深圳市天微电子有限公司
地址：深圳市南山区高新技术产业园北区紫光信息港A栋10层
原厂销售总部：手机18682063283 QQ：709072958 E-mail: 709072958@qq.com

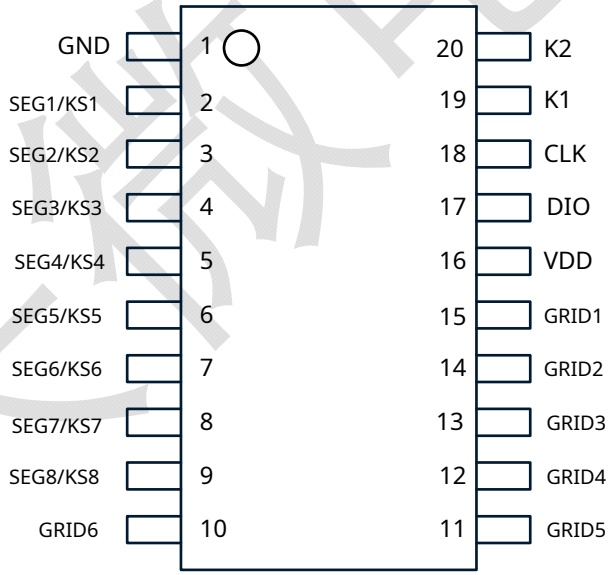
Feature description

TM1637 is a special circuit for LED (light emitting diode display) drive control with a keyboard scanning interface. It integrates MCU digital interface, data latch, LED high-voltage driver, keyboard scanning and other circuits. This product has excellent performance and reliable quality. Mainly used in display drivers for induction cookers, microwave ovens and small household appliances. Adopt DIP/SOP20 packaging form.

Features

- Using power CMOS technology
- Display mode (8 segments × 6 bits), supports common anode digital tube output
- Key scanning (8×2bit), enhanced anti-interference key recognition circuit
- Brightness adjustment circuit (8 levels of duty cycle adjustable)
- Two-wire serial interface (CLK, DIO)
- Oscillation mode: built-in RC oscillation (450KHz+5%)
- Built-in power-on reset circuit
- Built-in automatic blanking circuit
- Packaging form: DIP20/SOP20

Pin information



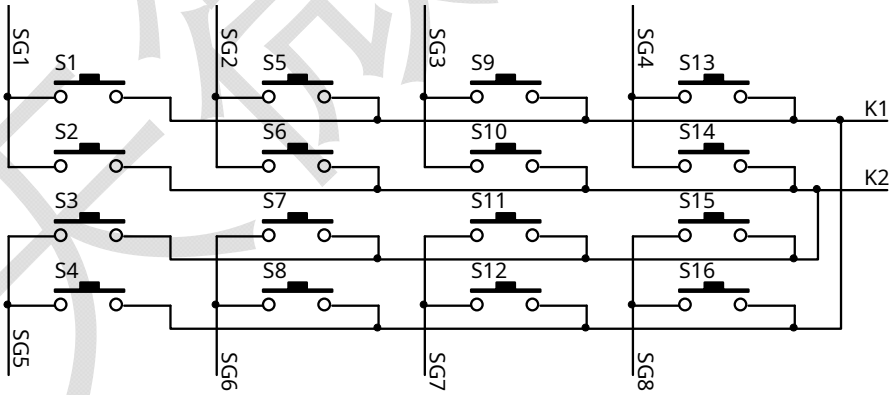
Pin function

symbol	Pin name	Pin number	illustrate
DIO	Data input/output out	17	Serial data input/output, the input data changes at the low level of SLCK and is transmitted at the high level of SCLK. Each time a byte is transmitted, an ACK will be generated inside the chip on the falling edge of the eighth clock.
CLK	clock input	18	Input/output data on rising edge
K1~K2	Key scan data entry	19-20	The data input to this pin is latched after the display period ends.
SG1~SG8	output(segment)	2-9	Segment output (also used as key scan) N tube open drain output
GRID6~GRID1	output (bits)	10-15	Bit output, P tube open drain output
VDD	Logic power	16	5V±10%
GND	logically	1	Connect to system ground

During the dry season or in a dry environment, a large amount of static electricity is likely to be generated. Electrostatic discharge may damage integrated circuits. Tianwei Electronics recommends taking all appropriate preventive measures for integrated circuits. Improper operation and welding may cause ESD damage or Performance degrades and the chip cannot function properly.

