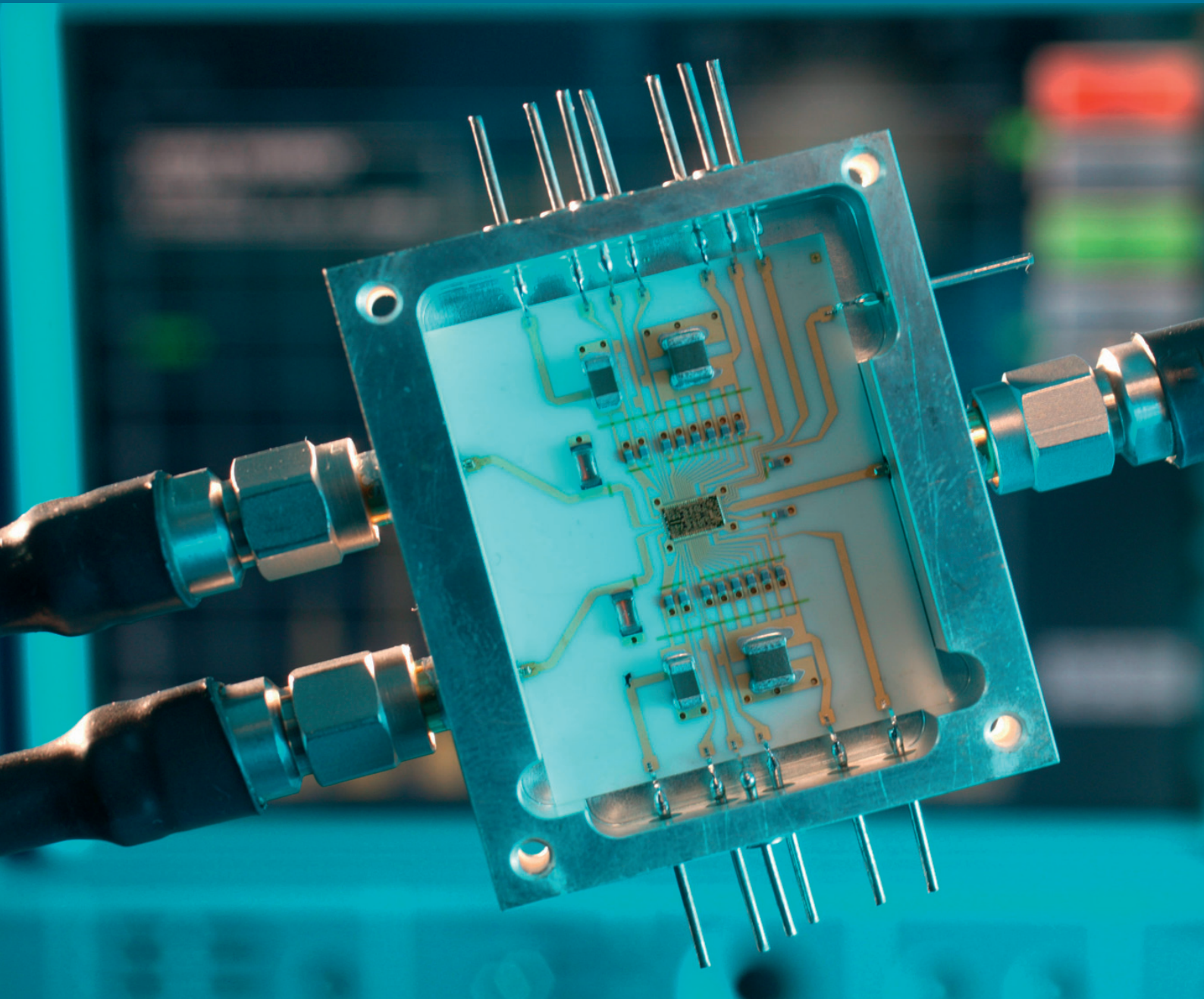


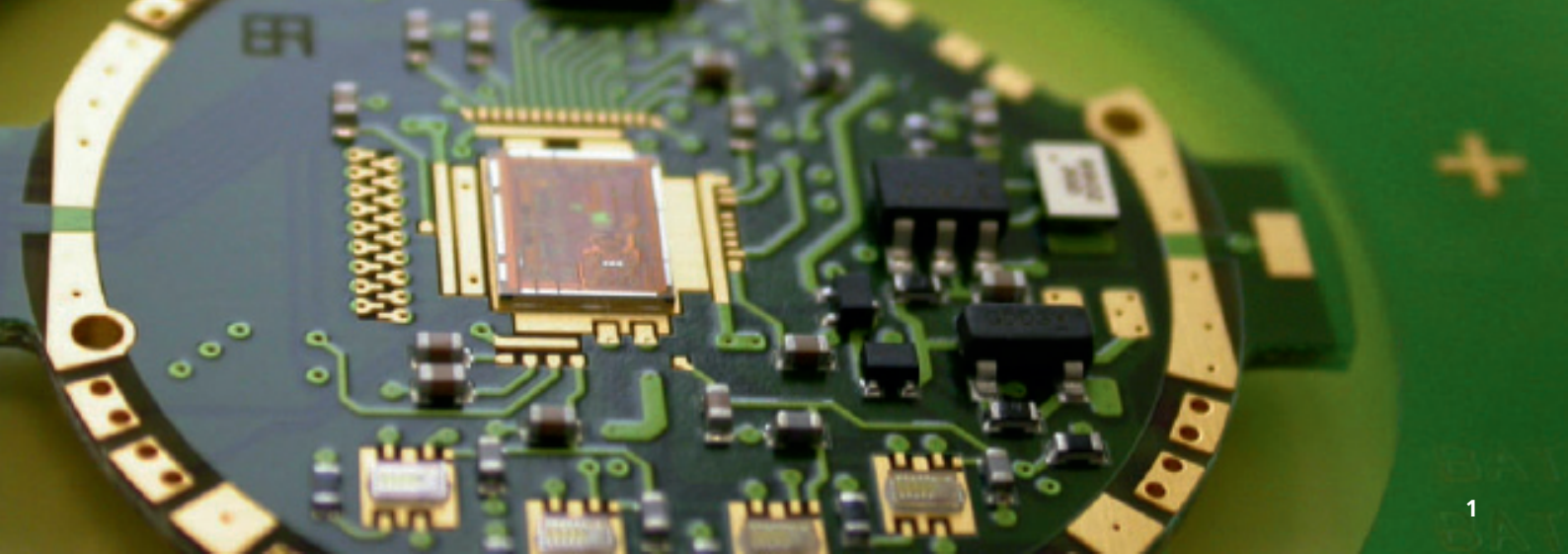


**Fraunhofer**  
IIS

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS

# RF & MICROWAVE IC DESIGN





# APPLICATION SPECIFIC INTEGRATED RF AND MICROWAVE SOLUTIONS FOR PROFESSIONAL APPLICATIONS

Fraunhofer Institute for Integrated Circuits IIS conducts research and design in the field of **high performance RF ASICs (RFIC)** in the frequency range between some 100 MHz and 20 GHz. The IC production is based on state-of-the-art silicon and GaAs technologies of commercial semiconductor vendors. Application fields, e. g. are linearization of RF power amplifiers in mobile radio base stations and broadband components for measurement technology.

In the area of **Embedded RF** we develop standard ICs and IPs in CMOS and SiGe BiCMOS technology achieving highly integrated and powerful cells. Together with complex digital circuits and analog functions, as sensor signal processing, these cells can be integrated in silicon.

