

# LM6029

## LCD Module User Manual

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Rev.	Descriptions	Release Date
0.1	Prelimiay release	2006-01-17

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# 1. Basic Specifications

## 1.1 Display Specifications

- 1) LCD Display Mode : FSTN, Positive, Transflective
- 2) Display Color : Display Data = "1" : Dark Gray (\*1)  
: Display Data = "0" : Light Gray (\*2)
- 3) Viewing Angle : 6H
- 4) Driving Method : 1/65 duty, 1/9 bias
- 5) Backlight : Nil

Note:

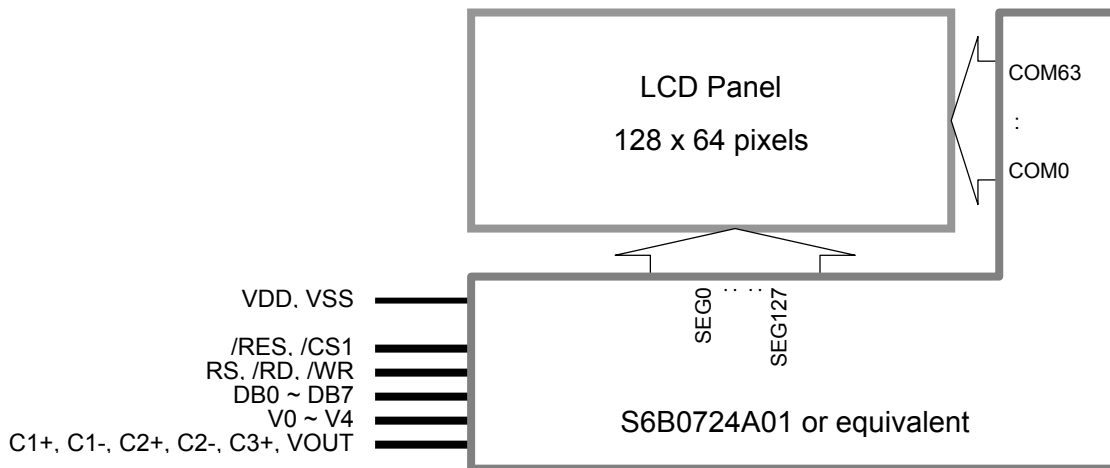
\*1. Color tone may slightly change by Temperature and Driving Condition.

\*2. The Color is defined as the inactive / background color

## 1.2 Mechanical Specifications

- 1) Outline Dimension : 57.6 x 42.0 x 2.0 (exclude FPC)  
(See attached Outline Drawing for details)

## 1.3 Block Diagram



## 1.4 Terminal Functions

Pin No.	Pin Name	I/O	Descriptions
1	NC	-	No connection, leave open
2	NC	-	No connection, leave open
3	V0	Power	LCD driver supply voltages where $V0 \geq V1 \geq V2 \geq V3 \geq V4 \geq VSS$
4	V4	Power	
5	V3	Power	
6	V2	Power	
7	V1	Power	
8	C2-	Power	DC-DC voltage converter capacitors terminals
9	C2+	Power	
10	C1+	Power	
11	C1-	Power	
12	C3+	Power	
13	VOUT	Power	Voltage converter Output
14	VSS	Power	Negative Power Supply, Ground (0V)
15	VDD	Power	Positive Power Supply
16	DB7	I/O	8-bit Data bus; Three state I/O terminal for display data or instruction data When /CS=H, DB0~DB7= High Impedance
	:	:	
23	DB0	I/O	
24	/RD	Input	/WR=H, /RD=L; Data or Status read form the LCD module
25	/WR	Input	/WR=L→H, /RD=H; Data or Instruction latch into the LCD module
26	RS	Input	Register Select RS = H, Transferring the Display Data RS = L, Transferring the Control Data
27	/RES	Input	Reset signal /RES = L, Initialization is executed /RES = H, Normal running.
28	/CS1	Input	Chip Select /CS1=L, enable access to the LCD module /CS1=H, disable access to the LCD module
29	NC	-	No connection, leave open