Read key scan data

The key scan matrix is 8×2bit, as shown below:



When a key is pressed, the key data is read as follows:

	SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8
K1	1110_1111	0110_1111	1010_1111	0010_1111	1100_1111	0100_1111	1000_1111	0000_1111
K2	1111_0111	0111_0111	1011_0111	0011_0111	1101_0111	0101_0111	1001_0111	0001_0111

Note: When no button is pressed, the read key data is: 1111_1111, with the low bit in front and the high bit in the back. In order to improve this problem due to strong interference in kitchen appliance applications such as induction cookers, TM1637 uses a negative edge trigger method to solve the false triggering phenomenon, which is the so-called "key skipping" phenomenon.

Display register address and display mode

This register stores data transmitted from external devices to TM1637 through the serial interface. The addresses 00H-05H are 6 byte units in total, which correspond to the LED lights connected to the SGE and GRID pins of the chip respectively. The distribution is as follows:

When writing LED display data, operate from the display address from low to high, and from the low to high of the data byte.

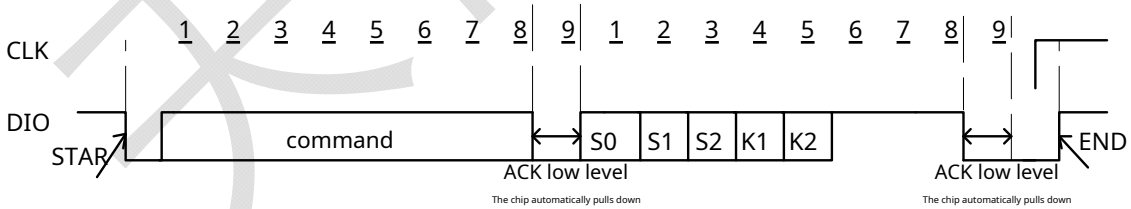
SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	
xxHL (lower four bits)				xxHU (higher four digits)				
B0	B1	B2	B3	B4	B5	B6	B7	
00HL				00HU				**GRID1**
01HL				01HU				**GRID2**
02HL				02HU				**GRID3**
03HL				03HU				**GRID4**
04HL				04HU				**GRID5**
05HL				05HU				**GRID6**

Interface Description

The data of the microprocessor communicates with TM1637 through the two-wire bus interface. When inputting data, when CLK is high level, the signal on DIO must remain unchanged; only when the clock signal on CLK is low level, the signal on DIO can Change. The start condition of data input is that when CLK is high, DIO changes from high to low; the end condition is that when CLK is high, DIO changes from low to high.

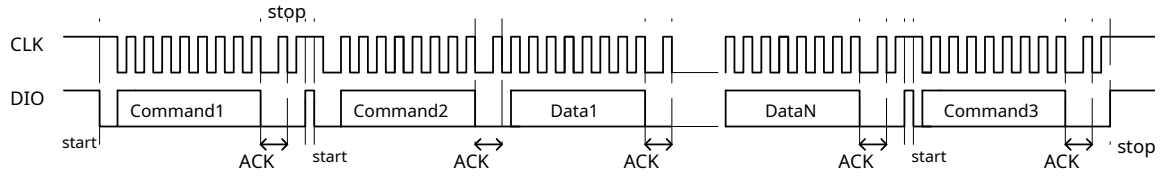
The data transmission of TM1637 has the response signal ACK. When the transmitted data is correct, at the falling edge of the eighth clock, the chip will generate a response signal ACK to pull the DIO pin low, and release the DIO after the end of the ninth clock. Oral line.

1. The command data transmission process is as shown below (reading key data timing)



Command: Read key instructions; S0, S1, S2, K1, and K2 form the key information code. S0, S1, and S2 are the codes of SGn, and K1 and K2 are the codes of the K1 and K2 keys. When reading the keys, the clock frequency should be less than 250K , read the low bit first, then the high bit.

2. Write SRAM data address automatically increment by 1 mode



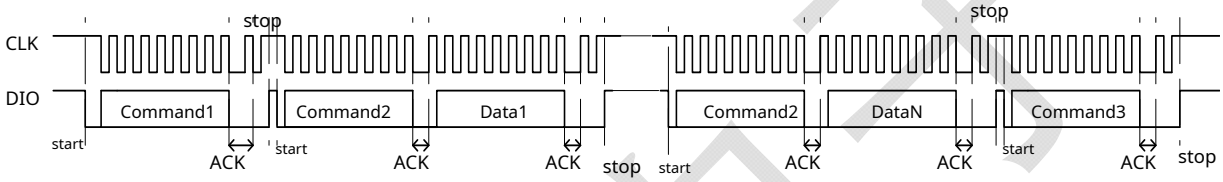
Command1: Set data

Command2: Set address

Data1~N: Transmit display data

Command3: Control display

3. Write SRAM data fixed address mode



Command1: Set data

Command2: Set address

Data1~N: Transmit display data

Command3: Control display

data instructions

Instructions are used to set the display mode and LED driver status.

