CY8CKIT-040T PSoC™ 4000T CAPSENSE™ Evaluation Kit guide

About this document

Scope and purpose

This guide helps you get acquainted with the CY8CKIT-040T PSoC™ 4000T CAPSENSE™ Evaluation Kit (EVK). The document explains the kit operation, describes the out-of-the-box (OOB) example and its operation, and the hardware details of the board.

Intended audience

This kit is intended for all technical specialists familiar with PSoC™ 4 MCU and CAPSENSE™.

Note: This kit is intended to be used under laboratory conditions.

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Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems*

Table 1 Safety precautions

	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*

Table of contents

1 Introduction

Wearable technology devices from fitness trackers to smart glasses and smart clothes are becoming increasingly popular. Capacitive sensing is one of the key features of any wearable solution. Battery life is the major challenge in any wearable technology today; therefore, there is a constant need to lower the power consumption while still needing the devices to be ON and responsive all the time.

PSoC™ 4000T series MCU (hereafter called "PSoC™ 4000T") addresses this challenge by introducing the new fifth-generation CAPSENSE™ and multi-sense low-power (MSC-LP) technology, offering an ultra-low-power touch HMI solution based on an integrated "Always-on" sensing technology. It enables scanning low-power buttons such as power/wakeup buttons while the device is in deep sleep and processing the results to wake the device in the event of a touch. This technology has an inherent autonomous scanning capability, which doesn't need CPU intervention for scanning sensors; the device can be kept in deep sleep while scanning, thus reducing the power in active mode as well.

The CY8CKIT-040T PSoC™ 4000T CAPSENSE™ EVK lets you evaluate the features of the PSoC™ 4000T device. The board has the following features:

- A PSoC™ 4000T device
- An onboard programmer/debugger (KitProg3)
- A capacitive button
- A capacitive proximity sensor
- A capacitive touchpad
- User LEDs (both serial RGB and single-color LEDs)

This kit demonstrates the following key capabilities of the fifth-generation CAPSENSE™ technology OOB:

1. Superior touch-sensing performance
   - Best-in-class sensitivity, SNR, and immunity to harsh environmental conditions such as temperature and moisture.
2. Ultra-low-power capability based on "Always-On" sensing.
   - Ability to obtain power numbers as low as 3.6 µA in the Wake-On-Touch mode and 74 µA in Active mode (see CE235111 for the scan conditions for achieving this), making it ideal for battery-operated wearable devices.
3. Superior liquid tolerance
   - The kit can be dipped into liquids such as soap water, seawater, and mineral water up to the immersible line or sprayed with liquid droplets without reporting any false touches (demonstrated in the CE234752).
   - A touchpad with a proximity sensor emulates a wearable screen with a bezel around it. Liquid tolerance on the touchpad is showcased in the CE234752, even with this loop grounded.

See the AN85951 - PSoC™ 4 and PSoC™ 6 MCU CAPSENSE™ design guide for details of the features of the fifth-generation CAPSENSE™ - MSC-LP.

You can use ModusToolbox™ software to develop and debug your PSoC™ 4 projects. ModusToolbox™ software is a set of tools that enables you to integrate Infineon devices into your existing development methodology.

If you are new to PSoC™ 4 and ModusToolbox™ software IDE, see the application note AN79953 - Getting started with PSoC™ 4 to help familiarize yourself with the PSoC™ 4 and help you create your own design.

1.1 Kit contents

The CY8CKIT-040T PSoC™ 4000T CAPSENSE™ EVK contains the following, as shown in Figure 1.

- PSoC™ 4000T CAPSENSE™ EVB with enclosure
- USB Type-A to Micro-B cable
- Water dropper
- Quick start guide (part of packaging)

Figure 1 **CY8CKIT-040T PSoC™ 4000T CAPSENSE™ EVK contents**

Inspect the kit's contents; if you find any part missing, contact your nearest Infineon sales office for help: www.infineon.com/support.

1.2 Getting started

This guide helps you get acquainted with the PSoC™ 4000T CAPSENSE™ EVK:

- See the Kit operation chapter for an overview of PSoC™ 4000T device features and follow section 2.2 to have a quick review of the OOB project pre-programmed in this kit. It also provides the steps to create a project and program/debug using the ModusToolbox™ software.
- See the Hardware chapter for detailed hardware description, kit schematics, rework instructions, and the bill of materials (BOM).
- Use ModusToolbox™ software for application development using the PSoC™ 4000T CAPSENSE™ EVK. See the kit webpage for the latest software support for this development kit.
  - ModusToolbox™ software is a free development ecosystem that includes the Eclipse IDE for ModusToolbox™ software. Using ModusToolbox™ software, you can enable and configure device resources, middleware libraries, and program and debug the device. You can download the software from the ModusToolbox™ software home page. See the ModusToolbox™ software user guide for additional information.
- See the wide range of code examples to evaluate the PSoC™ 4000T CAPSENSE™ EVB. These examples help you familiarize yourself with the PSoC™ 4000T device and create your design. You can also find code examples on the GitHub page dedicated to ModusToolbox™ software-based examples.
  - To access code examples through ModusToolbox™ software, see the “Code examples” section in AN79953 - Getting started with PSoC™ 4 under “ModusToolbox™ software resources”.

1.3 Board details

PSoC™ 4000T CAPSENSE™ EVK has the following peripherals:

- PSoC™ 4000T MCU - CY8C4046LQI-T452. See the device datasheet.
- Capacitive touchpad with four rows and five columns supporting self-capacitance (CSD) and mutual-capacitance (CSX) sensing modes, a capacitive button and a capacitive proximity loop with a 3.5 cm diagonal length supporting a self-capacitance (CSD) sensing enclosed in a 1.2-mm thick surface of polycarbonate enclosure (act as overlay) to support smooth touch sensing and liquid-tolerant operation.
- Three serial addressable RGB LEDs, an user LED, and a reset button for the PSoC™ 4000T MCU.
- A Micro-B connector for power input to the kit and KitProg3 USB device interface.
- Selectable input supply voltages of 1.8 V, 3.3 V, and 5 V for the PSoC™ 4000T MCU.
- KitProg3 onboard SWD programmer/debugger, USB-to-UART, and USB-I2C bridge functionality.
- KitProg3 programming mode selection button a status LED
- I2C/UART header provision to interface PSoC™ 4000T device with an external host device.

1.4 Additional learning resources

Infineon provides a wealth of data in the PSoC™ 4 product webpage to help you to select the suitable PSoC™ device for your design and to help you quickly and effectively integrate the device into your design.

1.5 Technical support

For assistance, visit Infineon support or visit community.infineon.com to ask your questions in the Infineon developer community.

You can also use the following support resources if you need quick assistance:

- Self-help (Technical documents)
- Local sales office locations

1.6 Documentation conventions

Table 2 Document conventions for guides

Convention	Usage
`Courier New`	Displays commands, user entered text, and source code: `cd mtb`
Italics	Displays file names and reference documentation: Read about the *sourcefile.hex* file in the *PSoC™ Creator User Guide*.
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 Kit operation

This chapter provides an overview of the features of the PSoC™ 4000T device and a quick review of the OOB project pre-programmed in this kit. It also provides the steps to create a project and program/debug using the ModusToolbox™ software.

2.1 Theory of operation

The PSoC™ 4000T CAPSENSE™ EVK is built around a PSoC™ 4000T device. Figure 2 shows the block diagram of the PSoC™ 4000T device used on the board. For details of device features, see the device datasheet.

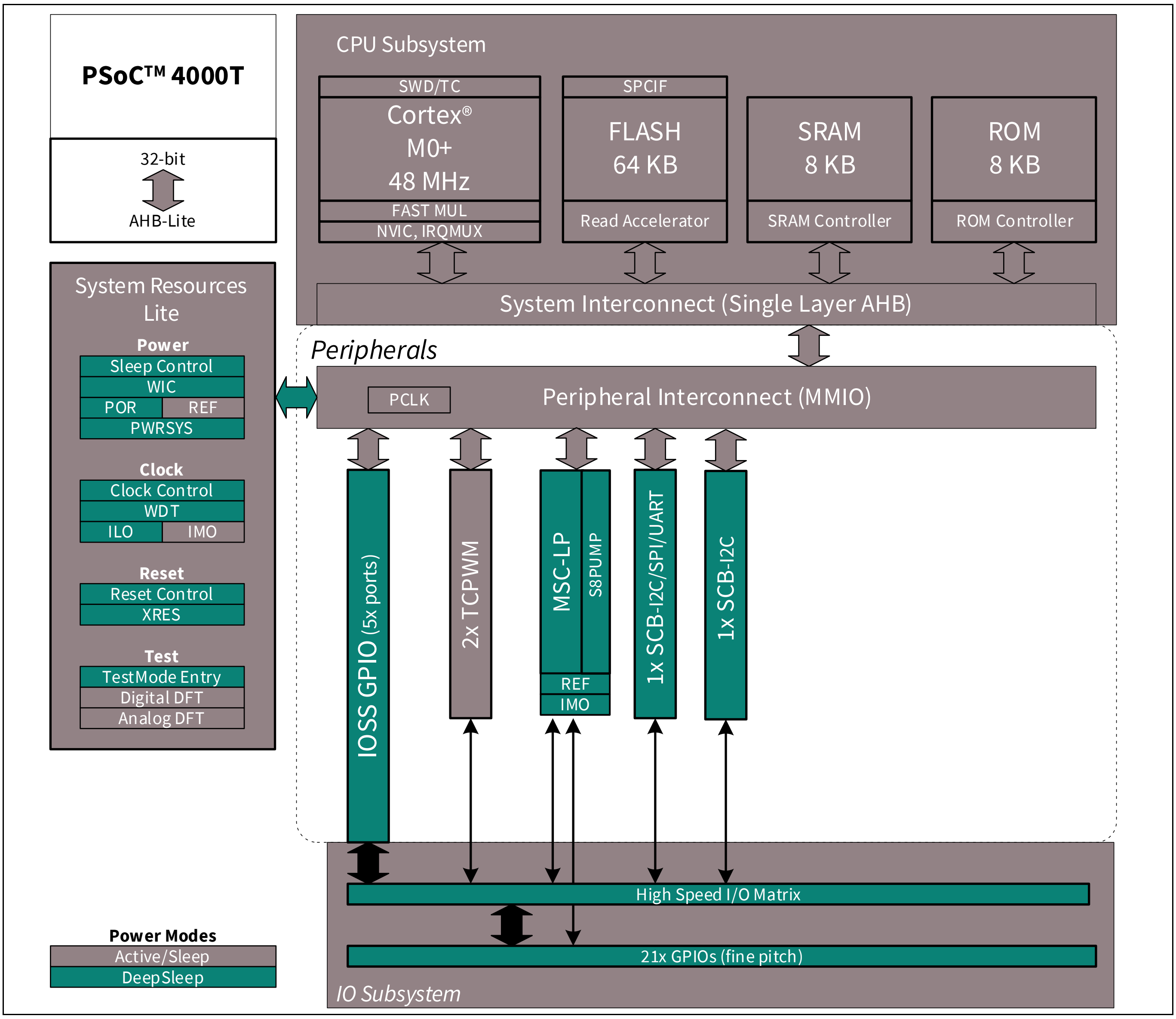


Figure 2 **PSoC™ 4000T device block diagram**

Figure 3 shows the block diagram of the PSoC™ 4000T CAPSENSE™ EVB.

