

# Integrated micro-inductors for innovative DC/DC converters

High switching frequency / high temperature / highly integrated

*DC/DC converter with integrated inductor*

## Interested in utilizing our technologies in your package and converter systems?

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## Going beyond borders with PowderMEMS technology

Fraunhofer ISIT has developed a technology that allows manufacturers of high-volume DC/DC converters to go beyond the limitations of current discrete micro-inductors, resulting in higher efficiency and reduced costs.

Incorporating high frequency switching techniques makes it possible to achieve high power density, low profile package and low noise without the need of an external heatsink.

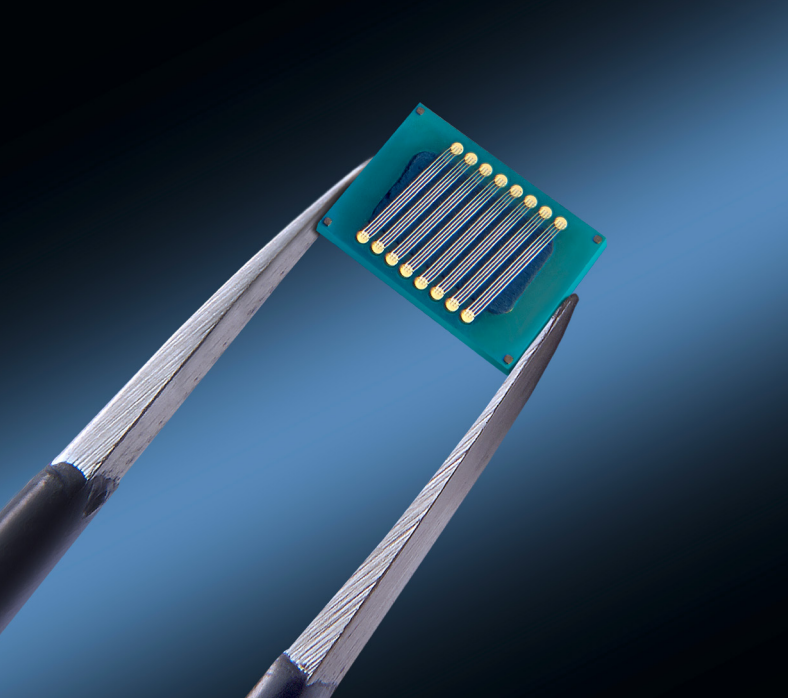
In addition to the extended frequency range, temperature range and magnetic core of those innovative inductors the developed process based on PowderMEMS offers a variety of design possibilities. A unique back-end-of-line compatible method offers great solutions to develop even smaller packages with highly integrated micro-inductors depicting high performance.

## Key features & technical advantages

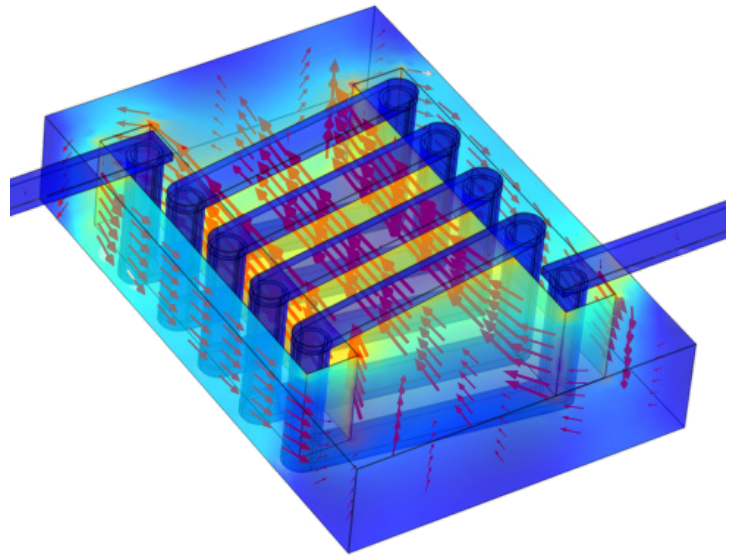
- High frequency DC/DC converter
- Wide temperature operating range
- Back-end-of-line compatible process
- Integration of inductor and GaN HEMT on the same substrate
- Small footprint with high design freedom

