Vital Sign monitor

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Project Overview:

The goal of my project is to design and implement a system which is able to monitor vital signs of a human body. There are 4 vital signs that I am going to target.

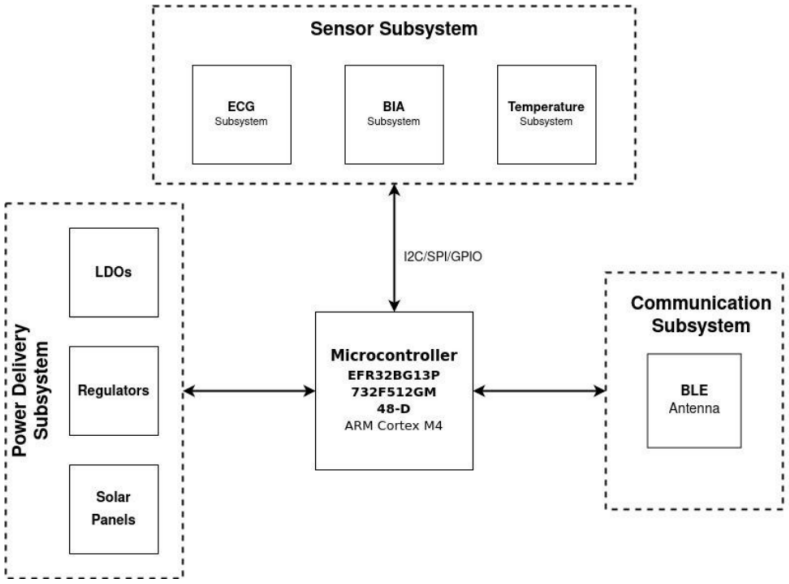
1. Temperature
2. ECG
3. Body Impedance
4. Pulse rate

The design comprises two separate devices connected to each other via Bluetooth Low Energy. The hardware board developed consisting of all the sensors will measure the vital signs while the application hosted on a mobile phone or PC will collect information and show it to the user. The main user group that we target are doctors or trained professionals.

Product Features:

- The mobile or PC application will show the vital sign measurements and save those values according to patient name
- The product implement load power management and harvests energy using solar power
- The product will use a high precision infrared temperature sensor
- The product monitors body impedance using a medical standard BIA IC
- The product measures ECG with the help of high precision medical IC.
- The product delivers pulse rate computed from ECG signal measurements.
- GPIO buttons to turn on and off the system and select functionalities.

Function Block Diagram:



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Component Selection:

Processor - EFR32BG13P732F512GM48-D seems to be the best option so far.

Sensor/Actuator Selection

ECG Sensor:

1. Analog Devices :
https://www.analog.com/en/applications/markets/healthcare-pavilion-home/vital-signs-measurement/electrocardiogram-ecg-measurement.html
2. Maxim Integrated :
https://www.maximintegrated.com/en/products/analog/data-converters/analog-front-end-ics/MAX30003.html
3. Texas Instruments : https://www.ti.com/product/AFE4960P
4. Texas Instruments :https://www.ti.com/product/AFE4960

Temperature:

1. Melexis Technologies :
https://www.digikey.com/en/products/detail/melexis-technologies-nv/mlx90614esf-bch-000-tu/5168323
2. Maxim Integrated:
https://www.maximintegrated.com/en/products/sensors/temperature-sensor-ics.html/tab1?fam=temp_sens&node=39783&metaTitle=Local%20Temperature%20Sensors&723=OR%7CClinical%20Grade
3. Mikroe Elektronika:
https://www.digikey.com/en/products/detail/mikroelektronika/mikroe-1362/4495441
4. Melexis Technologies:
ttps://www.digikey.com/en/products/detail/melexis-technologies-nv/MLX90614ESF-AAA-000-TU/1647940

Body Impedance:

1. Maxim Integrated:
https://www.maximintegrated.com/en/products/interface/sensor-interface/MAX30002.html
2. Analog Devices:
https://www.analog.com/en/applications/markets/healthcare-pavilion-home/disease-management-and-wellness/body-comp-hydration-bio-impedance-analysis.html
3. Texas Instruments:
https://www.ti.com/lit/ds/symlink/afe4500.pdf?ts=1662242890035&ref_url=https%253A%252F%252Fwww.google.com%252F

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Part selection:

Part	Number	Manufacturer	Features
Microcontroller	EFR32BG13P732F512 GM48-D	Silicon labs	● Arm Cortex M-4 ● In-built FPU ● 512 kB Flash ● 64 Kb RAM ● Support BLE,Bluetooth and Bluetooth-5
ECG sensor	AD8232	Analog Devices	● Low supply current ● Specially designed for ECG ● Shutdown pin available. ● Lead-off detection
Temperature sensor	MLX90614ESF-AAA	Melexis Technologies	● Infrared sensing ● Compatible power requirements.

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			● Through-hole component. ● Very small form factor.
BioImpedance sensor	AD5941BCPZ	Analog Devices	● 16-Bit ADC in-built. ● Voltage/Current/ Impedance measurement capability. ● On -Chip peripherals.

State Definitions:

The goal of the device is to be used per patient and not continuous. Here are the associated states based on 1 minute reference per state.

S-1 : Deep Sleep
S-2 : Startup
S-3 : Sensing
S-4 : Transmit

Energy Storage element selection

Part	Current	Voltage	Power	S-1	S-2	S-3	S-4
ECG AD8232	230 µA	3.3 V	759 µW			*	
Temperature MLX90614ESF	1300 µA	5 V				*	

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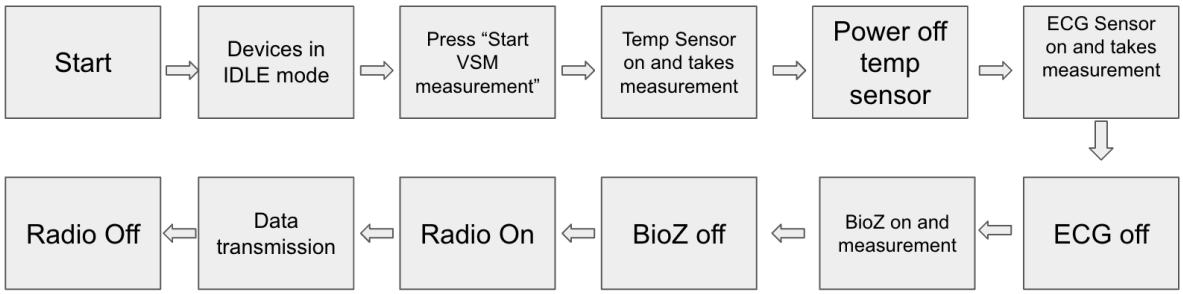
Microcontroller EFR32BG13P732F512GM48-D				*	*	*	*
Bioimpedance sensor AD5941BCPZ	106 µA	3.3 V	349.8 µW			*	
BLE transmit							
Total							

Flow diagram



My system will be designed in such a way that it can take all the necessary readings in one go.