

IEGULDĪJUMS TAVĀ NĀKOTNĒ



EEG DATA ACQUISITION SYSTEM BASED ON ASYNCHRONOUS SIGMA-DELTA MODULATOR

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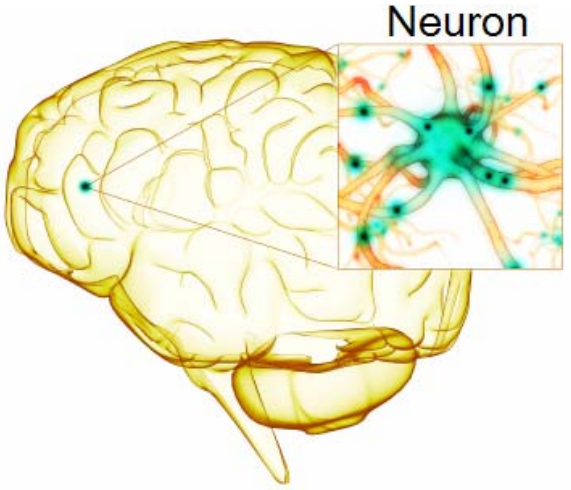
Project title: R&D Center for Smart Sensors and Networked Embedded Systems. The project is supported by European Social Fund ESF grant No. 2009/0219/1DP/1.1.1.2.0/09/APIA/VIAA/020

Brain signals (EEG)

- The human brain has a huge number of neurons. Approximately 10^{11} (one hundred billion) neurons

- The Information from periphey to our brains are transmitter by neurons and vice versa

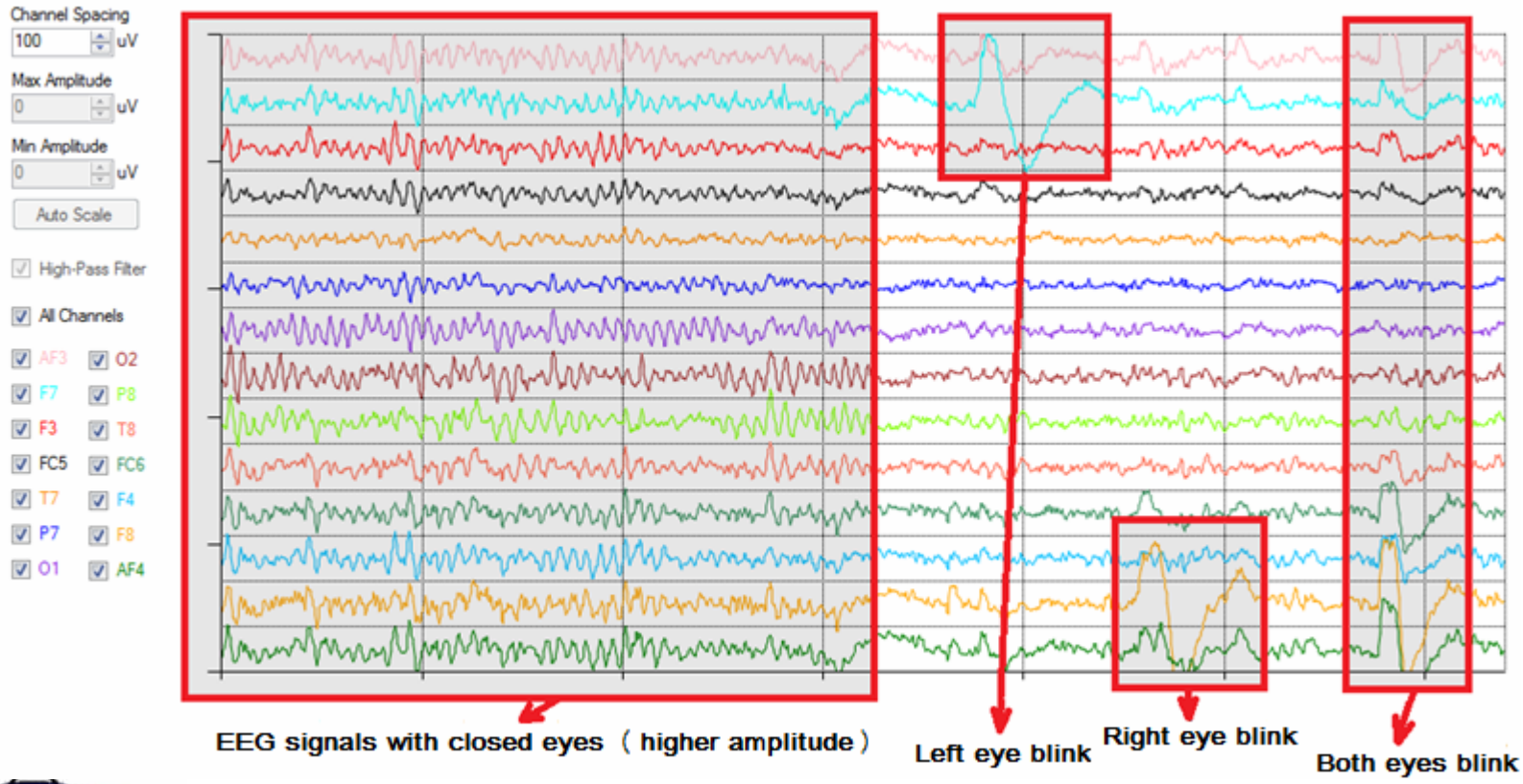
- Using special electrodes it's possible to measure our brain electrical activities

