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Design of Sepic Converter Using PID Controller

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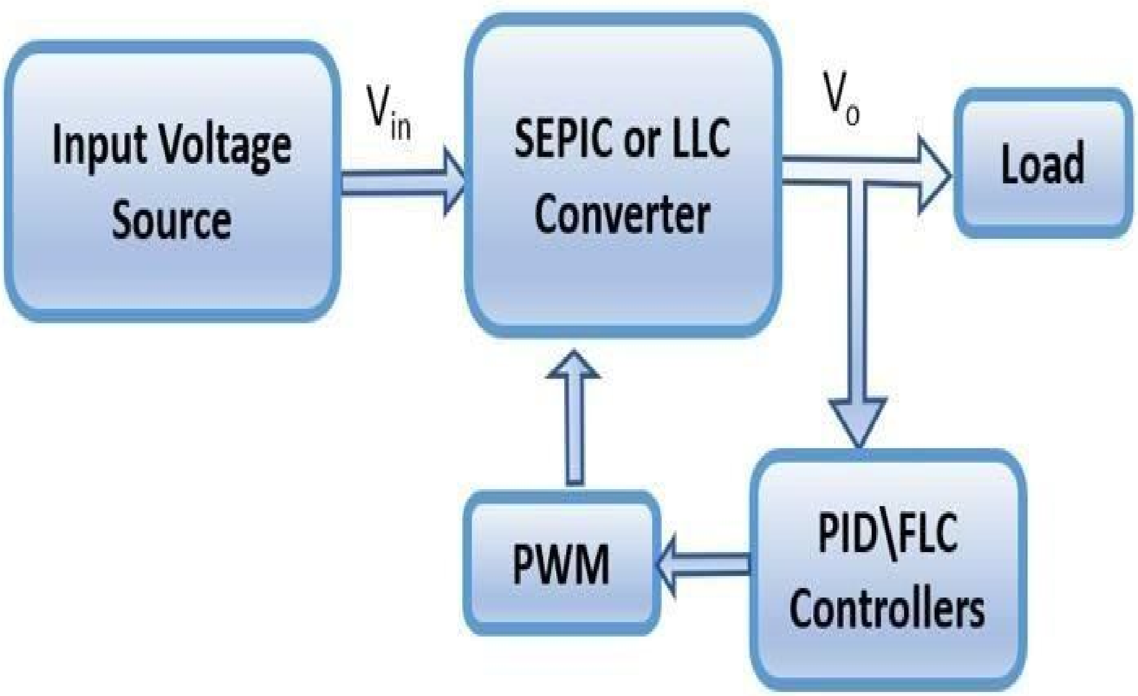
Abstract: Single-Ended Primary Inductor Converter (SEPIC) is widely used in battery charging of renewable energy and electric/hybrid vehicles due to its output gains range flexibility,less complex switching design, providing an isolation by capacitor and producing non-inverted output. This project presents a modified PID controller to obtain excellent dynamic performance with zero steady-state error. The controller design is discussed and built in discrete model simulation on Matlab-Simulink. The effectiveness of the proposed modified PID control strategy is tested for the transient cases in step-changed reference voltage, and varying input voltages. The results show the proposed controller can reach zero steady-state error and produce lower ripple in voltage.

I. INTRODUCTION

The SEPIC converter provides the desired output voltage through duty cycle gain. However a feedback controller is required to maintain the output voltage equals voltage reference when disturbance exist to the system, such as load, voltage input and reference are changed. The most popular feedback control is proportional-integral-derivative (PID)controller and PI controller. This paper presents a design of a discrete modified PID controller of the SEPIC converter and verified through Matlab-Simulink. The proposed controller regulate the output voltage equal the reference with excellent dynamic response. The advantage of using the proposed control technique is that the transient response of the system can be controlled by tuning only the integral gain to achieve the desired response. Unlike other controllers (e.g., current controller, sliding mode controller, and fuzzy plus-PI controller), this controller also uses only the DC-voltage sensor to achieve zero-steady-state error output voltage with high dynamic response, whether the disturbance is small or large.

