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

LM128128ABY-2

LCD Module User Manual

Prepared by:	Checked by:	Approved by:
Zhou Date: 2011-11-16	Date:	Date:

Rev.	Descriptions	Release Date
0.1	New release	2011-11-16

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1. Basic Specifications

1.1 Display Specifications

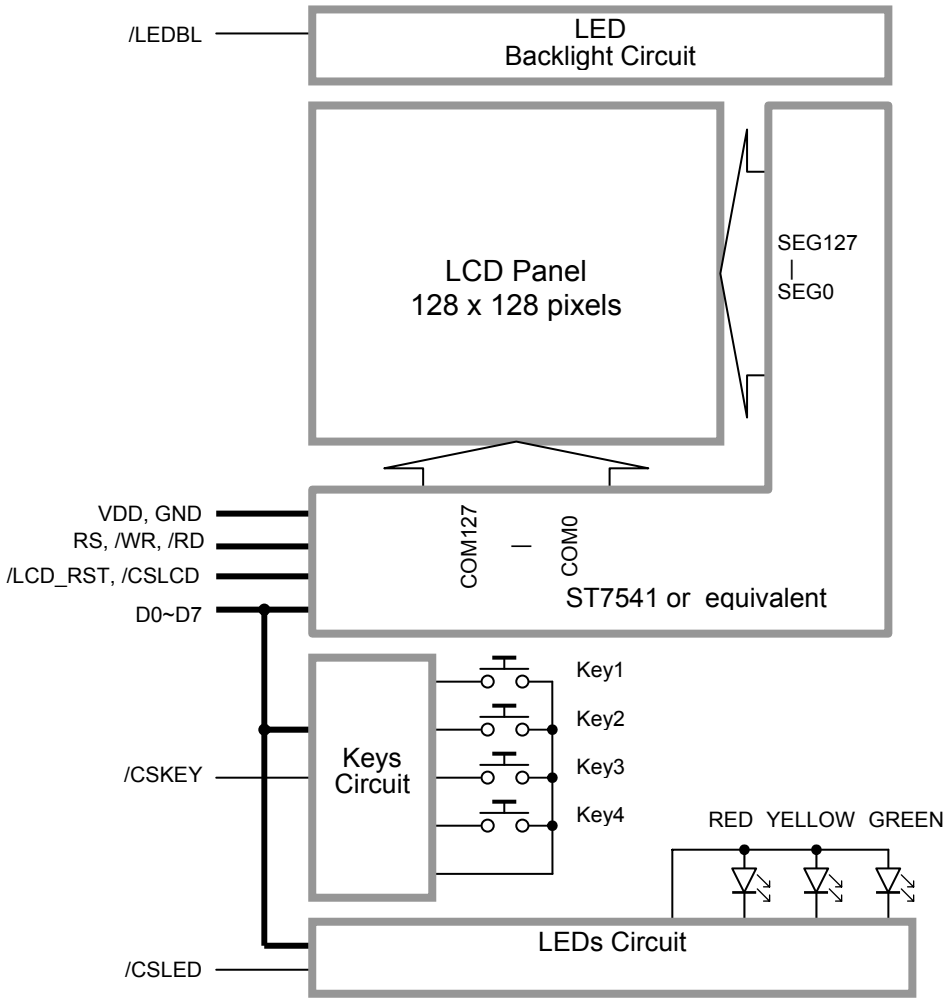
1) LCD Display Mode : STN-YG, Positive, Transflective
2) Display Color : Display Data = “1” : Deep Blue (*1)
: Display Data = “0” : Light Yellow Green (*2)
3) Viewing Angle : 9 H
4) Driving Method : 1/128 duty, 1/12bias
5) Back Light : Yellow Green backlight

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 : 52.0 x 37.5 x 9.8MAX
(see attached Outline Drawing for details)

1.3 Block Diagram



1.4 Terminal Functions

Pin No.	Pin Name	I/O	Descriptions
1	GND	Power	Ground (0V supply)
2	D0	I/O	Data I/O
3	D1		
4	GND	Power	Ground (0V supply)
5	D2	I/O	Data I/O
6	D3		
7	GND	Power	Ground (0V supply)
8	D4	I/O	Data I/O
9	D5		
10	GND	Power	Ground (0V supply)
11	D6	I/O	Data I/O
12	D7		
13	GND	Power	Ground (0V supply)
14	/WR	Input	/WR=L→H, /RD=H; Data or Instruction, latch into the LCD module
15	/RD	Input	/WR=H, /RD=L; Data or Status, read form the LCD module
16	GND	Power	Ground (0V supply)
17	RS	Input	Register Select RS = H, Transferring the Display RAM data RS = L, Transferring the Instruction data
18	GND	Power	Ground (0V supply)
19	/CSLCD	Input	LCD Chip Select /CS=L, enable access to the LCD module /CS=H, disable access to the LCD module
20	/CSLED	Input	LEDs Driver Chip Input Latch Signal
21	/CSKEY	Input	Keys Buffer Output Enable Signal
22	GND	Power	Ground (0V supply)
23	/LEDBL	Input	Backlight Enable input
24	/LCD_RST	Input	LCD Reset signal /RST = L, Initialization is executed /RST = H, Normal running.
25	GND	Power	Ground (0V supply)
26	VDD	Power	Positive supply
27	VDD		
28	VDD		
29	GND	Power	Ground (0V supply)
30	GND		

