

# Product Specification

Number: L-KLS9-1602C-W  
Name: Character LCD module  
Specification: \_\_\_\_\_  
Customer: A05  
Date: 2023-11-3

Customer Signature:



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# **NINGBO KLS ELECTRONIC CO; LTD**

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**1 .Revision history**

<b>Version</b>	<b>issue date</b>	<b>New/revised content</b>
V1.0	2020-8-12	Newly made

Note: The upgraded version is backward compatible without further notice.  
If compatibility issues affect performance, please contact our company for resolution.



# NINGBO KLS ELECTRONIC CO; LTD

## 2. Overview

KLS9-1602C-W character LCD module is a dot matrix LCD module specially used to display letters, numbers, symbols, etc. Divided into 4-bit and 8-bit data transmission modes. Provides 5×7 dot matrix + cursor display mode. Provides display data buffer DDRAM, character generator CGROM and character generator CGRAM. You can use CGRAM to store the font data of up to eight 5×8 dot matrix graphic characters that you define. Provides a wealth of command settings: clear display; cursor return to origin; display on/off; cursor on/off; display character flashing; cursor shift; display shift element, etc. Provides an internal power-on automatic reset circuit, which automatically initializes the module when external power is applied and sets the module to the default display working state.

Number of characters displayed: 16 characters

Character dot matrix: 5X7 character matrix + cursor

**Display color and backlight color: STN blue, yellow-green, gray; backlight black, white, yellow-green**

polarizing film: fully

transparent/semi-transparent viewing angle:

6:00 display duty cycle: 1/16 driving bias: 1/5 Control chip:

SPLC780D or compatible IC (such as AIP31066) character generator ROM (CGROM): 10880 bits (192 character 5\*8 dots) or

(64 character 5\*11 dots) character generator RAM (CGRAM): 64X8 bits (8 characters 5\*8 dots) or (4 characters 5\*11 dots)

Display data RAM (DDRAM): 80X8 bits (80 characters max)

**Size (Unit: mm)**

**Overall size: 84X44X11.2**

visible area : 64.5X16

Character font: 5X7 dots + cursor

Character size: 56.21X11.51

Point size:0.54X0.6

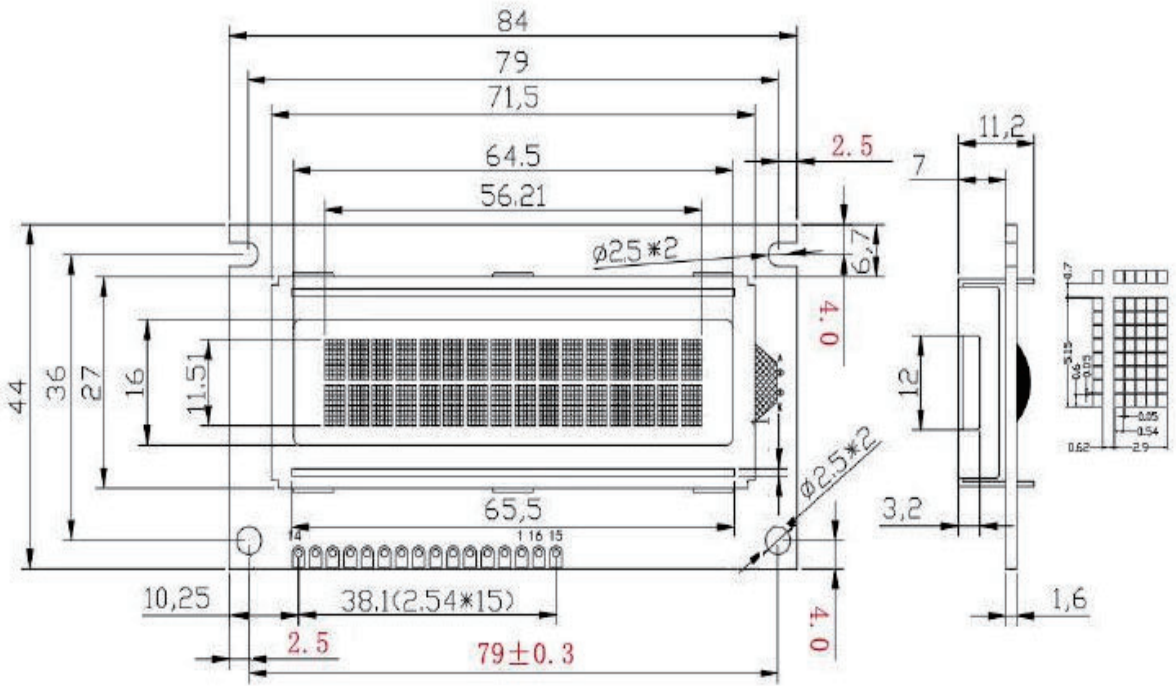
Character spacing: 3.52X5.85

Contrast: V0 external adjustment or internal fixed contrast

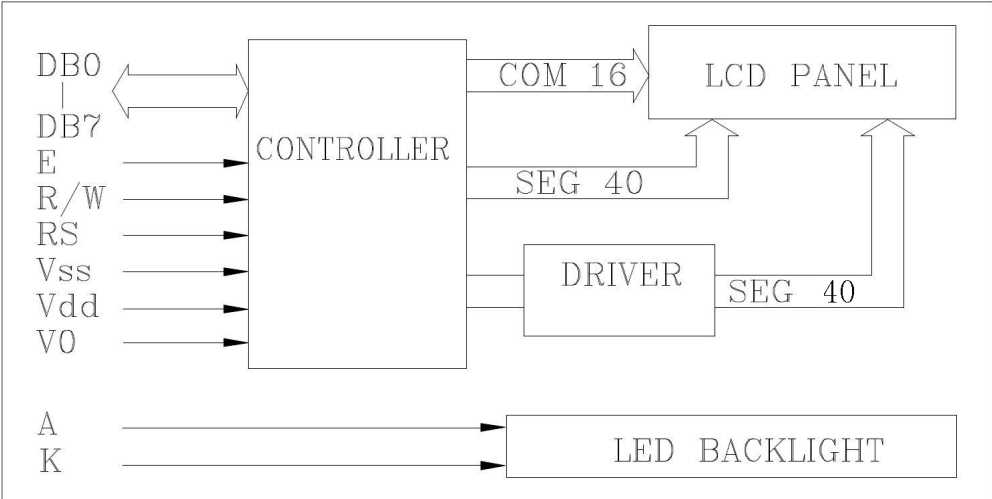
**Weight: g**

Working voltage: +3.3V or +5V, default 5V

**3. Dimensions:**



**4. Hardware block diagram:**



## 5. Electrical characteristics

### 5.1 Limit parameters

parameter name	symbol	condition	Typical value		unit
			minimum value	maximum value	
voltage	Vdd		-0.3	7.0	V
LCD driving voltage	V5		Vdd-10.0	Vdd+0.3	V
input voltage	Vi		-0.3	Vdd+0.3	V
operating temperature	Top	-	-20	70	°C
(T) storage temperature (T)	Txt	-	-30	80	°C

