GT917S

Capacitive Touch Controller with Customized Smart Wake-Up Gestures

Rev 0.1—Dec. 17th, 2018

Contents

1. Overview

GT917S is a new-generation 10-point capacitive touch solution designed for 5”-6” touch panels; it contains 16 Tx channels and 29 Rx channels to achieve higher touch accuracy.

In addition, it supports customized smart wake-up gestures and gloved hand input, which greatly enriches the user experience and enables customers to differentiate their products from those of their competitors.

2. Features

- ✧ Built-in capacitive sensing circuit and high-performance MPU
  - ➢ Report rate: ≤120Hz
  - ➢ Outputs touch coordinates in real time
  - ➢ Unified software applicable to mutual capacitive touch sensors of various sizes
  - ➢ Single power supply, internal 1.8V LDO
  - ➢ Flash embedded; In-system reprogrammable
- ✧ Capacitive touch sensor
  - ➢ Channels: 16 (Tx channels) * 29 (Rx channels)
  - ➢ Capacitive touch sensor sizes: ≤5-6”
  - ➢ Supports touch key on FPC
  - ➢ Supports ITO glass and ITO Film
  - ➢ Cover Lens thickness: 0.4mm≦ Glass≦ 2mm, 0.4mm≦ PMMA≦ 1.2mm
  - ➢ Adaptive frequency hopping
  - ➢ OGS full lamination
- ✧ Customized smart wake-up
  - ➢ Embedded gestures:
  - ➢ o,w,m,e,c,v,>,s, ↑ , ↓ ,←,→,^,<, single tap and double-tap
  - ➢ Supports up to 10 customized multi-stroke gestures
  - ➢ Provides *.so* algorithms library for AP development
- ✧ Environmental adaptability
  - ➢ Self-calibration during initialization
  - ➢ Automatic drift compensation
  - ➢ Operating temperature: -20℃ to +85℃; humidity: ≦95%RH
- ✧ Communication interface
  - ➢ Standard I^2C interface

- Works in slave mode
- Supports 1.8V to 3.3V host interface voltage

✧ Power supply voltage:

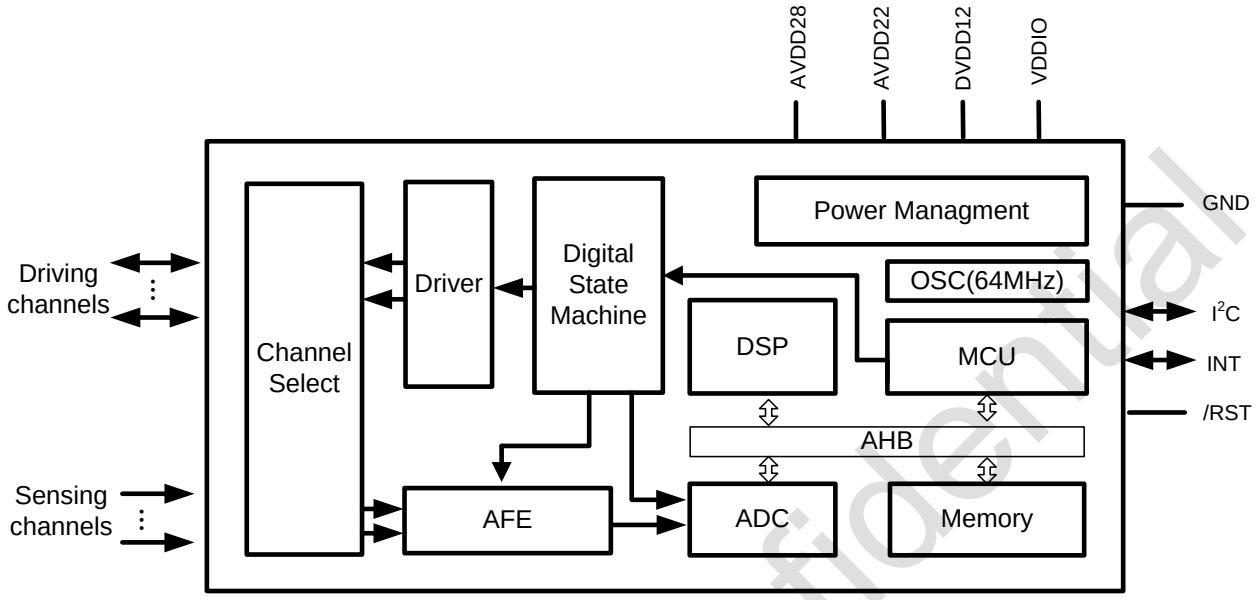
- Single supply (Typ.) : 2.8V/3.0V/3.3V

✧ Package: 58pins, QFN 6X6X0.60, pitch 0.35mm

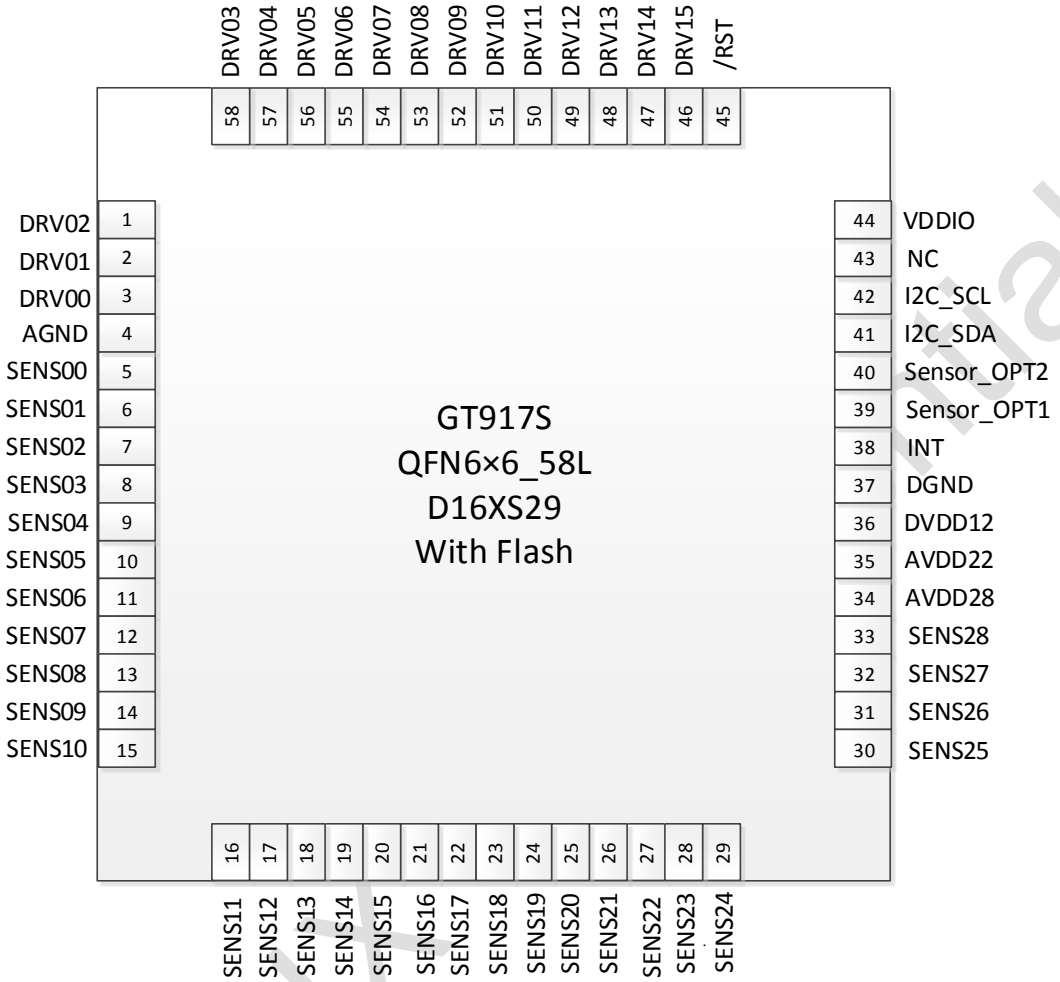
✧ Tools that support application development:

- Touch panel parameter detector and generator
- Touch panel performance tester
- Mass production test kit
- Reference driver code and guidance files for host-side software development

3. Block Diagram



4. Pin Definition



Pin No.	Name	Function description	Remarks
1	DRV02	Transmitter	
2	DRV01	Transmitter	
3	DRV00	Transmitter	
4	AGND	Analog ground	
5	SENS00	Receiver	
6	SENS01	Receiver	

7	SENS02	Receiver	
8	SENS03	Receiver	
9	SENS04	Receiver	
10	SENS05	Receiver	
11	SENS06	Receiver	
12	SENS07	Receiver	
13	SENS08	Receiver	
14	SENS09	Receiver	
15	SENS10	Receiver	
16	SENS11	Receiver	
17	SENS12	Receiver	
18	SENS13	Receiver	
19	SENS14	Receiver	
20	SENS15	Receiver	
21	SENS16	Receiver	
22	SENS17	Receiver	
23	SENS18	Receiver	
24	SENS19	Receiver	
25	SENS20	Receiver	
26	SENS21	Receiver	
27	SENS22	Receiver	

28	SENS23	Receiver	
29	SENS24	Receiver	
30	SENS25	Receiver	
31	SENS26	Receiver	
32	SENS27	Receiver	
33	SENS28	Receiver	
34	AVDD28	Analog power	2.2uF filter capacitor to GND
35	AVDD22	LDO output	2.2uF filter capacitor to GND
36	DVDD12	LDO output	2.2uF filter capacitor to GND
37	DGND	Digital ground	
38	INT	Interrupt signal	
39	Sensor_OPT1	Vendor ID pin	
40	Sensor_OPT2	Vendor ID pin	Cannot be left floating
41	I²C_SDA	I²C data signal	
42	I²C_SCL	I²C clock signal	
43	NC		
44	VDDIO	GPIO supply voltage	2.2uF filter capacitor to GND Floating: 1.8V Connect to AVDD: AVDD

45	/RST	System reset pin	Active low
46	DRV15	Transmitter	
47	DRV14	Transmitter	
48	DRV13	Transmitter	
49	DRV12	Transmitter	
50	DRV11	Transmitter	
51	DRV10	Transmitter	
52	DRV09	Transmitter	
53	DRV08	Transmitter	
54	DRV07	Transmitter	
55	DRV06	Transmitter	
56	DRV05	Transmitter	
57	DRV04	Transmitter	
58	DRV03	Transmitter	

5. Sensor Design

5.1 Layout of Rx Channels

SENS00 to SENS28 are 29 Rx channels on the chip which can be directly connected to 29 ITO Rx electrodes on the touch panel module in sequence. After the layout of the Rx channels is determined, relevant registers of GT917S shall be configured to ensure that the logic positions of the Rx channels are consistent with their physical positions, so that the reported coordinates match with the physical coordinates.

