CY3218-CAPEXP2 CapSense® Express™ Evaluation Kit Guide

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1. Introduction

1.1 Overview

The CY3218-CAPEXP2 CapSense® Express™ Evaluation Kit is used to evaluate the CapSense Express device. This kit demonstrates the following features: CapSense buttons, LED drive, digital input, and I2C. The CapSense Express device is configured via a system-level project in PSoC® Designer™. A 16-pin QFN package device is mounted on the board. The board is powered with a AAA battery. A boost converter converts the input, in the range of 1.1 V to 1.5 V, to the device operating voltage of 3.3 V. The board can also be powered using the CY3240-I2USB bridge connected to the I2C header.

1.2 Kit Contents

The CY3218-CAPEXP2 CapSense Express Evaluation Kit includes:

- CY3218-CAPEXP2 CapSense Express Evaluation Board
- CY3240-I2USB Bridge Board
- USB A to Mini-B cable
- AAA battery
- 1 mm acrylic overlay
- Quick Start Guide
- Kit CD, which includes
  - PSoC Designer IDE
  - Bridge Control Panel software
  - CapSense Express datasheets
  - Kit release notes
  - Kit user guide
  - Software release notes
  - Code example documentation
  - Hardware design files
  - Sample silicon CY8C201A0-LDX2I (5 numbers)

1.3 Default Jumper Settings

Jumper (J2) on the CY3218-CAPEXP2 CapSense Express Evaluation Kit board configures the power setting for the board.

- Default position for J2: Jumper on pin 1 and 2; this enables powering the board via the CY3240-I2USB bridge.
- To power the board via battery, remove the jumper at J2.

1.4 Additional Resources

Visit http://www.cypress.com for additional learning resources in the form of datasheets, technical reference manual, and application notes.

- Getting Started with CapSense

This guide is an ideal starting point for those new to capacitive touch sensing (CapSense) as well as for learning key design considerations and layout best practices to ensure design success.

1.5 Documentation Conventions

Table 1-1. Document Conventions for Guides

Convention	Usage
`Courier New`	Displays file locations, user entered text, and source code: `C:\ ...cd\icc\`
Italics	Displays file names and reference documentation: Read about the *sourcefile.hex* file in the *PSoC Designer User Guide*.
[**Bracketed, Bold**]	Displays keyboard commands in procedures: [**Enter**] or [**Ctrl**] [**C**]
File > Open	Represents menu paths: File > Open > New Project
Bold	Displays commands, menu paths, and icon names in procedures: Click the **File** icon and then click **Open**.
Times New Roman	Displays an equation: 2 + 2 = 4
Text in gray boxes	Describes cautions or unique functionality of the product.

2. Getting Started

2.1 Hardware

The following figure illustrates the CY3218-CAPEXP2 CapSense Express Evaluation Kit board features.

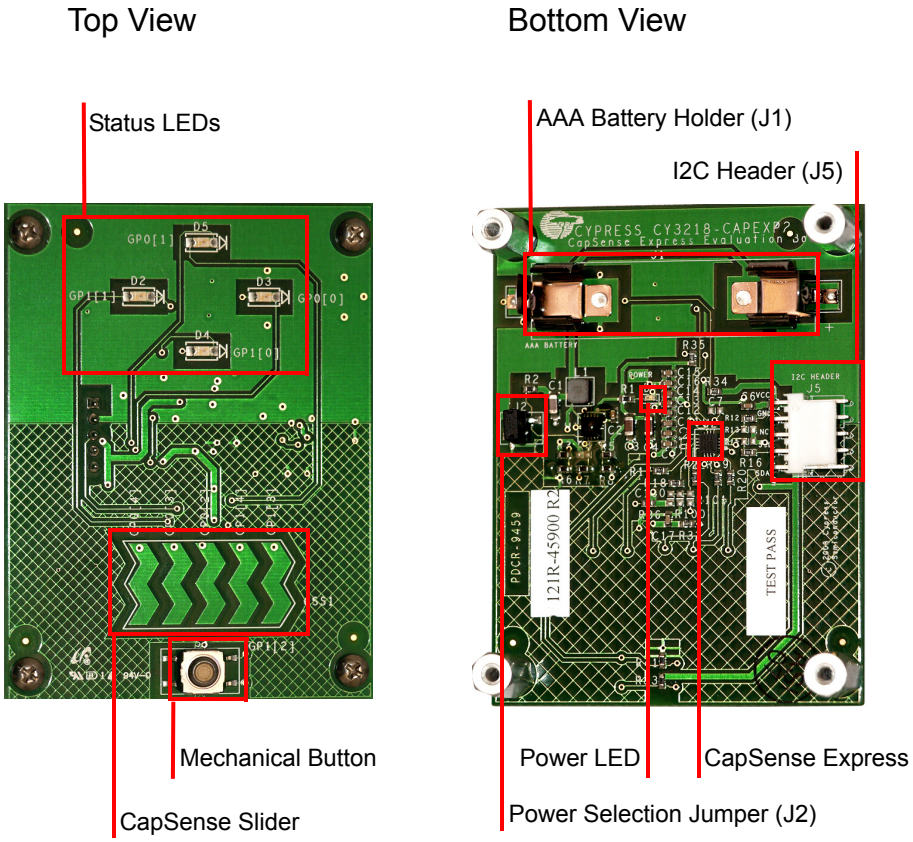
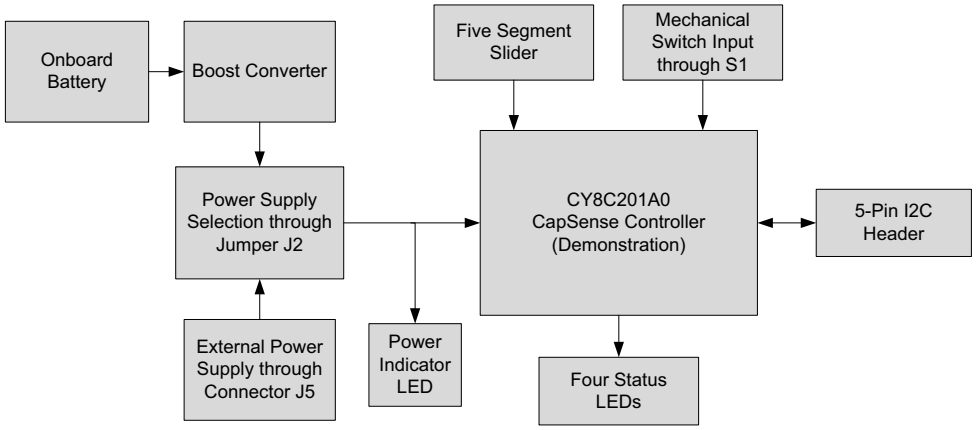


Figure 2-1 shows the block diagram of the CY3218-CAPEXP2 CapSense Express Evaluation Kit. The block diagram has two main sections, power supply and CapSense controller. The power supply section is based on the onboard battery power. The 1.5 V battery voltage is converted into 3.3 V with boost converter because the CapSense controller does not work below 2.4 V. The connector J2 provides an option to power the kit from the onboard battery or an external power source, which must be connected to the J5 connector. An LED indicates the power status of the kit.

A five-segment CapSense-based slider indicates the positional values using the four LEDs connected to the GPIOs of CapSense Express. A mechanical switch, which demonstrates the capability of CapSense Express to read the status of external signals, is also provided with the kit. The CapSense Express controller can be configured and controlled through the I2C interface; therefore, a 5-pin header is provided for the I2C interface.

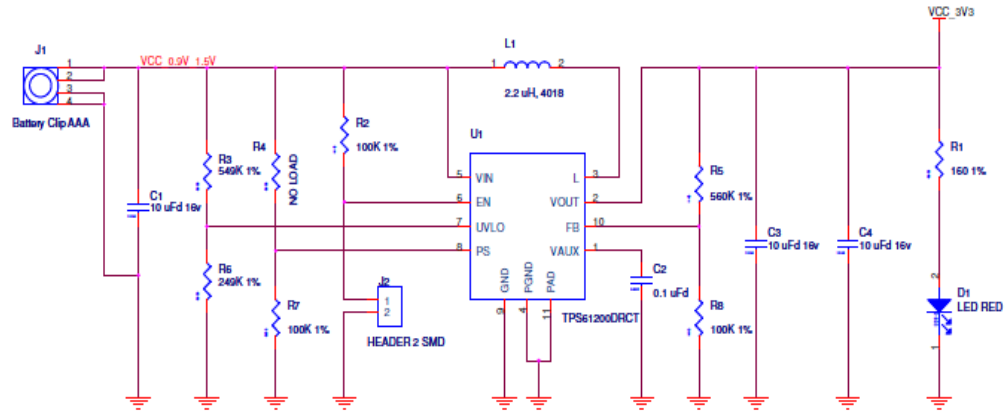
Figure 2-1. CY3218-CAPEXP2 CapSense Express Evaluation Kit Block Diagram



2.1.1 Power Supply System

The CY8C201A0 chip is a low-power CapSense Express Controller, which can be powered from a single 1.5 V AAA battery. The CapSense Express controller can work only from 2.4 V to 5.5 V power supply; therefore, a boost converter is used in the kit to generate the 3.3 V power supply required from the 1.5 V battery.

Figure 2-2. Power Supply System



Boost Regulator, 0.9V to 1.5V Input, 3.3V, 200mA Output

The jumper J2 provides power on/off control for the kit. When the jumper is inserted, the Enable Input (EN) pin of the boost converter is connected to ground, which cuts off power to the kit. Removing the jumper J2 connects the EN pin to VDD, to power the kit. The LED turns on when the kit is powered.

2.1.2 Slider and Mechanical Button

Figure 2-3. Input Schematic (Slider and Mechanical Button)

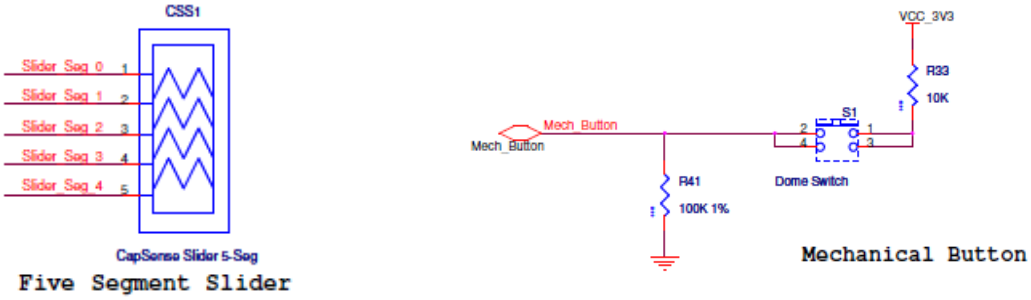
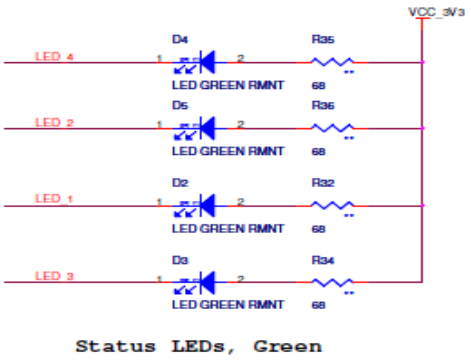


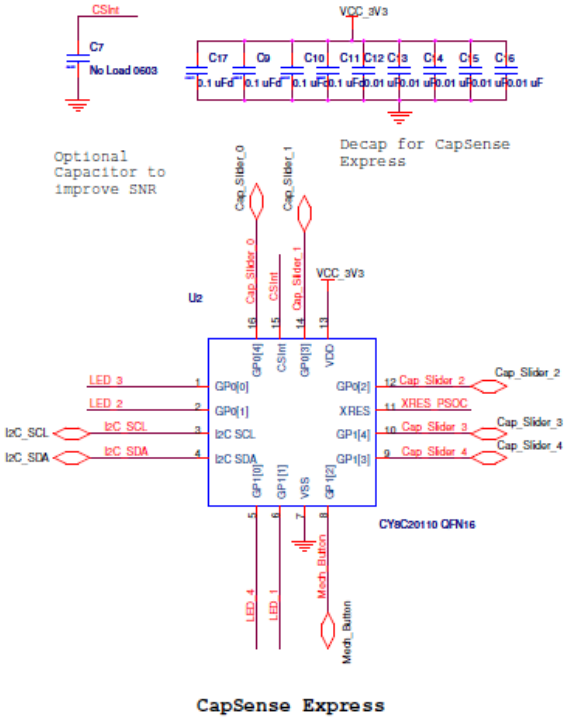
Figure 2-4. LED Schematic



2.1.3 CapSense Controller

The CapSense Express controller chip is connected to two input sections and one output section. The five-segment slider and mechanical button provides input to the chip through the I2C interface. The output is provided through the status LEDs, which turn green. The mechanical button also provides the signal with mechanical on/off similar to the slider.

