LM240160GCW
LCD Module User Manual

Shenzhen TOPWAY Technology Co., Ltd.

Rev.	Descriptions	Release Date
0.1	Prelimiay release	2008-03-27

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1. Basic Specifications

1.1 Display Specifications

1) LCD Display Mode   : FSTN, Positive, Transmissive
2) Display Color   : Display Data = "1" : Dark Gray (*1)
                                : Display Data = "0" : Light Gray (*2)
3) Viewing Angle   : 6H
4) Driving Method   : 1/160 duty, 1/12 bias
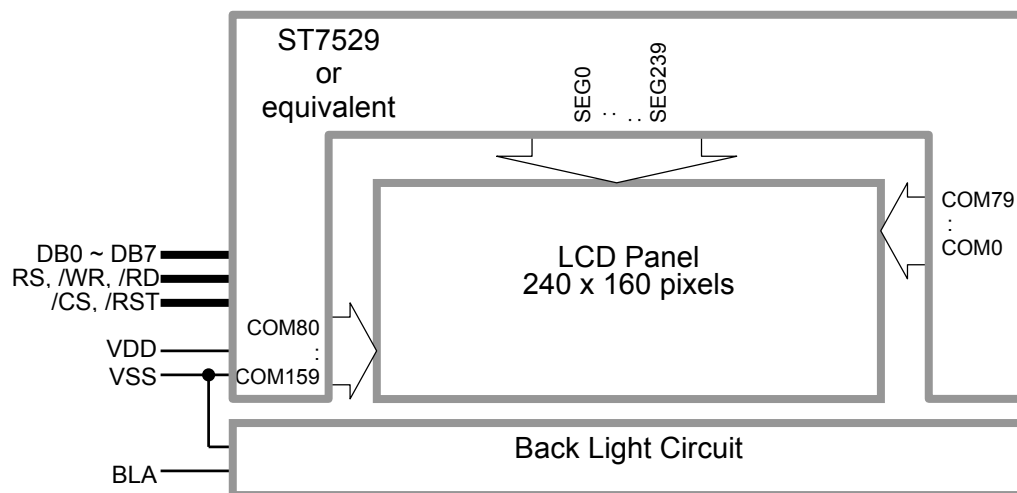5) Back Light   : White LED backlight

Note:
*1. Color tone may slightly change by Temperature and Driving Condition.
*2. The Color is defined as the inactive / background color

1.2 Mechanical Specifications

1) Outline Dimension   : 84.5 x 71.0 x 9.7MAX
                                    (See attached Outline Drawing for details)

1.3 Block Diagram

1.4 Terminal Functions

Pin No.	Pin Name	I/O	Descriptions
1	VDD	Power	Positive Power Supply
2	VSS	Power	0V Supply, Ground (0V)
3	/CS	Input	Chip Select /CS=LOW : Data IO is enabled
4	RS	Input	Register Select RS=HIGH: data on DB0 to DB7 is display data RS=LOW: data on DB0 to DB7 is control data
5	/WR	Input	Write enable input, active LOW
6	/RD	Input	Read enable input, active LOW
7	DB0	I/O	Bi-directional data bus:
:	:		
14	DB7		
15	/RST	Input	Reset: /RST=LOW: Initialization is executed /RST=HIGH: Normal
16	BLA	Power	Backlight Positive Power Supply

2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	-0.3	+4.0	V	V_{SS} = 0V
Input Voltage	V_{IN}	-0.3	V_{DD}+0.3	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.

3. Electrical Characteristics

3.1 DC Characteristics

V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Condition / Application Pin
Operating Voltage	V_{DD}	3.1	3.3	3.6	V	VDD
Input High Voltage	V_{IH}	0.8xV_{DD}	-	V_{DD}	V	/RST, /CS, RS, /WR, /RD, DB0~DB7
Input Low Voltage	V_{IL}	0	-	0.2xV_{DD}	V	
Operating Current	I_{DD}	-	1.5	7.0	mA	VDD

3.2 LED Backlight Circuit Characteristics

V_{SS}=0V, If_{BLA}=85mA, T_{OP}=25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Forward Voltage	Vf_{BLA}	-	3.3	-	V	VLED-
Forward Current	If_{BLA}	-	85	110	mA	VLED-

Cautions:

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

No. of LED = 5pcs
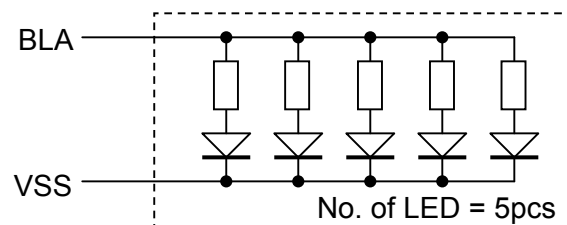
3.3   AC Characteristics

3.3.1   8080 Mode System Bus Timing

V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25°C

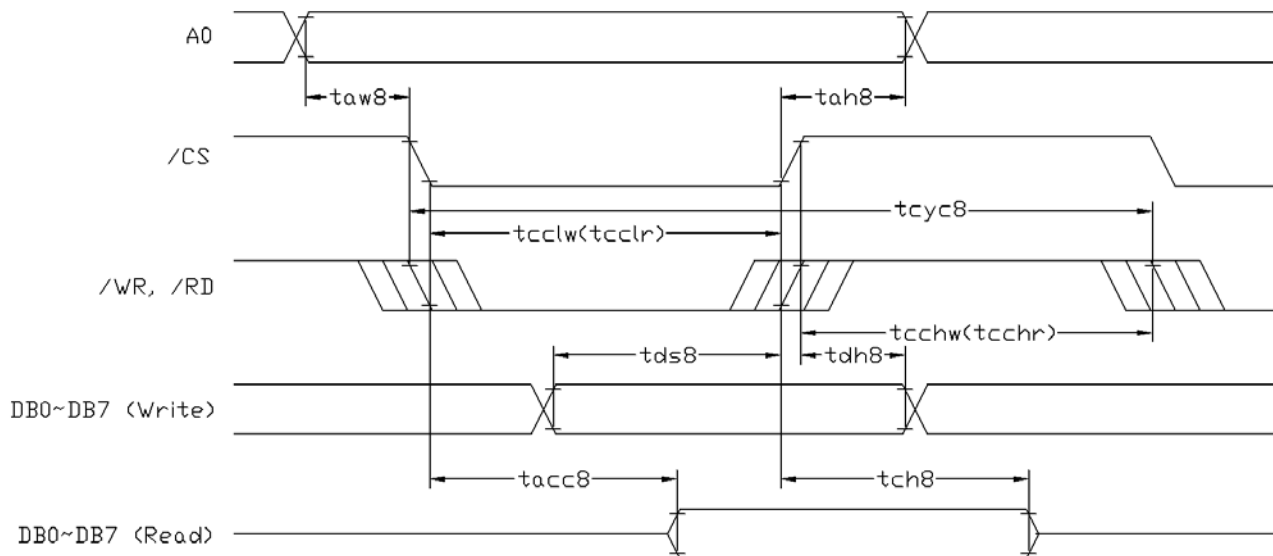| Item	Symbol	MIN.	TYP.	MAX.	Unit
System cycle time	tcyc8	285	-	-	ns
Address setup time (A0)	taw8	29	-	-	ns
Address hold time (A0)	tah8	29	-	-	ns
Control LOW pulse width (/WR)	tcclw	143	-	-	ns
Control LOW pulse width (/RD)	tcclr	143	-	-	ns
Control HIGH pulse width (/WR)	tcchw	143	-	-	ns
Control HIGH pulse width (/RD)	tcchr	143	-	-	ns
Data setup time	tds8	100	-	-	ns
Data hold time	tdh8	29	-	-	ns
/RD access time (*2)	tacc8	-	-	57	ns
Output disable time (*2)	tch8	-	-	38	ns

Note:
*1. Input signal rise/fall time should be less than 12ns
*2. CL=100pF

3.4   Reset Timing
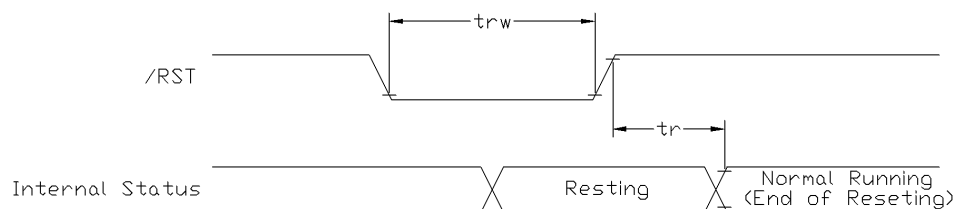
V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset time	tr	-	-	2	µs
Reset LOW pulse width	trw	2	-	-	µs

