QTouch and QMatrix Sensitivity Tuning for Keys, Slider and Wheels

1. Introduction

This Application note aims to explain the factors affecting the sensitivity of QTouch® and QMatrix® sensors and ways to optimize the design for sensitivity. It also provides step-by-step procedures on how to tune the keys, slider and wheels.

For specific information on the various QTouch and QMatrix devices, refer to their respective datasheets. For design-related information, refer to the *Touch Sensors Design Guide,* which is also suitable for Atmel® QTouch Library applications.

2. Factors Affecting Touch Sensitivity

2.1 Introduction

The main factors affecting sensitivity of a QTouch/QMatrix sensor are:

- Electrode size and design
- Dielectric front panel thickness and material (that is, the panel between finger and sensor)
- Ground loading and other signals
- Ground return
- Supply voltage
- Detection threshold (negative threshold – NTHR)
- Sampling capacitor (Cs)
- Burst length
- QMatrix sampling resistor (Rsmp)

Factors such as electrode size, dielectric panel and ground loading are optimized during the design and routing of the sensor board.

Tuning the sensitivity of a QTouch sensor involves selecting the right Cs value and then fine tuning the Detection Threshold.

Tuning the sensitivity of a QMatrix sensor involves setting the burst length (BL) and then fine tuning the detection threshold (Rsmp and Cs may also be optimized).

2.2 Electrode Size and Design

2.2.1 QTouch

Capacitance is a function of surface area; therefore the larger the surface area of the touch target and the electrode, the larger the change in capacitance.

If the electrode is too small there will not be optimal surface area coupling to the finger; therefore the sensor will be operating at reduced sensitivity.

If the electrode is too big the extra surface area may add more parasitic capacitance to nearby ground returns, for example, foreign tracks and ground planes.

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The optimal electrode size is an electrode that is slightly larger (by a few millimeters) than the touch target, to allow for slightly off-centre touches. The touch target is usually a finger – generally around 8 – 12 mm wide.

2.2.2 QMatrix

Although based on the same Charge Transfer principle, a QMatrix electrode is different from a QTouch electrode.

A QMatrix contains an X electrode (transmitter) and a Y electrode (receiver). The mutual capacitance between the X and Y electrodes is measured. Therefore, the sensitive touch area is the gap between the X and Y electrodes.

Key sensitivity is improved by increasing field penetration and density.

Field penetration through the dielectric front panel is improved by increasing the XY gap. The bigger the XY gap, the further sense fields propagate through the dielectric panel towards the users touch. Ideally, the XY gap should be T/2 whereby T is the front panel thickness. If the XY gap is over-large then the sensor may have a proximity effect instead of requiring actual touch. Also, the sensor may become overly sensitive to moisture. See the diagrams in Table 2-1.

Field density is improved by increasing the amount of interleaving between the X and Y electrodes. This means creating more 'teeth' in a QMatrix key. A key with more interleaving (while still adhering to the T/2 rule) will have better sensitivity. See the diagrams in Table 2-1.

For further information and examples on key design, refer to the Atmel *Touch Sensor Design Guide.*

Table 2-1. Increasing X and Y Separation Increases Field Penetration Through the Front Panel

