



## Bluetooth Low-energy Integrated Module for SME's (BLIM4SME)

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## **Executive Summary**

This document is the Demonstrator documentation of the BLIM4SME project (Grant Agreement Number 605264) that is funded under Research for SMEs of the Seventh Framework Programme.

The document presents the demonstration of all the final elements of the project. First, it presents physically the demonstrator, then the principle of the demonstration and how it is achieved.

# Introduction

## Project overview

The demand for wireless sensors in healthcare and lifestyle areas is experiencing rapid growth. Such applications call for radio links which have to fulfil several stringent requirements, such as: standardized connectivity for plug-and-play interconnection with other devices; ultra-portability with tiny modules for maximal comfort for the wearer; ultra-low-power consumption for long autonomy; and flexibility for being easily embedded with a heterogeneous set of other components like sensors, signal processors, energy harvesters.

The BLIM4SME project addresses these challenges by developing an ultra-low-power Bluetooth Low Energy (BLE or Bluetooth Smart) module focusing on healthcare and lifestyle. BLE is currently addressed by large semiconductor industries, in the form of complex systems-on-chip (SoC) which aim at covering many applicative areas, but their excessive versatility makes them non-optimal for those applications where ultra-portability and ultra-low-power are mandatory. Therefore, BLIM4SME aims at developing an optimized solution targeting the rapidly increasing landscape of EU SME's and industries that require beyond state-of-the-art, highly integrated and ultra-low-power BLE radios for their next generation bio-medical, healthcare, sports and fitness products.

Concretely, the project developed a tiny  $1.7 \text{ mm}^2$  RF IC consuming less than 10mW for operation with coin cell batteries, which is embedded into the first time realization of a single "antenna-and-radio" miniaturized module leveraging an innovative "integrated passive devices" (IPD) technology platform. The outcome is a BLE module yielding a factor of 2 times better "power-size" figure of merit compared to today's leading industrial solutions.

## Purpose of the document

The purpose of the document is to record in the most effective way how the Project partners have demonstrated the outcomes of the Project. It is decomposed as follows:

- a) Demonstrator – Description of the Project Demonstrator set-up, and its objectives
- b) Principle of the Demonstration - Description of how the Demonstration operates
- c) Demonstration – Capture of an actual Demonstration

## Demonstrator

### About the Project Results & terminology

For sake of readability of this document, and for respecting coherence with the DoW, the Project Results are summarized in this subsection (see also DoW table 3.2.2a). The correspondence with the technical/technology terminology used in this document is also provided (see also DoW section 1.1.2).

#### Result 1: BLE Generic Module:

This concern in the BLE Generic Module in the form of a PCB that will embed the outcome(s) of Result 2 below, with additional features (e.g. bunch of sensors, etc).

The principal exploiter of this Result 1 is **PRISMA**.

The below figure depicts the BLIM4SME final platform architecture, which is composed of:

- The BLE Generic module. This module, to be provided by PRISMA, contains all elements for a functional BLIM4SME system. It is further composed of the BLIM module, and some associated Sensors (Temperature and humidity, barometer, accelerometer)

