

## C8051F990 SLIDER EVALUATION KIT USER'S GUIDE

### 1. Kit Contents

The C8051F990 Slider Evaluation Kit contains the following items:

- C8051F990 Slider board (with pre-installed 3.0 V coin cell battery—CR2032)
- F990Slider-EK Quick Start Guide

For more detailed discussions on capacitive sensing best practice methods and firmware, please refer to the following documents:

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

### 2. C8051F990 Slider Evaluation Kit Overview

The C8051F990 Slider Evaluation Kit demonstrates the system level possibilities that can be achieved with the C8051F99x ultra low power capacitive sensing MCU. The result is a battery powered capacitive sensing solution that has the following features:

- **Low Power Wake-on-Slide**—Allows the system to be designed without any mechanical components. The system wakes up when the user slides a finger across the slider. The system has a shelf life of over 5 years in this low power wake-on-slide mode. For more information on how the wake-on-slide feature achieves gesture recognition in a low-power system, see "3.5. Wake-on-Slide Firmware Functionality" on page 3.
- **Slider Control**—Allows multiple capacitive sensing pads to be bound together to form a slider control. The API performs all required calculations and notifies the application software of the finger position on the slider. The slider demo demonstrates this capability and has a runtime of over 120 hours at the maximum LED setting. Runtime is limited by LED current and can be increased by dimming the LED.
- **Gesture Recognition**—Events enable the ability to detect gestures, such as a “pinch”, on the slider. In this system, the “pinch” gesture is used to switch between different demonstration modes.
- **Miniature Size**—The C8051F990 MCU has a built in SmaRTClock oscillator (no crystal required) and is available in a 3x3 mm package. The sleep mode current is 300 nA and the active mode current is 150  $\mu$ A/MHz.
- **Battery Meter**—Using the C8051F990's 12-bit ADC, the system is able to measure the battery voltage and determine the remaining battery capacity.
- **LED Dimmer**—The system dynamically reduces LED power consumption by driving the LEDs with a PWM signal. Taking advantage of the fast 2  $\mu$ s wake-up time, the MCU can efficiently wake up from sleep, adjust the state of the LED, and go back to sleep very efficiently. This allows a flicker-free, low power, LED dimming mode.

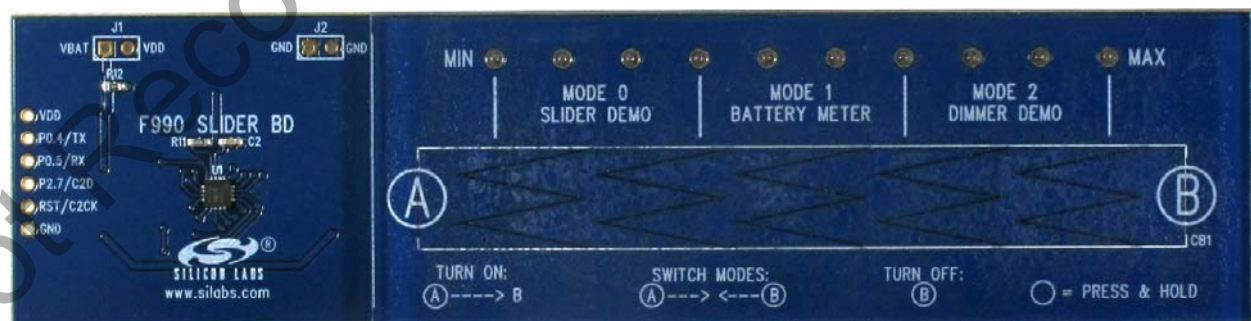


Figure 1. C8051F990 Slider Evaluation Board

## 3. C8051F990 Slider Evaluation Kit Demo

The C8051F990 Slider Evaluation Board is ready to use out of the box. Simply lay the board on a flat surface, remove the paper tab to allow the battery to make contact with the battery holder, touch the A button on the left side of the slider, and slowly slide your finger towards the B button on the right side of the slider. Once the system turns on, the two LEDs corresponding to “Mode 0: Slider Demo” will flash four times indicating that the system is in slider demo mode. The slider board has three modes: “Mode 0: Slider Demo”, “Mode 1: Battery Meter”, and “Mode 2: Dimmer Demo”. The user may cycle through the modes by performing a “pinch” gesture. The slider may be pinched by placing one finger on the A button and another finger on the B button then simultaneously sliding both fingers towards the middle of the slider.

