SIMULTANEOUS MICROGRID VOLTAGE AND CURRENT HARMONICS COMPENSATION USING COORDINATED CONTROL OF DUAL-INTERFACING-CONVERTERS

V. RAGHAVENDRA RAJU[1], D. MAHABOOB BASHA[2], P. NAGENDRA[3], V. SURYA PRAKASH[4]

---***---

ABSTRACT:- *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, the grid voltage phase-locked loop and the detection of the load current and the supply voltage harmonics are unnecessary for both interfacing converters. Thus, the computational load of interfacing converters can be significantly reduced. Simulated and experimental results are captured to validate the performance of the proposed topology and the control strategy.*

1. INTRODUCTION

Contrasting with massive aloof filters that are highly touchy to circuit parameters varieties, the active power molding equipment including active power filter (APF), dynamic voltage restorer (DVR), and brought together power quality conditioner (UPQC) is favored due the quick unique reaction and the great invulnerability to system parameter changes. Then again, the high penetration of disseminated generation (DG) unit with power gadgets interfacing converter offers the likelihood of power distribution system harmonic current compensation utilizing multi-practical DG interfacing converter. Past research for the most part centered around the control of a single DG shunt interfacing converter as an APF, as their power hardware circuits have comparable topology. To understand an enhanced active filtering objective, the conventional current control methods for grid-tied DG interfacing converter shall be altered. In the first place, the wide bandwidth current controllers are utilized with the goal that the frequencies of harmonic load current can fall into the bandwidth of the current controller. On the other hand, the specific frequency harmonic compensation utilizing multi-full current controller has gotten a great deal of weakenings, as detailed in and the miscreant controller is produced for multiple DG units with active harmonic filtering ability. In the neural system method is utilized to enhance the harmonic filtering execution of DG interfacing converters that are associated with a grid with vast variety of grid impedance. Notwithstanding the compensation of harmonics at low voltage distribution arranges, the active filtering of harmonics in higher voltage distribution system utilizing multi-level converters is examined, as show in However, it is vital to take note of that previously mentioned compensation methods are fundamentally utilized in grid-tied converter systems. In ongoing writing, the hybrid voltage and current control is likewise created to understand a basic voltage control for DG power direction and a harmonic current control for nearby load harmonic compensation. Contrasted with the previously mentioned conventional current control methods, the hybrid controller enables an interfacing converter to repay harmonics in both grid-tied and islanding micorgrids. With help of the low bandwidth correspondences between DG units, it likewise conceivable to achieve harmonic power sharing among parallel DG systems.

2. DIGITAL CONTROLLER

2.1. Introduction:

The computerized pulse width modulation control of BLDC engine will be proficient and practical. The computerized control of the four quadrant operation of the three phase BLDC engine is achieved with advanced controller. This advanced controller joins the Digital Signal Processor highlights and PIC smaller scale controller highlights, making it flexible.

The controller has an adjusted Harvard architecture, with a16 *16 bit working register cluster. It has two 40 bit wide aggregators. All the DSP directions are performed in a single cycle. The three outside interrupt sources, with eight client selectable need levels for each interrupt source helps to get the Hall sensor inputs from the engine. The reference speed and the required duty cycle can be fed into the controller. The shut loop control is achieved with the PI controller.

2.2. PI Controller:

The direction of speed is accomplished with PI Controller. By expanding the relative gain of the speed controller, the controller's affectability is expanded to have quicker response for little speed direction mistakes. This permits a superior starting following of the speed reference by a quicker response of the current reference issued by the speed controller. This expanded affectability likewise lessens the speed overshooting. The armature current decreases quicker, when the coveted speed is achieved.

An expansion of the vital gain will enable the engine speed to catch up with the speed reference slope significantly quicker amid examining periods. This will in reality enable a quicker response to little speed blunder vital terms that happen when a signal is directed after an incline. The controller will respond with the end goal to diminish the speed blunder essential much quicker by creating a slightly higher quickening torque when following a quickening slope. Then again, too high increment of the corresponding and basic gains can cause flimsiness, and the controller getting to be harsh. Too high gains may likewise result in saturation. Tuning process is by experimentation method and the Proportional Constant (Kp) and Integral Constant (Ki) are 0.1 and0.03 separately.