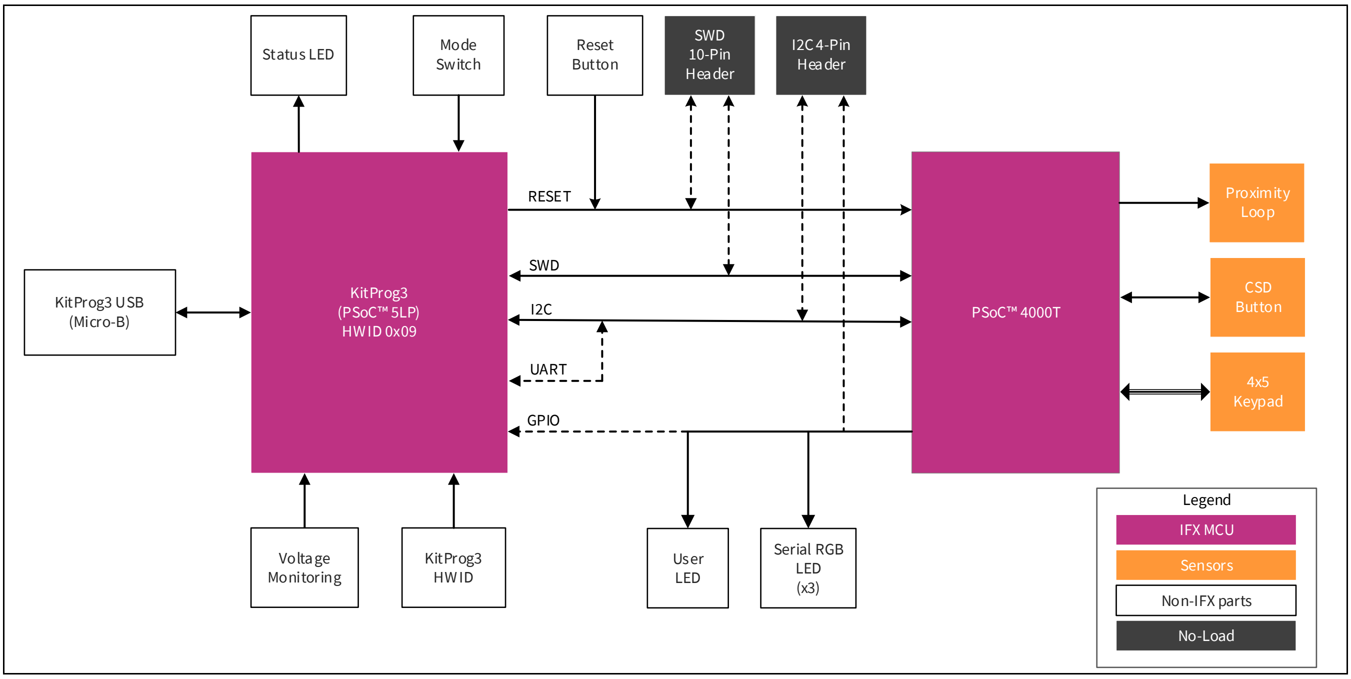


Figure 3 Functional block diagram of CY8CKIT-040T PSoC™ 4000T CAPSENSE™ EVK

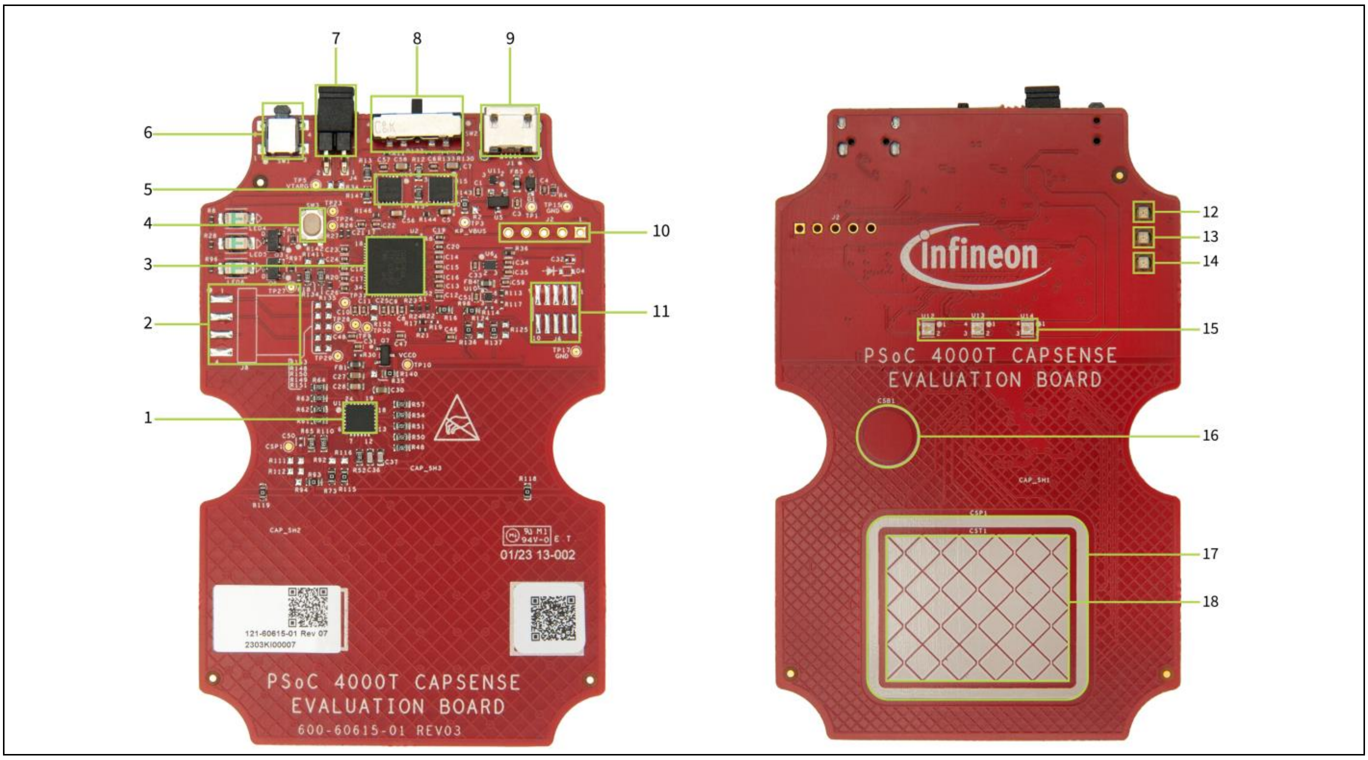


Figure 4 PSoC™ 4000T CAPSENSE™ EVB details

PSoC™ 4000T CAPSENSE™ EVK focuses on demonstrating the capabilities of 5th-generation CAPSENSE™ technology like low power operation with always-on sensing, and improved touch sensing performance with robust and liquid tolerant CAPSENSE™ widgets using PSoC™ 4000T device. This kit supports the following features:

1. **PSoC™ 4000T device (CY8C4046LQI-T452, U1):** This kit highlights the features of the PSoC™ 4000T device and has been designed for the 24-pin QFN part with 64KB flash capacity.
2. **PSoC™ 4000T device I2C/UART interface header (J8) (footprint only):** This 4-pin header provision allows to interface of the PSoC™ 4000T device with an external host device over I2C/UART.
3. **PSoC™ 5LP-based KitProg3 programmer and debugger (CY8C5868LTI-LP039, U2):** The PSoC™ 5LP device (CY8C5868LTI-LP039) serving as KitProg3 is a multi-functional system, which includes an SWD programmer, debugger, USB-I2C bridge, and USB-UART bridge. For more details, see the KitProg3 user guide.
4. **KitProg3 programming mode selection button (SW3):** This button is used to get into the Bootloader mode. The button connects the PSoC™ 5LP pin to the ground when pressed. For more details, see the KitProg3 user guide.
5. **Voltage regulator (TLS205B0LDVXUMA1; U15 and U16):** The kit has two onboard regulators configured to generate 1.8 V and 3.3 V; the input voltage to the regulator is derived from the USB connector.
6. **PSoC™ 4000T device reset button (SW1):** This button resets the PSoC™ 4000T device. It connects the PSoC™ 4000T device reset (XRES) pin to the ground when pressed.
7. **PSoC™ 4000T device current measurement header (J4):** An ammeter can be connected to this header to measure the current consumed by the PSoC™ 4000T device.
8. **Target voltage selection switch (SW2):** A slide switch (SW2) to select the 5 V, 3.3 V, and 1.8 V target voltages.
9. **KitProg3 USB connector (J1):** Use the USB cable provided along with the EVB to connect the board to a PC to power the board and program/debug using the KitProg3 onboard programmer and debugger.
10. **Programming header for PSoC™ 5LP (J2) (footprint only):** This 5-pin header provision can be used to program the PSoC™ 5LP device. By default, the PSoC™ 5LP device is loaded with KitProg3 firmware.
11. **PSoC™ 4000T device program and debug interface header (J6) (footprint only):** This 10-pin standard SWD/JTAG header provision allows to interface external programmers such as MiniProg4 for programming and debugging.
12. **Power LED (LED4 - Green):** Indicates the status of the power supplied to the board.
13. **KitProg3 status LED (LED5 - Green):** Indicates the status of the KitProg3. See the KitProg3 user guide.
14. **Single color user LED (LED6):** This user LED operates at the entire operating voltage range of the PSoC™ 4000T device. The LED is active LOW; therefore, the pin must be driven to the ground to turn ON the LED.
15. **Serial RGB LED (U12, U13, and U14):** These three user LEDs are serial RGB LEDs driven by the SPI master and operate at the entire operating voltage range of the PSoC™ 4000T device. These can be used to show the capacitive button and touchpad statuses.
16. **Capacitive button (CSB1):** One 7-mm diameter capacitive sensing button, configured as a self-capacitance (CSD) button, allows you to evaluate Infineon's fifth-generation CAPSENSE™ technology. It has a 1.2-mm thick surface of polycarbonate enclosure for smooth touch sensing.
17. **Capacitive CSD Proximity Sensor (CSP1):** Capacitive proximity loop with 3.5 cm diagonal length.
18. **Capacitive Touchpad (CST1):** 20-segment capacitive touchpad that has four rows and five columns, which can be configured as a self-capacitance (CSD) touchpad or a mutual-capacitance (CSX) touchpad.

See 3.2 Functional description for details on various hardware blocks.

2.2 Using the OOB example – CE234752

The PSoC™ 4000T CAPSENSE™ EVB is pre-programmed with the CE234752 – PSoC™ 4: MSC-LP robust low-power liquid-tolerant CAPSENSE™ code example (CE). This CE demonstrates the key features of fifth-generation CAPSENSE™ technology in PSoC™ 4000T, such as the following:

- Robust operation of the capacitive touchpad and capacitive button
- Low-power wake-on-touch approach using a ganged sensor (power consumption is optimized for battery-powered devices)
- Tolerance in the presence of various liquids (immersible in freshwater and saltwater)

Do the following to use the example. For a detailed description of the project, see the example's README file in the GitHub repository or from the application's top-level directory when the example has been created using ModusToolbox™ software.

