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CY8CKIT-042-BLE-A

Bluetooth® Low Energy (BLE) Pioneer Kit Guide

Doc. # 002-11468 Rev. *E

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Contents

Safety Information 6

1. Introduction 10

1.1 Kit Contents 11
1.2 BLE Pioneer Baseboard Details 12
1.3 PSoC Creator 14
1.3.1 PSoC Creator Code Examples 15
1.3.2 Kit Code Examples 16
1.3.3 PSoC Creator Help 16
1.3.4 Component Datasheets 17
1.4 Getting Started 17
1.5 Additional Learning Resources 17
1.5.1 Bluetooth Learning Resources 18
1.5.2 Other Related Resources 18
1.6 Technical Support 19
1.7 Documentation Conventions 19
1.8 Acronyms 19

2. Software Installation 21

2.1 Before You Begin 21
2.2 Install Software 21
2.3 Windows 8.1 and Windows 10 USB Selective Suspend Setting 24

3. Kit Operation 25

3.1 Theory of Operation 25
3.2 KitProg 27
3.3 BLE Pioneer Kit USB Connection 27
3.4 Placing PSoC 4 BLE Module on Baseboard 28
3.5 Programming and Debugging BLE Device 29
3.5.1 Programming using PSoC Creator 29
3.5.2 Debugging using PSoC Creator 30
3.5.3 Programming using PSoC Programmer 31
3.6 Updating BLE Dongle for CySmart Central Emulation Tool 32
3.7 USB-UART Bridge 34
3.8 USB-I2C Bridge 35
3.9 Updating the KitProg Firmware 36

4. Code Examples 37

4.1 Using Code Examples 37
4.2 CapSense Slider and LED 41
4.2.1 Project Description 41
4.2.2 Hardware Connections 43

4.2.3 Flow Chart 44
4.2.4 Verify Output 45
4.3 CapSense Proximity 53
4.3.1 Project Description 53
4.3.2 Hardware Connections 55
4.3.3 Flow Chart 56
4.3.4 Verify Output 57
4.4 BLE Central Mode 62
4.4.1 Project Description 62
4.4.2 Hardware Connections 64
4.4.3 Flow Chart 65
4.4.4 Verify Output 66
4.5 Eddystone 69
4.5.1 Project Description 69
4.5.2 Hardware Connection 72
4.5.3 Flow Chart 73
4.5.4 Verify Output 73
4.6 Direct Test Mode (DTM) 78
4.6.1 Project Description 78
4.6.2 Hardware Connection 80
4.6.3 Verify Output 81

5. Hardware 82

5.1 BLE Pioneer Baseboard 82
5.1.1 PSoC 5LP 82
5.1.2 Power System 82
5.1.3 Programming Interface 89
5.1.4 Expansion Connectors 89
5.1.5 USB Mini-B Connector 92
5.1.6 CapSense Circuit 93
5.1.7 BLE Pioneer Baseboard LEDs 94
5.1.8 Push-Buttons 96
5.1.9 Cypress Ferroelectric RAM (F-RAM) 97
5.1.10 Serial Interconnection between KitProg and Module 98
5.1.11 Module Headers 99
5.2 Module Board 100
5.2.1 PSoC 4 BLE Device 100
5.2.2 Module Power Connections 101
5.2.3 Module Headers (20-Pin and 24-Pin Headers) 102
5.2.4 Wiggle Antenna 103
5.2.5 Antenna Matching Network 104
5.2.6 BLE Passives 105
5.2.7 Test Points 106
5.3 BLE Dongle Board 106
5.3.1 Power System 107
5.3.2 USB Type-A Plug 107
5.3.3 User LED 108

6. Advanced Topics 109

6.1 Using FM24V10 F-RAM 109
6.1.1 Address Selection 109
6.1.2 Write/Read Operation 110

A. Appendix **111**

A.1 Bill of Materials (BOM) 111
A.2 KitProg Status LED States 111
A.3 Adding BLE Module-Compatible Headers on Your Baseboard 113
A.4 Programming BLE PSoC 4 BLE Module via MiniProg3 114
A.5 BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit 115
A.5.1 CY8CKIT-142 PSoC 4 BLE Module 115
A.5.2 CY8CKIT-141 PSoC 4 BLE SMA Module 116
A.5.3 CY8CKIT-143 PSoC 4 BLE 256KB Module 116
A.5.4 CY8CKIT-143A PSoC 4 BLE 256KB Module 117
A.5.5 CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle) 117
A.6 Migrating Projects Across Different Pioneer Series Kits 118
A.6.1 Arduino Uno-Compatible Headers 119
A.6.2 Onboard Peripherals 122

Revision History **124**

Safety Information

The CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit is intended for development purposes only. Users are advised to test and evaluate this kit in an RF development environment.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required authorizations are first obtained. Contact support@cypress.com for details.

CY8CKIT-042-BLE-A boards contain ESD-sensitive devices. Electrostatic charges readily accumulate on the human body and any equipment, and can discharge without detection. Permanent damage may occur on devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Store unused CY8CKIT-042-BLE-A boards in the protective shipping package.

End-of-Life/Product Recycling

The end-of-life cycle for this kit is five years from the date of manufacture mentioned on the back of the box. Contact your nearest recycler to discard the kit.

General Safety Instructions

ESD Protection

ESD can damage boards and associated components. Cypress recommends that the user perform procedures only at an ESD workstation. If an ESD workstation is not available, use appropriate ESD protection by wearing an antistatic wrist strap attached to the chassis ground (any unpainted metal surface) on the board when handling parts.

Handling Boards

CY8CKIT-042-BLE-A boards are sensitive to ESD. Hold the board only by its edges. After removing the board from its box, place it on a grounded, static-free surface. Use a conductive foam pad if available. Do not slide the board over any surface.

Battery Care and Use

- Use the correct size and type of battery specified in this guide.
- Keep battery contact surfaces and battery compartment contacts clean by rubbing them with a clean pencil eraser or a rough cloth each time you replace batteries.
- Remove the battery from a device when it is not expected to be in use for several months.
- Make sure that you insert the battery into your device properly, with the + (plus) and – (minus) terminals aligned correctly.
- Do not place the battery next to metallic objects such as keys and coins.
- Never throw the battery into fire.
- Do not open up the battery.
- Do not short the battery.
- Do not subject the battery to high temperatures or high humidity.
- Store the battery in a dry place.
- Do not recharge a battery unless it is marked “rechargeable.”

Battery Disposal

Batteries can be safely disposed with normal household waste. Never dispose batteries in fire because they can explode. It is important not to dispose large amounts of batteries in a group. Used batteries are often not completely “dead.” Grouping used batteries together can bring these “live” batteries into contact with one another, creating safety risks.

Regulatory Compliance Information

The CY8CKIT-042-BLE-A kit contains devices that transmit and receive radio signals in accordance with the spectrum regulations for the 2.4-GHz unlicensed frequency range.

Cypress Semiconductor Corporation has obtained regulatory approvals for this kit to be used in specific countries. These countries include the United States (FCC Part 15), Canada (IC RSS210), and Japan (JRF/TELEC). Additional regional regulatory agency approval may be required to operate these throughout the world.

This kit, as shipped from the factory, has been tested and found to comply with the limits and requirements for the following compliances:

- As a Class B digital device, pursuant to part 15 of the FCC Rules.
- As a Class B digital apparatus, compliant with Canadian ICES-003.

Regulatory Statements and Product Labeling

United States (FCC)

The CY8CKIT-143A PSoC 4 BLE and CY5677 PSoC 4 BLE modular transmitter complies with Part 15 of the Federal Communications Commission (FCC) Rules. The FCC ID for these devices are **WAP-CY5677** for CY5677 and **WAP-CY5676A** for CY8CKIT-143A.

Operation is subject to the following two conditions:

- This device may not cause harmful interference
- This device must accept any interference received, including interference that may cause undesired operation.

Canada (IC)

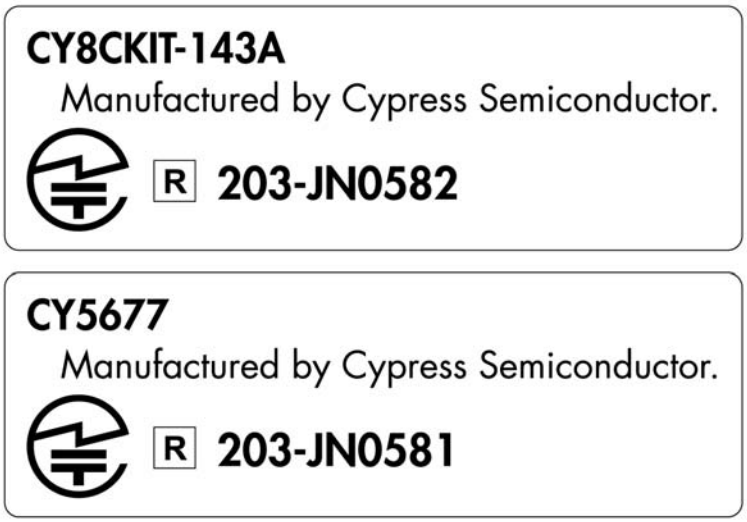
This device complies with the Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

- This device may not cause interference.
- This device must accept any interference, including interference that may cause undesired operation of the device.

This equipment complies with radio frequency exposure limits set forth by Industry Canada for an uncontrolled environment.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Japan (TELEC)


CY8CKIT-143A
Manufactured by Cypress Semiconductor.
R 203-JN0582
CY5677
Manufactured by Cypress Semiconductor.
R 203-JN0581

1. Introduction

Thank you for your interest in the CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit. The BLE Pioneer Kit enables customers to evaluate and develop BLE projects using the PSoC® 4 BLE device.

Bluetooth SMART™ or Bluetooth Low Energy (BLE) is a full-featured, layered, communication protocol that includes a 2.4-GHz radio, a link layer, and an application layer. However, you do not need to understand the complex protocol to implement your projects using PSoC 4 BLE. The Cypress BLE solution, which includes the device, the BLE Component, and the BLE firmware stack will take care of it for you. The Cypress BLE firmware stack is royalty free.

You will use two software tools, PSoC Creator™ and CySmart Central Emulation Tool, to develop and debug your BLE project. PSoC Creator is Cypress' standard integrated design environment (IDE). The BLE protocol has been abstracted into an easy drag-and-drop BLE Component in PSoC Creator. The CySmart Central Emulation Tool is a host tool for Windows PCs, which provides an easy-to-use GUI to enable customers to test and debug their BLE projects.

The BLE Pioneer Kit offers footprint-compatibility with Arduino™ shields as well as 6-pin Digilent® Pmod™ daughter cards. In addition, the kit features a CapSense® slider, an RGB LED, a push-button switch, an onboard programmer/debugger and the USB-UART/I^2C bridge functionality block (KitProg), a coin cell battery holder, and a Cypress F-RAM™. The BLE Pioneer Kit supports 1.9 V, 3 V, 3.3 V, or 5 V as operating voltages. The BLE Pioneer Kit supports the PSoC4 BLE device which is a 32-bit, 48-MHz Arm® Cortex®-M0 BLE solution with CapSense, 12-bit analog front end (1x SAR ADC, 4x low-power opamps, 2x low-power comparators, and 2x current DACs), 4x TCPWM[1], 2x SCBs[2], 4x UDBs[3], LCD[4], I^2S[5], and 36 GPIOs. PSoC 4 BLE provides a complete solution for sports and fitness monitors, wearable electronics, medical devices, home automation systems, and sensor-based low-power systems for the Internet of Things (IoT).

The PSoC 4 BLE is available in 128KB and 256KB flash configurations. The PSoC 4 BLE is supported by royalty-free protocol stacks compatible with Bluetooth 4.1 and Bluetooth 4.2.

1. Configurable timer, counter, and pulse-width modulator.
2. Serial communication blocks (configurable to I^2C, SPI, or UART).
3. Universal digital blocks
4. Configurable liquid crystal display driver.
5. Configurable integrated interchip sound serial bus interface.

1.1 Kit Contents

The BLE Pioneer Kit contains the following items (see Figure 1-1):

- BLE Pioneer Baseboard preloaded with the CY8CKIT-143A PSoC 4 BLE 256KB Module
- CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)
- Quick start guide
- USB Standard-A to Mini-B cable
- Four jumper wires (4 inch) and two proximity sensor wires (5 inch)
- Coin cell (3 V CR2032)

Figure 1-1. Kit Contents

If any part of the BLE Pioneer Kit is missing, contact your nearest Cypress sales office for help: www.cypress.com/go/support.

1.2 BLE Pioneer Baseboard Details

The BLE Pioneer Baseboard consists of the blocks shown in Figure 1-2.

1. RGB LED
2. BLE device reset button
3. CapSense proximity header
4. User button
5. CapSense slider
6. Arduino-compatible I/O headers (J2/J3/J4)
7. Arduino-compatible power header (J1)
8. Digilent Pmod-compatible I/O header (J5)
9. Cypress F-RAM 1 Mb (FM24V10-G)
10. PSoC 5LP I/O header (J8)
11. PSoC 5LP programmer and debugger (CY8C5868LTI-LP039)
12. Coin cell holder (bottom side)
13. USB connector (J13)
14. Power LED and Status LED
15. System power supply jumper (J16) - LDO 1.9 V~5 V
16. BLE power supply jumper / current measurement (J15)
17. BLE module headers (J10/J11)

Figure 1-2. BLE Pioneer Baseboard

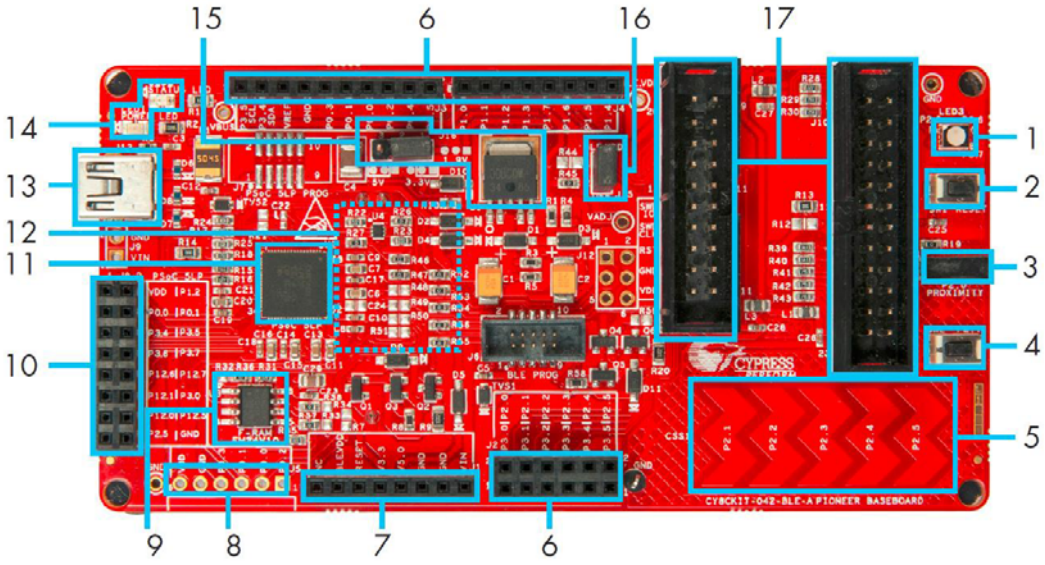


Figure 1-3 shows a markup of the onboard components of the PSoC 4 BLE module. See BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit on page 115 for more details. Figure 1-4 shows the BLE Dongle board blocks.

Figure 1-3. BLE Module Markup

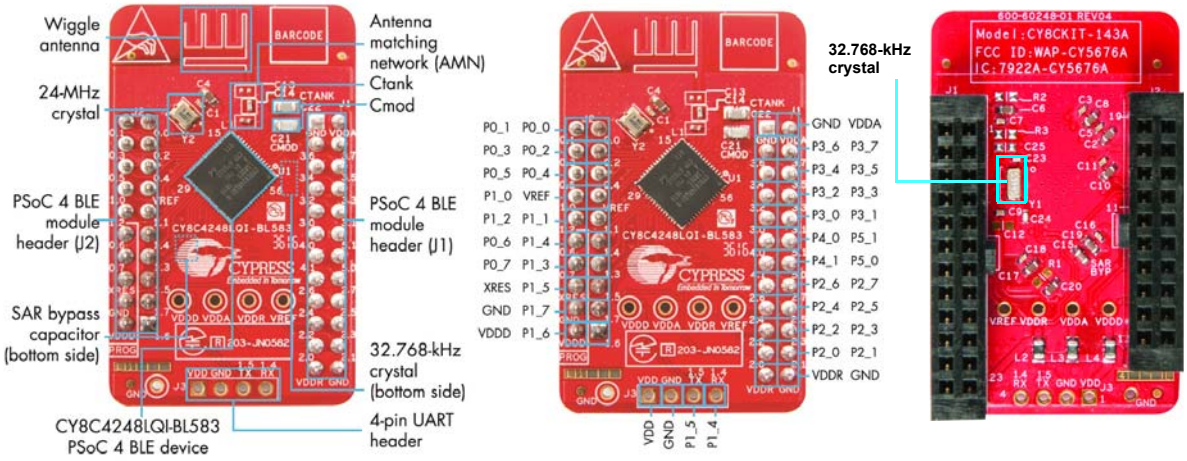
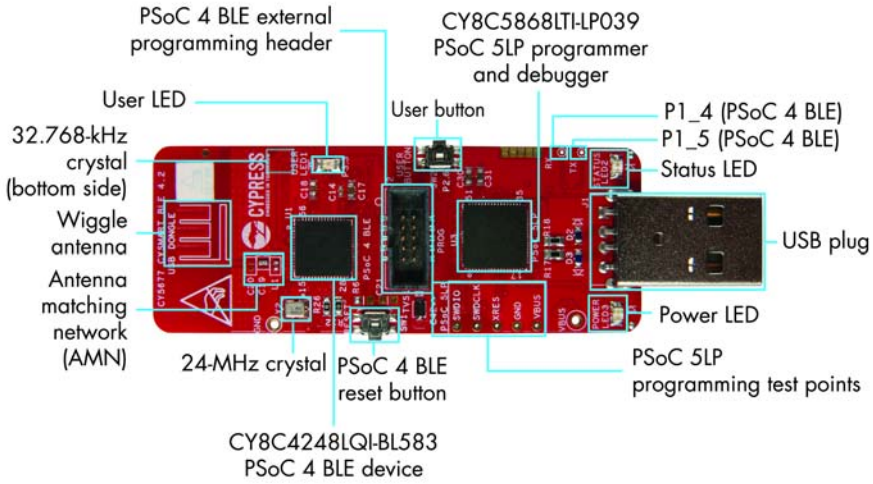


Figure 1-4. BLE Dongle Markup

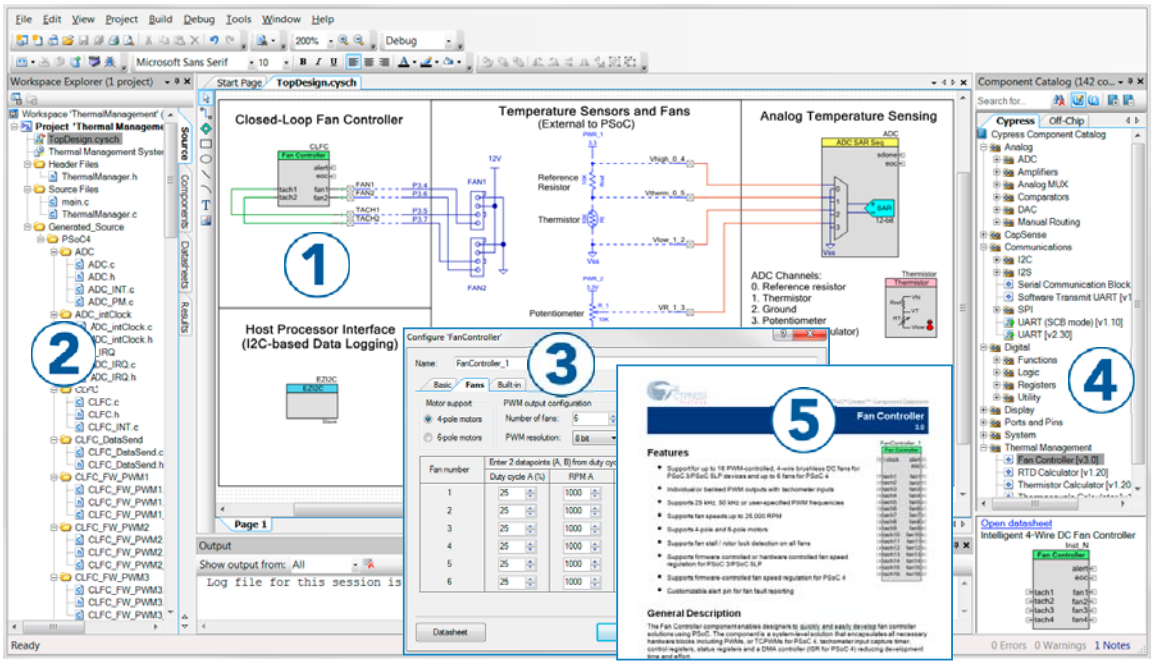


1.3 PSoC Creator

PSoC Creator is a state-of-the-art, easy-to-use integrated design environment (IDE). It introduces revolutionary hardware and software co-design, powered by a library of pre-verified and pre-characterized PSoC Components. With PSoC Creator, you can:

1. Drag and drop Components to build your hardware system design in the main design workspace
2. Codesign your application firmware with the PSoC hardware
3. Configure Components using configuration tools
4. Explore the library of 100+ Components
5. Review Component datasheets

Figure 1-5. PSoC Creator Features



PSoC Creator also enables you to tap into an entire tool ecosystem with integrated compiler chains and production programming programmers for PSoC devices.

For more information, visit www.cypress.com/psoccreator. Visit PSoC Creator training page for video tutorials on learning and using PSoC Creator.

1.3.1 PSoC Creator Code Examples

PSoC Creator includes a large number of code examples. These examples are available from the PSoC Creator Start Page, as Figure 1-6 shows.

Code examples can speed up your design process by starting you off with a complete design, instead of a blank page. The code examples also show how PSoC Creator Components can be used for various applications. Code examples and documentation are included, as shown in Figure 1-7 on page 16.

In the **Find Code Example** dialog shown in Figure 1-7, you have several options:

- Filter for examples based on architecture or device family, that is, PSoC 3, PSoC 4 or PSoC 5LP; project name; or keyword.
- Select from the menu of examples offered based on the **Filter Options**.
- Review the code example's description (on the **Documentation** tab).
- Review the code from the **Sample Code** tab. You can copy the code from this window and paste to your project, which can help speed up code development.
- Create a new project (and a new workspace if needed) based on the selection. This can speed up your design process by starting you off with a complete, basic design. You can then adapt that design to your application.

Figure 1-6. Code Examples in PSoC Creator

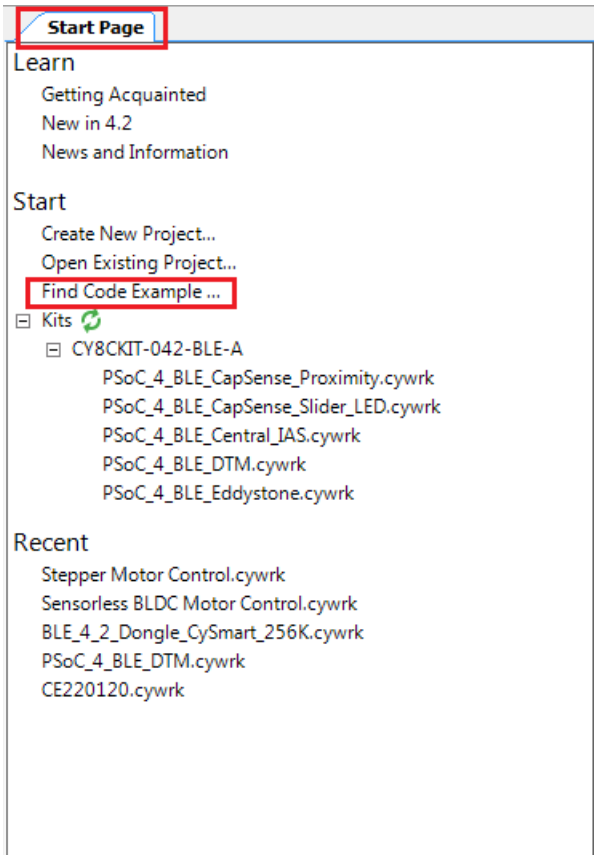
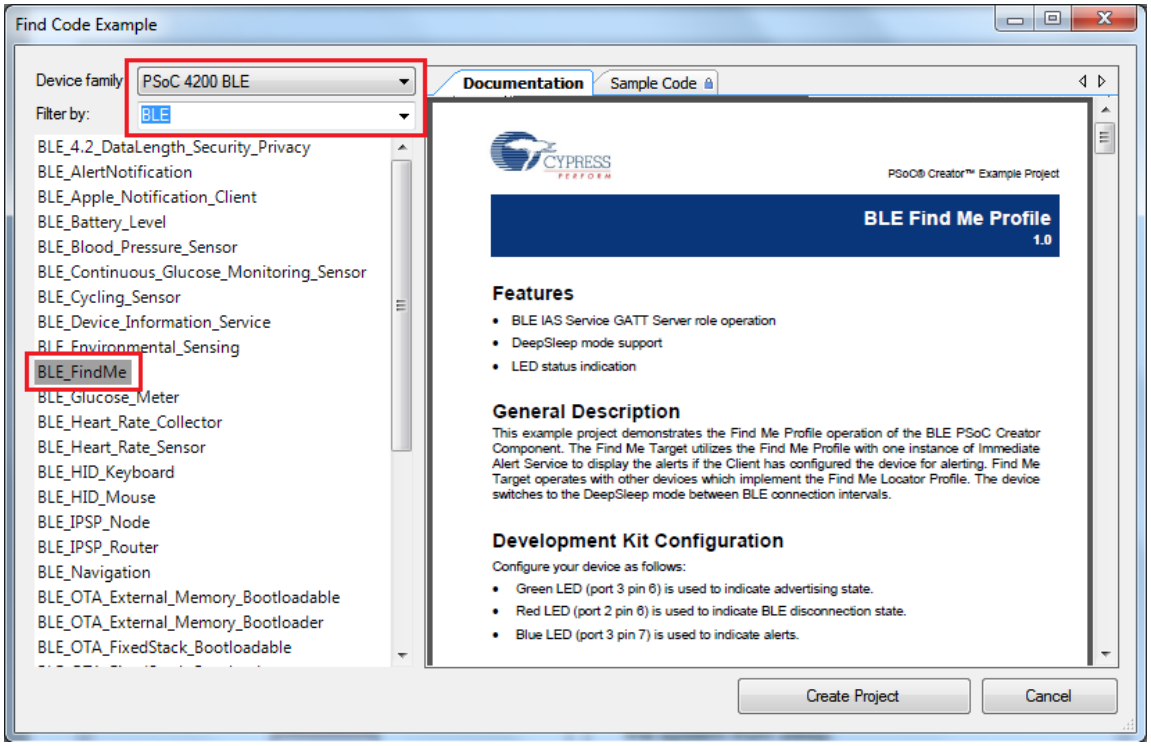


Figure 1-7. Code Examples with Sample Code



1.3.2 Kit Code Examples

This kit includes a number of code examples, which can be used to quickly evaluate the functionality of this kit. These examples are described in the Code Examples chapter on page 37.

If you are a beginner in BLE, refer to the PSoC Creator code examples such as BLE_FindMe and BLE_Device_Information_Service as described in 1.3.1 PSoC Creator Code Examples. You may also refer the application note Getting Started with PSoC 4 BLE.

The four Kit code examples viz CapSense Slider and LED, CapSense Proximity, BLE Central Mode and Eddystone are intermediatory level examples that will help to design a system around the kit. Refer to the 4.2 CapSense Slider and LED and later for details.

1.3.3 PSoC Creator Help

Visit the PSoC Creator home page to download the latest version of PSoC Creator. Then, launch PSoC Creator and navigate to the following items:

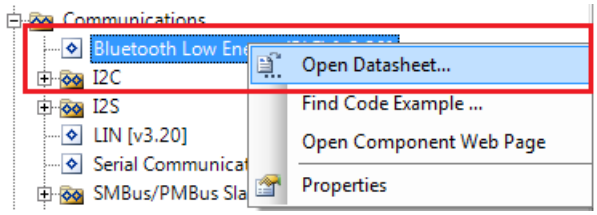
- **Quick Start Guide**: Choose **Help** > **Documentation** > **Quick Start Guide**. This guide gives you the basics for developing PSoC Creator projects.
- **Simple Component code examples**: Choose **File** > **Code Example**. These code examples demonstrate how to configure and use PSoC Creator Components.
- **System Reference Guide**: Choose **Help** > **System Reference Guide**. This guide lists and describes the system functions provided by PSoC Creator.
- **Component datasheets**: Right-click a Component and select **Open Datasheet**, as shown in Figure 1-8 on page 17. Visit the PSoC 4 Component Datasheets page for a list of all PSoC 4 Component datasheets.

- **Document Manager**: PSoC Creator provides a document manager to help you to easily find and review document resources. To open the document manager, choose the menu item **Help** > **Document Manager**.

1.3.4 Component Datasheets

Right-click a Component and select **Open Datasheet** (see Figure 1-8 on page 17).

Figure 1-8. Opening Component Datasheet



1.4 Getting Started

This guide will help you get acquainted with the BLE Pioneer Kit:

- The Software Installation chapter on page 21 describes the installation of the kit software. This includes the PSoC Creator IDE for development and debugging applications, PSoC Programmer for programming hex files, and the CySmart Central Emulation Tool for BLE Central emulation.
- The Kit Operation chapter on page 25 describes the major features of the BLE Pioneer Kit such as USB-UART and USB-I^2C bridges and functionalities such as programming and debugging.
- The Code Examples chapter on page 37 describes multiple PSoC 4 BLE code examples that will help you understand how to create your own BLE application using the BLE Component and device.
- The Hardware chapter on page 82 details the hardware content of the BLE Pioneer Kit and BLE Dongle, and the hardware operation.
- The Advanced Topics chapter on page 109 explains the functionality of FM24V10 F-RAM.
- The Appendix on page 111 provides the bill of materials (BOM), KitProg LED states, list of BLE modules and dongles compatible with the BLE Pioneer Kit, migrating projects across Pioneer series kits, and programming BLE modules using MiniProg3.

1.5 Additional Learning Resources

Cypress provides a wealth of information at www.cypress.com to help you to select the right PSoC device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see KBA86521, How to Design with PSoC 3, PSoC 4, and PSoC 5LP.

Visit www.cypress.com/go/psoc4ble for additional learning resources including datasheets, technical reference manuals, and application notes.The following is an abbreviated list:

- Overview: PSoC 4 BLE Portfolio and PSoC Roadmap
- Product Selectors: PSoC 1, PSoC 3, PSoC 4, or PSoC 5LP. In addition, PSoC Creator includes a device selection tool.
- Datasheets: Describe and provide electrical specifications for the PSoC 4 device family

- CapSense Design Guide: Learn how to design capacitive touch-sensing applications with the PSoC 4 family of devices.
- Application Notes and Code Examples: Cover a broad range of topics, from basic to advanced level. Many of the application notes include code examples. Visit the PSoC 3/4/5 Code Examples webpage for a list of all available PSoC Creator code examples. To access code examples from within PSoC Creator, see PSoC Creator Code Examples on page 15.
- Technical Reference Manuals (TRM): Provide detailed descriptions of the architecture and registers in each PSoC 4 device family.
- Development Kits:
  - CY8CKIT-040, CY8CKIT-042, and CY8CKIT-044 are easy-to-use and inexpensive development platforms. These kits include connectors for Arduino-compatible shields and Digilent Pmod peripheral modules.
  - CY8CKIT-049 is a very low-cost prototyping platform for PSoC 4100/4200 families.
  - The MiniProg3 kit provides an interface for flash programming and debug.
- Knowledge Base Articles (KBA): Provide design and application tips from experts on using the device.
- PSoC Creator Training: Visit www.cypress.com/go/creatorstart/creatortraining for a comprehensive list of video trainings on PSoC Creator.
- Cysmart Central Emulation Tool: Visit www.cypress.com/go/cysmart for information on the CySmart Central Emulation Tool.
- Learning From Peers: Visit www.cypress.com/forums to meet enthusiastic PSoC developers discussing the next generation embedded systems on Cypress Developer Community Forums.

1.5.1 Bluetooth Learning Resources

The Bluetooth Developer Portal provides material by the Special Interest Group (SIG) for learning various aspects of the Bluetooth Low Energy protocol and systems. Some of them are:

- Training videos
- GATT profiles
- Bluetooth community forum

1.5.2 Other Related Resources

- Digilent Pmod: www.digilentinc.com/pmods/
- Arduino: http://arduino.cc/en/Main/ArduinoBoardUno

1.6 Technical Support

If you have any questions, our technical support team is happy to assist you. You can create a support request on the Cypress Technical Support page.

If you are in the United States, you can talk to our technical support team by calling our toll-free number: +1-800-541-4736. Select option 3 at the prompt.

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

- Self-help
- Local Sales Office Locations

1.7 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 Creator 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.

1.8 Acronyms

Table 1-2. Acronyms Used in this Document

Acronym	Definition
ADC	analog-to-digital converter
API	application programming interface
BD address	Bluetooth device address
BLE	Bluetooth Low Energy
CDC	Communications Device Class
COM	communication port
DLE	data length extension
ECDH	Elliptic Curve Diffie-Hellman
DVD	digital video disc
ESD	electrostatic discharge
F-RAM	ferroelectric random access memory
GATT	generic attribute profile

Table 1-2. Acronyms Used in this Document

Acronym	Definition
GUI	graphical user interface
GPIO	general-purpose input/output
I^2C	inter-integrated circuit
IAS	immediate alert service
IDAC	current output digital-to-analog converter
IDE	integrated development environment
LDO	low drop out (voltage regulator)
LE	low energy
LED	light-emitting diode
LP	low power
LPT	line print terminal
MTU	maximum transmission unit
OTA	over-the-air
PHY	physical layer
PrISM	Precise Illumination Signal Modulation
PSM	protocol service multiplexer
PSoC	Programmable System-on-Chip
PWM	pulse width modulation
QFN	quad flat no-lead (package)
RDK	reference design kit
RGB	red green blue
SAR	successive approximation register
SIG	special interest group
SMA	SubMiniature version A
SPI	serial peripheral interface
SWD	serial wire debug
TLM	telemetry
UART	universal asynchronous receiver transmitter
UID	universal identifier
URI	uniform resource identifier
URL	uniform resource locator
USB	Universal Serial Bus
UUID	universal unique identifier

2. Software Installation

This chapter describes the steps to install the software tools and packages on a computer for using the BLE Pioneer Kit. This includes the IDE in which the projects will be built and used for programming.

2.1 Before You Begin

All Cypress software installations require administrator privileges. Ensure you have the required privileges on the system for successful installation. Before you install the kit software, close any other Cypress software that is currently running.

2.2 Install Software

Follow these steps to install the BLE Pioneer Kit software:

1. Download the kit software from www.cypress.com/CY8CKIT-042-BLE-A. The software is available in the following formats:
   a. CY8CKIT-042-BLE-A Kit Complete Setup: This installation package contains the files related to the BLE Pioneer Kit. However, it does not include the Windows Installer or Microsoft .NET framework packages. If these packages are not on your computer, the installer directs you to download and install them from the Internet.
   b. CY8CKIT-042-BLE-A Kit Only Package: This executable file installs only the BLE Pioneer Kit contents, which include code examples, hardware files, and user documents. This package can be used if all the software prerequisites (listed in step 5) are installed on your computer.
   c. CY8CKIT-042-BLE-A DVD ISO: This file is a complete package, stored in a DVD-ROM image format, that you can use to create a DVD or extract using an ISO extraction program such as WinZip or WinRAR. The file can also be mounted similar to a virtual CD/DVD using virtual drive programs such as 'Virtual CloneDrive' and 'MagicISO'. This file includes all the required software, utilities, drivers, hardware files, and user documents.
2. If you have downloaded the ISO file, mount it on a virtual drive; if you do not have a virtual drive to mount, extract the ISO contents using the appropriate ISO extractor (such as MagicISO or PowerISO). Double-click *cyautorun.exe* in the root directory of the extracted content or mounted ISO if "Autorun from CD/DVD" is not enabled on the computer. The installation window will appear automatically.

   Note: If you are using the "Kit Complete Setup" or "Kit Only Package" file, then go to step 4 for installation.

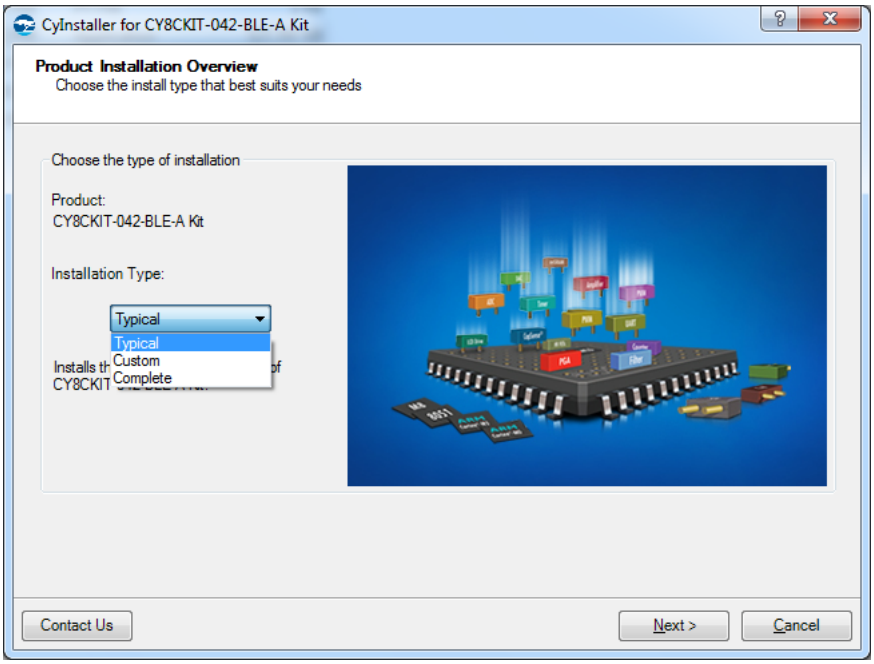
3. Click **Install CY8CKIT-042-BLE-A Kit** to start the installation, as shown in Figure 2-1.

Figure 2-1. Installer Screen

4. Select the folder in which you want to install the CY8CKIT-042-BLE-A kit-related files. Choose the directory and click **Next**.
5. When you click **Next**, the CY8CKIT-042-BLE-A Kit installer automatically installs the required software, if it is not present on your computer. The following software packages are required:
   Note: For the Kit Only Package, download and install the following prerequisites.
   a. PSoC Creator 4.2 or later: Download the latest version from www.cypress.com/psoccreator.
   b. PSoC Programmer 3.27.1 or later: This is installed as part of PSoC Creator installation (www.cypress.com/programmer).
   c. CySmart 1.3 or later: Download the latest version from www.cypress.com/cysmart.

6. Choose the Typical/Custom/Complete installation type in the **Product Installation Overview** window, as shown in Figure 2-2. Click **Next** after you select the installation type.

Figure 2-2. Product Installation Overview



7. Read the license agreement and select **I accept the terms in the license agreement** to continue with installation. Click **Next**.
8. When the installation begins, a list of packages appears on the installation page. A green check mark appears next to each package after successful installation.
9. Click **Finish** to complete the CY8CKIT-042-BLE-A kit installation.
10. Enter your contact information or select the **Continue Without Contact Information** check box. Click **Finish** to complete the CY8CKIT-042-BLE-A kit installation.
11. After the installation is complete, the kit contents are available at the following location:

`<Install_Directory>\CY8CKIT-042-BLE-A Kit`

Default location:

Windows 7 (64-bit): `C:\Program Files (x86)\Cypress\CY8CKIT-042-BLE-A Kit`

Windows 7 (32-bit): `C:\Program Files\Cypress\CY8CKIT-042-BLE-A Kit`

Note: For Windows 7/8/8.1/10 users, the installed files and the folder are read only. To use the code examples, follow the steps outlined in the Code Examples chapter on page 37.

The BLE Pioneer Kit installer also installs the CySmart Central Emulation Tool on your computer. This software, along with the BLE Dongle, allows the computer to emulate a BLE Central device.

2.3 Windows 8.1 and Windows 10 USB Selective Suspend Setting

The Windows 8.1 and Windows 10 operating systems issue a suspend command to a connected USB device if there is no activity on its USB bus. This may happen to the BLE Pioneer Kit/BLE Dongle if the driver installation is not complete or the driver is not found. In this situation, as a response to the suspend command from the operating system, the KitProg will shut down the onboard LDO to remain within the USB suspend current requirement. Due to this, the BLE Pioneer Kit will not be powered and will not be functional.

To prevent this, do either of the following:

- Install the kit software on the Windows 8.1 or Windows 10 operating system before using the BLE Pioneer Kit.
- Disable the USB selective suspend setting for the BLE Pioneer Kit from Power Options on Windows 8.1, by following these steps:
  a. From **Control Panel**, go to **Power Options**.
  b. Click **Change Plan Settings** corresponding to your power plan.
  c. Click **Change Advanced Power Settings**.
  d. Under Advanced settings, expand **USB Settings** > **USB selective suspend setting**.
  e. Select the **Disabled** option for **Plugged in** and **On battery** operation.
  f. Click **OK**.