Note:
*1. Input signal rise/fall time should be less than 12ns

4.   Function Specifications

4.1   Basic Setting

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

-   Internal Oscillator = ON
-   DC-DC Booster (VB)= ON
-   Voltage Follower (VF) = ON
-   Reference Voltage (VR) = ON
-   Clock Divider (CL) = ½
-   Driver duty = 1/160
-   FI = 0
-   FR Inverse-Set Value (LF) = 0
-   COMMON Scan Mode = 001(binary)
-   Direction of the Line Address (LI) = Inverse
-   Direction of the Column Address (CL) = Normal
-   Address-scan direction (C/L) = column direction
-   P1, P2, P3 arrangement (CLR) = Normal (P1, P2, P3)
-   Gray Scale Display Mode = 3Bit per 3Pixel mode
-   OSC Frequency = 19.3kHz
-   Booster Efficiency Set = 00(binary)
-   LCD Bias Set = 1/12
-   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.

4.2   Resetting the LCD module

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

4.3   Display Memory Map

0,0 (P1)	1,0 (P2)	2,0 (P3)	3,0 (P1)	4,0 (P2)	- - -	- - -	235,0 (P2)	236,0 (P3)	237,0 (P1)	238,0 (P2)	239,0 (P3)
0,1 (P1)	1,1 (P2)	2,1 (P3)	3,1 (P1)	4,1 (P2)	- - -	- - -	235,1 (P2)	236,1 (P3)	237,1 (P1)	238,1 (P2)	239,1 (P3)
0,2 (P1)	1,2 (P2)	2,2 (P3)	3,2 (P1)	4,2 (P2)	- - -	- - -	235,2 (P2)	236,2 (P3)	237,2 (P1)	238,2 (P2)	239,2 (P3)
: : :	: : :	: : :	: : :	: : :	: : :	: : :	: : :	: : :	: : :	: : :	: : :
0,157 (P1)	1,157 (P2)	2,157 (P3)	3,157 (P1)	4,157 (P2)	- - -	- - -	235,157 (P2)	236,157 (P3)	237,157 (P1)	238,157 (P2)	239,157 (P3)
0,158 (P1)	1,158 (P2)	2,158 (P3)	3,158 (P1)	4,158 (P2)	- - -	- - -	235,158 (P2)	236,158 (P3)	237,158 (P1)	238,158 (P2)	239,158 (P3)
0,159 (P1)	1,159 (P2)	2,159 (P3)	3,159 (P1)	4,159 (P2)	- - -	- - -	235,159 (P2)	236,159 (P3)	237,159 (P1)	238,159 (P2)	239,159 (P3)

Pixel mapping (Top View)

Based on the top view of the LCD module,
X = COLUMN, Y = Line
0, 0 (x, y) pixel is the upper-left pixel;
239, 159 (x, y) pixel is the lower-right pixel.

Note:
*1. Based on the Basic Setting

4.4   Commands

4.4.1   EXT select Commands

Command	Para-meter	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Descriptions
Ext=0	-	0	1	0	0	0	1	1	0	0	0	0	30	Set Ext=0
Ext=1	-	0	1	0	0	0	1	1	0	0	0	1	31	Set Ext=1

