	2
0	0	0	0	0	1	1	3
:	:	:	:	:	:	:	:
1	1	0	0	0	1	0	98
1	1	0	0	0	1	1	99
1	1	0	0	1	0	0	100
1	1	0	0	1	0	1	101

H= “1”

Display configuration

Top/bottom row mode set data order

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	1	DO	X	X

Flag	Description
Do	Do=0:MSB is on top Do=1:LSB is on top

System Bias

Select LCD bias ratio of the voltage required for driving the LCD.

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	1	0	BS_2	BS_1	BS_0

BS_2	BS_1	BS_0	Bias	Recommend Duty
0	0	0	11	1:100
0	0	1	10	1:81
0	1	0	9	1:65/1:68
0	1	1	8	1:49
1	0	0	7	1/40:1/36
1	0	1	6	1/24
1	1	0	5	1:18/1:16
1	1	1	4	1:10/1:9/1:8

Set V0 voltage (Set V_{OP})

A0	WR(R/W)	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	V_{OP6}	V_{OP5}	V_{OP4}	V_{OP3}	V_{OP2}	V_{OP1}	V_{OP0}

The operation voltage V0 (V_{OP}) can be set by software.

$$V0=(a + V_{OP} \times b) \quad (1)$$

The maximum voltage that can be generated is depending on the VDD1 voltage and the display load current. Two overlapping V0 ranges are selectable via the command “Set V0 Range”. For the LOW (PRS=0) range a=a1 and for the HIGH (PRS=1) range a=a2 with steps equal to “b” in both ranges. Note that the charge pump is turned off if V_{OP} [6;0]
and the bit PRS are all set to zero

Typical values for parameter for the HV-Generator programming

SYMBOL	VALUE	UNIT
a1	2.94(PRS=0)	V
a2	6.75(PRS=1)	V
b	0.03	V

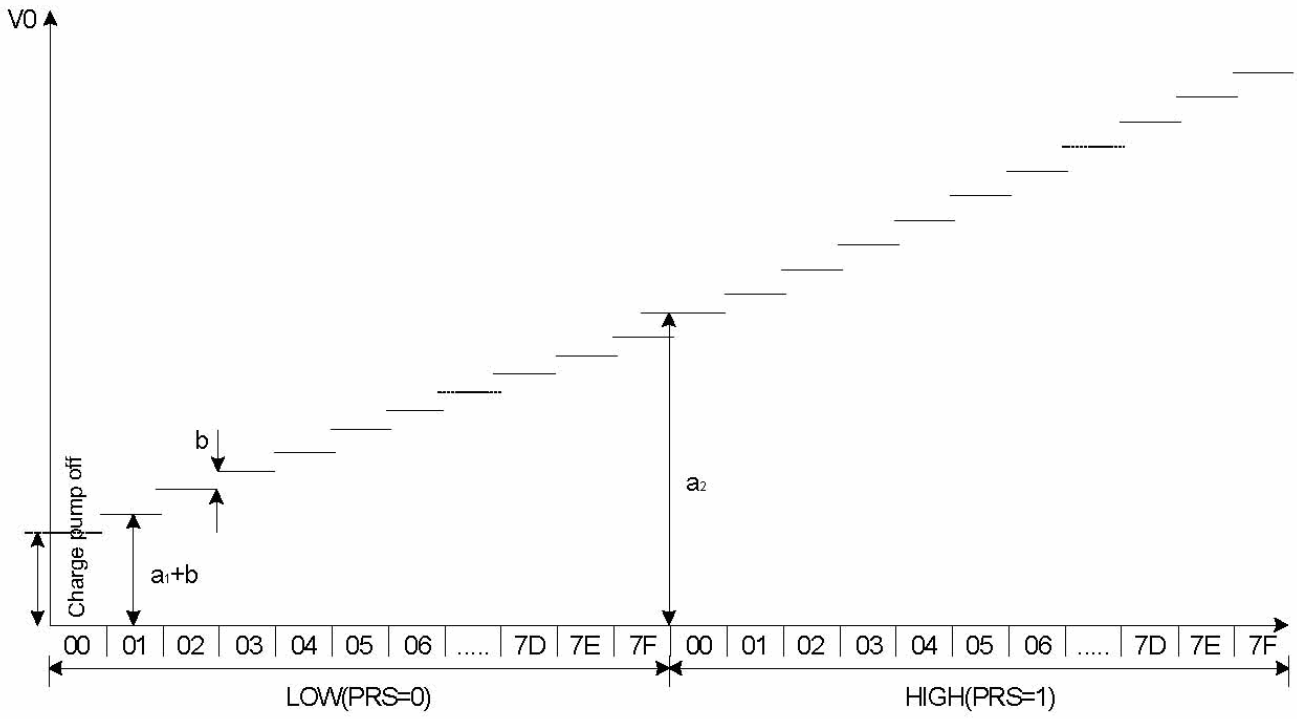
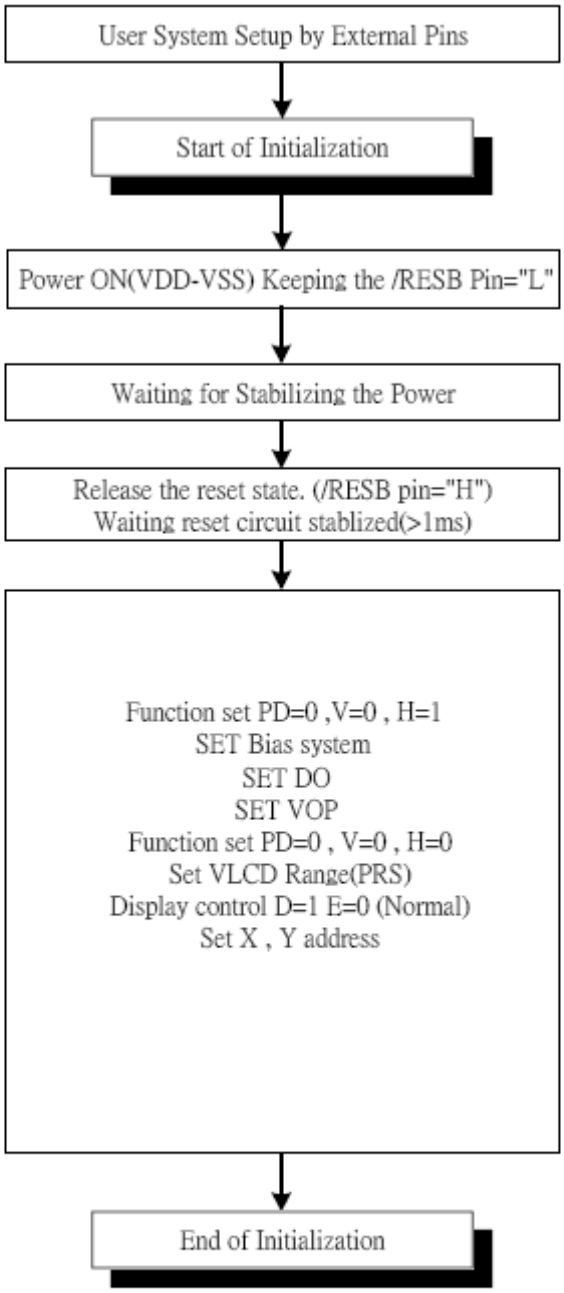


