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15-Channel Capacitive Touch Sensor IC

Overview

The XW15A is a 15-channel capacitive touch sensor chip, which can replace the mechanical light-touch button and achieve an integrated, sealed and beautiful appearance.

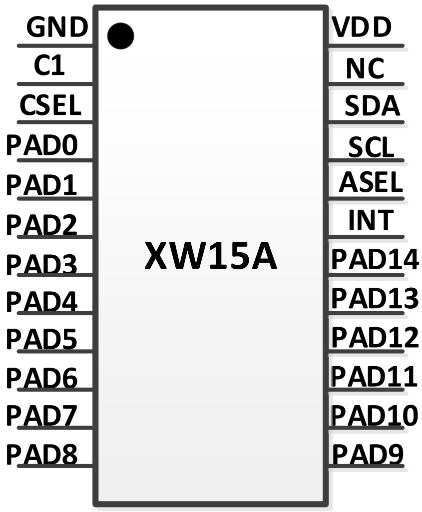
Applications

- Consumer Electronics
- Home Appliances
- Mechanical Button Replacement.

Features

- Extremely high sensitivity, sensing finger touch through 13mm glass(electrode size dependent)
- ESD: ±8KV(HBM)
- Built-in key debounce, no need for software to debounce
- Sleep mode to reduce the power consumption.
- I2C interface for channel state.
- Operating Voltage: 2.9V ~ 5.5V
- Package:SSOP24

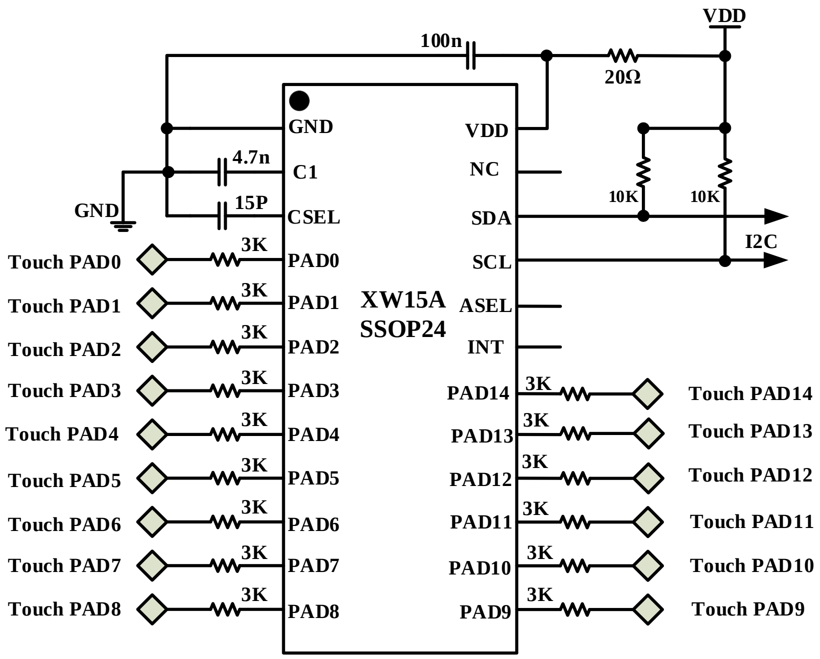
Pin Diagram



Pin Descriptions

NO.	PADNAME	Descrption	NO.	PADNAME	Descrption
1	GND	GND Ground	**24**	VDD	VDD Power
2	C1	Internal Cap interface	**23**	NC	NC
3	CSEL	Sensitivity adjustment capacitor	**22**	SDA	SDA pin for I2C
4	PAD0	Touch buttons (float when not in use)	**21**	SCL	SCL pin for I2C
5	PAD1		**20**	ASEL	I2C address selection PIN
6	PAD2		**19**	INT	Pad-pressed indication PIN(Open drain output)
7	PAD3		**18**	PAD14	Touch buttons (float when not in use)
8	PAD4		**17**	PAD13	
9	PAD5		**16**	PAD12	
10	PAD6		**15**	PAD11	
11	PAD7		**14**	PAD10	
12	PAD8		**13**	PAD9	

Application circuit



- C1 is the internal balance capacitor, the value range is 1nf~10nf. It is recommended to use 4.7nf.
- CSEL is the sensitivity setting capacitor, the smaller the capacitance value, the higher the sensitivity. The value of the C1 is from 10pf to 100pf. According to the application environment and the size of the PAD to choose the value of the C1.
- The 20Ω resistor between the power supply VDD and the chip VDD pin in the above diagram is recommended to be added and shouldn't be omitted.

