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Power Electronic Converters for High Voltage and Renewable Energy Applications

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Abstract

We have proposed several power electronic converters for renewable energy and high voltage DC power applications such as solar photovoltaic systems, electron accelerators for X-ray production, battery charging and high voltage pulse generation systems. The proposed converters are designed to operate in continuous conduction mode (CCM) operation and have desirable features such as low voltage stress on the switching devices, continuous input current, non-inverting output voltage, and wide input voltage range.

Research Focus

The voltage produced by most renewable energy sources is very low and cannot be used for high voltage applications to achieve a desirable high voltage and high current series-parallel combination of these sources is used that increases the size, and cost while decreasing the efficiency of the overall system. To overcome this issue of voltage-boosting high-voltage gain converters are used.

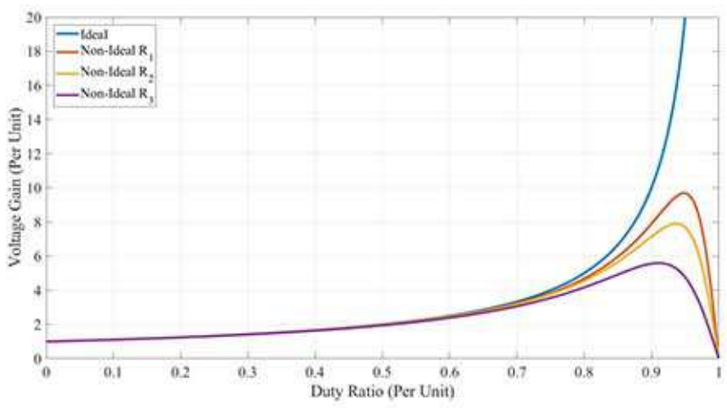


Figure 1: Comparison of ideal and non-ideal voltage gain for conventional boost converter