5.2 Layout of Tx Channels

DRV00 to DRV15 are 16 Tx channels on the chip which can be directly connected to 16 ITO Tx electrodes on the touch panel module. After the layout of the Tx channels is determined, relevant registers of GT917S shall be configured to ensure that the logic positions of the Tx channels are consistent with their physical positions, so that the reported coordinates match with the physical coordinates.

For detailed sensor design rules, please refer to *Sensor Guidelines* of GOODIX.

5.3 Sensor Design Specifications

GT917S	DITO	SITO
Impedance of Tx routing trace	≦3KΩ	≦3KΩ
Impedance of Tx electrode	≦10KΩ	≦10KΩ
Impedance of Rx routing trace	≦10KΩ	≦10KΩ
Impedance of Rx electrode	≦40KΩ	≦10KΩ
Node capacitance	≦4pF	≦4pF

When metal traces are employed for routing, some traces may be oxidized due to process control or other reasons and their impedance will become larger, making the impedance vary between traces. When ITO traces are employed for routing, though we've done our utmost to obtain impedance consistency between traces by adopting matched length and width in design, there are still differences.

To ensure data consistency and uniformity onthe entire touch screen, it is required to ensure the sensor design complies with the above requirements. For details of the requirements, please refer Sensor Design Guide of Goodix.

5.4 Touch Key Design

GT917S supports a maximum of 4 touch keys. There are two design solutions:

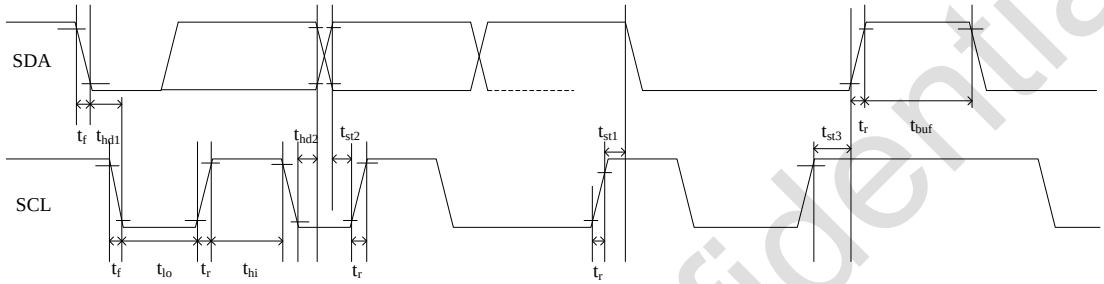
1) Sensor extension: Take one Rx channel as a common line for the touch keys and connect the Rx channel to four Tx channels to form four touch keys. The touch keys must not share their Rx channel with the touch screen. However, Tx channels have to be shared.

2) Touch key design on FPC: Connect one separate Rx channel to four Tx channels to form four touch keys. The touch keys have to share their Tx channels with the touch screen. Touch key pattern on FPC should be designed independently.

6.I²C Communication

6.1 I²C Timing

GT917S provides a standard I²C interface for SCL and SDA to communicate with the CPU. GT917S always serves as slave device (the address is 0X28/0X29) in the system with all communication being initialized by the CPU. It is strongly recommended that communication speed be kept at or below 400Kbps. The diagram below illustrates the I²C timings:



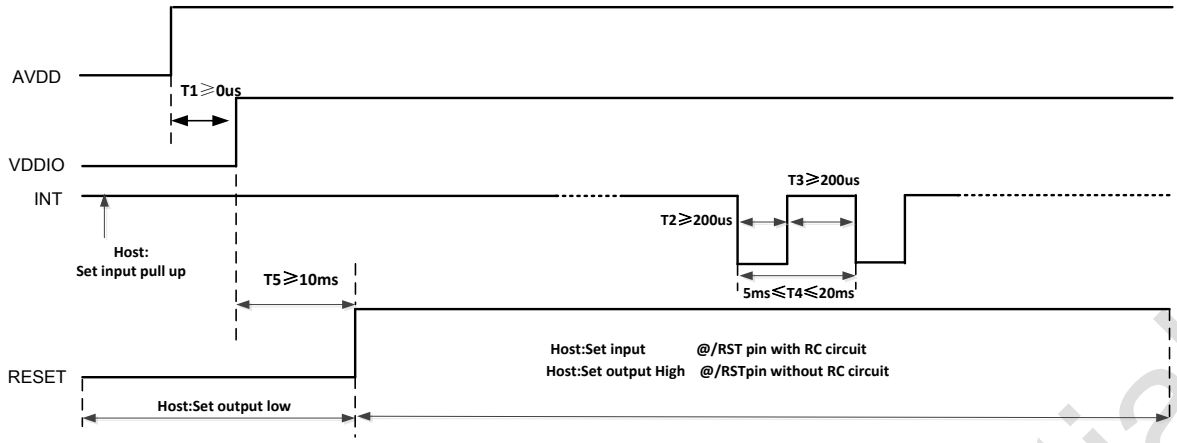
Test condition 1: 1.8V host interface voltage, 400Kbps communication sped, 2KΩ pull-up resistor