Rated Operating Conditions

Parameter	Range	Units
VDD	-0.3~5.5	V
IO Voltage	-0.3~5.5	V
Operating temperature	-40~85	℃
Store temperature	-55~150	℃
ESD(HBM)	⩾8000	V

Electrical Specifications

(Ta=25℃，VDD=5V)

Description	Symbol	Condition	Minimum	Typical	Maximum	Units
Operation voltage	Vcc		2.9		5.5	V
Current consumption	Idd	VCC=5.0V		2.15		mA
		VCC=3.0V		1.12		mA
		VCC=5.0V &SLEEP		42		UA
		VCC=3.0V &SLEEP		5		UA
Initialization time when power up	Tini			600		ms
Output impedance (OD output)	Zo	Low level		50		Ohm
		High resistance		100M		
Output irrigation current	Isk	VCC=5V			10.0	mA
Minimum detection capacitance	delta_CX	CSEN=15pf		0.2		pF
Sampling period	Tsi	normal operation condition		15		ms
Standby time	Tidle	No buttons		18		s

Function description

Initialization

The chip needs about 600mS to calculate the environmental parameters after power on, and automatically calibrate the parasitic capacitance.

Automatic Calibration Function

The chip automatically recalibrate and compensate for gradual environmental changes. When any touch PAD is pressed and hold about 48 seconds, the chip will consider the sensing capacitance as environmental factor and automatically recalibrate and compensate it.

PAD-Pressed Indication

The INT pin of the chip is a pad-pressed indication. The internal structure is Everyone channel is detected about 15ms sampling time at every time. The checking time of the buttons which are pressed is 110ms,the checking time of the buttons which are no pressed after the key filtering processing. So the fastest frequency of the detecting buttons is about 5 times per second. You can set the internal register If you want to increase the reaction speed.

Sleep Mode

The chip enters the sleep mode if SDA is high and no pad operation for longer than 18 seconds. The chip will exit the sleep mode if the SDA is pulled low in the 18 seconds. In sleep mode,the PAD sampling interval time is longer, the VDD current decreases, the chip power consumption decreases. if any PAD operation is detected, The chip will exit the sleep mode and operate in the normal mode immediately.

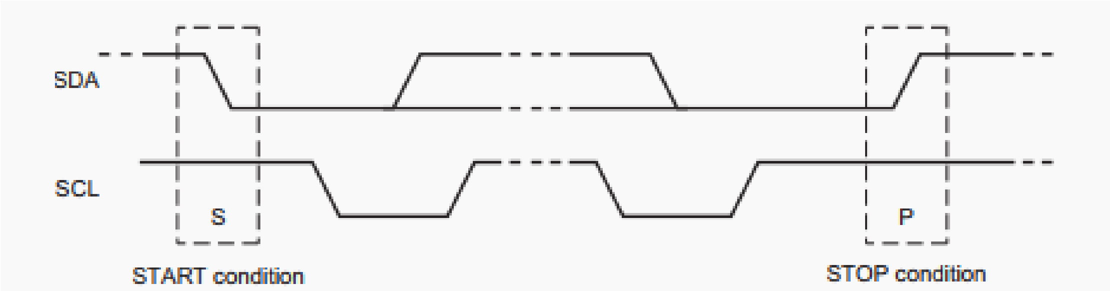
I2C Interface

The XW15A supports the I2C protocol. I2C is a bi-directional, two-wire communication interface with the serial data line SDA and the serial clock line SCL.

