WTC6316BSI Inductive touch key chip of sixteen-channel electric capacitance

Fast Browsing（1.5）

Number of keys	4-16 keys
Key response mode	Single key response and multi-key combination (SHIFT) mode can be selected
Technical principle	Capacitive to digital conversion technology
Dimension of key sense element	Minimum 3mm ×3mm, maximum 30mm ×30mm, to be determined according to actual demand and panel thickness
Spacing of key sense element	Single key mode, Minimum spacing 0.5mm, to be determined according to actual demand
Shape of key sense element	Arbitrary polygon, rotundity or ellipse, either panel with hole in the middle or hollow panel (optional)
Material of key sense element	PCB copper coil, sheet metal, flat-top cylinder spring, conductive rubber, conductive ink, ITO layer of conductive glass, etc.
Requirements for PCB	Single-sided PCB and double-sided PCB
Panel material	Insulating materials, such as organic glass, ordinary glass, tempered glass, plastic, wood timber, paper, ceramics and stone
Panel thickness	0 – 20 mm
Adjustment method of key sensitivity	Key sensitivity can be adjusted by changing value of base capacitance CSEL.
Effective touch response time	Less than 150 ms
Water resistance	Watering or spraying water on the panel will not cause malfunction of keys; when flooded or with water accumulation, no abnormal response occurs by touching the panel.
RFI resistance	Effectively suppress RFI (radio frequency interference) caused when GSM cell phone is used to make a call or answer a call next to the panel or a talk proceeds next to the panel over high-power walkie-talkie.
Operating voltage range	3.3V-5.5V
Operating temperature range	—40°C—+85°C
Data transmission interface	Slave mode of serial interface (SPI)
Storage temperature range	—50°C—+125C
Chip sealing mode	SSOP28(150MIL)
Typical application	Various home appliances, security equipment, communication equipment, industrial control equipment & instruments, entertainment equipment, medical equipment, sport facilities, toy,etc.

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WTC6316BSI Inductive touch key chip of sixteen-channel electric capacitance

Specification （V1.5）

1. Product Introduction

1.1. Overview

WTC6316BSI series touch sensing IC is an integrated circuit designed to achieve human touch interface. It can replace the mechanical light touch key to realize waterproof and dustproof, seal isolation, with strong and artistic operation interface. A WTC6316BSI can achieve 4 to 16 independent keys. The user can use it flexibly according to the needs.

1.2. Working mechanism

WTC6316BSI uses the change of capacitance on the 16 bit high precision of CDC (digital capacitance transducer) IC detection sense element (capacitance sensor) to identify the touch action of the human finger. The data of CDC output is processing by the embedded RISC CPU with efficient and reliable algorithms. The user can read the key state of the touch key through the SPI interface.

1.3. Sensitivity adjustment mode

It is only needed to adjust one capacitor Csel that can change the sensitivity of all channels, with less peripheral component, and high production efficiency.

1.4. Adapt to different thickness panels

Through selecting the appropriate Csel capacitance value, appropriately adjusting the sense element can make WTC6316BSI to adapt the insulation panel of the different thickness of 0-20mm.

1.5. Chip Package Type

WTC6316BSI is packaged with standard 28PIN SSOP28A(150mil).

2. Technical Features and Parameters

2.1. Technical Features

2.1.1. Simple Peripheral Circuits, and A Few Peripheral Components

With independently designed special test circuit, self-calibration circuit and RISC processor integrated inside the IC, there are a few peripheral components.

2.1.2. Debugging-free Production and Excellent Long-time Working Stability

Calibration is not necessary for the system after the set value for capacitor Csel of sensitivity is determined. The system can automatically overcome the interference caused by electrostatic discharge, electromagnetic interference, temperature variation and accumulation of moisture and pollutants on the surface, and provide good precision and operation consistency in various environments, so the product can suffer long-distance transportation and be used in various environments. The unique compensation algorithm and high-strength anti-interference design can guarantee no occurrence of malfunction during long-time work of the product.

2.1.3. The user can use the compact keyboard of smaller spacing

The adjacent key suppression function can prevent the adjacent keys from the faulty action. That is when the same finger touches two or more than two keys, only the finger occupies the key which the area is largest that can make the response, and the key which the relatively small area is occupied by finger is suppressed and not making the response. If the finger occupies two or more than two keys at the same area, these keys do not make the response. The minimum clearance of the key can reach 0.5mm

2.1.4. Excellent Water Resistance

The special waterproof design is used for it. The keyboard not only can be splash proof, flood water proof, but also can be normal use after completely flooded, is different from the general induction at present which when the splashing water, flood water of key panel, it is easily getting false action and is unresponsive after waterlogging, or is occurring false action after pressing it by finger.

