International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 1 (2017)
© Research India Publications. http://www.ripublication.com

PERFORMANCE ANALYSIS OF FUZZY LOGIC DC-DC BUCK CONVERTER

K.Indrani
UG Student, EEE Dept.
K L University, Guntur,
AndhraPradesh ,India
indranikaikala@gmail.com

L.Durga kalyani
UG Student , EEE Dept.
K L University, Guntur
Andhra Pradesh, India
Kalyanilanke202@gmail.com

Abstract— In this paper a fuzzy logic control technique has been proposed for dc-dc buck converter. The dc-dc buck converter operates with voltage mode control. The proposed control scheme maintains the voltage across the load constant for variation of load. The control scheme has been implemented in closed loop manner. The proposed fuzzy controlled dc-dc buck converter has been implemented using matlab/simulink software and simulation results are presented to validate the proposed scheme.

Keywords— *PWM technique, Induction heating, Eddy current control technique, resonant inverter.*

I. INTRODUCTION

DC-DC convert the fixed dc voltage to variable dc voltage. There are many types of dc-c converters which includes buck converter, boost converter, buck-boost converters. Buck converter is step down converter which converters higher voltage by storing the input energy periodically and then releasing the energy to the output at lower voltage. The inductor current plays significant role in dynamic response of buck converter [1]. The application results with electronic devices like solar charger etc [6]. Boost converter is step up converter which converts lower voltage to higher voltage. There are several methods of analysis for DC-DC converters. One approach is to infer the differential equation that describes about the inductor current and capacitor voltage and then solve them in accordance with the boundary conditions of the switching period. This exacting method, although accurate, produces a cumber-some set of equations that require extensive computation and is best reserved for simulation purposes. To overcome the efficiency and regulation problems acontrol scheme must be introduced.

If the source voltage increases the controller must decrease the source current to prevent an increase in load voltage. DC-DC converters are controlled in either voltage mode or current mode by using analog methodologies to perform PWM technique to the transistor gate-source voltage. The desired performance is difficult to obtain as the parasitic elements are not considered. To reduce the -difficulties FLC has been proposed. The control complexity is less in fuzzy logic system [4].
voltage modulation technique .Section IV presents the simulation Results. Section V the Conclusion.

II. BREIF DESCRIPTION OF DC-DC CONVERTER(BUCK):

The dc-dc converter is an electronic switch which transfers energy from a DC voltage source to the load. The energy is first transfers via electronic switches to energy storage devices and then subsequently switched from source to load.To overcome the efficiency and regulation problems acontrol scheme mustbe introduced whereby the output voltage is measured and the supplied energy is varied in accordance with the requirements of the load. If the source voltage increases the controller must decrease the source current to prevent an increase in load voltage.

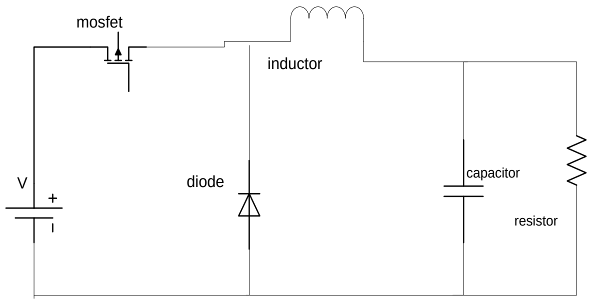

Fig.1: block diagram of buck converter

Basic equations of buck converter:

The relationship between input and output voltages are given by
$V_{out}= V_{in} *D$ --------- (1)
$D= T_{on} / (T_{on}+ T_{off})$ --------- (2)
The duty ratio of the switch can be controlled with in the range of 0-1 by adjusting T_{on}
Thus the required output voltage is obtained which is always lesser than or equal to the input voltage.
The proper selection of the inductance and capacitance minimizes the output ripple voltage
$L= D (V_{in}- V_{out})/ (F_s* I_{ripple})$ ----------- (3)
$C= I_{ripple}/ 8*F_s*\Delta V$ ----------- (4)
Where,
F_s= switching frequency
A control method by which the transistor operates in the saturation or cutoff is called pulse width modulation. When controlled by PWM the transistor is saturated for a length of time known as on time, it is then driven to the cutoff region for a time called the off time. During the on time V_{CE} is very

small in comparison to the other voltages in the circuit and is typically approximated as zero to simplify the circuit analysis. During the off time the transistor is cutoff, which effectively results in an open circuit between the collector and the emitter.

