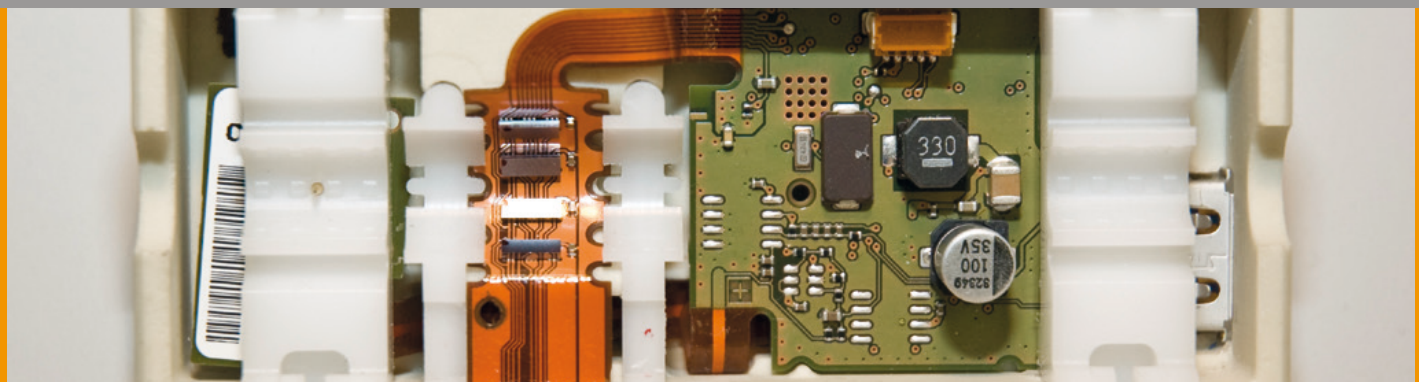
Fraunhofer
IIS

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS



SENSOR SYSTEM FOR METERING AND ENERGY MANAGEMENT APPLICATIONS

Fraunhofer Institute for Integrated Circuits IIS

Director
Prof. Dr.-Ing. Albert Heuberger

Am Wolfsmantel 33
91058 Erlangen, Germany

Networked Systems and Applications Department
Nordostpark 93
90411 Nürnberg

Contact
Jasmin Specht
Phone +49 9131 776-4440
jasmin.specht@iis.fraunhofer.de

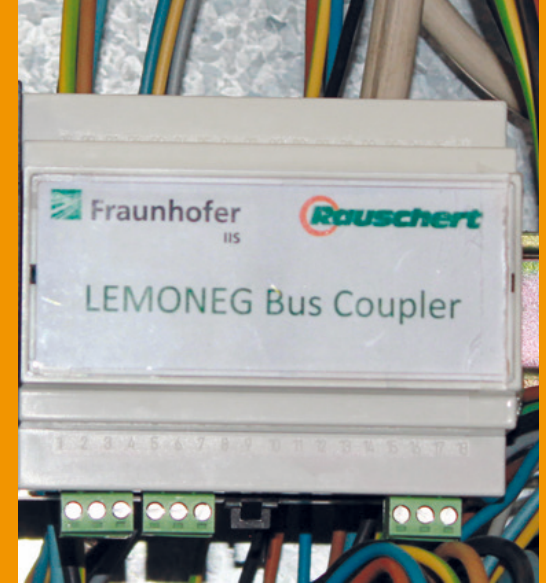
www.iis.fraunhofer.de

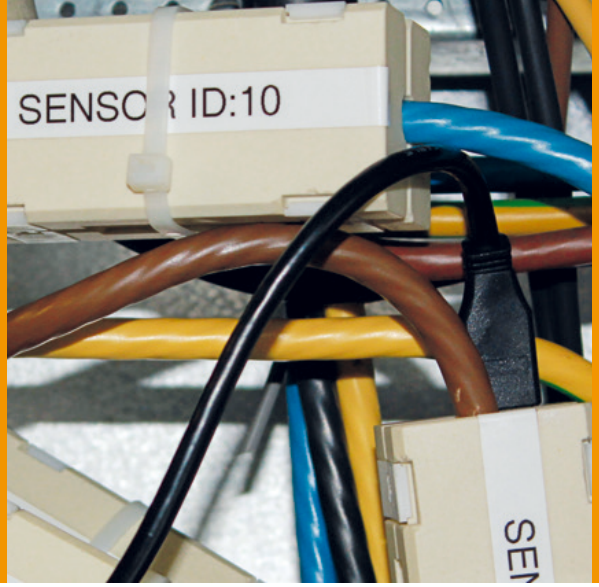
Motivation and Context

The introduction of the ISO 50001 energy management norm will put the responsibility on the industrial energy consumers to conduct periodic energy management reviews. The biggest challenge in conducting such reviews up to now has been the integration of measurement systems in an operational industrial process without intervention in the existing control logic or temporary shutdown of the system. These challenges were the main reasons behind the development of the power monitoring sensor developed by Fraunhofer IIS in cooperation with Rauschert GmbH.

Power Monitoring System

- Modular system for highly accurate measurement of power parameters of consumers in industrial applications
- Hall effect sensors for current measurement based on a measurement principle developed at Fraunhofer IIS
- Voltage measurement through a single punch-through contact trough the isolation to the electrical conductor
- Clamp like construction and optimized form factor for installation in operational conditions without depowering of the system being monitored
- Well suited for mounting of multiple sensors in distribution cabinets
- Serial communication (up to 1 Mbps) based on the MODBUS protocol over the RS 485 interface
- Various measurement modes ideally suited for specific applications





Bus coupler and measurement clamp mounted in a distribution cabinet.

Technical Details

- Ceramic housing and mounting accessories designed and tested for mechanical stresses and installation demands
- A novel state-of-the art PCB design with a separate flexible part for circumferential mounting of the current sensor around the power line
- Current measurement up to 80 Amp RMS and 1900 Amp RMS without range calibration at a configurable sampling rate of 1.6 KHz to 100 KHz
- Built-in PLL module to synchronize the sampling clock of the analog digital module to the phase frequency. Input frequency range for the PLL: 45-60 Hz
- Microcontroller with an on chip DSP module, ADC module, direct memory access and hierarchical interrupt control for power calculations and spectral analysis (optional)