The first byte input by DIO after the falling edge of CLK is treated as an instruction. After decoding, the highest two bits B7 and B6 are taken to distinguish different instructions.

B7	B6	instruction
0	1	Data command settings
1	0	Display control command settings
1	1	Address command settings

If a STOP command is sent during command or data transmission, serial communication is initialized and the command or data being transmitted is invalid (the previously transmitted command or data remains valid)

1. Data command settings

This instruction is used to set data writing and reading. B1 and B0 bits are not allowed to be set to 01 or 11. **MSB**

LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	illustrate
0	1	Irrelevant items, fill in 0				0	0	Data read and write mode settings	Write data to display register
0	1					1	0		Read key scan data
0	1				0			Address addition mode setting	Automatic address addition
0	1				1				fixed address
0	1			0				Test mode settings (within	Normal mode
0	1			1				(Partial use)	test mode

2. Address command settings

MSB **LSB**

B7	B6	B5	B4	B3	B2	B1	B0	Show address
1	1	Irrelevant items, fill in 0		0	0	0	0	00H
1	1			0	0	0	1	01H
1	1			0	0	1	0	02H
1	1			0	0	1	1	03H
1	1			0	1	0	0	04H
1	1			0	1	0	1	05H

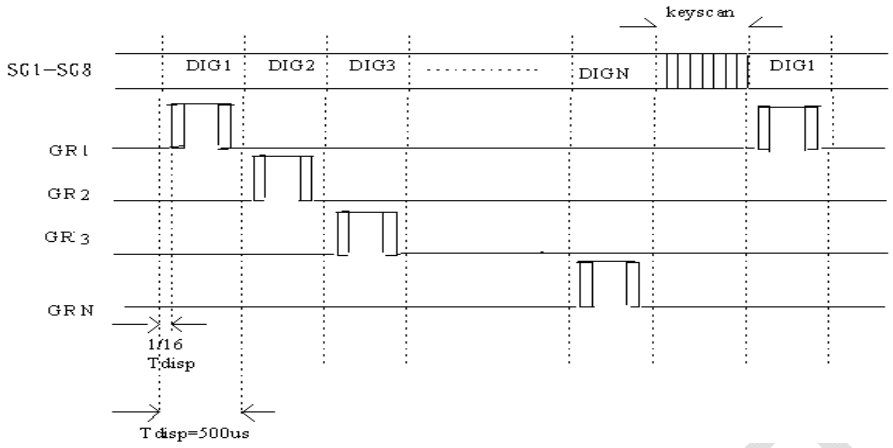
This command is used to set the address of the display register; if the address is set to 0C6H or higher, the data is ignored until the effective address is set; when powered on, the address is set to 00H by default.