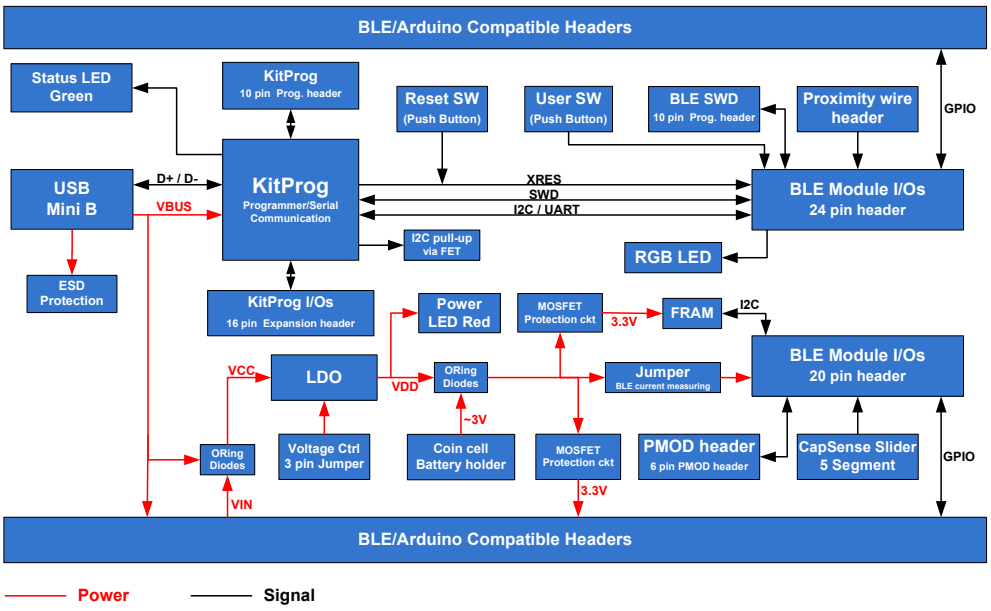
3. Kit Operation

This chapter introduces you to the BLE Pioneer Kit and the features that will be used as part of its operation. We will discuss features such as USB connection, programming/debugging, and programmer firmware update. The chapter also describes the USB-UART and USB-I^{2}C bridges along with the PC tools that can be used to communicate with the BLE device on the BLE Pioneer Kit.

3.1 Theory of Operation

Figure 3-1, Figure 3-2, and Figure 3-3 show the block diagrams for the BLE Pioneer Baseboard, PSoC 4 BLE Module, and BLE Dongle.

Figure 3-1. BLE Pioneer Baseboard Block Diagram

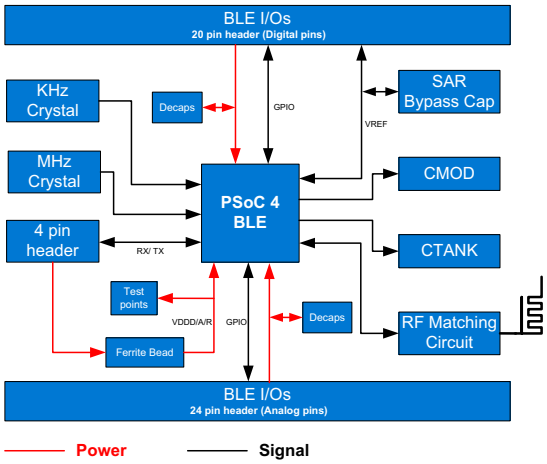


The BLE Pioneer Baseboard acts as the baseboard for the PSoC 4 BLE Module. The BLE Pioneer Baseboard contains a PSoC 5LP device, that has KitProg firmware, used as an onboard programmer or debugger, and for the USB-Serial interface.

The baseboard is Arduino form-factor compatible, enabling Arduino shields to be connected on top of the board to extend the functionality of PSoC 4 BLE Module. The board also features a 1-Mb F-RAM, an RGB LED, a five-segment CapSense slider, a proximity header, a user switch, and a reset switch for the PSoC 4 BLE device on the module. The BLE Pioneer Baseboard supports three voltage levels: 1.9 V, 3.3 V, and 5 V.

The BLE Pioneer Baseboard can also be used as a standalone programmer to program and debug other BLE devices using SWD, and as a USB-Serial interface. The KitProg firmware on PSoC 5LP device enables bootloading PSoC 5LP over USB to upgrade the firmware.

Figure 3-2. PSoC 4 BLE Module Block Diagram

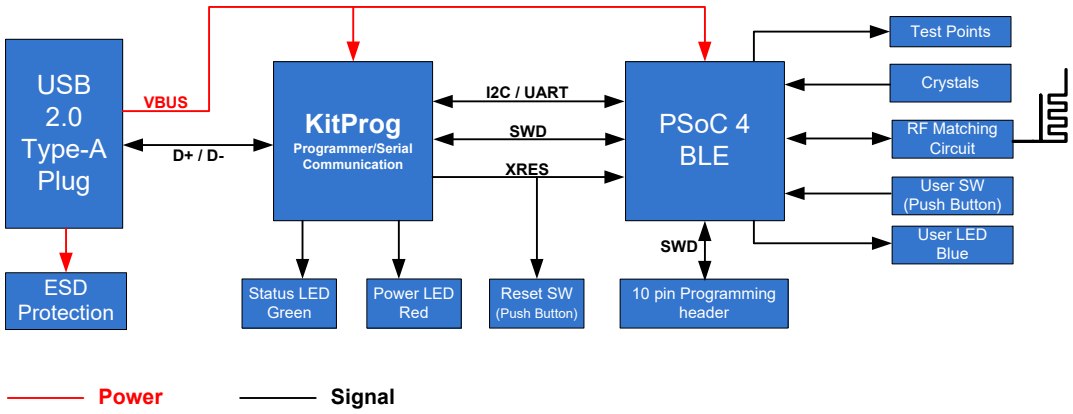


This BLE Pioneer Kit includes the PSoC 4 BLE Module. This module acts as a basic breakout board for the CY8C4248LQI-BL583 (PSoC 4 BLE) device. Besides the PSoC 4 BLE Module, there are additional modules available, which can be ordered separately. The complete list is available in BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit on page 115.

The BLE Dongle is the wireless interface for the CySmart Central Emulation Tool. It has a PSoC 4 BLE device for BLE communication and KitProg for onboard programming, debugging, and for the USB-Serial interface, as shown in Figure 3-3.

The BLE Dongle has a USB Type-A plug to connect the KitProg to the USB port of the host computer. The KitProg then communicates with the PSoC 4 BLE device over UART or multiplexed I^2C or an SPI bus. The BLE Dongle also features a user LED, a user switch, and a reset switch for the PSoC 4 BLE device. The dongle is powered directly through the USB port (VBUS) at 5.0 V.

Figure 3-3. BLE Dongle Block Diagram



3.2 KitProg

KitProg is the hardware/firmware block for onboard programming, debugging, and bridge functionality. It is a common reusable hardware/firmware block used across many Cypress kit platforms. It consists of a PSoC 5LP, which connects to the computer over an USB interface and connects to the PSoC 4 BLE device over SWD, I^2C, and UART pins.

The KitProg communicates with PSoC Programmer and PSoC Creator software to program/debug the target PSoC 4 BLE over the SWD interface. The main advantage of an onboard programmer/debugger is that users do not have to buy an extra programmer/debugger hardware.

3.3 BLE Pioneer Kit USB Connection

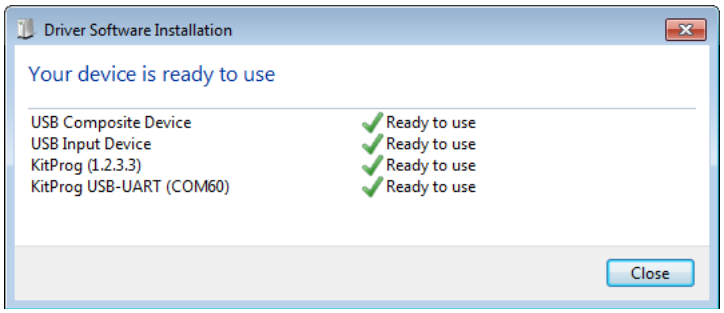
The BLE Pioneer Kit powers from a computer over the USB interface (J13). It enumerates as a composite device, as shown in Table 3-1. USB drivers required for this enumeration are part of the kit installer. The kit should be installed properly for its correct operation.

Visit www.cypress.com/CY8CKIT-042-BLE for the latest kit installer.

Table 3-1. BLE Pioneer Kit Enumerated Interfaces

Port	Description
USB Composite Device	Composite device
USB Input Device	USB-I^2C bridge, KitProg command interface
KitProg	USB-I^2C bridge, programmer, and debugger
KitProg USB-UART	USB-UART bridge, which appears as a COM# port

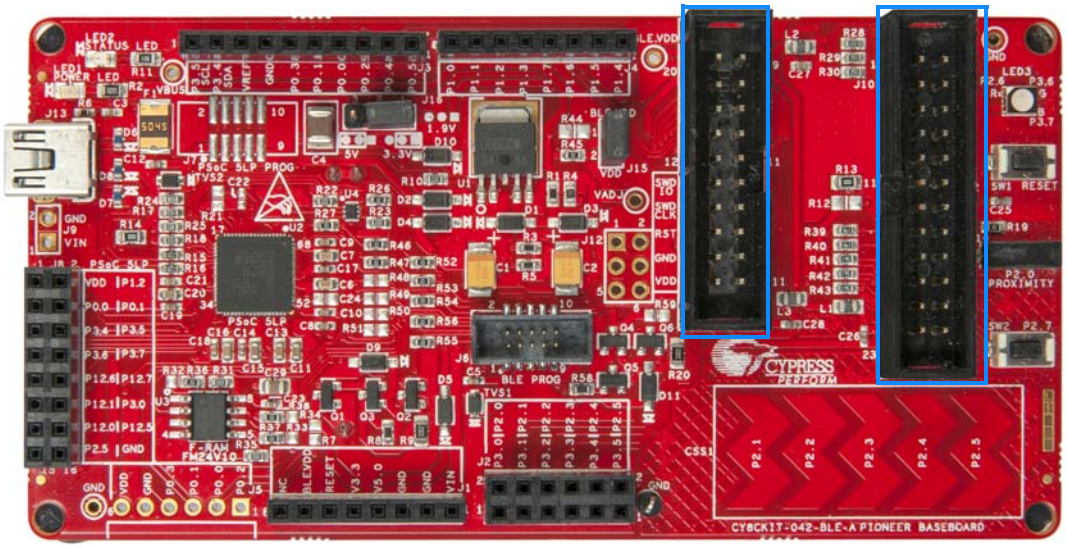
Figure 3-4. KitProg Driver Installation (appearance may differ depending on Windows version)



3.4 Placing PSoC 4 BLE Module on Baseboard

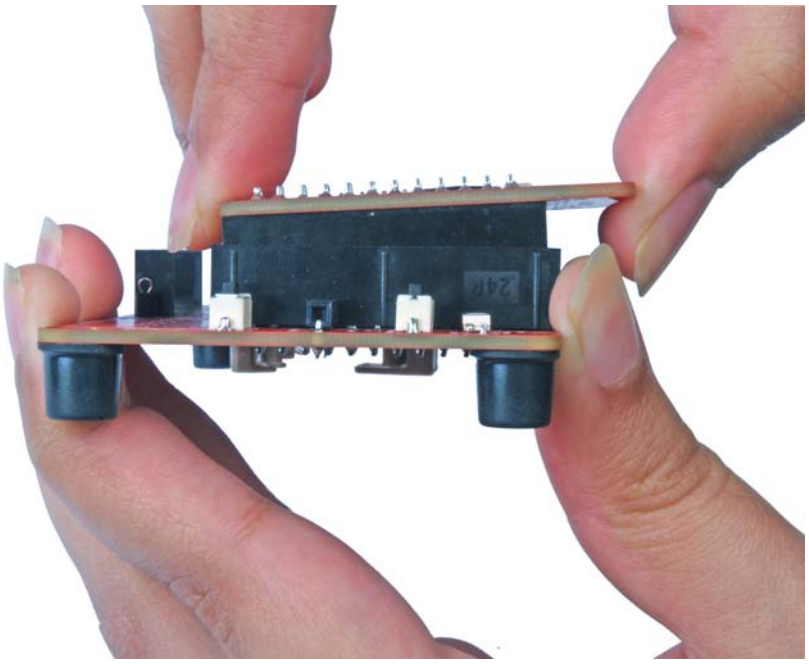
Plug the module into the BLE Pioneer Baseboard on headers J10 and J11, while keeping the antenna directed outside. Note that the two parallel headers J10 and J11 are not equal (24-pin and 20-pin, respectively) and will not allow the module to be inserted in the opposite direction.

Figure 3-5. Baseboard with J10 and J11 Headers to Connect PSoC 4 BLE Module



To remove the PSoC 4 BLE Module from the BLE Pioneer Kit, hold the BLE Pioneer Kit in one hand and the module in the other, as shown in Figure 3-6, and pull it out using a rocking motion.

Figure 3-6. Remove Module Connected on BLE Pioneer Kit



3.5 Programming and Debugging BLE Device

The BLE Pioneer Kit and BLE Dongle can be programmed and debugged using the KitProg. Before programming the device, ensure that PSoC Creator and PSoC Programmer are installed on the computer. See Install Software on page 21 for more information.

3.5.1 Programming using PSoC Creator

1. Connect the BLE Pioneer Kit/BLE Dongle to the computer's USB port, as shown in Figure 3-7 and Figure 3-8.

Figure 3-7. Connect USB Cable to J13

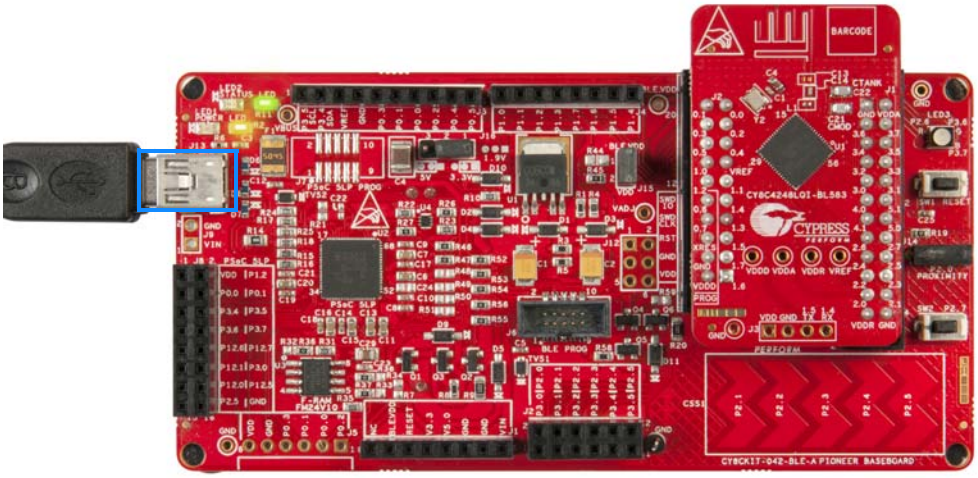
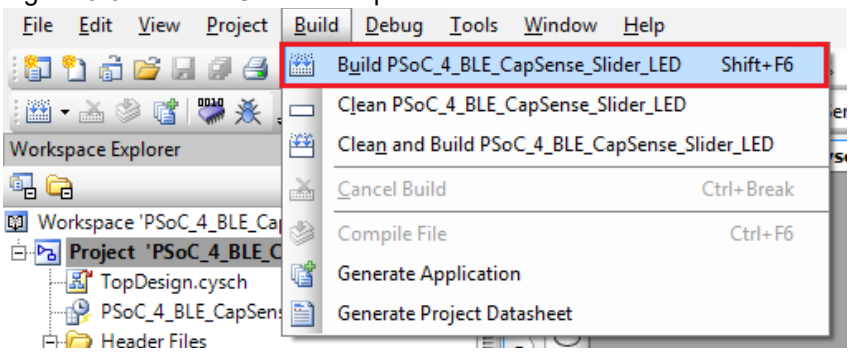


Figure 3-8. Connect Dongle to PC

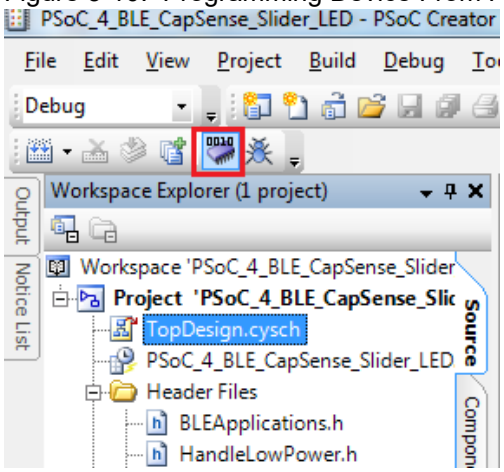
2. Load the desired code example in PSoC Creator from **File** > **Open** > **Project/Workspace**.
3. Build the project by choosing **Build** > **Build <Project Name>** or **[Shift] [F6]**, as shown in Figure 3-9.

Figure 3-9. Build a Code Example



4. If there are no errors during build, program the firmware by clicking the **Program** button on the tool bar or pressing **[Ctrl] [F5]**, as shown in Figure 3-10. This will program the device on the BLE Pioneer Kit/BLE Dongle and it will be ready for use.

Figure 3-10. Programming Device From PSoC Creator

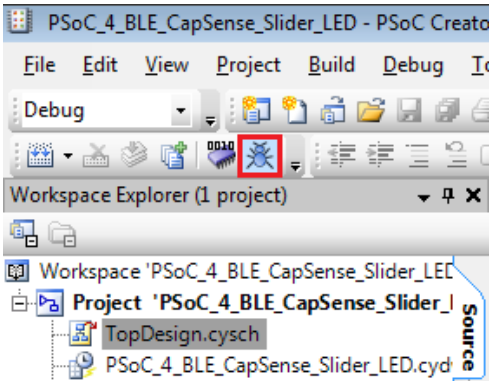


3.5.2 Debugging using PSoC Creator

For debugging the project using PSoC Creator, follow steps 1 to 5 from Programming using PSoC Creator on page 29 followed by:

1. Click the **Debug** icon or press **[F5]**, as shown in Figure 3-11.

Figure 3-11. Start Debug on PSoC Creator



2. When PSoC Creator opens in debug mode, use the buttons on the toolbar for debugging.

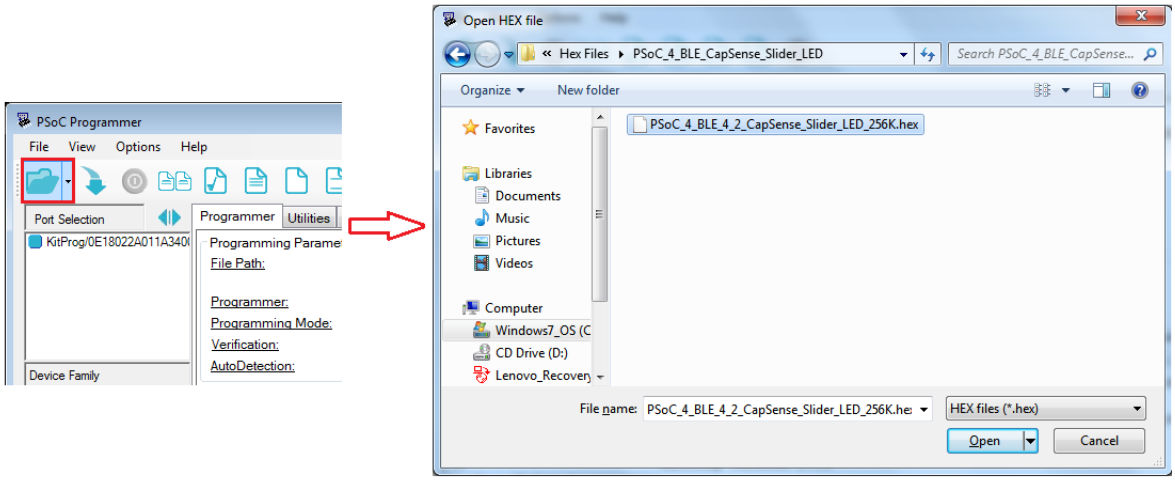
For more details on using the debug features, see the Cypress application note Getting Started with PSoC 4 BLE.

3.5.3 Programming using PSoC Programmer

PSoC Programmer (3.27.1 or later) can be used to program existing hex files into both BLE Pioneer Kit or BLE Dongle. To do this, follow these steps.

1. Connect the BLE Pioneer Kit or BLE Dongle to a computer and open PSoC Programmer from **Start** > **All Programs** > **Cypress** > **PSoC Programmer <version>** > **PSoC Programmer <version>**.
2. Click the **File Load** button at the top left corner of the window. Browse for the desired hex file and click **Open**.

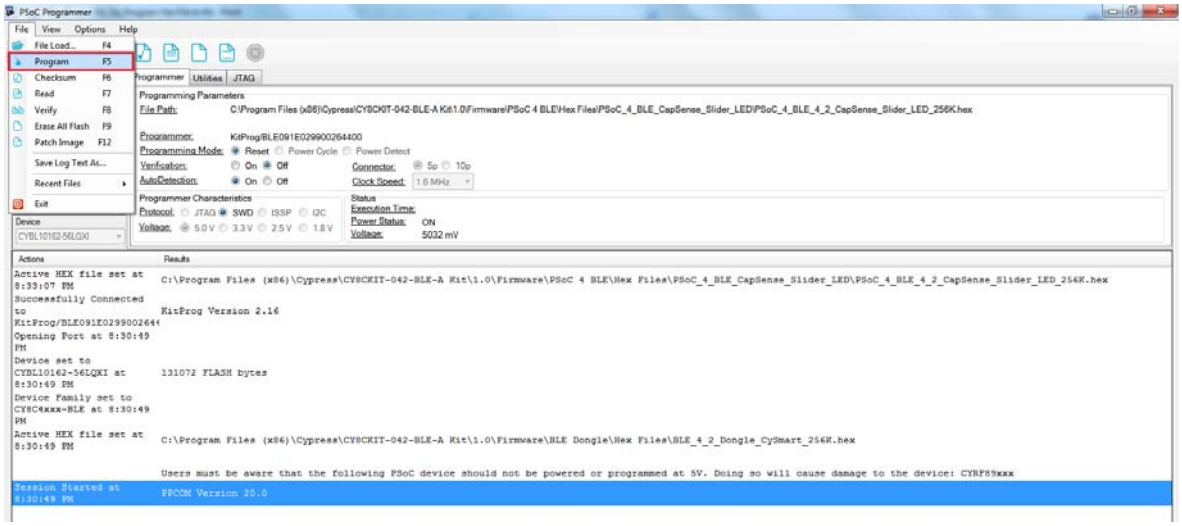
Figure 3-12. Select Hex File



3. Go to **File** > **Program** to start programing the kit with the selected file.

   Note: If the hex file does not match the device selected, then PSoC Programmer will throw an error of device mismatch and terminate programming.

Figure 3-13. Program Hex File to Kit



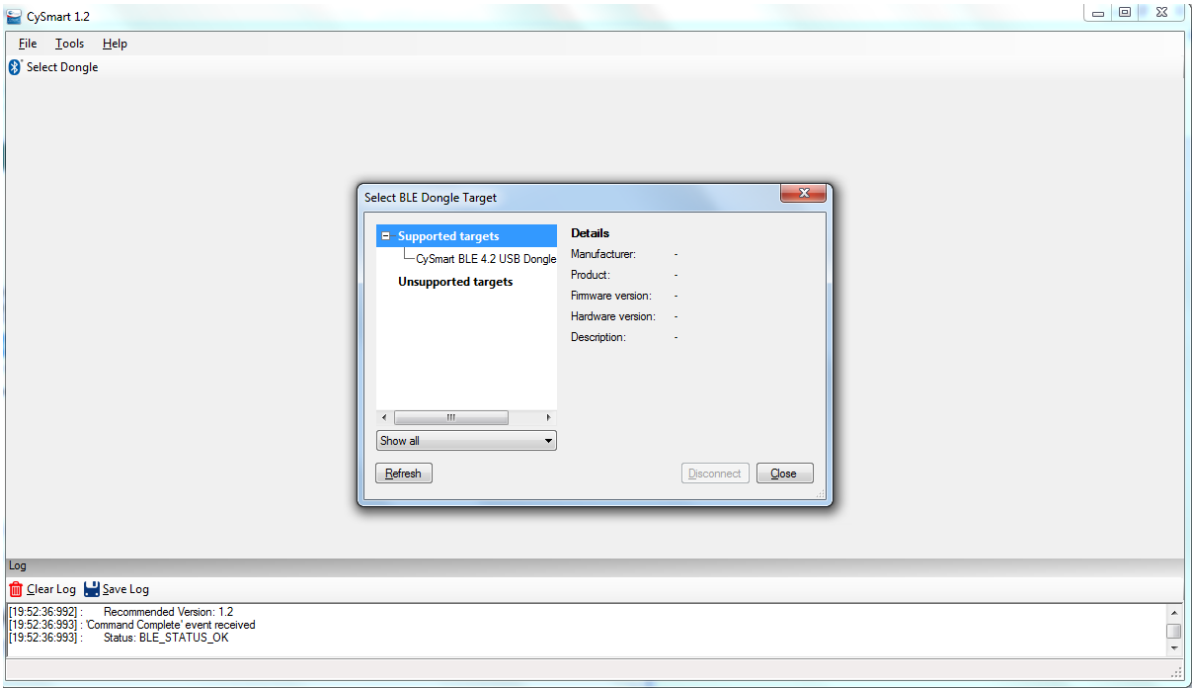
4. When the programming is finished successfully, indicated by a PASS message on the status bar, the BLE Pioneer Kit/BLE Dongle is ready for use. Close PSoC Programmer.

3.6 Updating BLE Dongle for CySmart Central Emulation Tool

The BLE Dongle, provides a BLE Central mode capability using the CySmart Central Emulation Tool on the computer. The CySmart Central Emulation Tool on the PC is the interface with which to configure the BLE Dongle and analyze the data transferred after connecting with a BLE Peripheral.

The BLE Dongle works along with the CySmart Central Emulation Tool, as shown in Figure 3-14. The CySmart Central Emulation Tool is installed as part of the BLE Pioneer Kit installation and can be opened from **Start** > **All Programs** > **Cypress** > **CySmart <version>** > **CySmart <version>**. The tool operation is explained in the user guide, which can be accessed from **Help** > **Help Topics**.

Figure 3-14. BLE Dongle Interface on CySmart Central Emulation Tool



If the BLE Dongle contains custom firmware on PSoC 4 BLE, the original CySmart firmware can be programmed back to restore the CySmart functionality. It must be connected through the USB and enumerated as KitProg. To do this, follow these steps:

1. Connect the BLE Dongle to the USB port on the computer.
2. Open PSoC Programmer by going to **Start** > **All Programs** > **Cypress** > **PSoC Programmer <version>** > **PSoC Programmer <version>**.
3. Click the **File Load** button and browse to the location of the *BLE_4_2_Dongle_CySmart_256K_psoc.hex* file. The hex file is located at: `<Install_Directory>\CySmart\<version>\dongle\CY5677\`.

   Note: If Cypress releases new versions of the CySmart Central Emulation Tool and the BLE Dongle firmware, then the CySmart Central Emulation Tool will display a message requesting to update the firmware, as shown Figure 3-15. Choose the *.hex* file from the respective location and update the BLE Dongle firmware.

Figure 3-15. Update BLE Dongle Firmware with Hex from CySmart PC Tool

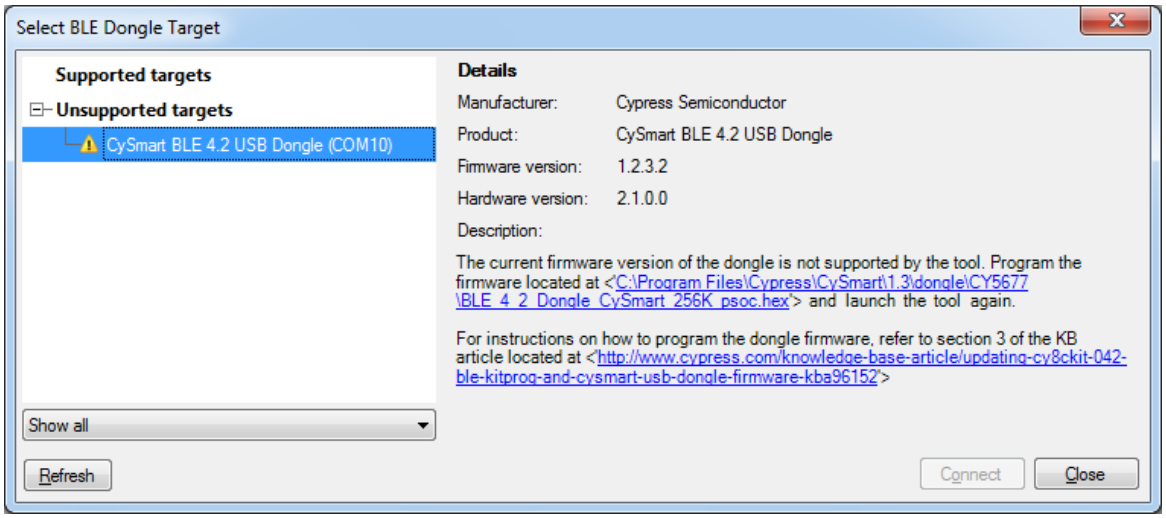
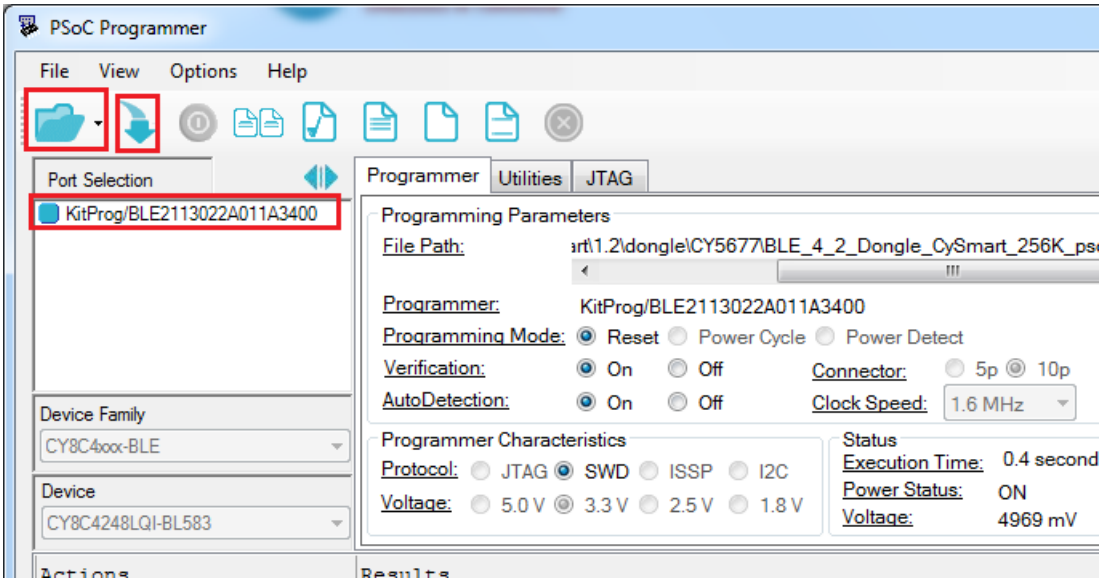


Figure 3-16. Open Hex File



4. Ensure the other settings match as shown in Figure 3-16. Click the **Program** button to start programming. The status bar at the bottom of the PSoC Programmer window will show the programming status and the result (Pass/Fail).
5. After programming is completed successfully, the BLE Dongle firmware is updated and can be used to connect to the CySmart Central Emulation Tool.

3.7 USB-UART Bridge

The KitProg on both the BLE Pioneer Baseboard and BLE Dongle acts as a USB-UART bridge. When connected to a computer, a device named **KitProg USB-UART** is available under **Ports (COM & LPT)** in the Device Manager. The UART lines between PSoC 4 BLE Module and KitProg are hard-wired onboard, with UART_RX assigned to **P1_4** and UART_TX assigned to **P1_5** on PSoC 4 BLE device.

COM terminal software, such as Hyperterminal or TeraTerm, can be used to send and receive data. UART data sent from the PSoC 4 BLE device on the UART_TX line will be received by the software. Data entered in the software will be received by PSoC 4 BLE on the UART_RX line. See CY8CKIT-042 PSoC 4 Pioneer Kit Guide for more details.

Table 3-2 lists the specifications supported by the USB-UART bridge.

Table 3-2. Specifications Supported by USB-UART Bridge

Parameter	Supported Values
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None
File Transfer Protocols supported	Xmodem, 1K Xmodem, Ymodem, Kermit, and Zmodem (only speeds greater than 2400 baud)

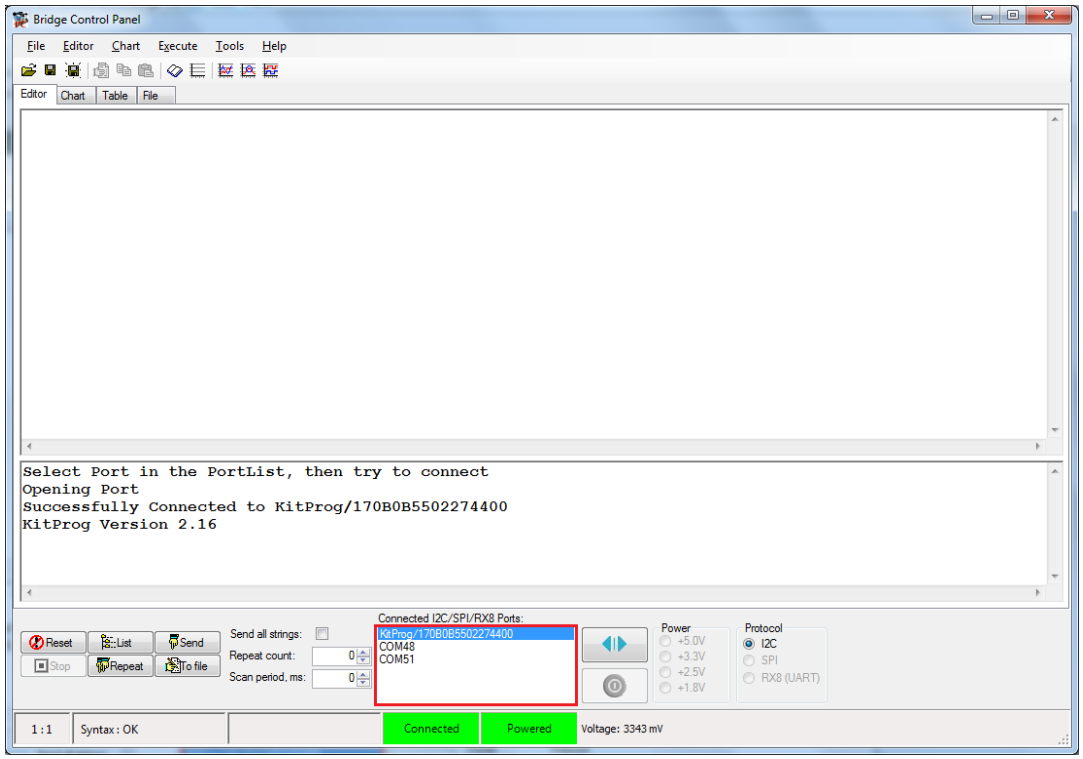
3.8 USB-I²C Bridge

The KitProg can function as USB-I²C bridge and communicate with the Bridge Control Panel (BCP) software utility. When connected to BCP, the **KitProg\<serial number>** is available under **Connected I2C/SPI/RX8 Ports** in the BCP. The I²C connection between PSoC 4 BLE device and KitProg is used to transfer data between BCP and the PSoC 4 BLE device. The I²C lines on PSoC 4 BLE device are **P3_4 (SDA)** and **P3_5 (SCL)**, which are hard-wired onboard to I²C lines of KitProg. The USB-I²C supports I²C speed of 50 kHz, 100 kHz, 400 kHz and 1 MHz.

BCP is installed as part of the PSoC Programmer installation and can be accessed from **Start** > **All Programs** > **Cypress** > **Bridge Control Panel**. Refer to the Advanced section in the CY8CKIT-042 PSoC 4 Pioneer Kit Guide for more details.

To use the USB-I²C functionality, select the **KitProg\<serial number>** in the BCP. On successful connection, the **Connected** and **Powered** status box turn green, as shown in Figure 3-17.

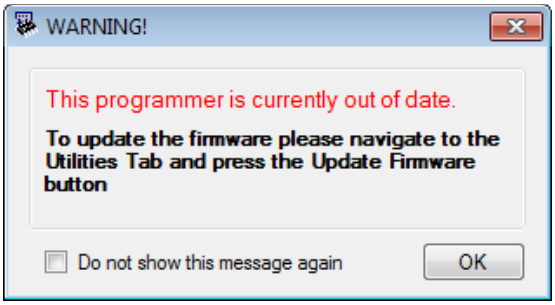
Figure 3-17. KitProg USB-I²C Connected in Bridge Control Panel



3.9 Updating the KitProg Firmware

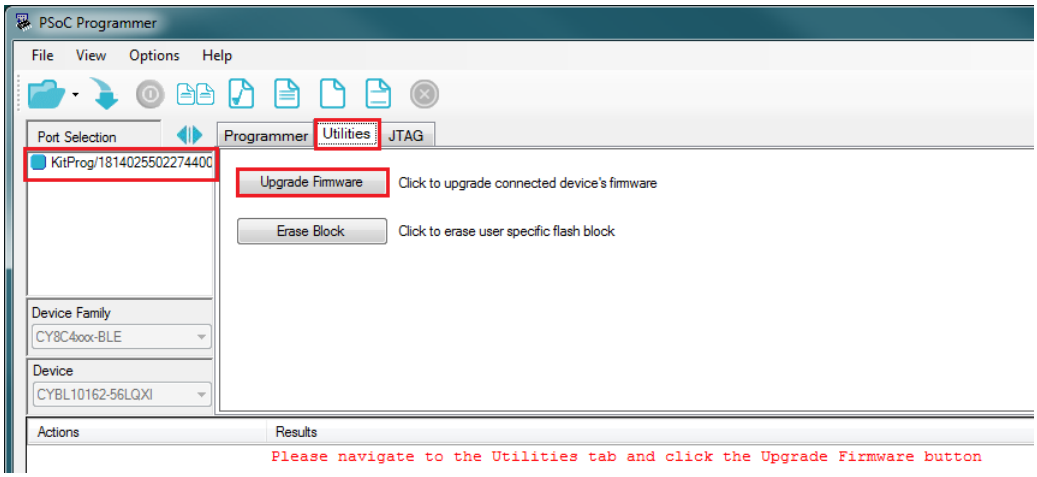
The KitProg firmware normally does not require any update. If an update is required, then PSoC Programmer will display a warning message when the kit is connected to it, as shown in Figure 3-18.

Figure 3-18. Update KitProg



To update the KitProg, go to the **Utilities** tab on PSoC Programmer and click **Upgrade Firmware**, as shown in Figure 3-19.

Figure 3-19. Update KitProg from PSoC Programmer



4. Code Examples

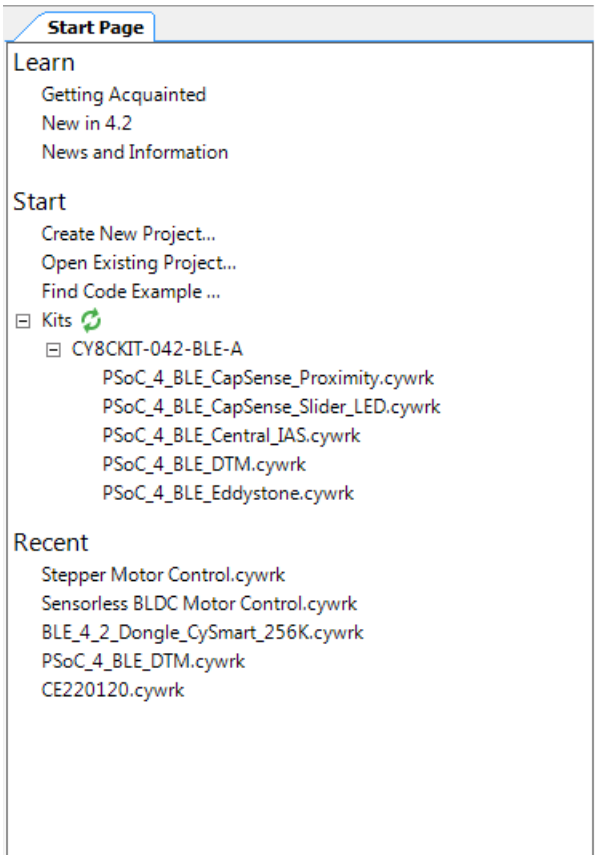
This chapter demonstrates the functionality of the PSoC 4 BLE device using the BLE Pioneer Kit code examples. Download and install the kit setup file from the kit webpage. The code examples can be accessed on the Start Page of PSoC Creator under **Kits**.

4.1 Using Code Examples

Follow these steps to open and use the code examples:

1. Launch PSoC Creator from **Start** > **All Programs** > **Cypress** > **PSoC Creator 4.2** > **PSoC Creator 4.2**.
2. On the **Start** page, click **CY8CKIT-042-BLE-A** under **Start > Kits**. A list of code examples appears, as shown in Figure 4-1.
3. Click the desired code example.

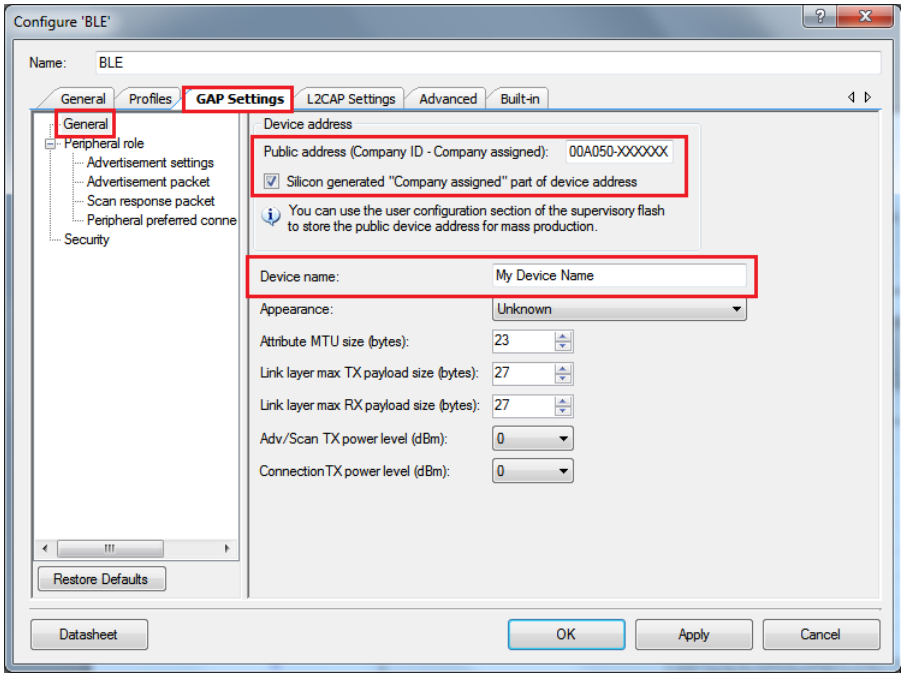
Figure 4-1. Open Code Example from PSoC Creator



4. Select the folder where you want to save the project and click **OK**.
5. Every BLE project uses a public address set in the BLE Component GUI to advertise and scan, depending on the role: Peripheral or Central mode. If multiple kits in close proximity have the same public address, then wrong devices may be connected or connections may fail. To prevent this, change the **Public address** (and preferably **Device name**) in the BLE Component **GAP Settings** tab as shown in Figure 4-2. Click **OK**.

