Atmel QTouch Layout Quick Reference

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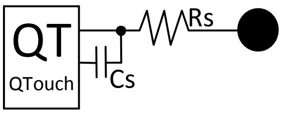
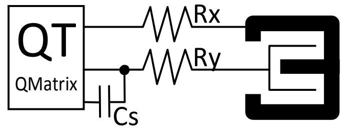
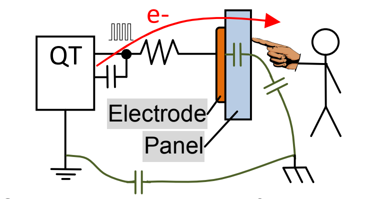
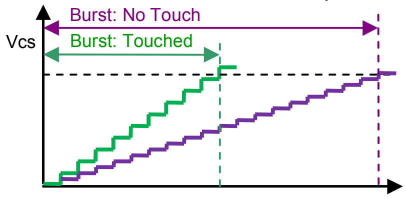
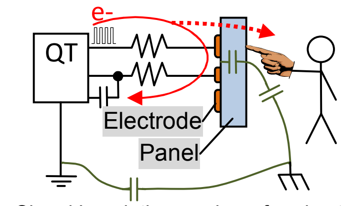
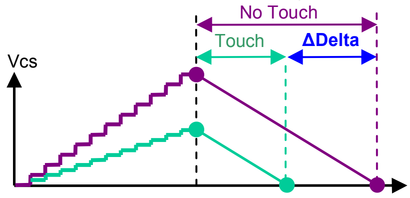
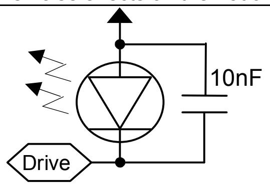
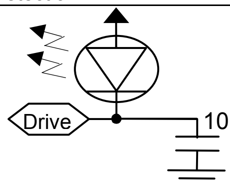
