

# RFID Research Activities at the Institute of Microwave and Photonic Engineering

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Commission D

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Jasmin Grosinger, Graz University of Technology

Lunghammer – TU Graz

DI Helmut Paulitsch

Prof. Dr. Wolfgang Bösch

Ao. Prof. Dr. Erich Leitgeb

**Radar and Wave Propagation**

**Optoelectronics and Photonics**

Dr. Helmut Schreiber

# Institute of Microwave and Photonic Engineering

Ass. Prof Dr. Jasmin Grosinger

**Microwave and Millimeter Wave Technologies**

**RFID Technologies**

Dr. Hossein S. Farahani

Ass. Prof. Dr. Michael Gadringer

Dr. Reinhard Teschl

**RF Antennas and Filters**

## Systems

- RFID Localization
- Passive Sensor Systems
- ...

## Methods and Tools

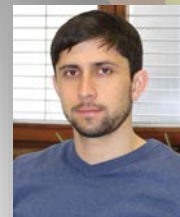
- System Design
- Performance Analysis
- ...



Benjamin Deutschmann



Jasmin Grosinger



Lukas Görtzschacher

# RFID

# Technologies

## Components and Devices

- RFID Sensor Tags
- Miniaturized RFID Tags
- RF Chip Design
- ...

## Applications

- Automotive
- Health
- Home
- Production
- ...



Darshan Shetty



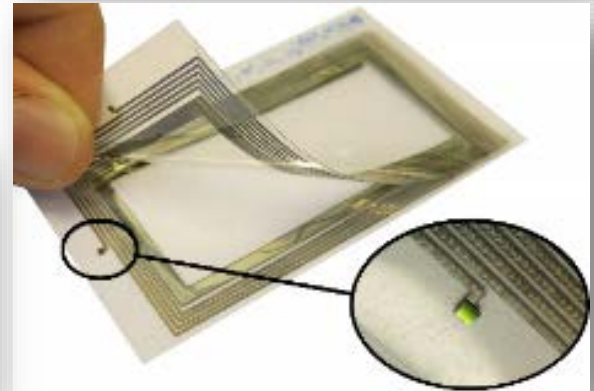
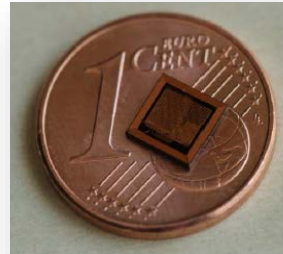
Richard Fischbacher

Est. April 2013

# Introduction

## Passive radio frequency identification (RFID) technologies

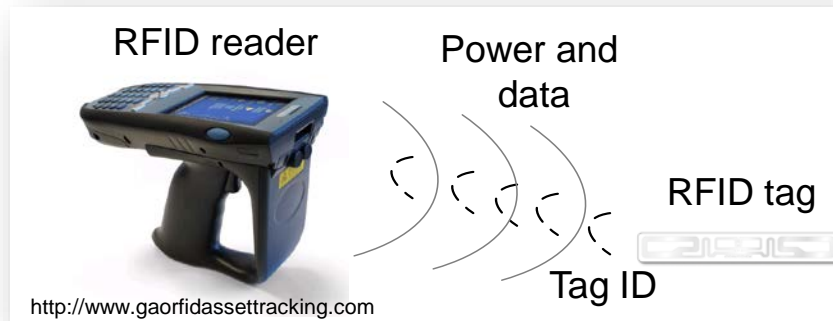
- State of the art: RFID technologies in logistics and maintenance
  - Low-cost and unique identification (ID) of tagged objects
  - Low-maintenance batteryless/passive RFID transponders (tags)
- Beyond the state of the art: Key enabling technology for the Internet of Things (IoT)
  - Enabling small devices to be part of the IoT (documents, jewelry, medicine, diagnostic devices, etc.)
  - Low-cost, long-lasting, and ubiquitous communication/sensor units with unique ID



