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Stabilizing of Grid and Power System Based Wind Power Generation Using FACTS Technology

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Abstract— Integration of large wind farms with power system holds stability and control problems. For identifying the potential issues and designing a strategy to alleviate them, a thorough know-how is required. Integrating high levels of wind power calls for further control and compensating equipments to facilitate recovery from system disturbances with high degree of severity. This paper throws light into using effectively, a Static Synchronous Compensator (STATCOM) for stabilizing the grid voltage following grid-side disturbances during disturbances the enhancement of FRT capability of IG is also verified by simulation results using MATLAB /SIMULINK.

Index Terms— Facts, STATCOM, Voltage Grid, disturbances, LVRT, Rotor Side Coverter, Grid Side Converter

1 Introduction

DYNAMIC stability of a wind farm interconnection with power grid on the power system is one of the most perplexing issues. Voltage instability troubles arise in a power system which is unable to keep up with the need for reactive power during faults and heavy loading conditions. In simulation studies, it's quite easy to model, analyze and regulate standalone systems as compared to their large counterparts (large power systems).

On account of their capacity to offer flexible power flow control, FACTS like STATCOM and UPFC are widely utilized in power systems. The key intention for settling on STATCOM in wind farms is its capability to endow bus bar system voltage, either by supplying and/or absorbing reactive power into the system. Reactive power requirements can be taken care of, under several operating conditions, by the application of a STATCOM in wind farms.

It also improves the steady-state stability limit of the network. Introducing a STATCOM into the system as an active voltage/var supporter gives better stability. The recently demanded pre-requisite by transmission operates includes Low Voltage Ride through (LVRT) from wind farms. STATCOM is under the process of evaluation of its performance efficiency for providing LVRT for wind turbines in a wind farm.

2 Wind Turbine

Induction Generators (IG) that can deliver variable speed operation have been selected as WT under consideration in this paper. An IG is equipped with a power electronic converter for controlling reactive power. A STATCOM was used for controlling the voltage at the bus and maintaining constant DC link voltages at individual wind turbine inverters during disturbances.

For simulations, the dynamic IG model Power has been employed. On the basis of research of an available low capacity STATCOM model, The STATCOM with a higher rating capacity was designed. The complete power grid analyzed in this work is a merged case study of interconnected two wind turbines, a synchronous generator, a STATCOM and a typical load, all of which form a four bus system.

A back-to-back converter is coupled between the rotor and IG. The major purpose of the grid side converter (GSC) is to maintain the DC link voltage constant. The reactive power keeps the power factor at unity. The GSC functions as additional reactive power compensation in course of a fault. A rotor side converter (RSC) controls the stator active and reactive powers, the machine speed and the stator reactive power. There is a direct connection between the stator of the IG and the grid. Self-commutated converters feed the slip-rings of the rotor. By controlling the reactive power produced or absorbed by the RSC, it's possible to control voltage or reactive power at the grid terminals.

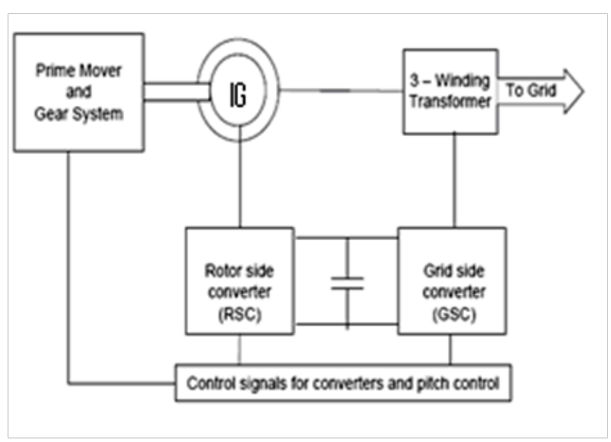

Figure 1: Block diagram of IG

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3 Sections Performance of A WT With Faults On System

Variable speed wind turbines produced more power than fixed speed wind turbines. Currently designed grid codes mandate that wind turbines should have the strength to sustain voltage disturbances without getting disconnected. This is termed as the LVRT capability of the wind turbine. The LVRT requirement for wind generation is shown in Fig 2. The LVRT commands that a WT doesn't trip even if the voltage drops to 0.15 per unit for about 0.625 seconds. In case the voltage drops below this value because of a fault, the wind turbine can be tripped until the system is restored and the wind turbine re-synchronized. This paper stresses basically on the low voltage ride through requirement for wind turbines.