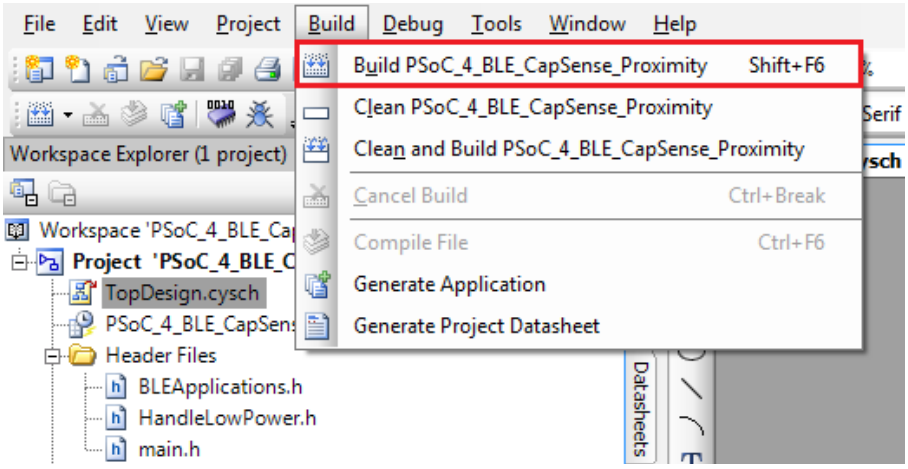
   Alternatively, you can select the 'Silicon generated' device address by selecting the check box. This way, the Bluetooth device (BD) address is generated using the silicon ID, unique to each device. Click **OK**.

Figure 4-2. Change BLE Public Address and Name



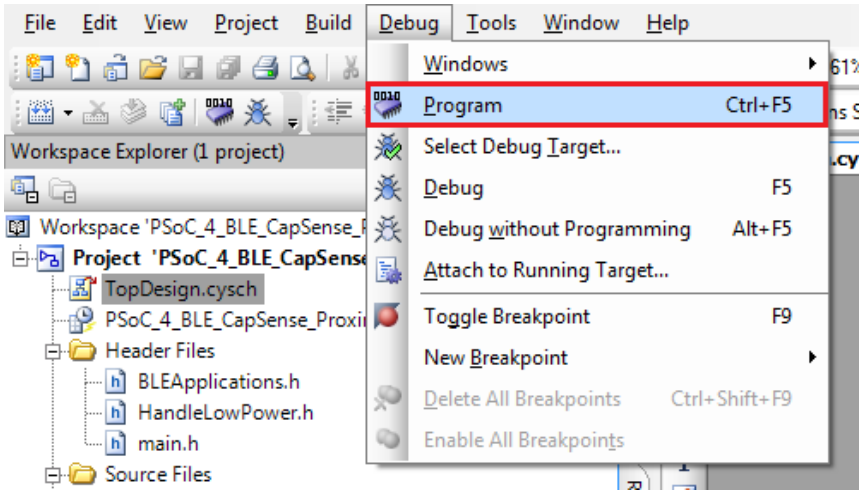
6. Build the code example by choosing **Build** > **Build <Project Name>**, as shown in Figure 4-3. A hex file will be generated.

Figure 4-3. Build Project from PSoC Creator



7. Connect the BLE Pioneer Baseboard to the computer through the USB Mini-B connector J13. Ensure that the PSoC 4 BLE module is placed on the baseboard.
8. Choose **Debug** > **Program** in PSoC Creator, as shown in Figure 4-4.

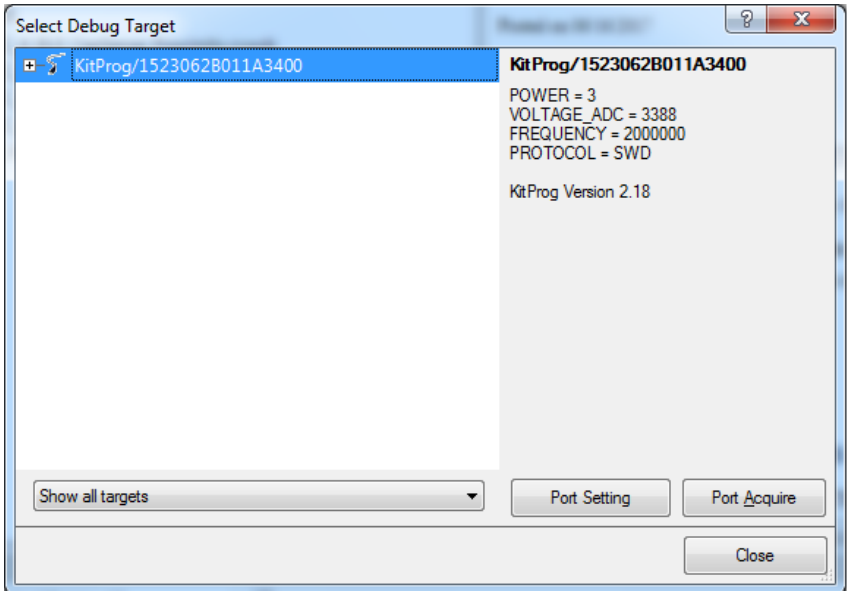
Figure 4-4. Program Device in PSoC Creator



9. If the device is not yet acquired, PSoC Creator will open the programming window. Select **KitProg** and click the **Port Acquire** button, as shown in Figure 4-5.

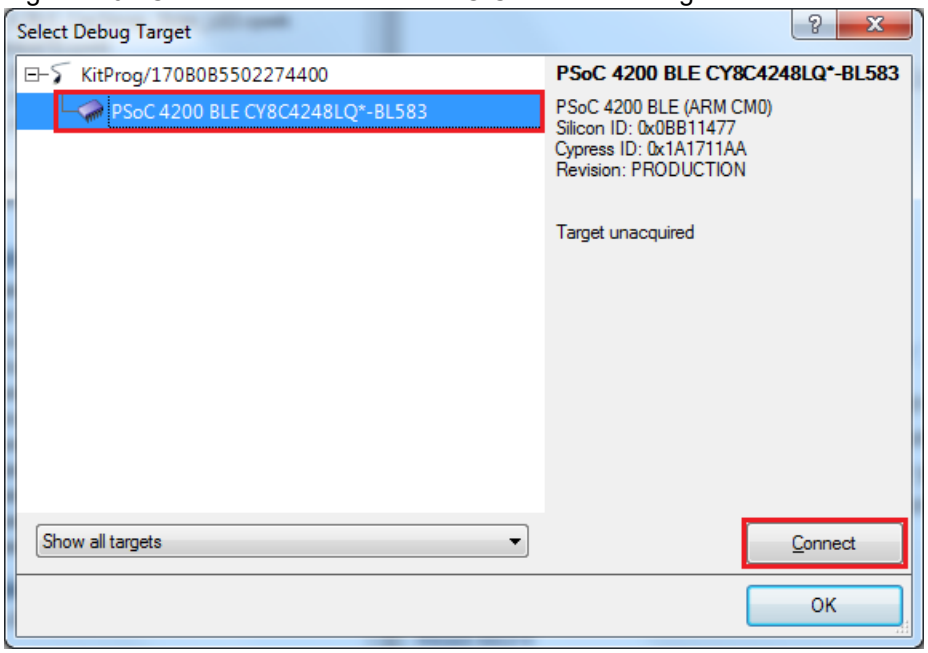
   Note: The serial ID starting with *'BLE'* belongs to the BLE Dongle (see Updating BLE Dongle for CySmart Central Emulation Tool on page 32).

Figure 4-5. Port Acquire



10. After the device is acquired, it is shown in a structure below the KitProg. Click the **Connect** button and then **OK** to exit the window and start programming, as shown in Figure 4-6.

Figure 4-6. Connect Device From PSoC Creator and Program



This document refers to the BLE Pioneer Kits, BLE Dongle, and PC/mobile as Central or Peripheral devices. A Central device is normally the master and requests/commands data from the Peripheral device. BLE-enabled phones and computers are one such example. Peripheral devices store the actual data and send it to the Central device when requested. Examples include BLE-enabled sensors, proximity beacons, and so on.

If you are a beginner in BLE, refer to the PSoC Creator code examples such as *BLE_FindMe* and *BLE_Device_Information_Service* as described in PSoC Creator Code Examples on page 15. You may also refer the application note Getting Started with PSoC 4 BLE.

The four Kit code examples viz. CapSense Slider and LED, CapSense Proximity, BLE Central Mode and Eddystone are intermediatory level examples that will help to design a system around the kit. Refer to the 4.2 CapSense Slider and LED for details.

4.2 CapSense Slider and LED

4.2.1 Project Description

This code example demonstrates connectivity between the BLE Pioneer Kit (acting as a Peripheral and GATT server device) and CySmart Central Emulation tool or mobile device running the CySmart mobile application (acting as a Central and GATT client device). This example demonstrates the following:

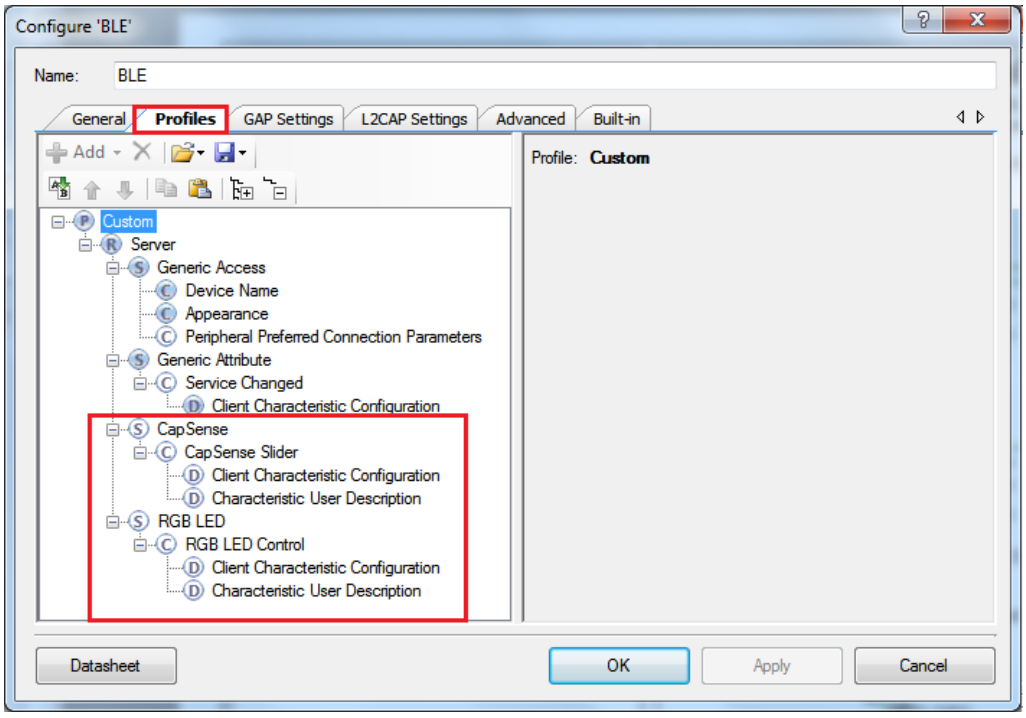
- Advertisement with timeout
- Connection with any Central device
- Two custom services in single profile
- Data transfer over BLE custom service using notifications, read, and write
- Low-power mode implementation for coin-cell operation

The BLE profile in this code example consists of two BLE custom services: CapSense and RGB LED. The **CapSense service** consists of one custom characteristic, termed as CapSense Slider. The CapSense slider characteristic is used to send one byte data, ranging from 0 to 100, as notification to the GATT client device. This data is the finger location read by the CapSense Component on the five-segment slider (CSS1) present on the kit. This characteristic supports notification, which allows the GATT server to send data to the connected client device whenever new data is available.

The **RGB LED service** also consists of one custom characteristic, termed as RGB LED Control. This characteristic supports two operations, read and write, through which the connected GATT client device can read data as well as write a new value to the characteristic. This data has four byte values indicating red, green, blue, and the intensity values to control the onboard RGB LED.

The properties for the custom service/characteristics are configured in the BLE Component under the Profiles tab, as shown in Figure 4-7.

Figure 4-7. Attributes Configuration in BLE Component for Custom Services



The code example consists of the following files:

- **main.c/.h**

  These files contain the main function, which is the entry point and execution of the firmware application. They also contain the function definition for initialization of the system and reading the CapSense slider data from the CapSense Component.

- **BLEApplications.c/.h**

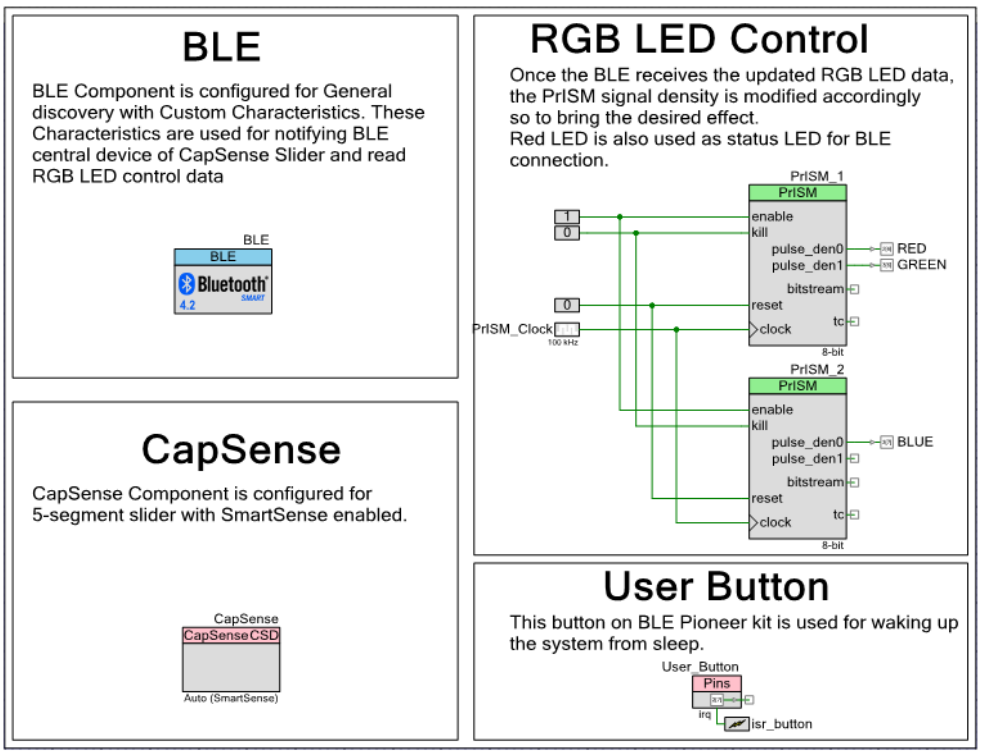
  These files contain all the macros and function definitions related to BLE communication and operation. They include the event callback function definition that is registered with the BLE Component startup and used to send BLE-related events from the BLE stack to the application layer for processing. These files contain a method to send CapSense notifications to the GATT client device and process the Read and Write commands on the RGB LED characteristic by the GATT client device. They update the BLE Connection parameter, which is important for low-power mode usage.

- **HandleLowPower.c/.h**

  These files contain the function to handle low-power mode. This function is continuously called in the main loop and is responsible for pushing the BLE hardware block (BLESS) as well as the CPU to Deep Sleep mode as much as possible. The wakeup source is either the BLE hardware block link layer internal timer or the interrupt from the user button press (**SW2**). This allows for very low power mode implementation and operation using a coin cell.

This is the default firmware that comes in the PSoC 4 BLE Module shipped with the kit.

Figure 4-8. TopDesign for PSoC_4_BLE_CapSense_Slider_LED Code Example

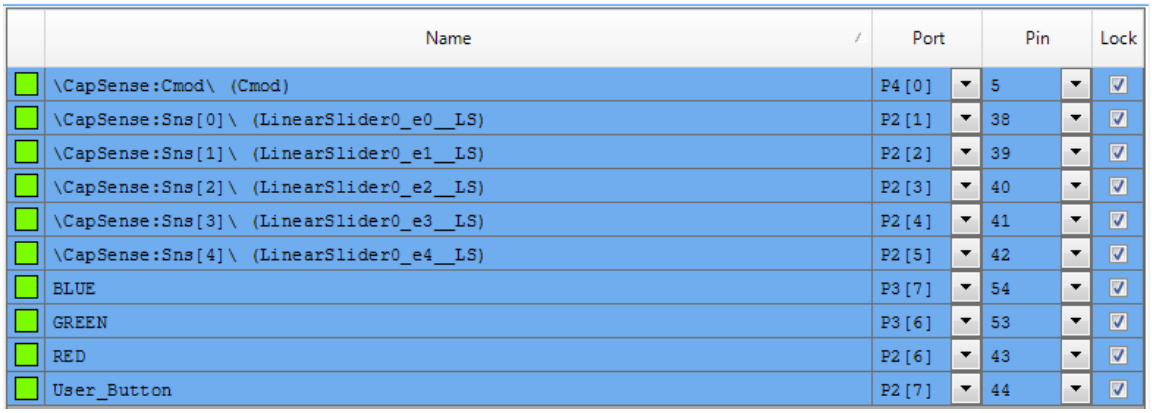


4.2.2 Hardware Connections

No specific hardware connections are required for this code example because all connections are hardwired on the BLE Pioneer Baseboard. Ensure that the PSoC 4 BLE Module is placed on the baseboard.

The pin assignment for this code example is in *PSoC_4_BLE_CapSense_Slider_LED.cydwr* in the Workspace Explorer, as shown in Figure 4-9.

Figure 4-9. Pin Selection for CapSense Slider and LED Code Example

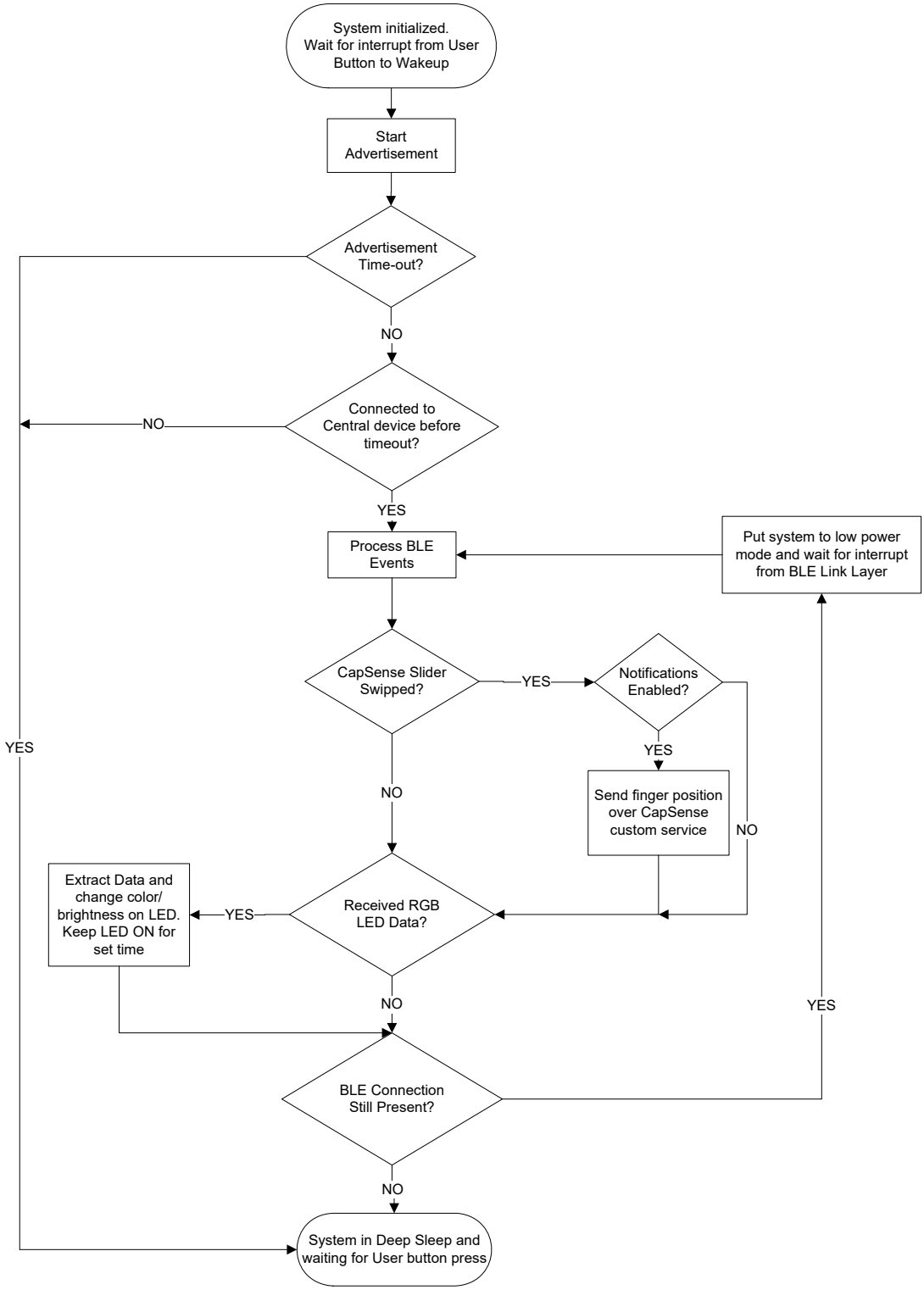


	Name	Port	Pin	Lock
	\CapSense:Cmod\ (Cmod)	P4[0]	5	☑
	\CapSense:Sns[0]\ (LinearSlider0_e0__LS)	P2[1]	38	☑
	\CapSense:Sns[1]\ (LinearSlider0_e1__LS)	P2[2]	39	☑
	\CapSense:Sns[2]\ (LinearSlider0_e2__LS)	P2[3]	40	☑
	\CapSense:Sns[3]\ (LinearSlider0_e3__LS)	P2[4]	41	☑
	\CapSense:Sns[4]\ (LinearSlider0_e4__LS)	P2[5]	42	☑
	BLUE	P3[7]	54	☑
	GREEN	P3[6]	53	☑
	RED	P2[6]	43	☑
	User_Button	P2[7]	44	☑

4.2.3 Flow Chart

Figure 4-10 shows the flow chart of the code implemented.

Figure 4-10. CapSense Slider and LED Code Example Flow Chart



4.2.4 Verify Output

The code example can be verified by two methods: using the CySmart Central Emulation Tool and BLE Dongle or using the CySmart mobile application.

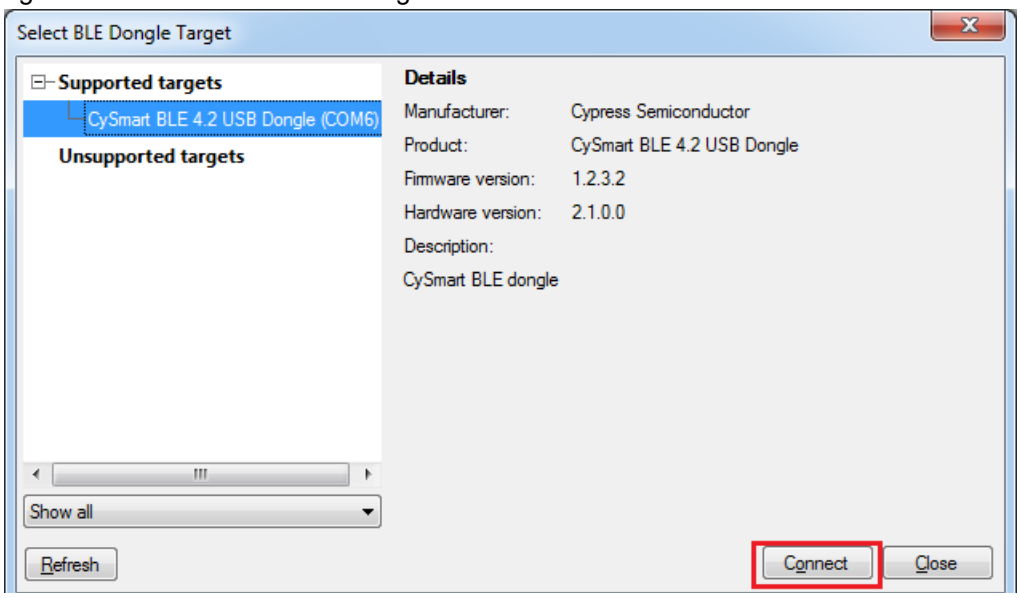
4.2.4.1 CySmart Central Emulation Tool

To verify the CapSense and LED code example using the CySmart Central Emulation Tool, follow these steps:

Note: Refer CySmart Central Emulation tool to learn how to use the tool.

1. Connect the BLE Dongle to one of the USB ports on the computer.
2. Start the CySmart Central Emulation Tool on the computer by going to **Start** > **All Programs** > **Cypress** > **CySmart <version>** > **CySmart <version>**. You will see a list of BLE Dongles connected to it. If no dongle is found, click **Refresh**. Select the BLE Dongle and click **Connect**.

Figure 4-11. Connect to BLE Dongle

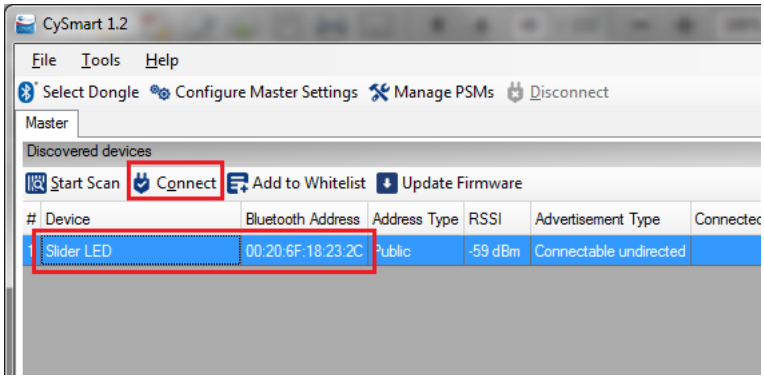


3. Place the module on the BLE Pioneer Kit.
4. Power the BLE Pioneer Kit through the USB connector **J13**.
5. Program the BLE Pioneer Kit with the *PSoC_4_BLE_CapSense_Slider_LED* code example. Follow steps in Using Code Examples on page 37 to program the device.
6. After programming successfully, press the user button (**SW2**) on the BLE Pioneer Kit to start the advertisement. Advertisement is indicated by a blinking red LED on the baseboard.

   Note: The code example has an advertisement timeout of 30 seconds after which it returns to Deep Sleep mode. Press **SW2** again to restart the advertisement.
7. On the CySmart Central Emulation Tool, click **Start Scan** to see the list of available BLE Peripheral devices.

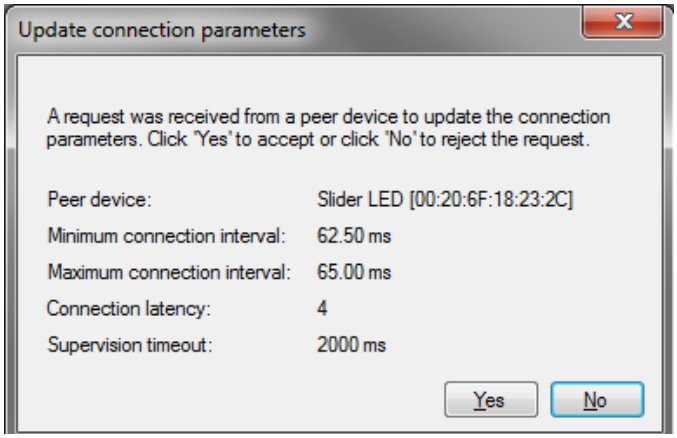
8. Double-click the **Slider LED** device to connect, or click **Slider LED** and then click **Connect**.

Figure 4-12. Connect to BLE Slider and LED Peripheral



9. When connected, the CySmart Central Emulation Tool will display a message for the **Update connection parameters**. Select **Yes**, as shown in Figure 4-13.

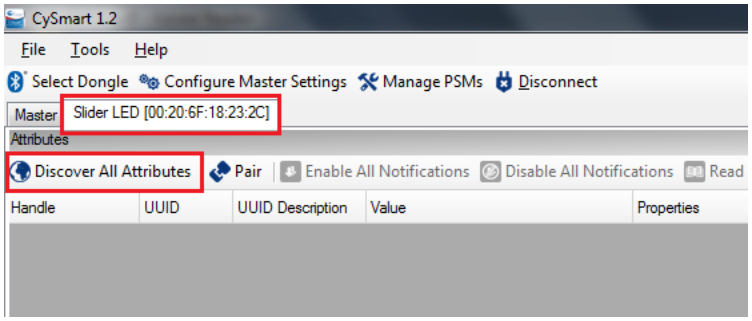
Figure 4-13. Update Connection Parameter Option



Note: If you select **No**, the code example will still work. However, the current consumption will be higher due to faster connection interval.

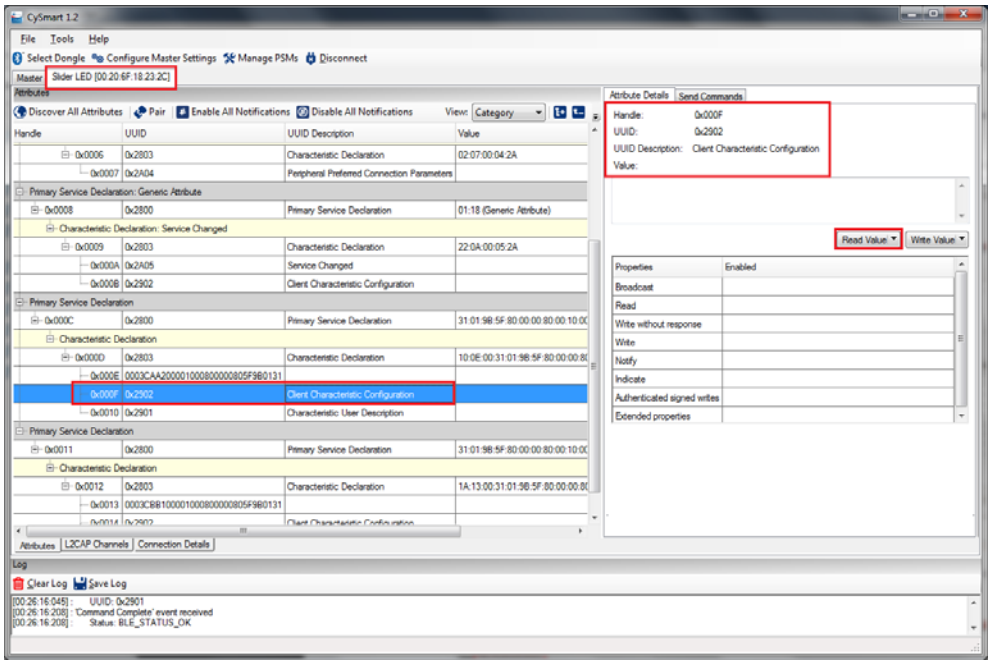
10. Click **Discover All Attributes** to find all attributes supported.

Figure 4-14. Discover All Attributes



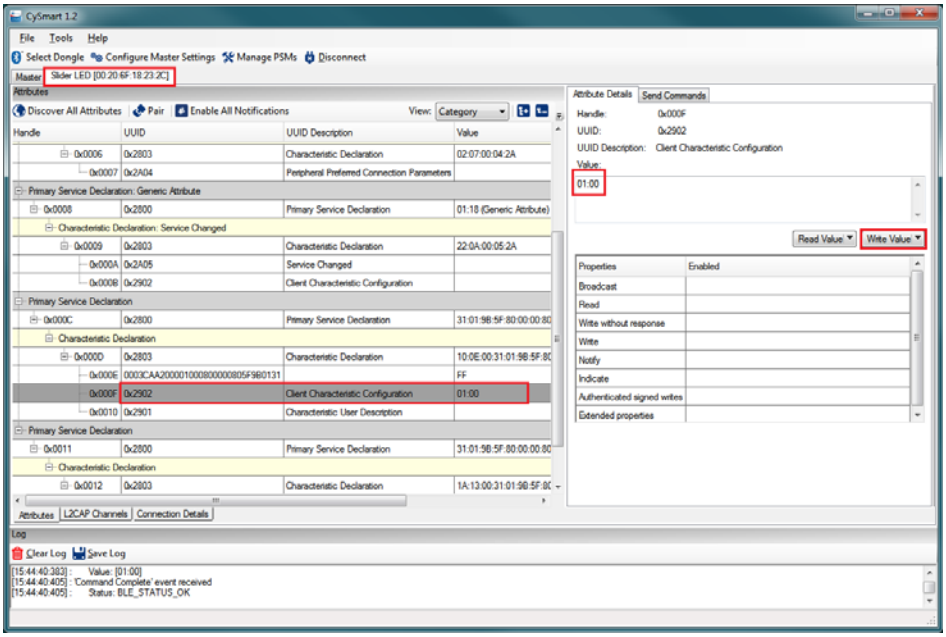
11. Locate the attribute **Client Characteristic Configuration** descriptor (UUID 0x2902) under CapSense slider characteristic (**UUID 0x0003CAA2-0000-1000-8000-00805F9B0131**). Click **Read Value** to read the existing Client Characteristic Configuration Descriptor (CCCD) value as shown in Figure 4-15.

Figure 4-15. Read CCCD for CapSense Slider Characteristic



12. Modify the **Value** field of CCCD to '01:00' and click **Write Value**. This enables the notifications on the CapSense slider characteristic.

Figure 4-16. Write CCCD to Enable Notifications



13. Swipe your finger on the CapSense slider on the BLE Pioneer kit, as shown in Figure 4-17 and see the notification values in the CapSense Slider value field, as shown in Figure 4-18.

Figure 4-17. CapSense Slider

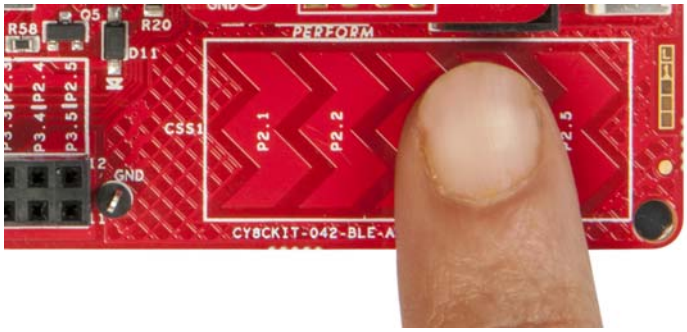
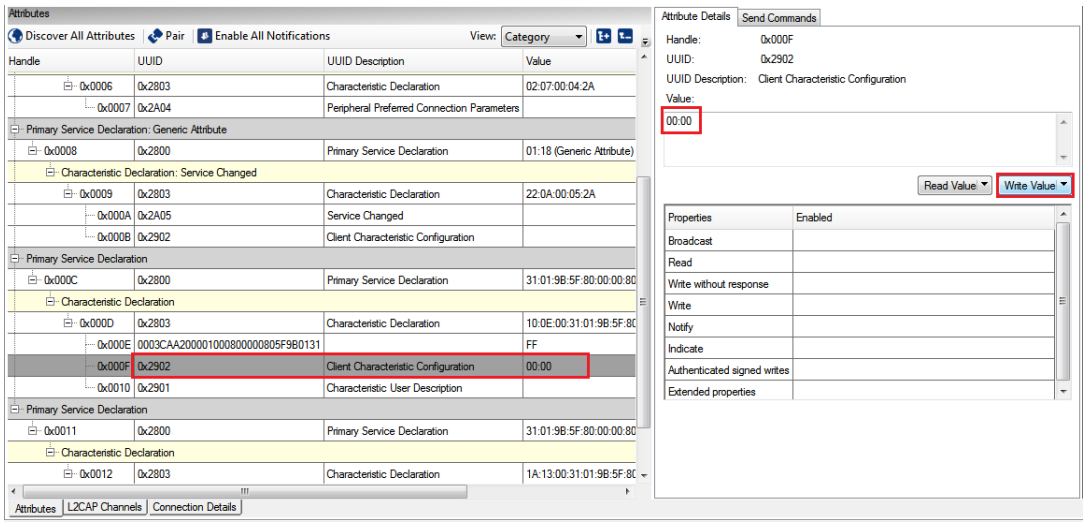


Figure 4-18. CapSense Slider Notification Received

Primary Service Declaration			
0x000C	0x2800	Primary Service Declaration	31:01:9B:5F:80:00:00:80:00:10
Characteristic Declaration			
0x000D	0x2803	Characteristic Declaration	10:0E:00:31:01:9B:5F:80:00:00
0x000E	0003CAA2000010008000000805F9B0131		25
0x000F	0x2902	Client Characteristic Configuration	01:00
0x0010	0x2901	Characteristic User Description	

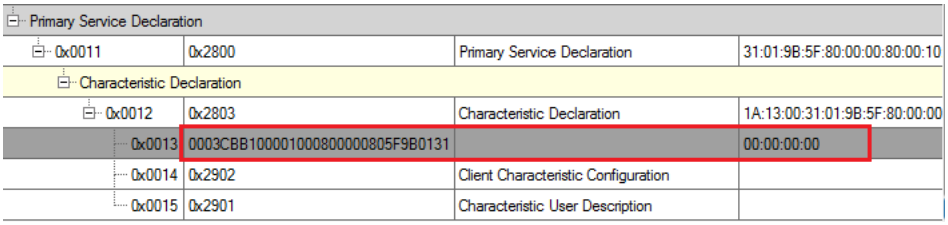
14. To disable notifications, modify the **Value** field of the **Client Characteristic Configuration** descriptor to '00:00' and click **Write Value**.

Figure 4-19. Disable Notifications



15. Locate the **RGB LED Control** characteristic (**UUID 0x0003CBB1-0000-1000-8000-00805F9B0131**). Click **Read Value** to read the existing 4-byte onboard RGB LED color information, as shown in Figure 4-20. The four bytes indicate red, green, blue, and the overall brightness, respectively.

Figure 4-20. Read RGB LED Control Characteristic Value



16. Modify the four bytes of data in the **Value** field and click **Write Value**. You will see the corresponding change in the color and intensity of the RGB LED on the BLE Pioneer Kit, as shown in Figure 4-22. The RGB LED will be on for 3 seconds before switching off to conserve power. The first byte indicates the red LED. The second byte indicates the green LED. The third byte indicates the blue LED. The fourth byte indicates the LED intensity.

    Note: If the kit is powered from a coin cell and not the USB Vbus, then the color mixing and intensity will vary. This is because the coin cell provides a lower driving voltage for RGB LEDs.

Figure 4-21. Write RGB LED Control Characteristic Value

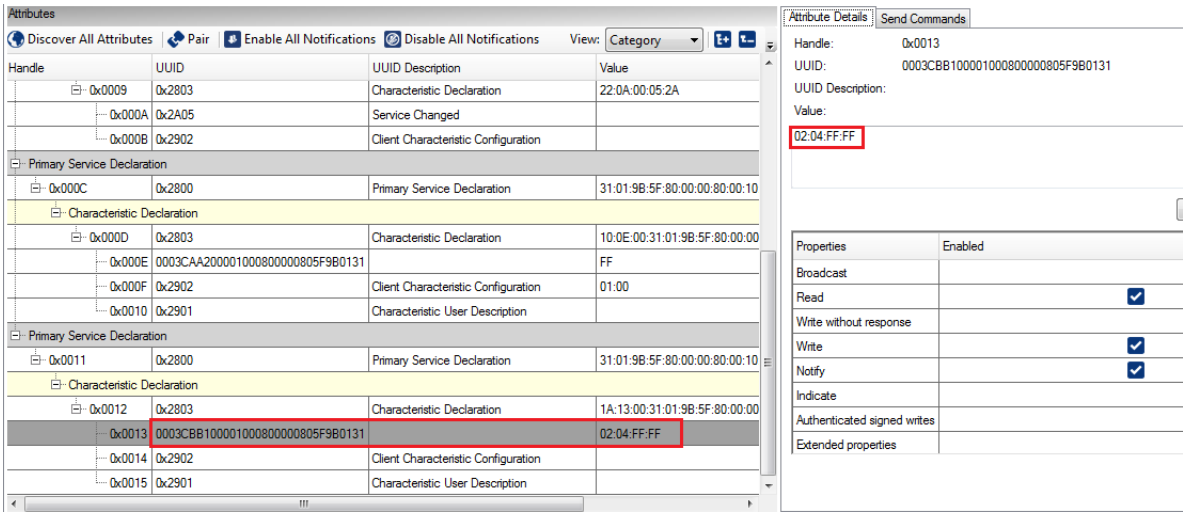
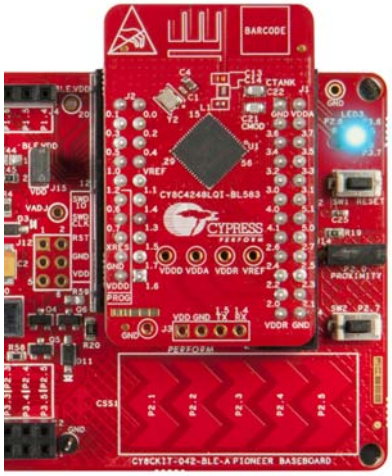
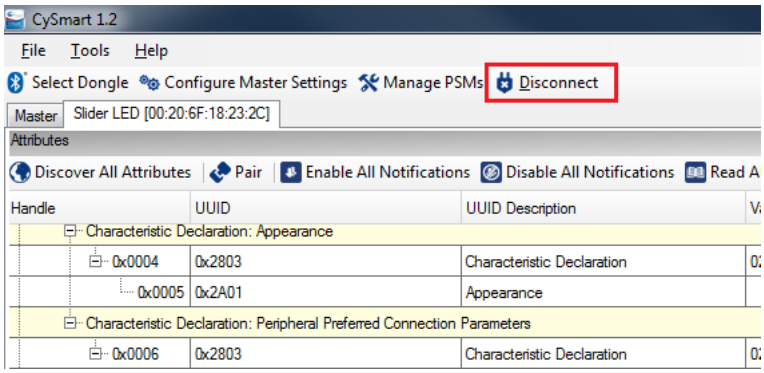


Figure 4-22. RGB LED Control with PSoC 4 BLE Module



17. To disconnect from the device, click **Disconnect**, as shown in Figure 4-23.

Figure 4-23. Disconnect from the Device



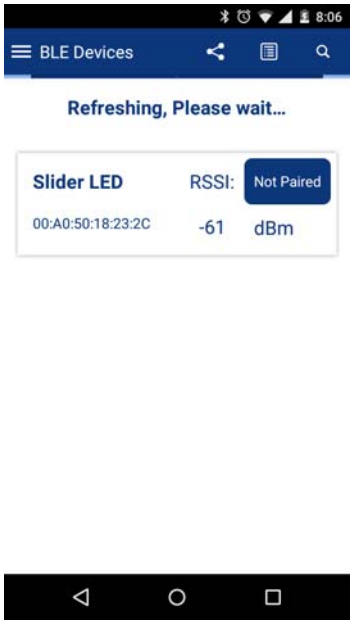
18. To connect to this peripheral again, restart advertising by pressing the user button (**SW2**) on the BLE Pioneer Kit. Advertising is indicated by the blinking red LED.

