

GEMAC - Gesellschaft für Mikroelektronikanwendung Chemnitz mbH



Innovative Low Power Electronics for Energy Autonomous Transducers: Pressure Sensors, Inclinometers, Accelerometers and Vibration Sensors

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Why energy autonomous?

- Increasing material and energy costs
 - Trend to preventive monitoring of technical installations and processes
 - Sensors at critical points of applications
 - Increasing installation effort
- Demand for unlimited life time

Intention:

Simple and flexible sensors with an autonomous power supply and data transmission

Fields of Application

- Tire pressure sensor
- Medical technology
- Building automation (switches)
- Condition monitoring
- Mobile machines



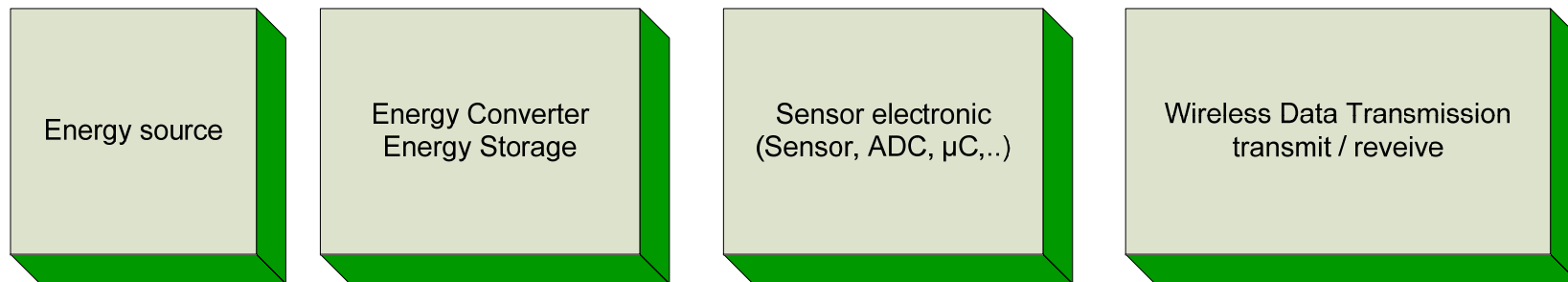
Why energy autonomous and GEMAC?

GEMAC products

- Sensors for inclination, acceleration and vibration
- Interpolation circuits
- Field bus tester
- Length measuring systems



Energy Autonomous System - Structure



Energy source

Physical principles:

- Temperature difference (i.e. thermo-electrical generators)
- Light (i.e. photovoltaic power plants, solar cell, solar thermal plants)
- Mechanical vibration (i.e. piezo-electrical or electro-mechanical)
- Streaming of gaseous and liquid substances (i.e. industrial mill, flow meter)
- extension, compression, pressure (i.e. actuation)
- Battery

