CURENT

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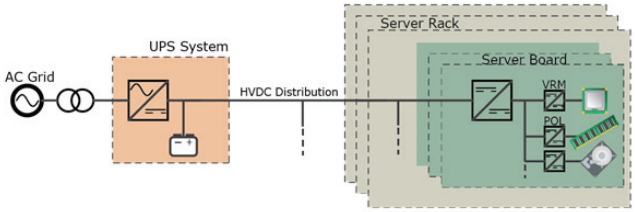
RESEARCH

Power Electronics for HVDC Distributions in Data Centers and Commercial Buildings

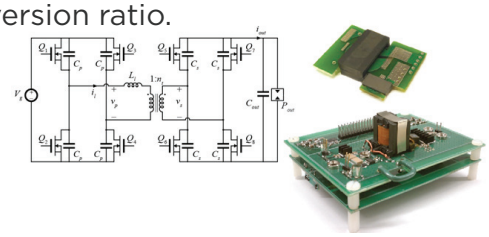
Overview



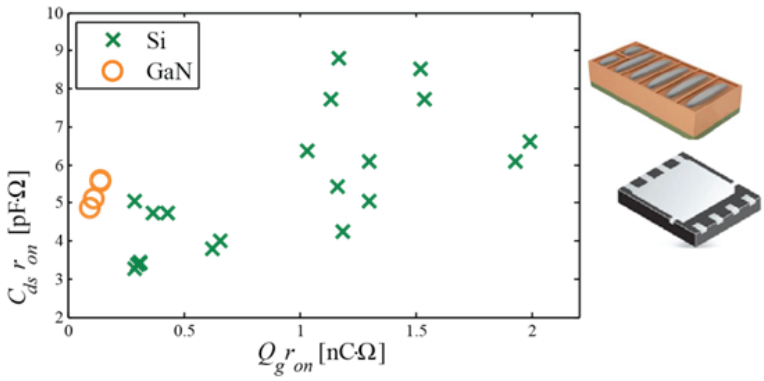
In 2010, more than 2% of all electricity generated in the United States was used to power data centers. Estimates indicate that as many as 85% of data centers constructed prior to 2006 expend more than three times as much electric power on cooling and inefficient conversion than on powering the server hardware itself. High voltage DC distribution architectures are being investigated as a potential for improved efficiency, reliability, and investment cost. The design of power electronics for HVDC distributions presents unique requirements, including constraints on form factor, efficiency, and control. Work at the center currently considers the design of high efficiency, high step-down, high frequency DC-DC converters for data centers and other applications.

Technology Pathway

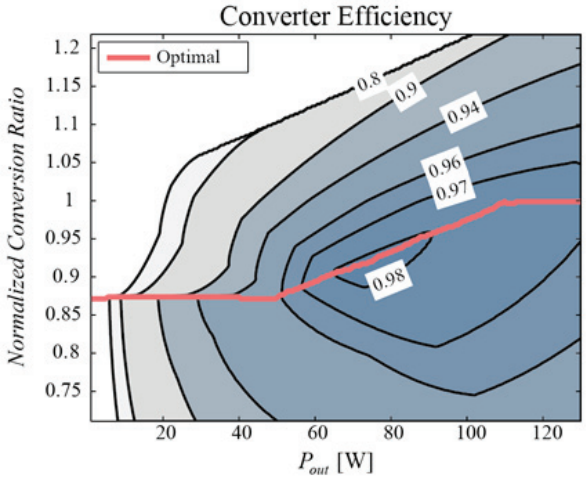
In order to reduce size while maintaining efficiency, high switching frequency zero-voltage switching power converters are considered, with transformer isolation to facilitate the large voltage step-down conversion ratio.



Wide bandgap devices are being assessed analytically and experimentally to determine the degree of benefit which can be obtained through the use of new semiconductor materials.



New control strategies are considered which facilitate optimal efficiency operation of individual converters or the entire system while maintaining simple and low-cost controller implementation. Detailed analysis of resonant ZVS behaviors is used to determine optimal operating conditions.



