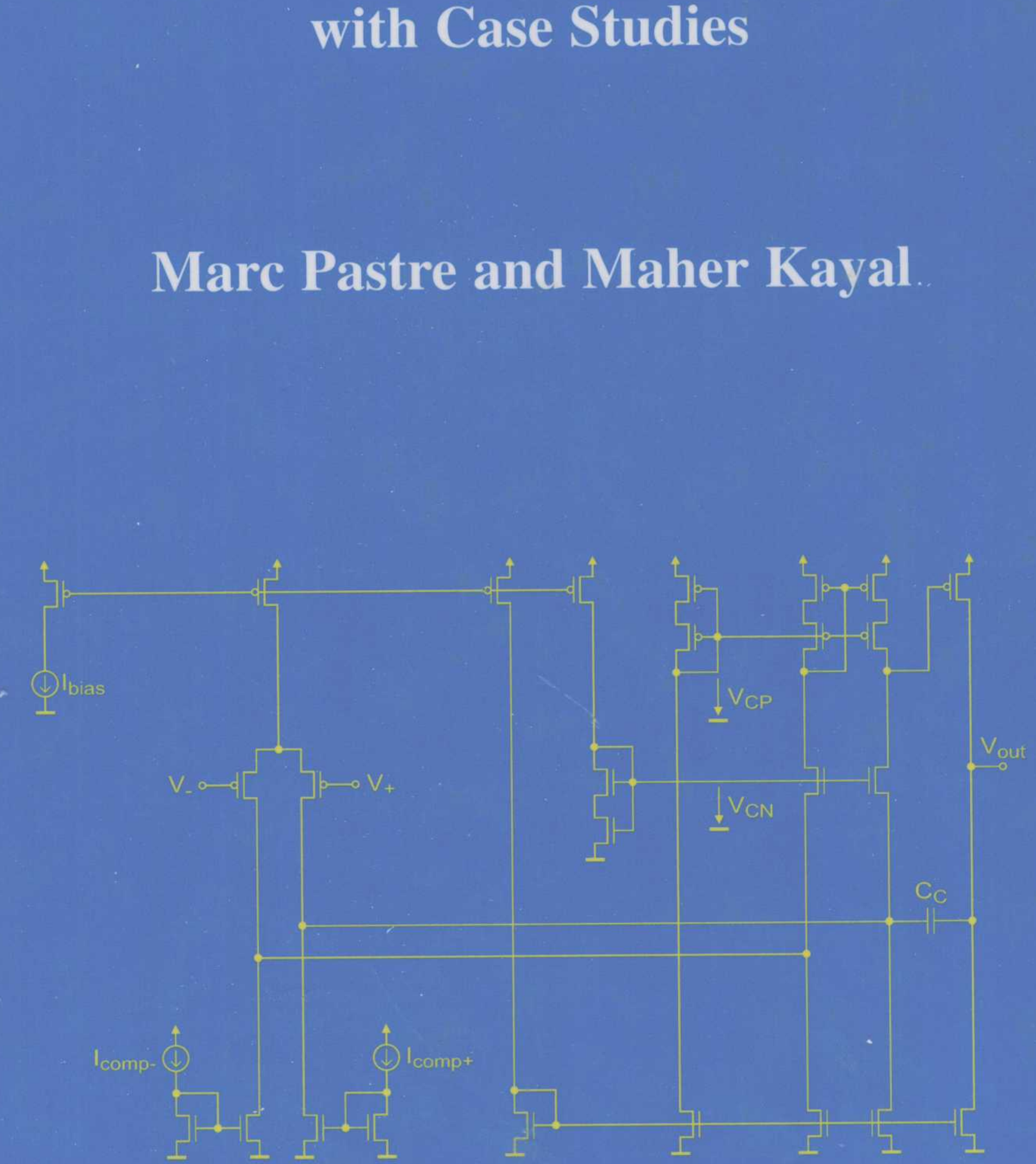
METHODOLOGY FOR THE DIGITAL CALIBRATION OF ANALOG CIRCUITS AND SYSTEMS

with Case Studies

Marc Pastre and Maher Kayal



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Contents

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List of Figures

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List of Tables

Chapter 1

Introduction

1 CONTEXT

Ever since the invention of the transistor in the late 50's, its fabrication technology has been evolving, allowing the device integration in a continuously shrinking area. High-performance integrated analog systems have always been difficult to design. Sometimes, calibration is used to gather the extra performance that the analog devices cannot provide intrinsically. But the evolution of the manufacturing technology renders even basic analog systems difficult to design today. With the size reduction, the intrinsic precision of the components degrades. In parallel, the supply voltage decreases, limiting the topologies which can be used. Many modern technologies are specifically suited for pure digital circuits, and some analog devices, like capacitors, are not available. In these conditions, analog design is a challenge even for experienced designers.

To relieve the extreme design constraints in analog circuits, digital calibration becomes a must. It allows a low-precision component to be used in high-performance systems. If the calibration is repeated, it can even cancel the effect of temperature drift and ageing.

The digital calibration is compatible with the evolution of fabrication technologies, which ever more facilitates the integration of digital solutions at the cost of a dramatic reduction of analog performances. Thanks to the reduction of the size of digital devices, even complex digital calibration solutions can be integrated and become a viable alternative to intrinsically precise analog designs.

Digital calibration allows to realize high-performance analog systems with modern technologies. This enables pure analog designs to be implemented even in fully digital processes. In existing mixed-signal designs, the full system realization also becomes possible with technologies providing higher integration density. Finally, because circuit performances rely on digital calibration, retargeting is simplified. The digital blocks can be synthesized automatically, whereas only a limited design effort is invested in the analog circuit.

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