# Introduction

Passive RFID technologies: Radio communication between an RFID reader – interrogator – and passive RFID tags

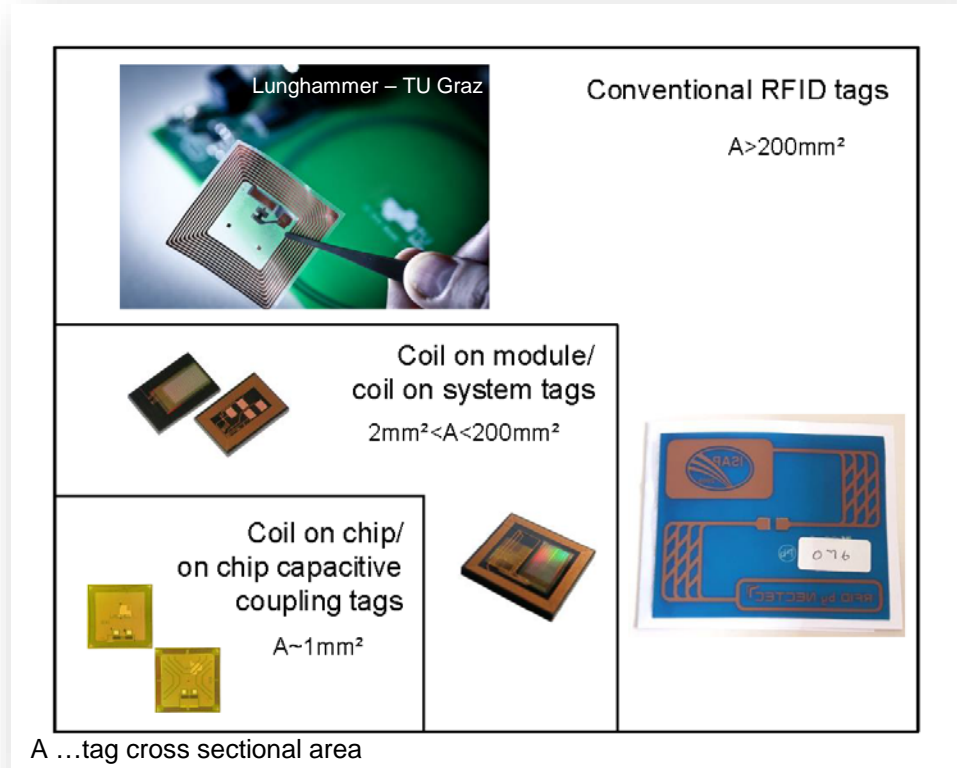
- Reader sends radio frequency (RF) power and data to the tag
- When reader commands, tag starts ID transfer via load modulation (near field communication) or backscatter modulation (far field communication)
- ID transfer (no transmitter): Signal from the reader is modulated/reflected by the tag depending on the transmitted data (i.e., logical '0' or '1')



# Miniaturized Tags

Classification of miniaturized high frequency (HF) and ultra-high frequency (UHF) RFID tags

- RFID tag miniaturization by miniaturizing tag antennas: Inherently leads to a limitation in tag read range
- Near field communication system (inductive coupling using coils, capacitive coupling using electrodes)
- Read range extension with passive booster antennas

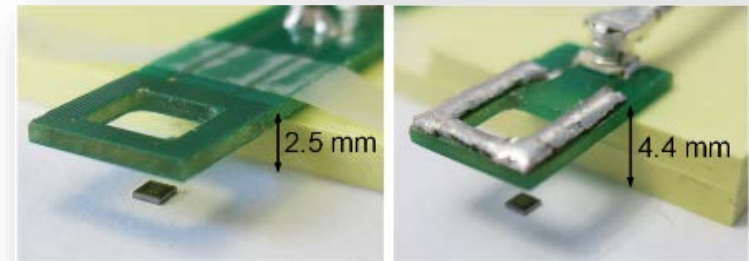
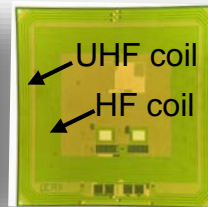
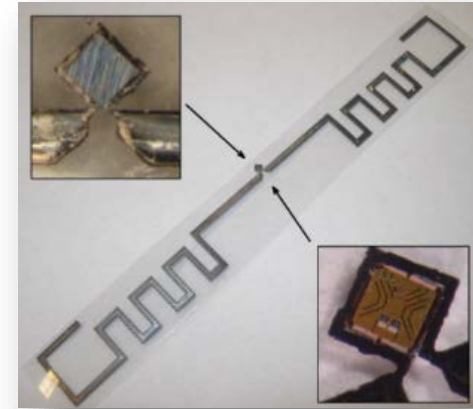


