International Journal of Recent Trends in Engineering & Research
ISSN (ONLINE) : 2455 – 1457
IMPACT FACTOR : 4.101

ICNSCET19- International Conference on New Scientific Creations in Engineering and Technology

CURRENT CONTROLLED DC-DC CONVERTER USING FUZZY LOGIC CONTROLLER

K.Santhana Kumar [1], M.Thanga Vignesh [2], Dr.N.Rathina Prabha[3], M.E., Ph.D.,

[1,2] Final year EEE, Dept. of EEE, Mepco Schlenk Engineering College (Autonomous), Sivakasi,
[3] Associate Professor (Sr. Gr), Dept. of EEE, Mepco Schlenk Engineering College (Autonomous), Sivakasi.

Abstract— This project aims to eliminate the voltage steady-state error and attain high-accuracy current estimation without using current sensor. The eradication of voltage steady-state error and achieve high-accuracy current estimation the comprehensive compensation strategy is used. This comprehensive compensation strategy algorithm cannot effectively riddance the output voltage steady-state error, so fuzzy logic controller is implemented. A digital current-mode controller for dc-dc converters is introduced. The current control mode includes current observer and Predictive Current Control (PCC) algorithm. This achieves the highest observation accuracy by compensating for all the known parasitic parameter. By adopting the perfect current observer-based predictive current controller, a boost converter is implemented. The current-mode control is sensorless and depend on constants and inner loop states.

Keywords— *Boost converter, voltage steady-state error, Fuzzy logic controller, fuzzy membership functions, Current observer.*

I. INTRODUCTION

In recent years, digital control of boost converter has become one of the significant research topics when compared with the voltage control mode, the current control mode has higher response speed and high loop gain bandwidth. However, in current control mode, when the Pulse Width Modulation (PWM) duty ratio is higher than 50%, a slope compensation circuit is necessary and to maintain system stability. Due to this high robustness and high response speed, PCC has been brought into boost converter current control loop design and has been widely investigated. In PCC mode, the inductor current of the next switching cycle should be predicted, and the duty ratio for the next switching cycle can be calculated according to the reference current and predicted current. The inductor current can only be sampled once in each switching cycle, it is normally equal to the control period in a digital control boost converter system. For conventional PCC of a boost converter system, precise current sampling is necessary. There are three most common current sampling types. The first type is a shunt resistor in series with the switching component, the second type uses current mirror to reconstruct the switch component current and the third type is a Hall effect current sensor and is very accurate, but the cost of Hall effect current sensors is relatively high, and the additional current sampling module reduces system reliability. The sensorless current control can maintain the advantages of current mode control without using the current sensor. Therefore, combining the sensorless current control with PCC for boost converter system design has very good potential for practical applications. Sensorless current observer is normally used for its current estimation. The input voltage of the system is 24 V and the output voltage is boosted 48 V by using boost converter. The fuzzy controller should be used to obtain a stable output voltage. The pulse width modulation technique is used and a pulse signal is given the driver circuit. The paper consists of the following sections: Block diagram of the proposed work DC-DC boost converter, Fuzzy controller, and Sensorless Current Control

The main objective of this paper is to design and execute battery charger application, which are simple, reliable, low cost and highly efficient.

II. BLOCK DIAGRAM

Figure 1 shows the proposed block diagram. Here, dc source is given to the inductor to boost the voltage and the boosted voltage is filtered using filter. The input and output voltages are feedback to current calculated block and it is compared with the reference value. After that the output is given to fuzzy logic controller. This fuzzy logic controller is used to control the gate driver circuit for driving the semiconductor switches. This process is continued till peak value is obtained. The input voltage of the converter is 24 V and the output voltage of 48 V is obtained by using boost converter

