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High Gain DC-DC Converter for Use in Automobiles

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***Abstract**: A high gain DC-DC converter designed for automotive applications is presented in this study. In these applications, voltage step-up is essential for supplying power to high-voltage systems from a low-voltage battery source. In order to achieve high voltage conversion efficiency while preserving dependability and compact size, the suggested converter incorporates cutting-edge topologies such linked inductors, switching capacitors, and active clamping. Minimal component stress, lower switching losses, and better thermal management are all guaranteed by the design. The converter's performance under various load conditions is validated by simulation and experimental findings, which makes it appropriate for use in electric and hybrid vehicles. This work helps the changing car industry find economical and energy-efficient power solutions.*

***Keywords**: High gain, Clamp circuit, Automotive Applications, DC-DC converter, HID lamps*

I. Introduction

Because electric and hybrid electric vehicles (EVs and HEVs) need efficient power conversion, there is a higher demand for compact electric motors in current automotive systems. It is important that these vehicles can change low-voltage sources into the level of voltage needed to power parts such as electric motors, inverters and in-car chargers. Frequently, high voltage requirements of conventional DC-DC converters result in limits on the converter's possible voltage gain, efficiency and the burden placed on its components.

To deal with these challenges, high gain DC-DC converters provide only a small reduction in efficiency, minimal losses during switching and the convenience of a compact design. Performance and dependability are improved by using interleaving, installed inductor pairs, switching capacitor networks and active clamping methods. Also, these converters improve the system's temperature management and can handle the typical dynamic loads found in automobiles.

This research focuses on developing and executing a specially designed high gain DC-DC converter for use in automobiles. The performance of the suggested design is determined through simulation and with experimental validation. The purpose is to ensure the system can meet the rising energy needs of modern cars, reduce energy use and boost environmentally friendly transportation technology.

II. Circuit Description

The high gain DC-DC converter proposed here contains a linked inductor, switching capacitor network and an active clamp circuit in its non-isolated configuration. By using a switching capacitor, voltage gain can be increased without causing many duty cycles and the added inductor lets high voltage be stepped up with little current variation.

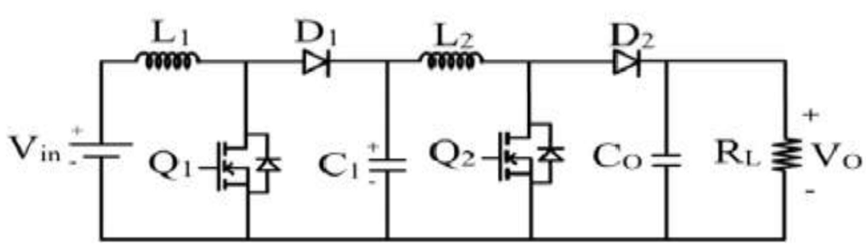

Fig 1: Boost converter Two-Stage

A more dependable and efficient system results when an active clamp circuit ensures leakage energy is recycled and minimizes voltage stress on the switching devices. Soft switching is adopted by a low-side MOSFET to reduce losses caused by switching operations. The circuit design can handle automotive power needs because it promises safe and effective conversion, occupies little space and stays cool even at high currents.

