On-chip CMOS RF Energy Harvesting System Using Parasitic Capacitance Compensation Technique

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Abstract— Recently, RF energy harvesting technology has become an important research issue for one of the eco-friendly energy reusing technologies. If RF energy harvesting system using CMOS process technology is applied into power transmission terminal and wireless communication, it will be great help to overcome the problem of battery efficiency. Since the RF energy floating in the air is the power of −30 dBm or less, generally it is not sufficient power to operate rectifier circuit in the RF energy harvesting system. Therefore, generally the rectifier circuit uses a Schottky diode having a low threshold voltage to minimize the loss of voltage and efficiency. However, the implementation of RF energy harvesting system using the Schottky diodes in CMOS process is difficult due to manufacturing cost and process technology. Therefore, the different design and research direction is necessary. Figs. 1 and 2 show the schematic and layout of the proposed high efficiency on-chip RF harvesting system using a 0.13 µm CMOS process, respectively. Since return loss (S_{11}) is better than −15 dB in overall operating bandwidth as shown in Fig. 3 due to the matching network, the input signal can enter into the rectifier smoothly. In this work, the rectifier circuit is a Villard Voltage doubler structure using a MOSFET diode connection. The PMOS has a floating body structure in order to reduce body effect losses. Since the parasitic capacitance of MOSFET can cause the degradation in conversion efficiency, it is necessary to compensate these parasitic components. For this purpose, the inductor was used which can provide a form of virtual series resonant circuit with parasitic capacitance of both transistors. Furthermore, it is possible to increase the conversion efficiency by suppressing the harmonic components generated by the MOSFET and flattening DC signal using a off-chip low pass filter. The load resistor value was optimized for maximum conversion efficiency. Fig. 4 shows simulation results of conversion efficiency and output DC voltage. From the simulation, the efficiency of 25% or more is obtained for an input power of 10 ∼ 20 dBm which can significantly affect in battery efficiency enhancement of near field communication systems.

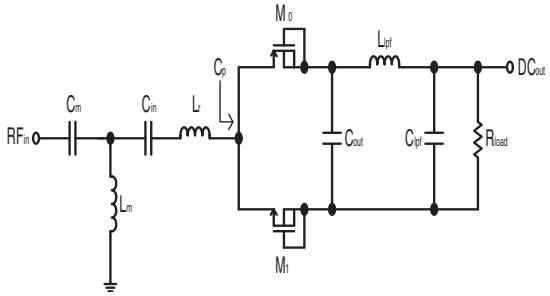

Figure 1.

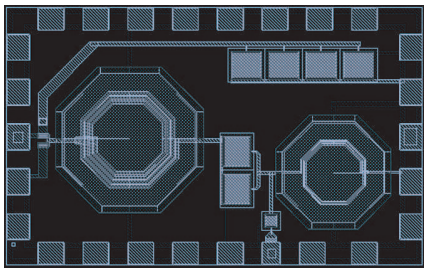

Figure 2.

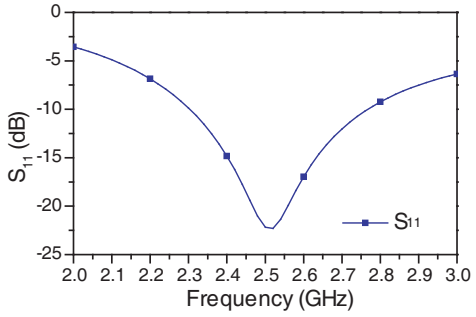

Figure 3.

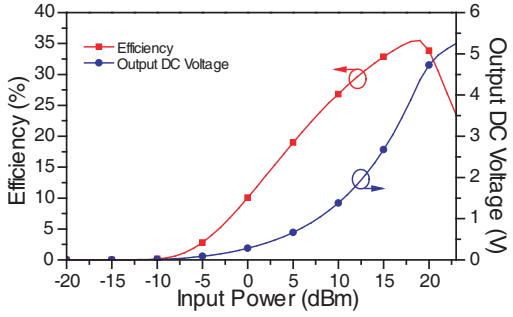

Figure 4.

