High performance mutual capacitance multi-touch chip

1. Overview

The CST328 series multi-point capacitive touch chip supports single-layer, multi-layer modules and a variety of patterns. It uses a high-voltage drive above 10V to achieve high performance, high sensitivity, and low power consumption for true multi-point touch (with pressure detection). Compared with traditional low-voltage drivers, it can provide higher signal-to-noise ratio and anti-interference capability. At the same time, the self-integrated capacitive sensing module inside the chip, combined with the intelligent scanning algorithm, achieves rapid response while It has excellent anti-noise, waterproof and low power consumption performance.

2. Feature

2.1. High performance capacitance detection circuit and DSP module

- Automatic and mutually integrated detection module;
- High voltage drive to achieve high sensitivity and high signal-to-noise ratio sampling;
- Support passive capacitive touch pen;
- Support standby gesture wake-up function;
- Support online programming;
- Built-in watchdog;
- Multiple button support.

2.2. Performance

- Typical refresh rate 120Hz;
- Operation with water, thumb recognition and large palm suppression;
- Typical power consumption in dynamic mode: 2.8mA;
- Typical power consumption in monitoring mode: 300uA;
- Typical power consumption in sleep mode: 50uA.

2.3. Capacitive screen support

- Supports up to 28 drive/sense channels and supports TX/RX swap;
- Channel floating/pull-down design support;
- Support traditional DITO and SITO and various patterns;
- Module parameters are automatically adjusted, and the maximum supported impedance reaches 120K;
- Cover Lens Thickness Support, Glass <= 2mm Acrylic <=1mm.

2.4. Communication Interface

- I2C master/slave communication interface, rate 10Khz~1Mhz configurable
- GPIO supports multiple configurable working modes, with built-in pull-up resistor mode
- Built-in 1.8V LDO, compatible with 1.8V/VDDA interface level.
- After the chip is running, VDD18 outputs 1.8V, and VDDHV output drives a high voltage of 6~12V.

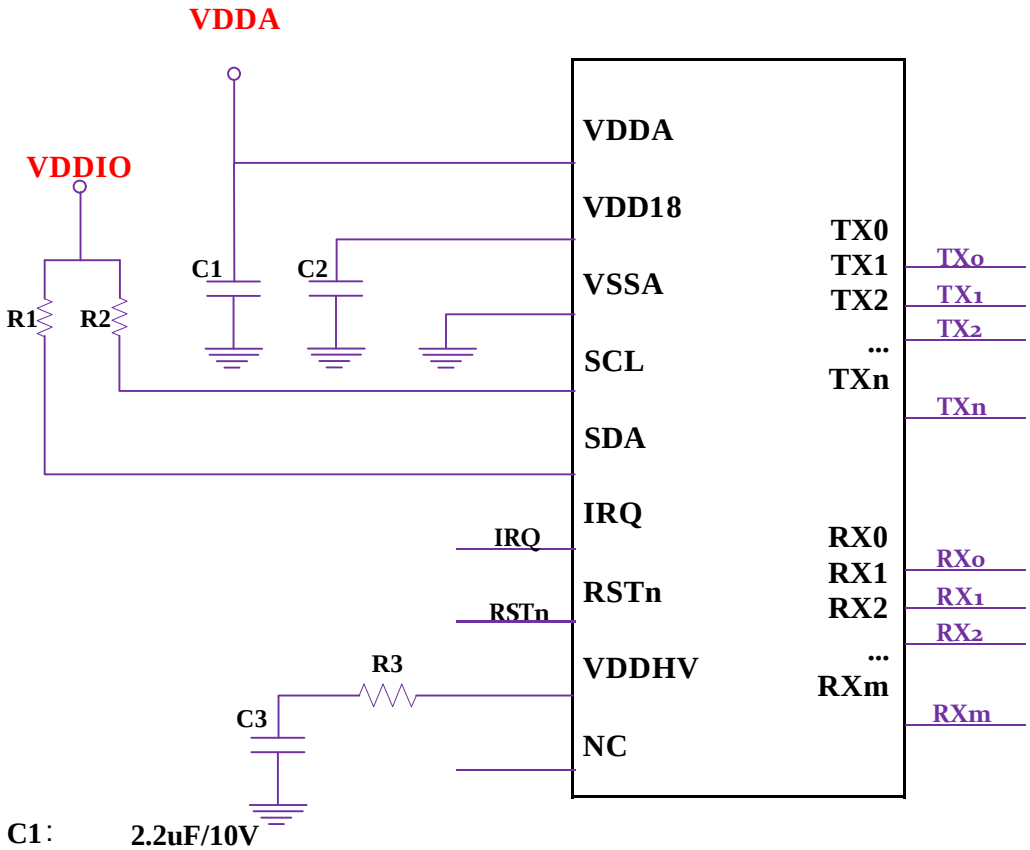
2.5. Power supply

- Single power supply 2.7V ~ 3.6V, power supply ripple <= 50mv; a small number of peripheral components.
- Package type: QFN40 5mm x 5mm