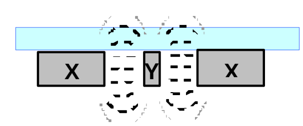
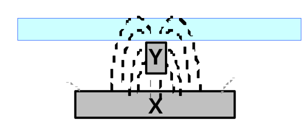
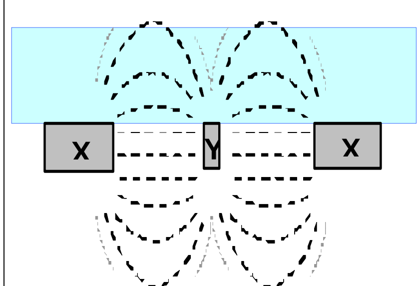
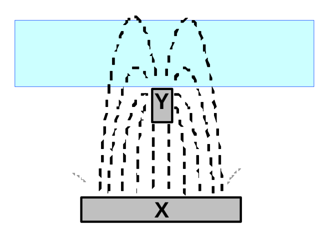
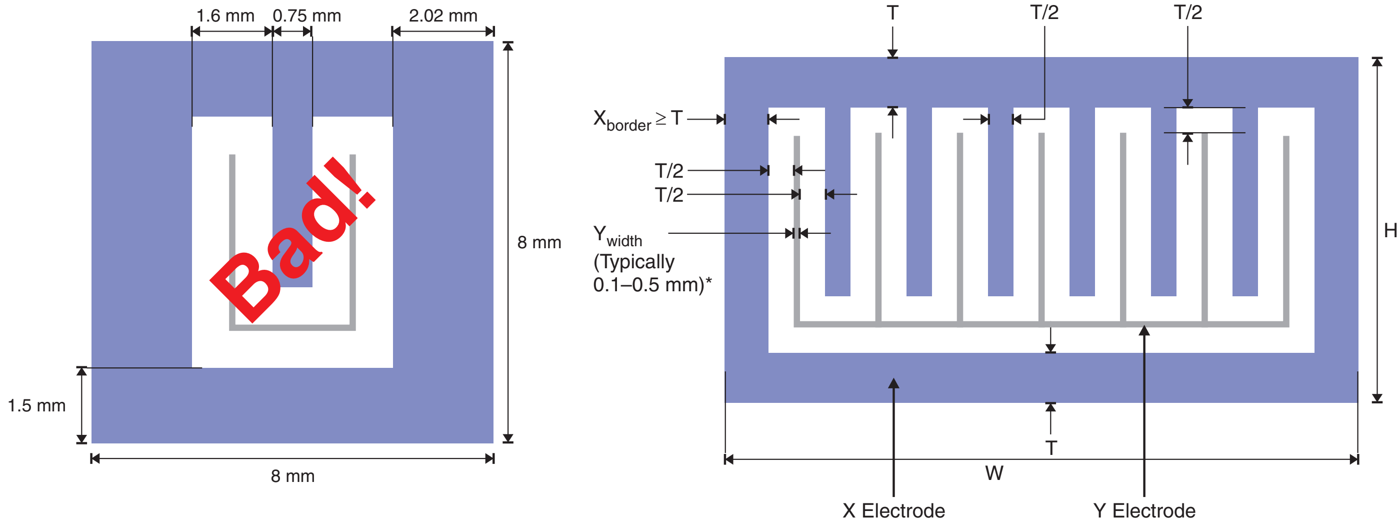
	Single Layer Planar Electrode Layout	Double Layer FloodX Electrode Layout
Small X-Y Separation = Thin panel		
Large X-Y Separation = Thicker panel		 Note how FloodX Field only extends towards touch

Figure 2-1. Increasing X and Y Interleaving Increases Field Density Through the Front Panel



T = Front panel thickness

* Y_{width} is related to electrode conductivity. Keep Y line worst case resistance in line with RC time constants rules (this is very important, for example, for ITO)

2.3 Dielectric Panel Thickness and Material

The thicker the dielectric front panel, the less sensitive the electrode will be (C=εA/D).

Each material has a relative dielectric constant associated with it. The higher the relative dielectric constant, the better the material is at propagating charge through it. Therefore, materials which have a higher dielectric constant will perform better with capacitive touch sensors. For example, glass typically has twice the dielectric constant of plastic; therefore a 5 mm glass panel would have sensitivity equivalent to a 2.5 mm plastic panel.

For QTouch, as a general rule, it is recommended to have the electrode's dimensions at least four times the panel thickness. For example, if the panel thickness is 2 mm, the minimum electrode size is recommended is 8 mm x 8 mm.

For QMatrix, the field penetration is controlled by XY separation in the electrode (see Section 2.2.2 on page 2), but increasing the number of interleave fingers (larger sensor) will improve sensitivity.

2.4 Ground Loading and Other Signals

2.4.1 QTouch

The QTouch sense electrodes, sense tracks and sense components (Rs, Cs) are all touch sensitive. Having ground tracks or planes nearby will make the sensor less sensitive. This is because the nearby ground increases the parasitic capacitance by providing an alternate return path for the charge.

Try to keep all ground away from the sense electrodes/tracks/components if possible. If a ground plane is necessary to shield from noise or provide a stable operating environment (in a portable device), then a hatched ground pattern can be used. Hatched patterns have reduced surface area, thus reducing loading but still providing shielding.

It is always beneficial to keep sense tracks as short as possible to reduce loading effects.

Note: All other foreign tracks near the sense electrode/tracks/components also have a desensitizing effect as they are AC ground return paths (and may also add crosstalk noise).

2.4.2 QMatrix

The X lines (transmitter) are always driven, therefore are virtually immune to ground loading. X lines can simply be routed almost anywhere (except near Y lines, as the XY coupling may form false touch sensors at those locations).

The Y (receiver) electrode/tracks behave similar to the QTouch sense electrode/tracks. Therefore, the above mentioned guidelines regarding QTouch routing applies to QMatrix Y lines as well.

2.5 Ground Return

All capacitive touch sensors rely on a return path for the charge to 'propagate' from the electrode back to the circuit ground of the sensor.

A human being, due to its mass and size, can be considered to be earth. Therefore, if the product with the capacitive touch sensor is connected to mains earth, there will be a consistent and good quality return path. Sensitivity is almost constant and improved.