## 2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	$V_{DD}$	-0.3	+3.7	V	$V_{SS} = 0V$
Input Voltage	$V_{IN}$	-0.3	$V_{DD}+0.3$	V	$V_{SS} = 0V$
Operating Temperature	$T_{OP}$	0	+50	°C	No Condensation
Storage Temperature	$T_{ST}$	-10	+60	°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

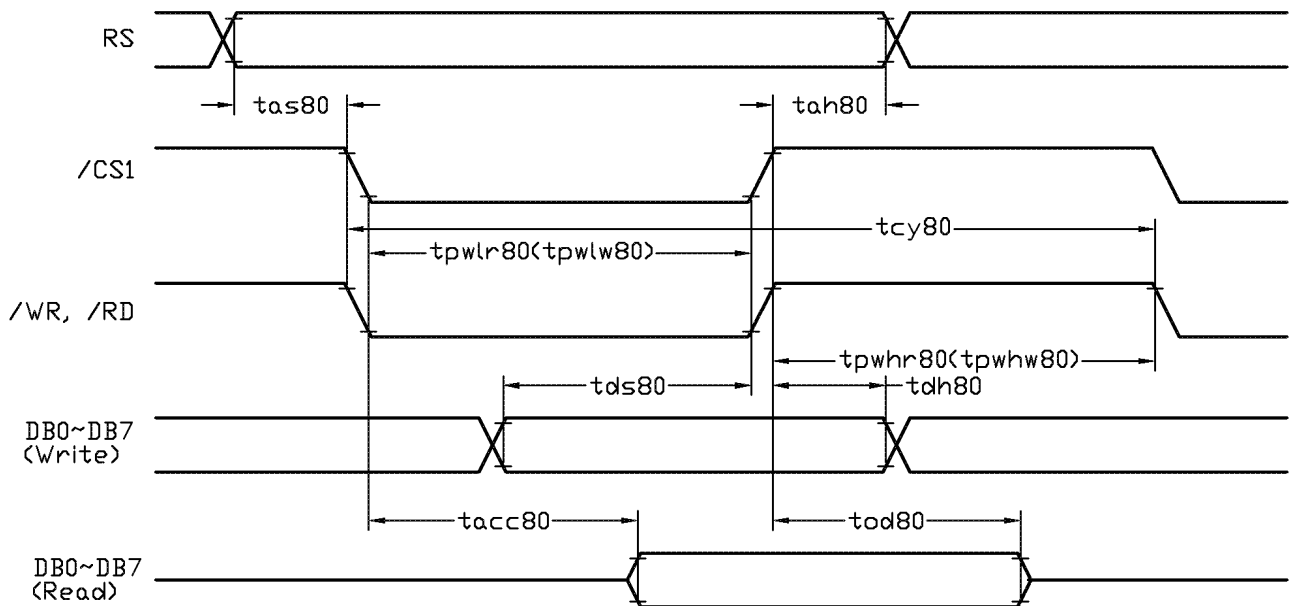
### 3.1 DC Characteristics

$V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25^{\circ}C$

Items	Symbol	MIN.	TYP.	MAX.	Unit	Condition / Application Pin
Operating Voltage	$V_{DD}$	2.9	-	3.6	V	VDD
Input High Voltage	$V_{IH}$	$0.8 \times V_{DD}$	-	$V_{DD}$	V	/HPM, PS, C68, /RESET,
Input Low Voltage	$V_{IL}$	$V_{SS}$	-	$0.2 \times V_{DD}$	V	/CS1, RS, /WR, /RD, DB0~DB7
Output High Voltage	$V_{OH}$	$0.8 \times V_{DD}$	-	$V_{DD}$	V	$I_{OH}=-0.5mA$ , DB0~DB7
Output Low Voltage	$V_{OL}$	$V_{SS}$	-	$0.2 \times V_{DD}$	V	$I_{OL}=0.5mA$ , DB0~DB7
Operating Current	$I_{DD}$	-	0.3	1.5	mA	VDD
Sleep Mode Current	$I_{DDS}$	-	-	2.0	$\mu A$	VDD

