PSoC 4 BLE – OTA Firmware Upgrade using Serial NOR Flash

Objective

This example demonstrates Over the Air (OTA) bootloading using the Serial NOR Flash. The communication interface between PSoC 4 BLE and Serial NOR Flash is SPI.

Overview

Over the Air (OTA) firmware upgrade can be done using PSoC 4 BLE and Serial NOR Flash.

The Serial NOR Flash memory can be communicated to via SPI protocol, in Motorola Mode 0 and Mode 3. The datasheet of the part used here (S25FL164K) is attached with this project. For a detailed product finder, refer to the Cypress website.

The OTA firmware upgrade is demonstrated using the CySmart tool.

Requirements

Design Tool: PSoC Creator 3.2 SP1

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, Serial NOR Flash part S25FL164K or any other suitable part.

Hardware Setup

On the BLE Pioneer Kit, replace the FRAM part with the Serial NOR Flash part. Both of these parts are 8-SOIC. The list of changes is the following:

1. Remove the on-board FRAM part (U3).
2. Solder the Serial NOR Flash on the U3 footprint, with pin1 of the chip matching with pin 1 on the footprint.
3. Remove the resistors R31, R36, R37, R38.
4. Place a 4.7K ohm (SMD-0603) resistor on R33, and another 4.7K ohm on R34.
5. Connect one end of a wire to Pin 1 of the Serial NOR Flash chip and connect its other end to P5[0] on the PSoC 4 BLE module.
6. Connect the common point between R32 and R36 resistors on the BLE Pioneer Kit to P4[1] on the PSoC 4 BLE module.
7. Cut the on-board copper trace between Pin 5 of the Serial NOR Flash and R35 resistor.
8. Connect one end of wire to Pin 5 of the Serial NOR Flash chip and connect its other end to P4[0] on the PSoC 4 BLE module.

PSoC Creator Schematic

Figure 1. PSoC Creator Schematic for the Bootloadable project

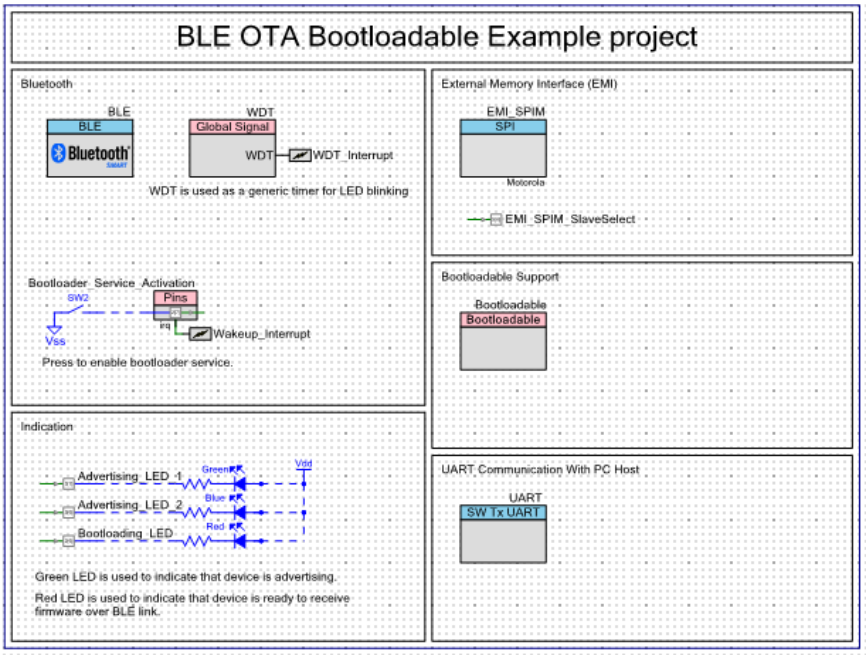
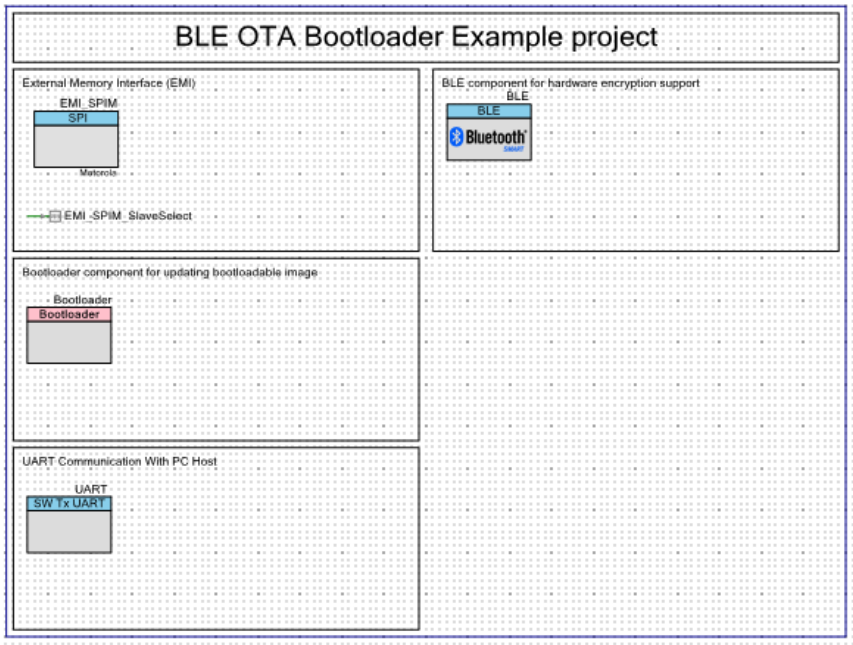


