The Classic of Touch Solution!

GREENCHIP

GreenTouch™ GT101L
Capacitive Touch Sensor

SPECIFICATION (Preliminary)

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GENERAL

The GT101L is one of GreenTouch™ capacitive touch sensor series. Especially the GT101L can do capacitance sensing under GreenTouch™ engine operation. GreenTouch™ engine is an environmental compensation circuit.
Thanks to GreenTouch™ engine, the application will be more robust and problem free against EMC, EMI, H/W variation, voltage disturbance, temperature drift, humidity drift and so on.

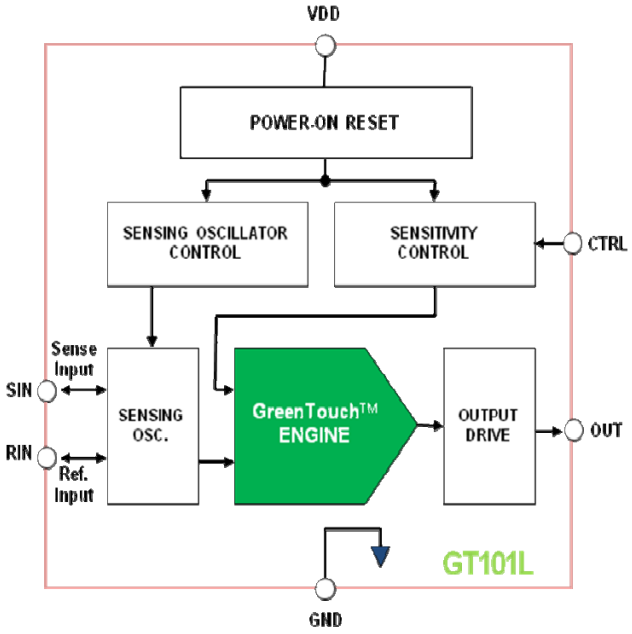
The GT101L offers whole solutions for 1-ch touch key applications, such as, normal mechanical switch replacements, liquid level sensor, and so on. Simple and easy application circuit can be also obtained by using GT101L because of its fundamental algorithms and pin maps. The GT101L has not only digital touch decision procedure that makes very reliable sensing determination but also smart algorithms that make it possible to detect initial touch (touch state remaining from pre-reset condition) and slow action touch (In case of other touch sensor slow action touch is generally compensated).

The GT101L has single touch sensing input pin and reference input pin to detect and determine capacitive touch, and single direct output pin which has open drain structure and operates as active low or toggle output function. Three connection types of CTRL pin make it possible to select two sensitivity options and toggle output function.

FEATURES

- 1 channel cap. Sensing input
- **Embedded GreenTouch™ Engine**
  - Analog noise compensation circuit
  - Embedded digital noise filter
  - Initial touch detection algorithms
  - Slow touch action detection algorithms
  - No sensitivity drift
  - Full digital touch decision procedures
- Direct interface mode
  - Open drain and active low function
- Toggle output mode
  - It is possible by CTRL R-connection
- Low power consumption
  - 55uA (@5.0V)
  - 35uA (@3.3V)
- 2.5V to 5.5V single supply operation
- Mini package type
  - SOT23(6LD)
- RoHS complaints

BLOCK DIAGRAM



APPLICATIONS

- Mechanical Switch Replacement
- Liquid Level Sensor – Water purifier, Bidet, Humidifier Etc.
- Human Body Awareness Sensor – Bidet seating sensor, Industrial safety sensor Etc.
- PC, OA and Others - PC, LCD monitor, Fax, Copy machine, Door lock, Lighting controls, Remote control, Toys, Gaming devices and Etc.
- Lighting system on/off key switch by using toggle output mode

ORDERING INFORMATION

Part No.	Package
GT101L-ST6	SOT23 (6LD)

REVISION HISTORY

Version	Date	Revision Contents
PRELIMINARY V0.0	November 2009	Preliminary release
PRELIMINARY V0.1	January 2010	Preliminary release