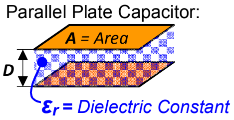
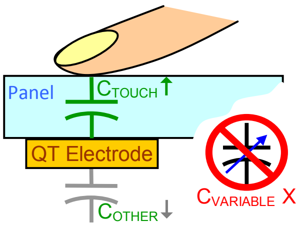
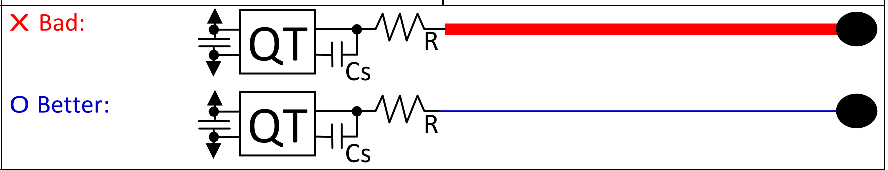
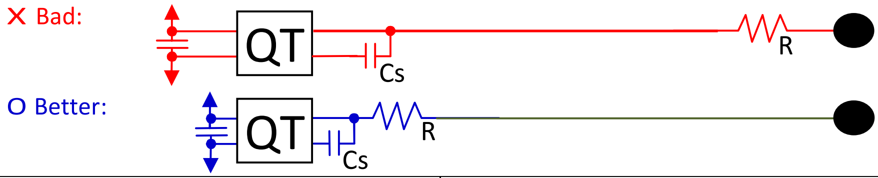
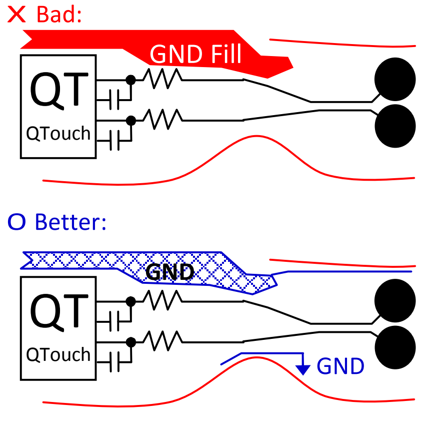
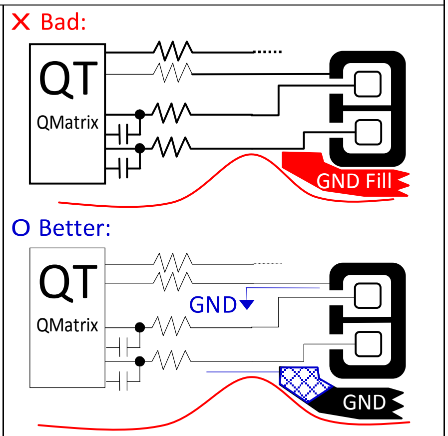
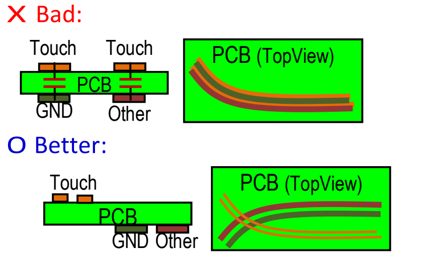
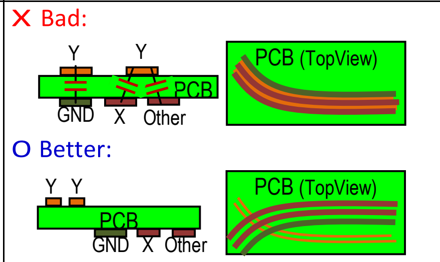
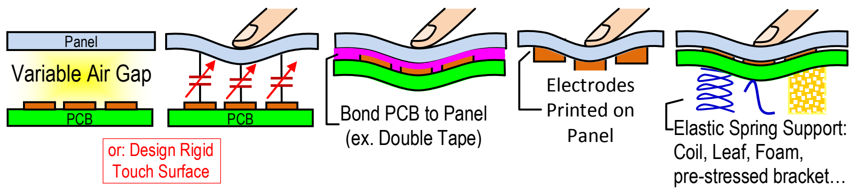
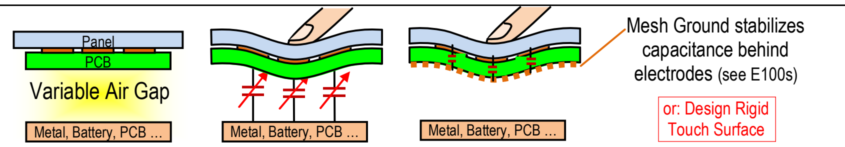
Ongoing...