## HIGH EFFICIENCY WIRELESS

Long-term wireless applications up to 10 years for low maintenance applications require new efficient RF solutions. Within our research area "High Efficiency Wireless" we develop low-current wireless transmitters and receivers for sub-GHz SRD bands in standard CMOS or BiCMOS technology. Low-current transmitters with 1 mW output power use SAW and FBAR resonators instead of PLL synthesizers.

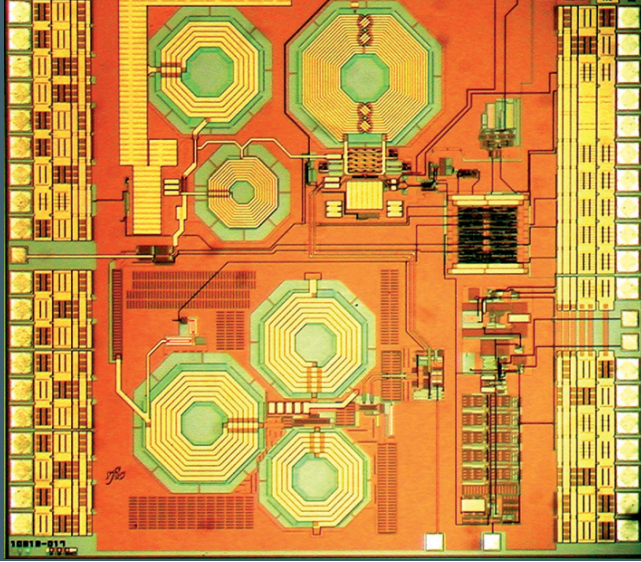
As the receiver current consumption dominates the time of operation, we have been developing button-cell driven integrated receivers with less than 10  $\mu$ A for sub-GHz bands. An OOK receiver prototype comprises RF receiver, demodulator and decoder suitable for forward error correction. Using Fraunhofer integrated low-current transceivers, the implementation of long-term wireless sensor networks with minimum latency is now possible.

