Storage Integrated AC-AC Converters

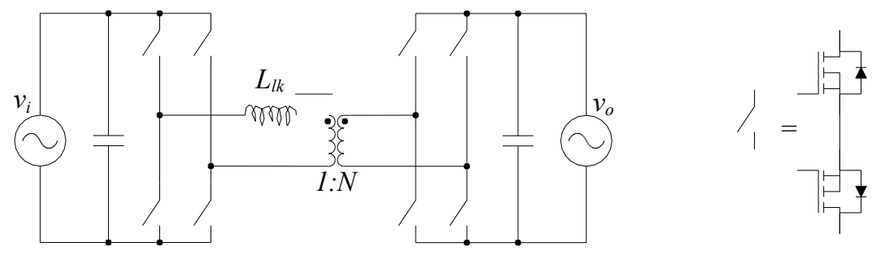
Jonathan W. Kimball
Department of Electrical and Computer Engineering
Missouri University of Science and Technology

Abstract

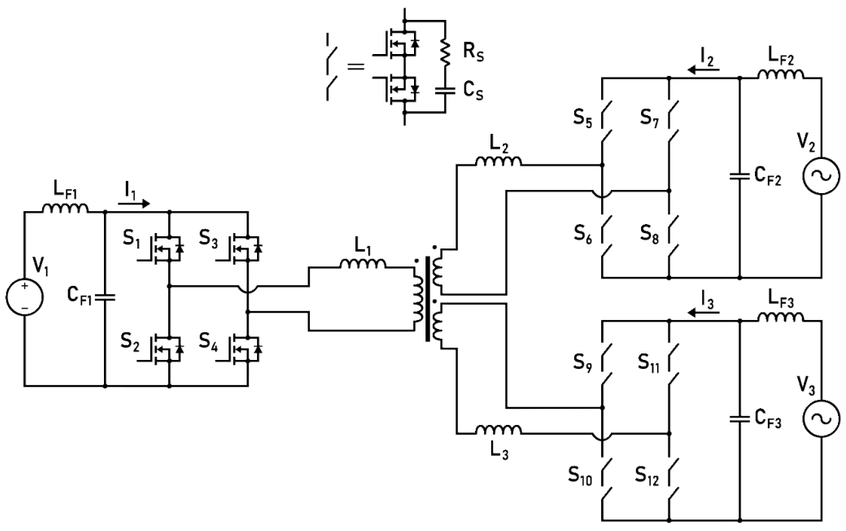
This project explores an innovative power converter that enables integration of energy storage with two single-phase ac grids *without* the need for a dc link. The basic building block of the converter is an active bridge, that is, an H-bridge of transistors, that connects to one winding of a high-frequency transformer. The topology is a "one-stop shop" to interface with any combination of ac and dc power systems.

The primary focus of the present work is a triple active bridge (TAB) in which energy storage is connected to the first port to support the power needs of the other two ports, which are connected to ac grids.

