World Leader in Capacitive Proximity Sensing

A Guide to Prolonged Detection Using Capacitive Proximity Sensors

Capacitive sensing proximity solutions are based on human or object interference with electrostatic fields. Most capacitive sensors compensate for larger, static system capacitance and focus on accurately measuring small capacitive differences. The ability to measure small differences is the key element of non-touch proximity detection.

Advantages:

- Ultra low-power options available
- Area-specific sensing (slightly directional with electrode design)
- Environmental shifts may cause favorable triggers
- Low cost

Disadvantages:

- Temperature-dependent internal capacitors
- Environment-specific calibration at power-on

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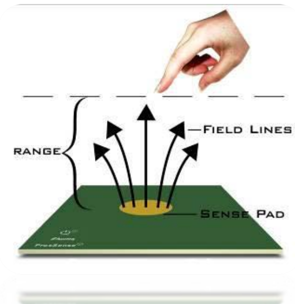
Content

Azoteq enables next generation user interfaces for users to interact naturally with products through capacitive proximity and touch

Using Active Parasitic Compensation

While the design guidelines will 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 sensor electrodes and overlay material and in many cases, the nearness of the product's housing.

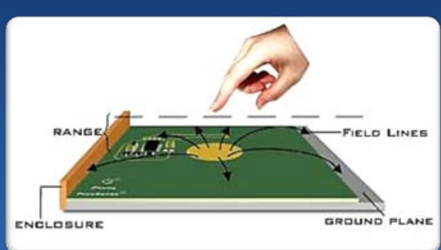
When housings are manufactured from a conductive material, the nearness of the housing introduces a large parasitic capacitance which has a significant impact on the sensor sensitivity. Parasitic capacitance is an unwanted capacitance between sensor electrode and a nearby (normally grounded) potential. 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.



Ideal Capacitive Sensing Case

The picture above shows the ideal case for an electrode without any parasitic capacitance around the electrode.

Advantages of parasitic compensation and auto tune algorithms



The real life case of an electrode design has the sensitivity reduced by filed lines terminating to surrounding components, tracks, ground planes and the housing

The largest advantage of parasitic compensation is that sensor sensitivity is maximized, even in environments with severe parasitic capacitance. In real life cases, the reduction of parasitic capacitance is one of the biggest challenges faced by designers. With compensation circuits, the designer has much greater degrees of freedom, resulting is much smaller PCB's and optimal performance within a product where the enclosure may add a significant parasitic capacitance. More information on auto tuning and parasitic capacitance is located here.

Using 1-Wire UART Streaming for Azoteq Stand-Alone Devices

Requirements for a UART Peripheral

The 1-wire streaming protocol operates in the same fashion as a UART protocol. Transmission starts with a start bit, followed by eight data bits and lastly a single stop bit. Please refer to the relevant datasheet for exact byte contents.

After the first start condition (LOW) a synchronization byte (0xAA) is transmitted. This synchronization byte can be used to determine the baud rate of the transmission, or to verify the baud rate. The baud rates of the ICs may vary due to changes in conditions such as temperature. The UART required for this application should therefore allow for precise baud rate settings.

Retrieving Data via UART

Upon capturing the data stream with most standard UARTs, the bit order of the data byte will be inverted. This can be adjusted manually, or by changing the Endian settings (if supported by the chosen UART).

To verify whether the UART is reading the data correctly just check the first byte of the data stream, which should be 0xAA. If 0x55 has been received the bit order needs to be flipped.