2.1.5. Excellent Electromagnetic Immunity

When applying to home apparatuses and ordinary application products, the user may get good immunity to radio frequency signals by using single-sided PCB, and easily resist the interference of most of radio frequency sources including GSM cell phone to the sensitive keys.

When applying to military and other special situations, it is suggested that double-sided PCB should be designed according to the layout requirements provided by us.

2.1.6. Unique Line Length Self-correction Function

It is common for the current similar products on the market that, the sensitivity largely differs according to the length of line from sensing key to IC pin. Our original line length self-correction technology can automatically correct such difference. The user can obtain almost uniform sensitivity for all keys of the whole sense element without complex adjustment.

2.1.7. Meet the specification requirements of the industrial application

It can provide users with more reliable performance and wider range of applications.

2.2 Technical Parameters

Operating voltage: 3.3V<Vcc<5.5V
Output voltage range: GND<Vout<Vcc
Sensing thickness (insulating medium): 0-20mm，Maximum: 50mm
Response time of effective touch: Less than 100ms
Operating temperature: -40°C—+85°C
Storage temperature: -50°C—+125°C

3. Typical Application

Be applicable to various kitchen apparatuses, audio and video devices, air conditioners, sanitary electrical apparatuses, lights and switches, security equipment, instruments, portable player, mobile phones, electronic toys and learning machines.
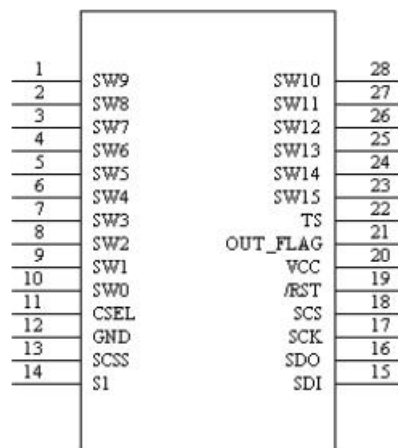
4. Definitions of WTC6316BSI Pins

Figure 1：Pin configuration diagram of WTC6316BSI

The definitions of WTC6316BSI pins

Pin No.	Pin Name	Usage	Function Description
1	SW9	I	Capacitive sensor (sense element) interface 9
2	SW8	I	Capacitive sensor (sense element) interface 8

3	SW7	I	Capacitive sensor (sense element) interface 7
4	SW6	I	Capacitive sensor (sense element) interface 6
5	SW5	I	Capacitive sensor (sense element) interface 5
6	SW4	I	Capacitive sensor (sense element) interface 4
7	SW3	I	Capacitive sensor (sense element) interface 3
8	SW2	I	Capacitive sensor (sense element) interface 2
9	SW1	I	Capacitive sensor (sense element) interface 1
10	SW0	I	Capacitive sensor (sense element) interface 0
11	CSEL	I	Capacitor interface for adjusting the sensitivity
12	GND	I	Power ground
13	SCSS	I	When the selection foot of the work mode: connects GND, the single key working mode is selected, and when it connects to VCC, the multi-key combination mode is selected.
14	S1	I	The S1 must be connected to VCC usufully for the internal test foot
15	SDI	I	Data input line of the chip SPI interface
16	SDO	O	The data output line of the chip SPI interface
17	SCK	I	The clock input line of the chip SPI interface
18	SCS	I	The chip selection enabled line of the Chip SPI interface
19	/RST	I	Chip reset pin
20	VCC	I	positive power supply output
21	OUT_FLAG	O	The key state indicator: when there is key pressed, it outputs the low level signal of 50mS
22	TS	I	The TS must be connected to VCC usufully for the internal test foot
23	SW15	I	Capacitive sensor (sense element) interface 15
24	SW14	I	Capacitive sensor (sense element) interface 14
25	SW13	I	Capacitive sensor (sense element) interface 13
26	SW12	I	Capacitive sensor (sense element) interface 12
27	SW11	I	Capacitive sensor (sense element) interface 11
28	SW10	I	Capacitive sensor (sense element) interface 10

