BURIED CAPACITIVE SENSORS FOR TAMPER PROTECTION

1. Relevant Devices

C8051F70x, C8051F71x, C8051F8xx, and C8051F99x.

2. Supporting Documentation

- AN367: Understanding Capacitive Sensing Signal to Noise Ratios and Setting Reliable Thresholds
- AN447: Printed Circuit Design Notes for Capacitive Sensing with the CS0 Module
- AN529: Capacitive Sensing Through Long Wires

3. Introduction

An individual's financial matters are increasingly electronic in nature and decreasingly interpersonal. As financial institutions replace human interaction with electronic interfaces such as ATMs, the need to make electronic circuits tamper-proof becomes critical. A typical numeric keypad for financial transactions may contain up to hundred or more tamper prevention and detection features. Tamper detection circuits raise alarms and disable functionality, while tamper prevention features are designed to prevent intrusions and breaches.

This application note addresses the elimination of copper pads on the accessible top surface of printed circuit boards (PCBs). Burying traces to internal layers of a PCB prohibits electrical contacts from snooping on copper elements within the PC board.

4. Applications

A typical button plunger application is depicted in Figure 1. Figure 1's top drawing is a side view of a single electrical switch. The plunger is either conductive or has a conductive material on the surface that interacts with two copper elements on the PCB. Figure 1's bottom drawing is a top view of the round plunger hovering over two semicircle copper pads. The copper pads are monitored by an MCU that identifies when the circuit is completed.

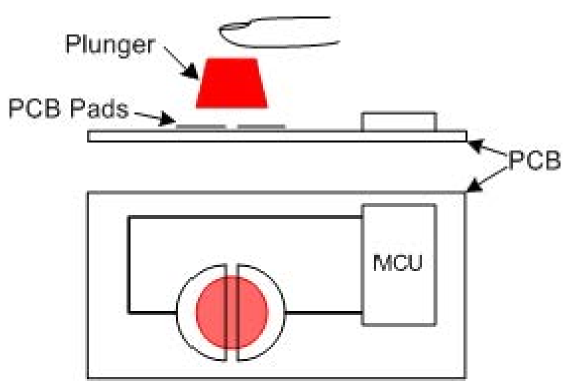


Figure 1. Conductive Plunger Switch

There is typically a gasket dome over the top of the plunger that contains the key label and provides some protection from the elements. If one were to attempt to snoop this system, it would not be all that difficult to attached conductive wires to the two semi-circle pads to monitor when they are shorted. Detecting that pads have shorted can enable someone to capture a sequence of keys signifying personal data such as a bank account PIN.

One solution to this problem is to bury the copper semi-circle pads and their connections within the inner layers of the printed circuit material. This disables the ability to solder wires directly to the conductive surface of the printed circuit. This scenario assumes that the MCU is mounted on the backside of the PCB and inaccessible. Figure 2 depicts this configuration. Note that no conductive layers should appear in the PCB between the semi-circle elements and the plunger.