The Proportional basic subsidiary (PID) controllers are the most commonly utilized shut loop controllers utilized in the business. PID parameters influence the accompanying system elements regarding shut loop step reaction.

• Rise time - time taken for the output to ascend past 90% of the coveted level.
• Overshoot - how much higher the pinnacle level is contrasted with the unfaltering state level.
• Settling time - time taken by the system to merge to its enduring state.
• Steady-state blunder - the distinction between the unfaltering state output and the coveted output.

The impacts of the PID-control parameters Kp, Ki, Kd can be outlined as:

• Kp diminishes the ascent time.
• Ki essentially diminishes the consistent state blunder.
• Kd diminishes the overshoot and settling time.

The indispensable parameter (Ki) nearly wipes out unfaltering state blunder in the output. Lower Ki values gradually push the engine speed to the normal set point, and higher Ki values can cause hunting around the set point speed.

The corresponding parameter (Kp) gives quick reaction to sudden changes in load, controlling the ascent time. This parameter is regularly much higher than Ki, so moderately little deviations in speed are rectified while Ki gradually moves the speed to the set point.

The subsidiary parameter (Kd) gives quick reaction to sudden changes in engine speed. However, with basic PID controllers, it very well may be hard to generate a subordinate term in the output that has any critical impact on engine speed. Therefore, PI controllers (with subordinate parameter Kd = 0) are utilized deepest shut loop procedures to give an equalization of intricacy and capacity. Likewise, these controllers are more straightforward to tune contrasted with the PID controllers

Corresponding Integral (P-I) controller:

The Proportional-Integral (P-I) controller is one of the conventional controllers and it has been broadly utilized. The real highlights of the P-I controller are its capacity to keep up a zero consistent state blunder to a step change in reference.

1. A PI Controller (relative vital controller) is an uncommon instance of the PID controller in which the subordinate (D) of the blunder isn't utilized. The controller output is given by

$$K_p\Delta + K_I \int \Delta dt \quad (1)$$

2. Where, Δ is the error or deviation of actual measured value (PV) from the set point (SP).

$$\Delta = SP - PV \qquad (2)$$

3. A PI controller can be modeled easily in software such as Simulink, using a "flow chart" box involving Laplace operators:

$$C = \frac{G(1+\tau S)}{\tau S} \qquad (3)$$

Where,

$G = K_p$ = proportional gain
$\frac{G}{\tau} = K_I$ = integral gain

1. Setting a value for G is often a tradeoff between decreasing overshoot and increasing settling time.

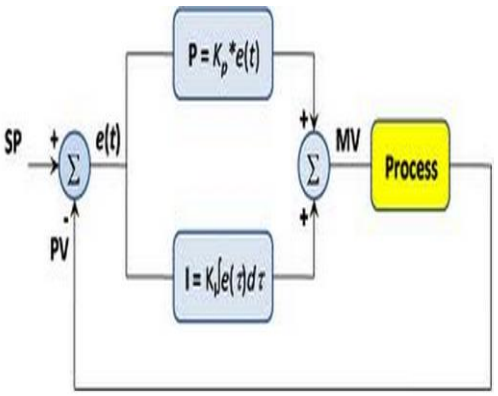

Fig 1 Basic block of a PI controller

The common PID tuning methods involve manual tuning: Ziegler-Nichols tuning and Cohen Coon tuning. In this application implementation, the PI controller was tuned using the manual tuning method. It involved subjecting the system to a step change in input, measuring the output as a function of time, and using this response to determine the control parameters.

3. EXISTING AND PROPOSED SYSTEM

3.1 Introduction:

Single interfacing converter is associated with the principle grid and the nearby nonlinear load is set at the output terminal of the DG unit. In this re-enactment, some consistent state harmonic distortion is added to the principle grid voltage and the grid voltage THD is 5.6%. When the current controller as shown in (13) is connected to the system, the execution of the system.