5. Output Display

When the effective touch on the sense element occurred is detected, the foot of OUT_ FLAG of WTC6316BSI within 150ms will output the level signal of 50ms. The customer can use this signal to realize the key awakening function, and at the same time, can externally connect a triode to drive a DC buzzer to realize the voice indication of the touch key . As shown in figure 2.
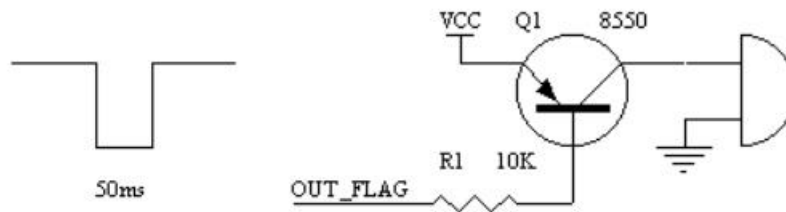
Figure 2: The signal driving buzzer of OUT_FLAG

OUT_FALG is an indication pulse that is output after the touch key is touched, but it does not indicate the touch time of the key. The key value of the touch key will kept on the finger all the time until the finger is left, and can it be continually read and judged in the program.

6. The SPI interface of WTC6316BSI

6.1 SPI sequence diagram

The SPI time sequence diagram is shown in figure 3:
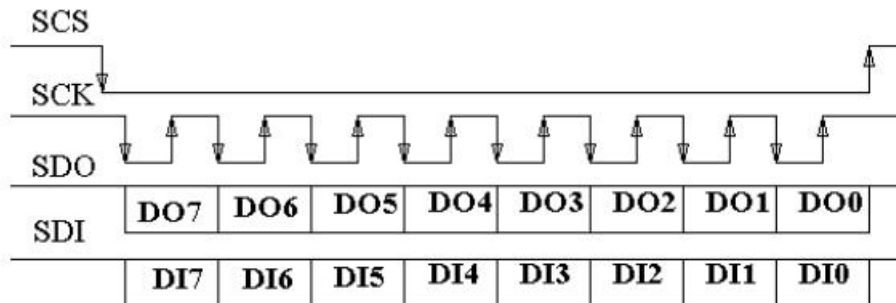
Figure 3: Sequence diagram of the SPI interface of WTC6316BSI

6.2. SPI port work status of WTC6316BSI

The working subordinate machine state of SPI port of WTC6316BSI

6.3. PI signal line function

SCS is the enable signal of chip selection of SPI port, is set by the user MCU. The SPI port does not work when SCS = 1. SPI port function is opened when SCS = 0.
SCK is the clock signal of SPI port, generated by user MCU. The initial electrical level should be high.
SDO is the SPI data output signal of WTC6316BSI, and the user MCU reads the status of SDO to obtain key data.

SDI is the SPI data input signal of WTC6316BSI, and the user MCU can set the sensitivity of the touch key with software by setting SDI. Please be sure to set the SDI to be high level when not in use.

6.4. Data transmission rules of SPI

The data of SPI is transmitted beginning from the highest level.

6.5. SDI signal processing

If you do not use software to set touch sensitivity through setting SDI, please connect SDI to VCC.
If SDI is needed to be used, SDI must be set to be high level before reading the SDO operation.
Otherwise, the touch sensitivity may be wrong set to be 0.

7. Notices for using the SPI interface

7.1. The two read intervals are not less than 4ms

If the SPI interface of WTC6316BSI is continuous read-write, it will cause the instability of the device working. The time of reading and writing twice should be more than 4ms.

7.2. SCS and SDI, SDO are not allowed to be suspended at any time

If there is no master control MCU of the SPI interface on the touchpad, then the pulling resistance must be added on the SCS and SDI and SD0 of WTC6316BSI, to ensure that the chip can steadily operate.
SCS and SDI, SD0 cannot be suspended at any time.

7.3. SDI can be fixed to connect VCC

If the sensitivity of WTC6316BSI is not set by using the software, the pulling resistance must be added to SDI
Or SDI must directly connect to fix the VCC to set the high.

7.4. SCS is not allowed to be fixed grounding

SCS is not allowed to be fixed grounding

8. WTC6316BSI work mode selection

When the 13th foot (SCSS foot) of WTC6316BSI is connected to VCC, the chip enters into the multi-key combination (SHIFT) working mode.
When the 13th foot (SCSS foot) of WTC6316BSI is connected to GND, the chip enters into the single-key working mode.

