深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LM6020FCW

LCD Module User Manual

Prepared by:	Checked by:	Approved by:
Dong		
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1. Basic Specifications

1.1 Display Specifications

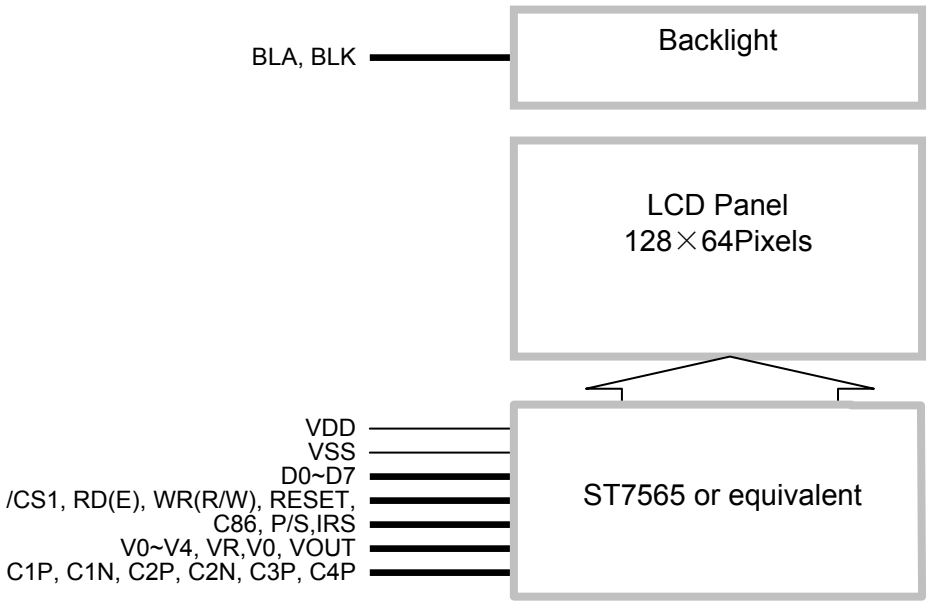
1) LCD Display Mode : FSTN, Positive, Transflective
2) Display Color : Display Data = “1” : Dark Gray(*1)
: Display Data = “0” : Light Gray (*2)
3) Viewing Angle : 6H
4) Driving Method : 1/65 duty, 1/9 bias
5) Backlight : White LED backlight

Note:
*1. Color tone may slightly change by Temperature and Driving Condition.
*2. The Color is defined as the inactive / background color
*3. Fine Contrast adjustment function is necessary in the application design for optimal display result.

1.2 Mechanical Specifications

1) Outline Dimension : 44.9 x 32.6 x 8.9MAX (mm) (exclude FPC terminal)
(See attached Outline Drawing for details)

1.3 Block Diagram



2. Terminal Functions

PIN NO.	PIN Name	I/O	Descriptions		
			8-bit parallel 8080 mode(Default)	8-bit parallel 6800 mode	Serial mode
1	/CS1	Input	Chip Select /CS1=L, enable access to the LCD module /CS1=H, disable access to the LCD module		
2	RESET	Input	Reset signal /RES = L, Initialization is executed /RES = H, Normal running.		
3	A0	Input	Register Select A0 = H, Transferring the Display Data A0 = L, Transferring the Control Data		
4	WR (R/W)	Input	/WR=L→H, /RD=H; Data or Instruction latch into the LCD module	R/W=H,E=H; Data or Status read from the LCD module R/W=L,E=H→L; Data or Status latch into the LCD module	Not used, Leave open or pull Hi
5	RD (E)	Input	/WR=H, /RD=L; Data or Status read form the LCD module		
6	D0	I/O	8-bit Data bus; Three state I/O terminal for display data or instruction data when /CS=H, D0~D7=High Impedance		Not used, Leave open
:	:	I/O			
11	D5	I/O			
12	D6	I/O			Serial clock input
13	D7	I/O			Serial data input
14	VDD	Supply	Positive power supply		
15	VSS	Supply	Negative power supply,0V		
16	VOUT	--	Power Booster Circuit output		
17	C3P	--	Power Booster Circuit Capacitance terminals		
18	C1N	--			
19	C1P	--			
20	C2P	--			
21	C2N	--			
22	C4P	--			
23	VRS	--	Internal output VREG power supply (leave open)		
24	V4	--	LCD driving voltage supply terminals		
:	:	:			
28	V0	--			
29	VR	Input	Power Booster Resistor ratio reference input		
30	C86	Input	C86=Low	C86=High	C86=Low
31	P/S	Input	P/S=High	P/S=High	P/S=Low
32	IRS	Input	Select the resistors for the V0 voltage level adjustment IRS=H, Using the internal resistors IRS=L, Using external attached to the VR Terminal		
-	BLA	Power	Backlight Positive Supply		
-	BLK	Power	Backlight Negative Supply		

3. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	-0.3	+3.6	V	V_{SS} = 0V
Input Voltage	V_{IN}	-0.2	V_{DD}+0.2	V	V_{SS} = 0V
Operating Temperature	T_{OP}	-20	+70	°C	No Condensation
Storage Temperature	T_{ST}	-30	+80	°C	No Condensation

Cautions:
Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

4. Electrical Characteristics

4.1 DC Characteristics

V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25°C

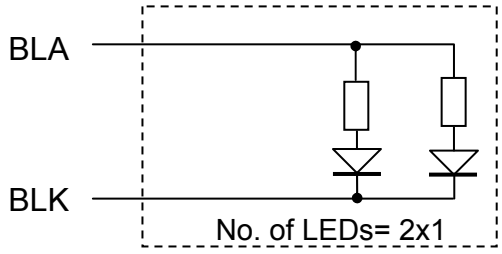
Items	Symbol	MIN.	TYP.	MAX.	Unit	Condition / Application Pin
Operating Voltage	V_{DD}	2.7	-	3.3	V	VDD
Input High Voltage	V_{IH}	0.85xV_{DD}	-	V_{DD}	V	RESET, /CS1, A0, WR(R/W), RD(E), D0~D7
Input Low Voltage	V_{IL}	V_{SS}	-	0.15xV_{DD}	V	
Output High Voltage	V_{OH}	0.75xV_{DD}	-	V_{DD}	V	D0~D7
Output Low Voltage	V_{OL}	V_{SS}	-	0.25xV_{DD}	V	D0~D7
Operating Current	I_{DD}	-	0.3	1.5	mA	VDD

