Implementation of Current Source Converter Based Wind Energy Conversion Systems in HVDC

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***Abstract*:- Design of bipolar current source converter based high voltage direct current (HVDC) system for wind energy conversation systems (WECS) is presentedbriefly in this paper.HVDC with mono polar is suffered with insulation issues, it is solved by employing transformers but it is not more economical. In paper bipolar HVDC system is proposed with optimized dc-link current control approach. In this control approach bipolar is treats as combination of two equivalent monopolar HVDC systems.Switching operation of current source converter is operated with sinusoidal pulse width modulation technique. Observed MATLAB simulation results and got desired performance results in bipolar HVDC transmission for WECS. This proposed technique improves overall system reliable, efficiency, and more economical.**

Keywords: Wind energy conversion systems, high voltage dc transmission, monopolar hvdc system, bipolar hvdc system, pwm-current source converter.

I. INTRODUCTION:

Offshore wind power is seeing an expanded pattern due to extensive wind assets, higher and steadier wind speed, and limited ecological impact. Two primary kinds of designs are proposed and executed for all intents and purposes for offshore wind vitality transformation configuration, parallel-associated arrangement and series associated setup. The previous is as of now actualized by and by where the greatest test is the in all respects expensive and massive offshore substation required to house venture up transformers, converters, and other related segments. The last is increasing more consideration in the writing as the offshore substation can be disposed of, however it has not been actualized at this point. Aside from voltage source converter (VSC)-based designs two or three current source converter (CSC)-based arrangements have likewise been concentrated in writing.Contrasted and thyristor-based configurations. Which include enormous impression, subordinate dynamic and reactive power control, and unprotected to ac system aggravation, the PWM CSC-based ones highlights regular favourable circumstances, for example, basic structure, grid benevolent waveforms, controllable power factor, and solid framework hamper. Ref. proposed an arrangement associated setup where PWM CSCs are introduced on both generator and lattice sides, while in the generator-side PWM CSC is supplanted with a particular medium-frequency transformer (MFT)-based converter. Contrasted and the setup in, the one in highlights littler size and weight.

One basic thing for existing CSC-based series associated designs is they are for the most part working under monopolar mode driving huge test for framework protection. The wind generator that is most distant from the establishing point must be fit for withstanding a full transmission level which is unrealistic. To handle this issue, a three-phase low-frequency high-power transformer is typically associated between the generator and the front-end converter. This transformer, nonetheless, is substantial and cumbersome expanding trouble on seaward development due to the restricted space either in the nacelle or in the pinnacle of the breeze turbine. Then again, a secluded medium-frequency transformer (MFT)-based arrangement is proposed in. Contrasted and the low-frequency transformer in, the measured MFT gives littler size and weight that is especially significant for seaward development. In outline, the bipolar CSC-based However, the most extreme protection prerequisite of the framework under monopolar activity is as yet the full transmission level. This acquaints noteworthy difficulties with the framework as far as cost, unwavering quality, and adaptability.

With an uncommon spotlight on diminishing the greatest protection level, the present work proposes and explores a bipolar framework. Bipolar mode that commonly utilized in VSCs gives a half protection prerequisite contrasted and monopolar mode. In any case, a major concern exists for the CSC-based [2] framework working under bipolar mode that is the dc-connect current control. Not at all like monopolar mode where there is just a single equal current way, has the bipolar activity mode had two proportional current ways. Hence, an ideal dc-connect current control is required to guarantee all the control destinations and give higher effectiveness, unwavering quality, and adaptability to the framework. As needs be, an advanced dc-interface current control is created arrangement associated setup with the assistance of the streamlined dc-connect current control highlights lower protection higher efficiency, reliability, and flexibility.

Power transmissions are broadly classified in ways like HVDC, HVAC and HVDC and HVAC. Beyond the breakeven point HVDC transmission is more economical [1]. In HVDC transmission network power electronics converters place a crucial role to exchange the power between the source and grid centers. HVDC transmission has more numerous advantages [2] compare to other transmission techniques such

as less cost, less maintenance, lower losses, lower environmental issues, deliver high amount of stable power to the load side. HVDC transmissions are mainly three ways like mono polar, bi polar and homo polar. In these techniques bipolar HVDC transmissions are more advantages, in this paper discussed about bipolar based HVDC transmission with WECS is discussed. The structure ofbipolar based HVDC transmission with WECS is shown in fig.1.

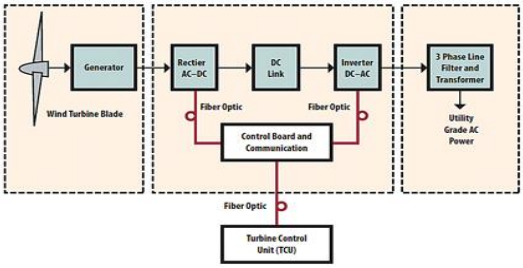


Fig.1. Structure of WECS with HVDC transmission

In literature available WECS with HVDC is available in shunt configuration and series configurations.Compare to voltage sources converters (VSC), current source converters (CSC) have significant features such as protects from the short circuits, improve power factor, control real & reactive power, and simple structure.The similarity in CSC employed series configurations is it can operate in mono polar mode. HVDC mono polar [9] is suffered with system insulation; wind generator must require the neutral point. To handle this problem require transformer (low frequency) connection between generator and converter. This problem is also solved by medium frequency rating transformer (MFT) reported in [5]. Mon polar HVDC has still facing challenges in terms of economical and flexibility.

