ISSN: 0975-766X
CODEN: IJPTFI
Available Online through
www.ijptonline.com
Research Article

SYNCHRONOUS BUCK CONVERTER USING PI AND PID CONTROLLER

Y.Apoorva[1], Chaitanya Kumar[2],R.Manikandan[3],R.Thangam[4]
U.G.Students, Dept. Electrical and Electronics Engineering, Saveetha School of Engineering, Chennai.
Assistant Professor, Department of Electrical and Electronics Engineering, Thandalam, Chennai.
Email: apoorvay2014@saveetha.com

Received on: 02.10.2016 *Accepted on: 28.10.2016*

Abstract

In latest power electronics, buck converter is a valuable and really original gadget. The dc-dc converters play an principal function in lots of the utility. For example an unregulated dc enter has to feed many circuits in an application like computing device with exclusive voltage/current standards. In some cases the vigour requirement range is of KW as in electrical automobiles and mw in case of telephones. All of the converters has few requisites like high density which leads to smaller measurement, excessive efficiency, which results in low losses and powerful to any alterations within the enter or output.PID controller is the amazing and common process to manage the buck converter. In modern computerized control also PID controller is generally used. Some applications require only one or two terms appropriate to the system. According to the system the required P, PI, PID controllers are used and the only the system works with high efficiency and gives high quality performance. PI controllers are fairly common.

Keywords: PID-Controller, PI - Controller, DC - DC Converter.

Introduction:

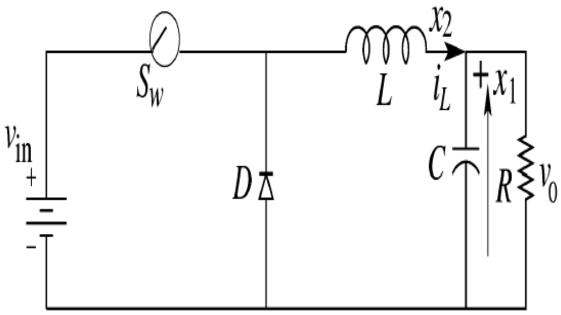
DC-DC converters are a portion of the most straightforward circuits which change over force level of DC power adequately. In advanced PC, dc engine drive, power framework, car, flying machines, it has wide application .The usually utilized control strategies are PWM , Voltage mode control, PWM current mode utilizing PI and PID controller .But this can't perform agreeably under *burden* conditions.

The PID control is named after its three terms who sum gives the manipulated variable. The proportional, the integral and the derivative terms are summed to give the output of the PID controller.

$$U(t)=K_p e(t)+K_i\int_0^t e\,(T)\,d(T)\;+K_d\frac{de(t)}{dt}$$

PID controller has all the necessary dynamics; fast reaction on the change of controller input, increase the control signal to lead error towards zero and suitable action inside the control error area to eliminate oscillations. Derivative mode improves the stability of the system and enables increase in gain K and decrease in integral time constant Ti, which increase the controller response. PID controller is used when dealing with higher order capacitive processes.

PI controllers will not increase the speed. PI controllers are very often used in industry, when speed of response is not an issue .A control with D mode is used when: fast response is not required, large disturbances and noise are present during operation of process, there is only one energy storagein process and there are large transport delays in the system. The direct controllers like PI and PID don’t offer a decent substantial sign working conditions. These controllers have the capacity of responding quickly to a transient condition.



Fig(1): Model of buck converter.

II.DC-DC Buck Converter:

A DC – DC converter converts high level voltage to a lower level voltage. The buck converter is represented in two ways i.e. innumerical displaying and in electrical demonstrating in this paper. The basic buck converter circuit consists of Inductance (L), Capacitance (C), Inductance series Resistance (RL), and Capacitance Series Resistance (R_c).

The numerical displaying consists of two loops. The first loop gives the information about inductor and the second loop is about the yield voltage. A mathematical statement is taken from variable framework structure model to show this two loops. From the basic model we can know that:

The primary loop is solving the Inductor current. The differential mathematical statement acquired from applying KVL

$$V_{in}D = \frac{Ldi_L}{dt} + i_L R_L + V_0 \ldots \ldots \ldots (1)$$

$$\frac{Ldi_L}{dt} = V_{in}D - i_L R_L - V_0 \ldots \ldots \ldots \ldots (2)$$

$$i_L = \left(\frac{i}{L}\right)\int (V_{in}D - i_L R_L - V_0)dt \ldots\ldots\ldots (3)$$

