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DC\DC CONVERTER FOR OFFSHORE WIND ENERGY BY USING RESONANT SWITCHED CAPACITOR CELL

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ABSTRACT

The future of energy generation purely lies on the renewable energy. In current situation non-renewable energy creates lot of environmental issues which makes people to move from non-renewable to renewable energy resource. In this regard, a three phase power source is generated through offshore wind energy system. This offshore wind farm has a dc/dc conversion system to get interact with high voltage transmission network. In this dc/dc converter system where deploying high-voltage resonant switch capacitor cell for high power conversion. The dc/dc converter also has a diode based rectifier circuit to convert the ac power generated by offshore wind farm into dc power which does not need any additional controller.

1. 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.

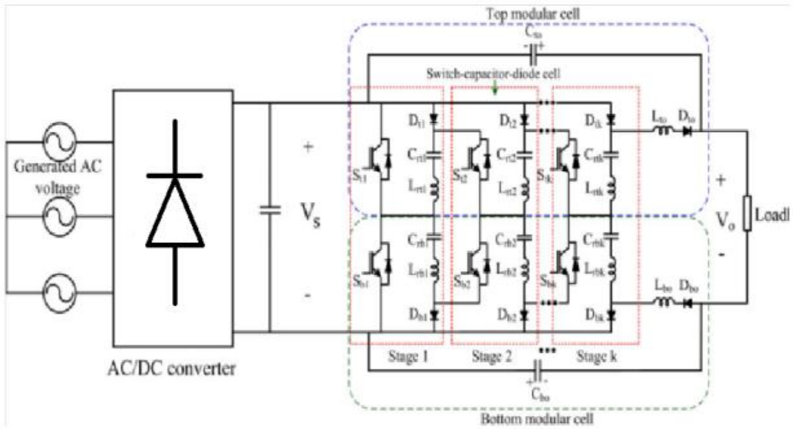
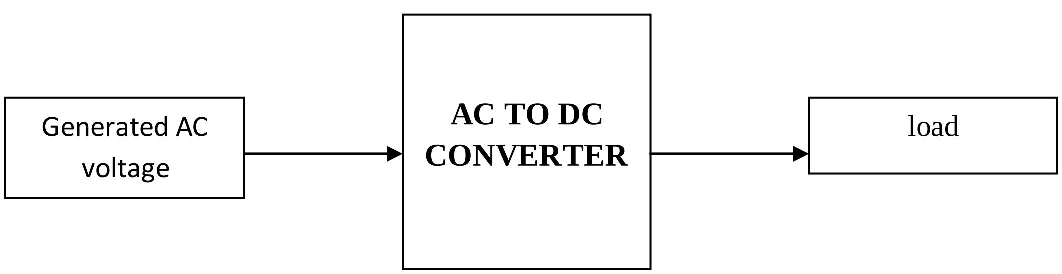


Fig.1 proposed RSC converter

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. Unfortunately, high-frequency transformers with large turn ratios are difficult to design at high voltages and mega power levels because of the enormous expense of the magnetic material, core, and dialectic losses. One of the key-enabling components for HVDC is the high power dc/dc conversion system because it has a rigid structure, is easy to control system and more compact [15], [16].



Fg.2.General block diagram of converter

The configuration with a three-phase generated ac voltage and an ac/dc converter in the front-end of the proposed RSC converter. A large capacitor is assumed to be used for energy storage at the output of the ac/dc converter. The RSC converter consists of two modular cells which use a new arrangement of the solid-state switches, diodes, capacitors, and inductors. 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.

2. MODULE DESCRIPTION

A. OFFSHORE WIND POWER

Offshore wind power refers to the construction of wind farms in bodies of water to generate electricity from wind. Unlike the typical usage of the term "offshore" in the marine industry, offshore wind power includes inshore water areas such as lakes, fjords and sheltered coastal areas, utilizing traditional fixed bottom wind turbine technologies, as well as deep-water areas utilizing floating wind turbine. India is looking at the potential of off-shore wind power plants, with a 100 MW demonstration plant being planned off the coast of Gujarat (2014). In 2013, a group of organizations, led by Global Wind Energy Council (GWEC) started project FOWIND (Facilitating Offshore Wind in India)to identify potential zones for development of off-shore wind power in India and to stimulate R & D activities in this area FOWIND. In 2014 FOWIND commissioned Center for Study of Science, Technology and Policy (CSTEP) to undertake pre-feasibility studies in eight zones in Tamil Nadu which have been identified as having potential.