*Note: At any point in time, if you overwrite the OOB example, you can restore it by programming the PSoC™ 4: MSC-LP Robust Low-Power Liquid-Tolerant CAPSENSE™ code example. See Creating a project and program/debug using ModusToolbox™ software for programming the board. Ensure that the voltage selection switch (**SW2**) must be at the 1.8 V position.*

1. Connect the board to your PC using the provided USB cable through the KitProg3 USB connector as Figure 5 shows. Ensure that the **voltage selection switch** (**SW2**) is at 1.8 V before programming the OOB code example.

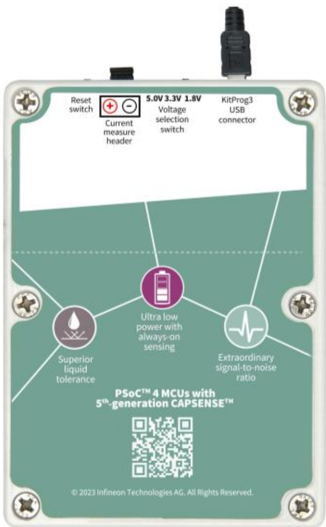


Figure 5 Connect USB cable to USB connector on the board

2. Touch the **Capacitive button** with your finger and observe the **LED1 (U12)** turn ON with blue color as Figure 6 shows.

Figure 6 CAPSENSE™ button operation with LED indication

3. Touch the touchpad with your finger as shown in the image and observe that **LED1 (U12)** and **LED3 (U14)** turn ON in green with medium brightness as Figure 7 shows.
   a) Move your finger horizontally and observe the variation in the brightness of **LED1 (U12)** accordingly.
   b) Move your finger vertically and observe the variation in the brightness of **LED3 (U14)** accordingly.

Figure 7 Capacitive touchpad operation with LED indication

4. Evaluate the low-power performance by measuring the current values in active, active low refresh rate, and wake-on-touch modes as explained in the "Measure current at different application states" section of the code example's README.
5. Evaluate the water tolerance performance by doing the following and observe that there is no false touch triggered (no serial RGB LEDs are ON):

Attention: ***Immerse the kit until the immersible line because there is an opening on the top side of the enclosure. Before immersion of the kit in water, ensure that the enclosure is assembled correctly.***

a) Spray water droplets on top of the widgets, as shown in Figure 8.

Figure 8 Water tolerance with water droplets sprayed on sensors

a) Place water droplets on top of the sensors using a water dropper.

b) Dip the kit inside the water (up to the immersible line) for some time and remove it. Repeat it multiple times. Observe that all LEDs are in an OFF state continuously, indicating that no false trigger occurs because of water immersion.

Figure 9 Immersing the kit inside water (up to immersible line)

See the README file of the PSoC™ 4: MSC-LP robust low-power liquid-tolerant CAPSENSE™ code example for further evaluation of the performance using the CAPSENSE™ Tuner.

Note: *More code examples are available in Eclipse IDE for ModusToolbox™ software (see Figure 13) or on the GitHub page dedicated to ModusToolbox™ software based examples to evaluate the board: PSoC™ 4: Blinky, PSoC™ 4: MSC LP CAPSENSE™ low power, PSoC™ 4: MSC-LP self-capacitance button tuning, etc.*

2.3 Creating a project and program/debug using ModusToolbox™ software

This section briefly introduces project creation, programming, and debugging using ModusToolbox™ software. For detailed instructions, see **Help > ModusToolbox™ General Documentation > ModusToolbox™ User Guide**

1. Connect the board to the PC using the USB cable through the KitProg3 USB connector (**J1**).

   The kit enumerates as a USB composite device if you are connecting it to your PC for the first time. KitProg3 operates in CMSIS-DAP Bulk mode; the status LED (green) is always ON in CMSIS-DAP Bulk mode.

   If you do not see the correct LED status, see the KitProg3 user guide for details on the KitProg3 status and troubleshooting instructions.

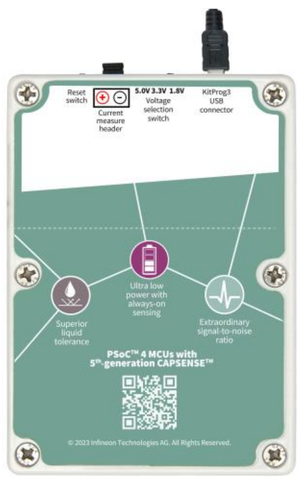


Figure 10 Connect the USB cable to the USB connector on the board

2. In Eclipse IDE for ModusToolbox™ software, import the required code example (application) into a new workspace.

   a) On the Quick Panel tab, click **New Application**.

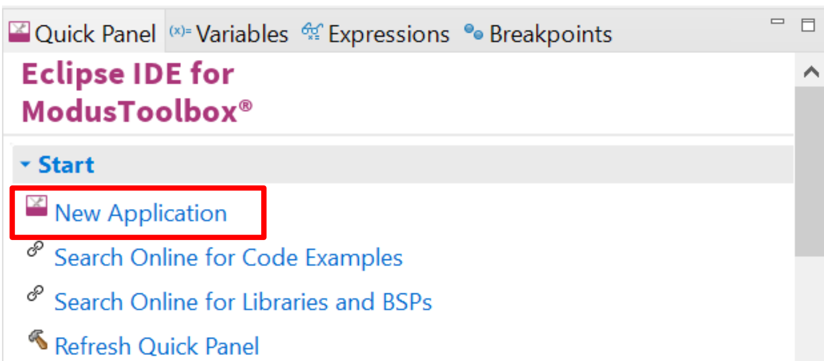


Figure 11 New Application in Quick Panel

On the **Choose Board Support Package (BSP) - Project Creator 2.0** window, expand PSoC™ 4 BSPs, select **CY8CKIT-040T**, and click **Next**, as shown in Figure 12.

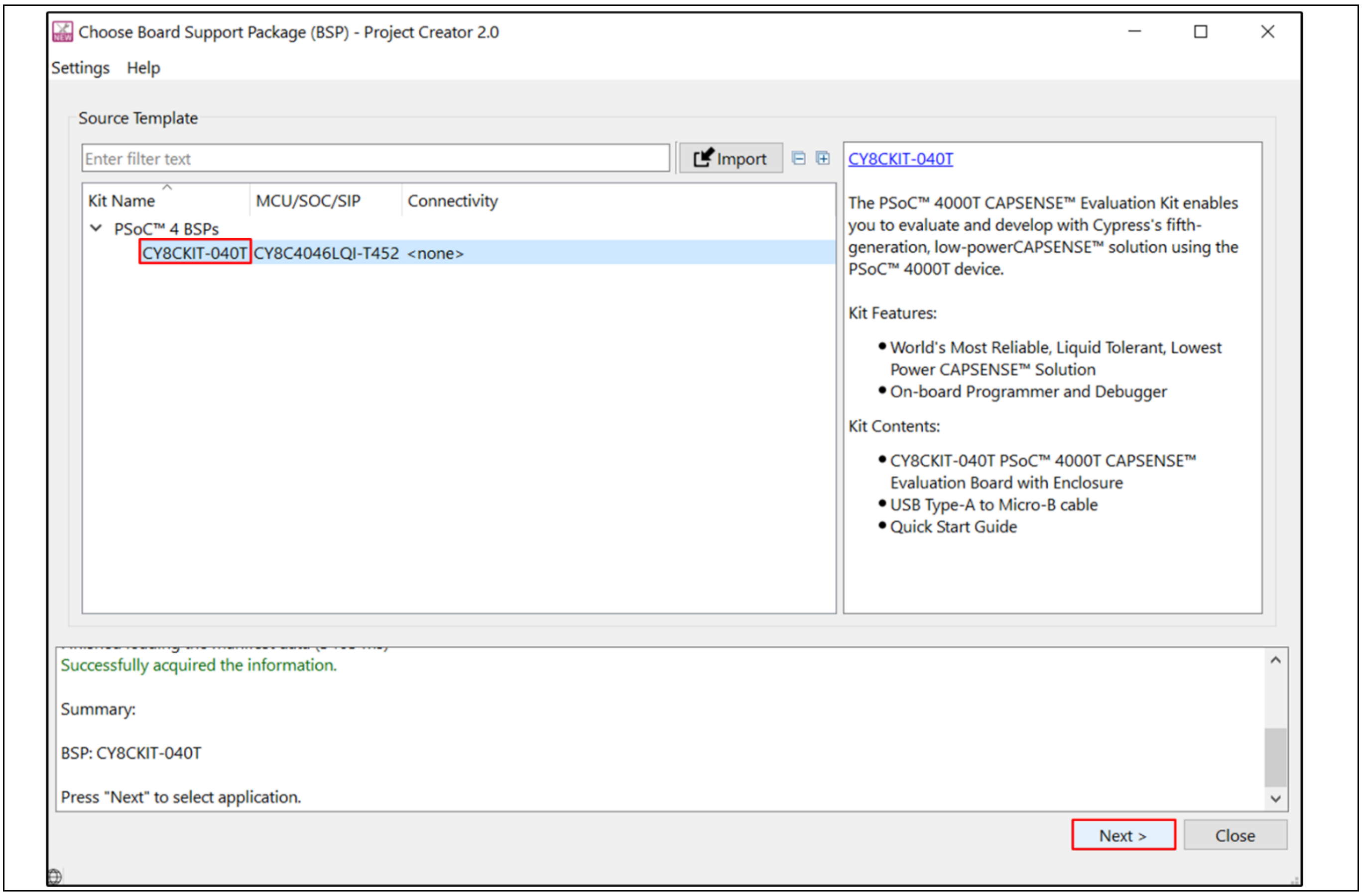


Figure 12 Creating a new application: Choose Board Support Package

b) Select the required application and click **Create**, as shown in Figure 13.

The right pane shows the description of the code example and the link to view the README file on GitHub.

