

PSoC 4 BLE Lab3: IoT Sensor-Based System Design

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Link: https://github.com/gbauman01/Embedded_Systems_Lab_3

Due: October 14th, 2016

Description

This lab teaches you to create a heart rate sensor device by measuring an analog signal input on the PSoC 4 BLE device and reporting the measured heart rate value to a BLE enabled device such as an iPhone.

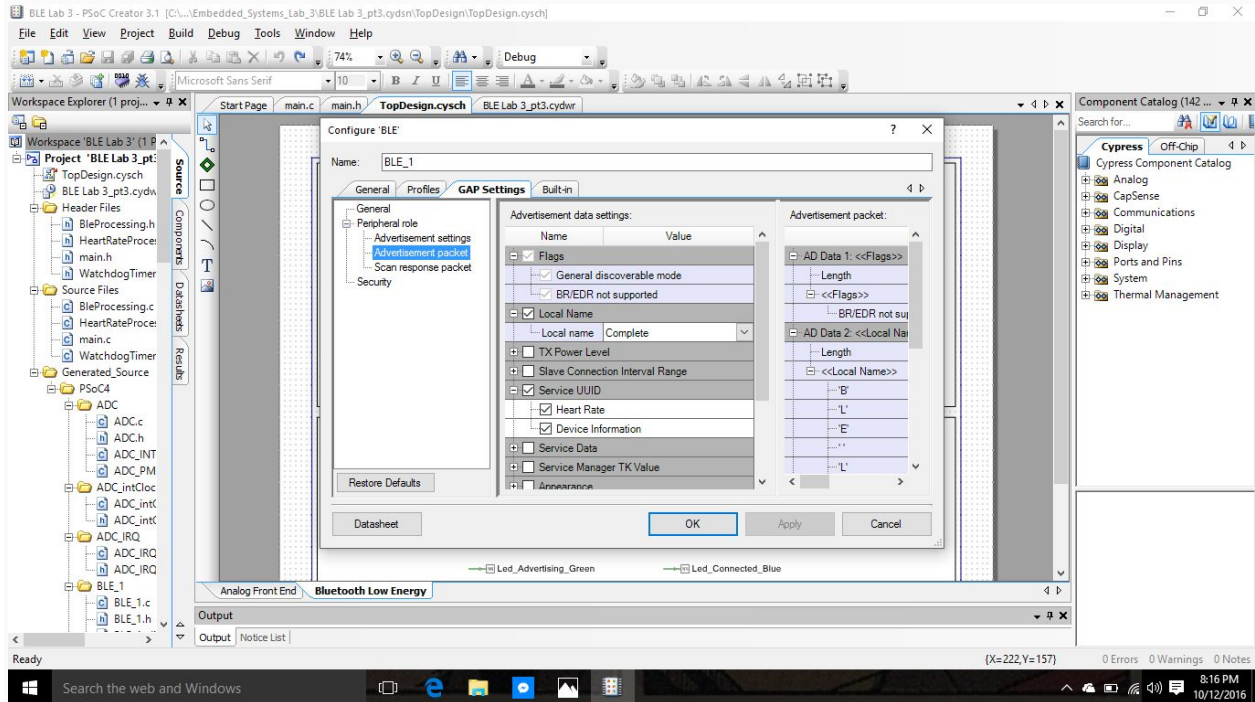
Objectives

1. Measure simulated heart rate using the Programmable Analog Blocks
2. Implement a Heart Rate Profile and send the data over BLE
3. Optimize the design for low power consumption using Sleep, Deep-Sleep and Hibernate modes

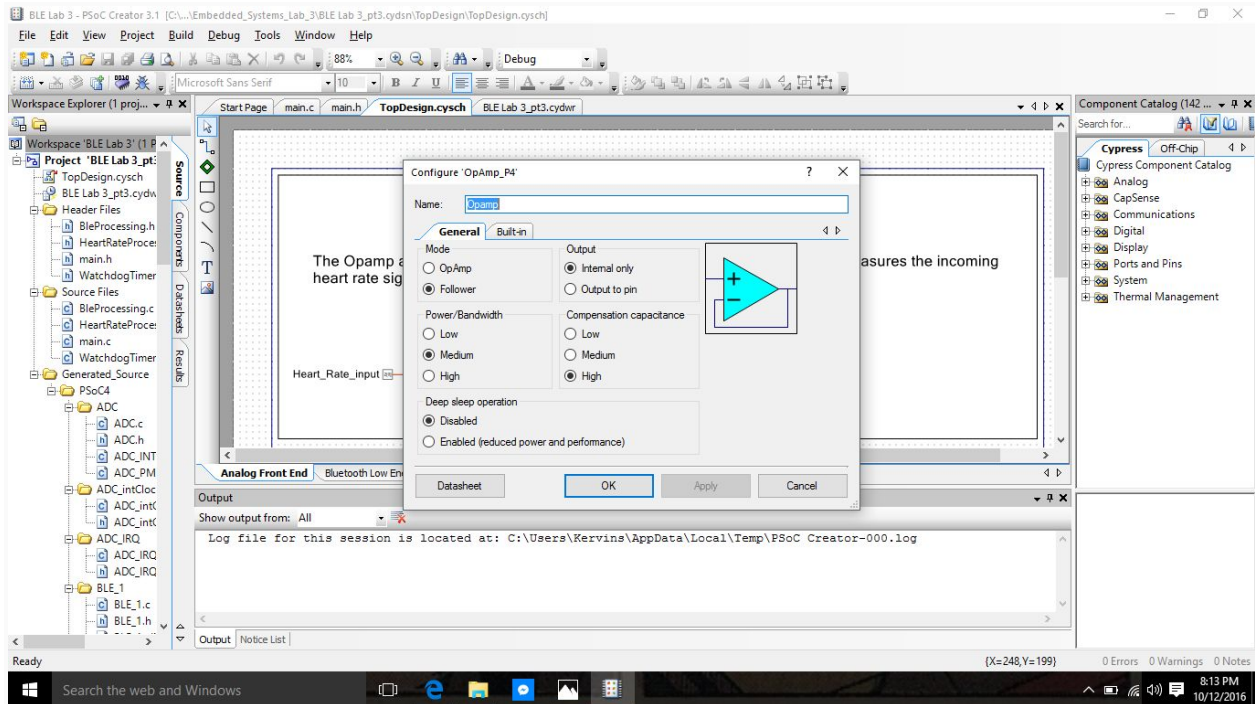
Process: Configure Schematic

- 1) Under the "TopDesign.cysch" from the "Workspace Explorer" drag and place a "Bluetooth Low Energy" Component from the "Component Catalog" under the communications category. This is in the "Bluetooth Low Energy tab" located at the bottom of the window.
- 2) Configure the component to the appropriate parameters and settings.
 - a) Under the "General Tab"
 - i) Profile: "Heart Rate"
 - ii) Profile Role: "Heart Rate Server (GATT Server)"
 - b) Under the "Profiles Tab"
 - i) "Device Information" Section
 - (1) "Manufacturer Name String" Sub-Section
 - (a) Type in "Cypress Semiconductor" in the "Manufacture Name" value
 - c) Under the "GAP Settings" tab
 - i) "General" Section
 - (1) Check off "Silicon generated 'Company assigned' part of the address (00A050-XXXXXX)"
 - (2) Device Name: "BLE Lab 3"
 - (3) Appearance: "Generic Heart Rate Sensor"
 - (4) MTU size (bytes): "23"
 - (5) TX power Level (dBm): "0"
 - ii) "Peripheral" Section
 - (1) "Advertisement Settings" Sub-section
 - (a) Discovery Mode: "General"
 - (b) Advertising Type: "Connectable undirected advertising"
 - (c) Filter policy: "Scan request Any | Connect request Any"
 - (d) Advertising channel map: "Any"
 - (e) Uncheck "Slow Advertising Interval"
 - (2) "Advertisement Packet" sub-section
 - (a) Check "Local name"
 - (i) Local Name: Complete
 - (b) Check "Heart Rate"
 - (i) Check "Device Information"
 - (3) "Scan Response Packet" sub-section
 - (a) Check "Local Name"
 - (i) Local Name: Complete
 - iii) "Security" Section
 - (1) Security Mode: "Mode 1"

- (2) Security Level: “No Security(No authentication, No encryption)”
- (3) I/O Capabilities: “No Input No Output”
- (4) Pairing Method: “Just Works”
- (5) Bonding Requirement: “No Bonding”
- (6) Encryption Key Size (bytes): “16”