START and STOP conditions

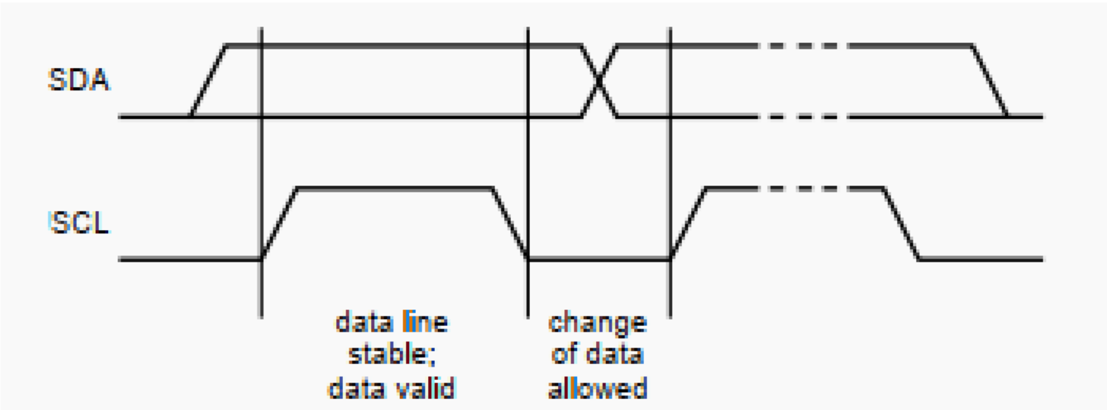
Both data and clock lines remain HIGH when the bus is not busy. All transactions begin with a START (S) and can be terminated by a STOP (P) (see the following figure). A HIGH to LOW transition on the SDA line while SCL is HIGH defines a START condition.

A LOW to HIGH transition on the SDA line while SCL is HIGH defines a STOP condition.



Bit transmission

Each clock pulse transmits one bit of data. The SDA must remain stable when the SCL is high, because the change in the SDA at this time is considered a control signal. Bit transfer refers to the following figure:



Byte format

Byte is consisted of 8-bit data and a response signal.

Device Address

The address of XW15A is shown in the table below.

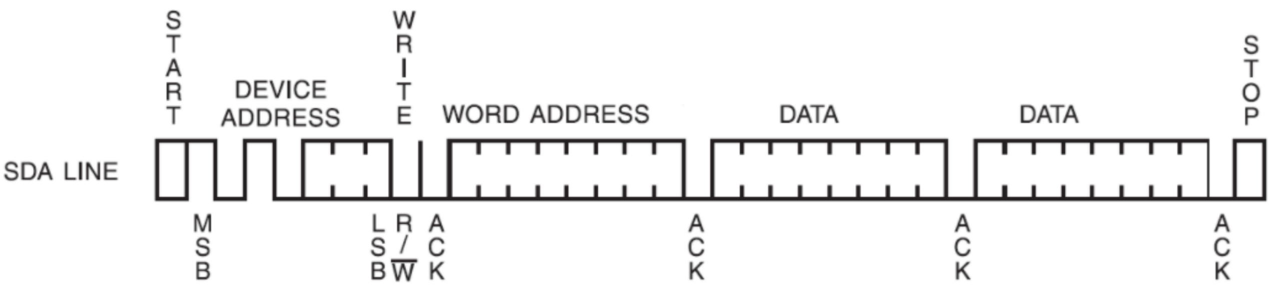
	ASEL is high level	ASEL is float	ASEL is low level
Address (A[6:0])	44H	40H	42H
Read command (A[6:0]+RWB)	89H	81H	85H
Write command (A[6:0]+RWB)	88H	80H	84H

A Complete communication procession

The XW15A supports with write-operation and read-operation as the slave chip：

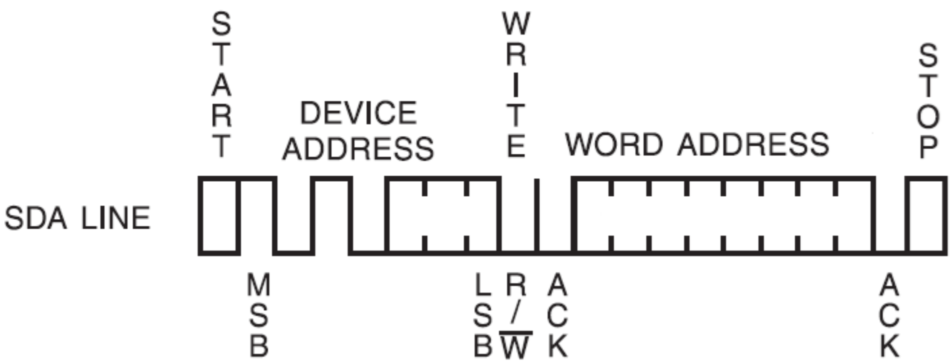
(1) Write-operation:

A: The 7 bit slave-device address and 1 bit write command(RWB=0) make up the first byte.
B: Then it needs to access to the 8-bit register address for the second byte.
C: It starts to the write the data into the register after the second step.
D: It will repeat the B and C step util the master device sends the stop signal.
(Note: The XW15A will respond the acknowledgment after the data.
Bit transfer refers to the following figure.)