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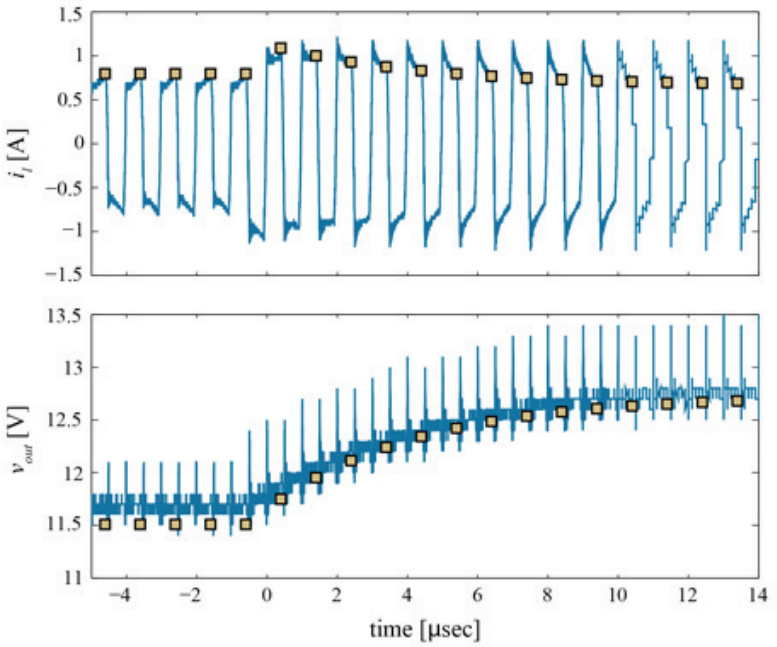
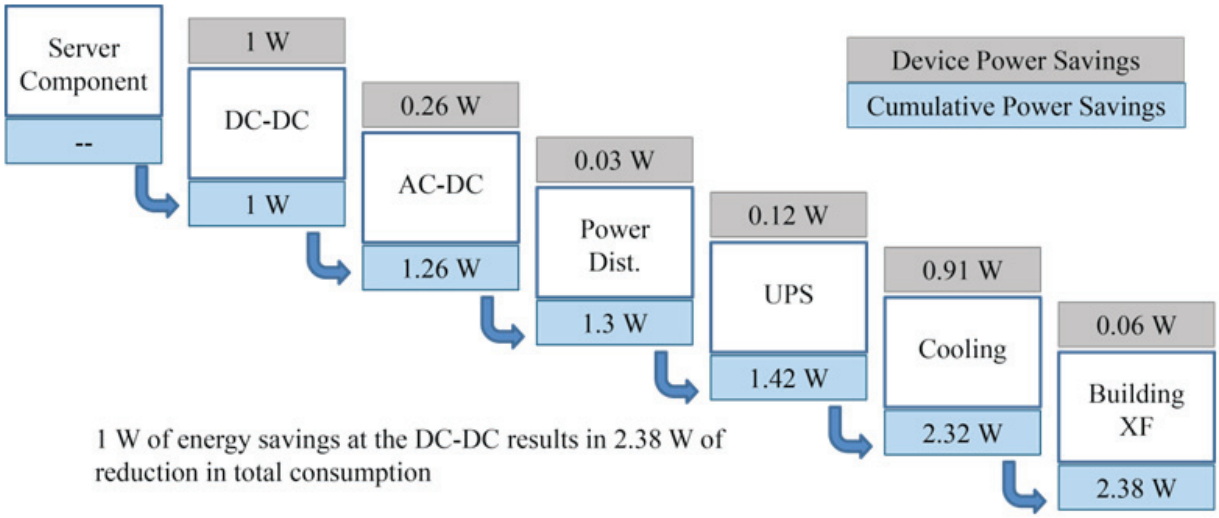
Highly accurate discrete time models of converter operation which explicitly include resonant interval dynamics are derived to allow the direct digital design of converter controller.



Impact

Due to the multitude of power conversion stages and cooling requirements in the data center application, any power losses which can be mitigated in the high voltage step-down converter will result in a cascading effect of reduced power losses in the system, reducing power processed by upstream conversion stages and facility-level ventilation and air conditioning units.



1 W of energy savings at the DC-DC results in 2.38 W of reduction in total consumption

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