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Compensation Of Microgrid Voltage And Current Harmonics By Employing Coordinated Control Of Pv Connected Dual Interfacing Converters

[1]Veerabrahma Reddy Gangavarapu, [2]Sayed Mohammed Aslam
[1]M.Tech (Power Systems) Department of EEE, Priyadarshini Institute of Technology and Management
[2]Assistant Professor, Department of EEE, Priyadarshini Institute of Technology and Management
Pulladigunta, Guntur, A.P.

ABSTRACT:

The main aim of this project is compensation of microgrid voltage and current harmonics by employing coordinated control of PV connected dual interfacing converters. The growing installation of distributed generation (DG) units in low voltage distribution systems has popularized the concept of nonlinear load harmonic current compensation using multi-functional DG interfacing converters. It is analyzed in this paper that the compensation of local load harmonic current using a single DG interfacing converter may cause the amplification of supply voltage harmonics to sensitive loads, particularly when the main grid voltage is highly distorted. To address this limitation, unlike the operation of conventional unified power quality conditioners (UPQC) with series converter, a new simultaneous supply voltage and grid current harmonic compensation strategy is proposed using coordinated control of two shunt interfacing converters. Specifically, the first converter is responsible for local load supply voltage harmonic suppression. The second converter is used to mitigate the harmonic current produced by the interaction between the first interfacing converter and the local nonlinear load. To realize a simple control of parallel converters, a modified hybrid voltage and current controller is also developed in the paper. By using this proposed controller. In extension we studied about PV connected interfacing converters

Key words: PV, Distribution generation, Harmonics, Interfacing converters, Grid, UPQC, Power quality,

I.INTRODUCTION

Previous research mainly focused on the control of a single DG shunt interfacing converter as an APF, as their power electronics circuits have similar topology. To realize an enhanced active filtering objective, the conventional current control methods for grid-tied DG interfacing converter shall be modified. First, the wide bandwidth current controllers are used so that the frequencies of harmonic load current can fall into the bandwidth of the current controller. Alternatively, the selective frequency harmonic compensation using multi-resonant current controller has received a lot of attenuations, the deadbeat controller is developed for multiple DG units with active harmonic filtering capability. In the neural network method is used to improve the harmonic filtering performance of DG interfacing converters that are connected to a grid with large variation of grid impedance.

In addition to the compensation of harmonics at low voltage distribution networks, the active filtering of harmonics in higher voltage distribution system using multi-level converters is discussed. However, it is important to note that abovementioned compensation methods are mainly used in grid-tied converter systems. In recent literature, the hybrid voltage and current control is also developed to realize a fundamental voltage control for DG power regulation and a harmonic current control for local load harmonic compensation. Nevertheless, it is important to emphasis that even when the local load harmonic current is properly compensated using various controllers as mentioned above, high quality supply voltage to local load cannot be guaranteed at the same time. This problem is particularly serious when the DG interfacing converter is interconnected to a weak microgrid with nontrivial upstream grid voltage distortions. To overcome this limitation, the dynamics voltage restorer (DVR) with series harmonic voltage compensation capability can be installed in the power distribution system. Unfortunately, the functionality of a DVR can hardly be implemented in a shunt DG interfacing converter. Using an additional series power conditioning equipment to ensure very low steady-state harmonic supply voltage to local loads is definitely feasible. However, it is associated with more expenses which might not be accepted for cost-effective power distribution systems.To realize simultaneous mitigation of the grid current and the supply voltage harmonics, this paper develops a parallel-converter topology where the local nonlinear load is directly installed to the shunt filter capacitor of the first converter. The local load supply voltage quality is enhanced by the first interfacing converter through harmonic voltage control. The harmonic current produced by the interactions between the local nonlinear load and the first converter is then compensated by the second converter. To reduce the computational load of the dual-converter system, a modified hybrid voltage and current control method is proposed for parallel interfacing converters. With cooperative operation of two converters, the load current and supply voltage harmonic extraction and the phase-locked loops are not needed to realize this proposed comprehensive power quality control objective. Note that this paper focuses on the compensation of supply voltage and grid current harmonics. When there are significant disturbances in the main grids, such as sags/swells and interruptions, the shunt converter is less effective to compensate these grid issues. Thus in these cases, the protection and the fault-ride through control schemes for a conventional single converter can be applied to this dual-converter in a similar manner.

II. PV CELL

PVs generate electric power when illuminated by sunlight or artificial light. To illustrate the operation of a PV cell the p-n homo junction cell is used. PV cells contain a junction between two different materials across which there is a built in electric field. The absorption of photons of energy greater than the band gap energy of the semiconductor promotes electrons from the valence band to the conduction band, creating hole-electron pairs throughout the illuminated part of the semiconductor [6].These electron and hole pairs will flow in opposite directions across the junction thereby creating DC power.

