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Synchronized Control of Voltage and Current Harmonics in Distributed Generation System using Fuzzy Controller

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Abstract—The worldwide energy demand is increasing due to increase in population and economic growth. The grid is gradually replaced by Distributed generation systems (DGs). Recently low voltage DG interfacing converter on the non linear load compensation is performed by unified power flow converter. The proposed control technique is analyzed for Simultaneous control of voltage and power under unbalanced load condition using MATLAB/SIMULINK software

Index Terms- Distributed generation, Micro grid, Low pass filter, Interfacing converter, THD, Power Quality

I. INTRODUCTION

Nowadays, in distributed systems, the parameter variations are controlled by the use of active filters. The Active filters are the well known condition monitoring device for obtaining desirable parameters from the grid. Load compensation for harmonic current of distributed generation are preferred from series-parallel interfacing converter [1], [2],[4],[5].

A multi-functional DG interfacing inverter is used. Formerly, harmonic selective frequency compensation technique was used for solving power quality issues and harmonics mitigations. The grid-tied converter systems make use of the above mentioned compensating methods. The robust synchronization of the main grid is maintained even though a series current compensator extracts the usage of PLL [6].

But the disadvantage of the previously said compensation techniques was the supplying of poor-quality voltage to the loads. The same scenario occurs when a weak micro grid with non-linear loads and a DG interfacing converter are unified. Regrettably, the shunt DG interfacing converter can only be operated with a DVR. Recently, two parallel converter control circuits were designed to alleviate load voltage harmonics and main grid voltage harmonics [7].

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II. SYNCHRONIZED CONTROL STRATEGY

The fuzzy controller is proposed for the series-parallel interfacing converters to mitigate ripple during supply voltage and grid current. The proposed control strategies are shown in Fig.2 and 3, respectively.

A common DC rail is shared by the shunt and series interfacing converters in a DG unit and this unit is connected with a PCC. The output produced by the converter1 is filtered by a low pass filter and is then coupled with the local nonlinear load.

The voltage supplied to the local load is improved by controlling the harmonics in the output of converter1 and converter 2 mitigates the grid current harmonics. The detailed control strategies are discussed respectively.

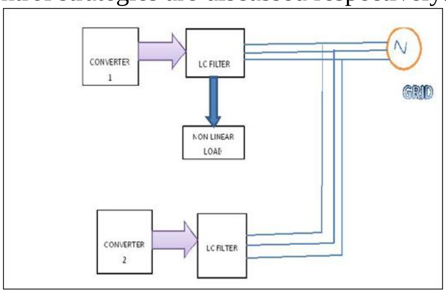

Fig.1. Configuration of Proposed Topology

A. SERIES INTERFACING INVERTER TOPOLOGY

The series inverter provides transformer isolation between the grid and non linear loads[8]. It also mitigates the voltage imbalance, voltage flicker compensation and voltage sag and swell compensation like DVR and harmonic compensation at PCC.

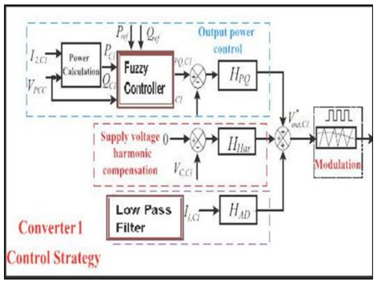

Fig.2. Proposed control strategy for Interfacing converter1

B. SHUNT INTERFACING INVERTER TOPOLOGY

The line is linked with the second interfacing converter in shunt connection so that it will feed the local load which can further be coupled with the main grid using a feeder. This can be now implemented for harmonic current mitigation and VAR compensation. Cosine and Sine functions obtained from PLL are used to transfer the stationary frame component into synchronously rotating component and for synchronizing the supply current and voltage. The harmonics and fundamental components are separated using a Low pass filter. After that, inverse park transformation is applied to transfer back the fundamental components to ABC frame. The ABC to DQO transformation is known as park transformation.

