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Spec No: 001-54657

Spec Title: AN54657 - CAPSENSE(R) EXPRESS(TM) - 1CS/2CS BUTTON SOFTWARE TOOL USAGE

Replaced by: None

AN54657

CapSense® Express™ – 1CS/2CS Button Software Tool Usage

Author: Vibheesh Bharathan
Associated Project: No
Associated Part Family: CY8C20111 and CY8C20121
Software Version: PSoC® Designer™ 5.0 SP6
Related Application Notes: AN42137, AN53490

CapSense® Express™ is a family of capacitive sensing devices that helps you do rapid prototyping of touch-sensing interfaces. Use the one-button and two-button low-pin-count devices to replace one or two mechanical switches with touch-sensing buttons. This application note describes how to use PSoC® Designer™ 5.0 to quickly configure and tune CapSense Express devices.

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1 Introduction

Cypress's CapSense is a widely accepted technology often used to replace mechanical switches and push buttons with little or no impact on the design. The high-performance, fixed-function family of devices does not require any programming effort, unlike other CapSense-enabled PSoC mixed-signal controllers. CapSense Express is a factory-configured plug-and-play family for standard designs, though some designs might require changing the tuning parameters of the CapSense block or the control logic of digital outputs. (For more information, see the datasheet CapSense Express™ – One Button and Two Button Capacitive Controllers). PSoC Designer 5.0 is a powerful, easy-to-use software tool for configuring and tuning CapSense Express devices. This application note describes how to use PSoC Designer to configure the CY8C20111 or CY8C20121 CapSense devices; you can perform similar tuning for your design.

2 Introduction to PSoC Designer 5.0

PSoC Designer 5.0 is an integrated design environment (IDE) that includes both code-free and high-level language programming modes in one package. It has two project design modes: system-level and chip-level. The fixed-function CapSense Express is supported only in system-level design mode or visual embedded system design mode, which is a drag-and-drop visual design (no coding) mode. The tool lets you configure, tune the target design, and create output files.

3 PSoC Designer Installation

CY8C201xx designs require PSoC Designer 5.0, Service Pack 6 as a configuration/tuning tool. Download the tool from http://www.cypress.com/go/pr/psocdesigner. For systems requirements for installation, refer to the release notes for installing the IDE.

4 Available Drivers for CapSense Express™

CapSense Express devices are offered in many feature sets, but this application note is relevant only for the two devices listed in Table 1. For information on the tool usage for other CapSense Express parts, see the application note *AN42137 - CapSense™ Express Software Tool*.

Table 1. Driver Selection Guide

Part #	Driver Name	Package	CS Inputs	Digital Output
CY8C20111	1 CS Button plus Output	8-pin SOIC	1	1
CY8C20121	2 CS Button plus Output	8-pin SOIC	2	2

5 Creating a System-Level Project for CapSense Express

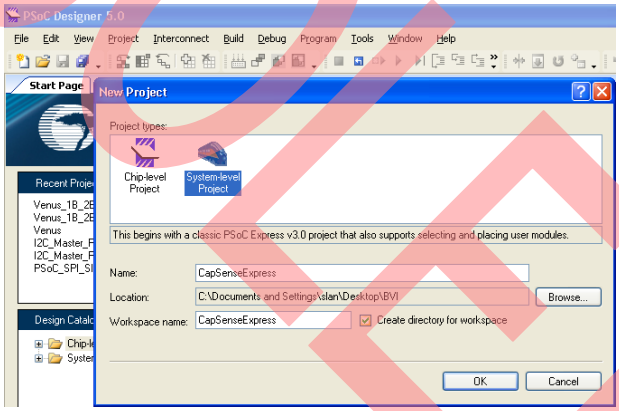
You can create a system-level project for CapSense Express within minutes using PSoC Designer. Here are step-by-step instructions for creating a CapSense Express project for CY8C201xx devices:

1. Open the PSOC Designer 5.0 SP6 as follows:

   Start->All Programs->Cypress->PSoC Designer 5

2. Select the New Project option from the File menu bar, as shown in Figure 1.

Figure 1. New Project Wizard



3. Highlight the System-Level Project option. Under Name, type the project name. Under Location, select the project location from the wizard. Click OK.

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5. A newly created system-level project opens, as shown in Figure 2. This tool has two modes of operation for CapSense Express devices: Design and Monitor, marked as 5 and 6 in Figure 2.

   Design mode lets you configure the CapSense Express devices, as explained in "Configuring CapSense Express" section.

