PSoC 4 BLE – Optical Heart Rate Monitor

Objective

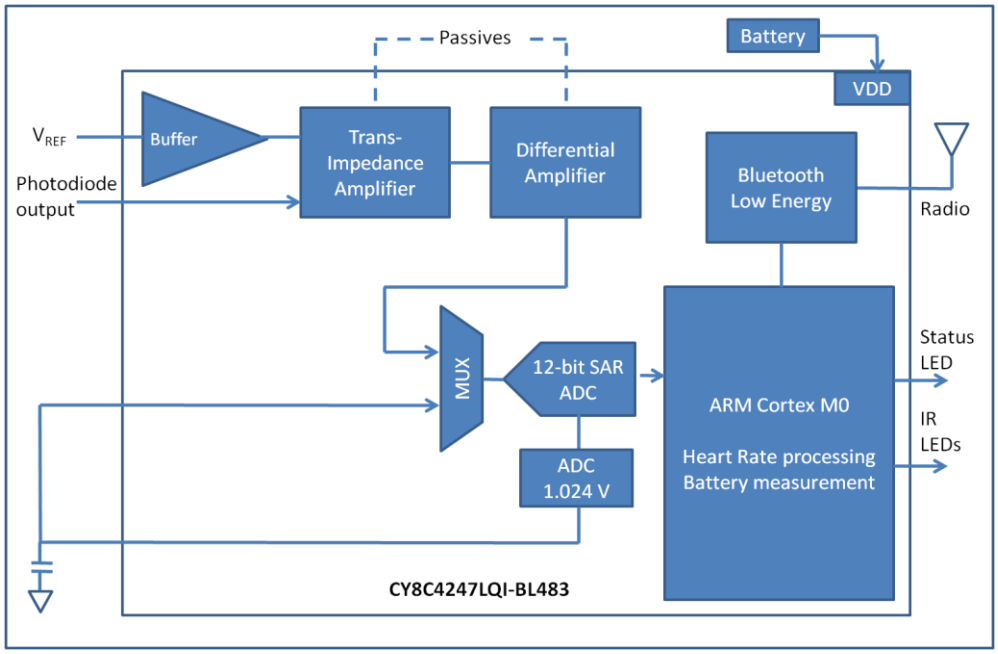
This example implements an actual Heart Rate Monitor on a wearable form-factor board, using the PSoC 4 BLE.

Overview

A custom board is created to have the PSoC 4 BLE, along with one photodiode and two LEDs to detect the human Heart Rate using photoplethysmography (PPG). Infrared wavelength is used for optical purpose. The blood reflects the light emitted by the LED, and it is captured by the photodiode. This is processed to get the heart rate, which is transmitted over BLE.

The example can also measure the battery voltage and report it over BLE.

