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Original Article

A New High Gain Active Switched Network-Based Boost

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Abstract: *This project deals with an active switched inductor network-based high gain boost converter. By using less number of components in circuit topology. A high gain in voltage can be attained at a small duty cycle value by using the proposed converter, which helps in reducing the switch voltage stress and conduction loss. In addition, it draws continuous input current, has lower diode voltage stress, and lower passive component voltage ratings. The operating principles and key waveforms in Continuous Conduction Mode (CCM) and Discontinuous Conduction Mode (DCM) are presented.*

Keywords: *Circuit Topology, Continuous Conduction Moe, Discontinuous Conduction Mode.*

I. INTRODUCTION

1.1 General High gain network

This is mainly caused by the low-output voltage derived from these sources, which have always stood as the foremost limitation in their utilization. An extendable converter using APICs. The DC-DC converter introduced is based on the technique that uses three states of switching. The converter is analyzed theoretically and is also verified experimentally through a laboratory prototype. Several other topologies are reviewed to understand their limitations and also to prove the advantages of the proposed topology.

1.2 DC Micro-Grid

Improving the output voltage level obtained from various distributed energy sources is very crucial to determine a common voltage throughout the DC link of a particular micro-grid. Mahajan et al. intended to eliminate the limitation of the conventional boost converters for this function. The recommended topology provides a quadratic voltage gain. The converter has been validated through comparison with existing topologies and also through loss analysis. The converter proposed by Hosseini et al. is appropriate for applications involving hybrid electric vehicles. The exceptional aspects include reduction in voltage stress, switching, and conduction losses. The method adopted is that of bipolar switching, to benefit from decreased losses. The converter discussed in Sundaram et al. is non-isolated and maintains a high gain. Low input current ripple makes it a good choice for realizing MPPT in photovoltaic systems. Further assessment of the converter is aided with steady-state analysis, which also justifies the efficacy of the converter.

II. SYSTEM IMPLEMENTATION

2.1 EXISTING SYSTEM

The existing boost converters typically utilize traditional topologies like the basic non-isolated boost converter or the interleaved boost converter. The conventional Cascade boost, quadratic boost, traditional boost converter combined with switched-capacitor technique, voltage lift, and capacitor–diode voltage multiplier are a few most commonly used non-isolated high gain converters. DC–DC converters with voltage boost capability are widely used in a large number of power conversion applications, from fraction-of-volt to tens of thousands of volts at power levels from milli watts to megawatts. The switched-inductor/capacitor stages incorporated in these converter configurations increase the voltage stress across the switches, The cascade boost converter, even though the two switches can be combined to make one switch to reduce circuit complexity, the voltage and current stress across the switch are still high. The major drawback of the converter topologies based on switched capacitor cells and voltage lift cells is high power switches and diodes current stress due to the presence of capacitor networks, hence leading to effciency reduction. A high gain and high efficiency can be achieved by employing the interleaved converter technique with a lesser number of control switches and filter size reduction.

2.2 PROPOSED SYSTEM

This project proposes a novel converter topology with reduced current stress across active switches to provide a stable constant dc voltage. The proposed topology has the advantage of providing a high voltage gain, low current stress, and low conduction loss on the active switches, simplified control, and high efficiency. The current is equally shared by both the switches and thereby reducing the conduction loss. The proposed converter topology is a transformer-less design. Both the switches are connected in parallel and thereby reducing the switch current stress. Therefore, the power circuit of the proposed converter can be designed by using low current rating switches.

2.2.1 PROPOSED CONVERTER

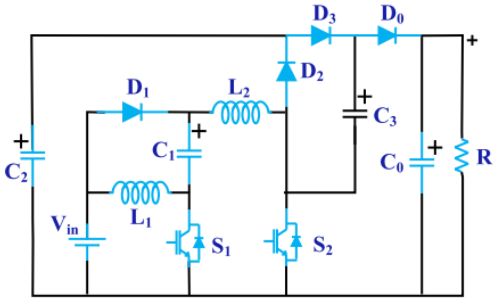

Fig: 2.1 Proposed Topology

2.2.2 PROPOSED TOPOLOGY

It is consisting of two inductors L1 and L2 which have the same inductance value and switch S1 and switch S2 are both being turned ON and OFF at once. There are four diodes (Do to D3) and four capacitors (Co to C3) in the circuit. The working principles and the steady-state analysis of the proposed converter in both CCM and DCM . First of all, considering all the circuit components to be ideal. Neglecting the ON-state resistance of the active switches, the forward voltages drop of the diodes and the effective series resistance (ESR) of the inductors and capacitors. However, it is assumed that both the inductors have equal inductance value and all the capacitors are large enough, and the capacitor voltages are considered to be constant.

