

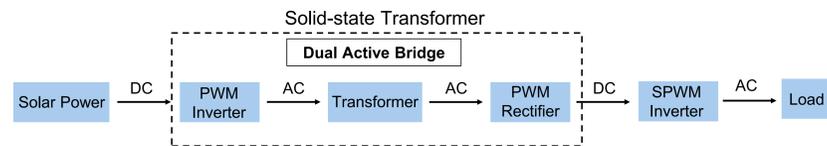
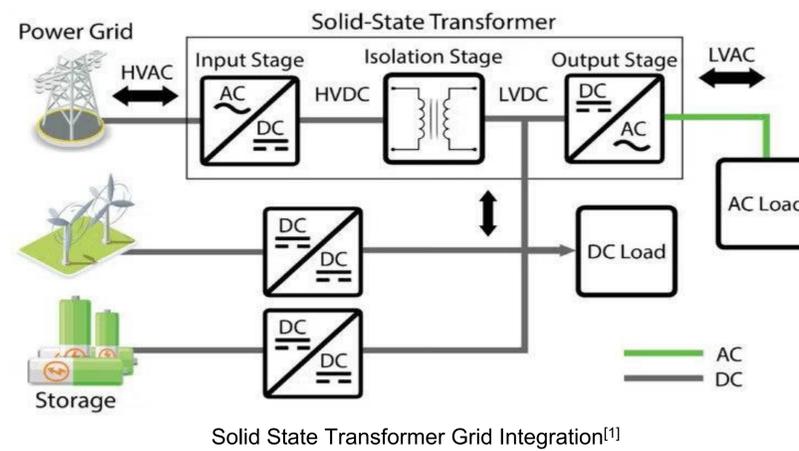
Abstract

Traditional power-distribution hardware is often bulky, rigid, and inefficient at supplying power in certain applications, such as large data centers and charging electric vehicles. We are utilizing a solid-state alternative to the conventional transformer that reduces the physical footprint while improving power transfer across a wide range of frequencies. By leveraging modern power electronics and renewable energy, our design aims to provide a more adaptable pathway for power distribution, enabling for more efficient and reliable power transfer across a variety of loads.

Introduction

Modern power infrastructure heavily relies on the conventional magnetic core transformer, but these devices impose heavy constraints in system flexibility. As power grids evolve to accommodate renewable energy sources and bidirectional power flow, traditional transformers struggle to meet the demands for compact size, rapid response, and intelligent control [4][5]. Applications ranging from electric vehicle (EV) fast charging to data center distribution, optimizing the power conversion is essential for both efficiency and reliability [5]. Solid-state transformer (SST) technology addresses these issues by replacing the bulky magnetic cores with high frequency power electronics, enabling considerable reductions in weight and size while also adding capabilities like voltage regulation and power quality correction [2][4]. SSTs have demonstrated their potential across multiple domains, from distribution grid modernization and fast EV charging stations to emerging green hydrogen production facilities [5], while the bidirectional power flow capabilities enable integration with energy storage systems [11]