- 3) Under the “Analog Front End” sheet of the schematic, and find the “Opamp” component in the Component Catalog. Drag the component and drop it onto the schematic, and double-click to configure it.
 - a) Name: “Opamp”
 - b) “General” Tab
 - i) Check “Follower” under Mode
 - ii) Check “Medium” under Power/Bandwidth
 - iii) Check “Disabled” under Deep Sleep Operation
 - iv) Check “Internal Only” under Output
 - v) Check “High” under Compensation Capacitance



4) Find the “Sequencing SAR ADC” component in the component catalog. Drag it onto the “Analog Front End” sheet and configure the component.

a) Name: “ADC”

b) “General” Tab

i) Timing

(1) Check “Channel sample rate (SPS)”: 166666

ii) Input Range

(1) Vref select: “Internal 1.024 volts, bypassed”

(2) Input buffer gain: “Disabled”

(3) Single ended negative input: “Yes”

iii) Clock Source

(1) Check “Internal”

iv) Sample Mode

(1) Check “Hardware trigger”

v) Result Data Format

(1) Differential Result Format: “Signed”

c) “Channels” tab

i) Sequenced Channels: “1”

ii) Channel 0

(1) Check “enable”

(2) Resolution: 12

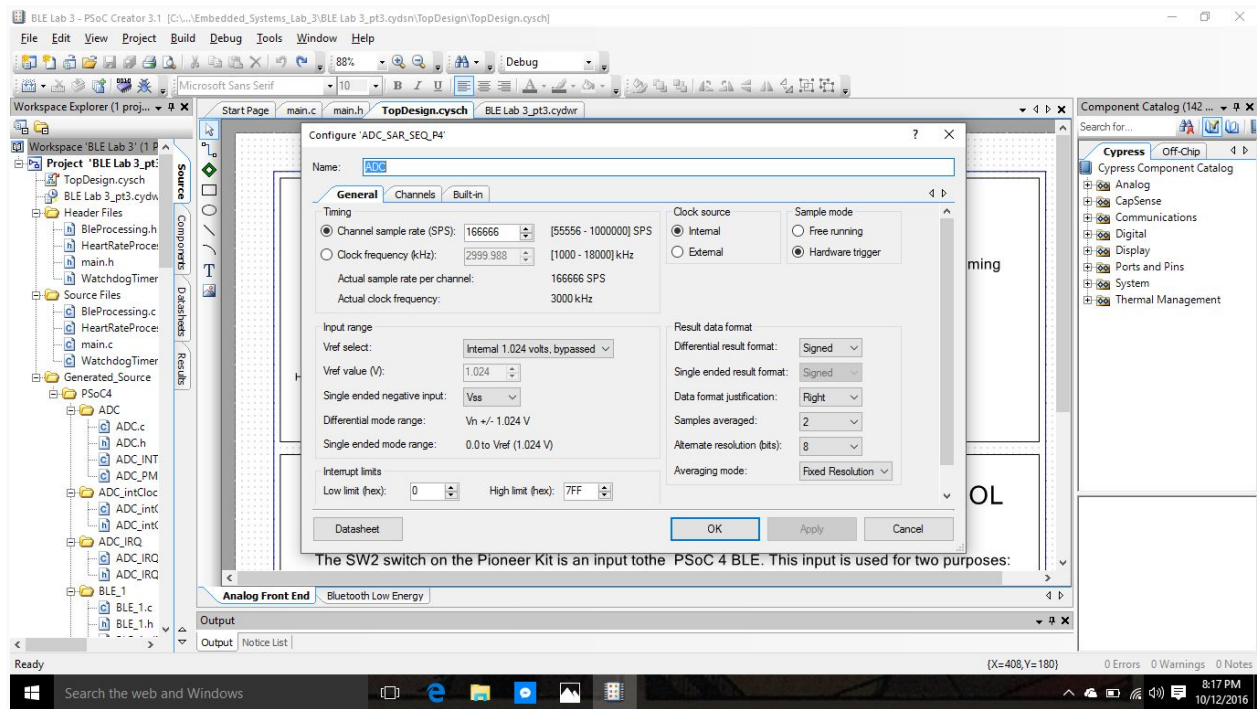
(3) Mode: Single

(4) AVG: unchecked

(5) ACq Time: “A clks”

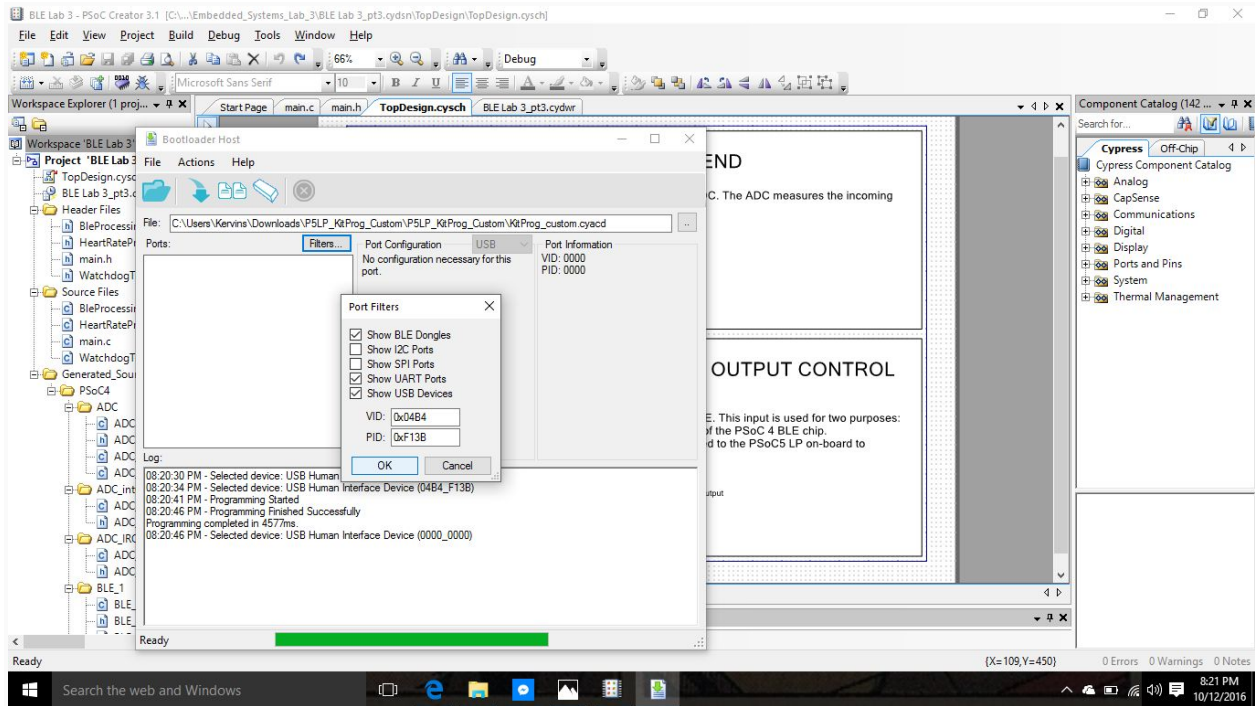
(6) Conversion time: 6us

- 5) Add a “Low Logic ‘0’” component to the schematic editor, and connect its output to the “soc” input of the “ADC” component. Then connect the “Heart_Rate_Input” pin terminal to the ‘+’ input of the “ADC”