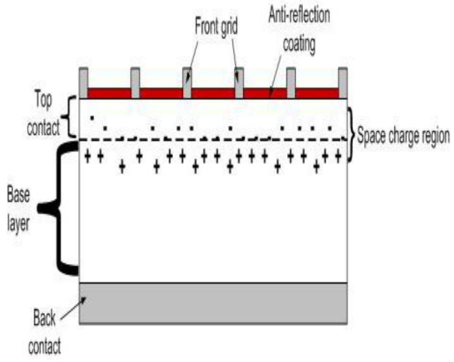

Figure 1: Structure of a PV cell

The cross-section of a PV cell is shown in Figure. The most common material used in PV cell manufacture is mono-crystalline or poly-crystalline silicon. Each cell is typically made of square or rectangular wafers of dimensions measuring about 10cm x10cm x0:3mm [6]. In the dark the PV cell's behaviour is similar to that of a diode and the well known Shockley-Read equation can be used to model its behaviour i.e. $i = I_S\left(e^{\frac{qV}{\beta kT}} - 1\right)$

III.PV MODULE

For the majority of applications multiple solar cells need to be connected in series or in parallel to produce enough voltage and power. Individual cells are usually connected into a series string of cells (typically 36 or 72) to achieve the desired output voltage. The complete assembly is usually referred to as a module and manufacturers basically sell modules to customers. The modules serves another function of protecting individual cells from water, dust etc. as the solar cells are placed into an encapsulation of single or double at glasses.

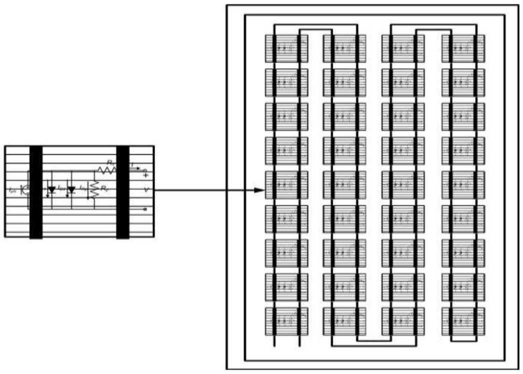

Figure 2: Structure of a PV module with 36 cells connected in series

Within a module the different cells are connected electrically in series or in parallel although most modules have a series connection. Figure shows a typical connection of how 36 cells are connected in series. In a series connection the same current flows through all the cells and the voltage at the module terminals is the sum of the individual voltages of each cell. It is therefore, very critical for the cells to be well matched in the series string so that all cells operate at the maximum power points. When modules are connected in parallel the current will be the sum of the individual cell currents and the output voltage will equal that of a single cell.

IV. SHUNT INTERFACING CONVERTERS

Fig shows the topology and control strategy of an interfacing converter for compensating harmonic current from a local nonlinear load. First, the local load is connected to the output of the interfacing converter, and then, they are coupled to the main grid through the grid feeder. The parameters of the interfacing converter LCL filter and the grid feeder are listed as $z_1(s) = sL_1 + R_1$, $z_2(s) = sL_2 +$

R_2, $z_3(s) = 1/(sC_f)$, and $z_g(s) = sL_g + R_g$, where L_1 , L_2 ,

R_1, and R_2 are the inductance and resistance of the filter

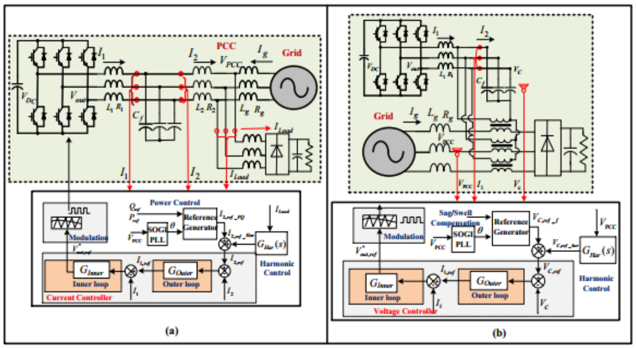

Fig. 3. Diagram of local harmonic compensation using interfacing converter.