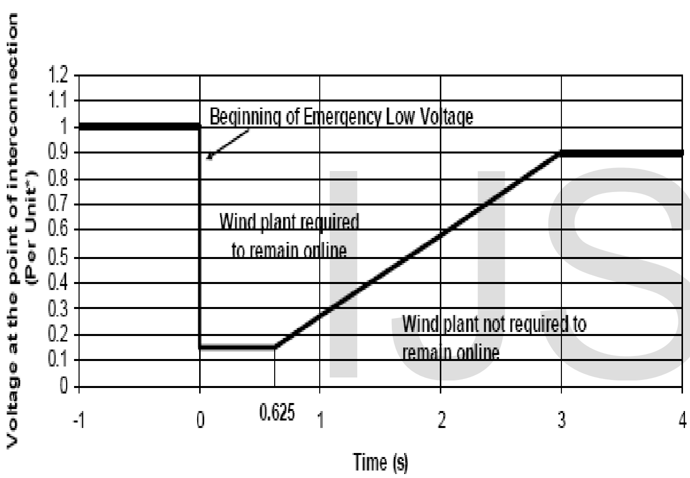

Figure 2: LVRT requirement for wind generation facilities

4 The Statcome

The basic model of a STATCOM is presented in Fig 3. It is linked with the ac system bus via a coupling transformer.

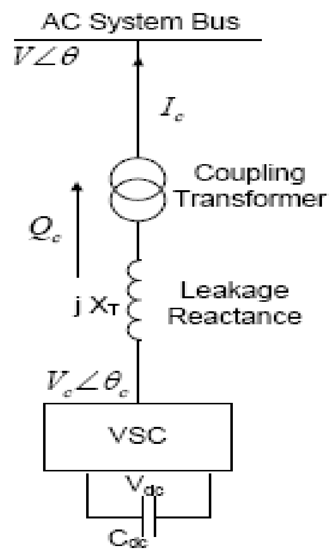

Figure 3: Basic model of a STATCOM

Control Scheme

The STATCOM is a static var generator which lets us vary its output, so that certain specific parameters of the electric power system can be maintained or regulated. Figure 4 presents the block diagram of the STATCOM controller. Controlling the phase and magnitude of the STATCOM output voltage assists effective control on the power exchange between the ac system and the STATCOM.

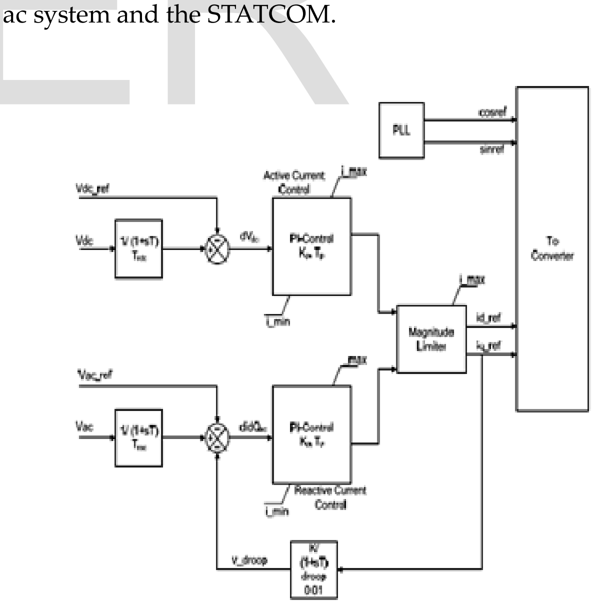

Figure 4: Control scheme of the STATCOM

5 Simulation Results

The performance of IG wind turbine during system fault caused by symmetrical three phase fault is to be analyzed . Two situation are analyzed which are with and without STATCOM application. In order to provide the grid code requirements and continuous wind turbine connection to the grid, the IG should not

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remove from the power system during voltage dip so the STATCOM is used to provide the required reactive power for voltage dip compensation and faster recovery after the fault.