3.2 AC Characteristics

3.2.1 8080 Mode System Bus Timing



$V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25^{\circ}C$

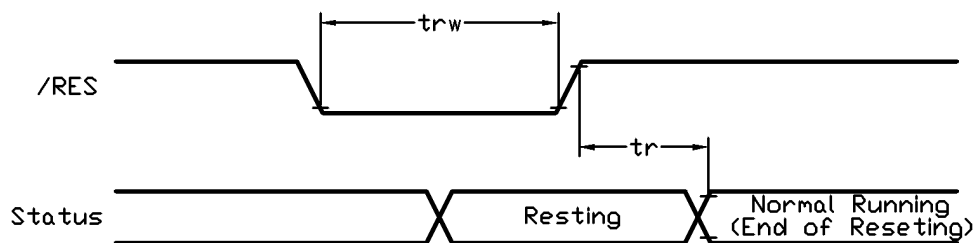
Item	Symbol	MIN.	TYP.	MAX.	Unit
System cycle time	tcy80	375	-	-	ns
Address setup time (RS)	tas80	10	-	-	ns
Address hold time (RS)	tah80	10	-	-	ns
Control LOW pulse width (/RD)	tpwlr80	150	-	-	ns
Control LOW pulse width (/WR)	tpwlrw80	75	-	-	ns
Control HIGH pulse width (/RD)	tpwhr80	75	-	-	ns
Control HIGH pulse width (/WR)	tpwhw80	75	-	-	ns
Data setup time	tds80	50	-	-	ns
Data hold time	tdh80	19	-	-	ns
/RD access time (*2)	tacc80	-	-	175	ns
Output disable time (*2)	tod80	-	-	125	ns

Note:

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

\*2. CL=100pF

3.2.2 Reset Timing



$V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25^{\circ}C$

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset time	tr	-	-	2	$\mu s$
Reset LOW pulse width	trw	2	-	-	$\mu s$

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

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

Note:

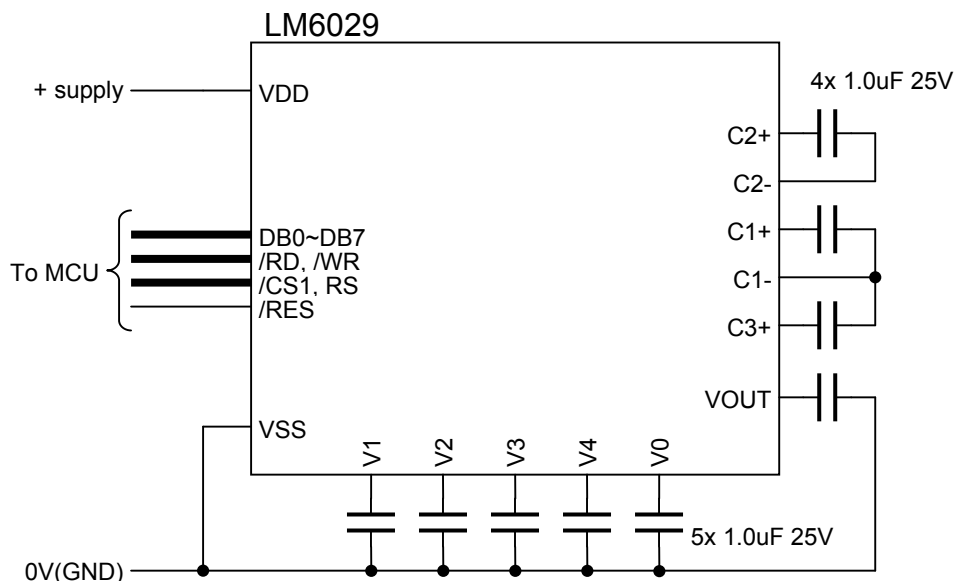
\*1. These setting/commands should issue the LCD module while start up.

