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Several component coupled inductor- based sepic converter for high-voltage wind energy systems

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ABSTRACT

A coupled inductor based high step-up dc–dc converter for high step-up applications is proposed. The concept is to utilize two capacitors and one coupled inductor. The two capacitors are charged in parallel during the switch-off period and are discharged in series during the switch-on period by the energy stored in the coupled inductor to achieve a high step-up voltage gain. In addition, the energy stored in the coupled inductor is recycled; the voltage stress of the main switch is reduced. The switch with low resistance RDS (ON) can be adopted to reduce the conduction loss and the reverse-recovery problem of the diodes is alleviated. Not only lower conduction losses but also higher power conversion efficiency is benefited from lower turns ratios. The operating principle and steady-state analyses. With the increasing integration of renewable energy generation into high-power grids, transmission at the dc level is becoming increasingly more useful than ac transmission. In this regard, emerging applications, such as offshore wind farms, require a high voltage gain dc/dc conversion system to interface with high-power transmission networks. This paper presents a new high-voltage gain coupled inductor

based dc/dc converter for high-power offshore wind energy systems. The proposed dc/dc converter is characterized by the resonant switching transitions to achieve minimal switching losses and maximum system efficiency. Therefore, a higher switching frequency is conceivable to attain a higher power density. The double stage output voltage of the proposed converter operates at seven times as high as the input voltage with a small device count. The output capacitors are charged and discharged continuously by a 180◦ phase shift with respect to each other to eliminate

the output voltage ripples with the low capacitance requirements.

Key words—DC–DC transformers, high-voltage DC transmission, offshore wind energy.

I.INTRODUCTION

Offshore wind farms are growing rapidly because of their comparatively more stable wind conditions than onshore and land-based wind farms. Offshore 5–10-MW marine turbines are becoming more attractive for the wind power industry. In particular, they increase the efficiency and reduce generation cost, compared to previous wind turbine technologies. The power capacities of these offshore behemoths result in an increase in the size of each component. Therefore, offshore wind turbine manufacturers are attempting to create an optimal design for large marine turbines. The optimized design of offshore wind turbines should cope with the following challenges to make high-power conversion systems a feasible alternative. Bulky and huge electrical components have high investment costs because of the more difficult erection and the equipment transportation from the shore to the installation sites. In addition, there is a greater need for high reliability due to the inherent lack of turbine access at sea, which makes operation and maintenance more difficult. Therefore, an optimal power conversion system should feature high-power density, high efficiency, high reliability, and low costs for high power offshore wind energy applications. Increasing the switching frequency of dc/dc converters has the benefits of requiring less passive energy storage and providing improved transient performance. Since passive components typically dominate converter size, increasing the switching frequency is a crucial step in the development of a fully integrated or co packaged power converter. Among the challenges standing in the way of such developments, however, are loss mechanisms that grow with switching frequency.

II.OBJECTIVE

Coupled inductor based DC/DC converter for offshore wind energy systems, can be employed for harmonic reduction since these converters are based on the series connection of single phase inverters and widely applied to the interface of renewable energy sources. There are three types of MLI structures such as diode clamped, flying capacitor and cascaded H Bridge. The drawback of this converter topology includes increased number of devices required and control complexity. The proposed DC/DC converter is put for wind energy applications which perform the necessary voltage conversion. This DC/DC converter is normally used in medium to high power applications; they operate to reduce number of levels, minimized harmonics and improvement of precision value. It can be perform positive source voltage of one level to positive load voltage of another required level and incorporating intelligent control techniques such as optimization technique for power quality important. To overcome the increasing power losses and maintain a high power density, it is expected that large marine turbines will require a higher voltage with high-voltage gain dc/dc conversion systems to interface with the power transmission networks. Single-module dc/dc boost converters can theoretically achieve infinite voltage conversion ratios but practically, the maximum gain is limited by circuit imperfections, such as parasitic elements and switch commutation times.

III.BLOCK DIAGRAM

The output voltage is the sum of the output filter capacitor voltages and input voltage. The resulting voltage has a frequency that is two times that of the switching frequency. The inherent interleaving property of the proposed circuit effectively reduces the output voltage ripple value without adding extra components. Therefore, the output capacitance requirement is one third of the capacitance in the conventional RSC converters for the same output voltage ripple.

