

Chapter 1: Introduction

After completing this chapter, you will understand what this class is, what topics are covered, and the overall class objectives. You will also have an overview of what development kits are available for the PSoC™ 4 and PSoC™ 6 device families.

Table of contents

1.1	What is this class?	2
1.2	Prerequisites	2
1.3	Development kits	3
1.3.1	PSoC™ 4 kit	3
1.3.2	PSoC™ 6 kit	4
1.3.3	Arduino compatible shield	5
1.4	Introduction to PSoC™	7
1.4.1	PSoC™ 4 MCUs	7
1.4.2	PSoC™ 6 MCUs	7
1.4.3	Development kits and Evaluation boards	7
1.5	PSoC™ KitProg programmer	8
1.6	PSoC™ Firmware Loader	9
1.7	Exercises	10
	Exercise 1: Download Class Material	10
	Exercise 2: Look at kit documentation.....	11
	Exercise 3: Update KitProg firmware	11

Document conventions

Convention	Usage	Example
Courier New	Displays code and text commands	CY_ISR_PROTO(MyISR) ; make build
<i>Italics</i>	Displays file names and paths	<i>sourcefile.hex</i>
[bracketed, bold]	Displays keyboard commands in procedures	[Enter] or [Ctrl] [C]
Menu > Selection	Represents menu paths	File > New Project > Clone
Bold	Displays GUI commands, menu paths and selections, and icon names in procedures	Click the Debugger icon, and then click Next .

1.1 What is this class?

This class is an in-depth look into the PSoC™ 4 and PSoC™ 6 MCU families. The learning objective is to introduce you to the basic operation of the PSoC™ 4 and PSoC™ 6 MCU devices and familiarize you with their development flow within the ModusToolbox™ ecosystem. This should enable you to create your own applications for devices in the PSoC™ 4 and PSoC™ 6 families.

This is a "Level 2" class, meaning that it is intended as a detailed look into a specific product, in this case the PSoC™ 4 and PSoC™ 6 MCUs. This class is part of a series of classes that also include these other "levels":

- "Level 1" classes are intended as an entry point into a particular topic and cover a broad range of topics at a shallow depth.
- "Level 3" classes dig even deeper by looking at complete solutions such as Bluetooth®, Wi-Fi, Motor Control, or Machine Learning.

1.2 Prerequisites

- ModusToolbox™ Software Training Level 1 - Getting Started

This class will not cover what ModusToolbox™ software is, what tools it includes, or how to use any of its features. If you are unfamiliar with ModusToolbox™ software, before embarking on this class, you should take the "ModusToolbox™ Software Training Level 1 - Getting Started" class.

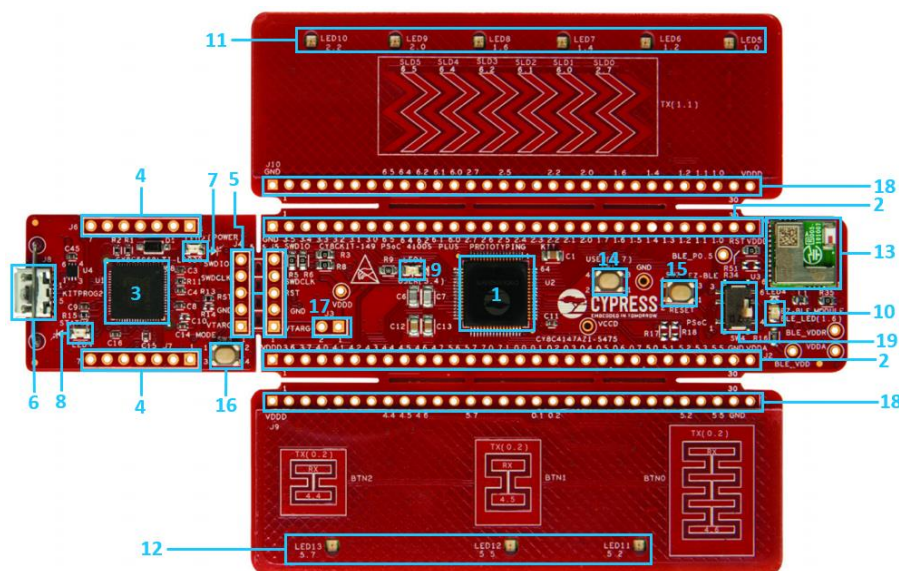
1.3 Development kits

Exercises in this class will use one or more of the following development kits.