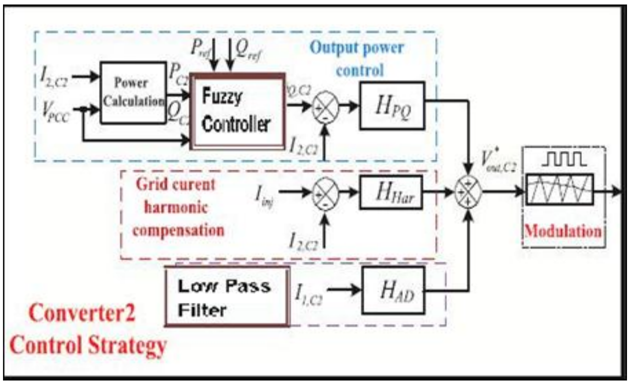

Fig.3. Proposed control strategy for interfacing converter 2

C. HYSTERESIS LOOP CONTROL BY SRC TECHNIQUE

Synchronous reference component (SRC) method is employed to mitigate the supply voltage and current harmonics, αβ transformation is used for producing the two-phase stationary coordinates from three phase distorted currents for the current harmonic compensation.

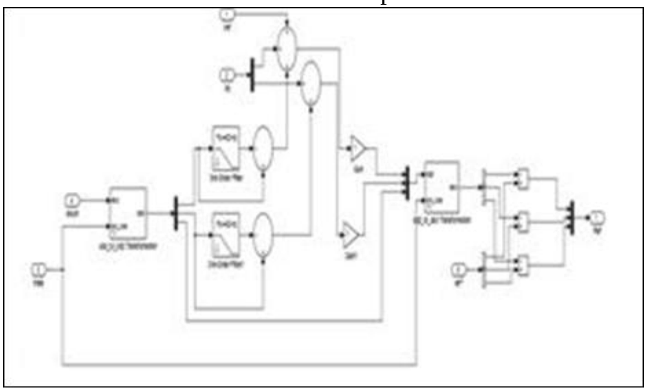

Fig.4. Simulated model of Hysteresis control Loop

III. SIMULATION RESULTS

The aforesaid control strategy for the DG system with series and shunt interfacing inverters is now simulated and at the disturbed load conditions, the harmonic mitigation in the supply quantities is monitored using fuzzy controller .

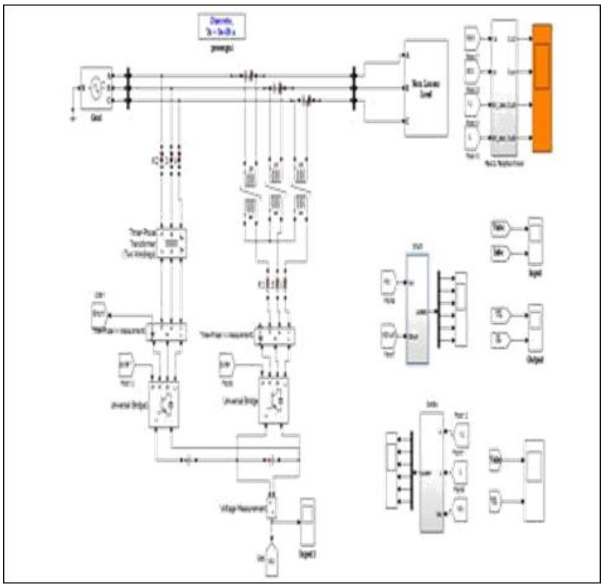

Fig.5. Simulation diagram of proposed Method

The Simulated PWM pulse is shown in Fig. 6, utilized to obain harmonic mitigated supply voltage in balanced condition. The higher order harmonics are suppressed in series pulse of converter 1.

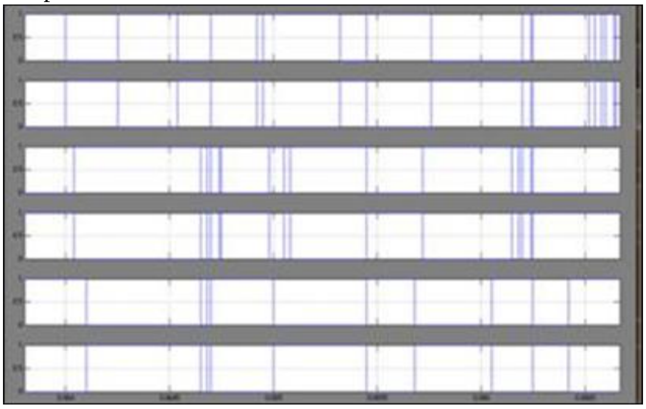

Fig.6.Simulation Waveforms of Series pulse of Converter1

The mitigation of the harmonics present in the grid current is obtained from shunt pulse convereter 2 as shown in Fig7.

