PSoC 4 BLE – BLE Proximity

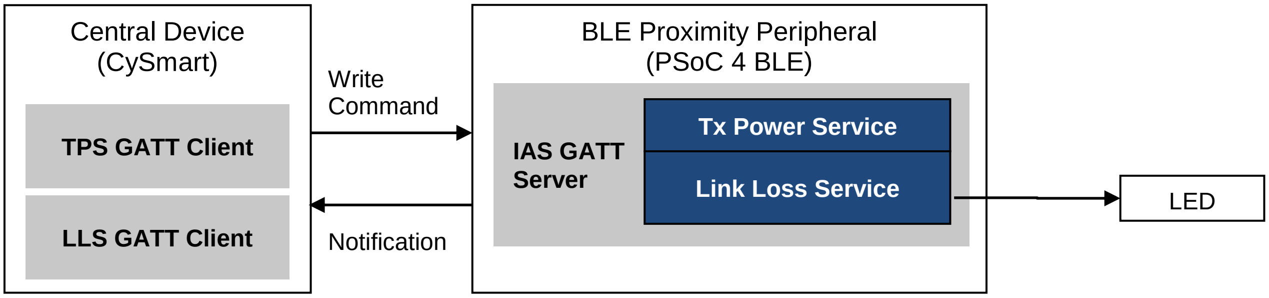
Objective

This example demonstrates the use of the BLE Component to design a BLE Proximity project utilizing BLE standard services Link Loss Service and Tx Power Service.

Overview

This example uses the BLE Pioneer Kit to design a Proximity application using the standard services defined by the Bluetooth SIG. In this example, the user button on BLE Pioneer Kit is used to decrement and cycle through the TX power of the radio and send these notifications back to Central device on Tx Power Service (TPS). Also, the project contains Link Loss Service (LLS), which can be written by Client device with one of the three alert levels, and is used to set the alert on disconnection (RGB LED).

Figure 1: PSoC 4 BLE Proximity Application



Requirements

Design Tool: PSoC Creator 3.1 SP1, CySmart 1.0

Programming Language: C (GCC 4.8.4 – included with PSoC Creator)

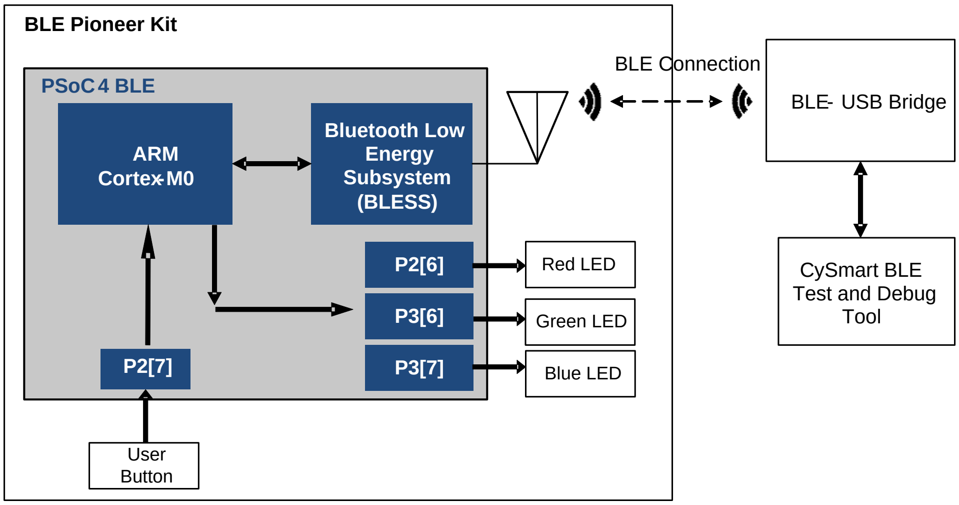
Associated Devices: All PSoC 4 BLE devices

Required Hardware: CY8CKIT-042-BLE Bluetooth® Low Energy (BLE) Pioneer Kit

Hardware Setup

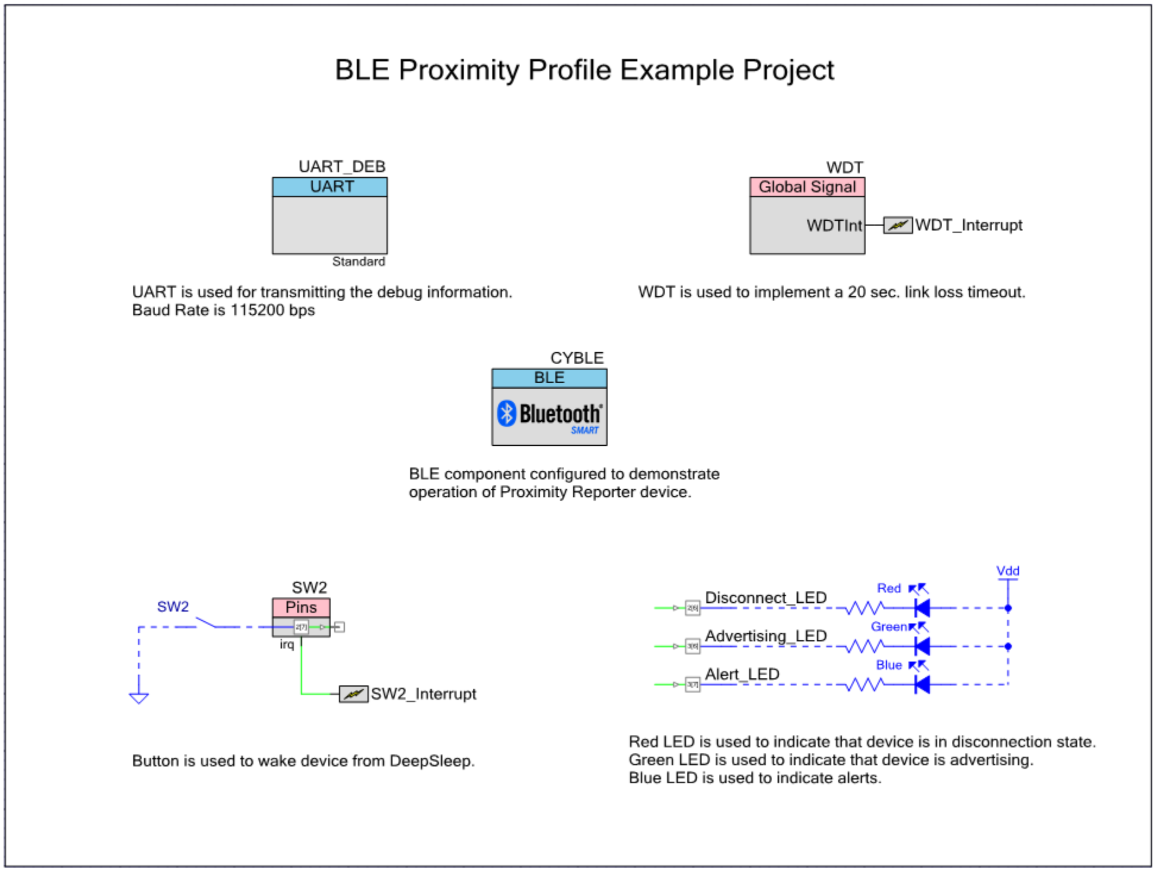
The BLE Pioneer Kit has all of the necessary hardware required for this lab. The RGB LED and User Button are connected to the GPIOs of the PSoC 4 BLE device, as shown in Figure 2.