Basic AC-AC DAB Topology

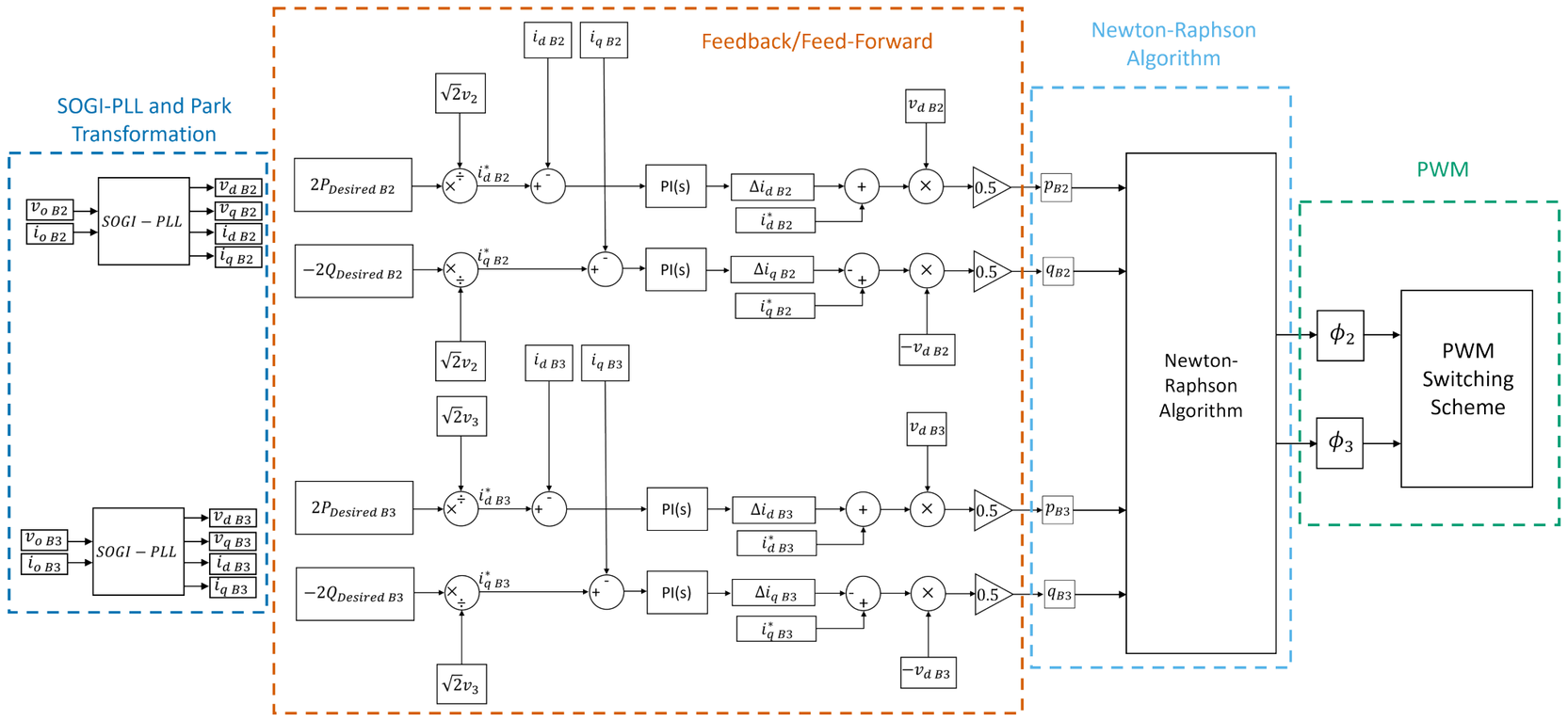


DC-AC-AC TAB Topology for Energy Storage Integration



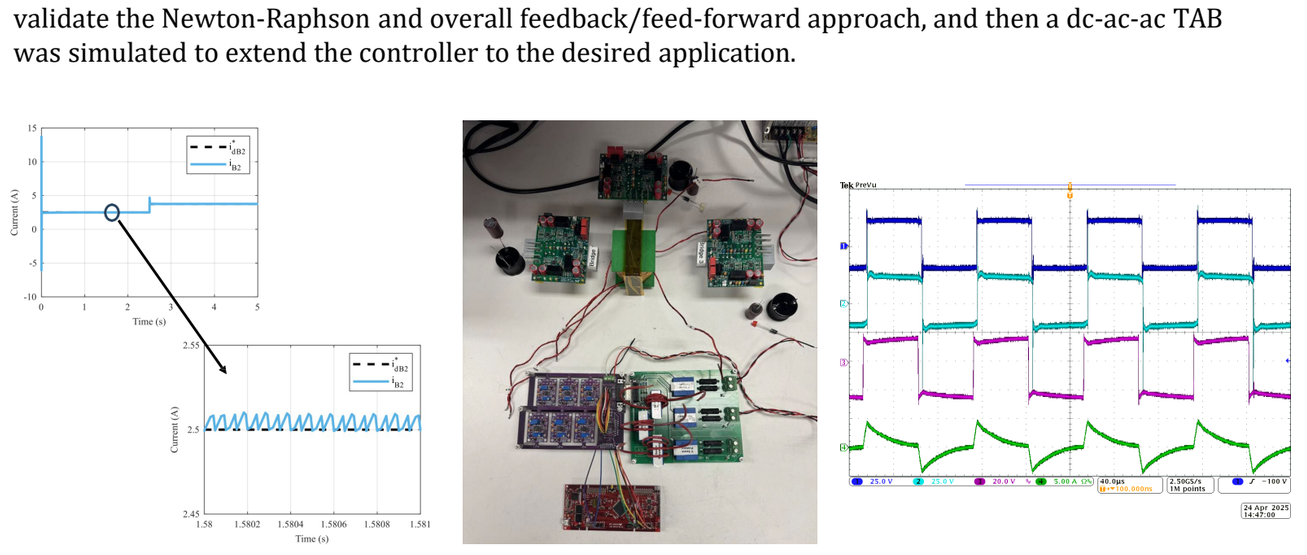
Advantages of DC-AC-AC TAB Over Conventional Solutions

- Direct ac-ac conversion of main power flow – **higher efficiency**
- No dc link capacitors – **higher reliability**
- High-frequency transformer – **high power density**
- **Integration of energy storage – can be used to support either ac port**
- Particularly useful on power distribution networks to provide voltage regulation, active & reactive power support, low voltage ride-through, and fault isolation



Simulation and Hardware Results

The complete controller comprises a SOGI-PLL for grid synchronization, a feedback loop to precisely track active and reactive power flow, and a feed-forward block that uses the Newton-Raphson algorithm to calculate phase shifts. A dc-dc-dc TAB was simulated and tested experimentally to validate the Newton-Raphson and overall feedback/feed-forward approach, and then a dc-ac-ac TAB was simulated to extend the controller to the desired application.



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Contact: kimballjw@mst.edu.

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