1.3.1 PSoC™ 4 kit

Note: The PSoC™ 4 kit is optional. Almost all of the exercises in this course can be done using one of the PSoC™ 6 kits.

[CY8CKIT-149](#) – PSoC™ 4100S Plus MCU prototyping kit with an "EZ-BLE" PSoC™ Module



- | | |
|--|---|
| 1. PSoC™ 4100S Plus device (CY8C4147AZI-S475) | 12. Three Green LEDs (LED11, LED12, LED13) (CAPSENSE™ Button User) |
| 2. PSoC™ 4100S Plus I/O headers (J1 and J2) | 13. EZ-BLE PSoC™ Module |
| 3. KitProg2 (PSoC™ 5LP MCU) device (CY8C5868LTI-LP039) | 14. One Push Button SW1 (User) |
| 4. KitProg2 I/O headers (J6 and J7) | 15. One Push Button SW2 (Reset) |
| 5. SWD connection headers (J4 and J5) | 16. One Push Button SW3 (KitProg2 Mode) |
| 6. USB 2.0 Micro-B connector (J8) | 17. Current Measurement Jumper J3 (foot-print only) (shorted by 0 ohm resistor R53) |
| 7. One amber LED, LED2 (Power) | 18. CAPSENSE™ headers (J9 and J10) |
| 8. One amber LED, LED3 (KitProg2 Status) | 19. Program select switch (SW4) |
| 9. One blue LED, LED1 (User) | |
| 10. One blue LED, LED4 (EZ-BLE PSoC™ User) | |
| 11. Six Green LEDs (LED5, LED6, LED7, LED8, LED9, LED10) (CAPSENSE™ Slider User) | |

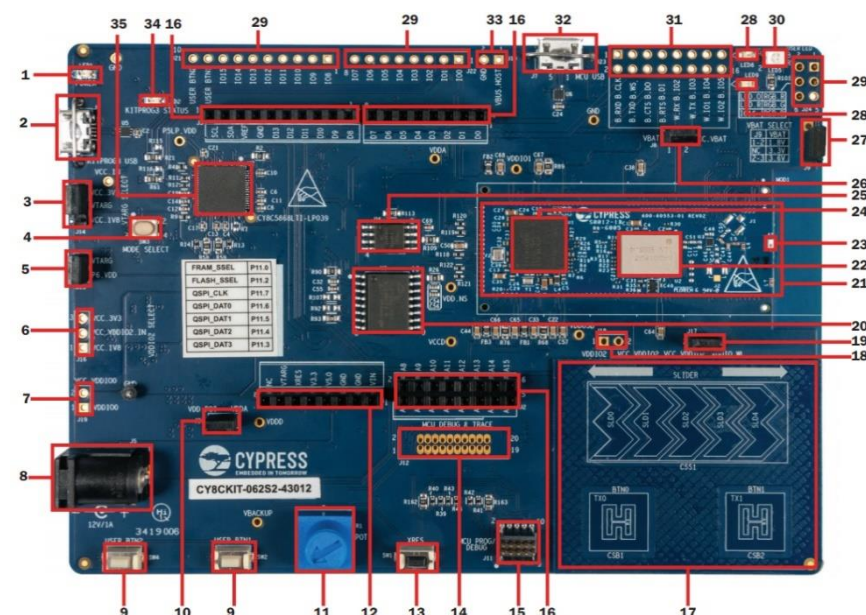
Note: Familiarize yourself with the locations of the user button (14) and the reset button (15). The user button is used in the exercises while the reset button can be used to reset the kit. After reset, the programmed firmware will execute starting from the beginning.