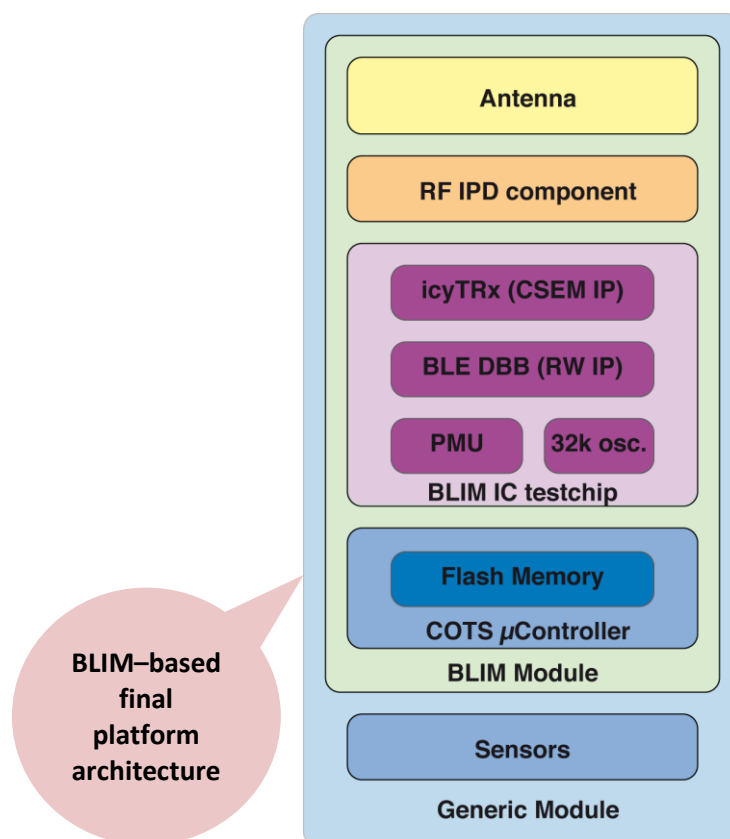


Figure 1: Final BLIM4SME platform architecture

The below picture shows the split of the Generic module.

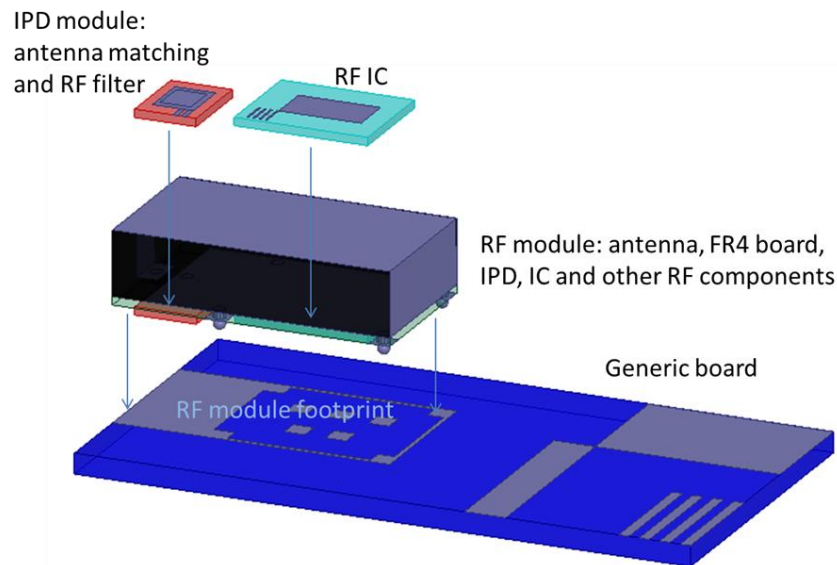


Figure 2: BLIM4SME Generic module decomposition

#### **Result 2: RF IPD Module:**

This is the radio module that embeds IPD technology and is provided as:

- The **BLIM module** which uses the BLIM4SME radio technology of Result 3 below.

The principal exploiter of this Result 2 is **NORDIC**.

The below picture depicts the physical BLIM module, which goal is to be mounted on the Generic module. In turn, the BLIM module embeds the BLIM IC testchip, the RF IPD and Antenna.