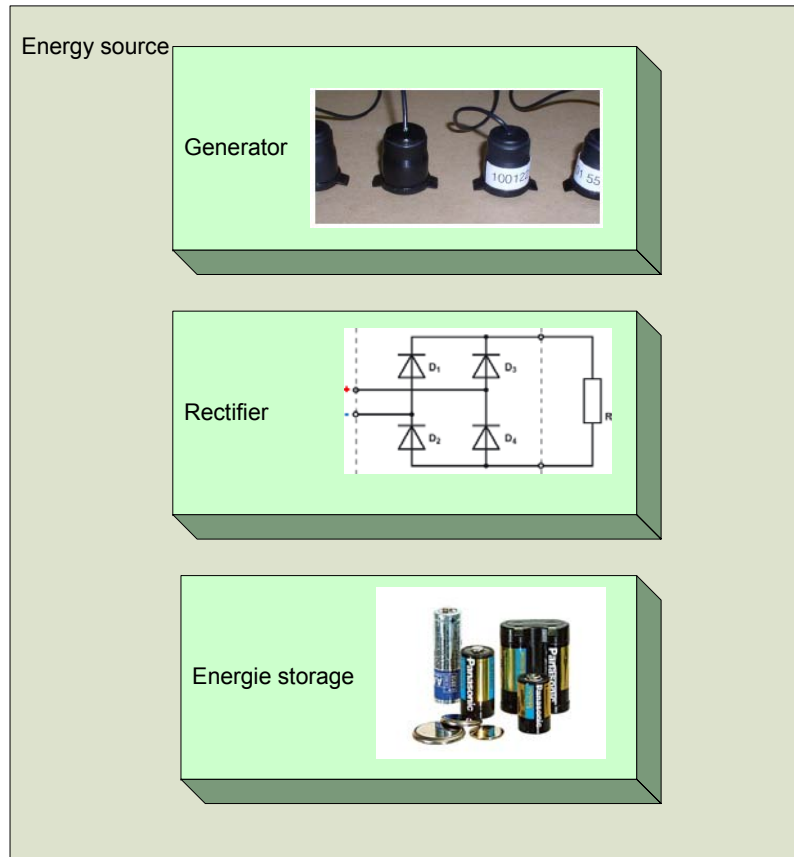


Energy source - Problems / Challenges

In all cases mentioned energy is available in limited quantities and/or limited time.

- How is it possible to generate as much energy as possible?
- How can energy be stored most effectively?

Example: Vibration Generator

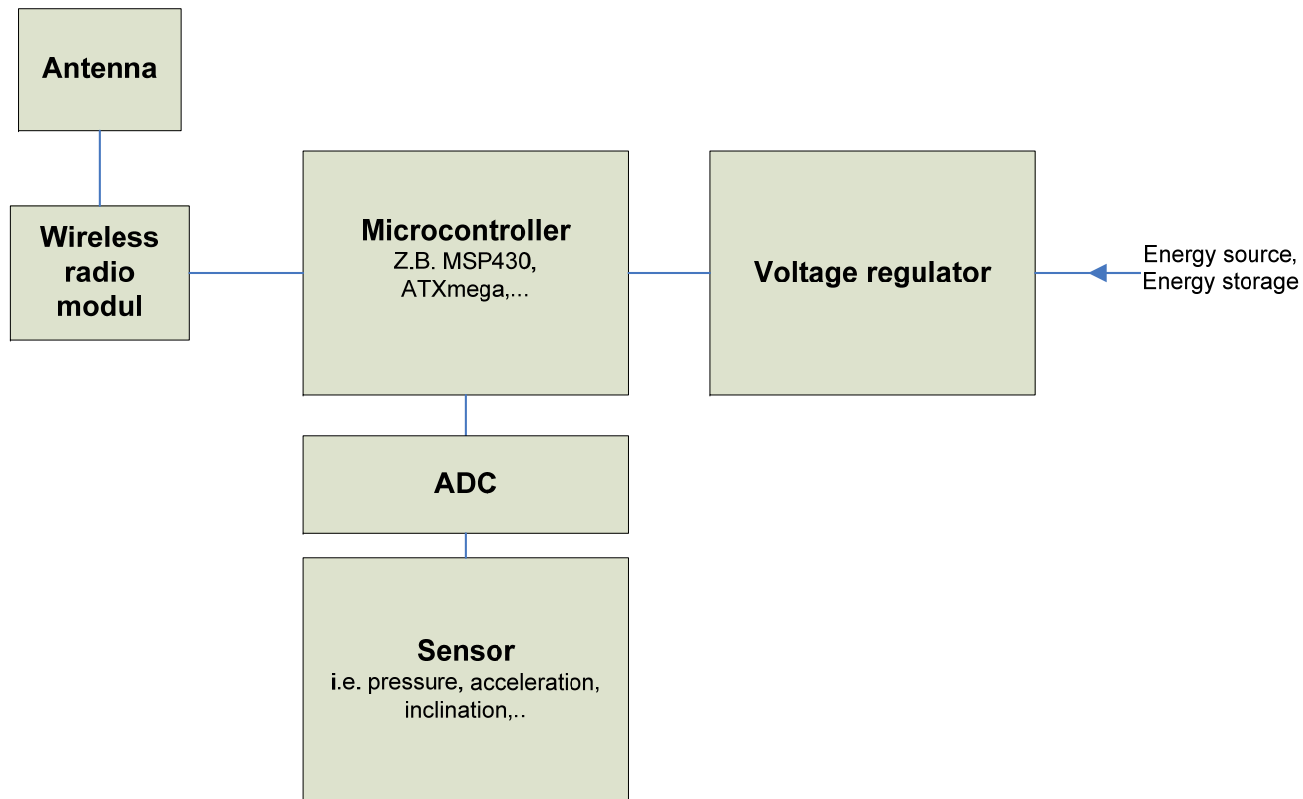


- Energy harvesting by a coil-magnet-arrangement
- Energy efficient rectifier → replacing the full bridge rectifier with a NMOS-rectifier
- Energy storage through battery or super-cap

e.g.: vibration generator from HSG-IMIT developed in the project IEKU supported by BMBF

