REDUCING HARMONICS IN MICRO GRID DISTRUBUTION SYSTEM USING APF WITH PI CONTROLLER

KADIKUNTA NAVEEN KUMAR[1], J. MURALI KRISHNA[2], P. NAGENDRA[3], M. RAVI KUMAR[4]

ABSTRACT:- *In distribution systems, the load has been a sudden increase or decreases and it is like as nonlinear loads so the load draws non-sinusoidal currents from the AC mains and causes the load harmonics and reactive power, and excessive neutral currents that give pollution in power systems. Most pollution problems created in power systems are due to the nonlinear characteristics and fast switching of power electronic devices. Shunt active filter based on current controlled PWM converters are seen as a most viable solution. This report presents the harmonics and reactive power compensation from 3P4W micro-grid distribution system by IP controlled shunt active. The technique which is used for generate desired compensation current extraction based on offset command instantaneous currents distorted or voltage signals in the time domain because compensation time domain response is quick, easy implementation and lower computational load compared to the frequency domain.*

1. INTRODUCTION

Renewable generation affects power quality due to its nonlinearity, since solar generation plants and wind power generators must be connected to the grid through high-power static PWM converters. The non uniform nature of power generation directly affects voltage regulation and creates voltage distortion in power systems. This new scenario in power distribution systems will require more sophisticated compensation techniques.

Although active power filters implemented with three-phase four-leg voltage-source inverters (4L-VSI) have already been presented in the technical literature, the primary contribution of this report is a predictive control algorithm designed and implemented specifically for this application.

2. PHOTOVOLTAIC TECHNOLOGY

Photovoltaic's is the field of technology and research identified with the devices which directly convert sunlight into power utilizing semiconductors that exhibit the photovoltaic impact. Photovoltaic impact includes the making of voltage in a material upon presentation to electromagnetic radiation. The photovoltaic impact was first noted by a French physicist, Edmund Becquerel, in 1839, who discovered that specific materials would create little measures of electric current when presented to light. In 1905, Albert Einstein depicted the idea of light and the photoelectric impact on which photovoltaic technology is based, for which he later won a Nobel prize in physics. During the 1960s, the space business started to make the primary genuine utilization of the technology to give power on board rocket. Through the space programs, the technology propelled, its unwavering quality was established, and the cost started to decay. Amid the vitality emergency during the 1970s, photovoltaic technology gained acknowledgment as a source of power for non-space applications.

The solar cell is the rudimentary building square of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most helpful is that their conductivity may effectively be adjusted by bringing debasements into their precious stone grid. For example, in the manufacture of a photovoltaic solar cell, silicon, which has four valence electrons, is blessed to receive increment its conductivity. On one side of the cell, the contaminations, which are phosphorus iotas with five valence electrons (n-contributor), give feebly bound valence electrons to the silicon material, making abundance negative charge carriers.

On the other side, molecules of boron with three valence electrons (p-benefactor) make a more prominent fondness than silicon to pull in electrons. Since the p-type silicon is in personal contact with the type silicon a p-n junction is established and a dissemination of electrons happens from the district of high electron concentration (the n-type side) into the area of low electron concentration (p-type side). When the electrons diffuse over the p-n junction, they recombine with holes on the p-type side.

However, the dispersion of carriers does not happen inconclusively, in light of the fact that the unevenness of charge instantly on either sides of the junction begins an electric field. This electric field shapes a diode that elevates current to stream in just a single direction.

.

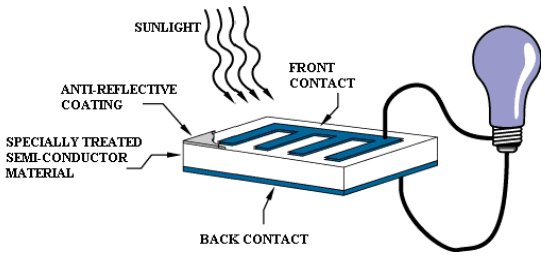


Fig 1 SOLAR CELL

Ohmic metal-semiconductor contacts are made to both the n-type and p-type sides of the solar cell, and the cathodes are prepared to be associated with an outside load. When photons of light fall on the cell, they exchange their vitality to the charge carriers. The electric field over the junction isolates photo-generated positive charge carriers (holes) from their negative partner (electrons). In this way an electrical current is extricated once the circuit is shut on an outside load

The photovoltaic impact was first announced by Edmund Becquerel in 1839 when he seen that the activity of light on a silver covered platinum terminal submerged in electrolyte delivered an electric current. After forty years the primary strong state photovoltaic devices were built by specialists researching the as of late found photoconductivity of selenium. In 1876 William Adams and Richard Day discovered that a photocurrent could be created in an example of selenium when reached by two heated platinum contacts. The photovoltaic activity of the selenium varied from its photoconductive activity in that a current was created suddenly by the activity of light.