Parameter	Symbol	Min.	Max.	Unit
SCL low period	t_{lo}	1.3	-	us
SCL high period	t_{hi}	0.6	-	us
SCL setup time for START condition	t_{st1}	0.6	-	us
SCL setup time for STOP condition	t_{st3}	0.6	-	us
SCL hold time for START condition	t_{hd1}	0.6	-	us
SDA setup time	t_{st2}	0.1	-	us
SDA hold time	t_{hd2}	0	-	us

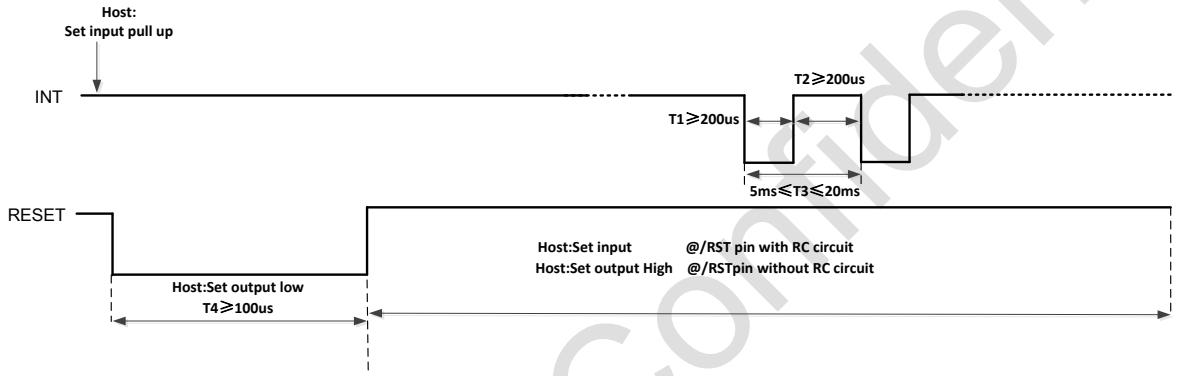
Test condition 2: 3.3Vhost interface voltage, 400Kbps communication speed, 2KΩ pull-up resistor

Parameter	Symbol	Min.	Max.	Unit
SCL low period	t_{lo}	1.3	-	us
SCL high period	t_{hi}	0.6	-	us
SCL setup time for START condition	t_{st1}	0.6	-	us
SCL setup time for STOP condition	t_{st3}	0.6	-	us
SCL hold time for START condition	t_{hd1}	0.6	-	us
SDA setup time	t_{st2}	0.1	-	us
SDA hold time	t_{hd2}	0	-	us

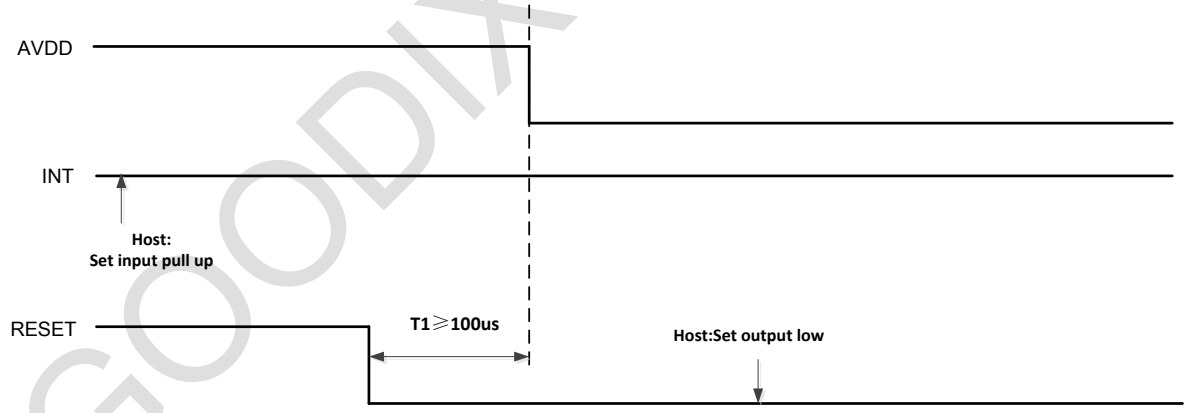
Power-on Timing:



Reset Timing (GT917S reset by host):



GT917S timing when the host is powered down



a) Data Transmission

Communication is always initiated by the CPU. Valid Start condition is signaled by pulling SDA line from high to low when SCL line is high. Data flow or address is transmitted after the Start condition.

All slave devices connected to I^2C bus should detect the 8-bit address issued after Start condition and

send the correct ACK. After receiving matching address, GT917S acknowledges by configuring SDA line as output port and pulling SDA line low during the ninth SCL cycle. When receiving mismatched address, namely, not 0X28 or 0X29, GT917S will stay in an idle state.

For data bytes on SDA, each of 9 serial bits will be sent on nine SCL cycles. Each data byte consists of 8 valid data bits and one ACK or NACK bit sent by the recipient. The data transmission is valid when SCL line is high.