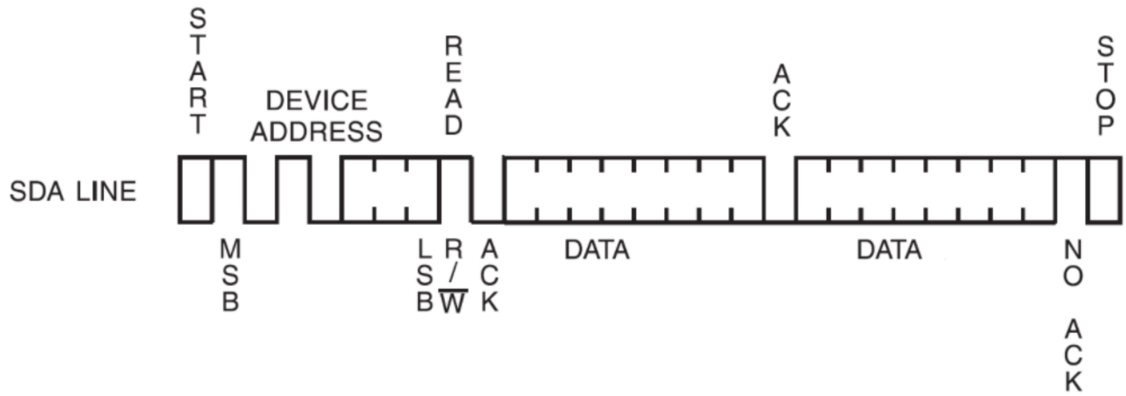


(2)Read-operation:

A: It starts with the first register which is no data on it and ends with the STOP signal. The transfer refers to the following figure.

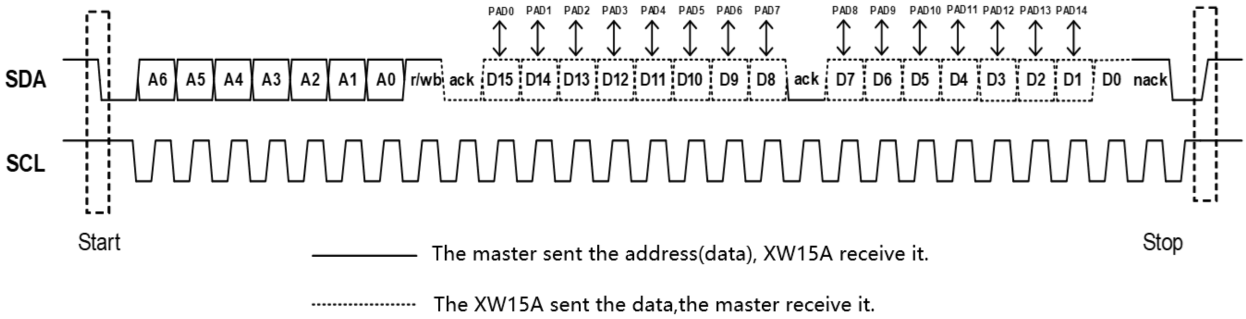


B: The master device sends the start signal, the slave device address with 1bit write command and the following data after the first step. The transfer refers to the following figure.



(3) Simple read-operation:

The primitive register adress of the XW15A is the 00H.It could directly read the pad data as the following time sequence if the other registers have not been written.



XW15A Simple IIC protocol

The list of the registers:

Register	Address (HEX)	R / W	Default (BIN)	The function of the registers							
				Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Output1	00H	R	1111 1111	CH0	CH1	CH2	CH3	CH4	CH5	CH6	CH7
Output2	01H	R	1111 1111	CH8	CH9	CH10	CH11	CH12	CH13	CH14	
CTRL0	02H	W	011 1 1001	SLPCYC[2:0]			RTM	SENSETCOM[3:0]			
CTRL1	03H	W	1000 0000	CHEEN	CHCDEN	CHABEN	CH89EN	CH67EN	CH45EN	CH23EN	CH01EN

(1) The key information registers are the Output1(address:00H) and Output2(address:01H).