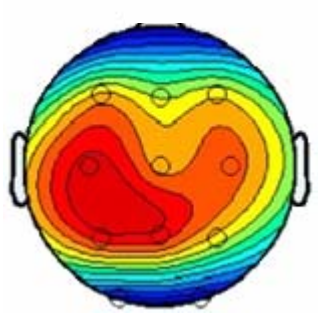




Pictures from http://biomechanism.com/

Brain signals (EEG)





Properties of the EEG waves:

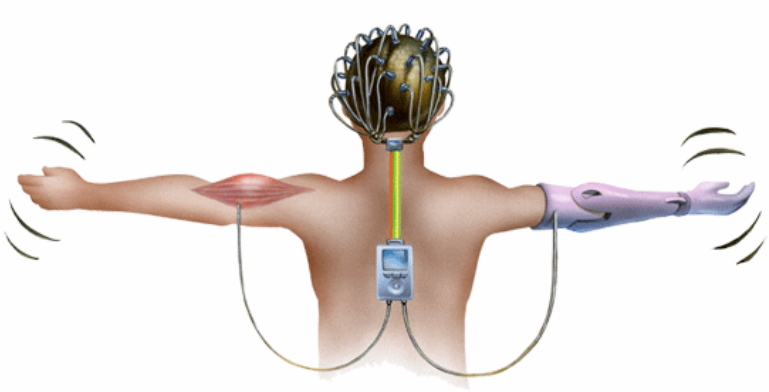
	Typical frequencies, Hz	Typical amplitudes, uV
α	8 – 13	2 – 100
β	13 – 22	5 – 10
γ	30 – 100+	3 – 5
Δ	0.5 – 4	20 – 100
θ	4 – 8	~ 10

Brain Computer Interface

Using Brain signals it's possible to create so-called «Brain Computer Interface»