4.2.4.2 *CySmart Mobile Application*

To verify the CapSense and LED code example using the CySmart mobile application (refer CySmart Mobile App webpage), follow these steps:

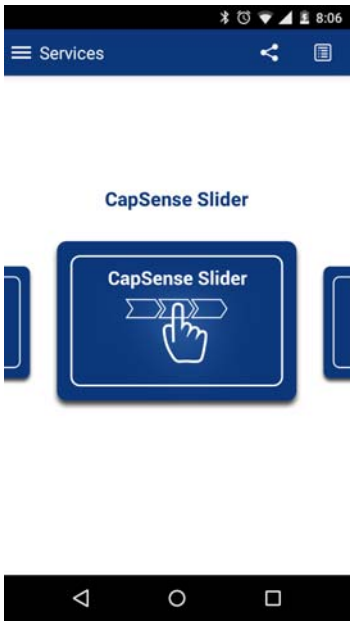
1. Plug the PSoC 4 BLE module on the BLE Pioneer Baseboard.
2. Connect the BLE Pioneer Kit to the computer using the USB connector J13.
3. Program the kit with the *PSoC_4_BLE_CapSense_Slider_LED* code example. See Using Code Examples on page 37 for programming instructions.
4. Press the user button (**SW2**) on the BLE Pioneer Kit to start the advertisement. This is indicated by the blinking red LED on the BLE Pioneer Kit.
5. Open the application on the mobile device. If Bluetooth is not enabled on the device, the application will ask to enable it.
6. After Bluetooth is enabled, the CySmart mobile application will automatically search for available peripherals and list them. Select the **Slider LED** peripheral as shown in Figure 4-24.

Figure 4-24. Slider LED Peripheral



7. When connected, the CySmart mobile application will list the profiles supported by the peripherals. Scroll and select the CapSense Slider service, as shown in Figure 4-25.

Figure 4-25. CapSense Service Page

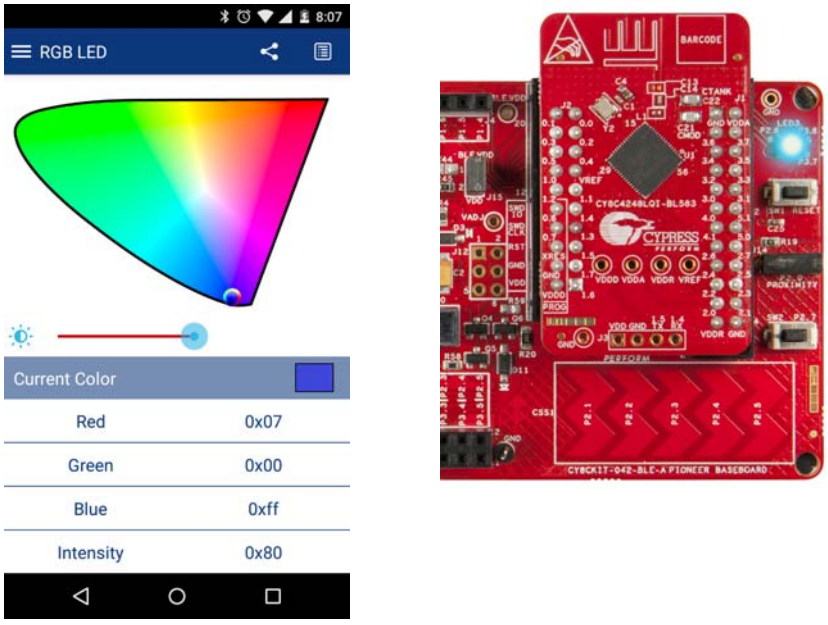


8. Swipe your finger on the CapSense slider on the BLE Pioneer Kit and see a similar response on the **CapSense** page in the CySmart application (Figure 4-26).

Figure 4-26. CapSense Slider

9. Press the back button to return to the service selection page. Scroll and tap on the RGB LED service.
10. On the RGB LED service page, swipe over the color gamut to see a similar color response on the BLE Pioneer Kit RGB LED. The slider below the color gamut controls the intensity of the RGB LED color. The RGB LED will be on for 3 seconds before switching off. This is done to conserve power.

Figure 4-27. RGB LED Control with CySmart Mobile Application



11. To disconnect from the BLE Pioneer Kit, return to the CySmart mobile application home screen by pressing the back button.
12. To reconnect to the Peripheral, press the user button (**SW2**) on the BLE Pioneer Kit again and then scan for devices using CySmart mobile application.

4.3 CapSense Proximity

4.3.1 Project Description

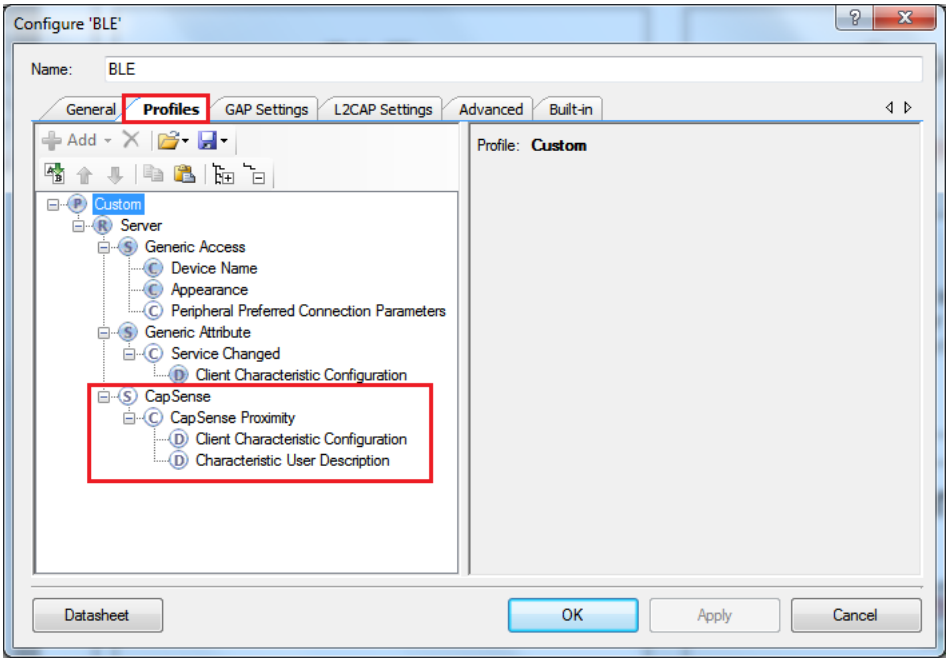
This code example demonstrates connectivity between the BLE Pioneer Kit (acting as a Peripheral and GATT server device) and the CySmart Central Emulation Tool or mobile device running the CySmart mobile application (acting as a Central and GATT client device). This code example demonstrates the following:

- Advertisement with timeout
- Connection with any Central device
- One custom service
- Data transfer over BLE custom service using notifications
- Low-power mode implementation for coin cell operation

The BLE profile in this code example consists of a single BLE custom service, called CapSense. The **CapSense service** consists of a custom characteristic, termed as **CapSense Proximity**. The CapSense proximity characteristic is used to send one byte data, ranging from 0 to 255, as notification to the GATT client device. This data is the difference count read by the CapSense Component on the one-wire proximity sensor (J14) connected on the kit. This characteristic supports notification, which allows the GATT server to send data to the connected GATT client device whenever new data is available.

The properties for the custom attributes are configured in the BLE Component under the Profiles tab, as shown in Figure 4-28.

Figure 4-28. Attributes Configuration in BLE Component for CapSense Proximity



The code example consists the following files:

- **main.c/.h**

  These files contain the main function, which is the entry point and execution of the firmware application. They contain function definition for initialization of the system and reading the CapSense proximity data from the CapSense Component.

- **BLEApplications.c/.h**

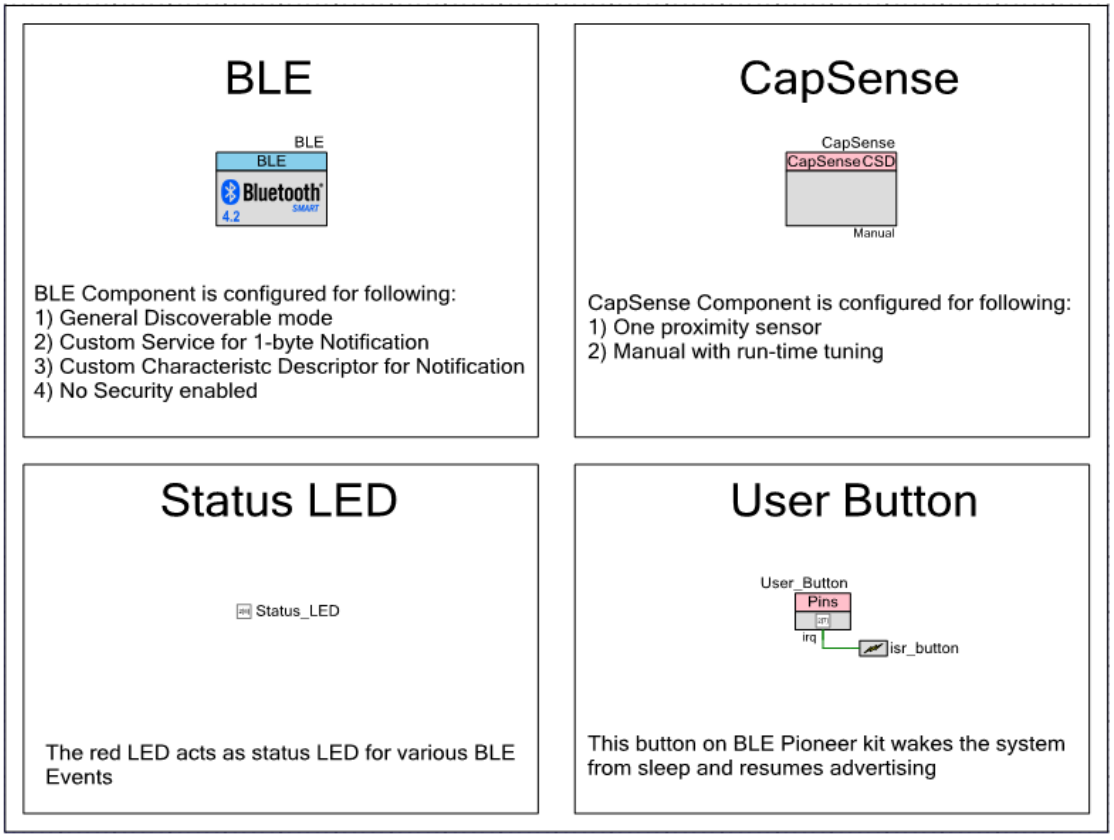
  These files contain all the macros and function definitions related to BLE communication and operation. They include the event callback function definition that is registered with the BLE Component startup and used to send BLE-related events from the BLE stack to the application layer for processing. These files contain a method to send CapSense notifications to the GATT client device. They update the BLE Connection parameter, which is important for low-power mode usage.

- **HandleLowPower.c/.h**

  These files contain the function to handle low-power mode. This function is continuously called in the main loop and is responsible for pushing the BLE hardware block (BLESS) as well as the CPU to Deep Sleep mode as much as possible. The wakeup source is either the BLE hardware block link layer internal timer or the interrupt from the user button press (**SW2**). This allows for very low-power mode implementation and operation using a coin cell.

The red LED is used as the status LED and provides visual confirmation on advertising or connection states. A blinking red LED indicates advertising state.

Figure 4-29. Top Design for PSoC_4_BLE_CapSense_Proximity Code Example



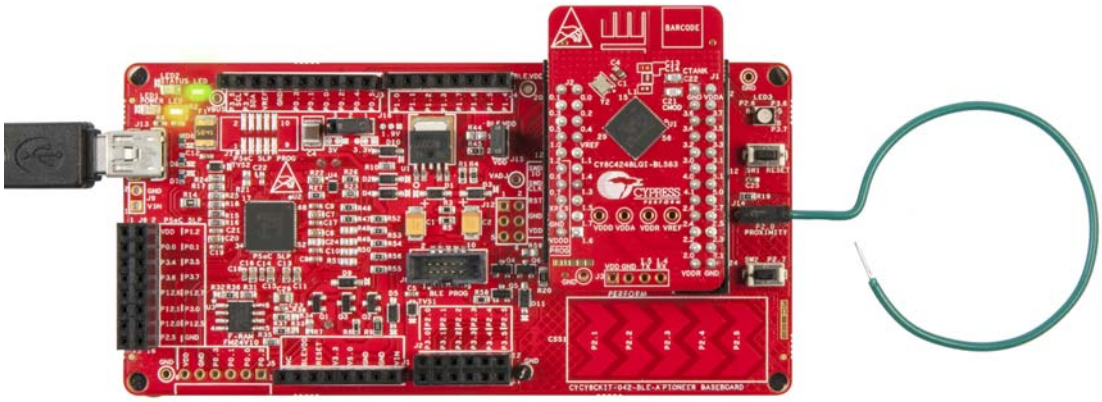
4.3.2 Hardware Connections

- Ensure that the PSoC 4 BLE Module is placed on the BLE Pioneer Baseboard.
- Connect a five-inch wire (provided as part of this kit) to the proximity connector J14 on the baseboard. Loop the wire as shown in Figure 4-30.

  The proximity range is approximately equal to the diameter of the proximity loop. For more information, refer to AN92239 - Proximity Sensing with CapSense.

  Note: Ensure that the proximity sensor loop wire is kept away as much as possible from the BLE antenna on the PSoC 4 BLE Module.

Figure 4-30. Proximity Sensor Connection on BLE Pioneer Kit with PSoC 4 BLE Module



The pin assignment for this code example is in *PSoC_4_BLE_CapSense_Proximity.cydwr* in the Workspace Explorer, as shown in Figure 4-31.

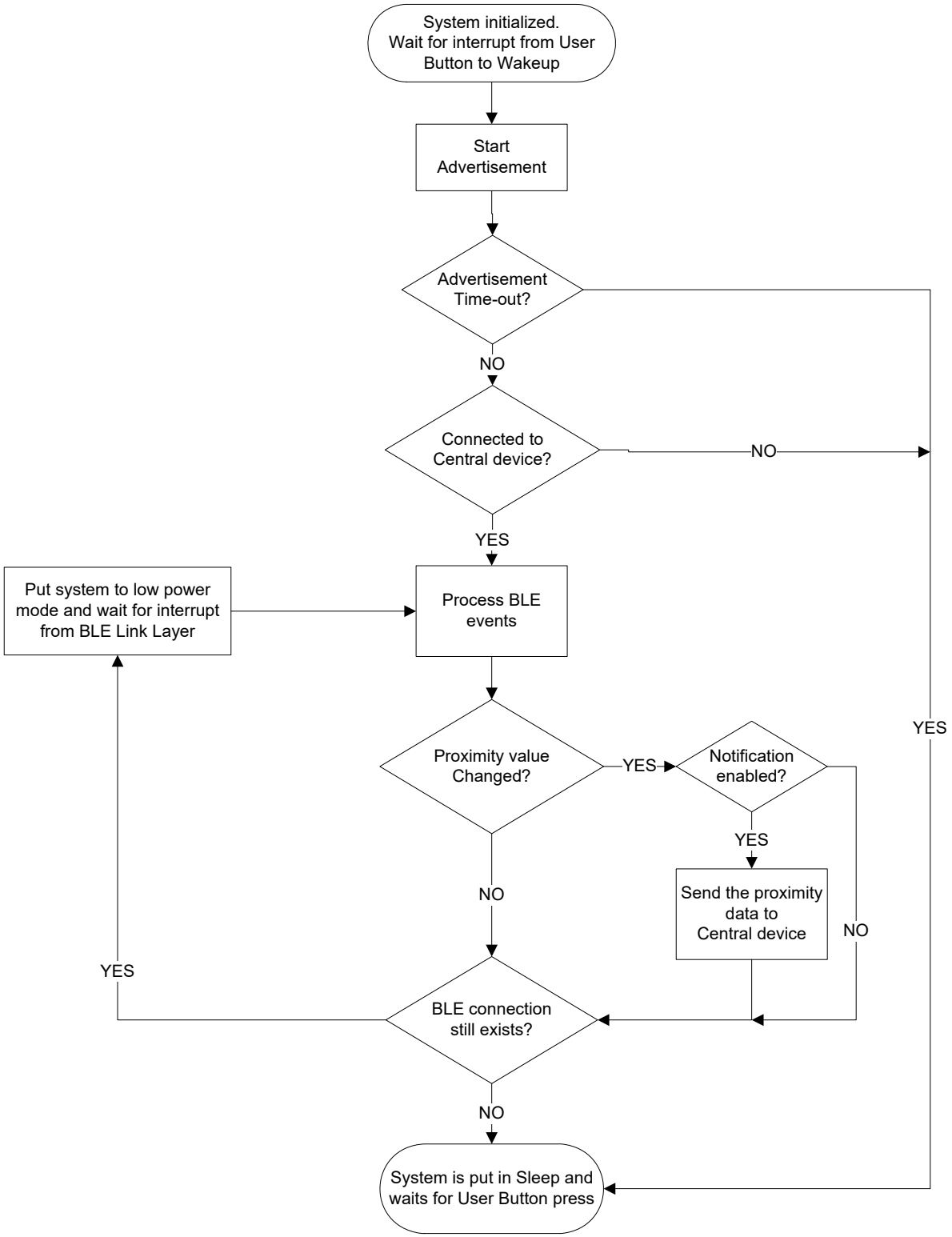
Figure 4-31. Pin Selection for CapSense Proximity Code Example

	Name	Port	Pin	Lock
	\CapSense:Cmod\ (Cmod)	P4[0]	5	☑
	\CapSense:Sns\ (ProximitySensor0_0__PROX)	P2[0]	37	☑
	Status_LED	P2[6]	43	☑
	User_Button	P2[7]	44	☑

4.3.3 Flow Chart

Figure 4-32 shows the flow chart of code implemented.

Figure 4-32. CapSense Proximity Code Example Flow Chart



4.3.4 Verify Output

The code example can be verified by two methods: using the CySmart Central Emulation Tool and BLE Dongle or using the CySmart iOS/Android app.

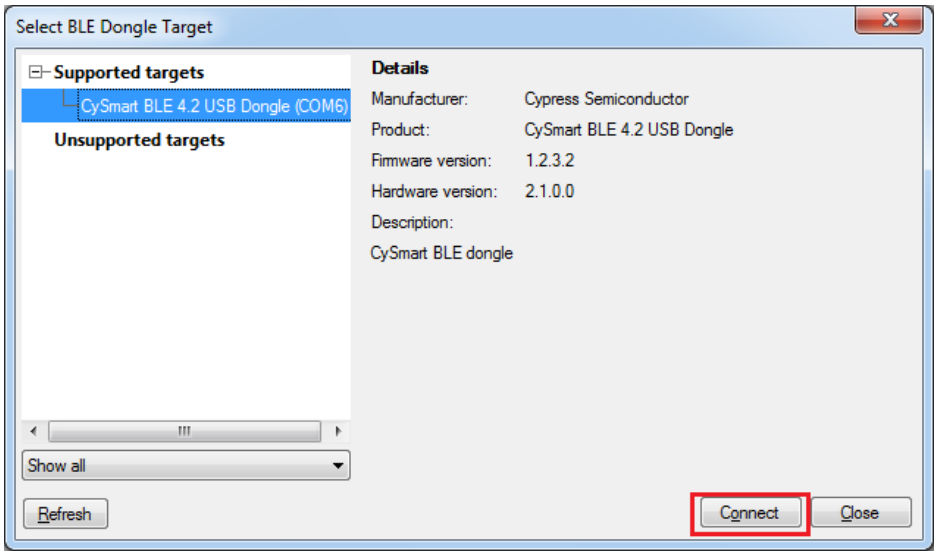
4.3.4.1 CySmart Central Emulation Tool

To verify the CapSense Proximity code example using the CySmart Central Emulation Tool, follow these steps:

Note: Refer CySmart Central Emulation tool to learn how to use the tool.

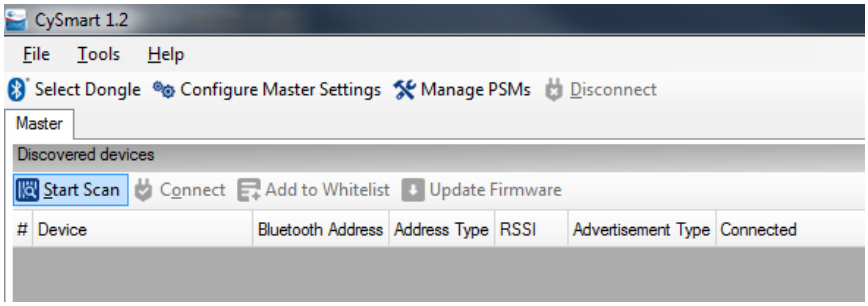
1. Connect the BLE Dongle to one of the USB ports on the computer.
2. Start the CySmart Central Emulation Tool on the computer by going to **Start** > **All Programs** > **Cypress** > **CySmart <version>** > **CySmart <version>**. You will see a list of dongles connected to it. If no dongle is found, click **Refresh**. Select the BLE Dongle and click **Connect**.

Figure 4-33. Connect to BLE Dongle



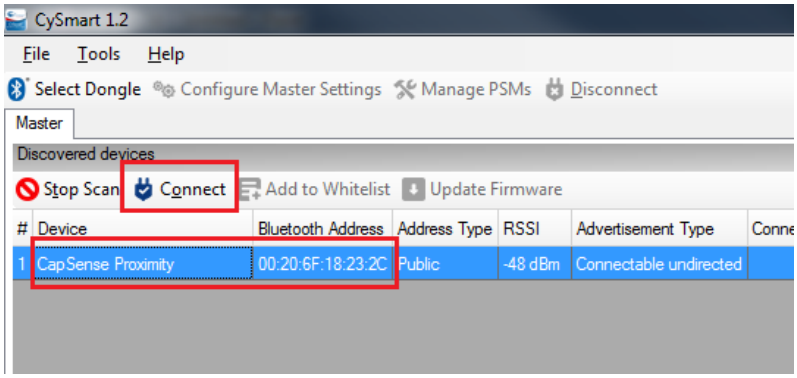
3. Connect a five-inch wire (included in the kit) to the proximity sensor connector J14 on the BLE Pioneer Kit and make a loop of it.
4. Power the BLE Pioneer Kit through the USB connector **J13**.
5. Program the BLE Pioneer Kit with the *PSoC_4_BLE_CapSense_Proximity* code example. Follow the steps in Using Code Examples on page 37 to program the device.
6. After programming successfully, press the user button (**SW2**) on the BLE Pioneer kit to start the advertisement. This is indicated by a blinking red LED on the baseboard.
   Note: The code example has an advertisement timeout of 30 seconds after which it returns to Deep Sleep mode. Press **SW2** again to restart the advertisement.
7. On the CySmart Central Emulation Tool, click **Start Scan** to see the list of available BLE Peripheral devices.

Figure 4-34. Start Scanning



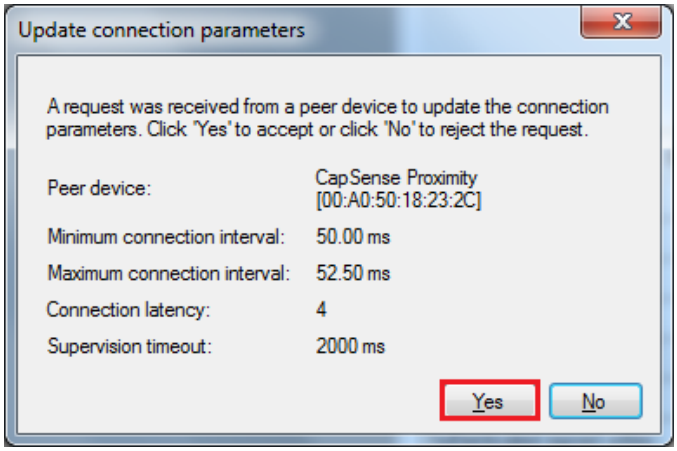
8. Double-click **CapSense Proximity** to connect, or click **CapSense Proximity** and then click **Connect**

Figure 4-35. Connect to CapSense Proximity Peripheral



9. When connected, the CySmart Central Emulation Tool will display a message for the **Update connection parameters**. Select **Yes**, as shown in Figure 4-36.

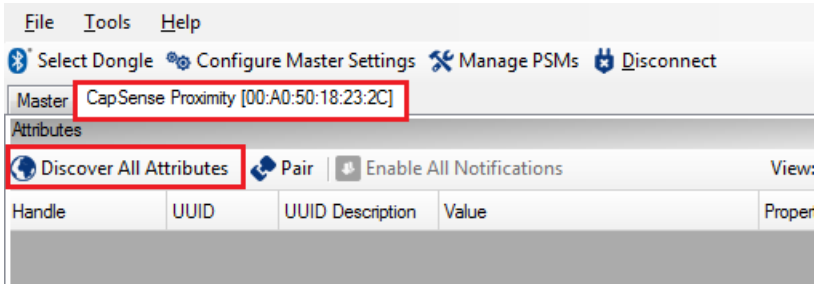
Figure 4-36. Update Connection Parameter Option



Note: If you select **No**, the code example will still work. However, the current consumption will be higher due to faster connection interval.

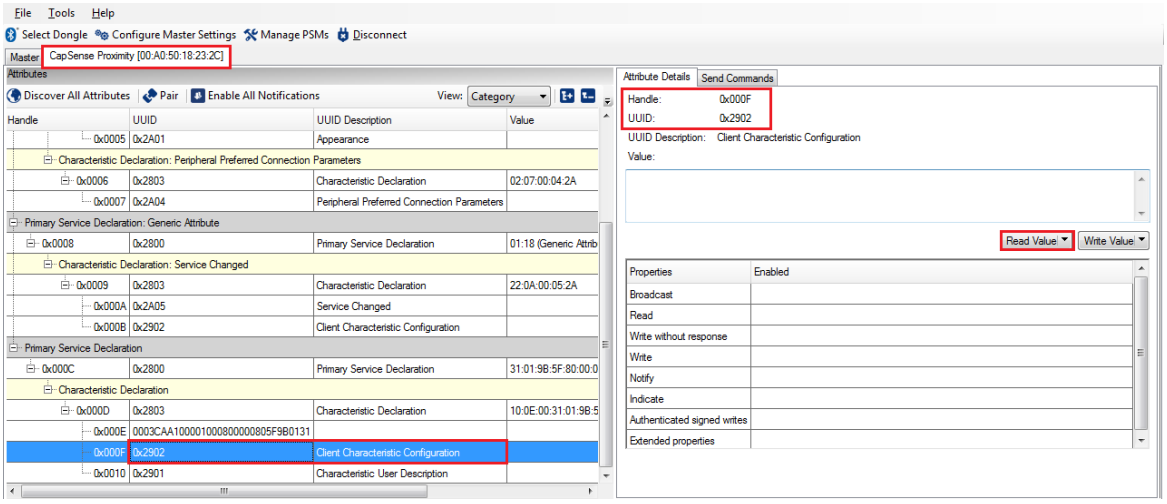
10. Click **Discover All Attributes** to find all attributes supported by the Peripheral.

Figure 4-37. Discover All Attributes



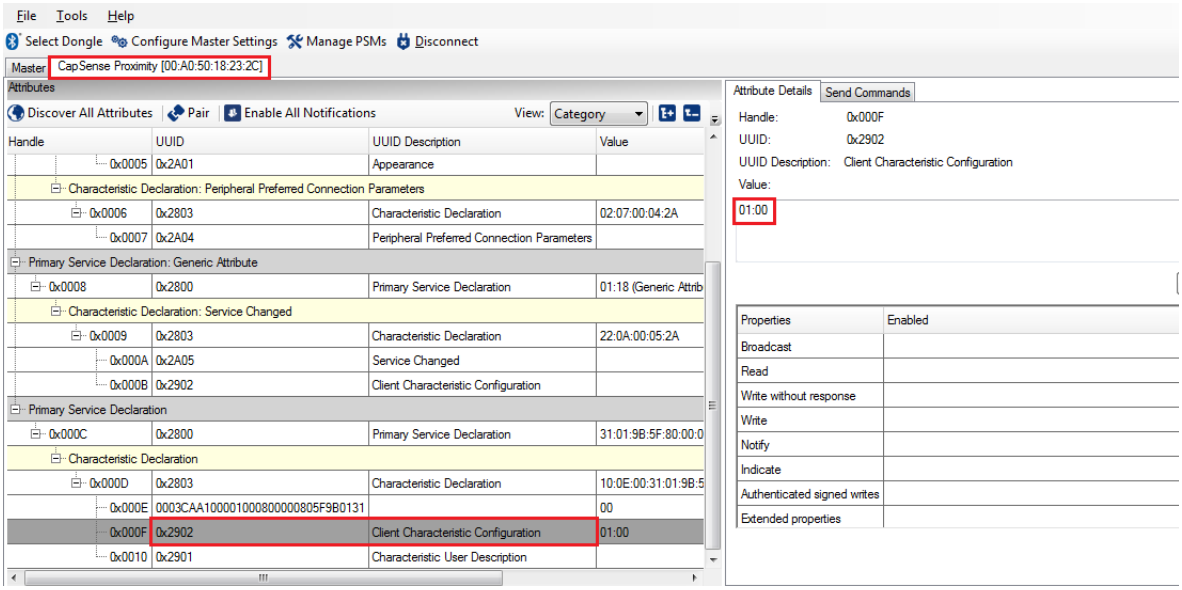
11. When all the attributes are listed, locate the **Client Characteristic Configuration** descriptor (UUID 0x2902) under CapSense Proximity characteristic (**UUID 0x0003CAA1-0000-1000-8000-00805F9B0131**). Click **Read Value** to read the existing CCCD value as shown in Figure 4-38.

Figure 4-38. Read CapSense Proximity CCCD



12. Modify the **Value** field to '01:00' and click **Write Value**. This enables the notifications on the CapSense proximity characteristic.

Figure 4-39. Write CCCD to Enable Notifications



13. Bring your hand closer to the proximity sensor on the BLE Pioneer Kit, as shown in Figure 4-40 and observe the value changing in the characteristic value field, as shown in Figure 4-41.

Figure 4-40. CapSense Proximity Sensing with PSoC 4 BLE Module

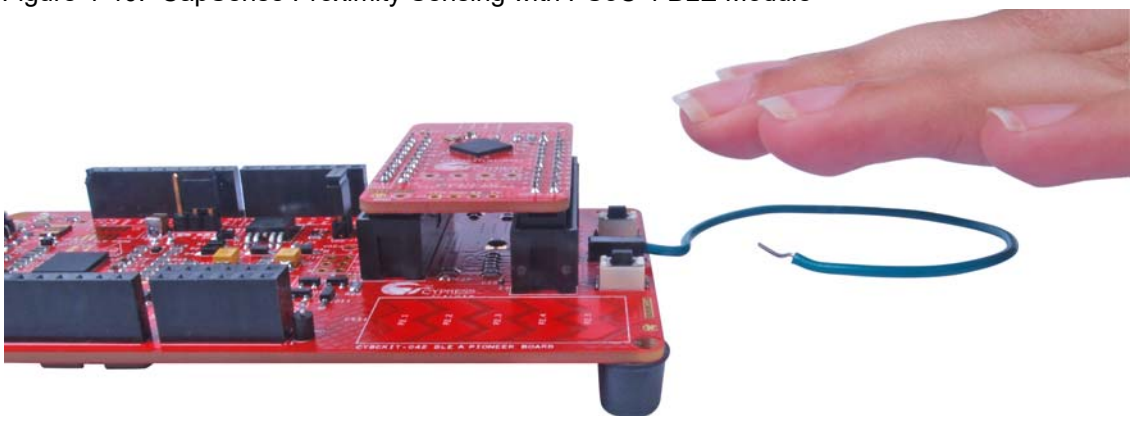
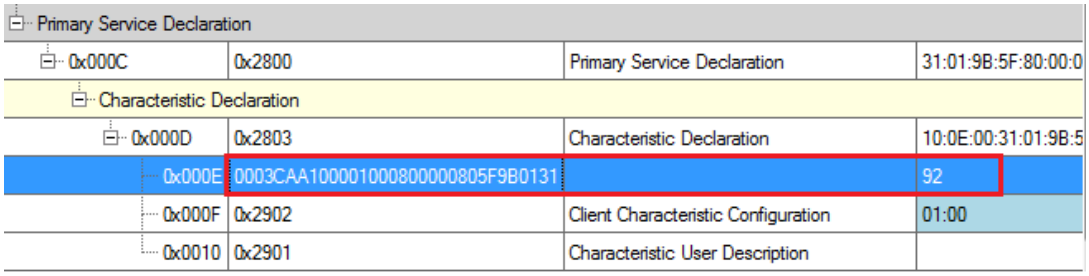
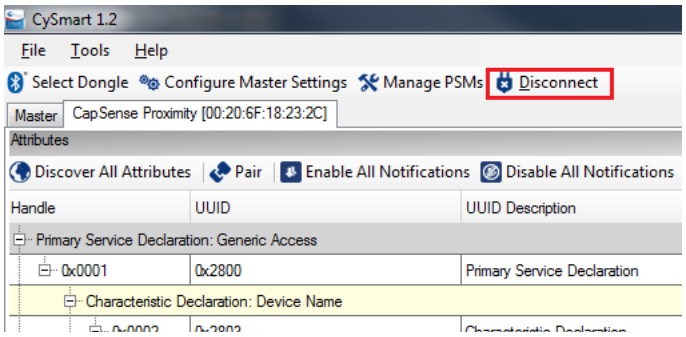


Figure 4-41. CapSense Proximity Notification Received



14. Modify the **Value** field of the Client Characteristic Configuration descriptor to '00:00' to disable notifications.
15. To disconnect from the device, click **Disconnect**, as shown in Figure 4-42.

Figure 4-42. Disconnect from the Device



16. Press user button (**SW2**) to wake up from sleep and restart the advertisement for the next connection.

4.3.4.2 *CySmart Mobile Application*

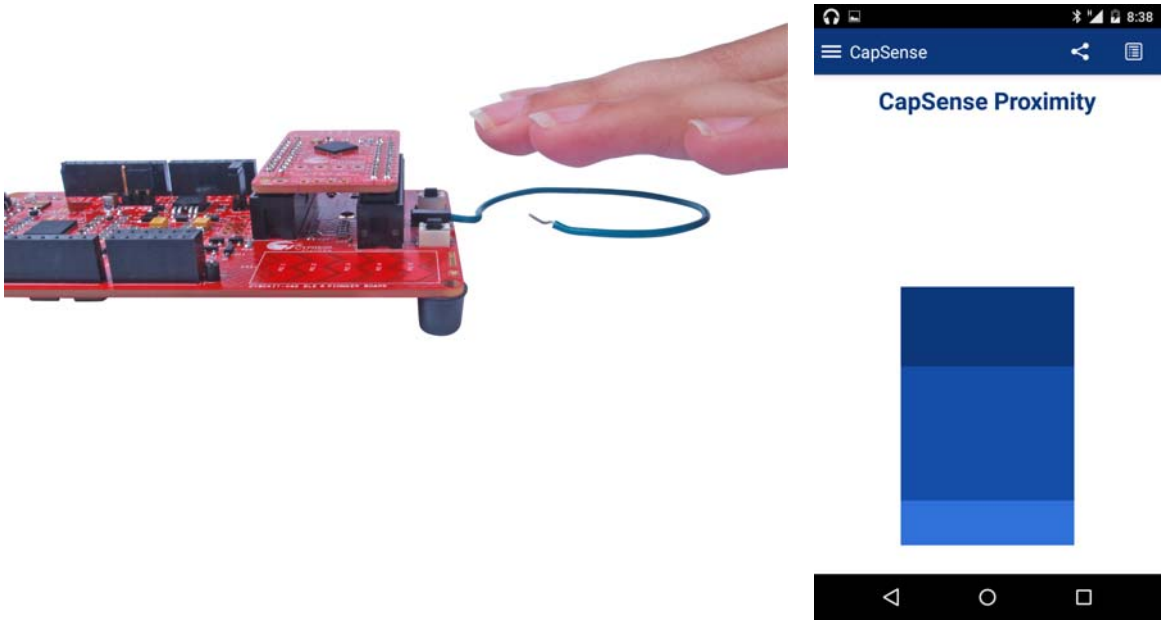
To verify the CapSense Proximity code example using the CySmart mobile application (refer CySmart Mobile App webpage), follow these steps:

1. Place the module on BLE Pioneer Baseboard.
2. Connect the five-inch wire as a loop to the proximity connector J14 on the baseboard.
3. Plug the BLE Pioneer Kit into the computer, using the USB connector J13.
4. Program the kit with the *PSoC_4_BLE_CapSense_Proximity* code example. Follow steps in Using Code Examples on page 37 to program the device.
5. Press the user button (**SW2**) on the BLE Pioneer Kit to start the advertisement.
6. Open the CySmart mobile application on the mobile device. If Bluetooth is not enabled on the device, the app will ask to enable it.
7. The app will automatically search for available peripherals and list them. Select the **CapSense Proximity** peripheral, as shown in Figure 4-43.

Figure 4-43. Connect to CapSense Proximity Peripheral

8. When connected, the app will list the services supported by the peripherals. Scroll and select the **CapSense Proximity** service.
9. When the CapSense service page opens, bring your hand near the sensor wire on the BLE Pioneer Kit; the proximity level is represented in the app as a bar graph, as shown in Figure 4-44. The darker shade in the graph indicates closer proximity. The app beeps when the graph fills up by 50 percent. Refer to CySmart iOS App User Guide for details.

Figure 4-44. CapSense Proximity Sensing with PSoC 4 BLE Module



10. To disconnect from the BLE Pioneer Kit, return to the device selection screen on the CySmart mobile application.
11. To reconnect to the Peripheral, press the user button (**SW2**) on the BLE Pioneer Kit to restart the advertisement and scan for the device in the CySmart mobile application.

4.4 BLE Central Mode

4.4.1 Project Description

The BLE code examples described above have been functioning as Peripheral devices. This means that the firmware role was set to be a Peripheral and GATT server; another device such as the CySmart Central Emulation Tool or CySmart mobile application will connect to it and collect the data.

This code example demonstrates the Central and GATT client mode where it will scan for a Peripheral device, connect to it, and send commands. In this code example, the BLE Pioneer Kit scans and auto-connects to a particular Peripheral device supporting **Immediate Alert Service (IAS)**. Whenever the Peripheral with a predetermined public address is found, a connection request is sent followed by discovering the attributes. When the discovery is over, you can send one of the three alert levels to the Peripheral device over the IAS. This is done by pressing the **SW2** button on the BLE Pioneer Kit and cycling through the alert levels.

The BLE Central code example supports low-power mode operation, where the firmware supports BLE Hardware block and CPU Deep Sleep mode whenever possible. The system remains in Deep Sleep when disconnected. Press **SW2** to wake up the system and start scanning (blinking blue LED). The scanning timeout interval is set to 30 seconds. If a particular Peripheral device is found

advertising before timeout, a connection is made (blue LED always ON). If no such device is found, then the system stops scanning and returns to Deep Sleep mode (LED OFF). Press **SW2** again to wake the system and restart scanning.

To aid in evaluation, the Peripheral code example with the particular public address is provided in the same workspace. This Peripheral code example supports IAS and has fixed public address that the Central device will recognize and auto-connect to. The code example should be programmed on the BLE Dongle and powered through the USB port of the computer. The received alert levels (No, Mid, and High alert) on the BLE Dongle are represented by different LED status. No Alert is represented by LED OFF, Mid Alert by blinking LED, and High Alert with LED always ON. Upon each successive button press on the BLE Pioneer Kit, the LED state on the BLE Dongle changes in a circular fashion.

Additionally, the *BLE_Dongle_Peripheral_IAS* code example is to be programmed on the BLE Dongle. This code example is present in the *PSoC_4_BLE_Central_IAS* workspace and can be used to program the BLE Dongle separately.

Note: If the BLE Dongle is programmed with the *BLE_Dongle_Peripheral_IAS* example, it will not work with the CySmart PC utility. Reprogram the BLE Dongle with the CySmart firmware according to Updating BLE Dongle for CySmart Central Emulation Tool on page 32 to use the CySmart Central Emulation Tool.