Figure 2: Block Diagram



PSoC Creator Schematic

Figure 3. PSoC Creator Schematic



UART is used for transmitting the debug information.
Baud Rate is 115200 bps

WDT is used to implement a 20 sec. link loss timeout.

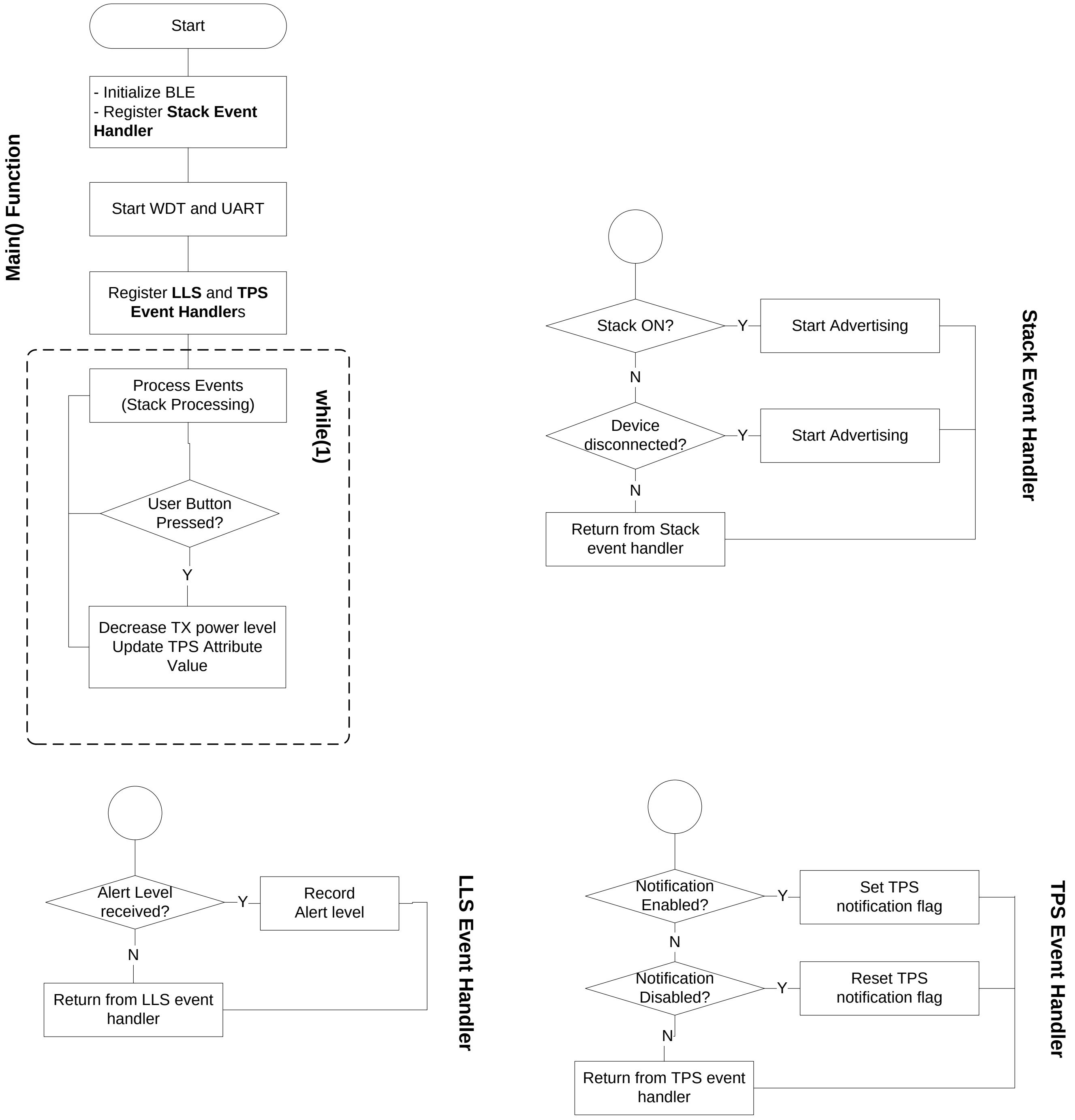
BLE component configured to demonstrate
operation of Proximity Reporter device.

Button is used to wake device from DeepSleep.

Red LED is used to indicate that device is in disconnection state.
Green LED is used to indicate that device is advertising.
Blue LED is used to indicate alerts.

Firmware Flow

Figure 4. Firmware Flow



1. **main() function**: This is the central function which performs the initialization of the BLE Stack, WDT for the LED timeout and UART for debugging. It then executes the necessary routines to process the BLE events and check user button input.

2. **GenericAppEventHandler () function**: This function handles the common events generated for the BLE Stack. For example, the event *CYBLE_EVT_STACK_ON* is received when the Stack is initialized and turned ON. The event *CYBLE_EVT_GAP_DEVICE_DISCONNECTED* is received when the BLE connection is disconnected.

