

## 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.

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### 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
<b>Bold</b>	Displays GUI commands, menu paths and selections, and icon names in procedures	Click the <b>Debugger</b> icon, and then click <b>Next</b> .

## 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

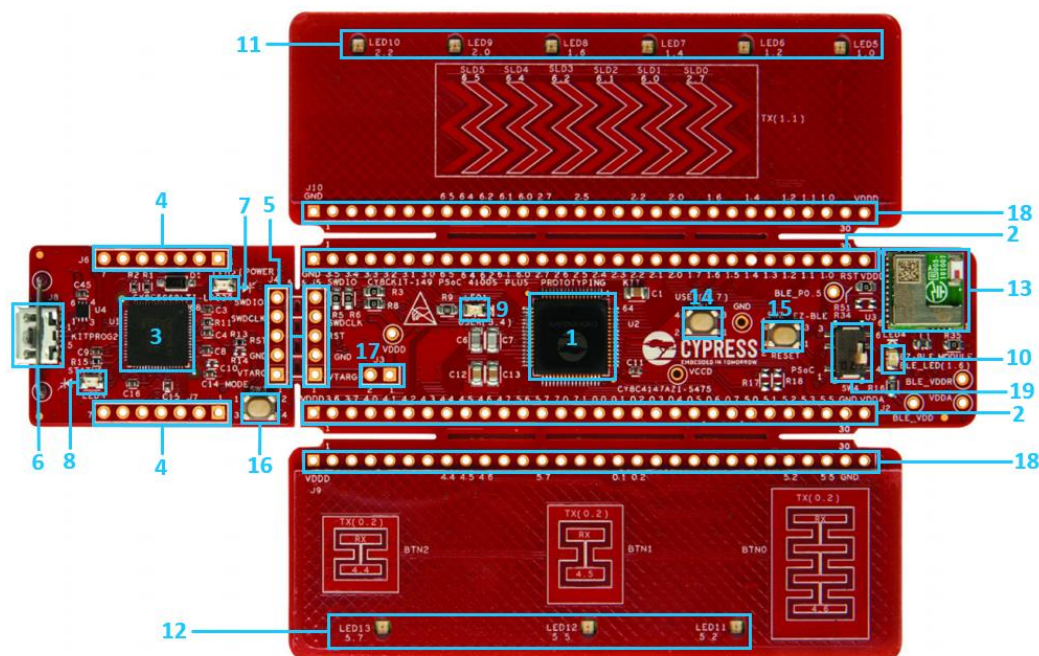
This class will not cover what ModusToolbox™ software is, what tools it includes, or how to use any of its features. If you are unfamiliar with ModusToolbox™ software, before embarking on this class, you should take the "ModusToolbox™ Software Training Level 1 - Getting Started" class.

## 1.3 Development Kits

For this class we will use the following development kits:

### 1.3.1 PSoC™ 4 Kit

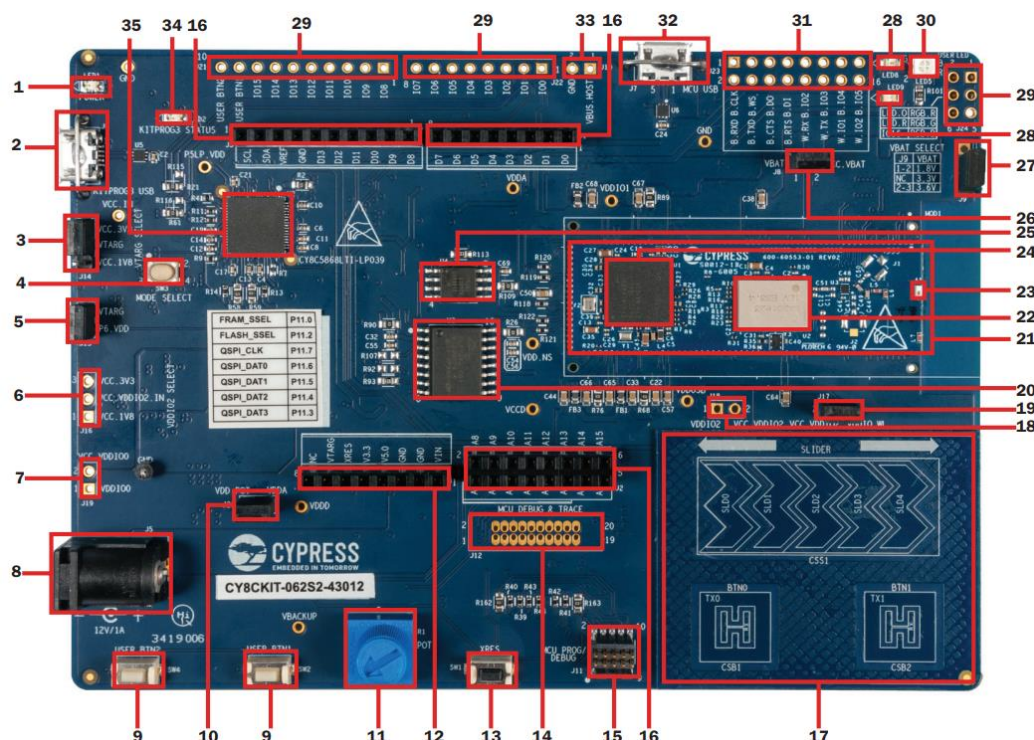
[CY8CKIT-149](#) – A PSoC™ 4100S Plus MCU prototyping kit with an "EZ-BLE" PSoC Module



