AT42QT1012 Data Sheet

Introduction

The AT42QT1012 (QT1012) is a single key device featuring a touch on/touch off (toggle) output with a programmable auto switch-off capability. The device is One-channel Toggle-mode QTouch® Touch Sensor IC with Power Management Functions.

The QT1012 features a digital burst mode charge-transfer sensor designed specifically for touch controls and a unique “green” feature - the timeout function, which can turn off power after a time delay.

Features

- Number of Keys:
  - One, toggle mode (touch-on / touch-off), plus programmable auto-off delay and external cancel
  - Configurable as either a single key or a proximity sensor
- Technology:
  - Patented spread-s
    6 mm x 6 mm or larger (panel thickness dependent); widely different sizes and shapes possible
- Electrode design:
  - Solid or ring electrode shapes
- PCB Layers required:
  - One
- Electrode materials:
  - Etched copper, silver, carbon, Indium Tin Oxide (ITO)
- Electrode substrates:
  - PCB, FPCB, plastic films, glass
- Panel materials:
  - Plastic, glass, composites, painted surfaces (low particle density metallic paints possible)
- Panel thickness:
  - Up to 12 mm glass, 6 mm plastic (electrode size and Cs dependent)
- Key sensitivity:
- Settable via external capacitor (Cs)
- Interface:
  - Digital output, active high or active low (hardware configurable)
- Moisture tolerance:
  - Increased moisture tolerance based on hardware design and firmware tuning
- Power:

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  - 1.8 V – 5.5 V; 32 µA at 1.8 V
- Package:
  - 6-pin SOT23-6 (3 x 3 mm) RoHS compliant
  - 8-pin UDFN/USON (2 x 2 mm) RoHS compliant
- Signal processing:
  - Self-calibration, auto drift compensation, noise filtering

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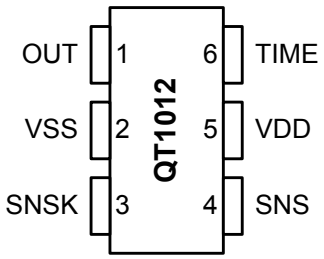
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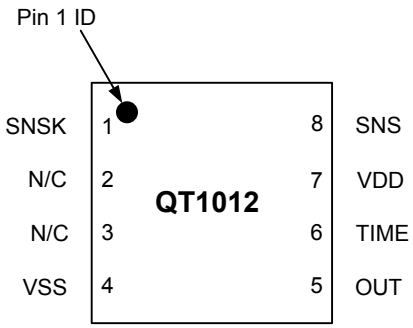
1. Pinout and Schematic

1.1 Pinout Configurations

1.1.1 6-pin SOT23-6



1.1.2 8-pin UDFN/USON



1.2 Pin Descriptions

Table 1-1. Pin Listing

6-Pin	8-Pin	Name	Type	Description	If Unused, Connect To...
1	5	OUT	O[(1)]	Output state. To switched circuit and output polarity selection resistor (Rop)	
2	4	VSS	P	Ground	
3	1	SNSK	I/O	Sense pin. To Cs capacitor and to sense electrode	Cs + key
4	8	SNS	I/O	Sense pin. To Cs capacitor and multiplier configuration resistor (Rm). Rm must be fitted and connected to either VSS or VDD. See Section 3.11.4 for details.	Cs
5	7	VDD	P	Power	
6	6	TIME	I	Timeout configuration pin. Must be connected to either VSS, VDD, OUT or an RC network. See Section 3.11 for details.	
—	2	N/C	—	Not connected	Do not connect
—	3	N/C	—	Not connected	Do not connect

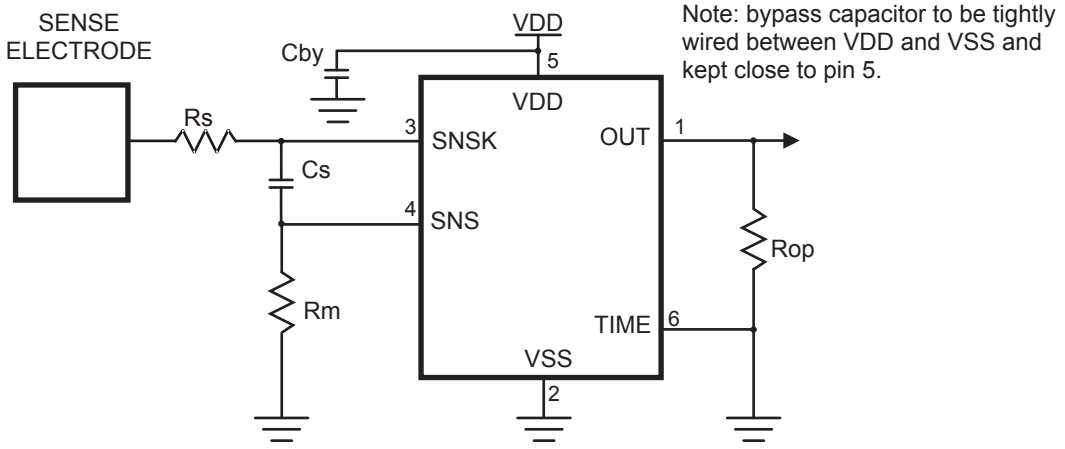
(1) I/O briefly on power-up
I Input only O Output only, push-pull

I/O Input/output P Ground or power

1.3 Schematics

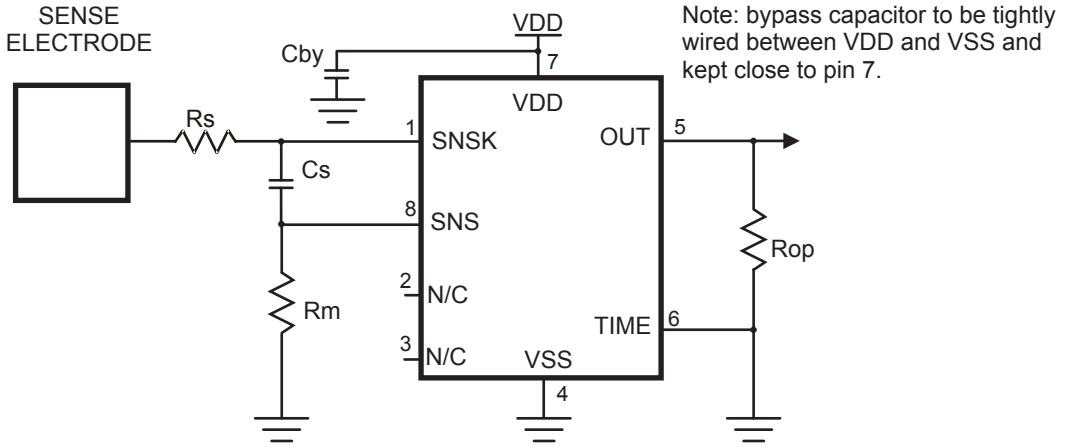
1.3.1 6-pin SOT23-6

Figure 1-1. Basic Circuit Configuration (active high output, toggle on/off, no auto switch off)



1.3.2 8-pin UDFN/USON

Figure 1-2. Basic Circuit Configuration (active high output, toggle on/off, no auto switch off)



For component values in Figure 1-1 and Figure 1-2, check the following sections:

- Cs capacitor (Cs) – see Section 4.2 on page 20
- Sample resistor (Rs) – see Section 4.3 on page 20
- Voltage levels – see Section 4.4 on page 20
- Output polarity selection resistor (Rop) – see Section 3.9 on page 10
- Rm resistor – see Section 3.11.2 on page 11
- Bypass capacitor (Cby) – see page 20

2. Overview of the AT42QT1012

2.1 Introduction

The AT42QT1012 (QT1012) is a single key device featuring a touch on/touch off (toggle) output with a programmable auto switch-off capability.

The QT1012 is a digital burst mode charge-transfer sensor designed specifically for touch controls. It includes all hardware and signal processing functions necessary to provide stable sensing under a wide variety of changing conditions; only low cost, noncritical components are required for operation. With its tiny low-cost packages, this device can suit almost any product needing a power switch or other toggle-mode controlled function, especially power control of small appliances and battery-operated products.

