V240019: DESIGN OF ISOLATED STEP-UP DC-DC CONVERTER WITH INTERLEAVED COUPLED-INDUCTOR AND ACTIVE-CLAMPED FRAMEWORK

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Abstract

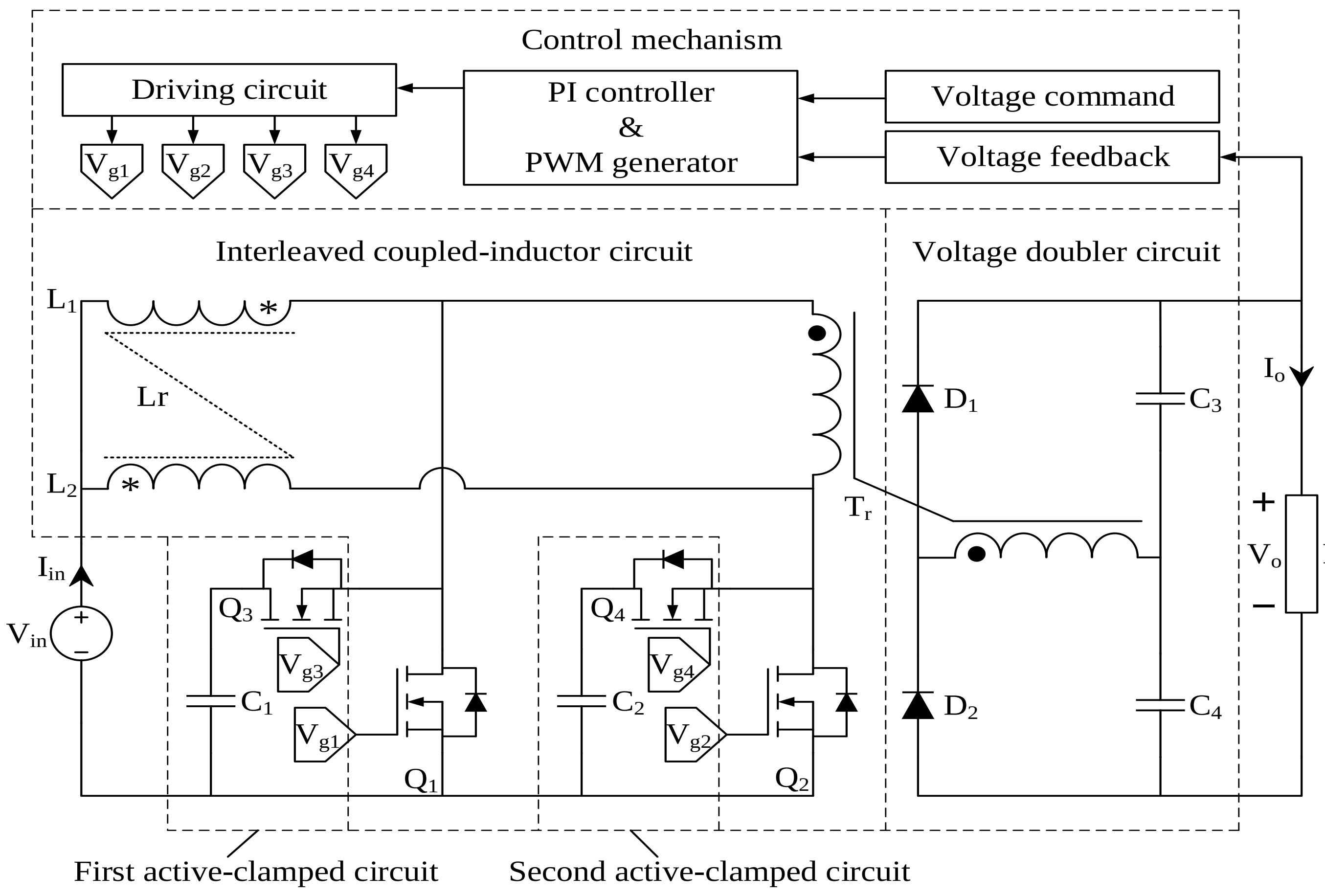
🗁This study proposed an isolated step-up DC-DC converter with an interleaved coupled-inductor scheme and active-clamped technique for renewable energy systems.

🗁 In the proposed converter, an interleaved-boost (IB) structure is adapted on the primary side instead of a current-fed push-pull (CFPP) framework for a higher voltage gain. Moreover, the design of active-clamped circuits reduces the voltage stresses on the active switches, and they recycle stray currents from the leakage inductance to achieve zero voltage switching (ZVS) turn-on capability for every active switch.

