深圳市华远显示器件有限公司

SHENZHEN HUAYUAN DISPLAY CO.,LTD.

液晶显示模块规格书

Specification for Liquid Crystal Display Module

HYG2406413G-FFC2L-VA

Prepared By	Reviewed By	Approved By
Date:	Date:	Date:

REVISION HISTORY

The following table tracks the history of the changes made to this document.

SN	Rev.	Content	Date	Design
1	R00	Origin Released	2011-10-18	

CONTENTS

1. 0 GENERAL DESCRIPTION

The HYG2406413G-FFC2L-VA is a 240x64 dots dot-matrix LCD module. It has a FSTN panel composed of 240 segments and 64 commons. The LCM can be easily accessed by microcontroller via 3- wires / 4-wires Serial Peripheral Interface.

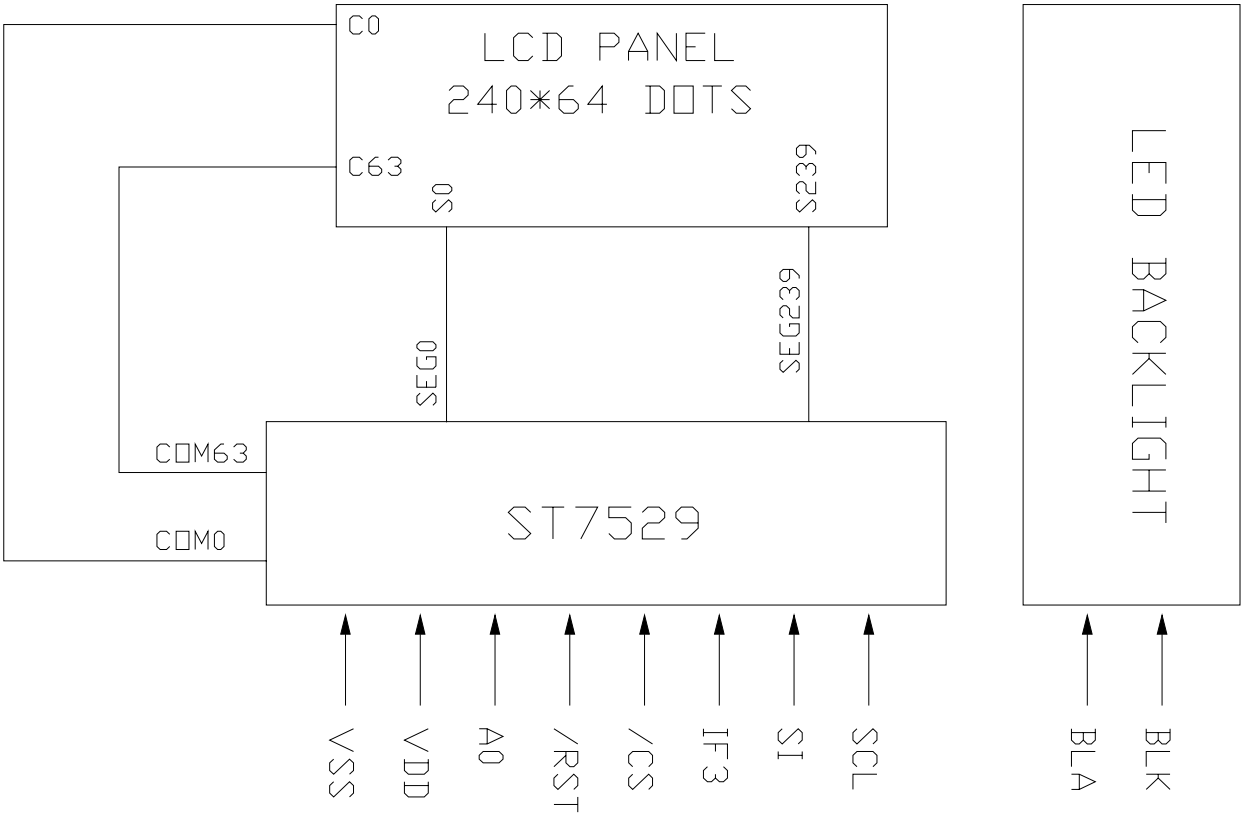
2. 0 FEATURES

Display Format	240x64 dots
LCD Type	FSTN-POSITIVE(32 GRAY SCALE)
Polarizer Mode	TRANSFLECTIVE
Drive Method	1/64 Duty, 1/9 Bias
Viewing Direction	12 O'clock
Controller	ST7529
Interface	3-wires(IF3=1) or 4-wires(IF=0) Serial Peripheral Interface
Backlight	White Side-Light Type LED Backlight

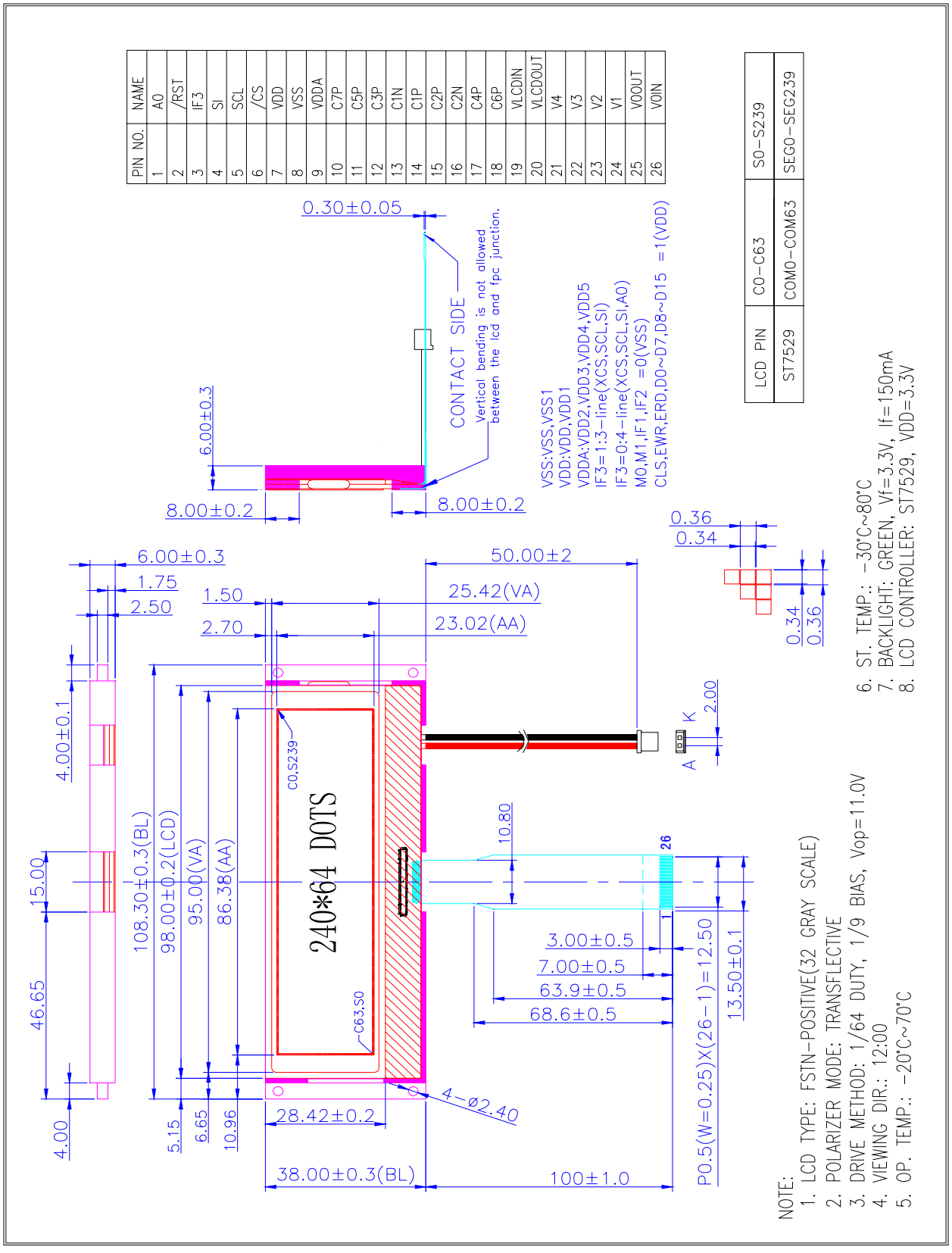
3. 0 MECHANICAL SPECIFICATION

Item	Description	Unit
Module Dimension	108.3(W) × 38.0(H) × 6.0(Max)(T)	mm
Viewing Area	95.0(W) × 25.42(H)	mm
Active Area	86.38(W) × 23.02(H)	mm
Dot Size	0.34(W) × 0.34(H)	mm
Dot Pitch	0.36(W) × 0.36 (H)	mm
Character Size	——	mm

4. 0 BLOCK DIAGRAM



5. 0 EXTERNAL DIMENSIONS



6. 0 INTERFACE PIN DESCRIPTIONS

PIN No.	Symbol	Level	Description
1	A0	H/L	Register select input pin A0 = "H": SI are display data; A0 = "L": SI are control data
2	/RST	H/L	Reset input pin When /RST is “L”, initialization is executed.
3	IF3	H/L	IF3=1:3-line(/CS,SCL,SI) IF3=0:4-line(/CS,SCL,SI,A0)
4	SI	H/L	This pin is used to input serial data
5	SCL	H/L	This pin is used to input serial clock The data is latched at the rising edge. (3 line and 4 line)
6	/CS	H/L	Chip select input pins Data/instruction I/O is enabled only when /CS is "L".
7	V_{DD}	P	Power supply for logic(+3.3V)
8	V_{SS}	P	Power supply for logic(0V)
9	V_{DDA}	P	Power supply for logic(+3.3V)
10	C7P	--	DC/DC voltage converter. Connect a capacitor between these terminals. See “***18.2 LCM Application Circuit Diagram***”
11	C5P	--	
12	C3P	--	
13	C1N	--	
14	C1P	--	
15	C2P	--	
16	C2N	--	
17	C4P	--	
18	C6P	--	

Continued

PIN No.	Symbol	Level	Description
19	VLCDIN	P	An external LCD supply voltage can be supplied using the VLCDIN pad. In this case, VLCDOUT has to be left open, and SET register VB=0)
20	VLCDOUT	P	If the internal voltage generator is used, the VLCDIN & VLCDOUT must be connected together. If an external supply is used, this pin must be left open.
21	V4	P	LCD driver supply voltages V0In & V0out should be connected together in FPC area. Voltages should have the following relationship: V0≥V1≥V2≥V3≥V4≥VSS See "***18.2 LCM Application Circuit Diagram***"
22	V3	P	
23	V2	P	
24	V1	P	
25	V0OUT	P	
26	V0IN	P	

7. 0 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic)	V_{DD}	2.4	3.3	V
Supply Voltage (LCD)	V_0	0	18.0	V
Input Voltage	V_I	0	3.3	V
Operating Temperature	Topr	-20	70	℃
Storage Temperature	Tstg	-30	80	℃

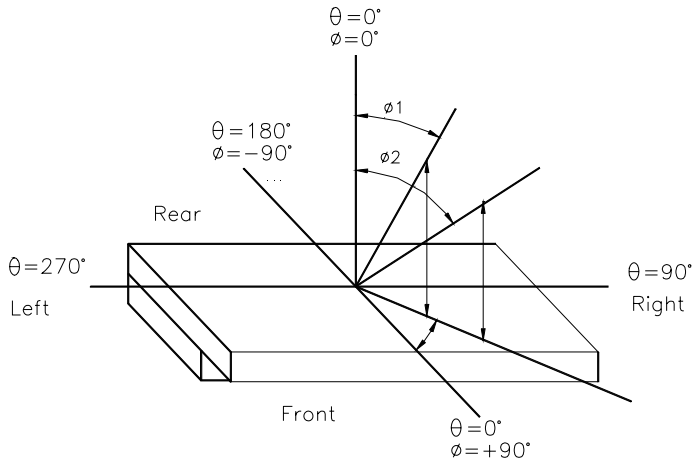
8. 0 ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for Logic		V_{DD}	--	3.0	3.3	3.3	V
LCD Operating Voltage		V_0	-20℃				V
			+25℃	10.8	11.0	11.2	V
			+70℃				V
Input voltage H level		V_{IH}		0.7V_{DD}	-	V_{DD}	V
Input voltage L level		V_{IL}		0	-	0.3V_{DD}	V
High-level Output Current		IOH	VDD=2.7V VOH =2.2V	0.5	-	-	mA
Low-level Output Current		IOL	VDD=2.7V VOL = 0.5V	-	-	-0.5	mA
Oscillator Frequency	Internal Oscillator	f_{OSC}	1/160 duty CLD = 0 V_{DD} = 2.7V	-	12.4	26	KHz
	External Input	f_{CL}		-	12.4	26	KHz
	Frame frequency	f_{FRAME}		-	78.0	160	Hz