II. BLOCK DIAGRAM



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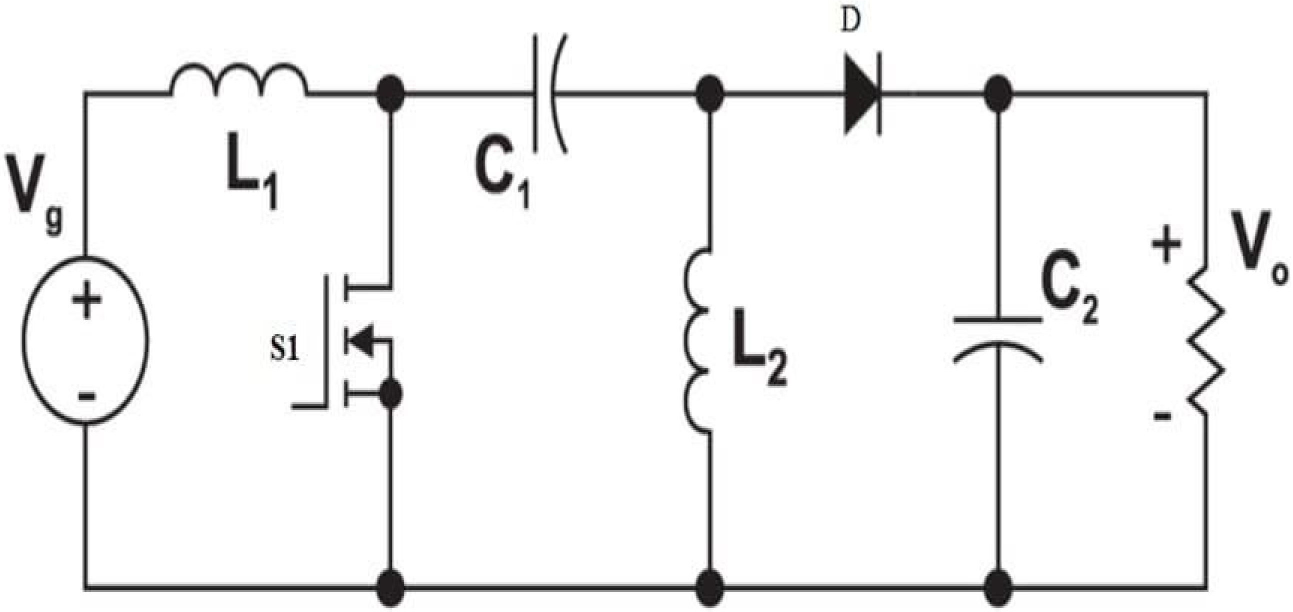
III. SEPIC CONVERTER

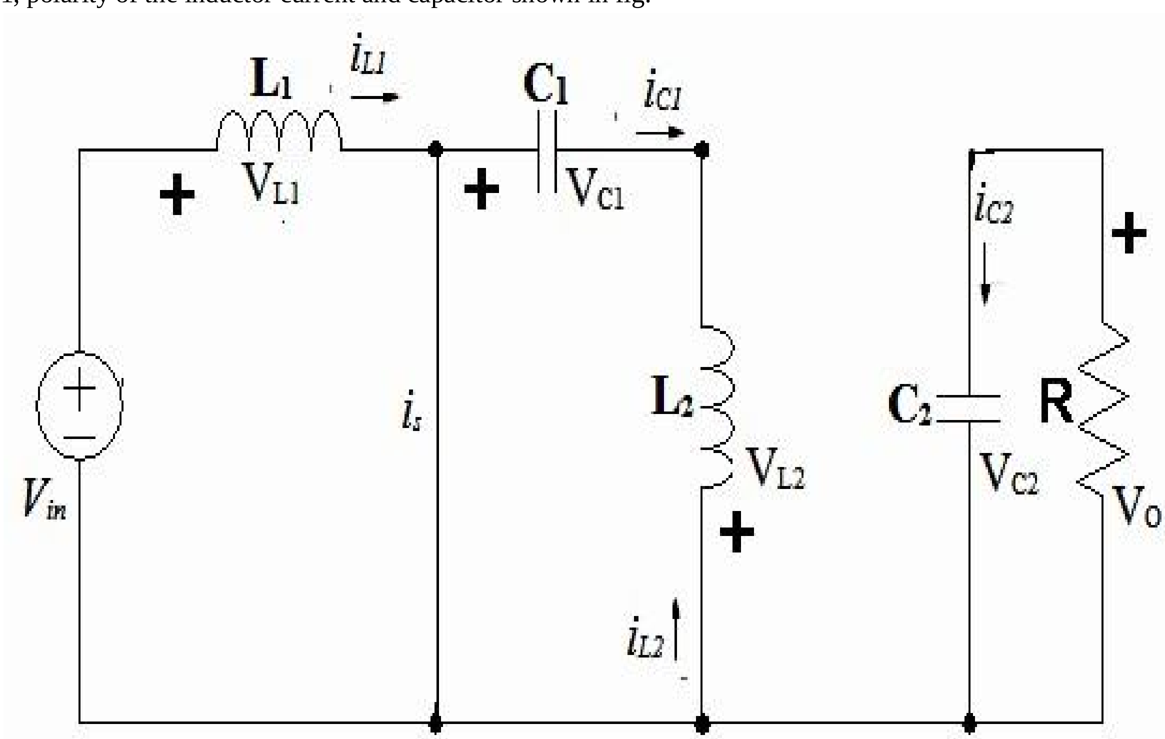
The single-ended primary-inductor converter (SEPIC) is a type of DC-DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control switch (S1).