### 3.1. Mode 0: Slider Demo

In the slider demo, the LED will track finger position on the slider for a slowly moving finger. If the finger performs a gliding motion across the slider, then the LED will continue moving in the direction of the glide. The LED will act as a ball in motion and will continue rotating until it is stopped. The LED may be stopped by pressing one finger on the slider. If two fingers are placed on the slider, the LED will stop faster. If the finger generates additional fast gliding motions on the slider, then the enabled LED will start rotating faster through the bank of LEDs. If left alone, the rotating LED will slow down until it comes to a complete stop. This simulates the force of friction on a moving ball.

### 3.2. Mode 1: Battery Meter

In battery meter mode, the system measures the battery voltage and slowly blinks an LED to indicate the approximate battery life remaining. If the MAX LED is blinking, then the battery is fully charged. If the MIN LED is blinking, then the battery is nearly depleted and it is time to replace the battery. From the slider demo mode, the system will enter battery meter mode when the slider is pinched once. After entering battery meter mode, the system will remain in this mode for approximately 10 seconds. The system may be held in battery meter mode for longer than 10 seconds by touching the slider. The system will remain in battery meter mode as long as the slider is touched. Upon exit from battery meter mode, the system goes back into slider demo mode.

### 3.3. Mode 2: Dimmer Demo

The dimmer demo mode allows the user to set the LED brightness. If the MAX LED is lit, the dim level is set at maximum brightness. If the MIN LED is lit, the dim level is set at minimum brightness. The LED brightness set by the dimmer demo is preserved and used throughout all three modes. To enter dimmer mode from the slider demo mode, pinch the slider twice and wait for the “Mode 2: Dimmer Demo” LEDs to stop blinking. Then, touch the slider at the desired position to set the LED brightness. The selected position will be saved 5 seconds after removing your finger from the slider. At that time, the system will automatically switch back to the slider demo mode.

Note: The “pinch” gesture detection is disabled once the system enters dimmer mode.