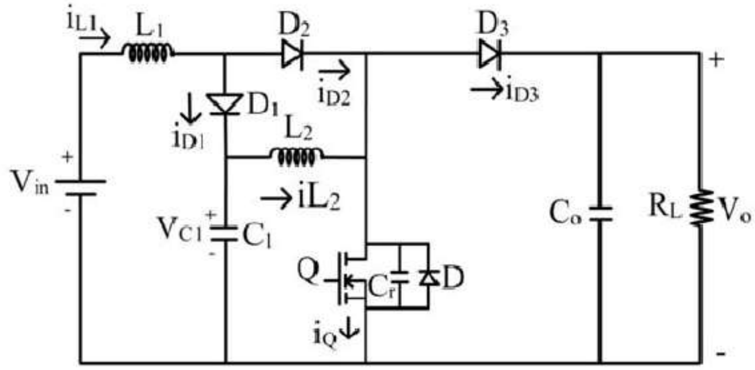

Fig 2: Boost converter Two-Stage with two switches

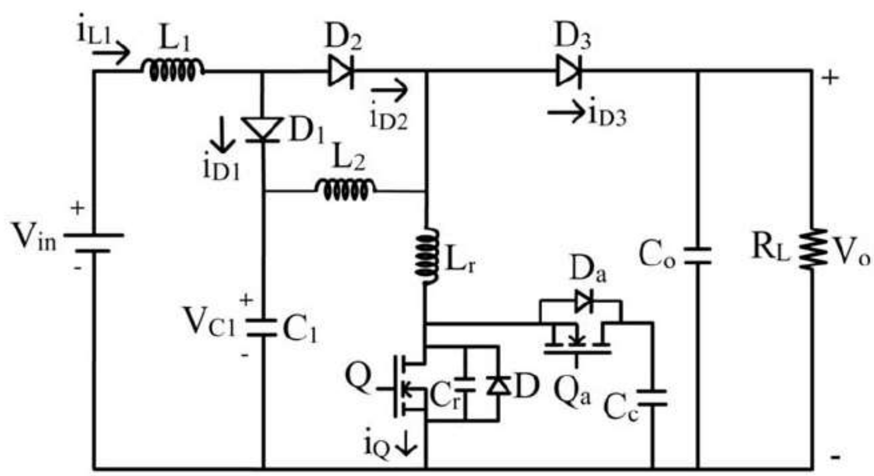

Fig 3: Boost converter with soft gain switch

III. Circuit Operation

With each switching cycle, the circuit operates in two essential modes. During this first mode, the clamp capacitor catches leakage energy to protect the MOSFET switch which is turned on and stores energy into the attached inductor. The switch being off during the second mode allows the energy from the clamp and inductor circuit to be released to the output through the network of switched capacitors and diodes. A larger voltage gain is possible by using switched capacitors and appropriately choosing the turns ratio in the connected inductor. This process provides stable performance, effective energy usage and decreases lost energy during all automobile load circumstances.

