



# SM1612

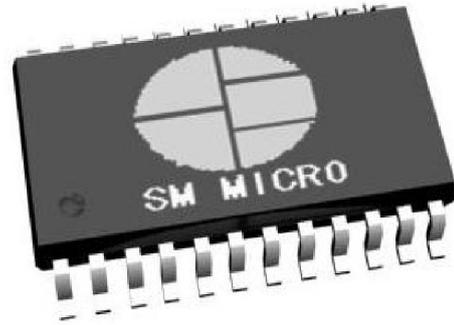
## Introduction:

The SM1612, which has keyboard scanning interface, is specially used for LED driving and controlling. It consist of many circuit, such as MCU digital interface, I2C crewel transport protocols, buzzer driving, digital flip-latch, LED driving, keyboard scanning and so on. Meanwhile, It has pull-up resistor inside the input port, so users can leave out outside pull-up resistor when using in practical circuit. Therefore, It is convenient and low-cost.

## Characteristic:

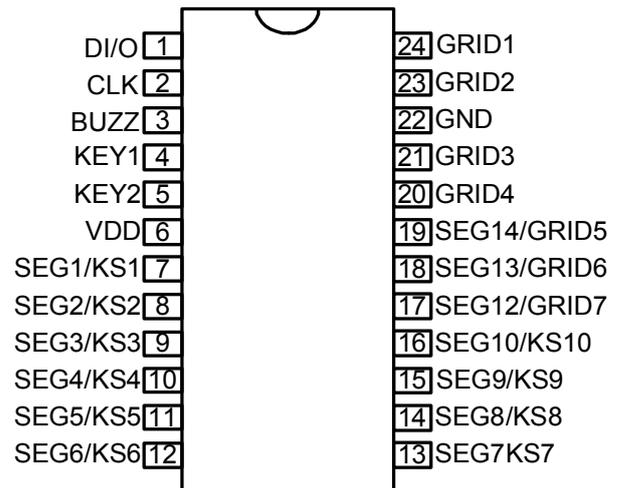
- ◆ Adopt CMOS technics
- ◆ Adjustable VDD voltage from 3.0 to 5.0V
- ◆ Input port has huge ability of resisting disturber
- ◆ Internal buzzer driving
- ◆ With pull-up resistor inside input port
- ◆ Display mode: 4bits\*13segments — 7bits\*10segments
- ◆ Keyboard scanning: 10\*2bits
- ◆ Gradation adjusting circuit (duty cycle is 8 grade adjustable)
- ◆ Serial interface (CLK, DI/O)
- ◆ Mode of oscillation: with built-in RC oscillating circuit
- ◆ Internal power on resetting circuit
- ◆ ESD HBM: >8KV
- ◆ Packaging form: SOP24