4.2 LED Backlight Circuit Characteristics

BLK=0V,BLA=3.3V, T_{OP}=25°C

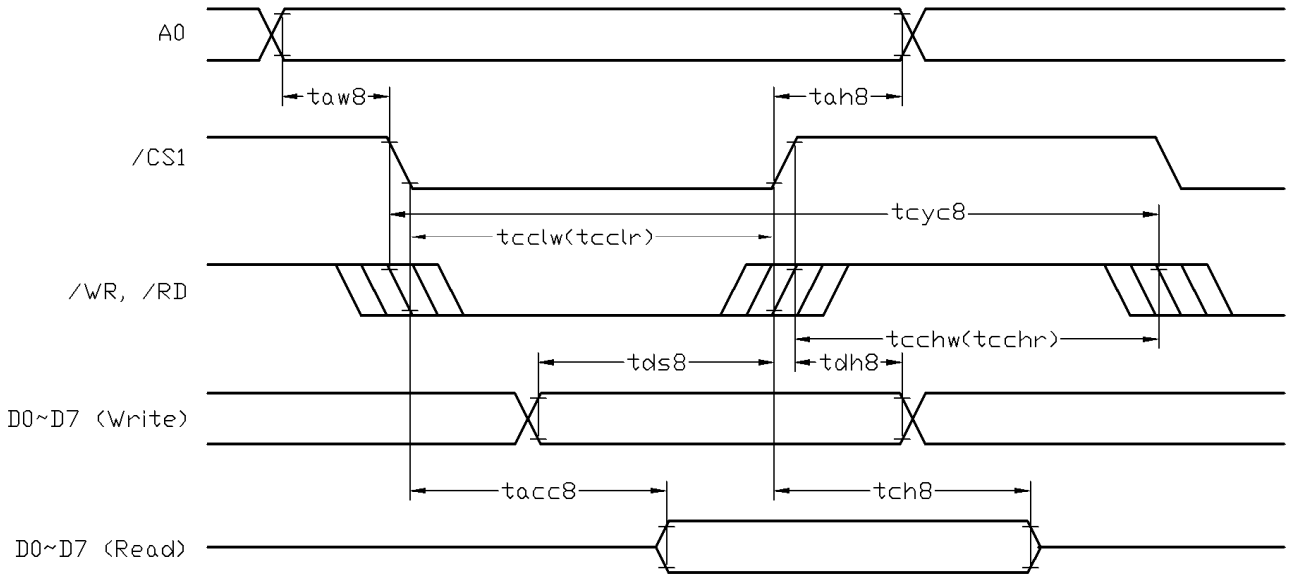
Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Forward Voltage	V_{BLA}	-	3.3	-	V	BLA
Forward Current	I_{BLA}	-	34	40	mA	BLA

Cautions:
Exceeding the recommended driving current could cause substantial damage to the backlight and shorten its lifetime.