With battery operated devices, for example, mobile phones, mp3 players, the return path depends on:

- Case design: metal casing with a big battery provides a better return path compared to plastic cases.
- Hand held: the return path improves if operated when held in the hand compared to placed on the table.
- Environment: better return path on metal table than wooden table.

Sensitivity change due to a change in return path (for example, a mobile device connected to a charger or not) is typically less than 15 percent, but can vary up to 40 percent in certain extreme cases. The sensitivity can usually be tuned to achieve a happy medium between the various operating conditions. If a happy medium is not achievable, dual configurations can be used.

If a device is battery operated, the device would need to be tuned under the same floating condition. If connecting to a PC to read out raw data, the connection would need to be isolated (for example, using opto-isolators or bluetooth isolators). This is because a connection to the PC will essentially be connecting the device to mains earth.

2.6 Sampling Capacitor (Cs)

2.6.1 QTouch

Increasing the sampling capacitor (Cs) increases the burst length and signal resolution, resulting in increased sensitivity.

It is recommended to optimize the design first (electrode size and ground loading), before attempting to increase Cs. Increasing Cs increases sensitivity to touch, but also increases susceptibility to external influences, such as temperature, noise and humidity.

Increasing Cs can also increase measurement time, which affects response time, power consumption, and EMC.

For a key, a typical Cs is between 1 nF – 22 nF, design dependent. It is not recommended to have Cs > 100 nF. If so, the design needs to be optimized.

For sliders and wheels, a typical Cs ranges from 18 nF – 68 nF. The slider/wheel operates optimally when all three sense channels are balanced. This means they all use the same Cs value with the same dielectric grade (for example, X7R).

2.6.2 QMatrix

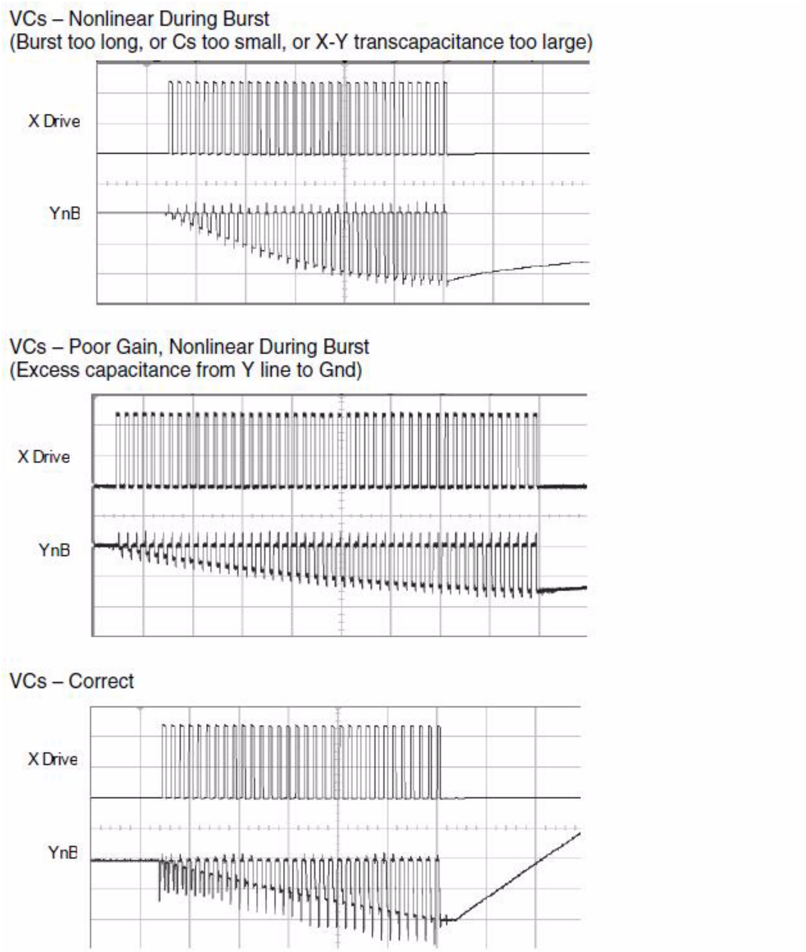
The sampling capacitor (Cs) in a QMatrix circuit does not directly affect the sensitivity. Due to the QMatrix's dual-slope measurement method, changes in Cs are mostly nullified. This feature minimizes the effects of capacitor tolerances and temperature variation on QMatrix measurements.

The Cs in a QMatrix is typically 4.7 nF but may be increased up to 10 nF if the Cs is saturating. Saturation of the Cs can occur, if:

- The design is heavily loaded (Y to ground or Y to X),
- Cs is too small, or
- The burst length is too high (see Section 2.7 on page 6).