B. RESONANT SWITCHED CAPACITOR INDUCTOR

Offshore wind farms in the MW range are needed to interface the high voltage power networks. To cope with this situation, the proposed series-modular and cascade RSC configurations can be introduced to achieve a high-voltage gain and high rated power. A 10-MW wind turbine with an output of 6.6 KV RMS is considered as an input source. This voltage will be boosted to 140 kV for HVDC transmission through a three-phase ac/dc converter and the proposed series-modular RSC converter. The RSC converter by itself has a poor regulation property; it only realizes a designed high-voltage gain and high efficiency with a fixed 50% duty cycle. The ac/dc interface converter supplies a regulated input dc voltage for the RSC converter against the generated voltage variation; however, this is not suitable method to regulate input dc voltage of the RSC converter under a wide range of the load variation. In order to regulate the output voltage against the load variation, a low power buck-boost converter can be connected in series with the proposed RSC converter. Switched capacitor converters rely on alternately connecting capacitors to the input and output in differing topologies. For example, a switched-capacitor reducing converter might charge two capacitors in series and then discharge them in parallel. This would produce an output voltage of half the input voltage, but at twice the current (minus various inefficiencies). Because they operate on discrete quantities of charge, these are also sometimes referred to as charge pump converters. They are typically used in applications requiring relatively small amounts of current, as at higher current loads the increased efficiency and smaller size of switch-mode converters makes them a better choice. They are also used at extremely high voltages, as magnetic would break down.

C. RESONANT SWICHING TRANSITION

The resonant "tank" is a set of two inductive elements and one capacitor (LLC). Even if the use of three different components, i.e. a discrete inductor, a conventional transformer and a capacitor is technically possible, poor results would be obtained on all fronts: cost, size and energy efficiency

3. OPERATION OF PROPOSED CONVERTER

A seven-level RSC converter with two stages. The RSC converter is composed of four resonant capacitors (Crt1, Crt2, Crb1 , and Crb2), two output filter capacitors (Ct0 and Cb0), four resonant inductors (Lrt1, Lrt2, Lrb1 , and Lrb2), two output resonant inductors (Lt0 and Lbo0), six diodes (Dt1 , Dt2, Dt0, Db1, Db2, and Db0), and four switches (St1, St2, Sb1, and Sb2). In this paper, subscripts "t" and "b" represent the corresponding variables to the circuit components at the top and bottom cells, respectively. The switches (St1, St2) and (Sb1, Sb2) are controlled complementarily with a 50% duty cycle to minimize the conduction losses in the power devices and passive components. Here, the following assumptions are made to.

MODE I:

In the beginning of this mode (t = t0), Sb1 and Sb2 are ON, whereas St1 and St2 are OFF. The diodes Db1 and Db2 are reverse biased. The charging currents flow through (Dt1, Sb1) and (Dt2, Sb2), as. In the top cell, Crt1 and Crt2 are charged, whereas Crb1 and Crb2 are discharged to Cb0 in the bottom cell (Crb1 and Crb2 were previously charged at one and two times the input voltage level in Mode III, respectively) through a resonant phenomenon . The resonant inductor currents rise and then fall in a sinusoidal manner, Sb1 and Sb2 can then be OFF under the zero-current condition. Here, opposite energy transmission is not allowed because Dt1, Dt2, and Db0 make three unidirectional paths in the resonant circuit and block the reverse.

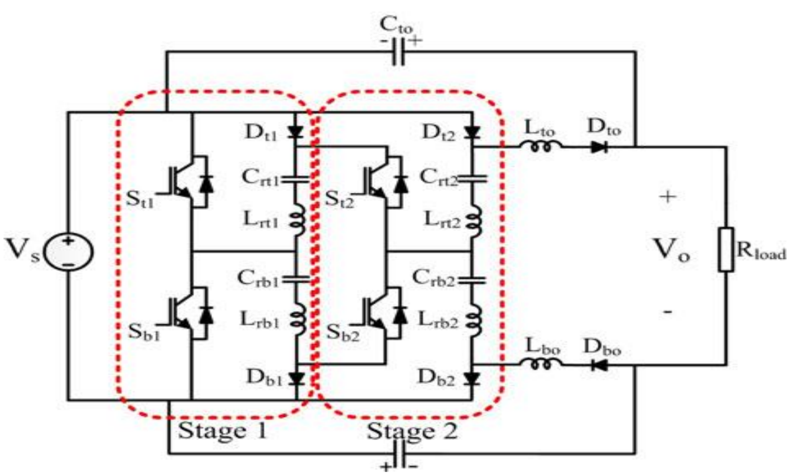


Fig. 3. seven levels RSC converter and mode I (t0, t1)

MODE II:

[t1, t2] In this mode, all the switches and diodes are turned OFF. resonances stop at three loops. Therefore, the inductor currents are equal to zero.

