Design and Test of a Unified Modular Pulsed Power Supply for All Magnets of the Negative Triangularity Spherical Tokamak (NTST)

Authors: Zhou Hongran, Zhu Diwei, Wei Guolin, Peng Jiachi, Wei Zeyu, Chen Rui, Wang Shouzhi, Wang Binbin, Tan Yi
Zhou Hongran, Zhu Diwei, Wei Guolin, Peng Jiachi, Wei Zeyu, Chen Rui and Wang Shouzhi are with the Shaanxi Startorus Fusion Technology Co., Ltd., Shannxi, China.
Wang Binbin and Tan Yi are with the Department of Engineering Physics, Tsinghua University, Beijing, China.

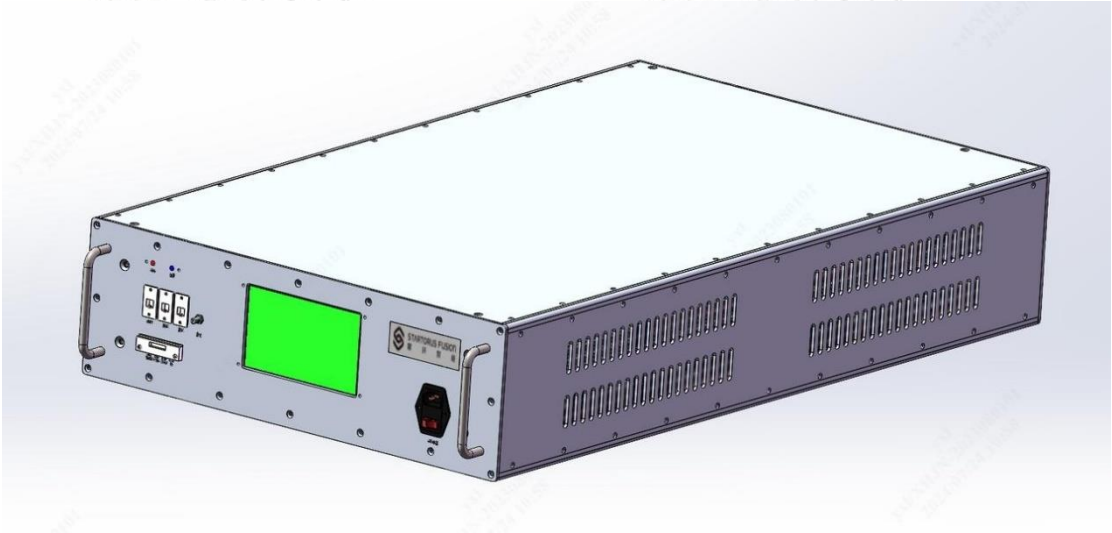
Abstract

The NTST (Negative Triangularity Spherical Tokamak) is the world's first original negative triangularity spherical tokamak device, featuring liquid nitrogen-cooled copper coils capable of generating a magnetic field strength of up to 1.4 T and a discharge duration of 1 s. To rapidly and cost-effectively validate the characteristics of NTST, a low-cost, unified modular pulsed power supply design has been adopted for the magnet driving system. Each module delivers an output power of 1 MW and supports flexible series-parallel configurations, simultaneously meeting the diverse voltage, current, and power requirements of the NTST toroidal field (TF), poloidal field (PF), and central solenoid (CS) magnets. This design significantly enhances the scalability and reliability of the power supply system, reduces experimental costs, and provides critical support for the efficient operation and characterization of NTST.

Introduction

The modular pulsed power supply utilizes supercapacitors as the energy storage unit, effectively reducing the impact on the power grid. Its core topology employs a 4-interleaved parallel H-bridge design, ensuring output current ripple below 1%. Each module provides an output voltage of 500V and an output current of up to 2000A.

Inter-module communication is achieved through wireless technology, combined with high-precision digital control, further enhancing system performance. Additionally, the design features a compact structure and high power density, making it suitable for demanding application scenarios.



Structural Diagram of the Modular Power Supply