2019.10

SC01T

Single channel self-correcting capacitive touch sensor

1. Overview

1.1 Introduction

SC01T touch sensor can use the average capacitance value as a reference to detect the capacitance change of the sensing point. It can sense capacitance changes through any non-conductive medium. In this way, the sensor module can be well isolated from water and dust. SC01T has stronger anti-interference and better consistency. This chip can work in a low power consumption environment, when the power supply is 5v, the working current is 43uA, the standby current is below 4ua, and it is also suitable for battery applications.

1.2 Characteristics

- ◇ Single-channel sensor chip with self-calibration function
- ◇ Can sense "key touch" through any non-conductive medium
- ◇ Sensitivity adjustment by external capacitor
- ◇ Output form of Open-Drain
- ◇ The key output is completely debounced
- ◇ Operating voltage range: 2.0v~6.5V

1.3 Application

- ◇ Alternative to mechanical switches
- ◇ Human body induction detection
- ◇ Human interface for toys and interactive games
- ◇ Access button
- ◇ Light control switch
- ◇ Sealed keyboard panel
- ◇ Alternative to diaphragm switch

1.4 Encapsulation

SOP23-5 encapsulation is adopted for SC01T

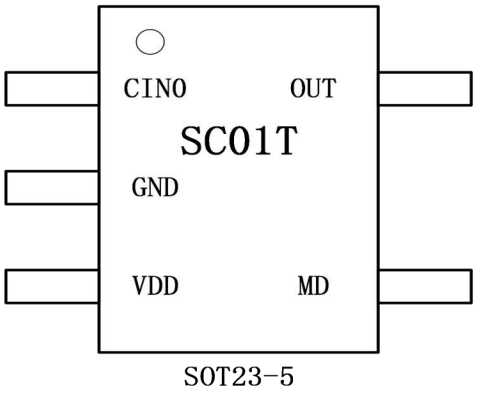


Figure 1-1 The schematic diagram of encapsulation

1.5 Pins

Table 1-1: Summary of pins

Pin No.	Name	Type	Function
1	GND	Pwr	Ground
2	CIN0	I/O	Touch detection terminal
3	OUT	OD	Output
4	MD	I/O	Setting model
5	VDD	Pwr	Power

Pin types

I	**CMOS input**
I/O	**CMOS input/output**
OD	**NMOS open-drain output**
Pwr	**Power supply/grounding**

1.6 Description of pins

VDD, GND

Supply voltage and ground pin

CMOD

Operation capacitance pin should be connected to a fixed capacitance

CIN0

Input sense port for sensing capacitors.

OUT

Touch the output port. The internal structure of the port is an NMOS open-drain output with a pull-up resistor, which outputs a weak high or strong low level, and the effective level is a strong low level.

MD

When MD is floated, the chip enters the normal key direct output mode. Detecting the finger touch, the output changes from high resistance to low level. After the finger leaves, the output changes from low level to high resistance.

When MD is connected to GND, the chip will enter the normal key latch output mode. When a finger touch is detected, the output level turns over and the state is latched.

When MD is connected to VDD, the chip enters the intelligent toilet body induction or water level detection mode. When it is detected that the human body is close to or the liquid level reaches the scale, the output changes from high resistance to low level. When the human body leaves or the liquid level is lower than the scale, the output changes to high resistance.

2. Functions of the chip

2.1 Initialization time

After a power-up reset, the device requires 300ms to initialize, calibrate, and start operating normally. Keys will work properly once all keys have been calibrated after reset.

2.2 Setting of sensitivity

The sensitivity is determined by the capacitor connected in parallel with the CIN0 channel. The capacitance range is 0pf minimum and 80pf maximum. The smaller the value, the higher the sensitivity. In order to ensure the consistency of sensitivity, it is best to use polyester capacitors, NPO capacitors or COG capacitors with an accuracy of 10% or more. Be sure to place this capacitor as close to the IC as possible during PCB layout.

2.3 Self-recalibration

According to the drift of the external environment temperature and humidity, the reference value of the button capacitance will also drift, and the chip will automatically adjust the reference value of the capacitance reference of the correction button to adapt to the changes in the current environment.