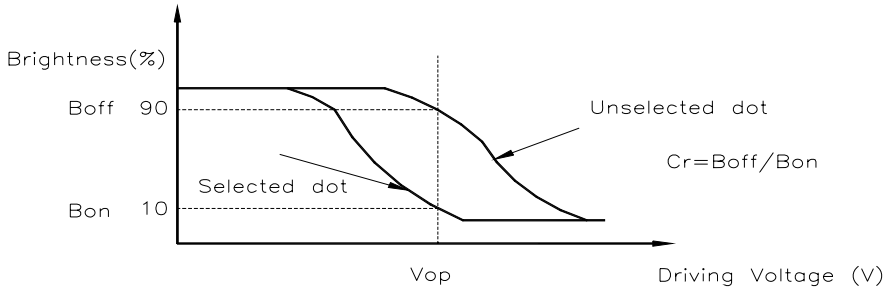
9. 0 OPTICAL CHARACTERISTICS

Item	Symbol	Condition		Min	Typ	Max	Unit
Response time	Ton	θ=0 ° and Ta=-20℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+70℃			--		ms
	Toff	θ=0 ° and Ta=-20℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+70℃			--		ms
Contrast ration	CR(MAX)	Ta=25℃		5	10		---
Viewing Angle	Ø	Deg θ=0 °	CR≥2.0 Ta=25℃		50		Deg
		Deg θ=90 °			35		
		Deg θ=180 °			30		
		Deg θ=270 °			35		
Crosstalk		Ta=25℃			1.2		---

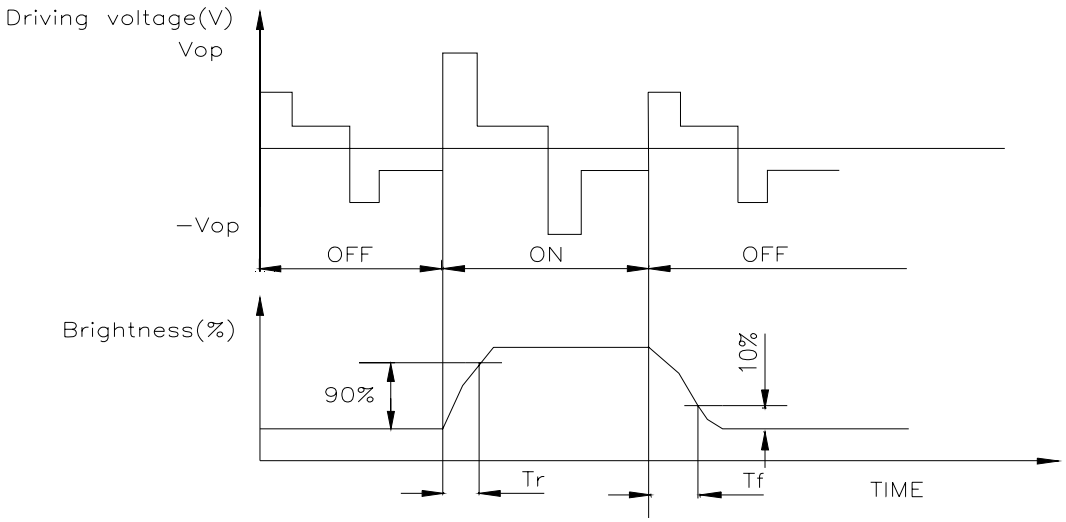
9.1 Viewing Angle θ , Ø and Viewing Angle Range: Δ Ø =|Ø2-Ø1|



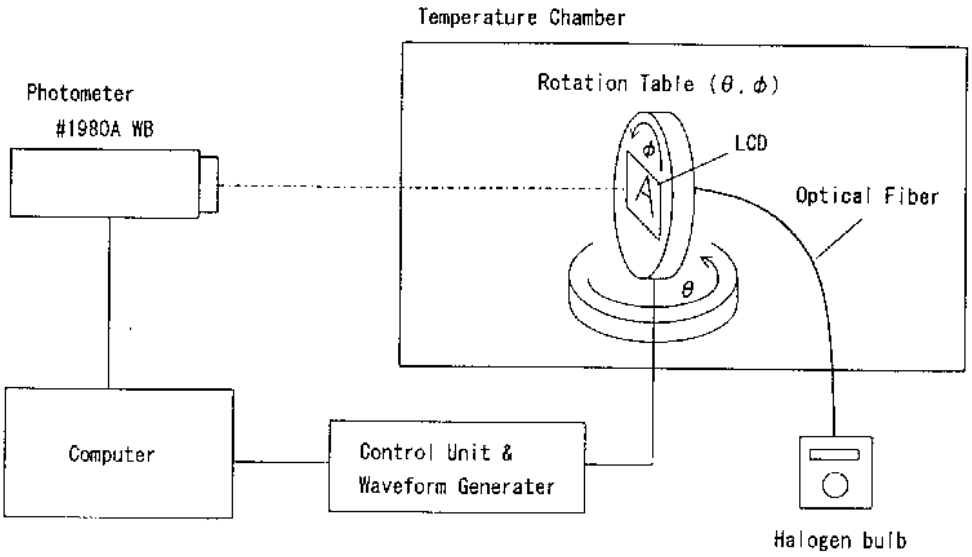
9.2 Contrast ratio(CR)



9.3 Response Time

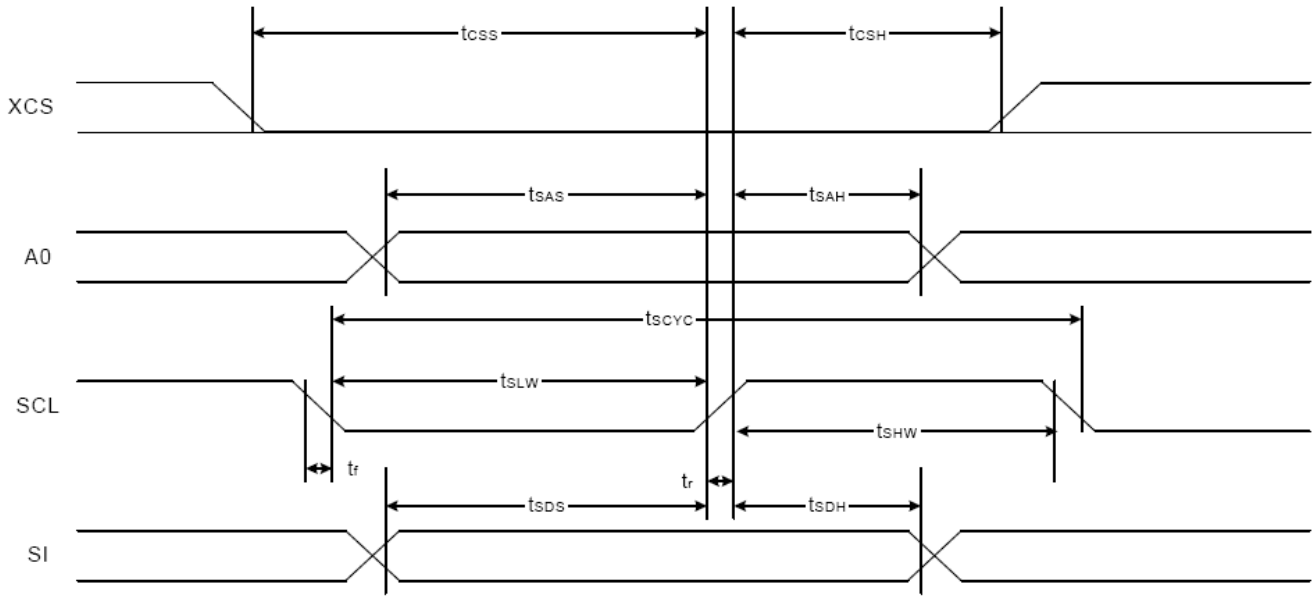


9.4 Optical Measurement System



10. 0 TIMING CHARACTERICS

10.1 SERIAL INTERFACE (4-Line Interface) Characteristics

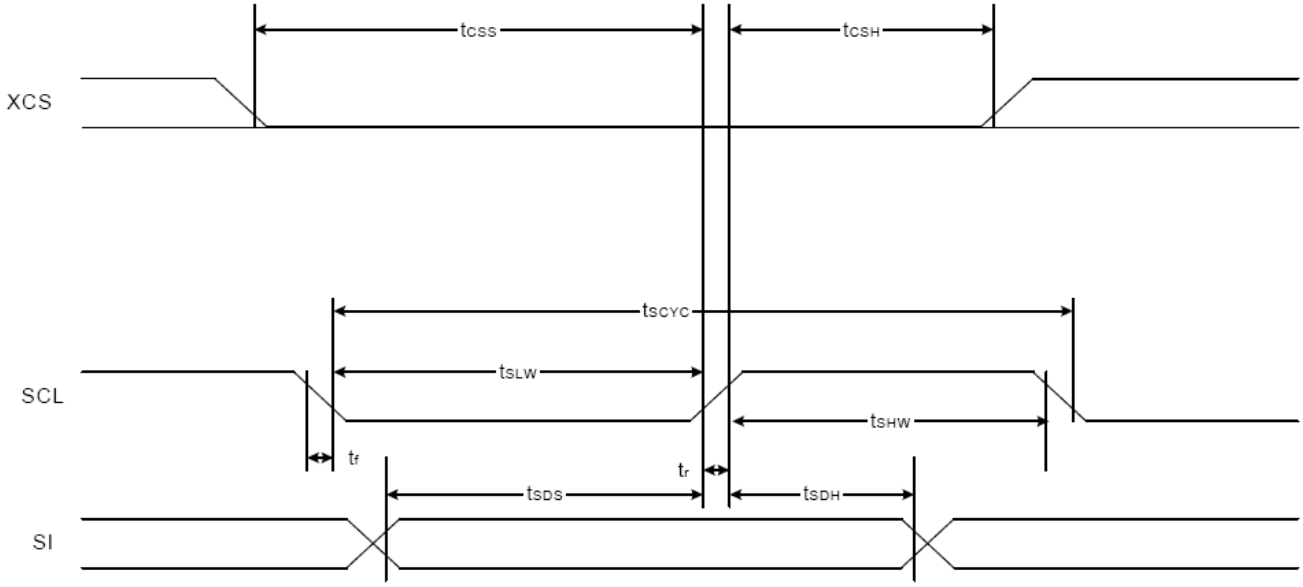


Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	tSCYC	-	100	-	ns
SCL “H” pulse width		tSHW	-	50	-	
SCL “L” pulse width		tSLW	-	50	-	
Address setup time	A0	tSAS	-	40	-	
Address hold time		tSAH	-	30	-	
Data setup time	SI	tSDS	-	30	-	
Data hold time		tSDH	-	30	-	
CS-SCL time	XCS	tCSS	-	20	-	
CS-SCL time		tCSH	-	50	-	

*1 The input signal rise and fall time (tr, tf) are specified at 15 ns or less.

*2 All timing is specified using 20% and 80% of VDD as the standard.

10.2 SERIAL INTERFACE (3-Line Interface) Characteristics

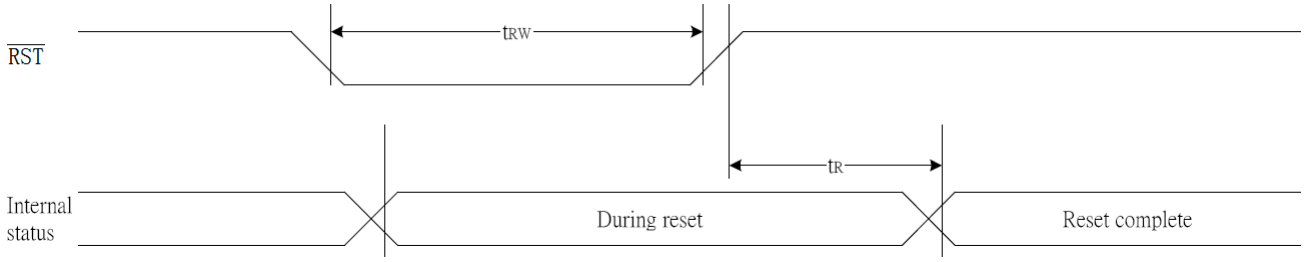


Item	Signal	Symbol	Condition	Rating		unit
				Min.	Max.	
Serial Clock Period	SCL	tSCYC	-	100	-	ns
SCL “H” pulse width		tSHW	-	50	-	
SCL “L” pulse width		tSLW	-	50	-	
Data setup time	SI	tSDS	-	30	-	
Data hold time		tSDH	-	30	-	
CS-SCL time	XCS	tCSS	-	20	-	
CS-SCL time		tCSH	-	50	-	

*1 The input signal rise and fall time (tr, tf) are specified at 15 ns or less.

*2 All timing is specified using 20% and 80% of VDD as the standard.