Figure 2-5. CapSense Controller Schematic



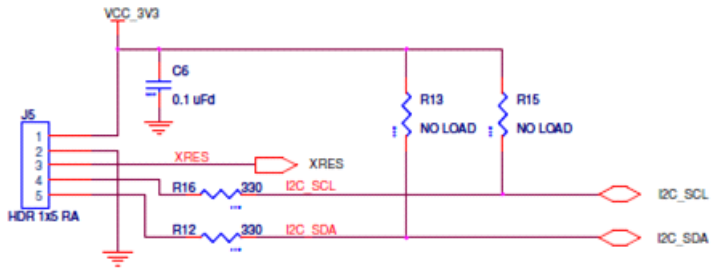
2.1.4 I2C Interface

The CY3218-CAPEXP2 CapSense Express Evaluation Kit has the 5-pin header J5 for I2C interface. The I2C interface is used to connect the CapSense controller with the host system to monitor the sensor status and configure the CapSense controller according to system requirements. The sensor is also tuned during the design stage using the I2C interface and the CY3240-I2USB Bridge tool.

I2C communication needs pull-up resistors, both SCL and SDA signals, on the master or slave side. The kit hardware has footprints R13 and R15 (no-load components by default) to populate pull-up resistors if they are not available on the master side.

The CapSense Express controller supports 50 kHz, 100 kHz, and 400 kHz data transfer speed for the I2C interface.

Figure 2-6. I2C Interface Schematic



3. Installation

3.1 Install Hardware

CAUTION Make sure you do not touch the board anywhere other than the edges or on the buttons. Touching the board in the wrong area can lead to a short and an unresponsive board. If this happens, reset power to the board. To do this, disconnect the battery supply by placing the jumper on J2. To power the board again, remove the jumper from J2.

The CY3218-CAPEXP2 CapSense Express Evaluation Kit is preprogrammed with demonstration firmware. These instructions assume that your board is not reconfigured from the factory settings. If it has, follow the instructions given in Create Project with CY3218-CAPEXP2 on page 21 to configure the board.

1. Unpack the CY3218-CAPEXP2 CapSense Express Evaluation Kit.
2. Insert the AAA battery into the battery holder.
3. Remove the jumper from J2 (back, left, and center of board).
4. Observe that the status LED D5 flashes and the red LED, D1, on the back of the board lights up.
5. Slide a finger over the CapSense slider to light the LEDs D2, D3 and D4. Also, the status LED D5 stops blinking while the slider is used.
6. Turn the board off by replacing the jumper on J2. Note that replacing the jumper disables battery operation.

3.2 Install Software

Install the software required to load and run the code examples.

3.2.1 Before You Begin

All Cypress software installations require administrator privileges, but this is not required to run the installed software.

1. Shut down all Cypress software that is currently running.
2. Disconnect ICE-Cube or MiniProg1 devices from your computer.

Note that CapSense Express runs on an older version of PSoC Designer (PD5.0). Therefore, both versions of PSoC Designer are required - PD5.0 for CapSense Express and PD5.1 for all other devices.

3.2.2 Installing Software

To use the CY3218-CAPEXP2 CapSense Express Evaluation Kit, you need:

- PSoC Designer 5.0 SP6
- PSoC Programmer 3.13.3 or later
- Bridge Control Panel 1.3 or later (packaged with PSoC Programmer)

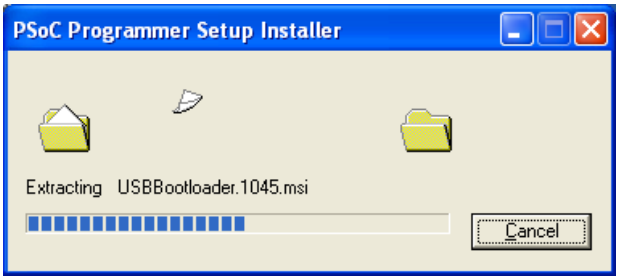
If PSoC Designer (versions older than PD5.0 SP6), PSoC Programmer (versions older than PP3.13.3), and Bridge Control Panel (versions older than BCP1.3) are currently installed, uninstall the same before reinstalling. To uninstall, go to **Start > Control Panel > Add or Remove Programs** and click the **Remove** button adjacent to the particular software. Follow the instructions to uninstall.

Follow these steps to install the software:

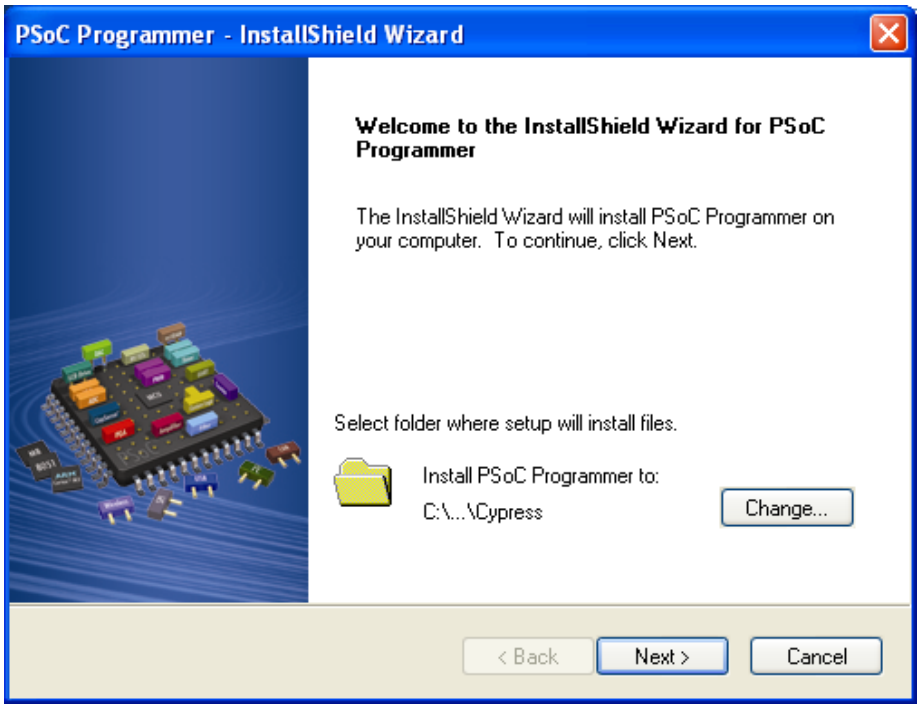
1. Insert the kit CD/DVD into your PC's CD/DVD-ROM drive. Click **Install PSoC Programmer 3.13.3…** on the installation startup screen.



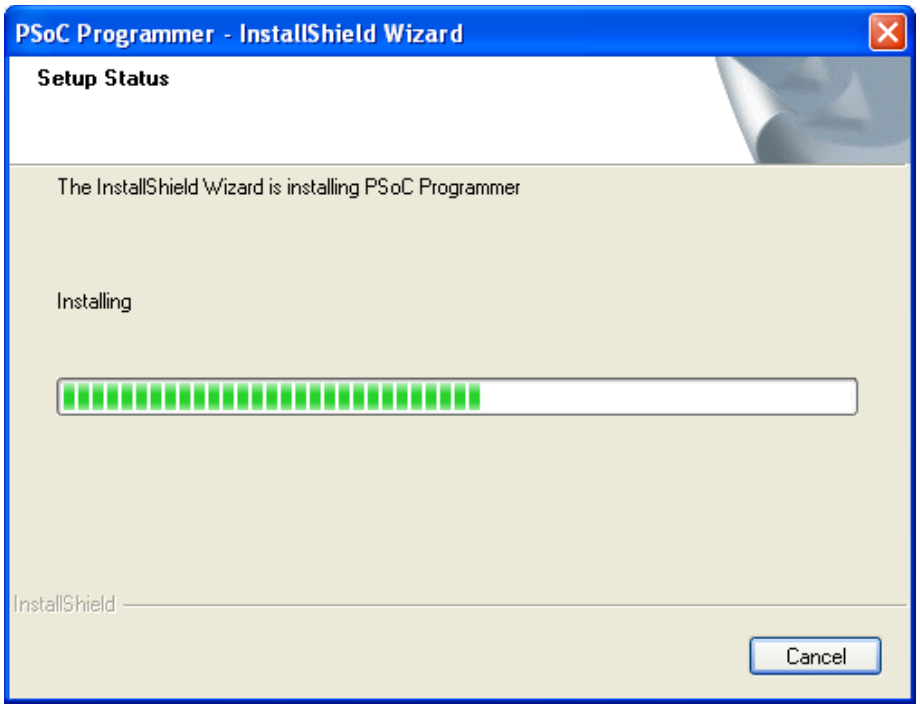
2. Wait for the installer to copy all the necessary files to a temporary folder.



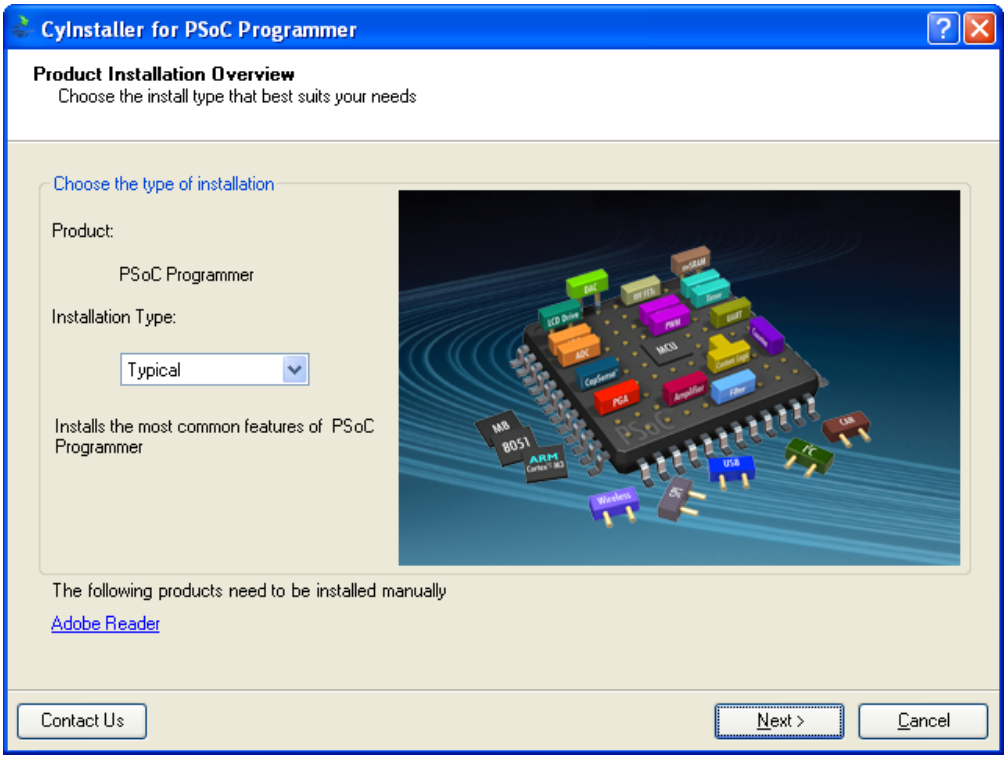
3. Click **Next** to install in the default location. To change the location, click the **Change** button.



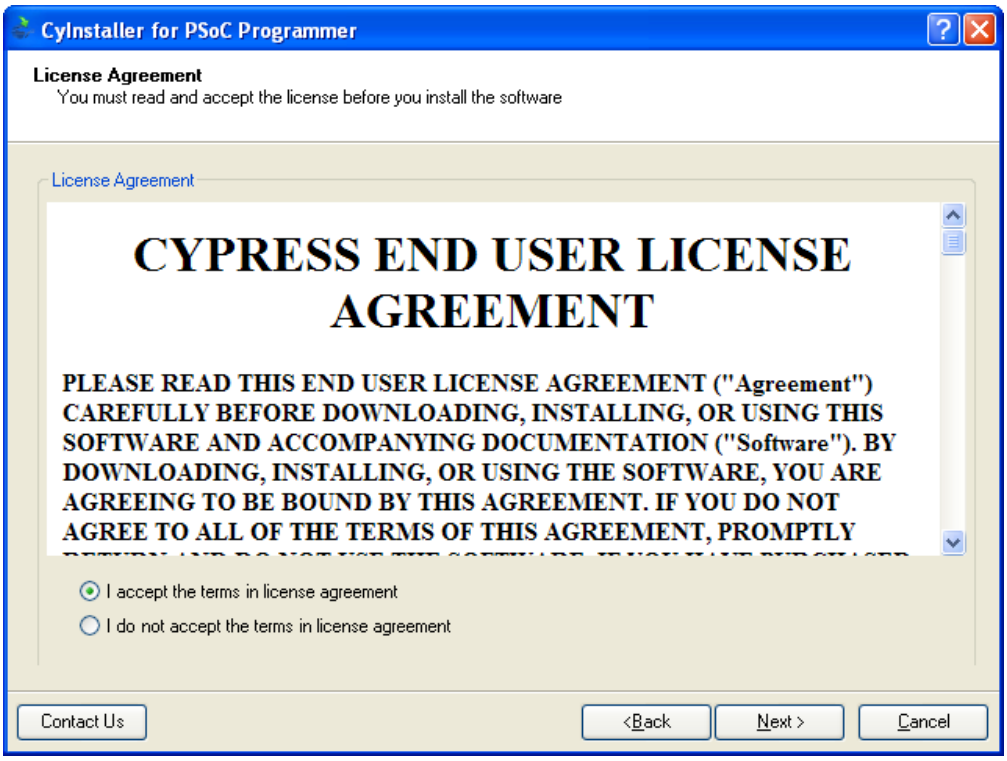
4. Wait for the installation to complete.