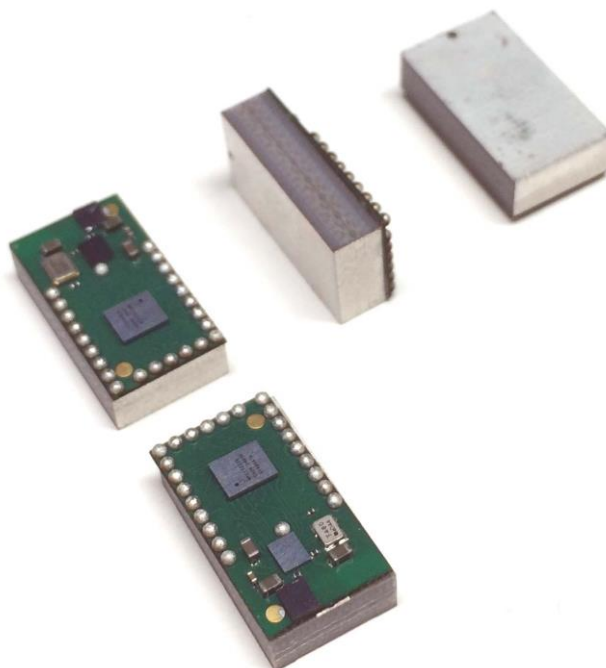


Figure 3: BLIM Physical Module

### **Result 3: RF IC IP:**

This concern the RF IC platform developed specifically in the project, and which is referred to as the **BLIM RF IC IP** or **BLIM chip**. This outcome is in the form of a silicon IP which will be integrated in the project as a chip.

The principal exploiter of this Result 3 is **RW**.

The below picture depicts the internal view of the BLIM IC Testchip, produced by TSMC (and provided by CSEM) which goal is to be mounted on the BLIM module. In turn, the BLIM IC embeds principally the IcyTRx RF macro from CSEM and the Base Band IP Core from RivieraWaves. It is the heart of the BLIM System when associated with a Processor (as instantiated in the BLIM Module) to execute the RW's software.

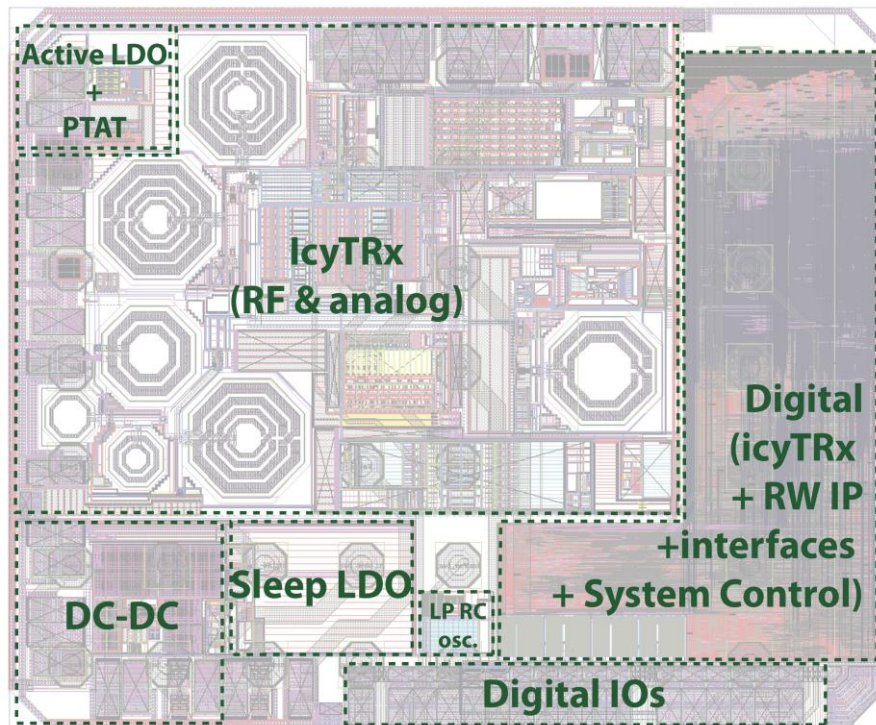


Figure 4: Internal view of the BLIM RF IC



## 1.1 Planned Demonstrator

The following figure show the Demonstrator set-up as initially planned. A BLE link establishes a connection with a smart phone, providing temperature samples showed on an application. This application is also able to send the collected data back to an infrastructure database in the cloud.

