AZD078 Test Finger Specification for Capacitive Sense Electrodes

1 Introduction

Before implementing a design, different touch scenarios may be taken into account in order to determine touch accuracy. Given the sensitivity of IQS devices, the designer may want to determine how the device will react under certain touch conditions before implementing the design.

This application note is intended to help the designer:

- Simulate touch conditions with a test finger
- Calculate the touch SNR(Signal to Noise Ratio)
- Determine touch accuracy

An example applying above mention principles using the IQS127 is added to aid with design.

2 Simulated Test Finger Specification

2.1 Conductive Rubber Test Finger

Cylindrical shaped conductive rubber with a length of 150mm and diameter of 10mm can be used as a test finger. The rubber must have resistivity of ρ ≈ 1.0Ω/mm.

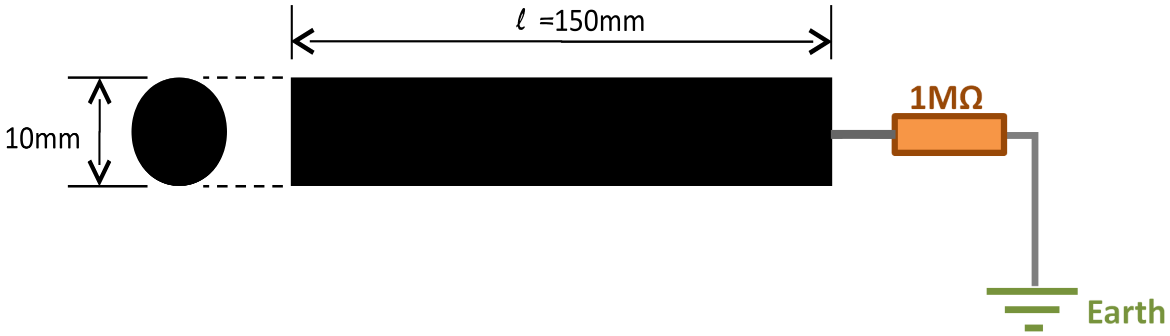


Figure 2.1 Grounded Conductive Rubber Test Finger.

2.2 Simulated Test Finger

A similar shaped object can be used to simulate an adult or child touch. A circular metal touch surface and nonconductive foam at the tip of an insulating handle with a conductor leading to ground can be guided onto the touch surface.

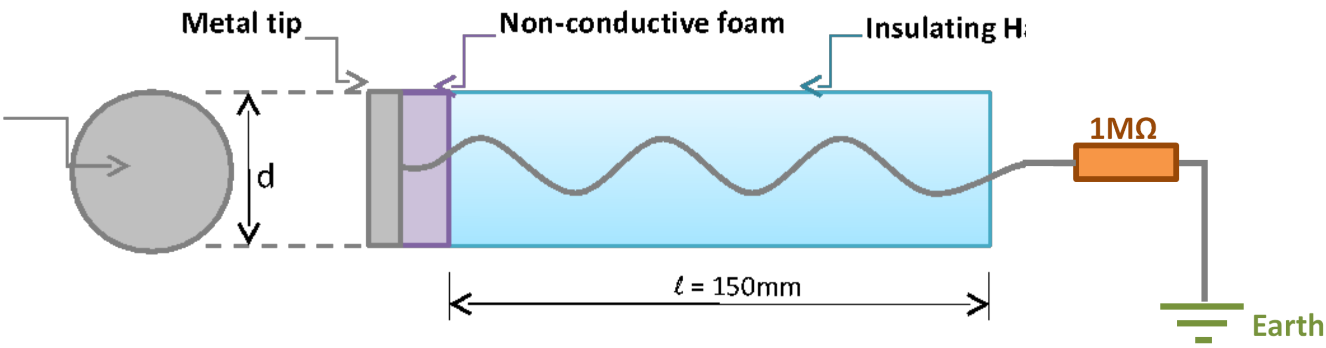
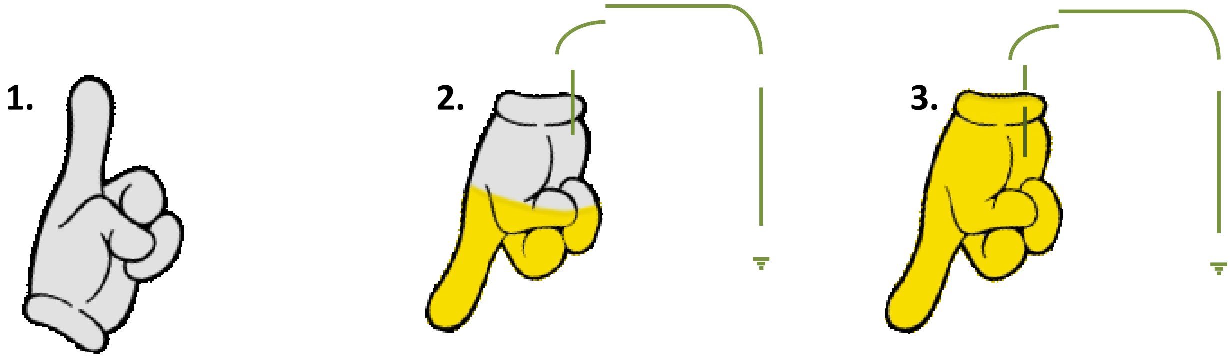


