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

LM9091BCT

LCD Module User Manual

Prepared by:	Checked by:	Approved by:
Li yinyang		
Date: 2015-12-08	Date:	Date:

Rev.	Descriptions	Release Date
0.1	Preliminary	2015-12-08

Table of Content

1. Basic Specifications

1.1 Display Specifications

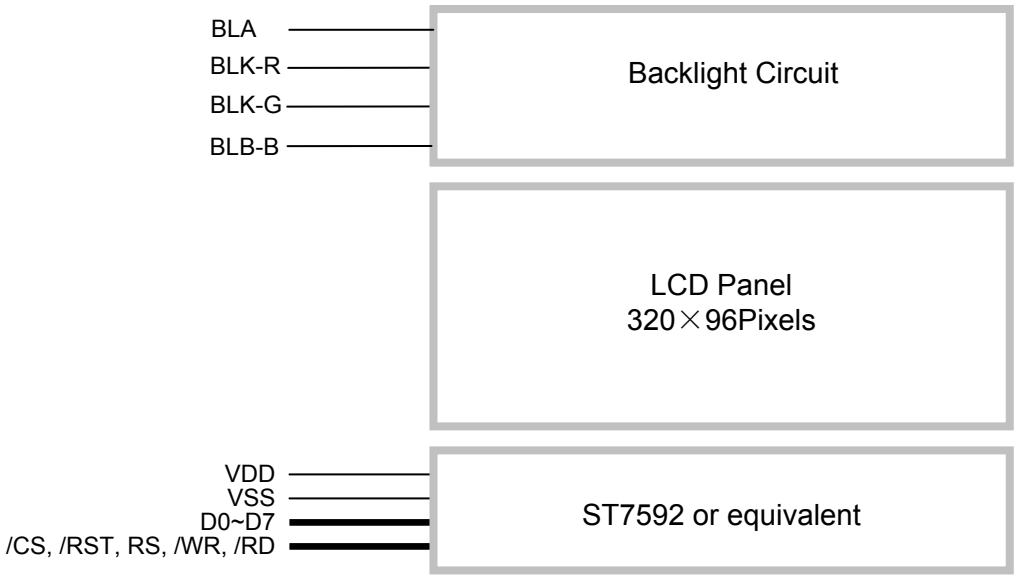
1) LCD Display Mode : FSTN,Positive, Transmissive
2) Display Color : Display Data = “1” : Dark Gray (*1)
: Display Data = “0” : Light Gray (*2)
3) Viewing Angle : 6H
4) Driving Method : 1/96 duty, 1/12 bias
5) Backlight : RGB LED backlight

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 : 103.7 x 38.7 x 11.5 MAX(exclude encoder component)
see attached Outline Drawing for details

1.3 Block Diagram



1.4 Terminal Functions

Pin No. K1&K2	Pin Name	I/O	Descriptions
1	VSS	Power	0V Power Supply, GND
2	VDD	Power	Positive Power Supply
3	D7	I/O	8-bit bi-directional data bus
:	:		
10	D0		
11	/RD	Input	Read enable input, active LOW
12	/WR	Input	Write enable input, active LOW
13	RS	Input	Register Select RS=HIGH: write address of register and read status word RS=LOW: write & read data of register and DDRAM
14	/CS	Input	Chip Select Signal /CS=LOW: Data IO is enabled
15	/RST	Input	Reset Signal: /RST = L, Reset the LCD Module /RST = H, Normal Running
16	BLK-B	Power	Blue color Negative Power Supply for LED backlight
17	BLK-G	Power	Green color Negative Power Supply for LED backlight
18	BLK-R	Power	Red color Negative Power Supply for LED backlight
19	BLA	Power	Positive Power Supply for LED backlight
20	VSS	Power	0V Power Supply, GND

2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	0	+5.5	V	V_{SS} = 0V
Input Voltage	V_{IN}	V_{SS}-0.3	V_{DD}+0.3	V	V_{SS} = 0V
Operating Temperature	T_{OP}	-25	+85	°C	No Condensation
Storage Temperature	T_{ST}	-40	+90	°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}=5.0V, T_{OP}=25°C