3. Display control

MSB LSB

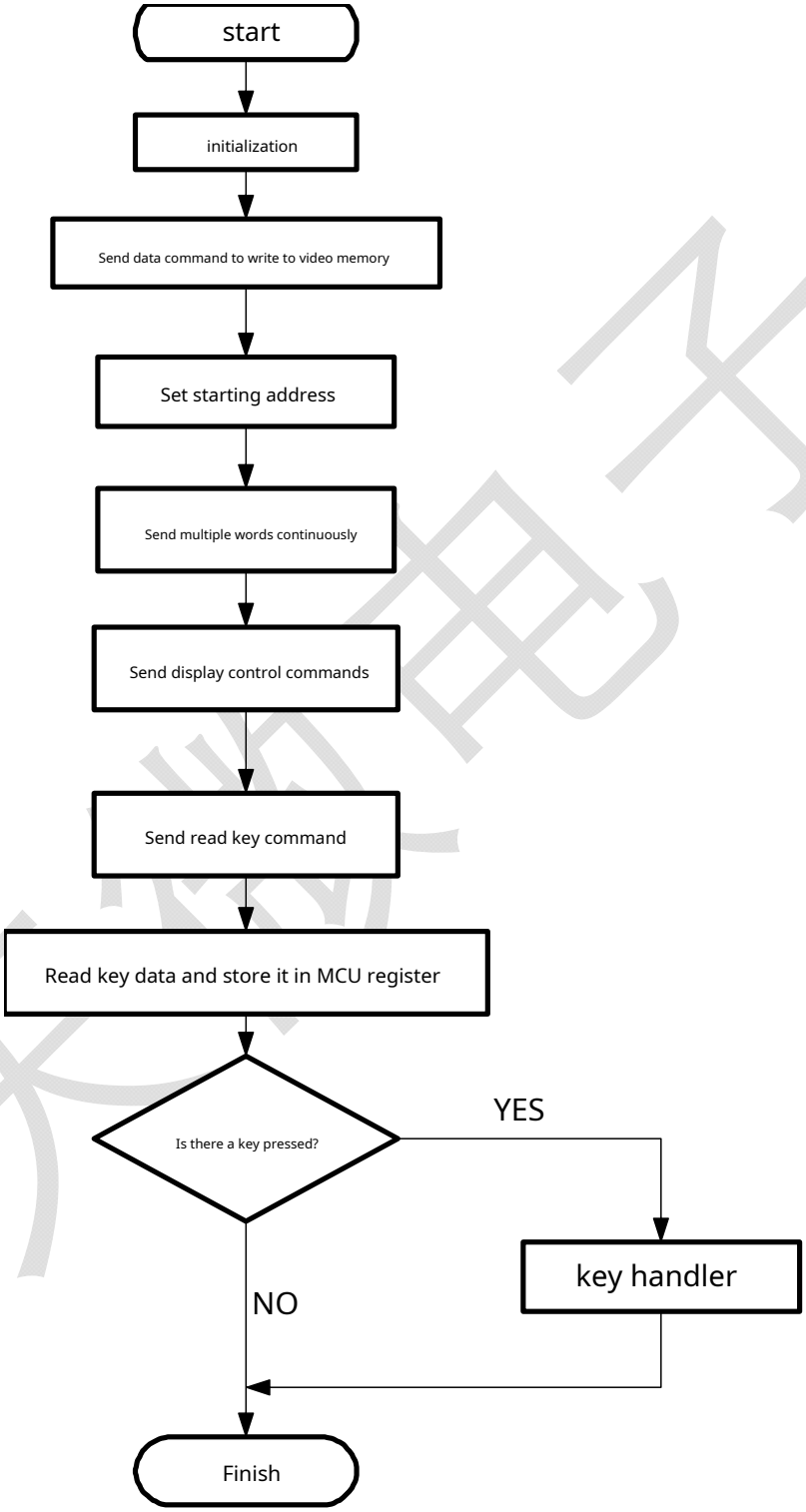
B7	B6	B5	B4	B3	B2	B1	B0	Function	illustrate
1	0	Irrelevant items, fill in 0			0	0	0	Extinction quantity setting	Set pulse width to 1/16
1	0				0	0	1		Set pulse width to 2/16
1	0				0	1	0		Set pulse width to 4/16
1	0				0	1	1		Set pulse width to 10/16
1	0				1	0	0		Set pulse width to 11/16
1	0				1	0	1		Set pulse width to 12/16
1	0				1	1	0		Set pulse width to 13/16
1	0				1	1	1		Set pulse width to 14/16
1	0			0				Display switch settings	Show off
1	0			1					Show on