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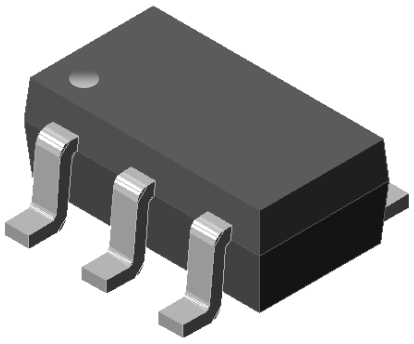
Chapter 1: Pinout Information

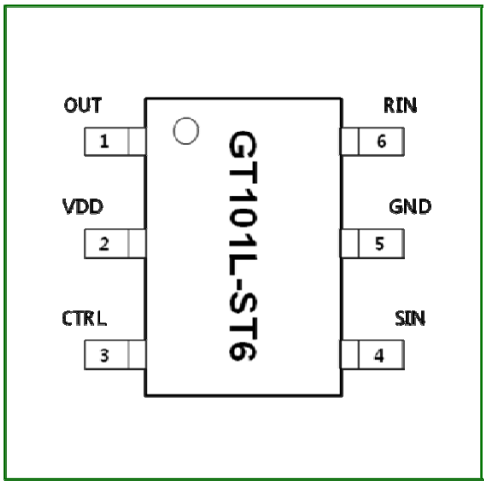
This section describes the pin names and pin functions of GT101L. Pinout configuration also illustrated as below. The GT101L device is available in the following packages.

1.1 SOT23 (6LD)

Port Number	Type	Name	Description
1	DO	OUT	Direct Output for Touch Detection (Open Drain)
2	PWR	VDD	Power Supply Voltage Input
3	DI	CTRL	Sensitivity Selection Input - Connection to GND : Higher Sensitivity Option - Connection to VDD : Lower Sensitivity Option Toggle Output Option Selection(CTRL R-connection) Input - Connect ion to GND via Resister (Over 500kΩ to 1MΩ)
4	AI	SIN	Touch Sensing Input
5	GND	GND	Ground Pin
6	AI	RIN	Touch Sensing Reference Input

* DI: Digital Input, DO: Digital Output, DIO: Digital Input and Output, AI: Analog Input, PWR: POWER





Refer to Chapter 5: Package Information for package outer scale

Chapter 2: Electrical Specification

2-1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Conditions
Maximum supply voltage	V_{DD_MAX}	-	8.0	V	
Supply voltage range(1)	V_{DD_RNG}	2.2	6.0	V	
Voltage on any input port	V_{IN_MAX}	-	V_{DD}+0.3	V	
Maximum current into any port	I_{MIO}	-200	200	mA	
Power dissipation	P_{MAX}	-	600	mW	
Storage temperature	T_{STG}	-65	150	℃	
Operating humidity	H_{OP}	5	95	%	8 hours
Operating temperature	T_{OPR}	-40	85	℃	
Junction temperature	T_J	-40	125	℃	

(1) The real valid power supply range consider supply ripple. Above range cannot be used as target supply voltage range.

2-2 DC & Operating Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply and current consumption						
Supply voltage	V_{DD}		2.5	3.3(5.0)	5.5	V
Current Consumption	I_{DD}	VDD = 3.3V	-	35	55	μA
		VDD = 5.0V	-	55	75	μA
Internal reset voltage(2)	V_{DD_RST}	T_A = 25℃	-	1.6	2.0	V
Digital input/output						
Input high level voltage	V_{IH}		V_{DD}*0.7	-	V_{DD}+0.3	V
Input low level voltage	V_{IL}		-0.3	-	V_{DD}*0.3	V
Output sink current	I_{SINK}		-	8	-	mA
Output impedance to GND	Z_{ON}	Touch detection output state (Active low)	-	15	-	Ω
		Normal output state	-	30	-	MΩ
Reset time and operations						
Time for stable power reset	T_{RST}		-	100	-	ms
Minimum detectable input capacitance variation	ΔC_{S_MIN}		0.1	-	-	pF
Internal input series resistor	R_S		-	40	-	Ω
Max. input capacitance	C_{IN_MAX}		-	-	50	pF
Max. SIN external series resistor	R_{S_EX}		-	-	1	kΩ
CTRL R-connection resistor	R_{CTRL}		500	-	1000	kΩ

(1) Test condition: V_{DD} = 5.0V, TA = 25℃ and normal operation mode (Unless otherwise noted)
(2) The GT101L has internal reset circuit, so external reset element or reset signal is not necessary for power reset.

