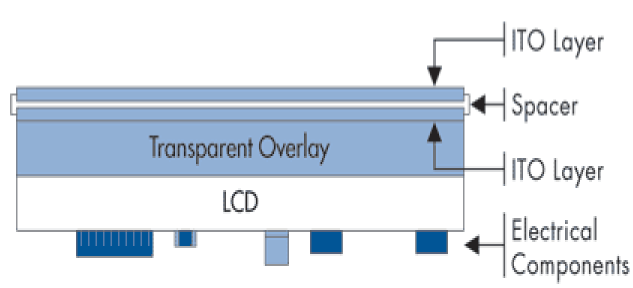
CAPSENSE TECHNOLOGY

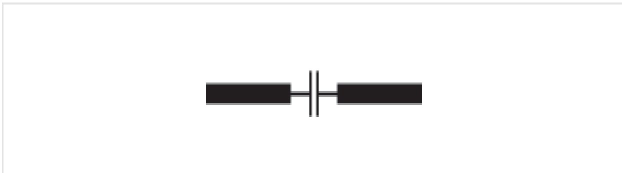
Sensor technologies allow designers to add a simple and robust interface to otherwise mechanical applications. Several sensor technologies exist today such as resistive film sensing and electric field sensing; each has benefits and drawbacks.



The most popular sensor technology is resistive film sensing, where two conductive, resistive plates are separated by a space (as shown in the diagram above). When one of these plates is contacted, the resistance of the system increases. The voltage across the system increases in turn. Measuring the voltage on the driven axis allows for positional measurement. This process is repeated on the other axis to give a two-dimensional measurement. One of the drawbacks of this sensor technology is that is relies upon the elastic properties of the film to return to a known state when contact force is removed. Eventually the elasticity of the sheet will degrade and the sensor will become unusable. In electric field sensing, the system emits a weak electric field from an antenna, then looks for changes in currents at one or more receivers. Practical systems require multiple transmitter and receiver locations; this adds to the cost of systems based on electric field sensing. A capacitive sensor detects the proximity of conductive objects. The capacitance measured by the sensor is a function of the distance from the sensor to the object. A capacitive sensor often requires a number of other support functions to be practical, such as programmable current source, an analog Multiplexer, and an auto-calibration system. There are now two new sensing algorithms, CapSense Successive Approximation and Capacitive Sensing using a Sigma-Delta Modulator. This kind of sensor design is greatly simplified by mixed-signal programmable system-on-chip devices.

Capacitive Sensing

Capacitive sensing is used in interface applications to build non-contact switches (or sensors). When protected by an insulating layer, capacitive sensors provide an elegant design overlay and provide robustness in severe environments. Very simply, a capacitive sensor is a pair of adjacent plates (electrodes).



When a conductive object is placed in proximity to these electrodes, there is capacitance between the electrodes and the conductive object. The conductive object is a finger in the following case, though this technique could be applied to any conductive object. Examples include conductive door plates or position sensors.

CapSense

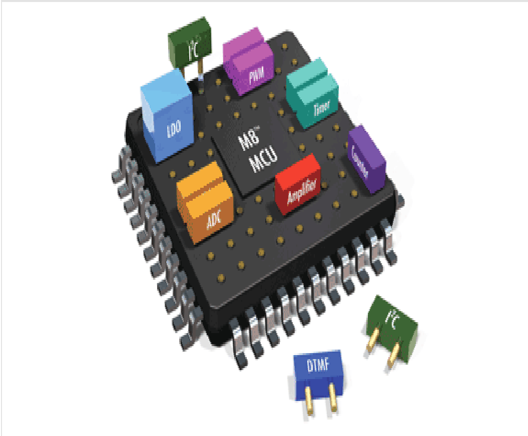
PSoC(R) CapSense takes advantage the unique features of the PSoC to enable efficient design of capacitive sensor scan applications. These features include:

- Wide analog MUX allowing all channels to be serviced by a common comparator and current source
- Internal programmable current source
- Automatic connection of comparator to sensor discharge switch

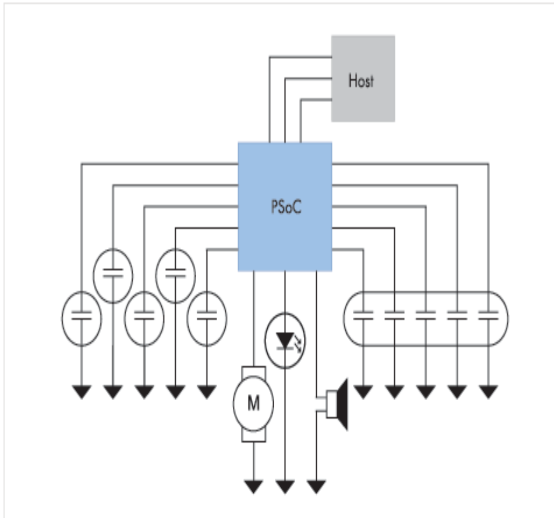
The PSoC architecture allows designers to incorporate multiple capacitive sensing design elements into an application. Buttons, sliders, touchpads and proximity detectors are supported simultaneously with the same device in the same circuit.