Build and Program

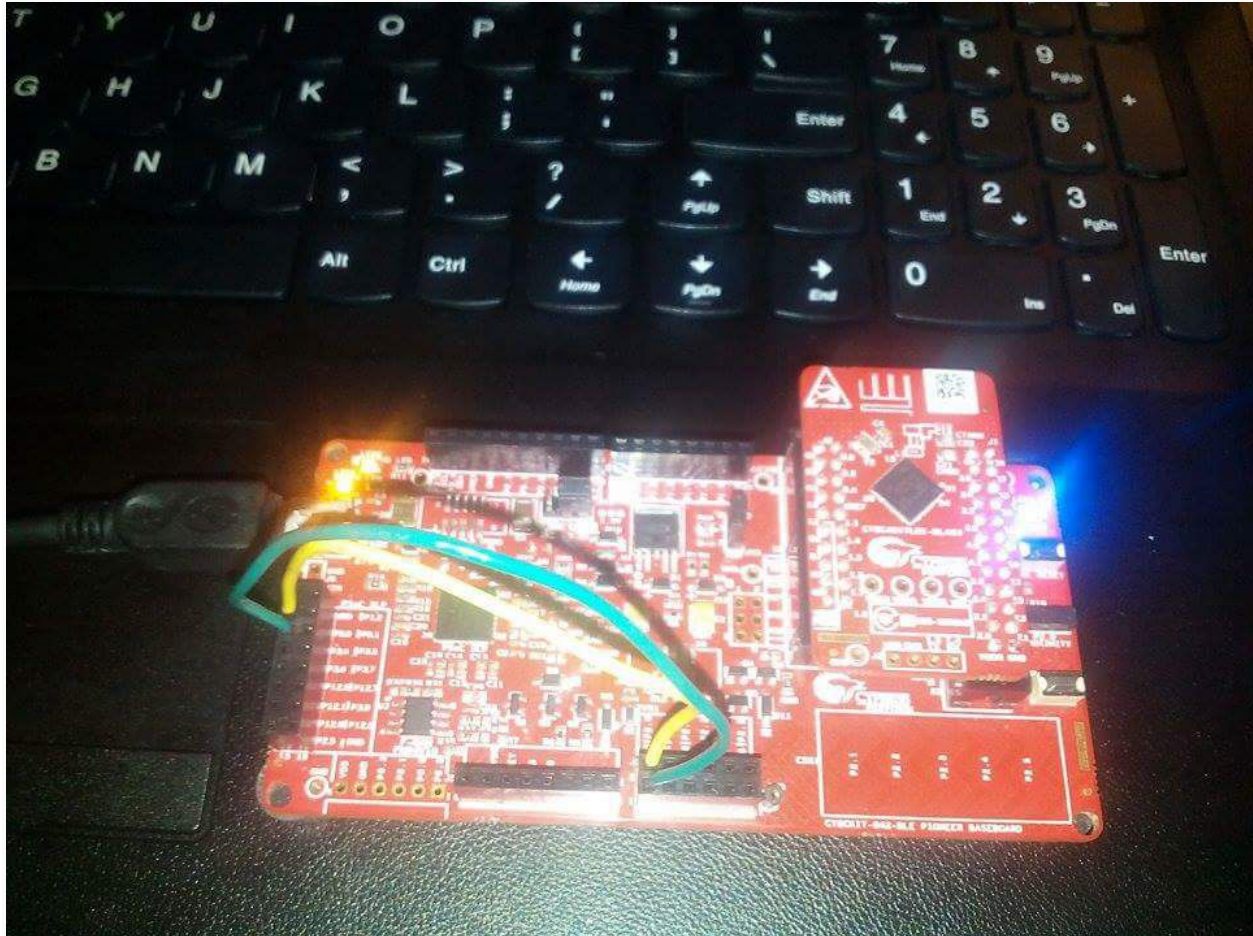
- 1) Bootloading PSoC 5: this will simulate a heart rate signal
 - a) Remove the kit's USB connector from PC
 - b) While holding down “SW1 (reset)” plug in the kit's usb connector to the PC, allowing the kit to enter the bootloader mode.
 - i) Status LED (LED 2) starts blinking at a frequency of 1Hz.
 - c) Launch “Bootloader Host Tools” through the “Tools” drop-down menu
 - i) Click “Filters”
 - ii) Check “Show USB Devices”
 - iii) VID: “0x04B4”
 - iv) PID: “0x0F13B”
 - d) After configuring the previous settings select the “USB Human Interface Device (04B4_F13B)”
 - e) Open the bootloadable (*.cyacd) file named “KitProg_custom.cyacd”



2) Program the PSoC 5 through the “Actions” drop-down menu

Testing

- 1) Bootloading the PSoC 5 simulated a heart rate signal on P0.0 with an expected value around 115. In order to see it connect that pin to “Pin 3” on “J8” to P2.0 of PSoC BLE “Pin 2” on “J2”
- 2) To change the heart rate value from a range of 60-115 bpm use “SW2” and connect PSoC 5 “Pin 5” on “J8” to PSoc BLE “pin 1” on “J2”
- 3) Check the status of the device by looking at the RGB LED



Testing with CySmart BLE Test and Debug Tool

- 1) Open CySmart 1.2 and connect it to the BLE-USB Bridge. Then “Starts Scan” (Press SW2 to restart advertising if it does not pop up) and connect your device.

Lab 3- EEC321 .pdf - Microsoft Edge

lms.manhattan.edu/pluginfile.php/328376/mod_resource/content/1/Lab%203-%20EECE%20321%20.pdf

CYPRESS
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PSoc 4 BLE Lab #3: IoT Sensor-Based System Design

Testing with CySmart BLE Test and Debug Tool

1. Open **CySmart 1.0** and connect the **BLE-USB Bridge** to it.
2. Make sure your device is advertising, and then click **Start Scan**. If you do not see your device appear, press **SW2** on the BLE Pioneer Kit to restart advertising.
3. Connect to your device: Select the appropriate device name and click **Connect**.
4. Upon connection, a new tab opens in the tool. Click **Discover Characteristics and Descriptors** of your device.
5. Click **Enable All Notifications** on the top to enable Heart Rate Measurement. See **Figure 23**.

Figure 23: Enable Notifications in CySmart 1.0

CySmart 1.2

File Tools Help

Select Dongle Configure Master Settings Manage PSMs Disconnect

Master

Discovered devices

Start Scan Connect Add to Whitelist Update Firmware

Advertisement data Scan response data

#	Device	Bluetooth Address	Address Type	RSSI	Advertisement Type
1	BLE Lab 3 (12:34:50:12:34:50)	12:34:50:12:34:50	Public	-70	Generic Access

Device List

+ Add - Remove Clear Refresh

Device Address	Identity Address	Whitelist	Bond List	Details
12:34:50:12:34:50	12:34:50:12:34:50			

Log

Clear Log Save Log

```

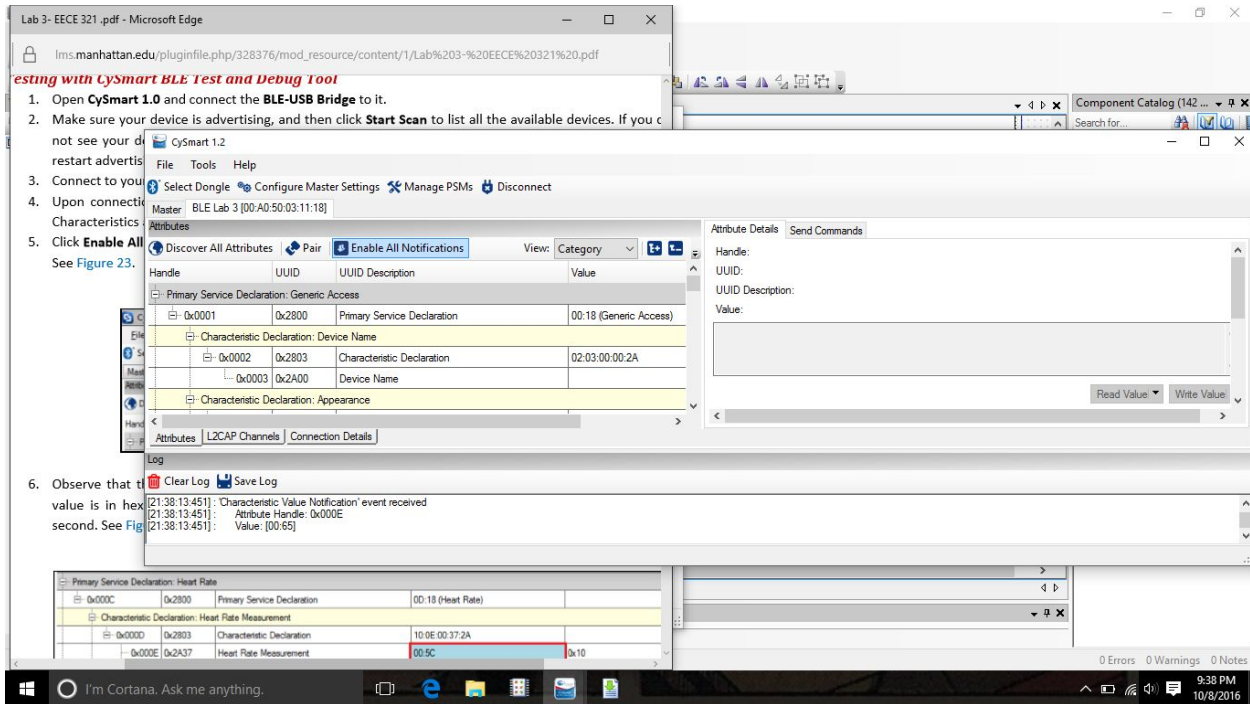
[21:17:24.832] : Channel Power: 3 dBm
[21:17:24.832] : Command Complete event received
[21:17:24.832] : Status: BLE_STATUS_OK
  
```

6. Observe that the value of the **Heart Rate Measurement** Characteristic is updated every second (the value is in hexadecimal), while the tool's log at the bottom shows new notification packets every second. See **Figure 24**.