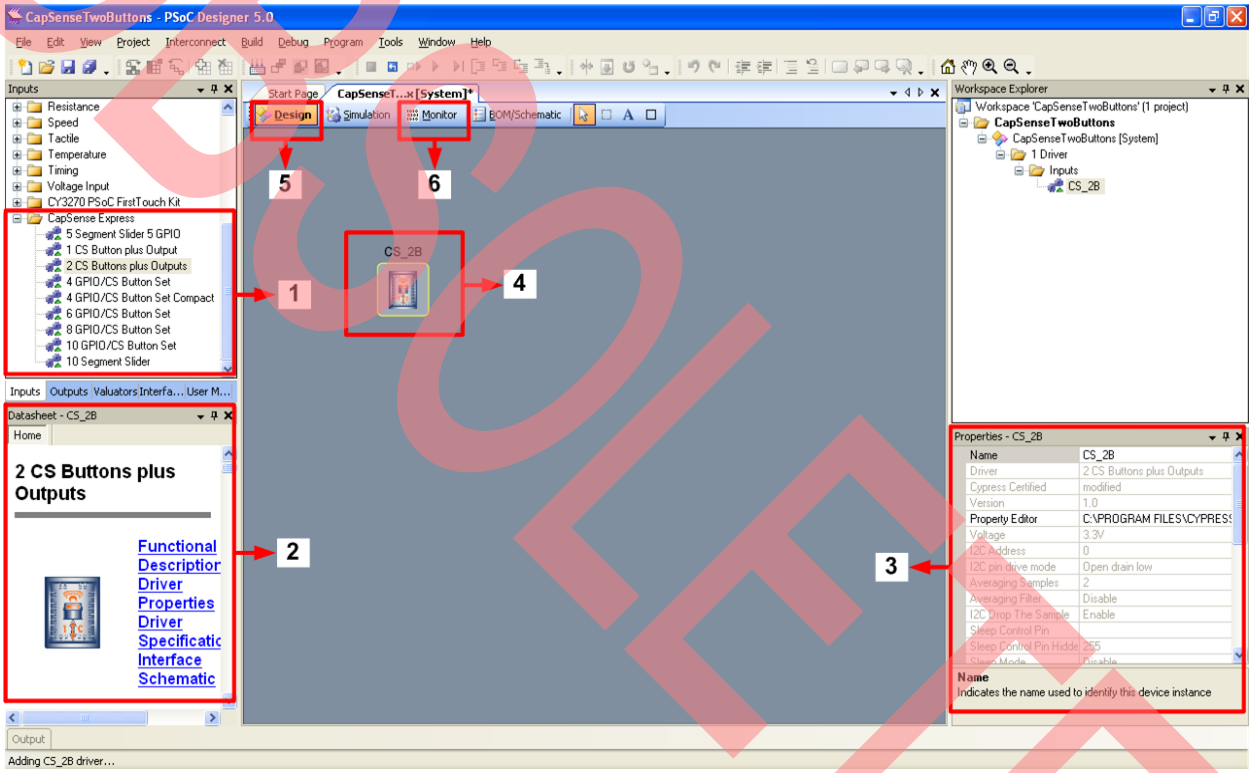
   Monitor mode lets you monitor the CapSense-related parameters from the target board and tune the device for a specific design.

6. Select the right driver in the CapSense Express drivers window, marked as 1 in Figure 2 below, based on Table 1, and drag and drop the same into your design (marked as 4 in Figure 2).

   The datasheet window, marked as 2 in Figure 2, shows information specific to the selected driver.

   The Properties window, marked as 3, shows the global parameter setting of the driver. You can change the values only after opening the properties of the driver.

Figure 2. CapSense Express Project Window

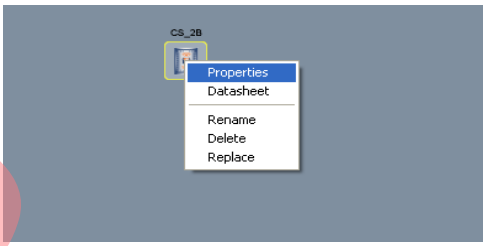


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6 Configuring CapSense Express

To configure CapSense Express, right-click on the driver and open Properties, as shown in Figure 3. That opens the factory default Configuration window of CapSense Express, as shown in Figure 4.