When a key is detected, the chip will immediately stop calibrating for a period of time, about 30~80S. The greater the working voltage of the chip, the shorter the time. When the working voltage value is fixed, the time for the chip to stop calibration is also fixed. Refer to the following table:

Table 2-1 The relationship between self-calibration time and voltage when a button is detected to stop:

Voltage(V)	2.0	2.5	3.3	4	5	6.5
Time(S)	80	75	65	55	50	30

When the stop calibration time is up, the chip will continue to self-calibrate. If the current key is still valid, the key information will be updated immediately as the drift of the environment, that is to say, the valid time of the key detection will not exceed 30~80S seconds.

2.4 Touch response time

The frequency of key presses that can be detected in normal working mode is greater than 10 times/second.

2.5 Output logic

The touch output has two states: weak high or strong low.

When MD is floating (power saving mode) or connected to GND (normal mode), when a touch is detected, the output intensity is low, and when there is no touch, the output is high impedance.

When the MD is connected to VDD (power saving mode), each touch will cause the output to flip and the state will be latched.

Direct Output Mode:

Time	1	2	3	4	5	6
Action	Reset	No touch	Touch	No touch	Touch	No touch
Output	High R	High R	Low level	High R	Low level	High R

Latch Output Mode

Time	1	2	3	4	5	6
Action	Reset	No touch	Touch	No touch	Touch	No touch
Output	High R	High R	Low level	Low level	High R	High R

2.6 power saving mode

If the MD pin is floating or connected to VDD, the chip will not be touched for about 25~180S, and the chip will automatically enter the power saving mode. The greater the working voltage of the chip, the shorter the time. When the working voltage value is fixed, the time to enter the power saving mode is also fixed. In the power saving mode, the sampling interval of the keys will be longer, the current consumption (Idd) will be reduced, and the sampling interval of the keys is about 500ms. If a key is detected, the chip immediately leaves the power saving mode and enters the normal mode.

Table 2-4 Time and voltage relationship for entering power saving mode:

Voltage(V)	2.0	2.5	3.3	4	5	6.5
Time(S)	180	105	60	45	34	25

3. Application

3.1 The application circuit

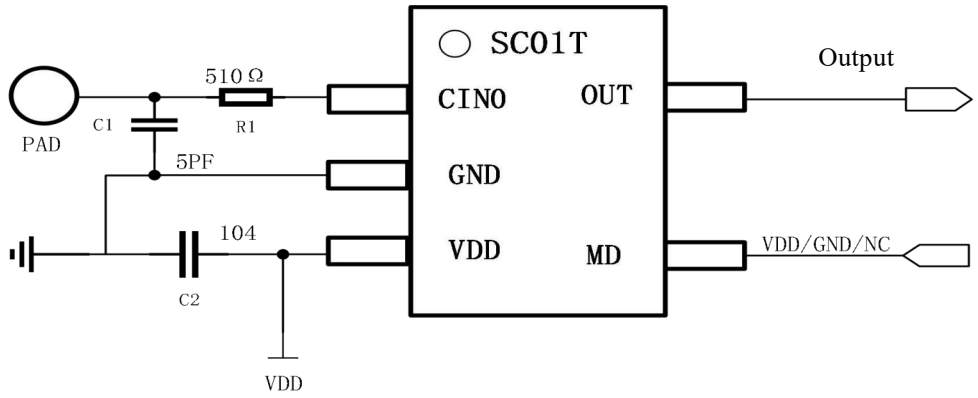


Figure 3-1: The application circuit

1. C1 is the sensitivity adjustment capacitor, which can be adjusted according to the sensitivity requirements of the product. The adjustment range is 0pf~80pf. The larger the capacitance value, the lower the sensitivity.

2. The MD port is directly connected to VDD or GND or left open according to functional requirements.

3. The OUT output pin integrates a 10K pull-up resistor, which can be directly connected to the microcontroller without the need for a pull-up.