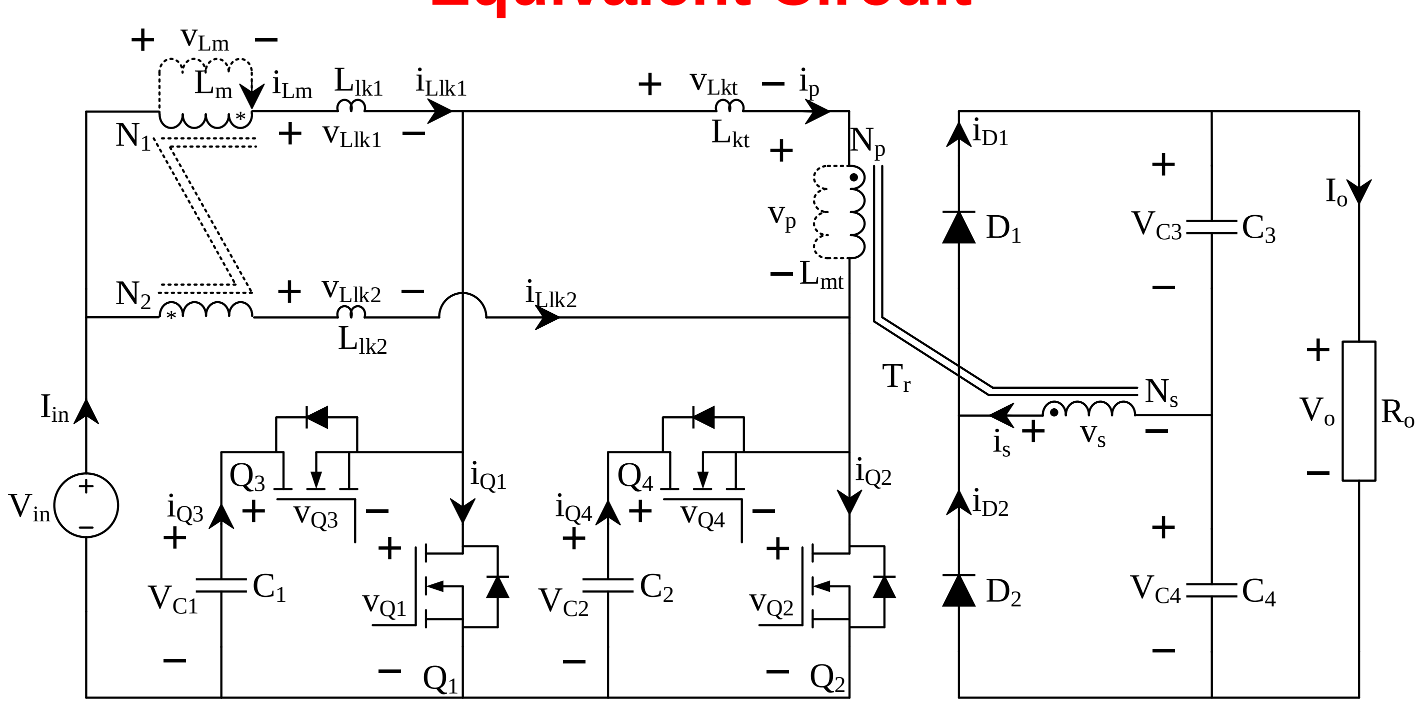
🗁 A novel partial-coupled winding method proposed in this study enables both input inductors to share a common magnetic core. Therefore, their individual current ripples can be reduced, and the utilization of the magnetic core can be improved.

🗁 A laboratory prototype with an input voltage of 25V, an output voltage of 400V, and a 2kW rated power is built to verify the effectiveness of the proposed converter. According to numerical simulations, the maximum power conversion efficiency reaches above 98%.