Figure 2.2 Insulated metal tip test finger.

With reference to Figure 2.2, the following dimensions are suggested:

- Adult model: d = 12mm, $l = 150$mm
- Child model: d = 6mm, $l = 150$mm

2.3 Ballistics-Gel Test



1) Use a latex type rubber glove
2) Fill 1/2 with ballistics gel
3) Insert wire and fill completely
4) Remove glove after gel has set
5) Clamp test finger in test device

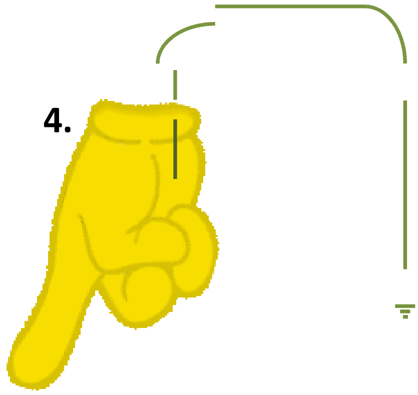


Figure 2.3 Ballistic-Gel fingers.

3 Accuracy and SNR

3.1 Touch area boundaries

Consistent touch generation during testing does not only rely on the touch finger being used. It is very important to consistently generate a touch in the same area of the touch electrode.

The touch boundary specifications are application dependant and it is left to the designer to decide what conditions will ultimately lead to the recognition of a touch. The following description is based on a circular touch electrode used on many IQS EV-kits and should be used as a guide when designing a different touch application.

The boundaries of the touch area are typically specified around the overlay button graphic and the SNR value specification are determined within the boundary areas.

Once again an adult and child model is used as an example.

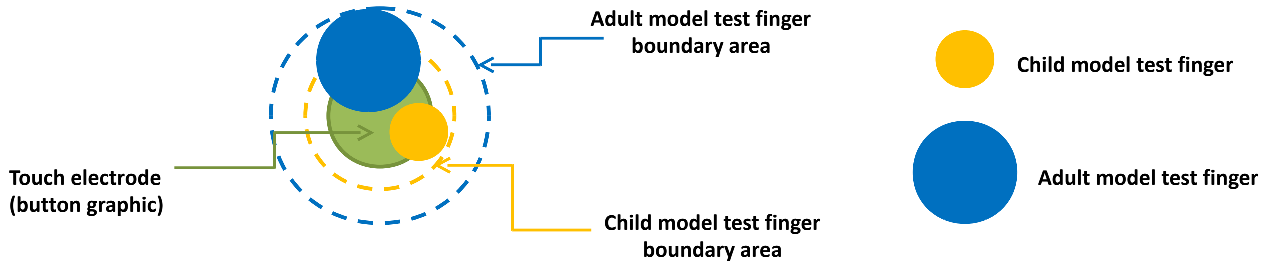


Figure 3.1 Valid touch area boundaries.

3.2 Touch SNR calculation

Touch Signal-to-Noise Ratio measurement is calculated within the boundary area discussed in the previous section.

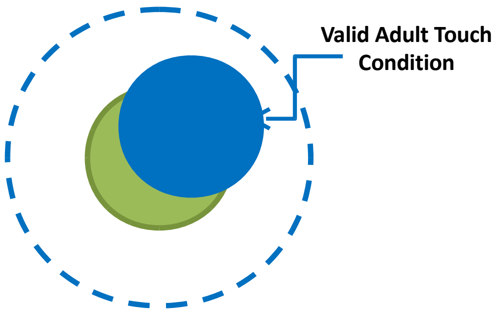


Figure 3.2 Adult touch condition.