http://www.biosignal.at





http://www.wired.com



http://neurogadget.com

Motivation

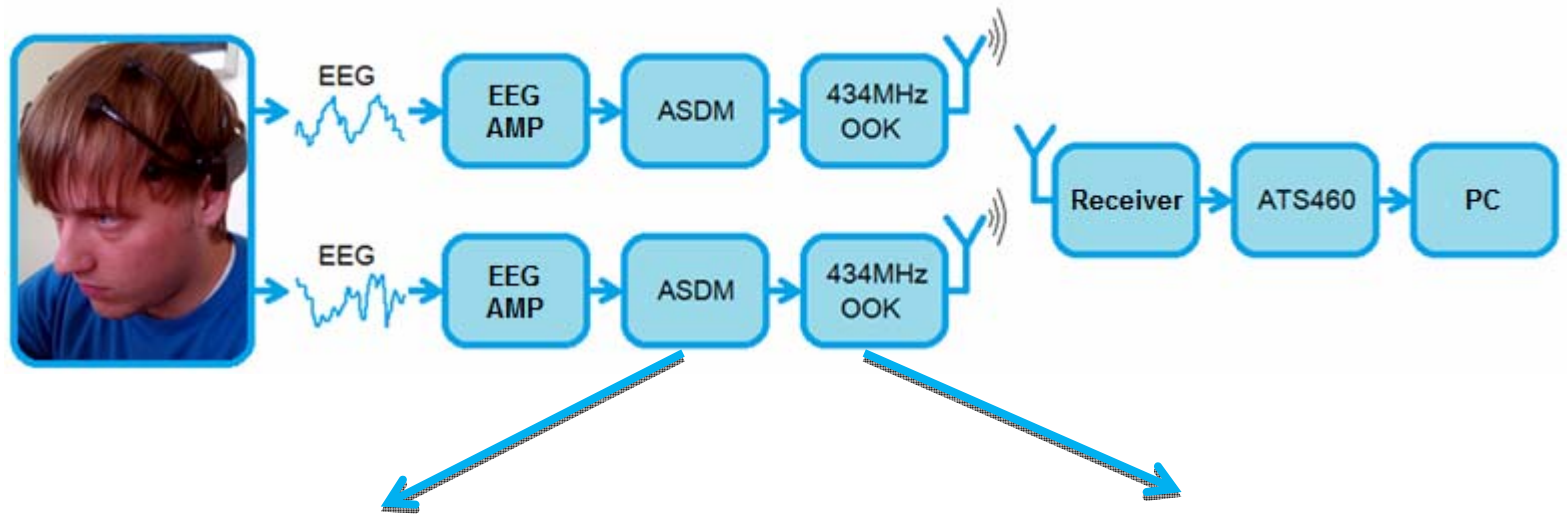
Current EEG acquisition systems limitations:

- Relatively big physical size of the system
- Data transmission using wires
- Energy consumption
- The number of channels (electrodes)
- etc.

Our Aim:

- Our aim is to develop small on-head sensor (One sensor corresponds to one channel), which performs data acquisition, amplification, encoding and wireless transmittion

Our approach



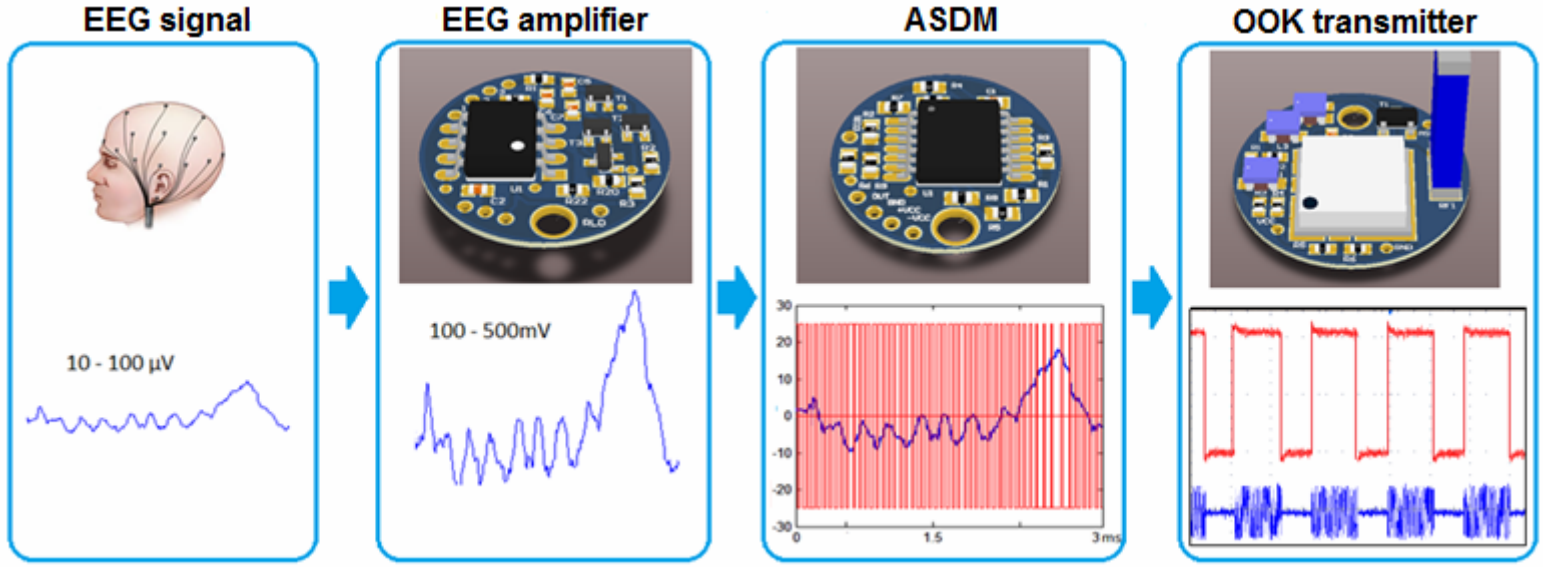
Asynchronous Sigma-Delta modulator :