3. Application

- Mobile phones, tablets, notebooks, touchpads, etc.

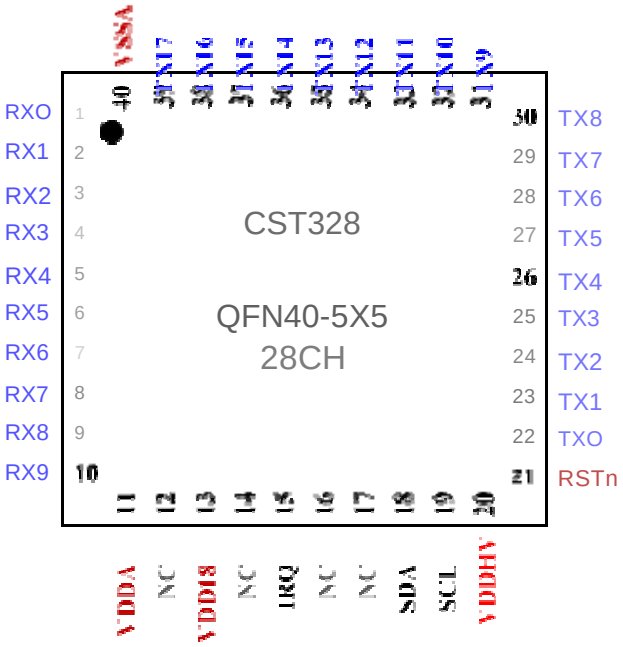
4. Typical application circuit diagram



C1: **2.2uF/10V**
C2: **0.1uF ~ 1uF/10V**
C3: **10nF ~ 100nF/16V**
R3: **200** ohm
VDDIO: **VDDA or VDD18**

R1/R2 can be equipped with an optional I2C bus pull-up resistor. You can also configure the chip's internal 5K pull-up resistor to replace the Sensor ID. You can use the extra TX or RX to distinguish between two modes: floating or connected to GND.

5. Pin arrangement



6 . Pin description

Pin	Name	Type	Function Description	Pin	Name	Type	Function Description
1	RX0	I/O	Capacitive Rx/Tx Channel	21	RSTn	I	Reset pin, active low
2	RX1	I/O	Capacitive Rx/Tx Channel	22	TX0	I/O	Capacitive Tx/Rx Channel
3	RX2	I/O	Capacitive Rx/Tx Channel	23	TX1	I/O	Capacitive Tx/Rx Channel
4	RX3	I/O	Capacitive Rx/Tx Channel	24	TX2	I/O	Capacitive Tx/Rx Channel
5	RX4	I/O	Capacitive Rx/Tx Channel	25	TX3	I/O	Capacitive Tx/Rx Channel
6	RX5	I/O	Capacitive Rx/Tx Channel	26	TX4	I/O	Capacitive Tx/Rx Channel
7	RX6	I/O	Capacitive Rx/Tx Channel	27	TX5	I/O	Capacitive Tx/Rx Channel
8	RX7	I/O	Capacitive Rx/Tx Channel	28	TX6	I/O	Capacitive Tx/Rx Channel
9	RX8	I/O	Capacitive Rx/Tx Channel	29	TX7	I/O	Capacitive Tx/Rx Channel
10	RX9	I/O	Capacitive Rx/Tx Channel	30	TX8	I/O	Capacitive Tx/Rx Channel
11	VDDA	PWR/I	2.7~3.6V，2.2uF	31	TX9	I/O	Capacitive Tx/Rx Channel
12	NC	NC	NC	32	TX10	I/O	Capacitive Tx/Rx Channel
13	VDD18	PWR/O	1.8V，0.1~1.0uF	33	TX11	I/O	Capacitive Tx/Rx Channel
14	NC	NC	NC	34	TX12	I/O	Capacitive Tx/Rx Channel

