CE195286 – PSoC 4 CapSense Tuner

Objective

This example demonstrates how to implement Tuner GUI interface for CapSense® design using UART and I²C interfaces in PSoC® 4 devices.

Overview

There are two CapSense projects with this code example. Code example 1 demonstrates tuning using the I²C interface; Code example 2 demonstrates tuning using the UART interface. This project features the CapSense Component configured with a CSD-based linear slider.

The key difference between I²C- and UART-based tuner interface are

- I²C-based tuning allows real-time tuning with read and write (update parameter values) access to CapSense Component parameters and UART-based tuner interface provides only read-only access and that it can be used for real-time sensor data monitoring.
- UART transmission and sensor scan are executed sequentially. Hence data transfer does not overlap with sensor scan.
- UART sends data after every scan so the graph displays all scanned results, but with I2C scan and data transfer execution are asynchronous to each other.
- UART can produce more accurate SNR measurement results as it captures every scan sample.

Requirements

Tool: PSoC Creator™ 4.2

Programming Language: C (Arm® GCC 5.4-2016-q2-update and Arm MDK 5.22)

Associated Parts: All PSoC 4 parts with CapSense

Related Hardware: CY8CKIT-042-BLE PSoC 4 BLE Pioneer Kit

Hardware Setup

This example uses the kit's default configuration. Refer to the kit guide to ensure that the kit is configured correctly.

Software Setup

None.

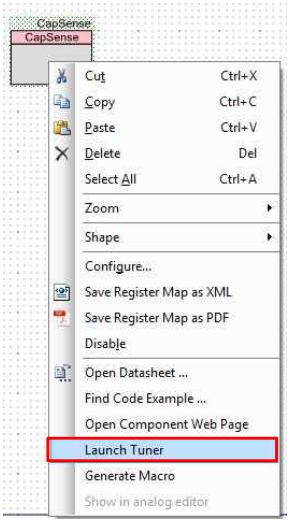
Operation

Plug the CY8CKIT-042-BLE kit board into your computer's USB port and follow the instructions.

Code example 1: CapSense Tuning over I²C Interface

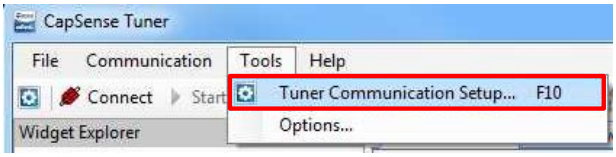
1. **Build project:** Build the project "PSoC4_CapSense_Tuner_I2C" and program it into the PSoC 4 device. Choose **Debug** > **Program**. For more information on device programming, see PSoC Creator Help.
2. **Launch tuner GUI:** Right-click and select **Launch Tuner** from the CapSense instance context menu, as Figure 1 shows.

Figure 1. Launch Tuner



3. **Establish I²C communication:** To establish communication between the tuner and a target device, configure the tuner communication parameters to match the I²C Component parameters.
   a. Open the Tuner Communication Setup dialog by selecting **Tools** > **Tuner Communication Setup…** in the menu, or clicking **Tuner Communication Setup**, as Figure 2 shows.

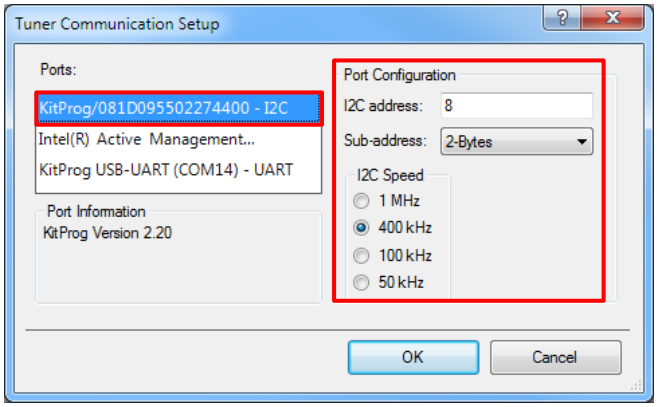
Figure 2. Tuner: Communication Setup



   b. Select the appropriate I2C communication device, which is KitProg2 (or MiniProg3) and set the following parameters:
      - I²C Address: 8 (or the address set in the EzI2C Component configuration wizard)
      - Sub-address: 2 bytes
      - I²C Speed: 400 kHz (or the speed set in the Component configuration wizard)

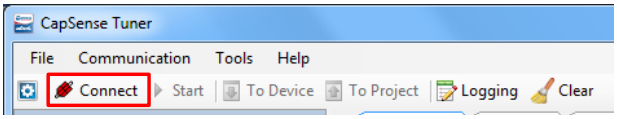
      Note: The I²C address, Sub-address, and I2C speed fields in the Tuner communication setup must be identical to the Primary slave address, Sub-address size, and Data Rate parameters in the EzI2C Component Configuration. Sub-address must be set to 2 bytes in both places.