1.3.2 PSoC™ 6 kits

There are two different PSoC™ kits that can be used for most of the exercises.

Note: Only one of the PSoC™ kits is necessary. The first kit with the potentiometer and Arduino compatible headers can be used for a few more exercises than the other PSoC™ 6 kit. Namely, exercises that use the potentiometer to create an analog voltage for the ADC and use resources on the shield such as I²C sensors and OLED display.

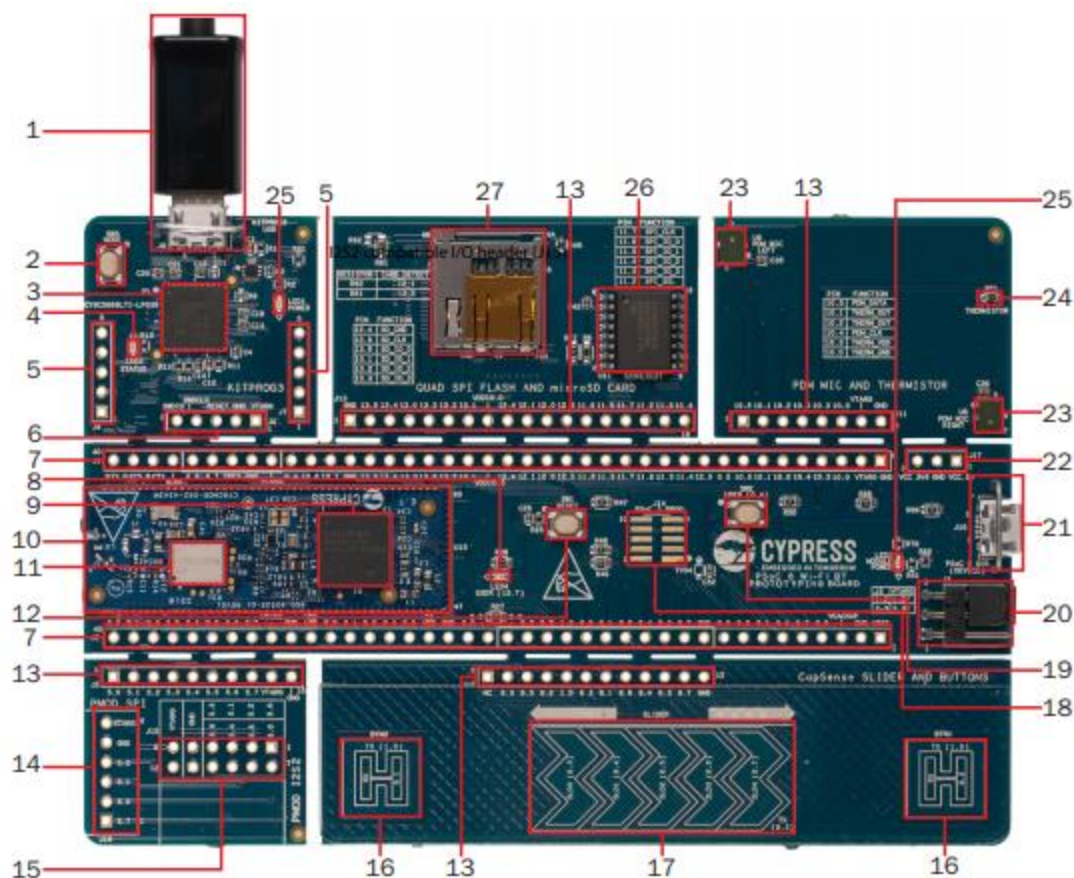
[CY8CKIT-062S2-43012](#) – PSoC™ 6-2M MCU and a CYW43012 Wi-Fi + Bluetooth® Combo



