GT9110P

Single-Chip Capacitive 10-Point Touch Controller with Active Stylus

Rev. 09 ——July 28, 2018

Contents

1. Overview

GT9110P is a new-generation single-chip 10-point capacitive touch solution designed for tablet PCs, with 42 transmitter electrodes and 30 receiver electrodes to provide superior touch accuracy.

GT9110P supports capacitive active stylus, able to capture every subtle detail of the stylus input on the capacitive screen, which greatly improves the user experience.

2. Features

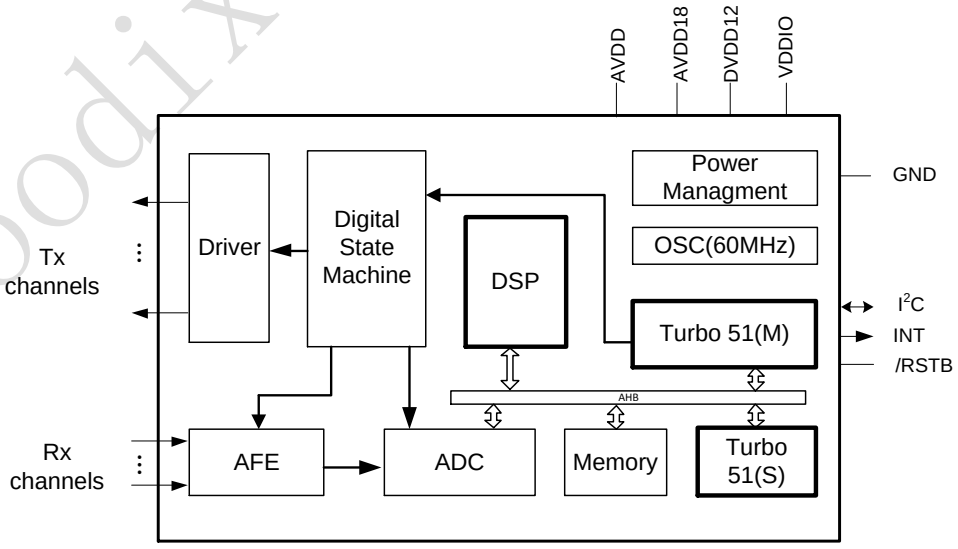
- ✧ Built-in capacitive sensing circuit and high-performance MPU
  - ➢ Report rate: 100Hz
  - ➢ Supports 10 concurrent touches and outputs touch coordinates in real time
  - ➢ Unified firmware applicable to touch panels of various sizes
  - ➢ Single power supply, internal 1.8V LDO
  - ➢ Flash embedded; In-system reprogrammable
- ✧ Touch screen sensor
  - ➢ Channels:42 (Tx channels)* 30 (Rx channels)
  - ➢ Capacitive touch screen size: 8.9” to 12.1” (diagonal)
  - ➢ Supports both ITO glass and ITO Film
  - ➢ Cover lens thickness requirement: 0.55mm≦Glass≦2mm

    0.5mm≦PMMA≦1.2mm

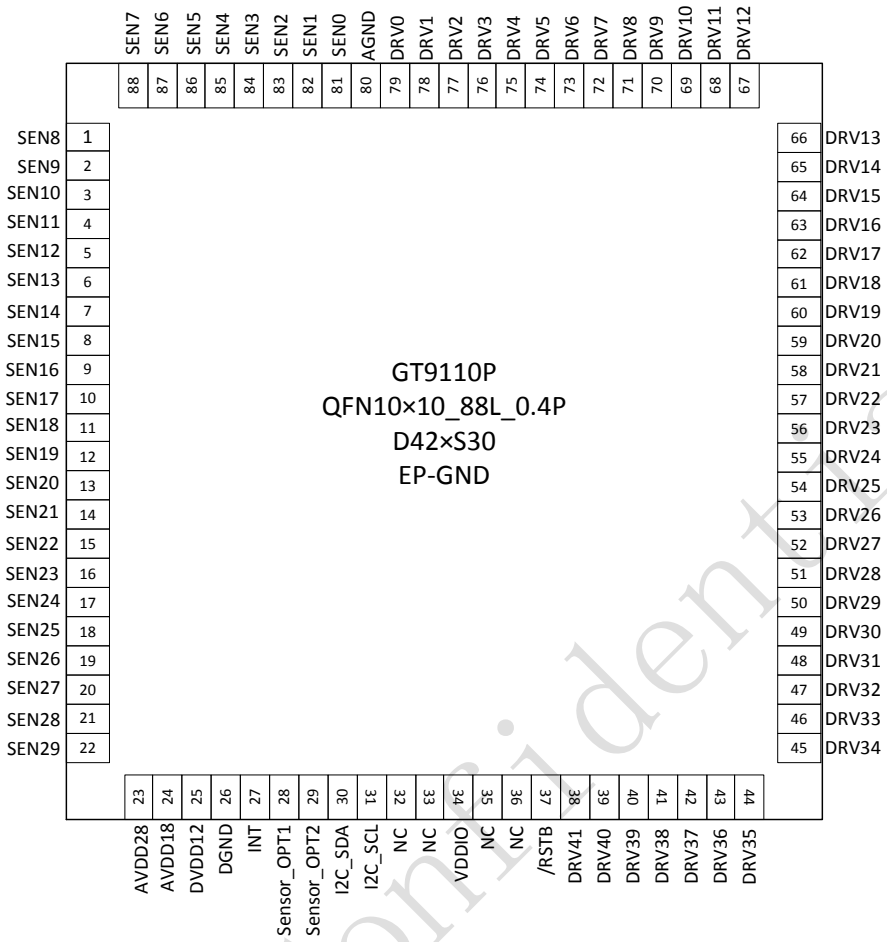
    (For details, please refer to *Sensor Design Guide.*)
  - ➢ Adaptive frequency hopping
- ✧ Environmental adaptability
  - ➢ Self-calibration during initialization
  - ➢ Automatic drift compensation
  - ➢ Operating temperature: -20℃ to +85℃, humidity: ≦95%RH