Furthermore, 250 samples were used and the average counts were recorded for a touch and untouched signal respectively:

- SU-AVG = Numerical Average of untouched signal count for 250 samples
- ST-AVG = Numerical Average of touched signal count for 250 samples
- Δtouch- AVG = SU-AVG - ST-AVG (for 250 samples)

The Δtouch-AVG value is calculated by subtracting the ST-AVG value from the SU-AVG value because we are working in surface mode*.

*Surface mode meaning capacitance is measured between the electrode and earth i.e. self capacitance. Refer to Application note AZD008.

For the touch samples the SNR is calculated as follows

$$SNRdb = 20\log\left(\frac{\Delta touch}{NRMS}\right)$$

Where NRMS is

$$\sqrt{\frac{\sum_{n=0}^{249}[Signal(n) - ST_{AVG}]^2}{250}}$$

The NRMS value is the Root-Mean-Square Noise value of 250 samples using SU-AVG as baseline.

Typical design specification dictates that

$$SNRdB > 20dB$$

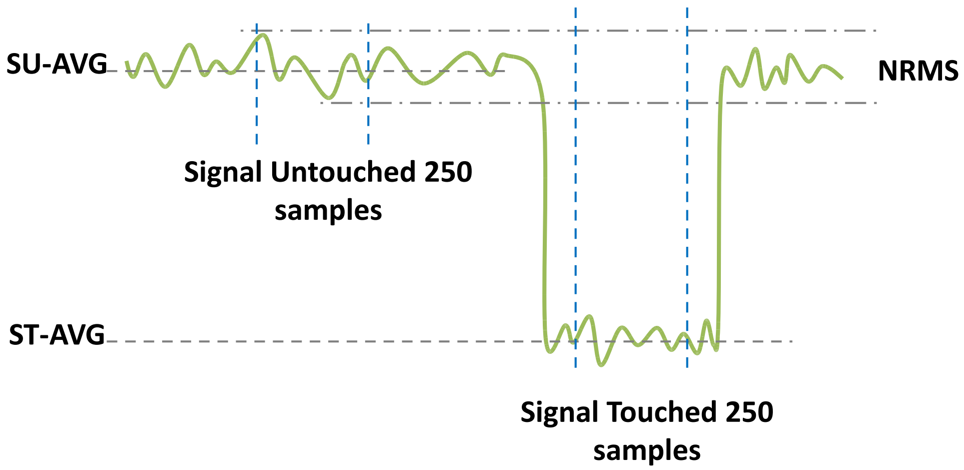


Figure 3.3 SNR calculation.

3.3 Touch Accuracy Calculation

Touch accuracy can be expressed as a ratio of average touch strength measured within boundary with lowest Δtouch value over average touch strength measured anywhere outside boundary with highest Δtouch value.

$$Touch\ accuracy = \frac{Av.\ lowest\ \Delta touch\ within\ boundary}{Av.\ highest\ \Delta touch\ outside\ boundary} = \frac{S\Delta\min\ \_valid}{S\Delta\max\ \_invalid}$$

Typical design specification dictates that

$$Touch\ accuracy > 4$$

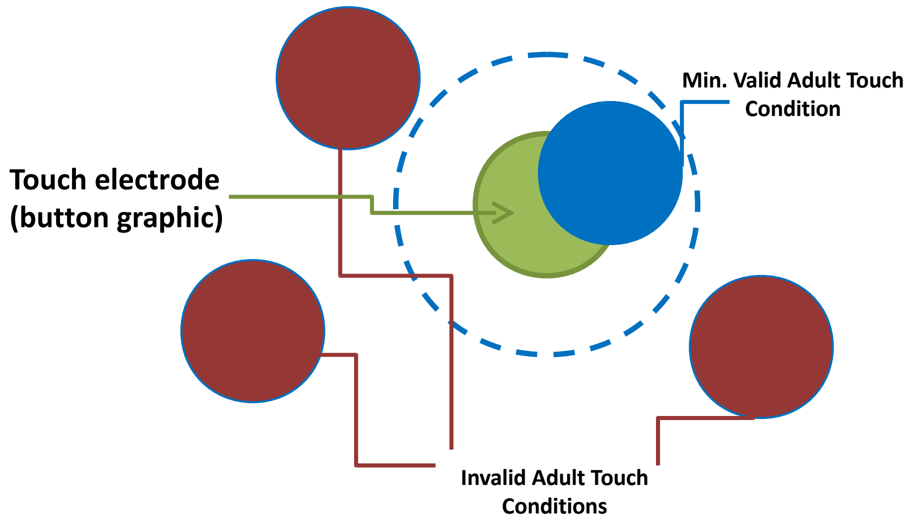


Figure 3.4 Valid and invalid touch conditions.