A unique “green” feature of the QT1012 is the timeout function, which can turn off power after a time delay.

Like all QTouch® devices, the QT1012 features automatic self-calibration, drift compensation, and spread-spectrum burst modulation in order to provide for the most reliable touch sensing possible.

2.2 Basic Operation

Figure 1-1 and Figure 1-2 show basic circuits for the 6-pin and 8-pin devices.

The QT1012 employs bursts of charge-transfer cycles to acquire its signal. Burst mode permits power consumption in the microamp range, dramatically reduces RF emissions, lowers susceptibility to EMI, and yet permits excellent response time. Internally the signals are digitally processed to reject impulse noise, using a “consensus” filter which requires four consecutive confirmations of a detection before the output is activated.

The QT switches and charge measurement hardware functions are all internal to the QT1012.

2.3 Electrode Drive

Figure 2-1 shows the sense electrode connections (SNS, SNSK) for the QT1012.

For optimum noise immunity, the electrode should only be connected to the SNSK pin.

In all cases the sample capacitor Cs should be much larger than the load capacitance (Cx). Typical values for Cx are 5 – 20 pF while Cs is usually 2.2 – 50 nF.

Note: Cx is not a physical discrete component on the PCB, it is the capacitance of the touch electrode and wiring. It is show in Figure 2-1 to aid understanding of the equivalent circuit.

Increasing amounts of Cx decrease gain, therefore it is important to limit the amount of load capacitance on both SNS terminals. This can be done, for example, by minimizing trace lengths and widths and keeping these traces away from power or ground traces or copper pours.

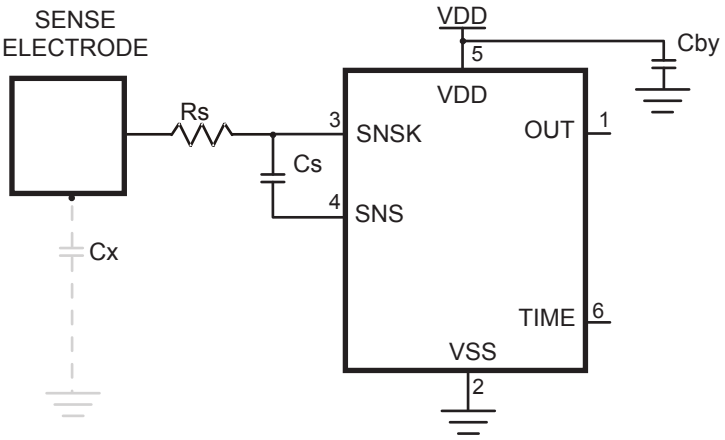
The traces, and any components associated with SNS and SNSK, will become touch sensitive and should be treated with caution to limit the touch area to the desired location.

To endure that the correct output mode is selected at power-up, the OUT trace should also be carefully routed.

A series resistor, Rs, should be placed in line with SNSK to the electrode to suppress electrostatic discharge (ESD) and electromagnetic compatibility (EMC) effects.

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Figure 2-1. Sense Connections



2.4 Sensitivity

2.4.1 Introduction

The sensitivity on the QT1012 is a function of things like the value of Cs, electrode size and capacitance, electrode shape and orientation, the composition and aspect of the object to be sensed, the thickness and composition of any overlaying panel material, and the degree of ground coupling of both sensor and object.

2.4.2 Increasing Sensitivity

In some cases it may be desirable to increase sensitivity; for example, when using the sensor with very thick panels having a low dielectric constant, or when the device is used as a proximity sensor. Sensitivity can often be increased by using a larger electrode or reducing panel thickness. Increasing electrode size can have diminishing returns, as high values of Cx will reduce sensor gain.

The value of Cs also has a dramatic effect on sensitivity, and this can be increased in value with the trade-off of a slower response time and more power. Increasing the electrode's surface area will not substantially increase touch sensitivity if its diameter is already much larger in surface area than the object being detected. Panel material can also be changed to one having a higher dielectric constant, which will better help to propagate the field.

Ground planes around and under the electrode and its SNSK trace will cause high Cx loading and decrease gain. The possible signal-to-noise ratio benefits of ground area are more than negated by the decreased gain from the circuit, and so ground areas around electrodes are discouraged. Metal areas near the electrode will reduce the field strength and increase Cx loading and should be avoided, if possible. Keep ground away from the electrodes and traces.

2.4.3 Decreasing Sensitivity

In some cases the QT1012 may be too sensitive. In this case gain can easily be lowered further by decreasing Cs.

2.5 Moisture Tolerance

The presence of water (condensation, sweat, spilt water, and so on) on a sensor can alter the signal values measured and thereby affect the performance of any capacitive device. The moisture tolerance of QTouch devices can be improved by designing the hardware and fine-tuning the firmware following the

recommendations in the application note Atmel AVR3002: Moisture Tolerant QTouch Design (downloadable from www.microchip.com).

3. Operation Specifics

3.1 Acquisition Modes

3.1.1 Introduction

The OUT pin of the QT1012 can be configured to be active high or active low.

- If active high then:
  - “on” is high
  - “off” is low
- If active low then:
  - “on” is low
  - “off” is high

3.1.2 OUT Pin

The QT1012 runs in Low Power (LP) mode. In this mode it sleeps for approximately 80 ms at the end of each burst, saving power but slowing response. On detecting a possible key touch, it temporarily switches to fast mode until either the key touch is confirmed or found to be spurious (via the detect integration process).

- If the touch is confirmed, the OUT pin is toggled and the QT1012 returns to LP mode (see figure "Low Power Mode: Touch Confirmed" below).
- If the touch is not valid then the chip returns to LP mode but the OUT pin remains unchanged (see figure "Low Power Mode: Touch Denied" below).

Figure 3-1. Low Power Mode: Touch Confirmed (Output in Off Condition)

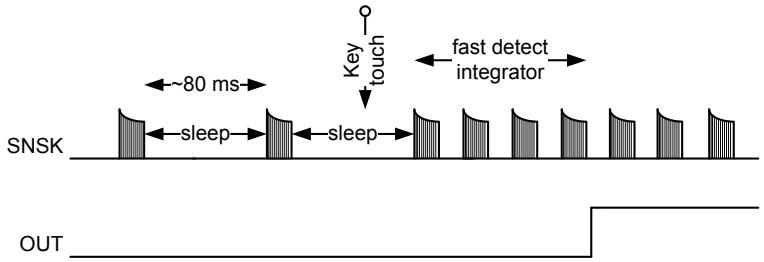
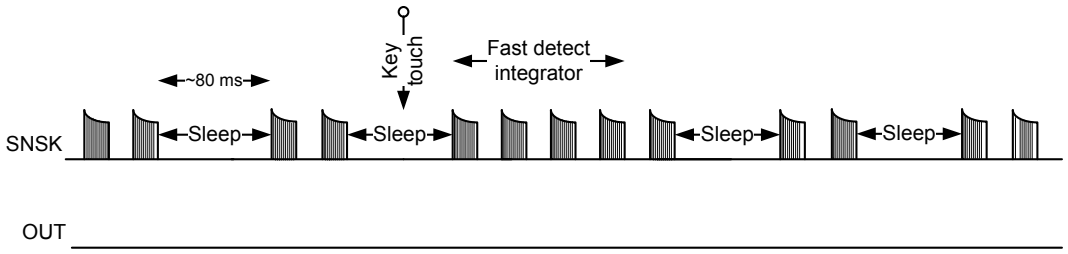


Figure 3-2. Low Power Mode: Touch Denied (Output in Off Condition)



3.2 Detect Threshold

The device detects a touch when the signal has crossed a threshold level. The threshold level is fixed at 10 counts.

3.3 Detect Integrator

It is desirable to suppress detections generated by electrical noise or from quick brushes with an object. To accomplish this, the QT1012 incorporates a detect integration (DI) counter that increments with each detection until a limit is reached, after which the output is activated. If no detection is sensed prior to the final count, the counter is reset immediately to zero. In the QT1012, the required count is four.

