



## Application Note: AZD022 Hardware setup for in-circuit testing of IQS devices

This document outlines hardware guidelines for automated testing of the IQS family Proximity and Touch sensors. With automated testing, capacitors are connected onto the CX channels of the IQS controller, using an external controller, to simulate proximity and/or touch conditions. This document outlines two approaches to connecting such capacitors in circuit to the IQS's.

### Option 1: Using FETs (Field Effect Transistors)

A FET can be used to switch a capacitor onto a CX channel to simulate activation (prox/touch) as shown in Figure 1. The required capacitor is connected in series with the CX channel and drain of the FET, the source is connected to ground and a voltage is applied to the gate to establish the connection as schematically shown in Figure 1 (NPN transistor).

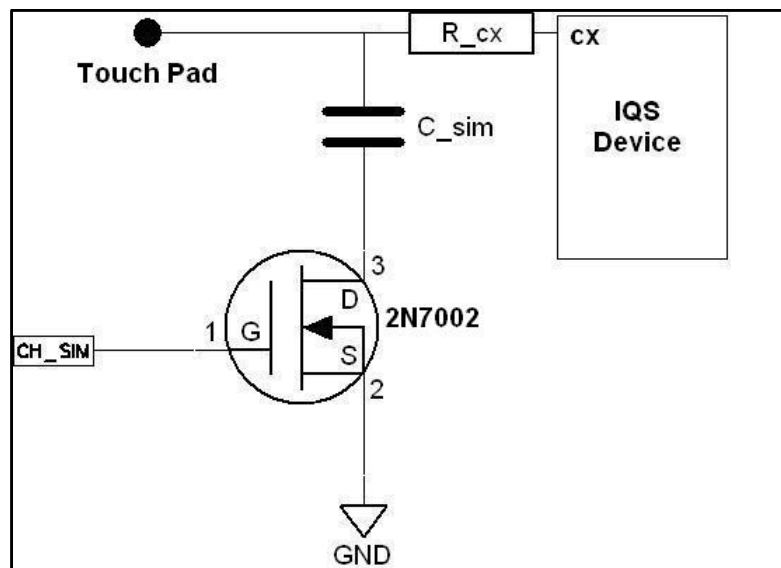


Figure 1. Transistor used for selecting capacitor

The recommended transistor is the 2N7002 or similar (with a lower output capacitance value,  $C_{oss} \leq 25\text{pF}$ ). Different values of capacitances are used to simulate different activation events. Table 1 summarises the values used with the 2N7002. (Note that using larger value capacitors with the 2N7002 introduces false events or touches on surrounding channels on multiple channel IC's. False touches result from traces influencing the capacitance on neighbouring channels.)

Table 1. Capacitor values used for proximity and touch events.

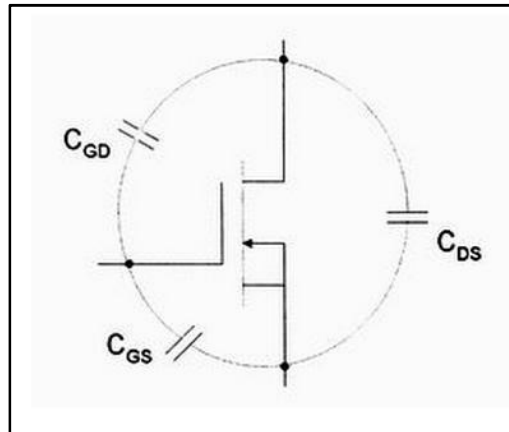
Transistor	Proximity Event	Touch Event
2N7002	6.8pF	39pF

The value of capacitance that could be used is dependent on several factors:

- Event(s) required
- Parasitic capacitance of the FET
- The number of channels to be tested



Care should be taken when choosing capacitor values and FETs. In the case where more than one channel is tested, i.e. more than one FET is being used, choosing the wrong FET (high parasitic or output capacitance) may cause false detections on surrounding channels. Care should be taken to ensure capacitors discharge between testing cycles, as stored charge will discharge when capacitors are switched in, leaving a different capacitance value on the CX channel (and lower CS) and which will make it seem as if the channel tested latched ON. Figure 2 indicates capacitive effects of FETs when used as switches, with Equations (1), (2) and (3) roughly estimating the equivalent circuit capacitors indicated on Figure 2 to values normally indicated on FET datasheets.



**Figure 2. Capacitive effects of FETs**

$$C_{GS} = C_{iss} + C_{rss} \tag{1}$$
$$C_{GD} = C_{rss} \tag{2}$$
$$C_{DS} = C_{oss} + C_{rss} \tag{3}$$

**Option 2: Using a combination of FETs and relays**

Another option with in-circuit testing is using relays. It is, however, very difficult to simulate a proximity event using a relay, because of its physical composition. It is recommended to use FET's for proximity, as even using a very small capacitor will create a touch event with a relay. When using a relay with an equivalent capacitance of 0.3pF or less (SIL05-1A72-71L recommended), a 6.8pF capacitor is recommended to simulate a touch event. A FET could be used to create a proximity event (if needed) as described above. Using higher capacitor values will result in false touch events on surrounding channels, as explained previously. Figure 3 illustrates how a relay switches in the desired capacitance, C<sub>sim</sub>.