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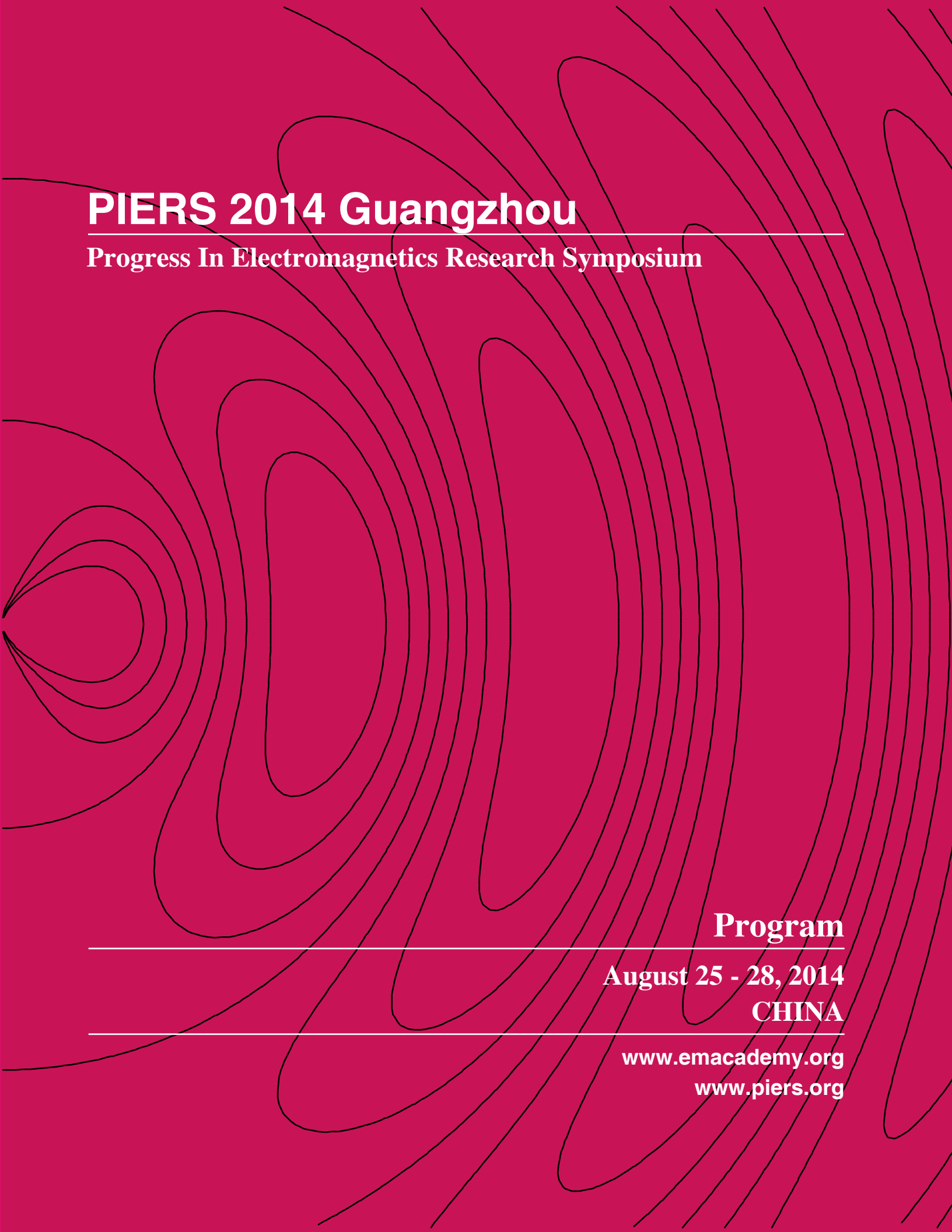

Program

August 25 - 28, 2014

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11:00 A Compact Triple-band MIMO Antenna for Wimax/WLAN Application
Hui-Fen Huang (*South China University of Technology, China*); *Yuanhua Hu* (*South China University of Technology, China*); *Wei Zhao* (*South China University of Technology, China*);