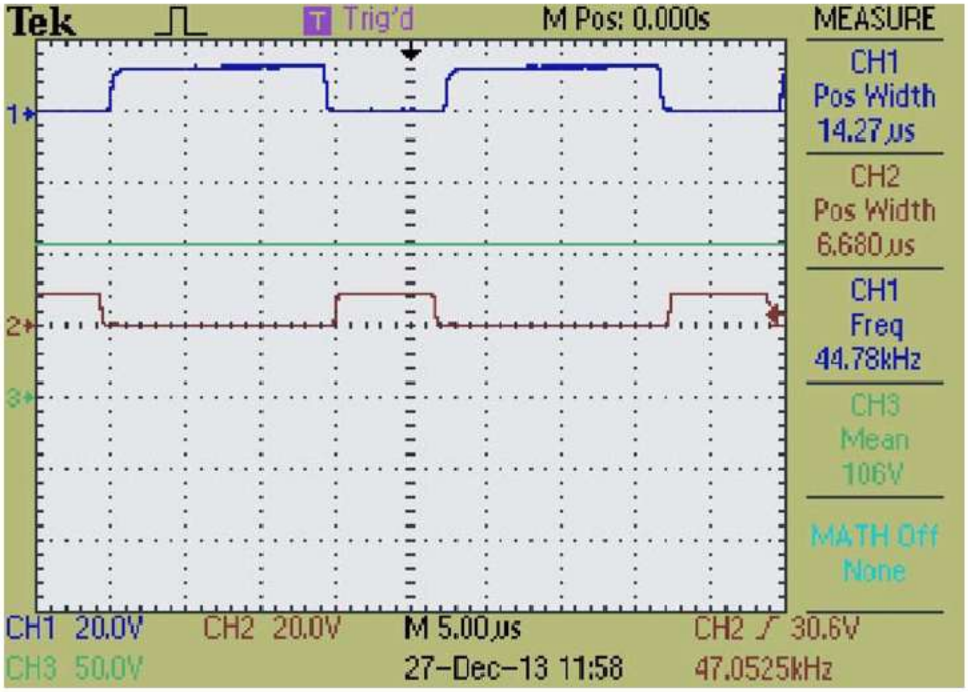

Fig 4: Q gate pulse, auxiliary Qa and output voltage

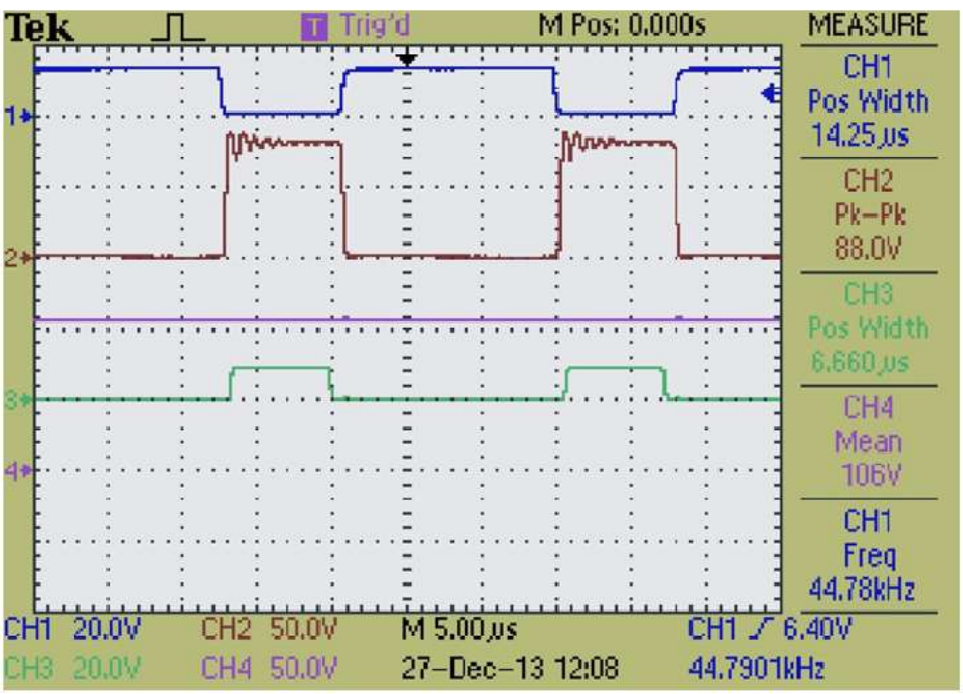

Fig 5: Gate pulses with different switching stages

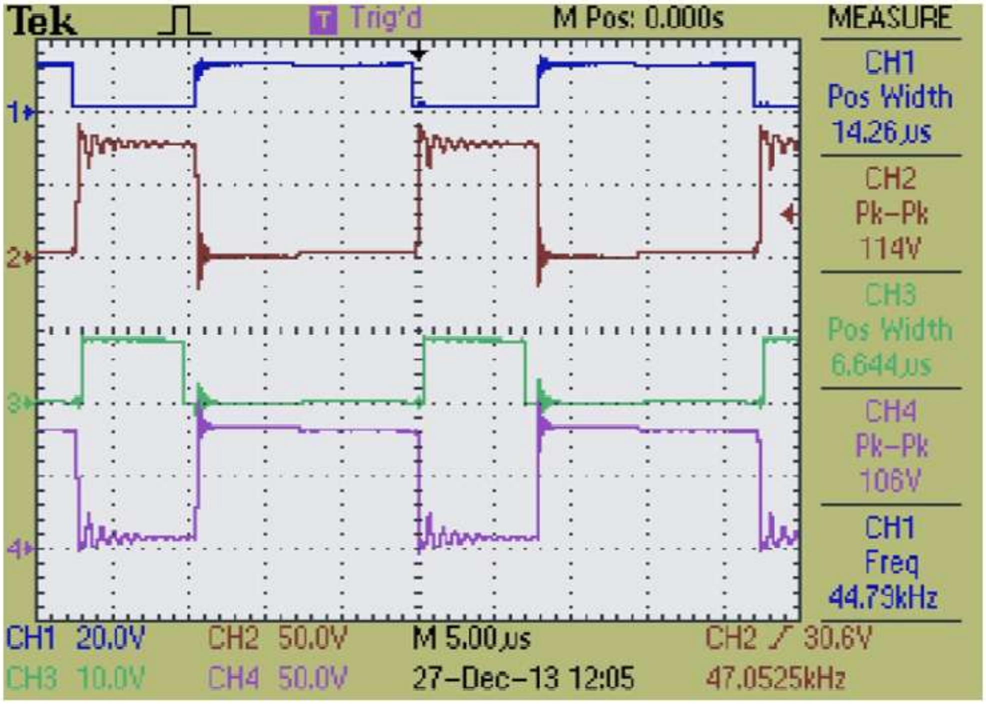

Fig 6: CRO waveforms with different switching

IV. Conclusion

When a large voltage increase is needed in cars, the described high gain DC-DC converter is both reliable and effective. The high gain and better efficiency are achieved by merging an active clamp circuit, a linked inductor and switched capacitor network in the converter. Batteries work well in electric and hybrid vehicles because they can cope with many load conditions while putting little strain on parts. Rigorous testing using simulations and real experiments confirms that the approach is suitable for today's automotive systems. The converter encourages new green transportation ideas by supplying a tiny and efficient source of power.

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