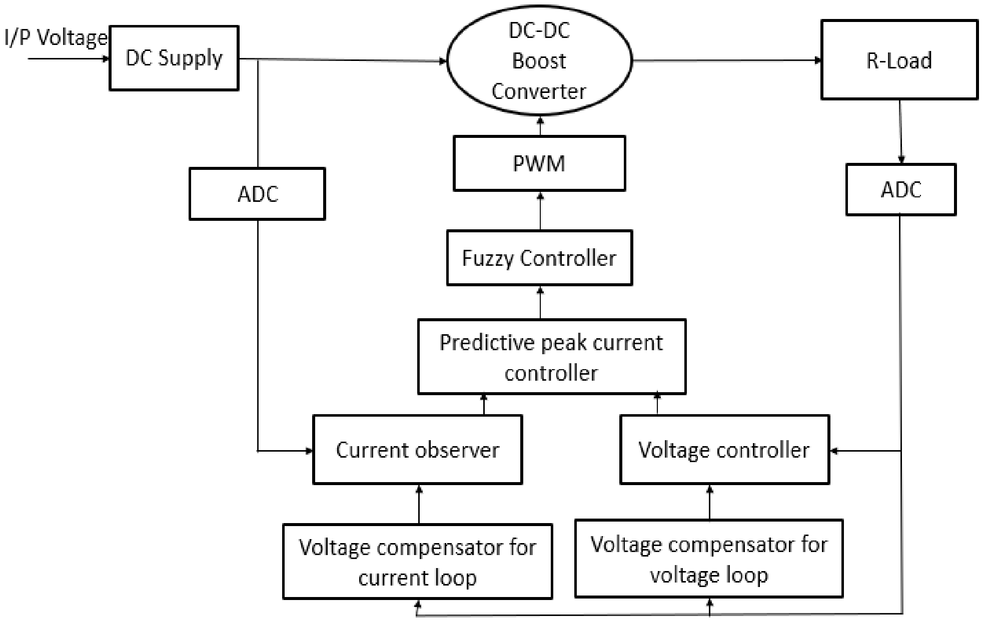

Fig.1.Block diagram.

A. BOOST CONVERTER

A Boost Converter is a power converter in which the output DC voltage is greater than its input DC voltage. It contains two semiconductor switches namely a diode, a transistor and an energy storage element. Filters are usually made of capacitors (sometimes in combination with inductors) are added to the output of the converter to decrease the output voltage ripple.

B. FUZZY CONTROLER

Fuzzy logic controller having one or more than one inputs and outputs are controlled. It can be implemented in both linear and non-linear system. Fuzzy logic controller provides a more efficient and powerful method to solve control systems. Fuzzy logic controller provides an alternative way to represent linguistic and subjective attributes of the real world in computing. In order to improve the efficiency and a simple fuzzy logic controller is adopted. Here, Mamdani Fuzzy interference system (FIS) is used. Pulse Width Modulation is the simplest technique. average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a faster rate.

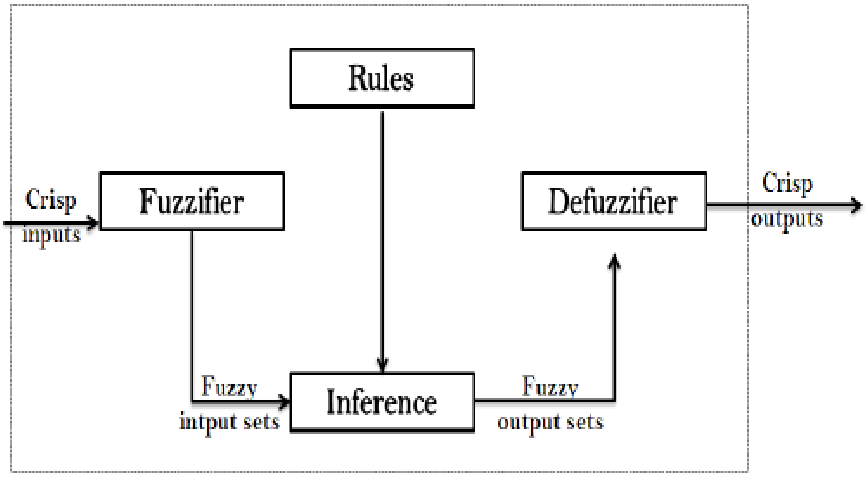

Fig.2.Fuzzy block diagram

III. FUZZY LOGIC MEMBERSHIP FUNCTION

The dc-dc boost converter is a nonlinear function of the duty cycle because of the small signal model and its control method was applied to the control of boost converters. Fuzzy logic controllers are designed to adapt to varying operating points. Fuzzy Logic Controller is designed to control the output of dc-dc boost converter using Mamdani fuzzy inference system. Two input variables, error (e) and change of error (de) are used in this fuzzy logic controller. Figures 3&4 show the linguistic variables for input and output respectively.

