ULTRALOW POWER WEARABLE BLUETOOTH LOW ENERGY (BLE) IN MULTI-CHANNEL EEG/EMG APPLICATIONS

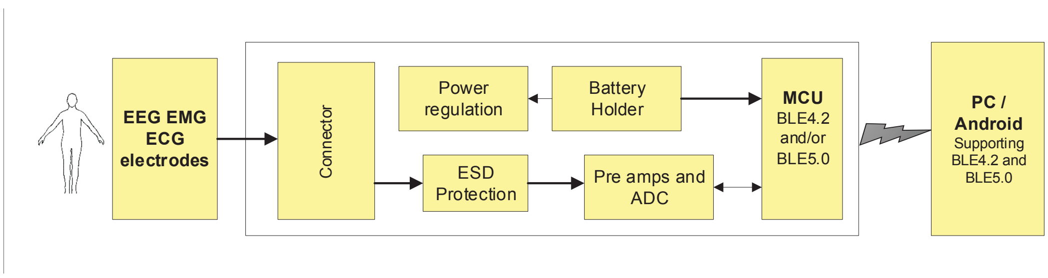
Maroun Farah, SensoMedical

Modern multi-channel online recording from multiple EEG electrodes requires connecting the electrodes to preamps, digitization unit, transferring the data to a digital system and then making this data available to the web. Bluetooth low energy (BLE) was made to support sensing applications that do not require high throughput, while the need for 20 channels EEG through put could reach 160Kbps @ 500 samples per second, data throughput reported with BLE 4.1 were only 20-30Kbps yielding BLE unsuitable for such applications, the introduction of BLE 4.2 with data length extension feature followed by 5.0 with double the bitrate, have theoretically opened the door for the implementation of ultralow power wireless EEG/EMG wearables. We present here some of the steps necessary to develop wearable based EEG/EMG wearables based on BLE 4.2 and 5.0.

OVERVIEW

The **SensoMedical BioPot V2** is an ultra-low-power device powered by a button cell battery, which utilizes a Bluetooth Low Energy (BLE) 4.2 and 5.0 protocol to connect to the host. It is capable of continuous and prolonged (over 10 hours) acquisition of 8 or 16 channel biopotential (EMG/EEG/ECG) signals. Bluetooth V4.2 superior specifications allow for a high over-the-air data throughput with low power consumption, monitoring eight channels of raw EMG data at 500 Samples (Android) and up to 2,000 Samples (8 channels Windows) per second. The wireless setup also allows for the continuous upload of data to cloud storage for remote monitoring and advanced data processing.

SYSTEM DIAGRAM



UTILIZING DATA LENGTH EXTENSION FOR HIGHER THROUGHPUT

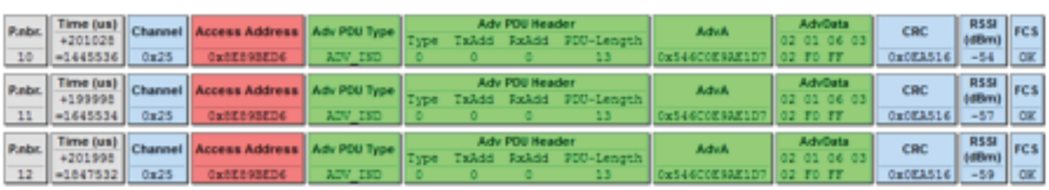


figure 1. Advertising Packets

Advertising packets are BLE data sent from the transmitter in this case every 200 mSec;

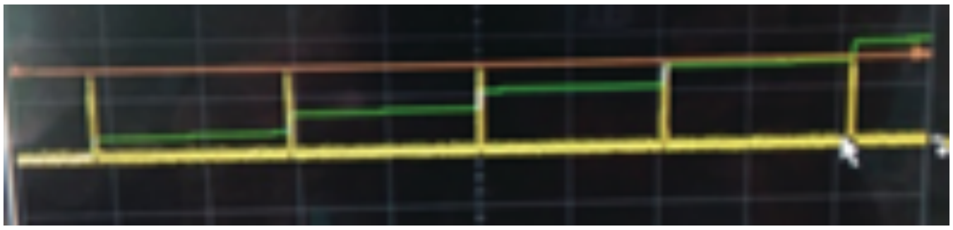


figure 2. power profile during advertising

Android or Windows systems listen to these packets, and a decision to connect and pair with the wearable can be made at any time. During this phase, power consumption should be minimal; the micro controller should wake up send the packet and then immediately sleeps back; Fig. 2 shows current profile with an average of 100uA; pulsed current draw with 8 mA for 0.2 mSec. After a connection is established and acquisition is started current consumption will be composed of DC current necessarily to power the ADC and communication between ADC and microcontroller. Fig. 3 shows packets being sent from a transmitter, followed by acknowledgment packets.

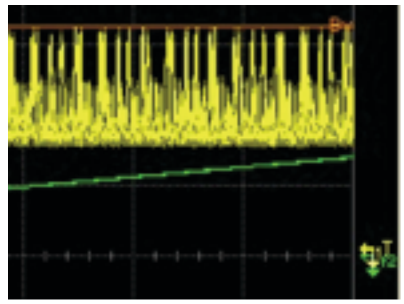


figure 4. Current profile during acquisition

Fig. 4 shows current consumption during acquisition.

figure 3. Data packets

BATTERY SELECTION

The first decision regarding the battery should be the selection between primary, disposable and rechargeable. Primary batteries are cheaper and can be incorporated inside electronics. When disposable wearables are required and no recharging mechanisms is needed, it will be sensible to use such batteries. However despite their capacity being much larger than disposable batteries, their effectiveness drops enormously when current draw rises. One specific battery optimized for these solutions is the CR2032 battery. When using it designers should make sure that total average current draw should not exceed 4 mA, batteries from different vendors have different performance; Rechargeable batteries (e.g. LIR1620) come in different shapes and configurations. Environmental regulation and safety issues might limit their use due to transportation and disposal limitation. Incorporating such batteries inside the solution will solve current draw problems, but increasing the cost of the wearable.

CONTACT:

Nazareth, Israel

Office: +972 4 6800668

Mobile: +972 54 6620033

E-mail: m.farah@sensomedical.com

SENSO MEDICAL

Where neuroproducts become reality