A Microelectronic Telemetrical Measurement System for Intracranial Pressure and Temperature
Overview

• Intracorporeal Measurement

• A Concept for Mobile Data-Recording

• Hardware Realization

• Signal Analysis

• Outlook
Patient’s care is difficult because of wiring.
Recording of Intracranial Pressure (ICP) data

State-of-the-art measurement
Measuring ICP in the cavities is unapplicable for patients under everyday conditions.
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The system-concept includes possibilities for home-monitoring.
A Concept for Mobile Data-Recording

Block-Diagram

Physician’s Equipment for Handling, Processing, Analysing, and Monitoring the Data

Portable Recording and Analysing Unit for Measuring under mobile Conditions

Skin

Energy Supply

Implant

Intracranial Unit

First Cut

Mobile Unit

Second Cut

Stationary Unit
A Concept for Mobile Data-Recording

Telemetrical Transponder Principle

The magnetic flow is responsible for power transmission.

Programmable and Portable Mobile Data-Recorder

Skin

Head

Pressure and Temperature Data

Sensor-Supply
A Concept for Mobile Data-Recording

Sensor Requirements

- Environment- and Biocompatibility
- Safe Operation
- Long Term Stability: Offset, Hysteresis and Linearity
- Accuracy
- Size
- Price and Availability
- Overload Resistant
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Data-management is solved with a master-servant concept.
Hardware Realization

Telemetrical Data-Transmission

Data-Processing

Digital Circuit

Analoquos Circuit

CMOS ASIC

No battery necessary
The implant-data are reconstructed by the comparator.
The telemetry-chip was concepted for programmable data-storage.
Hardware Realization

Capazitive Sensor

Source: Fraunhofer Gesellschaft Duisburg, Germany
Size: 0.7mm x 1mm x 4mm
The diaphragm-distance is proportional to the capacity and the pressure is encoded in the puls-width.
Stability of power supply is distance dependent.
Hardware Realization

State-diagramm

Red/Yellow/Blue: Color of switch
- - - - - Selfrunning forward
--------- Autorun after Power-On or Reset

The requirement was easiest handling with three switch menu.

- Time-Modus
  - Day Modus
  - Hours Modus
  - Minute Modus

- Measurement-Stop-Modus
  - Show Data Storage
  - Show Errorbyte

- Standard-Modus
  - Show ICP
  - Show intracranial Temperature

- Running-Measurement-Modus
  - Display: 'Go: Red'

- Diagnose-Modus
  - Back after 10 min

- Power-On
  - Self-Test
  - RESET

- Show Storage capacity
  - Show Errorbyte
Hardware Realization

Implant

Illustration of the prototype development
First concept realization of the system
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Data window for recording and processing the measured data
The relation between injected volume and corresponding pressure change is strongly non linear.

\[ C_{ompliance} = \frac{dV}{dP} \]

The relation between injected volume and corresponding pressure change is strongly non linear.
Dependent on pre-pressure, different injected volumes have different pressure changes for consequence.
The signal consists of different important compartments.
The brain pressure consists of blood-, respiration- and plateau compartiments.
Signal Analysis

Spectral Analysis of the Signal Components

Three significant compartiments: Plateauwave, respiration and arterial blood pressure.
Signal Analysis

Short-Time-Fourier Transformed (STFT)

Three dimensional presentation for data screening and event looking
The physician is able to diagnose with this kind of measurement.
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Outlook

Telemetrical Measurement of ICP and Temperature

Fullfilling of all Requirements:
• Mobility of the Patient
• Making Patient’s Care easier
• Non-Invasive Brain Pressure Measurement
• No Damaging of Brain Tissue
• Home Monitoring on Smart-Cards
• Stand-by System for Long-Time-Measures
• Minimizing the Infection Risk

Highlights:
• New Construction (patented)
• Implantable Sensor will be distributed soon
• Connection to PC and Portable Electronics
• Signal analysis for Diagnostical Aid