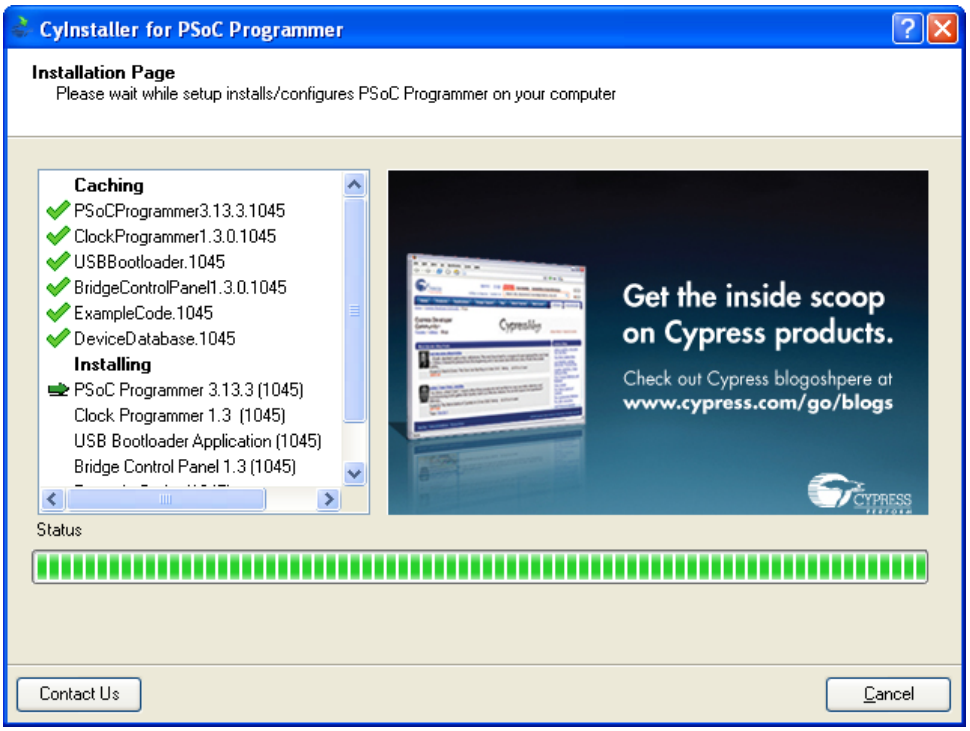
5. The CyInstaller window for PSoC Programmer is displayed when the installer is ready. Select **Typical** in the **Installation Type** options list and click **Next** to proceed.



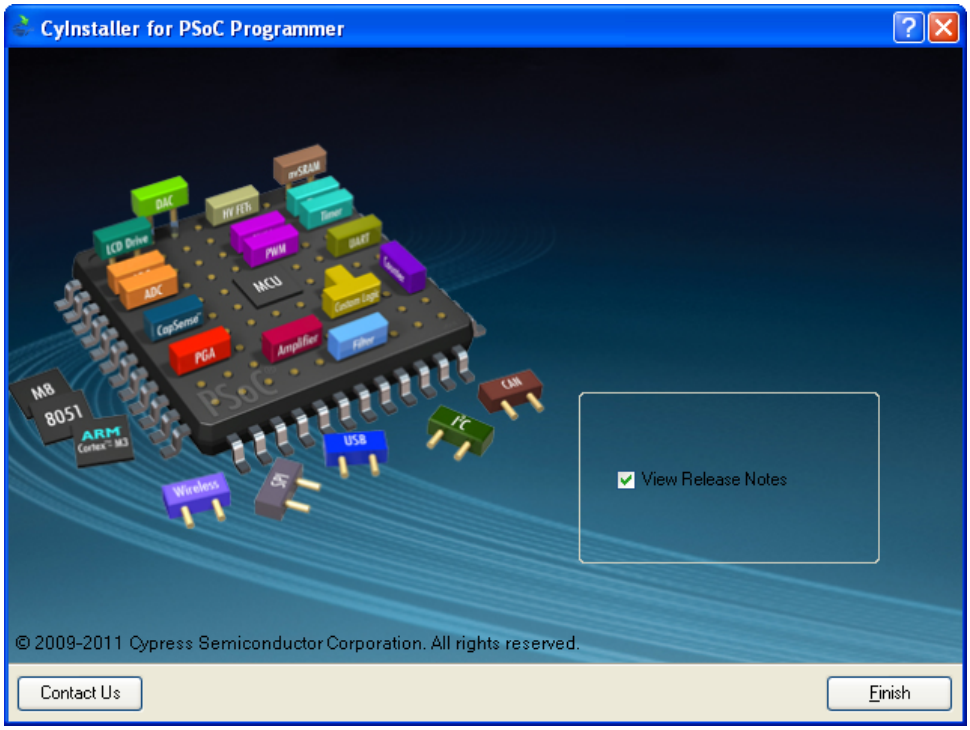
6. Read the Software License Agreement and select **I accept the terms in the license agreement**; click the **Next** button.



7. Wait for the installation to complete.



8. Click **Finish** to complete the installation. Select the **View Release Notes** option to open the release notes after the installer window closes.

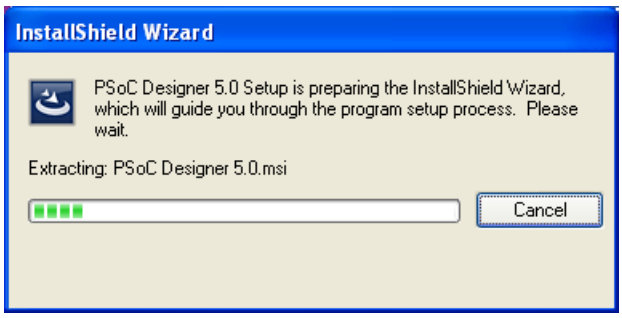


9. Click **Install PSoC Designer 5.0…** in the installer startup screen.

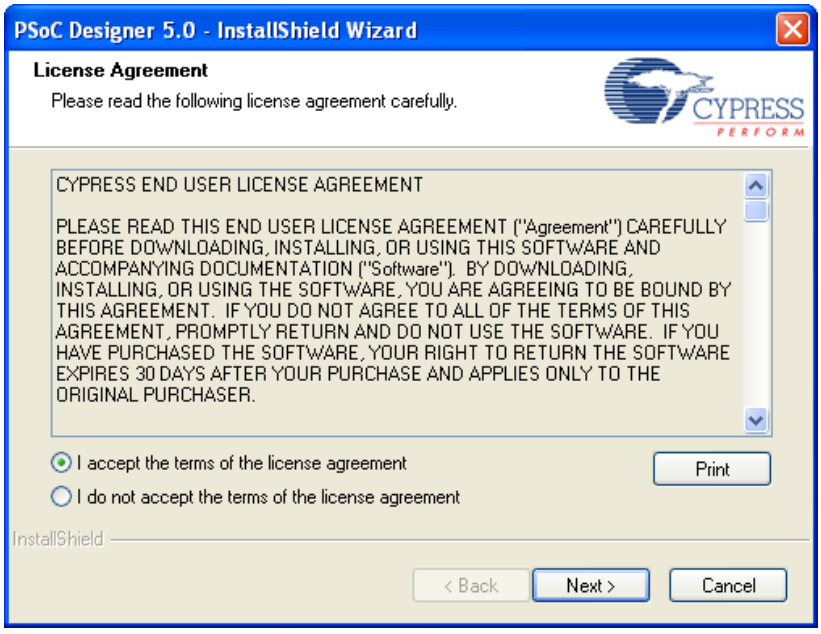


Note If the installer does not start automatically, start it manually by executing *cyautorun.exe* in the CD/DVD's root directory.

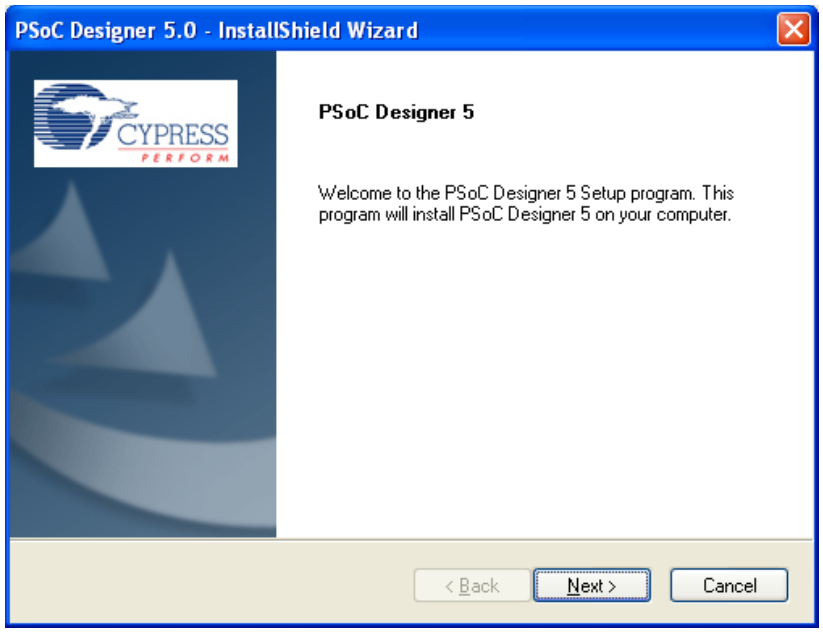
10. Wait for the installer to copy all the necessary files to a temporary folder.



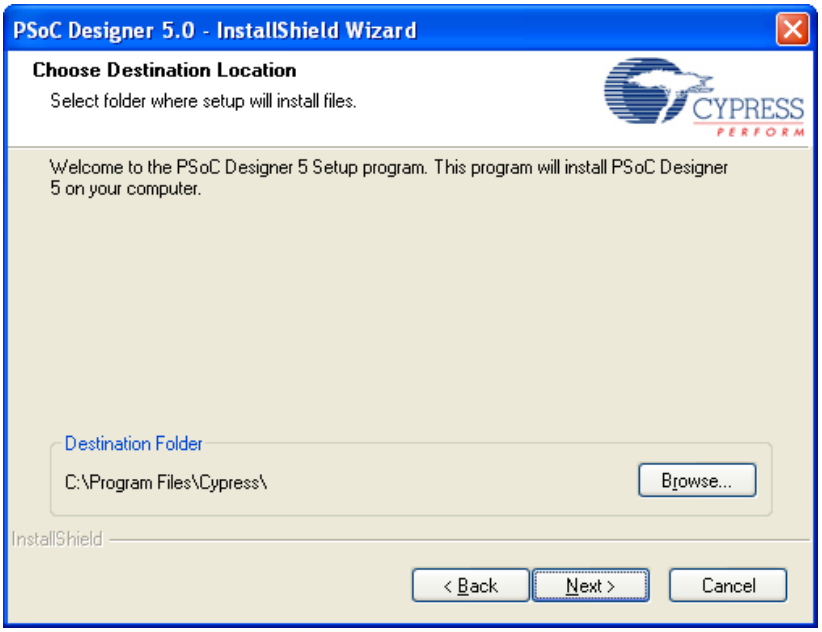
11. Read the Software License Agreement and select **I accept the terms of the license agreement**; click the **Next** button.



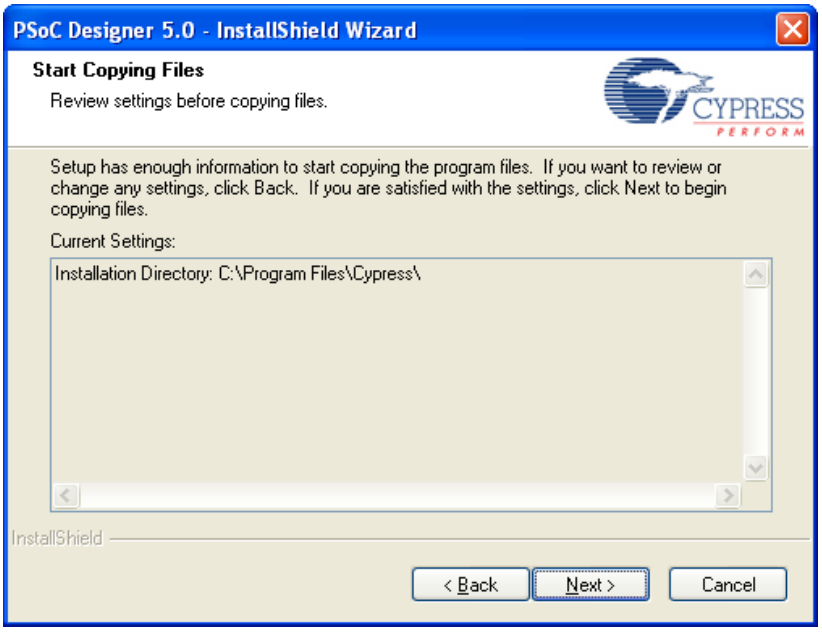
12. Click **Next** to proceed with the Installation.