1. Power LED (LED1)	19. CYW43012 VDDIO current measurement jumper(J17)
2. KitProg3 USB connector (J6)	20. Infineon serial NOR flash memory (S25FL512S, U3)
3. PSoC™ 6 MCU VDD power selection jumper (J14)	21. Infineon PSoC™ 6 (2M) MCU with CYW43012 Carrier Module (CY8CMOD-062S2-43012, MOD1)
4. KitProg3 programming mode selection button (SW3)	22. CYW43012 based Murata Type 1LV module
5. PSoC™ 6 MCU VDD current measurement jumper (J15)	23. Wi-Fi/Bluetooth® antenna
6. PSoC™ 6 MCU VDDIO2 and CYW43012 VDDIO power selection jumper (J16)	24. PSoC™ 6 MCU
7. PSoC™ 6 MCU VDDIO0 current measurement jumper (J19)	25. Infineon serial Ferroelectric RAM (CY15B104QSN, U4)
8. External power supply VIN connector (J5)	26. CYW43012 VBAT current measurement jumper (J8)
9. PSoC™ 6 MCU user buttons (SW2 and SW4)	27. CYW43012 VBAT power selection jumper (J9):
10. Potentiometer connection jumper (J25)	28. PSoC™ 6 MCU user LEDs (LED8 and LED9)
11. Potentiometer (R1)	29. PSoC™ 6 I/O header (J21, J22, J24)
12. Arduino-compatible power header (J1)	30. RGB LED (LED5)
13. PSoC™ 6 MCU reset button (SW1)	31. Wi-Fi/Bluetooth® GPIO header (J23)
14. PSoC™ 6 MCU debug and trace header (J12)	32. PSoC™ 6 USB device connector (J7)
15. PSoC™ 6 MCU program and debug header (J11)	33. Optional USB Host power supply header (J10)
16. Arduino Uno R3-compatible I/O headers (J2, J3, and J4)	34. KitProg3 status LED (LED2)
17. CAPSENSE™ slider (SLIDER) and buttons (N0 and BTN1)	35. KitProg3 (PSoC™ 5LP MCU) programmer and debugger (CY8C5868LTI-LP039, U2)
18. PSoC™ 6 MCU VDDIO2 current measurement jumper (J18)	36. MicroSD Card holder (J20) (on back of board)

Note: Familiarize yourself with the locations of the USB connector for programming (2), white user buttons (9) and black reset button (13). The user buttons are used in the exercises while the reset button can be used to reset the kit.