4 IQS127 Example

Below is a detailed example where touch accuracy and SNR calculations are used to confirm good design practice

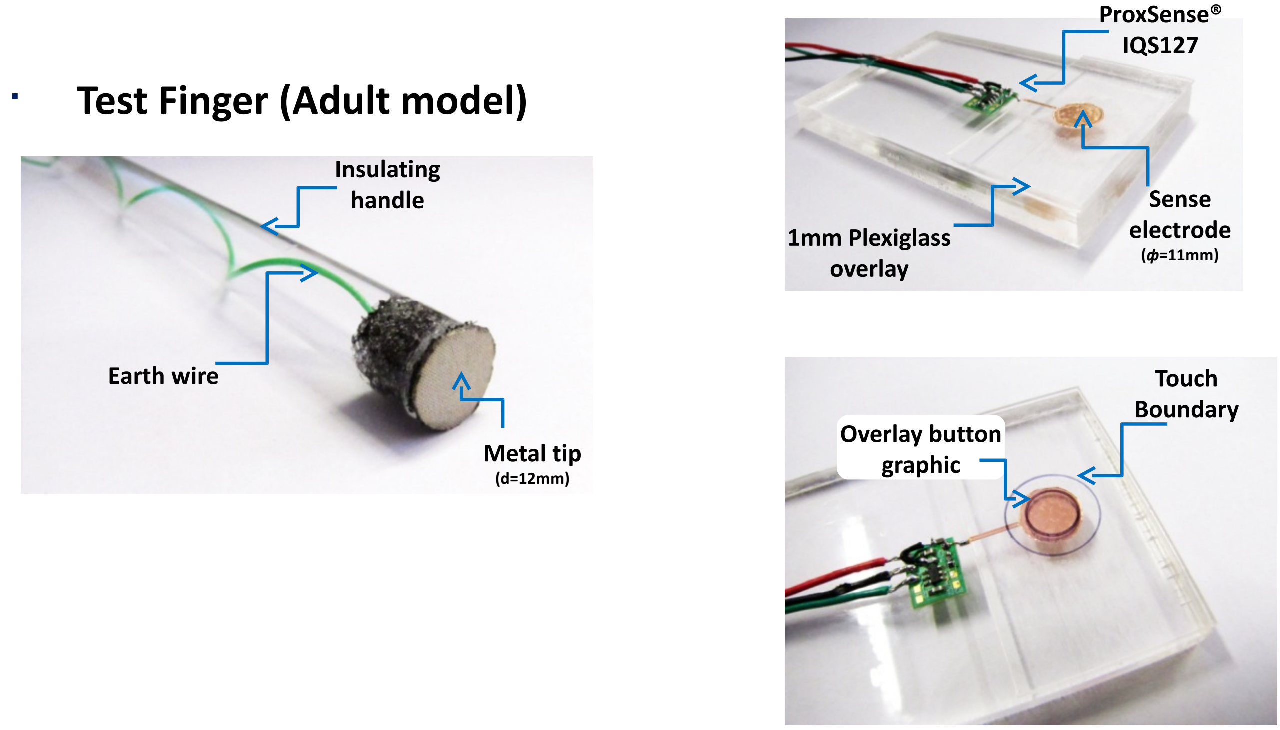


Figure 4.1 Test setup.