Figure 3. Tuner Communication Parameters Selection



c. Click **Connect** to establish connection as Figure 4 shows. If the connection is set up correctly, the “Start” button turns active and, status bar indicates the Bridge status as “Connected” and shows the comunication parameters.

Figure 4. Tuner: Connect Option



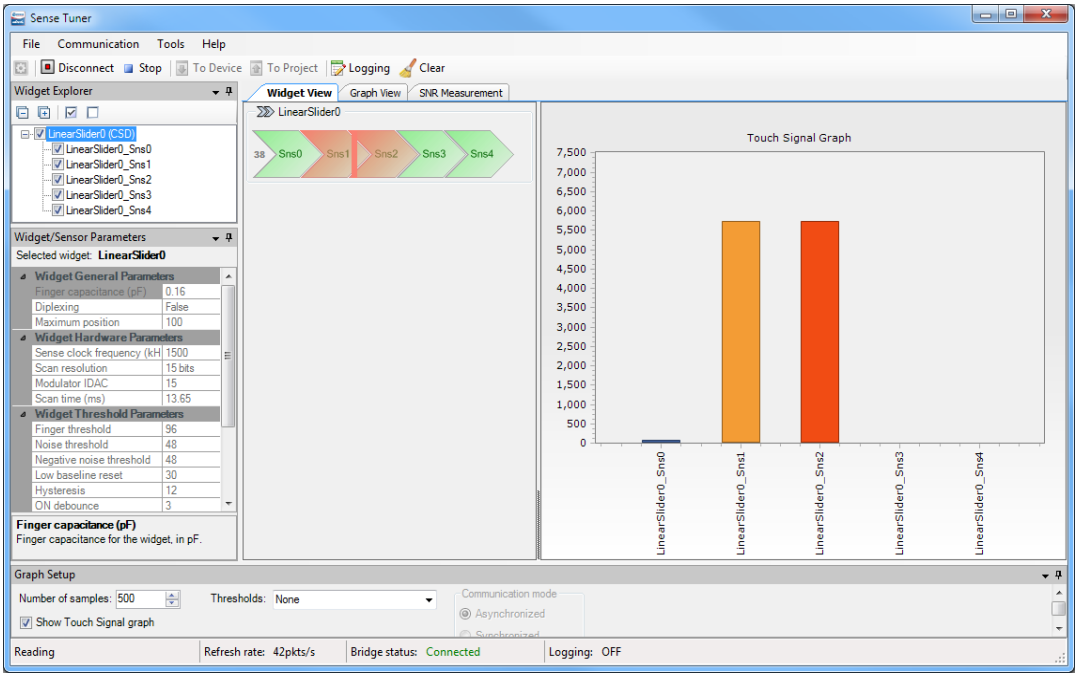
d. Click **Start** to start data streaming from the device. The tuner GUI displays data from the sensor in the widget view and Graph view tabs. See the CapSense Component datasheet for detailed information of tuner GUI. However, the following sections document a few quick examples on Tuner GUI usage.

4. **Monitor data in Tuner GUI:** The application consists of the following tabs:

a. **Widget View:** Displays the widgets, their touch status, and the touch signal bar graph. Widget sensors are highlighted in red color when the device reports their touch status as active. Some additional features are available depending on the widget type.

Touch Signal Graph: The Widget view also displays a Touch Signal Graph when the **Display Touch Signal graph** option is selected in the **Graph Setup Pane**. This graph contains a touch signal level for each sensor selected in the Widget Explorer Pane, as Figure 5 shows.