The impact of a symmetrical three phase fault on IG performance has been investigated. The system has been simulated in MATLAB. The fault initiation takes place at t=0.1 sec and clearance at t=0.15 sec. The system study has been done with and without STATCOM employment. The three phase and magnitude stator ,rotor voltages ,and grid voltage profile shown in Fig.5 , Fig 6 , Fig 7, respectively indicate that the amplitude of these voltage have been declined during the fault without using STATCOM . By comparing Fig.5,Fig.6,Fig.7 (without STATCOM) with Fig .8,Fig 9,Fig 10 (with STATCOM) , the voltage dip will be mitigated considerably .Because of the typical function of voltage compensation unit represented by STATCOM, the required amount of reactive power will be injected when the voltage got dipped due to fault .

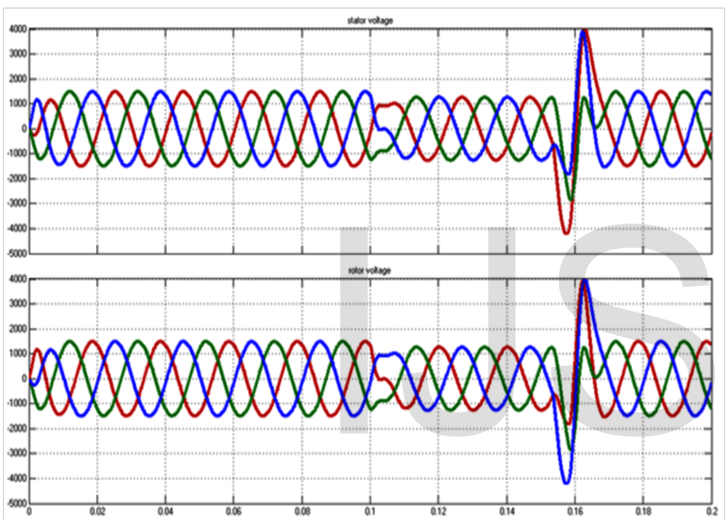

Figure 5: Stator, Rotor voltages without STATCOM

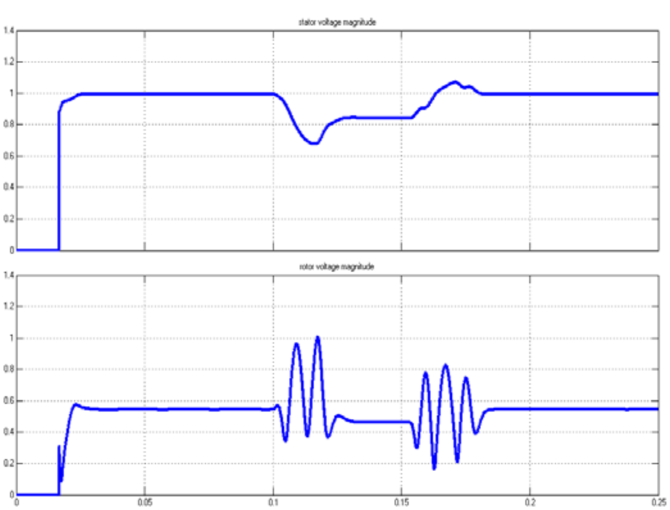