\*2. See the Display Commands section for details.

### 4.2 Application Circuit (Example)

The following is the basic application circuit

- High Power Mode = OFF
- 8bit Parallel Interface
- 8080mode Interface
- Internal 4X DC-DC converter



Note: For the details of the application circuit or different kind of configuration, please refer to S6B0724A01 datasheet

### 4.3 Resetting the LCD module

The LCD module should be initialized by using /RES terminal.

While turning on the VDD and VSS power supply, maintain /RES terminal at LOW level. After the power supply stabilized, release the reset terminal (/RES=HIGH)

**4.4 Display Memory Map**

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

Note:

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



**4.5 Display Commands**

No.	Instructions	Code											Function
		RS	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	
1	Display ON/OFF	0	1	0	1	0	1	0	1	1	1	DON	DON=0, display off DON=1, display oin
2	Initial Display Line	0	1	0	0	1	Initial Display Line						Specifies DDRAM line for COM0
3	Set Page Address	0	1	0	1	0	1	1	Page Address				Set page address
4	Set Column Address (Upper-4-bits)	0	1	0	0	0	0	1	Col. Add. Upper				Set the upper-4-bit of column address counter
	Set Column Address (Lower-4-bits)	0	1	0	0	0	0	0	Col. Add. Lower				Set the lower-4-bit of column address counter
5	Read Status	0	0	1	Status				0	0	0	0	Read the internal status D4=RESET, 1=resetting, 0=normal D5=Display ON/OFF, 1=off, 0=on D6=ADC Flag, D7=BUSY Flag, 1=busy, 0=ready
6	Write Display Data	1	1	0	Display Data								Write data into the display RAM
7	Read Display Data	1	0	1	Display Data								Read data form the display RAM
8	ADC Select	0	1	0	1	0	1	0	0	0	0	ADC	Sets the Column Address direction ADC= 0, Normal display (SEG0→SEG131) ADC=1, flipped in x direction (SEG131→SEG0)
9	Normal/Reverse Display	0	1	0	1	0	1	0	0	1	1	REV	REV=0, Normal display REV=1, Reverse display
10	Entire Display ON	0	1	0	1	0	1	0	0	1	0	EON	EON=0, Normal display EON=1, Entire display ON
11	Set LCD Bias	0	1	0	1	0	1	0	0	0	1	BIAS	Set the LCD driving voltage bias BIAS=0, 1/9 BIAS BIAS=1, 1/7 BIAS
12	Set Read-Modify-Write	0	1	0	1	1	1	0	0	0	0		Enter the "Read-Modify-Write" mode column address counter will increase in each "Write Display Data", and will not increase in each "Read Display Data command"
13	Reset Read-Modify-Write	0	1	0	1	1	1	0	1	1	1	0	Release the "Read-Modify-Write" mode
14	Reset	0	1	0	1	1	1	0	0	0	1	0	Resets the LCD module
15	SHL Select	0	1	0	1	1	0	0	SHL	*	*	*	Set the COM scanning direction SHL=0, Normal display SHL=1, Flipped in y direction * = don't care terms
16	Power Control Set	0	1	0	0	0	1	0	1	VC	VR	VF	Set the power circuit operation mode VF: LCD Supply Voltage Follower VR: LCD Supply Voltage Regulator VC: LCD Supply Voltage Converter (1=ON, 0=OFF)