Figure 5. Tuner: Widget View



b. **Graph View:** Displays graphs for selected sensors in the Widget Explorer Pane as Figure 6 shows. The following charts are available:

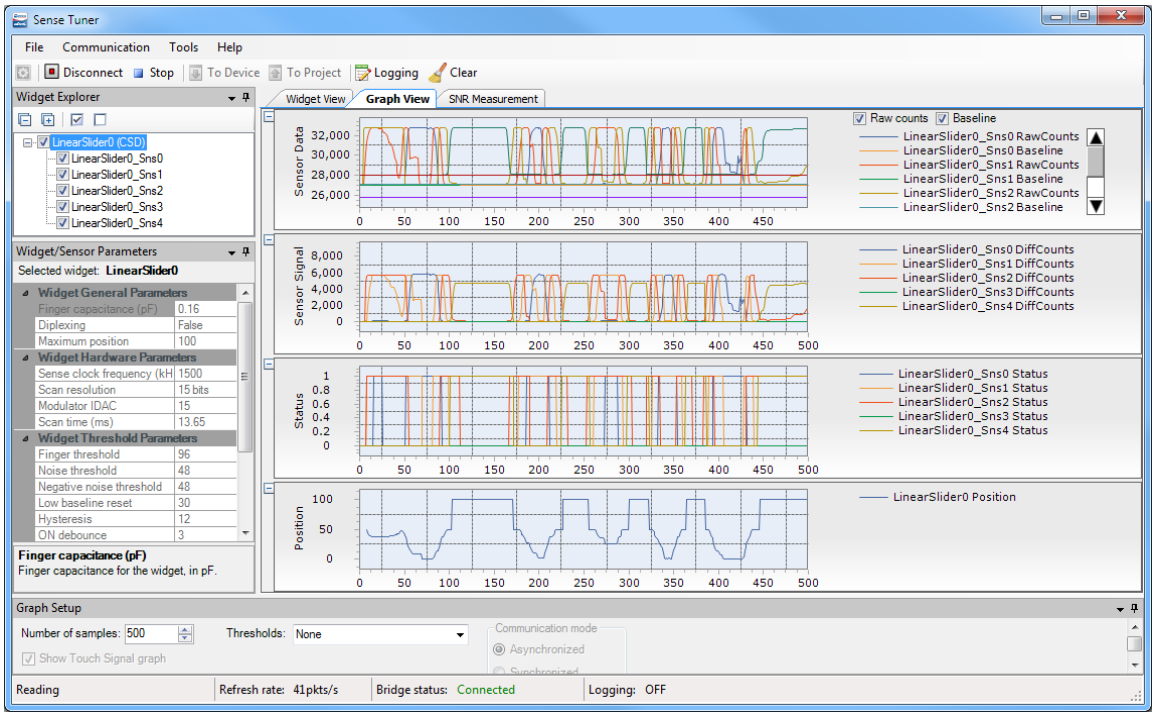
– **Sensor Data graph** – Displays raw counts and baseline. Use the checkboxes on the right to select the series to be displayed:
  - Raw counts and baseline
  - Raw counts
  - Baseline

– **Sensor Signal graph** – Displays a signal difference

– **Status graph** – Displays the sensor status (Touch/No Touch)

– **Position graph** – Displays touch positions for the Linear Slider, Radial Slider, and Touchpad widgets