The second loop gives the ouput voltage. The output voltage was given by the sum of the Capacitor Voltage and the drop across the Capacitor Series Resistance (Rc)

$$C\left(\frac{dV_C}{dt}\right) = i_L - i_{out} \ldots\ldots\ldots\ldots (4)$$

$$V_c = \frac{1}{C}\int (i_L - i_{out})dt \ldots\ldots\ldots..(5)$$

Withrespect to duty cycledesign a transfer function of the systemand then design a PID controller. By applying Laplace Transform to Eqn (2), we get:

$$V_{in}D = Li_L S + i_L R_L + V_0 \ldots\ldots(6)$$

the drop across Rc is neglected. We can assume that V_c=V_o. using Laplace Transform, rearrange the terms on Eqn (9) ,we get

$$\frac{V_0}{D} = \frac{\frac{V_{in}}{LC}}{S^2 + S\left(\frac{1}{R_0 C} + \frac{R_L}{L}\right) + \left(\frac{1}{LC} + \frac{R_L}{R_0 LC}\right)} \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

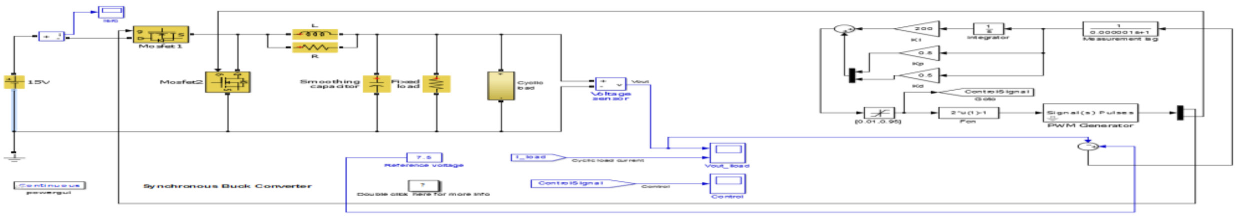
The value of K_p, K_i ,$K_d$can be derived for the system by applying different tuning technique like Ziegler– Nichols, Cohen–Coon. PID tuning is a difficult problem. Tuning is adjustment of control parameters to the optimum values for the desired control response.

The modified version of basic buck converter is a synchronous buck converter. In this the second switch replaces the diode. This modified version made a balance between increased cost and improved efficiency. As a result of the rising voltage across the diode, the fly back diode turns on, on its own after the switch turns off in a standard buck converter.The power loss occurs due to the voltage drop across the diode which is equal to

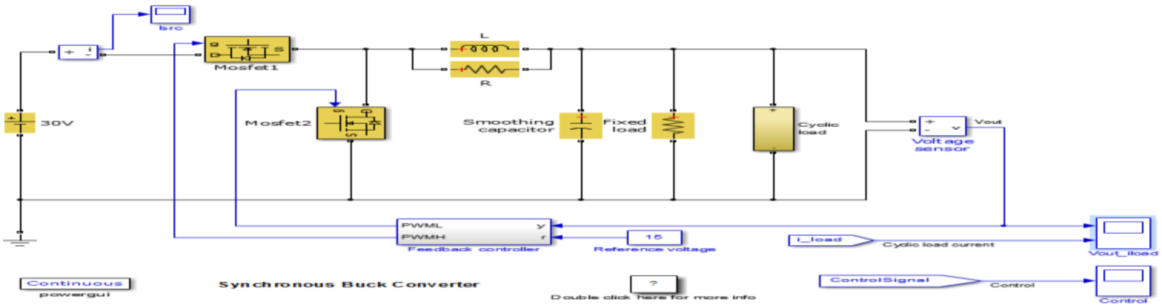
IV. Implementation of Pi and Pid Controlled Buck Converter

A power electronics device which is used to convert high level of voltage to a lower level voltage is a DC DC buck converter. This paper shows the implementation of buck converter using PI and PID controllers. A buck converter consists of Inductance, Capacitance,resistive load. The output voltage isV_{out} and is compared with a reference voltage V_{ref} . Then it produces an error signal. The error signal is sent toPID controller to generate control voltage V_c.The control voltage is then fed to the PWM generator which depends on the waveform to alter the duty cycle. The signal has fixed frequency, and therefore the switch has constant frequency. The PID controller parameters can take any three values and finding these values by different are collectively called as PIDtuning. There are numerous methods for tuning PID controllers.

V. Simulation:



Fig(3):Synchronous Buck Converter using PID Controller.



Fig(4):Synchronous Buck Converter using PI controller

Results:

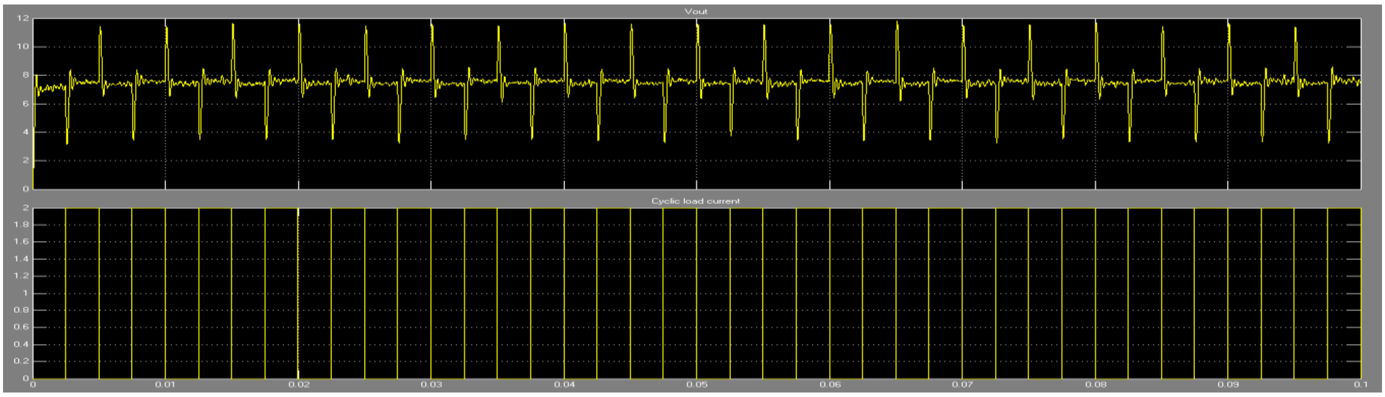


Fig (6): When Vin=15v, F=50,000Hz using PID controller

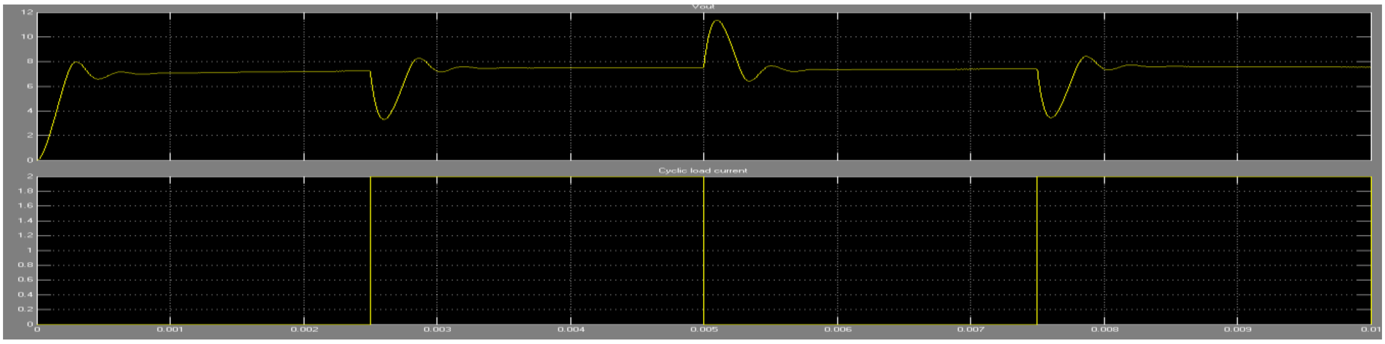


Fig (7): When Vin=15v,F=50,000Hz using PI controller

The circuit model is designed and verified in MATLAB/simulink. The synchronous buck converter is implemented using PI and PID controller of different inputs and different output parameters are observed. The input voltage is taken as V_{in} = 15V and the reference signal of the system is taken as V_{ref}=7.5V for simulation. The desired output voltage is V_{out}=7

Conclusion:

In this paper, the PI and PID controller scheme is applied for output voltage regulation in a dc dc converter. It is possible to design a stable, efficient and ruggedized buck converter by PID controller which has faster transient response. The PID controller results in a significantly faster response that obtained with regard to the output voltage to the desired voltage. Higher efficiency switch mode supplies can be designed by using PID control action.

Reference:

1. Eric William Zurita- Bustamante, "A Comparison between the, GPI and PID controllers for the stabilization of a DC–DC buck converter: and a field programmable gate array implementation" IEEE transactions on industrial electronics, Vol. 58, No. 11, pp. 1-12, November2011.
2. Paresh J. Shah, RakeshSaxena , M.P.S. Chawla, "Digital filter design with harmonics estimation for power supplies", Springer journal of the institution of engineers, Vol.93, No. 2, 73-79, July 2012.
3. Myaing and V. Dinavahi, "FPGA-based real-time emulation of power electronic systems with detailed representation of device characteristics", IEEE transactions on industrial electronics, vol. 58, no. 1, pp. 300 –368, Jan. 2011.
4. M. Cirstea and A. Dinu, "A VHDL holistic modeling approach and FPGA implementation of a digital sensor less induction motor control scheme," IEEE transactions on industrial electronics, Vol.54, No.4, pp.153 –186, Aug. 2007.
5. Y. F. Chan, M. Moallem, and W. Wang, "Design and implementation of modular FPGA-based PID controllers," IEEE transaction on industrial electronics , Vol. 54, no. 4, pp. 1108–190, August, 2007.