4.3 AC Characteristics

4.3.1 8080 Mode System Bus Timing

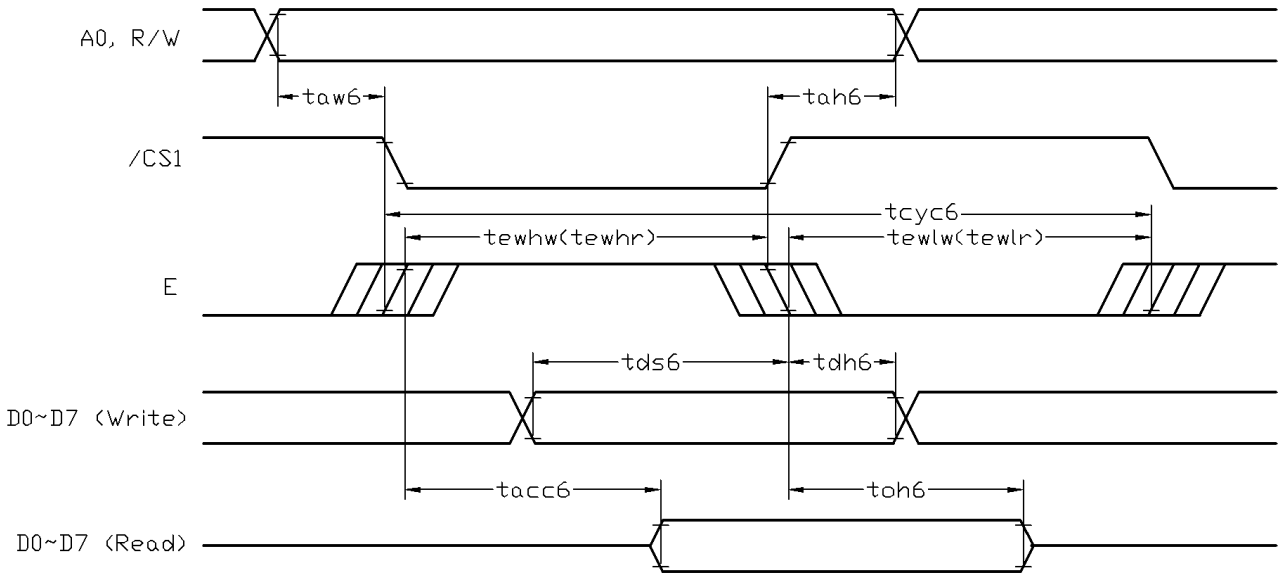


V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
System cycle time	tcyc8	312	-	-	ns
Address setup time (A0)	taw8	5	-	-	ns
Address hold time (A0)	tah8	5	-	-	ns
Control LOW pulse width (/RD)	tcclr	182	-	-	ns
Control LOW pulse width (/WR)	tcclw	104	-	-	ns
Control HIGH pulse width (/RD)	tcchr	104	-	-	ns
Control HIGH pulse width (/WR)	tcchw	104	-	-	ns
Data setup time	tds8	52	-	-	ns
Data hold time	tdh8	5	-	-	ns
/RD access time (*2)	tacc8	-	-	49	ns
Output disable time (*2)	toh8	7	-	35	ns

Note:
*1. Input signal rise/fall time should be less than 15ns .
*2.All timing is using 20% and 80% of VDD as the reference.

4.3.2 6800 Mode System Bus Timing

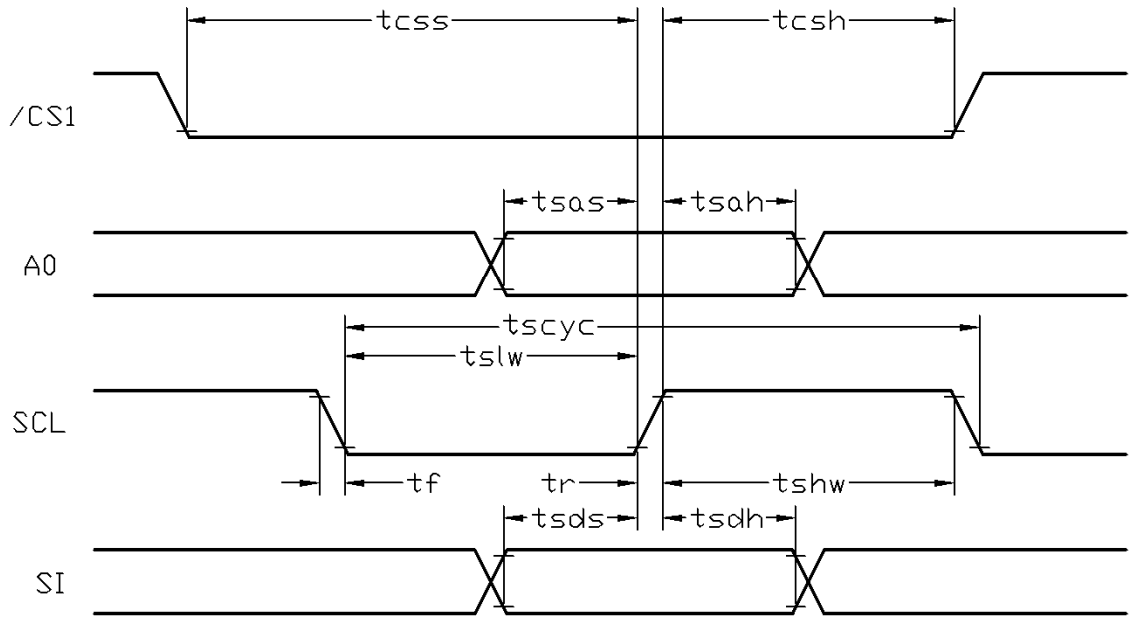


V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
System cycle time	tcyc6	312	-	-	ns
Address setup time (A0)	taw6	5	-	-	ns
Address hold time (A0)	tah6	5	-	-	ns
Control LOW pulse width (R/W)	tewlr	104	-	-	ns
Control LOW pulse width (R/W)	tewlw	104	-	-	ns
Control HIGH pulse width (/RD)	tewhr	182	-	-	ns
Control HIGH pulse width (R/W)	tewhw	104	-	-	ns
Data setup time	tds6	52	-	-	ns
Data hold time	tdh6	5	-	-	ns
/RD access time (*2)	tacc6	-	-	49	ns
Output disable time (*2)	tch6	7	-	35	ns

Note:
*1. Input signal rise/fall time should be less than 15ns .
*2. CL=100pF
*3.All timing is using 20% and 80% of VDD as the reference.

