

Performance of Single Phase PV Integrated DSTATCOM Operating in Polluted Utility Condition

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Abstract—In this paper, a control technique based on cascaded second order-generalized integrator (CSOGI) is presented for the control of single phase photovoltaic integrated distribution static compensator (PV-DSTATCOM). The system compensates for reactive power and harmonics in the load current along with injecting power from PV array. Two SOGI blocks are used to extract the fundamental component of grid voltage and load current which is then used in control of PV-DSTATCOM. Due to the cascaded structure, CSOGI can better filter the third and fifth harmonic voltage present in the grid and can extract the fundamental component. Maximum power point tracking (MPPT) algorithm is used to get the reference voltage for dc-link voltage control. System performance is evaluated by simulating it in MATLAB/Simulink environment under dynamic conditions like irradiation and load change.

Keywords—Power quality, PV-DSTATCOM, CSOGI, MPPT.

I. INTRODUCTION

Day by day, power generation through renewable sources is increasing due to environmental issues arising from fossil fuels. Grid connected systems are extensively used for distributed power generation. But grid connected renewable generation would create power quality issue in the grid. Renewable energy generation sources are intermittent and have high fluctuations due to time dependent nature of renewable energy. As renewable energy penetration increases over time, these high fluctuations would create serious challenges to the power quality in the grid. Different kinds of loads draw current according to their real and reactive power needs. Nonlinear loads like switch mode power supplies (SMPS), controlled and uncontrolled rectifiers draw harmonic power and thus create power quality problem in the utility grid. Power quality is one of the important parameters for efficient functioning and stability of the grid.

Static compensator with the help of fixed capacitor is traditionally used to improve power quality related problems. But it comes with many limitations like fixed system dependent performance, fixed compensation, and resonance with line reactance [1]. DSTATCOM has been introduced in the literature which helps in solving these power quality problems. It is a shunt compensator device which when connected in parallel with nonlinear load can fulfill the harmonic current

demand of non-linear loads. DSTATCOM, with the help of control algorithm, draws only sinusoidal current from the grid when the load connected at the point of common coupling (PCC) is nonlinear. Control requires sensing of grid current, grid voltage, load current and voltage of dc link capacitor. In [2], control algorithms have been described for active power filtering and their comparison has also been given. In [3], control based on state feedback is described. Other types of control are also being presented in the literature. Different DSTATCOM topologies have been used and control algorithms are selected accordingly. But some researchers have changed the system for implementing control algorithm [4]–[7]. For single phase system, a different topology other than traditional converter has been proposed in [4]. Control technique model DSTATCOM and load collectively as a resistor. In [5], control is implemented with the help of power that makes it an intricate technique.

A major part of DSTATCOM is to extract fundamental component from the grid voltage. The success of DSTATCOM depends upon how well it can generate the reference signal [8]. Various Phase locked loop (PLL) and their control have been described to extract the fundamental component of grid voltage in the literature [9]. Some of the important PLL are E-PLL, SRF-PLL, SPLL, and power based PLL in [8], [10]–[12]. A digital adaptive notch filter (DANF) based filter has been used for extracting fundamental component of load current and grid voltage [13]. Second order generalized Frequency locked loop (SOGI-FLL) has been proposed in [14] which gives good performance under distorted conditions. In [15], Cascaded SOGI-Band Pass Filter (CSOGI-BPF) has been used to extract the fundamental component of grid voltage for UPQC operating under polluted condition. But to extract active fundamental component of load current, series combination of CSOGI-BPF and digital signal cancellation (DSC) has been employed. A CSOGI scheme has been reported in [16] which has de-offset rejection capability. Every PLL has their own pros and cons. SOGI is a simple PLL which has a less computational burden. But accurate extraction of fundamental component is difficult when harmonics closer to fundamental frequency are sufficiently present in the signal.