2-3 ESD & Latch-Up Characteristics

2-3.1 ESD Characteristics

Mode	Polarity	Max	Reference
H.B.M	POSITIVE / NEGATIVE	8000V	VDD/VSS/P to P
M.M	POSITIVE / NEGATIVE	500V	VDD/VSS/P to P

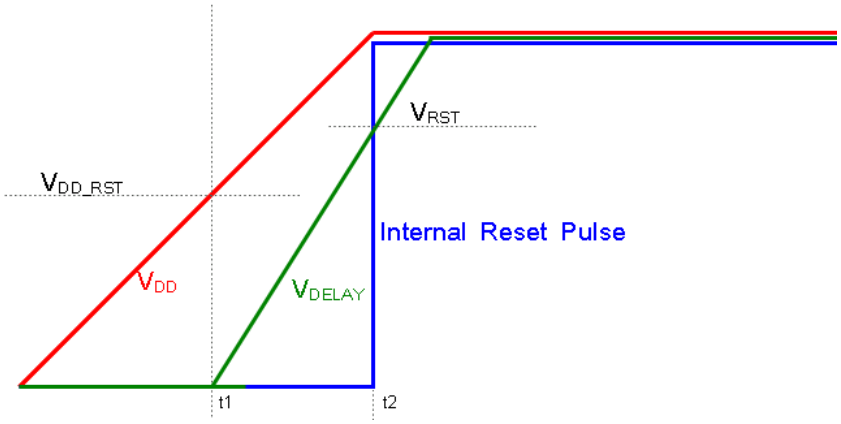
2-3.2 Latch-Up Characteristics

Mode	Polarity	Max	Test Step
I Test	POSITIVE	200mA	25mA
	NEGATIVE	-200mA	
V supply over 3.3V	POSITIVE	~ 5.0V	0.5V