4.3.3 Serial Mode Interface

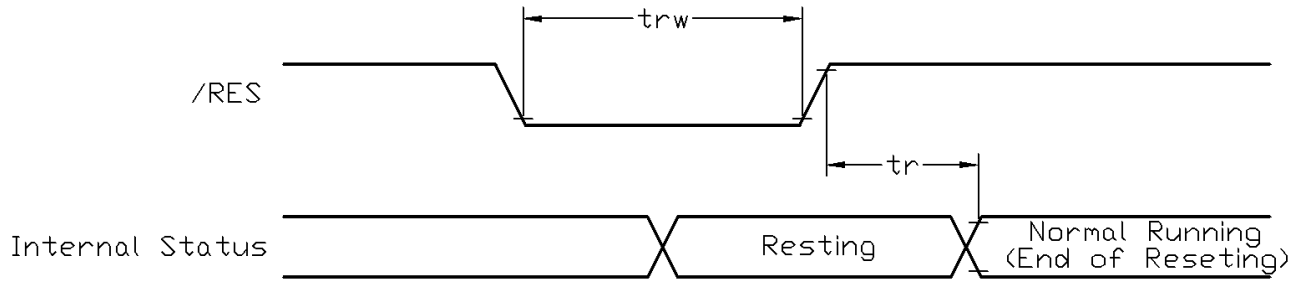


V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Serial Clock Period	tscyc	65	-	-	ns
Address setup time (A0)	tsas	26	-	-	ns
Address hold time (A0)	tsah	13	-	-	ns
SCL “H” pulse width	tshw	33	-	-	ns
SCL “L” pulse width	tslw	33	-	-	ns
Data setup time	tsds	26	-	-	ns
Data hold time	tsdh	13	-	-	ns
CS-SCL time	tcss	26	-	-	ns
CS-SCL time	tcsh	52	-	-	ns

Note:
*1. Input signal rise/fall time should be less than 15ns .
*2. CL=100pF
*3.All timing is using 20% and 80% of VDD as the reference.

4.4 Reset Timing



V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset time	tr	-	-	1.3	µs
Reset LOW pulse width	trw	1.3	-	-	µs

Note:
*1.All timing is using 20% and 80% of VDD as the reference.