8.1 The characteristics of the multi-key combination (SHIFT) working mode

Under the multi-key combination (SHIFT) working mode, if the user presses the multiple keys without release, then multiple keys can respond in turn. That is, after the user touches any of the keys, if the finger doesn't leave the sense element, and then the user touches the other keys, WTC6316BSI will put the switch information of all the corresponding keys that are touched into the key data register of WTC6316BSI. The user can read the switch information of all the keys through the SPI interface. The system designer can design various key combination operation functions accordingly.

8.2 The characteristics of the single-key working mode

Under the single-key mode, only one key can be touched at a time. That is after the user touches any key, if the finger does not leave and touches other key, WTC6316BSI will not respond. Until the finger leaves the sense element, other keys begin to respond to the touch of the user. The customer can use this mode to implement the function of "only one touch is allowed at a time".

The introduction in Chapter 9 is the multi-key combination (SHIFT) mode of WTC6316BSI and the introduction in chapter 10 is the single key mode of WTC6316BSI. The user can choose to read according to the own usage requirements, and make thee design according to the corresponding requirements.

9. Multi-key combination (SHIFT) mode

9.1The peripheral circuit of the multi-key combination (SHIFT) mode and the matters needing attention

The peripheral circuit of WTC6316BSI is very simple, and only needs a few resistors and capacitors. The key component is capacitor CSEL for adjusting the sensitivity and IK resistance group for measuring the matched impedance of circuit. CSEL should use 10%-precision polyester capacitor, capacitor made of NOP material paster or capacitor made of X7R material paster. 1K resistance group can provide you with the best and most stable measurement effect, and CSEL and matched resistance shall be placed as close as possible to IC at PCB layout.

Figure 5 is the application circuit diagram of WTC6316BSI of WTC6316BSI work under the multicity combination of 16 keys（SHIFT) mode

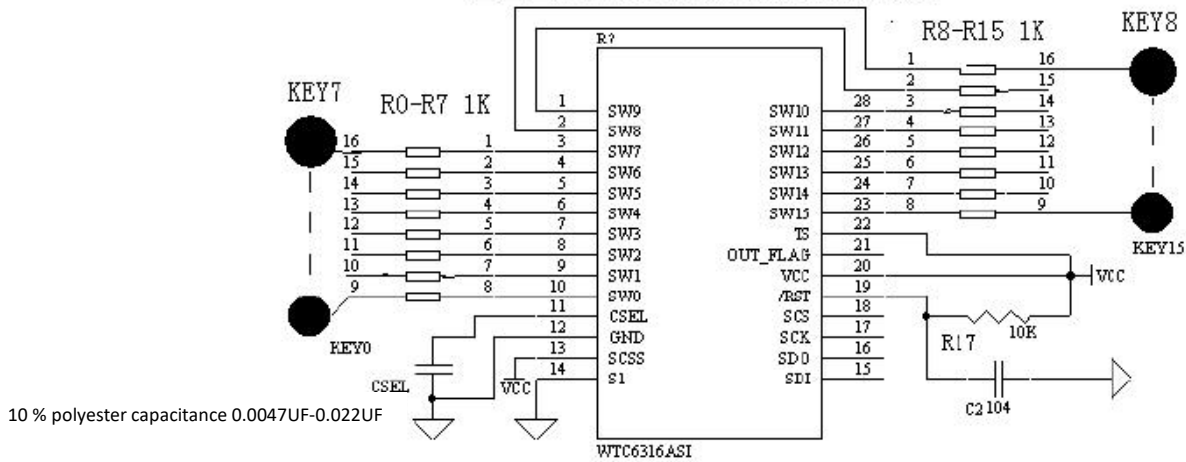The channel matching resistance R0-R15 should be put as close to IC as possible

10 % polyester capacitance 0.0047UF-0.022UF

Figure 4: Application schematic diagram of WTC6316BSI under multi-key combination (SHIFT) working mode

9.2 The data format and transport protocol of the multi-key combination (SHIFT) mode

Under the multi-key combination（SHIFT) working mode. When the user reads the full 12 touch key information from the SPI interface of WTC6316BSI, the user needs read the SPI mouth twice.