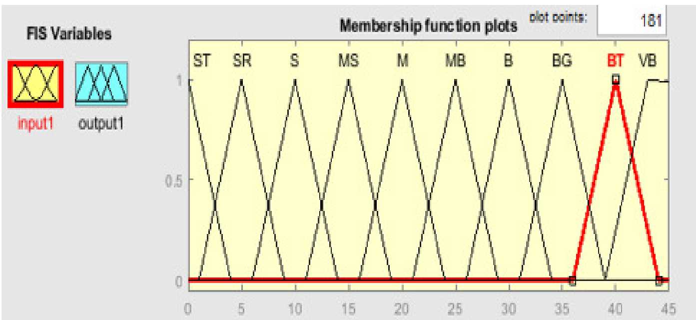

Fig.3.Input variable of membership function

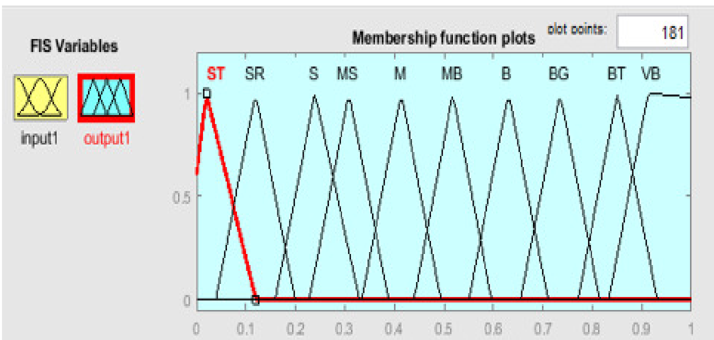

Fig.4.Output variable of membership function

Table 1 shows the Fuzzy Rules for the input and output variable

Ce \ e	NB	NM	NS	NE	ZE	PE	PS	PM	PB
NB	NB	NB	NB	NB	NB	NM	NS	NE	ZE
NM	NB	NB	NB	NB	NM	NS	NE	ZE	PE
NS	NB	NB	NB	NM	NS	NE	ZE	PE	PS
NE	NB	NB	NM	NS	NE	ZE	PE	PS	PM
ZE	NB	NM	NS	NE	ZE	PE	PS	PM	PB
PE	NM	NS	NE	ZE	PE	PS	PM	PB	PB
PS	NS	NE	ZE	PE	PS	PM	PB	PB	PB
PM	NE	ZE	PE	PS	PM	PB	PB	PB	PB
PB	ZE	PE	PS	PB	PB	PB	PB	PB	PB

Table.1. Fuzzy rule

NB-Negative Big,
NM-Negative Medium
NS-negative Small
NE-negative Equal
ZE-Zero Equal
PE-Positive Equal
PS-Positive Small
PM-Positive Medium,

IV. SENSORLESS CUREENT CONTROL

The structure of conventional sensor less current control for a boost converter is shown in fig 5. The Inductor current and PWM duty cycle are predicted according to the input and output voltage. The system contains of two control loops namely: voltage control loop and current control loop. Voltage control loop is used to control the uses of fuzzy logic controller and the current control loop is used to control the uses of sensorless predictive current controller. In continuous current mode without consider in the parasitic parameters of inductor L and output capacitor C, the average inductor currents I_o(t) and average output voltage v_0(t) as variables.

$$d_i L(t) = \frac{V_i n(t)}{L} - \frac{[1-D]V_o[t]}{L} \longrightarrow (1)$$

$$\frac{dv_o(t)}{dt} = \frac{(1-D)I_L[t]}{C} - \frac{v_o(t)}{RC} \longrightarrow (2)$$

Where D is the duty ratio, R is the equivalent load, and v_{in}(t) is the input voltage. Equations (1) and (2) are the basic boost converter state equations.