- Synchronized voltage measurement using the 12 Bit ADC module on the microcontroller with configurable sampling rate of 100 Hz to 2 MHz
- Microcontroller UART module and a RS 485 transceiver with galvanic isolation allow serial communication up to 1 Mbps
- Modular software application for controlling the measurement, calculation and communication blocks of the system
- Fully tested MODBUS slave API for communication with an external gateway
- Synchronized phase measurement on different measurement modules for multi-phase power systems by means of software synchronization

Applications: Load Monitoring and Energy Management

The various hardware and software peripherals of the power monitoring sensor can be used for monitoring different scenarios and parameters in industrial applications.

- Monitoring the power consumption of industrial equipment in different operating and loading conditions
- Optimizing power consumption by analyzing the parameters like process efficiency and process losses
- Optimizing energy cost with integration into the smart grid and using tariff information from the grid as a control parameter (Multi Agent Systems)
- Monitoring performance of existing industrial units and generation of information essential for retrofitting

Fault Detection and Condition Monitoring

Several scenarios exist where the features of the sensor system can be used for condition monitoring applications

- Monitoring of asymmetrical loading of individual phases in multi-phase systems
- Monitoring of faults in electrical transformers and other power regulation devices on the low voltage side
- Monitoring mechanical and electrical defects in rotating equipment
- Spectral analysis of the current and voltage components on the power sensing sensor's DSP module

Dynamic Software Architecture and Upgrade Possibilities

The software module of the power monitoring sensor has been developed keeping in mind the perpetually expanding and changing demands of energy management and power monitoring. The possibility of implementing new digital blocks and classification algorithms on the microcontroller's DSP module and the configurable measurement parameters of the current and voltage measurement units make the power sensing module highly flexible and adaptable.

A modular software architecture and optimized utilization of computational resources on the module enable integration of new applications and dynamic upgrade of the existing applications.

The Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology has been funding this development.