3. **LlsServiceAppEventHandler() function**: This function handles the events for Link Loss Service. As a part of the event, it receives the alert levels which are used to drive the Blue LED after disconnection, as given in Table 1.

Table 1: Alert Level vs LED Blink Rate

Alert Level	LED Status
NO_ALERT	Always OFF
MILD_ALERT	LED toggling
HIGH_ALERT	Always ON

4. **TpsServiceAppEventHandler() function**: This function handles the events for Tx Power Service. As a part of the event, it receives the notification enable/disable events, which are used to send notification to the service from main loop.

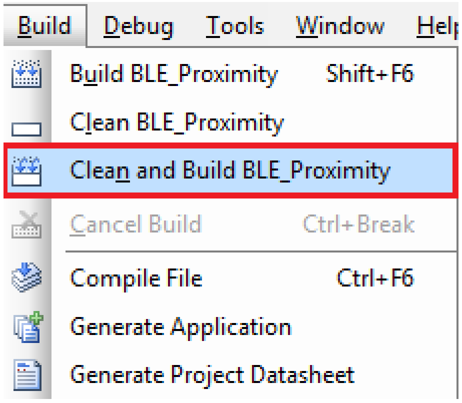
Build and Program

This section shows how to build the project and program the PSoC 4 BLE device. If you are using a development kit with a built-in programmer (BLE Pioneer Kit, for example), connect the BLE Pioneer Baseboard to your computer using the USB Standard-A to Mini-B cable. For other kits, refer to the kit user guide.

If you are developing on your own hardware, you need a hardware debugger, for example, a Cypress CY8CKIT-002 MiniProg3.

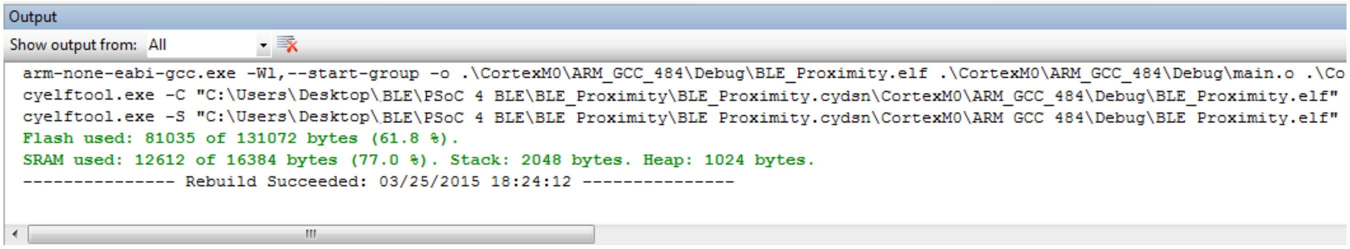
1. On PSoC Creator, select **Build** > **Clean and Build BLE_Proximity**, as shown in Figure 5.

Figure 5. Build Project



2. On a successful build, the total flash and SRAM usage is reported as shown in Figure 6.

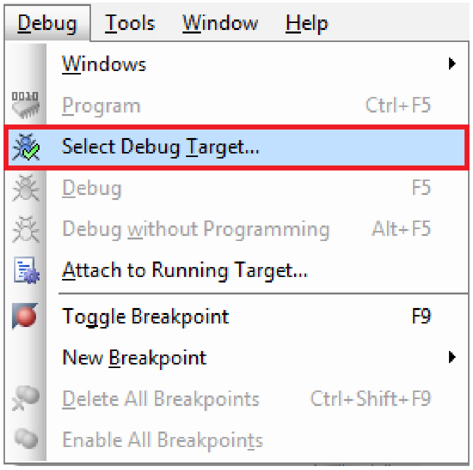
Figure 6. Build Succeeded



```
arm-none-eabi-gcc.exe -Wl,--start-group -o .\CortexM0\ARM_GCC_484\Debug\BLE_Proximity.elf .\CortexM0\ARM_GCC_484\Debug\main.o .\Co
cyelftool.exe -C "C:\Users\Desktop\BLE\PSoC 4 BLE\BLE_Proximity\BLE_Proximity.cydsn\CortexM0\ARM_GCC_484\Debug\BLE_Proximity.elf"
cyelftool.exe -S "C:\Users\Desktop\BLE\PSoC 4 BLE\BLE Proximity\BLE Proximity.cydsn\CortexM0\ARM GCC 484\Debug\BLE Proximity.elf"
Flash used: 81035 of 131072 bytes (61.8 %).
SRAM used: 12612 of 16384 bytes (77.0 %). Stack: 2048 bytes. Heap: 1024 bytes.
--------------- Rebuild Succeeded: 03/25/2015 18:24:12 ---------------
```

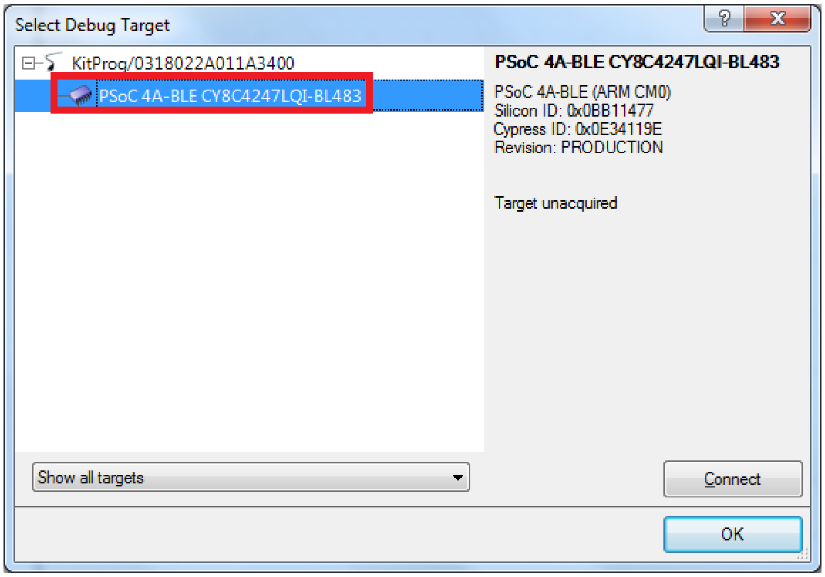
3. Select **Debug** > **Select Debug Target**, as shown in Figure 7.