Sensor Electronic

- How can the sensor information be processed and transmitted in the most energy efficient way?
- Energy analysis of each step necessary



Capability influences on the sensor electronic

■ Sensors

Working principle (conversion of physical values to electrical signals)

Number and complexity of parts for external sensor circuits

sample rate

signal conditioning

■ ADC

Working principle

sample rate

■ Micro controller

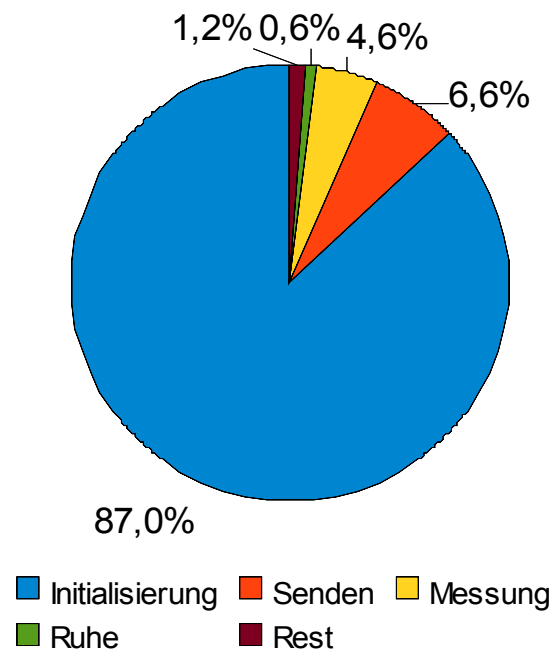
clock frequency

Architecture and Periphery

Energy analysis

- Main problem of energy - autonomous systems is the limited energy (time and volume) available.
- Therefore an exact analysis of the energetic operation within the system is necessary.

Energieverbrauch IEKU



e.g.: pressure sensor for automotive application

High energy demand for Initialization of the wireless module

Energy analysis

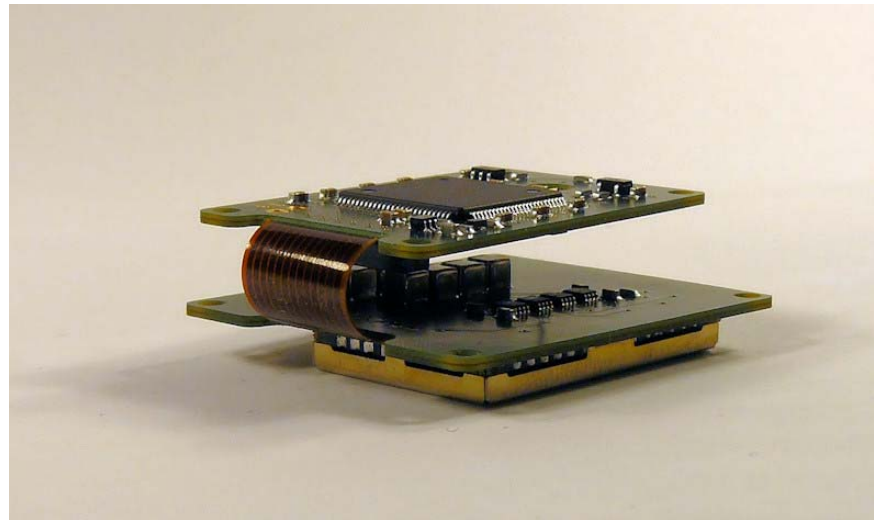
Hardware component selection and optimizing (based on energy analysis)

- components with a minimum of power loss in dependence on target application
- Microcontroller
- ADC
- Wireless radio module → wireless technology selection (WLAN, Zigbee, Bluetooth, NanoNet)

Positive effects of using an optimized hardware:

