PERFORMANCE ANALYSIS OF BUCK &BOOST CONVERTER

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ABSTRACT

This paper presents performance analysis of buck & boost converter. Buck converter step up DC input voltage while boost converter step down DC input voltage. Both converters are analysed in closed loop mode. Firstly a PI controller is used to analyze the performance of buck & boost converters. Later we have used a fuzzy controller to analyse these converters. Circuit model has been developed using MATLAB. Different voltage waveform is being compared for different reference voltage. We also analyze that using FLC (fuzzy logic controller) gives better response than PI controller in feedback path.

***Keywords**: Buck & boost converter, PI controller, fuzzy controller.*

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I. INTRODUCTION

A buck converter is a step-down DC to DC converter. It is a switched-mode power supply that uses two switches (a transistor and a diode), an inductor and a capacitor. A boost converter is also a step-up DC-to-DC power converter with an output voltage greater than its input voltage and its design is similar to the buck converter. A Buck- Boost converter is a combination of both buck and boost converter whose output voltage is either less or greater than the input voltage. The output voltage is of the opposite polarity as the input. This is a switched-mode power supply with a similar circuit topology to the boost converter and the buck converter. The output voltage is adjustable based on the duty cycle of the switching device.

The work in paper [1] gives the modeling and simulation technique to analyze and design for an overall efficiency optimization. The paper [2] describes a comparison of the characteristics of buck converter and applying PSM (pulse space modulation) by obtaining experimental results from a (1.2 kW)setup and their computer simulation.

The step by step process of designing, construction and testing a bidirectional buck-boost converter for an ultra capacitor based auxiliary energy system of electric vehicles is introduced in paper [3], converter is used as a controlled energy transfer equipment between main and auxiliary energy system that transfers energy in both directions.

II. THEORY OF OPERATION

A. BUCK CONVERTER

The operation of the buck converter is fairly simple, with an inductor and two switches (usually a transistor and a diode) that control the inductor. It alternates between connecting the inductor to source voltage to store energy in the inductor and discharging the inductor into the load.

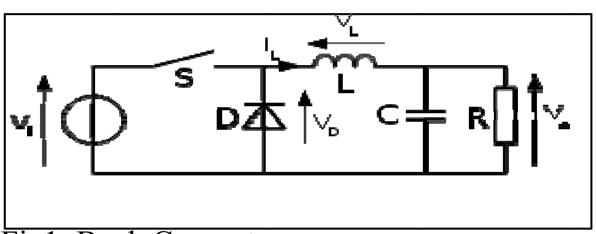

Fig1: Buck Converter

B. BOOST CONVERTER

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. In a boost converter, the output voltage is always higher than the input voltage. When the switch is closed, current flows through the inductor in clockwise direction and the inductor stores the energy. Polarity of the left side of the inductor is positive. When the switch is opened, current will be reduced as the impedance is higher.

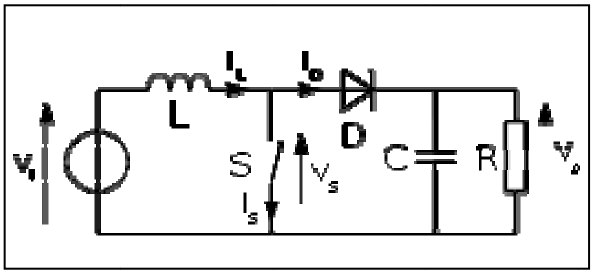

Fig2: Boost Converter

III. BOOST CONVERTER WITH PI CONTROLLER

Now to achieve proper objective of converter, it is need to measure and maintain output voltage at required voltage level. So for that purpose it is needed to use feedback loop into the system. Conventionally, PI, PD and PID controller are most popular controllers and widely used in most Power Electronic closed loop appliances. The PI control is the most popular control system; it is versatile and can be tuned adjusting three constants. PI is a well proved and successfully applied in many control systems.

$V_i * t_{on} + (V_i - V_o) * t_{off} = 0$……….(1)

Where

Vi = The input voltage, V.

Vo =The average output voltage, V.

ton = The switching ON time of the MOSFET, sec

toff = The switching OFF time of the MOSFET, sec

Dividing both sides by TS and re-arranging items

—=——=——.............(2)

Where,

Ts : The switching period, s.