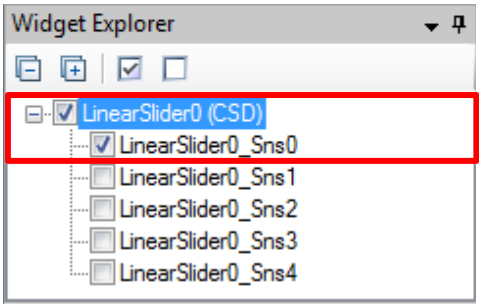
Figure 6. Tuner: Graph View



5. **Manual Parameter Tuning:**

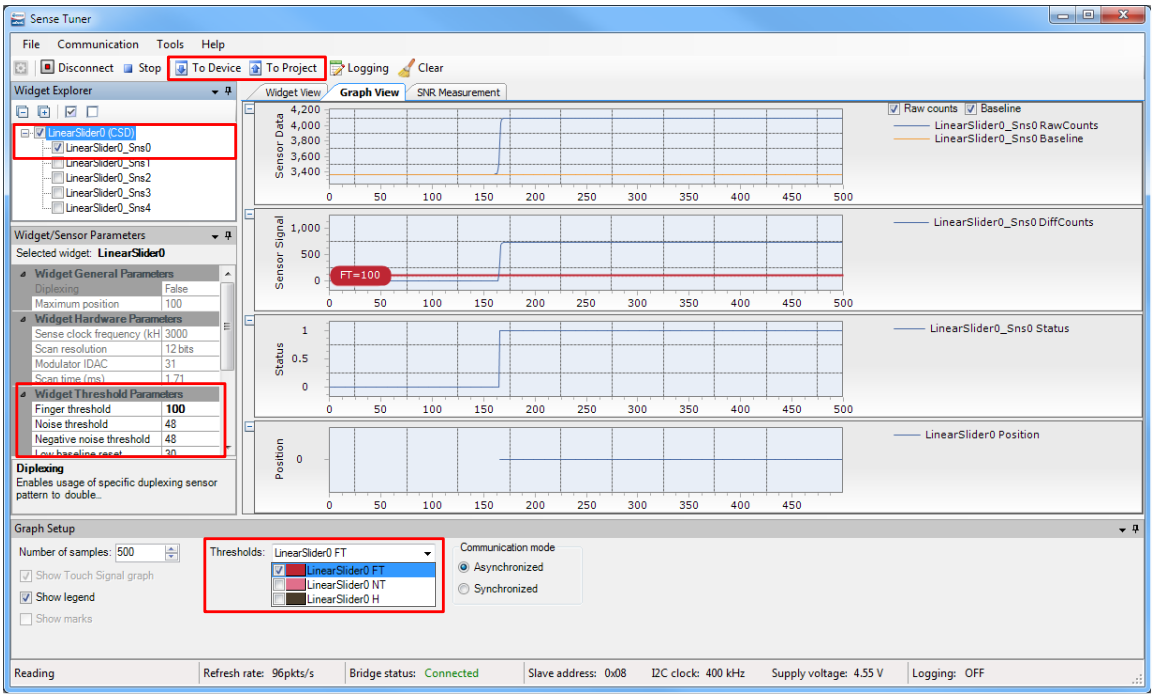
   a. Select one of the widget or sensors to display the parameters associated with sensor/widget.

Figure 7. Tuner: Sensor Selection



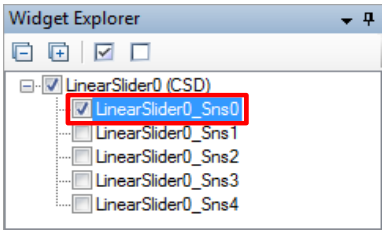
   b. Change the parameter value and press **Enter**. The new value is highlighted in bold. To apply the new value to the device, click **To Device**. The new value is applied to device and respective change is displayed in the device behavior. The **To Project** button applies the attest parameter to the CapSense Component Customizer in the project. The changes are applied after the Tuner is closed and the Customizer is opened. Changes to widget / sensor parameters made in the Tuner GUI are not automatically updated to the PSoC Creator project, unless specially saved.