- Increased measuring accuracy and reduction of measuring time
- Usage of efficient components for power supply with minimum input voltages
- Minimization of PCB area

System Electronic

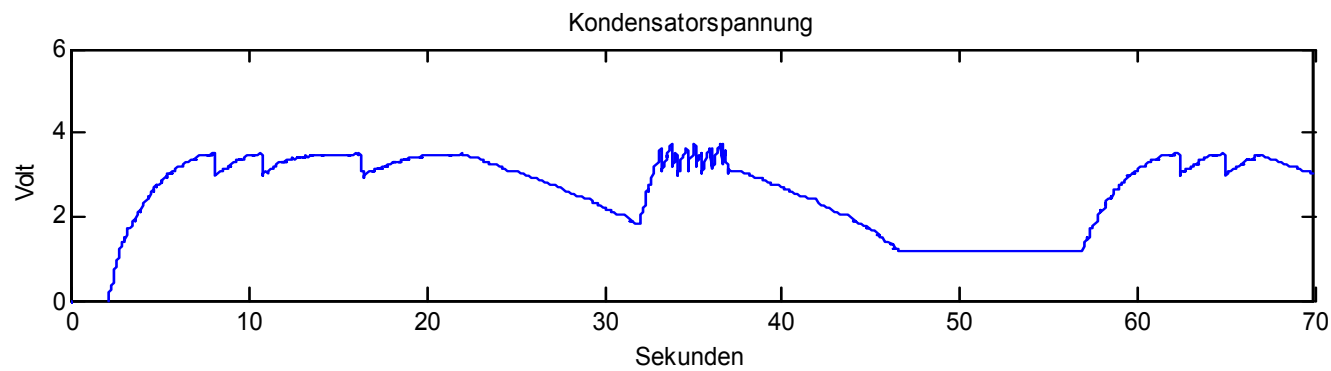
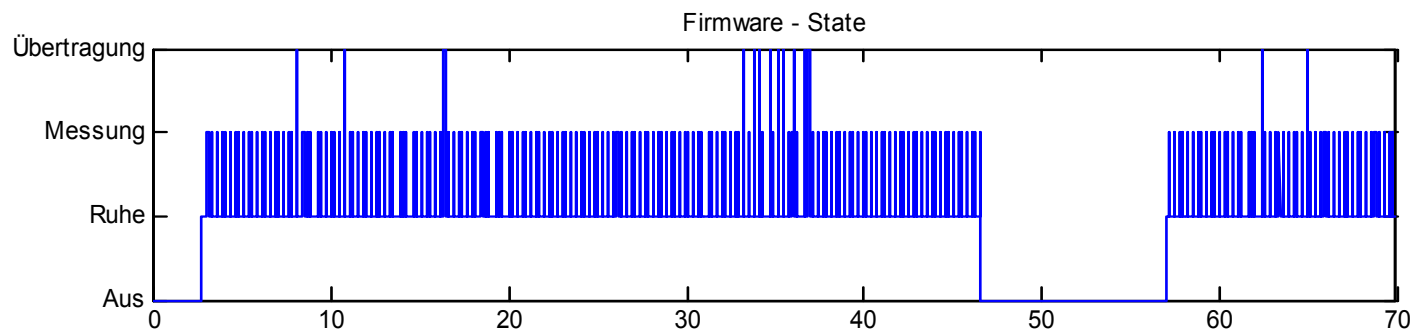
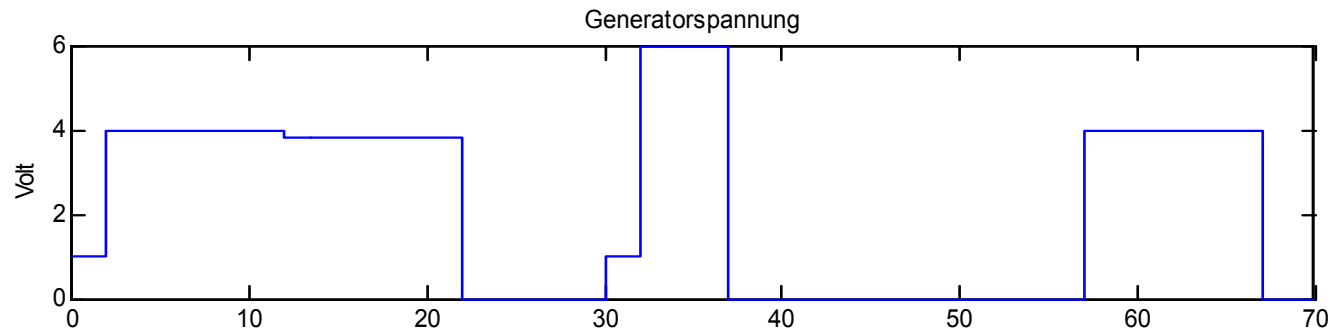