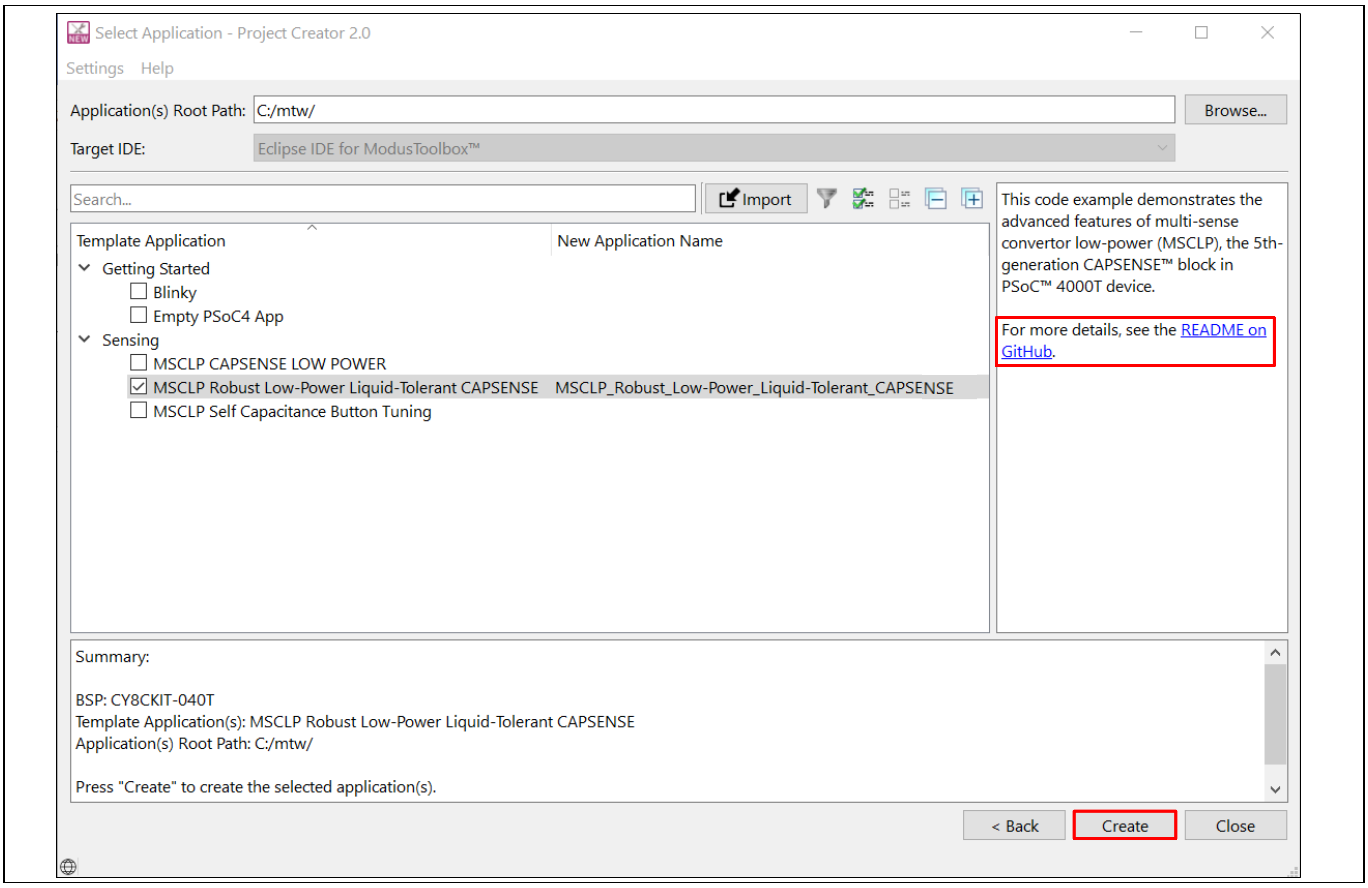


Figure 13 Creating a new application: Select Application

3. To build and program a PSoC™ 4000T device application, in the **Project Explorer** tab, select **<App_Name>** project. In the **Quick Panel** tab, scroll to the **Launches** section, and click the **<App_Name> Program (KitProg3_MiniProg4)** configuration, as shown in Figure 14.

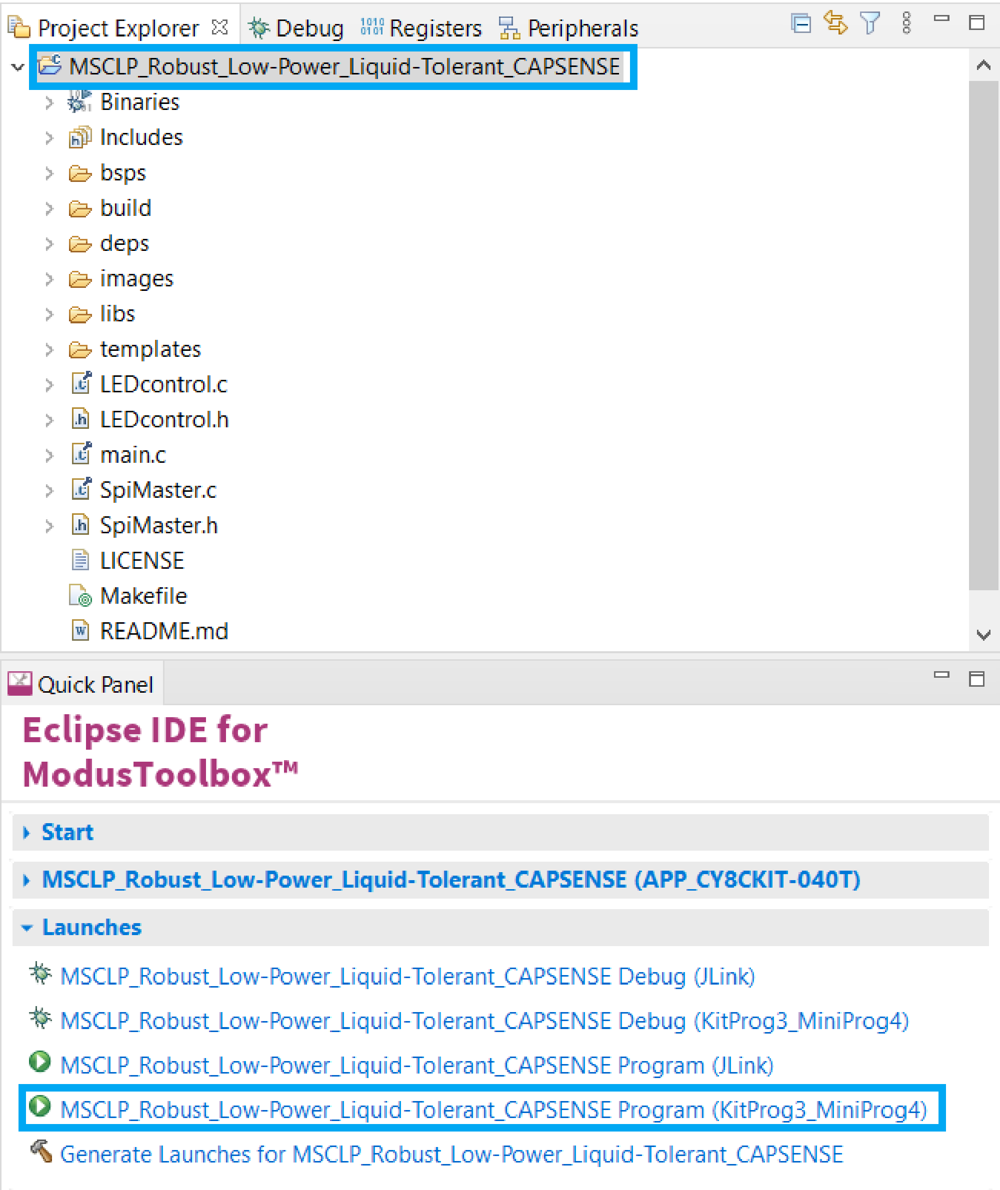


Figure 14 Building and programming the code example

4. ModusToolbox™ software has an integrated debugger. To debug a PSoC™ 4000T device application, in the **Project Explorer** tab, select **<App_Name>** project. In the **Quick Panel**, scroll to the **Launches** section, and click the **<App_Name> Debug (KitProg3_MiniProg4)** configuration, as shown in Figure 15. For a detailed explanation on how to debug using ModusToolbox™ software, see "Program and debug" section in Eclipse IDE for ModusToolbox™ user guide.

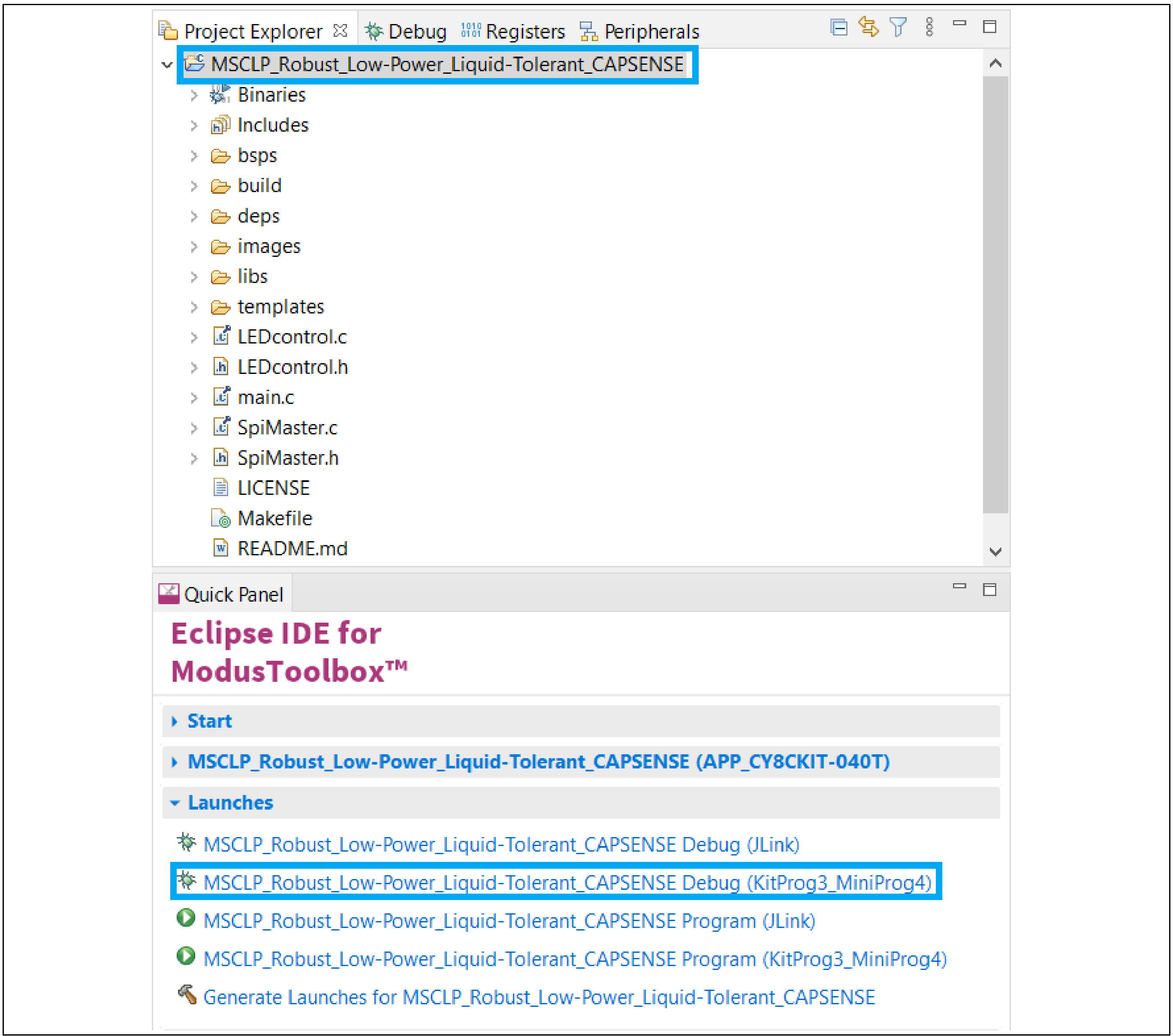


Figure 15 Debugging the code example

3 Hardware

3.1 Schematics

See the schematic files available on the kit webpage.