- |  |   |
|--|---|
| 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) |   |

## 1.3.2 PSoC™ 6 Kit

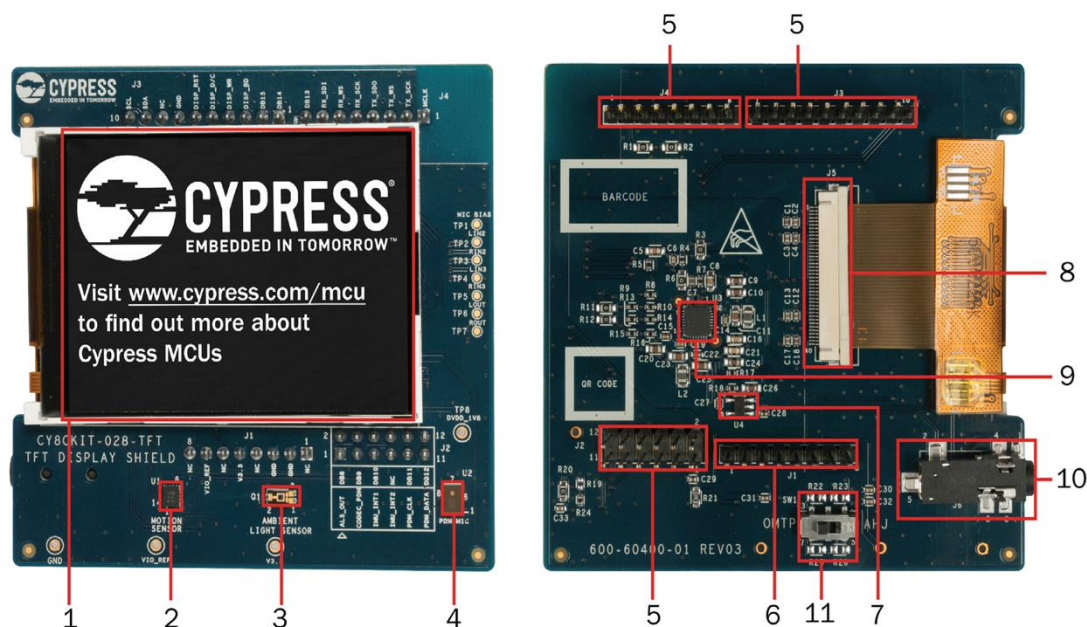
[CY8CKIT-062S2-43012](#) – A PSoC™ 6-2M MCU and a CYW43012 Wi-Fi + Bluetooth® Combo



- |   |  |
|---|--|
| 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)                                       |

### 1.3.3 Arduino Compatible Shield

#### CY8CKIT-028-TFT



- |  |  |
|--|--|
| 1. 2.4-inch TFT display                        | 7. TFT display power control load switch (U4)    |
| 2. Motion Sensor (U1)                          | 8. TFT display connector (J5)                    |
| 3. Ambient Light Sensor (Q1)                   | 9. Audio CODEC (U3)                              |
| 4. PDM microphone (U2)                         | 10. Audio Jack (J6)                              |
| 5. Arduino compatible I/O headers (J2, J3, J4) | 11. Audio Jack Selection (OMTP/AHJ) Switch (SW1) |
| 6. Arduino compatible power header (J1)        |  |



## 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™, resulting in the industry's most flexible and scalable low-power mixed-signal architecture.

#### 1.4.1.1 Development Kits

A list of some PSoC™ 4 development kits is shown below. More kits are released all the time so when you read this, additional kits may be available.