2.3 MODE OF OPERATION

- The proposed converter consisting of two switches that are operating at the same time with the same duty pulse and duty ratio. Therefore, the proposed converter has two operating modes in CCM as
    - CCM 1
    - CCM 2

2.3.1 CCM1

The switch S1 and switch S2 both are kept ON during mode I. The equivalent circuit of the proposed converter for this mode is displayed in Fig. The input supply Vin charges inductor L1 via switch S1, the capacitor C1 via diode D1 and switch S1, and inductor L2 via diode D1 and switch S2, respectively.

Simultaneously, capacitor C3 is charged by capacitor C2 via diode D3 and switch S2, and the energy stored in capacitor Co is transferred to the load R.

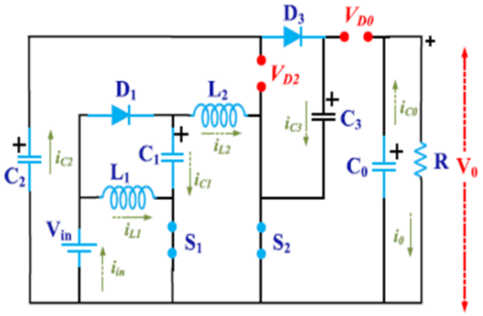

Fig 2.2 Mode Of Operation Ccm1

2.3.2 CCM2

During mode 2, switch S1 and switch S2 are both being turned OFF simultaneously. Mode 2 equivalent circuit of the proposed converter is displayed in Fig. In mode 2, the input supply Vin charges the output capacitor Co, inductor L1, capacitor C1, inductor L2, and capacitor C3 via diode Do. At the same time, capacitor C2 is charged by the input supply voltage Vin, inductor L1, capacitor C1, and inductor L2 through diode D2. N switches S1 andS2 are just turned OFF. Forward biased. During this mode, the current through Inductor L1 increases with a positive slope and the current through inductor L2 decreases with large negative slope. The value of current through inductor L2 is larger than current through inductor L1. Also, the input current I in is equal to inductor L2 current I in I L2 and the result an current through diode D1is subtraction inductors L2 and L1 currents.

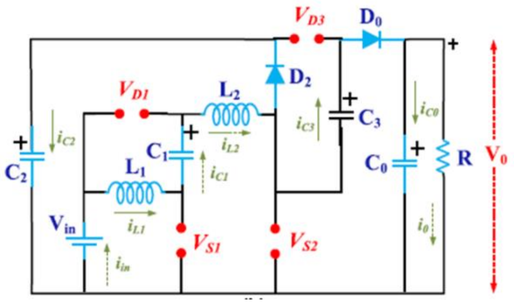

Fig 2.3 Mode of Operation Ccm2

Switches S1 and S2 are turned OFF and equivalent circuitry is same as CCM mode II. In mode 2, the input supply V in charges the output capacitor Co, inductor L1, capacitorC1, inductorL2, and capacitor C3 a diode Do. At the same time, capacitor C2 is charged by the input supply voltage V in, inductor L1, capacitorC1, and inductor L2 through diode D2. In this case, input current and the current through inductor L2 and L1 are equal. DC-DC converters of the non-isolated type are incorporated to attain a high voltage gain thereby reducing the overall size, weight, and volume since a high frequency transformer is not present and hence leading to an improved effciency.

2.3 EFFECT OF INDUCTOR

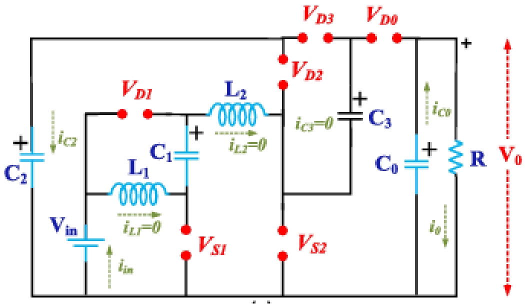

Fig 2.4 Effect Of Inductor

The operation of proposed converter depends on the values of the inductorsL1 and L2. Hence, the currents through inductors L1 and L2 depend on the values of inductors L1 and L2. Stored in capacitor Co is transferred to the load R. The different converters indicates that the proposed converter has the lowest switch current stress through the active switches and the value is half the value of input current. Hence, active switches with low current rating are required as the total input current is shared by these two active switches. Generally, the increase in the rating of a device leads to an increment in its ON-state resistance.

