DESIGN AND IMPLEMENTATION OF HIGH GAIN ISOLATED DC-DC CONVERTER FOR GRID TIED OFFSHORE WIND ENERGY SYSTEM

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Abstract

This paper explores the problems in offshore wind systems regarding low power generation and size of the system. To overcome this problem, we use forward converter with onshore current source inverter. The input voltage from wind energy conversion systems gets boosted into desired output voltage using forward DC-DC converter with high frequency based transformer. By using high frequency
transformer based forward converter, the mass and size of the system is reduced. This proposed system is designed to give robust, effective operation in the system and the obtained voltage gets converted into AC voltage using current source inverter in onshore. The current source converter gets triggered by PWM pulse which gives accuracy. This system will provide the optimal solution to linear robust control problems; it carries a low computational cost.

Key Words: Permanent magnet synchronous generator, Forward converter, current source inverter.

1 INTRODUCTION

The wind energy conversion systems have emerged as the popular trend due to increased demand for green and secure electricity supply. These applications are widely used in remote areas where normal electric supply is difficult. Over the last few years, the penetration of renewable energy has been increasing steadily in the power system. There are two types of wind energy like offshore wind system and onshore wind system. Normally, offshore farm get more energy compared to onshore farms. The energy obtained from the wind is maximized and a wind speed region toward the lower speed range is accomplished than higher region[1]. It provides AC voltage from permanent magnet synchronous generator and mechanical input torque has been obtained from the turbine[2]. Modern windmills are designed with permanent synchronous generator to reduce losses and external excitation. The single wind turbines will produce up to 6MW of renewable power (when it is compared with non-renewable power plant generates up to 1,300MW). In this paper, we use forward converter to reduce mass and size of the power system. The forward converter is a single stage converter which has a transformer to boost DC voltage. It is also used to provide isolation between input and output in the system. While varying secondary windings of the transformer, it is possible to get both higher and lower output voltages[3]. Forward converter is used as step up or step down converter according to the demand[4]. Due to the presence of the high frequency transformer, the mass and size of the system is reduced to considerable extend[5,6]. DC supply for three phase inverters is taken from a Forward converter with high
frequency transformer. The current source inverter is connected with the grid in onshore.

2 CURRENT TOPOLOGY:

The existing configuration consists of an offshore wind farm has medium frequency transformer based modular dc-dc converter and onshore current source inverter which has sinusoidal pulses for switching operation. Generally the size and weight of transformer increases with the respect to decrease in frequency. The diode rectifier used in the system produced more ripple current because of its complex configuration. The dc-dc converter used in the system is three stage converters[7]. And it also has medium frequency transformer which is normally large in size and weight. More number of switches are used in the system due to three stage conversion which makes system more complex. The output from medium frequency transformer has harmonic distortion. Then the supply is transmitted to current source inverter in onshore. For long distance transmission, HVDC transmission is preferred to minimize transmission losses.

The onshore current source inverter converts the dc supply into ac supply. The harmonics present in the output are filtered by using inductance and capacitance circuits.

The current topology has three stage converter. So, it consists of more number of switches. The medium frequency is large in size and weight. The modular dc-dc converter gives low output voltage. Due to this conditions, the output has distortion.

3 PROPOSED SYSTEM:

Proposed system consisting of highly frequency transformer based forward converter produces high reliable dc voltage compared to the existing system. Normally, the wind energy conversion system works with induction generators or synchronous generators. In this system, permanent magnet synchronous generator (PMSG) with feedback control is used. The AC voltage is generated through PMSG and provides an ac supply to diode. PMSG has the significant advantage due to the absence of brushes and slip rings. The
external excitation is not needed in PMSG.

The output of PMSG is connected as a input to the Diode rectifier. It converts the three phase ac supply into variable dc supply. The forward converter is a single stage converter which has a transformer to boost DC voltage. It works on the principle of passing bidirectional dc supply to secondary winding without any magnetizing inductance or leakage flux.

![Fig 1: General outline for forward converter based WECS.](image)

The boosted dc voltage is transmitted to the current source inverter by HVDC transmission system. By using HVDC line the offshore boosted voltage is given to the current source inverter of the onshore system. For the reliable operation, The PWM pulses are given to the current source inverter. The DC is converted to the AC using inverter. The inductors and capacitors in the system are used to suppress the harmonics. Fig 1 Shows the wind energy conversion system with forward converter.

4 RESULTS AND DISCUSSION:

![Fig 2: Output waveform from WECS.](image)
Fig 3: Simulation diagram for WECS with forward converter

Fig 4: Output waveform from forward converter.

Fig 5: Final output of the wind system.
Fig 6: Waveform for PWM pulses to CSI.

Fig 7: Overall output from wind system.

Fig 8: THD value of the system.

Fig :2 Shows the output obtained from permanent magnet synchronous generator. The less distortion output is obtained with the help of feedback circuit. The diode rectifiers which is simple in construction converts the AC supply into DC voltage. Fig:3 represents Simulink of the proposed system. The newly designed coupled forward converter is used to increase the efficiency. The PWM inverter is also implemented in the simulation which helps to get distortion less output.

Fig 5 shows above represents the distortion-less output from wind system. It is achieved by using forward converter with high
frequency transformer. Fig 6 illustrates the six different input PWM pulses given to current source inverter. The pulses helps the output would be continuous and less in distortion. THD of the system is 10.54% as visualized from Fig 8. It is low when compared to current topology.

5 CONCLUSION:

A simple and suitable DC-DC forward converter and a CSI design for a WECS connected to a variable speed PMSG is presented here. This system has less distortion of 10.54% which shows in Fig 8. So, The output waveform is distortion less and by using forward converter the size and weight is minimized. The operation of forward converter and CSI is verified by developing a MATLAB/Simulink model for the proposed system.

References