Figure 7. Selecting Debug Target



4. In the **Select Debug Target** dialog box, click **Port Acquire**, and then click **Connect** as shown in Figure 8. Click **OK** to close the dialog box.

Figure 8. Connecting to a Device



PSoC 4A-BLE CY8C4247LQI-BL483

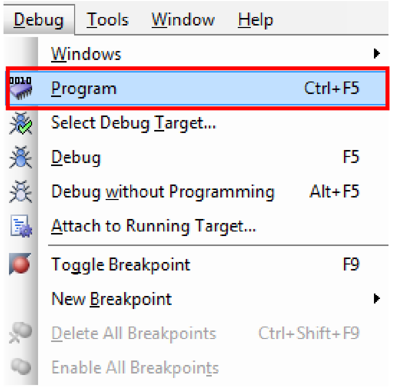
PSoC 4A-BLE (ARM CM0)
Silicon ID: 0x0BB11477
Cypress ID: 0x0E34119E
Revision: PRODUCTION

Target unacquired

If you are using your own hardware, make sure the Port Setting configuration under Select Debug Target window for your programming hardware is configured as per your setup.

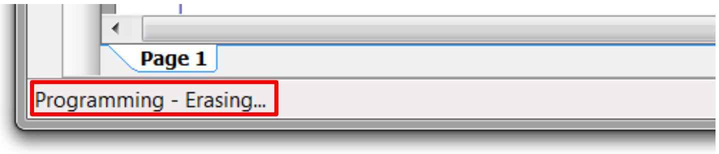
5. Select **Debug** > **Program** to program the device with the project, as shown in Figure 9.

Figure 9. Programming the Device



You can view the programming status on the PSoC Creator status bar (lower-left corner of the window), as shown in Figure 10.

Figure 10. Programming Status

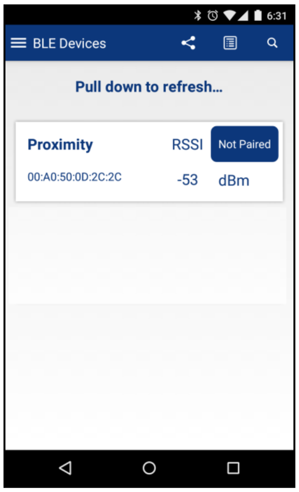


Testing

Testing with the CySmart iOS® or Android™ Mobile Apps:

1. Plug the BLE Pioneer Kit in your computer’s USB port. Ensure it has been programmed with *BLE_Proximity* project as per steps in previous section. The BLE Pioneer kit will start advertising, indicated by blinking Green LED.
2. If the BLE Pioneer kit is not connected within 20 seconds, the advertisement is stopped, indicated by a Red LED remaining ON. Click on user button SW2 to restart advertisement.
3. On your BLE-enabled mobile phone, open the **CySmart app** (available on the iOS and Android app stores)
4. Once the app is open, **swipe down** to refresh the list of nearby advertising BLE devices. See Figure 11.

Figure 11: CySmart App Scanning for BLE Devices

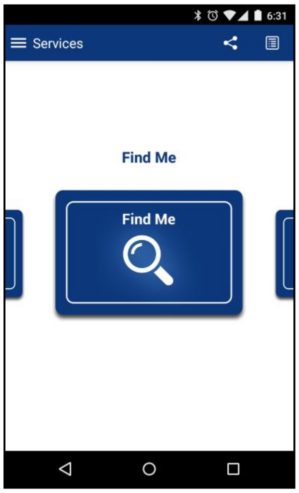


Pull down to refresh...

Proximity RSSI
00:A0:50:0D:2C:2C -53 dBm

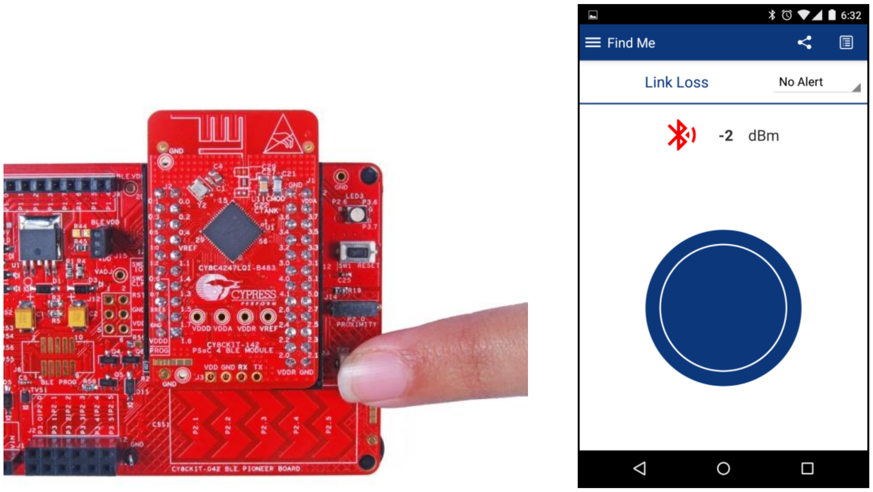
5. Tap on the device **Proximity** to connect to it.
6. **Swipe right** to see the **Find Me Profile** and tap on it to open the GUI page as shown in Figure 12.

Figure 12: CySmart App Find Me Service Tab



7. Press **user button (SW2)** on the BLE Pioneer Kit to reduce the **TX power**. See the current TX power on the App in dBm, as shown in Figure 13. If the current TX power is -18 dBM, pressing the user button will set TX power to +3 dBm.

Figure 13: Press User Button to change TX Power

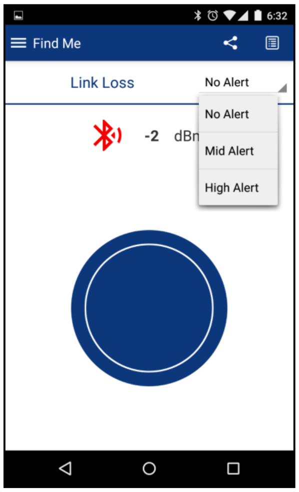


Link Loss No Alert

-2 dBm

8. For Link Loss alert setting, select from the **No Alert**, **Mid Alert**, or **High Alert** options as shown in Figure 14.