Session 2A_13
SC4: Wireless Power Transfer

Tuesday AM, August 26, 2014

Room 13

Organized by Qiaowei Yuan, Elisenda Bou Balust

Chaired by Qiaowei Yuan, Elisenda Bou Balust

08:00 invited Power Transfer ***k*-*Q*** Product Explored for a Variety of Two-port LCR Circuit Topologies
Naoki Sakai (*Toyohashi University of Technology, Japan*); *Takashi Ohira* (*Toyohashi University of Technology, Japan*);

08:20 Three-phase Symmetrical Inductive Coupled Structure for Wireless EV Charging System
Jia-You Lee (*National Cheng Kung University, Taiwan, R.O.C.*); *Hung-Yu Shen* (*National Cheng Kung University, Taiwan*); *Shan-Jen Chao* (*Lite-On Technology Corporation, Taiwan, R.O.C.*);

08:40 On Frequency Optimization of Assymetric Resonant Inductive Coupling Wireless Power Transfer Links
Nuria Egidos (*UPC BarcelonaTech, Spain*); *Elisenda Bou Balust* (*UPC BarcelonaTech, Spain*); *Raymond J. Sedwick* (*University of Maryland, USA*); *Eduard Alarcon* (*UPC BarcelonaTech, Spain*);

09:00 Input and Output Impedance Matching Conditions and Maximum RF-to-DC Rectification Efficiency in Wireless Power Transfer System
Qiaowei Yuan (*Sendai National College of Technology, Japan*); *Shinji Abe* (*Sendai National College of Technology, Japan*); *Satoshi Suzuki* (*Sendai National College of Technology, Japan*); *Takashi Ohira* (*Toyohashi University of Technology, Japan*);

09:20 invited Development of Gallium Nitride Schottky Barrier Diode for Microwave Rectification
Jin-Ping Ao (*The University of Tokushima, Japan*);

09:40 Design and Implementation of Wireless RF Power Transfer Circuit for Implantable Neurostimulator
Jia-You Lee (*National Cheng Kung University, Taiwan, R.O.C.*); *Hung-Yu Shen* (*National Cheng Kung University, Taiwan*); *Che-Li Lin* (*TSMC Ltd., Taiwan, R.O.C.*);

10:00 **Coffee Break**

10:20 Wireless Power Supply for ICP Devices with Hybrid Supercapacitor and Battery Storage
Aiguo Patrick Hu (*University of Auckland, New Zealand*); *Fu-Yu Beverly Chen* (*University of Auckland, New Zealand*); *Yee Wen You* (*University of Auckland, New Zealand*); *Daniel McCormick* (*University of Auckland, New Zealand*); *David M. Budgett* (*University of Auckland, New Zealand*);

10:40 On-chip CMOS RF Energy Harvesting System Using Parasitic Capacitance Compensation Technique
Junsik Park (*Chonbuk National University, Republic of Korea*); *Jaeyeon Kim* (*Chonbuk National University, Republic of Korea*); *Namsik Ryu* (*Electronics and Telecommunications Research Institute, Republic of Korea*); *Sutae Kim* (*Samsung Electronics, Republic of Korea*); *Yongchae Jeong* (*Chonbuk National University, Republic of Korea*);

11:00 Graphical Interactivity in Power Device and Circuit ***S***-parameter Measurement Exploiting Möbius Transformation
Kyohei Yamada (*Toyohashi University of Technology, Japan*); *Sonshu Sakihara* (*Toyohashi University of Technology, Japan*); *Takashi Ohira* (*Toyohashi University of Technology, Japan*);

Session 2A_14
SC5: Remote Sensing

Tuesday AM, August 26, 2014

Room 14

Organized by Jian-Cheng Shi

Chaired by Jian-Cheng Shi

08:00 Removal of Synthetic Aperture Effect in Stepped Frequency Radar
Yake Li (*Memorial University of Newfoundland, Canada*); *Siu O'Young* (*Memorial University of Newfoundland, Canada*);

08:20 Refinement of the X and Ku Band Dual-polarization Scatterometer Snow Water Equivalent Retrieval Algorithm
Jian-Cheng Shi (*Institute of Remote Sensing Applications, Chinese Academy of Sciences, China*); *Chuan Xiong* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, China*);

Session 2A13
SC4: Wireless Power Transfer