PROJECT III.4
CIRCUITS & DEVICES FOR SENSOR NETWORKS & SYSTEMS

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OBJECTIVES

The main objective of the activity is the development of the necessary technologies for future sensor networks and systems. In the context of this objective the research targets of sensor readout, wireless telemetry, RF remote powering in the near as well as the far field are pursued. Special consideration is given in operation in special environments such as large engineering structures (e.g. buildings, bridges, naval ships etc).

MAIN RESULTS in 2012

Wireless telemetry and RF remote powering of sensor tags

RF power-harvesting systems are of particular interest in autonomous sensor tag design because of their ability to draw power from electromagnetic fields generated by controlled and stable RF power sources. RF sensor tags are based on the technology of RF identification systems which are widely used in product chain applications. A variety of real-time monitoring applications such as structural health monitoring in large structures, often require the deployment of such remotely powered sensor tags. In this case the tags are often installed in inaccessible places or integrated in the monitored structure during construction.

In this work, a power-harvester with an embedded antenna operating at the 430 MHz band capable of operating near ground or metal planes has been developed. The tag uses discrete components including an onboard microcontroller for supervision of system functions and interfacing with different types of low power sensors, thus resulting to a flexible passive sensor platform. Furthermore, the system comprises a low-profile optimized multi-slotted PIFA (Planar Inverted F Antenna) integrated within the system volume, which enables operation near metal and ground surfaces, and results in a slim packaged system. A power harvesting strategy that allows tag operation over cycles has been implemented in order to allow operation at an incident power level that is lower than the power required when the tag is fully active. Tag operation is divided in two cycles; a standby mode during which only the energy-accumulation supervising circuit is active, as well as a fully operational mode.

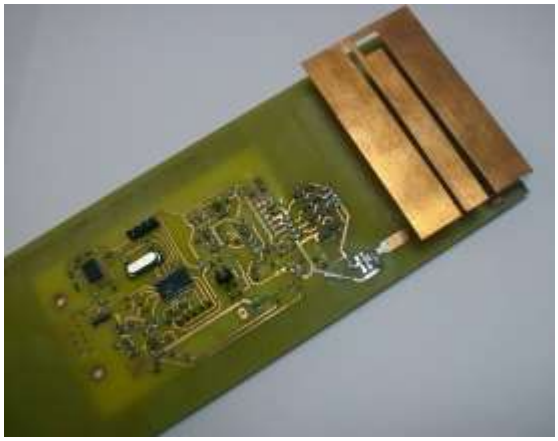

Fig. 1. *System implementation on FR4 PCB with the PIFA antenna.*

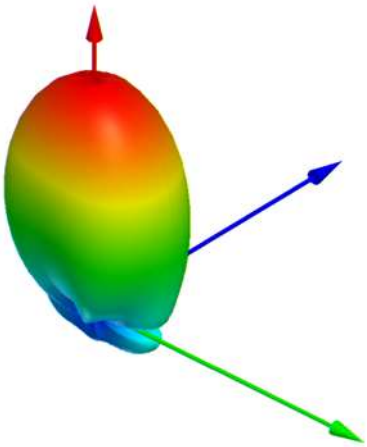

Fig. 2. *Simulated radiated gain of the antenna with the backplane 1cm apart.*

In order to compare the performance of the selected PIFA antenna to a half-wavelength dipole antenna, measurements with a Vector Network Analyzer (VNA) in free space as well as near a metal plate have been performed in order to compare the two antennas. In addition, a wireless link established between a low power base station emitting 200 mW of power at 430 MHz and the tag placed at 1cm distance from a metal plane has been demonstrated.

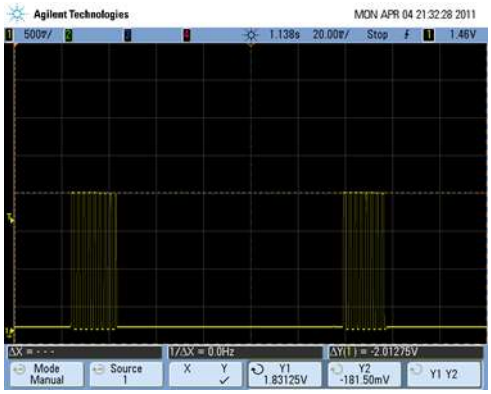

Fig. 3. *Output pulse train of the microcontroller, with the system placed 1cm apart from the metal plane.*

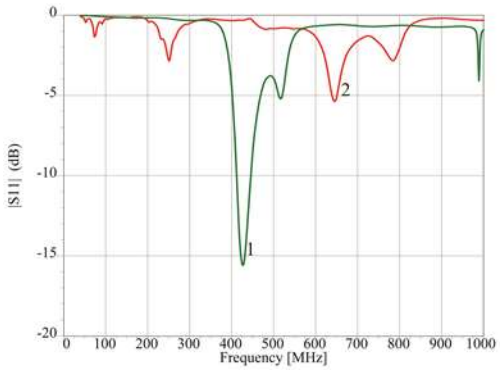

Fig. 4. *Comparison of the PIFA antenna performance (curve 1) to the dipole antenna (curve 2) at a distance of 1cm above a metal plate*

PROJECT OUTPUT in 2012

Publications in International Refereed Journals

1. *Embedded multi-slotted PIFAs for remotely powered passive UHF RFID tags,*
   H. Contopanagos, P. Broutas and S. Chatzandroulis
   Microwave and Opt. Tech. Lett., Vol. 54, No. 10 (October 2012), pp. 2379-2383
2. *A RF power harvester with integrated antenna capable of operating near ground planes,*
   P. Broutas, H. Contopanagos, D. Tsoukalas and S. Chatzandroulis
   Sensors and Actuators A, Vol. 186, (October 2012), pp. 284-288
3. *A low-power RF harvester for a smart passive sensor tag with integrated antenna,*
   P. Broutas, H. Contopanagos, E. Kyriakis-Bitzaros, D. Tsoukalas and S. Chatzandroulis
   Sensors and Actuators A, Vol. 176 (April 2012), pp. 34-45