The current control scheme is shown in the lower part of Fig. 1(a). According to the traditional APF control theory, the local load current is measured and the harmonic components are detected as:

$$I_{2,ref\_h} = H_{Har}(s) \cdot I_{Load}$$

V.PROPOSED CONTROL METHOD

To have simultaneous mitigation of the supply voltage and the grid current harmonics, a compensation method using coordinated control of two parallel interfacing converters is proposed in this section. The circuitry and control diagrams of the proposed system are shown in Fig. and Fig., respectively. First, a DG unit with two parallel interfacing converters sharing the same DC rail is connected to PCC. Each interfacing converter has an output LCL filter and the local nonlinear load is placed at the output filter capacitor of converter1. In this topology, the supply voltage to local nonlinear load is enhanced by controlling the harmonic component of interfacing converter1. Meanwhile, the grid current harmonic is mitigated via the power conditioning through interfacing converter2. Their detailed control strategies are discussed respectively, as shown below:

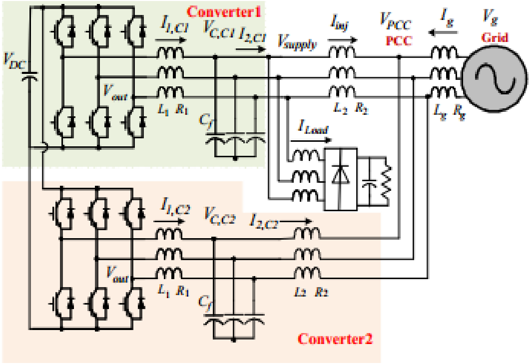

Fig. 4. Diagram of the proposed topology.

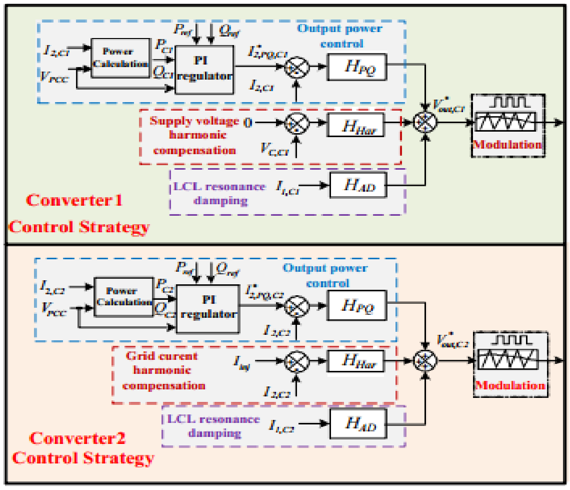

Fig. 5. Diagram of the proposed interfacing converter control strategies.

