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OPTIMAL DYNAMIC FRACTIONAL-ORDER CONTROL OF PHOTOVOLTAIC SYSTEM BASED ON NOVEL MULTI-STAGE MULTI-LEVEL CONVERTER IN POWER NETWORK CONNECTION STATUS

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Abstract

Photovoltaic (PV) systems play a vital role in the transition to clean energy, yet their integration into power networks through conventional power electronic converters often results in high ripple currents, switching losses, and reduced overall efficiency—factors that not only impair performance but also limit environmental gains. This study proposes a novel multi-stage power electronic converter combining a T-type inverter and a dual-output boost converter with a low switch count, aiming to enhance energy efficiency while reducing component usage and power losses. By minimizing leakage currents and total harmonic distortion, the system supports more stable and environmentally friendly energy delivery. To maximize solar energy harvesting, a dynamic fractional-order perturbation and observation (DFOP&O) algorithm is employed, with parameters tuned using the flower pollination optimization algorithm. The proposed converter's performance is validated through simulation and experimental implementation on a DSP28335 prototype. Results confirm superior efficiency and power quality, reinforcing the potential of advanced converter designs to contribute to sustainable and low-impact renewable energy integration in modern grids.

Key words: converter, efficiency, harmonic distortion, photovoltaic, power losses

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