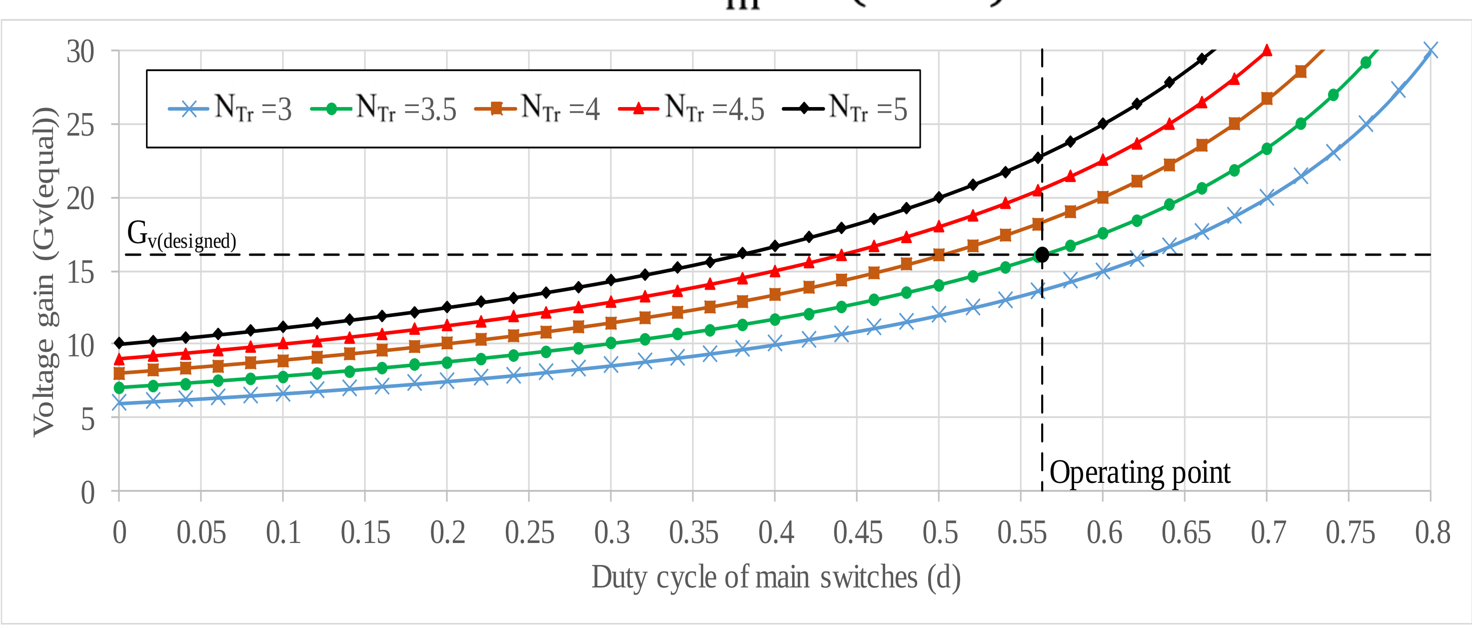
Isolated Step-Up DC-DC Converter



Equivalent Circuit

