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Novel Multilevel Inverter Circuit with Solar-Thermal Energy Conversion for Low-Power Applications

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INTRODUCTION & AIM

The global urgency to shift from fossil fuels toward renewable energy has never been greater, driven by environmental concerns and the finite nature of conventional energy resources. Solar energy, abundant and clean, represents one of the most promising solutions in this transition capable of supplying vast amounts of power without greenhouse-gas emissions. However, effective harvesting and conversion of solar energy into usable electrical power remains a technical challenge, especially for low-power applications. Traditional inverters convert DC from solar sources to AC, but simple two-level inverters often suffer from poor output waveform quality, higher harmonic distortion and lower power efficiency. In contrast, Multilevel Inverter (MLI) topologies by producing AC voltages via multiple stepped DC levels are able to approximate sinusoidal waveforms with significantly lower total harmonic distortion and reduced switching stress, improving both power quality and efficiency. Moreover, when the input DC is derived from novel sources such as a Thermoelectric Generator (TEG), which transforms heat to electricity without moving parts, there is potential for compact, maintenance-free, and reliable power generation especially suited for remote or low-power applications. By coupling a TEG with an appropriately designed MLI, one can envision a hybrid renewable-energy converter that leverages thermal harvesting and efficient AC conversion. In this work, we propose such a system: solar-thermal energy is captured and converted to DC via a TEG; this DC feeds a novel MLI topology designed for compactness and low-cost operation; the inverter then provides stable AC power to resistive or impedance loads. Through simulation, the performance of the TEG-inverter combination is evaluated demonstrating suitability for low-voltage AC applications with minimal harmonics.