Figure 8. Tuner: Manual Tuning



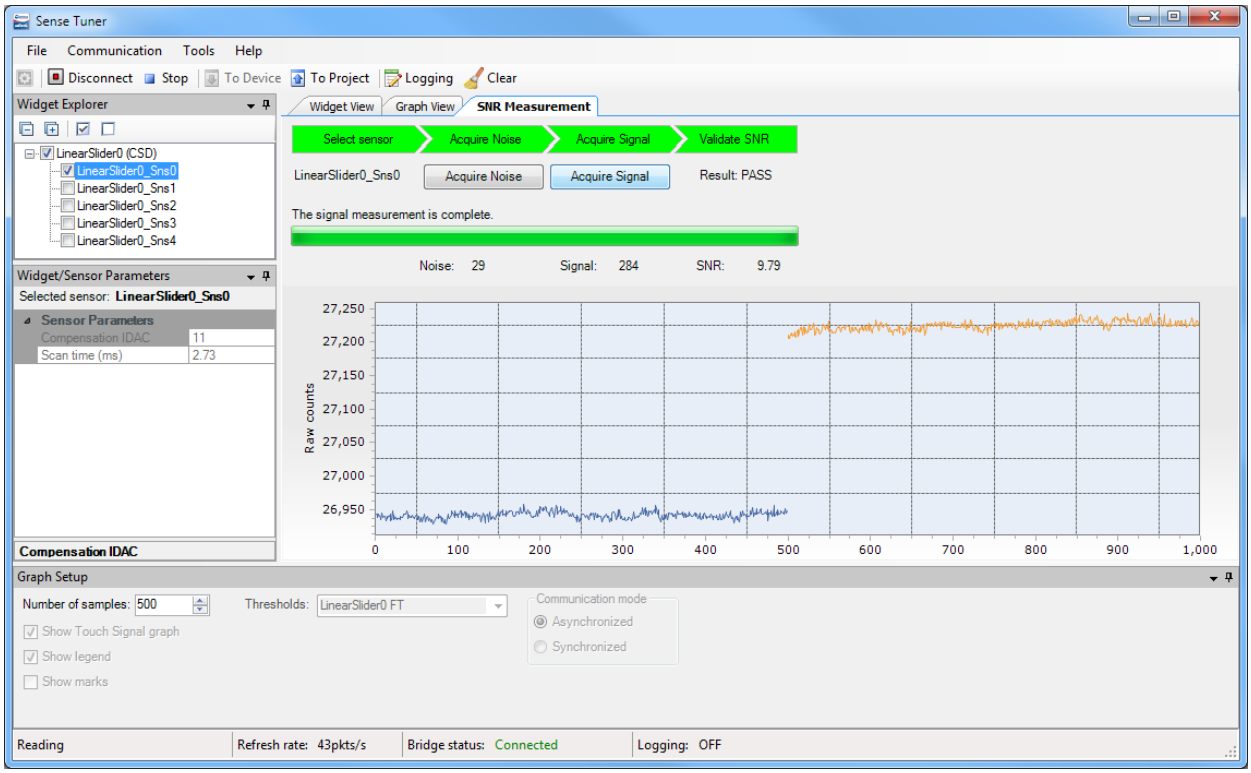
6. **SNR Measurement** – Provides the SNR measurement functionality.
   a. Select the sensor for SNR measurement.

Figure 9. Tuner: Select sensor for SNR Measurement



   b. Click on **Acquire Noise** and wait for noise measurement to complete (do not touch any sensor during noise measurement).
   c. Touch the selected sensor and click **Acquire Signal**. (Do not release the finger until signal measurement is completed).
   d. After noise and signal are measured, tuner GUI displays the SNR, as shown in Figure 10.

Figure 10. Tuner: SNR Measurement



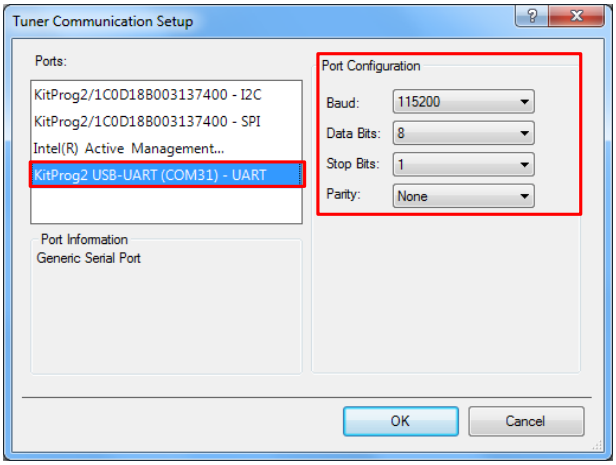
For more details on CapSense tuning, see CapSense Component datasheet and PSoC 4 and PSoC 6 MCU CapSense Design Guide.

Code example 2: CapSense Tuning over UART Interface

1. **Build project:** Build the project "PSoC4_CapSense_Tuner_UART" and program it into the PSoC 4 device. Choose **Debug** > **Program**. For more information on device programming, see PSoC Creator Help. Flash for both CPUs is programmed in a single program operation.
2. **Launch tuner GUI:** Right-click and select **Launch Tuner** from the CapSense instance context menu, as Figure 1 shows.
3. **Establish UART communication:** To establish communication between the tuner and a target device, configure the tuner communication parameters to match the UART Component parameters.
   a. Open the Tuner Communication Setup dialog by selecting **Tools** > **Tuner Communication Setup…** in the menu or clicking **Tuner Communication Setup** as Figure 2 shows.
   b. Select the appropriate UART communication device which is KitProg2 (or MiniProg3) and set the following parameters:
      - Baud: 115200
      - Data Bits: 8
      - Stop Bits: 1
      - Parity: None

      Note: The parameters in the Tuner Communication Setup must be identical to the parameters in the UART SCB Component Configure dialog.