Chapter 3: Functional Description

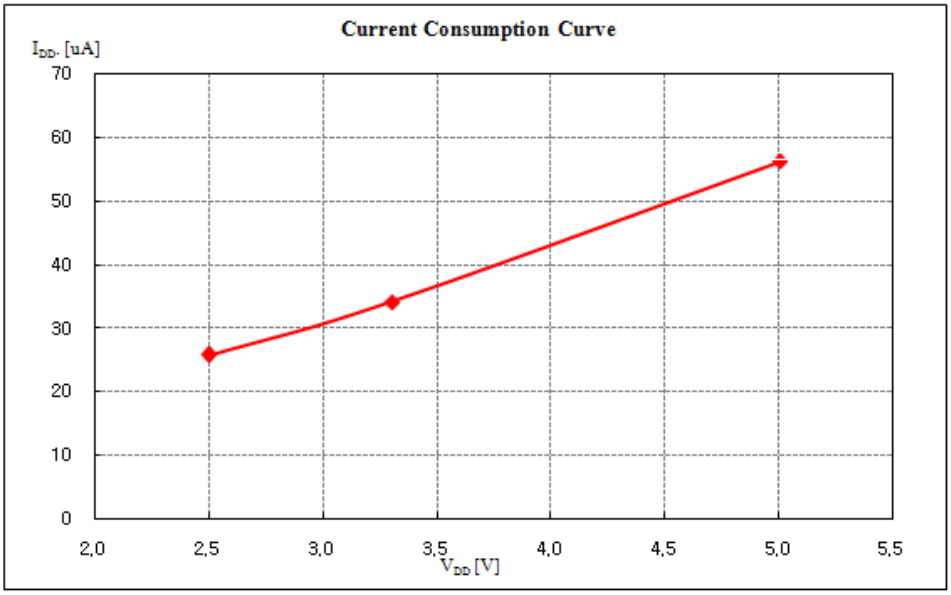
3-1 Reset and Operating Current

The GT101L has internal reset circuit for initial power reset operation without any external reset component. The internal power reset sequence is represented as below. The internal V_{DELAY} voltage is raised when V_{DD} come up to V_{DD_RST} level. The internal reset pulse is maintained as low until V_{DELAY} reaches V_{RST} which is internal reset reference voltage. Eventually reset pulse maintains low between t1 and t2 period and during this low pulse the internal digital power reset is finished. This reset pulse duration is more than 100usec independent to V_{DD} rising speed. Thanks to this internal reset function, no external component is needed for initial power reset. When V_{DD} voltage falls under V_{DD_RST}, reset pulse is regenerated by reset operation circuit and full digital logics are stated to be reset.



Internal reset operation description of GT101L

The typical current consumption curves of GT101L are represented in accordance with V_{DD} voltage as below figure. Because a new low current consumption GreenTouch™ engine is adopted current consumption of the GT101L is very low at both normal standby mode and active operation mode. Typical consumption current at 5.0V V_{DD} is 55uA.



Typical current consumption curve of GT101L

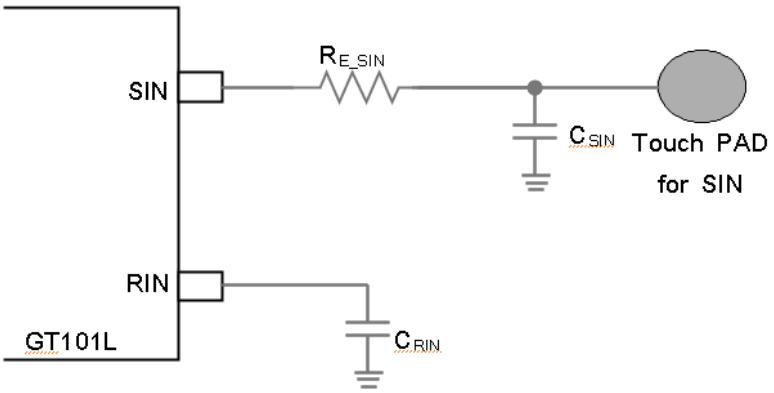
3-2 Basic Sensing Principle & Implementation of SIN, RIN

SIN input and RIN input are used for touch detection by capacitance variation sensing. The SIN input which is for direct touch sensing input is connected to touch sensing pad and catches capacitance variation caused by touching or approaching. The other RIN input which is for the reference capacitance measuring is connected only to a capacitor to compensate capacitance difference between SIN input and RIN input. The GT101L compares capacitance of SIN input and that of RIN input and makes touch detection output when capacitance of SIN input increases. So, for correct capacitance comparing both SIN input and RIN input, initial and steady state capacitance of both SIN input and RIN input is recommended approximately equal. Whenever SIN input has bigger capacitance than RIN input, the GT101L can make output signal of touch detection and output drive TR is activated to make OUT pin level “low”. However in opposite case, in other words, when SIN input has much smaller capacitance than RIN input the GT101L cannot detect initial touch (Touch which is carried out from before power reset). User can adjust initial steady state capacitance difference between SIN input and RIN input by adding capacitors to RIN pin. By above initial capacitance meditation and touch detection method, the GT101L can detect above initial touch.

The GT101L also has various another intelligent sensing properties to detect correct touch free from error or sensitivity caused by various environmental noise effects. These advanced sensing methods will help faultless touch key systems under the worst conditions. Two sensitivity options of the GT101L are available and C_{SIN} capacitor is useful to adjust fine sensitivity reduction tuning, there will be no difficulty to satisfy systems require sensitivity. The internal intelligent sensitivity adjustment algorithm removes sensitivity rolling caused by system noise, circuit deviation, and circumstantial drift. The GT101L has a special noise elimination filter for more powerful noise rejection and it will be very helpful for proper touch operation even if the system environment becomes very deteriorative.