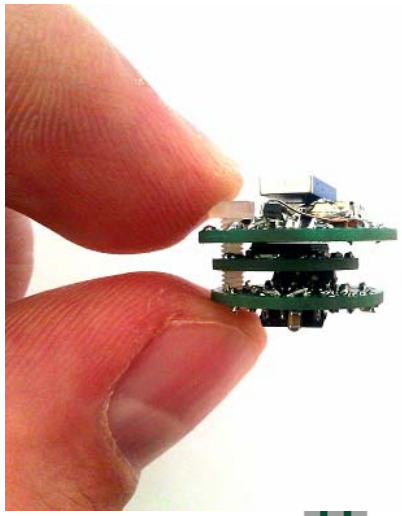
- Amplitude information of the signal ir transformed into time information without quantization error
- Energo efficient
- Feasible in small-size system
- Excludes electromagnetic interference

On-Off keying (OOK) wireless transmittion :

- Simple architecture
- Good performance in the presence of co-channel interference
- Robust when exposed to vibration or shock
- Small dimensions for on-head device implementation

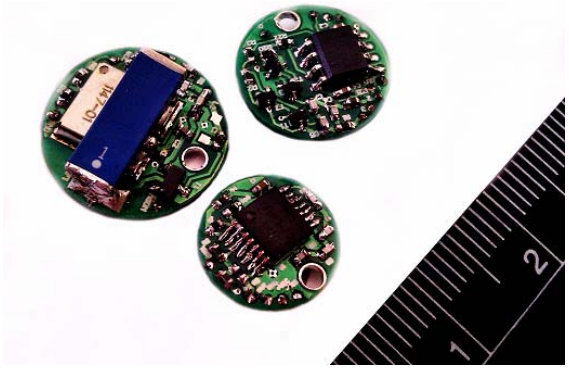
EEG data acquistion sensor



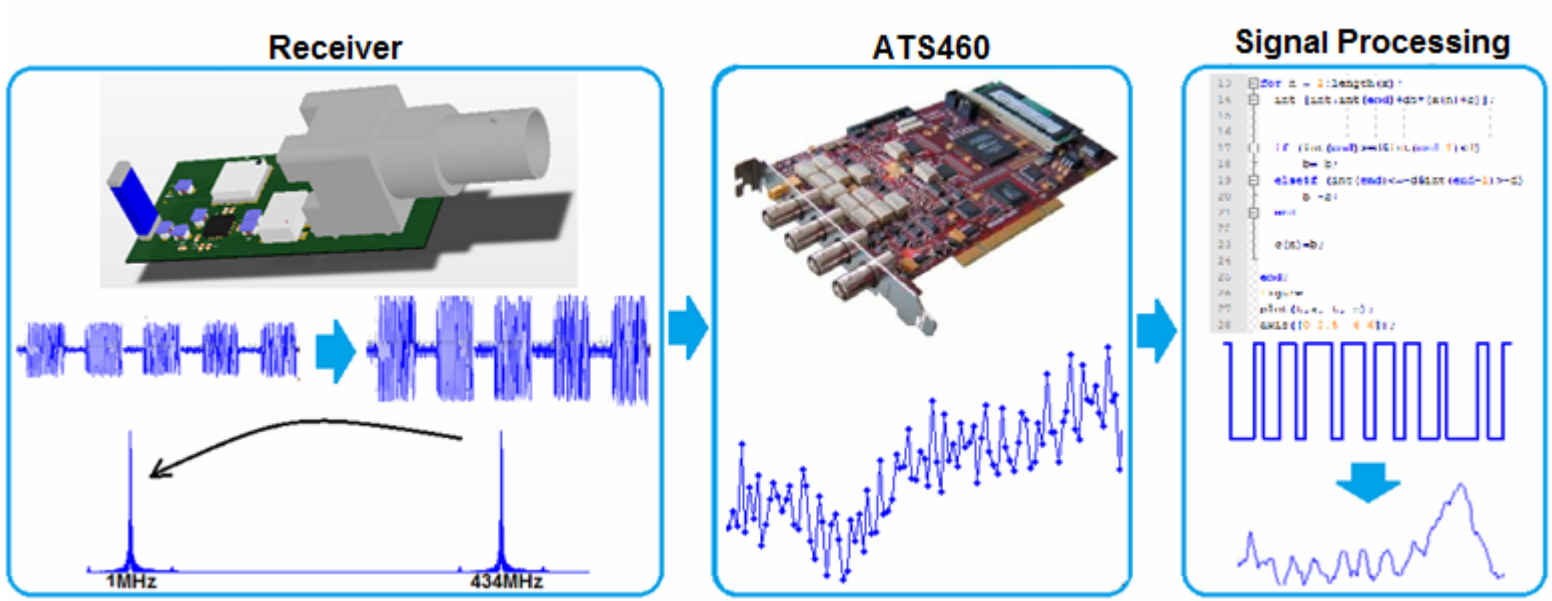


- AgCl electrodes
- EEG signal amplifier
  (gain ~10 000, CMRR ~120dB)