Figure 11. Tuner: UART Communication Parameters Selection



   c. Click **Connect** to establish connection as Figure 4 shows. If the connection is set up correctly, the **Start** button turns active and, the status bar indicates the Bridge status as "Connected".
   d. Click **Start** to start data streaming from the device. The tuner GUI displays the data from sensor in the widget view and Graph view tabs. See the CapSense Component datasheet for a detailed information on the tuner GUI.
4. **Monitor data in Tuner GUI:** To monitor CapSense data using the Tuner application, follow Step 4 Monitor Data in Tuner GUI of code example 1. Manual parameter tuning option is not available because UART-based tuner interface provides only read-only access.

Design and Implementation

This example features CapSense with and liner slider(self-capacitance). Tuner GUI is used to visualize CapSense scanning data. I2C or UART is used to establish communication with the Tuner application.

Figure 12 and Figure 13 show the PSoC Creator schematic for this code example.

Figure 12. TopDesign Schematic of PSoC4_CapSense_Tuner_I2C

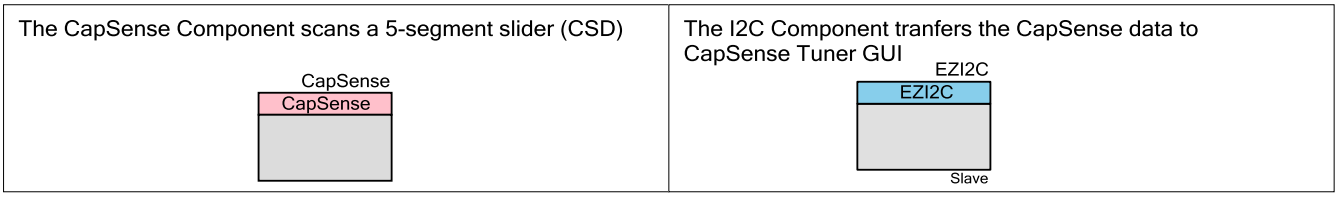
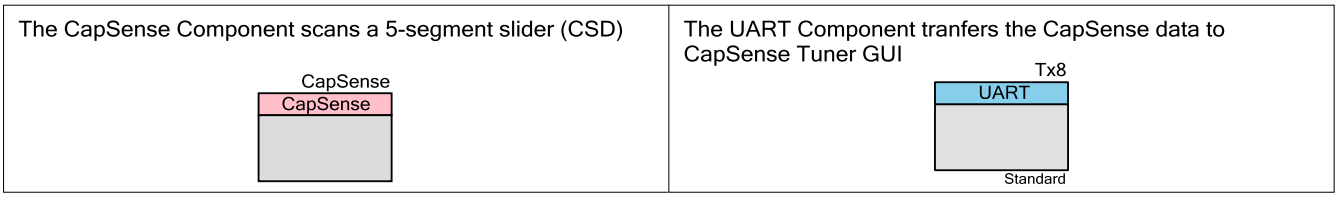


Figure 13. TopDesign Schematic of PSoC4_CapSense_Tuner_UART



Components and Settings

Table 1 lists the PSoC Creator Components used in this example, how they are used in the design, and the non-default settings required so they function as intended.

Table 1. PSoC Creator Components

Component	Instance Name	Purpose	Non-default Settings
CapSense	CapSense	The CapSense Component is configured to scan a 5-segment slider (CSD	See Parameter Settings
UART	Tx8	To establish communication with the Tuner application	TX/RX Mode: Tx only
EZI2C	EZI2C	To establish communication with the Tuner application	Data Rate (kbps): 400 Sub-address size (bits): 16

For information on the hardware resources used by a Component, see the Component datasheet.

Parameter Settings

Figure 14 and show the modified settings for the CapSense Component.