3.2 Functional description

This section describes the individual hardware blocks. The kit comes with a PSoC™ 4000T CAPSENSE™ EVB. It consists of the PSoC™ 4000T device, KitProg3 programmer/debugger and bridge, voltage regulators, CAPSENSE™ button, CAPSENSE™ proximity sensor, CAPSENSE™ 4x5 touchpad, user LED, serial RGB LEDs, and other passives required for the essential operation of the kit.

3.2.1 Features

This kit features a PSoC™ 4000T device, a member of the PSoC™ 4 platform with scalable and reconfigurable architecture with an Arm® Cortex®-M0+ CPU. It combines a high-performance capacitive sensing subsystem, and programmable, reconfigurable analog and digital blocks.

For more information, see the PSoC™ 4000T device family datasheet.

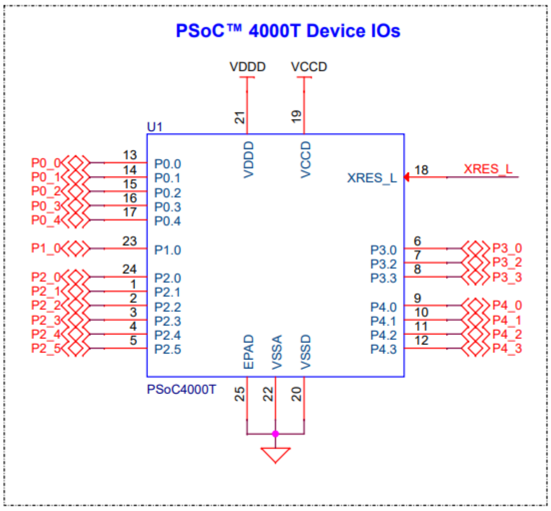


Figure 16 Schematics of the PSoC™ 4000T device

Table 3 Pin assignment of PSoC™ 4000T device in the EVB

Pin details	Primary onboard function	Secondary onboard function
P0[0]	Capacitive touchpad (CST_C4) – Col4	–
P0[1]	Capacitive touchpad (CST_C3) – Col3	–
P0[2]	Capacitive touchpad (CST_C2) – Col2	–
P0[3]	Capacitive touchpad (CST_C1) – Col1	–
P0[4]	Capacitive touchpad (CST_C0) – Col0	–
P1[0]	Capacitive touchpad (CST_R3) – Row3	–
P2[0]	Capacitive touchpad (CST_R2) – Row2	–
P2[1]	Capacitive touchpad (CST_R1) – Row1	–

Pin details	Primary onboard function	Secondary onboard function
P2[2]	KitProg3 I2C interface clock (KP_ SCL)	KitProg3 UART interface TX (KP_ UART_TX)
P2[3]	KitProg3 I2C interface data (KP_ SDA)	KitProg3 UART interface RX (KP_ UART_RX)
P2[4]	Capacitive touchpad (CST_R0) – Row0	–
P2[5]	CAPSENSE™ proximity sensor (PROX_LP)	–
P3[0]	CAPSENSE™ driven shield (SHIELD)	–
P3[2]	SWD interface data I/O – SWDIO	–
P3[3]	SWD interface clock – SWDCLK	–
P4[0]	Serial RGB LED data	User LED
P4[1]	CAPSENSE™ button (CSD_BTN)	–
P4[2]	CAPSENSE™ CMOD1	–
P4[3]	CAPSENSE™ CMOD2	–
XRES	Hardware reset	–

3.2.1.1 PSoC™ 4000T device power

The PSoC™ 4000T device operates at 5 V, 3.3 V, and 1.8 V (default configuration 1.8 V) in this kit. Ferrite bead (**FB1**) supplies these voltages. By default, (target voltage is set at 1.8 V), the PSoC™ 4000T device core voltage (VCCD) is provided from VDDD through **Q7**. For 3.3 V and 5 V operation, **Q7** is turned off; the internal regulator generates the VCCD core supply (1.8 V).

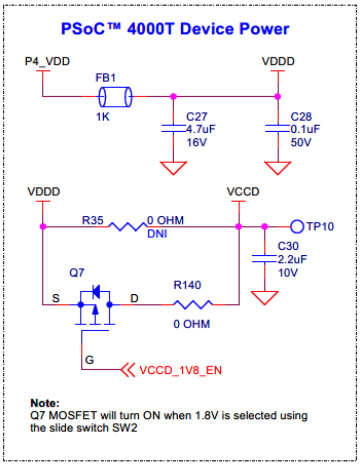


Figure 17 Schematic of PSoC™ 4000T device power

A set of decoupling capacitors is provided for both digital and core voltage rails of the MCU (VDDD and VCCD).

Use header J4 in the power rail of the PSoC™ 4000T target device to measure the current consumption at different modes of operation. By default, J4 is shorted with a jumper (**ACC7**). For current measurement, remove this jumper and connect an ammeter between the pins of J4.

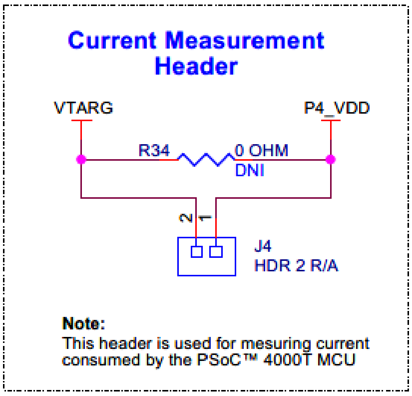


Figure 18 Schematic of current measurement header (J4)

For current measurement, remove this jumper and connect it to a current measurement device (ammeter) between the pins of J4, as Figure 19 shows.

Note: Do not remove the jumper while the target device is powered.

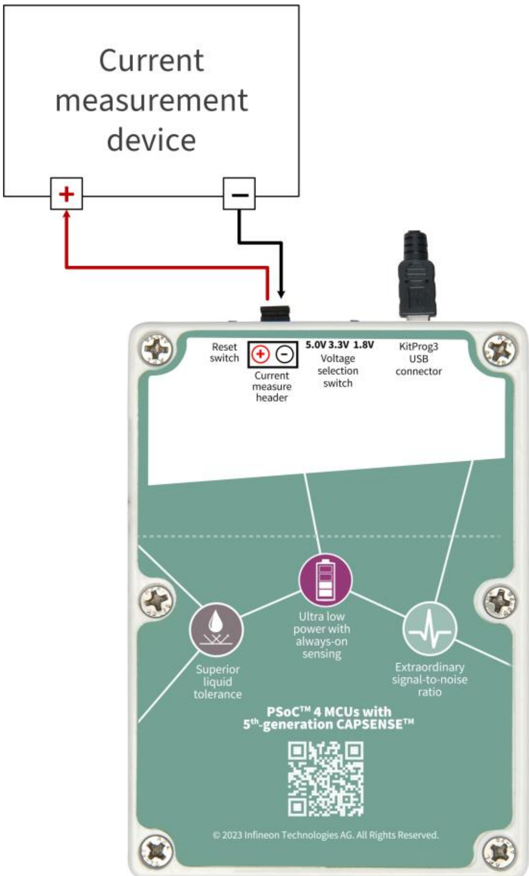


Figure 19 Connection diagram of the current measurement device with J4 header

The onboard LED (**LED4**) indicates the status of PSoC™ 4000T device power. When the current measurement header is not present, **LED4** will turn OFF to indicate that the target device is not powered.

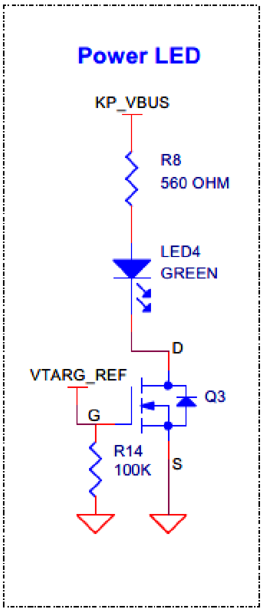


Figure 20 Schematic of power LED indication (LED4)

3.2.1.2 PSoC™ 4000T device 10-pin programming/debugging header

The target MCU default programming/debugging interface is through the onboard KitProg3 programmer/debugger. In addition, you can use an external MiniProg4 programmer/debugger through the 10-pin header (**J6**) provision (no load by default).

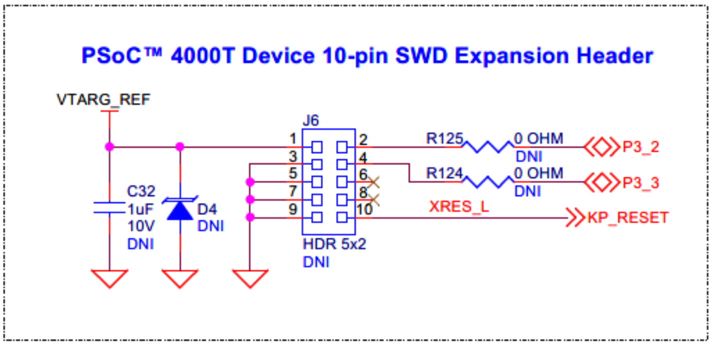


Figure 21 Schematic of PSoC™ 4000T device 10-pin programming/debugging header

3.2.1.3 PSoC™ 4000T device 4-pin I2C/UART expansion header

The target MCU can be interfaced with an external host over I2C with a 4-pin expansion header provision (no load by default). MCU GPIO pins P2[2] and P2[3] supports I2C and UART. Therefore, the same header can be used for UART too.

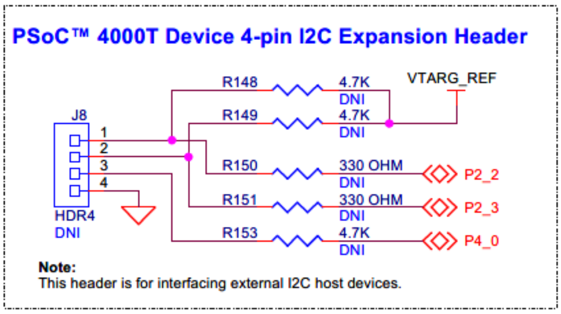


Figure 22 Schematic of PSoC™ 4000T device 4-pin I2C/UART expansion header

3.2.1.4 Reset button

Use the push button (SW1) on the PSoC™ 4000T CAPSENSE™ EVB to reset the target MCU. SW1 provides an active LOW signal.