In paper mainly focused on reduces the insulation of WECS system employing bi polar converters. In Mono polar need the transformer setup it may act as bulk on total system. In monopolar links current divides equally, in bi polar used dc link control method it helps to improve over system efficiency. The next sections of this paper is summarized as follows, configuration of CSC based WECS in Section –II, presented control scheme in section –III, MATLAB simulation results in section –IV and concluded in section-V.

II. CONFIGURATION OF CSC BASED WECS:

The block diagram of PMSG based WECS with CSC is shown in fig.2. It mainly contains generator side converters it converts power produced by wind (A.C) into D.C act as rectifier. And grid side converter converts the D.C into A.C act as inverter and connected to grid.

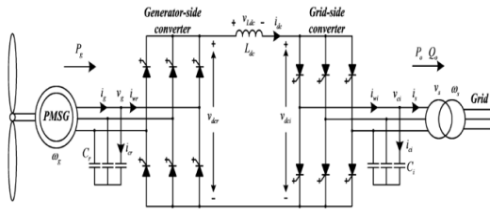


Fig.2. PMSG based WECS with CSC

The power produced from the wind i.e. captured energy from the wind, for an effective area $A_r$is given by

$P = 0.5\ \rho_{air} C_p A_r V_w^3$

Where

ρ_{air}= Density of air [kg/m^3]

V_w= Speed of the wind

C_p = Coefficient of power

To receive maximum power from in WECS the rotor speed can be adjusted. Maximum power is acquired from WECS by controlling rotor speed of PMSG i.e. maximum power point tracking (MPPT) method, reported in literature widely [2].

III. CONTROL SCHEME:

Various control schemes are available to operate the CSC such as direct torque control (DTC), direct power control (DPC), voltage oriented control and field oriented control techniques.

A. Generator Side Control scheme:

Field oriented control (FOC) technique is adopted to control the generator side and sinusoidal pulse width modulation is employed to operate the switching operation of current source converter. The block diagram of generator side control scheme is shown in figure.3.

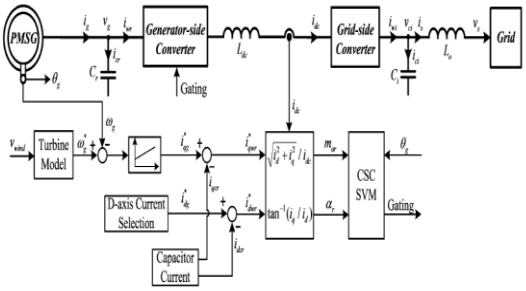


Fig.3. Configuration of generator side control scheme employing FOC control Scheme

B. Grid Side Control Scheme:

Voltage oriented control (VOC) technique is adopted to control the grid side and sinusoidal pulse width modulation is employed to operate the switching operation of current source converter. The block diagram of generator side control scheme is shown in figure.4.

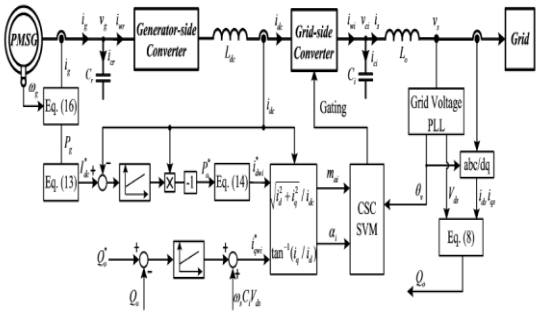


Fig.4. Configuration of generator side control scheme employing FOC control Scheme.

The schematic diagram of dc link current control method is shown in figure.5. n. no. of wind power generations are connected to PCC to reach the power demand. This proposed bi polar HVDC transmission is equivalent of mono polar HVDC systems operates independently. It gives more flexible and high efficiency compare mono polar HVDC systems and reduces insulation greater extent.

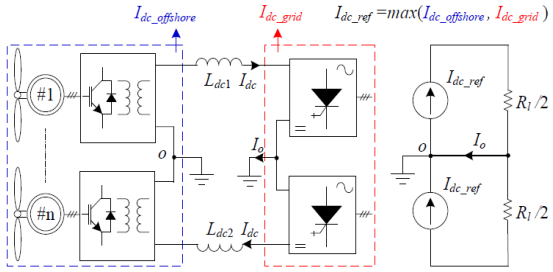


Fig.5. Bipolar HVDC transmission configuration with DC link current control.

IV. SIMULATION DISCUSSIONS:

The present focus is on the bipolar operation of the CSC-based system with the help of the optimized dc-link current control. The other related objectives such as MPPT, voltage balance control, active and reactive power control, and load current performance are also considered for analysis.