Nevertheless, it is vital to emphasis that notwithstanding when the nearby load harmonic current is legitimately remunerated utilizing different controllers as specified above, high quality supply voltage to neighbourhood load can't be ensured in the meantime. This issue is especially genuine when the DG interfacing converter is interconnected to a powerless micro grid with nontrivial upstream grid voltage distortions. To conquer this impediment, the elements voltage restorer (DVR) with series harmonic voltage compensation capacity can be introduced in the power distribution system, as proposed in and . Tragically, the usefulness of a DVR can hardly be actualized in a shunt DG interfacing converter. Utilizing an extra series power melding equipment to guarantee low enduring state harmonic supply voltage to nearby loads is unquestionably practical. However, it is related with more costs which might not be acknowledged for practical power distribution systems. To acknowledge concurrent alleviation of the grid current and the supply voltage harmonics, this project report builds up a parallel-converter topology where the neighbourhood nonlinear load is directly introduced to the shunt filter capacitor of the primary converter.

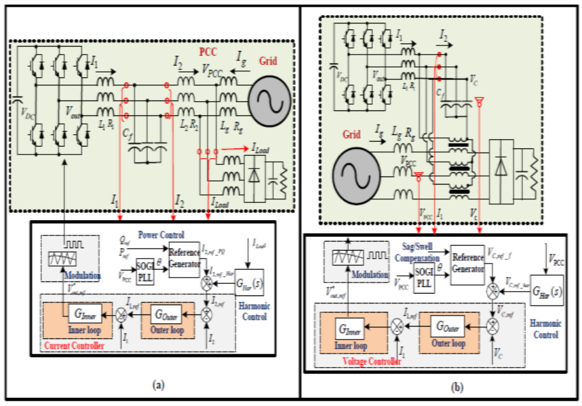

Fig 2. Diagram of local harmonic compensation using interfacing converter

The nearby load supply voltage quality is enhanced by the principal interfacing converter through harmonic voltage control. The harmonic current delivered by the communications between the neighbourhood nonlinear load and the principal converter is then repaid constantly converter. To diminish the computational load of the double converter system, a changed hybrid voltage and current control method is proposed for parallel interfacing converters. With agreeable operation of two converters, the load current and supply voltage harmonic extraction and the phase-bolted loops are not expected to understand this proposed comprehensive power quality control objective. Note that this project report centers around the compensation of supply voltage and grid current harmonics. When there are huge unsettling influences in the fundamental grids, such as hangs/swells and interruptions, the shunt converter is less viable to repay these grid issues. Thus in these cases, the protection and the fault-ride through control schemes for a conventional single converter can be connected to this double converter likewise.

To acknowledge synchronous relief of the grid current and the supply voltage harmonics, this project report builds up a parallel-converter topology where the nearby nonlinear load is directly introduced to the shunt filter capacitor of the primary converter. The neighborhood load supply voltage quality is enhanced by the main interfacing converter through harmonic voltage control. The harmonic current created by the cooperations between the neighborhood nonlinear load and the primary converter is then remunerated constantly converter. To lessen the computational load of the double converter system, an adjusted hybrid voltage and current control method is proposed for parallel interfacing converters. With agreeable operation of two converters, the load current and supply voltage harmonic extraction and the phase-bolted loops are not expected to understand this proposed comprehensive power quality control objective. Note that this project report centers around the compensation of supply voltage and grid current harmonics. When there are noteworthy unsettling influences in the principle grids, such as droops/swells and interruptions, the shunt converter is less powerful to repay these grid issues.