Display and key scan cycles

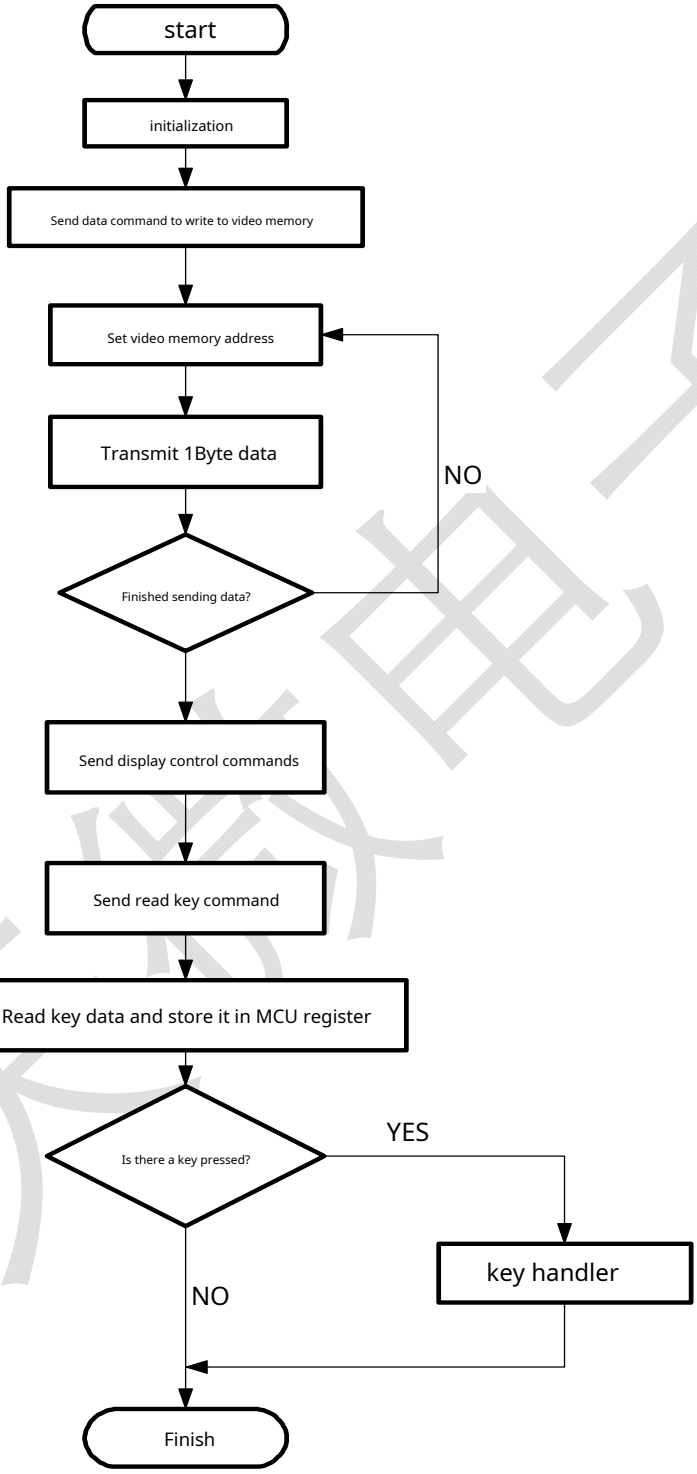


Program flow chart

1. Program flow chart using address automatic increment mode



2. Programming flow chart using fixed address



Reference procedure

```
/*
* Copyright Information:      Shenzhen Tianwei Electronics
* file name:                  TM1637
* current version:            1.0
* Microcontroller model: AT89S52
* Development environment:    Keil uVision3
* Crystal vibration frequency: 11.0592M
* Program features:           Fill all the display register addresses of TM1637 with data 0xff, turn on the display, and then read the key values.
*/
#include<reg52.h>
#include<intrins.h>
//Define port
sbit clk = P1    2;
sbitdio=P1       1;

///======================================== void
Delay_us(unsigned int i) / /nus delay
{
        for(;i>0;i--)
        _nop_();
}

///====================================== void
I2CStart(void)                    //1637 start
{
        clk = 1;
        dio = 1;
        Delay_us(2);
        dio = 0;
}

///========================================== void
I2Cask (void)                              //1637 response
{
      clk = 0;
       Delay_us(5);                  //Delay 5us after the falling edge of the eighth clock and start judging the ACK signal
       while(dio);
           clk = 1;
      Delay_us(2);
           clk=0;
}
///======================================
```