### 5.2.1 DC parameter 1 (Ta=25°C, Vdd=4.5V~5.5V)

parameter name	symbol	condition	nominal value			unit
			min	typical	max	
Supply voltage	Vdd-GND	-	4.5	5.0	5.5V	
operating current (excluding backlight)	Idd	Vdd=5V	0.9	1.5	1.7mA	
LCD drive current	iee		-	0.6	- mA	
LCD driving voltage	Vdd-V5		4.2	4.5	4.8 V	
LED backlight operating current	If	Vf=3.0~3.2V	17		20mA	
LED backlight power	Pd		90	18	100 110 mW	
consumption input	Vih		2.5	-	Vdd V	
high level input	Vil		-0.3	-	0.6 V	
low level output	Voh	Ioh=-0.205mA	2.4	-	-	V
high level output low level	Vol	Iol=1.2mA	-	-	0.4V	

### 5.2.2 DC parameter 2 (Ta=25°C, Vdd=2.7V~4.5V)

parameter name	symbol	condition	nominal value			unit
			min	typical	max	
Supply voltage	Vdd-GND	-	2.7	3.3	4.5 V	
operating current (excluding backlight)	Idd	Vdd=3.3V	0.45	0.9	1.0mA	
LCD drive current	iee		-	0.6	- mA	
LCD driving voltage	Vdd-V5		4.2	4.5	4.8 V	
LED backlight operating current	If	Vf=3.0~3.2V	17	18	20mA	
LED backlight power	Pd		55	60	66 mW	
consumption input	Vih		0.7Vdd	-	Vdd V	
high level input	Vil		-0.3	-	0.55 V	
low level output	Voh	Ioh=-0.1mA	0.75Vdd	-	-	V
high level output low level	Vol	Iol=0.1mA	-	-	0.2VddV	

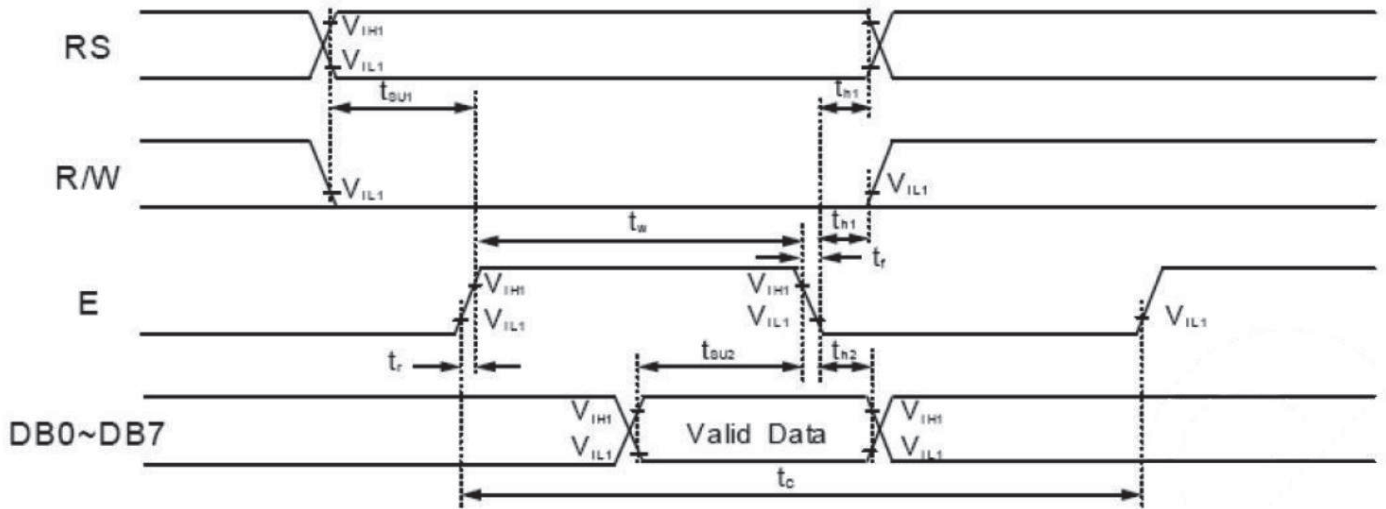
**5.3.1 AC parameters 1 (Ta=25oC, Vdd=4.5V~5.5V)**

参数名称	符号	测试条件	最小	典型	最大	单位
E周期	t <sub>c</sub>	写模式	500	-	-	ns
E上升/下降时间	t <sub>R,tF</sub>		-	-	20	
E脉冲宽度(1,0)	t <sub>w</sub>		230	-	-	
R/W和RS建立时间	t <sub>su1</sub>		40	-	-	
R/W和RS保持时间	t <sub>H1</sub>		10	-	-	
数据建立时间	t <sub>su2</sub>		80	-	-	
数据保持时间	t <sub>H2</sub>		10	-	-	
E周期	t <sub>c</sub>	读模式	500	-	-	ns
E上升/下降时间	t <sub>R, tF</sub>		-	-	20	
E脉冲宽度(1,0)	t <sub>w</sub>		230	-	-	
R/W和RS建立时间	t <sub>su</sub>		40	-	-	
R/W和RS保持时间	t <sub>H</sub>		10	-	-	
数据输出延迟时间	t <sub>D</sub>		-	-	120	
数据保持时间	t <sub>DH</sub>		5	-	-	

