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Interleaved Buck Boost Converter Fed DC Motor

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Abstract

Nowadays, DC-DC converters are widely required in many applications using resources such as renewable energy sources. In the conventional DC-DC buck-boost converter current stress is high. To overcome this issue, the efficient technique known as Interleaved is implemented. The interleaved method provides the same switching frequency and phase shift. The interleaved buck boost converter is implemented with DC Motor. The proposed chopper, interleaved buck boost converter firing circuit receives signal from controller and the desired speed control is achieved. This paper presents, the Implementation of the interleaved buck-boost converter fed dc motor with desired speed control through MATLAB/Simulink Simulation.

Keywords: Renewable energy sources; Interleaved; current stress; DC motor; firing circuit; desired speed.

I. Introduction

Renewable energy sources such as Solar, Wind Energy are available plenty on the whole with free of cost. Recently, Renewable energy sources such as the fuel cell stacks and photo-voltaic (PV) generation system are involving much in research fields. Because of using these resources result the possible solutions to the

environmental problems. The characteristics of the PV panels, the output voltage from the PV panels varies greatly due to different temperature, clouding effects, irradiation conditions, and shading.

So, a dc–dc converter with either step-up operation or step-down operation or even both step-up and step-down operation is needed. With the conventional converter, the technique interleaved method is implemented to improve power converter performance in terms of reduction in current stress and inductor size.

The proposed system consists of the renewable energy source as the input source, buck-boost converter with interleaved technique for stepping up and stepping down operation of input voltage. The DC motor is connected with these components and the speed control of the motor is achieved by this proposed system.

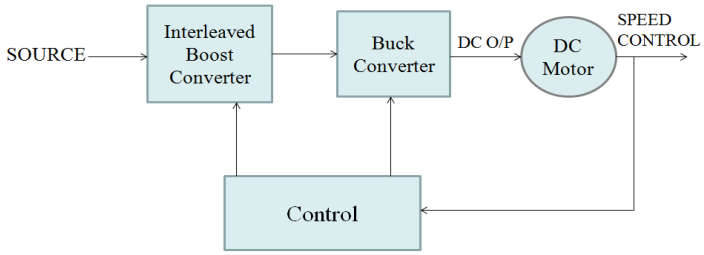

Fig1. Block Diagram of the Proposed System

II. System Configuration

A. Interleaved Buck-Boost Converter

The interleaved buck boost converter consists of several identical boost converters connected in parallel and buck converter in series. As shown in fig 1. Interleaved Buck Boost converter consists of inductors, IGBT switches, diodes, capacitors. Inductors L1 and L2 are used for storage purpose and capacitor C1 and C2 are used for filtering. The semiconductor device S1, S2 and S3 are used as switches. The diodes D1, D2 and D3 are used to create the path to current flow.

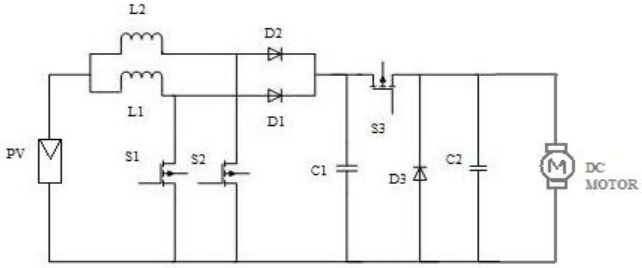

Fig2. Circuit Diagram of Interleaved Buck Boost Converter Fed DC Motor

a) Boost Mode

When the PV panel's voltage is lower than the desired voltage, it will operate in boost mode, in which the *boost Switch* will be switched ON and OFF. The *buck Switch* will be always ON .In this mode, the duty cycle of the *boost Switch* can be found as

$D_{boost} = 1 - Vin/Vo$ *(1).*

Where
Vin is Input Voltage.
Vo is Output Voltage.

b) Buck Mode
When the PV panel's voltage is higher than the instantaneous grid voltage, it will operate in buck mode, in which *buck Switch* will be switched ON and OFF and *boost Switch* will be always OFF. In this mode, the duty cycle of *buck Switch* can be found as

$D_{buck} = Vo/Vin$ (2).

Where
*V*in is Input Voltage.
Vo is Output Voltage.

Thus, if the PV panel's voltage is lower than or higher than the desired voltage, the proposed converter will switch between boost mode and buck mode.

