Dc-Dc converter

Project synopsis submitted in partial fulfillment

for the Award of

MASTER CERTIFICATION

in

ELECTRIC VEHICLE NANODEGREE PROGRAM

by

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CHAPTER 1

PROJECT DESCRIPTION

Objectives: Design of DC-DC converters using the Simulink model and analysis of their characteristic curve.

Dc-Dc converter: A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a typeof electric power converter. The DC-DC converter is the electronic device that is used to step-up or step-down the applied DC signal. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

The devices that convert AC to DC are called rectifiers. The devices that convert DC to AC are called Inverters. The devices that convert a certain level of DC voltage to another voltage level (low, high) are called choppers. Which are further classified as buck, boost, and buck-boost/bidirectional converters.

There is three types of DC-DC converter as follow:

i. Buck Converter
ii. Boost Converter
iii. Buck-Boost Converter

Buck Converter: A buck converter (step-down converter) is a DC-to-DC power converter that steps down voltage (while stepping up current) from its input (supply) to its output (load). This type of DC-to-DC converter is used to step down high-level DC voltage to low-level dc voltage. It is also called a step-down chopper.

It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). Its name derives from the inductor that “bucks” or opposes the supply voltage.

Circuit diagram:

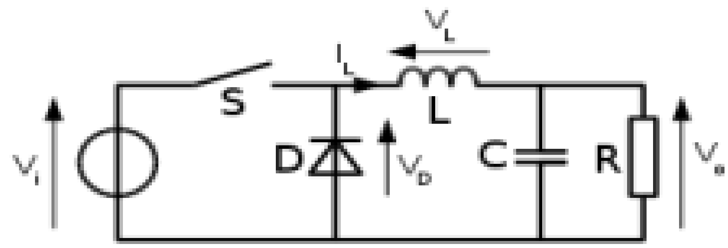

Fig 1: buck-converter circuit diagram

Boost converter: Boost converter is also called step-up choppers, it is a type of chopper circuit that provides an output voltage that is more than the input voltage. In the use of a booster converter, the DC-DC conversion takes place in a manner that the circuit provides a magnitude of output voltage than the magnitude of the supply voltage.

It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). Boost converters are highly nonlinear systems and a wide variety of linear and nonlinear control techniques for achieving good voltage regulation with large load variations have been explored.

Circuit diagram:

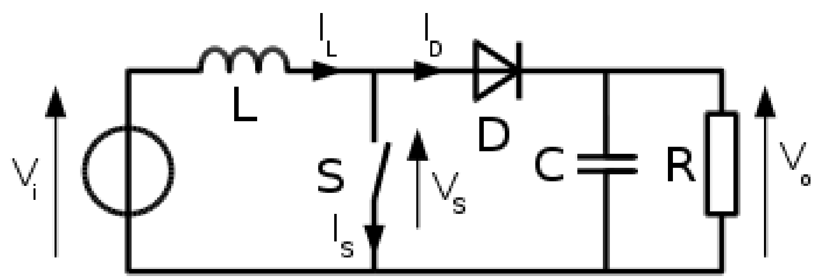

Fig 2: boost converter circuit diagram

Bi-directional converter (buck-boost convertor): The buck-boost converter is a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. The buck-boost converter is a type of DC-DC converter also known as a chopper that has an output voltage magnitude that is either greater than or less than the input voltage magnitude.

The output voltage is adjustable based on the duty cycle of the switching transistor. One possible drawback of this converter is that the switch does not have a terminal at the ground; this complicates the driving circuitry. However, this drawback is of no consequence if the power supply is isolated from the load circuit.

Circuit diagram:

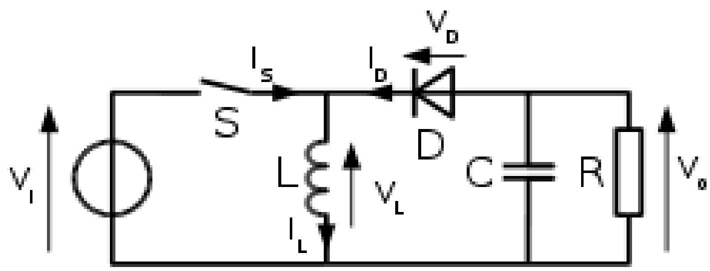

Fig 3: bi-directional converter (buck-boost converter)

CHAPTER 2

REQUIRED INPUT PARAMETERS AND CALCULATIONS

Input parameter of the buck converter:

Parameters	Symbol	Values	Units
Inductance	L	$3*10^{-3}$	H
Capacitance	C	$30*10^{-6}$	F
Switching Frequency	F_{st}	10^{3}	Hz
Load Resistance	R_{Load}	10	Ω
Duty Cycle	D	0.75	
Input Voltage	V_{in}	200	V
Output Voltage	V_{out}	149	V