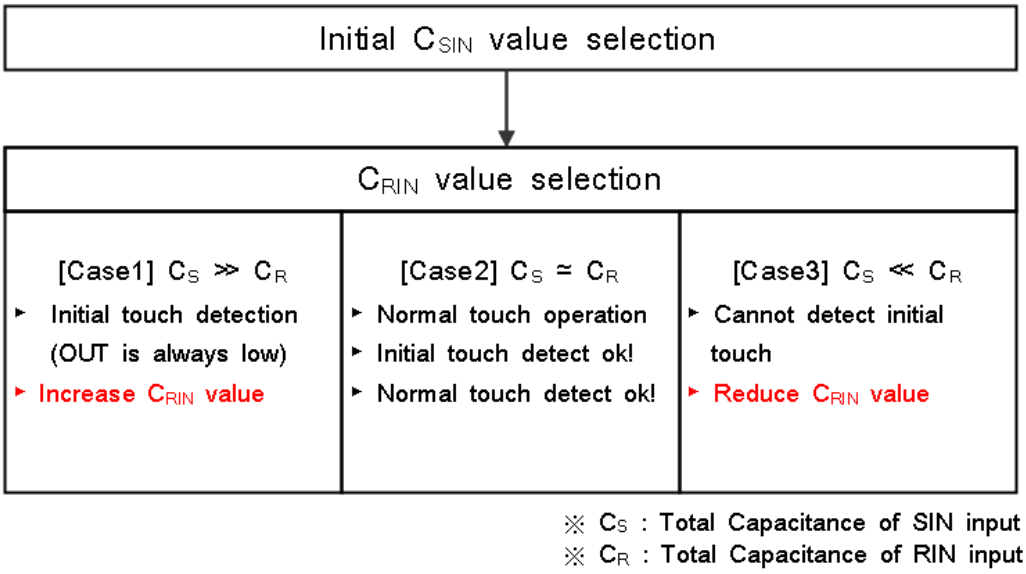
Implementation circuit for SIN pin and RIN pin is as below figure. The GT101L SIN input and RIN input have an internal series resistor for ESD protection. But in any case, if the additional external series resistor (R_{EX_SIN}) of SIN input is required then it should be less than 1kΩ and the location of resister is recommended as closer to the SIN ports. Less 50pF capacitor can be used as C_{SIN}, C_{RIN} capacitor. Different form C_{RIN}, Both R_{EX_SIN} and C_{SIN} are not obligatory components.

The SIN input and RIN input routing lines for touch detection is desirable to be routed as short as possible and the width of routing path should be as narrow as possible and should be formed by bottom metal, in other words, an opposite metal of a touch PAD. In addition, The SIN input and RIN input lines for touch detection are desirable to be routed as far as possible from impedance varying path such as LED drive current path.



Implementation for SIN and RIN ports with external components and sensing pad.

It is possible to control initial capacitance difference between SIN input and RIN input by using C_{RIN} capacitor according to C_{SIN}. For correct touch detection, initial and steady state capacitance of both SIN input and RIN input is recommended to be approximately equal. The procedure to reduce capacitance difference is expressed as below chart. Firstly, C_{SIN} capacitor must be determined considering proper sensitivity and then C_{RIN} capacitor value can be selected. If a too small C_{RIN} capacitor is used, the GT101L output has touch detection and output drive TR is activated to make OUT pin level “low”. However in opposite case, in other words, when too big C_{RIN} capacitor is used the GT101L cannot detect initial touch. Experimentally, proper C_{RIN} capacitor value is about the summation of C_{SIN} capacitor and parasitic capacitance of touch pattern and SIN routing pattern which is about a few pF.