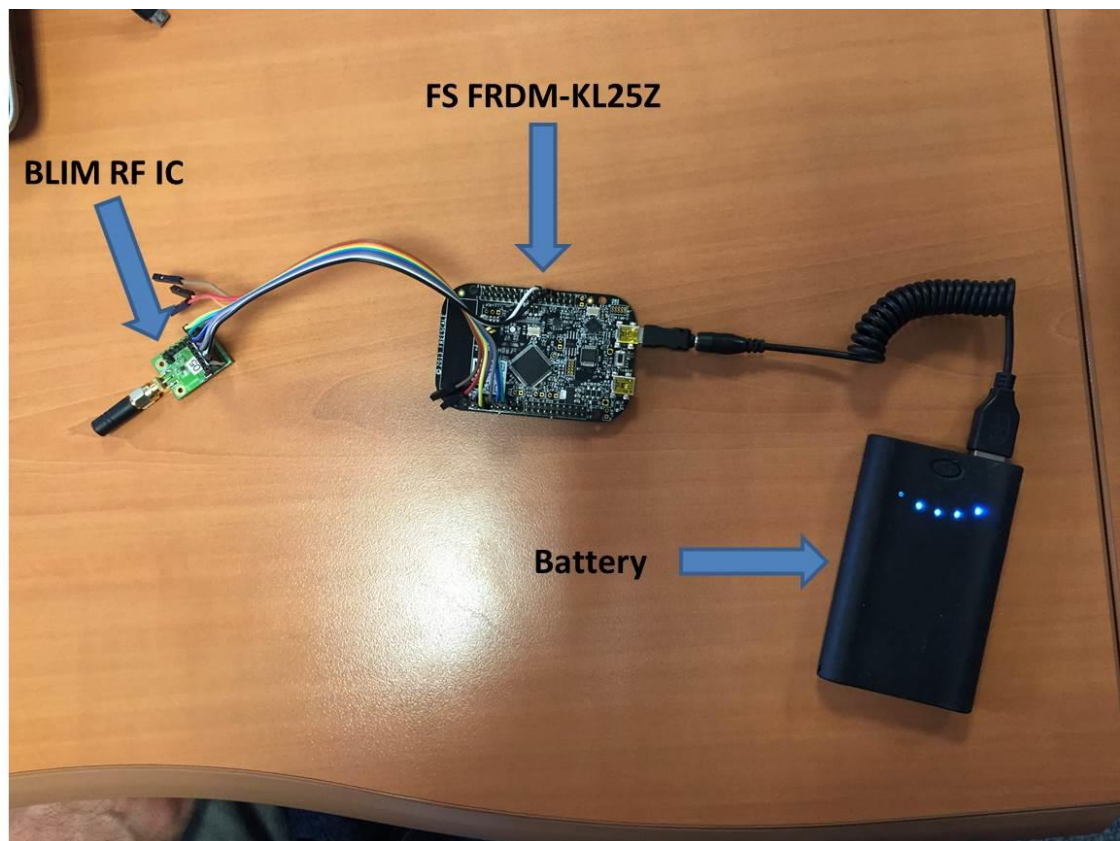


## 1.2 Demonstrator Fall back solution

Unfortunately, the BLIM4SME Generic module has not been made available in time for the Demo, so a fall back solution was necessary in order to overcome the problem. The chosen solution was to mimic totally the final system but with a larger physical size. The demonstrator was then based on using an off the shelf MCU platform available associated to the BLIM IC testchip. We selected the FreeScale FRDM-KL25Z, which contains the same ARM Cortex M0+ MCU, with same intrinsic characteristics in terms of ports and memory (128kB), as initially planned in our BLIM Module. This platform, in turns, is connected using direct wires to the BLIM IC by one of the SPI interfaces to replicate the BLIM Module.

With this, we enable to work exactly as planned in terms of technical constraints, but a bigger form factor.

The below picture show the set-up instantiated for the Demo:



**Figure 5: BLIM Demo Fall back solution**

In order to simplify the work for the Demo, an existing BLE application from Nordic Semiconductors is preferred to be executed on the Android mobile phone. This also gives the advantage of showing total interoperability with an existing phone and BLE application. A simple application is developed by RW on the module so that to show a temperature random variation to be seen when connected on the mobile phone.

