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A New Proposal of SFCL in AC & DC Micro Grid to Limit the Fault Currents

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Abstract: ***In a smart grid, various kinds of distributed generation (DG) sources could be connected into the main power grid in order to enhance the reliability of the power system. The combination of ac and dc distribution grid is also considered for the efficient connection of renewable power resources. In this case, one of the critical problems due to these integrations is the excessive increase in the fault current because of the presence of DG within the smart grid. In order to protect the smart grid from increasing fault current, a superconducting fault current limiter (SFCL) could be applied, which has negligible power loss and capability to limit initial fault currents effectively. This paper presents feasibility analysis results of the positioning of the SFCL and its effects on reducing fault current in a smart grid having ac and dc micro grid. IEEE-13 bus system is implemented with DC&AC grids to limit the fault currents with in a cycle of time and improve the stability of the system.***

Keywords: Distributed Generation, SFCL, IEEE

1. Introduction

As per statistics of energy consumption, electrical energy consumption has continually grown and transmission and distribution infrastructure has been more complicated. For such reasons, smart grid concept has been suggested, which could manage the electricity consumption in real time and be more flexible, reliable and responsive than conventional power systems [1]. In a smart grid, transmission and distribution infrastructure will be better able to handle possible bi-direction energy flows, allowing for distributed generation such as wind turbines, photovoltaic (PV) farms and other power resources. However, one critical problem of these integrations is the excessive increase in a fault current due to the presence of distributed generation within a smart grid By the multiple routes from power plant to conventional grid, AC and DC microgrid, the excessive fault current in one microgrid could affect the neighboring microgrid and it could be able to cause a domino effect which leads a blackout eventually. Therefore, smart power devices which could protect smart grid from the increasing fault current are required for the reliability and the safety of power systems. In order to reduce the fault current in smart grid having AC and DC micro grida, SFCL could be applied which is mot fastest device to reduce fault currents. This paper flow to be like this, second section we will discuss about simulation setup then third section generating systems. Fourth section we will ac/DC SFCL. Then simulation results.

2. Simulation Setup

The smart grid having three branches was designed and this power system configuration basically referred to General distribution system. This setup consists of a conventional generating system with PV and wind system. The wind system directly interfaced with the conventional, for PV system the conventional system converted into dc to be interfaced. The fault current was measured for .1 sec of duration. In both grids (ac/DC) fault will occur at a time then The SFCL will come into act and it will interrupt the current through the fault. The simulink model is shown in the figure 1.

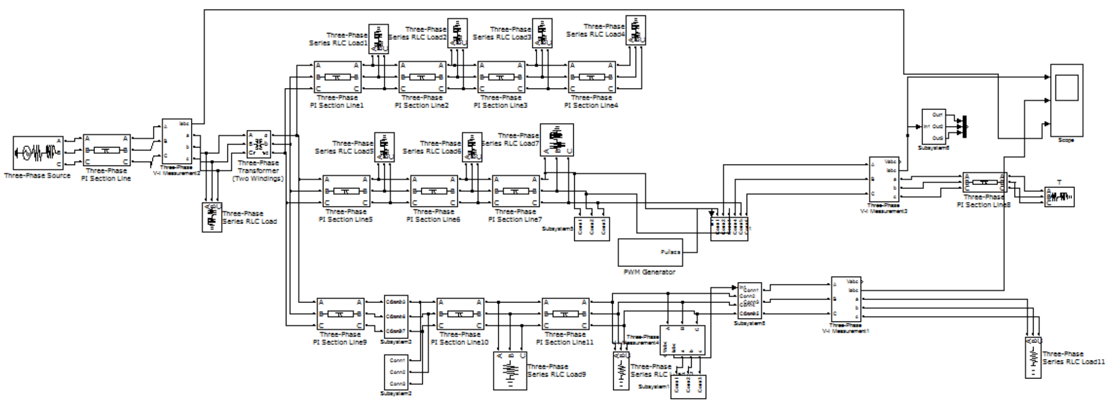

Figure 1: Simulation setup of IEEE 13 bus system with dc s well as ac SFCL for studding fault currents

The microgrid has AC microgrid and DC microgrid together. Each microgrid is integrated with distributed generation sources. AC microgrid has the wind farm which is composed of five fixed speed induction type wind turbine. Each wind turbine has a 1 MVA rating. The working voltage of AC microgrid is 440v which is general distribution voltage.

3. Generating Systems

In case of DC microgrid, photovoltaic farm which is composed of 200 solar panels were connected to the grid. Each photovoltaic module has a 3 kW rating. The working voltage of DC microgrid is 600V and this voltage was chosen by considering the operating voltage of LVDC. The outstanding difference between AC and DC microgrid is the existence of voltage source convertor (VSC), pole mounted transformer (PMT) and domestic power convertor (DPC).

