INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The effective operation of a typical doubly-fed induction generator (DFIG)-based wind energy conversion system (WECS) requires efficient control of the two power electronic converters connected back-to-back. Out of these two converters, one converter is tied to the grid or the stator of the DFIG and is called active front-end converter or grid side converter (GSC) or stator side converter (SSC), and another one is tied to the rotor of the DFIG and is called rotor side converter (RSC). The present thesis mainly focuses on the design of controllers and observers for the DFIG.

The efficient control of the GSC depends upon the accurate information on the phase and frequency of the grid voltage, which can be estimated through a phase-lock-loop (PLL) system. Hence, a modified synchronous reference frame (SRF)-based PLL technique is proposed to estimate the phase and frequency of the grid. The estimated phase from the proposed PLL is utilized to convert the three-phase sinusoidal variables in the stationary reference frame (*abc*) of the grid (voltage and current) to two-phase stationary DC variables in the synchronously rotating reference frame (*dq*). The dynamic model of the GSC in *dq*-reference frame is utilized here to develop the controllers for the GSC. Two current control algorithms are proposed to control the active and reactive grid currents of the GSC, and one voltage control algorithm is proposed to control the DC-bus voltage of the GSC. One of the current controllers is based on adaptive multiple-input multiple-output (MIMO) control, and the other current controller is based on first-order sliding mode control (FOSMC). The developed voltage controller is based on an extended state observer (ESO) augmented with an adaptive control technique.

Efficient control of the RSC depends upon the accurate information on the rotor speed and rotor position/angle, which can be measured directly by a rotary encoder. However, the failure-prone nature of these encoders makes the system unreliable; hence, reliable solutions in the form of rotor speed and position observers are proposed in this thesis. Two observers are developed using the dynamic model of the DFIG. The stator current and rotor flux are used as the states for both the observer models. The first observer is based on the first-order sliding mode observer (FOSMO), and the second observer is based on second-order sliding mode observer (SOSMO). The performance of these observers is also validated in real-time with close loop terminal voltage control of a standalone DFIG system.