## Technical specifications

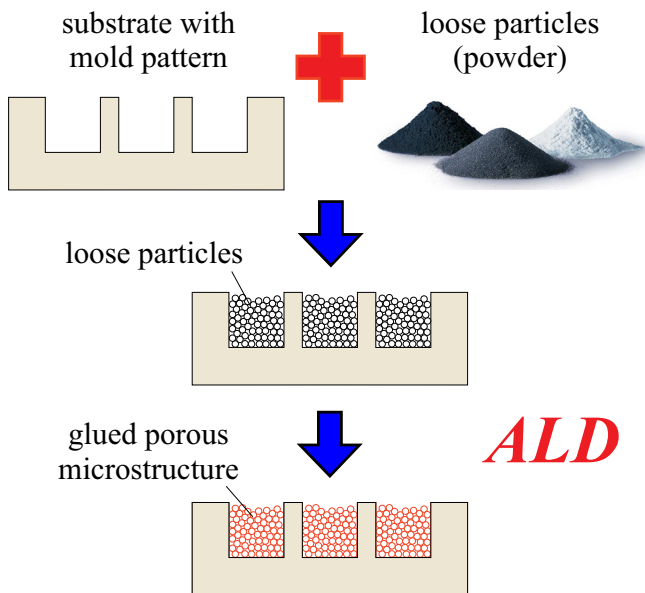
Max. inductance	300nH
Max. quality factor	45
Preferred frequency range	1-40MHz
Form factor (100nH)	2 x 3 mm <sup>2</sup>
Saturation of magnetic flux density	2.1T
Max. permeability	7
Max. temperature	400°C



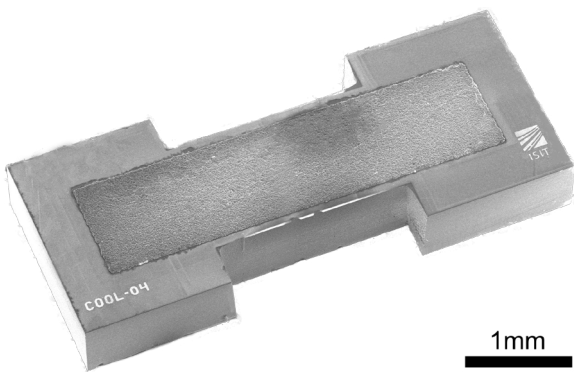
Micro-inductor with bond wires on FR4 substrate



FEM based designs for micro-inductances



Simplified ALD process



SEM image of silicon chip with agglomerated powder core

### Applications - DC/DC converter

- Smart Home
- Internet of Things
- Switched-mode power supplies
- Embedded Systems
- Multimedia power supply

### Fabrication process based on PowderMEMS technology

The developed process enables the realization of highly efficient DC/DC converters on the PCB level, resulting in a high level of integration and higher power density on a chip. After the ALD process, windings can be closed by bond wires or another inductor in a flip chip configuration.

Micro-inductors on PCB level have been shown to deliver excellent performance in the power range of 10 W and above and a switching frequency of 20 to 30 MHz.

With fabrication capabilities of 30nH/mm<sup>2</sup> on a chip and the use of commercially available PCB materials and silicon substrates, compact DC/DC converters can achieve efficiency of over 80%.

### Tailor-made for DC/DC converters on PCB level

First prototypes were built on 8" silicon wafers, consisting of a magnetic core-based carbonyl iron powder and copper windings from 5 to 12 turns. The powder is agglomerated by atomic layer deposition (ALD) with a process temperature of 75°C only. As a result, the magnetic particles are covered with a thin dielectric layer, suppressing eddy currents.

Especially in terms of integration, this back-end-of-line compatible method offers great solutions to develop small packages with high performance.