RESULTS & DISCUSSION

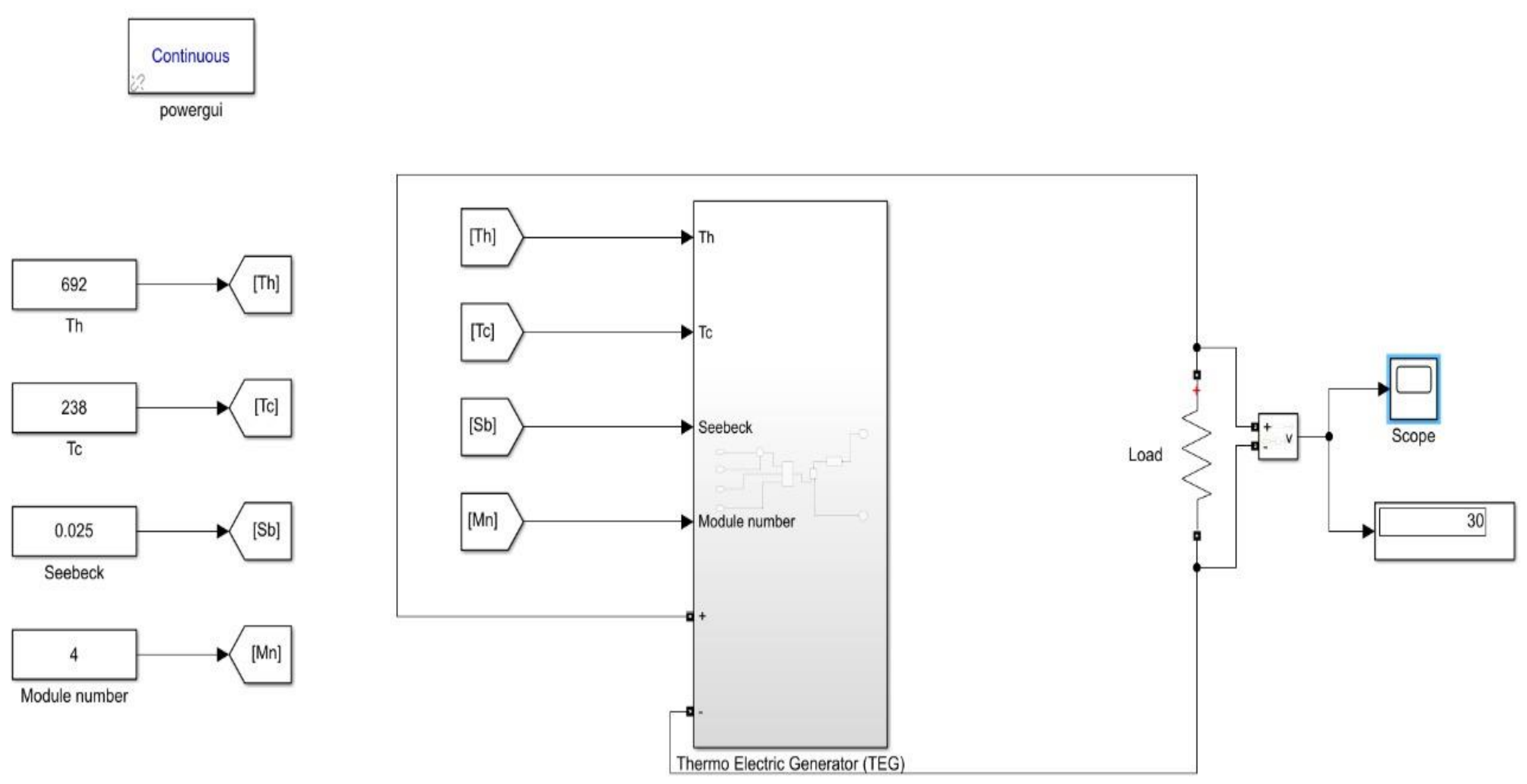

Fig 1: Thermo-Electric Generator (TEG) Power