The DI can also be viewed as a “consensus filter” that requires four successive detections to create an output.

3.4 Recalibration Timeout

If an object or material obstructs the sense electrode the signal may rise enough to create a detection, preventing further operation. To stop this, the sensor includes a timer which monitors detections. If a detection exceeds the timer setting, the sensor performs a full recalibration. This does not toggle the output state but ensures that the QT1012 will detect a new touch correctly. The timer is set to activate this feature after ~60 s. This will vary slightly with Cs.

3.5 Forced Sensor Recalibration

The QT1012 has no recalibration pin; a forced recalibration is accomplished when the device is powered up or after the recalibration timeout. However, supply drain is low so it is a simple matter to treat the entire IC as a controllable load; driving the QT1012 VDD pin directly from another logic gate or a microcontroller port will serve as both power and “forced recalibration”. The source resistance of most CMOS gates and microcontrollers is low enough to provide direct power without a problem.

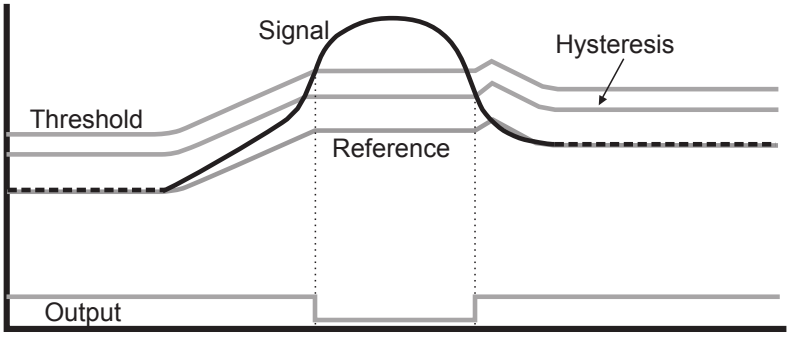
3.6 Drift Compensation

Signal drift can occur because of changes in Cx and Cs over time. It is crucial that drift be compensated for, otherwise false detections, nondetections, and sensitivity shifts will follow.

Drift compensation (Figure 3-3) is performed by making the reference level track the raw signal at a slow rate, but only while there is no detection in effect. The rate of adjustment must be performed slowly, otherwise legitimate detections could be ignored. The QT1012 drift compensates using a slew-rate limited change to the reference level; the threshold and hysteresis values are slaved to this reference.

Once an object is sensed, the drift compensation mechanism ceases since the signal is legitimately high, and therefore should not cause the reference level to change.

Figure 3-3. Drift Compensation



The QT1012 drift compensation is asymmetric; the reference level drift-compensates in one direction faster than it does in the other. Specifically, it compensates faster for decreasing signals than for

increasing signals. Increasing signals should not be compensated for quickly, since an approaching finger could be compensated for partially or entirely before even approaching the sense electrode. However, an obstruction over the sense pad, for which the sensor has already made full allowance, could suddenly be removed leaving the sensor with an artificially elevated reference level and thus become insensitive to touch. In this latter case, the sensor will compensate for the object's removal very quickly.

With large values of Cs and small values of Cx, drift compensation will appear to operate more slowly than with the converse. Note that the positive and negative drift compensation rates are different.

3.7 Response Time

The QT1012 response time is highly dependent on the run mode and burst length, which in turn is dependent on Cs and Cx. With increasing Cs, response time slows, while increasing levels of Cx reduce response time.

3.8 Spread Spectrum

The QT1012 modulates its internal oscillator by ±7.5% during the measurement burst. This spreads the generated noise over a wider band, reducing emission levels. This also reduces susceptibility since there is no longer a single fundamental burst frequency.

3.9 Output Polarity Selection

The output (OUT pin) of the QT1012 can be configured to have an active high or active low output by means of the output configuration resistor Rop. The resistor is connected between the output and either Vss or Vdd (see Figure 3-4 and Table 3-1). A typical value for Rop is 100 kΩ.

Figure 3-4. Output Polarity (6-pin SOT23)

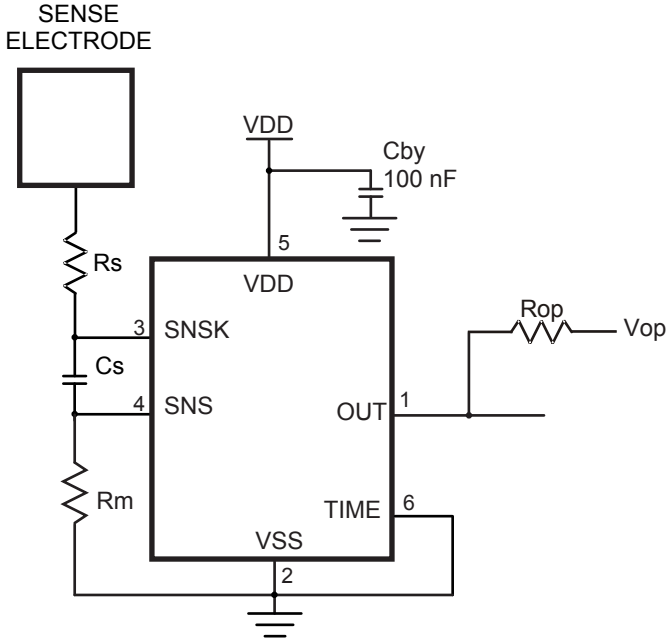
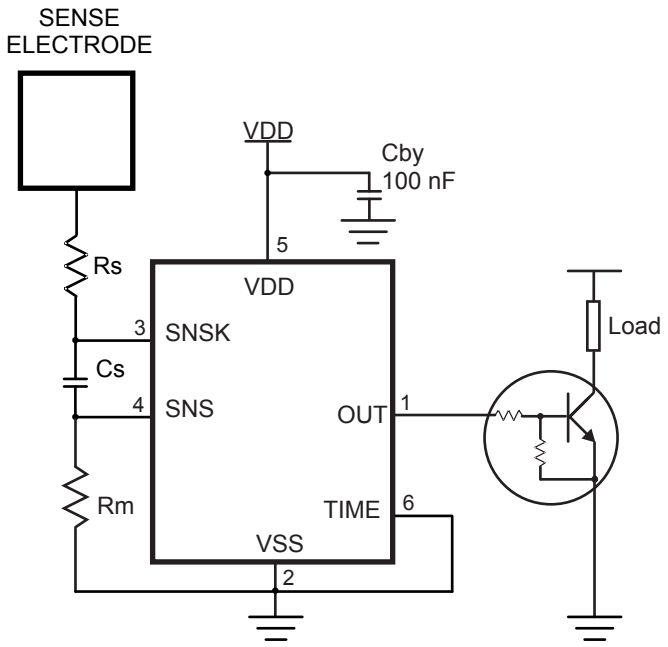


Table 3-1. Output Configuration

Name (Vop)	Function (Output Polarity)
Vss	Active high
Vdd	Active low

Note: Some devices, such as Digital Transistors, have an internal biasing network that will naturally pull the OUT pin to its inactive state. If these are being used then the resistor Rop is not required (see Figure 3-5).

Figure 3-5. Output Connected to Digital Transistor (6-pin SOT23)



3.10 Output Drive

The OUT pin can sink or source up to 2 mA. When a large value of Cs (>20 nF) is used the OUT current should be limited to <1 mA to prevent gain-shifting side effects, which happen when the load current creates voltage drops on the die and bonding wires; these small shifts can materially influence the signal level to cause detection instability.

3.11 Auto-Off Delay

3.11.1 Introduction

In addition to toggling the output on/off with a key touch, the QT1012 can automatically switch the output off after a time, typically ±10 percent of the nominal stated time. This feature can be used to save power in situations where the switched device could be left on inadvertently.

The QT1012 has:

- three predefined delay times (Section 3.11.2)
- the ability to set a user-programmed delay (Section 3.11.3)
- the ability to override the auto-off delay (Section 3.11.5)

The TIME and SNS pins are used to configure the Auto-off delay and must always be connected in one of the ways described in Section 3.11.2.