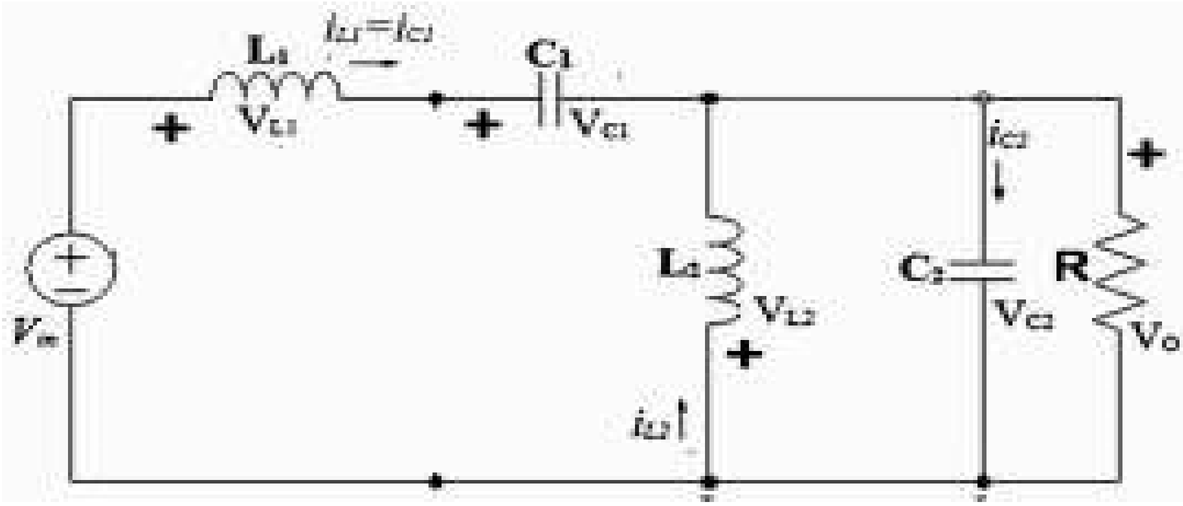
IV. CIRCUIT OPERATION

The SEPIC converter contains a power switch (MOSFET), a diode, an input filter capacitor, an output capacitor and coupled inductors.

TURN ON:When the switch S is closed, the diode open, the inductor L1 occupied by the source voltage Vin, the L2 charges to the capacitor C1, polarity of the inductor current and capacitor shown in fig.



TURN OFF:When the switch is open, diode D is closed, Inductor L1 charges the capacitor C1.Capacitor C2 will charge through diode and output appears across the load.