5. Function specifications

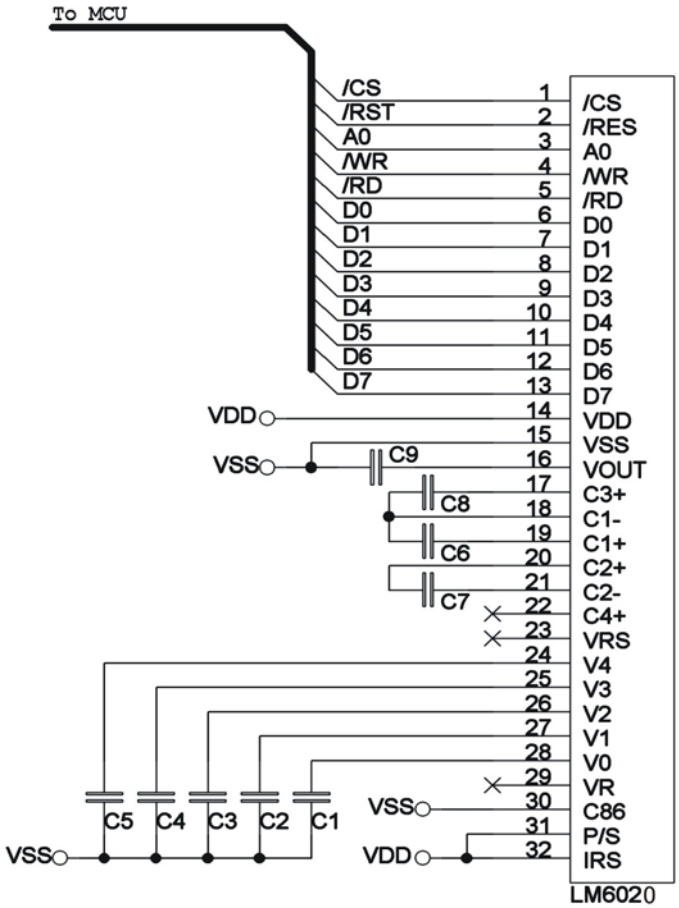
5.1 Adjusting the Display Contrast

- This LCD module equipped with latest digital contrast adjustment function.
- Its display contrast could be adjusted by MCU command. (please see the command tables for details)
- It is recommended to provide a contrast adjustment interface for end-user, where the best display result could meet the individual preference in mass production.

5.2 Application circuit (Example)

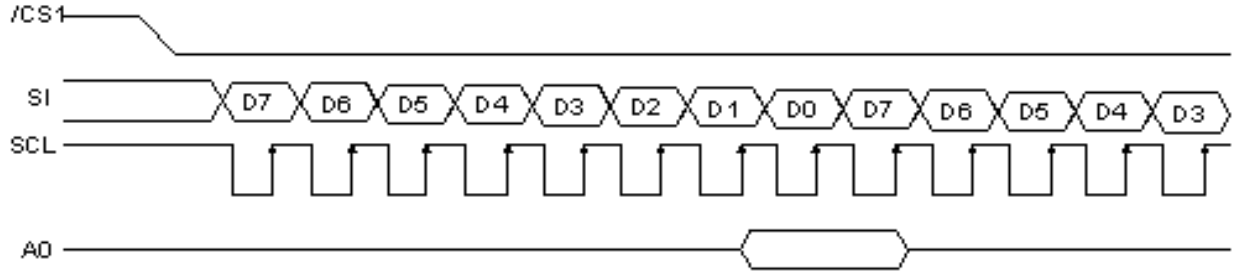
- 4x boosting
- 80 mode
- Using internal ref resistor
- C1~C5 = 1.0uF (25V)
- C6~C9 = 1.0uF (25V)

Note:
Please refer to the ST7565 data sheet for details



5.3 The Serial Interface

When the serial interface has been selected then when the chip is in active state the serial data input(SI) and the serial clock(SCL) can be received. The serial data is read from the serial data input pin in the rising edge of the serial clock . When “A0”=“H”, the data is display data, and when “A0”=“L”, the data is command.



5.4 Basic Setting

To drive the LCD module correctly and provide normally display, please use the following setting

- ADC = 0 (normal)
- SHL select = 1 (reverse)
- LCD Bias Select = 1/9
- Initial Display Line = 0
- Entire Display ON/OFF = OFF (normal)
- Reverse Display ON/OFF = OFF (normal)
- Set Power Control Set:
  voltage follower = ON, voltage converter = ON, voltage regulator = ON
- Display ON/OFF = ON

Note:
*1. These setting/commands should issue the LCD module while start up.
*2. See the Display Commands section for details.