The key information of the PAD[14:0] is corresponding to the CH[14:0]. If the PAD is pressed, the data for the PAD is high level, otherwise it is low level.

（2）The function control register is the CTRL0(address:02H)

SENSETCOM[3:0]: The set of the other pads' sensitivity.

The 15th level data of the sensitivity from low to high are：【F】【E】【D】【C】【B】【A】【9】【8】【7】【6】【5】【4】【3】【2】【1】

RTM The setting of the reaction speed when the pad is touched

RTM	0	1（Default）
The pad be touched effective judgment	3 sampling period	6 sampling period
The pad be touched invalid judgment	1 sampling period	4 sampling period

SLPCYC[2:0] The setting of the sampling interval time in the sleep mode

SLPCYC[2:0]	0	1	2	3（Default）	4	5	6	7
sampling interval	Infinite	1T	2T	3T	4T	5T	6T	7T

T≈87ms Vdd=3v

（**3**） The function control register is the CTRL1(address:03H).

CH01EN The register controls whether the channel of the CH0 and CH1 could be waked up or not. 0：not be awakened .1：be awakened

CH23EN The register controls whether the channel of the CH2 and CH3 could be waked up or not. 0：not be awakened .1：be awakened

CH45EN The register controls whether the channel of the CH4 and CH5 could be waked up or not. 0：not be awakened .1：be awakened

CH67EN The register controls whether the channel of the CH6 and CH7 could be waked up or not. 0：not be awakened .1：be awakened.

CH89EN The register controls whether the channel of the CH8 and CH9 could be waked up or not. 0：not be awakened .1：be awakened.

CHABEN The register controls whether the channel of the CH10 and CH11 could be waked up or not. 0：not be awakened .1：be awakened.

CHCDEN The register controls whether the channel of the CH12 and CH13 could be waked up or not. 0：not be awakened .1：be awakened.

CHEEN The register controls whether the channel of the CH14 could be waked up or not. 0：not be awakened .1：be awakened.

Application Notes

XW15A has the simplify PCB design for only the few capacitors and resisters needed.

Internal balance capacitance and sensitivity

C1 capacitor and CSEL capacitor are recommended to use 10% precision NPO material capacitor. Please place the C1 capacitor and CESL capacitor as close to the IC as possible when layout the PCB board.

Sensitivity capacitance and PAD consideration

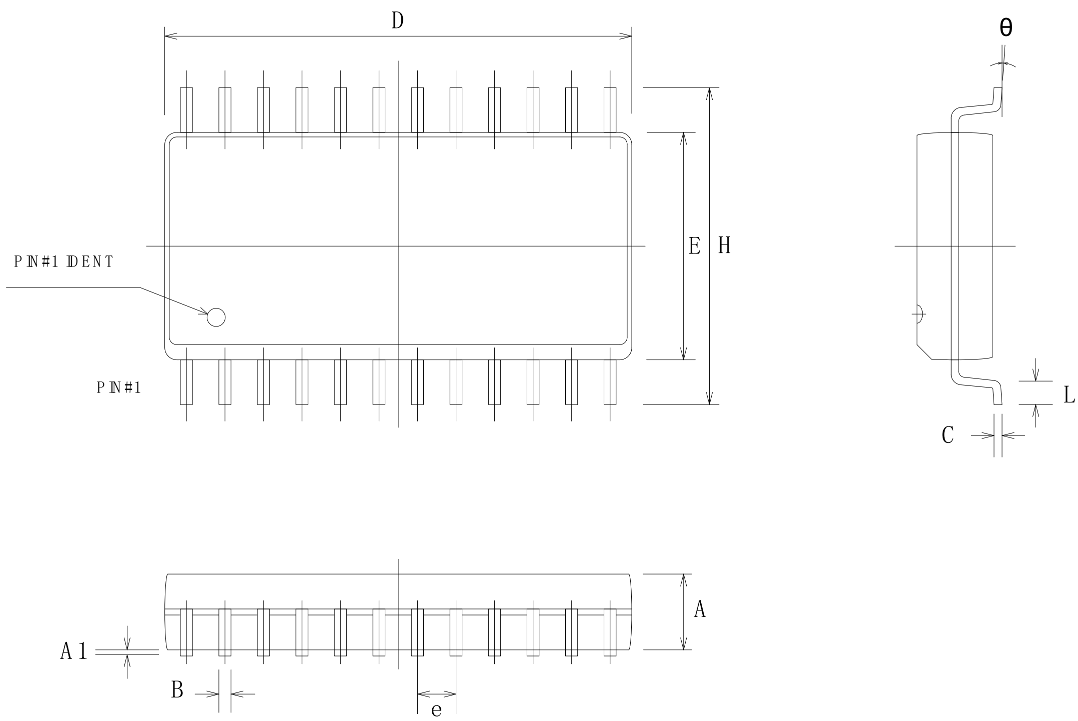
The electrode materials can be glass, acrylic, plastic, ceramics and so on. The CSEL capacitor value is decided by the area of the electrode、the thickness of the panel、the panel material and the layout of the PCB board. The thicker the isolation material, the smaller the CSEL capacitor is required to be used (which will increase the sensitivity of the detection). Meanwhile, increasing the area of PAD appropriately increase the sensitivity too. On the contrary, the thinner the isolation material, and increasing the CSEL capacity appropriately will increase the system's ability to resist interference. The general recommendation capacitance value is 10~100pF.