[X=586,Y=173] 0 Errors 0 Warnings 0 Notes

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- 2) Click “Discover All Attributes” and “Enable All Notifications”
 - a) Observe “Heart Rate Measurement”



- i) 00:5C
 - b) Press “SW2” to change heart rate measurement

Lab 3- EECE 321.pdf

CySmart 1.2

File Tools Help

Select Dongle Configure Master Settings Manage PSMs Disconnect

Master BLE Lab 3 [00:A0:50:03:11:18]

Attributes

Discover All Attributes Pair Enable All Notifications View: Category

Handle	UUID	UUID Description	Value
Characteristic Declaration: Heart Rate Measurement			
0x0000	0x2803	Characteristic Declaration	10:0E:00:37:2A
0x000E	0x2A37	Heart Rate Measurement	00:5C
0x000F	0x2902	Client Characteristic Configuration	01:00
Characteristic Declaration: Body Sensor Location			
0x0010	0x2803	Characteristic Declaration	02:11:00:38:2A

Attribute Details Send Commands

Handle:

UUID:

UUID Description:

Value:

Read Value Write Value

Log

Clear Log Save Log

Primary Service

0x0000

Characteristic Declaration

0x000E 0x2A37 Heart Rate Measurement 00:5C 0x10

0x000F 0x2902 Client Characteristic Configuration 01:00

6. Observe the value in the second. See

7. Press the SW2 switch on the kit and observe that the heart rate number changes.

8. Disconnect the device and notice that the RGB LED turns off. At this point, the device has entered the Hibernate mode.

9. Press the SW2 switch now to see that the Green LED turns on and the device starts advertising again.

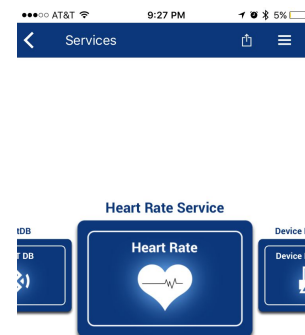
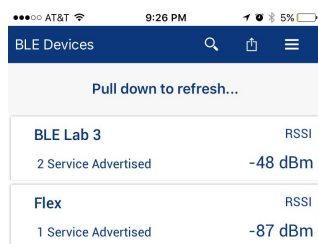
PSoC 4 BLE. This input is used for two purposes: mode of the PSoC 4 BLE chip. connected to the PSoC5 LP on-board to

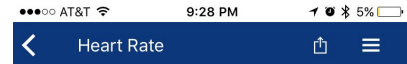
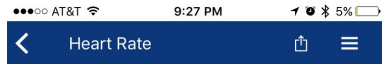
0 Errors 0 Warnings 0 Notes

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Testing with CySmart BLE Test and Debug Tool

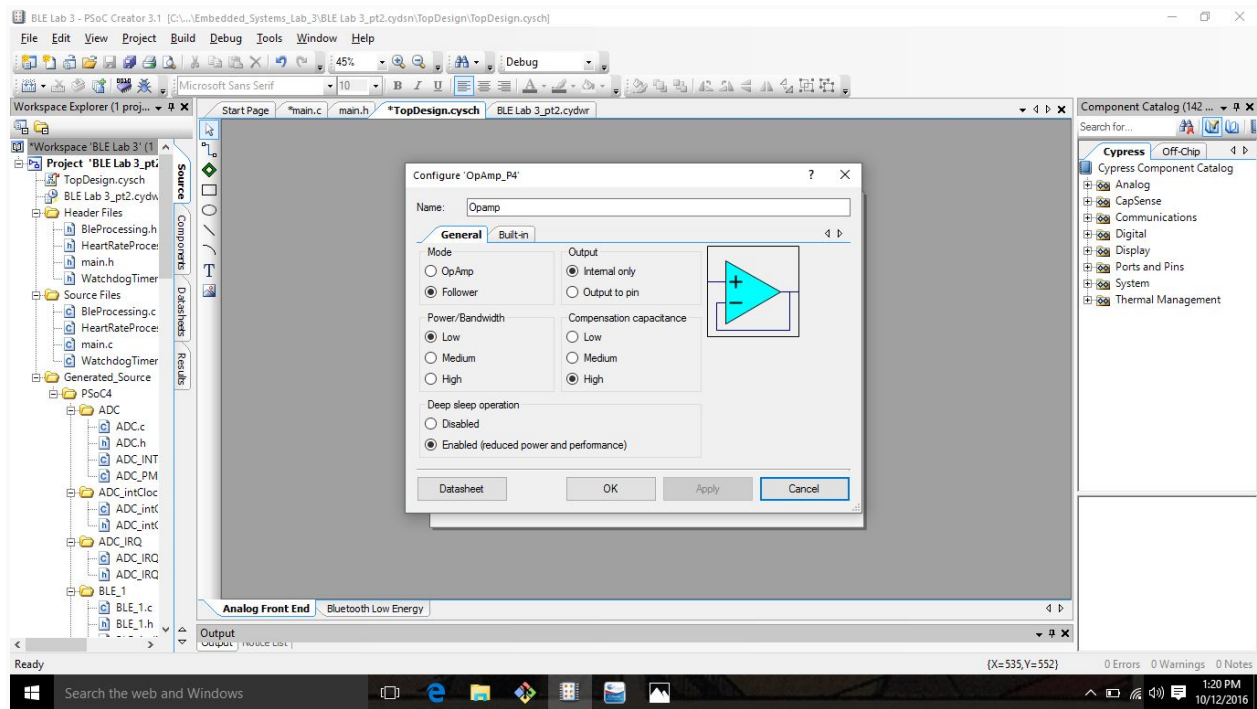
- 1) Open "CySmart Mobile App" on your mobile Bluetooth capable device
- 2) Find your device listed under the home screen as "BLE Lab 3" and tap on it.
- 3) Go to the "Profile" Screen and tap on the "Heart Rate" service.
- 4) Press "SW2" to change the heart rate.