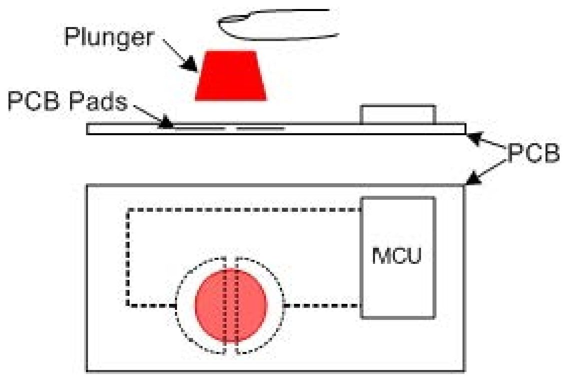


Figure 2. Conductive Plunger Switch

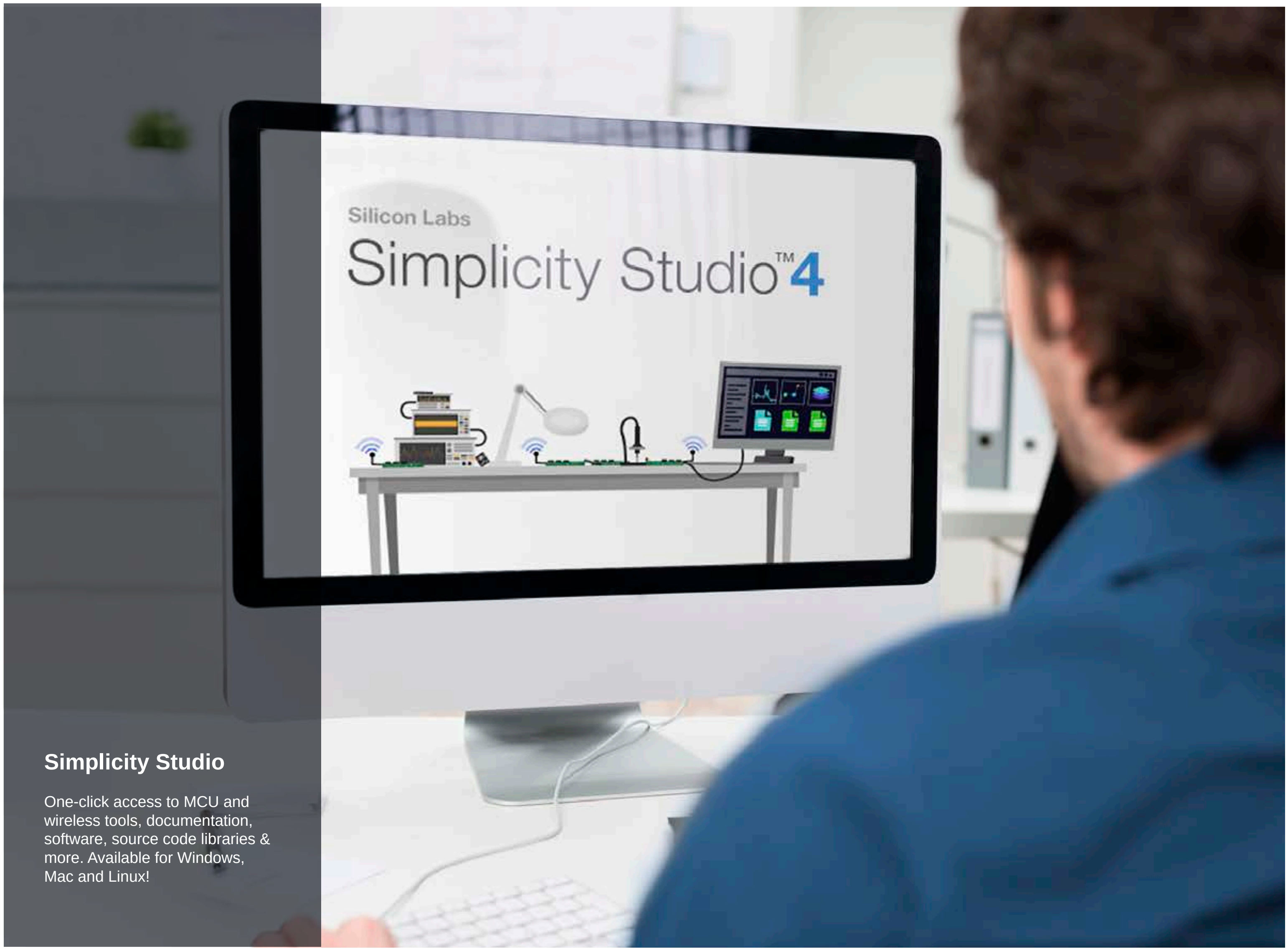
While this approach eliminates the soldered form of snooping, it also eliminates the direct conductive contact of the plunger to the semi-circles, which prevents the key press from being detected. One method of sensing a key press in a system with buried semi-circle sensors is to measure the change in capacitance as the plunger approaches. The magnitude of this capacitive change is a function of how deeply the traces are buried, the traces' size, the material dielectrics, and the plunger's size and conductivity. This change, which can be relatively slight, requires the high level of sensitivity achieved with the capacitance-to-digital converter (CDC) in Silicon Labs' MCU families. The suggested implementation is to connect one of the semi-circles to ground and to measure the capacitance of the two plate + dielectric system.

Considerable material disclosed in this article is the subject of patents applied for. Consult appropriate party for details.

Document Change List

Revision 0.1 to Revision 0.2

- Removed “QuickSense”



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Austin, TX 78701
USA

http://www.silabs.com