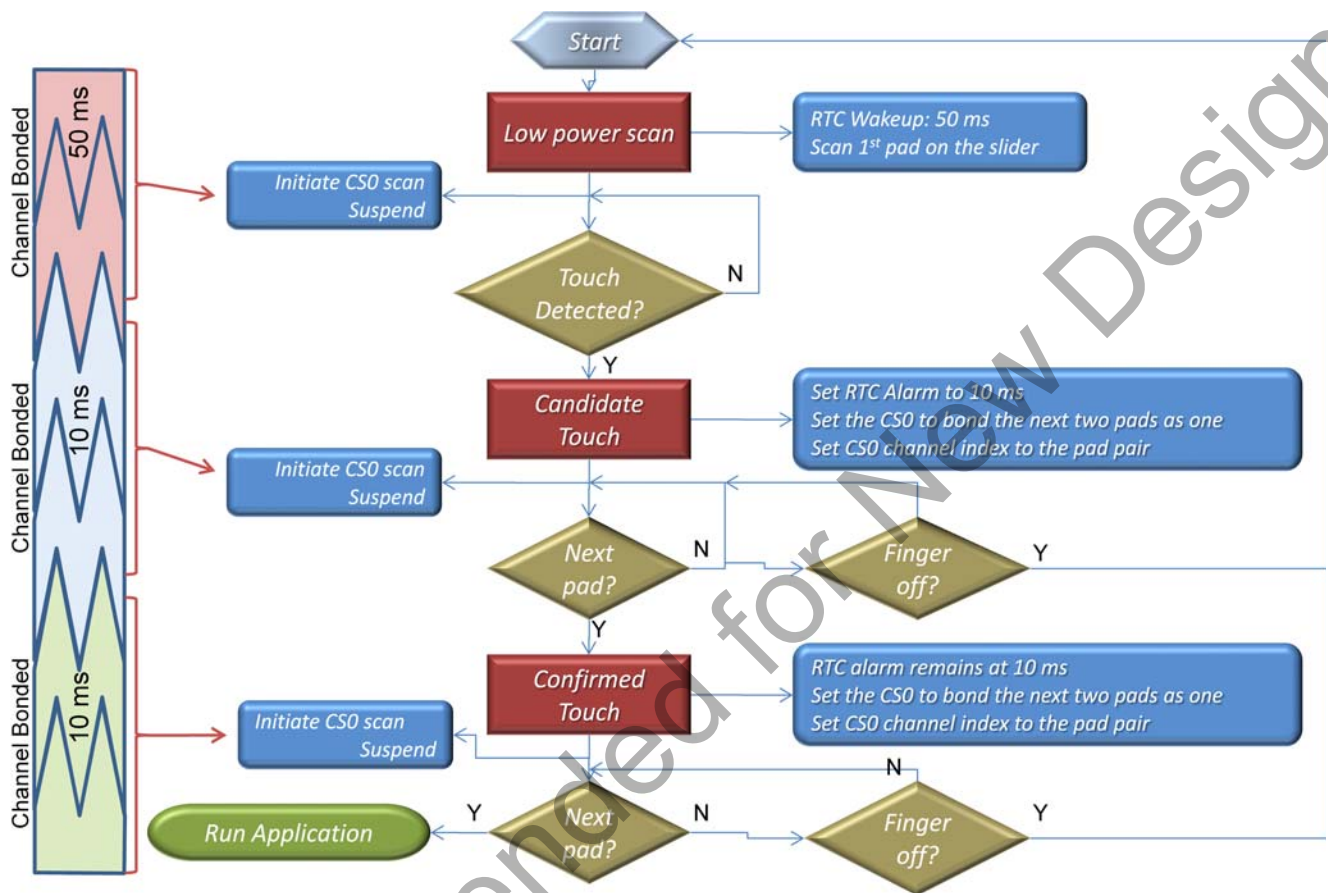
### 3.4. Turning Off the Board

The C8051F990 slider board will automatically turn off if the slider is not touched in 60 seconds. You may also turn off the slider board by holding down the B button for 3 seconds.

**Important Note:** The back side of the slider board is sensitive to touch. The slider board should be placed on a flat surface while in use to prevent the PCB traces on the back from being accidentally touched. If the back side is accidentally touched, or after the board is taken out of a static bag, let it sit for 30 seconds on a flat surface to allow the baselining algorithm to adapt to its new environment.

## 3.5. Wake-on-Slide Firmware Functionality

The F99x slider firmware operates in a low-power state until the user slides a finger across the slider sensor. Firmware stays in this low-power state while continuously sampling the slider by following the state machine shown in Figure 2.



**Figure 2. State Machine for Wake-on-Slide Functionality**

In its first set of states, the slider only samples the pair of pads that the user is required to touch first in order to begin a slide gesture. When firmware detects a “candidate” touch, the next two pad pairs are sampled at a rate that is fast enough to detect even a fast swipe. When firmware detects a touch first on the center pads and then on the final pad pair, it switches to a full-power operational state where the three demos can run.

Note that baselining updates are not shown in the above state machine. In order for the system to reliably detect a touch event, firmware must maintain a baseline for each pad pair that describes the expected untouched or “inactive” capacitance of the pad pair.

Figure 3 shows the activity profile for the F99x slider firmware. The X-axis of the drawing is time, and the Y-axis is current consumed. The system spends most of its time in a low-power sleep mode and only wakes from this low-power state when firmware detects a wake-on-slide event.