4. Detailed parameters

4.1 Rated value*

Working temperature ……-40 - +85ºC
Storage temperature ……-50 - +150ºC
Maximum Vdd voltage ……6.5V
The maximum DC output current of the pin ……10mA
The margin voltage of the pin …… (Vdd + 0.3) Volts
* Note: exceeding the above value may result in the permanent damage of the chip

4.2 Electrical characteristics

Table 4-1: Electric parameter TA = 25℃

Characteristics	Symbol	Condition	Min	Typ	Max	Units
Operating Voltage	Vdd		2.5		6.5	V
Current consumption （Normal mode）	Ind	VDD=5.0V			43	uA
		VDD=3.0V			32	uA
		VDD=2.0V			18	uA
Current consumption （ Power saving mode）	Iid	VDD=5.0V			4	uA
		VDD=3.0V			3	uA
		VDD=2.0V			1	uA
Check input capacitance	Cs		0		80	pF
Output Impedance (open drain)	Zo	delta Cs > 0.2pF delta Cs < 0.2pF		50 100M		Ohm

		delta Cin < 0.2pF		100M		
Output Sink Current	Isk	VDD=5V&&OUT =0			10.0	mA
Minimum detective capacitance	delta_Cs	CDC=15pf		0.2		pF

4.3 The dimensional drawing of encapsulation (SOT23-5)

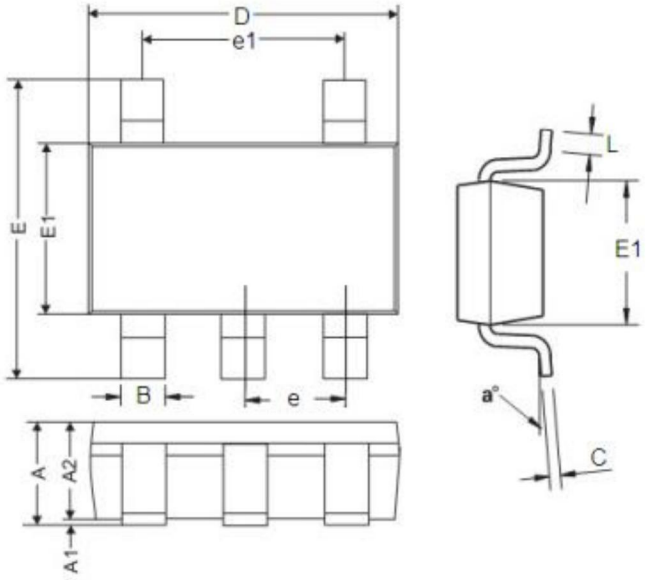


Figure 4-1: The example of SOP8 encapsulation

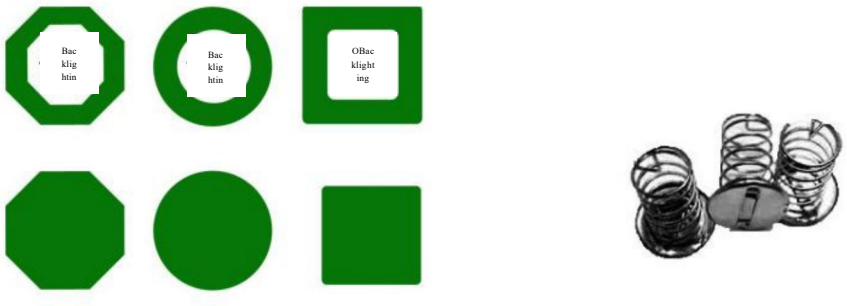
Table 4-2: Dimension parameters of encapsulation

Symbol	mm		Inch	
	Min	Max	Min	Max
A	0.9	1.45	0.0354	0.0570
A1	0	0.15	0	0.0059
A2	0.9	1.3	0.0354	0.0511
B	0.2	0.5	0.0078	0.0196
C	0.09	0.26	0.0035	0.0102
D	2.7	3.10	0.1062	0.1220
E	2.2	3.2	0.0866	0.1181
E1	1.30	1.80	0.0511	0.0708
e	0.95REF		0.0374REF	
e1	1.90REF		0.0748REF	
L	0.1	0.6	0.0039	0.0236
a。	0 °	30 °	0 °	30 °

