Department of Electrical Engineering

Delhi Technological University

(Formerly Delhi College of Engineering)

CERTIFICATE

This is to certify that the project entitled, "**DISTURBANCE IMMUNE DFIG FOR WIND FARM APPLICATIONS**", submitted by **Ms. Swati Tandon**, University Roll No. 2k11/PSY/19, student of Master of Technology (Power System) in Electrical Engineering department from Delhi Technological University (Formerly Delhi college of Engineering), is a dissertation work carried out by her under my guidance during session 2012-2013 towards the partial fulfillment of the requirements for the award of the degree of Master of Technology in Power System.

I wish her all the best in her future endeavours.

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DECLARATION

I, hereby declare that the work being presented in this Project Report entitled **"DISTURBANCE IMMUNE DFIG FOR WIND FARM APPLICATIONS"** is an original piece of work and an authentic report of my own work carried out during the period of 4^{th} Semester as a part of my major project.

The model developed and results presented in this report is an outcome of the work carried out during the above said period and is also compiled as thesis for my Major Project for completing the requirements of Master's Degree of Examination in Power System Engineering, as per Delhi Technological University curriculum.

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ABSTRACT

Energy is one of the most important factors that continue to influence the shape of civilization since evolution of mankind to this 21st Century. The cost and availability of energy significantly impacts the quality of our life, growth of the country and the stability of our environment. In recent years there has been a global commitment to develop clean and alternative forms of energy resources.

Among renewable energy resources, wind generation technology has matured considerably, as wind is fairly distributed around the globe, and the conversion is low cost. However, more penetration of wind energy into existing power networks raises concern for power system operators and regulators. The problems of wind are associated with dependence on the local environmental conditions. Variability of the wind speed causes oscillations in the output power of the wind generators, resulting in a variety of consequences within the power system and in its operation.

The stable operation of the Wind Energy Conversion System (WECS) amidst variety of disturbance on the microgrid is seen as a challenging task. Unbalanced magnetization of the Doubly Fed Induction Generator (DFIG) largely affect the generation profile and could cause cascading effect eventually leading to shut down of the wind farm. Moreover, popular WECS, Induction Generators (IG) in order to generate real power consumes reactive power from the mains making the operation with relatively lower power factor (pf). In order to provide requisite immunity to the DFIG based WECS, each system should be controlled in way that only balanced currents are transacted by the WECS at near unity pf. The thesis dissertation presents Synchronous reference frame (SRF) method based current estimation of the reference currents both in positive and negative sequence for control of the stator side Voltage Source Converter (VSC)and slip frequency based load levelling by rotor side VSC (RSC). MATLAB based simulation results presented in the thesis show the efficient working of WECS control amidst distorted conditions at Point of Common Coupling (PCC).

Keywords: *Induction Generator, Back-to-Back Converters, Wind Energy Conversion, DFIG, Voltage Source Converter*

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List of Abbreviations and Symbols

DFIG	Doubly-Fed Induction Generator.
SCIG	Squirrel Cage Induction Generator
PMSG	Permanent Magnet Synchronous Generator
DFSG	Doubly Fed Synchronous Generator
WT	Wind turbine
FSWT	Fixed Speed Wind Turbine
VSWT	Variable Speed Wind Turbine
WECS	Wind Energy Conversion Systems
DG	Distributed Generation
PWM	Pulse Width Modulation
PI	Proportional-Integral
PLL	Phase Locked Loop
PCC	Point of common coupling
VSC	Voltage Source Converter
GSC	Grid Side Converter
SSC	Stator Side Converter
RSC	Rotor Side Converter
DTC	Direct Torque Control
DPC	Direct Power Control
P_{mech}	Mechanical Power
λsd, λrd	Stator, Rotor flux linkage
Rs, Rr	Stator, Rotor winding resistance
Ls, Lr, Lm	Stator, Rotor winding leakage inductance, mutual inductance
d,q	direct and quadrature axis component
V_{ds}, V_{qs}, V_{dr} , V_{dr}	Stator, Rotor direct and quadrature axis voltages
I_{ds}, I_{qs}, I_{dr}, I_{qr}	d and q-axis stator and rotor currents
ψ_{ds}, ψ_{dr} ψ_{qs}, ψ_{qr}	q and d-axis stator and rotor fluxesPs, Qs, Pr, Qr Stator, Rotor active and reactive power
Pwind	Wind turbine power
ωs, ωr	Generator rotating speed, generator synchronous speed

P	Number of poles of the machine
K_f, J	Friction coefficient, Inertia of the rotor
Tm, Te	Mechanical torque generated by wind turbine, Electromagnetic torque generated by the machine
ρ, R, A	Air density, radius of turbine rotor blades, area swept by rotor blades
Cp, λ, β, vwind	Turbine performance coefficient, turbine tip-speed-ratio, pitch angle of rotor blades, wind speed

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