After electrifying, the master control MCU reads SPI mouth for the first time, WTC6316BSI will send the first frame data, and when reading SPI mouth WTC6316BSI for second time, it will send out the second frame data. When reading SPI for the third time, it will get the first frame data, and when reading SPI for the fourth time, it will get the second frame data and 1-2-1-2-1-2 circulation on this.
When reading of the SPI mouth each time, please take more than 4ms of interval time.

The data format of the first data frame is

Bit7	SW5 key state. 1 indicates that SW5 is pressed and 0 indicates that SW5 is not touched or has been flicked
Bit6	SW4 key state. 1 indicates that SW4 is pressed and 0 indicates that SW4 is not touched or has been flicked
Bit5	SW3 key state. 1 indicates that SW3 is pressed and 0 indicates that SW3 is not touched or has been flicked
Bit4	SW2 key state. 1 indicates that SW2 is pressed and 0 indicates that SW2 is not touched or has been flicked
Bit3	SW1 key state. 1 indicates that SW1 is pressed and 0 indicates that SW1 is not touched or has been flicked
Bit2	SW0 key state. 1 indicates that SW0 is pressed and 0 indicates that SW0 is not touched or has been flicked
Bit1	The frame number indicates that the first frame is 0
Bit0	The frame number indicates that the first frame is 0

The data format of the second data frame is

Bit7	SW11 key state. 1 indicates that SW11 is pressed and 0 indicates that SW11 is not touched or has been flicked
Bit6	SW10 key state. 1 indicates that SW10 is pressed and 0 indicates that SW10 is not touched or has been flicked
Bit5	SW9 key state. 1 indicates that SW9 is pressed and 0 indicates that SW9 is not touched or has been flicked
Bit4	SW8 key state. 1 indicates that SW8 is pressed and 0 indicates that SW8 is not touched or has been flicked
Bit3	SW7 key state. 1 indicates that SW7 is pressed and 0 indicates that SW7 is not touched or has been flicked

Bit2	SW6 key state. 1 indicates that SW6 is pressed and 0 indicates that SW6 is not touched or has been flicked
Bit1	The frame number indicates that the second frame is 0
Bit0	The frame number indicates that the second frame is 1

The data format of the thirdly data frame is

Bit7	The reserved fixation of the system is 0
Bit6	The reserved fixation of the system is 0
Bit5	SW15 key state. 1 indicates that SW15 is pressed and 0 indicates that SW15 is not touched or has been flicked
Bit4	SW14 key state. 1 indicates that SW14 is pressed and 0 indicates that SW14 is not touched or has been flicked
Bit3	SW13 key state. 1 indicates that SW13 is pressed and 0 indicates that SW13 is not touched or has been flicked
Bit2	SW12 key state. 1 indicates that SW12 is pressed and 0 indicates that SW12 is not touched or has been flicked
Bit1	The frame number indicates that the thirdly frame is 1
Bit0	The frame number indicates that the thirdly frame is 0

10.Single key work mode

10.1 The peripheral circuit of the single key work and the matters needing attention

The peripheral circuit of WTC6316BSI is very simple, and only needs a few resistors and capacitors. The key component is capacitor CSEL for adjusting the sensitivity and IK resistance group for measuring the matched impedance of circuit. CSEL should use 10%-precision polyester capacitor, capacitor made of NOP material paster or capacitor made of X7R material paster. 1K resistance group can provide you with the best and most stable measurement effect, and CSEL and matched resistance shall be placed as close as possible to IC at PCB layout.