Fig.23 V0 (V_{OP}) programming of ST7548T

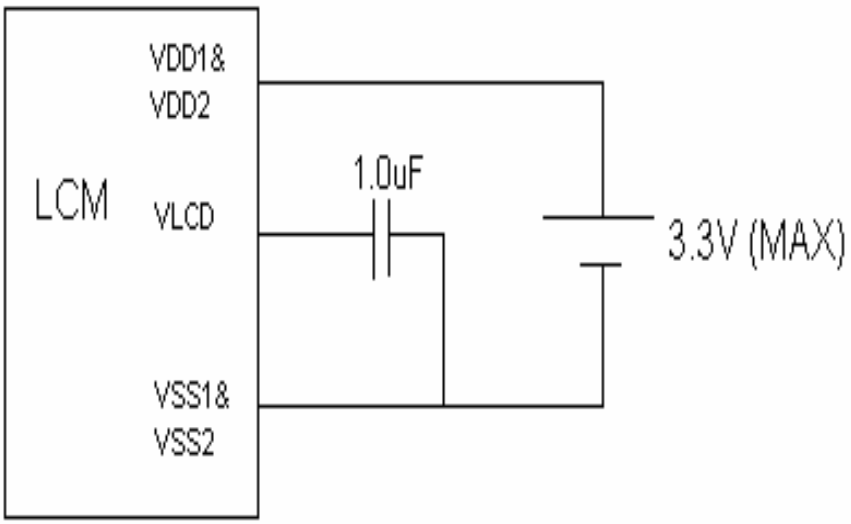
12.Command description

Referential Instruction Setup Flow: Initializing with the built-in Power Supply Circuits



Initializing with the Built-in Power Supply Circuits

13.Power Supply for LCD Module



14. Quality

14-1Test Conditions

Tests should be conducted under the following conditions :

Ambient temperature : 25 ± 5°C

Humidity : 60 ± 25% RH.