2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	0	3.6	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	Applicable Pin
Operating Voltage	V_{DD}	3.0	-	3.3	V	VDD
Input High Voltage	V_{IH}	$0.8V_{DD}$	-	V_{DD}	V	I/O and Input
Input Low Voltage	V_{IL}	V_{SS}	-	$0.2V_{DD}$	V	
Output High Voltage	V_{OH}	$0.7V_{DD}$	-	V_{DD}	V	DB0-DB7
Output Low Voltage	V_{OL}	V_{SS}	-	$0.3V_{DD}$	V	
Operating Current (Backlight off)	I_{DD}	-	TBD	TBD	mA	VDD
Operating Current (Backlight on)	I_{DD}	-	TBD	TBD	mA	VDD

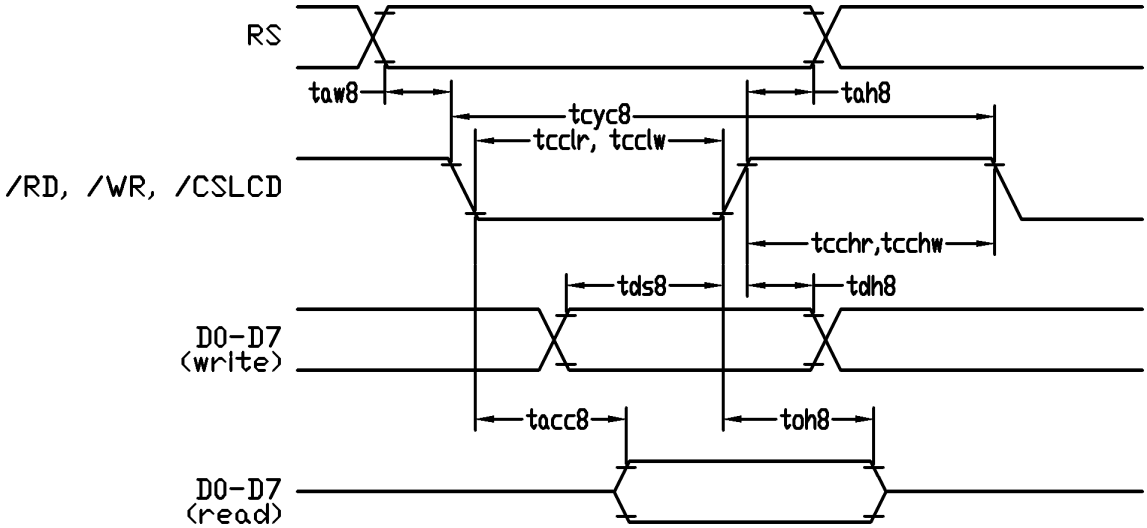
3.2 AC Characteristics

3.2.1 8080 Interface

V_{SS}=0V, V_{DD} =3.3V, T_{OP} =25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Address Hold Time	tah8	5	-	-	ns
Address Setup Time	taw8	5	-	-	ns
System Cycle Time	tcyc8	300	-	-	ns
Enable L Pulse Width (write)	tcclw	100	-	-	ns
Enable H Pulse Width (write)	tcchw	100	-	-	ns
Enable L Pulse Width (read)	tcclr	175	-	-	ns
Enable H Pulse Width (read)	tcchr	100	-	-	ns
Write Data Setup Time	tds8	50	-	-	ns
Write Data Hold Time	tdh8	13	-	-	ns
Read Access Time	tacc8	-	-	88	ns
Read Output Disable Time	toh8	4	-	63	ns

note: signal rise time and fall time should less than 12ns

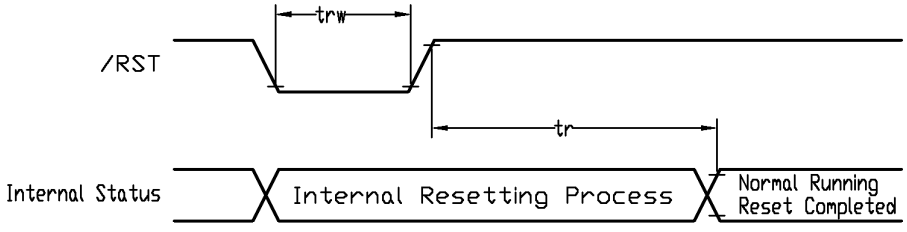


8080 Interface Timing Diagram

3.2.2 Reset Input

V_{SS}=0V, V_{DD} =3.3V, T_{OP} =25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset Low Pulse Width	trw	1.2	-	-	us
Reset Time	tr	-	-	1.2	us



Reset Timing Diagram

4. Function Specifications

4.1 Resetting the LCD module

The LCD module should be initialized by setting /RST terminal at low level after the power supply stable.