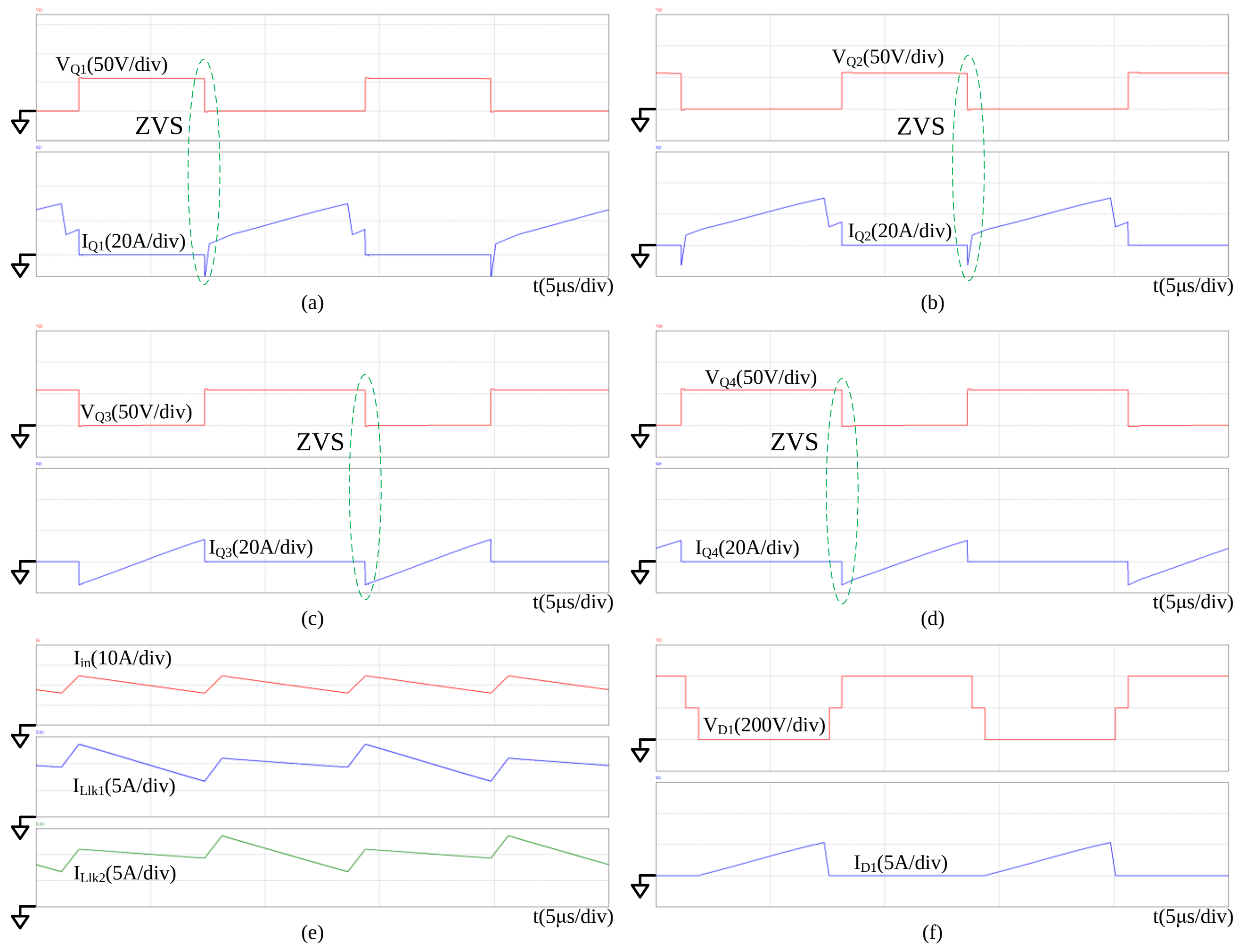


- **Voltage gain** $$G_{v(equal)} = \frac{V_o}{V_{in}} = \frac{2N_{Tr}k_{Tr}}{(1-d)}$$