3.11.2 Auto-off – Predefined Delay

To configure the predefined delay the TIME pin is hard wired to Vss, Vdd or OUT as shown in Table 3-2 and Table 3-3. This provides nominal values of 15 minutes, 60 minutes or infinity (remains on until toggled off).

A single 1 MΩ resistor (Rm) is connected between the SNS pin and the logic level Vm to provide three auto-off functions: delay multiplication, delay override and delay retriggering. On power-up the logic level at Vm is assessed and the delay multiplication factor is set to x1 or x24 accordingly (see Figure 3-6, Table 3-2 and Table 3-3). At the end of each acquisition cycle the logic level of Vm is monitored to see if an Auto-off delay override is required (see Section 3.11.5).

Setting the delay multiplier to x24 will decrease the key sensitivity. To compensate, it may be necessary to increase the value of Cs.

Figure 3-6. Predefined Delay

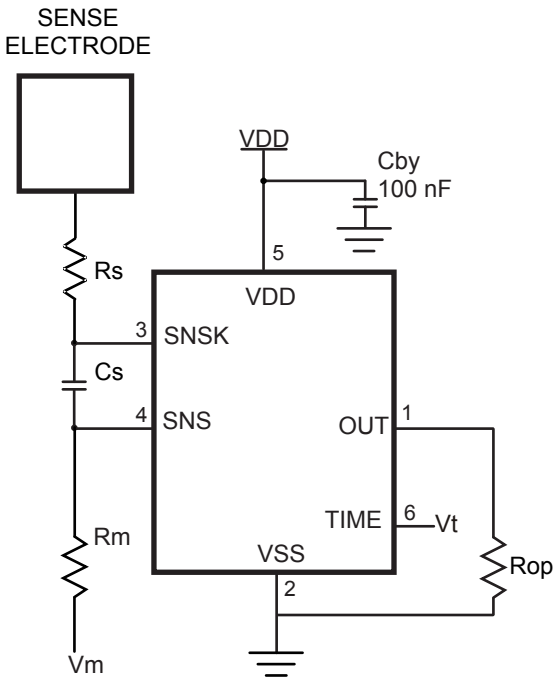


Table 3-2. Predefined Auto-off Delay (Active High Output)

Vt	Auto-off Delay (t_o)
Vss	Infinity (remain on until toggled to off)
Vdd	15 minutes
OUT	60 minutes

Table 3-3. Predefined Auto-off Delay (Active Low Output)

Vt	Auto-off Delay (t_o)
Vss	15 minutes
Vdd	Infinity (remain on until toggled to off)
OUT	60 minutes

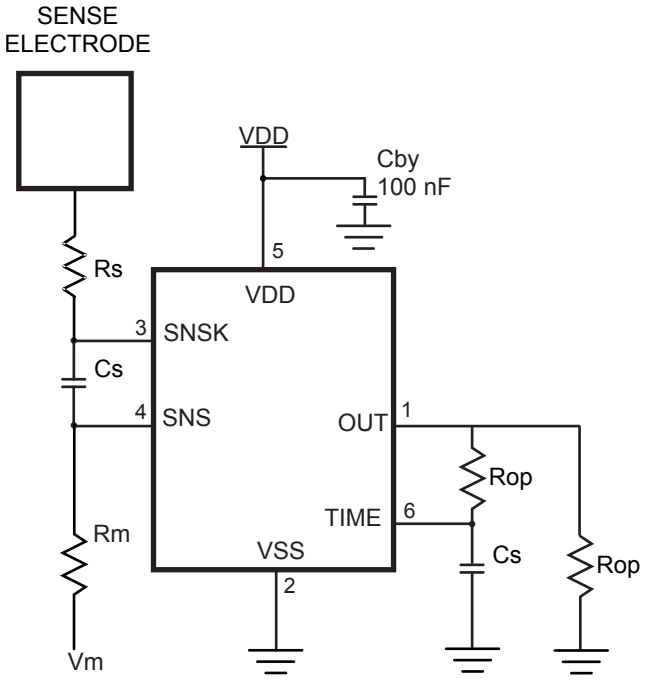
Table 3-4. Auto-off Delay Multiplier

Vm	Auto-off Delay Multiplier
Vss	$t_o \times 1$
Vdd	$t_o \times 24$

3.11.3 Auto-off – User-programmed Delay

If a user-programmed delay is required, a RC network (resistor and capacitor) can be used to set the auto-off delay (see Table 3-5 and Figure 3-7). The delay time is dependent on the RC time constant (Rt × Ct), the output polarity and the supply voltage. Section 3.11.4 gives full details of how to configure the QT1012 to have auto-off delay times ranging from minutes to hours.

Figure 3-7. Programmable Delay



3.11.4 Configuring the User-programmed Auto-off Delay

The QT1012 can be configured to give auto-off delays ranging from minutes to hours by means of a simple RC network and the delay multiplier input.

With the delay multiplier set at x1 the auto-off delay is calculated as follows:

Delay value = integer value of $\frac{Rt \times Ct}{K}$ x 15 seconds

and Rt × Ct = $\frac{\text{Delay} \times K}{15}$

Note: Rt is in kΩ, Ct is in nF, Delay is in seconds. K values are obtained from Figure 3-8.

To ensure correct operation it is recommended that the value of $\frac{\text{Rt} \times \text{Ct}}{K}$ is between 4 and 240.

Values outside this range may be interpreted as the hard wired options TIME linked to OUT and TIME linked to “off” respectively, causing the QT1012 to use the relevant predefined auto-off delays.

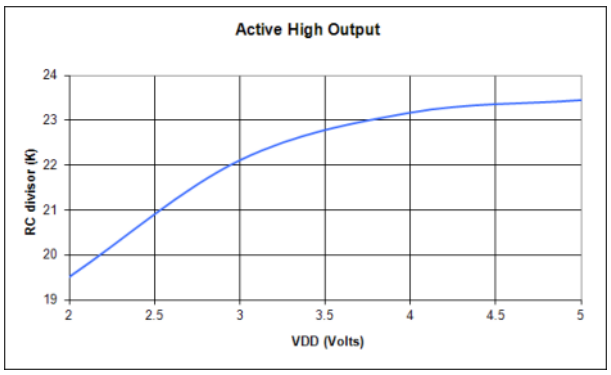
Table 3-5. Programmable Auto-off Delay (Example)Vm = Vss (delay multiplier = 1), Vdd = 3.5 V

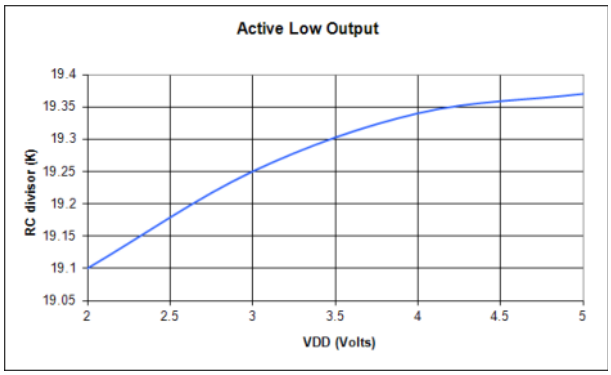
Output Type	Auto-off Delay (Seconds)
Active high	(Rt × Ct × 15) / 19
Active low	(Rt × Ct × 15) / 22

K values (19 and 22) are obtained from Figure 3-8.

Note: Rt is in kΩ, Ct is in nF.

Figure 3-8. Typical Values of K Versus Supply Voltage





The charts in Figure 3-8 show typical values of K versus supply voltage for a QT1012 with active high or active low output.