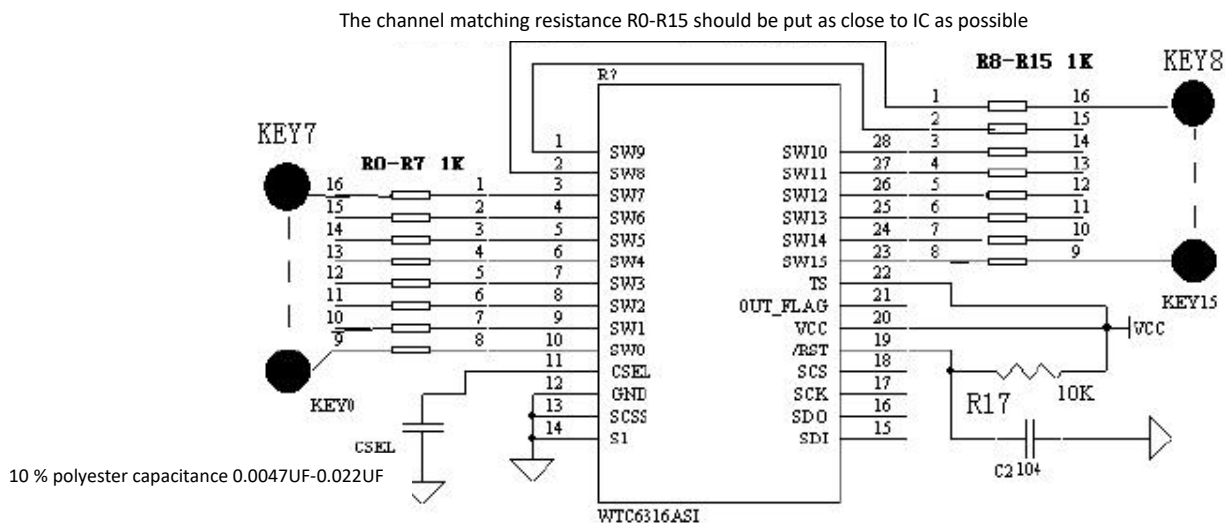Figure 5 is the application circuit diagram of WTC6316BSI working under the 16-keys single key working mode

Figure 5: Application schematic diagram of WTC6316BSI under the single key working mode

10.2 The data format of the single key working mode and transport protocol

The data format of the single bond work mode and transport protocol is relatively simple. The data obtained from the every read of master control MCU to the SPI interface is the key value of the touched key. If the data obtained is 0, it indicates that the sense element connected to the SW0 channel is touched by the user.
If the data obtained is 15, it indicates that sense element connected to the SW15 channel is touched by the user, and the rest can be done in the same manner. When you read 0FFH, it indicates that there is no key touched or the touched key has been flipped.

11. Sensitivity Setting

11.1. The adjustment mode of the sensitivity

The sensitivity setting of WTC6316BSI enables the user to use isolated media of various thicknesses to implement reliable and flexible touch function.
The sensitivity of WTC6316BSI is set by the double setting of soft and hardware. The user can fix the SD to connect the high level, so the software sensitivity adjustment function is not used, and the Csel is just adjusted to realize the sensitivity setting, so that the master control MCU can save a I/0 interface line, but also can reduce the software space of the master MCU.

11.2. Benchmark capacitance CSEL material, range and precision requirements

The user can select the appropriate capacitance Csel according to the own use case. The larger the separation medium is, the larger the Csel capacity is. It is generally recommended to choose the appropriate capacitance between 0.0047UF and 0.022UF from large to small.
It is recommends that it is best to use the A 5 % precision polyester capacitor with a small temperature coefficient for Csel. 10 percent accuracy of polyester capacitance can also be used. If needing use of patch capacitors, 10% or higher precision NPO material or X7R capacitance needs to be used.

11.3 The software fine adjustment of the Sensitivity

After determining the value of Csel, the software sensitivity setting can be used to make the fine adjustment, to ensure that it can achieve good results without having to make the refined adjustment to Csel. After the user MCU sets the sensitivity series through the SPI interface, WTC6316BSI uses the new set sensitivity series to perform the work.

11.3.1 The software fine adjustment series of the sensitivity

WTC6316BSI provides level 16 software sensitivity adjustment of 15~0. The higher the level is, the more sensitive the key is. If the data received by WTC6316BSI is not within 15~0, then WTC6316BSI will consider this data illegal, and will ignore this operation

11.3.2. Factory setting sensitivity initial value of chip

The factory setting sensitivity initial value of WTC6316BSI is 10. The user also does not use the software sensitivity adjustment function and only uses the original factory setting and only makes the Csel adjustment.

11.4 The effect of the size of the sense element on the sensitivity

Increasing the area of sense element is benefit to improve the penetration ability of touch sensing.