10.3 Reset Timing



Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max	
Reset “L” pulse width	/RST	tRW		—	1	us
Reset time		tR		1	—	

11. 0 BACKLIGHT CHARACTERISTICS

11.1 ABSOLUTE MAXIMUM RATINGS

(Ta=25℃)

Item	Symbol	Condition	Rating	Unit
Reverse Voltage	Vr		5.0	V
Absolute maximum forward current	Ifm		200	mA
Forward current	If	Vf=3.3v	150	mA
Power Description	Pd		450	mW
Operating temperature range	Topr		-20~+70	^{0}C
Storage temperature range	Tst		-30~+80	^{0}C

11.2 ELECTRICAL/OPTLCAL CHARACTERISTICS

(Ta=25℃)

Item	Symbol	Min	Typ	Max	Unit	Condition
Forward Voltage	Vf	3.2	3.3	3.4	V	If=150 mA
Reverse Current	Ir		100		uA	Vr=5.0 V
Dominant wave length	λp	--	--	--	nm	If=150 mA
Spectral Line Half width	Δ λ		--			If=150 mA
Luminance	Lv				cd/m^2	If=150 mA
Color Coordinate	X		GREEN			If=150 mA
	Y					

12. 0 OPERATING PRINCIPLES & METHODS

12.1 Display Data RAM

1) 32 Gray Scale Display Memory Map (2B3P, 8-bit mode)

			Column									
LCD read direction	CI = 0		0			1				84		
	CI = 1		84			83				0		
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		$D7'_{1,0}$ $D6'_{1,0}$ $D5'_{1,0}$ $D4'_{1,0}$ $D3'_{1,0}$	$D2'_{1,0}$ $D1'_{1,0}$ $D0'_{1,0}$ $D7'_{2,0}$ $D6'_{2,0}$	$D4'_{2,0}$ $D3'_{2,0}$ $D2'_{2,0}$ $D1'_{2,0}$ $D0'_{2,0}$	$D7'_{1,1}$ $D6'_{1,1}$ $D5'_{1,1}$ $D4'_{1,1}$ $D3'_{1,1}$	$D2'_{1,1}$ $D1'_{1,1}$ $D0'_{1,1}$ $D7'_{2,1}$ $D6'_{2,1}$	$D4'_{2,1}$ $D3'_{2,1}$ $D2'_{2,1}$ $D1'_{2,1}$ $D0'_{2,1}$		$D7'_{1,84}$ $D6'_{1,84}$ $D5'_{1,84}$ $D4'_{1,84}$ $D3'_{1,84}$	$D2'_{1,84}$ $D1'_{1,84}$ $D0'_{1,84}$ $D7'_{2,84}$ $D6'_{2,84}$	$D4'_{2,84}$ $D3'_{2,84}$ $D2'_{2,84}$ $D1'_{2,84}$ $D0'_{2,84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

2) 32 Gray Scale Display Memory Map (3B3P, 8-bit mode)

			Column									
LCD read direction	CI = 0		0			1				84		
	CI = 1		84			83				0		
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		$D7'_{1,0}$ $D6'_{1,0}$ $D5'_{1,0}$ $D4'_{1,0}$ $D3'_{1,0}$	$D7'_{2,0}$ $D6'_{2,0}$ $D5'_{2,0}$ $D4'_{2,0}$ $D3'_{2,0}$	$D7'_{3,0}$ $D6'_{3,0}$ $D5'_{3,0}$ $D4'_{3,0}$ $D3'_{3,0}$	$D7'_{1,1}$ $D6'_{1,1}$ $D5'_{1,1}$ $D4'_{1,1}$ $D3'_{1,1}$	$D7'_{2,1}$ $D6'_{2,1}$ $D5'_{2,1}$ $D4'_{2,1}$ $D3'_{2,1}$	$D7'_{3,1}$ $D6'_{3,1}$ $D5'_{3,1}$ $D4'_{3,1}$ $D3'_{3,1}$		$D7'_{1,84}$ $D6'_{1,84}$ $D5'_{1,84}$ $D4'_{1,84}$ $D3'_{1,84}$	$D7'_{2,84}$ $D6'_{2,84}$ $D5'_{2,84}$ $D4'_{2,84}$ $D3'_{2,84}$	$D7'_{3,84}$ $D6'_{3,84}$ $D5'_{3,84}$ $D4'_{3,84}$ $D3'_{3,84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

12.2 Voltage Regulator Circuits

SET VOP (SETVOP)

The set VOP function is to program the optimum LCD supply voltage V0.

Reset state of VPR[8:0] is 257DEC = 13.88V.

The V0 value is programmed via the VPR[8:0] register.

V0 = a + (VPR[8:6]VPR[5:0]) x b

Ex: VPR[5:0]=000001, VPR[8:6]=100

→ VPR[8:0]=100000001

→ 3.6+257x0.04=13.88

Where a is a fixed constant value 3.6, b is a fixed constant value 0.04, VPR[8:0] is the programmed V0 value with programming range from 5 to 410 (19AHEX), and VPR[5:0] is the set contrast value which can be set via the interface and is in two's complement format.(See command VOLUP & VOLDOWN)

The VPR[8:0] value must be in the V0 programming range as given in Fig.13.1.

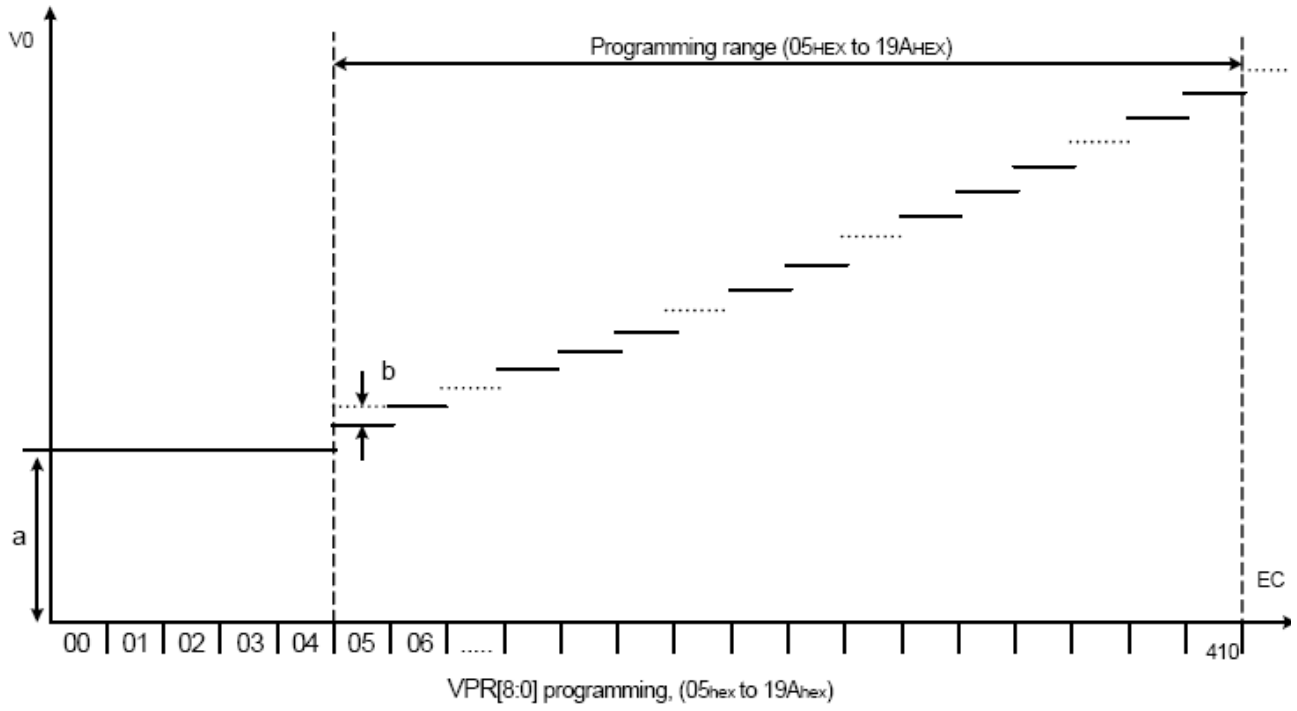


Fig. 13.1 V0 programming range

Although the programming range for the internally generated V0 allows values above the maximum allowed V0, the customer has to ensure setting the VPR register and selecting the temperature compensation under all condition and including all tolerances that the maximum allowed V0 (20V) will never be exceeded.

12.3 The Reset Circuit

When Power is Turned On
Input power (VDD1~VDD5)

↓

Be sure to apply POWER-ON RESET (RST = LOW)

↓

<Display Setting>	**<<State after resetting>>**
Display control (DISCTRL)	
Setting clock dividing ratio:	2 dividing
Duty setting:	1/4
Setting reverse rotation number of line:	11H reverse rotations
Common scan direction (COMSCN)	
Setting scan direction:	COM0 -> COM79, COM80-> COM159

↓

Oscillation ON (OSCON)	Oscillation OFF

↓

Sleep-out (SLIPOUT)	Sleep-in

↓

<Power Supply Setting>	**<<State after resetting>>**
Electronic volume control (VOLCTRL)	
Setting volume value_:	0
Setting built-in resistance value:	0 (3.95)
Power control (PWRCTR)	
Setting operation of power supply circuit:	All OFF

↓

<Display Setting 2>	**<<State after resetting>>**
Normal rotation of display (DISNOR)/Inversion of display (DISINV):	Normal rotation of display
Partial-in (PTLIN)/Partial-out (PTLOUT)	Partial-out
Setting fix area:	0
Area scroll set (ASSET)	
Setting area scroll region:	0
Setting area scroll type:	Full-screen scroll
Scroll start set (SCSTART)	
Setting scroll start address:	0

↓

<Display Setting 3>	**<<State after resetting>>**
Data control (DATCTRL)	
Setting normal rotation/inversion of line address:	Normal rotation

Setting normal rotation/inversion of column address: Normal rotation
Setting direction of address scanner: Column direction
Setting gradation: 2B3P mode

↓

<RAM Setting> **<<State after resetting>>**
Line address set (LASET)
Setting start line address: 0
Setting end line address: 0

Column address set (CASET)
Setting start column address: 0
Setting end column address: 0

↓

<RAM Write> **<<State after resetting>>**
Memory write command (RAMWR)
Writing displayed data: Repeat as many as the number needed and exit by entering other command.

↓

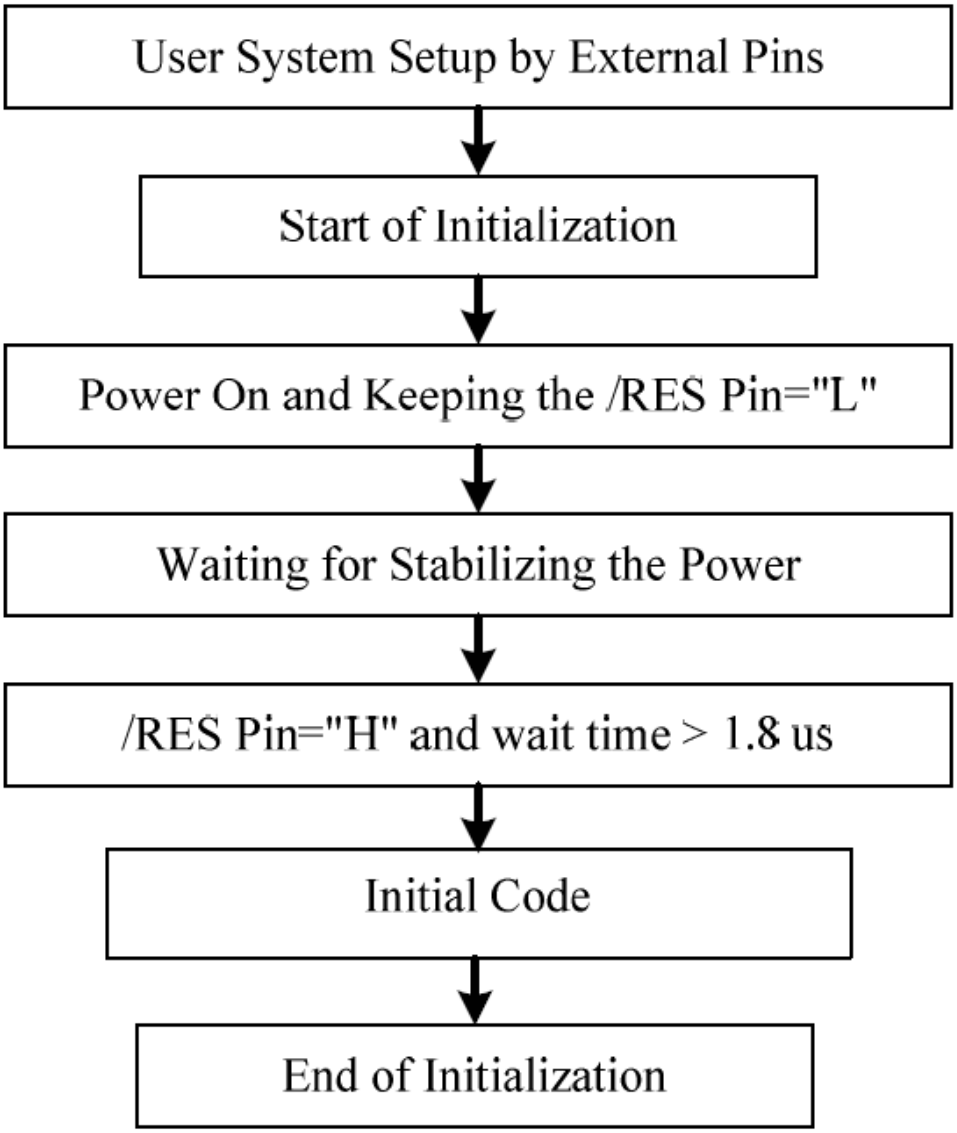
<Waiting (approximately 100ms)>
Wait until the power supply voltage has stabilized.
Enter the command of power supply control first, and then wait at least 100ms before entering the display ON command when the built-in power supply circuit operates.
If you do not wait, an unexpected display may appear on the liquid crystal panel.