## Package Chart



SOP24

## Pin Configuration



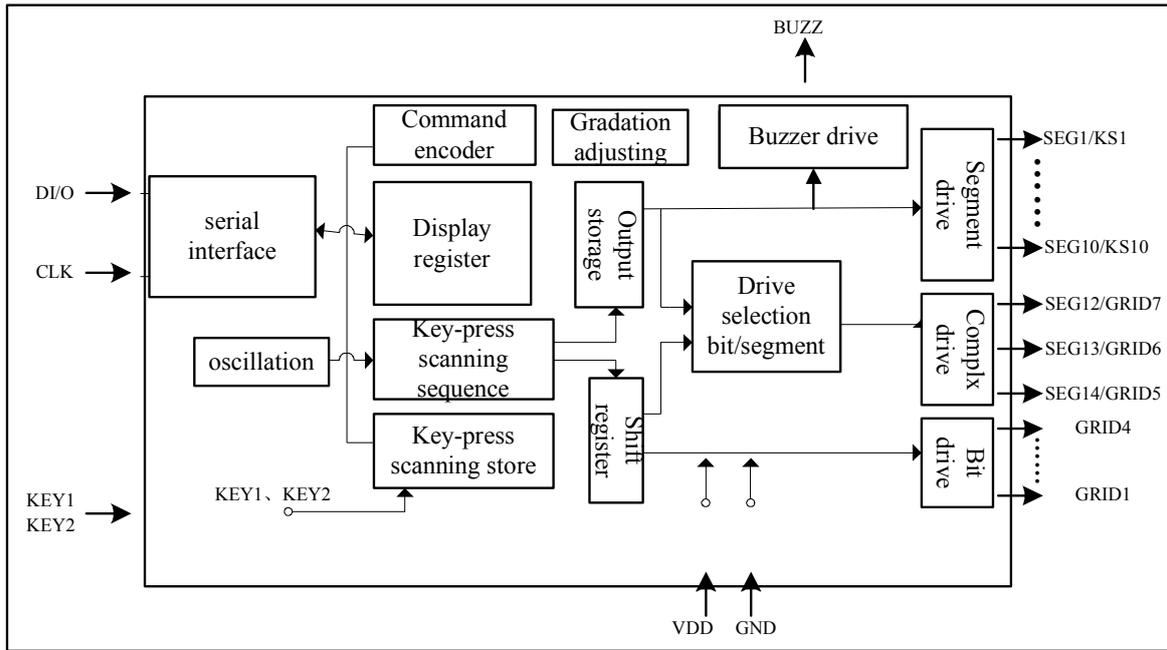


### Application:

- ◆ VCD/DVD/DVB display
- ◆ Induction cooker display
- ◆ Electric cooker display
- ◆ Air-condition display
- ◆ Set top box (STB) display



## BLOCK DIAGRAM



### Pin Description:

Symbol	Pin Name	Pin Number	Description
DI/O	Digital input/output	1	Internal built-in pull-up resistor. It will export serial digital from the high bit at the falling edge of clock and input serial digital from the high bit at the rising edge of clock.
CLK	Clock input	2	With built-in pull-up resistor. It will read serial digital at the rising edge and export the digital at the falling edge of clock.
BUZZ	Buzzer output	3	Export square signal and drive buzzer
KEY1—KEY2	Keyboard scanning signal input	4—5	The signal of keyboard scanning will be latched at the end of display cycle.
SEG1/KS1—SEG10/KS10	Segment output	7—16	P tube open drain output, the pin also use for keyboard scanning.
SEG12/GRID7—SEG14/GRID5	Segment/bit output	17—19	Segment/bit drive output
VDD	Logic power supply	6	5V±10%
GRID3—GRID4	Bit output	20—21	N tube open drain output



GND	Logic ground	22	The ground of IC
GRID1—GRID2	Bit output	23—24	N tube open drain output

### Electrical Parameter:

Ultimate parameter (Ta = 25°C, if not otherwise noted)

Parameter	Symbol	Range	Unit
Logic voltage of power supply	VDD	-0.5——+7.0	V
logic input voltage	VCLK, VDI/O	-0.5——VDD + 0.5	V
LED SEG drive output current	ISEG	-50	mA
LED GRID drive output current	IGRID	700	mA
Operating temperature	TOPT	-40——+80	°C
Storage temperature	TSTG	-65——+150	°C

### Electrical Characteristic (Ta = 25°C, if not otherwise noted)

Parameter	Symbol	Testing condition	Min	Typ	Max	Unit
Logic voltage of power supply	VDD	-	3.0	5.0	5.5	V
Input voltage of high level	VIH	-	0.7VDD	-	VDD	V
Input voltage of low level	VIL	-	0	-	0.3VDD	V
Static current	IDD	VDD=5.0V, no load, display turn off.	-	-	1.2	mA
SEG drive current	ISEG	VDD=5.0V, SEG→GND	-	-47	-	mA
GRID drive current	IGRID	VDD=5.0V, GRID→VDD	-	650	-	mA
BUZZ drive current	IOH_BUZZ	VDD=5.0V, BUZZ→GND	-	30	-	mA
	IOL_BUZZ	VDD=5.0V, BUZZ→VDD	-	30	-	mA
KEY pull-down resistor	RKEY	-	10	-	25	KΩ
DI/O、CLK pull-up resistor	R	-	-	10	-	KΩ
GRID oscillation frequency	fGRID	VDD=5.0V	-	250	-	Hz
Transmission delay time	tPLZ	VDD=5.0V, CLK→DI/O	-	75	-	ns
	tPZL	CL=15pF	-	50	-	ns
Rise time	tTZH(SEG)	VDD=5.0V, RL=10KΩ, CL=15pF	-	-	2	us
	tTLZ(GRI)		-	-	2	us