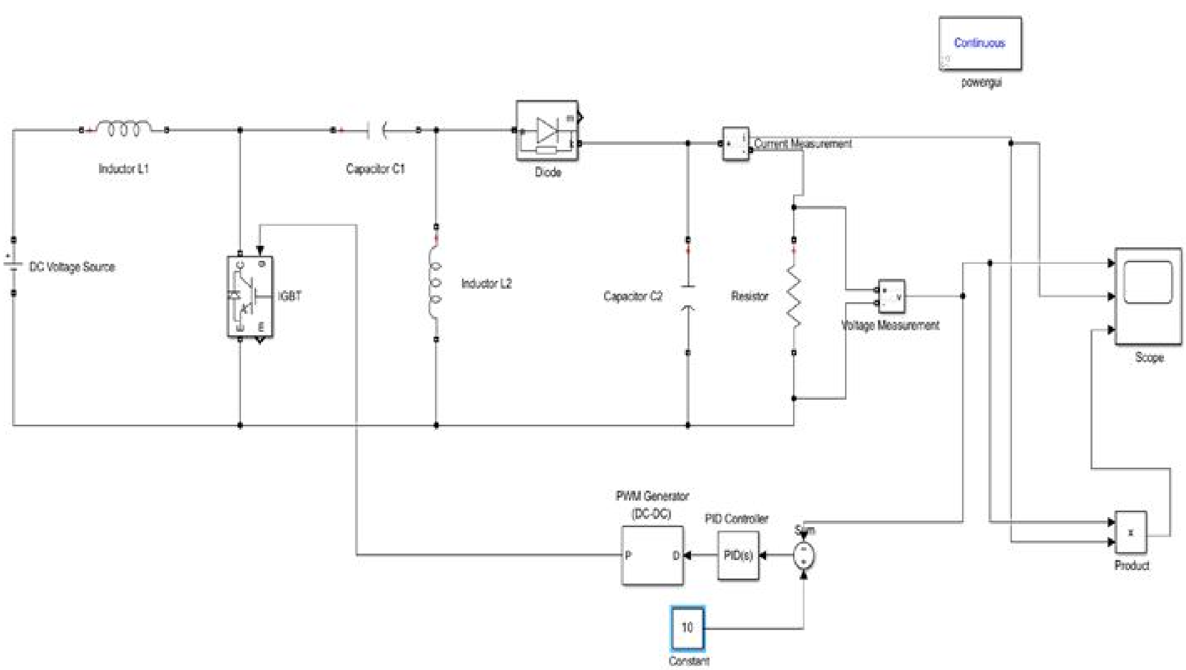


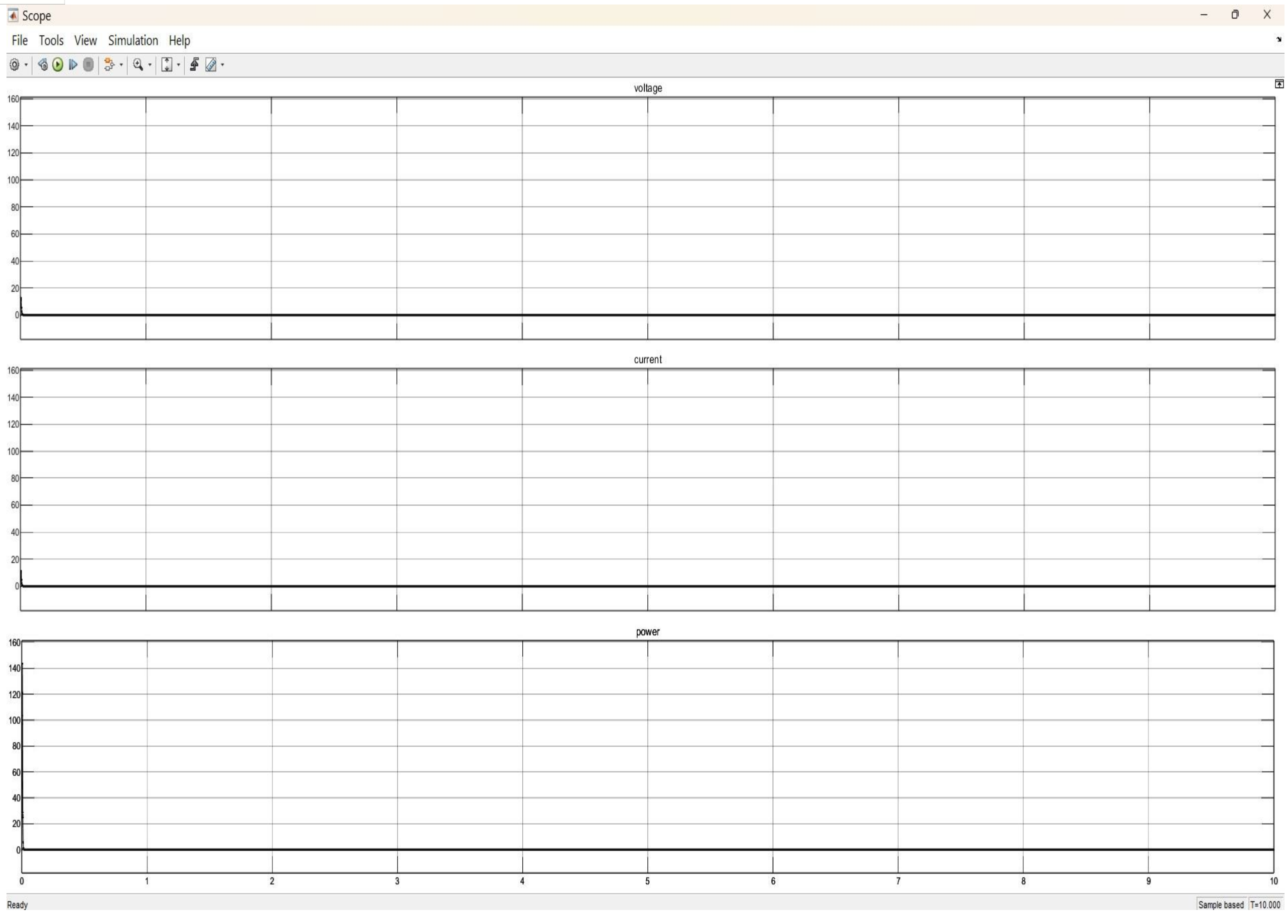
V. SEPIC CONVERTER SPECIFICATIONS

Parameter	Value
Output DC voltage, vo	12V
Switching frequency, fs	23kHz
Inductors, L1 and L2	100e-6 H
Capacitors, C1 and C2	82e-6 H
Load resistor, RL	10ohms

