Smartwatch with BLE LC3 Audio

Degree programme: BSc in Electrical Engineering and Information Technology | Specialisation: Embedded Systems
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Bluetooth LE Audio is the next generation of Bluetooth Audio. Together with the new audio codec „LC3“, the technology is well suited for size- and power-constrained devices. In this project a HW demonstrator for a smartwatch was designed, which can be used as LE Audio source/sink together with a peer device (e.g. a development kit) acting as LE Audio sink/source, respectively.

Initial situation

Bluetooth Classic Audio is the standard for wireless audio streaming. However, the technology has several limitations, such as high power consumption. To address these limitations, Bluetooth LE Audio was developed as the next generation standard using Bluetooth Low Energy (BLE) for data transmission. It incorporates the Low Complexity Communication Codec (LC3) to compress audio data for high-quality audio even at low bit rates. The low complexity of the codec also ensures low latency and minimal memory requirements. This makes LE Audio with the LC3 codec suitable for size- and power-constrained audio streaming devices.

Objectives

The aim of this bachelor's thesis was to develop a HW demonstrator for a smartwatch able to transmit/receive LC3-encoded audio streams to/from a peer device acting, e.g. as wireless headphones. To this end, the nRF5340 dual-core Bluetooth 5.3 System on Chip (SoC) from Nordic Semiconductor was already evaluated in the project study. Its ability to act as a source and sink for audio streaming over BLE has been successfully tested using the audio development kit available from the manufacturer.

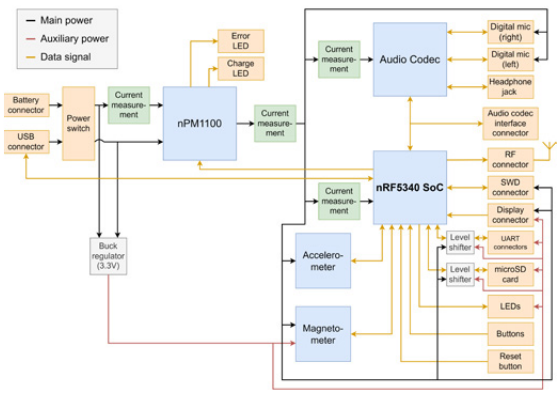

Figure 1: Block diagram of the smartwatch demonstrator.

Implementation

For the hardware design, the „nRF5340 Audio DK“ was used as a starting point. Unnecessary components were removed to reduce the complexity and load of the system. Additional components were added to meet the project requirements (e.g., an e-paper display or a stereo audio DSP). The final block diagram is shown in figure 1.
In parallel, Nordic Semiconductor's „nRF5340 Audio“ sample application, which demonstrates audio streaming with the LC3 codec using two nRF5340 Audio DKs, was adapted and extended with additional tasks to control the new components. Care was taken to facilitate its porting to the new HW demonstrator.

Results

The designed smartwatch demonstrator is shown in figure 2. Two prototypes have been successfully assembled so far. The power supply works and the SoC can be detected by the debugger. Difficulties in programming the SoC are still under investigation.
In software development, a new task for the e-paper display was successfully implemented. An additional task that reads audio data from the SD card and feeds it into the LC3 encoder buffer of the audio stream has also been implemented. The audio quality can be further improved. The next step would be to port Nordic's sample application to the smartwatch demonstrator and exploit its capabilities.

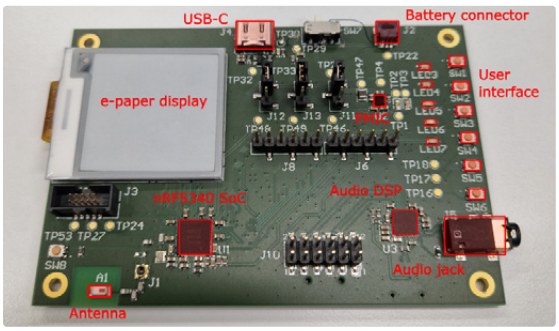

Figure 2: Manufactured Printed Circuit Board (PCB) of the designed smartwatch demonstrator.

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