12. WTC6316BSI Power Supply

12.1 It is recommended to use DC Voltage Stabilizer for power supply

WTC6316BSI measures small change in capacitance, so it is required that the power ripple and noise should be small and the external strong interference involved from power supply shall be avoided. Particularly when it is applied to induction cooker and microwave oven, the external interference and voltage leap must be effectively isolated, and the power supply must have high stability. It is suggested that the voltage stabilizing circuit constituted by 78L05 as shown in the figure 6 should be adopted.
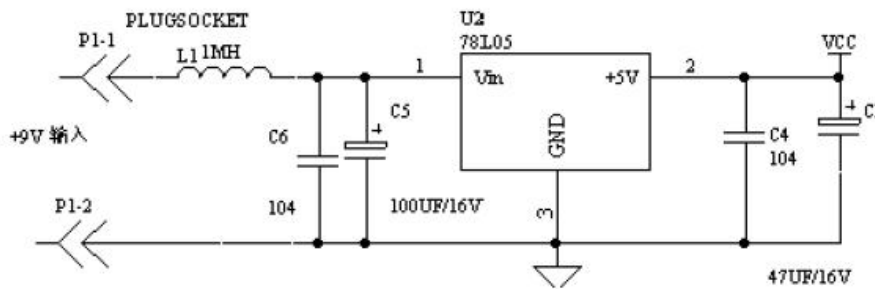

Figure 6: Voltage regulator circuit

12.2. Placement of Voltage Stabilizer Component

At PCB LAYOUT, such 78L05 power component must be close to WTC6316BSI Vcc pin. 78L05, peripheral components and WTC6316BSI must be placed on the same circuit board centrally, to put an end to the noises caused by overlong power connection line.

12.3. Grounding

The common ground of the components as shown in the figure shall be separately connected into an independent group and then it shall be connected to the common ground of the whole machine from one point of it. (Use one point of star shape to connect the ground)

12.4 Valuing of the capacitor C2

The C2 capacity affects the discharge time after power failure. Too large capacity requires a longer reset time. In the figure, it is the e recommended value, and the different applications can be flexibly adjusted.

12.5. Precautions for High Noise Condition

In case of application in a high-noise environment, up and down overlapped placement shall be avoided between high-voltage (220V), high-current, and high-frequency-operation main board and the touch circuit board. If such overlapped placement is unavoidable, try to keep far achannel from high-voltage, high-current components area or add shield on the main board.

12.6. Power Filter

When typesetting in PCB, it is recommended to reserve the inductor L1 (1MH) welding disc, but the general and the non-special applications do not need this inductance. The users can also cancel it.
When inputting 78L05 power supply, it needs to pay attention to ripple size. Please don't make the trough of ripple wave lower than DC 9V.

12.7. Use of +5V Power Supply of the Host
If the user directly uses 5V power supply of the main engine, it needs adding the power supply filter circuit in the front of the   power supply of the modules or sensing power chips as shown in the figure. The requirement for PCB layout is the same as the above circuit
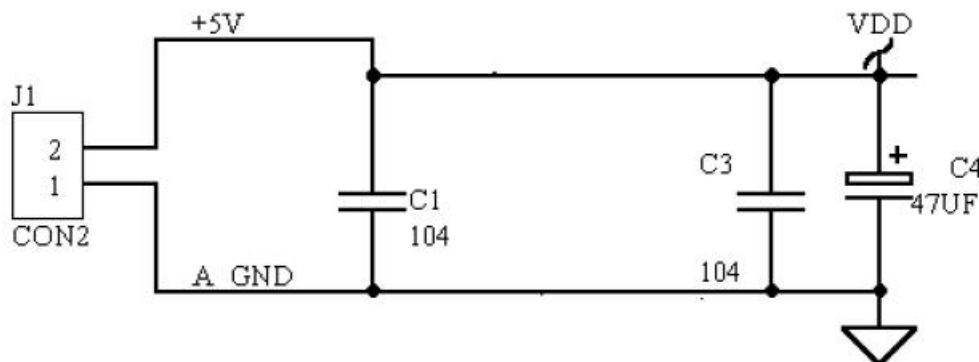
The analog and digital powers of circuit shall be connected separately to the ground in Y-connection method.

The capacitors shall be arranged in the sequence indicated in the schematic diagram and shall not be arranged arbitrarily.

Figure 7: Power Filter Circuit

Precautions:

The above circuit should connect the 104 capacitors and electrolytic capacitors of the filter circuit according to the order in the chart, and 104 capacitors should be in front of the electrolytic capacitance that can better suppresses the high frequency noise.