Figure 6: Stator , Rotor voltage magnitude without STATCOM

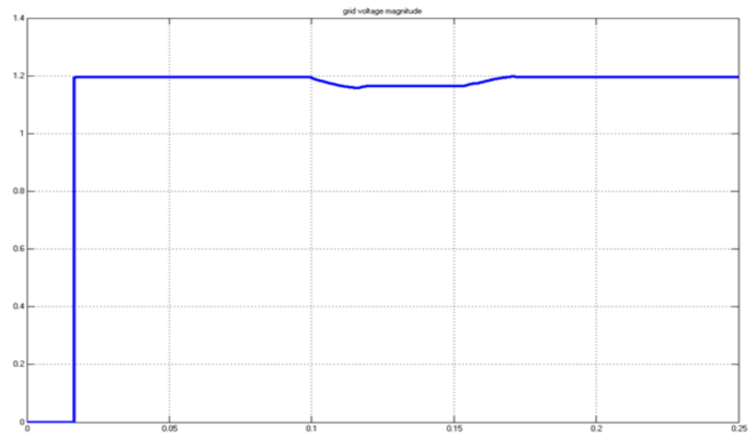

Fig 7: Grid voltage magnitude without STATCOM

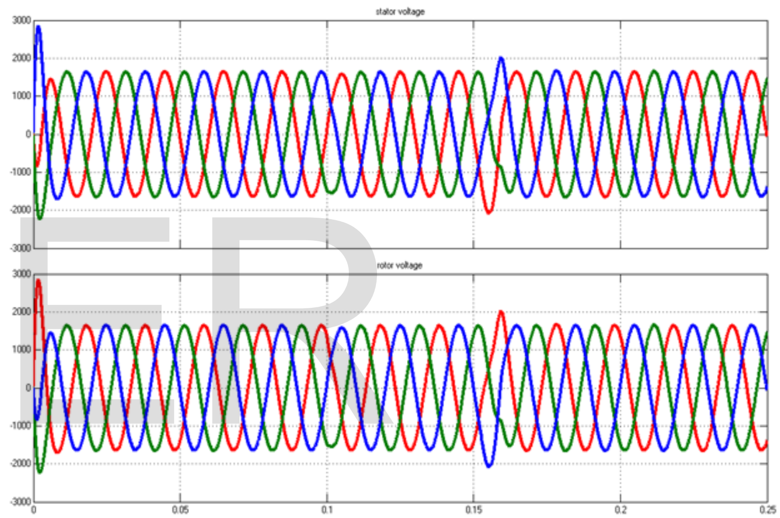

Fig 8: *Stator, Rotor voltages with STATCOM*

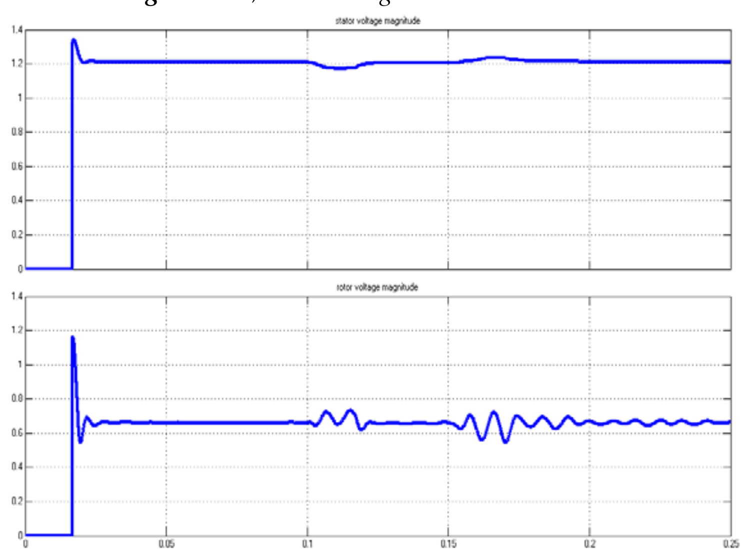

Figure 9: Stator, Rotor voltage magnitude with STATCOM

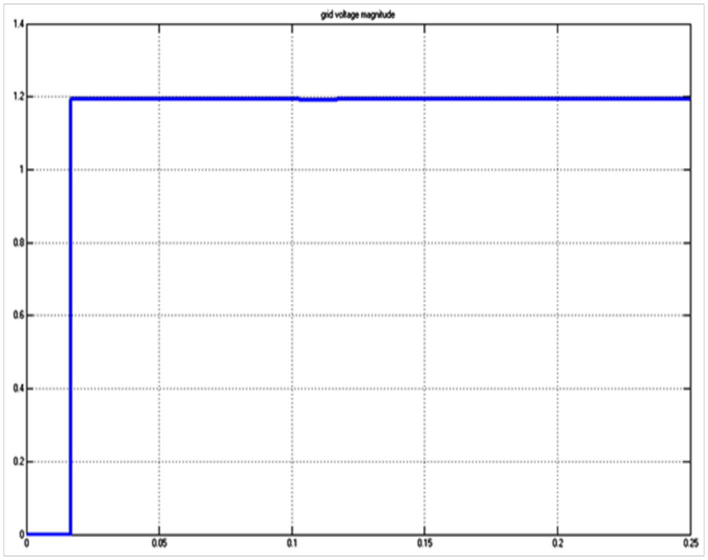

Figure 10: Grid voltage magnitude with STATCOM.

6 Conclusion

The dynamic performance of wind farms in a power grid can be enhanced by utilizing a STATCOM. The STATCOM helps in providing improved voltage characteristics during severe faults such as symmetrical three phase faults. With the use of STATCOM an uninterrupted operation and regulation of voltage at PCC during fault condition had been achieved .The overall system stability can be improved and grid codes have been satisfied as well. The results have been validated by simulation.

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