Example using the formula to calculate Rt and Ct

Requirements:

- Active high output (Vop connected to VSS)
- Auto-off delay nominal 45 minutes
- VDD = 3.5 V

Proceed as follows:

1. Calculate Auto-off delay in seconds 45 x 60 = 2700
2. Obtain K from Figure 3-8, K = 22.8
3. Calculate Rt × Ct = $\frac{2700 \times 22.8}{15}$ = 4104
4. Decide on a value for Rt or Ct (for example, Ct = 47 nF)
5. Calculate Rt = $\frac{4104}{47}$ = 87 k
6. Verify that $\frac{\text{RtxCt}}{K}$ = 179 (which is between 4 and 240)

As an alternative to calculation, Figure 3-9 and Figure 3-10 show charts of typical curves of auto-off delay against resistor and capacitor values for active high and active low outputs at various values of VDD (delay multiplier = x1).

Figure 3-9. Auto-off Delay, Active High Output
Vm = Vss (delay multiplier = x1)

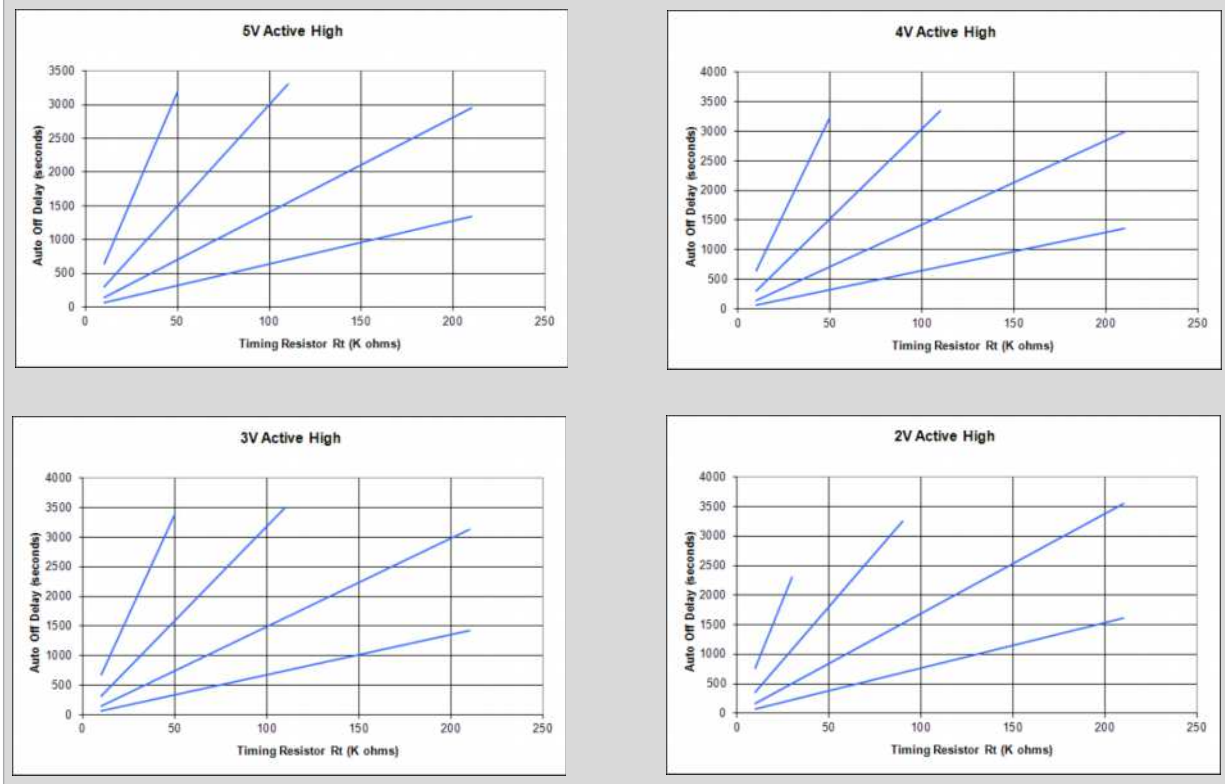
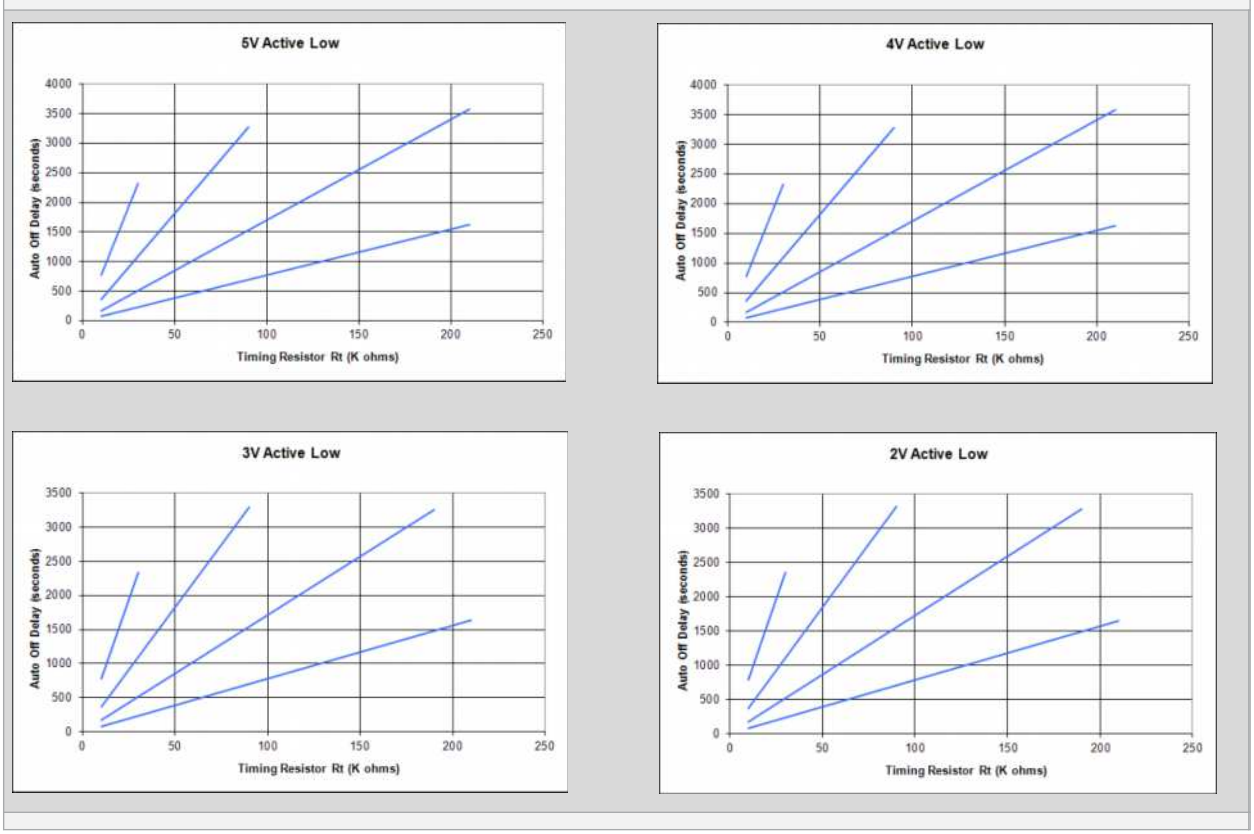


Figure 3-10. Auto-off Delay, Active Low Output
Vm = Vss (delay multiplier = x1)



Example using a chart to calculate Rt and Ct

Requirements:

- Active low output (Vop connected to VSS)
- Auto-off delay 25 minutes
- VDD = 4 V

1. Calculate Auto-off delay in seconds 25 × 60 = 1500.
2. Find $\frac{1500}{1}$ = 1500 on the 4 V chart in Figure 3-10.
3. This shows the following suitable Ct / Rt combinations:
   - 100 nF / 20 kΩ
   - 47 nF / 40 kΩ
   - 22 nF / 90 kΩ
   - 10 nF / 190 kΩ

     Note: The Auto-off delay times shown are nominal and will vary from chip to chip and with capacitor and resistor tolerance.

3.11.5 Auto-off – Overriding the Auto-off Delay

In normal operation the QT1012 output is turned off automatically after the auto-off delay. In some applications it may be useful to extend the auto-off delay (“sustain” function) or to switch the output off immediately (“cancel” function). This can be achieved by pulsing the voltage on the delay multiplier resistor Rm as shown in Figure 3-11 and Figure 3-12 on page 18.