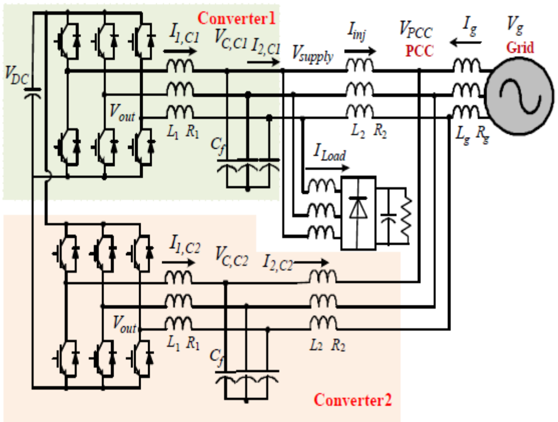

Fig.3. Diagram of the proposed topology

EXISTING SYSTEM:

The current method depicts this segment quickly surveys the control of shunt APFs for grid current harmonic moderation and series DVRs for supply voltage harmonic suppression. With the end goal to contrast and the proposed parallel-converter utilizing adjusted hybrid voltage and current controller as shown in the following area, the surely knew twofold loop current control and voltage control are connected to APFs and DVRs, separately.

When an interfacing converter is connected to remunerate shunt loads harmonic current, growing high productivity controller to diminish the computational load of the DG system is imperative. To understand this assignment, the compensation without load harmonic current extraction turns out to be exceptionally attractive.

In the phase-bolted loop is expelled by utilizing a series current compensator, meanwhile keeping robust synchronization with the principle grid. In an enhanced current controller using the frequency y specific element of thunderous controllers was proposed to evacuate both the load current harmonic extraction and the phase-secured loop a single-phase DG unit. Nevertheless, it is essential to emphasis that notwithstanding when the nearby load harmonic current is legitimately remunerated utilizing different controllers as made reference to above, high-quality supply voltage to neighbourhood load can't be ensured in the meantime. This issue is especially genuine when the DG interfacing converter is interconnected to a feeble microgrid with nontrivial upstream grid voltage distortions. To defeat this constraint, the elements voltage restorer (DVR) with series harmonic voltage compensation capacity can be introduced in the power distribution system, as proposed. Tragically, the usefulness of a DVR can hardly be executed in a shunt DG interfacing converter. Utilizing an extra series power molding equipment to guarantee low relentless state harmonic supply voltage to neighbourhood loads is unquestionably doable. However, it is related with more costs which might not be acknowledged for financially savvy power distribution systems

PROPOSED SYSTEM:

An epic composed voltage and current controller for double converter system in which the neighbourhood load is directly associated with the shunt capacitor of the principal converter. With the configuration, the quality of supply voltage can be enhanced through a direct shut loop harmonic voltage control of filter capacitor voltage. In the meantime, the harmonic current caused by the nonlinear load and the main converter is repaid continuously converter.

Thus, the quality of the grid current and the supply voltage are both fundamentally made strides. To lessen the computational load of dg interfacing converter, the planned voltage and current control without utilizing load current/supply voltage harmonic extractions or phase-bolt loops is created to acknowledge to facilitated control of parallel converters. Here builds up a parallel converter topology where the neighbourhood nonlinear load is directly introduced to the shunt filter capacitor of the main converter. The nearby load supply voltage quality is enhanced by the principal interfacing converter through harmonic voltage control. The harmonic current delivered by the connections between the nearby nonlinear load and the main converter is then repaid continuously converter. To diminish the computational load of the double converter system, an adjusted hybrid voltage and current Control method is proposed for parallel interfacing converters. With helpful operation of two converters, the load current and supply voltage harmonic extraction and the phase-bolted loops are not expected to understand this proposed comprehensive power quality control objective.

4. SIMULATION RESULTS

Initially, like a single interfacing converter is associated with the fundamental grid and the nearby nonlinear load is put at the output terminal of the DG unit. In this reproduction, some consistent state harmonic distortion is added to the principle grid voltage and the grid voltage THD is 5.6%. When the current controller is connected to the system, the execution of the system is shown in. As the neighborhood load harmonic current is remunerated by the DG unit, it very well may be seen from the second channel of that the grid current is nearly ripple free with just 4.57% THD. Then again, the interfacing converter line current 2 is highly twisted for this situation. Because of the absence of supply voltage harmonic control, the supply voltage to the neighborhood nonlinear load is mutilated with 6.45% THD. To have a superior understanding of the power quality of the system, the harmonic range of the grid current and the supply voltage in are given in separately. When the supply voltage harmonic segment is controlled by a single interfacing converter utilizing the hybrid voltage and current control as shown in (9), the execution is as represented, the quality of supply voltage for this situation is essentially enhanced with just 1.48% THD. Nevertheless, the grid current has more harmonics and the relating THD is 12.28%. Likewise, the comparing harmonic range of the supply voltage and the grid current are shown in, separately. Contrasting with the past range examination results in and, it very well may be obviously observed that the supply voltage harmonic reduction is achieved to the detriment of more grid current distortions. The concurrent supply voltage and grid current harmonics moderation is tried by utilizing a single DG