- Asinchronous Sigma-Delta modulator
- OOK 434MHz transmitter
  (In ISM band, it's possible to transmit up to 85 channels)

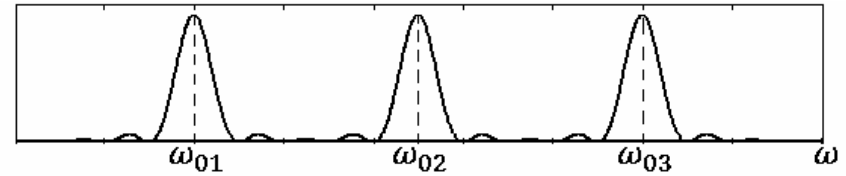
Sensor size: 16x11mm



Receiver and signal processing



- Superheterodine receiver (we use LT5526 mixer), for signal amplification and frequency downcovertion. Receivers size: 4 x 2cm
- ATS460 digitizer (14-biti, 125MS/s)
- *Matlab* and *LabView* software is used for each channel filtering, signal processing and EEG signal reconstruction



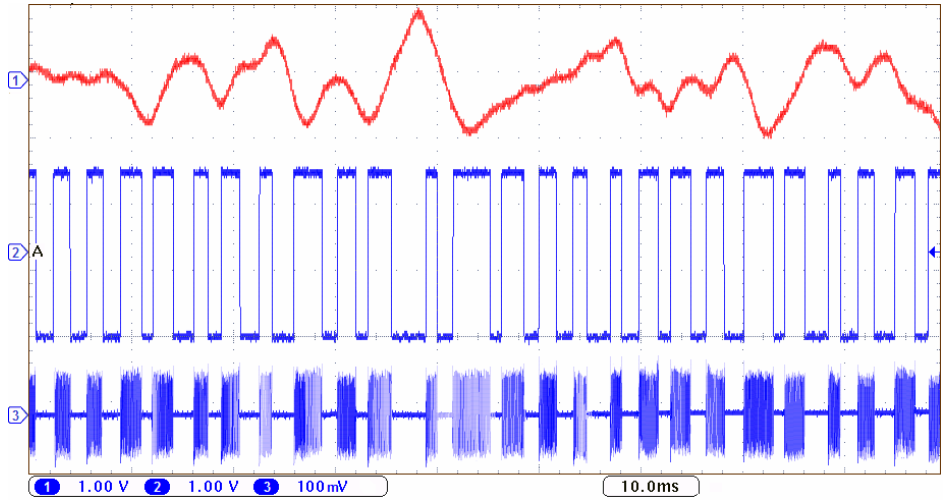
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Graphical Summary