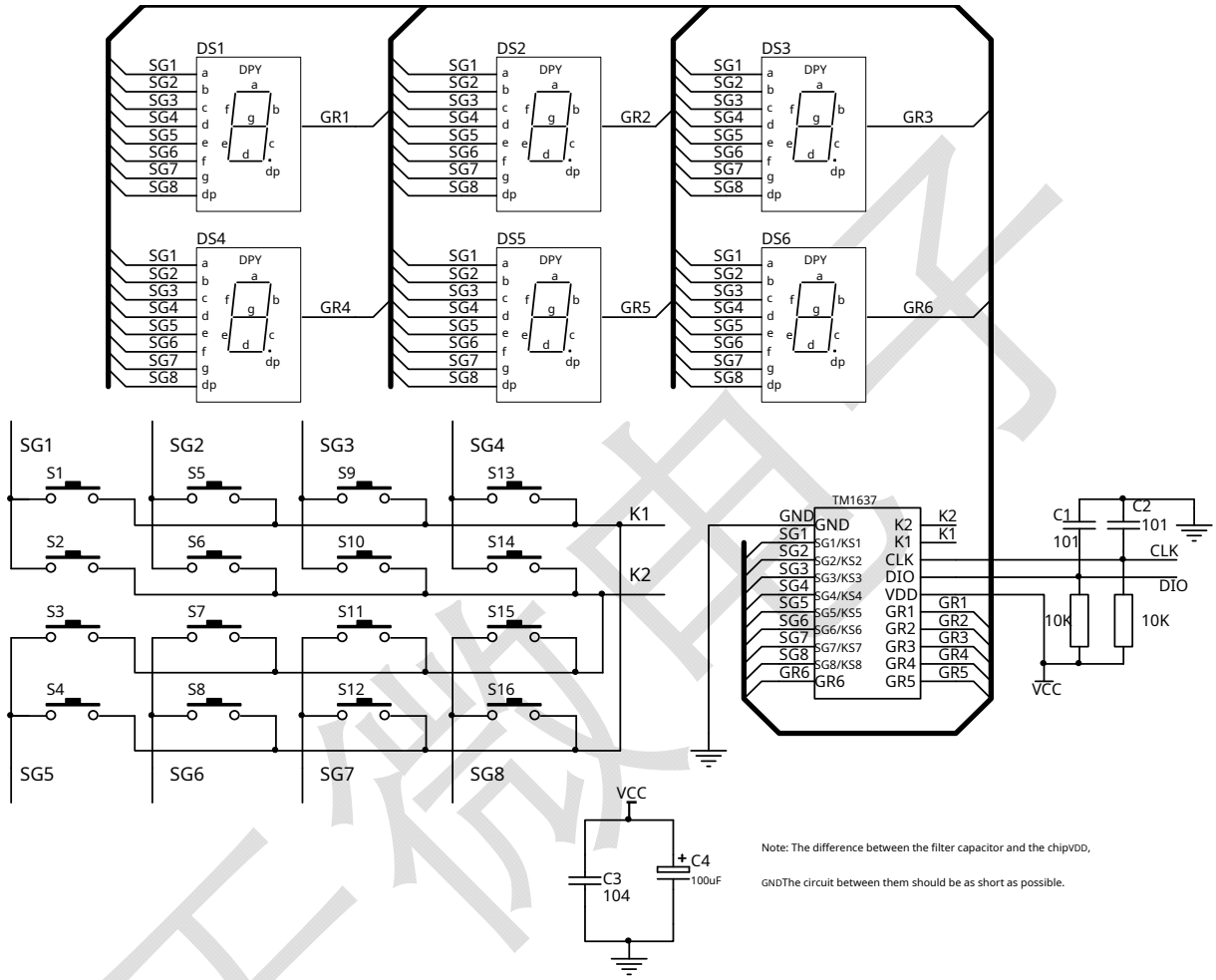
```
void I2CStop(void)                      // 1637 Stop
{
        clk = 0;
        Delay_us(2);
        dio = 0;
        Delay_us(2);
        clk = 1;
        Delay_us(2);
        dio = 1;
}

///========================================= void
I2CWrByte(unsigned char oneByte ) //Write a byte {

    unsigned char i;
        for(i=0;i<8;i++)
        { clk = 0;
            if(oneByte&0x01)            //low bit first
            {
                dio = 1;
            }
              else
            {
                dio = 0;
            }
             Delay_us(3);
            oneByte=oneByte>>1;
            clk=1;
            Delay_us(3);
        }
}

///---------------------------------------------- --
unsigned char ScanKey(void)                 //read button
{
     unsigned char rekey,rkey,i;
        I2CStart();
        I2CWrByte(0x42);                    //Read key commands
        I2Cask();
        dio=1;                              //Pull the data line high before reading the button
        for(i=0;i<8;i++)                    //Start reading from the low bit
        { clk=0;
            rekey=rekey>>1;
```

```
                Delay_us(30);
                clk=1;
                if(dio)
                {
                    rekey=rekey|0x80;
                }
                else
                {
                    rekey=rekey|0x00;
                }
                Delay_us(30);
            }
            I2Cask();
          I2CStop();
        return (rekey);
}

///================================================ = void
SmgDisplay(void)                                    //Write display register
{
    unsigned char i;
    I2CStart();
    I2CWrByte(0x40);                                // 40H address automatically increases by 1 mode, 44H fixed address mode, this program adopts
Use self-increment 1 mode
    I2Cask();
    I2CStop();
    I2CStart();
    I2CWrByte(0xc0);                                //Set the first address,
    I2Cask();

      for(i=0;i<6;i++)                              //The address is added automatically, there is no need to write the address every time
       {
            I2CWrByte(0xff);                        //Send data
            I2Cask();
     }
       I2CStop();

       I2CStart();
       I2CWrByte(0x8f);                             //Open display , maximum brightness
       I2Cask();
       I2CStop();
}
///================================================
```

```
void init()                                    //Initialize subroutine
{
    //Initialization abbreviation
}

///============================================== void
main(void)
{
    unsigned char keydate;
    init();                                    //initialization
    SmgDisplay();                              //Write register and turn on display
    while(1)
    {
        keydate=Scankey();                     //Read the key value, and the read key value will not be processed.
    }
}
//===========end==================================
```

Hardware connection diagram

The digital tube connected in the circuit diagram is a common anode digital tube.



Note: The difference between the filter capacitor and the chip$_{VDD}$, $_{GND}$The circuit between them should be as short as possible.

