Dear Editor,
We present our new research article entitled "*Numerical Model of Directional Radiation Pattern Based on Primary Antenna Parameters*". This work was supported in part by the Polish National Centre for Research and Development (NCBR) under Grant No. PBS1/A3/3/2012. In relation to this manuscript all authors declare that this submission is their original work. The elaborated work was possible thanks to huge donation from European Union (please, see the Acknowledgments). More supporting information is attached at the end of this letter, fallowing the general details.

Yours faithfully,

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Short background, relevance, topicality and some other significant information

The justification of undertaking the problem

Nowadays, an intensive development of the RFID technology can be observed. Scientific research driving at the synthesis of new solutions and searching areas of innovative applications for them is carried out in many laboratories all over the world. Because it is a very young brunch of electronics there is lack of unequivocal guidelines ordering selection, nomenclature and definitions of parameters of the RFID system components, especially in relation to the anticollision systems working in dynamic conditions. The limitation of applicability of the RFID systems to few typical applications in which objects are fixed in space is a result of it. Moreover, applicant's experiences show that the majority of applications are worked out by very expensive and low-efficient method of trial and error, which results from a very complicated multiaspect process of modelling such resolutions, interaction and interference among many transponder and read/write device antennas, and from a lack of proper manufacturer's specifications and unclear rules of parametric evaluation of environment of the system. This situation brakes development of non-typical applications in which additional functions already implemented in the RFID transponders (e.g., measurement of environment parameters, read/write of usable data) could be used. Applicant is of the opinion that there is the possibility of large increasing the application area for the passive identification by using alternate energy sources in the transponders. However, it requires the synthesis of the transponder structure incorporating an element (e.g., capacitor) converting the ambient energy (e.g., electromagnetic energy) into the electrical energy.

Breaking this barrier will contribute to the development of the anticollision RFID systems and will allow one to meet the growing demands for safety, integrity and authenticity of data transmission in the automatic identification process.

The perspective of the results implementation

In the applicant's opinion, the feasibility of taking advantage of the project results is very high. It is confirmed by the research work the applicant has been doing so far and by recognition of commercial market demands. The applicant's works are recognized at home and abroad. Currently, the applicant is conducting works towards implementation of the RFID technology in the field of production and personalization of identity documents (cooperation with Polish Security Printing Works), logistics of units for cars (cooperation with HBPO GmbH), railway rolling stock management (cooperation with PKP Cargo) and different kinds of applications (cooperation with local companies ELMAK Ltd., HYBRES Ltd. and with many others such as MOKATE, EAE Elektronik, Tatra Card System). The applicant possesses letters of intent confirming the desire to implement the results of these studies.

The scientific workshop

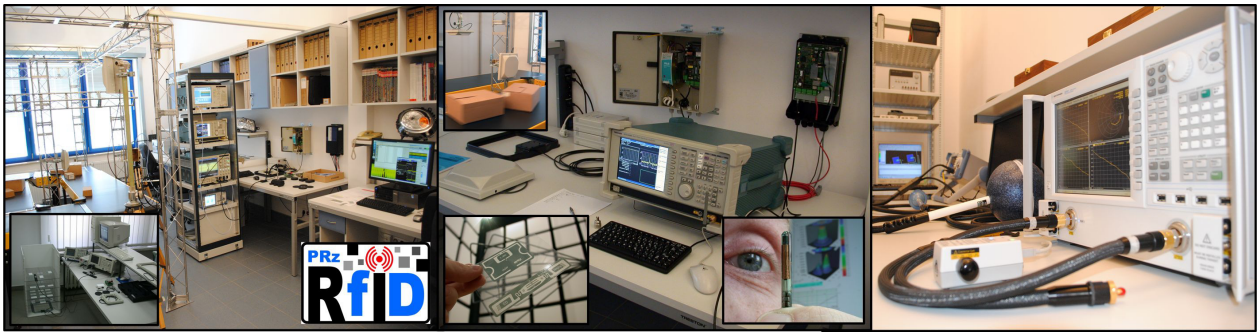
The basis of the applicant's scientific workshop is the twelve years experience in analyzing the effectiveness of single and anticollision radio frequency identification systems and also extensive practise and knowledge in designing analogue and digital electronic devices by using various technologies. The thoroughgoing diagnosis of technical limitations in currently used methods of objects identification allows the applicant to conduct extensive effective works in the above mentioned field.

The research team consist of workers possessing a wide experience in research works and workers starting in such works but already having some achievements in the RFID area. The applicant has also the own extensive library of world scientific literature that is the primary source of knowledge. This collection of books in the field RFID technology has been completing and analyzing for many years. It is still completed with the most actual publications from the international publishing market.

The applicant's research laboratories

The applicant has – at its own disposal – the modern and full equipped laboratory base with the professional research and technological apparatus. The considerable investments have been realized in the three laboratories for the last three years – on the total amount more than 20 million PLN obtained mainly from the EU. It allows the applicant to carry out any kind of research, development and application project in the RFID technology area.