Figure 14: Set Link Loss Alert Level on BLE Pioneer Kit



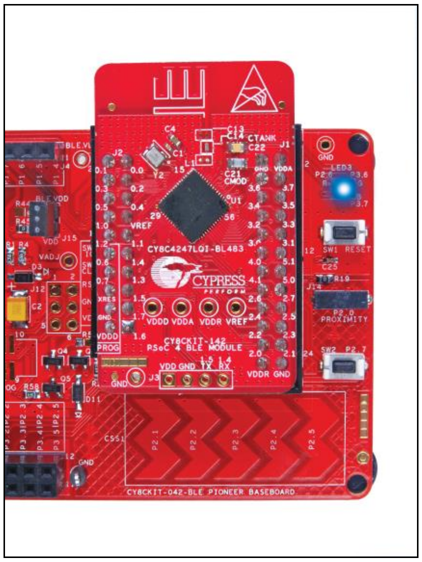
Link Loss No Alert

No Alert
Mid Alert
High Alert

-2 dBm

9. **Disconnect** from the BLE Pioneer Kit by either clicking on back button repeatedly until you are in device selection page, or by moving far from the BLE Pioneer Kit to go out of the RF range. As soon as the **disconnection/link loss** happens, the Blue LED will start blinking or remain ON, depending on whether Alert level was set as **Mid** or **High**, respectively. Blue LED will remain off for **No Alert** set.
Note: After disconnection, the Green LED will start blinking to indicate advertisement. The final color will be mix of both.

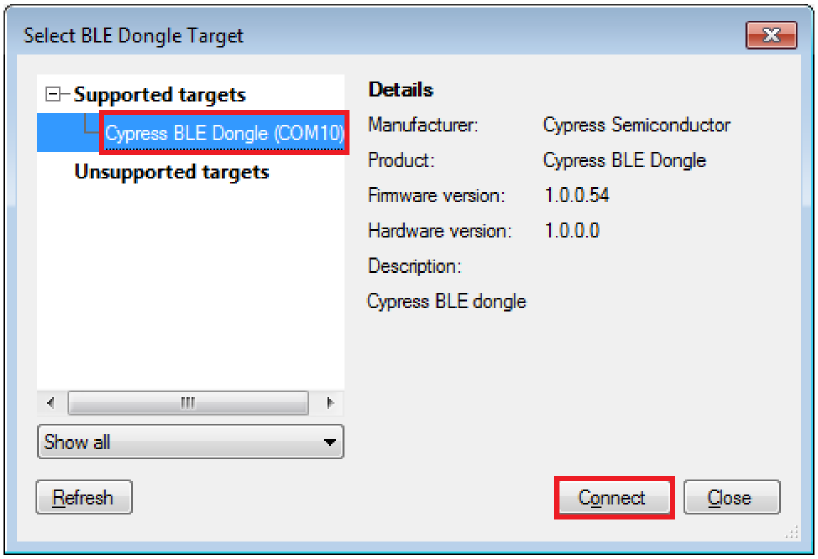
Figure 15. Blue LED status as per Alert level set.



Testing with the CySmart BLE Test and Debug Utility for Windows PC:

1. Plug the BLE-USB Bridge (included with the BLE Pioneer Kit) in your computer's USB port.
2. On your computer, launch **CySmart 1.0**. It is located in the **All Programs -> Cypress -> CySmart** folder in the Windows start menu. The tool opens up and asks you to **Select BLE Dongle Target**. Select the **Cypress BLE Dongle (COMxx)** and click **Connect**, as shown in Figure 16.

Figure 16: CySmart: Select BLE Dongle Target



Select BLE Dongle Target

Supported targets
- Cypress BLE Dongle (COM10)

Unsupported targets

Details

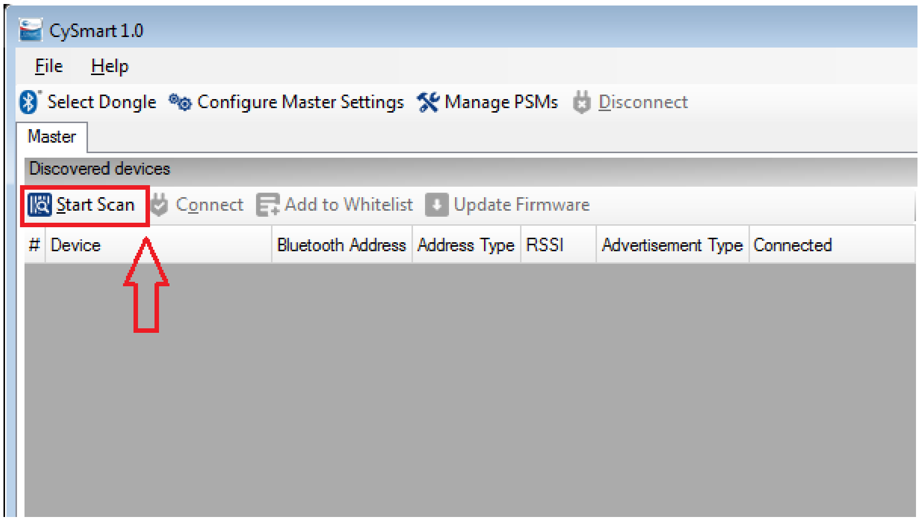
Manufacturer:	Cypress Semiconductor
Product:	Cypress BLE Dongle
Firmware version:	1.0.0.54
Hardware version:	1.0.0.0

Description:

Cypress BLE dongle

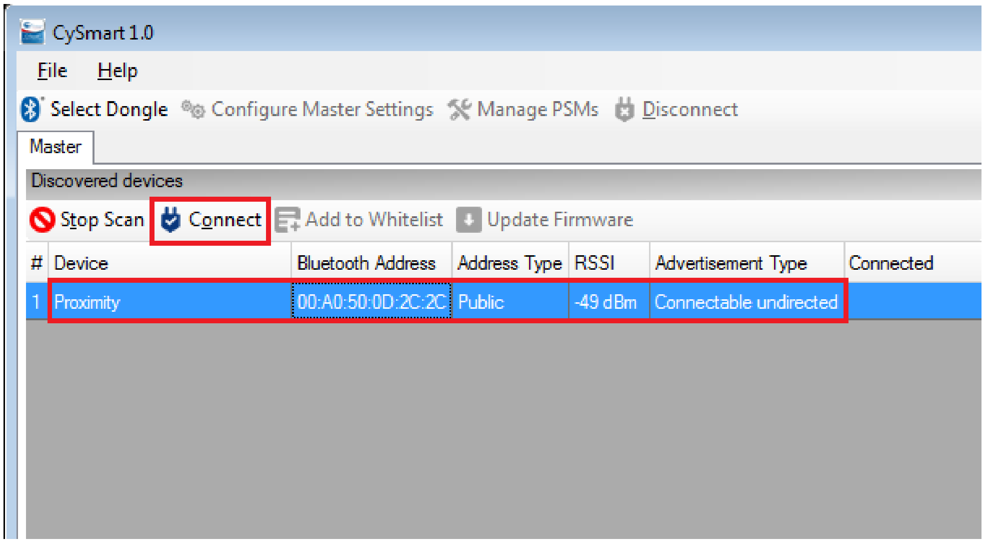
3. When the BLE-USB Bridge is connected, click on **Start Scan** to find your BLE device. See Figure 17.

Figure 17: Finding a BLE Device



4. The scanning stops automatically once all the nearby devices are known. The tool lists all the nearby devices in the Discovered devices section.
5. Click on **Proximity** device name. The **Connect** option is enabled. See Figure 18.

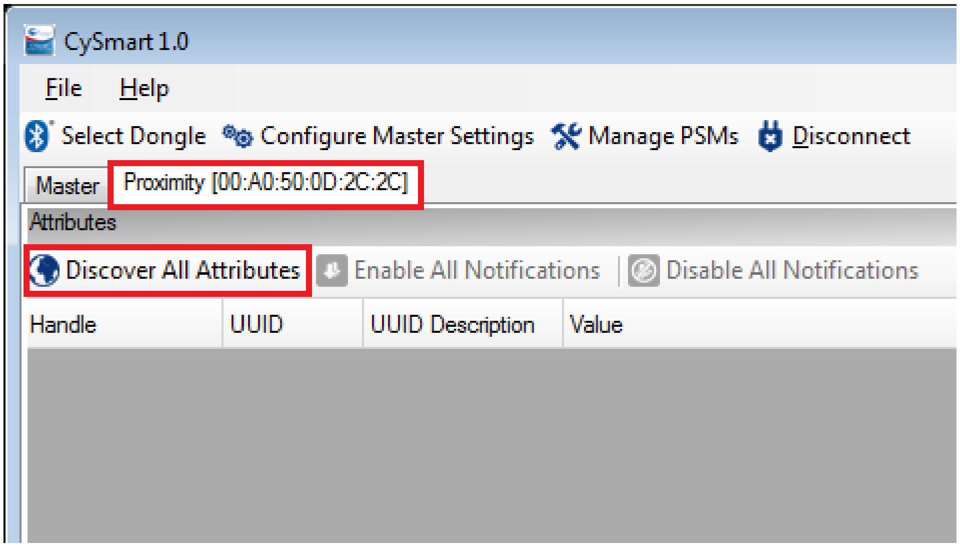
Figure 18: Device found



#	Device	Bluetooth Address	Address Type	RSSI	Advertisement Type	Connected
1	Proximity	00:A0:50:0D:2C:2C	Public	-49 dBm	Connectable undirected	

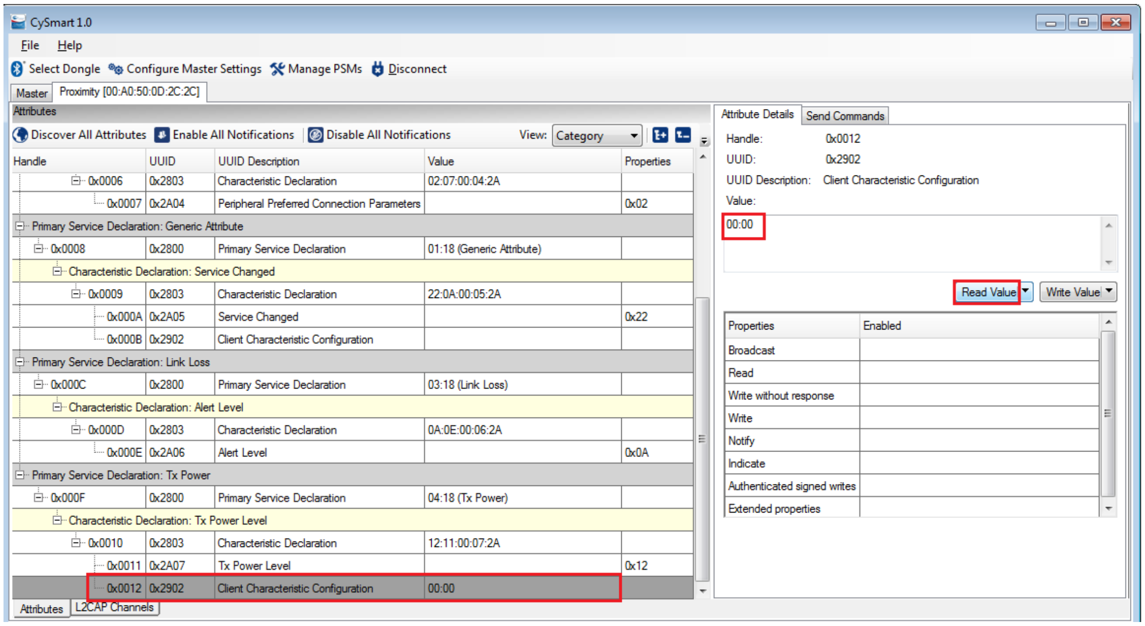
6. Click **Connect** as seen in Figure 18 to connect to the device.
7. The tool will now open a separate tab for the device. Click **Discover All Attributes** to list all the Attributes in the device, with their respective UUIDs and descriptions. See Figure 19.