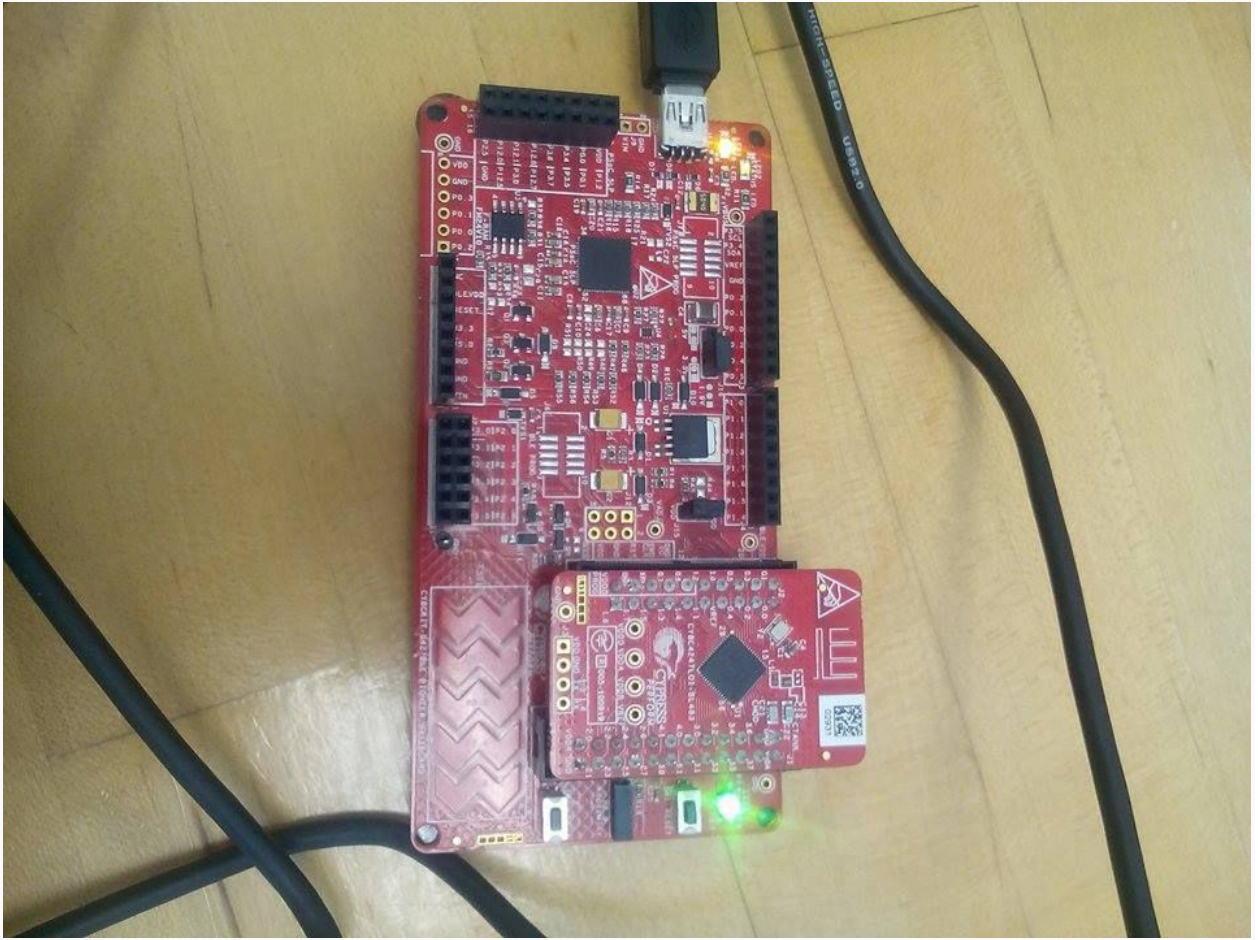


Additional Exercises

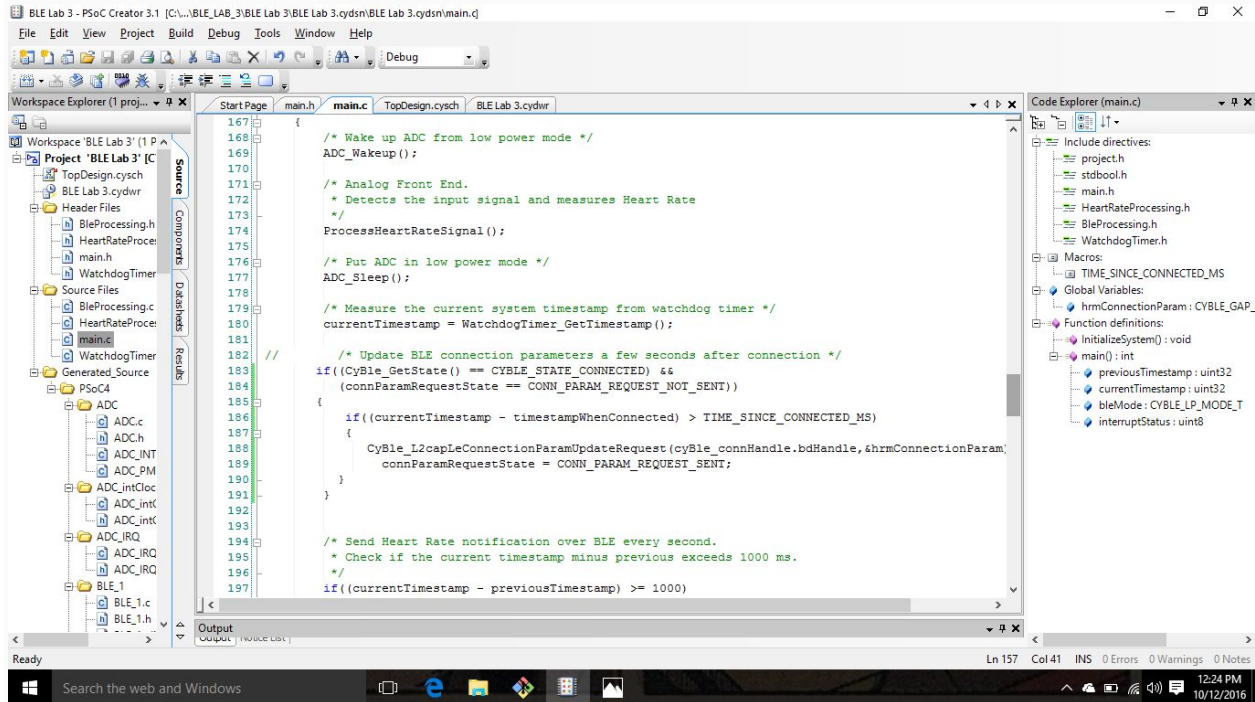
- 1) Configure the Opamp, used as a follower, to work in Deep-Sleep mode with lower power settings.
 - Double-click the Opamp component
 - Then change:
 - Mode to Follower
 - Power to Low
 - Enable the Deep Sleep Operation



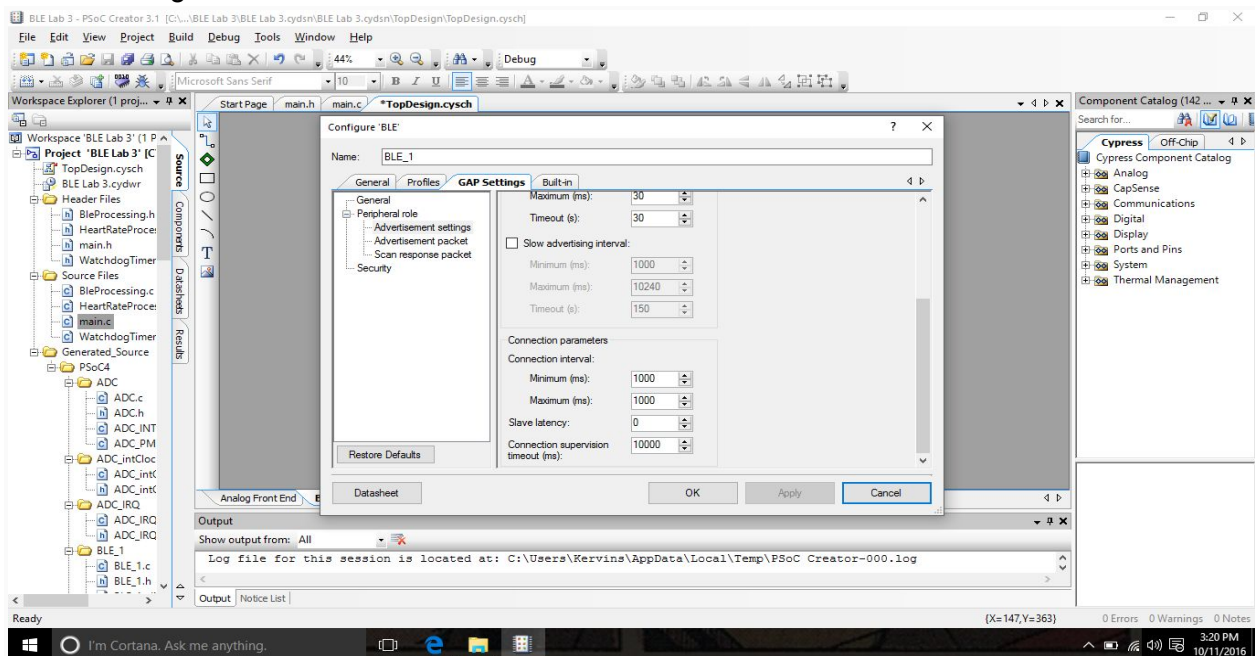
- Build the project
(No need to change the code)



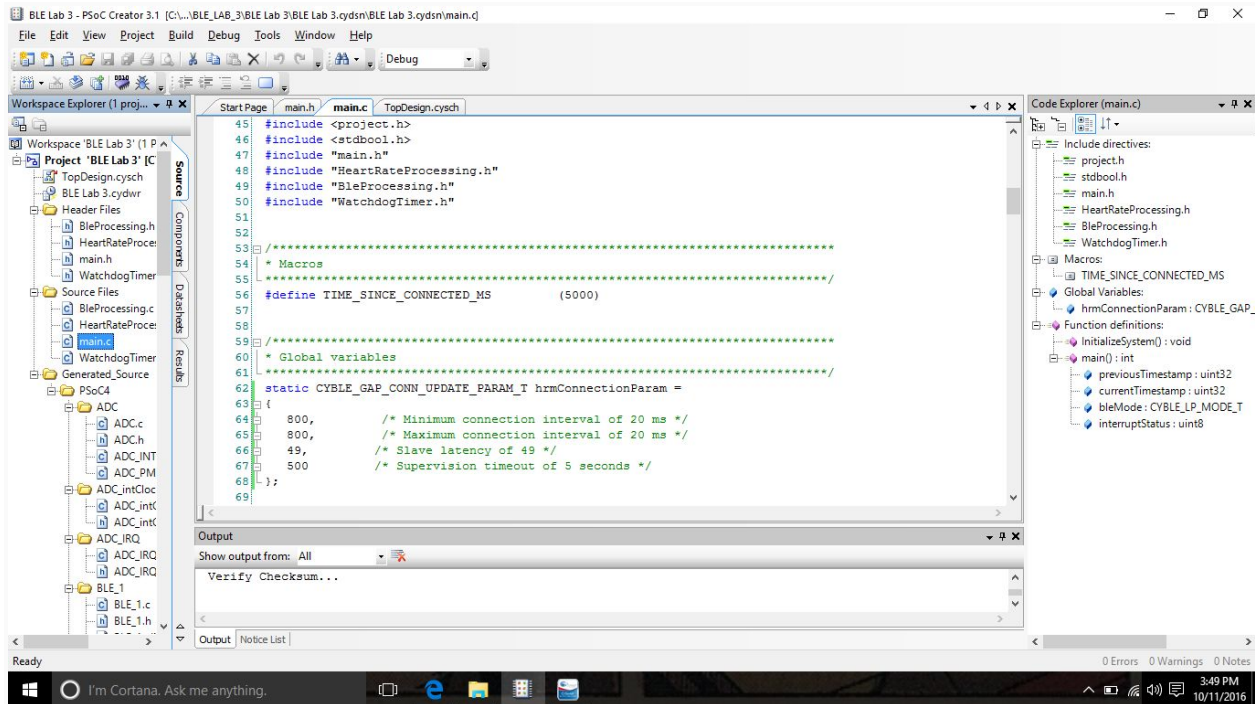
- 2) Update the Connection Interval to 1 second from the PSoC 4 BLE device.
Hint: Use the API function `CyBle_L2capLeConnectionParamUpdateRequest()` to update the connection parameters. The API function is available in the completed firmware as commented code.
- Uncomment code in the main.c that update the BLE Connection