Electrical parameters:

1. Limit parameters (Ta = 25℃, Vss = 0 V)

parameter	symbol	scope	unit
Logic supply voltage	VDD	- 0.5 ~ +7.0	V
Logic input voltage	VI1	- 0.5 ~ VDD + 0.5	V
LED SEG drive output current	IO1	- 200	mA
LED GRID driver output current	IO2	+20	mA
Power loss	PD	400	mW
Operating temperature	Topt	- 40 ~ +85	℃
Storage temperature	Txt	- 65 ~ +150	℃

2. Normal working range (Ta = -40～+85℃, Vss = 0 V)

parameter	symbol	smallest	typical	maximum	unit	Test Conditions
Logic supply voltage	VDD		5		V	-
High level input voltage	VIH	0.7 VDD	-	VDD	V	-
low level input voltage	VIL	0	-	0.3 VDD	V	-

3. Electrical characteristics (Ta = -40～+85℃, VDD = 4.5～5.5 V, Vss = 0 V)

parameter	symbol	smallest	typical	maximum	unit	Test Conditions
High level output current	Ioh1	- 20	- 25	- 40	mA	GRID1~GRID6, Vo = vdd-2V
	Ioh2	- 20	- 30	- 50	mA	GRID1~GRID6, Vo = vdd-3V
Low level output current	IOL1	80	140	-	mA	SEG1~SEG8 Vo=0.3V
Low level output current	IDout	4	-	-	mA	VO = 0.4V,dout
High level output current allowable amount	Itolsg	-	-	5	%	VO = VDD – 3V, GRID1～GRID6

Output pull-down resistor	RL		10		KΩ	K1~K2
Input Current	II	-	-	±1	μA	VI = VDD/VSS
High level input voltage	VIH	0.7 VDD	-		V	CLK,DIN
low level input voltage	VIL	-	-	0.3 VDD	V	CLK,DIN
hysteresis voltage	VH	-	0.35	-	V	CLK,DIN
Dynamic current consumption	IDDDyn	-	-	5	mA	No load, display off

4. Switching characteristics (Ta = -40～+85℃, VDD = 4.5～5.5 V)

parameter	symbol	smallest	typical	maximum	unit	Test Conditions	
Oscillation frequency	fosc	-	450	-	KHz		
transmission delay time	tPL	-	-	300	ns	CLK → DIO	
	htK	-	-	100	ns	CL = 15pF, RL = 10KΩ	
Rise Time	TTZH 1	-	-	2	μs	CL = 300pF	GRID1～GRID6
	TTZH 2	-	-	0.5	μs		SEG1～SEG8
Fall time	TTHZ	-	-	120	μs	CL = 300pF,Segn, Gridn	
maximum clock frequency	Fmax	-	-	500	KHz	Duty cycle 50%	
Input capacitance	CI	-	-	15	pF	-	

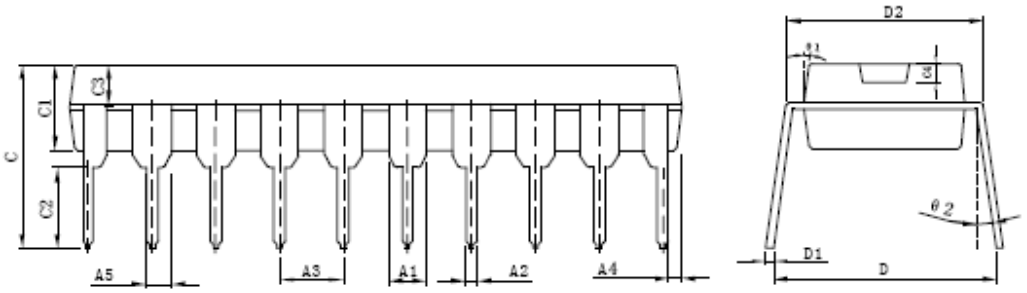
5. Timing characteristics (Ta = -40 ~ +85℃, VDD = 4.5 ~ 5.5 V)

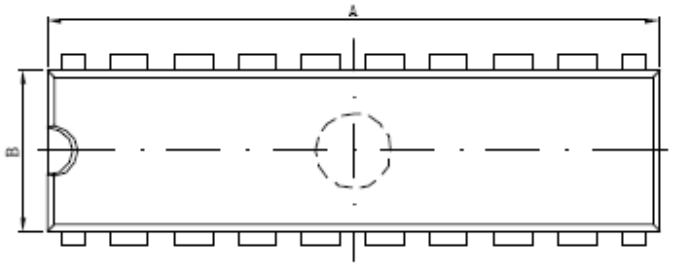
parameter	symbol	smallest	typical	maximum	unit	Test Conditions
clock pulse width	PWCLK	400	-	-	ns	-
Data creation time	tSETUP	100	-	-	ns	-
Data retention time	tHOLD	100	-	-	ns	-
waiting time	tWAIT	1	-	-	μs	CLK↑→CLK↓

