Power distribution networks are typically allocated across a number of metal layers to enhance the performance characteristics of the network. These networks are reviewed in Part VII, with an emphasis on providing design intuition. The effects of multi-layer power distribution networks and tradeoffs among different properties of these networks are described in this part.

The impedance characteristics of on-chip multi-layer power distribution grids are described in Chap. 35. A circuit model of a multi-layer power distribution grid is reviewed. Analytic expressions describing the variation in the resistance and inductance of multi-layer grids with frequency are described. An intuitive explanation of the electrical behavior of power grids is offered. The results are supported with a case study.

Due to the large number of interconnect in interdigitated power and ground networks, excessive time is required to determine the inductance from electromagnetic simulation tools. In Chap. 36, a closed-form expression is described to accurately estimate the effective inductance of a single layer within an interdigitated power and ground distribution network. This expression is compared with previous models and FastHenry, exhibiting accurate and computationally efficient results. The inductance of a single layer within an interdigitated power and ground distribution network is bounded for any number of lines. The error of this expression decreases rapidly with increasing number of pairs within the network. The upper bound for the error of the closed-form model is also provided.

Two methods for optimizing a multi-layer interdigitated power and ground network are presented in Chap. 37. Based on the resistive and inductive (both self- and mutual) impedance, a closed-form expression for determining the optimal power and ground wire width that produces the minimum impedance for a single metal layer is described. Electromigration is also considered, permitting the appropriate number of metal layers to be determined. A tradeoff between the network impedance and current density is discussed. The optimal width as a function of metal layer is determined for different frequencies, suggesting important trends for interdigitated power and ground networks.
The global networks within conventional integrated circuits consists of three major types: power, ground, and clock distribution networks. These three networks consume most of the metal resources in the highest metal layers. The signals traversing the power and clock distribution networks are fundamentally different in terms of signal frequency and current flow. Combining the power and clock network into a multi-layer, globally integrated network is therefore possible. In Chap. 38, this general concept of a globally integrated power and clock (GIPAC) network is reviewed. The circuitry supporting this GIPAC system is also discussed.