15	IRQ	I/O	interrupt	35	TX13	I/O	Capacitive Tx/Rx Channel
16	NC	NC	interrupt	36	TX14	I/O	Capacitive Tx/Rx Channel
17	NC	NC	interrupt	37	TX15	I/O	Capacitive Tx/Rx Channel
18	SDA	I/O	I2C Data Signal	38	TX16	I/O	Capacitive Tx/Rx Channel
19	SCL	I/O	I2C Clock Signal	39	TX17	I/O	Capacitive Tx/Rx Channel
20	VDDHV	PWR/O	max12V，10~100nF	40	VSSA	GND	Analogly

I Input Only
O Output Only
I/O Input And Output

7. Ordering Information

Part Num	Package	Surface Printing	Package
CST328	QFN40-5*5(P0.40 T0.55)	方向点 +LOGO+CST328+PO	5000/tray, taped and shipped.

8. Limit parameter table

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Comment
Operating voltage VDDA	Vdd	2.7	3.0	3.6	V	
Power ripple	Vrip	-	-	50	mV	
Analog I/O withstand voltage	Vioa	-0.3	-	12	V	
Digital I/O withstand voltage	Viod	-0.3	-	3.6	V	
I/O withstands maximum current	Iiom	-15	-	15	mA	
Working temperature range	Topr	-40	+25	+85	℃	
Storage temperature range	Tstg	-60	-	+125	℃	
Working humidity	Hopr	-	-	95	%	
ESD HBM	ESD	3000	-	-	V	Human Body Model ESD
ESD MM	ESD	200	-	-	V	Machine Mode
Latch-up Current	LU	-	-	200	mA	

9. Electrical characteristics

9.1 Direct current (DC) electrical characteristics

Ambient temperature 25℃, VDDA=2.8V.

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Low level output voltage value	Vol	-	-	0.3*IOVCC	V
High level output voltage value	Voh	0.7*IOVCC	-	-	V
Input low level voltage value	Vil	-0.3	-	0.3*IOVCC	V
Input high level voltage value	Vih	0.7*IOVCC	-	IOVCC	V
Operating current (dynamic mode)	Iopr	-	2.8	-	mA
Operating current (monitor mode)	Imon	-	300	-	uA
Operating current (standby mode)	Ista	-	300	-	uA
Operating current (sleep mode)	Islp	-	50	-	uA

9.2 Alternating Current (AC) Electrical Characteristics

The ambient temperature is 25℃, VDDA=2.8V.

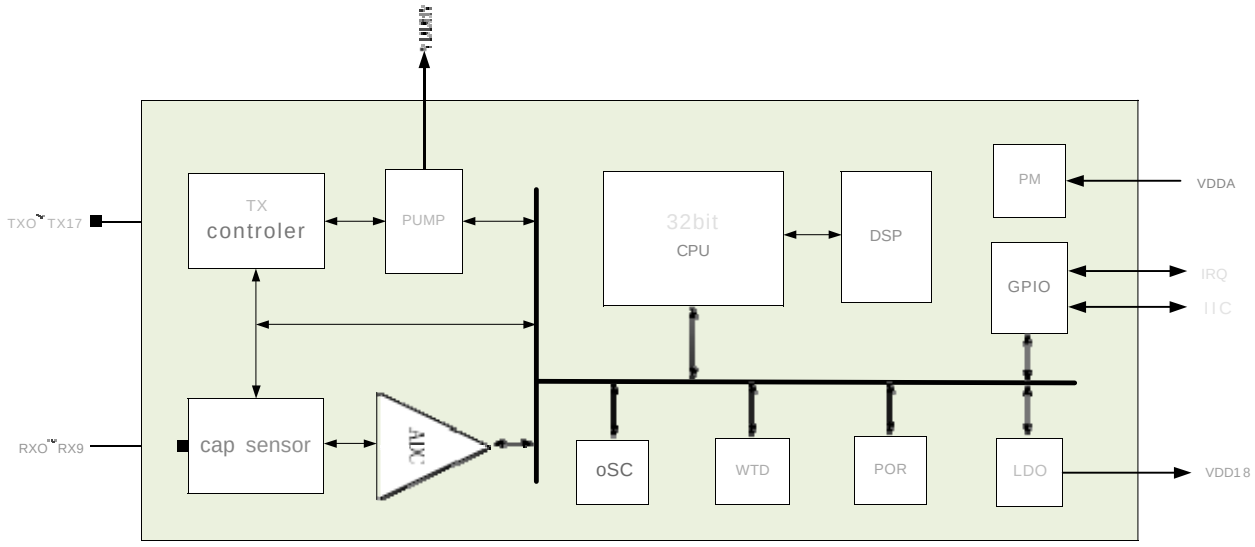
Parameter	Symbol	Minimum	Typical	Maximum	Unit
TX clock frequency	ftx	-	-	350	KHz
TX output voltage	Vtx	-	-	12	V
RX input voltage	Vrx	-	1.4	-	V