↓

DISPLAY ON (DISON): DISPLAY OFF

*1: When the IC is in SLEEP IN state, the liquid crystal drive power supply, the boosting power output, and GND pin are connected together, therefore, the SLEEP OUT command must be entered to cancel the SLEEP state prior to turning on the built-in circuit.
(Note) If changes are unnecessary after resetting, command input is unnecessary.

12.4 Initializing with the Built-in Power Supply Circuits



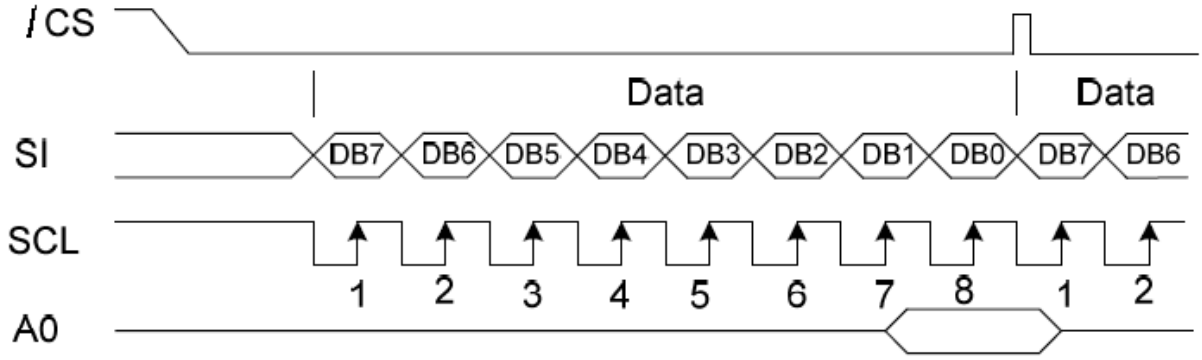
12.5 8-bit (4 wires) and 9-bit (3 wires) Serial Interface

The 8-bit serial interface uses four pins /CS, SI, SCL, and A0 to enter commands and data. Meanwhile, the 9-bit serial interface uses three pins /CS, SI and SCL for the same purpose.

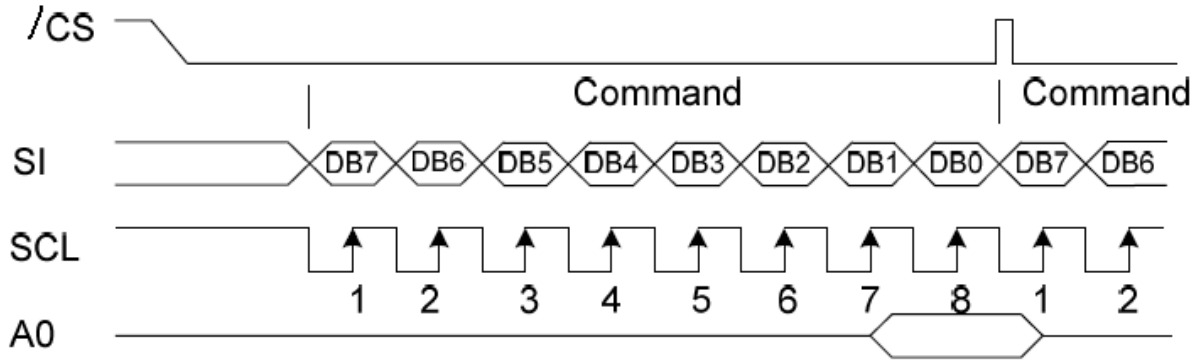
Data read is not available in the serial interface. The entered data must be 8 bits. Refer to the following chart for entering commands, parameters or gray-scale data.

(1) 8-bit serial interface (4 wires)

When entering data (parameters): A0= HIGH at the rising edge of the 8th SCL.

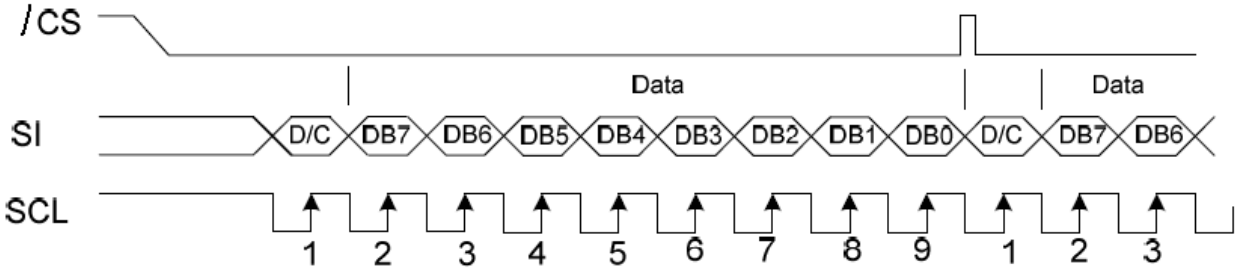


When entering command: A0= LOW at the rising edge of the 8th SCL

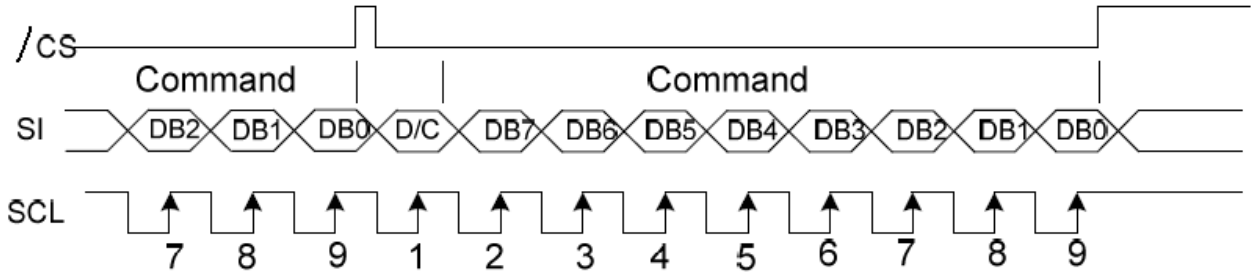


(2) 9-bit serial interface (3 wires)

When entering data (parameters): SI= HIGH at the rising edge of the 1st SCL.



When entering command: SI= LOW at the rising edge of the 1st SCL.



13. 0 INSTRUCTION DESCRIPTION

13.1 INSTRUCTION TABLE

Ext=0 or Ext=1:

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
1	Ext In	0	1	0	0	0	1	1	0	0	0	0	Ext=0 Set	30	None
2	Ext Out	0	1	0	0	0	1	1	0	0	0	1	Ext=1 Set	31	None

Ext=0:

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
1	DISON	0	1	0	1	0	1	0	1	1	1	1	Display On	AF	None
2	DISOFF	0	1	0	1	0	1	0	1	1	1	0	Display Off	AE	None
3	DISNOR	0	1	0	1	0	1	0	0	1	1	0	Normal Display	A6	None
4	DISINV	0	1	0	1	0	1	0	0	1	1	1	Inverse Display	A7	None
5	COMSCN	0	1	0	1	0	1	1	1	0	1	1	COM Scan Direction	BB	1 byte
6	DISCTRL	0	1	0	1	1	0	0	1	0	1	0	Display Control	CA	3 bytes
7	SLPIN	0	1	0	1	0	0	1	0	1	0	1	Sleep In	95	None
8	SLPOUT	0	1	0	1	0	0	1	0	1	0	0	Sleep Out	94	None
9	LASET	0	1	0	0	1	1	1	0	1	0	1	Line Address Set	75	2 bytes
10	CASET	0	1	0	0	0	0	1	0	1	0	1	Column Address Set	15	2 bytes
11	DATSDR	0	1	0	1	0	1	1	1	1	0	0	Data Scan Direction	BC	3 bytes

续表：

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
12	RAMWR	0	1	0	0	1	0	1	1	1	0	0	Writing to Memory	5C	Data
13	RAMRD	0	1	0	0	1	0	1	1	1	0	1	Reading from Memory	5D	Data
14	PTLIN	0	1	0	1	0	1	0	1	0	0	0	Partial display in	A8	2 bytes
15	PTLOUT	0	1	0	1	0	1	0	1	0	0	1	Partial display out	A9	None
16	RMWIN	0	1	0	1	1	1	0	0	0	0	0	Read and Modify Write	E0	None
17	RMWOUT	0	1	0	1	1	1	0	1	1	1	0	RMW end	EE	None
18	ASCSET	0	1	0	1	0	1	0	1	0	1	0	Area Scroll Set	AA	4 bytes
19	SCSTART	0	1	0	1	0	1	0	1	0	1	1	Scroll Start Set	AB	1 byte
20	OSCON	0	1	0	1	1	0	1	0	0	0	1	Internal OSC on	D1	None
21	OSCOFF	0	1	0	1	1	0	1	0	0	1	0	Internal OSC off	D2	None
22	PWRCTRL	0	1	0	0	0	1	0	0	0	0	0	Power Control	20	1 byte
23	VOLCTRL	0	1	0	1	0	0	0	0	0	0	1	EC control	81	2 bytes
24	VOLUP	0	1	0	1	1	0	1	0	1	1	0	EC increase 1	D6	None
25	VOLDOWN	0	1	0	1	1	0	1	0	1	1	1	EC decrease 1	D7	None
26	RESERVED	0	1	0	1	0	0	0	0	0	1	0	Not Use	82	0
27	EPSRRD1	0	1	0	0	1	1	1	1	1	0	0	READ Register1	7C	None
28	EPSRRD2	0	1	0	0	1	1	1	1	1	0	1	READ Register2	7D	None
29	NOP	0	1	0	0	0	1	0	0	1	0	1	NOP Instruction	25	None
30	STREAD	0	0	1	Read Data								Status Read		
31	EPINT	0	1	0	0	0	0	0	0	1	1	1	Initial code(1)	07	1 byte

Ext=1

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
1	Gray 1 Set	0	1	0	0	0	1	0	0	0	0	0	FRAME 1 Gray PWM Set	20	16 bytes
2	Gray 2 Set	0	1	0	0	0	1	0	0	0	0	1	FRAME 2 Gray PWM Set	21	16 bytes
3	ANASET	0	1	0	0	0	1	1	0	0	1	0	Analog Circuit Set	32	3 bytes
4	SWINT	0	1	0	0	0	1	1	0	1	0	0	Software Initial	34	None
5	EPCTIN	0	1	0	1	1	0	0	1	1	0	1	Control EEPROM	CD	1 byte
6	EPCOUT	0	1	0	1	1	0	0	1	1	0	0	Cancel EEPROM	CC	None
7	EPMWR	0	1	0	1	1	1	1	1	1	0	0	Write to EEPROM	FC	None
8	EPMRD	0	1	0	1	1	1	1	1	1	0	1	Read from EEPROM	FD	None

13.2 DESCRIPTION OF INSTRUCTION

EXT= "0" or "1"

(1) Extension instruction disable (EXT IN) - Parameter Byte: None (30H)

Use the "EXT=0" command table

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	0	0	0

(2) Extension instruction enable (EXT OUT) - Parameter Byte: None (31H)

Use the extended command table EXT="1"

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	0	0	1

EXT= "0"

(1) Display ON (DISON) -Parameter Byte: None (AFH)

It is to turn the display on. When the display is turned on, segment and common outputs are generated at the level corresponding to the display data and display timing. As long as the sleep mode is selected, the display cannot be turned on. Thus, whenever using this command, the sleep mode must be cancelled first.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	1	1	1

(2) Display OFF (DISOFF) -Parameter Byte: None (AEH)

It is to forcibly turn the display off. As long as the display is turned off, every segment and common outputs are forced to VSS level.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	1	1	0

(3) Normal display (DISNOR) -Parameter Byte: None (A6H)

It is to normally highlight the display area without modifying contents of the display data RAM.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	0	1	1	0

(4) Inverse display (DISINV) -Parameter Byte: None (A7)

It is to inversely highlight the display area without modifying contents of the display data RAM. This command does not invert non-display areas in case of using partial display.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	0	1	1	1

(5) Common scan (COMSCN) - Parameter Byte: 1 (BBH)

It is to specify the common output scan direction. This command is for the convenience of wiring on the LCD panel.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	1	1	0	1	1	——
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	CD2	CD1	CD0	Common Scan direction

When 1/160 is selected for the display duty, pins and common output are scanned in the order shown below.

