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Analysis and Design of High Efficiency, High Conversion Ratio, DC-DC Power Converters

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In 2010, more than 2% of all electricity generated in the United States was used to power data centers. Estimates indicate that as many as 85% of data centers constructed prior to 2006 expend more than three times as much electric power on cooling and inefficient conversion than on powering the server hardware itself. One key contributor to the poor energy efficiency in these data centers is power distribution architectures characterized by many cascaded and inefficient power converters. Though the architectures in these data centers vary greatly, they each stand to benefit significantly from a well-designed, highly efficient power converter capable of stepping down the high DC voltages generated in AC rectification to the low DC voltages capable of being distributed across the server motherboard. The design of this converter has unique requirements for the power electronics designer, including constraints on form factor, efficiency, and control. This thesis considers the requirements imposed by the data center application to motivate the analysis and design of high efficiency, high step-down, high frequency DC-DC converters for data centers and other applications.