4.4.2   EXT=0 Commands

Command	Para-meter	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Descriptions
DISON	-	0	1	0	1	0	1	0	1	1	1	1	AF	Display ON
DISOFF	-	0	1	0	1	0	1	0	1	1	1	0	AE	Display OFF
DISNOR	-	0	1	0	1	0	1	0	0	1	1	0	A6	Normal Display
DISINV	-	0	1	0	1	0	1	0	0	1	1	1	A7	Inverse Display
COMSCN	-	0	1	0	1	0	1	1	1	0	1	1	BB	COM Scan Direction (with 1 parameter)
	PB1	1	1	0	*	*	*	*	*	CD2	CD1	CD0	**	000: C0→C79, C80→C159 001: C0→C79, C159→C80 010: C79→C0, C80→C159 011: C79→C0, C159→C80
DISCTRL	-	0	1	0	1	1	0	0	1	0	1	0	CA	Display Control (with 3 parameter)
	PB1	1	1	0	*	*	*	0	0	CLD	0	0	**	CLD=0: CLOCK no division, CD=1: CLOCK divide by 2
	PB2	1	1	0	*	*	DT5	DT4	DT3	DT2	DT1	DT0	**	DT= (duty no/4 - 1)
	PB3	1	1	0	*	*	*	FI	LF3	LF2	LF1	LF0	**	FI=inversion type, LF=n-line inversion
SLPIN	-	0	1	0	1	0	0	1	0	1	0	1	95	Sleep In
SLPOUT	-	0	1	0	1	0	0	1	0	1	0	0	94	Sleep Out
LASET	-	0	1	0	0	1	1	1	0	1	0	1	75	Line Address Set (with 2 Parameter)
	PB1	1	1	0	SL7	SL6	SL5	SL4	SL3	SL2	SL1	SL0	**	Start Line
	PB2	1	1	0	EL7	EL6	EL5	EL4	EL3	EL2	EL1	EL0	**	End Line
CASET	-	0	1	0	0	0	0	1	0	1	0	1	15	Column Address Set (with 2 Parameter)
	PB1	1	1	0	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0	**	Start Column
	PB2	1	1	0	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0	**	End Column
DATSDR	-	0	1	0	1	0	1	1	1	1	0	0	BC	Data Scan Direction (with 3 Parameter)
	PB1	1	1	0	*	*	*	*	*	C/L	CI	LI	**	Address Scan Direction, C/L=0: column dir; C/L=1: line dir Column Address Direction, CI=0: normal; CI=1: reverse Line Address Direction, LI=0: normal; LI=1: inverse
	PB2	1	1	0	*	*	*	*	*	*	*	CLR	**	Pixel arrangement, CLR=0: P1, P2, P3…. CLR=1: P3, P2, P1…
	PB3	1	1	0	*	*	*	*	*	GS2	GS1	GS0	**	GS=001: 32 Gray Scale 2byte 3pixel mode GS=010: 32 Gray Scale 3byte 3pixel mode
RAMWR	-	0	1	0	0	1	0	1	1	1	0	0	5C	Writing to Memory (with data)
	Data	1	1	0	Data to be Write								**	Data to be Write
	:	:	:	:	:								:	:
RAMRD	-	0	1	0	0	1	0	1	1	1	0	1	5D	Reading from Memory (with data)
	Data	1	0	1	Data to be Read								**	Data to be Read
	:	:	:	:	:								:	:
PTLIN	-	0	1	0	1	0	1	0	1	0	0	0	A8	Partial Display In (with 2 parameter)
	PB1	1	1	0	*	*	PTS5	PTS4	PTS3	PTS2	PTS1	PTS0	**	Start Block Address
	PB2	1	1	0	*	*	PTE5	PTE4	PTE3	PTE2	PTE1	PTE0	**	End Block Address
PTLOUT	-	0	1	0	1	0	1	0	1	0	0	1	A9	Partial Display Out
RMWIN	-	0	1	0	1	1	1	0	0	0	0	0	E0	Read and Modify Write
RMWOUT	-	0	1	0	1	1	1	0	1	1	1	0	EE	Read and Modify Write End
ASCSET	-	0	1	0	1	0	1	0	1	0	1	0	AA	Area Scroll Set (with 4 parameter)
	PB1	1	1	0	*	*	TB5	TB4	TB3	TB2	TB1	TB0	**	Top Block Address
	PB2	1	1	0	*	*	BB5	BB4	BB3	BB2	BB1	BB0	**	Bottom Block Address
	PB3	1	1	0	*	*	NSB5	NSB4	NSB3	NSB2	NSB1	NSB0	**	Number of Specified Blocks
	PB4	1	1	0	*	*	*	*	*	*	SCM1	SCM0	**	Area Scroll Mode, 00=Center Mode 01=Top Mode 10=Bottom Mode 11=Whole Mode
SCSTART	-	0	1	0	1	0	1	0	1	0	1	1	AB	Scroll Start Set (with 1 parameter)
	PB1	1	1	0	*	*	SB5	SB4	SB3	SB2	SB1	SB0	**	Start Block Address
OSCON	-	0	1	0	1	1	0	1	0	0	0	1	D1	Internal OSC On
OSCOFF	-	0	1	0	1	1	0	1	0	0	1	0	D2	Internal OSC Off
PWRCTRL	-	0	1	0	0	0	1	0	0	0	0	0	20	Power Control (with 1 parameter)
	PB1	1	1	0	*	*	*	0	VB	0	VF	VR	**	VR=1: Reference Voltage ON VF=1: Voltage Follower ON VB=1: Booster ON

