National Journal of Multidisciplinary Research and Development
ISSN: 2455-9040
Impact Factor: RJIF 5.22
www.nationaljournals.com
Volume 3; Issue 1; January 2018; Page No. 1063-1066

Analytical analysis and novel determination of feasibility for modeling of boost and buck converter

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Abstract
This paper presents Modeling and analysis of Boost and Buck device control system theme victimization PI Controller. DC-DC Converters area unit accustomed offer a regulated variable dc voltage for several applications like power provides for equipment. DC-DC Converters area unit used once conversion of voltage level is needed. The modeling of device schemes is finished victimization MATLAB/Simulink.

Keywords: boost converter, PI controller, buck converter, DC-DC power conversion, PWM

1. Introduction
The DC-DC converters area unit Electronic devices accustomed modification DC electrical voltage with efficiency from one level to another [1, 2]. These Converters area unit static devices that convert mounted dc input voltage to a variable dc output voltage directly. The aim of a DC-DC convertor is to provide a regulated DC output voltage to a variable load resistance from a unsteady DC input voltage. In several cases, the input DC voltage is obtained by rectifying a line voltage that's ever-changing in magnitude. DC-DC Converters area unit ordinarily utilized in application requiring regulated DC power, like computers, receivers, medical instrumentation, communication device, television, receivers, and battery chargers.

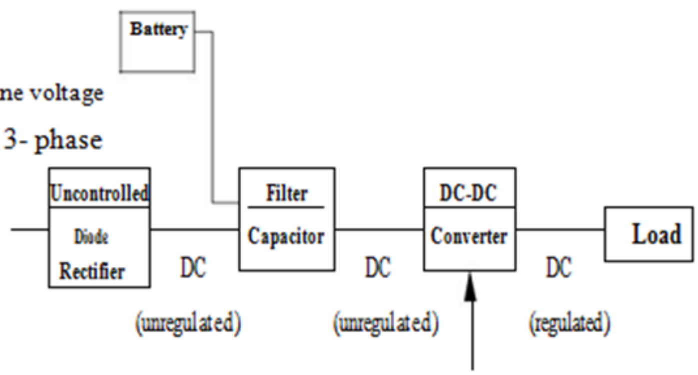

Fig 1: Basic Dc conversion system

DC-DC converters also are accustomed offer a regulated variable DC voltage for DC motors speed management applications. The output Voltage in DC-DC converters area unit usually controlled victimization switch concepts [3]. A basic DC-DC converters were called choppers with silicon-controlled rectifiers used because the switch mechanism. Trendy DC-DC converters classified as switch mode power supply (SMPS) use insulated gate bipolar transistor (IGBT) and metal chemical compound semiconductor field result transistors (MOSFETs).

2. Basic ideas of boost and buck convertor
A. Boost convertor
In a boost convertor, the output voltage is bigger than the input DC voltage. It’s a category of switch mode power supply (SMPS) containing a diode and a semiconductor unit with one energy storage element [4, 5]. Filters square measure unremarkably supplemental to the output of the convertor to scale back output voltage ripple. Since it step or maximize the input or supply voltage, typically known as a change of magnitude convertor. Since power (P=VI) should be preserved, the output current is less than the supply current. For steady-state operation its output voltage is often beyond the input voltage. It boosts the voltage to a better level. The convertor consists of AN electrical device L, an influence MOSFET, a diode D, a filter electrical condenser C, and a load electrical device. The switch S is turned on and off at the switch frequency fs=1/T with the wherever is that the quantity once the switch s is on the boost.
Converter will operate in either continuous or discontinuous physical phenomenon mode, looking on the undulation of the electrical device current [6, 8].
The circuit of the PWM control system boost convertor mistreatment PI controller.

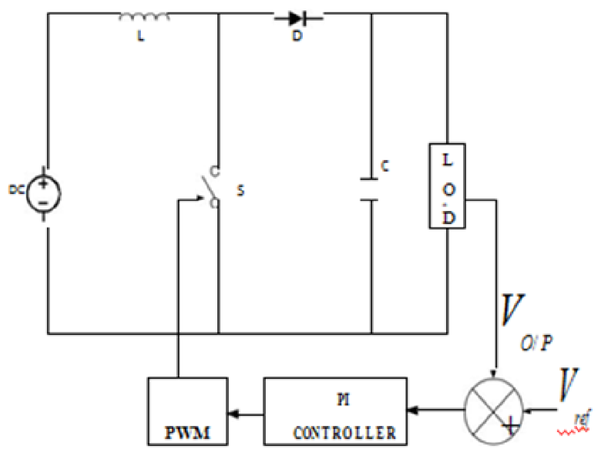

Fig 2: Circuit diagram of closed loop boost

Let us consider operation in the CCM the boost converter for CCM When the switch S is ON and the diode is OFF, and when the switch is OFF and the diode is ON, respectively the current and voltages waveforms are shown in Fig.3.