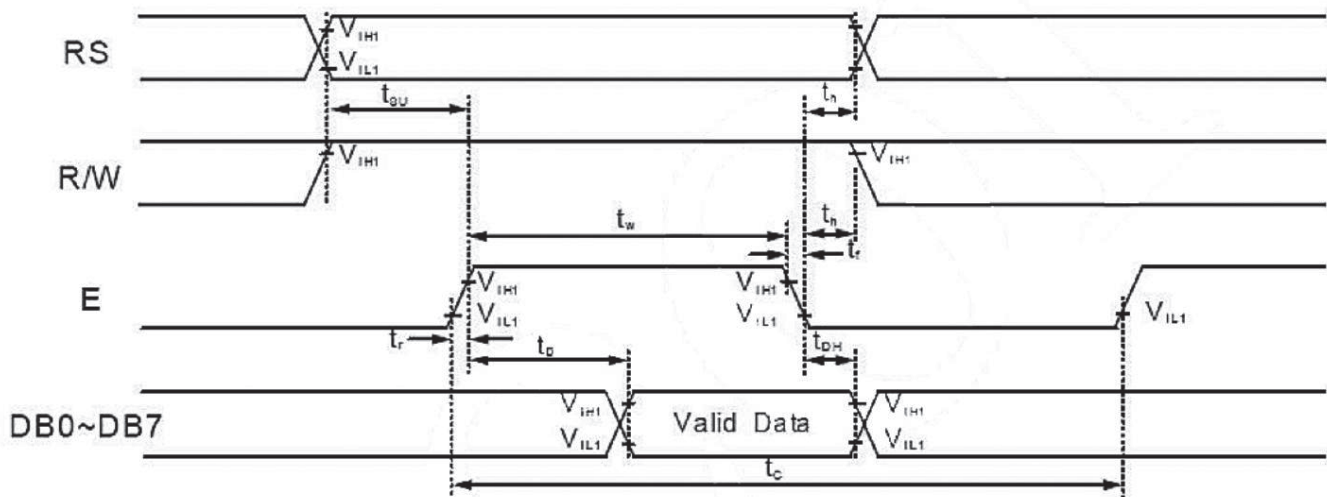
**5.3.2 AC parameters 2 (Ta=25oC, Vdd=2.7V~4.5V)**

参数名称	符号	测试条件	最小	典型	最大	单位
E周期	t <sub>c</sub>	写模式	1000	-	-	ns
E上升/下降时间	t <sub>R,tF</sub>		-	-	25	
E脉冲宽度(1,0)	t <sub>w</sub>		450	-	-	
R/W和RS建立时间	t <sub>su1</sub>		60	-	-	
R/W和RS保持时间	t <sub>H1</sub>		20	-	-	
数据建立时间	t <sub>su2</sub>		195	-	-	
数据保持时间	t <sub>H2</sub>		10	-	-	
E周期	t <sub>c</sub>	读模式	1000	-	-	ns
E上升/下降时间	t <sub>R, tF</sub>		-	-	25	
E脉冲宽度(1,0)	t <sub>w</sub>		450	-	-	
R/W和RS建立时间	t <sub>su</sub>		60	-	-	
R/W和RS保持时间	t <sub>H</sub>		20	-	-	
数据输出延迟时间	t <sub>D</sub>		-	-	360	
数据保持时间	t <sub>DH</sub>		5	-	-	

AC test waveform diagram



write mode



read mode



## 6. Interface description

Foot number	symbol	Function	Remark
1	Vss	power supply	0V
2	Vdd		+5V
	Vo		LCD bias adjustment contrast adjustment
3 4	RS	Data/instruction selection (H: data L: instruction)	
5	R/W	Read/write selection (H: read L: write)	
6	E	enable signal	
7	DB0	Data bit 0	
8	DB1	Data bit 1	
9	DB2	Data bit 2	
10	DB3	Data bit 3	
11	DB4	Data bit 4	
12	DB5	Data bit 5	
13	DB6	Data bit 6	
14	DB7	Data bit 7	
15	A	LED backlight positive	
16	K	LED backlight negative	

## 7. Instruction description

The module has a 4-bit/8-bit MCU parallel communication mode, and the 4-bit/8-bit bus is selected through the DL bit of the instruction register.

During read and write operations, two 8-bit registers are used, one is the data register DR and the other is the instruction register IR. data Register DR serves as a temporary storage place for writing and reading DDRAM/CGRAM data. The target RAM sets instructions through the RAM address. Select, any internal operations of reading and writing RAM are completed automatically. When the MCU reads the data in DR, DDRAM/CGRAM Data is automatically transferred to DR. Similarly, when MCU writes data to DR, the data in DR is automatically transferred out of DDRAM/CGRAM. refer to The register IR is used to store the instruction code from the MCU. The MCU cannot read the instruction data and can switch the selected register through the RS pin. device.

Various operations by setting the RS/RW bit:

RS	RW	operate
L	L	Write instruction operation (MCU writes instruction code to IR)
L	H	Read busy flag (DB7) and address counter (DB0~DB6)
H	L	Write data operation (MCU writes data to DR)
H	H	read data operation (MCU reads data from DR)

### 7.1 Busy flag (BF)

BF is high, indicating that internal operations are in progress, so within this time, the next instruction will not be executed. When RS="0" And R/W = "1" (during read instruction operation), the value of BF can be read from DB7 port. When executing the next instruction, it must be confirmed that BF is not "1".

### 7.2 Address Counter (AC)

When the DDRAM/CGRAM address from the instruction register is stored in the address counter, the data in the address counter is written increment or decrement after entering or reading DDRAM/CGRAM. When RS = "0" and R/W = "1", the data in the address counter can be changed from DB0~DB6 read.

### 7.3 Display data RAM (DDRAM)

The DDRAM address range of the module is 00H~27H and 40H~67H.

### 7.4 Character generation ROM (CGROM)

Character generation ROM has 5x8 dot matrix, 192 characters, and 5x11 dot matrix, 64 character mode

### 7.5 Character generation RAM (CGRAM)

The character generation RAM has a 5\*8 dot matrix and 8 character spaces. Each character space consists of 8 5-bit byte spaces. By writing

Customize character data to CGRAM. Users can call custom character data by writing DDRAM data 00H~07H into this 8-character space.

meaning characters.

