MICROINSTRUMENTATION SYSTEM IN SILICON FOR INDUSTRIAL APPLICATIONS

J.H. Correia, E. Cretu, S.H. Kong, M.P. Brünner, M. Bartek and R.F. Wolffenbuttel

DIMES
Delft Institute of Microelectronics and Submicrontechnology
Electronic Instrumentation Laboratory

Introduction

Modern data-acquisition systems realized in silicon technology (see Fig. 1) can benefit from further miniaturization and function integration. However, the smart sensor concept based on on-chip integration has economical and technological limitations. The proposed generally applicable microinstrumentation silicon platform can overcome some of these limitations resulting in a complete Multi Chip Module suitable for application in distributed data-acquisition systems.

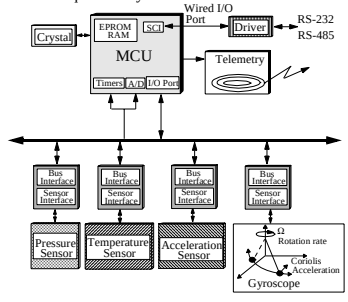

Fig. 1 *Block diagram of the microinstrumentation system.*

Microinstrumentation system in silicon

A microinstrumentation system in silicon is composed of a platform chip providing infrastructural functions, such as a local bus for data exchange, power management and several mounting sites for smart sensors and a microcontroller. Population of those sites with the appropriate sensors as shown in Fig. 2 and programming the microcontroller makes the system suitable to a wide range of applications. The smart sensor concept should be pushed up to an economically viable limit to have the sensors capable of communication with the bus.

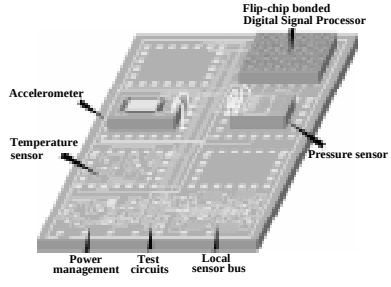

Fig. 2 *Microinstrumentation platform.*

Local sensor bus

An upgraded version of the Integrated Smart Sensor (IS^2) bus, developed at the Electronic Instrumentation Laboratory - Delft University of Technology, has been implemented for the data exchange in the microinstrumentation platform and has the following features:

Simplicity - only two communication wires are used in the minimum configuration.

Reliable data transfer by using the Manchester encoding with error detection schemes.

Flexibility of signal type, as synchronous and asynchronous transmission of digital data is possible in combination with semi-digital signals, such as bitstreams, or even analog signals.

Flexibility of signal handling based on a maskable interrupt mechanism.

Sensor self-test capability over the bus using separate directional data lines.

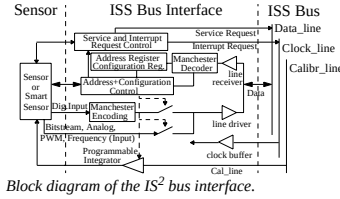

Fig. 3 *Block diagram of the IS^2 bus interface.*

The bus interface, realised in a 1.6 µm CMOS process, has dimensions of 1.5 x 0.7 mm^2 and a power consumption of 500µW at 100kHz. A typical addressing sequence transmitted serially over the data bus is shown in Fig. 5.

Fig. 4 *A photograph of the realized IS^2 bus interface.*

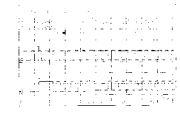

Fig. 5 *The oscilloscope traces of the data and clock lines.*

Applications

The proposed microinstrumentation system is investigated in applications where extended data processing from multi-channel sensors is required and where measured quantities (mechanical, thermal and optical domain) will not complicate the packaging.

Condition monitoring system

Condition monitoring of machines and major mechanical structures has become increasingly important for the early detection of upcoming failures. A compact condition monitoring system based on the micro-instrumentation cluster on silicon that contains three accelerometers for the detection of the vibration spectrum in three dimensions plus a thermal sensor, is a very convenient device in such an application.

Inertial navigation system

This application requires three accelerometers and three gyroscopes for measuring of linear and angular acceleration in three dimensions from which the actual position can be calculated.

Miniature spectrometer

An array of tunable Fabry-Perot resonance cavities for the spectral analysis of visible and near-infrared radiation is another application where the data-processing requirements will match the capabilities offered by the microinstrumentation platform infrastructure.

Acknowledgments

This work is supported by STW (project DEL 55.3733), TU Delft and JNICT - Portugal (PRAXIS XXI-BD/5181/95).

TUDelft
Delft University of Technology.

Delft University of Technology
Department of Electrical Engineering
Electronic Instrumentation Laboratory
P.O. Box 5031, 2600 GA Delft
The Netherlands
Phone: +31-15-2785745
Fax: +31-15-2785755