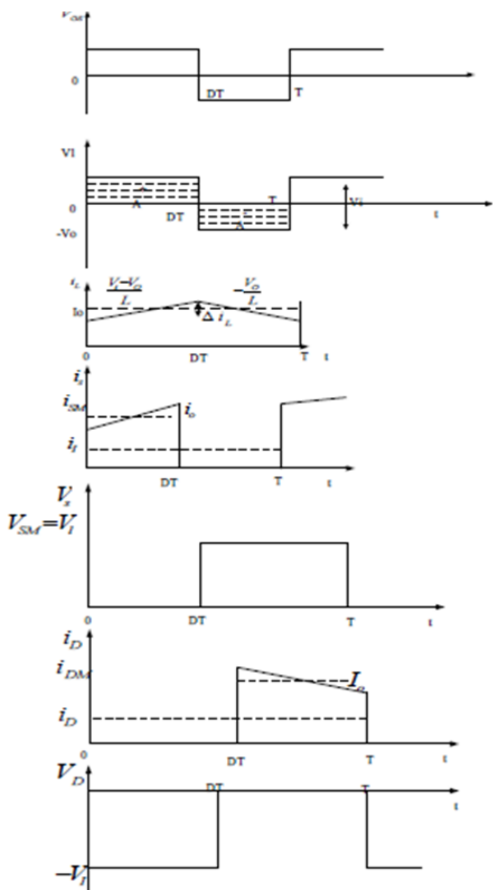

Fig 3: Current & voltage waveforms in the boost converter

The current equals the inductor current. During this time interval, the energy is transferred from the inductor L to the filter capacitor C and the load resistance RL. At time t=T, the switch is turned on again, terminating the cycle. The boost converter has poor ability to prevent hazardous transients and failures.

The converter consist duty ratio: $D = \frac{V_O - V_S}{V_O}$

Calculation of ripple current: $\Delta i_L = \frac{V_O D(1-D)}{L f_s}$

Calculation of inductance: $L = \frac{R_L D(1-D)^2}{2 f_s}$

Calculation of capacitor: $C = \frac{D V_O}{f_s R_L V_r}$

B. Buck Convertor

In a buck convertor circuit usually employed in step down the voltage level from the input voltage consistent with the necessity. It's the benefits of simplicity and low price. A pulse breadth modulated buck dc-dc convertor circuit contain four elements an influence MOSFET used as a switch S, a diode D, Associate inductance L, and a filter condenser C. resistance represents a dc load. Power MOSFETs area unit principally used as manageable switches in dc-dc converters attributable to their high speeds [9, 10]. The diode D is termed a freewheeling diode. The shift network created of the junction transistor and also the diode "chops" the dc input voltage and thus the convertor is termed a „ chopper", that produces a reduced average output voltage [11, 13]. The switch S is Controlled by a pulse-width modulator and is turned on and off at the shift frequency fs=1/T and also the duty cycle D is outlined as

$$D = \frac{t_{ON}}{T} = \frac{t_{ON}}{t_{ON} + t_{OFF}} = f_s t_{on}.$$

The circuit of the PWM closed loop buck converter using PI controller is shown in Fig.4.

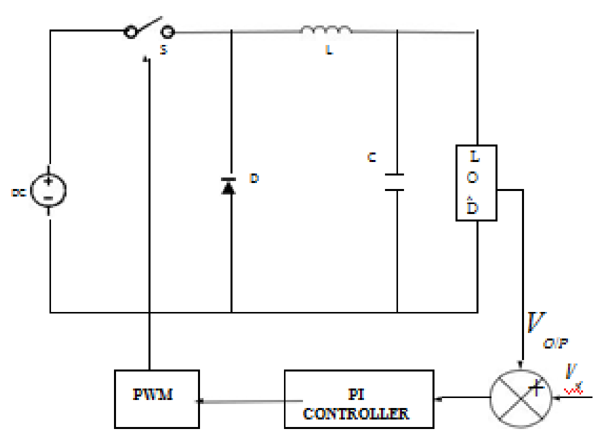

Fig 4: circuit diagram of close loop buck

The converter consist duty ratio: $D = \frac{V_O}{V_I}$

Calculation of Inductance: $L = \frac{R_L(1-D)}{2 f_s}$

Calculation of Capacitor: $C = \frac{D}{2 f_s r_c}$

3. Simulation Result

Table 1: Component value of boost converter

COMPONENTS	VALUE
V_I	12V
V_O	24V
I_O	1 Amp
L	$15\mu H$
C	$20.83\mu F$
R	24ohm

The Closed loop boost converter using PI Controller is shown in Fig.5.