4.4.3 EXT=0 Commands (continue)

Command	Para-meter	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Descriptions
VOLCTRL	-	0	1	0	1	0	0	0	0	0	0	1	81	EC control (with 2 parameter)
	PB1	1	1	0	*	*	VPR5	VPR4	VPR3	VPR2	VPR1	VPR0	**	VPR[5:0]
	PB2	1	1	0	*	*	*	*	*	VPR8	VPR7	BPR6	**	VPR[8:6]
VOLUP	-	0	1	0	1	1	0	1	0	1	1	0	D6	EC increase 1
VOLDOWN	-	0	1	0	1	1	0	1	0	1	1	1	D7	EC decrease1
RESERVED	-	0	1	0	1	0	0	0	0	0	1	0	82	Not Use
EPSRRD1	-	0	1	0	0	1	1	1	1	1	0	0	7C	Read Register1
EPSRRD2	-	0	1	0	0	1	1	1	1	1	0	1	7D	Read Register2
NOP	-	0	1	0	0	0	1	0	0	1	0	1	25	NOP Instruction
STREAD	-	0	0	1				Status					**	Status Read D7=Area Scroll Mode (SCM1) D6=Area Scroll Mode (SCM0) D5=1:PMW IN; D5=0:PMW OUT D4=1:Line Scan Dir; D4=0:Column Scan Dir D3=1:Display On; D3=0:Display Off D2=1:EEPROM In Access; D2=0:EEPROM Out Access D1=1:Display Normal; D1=0:Display Inverse D0=1:Partial Display On; D0=0:Partial Display Off
EPINT	-	0	1	0	0	0	0	0	0	1	1	1	07	Initial code (with 1 parameter)
	PB1	1	1	0	0	0	0	1	1	0	0	1	19	

4.4.4 EXT=1 Commands

Command	Para-meter	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Descriptions
Gray1 Set	-	0	1	0	0	0	1	0	0	0	0	0	20	Odd Frame Gray PWM Set (with 16 parameter)
	PB1	1	1	0	*	*	*	G0F14	G0F13	G0F12	G0F11	G0F10	**	Set Gray Level 0 at Odd Frames
	:				*	*	*	:	:	:	:	:	:	
	PB16	1	1	0	*	*	*	G15F14	G15F13	G15F12	G15F11	G15F10	**	Set Gray level 15 at Odd Frames
Gray2 Set	-	0	1	0	0	0	1	0	0	0	0	1	21	Even Frame Gray PWM Set (with 16 parameter)
	PB1	1	1	0	*	*	*	G0F24	G0F23	G0F22	G0F21	G0F20	**	Set Gray Level 0 at Even Frames
	:				*	*	*	:	:	:	:	:	:	
	PB16	1	1	0	*	*	*	G15F24	G15F23	G15F22	G15F21	G15F20	**	Set Gray Level 15 at Even Frames
ANASET	-	0	1	0	0	0	1	1	0	0	1	0	32	Analog Circuit Set (with 3 parameter)
	PB1	1	1	0	*	*	*	*	*	OSF2	OSF1	OSF0	**	OSC Frequency Adjustment 000=12.7kHz, 100=13.2kHz, 010=14.3kHz, 110=15.7kHz, 001=17.3kHz, 101=19.3kHz 011=21.9kHz, 111=25.4kHz
	PB2	1	1	0	*	*	*	*	*	*	BE1	BE0	**	Booster Efficiency Set 00=3kHz, 01=6kHz, 10=12kHz, 11=24kHz
	PB3	1	1	0	*	*	*	*	*	BS2	BS1	BS0	**	Bias Set 000=1/14bias, 001=1/13bias, 010=1/12bias, 011=1/11bias, 100=1/10bias, 101=1/9bias, 110=1/7bias, 111=1/5bias
SWINT	-	0	1	0	0	0	1	1	0	1	0	0	34	Software Initial
EPCTIN	-	0	1	0	1	1	0	0	1	1	0	1	CD	Control EEPROM (with 1 parameter)
	PB1	1	1	0	0	0	EEWR	0	0	0	0	0	**	EEW=1, EEPROM Write Enable EEW=0, EEPROM Read Enable
EPCOUT	-	0	1	0	1	1	0	0	1	1	0	0	CC	Cancel EEPROM
EPMWR	-	0	1	0	1	1	1	1	1	1	0	0	FC	Write to EEPROM
EPMRD	-	0	1	0	1	1	1	1	1	1	0	1	FD	Read from EEPROM

Note: Please refer to ST7529 datasheet for details

4.4.5 Power off the LCD Module

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

4.4.6 Refreshing The LCD Module

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

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4.5 Basic Operating Sequence (example)

The following setting should be issue to LCD module after hardware reset.
(It is an example only; it could be adjusted if necessary.)