When communication is completed, CPU will issue the Stop condition which implies the transition of SDA line from low to high when SCL line is high.

b) Writing Data to GT917S

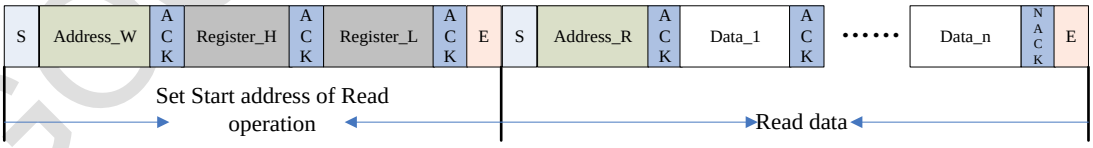
Timing for Write Operation

The diagram above displays the timing sequence of the CPU writing data onto GT917S. First, the CPU issues a Start condition. Then, the host sends 0X28 (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the CPU sends the 16-bit register address (where writing starts) and the 8-bit data bytes (to be written onto the register).

The location of the register address pointer will automatically add 1 after every Write Operation. Therefore, when the CPU needs to perform Write Operations on a group of registers of consecutive addresses, it is able to write continuously. The Write Operation is terminated when the CPU issues the Stop condition.

c) Reading Data from GT917S



Timing for Read Operation

The diagram above is the timing sequence of the CPU reading data from GT917S. First, the CPU issues a Start condition and sends 0X28 (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the CPU sends the 16-bit register address (where reading starts) to the slave device.

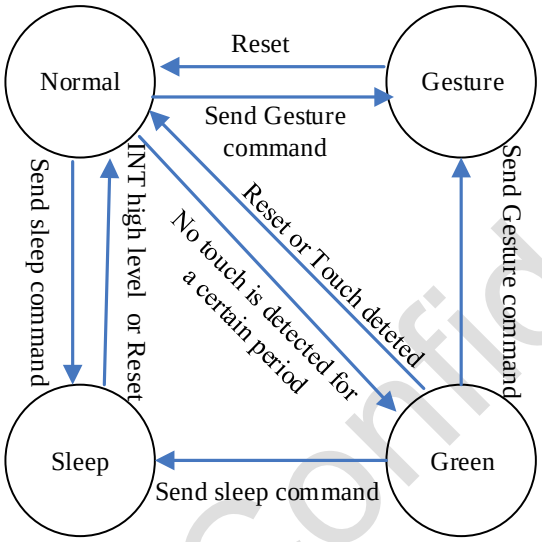
Then the CPU sets register addresses which need to be read.

Also after receiving ACK, the CPU issues the Start condition once again and sends 0X29 (Read Operation). After receiving ACK, the CPU starts to read data.

GT917S also supports continuous Read Operation and, by default, reads data continuously. Whenever receiving a byte of data, the CPU sends an ACK signal indicating successful reception. After receiving the last byte of data, the CPU sends a NACK signal followed by a Stop condition which terminates communication.

7. Functional Description

7.1 Operating Modes



a) Normal Mode

When GT917S is operating in Normal mode, its minimum coordinate refresh period is 5ms to 20ms (subject to configuration; one step is 1ms).

b) Green Mode

When no touch is detected for a certain period in Normal mode, GT917S will automatically switch to Green mode to reduce power consumption .The no-touch duration for GT917S to enter Green mode is subject to configuration. The valid range is 0s to 14s; one step is 1s. Please note that Green mode can be turned off.

In Green mode, the scan period of GT917S is about 40ms. GT917S automatically enters Normal mode if any touch is detected.

c) Gesture Mode

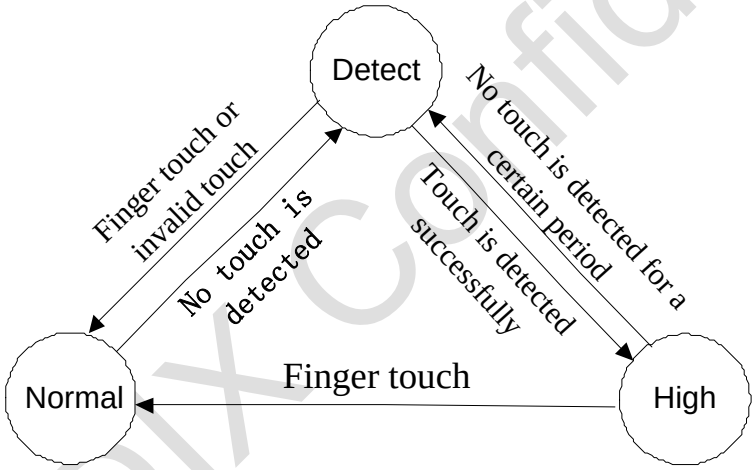
After the host enables GT917S to enter Gesture mode by sending corresponding I^2C command, wake-up can be achieved by swipe, double-tap, or writing specified letters on the touch panel.

In Gesture mode, when GT917S detects finger swipe (for a sufficiently long distance), double-tap or writing of embedded/customized letters (wake-up gestures) on touch panel, INT will output a pulse for longer than 250us (subject to configuration) or keep output high. Subsequently, the host will wake up and turn on the screen after receiving such pulse or high level.

d) Sleep Mode

GT917S enters Sleep mode if it receives the corresponding I^2C command from the host. GT917S is required to exit Sleep mode, the host resets GT917S and then GT917S will enter Normal mode. The interval between sending command and reset should be longer than 58ms.