4.2 Display Memory Map

Internal Display RAM Address		LCD module Top View						
Y7… Y1	Y0							
7Fh	1							
	0							
7Eh	1							
	0							
7Dh	1							
	0							
:	:			128x128 pixels				
:	:							
02	1							
	0							
01	1							
	0							
00	1							
	0							
Data		D0…D7	D0…D7	D0…D7	… …	D0…D7	D0…D7	D0…D7
Page Address		0	1	2	… …	13	14	15

Note: Display start line = 0, COM0 Register=0, Duty Ratio = 1/128, ADC=0, SHL=1

Only the upper 7bit (Y7:Y1) could be accessed by Column Address instruction, and the instruction will set the Y0 to “0”.

The 4-Gray Level are controlled by the combination of two bits in two adjacent byte of Internal Display RAM Address (same Column Address). Please see the following diagram for example.

Internal Display RAM Address								
hex	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
00	0	0	0	0	0	0	0	0
:	:	:	:	:	:	:	:	:
2n	:	:	:	:	:	:	:	0
2n + 1	:	:	:	:	:	:	:	1
:	:	:	:	:	:	:	:	:
FF	1	1	1	1	1	1	1	1

Data bit Value			
0	0	1	1
0	1	0	1

00	0	0	0	0	0	0	0
:	:	:	:	:	:	:	:
n	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
7F	1	1	1	1	1	1	1
hex	Y7	Y6	Y5	Y4	Y3	Y2	Y1
Column Address							

0%	30%	60%	100%
Column Dot Gray Level			

Since the internal display RAM address counter is increased by 1, at each read or write data instruction. The microprocessor could access the display data continuously.
Note, the Column address counter is independent of page address register.

4.3 Instructions

Instruction	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	Description
Mode Set	0	0	0	0	1	1	1	0	0	0	2-byte instruction to set Mode and FR(Frame frequency control) BE(Booster efficiency control)
	0	0	FR3	FR2	FR1	FR0	0	BE	x'	0	
Read display data	1	1	Read data								Read data into DDRAM
Write display data	1	0	Write data								Write data into DDRAM
Read status	0	1	BUSY	ON	RES	MF2	MF1	MF0	DS1	DS0	Read the internal status
ICON control register ON/OFF	0	0	1	0	1	0	0	0	1	ICON	ICON=0: ICON disable(default) ICON=1: ICON enable & set the page address to 16
Set page address	0	0	1	0	1	1	P3	P2	P1	P0	Set page address
Set column address MSB	0	0	0	0	0	1	0	Y7	Y6	Y5	Set column address MSB
Set column address LSB	0	0	0	0	0	0	Y4	Y3	Y2	Y1	Set column address LSB
Set modify-read	0	0	1	1	1	0	0	0	0	0	Set modify-read mode
Reset modify-read	0	0	1	1	1	0	1	1	1	0	release modify-read mode
Display ON/OFF	0	0	1	0	1	0	1	1	1	D	D=0: Display OFF D=1: Display ON
Set initial display line register	0	0	0	1	0	0	0	0	x'	x'	2-byte instruction to specify the initial display line to realize vertical scrolling
	0	0	x'	S6	S5	S4	S3	S2	S1	S0	
Set initial COM0 register	0	0	0	1	0	0	0	1	x'	x'	2-byte instruction to specify the initial COM0 to realize window scrolling
	0	0	x'	C6	C5	C4	C3	C2	C1	C0	
Set partial display duty ration	0	0	0	1	0	0	1	0	x'	x'	2-byte instruction to set partial display duty ratio
	0	0	D7	D6	D5	D4	D3	D2	D1	D0	
Set N-line inversion	0	0	0	1	0	0	1	1	x'	x'	2-byte instruction to set N-line inversion register
	0	0	x'	x'	x'	N4	N3	N2	N1	N0	
Release N-line inversion	0	0	1	1	1	0	0	1	0	0	Release N-line inversion mode
Reverse display ON/OFF	0	0	1	0	1	0	0	1	1	REV	REV=0: normal display REV=1: reverse display
Entire display ON/OFF	0	0	1	0	1	0	0	1	0	EON	EON=0: normal display EON=1: entire display ON

Note:

*1. For the details of the Display Control Instructions, please refer to ST7541 datasheet.