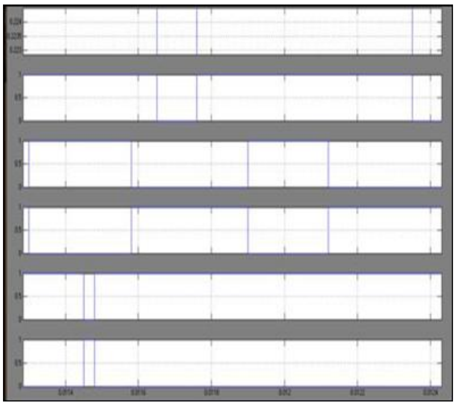

Fig.7 Simulation Waveforms of Shunt pulse of Converter 2

The sag and swell are obtained as a result of non linear loads without implementing compensation are shown in the Fig.8.

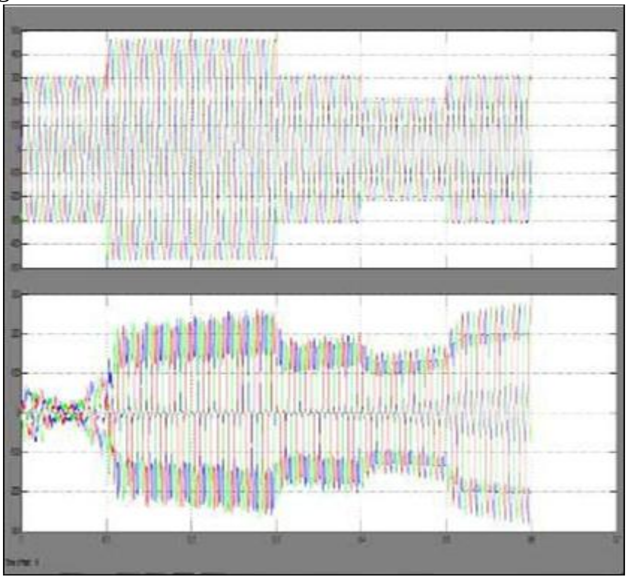

Fig.8. sag and swell are obtained as a result of non linear loads

The regulated voltage and grid current after compensation are obtained with fully logic controller implementing synchronized control technique is shown in fig. 9 & fig.10

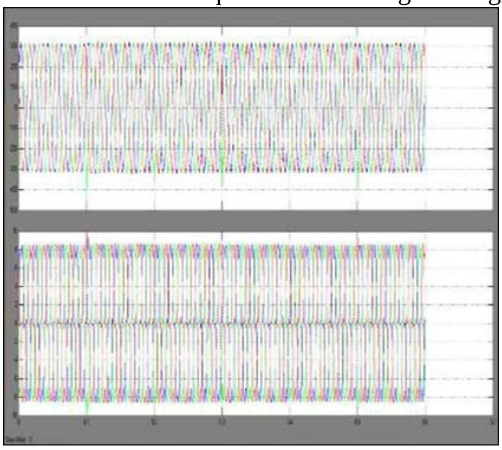

Fig.9.Simulated Grid voltage and current

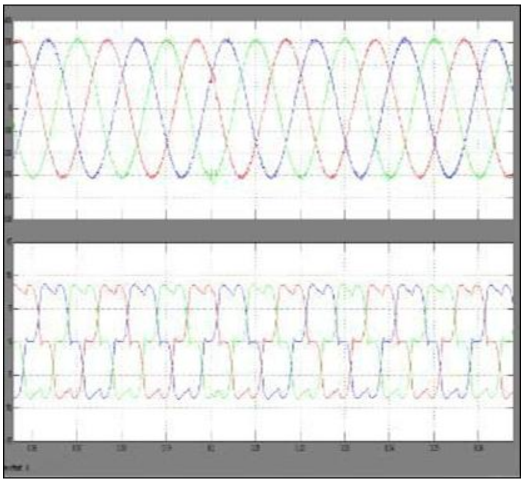

Fig.10. Load voltage and local load harmonic current (After compensation)