D : The duty cycle

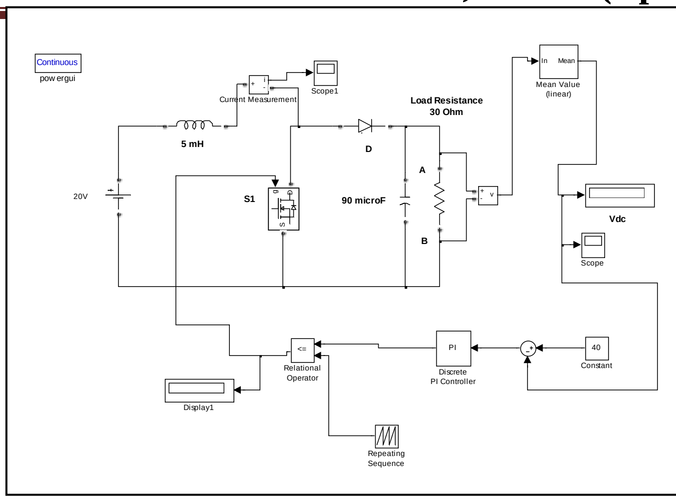

Fig3: Close loop Simulink Model for Boost Converter Using PI Controller

Table I: The parameters and values for the boost dc-dc converter.

Parameters	Values
Voltage Input V_{in}(V)	10
Voltage Output V_{out}(V)	45
Inductor(mH)	5
Resistance(Ω)	30
Capacitor(μF)	90

IV. BUCK CONVERTER WITH PI CONTROLLER

The buck converter from previous context is extended with a PI control. We will create a model where the mosfet is controlled from the block diagram where the PI controller is modeled.

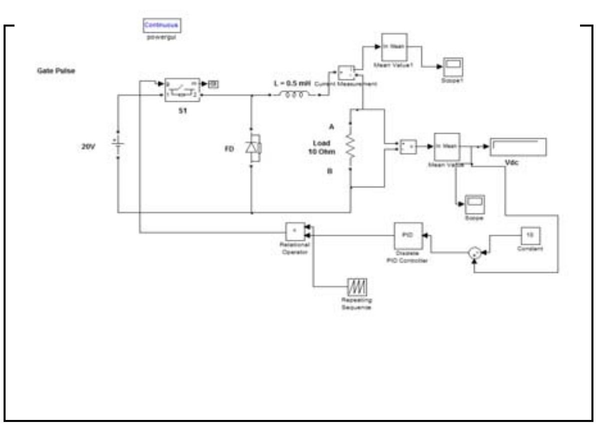

Fig4: Close loop Simulink Model for Boost Converter Using PI Controller

V. BOOST CONVERTER WITH FUZZY CONTROLLER

A simple fuzzy logic control is built up by a group of rules based on the human knowledge of system behaviour. Matlab/Simulink simulation model is built to study the dynamic behaviour of dc-to-dc converter and performance of proposed controllers.

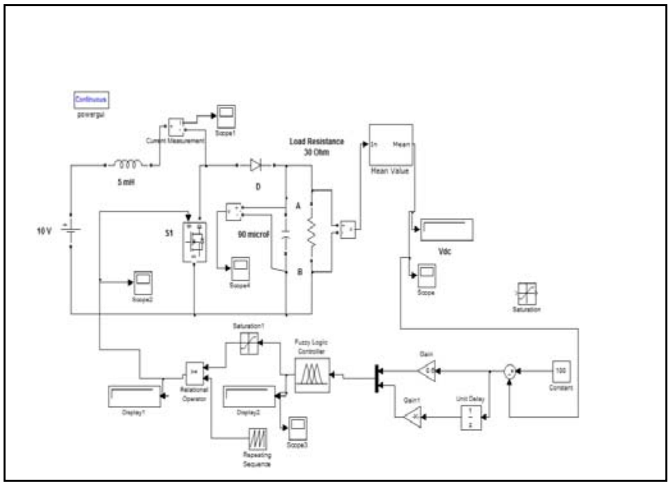

Fig5: Close loop Simulink Model for Boost Converter Using Fuzzy Controller

VI. BUCK CONVERTER WITH FUZZY CONTROLLER

Traditionally, PI, PD and PID controller are most popular controllers and widely used in most power electronic closed loop appliances however recently there are many researchers reported successfully adopted Fuzzy Logic Controller (FLC) to become one of intelligent controllers to their appliances. With respect to their successful methodology implementation, control closed loop boost converter and opened loop boost converter will compare the efficiency of the converters.