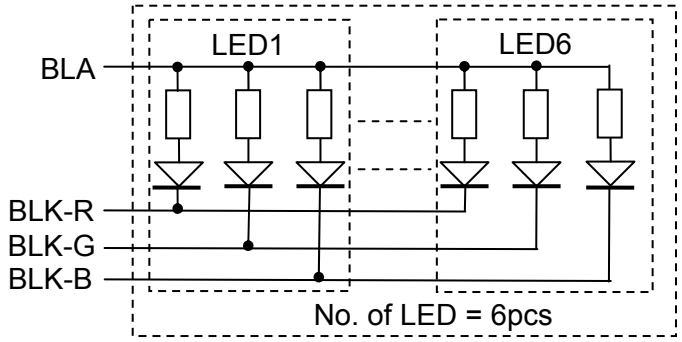
Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Operating Voltage	V_{DD}	4.7	5.0	5.3	V	VDD
Input High Voltage	V_{IN}	0.8xVDD	-	VDD	V	D0~D7, /WR, /RD, /CS, RS, /RES
Input Low Voltage	V_{IN}	VSS	-	0.1xVDD	V	D0~D7, /WR, /RD, /CS, RS, /RES
Operating Current	I_{DD}	-	1.3	3.0	mA	VDD

3.2 LED Backlight Circuit Characteristics

BLK=0V, BLA=5.0V, T_{OP} =25°C

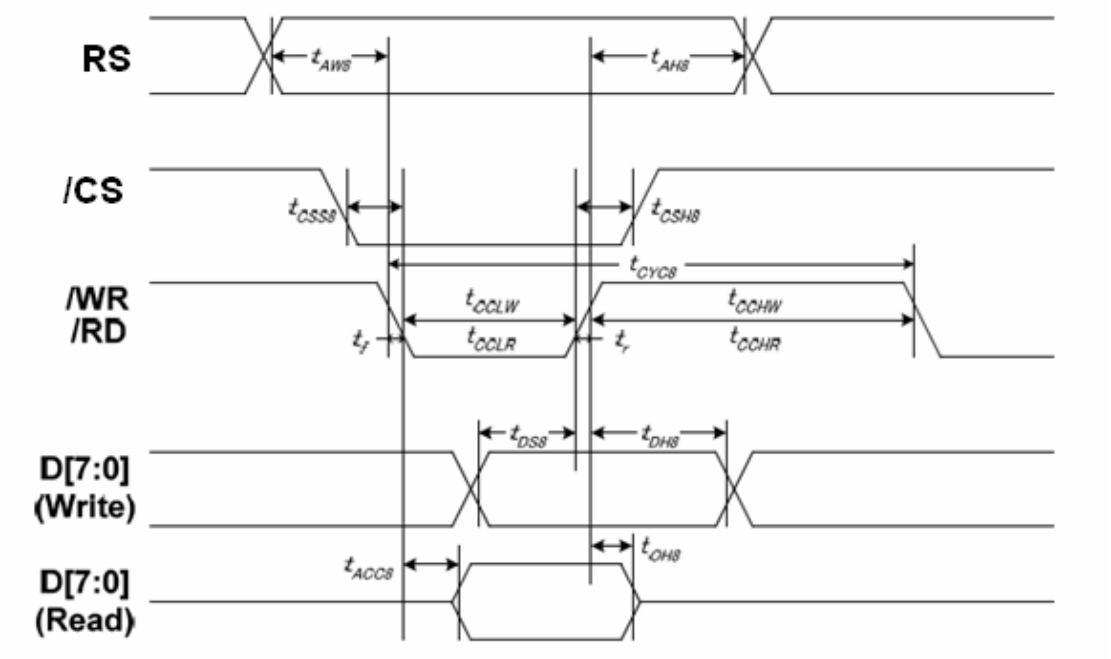
Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Forward Voltage	BLA	-	5.0	-	V	BLA
Forward Current	I_{BLK-R}	-	90	120	mA	BLK-R
Forward Current	I_{BLK-G}	-	70	120	mA	BLK-G
Forward Current	I_{BLK-B}	-	64	120	mA	BLK-B

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



3.3 AC Characteristics

3.3.1 8080 Mode System Bus Timing



V_{SS}=0V, V_{DD}=5.0V, T_{OP}=25°C

Item	Symbol		Condition	MIN.	MAX.	Unit
Address setup time	RS	t_{AW8}		13	-	ns
Address hold time		t_{AH8}		0	-	
System cycle time	/WR	t_{cyc8}		416	-	
/WR L pulse width (WRITE)		t_{CCLW}		195	-	
/WR H pulse width (WRITE)		t_{CCHW}		195	-	
/RD L pulse width (READ)	/RD	t_{CCLR}		195	-	
/RD H pulse width (READ)		t_{CCHR}		195	-	
/CS setup time	/CS	t_{CSS8}		98	-	
/CS hold time		t_{CSH8}		65	-	
WRITE Data setup time	D[7:0]	t_{DS8}		65	-	
WRITE Data hold time		t_{DH8}		65	-	
READ access time		t_{ACC8}	CL = 100 pF	-	70	
READ Output disable time		t_{OH8}	CL = 100 pF	0	56	