Figure 19: Discovering Attributes of a Connected BLE Device



8. Locate the attributes for **Tx Power service** (end of the Attribute list). Select the **Client Characteristic Configuration** (Handle value as 0x0012) and click on **Read Value** on right to read its current value, as shown in Figure 20.

Figure 20: Reading Client Characteristic Configuration Descriptor Value



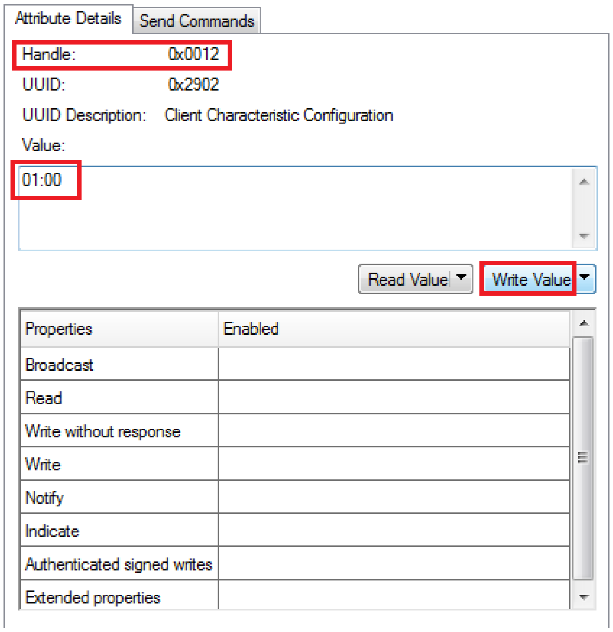
Handle	UUID	UUID Description	Value	Properties
0x0006	0x2803	Characteristic Declaration	02:07:00:04:2A	
0x0007	0x2A04	Peripheral Preferred Connection Parameters		0x02
Primary Service Declaration: Generic Attribute				
0x0008	0x2800	Primary Service Declaration	01:18 (Generic Attribute)	
Characteristic Declaration: Service Changed				
0x0009	0x2803	Characteristic Declaration	22:0A:00:05:2A	
0x000A	0x2A05	Service Changed		0x22
0x000B	0x2902	Client Characteristic Configuration		
Primary Service Declaration: Link Loss				
0x000C	0x2800	Primary Service Declaration	03:18 (Link Loss)	
Characteristic Declaration: Alert Level				
0x000D	0x2803	Characteristic Declaration	0A:0E:00:06:2A	
0x000E	0x2A06	Alert Level		0x0A
Primary Service Declaration: Tx Power				
0x000F	0x2800	Primary Service Declaration	04:18 (Tx Power)	
Characteristic Declaration: Tx Power Level				
0x0010	0x2803	Characteristic Declaration	12:11:00:07:2A	
0x0011	0x2A07	Tx Power Level		0x12
0x0012	0x2902	Client Characteristic Configuration	00:00	

Handle: 0x0012
UUID: 0x2902
UUID Description: Client Characteristic Configuration
Value:
00:00

Properties	Enabled
Broadcast	
Read	
Write without response	
Write	
Notify	
Indicate	
Authenticated signed writes	
Extended properties	

9. Modify the value to **01:00** and click on **Write Value** to enable notifications, as shown in Figure 21.

Figure 21. Write to Client Characteristic Configuration to enable notifications



Handle: 0x0012

UUID: 0x2902

UUID Description: Client Characteristic Configuration

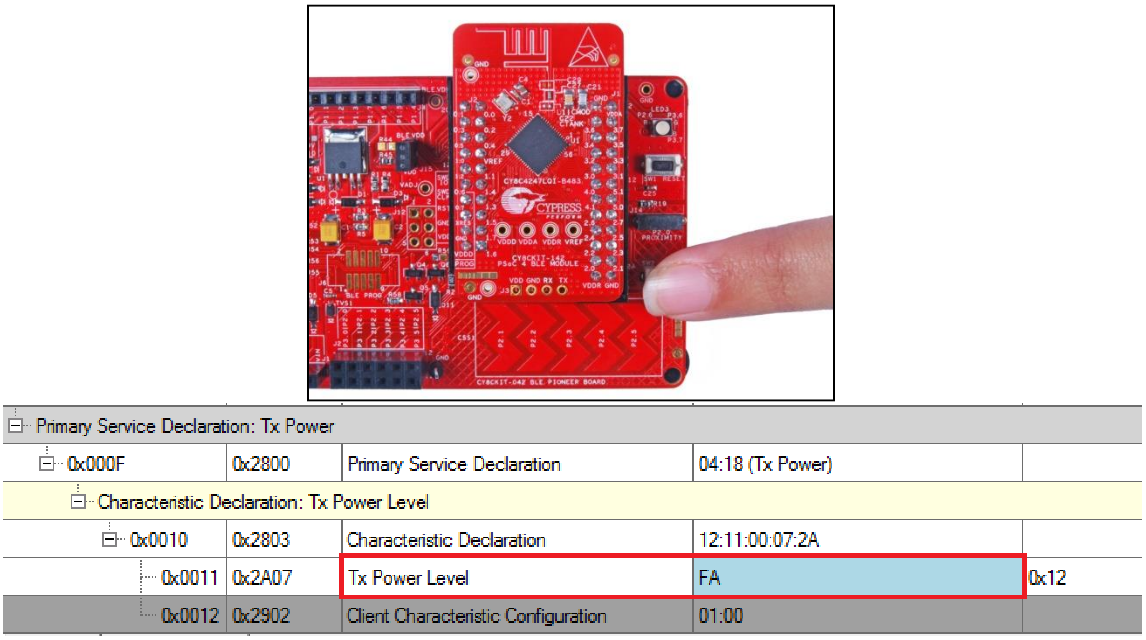
Value:

01:00

Properties	Enabled
Broadcast	
Read	
Write without response	
Write	
Notify	
Indicate	
Authenticated signed writes	
Extended properties	

10. Press the **user button (SW2)** on BLE Pioneer Kit to change TX power. You will also see the new TX power value being received on CySmart PC Tool on TX Power Level Characteristic (Handle value as 0x0011), as shown in Figure 22.

