Performance Evaluation of PV Integrated DSTATCOM Based on Complex Variable Filter

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Abstract—**Extraction of fundamental active component of load current is the key for any distribution static compensator (DSTATCOM). In this study, a control technique based upon complex variable filter and second order generalized integrator (SOGI) has been used for single phase photovoltaic integrated distribution static compensator (PV-DSTATCOM). Active component of load current is extracted with the help of a filter and it is used to control the pulses of DSTATCOM. A two stage system consisting of a full bridge boost converter in cascade with an inverter is taken to model a DSTATCOM. Power is drawn maximally from the PV panel. Dynamic conditions like step load change and linear irradiation change have been employed to study the performance of the system for this control strategy.**

Keywords—**Power quality, PV-DSTATCOM, SOGI, CC-CVF, MPPT.**

I. Introduction

Modern day equipments like computers, printers, motor soft start modules and telecommunication equipments etc. invariably need switch mode power supply (SMPS) which demand non-linear current from the grid. As the penetration of these devices increases, the burden of non-linear current, which can disturb the normal functioning of the equipments connected to the grid, on the grid also increases. Harmonic current limits which can be injected by an equipment has been summarized in various standards in [1]. So special devices like distribution static compensator (DSTATCOM) are needed which can supply the non-linear current demand of the load locally, thereby reducing the distortions in the grid and effectively improving the power quality.

Integration of renewable energy sources with the existing grid reduces the active power demand from the grid when power is available from the renewable source. So single phase inverters are becoming a popular choice for roof-top applications. Single phase grid connected full bridge inverters are usually designed for 3 kW to 5 kW power level because of limited space and investment reasons. It is able to feed surplus power to the grid and thereby reducing the consumer's bill. But if the power from PV panel is not available, it remains idle. Some additional features like reactive power compensation and harmonic compensation can be added so that even if sufficient power is not available from PV panel, it should not remain unutilised. This will improve the utilization factor of the system. Thus renewable energy based DSTATCOM is a good option not only in terms of improving power quality but also in active power generation. The functioning of DSTATCOM depends mainly upon the extraction scheme to estimate the reference current signal [2]. The better the extracted component of fundamental current would be, the better the power quality would be.

In the literature, various control schemes have been reported to extract the fundamental component of signal from the polluted voltage signal. Instantaneous reactive power theory (IRP), adaline based control and synchronous reference frame theory (SRF) and second order generalized integrator (SOGI) based control are some of the techniques used to control DSTATCOM [3]. Three phases are required for using SRF-PLL. For less polluted grid, SRF-PLL correctly estimates the fundamental component. PLL adds some distortion if the point of common coupling (PCC) of inverter is corrupted with noise or harmonics [4]–[6]. Leaky least mean square (LMS) adaptive filter has been implemented to extract the active and reactive components of load currents in a three phase system in [7]. In [8], back propogation algorithm has been used to extract the weighted value of active and reactive power of load in a three phase system. But this algorithm needs more time for training. In [9], adaptive notch filter technique has been used to estimate the fundamental signal from the polluted signal. Various schemes for frequency locked loop applications such as second order generalized integrator (SOGI) [10] and reduced order generalized integrator [11] have been developed. If lower order harmonics are present in the signal, SOGI can not accurately extract the fundamental component from the signal without compromising the dynamic performance. Complex coefficient complex variable filter (CC-CVF) has been reported to extract the fundamental component of signal in [12].

In this paper, SOGI and CC-CVF are combined to extract the benefits of both the schemes to control PV-DSTATCOM. Fundamental component of load current is extracted with the help of this combined filter (SOGI-CVF) while the grid fundamental voltage is extracted with SOGI algorithm only. PV-DSTATCOM is modelled by a two staged inverter. Input is directly clubbed to the PV-DSTATCOM. A fix value of dc-link reference voltage is used which is obtained depending upon the peak value of maximum grid voltage. Gate pulses for the first stage are generated by Maximum power point tracking (MPPT) algorithm while gate pulses for the second stage are derived by the hysteresis controller. Performance of the system is measured by testing it under a) changing