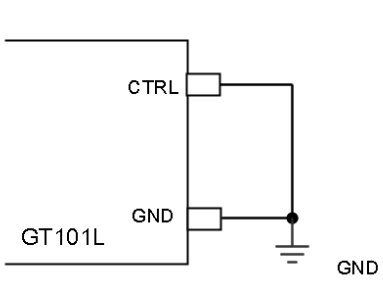
Control procedure for capacitance difference between SIN input and RIN input

3-3 Sensitivity and Output Mode Selection (CTRL)

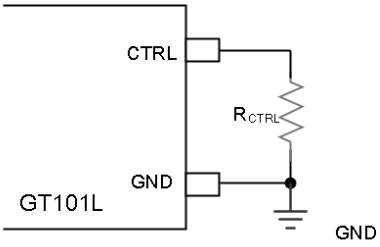
In the GT101L, two optional sensitivities and toggle output mode options are available by CTRL pin connection. Each options and respective connection are shown in below table and figures. A current source is implemented for pulse generation of CTRL pin that is connection indication signal. This CTRL pulse signal starts at internal power reset signal and ends with finish of initial condition setting operation. In R connection case, R value must be higher than 100kΩ and 1MΩ is typical. Toggle output mode is useful at lighting system on/off key switch application. For instance first touch can make light on output signal via OUT pin of the GT101L and this output signal maintains same light on states until next touch occurs.

Sensitivity selection [CTRL pin connection]		
[Case1] GND Connection ▸ High sensitivity option ▸ Pulse output mode	[Case2] R Connection ▸ High sensitivity option ▸ Toggle output mode	[Case3] VDD Connection ▸ Low sensitivity option ▸ Pulse output mode

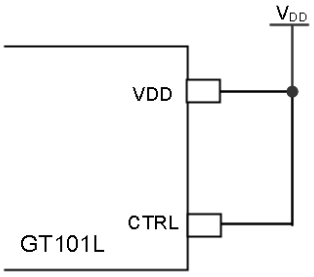
Sensitivity selection table



[Case1] GND Connection



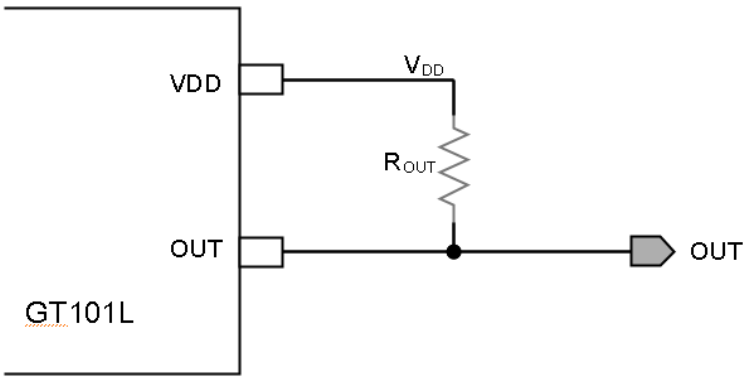
[Case2] R Connection



[Case3] VDD Connection

3-4 Output Interfaces (OUT)