SNR Calculation

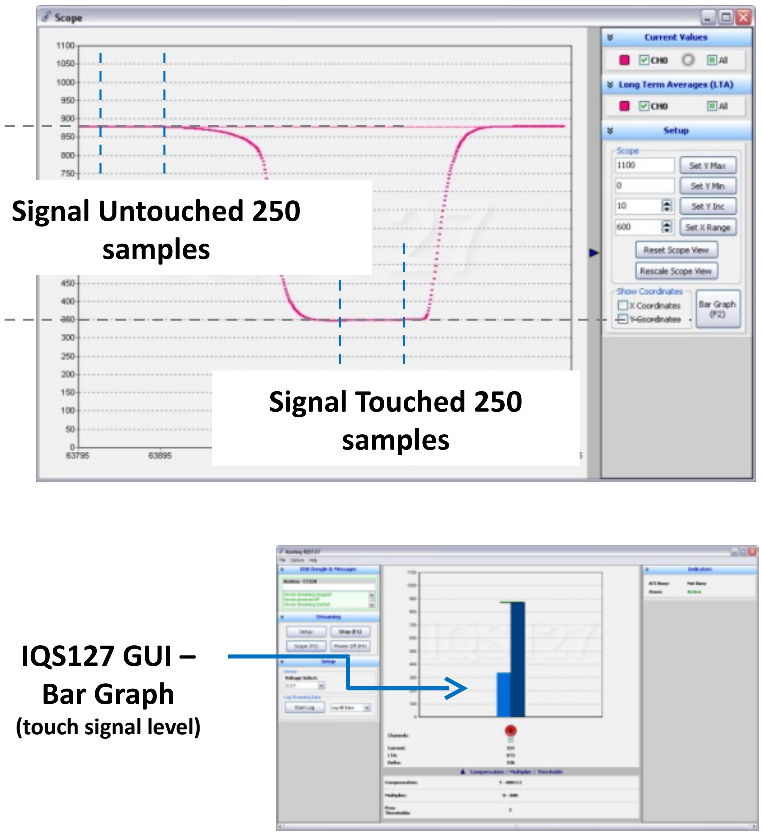


Figure 4.2 Using GUI to determine values

Table 4.1 Experimental values and calculation.

SU-AVG	881
ST-AVG	342
∆touch	539
NRMS	0.50
SNR = ∆touch/ NRMS	1078
SNRdB = 20log(SNR)	60.7dB

· **Touch Accuracy**

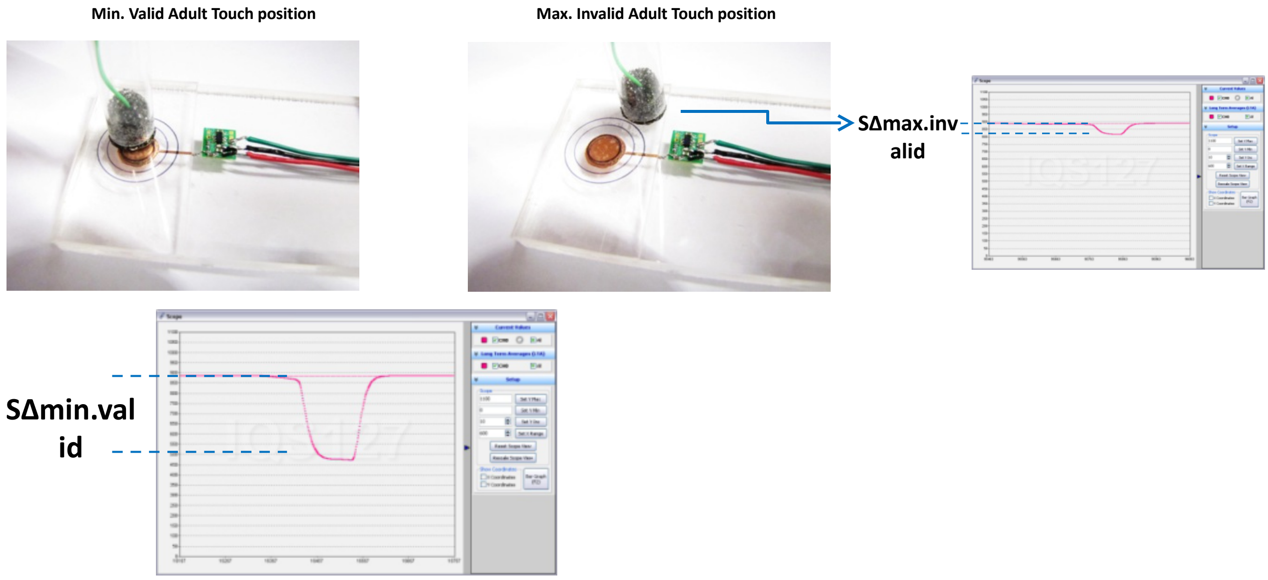


Figure 4.3 Touch accuracy setup and GUI values

Table 4.2 Touch accuracy calculation.

SΔmin_valid	416
SΔmax_invalid	62
Touch accuracy	6.7

5 Conclusion

It is necessary to pre-emptively design with different touch conditions in mind. Testing the design with consistent touches and collecting the relevant data is also very important. Using this data to calculate numerical values for the SNR and Touch Accuracy (with design specifications in mind) can help the designer to better understand and optimize the end product.

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Please visit www.azoteq.com for a list of distributors and worldwide representation.

The following patents relate to the device or usage of the device: US 6,249,089 B1, US 6,952,084 B2, US 6,984,900 B1, US 7,084,526 B2, US 7,084,531 B2, EP 1 120 018 B2, EP 1 206 168 B1, EP 1 308 913 B1, EP 1 530 178 A1, ZL 99 8 14357.X, AUS 761094, HK 104 14100A, US13/644,558, US13/873,418

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