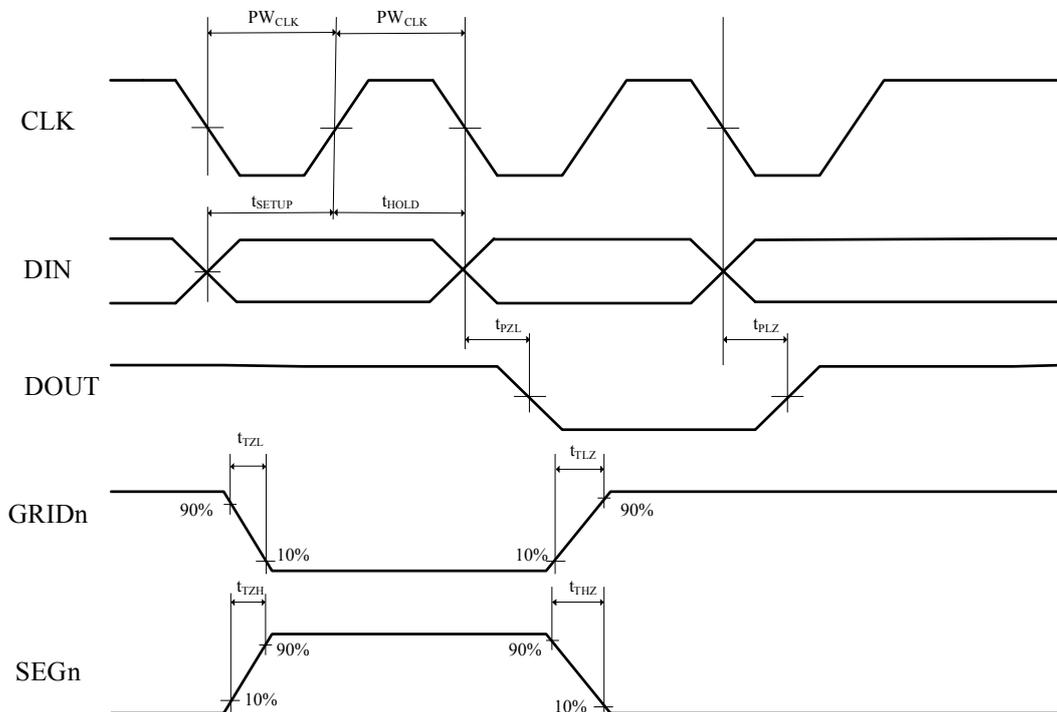


	D)					
Fall time	t <sub>THZ</sub> (SE G)		-	-	2	us
	t <sub>TZL</sub> (GRI D)		-	-	2	us
Buzzer output frequency	f <sub>BUZZ</sub>	Duty cycle50%	-	4	-	KHz
Max clock frequency	f <sub>CLK</sub> (ma x)	Duty cycle50%	-	-	1	MHz

**Sequence Characteristic** (V<sub>DD</sub>=5.0V, T<sub>a</sub>=25°C , if not otherwise noted)

Parameter	Symbol	Testing condition	Min	Typ	Max	Unit
Clock-pulse width	PW <sub>CLK</sub>		500	-	-	ns
Set up time of the data	t <sub>SETUP</sub>		100	-	-	ns
Hold up time of the data	t <sub>HOLD</sub>		100	-	-	ns

**Sequence chart**



Notes: DIN and DOUT is built-in PAD bit of the chip, they combine to DI/O by packaging.

## Function Description

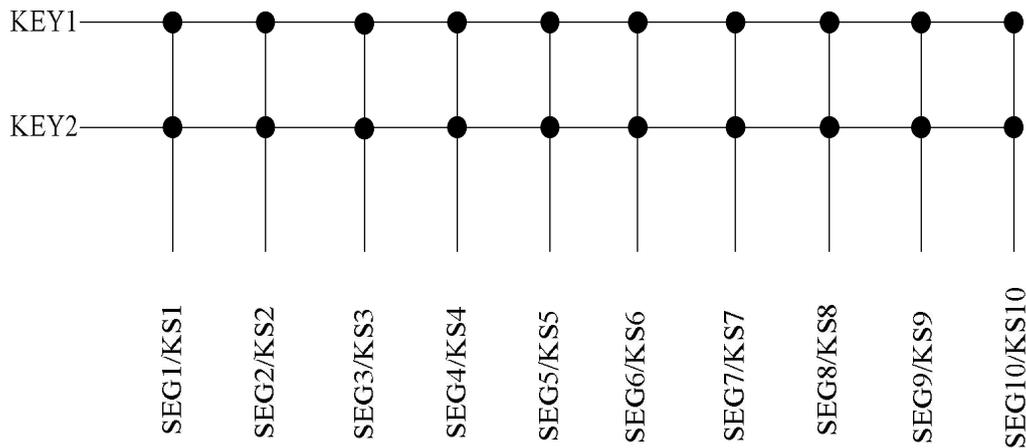
◆ The address of display register and display mode:

This register stores data which is transmitting to SM1612 from outside instrument by serial interface, and address assignment is as follows:

SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	SEG9	SEG10	X	SEG12	SEG13	SEG14	X	X	
b0	b1	b2	b3	b4	b5	b6	b7	b0	b1	b2	b3	b4	b5	b6	b7	Display byte
Display address 00H								Display address 01H								GRID1
Display address 02H								Display address 03H								GRID2
Display address 04H								Display address 05H								GRID3
Display address 06H								Display address 07H								GRID4
Display address 08H								Display address 09H								GRID5
Display address 0AH								Display address 0BH								GRID6
Display address 0CH								Display address 0DH								GRID7

◆ Key-press scanning and data register of key-press scanning

The key-press scanning matrix is 10\*2bits, as follows:



The memory address of key-press data is as follows, and we can use read instruction to read data from the lowest bit.

b7	b6	b5	b4	b3	b2	b1	b0	Key-press byte
KEY1	KEY2	-	KEY1	KEY2	-	-	-	KEY port
SEG1/KS1		0	SEG2/KS2		0	1	1	Sequence of reading byte, from the top down.
SEG3/KS3		0	SEG4/KS4		0	1	1	
SEG5/KS5		0	SEG6/KS6		0	1	1	
SEG7/KS7		0	SEG8/KS8		0	1	1	
SEG9/KS9		0	SEG10/KS10		0	1	1	

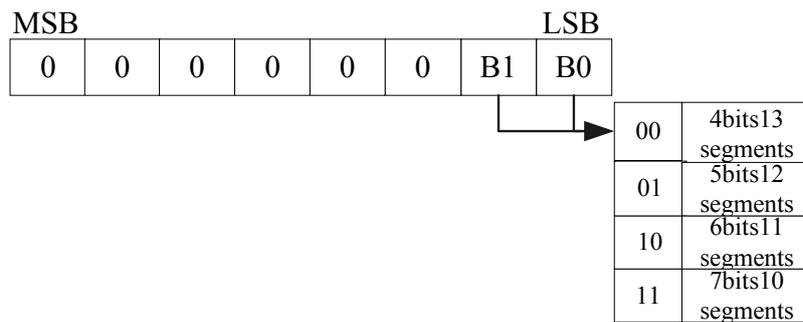


## Instruction description

Instruction is used to set up display mode and the state of LED drivers. After the START signal of I2C protocols, we make the first byte by DI/O pin inputting as an instruction. If it produce STOP signal of I2C protocols in the process of transferring instruction or data, serial communication will be initialized, and the instruction or data that is transferring will be of no effect (the instruction or data that is transferring early will be keep in effect).

### ◆ Set up display mode

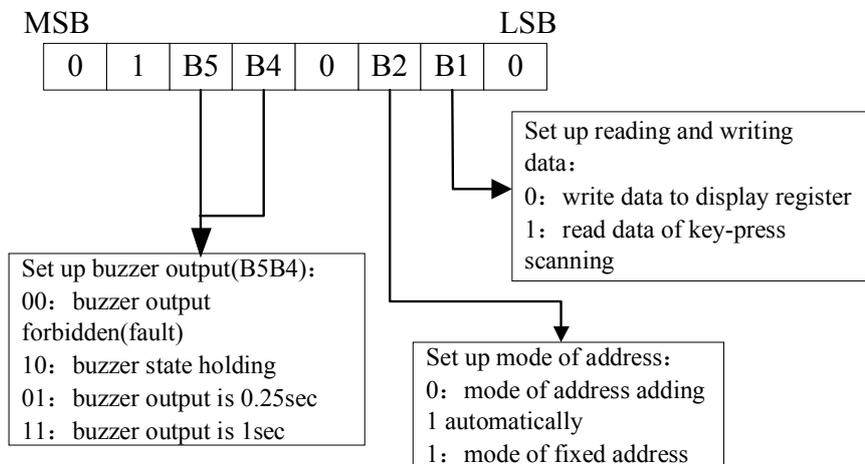
The instruction is used to set up the mount of segments and bits which is choosing, the default is 7bits 10segment when power on. While executing instruction, display is stopped forcibly and key-press signal will be stopped too. If you want to redisplay, you must execute ON instruction which is used for showing the state of turn on/ turn off. If the same mode is installed, the condition above will not happen.