VI. SIMULATION DIAGRAM

SEPIC AS BOOST OPERATION(Vin=10v)

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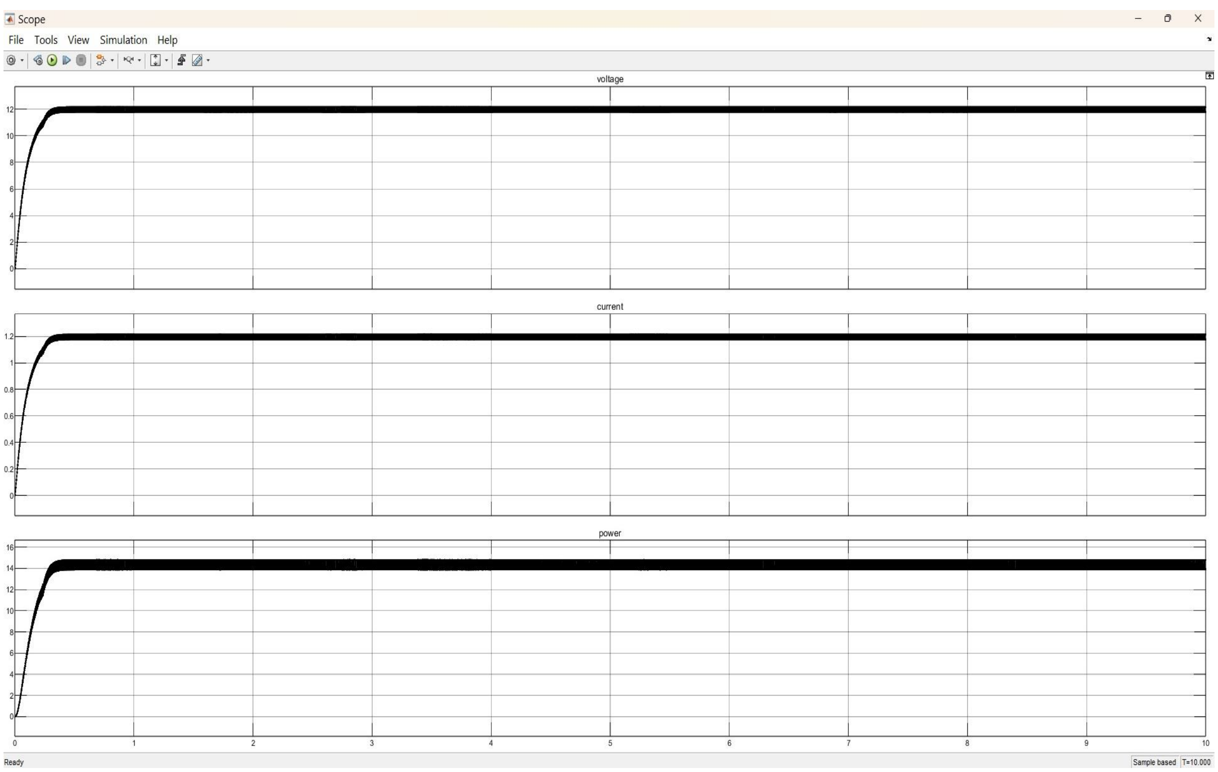
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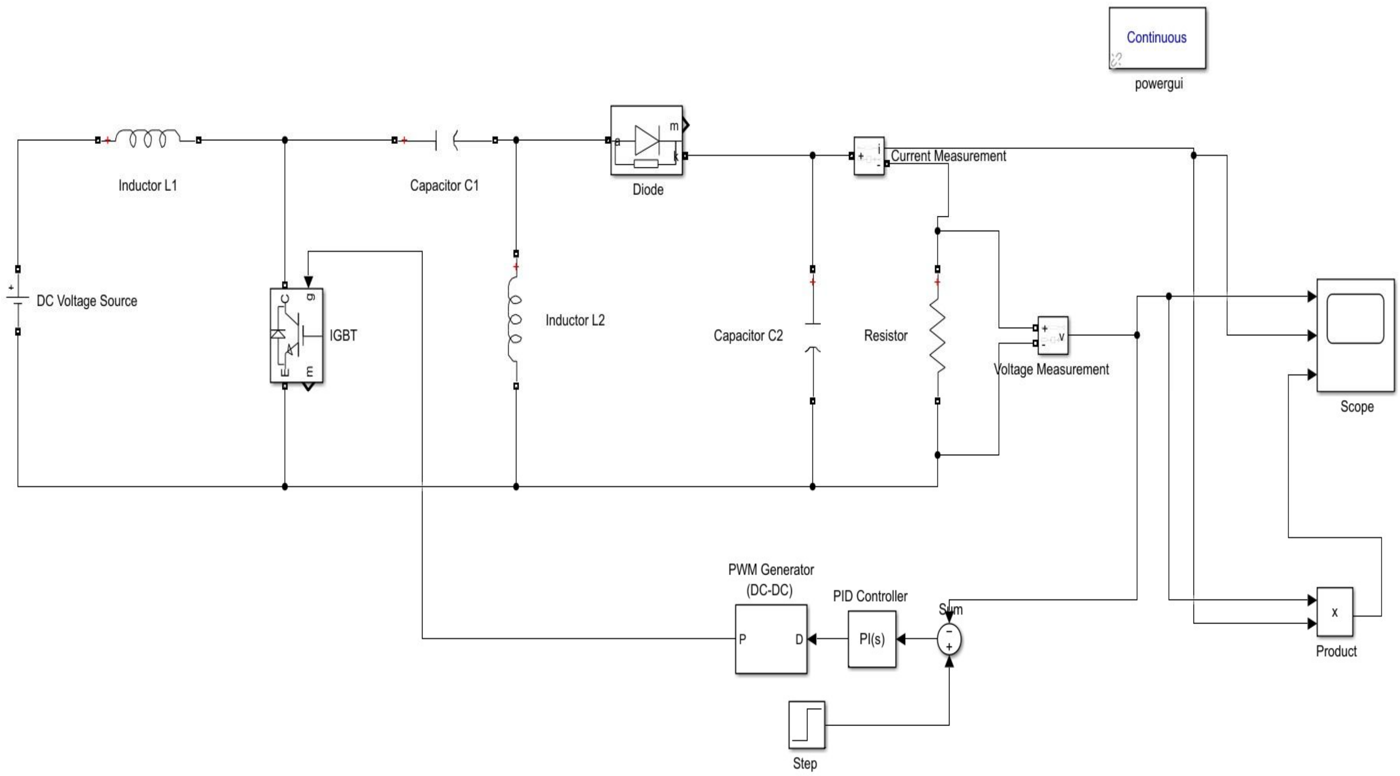