5. Button sensor of the capacitor

5.1 The material and shape of the touch button

The touch button can be a conductor in any shape, with a hole or hollow in the middle. However, a certain flat area shall be guaranteed. The round or square touch button with the diameter larger than 12mm is recommended. However, the point effect shall be avoided. The touch induction plate may be PCB copper foil, metal sheet, flat-top cylinder spring, conductive cotton, conductive ink, conductive rubber, conductive glass with ITO layer, etc.. As shown in Figure 5-1:



The button induction plate may be solid or hallow, in rectangle, circle or polygon

Figure 5-1: Examples of button induction plates with different shapes

5.2 The dimension of the touch induction plate

The size dimension of the touch induction plate: Minimum 4mmX4mm, Maximum 30mmX30mm. The actual area shall be determined according to the sensitivity. The area is proportional to the sensitivity. Generally, the diameter of the button induction plate shall be larger than 4 times of the thickness of the plate. The increasing of the electrode dimension may improve the signal-to-noise ratio. The shape and area of each induction plate shall be the same, so as to ensure the consistent sensitivity. In general, the typical value for most applications is 12mmX12mm.

5.3 The connection way of the touch PAD and touch panel

(1) When PCB copper foil is used for manufacturing the touch PAD, the touch PAD shall be directly pasted on the touch panel with the double-side adhesive tape.

(2) When the paster with the spring is used for manufacturing the touch PAD, the touch PAD must be pressed against the panel.

(3) When the conductive rubber or conductive cotton is used, the bottom of the conductive rubber or conductive cotton shall be pasted in the copper foil of PCB. The top shall be closely attached to the panel as the induction plate.

(4) The flexible PCB made of conductive ink or ITO shall be inserted into the interface of the

touch port.

5.4 The selection of the touch panel

The panel must be made of insulating materials, such as glass, polystyrene, polyvinyl chloride (PVC), nylon and resin glass. During the production, the material and thickness of the panel shall remain unchanged. Insulating paints must be used for the surface spraying of the panel. When the area of the touch induction plate is fixed, the sensitivity is based on the thickness and material of the plate.

The general plate thickness is 0-10 MM. The typical thickness of different materials is different. The surface of the button induction plate shall be flat and tightly attached to the panel, without air gap.

In the actual application, the customer shall find the ideal compromise value according to the actual needs. The following table shows the recommended values of PAD size and the thickness of different plates.

Table 5-1: Recommended values for PAD size and the thickness of different plates

PAD diameter (MM)	Acrylic (Dielectric constant of 2.6-3.7) (MM)	Resin glass (Dielectric constant of 3.4)	ABS (Dielectric constant of 3.8-4.5)	Mica sheet (Dielectric constant of 4-8)	Common glass (Dielectric constant of 7.6-8.0)
8	2.25	2.5	3	4.1	5
10	3.25	3.8	4.3	6.2	8
12	4.5	5.1	5.6	8	10
14	5.5	6	6.8	10	12.5

6. Power supply

6.1 DC voltage stabilizer

SC series touch chip can reflect the touch output by measuring the minor change of capacitance. Therefore, it is required that the ripple wave and noise of the power supply shall be small. Strong external interference due to the connection of the power supply shall be avoided. Especially for application in the induction cooker and the microwave oven, the external interference and voltage leap must be isolated effectively. Therefore, the power supply is required to have a higher stability. The 7805 voltage stabilizing circuit shown in the following figure is recommended to be adopted.