- **These are guidelines only**. Actual requirements and performance depends on panel construction, items behind panel, connection length, noise sources, etc.
- **QT**: Atmel QTouch Technology including QTouch and QMatrix, such as a **QT IC**, or an AVR MCU with **TLib** (Atmel QTouch Library).
- **For more details** on the ideas presented in this document, please refer to the QT IC's datasheet, and the official Atmel Touch Sensors Design Guide.

	Technology:	QTouch	QMatrix
G1.	Technology also used for:	TLib QSlide QWheel ...	TLib Slider Wheel QField QTwo ...
G2.	Available Interfaces:	TLib I2C SPI PPK(Pin Per Key)	TLib I2C SPI UART
G3.	Sensitivity:	Cs, Threshold	Set Parameters via Serial Interface
G4.	Configuration (Parameter Setting):	Option Pins, Resistors, and/or Serial	Set Parameters via Serial Interface
G5.	Electrode Circuits: For sensor design refer to the Touch Sensors Design Guide available on the Atmel Website.		 • Standard: Thin Y within X (Shown above). • PCB 1Layer: For FMEA put jumpers on Y signal. • FloodX: Thin Y (Touch Side) over solid X. • Thick Y gathers noise without helping signal.
G6.	Charge Transfer Operation: An output pulse transfers charge e- to the panel. The amount of Charge transferred to Cs per pulse depends upon the amount of Touch. A series of Pulses is a **Burst.** **Burst Length (BL)** is the number of pulses.	 Signal Level: The number of Burst Pulses till Cs voltage crosses a threshold. More Touch = Less Pulses Required 	 Signal Level: the number of cycles to discharge Cs after a fixed Burst (BL). More Touch = Less Discharge Time 
G7	Sensors and Component Location:	• Do not add ANY circuitry to sensor signals other than shown in Datasheet. Any additional components will affect touch sensing and noise performance. • Best performance when QT circuit located as near as possible to the electrodes. With careful design the electrodes may be a few hundred mm from QT. • The QT circuit may be on the opposite side of the PCB from the Electrodes, but no other ICs or components should be located so close to the electrodes. • The interface circuitry near the QT and Electrodes should be minimal to minimize communications noise effects on the Touch Detection.	
G8.	LEDs (or any device that varies in capacitance) LEDs near Electrode Signals may require Decoupling Capacitors. Recommend always providing footprint and then determining if population needed by testing (Blink LED).		
G9	The primary guideline: $C = \varepsilon_r \frac{A}{D}$ Target is a "Finger Detector". Maximize the capacitance from sensor to touch surface. Minimize capacitance from sensor and sensor signals to other such as Ground or non-touch signals, and ensure a stable structure to remove variable capacitance and avoid false detection from mechanical changes.	Parallel Plate Capacitor:  	Optimize Touch Performance: Maximize C_{TOUCH}: A: Electrode Size matched to Touch D: Thin Panel ε: Appropriate Panel Material Minimize C_{OTHER}: A: Minimize parallel conductors ex: Use Mesh for Ground Fills D: Large Gap, Max separation ε: Air or low permittivity material Remove $C_{VARIABLE}$: D: Ensure Stable Construction

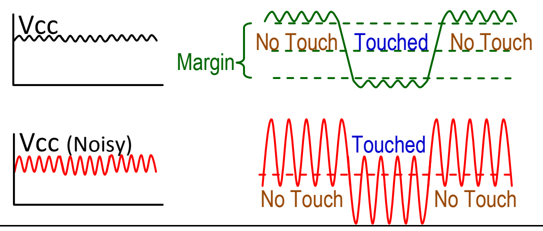
Material	ε_r
Vacuum	1
Air	1.00054
Acrylic Resin	2.7 ~ 4.5
Polyethylene	2.2
Polystyrene	2.56
PET	3.7
PMMA	2.6 ~ 4
FR4	4.2
Glass	4 ~ 10
Sapphire Glass	9 ~ 11

	Technology:	QTouch	QMatrix
G10	Keep sensor traces thin, short, and on farthest layer from Touch surface. This will prevent false detect over electrode traces.		
G11	Sensor Components (Cs, Rs, Rx, Ry) and Vcc Decoupling Capacitors **must** be located next to QT IC to minimize noise and to prevent crosstalk between signals.		
G12	Keep other signals and solid ground fills away. $C=\varepsilon\frac{A}{D}$ • If necessary a thin ground trace may be used to separate them. • QTouch signals and QMatrix Y signals are very sensitive, and may be affected by capacitive coupling to nearby solid ground fills, thick ground signals, power signals, or noisy signals. • If a nearby ground fill is necessary, change it to a low density mesh pattern (<40%, Using Thin traces).	 QTouch signals may be close together.	 QMatrix Y signals may be close together.
G13	PCB Layers: $C=\varepsilon\frac{A}{D}$ Don't locate sensitive QTouch Electrode signals or QMatrix Y signals on opposite side from other traces or solid ground fills. Crossovers are OK, but long parallel traces over each other will act as capacitors.	 QTouch signals may be thin and close together.	 QMatrix Y signals may be thin and close together.
G14	Electrode to Panel: $C=\varepsilon\frac{A}{D}$ Ensure stable layer spacing between Electrodes and Panel Surface to avoid unstable touch detection from Variable Capacitance of Variable Air Gaps. Options: Bond the Electrodes to the Panel, use an Elastic or Spring mechanical support, Print the electrodes on the inside of the Panel, etc.	 Use non-conductive supports, or position supports away from electrodes. **Variable Airgap Test:** Use a non-conductive rod (chopstick, straw, plastic knife…) to press all over the panel while monitoring signal levels. Signal changes should be much **less** than Touch threshold.	
G15	Behind Electrode: $C=\varepsilon\frac{A}{D}$ A mesh ground pattern may be used to block effects from behind sensor, but be **careful with thin designs** as Gnd Loading will be significantly higher: small D → big C.	 **Variable Airgap Test:** Use a non-conductive rod (chopstick, straw…) to press all over the panel while monitoring signal levels. Signal changes should be much **less** than Touch threshold.	