Notes: If command code Command is wrong, it will resend STOP+START+ command code Command+..... , If data DATAn is wrong, it will resend DATAn+......

### ◆ Set up buzzer and data

The instruction is used to set up the output of buzzer, how to adopt address mode and read/write of data.



Notes: 1、 Before the buzzer begin to export, you must set up forbidden state of buzzer first (B5B4=00), make the calculagraph to clear and timing again. Otherwise, buzzer output timing will be wrong.

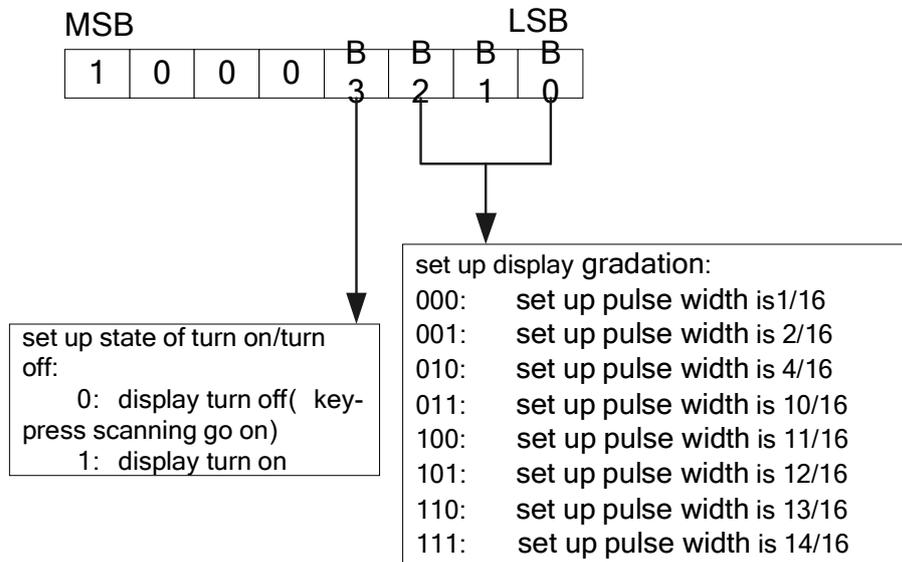
2、 If the buzzer output is 1 sec, you can use B5B4=11 to go on when you use data to set up and It could not affect output of the buzzer. If using key-press instruction to set up, you can use 0X72.



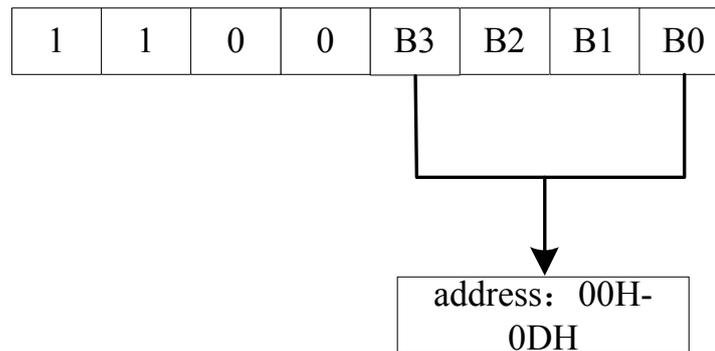
3、When the output of buzzer is 0.25 sec or 1 sec and it is necessary to set up data again in the period of buzzer output, you can make the state of buzzer holding (B5B4=10)。If the output of buzzer is 1sec, and it is necessary to set up data of reading key-press again in the period of the 1 sec, you can write 0x62 behind 0x70.