Figure 3. Open the Configuration Window



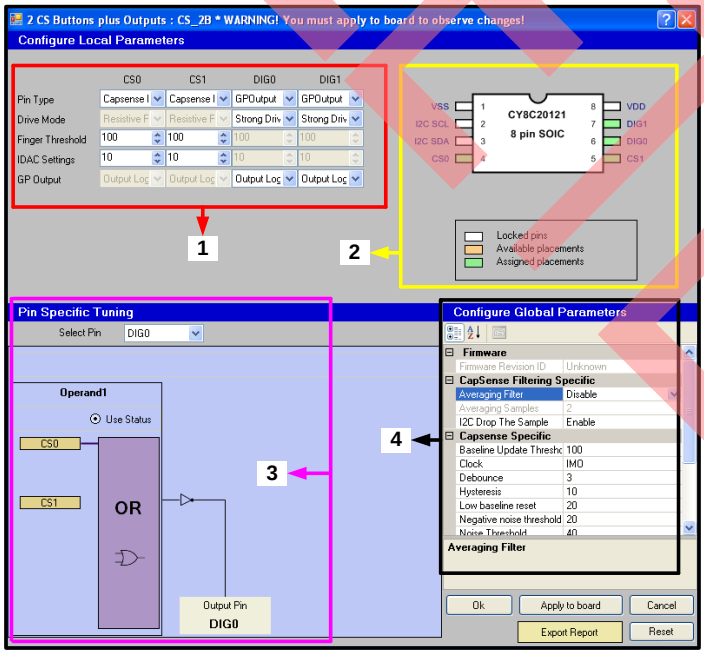
Unlike the other CapSense Express devices, one-button and two-button devices (CY8C20111 and CY8C20121) have fixed-function port pins; you can enable or disable their functionality.

The yellow box in Figure 4 (marked as 2) shows pin assignment of the device, based on the selection made for each port pin in the red box (marked as 1) in Figure 4. CS0 and CS1 are CapSense inputs, and you can enable functionality by selecting CapSense input in the Pin Type combo box. Similarly, selecting GPOutput for DIG0 and DIG1 enables the digital output pins. Digital outputs have strong drive mode after they are enabled, and the disabled digital port pins have High-Z drive mode. (Note that CS1 and DIG1 are available only in CY8C20121.)

You can select the output logic of the digital port pins from the GP Output combo box. Selecting Logic 0 or Logic 1 determines the default state of the port pin on power. The output can be changed by modifying the value of OUTPUT_PORT register of the CapSense Express device through I^2C interface. Selecting the Output Logic operation option makes the CapSense input(s) and logic block control the digital output pin. The desired logic operation for the port pin can be configured from the Pin Specific Tuning section in the pink box (marked as 3) of Figure 4. In this mode, the OUTPUT_PORT register does not have any effect on the logic levels of GP outputs.

The black box area (marked as 4) of Figure 4 shows the Configure Global Parameters window and contains parameters related to CapSense functionality, software filter, and I^2C slave communication interface.

Figure 4. Driver Configuration Window

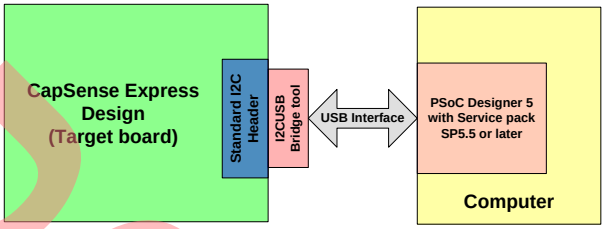


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6.1 Tuning CapSense Express

After the functionality is configured using the Properties window of the driver, tune the CapSense inputs by using the setup shown in Figure 5. The only hardware tool required for tuning is CY3240-I2USB Bridge. Different methods and tools are available for mass-production programming. For more information, see the application note *AN53490 - CapSense Express™ – Design to Production*.

Figure 5. Tuning Hardware Setup



Open the Monitor mode of the PSoC Designer (marked as 6) in Figure 2. Right click on the driver and open the tuner, as shown in Figure 6.

Figure 6. Opening CapSense Tuner



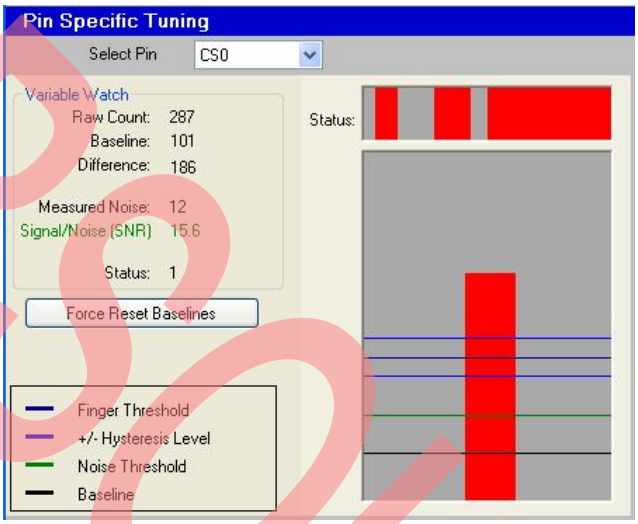
Click **Apply** to download the configuration to the target device and ensure the device is configured successfully. Select a CapSense input in the Select Pin selection box. The data from selected input is displayed in real time, and it indicates the amount of signal when the finger is kept on the button.