To ensure the pulse is detected it must be present for typical times as shown in Table 3-6.

Table 3-6. Time Delay Pulse

Pulse Duration	Action
tp – series of short pulses, typically 65 ms	“Sustain”/retrigger (reload auto-off delay counter)
tp – long pulse, typically 250 ms	“Cancel”/switch output to off state and inhibit further touch detection until Vm returns to original state

While Vm is held in the override state the QT1012 inhibits bursts and waits for Vm to return to its original state. When Vm returns to its original state the QT1012 performs a sensor recalibration before continuing in its current output state.

Figure 3-11. Override Pulse (Delay Multiplier x1)

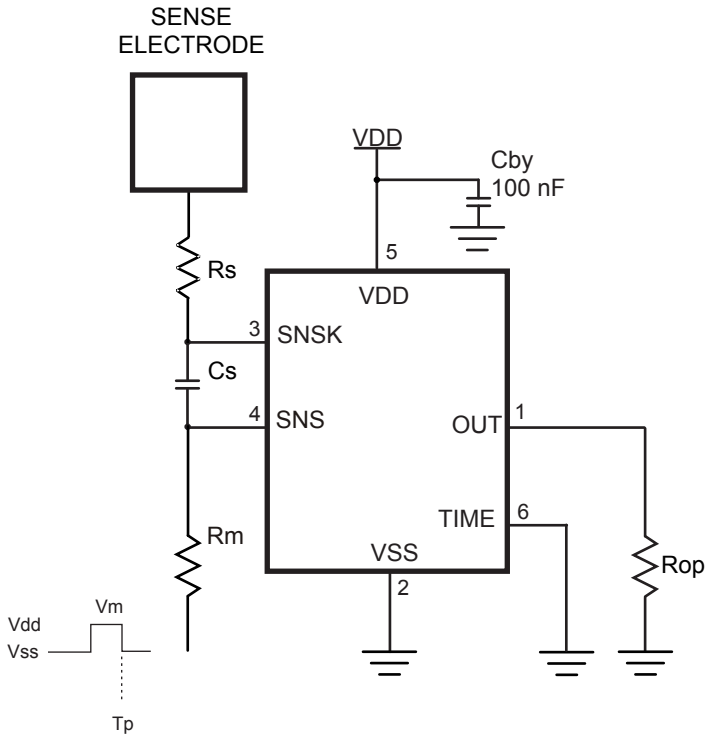


Figure 3-12. Override Pulse (Delay Multiplier x24)

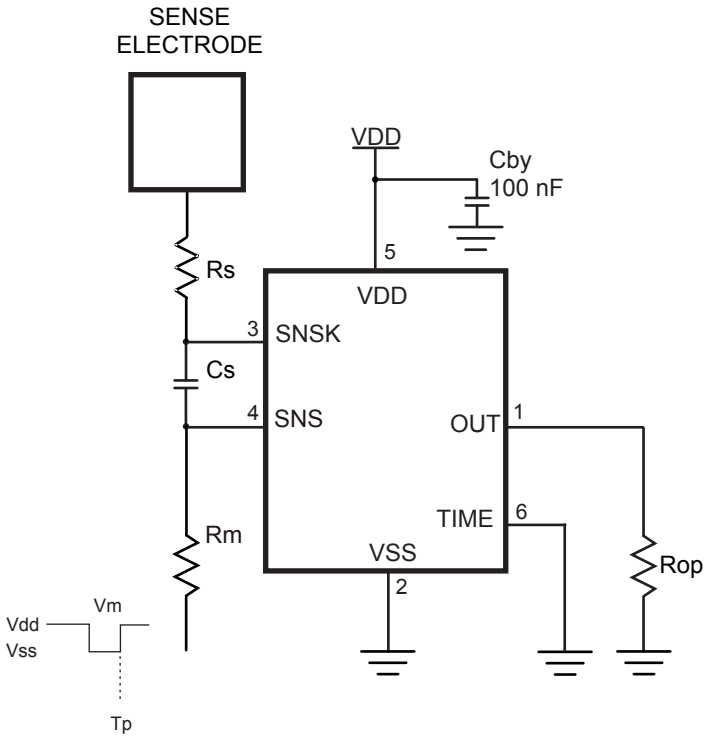
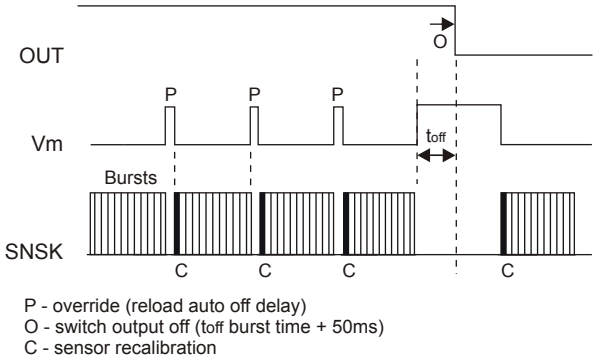


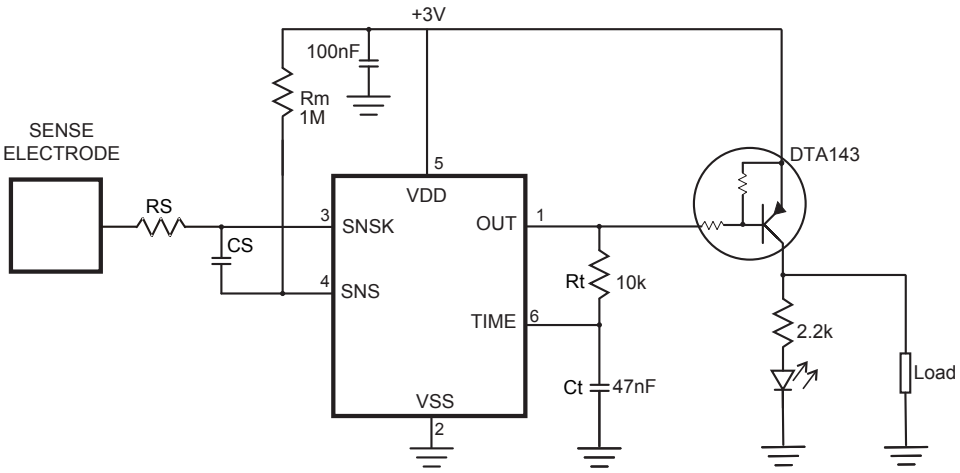
Figure 3-13 shows override pulses being applied to a QT1012 with delay multiplier set to x1.

Figure 3-13. Overriding Auto-off



3.12 Examples of Typical Applications

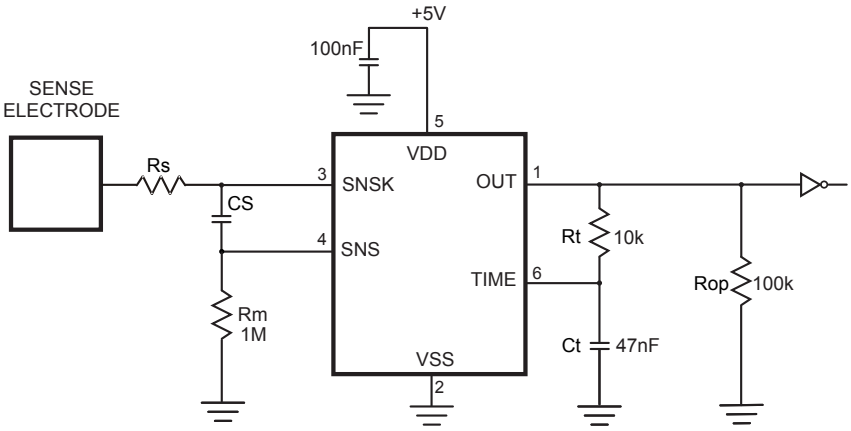
Figure 3-14. Application 1:
Active low, driving PNP transistor, auto-off time 375 s x 24 = 9000 s = 2.5 hours



Auto-off time obtained from 3 V chart in Figure 3-10 on page 16

Auto-off time obtained from 3 V chart in Figure 3-10

Figure 3-15. Application 2:
Active high, driving high impedance, auto-off time 315 s x 1 = 5.25 minutes



Auto-off time obtained from 5 V chart in Figure 3-9 on page 15

Auto-off time obtained from 5 V chart in Figure 3-9

4. Circuit Guidelines

4.1 More Information

Refer to Application Note QTAN0002, Secrets of a Successful QTouch Design and the Touch Sensors Design Guide (both downloadable from the Microchip website), for more information on construction and design methods.