## 868 MHZ ISM BAND TRANSCEIVER IN CMOS

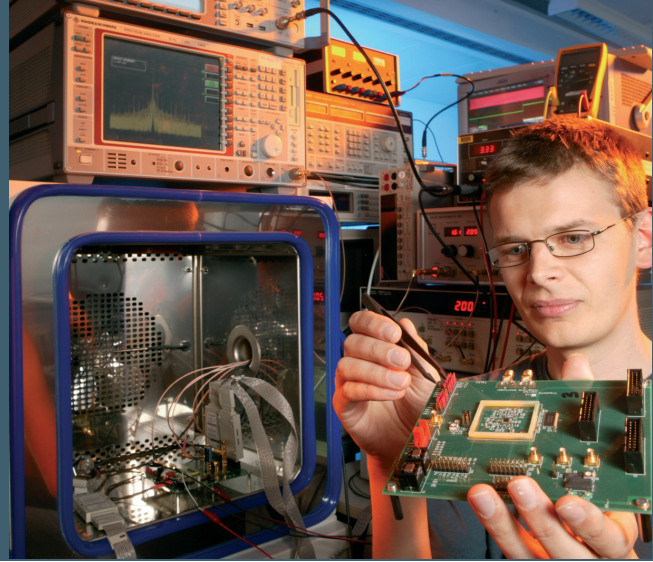
This transceiver works in the licence-free European ISM band. It was implemented in a low-cost standard CMOS process, appropriate for large and small volume. A joint integration with sensors or digital circuits is possible.

The complete circuit is also available as a standard cell where only the interface has to be adjusted to the required application. The effect is a reduction of design expense leading to a fast and low-cost implementation.





2



3

## INTEGRATED 2.4 GHZ TRANSMITTER FOR 3D LOCALIZATION WITRACK

Fraunhofer IIS is designing and developing wireless tracking technologies for highly accurate 3D localization for applications in sports, logistics, production and security. For soccer miniaturized transmitters are implemented both in the ball and the players' shin pads.

This application requires an extremely low form factor and lightweight assembly demanding a high integration level with only very few additional external devices. The transmitter chip was implemented in SiGe BiCMOS technology in order to be prepared for future integration together with the digital control and signal processing. The transmitter converts the digital base band signal into the ISM band at 2.4 GHz. It comprises D/A converters and analog low-pass filters in order to process the base band signals, the frequency conversion and the complete frequency generation. The external circuitry could be reduced to a minimum by using integrated inductors in the oscillator and the power amplifier which delivers the RF signal to an antenna.

**1** Miniaturized transmitter board for WITRACK with chip-on-board

**2** Die photo of 868 MHz ISM band transceiver in CMOS

**3** Evaluation of the WITRACK transmitter chip

## BROADBAND IQ MODULATOR ASIC

The extremely high demands on components utilized in measuring instruments are often not met by commercially available parts. For Rohde & Schwarz, a German manufacturer of test and measurement equipment, Fraunhofer IIS developed broadband IQ modulator ASICs meeting the demands of frequency range, modulation bandwidth, linearity and noise.

Besides 1 GHz and 4 GHz modulators in GaAs-MESFET technology, an 8 GHz chip was implemented in GaAs-HEMT technology representing one of the key components of the high-end vector signal generator R&S SMU200A. The IQ modulator chip works in the frequency range from 200 MHz to 8 GHz and achieves a typical ACLR value of 73 dB with a 3GPP signal (test model 1, 64 DPCH) in the first adjacent channel.

From the first feasibility studies to series production the project was performed in close cooperation with Rohde & Schwarz. Besides the actual IC design, the project comprised the selection of the suitable semiconductor technology, application-specific packaging and the implementation of production testing.

Fraunhofer IIS coordinates the IQ modulator production and delivers the tested chips exclusively to Rohde & Schwarz.

**Fraunhofer Institute for  
Integrated Circuits IIS**

**Director**

*Prof. Dr.-Ing. Albert Heuberger*

*Am Wolfsmantel 33  
91058 Erlangen, Germany  
Phone +49 9131 776-0  
Fax +49 9131 776-999  
[info@iis.fraunhofer.de](mailto:info@iis.fraunhofer.de)  
[www.iis.fraunhofer.de](http://www.iis.fraunhofer.de)*

**Contact**

*Dr.-Ing. Frank Oehler  
Phone +49 9131 776-4414  
Fax +49 9131 776-4499  
[frank.oehler@iis.fraunhofer.de](mailto:frank.oehler@iis.fraunhofer.de)*