Figure 1. Heart Rate Monitor



Requirements

Design Tool: PSoC Creator 3.1 SP1, CySmart 1.0, CySmart Android or iOS App

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

Associated Devices: All PSoC 4 BLE devices

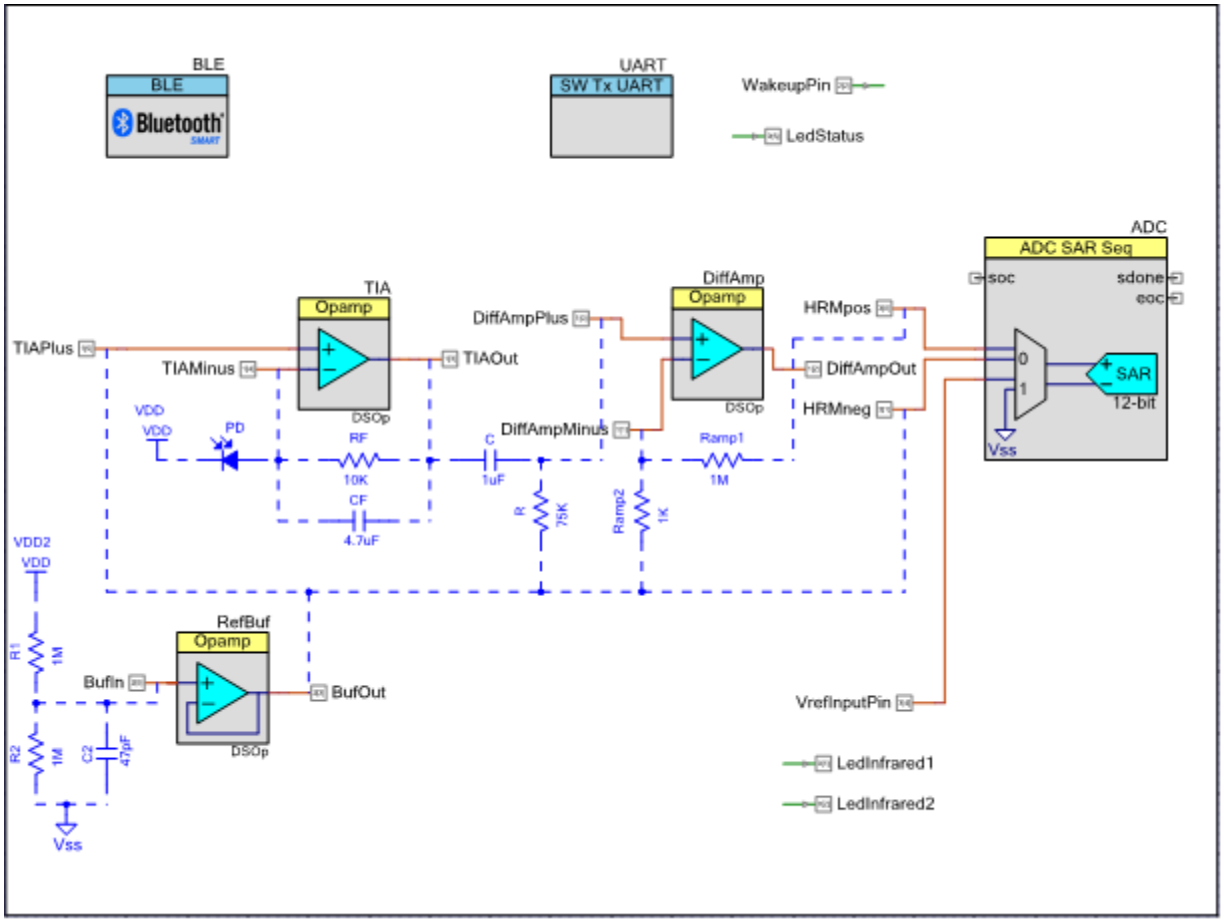
Required Hardware: Heart Rate Monitor demo board (contact our Sales representatives to get a demo)

Hardware Setup

To work with this example, you need the Heart Rate Monitor demo board. This is a custom board and you can contact Cypress Sales representatives to get a demo. You can also manufacture your own board by using the hardware files present along with this example.

PSoC Creator Schematic

Figure 2. PSoC Creator Schematic



Project Description

LEDs are driven to emit light onto the human body skin, which is reflected back and captured by the photodiode. The photodiode output goes to the chip, which uses three internal opamps to amplify and condition the signal. The output is then given to the ADC for conversion to digital counts. The ADC output is further filtered using an FIR filter and then a baseline mechanism is implemented to detect the heart rate waveform's R peaks.

The time between consecutive R peaks is measured and extrapolated to get the actual heart rate. The number of peaks for which the time is noted continues to rise until it hits an upper limit, when the time between N number of peaks is measured for better accuracy. N here can be user defined.

The battery voltage (the chip's VDD) is also measured by routing the ADC's Vref back to the ADC, and comparing against VDD to back-calculate VDD. Accordingly, a linear plot is created between 2.0V and 3.0V to get the remaining battery level in percentage terms. This value is then reported to the peer BLE device.

Testing

Build and program the project to the board and power it up. Place your finger over the LED/Photodiode pair to cover it completely. Now connect to the CySmart app to get the heart rate data. Your actual heart rate will be shown on the app.

Go to the battery page on the app and you will be able to see the remaining battery level.

Related Documents

Table 1 lists all relevant application notes, code examples, knowledge base articles, device datasheets, and Component / user module datasheets.

Table 1. 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.