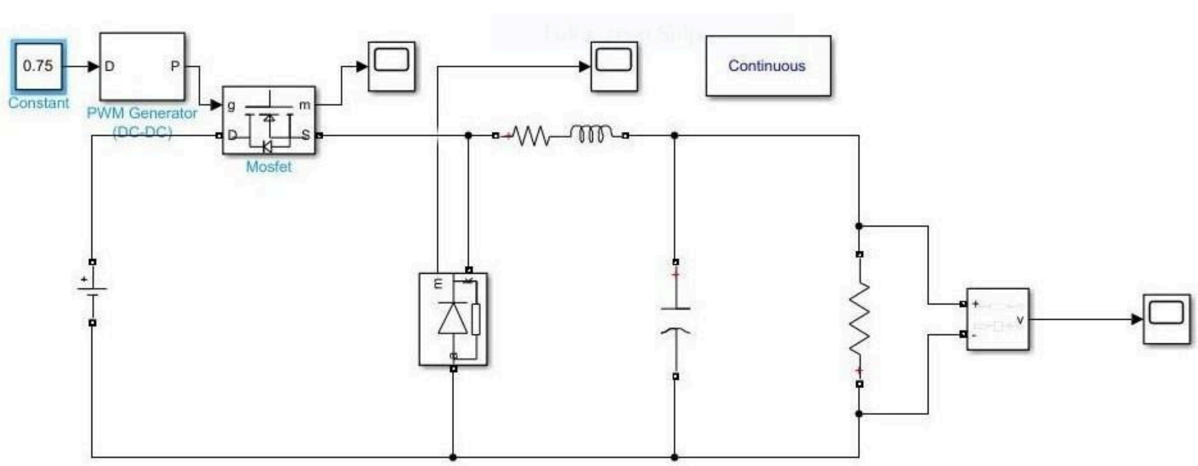

Fig 4: Simulink model of the buck converter

Input parameter of the boost converter:

Parameters	Symbol	Values	Units
Inductance	L	$250 * 10^{-6}$	H
Capacitance	C	$200 * 10^{-6}$	F
Switching Frequency	F_{st}	$20 * 10^{3}$	Hz
Load Resistance	R_{Load}	3	Ω
Duty Cycle	D	0.5	
Input Voltage	V_{in}	24	V
Output Voltage	V_{out}	46	V

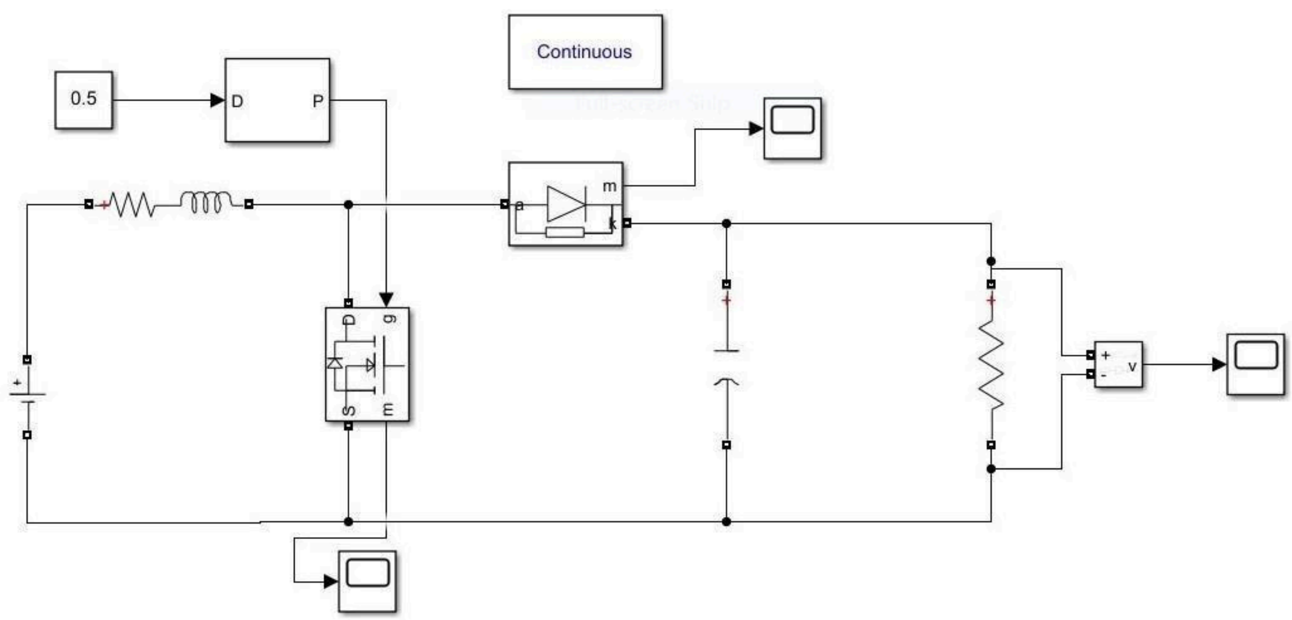

FIG 5: Simulink model of the boost converter

CHAPTER 3:

OUTPUT PARAMETERS

The output of the buck converter:

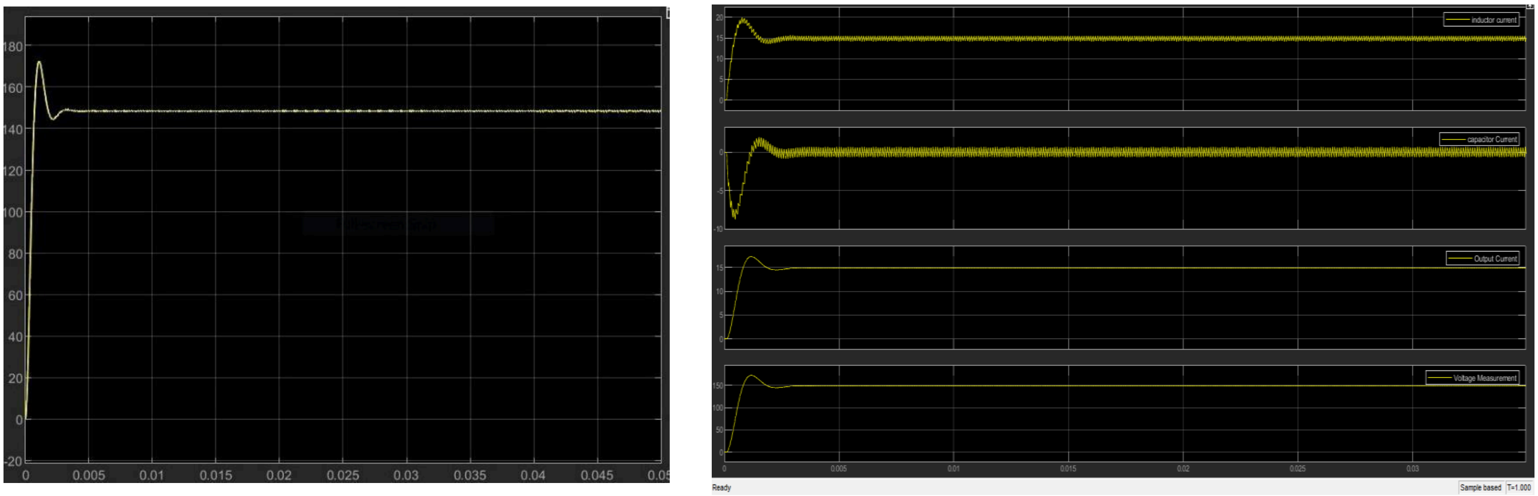

FIG 6: FINAL VOLTAGE AT OUTPUT

The output of the boost converter:

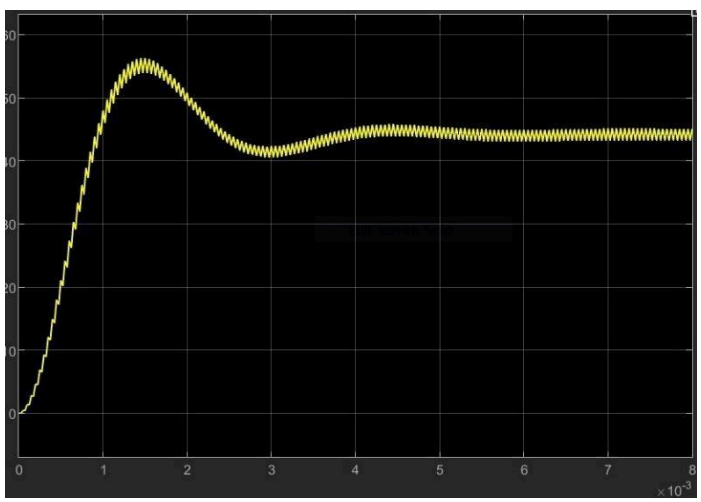

Fig 7: Final voltage at the output

CHAPTER 4

RESULTS AND CONCLUSIONS

Conclusion: From the above result, we can conclude that when we use a buck converter we can step down the input voltage. When we use a boost converter we can step up the input voltage. When we use a buck-boost converter we can get the step-up and step-down voltage as per the duty ratio.

In the DC-DC buck converter, we found voltage has been increased at the output by setting the duty cycle.

In the DC-DC boost converter, we found voltage has been decreased at the output by setting the duty cycle.

Hence when we are using a buck converter than it step-down the output voltage signal and when we are using a boost converter it step-up the output voltage signal.