

- 1 Photograph of the IMS-CAP51 bare die
- 2 IMS-CAP51 in CLC44 package

HIGH PRECISION READOUT IC FOR ACCELEROMETERS

Fraunhofer Institute for Microelectronic Circuits and Systems IMS

Finkenstr. 61
D - 47057 Duisburg
Phone +49 203 37 83-0
Fax +49 203 37 83-266
www.ims.fraunhofer.de

Contact
Michael Bollerott
Phone +49 203 37 83-227
vertrieb@ims.fraunhofer.de



**Forschungsfabrik
Mikroelektronik**
Deutschland



Introduction

Earthquakes can produce severe damages. Early detection of earthquakes can help to prevent these damages. To realize early detection systems, very precise and sensitive accelerometers and readout circuits are needed.

Seismic measurements are used in oil exploration, a time consuming and very cost intensive business. To produce high quality and reliable measurement figures, high performance sensors and specialized readout circuits are needed. For applications like this, Fraunhofer IMS offers its IMS-CAP51 capacitive readout ASIC.

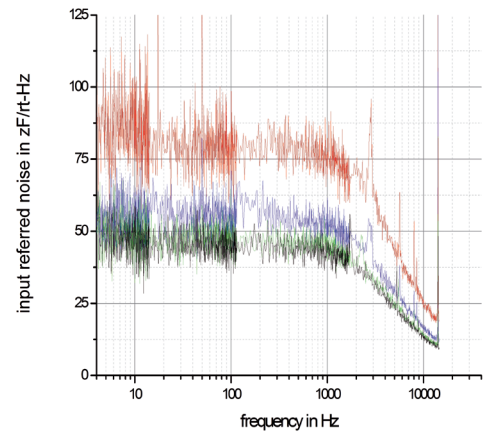
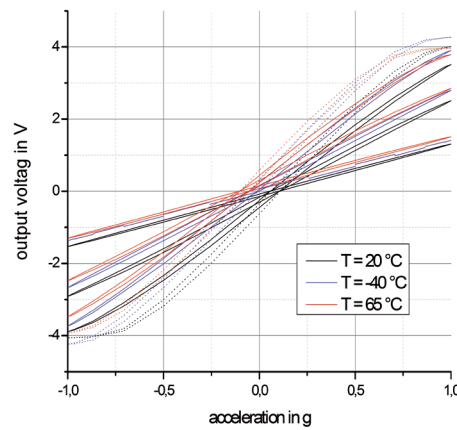
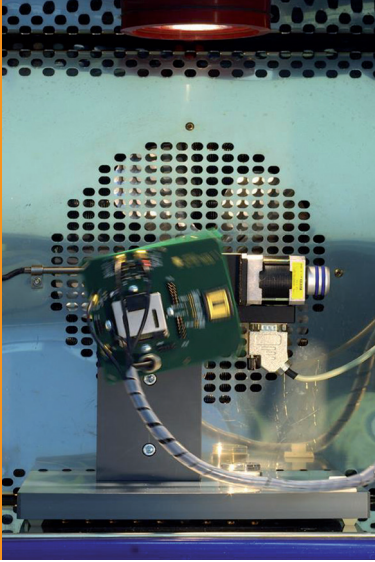
Additional applications for such measurement systems are antenna alignment, high precision position detection or fundament monitoring in buildings.

The IMS-CAP51 is a low noise, high precision readout ASIC for capacitive sensor

systems, such as accelerometer MEMS or gyrosopes. Such MEMS (Micro Electro Mechanical Systems) translate the quantity to be measured (e.g. acceleration or position) into a change of a differential capacitance. These capacitance changes are converted into a fully differential analog signal with very high resolution and accuracy by the IMS-CAP51.

Chip description

The core of the ASIC is an ultra-low noise capacitance to voltage (C2V) conversion stage with tunable gain setting and optional output buffer to drive high resistive loads. A fully differential analog output allows high precision signal post processing with very low sensitivity to common mode interference. Additionally, the chip can be delivered with an integrated ADC for on-chip data conversion. The digitized data with a resolution of 11-Bit is then accessible via a parallel digital data output.



The measurement full scale range can be set between ± 0.75 pF and ± 3.0 pF, which allows adapting to a wide range of sensors and measurement applications. The IC's own noise is effectively reduced by chopping of the DC measurement signal. All control signals are generated on-chip and only a 5 MHz external clock must be provided. The conversion bandwidth ranges from DC signals up to 10 kHz and more.

Two banks of internal capacitors allow the compensation of capacitance mismatches at the measurement input, which may result from the connected sensor or system setup (e.g. bond wires, system PCB etc.). The configuration of the chip takes place via a simple SPI interface.

The integrated thermometer provides a temperature proportional voltage signal which can be accessed via an analog output

of the chip. Thus, temperature effects can be easily calibrated and compensated.

The IMS-CAP51 is available as bare die or assembled in a CLCC44 ceramic package. Samples can be ordered on short notice. For higher quantities and other packaging options, please contact Fraunhofer IMS.

In addition to the described low noise version of the chip for high accuracy applications, a low power version can also be obtained. The reduced current consumption, down to the amount of only several mA, allows the use in battery powered devices such as mobile phones or handheld devices..

Characterization setup

Fraunhofer IMS also offers an automated test and characterization environment for acceleration measurement systems. It allows

the characterization of sensor MEMS, readout ICs and complete systems. By the aid of a motorized rotary unit, accelerations in the range of ± 1 g inside a climatic chamber with well controlled temperature and humidity conditions are applicable. Temperatures between -40 °C and 100 °C can be applied. Noise measurements on the system outputs can be performed using high precision voltage amplifiers and spectrum analyzers. Noise densities of less than 100 nV/rt-Hz can be measured.

Test execution and control of all measuring instruments is handled by a LabVIEW test software. Figure 3 shows a picture of the test setup in the Fraunhofer laboratories and figure 4 some examples for measurement results.

Specifications of the IMS-CAP51:

- 5 V single Supply Voltage
- Temperature range: -40 °C – 65 °C
- Input referred noise: 60 zF/rt-Hz
- Dynamic range: 120 dB
- Fully differential analog output
- Optional integrated 11-Bit ADC
- Bandwidth: 0 Hz – 10 kHz
- 4 tunable gain settings
- 3.3V Supply for digital control logic internally generated
- Measurement range: ± 0.75 pF – ± 3.0 pF
- 5 MHz external clock
- Integrated Temperature Sensor
- MEMS nominal capacitance range: 2 pF – 20 pF