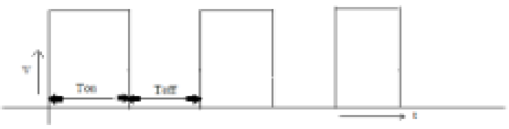

Fig.2(a): output voltage waveform of inductor current

Fig2(b): wave form of inductor current

The transistor thus operates as a switch that is closed during the on-time and open during the off-time, when the switch is closed, the full source voltage appears across the load: when the switch is opened, the load voltage is zero. The sum of the on and off times is the total period of the switch.

closed loop pi controller of buck converter:

The output voltage of the buck converter is controlled by using PI controller. The input voltage V ref is compared with the output voltage V out an error signal is produced which is then processed through PI controller to obtain a control voltage. The PWM generator is fed with the control voltage obtained for The control of switch . PI controller consists of two parameters those are K p and K i. The transfer function of pi controller.

$C(s) = K_p + K_i/s$ ----------- (5)

Where,

K_p =Proportional gain

K_i =Integral gain

III . *FUZZY LOGIC CONTROL STRATEGY*:

A fuzzy logic is a form of valued logic where the truth values of the variables may be a real number which is in between 0 and 1.This fuzzy logic is based on an "IF-THEN" rule system. Generally, a fuzzy logic rule system has four modules: fuzzification, fuzzy interface, rule base, defuzzification. The crisp normalized input data is transformed into membership grades of fuzzy sets by fuzzification. Therefore here we require fuzzy sets. We have considered two inputs, they are: error and the second input is the change of error. After the transformation of crisp values into fuzzy sets, an interface is drawn on it. So, we need a rule base which consists of if-then rules. The controller infers the control action using these rules that has to be taken. Fuzzy values are transformed back to the crisp values by defuzzification which controls the actuators. For this we require fuzzy sets. We have used triangular fuzzy sets for output variable,

Membership functions of error:

i.e., control action that has to be taken over the motor actuators. This output is then scaled that denormalize it and bring it back to the operating range. This is then supplied to the motor to serve our purpose.

fuzzy logic controller general structure:

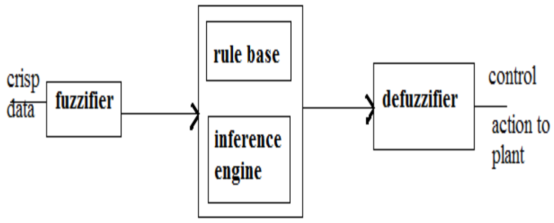

Fig.3: general structure of fuzzy logic controller

Fuzzifier decides the fuzzification strategies and interpretation of a fuzzification operator. InthetypicalFLC, theinput variables are choosen as error e and change in error Δe, which are converted in to fuzzy sets using triangular membership functions. The rule base is the collection of rules that describe the control strategy which depends on the choice of process state (input) variables and control (output) variables. Defuzzifier decides the defuzzification strategy to convert the output fuzzy variable in to a corresponding crisp value. Here the centre of gravity(COG) method is considered.
fuzzy logic controller has the error e and the change of error C e as two inputs, which are defined

$e = V_0 - V_{ref},$ -------- (6)

$C_e = e_k - e$ --------- (7)

Where the present output voltage is VO , the reference output voltage is Vref . The values which are taken at the beginning of the kth switching cycle is denoted as k. The duty cycle obtained is considered as the output of the fuzzy controller

$D_{k} = d_{k-} \alpha \delta d$ -------- (8)

SIMULINK MODELS

Fuzzy control block diagram:

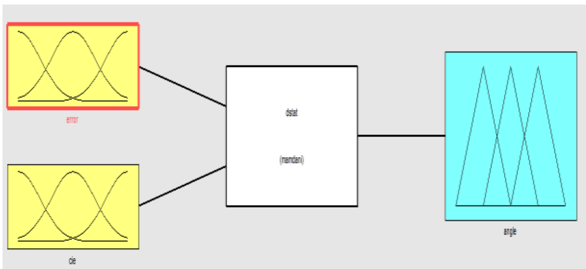

Fig.4: block diagram of fuzzy logic controller

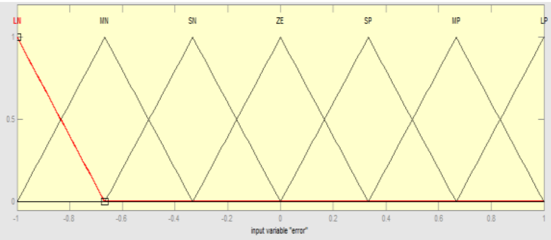

Fig.5: member ship function of error

Membership functions of change in error:

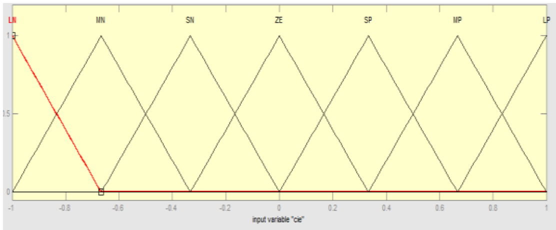

Fig.6:member ship function of change in error

Membership function of output variable:

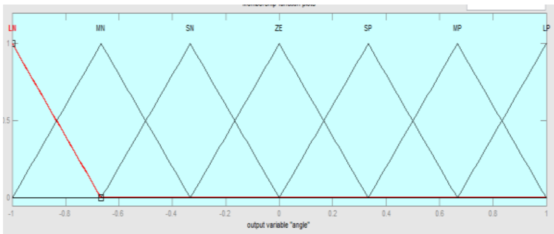

Fig.7: output variable membership function

IV. SIMULATION RESULTS:

With PI and fuzzy logic controlling techniques the simulation of the project is conducted in matlab/simulink and the results are given below:

PARAMETER	VALUES
Input voltage	48v
Output voltage	24v
Inductance(L)	1mh
Capacitance(C)	500e-6
Resistance (load)	80
frequency	50khz

Table.1: parameters of buck converter

Simulink model for buck converter connected PI controller:

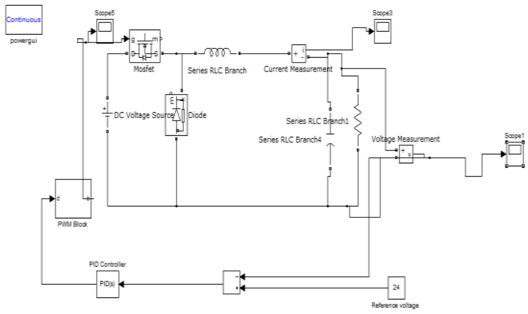

Fig.8: buck converter connected PI controller simulink model

Output voltage waveform of buck converter with pi controller:

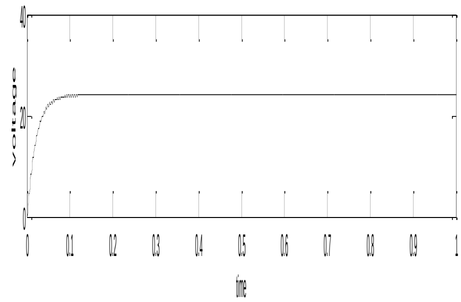

Fig.9: output voltage waveform of buck converter with PI controller

the output voltage of buck converter has been controlled to 24v with a rise time (t_r) 0.02s, peak time (t_p) 1.3ms settling time of 0.016s

Simulation diagram of buck converter with fuzzy logic control:

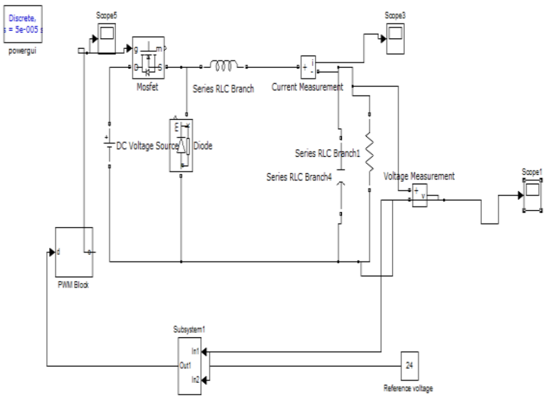

Fig.10: simulink model of buck converter with fuzzy logic control

Controlled output voltage of buck with fuzzy logic controller:

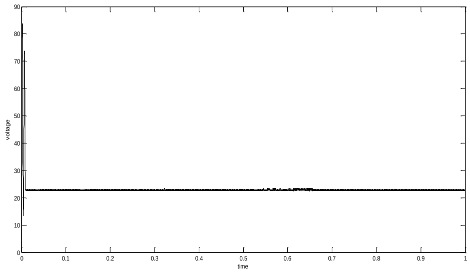

Fig 11: Controlled output voltage wave form of buck with fuzzy logic controller

The output voltage of buck converter has been controlled to 24v with a rise time(t_r)0.7ms, peak time(t_p) 2.2ms settling time of 0.01s

Simulink model of buck converter using fuzzy logic controller with load variation:

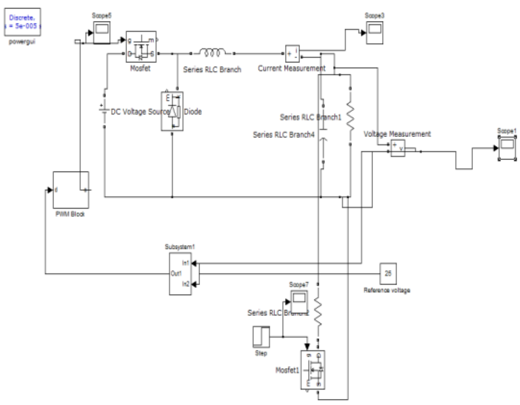

Fig.13: simulink model of buck converter using fuzzy logic controller with load variation.

output voltage waveform:

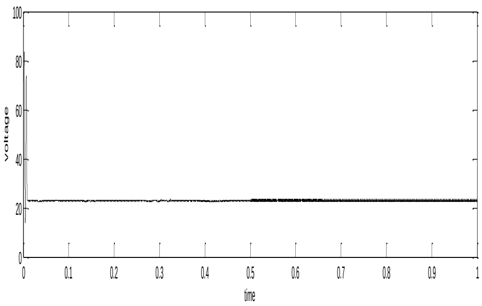

Fig.12: output voltage waveform of buck converter using fuzzy logic controller with load variation

The output voltage of buck converter has been controlled to 24v with a rise time(t_r) 0.7ms, peak time(t_p) 2.2ms settling time of 0.01s .

*performance comparision***:**

The combined performance analysis is done between PI controlled buck converter, fuzzy controlled buck converter and the load variation of buck converter with fuzzy logic controller. The complete analysis is represented in Table. By this analysis the performance of fuzzy logic controller is much preferred than that of PI controller in terms of rise time, peak time, peak overshoot with the system stability and the constant required output voltage with fuzzy logic control even when there is a load change.

PARAMETERS	*With PI controller*	*With fuzzy control*
Input voltage(V_{in})	48v	48v
Rise time(t_r)	0.02s	0.7ms
Peak time(t_p)	1.3ms	2.2ms
Settling time(t_s)	0.016s	0.01s
Output voltage (V_{out})	24v	24v

Table.2:comparision between PI and FLC

CONCLUSION:

The comparison between the working performance of fuzzy logic controlled buck converter and pi controlled buck converter has been analysed with an input voltage of 48v which is controlled to 24v with a load resistance of 80 ohms. The settling time in fuzzy logic controlled buck converter is very less when compared with pi controlled buck. The output voltage is maintained constant with the consideration of FLC even when there is a load variation which gets reduced to 40 ohms. Thus fuzzy logic controller maintains the output voltage constant even with the consideration of small parasitic elements. Fuzzy logic controller (FLC) is comparatively much preferred than pi controller in terms of performance measures like rise time, peak time, settling time in addition to the constraints of size and cost . There is a less voltage deviation in fuzzy logic controller. There is a better dynamic performance in fuzzy logic controller due to small peak over shoot and sensitive to parametric variations. It is applied to many converter topologies. Fuzzy logic controllers has an advantage of higher accuracy with fast response. The study of Simulation has been done with the comparison of PI ,fuzzy controlled buck converter and the constant output voltage even when there is a load deviation.

REFERENCES:

.

1. Design and Simulation of Fuzzy Logic Controller based Switched-Mode Power Supply, *IPASJ International Journal of Electrical Engineering (IIJEE)*

2. fuzzy logic control for a dc to dc buck converter Jenica-Ileana CORCAU, Liviu DINCA **,**University of Craiova, Faculty of Electrical Engineering.

3. International Research Journal of Engineering and Technology (IRJET),
Chetan P. Ugale1, R. B. Dhumale2, V. V. Dixit3

4. Alexander G. Perry. "", IEEE Transactions on Industrial Electronics, 10/2007.

5. Witold Pedrycz, *Fuzzy Control And Fuzzy Systems*, Research Studies Press LTD., 1989.

6. Adaptive Fuzzy Logic Controller for Buck Converter
Bhagyashri U. Patil, Satyawan R. Jagtap.

7. Wing-Chi So,Chi K. Tse, Yim-Shu-Lee, *Development of a Fuzzy Logic Controller for DC/DC Converters: Design, Computer Simulation, and Experimental Evaluation*, IEEE Transaction On Power Electronics, Vol. 11, NO.1.

8. M. Smyej & A. Cheriti, *Fuzzy logic control of DC to DC converter*, IEEE Canadian Conference.