DDRAM/CGRAM address correspondence diagram:

Character Code (DDRAM data)								CGRAM address						CGRAM Data								Pattern number
D7	D6	D5	D4	D3	D2	D1	D0	A5	A4	A3	A2	A1	A0	P7	P6	P5	P4	P3	P2	P1	P0	
0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	x	x	0	1	1	1	0	pattern1
											0	0	1				0	0	1	0	0	
											0	1	0				0	0	1	0	0	
											0	1	1				0	0	1	0	0	
											1	0	0				0	0	1	0	0	
											1	0	1				0	0	1	0	0	
											1	1	0				0	1	1	1	0	
											1	1	1				0	0	0	0	0	
0	0	0	0	x	0	0	1	0	0	1	0	0	0	x	x	x	0	1	1	1	0	pattern2
											0	0	1				1	0	0	0	1	
											0	1	0				1	0	0	0	0	
											0	1	1				1	0	0	0	0	
											1	0	0				1	0	0	0	0	
											1	0	1				1	0	0	0	1	
											1	1	0				0	1	1	1	0	
											1	1	1				0	0	0	0	0	
				*	*	*	*			*	*	*	*				*	*	*	*		
0	0	0	0	x	1	1	1	1	1	1	0	0	0	x	x	x	1	1	1	1	1	pattern8
											0	0	1				1	0	0	0	0	
											0	1	0				1	0	0	0	0	
											0	1	1				1	1	1	1	0	
											1	0	0				1	0	0	0	0	
											1	0	1				1	0	0	0	1	
											1	1	0				1	1	1	1	0	
											1	1	1				0	0	0	0	0	

### 7.6 Instruction description

instruction list

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	execution time	clear		describe
show	0	0	0	0	0	0	0	0	0	0	1.53ms	1		Write 20H to DDRAM and count the address Set the device address to 00H
Return 0			0	0	0	0	0	0	0	1	1.53ms	-		Set the address counter address to 00H, and Return the cursor to its original position, DDRAM contents remain unchanged
input module Setting	0	0	0	0	0	0	0	0	0	1	I/D SH		39us	Sets the cursor movement direction and allows the entire show movement
display switch	0	0	0	0	0	0	0	0	1	DCB			39us	Set display, cursor, and cursor blinking control Positioning

## LCD module instruction manual

Shift 0		0	0	0	0	1	S/CR/L	-	-	39us	Set cursor movement and display movement direction control bits, DDRAM data remains unchanged
Function set up	0	0	0	0	1	DLNF		-	-	39us	Set the interface data width (DL: 8 bits/4 bits), display the number of lines (N: 2 lines/1 line), display Font (F:5x11 dot matrix/5x8 dot matrix)
set up CGRAM address	0	0	0	1	AC5 AC4 AC3 AC2 AC1 AC0					39us	Set the CGRAM address in the address counter
set up DDRA M address	0	0	1	AC6 AC5 AC4 AC3 AC2 AC1 AC0						39us	Set the DDRAM ground in the address counter site
busy reading Logo& address	0	1	BF AC6 AC5 AC4 AC3 AC2 AC1 AC0							0us	Read the busy flag bit BF, in the address counter contents are read out at the same time
Write data	1	0	D7 D6 D5 D4 D3 D2 D1 D0							43us	Write data to internal RAM (DDRAM/CGRAM)
Read data	1	1	D7 D6 D5 D4 D3 D2 D1 D0							43us	From internal RAM (DDRAM/CGRAM) Read data in

Note: "-" means not considered

### 7.6.1 Clear display

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	0	0	0	0	0	1
---	---	---	---	---	---	---	---	---	---	---	---

code) to all DDRAM addresses and setting the address counter to 00H, the display data can be cleared.

Place the cursor at the initial state position and set the input mode to incremental (I/D is high).

### 7.6.2 Return

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	0	0	0	0	1	-
---	---	---	---	---	---	---	---	---	---	---	---

"-" means not to consider

The return command is to return the cursor to the starting position, set the DDRAM address to 00H, write the address counter, and change the display to the initial state, the data in DDRAM remains unchanged.

### 7.6.3 Input mode

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	0	0	1	I/D SH	
---	---	---	---	---	---	---	---	---	--------	--

direction of the cursor and display

I/D: Increment or decrement of DDRAM address (cursor or flash)

When I/D is 1, the cursor flashes and moves to the right, and the DDRAM address is incremented; when I/D is 0, the cursor flashes and moves to the left, and the DDRAM address is decremented, and when reading or writing to CGRAM, the movement method is consistent with DDRAM.

SH: display shift

When SH is 0, the entire display will not shift when reading or writing DDRAM or CGRAM. When SH is 1, for DDRAM the writing operation is that the entire display will be shifted according to the direction set by I/D.

### 7.6.4 Display switch control

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	0	0	1	DCB	
---	---	---	---	---	---	---	---	---	-----	--

Cursor and Blink Control

D: Display switch control bit

When D is 1, the display is on; when D is 0, the display is off, but the display data in DDRAM remains unchanged.

## C: Cursor switch control bit

When C is 1, the cursor is on; when C is 0, the cursor disappears, but the I/D register saves its data.

## B : Cursor flashing switch control bit

When B is 1, the cursor flashes on, when B is 0, the cursor flashes off.

### 7.6.5 Cursor flashing/shifting

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	S/CR/L	-	-

Do not read or write display data. Move the cursor position or display left or right. This instruction is used to correct and find display data. When 2 lines in display mode, after the 40th character on line 1, the cursor moves to line 2. Note that in all rows, the display shift is performed simultaneously. When the display data is repeatedly shifted, each bit is shifted independently. When the display is shifted, the contents of the address counter remain unchanged.

#### Shift format table

S/C	R/L	operate
0	0	The cursor moves to the left and the address counter decreases by 1
0	1	The cursor moves to the right and the address counter increments by 1
1	0	So the display moves to the left, and the cursor follows the display shift.
1	1	All displays move to the right, and the cursor follows the display shift

### 7.6.6 Function settings

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	DL	NF	-	-

## DL: Interface data width control bit

When DL is 1, it means that the 8-bit bus is connected to the MCU

When DL is 0, it means that the 4-bit bus is connected to the MCU. When it is 4-bit bus mode, 8-bit data needs to be transmitted through 4-bit data 2 completed.

## N: display line number control bit

When N is 0, it is a 1-line display mode; when N is 1, it is a 2-line display mode.

## F: Display font settings

When F is 0, the font is in 5x8 dot matrix mode; when F is 1, the font is in 5x11 dot matrix mode.

### 7.6.7 Set CGRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Place the CGRAM address into the address counter to make the CGRAM data from the MCU valid.

### 7.6.8 Set DDRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Put the DDRAM address into the address counter to make the DDRAM data from the MCU valid. When in 1-line display mode, DDRAM address 00H~4FH; when in 2-line display mode, the DDRAM address of the first line is from 00H~27H, and the DDRAM address of the second line is from 00H~27H. From 40H~67H.