CD2	CD1	CD0	Common scan direction	
			COM 0 pin → COM 79 pin	COM 80 pin → COM 159 pin
0	0	0	0 → 79	80 → 159
0	0	1	0 → 79	159 → 80
0	1	0	79 → 0	80 → 159
0	1	1	79 → 0	159 → 80

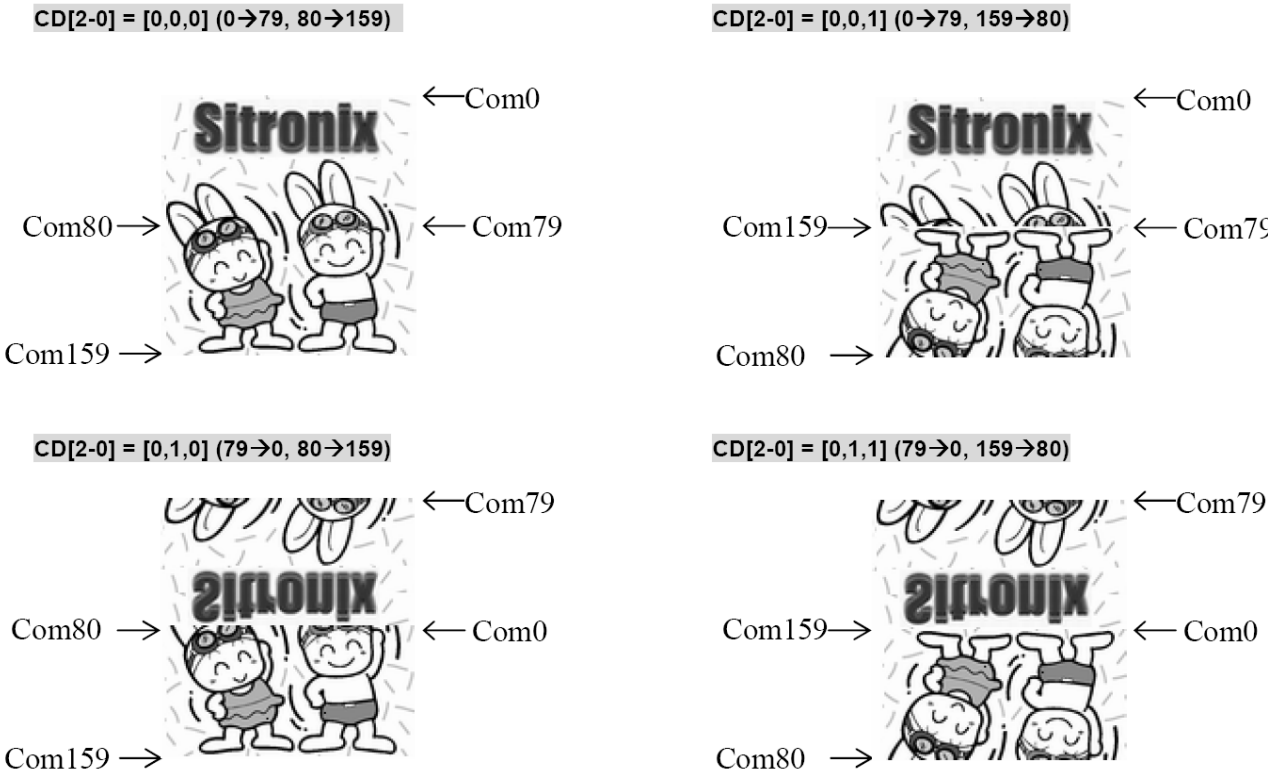


Figure 13.1 Common scan direction configuration

(6) Display control (DISCTRL) -Parameter Byte: 3 (CAH)

This command and succeeding parameters are used to perform the display timing-related setups. This command must be selected before using SLPOUT. Do not change this command while the display is turned on.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	1	0	0	1	0	1	0	——
Parameter Byte 1 (PB1)	1	1	0	*	*	*	0	0	CLD	0	0	CL dividing ratio, F1 and F2 drive pattern.
Parameter Byte 2 (PB2)	1	1	0	*	*	DT5	DT4	DT3	DT2	DT1	DT0	Drive duty
Parameter Byte 3 (PB3)	1	1	0	*	*	*	FI	LF3	LF2	LF1	LF0	FR inverse-set value

PB1 specifies the CL dividing ratio. CLD: CL dividing ratio. They are used to change number of dividing stages of external or internal clock.

CLD=0: not divide, CLD=1: 2 divisions.

PB2 specifies the duty of the module on block basis. Initial: 00H(

(Numbers ofdisplay lines)/4-1= DT5 $x2^5$ + DT4 $x2^4$ + DT3 x 2^3 + DT2 $x2^2$ + DT1 $x2^1$ + DT0 $x2^0$.

For example, 1/128 duty →128/4-1=31 →(DT5, DT4, DT3, DT2, DT1, DT0) = (0, 1, 1, 1, 1, 1)

PB3 specifies number of line cycles (range from 2 to 16) in a frame.

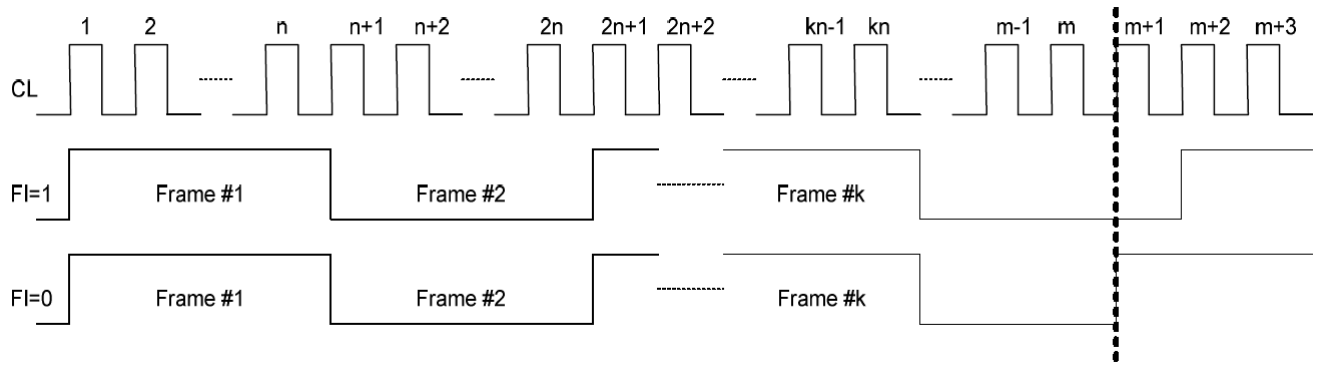
Number of linecycles-1= LF3$x2^3$ + LF2 $x2^2$ + LF1 $x2^1$ + LF0 $x2^0$.

For example, 11 line cycles in a frame →11-1=10 →(LF3, LF2, LF1, LF0) = (1, 0, 1, 0).

In the default, 11 line cycles in a frame is selected.FI decides the inversion type of frame at the end of common scan cycle while the number of duty is not divisible by the number of line cycles per frame.

For example, in the application of 1/m duty and n line cycles in a frame set, the difference of the choice in FI is shown as the following figure.

m = n x k + r, where m, n, k, and r are all whole numbers, and r is the remainder of m divided by n (r < n).



(7) Sleep in (SLPIN) -Parameter Byte: None (95H)

This command is to enter the SLEEP MODE.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	1	0	1	0	1

(8) Sleep out (SLPOUT) - Parameter Byte: None (94H)

This command is to exit the SLEEP MODE.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	1	0	1	0	1

(9) Line address set (LASET) - Parameter Byte: 2 (75H)

This command is to specify the line address area when MPU makes access to the display data RAM. As the addresses are increased from the start to the end line in the line-direction scan, the column address is increased by 1 and the line address return to the start line. Note that the start and end line must be a pair. Moreover, the relation “start line <end line” must be maintained.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	1	1	1	0	0	1	——
Parameter Byte 1 (PB1)	1	1	0	SL7	SL6	SL5	SL4	SL3L	SL2	SL1	SL0	Start Line
Parameter Byte 2 (PB2)	1	1	0	EL7	EL5	EL5	EL4	EL3	EL2	EL1	EL0	End Line

Note: The range of line address is 0 ~ 159.

(10) Column address set (CASET) - Parameter Byte: 2 (15H)

This command is to specify the column address area when MPU makes access to the display data RAM. As the addresses are increased from the start to the end column in the column-direction scan, the line address is incremented by 1 and the column address is returned to the start column. Note that the start and end line must be a pair. Moreover, the relation “start column <end column” must be maintained.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	1	1	1	0	0	1	——
Parameter Byte 1 (PB1)	1	1	0	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0	Start Column
Parameter Byte 2 (PB2)	1	1	0	EC7	EC5	EC5	EC4	EC3	EC2	EC1	EC0	End Column

(11) Data scan direction (DATSDR) - Parameter Byte: 3 (BCH)

This command is to setup various parameters in the operations of display data stored on the built-in RAM by MPU.

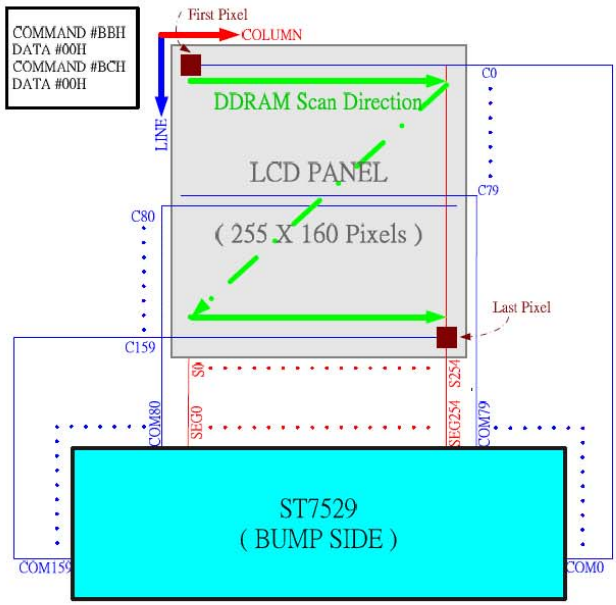
	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	1	1	1	0	0	——
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	C/L	CI	LI	Normal/inverse display of address
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	*	*	CLR	P1, P2, P3 arrangement
Parameter Byte 3 (PB3)	1	1	0	*	*	*	*	*	GS2	GS1	GS0	Gray-scale setup

PB1 is to specify the normal/inverse display of the line and column address and the address scanning direction.

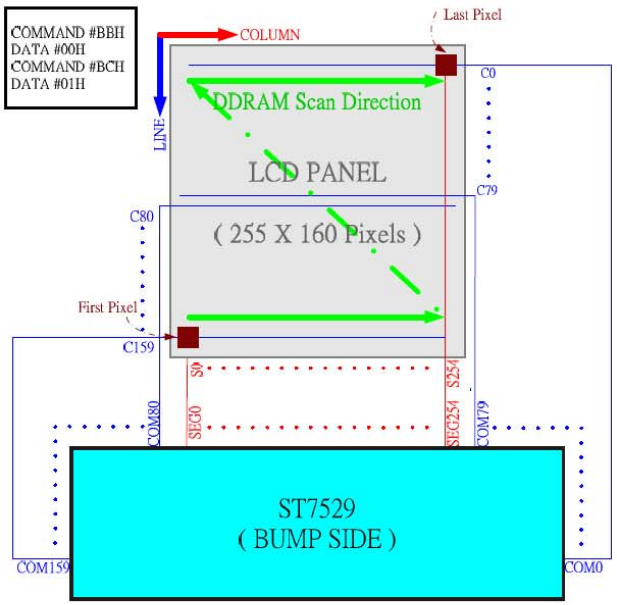
LI: Normal/inverse direction of the line address. LI =0: Normal, LI =1: Inverse

CI: Normal/reverse direction of the column address. CI =0: Normal, CI =1: Reverse

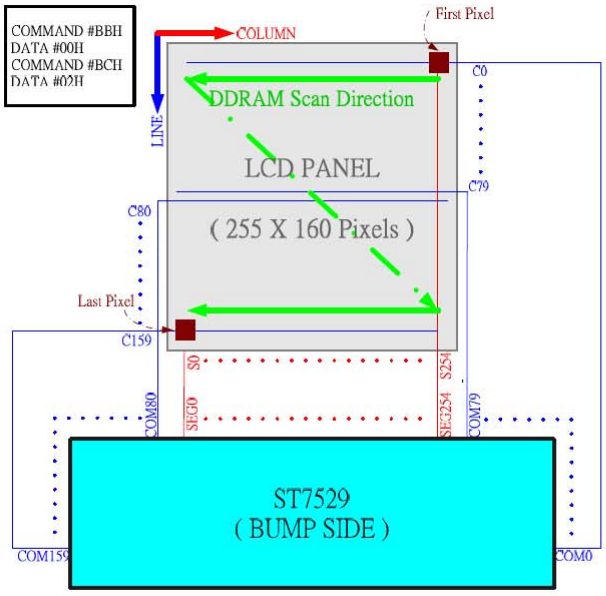
C/L: Address-scan direction. C/L =0: In the column direction, C/L =1: In the line direction