Figure 4-45. PSoC_4_BLE_Central_IAS TopDesign

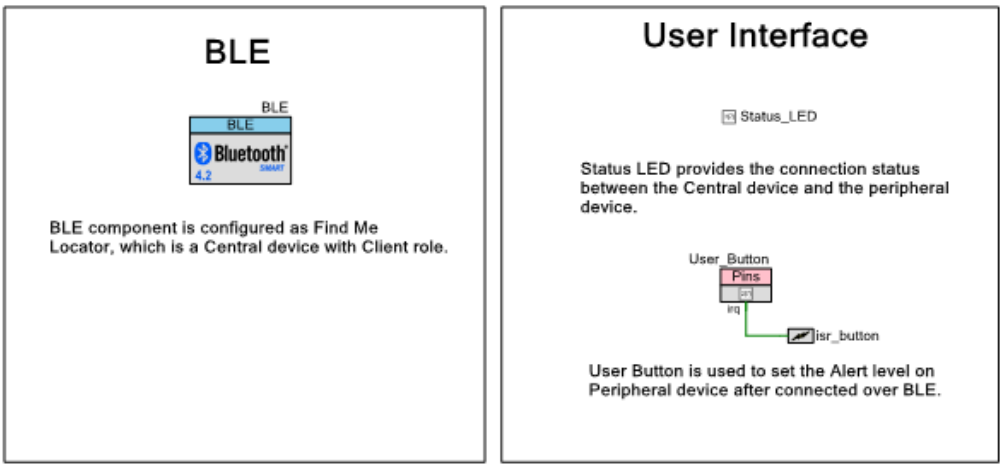
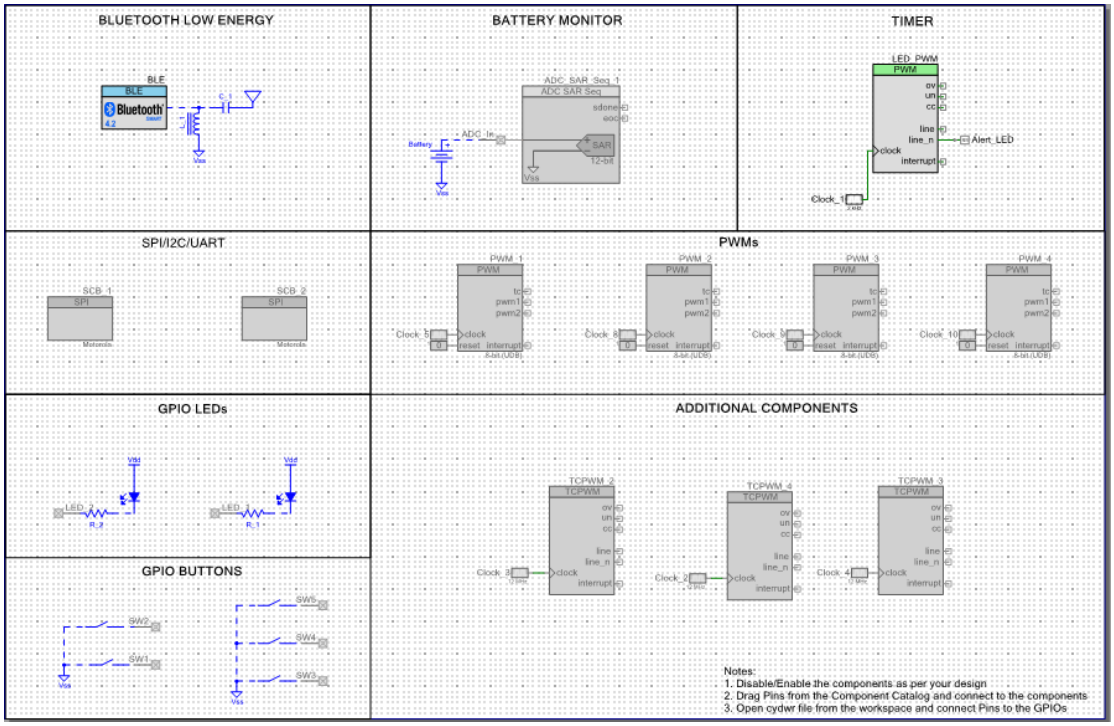


Figure 4-46. BLE_Dongle_Peripheral_IAS TopDesign



4.4.2 Hardware Connections

No specific hardware connections are required for this code example because all connections are hardwired on the BLE Pioneer Baseboard.

Ensure that the PSoC 4 BLE Module is placed on the BLE Pioneer Baseboard. *BLE_Dongle_Peripheral_IAS* is part of the *PSoC_4_BLE_Central_IAS* workspace and programs the BLE Dongle with Peripheral mode firmware.

The pin assignment for this code example is in *PSoC_4_BLE_Central_IAS.cydwr* in the Workspace Explorer, as shown in Figure 4-47.

Figure 4-47. Pin Selection for BLE IAS Central Code Example

Name	Port	Pin	Lock
Status_LED	P3[7]	54	☑
User_Button	P2[7]	44	☑

Similarly, the pin assignment for the BLE Dongle Peripheral code example is in *BLE_Dongle_Peripheral_IAS.cydwr* in the Workspace Explorer as shown in Figure 4-48.

Figure 4-48. Pin Selection for BLE IAS Peripheral Code Example

Name	Port	Pin	Lock
Alert_LED	P3[3]	50	☑

4.4.3 Flow Chart

Figure 4-49 shows the flow chart for the IAS GATT client mode code example.

Figure 4-49. IAS GATT Client Mode Flow Chart

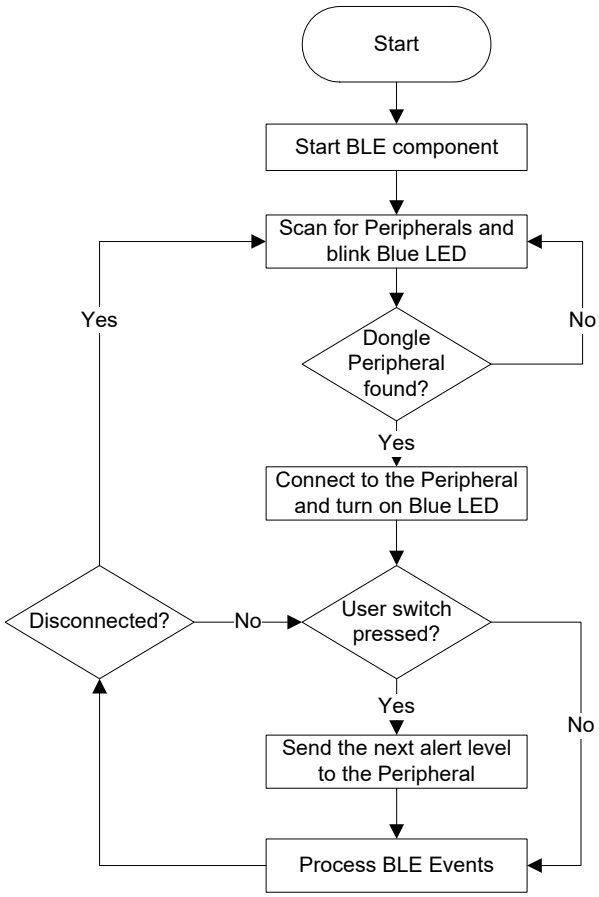
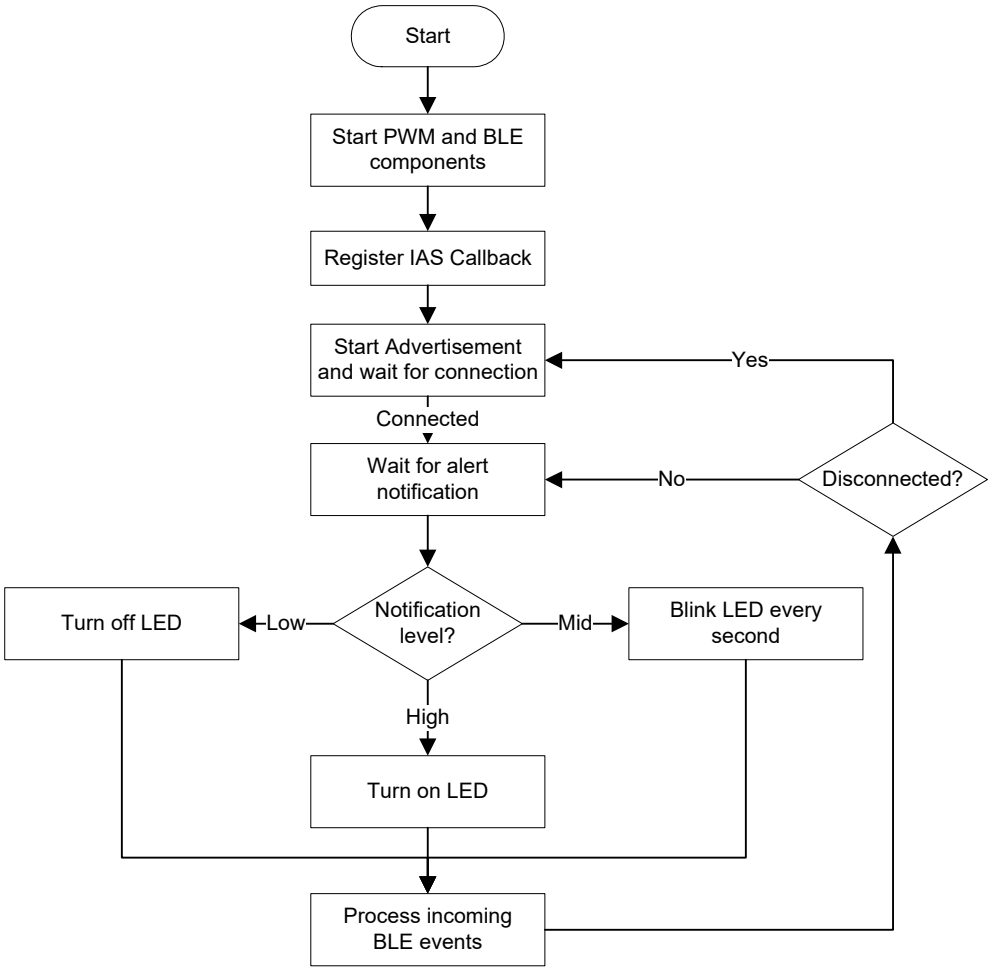


Figure 4-50 shows the flow chart for the IAS GATT server mode code example.

Figure 4-50. IAS GATT Server Mode Flow Chart



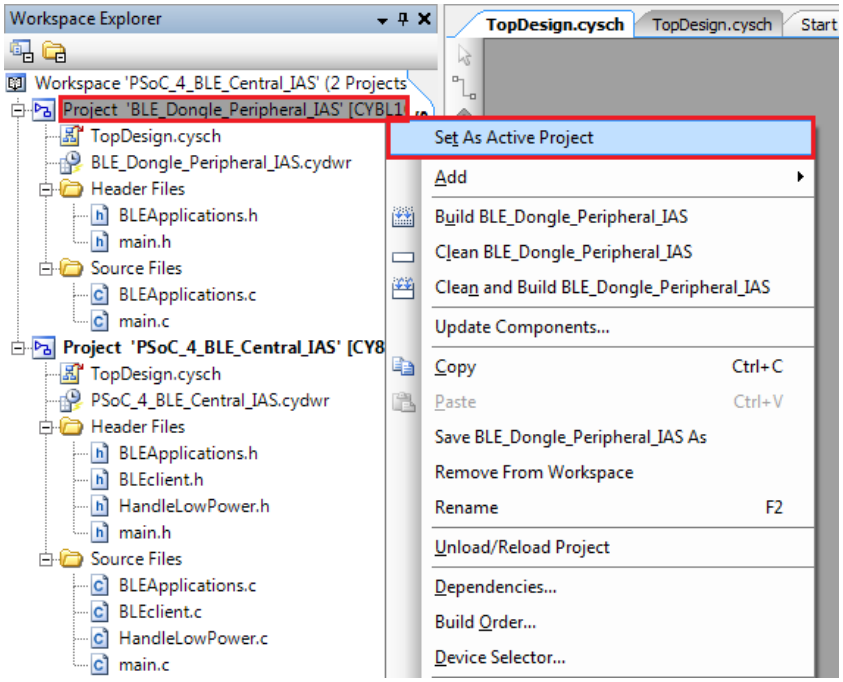
4.4.4 Verify Output

1. Connect the BLE Dongle to one of the USB ports on the computer.

Figure 4-51. Connect BLE Dongle to USB Port

2. In the PSoC Creator Workspace Explorer, right-click the *BLE_Dongle_Peripheral_IAS* code example and select **Set As Active Project**, as shown in Figure 4-52.

Figure 4-52. Set Dongle Peripheral Project as Active

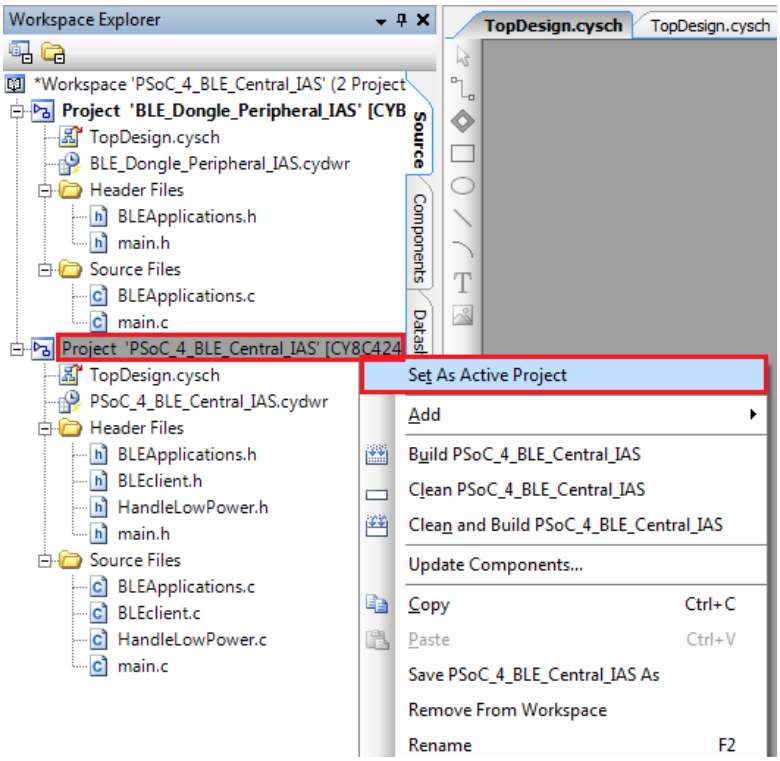


3. Program the BLE Dongle with the *BLE_Dongle_Peripheral_IAS* code example described in Using Code Examples on page 37.

   Note: Do not update the public device address (inside the BLE Component) for the *BLE_Dongle_Peripheral_IAS* code example. Changing the *BLE_Dongle_Peripheral_IAS* code example public address will lead to no connection with the BLE Central device on the BLE Pioneer kit.

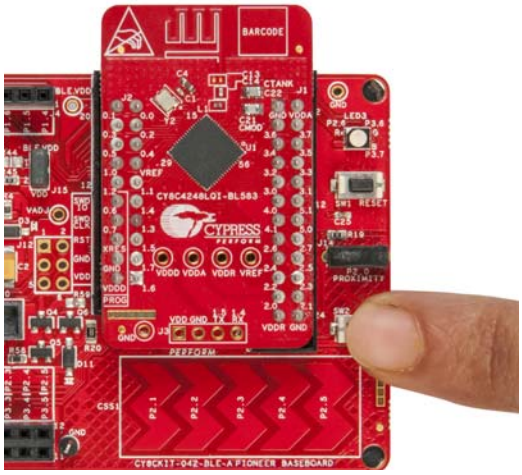
4. Power the BLE Pioneer Kit through USB connector **J13**.
5. In the Workspace Explorer, right-click the *PSoC_4_BLE_Central_IAS* code example and select **Set As Active Project**, as shown in Figure 4-53.

Figure 4-53. Set Central IAS Code Example as Active



6. Program the BLE Pioneer Kit with the *PSoC_4_BLE_Central_IAS* code example.
7. Press the **SW2** button on the BLE Pioneer Kit to wake the system and start scanning. Scanning is indicated by a blinking LED.
8. Wait for the BLE connection between the BLE Dongle and the BLE Pioneer Kit. The connection success status is indicated on the baseboard in the following three stages:
   a. Fast blinking blue LED represents scanning mode. During this mode, the BLE Pioneer Kit is scanning for Peripheral devices.
   b. Slow blinking blue LED represents discovery mode. During this mode, the BLE Pioneer Kit has found the BLE Dongle Peripheral device and has started the connection procedure.
   c. The blue LED remains on, representing the connected mode. This mode indicates that the Peripheral device is connected and the application can now send alert levels.
9. Press the **SW2** button on the BLE Pioneer Kit to send the next alert level to the BLE Dongle. The alert level will rotate from No Alert to Mid Alert to High Alert.

Figure 4-54. User Button (SW2) on BLE Pioneer Kit with PSoC 4 BLE Module



10. Check if the LED behavior changes for each alert notification on the BLE Dongle according to the following table:

Alert Level	LED State
No Alert	LED Off
Mild Alert	LED Blinking
High Alert	LED On

Note: To revert the CySmart functionality to the dongle, program the dongle hex file, as described in Updating BLE Dongle for CySmart Central Emulation Tool on page 32.

4.5 Eddystone

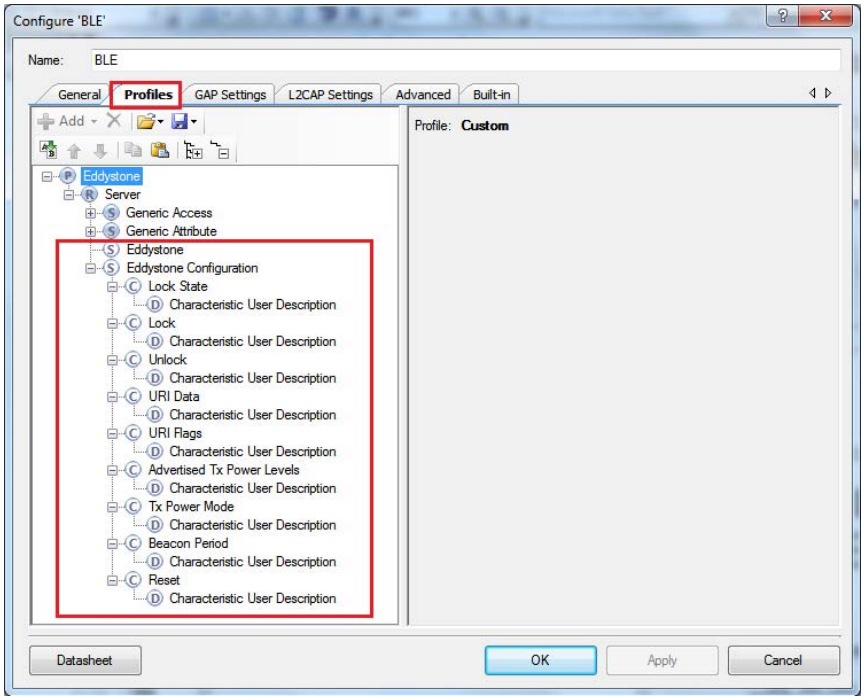
4.5.1 Project Description

This code example demonstrates a BLE beacon based on Google's Eddystone™ protocol on the BLE Pioneer Kit. A beacon is a wireless device that broadcasts data (such as temperature) over a periodic radio signal from a known location. BLE-based beacons use the BLE advertisement packets to broadcast data. This code example demonstrates the following:

- Beacon (non-connectable advertisement)
- Beacon configuration (connectable advertisement)

Google's Eddystone is a protocol that defines BLE advertisement data formats for beacons. In Eddystone parlance, the advertisement data is called a frame and the advertisement data format is called a frame type. The protocol supports multiple frame types that may be used individually or in combinations to create beacons for a variety of applications.

Figure 4-55. Characteristic Configuration in BLE Component for Eddystone Beacon



The BLE profile in this code example consists of two BLE custom services, **Eddystone** and **Eddystone Configuration** (see Figure 4-55). The code example broadcasts one of the following beacon frames in a non-connectable advertisement packet.

- **Eddystone-UID** frame broadcasts a unique 16-byte Beacon ID composed of a 10-byte namespace and a 6-byte instance. The Beacon ID may be useful in mapping a device to a record in external storage. The namespace portion of the ID may be used to group a particular set of beacons, while the instance ID identifies individual devices in the group. The division of the ID into namespace and instance components may also be used to optimize BLE scanning strategies, for example, by filtering only on the namespace. More details are available here.
- **Eddystone-URL** frame broadcasts a URL using a compressed encoding format to fit more within the limited advertisement packet. More details are available here.
- **Eddystone-TLM** frame broadcasts telemetry information about the beacon itself such as battery voltage, device temperature, and counts of broadcast packets. More details are available here.

The Eddystone Configuration Service consists of nine characteristics as follows.

- **Lock State** – Read returns true if the device is locked.
- **Lock** – Locks the beacon and sets the single-use lock-code.
- **Unlock** – Unlocks the beacon and clears the single-use lock-code.
- **URI Data** – Reads/writes the URI.
- **URI Flags** – Reads/writes the flags.
- **Advertised Tx Power Levels** – Reads/writes the Advertised Power Levels array.
- **Tx Power Mode** – Reads/writes the TX Power Mode.
- **Beacon Period** – The period in milliseconds that an Eddystone-URL packet is transmitted.
- **Reset** – Resets to default values.

More details on the Eddystone Configuration service can be found here.

The code example consists of the following files:

- **main.c/.h**

  These files contain the main function, which is the entry point and execution of the firmware application. They contain function definitions for initialization and handling low power mode of the system. By default on power-on-reset, the system will do a non-connectable advertisement of URL/URI and TLM packets. When the **SW2** button is pressed, the device will enter connectable mode and various characteristics can be configured.

- **Eddystone.c/.h**

  These files contain the functions required to implement the Eddystone protocol including advertisement packet creation (for UID/URL and TLM), advertisement scheduling, and configuration read/write. The battery and temperature data are also updated before the TLM packets are constructed and advertised.

- **WatchdogTimer.c/.h**

  These files contain functions that provide necessary timing for the operation of the system.

- **Battery.c/.h**

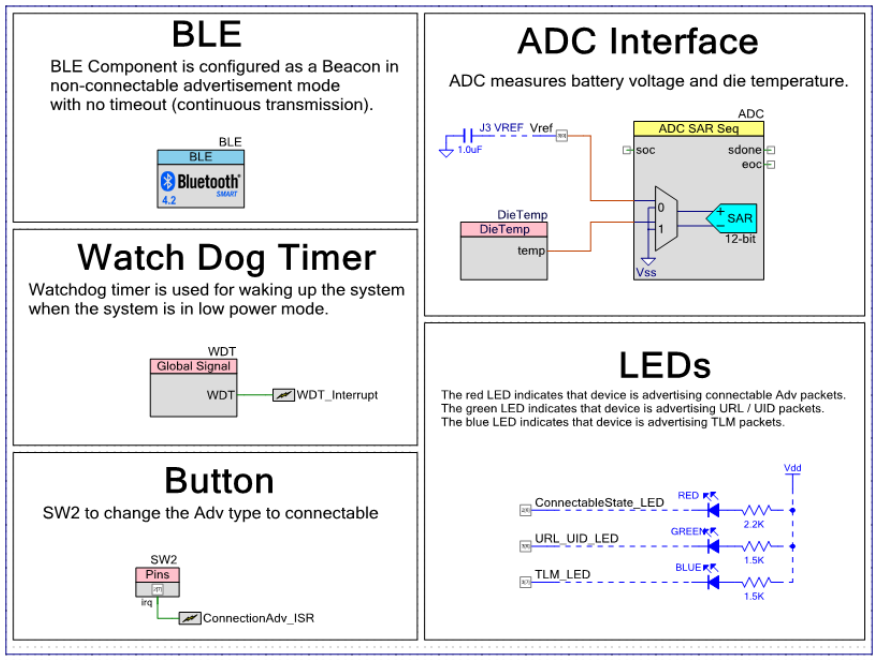
  These files contain a function that will measure the battery voltage of the kit. This information is advertised as part of the TLM packets.

- **Temperature.c/.h**

  These files contain a function that will measure the die temperature of the PSoC 4 BLE device. An external sensor may be attached to measure ambient temperature. This information is advertised as part of the TLM packets.

The green LED indicates UID/URL packet transmissions, the blue LED indicates TLM packet transmissions, and the red LED indicates that the device is in connectable mode. In this mode, when connected, the beacon configuration can be modified.

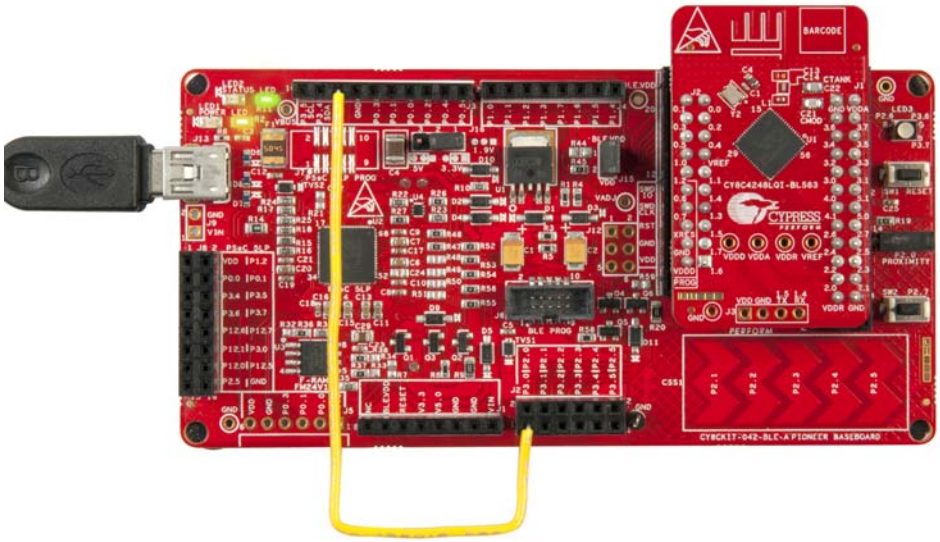
Figure 4-56. Top Design for PSoC_4_BLE_Eddystone Code Example



4.5.2 Hardware Connection

- Ensure that the PSoC 4 BLE Module is placed on the baseboard.
- Connect a wire (provided as part of this kit) between VREF (connector J3) and P3.0 (connector J2) on the baseboard (see Figure 4-57).

Figure 4-57. VREF (J3) and P3.0 (J2) Connectors on BLE Pioneer Kit with PSoC 4 BLE Module



The pin assignment for this code example is in *PSoC_4_BLE_Eddystone.cydwr* in the Workspace Explorer, as shown in Figure 4-58.

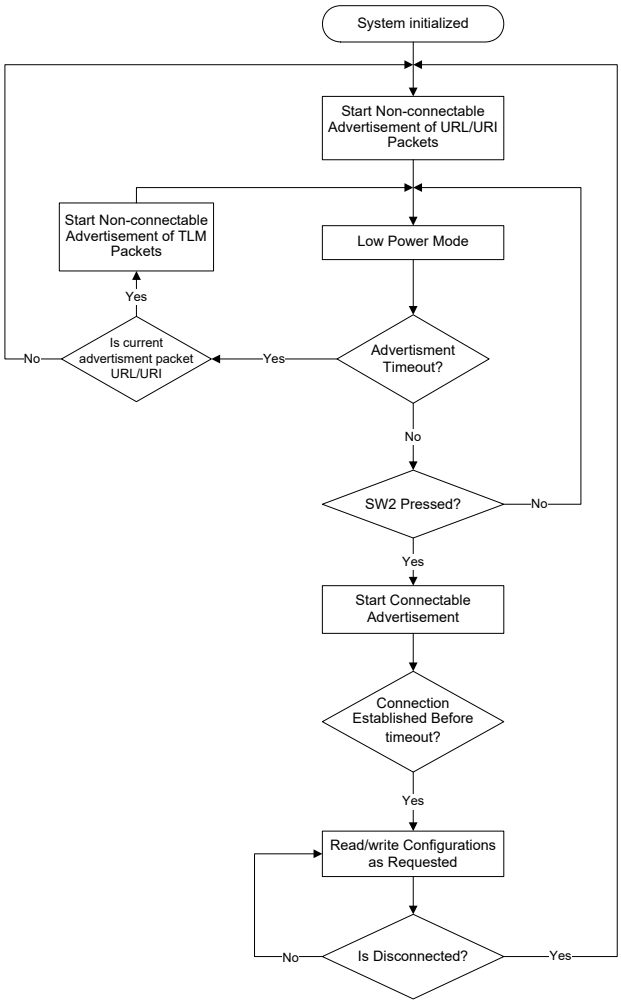
Figure 4-58. Pin Selection for Eddystone Code Example

	Name	Port	Pin	Lock
	ConnectableState_LED	P2[6]	43	☑
	SW2	P2[7]	44	☑
	TLM_LED	P3[7]	54	☑
	URL_UID_LED	P3[6]	53	☑
	Vref	P3[0]	47	☑

4.5.3 Flow Chart

Figure 4-59 shows the flow chart of code implemented.

Figure 4-59. Eddystone Code Example Flow Chart



4.5.4 Verify Output

The code example can be verified using an Android smart phone. Before proceeding further make sure that a beacon application (such as Locate Beacon) and the CySmart app are installed on the smart phone/device. Also make sure that Bluetooth is turned on in the device, and you have a working internet connection.

To verify the Eddystone code example in Android devices using the Locate Beacon application, follow these steps.

1. Place the PSoC 4 BLE Module on the BLE Pioneer Kit.
2. Power the BLE Pioneer Kit through the USB connector J13.
3. Program the BLE Pioneer Kit with the *PSoC_4_BLE_Eddystone* code example. Follow steps in Using Code Examples on page 37 to program the device.
4. After programming successfully, the firmware starts the non-connectable advertisement of UID/URL and TLM packets. Advertisement of UID/URL packets is indicated by the green LED and TLM packets is indicated by blue LED on the baseboard.

5. Launch the **Locate** application on the smart phone/device.
6. Click the **Locate Beacons** button to start scanning for beacons (see Figure 4-60).

Figure 4-60. Locate Beacon App Home Screen

7. In the next screen a list of **Visible Beacons** will be displayed. Click the desired beacon (see Figure 4-61) to display its status and information (see Figure 4-62).

Figure 4-61. Locate Beacon App Showing Discovered Beacons

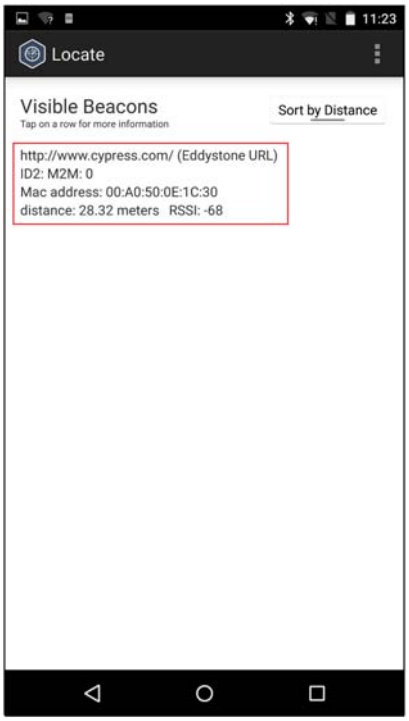


Figure 4-62. Locate Beacon Showing Details about Selected Beacon

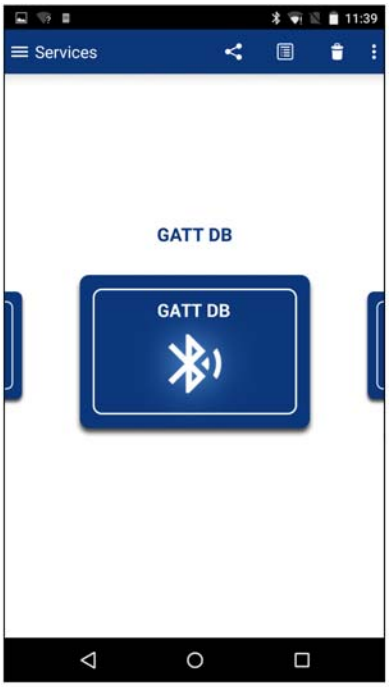
To read and write characteristics (using an Android or iOS device, and CySmart app) of the beacon follow these steps:

1. Press **SW2** on the BLE Pioneer Kit baseboard to start the connectable advertisement. The advertisement state is indicated by the red LED.
2. Launch the CySmart app on your Android smart phone/device.
3. Connect to the **CY Eddystone** device from the list by clicking on it (see Figure 4-63).

Figure 4-63. CySmart App Showing the CY Eddystone Beacon

4. Click the **GATT DB** menu option (see Figure 4-64).

Figure 4-64. CySmart Showing GATT DB Option for CY Eddystone Device



5. Click on **Unknown Service** (see Figure 4-65) to see all available characteristics.

Figure 4-65. CySmart Showing Unknown Service in GATT DB

6. Click any of the characteristics to read and modify it. For reference on Eddystone Configuration characteristics, see the Google Eddystone page. To understand more about the CySmart app, see the CySmart user guide.
7. Disconnect from the device to go back to the beacon mode.

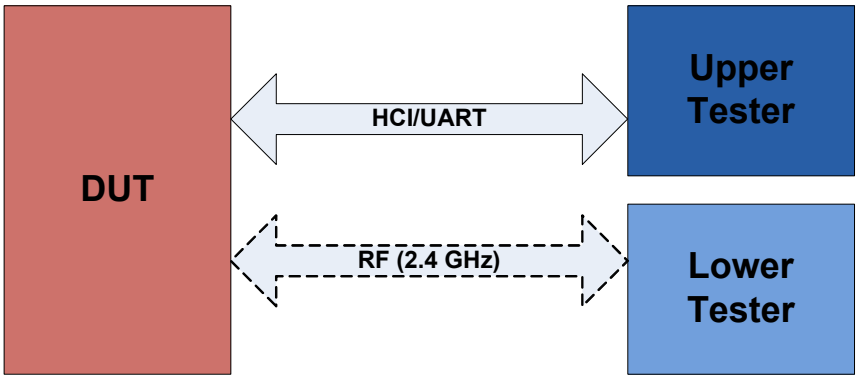
4.6 Direct Test Mode (DTM)

4.6.1 Project Description

Bluetooth Core specification (v4.0 and later), Volume 6, Part F defines Direct Test Mode (DTM) as a method to test the BLE PHY layer and provide a report back to the tester. It uses a **Host Controller Interface (HCI)** with a **two-wire UART** as the communication protocol.

The Device Under Test (DUT) is the BLE system that is to be tested (for example, BLE Pioneer Kit). With DTM, the RF performance of the BLE system can be verified during development or on a production line. The environment consists of the DUT and a tester. The tester has two parts; the **upper tester** sends commands through the HCI and the **lower tester** performs the corresponding action over the RF link. The tester compares the command sent over the HCI and the response received over RF, and provides a result of the performance.

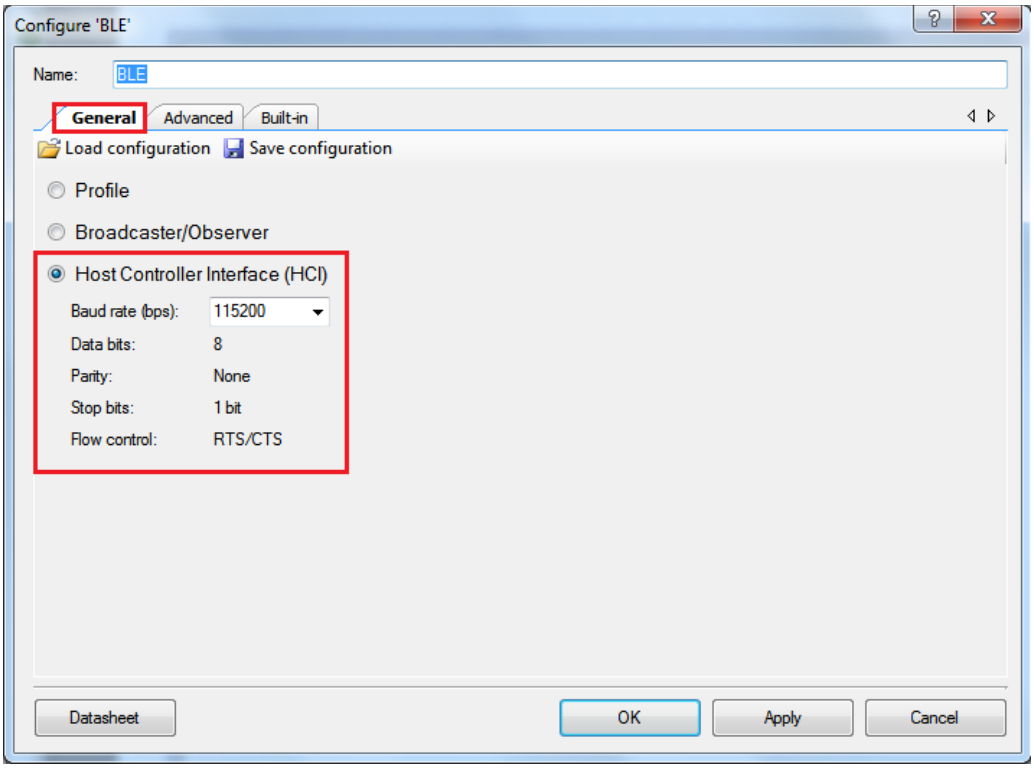
Figure 4-66. Direct Test Mode (DTM) Setup



The BLE Component allows configuring the device in DTM by enabling the HCI. The appropriate responses to commands from the tester are performed by the BLE protocol stack and does not involve separate application handling. The only tasks required are to start the BLE Component and call the API to process the events.

The HCI is enabled in the BLE Component under the General settings. Note that when the HCI mode is selected, all other tabs are hidden and cannot be configured. This is because in HCI mode, there are no upper layer processes. On enabling HCI mode, the component automatically reserves a UART block to allow communication between the tester and BLE stack. The UART exposes the pins that can be assigned in *<project.cydwr>* file under the **Pins** tab. The only options to be configured for HCI mode are the baud rate and the pins for communication with the tester.

Figure 4-67. HCI Mode in BLE Component

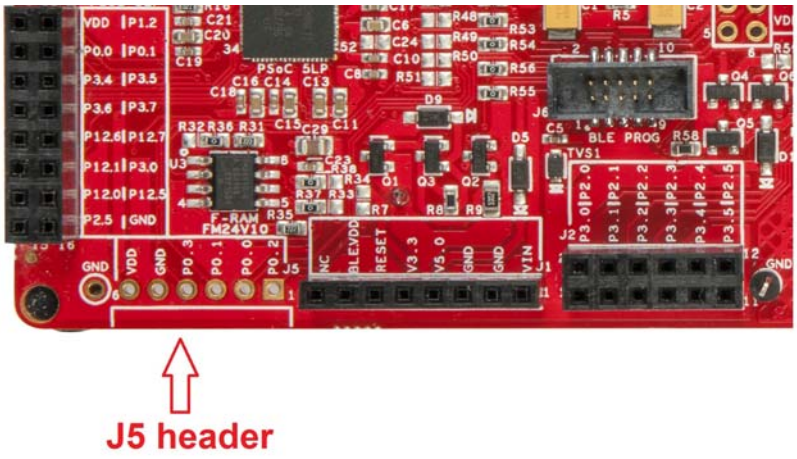


Many companies develop BLE testers for Direct Test Mode. It is also possible to create PC-based software tools that will send HCI commands over serial communication links.

For PC-based software, the serial communication link is the COM port, which is enumerated by the KitProg on the PSoC 5LP of the BLE Pioneer kit. In such a case, the UART pins on the PSoC 4 BLE should be assigned to P1_4 and P1_5. These pins are hardwired to pins on the PSoC 5LP which allows USB-UART data communication between the PC-based software and the BLE device.

For external BLE testers, the serial communication is mostly over RS232. To test with that type of system, an external RS232 voltage translator is required, such as Digilent's PmodRS232. This translator will modify the signal levels of the serial communication between the BLE device and the RS232 port on the tester. The UART pins of the BLE device can be assigned to P0_0 and P0_1 and header J5 can be used to connect to the RS232 translator.

Figure 4-68. J5 Header to Interface RS232 Translator



4.6.2 Hardware Connection

For DTM test mode, it is recommended to use SMA connectors and connect the tester and DUT using an SMA to SMA connector cable. This ensures that there is minimum interference to RF communication between the DUT and tester, and the performance measured is the true RF performance of the device. The BLE Pioneer Kit module with SMA connector (CY8CKIT-141 PSoC 4 BLE) is available separately and can be ordered from the Cypress webpage.

Four UART pins are exposed when HCI mode is selected in the BLE Component. These pins should be assigned to allow communication with the external tester. The connection depends on the tester being used.

If the tester is PC-based software that communicates with HCI over a serial link, then the onboard PSoC 5LP on the BLE Pioneer Kit can act as the USB-UART bridge. The KitProg on the PSoC 5LP enumerates as a USB-UART interface and opens a COM port on the computer. This COM port is then used by the software tool to communicate commands to the BLE device. In this case, the UART pins should be assigned as follows.

Table 4-1. UART Pin Assignment for PC Software Tester

UART Pins	Pin Assigned
RX	P1_4
TX	P1_5
RTS	P1_6
CTS	P1_7

The UART for HCI communication exposes hardware flow control lines CTS and RTS. They can either be connected to the hardware control lines of the tester or CTS connected to ground for operation without hardware flow control.

If the tester is an external hardware tester (CBT), then connect any of the RS232 voltage translators to header J5 on the BLE Pioneer Kit. The UART pins should be assigned as follows.

Table 4-2. UART Pin Assignment for RS232 Voltage Translator

UART Pins	Pin Assigned
RX	P0_0
TX	P0_1
RTS	P0_2
CTS	P0_3

4.6.3 Verify Output

1. Connect the BLE Pioneer Kit through the USB connector J13.
2. Program the BLE Pioneer Kit with the *PSoC_4_BLE_DTM* code example, as described in Using Code Examples on page 37. Programming should complete successfully.
3. Connect the serial link, UART, or RS232 to the tester.
4. On the software tool for tester, configure the UART communication with the correct COM port and baud rate, as set in the BLE Component.
5. Start the test. The tool will generate the report after the end of the test. This depends on the tester/tool being used.

5. Hardware

This chapter describes the contents of the BLE Pioneer Kit hardware and its different blocks, such as the power block, USB connection, Arduino-compatible headers, module connectors, and CapSense slider.

The schematic and board layouts are available at the following location: `<Install_Directory>\Cypress\CY8CKIT-042-BLE-A Kit\<version>\Hardware`.

