A New Method for Uninterrupted Operation of Wind Turbine Equipped with DFIGs During Grid Faults With Using of FCL

Abstract

The main issue of wind turbines that equipped with doubly fed induction generators (DFIGs) is the grid faults or low voltage ride through capability. In this paper, a new solution for uninterrupted operation of wind turbine driving a DFIG has been proposed during fault condition in the grid. A fault current limiter (FCL) is placed in series with the rotor circuit. During fault condition FCL enters a huge solenoid in the rotor circuit to inhibit increasing of current in the rotor circuit. When the fault is cleared the FCL bypasses the solenoid. A static synchronous compensator (STATCOM) has been applied for supplying required reactive power in faults and steady states. Capability and modeling accuracy of the proposed method confirmed with simulating a sample power system in PSCAD/EMTDC software.

Objectives

In this paper, a new solution for uninterrupted operation of wind turbine equipped with doubly fed induction generator has been proposed during fault condition in the grid. A fault current limiter (FCL) is placed in the rotor circuit. When the fault occurs in the network, the gate turn-off thyristors (GTOs) of FCL turns off and enters a huge solenoid in the rotor circuit to inhibit increasing of current in the rotor circuit. When the fault is cleared, the GTOs of FCL turns on and bypass the solenoid out of rotor circuit. The advantage of this method is that generator and power electronic converter stay connected to the network, synchronous operation of WTG can be provided significantly during fault condition and normal operation can be continued immediately after fault clearance. On the other hand, in this paper has been used from a static synchronous compensator (STATCOM) for supplying required reactive power in steady and occurring fault states, which is placed in the bus that wind turbine is connected to the power system. Applicability and accuracy of this method will be confirmed by simulating a sample power system in PSCAD/EMTDC framework.

Uninterrupted Operation Feature

A new method that is proposed here for uninterrupted operating of wind turbines equipped with DFIGs during the fault condition is applying a FCL that is placed in series with circuit of rotor for RSC protection. In normal operation, the GTOs of FCL are gated for full conduction. When a fault occurs in power grid and voltage drop is distinguished, GTOs of the FCL turn off immediately and a huge inductance is placed in series with the rotor circuit to avoid destructing RSC from over current that has flown through rotor circuit and prohibiting the outage of wind turbine from power network. In this case, the wind turbine continues to its operation and when the fault is cleared and voltage returns to an acceptable level, GTOs of the FCL turn on rapidly and the huge inductance exits from circuit of the rotor. So, the wind turbine returns to its normal operation condition. Also a STATCOM has been applied for reactive compensation in steady and occurring fault states. STATCOM help to achieve uninterrupted operation of the wind turbine. The advantage of this proposed method is due to continues normal Operation after fault clearance and synchronous operation mode remains suitably during fault occurrence and after fault Clearance.

Simulation

In this stage, the new proposed method of this paper has been simulated. A three phase short circuit has been imposed to the power system bus at t = 2 sec. After detecting voltage dip, GTOs of the FCL turned off quickly and a huge inductance is placed in the rotor circuit for limiting the current. In t = 2.2 sec the fault is cleared and then after reaching the voltage to the specified level the GTOs of the FCL turned on and the inductance has been forced to get throw out of the rotor circuit. At this stage, a STATCOM has been adopted for reactive power compensation. As below Figure shows, in the presence of the STATCOM, the produced voltage of generator quickly reestablished shortly after the FCL cuts the huge inductance out of the rotor circuit. So, the uninterrupted operation of the wind turbine that is equipped with DFIG is obtained easily and reliably.

Conclusions

In this paper, application of the FCL and STATCOM for obtaining uninterrupted operation of wind turbine equipped with DFIG during fault condition of the power system has been studied. The FCL is placed in series with rotor circuit and protects the RSC from the over currents that has been induced during fault condition on the power system. Also the paper has applied a STATCOM that is parallel with the WTS bus for supplying required reactive power in fault condition and steady states operation. Simultaneous using of the FCL and the STATCOM during the fault conditions insures that, the current of rotor is limited significantly and the voltage of the WTS bus returns to its previous value immediately after the fault clearing. Therefore the wind turbine can continue to its normal operation reliably.

References

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European Wind Energy Conference & Exhibition 2010, Tuesday 20 - Friday 23 April 2010, Warsaw, Poland