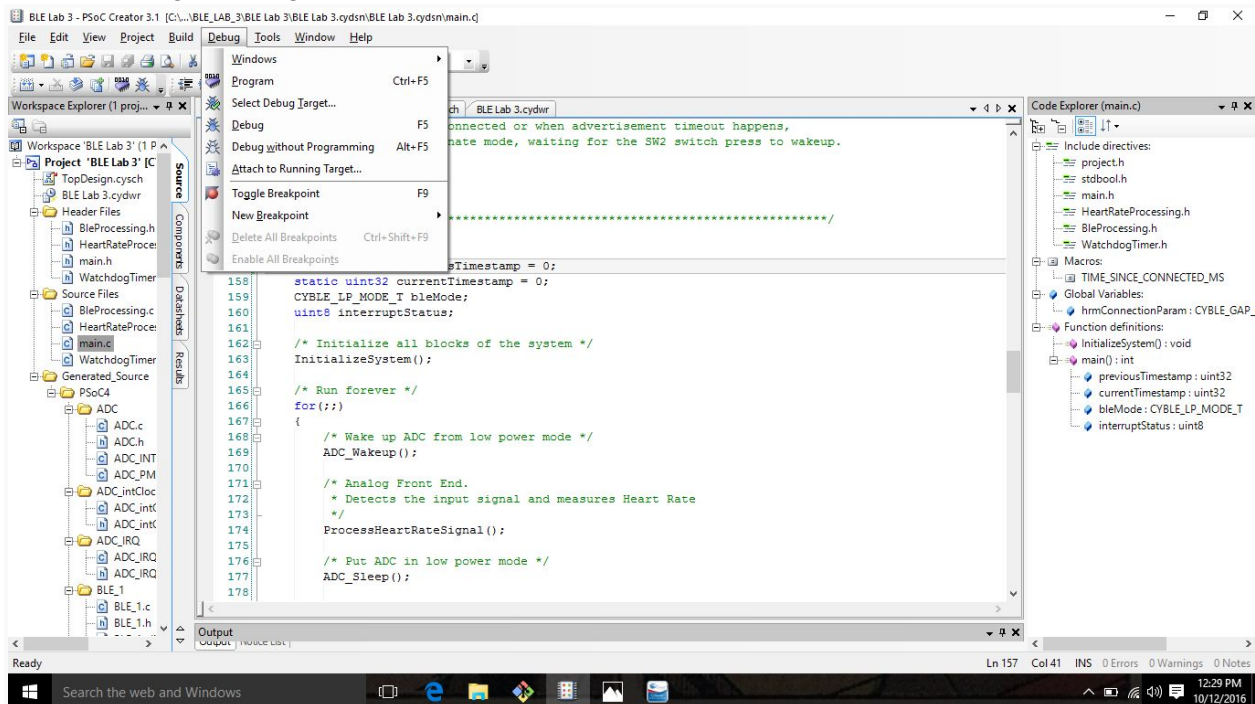
- Configure the BLE_1 in the GAP Setting
- Go to the Connection Parameter
- Change the Min and Max values of the Connection Interval to 1000ms



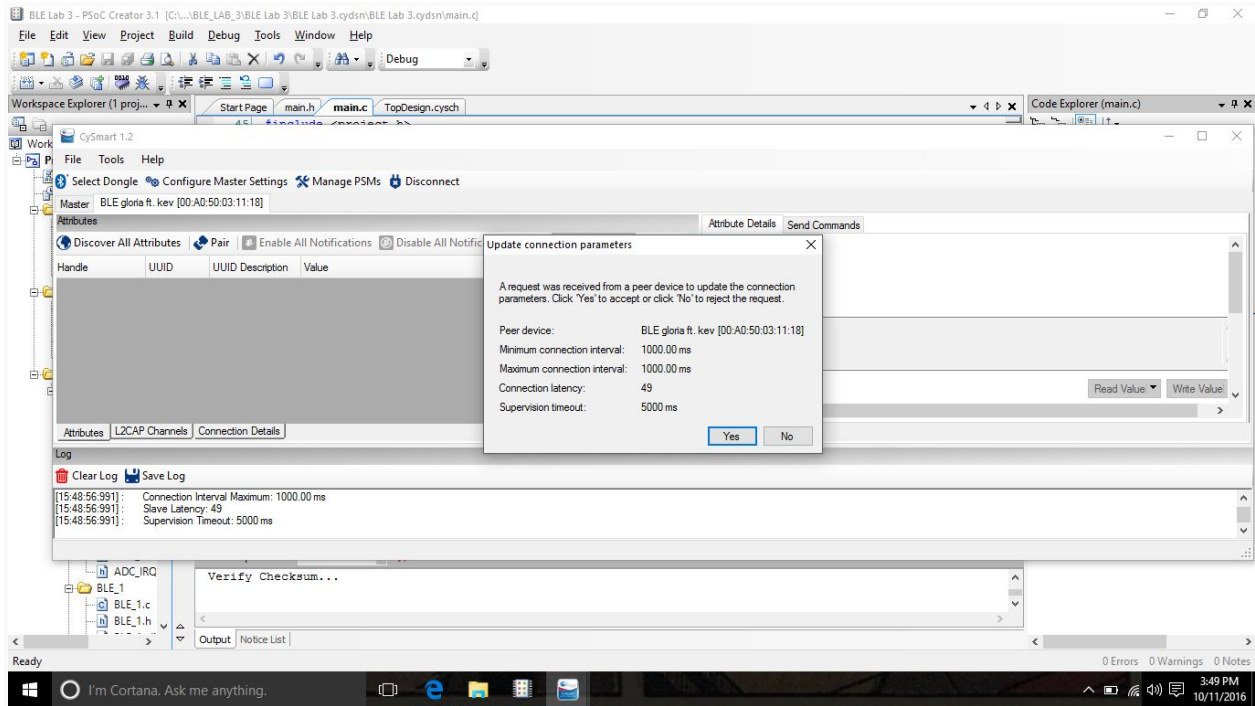
- Locate Global Variables in the main.c
- Uncomment the code for the connection parameter
- Must configure the Min and Max values of the Connection Interval of 20ms into a number that will allow the connection intervals equal to 1000 (Number = 800;)



- Debug the program



- Connect the BLE Dongle
- Open Cysmart 1.2
- Connect to your project file
- Word Box should pop up after giving information on device, stating the Connection Interval