Internal hardware eliminates the need for external components to set charging current or to calibrate sensitivity.

The flexibility of PSoC and CapSense allows designers to move across platforms and adapt to design changes quickly. All calibration is completed in software through an easy-to-use, graphical development environment. Application changes do not require migration to other devices because PSoC is highly configurable.



Non-CapSense applications are easily accomplished using PSoC's digital and analog resources. Use PSoC to scan switches and use the activation status to drive LEDs, control a motor, drive a speaker, etc.



Sensing Algorithms

The PSoC(R) architecture supports two techniques for capacitive sensing, Successive Approximation and Sigma-Delta Modulation. Successive Approximation is implemented in the CSA User Module and the Sigma-Delta Modulator in the CSD User Module. The CSA block diagram:

CSA Features

- Scan 1 to 28 capacitive sensors.
- Scan capacitive slide sensors with 2 to 28 elements.
- Slide sensor physical resolution doubling using diplexing.
- Slide sensor interpolated resolution up to 1 part in 65535.
- Generate touch-pad using multiple slider sensors.
- Adjustable sensor sensitivity, detection threshold and sampling rate.
- Guided sensor/pin assignments using the CSA Wizard.
- Integrated baseline update algorithm for handling temperature changes.

CSD Features

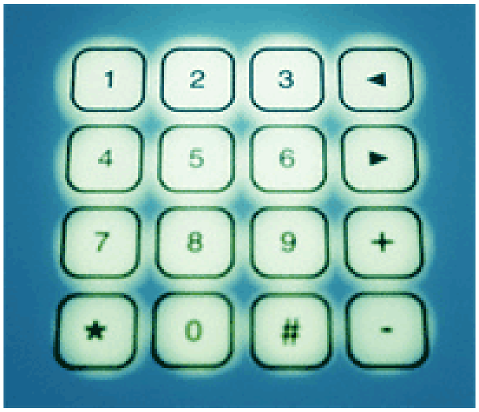
- Scan 1 to 28 capacitive sensors.

- Sensing possible with up to a 15-mm glass overlay.
- Proximity detection to 20 cm with a wire-based sensor.
- High immunity to AC mains noise, EMC noise, and power supply voltage changes.
- Supports different combinations of independent and slide capacitive sensors.
- Double slide sensor physical resolution using diplexing.
- Increase slide sensor resolution using interpolation.
- Touchpad support with two slide sensors.
- Sensing support via high-resistive conductive materials (ITO films for example).
- Shield electrode support for reliable operation in the presence of water film or droplets.
- Guided sensor and pin assignments using the CSD Wizard.
- Easily adjustable operational parameters.
- PC GUI application support for raw data monitoring and parameter optimization in real-time.

Buttons

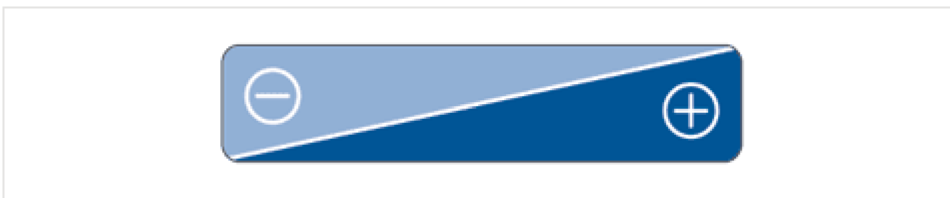
CapSense buttons represent the most basic function of a capacitive sensing application. Detecting the presence or absence of a conductive object (such as a finger) can be easily accomplished through a variety of materials and thicknesses.

Use CapSense buttons for media, volume, brightness, power status, and other control functions. CapSense buttons can replace discrete, mechanical buttons in virtually any application. CapSense buttons are capable of sensing though up to 5 mm of plastic or glass.