4.2 Sample Capacitor

Cs is the charge sensing sample capacitor. The required Cs value depends on the thickness of the panel and its dielectric constant. Thicker panels require larger values of Cs. Typical values are 2.2 nF to 50 nF depending on the sensitivity required; larger values of Cs demand higher stability and better dielectric to ensure reliable sensing.

The Cs capacitor should be a stable type, such as X7R ceramic or PPS film. For more consistent sensing from unit to unit, 5% tolerance capacitors are recommended. X7R ceramic types can be obtained in 5% tolerance at little or no extra cost. In applications where high sensitivity (long burst length) is required the use of PPS capacitors is recommended.

For battery powered operation a higher value sample capacitor may be required.

4.3 Rs Resistor

Series resistor Rs is in line with the electrode connection and should be used to limit ESD currents and to suppress radio frequency interference (RFI). It should be approximately 4.7 kΩ to 33 kΩ.

Although this resistor may be omitted, the device may become susceptible to external noise or RFI. See Application Note QTAN0002, Secrets of a Successful QTouch Design, for details of how to select these resistors.

4.4 Power Supply and PCB Layout

See Section 5.2 for the power supply range.

If the power supply is shared with another electronic system, care should be taken to ensure that the supply is free of digital spikes, sags, and surges which can adversely affect the QT1012. The QT1012 will track slow changes in Vdd, but it can be badly affected by rapid voltage fluctuations. It is highly recommended that a separate voltage regulator be used just for the QT1012 to isolate it from power supply shifts caused by other components.

If desired, the supply can be regulated using a Low Dropout (LDO) regulator, although such regulators often have poor transient line and load stability. See Application Note QTAN0002, Secrets of a Successful QTouch Design, for further information on power supply considerations.

Parts placement: The chip should be placed to minimize the SNSK trace length to reduce low frequency pickup, and to reduce stray Cx which degrades gain. The Cs and Rs resistors (see Figure 1-1) should be placed as close to the body of the chip as possible so that the trace between Rs and the SNSK pin is very short, thereby reducing the antenna-like ability of this trace to pick up high frequency signals and feed them directly into the chip. A ground plane can be used under the chip and the associated discrete components, but the trace from the Rs resistor and the electrode should not run near ground, to reduce loading.

For best EMC performance the circuit should be made entirely with SMT components.

Electrode trace routing: Keep the electrode trace (and the electrode itself) away from other signal, power, and ground traces including over or next to ground planes. Adjacent switching signals can induce noise onto the sensing signal; any adjacent trace or ground plane next to, or under, the electrode trace will cause an increase in Cx load and desensitize the device.

Bypass Capacitor: Important – For proper operation a 100 nF (0.1 µF) ceramic bypass capacitor must be used directly between Vdd and Vss, to prevent latch-up if there are substantial Vdd transients; for example, during an ESD event. The bypass capacitor should be placed very close to the VSS and VDD pins.

4.5 Power On

On initial power up, the QT1012 requires approximately 250 ms to power on to allow power supplies to stabilize. During this time the OUT pin state is not valid and should be ignored.

Note that recalibration takes approximately 200 ms, so the QT1012 takes approximately 450 ms in total from initial power on to become active.

5. Specifications

5.1 Absolute Maximum Specifications

Operating temperature	–40°C to +85°C
Storage temperature	–55°C to +125°C
Vdd	0 to +6.5 V
Max continuous pin current, any control or drive pin	±20 mA
Short circuit duration to Vss, any pin	Infinite
Short circuit duration to Vdd, any pin	Infinite
Voltage forced onto any pin	–0.6 V to (Vdd + 0.6) V
CAUTION: Stresses beyond those listed under Absolute Maximum Specifications may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum specification conditions for extended periods may affect device reliability	

5.2 Recommended Operating Conditions

Vdd	+1.8 to +5.5 V
Short-term supply ripple + noise	±20 mV
Long-term supply stability	±100 mV
Cs value	2.2 to 50 nF
Cx value	5 to 20 pF

5.3 AC Specifications

Table 5-1. Vdd = 3.0V, Cs = 10 nF, Cx = 5 pF, Ta = recommended range, unless otherwise noted

Parameter	Description	Min	Typ	Max	Units	Notes
Trc	Recalibration time	–	200	–	ms	Cs, Cx dependent
Tpc	Charge duration	–	3	–	µs	±7.5% spread spectrum variation
Tpt	Transfer duration	–	6	–	µs	±7.5% spread spectrum variation
Tg1	Time between end of burst and start of the next (Fast mode)	–	2.6	–	ms	
Tg2	Time between end of burst and start of the next (LP mode)	–	80	–	ms	Increases with decreasing Vdd

Parameter	Description	Min	Typ	Max	Units	Notes
Tbl	Burst length	–	1.86	–	ms	Vdd, Cs and Cx dependent. See Section 4.2 for capacitor selection.
Tr	Response time	–	–	100	ms	

5.4 Signal Processing

Table 5-2. Vdd = 3.0V, Cs = 10 nF, Cx = 5 pF, Ta = recommended range, unless otherwise noted

Description	Min	Typ	Max	Units	Notes
Threshold differential	10			counts	
Hysteresis	2			counts	
Consensus filter length	4			samples	

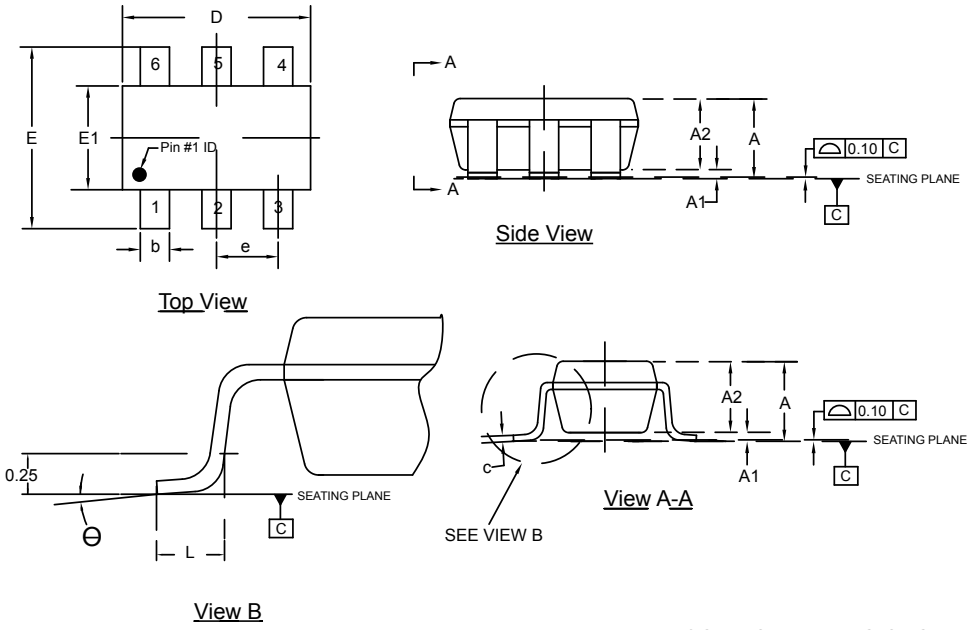
5.5 DC Specifications

Table 5-3. Vdd = 3.0V, Cs = 4.7 nF, Cx = 5 pF, short charge pulse, Ta = recommended range, unless otherwise noted

