

Book Review

Power Distribution Networks in High Speed Integrated Circuits; Andrey Mezhiba, Eby Friedman. Kluwer Academic Publishers, Boston, 2004. Hardcover, 280pp, plus XXIII, 129 euro. ISBN 1-4020-7534-0

As VLSI ICs grow more and more powerful, designers are now building larger and ever more sophisticated systems to solve complex problems. As a result, electronic system designers are now using multiple processors in a single system, either in the form of system-on-a-chip (SoC) or in a multiprocessor board, in order to address the computational requirements of a wide variety of applications. Present-day microelectronic system designs are faced with the daunting task of reducing power dissipation since power dissipation is quickly becoming a bottleneck for future technologies. Lowering power consumption and related thermal issues are important for not only lengthening battery life in portable systems, but also to affect performance, packaging, heat removal costs, and improving ICs' reliability. In addition, as the electronics industry moves towards deep-sub-micrometer range and gigahertz frequencies of operation, the interconnects are emerging as one of the more pronounced bottleneck to the growth of IC technology. In order to address the challenging interconnection issues, engineers will need to adopt novel methods for fabrication, design, architecture, power distribution, testing, modeling, and simulation. Voltage drop in the power distribution networks of VLSI IC design is a function of the instantaneous current being drawn from the supply as well as the distribution network resistance. Significant IR drops lead to delay variation and reduced noise margins. With rising power consumption yet dropping V_{dd} values, the supply current in future VLSI ICs will increase quickly. Larger wires are needed in order to limit IR drops, which negatively impacts global routing.

This book addresses the problem of distributing power in high-speed, high-complex VLSI ICs. It is divided into two parts organized into fourteen chapters, List of Figures, List of Tables, a Bibliography with 195 entries, an Index, and short information About the Authors. Part I composed of Chapters 1–5 gives an overview of power distribution networks in ICs, and provides relevant background information related to inductive properties of on-chip power distribution net-

works. Part II composed of Chapters 6–13 deals with electrical properties of on-chip power distribution networks. We now turn to a chapter-by-chapter description and critique of the chapters.

Chapter 1 (*Introduction*, pp. 1–190) provides a brief perspective on the development of ICs, and points to the problem of power distribution. Chapter 2 (*Inductive properties of electric circuits*, pp. 21–51) describes various ways to represent inductive characteristics of complex interconnect systems. Chapter 3 (*Properties of on-chip inductive current loops*, pp. 53–63) covers details related to variation of the partial and loop inductance with line length. Chapter 4 (*Electromigration*, pp. 65–79) discusses the problem of *electromigration* and related circuit reliability implications of ICs. In Chapter 5 (*High performance power distribution systems*, pp. 81–117) an overview of power distribution systems for ICs is presented, and impedance characteristics of power distribution systems with multiple stages of decoupling capacitances are described.

Chapter 6 (*On-chip power distribution networks*, pp. 119–145) is concerned with the structure of the on-chip power and ground distribution networks, and related design considerations. Chapter 7 (*Computer-aided design and analysis*, pp. 147–169) is concerned with the process of designing and analyzing on-chip power distribution networks. Chapter 8 (*Inductive properties of on-chip power distribution grids*, pp. 171–186) considers the inductive properties of single layer regularly structured power distribution grid. Chapter 9 (*Variation of grid inductance with frequency*, pp. 187–195) considers the variation of inductance with frequency in high-performance power distribution grids. In Chapter 10 (*Inductance area resistance tradeoffs*, pp. 197–204) different scenarios among inductance, area, and resistance of power distribution grids are considered. Chapter 11 (*Scaling trends of on-chip power distribution noise*, pp. 205–223) presents a scaling analysis of power distribution noise in flip-chip packaged ICs. Chapter 12 (*Impedance characteristics of multi-layer grids*, pp. 225–241) considers the electrical characteristics of multi-layer power distribution grids and the relevant design implications. Chapter 13 (*Inductive effects in on-chip power distribution networks*, pp. 243–253) focuses on the effect of inductance of on-chip interconnect on high frequency impedance characteristics of a power distribution system.

Finally, Chapter 14 (*Conclusions*, pp. 255–257) summarizes in an effective way the design process of power distribution networks, particularly for high complex and high performance ICs.

This authoritative and interesting book concentrates on explanation of behavior and design of power distribution systems for high-speed and high-complex ICs. Numerous techniques and algorithms of on-chip power distribution networks are presented. It is a nice introductory text on basic principles that govern the design and operation of on-chip power distribution networks.

This book is timely, and very well written. Its style is clear and readable. It should make an important reference book for graduate students in electrical engineering, professionals, and researchers active in the field of VLSI ICs design.

Having in mind all things together, this book represents an excellent work and should be read by many of us. It is simply what it states itself to be, both an instructive and informative well-written book.

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