In general, the area of touch pad plate is between 3mm*3mm and 30mm*30mm. Each plate should be the same area as possible as it can be to ensure the same sensitivity. The sensing plate can be a conductor of any shape and is recommended to circular or square. The circular diameter or the square width is recommended to be larger than 10mm. The general sensing plate materials include copper foil on PCB board, flat top cylinder, spring, metal sheet and conductive rubber, etc.

VDD power supply voltage notes

The XW15A measures the tiny change of capacitance, which requires the ripple and noise of power supply to be small, and the external power supply interference should be avoid. Especially when applied to high noise environment, it must be able to effectively isolate external interference and voltage mutation. The layout of Power supply in PCB should be keep away from the high-voltage high-current device area as far as possible or add shielding. If the power ripple is too large, it is recommended to do special treatment to the power supply, such as adding filtering circuit or regulating circuit such as 78L05. In certain applications, keep the XW15A as far away from certain functional circuits as possible, such as radios, RF, etc.

Package size information (SSOP-24) （0.635）



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.25	1.55	0.049	0.061
A1	0.05	0.25	0.002	0.010
B	0.194	0.314	0.008	0.012
C	0.15	0.25	0.006	0.010
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.015	0.157
e	0.635		0.025	
H	5.70	6.30	0.224	0.248
L	0.30	0.90	0.012	0.035
θ	0°	7°	0°	7°

Appendix：The presentation program use C language to read and write the XW15A through the IIC interfaceI2C

The function to write the control register

void i2c_write(unsigned dev_addr, unsigned reg_addr, unsigned char * src_buf, unsigned char len)

dev_addr The setting of the device address
reg_addr The setting of the register address
scr_buf The first-byte address of the written data content
len The length of the written data content

For example：To write the 0x93 data into the register of the XW15A.The register is the CTRL0(address:0x03). The ASEL pin of the XW15A is floated.

```
char buffer;
buffer=0x93;
i2c_write(0x40, 3,   &buffer, 1);
```

1) The function to read the key information register

void i2c_read_direct(unsigned dev_addr,unsigned char * dest_buf,unsigned char len)

dev_addr The setting of the device address
reg_addr The setting of the register address
dest_buf The first-byte address of the written data content
Len The length of the written data content