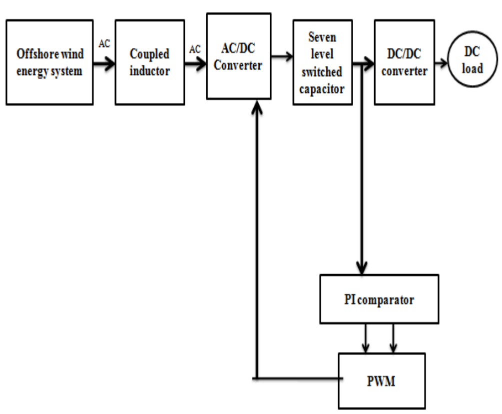

Fig.1.Block diagram of proposed DC/DC converter.

A coupled inductor based high step-up dc–dc converter for high step-up applications is proposed. The concept is to utilize two capacitors and one coupled inductor. The two capacitors are charged in parallel during the switch-off period and are discharged in series during the switch-on period by the energy stored in the coupled inductor to achieve a high step-up voltage gain. In addition, the energy stored in the coupled inductor is recycled; the voltage stress of the main switch is reduced. The switch with low resistance RDS (ON) can be adopted to reduce the conduction loss and the reverse-recovery problem of the diodes is alleviated. PI comparator is a device that compares two voltage or current and output a digital signal indicating which is larger. It has two analog input terminals positive voltage and negative voltage and one binary digital output V0.Comparator Not only lower conduction losses but also higher power conversion efficiency is benefited from lower turns ratios. The operating principle and steady-state analysis. The proposed series-modular and cascade RSC configurations have the inherent advantage of being readily applicable to multi-stage power switching converters. A new resonant switched-capacitor (RSC) cell-based DC/DC converter with a high voltage gain is proposed for offshore wind energy applications. High efficiency, High reliability, Low cost for high power offshore energy. HVDC transmission is very flexible and efficient technology. This technology is robust and reliable.

IV.COUPLED INDUCTOR BOOST CONVERTER

Bidirectional dc–dc converters are used to transfer the power between two dc sources in either direction. These converters are widely used in applications, such as hybrid electric vehicle energy systems, uninterrupted power supplies, fuel-cell hybrid power systems and battery chargers

.Many bidirectional dc– dc converters have been researched. The bidirectional dc–dc fly back converters are more attractive due to simple structure and easy control However; these converters suffer from high voltage stresses on the power devices due to the leakage inductor energy of the transformer. In order to recycle the leakage inductor energy and to minimize the voltage stress on the power devices, some literatures present the energy regeneration techniques to clamp the voltage stress on the power devices and to recycle the leakage inductor energy .Some literatures research the isolated bidirectional dc–dc converters, which include the half-bridge and full-bridge types. These converters can provide high step-up and step-down voltage gain by adjusting the turns ratio of the transformer. The multilevel type is a magnetic less converter, but 12 switches are used in this converter.

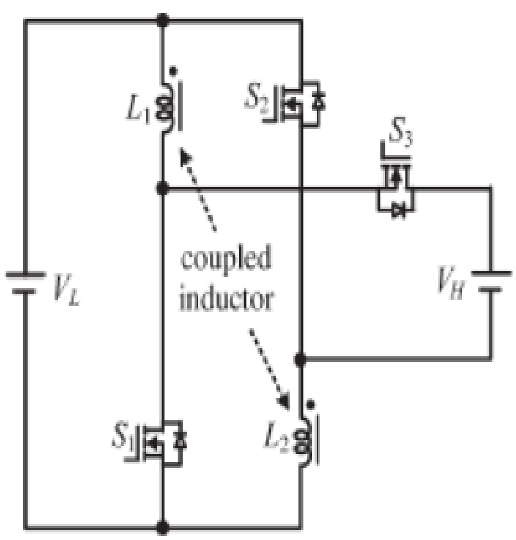

Fig.2.proposed dc/dc converter

A modified dc–dc boost converter is presented the voltage gain of this converter is higher than the conventional dc–dc boost converter. Based on this converter, a novel bidirectional dc–dc converter is proposed, as shown in Fig. 2. The proposed converter employs a coupled inductor with same winding turns in the primary and secondary sides. Comparing to the proposed converter and the conventional bidirectional boost/buck converter, the proposed converter has the following advantages: 1) Higher step-up and step-down voltage gains and 2) lower average value of the switch current under same electric specifications. The following sections will describe the operating principles and steady-state analysis for the step-up and step-down modes. In order to analyze the steady-state characteristics of the proposed converter, some conditions are assumed: The ON-state resistance *RDS* (*ON*) of the switches and the equivalent series resistances of the coupled inductor and capacitors are ignored; the capacitor is sufficiently large; and the voltages across the capacitor can be treated as constant.