Firmware

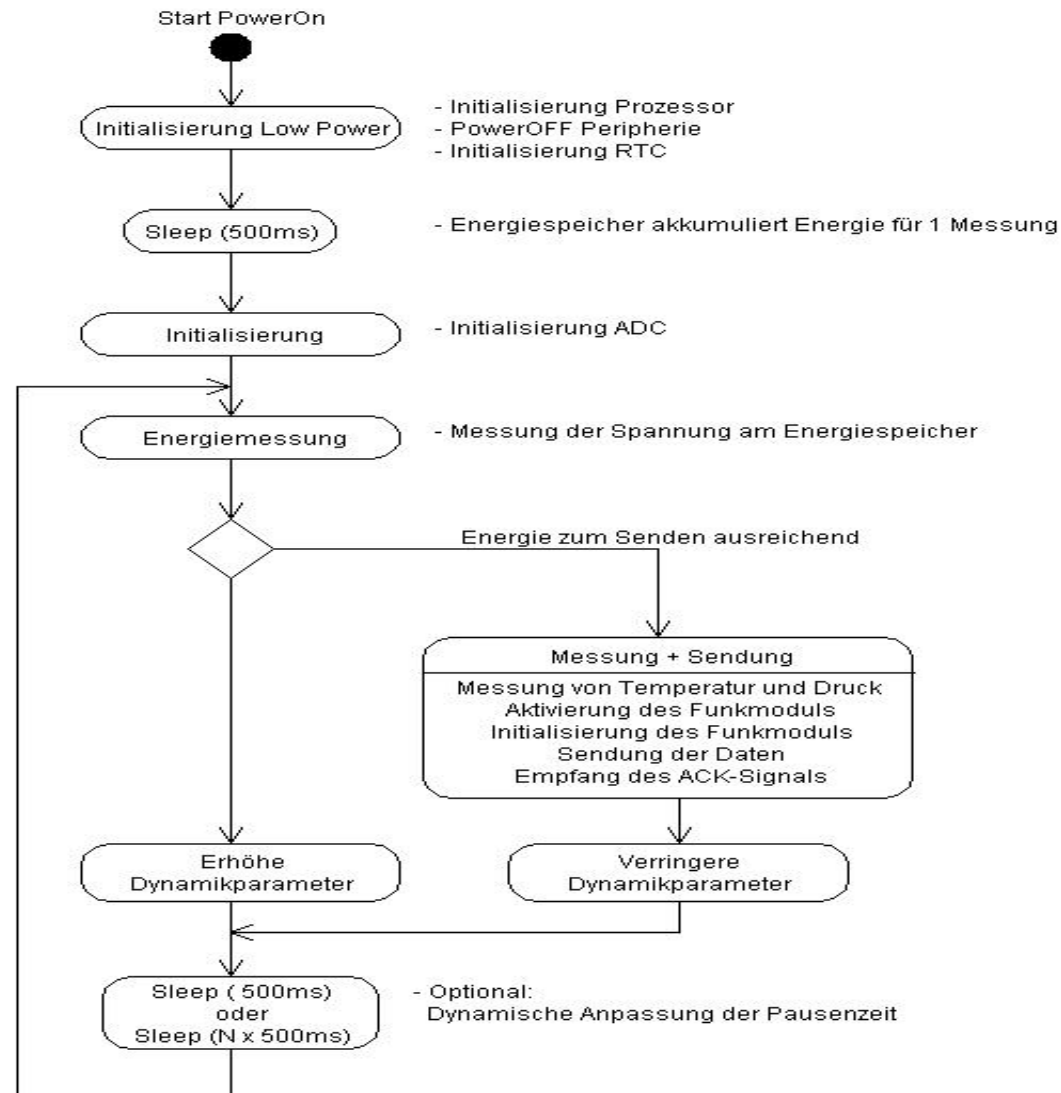


- Usage of special working modes such as „sleep“ or „power-down“
- Testing of methods for initialization
- Function reducing
- Intelligent solutions for energy efficient data processing
- Consideration of safety aspects
- Active adaption to existing energy