Table I: Design Parameters

Parameter	Value
Input Voltage	12v
Output Voltage	24v
Periods	1msec
Frequency	1khz
Pulse Width	50%
Duty Cycle	0.5

III. Simulation Results & Discussions

a) System Model of Boost converter
The simulation model was done in MATLAB SIMULINK environment with the help of SIMPOWER system and SIMSCAPE tools. In the MATLAB Model of Boost converter, the semiconductor device IGBT is used as a switch. The pulses given to the switches are generated by pulse generator. The DC source supplies the dc voltage to the circuit. There are voltage measurements for input and output voltages. The input current is measured by the current measurement item.

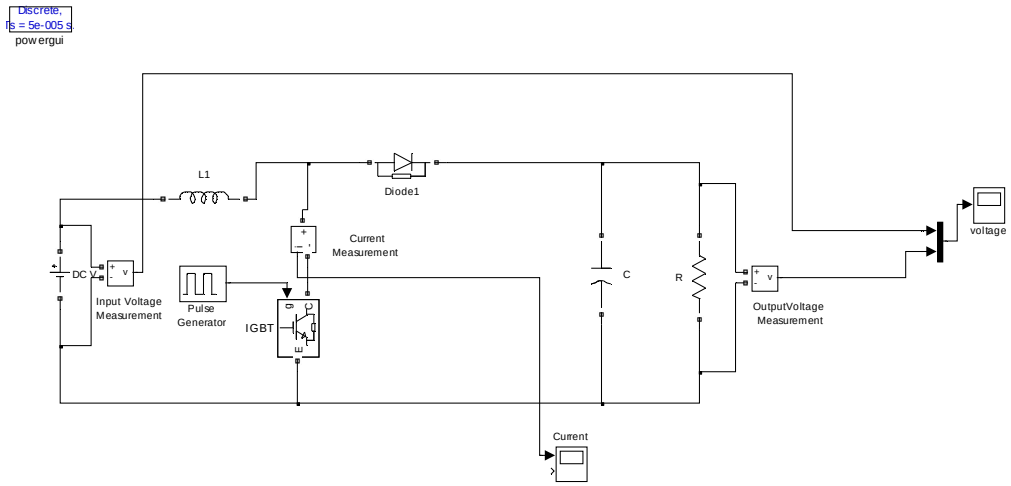

Fig 3. System Model of Boost converter

As shown in fig 3. MATLAB model of Boost converter consists of inductor, IGBT switch, diode, and capacitor and pulse generator. Inductor L1 is used for storage purpose and capacitor C is used for filtering.

b) Simulation result of boost converter

Simulation of boost converter results the input voltage and output voltage of the boost converter. The input voltage is 12volts and the output voltage is 24volts.

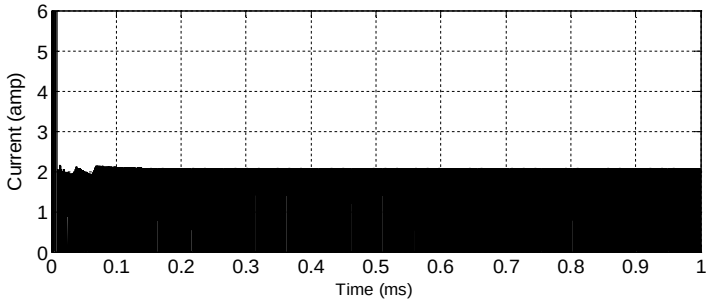

Fig 4. Simulation result of boost converter (Current)

As shown in fig4, Simulation of boost converter displays the input current of the boost converter. The input current is 2 amps. This current flows through the single inductor and semiconductor device.

c) System Model Of Interleaved Boost Converter

The interleaved boost converter consists of two identical boost converters connected in parallel. The interleaved method provides the same switching frequency and phase shift. The system provides easier control and greater stability.