4.1 .Step-Up Mode

The proposed converter can be used for both step up and step down modes with suitable switching of the devices. The proposed converter in step-up mode. Since the primary and secondary winding turns of the coupled inductor is same, the inductance of the coupled inductor in the primary and secondary sides are expressed as

$$L1=L2=L \qquad (1)$$

Thus, the mutual inductance M of the coupled inductor is given by

$$M = k\, L1\, L2 = KL \qquad (2)$$

Where k is the coupling coefficient of the coupled inductor. The voltages across the primary and secondary windings of the coupled inductor are as follows:

$$V_{L1}=L1\frac{\mathrm{diL1}}{\mathrm{dt}}+M\frac{\mathrm{diL2}}{\mathrm{dt}}=\frac{\mathrm{LdiL1}}{\mathrm{dt}}+KL\frac{\mathrm{diL2}}{\mathrm{dt}} \quad (3)$$

$$V_{L2}=M\frac{diL1}{dt}+L2\frac{diL2}{dt}=KL\frac{diL1}{dt}+\frac{diL2}{dt} \quad (4)$$

Since the proposed converter can be used for both continuous (CCM) and discontinuous conduction (DCM) only the continuous conduction mode (CCM) is preferred for the analysis for best understanding of the operation.

4.2 CCM operation

Mode 1: During this time interval [*t*0, *t*1], *S*1*S*1 and *S*2 are turned on and *S*3 is turned off. The current flow path is shown in Fig. 3(a). The energy of the low-voltage side *VL* is transferred to the coupled inductor. Meanwhile, the primary and secondary windings of the coupled inductor are in parallel. The energy stored in the capacitor *CH* is discharged to the load. Thus, the voltages across *L*1 and *L*2 are obtained as

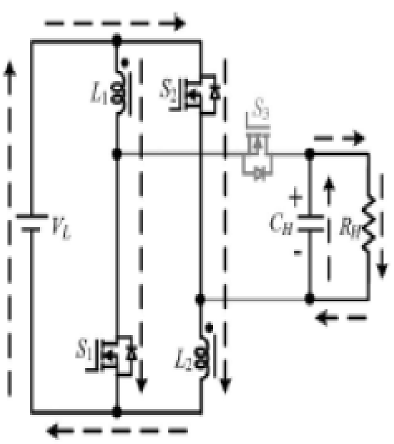

Fig.3.mode 1(a)

$$VL1=VL2=VL \quad (5)$$

Substituting (3) & (4) in (5) we get

$di_{L1}(t)/dt = di_{L2}(t)/dt = V_L/(1+K)L \quad t_0 \le t \le t_1$

Mode 2: During this time interval, *S*1 and *S*2 are turned off and *S*3 is turned on. The current flow path is shown in Fig.4. The low-voltage side *VL* and the coupled inductor are in series to transfer their energies to the capacitor *CH* and the load. Meanwhile, the primary and secondary windings of the coupled inductor are in series. Thus, the following equations are found to be obtained. coupled inductor based high step-up application is proposed. The concept is utilize two capacitors and one coupled inductor. The two capacitors are charged in parallel during the switch off period and two capacitors are discharged in series during the switch on period. The main RDS(ON)switch, so the conduction losses reduced and resistance losses are reduced.

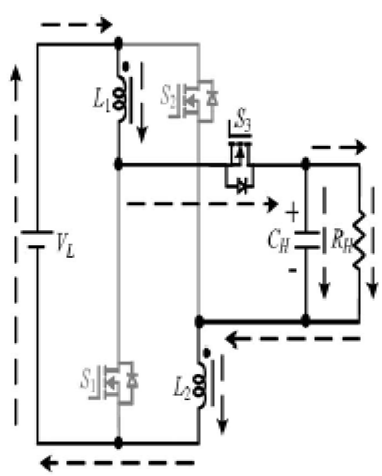

Fig.4. mode 2(b)

$di_{L1}(t)/dt = di_{L2}(t)/dt = V_L - V_H/2(1+K)L \quad (6)$

By using the state-space averaging method.