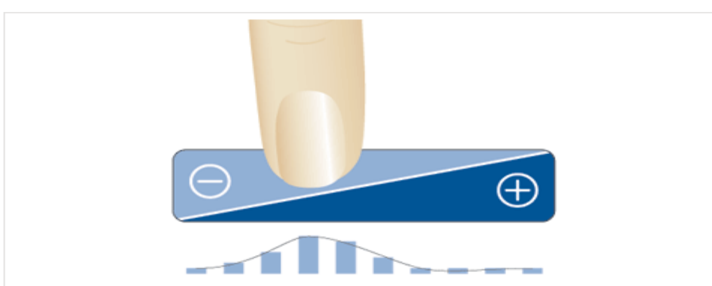


Sliders

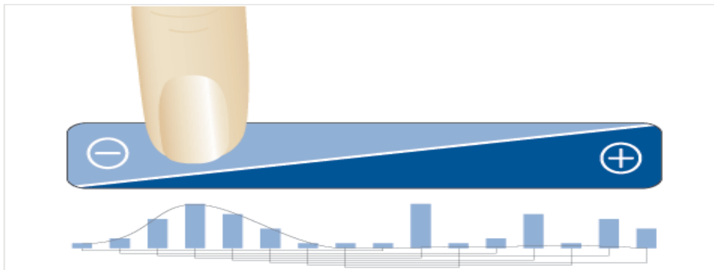
Sliders offer a higher level of functionality to your interface design. Use a slider to discern position to a much greater resolution than is capable from the individual sensor elements alone. Sliders are capable of providing a resolution 100 times greater.



This increased resolution is made possible using a mathematical operation called interpolation. Capacitance change is measured on all slider elements and the capacitance values on adjacent elements are used to determine position.



It is also possible to achieve even greater I/O efficiency or resolution by diplexing pins. Diplexing is a method where each PSoC(R) CapSense pin is attached to two sensor elements. These sensor elements are ordered in a scattered fashion to eliminate confusion as to which side of the slider is active.



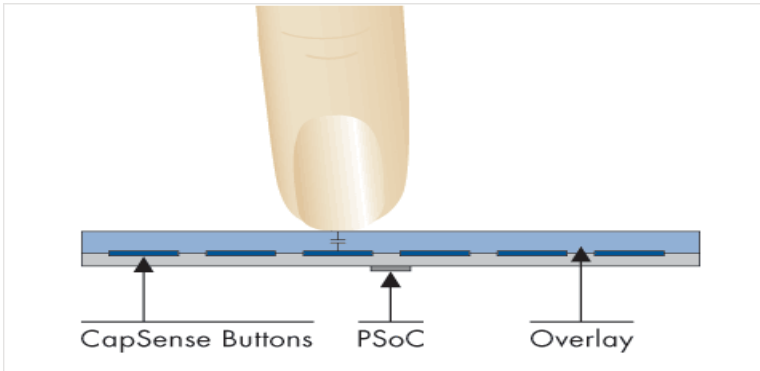
Proximity Detection

Capacitive sensing is by definition proximity detection. For standard buttons, the thickness of the overlay is the proximity setting. The sensor response is highest when a finger is pressing on the overlay.

In true proximity sensing, no contact is required between the sensor overlay and the user's finger or hand. In this application, it is necessary to increase the sensitivity of the sensor over that required for buttons. Increased sensitivity is realized by acquiring data from the sensor for a greater time. Longer acquisition times allow very small

changes in capacitance that arise from more distant conductive objects to be magnified.

Obviously, when the acquisition time is increased for such applications, the update rate is slower. However, proximity detection applications require that sensors only detect presence, not fine, rapid movements. Therefore, it is possible to detect conductive objects over greater distances while achieving the kind of update rate and response time that proximity sensing requires.



There are also some changes that can occur in hardware to increase the sensitivity of a proximity sensing apparatus. Larger sensors have greater sensitivity to larger conductive objects, such as a hand. Removing the ground plane from the underside of the sensor PCB increases the sensitivity, but allows the field lines to direct themselves toward the user, rather than toward a ground plane. Increasing the space between the sensor and the surrounding ground plane also directs field lines toward the user.

Research and Development Office
First Floor, Sri Siddaganga Complex,
B.H Road, Tumkur-572 102.
Karnataka. INDIA.
Phone : +91 816 4021402, 4021403

Corporate Office
280, 59th Cross, 17C Main, 3rd Y' Block,
Rajajinagar, Bangalore -560 010.
Karnataka. INDIA.
Phone: +91 98862 02483.