14-2 Sampling Plan

Sampling method shall be in accordance with MIL-STD-105E , level II, normal single sampling plan .

14-3 Acceptable Quality Level

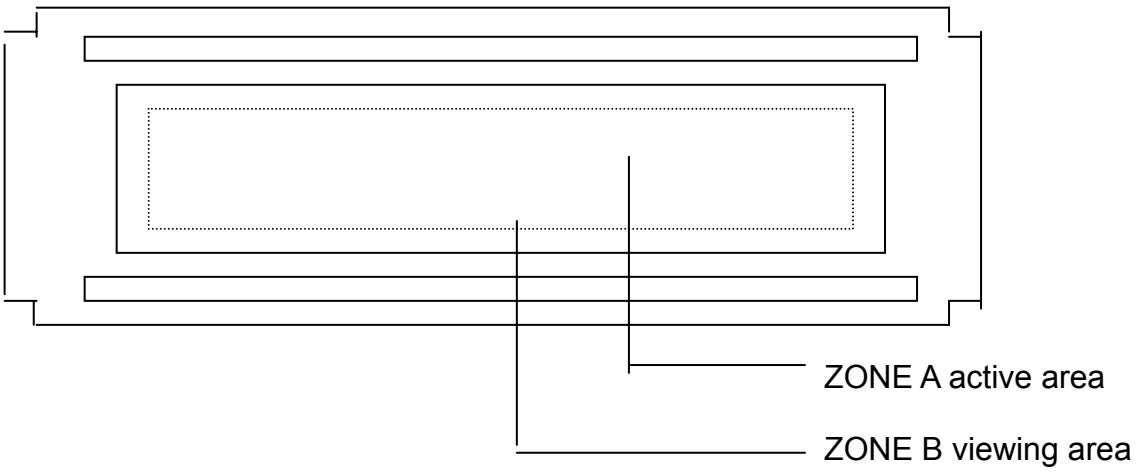
A major defect is defined as one that could cause failure to or materially reduce the usability of the unit for its intended purpose. A minor defect is one that does not materially reduce the usability of the unit for its intended purpose or is an infringement from established standards and has no significant bearing on its effective use or operation.

14-4 Appearance

An appearance test should be conducted by human sight at approximately 30 cm distance from the LCD module under flourescent light. The inspection area of LCD panel shall be within the range of following limits.

14-5 Inspection Quality Criteria

Item	Description of defects			Class of Defects	Acceptable level (%)
Function	Short circuit or Pattern cut			Major	0.65
Dimension	Deviation from drawings			Major	1.5
Black spots	Ave . dia . D	area A	area B	Minor	2.5
	D≤0.2	Disregard			
	0.2<D≤0.3	3	4		
	0.3<D≤0.4	2	3		
	0.4<D	0	1		
Black lines	Width W, Length L	A	B	Minor	2.5
	W≤0.03	disregard			
	0.03<W≤0.05	3	4		
	0.05<W≤0.07 , L≤3.0	1	1		
	See line criteria				
Bubbles in polarizer	Average diameter D 0.2 < D < 0.5 mm for N = 4 , D > 0.5 for N = 1			Minor	2.5
Color uniformity	Rainbow color or newton ring.			Minor	2.5
Glass Scratches	Obvious visible damage.			Minor	2.5
Contrast ratio	See note 1			Minor	2.5
Response time	See note 2			Minor	2.5
Viewing angle	See note 3			Minor	2.5



15. Reliability

Test Item	Test Conditions	Note
High Temperature Operation	70±3°C , t=96 hrs	
Low Temperature Operation	-20±3°C , t=96 hrs	
High Temperature Storage	80±3°C , t=96 hrs	1,2
Low Temperature Storage	-30±3°C , t=96 hrs	1,2
Thermal Shock Test	-30°C ~ 25°C ~ 80°C 30 min. 5 min. 30 min. (1 cycle) Total 5 cycle	1,2
Vibration Test (Packing)	Sweep frequency：10~55~10 Hz/1min Amplitude : 0.75mm Test direction : X.Y.Z/3 axis Duration : 30min/each axis	2

Note 1 : Condensation of water is not permitted on the module.

Note 2 : The module should be inspected after 1 hour storage in normal conditions (15-35°C , 45-65%RH).

Definitions of life end point :

- Current drain should be smaller than the specific value.
- Function of the module should be maintained.
- Appearance and display quality should not have degraded noticeably.
- Contrast ratio should be greater than 50% of the initial value.

16. Handling Precautions

(1) An LCD module is a fragile item and should not be subjected to strong mechanical shocks.

(2) Avoid applying pressure to the module surface. This will distort the glass and cause a change in colour.

(3) Under no circumstances should the position of the bezel tabs or their shape be modified.