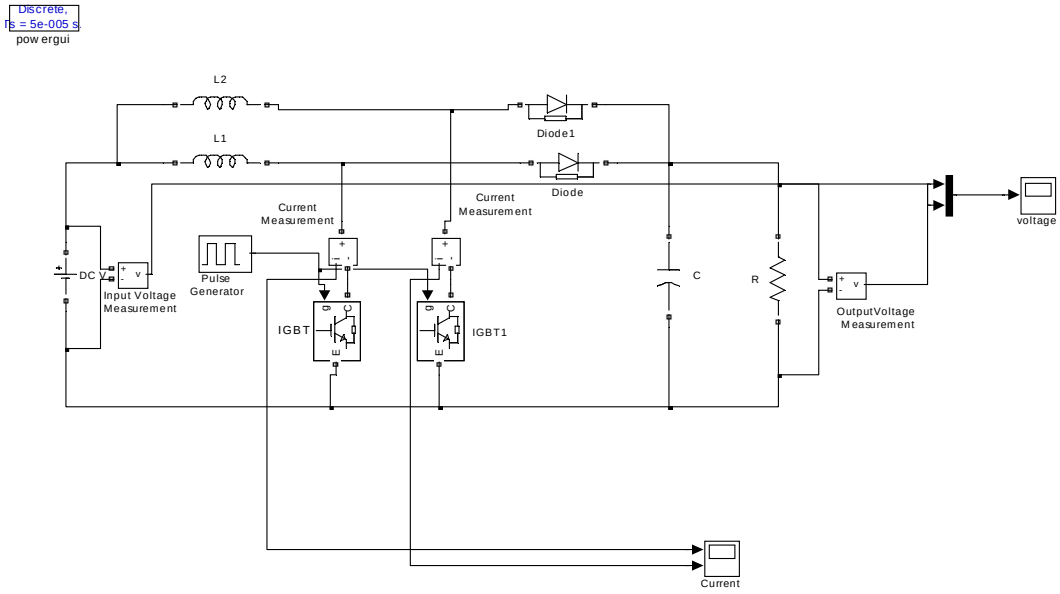

Fig 5. System Model of Interleaved Boost Converter.

As shown in fig5, MATLAB model of Interleaved Boost converter consists of inductors, IGBT switches, diodes, capacitors. Inductors L1 and L2 are used for storage purpose and capacitor C and C2 are used for filtering. The semiconductor devices IGBT and IGBT1 are used as switches for boost operation.

d) Simulation result of interleaved boost converter

Simulation of interleaved boost converter shows the input voltage and output voltage of the interleaved boost converter. The input voltage is 12volts and the output voltage is 24volts.

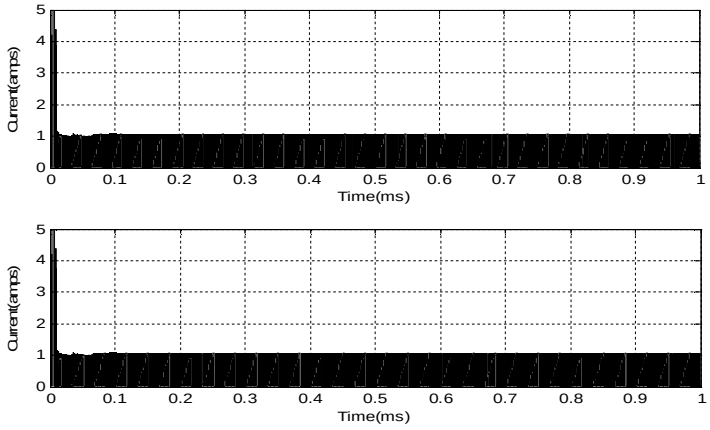

Fig 6. Simulation result of interleaved boost converter (current)

As shown in fig6, Simulation of interleaved boost converter displays the input current which is shared by the inductor and switches by interleaved boost converter architecture. Each element is having 1 amp current.

e) System Model Of Interleaved Buck-Boost Converter

The simulation model was done in MATLAB SIMULINK environment with the help of SIMPOWER system and SIMSCAPE tools. The interleaved buck boost converter consists of two identical boost converters connected in parallel and buck converter in series.