5.5 Resetting the LCD module

The LCD module should be initialized by using /RES terminal.
While turning on the VDD and VSS power supply, maintain /RES terminal at LOW level. After the power supply stabilized, release the reset terminal (/RES=HIGH)

5.6 Display Memory Map

Page address	data	LCD Display (front view)
0	D0 : D7	
1	D0 : D7	
2	D0 : D7	
3	D0 : D7	128x64 pixels
4	D0 : D7	
5	D0 : D7	
6	D0 : D7	
7	D0 : D7	
Column Address		00h → 7Fh

Note:
*1. ADC = 0 (normal)
*2. SHL Selection = 1 (reverse)
*3. Initial Display Line = 0

5.7 Display Commands

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 1	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	1	Page address				Sets the display RAM page address
(4) Column address set upper bit Column address set lower bit	0	1	0	0 0	0 0	0 0	1 0	Most significant column address Least 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.
(5) Status read	0	0	1	Status				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 1	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 1	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 1	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 1	Sets the LCD drive voltage bias ratio 0: 1/9 bias, 1: 1/7 bias (ST7565R)
(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 1	*	*	*	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_0 voltage regulator internal resistor ratio set	0	1	0	0	0	1	0	0	Resistor ratio			Select internal resistor ratio(Rb/Ra) mode
(18) Electronic volume mode set Electronic volume register set	0	1	0	1 0	0 0	0	0	0 Electronic volume value	0	0	1	Set the V_0 output voltage electronic volume register
(19) Sleep mode set	0	1	0	1 * *	0 * *	1 * *	0 * *	1 * *	1 * *	0 0 0	0 1 0	0: Sleep mode, 1: Normal mode
(20) Booster ratio set	0	1	0	1 0	1 0	1 0	1 0	1 0	0 0	0 step-up value	0	select booster ratio 00: 2x,3x,4x 01: 5x 11: 6x
(21) NOP	0	1	0	1	1	1	0	0	0	1	1	Command for non-operation
(22) Test	0	1	0	1	1	1	1	*	*	*	*	Command for IC test. Do not use this command

Note: *1. Do not use any other command not listed, or the system malfunction may result.
*2. For the details of the Display Commands, please refer to ST7565 data sheet.

5.7.1 Power off the LCD Module

It recommends that enter Power Save mode before power off the LCD module.

5.7.2 Refreshing The LCD Module

It recommends that the operating modes and display contents be refreshed periodically to prevent the effect of unexpected noise.

6. Design and Handling Precaution

1. The LCD panel is made by glass. Any mechanical shock (eg. dropping form high place) will damage the LCD module.
2. Do not add excessive force on the surface of the display, which may cause the Display color change abnormally.
3. The polarizer on the LCD is easily get scratched. If possible, do not remove the LCD protective film until the last step of installation.
4. Never attempt to disassemble or rework the LCD module.
5. Only Clean the LCD with Isopropyl Alcohol or Ethyl Alcohol. Other solvents (eg. water) may damage the LCD.
6. When mounting the LCD module, make sure that it is free form twisting, warping and distortion.
7. Ensure to provide enough space (with cushion) between case and LCD panel to prevent external force adding on it, or it may cause damage to the LCD or degrade the display result.
8. Only hold the LCD module by its side. Never hold LCD module by add force on the heat seal or TAB.
9. Never add force to component of the LCD module. It may cause invisible damage or degrade of the reliability.
10. LCD module could be easily damaged by static electricity. Be careful to maintain an optimum anti-static work environment to protect the LCD module.
11. When peeling off the protective film from LCD, static charge may cause abnormal display pattern. It is normal and will resume to normal in a short while.
12. Take care and prevent get hurt by the LCD panel sharp edge.
13. Never operate the LCD module exceed the absolute maximum ratings.
14. Keep the signal line as short as possible to prevent noisy signal applying to LCD module.
15. Never apply signal to the LCD module without power supply.
16. IC chip (eg. TAB or COG) is sensitive to the light. Strong lighting environment could possibly cause malfunction. Light sealing structure casing is recommend.
17. LCD module reliability may be reduced by temperature shock.
18. When storing the LCD module, avoid exposure to the direct sunlight, high humidity, high temperature or low temperature. They may damage or degrade the LCD module