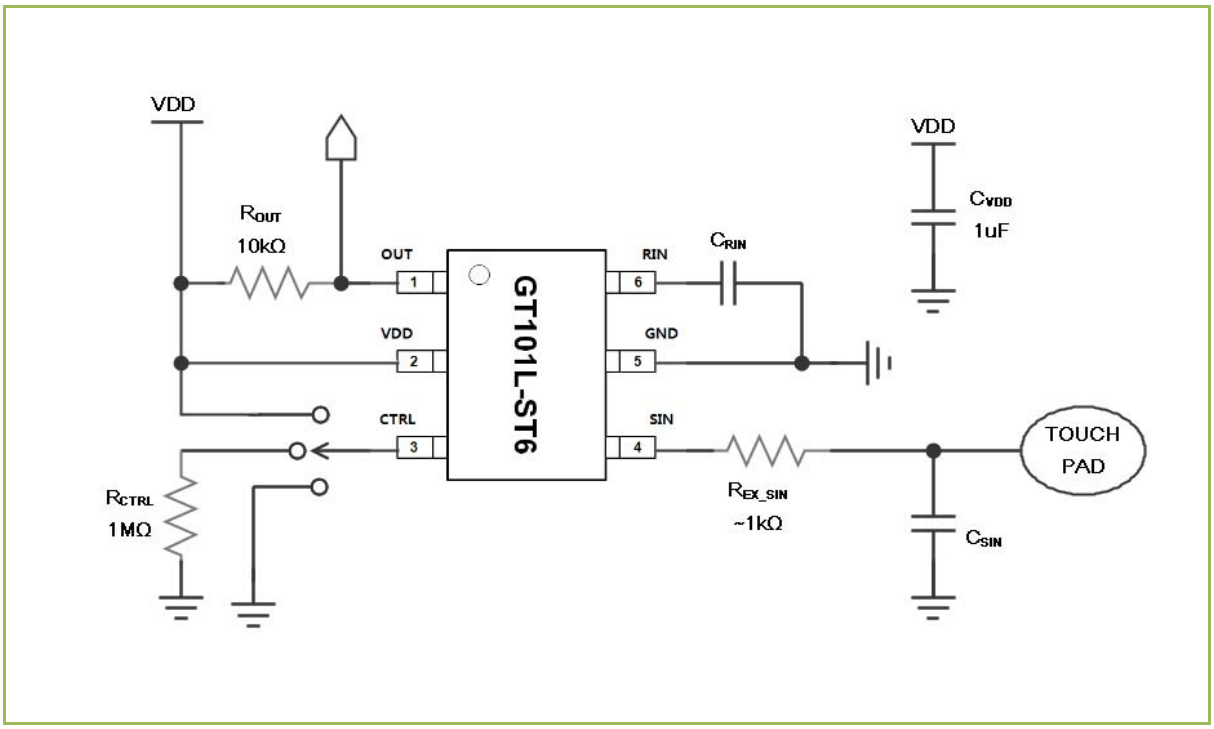
The GT101L has OUT pin for direct output interface. The OUT pin has open drain NMOS structure and it needs pull-up resistors. Maximum output sink current of OUT pin is 8mA and a couple of kΩ can be used for these pull-up resistors (R_{OUT}). The implementation for OUT pin is shown in below figures.



Implementation example for OUT pin

Chapter 4: Application Notes

4-1 Circuit Examples for Various Applications



Application example circuit for GT101L

4-2 Application Notes

Normally a touch sensing operation is ultimately impedance variation sensing. Hence a touch sensing system is recommended to be taken care of prevention of the external sensing disturbance. Although the GT101L has enough noise rejection algorithms and various protection circuits to prevent noise causing error touch detection or incapable sensing, it is better to take care in noisy applications such as home appliances. There are many measurable or invisible noises in system that can affect the impedance sensing signal and distort that signal. The main principal design issues and required attentions are such as below.

4-2-1 Power Line

- The touch sensor power line is recommended to be split from the other power lines such as relay circuits or LED that can make pulsation noise on their power lines.
- The big inductance that might exist in long power connection line can cause power fluctuation by other noise sources.
- The lower frequency periodic power noise such as a few Hz ~ kHz has more baneful influence on sensitivity calibration.
- An extra regulator for touch sensor is desirable for prevention above power line noises.
- The V_{DD} under shooting pulse less than internal reset voltage (V_{DD_RST}) can cause system reset.
- The capacitor connected between V_{DD} and GND is somehow obligation element for buffering above power line noises.

4-2-2 SIN Input and RIN input for Touch Detect

- The SIN input and RIN input lines for touch detection is desirable to be routed as short as possible and the width of routing path should be as narrow as possible.
- The SIN input and RIN input lines for touch detection should be formed by bottom metal, in other words, an opposite metal of a touch PAD pattern.

- The SIN input and RIN input lines for touch detection are desirable to be routed as far as possible from impedance varying path such as LED drive current path.
- It is possible to control initial capacitance difference between SIN input and RIN input by using C_{RIN} capacitor according to C_{SIN}. For correct touch detection, initial and steady state capacitance of both SIN input and RIN input is recommended approximately equal. (Refer to 3-2)
- The series resistor value should be less than 1kΩ and the location of resister is better if it is closer to the SIN ports for better stable operation. (Refer to 3-2)