- Host interface
  - Standard I^2C interface
  - Works in Slave mode
  - Supports 1.8V to 3.3V host interface voltage
- Power supply voltage:
  - Single power(Typ.) : 2.8V/3.0V/3.3V
- Packaging:
  - 88 pins, 10mm*10mm*0.8mm QFN, 0.4P
- Tools that support application development:
  - TP module parameter detector and generator
  - TP module performance tester
  - Mass production test kit
  - Reference driver code and documentary guide for host software development

3. Block Diagram



4. Pin Definition



Pin No.	Name	Description	Remark
1~22	SENS8~SENS29	Receiver electrodes	
23	AVDD28	Analog VDD 2.8V	2.2uF to GND
24	AVDD18		2.2uF to GND
25	DVDD12		2.2uF to GND
26	DGND	Digital ground	
27	INT	Interrupt	Edge triggered; Configurable through register
28	Sensor_OPT1	Vendor ID pin 1	
29	Sensor_OPT2	Vendor ID pin 2	External pull-down resistor required
30	I2C_SDA	I^2C_data	
31	I2C_SCL	I^2C_clock	
32-33	NC		

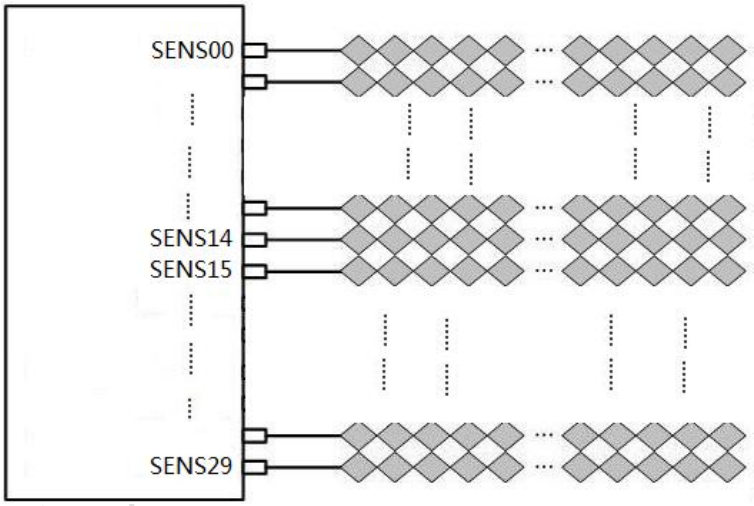
34	VDDIO	GPIO supply voltage	2.2uF to GND 1. Floating:1.8V 2. Connect to AVDD: AVDD
35-36	NC		
37	/RSTB	Reset	External 10-K pull-up resistor required, active-low reset
38~79	DRV41~DRV0	Transmitter electrodes	
80	AGND	Analog ground	
81~88	SENS0~SENS7	Receiver electrodes	

5. Sensor Design

5.1. Layout of Rx channels

SENS0 to SENS29 are 30 Rx channels on the chip directly connected to 30 ITO Rx channels on the sensor either in sequence or reverse sequence. Please refer to the tool “Channel Selector” for channel selection when there are less ITO Rx channels on sensor than Rx channels on the chip.

- Sample Layout: the ITO Rx channels on the sensor are connected to the Rx channels on the chip in sequence from SENS0 to SENS29:



5.2. Layout of Driving Channels

DRV0 to DRV41 are 42 Tx channels on the chip directly connected to 42 ITO Tx channels on the sensor. Please refer to the tool “Channel Selector” for channel selection and assignment.

After the layout of the Tx channels is determined, relevant registers of GT9110P shall be configured to ensure the logic positions of Tx channels are consistent with their own physical positions, so that the reported coordinates match the physical coordinates.

For details of Sensor design, please refer to layout guidelines.

5.3. Sensor Design Specifications

GT9110P	DITO	SITO
Impedance of Tx routing trace	≦3KΩ	≦3KΩ
Impedance of Tx channel	≦10KΩ	≦10KΩ
Impedance of Rx routing trace	≦10KΩ	≦10KΩ
Impedance of Rx channel	≦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 are employed for routing, though we've done our utmost to obtain impedance consistency by using matched length and width in design, there are still differences.

To ensure data consistency and uniformity on the entire screen, it is necessary to ensure the sensor design complies with the above requirements.

In addition, when Tx trace and Rx trace are adjacent and parallel to each other, separate the them with a ground trace. For details of the specifications, please refer to *Sensor Design Guide*.

5.4. Touch Key Design

GT9110P supports 4 separated touch keys in the following two ways:

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

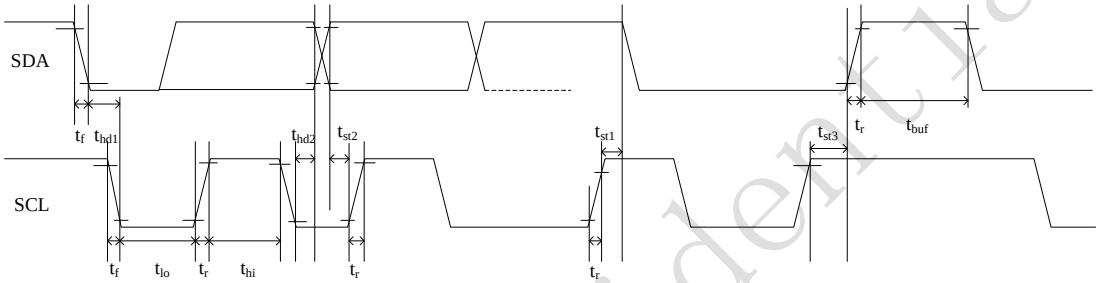
2) *Touch key design on FPC:* Connect one separate Tx channel to four Rx channels to form four touch keys. The touch keys have to share their Rx channels with the touch screen. Touch key pattern on FPC should be designed independently.

Note: the touch key and the touch screen cannot share the same pattern.

6. I²C Interface

6.1. I²C Timing

GT9110P provides a standard I²C communication interface for SCL and SDA to communicate with the host. GT9110P always serves as slave device in the system with all communication being initialized by the host. It is strongly recommended that transmission rate be kept at or below 400Kbps. The diagram below illustrates the I²C timing:



Test condition1: 1.8V host interface voltage; transmission rate 400Kbps; pull-up resistor 2K ohm.