Command	Para-meter	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Descriptions
Hard Reset	-	-	-	-	-	-	-	-	-	-	-	-	-	Hardware Reset by pulling the /RST pin to low
Delay	-	-	-	-	-	-	-	-	-	-	-	-	-	Wait until Reset Routine to be finish
Ext=0	-	0	1	0	0	0	1	1	0	0	0	0	30	Set Ext=0
SLPOUT	-	0	1	0	1	0	0	1	0	1	0	0	94	Sleep Out
OSCON	-	0	1	0	1	1	0	1	0	0	0	1	D1	Internal OSC On
PWRCTRL	-	0	1	0	0	0	1	0	0	0	0	0	20	Power Control (with 1 parameter)
	PB1	1	1	0	0	0	0	0	1	0	0	0	08	Booster ON
Delay	-	-	-	-	-	-	-	-	-	-	-	-	-	Wait for booster fully on
PWRCTRL	-	0	1	0	0	0	1	0	0	0	0	0	20	Power Control (with 1 parameter)
	PB1	1	1	0	0	0	0	0	1	0	1	1	0B	Booster ON, Reference Voltage ON, Voltage Follower ON
VOLCTRL	-	0	1	0	1	0	0	0	0	0	0	1	81	EC control (with 2 parameter)
	PB1	1	1	0	0	0	1	0	1	1	0	1	2D	VPR=032D
	PB2	1	1	0	0	0	0	0	0	0	1	1	03	
DISCTRL	-	0	1	0	1	1	0	0	1	0	1	0	CA	Display Control (with 3 parameter)
	PB1	1	1	0	0	0	0	0	0	1	0	0	04	CLD=0: CLOCK no division, CD=1: CLOCK divide by 2
	PB2	1	1	0	0	0	1	0	0	1	1	1	27	DT= (duty no/4 - 1)
	PB3	1	1	0	0	0	0	0	0	0	0	0	00	FI=0, LF=0
COMSCN	-	0	1	0	1	0	1	1	1	0	1	1	BB	COM Scan Direction (with 1 parameter)
	PB1	1	1	0	0	0	0	0	0	0	0	1	01	001: C0→C79, C159→C80
DATSDR	-	0	1	0	1	0	1	1	1	1	0	0	BC	Data Scan Direction (with 3 Parameter)
	PB1	1	1	0	0	0	0	0	0	0	0	1	01	C/L=0, Address Scan Direction by column CI=0, Column Address Direction is normal LI=1, Line Address Direction is inverse
	PB2	1	1	0	0	0	0	0	0	0	0	0	00	CLR=0: Pixel arrangement are P1, P2, P3....
	PB3	1	1	0	0	0	0	0	0	0	1	0	02	GS=010: 32 Gray Scale 3byte 3pixel mode
Ext=1	-	0	1	0	0	0	1	1	0	0	0	1	31	Set Ext=1
ANASET	-	0	1	0	0	0	1	1	0	0	1	0	32	Analog Circuit Set (with 3 parameter)
	PB1	1	1	0	0	0	0	0	0	1	0	1	05	OSF=101, OSC Frequency Adjustment101=19.3kHz
	PB2	1	1	0	0	0	0	0	0	0	0	0	00	BE=00, Booster Efficiency Set 3kHz
	PB3	1	1	0	0	0	0	0	0	0	1	0	02	BS=010, Bias Set 1/12bias
Ext=0	-	0	1	0	0	0	1	1	0	0	0	0	30	Set Ext=0
DISON	-	0	1	0	1	0	1	0	1	1	1	1	AF	Display ON
CASET	-	0	1	0	0	0	0	1	0	1	0	1	15	Column Address Set (with 2 Parameter)
	PB1	1	1	0	0	0	0	0	0	0	0	0	00	Start at 00
	PB2	1	1	0	0	1	0	0	1	1	1	1	4F	End at (240/3)-1=79
LASET	-	0	1	0	0	1	1	1	0	1	0	1	75	Line Address Set (with 2 Parameter)
	PB1	1	1	0	0	0	0	0	0	0	0	0	00	Start at 00
	PB2	1	1	0	1	0	0	1	1	1	1	1	9F	End at 160-1=159
RAMWR	-	0	1	0	0	1	0	1	1	1	0	0	5C	Writing to Memory (with data)
	Data	1	1	0	Data to be Write								**	Display Data to be Write
	:	:	:	:	:								:	:

Note: Please refer to ST7529 datasheet for details

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