Parameter	Description	Min	Typ	Max	Units	Notes
Vdd	Supply voltage	1.8		5.5	V	
Idd	Supply current	–	32 36 59 88 124	–	µA	1.8 V 2.0 V 3.0 V 4.0 V 5.0 V
Vdds	Supply turn-on slope	100	–	–	V/s	Required for proper start-up
Vil	Low input logic level	–	–	0.2 × Vdd 0.3 × Vdd	V	Vdd = 1.8 V – 2.4 V Vdd = 2.4 V – 5.5 V
Vhl	High input logic level	0.7 × Vdd 0.6 × Vdd	–		V	Vdd = 1.8 V – 2.4 V Vdd = 2.4 V – 5.5 V
Vol	Low output voltage	–	–	0.6	V	OUT, 4 mA sink
Voh	High output voltage	Vdd – 0.7	–	–	V	OUT, 1 mA source
Iil	Input leakage current	–	–	±1	µA	
Cx	Load capacitance range	0	–	100	pF	
Ar	Acquisition resolution	–	9	14	bits	

5.6 Mechanical Dimensions

5.6.1 6-pin SOT23-6



COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.45	
A1	0	–	0.15	
A2	0.90	–	1.30	
D	2.80	2.90	3.00	2
E	2.60	2.80	3.00	
E1	1.50	1.60	1.75	
L	0.30	0.45	0.55	
e	0.95 BSC			
b	0.30	–	0.50	3
c	0.09	–	0.20	
q	0°	–	8°	

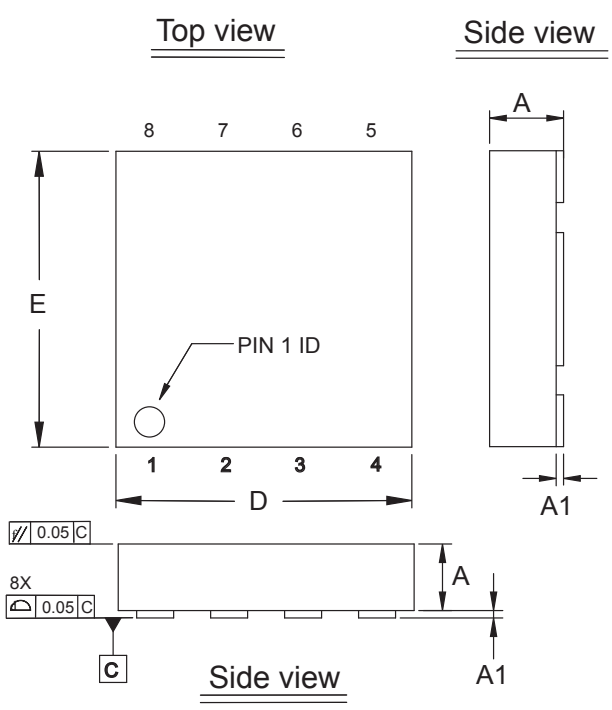
Notes:
1. This package is compliant with JEDEC specification MO-178 Variation AB.
2. Dimension D does not include mold Flash, protrusions or gate burrs. Mold Flash, protrustion or gate burrs shall not exceed 0.25 mm per end.
3. Dimension b does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum b dimension by more than 0.08 mm
4. Die is facing down after trim/form.

1/25/13

Atmel Package Drawing Contact: packagedrawings@atmel.com	TITLE **6ST1**, 6-lead, 2.90 x 1.60 mm Plastic Small Outline Package (SOT23)	GPC TAQ	DRAWING NO. 6ST1	REV. B

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

5.6.2 8-pin UDFN/USON



COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	-	-	0.60	
A_1	0.00	-	0.05	
b	0.20	-	0.30	
D	1.95	2.00	2.05	
D2	1.40	1.50	1.60	
E		1.95	2.00	2.05
E2	0.80	0.90	1.00	
e		0.50 BSC		
L	0.20	0.30	0.40	
k	0.20	-	-	

NOTES:
1. All dimensions are in mm. Angles in degrees.
2. Coplanarity applies to the exposed pad as well as the terminals. Coplanarity shall not exceed 0.05 mm.
3. Warpage shall not exceed 0.05 mm.
4. Refer to JEDEC MO-236/MO-252.

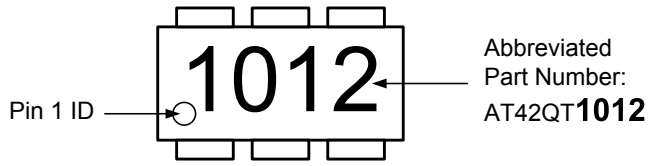
01/25/13

Atmel Package Drawing Contact: packagedrawings@atmel.com	TITLE **8MA4**, 8-pad, 2.0x2.0x0.6 mm Body, 0.5 mm pitch, 0.9x1.5 mm Exposed ePad, Ultra-Thin Dual Flat No Lead Package (UDFN/USON)	GPC YAG	DRAWING NO. 8MA4	REV. B

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

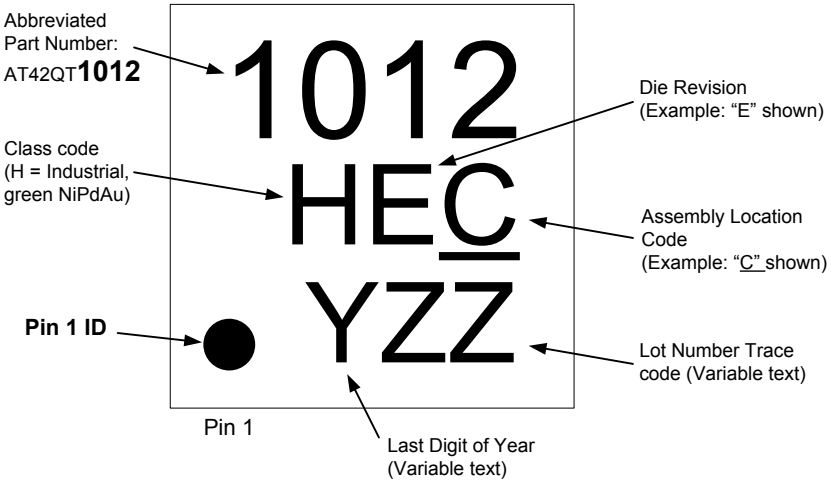
5.7 Part Marking

5.7.1 AT42QT1012– 6-pin SOT23-6



Note: Samples of the AT42QT1012 may also be marked T10E.

5.7.2 AT42QT1012 – 8-pin UDFN/USON



Note: Samples of the AT42QT1012 may also be marked T10

5.8 Part Number

Part Number	Description
AT42QT1012[(1)]	6-pin SOT23 RoHS compliant IC
AT42QT1012-TSHR	6-pin SOT23 RoHS compliant IC
AT42QT1012-MAH	8-pin UDFN/USON RoHS compliant IC

Notes: 1. Marking details:
Top mark 1st line: ddddTY
Top mark 2nd line: wwxxx

dddd= device, special code
T= Type
Y= Year last digit
ww= calendar workweek
xxx = trace code

5.9 Moisture Sensitivity Level (MSL)

MSL Rating	Peak Body Temperature	Specifications
MSL1	260°C	IPC/JEDEC J-STD-020

6. Associated Documents

For additional information, refer to the following document (downloadable from the Touch Technology area of the Microchip website, www.microchip.com):

- Touch Sensors Design Guide
- QTAN0002 – Secrets of a Successful QTouch® Design

7. Revision History

Revision No.	History
Revision A – May 2009	Initial release
Revision B – August 2009	Update for chip revision 2.2
Revision C – August 2009	Minor update for clarity
Revision D – January 2010	Power specifications updated for revision 2.4.1
Revision E – January 2010	Part markings updated
Revision F – February 2010	MSL specification revised Other minor updates
Revision G – March 2010	Update for chip revision 2.6
Revision H – May 2010	UDFN/USON package added
Revision I – May 2013	Applied new template
DS40001948A – August 2017	Part marking clarification added. Replaces Atmel document 9543I.

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