### 7.6.9 Reading busy flag and address

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	1 BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0				
---	------	-----	-----	-----	-----	-----	-----	-----	--	--	--	--

This instruction displays whether the module is in internal work. If BF is 1, internal work is in progress. You need to wait until BF is set to 0 before the next instruction can be executed. In this instruction, you can also read the address counter. value.

### 7.6.10 Write data to RAM

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

1	0 D7	D6	D5	D4	D3	D2	D1	D0				
---	------	----	----	----	----	----	----	----	--	--	--	--

Write 8-bit data to DDRAM/CGRAM. The selection between DDRAM and CGRAM is determined by the address setting command (DDRAM address setting command and CGRAM address setting command). After the write operation, the address will be incremented or decremented according to the address counter set by the RAM setting command.

### 7.6.11 Reading data from RAM

RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

1	1 D7	D6	D5	D4	D3	D2	D1	D0				
---	------	----	----	----	----	----	----	----	--	--	--	--

Read 8-bit data from DDRAM/CGRAM. The choice between DDRAM and CGRAM is determined by the address setting instruction. If there is no address setting instruction written before reading the data, the read data is invalid; if there is no address setting instruction before the read operation, If you write the RAM address setting command and read the data multiple times, the second data is valid starting from the second data. The first data is incorrect because there is no timing to match the RAM data output. In the read operation of DDRAM, the cursor moves The instruction plays the same role as the DDRAM address setting instruction. It also sends RAM data to the output register. After the read operation, the address counter is incremented or decremented according to the input mode instruction. After the CGRAM read operation, the display shift may not be performed correctly.

### 7.6.12 Initialization

When powered on, the module will be initialized. During this process, the following instructions will be executed. The busy flag remains high

before the initialization is completed. 1. Clear display command:

all DDRAM is written to 20H 2. Set function command:

DL=1, 8-bit bus mode N=0, 1-

line display mode F=0, 5x8 font

3. Display switch command: D=0, display off

C=0, cursor off

B=0, flashing off

4. Set the return command: I/D=1, increment SH=0,

and the display does not shift.

7.7 Correspondence table between display position and RAM address

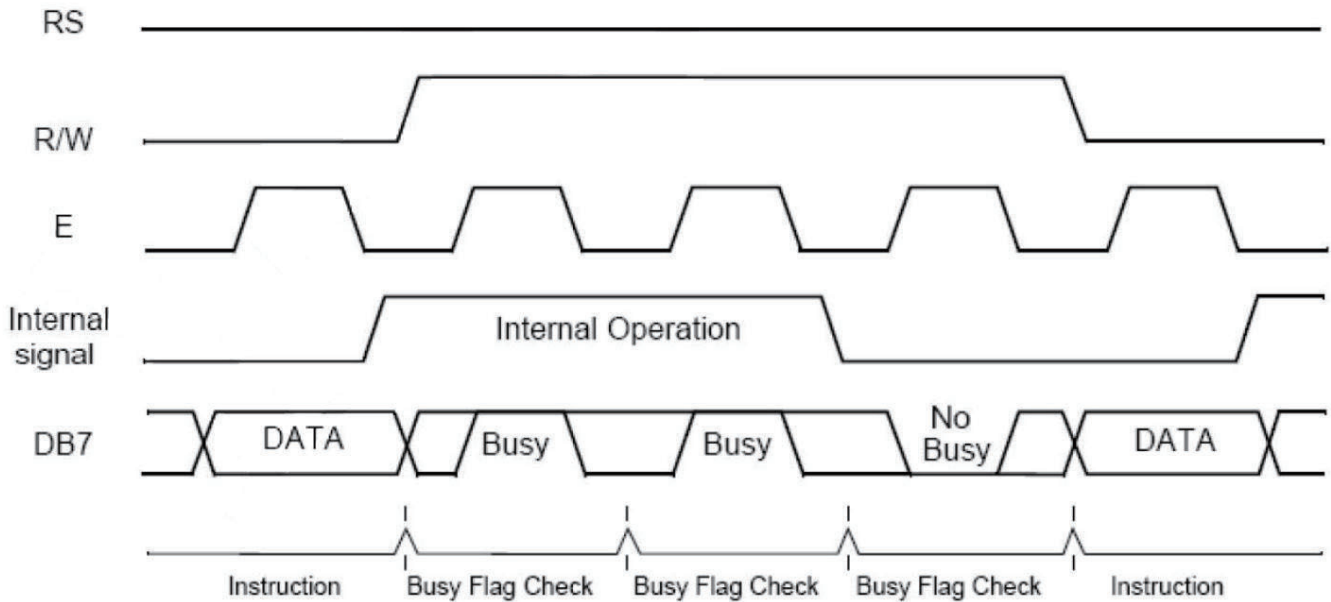
show location	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10			
DDRAM address	00	01	02	03	04	05	06	07	08	09			
show location	1-11	1-12	1-13	1-14	1-15	1-16	1-17	1-18	1-19	1-20			
DDRAM address	0A	0B	0C	0D	0E	0F	10				11	12	13
show location	1-21	1-22	1-23	1-24	1-25	1-26	1-27	1-28	1-29	1-30			
DDRAM address	14	15	16	17		18	19	1A	1B	1C	1D		
show location	1-31	1-32	1-33	1-34	1-35	1-36	1-37	1-38	1-39	1-40			
DDRAM address	1E	1F	20	21	22	23	24	25	26	27			
show location	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9	2-10			
DDRAM address	40	41	42	43	44	45	46	47	48	49			
show location	2-11	2-12	2-13	2-14	2-15	2-16	2-17	2-18	2-19	2-20			
DDRAM address	4A	4B	4C	4D	4E	4F	50	51	52	53			
show location	2-21	2-22	2-23	2-24	2-25	2-26	2-27	2-28	2-29	2-30			
DDRAM address	54	55	56	57	58	59	5A	5B	5C	5D			
show location	2-31	2-32	2-33	2-34	2-35	2-36	2-37	2-38	2-39	2-40			
DDRAM address	5E	5F	60	61	62	63	64	65	66	67			