[CY8CPROTO-062-4343W](#) – PSoC™ 6 Wi-Fi BT Prototyping Kit



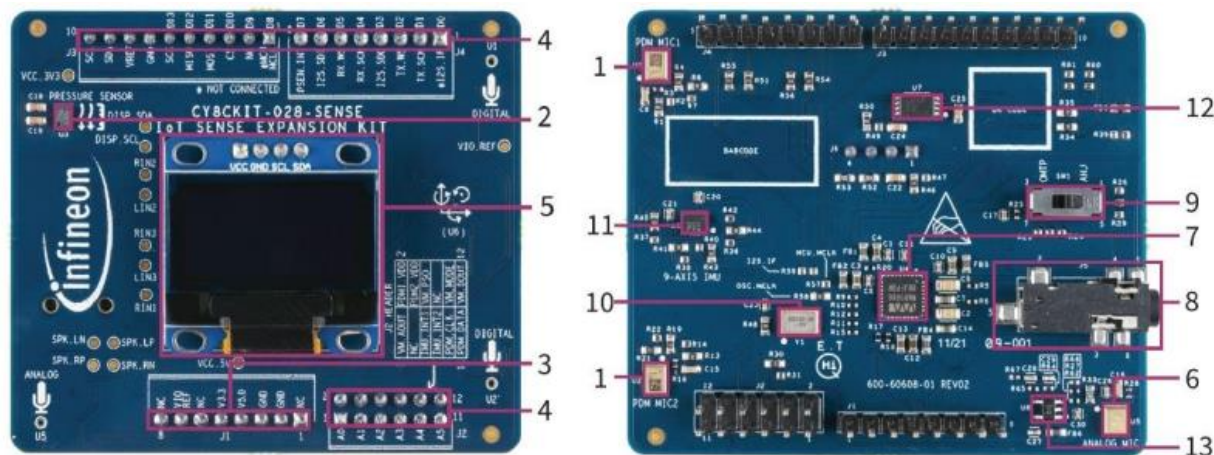
- | | |
|--|---|
| 1. KitProg3 USB connector (J8) | 14. Digilent® Pmod™ SPI compatible I/O header (J16) |
| 2. KitProg3 programming mode selection button (SW3) | 15. Digilent® Pmod™ I2S2 compatible I/O header (J15) |
| 3. KitProg3 (PSoC 5LP) programmer and debugger (CY8C5868LTI-LP039, U1) | 16. CapSense buttons |
| 4. KitProg3 status LED (LED2) | 17. CapSense slider |
| 5. KitProg3 I/O headers (J6, J7) | 18. PSoC 6 MCU program and debug header (J14) |
| 6. KitProg3 5-pin programming header (J4) | 19. PSoC 6 MCU user button (SW2) |
| 7. PSoC 6 MCU I/O headers (J1, J2) | 20. Power selection jumper (J3) |
| 8. PSoC 6 MCU user LED (LED4) | 21. PSoC 6 USB device Connector (J10) |
| 9. PSoC 6 MCU (CY8C624ABZI-D44) | 22. External power supply connector (J17) |
| 10. Cypress PSoC 6 WiFi-BT Module (CY8CMOD-062-4343W, U15) | 23. PDM microphones (U8, U9) |
| 11. CYW4343W based Murata Type 1DX Module (LBEE5KL1DX) | 24. Thermistor (RT1) |
| 12. Reset button (SW1) | 25. Power LEDs (LED1, LED3) |
| 13. On-board peripheral headers (J5, J11, J12 and J13) | 26. Cypress 512-Mbit serial NOR flash memory (S25HL512T, U11) |
| | 27. microSD Card holder (J9) |

Note: Familiarize yourself with the locations of the USB connector for programming (1), user button (9) and reset button (12). The user button is used in the exercises while the reset button can be used to reset the kit.

1.3.3 Arduino compatible shield

The shield kit is only useful if you also have the CY8CKIT-062S2-43012 kit. If you are using the PSoC™ kit or the other PSoC™ 6 kit, you do not need the shield board.

[CY8CKIT-028-SENSE](#)



- | | |
|--|---|
| 1. XENSIV™ digital MEMS microphones (U1, U2) | 8. 3.5-mm stereo audio jack socket (J5) |
| 2. XENSIV™ digital barometric air pressure sensor (U3) | 9. Audio jack socket type selection switch (SW1): |
| 3. Arduino™ UNO R3 compatible power header (J1) | 10. Crystal oscillator (Y1) |
| 4. Arduino™ UNO R3 compatible I/O headers (J2, J3, J4) | 11. Bosch 9-axis absolute orientation sensor (U6) |
| 5. OLED module (ACC6) | 12. I2C level translator (U7) |
| 6. Vesper piezoelectric MEMS analog microphone (U5) | 13. Preamplifier (U8) |
| 7. Audio codec (U4) | |

1.4 Introduction to PSoC™

PSoC™ is a true programmable embedded SoC integrating configurable analog and digital peripheral functions, memory and a microcontroller on a single chip.

1.4.1 PSoC™ 4 MCUs

PSoC™ 4 devices are Arm®-based programmable devices, featuring the low-power Cortex®-M0 and Cortex®-M0+ cores combined with Infineon's unique programmable mixed-signal hardware IP and CAPSENSE™ technology, resulting in the industry's most flexible and scalable low-power mixed-signal architecture.

1.4.2 PSoC™ 6 MCUs













The PSoC™ 6 MCU is purpose-built for the IoT, delivering the industry's lowest power, most flexibility and most secure solution. It provides dual-core Arm Cortex®-M4 and Arm Cortex®-M0+ CPUs running at 150-MHz and 100-MHz on an industry-leading ultra-low-power 40nm process that consumes as little as 22-µA/MHz in active power mode. It provides best-in-class flexibility with wired and wireless connectivity options, software-defined peripherals and industry-leading CAPSENSE™ technology, and integrated hardware-based Trusted Execution Environment (TEE) with secure data storage.