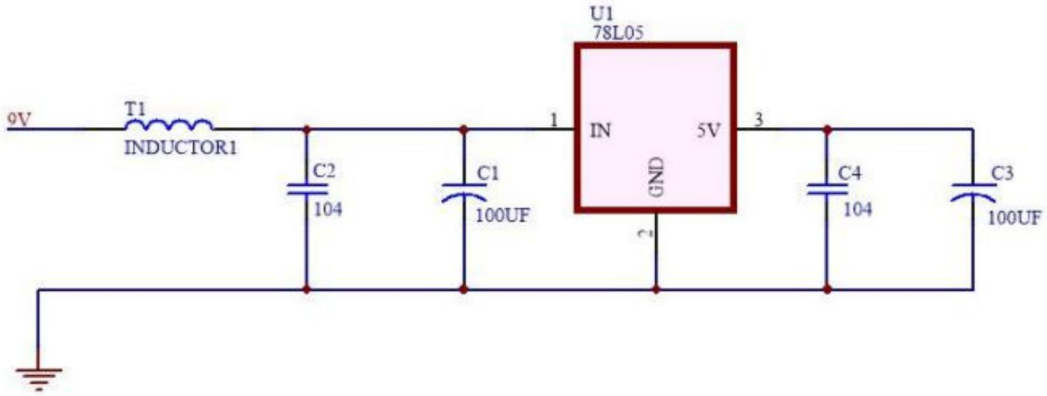


Figure 6-1: 7805 voltage stabilizer

During PCB layout, if the environment is harsh, the inductor T1 bonding pad in the above figure is recommended to be reserved to cope with the interference of high noise such as the induction cooker. During common applications, the inductor is not required.

6.2 The placement of the voltage stabilizer

During PCB LAYOUT, the devices of 7805 electrical power package shall be as close to the VDD and GND pins of the chip as possible. The devices of 7805 electrical power package shall be placed on the same circuit board as the touch chip to the greatest extent, and be placed centrally, so as to eliminate the noise caused by the excessively long power line.

6.3 Precautions under high noise conditions

For application in the high noise environment, the overlapping of the mainboard with high voltage (220V), large current and high frequency and the touch circuit board shall be avoided. If it is unavoidable, it shall be away from the area with high-voltage large-current devices as far as possible or a shielding shall be installed on the mainboard.

6.4 The 5V power supply of the host shall be used

If the user uses the 5V power supply of the host directly, it shall be connected to the filter circuit as shown in the following figure. The placement rules of C3 capacitor and C2 capacitor in the filter circuit are the same as that in 6.2.

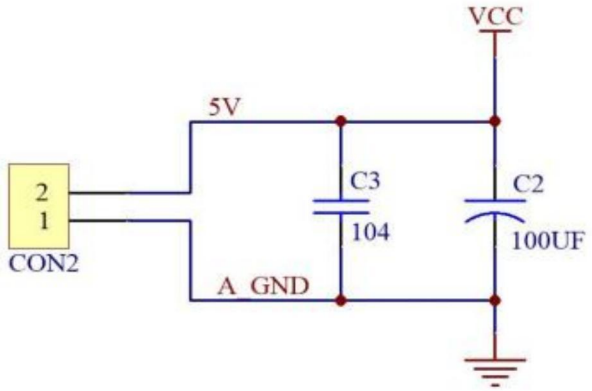


Figure 6-2: The filter circuit with 5V power supply

7. The design of the PCB for the touch induction circuit

7.1 Wiring design of the power line

The touch part is the analog sensitive device. The circuits of other sub-units in the same system shall avoid affecting the circuit of the touch part. Therefore, the VCC power line of the touch circuit shall be wired separately. The length shall be as short as possible. The wiring shall be thickened appropriately.

7.2 Wiring design of the grounding wire

The grounding wire of the touch chip shall not be shared with other circuits, and is better to be connected to the grounding point of the board power supply, i.e., usually referred to as the "star-earthed topology". The power grounding of the digital part and the analog part of the circuit shall be connected with star-connection respectively.

7.3 The wiring design of peripheral components and parts of the touch application circuit

The decoupling capacitors, CMOD capacitors, CDC capacitors and touchable current-limiting resistances of the touch-type chips shall be placed closely to the chips to the maximum extent and the routing distance shall be as short as possible.

7.4 Wiring between input pins of the sense element of PAD and IC

The touch-type IC shall be placed in a central position to the greatest extent and the distance between such chip and PAD is balanced basically.

The routing of PAD input end and routing of a single sided board are suggested to be 8MIL-13MIL in distance and the routing of a double-sided board is suggested to be 5-8mil in distance. Where the process permits, it is suggested that the thinner the better is.