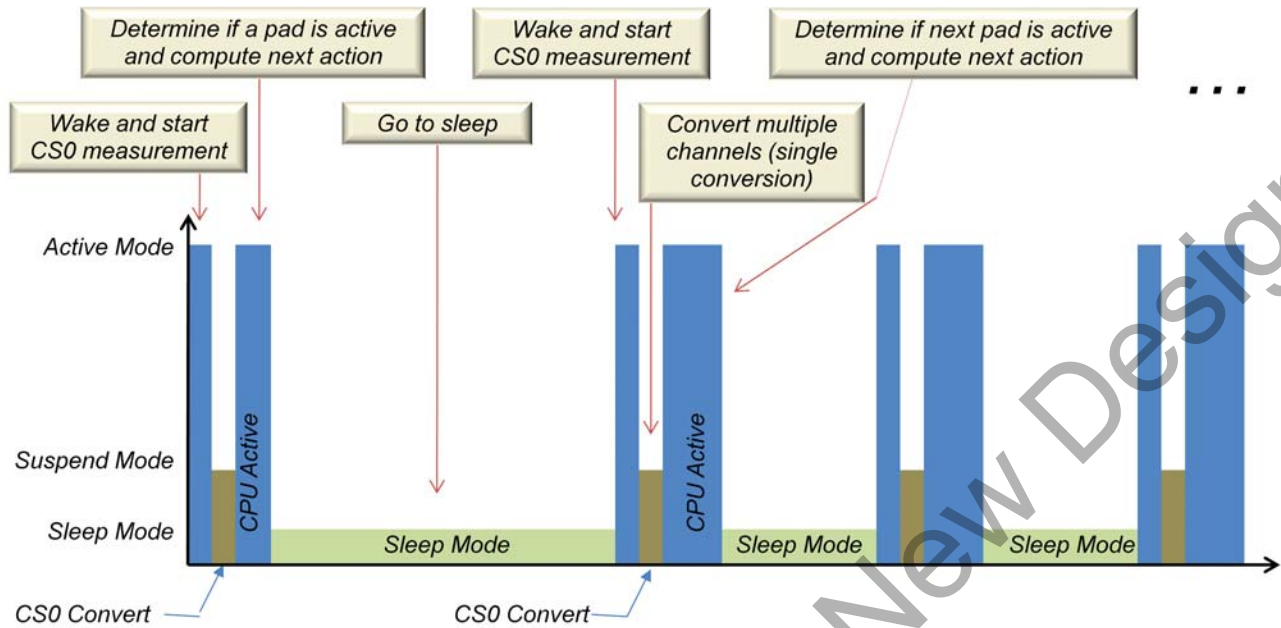


Figure 3. Activity Profile for the C8051F99x Slider Firmware

## Rev. 0.3



**Figure 4. C8051F990 Slider EK Schematic**

# F990-Slider-EK UG

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## DOCUMENT CHANGE LIST

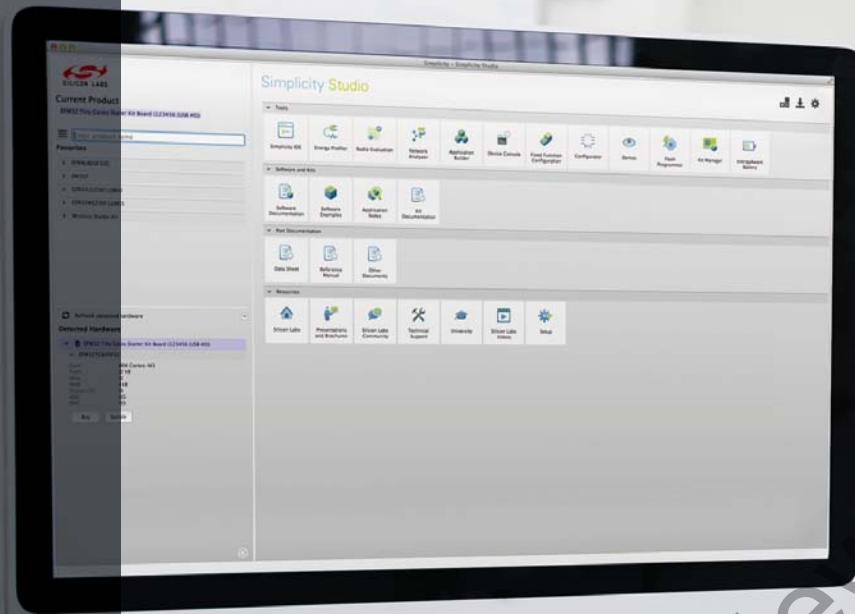
### Revision 0.1 to Revision 0.2

- Added firmware description and related application notes.
- Modified out-of-box instructions.

### Revision 0.2 to Revision 0.3

- Removed “QuickSense”





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