QT Tuning with Serial or *Scope Pad*

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*** Guidelines only, actual requirements and performance will vary depending on: design, noise sources, Vdd, touch settings, component tolerance, environment, etc.

1. Including serial in designs is recommended to allow monitoring actual signals during development for easier tuning and diagnostics, to allow logging during testing (EMC, Environmental), and to avoid test equipment effects of directly probing the sensors.
   - For testing needing to avoid alternate Ground Paths through test equipment: display signal level on product's display; log in product's memory; or use a NotePC running on battery. See: QTAN0016A Diagnostic Modes For QT ICs
   - I^2C: For most QT ICs using I^2C the protocol is very similar to standard I^2C EEPROM, so you can use standard EEPROM AppNote or sample code from your MCU's website as a quick start. The I^2C is very easy to use.
2. **QMatrix**:
   - Check signal levels by serial.
   - Sensitivity depends primarily on BL and NTHR, but only if other components and settings are properly tuned.
   - Sensor X-Y Gap typically ½ of panel thickness, but may vary with space, material, and water tolerance test results.
   - Settings should be matched to the design, especially: BL, NTHR, DWELL (in some ICs DWELL isn't configurable).
   - Cs and Rsmp should be matched to the design. Start with small Cs, and other items as in Datasheet or demo.
   - If Cs is too small the signal may saturate (max out) loosing touch delta. If Cs too big you may not see touch delta. Refer to IC Datasheet for waveforms of Cs Saturation.
   - If Rsmp is too small you may need wasteful long BL and big Cs. If Rsmp is too big you will only amplify signal jitter.
   - For discrete button designs Rx and Ry may be adjusted for EMC (Typically Rx=Ry), but tune Dwell and Reference.
   - For tuning see: QAN0018_r01_ThresholdProbe_2cb[Preliminary_NDA].pdf.
3. **QTouch**:
   - Check signal levels by serial, or by using the Scope Pad technique shown below.
     When using Scope Pad: To account for Spread Spectrum variations on pulse width measure at least 16 pulses
     QTouch Signal Level = Burst Length = (N **x** (Period of the whole Burst) **/** (Period of N Pulses)), where N≧16
   - Sensitivity depends primarily on Cs and NTHR, but only if other components and settings are properly tuned.
   - Settings should be matched to the design, especially: NTHR, Charge Time (in most ICs Charge time is fixed).
   - Cs and Rs should be matched to the design. Start with small Cs, and other items as in Datasheet or demo.
   - If Sensor Cx is small and Cs is too big then burst may max out before Vcs reaches threshold (Target Signal <1500, best <1000)
   - Larger electrodes typically allow a smaller Cs, which usually improves response time and reduces power (mA).
   - For tuning see: QAN0018_r01_ThresholdProbe_2cb[Preliminary_NDA].pdf (Signal level by Serial or Scope Pad)
   - For tuning without signal levels see QT_Calibration_MultipleProbes_v01.pdf
4. Tuning QMatrix Dwell Time or QTouch Charge Time:
   - Objective: Minimize Time for fastest response and lowest power, without affecting sensitivity.
   - Set QTouch Rs or QMatrix Rx/Ry to minimum (~100Ω)
   - Set for longest Dwell/Charge time
   - Check Signal Level (=**Max**)
   - Shorten Dwell/Charge time step by step until signal level starts to Degrade (Target >99% of **Max**)
   - Lengthen Dwell/Charge time one or two steps (for safety margin in later tuning and for EMC and Environmental)
   - The Dwell/Charge time is basically the Pulse width. If too short then the series resistance to the sensor will control how much charge gets to the sensor, introducing temperature dependence on circuit resistance.
5. Tuning QMatrix Rx/Ry or QTouch Rs:
   - Objective: Maximize R for EMC, without affecting Sensitivity
   - Basically same procedure as tuning Charge/Dwell time, except start with small R and increase
   - Set R to minimum (~100Ω for QTouch Rs or QMatrix Rx=Ry)
   - Check Signal Level (=**Max**)
   - Increase R step by step until signal level starts to Degrade (Target >99% of **Max**, R=100Ω,1K,2K…<22K)
   - Decrease R a few steps to account for R's tolerance and product's temperature range (and also for safety margin in later tuning and for EMC and Environmental).
   - If R too big then capacitances won't reach full charge, introducing temperature dependence on circuit resistance.
   - Large R rounds output pulses reducing output noise, and with Cs forms LPF protecting from input noise and ESD.
6. You should also refer to the Touch_Sensors_Design_Guide, or at least to the Quick Reference: QT_Guidelines_NDA_v06_20090209.pdf

QTouch: Using a *Scope Pad* to view a QTouch burst without affecting Touch and without AC Noise

- Directly probing the QTouch signals changes capacitance and loading, affecting the signal levels and waveforms (less for QMatrix).
- Scope Pad can be on back side of senor, or to one edge of sensor on the touch side. Don't touch Scope Pad since gives AC 60Hz noise.
- Minimize effect of Scope Pad on signals by using minimum overlap of Scope Pad and sensor, just enough to see the burst on the scope. For clear low noise signal removing any unshielded scope probe tip may help, also connect probe ground to ground closest to test area. A Scope Pad can also be made using a thin insulated wire taped parallel to a sensor trace for several millimetres.

Using a Scope Pad: (instead of coin probe)

1. Connect Oscilloscope Gnd to QT Gnd
2. Put Scope Pad on Sensor (either side of Panel is OK):
   - Put insulating plastic tape over sensor.
   - Put narrow strip of metal tape over this.
   - Connect 1MΩ from metal tape to Gnd (removes 60Hz Noise).
   - Connect Scope Probe to 1MΩ on metal tape side.
   - If Signal level changes, then use less metal tape over sensor.
3. Put second scope probe to QT Touch Output pin or Change Pin.
   - Set oscilloscope to trigger on this signal
   - Set trigger edge for Touch or Release
4. Recalibrate sensor by resetting the Touch IC (reset the debugger, cycle the power, use reset pin, or maybe a serial command).
5. Touch the Panel (not the Scope Pad). The Scope Pad will alter the signal level a bit, but will give approximate burst length and timing.