1.4.3 Development kits and Evaluation boards

Many development kits are available for both PSoC™ 4 and PSoC™ 6 devices. To find the list of kits, visit:

<https://www.infineon.com/cms/en/product/microcontroller/32-bit-psoc-arm-cortex-microcontroller>

Click the link that says Boards on the left side of the page for a list of all available kits.

Home > Products > Microcontroller > 32-bit PSoC™ Arm® Cortex® Microcontroller																													
Overview Products Details Boards Tools & Software Training Support	<h2>Boards</h2> <p>43 out of 43 boards</p> <table> <tr> <th>Image</th><th>Board</th><th>Family</th><th>Description</th><th>Status</th></tr> <tr> <td></td><td>CY8CKIT-028-SENSE</td><td>Microcontroller, Sensor</td><td>The IoT sense expansion kit CY8CKIT-028-SENSE is a low-cost shield compatible to Arduino interfacing the PSoC™ 6 MCU to a variety of XENSIV™ sensors targeted for audio and machine learning applications. DPS310 IM69D130</td><td>active and preferred</td></tr> <tr> <td></td><td>CYBLE-416045-EVAL</td><td>Wireless Connectivity, Microcontroller</td><td>The EZ-BLE Arduino compatible Evaluation Board CYBLE-416045-EVAL enables you to evaluate and develop applications on the CYBLE-416045-02 EZ-BLE Creator Module. CYBLE-416045-02 CY8C5868LTI-LP039</td><td>active and preferred</td></tr> <tr> <td></td><td>CY8CPROTO-064S1-SB</td><td></td><td>The PSoC™ 64 Secure Boot Prototyping Kit (CY8CPROTO-064S1-SB) is a low-cost hardware platform that enables you to easily design and debug your IoT application with PSoC™ 64 Secure Boot MCU. Buy online</td><td>active and preferred</td></tr> <tr> <td></td><td>CY8CPROTO-062-4343W</td><td>Microcontroller, Memories</td><td>The PSoC™ 6 AIROC™ Wi-Fi BT Prototyping Kit (CY8CPROTO-062-4343W) is a low-cost hardware platform that enables design and debug of PSoC™ 6 MCUs. It comes with a CY8CMOD-062-4343W module, industry-leading CAPSENSE™ features. Buy online</td><td>active and preferred</td></tr> </table>				Image	Board	Family	Description	Status		CY8CKIT-028-SENSE	Microcontroller, Sensor	The IoT sense expansion kit CY8CKIT-028-SENSE is a low-cost shield compatible to Arduino interfacing the PSoC™ 6 MCU to a variety of XENSIV™ sensors targeted for audio and machine learning applications. DPS310 IM69D130	active and preferred		CYBLE-416045-EVAL	Wireless Connectivity, Microcontroller	The EZ-BLE Arduino compatible Evaluation Board CYBLE-416045-EVAL enables you to evaluate and develop applications on the CYBLE-416045-02 EZ-BLE Creator Module. CYBLE-416045-02 CY8C5868LTI-LP039	active and preferred		CY8CPROTO-064S1-SB		The PSoC™ 64 Secure Boot Prototyping Kit (CY8CPROTO-064S1-SB) is a low-cost hardware platform that enables you to easily design and debug your IoT application with PSoC™ 64 Secure Boot MCU. Buy online	active and preferred		CY8CPROTO-062-4343W	Microcontroller, Memories	The PSoC™ 6 AIROC™ Wi-Fi BT Prototyping Kit (CY8CPROTO-062-4343W) is a low-cost hardware platform that enables design and debug of PSoC™ 6 MCUs. It comes with a CY8CMOD-062-4343W module, industry-leading CAPSENSE™ features. Buy online	active and preferred
Image	Board	Family	Description	Status																									
	CY8CKIT-028-SENSE	Microcontroller, Sensor	The IoT sense expansion kit CY8CKIT-028-SENSE is a low-cost shield compatible to Arduino interfacing the PSoC™ 6 MCU to a variety of XENSIV™ sensors targeted for audio and machine learning applications. DPS310 IM69D130	active and preferred																									
	CYBLE-416045-EVAL	Wireless Connectivity, Microcontroller	The EZ-BLE Arduino compatible Evaluation Board CYBLE-416045-EVAL enables you to evaluate and develop applications on the CYBLE-416045-02 EZ-BLE Creator Module. CYBLE-416045-02 CY8C5868LTI-LP039	active and preferred																									
	CY8CPROTO-064S1-SB		The PSoC™ 64 Secure Boot Prototyping Kit (CY8CPROTO-064S1-SB) is a low-cost hardware platform that enables you to easily design and debug your IoT application with PSoC™ 64 Secure Boot MCU. Buy online	active and preferred																									
	CY8CPROTO-062-4343W	Microcontroller, Memories	The PSoC™ 6 AIROC™ Wi-Fi BT Prototyping Kit (CY8CPROTO-062-4343W) is a low-cost hardware platform that enables design and debug of PSoC™ 6 MCUs. It comes with a CY8CMOD-062-4343W module, industry-leading CAPSENSE™ features. Buy online	active and preferred																									