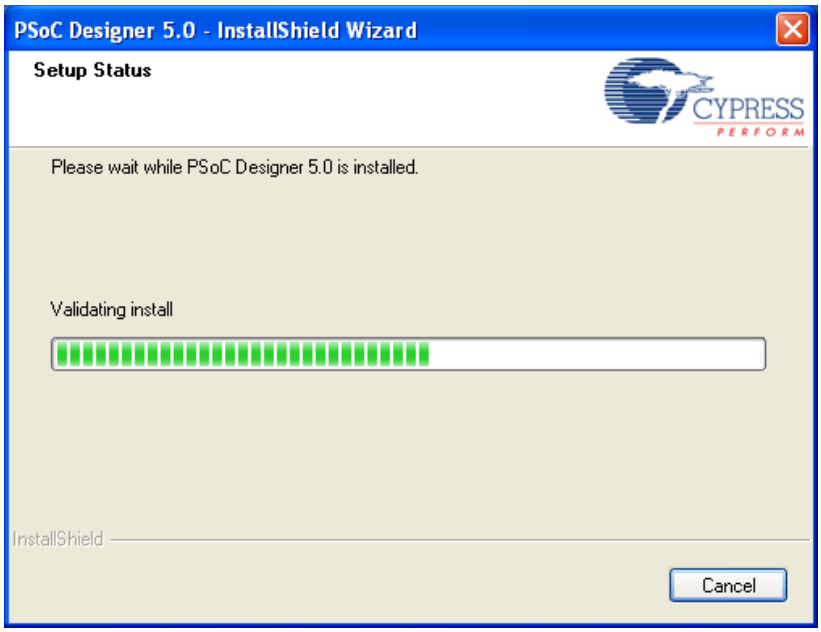
13. Click **Next** to install in the default location. To customize the install location, click on the **Browse** button and navigate to the respective directory.



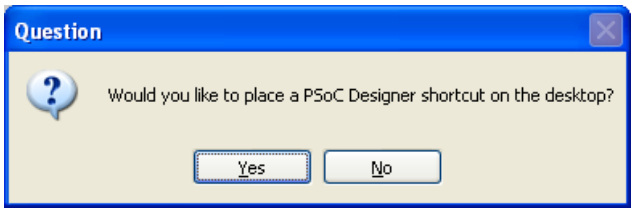
14. Review the settings before starting the installation. Click **Back** to change the settings, if required. Otherwise, click **Next** to start the installation.



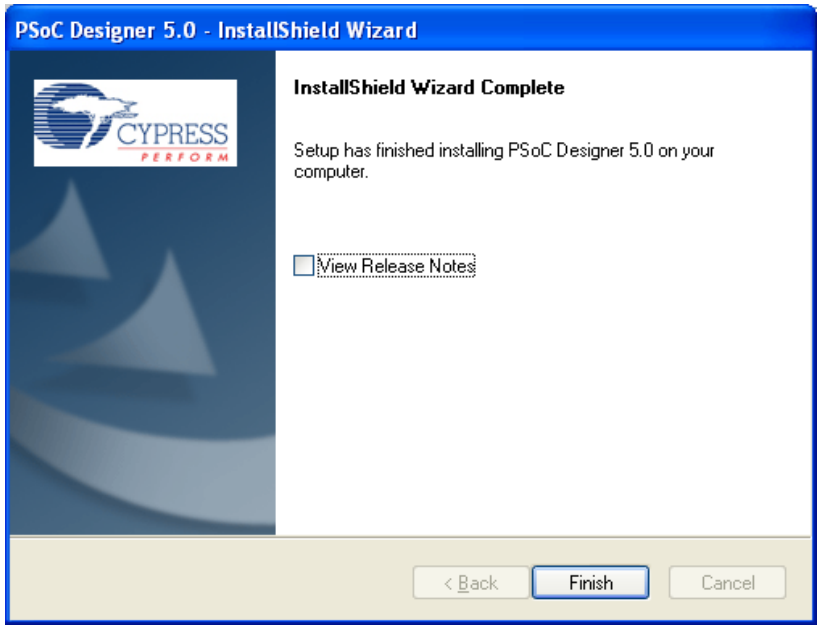
15. Wait for the PSoC Designer 5.0 installation to complete.



16. Click **Yes** if you want a shortcut to PSoC Designer on your desktop; click **No** to continue with the installation.



17. Click **Finish** to complete the installation. Select the **View Release Notes** option to open the Release Notes after completing the installation.



3.2.2.1 PSoC Designer Overview

PSoC Designer is the revolutionary integrated design environment (IDE) that helps you to customize PSoC to meet your specific application requirements. PSoC Designer accelerates system bring-up and time-to-market. Develop your applications using a library of pre-characterized analog and digital peripherals in a drag-and-drop design environment. Then, customize your design leveraging the dynamically generated API libraries of code. Finally, debug and test your designs with the integrated debug environment including in-circuit emulation and standard software debug features.

To open the application, click **Start > All Programs > Cypress > PSoC Designer <version>> PSoC Designer <version>**.

For instructions on creating and developing firmware projects for CapSense Controller in PSoC Designer, see the *IDE User Guide.pdf* available at the following location:
`<Install_directory>:\PSoC Designer\<version>\Documentation\`.

4. Create Project with CY3218-CAPEXP2

4.1 Functional Description

The board consists of one five-segment CapSense slider and four status LEDs associated with the slider. It also has a mechanical button. The status LEDs 1 to 3 light up when a finger is moved over the slider. The device enters into sleep mode if no sensor or mechanical button is touched. When the device is in sleep mode, the fourth LED toggles its state. If the device is not in sleep mode, the LED is continuously on to indicate the same.

The completed project is available in `<CD_root>:\Program\CapSenseSlider\`.

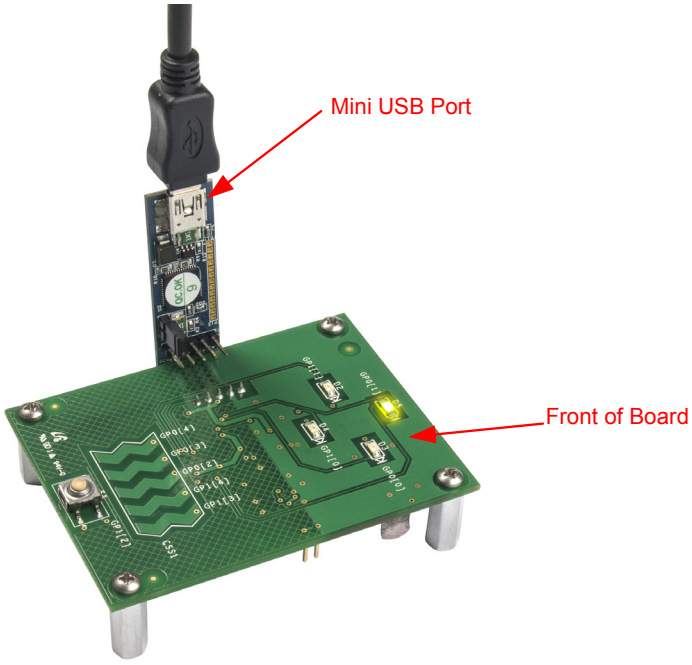
The CY3240-I2USB Bridge is used to transfer the configurations done in PSoC Designer to the PSoC device on the board. The CY8C201A0 device in this kit is an I2C communication-enabled device for CapSense configuration, reading the status and data registers of the device, and so on. See the device datasheet for more details.

The I2USB Bridge is used to monitor and tune the CapSense parameters; these parameters can be transferred to the device from the GUI through the I2USB Bridge without reprogramming the device.

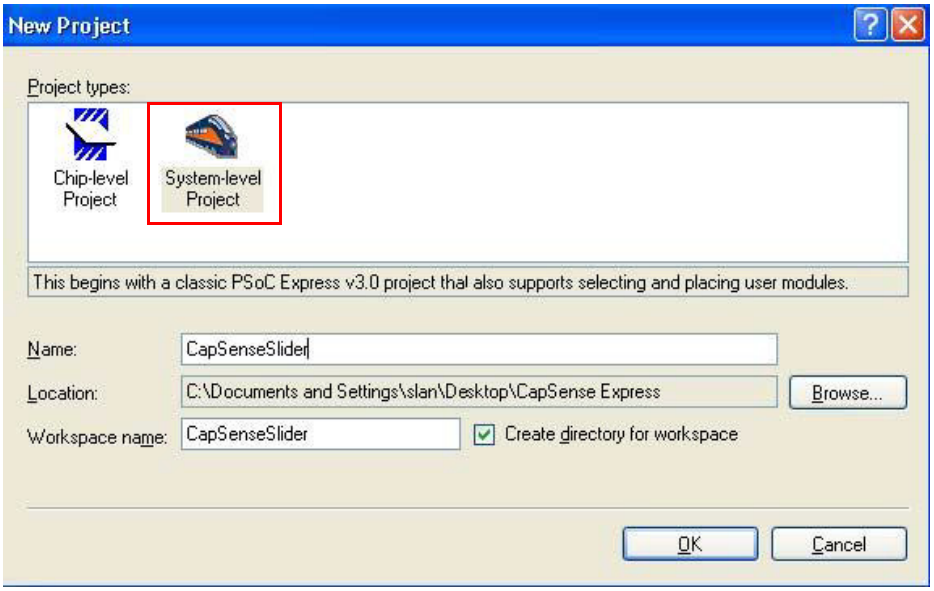
4.2 Create New Project

1. Connect your computer to the CapSense test board I2C connector (J5) using the CY3240-I2USB Bridge and a USB cable, as shown in Figure 4-1.

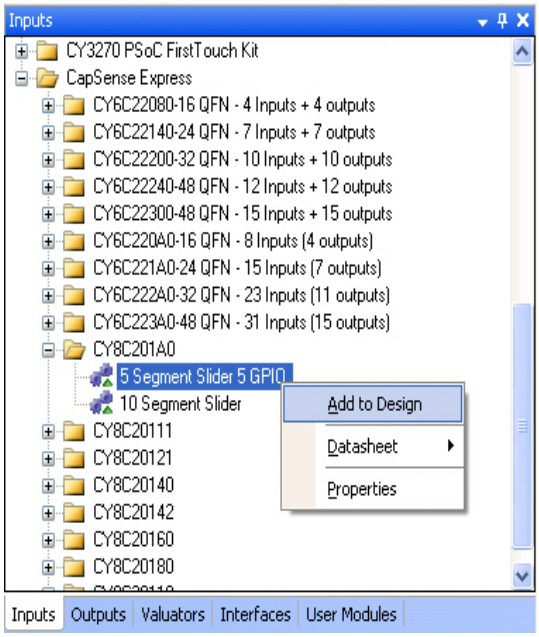
Figure 4-1. CY3240-I2USB Connection to CY3218-CAPEXP2 Kit



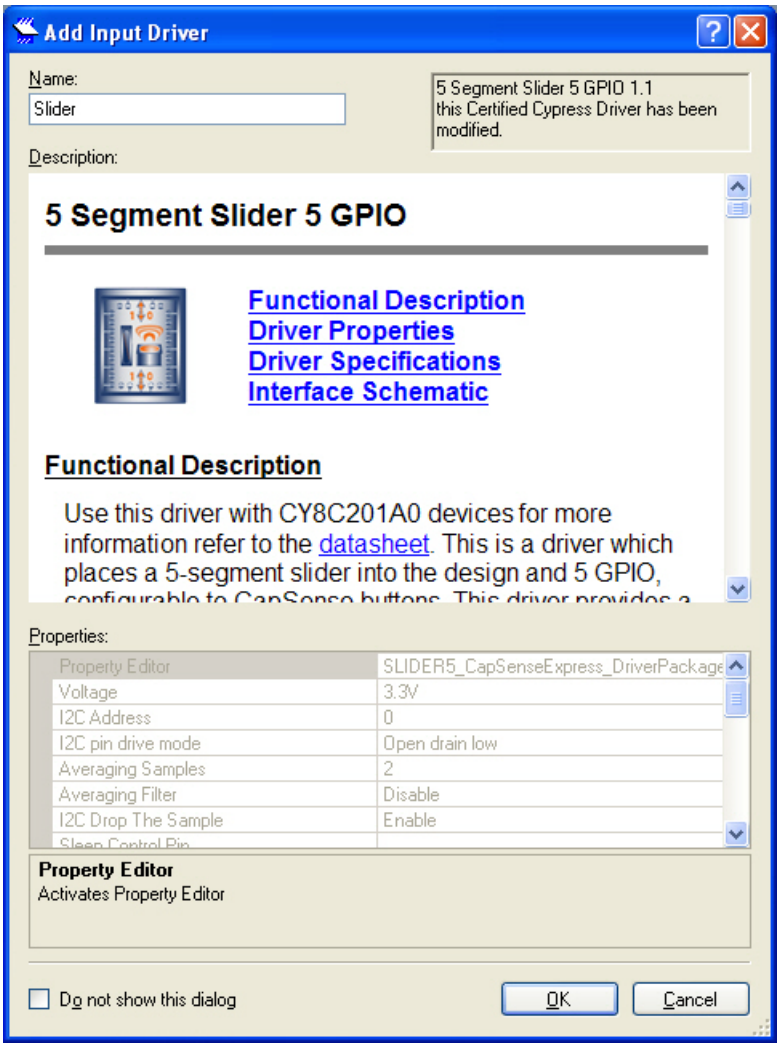
2. Ensure that the jumper J2 at the back of the board is open and the red LED, D1, is ON.
3. Launch **PSoC Designer**.
4. To create a new project, click on **File > New Project**.
5. Select the **System-level Project** icon in **Project types**; name the project 'CapSenseSlider' and save it to a location of your choice on the computer.