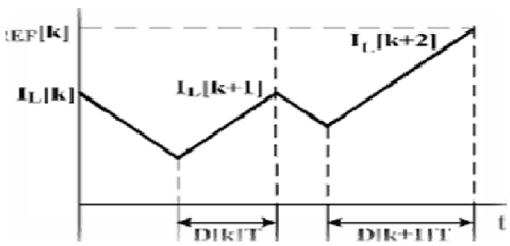

Fig.5. Inductor current waveform of peak current control mode.

D. FIRST ORDER CURRENT OBSERVER

According to (1) and (2), when the boost converter works under Current control mode, the system is observable. The inductor current can be estimated by using current observer. In the actual system, voltage sampling, predictive current calculation, and duty ratio updating is finished in one switching cycle. In order to precisely control the sampling value and to have enough time for algorithm calculation input and output voltage sampling is done at the beginning of the switching cycle and the sampled values are used for inductor current estimation. The deducing process for the first-order current observer in discrete format is as follows.

V. SIMULATION DIAGRAM

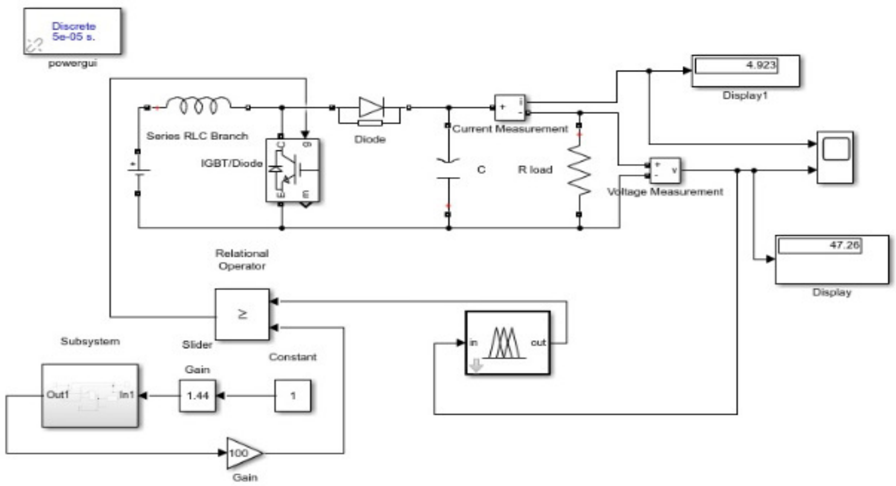

Fig.6.shows the closed loop boost converter

VI.RESULTS AND DISCUSSION:

For the input voltage of 24V and an output voltage is 48V by using boost converter. Here, fuzzy controller is used to get the stable output voltage. In existing system PI controller is used but that controller cannot effectively remove the steady state output voltage error. So, here Fuzzy controller is used. It was effectively eliminated and the stable output voltage is obtained. The open loop output voltage and output current waveforms are as shown in figure 9. when the gate pulse is given to the MOSFET it will generate the Pulse width modulation (PWM). The closed loop output voltage and current waveforms are shown in figure 10.