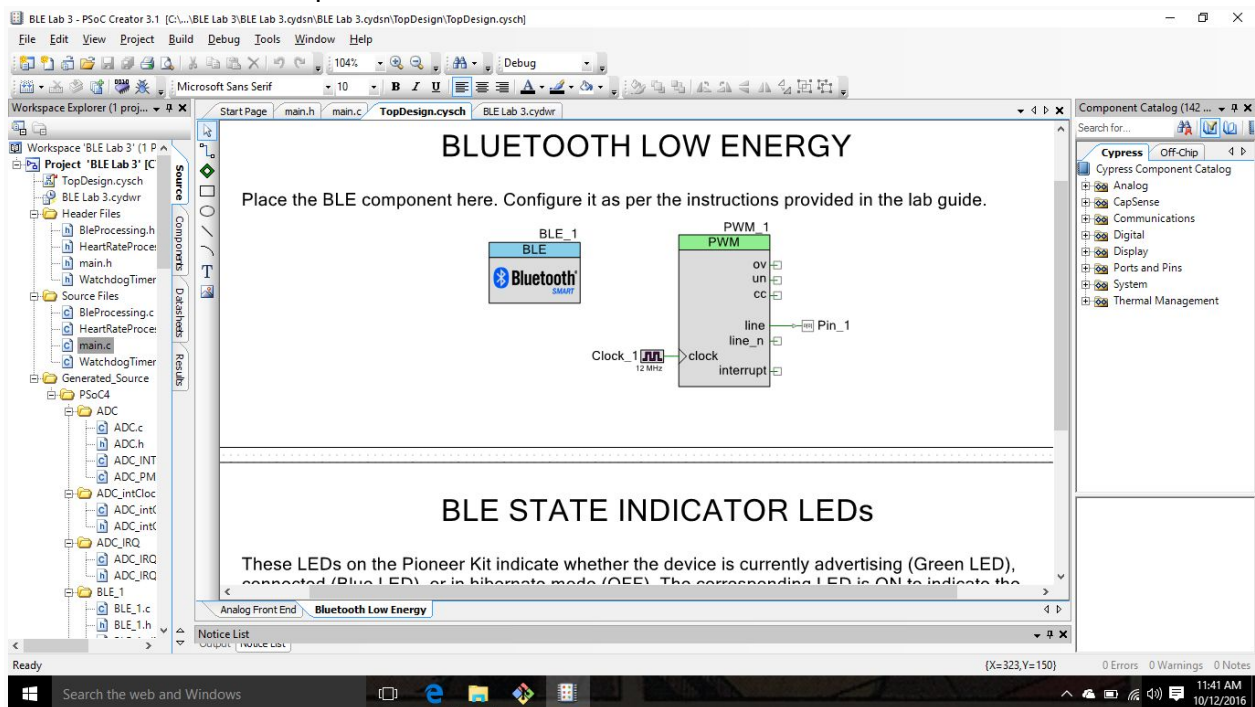
3) Generate the heart rate pulses using a PWM Component inside the PSoC 4 BLE.

Hints:

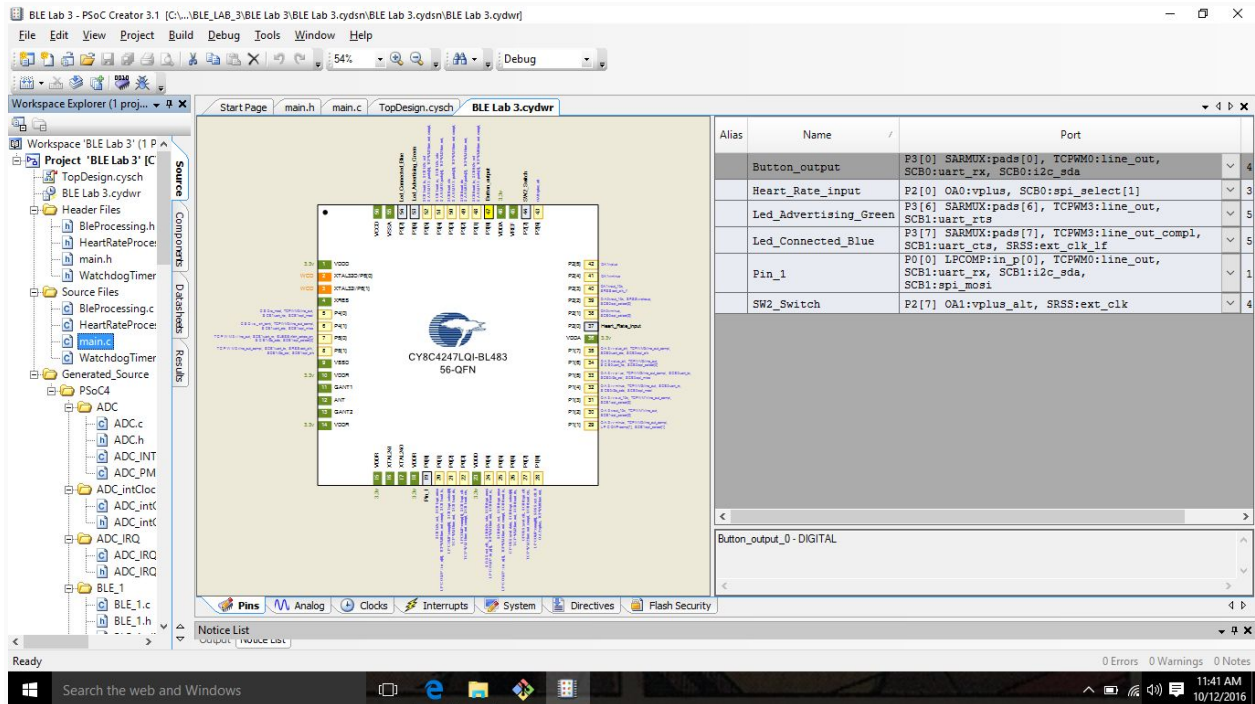
Don't forget to start the PWM Component using the <component_name>_Start() API.

As the TCPWM block is not active during the Deep-Sleep mode, comment out the code for putting the device into the Deep-Sleep mode.

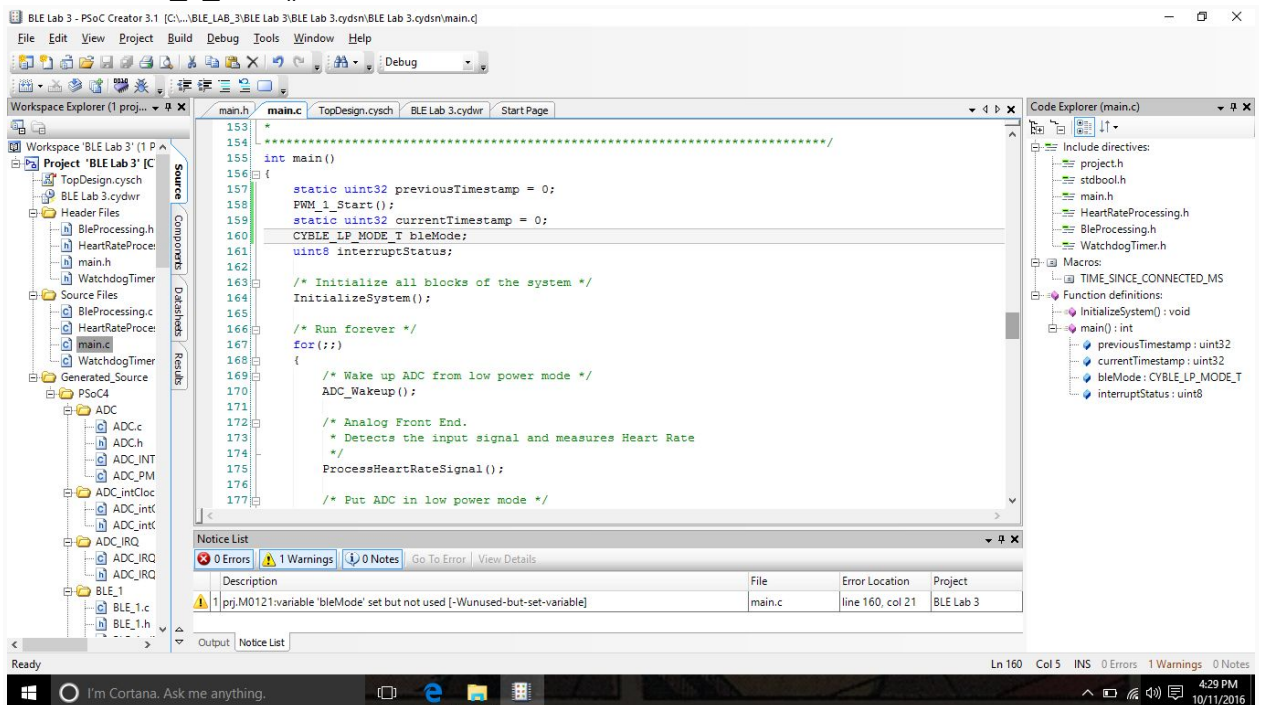
- Add a PWM component into the Bluetooth Low Energy
- Add a Clock component
- Connect to PWM clock
- Add Pin Output component
- Connect Pin Output to PWM line