10. Function description

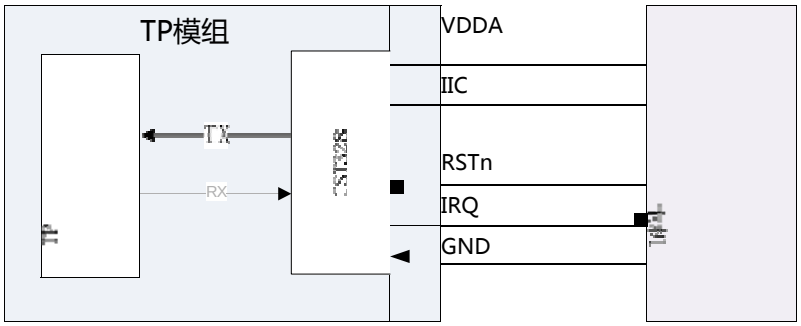
The CST328 series multi-point capacitive touch chip uses a high-voltage driver above 10V. Compared with traditional low-voltage drivers, it can provide a higher signal-to-noise ratio and anti-noise capability, achieving ultra-sensitive touch. At the same time, the self-mutual capacitance sensing module inside the chip, combined with the intelligent scanning algorithm, achieves rapid response.

At the same time, it has extremely excellent anti-noise, waterproof, and low power consumption performance.

The overall system block diagram is as follows:



10.1 Host interface



The above picture is the interface relationship between the host and CST328. The host and CST328 include IIC, IRQ, RSTn and VDDA signals. CST328

Contains TX and RX signals between and TP.

VDDA: The operating voltage of CST328.

SCL and SDA: Serial communication interface, the mobile phone is Master and CST328 is Slave.

IRQ: Interrupt signal, this is a general GPIO interface. When CST328 is ready with data, it is used to notify the host to read the data, such as:

Touch data, gesture data, etc.

10.2 Working mode

Dynamic mode

This mode is used when there are frequent touch operations. In this mode, the touch chip quickly and intelligently scans the touch screen for timely detection.

Touch and report to the host.

Monitor mode

When the touch screen times out and there is no touch action, the chip automatically switches to monitoring mode. In this mode, the touch chip scans the

Scan detects possible touch actions and quickly switches to dynamic mode.

Standby mode

It is in this mode after receiving the standby command. In this mode, the touch chip scans the touch screen at a lower frequency to match the wake-up time

Enter the dynamic mode after the gesture, and wake up the host through the IRQ pin. You can also switch to the dynamic mode through the wake-up command.

Sleep mode

After receiving the sleep command, it is in this mode. In this mode, the touch chip is in deep sleep state to maximize power consumption.

Can be woken up by external interrupt or external reset.

10.3 Channel/node configuration

The CST328 multi-touch chip can provide up to 28 channels, and each channel can be flexibly configured between drive/sensing functions. Each channel supports

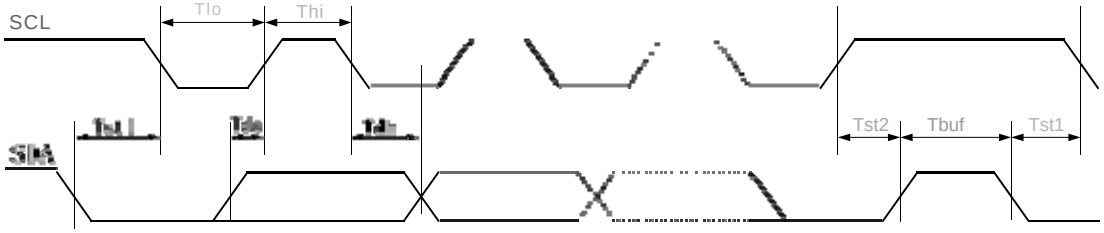
Maintain self-mutual capacitance scanning. When allocating drive/sense pins, try to select continuously distributed pins.

