Calibrating Quantum capacitive-touch ICs using a threshold probe

This application note discusses the design and manufacture of customized test probes for use when calibrating a product that contains a Quantum capacitive-touch integrated circuit (QT IC). it also includes guidelines for the calibration procedure.

Why do I need special probes?

The physical characteristics of each human finger are different, and people apply touch in different ways - sometimes with different fingers. The tip of the finger touches a relatively small surface area, the ball of the finger interacts with a larger area, and pressure flattens the finger to present even more surface area.

When calibrating a product, consistent and reproducible results are obtained by using a threshold probe, or a set of different probes, to represent the touch of a finger. Depending on the desired sensitivity, a probe tip of 6 mm to 8 mm in diameter is usually suitable for most applications.

Only a single probe is required to calibrate QT ICs that permit the signal level to be read.

Probe design

Figure 1 illustrates the basic design principles of a threshold probe, which consists of a body, a tip and a ground lead. If desired, the body of the probe can be electrically insulated.

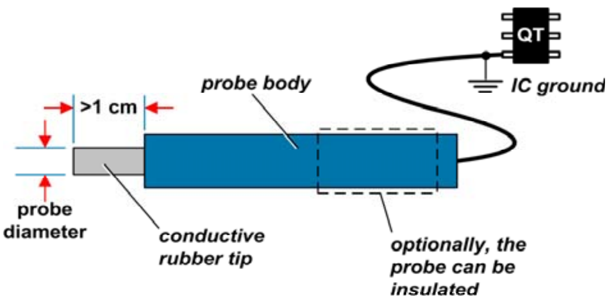

Figure 1: Principle of threshold probe design

Body

The body is usually a hollow cylinder of brass, copper, mild steel or a similar conductive metal. The inside diameter of the body should be the same as the outside of the tip, so that the tip can fit securely. The length of the body should be such that, when the probe is in use, the distance between the tip and the fingers holding the body is approximately 50 mm (2").

Tip

A conductive rubber tip is flexible and ensures full contact, even if the probe is not exactly perpendicular to the surface of the touched key. See Figure 2.

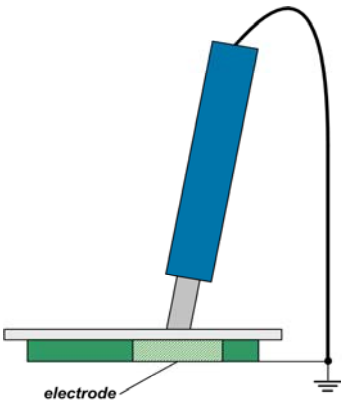

Figure 2: Tip in contact with touched key

The tip should be 1 cm (0.4"), or greater, in length. The diameter of the tip depends on its construction and your preference for sensitivity. A typical set of probes would have tips of 4 mm to 12 mm in diameter, increasing in increments of 0.5 mm.

The tips can be of various designs, including cone-shaped, square or rectangular. The same tip design must be used for additional probes of the same size. If the design of the probe is changed, then the entire procedure should be repeated to find the correct size probe for the new design.

Thin tips may be cone-shaped for strength. Cool the rubber and use a pencil sharpener to shape the tip.

The other end of the rubber is fitted into the hollow body. A friction fit is best because glue can interfere with the electrical signals.

Ground lead

The ground lead can connect to the body in different ways, including using a banana clip, a screw eye, or by soldering. In use, the lead should be connected to the same ground terminal as the QT IC, to cancel the effects of different people holding the probe.

Determine the appropriate sensitivity for the product

1. Adjust some product samples, so that, when used by several people, the samples give the desired feel for the target product.
2. Check the product samples with probes of various sizes to determine the best probe to use as a threshold probe or reference.
3. Decide whether to use [INTERMITTENT, 50% or ALWAYS] as the detection rule for further tests.

Test setup

1. Prepare a test setup for reading the signal level of the key being probed.
2. Choose the data to appear on the product's display (no external equipment effects). The options are:

   CYCLE DISPLAY

   SIGNAL LEVEL

   REFERENCE LEVEL

   DELTA (reference level - signal level)
3. Output the test data over a communications interface (useful for logging the information).
4. Optionally, use the passthrough diagnostic method in the product's MCU to allow the Quantum evaluation software to communicate with the QT IC.

Jitter

Extreme jitter can cause false or missed detections. The jitter on the signal level should not exceed ±2 points. If the jitter is excessive, the product may have a noise problem that should be corrected.

Check for:

- A noisy power supply
- Insufficient or improperly located decoupling capacitors
- Decoupling capacitors that are too small, too large
- Interfering signals near the electrodes or traces

Calibrating the product

Final sensitivity settings should be based on a review of data from several samples prepared in accordance with the production specification.

Flux residue can affect sensitivity. Ensure that all calibration samples are properly cleaned and dried before each test and after any hardware changes.

1. Using the threshold probe, touch the key and record the TOUCHED signal level.
2. Remove the probe and record the NO TOUCH signal level.
3. Calculate the Delta value (NO TOUCH - TOUCHED).
4. Adjust the gain of the key so that the Delta value is within specification.
5. Repeat the test, then set the threshold according to the Delta value.

The following is an example of QT60326 data:

Measured Delta value 35

Specification 4 to 20

Reduce gain (BL): the signal level should remain between 200 to 750 counts

New Delta value 17

Set NTHR = 17 - 4 = 13

Many QT ICs permit a direct reading of the Delta value or reference level. To overcome drift effects, allow more than 10 seconds to elapse between touches.

Production tests

A larger diameter probe tip (typically 8 mm) can be used for production ALWAYS DETECT tests. A smaller diameter probe tip (typically 2 mm) can be used for production NEVER DETECT tests.

Associated publications

The following documents published by Quantum Research Group (QRG) are also of interest:

- QAN0012 - Diagnostic modes for products with Quantum capacitive-touch ICs
- QAN0014 - Calibrating a Quantum capacitive-touch IC by using multiple probes