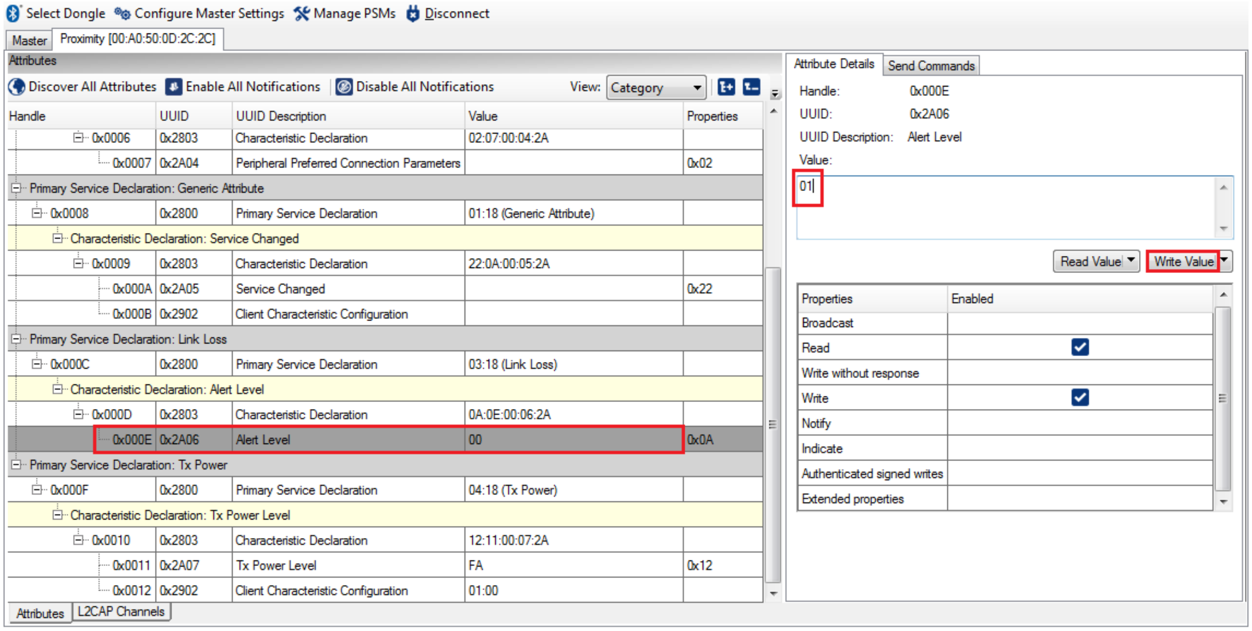
Figure 22. Change TX Power level



Primary Service Declaration: Tx Power				
0x000F	0x2800	Primary Service Declaration	04:18 (Tx Power)	
Characteristic Declaration: Tx Power Level				
0x0010	0x2803	Characteristic Declaration	12:11:00:07:2A	
0x0011	0x2A07	Tx Power Level	FA	0x12
0x0012	0x2902	Client Characteristic Configuration	01:00	

11. Locate the **Alert Level** Attribute for the **Link Loss Service** (Handle value as 0x000E). On the right, write a value of **01** to send LLS Alert Level to the Kit. See Figure 23.

Figure 23: Writing LLS Alert Level Value



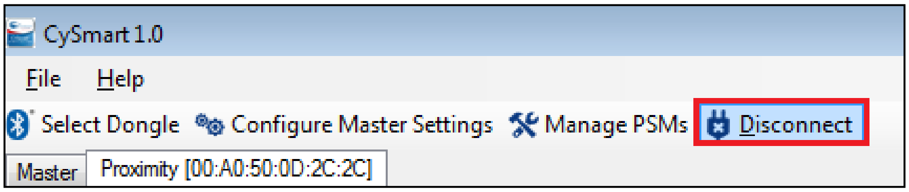
Handle	UUID	UUID Description	Value	Properties
0x0006	0x2803	Characteristic Declaration	02:07:00:04:2A	
0x0007	0x2A04	Peripheral Preferred Connection Parameters		0x02
Primary Service Declaration: Generic Attribute				
0x0008	0x2800	Primary Service Declaration	01:18 (Generic Attribute)	
Characteristic Declaration: Service Changed				
0x0009	0x2803	Characteristic Declaration	22:0A:00:05:2A	
0x000A	0x2A05	Service Changed		0x22
0x000B	0x2902	Client Characteristic Configuration		
Primary Service Declaration: Link Loss				
0x000C	0x2800	Primary Service Declaration	03:18 (Link Loss)	
Characteristic Declaration: Alert Level				
0x000D	0x2803	Characteristic Declaration	0A:0E:00:06:2A	
0x000E	0x2A06	Alert Level	00	0x0A
Primary Service Declaration: Tx Power				
0x000F	0x2800	Primary Service Declaration	04:18 (Tx Power)	
Characteristic Declaration: Tx Power Level				
0x0010	0x2803	Characteristic Declaration	12:11:00:07:2A	
0x0011	0x2A07	Tx Power Level	FA	0x12
0x0012	0x2902	Client Characteristic Configuration	01:00	

Handle: 0x000E
UUID: 0x2A06
UUID Description: Alert Level
Value:
01

Properties	Enabled
Broadcast	
Read	☑
Write without response	
Write	☑
Notify	
Indicate	
Authenticated signed writes	
Extended properties	

12. Click on **Disconnect** to disconnect from the device, as shown in Figure 24. The Blue LED will start to blink.

Figure 24. Disconnect from CySmart PC Tool



13. Repeat the step for High Alert.

Related Documents

Table 2 lists all relevant application notes, code examples, knowledge base articles, device datasheets, and Component / user module datasheets.

Table 2. Related Documents

Document	Title	Comment
AN91267	Getting Started with PSoC 4 BLE	Provides an introduction to PSoC 4 BLE device that integrates a Bluetooth Low Energy radio system along with programmable analog and digital resources.
AN91445	Antenna Design Guide	Provides guidelines on how to design an antenna for BLE applications.