Note:

*1. The input signal rise time and fall time (tr, tf) is specified at 20 ns or less. When the system cycle time is extremely fast,(tr + tf) ≤ (tCYC8 – t_{CCLW}– t_{CCHW}) for (tr + tf) ≤ (t_{cyc8} – t_{CCLR} – t_{CCHR}) are specified.

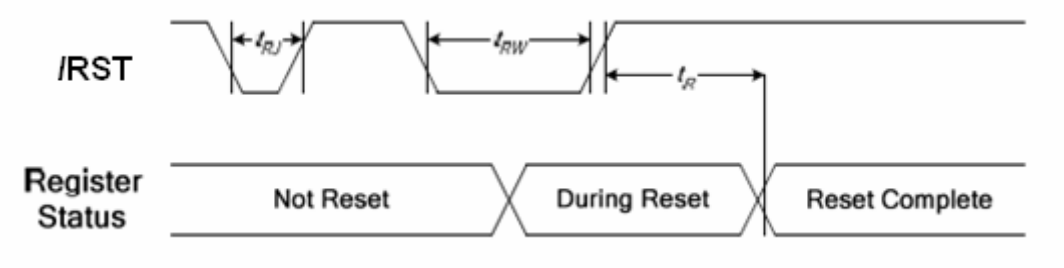
*2. All timing is specified using 20% and 80% of VDD1 as the reference.

*3. t_{CCLW} and t_{CCLR} are specified as the overlap between /CS being “L” and /WR and /RD being at the “L” level./CS and /WR (or /RD) cannot act at the same time and /CS should be 100ns widther than /WR (or /RD).

*4. The system voltage apply to IC will be decreased by ITO resistance. For example, a system using 3V for VDDI, the voltage apply to IC will be lower than 3.0V. Therefore, the AC timing maybe a little bit larger than the value listed above.

*5. Bus timing is for one byte transaction only.
For details, please refer to ST7592 datasheet.

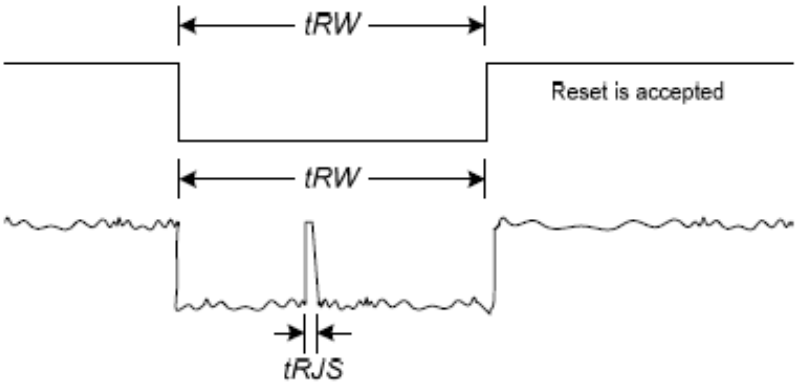
3.4 Reset Timing



Reset Timing Diagram

V_{SS}=0V, V_{DD}=5.0V, T_{OP}=25°C

Item	Signal	Symbol	MIN.	TYP.	MAX.	Unit
Reset time	/RST	t_R	-	-	3*1	us
Reset "L" pulse width		t_{RW}	20	-	-	
Reset rejection		t_{RJ}	-	-	3	
Reset rejection (for noise spike)		t_{RJS}	-		7	ns



Note:
1. For PROM related operation, it takes 50ms at least for PROM Registers to load PROM contents.Do NOT use any PROM related command during this period.
2. When the system issues a RSTB LOW pulse, the reset procedure of IC will start if the LOW pulse is longer than tRW specified above. If the LOW pulse is less than tRJ specified above, the reset procedure of IC will not start.
   If the LOW pulse is longer than tRJ and less than tRW, the reset procedure of IC is not guaranteed.

4. Function Specifications

4.1 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.

