Part II
High-Performance Amplifiers

The second chapter of this book is on high-performance amplifiers. Amplifiers come in different flavors. Here, several types of instrumentation amplifiers, basic IC building-block amplifiers, and audio power amplifiers are discussed, all with their special requirements and challenges.

The first paper, of Johan Huijsing, gives an overview on instrumentation amplifiers, where precise gain, low offset and high CMRR are challenges that should be fulfilled simultaneously, what asks for a special approach: the instrumentation amplifier. It describes the requirements on the basis of the applications, and addresses the developments in the field: aspects like the three-opamp configuration, indirect current feedback, auto-zeroing, and chopping, are discussed. This paper systematically builds up the techniques available now, and thus provides a thorough overview.

The second paper, of Wilko Kindt, addresses a specific sub class of instrumentation amplifiers: the current-sense amplifiers, where a current is sensed via a shunt resistor. More specifically, he addresses the very specific problem of a voltage common-mode range larger than the supply range, and even potentially above the technology specification, that can be encountered in current-sensing applications. On the other hand, high input impedances are not required in these applications. These properties distinguish these types of amplifiers from the instrumentation amplifiers that were discussed in the first paper. Several topologies, both in low-voltage and in high-voltage technology, are discussed.

The third paper, of Ramón González Carvajal et al., addresses high power efficiency of basic amplifier structures on IC at very low supply voltages, for applications which must be implemented in emerging technologies. Class AB systems are addressed because of their power efficiency, while still being fast, because not limited by SR. A special focus is on new design techniques that aim for current efficiency, ensuring both static and dynamic power consumption to be low. Super-class-AB amplifiers, with dynamic biasing, and Quasi-Floating-Gate amplifiers, with efficient implementations for the DC level shift, are introduced and analyzed.

The next two papers address the high-accuracy amplifier problem from the application area of very high sensitivity bio and nano-biosensors. Timothy Denison and Reid Harrison describe the challenges for the amplifiers in the readout circuits, for two application areas: detecting spike signals from individual neurons for a
neuroprosthesis, and detecting the field potential of large ensembles of neuron cells to measure bio-markers like a seizure. The challenges are a.o.: very weak signals, high spatial resolution in case of single-cell recording, signals drowned in 1/f and white noise in the same spectral domain, and severe power constraints, not just for power supply reasons, but also to prevent damage in the brain.

The fifth paper, of Marco Sampietro et al., describes an extremely sensitive current-sensing amplifier for the characterization of nano-biodevices. The currents to be sensed are in the order of picoamps at a bandwidth of 100kHz, the required resistances to sense these currents and to realize DC decoupling are in the order of several tens up to even several hundreds of gigaohms, and the capacitances are in the order of attofarads. This together makes the realization of such an amplifier a real and very specific challenge.

The last paper, of Marco Berkhout, addresses a complete other field for high-performance amplifiers: hifi audio, with class-D amplifiers. Distortion is a key issue here, but not the only one. In fact, the paper focuses on the aspects of the robustness and the prevention of audible artifacts, which consume most effort in the design of these amplifiers. Especially the artifacts arising from the switching, and the solutions found for this, will be highlighted here.