**4.6 Display Commands (continue)**

No.	Instructions	Code										Function	
		A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1		D0
17	Regulator Resistor Select	0	1	0	0	0	1	0	0	Ratio Setting		Set the built-in resistor ratio (Rb/Ra)	
18	Set Reference Voltage Mode	0	1	0	1	0	0	0	0	0	0	1	Set reference voltage mode
	Set Reference Voltage Register	0	1	0	x	x	Electronic Control value				Set reference voltage register (Display contrast value)		
20	Power Save	-	-	-	-	-	-	-	-	-	-	Compound Instruction: Display OFF + Entire Display ON	
21	Power Save Reset	-	-	-	-	-	-	-	-	-	-	Compound Instruction: Display ON + Entire Display OFF	
22	NOP	0	1	0	1	1	1	0	0	0	1	1	Non-operation command
23	Test_1	0	1	0	1	1	1	1	x	x	x	x	Test Command. Do not use.
24	Test_2	0	1	0	1	0	0	1	x	x	x	x	Test Command. Do not use.

Note: \*1. Do not use any other command not listed, or the system malfunction may result.  
 \*2. For the details of the Display Commands, please refer to S6B0724 data sheet.

**4.6.1 Power off the LCD Module**

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

**4.6.2 Refreshing The LCD Module**

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

**4.7 Basic Operating Sequence (example)**

**4.7.1 Initialization Sequence**

		Code Function										Note	
A0	D7	D6	D5	D4	D3	D2	D1	D0	hex				
Turn on Power Supply VDD & VSS While maintaining /RES at LOW		-	-	-	-	-	-	-	-	-	-	-	-
Wait until power supply is stabilized		-	-	-	-	-	-	-	-	-	-	-	-
Release the /RES Reset Signal (/RES = HIGH)		-	-	-	-	-	-	-	-	-	-	-	See AC Characteristics section for timing details
LCD bias = 1/9		0	1	0	1	0	0	0	1	0	A2h	LCD panel Characteristic	
ADC = normal		0	1	0	1	0	0	0	0	0	A0h	No flip on x-direction (SEG)	
SHL = reverse		0	1	1	0	0	1	0	0	0	C8h	Flip on y-direction (COM)	
Initial Display Line=0		0	0	1	0	0	0	0	0	0	40h	i.e. Display RAM "page 0 - D0" Matched to top line of the LCD	
Power Control Voltage Follower = OFF Voltage Regulator = OFF Voltage Converter = ON Delay 50ms		0	0	0	1	0	1	1	0	0	26h	Turn on the internal Voltage Converter and wait until VOUT stable.	
Power Control Voltage Follower = OFF Voltage Regulator = ON Voltage Converter = ON Delay 50ms		0	0	0	1	0	1	1	1	0	2Eh	Turn on the Internal Voltage Regulator and wait until VOUT stable.	
Power Control Voltage Follower = ON Voltage Regulator = ON Voltage Converter = ON Delay 50ms		0	0	0	1	0	1	1	1	1	2Fh	Turn on the internal Voltage Follower and wait until VOUT stable	
Regulator Resistor Select		0	0	0	1	0	0	1	0	1	25h	Set the built-in resistor ratio to middle	
Set Reference Voltage Mode		0	1	0	0	0	0	0	0	1	81h	Set to the middle of the range It may be adjusted for achieving the best display contrast	
Set Reference Voltage Resistor		0	0	0	1	0	0	0	0	0	20h		
Display ON		0	1	0	1	0	1	1	1	1	AFh	Turn on the LCD display	
Set Page Address = 0		0	1	0	1	1	0	0	0	0	B0h	Specify the Display Data RAM page address to 00h	
Set Column Address (Upper-4bit=0)		0	0	0	0	1	0	0	0	0	10h	Specify the Display Data RAM column address to 00h	
Set Column High (Lower-4bit=0)		0	0	0	0	0	0	0	0	0	00h		
Write Display Data		1	Display Data									Write data to Display Data RAM. After write, the internal Column Address Counter will be increased by 1 automatically	
Write Other Display Data ...													

## 5. Design and Handling Precaution

1. The LCD panel is made by glass. Any mechanical shock (eg. dropping from 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 from 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