How to determine the start of a data transmission

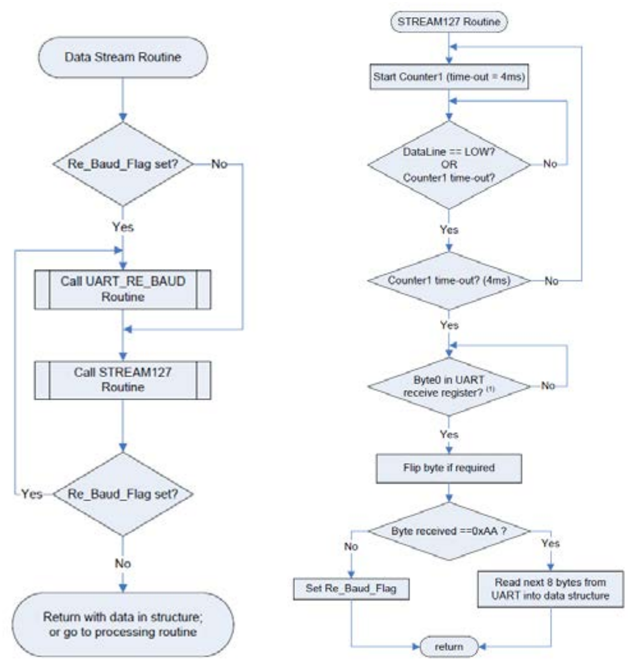
Each data stream of the 1-wire streaming protocol consists of a synchronization byte and 8 data bytes. There will at most be approximately 1ms between two of these data bytes. Between data transmissions will be approximately 9ms. To ensure that the start of a data transmission is found, first ensure that the data transmission line is silent for at least 3-4ms. Once this has been done, the next level change of the data line will be the falling edge of the start condition of the synchronization byte.

UART Flow Diagrams

It is suggested to use the first data transmission to determine the baud rate. A timer can be used to determine the length of the synchronization byte, but it is important to disable all interrupts during this time.

Once the baud rate has been set, the data stream can be read using the UART, but always verify that the first byte has been read correctly. In the case that the first byte is not read correctly, a re-bauding routine should be executed to recalculate the baud rate used by the UART.

The following flow diagrams illustrate such an implementation.



Full Application Note on here.

Page 1 Continued

Self vs. Mutual Capacitive Sensing

There are two types of capacitive sensing technologies: mutual capacitance and self-capacitance. Although mutual capacitance is less dependent on a common reference (signal ground), the effects of a varying reference cannot be ignored. Some effects of this technology deem self-capacitance a safer option, especially with reference to area-restricted custom electrode designs.

Obtaining Sensitivity

Capacitive sensing uses either of the following:

1. Charge transfer method
2. A relaxation oscillator circuit in which variance in capacitance is translated into variance in frequency
3. A fixed frequency AC signal, where the variance in capacitance is translated into voltage differences using a fixed known capacitor and an unknown capacitor

The first method is by far the more popular for proximity sensing because of the leverage obtained from multiple charge transfers (into a "reservoir" capacitor) becoming an integrated average of the instantaneous capacitance. Various other techniques in this architecture seamlessly enable charge multiplication (higher SNR) and parasitic charge subtraction, thereby enabling the detection of extremely small capacitive changes.

Understanding Sensitivity in a Mobile Device

Capacitive proximity sensors include the measurement of human interference. Humans generally have a fixed coupling to earth. The device has a variable coupling to earth (in hand versus on table).

Shown in Figure 1 is a simplified diagram of the loop that is formed with capacitive sensing. When the GND reference between the body and the device is tightly coupled, the sensing is optimal, with the sensor charge current only bridging a single unknown and dominating capacitor (C1).

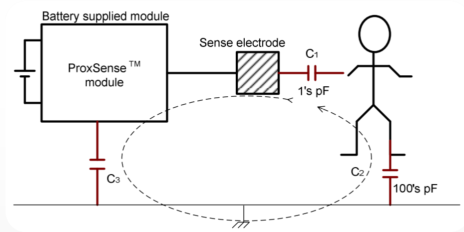


Figure 1

A simplified diagram of the main capacitive elements that influence sensitivity

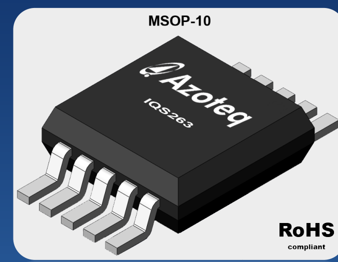
Full Application Note on here.

ProxSense® Devices for SAR Detection

With the steady rise of mobile devices, the need to meet SAR (Specific Absorption Rate) regulations is rising as well. Azoteq has been a solution provider since the inception of the FCC regulation and remains a world leading supplier of sensor solutions. Recommended devices for new designs are:

- IQS128, Single Channel Device with DYCAL
- IQS229, Single Channel Device with Movement Detect
- IQS263, Three Channel Device with Movement Detect

The Azoteq roadmap includes an emphasis on SAR sensor solutions and we are committed to remain a leader in this field. For more information on these devices, please contact us at info@azoteq.com



The Three Channel IQS263 Controller Available Now!

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