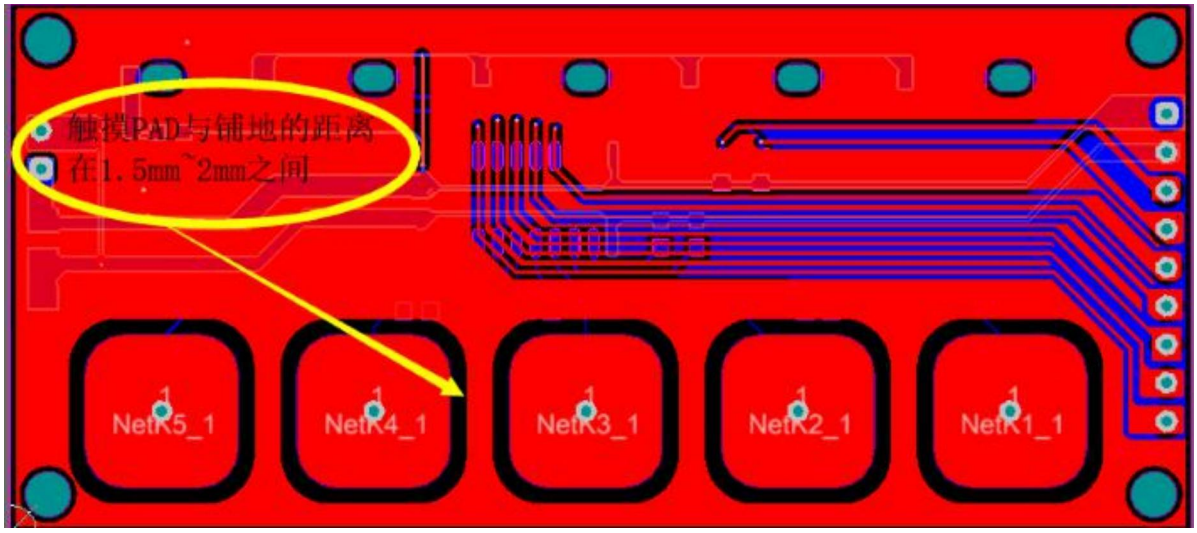
The wire between PAD input end and the touch-type IC cannot be across other signal lines. Especially, it cannot be across high-frequency signal lines with strong interference.

Other signal lines shall not be routed within 0.5MM scope around the wire between PAD input end and the touch-type IC.

7.4 Circuit routing rules in the ground

Circuits of the touch-type IC and other related peripheral circuits shall be routed in the ground, which can effectively enhance the capacity of resisting disturbance of products. The attention shall be paid on key points below about circuit routing in the ground:

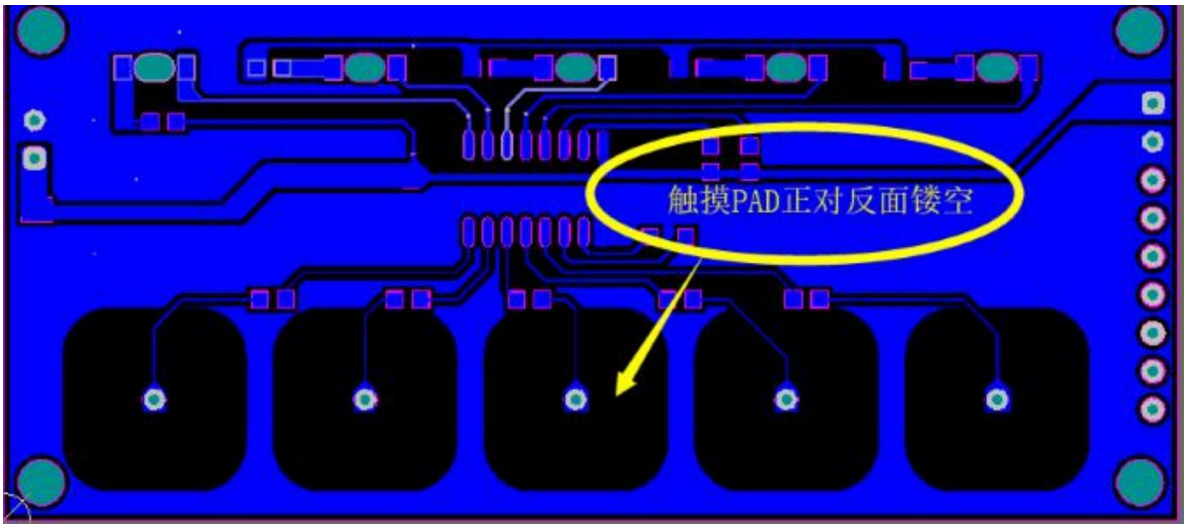
(1) It is recommended that the distance between the touch-type PAD and the ground where it is routed should be 1.5MM-2.0MM, where the interference rejection of the system and the sensitivity to touch can be balanced effectively.