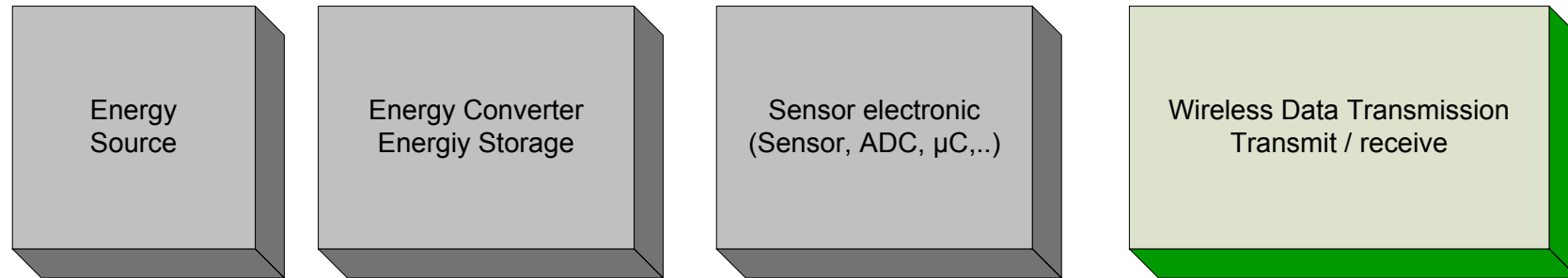
Firmware



Firmware



Data Transmission



Methods for data transmission:

- By wire
- Wireless radio
- optical

Data Transmission

Requirements for the data transmission

- High reliability
 - High availability
 - Less demand on energy
 - Application specific range of operation
 - Application specific data transmission rate
- Conflict as not all requirements can be met
- Therefore application specific adaptation necessary
- Pulse mode,...

Advantages / Disadvantages Wireless Radio

Advantages

- High flexibility
- Low costs
- New fields of application
- Information availability in a wide range

Disadvantages / Main problems

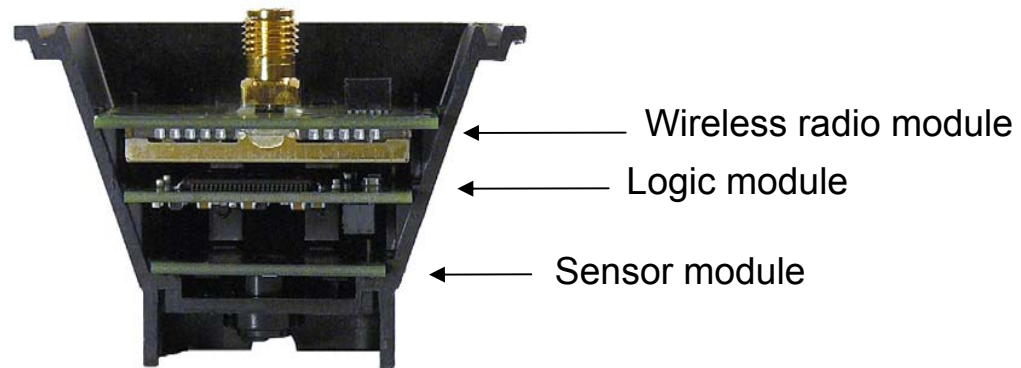
- Usage of primary batteries impossible
- Energy demand is too high resp. energy supply is not sufficient
- No optimal wireless standard for special applications available

Wireless Data Transmission

Optimized wireless driver stack effects:

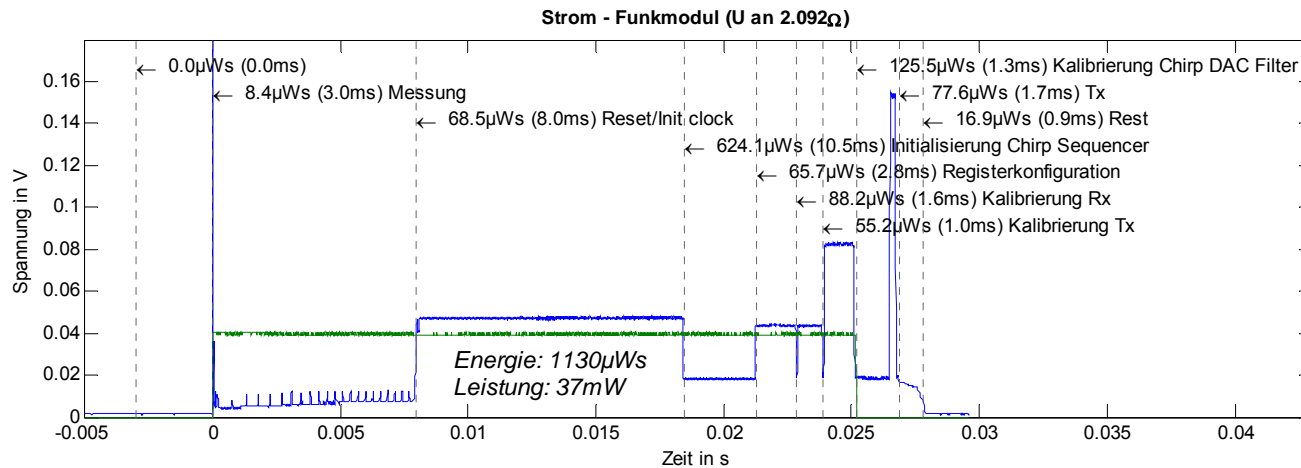
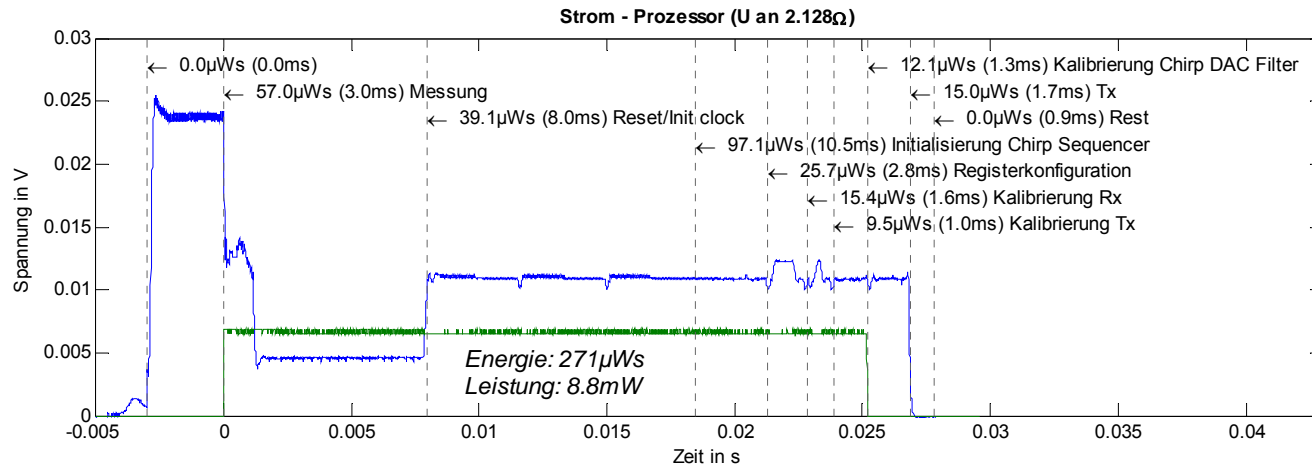
- High data transmission safety
- Low energy demand
- Wide transmission range
- Possibility of using different numbers of sensors within a network

Customized solution



Energy balance

Auto-Mode Default-Initialisierung



Fields of application

Family of inclination and acceleration sensors

Current applications :

- Mobile machines (building-, agricultural and forestry machines)
- Lorries
- Ship building
- Solar plants
- Condition Monitoring



Examples for application of energy-autonomous sensors

- Tower crane (construction progress depended on length)
- Vibration diagnosis (CMS)
- Monitoring of hydraulic pumps
- Moved systems (measuring value logging and transmission at motor spindle)
- Reducing of cables in length and angular measuring systems

Contact

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