The mutual capacitance size range that each node can support: 0.5pF ~ 20pF (assuming the driving voltage is 10V).

10.4 I2C communication

CST328 supports the standard I2C communication protocol and can achieve a configurable communication rate of 10Khz~1Mhz. Two I2C pins SCL and SDA,

In addition to supporting open-drain mode, it also supports internal pull-up mode for flexible selection.



Description	Symbol	Fast Mode		HS Mode		Unit
		Min	Max	Min	Max	
SCL clock frequency	Fscl	0	400	0	1000	kHz
SCL hold time for START condition	Tst1	0.6	-	0.5	-	us
LOW period of SCL	Tlo	1.3	-	0.26	-	us
HIGH period of SCL	Thi	0.6	-	0.26	-	us
SDA setup time	Tds	0.1	-	0.05	-	us
SDA hold time	Tdh	0	0.9	0	0.9	ns
SCL setup time for STOP condition	Tst2	0.6	-	0.26	-	us
Ready time between STOP and START	Tbuf	20	-	20	-	us

CST328 always acts as a slave, and startup is actively established by the host. While the clock line SCL remains high, the data line SDA
The level is pulled low (that is, a negative transition), which is defined as the start signal of the I2C bus.
CST328 detects the 8-bit address sent after the start signal on the bus (the address can be customized in the chip, the default is 0x34/0x35). In the 9th clock cycle, the data line SDA is changed to an output port and pulled low. as a response signal. The data line SDA will send 9 bits of data serially in 9 clock cycles, 8 bits of valid data plus 1 bit of the response signal ACK or non-response signal NACK sent by the receiver.
The stop signal is also actively established by the host after the communication ends. The stop signal is that while the clock line SCL remains high, the data line SDA
is released, causing SDA to return to high level (i.e. positive transition). It marks the end of a data transfer.

a. The host writes data to CST328. The data transmission format is shown in the figure below:

S	slave Address[7bit]	W[1bit]	ACK	DATA[8bit]	ACK	...	DATA[8bit]	ACK/ NACK	P

b. The host reads data from CST328. The data transmission format is shown in the figure below:

S	slave Address[7bit]	R[1bit]	ACK	DATA[8bit]	ACK	...	DATA[8bit]	NACK	P

c. The host writes data to CST328, then restarts the starting condition, and then reads data from CST328; or the main device reads data from CST328, then restarts the starting condition, and then the main device writes data to CST328. The data transmission format is shown in the figure below:

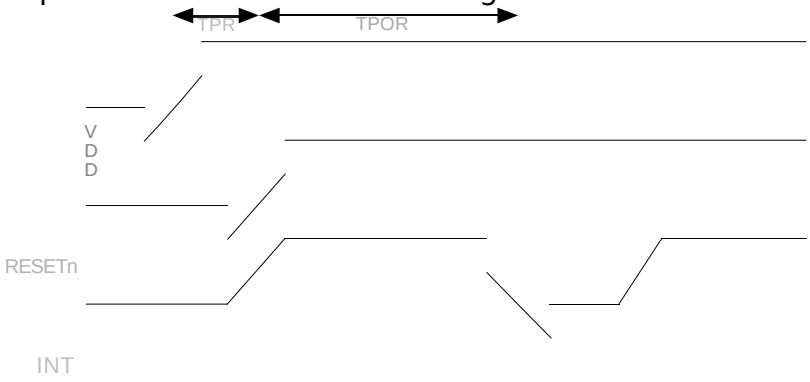
S	slave Address[7bit]	W[1bit]	ACK	DATA[8bit]	ACK	. .	DATA[8bit]	ACK/ NACK	
RS	slave Address[7bit]	R[1bit]	ACK	DATA[8bit]	ACK	. .	DATA[8bit]	NACK	P