For example：To read the key information into the register of the XW15A.The registers are the Output1(address 0x00) and Output2(address 0x01. The ASEL pin of the XW15A is floated.

```
char buffer[2]={0,0};
i2c_write(0x40, 0, &buffer, 0);    //To set the read register address into 0x00 firstly. The step could be ignore if the register is not written after the power is on. Because the default read address of the chip is 0x00
i2c_read_direct(0x40, &buffer, 2);    // Read the data of address(0x00) into buffer[0] and the data of address(0x01) into buffer[1.if the PAD is pressed, the data for buffer[2] is low, otherwise it is high.
//*************************************************************************
void i2c_delay()// Simple time-lapse function
```

```
{
	char i;
	for(i=0;i<2;i++); }
//***************************************************************************
void i2c_start() // A HIGH to LOW transition on the SDA line while SCL is HIGH defines a START condition.
{
	SDA=1; // Release the SDA bus
	i2c_delay();
	SCL=1;
	i2c_delay();
	SDA=0;
	i2c_delay();
	SCL=0;
	i2c_delay();
//	SDA=1;
}
//***************************************************************************
void i2c_stop() // A LOW to HIGH transition on the SDA line while SCL is HIGH defines a STOP condition.
{
	SCL=0;
	SDA=0;
	i2c_delay();
	SCL=1;
    i2c_delay();
    SDA=1;
    i2c_delay();
}
//***************************************************************************
void i2c_checkack()    // The Acknowledge signal is defined as follows:
// the transmitter releases the SDA line during the acknowledge clock pulse so the receiver can
//pull the SDA line low and it remains stable LOW during the HIGH period of this block pulse
{
	bit    bit_temp;
	SCL=1;
	bit_temp=SDA;
/*	if(bit_temp)
		//No ACK reply
		ERR=0;
	else
		ERR=1;    */
	SCL=0;
```

```
//      i2c_delay();
}
void i2c_sendack()    // The Acknowledge signal is defined as follows:
// the transmitter releases the SDA line during the acknowledge clock pulse so the receiver can
//pull the SDA line low and it remains stable LOW during the HIGH period of this block pulse
{
        SDA=0;
        i2c_delay();
        SCL=1;
        i2c_delay();
        SCL=0;
        SDA=1;
}
void i2c_sendnack()    // When SDA    remain HIGH during this ninth clock pulse, this is defined as
//the Not Acknowledge signal.
{
        SDA=1;
        i2c_delay();
        SCL=1;
        i2c_delay();
        SCL=0;
}
//****************************************************************************
//****************************************************************************
void i2c_write_byte(unsigned char date) // Function to write a byte
{
        unsigned char i,temp;
        temp=date;
        for(i=0;i<8;i++)
        {
                temp=temp<<1;
//               i2c_delay();
                SDA=CY;
                i2c_delay();
                SCL=1; // The SDA remain stable when the SCL is high
                i2c_delay();
                SCL=0;// Because the change in the SDA at this time is considered a control signal when
the SCL is low . And make up the rising edge by the previous clock signal
        }
//      SCL=0;// Pull down the SCL to prepare for the next data transfer
//      i2c_delay();
```

```
	SDA=1;// The SDA bus is released and then controlled by the slave device，then the slave
//device pull down the SDA as a ACK response signal after the slave receive the address data
//when the SCL is high.
	i2c_delay();
}
//*************************************************************************
unsigned char i2c_read_byte()//Function to read a byte
{
	unsigned char i,k;

	for(i=0;i<8;i++)
	{
		i2c_delay();
		SCL=1;// At the rising edge, the IIC device puts the data on the sda line, and the data is
//stable during the high level
		i2c_delay();
		k=(k<<1)|SDA;
		SCL=0;
	}
	return k;
}
//*************************************************************************
void i2c_write(unsigned dev_addr, unsigned reg_addr, unsigned char * src_buf, unsigned char
len)
{
	char i;
	i2c_start();
	i2c_write_byte((dev_addr<<1));// send the slave device address by the write operation
	i2c_checkack();// wait for the respond from the slave device
	i2c_write_byte(reg_addr);// send the register address by the write operation
	i2c_checkack();//wait for the respond from the slave device
	for(i=0;i<len;i++)
	{
		i2c_write_byte(src_buf[i]);// send the buffer data by the write operation
		i2c_checkack();//wait for the respond from the slave device
	}
	i2c_stop();// Stop signal
}
void i2c_read_direct(unsigned dev_addr,unsigned char * dest_buf,unsigned char len)
{
	char i;
```

```
	i2c_start();// Start signal
	i2c_write_byte((dev_addr<<1)+1);// send the register address by the write operation
	i2c_checkack();//Waiting for the response from the salve device
	dest_buf[0]=i2c_read_byte();// get the data

	for(i=1;i<len;i++)
	{
		i2c_sendack();
		dest_buf[i]=i2c_read_byte();
	}
	i2c_sendnack();
	i2c_stop();//	Stop signal
}
```