National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Design and Development of Various Adaptive Filtering-Based Control Schemes for a GridTied Multifunctional Photovoltaic System
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Abstract

: The need for environmentally friendly alternatives to traditional methods of electrical energy generation has grown due to the rising demand for electrical energy and the pollution caused by using fossil fuels. One potential solution is to employ renewable energy sources (RES) to generate electricity, which mitigates the adverse environmental impacts. Solar photovoltaic (PV)-based power generation has gained popularity among a variety of RES due to its numerous advantages such as its decentralized nature, reduced transmission losses, increased overall efficiency, minimal maintenance, safety, and decreased cost of solar panels as a result of technological advancements over time. Large PV systems are generally configured to operate in a grid-tied mode to utilize solar PV power effectively. The features of a distribution static compensator (DSTATCOM) can also be incorporated into the PV system while synchronizing the PV system to the utility grid, thus naming the system as a grid-tied multifunctional PV system (GTPVS). The configuration of GTPVS is contingent upon the conversion stages, which are based on the power electronics converters. This configuration can be either single-stage or double-stage. In contrast to a double-stage GTPVS, single-stage GTPVS exhibits reduced complexity and losses. Therefore, in the current research work, a single-stage configuration is preferred. Conversely, due to their nature, nonlinear loads connected at the point of common coupling (PCC) in the distribution grid (DG) decrease power quality (PQ) by drawing harmonic currents from the grid. The single-phase loads on the three-phase system result in unbalanced grid currents, which makes the synchronization of PV systems to the utility grid challenging. The intermittent nature of PV power further complicates the synchronization process. Thus, to enhance PQ while handling the dynamic conditions associated with the environment and loads, this thesis focuses on the development of multifunctional control schemes based on various adaptive filters to operate the three-phase single-stage GTPVS. Firstly, the control scheme is developed by employing a generalized soft-root-sign (GSRS) adaptive filter for a GTPVS to improve PQ while extracting maximum PV power using an incremental conductance (InC) method and synchronizing the PV system to the grid. To improve the dynamic response, the variable step size (VSS) strategy is considered, thus developing a variable step size robust normalized least mean absolute third (VSSRNLMAT) adaptive filter and robust variable-*&lambda* least logarithmic hyperbolic cosine function (VLlncosh) adaptive filter. The interconnection of PV systems to the weak grid faces challenges like non-ideal grid conditions like voltage distortions, swell, sag, unbalanced voltages, and DC offset. A control architecture using an adaptive vectorial filter (AVF) and a robust generalized modified Blake-Zisserman adaptive filter (GMBZAF) is developed for a GTPVS to enhance power quality during non-ideal grid conditions. The AVF filters grid-distorted voltages, while the GMBZAF estimates the peak magnitudes of load current. The proposed control architecture also incorporates multifunctional capabilities for balanced sinusoidal currents and effective power management. It ensures the THD of grid currents as specified by IEEE 519 standard. To incorporate selective harmonics and DC offset rejection capabilities, a control scheme for a GTPVS is developed based on multiple circular limit cycle oscillator frequency locked loop (MCLO-FLL) and variable scaling factor and step size logarithmic hyperbolic cosine adaptive filter (VSS-LHCAF). The MCLO-FLL and VSS-LHCAF-based control scheme also enhances grid PQ during adverse grid condition Further, to eliminate the need for designing and implementing separate controllers to address non-ideal voltages and distorted currents, a control scheme for a GTPVS is developed using a modified robust least mean logarithmic square (M-RLMLS) adaptive filtering algorithm. The M-RLMLS algorithm obtains ripple-free*dq*-axis components of load currents and can be used as a prefilter to filter distortions in sensed voltages at the PCC, eliminating the need for an additional controller to handle voltage distortions. A simulation model of GTPVS is developed in MATLAB/Simulink to validate the control schemes that have been developed. A laboratory scaled-down prototype of GTPVS is developed to implement the developed control schemes and verify their performance.