V.SIMULATION RESULTS

EXISTING RESULTS

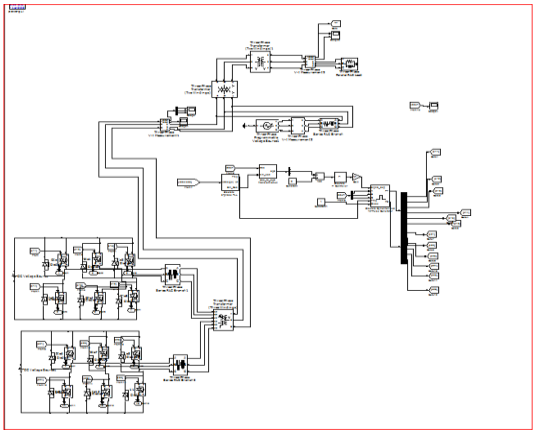

Fig 6 MATLAB/SIMULINK diagram of interfacing converter

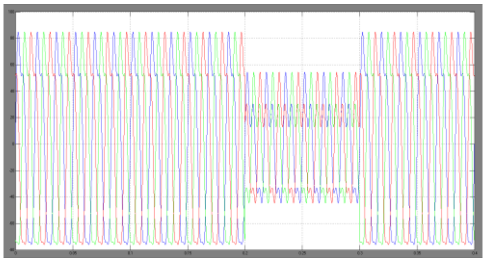

Fig 7 Source voltage

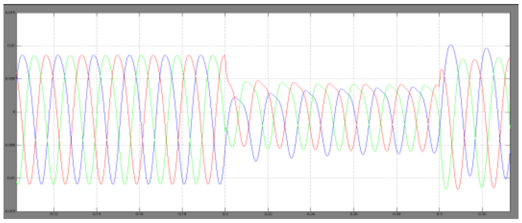

Fig 8 Source current

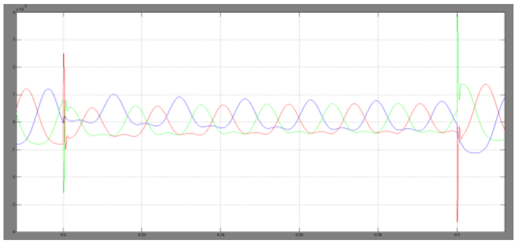

Fig 9 Injected current

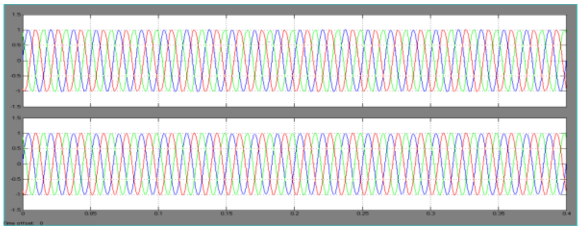

Fig 10 Load voltage and current

6.2 EXTENSION RESULTS

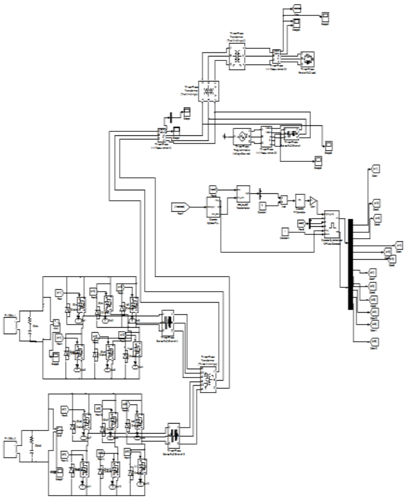

Fig 11 MATLAB/SIMULINK diagram of proposed pv connected interfacing converter

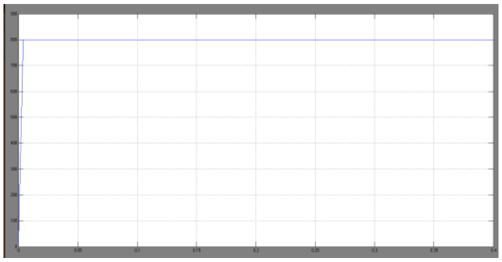

Fig 12 PV voltage

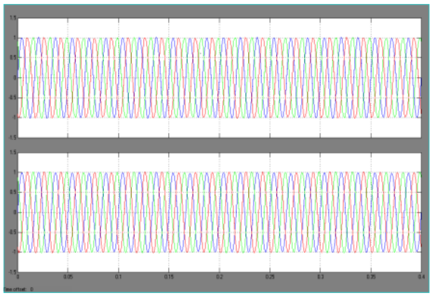

Fig 13 Load voltage and current

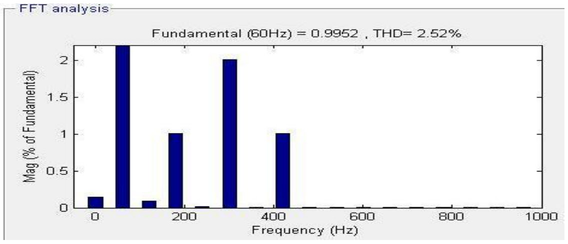

Fig 14 Thd of load current

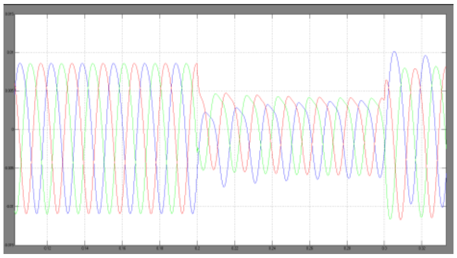

Fig 15 Source current

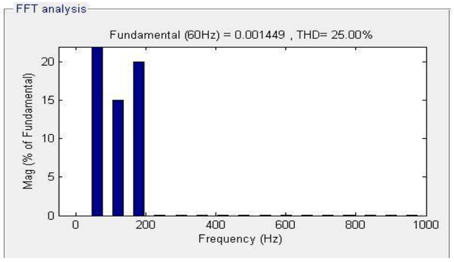

Fig 16 Thd at source current

CONCLUSION

This paper discusses a novel coordinated voltage and current controller for dual-converter system in which the local load is directly connected to the shunt capacitor of the first converter. With the configuration, the quality of supply voltage can be enhanced via a direct closed-loop harmonic voltage control of filter capacitor voltage. At the same time, the harmonic current caused by the nonlinear load and the first converter is compensated by the second converter. Thus, the quality of the grid current and the supply voltage are both significantly improved. To reduce the computational load of DG interfacing converter, the coordinated voltage and current control without using load current/supply voltage harmonic extractions or phase-lock loops is developed to realize to coordinated control of parallel converters. In extension we studied about PV connected interfacing converter

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