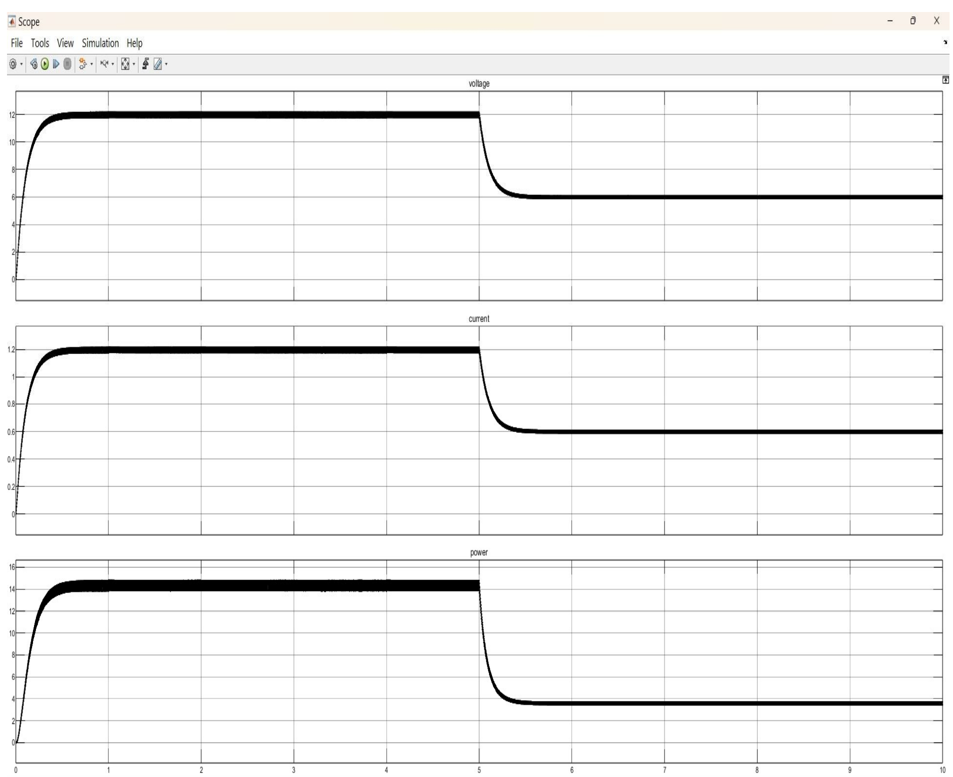
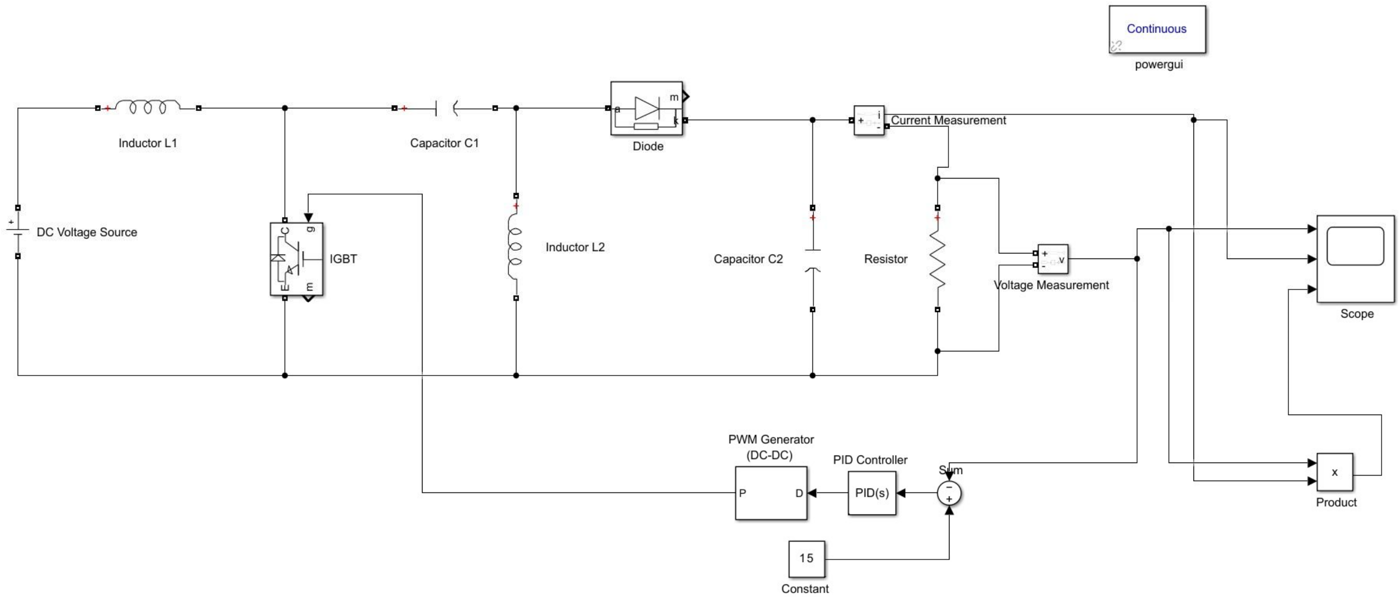
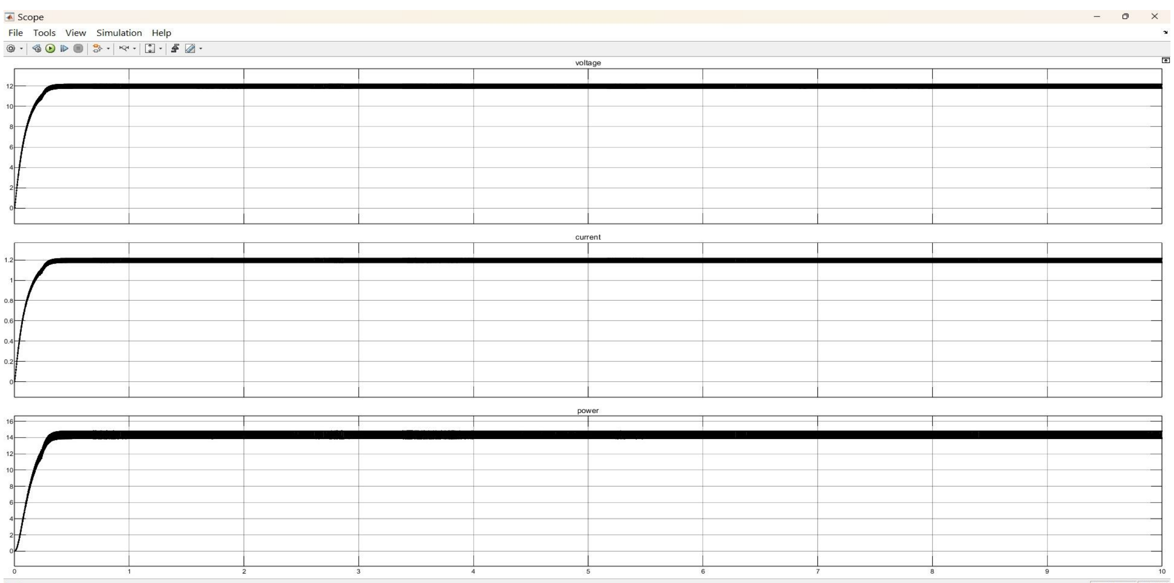