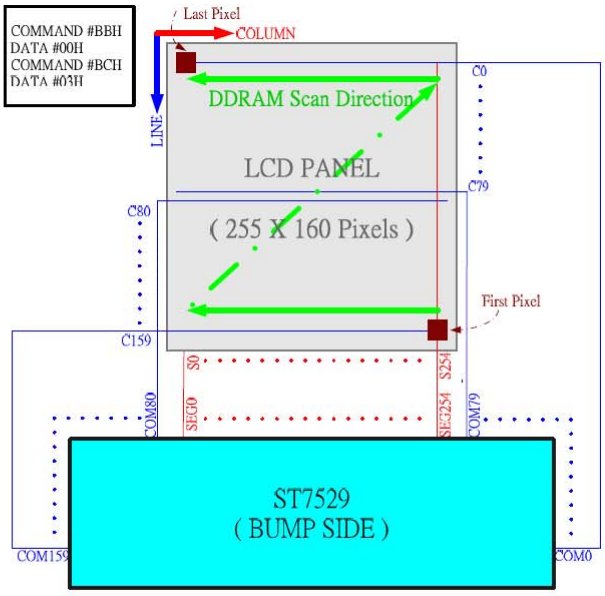
(a) COMMAND #BCH, DATA #00H



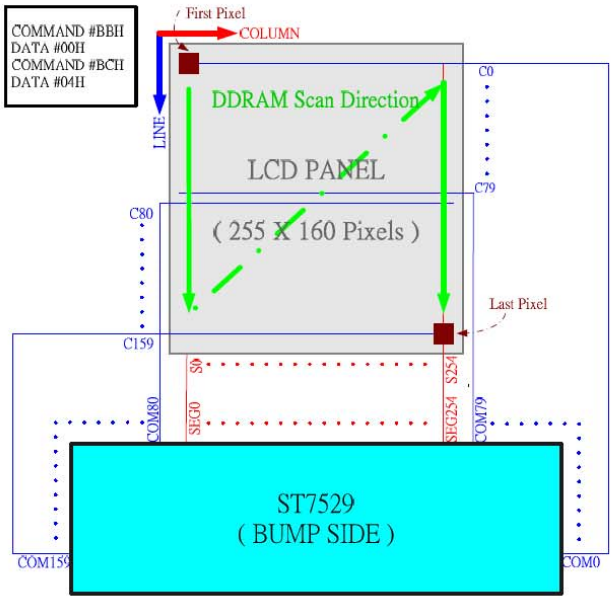
(b) COMMAND #BCH, DATA #01H



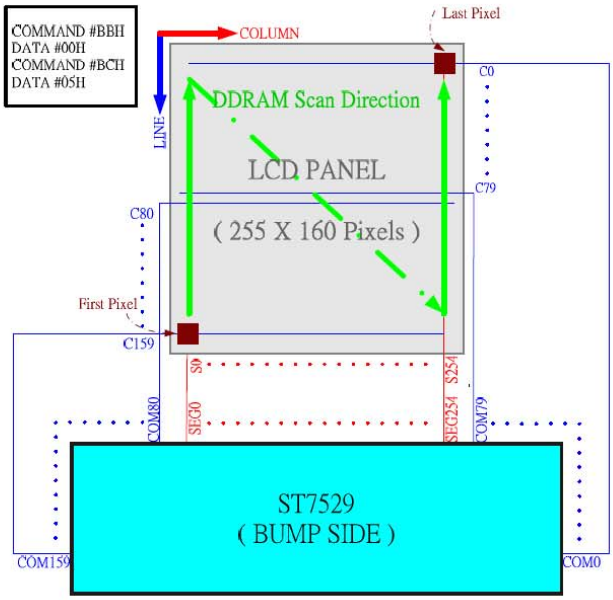
(c) COMMAND #BCH, DATA #02H



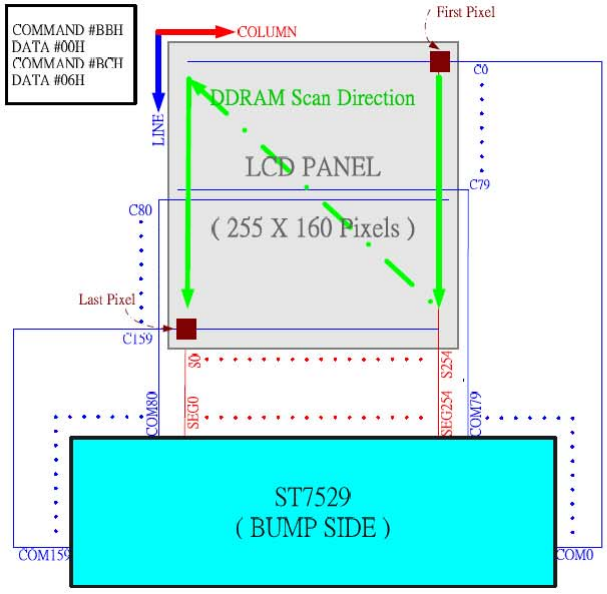
(d) COMMAND #BCH, DATA #03H

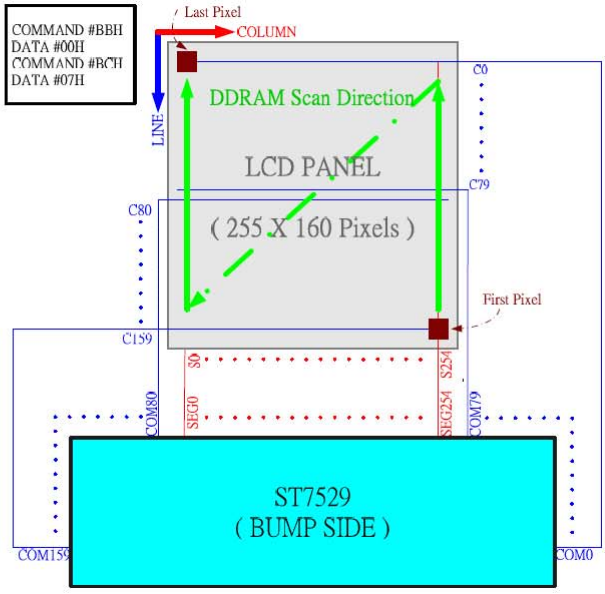


(e) COMMAND #BCH, DATA #04H



(f) COMMAND #BCH, DATA #05H





PB2 is to change P1, P2, P3 arrangement of the segment output according to P1, P2, P3 arrangement on the LCD panel.

This command will set the writing position of data (P1, P2, P3) on the display memory to be changed or not.

CLR	SEG0	SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	….	SEG254
0	P1	P2	P3	P1	P2	P3	P1	P2	…	P3
1	P3	P2	P1	P3	P2	P1	P3	P2	…	P1

PB3 is to select desired gray scale display 2B3P mode or 3B3P mode.

GS2	GS1	GS0	Numbers of gray-scale
0	0	1	32 gray-scale 2Byte 3Pixel mode
0	1	0	32 gray-scale 3Byte 3Pixel mode

(12) Memory write (RAMWR) - Parameter Byte: Numbers of data written (5CH)

This command turns on the data entry mode when MPU writes data to the display memory. This command will always sets the line and column address at the start address while executed. The following parameter byte rewrites contents of the display data RAM and increases the line or column address automatically. The write mode is automatically cancelled if any other command is entered.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	0	1	1	1	0	0	——
Parameter Byte 1 (PB1)	1	1	0	Data to be written								Data to be written

(13) Memory read (RAMRD) - Parameter Byte: Numbers of data read (5DH)

This command turns on the data read mode when MPU read data from the display memory. This command will always sets the line and column address at the start address while executed. The contents of the display data RAM will be read in the following parameter byte and increases the line or column address automatically. The data read mode is automatically cancelled if any other command is entered.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	0	1	1	1	0	1	——
Parameter Byte 1 (PB1)	1	0	1	Data to be read								Data to be read

(14) Partial in (PTLIN) -Parameter Byte: 2(A8H)

This command is to specify the partial display area. It will turn on partial display of the screen (dividing screen by lines) to save power. Since ST7529 processes the liquid crystal display signal on 4-line basis (block basis), the display and no-display areas are also specified on 4-bit line (block basis).

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	0	0	
Parameter Byte 1 (PB1)	1	1	0	*	*	PTS5	PTS4	PTS3	PTS2	PTS1	PTS0	Start block address
Parameter Byte 2 (PB2)	1	1	0	*	*	PTE5	PTE4	PTE3	PTE2	PTE1	PTE0	End block address

Only the address of the display block can be specified for the partial display. Do not specify an address not to be displayed when scrolled.

(15) Partial out (PTLOUT) -Parameter Byte: none (A9H)

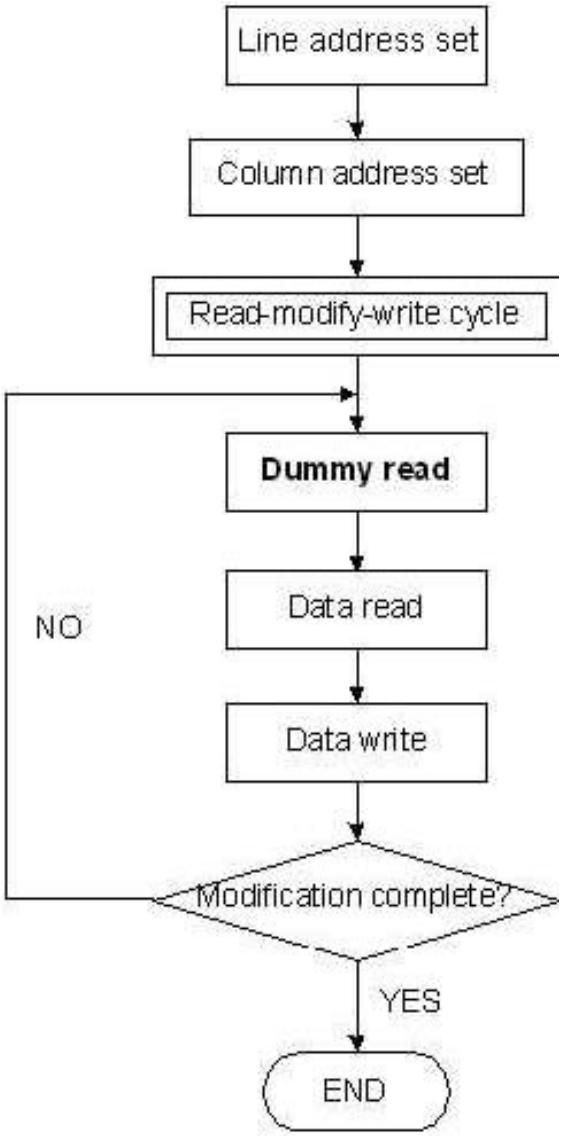
This command is to exit the PARTIAL DISPLAY MODE.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	0	0	1

(16) Read modify write in (RMWIN) -Parameter Byte: none (E0H)

This command is used along with the (9) line address set command (LASET), (10) column address set command (CASET), and (17) read modify write out command (RMWOUT). This function is for frequently modified data on a specific area, such as blinking cursor. First, set a specific display area using the column and line address commands. Then, execute this command to set the column and line addresses as the start address of the specific area. When this operation is complete, the column and line address will not be modified by the display data read command. It is increased only when the display data write command is executed. You can cancel this mode by entering the read modify write out or any other command.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	0	0	0	0	0



(17) Read modify write out (RMWOUT) -Parameter Byte: none (EEH)

This command cancels the read modify write mode.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	0	1	1	1	0

(18) Area scroll set (ASCSET) -Parameter Byte: 4 (AAH)

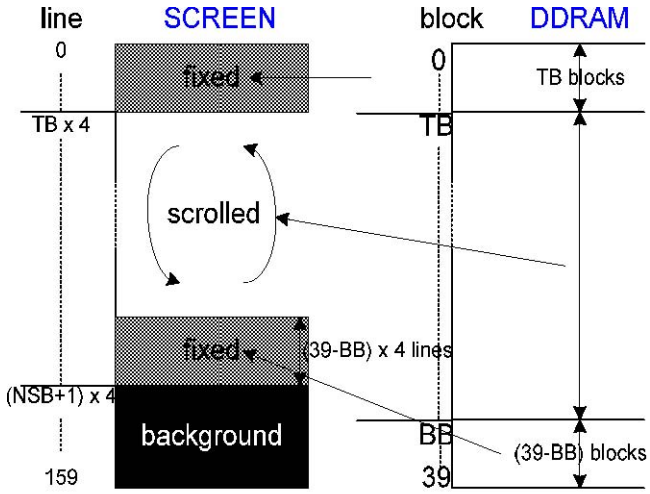
It is to scroll only the specified portion of the screen (dividing the screen by lines). This command specifies the scrolling type of area, fixed area and scrolled area.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	1	0	
Parameter Byte 1 (PB1)	1	1	0	*	*	TB5	TB4	TB3	TB2	TB1	TB0	Top block address
Parameter Byte 2 (PB2)	1	1	0	*	*	BB5	BB4	BB3	BB2	BB1	BB0	Bottom block address
Parameter Byte 3 (PB3)	1	1	0	*	*	NSB5	NSB4	NSB3	NSB2	NSB1	NSB0	Number of specified blocks
Parameter Byte 4 (PB4)	1	1	0	*	*	*	*	*	*	SCM1	SCM0	Area scroll mode

PB4: It is used to specify the scrolling mode.

