Impact of an SoC Research Project on Microelectronics Education: A Case Study

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Abstract

Microelectronics systems design is a collaborative, multidisciplinary activity, involving the combined efforts of system architects, circuit designers, device engineers, software developers, and process engineers. Semiconductor products are vital to today's $1 Trillion/year electronic industry [1]. There is a need for educational programs that prepare engineers for the semiconductor industry. This paper presents the impact of an RF-SoC research project on the career choices of students involved and its broader impact on the microelectronics education in the participating universities. Teaching students the design and test at the physical level is valuable in that it provides the understanding and skills they will need to perform these functions in their subsequent employment.

1. Introduction

Since the start of the commercial IC products in the early 1960's, there has been a steady increase of educational programs in microelectronics at the undergraduate and graduate level. Microelectronics systems design is a collaborative, multidisciplinary activity, involving the combined efforts of system architects, circuit designers, device engineers, software developers, and process engineers. Realizing the importance of Electronics and Microelectronic Systems Education, special programs are initiated by Industry and Government agencies throughout the World [2-3]. This paper presents the impact of a multi-University collaborative research project, low-power UHF SOI CMOS receiver, on the career choices of the students involved and the impact on microelectronics education at the graduate and undergraduate level.

2. UHF Receiver Project

Through a grant funded by NASA, North Carolina A&T State University established a research team involving faculty, senior engineers, graduate students, and undergraduate students from North Carolina A&T State University, North Carolina State University (NCSU), and JPL. Future Mars missions require low-power, rad-hard UHF receivers for orbiter-lander communication. To meet the requirements for low-power/rad-hard, Honeywell's 0.35-µm SOI CMOS process was chosen for design/implementation. Figure 1 shows the block diagram of the low-power UHF SOI CMOS receiver.

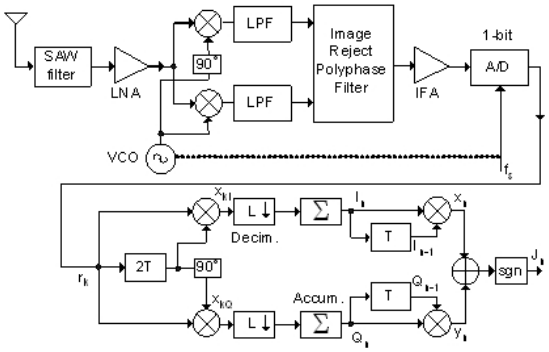

Figure 1. Low-power UHF SOI CMOS receiver

It is an ideal vehicle for design experiences in RF CMOS (LNA, Mixer, VCO), frequency synthesizer (PLL), continuous-time CMOS filters, IF amplifiers, and low-power digital circuits for baseband. Figure 2

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shows the Microphotograph of the UHF SOI CMOS Receiver.

3. Impact of the Project

The project involved active participation of four faculty members, three PhD candidates, six master students, and two undergraduate students. Two of the PhD candidates and four of the master students received their degrees and currently working as design engineers in leading RF IC companies. Two master students completed their degrees and currently pursuing a PhD degree in RF IC design. The experience gained through research involvement had a significant impact on their career choices and professional development. Students participated in the design review meetings attended by JPL engineers, NASA technical monitor and faculty from NC A&T State University and NCSU. JPL engineers provided feedback and guidance on the work performed throughout the life of the project and interacted with students by e-mail and meetings at JPL, NC A&T SU, and NCSU.

The funds provided by the NASA grant insured that Cadence design tools were maintained and supported for the low-power SOI CMOS receiver project and courses in VLSI design and RF CMOS integrated circuits. As a result, two new courses are developed and currently being offered to graduate students (ELEN 724, Mixed-Signal VLSI Design, and ELEN 885 Doctoral Special Topics: RF CMOS Integrated Circuits). Design experience gained through the RF-SoC project is significantly impacting these new courses. RF and mixed-signal circuits developed in the RF-SoC project are used as "real life examples" that supplement the theory and standard course material. For the first time, NC A&T State University is participating in the "SoC Design Challenge" sponsored by the Semiconductor Research Corporation (SRC), the Semiconductor Industry Association (SIA), and their corporate sponsors. As a result of RF-SoC design experience gained through NASA research grant, NC A&T State University is now "one of 27 Universities" competing in the design phase of the contest.

NASA grant to develop low-power UHF receiver for space applications played an important role to jumpstart SoC design experience at one of the leading HBCU, North Carolina A&T State University. Our experience clearly demonstrated that "a large research grant to develop RF-SoC" is very effective to jump start a microelectronics program in SoC. It would be interesting to quantitatively compare the impact of such a program with more specialized efforts like establishment of "Center of Excellence in Microelectronics".

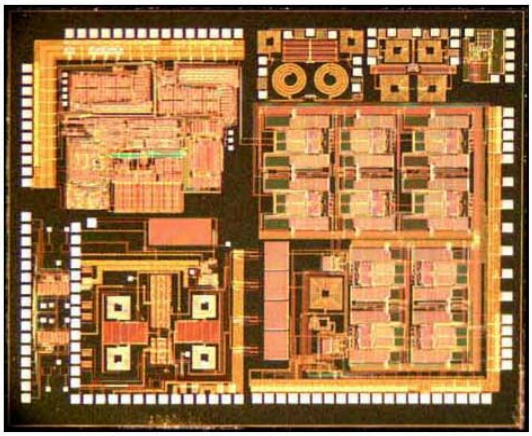

Figure 2 Microphotograph of the UHF SOI CMOS Receiver (~5mmX6mm)

4. Acknowledgments

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5. References

[1] Lynn Fuller, "Past and Current Status of Microelectronics Education for Undergraduates", Proceedings of the 15th Biennial University/Government/Industry Microelectronics Symposium, 2003., 30 June-2 July 2003, Pages:162 – 165.

[2] Wei-Chang Tsai, Chun-Ming Huang, Jiann-Jenn Wang, and Chen-Yi Lee, "Infrastructure for Education and Research of SOC/IP in Taiwan", Proc. 2003 IEEE Intl. Conf. on Microelectronic Systems Education, pp. 39 – 40.

[3] K.C. Shet, "Manpower Development in VLSI in India: A Case Study", Proc. 2003 IEEE Intl. Conf. on Microelectronic Systems Education, pp.29 –30.