ACTIVE TUNING OF RESONANT SWITCHED-CAPACITOR CONVERTERS FOR SOFT SWITCHING OPERA

Tech ID: 33638 / UC Case 2024-165-0

PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO2026/006309	01/02/2026	2024-165

BRIEF DESCRIPTION

Resonant switched-capacitor (ReSC) converters are increasingly favored in high-density power applications, such as data centers and telecommunications, due to their ability to achieve high efficiency with minimal passive component volume. However, component tolerances and variable operating conditions often cause these converters to deviate from ideal soft-switching points, leading to increased switching losses. Researchers at UC Berkeley have developed a closed-loop autotuning control technique that dynamically modulates switching frequency and duty cycle to maintain optimal soft-switching. The system senses voltage nodes, such as inductor switch nodes, during transitions to detect incomplete zero-current switching (ZCS) or zero-voltage switching (ZVS). By independently tuning the duration of each switching phase based on this real-time feedback, the controller ensures the converter maintains near-peak efficiency across a wide range of loads and component variations.

SUGGESTED USES

» Data Center Power Delivery: Optimizing 48V-to-12V intermediate bus converters for high-efficiency server power.

» Telecommunications: Enhancing reliability and power density in base station power modules.

» Electric Vehicles: Improving DC-DC conversion efficiency for auxiliary power systems and battery management.

» Portable Electronics: Extending battery life through high-efficiency, small-form-factor voltage regulators.

» Renewable Energy Systems: Managing power conversion in solar micro-inverters and battery storage interfaces.

ADVANTAGES

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INVENTORS

» Pilawa-Podgurski, Robert C.N.

OTHER INFORMATION

CATEGORIZED AS

» **Computer**

» Software

» **Energy**

» Storage/Battery

» Transmission

RELATED CASES

2024-165-0

Optimized Efficiency: Dynamically tracks ZCS and ZVS to eliminate voltage-current overlap losses and recover parasitic capacitance charge.

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Self-Correcting: Automatically compensates for passive component aging, manufacturing tolerances, and temperature-induced derating.

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Reduced Component Stress: Minimizes current spikes and voltage ringing, improving the long-term reliability of power MOSFETs and capacitors.

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Simplified Design: Eliminates the need for highly precise (and expensive) passive components by utilizing active control to manage timing.

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Versatile Soft-Switching: Capable of achieving ZCS, ZVS, or a unique "merged ZCS/ZVS" mode to balance conduction and switching losses.

RELATED MATERIALS

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Current-Programmed Modulation of Flying Capacitor Multilevel Converters
- Multi-Phase Hybrid Power Converter Architecture With Large Conversion Ratios
- Enabling Partial Soft-Switching Within Regulating Switched Capacitor Converter
- Thermal Test Vehicle For Electronics Cooling Solutions

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