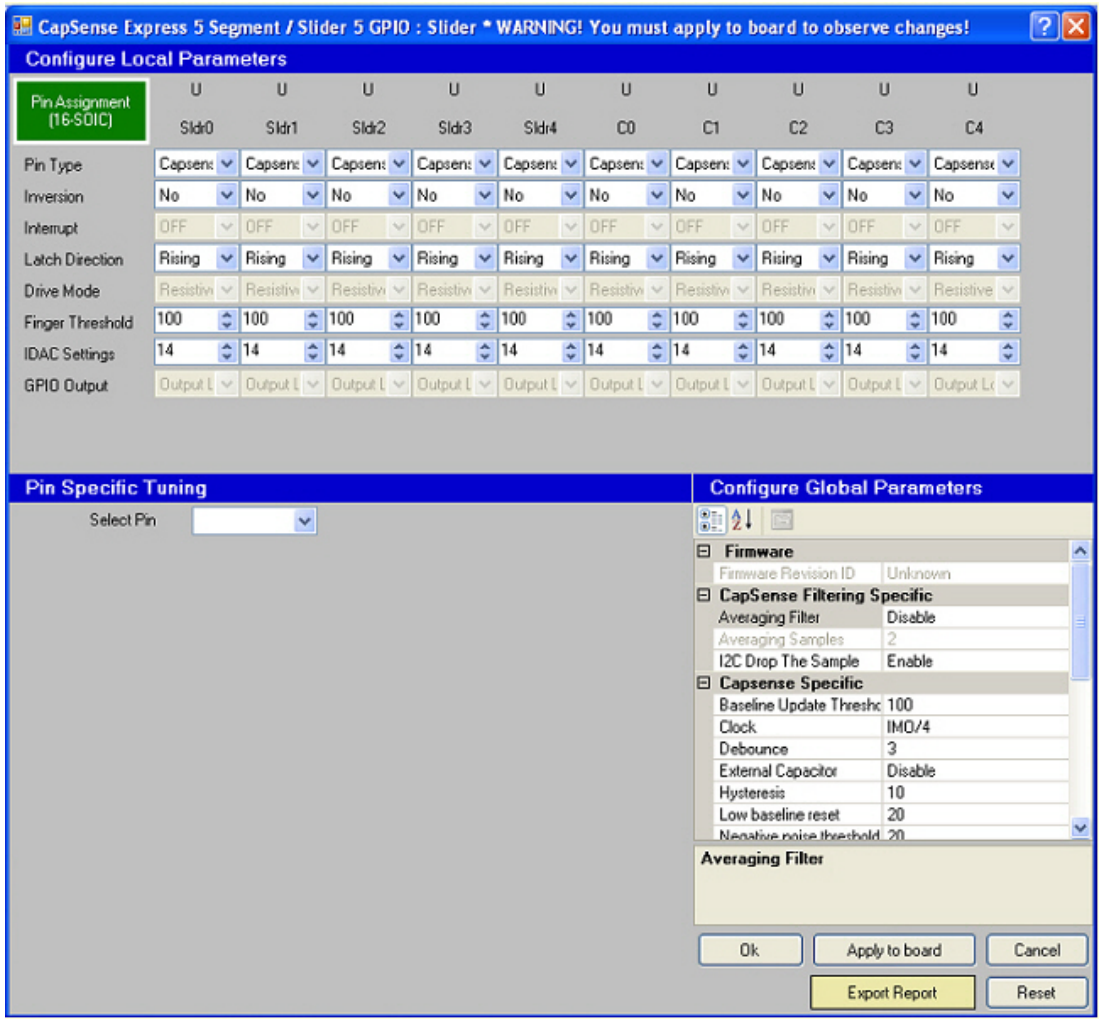
6. Select **View** > **All Driver Catalogs** and then select the **Inputs** tab. Open **CapSense Express > CY8C201A0**, right-click the **5 Segment Slider** driver, and select **Add to Design**. The Add Input Driver window opens.



7. Name the driver ‘Slider’ and click **OK.** The CapSense Express 5 Segment Slider opens.

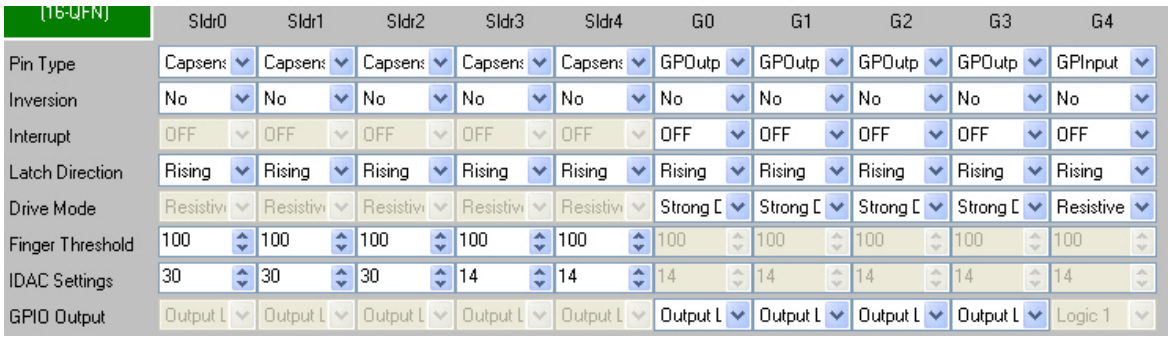


8. In the system-level project, the CapSense slider, LED, and the mechanical button require a separate driver. The ‘5 GPIO/CS Button’ driver is a special driver that allows you to configure all the buttons, LEDs, and the mechanical button in one interface. Each driver is listed in the **Configure Local Parameters** pane.


CapSense Express 5 Segment / Slider 5 GPIO : Slider * WARNING! You must apply to board to observe changes!
Configure Local Parameters
Pin Assignment (16-SOIC)
Sldr0
Sldr1
Sldr2
Sldr3
Sldr4
C0
C1
C2
C3
C4
Pin Type
Inversion
Interrupt
Latch Direction
Drive Mode
Finger Threshold
IDAC Settings
GPIO Output
Pin Specific Tuning
Select Pin
Configure Global Parameters
Firmware
Firmware Revision ID
Unknown
CapSense Filtering Specific
Averaging Filter
Disable
Averaging Samples
I2C Drop The Sample
Enable
Capsense Specific
Baseline Update Thresh
Clock
IMO/4
Debounce
External Capacitor
Disable
Hysteresis
Low baseline reset
Averaging Filter
Ok
Apply to board
Cancel
Export Report
Reset

4.3 Configure the Driver

By default, all driver types in the Configure Local Parameters pane are set to CapSense Input. To set up the LEDs, set the Pin Type for C0 through C3 to **GPOutput** and the Drive Mode to **Strong Drive**. To set up the mechanical button, set the Pin Type for C4 to **GPInput** and the Drive Mode to **Resistive Pull Up**. Set the IDAC setting to 30 for all slider sensors.

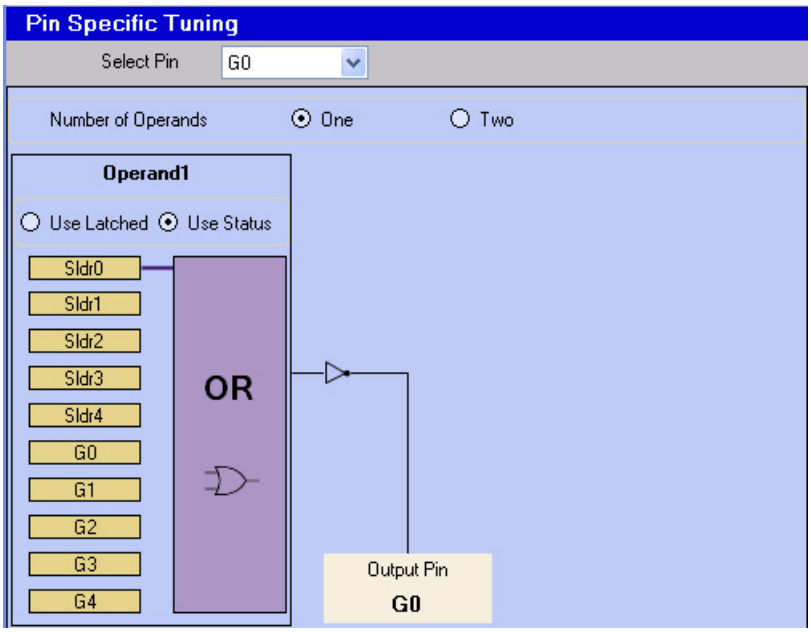


4.4 Configure Button and LED Behavior

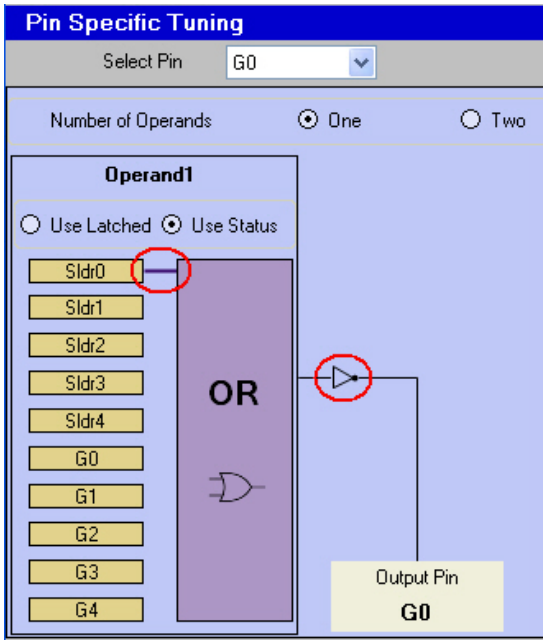
1. In the Pin Specific Tuning pane, choose **G0** from the Select Pin menu.



2. Click on the yellow box of the CapSense slider segment you want to assign to LED **G0**. For LED output pin **G0**, select the CapSense sensor **Sldr0**. A small line connects **Sldr0** to the purple OR box. To turn the LED on when the button is touched, click the small box (highlighted in the following figure) to the right of the purple OR box.



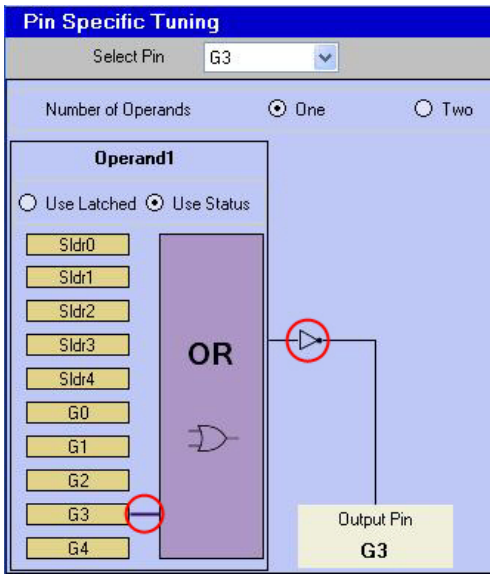
3. This changes the square to an invert symbol; this is needed as the LED is connected in current sink mode.



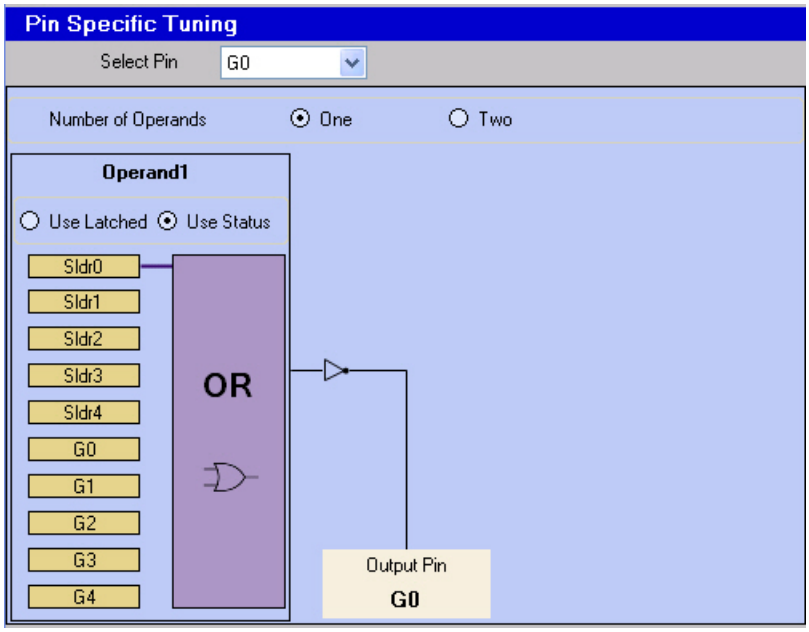
4. Repeat step 1 and step 2 for drivers G1 and G2 according to the following table.