If Cs is too large it may increase noise jitter due to the low angle of the Discharge slope. You can check if Cs is near the limit by temporarily increasing BL (approximately double) and seeing where the Cs charging starts to develop a curve. If there is significantly more room then consider using a smaller Cs to take advantage of the available charging range.

Figure 2-2. Voltage Accumulated on Cs



2.7 Burst Length

Burst Length (BL) refers to the total number of charge pulses in a burst measurement.

In QTouch, the burst length varies with the design, Cs, and amount of touch. It is not a parameter directly specified by the user.

For QMatrix, the burst length is user specified and is one of the main parameters used to tune the sensitivity of a QMatrix sensor. Increasing BL increases the signal resolution, resulting in increased sensitivity.

It is recommended to optimize the design first (electrode size and ground loading), before attempting to increase BL. Increasing BL also increases measurement time which affects response time, power consumption, and EMC.

2.8 Supply Voltage

2.8.1 QTouch

The supply voltage at which the QTouch sensor is powered affects the sensitivity. This is because as the supply voltage changes, the amount of charge 'transferred' during measurements will change.

Apart from that, with certain silicon bases, the input threshold voltage (Vih) changes relative to the supply voltage. So, the burst length can either increase or decrease depending on the relationship between supply voltage and Vih. Thus, sensitivity can change either way depending on device.

Therefore, if the supply voltage is changed, the QTouch sensor will need to be retuned. It is always recommended to have a dedicated regulator for the QTouch IC to ensure supply voltage stability.

2.8.2 QMatrix

Due to the dual slope measurement method applied in QMatrix, slow changes in operating voltage will be nullified. This means a QMatrix sensor will have the same sensitivity throughout its operating voltage range; for example, a QMatrix sensor tuned to work at 5V will still have the same sensitivity at 2V.

However, higher frequency ripples in the operating voltage around the burst measurement frequency (typically around 100 kHz – 400 kHz depending on device) can affect the measurements.

2.9 Detection Threshold (Negative Threshold, NTHR)

The Detection Threshold is the amount of change required in the sensor measurement for it to be reported as a touch. Therefore, a lower Detection Threshold means increased sensitivity for a key, as it requires less change to be reported as a touch.

For keys, a good Detection Threshold value is 10, although this can range from 7 – 12.

For sliders/wheels, the Detection Threshold can be much higher than 12 (threshold tuning described in Section 5 on page 12), but be wary if the threshold required is less than 7.

Note: This adjusting of the Threshold is never a substitute for proper electrode design and sampling capacitor value. The Detection Threshold is mostly used as a fine tuning tool to get the right touch sensitivity from a key.

Ensure that the Threshold is significantly higher than the variations in signal level when there is no touch. With a good design the signal jitter is typically less than ±2 points. If untouched signal jitter is significantly higher then check your power supply stability and also the touch signal layout (see Section 2.2 on page 1 and Section 2.8 on page 7, otherwise your thresholds will need to be much higher to ensure no false detections due to noise.

2.10 Sampling Resistor (Rsmp) [QMatrix only]

The Sampling Resistor (Rsmp) is only present in the QMatrix type sensor. The Rsmp is used to discharge the Sampling Capacitor (Cs).

In a QMatrix sensor, the time it takes to discharge the Cs to a preset voltage (usually to ground – that is, 0V) gives a measure of the capacitance. The value of Rsmp directly controls the discharge slope. Therefore, changing the Rsmp value changes the sensitivity of the sensor too.

Increasing the Rsmp will increase the sensitivity of the sensor, and vice-versa.

The Rsmp is typically 470 kΩ, but the value can range from 220 kΩ to 1 MΩ. It is not recommended to use values above 1 MΩ, as it can lead to increased susceptibility to external effects such as temperature variations.

If the noise jitter on the signal is much above ±3points, then the larger Rsmp is only amplifying noise without any improvement in resolution; try reducing Rsmp. If noise jitter is 0 or ±1 points then there may be more resolution available in the signal. Try increasing Rs which may give more Touch delta and allow a shorter BL. In some cases decreasing or increasing Cs may also help reduce noise jitter.

3. Factors That Should NOT Affect Sensitivity

Series Resistor (referred to as Rs in QTouch or Rx and Ry in QMatrix)

The Rs is inserted is series with the electrode in both QTouch and QMatrix sensors. The Rs resistor can be tuned to improve EMC/EMI/ESD performance of the sensor.

The Rs should NOT affect the sensitivity of a touch key. If changing Rs varies the sensitivity or the signal level, then the electrode is not fully charged by the charge transfer process.