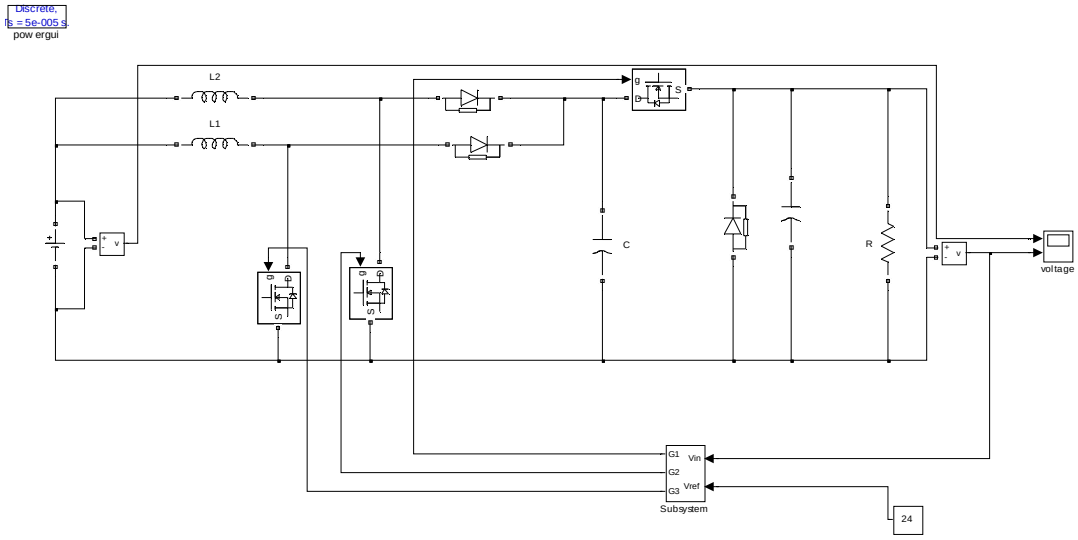

Fig 7. System Model Of Interleaved Buck-Boost Converter

As shown in fig 7. MATLAB model of Interleaved Boost converter consists of inductors, IGBT switches, diodes, capacitors. Inductors L1 and L2 are used for storage purpose and capacitor C and C2 are used for filtering. The semiconductor devices IGBT and IGBT1 are used as switches for boost operation. IGBT2 is for buck mode operation.

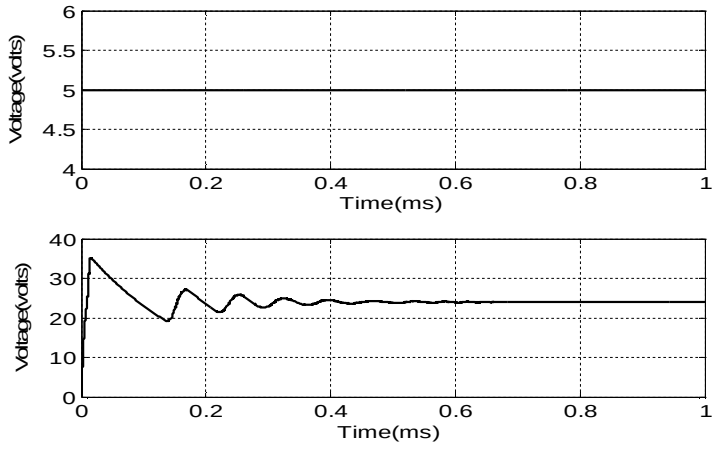

Fig 8. Simulation result of interleaved buck- boost converter (Voltage-boost mode)

As shown in fig 8, Simulation of interleaved buck-boost converter shows the input voltage and output voltage of the interleaved buck-boost converter. In the boost mode, the input voltage is 5volts and the output voltage is 24volts.

f) Simulation result of interleaved buck-boost converter (Voltage-buck mode)
Simulation of interleaved buck-boost converter results the input voltage and output voltage of the interleaved buck-boost converter.

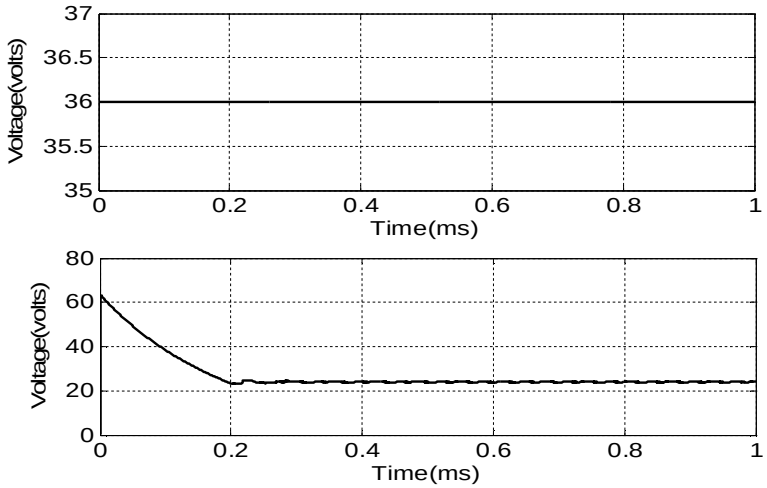

Fig 9. Simulation Result of Interleaved Buck Boost Converter (Buck Mode-Voltage)