V. Matlab Model of Coupled Inductor Dc Converter for offshore wind energy System

The proposed system was developed on Mat lab/simulink in a lucid fashion and in the simple way. The model was simulated only for two inputs and can be further added depending on the requirement. The converters use two coupled inductances of same value. Typically we took a Mutual inductance block and is modeled for two windings only. The devices were switched at high frequency. Stability optimization for coupled inductor based dc-dc converter is designed and the output voltage and output current is simulated successfully.

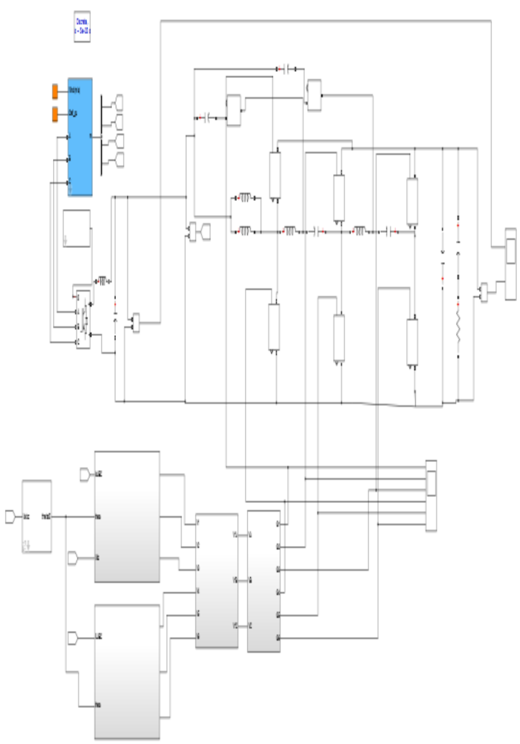

Fig.5. simulation circuit diagram

VI.SIMULATION RESULTS

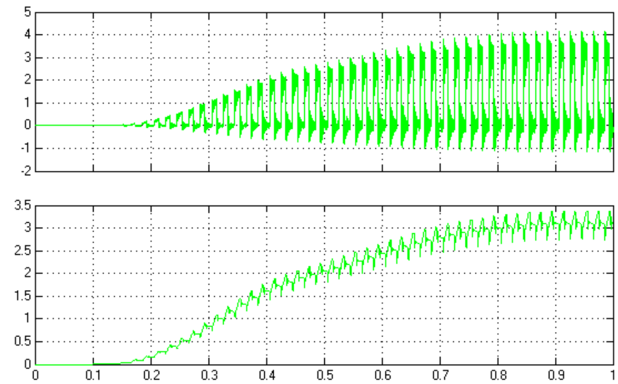

Fig.6.Output voltage 96.5V

Coupled inductor based dc/dc converter for multiple module of an offshore wind energy systems thus the output voltage is obtained as 96.5V.Then the input voltage is 12V.simulation results of output voltages and pulse width modulation.pwm can be used to control the supply voltages.

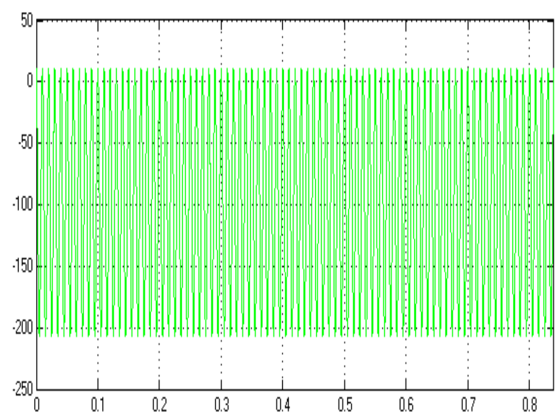

Fig.7.Pulse width modulation output waveform

VII.CONCLUSION

The proposed dc-dc converter is simple in construction and has more efficiency than the conventional dc-dc converter. This can be used in battery operated vehicles, and wind powered uninterrupted power supplies and can have significant use in renewable energy sources where there is a need of efficient dc conversion.

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