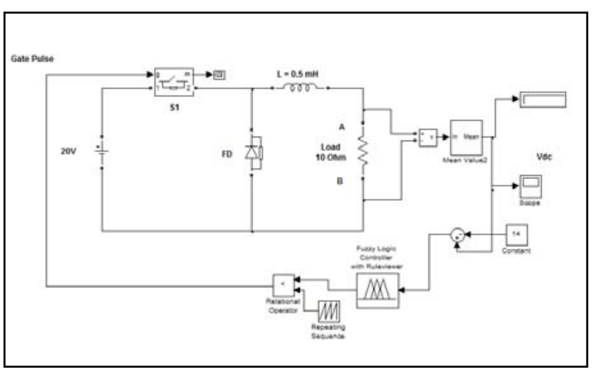

Fig6: Close loop Simulink Model for Buck Converter Using Fuzzy Controller

VII. RESULTS OF SIMULINK MODEL

A. Boost Converter using PI

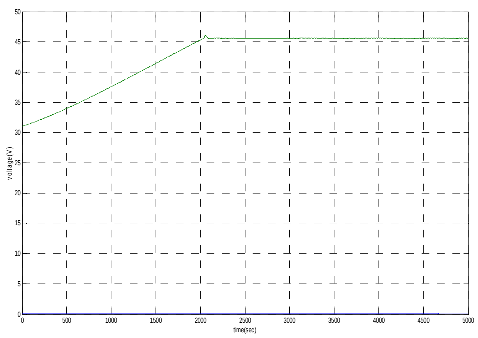

Fig7: Output voltage across load using PI converter

B. Boost converter using fuzzy controller

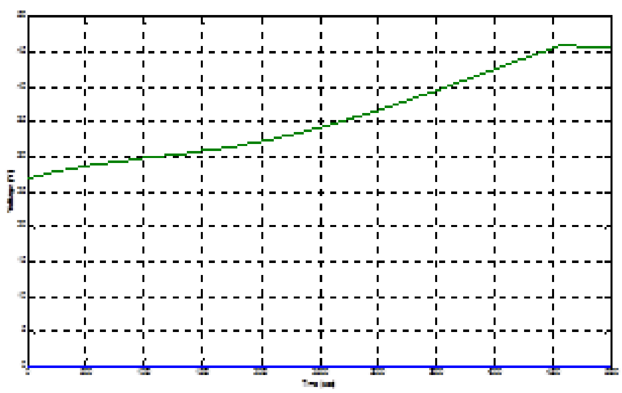

Fig8: Output voltage across load using fuzzy controller

C. Buck converter using PI controller

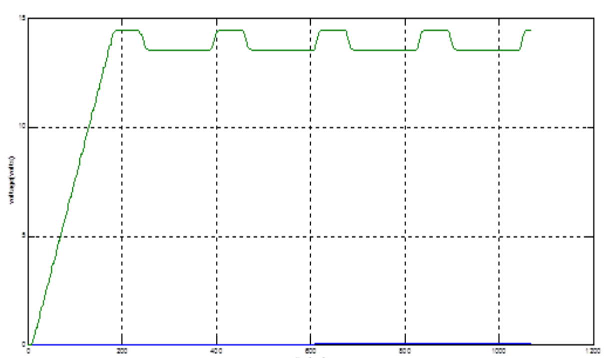

Fig9: Output voltage across load using PI controller

D. Buck converter using fuzzy controller

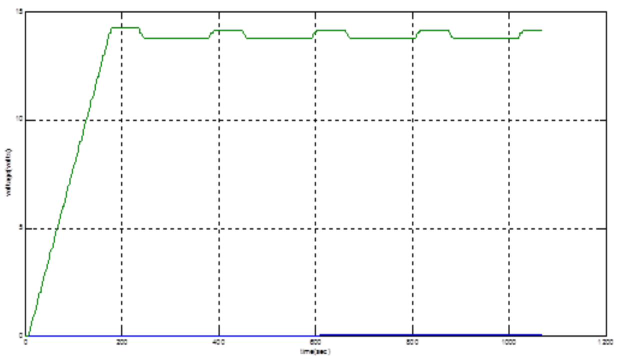

Fig10: Output voltage across load using fuzzy controller

VII. COMPARISON OF RESULTS

TABLE 2: BOOST CONVERTER

Parameters	PI controller	FUZZY controller
Input Voltage (V)	10	10
Output Voltage (V)	40.48	39.99
% Error	1.2	0.025
Settling Time (sec)	6000	5000

TABLE 3: BUCK CONVERTER

Parameters	PI controller	FUZZY controller
Input Voltage (V)	20	20
Output	14.45	14.19

Voltage (V)		
% Error	3.2	1.357
Settling Time (sec)	183	160

VIII. CONCLUSION

Design of a fuzzy logic controller on control buck converter and boost converter by using MATLAB has been successfully achieved. A simple algorithm based on the prediction of fuzzy logic controller, possibly using the fuzzy rules parameter, is showing to be more convenient than the circuit without fuzzy. Using a closed loop circuit with fuzzy logic controller, it is confirmed that the dc-dc converter gives a value of output voltage exactly as circuit requirement. Hence, the closed loop circuit of dc-dc converter controlled that by fuzzy logic controller confirmed the methodology and requirement of the proposed approach. These studies could solve many types of problems regardless on stability because as we know that fuzzy logic controller is an intelligent controller to their appliances.

IX. REFRENCES

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