Step time-5;Intial value-12;Final value-6



SEPIC as Buck operation(Vin=15v)





VII. ADVANTAGES

1) Lower switching losses
2) Low output voltage noise
3) Higher efficiency
4) Allows high frequency of operation

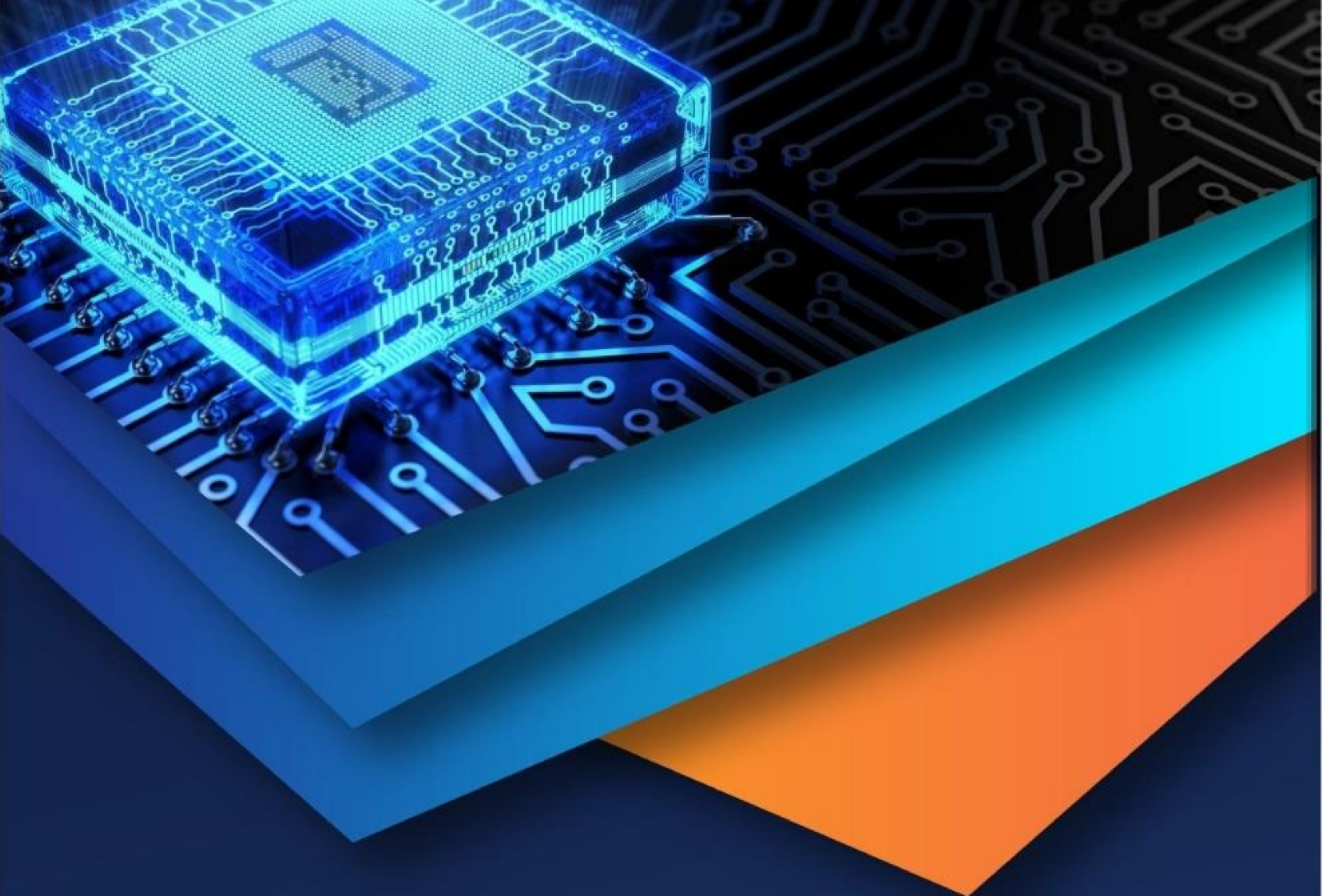
VIII. DISADVANTAGES

1) Complex control loop
2) Non isolated topology
3) Since the SEPIC converter transfers all its energy via the series capacitor, a capacitor with high capacitance and current handling capability is required.

IX. CONCLUSION

The modified PID, known as I-D voltage feedback controller for SEPIC converter was presented. The algorithm is modeled in discrete domain, and then verified by MATLAB/Simulink simulation. The results show the proposed controller can reach zero steady-state error, in two transient cases: the voltage reference changed and varying the input voltage for 10V and 15V. The SEPIC converter acts as boost converter during input voltage of 10V, where output voltage is higher than input voltage. During input voltage is 15V, the SEPIC converter turns to buck converter since the output is lower than input voltage.

THANK YOU



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