4.2 Resetting the LCD module

The LCD module should be initialized by hardware reset, 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 Pixel Map

Page add.	data	LCD Display (front view)												
0	D0~D7													Non-displaying Area
1	D0~D7													
2	D0~D7													
:	:	320 x 96 pixels												
9	D0~D7													
10	D0~D7													
11	D0~D7													
12	D0~D7	Non-displaying Area												
13	D0~D7													
Column no.		1st	2nd	3rd	4th	5th	6th	→	317th	318th	319th	320th	321st	322nd
Column Address		00h	01h	02h	03h	04h	05h	→	13Ch	13Dh	13Eh	13Fh	140h	141h

Pixel mapping (Top View)

Note:
*1. inverse display mode = 0 (normal)
*2. all pixel on mode = 0 (normal)
*3. COM output mode,SCAN=1: interlace scan,MY=0: COM131→COM0
*4. column addressing direction: MX=0: SEG0→SEG395
*5. For the details of memory mapping please refer to ST7592 datasheet

4.4 Control Data and Command

The LCD module setting is controlled by the internal Register Values.
The Register Address should be addressed when RS=0 and Register Value should be issued when RS=1.

A full command sequence should be as follow.

Steps	/RD	/WR	RS	Data (DB0~ DB7)
1st	1	0	0	Register Address
2nd	1	0	1	Register Value

4.5 Register Table Summary

INSTRUCTION	A0	R/W	COMMAND BYTE								Descriptions
			D7	D6	D5	D4	D3	D2	D1	D0	
Display ON/OFF	0	0	1	0	1	1	1	1	1	D	Set LCD display mode D=0: display off D=1: display on
Display Inverse	0	0	1	0	1	0	0	1	1	INV	Set inverse display mode INV=0: normal display INV=1: inverse display
Display All Pixel ON	0	0	1	0	1	0	0	1	0	AP	Set all pixel on mode AP=0: normal display AP=1: all pixel on
COM Output Status	0	0	1	1	0	0	0	1	0	0	Set COM output mode SCAN=0: normal scan SCAN=1: interlace scan MY=0: COM0→COM131 MY=1: COM131→COM0
	1	0	-	-	-	-	-	-	SCAN	MY	
Display Start Line	0	0	1	0	0	0	1	0	1	0	Set display start line
	1	0	-	-	S5	S4	S3	S2	S1	S0	
Page Address	0	0	1	0	1	1	0	0	0	1	Set the page address of DDRAM
	1	0	-	-	-	Y4	Y3	Y2	Y1	Y0	
Column Address	0	0	0	0	0	1	0	0	1	1	Set the column address of DDRAM
	1	0	-	-	-	-	-	-	-	X8	
	1	0	X7	X6	X5	X4	X3	X2	X1	X0	
Display Data Write	0	0	0	0	0	1	1	1	0	1	Write display data to DDRAM
	1	0	D7	D6	D5	D4	D3	D2	D1	D0	
Display Data Read	0	0	0	0	0	1	1	1	0	0	Read display data from DDRAM
	1	1	D7	D6	D5	D4	D3	D2	D1	D0	

Register Table Summary (cont')

Display Data Input/Output Direction	0	0	1	0	0	0	0	1	0	DIR	Set DDRAM data input direction DIR=0: column direction DIR=1: page direction
Column Address Direction	0	0	1	0	1	0	0	0	0	MX	Set column addressing direction MX=0: COL-0 → COL-395 MX=1: COL-395 → COL-0
N-Line Inversion	0	0	0	0	1	1	0	1	1	0	Set N-Line inversion
	1	0	-	-	-	NL4	NL3	NL2	NL1	NL0	
N-Line Inversion ON/OFF	0	0	1	1	1	0	0	1	0	NL	Set N-Line inversion mode NL=0: N-Line inversion off NL=1: N-Line inversion on
Display Area	0	0	0	1	1	0	1	1	0	1	Set the display area DTY[5:0]=00h~20h SP[5:0]=00h~20h
	1	0	-	-	DTY5	DTY4	DTY3	DTY2	DTY1	DTY0	
	1	0	-	-	SP5	SP4	SP3	SP2	SP1	SP0	
Read Modify Write	0	0	1	1	1	0	0	0	0	0	Enable Read Modify Write mode
Read Modify Write End	0	0	1	1	1	0	1	1	1	0	Disable Read Modify Write mode
Built-in Oscillator Circuit ON/OFF	0	0	1	0	1	0	1	0	1	OSC	Set built-in oscillator mode OSC=0: built-in oscillator off OSC=1: built-in oscillator on
Operation Clock Frequency	0	0	0	1	0	1	1	1	1	1	Set frame rate in different temperature range
	1	0	FRB3	FRB2	FRB1	FRB0	FRA3	FRA2	FRA1	FRA0	
	1	0	FRD3	FRD2	FRD1	FRD0	FRC3	FRC2	FRC1	FRC0	
0 0 0 0 1 0 0 1 0 1 Power Control	0	0	0	0	1	0	0	1	0	1	Set built-in power circuits on/off
	1	0	-	-	VAD	V3	VPF	VMV3	VNAD	VNF	
Booster Level	0	0	0	0	1	0	1	0	1	1	Set the level of built-in booster circuit
	1	0	-	-	-	-	-	-	0	BL	
BIAS	0	0	1	0	1	0	0	0	1	0	Set the bias ratio of liquid crystal driving voltage
	1	0	-	-	-	-	BS3	BS2	BS1	BS0	