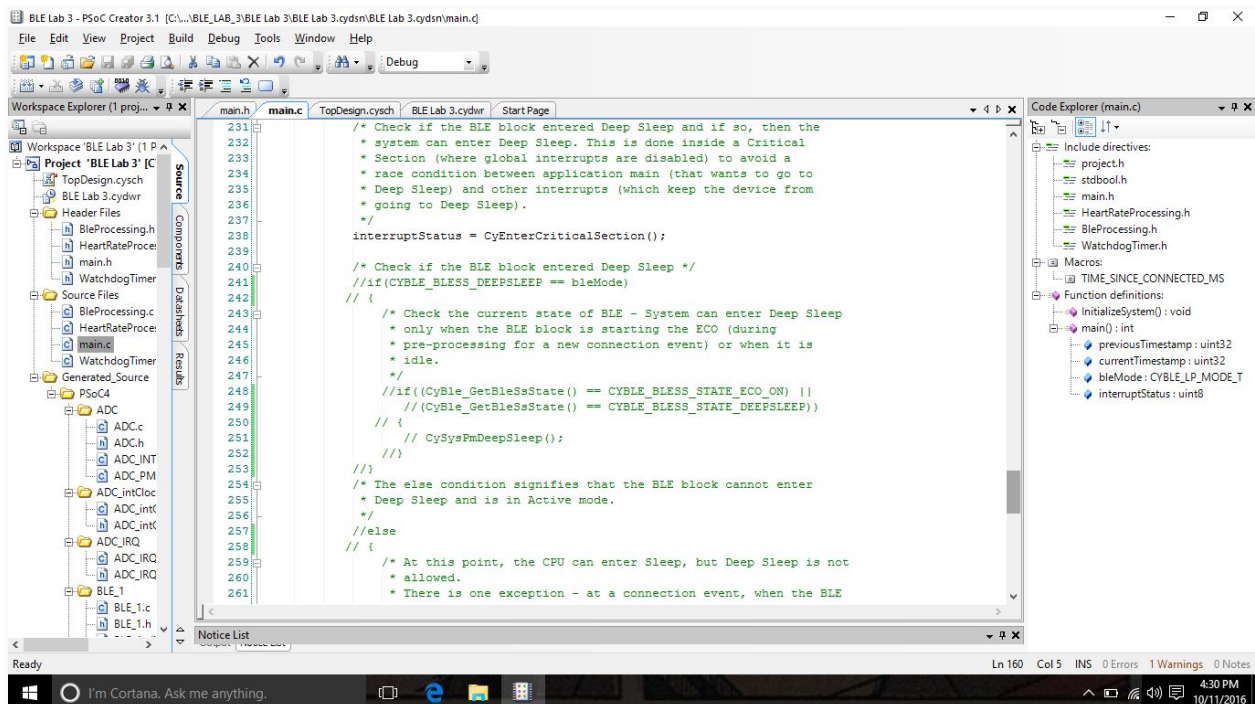
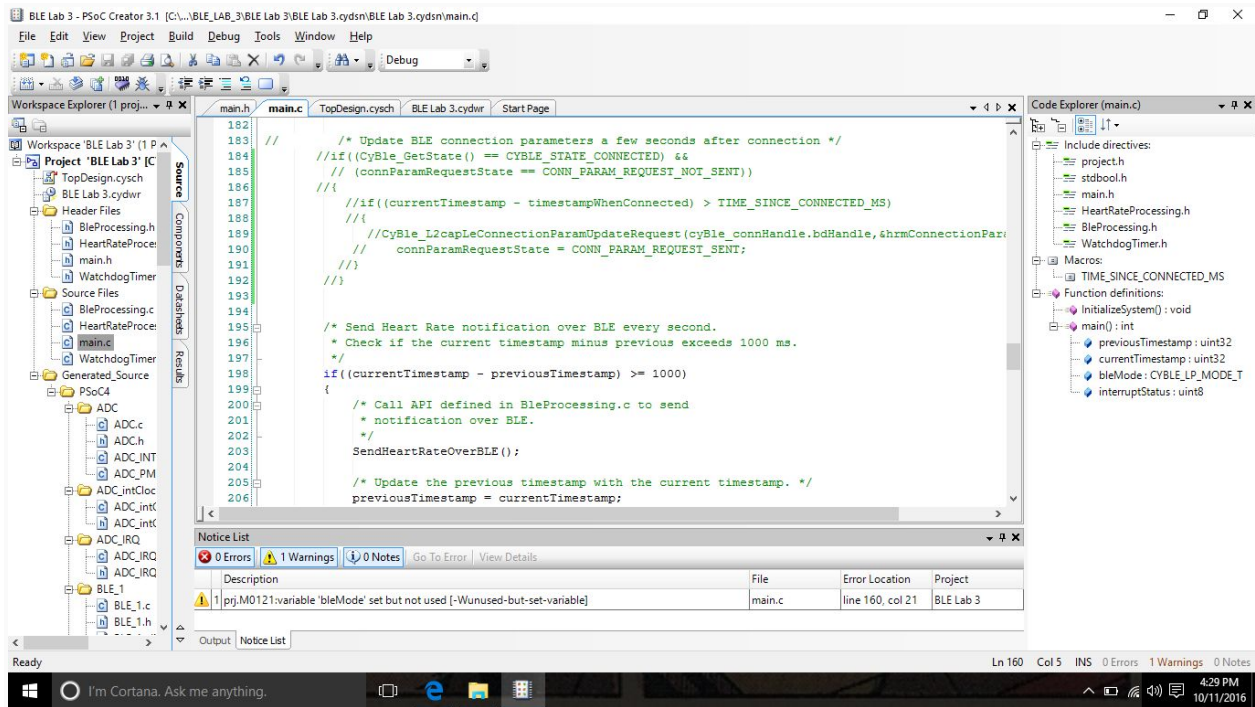
- Initialize Pin_1 in .cydwr
- Change port to P0[0] for the Pin

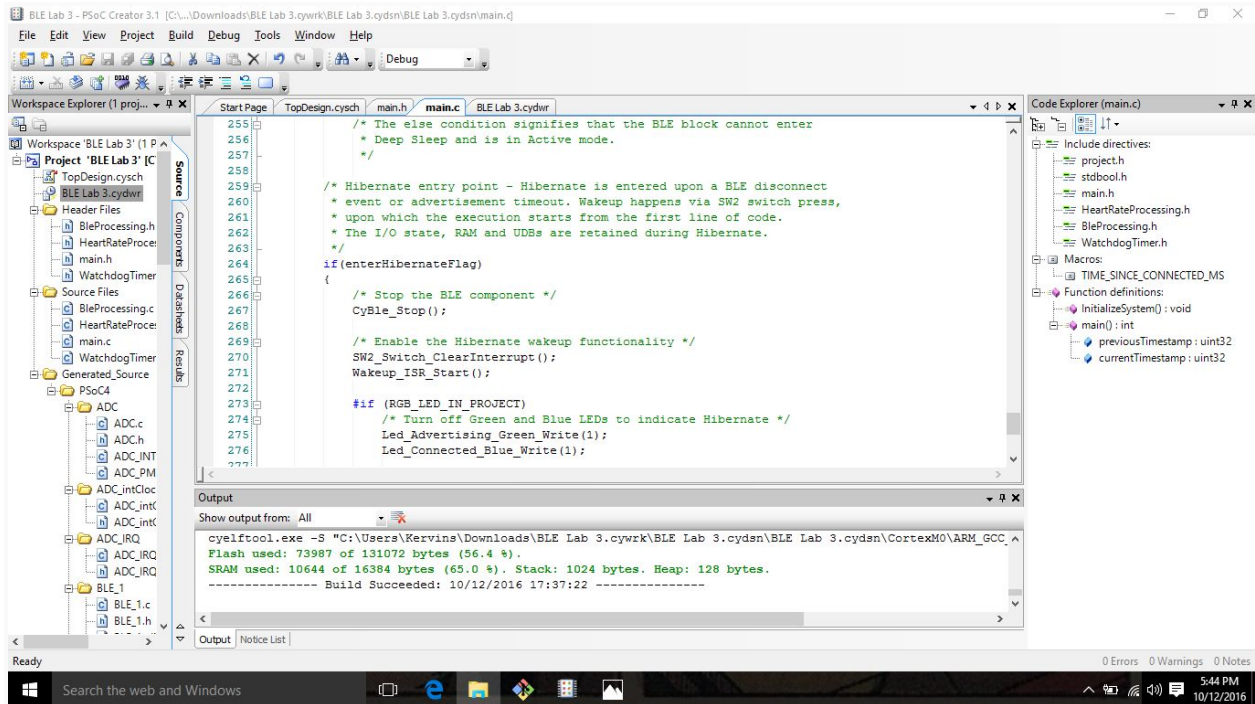


- Initialize the PWM in the code:
PWM_1_Start();



- Comment out all code regarding Deep-Sleep mode
(Don't want to put device in Deep-Sleep mode)





- Debug Program
- Build Project
- Open the Cysmart App on phone
Refresh until you find project
Go to Heart Rate screen



184 bpm

Sensor Location:

Other



0 kcal

Energy Expended



s

RR-Interval

