

# *Designing Audio Circuits and Systems*

## **Preface**

*Designing Audio Circuits and Systems* is a sequel to *Designing Audio Power Amplifiers* that covers a very broad range of audio design topics - all but power amplifiers. As such, this book provides broad, in-depth coverage of circuit and system design for audio. While there is some coverage of digital audio presented in the chapter on DACs, the primary goal of this book is to cover virtually all analog circuit design pertaining to audio.

*Designing Audio Circuits and Systems* is written to address many advanced topics and important design subtleties. At the same time, however, it has enough introductory and tutorial coverage to allow designers relatively new to the field to absorb the material of the book without being overwhelmed. It is targeted to professionals in the audio field as well as enthusiasts and students learning electronics. To this end, the book starts off at a relaxing pace that helps the reader develop an intuitive feel and understanding for analog audio design. Although it covers advanced subjects, highly involved mathematics is kept to a minimum – much of that is left to the academics. Design choices and decisions are explained and analyzed. Practical circuits for numerous different audio processing functions in many different ways are described in depth.

This is not just a cookbook; it is intended to teach the reader how to think about audio circuit design and the implementation of the most important functions used in pro audio and consumer audio systems. The book helps readers understand the many concepts and nuances, then analyze and synthesize the many possible variations of the design of audio circuits that underlie most audio functions, like preamplifiers, equalizers, digital-to-analog converters, compressors and mixing consoles, just to name a few. Multiple topologies and circuits for each of the covered audio functions are described.

The design of modern high-performance audio circuits touches on most aspects of electronic design, including solid state devices, feedback theory, low noise design, switching power supplies and laboratory measurement, to name a few. As such, skills acquired in audio circuit design can provide a sound educational basis for the study of a wide spectrum of other areas in electronics. Analog circuit design is covered broadly and in depth.

The early chapters in the book introduce audio circuit design and include the basics. This part is designed to be readable and friendly to those with less technical experience while still providing a very sound footing for the more detailed design discussions that follow. Even experienced designers may gain valuable insights here. Chapter 2 covers the design and construction of a complete audio preamplifier as an example to provide some circuit design context for the discussions that follow. A large chapter is devoted to transistor characteristics and circuit design, including many key

circuit building blocks. The early chapters of the book cover circuit building blocks, negative feedback principles, low-noise circuit design and filter design.

A group of 4 chapters covers low-noise preamplifiers for moving magnet phono cartridges, moving coil phono cartridges, tape head playback and microphones. Dynamic, condenser, electret and ribbon microphones are explained and preamplifiers for each are covered in depth. The design of mixing console preamplifiers is also covered.

Playing a very important role in modern audio systems, the design of DACs and use of DAC chips is discussed in detail, from the S/PDIF input to the low-distortion analog output. Coverage includes R2R DACs and  $\Sigma\Delta$  DACs, and the signal processing that makes them work, including oversampling, interpolation, decimation, aliasing and reconstruction.

Numerous approaches to distortion measurement are also explained. Some techniques for achieving the high sensitivity required to measure the low-distortion designs discussed in the book are described. Less well-known distortion measurements, such as TIM, PIM and IIM are also described. In the quest for meaningful correspondence between listening and measurement results, other sources of sound quality degradation are also explained. These include nonlinearity in passive components, EMI ingress, ground loops and power supply noise.

In summary, many of the following topics covered in *Designing Audio Circuits and Systems* should prove especially interesting to readers familiar with earlier texts:

- Ultra-low distortion circuit topologies
- Low-noise amplifier design
- High-performance feedback circuits
- Balanced interconnects, including line drivers and line receivers
- Switch-mode power supplies (SMPS)
- Integrated circuit functions
- Headphone amplifiers and crossfeed circuits
- Active filter and equalizer design
- Digital-to-Analog Converters (DACs)
- Self-powered loudspeakers and active crossovers

It is my hope that an experienced designer, a student or an enthusiast who seeks to learn more about high-performance circuit design will find this book most helpful. I also hope that this text will provide a sound basis for those wishing to learn analog circuit design techniques.