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Figure 7 shows the real-time data display of the CS0 CapSense input. The Variable Watch section shows the raw count, difference count, and baseline data captured from the device and the measured noise, and signal/noise (SNR) of the selected input.

The Status section shows the ON/OFF status of the input, and the graph under the Status section shows the signal when the finger is kept on the button. Different colored lines represent the finger threshold, hysteresis level, noise threshold, and baseline of the parameter setting window. Based on the signal from the device, adjust the CapSense tuning parameters according to best practices described below.

Figure 7. Tuning CapSense Input



How well the CapSense Express design works depends on how well the device is tuned for the overlay as well as button size and environmental conditions. As a rule, any CapSense design should have a minimum 5:1 signal-to-noise ratio (SNR) to detect a finger press properly without false detection. Higher SNR results in higher reliability and performance. Here are ways to improve SNR and to set the right tuning parameters:

- IMO Clock: The recommended clock for CapSense is IMO/1. But, in some cases when C_P is high, the fastest clock does not provide enough time to charge the sensor capacitor (this is based on the 5*RC constant) and results in reduced sensitivity. If the sensors in a particular design have higher C_P, then reduce the clock.
- Settling Time: Select a value from Table 2 for settling time based on the CapSense clock chosen for the design.

Table 2. Recommended Minimum Settling Time Values

V_{DD}	IMO/1	IMO/2	IMO/4	IMO/8
2.7 V	40	80	160	255
3.3 V	160	255	255	255
5 V	160	255	255	255

- Setting a higher settling time than required increases the scan time of the sensor. However, choosing a value that is too low reduces the sensitivity.
- Decreasing the IDAC value increases the signal level considerably. Using higher IDAC reduces the finger response but also reduces noise and scan time.
- Start the process with an IDAC value of 14; if SNR is not 5:1, reduce the IDAC to increase the signal strength. Similarly, if the SNR is too high (for example, more than 15) increase the IDAC and reduce the signal strength. This helps to achieve optimum scan time. The minimum IDAC value can be 4, and the maximum can be 255.

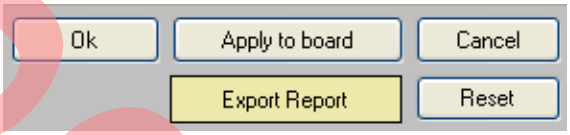
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- Repeat the previous step until the design meets a 5:1 SNR. Higher SNR results in a more stable design.
- To optimize the working of CapSense Express device, set parameters, such as finger threshold and noise threshold, properly. In general, set the finger threshold to 75 percent of finger response, set hysteresis to 15 percent of finger response, and set noise threshold to 40 percent of finger response.

6.2 Creating Output File and Applying to Board

To apply the new configuration to the target device; use the Apply to Board button shown in Figure 8. This button will be active only if the test setup shown in Figure 5 is made. The configuration process summary pops up after the apply process is completed. If the I^2C communication and device powering are not correct, the configuration process fails.

Figure 8. Tuner Control Buttons



Clicking OK creates two output files from the software tool: *<project name>_flash.iic* file and *<project name>_reg.iic* file.

- The *flash.iic* file is used by third-party programmers and other mass-production programming methods. For more information, see the application note *AN53490 - CapSense Express™ – Design to Production*.
- The *reg.iic* file can be used for debugging using Bridge Control Panel software.

7 Summary

This application note described how to use PSoC Designer 5.0 to help you quickly configure and tune the CapSense Express one-button and two-button drivers for CY8C20111 and CY8C20121 devices.

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	2746463	BVI/VED	07/30/2009	New Application Note.
*A	3347486	BVI	08/18/2011	Updated Software Version as “PSoC Designer 5.0 SP6” in page 1.
*B	3718761	PRIA	08/21/2012	Updated Available Drivers for CapSense Express™: Updated Table 1. Updated Creating a System-Level Project for CapSense Express (with step-by-step instructions). Updated to new template.
*C	4088085	PRIA	08/06/2013	Updated links of Related Application Notes in page 1 and also across the document.
*D	4626407	SSHH	01/16/2014	Updated Configuring CapSense Express: Updated Tuning CapSense Express: Replaced “I2USB Bridge” with “CY3240-I2USB Bridge”.
*E	4976948	PRIA	12/02/2015	Updated links of Related Application Notes in page 1 and also across the document. Updated to new template.
*F	5092581	PRIA	01/19/2016	Obsoleting the Application Note

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