◆ Display controlling

The instruction is used to display the state of turn on/ turn off and gradation, the default state is turn off when power on。



◆ Command of address setting



◆ Form of serial data transferring

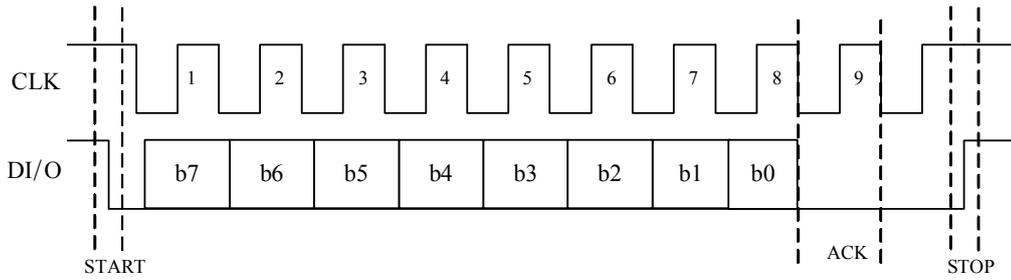
When transferring data, CLK is high level, DI/O (data) must be hold the line; CLK is low level, DI/O (data) could be changed。In the ninth clock, answering signal producing inside the chip will pull DI/O pin down to natural level。

CLK is high level, when the level of DI/O pin change from high to low, it is means that data begin to transferring;

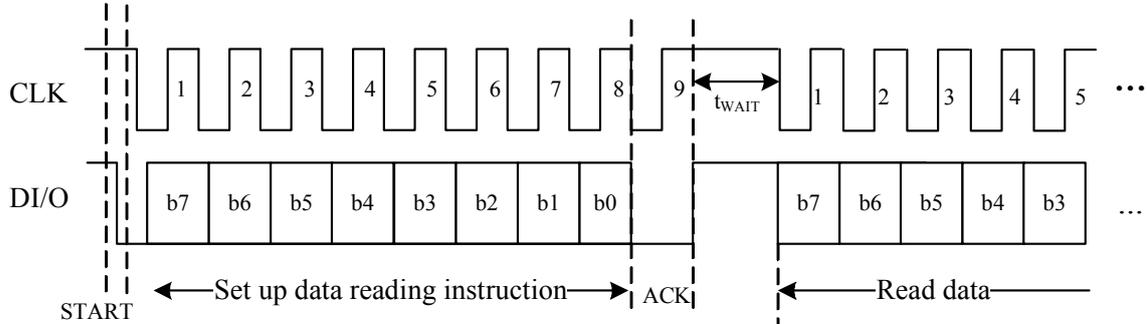
CLK is high level, when the level of DI/O pin change from low to high, it is means that data finish transferring。



Receive data (write data)