System Diagram

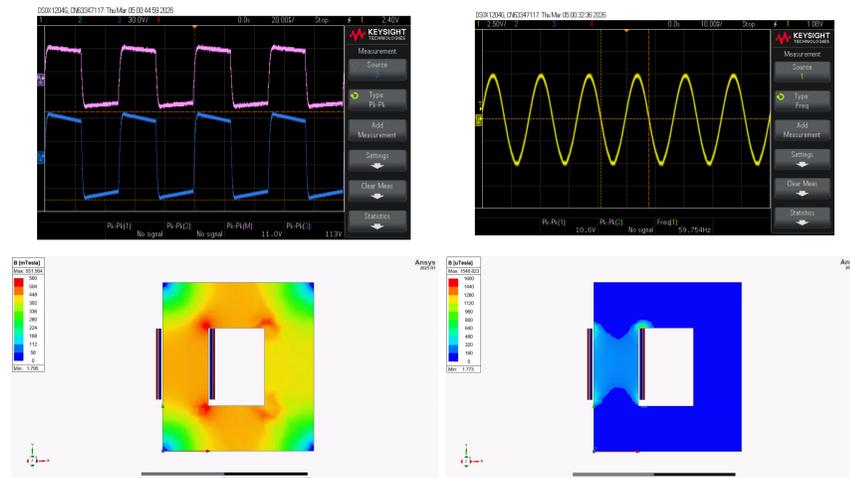


Discussion

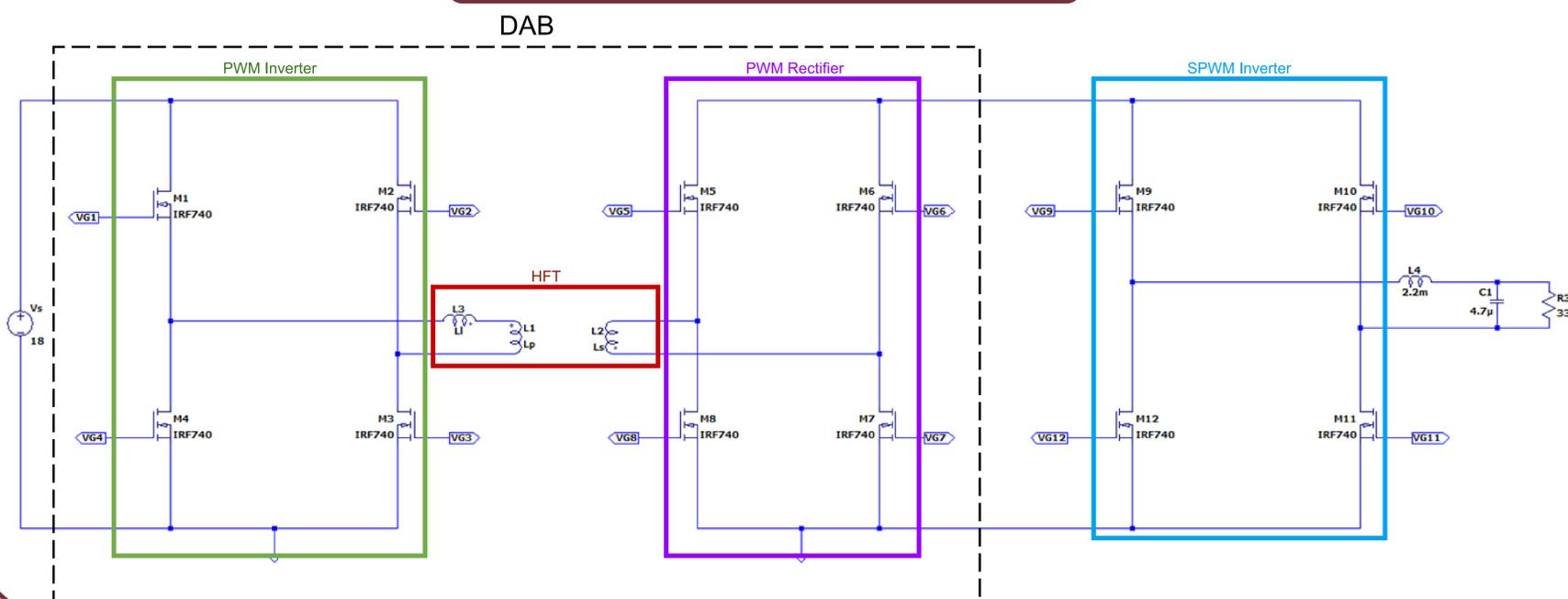
An SST is made up of cascaded H-bridges that perform different transformations within the SST. These transformations are broken up into four distinct stages: Pulse-Width Modulation (PWM) inverter, High Frequency Transformer (HFT), PWM Rectifier, and Sinusoidal Pulse-Width Modulation (SPWM) inverter. In the circuit diagram a voltage source feeds into a PWM inverter which converts the DC input into a square wave. This square wave feeds into a custom built HFT that steps up the wave by a factor of 10. The output of the HFT feeds into a PWM rectifier that converts the square wave signal back into a DC signal at a higher voltage. The stepped up DC output of the PWM rectifier then feeds into an SPWM inverter that converts the DC signal into a sinusoidal signal at 60Hz.

The HFT was modeled and validated in the ANSYS software through a series of tests. An open circuit test was done to see how the transformer behaves with its maximum flux density and a short circuit test to see if the magnetic motive forces properly cancel out.

Results



Circuit Schematic



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