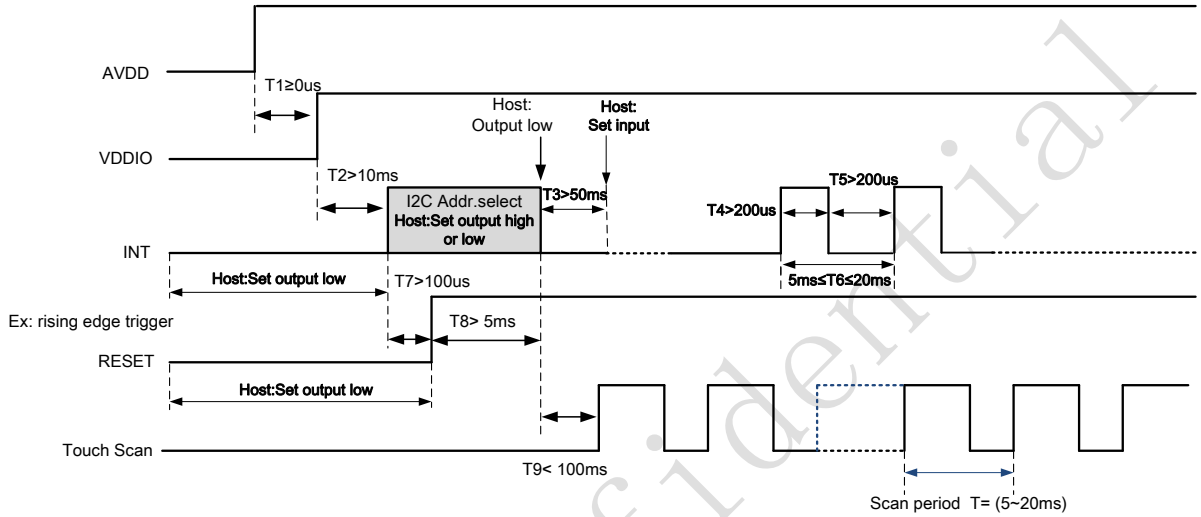
Parameter	Symbol	Min.	Max.	Unit
SCL low period	tlo	1.3	-	us
SCL high period	thi	0.6	-	us
SCL setup time for START condition	tst1	0.6	-	us
SCL setup time for STOP condition	tst3	0.6	-	us
SCL hold time for START condition	thd1	0.6	-	us
SDA setup time	tst2	0.1	-	us
SDA hold time	thd2	0	-	us

Test condition2: 3.3V host interface voltage, transmission rate 400Kbps, pull-up resistor 2K ohm.

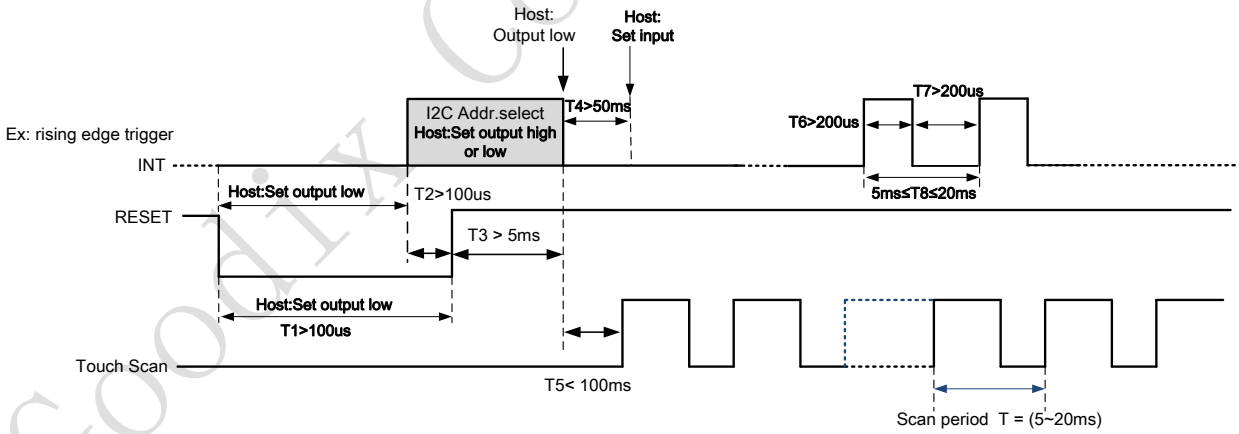
Parameter	Symbol	Min.	Max.	Unit
SCL low period	tlo	1.3	-	us
SCL high period	thi	0.6	-	us
SCL setup time for START condition	tst1	0.6	-	us
SCL setup time for STOP condition	tst3	0.6	-	us
SCL hold time for START condition	thd1	0.6	-	us
SDA setup time	tst2	0.1	-	us
SDA hold time	thd2	0	-	us

GT9110P supports two I^{2}C slave addresses: 0xBA/0xBB & 0x28/29. The host can select the address by controlling the Reset and INT pins during the power-on initialization. See the diagram below for detailed timings:

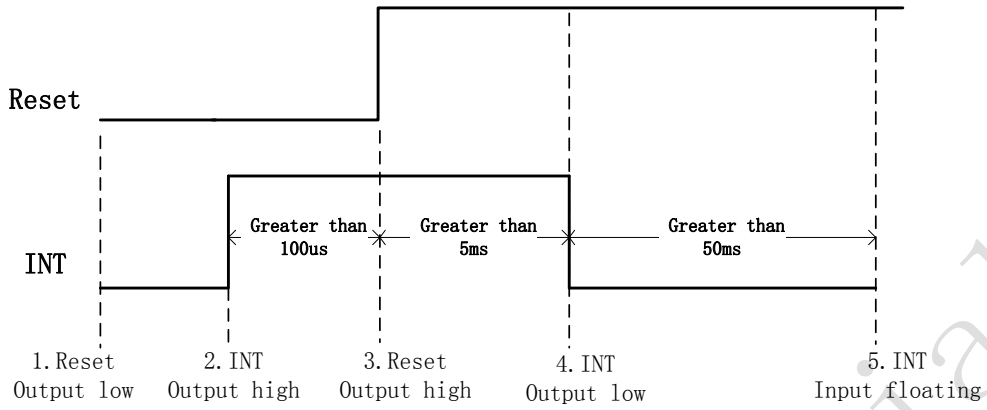
Power on Timing:



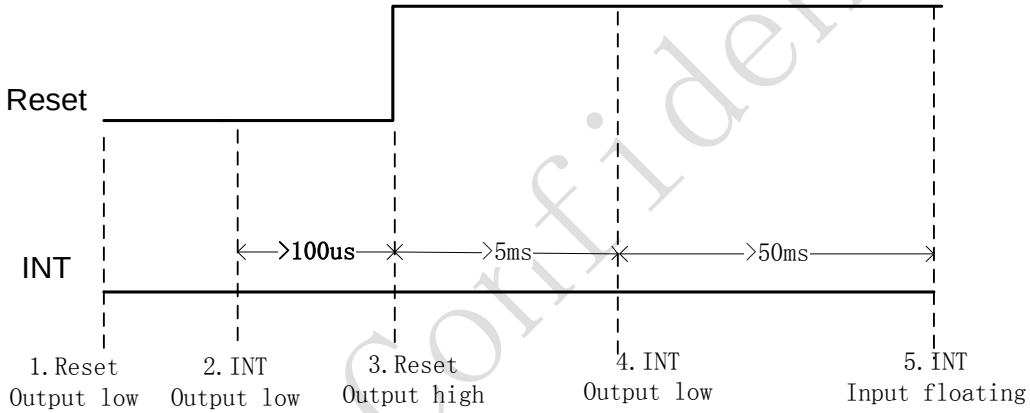
Timing for host resetting GT9110P:



Timing for setting slave address to 0x28/0x29:



Timing for setting slave address to 0xBA/0xBB:



a) Data Transmission

(For example: slave address is 0xBA/0xBB)

Communication is always initiated by the host. 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.

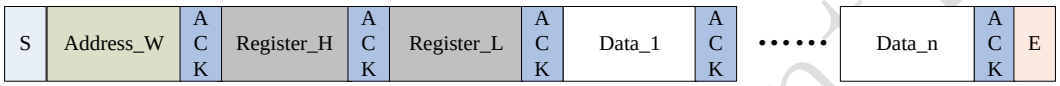
All slave devices connected to I^2C bus should detect the 8-bit address issued after Start condition and send the correct ACK. After receiving matching address, GT9110P acknowledges by configuring SDA line as output port and pulling SDA line low during the ninth SCL cycle. When receiving unmatched address, namely, not 0XBA or 0XBB, GT9110P 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, the host will issue the Stop condition which implies the transition of SDA line from low to high when SCL line is high.

b) Write Data to GT9110P

(For example: slave address is 0xBA/0xBB)



Timing for Write operation

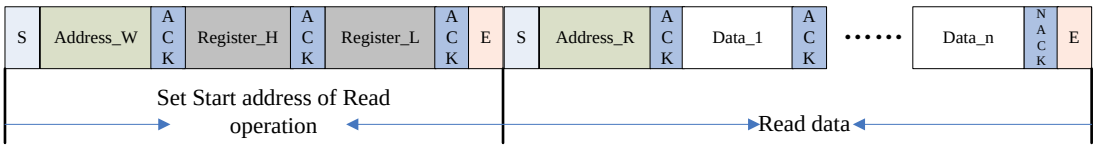
The diagram above displays the timing sequence of the host writing data onto GT9110P. First, the host issues a Start condition. Then, the host sends 0XBA (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the host 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 host 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 host issues the Stop condition.

c) Read Data from GT9110P110P

(For example: slave address is 0xBA/0xBB)



Timing for Read operation

The diagram above is the timing sequence of the host reading data from GT9110P. First, the host issues a Start condition and sends 0XBA (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the host sends the 16-bit register address (where reading starts) to the slave device. Then the host sets register addresses which need to be read.

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

GT9110P also supports continuous Read Operation and, by default, reads data continuously. Whenever receiving a byte of data, the host sends an ACK signal indicating successful reception. After receiving the last byte of data, the host sends a NACK signal followed by a Stop condition which terminates communication.

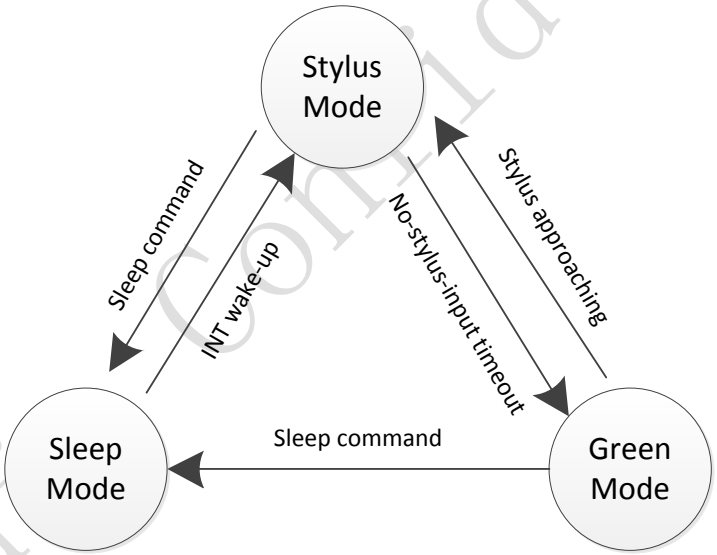
7. Operating States and Modes

The operating modes of GT9110P include Finger Mode, Stylus Mode, Finger + Stylus Mode, Green Mode and Sleep Mode. According to different transition mechanism, it can operate in three detection states: stylus detection state, Finger detection state, Auto-transition detection state. By sending real-time command (please refer to section 6.2), the host enables the chip to switch between different operating modes.