4-2-3 Output Applications

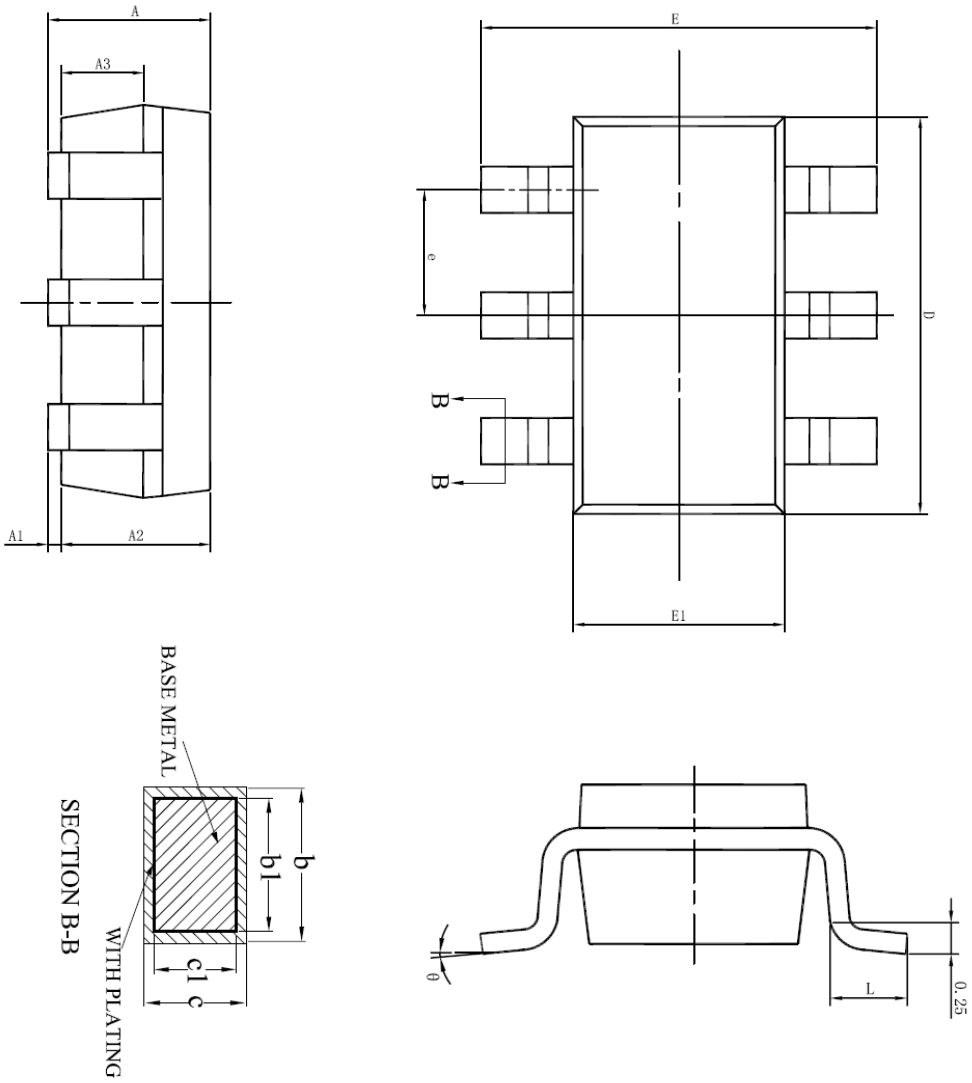
- OUT ports that is open drain NMOS TR type. Therefore a pull- resistor is required for a valid output. A couple of kΩ can be used for these pull-up resistors. (Refer to 3-4)

4-2-4 CTRL Sensitivity Selection

- Two optional sensitivity and toggle output mode options are available in the GT101L. User can select one of these options by CTRL pin connection. (Refer to 3-3)
- Toggle output mode can be realized by R-connection of CTRL pin. (Refer to 3-3)

Chapter 5: Package information

5-1 Package Outside Drawings for GT101L-ST6



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.30
A1	0.04	—	0.10
A2	1.00	1.10	1.20
A3	0.55	0.65	0.75
b	0.34	—	0.43
b1	0.33	0.35	0.38
c	0.15	—	0.21
c1	0.14	0.15	0.16
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95BSC		
L	0.30	—	0.60
θ	0	—	8°