

# Preface

The rapid evolution and widespread use of consumer electronic devices such as cell phones, tablets, or smart TV puts a great innovative pressure on the integrated circuit industry. Most of the functionalities of such devices are implemented using digital circuitry but analog tasks such as converting, receiving, and emitting signals, regulating power or communicating to device sensors still play a major role in modern ICs, leading to mixed-signal systems. However, the design automation of analog circuits is far behind that of the digital circuits, either in techniques or in tools, failing to help designers to compete with the demanding time-to-market, lowering the costs and cutting development time. In this context, AIDA Framework fully developed at the Integrated Circuits Group from Instituto de Telecomunicações, Lisbon, Portugal, appears as an Electronic Design Automation tool to aid designers to do their job better and faster. This work focuses on AIDA-CMK, by enhancing AIDA-C, which is the circuit optimizer component of AIDA, with a new multi-objective multi-constraint optimization module that constructs a base for multiple algorithm implementations. In the proposed solution, three approaches to multi-objective multi-constraint optimization, namely, an evolutionary approach with NSGA-II, a swarm intelligence approach with MOPSO, and stochastic hill climbing approach with MOSA are implemented. Moreover, the implemented structure allows the easy hybridization between kernels transforming the previous simple NSGA-II optimization module into a more evolved and versatile module supporting multiple single and multi-kernel algorithms. The three multi-objective optimization approaches were validated with CEC2009 benchmarks to constrained multi-objective optimization and tested with real analog IC design problems. The achieved results were compared in terms of performance, using statistical results obtained from multiple independent runs showing that NSGA-II outperforms the other two single kernel reference approaches by having a better convergence time, a widespread set of solutions, and, in general, achieving better Pareto fronts. Finally, some hybrid approaches were also experimented, giving a foretaste to a wide range of opportunities to explore in future work.

The book is organized in seven chapters.

Chapter 1 presents a brief introduction to the area of analog IC design automation, with special emphasis to the automatic circuit sizing. First, the analog design problem is characterized, then, a well-accepted design flow for analog IC is presented, and finally, AIDA-CMK features are outlined.

Chapter 2 presents an overview of the state of the art in analog circuit optimization, focusing on the optimization approaches that are used. This study is then used to select the optimization methods to be considered in the framework to be developed.

Chapter 3 presents AIDA-CMK and the circuit optimization, describing the proposed architecture for the multi-objective circuit optimization framework. Also, the NSGA-II, MOSA, and MOPSO algorithms implemented are described.

Chapter 4 details the implementation, showing the application layers and their implementation. The structure of the classes implemented is described in detail showing their relations and the flexibility of the implemented framework.

Chapter 5 shows the results obtained from applying the implemented algorithms to the constrained problems from CEC 2009 competition. These analytical benchmarks are used to tune the algorithms' parameters and make a preliminary assessment of their performances.

Chapter 6 applies the developed algorithms to the optimization of real analog IC designs, showing that the behavior of the algorithms strongly differs from that that was obtained using the analytical benchmarks.

Chapter 7 addresses the conclusions and some directions for future developments are suggested.

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