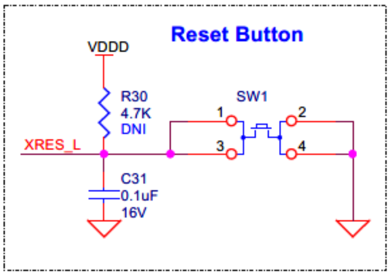


Figure 23 Schematic of reset button (SW1)

3.2.2 PSoC™ 5LP based KitProg3 programmer and debugger

An onboard PSoC™ 5LP (CY8C5868LTI-LP039 - **U2**) device is used as the KitProg3 programmer/debugger to program and debug PSoC™ 4000T device. The PSoC™ 5LP device is connected to the USB port of a PC through a USB connector and to the SWD and other communication interfaces of the PSoC™ 4000T device. For more information, visit the PSoC™ 5LP web page and see the CY8C58LPxx family datasheet.

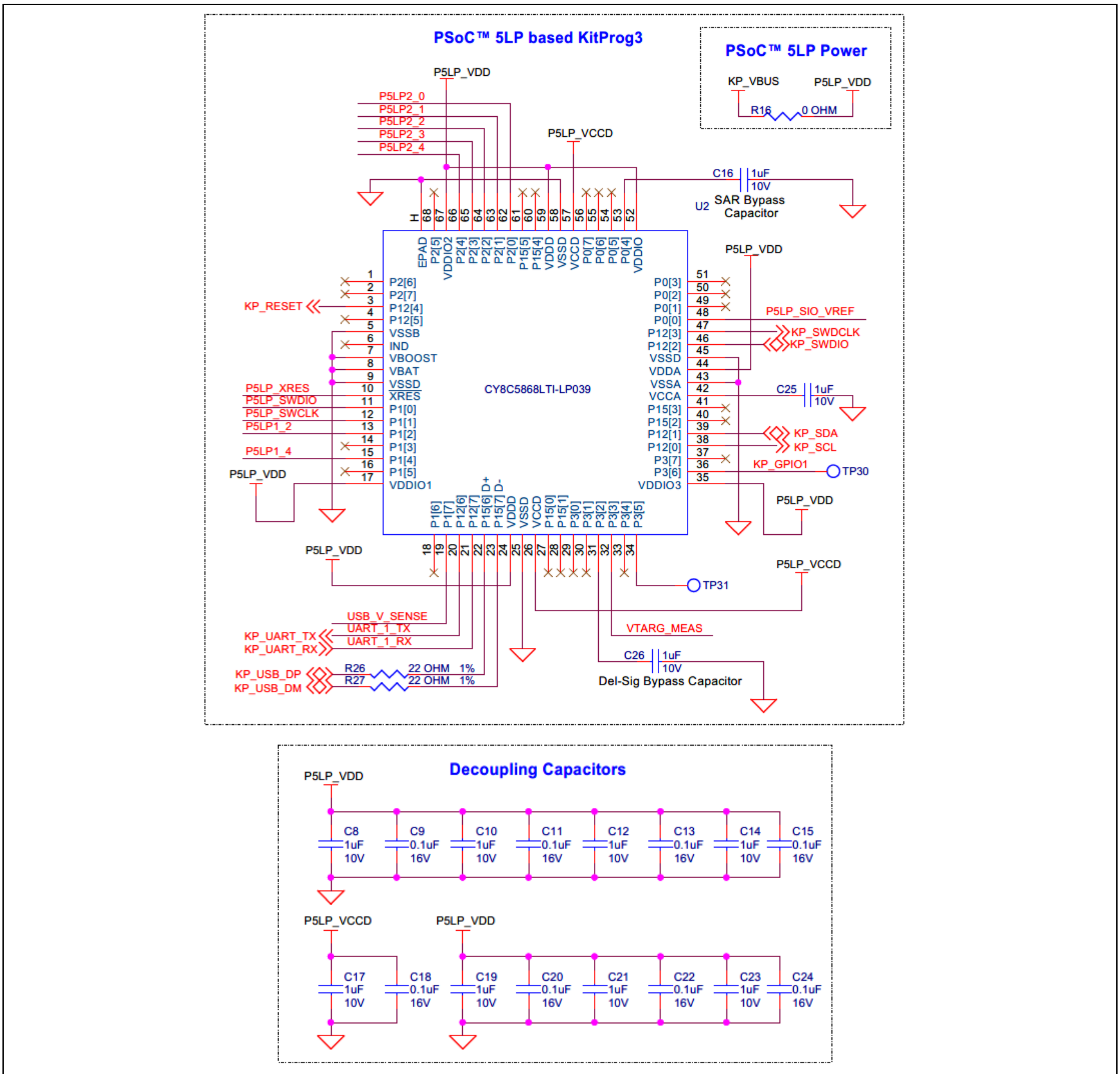


Figure 24 Schematic of PSoC™ 5LP based KitProg3

3.2.2.1 KitProg3 onboard target voltage measurement

PSoC™ 5LP of KitProg3 uses an ADC to measure the onboard target voltage. There is a voltage divider before the ADC input to bring the target voltage within the dynamic range.

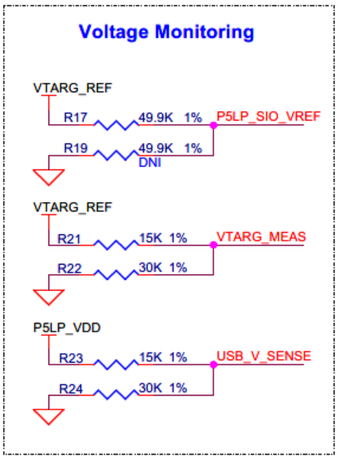


Figure 25 Schematic of KitProg3 onboard target voltage monitoring circuit

3.2.2.2 KitProg3 programming mode selection button and status LED

Use this button to switch between various modes of operation of KitProg3. Note that this board supports only CMSIS-DAP BULK mode. This button function is reserved for future use. The status LED (LED5) indicates the current mode of KitProg3.

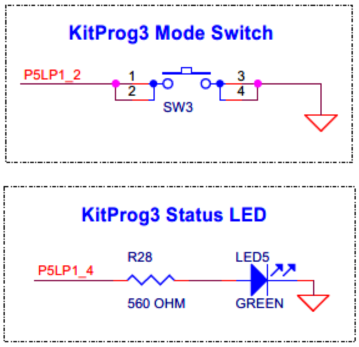


Figure 26 Schematic of KitProg3 mode selection button (SW3) and status LED (LED5)

3.2.3 Power supply system

The PSoC™ 4000T CAPSENSE™ EVB has only one input power source: a USB connector (**J1**). Low capacitance bi-directional TVS diodes (**D1** and **U11**) to provide ESD and overvoltage protection (OVP). The current-limiting load switch (**U5**) at the USB power output limits the maximum current to **400 mA**.

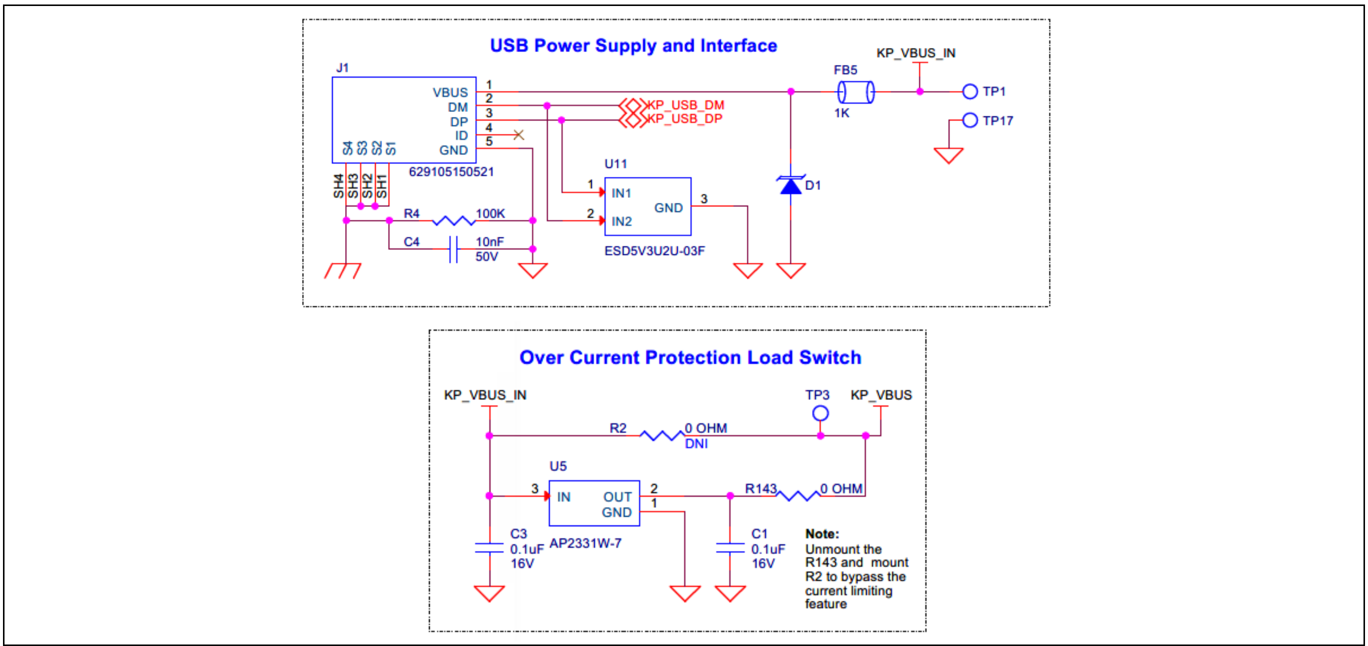


Figure 27 Schematic of USB connector (J1) and current limiting switch (U5)

3.2.3.1 Voltage regulators

The PSoC™ 4000T CAPSENSE™ EVB has two voltage regulators configured to provide 3.3 V and 1.8 V as the target voltage for PSoC™ 4000T device. With the help of a slide switch, select the target voltage between 1.8 V, 3.3 V, and 5 V.

