Software-Defined Radio Transceivers

Related to this topic, the following work was done in 2017.

A High-Precision Quadrature Modulator and High-Performance RF Front-End Circuits suitable for Multi-band Wireless Transceivers:

Recently the demand for wireless systems such as sensor networks has been rapidly growing. However, radio-wave resources are limited and invaluable especially in these days. Therefore, software-defined radios (SDRs) and cognitive radios, which is a principal application of SDR, can be the key to greatly improving frequency-spectrum efficiency. SDRs demand flexibility and reconfigurability in RF (Radio Frequency) circuits. Therefore, a spectrum-efficient wireless transceiver architecture is indispensable. In this research, we proposed a multi-band wireless transceiver using a high-precision complex quadrature modulator (HP-CQMOD) and a flexible-filtering receiver suitable for sensor networks. As the final goal of our research, we would like to establish a reconfigurable wireless communicator, whose frequency band can be changed according to communication conditions and/or regulations using reconfigurable RF and baseband processors and downloadable software. This is a kind of cognitive radios based on SDR (Software-Defined Radios). In recent years, multi-level modulations such as Quadrature Amplitude Modulation (QAM) are or will be used in Wireless LANs, digital TVs, and the 4th-generation cell-phones. So, very small modulation errors of QMOD are strongly demanded. In the 2017, we concentrated on circuit design of low-power HP-CQMODs, RF-band complex bandpass filters, and image-rejection receivers in wireless transceivers. Moreover, we devised and analyzed a low-
distortion rail-to-rail amplifier, and rail-to-rail voltage-controlled oscillators suitable for quadrature LO generation and wireless power transfer.

RF/IF building blocks we designed have three features as follows:

1. Low-power high-precision complex quadrature modulators are developed and designed, featuring a dual-LO switching quadrature mixer and an RF-band complex bandpass filter. Regarding the dual-LO switching quadrature modulator, we made breadboard experiments using commercially available ICs for analog switches and OP amplifiers and confirmed the usefulness of LO-phase error compensation mechanism.

2. Low-distortion and wideband rail-to-rail amplifiers combining with the Cherry-Hooper architecture.

3. Rail-to-rail voltage-controlled oscillators suitable for quadrature LO generation and wireless power transfer applications.

4. A low-voltage operation operational amplifier based on CMOS inverters suitable for complex bandpass filters.

Yukihide Kohira:

We investigate design automation methodology for LSI circuits. Due to the increase of scales of LSI circuits and the decrease of time to market of LSI products, design automation systems are widely used in order to design LSI circuits. Since the performance of LSI depends on the used design automation systems, it is important to develop design automation methodology continuously in order to obtain good products.

Our research interests are design automation for clock synchronous framework and layout design. In 2017, we focused on following two topics.

Post-silicon Delay Tuning

In recent LSI circuits, process variations increase significantly because of the progress of the process technology. The process variations significantly cause delay variations and delay variations affect the performance and the yield of VLSI chips. If the circuit cannot work at the testing process after the fabrication of LSI chips, the circuit can be recovered by adjusting delays of the programmable delay elements. In 2017, we investigated delay turning methods to improve the yield and to reduce the power consumption and published theses in two domestic conferences.
Dynamic Voltage and Frequency Scaling

In recent years, the usage of Arduino has attracted attention for controlling sensor nodes in IoT. Low power is required for sensor nodes and the reduction of the power consumption in Arduino controlling sensor nodes is also required. In 2017, we created an Arduino compatible machine by removing extra elements from Arduino Uno. In addition, we applied Dynamic Voltage and Frequency Scaling (DVFS) to Arduino compatible machines and measured the current and power consumption by changing the power supply voltage and clock frequency. We published a thesis in a domestic conference.
Summary of Achievement

Refereed academic journal


A High-image-rejection wireless receiver with N-phase active RC complex filter is proposed and analyzed. Signal analysis shows that the double-conversion receiver with (N+N2) mixers corrects the gain and phase mismatches of the adjacent image. The Monte Carlo simulations show that the image rejection ratio of the adjacent image depends almost only on R and C mismatches in the complex filter.

Unrefereed proceedings of an academic conference


Summary of Achievement


Research grants from scientific research funds and public organizations


Academic society activities

Treasurer, IEEE CEDA All Japan Joint Chapter

Committee Member, IEICE Technical Committee on VLSI Design Technologies (VLD)
Summary of Achievement

Associate Editor, IEICE Trans. Fundamentals

Committee Member, IEICE Tohoku Section

Guest Editor, IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, Special Section on Design Methodologies for System on a Chip

Guest Editor, IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, Special Section on VLSI Design and CAD Algorithms

Technical Program Committee Secretary, 23rd Asia and South Pacific Design Automation Conference (ASPDAC 2018)

Technical Program Committee Member, 23rd Asia and South Pacific Design Automation Conference (ASPDAC 2018), Design for Manufacturability track

Confirmed Committee Member, ACM SIGDA Student Research Forum at ASPDAC 2018

TPC Subcommittee Chair, Workshop on Synthesis And System Integration of Mixed Information technologies (SASIMI 2018), Physical subcommittee

Chair of the IEEJ Investigation R/D Committee on High-Performance and Wide-Variation Technologies of High-Frequency Integrated Circuits, IEE Japan, 2017

Advisor for undergraduate research and graduate research
Summary of Achievement

Thesis Advisor: Y. Kohira

Thesis Advisor: Y. Kohira

Thesis Advisor: Y. Kohira

Thesis Advisor: Y. Kohira

Thesis Advisor: Y. Kohira


Summary of Achievement


Others


The 31st Radio Engineering and Electronics Association Award, Nov. 7, 2017

Contributions related to regional education

[tsuka-202-034-17:2017] Chair of the Aizu-Area Education and Science Foundation Evaluation Committee