Register Table Summary (cont')

Electronic Volume	0	0	1	0	0	0	0	0	0	1	Set the V3 level for liquid crystal driving voltage
	1	0	EV7	EV6	EV5	EV4	EV3	EV2	EV1	EV0	
	1	0	-	-	-	-	-	-	-	EV8	
Power Discharge	0	0	1	1	1	0	1	0	1	0	Set power circuits discharge
	1	0	-	-	-	-	DV3	DVPF	DVNF	DVMV3	
Power Save	0	0	1	0	1	0	1	0	0	PD	Set power save mode PD=0: normal mode PD=1: standby mode
Temperature Gradient Compensation	0	0	0	1	0	0	1	1	1	0	Set temperature gradient compensation coefficient
	1	0	MT1[3:0]				MT0[3:0]				
	1	0	MT3[3:0]				MT2[3:0]				
	1	0	MT5[3:0]				MT4[3:0]				
	1	0	MT7[3:0]				MT6[3:0]				
	1	0	MT9[3:0]				MT8[3:0]				
	1	0	MTB[3:0]				MTA[3:0]				
	1	0	MTD[3:0]				MTC[3:0]				
	1	0	MTF[3:0]				MTE[3:0]				
Temperature Gradient Compensation Flag	0	0	0	0	1	1	1	0	0	1	Set the slope of temperature gradient is positive or negative
	1	0	FMT7	FMT6	FMT5	FMT4	FMT3	FMT2	FMT1	FMT0	
	1	0	FMTF	FMTE	FMTD	FMTC	FMTB	FMTA	FMT9	FMT8	

Register Table Summary (cont')

Read Status	0	0	1	0	0	0	1	1	1	0	Read IC status
	1	1	D	OSC	AVD	V3	VPF	VMV3	VNAD	VNF	
	1	1	DISV	SCAN	MY	PD	TD	NLFR	-	-	
Temperature Detection	0	0	0	1	1	0	1	0	0	TD	Set temperature detection mode TD=0: disable mode
LCD Driving Method	0	0	1	1	1	0	0	1	1	1	Set LCD driving method
	1	0	-	-	-	NLFR	1	-	-	1	
NOP	0	0	1	1	1	0	0	0	1	1	No operation
Frequency Compensation Temperature Range	0	0	1	1	1	0	1	1	0	0	Set temperature range for frequency compensation
	1	0	-	TA6	TA5	TA4	TA3	TA2	TA1	TA0	
	1	0	-	TB6	TB5	TB4	TB3	TB2	TB1	TB0	
	1	0	-	TC6	TC5	TC4	TC3	TC2	TC1	TC0	
Temperature Hysteresis Value	0	0	1	1	1	0	1	1	0	1	Set temperature hysteresis value
	1	0	-	-	0	0	THV3	THV2	THV1	THV0	
	1	0	-	-	-	-	THF3	THF2	THF1	THD0	
Current Temperature	0	0	1	1	1	0	1	1	1	1	Monitor current temperature
	1	1	T7	T6	T5	T4	T3	T2	T1	T0	
Test	0	0	1	1	1	1	1	1	TE	T	Set test command mode TE=0: normal command mode TE=1: test command mode T: select test command mode

Note:

*1. Do not use any other commend not listed,or the system malfunction will result.

*2. For the details, please refer to ST7592 Datasheet.

5. 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