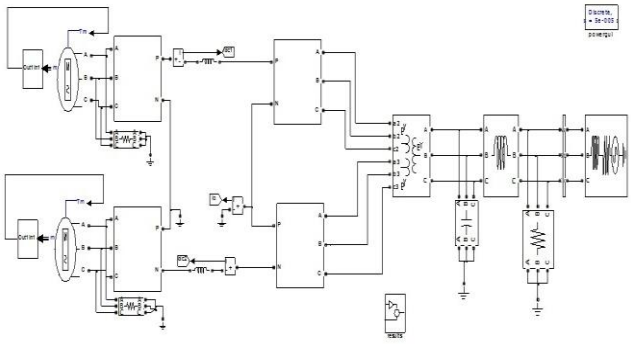
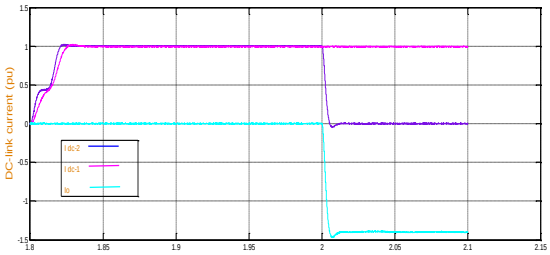
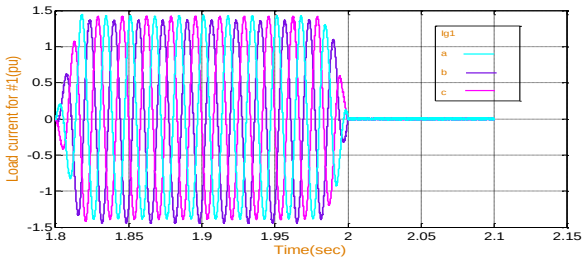


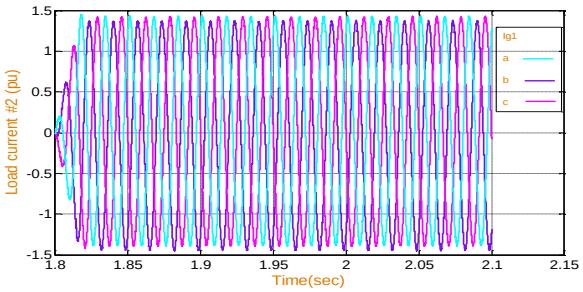
Fig.6. Simulation diagram of Current Source Converter based Wind Energy Conversion Systems.



a) Dc-link currents (pu).

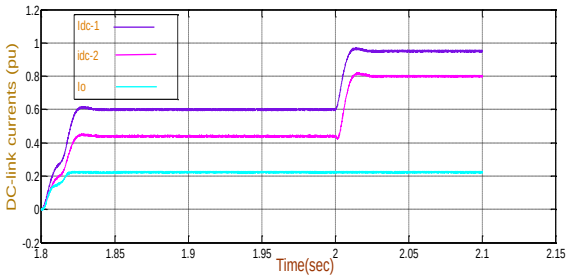


b) Load Currents for #1 (pu)

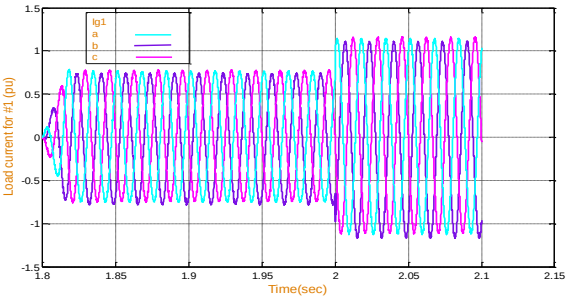


c) Load Currents for #2 (pu)

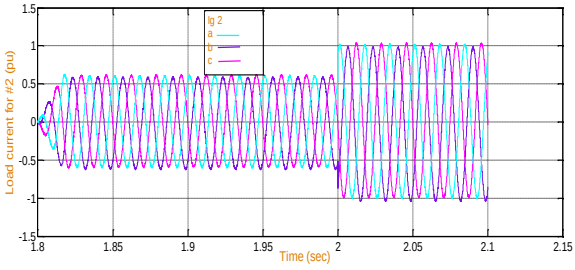
Fig.7. Simulated performance of the bipolar system when one module is by passed.



(a) Dc-link currents (pu)



(b) Load Currents for #1 (pu)



(c) Load Currents for #2 (pu)

Fig.8. Simulated performance of the bipolar system under stepped dc-link Current.

V. CONCLUSION:

In this work, the performance of the CSC-based series-connected offshore wind farm under bipolar operation mode is investigated. Compared with monopolar mode, bipolar mode gives lower insulation level, thus contributing to significant cost saving and higher reliability. In addition, an optimized dc-link current control is developed, based on which the bipolar system is equivalent to two independent monopolar systems that can operate with their own dc-link reference independently with the same earth return. Compared with conventional dc-link current control, the proposed one features higher efficiency and flexibility.

Furthermore, the bipolar system can be extended to a multi-terminal system with larger power capacity. In summary, the bipolar system with the help of the optimized dc-link current control features lower insulation level, higher reliability, higher efficiency, and higher flexibility.

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