Attention: ***Do not change the slide switch position while the kit is powered.***

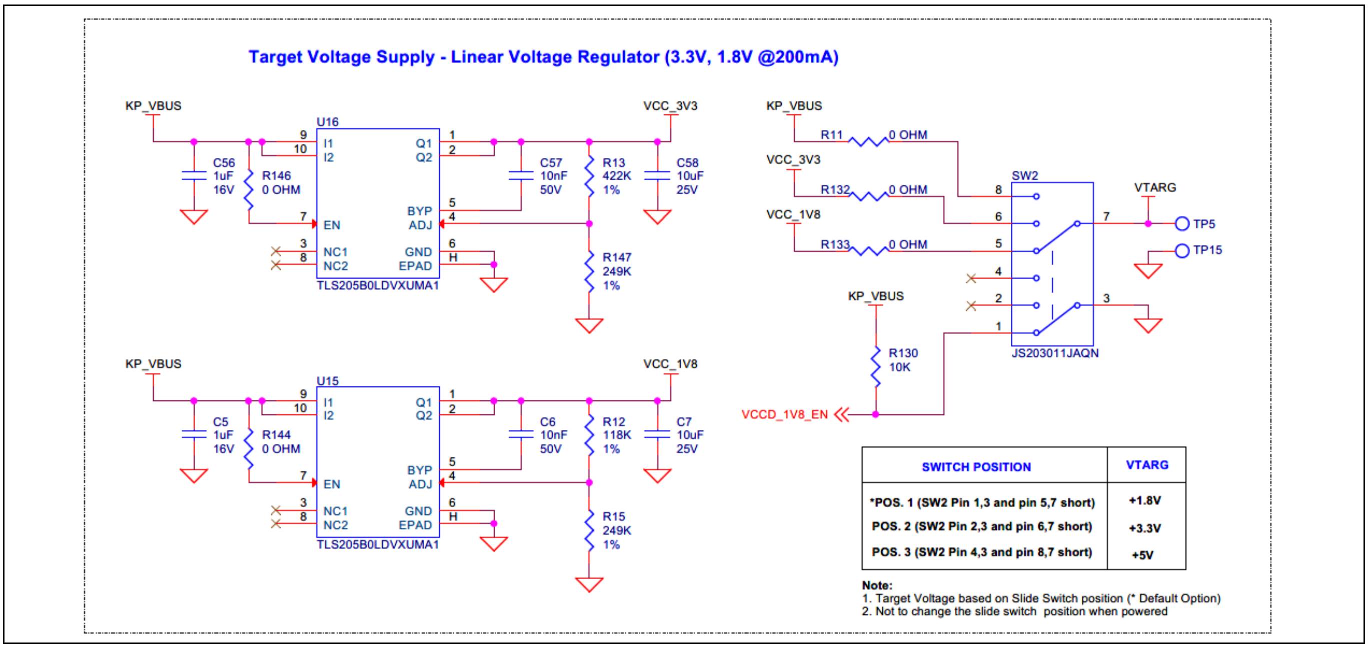


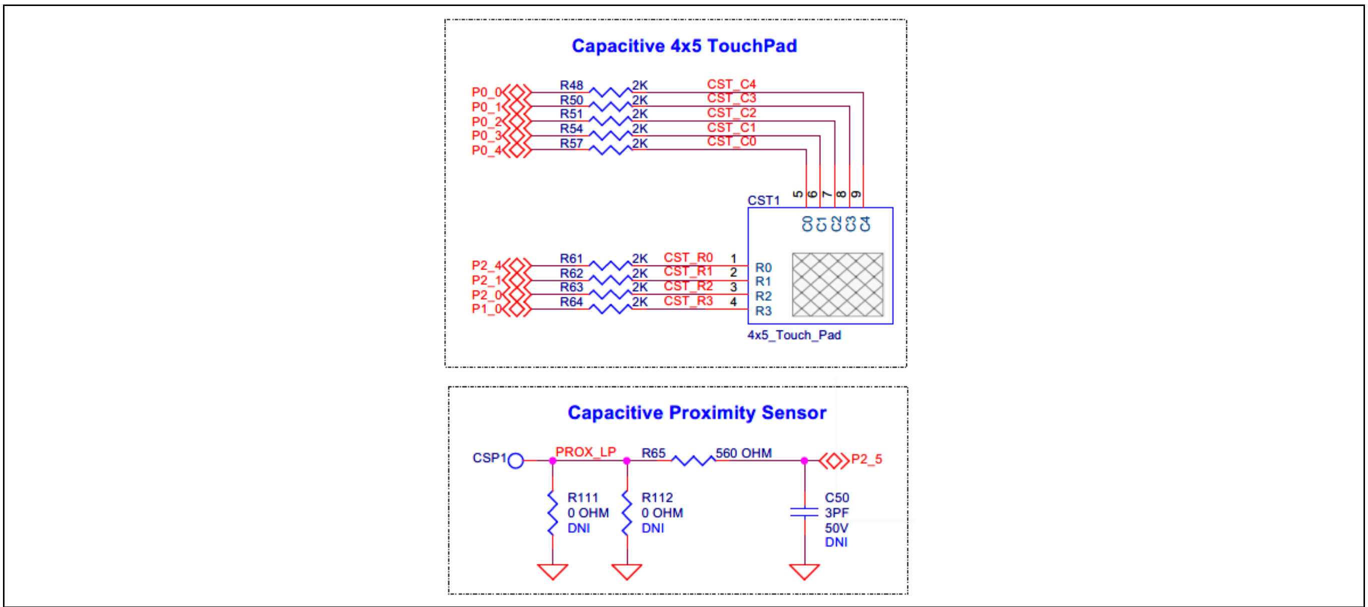
Figure 28 **Schematic of voltage regulators**

3.2.4 CAPSENSE™

3.2.4.1 Capacitive sensing

PSoC™ 4000T EVB consists of a 4x5 touchpad (**CST1**), a button (**CSB1**), and a proximity sensor (**CSP1**). Two external modulation capacitors (CMOD capacitors C36 and C37) on the board enable the CAPSENSE™ functionality. The board supports a driven shield that can drive the hatch pattern surrounding the sensor region; by default, all the hatch patterns are connected to the shield.

For details on using CAPSENSE™ including design guidelines, see the PSoC™ 4 and PSoC™ 6 MCU CAPSENSE™ design guide.



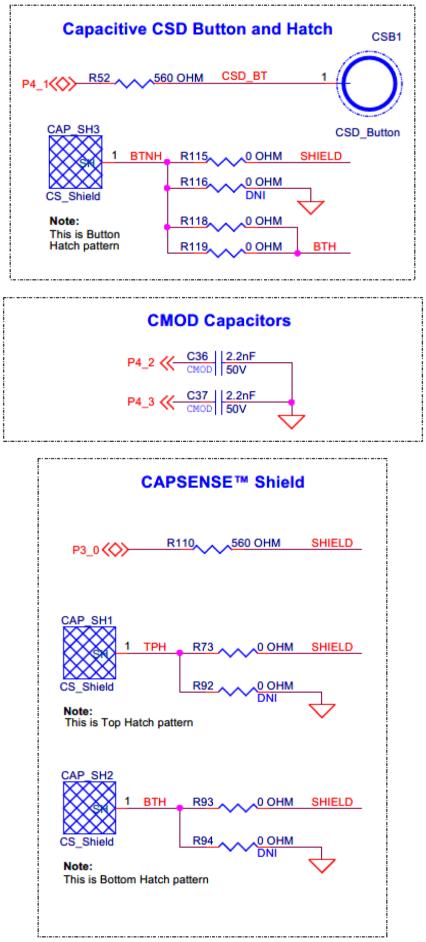


Figure 29 **Schematic of capacitive sensing widgets**

3.2.5 User LED and serial RGB LEDs

The PSoC™ 4000T CAPSENSE™ EVB has one single-color user LED (**LED6**, green) and three serially controlled RGB LEDs **LED1 (U12)**, **LED2 (U13)**, and **LED3 (U14)**. Note that the LED intensity does not change according to the target voltage as **LED6** is driven by MOSFET **Q6**.

The serial RGB LEDs are connected in a daisy chain configuration; a single GPIO controls all three RGB LEDs. Drive precise data signals with predefined ON and OFF pulses on the DIN pin of **U12** to enable the LEDs. For more details, see the datasheet for serially controlled RGB LEDs.

Note: *Serially controlled RGB LEDs needs a precise timing signal for controlling the color and brightness. If these timing requirements are not met, U12 glows in blue color which may be observed while driving the user LED, as both are driven by GPIO P4[0].*

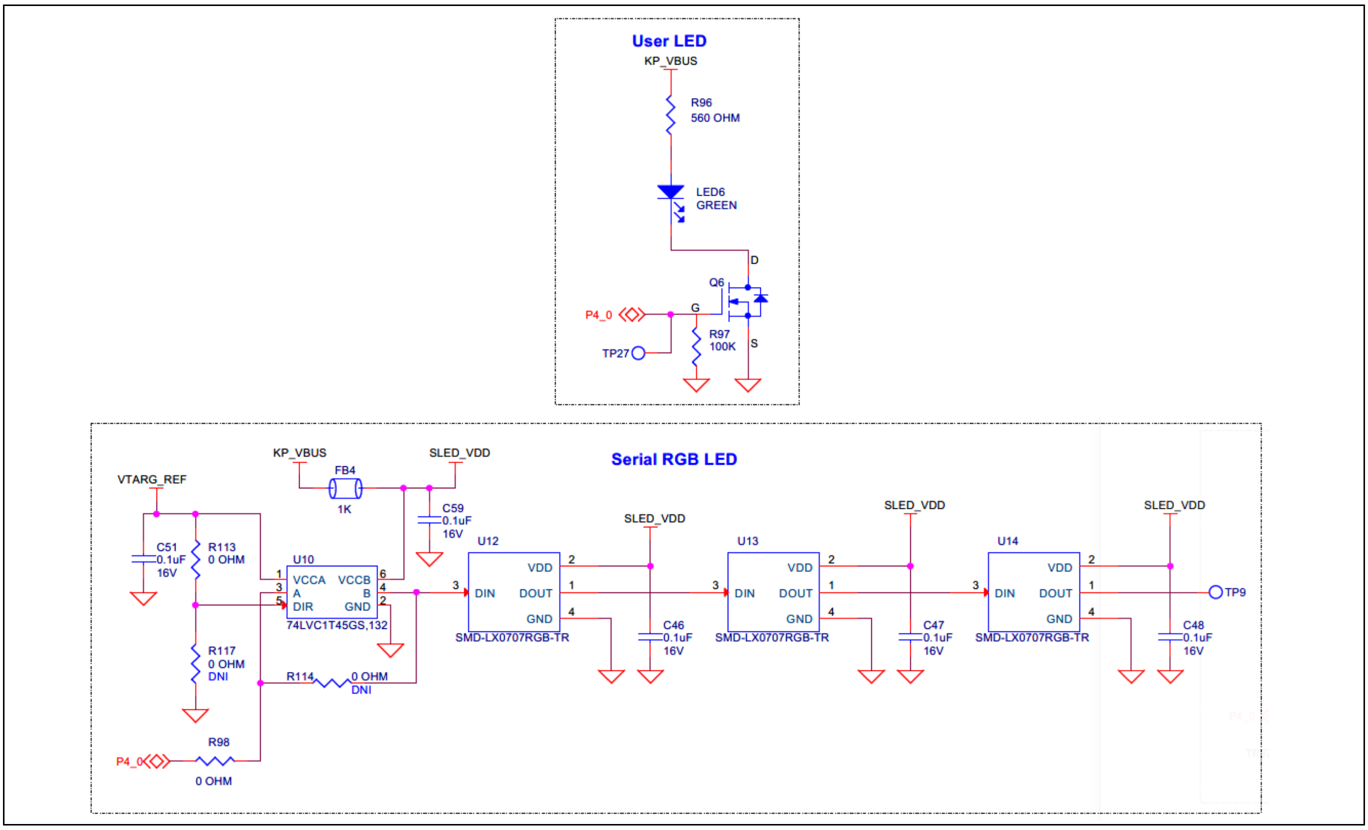


Figure 30 Schematic of user LED and serial RGB LEDs

3.2.6 Enclosure of PSoC™ 4000T CAPSENSE™ EVB

The PSoC™ 4000T CAPSENSE™ EVB is enclosed in a 2-part enclosure (enclosure base and cover). The enclosure base houses the EVB and serves as an overlay for the capacitive sensors. It also has a water-sealing gasket to waterproof the EVB while evaluating the liquid tolerance performance of the PSoC™ 4000T device.