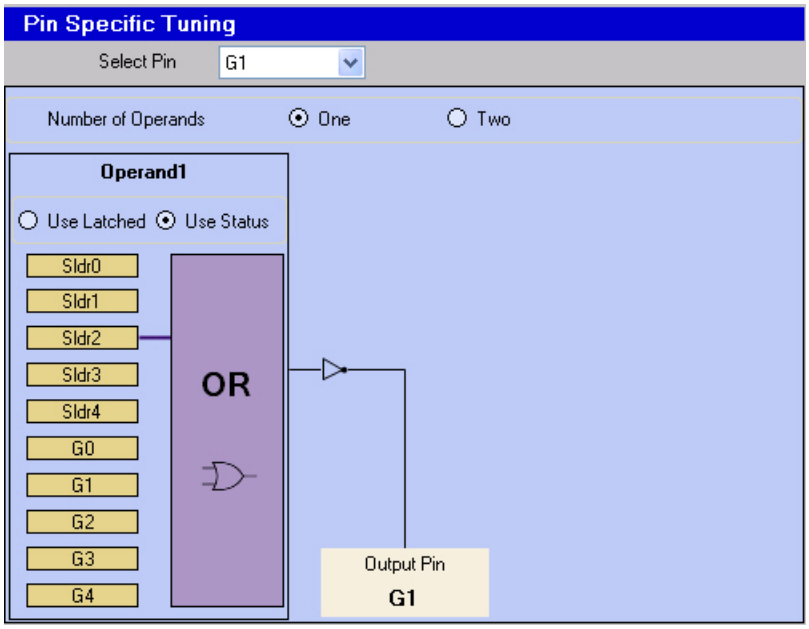
LED	Input
G0	Sldr0
G1	Sldr2
G2	Sldr4

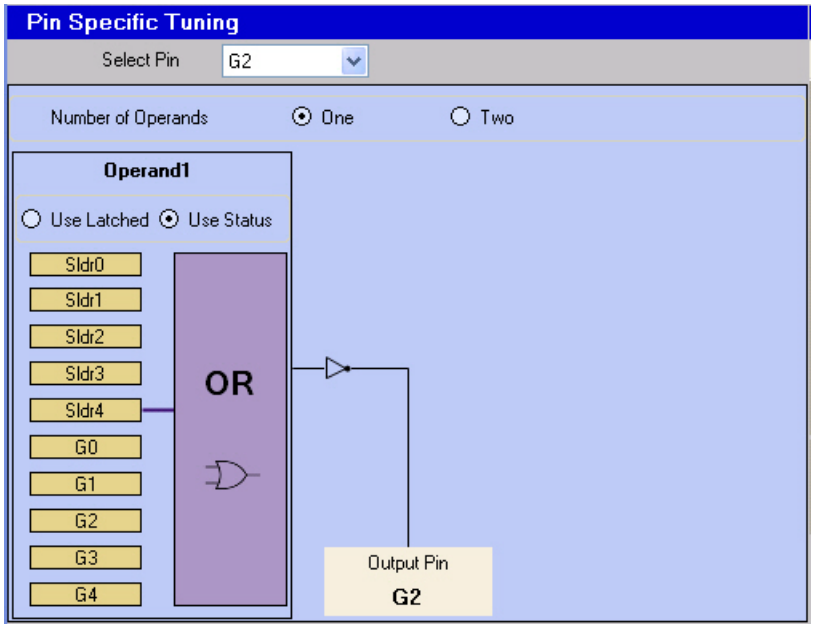
5. To have G3 LED toggled upon every wake from sleep, select G3 from drop-down menu and click the yellow G3 box. A small line then connects **G3** to the purple OR box. Click the small box to the right of the purple OR box. This changes the square to an invert symbol; this is needed because the LED is connected in current sink mode.

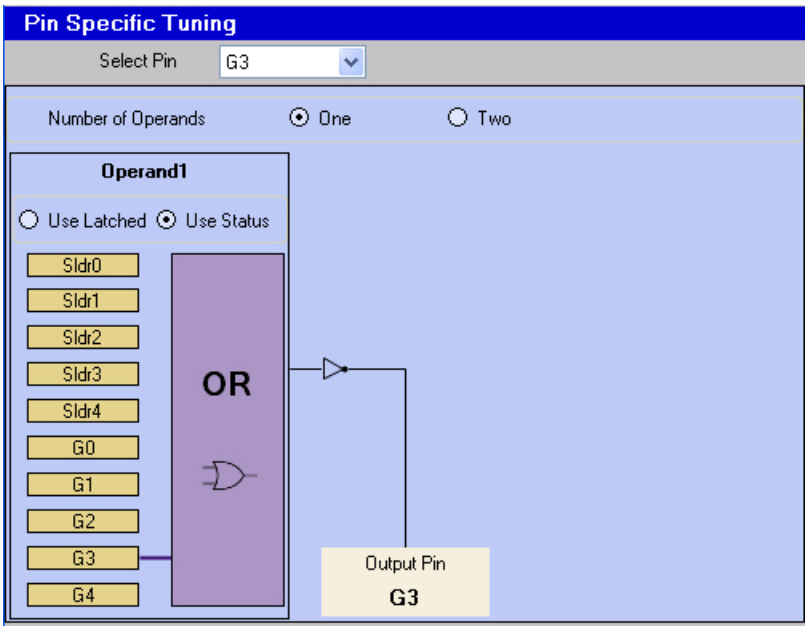


6. The configuration of all the LEDs appear as follows.

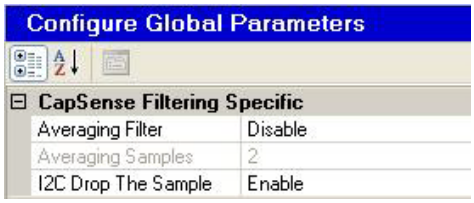




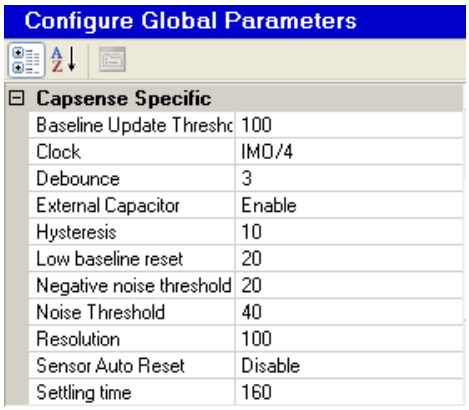




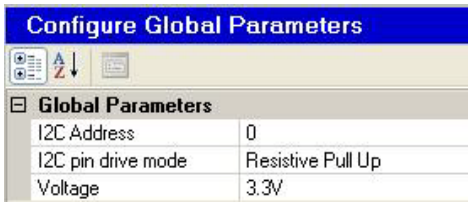
7. Enable the **I2C Drop The Sample** filter in the CapSense Filtering Specific section in the Global Parameters Window.



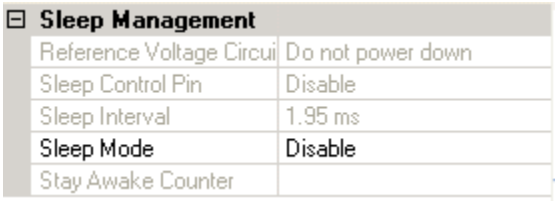
8. Enable **External Capacitor** in the **CapSense Specific** parameters. The external capacitor is enabled to get higher finger response when using overlay.



9. Configure I2C related parameters in **Global Parameters,** as shown in the following figure.



10. Disable sleep mode in the Sleep Management section because it does not allow CapSense tuning.



4.5 Pin Assignment

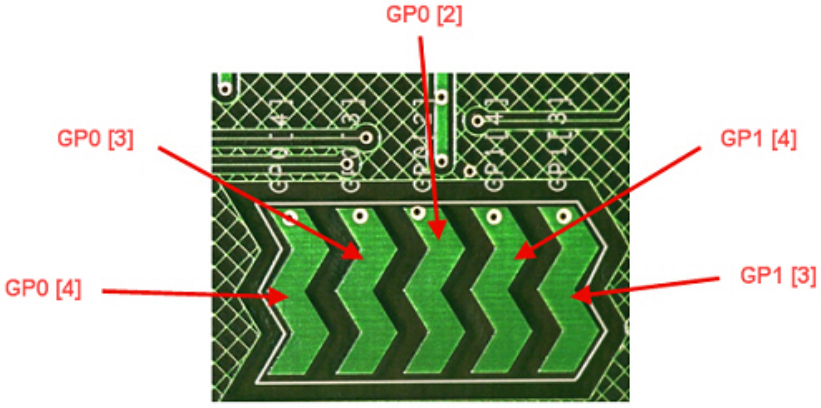
1. Click the **Pin Assignment (16-QFN)** button in the top left. The User Pin Assignment window opens.



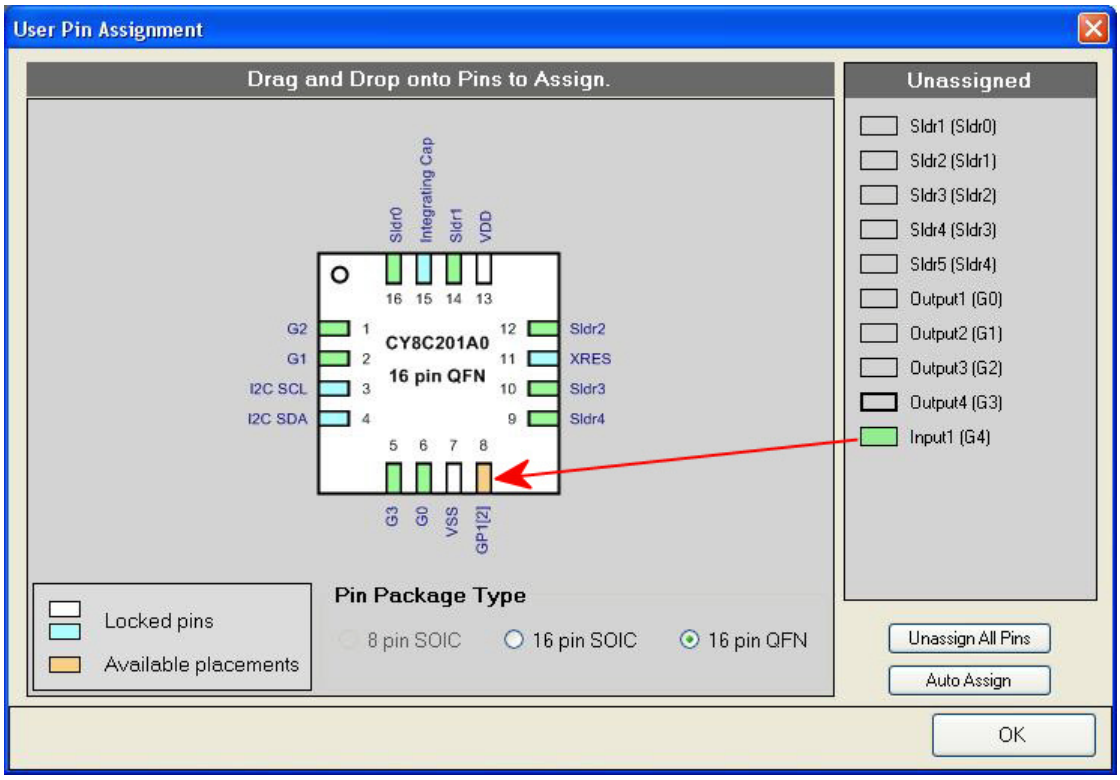
2. Select **16 pin QFN** as the Pin Package Type.



3. Assign each CapSense button, LED, and mechanical button on the board to the pin annotated on the board. For example, the CapSense sensor in the extreme left is labeled GP0[4].



4. Drag each driver from the unassigned list to the appropriate pin.

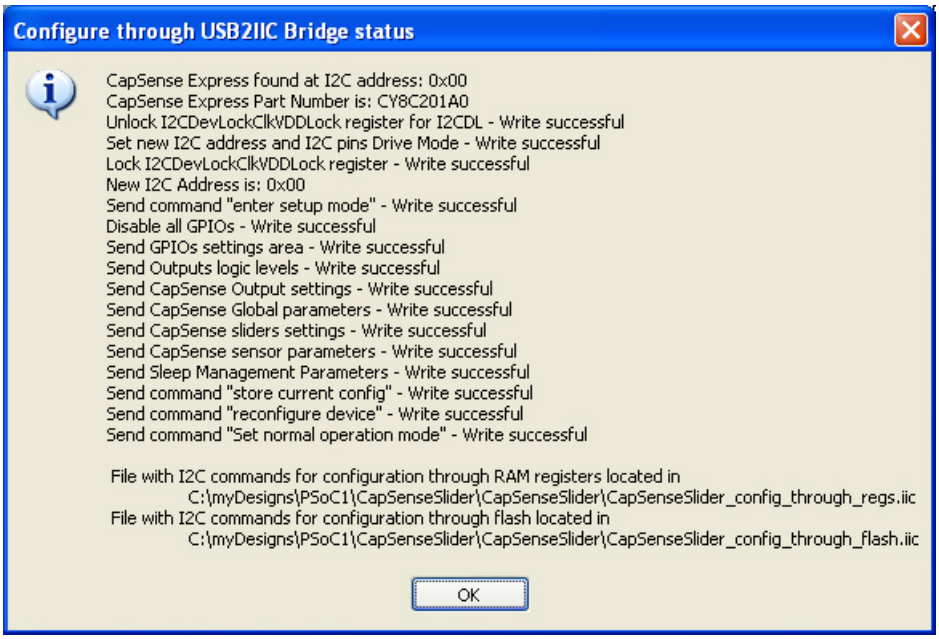


Driver	Pin
Sldr 1 (Sldr0)	GP0[4]
Sldr 2 (Sldr1)	GP0[3]
Sldr 3 (Sldr2)	GP0[2]
Sldr 4 (Sldr3)	GP1[4]
Sldr 5 (Sldr4)	GP1[3]
Output1 (G0)	GP1[1]
Output2 (G1)	GP0[1]
Output3 (G2)	GP0[0]
Output4 (G3)	GP1[0]
Input3 (G4)	GP1[2]

5. Click **OK** to close the User Pin Assignment window.
6. Click **Apply to board**.



7. Wait for the **Configure through USB2IIC Bridge status** window to appear and click **OK**.



8. Click **OK** to close the CapSense Express 5 Segment/Slider window.

5. Tune CY3218-CAPEXP2

5.1 Monitor CapSense Signal

Follow these steps to monitor the CapSense signal.