Rs can be tuned by checking:

- The Signal level (Reference level) of the sensor, or
- Using the scope and coin method (If the coin probe has too much AC power line noise try adding a 1 MΩ resistor from the coin to Touch IC's ground).

Procedure for Rs tuning by checking Reference

1. Get the maximum Reference value by using a small Rs value (1 kΩ) and the maximum charge/dwell time (if parameter is adjustable).
2. Adjust the Rs or charge/dwell time to user values.
3. Calibrate (or reset the device) and check the Reference values.
   – If the electrode is fully charged, the Reference should not change by > 1 percent.
   – If the Reference is <99 percent of the maximum Reference, then the electrode is not fully charged. Decrease the Rs or increase the charge/dwell time.
4. It is good to have some allowance from the point of the Reference being <99 percent of the maximum reference. Therefore, decrease the Rs or increase the charge/dwell time to have some allowance.

   Aim for a larger Rs for better EMC/EMI/ESD protection, and the lowest charge/dwell time for better moisture tolerance.

Refer to the *Touch Sensor Design Guide* for more information on charge transfer and Rs tuning.

Typical Rs values are between 1 kΩ – 10 kΩ. Rs can generally be set at 4.7 kΩ and only modified to suit EMC/RFI/ESD requirements.

4. Tuning Sensitivity for Keys

4.1 Introduction

Before tuning the sensitivity, make sure that the unit is set up to represent the final operating condition. For example:

- having the dielectric front panel properly mounted
- operating the chip at the required supply voltage
- ensuring all other components are running

If the sensor is unstably supported or signal lead wires move then proper tuning will not be possible.

The tuning process for keys (QTouch and QMatrix) can be done both with and without the capacitive measurement data.

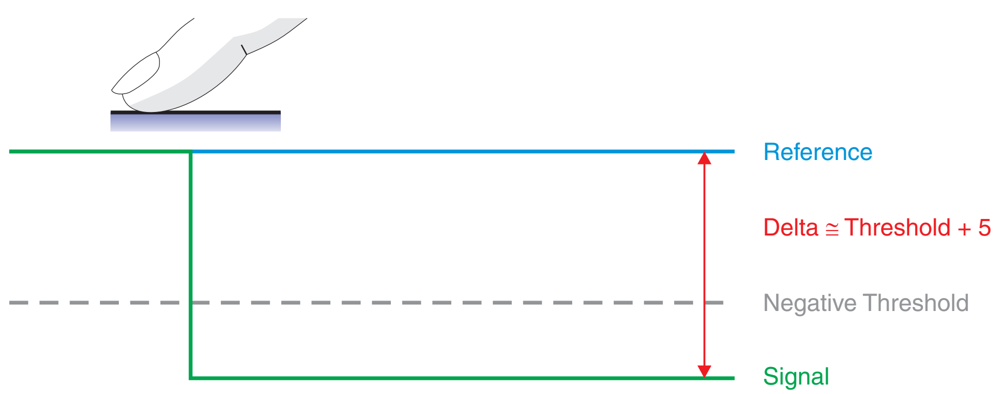
4.2 Capacitive Measurement Data

Many Atmel Touch ICs and also the Atmel QTouch Library allow monitoring of the capacitive measurement data. The measurement data can be obtained through debug interfaces or normal communications ports (for example, I^2C-compatible, SPI, UART).

This raw measurement data may include the Signal, Reference and Delta (see Figure 4-1).

- Signal = currently measured value
- Reference = ‘no touch’ Signal value (a slow average of Signal)
- Delta = Reference minus Signal (the amount of touch)

Figure 4-1. Raw Measurement Data



4.3 Tuning QTouch and QMatrix Keys

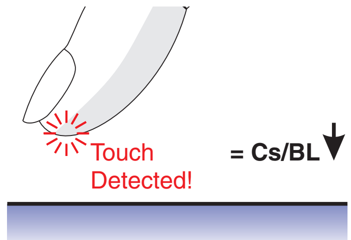
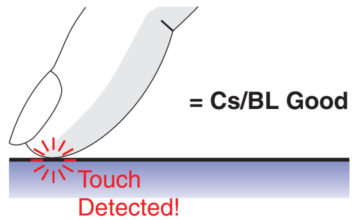
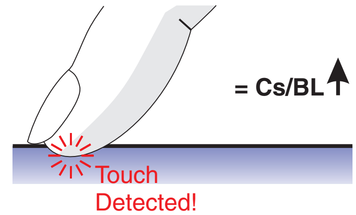
If tuning a multikey chip, all keys in use should be enabled. For QTouch, the Cs for each key in use must be populated; for QMatrix, each key should be enabled with a valid BL; for the Touch Library call the appropriate enable function for each key.