In the software side, we started by using the Freescale application, Code Warrior, which allows to generate code for using on the MCU. This code generated is then integrated in our compiling environment to generate the BLE SW for the MCU. The MCU is connected through a USB interface to a PC, which allows controlling and loading the firmware into the MCU.

## Demonstration

With the aforementioned set-up, the Demonstration consists of these steps:

- Connect the battery (or the USB cable to a PC) to power up and start the Freescale MCU executing the Code which has been previously loaded into its Flash.
- Leds are flashing on the MCU board, corresponding to BLE events interrupts (controlled by RW firmware)

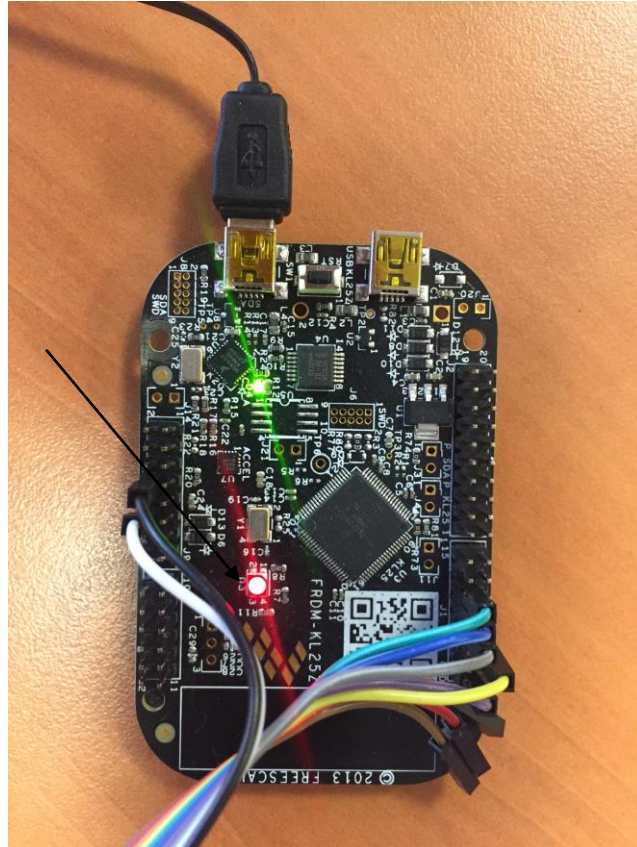
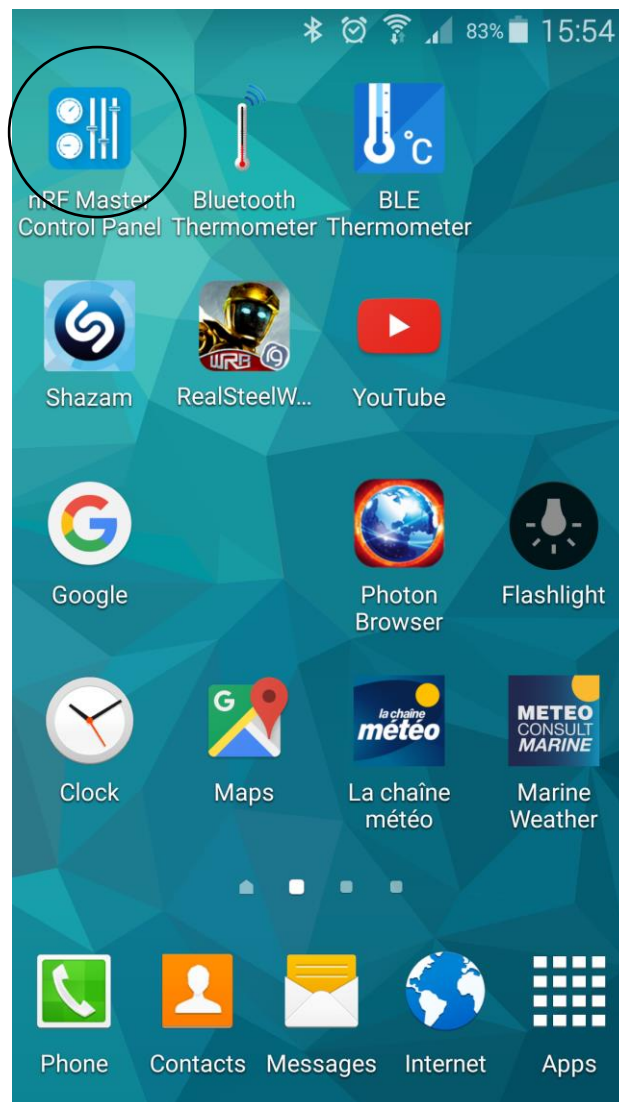