(4) Do not modify the display PCB in either shape or positioning of components.

(5) Do not modify or move location of the zebra or heat seal connectors.

(6) The device should only be soldered to during interfacing. Modification to other areas of the board should not be carried out.

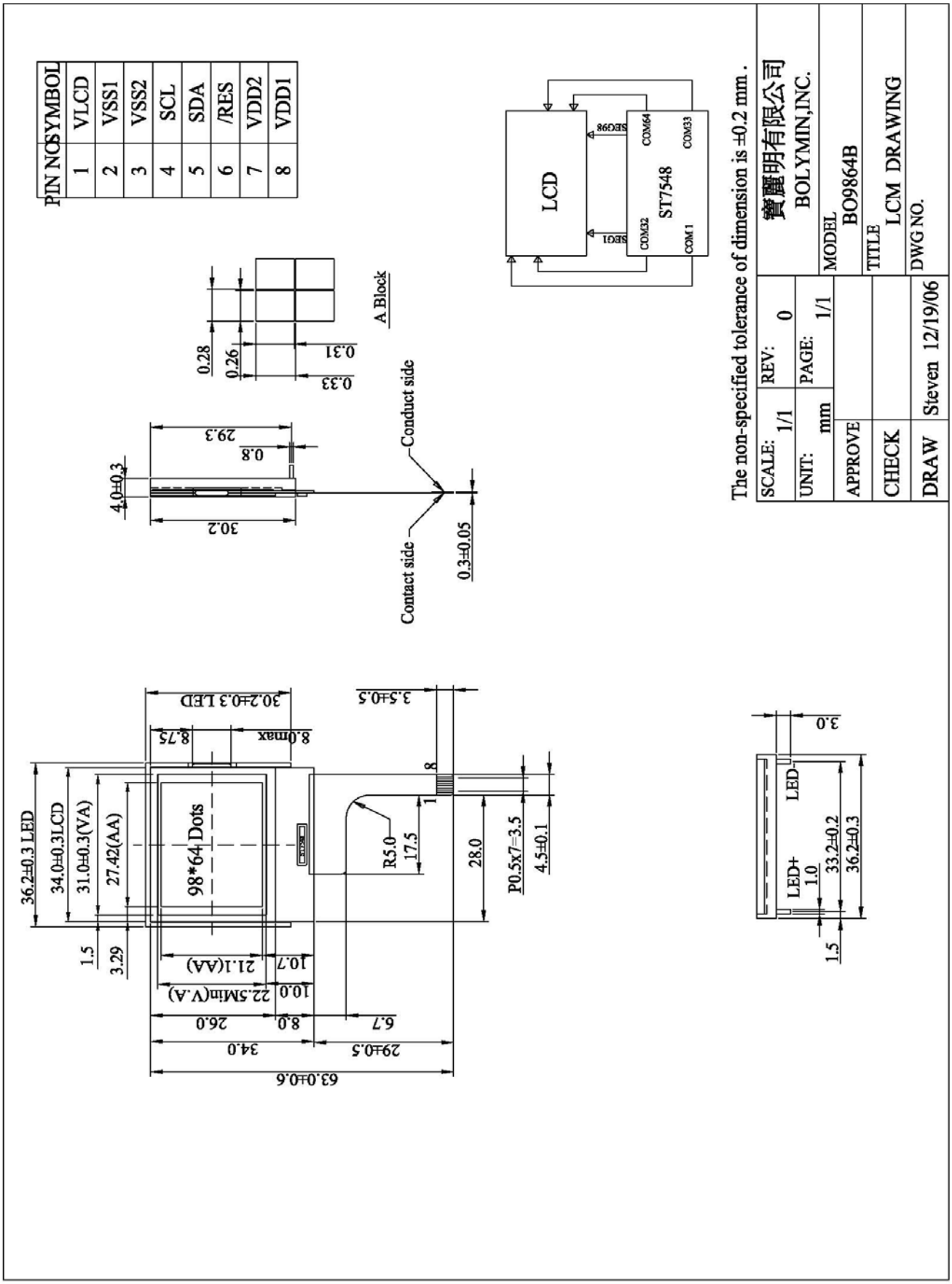
(7) In the event of LCD breakage and resultant leakage of fluid do not inhale, ingest or make contact with the skin. If contact is made rinse immediately.

(8) When cleaning the module use a soft damp cloth with a mild solvent, such as Isopropyl or Ethyl alcohol. The use of water, ketone or aromatic is not permitted.

(9) Prior to initial power up input signals should not be applied.

(10) Protect the module against static electricity and observe appropriate anti-static precautions.

17.Drawing (Outline Dimension)



Internal DC/DC generator

