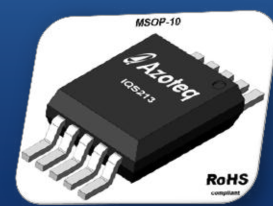
World Leader in Capacitive Proximity Sensing



Implementing a Capacitive Swipe Switch

Switches have been around since the start of electricity and to envision a world without switches seems almost senseless.

Switching on and off is simple, but remains an integral component in all electronic circuitry.

Electronic switches such as capacitive touch sensors are becoming the technology of choice for modern applications. The requirement for invariable functioning of capacitive sensors is imperative.

Sophisticated product specifications require better sensitivity, higher levels of safety, improved immunity against aqueous substances and ultra-low power consumption, especially for portable and battery operated devices.

With modern day capacitive sensing solutions the designer has the choice of implementing either a self- or projected capacitive sense electrode.

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Content

To enable next generation capacitive user interfaces and intelligent switch applications for users to interact naturally with products through capacitive proximity and touch

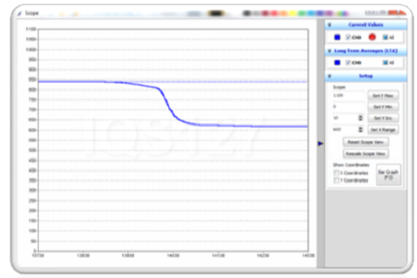
Capacitive touch SNR (Signal-to-Noise Ratio)

The signal-to-noise ratio (SNR) in capacitive touch systems can be defined as the ratio between the "increase/decrease in counts due to a touch activity" and the "RMS (root-mean-square) value of noise present in the system", taken over a certain number of samples.

In general, the basic SNR for a specific application may depend on the actual/physical device setup and factors like system sensitivity and sampling frequency can influence the relevant SNR measurement.

In order to eliminate the effects of human error introduced into the characterization of the device's SNR measurements, the touch activity can be emulated by coupling a passive load (external capacitor) to the sense antenna.

For emulating a moderate to strong touch activity, a 1-2 pF load can be applied.

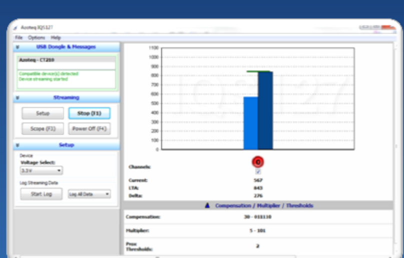


To measure SNR

For performing the SNR measurements, a single channel is used for the tests. Touched and Untouched data points are used to calculate SNR

For more information, view full Application Note here.

Signal-to-Noise-Ratio Calculation



For calculation of the typical SNR of ProxSense® devices during a touch activity, the following equation can be implemented:

$SNR_{db} = 20\log(\Delta_{touch}/Noise_{RMS})$

Where

Δ_{touch} = Signal $AVG_{untouched}$ – Signal $AVG_{touched}$

The RMS noise, during a touch activity, is thus calculated by:

$Noise_{RMS} = \sqrt{(\sum(Signal[n]-SignalAVG_{touched})^2/1000)}$

Page 1 Continued

Figure 1 illustrates examples of simple 2 and 3-channel sense electrodes in both self- and projected configurations, which can be utilized for the detection of swipe or gesture events.

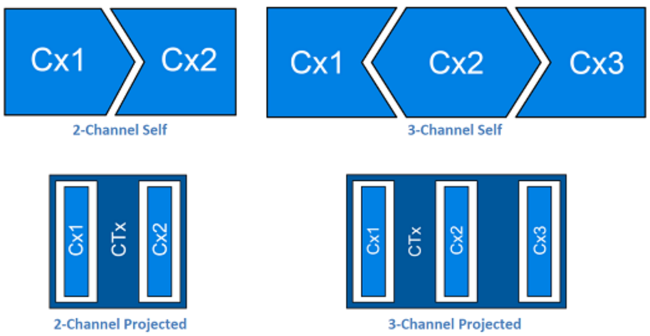


Figure 1: Example of Sense Electrodes

Typical user interfaces (UIs) that can be designed to complement a swipe-switch configuration include the following:

- **Single direction** - only one direction is allowed
- **Bi directional** - swipes in both directions toggles the same response. This is useful for applications where the first swipe can be in any direction.
- **Directional** - for specific applications where responses are dependent on the direction, for example volume control or a light switch.
- **Dual swipe** - A swipe in 1 direction followed by another in the opposite direction toggles the output. This can be used for applications where more switching reliability is required.
- Combined swipe and button actions to provide more UI options.