2.3.1 DC to DC Boost Converter

The low input DC voltage is converted into high output DC voltage using DC to DC boost converter. As the input voltage is stepped up compared to output voltage, hence, it is also called as a step up converter. Generally, DC to DC converters can be designed using power semiconductor switching devices and discrete electrical and electronics components. In DC to DC converter, the converter operates in two modes:

- Continuous Conduction Mode
- Discontinuous Conduction Mode

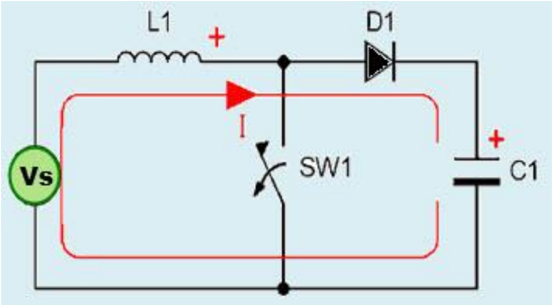

Fig 2.5 DC to DC Boost Converter Continuous Conduction Mode Circuit

The continuous conduction mode circuit of the DC to DC boost converter is shown in the figure that consists of an inductor, capacitor, switching device, diode, and input voltage source. This boost converter circuit switch is controlled using a pulse width modulator (PWM). If this switch is in ON state, then energy will be developed in the inductor and thus more energy will be delivered to the output.

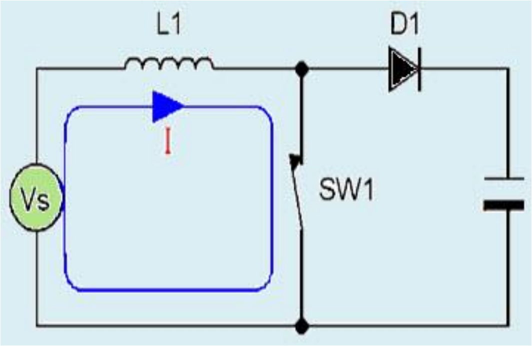

Fig 2.6 DC to DC Boost Converter Discontinuous Conduction Mode Circuit

The discontinuous conduction mode circuit of the DC to DC boost converter is shown in the figure that consists of elements such as capacitor, inductor, voltage source, diode, and switching device. In this discontinuous conduction mode, if the switch is in ON state, then energy will be delivered to the power storage element, inductor. If the switch is in OFF state for some period, then the inductor current will reach zero until the next switching cycle is on. Thus, the capacitor gets charged and discharged with respect to the input voltage. But, here the output voltage in discontinuous conduction mode is less than the output voltage in continuous conduction mode.

Similarly, buck converters are used for converting high input DC voltage into low output DC voltage. Buck-boost converters are used for maintaining output DC voltage high or low based on the input DC voltage source. If the input DC voltage is high, then the output will be low and vice-versa. Thus, we can maintain regulated DC voltage using buck-boost converters.

III. RESULT

3.1 SOFTWARE MODEL

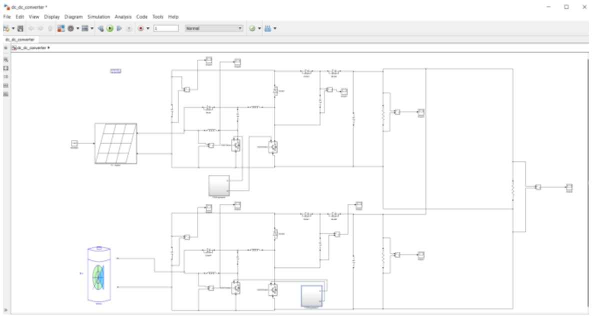

Fig: 3.1 Overall Simulink model

This above figure is 4.3 is show know Simulink model for High Gain DC Micro-Grid model for design in Matlab 2014b.

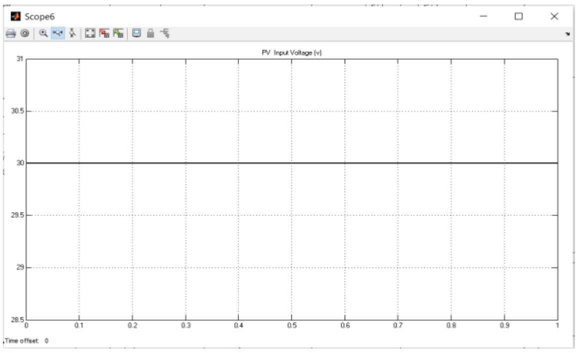

Fig: 3.2 solar input voltage 30 VDC for matlab scope output

The above image (Fig: 4.4) is a scope6 output for Simulink model for solar input voltage for our DC/DC converter. Our solar voltage 30VDC panel design in matlab model.