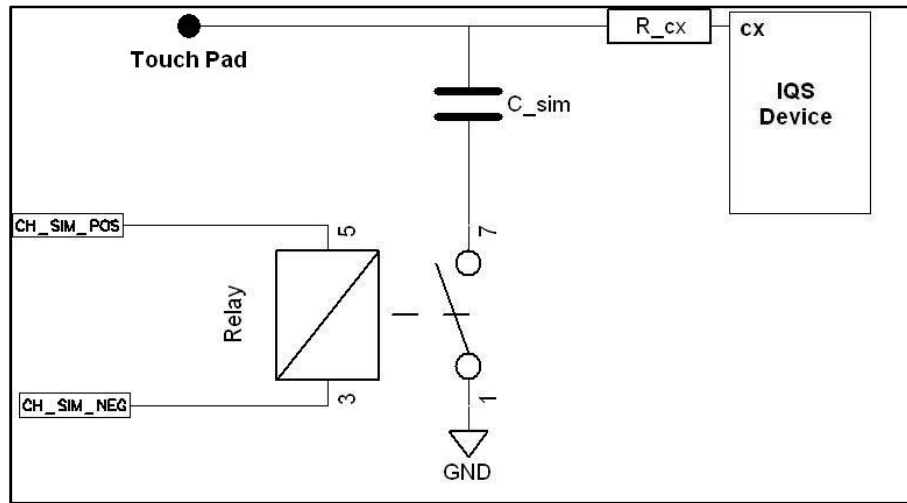


Figure 3. Relay switching capacitor in circuit.

Figures 4, 5 and 6 show the difference between 39pF, 27pF and 6.8pF capacitors respectively, each time the capacitor is switched onto CH0. Note the influence on neighbouring channels (layout dependant). Note that proximity is still detected on neighbouring channels, and that smaller capacitors reduce the occurrence of false touches.

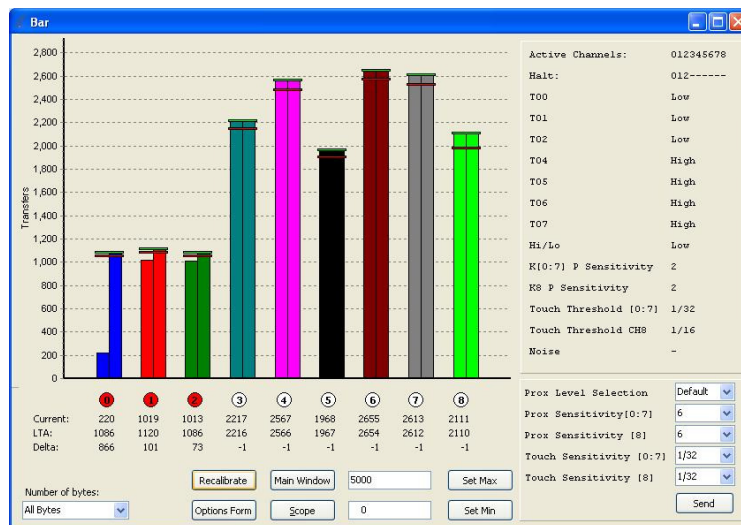


Figure 4. Relay switching a 39pF capacitor.

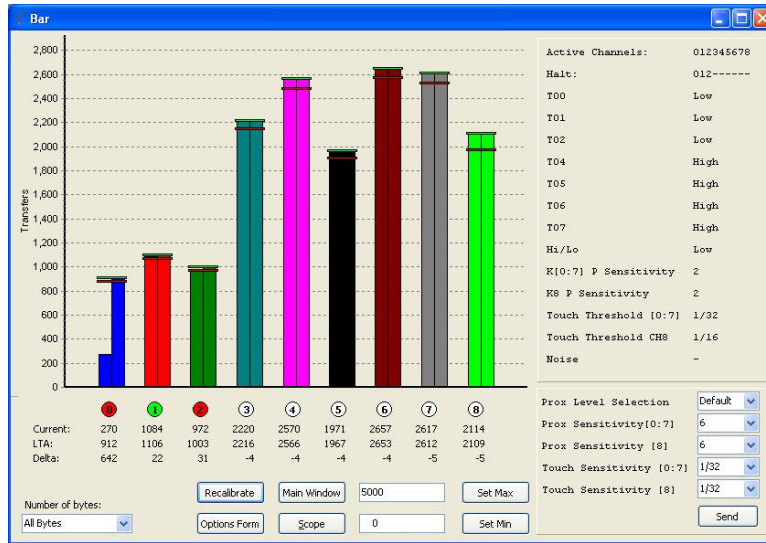


Figure 5. Relay switching a 27pF capacitor.



Figure 6. Relay switching a 6.8pF capacitor.

The same principles apply to the layout of the test circuit to that of the sensor application. Tracks should be kept as short and narrow as possible (to reduce parasitic capacitance), and as far away as possible from communication lines. The layout will have an influence on the size of the  $C_{sim}$  capacitor (and each application is different). Therefore  $C_{sim}$  is mostly chosen by trial and error.