5.1 BLE Pioneer Baseboard

5.1.1 PSoC 5LP

An onboard PSoC 5LP contains the KitProg, which is used to program and debug the BLE device. The PSoC 5LP connects to the USB port of the computer through a USB Mini-B connector and to the SWD interface of the BLE device. PSoC 5LP is a true system-level solution providing MCU, memory, analog, and digital peripheral functions in a single chip. The CY8C58LPxx family offers a modern method of signal acquisition, signal processing, and control with high accuracy, high bandwidth, and high flexibility. The analog capability spans the range from thermocouples (near DC voltages) to ultrasonic signals.

For more information, visit the PSoC 5LP web page.

See Serial Interconnection between KitProg and Module on page 98 for more details.

5.1.2 Power System

The power supply system on the BLE Pioneer Baseboard is versatile, allowing the input supply to come from the following sources:

- 5-V power from the onboard USB connector
- 5-V to 12-V VIN power from the Arduino power header (J1)
- 3-V from the CR2032 coin cell

An adjustable LDO is used to output three different voltage levels (1.9 V, 3.3 V, and 5 V) to power the module. These voltages are selected with the J16 jumper, as shown in Figure 5-1.

Figure 5-1. Schematics and Board Highlight of LDO and Power Selection Jumper

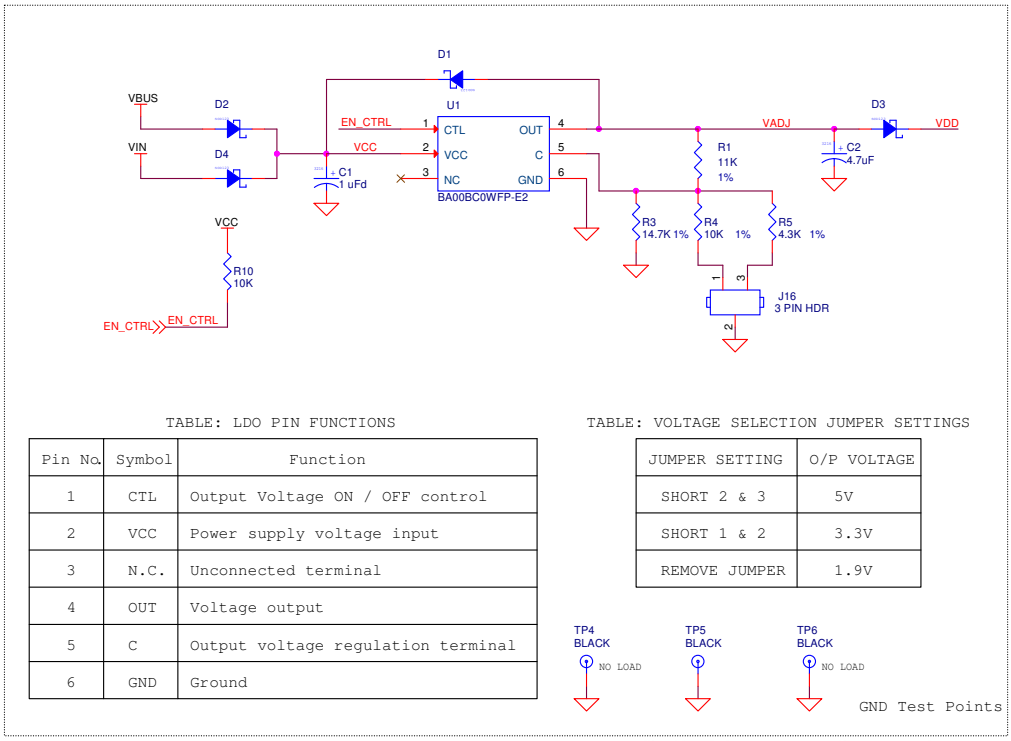
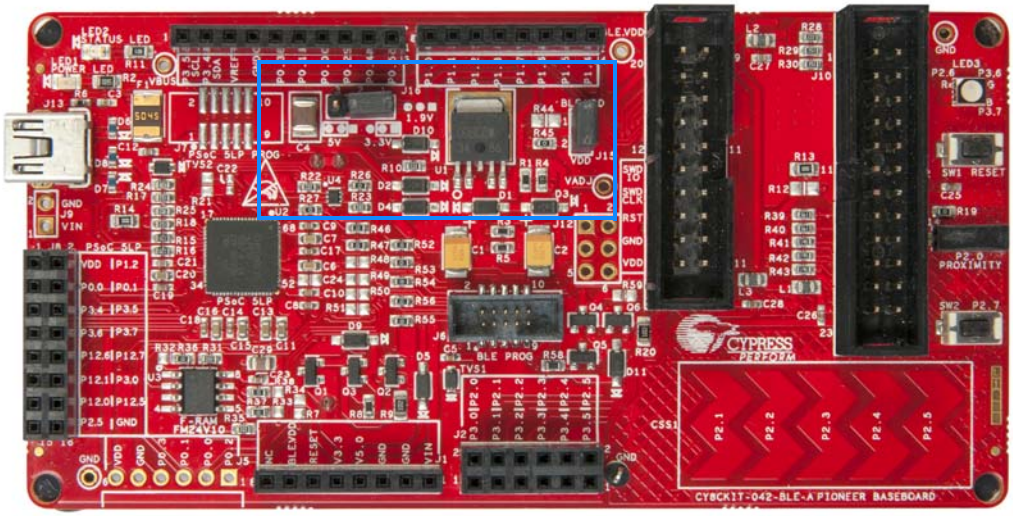


TABLE: LDO PIN FUNCTIONS

Pin No.	Symbol	Function
1	CTL	Output Voltage ON / OFF control
2	VCC	Power supply voltage input
3	N.C.	Unconnected terminal
4	OUT	Voltage output
5	C	Output voltage regulation terminal
6	GND	Ground

TABLE: VOLTAGE SELECTION JUMPER SETTINGS

JUMPER SETTING	O/P VOLTAGE
SHORT 2 & 3	5V
SHORT 1 & 2	3.3V
REMOVE JUMPER	1.9V

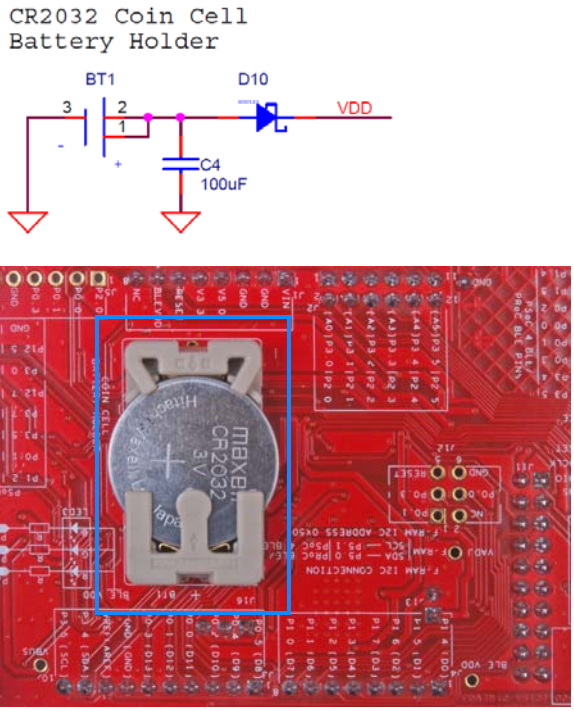


The input to the LDO can come from either the USB, the VIN pin in the Arduino header J1, or header J9.

Note: The typical dropout voltage of the selected LDO is 0.3 V at 500-mA output current. This gives a minimum output of 4.6 V from the input voltage of 5 V from the VBUS. This drop also considers the voltage drop across the Schottky diode connected at the output of the LDO to protect against voltage applied at the output terminal of the regulator. An input voltage supply over 12 V can damage the board.

The BLE Pioneer Baseboard also contains a CR2032 coin cell holder to power it using a coin cell, as shown in Figure 5-2.

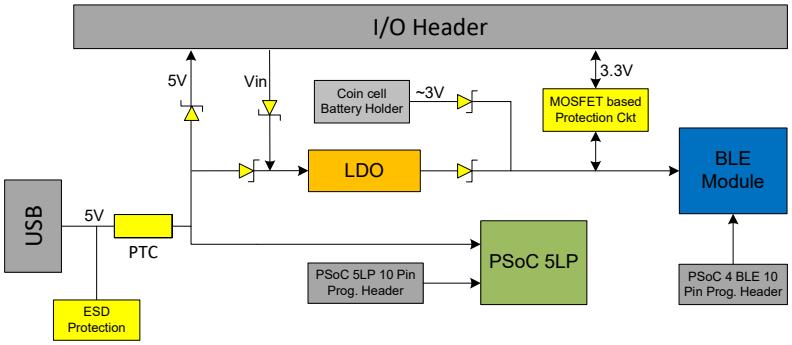
Figure 5-2. Schematics and Board Highlight of Coin Cell Holder



5.1.2.1 *Protection Circuits*

The power supply rail has reverse-voltage, overvoltage, short circuits, and excess current protection features, as shown in Figure 5-3.

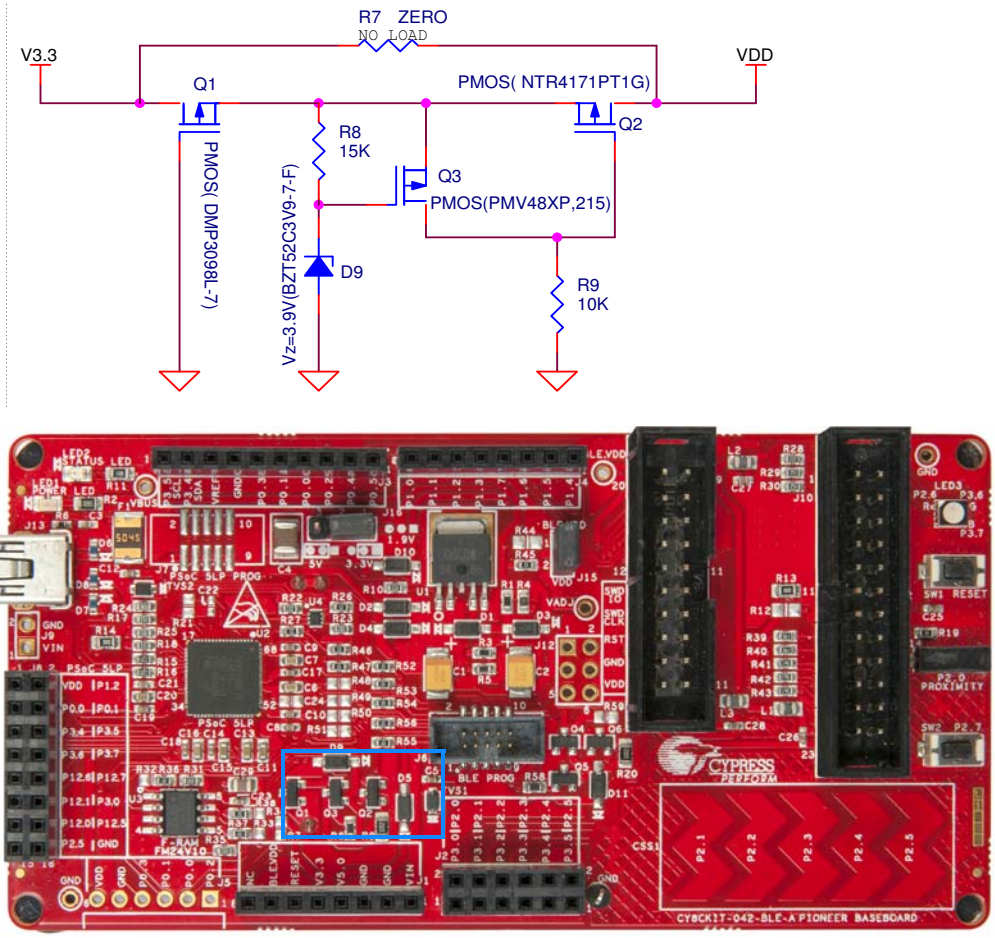
Figure 5-3. Power Supply Block Diagram With Protection Circuits



- A PTC resettable fuse is connected to protect the computer's USB ports from shorts and overcurrent.
- ORing diodes prevent damage to components when the BLE Pioneer Baseboard is powered from different voltage sources at the same time.
- ESD protection is provided for the USB Mini-B connector.

- A MOSFET-based protection circuit is provided for overvoltage and reverse-voltage protection for the 3.3-V rail from J1.5, as shown in Figure 5-4.

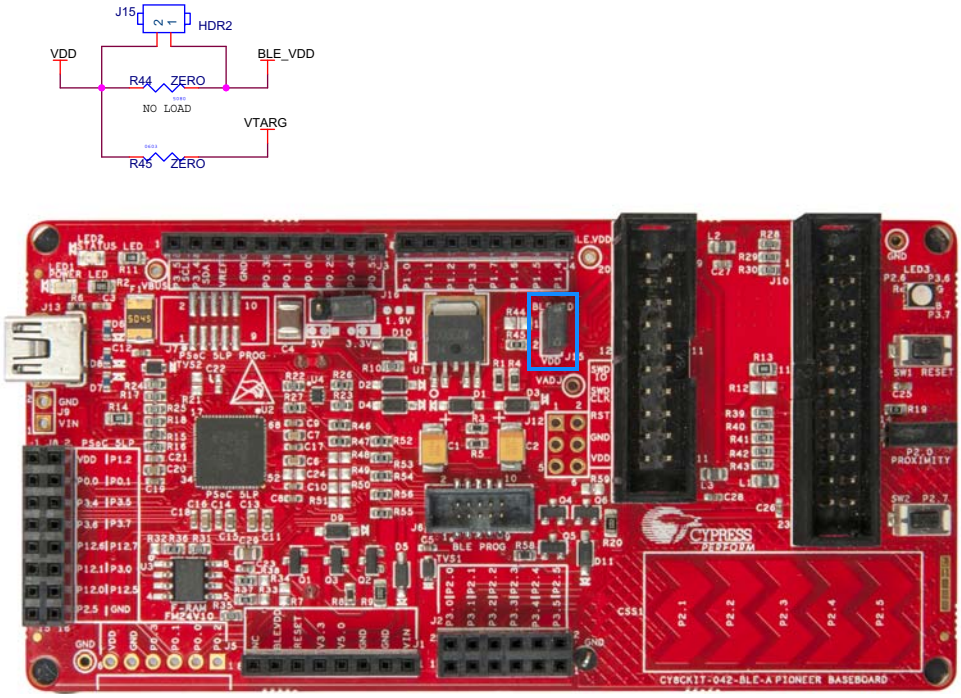
Figure 5-4. Schematics and Board Highlight of MOSFET Protection Circuit for 3.3-V Rail from J1.5



5.1.2.2 *Current Measurement Jumper*

To demonstrate the low power consumption of PSoC 4 BLE Module, a two-pin header (J15) is populated in series with the power supply to the module. This can be used to measure current using an ammeter without the need to desolder any component from the BLE Pioneer Baseboard, as shown in Figure 5-5.

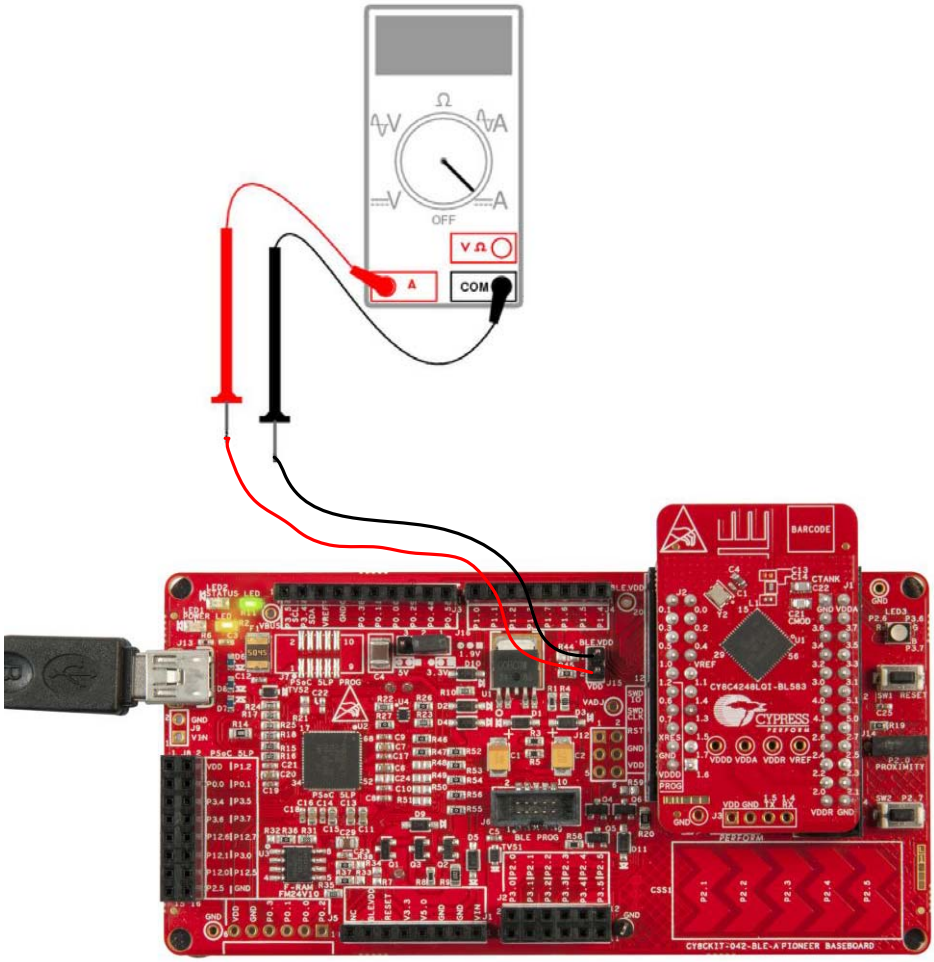
Figure 5-5. Schematics and Board Highlight of Current Measurement Jumper



The following methods are supported for measuring the current consumption of the module.

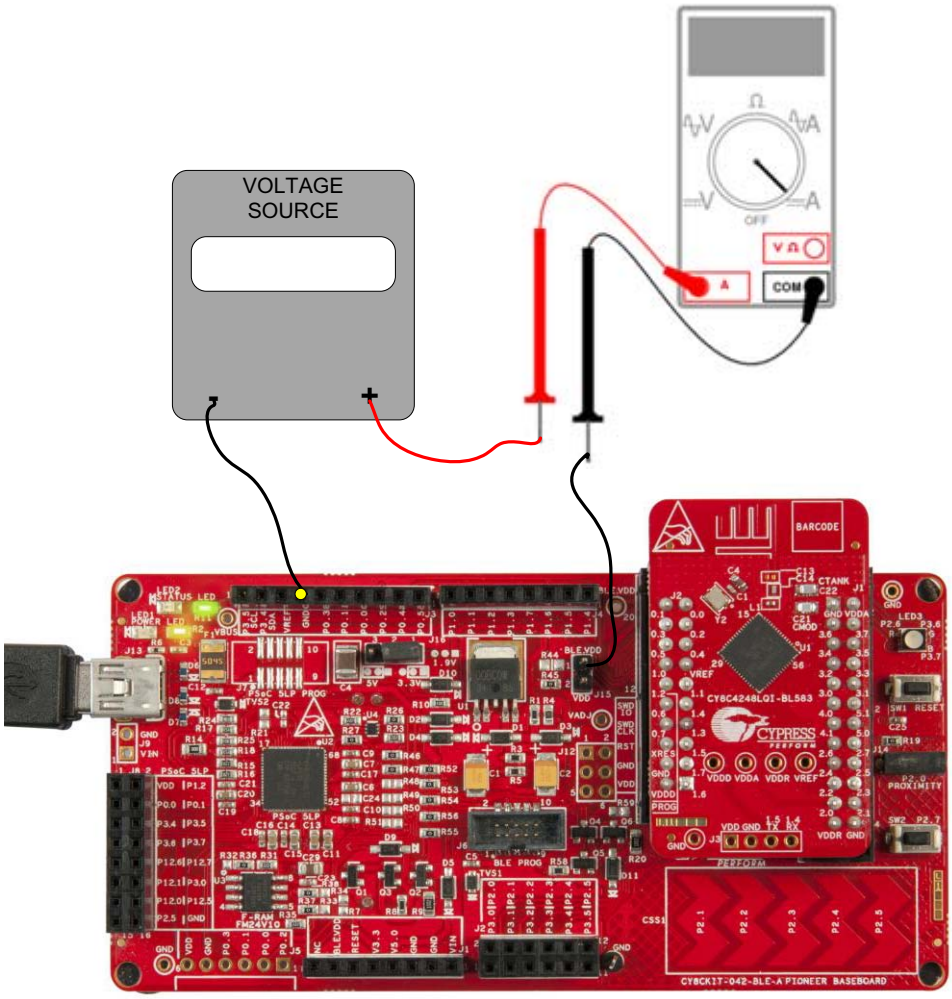
- When the BLE Pioneer Baseboard is powered through the USB port (J13), remove jumper J15 and connect an ammeter, as shown in Figure 5-6.

Figure 5-6. Current Measurement when Powered from USB Port



- When the BLE Pioneer Baseboard is powered from an external voltage supply, remove the USB cable from J13. Connect the positive terminal of the external voltage supply to the positive terminal of the ammeter and the negative terminal of the ammeter to the upper pin of J15. Connect the negative terminal of the external voltage supply to an onboard GND pin. Figure 5-7 shows the required connections.

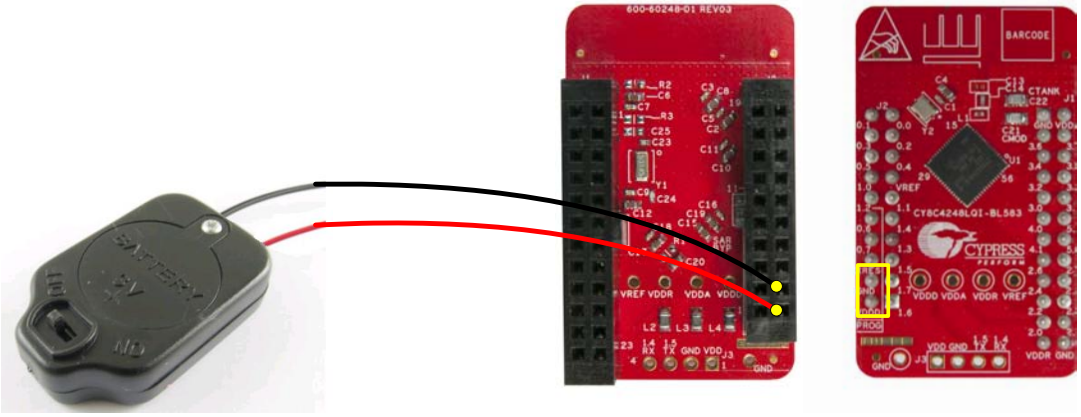
Figure 5-7. Current Measurement when Powered Separately



To measure the power consumption of only the module with coin cell, connect the coin cell directly to the PSoC 4 BLE Module, as shown in Figure 5-8. The BLE Pioneer Baseboard is designed with additional circuits to protect the BLE device and the F-RAM in an Arduino environment. Note that power consumption measurements on the BLE Pioneer Baseboard will also include the power consumed by these additional circuits.

Connect the positive terminal of the coin cell to pin J2.2 and negative terminal to pin J2.4 using wires.

Figure 5-8. Powering the Module using a Coin Cell



5.1.3 Programming Interface

The BLE Pioneer Kit allows you to program and debug the PSoC 4 BLE in two ways:

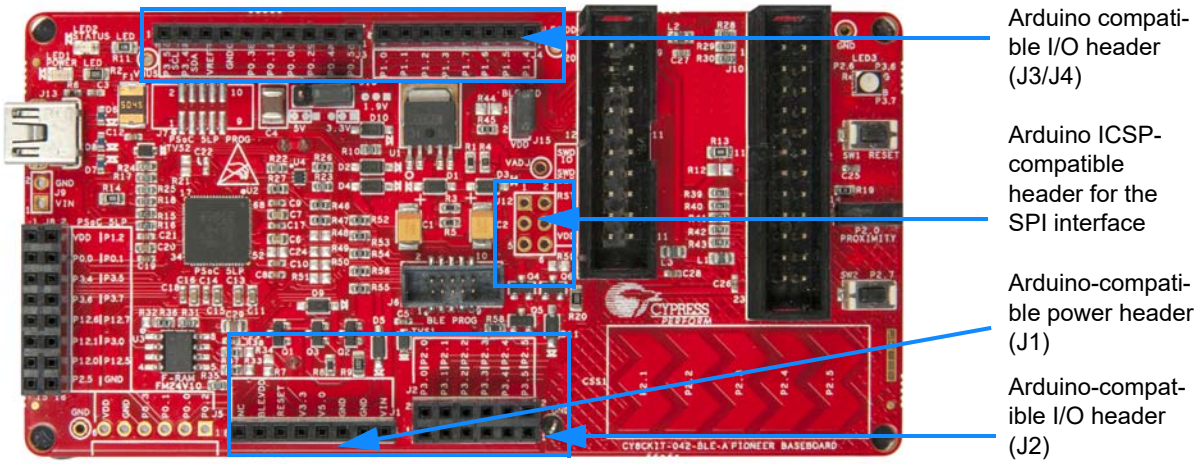
- Using the onboard KitProg
- Using a CY8CKIT-002 MiniProg3 programmer and debugger

5.1.4 Expansion Connectors

5.1.4.1 Arduino-Compatible Headers (J1, J2, J3, J4, and J12-unpopulated)

The BLE Pioneer Kit has five Arduino-compatible headers: J1, J2, J3, J4, and J12, as shown in Figure 5-9. You can develop applications based on the Arduino shield's hardware.

Figure 5-9. Arduino Headers



The J1 header contains I/O pins for reset, I/O reference voltage (IOREF), and power supply line. The J2 header is an analog port that contains I/O pins for SAR ADC, comparator, and opamp. The J3 header is primarily a digital port that contains I/O pins for PWM, I^2C, SPI, and analog reference. The J4 header is also a digital port that contains I/O pins for UART and PWM. The J12 header is an Arduino ICSP-compatible header for the SPI interface and is not populated. Refer to the “No Load Components” section of Bill of Materials (BOM) on page 111 for the header part number.

Note: Take care when powering the Arduino shields via Arduino-compatible power header (J1). The V3.3 pin will output 5 V when the board is powered from USB/VIN and the system power supply jumper (J16) is set to 5 V operation.

Additional Functionality of Header J2

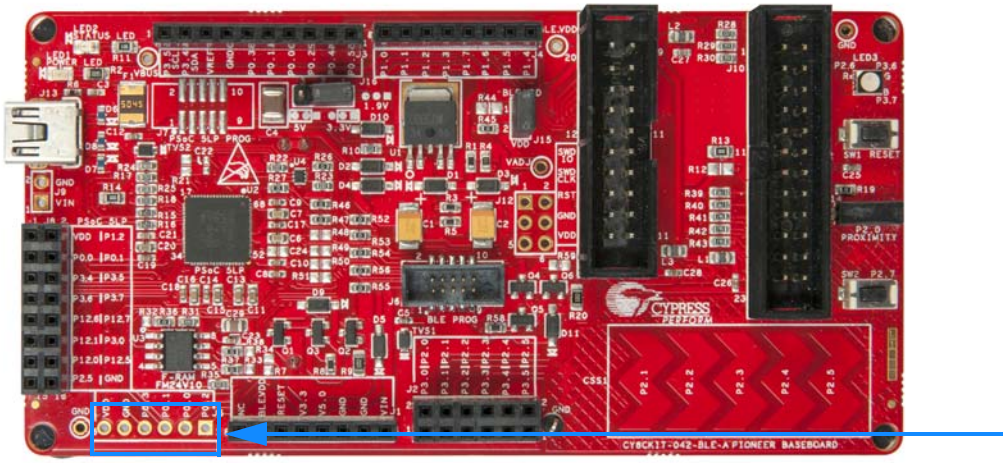
The J2 header is a 6×2 header that supports Arduino shields. The Port 2 and Port 3 pins of PSoC 4 BLE are brought to this header. The Port 2 pins also connect to the onboard CapSense slider through 560-ohm resistors. When the CapSense feature is not used, remove these resistors to help ensure better performance with these pins.

5.1.4.2 *Pmod Connector - Digilent Pmod Compatible (J5-unpopulated)*

This port supports Digilent Pmod modules (see Figure 5-10). Pmods are small I/O interfaces that connect with the embedded control boards through either 6- or 12-pin connectors. The BLE Pioneer Kit supports the 6-pin Pmod Type 2 (SPI) interface. For Digilent Pmod cards, go to www.digilentinc.com.

This header is not populated on the BLE Pioneer Baseboard. You must populate this header before connecting the Pmod daughter cards. Refer to the “No Load Components” section of Bill of Materials (BOM) on page 111 for the header part number.

Figure 5-10. Schematics and Board Highlight of Pmod Connector

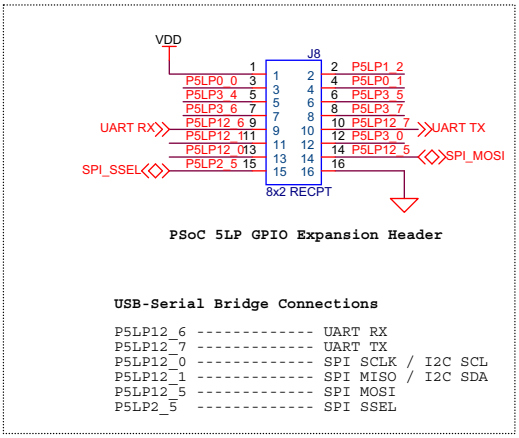


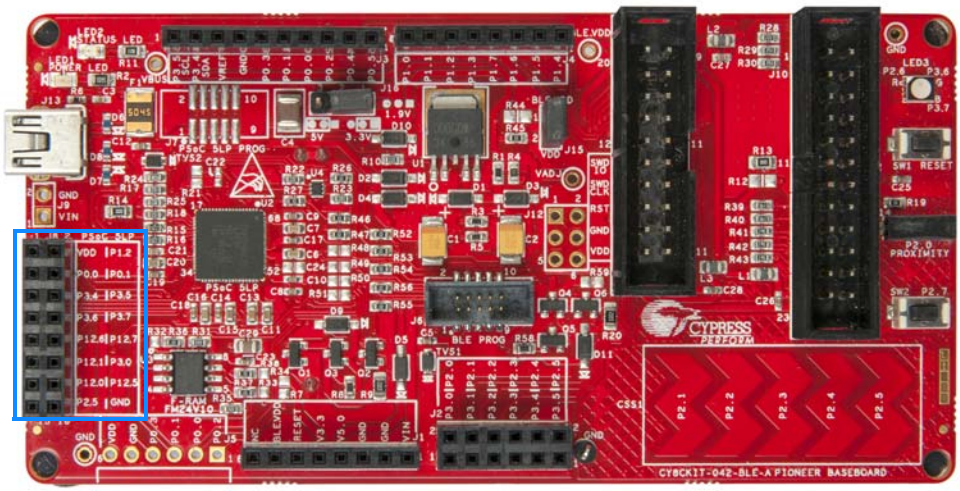
5.1.4.3 PSoC 5LP GPIO Header (J8)

An 8×2 header is provided on the BLE Pioneer Baseboard to pull out several pins of PSoC 5LP to support advanced features such as a low-speed oscilloscope and a low-speed digital logic analyzer (see Figure 5-11). This header also contains the USB-Serial interface pins that can be used when these pins are not accessible on the Arduino headers because a shield is connected.

Note: You can use PSoC 5LP for your own custom firmware.

Figure 5-11. Schematics and Board Highlight of PSoC 5LP GPIO Expansion Header

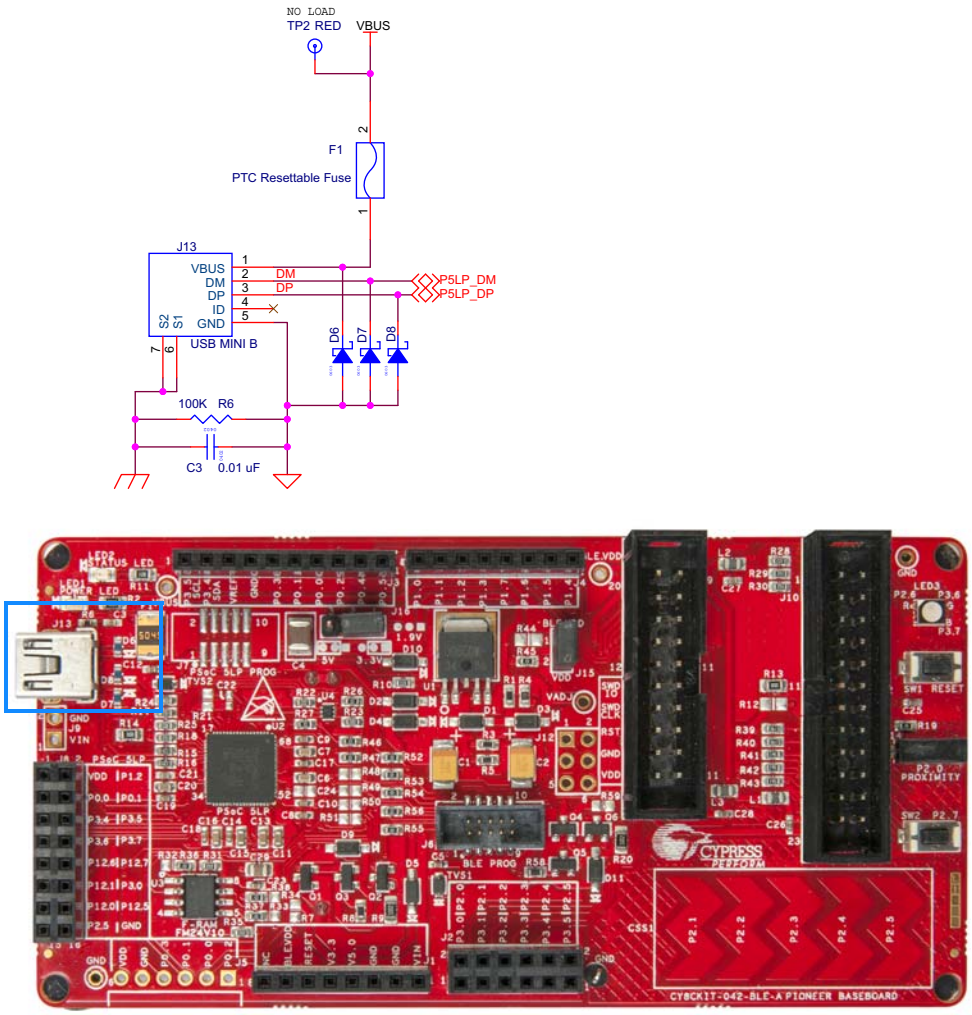




5.1.5 USB Mini-B Connector

The PSoC 5LP connects to the USB port of a computer through a Mini-B connector (see Figure 5-12), which can also be used to power the BLE Pineer Baseboard. A resettable polyfuse is used to protect the computer's USB ports from shorts and overcurrent. If more than 500 mA is drawn from the USB port, the fuse will automatically break the connection until the short or overload is removed.

Figure 5-12. Schematics and Board Highlight of USB Mini-B Connector

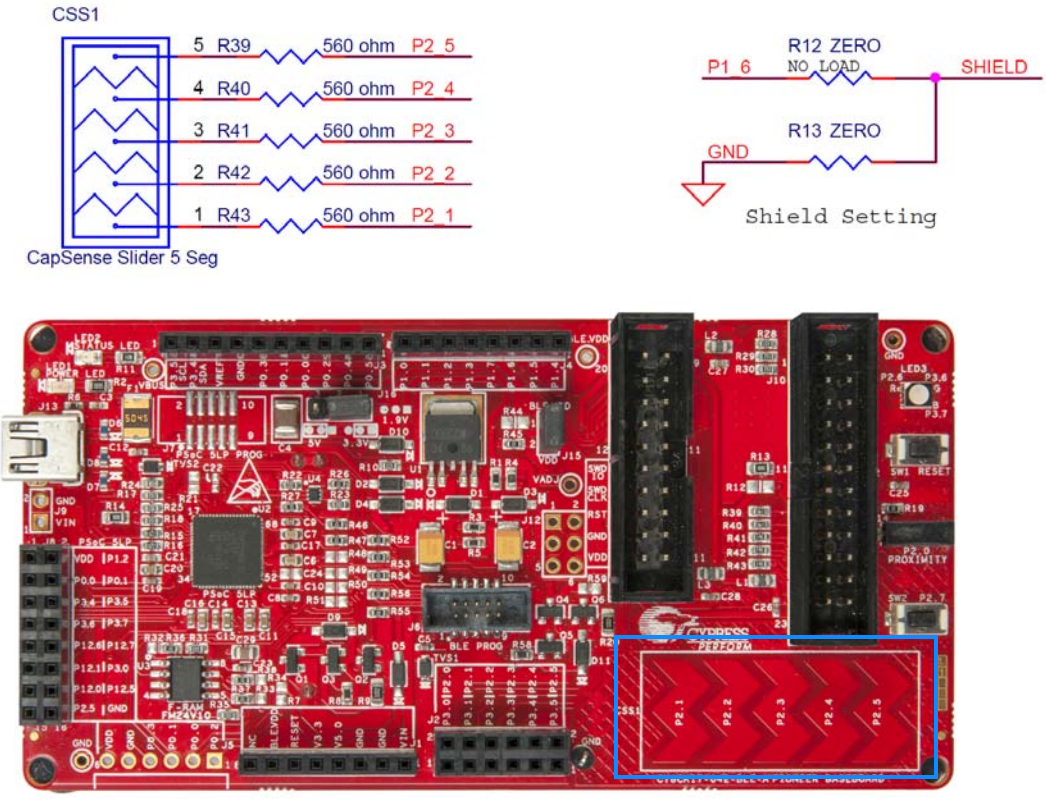


5.1.6 CapSense Circuit

5.1.6.1 CapSense Slider

The BLE Pioneer Kit has a five-segment linear capacitive touch slider, which is connected to the PSoC 4 BLE Module pins (see Figure 5-13). The CMOD and CTANK capacitors are required for CapSense functionality and are provided on the PSoC 4 BLE Module (see Module Board on page 100). A 2.2-nF capacitor is present on the CMOD pin, P4[0], for CapSense operation. BLE Pioneer Kit also supports CapSense designs that enable waterproofing. The connection of the shield to the pin or to ground is made by resistors R12 and R13, respectively. By default, R13 is mounted on the BLE Pioneer Baseboard, which connects the shield to ground. Populate R12 and remove R13 when evaluating waterproofing designs, which will connect the shield to the designated pin, P1[6].

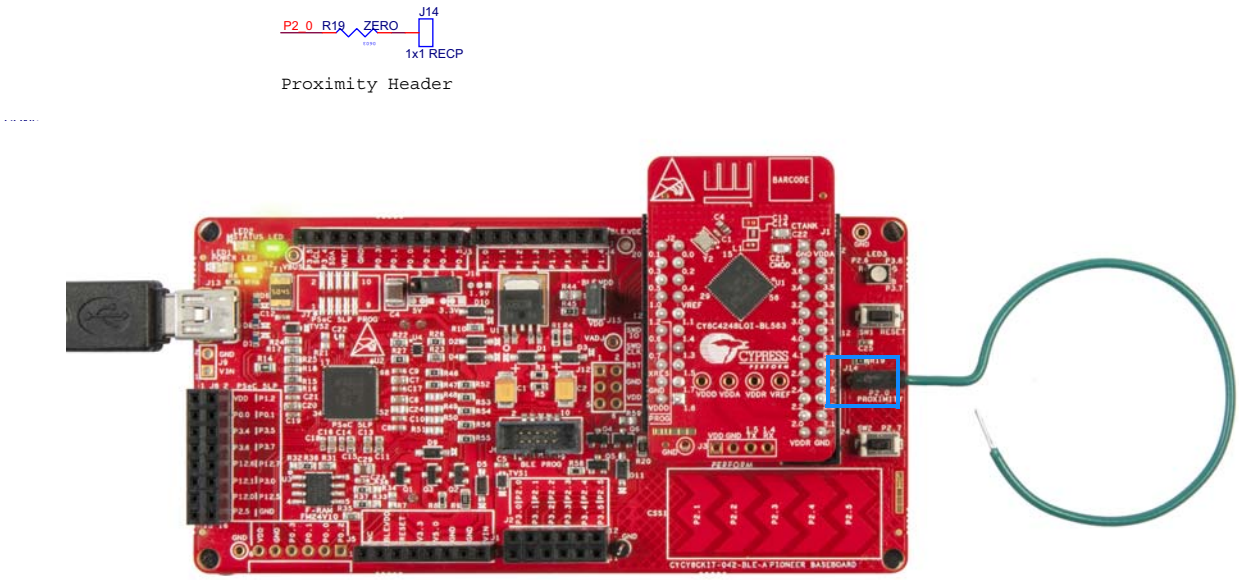
Figure 5-13. Schematics and Board Highlight of CapSense Slider and Shield Setting



5.1.6.2 Proximity Header

The BLE Pioneer Baseboard contains a header (J14) for CapSense proximity wire connection (see Figure 5-14).

Figure 5-14. Schematics and Board Highlight of Proximity Header



5.1.7 BLE Pioneer Baseboard LEDs

The BLE Pioneer Baseboard has three LEDs. A green LED (LED2) indicates the status of the programmer. An amber LED (LED1) indicates the status of power supplied to the board. The BLE Pioneer Kit also has a general-purpose tricolor LED (LED3) for user applications. These are connected to P2_6 (red LED), P3_6 (green LED) and P3_7 (blue LED). Figure 5-15 and Figure 5-16 show the schematics of these LEDs.