13. WTC6316BSI used capacitive sensors (sense element)

13.1.The material and shape of the capacitive sensors

The capacitive sensors can be any type of conductor, but certain flat surface should be ensured. It is recommended to use a round metal sheet or other conductor with a diameter greater than 12mm. The commonly used sense element are copper foil, spring, thin film line and ITO glass, etc. on the PCB plate etc.
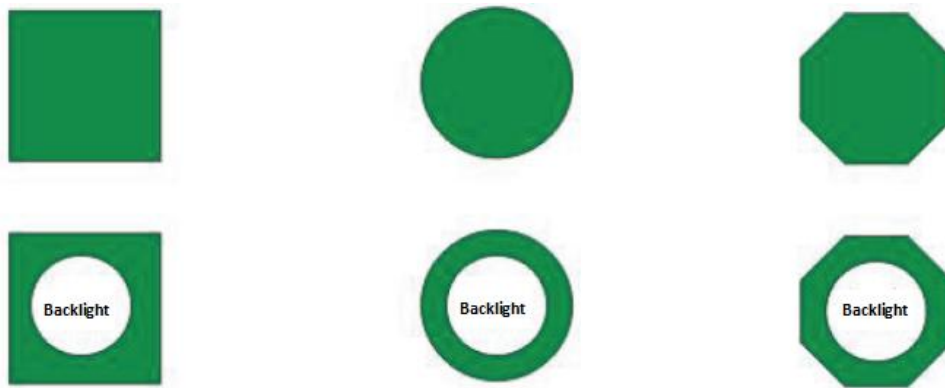
The key sense element can be solid or hollow rectangle, circle or polygon.

Figure 8: PCB Copper Foil sense element

13.2. The area of the sense element

The area of each sense element should be kept as same as possible to ensure the same sensitivity.

13.3. The bonding between the sensor plate and the panel

The capacitive sensor should be glued to glass and other insulating panels, or the elastic bonding is used for it

The common elastic connection methods are:
Use the sense element with spring
Use cylindrical conductive rubber to conduct elastic connection
Paste the sense element onto the panel with imported super double-sided glue, and the double-sided glue layer cannot be too thick.

Figure 9: Spring sense element

13.4 Eliminate the bonding gap

The bonding face of the sense element and the insulation panel must be flat, ensuring that there is bonding fit and no clearance between them.

14. Processing of Vacant Sensor Channel

WTC6316BSI at least must use four touch keys, to ensure the steady operation of the chip. When it applies to the situation of less than 16 keys, SW15~SW0 will have the empty unused sensor input channel. The empty input channel only needs a simple suspending in midair, and the empty input channel cannot be added any pull-up or pull-down resistance.

If the user must use four or less sensitive keys, please be sure to contact us for the corresponding technical support.

15. Package Dimension Drawing of WTC6316BSI

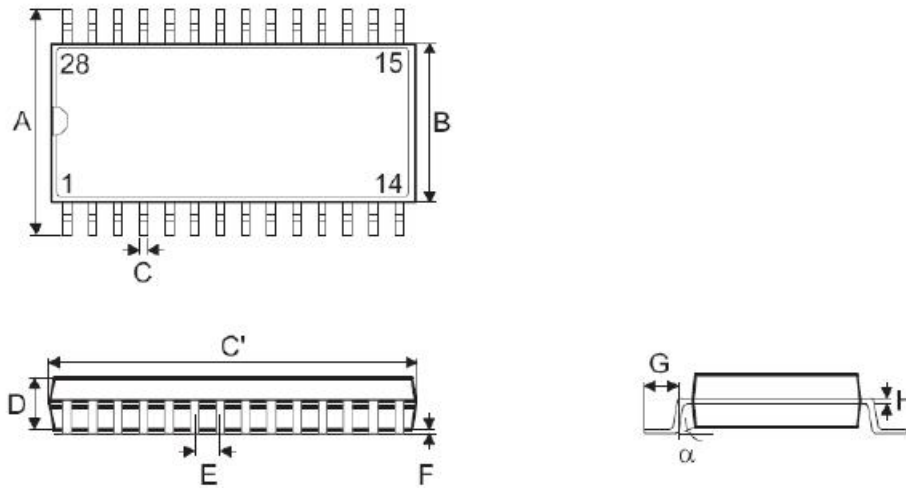| Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	150	—	157
C	8	—	12
C'	386	—	394
D	54	—	60
E	—	25	—
F	4	—	10
G	22	—	28
H	7	—	10
α	0°	—	8°

Figure 10: Package Dimension Drawing of WTC6316BSI