IC packaging diagram

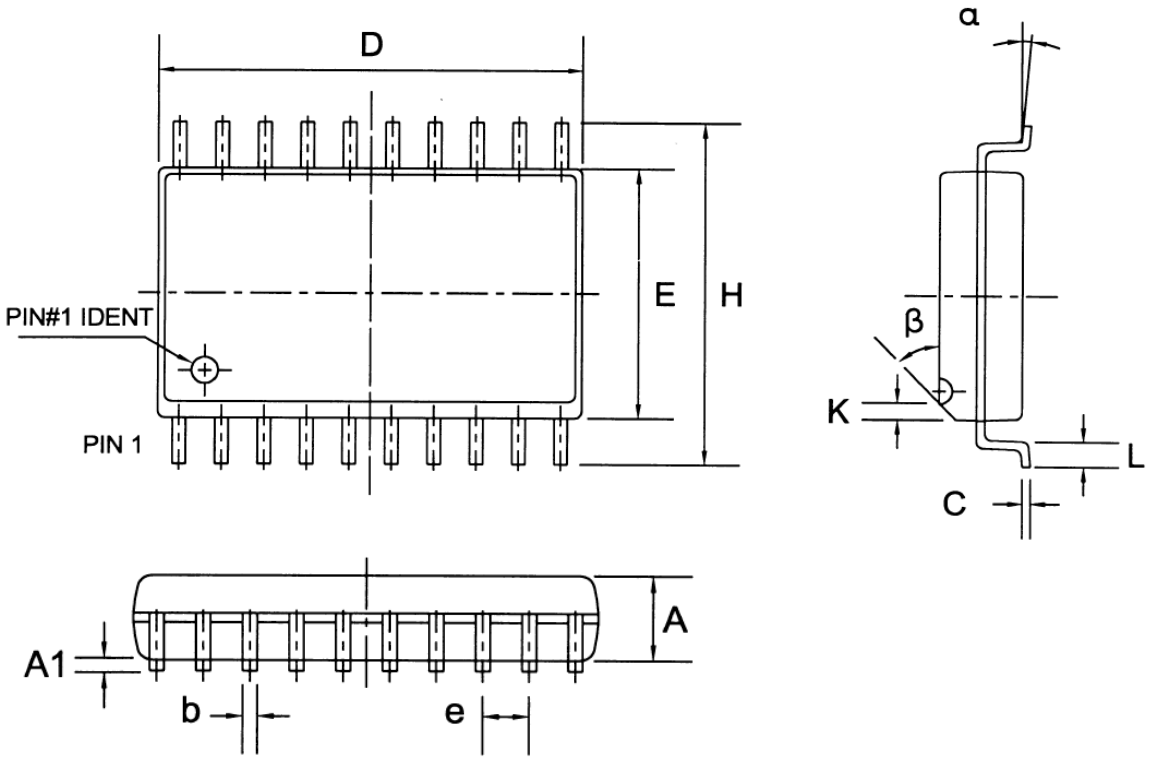
DIP20

尺寸 / 标注	最 小（mm）	最 大（mm）	尺寸 / 标注	最 小（mm）	最 大（mm）
A	24.50	24.70	C2	2.9	
A1	1.40TYP		C3	1.56TYP	
A2	0.43	0.57	C4	0.80TYP	
A3	2.54TYP		D	7.87	8.60
A4	0.62TYP		D1	0.20	0.35
A5	0.95TYP		D2	7.62	7.87
B	6.3	6.5	θ1	8° TYP	
C	7.5TYP		θ2	5° TYP	
C1	3.30	3.50			





SOP20



Symbol	Dimensions In Millmeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	2.15	2.35	2.55	0.085	0.093	0.100
A1	0.05	0.15	0.25	0.002	0.006	0.010
b	—	0.40	—	—	0.016	—
C	—	0.25	—	—	0.010	—
D	12.40	12.70	13.00	0.488	0.500	0.512
E	7.40	7.65	7.90	0.291	0.301	0.311
e	—	1.27	—	—	0.050	—
H	10.15	10.45	10.75	0.400	0.411	0.423
K	—	0.50	—	—	0.020	—
L	0.60	0.80	1.00	0.024	0.031	0.039
α	0°	—	8°	0°	—	8°
β	—	45°	—	—	45°	—

Modify the description

Version	Modification date	Modify the description
Ver1.0	2011-06-28	Original Issue
Ver2.0	2011-09-22	1.Change the description of ack signal 2. Change the program error of ack signal in the routine
Ver1.2	2012-08-12	1. Modify the layout format 2. Modify the STOP timing in the routine 3. Modify the description of the ACK signal