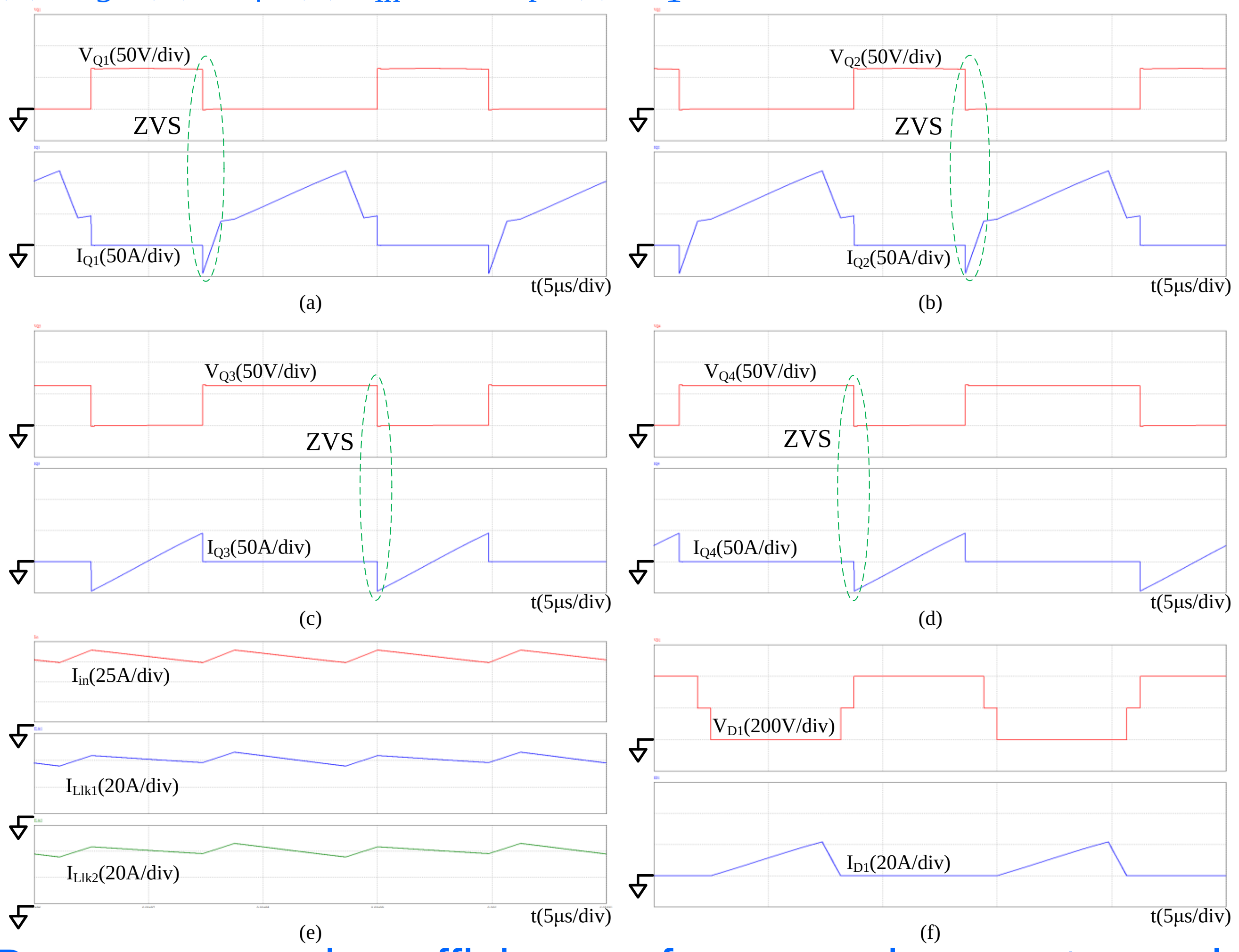


Numerical Simulations

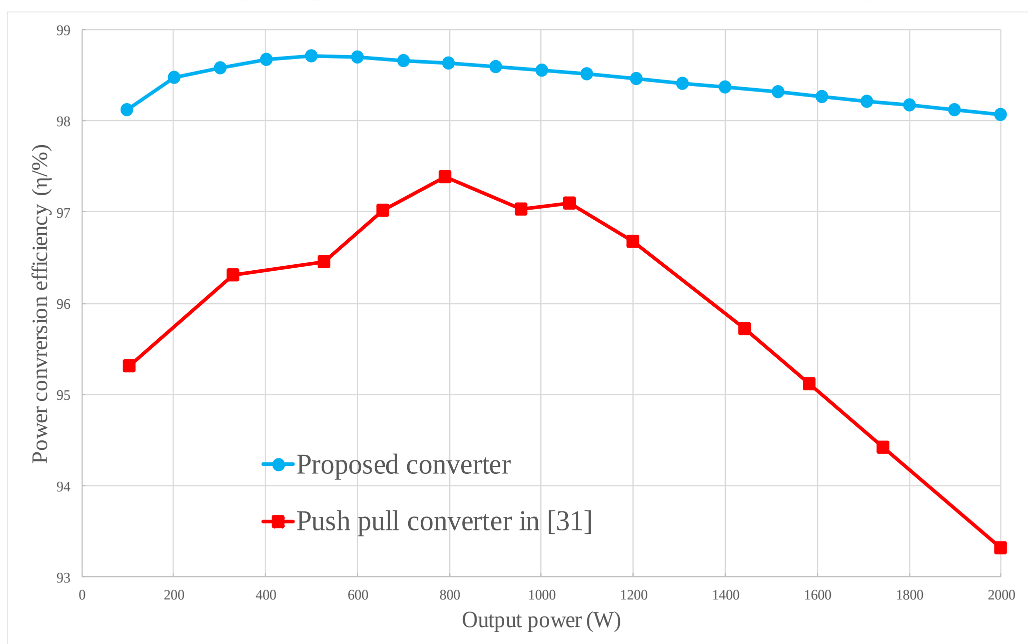
🗁Simulation waveforms of main switches, clamped switches, coupled inductor, and rectifying diode at P_o = 500W. (a) Q_1; (b) Q_2; (c) Q_3; (d) Q_4; (e) I_{in} and L_r; (f) D_1.



🗁Simulation waveforms of main switches, clamped switches, coupled inductor, and rectifying diode at P_o = 2kW. (a) Q_1; (b) Q_2; (c) Q_3; (d) Q_4; (e) I_{in} and L_r; (f) D_1.



🗁Power conversion efficiency of proposed converter and push-pull converter in [31] under different output powers.



Conclusions

☑ This study proposes an isolated step-up converter based on interleaved circuits, active clamping technology, and coupled inductors.

☑According to numerical simulation results, active clamping technology can enable all active switches to have zero-voltage conduction capabilities.

☑At the same time, using interleaved circuits has lower primary-side component voltage stress than push-pull circuits, which can reduce conduction losses and increase power conversion efficiency to be over 98%.