Instruction (cont')

Instruction	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	Description
Power control	0	0	0	0	1	0	1	VC	VR	VF	Control power circuit operation
Select DC-DC step-up	0	0	0	1	1	0	0	1	DC1	DC0	Select the step-up of internal voltage converter
Select regulator register	0	0	0	0	1	0	0	R2	R1	R0	Select the internal resistance ratio of the regulator resistor
Select electronic volume register	0	0	1	0	0	0	0	0	0	1	2-byte instruction to specify the reference voltage
	0	0	x'	x'	EV5	EV4	EV3	EV2	EV1	EV0	
Select LCD bias	0	0	0	1	0	1	0	B2	B1	B0	Select LCD bias
Bias Power Save	0	0	1	1	1	1	0	0	1	1	Bias Power save Save the Bias current consumption
	0	0	0	0	0	0	0	0	0	0	
Release Bias Power Save Mode	0	0	1	1	1	1	0	0	1	1	Bias Power save release set the Bias power to normal
	0	0	0	0	0	0	0	1	0	0	
SHL select	0	0	1	1	0	0	SHL	x'	x'	x'	COM bi-directional selection SHL=0: normal direction SHL=1: reverse direction
ADC select	0	0	1	0	1	0	0	0	0	ADC	SEG bi-direction selection ADC=0: normal direction ADC=1: reverse direction
Oscillator on start	0	0	1	0	1	0	1	0	1	1	Start the built-in oscillator
Set power save mode	0	0	1	0	1	0	1	0	0	P	P=0: normal mode P=1: sleep mode
Release power save mode	0	0	1	1	1	0	0	0	0	1	release power save mode
Reset	0	0	1	1	1	0	0	0	1	0	initial the internal function
Set data direction & display data length(DDL)	x'	x'	1	1	1	0	1	0	0	0	2-byte instruction to specify the number of data bytes. (SPI mode)
	x'	x'	D7	D6	D5	D4	D3	D2	D1	D0	
Select FRC and PWM mode	0	0	1	0	0	1	0	FRC	PWM1	PWM0	FRC(1:3FRC, 0:4FRC) PWM1 PWM0 0 0 9PWM 0 1 9PWM 1 0 12PWM 1 1 15PWM
NOP	0	0	1	1	1	0	0	0	1	1	*No operation*
Test Instruction	0	0	1	1	1	1	x'	x'	x'	x'	*Don't use this instruction*

Note:
*1. For the details of the Display Control Instructions, please refer to ST7541 datasheet.

Instruction (cont')

Instruction	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	Description
Set white mode and 1st/2nd rame, set pulse width	0	0	1	0	0	0	1	0	0	0	Set white mode and 1st/2nd frame
	0	0	WB3	WB2	WB1	WB0	WA3	WA2	WA1	WA0	
Set white mode and 3st/4nd rame, set pulse width	0	0	1	0	0	0	1	0	0	1	Set white mode and 3rd/4th frame
	0	0	WD3	WD2	WD1	WD0	WC3	WC2	WC1	WC0	
Set light gray mode and 1st/2nd rame, set pulse width	0	0	1	0	0	0	1	0	1	0	Set light gray mode and 1st/2nd frame
	0	0	LB3	LB2	LB1	LB0	LA3	LA2	LA1	LA0	
Set light gray mode and 3st/4nd rame, set pulse width	0	0	1	0	0	0	1	0	1	1	Set light gray mode and 3rd/4th frame
	0	0	LD3	LD2	LD1	LD0	LC3	LC2	LC1	LC0	
Set drak gray mode and 1st/2nd rame, set pulse width	0	0	1	0	0	0	1	1	0	0	Set dark gray mode and 1st/2nd frame
	0	0	DB3	DB2	DB1	DB0	DA3	DA2	DA1	DA0	
Set dark gray mode and 3st/4nd rame, set pulse width	0	0	1	0	0	0	1	1	0	1	Set dark gray mode and 3rd/4th frame
	0	0	DD3	DD2	DD1	DD0	DC3	DC2	DC1	DC0	
Set dark mode and 1st/2nd rame, set pulse width	0	0	1	0	0	0	1	1	1	0	Set dark mode and 1st/2nd frame
	0	0	BB3	BB2	BB1	BB0	BA3	BA2	BA1	BA0	
Set dark mode and 3st/4nd rame, set pulse width	0	0	1	0	0	0	1	1	1	1	Set white mode and 3rd/4th frame
	0	0	BB3	BD2	BD1	BD0	BC3	BC2	BC1	BC0	

Note:
*1. For the details of the Display Control Instructions, please refer to ST7541 datasheet.

4.3.1 Power off the LCD Module

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

4.3.2 Refreshing The LCD Module

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

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