High-Speed DSP and Analog System Design

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To my family, Nga, Lily, Kevin and Robin

Preface

This book covers the high-speed DSP and analog system design techniques and highlights common pitfalls causing noise and electromagnetic interference problems engineers have been facing for many years. The material in this book originated from my high-speed DSP system design guide (Texas Instruments SPRU 889), my system design courses at Rice University and my experience in designing computers and DSP systems for more than 25 years. The book provides hands-on, practical advice for working engineers, including:

- Tips on cost-efficient design and system simulation that minimize late-stage redesign costs and product shipment delays.
- 11 easily-accessible chapters in 210 pages.
- Emphasis on good high-speed and analog design practices that minimize both component and system noise and ensure system design success.
- Guidelines to be used throughout the design process to reduce noise and radiation and to avoid common pitfalls while improve quality and reliability.
- Hand-on design examples focusing on audio, video, analog filters, DDR memory, and power supplies.

The inclusion of analog systems and related issues cannot be found in other high-speed design books.

This book is intended for practicing engineers and is organized as follows:

- **Chapter 1:** Highlights challenges in designing video, audio, and communication systems.
- **Chapter 2:** Covers transmission line theories and effects. Demonstrates different signal termination schemes by performing signal integrity simulations and lab measurements.
- **Chapter 3:** Shows the effects of crosstalk and methods to reduce interference.
- **Chapter 4:** Provides an overview of switching and linear power supplies and highlights the importance of having proper power sequencing schemes and power supply decoupling.
- **Chapter 5:** Covers the analytical and general power supply decoupling techniques.
- **Chapter 6:** Covers design considerations of analog phase-locked loop (APLL) and digital phase-locked loop (DPLL) and how to isolate noise from affecting APLL and DPLL jitter.
- **Chapter 7:** Presents an overview of data converter, sampling techniques and quantization noise.
- **Chapter 8:** Covers analog active and passive filter design including operational amplifier design with single-rail and dual-rail power supplies.
- **Chapter 9:** Provides memory sub-system design considerations. Includes DDR overview, signal integrity and design example.
- **Chapter 10:** Covers printed circuit board (PCB) stackup and signal routing considerations.
- **Chapter 11:** Describes sources of electromagnetic interference (EMI) and how to mitigate them.

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Finally, for my wife, Nga, I am still amazed with how she can hold a very demanding full-time job at HP and still find time to provide great support to me and care to our kids. She is truly an amazing friend and a remarkable soccer mom.

Thanh T. Tran
Houston, Texas, 2010

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About The Author

DR. THANH TRAN has over 25 years of experience in high-speed DSP, computer and analog system design and is an engineering manager at Texas Instruments Incorporated. He currently holds 22 issued patents and has published more than 20 contributed articles. He is also an adjunct faculty member at Rice University where he teaches analog and digital embedded systems design courses. Tran received a BSEE degree from the University of Illinois at Urbana-Champaign, Illinois in 1984 and Master of Electrical Engineering and Ph.D. in Electrical Engineering degrees from the University of Houston, Houston, Texas in 1995 and 2001 respectively.