

Sensitivity Differences When Migrating from QT100 to QT100A

The QT100A is designed to replace the QT100 with almost identical electrical characteristics. The sensitivity of the two devices is virtually identical in certain voltage ranges but may require a change of the Cs capacitor outside this range. This Application Note will help guide you in determining whether to be concerned about any potential changes and if so, how to go about making the QT100A more similar in behavior to the QT100. This Application note will also be applicable to the QT102A upon its release.

Mechanical packaging considerations are dealt with in Application Note QAN0027.

Overview

The QT100A uses different silicon to the QT100. Although every effort has been made to ensure that the two devices perform similarly, in fact there are subtle sensitivity differences which can become apparent above $V_{dd}=3.5V$ due to the input threshold characteristics of the SNS pins.

Comparing Sensitivities

Figure 1 shows the sensitivity plots for the QT100 and QT100A in a circuit where the capacitive loading on the SNS pins (due to trace wiring and the sensing electrode capacitance) is 5pF and the Cs capacitor is set to 10nF (0.01uF) for both devices. Most touch sensors are designed to trigger on Cx changes in the range of 0.25pF to 1pF; the values shown in Figure 1 are at the more sensitive end of this range.

The vertical axis represents the amount of Cx required to trigger the chip and thus higher amounts of Cx on this graph mean less sensitivity.

As can be seen there is a crossover point at $V_{dd}=2.75$ where the sensitivities of the two parts are identical. Due to the fact that human perception of sensitivity is extremely coarse (a 20% variance before sensitivity is barely noticed), and the fact that the QT100A becomes more sensitive with increasing V_{dd} , there is a 'safe zone' centering around 2.75 volts where the two parts are perceptually identical.

Above $V_{dd}=2.75$, the QT100A becomes more sensitive than the QT100; it is very difficult for most people to notice this effect until $V_{dd}=4V$. When replacing the QT100 with the QT100A at these elevated voltages, the worst that can happen is that the touch button becomes slightly *more* sensitive, which of course is far better than becoming *less* sensitive.

Figure 1: Sensitivity performance of QT100 and QT100A vs V_{dd} , with $C_s=10nF$ and $C_x=5pF$. Higher values mean less sensitivity. Sensitivity differences are imperceptible in the range of $V_{dd} = 2.0V \sim 3.5V$.

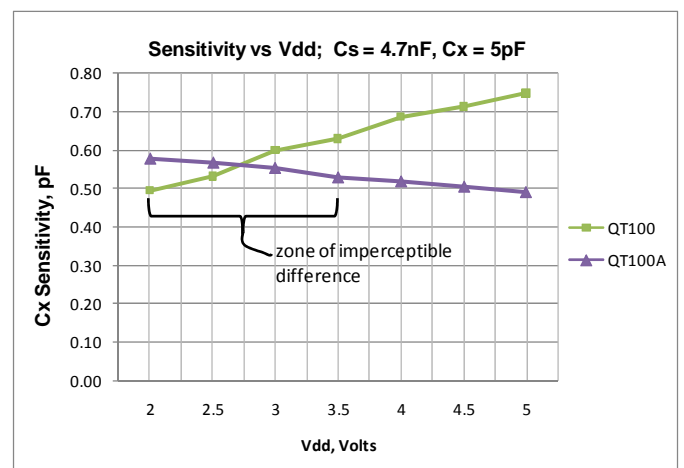
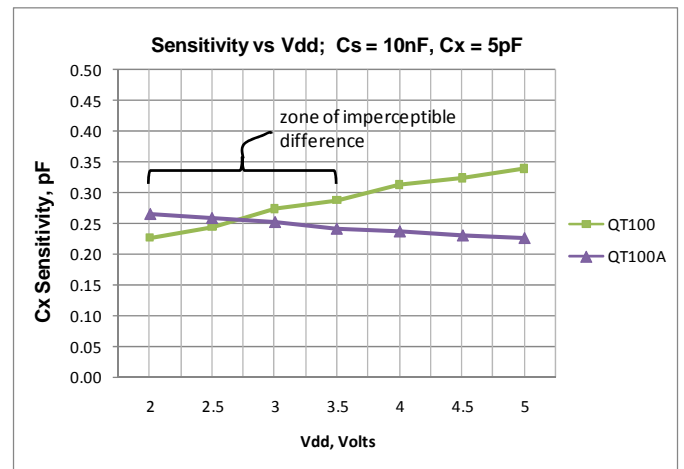


Figure 2: Sensitivity performance comparison with $C_s=4.7nF$ and $C_x=5pF$. Once again, sensitivity differences are imperceptible in the range of $V_{dd} = 2.0V \sim 3.5V$.

Figure 2 shows the same type of plot but with a lower Cs capacitor value (4.7nF) and therefore, lower overall sensitivity compared to Figure 1. Once again, the 'safe zone' ranges from Vdd=2.0 to Vdd=3.5V.

Figure 3 is nearly identical to Figure 2, but the values of Cs and Cx have both doubled. Again, the safe zone is in the same range as the other two plots.

The 'safe zone' is independent of either Cs or Cx for mathematical reasons relating to the relative designs of the two devices. The designer can confidently use the QT100A to replace the QT100 with no circuit changes at all, provided that Vdd is below 3.5V.

Circuit Changes Above Vdd=3.5V

Above 3.5V, a QT100A based touch button will appear to be increasingly more sensitive relative to the QT100. To compensate, the Cs capacitor can be adjusted in value according to the following table:

Vdd	Cs Multiplier
3.5	0.84
4.0	0.76
4.5	0.71
5.0	0.65

For example, if Vdd=5.0 and the QT100 circuit being replaced uses Cs= 22nF, then to calculate a new value of Cs for the QT100A (Cs'):

$$Cs' = 22nF * 0.65 = 14.3nF \text{ (for QT100A)}$$

The nearest commercially available capacitor to this is 15nF (always try to round up, not down, to err on the side of being slightly more sensitive).

For other voltages, simply interpolate between the values listed in the table.

Conclusion

The QT100A exhibits remarkably similar performance to the QT100 in all circuits when Vdd is at or below 3.5V. Below Vdd=3.5V, no change to Cs is required.

Above 3.5V operation, it is advisable to reduce the value of Cs in accordance with the above table so that the touch button is not overly sensitive.

As always, the value of Cs should be 10% tolerance or better (5% is preferred), type X7R. The designer should always re-test the circuit to validate performance before commencing production.

Figure 3: Sensitivity performance comparison with Cs=10nF and Cx=10pF. Note that this plot is essentially identical to Figure 2.