Figure 14. CapSense: Basic Tab

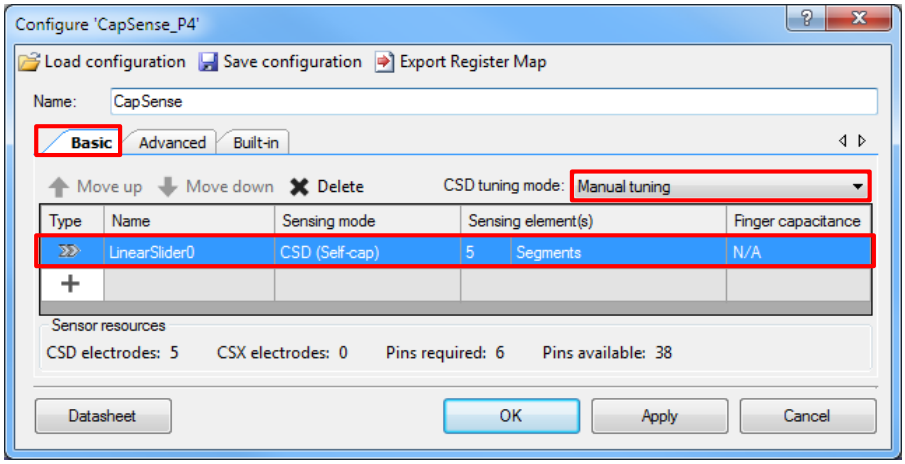


Table 2 and Table 3 show the pin assignments for the project done through the **Pins** tab in the **Design Wide Resources** window for code example 1 and code example 2 respectively. These assignments are compatible with CY8CKIT-042-BLE.

Table 2. Pin Assignments for Code Example 1

Pin Name	CY8CKIT-042-BLE
CapSense:Cmod	P4[0]
CapSense:Sns[0]	P2[1]
CapSense:Sns[1]	P2[2]
CapSense:Sns[2]	P2[3]
CapSense:Sns[3]	P2[4]
CapSense:Sns[4]	P2[5]
EZI2C:scl	P3[5]
EZI2C:sda	P3[4]

Table 3. Pin Assignments for Code Example 2

Pin Name	CY8CKIT-042-BLE
CapSense:Cmod	P4[0]
CapSense:Sns[0]	P2[1]
CapSense:Sns[1]	P2[2]
CapSense:Sns[2]	P2[3]
CapSense:Sns[3]	P2[4]
CapSense:Sns[4]	P2[5]
Tx8:tx	P1[5]

Reusing This Example

This example is designed for the CY8CKIT-042-BLE Pioneer Kit. To port the design to a different PSoC 4 device and/or kit, change the target device using **Device Selector** and update the pin assignments in the **Design Wide Resources Pins** settings as needed. Table 4 shows the pin assignment for different PSoC 4 kits.

Table 4. Pin Assignment for PSoC 4 kits

Pin Name	CY8CKIT-042-BLE	CY8CKIT-042	CY8KIT-149	CY8KIT-145
CapSense:Cmod	P4[0]	P4[2]	P4[2]	P4[2]
CapSense:Sns[0]	P2[1]	P1[1]	P2[7]	P0[0]
CapSense:Sns[1]	P2[2]	P1[2]	P6[0]	P0[1]
CapSense:Sns[2]	P2[3]	P1[3]	P6[1]	P0[2]
CapSense:Sns[3]	P2[4]	P1[4]	P6[2]	P0[3]
CapSense:Sns[4]	P2[5]	P1[5]	P6[4]	P0[6]
Tx8:tx	P1[5]	P0[5]	P7[1]	P3[1]
EZI2C:scl	P3[5]	P3[0]	P3[0]	P1[0]
EZI2C:sda	P3[4]	P3[1]	P3[1]	P1[1]

Related Documents

Application Notes	
AN91267 – Getting Started with PSoC® 4 BLE	Describes PSoC 4 with BLE Connectivity devices and how to build your first PSoC Creator project
AN79953 – Getting Started with PSoC® 4	Describes PSoC 4 devices and how to build your first PSoC Creator project
AN85951 – PSoC® 4 and PSoC 6 MCU CapSense® Design Guide	Describes CapSense operation, CapSense design tools, performance tuning of the PSoC Creator™ CapSense CSD Component and design considerations.
AN64846 – Getting Started with CapSense®	Describe key design considerations and layout best practices for CapSense design.
PSoC Creator Component Datasheets	
CapSense	Provides guidelines to use the CapSense component.
UART	Provides asynchronous communications
Device Documentation	
PSoC 4 Datasheets	PSoC 4 Technical Reference Manuals
Development Kit (DVK) Documentation	
CY8CKIT-042-BLE PSoC 4 BLE Pioneer Kit	

Document History

Document Title: CE195286 – PSoC 4 CapSense Tuner

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5423009	WESL	09/01/2016	New Spec
*A	6088713	AJYA	04/06/2018	Updated the project to PSoC Creator 4.2 Added code example to demonstrate Tuner GUI interface using UART

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