The transition diagram between different states is shown below:

a) Stylus detection state

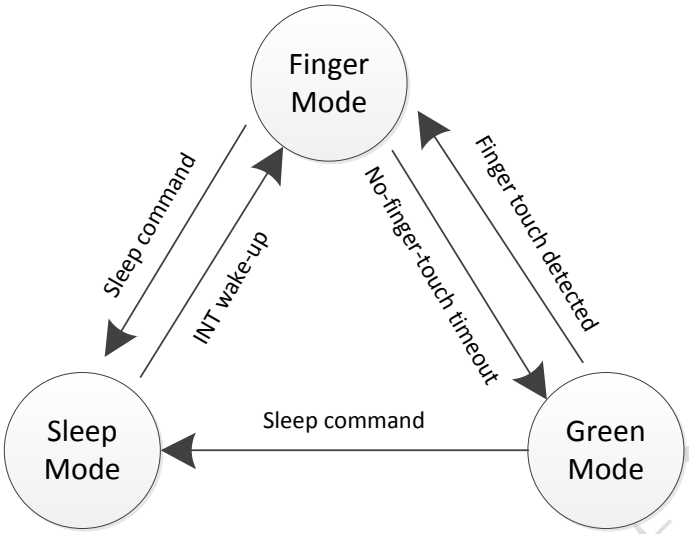
(The host sends command “13”):



In stylus detection state, GT9110P will only detect stylus input. Finger touch is invalid.

b) Finger detection state

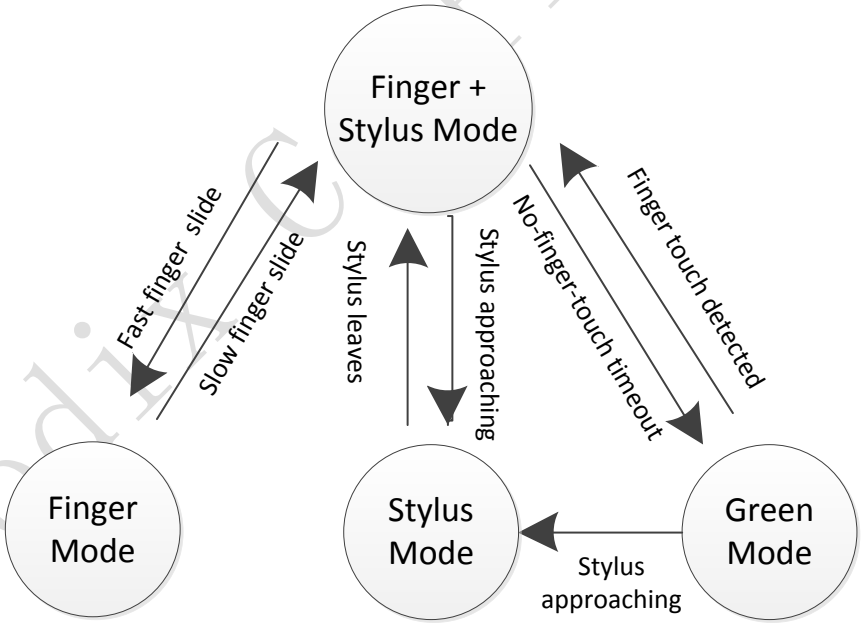
(The host sends command “10”):



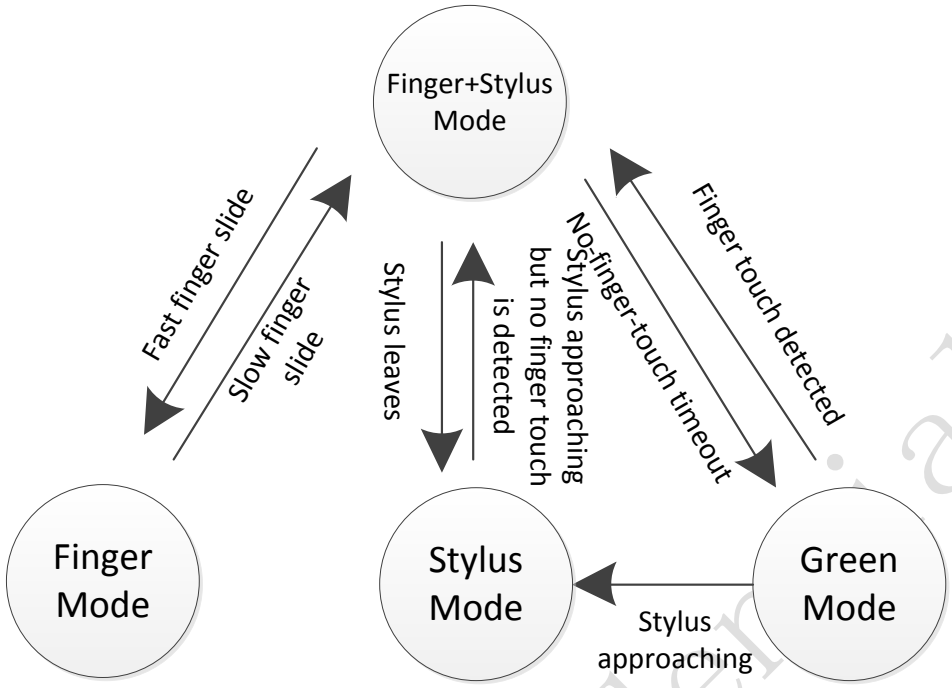
In Finger detection state, GT9110P will only detect finger touch. Stylus input is invalid.

c) Auto-transition detection state

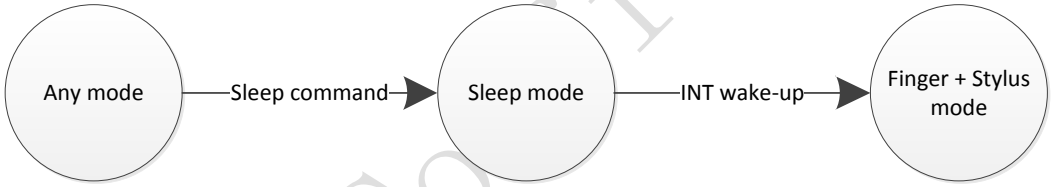
(The host sends command “11”):



In auto-transition state, if GT9110P wants to switch to stylus mode after the host has issued the charge command, it is required that no finger touch should be present. The diagram below provides details:

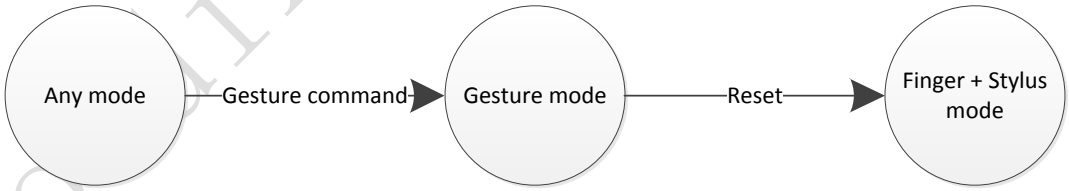


In auto-transition state, enter/exit sleep mode as follows:



Any mode can be Finger mode, Stylus mode, Finger + Stylus mode and Green mode.