1.5 PSoC™ KitProg programmer

The programmer firmware on the PSoC™ development kits is called KitProg3 (some kits ship with KitProg2 firmware, but we'll show you how to update it later). It runs on a PSoC™ 5LP chip also located on the kit. This firmware talks to your computer via USB and to the PSoC™ target device via a protocol called Serial Wire Debug (SWD). The host application on your computer needs to talk to the programmer to debug the PSoC™ MCU and to download firmware into the PSoC™ flash. There are a bunch of different protocols out there for accomplishing this task. However, a few years ago Arm developed a standard called CMSIS-DAP, which has two variants that are implemented in the KitProg firmware (Bulk and DAPLink).

Note: Older versions of KitProg firmware also support HID mode, which we typically don't use anymore.

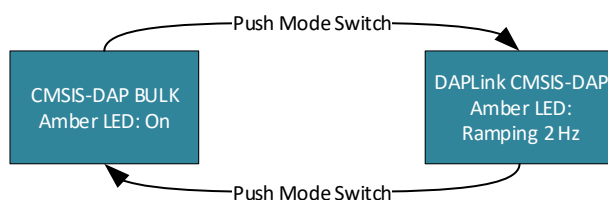
In addition to the CMSIS functions, there is also a function called "Mass storage". When the mass storage functionality is turned on, the programmer appears as a "flash drive" on your computer. You can copy – using the file manager – hex files to the flash drive, which will then be programmed. This function typically runs at the same time as the DAPLink functionality.

The programming firmware typically provides one or more communication bridge modes that allow the PSoC™ MCU to talk to your PC via I²C or UART. These also typically run at the same time as the programming firmware.

The KitProg will appear to your computer to be multiple USB endpoints that implement each of the functions described in the previous paragraphs.

In order to program the PSoC™ MCU, KitProg needs to be in the right mode – meaning the mode that has the functionality that works with your environment. You can switch modes by pressing the mode button on the development kit, or by using the [firmware loader program](#). Each PSoC development kit has an LED that will be solid or ramping (~2 Hz) to indicate the mode. See the following table.

CMSIS Mode	Application	Mass Storage	Bridges	Solution	Description	LED
BULK	Eclipse IDE	No	UART I2C	PSoC™ 6 devices, PSoC™ 4 devices& AFR	The latest version of the protocol which uses USB bulk mode – by far the fastest.	Solid
DAPLink	N/A	Yes	UART	N/A	A modified version of CMSIS-DAP that enables web debugging	2 Hz Ramping



The PSoC™ 4 development kit we will use in this class, when updated to the latest KitProg, only has the CMSIS-DAP BULK mode.

