

Current-Source Converter with Superconducting Magnetic Energy Storage (SMES) | USU Ref. C27003

Hang Dai, Bulent Sarlioglu

09/22/2026



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Energy, Environment & AerospaceAI Infrastructure

Abstract

This invention is a novel power delivery architecture that integrates superconducting magnetic energy storage (SMES) with advanced current-source converters. Designed to support the extreme, instantaneous power fluctuations inherent in AI data centers, this system bypasses conventional voltage-type energy limitations. By streamlining the energy conversion stages, it provides reliable, efficient, ultra-fast power adjustments to maintain grid stability and protect sensitive hardware.

What It Is

A novel power delivery architecture integrating superconducting magnetic energy storage (SMES) with current-source converters to manage extreme, instantaneous load transients in high-power systems.

Value Proposition

This innovation delivers ultra-fast, high-power stability to support AI data centers' severe power fluctuations. This invention lasts millions of cycles, improves safety, and offers instantaneous energy transfer.

Applicable Markets

This technology primarily targets large-scale AI data centers, GPU compute centers, and internet data centers, but it works for EV charging, large grid power development, and microgrid environments.

Benefit

AI data centers cause extreme, instantaneous power variations that destabilize conventional power grids. Traditional mitigation methods rely on voltage-type energy storage, such as batteries and capacitors, which suffer from limited cycle life and inadequate high-scale power output. In contrast, this invention utilizes superconducting magnetic energy storage (SMES), functioning as a near-zero-resistance electric flywheel that loses only about 0.1% of its energy per hour. The architecture innovatively interfaces the SMES system with advanced current-source converters (CSC) and current-source inverters (CSI) to optimize grid integration. By altering traditional AC-DC conversion structure, the system avoids relying on supplementary, less durable energy storage components and significantly streamlines the conversion process. Furthermore, unique bypass routing fundamentally improves overall switching performance and system efficiency. This targeted topology ensures improved safety and high-power capability for extreme load transients. Compared to conventional solutions, the structure delivers lower electrical ripples, higher power quality, and enhanced fault tolerance. Additionally, when properly maintained, the SMES system allows for millions of operating cycles with minimal degradation, providing a highly reliable and long-lasting power delivery solution for sensitive data center components.

Market Application

This technology targets the rapidly expanding artificial intelligence hardware sector. The technology is primarily designed for large-scale AI data centers, where massive computational clusters demand extreme, instantaneous power adjustments. Beyond AI infrastructure, the

technology is highly applicable to EV charging, large grid power development, and microgrid environments.

Researchers

Hang Dai

Utah State University

Bulent Sarlioglu

University of Wisconsin–Madison

USU Department(s): **Electrical and Computer Engineering, ASPIRE Engineering Research Center**

Developed in cooperation with:

University of Wisconsin–Madison, ECE Department

USU Reference No. C27003

Intellectual Property

Not yet filed.

Development Stage

Technology Readiness Level (TRL): 3–4