Figure 5-15. Schematics of Status and Power LED

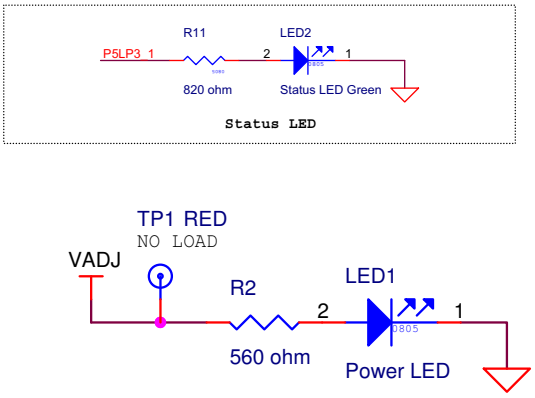
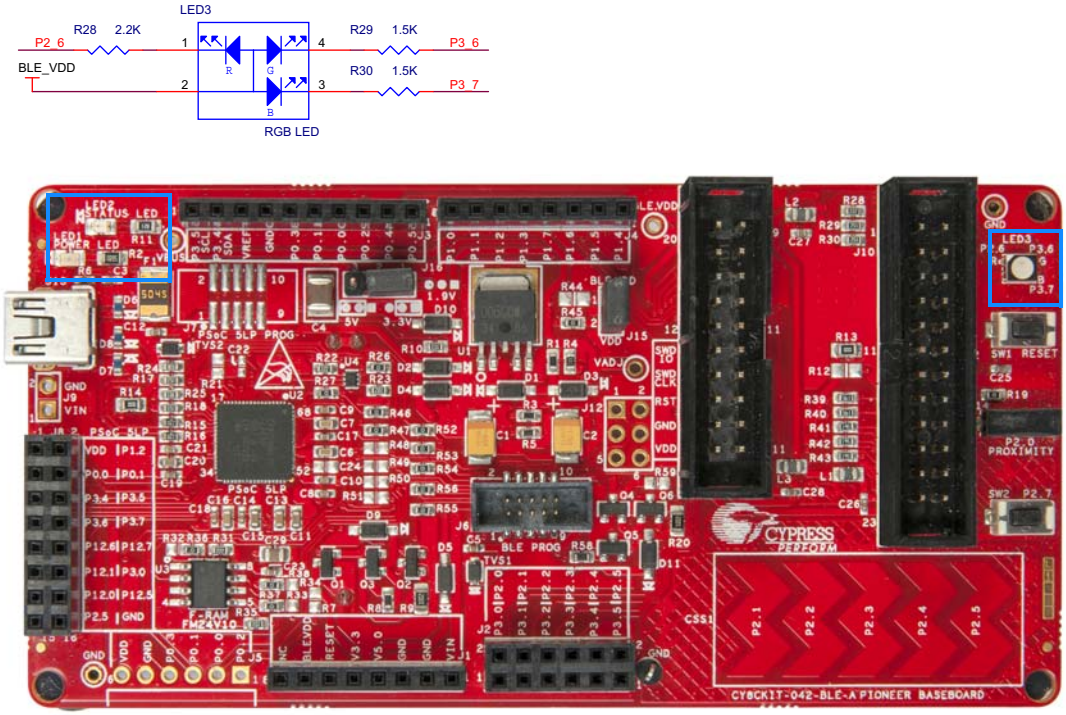


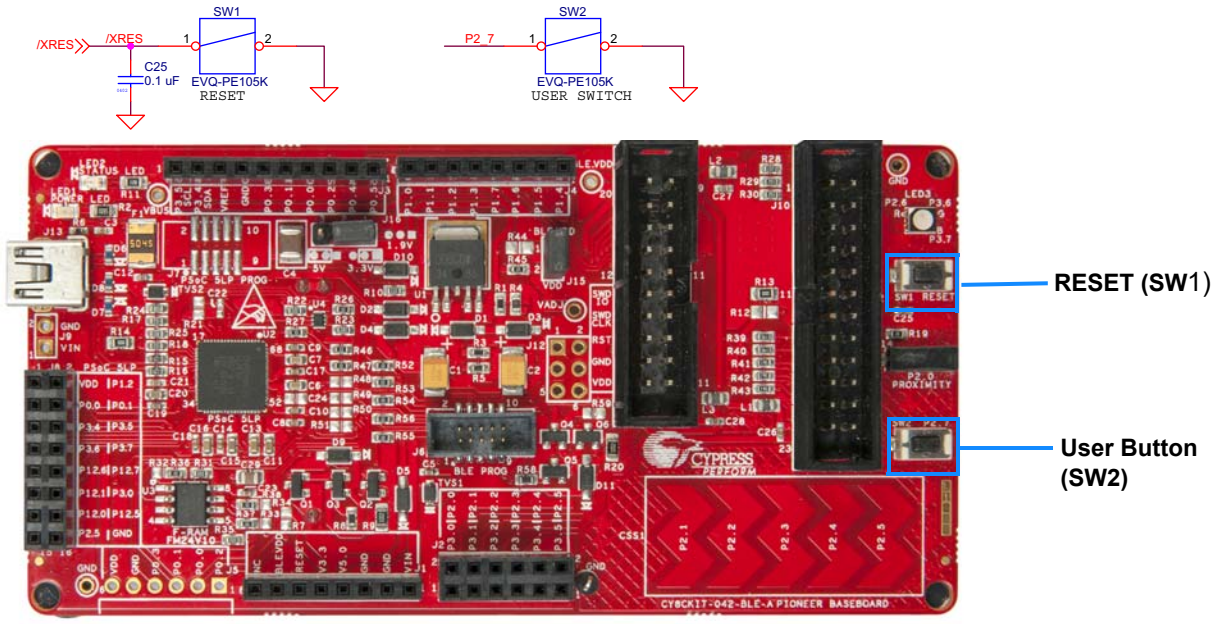
Figure 5-16. Schematics and Board Highlight of RGB LED



5.1.8 Push-Buttons

The BLE Pioneer Baseboard contains a reset push-button and a user push-button, as shown in Figure 5-17. The reset button is connected to the XRES pin of BLE device and is used to reset it. The user button is connected to P2[7] of the BLE device. Both the buttons connect to ground on activation (active low).

Figure 5-17. Schematics and Board Highlight of Reset Button and User Button

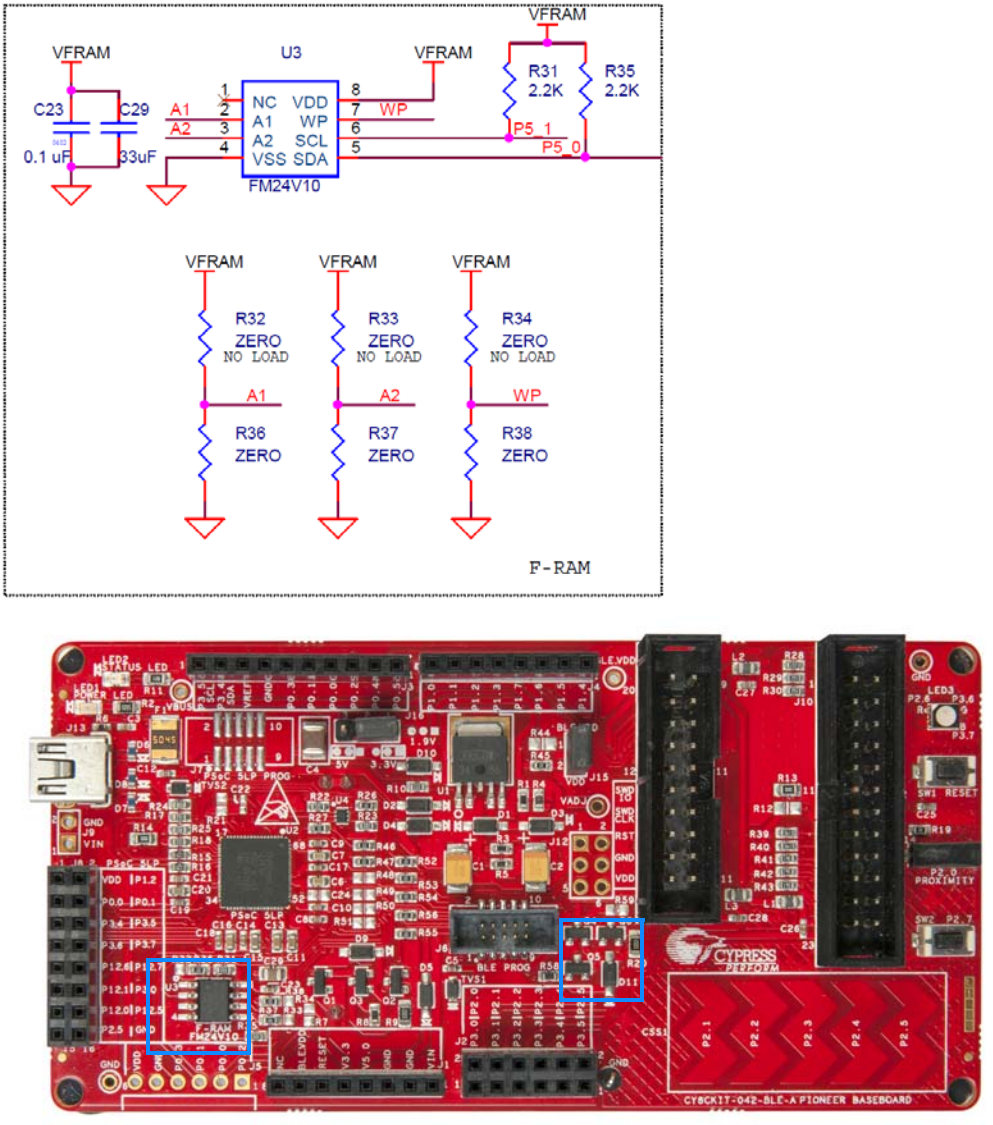


Note: The PSoC 4 BLE Reset pin (XRES) has an internal pull-up resistor. However, external pull-up resistor R3 and capacitor C25 are connected to PSoC 4 Reset pin on the PSoC 4 BLE Module, which is optional and required only in a noisy system.

5.1.9 Cypress Ferroelectric RAM (F-RAM)

The BLE Pioneer Baseboard contains the FM24V10-G F-RAM device (see Figure 5-18), which can be accessed through I^2C lines P5[0] and P5[1] of the PSoC 4 BLE Module. The F-RAM is 1-Mbit (128KB) with an I^2C speed up to 1 Mbps. The I^2C slave address of the F-RAM device is seven bits wide, and the LSB two bits are configurable through physical pins and are hardwired to 00 on the board. By default, the address of the F-RAM device used on the BLE Pioneer Baseboard is 0x50. This address can be modified by changing the R32/R36 and R33/R37 pairs. The operating voltage range of the F-RAM is between 2 V and 3.6 V. To prevent the application of 5 V from the adjustable LDO regulator on the BLE Pioneer Baseboard, a MOSFET-based protection circuit similar to the one used for the 3.3-V rail is connected between the output of the regulator and the VDD pin of the F-RAM. The protection circuit cuts off the power to the F-RAM when the output of the regulator is greater than 3.6 V.

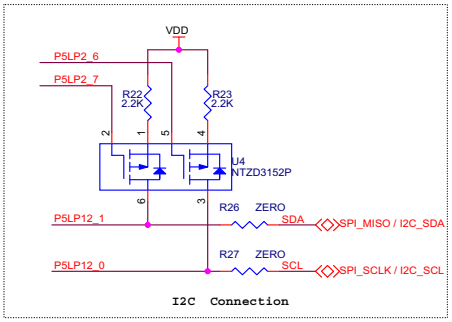
Figure 5-18. Schematics and Board Highlight of F-RAM

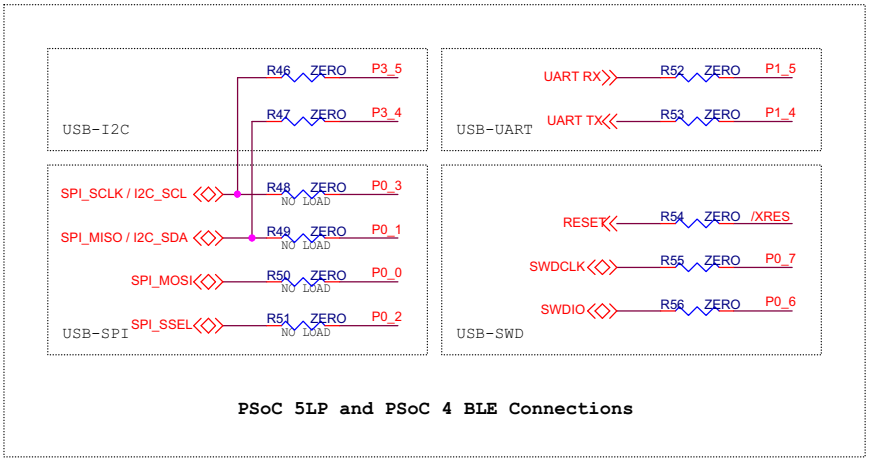


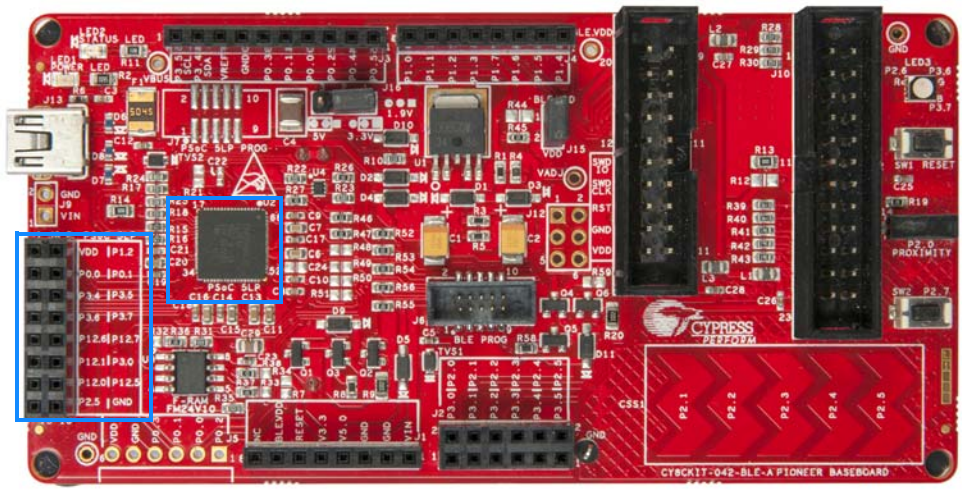
5.1.10 Serial Interconnection between KitProg and Module

The KitProg is also a USB-Serial interface. It supports USB-UART and USB-I^{2}C bridges (see Figure 5-19). The pull-up resistors on the I^{2}C bus are enabled when the protocol is selected from the user interface (such as Bridge Control Panel). The USB-Serial pins of the KitProg are also available on the Arduino header; therefore, it can be used to control Arduino shields with the SPI/I^{2}C/UART interface. Refer USB-UART Bridge on page 34 and USB-I2C Bridge on page 35 for more information on how to use these serial interconnections.

Figure 5-19. Schematics and Board Highlight of Serial Interface and I^{2}C Pull-Up via FET



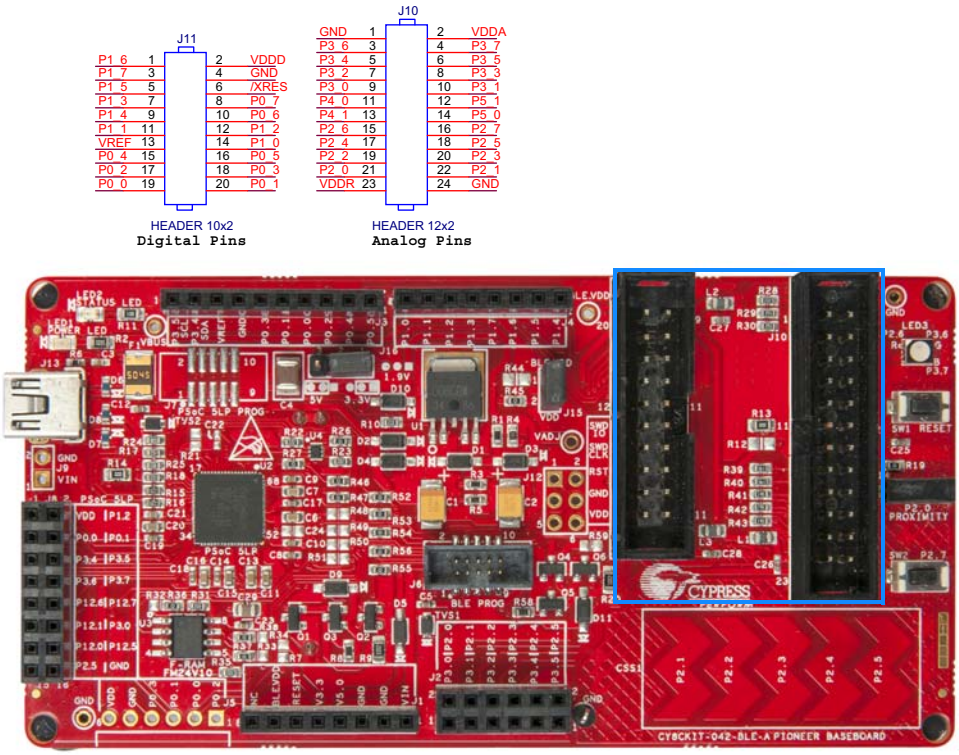




5.1.11 Module Headers

The PSoC 4 BLE Module is connected to the BLE Pioneer Baseboard using the two (24-pin and 20-pin) module headers, as shown in Figure 5-20.

Figure 5-20. Schematics and Board Highlight of Module Headers



For information on how to add these on your own board, refer to Adding BLE Module-Compatible Headers on Your Baseboard on page 113.

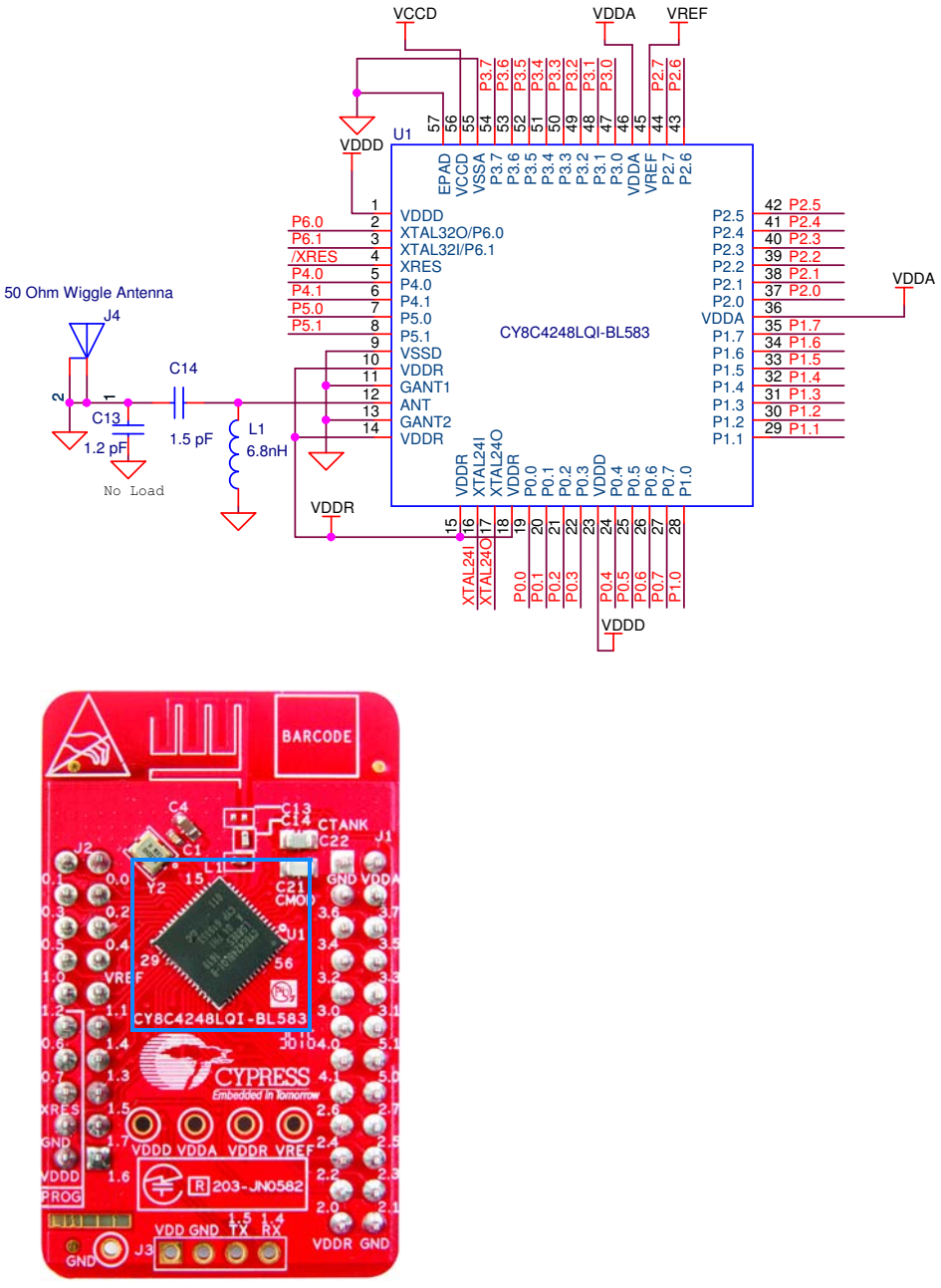
5.2 Module Board

5.2.1 PSoC 4 BLE Device

The PSoC 4 BLE device is the main component on the module. It provides the RF interface and analog and digital capability. The PSoC 4 BLE pins are mapped to the module headers (see Figure 5-21). For more information, refer to the BLE web page.

See BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit on page 115 for details.

Figure 5-21. Schematics and Board Highlight of Module Headers for BLE Pins

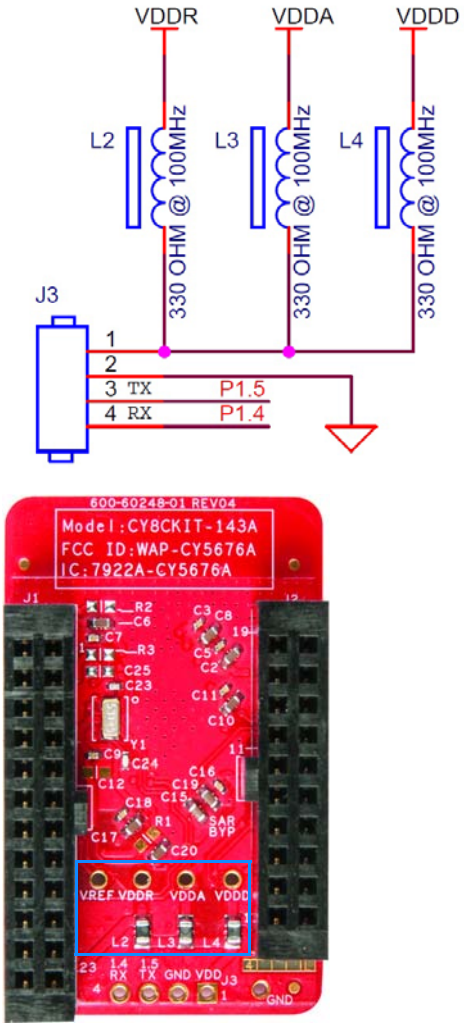


5.2.2 Module Power Connections

The module has three power domains: VDDD, VDDA, and VDDR. The VDDD connection supplies power for digital device operation, VDDA supplies power for analog device operation, and VDDR connection supplies power for the device radio. By default, these domains are shorted using a 330-ohm, 100-MHz ferrite bead. The domains are shorted for standalone usage scenarios of module, such as programming the module using MiniProg 3 or using the module as a standalone data acquisition unit.

It is recommended to place the ferrite bead between the supply to avoid ripple between VDDR and the other two domains. If the supply ripple is less that 100 mV, these can be changed to a zero-ohm resistor.

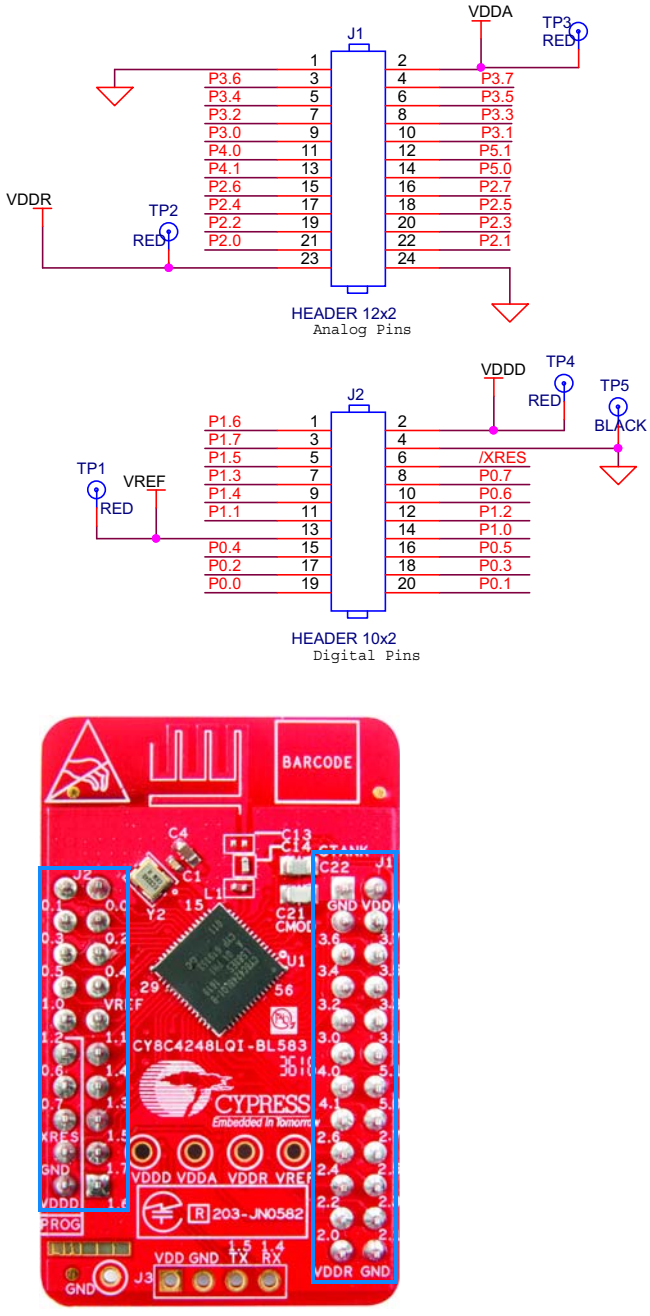
Figure 5-22. Schematics and Board Highlight of Ferrite Bead and Power Pin



5.2.3 Module Headers (20-Pin and 24-Pin Headers)

The PSoC 4 BLE Module connects to the BLE Pioneer Baseboard using two (20-pin and 24-pin) module headers (Figure 5-23). All GPIOs and power domains are brought out to these headers. These headers are the counterparts of the connectors in Expansion Connectors on page 89.

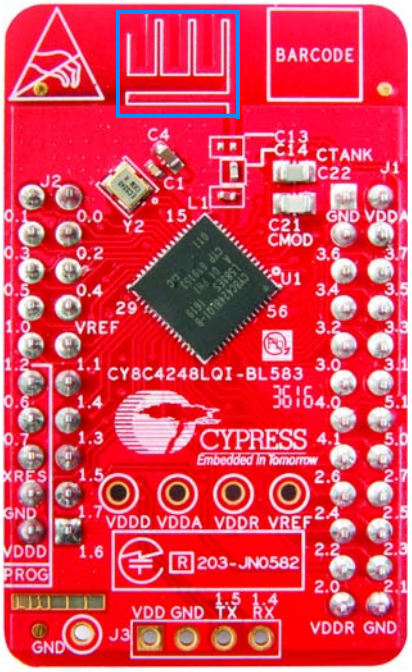
Figure 5-23. Schematics and Board Highlight of Headers



5.2.4 Wiggle Antenna

PSoC 4 BLE Module uses the wiggle antenna. Refer to the Antenna Design Guide (AN91445) for details.

Figure 5-24. Board Highlight of Wiggle Antenna

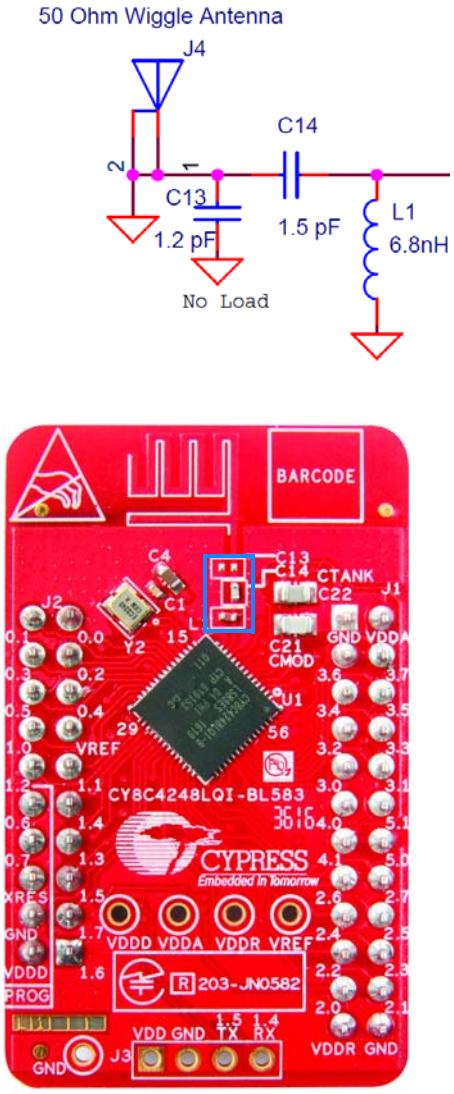


5.2.5 Antenna Matching Network

An Antenna Matching Network is required between the BLE device and the antenna to achieve optimum performance (Figure 5-25). The matching network has four main tasks:

- Transform the balanced output of the radio to an unbalanced connection to the antenna (balun).
- Transform the output impedance of the radio to a 50-ohm antenna.
- Suppress harmonics to a level below the regulations level in TX mode.
- Suppress the local oscillator (LO) leakage in RX mode.

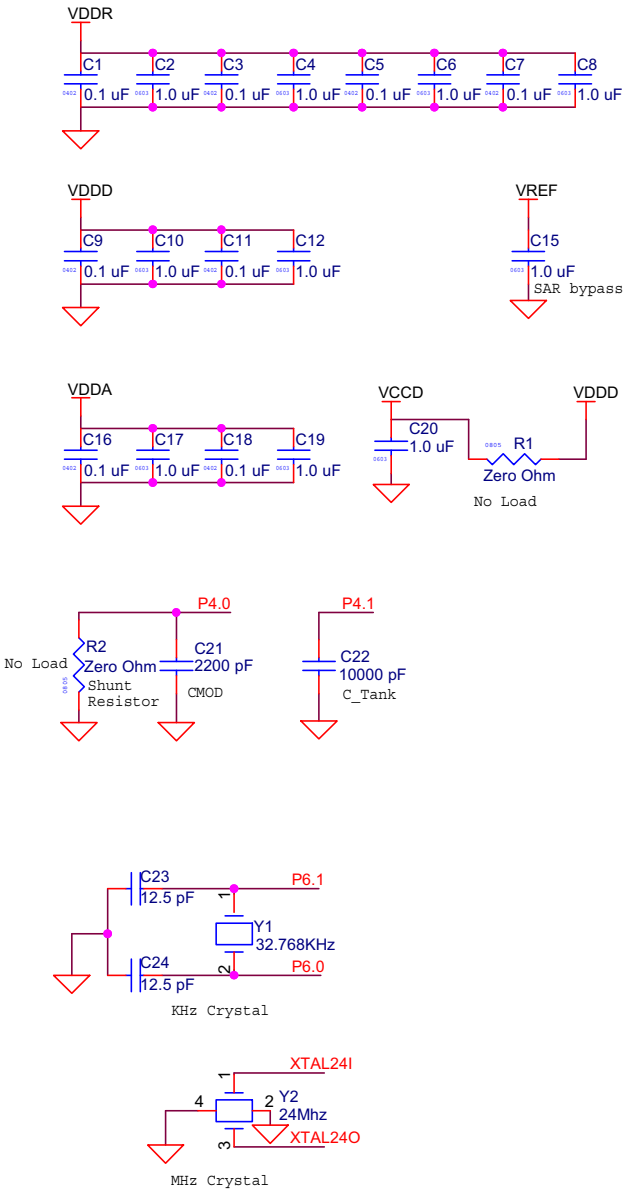
Figure 5-25. Schematics and Board Highlight of Antenna Matching Network and Antenna

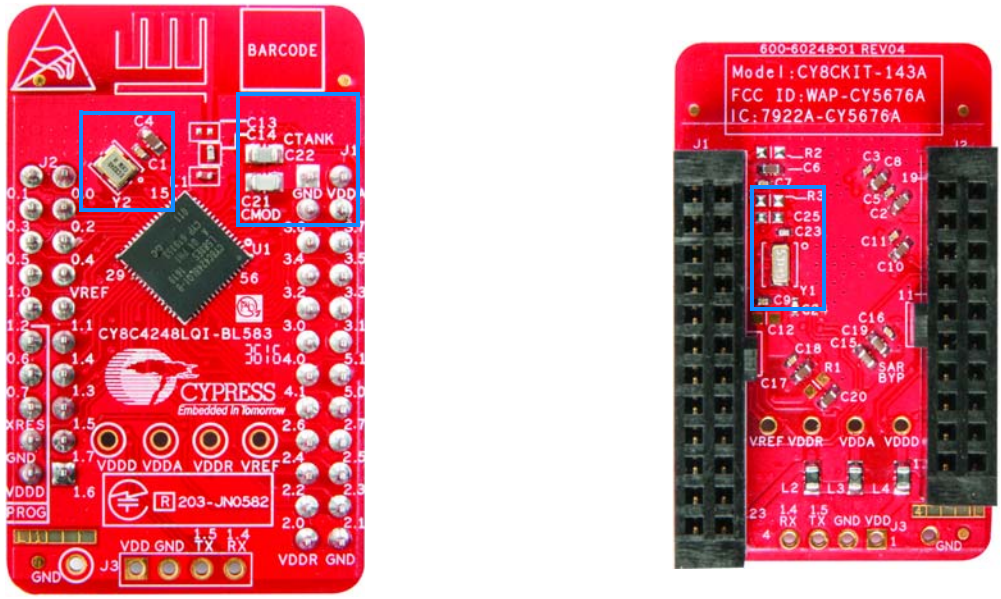


5.2.6 BLE Passives

Module boards include a 24-MHz crystal and a 32-kHz crystal, the CMOD and shield (CTANK) circuit for CapSense, a SAR bypass capacitor, and adequate decoupling capacitors for all the power domains, as shown in Figure 5-26.

Figure 5-26. Schematics and Board Highlight – External Crystal, CMOD, CTANK, Decaps, Jumpers





5.2.7 Test Points

All power domains are brought out as test points for easy probing.

5.3 BLE Dongle Board

See PSoC 4 BLE Device on page 100 for schematics of PSoC 4 BLE pins.

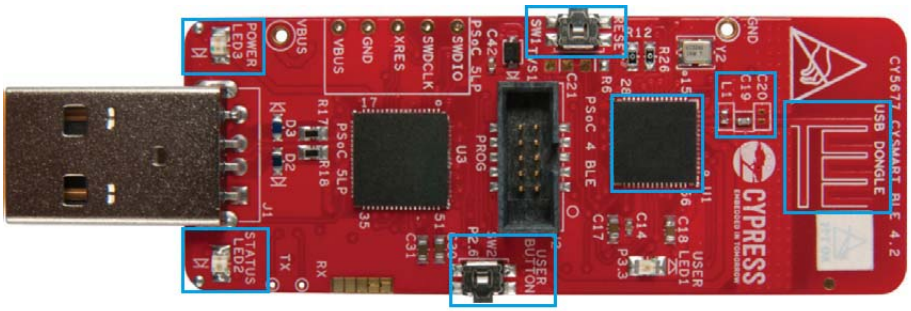
See Wiggle Antenna on page 103 for image of wiggle antenna.

See Antenna Matching Network on page 104 for schematics of antenna matching network.

See BLE Pioneer Baseboard LEDs on page 94 for schematics of power and status LED.

See Push-Buttons on page 96 for schematics of push-buttons.

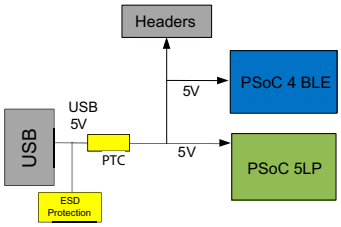
Figure 5-27. Board Highlight



5.3.1 Power System

The BLE Dongle is powered directly using 5 V from the USB port, as shown in Figure 5-28.

Figure 5-28. Power Supply Block Diagram With Protection Circuits



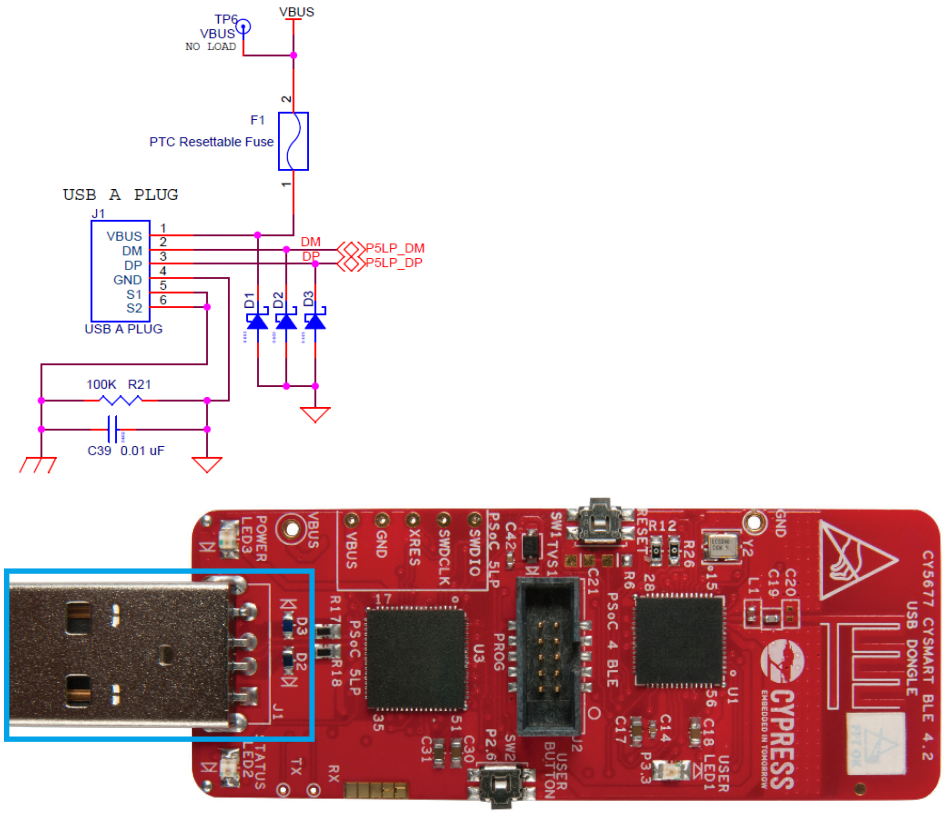
5.3.1.1 Protection Circuits

The PTC resettable fuse is connected to protect the computer's USB ports from shorts and overcurrent.

5.3.2 USB Type-A Plug

The KitProg on the BLE Dongle connects to the USB port of a computer through a USB Type-A plug (Figure 5-29). The BLE Dongle is powered using the same plug. A resettable polyfuse is used to protect the computer's USB ports from shorts and overcurrent. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed. The VBUS, D+, and D– lines from the USB connector are also protected against ESD events using TVS diodes.

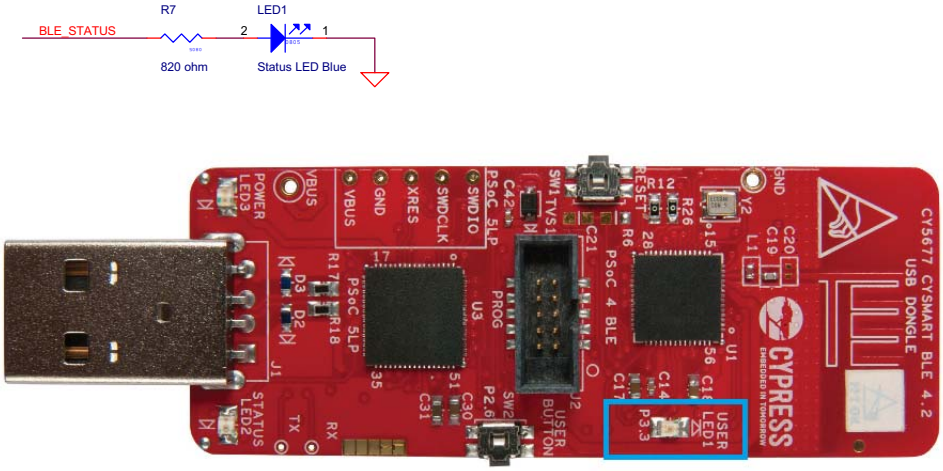
Figure 5-29. Schematics and Board Highlight of USB Type-A Plug



5.3.3 User LED

A user LED is provided to indicate status from the PSoC 4 BLE device (Figure 5-30). It is also used to show the bind status.

Figure 5-30. Schematics and Board Highlight of User LED



6. Advanced Topics

This chapter describes the functionality of the FM24V10 F-RAM in the BLE Pioneer Kit.

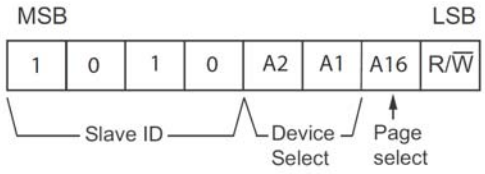
6.1 Using FM24V10 F-RAM

The BLE Pioneer Baseboard has an onboard ferroelectric RAM chip that can hold up to 1 Mb of data. The chip provides an I^2C communication interface for data access. It is hardwired to the I^2C lines (P5_0 and P5_1). Because the F-RAM device is an I^2C slave, it can be accessed or shared among various I^2C masters on the same line. For more details on the F-RAM device, refer to the device datasheet.

6.1.1 Address Selection

The slave address of the F-RAM device consists of three parts, as shown in Figure 6-1: slave ID, device select, and page select. Slave ID is an F-RAM family-specific ID located in the datasheet of the particular F-RAM device. For the device used in the BLE Pioneer Baseboard (FM24V10), the slave ID is 1010b. Device select bits are set using the two physical pins A2 and A1 in the device. The setting of these two pins on the BLE Pioneer Baseboard is controlled by resistors R32/R36 (A1) and R33/R37 (A2). Because the memory location in F-RAM is divided into two pages of 64KB each, the page select bit is used to refer to one of the two pages in which the read or write operations will take place.