##### [CY8CKIT-041-41XX](#)

- PSoC™ 4 MCU with 48 MHz M0+
- 64 KB On-Chip Flash, 8 KB SRAM
- 1 Mbit 3.4 MHz F-RAM
- CAPSENSE™ Trackpad, 2 Buttons
- 2 user mechanical buttons, 1 potentiometer
- 1 RGB LED
- EZ-BLE PSoC Module



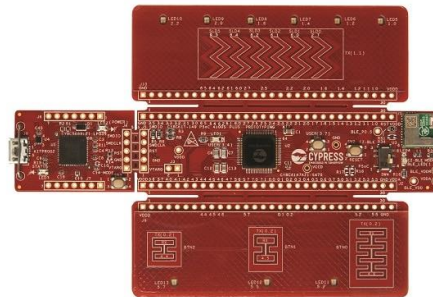
##### [CY8CKIT-145-40XX](#)

- PSoC™ 4 MCU with 48 MHz M0+
- 32 KB On-Chip Flash, 4 KB SRAM
- CAPSENSE™ Slider, 3 Buttons
- 1 user mechanical button
- EZ-BLE PSoC Module



## CY8CKIT-149

- PSoC™ 4 MCU with 48 MHz M0+
- 128 KB On-Chip Flash, 16 KB SRAM
- CAPSENSE™ Slider, 3 Buttons
- 1 user mechanical button
- 1 LED
- EZ-BLE PProC Module



## 1.4.2 PSoC™ 6 MCUs

The PSoC™ 6 MCU is Infineon's newest PSoC™ MCU, 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™, and integrated hardware-based Trusted Execution Environment (TEE) with secure data storage.

### 1.4.2.1 Development Kits

A list of some PSoC™ 6 development kits is shown below. More kits are released all the time so when you read this, additional kits may be available.

#### CY8CKIT-062-BLE

- Bluetooth® LE kit (CY8C6347BZI-BLD53)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 4 Mbit 108 MHz F-RAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons, and Proximity
- 1 user mechanical button
- 2 LEDs, 1 RGB LED
- Mbed OS support
- Includes a CY8CKIT-028-EPD E-INK Display Shield
- Includes a CY5677 CySmart Bluetooth® LE 4.2 USB Dongle



#### CY8CKIT-062S2-43012

- Wi-Fi + Bluetooth® Combo kit (CYW43012)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 2 MB On-Chip Flash, 1 MB SRAM
- 4 Mbit 108 MHz F-RAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 2 user mechanical buttons, 1 potentiometer
- 2 LEDs, 1 RGB LED
- microSD Card holder
- Mbed OS support





## CY8CKIT-062-WiFi-BT

- Wi-Fi + Bluetooth® combo kit (CYW4343W)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 512 Mbit serial NOR flash memory
- CCG3 USB Type-C Power Delivery
- CAPSENSE™ Slider, 2 Buttons, and Proximity
- 1 user mechanical button
- 2 LEDs, 1 RGB LED
- Mbed OS support
- Includes a CY8CKIT-028-TFT Display Shield



## CY8CKIT-064B0S2-4343W

- Wi-Fi + Bluetooth® combo kit (CYW4343W)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 2 MB On-Chip Flash, 1 MB SRAM
- 4 Mbit 108 MHz F-RAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 2 user mechanical buttons, 1 potentiometer
- 2 LEDs, 1 RGB LED
- microSD Card holder
- Mbed OS support



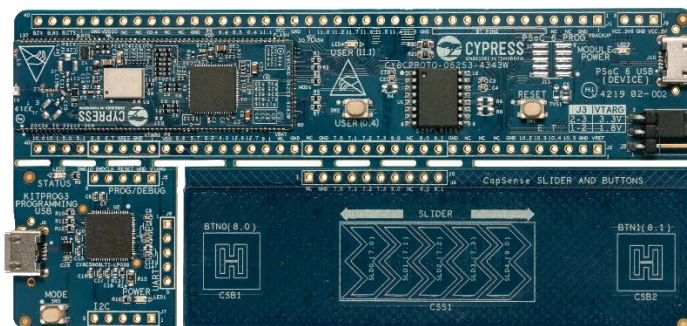
## CY8CPROTO-062-4343W

- Wi-Fi + Bluetooth® combo kit (CYW4343W)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 2 MB On-Chip Flash, 1 MB SRAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 1 user mechanical button
- 1 thermistor, 2 PDM microphones
- 1 LED
- microSD Card holder
- Mbed OS support



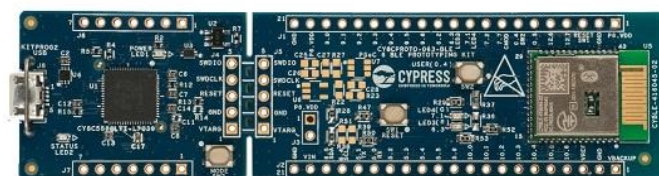
### CY8CPROTO-062S3-4343W

- Wi-Fi + Bluetooth® combo kit (CYW4343W)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 512 KB On-Chip Flash, 256 KB SRAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 1 user mechanical button
- 1 LED
- Mbed OS support