In auto-transition state, enter/exit Gesture mode as follows:



Any mode can be Finger mode, Stylus mode, Finger + Stylus mode and Green mode.

7.1. Description on Operating Modes

a) Finger + Stylus Mode

In this mode, the scan period is fixed to 20ms. GT9110P will implement Finger touch detection and stylus input detection simultaneously. If fast finger slide is detected, it enters

Finger Mode; if stylus approaching is detected, it enters Stylus Mode. If no Finger touch and stylus approaching for a certain period, it enters Green Mode.

b) Green Mode

In Green mode, the scan period is fixed to 40ms.

In stylus detection state, it only detect stylus input signal, if stylus input is detected, it will enter stylus mode automatically;

in finger detection state, it only detect finger touch signal, if finger touch is detected, it will enter finger mode automatically;

In auto-transition state, it detects finger and stylus signal simultaneously, if stylus input is detected, it enters stylus mode automatically, if finger touch is detected, it enters finger mode.

c) Finger Mode

In Finger Mode, the scan period is subject to configuration;

In finger detection state, if no finger touch is detected for a certain period, GT9110P enters Green Mode automatically;

In auto-transition state, if slow finger slide is detected, it enters Finger + Stylus Mode automatically.

d) Stylus Mode

In Stylus Mode, it only detects stylus signal, the scan period is 10ms.

In stylus detection state, if there's no stylus input for a certain period, it enters Green Mode automatically.

In auto-transition state, if there's no stylus input for a certain period, it enters Finger + Stylus Mode automatically.

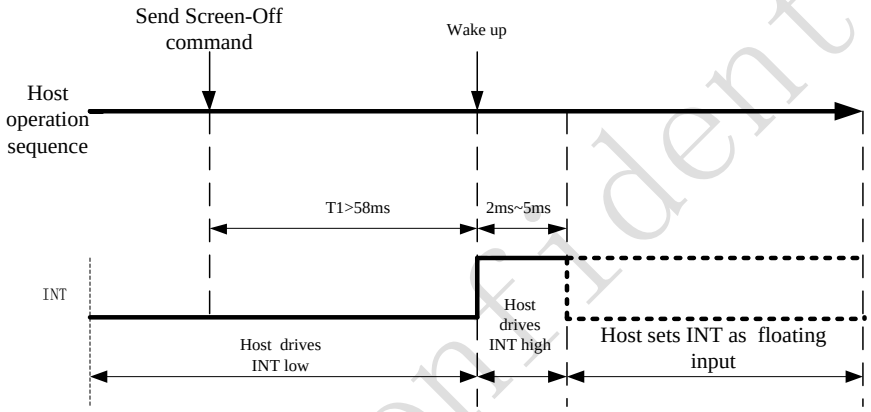
e) Sleep Mode

The host enables GT9110P to enter Sleep mode by sending corresponding I^2C command (before sending the command, please drive INT low). The host allows GT9110P to exit sleep mode by driving INT high for 2ms to 5ms.

In stylus detection state, GT9110P enters Stylus Mode after being awakened;

In finger detection state, GT9110P enters Finger Mode after being awakened;

In auto-transition state, GT9110P enters Finger + Stylus Mode after being awakened.



f) Gesture mode

The host enables GT9110P to enter Gesture mode by sending I2C command 8 to 0x8046 and then to 8040. After entering Gesture mode, wake-up can be achieved by swipe, double-tap and writing of specified lower-case letters on the touch screen.

In Gesture mode, if GT9110P detects the correct gesture inputted by finger or stylus, INT will output a pulse for longer than 250us or keep output high. The host wakes up and turns on the screen after receiving such pulse or high level.

7.2. Interrupt Triggering Mechanism

To lighten the burden on the host, GT9110P notify the host to read coordinates by sending a pulse via INT only when there is change in coordinate position. Host will then set a triggering mechanism via relevant register bit “INT”. INT bit as “0” indicates rising edge-triggered,

which means GT9110P will notify the host by driving INT from low to high when operated by user; INT bit as “1” indicates falling edge-triggered; INT bit as “2” indicates high-level triggered; INT bit as “3” indicates low-level triggered.

7.3. Self-Calibration

a) Self-Calibration during Initialization

Fluctuations in temperature, humidity and environment may affect the baseline of the capacitive sensor in idle state. GT9110P will update the baseline according to environmental conditions within the first 200ms of initialization. Then, GT9110P will complete the initialization of the TP test.

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. GT9110P will detect real-time changes in data and perform statistic analysis of historic data to update the baseline and thus reduce the impact that environmental changes have on the TP test.

7.4. Stationary Configuration

GT9110P support Stationary Configuration. After receiving configuration parameters from the host, GT9110P will fix the parameters to the latest version. Once these parameters are fixed, GT9110P will communicate with the host solely via I^2C bus and will not receive any parameters of previous versions from the host.

7.5. Adaptive Frequency Hopping

GT9110P is equipped with reliable anti-interference hardware. When the drive spectrum of GT9110P overlaps with the peak spectrum of noise signal, GT9110P will switch to another frequency using a self-adaptive frequency hopping mechanism to avoid interference.

7.6. Host System Driver Modification in Gesture Mode

➢ **Enter Gesture mode after screen off**

1) If screen off is achieved by pressing Power key (or any other key), send Command 8 to 0x8040;

2) If screen off is achieved due to timeout, send Command 8 to 0x8040;

3) When the screen is off, if there is swipe, double-tap or writing of specified letters on TP, the INT pin will output a pulse for 250us to notify the host. The host reads the value of 0x814B after receiving such pulse. If the value meets wake-up conditions, the host wakes up, then resets GT9110P and turns on the screen. Otherwise, the host resets 0x814B and waits for the next pulse.