The real and reactive power output as the influence of non linear load is shown in fig. 11 and fig. 12

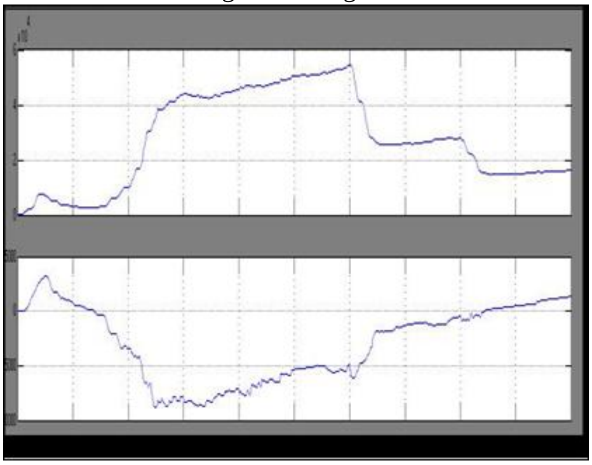

Fig.11. Before compensated real and reactive power output

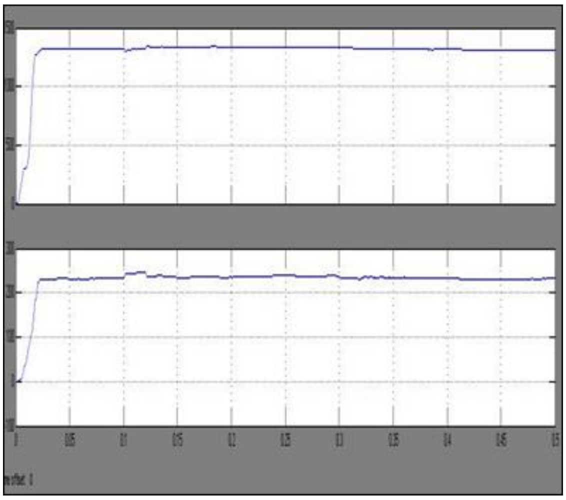

Fig.12. After compensated real and reactive power output

A harmonics are calculated using hysteresis loop controller. The calculated harmonics are extracted by adopting the low pass filter. The 0.66% and 2.31 % of total harmonic distortion for supply voltage and grid current.

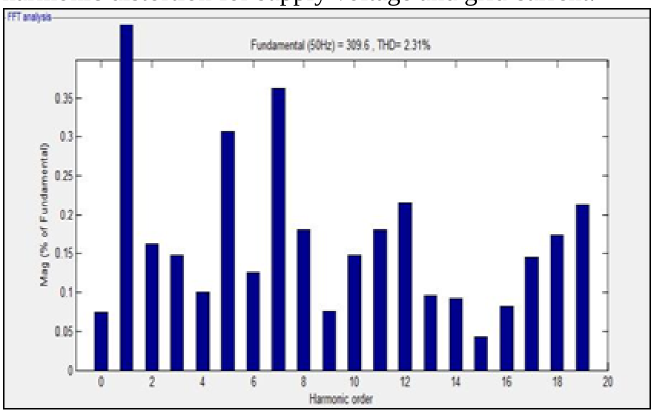

Fig 13.Total harmonic distortion of supply voltage of the proposed controller

Fuzzy controller Fig 14.Total harmonic distortion of grid current of the proposed controller

IV. DISCUSSION

The proposed control method has been presented for both supply voltage and local load current harmonic mitigation under all load disturbance conditions. The Power grid or microgrid voltage is improved by the synchronized control of series and parallel interfacing voltage source inverters. The response of the system is also improved. The proposed controller operates in The grid and island mode are the two modes of control of proposed controller. If any interruptions occur in the power grid, this system may act as island mode.

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