SCM1	SCM0	Scrolling Mode	Settings		
			Top block address (TB)	Bottom block address (BB)	Number of specified blocks (NSB)
0	0	Center mode	Top(fixed area) height = Top address	Bottom(fixed area) height = 39-Bottom address	Bottom start address = Specified number
0	1	Top mode	0	Bottom(fixed area) height = 39-Bottom address	Bottom start address = Specified number
1	0	Bottom mode	Top(fixed area) height = Top address	39	39
1	1	Whole mode	0	39	39

Since ST7529 processes the liquid crystal display signals on the four-line basis (block basis), fixed and scrolled areas are also specified on the four-line basis (block basis). DDRAM address of the top fixed area is set in the block address increasing direction starting with the 0th block. DDRAM address of the bottom fixed area is set in the block address decreasing direction starting with 39st block. The DDRAM address of other blocks fixed areas are assigned to the scrolled + background areas.



PB1 is to specify the top block address of the scrolled + background areas. Specify the 0th block for the top screen scroll or whole screen scroll. PB2 specifies the bottom address of the scroll + background areas. Specify the 39th block for the bottom or whole screen scroll. The relation that top block address < bottom block address must be maintained. PB3 specifies a specific number of blocks {Numbers of (Top fixed area +Scroll area) block-1}. In the case of the bottom scroll or whole screen scroll, the value is identical with PB2.

The user can turn on the area scroll function by executing the area scroll set command first and then specifying the display start block of the scroll area with the scroll start set command.

(19) Scroll start address set (SCSTART) -Parameter Byte: 1 (ABH)

This command is to specify which line address of DDRAM to be the start line content shown on screen. Note that you must execute this command after executing the area scroll set command. Scroll becomes available by dynamically changing the start block address.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	1	1	——
Parameter Byte 1 (PB1)	1	1	0	*	*	SB5	SB4	SB3	SB2	SB1	SB0	Start block address

Note : Don’t repeat “Area scroll set(AAH)” instruction when “Scroll start address set” is executed.

(20) Internal oscillation on (OSCON) -Parameter Byte: none (D1H)

This command turns on the internal oscillation circuit. It is valid only when the internal oscillation circuit CLS = HIGH.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	0	1	0

(21) Internal oscillation off (OSCOFF) -Parameter Byte: none (D2H)

It turns off the internal oscillation circuit. The circuit is also turned off in the reset mode.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	0	1	0

(22) Power control set (PWRCTRL) -Parameter Byte: 1 (20H)

This command is used to turn on or off the Booster circuit, voltage regulator circuit, and reference voltage.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	1	0	0	1	0	0	0	0	0	——
Parameter Byte 1 (PB1)	1	1	0	*	*	*	0	VB	0	VF	VR	LCD drive power

VR: Turns on/off the reference voltage generation circuit. VR = “1”: ON, VR =” 0”: OFF
VF: Turns on/off the circuit voltage follower. VF = “1”: ON, VF =” 0”: OFF
VB: It turns on or off the Booster. VB = “1”: ON, VB =” 0”: OFF

(23) Electronic volume control (VOLCTRL) -Parameter Byte: 2 (81H)

The command is used to program the optimum LCD supply voltage V0. Refer to 7.10.2.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	0	0	0	0	0	1	——
Parameter Byte 1 (PB1)	1	1	0	*	*	VPR5	VPR4	VPR3	VPR2	VPR1	VPR0	VPR[5:0]
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	VPR8	VPR7	VPR6	VPR[8:6]

With the VOLUP and VOLDOWN command the V0 voltage and therewith the contrast of the LCD can be adjusted.

(24) Increment electronic control (VOLUP) -Parameter Byte: none (D6H)

This command increments electronic control offset value of voltage regulator (V0) circuit by 1. Each step is 0.04V.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	1	1	0

If you set the electronic control value to 111111, the control value is set to 000000 after this command has been executed.

(25) Decrement electronic control (VOLDOWN) -Parameter Byte: none (D7H)

This command decrements electronic control offset value of voltage regulator (V0) circuit by 1. Each step is 0.04V.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	1	1	1

If you set the electronic control value to 000000, the control value is set to 111111 after this command has been executed.

(26) Reserved (82H)

Do not use this command.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	0	0	0	1	0

(27) Read Register 1 (EPSRRD1) Command: 1 Parameter Byte: none (7CH)

Execute the EPSRRD1 and STREAD (Status Read) commands in succession to read the Electronic Control value.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	1	1	1	1	1	0	0

Execute the Status Read command immediately after this command and execute the NOP command after the STREAD (Status Read) command.

(28) Read Register 2 (EPSRRD2) Command: 1 Parameter Byte: none (7DH)

Execute the EPSRRD2 and STREAD (Status Read) commands in succession to read the built-in resistance ratio.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	1	1	1	1	1	0	1

Execute the Status Read command immediately after this command and execute the NOP(Reset) command after the STREAD (Status Read) command.

(29) Non-operating (NOP) -Parameter Byte: none (25H)

This command does not affect the operation but has the function of canceling the IC test mode. Thus, it is recommended to enter it periodically to prevent malfunctioning due to noise and so on.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	0	0	1	0	1

(30) Status read (STREAD) -Parameter Byte: none

The command is to read the internal condition of the IC. One status can be displayed depending on the setting status after reset or after NOP operation.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	0	1	Status data							

D7: Area scroll mode	Refer to SCM1 (ASCSET)	
D6: Area scroll mode	Refer to SCM0 (ASCSET)	
D5: RMW on/off	0 : Out	1 : In
D4: Scan direction	0 : Column	1 : Line
D3: Display ON/OFF	0 : OFF	1 : ON
D2: EEPROM access	0: OutAccess	1: InAccess
D1: Display normal/inverse	0 : Inverse	1 : Normal
D0: Partial display	0 : OFF	1 : ON

(31) Initial code (1) (EPINT) Command: 1; Parameter: 1 (07H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	0	0	0	1	1	1	——
Parameter Byte 1 (PB1)	1	1	0	0	0	0	1	1	0	0	1	19H

This command is used for EEPROM internal ACK signal generating ,suggest using this command before EEPROM read/write operation . This command improve the EEPROM internal ACK signal under unstable power system.

EXT= "1"

The ST7529 applies 16-gray level and 2 FRC to achieve 32-gray scale display. Every gray level is in the strength controlled by 31-PWM (5-bit). The following 2 commands are to set the gray scale value.

(1) Set Gray 1 value (Gray 1 set) - Parameter Byte: 16 (20H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	1	0	0	0	0	0	ODD FRAME Gray PWM Set
Parameter Byte 1 (PB1)	1	1	0	*	*	*	G0F14	G0F13	G0F12	G0F11	G0F10	Set Gray level 0 at odd frames
Parameter Byte 2 (PB2)	1	1	0	*	*	*	G1F14	G1F13	G1F12	G1F11	G1F10	Set Gray level 1 at odd frames
- -												- -
Parameter Byte 15 (PB15)	1	1	0	*	*	*	G14F14	G14F13	G14F12	G14F11	G14F10	Set Gray level4 14 at odd frames
Parameter Byte 16 (PB16)	1	1	0	*	*	*	G15F14	G15F13	G15F12	G15F11	G15F10	Set Gray level 15 at odd frames

(2) Set Gray 2 value (Gray 2 set) - Parameter Byte: 16 (21H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	1	0	0	0	0	1	EVEN FRAME Gray PWM Set
Parameter Byte 1 (PB1)	1	1	0	*	*	*	G0F24	G0F23	G0F22	G0F21	G0F10	Set Gray level 0 at even frames
Parameter Byte 2 (PB2)	1	1	0	*	*	*	G1F24	G1F23	G1F22	G1F21	G1F20	Set Gray level 1 at even frames
-												-
Parameter Byte 15 (PB15)	1	1	0	*	*	*	G14F24	G14F23	G14F22	G14F21	G14F20	Set Gray level4 14 at even frames
Parameter Byte 16 (PB16)	1	1	0	*	*	*	G15F24	G15F23	G15F22	G15F21	G15F20	Set Gray level 15 at even frames

(3) Analog circuit set (ANASET) – Parameter Byte: 3 (32H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	1	1	0	0	1	0	——
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	OSF2	OSF1	OSF0	OSC frequency Adjustment
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	*	BE1	BE0	Booster Efficiency Set
Parameter Byte 3 (PB3)	1	1	0	*	*	*	*	*	BS2	BS1	BS0	Bias Setting

PB1: Oscillator frequency adjustment

OSF2	OSF1	OSF0	Frequency (KHz)
0	0	0	12.7(default)
0	0	1	13.2
0	1	0	14.3
0	1	1	15.7
1	0	0	17.3
1	0	1	19.3
1	1	0	21.9
1	1	1	25.4

Condition : 1/160 duty, fCL(Hz) = Frame frequency x (duty + 1dummy)

PB2: Booster Efficiency set

BE1	BE0	Frequency on booster capacitors (Hz)
0	0	3K
0	1	6K (Default)
1	0	12K
1	1	24K

PB3: Select LCD bias ratio of the voltage required for driving the LCD.

BS2	BS1	BS0	LCD bias
0	0	0	1/14
0	0	1	1/13
0	1	0	1/12
0	1	1	1/11
1	0	0	1/10
1	0	1	1/9
1	1	0	1/7
1	1	1	1/5

(4) Software Initial (SWINT) -Parameter Byte: None (34H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	1	0	0

(5) Control EEPROM (EPCTIN) -Parameter Byte: 1 (CDH)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	0	1	1	0	1
Parameter Byte 1 (PB1)	1	1	0	0	0	EEWR	0	0	0	0	0

When EEWR = “1”, EEPROM will be Write Enable; when EEWR = “0”, EEPROM will be Read Enable.

(6) Cancel EEPROM Command (EPCOUT) -Parameter Byte: None (CCH)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	0	1	1	0	0

This command is to cancel the EEPROM Read/Write Enable.

(7) Write data to EEPROM (EPMWR) -Parameter Byte: None (FCH)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	1	1	1	0	0

This command is to Write data to EEPROM.

(8) Read data from EEPROM (EPMRD) -Parameter Byte: None (FDH)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	1	1	1	0	1

This command is to Read data from EEPROM.

14. 0 QUALITY GUARANTEE

14.1 ACCEPTABLE QUALITY LEVEL

Inspection items	Sampling procedures	AQL
Visual-operating (Electro-optical)	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	0.65
Visual-not operating	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	1.5
Dimension measurement	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	1.5

14.2 Conditions of Cosmetic Inspection

- Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25℃ and normal humidity 60±15%RH).

- Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

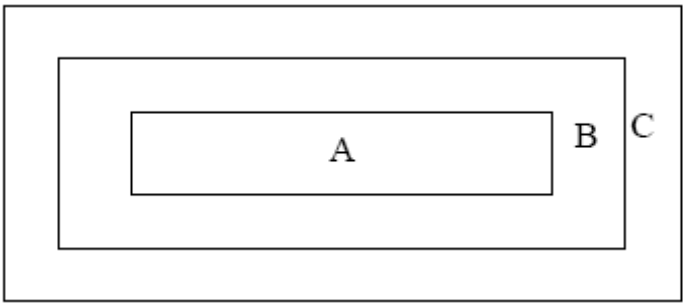
The V0 value which the most optimal contrast can be obtained near the specified V0 in the specification. (Within ±0.5V of the typical value at 25℃.).