触摸PAD与铺地的距离在1.5mm-2mm之间	The distance between the touch-type PAD and the ground where it is routed is 1.5mm-2mm

Figure 7-1: The touch-type PAD is 1.5MM above the ground where it is routed

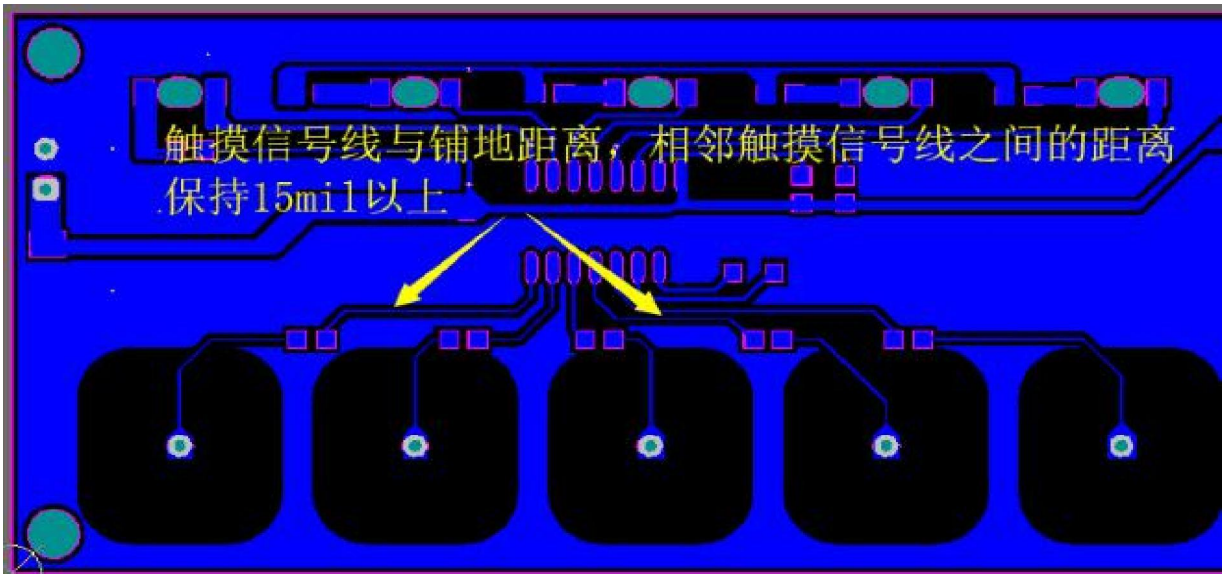
(2) The periphery parts of the touch-type PAD need to be routed in the ground. And the obverse and reverse sides of the touch-type PAD need to be subject to hollow-out processing for routing in the ground, so as to reduce the stray capacitance, improve the sensitivity. And there shall be no other devices or large-area copper foils and no other high-frequency signal lines.



触摸PAD正对反面镂空	The obverse and reverse sides of the touch-type PAD are hollowed out

Figure 7-2: The obverse and back sides of the touch-type PAD are hollowed out

(3) The touch-type signal line keeps 15mil above the ground where it is routed and 15mil above needs to be kept between adjacent touch-type signal lines, so as to avoid crosstalk. As shown in the figure below:



触摸信号线与铺地距离，相邻触摸信号线之间的距离保持15mil以上	15mil above needs to be kept between the touch-type signal line and the ground where it is routed as well as between adjacent touch-type signal lines

Figure 7-3: 15mil above needs to be kept between the touch-type signal line and the ground where it is routed and adjacent touch-type signal line

(4) It is suggested that the touch-type IC and its related peripheral circuits should be routed with the solid copper, so as to enhance the capacity of resisting disturbance of the chip.