1. Click **Monitor** to open the Monitor view.



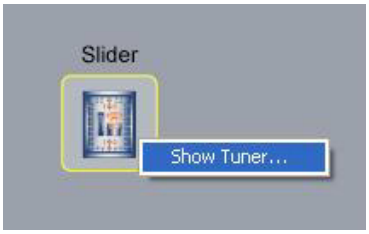
2. The Monitor Status indicator shows **Connected**.



3. Select the I2CUSB bridge power supply option.



4. Right-click **Slider** and select **Show Tuner**.



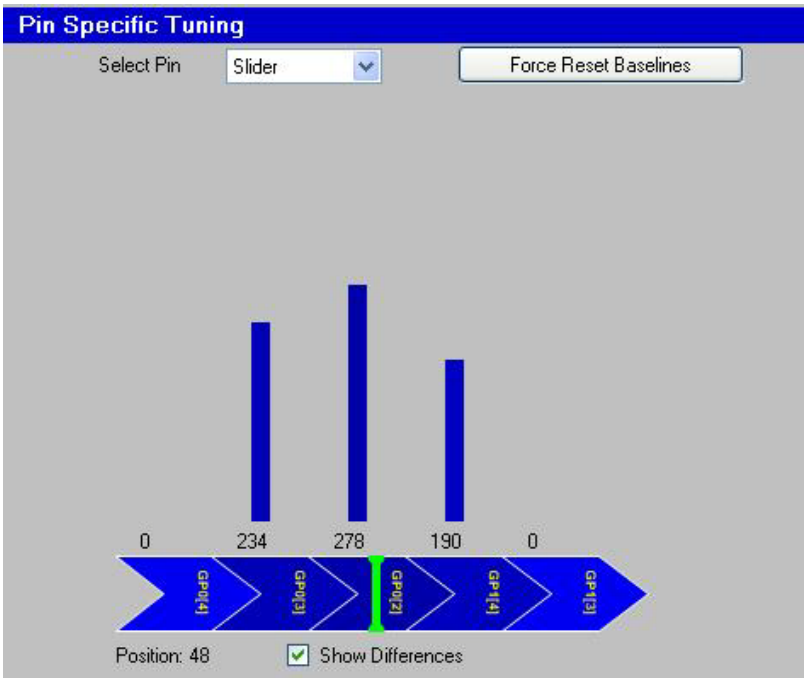
5. The Monitor Status indicator changes to **Running** and the CapSense Express window opens.
6. If your board is configured with another design, click **Apply to board** in the lower right of the CapSense Express window. When the **Configure through USB2IIC Bridge status** dialog appears, click **OK**. If your board is already configured with the correct design, the Apply to board button is grayed out.

5.2 Tune Slider

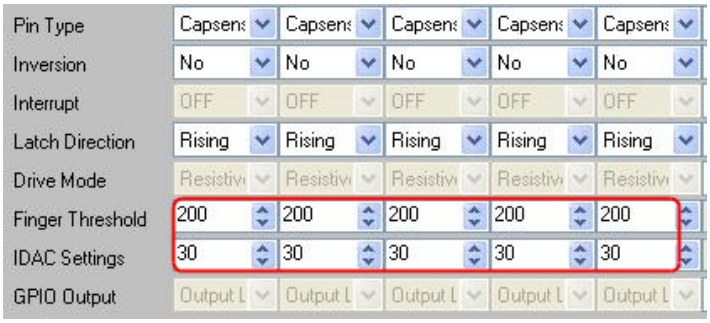
1. Select **Slider** from the Select Pin menu.



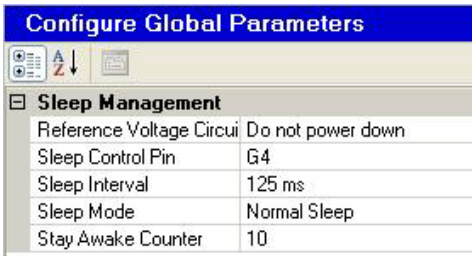
2. Check the **Show Difference** option and touch each sensor of the slider to see the signal.



3. Reduce the IDAC setting to increase the signal strength and vice-versa. To do this, keep a finger on the CapSense slider sensor and reduce IDAC value until required signal is produced. In this example, it is set to 30 for the 1-mm acrylic overlay provided with the kit.



4. When the slider tuning is complete, enable **Normal Sleep** with **125 ms** sleep interval. **Sleep Control Pin** should set as mechanical button (**G4**) for the device to wake from sleep. Finally, set **Stay Awake Counter** to **10**.



5. Hold the mechanical button pressed while applying the new setting to the board, because the device should not enter into sleep while configuring.
6. Verify the three LEDs representing the finger position on the slider. The G3 LED flashes with a period of approximately 125 ms. When the mechanical button or slider is pressed, the device never enters into sleep and LED is continuously on.
7. Experiment with other materials such as plastic and wood or overlay used for your product.

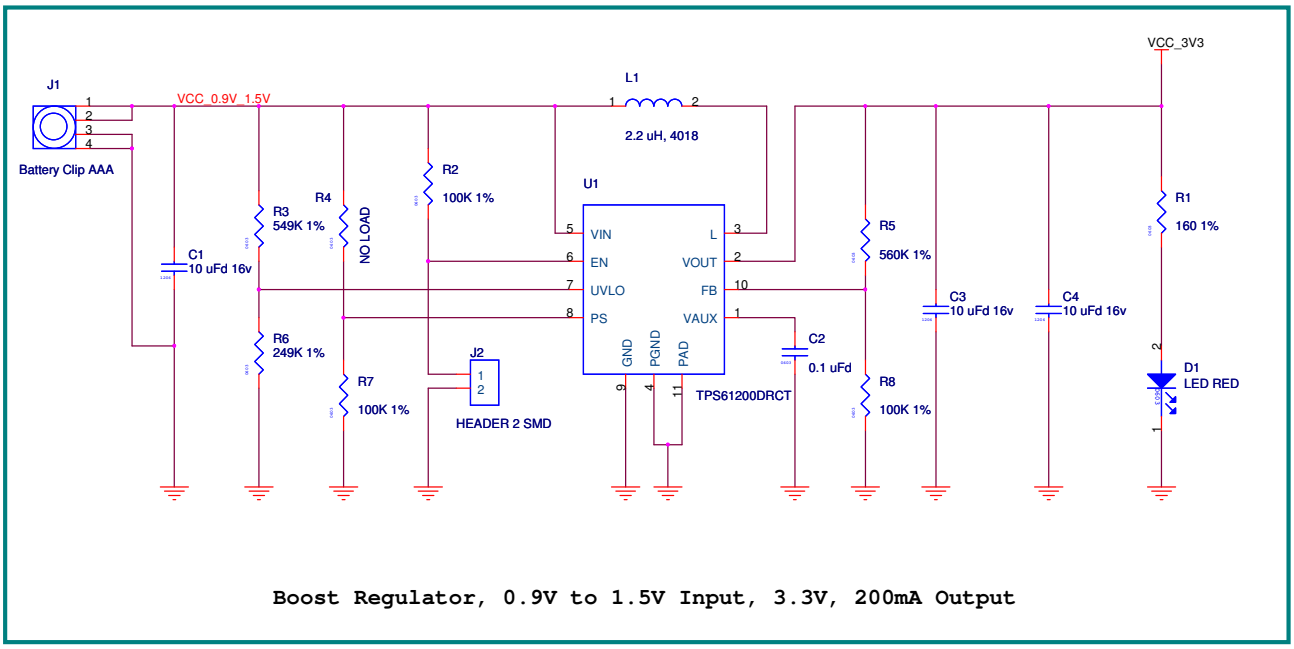
6. Technical References

6.1 CY3218-CAPEXP2 Schematic

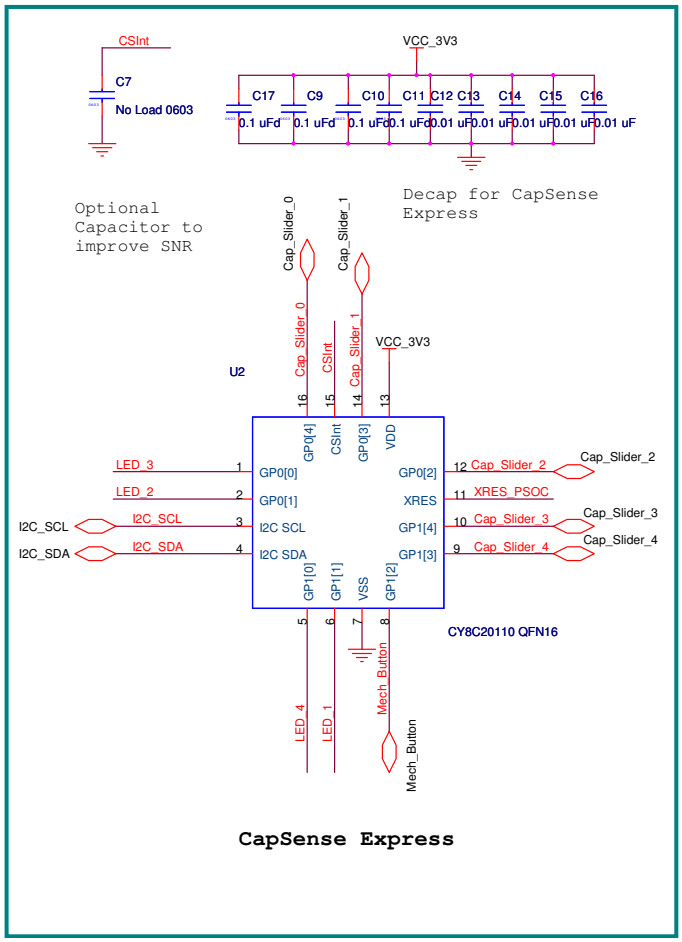
The schematic for the CY3218-CAPEXP2 CapSense Express Evaluation Kit is available on the kit CD/DVD:

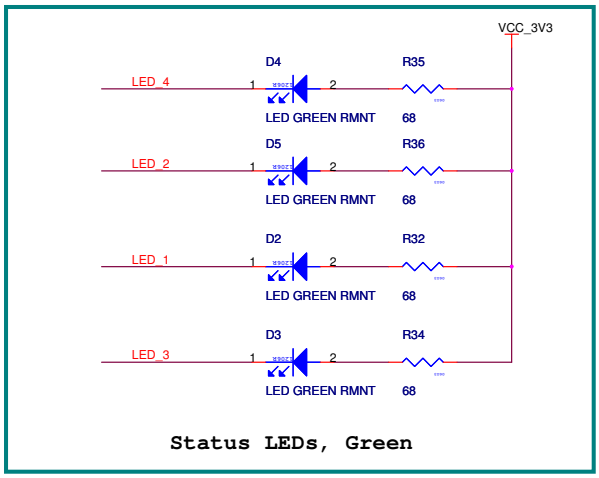
- PDF file: `<CD_root>\Hardware\REF_14696_REVSA_Schematic.pdf`
- DSN file: `<CD_root>\Hardware\REF_14696_REVSA.dsn`