Figure 6: MCU Up and led flashing

- The set-up is directly launched in advertising mode, ready to accept BLE connections.
- Launching the Nordic “nRF Master Control Panel” application on the Smart Phone



**Figure 7: Launch the nRF app**

- The application allows discovering the surrounding devices. The BLIM4SME is found on the graphical interface. We select it and it goes into CONNECTED mode.



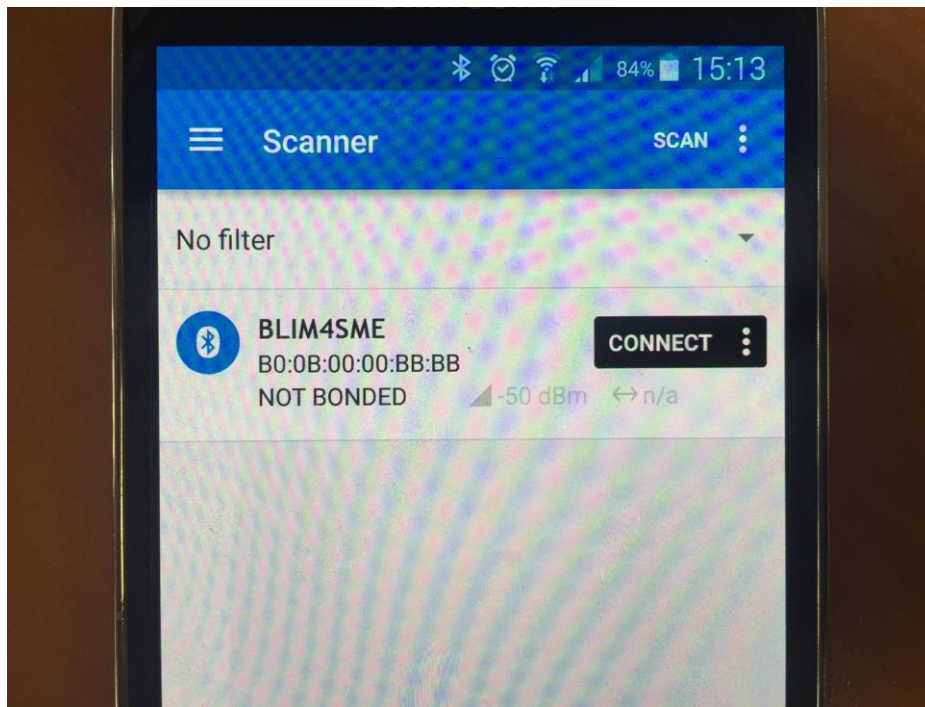


Figure 8: Setting to connected

- The application discovers the Services of the device

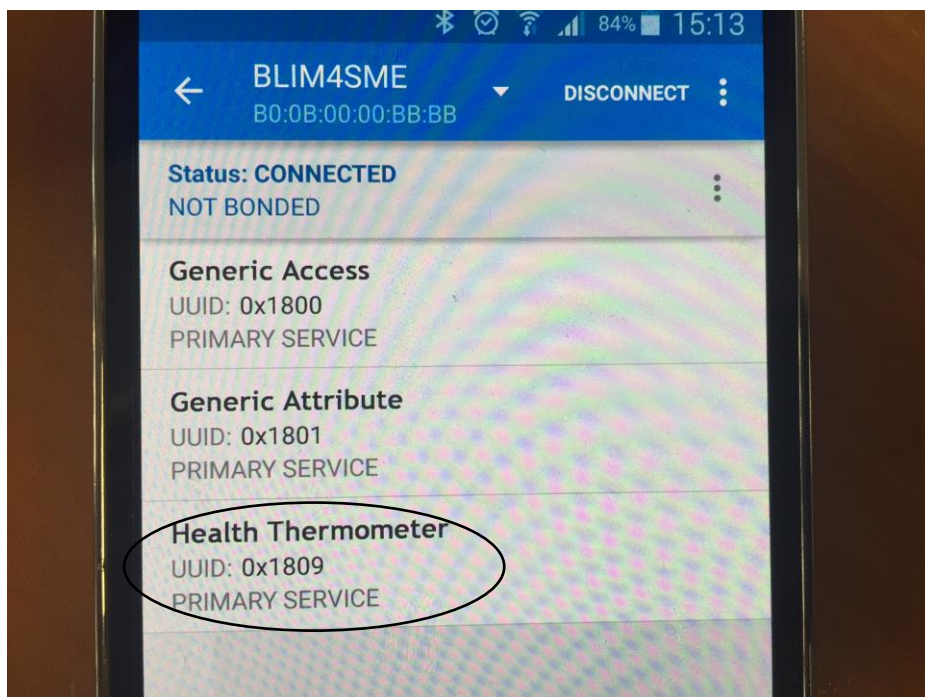


Figure 9: Select Thermometer Service

- Select the Health Thermometer Service
- Modify the Measurement interval to 1 second

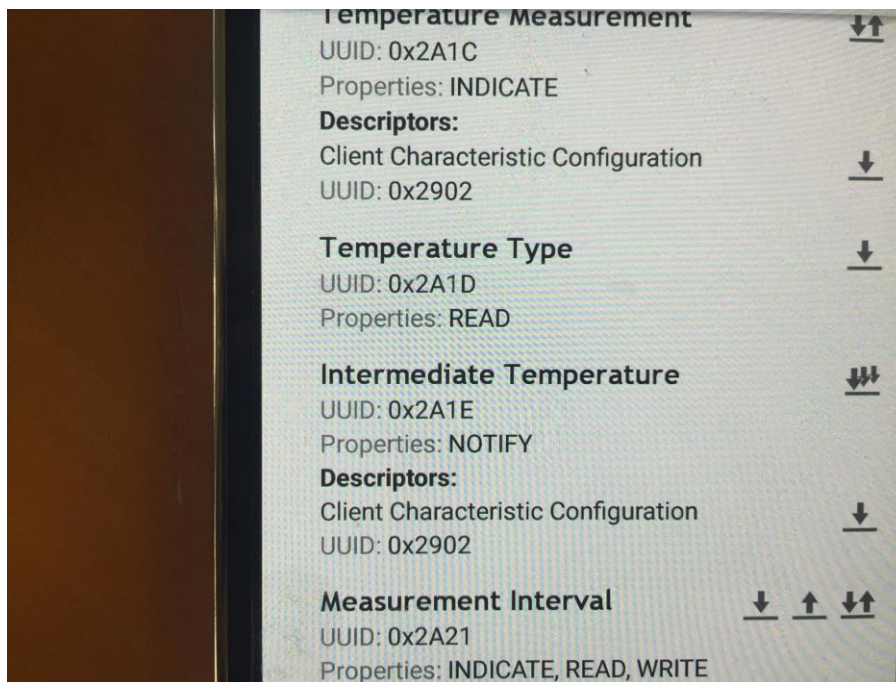
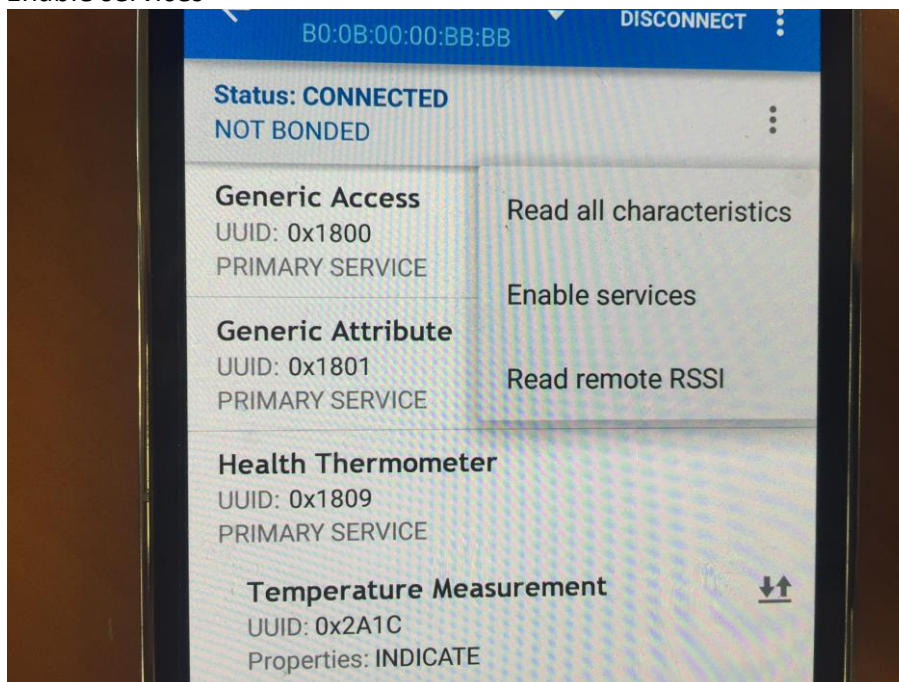