10.5 Power on/reset

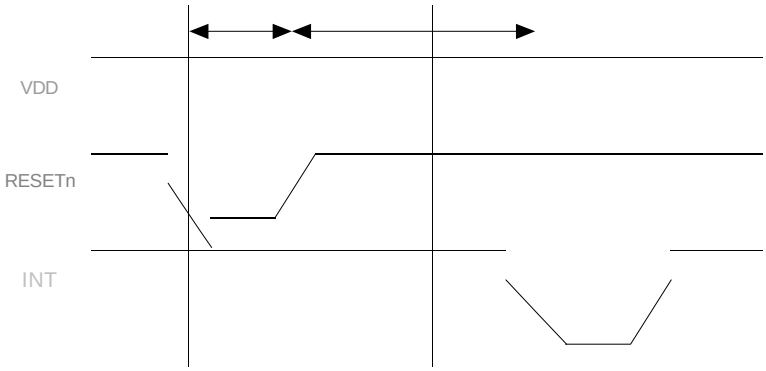
The built-in power-on reset module will keep the chip in the reset state until the voltage is normal. When the voltage is lower than a certain threshold, the chip will also be reset. When the external reset pin RSTn is low, the entire chip will be reset. This pin has a built-in pull-up. Resistor and RC filter, this pin can be left floating externally, and the core

The built-in watchdog ensures that when an abnormal situation occurs, the chip can still return to normal working status within the specified time.

The timing sequence of power-on reset is shown in the figure below:



Power-on sequence



External reset timing

Symbol	Description	Typical	Value Unit
TPOR	Chip initialization time after power-on	200	ms
TPR	RST pin delayed pull-up time	1	ms
TRON	Chip re-initialization time after reset	200	ms
TRST	reset pulse time	0.1	ms

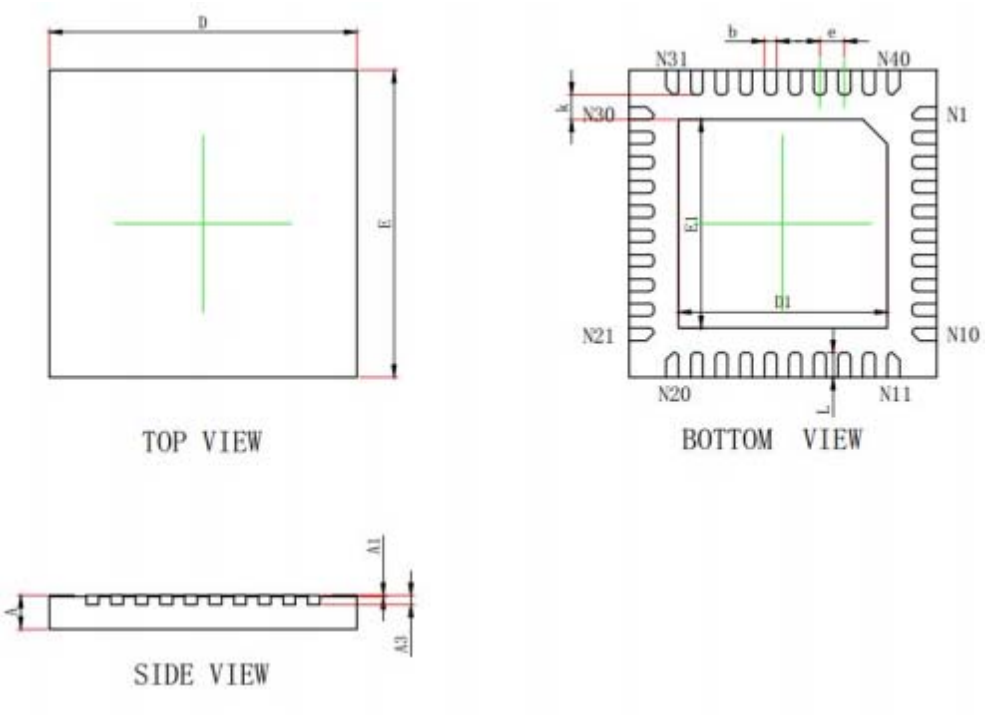
10.6 Interrupt mode

Only when a valid touch is detected and needs to be reported to the host, the touch chip will notify the host to read valid data through the IRQ pin to improve efficiency and reduce the burden on the CPU. The interrupt edge can be configured as a rising edge or a falling edge as needed. Valid, when in standby mode matching predefined

The IRQ pin is also used to wake up the host during gestures.