1. Start at nominal values.
   a. For QTouch, start with a nominal Cs value, for example 10 nF.
   b. For QMatrix, start at a nominal value for all of the following:
      –Rsmp (typically 470 kΩ, see Section 2.10 on page 8)
      –Cs (typically 4.7 nF, see Section 2.6 on page 5)
      –Burst Length (typically 16 – 64, see Section 2.7 on page 6)
2. If the Detection Threshold is adjustable through software, set it to 10.
3. Apply a light touch on the key being tuned. A light touch would be a finger tip that just lightly contacts the touch surface.
4. If the touch is reported before the finger contacts the touch surface, then it is oversensitive.
   a. For QTouch, reduce the Cs and retest.
   b. For QMatrix, reduce the BL and retest.

   If the touch is not reported or requires a heavy touch to activate, then it is too insensitive.
   a. For QTouch, increase the Cs and retest.
   b. For QMatrix, increase the BL and retest.

   Repeat this step until the key reports a touch when the finger lightly contacts the touch surface. This will be the Cs (QTouch) or BL (QMatrix) value that gives good sensitivity (see Table 4-1).

Table 4-1. Variations in Tuning Sensitivity

Over-sensitive	Good Sensitivity	Under-sensitive
		
If the key is reporting touch before contact with the touch surface, then the key is too sensitive.	A key is at the right sensitivity when it only detects the finger as it lightly contacts the touch surface.	If the key is not detecting the touch or requires a heavy touch to activate, then the key is too insensitive. Note: Capacitive Touch is not sensitive to pressure, but to the expanded area of the flattened finger.
QTouch		
Reduce the Cs value and retest with a light touch.	Cs = correct value	Increase the Cs value and retest with a light touch.
QMatrix		
Reduce the BL value and retest with a light touch.	BL = correct value	Increase the BL value and retest with a light touch.

5. QMatrix only

   If a suitable sensitivity cannot be achieved by adjusting BL, the Rsmp value can be modified. For a given BL, changing the Rsmp will change the sensitivity (signal and delta) by a proportionate amount. This holds true until the Cs has saturated. Refer to Section 2.6 on page 5 and Section 2.10 on page 8 for information on Cs and Rsmp. Change the Rsmp value, then repeat the BL tuning process in Step 3. and Step 4.

   Note: Changing the Rsmp value will change the sensitivity for all keys connected to the same Y line. Therefore, BL for all other keys might have to be retuned if Rsmp is changed.

6. Sometimes the best values to obtain optimal sensitivity cannot be obtained. For example, in a QTouch design, the best sensitivity might require a Cs capacitor value that is between the common capacitor values available. In a QMatrix design, the best BL might not be obtainable as some QMatrix devices only allow step changes in the BL setting (for example, 16, 36, 48, 64).

   In situations like this, the Detection Threshold (NTHR) can be adjusted to fine tune the key to give the best sensitivity with the available Cs value.

   If NTHR cannot be modified, then use the Cs (QTouch) or BL (QMatrix) value that gives the higher sensitivity as this may be better from a user perspective than having slightly insensitive keys.

7. If measurement data is available (see Section 4.2 on page 9), apply a light touch on the key being tuned and note the Delta produced. As a guide, a key would usually be at the right sensitivity if the Delta is approximately 5 counts more than the Detection Threshold. Adjust the Cs (QTouch) or BL (QMatrix) value accordingly to get this condition.

   For example, if the Detection Threshold = 10, then aim to get Delta = 15 by changing the Cs (QTouch) or BL (QMatrix) value.
8. Repeat the process for all the other keys.

5. Tuning Sensitivity for Slider and Wheels

5.1 Introduction

Tuning a slider or wheel is done in two phases:

- Signal Resolution (see Section 5.2 on page 12)
- Detection Threshold (see Section 5.3 on page 14)

Before tuning the sensitivity, make sure that the unit is set up to represent the final operating condition. For example:

- Having the dielectric front panel properly mounted
- Operating the chip at the required supply voltage
- Ensuring all other components are running.

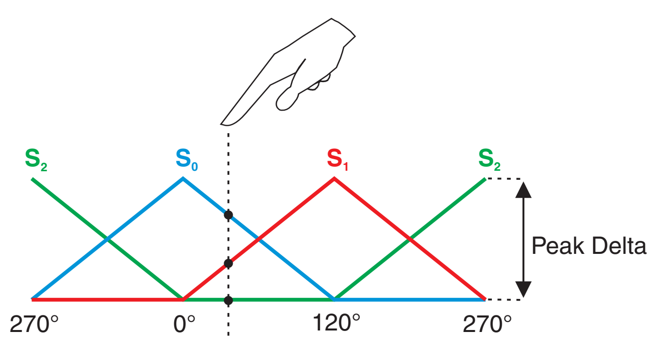
The tuning procedures outlined in this section apply to both QTouch and QMatrix type sliders/wheels, unless specified otherwise.