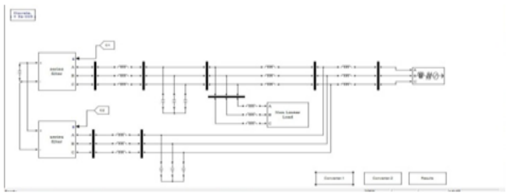

Fig.4. Block Diagram of Dual-Interfacing Converters

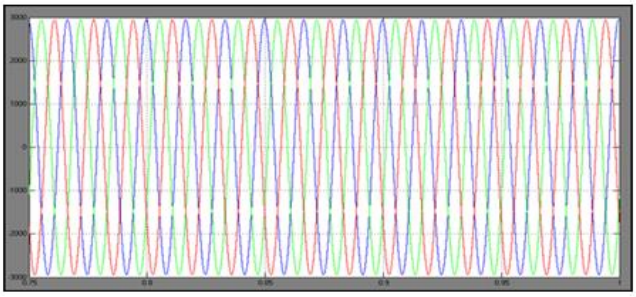

Fig. 5. Simulation results of Grid current

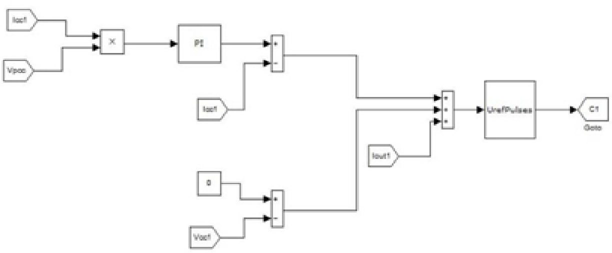

Fig.6. Block Diagram of the proposed interfacing converter control strategies

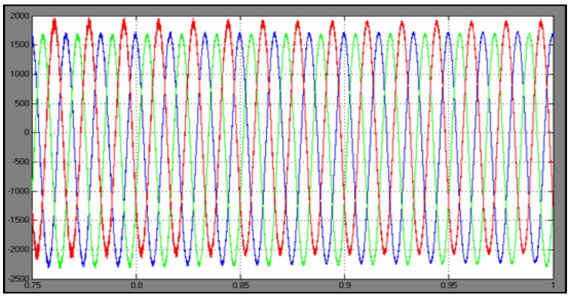

Fig.7. Simulation result *of Conveter current*

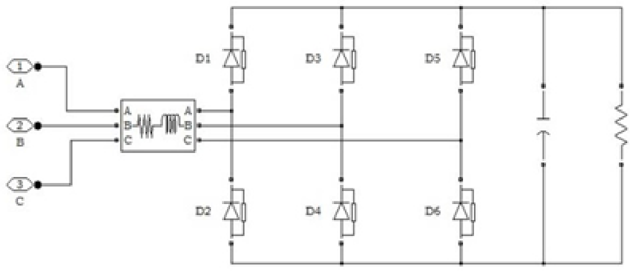

Fig.8. Block* Diagram *of an LCL filter with a local nonlinear load.