The modern and full equipped laboratory of the RFID technology is the main element of the base from the viewpoint of the project realizability. It is fully compatible with the professional laboratory of integrated micro- and nanoelectronic technologies in which applicant can realise every kind of read/write devices, transponder structures and their antennas etc. The unique laboratory of electromagnetic compatibility EMC (with option of antennas measurements) constructed according to the EU standards complements this research base. The research workers have also full access to the automated production lines in the Innovation and Implementation Electric Plant HYBRES thanks to the long-term close cooperation. Such a rich research-technological complex is unique on a national scale.



Laboratory of RFID technology in Dept. of Electronic and Communications Systems of Rzeszów University of Technology

a)

b)

Others laboratories in Dept. of Electronic and Communications Systems of Rzeszów University of Technology: a) laboratory integrated micro- and nanoelectronic technologies, b) laboratory of EMC (with antennas measurements)

The research laboratory of RFID is equipped with the rich base of hardware and software. A few unique test stands have been designed, realised and implemented to the comprehensive analysis of the RFID systems. These experimental stands are arranged by the applicant on the basis of below mentioned professional laboratory apparatus according to conditions of real applications and they are important support for realising the project aims. Their non-standard construction enables to realise such objectives as selection of electronic transponders and read/write devices and their antennas to any specified process of the automatic identification in the full frequency range for short and long-range as well as for inductively coupled and propagation RFID systems. It is also possible to perform research in static and dynamic conditions. The current advancement of laboratory gives opportunities to lead works that are aimed at the development of commercial processes of automatic identification by determining the interrogation zone of any RFID system and by using the simulator based on Monte Carlo method.

The main elements of the current equipment of the RFID and EMC laboratories can be divided into a few groups according to their planned usage within the project framework. In the construction of automatic identification stands, the fallowing equipment will be used: RFID measurement chamber with mobile platforms; set of conveyor belts and multi-axes turntables dynamic tests; set of RWD devices produced by Philips, Texas Instruments, Feig; set of RWD antenna units and transponders; specialized software for RFID development; different kind of impedance matching and tuning elements for newly developed antennas. Also, specialized measuring apparatus will be used for controlling automatic identification processes in the field of energy and communication conditions for the given RFID system. The energy conditions cover inspection of electrical parameters of the antenna unit assembly in RWD-transponders system (by using oscilloscope Tektronix DPO71254B with probes P7504, CT1, TCP312+TCPA300) and also the measurement of vector components of magnetic field intensity (by using spectrum analyzer R&S FSL18 with probes of near-range magnetic field HZ-14 and HZ-15). The communication conditions cover inspection of communication protocol parameters in processes of data exchange (by using measuring equipment produced by Tektronix: spectrum analyzer RSA 3408B and arbitrary waveform generator AWG5002B, supplemented by the vector generator R&S SMBV100A). The professional software will be used as the base for calculation and processing of acquired data: package IE3D by Mentor Graphics, 4NEC2 for modelling of antennas; the environment of Mathcad 15, Ansys 10, Scilab for solving numerical problems of interrogation zone; Labview 8 for process controlling of measurements; different kind of development software dedicated to design and program digital and analog circuits; and other. In the area of EMC issues, the fallowing equipment will be used: TDK anechoic chamber along with a measurement cabin and their equipment (GPIB drivers with antenna masts and rotary table; sets of optical interfaces USB, RS232, RS485; sets of equipment for measuring the emission of electromagnetic disturbances; and many others). In the area of antenna parameter measurement, the fallowing equipment will be used: MI Technoogies set of 3D positioner, controller and Agilent vector network analyzer N5242A PNA-X with automatic calibrator ECAL; Advantest spectrum analyzer R3132 and R3131; Tektronix digital oscilloscopes MSO4104, TDS3054; Tektronix arbitrary waveform generator AFG3252; Agilent signal generator HP33120A; Agilent RLC bridge 4284A, LA Techniques vector network analyzer, and other.

Moreover, in the laboratory of integrated micro- and nanoelectronic technologies, the applicant has modern full-equipped base which enables to create and test hybrid electronic structures by using all of the core technologies: LTCC (Low Temperature Co-fired Ceramic), HTCC (High Temperature Co-fired Ceramic), with full instrumentation for development and thermal treatment of structures (precise mechanical and laser cutting, packaging, laminating, drying, firing etc.); conventional multilayer hybrid technology with using a ceramic and flexible substrates (precision screen printing device, jet printer - ink-jet, the exposure device for photosensitive materials, physical vacuum deposition device, and other); assembly of discrete components, bare IC and SMD, BGA (rework system, precise manipulators); multilayer PCB technologies (CNC milling machine, press, UV exposure devices, devices for chemistry). In addition, the applicant has own laboratories of the microprocessor technology and telecommunications systems with modern software and instrumentation for designing advanced digital systems based on single-chip microcomputers.