Read data

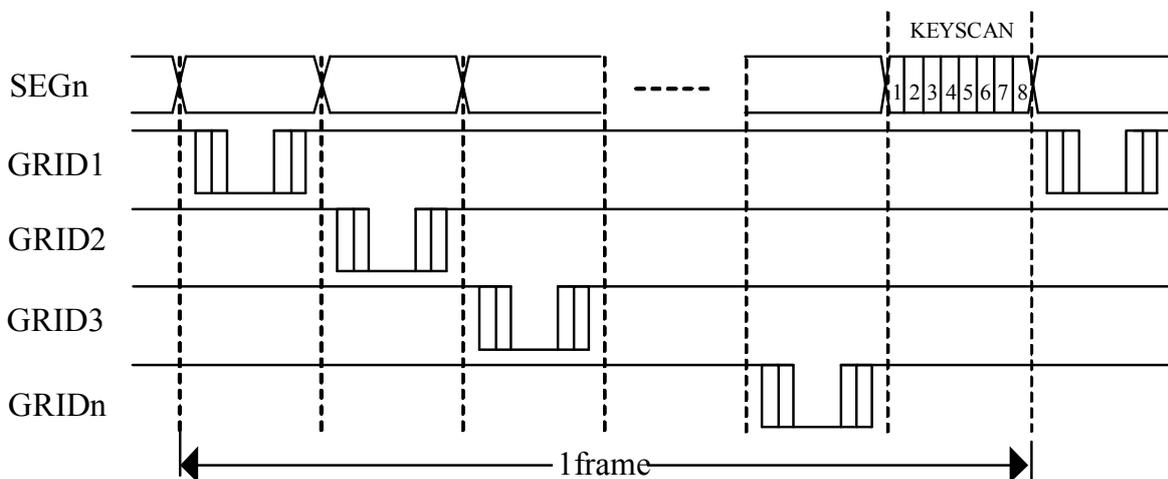


Notes: 1、 $t_{WAIT} \geq 1\mu s$ 。

2、after MCU send the instruction of data reading, it is necessary to release DI/O data bus that you can read right key-press data。

3、In the period of DI/O sending data, output is N tube open drain output, make reference to the signal driving ability in the application project and built-in pull-up resistor of this port, you can read right key-press data。 If MCU sending CLK frequency is too fast to key-press data can not read normally, you can adjust or increase outside pull-up resistor, but the pull-up resistor you added can not be too small, otherwise, the level of MCU input signal will be not matched with the chip。

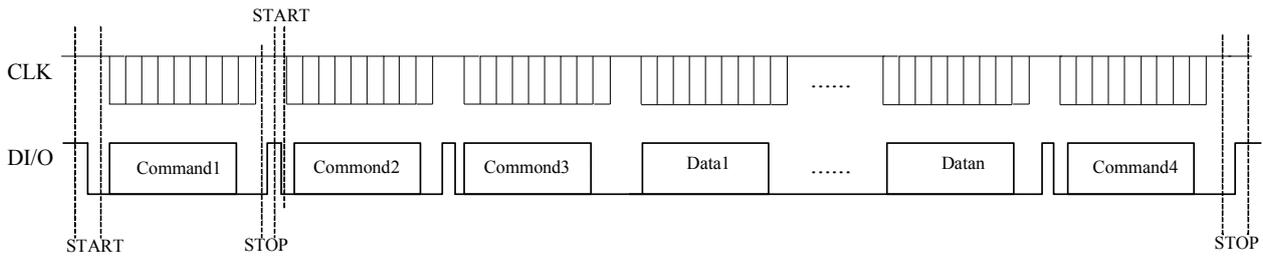
◆ Display and cycle of key-press scanning



Notes: 2frame is a cycle of key-press scanning

◆ Serial data transferring

Mode of address adding 1 automatically



Command1: Set the mode of display

Command2: Set data

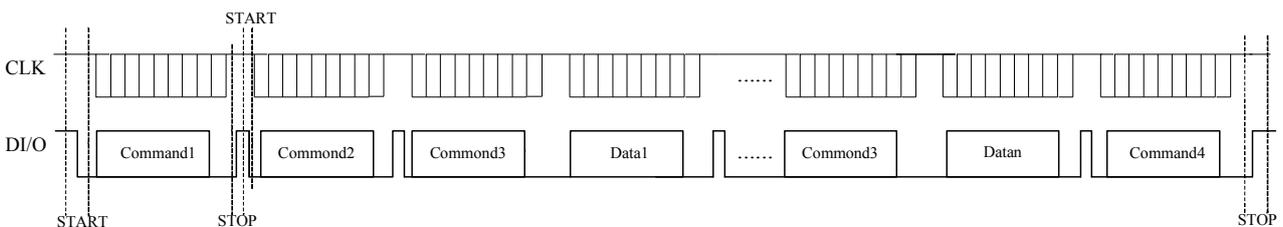
Command3: Setup address

Data1~n : Transmit data display (14 bytes max)

Command4: Display controlling

Notes: the address range of display register is 00H-ODH, 14bits in number. When using continuous address mode to write, if the address is 00H, there will have 14 bytes displaying data in the wake of address 00H; if the address is 01H, then there will be 13 bytes and so on; if the address is n, there will follow 14-n bytes displaying data.