7.2 Sensitivity Status Transition



a) Normal Status (Normal Sensitivity)

In Normal status, higher touch threshold is used to identify touch signal and locate touch position to reduce noise interference. This status only supports finger touch.

b) High Status (High Sensitivity)

In High status, lower touch threshold is used to identify touch signal and locate touch position. This status supports gloved hand and passive stylus input. When detecting finger touch, GT917S will immediately return to Normal status.

c) Detect Status

When there is no touch for a certain period in Normal status or High status, GT917S will automatically switch to Detect status. When GT917S detects finger touch or multiple weak-signal touches in Detect

status, it will automatically switch to Normal status. When GT917S detects a single weak-signal swipe or double-tap in Detect status, it will enter High status. While in Detect status, GT917S will not report coordinates to the host.

d) Glove Material

There is a variety of gloves in the market due to varied materials and thickness. Therefore, we provide an adaptability description here. For surface layer materials of the glove, conductive materials and leather are preferable to wool, nylon and cotton. Further, referring to glove thickness, wool, nylon, and cotton gloves should be thinner while thicker leather and conductive material gloves are acceptable.

7.3 Interrupt Triggering Mechanism

When touched, GT917S sends a falling edge pulse via INT pin in every scanning cycle to notify the CPU to read coordinates.

7.4 Stationary Configuration

GT917S supports Stationary Configuration. A set of fixed parameters can be saved in the chip Flash. After saving the configuration parameters, GT917S will communicate with the host solely via I^2C bus and will not receive any parameters which are not fixed .

7.5 Adaptive Frequency Hopping

GT917S is equipped with reliable anti-interference hardware. When the drive spectrum of GT917S overlaps with the peak spectrum of noise signal, GT917S will switch to another frequency by using a self-adaptive frequency hopping mechanism to avoid interference.

7.6 Self-Calibration

a) Self-calibration during Initialization

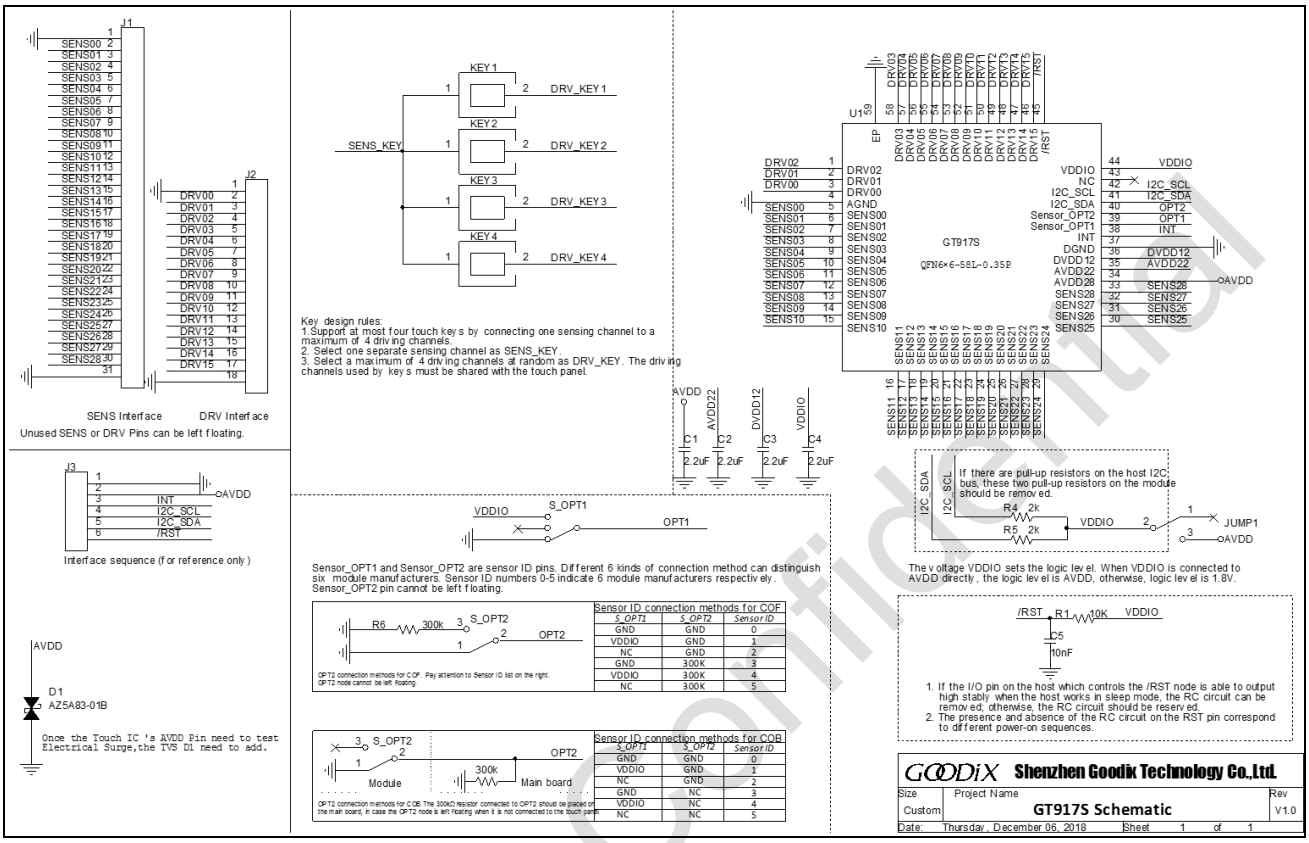
Fluctuations in temperature, humidity and environment may affect the baseline of the capacitive sensor in idle state. GT917S will update detection baseline according to environmental conditions within the first 200ms of initialization. Then, GT917S will complete the initialization.

b) Automatic Drift Compensation

Gradual changes in environmental factors such as temperature, humidity, or dust may also affect the baseline of the capacitive sensor in idle state. GT917S will detect real-time changes in data and perform

statistical analysis of historic data to revise the baseline and thus reduce the impact that the environmental changes have on the touch panel performance.

