

Integrated Magnetic Components for Distributed Power Conversion

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On-chip inductive elements comprised of planar metal spiral patterns are widely used in monolithic RF circuits. Although these inductors possess high Q values in the GHz range, they exhibit insufficient inductance for use in switched mode power supply applications, which operate at lower frequencies. Due to this limitation, integrated magnetic elements for practical power converters remain elusive. With the current trends in power electronics toward higher switching frequencies and distributed architectures, however, there have been increased efforts to develop planar inductive elements that could be readily incorporated with active switching circuitry for highly miniaturized power converters. Higher value “microinductors” that are useable at lower frequencies may be constructed using standard microelectronic fabrication techniques through the addition of magnetic films deposited above and below the spiral plane, or through replication of a toroid geometry using a combination of thick photolithography and electroplating techniques. Although microinductors displaying relatively high inductance values in the kHz range can be fabricated using such an approach, implementing integrated microinductors for efficient power conversion requires overcoming several significant design challenges. Integrated, in this sense, refers not necessarily to integration with active devices such as transistors to form a monolithic unit, but to fabrication directly on a substrate such as silicon, glass or polyimide along with other passive devices such as capacitors and resistors using standard thin film technologies. The focus of our work has been to design and fabricate a microinductor that balances the various design trade-offs yet displays adequate performance for a variety of power related applications. This includes using low temperature fabrication techniques and limiting the area used while still targeting reasonable inductance and Q values at 1 MHz, so that it could be used in a highly miniaturized switched mode power supply for stepping up and down a wide range of voltages.