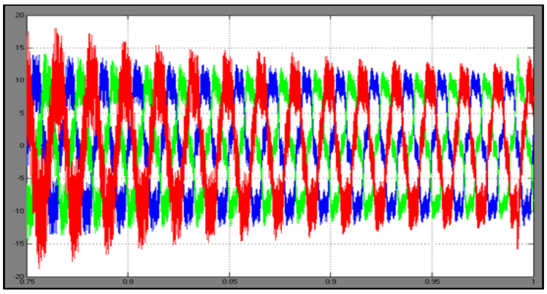

Fig.9. Simulation Results of Load current

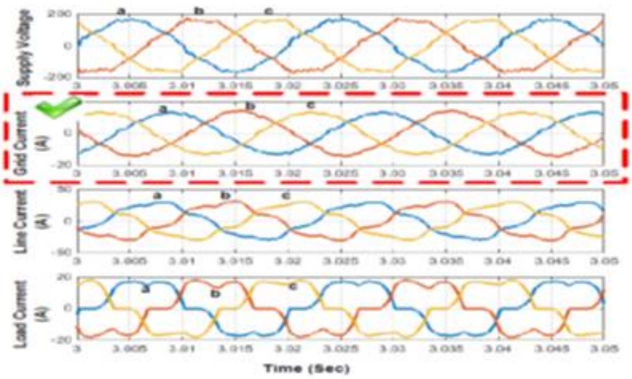

Fig. 10. Only the local load harmonic current is compensated

5. CONCLUSION

When a single multi-utilitarian interfacing converter is embraced to repay the harmonic current from nearby nonlinear loads, the quality of supply voltage to neighbourhood load can hardly be enhanced in the meantime, specific when the principle grid voltage is twisted. This project report examines a novel facilitated voltage and current controller for double converter system in which the neighbourhood load is directly associated with the shunt capacitor of the principal converter. With the configuration, the quality of supply voltage can be enhanced by means of a direct shut loop harmonic voltage control of filter capacitor voltage. In the meantime, the harmonic current caused by the nonlinear load and the primary converter is repaid continuously converter. Thus, the quality of the grid current and the supply voltage are both essentially moved forward. To lessen the computational load of DG interfacing converter, the organized voltage and current control without utilizing load current/supply voltage harmonic extractions or phase-bolt loops is created to acknowledge to facilitated control of parallel converters.

FUTURE SCOPE

The developing establishment of disseminated generation (DG) units in low voltage distribution systems has advanced the idea of nonlinear load harmonic current compensation utilizing multi-practical DG interfacing converters. It is broke down in this paper that the compensation of nearby load harmonic current utilizing a single DG interfacing converter may make the enhancement of supply voltage harmonics delicate loads, especially when the principle grid voltage is highly mutilated.

REFERENCES

1. B. Singh, K. AI-Haddad, A. Chandra, “A review of active filters for power quality improvement,” IEEE Trans. Ind. Electron., vol. 46, no. 5, pp. 960 - 971, May. 1999.

2. P. Acuna, L. Moran, M. Rivera, J. Dixon, and J. Rodriguez, “Improved active power filter performance for renewable power generation systems,” IEEE Trans. Power Electron., vol. 29, no.2, pp. 687-694, Feb. 2013.

3. Y. W. Li, F. Blaabjerg, D. M. Vilathgamuwa, and P. C. Loh, “Design and Comparison of High Performance Stationary-Frame Controllers for DVR Implementation,” IEEE Trans. Power Electron., vol. 22, pp. 602-612, Mar. 2007.

4. C. Meyer, R. W. DeDoncker, Y. W. Li, and F. Blaabjerg, “Optimized Control Strategy for a Medium-Voltage DVR – Theoretical Investigations and Experimental Results,” IEEE Trans. Power Electron., vol. 23, pp. 2746-2754, Nov. 2008.

5. F. Blaabjerg, Z. Chen, and S. B. Kjaer, “Power electronics as efficient interface in dispersed power generation systems,” IEEE Trans. Power Electron., vol. 19, pp. 1184-

AUTHORS:

1. **V. RAGHAVENDRA RAJU,**

MASTER OF TECHNOLOGY in POWER ELECTRONICS to the Jawaharlal Nehru technological university

2. **D. MAHABOOB BASHA,**

Assistant Professor, Department of EEE.

3. **P. NAGENDRA,**

Assistant Professor, Department of EEE.

4. **V. SURYA PRAKASH**

Assistant Professor, Department of EEE.