Figure 2. PSoC Creator Schematic for the Bootloader project



Project Description

The Bootloadable implements a custom BLE service to get the new application image over BLE. When the user switch is pressed, this service is enabled and the device is ready to receive the new image. Once the new image starts coming in via BLE characteristic writes, the image is copied to the Serial NOR Flash, row by row (each row size being equal to the row size of the PSoC 4 BLE flash – 128 or 256 bytes depending on the chip).

Before starting the write to the Serial NOR Flash, the entire content of the memory is erased first. This is done so that the Serial NOR Flash accepts the new data. Once the erase is complete, the write is done.

Encryption for the data write to Serial NOR Flash can be enabled in the project, via Options.h file.

UART debug information is also available which can be enabled/disabled via Options.h.

Once the entire content is written to the Serial NOR Flash, the device issues a software reset and the bootloader part is then started, which copies the entire content from the Serial NOR Flash to its own flash, row by row.

Memory Organization

The Serial NOR Flash memory has defined three terms –

a. Page – Each page is a 256 byte memory area.

b. Sector – Each sector is a 4 kB memory area.

c. Block – Each block is a 64 kB memory area.

A write operation can be done page-by-page, whereas an erase operation can be done either sector-wise, block-wise, or for the entire chip. Because of this, the memory layout for OTA firmware upgrade has been defined as follows –

- Metadata is stored from the memory location 0x000000 to 0x00007F (128 bytes).
- Application is stored starting from the memory location 0x001000 onwards.

This allows the entire first sector to be independently used for storing metadata, so that metadata and the application can be erased independent of each other. Also, for PSoC 4 BLE chips with 128 kB flash size, only the first 128 bytes per page in the Serial NOR Flash are used, the remaining being 0xFF. For PSoC 4 BLE chips with 256 kB flash size, the entire width of the page in the Serial NOR Flash is used.

SPI Communication

PSoC 4 BLE acts as the SPI master, with the following configuration –

- Motorola Mode 0 (CPHA = 0, CPOL = 0)
- 1 Mbps data rate
- MISO late sampling
- MSB first data transfer
- Firmware controlled Slave Select

The slave select line is controlled in firmware so that the required data is transmitted as a single transaction, in case interrupts hit and the data push to SPI FIFO is affected, since a hardware controlled Slave Select immediately de-asserts as soon as the FIFO is found to be empty.

Expected Results

Build the Bootloader project first, and then the Bootloadable project. Program the Bootloadable project to the BLE Pioneer Kit with the PSoC 4 BLE module. Once programmed, follow these steps to test –

1. If the UART debugging is enabled, open a terminal emulator such as Putty or Tera Term for the Pioneer Kit. The COM settings are: Baud rate – 115200 bps, Data bits – 8, Stop bits – 1, Parity – None.
2. Reset the device (by pressing the Reset switch) to see a welcome message on the terminal. The device is advertising at this point and waiting to be connected.
3. Press the User Switch (SW2) on the kit to enable bootloading mode.
4. Connect a BLE Dongle to the PC and open CySmart tool.
5. Start scanning for active devices in CySmart tool. You will see the device “Device Info Example” available.
6. Change your existing Bootloadable project to get a new functionality (such as a different LED color) and build it to get the .CYACD file for bootloading.
7. In CySmart, click on the device titled “Device Info Example” in the list of available devices, and then click “Update Firmware”.
8. In the Update Firmware dialog, choose the required .CYACD file, and click OK.
9. Observe that the UART debug log starts showing information for the bootloading process, and the corresponding progress is also shown in CySmart.
10. Once all the data is copied to the Serial NOR Flash, CySmart shows that the firmware upgrade is complete. At this time, the Bootloader starts copying data from the Serial NOR Flash to overwrite the existing application. This step will take some time.
11. Once this is done, the new application is loaded and the test is complete.

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.