14.3 Definition of inspection zone in LCD

Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)



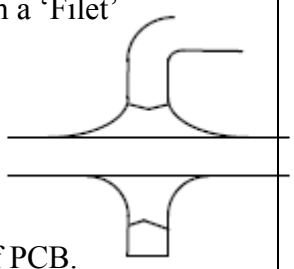
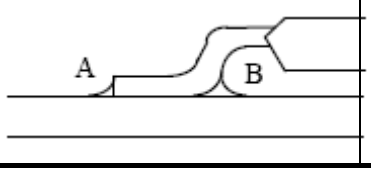
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

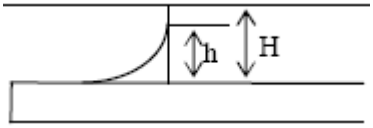
14.4 Inspection Standard

- **Major Defect**

Item No	Items to be inspected	Inspection Standard	Classification of defects
1	All functional defects	1) No display 2) Display abnormally 3) Missing vertical，horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting.	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	

- **Module Cosmetic Criteria**

No.	Item	Judgment Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. Lead parts	a. Soldering side of PCB Solder to form a ‘Filet’ all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of ‘Through Hole PCB’) Solder to reach the Components side of PCB. 	Minor
	2. Flat packages	Either ‘Toe’ (A) or ‘Seal’ (B) of the lead to be covered by ‘Filet’. Lead form to be assume over solder. 	Minor

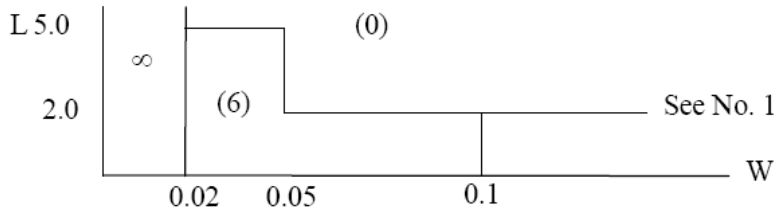
No.	Item	Judgment Criterion	Partition
8	3. Chips	(3/2) H ≥ h ≥ (1/2) H 	Minor

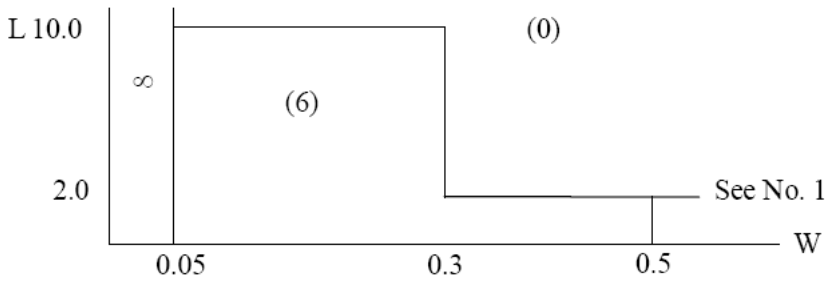
● Screen Cosmetic Criteria (Non-Operating)

No.	Defect	Judgement Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1*.	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2*.	Minor
3	Bubbles in polarizer	<table><tr><td>Size : d</td><td>mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d</td><td>≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d</td><td>≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d</td><td>≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td></td><td>0</td></tr></table>	Minor
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor
7	Contamination	Not to be noticeable.	Minor

Note: Size : d = (long length + short length) / 2

● Screen Cosmetic Criteria (Operating)

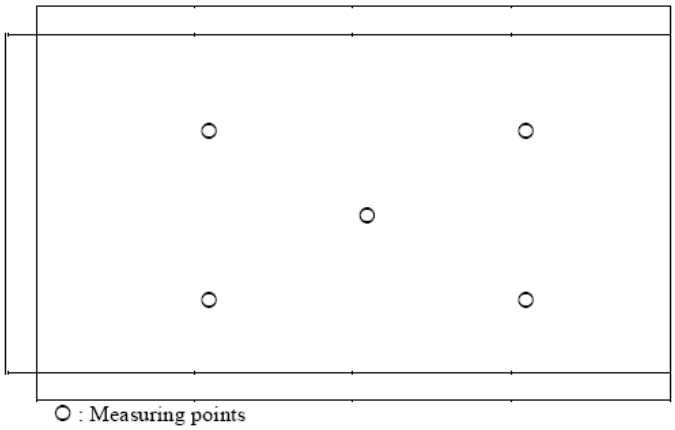
<table>
<tr><th>No.</th><th>Defect</th><th>Judgment Criterion</th><th>Partition</th></tr>
<tr><td>1</td><td>Spots</td><td>A) Clear
<table>
<tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td>d ≤ 0.1</td><td>Disregard</td></tr>
<tr><td>0.1 < d ≤ 0.2</td><td>6</td></tr>
<tr><td>0.2 < d ≤ 0.3</td><td>2</td></tr>
<tr><td>0.3 < d</td><td>0</td></tr>
</table>
Note : Including pin holes and defective dots which must be within one pixel size.
B) Unclear
<table>
<tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td>d ≤ 0.2</td><td>Disregard</td></tr>
<tr><td>0.2 < d ≤ 0.5</td><td>6</td></tr>
<tr><td>0.5 < d ≤ 0.7</td><td>2</td></tr>
<tr><td>0.7 < d</td><td>0</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>2</td><td>Lines</td><td>A) Clear
 

Note :
( ) - Acceptable Qty in active area
L - Length (mm)
W - Width (mm)
∞ - Disregard
B) Unclear
 

‘Clear’ = The shade and size are not changed by Vop.
‘Unclear’ = The shade and size are changed by Vop.</td><td>Minor</td></tr>
</table>

Note: Size : d = (long length + short length) / 2

● Screen Cosmetic Criteria (Operating) (Continued)

No.	Defect	Judgment Criterion	Partition
3	Rubbing line	Not to be noticeable.	Minor
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as pot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.  	Minor

Note :

(1) The limit samples for each item have priority.

(2) Complex defects are defined item by item, but if the numbers of defects are defined in above table, the total number should not exceed 10.

(3) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.

- 7 or over defects in circle of Æ5mm.
- 10 or over defects in circle of Æ10mm.
- 20 or over defects in circle of Æ20mm.

15. 0 RELIABILITY

15.1 Content of Reliability Test

No.	Test Item	Test Condition	Inspection after test
1	High Temperature Storage	80℃±2℃/200 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack; 6.Current Idd is twice higher than initial value.
2	Low Temperature Storage	-30℃±2℃/200 hours	
3	High Temperature Operating	70℃±2℃/120 hours	
4	Low Temperature Operating	-20℃±2℃/120 hours	
5	Temperature Cycle	-20℃±2℃~25~70℃±2℃×10cycles (30min.) (5min.) (30min.)	
6	High Temperature / Humidity operation	50℃±5℃×90%RH/120 hours	
7	Vibration Test	Frequency：10Hz~55Hz~10Hz Amplitude：1.5mm, X，Y，Z direction for total 3hours (Packing condition)	
8	Drooping test	Drop to the ground from 1m height, one time, and every side of carton. (Packing condition)	
9	Static electricity test	Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time	

Remark:

1. The test samples should be applied to only one test item.
2. Sample size for each test item is 5~10pcs.
3. For Damp Proof Test, Pure water(Resistance＞10MΩ) should be used.
4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part.
5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.
6. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

16. 0 PRECAUTIONS FOR USING LCD MODULES

16.1 Handing Precautions

(1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :

- Isopropyl alcohol
- Ethyl alcohol

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

16.2 Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below 0°C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

16.3 Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

17. 0 USING LCD MODULES

17.1 About Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizer and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

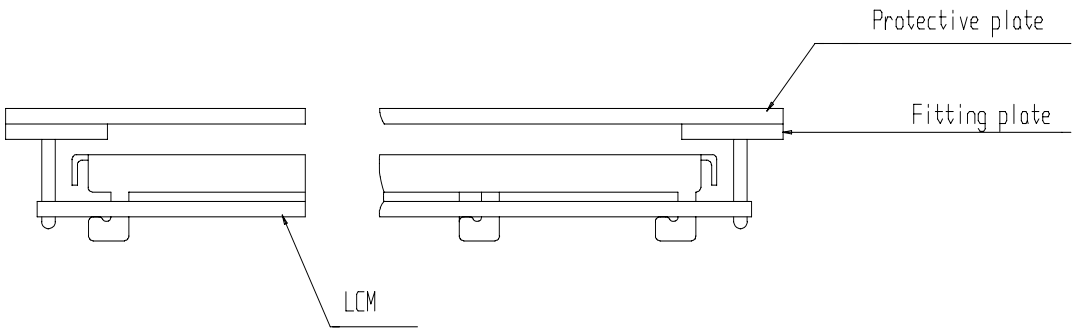
(9) Do not touch the display with bare hands. This will stain the display area and degradate insulation between terminals (some cosmetics are determinate to the polarizer).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.

17.2 Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the

individual specifications for measurements. The measurement tolerance should be ±0.1mm.

17.3 Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

(1) Make certain that you are grounded when handing LCM.

(2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.

(3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.

(4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutation of the motor.

(5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.

(6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

17.4 Soldering to the LCM

(1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.

- Soldering iron temperature : 280°C ± 10°C.
- Soldering time : 3-4 sec.
- Solder : eutectic solder.

If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage dur to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

17.5 Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.

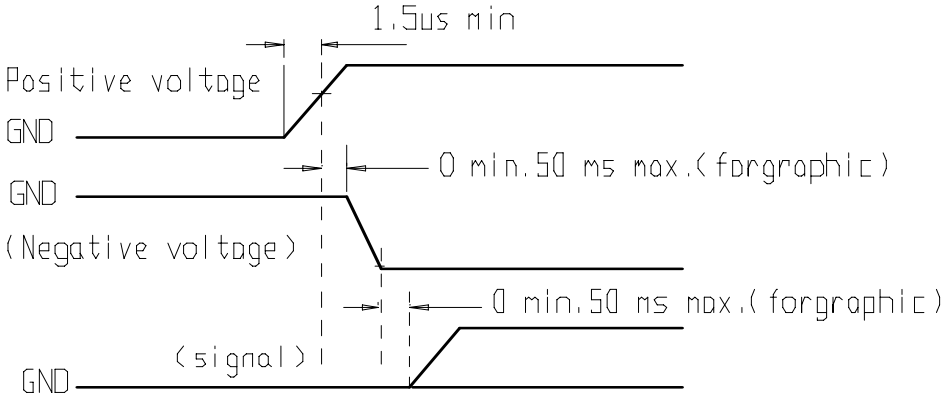
(2) Driving the LCD in the voltage above the limit shortens its life.

(3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it must be used under the relative condition of 40°C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.



17.6 Storage

When storing LCDs as spares for some years, the following precaution are necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

(4) Environmental conditions :

- Do not leave them for more than 168hrs. at 60°C.
- Should not be left for more than 48hrs. at -20°C.

17.7 Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leakes out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

17.8 Limited Warranty

Unless agreed between HYDISPLAY and customer, HYDISPLAY will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with HYDISPLAY LCD/LCM acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to HYDISPLAY within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of HYDISPLAY limited to repair and/or replacement on the terms set forth above. HYDISPLAY will not be responsible for any subsequent or consequential events.

17.9 Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

18. 0 APPENDIX

18.1 Initialization Code

```
//Send 8-Bit Data To ST7529
#pragma disable
void SendBit(uchar uc_dat)
{
    uchar uc_BitCnt;

    LCD_SID = 1;
    for(uc_BitCnt=0;uc_BitCnt<8;uc_BitCnt++)
    {
        if(( uc_dat & 0x80 ) == 0)
            LCD_SID = 0;
        else
            LCD_SID = 1;
        LCD_SCL = 0;
        LCD_SCL = 1;
        uc_dat =uc_dat <<1;
    }
}

//Write Instruction Data
#pragma disable
void wr_cmd(uchar uc_cmd)
{
    LCD_CS = 0;
    LCD_A0 = 0;
    SendBit(uc_cmd);
    LCD_CS = 1;
}

//Write Diaply data
#pragma disable
void wr_dat(uchar uc_dat)
{
    LCD_CS = 0;
    LCD_A0 = 1;
    SendBit(uc_dat);
    LCD_CS = 1;
}
```

```
#pragma disable
void Initialization(void)
{
    wr_cmd(0x30); //EXT=0
    wr_cmd(0x94); //SLEEP OUT
    wr_cmd(0xD1); //OSC ON

    wr_cmd(0x20);//POWER CONTROL SET
    wr_dat(0x0B);//BOOSTER ON

    wr_cmd(0x81);//ELECTRONIC CONTROL
    wr_dat(0x16);//DL
    wr_dat(0x03);//DH Vop=12.0V,Normal display

    wr_cmd(0xCA);//DISPLAY CONTROL
    wr_dat(0x04);//CLD=0,NOT DIVIDE
    wr_dat(0x0F);//64/4-1 =15 DUTY
    wr_dat(0x00);//FR

    wr_cmd(0xA7);//Inverse display

    wr_cmd(0xBB);//COM SCAN DIRECTION
    wr_dat(0x00);//

    wr_cmd(0xBC);
    wr_dat(0x00);
    wr_dat(0x00);//CLR=0
    wr_dat(0x02);//32 Gray-scale 3byte 3pixel mode

    wr_cmd(0x75);//Line address set
    wr_dat(0x00);//Start Line 0
    wr_dat(0x3F);//End Line      63

    wr_cmd(0x15);//Column address set
    wr_dat(0x00);//Start Column 0
    wr_dat(0x4F);//End Column      79

    wr_cmd(0x31); //ext=1

    wr_cmd(0x32);//Analog circuit set
    wr_dat(0x00);//FR=12.7KHZ
    wr_dat(0x01);//Booster FR=6KHZ
    wr_dat(0x05);//1/13bias
```

```
    wr_cmd(0x34);//Dithering off
    wr_cmd(0x30);//EXT=0

    wr_cmd(0xAF);//DISP ON
}
```

18.2 LCM Application Circuit Diagram