➢ **Enter Sleep Mode after screen-off**

1) If screen-off is achieved by pressing Power key (or any other key), send Command 5 to 0x8040 ;

2) If screen-off is achieved by timeout, send Command 5 to 0x8040 ;

3) In Sleep mode, host can be awakened only by pressing Power key (or Home key).

➢ **Press Power (or Home) key to wake up host**

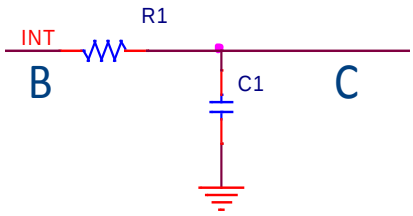
In any modes, if awakened by pressing power key (or Home key), the host will reset GT9110P based on reset timing sequence and implement reset process.

➢ **Recommended to apply in conjunction with IR**

If gesture wake-up function is applied in conjunction with IR, the host can enable GT9110P to enter Sleep mode to reduce power consumption when IR detects shielding object while screen-off. Otherwise, GT9110P enters Gesture mode. To enter different modes, use the methods described above (reset is required before sending command).

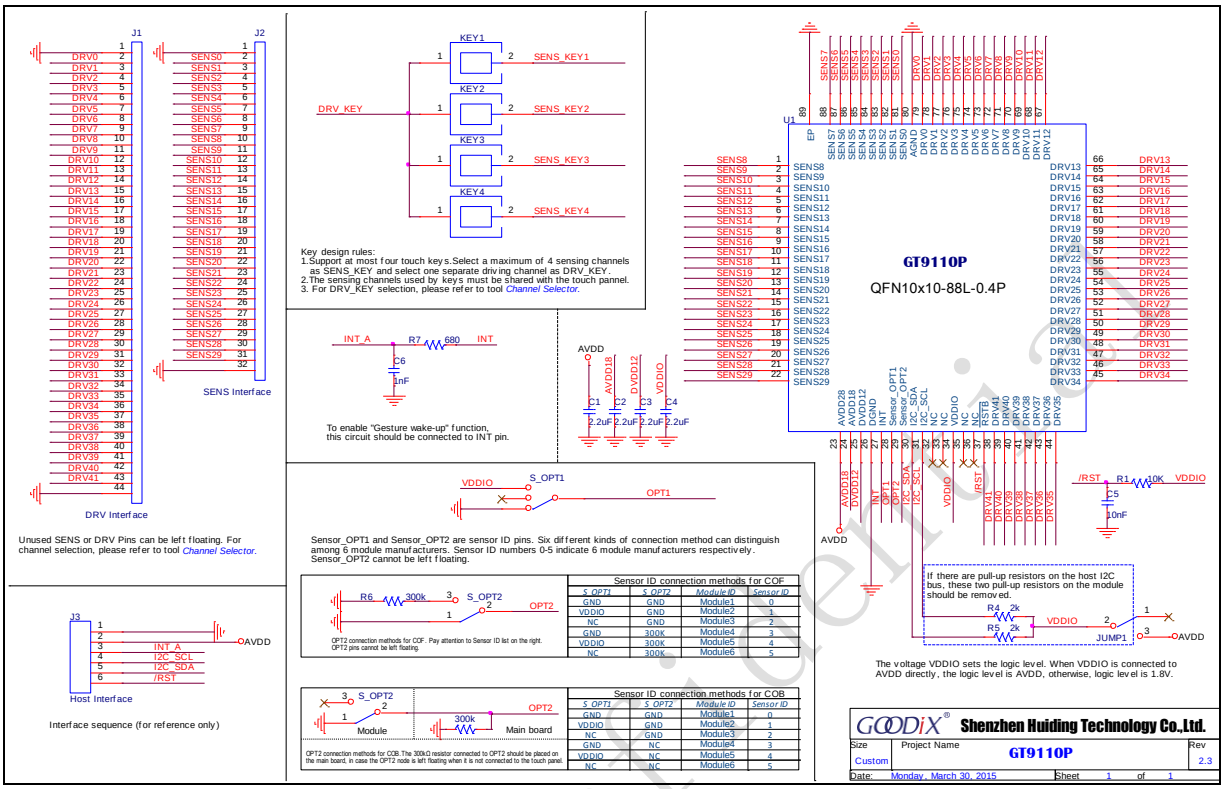
- **Hardware schematic modification**

When tuning, connect RC circuit to INT pin in series (R: 680Ω, C: 1nF) as shown below:



Connect B to GT9110P INT and C to host INT; pull-up resistor cannot be connected to the host INT.

8. Sample Schematic



GT9110P Sample Schematic

Notes:

1) This schematic only represents basic application. Adjustments may be required to fit in with actual situations and application environments.

2) It is recommended that the capacitor be ceramic X7R.

9. Electrical Characteristics

9.1 Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Analog power AVDD28 (Refer to AGND)	-0.3	3.47	V
VDDIO (Refer to DGND)	-0.3	3.47	V
Input voltage on digital I/O	-0.3	3.47	V
Input voltage on analog I/O	-0.3	3.47	V
Storage temperature	-60	125	℃
ESD susceptibility（HB Model）	±4		KV

9.2 Operating Characteristic

(Ambient Temperature 25℃)

Parameter	Min.	Typical	Max.	Unit
AVDD28①	2.7	2.8/3.0/3.3	3.4	V
VDDIO②	-	1.8	-	V
Operating temperature	-20	25	85	℃

9.3 AC Characteristic

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

Parameter	Min.	Typical	Max.	Unit
OSC oscillation frequency	59	60	61	MHz
I/O output rise time	-	14@100pf	-	ns
I/O output fall time	-	14@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.