	Technology:	QTouch	QMatrix

G16 Minimize QT IC Power Supply Ripple for best Touch SNR. See QT IC datasheet for recommended limit.

If power supply ripple is over spec then circuit may become unreliable, or may require excessive Cs or BL to get margin for Threshold, resulting in delayed response times and higher power consumption.

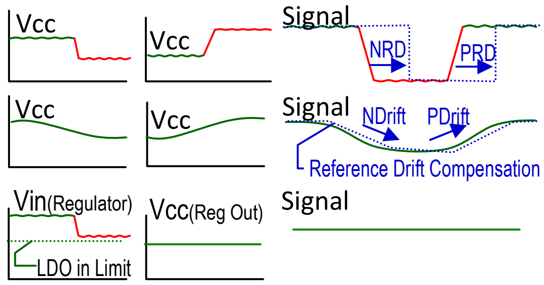


Touch Signal with small noise has margin either side of Threshold.

Touch Signal with Noisy Power supply has no margin for Touch Detect Threshold.

G17 Avoid Step Changes in QT IC Power as they can cause False Detection.

Protect against the unexpected… Some products must survive varying power input during approvals testing, such as automotive.



Enable Recalibration timeouts for recovery (NRD, PRD, PTHR).

Smooth the Vcc changes so Drift can compensate (R.in + Caps).

An LDO Regulator (Low Drop Out) may protect QT from Step Changes.

G18 QT IC Power Input

Typical Circuit Optional Components

Clean power is required for proper Touch Detection. See QT IC and Regulator Datasheets for requirements.

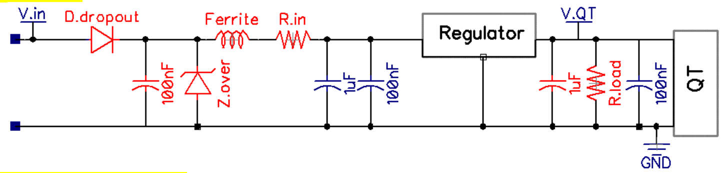
Components Values (C, R, D, Z, Ferrite, Regulator …) should be appropriate for the QT IC used and the product design.

For improved noise performance components in Red may be useful:

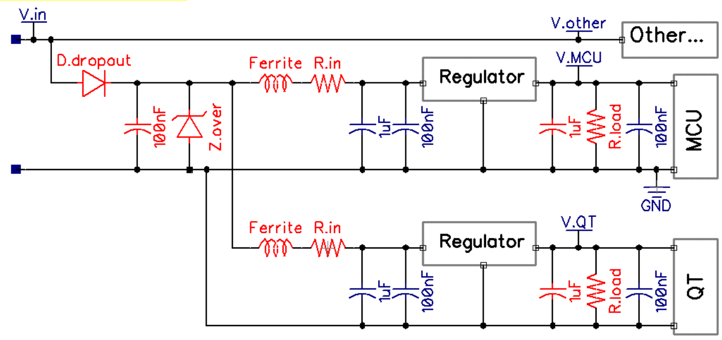
- D.dropout Blocks drops in V.in (from draining Caps)
- Z.over Limits Over Voltage Spikes
  Ensure Vz(min) > V.in(max)
- Ferrite Limits HF Noise (High Freq)
  Example Spec: DC <2Ω, HF >1KΩ, 25mA
- Regulator An LDO Regulator (Low Drop Out) may be used for low V.in
- R.load Some Regulators require a minimum load for best noise performance.
  R.load should be appropriate with the QT power modes used by product.
- R.in Smoothes Input, Forms an LPF with the Capacitors (Low Pass Filter)
  With appropriate capacitors:
  R.in = (Vmin – Vrequired)/PeakCurrent
  Example (A):
  V.in(min)=11V
  Vregulator(min)=7V
  Current=5mA (Total Peak)
  R.in = (11V-7V)/0.005A= 800Ω
  Try R.in=620Ω (safety margin 20%)
  Example (C):
  V.in(min)=11V
  Vregulator(min)=7V
  Current=25mA (Total Peak)
  R.in = (11V-7V)/0.025A= 160Ω
  Try R.in=120Ω (safety margin 20%)
  Example (D):
  V.MCU(min)=5V
  V.QT(min)=4.75V
  Current=5mA (QT Peak)
  R.in = (5V-4.75V)/0.005A= 50Ω
  Try R.in=40Ω (safety margin 20%)

See also AppNote:
QAN0011 Power Supply Considerations

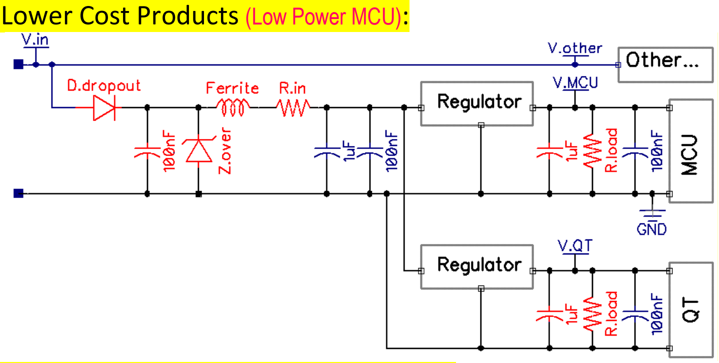
A. QT Power: Typical Circuit Optional Components



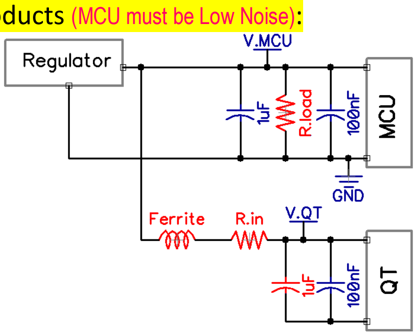
B. With other devices:

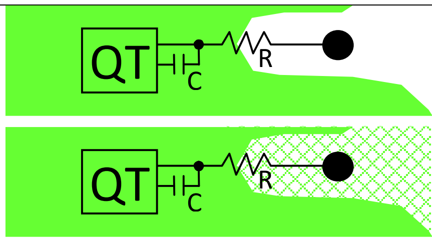
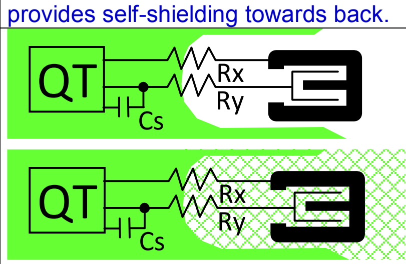
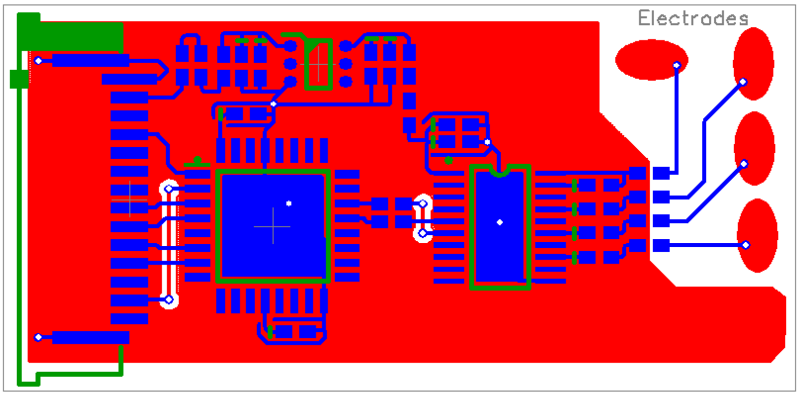
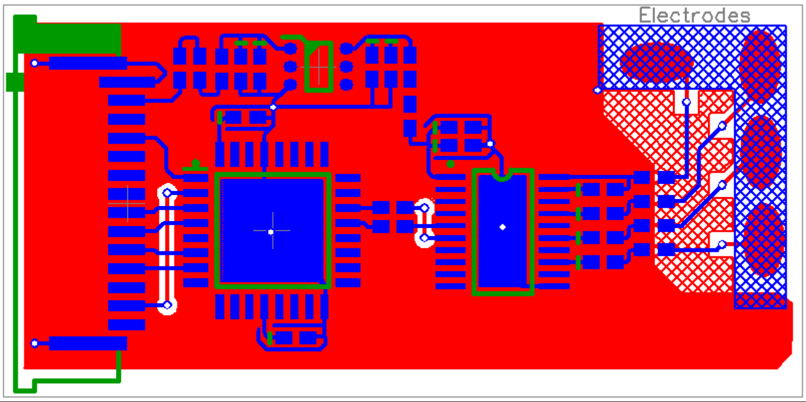
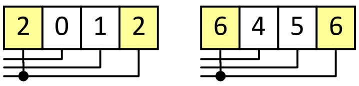
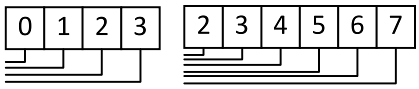


C. For Lower Cost Products (Low Power MCU):



D. For Low Cost Products (MCU must be Low Noise):



	Technology:	QTouch	QMatrix
G19	Ground Shield behind Electrodes Test Ground Loading effects by comparing signals on samples with and without the Gnd shield/layer/fill.	Usually an Air Gap is provided behind QTouch electrodes, although an appropriately designed Mesh ground shield is possible (see E100s Demo)	Resistive and Mesh ground shields may be placed close behind the electrodes, sometimes only separated by a thin film. **FloodX** Style: Thin Y over solid X provides self-shielding towards back.
G20	Ground Plane: $C = \varepsilon_r \frac{A}{D}$ Keep solid Ground Fills away from the Sensor Signals. • If necessary a thin GND mesh may be used behind electrodes, <40% copper • For multilayer put GND on farthest layer from touch sensor circuits • In thin designs like FPC the GND loading will be much stronger (small D → big C) so may not be able to use Gnd behind sensors or sensor circuits.		
G21	Example Layouts: C = Component Side, T = Touch Side • T_Copper (Electrodes, Jumpers) • C_Copper (Components) • C_Silk • PCB Options: • Reduce RFI from IC Power: add Ground around Decoupling Capacitors. • Reduce RFI from ICs: add GND under IC. • Improve EMS (EMI, RFI …): Add Ground fill in all unused areas (but keep away from Sensors and sensor Traces). Gaps in the Ground fill allow for trace crossovers. In thin designs like FPC the GND loading will be much stronger (small D → big C) so may not be able to use Gnd behind sensors or sensor components. $C = \varepsilon_r \frac{A}{D}$	L1) With Ground Plane (Touch opposite side from QT IC):  L2) With Ground Shield Behind Electrodes and Ground Plane: 	
G22	TLib Sliders:	 For TLib QTouch Sliders the highest numbered channel connects at both ends.	 For TLib QMatrix Sliders nodes are connected to consecutive channels.