Figure 6-1. F-RAM I^2C Address Byte Structure



6.1.2 Write/Read Operation

The device datasheet includes details on how to perform a write/read operation with the F-RAM. Figure 6-2 and Figure 6-3 provide a snapshot of the write/read packet structure as a quick reference.

Figure 6-2. F-RAM Single-Byte and Multiple-Byte Write Packet Structure

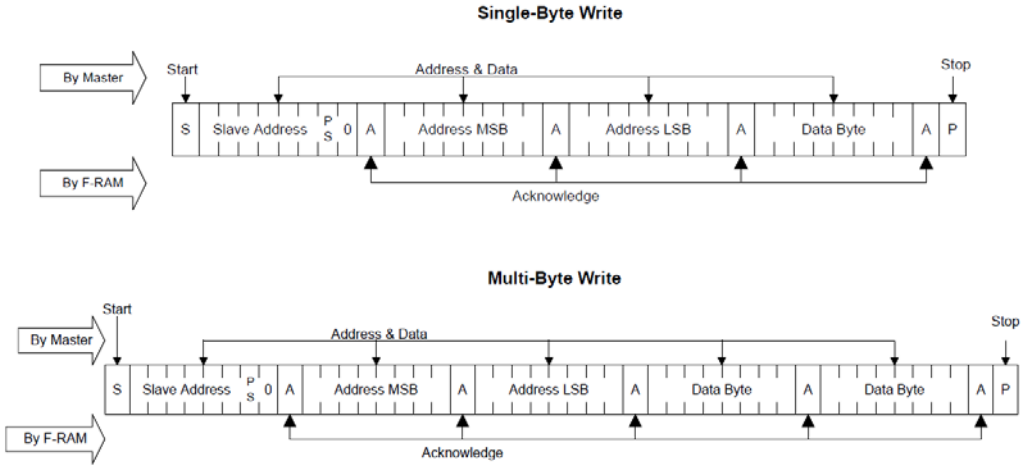
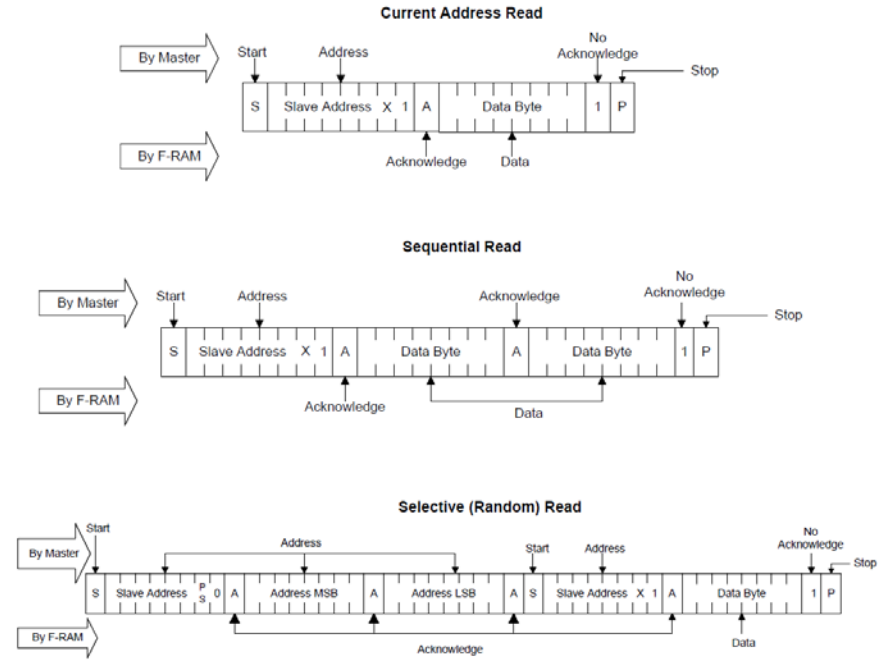


Figure 6-3. F-RAM Single-Byte and Multiple-Byte Read Packet Structure



As shown in the figures, all operations start with the slave address followed by the memory address. For write operations, the bus master sends each byte of data to the memory, and the memory generates an acknowledgement condition. For ‘Current Address Read’ and ‘Sequential Read’, the bus master sends only the slave address. The memory address used is the same address that was set by the previous ‘Write’ or ‘Selective Read’ operation. For ‘Selective Read’ operations, after receiving the complete slave address and memory address, the memory will begin shifting data from the current address on the next clock.

A. Appendix

A.1 Bill of Materials (BOM)

The BOM for the BLE Pioneer Baseboard is available at the following location in the installation directory:

`<Install_Directory>\CY8CKIT-042-BLE-A Kit\<version>\Hardware\BLE Pioneer Board\BLE Pioneer Board PCBA BOM.xlsx`

The BOM for the CY8CKIT-143A PSoC 4 BLE Module is available at the following location in the installation directory:

`<Install_Directory>\CY8CKIT-042-BLE-A Kit\<version>\Hardware\PSoC 4 BLE Module\PSoC 4 BLE Module PCBA BOM.xlsx`

The BOM for the CY5677 CySmart BLE 4.2 USB Dongle is available at the following location in the installation directory:

`<Install_Directory>\CY8CKIT-042-BLE-A Kit\<version>\Hardware\BLE Dongle\BLE Dongle PCBA BOM.xlsx`

A.2 KitProg Status LED States

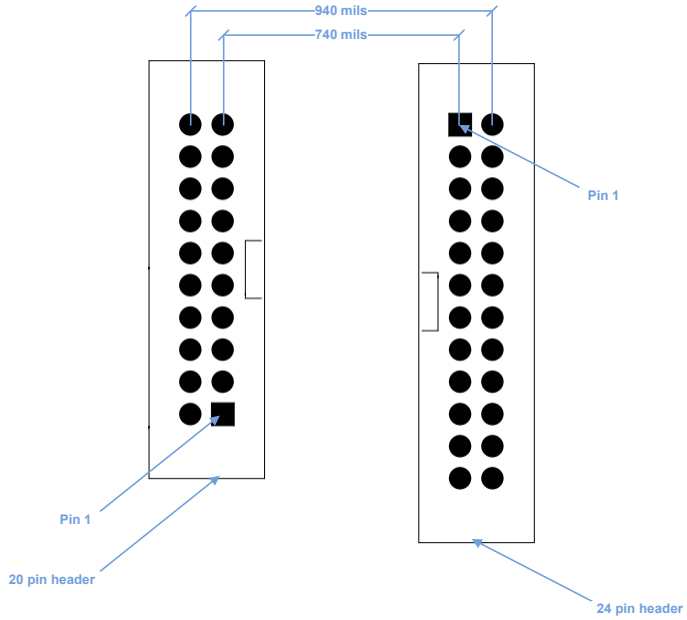
User Indication	Scenario	Action Required by user
LED blinks fast: Frequency = 4.00 Hz	LED starts blinking at power up, if bootloadable file is corrupt.	Bootload the *KitProg.cyacd* file: In PSoC Programmer, connect to the kit, open the **Utilities** tab, and press the **Upgrade Firmware** button.
LED blinks slow: Frequency = 0.67 Hz	Entered Bootloader mode by holding the Reset button of the BLE Pioneer Kit/BLE Dongle during kit power up.	Release the Reset button and replug power if you entered this mode by mistake. If the mode entry was intentional, bootload the new *.cyacd* file using the Bootloader Host tool shipped with PSoC Creator.

User Indication	Scenario	Action Required by user
LED blinks very fast: Frequency = 15.0 Hz	SWD operation is in progress. Any I^2C traffic. Kit's COM port connect/disconnect event (one blink).	In PSoC Programmer, watch the log window for status messages for SWD operations. In the Bridge Control Panel, the LED blinks on I^2C command requests. In Bridge Control Panel or any other serial port terminal program, distinguish the kit's COM port number by the blinking LED when the port is connected or disconnected.
LED is ON.	USB enumeration successful. Kit is in the idle state waiting for commands.	The kit functions can be used by PSoC Creator, PSoC Programmer, Bridge Control Panel, and any serial port terminal program.
LED is OFF.	Power LED is ON.	This means that the USB enumeration was unsuccessful. This can happen if the kit is not powered from the USB host or the kit is not connected to the USB host through the USB cable. Verify the USB cable and check if PSoC Programmer is installed on the PC.
LED is breathing	Kit is in Mass Storage\CMSIS-DAP mode	This means that the kit is in Mass Storage\CMSIS-DAP mode. This can happen if you press the SW1 button for more than 5 seconds. During Mass Storage or CMSIS- DAP programming, the LED blinks fast (Frequency = 15 Hz). Press and release the SW1 for more than 5 seconds to re-enumerate the KitProg in the alternate configuration, that is, Mass Storage\CMSIS-DAP mode to KitProg mode or vice versa.

A.3 Adding BLE Module-Compatible Headers on Your Baseboard

The baseboard should have a 20-pin header and a 24-pin header. Dimension of these connectors are given here.

Figure A-1. Connectors on BLE Pioneer Kit Baseboard



These headers are available for purchase from Digikey.

Description	Manufacturer	Manufacturer Part Number	Digikey Part Number
CONN HEADER 2.54MM 24POS GOLD	Sullins Connector Solutions	SBH11-PBPC-D12-ST-BK	SBH11-PBPC-D12-ST-BK-ND
CONN HEADER 2.54MM 20POS GOLD	Sullins Connector Solutions	SBH11-PBPC-D10-ST-BK	S9172-ND

A.4 Programming BLE PSoC 4 BLE Module via MiniProg3

If the PSoC 4 BLE Module is to be used without the BLE Pioneer Baseboard, it can be programmed using MiniProg3. The J2 header has five adjacent pins – VDDD, GND, XRES, P0[7], and P0[6]. These pins can be used to program the BLE Module using MiniProg3.

Figure A-2. Programming a BLE Module via MiniProg3

Follow these steps to program the module:

1. Connect the MiniProg3 to the J2 connector, with the VDD of the MiniProg3 aligned to the VDDD on the module.
2. Click **Start** > **All Programs** > **Cypress** > **PSoC Programmer <version>** > **PSoC Programmer <version>**.
3. Open the desired *.hex* file in PSoC Programmer.
4. On the **Programmer** tab, set the **Programming Mode** to **Reset**.
5. Set **AutoDetection** to **On**.
6. Set **Programmer Characteristics > Protocol** to **SWD**.
7. Set **Programmer Characteristics > Voltage** to the desired value.
8. Click the **Toggle Power** icon below the menu bar to power the module.
9. Click the **Program** icon below the menu bar to program the module.

A.5 BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit

Different BLE modules and BLE dongles can work with the BLE Pioneer Kit, as listed in the following tables.

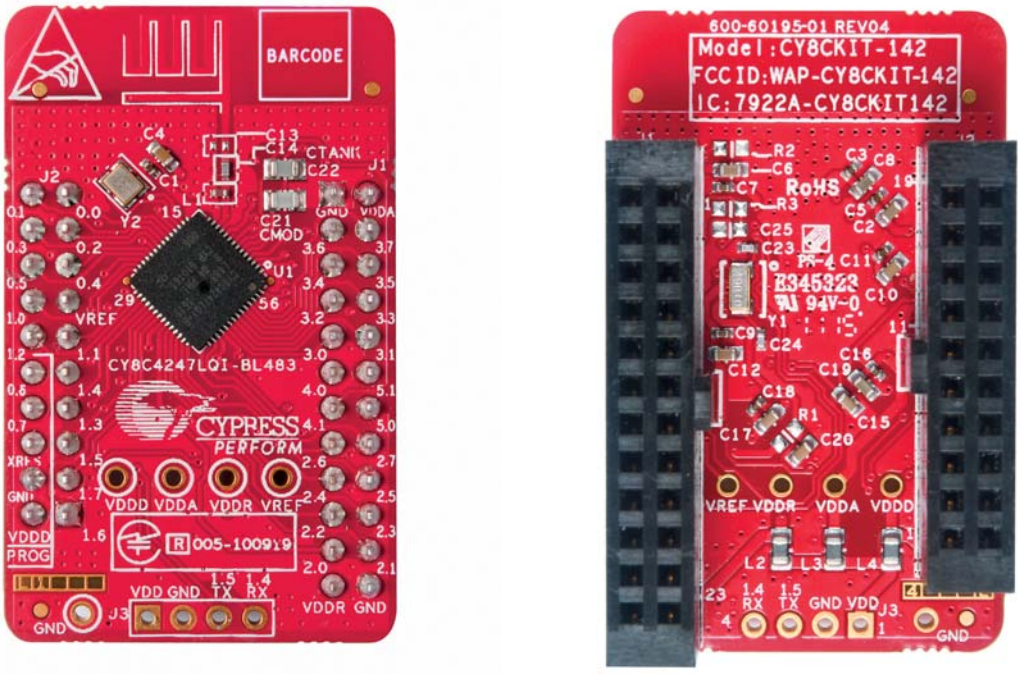
BLE Module	Availability	Flash Size	Bluetooth Version
CY8CKIT-142 PSoC 4 BLE Module	Available separately	128KB	Bluetooth 4.1
CY8CKIT-141 PSoC 4 BLE SMA Module	Available separately	128KB	Bluetooth 4.1
CY8CKIT-143 PSoC 4 BLE 256KB Module	Available separately	256KB	Bluetooth 4.1
CY8CKIT-143A PSoC 4 BLE 256KB Module	As part of the kit	256KB	Bluetooth 4.2

BLE Dongle	Availability	Flash Size	Bluetooth Version
CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)	As part of the kit	256KB	Bluetooth 4.2

A.5.1 CY8CKIT-142 PSoC 4 BLE Module

This is the lower flash version of the PSoC 4 BLE Module. It can be ordered separately. This module has the CY8C4247LQI-BL483 silicon, with 128KB flash and 16KB RAM. It supports Bluetooth 4.1.

Figure A-3. CY8CKIT-142 PSoC 4 BLE Module



A.5.2 CY8CKIT-141 PSoC 4 BLE SMA Module

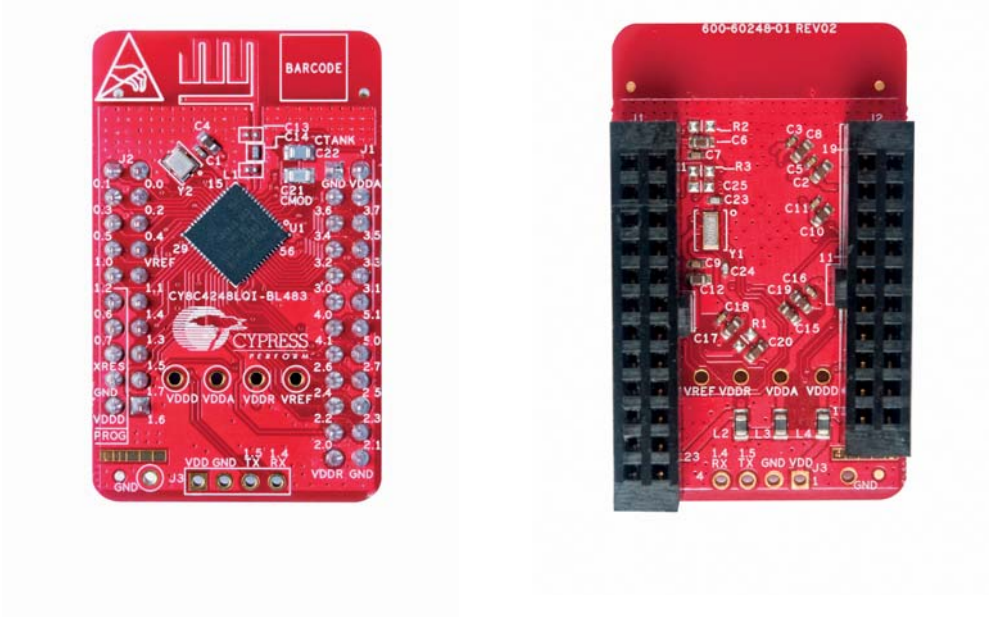
This module is identical to the CY8CKIT-142 PSoC 4 BLE Module, except that it has an SMA connector instead of a wiggle antenna; this connector can be used to connect to an external antenna. This module can be ordered separately.

Figure A-4. CY8CKIT-141 PSoC 4 BLE SMA Module

A.5.3 CY8CKIT-143 PSoC 4 BLE 256KB Module

This is the Bluetooth 4.1 equivalent of the CY8CKIT-143A PSoC 4 BLE 256KB Module. It has the CY8C4248LQI-BL483 silicon, with 256KB flash and 32KB RAM. It can be ordered separately.

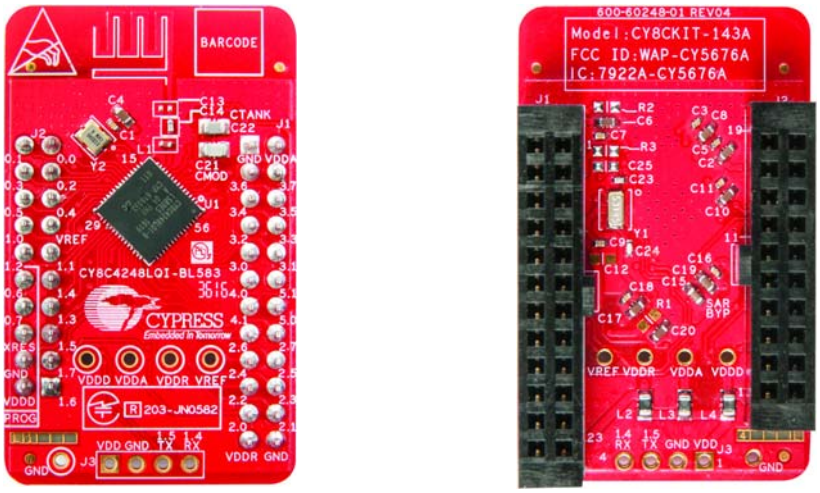
Figure A-5. CY8CKIT-143 PSoC 4 BLE 256KB Module



A.5.4 CY8CKIT-143A PSoC 4 BLE 256KB Module

This is the default PSoC 4 BLE Module shipped as part of the BLE Pioneer Kit. It supports Bluetooth 4.2 features and DMA. It has the CY8C4248LQI-BL583 silicon, with 256KB flash and 32KB RAM.

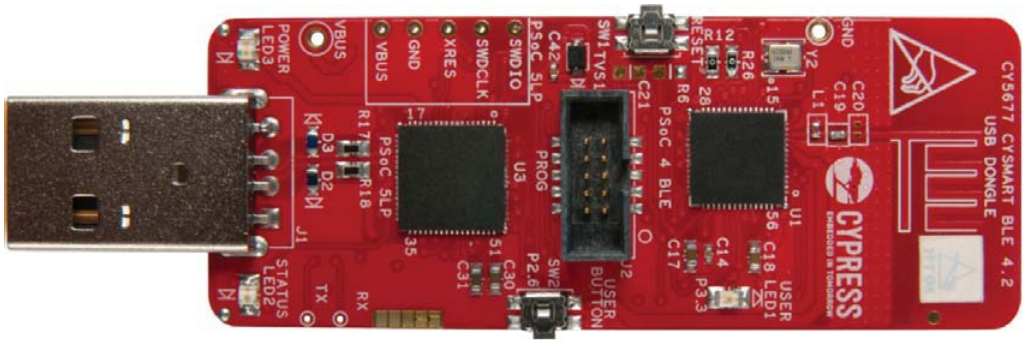
Figure A-6. CY8CKIT-143A PSoC 4 BLE 256KB Module



A.5.5 CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)

This is the default BLE Dongle shipped as part of the BLE Pioneer Kit. It has the CY8C4248LQI-BL583 silicon, with 256KB flash and 32KB RAM. It supports Bluetooth 4.2 and DMA.

Figure A-7. CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)

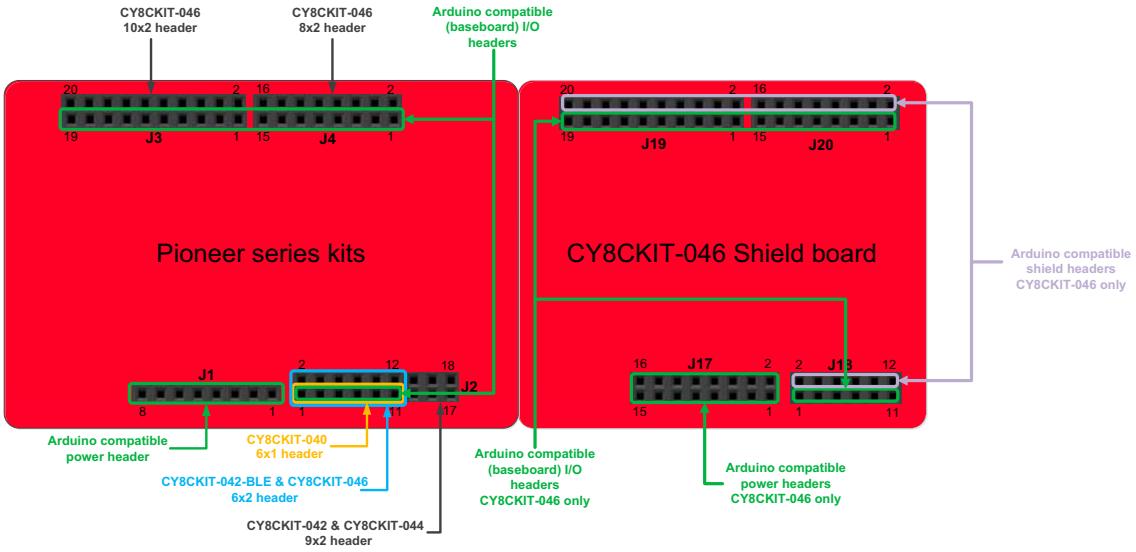


A.6 Migrating Projects Across Different Pioneer Series Kits

All Cypress Pioneer series kits are Arduino Uno-compatible and have some common onboard peripherals such as RGB LED, CapSense, and a user switch. However, the pin mapping in each of the boards is different due to differences in pin functions of the PSoC device used. This guide lists the pin maps of the Pioneer series kits to allow easy migration of projects across different kits.

In some cases, the pins available on the Pioneer kit headers are a super set of the standard Arduino Uno pins. For example, J2 contains only one row of pins on the Arduino Uno pinout while it contains two rows of pins on many of the Pioneer series kits.

Figure A-8. Pioneer Series Kits Pin Map



A.6.1 Arduino Uno-Compatible Headers

J1 Arduino-Compatible Header Pin Map						
Pin #	Arduino Pin	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	VIN	VIN	VIN	VIN	VIN	VIN
2	GND	GND	GND	GND	GND	GND
3	GND	GND	GND	GND	GND	GND
4	5V	V5.0	V5.0	V5.0	V5.0	V5.0
5	3.3V	V3.3	V3.3	V3.3	V3.3	V3.3
6	RESET	RESET	RESET	RESET	RESET	RESET
7	IOREF	P4.VDD	P4.VDD	BLE.VDD	P4.VDD	P4L.VDD
8	NC	NC	NC	NC	NC	NC

J2 Arduino-Compatible Header Pin Map						
Pin #	Arduino Pin	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	A0	P2[0]	P0[0]	P3[0]	P2[0]	P2[0]
2	–	P0[2][a]	–	P2[0]	P2[6][a]	P3[6][a]
3	A1	P2[1]	P0[1]	P3[1]	P2[1]	P2[1]
4	–-	P0[3][a]	–	P2[1][a]	P6[5][a]	P3[7][a]
5	A2	P2[2]	P0[2][a]	P3[2]	P2[2]	P2[2]
6	–	P4_VDD	–	P2[2][a]	P0[6][a]	P9[0]
7	A3	P2[3]	P0[4][a]	P3[3]	P2[3]	P2[3]
8	–	P1[5][a]	–	P2[3][a]	P4[4][a]	P9[1]
9	A4	P2[4]	P1[3]	P3[4]	P2[4]	P2[4]
10	–	P1[4][a]	–	P2[4][a]	P4[5][a]	P9[2]
11	A5	P2[5]	P1[2]	P3[5]	P2[5]	P2[5]
12	–	P1[3][a]	–	P2[5][a]	P4[6][a]	P9[3]
13	–	P0[0]	–	–	P0[0]	–
14	–	GND	–	–	GND	–
15	–	P0[1]	–	–	P0[1]	–
16	–	P1[2][a]	–	–	P3[4][a]	–
17	–	P1[0]	–	–	P0[7][a]	–
18	–	P1[1][a]	–	–	P3[5][a]	–

a. These pins are also used for onboard peripherals. See the tables in "Onboard Peripherals" on page 122 for connection details.

J3 Arduino-Compatible Header Pin Map						
#	Arduino Pin	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	D8	P2[6]	P1[4]	P0[5]	P0[2]	P0[2]
2	-	-	-	-	-	P3[4]
3	D9	P3[6]	P1[5]	P0[4]	P0[3]	P0[3]
4	-	-	-	-	-	P6[5]
5	D10	P3[4]	P1[6]	P0[2]	P2[7]	P6[3]
6	-	-	-	-	-	P6[3]
7	D11	P3[0]	P1[1][a]	P0[0]	P6[0]	P6[0]
8	-	-	-	-	-	P6[0]
9	D12	P3[1]	P3[1]	P0[1]	P6[1]	P6[1]
10	-	-	-	-	-	P6[1]
11	D13	P0[6]	P1[7]	P0[3]	P6[2]	P6[2]
12	-	-	-	-	-	P6[2]
13	GND	GND	GND	GND	GND	GND
14	-	-	-	-	-	GND
15	AREF	P1[7]	NC	VREF	P1[7]	VREF
16	-	-	-	-	-	VREF
17	SDA	P4[1]	P1[3]	P3[4]	P4[1]	P4[1]
18	-	-	-	-	-	P4[1]
19	SCL	P4[0]	P1[2]	P3[5]	P4[0]	P4[0]
20	-	-	-	-	-	P4[0]

a. These pins are also used for onboard peripheral connections. Refer to the A.6.2 Onboard Peripherals section for connection details.

J4 Arduino-Compatible Header Pin Map						
#	Arduino Pin	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	D0	P0[4]	P0[5]	P1[4]	P3[0]	P3[0]
2	-	-	-	-	-	P8[0]
3	D1	P0[5]	P0[6]	P1[5]	P3[1]	P3[1]
4	-	-	-	-	-	P8[1]
5	D2	P0[7][a]	P0[7]	P1[6]	P1[0]	P1[0]
6	-	-	-	-	-	P8[2]
7	D3	P3[7]	P3[2][a]	P1[7]	P1[1]	P1[1]
8	-	-	-	-	-	P8[3]
9	D4	P0[0]	P0[3]	P1[3]	P1[2]	P1[2]
10	-	-	-	-	-	P8[4]
11	D5	P3[5]	P3[0]	P1[2]	P1[3]	P1[3]
12	-	-	-	-	-	P8[5]
13	D6	P1[0]	P1[0]	P1[1]	P5[3]	P5[6]
14	-	-	-	-	-	P8[6]
15	D7	P2[7]	P2[0][a]	P1[0]	P5[5]	P5[5]
16	-	-	-	-	-	P8[7]

a. These pins are also used for onboard peripheral connections. Refer to the A.6.2 Onboard Peripherals section for connection details.

A.6.2 Onboard Peripherals

#	CapSense Pin	Pioneer Series Kits				
		CY8CKIT-042 (Linear Slider)	CY8CKIT-040	CY8CKIT-042-BLE (Linear Slider)	CY8CKIT-044 (Gesture Pad)	CY8CKIT-046 (Gesture Pad with Radial Slider)[a]
1	CapSense Sensor 1	P1[1]/ CS_LS_E0	–	P2[1]/CS_LS_E0	P4[4]/ CS_GES_CR	P0[6]/ CS_GES_CR
2	CapSense Sensor 2	P1[2]/ CS_LS_E1	–	P2[2]/CS_LS_E1	P4[5]/ CS_GES_UP	P4[5]/ CS_GES_LT
3	CapSense Sensor 3	P1[3]/ CS_LS_E2	–	P2[3]/CS_LS_E2	P4[6] /CS_GES_LT	P4[4]/ CS_GES_UP
4	CapSense Sensor 4	P1[4]/ CS_LS_E3	–	P2[4]/CS_LS_E3	P3[4]/ CS_GES_DN	P4[7]/ CS_GES_RT
5	CapSense Sensor 5	P1[5]/ CS_LS_E4	–	P2[5]/CS_LS_E4	P3[5]/ CS_GES_RT	P4[6]/ CS_GES_DN
6	CapSense Sensor 10	–	–	–	–	P7[4]/ CS_RS_E0
7	CapSense Sensor 11	–	–	–	–	P7[5]/ CS_RS_E1
8	CapSense Sensor 12	–	–	–	–	P7[6]/ CS_RS_E2
9	CapSense Sensor 13	–	–	–	–	P7[7]/ CS_RS_E3
10	CapSense Sensor 6	–	–	–	–	P0[0]/ CS_RS_E4
11	CapSense Sensor 7	–	–	–	–	P0[1]/ CS_RS_E5
12	CapSense Sensor 8	–	–	–	–	P7[2]/ CS_RS_E6
13	CapSense Sensor 9	–	–	–	–	P7[3]/ CS_RS_E7
14	CMOD[b]	P4[2]	P0[4]	P4[0]	P4[2]	P4[2]
15	CTANK[b]	P4[3]	P0[2]	P4[1]	P4[3]	P4[3]
16	CMOD[b]	–	–	–	–	P5[0]
17	CTANK[b]	–	–	–	–	P5[1]
18	CapSense Shield	P0[1]	–	P1[6]	P0[1]	P0[2]

a. The CapSense elements are present on the CY8CKIT-046 shield board. The radial slider (CapSense sensors 6 to 13) is symmetric and the sensor order can be shifted to fit your requirement, that is, the desired zero position on the slider.
b. CMOD0, CTANK0, CMOD1, and CTANK1 are only present in the CY8CKIT-046 PSoC 4 L-Series Pioneer Kit.

Proximity Header Pin Map						
Pin #	Description	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	PROXIMITY	–	P2[0]	P2[0]	P3[7]	P9[4]
2		–	–	–	P3[6]	P9[5]

RGB LED Pin Map						
Pin #	Color	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	Red	P1[6]	P3[2]	P2[6]	P0[6]	P5[2]
2	Green	P0[2]	P1[1]	P3[6]	P2[6]	P5[3]
3	Blue	P0[3]	P0[2]	P3[7]	P6[5]	P5[4]

User Switch Pin Map						
Pin #	Description	Pioneer Series Kits				
		CY8CKIT-042	CY8CKIT-040	CY8CKIT-042-BLE	CY8CKIT-044	CY8CKIT-046
1	SW2	P0[7]	–	P2[7]	P0[7]	P0[7]

Revision History

Document Revision History

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
**	5162292	03/04/2016	UDYG	New kit guide.
*A	5631447	02/17/2017	AARA / SRDS	Updated Safety Information chapter on page 6: Added "Regulatory Compliance Information" on page 8. Updated Introduction chapter on page 10: Updated description. Updated table "Default BLE Modules and BLE Dongle in the Two BLE Pioneer Kits". Updated "Kit Contents" on page 11: Updated description. Updated "BLE Pioneer Baseboard Details" on page 12: Updated description. Updated Figure 1-3, and Figure 1-4. Updated "Getting Started" on page 17: Updated description. Updated "Additional Learning Resources" on page 17: Updated description. Updated Kit Operation chapter on page 25: Updated "Theory of Operation" on page 25: Updated description. Updated Figure 3-2. Updated "KitProg" on page 27: Updated description. Updated "Placing PSoC 4 BLE Module on Baseboard" on page 28: Updated heading to read as "Placing PSoC 4 BLE Module on Baseboard". Updated Figure 3-5 (Updated caption only). Updated description. Updated "USB-UART Bridge" on page 34: Updated description. Updated "USB-I2C Bridge" on page 35: Updated description.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*A (cont.)	5631447	02/17/2017	AARA / SRDS	Updated Code Examples chapter on page 37: Updated description. Updated “Using Code Examples” on page 37: Updated Figure 4-1. Updated description. Updated “CapSense Slider and LED” on page 41: Updated “Project Description” on page 41: Updated description. Removed figure “TopDesign for PRoC_BLE_CapSense_Slider_LED Project”. Updated “Hardware Connections” on page 43: Updated description. Updated “Verify Output” on page 45: Updated “CySmart Central Emulation Tool” on page 45: Updated description. Updated Figure 4-22. Updated “CySmart Mobile Application” on page 50: Updated description. Updated “CapSense Proximity” on page 53: Updated “Project Description” on page 53: Updated description. Removed figure “Top Design for PRoC_BLE_CapSense_Proximity Project”. Updated “Hardware Connections” on page 55: Updated description. Removed figure “Proximity Sensor Connection on BLE Pioneer Kit with PRoC BLE Module”. Updated “Verify Output” on page 57: Updated “CySmart Central Emulation Tool” on page 57: Updated description. Updated “CySmart Mobile Application” on page 61: Updated description. Updated “BLE Central Mode” on page 62: Updated “Project Description” on page 62: Updated description. Removed figure “PRoC_BLE_Central_IAS TopDesign”. Updated “Hardware Connections” on page 64: Updated description. Updated “Verify Output” on page 66: Updated description.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*A (cont.)	5631447	02/17/2017	AARA / SRDS	Updated “Eddystone” on page 69: Updated “Project Description” on page 69: Updated description. Updated Figure 4-56 (Updated caption only). Updated “Hardware Connection” on page 72: Updated description. Updated “Verify Output” on page 73: Updated description. Updated “BLE Dongle and LED Control”: Updated “Verify Output”: Updated description. Updated “Direct Test Mode (DTM)” on page 78: Updated “Project Description” on page 78: Updated description. Updated “Verify Output” on page 81: Updated description. Updated Hardware chapter on page 82: Updated “BLE Pioneer Baseboard” on page 82: Updated “Power System” on page 82: Updated “Current Measurement Jumper” on page 86: Updated description. Updated “Programming Interface” on page 89: Updated description. Updated “Expansion Connectors” on page 89: Updated “Arduino-Compatible Headers (J1, J2, J3, J4, and J12-unpopulated)” on page 89: Updated description. Updated “CapSense Circuit” on page 93: Updated “CapSense Slider” on page 93: Updated description. Updated “Cypress Ferroelectric RAM (F-RAM)” on page 97: Updated description. Updated “Serial Interconnection between KitProg and Module” on page 98: Updated Figure 5-19. Updated “Module Headers” on page 99: Updated description.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*A (cont.)	5631447	02/17/2017	AARA / SRDS	Updated “Module Board” on page 100: Updated “PSoC 4 BLE Device” on page 100: Updated heading to read as “PSoC 4 BLE Device”. Updated description. Updated Figure 5-21. Updated “Module Power Connections” on page 101: Updated Figure 5-22. Updated “Module Headers (20-Pin and 24-Pin Headers)” on page 102: Updated description. Updated Figure 5-23. Updated “Wiggle Antenna” on page 103: Updated description. Updated Figure 5-24. Updated “Antenna Matching Network” on page 104: Updated Figure 5-25. Updated “BLE Passives” on page 105: Updated Figure 5-26. Updated “BLE Dongle Board” on page 106: Updated Figure 5-27. Updated “Power System” on page 107: Updated Figure 5-28. Updated “USB Type-A Plug” on page 107: Updated Figure 5-29. Updated “User LED” on page 108: Updated Figure 5-30. Updated Appendix chapter on page 111: Updated “Bill of Materials (BOM)” on page 111: Updated “KitProg Status LED States” on page 111: Removed “CY5676A PRoC BLE 256KB Module”. Updated “Programming BLE PSoC 4 BLE Module via MiniProg3” on page 114: Updated heading to read as “Programming BLE PSoC 4 BLE Module via MiniProg3”. Updated description.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*A (cont.)	5631447	02/17/2017	AARA / SRDS	Updated "BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit" on page 115: Updated description. Updated "CY8CKIT-143A PSoC 4 BLE 256KB Module" on page 117: Updated Figure A-6. Removed "CY5671 PRoC BLE Module". Removed "CY5674 PRoC BLE SMA Module". Removed "CY5676 PRoC BLE 256KB Module". Removed "CY5676A PRoC BLE 256KB Module". Updated "CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)" on page 117: Updated Figure A-7. Updated to new template. Completing Sunset Review.
*B	5751101	05/26/2017	SAGA	Updated Introduction chapter on page 10: Updated description. Updated table "Default BLE Modules and BLE Dongle in the Two BLE Pioneer Kits" (Removed CY8CKIT-042 BLE related information). Updated "Kit Contents" on page 11: Updated Figure 1-1 (Updated with latest Cypress logo). Updated "Additional Learning Resources" on page 17: Updated description. Updated Software Installation chapter on page 21: Updated "Install Software" on page 21: Updated Figure 2-1. Updated description. Updated Code Examples chapter on page 37: Updated "BLE Dongle and LED Control": Updated "Project Description": Updated description (Removed CY5670 related information from the note above figure "Top Design for BLE_4_2_Dongle_CySmart_256K Project"). Updated Appendix chapter on page 111: Updated "BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit" on page 115: Updated tables (Removed CY8CKIT-141, CY8CKIT-142 and CY5670 related information). Removed "CY8CKIT-142 PSoC 4 BLE Module". Removed "CY8CKIT-141 PSoC 4 BLE SMA Module". Removed "CY5670 CySmart USB Dongle (BLE Dongle)".

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*C	5801218	07/06/2017	SAGA	Updated Software Installation chapter on page 21: Updated “Install Software” on page 21: Updated description. Updated Code Examples chapter on page 37: Updated “Using Code Examples” on page 37: Updated Figure 4-1.
*D	5823124	07/18/2017	GRSK / SAGA	Updated Introduction chapter on page 10: Updated description. Updated table “Default BLE Modules and BLE Dongle in the Two BLE Pioneer Kits”. Updated “Additional Learning Resources” on page 17: Updated description. Updated Code Examples chapter on page 37: Updated “Eddystone” on page 69: Updated “Verify Output” on page 73: Updated description. Updated Hardware chapter on page 82: Updated “BLE Dongle Board” on page 106: Updated description. Updated Appendix chapter on page 111: Updated “BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit” on page 115: Updated tables. Added “CY8CKIT-142 PSoC 4 BLE Module” on page 115. Added “CY8CKIT-141 PSoC 4 BLE SMA Module” on page 116.
*E	6190680	05/30/2018	SAGA	Replaced “PRoC BLE” with “PSoC 4 BLE” in all instances across the document. Replaced “Example Projects” with “Code Examples” in all instances across the document. Replaced “Projects” with “Code Examples” in all instances across the document.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*E (cont.)	6190680	05/30/2018	SAGA	Updated Introduction chapter on page 10: Updated description. Removed table “Default BLE Modules and BLE Dongle in the Two BLE Pioneer Kits”. Updated “Kit Contents” on page 11: Updated Figure 1-1. Updated “BLE Pioneer Baseboard Details” on page 12: Updated Figure 1-4. Updated “PSoC Creator” on page 14: Updated “PSoC Creator Code Examples” on page 15: Updated Figure 1-6. Updated “Kit Code Examples” on page 16: Updated description. Updated “Technical Support” on page 19: Updated description. Updated Software Installation chapter on page 21: Updated “Install Software” on page 21: Updated description. Updated Kit Operation chapter on page 25: Updated “Programming and Debugging BLE Device” on page 29: Updated “Programming using PSoC Creator” on page 29: Updated Figure 3-7. Updated “Programming using PSoC Programmer” on page 31: Updated description. Updated “Updating BLE Dongle for CySmart Central Emulation Tool” on page 32: Updated description. Updated Figure 3-14, and Figure 3-15. Removed figure “Programming Hex File to Dongle”. Updated “USB-UART Bridge” on page 34: Updated description. Updated “USB-I2C Bridge” on page 35: Updated description.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*E (cont.)	6190680	05/30/2018	SAGA	Updated Code Examples chapter on page 37: Updated description. Updated “Using Code Examples” on page 37: Updated description. Updated Figure 4-1. Updated “CapSense Slider and LED” on page 41: Updated “Verify Output” on page 45: Updated “CySmart Central Emulation Tool” on page 45: Updated description. Updated Figure 4-11. Updated “CySmart Mobile Application” on page 50: Updated description. Updated “CapSense Proximity” on page 53: Updated “Verify Output” on page 57: Updated “CySmart Central Emulation Tool” on page 57: Updated description. Updated “CySmart Mobile Application” on page 61: Updated description. Updated “BLE Central Mode” on page 62: Updated “Project Description” on page 62: Updated description. Updated “Verify Output” on page 66: Updated Figure 4-51. Updated “Eddystone” on page 69: Updated “Verify Output” on page 73: Updated description. Removed figure “iOS Notification Shade Showing the Beacon Advertised Web Link”. Removed “BLE Dongle and LED Control”.

Document Revision History *(continued)*

Document Title: CY8CKIT-042-BLE-A Bluetooth® Low Energy (BLE) Pioneer Kit Guide Document Number: 002-11468				
Revision	**ECN Number**	**Issue Date**	**Origin of Change**	**Description of Change**
*E (cont.)	6190680	05/30/2018	SAGA	Updated Hardware chapter on page 82: Updated “BLE Pioneer Baseboard” on page 82: Updated “Expansion Connectors” on page 89: Updated “Arduino-Compatible Headers (J1, J2, J3, J4, and J12-unpopulated)” on page 89: Updated Figure 5-9. Updated “Push-Buttons” on page 96: Updated description. Updated “Module Board” on page 100: Updated “BLE Passives” on page 105: Updated Figure 5-26. Updated “BLE Dongle Board” on page 106: Updated description. Updated Figure 5-27. Updated “USB Type-A Plug” on page 107: Updated Figure 5-29. Updated “User LED” on page 108: Updated Figure 5-30. Updated Advanced Topics chapter on page 109: Updated “Using FM24V10 F-RAM” on page 109: Updated “Write/Read Operation” on page 110: Updated description. Updated Appendix chapter on page 111: Updated “Bill of Materials (BOM)” on page 111: Added description. Removed “BLE Pioneer Baseboard”. Removed “Module”. Removed “CY5677 CySmart BLE 4.2 USB Dongle”. Updated “KitProg Status LED States” on page 111: Added “LED is breathing” and its details Updated “BLE Modules and BLE Dongles Compatible with the BLE Pioneer Kit” on page 115: Updated “CY5677 CySmart BLE 4.2 USB Dongle (BLE Dongle)” on page 117: Updated description. Updated Figure A-7.