MODE III:

[t2, t3] At the instant t = t2, St1 and St2 are turned ON, while Sb1 and Sb2 are OFF. I that the currents through St1 and St2 are increased by a soft-switching operation with the half-cycle resonant shape. In this mode, Crt1 and Crt2 are discharged to Ct0 , whereas Crb1 and Crb2 are charged through a resonant phenomenon. In this mode, Db1, Db2, and Dt0 make three unidirectional paths in the resonant circuit to avoid opposite energy transmission. The current through Lt0 is decreased to zero after the half-resonant period. At the time of t3, St1, and St2 become OFF under the zero-current condition, as illustrated.

MODE IV:

Mode [t3, t4].The operation of this mode is similar to that of Mode II. Therefore, all the switches and diodes are turned OFF. The resonances stop at three loops and the inductor currents are equal to zero.

4. RESULT ANALYSIS

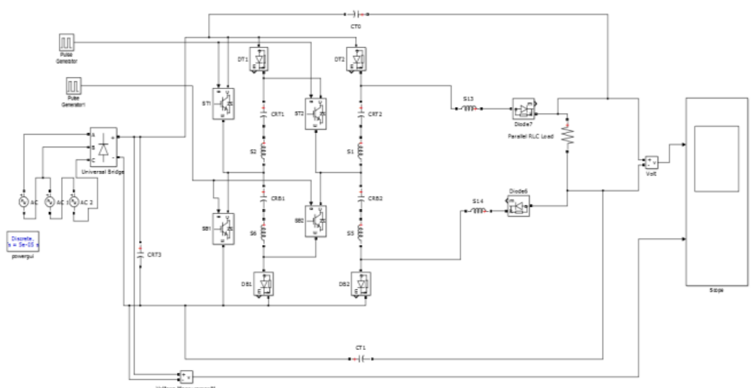


Fig.4. Simulation Diagram

In figure 3 and 4 shows the simulation diagram and graph of the DC to DC converter offshore wind energy. In the graph results shows the exact output waves of the converter..The simulation and experimental results confirm to verify the feasibility of the proposed converter. The simulation and output waveform s are done by MATLAB software.

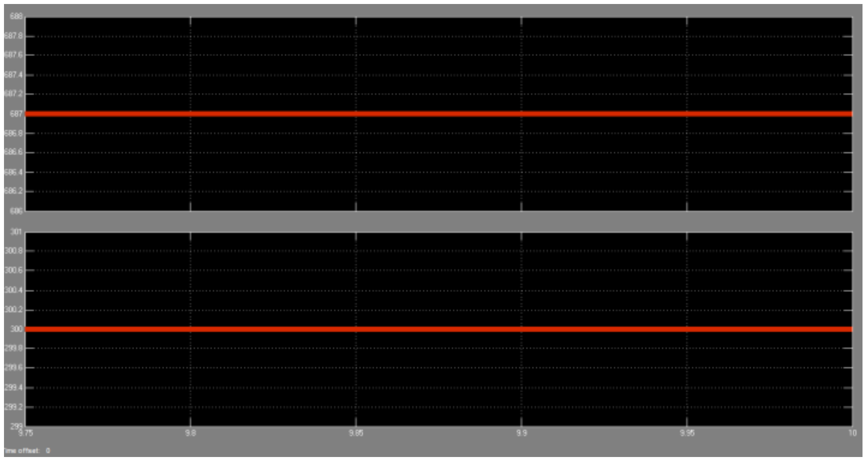


Fig.5. Simulation Graph

CONCLUSION

A new RSC cell-based dc/dc converter with a high voltage gain is proposed for offshore wind energy applications. The soft-switching action is provided by the resonant condition of the circuit. Therefore, the switching losses are minimal in both ON and OFF instants, and the power density of the system can be enhanced by increasing the switching frequency. Output filter capacitor voltages are phase shifted by 180◦ with respect to each other to eliminate the output voltage ripples without adding extra components. So that we have to reduce the cost of the paper, by increasing the no of the stage we can boost the dc voltage in kV range also

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