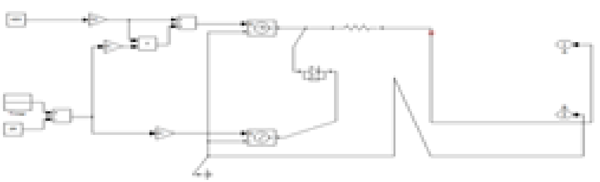

Figure 2: PV model used for simulation

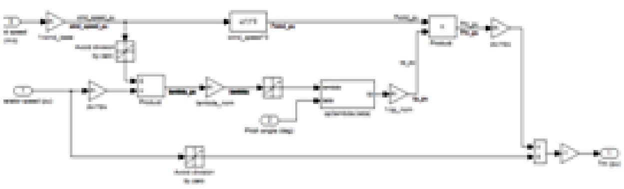

Figure 3: Characteristics of PV array

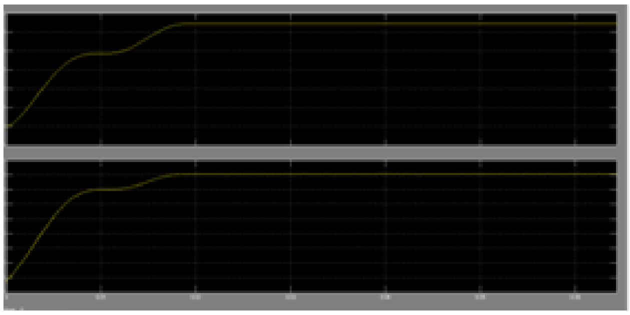

Figure 4: Wind turbine model used for simulation

The characteristics equation of solar generation as follows

$$I = I_{SC}\left[1 - \frac{I_o}{I_{SC}}\left(e^{\ln\left(\frac{I_{SC}}{I_o}+1\right)\frac{(V+R_s I)}{V_{OC}}} - 1\right)\right].$$

Power equation of Wind Turbine

$$P_{m,\mathrm{ideal}} = P_1 - P_4 = \frac{1}{2}\rho(A_1 u_1^3 - A_4 u_4^3) = \frac{1}{2}\rho\left(\frac{8}{9}A_1 u_1^3\right) \quad \mathrm{W}$$

Characteristics of wind turbine as show in figure:

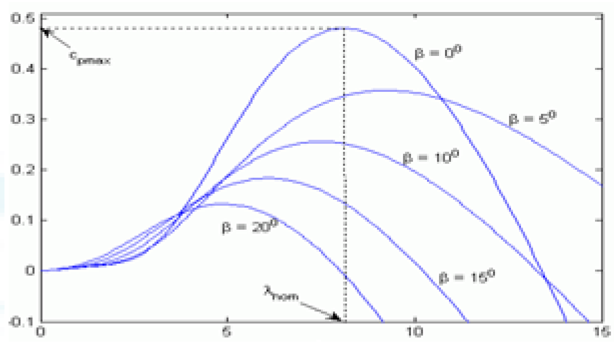

Figure 5: characteristics of the wind turbine

4. Super Fault Current Limiter (SFCL)

a) DC SFCL

DC SFCL modeled based on the fault currents. When the fault accord in dc micro grid the fault current going to be increased. At this incident the voltage going to be injected by using current controlled voltage source with the magnate of V(=R*If).from that the corresponding resistance is calculated using R_{sfcl}=V/If. So that the current through the fault going to be zero(i.e.) minimum)

b) AC SFCL

In this model we are using the transformer type SFCL in order to limit the currents easily. Here the primary winding of the transformer is connected to the line. Hence, it transfer the voltage of magnitude of n*V1. Where n is the turns ratio.V1 is the voltage induced in the primary winding based on the current flows through it. When the fault accord. Due to heavy fault current the voltage in the winding going to be high. This voltage opposes current flows through it. Hence the currents in line going to be decreased.

5. Simulation Results and Discussion

A) When fault accord in DC micro grid

At the time of fault accord in dc micro grid the fault current going to be high. To reduce this fault current we are going to calculate dropped voltage from that you can inject the voltages to the system. Characteristics as shown in figure bellow.

B) When fault accord in AC MICRO grid

At the time of fault accord in dc micro grid the fault current going to be high. At this time voltage induced in the transformer windings going to be high, this will opposes the flow of fault currents in the system

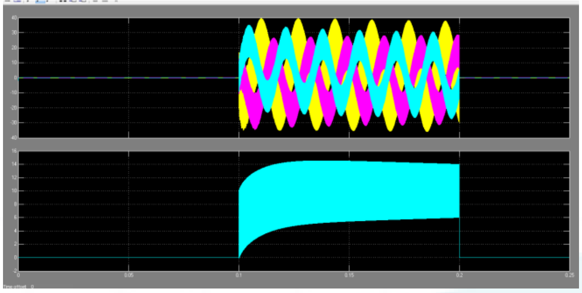

Figure 6: DC and AC fault condition

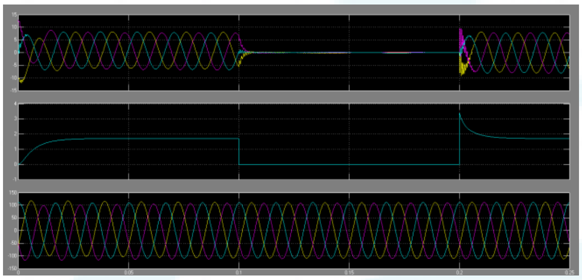

Figure 7: Protected system from the fault

6. Conclusion

This paper presented feasibility analysis results of positioning of the SFCL and its effects on reducing fault current in smart grid having AC and DC microgrid together. In order to determine the SFCL in neighboring AC and DC smart grid, AC and DC SFCL models were designed to perform for the worst case faults.

From the simulation results, the optimal strategic installation of SFCLs in power systems, which limits all abnormal fault currents and has no negative effect on the distributed generation resources, has been proposed. And the efficient way to reduce fault currents in system was analyzed and proved with simulation in MATLAN/SIMULINK.

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