IC1301 – WiPE

Wireless Power Transmission for Sustainable Electronics

RFID Technologies and Applications at the Graz University of Technology

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» Team

> Prof. Wolfgang Bösch and Dr. Jasmin Grosinger

> Seven predocs and one Master student closely related to industry
RFID Technologies and Applications

» Radio frequency identification (RFID) technologies at high frequencies (HF) and ultra high frequencies (UHF)
  > Reader design
  > Transponder (tag) design
  > Radio frequency (RF) communication system design

» RFID applications
  > Automotive systems
  > Home appliances
  > Health issues
  > Environmental sensing applications
RFID tag antenna design for car tire monitoring

- Tire-specific antenna design to account for varying detuning effects
- Broadband T-matched dipole antenna
  - Power transmission coefficient of $\tau=63\%$ at 864MHz, bandwidth of $B_{\tau\geq60\%}=200$MHz

$\varepsilon_r$ ... relative permittivity
$\tan(\delta)$ ... loss tangent

Home Appliances

» Smart RFID technologies for a connected word
   > Near field communication (NFC) enhanced wireless sensor network node for a smart home demonstrator
     + NFC link at 13.56MHz for device pairing (system configuration)
     + Active UHF link at 868MHz for current sensor data transmission (energy metering)

Health Issues

» RF powered sensor grain for micro labs
   > 3D embedded wafer-level ball grid array (eWLB) system in package (SiP) sensor grain
     + HF RFID for wireless energy and data transfer at 13.65MHz
     + Size of eWLB SiP: (5.6x3.6x0.7)mm

TMR ... tunnel magneto resistance
ASIC ... application-specific integrated circuit
Health Issues

» On-body RFID system for remote health monitoring

> Performance of a passive ultra high frequency (UHF) RFID system based on outage probabilities
> Forward link gain threshold of $F_{Th} = -47\, \text{dB}$
> Backward link gain threshold of $B_{Th} = -118\, \text{dB}$

CDF ... cumulative distribution function

Environmental Sensing Applications

» Passive RFID sensor tag for liquid level sensing

> Antenna transducer prototype: antenna acts as sensing element

+ Sophisticated antenna impedance design to assure a high sensor performance

+ Stable power supply to passive tag chip (power transmission coefficient of $\tau \geq 90\%$ at 868MHz)

![Diagram of reflection coefficients](image)

$L. \ \text{Görtscacher, Design and Development of an Antenna Transducer for a Backscatter RFID Sensor Tag, MSc Thesis, TU Graz, 2014}$
Environmental Sensing Applications

» Passive RFID sensor tag for curvature monitoring

> Chip transducer prototype included in tag reflecting state $S_{\text{Ref}}$
> Stable power supply to passive tag chip (tag absorbing state: $S_{\text{abs}}$)
> Monitoring of three bend radii $R_{\text{Bend}}$ at 5.8GHz

Tag response

$\eta = 10\%$

$S_{\text{Ref}} @ R_{\text{Bend}} = 21.1\,\text{mm}$
$S_{\text{Ref}} @ R_{\text{Bend}} = 84.1\,\text{mm}$
$S_{\text{Ref}} @ R_{\text{Bend}} = \infty$

$\eta_{\text{... modulation efficiency}}$

Tag response

Awards and Prices

> 1st price of the Loughborough Antennas & Propagation Conference non-student paper competition, 2014

> 2nd place of the IEEE RFID Technology and Applications Conference student contest, 2014

> 1st prize of the “Fahrzeugverband Jubiläumsstiftung” by the Industrial Union of the Austrian Automotive Industry, 2013

> Winner of the International EURASIP Workshop on RFID Technology best paper award, 2012
Teaching

» RFID qualification network Austria
   > RFID courses for companies in the Graz region
     + RF measurement lab
     + RFID antenna theory and design, propagation
     + Advanced RFID lab
Microwave Laboratory

» Measurement devices
» Automated wafer prober (110GHz)
» Dedicated cleanrooms
» Anechoic chamber
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