Note: Each individual sense channel in the wheel/slider has it own Delta (Reference minus Signal). But an accumulated Delta for the wheel/slider is calculated and is compared to the Detection Threshold. The calculation for the accumulated Delta value may differ from device to device, but that is not critical to the tuning procedure described in this section.

When using the Atmel QTouch Library it may help to temporarily enable all the channels as discrete keys, and then set the appropriate sensors as wheels/sliders for final tuning. Ensure any ladder resistors used in the wheel/slider layout are properly populated even when examining as keys, or data will be meaningless.

5.2 Signal Resolution

Figure 5-1. Ideal Delta for a Three-channel Slider/Wheel



A wheel or slider requires enough signal resolution from the capacitive measurements to calculate a stable touch position.

The following procedure assumes that the slider/wheel has been designed adhering to the guidelines laid out in the *Touch Sensors Design Guide*. If the guidelines are not followed, the slider/wheel might produce unstable or nonlinear results that may make tuning difficult.

1. Set the Detection Threshold for the slider/wheel to be low, for example, 7 or less. This is to ensure that the touch gets reported.
2. Set the number of touch positions the wheel/slider is required to report, for example, 2 bits (4 positions) to 8 bits (256 positions) supported on most devices.
3. For QTouch start with a nominal Cs on all channels of the slider/wheel, for example, 22 nF.
4. For QMatrix start at a nominal value for all of the following:

   –Rsmp (typically 470 kΩ, see Section 2.10 on page 8)

   –Cs (typically 4.7 nF, see Section 2.6 on page 5)

   –Burst Length (typically 16 – 64, see Section 2.7 on page 6
5. Apply light touches all along the slider/wheel and observe the reported position.

   If the reported position is jittery, then there is not enough signal resolution to calculate a stable touch position.

   a. For QTouch, increase the Cs values for all slider/wheel channels.

   b. For QMatrix, increase the BL values for all slider/wheel channels.
6. Repeat the above process until a Cs or BL value has been found that produces a stable reported touch position. Then go to Section 5.3 for tuning the Detection Threshold for a slider/wheel.
7. If the measurement data is available, then the individual channel Deltas for the slider/wheel can be observed when sliding across the touch surface.

   If the Atmel touch device does not return the Deltas of the individual channels then they can be calculated if the References and Signals are returned, using the formula Delta = Reference minus Signal.

   A graph of the individual Deltas can be plotted (see Figure 5-1). This graph allows for better tuning of the slider/wheel.

   Each individual Delta should ideally peak at the same amplitude. This gives improved linearity of reported position and also uniform sensitivity across the slider/wheel. With good sense track routing and design as recommended by the *Touch Sensors Design Guide*, the individual channel Deltas should be quite closely matched.

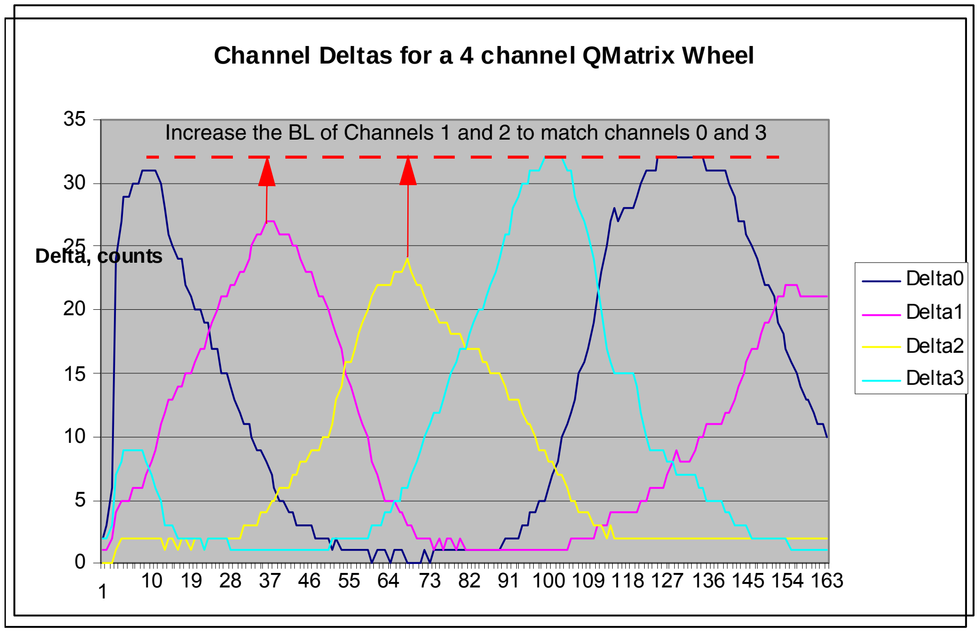
   In a QMatrix design, BL/Rsmp can be adjusted to compensate for imbalances.