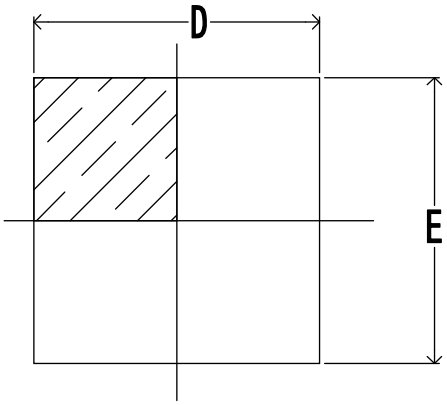
9.4 DC Characteristic

(Ambient Temperature 25℃, AVDD28=2.8V, VDDIO=1.8V or VDDIO=AVDD28)

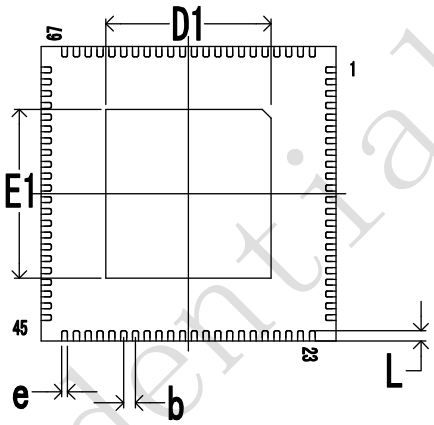
Parameter	Min.	Typical	Max.	Unit
Operating current (Finger mode)	-	13	-	mA
Operating current (Stylus mode)	-	12	-	mA
Operating current (Green mode)	-	8	-	mA
Operating current (Sleep mode)	-	100	-	uA
Digital input low voltage/VIL	-0.3		0.25*VDDIO	V
Digital input high voltage/VIH	0.75*VDDIO		VDDIO+0.3	V
Digital output low voltage/VOL			0.15*VDDIO	V
Digital output high voltage/VOH	0.85*VDDIO			V

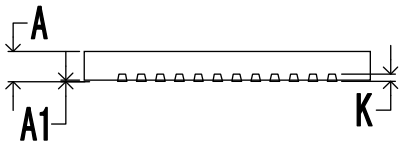
10. Package

TOP VIEW



BOTTOM VIEW





SIDE VIEW

QFN 10 X 10 88PIN
0.4 PITCH SQUARE

Symbol	Dimensions In Millimeters		
	Min.	Normal	Max.
A	0.70	0.75	0.80
A1	0.00	0.035	0.05
b	0.40BSC		
D	10.00BSC		
D1	5.50	5.60	5.70
E	10.00BSC		
E1	5.63	5.70	5.83
e	0.15	0.20	0.25
L	0.274	0.35	0.426
K	0.203BSC		

11. Requirements on SMT Reflow Solder

11.1 Moisture Sensitivity Level (MSL)

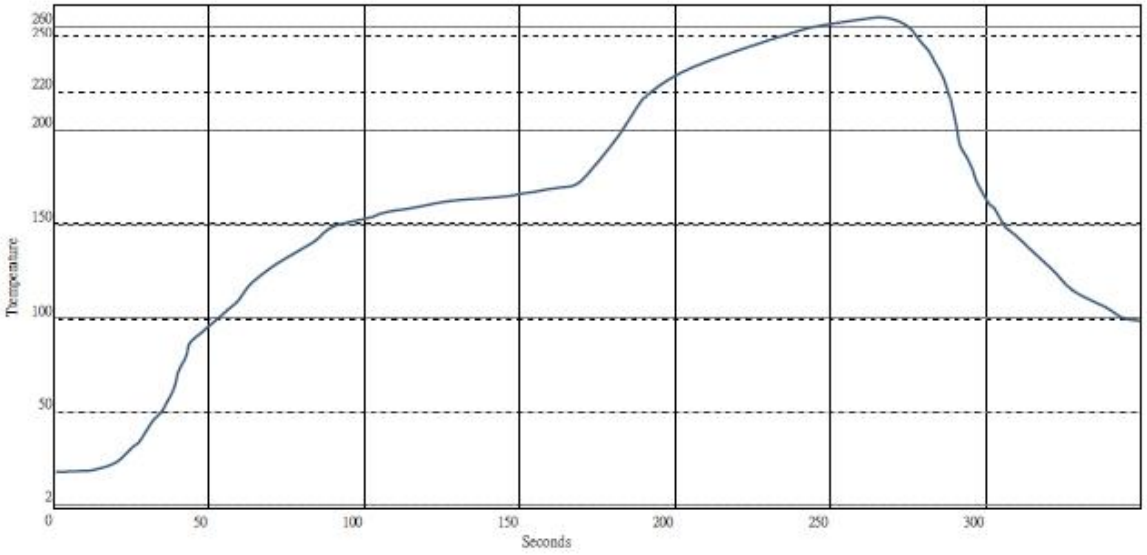
GT9110P is classified as **MSL3**. The detailed requirements are listed below:

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



GT9110P 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>Ramp Up Rate</td></tr>
<tr><td rowspan="4">Time Above 217℃</td><td rowspan="2">C. 217℃—260℃</td><td>Duration</td><td>60s—85s</td><td rowspan="4">Time above 217℃: 60s—150s</td></tr>
<tr><td>Ramp Up Rate</td><td><3℃/s</td></tr>
<tr><td>D. Peak Temp. (255℃—260℃)</td><td>Duration</td><td>20s—30s</td></tr>
<tr><td rowspan="2">E .260℃—217℃</td><td>Duration</td><td>60s—75s</td><td>--</td></tr>
<tr><td>--</td><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
Rev. 00	2012-7-23	Draft version
Rev. 01	2012-11-26	Updated package information
Rev.02	2012-12-08	Modified operating temperature, storage temperature, Updated package information
Rev.03	2013-04-11	Modified GT9110P30 description, circuit reference diagram; Updated GT9110P110P register instruction, working mode instruction.
Rev.04	2013-05-14	Added reflow condition
Rev.05	2014-07-18	Modified Power-on and resetting timing diagram
Rev.06	2015-03-26	Added description on touch key design Updated description on operating modes Deleted register map Deleted description on GT930
Rev.07	2015-07-01	Added section 11 “Requirements on SMT Reflow Solder” (including MSL); Deleted description on “soldering temperature” in Absolute Maximum Ratings; Deleted description on ground trace width in sensor design.
Rev.08	2016-12-28	Deleted description on storage temperature and response time in Chapter 2; Deleted description on power supply ripple in Chapter 2 and added the footnote(on power supply ripple) in section 9.2. Updated description on some parameters in Chapter 9 and modified the corresponding parameter value.
Rev.09	2018-07-12	Modified overview.

13. Contact Information

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