**1-1 represents the first character of the first line**

## 8. Operation timing

### 8.1 8-bit MCU interface

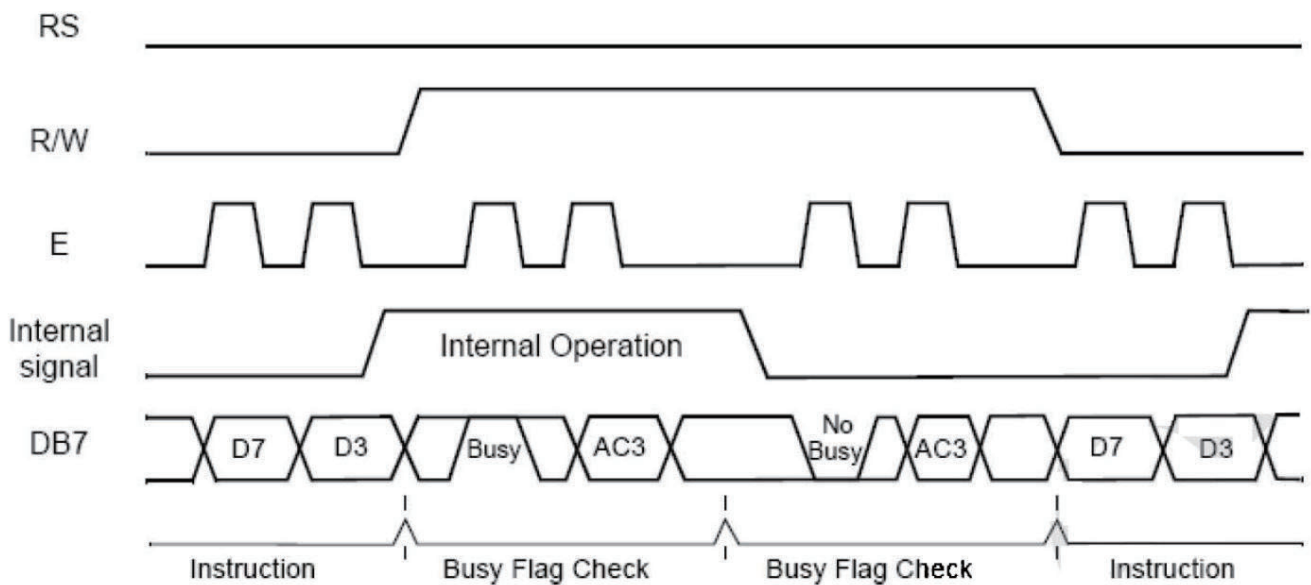
When the interface data width is set to 8 bits, data is read and written from the 8-bit ports (DB0~DB7) at the same time. The timing is as shown in the figure below:



### 8.2 4-bit MCU interface

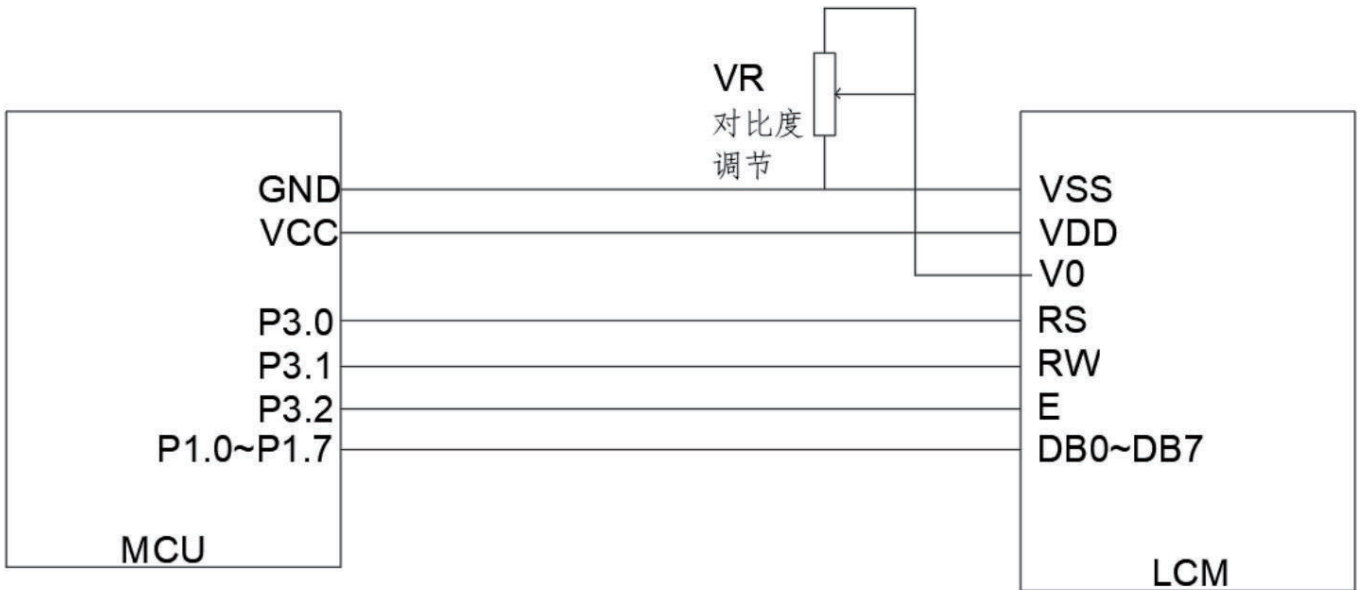
When the interface data width is set to 4 bits, data is only read and written from the upper 4 bits (DB4~DB7) of the 8-bit port, and the upper 4 bits are transmitted first.

bits and then transmit the lower 4 bits, the timing is as shown in the figure below:



9. Application routines

9.1 8-bit wiring diagram



8位接线方法

9.2 8-bit C51 routine

```

#include <STC15.H>
#include <string.h>
#include <INTRINS.H>

#define uchar unsigned char
#define uint unsigned int
#define DB07 P1

sbit RS=P3^0;
sbit RW=P3^1;
sbit E=P3^2;

//////////DB area

uchar code border_inf[16] =
{ 0xaa,0x55,0xaa,0x55,0xaa,0x55,0xaa,0x55,
  0x55,0xaa,0x55,0xaa,0x55,0xaa,0x55,0xaa, };

uchar code
string[]={ 0xa0,0xa1,0xa2,0xb0,0xb1,0xb2,0xc0,0xc1,0xc2,0xd0,0xd1,0xd2,0xe0,0xe1,0xe2,0xf0,
0xf1,0xf2,0xa3,0xa4,0xa5,0xa6 ,0xb3,0xb4,0xb5,0xb6,0xc3,0xc4,0xc5,0xc6,0xd3,0xd4,
0xd5,0xd6,0xe3,0xe4,0xe5,0xf3,0xf4,0xf5 };