8. Sample Schematic



GT917S Sample Schematic

Note:

- This circuit only represents basic application. Adjustments may be required to fit in with actual situations and application environments.
- It is recommended that the capacitor be ceramic X7R.

9. Electrical Characteristics

9.1 Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Analog power AVDD28 (take AGND as reference)	-0.3	4.2	V
Analog power AVDD22 (take AGND as reference)	-0.3	4.2	V
Digital power DVDD12 (take GND as reference)	-0.3	4.2	V
VDDIO (take AGND as reference)	-0.3	4.2	V
Voltage on digital I/O	-0.3	4.2	V
Voltage on analog I/O	-0.3	4.2	V
Storage temperature	-60	125	℃
Soldering temperature (10s)	-	260	℃
ESD Susceptibility (HB Model)	±4		kV

9.2 Recommended Operating Conditions

(Ambient temperature: 25℃)

Parameter	Min.	Typ.	Max.	Unit
AVDD28①	2.7	2.8/3.0/3.3	3.4	V
AVDD22	-	2.2	-	V
DVDD12	-	1.2	-	V
VDDIO②	-	1.8	-	V
Operating temperature	-20	25	85	℃

9.3 AC Electrical Characteristics

(Ambient temperature: 25℃, AVDD28=2.8V, VDDIO=1.8V)

Parameter	Min.	Typ.	Max.	Unit
OSC oscillation frequency	63.36	64.0	64.64	MHz
I/O output rise time, low to high	-	15@100pf	-	ns
I/O output fall time, high to low	-	12.5@100pf	-	ns

① Power supply ripple Vpp≤100mV @ Typical supply voltage;
Power supply ripple Vpp≤50mV @ Maximum or Minimum supply voltage.

② When VDDIO is floating, the logic level is 1.8V; when VDDIO is connected to AVDD28, the logic level is AVDD28.

9.4 DC Electrical Characteristics

(Ambient temperature: 20℃-70℃, AVDD28=2.8V, VDDIO=1.8V or VDDIO=AVDD28)

Parameter	Min.	Typ.	Max.	Unit
Normal mode peak current @120Hz	-	44	50	mA
Normal mode operating current @120Hz		32		
Green mode operating current@32ms[③]	-	3	-	mA
Gesture mode operating current[④]	-	0.8	-	mA
Sleep mode operating current	-	100	-	uA
Digital input low voltage/VIL	-0.3	-	0.25*VDDIO	V
Digital input high voltage/VIH	0.75*VDDIO	-	VDDIO+0.3	V
Digital output low voltage/VOL	-	-	0.15*VDDIO	V
Digital output high voltage/VOH	0.85*VDDIO	-	-	V

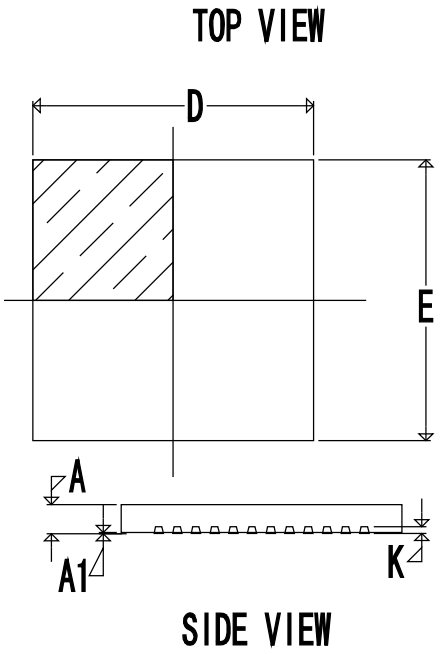
Note: In every mode, the actual current will vary due to the number of channels and firmware configuration.

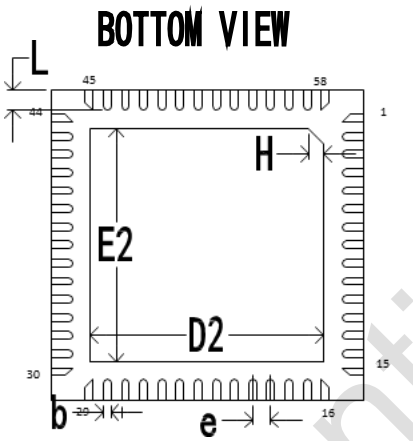
According to the actual verification results, after the IC is made into a module, the peak current will be reduced by 0.5mA.

[③] 32ms is the scan period in Green mode

[④] The operating current in Gesture mode is measured when no touch is present.