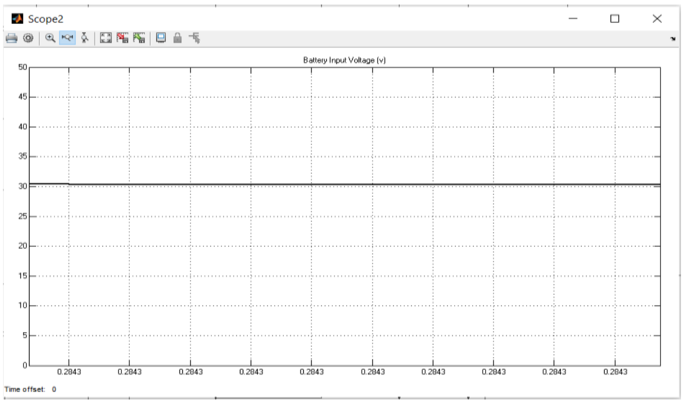

Fig: 3.3 Battery input voltage for DC-DC converter for 30VDC for simulation scope output

The above figure 4.5 is a scope2 output for Simulink model for Battery voltage for our DC/DC converter in second source. Our battery voltage is 30VDC in the matlab model.

The below image (Fig: 4.6) is a scope output for Simulink model for IGBT gate pulse in our DC/DC converter.

Fig: 3.4 IGBT gate pulse matlab scope

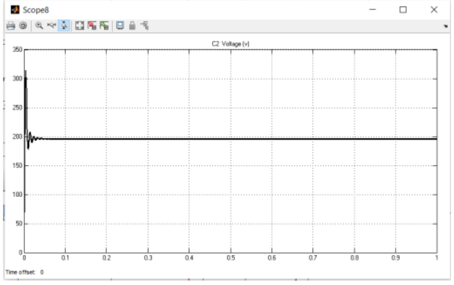

Fig: 3.5 Capacitor Charging voltages

The figure 4.7 &4.8 is scope8 & 9 output of C2&C3 capacitor charging voltage of our converter side. This capacitor charging voltage is maximum 300VDC charging in peak voltage stable than 200VDC.

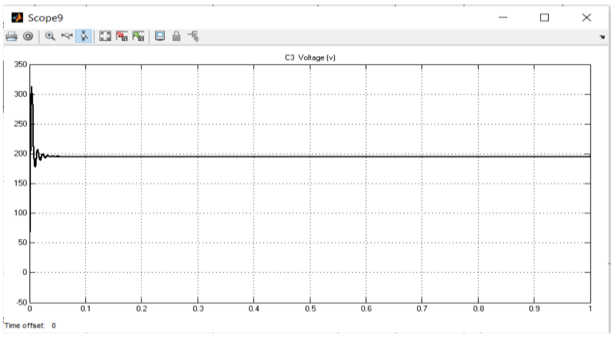

Fig: 3.6 charging voltage for C3 Capacitor

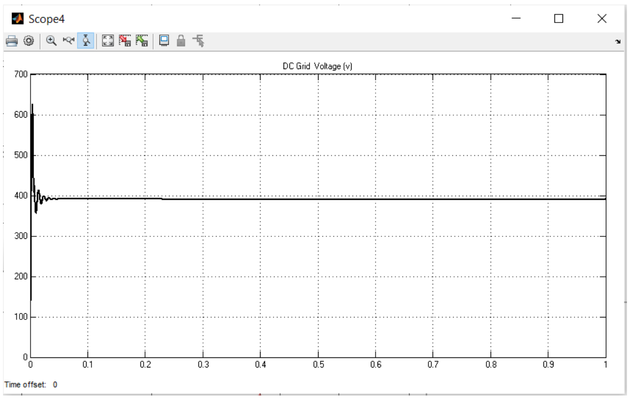

Fig: 3.7 Output Load voltages 400VDC

The image above (Fig: 4.9) shows the output load voltage of our converter. The scope output is a final output for the load side is 400VDC in boost output. Our converter input voltage in solar and battery side voltage 30VDC.

IV. CONCLUSION

The DC-DC high gain boost converter with active switched inductor network and Model Predictive control for DC microgrid has been presented in the paper. The proposed converter has utilized two switches to reduce the current stress. The active switched inductor network and voltage multiplier structure have been effectively arranged to boost the output voltage and for the equal distribution of capacitor voltage stress. Furthermore, the presented topology drains a continuous current from the input supply. Hence, high-voltage boost ability and continuous input current make it suitable for PV and fuel cell applications. A detailed CCM analysis of the proposed converter has been presented. The hardware prototype model and Simulink model has been made and tested successfully.

V. REFERENCES

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