```



```
void delay(unsigned int m) //delay program
```

```
    { unsigned int i,j;
      for(i=0;i<m;i++)
        for(j=0;j<20;j++);
    }
```

```
void delayms(unsigned int n) //Delay 10×n milliseconds program
```

```
    { unsigned int i,j;
      for(i=0;i<n;i++)
        { for(j=0;j<800;j++);
        }
    }
```

```
void LcdWriteCom(uchar com) {
```

```
    E=0;
    RW=0;
    RS=0;
    DB07=com;
    E=1;
    delay(10);
    E=0;
}
```

```
void LcdWriteData(uchar dat) {
```

```
    E=0;
    RW=0;
    RS=1;
    DB07=dat;
    E=1;
    delay(10);
    E=0;
}
```

```
void LcdInit() {
    LcdWriteCom(0x38);
    LcdWriteCom(0x0c);
    LcdWriteCom(0x06);
    LcdWriteCom(0x01);
    delayms(5);
}
```

```
void Show_string1(uchar a[])
{
    uchar
    i; LcdWriteCom(0x80);
    for(i=0;a[i]!='\0';i++)

        { LcdWriteData(a[i]); }

}
```

```
void Show_string2(uchar *a)
{
    uchar i;
    LcdWriteCom(0x80+0X40);
    for(i=0;i<16;i++) {

        LcdWriteData(a[i]); }

}
```

/\*\*\*\*\*\* \* Name: Main() \*

Function: Main

function \* Input:

None \*

Output: None

\*\*\*\*\*

/

```
void main(void)
```

```
{
    uchar i,j;
    LcdInit();
    LcdWriteCom(0x40);
    for(i=0;i<16;i++) {

        LcdWriteData(border_inf[i]); }

        while(1)
        {
            for(j=0;j<2;j++)
            {
                LcdWriteCom(0x80);
                for(i=0;i<16;i++) {

                    LcdWriteData(j); }

                LcdWriteCom(0xC0);
                for(i=0;i<16;i++) {

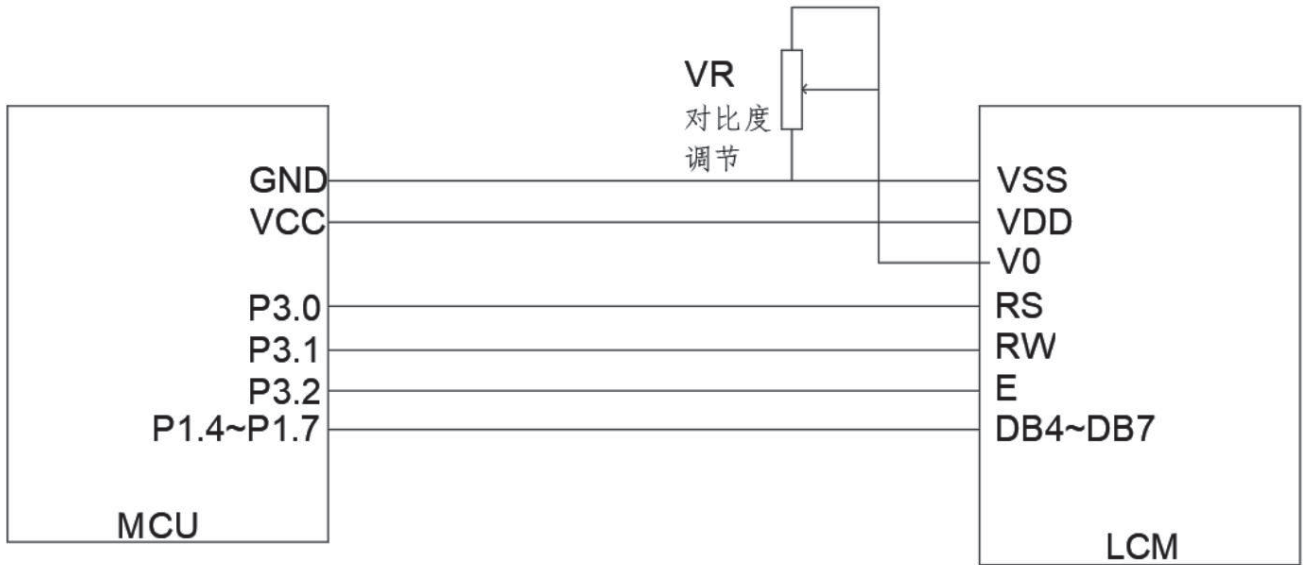
                    LcdWriteData(j); }

                delayms(500); }

            Show_string1("12345abcefg!@$%");
            Show_string2(string);
            delayms(600);

        }
}
```

9.3 4-digit wiring diagram



4位接线方法

9.4 4-bit C51 routine

```

#include <STC15.H>
#include <string.h>
#include <INTRINS.H>
#define uchar unsigned char
#define uint unsigned int
#define DB07 P1
sbit RS=P3^0;
sbit RW=P3^1;
sbit E=P3^2;

uchar code border_inf[16] =
    { 0xaa,0x55,0xaa,0x55,0xaa,0x55,0xaa,0x55,
      0x55,0xaa,0x55,0xaa,0x55,0xaa,0x55,0xaa, };

uchar code
string[]={ 0xa0,0xa1,0xa2,0xb0,0xb1,0xb2,0xc0,0xc1,0xc2,0xd0,0xd1,0xd2,0xe0,0xe1,0xe2,0xf0,
           0xf1,0xf2,0xa3,0xa4,0xa5,0xa6 ,0xb3,0xb4,0xb5,0xb6,0xc3,0xc4,0xc5,0xc6,0xd3,0xd4,
           0xd5,0xd6,0xe3,0xe4,0xe5,0xf3,0xf4,0xf5 };

void delay(unsigned int m) //delay program