Generation Circuit

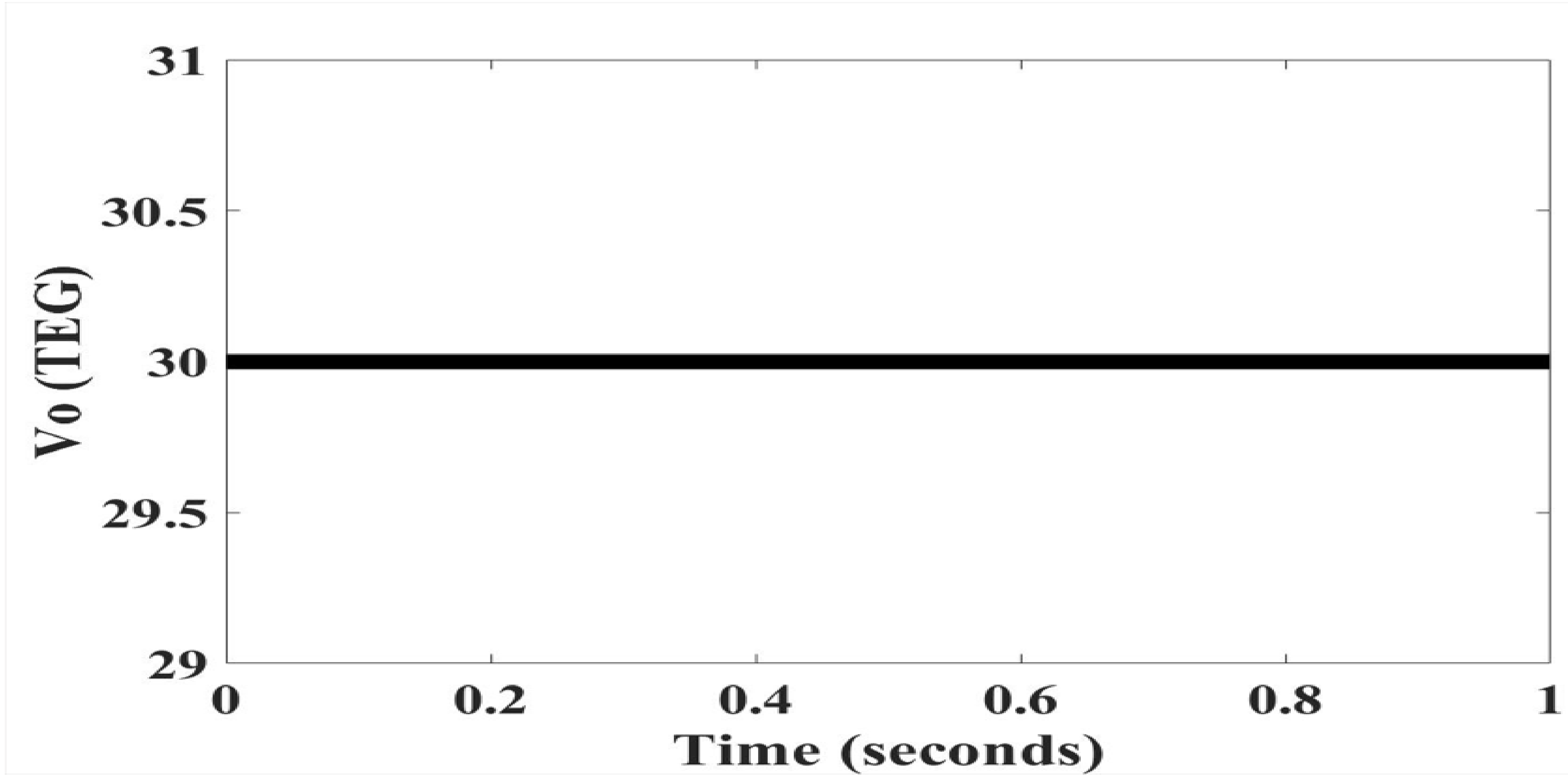

Fig 2: TEG output voltage (V_o vs. time)