   In a QTouch design, it is NOT recommended to have different Cs values for each wheel/slider channel to compensate for imbalances. Different Cs values will cause the wheel/slider channels to react differently to common influence, for example, temperature shifts, voltage fluctuation. QTouch wheels/sliders have normalization algorithms to compensate for up to 30 percent of imbalances between channels, for example, Cs capacitor tolerances. If there is a large variation between channels, review the sense track routing and layout for improvements.

   - For QTouch, the Deltas typically peak at around 40 counts and above
   - For QMatrix, the Deltas typically peak at around 25 counts and above

   See the example in Figure 5-1 on page 12.

Figure 5-2. Example of QMatrix Wheel Deltas That Required Tuning

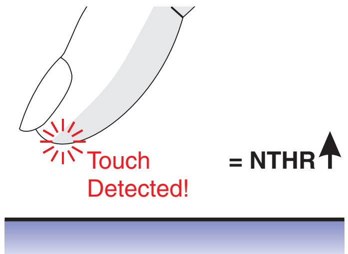
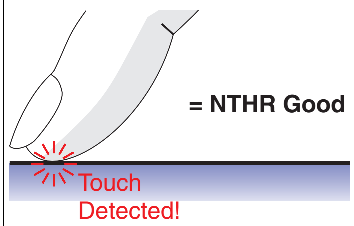
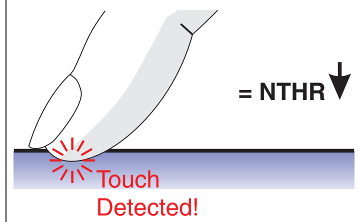


5.3 Detection Threshold

After a suitable signal resolution has been obtained, tune the Detection Threshold so that the slider/wheel reports the touch only upon the finger's contact on the surface. The Detection Threshold is always adjustable on sliders and wheels.

1. Set the Detection Threshold to a nominal value, for example, 10.
2. Apply light touches along the slider/wheel. A light touch is a finger that just lightly contacts the touch surface. See Table 5-1 on page 15 for variations of touch.
3. If the touch is reported before the finger contacts the touch surface, then it is oversensitive; increase NTHR and retest. If the touch is not reported or requires a heavy touch to activate, then it is too insensitive; decrease the NTHR and retest. Repeat this step until the key reports a touch when the finger lightly contacts the touch surface; this would be the NTHR value that gives good sensitivity. (see Table 5-1 on page 15).

Table 5-1. Variations in Detection Threshold

Over-sensitive	Good Sensitivity	Under-sensitive
		
If the slider/wheel is detecting touch before contact with the touch surface, then the slider/wheel is too sensitive.	A slider/wheel is at the right sensitivity when it detects the finger only as it lightly contacts the touch surface.	If the slider/wheel is not detecting the finger or requires a heavy touch to activate, then the slider/wheel is too insensitive. Note: Touch is not sensitive to pressure but to the expanded area of the flattened finger.
QTouch and QMatrix		
Increase the NTHR value and retest with a light touch.	NTHR = correct value	Reduce the NTHR value and retest with a light touch.

4. Ensure that all touch areas on the slider/wheel are checked and correct according to Table 5-1. There might be certain areas on the slider/wheel that are slightly less sensitive than others. Reduce the Detection Threshold to accommodate these areas which might be caused by different sense track routings or placement of ground planes and foreign tracks, resulting in loading.
5. If the measurement data is available, then the accumulated Delta for the slider/wheel can be observed when sliding across the touch surface.

   A suitable Detection Threshold value will be one that is approximately 5 counts lower than the minimum accumulated Delta value.

6. Standard Fingers and Touch Probes

For more formal tuning or testing of sensitivities, ‘standard fingers’ or ‘touch probes’ can be employed. These standard fingers and touch probes can provide a means of characterizing and tuning touch sensors, without relying on fingers, which can vary from person to person or even day to day.

Touch probes are plastic tubes with a conductive rubber tip at one end and a ground lead at the other. For more information on touch probes refer to Application note *QTAN0018, Calibrating Touch ICs Using a Threshold Probe*.

Associated Documents

- Guide – *Touch Sensor Design Guide*
- Application Note – *QTAN0018*, *Calibrating Touch ICs Using a Threshold Probe*

Revision History

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Notes

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