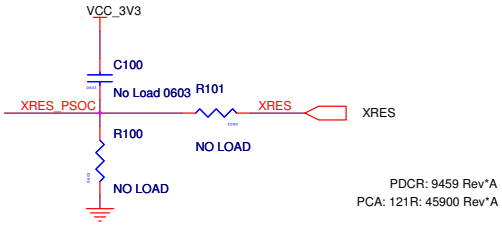
6.1.1 Schematic Page 1



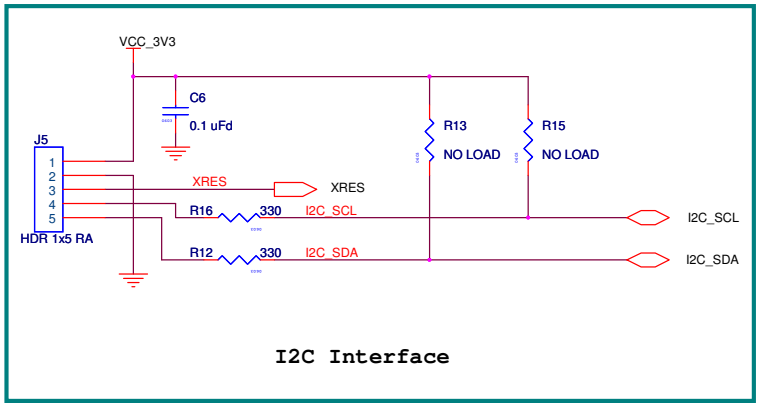
6.1.2 Schematic Page 2



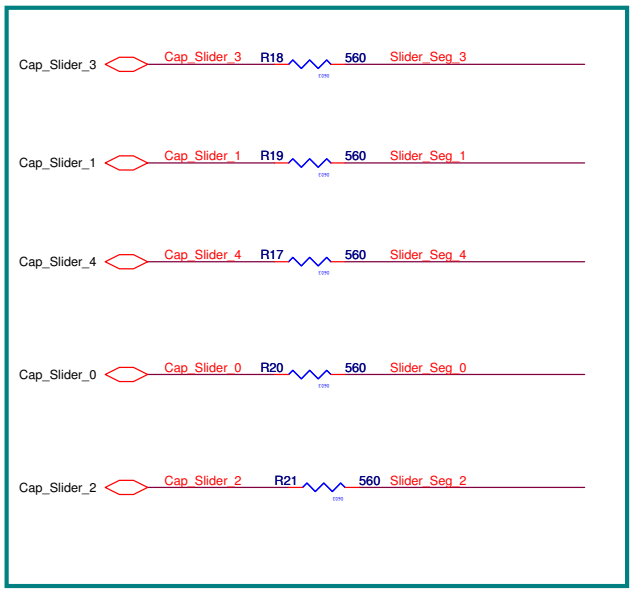


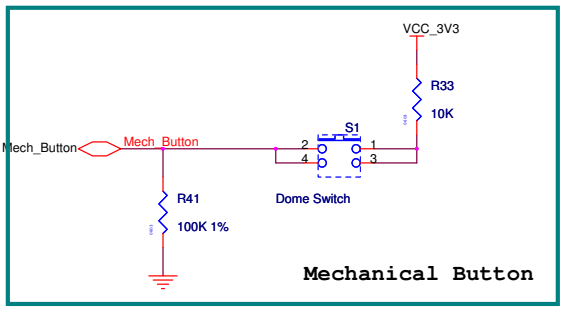


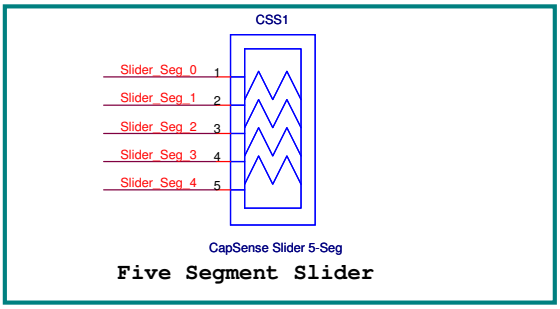
6.1.3 Schematic Page 3



6.1.4 Schematic Page 4





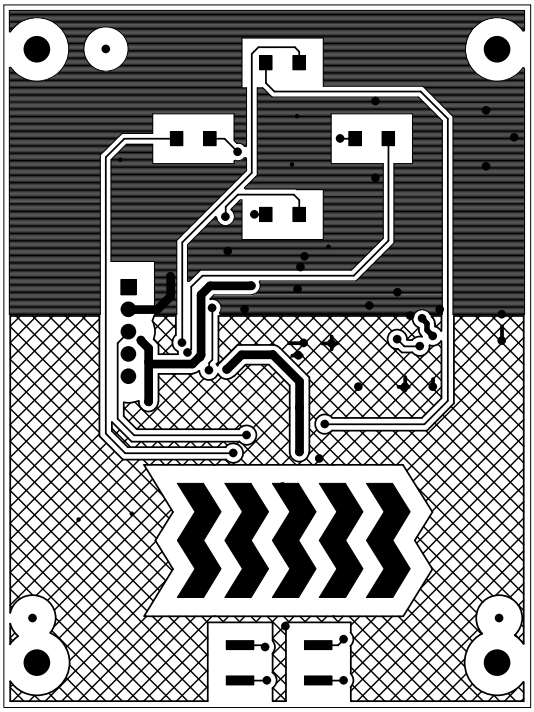


6.2 CY3218-CAPEXP2 Board Layout

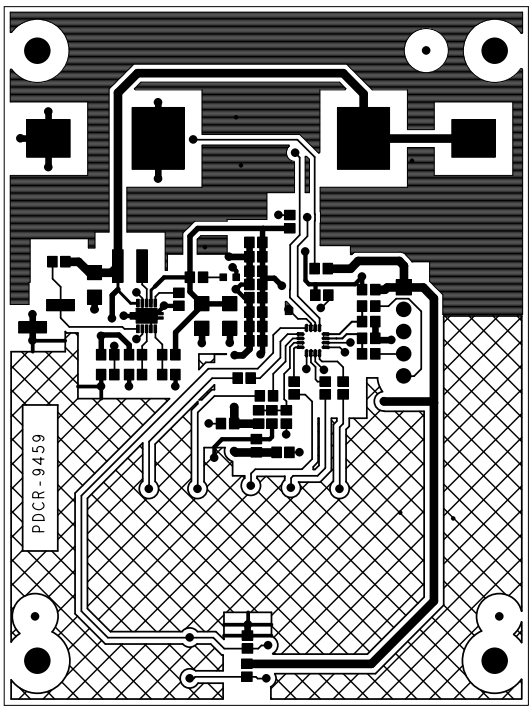
The board layout for CY3218-CAPEXP2 CapSense Express Evaluation Kit is available on the kit CD/DVD:

- PDF file: `<CD_root>\Hardware\PDCR_9459_REVSS_Layout.pdf`
- Board file: `<CD_root>\Hardware\PDCR_9459_REVSS.brd`
- Gerber file: `<CD_root>\Hardware\PDCR_9459_REVSS.zip`

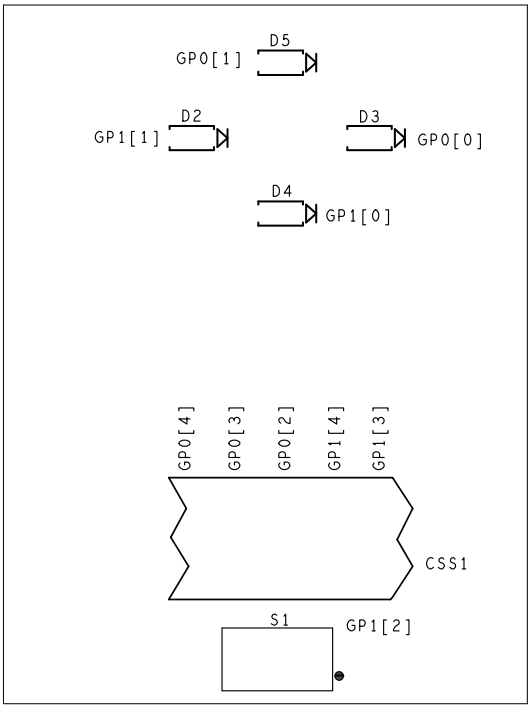
6.2.1 PDCR-9459 Top Layer



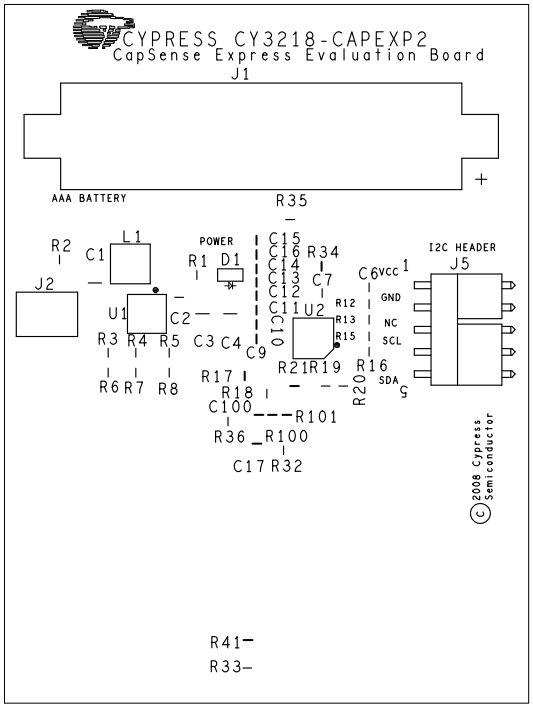
6.2.2 PDCR-9459 Bottom Layer



6.2.3 PDCR-9459 Top Silk Screen



6.2.4 PDCR-9459 Bottom Silk Screen



6.3 CY3218-CAPEXP2 Bill of Material (BOM)

The BOM for the CY3218-CAPEXP2 CapSense Express Evaluation Kit is available on the kit CD/DVD as an Excel file: `<CD_root>\Hardware\121R_45900_REVSS_BOM.xls`

Item	Qty	Reference	Part	Manufacturer	Manuf. Part#
1	1	CSS1	CapSense Slider 5-Segment 10x44mm	Manufacturing Process	
2	3	C1,C3,C4	CAP CERAMIC 10.0UF 16V X5R 1206	Kemet	C1206C106K4PACTU
3	6	C2,C6,C9,C10,C11,C17	CAP .10UF 10V CERAMIC X7R 0603	Kemet	C0603C104K8RACTU
4	2	C7,C100	CAP NO LOAD 0603	NA	NA
5	5	C12,C13,C14,C15,C16	CAP .10UF 10V CERAMIC X7R 0603	Kemet	C0603C104K8RACTU
6	1	D1	LED RED CLEAR 0603 SMD	Lite-On Trading USA, Inc.	LTST-C190CKT
7	4	D2,D3,D4,D5	LED GREEN CLEAR 1206 SMD	LITE-ON INC	LTST-C150GKT
8	1	J1	CLIP BATTERY AAA/N .375X.460" SS	Keystone Electronics	55
9	1	J2	CONN HEADER 2POS .100" VERT 15AU	Molex/Waldom Electronics Corp	68301-1055
10	1	J5	CONN HEADER 5POS 0.1 RA KEYED	Molex	22-05-3051
11	1	L1	INDUCTOR 2.2UH 1.44A 20% 1607 SMD	Taiyo Yuden / Kemet	NR4018T2R2M
12	1	R1	RES 160 OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07160RL
13	4	R2,R7,R8,R41	RES CHIP 100K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07100KL
14	1	R3	RES 549K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07549KL
15	5	R4,R13,R15,R100,R101	RES NO LOAD 0603 SMD	NA	NA
16	1	R5	RES 560K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-07560KL
17	1	R6	RES 249K OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF2493V
18	2	R12,R16	RES 330 OHM 1/16W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ331V
19	6	R17,R18,R19,R20,R21,R24	RES 560 OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ561V
20	4	R32,R34,R35,R36	RES 68 OHM 1/16W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ680V
21	1	R33	RES 10K OHM 1/16W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ103V
22	1	S1	SWITCH TACT SEAL 7.20MMx7.20MM H=4.7MM 160GF SMT	E-Switch	TL6120AF160QG
23	1	U1	IC SYNC BOOST CONV 1.3A SW ADJ 10SON	Texas Instruments	TPS61200DRCT
24	1	U2	nanoPSoC - Capsense Lite Family 16-QFN	Cypress Semiconductor	CY8C201A0-SX2I
Special Jumper Installation Instructions					
25	1		Install jumper across pins of J2	Sullins Electronics Corp.	STC02SYAN
Special Standoff Installation Instructions					
26	4		Install standoffs with screws into holes on corners such that they hold the battery terminals (on the bottom of the board) off the tabletop.	Keystone Electronics	24395
27	4			Keystone Electronics	29311

6.4 CY3218-CAPEXP2 Pin Assignment

Pin Number	Port Number	Design Function
1	GP0[0]	LED 4 (D3)
2	GP0[1]	LED 2 (D5)
3	I2C SCL	I2C clock
4	I2C SDA	I2C data
5	GP1[0]	LED 1 (D4)
6	GP1[1]	LED 3 (D2)
7	VSS	Ground connection
8	GP1[2]	Mechanical button
9	GP1[4]	Cap slider segment 4
10	GP0[3]	Cap slider segment 2
11	XRES	Active HIGH external reset with internal pull down
12	GP1[3]	Cap slider segment 5
13	VDD	Supply voltage (3.3 V)
14	GP0[4]	Cap slider segment 1
15	CSInt	Integrating capacitor input
16	GP0[2]	Cap slider segment 3

Revision History

Document Revision History

Document Title: CY3218-CAPEXP2 CapSense® Express™ Evaluation Kit Guide Document Number: 001-54703				
Revision	**ECN#**	**Issue Date**	**Origin of Change**	**Description of Change**
**	3187059	03/08/2011	RKPM	New kit guide for CapSense Express.
*A	3277428	12/01/2011	SRVS	Updated Figure 2-1. Added content in the Hardware section. Updated the Install Software section. Updated schematics, board layout, and BOM.
*B	3620227	05/17/2012	SASH	Modified installation instructions in section 3.2.2. Updated chapter 4. Minor updates throughout the guide.
*C	4290899	02/25/2014	PRIA	Updated in new template. Completing Sunset Review.
*D	4722890	05/05/2015	PRIA	Updated Figure 4-1 in 4.2 Create New Project.
Distribution: Web **Posting**: None				