```

```
    { unsigned int i,j;
      for(i=0;i<m;i++)
        for(j=0;j<20;j++);
    }
```

```
void delays(unsigned int n)           //Delay 10×n milliseconds program
```

```
    { unsigned int i,j;
      for(i=0;i<n;i++)

        { for(j=0;j<800;j+
          +); }
    }
```

```
void LcdWriteCom(uchar com) {
```

```
    uchar com1,com2;
    com1=com&0xf0;
    com2=(com<<4)&0xf0;
    E=0;
    RW=0;
    RS=0;
    DB07=com1;
    E=1;
    delay(10);
    E=0;
    RW=0;
    RS=0;
    DB07=com2;
    E=1;
    delay(10);
    E=0;
}
```

```
void LcdWriteData(uchar dat) {
```

```
    uchar dat1,dat2;
    dat1=dat&0xf0;
```

```
dat2=(dat<<4)&0xf0;
E=0;
RW=0;
RS=1;
DB07=dat1;
E=1;
delay(10);
E=0;
RW=0;
RS=1;
DB07=dat2;
E=1;
delay(10);
E=0;
}

void LcdInit() {

    LcdWriteCom(0x28);
    LcdWriteCom(0x0c);
    LcdWriteCom(0x06);
    LcdWriteCom(0x01);
    delayms(5);
}

void Show_string1(uchar a[]) {

    uchar
    i; LcdWriteCom(0x80);
    for(i=0;a[i]!='\0';i++)

        { LcdWriteData(a[i]); }

}

void Show_string2(uchar *a) {

    uchar i;
    LcdWriteCom(0x80+0X40);
    for(i=0;i<16;i++)
```

```
{
    LcdWriteData(a[i]); }

} /***** *****/
* Name: Main() *
Function: Main
function *
Input: None * Output: None
*****/
/
void main(void) {

    uchar i,j;
    LcdInit();
    LcdWriteCom(0x40);
    for(i=0;i<16;i++) {

        LcdWriteData(border_inf[i]); }

    while(1)
    {
        for(j=0;j<2;j++)
        {
            LcdWriteCom(0x80);
            for(i=0;i<16;i++) {

                LcdWriteData(j); }

            LcdWriteCom(0xC0);
            for(i=0;i<16;i++) {

                LcdWriteData(j); }

            delayms(500); }

    Show_string1("12345abcefg!@#$%");
    Show_string2(string);
```

delays(600); } }

9.5 Font library

b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)			0	a	P	\	F				-	9	3	o	p
0001	(2)	!	1	A	a	a					.	7	*	G	3	q
0010	(3)	"	2	B	R	b	r				7	7	W	X	P	o
0011	(4)	#	3	C	S	c	s				7	7	T	E	e	o
0100	(5)	\$	4	D	T	d	t				\	7	7	h	p	o
0101	(6)	%	5	E	U	e	u				.	*	*	7	o	o
0110	(7)	&	6	F	V	f	v				9	9	=	3	p	z
0111	(8)	'	7	G	W	g	w				7	*	*	7	g	a
1000	(1)	(	C	H	X	h	x				4	9	*	U	7	X
1001	(2)	)	9	I	Y	i	y				9	7	7	U	7	U
1010	(3)	*	*	J	Z	j	z				7	7	7	U	7	7
1011	(4)	+	*	K	C	k	c				*	9	E	7	7	7
1100	(5)	,	<	L	*	l	l				9	9	9	9	7	7
1101	(6)	-	=	N	J	n	j				7	*	*	7	7	*
1110	(7)	.	>	N	^	n	*				9	9	9	9	9	9
1111	(8)	/	?	O	L	o	e				9	9	9	9	9	9



## 10. Notes 1. Liquid

crystal display (LCD) LCD is

made of glass, organic sealant, organic fluid, and polymer-based polarizer. The following matters should be noted when handling: (1) Keep the temperature within the range of use and storage. Excessive temperature and humidity can cause polarization degradation, polarizer peeling, or bubbles. (2). Do not touch the exposed polarizer with anything harder than HB pencil lead. Remove the dust on the monitor surface by gently using cotton Wipe, deerskin towel or other soft material soaked in cleaning oil. (3)

Wipe off saliva or water droplets immediately. Excessive contact time between ITO and water will cause the surface of the LCD display to deform or discolor. (4) Glass can easily break due to rough handling. Especially in corners and edges. (5). Do not use DC voltage to drive the LCD display.

## 2. LCD Module 2.1

### Mechanical Precautions

The LCM is assembled and adjusted with high precision. Avoid excessive vibration and do not make any changes or modifications. The following points should be noted. (1). Do not alter the lugs on the metal frame in any way. (2) . Do not modify the PCB by drilling additional holes, changing its outline, moving its components, or modifying its pattern. (3). Do not touch the elastomer connector, especially when plugged into a backlight panel (e.g., EL). (4). When installing the LCM, please ensure that the PCB board is not subject to any pressure, such as bending or twisting. Elastomer contacts are very delicate and the slightest misalignment of any element can result in missing pixels. (5). Avoid pressing against the metal bezel, otherwise the elastomer connector may deform and lose contact, resulting in

lost pixels. 2.2. Static LCM contains CMOS LSI, the same precautions should be taken for such

devices, namely (1). When the operator comes into contact with the module, it should be grounded. Never touch any conductive parts such as LSI pads, copper wires on PCB, and interface terminals with any part of your body. (2). Modules should be stored in anti-static bags or other anti-static containers. (3). Only use a properly grounded soldering iron. (4). If an electric screwdriver is used, it should be well grounded and prevent sparks from the commutator. (5). Work clothes and workbenches should comply with normal anti-static measures; for the latter, the use of conductive (rubber) mats is recommended. (6). Since dry air induces static electricity, a

relative humidity of 50-60% is

recommended. 2.3. Soldering (1) . Solder to I/O terminals only.

(2) Only use a soldering iron that is properly grounded and has no leakage.

(3). Welding temperature:  $280 \pm 10$  (4). Welding time: 3 to 4

seconds. (5). Use low-temperature solder filled with resin flux. (6). If flux is used, the LCD surface should be covered to avoid flux splashing. Flux residue

should be removed after shielding. 2.4. Operation (1) The viewing angle can be

adjusted by changing the LCD driving voltage  $V_0$ . (2) The driving voltage should be kept within the specified range. Excessive voltage will shorten the life of the display increases with decreasing temperature.

(4). At temperatures above its operating range, the display may turn black or dark blue; this (but do not press the display area domain) may cause some display segments to "break".

(5) Mechanical damage during operation (such as pressing the display area) may cause "breaks" in the line segments.

## 2.5. Storage

If liquid leaks from a damaged glass battery, rinse any exposed body parts with soap and water. Never swallow liquid. Very low toxicity, but caution should always be used.

## 2.6. Limited Warranty

Unless otherwise agreed with the customer, any LCD and IC will be serviced or repaired when electrical and cosmetic defects are found when inspected according to the acceptance criteria within one year from the date of shipment. Confirmation of this date shall be with the shipping document. Subject to this, warranty liability is limited to repairs and/or replacements made in accordance with the above terms. will not be held responsible for any subsequent or consequential events.