Figure 10: Change Measurement interval

- Then Enable services



- The graphical interface display information, among which the Temperature indication received from the device. This temperature, controlled by the local device application, changes continuously.
- Displaying the remote device temperature, changing every second.

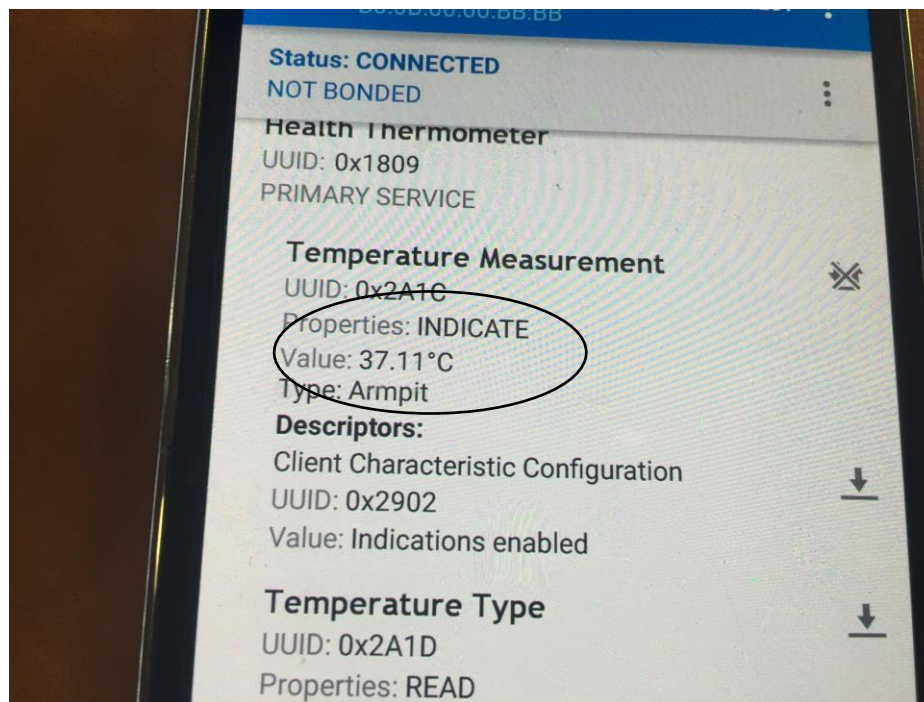


Figure 11: Temperature change

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