Endeavoring to mitigate the limiting criteria on capacitive sensors, Azoteq introduced their new ProxSense® SwipeSwitch™ IC – the IQS213. The SwipeSwitch™ device can provide an effective swipe or "gesture" activation of an electronic product.

Together with the unsurpassed sensitivity and remarkable signal-to-noise ratios (SNR) of the latest ProxSense® capacitive sensors, the SwipeSwitch™ technology offers a unique sense of style to any application. Compared to ordinary touch sensors, the new SwipeSwitch™ technology not only provides better safety features that prevent accidental activation, but it also features as a "Zero-Power" electronic switch.

With current consumptions in the sub 2 μ A range with selected low power modes, the IQS213 offers extended battery life without sacrificing performance, whilst the average device current consumption is negligible compared to almost any realistic load.

Through patented market leading technology such as automatic ATI algorithms, the ProxSense® SwipeSwitch™ can easily be installed in a wide range of applications and designs with various non-conducting overlay materials, including wood, plastic and glass.

Furthermore, the automatic drift compensation and advanced parasitic capacitance cancellation abilities of the innovative ProxSense® technology, makes the IQS213 SwipeSwitch™ ideal for portable and battery operated devices. These features, together with smart processing algorithms also results in better immunity against aqueous substances, without the implementation of sensor shield- and/or guard-electrodes

The full Application Note can be found here.

Using Active Parasitic Cancellation

While the design guidelines can certainly improve the system sensitivity and robustness, a device which will auto tune to its environment for optimal sensitivity, will shorten design times with less PCB iterations. More importantly it will save costly delays in production where process variations, often in the mechanical construction, causes production delays due to the non-conformance of the touch sensing circuit.

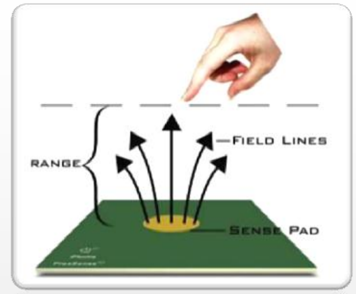
From the sensor perspective, minute differences in process parameters may render the touch sensor unstable or un-usable.

These include variations in the power supply stability, thickness of the overlay material, possible air gaps between the sensor electrode and overlay material and in many cases, the nearness of the product's housing. When housings are manufactured from a conductive material, the nearness of the housing introduces a large parasitic capacitance which has a significant impact on the sensor sensitivity.

Parasitic capacitance is an unwanted capacitance between sensor electrode and a nearby (normally grounded) potential. The aim of achieving a sensitive capacitive sensor is to have the sensor project electric field into a dielectric overlay material and further into free air. The user touching the designated touch sensor area would disturb this electric field.

In real life the electric field from the sensor would rather terminate to the nearby grounded potential, than be projected through a die-electric overlay and into free air. Parasitic capacitance can often account for up to 95% of the total capacitance as seen from the sensor. When 95% of the sensor capacitance is static, touching the electrode, can only impact the remaining 5% of variable capacitance.

Once overlay materials exceed 1mm, the effect of the touch is as little as 5%, meaning the sensor only sees a 0.25% change between touch and non-touch. This may be very close the noise level of the system.



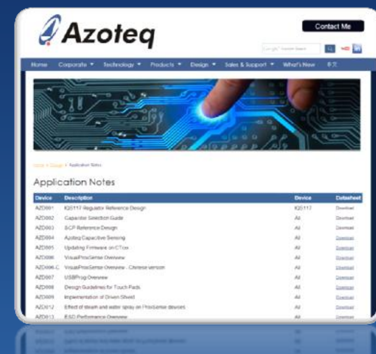
Ideal Case

The picture above is the ideal case where field lines are projecting freely into the air

The full Application Note can be found here.

Application Notes

Azoteq has a wide variety of knowledge that we keep available our website. If there is anything on there that you have questions on, be sure to contact us for more information.



Our Application Notes are located under the design tab of Azoteq's website here.

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