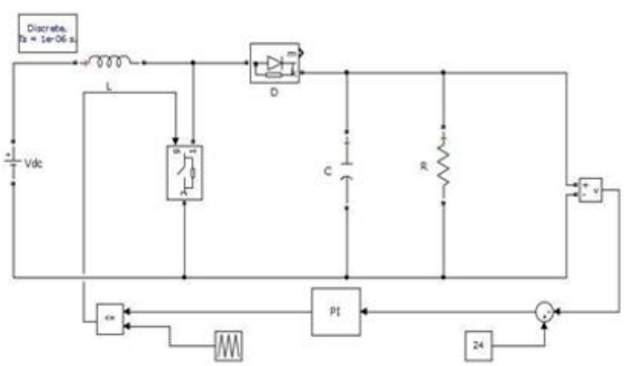

Fig 5: Simulink model of boost converter

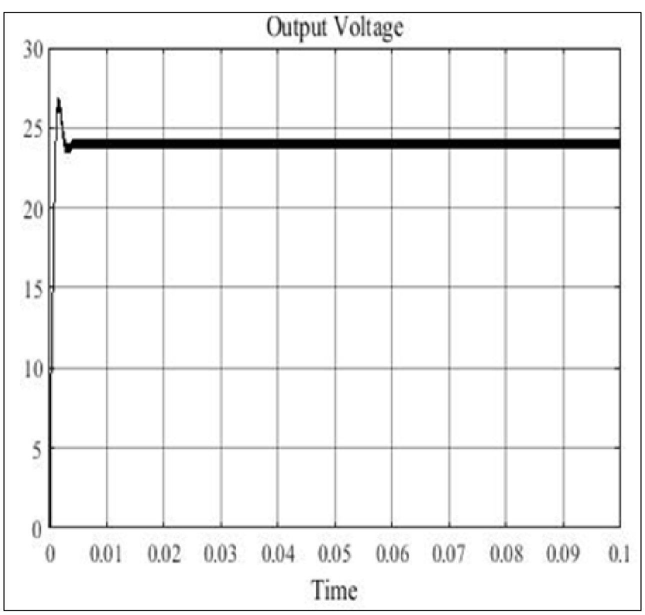

Fig 6: waveform of output voltage of boost converter

Table 2: Component value of buck converter

COMPONENTS	VALUE
V_I	24V
V_O	12V
I_O	0.861 Amp
L	$34.75\mu H$
C	$35.83\mu F$
R	13.9ohm

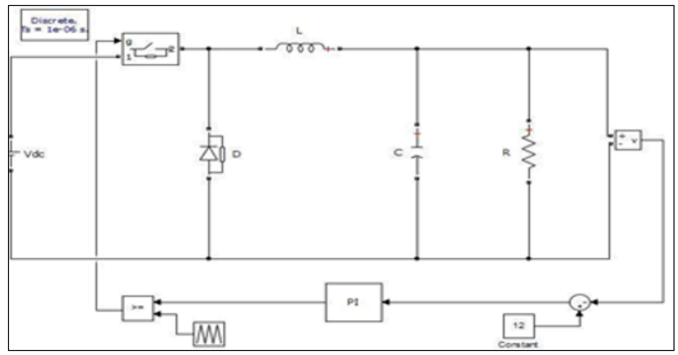

Fig 7: Simulink model of buck converter

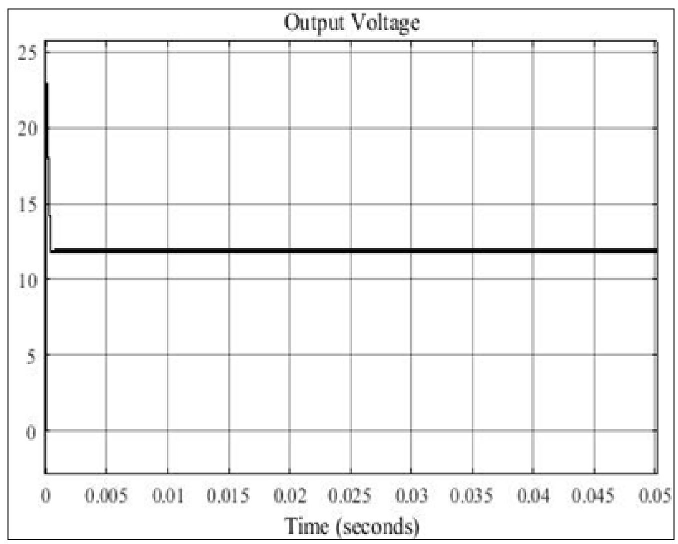

Fig 8: Waveform of output voltage of buck converter

4. Conclusion

Modeling and Simulation of non-isolated dc-dc Boost and Buck converters is presented in this paper. The Boost converter is designed for 12V to 24V with output current 1 amp at 100 kHz switching frequency. Similarly, the Buck convertor is intended for 24V to 12V with output current of zero.86 amp at 100 kHz change frequency. Calculation of electrical device and electrical condenser for desired output parameters is additionally done. The output voltage waveforms obtained when simulation ar enclosed that shows the control system response of each dc-dc converters. Within the given control system models, PI controller parameters will be tuned for higher response of dc-dc converters.

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