As shown in fig 9, In the buck mode, the input voltage is 36volts and the output voltage is 24volts.so the results shows the stepping up and stepping down operation of input voltage is achieved efficiently.

g) System Model of Interleaved Buck-Boost Converter Fed DC Motor.
The proposed model consists of the DC input source, buck-boost converter with interleaved technique for stepping up and stepping down operation of input voltage. The DC motor is connected with these components and the speed control of the motor is achieved. Here, the PI controller is used efficiently.

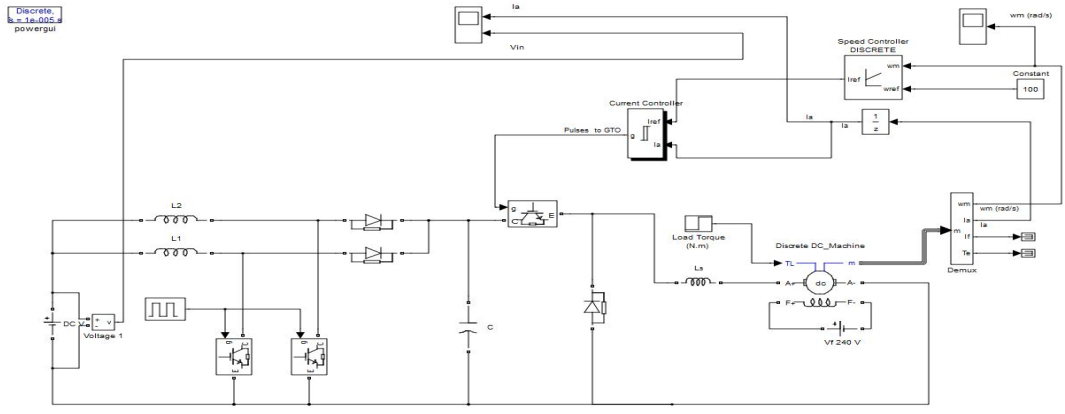

Fig 10. System Model of Interleaved Buck-Boost Converter Fed DC Motor.

As shown in fig10, the efficient technique Interleaved has been implemented with the buck-boost converter which is connected with the DC motor. The speed control of the motor with the help of the controller is achieved.

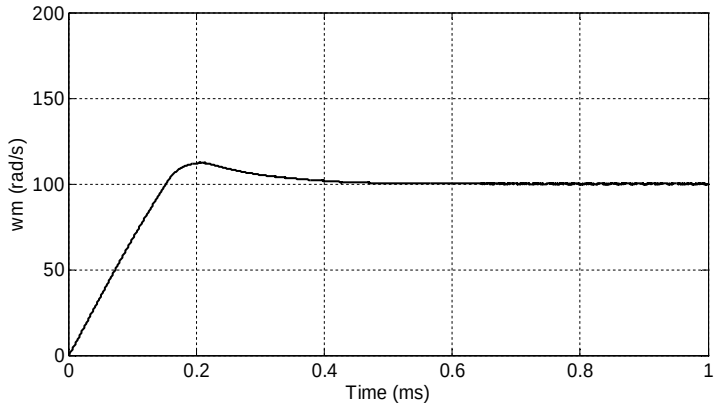

Fig11. Simulation result of interleaved buck- boost converter fed DC motor.

As shown in fig11, the proposed system provides the speed control of the DC motor. The obtained speed of the motor is 100 radians/second.

Conclusion

The efficient technique such as Interleaved has been implemented on Conventional Buck-Boost Converter. By Interleaved operation, inductor current is reduced and current stress is reduced. The proposed system is validated through MATLAB/Simulink simulations. The interleaved buck boost converter has been implemented with DC Motor. The proposed chopper, interleaved buck boost converter circuit receives signal from the controller and the speed control of the DC motor is achieved.

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