10. Package





QFN 6 X 6 58PIN

0.35 PITCH SQUARE

Symbol	Dimensions In Millimeters		
	Min.	Normal	Max.
A	0.5	0.55	0.60
A1	0.00	0.035	0.05
b	0.10	0.15	0.20
D	5.90	6.00	6.10
E	5.90	6.00	6.10
D2	4.40	4.50	4.60
E2	4.40	4.50	4.60
e	0.35BSC		
H	0.30REF		
K	0.152REF		
L	0.35	0.40	0.45

11. Requirements on SMT Reflow Solder

11.1 Moisture Sensitivity Level (MSL)

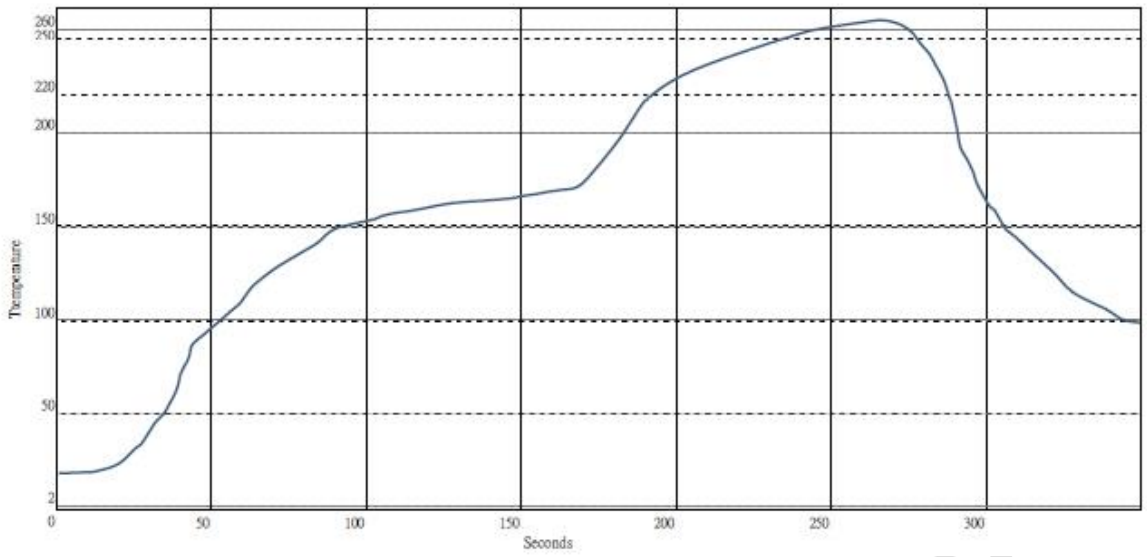
GT917S is classified as **MSL3**. The detailed requirements are listed below:

1) Calculated shelf life in sealed Moisture-Barrier Bag: 12 months at <40℃ and < 90% relative humidity (RH)
2) After bag is opened, devices that will be subjected to IR reflow solder or other high temperature process (<260℃) must be
   a) Mounted within: 168 hours of factory conditions ≤30℃/60% RH, OR
   b) Stored at < 10% RH (such as a dry cabinet)
3) Devices require bake, before mounting, if:
   a) Humidity indicator card is >20% when read at 23±5℃
   b) 2a or 2b not met
4) If baking is required:
   a) Devices shipped in low temperature carriers (such as Tape and Reel) can be baked in carriers for 192 hours at 40℃+5℃/-0℃ and <5% R.H.
   b) Devices shipped in high temperature carriers (such as Tray) can be baked in carriers for 24 hours at 125°C +5/-0℃
   c) After baking, device should be put into the Moisture-Barrier Bag right after it cools down. Device shipped in low temperature carriers (such as Tape and Reel) should be packed inside the bag along with at least 5g desiccant and a six-spot humidity indicator card; Device shipped in high temperature carriers (such as Tray) should be packed inside the bag along with at least 10g desiccant and a six-spot humidity indicator card. Each bag should be vacuumized and sealed.

11.2 Reflow Passes

Number of reflow passes: ≤3.

11.3 Pb-Free Reflow Temperature Profile



GT917S follows the standard J-STD-020D-01 and more particularly these parameters:

<table>
<tr><th colspan="5">Profile Feature</th><th colspan="3">Pb-Free Assembly (For reference)</th></tr>
<tr><td rowspan="8">Room Temperature to Peak Temperature</td><td colspan="2" rowspan="2">A . Pre-heating zone (25℃—150℃)</td><td>Duration</td><td colspan="2">80s—120s</td><td rowspan="8">The time spent on ramping up from room temperature to peak temperature should be less than 8 minutes.</td></tr>
<tr><td>Ramp Up Rate</td><td colspan="2"><3℃/s</td></tr>
<tr><td colspan="2" rowspan="2">B. Soak zone (150℃—200℃)</td><td rowspan="2">Duration</td><td colspan="2" rowspan="2">60s—120s （100s is recommended by Goodix）</td></tr>
<tr><td></td></tr>
<tr><td rowspan="2">Time Above 217℃</td><td rowspan="2">C. 217℃—260℃</td><td>Ramp Up Rate</td><td colspan="2"><3℃/s</td></tr>
<tr><td rowspan="3">D. Peak Temp. (255℃—260℃)</td><td>Duration</td><td>20s—30s</td><td rowspan="3">Time above 217℃: 60s—150s</td></tr>
<tr><td>--</td><td rowspan="3">E .260℃—217℃</td><td>Duration</td><td>60s—75s</td><td>--</td></tr>
<tr><td>--</td><td>Ramp Down Rate</td><td><6℃/s</td><td>--</td></tr>
<tr><td>--</td><td colspan="2">F. Time Below 217℃ (Cooling zone)</td><td>Ramp Down Rate</td><td colspan="2">1 ℃/s—3℃/s</td><td>--</td></tr>
</table>

Note: Please follow the standard “J-STD-020D-01”.

12. Revision History

Revision	Date	Description
01	2018-12-17	Preliminary version

13. Contact Information

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