J. Grosinger et al., Tag Size Matters - Miniaturized RFID Tags to Connect Smart Objects to the Internet, IEEE Microwave Magazine, vol. 19, no. 6, 2018

# Miniaturized Tags

Dual-band coil-on-chip (CoC) tag: Small RFID tag with on-chip HF and UHF antennas

- Operating frequencies:  $f = 13.56$  MHz and  $f = 868$  MHz
- Size:  $1.32$  mm<sup>2</sup>
- Low cost 130 nm complementary metal oxide semiconductor (CMOS) process
- Read range: 2.5 mm (booster antenna: 40 cm) at HF and 4.4 mm (booster antenna: 2 m) at UHF



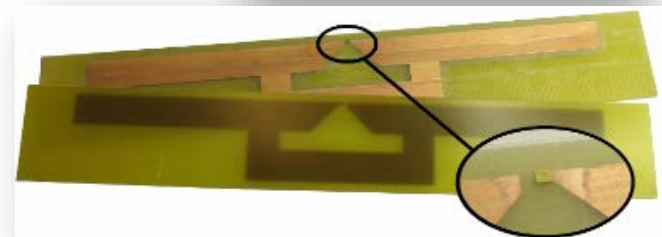
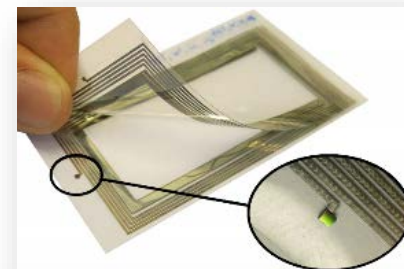
W. Pachler et al., A Miniaturized Dual Band RFID Tag, Proc. IEEE RFID-TA 2014



# Miniaturized Tags

On-chip capacitive coupling (OC3) tag for tagging of metal objects

- Operating frequencies:  $f = 13.56$  MHz and  $f = 868$  MHz (dual-band chip)
- Size:  $1 \text{ mm}^2$
- Low cost 130 nm CMOS process: Reduced production costs in comparison to tags with on-chip coils
- Read range:  $200 \mu\text{m}$  (booster antenna: 30 cm) at HF and  $400 \mu\text{m}$  (booster antenna: 1 m) at UHF



W. Pachler et al., A On-Chip Capacitive Coupled RFID Tag, Proc. EuCAP 2014



# DeSSnet Research Project

Dependable, secure and time-aware sensor networks (DeSSnet)

- Key enabling technologies for wireless sensors and communication
  - Dependable wireless power transfer and communication technologies to ensure a simultaneous robust and reliable operation of both in wireless sensors
  - Sensor add-ons for wireless communication chips for low cost wireless status information monitoring
  - Miniaturized integrated wireless sensors exploiting novel packaging, printing, and co-integration technologies
- Main project partners



# Contact

Ass.-Prof. DI Dr.techn. Jasmin Grosinger  
Ultra-Low Power Microwave Components and Systems – RFID Technologies  
Institute of Microwave and Photonic Engineering  
Graz University of Technology  
Inffeldgasse 12, 8010 Graz  
[jasmin.grosinger@tugraz.at](mailto:jasmin.grosinger@tugraz.at)