1.6 PSoC™ Firmware Loader

Firmware loader (fw-loader) is a tool that we deliver as part of ModusToolbox™ software. It is a command-line tool that allows you to install new KitProg firmware onto a PSoC™ kit, and switch modes programmatically.

You can find it in the following directory:

```
<install_dir>/ModusToolbox/tools_<version>/fw-loader/bin
```

It is also available independently on GitHub at <http://github.com/infineon/firmware-loader>.

The following table shows some of the basic fw-loader commands:

Command	Description
<code>fw-loader --help</code> (or no argument)	Print out help information.
<code>fw-loader --device-list</code>	List all the KitProg devices attached to your computer.
<code>fw-loader --update-kp3</code>	Install the latest firmware onto your KitProg.
<code>fw-loader --mode kp3-daplink</code>	Put the KitProg into DAPLink CMSIS-DAP mode.
<code>fw-loader --mode kp3-bulk</code>	Put the KitProg into CMSIS-DAP Bulk mode.
<code>fw-loader --mode kp3-hid</code>	Put the KitProg into CMSIS-DAP HID mode (not typically used).
<code>fw-loader --mode kp3-bootloader</code>	Put the KitProg into bootloader mode (not typically used).

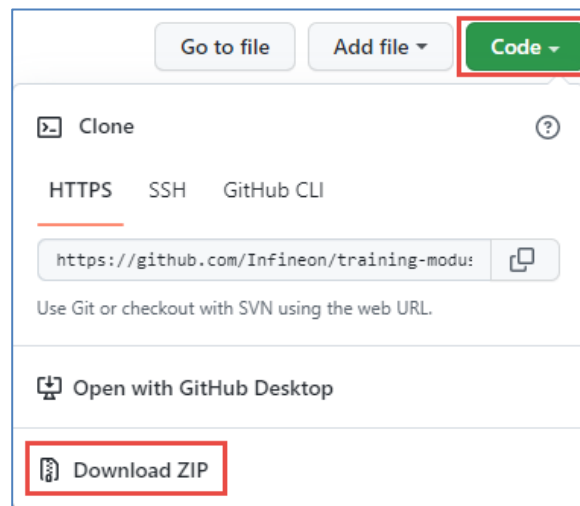
You will practice using this tool in exercise 2.

1.7 Exercises

Exercise 1: Download Class Material

In this exercise, you will download the class material from GitHub. This will provide local access to the manuals and projects.

- ☐ 1. Use a Web browser to go to the class GitHub site at: <https://github.com/Infineon/training-modustoolbox-level2-psoc>
- ☐ 2. Click the **Code** button.



- ☐ 3. Click the **Download ZIP** button to download the repo to your local disk to a convenient location and then unzip it.

Note: If you are familiar with Git operations, you can clone the repository to your local disk using the URL instead of downloading a ZIP file if you prefer.

Exercise 2: Look at kit documentation



1. Visit the websites for the kits used in this class and familiarize yourself with the kit documentation.

All the relevant documentation can be found at the bottom of the kit's website in the "Related Files" section.

Exercise 3: Update KitProg firmware

Your kits may have KitProg2 installed rather than KitProg3. In this exercise we will determine what version of KitProg your kits have and update them if necessary.

Repeat these steps for each of your development kits.



1. Connect your kit to your computer using the provided USB cable. If your kit has multiple USB connectors, be sure to connect to the one labeled KITPROG.



2. Start the fw-loader tool.

- a. On Windows, either run `fw-loader` from the Start menu list or by entering `fw-loader` in the Windows search box.
- b. MacOS or Linux: Start a standard command terminal, and navigate to the directory `<install_dir>/ModusToolbox/tools_<version>/fw-loader/bin`



3. Check the KitProg firmware version on the kit:

```
./fw-loader --device-list
```



4. Does a device show up? What mode is it in? What version of KitProg does it have installed? Update it to the latest version of KitProg3:

```
./fw-loader --update-kp3
```

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Published by
Infineon Technologies AG
81726 Munich, Germany

© 2023 Infineon Technologies AG.
All Rights Reserved.

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies office (www.infineon.com).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.