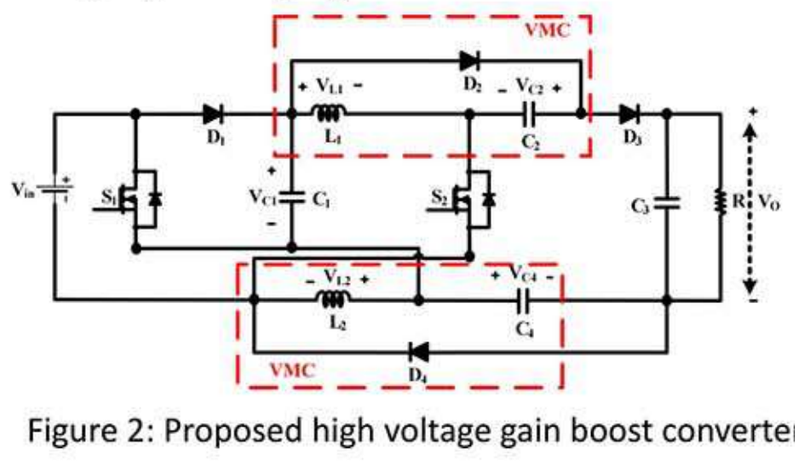


Figure 2: Proposed high voltage gain boost converter

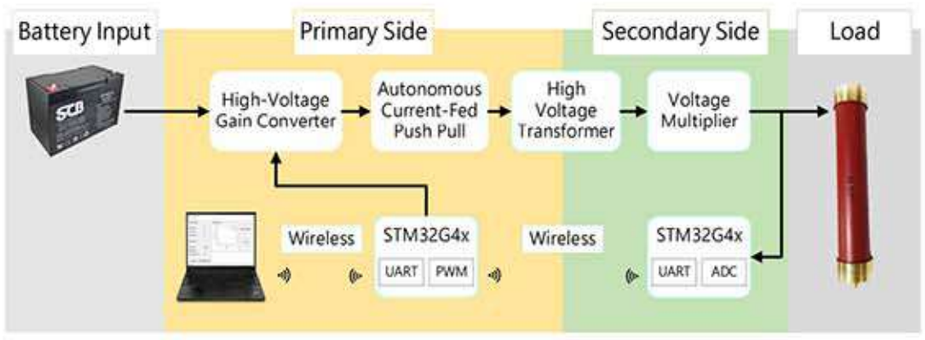


Figure 3: Proposed high voltage system for X-ray generation

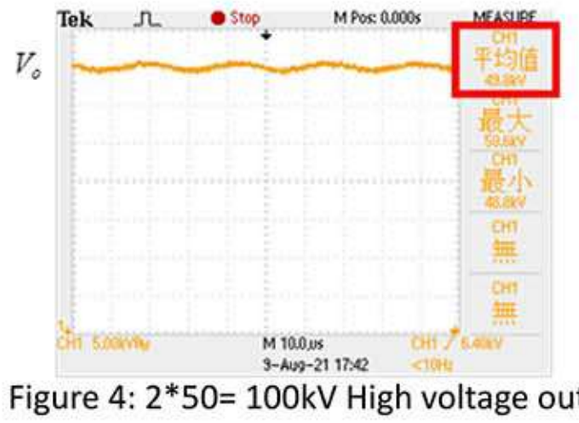
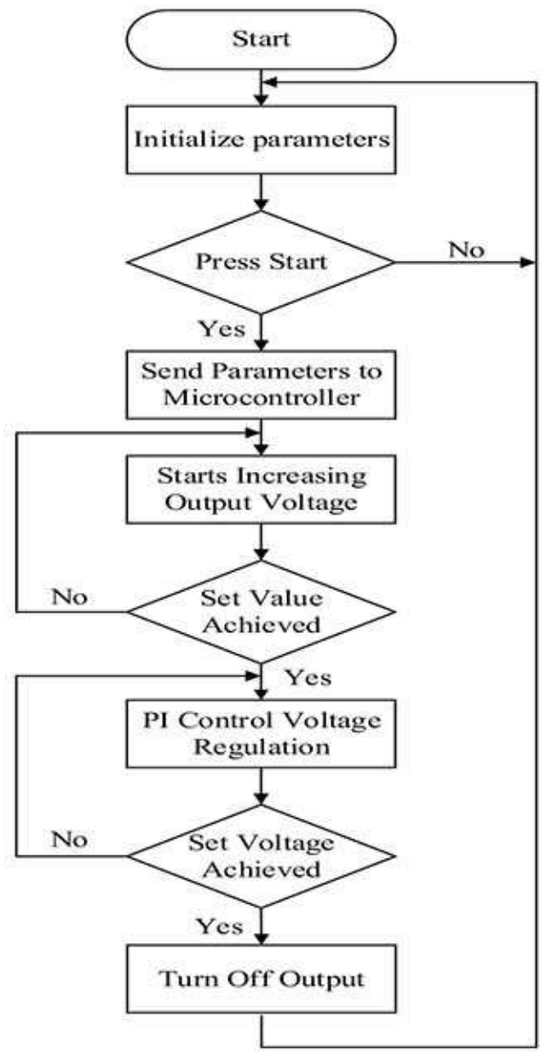


Figure 4: 2*50= 100kV High voltage output



Conclusion

An adjustable high-voltage DC power supply with a linearly adjustable output voltage of 10 kV DC to 100 kV DC with wireless communication feedback is realized. The leakage inductance of the high-voltage transformer and the external capacitor are utilized to form a parallel resonant circuit so that the push-pull switch can achieve zero-voltage switching. The Miller effect of the power switch is used to provide the freewheeling path to the current of the choke inductors. For safety regulations, epoxy resin is used for the insulation of high-voltage transformers and voltage multiplier circuits, and a proper environmental distance is practically considered while designing the system especially the distance between the primary and secondary winding of the transformer is large enough to prevent the breakdown of the insulation.

Selected Journal Publications

1. Ahmad, J.; Lin, C.-H.; Zaid, M.; Sarwar, A.; Ahmad, S.; Sharaf, M.; Zaindin, M.; Firdausi, M. A New High Voltage Gain DC to DC Converter with Low Voltage Stress for Energy Storage System Application. Electronics 2020, 9, 2067. https://doi.org/10.3390/electronics9122067
2. Ahmad, J.; Zaid, M.; Sarwar, A.; Lin, C.-H.; Ahmad, S.; Sharaf, M.; Zaindin, M.; Firdausi, M. A Voltage Multiplier Circuit Based Quadratic Boost Converter for Energy Storage Application. Appl. Sci. 2020, 10, 8254. https://doi.org/10.3390/app10228254
3. Ahmad, J.; Zaid, M.; Sarwar, A.; Lin, C.-H.; Asim, M.; Yadav, R.K.; Tariq, M.; Satpathi, K.; Alamri, B. A New High-Gain DC-DC Converter with Continuous Input Current for DC Microgrid Applications. Energies 2021, 14, 2629. https://doi.org/10.3390/en14092629