Live-View Device for eECG Measurement

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The Live-View Device for eECG (esophagus electrocardiogram) Measurement is a proof of concept for the wireless communication within the esophageal electrocardiogram recorder (E2C) project. The Live View-Interface (LV-I) establishes a link between the E2C inside the nose of the patient to the outside using Near field communication (NFC) and Bluetooth low energy (BLE). A datarate of 2 kBytes/s is achieved with an NFC tag antenna of only 1 cm in diameter at a distance of 20 mm.

Background

The eECG is a research and development project with the goal to develop a new ECG device located in the nose of the patient and capable of recording up to 30 days. The ECG-sensors are located in the esophagus behind the heart and connected to the recording device in the nose. This offers new opportunities to detect very rare cardiac arrhythmia with minimal disturbance of the patient›s daily life.

The goal of this work is to design a Live View-Interface (LV-I) which establishes a communication channel from the outside world to the E2C facing the following challenges.

Challenges

- The E2C device in the patients nose is small (area maximum 1 cm^2) => NFC tag and antenna as small as possible
- The LV-I should be as small as a key fob so the patient can carry it with him all the time
- The LV-I should come in a hermetically sealed housing
- The LV-I should be low power to run for 30 days
- The LV-I offers two operating modes:
  1. Live View: the doctor can check the ECG signal quality during the installation of the E2C and perform configurations
  2. Event Marker: the patient can press a ‹event button› on the LV-I when he experiences an arrhythmia. This will log an event on the E2C and the LV-I in order to help finding the event at a later date.

Solution

To achieve a hermetically sealed housing, all interfaces are designed with wireless technologies (Bluetooth, NFC). Moreover, the device is charged through a wireless Qi power charger and the Human-Machine-Interface consists of a touch sensor and an LED. To keep the size of the device small, we choose the smallest available components and as few as possible. To save battery energy, the device is divided in two power domains: VBAT is connected directly to the battery and always running whereas VDD is powered through a voltage regulator which can be switched off temporarily. We thus achieve a battery life of 90 days in event marker mode.

The heart of the circuit is the BLE-Module with an integrated microcontroller. This module contains the bluetooth stack and controls the whole device. Through an I2C bus it is connected to the real time clock (RTC) and the NFC-Reader. The latter scans for an NFC tag and connects to it. The firmware running on the prototype is capable of receiving commands over BLE from a computer and sending them to the E2C over NFC using the developed Live View Protocol communication protocol.

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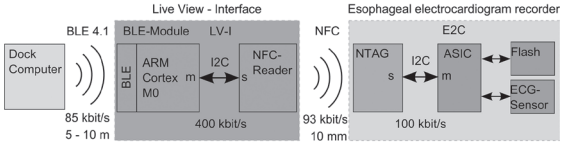

The Live View- Interface communication overview (datarates are actual data throughput)

Live View-Interface prototype with NFC-Antenna (front), Bluetooth Low Energy and Qi wireless charging