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Analysis and Implementation of Multi Input Multi Output DC-DC Buck-Boost Converters for Renewable Energy Applications

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INTRODUCTION & AIM

Due to the increasing demand for the use of various renewable energy sources, multi-ports power electronics supplies are experiencing increased attention over the past decades. It is well known that renewable energy sources have great economic, environmental and reliability advantages, yet they require conversion circuits in order to benefit from their output power.

Among different DC-DC conversion topologies, in this paper we are going to address Buck- Boost multiinput multi output (MIMO) DC-DC converter. In this work, the effect of different number of inputs and outputs on the system performance is investigated, in other words, how the efficiency is changing when the number of ports increases.

It is also important to study the relationship between duty cycle of the converter and the number of sources output that serve as input to the power electronic circuit.

The proposed system aims to overcome the limitations of conventional single-input converters by offering flexibility, improved efficiency, and better energy utilization. It allows seamless power flow control between different DC sources, such as solar panels, batteries, or fuel cells, ensuring uninterrupted power delivery even under fluctuating input conditions and load disturbances.

The Multi-Input Multi-Output (MIMO) DC–DC Buck–Boost Converter successfully achieves the goal of developing a flexible and efficient power conversion system capable of handling multiple DC sources and delivering multiple regulated outputs

METHOD

The Multi-Input Multi-Output (MIMO) DC–DC Buck–Boost Converter is designed to efficiently manage power from multiple input sources and provide multiple regulated output voltages for various load requirements. The Multi Input may be from Solar PV , Battery, Fuel cells.

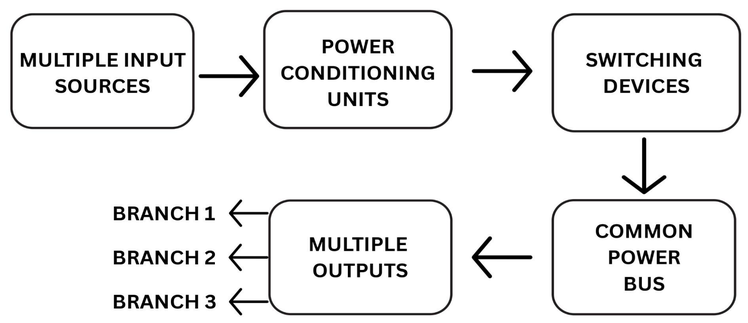

Fig.1. Block Diagram

The project is implemented using an Arduino Mega microcontroller that generates PWM signals to control MOSFET switches, enabling buck, boost, and buck–boost operations as required. Hardware components such as inductors, capacitors, and diodes ensure stable energy transfer, while voltage and current sensors provide real-time feedback for precise control. In this project, pulse width modulation technique is used.

RESULTS & DISCUSSION

A different width duty cycle is applied to the input stage switches, based on enabling of duty cycle, the input can be prioritized. All the switches have different duty cycle with delay between them. On time of three stage outputs are different width as 0.7µs, 5µs, 7µs respectively to obtain the output voltage value of 3v,12v, 28v, also respectively with ripple voltage of 0.1mv,150mv, 50 mv Switching frequency of 100KHz.Keeping Four inputs as same voltage 12V.

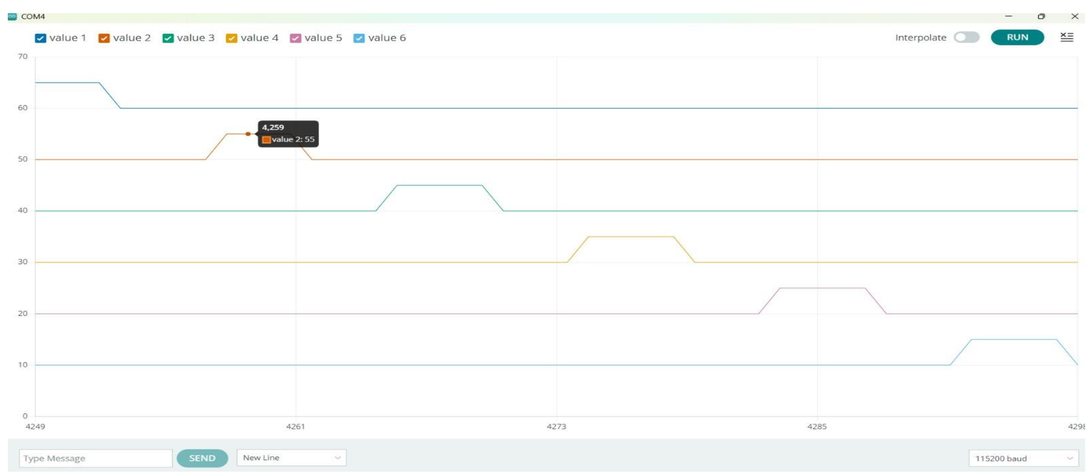

Fig.2. Generation of pulses for Multi input Switches

CONCLUSIONS

The converter's operation is simulated and tested for different voltage levels and various Duty ratio to verify efficiency, regulation, and to provide ripple minimization. This project demonstrates a cost-effective, compact, and scalable converter suitable for renewable energy systems, hybrid power architectures, and embedded applications. The combination of hardware design and embedded software control achieves efficient power conversion with improved voltage stability and reduced losses. The project demonstrates the potential of the MIMO converter for applications such as solar power integration, electric vehicles, and portable DC systems. Its adaptability allows for future enhancements like digital communication, IoT-based monitoring, or adaptive control algorithms. Overall, the project validates the feasibility, efficiency, and versatility of a multi-input multi-output converter, offering a significant contribution to modern power electronics and energy management systems.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

From the research done before in relation to this topic much has been accomplished, but a lot remains to be done in areas such as,· Increase of switching frequency and isolated transformer, Smart power electronic, Output regulation, Input regulation.