SpringerBriefs in Electrical and Computer Engineering

For further volumes:
http://www.springer.com/series/10059

Samantha Yoder • Mohammed Ismail
Waleed Khalil

VCO-Based Quantizers Using Frequency-to-Digital and Time-to-Digital Converters

Springer

Samantha Yoder
The ElectroScience Laboratory
The Ohio State University
Columbus, OH 43212, USA
yoder.164@osu.edu

Waleed Khalil
The ElectroScience Laboratory
The Ohio State University
Columbus, OH 43212, USA
khalil@ece.osu.edu

Mohammed Ismail
Department of Electrical
and Computer Engineering
The Ohio State University
Columbus, OH 43210-1272, USA
ismail@ece.osu.edu

ISSN 2191-8112 e-ISSN 2191-8120
ISBN 978-1-4419-9721-0 e-ISBN 978-1-4419-9722-7
DOI 10.1007/978-1-4419-9722-7
Springer New York Dordrecht Heidelberg London

Library of Congress Control Number: 2011934750

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Traditional analog-to-digital converters (ADCs) face many design challenges as technology scales. A few of these challenges are (1) voltage dynamic range decreases making it difficult to accurately quantize in the voltage domain (2) architecture contains many analog components which are challenging to design in deep submicron complementary metal oxide semiconductor (CMOS) processes. Voltage-controlled oscillator (VCO)-based ADCs are gaining popularity due to the highly digital architecture and improved timing resolution in deep submicron CMOS processes.

This book presents a theoretical and modeling approach to understanding the VCO-based quantizer. Two digital time quantizer architectures are reviewed: one using a frequency-to-digital converter (FDC) and the other using a time-to-digital converter (TDC). The TDC architecture is new to the application of the VCO-based quantizer.

Chapter 1 provides an introduction including the motivation for this topic, background on the subject, and goals of this work.

Chapter 2 provides an introduction and theoretical analysis of the FDC and TDC VCO-based quantizer. Theoretical equations are developed to determine the resolution of the quantizers and verified through a VerilogA model.

Chapter 3 provides modeling and analysis of circuit nonidealities of the VCO-based quantizer. These nonidealities are added to the VerilogA model and theoretical equations derived to verify the effects on both the FDC and TDC architecture.

Chapter 4 provides some final thoughts and analysis on the FDC and TDC VCO-based quantizer.

Chapter 5 concludes the book.

Columbus, OH, USA

Samantha Yoder
Mohammed Ismail
Waleed Khalil

Contents

Abbreviations

ADC	Analog-to-digital converter
CMOS	Complementary metal oxide semiconductor
CP	Charge pump
DAC	Digital-to-analog converter
DEM	Dynamic element matching
DFF	D flip-flop
ΔΣ	Delta-sigma
FDC	Frequency-to-digital converter
FFT	Fast Fourier transform
MB	Multibit
NTF	Noise transfer function
OSR	Oversampling ratio
PLL	Phase-locked loop
PSD	Power spectral density
PWM	Pulse width modulation
RVCO	Ring VCO
SNR	Signal-to-noise ratio
SNDR	Signal-to-noise plus distortion ratio
STF	Signal transfer function
TDC	Time-to-digital converter
THD	Total harmonic distortion
VCO	Voltage-controlled oscillator