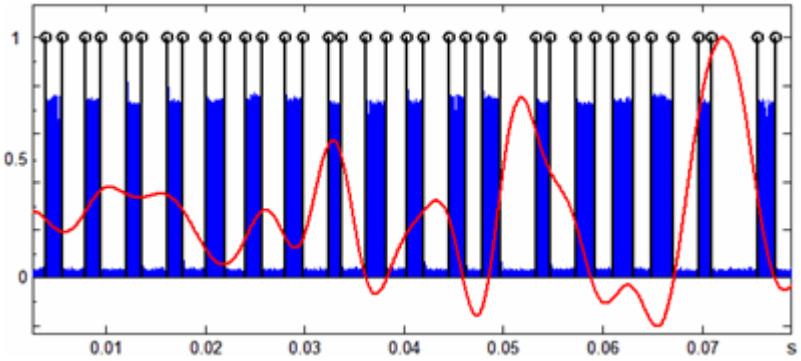
Brain Signals (EEG)

Asynchronous Sigma Delta modulator output signal

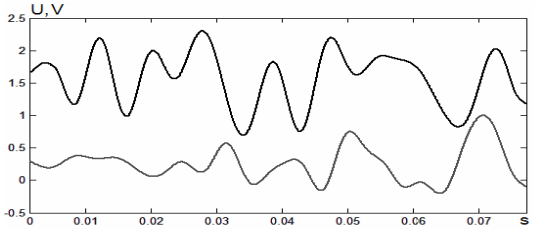
Transmitter output signal On-Off keying (OOK)



Received filtered one channel signal and reconstructed EEG signal

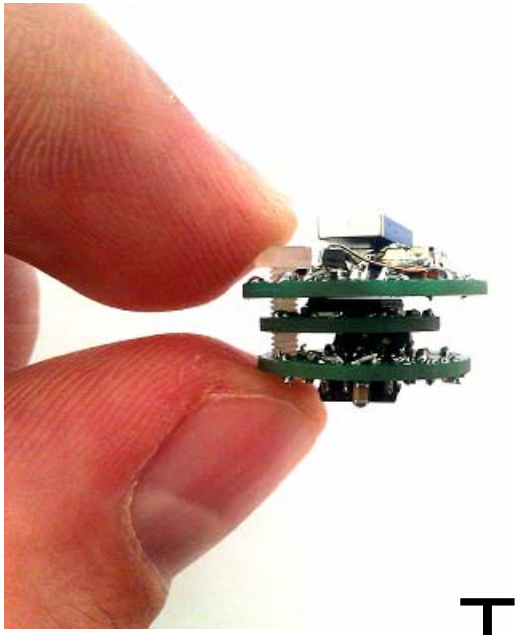


Reconstructed EEG signals

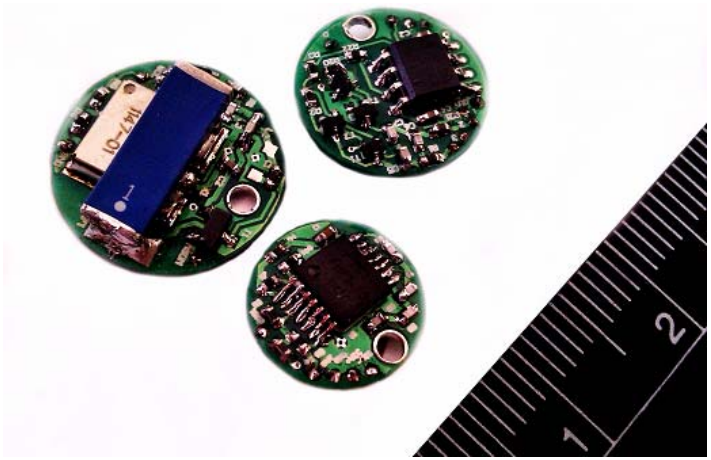


Conclusion

- The main aim of developing an alternative, mobile system instead of classical, for EEG data acquistion is achieved
- This is the first ever built real EEG data acquistion system which contains multiple on-head sensors with asynchronous data acquistion
- The analysis of the experimental results shows that by using created sensors it is possible to amplify, encode, transmit and reconstruct the multichannel EEG signals
- Using such a signal acquisition and processing aproach it is possible to increase the number of channel up to 64 and more
- The major advantage of this system is the small size which allows to increase the number of channles just by adding one more sensor and connecting it to power supply



Thank you for attention!



“If our brain were so simple that we could understand it, we would be so simple that we couldn’t” – Pugh, 1977