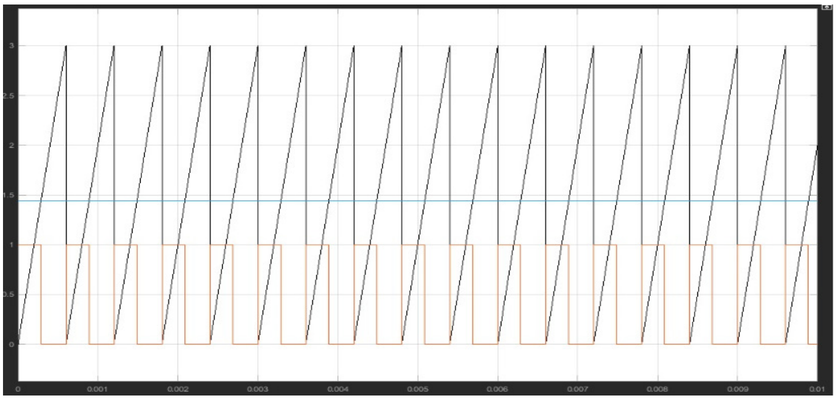

Fig.8.PWM output waveform

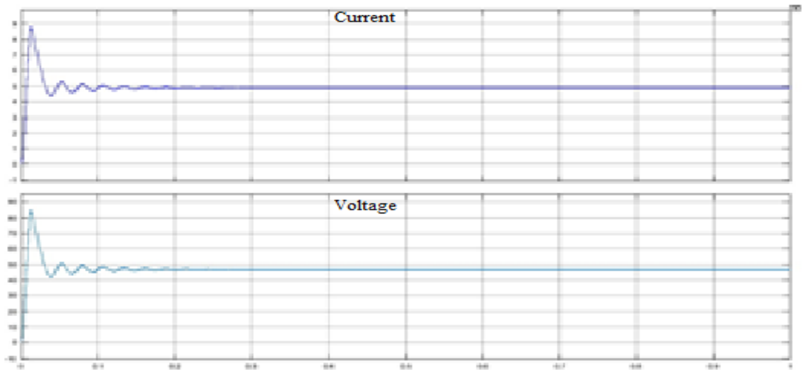

Fig.9.Open Loop voltage and current waveform

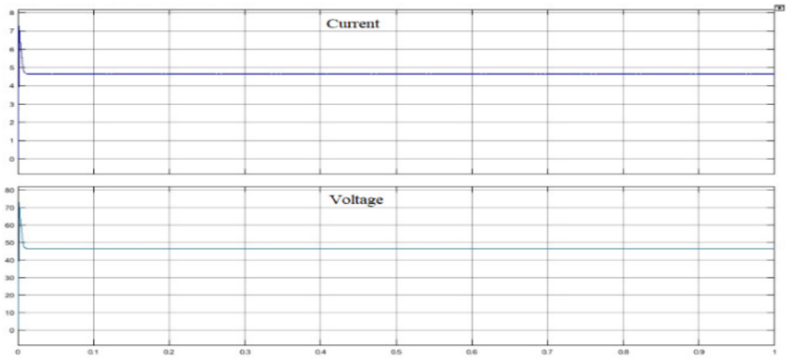

Fig.10.Closed loop voltage and current waveform

VII. CONCLUSION

A sensorless predictive peak current control has been presented in this paper. The Fuzzy logic controller is implemented in this paper. This controller is effectively removes the voltage steady state error and achieves high accuracy current estimation without using current sensor. By employing the observer-based predictive current controller, a boost converter is implemented.

VIII. REFERENCES

[1]. Y.Li,K.R.Vannorsdel and D.Maksimovic, “Current mode control for boost converters with constant power loads,” IEEE Trans. Circuits Syst. I, Reg.Papers, vol. 59, no. 1, pp. 198–206, Jan. 2012.

[2]. M.Veerachary and R.Saxena, “Design of robust digital stabilizing controller for fourth-order boost DC–DC converter: A quantitative feedback theory approach,” IEEE Trans. Ind. Electron., vol. 59, no. 2, pp. 952–963,Feb. 2012.

[3]. F.Taeed, Z.Salam, and M.Ayob, “FPGA implementation of a single input fuzzy logic controller for boost converter with the absence of an external analog-to-digital converter,” IEEE Trans. Ind. Electron., vol. 59,no. 2, pp. 1208–1217, Feb. 2012.

[4]. YingQiu, Helen Liu, and Xiyou Chen, "Digital Average Current-Mode Control of PWM DC–DC Converters without Current Sensors," IEEE Trans. Ind. Electron.,VOL. 57, NO. 5, MAY 2010.
[5]. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R. University,Chennai.Vol.no.1, pp.199-207, Dec.2007.
[6]. P. Midya, P. T. Krein, and M. F. Greuel, ``Sensorless current mode control-an observer-based technique for DC_DC converters," IEEE Trans. PowerElectron., vol. 16, no. 4, pp. 522_526, Jul. 2001.
[7]. H. El Fadil and F. Giri, ``Backstepping based control of PWM DC_DC boost power converters," in Proc. IEEE Int. Symp. Ind. Electron.,Jun. 2007, pp. 395-400.
[8]. DakeHe and R. M. Nelm, "Peak currentcodecontrol far a boost converter using an 8 bit microcontroller." Proceedings of the 2003 IEEE 34th Annual Conference on Power Electronics Specialist (PESC 2003), VoIume: 2, 15-19June 2003, Acapulco, Mexico, pp. 938-943.