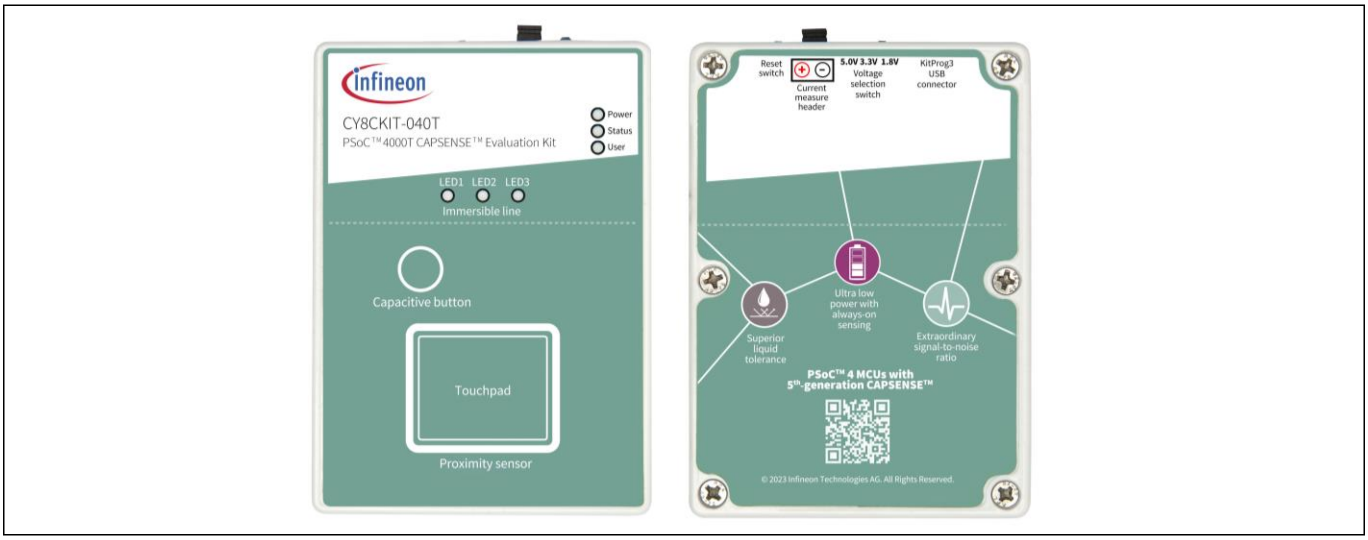


Figure 31 PSoC™ 4000T EVB with enclosure base and cover

Note: While evaluating the liquid tolerance, ensure that the enclosure is assembled correctly, and test that the liquid does not seep in before powering up the board.

3.3 CY8CKIT-040T kit rework for evaluating additional features

This section explains modifications to the board to evaluate different features that are not available out of the box.

Note: *While performing reworks with the enclosure, ensure the rework station temperature should not exceed the melting temperature of the enclosure. The enclosure is made with polycarbonate plastic whose melting temperature is 265°C.*

3.3.1 Enabling the external programming/debugging interface to PSoC™ 4000T device

The default programming/debugging interface for PSoC™ 4000T device is the onboard KitProg3. A 10-pin header (**J6**) is provided on the kit to interface an external programmer such as MiniProg4. By populating the **J6** header and the series resistors (**R124**, **R125**), MiniProg4 can be directly connected to J6 via a 10-pin programming male polarity header.

The EVB also has a provision for ESD and decoupling capacitors. To enable ESD protection, populate **D4**; to filter the noise on the target reference voltage, populate **C32**.

Table 4 Rework components with reference and manufacturer details

Reference	Description	Manufacturer	Manufacturer part number
J6	CONN, HDR, MALE, DUAL, 10POS, 1.27 mm, GOLD, STR, SMD	Samtec	FTSH-105-01-L-DV-K-P-TR
D4	DIO, TVS, UNIDIR, 5 V, 18.6 V, 174 W, SOD-523	MCC	ESD5V0D5-TP
C32	CAP, CER, 1 uF, 10%, X5R, 10 V, 0402	Yageo	CC0402KRX5R6BB105
R124, R125	RES, Fixed, 0 OHM, JUMPER, 1A, 0603	Yageo	RC0603JR-070RL

Figure 32 shows the reworked schematic sections.

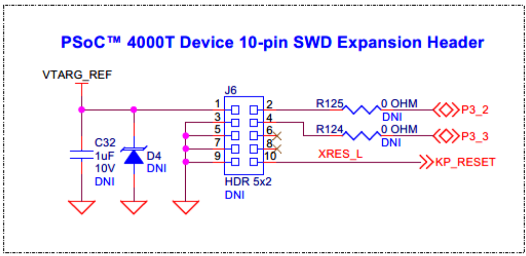


Figure 32 Schematic of rework regions to enable the external programming interface

Table 5 J6 header pin assignment for interfacing with MiniProg4

Pin details	Kit function	MiniProg4 interface function
J6.1	VTAR_REF, PSoC™ 4000T device voltage reference	VTARG, to sense the target MCU voltage
J6.2	P3[2], Port 3 Pin 2 GPIO of PSoC™ 4000T device that supports the SWD interface with an SWDIO signal connection to the target MCU	SWDCLK, SWD data in/out interface with the target MCU
J6.3	GND, ground reference of an EVB	GND, ground reference of MiniProg4

Pin details	Kit function	MiniProg4 interface function
J6.4	P3[3], Port 3 Pin 3 GPIO of PSoC™ 4000T device that supports the SWD interface with an SWDCLK signal connection to the target MCU	SWDIO, SWD clock interface with the target MCU
J6.5	GND, ground reference of an EVB	GND, ground reference of MiniProg4
J6.6	N.C.	N.C.
J6.7	GND, ground reference of an EVB	GND, ground reference of MiniProg4
J6.8	N.C.	N.C.
J6.9	GND, ground reference of an EVB	GND, ground reference of MiniProg4
J6.10	XRES_L, reset signal for PSoC™ 4000T device	XRES, reset signal for the target MCU

3.3.2 Enabling the external host I2C/UART interface to PSoC™ 4000T device

A 4-pin header (**J8**) provision is provided on the kit to interface an external host via I2C/UART with a PSoC™ 4000T device by populating the J8 header and associated resistor (**R148**, **R149** as pull-ups, and **R150**, **R151**, and **R153** as series resistors). The MCU GPIOs P2[2] and P2[3] support I2C and UART interfaces. Therefore, use the same header for the UART interface too.

Table 6 Rework components with reference and manufacturer details

Reference	Description	Manufacturer	Manufacturer part number
J8	CONN, HEADER, SMD, R/A, 4POS, 2.54 mm	Harwin Inc.	M20-8890445R
R148, R149	RES, Fixed, 4.7K, 5%, 1/10 W, 0603	Yageo	RC0603JR-074K7L
R150, R151, R153	RES, Fixed, 330 Ω, 5%, 1/10 W, 0603	Yageo	RC0603JR-07330RL

Figure 33 shows the reworked schematic sections.

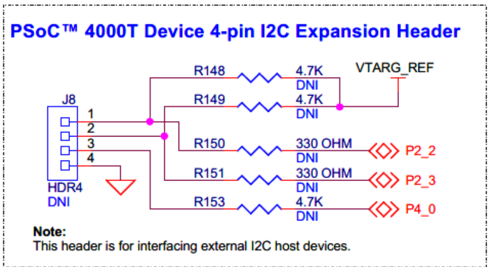


Figure 33 Schematic of rework regions to enable the external host I2C/UART interface

Table 7 J8 header pin assignment for interfacing with MiniProg4

Pin details	Kit function	External host I2C/UART interface function
J8.1	MCU-GPIO P2[2] which can be configured as I2C clock and UART transmit	Connect external host I2C clock or UART receive signal
J8.2	MCU-GPIO P2[3] which can be configured as I2C data and UART receive	Connect external host I2C data or UART transmit signal

Pin details	Kit function	External host I2C/UART interface function
J8.3	MCU-GPIO P4[0] which can be configured as an output to interrupt the host based on data availability	Connect to interrupt input of external host
J8.4	GND, ground reference of an EVB	GND, ground reference of an external host

3.3.3 Enabling the KitProg3 UART interface to PSoC™ 4000T device

By default, the KitProg3 uses an I2C interface to communicate with a PSoC™ 4000T device. There is a provision provided on the EVB to enable the KitProg3 UART interface option with the PSoC™ 4000T device. Enable this option by reworking a couple of 330 Ω resistors used on EVB.

Table 8 Rework components with reference and manufacturer details

Reference	Description	Manufacturer	Manufacturer part number
R134, R135, R141, R142	RES, Fixed, 330 Ω, 5%, 1/10 W, 0603	Yageo	RC0603JR-07330RL

Figure 34 shows the reworked schematic sections.

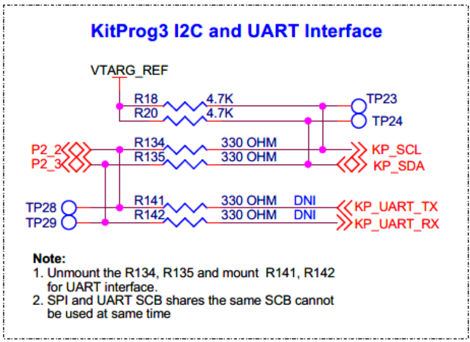


Figure 34 Schematic of rework regions to enable the Kitprog3 UART interface

Table 9 J8 header pin assignment for interfacing with MiniProg4

Kit function	Resistor to be populated	Resistor to be depopulated
Enable I2C interface between KitProg3 and PSoC™ 4000T MCU	R134, R135	R141, R142
Enable UART interface between KitProg3 and PSoC™ 4000T MCU	R141, R142	R134, R135

3.4 Bill of materials

See the BoM files available on the kit webpage.

Glossary

ADC
analog-to-digital converter

BOM
bill of materials

BSP
board support package

CLI
command line interface

CMOD
modulator capacitor

CMSIS-DAP
Cortex® Microcontroller System Interface Standard – Debug Access Port

CPU
central processing unit

CSD
self-capacitance

CSX
mutual-capacitance

EMC
electromagnetic compatibility

ESD
electrostatic discharge

EVB
Evaluation Board

EVK
Evaluation Kit

GND
ground

GPIO
general-purpose input/output

HMI
human-machine interface

I2C
inter-integrated circuit

IDE
integrated development environment

LED
light emitting diode

MCU
microcontroller unit

MSC
multi sense converter

OOB
out-of-the-box

PSoC™
programmable system on chip

SCL
serial clock (I2C)

SDA
serial data (I2C)

SWD
Serial Wire Debug

UART
Universal Asynchronous Receiver-Transmitter

USB
Universal Serial Bus

XRES
external reset

Revision history

Document revision	Date	Description of changes
**	2022-06-15	Initial release
*A	2023-03-06	Fixed hyperlinks throughout the document Updated Figure 14, Figure 15, and Figure 29
*B	2023-06-24	Updated the content to Rev 03 board

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Edition 2023-06-24

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference

002-34870 Rev. *B

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