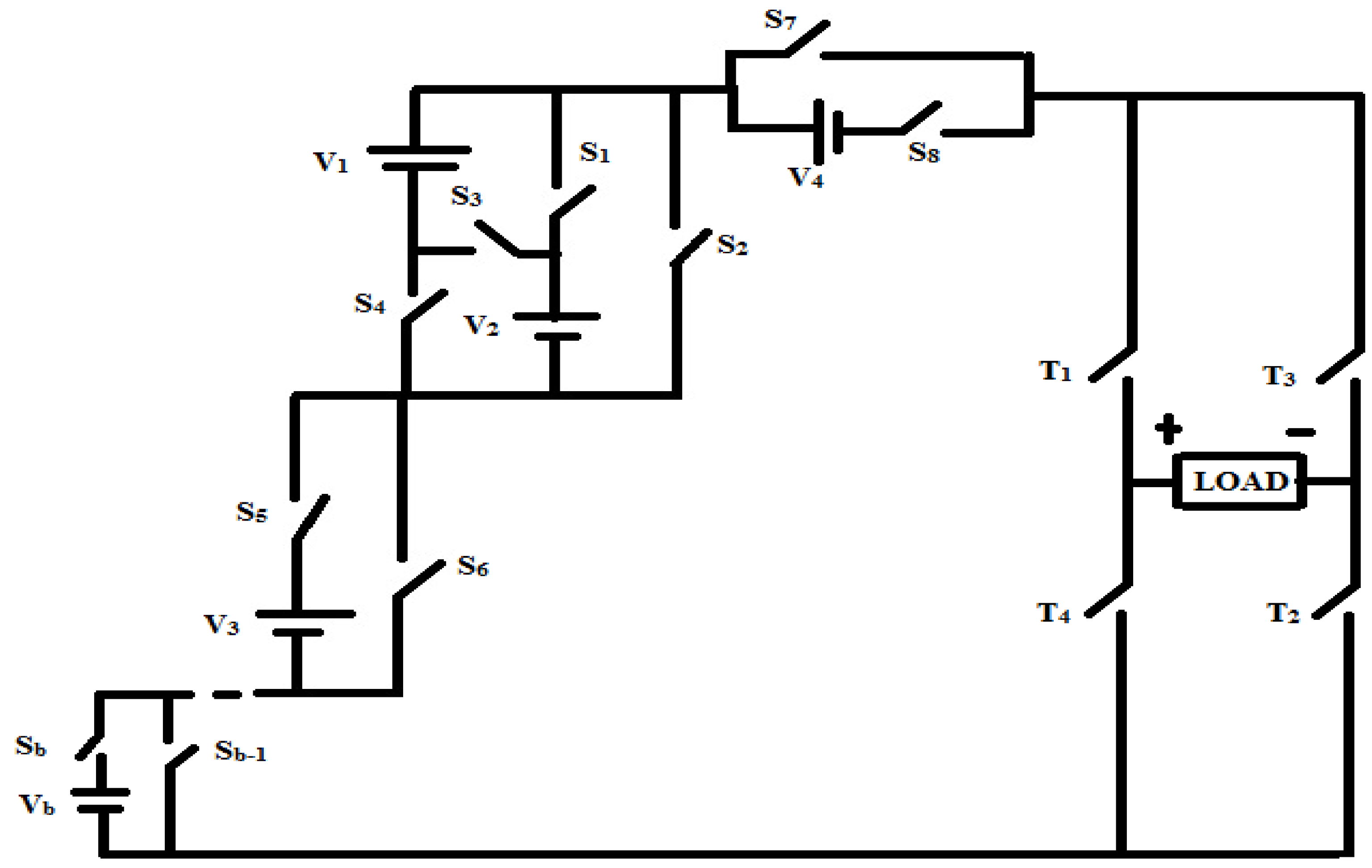

Fig 3: Multilevel DC–AC Inverter Topology

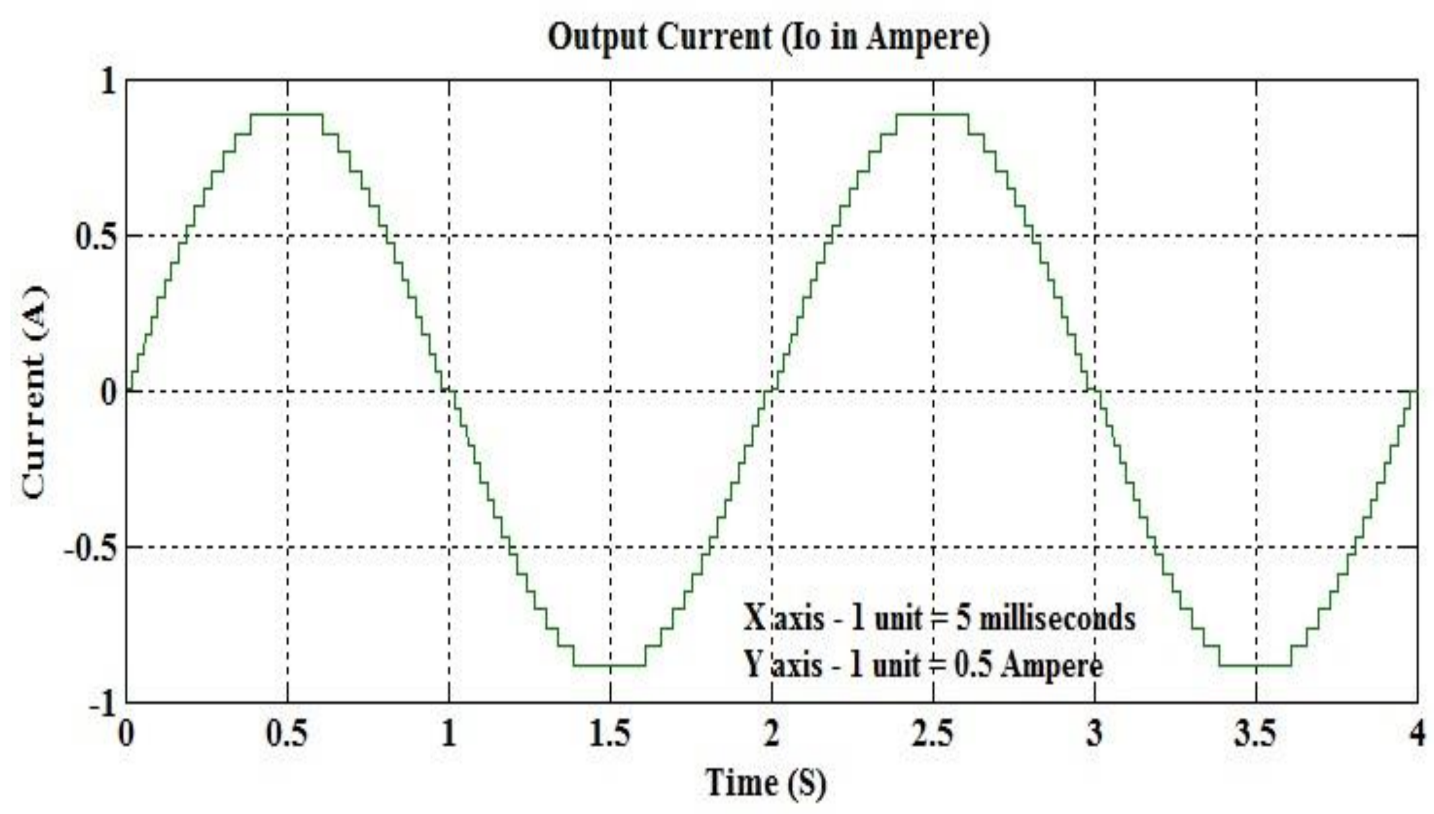

Fig 4: Inverter output voltage (V_o vs. time)

