Development of radio frequency channel for wireless electrocardiographic amplifier

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Introduction

Current systems of electrocardiograph (ECG) analysis successfully solve problems of clinical diagnosing. But continuous ECG monitoring practiced only for critical patients. It concerned with technical, economical and exploitation limitations. Cheap and ergonomically wireless ECG sensors may monitor essentially more patients and achieve early cardiological help.

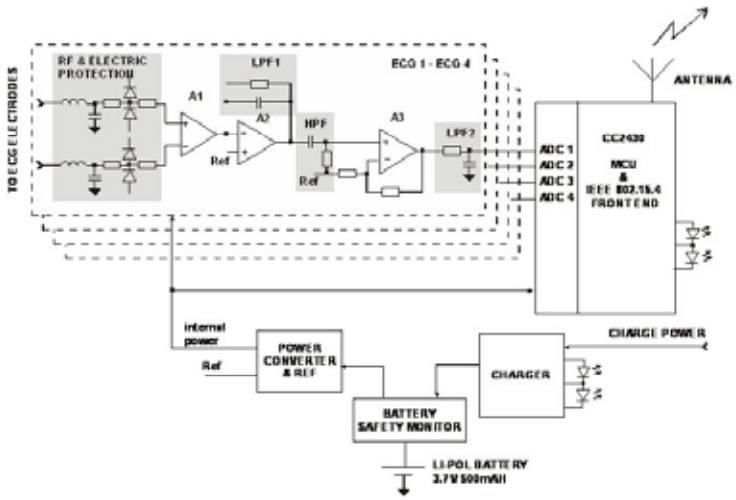
Was developed 4-channels wireless ECG amplifier with battery powering. To improve range was performed antennas' test and made choice of its type.

Wireless ECG amplifier's parameters

- Number of ECG channels:
  4 differential
- Analog gain:
  124
- Passband:
  0,15 – 106 Hz
- Wireless protocol:
  IEEE 802.15.4 / ZigBee
- Dimensions:
  55x35x15 mm
- Time in stand-by mode:
  up to 500 hours (20 days)
- Time in transmission mode:
  up to 13 hours

3

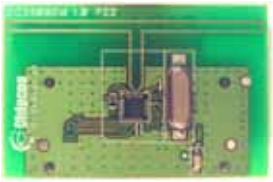
Block diagram of device



4

Types of antennas

There are three main types of antennas for short range devices



1) PCB antenna 2) chip antenna 3) whip antenna

Type	Pros	Cons
PCB antenna	• Low cost • Good performance	• Large size • Development difficulties
Chip antenna	• Small size	• Medium performance • Medium cost
Whip antenna	• Good performance	• High cost • Large size

5

Comparison of antennas' dimensions

Inverted F PCB antenna
(26x8mm)

Inverted F PCB antenna
(15x6mm)

Folded dipole PCB antenna
(47x6mm)

Fractus chip antenna
(7x3x2 mm)

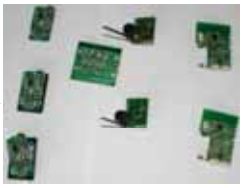
Antenna Factor chip antenna
(6,5x2,5x1 mm)

Whip antenna
(Φ7 mm, 55 mm)

6

Testing method

2 - 5 m.



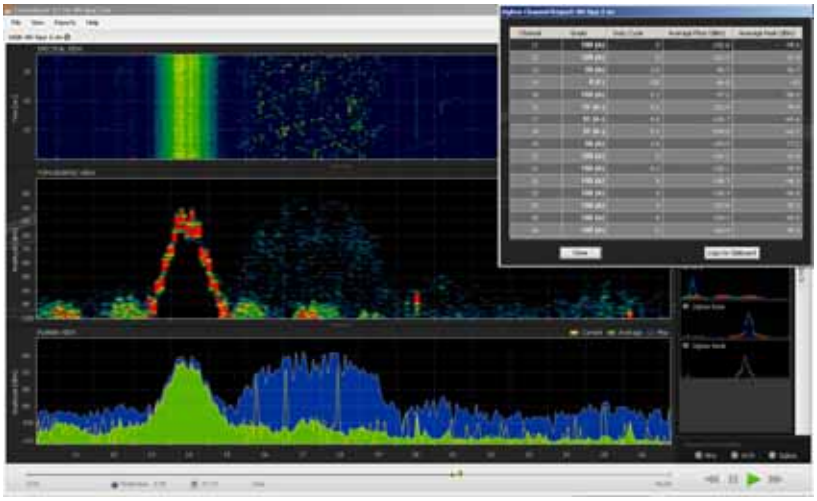
Notebook with Wi-Spy adapter

PCBs with various antenna type

CC2430 Evaluation board
(initialize chosen radio channel)

7

Typically ZigBee signal's spectral view



8

Results

Type	Measured signal level at 2m. from source (average, dBm)	Measured signal level at 5m. from source (average, dBm)
PCB antenna (Folded dipole, Texas Instruments AN040)	-68	-71,5
Chip antenna (Fractus)	-64	-66,5
Chip antenna (Antena Factor)	-71	-74
Whip antenna (quarter-wave)	-63,5	-69

$$A(dBm) = 10 * \log_{10}\left(\frac{P_{out}(mWt)}{1(mWt)}\right)$$

9

Conclusion

Functionality of wireless sensor directly depends on its radio channel. The choice of antenna is a trade off between cost, size and performance.

Type	Typical cost
PCB antenna	0 $
Chip antenna	0,5 – 3 $
Whip antenna	5 – 15 $

Ideology of personal electrocardiographic amplifier not allows using large or expensive components. PCB antenna sets some dimensional limitations and has hard predictable characteristics. Whip antennas have high cost and not comfortable in use. That's why chip antenna is a optimal choice for developers of wireless medical sensors.

10