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The Design Aspects Of An Optically Powered CMOS Receiver Front-End For Electrically Isolated Applications

Abstract

The receiver circuitry in a wireless communication system is a key component in determining the overall system performance. The power of the receiver circuitry is usually provided from a battery or through copper wires. However, there are a number of application areas including wireless communication, aerospace, defense, and medical, which subject sensors, transducers, and other communication devices to high readio frequency (RF), electromagnetic interference (EMI), or magnetic fields. It is more appropriate to provide power of these systems via optical rather than electrical means. This thesis presents the design and implementation of an optically powered receiver front-end for electrically -isolated micro-scale applications. The presented work first deals with the realization of a miniaturized optical power supply unit. The monolithic integration of complementary metal oxide semiconductor (CMOS) photodiodes together with the active circuitry on the same substrate has been considered in detail. A novel architecture consisting of an integrated photodiode connected to a direct current to direct current (DC/DC) converter has been presented and designed in a low-cost 0.18 μm CMOS process. The DC/DC converter utilized in the presented architecture has a maximum efficiency of 56 % and is able to increase the photodiode voltage of 0.5 V and 0.6 V to 1.2 V and 1.5 V, respectively. In the second part of the thesis, the design of a low-power integrated receiver front-end that consists of a low noise amplifier (LNA), voltage gain amplifier, a mixer and a low-pass filter has been presented. A different design technique so-called noise matching has been introduced for the design of the LNA. The differential LNA consumes 1.4mA from a 1.2 V supply voltage and has a measured S_{21} of 30 dB. The noise figure of the LNA has been measured as 7.3 dB with respect to 50 Ω. This translates into a projected noise of 0.35 dB when the LNA is used with an example solenoid coil given in this thesis. Finally, the receiver front-end has been powered optically and tested with a light-emitting diode (LED) driver circuitry.

PUBLICATIONS

Journals

1. O. Aktan, B. Sarioglu, U. Cindemir, S.O. Unlu, G. Dundar, S. Mutlu, A.D. Yalcinkaya, "Optoelectronic CMOS Power Supply Unit for Electrically Isolated Micro-Scale Applications", IEEE Journal of Selected Topics in Quantum Electronics, May-June 2011, Volume 17, Issue 3, pp. 747 – 756.
2. B. Sarioglu, O. Aktan, A. Oncu, S. Mutlu, G. Dundar, and A.D. Yalcinkaya, ”An Optically Powered CMOS Receiver System for Intravascular Magnetic Resonance Applications”, IEEE Journal on Emerging and Selected Topics in Circuits and Systems, Vol. 2, No. 4, Dec. 2012.

Conferences

1. B. Sarioglu, O. Aktan, U. Cindemir, G. Dundar, C. Ozturk, S. Mutlu, A. D. Yalcinkaya, ”An RF Front-End with Optically Powered CMOS Power Supply”, OMN 2011, 8-11 Aug 2011, Istanbul, Turkey.

2. B. Sarioglu, O. Aktan, U. Cindemir, G. Dundar, C. Ozturk, S. Mutlu, A. D. Yalcinkaya, ”Optoelectronic CMOS Power Supply Unit for Interventional MRI Devices ”, Proceedings of ISMRM 2011, 7-13 May 2011, Montreal, Canada

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