Mode of fixed address



Command1: Set up the mode of display

Command2: Set up data

Command3: Set up address

Data1: Display data 1

Command3: Set up address

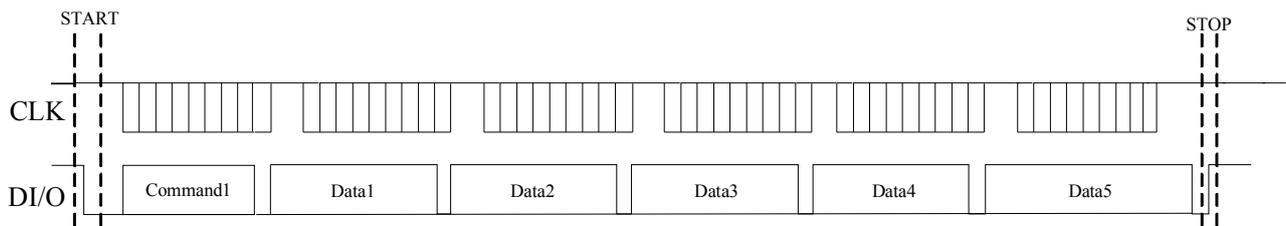
Data2: Display data 2

...

Command4: Display controlling



### Mode of reading key-press



Command1: Set up the mode of reading key-press

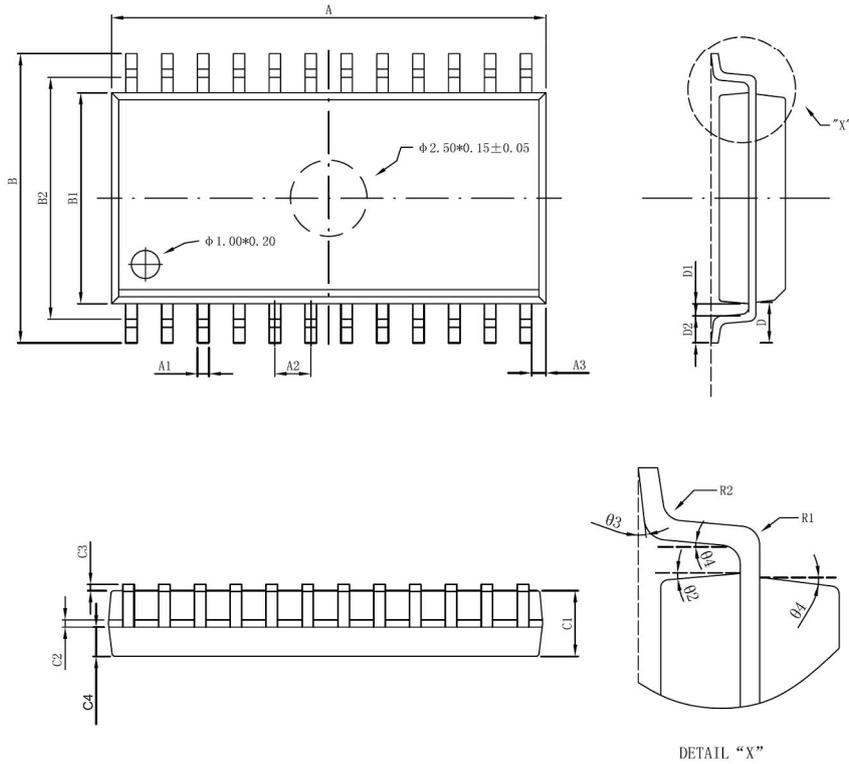
DATA1~n: Key-press data

Notes: Reading every DATA needs 9 clocks(6 clocks of key-press data plus 2 clocks of high level plus 1 clock of ACK), at the seventh and eighth clock of every 9 clocks can produce STOP signal, which could dap the state of reading key-press data. And at the other clocks DI/O might export low level, If the high level driving ability of MCU less than the low level driving ability of DI/O, DI/O will be pull down to low level forcibly, then DI/O signal and CLK signal can not combine to STOP signal, so it will could not dap the state of reading key-press data.



## Packaging form

SOP24



Label	Size	Min(mm)	Max (mm)	Label	Size	Min(mm)	Max (mm)
A		15.28	15.48	C4		0.86TYP	
A1		0406TYP		D		1.34TYP	
A2		1.27TYP		D1		0.33TYP	
A3		0.50TYP		D2		0.70	0.90
B		9.90	10.50	R1		0.25TYP	
B1		7.42	7.62	R2		0.25TYP	
B2		8.7TYP		#1		7°	
C1		2.13	2.23	#2		7°	
C2		0.204	0.33	#3		4°	
C3		0.10	0.23	#4		10°	