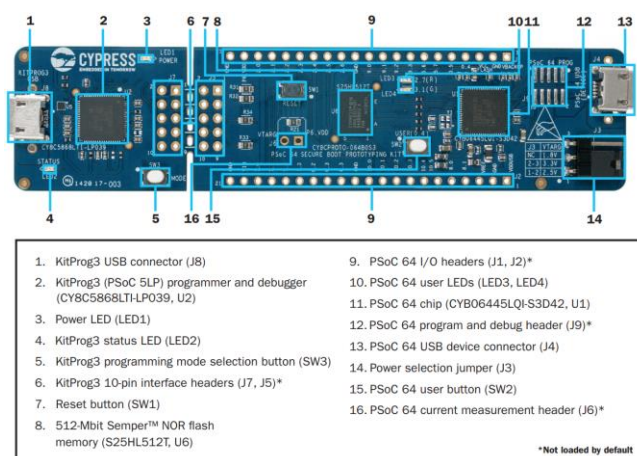
### CY8CPROTO-063-BLE

- Bluetooth® LE kit (CYBLE-416045-02)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 1 user mechanical button
- 2 LEDs



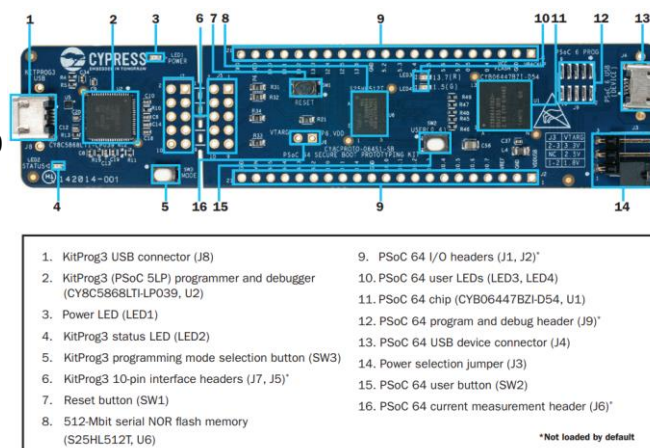
### CY8CPROTO-064B0S3

- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 384 KB On-Chip Flash, 176 KB SRAM
- 512 Mbit serial NOR flash memory
- 1 user mechanical button
- 2 LEDs



## CY8CPROTO-064S1-SB

- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 896 KB On-Chip Flash, 184 KB SRAM
- 512 Mbit serial NOR flash memory
- 1 user mechanical button
- 2 LEDs



## CYBLE-416045-EVAL

- Bluetooth® LE kit (CYBLE-416045-02)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 1 user mechanical button
- 1 RGB LED



## CYW9P62S1-43012EVB-01

- Wi-Fi + Bluetooth® Combo kit (CYW43012)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 4 Mbit 108 MHz F-RAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 1 user mechanical button
- 2 LEDs





### CYW9P62S1-43438EVB-01

- Wi-Fi + Bluetooth® Combo kit (CYW43438)
- PSoC™ 6 MCU with 150 MHz Cortex®-M4 and 100 MHz Cortex®-M0+
- 1 MB On-Chip Flash, 288 KB SRAM
- 4 Mbit 108 MHz F-RAM
- 512 Mbit serial NOR flash memory
- CAPSENSE™ Slider, 2 Buttons
- 2 user mechanical buttons, 1 potentiometer
- 2 LEDs, 1 RGB LED



## 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.*

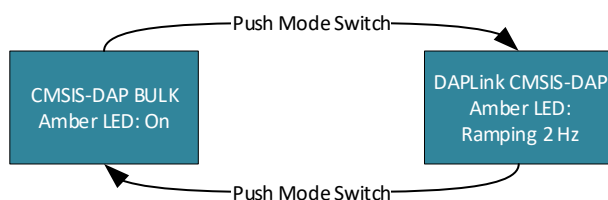
In addition to the CMSIS functions, there is also a function called "Mass storage". When the mass storage functionality is turned on, the programmer appears as a "flash drive" on your computer. You can copy – using the file manager – hex files to the flash drive, which will then be programmed. This function 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 I<sup>2</sup>C 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	Mbed Studio or Mbed CLI	Yes	UART	Mbed OS	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: 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 2: 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. Run a command line terminal

Windows: run `modus-shell` from the Start menu or enter `modus-shell` in the Windows search box.

MacOS or Linux: start a standard command terminal



3. Navigate to the directory `<install_dir>/ModusToolbox/tools_<version>/fw-loader/bin`

*Note: On Windows, steps 2 and 3 can be done together by either running `fw-loader` from the Start menu list or by entering `fw-loader` in the Windows search box.*



4. Check the KitProg firmware version on the kit:

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



5. 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
```

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