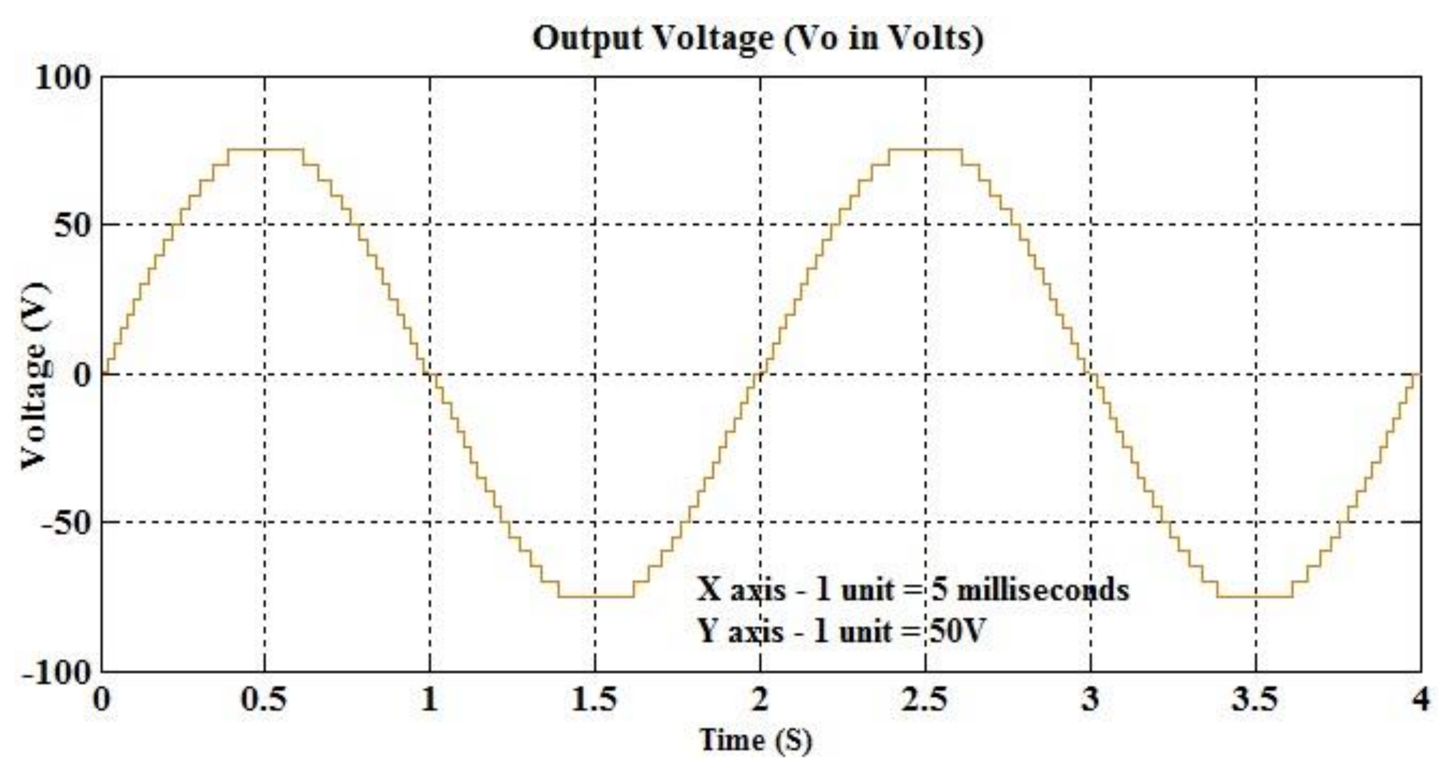

Fig 5: Inverter output current (I_o vs. time)

CONCLUSION

This study demonstrates that integrating a TEG with a multilevel inverter can successfully produce usable AC power from low-grade heat sources. The simulations confirm that the TEG delivers a stable DC voltage, and the cascaded-cell inverter converts this to a stepped AC output suitable for loads. The topology improves voltage regulation and reduces harmonic distortion compared to simpler inverter circuits. These results validate the potential of the TEG-inverter system as a practical solution for decentralized , off-grid energy supply especially in environments lacking grid access or solar-panel infrastructure