11. Product packaging

QFN40-5*5(Po.40 To.55)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
A3	0.152REF.		0.006REF.	
D	4.924	5.076	0.194	0.200
E	4.924	5.076	0.194	0.200
D1	3.300	3.500	0.130	0.138
E1	3.300	3.500	0.130	0.138
b	0.150	0.250	0.006	0.010
e	0.400TYP.		0.016TYP.	
k	0.200MIN.		0.008MIN.	
L	0.350	0.450	0.014	0.018

12. Register appendix

Version information register (ENUM_MODE_DEBUG_INFO mode)

Register address	Register description	BYTE3	BYTE2	BYTE1	BYTE0
0xD1F4	Number of buttons, TX and RX channels	KEY_NUM	TP_NRX	NC	TP_NTX
0xD1F8	X/Y resolution	TP_RESY		TP_RESX	
0xD1FC	Firmware verification code, Bootloader time	0xCACA		BOOT_TIMER	
0xD204	Chip type, firmware project ID	IC_TYPE		PROJECT_ID	
0xD208	Chip firmware version number	FW_MAJOR	FW_MINOR	FW_BUILD	
0xD20C	Chip firmware checksum	checksum_H	checksum_H	checksum_L	checksum_L

模式命令寄存器

Command	Command description	Command format
0xD101	ENUM_MODE_DEBUG_INFO mode, enter the reading firmware information mode.	Write 0xD1 0x01
0xD102	System_Reset flag, resets the chip.	Write 0xD1 0x02
0xD104	Redo_Calibration flag, reinitializes the algorithm.	Write 0xD1 0x04
0xD105	Deep sleep, enter sleep mode.	Write 0xD1 0x05
0xD108	ENUM_MODE_DEBUG_POINTS，Enter debug reporting mode.	Write 0xD1 0x08
0xD109	ENUM_MODE_NORMAL ，Enter the normal reporting mode, which is the default mode.	Write 0xD1 0x09
0xD10A	ENUM_MODE_DEBUG_RAWDATA, enter the reading rawdata data mode。	Write 0xD1 0x0A
0xD10B	ENUM_MODE_DEBUG_WRITE, enter debug write mode.	Write 0xD1 0x0B
0xD10C	ENUM_MODE_DEBUG_CALIBRATION, enter redo debugging mode.	Write 0xD1 0x0C
0xD10D	ENUM_MODE_DEBUG_DIFF	Write 0xD1 0x0D
0xD119	ENUM_MODE_FACTORY	Write 0xD1 0x19

Touch information register（ENUM MODE NORMAL ）

Register address	Senior four				Low four bits			
	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0xD000	1st finger ID				1st finger status: pressed (0x06) or lifted			
0xD001	The upper eight digits of the X coordinate value of the 1st finger： X_Position>>4							

0xD002	The upper eight digits of the Y coordinate value of the 1st finger： Y_Position>>4	
0xD003	1st X coordinate value of finger X_Position&0x0F	1st Y coordinate value of finger Y_Position&0x0F
0xD004	1st finger pressure value	
0xD005	Report button flag (0x80)	Report the number of fingers
0xD006	Fixed 0xAB	
0xD007	2nd finger ID	2nd finger status: pressed (0x06) or lifted
0xD008	The upper eight digits of the X coordinate value of the 2nd finger: X_Position>>4	
0xD009	The upper eight digits of the Y coordinate value of the 2nd finger: Y_Position>>4	
0xD00A	2nd X coordinate value of finger X_Position&0x0F	2nd Y coordinate value of finger Y_Position&0x0F
0xD00B	2nd finger pressure value	
0xD00C	3rd finger ID	3rd finger status: pressed (0x06) or lifted
0xD00D	The upper eight digits of the X coordinate value of the 3rd finger: X_Position>>4	
0xD00E	The upper eight digits of the Y coordinate value of the 3rd finger: Y_Position>>4	
0xD00F	3rd X coordinate value of finger X_Position&0x0F	3rd Y coordinate value of finger Y_Position&0x0F
0xD010	3rd finger pressure value	
0xD011	ID of 4th finger	4th finger status: pressed (0x06) or lifted
0xD012	The upper eight digits of the X coordinate value of the 4th finger: X_Position>>4	
0xD013	The upper eight digits of the Y coordinate value of the 4th finger: Y_Position>>4	
0xD014	4th X coordinate value of finger X_Position&0x0F	4th Y coordinate value of finger Y_Position&0x0F
0xD015	4th finger pressure value	
0xD016	5th finger ID	5th finger status: pressed (0x06) or lifted
0xD017	The upper eight digits of the X coordinate value of the 5th finger: X_Position>>4	
0xD018	The upper eight digits of the Y coordinate value of the 5th finger: Y_Position>>4	
0xD019	5th X coordinate value of finger X_Position&0x0F	5th Y coordinate value of finger Y_Position&0x0F
0xD01A	5th finger pressure value	