3. INVERTERS

The fundamental goal of static power converters is to deliver an air conditioner output waveform from a dc power supply. These are the kinds of waveforms required in customizable speed drives (ASDs), uninterruptible power supplies (UPS), static var compensators, active filters, adaptable air conditioning transmission systems (FACTS), and voltage compensators, which are just a couple of uses. For sinusoidal air conditioning outputs, the size, frequency, and phase should be controllable. As per the kind of air conditioning output waveform, these topologies can be considered as voltage source inverters (VSIs), where the autonomously controlled air conditioning output is a voltage waveform.

These structures are the most generally utilized in light of the fact that they normally behave as voltage sources as required by numerous modern applications, such as customizable speed drives (ASDs), which are the most well known utilization of inverters; see Fig. 6.1. So also, these topologies can be found as current source inverters (CSIs), where the freely controlled air conditioning output is a current waveform. These structures are still generally utilized in medium-voltage modern applications, where high-quality voltage waveforms are required.

Static power converters, particularly inverters, are built from power switches and the air conditioner output waveforms are therefore comprised of discrete values. This prompts the generation of waveforms that highlight quick changes rather than smooth ones. For example, the air conditioner output voltage delivered by the VSI of a standard ASD is a three-level

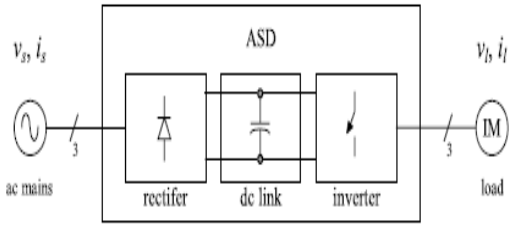


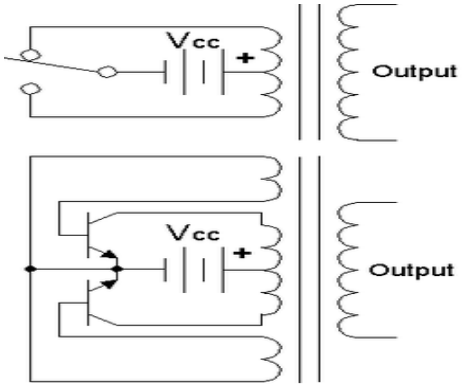
Fig: 2 Adujustable speed drive

Basic designs:

In one simple inverter circuit, DC power is connected to a transformer through the centre tap of the primary winding. A switch is rapidly switched back and forth to allow current to flow back to the DC source following two alternate paths through one end of the primary winding and then the other. The alternation of the direction of current in the primary winding of the transformer produces alternating current (AC) in the secondary circuit.

The electromechanical version of the switching device includes two stationary contacts and a spring supported moving contact. The spring holds the movable contact against one of the stationary contacts and an electromagnet pulls the movable contact to the opposite stationary contact. The current in the electromagnet is interrupted by the action of the switch so that the switch continually switches rapidly back and forth. This type of electromechanical inverter switch, called a vibrator or buzzer, was once used in vacuum tube automobile radios. A similar mechanism has been used in door bells, buzzers and tattoo. As they became available with adequate power ratings, transistors and various other

types of semiconductor switches have been incorporated into inverter circuit designs.



Output waveforms:

The switch in the straightforward inverter portrayed above, when not coupled to an output transformer, delivers a square voltage waveform because of its basic now and again nature instead of the sinusoidal waveform that is the typical waveform of an AC power supply. Utilizing Fourier examination, occasional waveforms are spoken to as the entirety of an unbounded series of sine waves. The sine wave that has indistinguishable frequency from the first waveform is known as the basic segment. The other sine waves, considered harmonics that are incorporated into the series have frequencies that are essential multiples of the central frequency.

The quality of the inverter output waveform can be communicated by utilizing the Fourier investigation information to ascertain the aggregate harmonic distortion (THD). The aggregate harmonic distortion is the square base of the total of the squares of the harmonic voltages separated by the basic voltage:

$$\text{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \cdots + V_n^2}}{V_1}$$

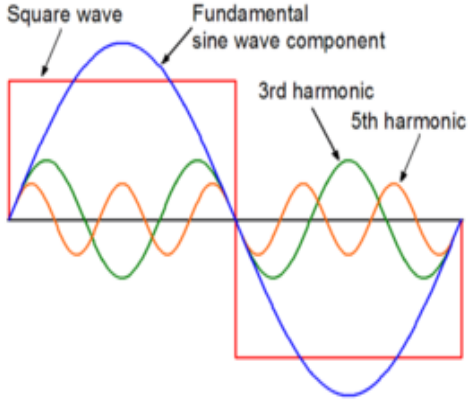


Fig 3 Fundamental and harmonic wave form

TYPES OF INVERTERS:

Generally inverters are of Two Types:

1. VOLTAGE SOURCE INVERTER
2. CURRENT SOURCE INVERTER

4. FOUR-LEG CONVERTER MODEL

Fig. 4 shows the configuration of a run of the mill power distribution system with inexhaustible power generation. It comprises of different kinds of power generation units and distinctive sorts of loads. Inexhaustible sources, such as wind and sunlight, are ordinarily used to generate power for private clients and little enterprises. Both sorts of power generation utilize air conditioning/air conditioning and dc/air conditioning static PWM converters for voltage change and battery banks for long haul vitality stockpiling. These converters perform most extreme power direct following toward concentrate the greatest vitality conceivable from wind and sun. The electrical vitality utilization behavior is random and eccentric, and therefore, it might be single-or three-phase, adjusted or unequal, and straight or nonlinear. An active power filter is associated in parallel at the purpose of common coupling to remunerate current harmonics, current unbalance, and reactive power. It is formed by an electrolytic capacitor, a four-leg PWM converter, and a first-arrange output ripple filter, as shown in Fig. 1.2. This circuit considers the power system proportionate impedance Zs, the converter output ripple filter impedance Zf , and the load impedance ZL .

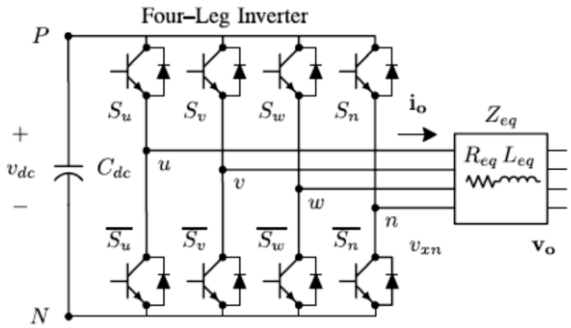


Fig. 4 Two-level four-leg PWM-VSI topology.

The four-leg PWM converter topology is shown in Fig. 5.1. This converter topology is like the conventional three-phase converter with the fourth leg associated with the impartial bus of the system. The fourth leg expands switching states from 8 (23) to 16 (24), enhancing control adaptability and output voltage

quality, and is reasonable for The voltage in any leg x of the converter, measured from the neutral point (n), can be expressed in terms of switching states, as follows:

$$v_{xn} = S_x - S_n v_{dc}, \quad x = u, v, w, n. \qquad (1)$$

The mathematical model of the filter derived from the equivalent circuit shown in Fig.5. 2 is

$$\mathbf{v_o} = v_{xn} - R_{eq}\,\mathbf{i_o} - L_{eq}\frac{d\,\mathbf{i_o}}{dt} \qquad (2)$$

where Req and Leq are the 4L-VSI output parameters communicated as Thevenin impedances at the converter output terminals Zeq. Therefore, the Thevenin proportional impedance is dictated by a series association of the ripple filter impedance Zf and a parallel course of action between the system equal impedance Zs and the load impedance ZL

$$Z_{eq} = \frac{Z_s Z_L}{Z_s + Z_L} + Z_f \approx Z_s + Z_f. \qquad (3)$$

For this model, it is expected that ZL »Zs, that the resistive piece of the system's comparable impedance is ignored, and that the series reactance is in the scope of 3– 7% p.u., which is a satisfactory guess of the genuine system. At long last, in (2) Req = Rf and Leq = Ls + Lf.

5. SIMULATION RESULTS

A reenactment model for the three-phase four-leg PWM converter with the parameters shown in Table I has been produced utilizing MATLAB-Simulink. The goal is to check the current harmonic compensation viability of the proposed control scheme under various working conditions. A six-pulse rectifier was utilized as a nonlinear load. The proposed prescient control algorithm was modified utilizing a S-work obstruct that permits recreation of a discrete model that can be effectively actualized in a continuous interface (RTI) on the dSPACE DS1103 R&D control board. Reproductions were performed considering a 20 [μs] of test time.

In the recreated results shown in Fig. 6.2, the active filter starts to remunerate at t = t1. Right now, the active power filter infuses an output current iou to repay current harmonic parts, current lopsided, and unbiased current all the while. Amid compensation, the system currents is show sinusoidal waveform, with low aggregate harmonic distortion (THD = 3.93%). At t = t2, a three-phase adjusted load step change is generated from 0.6 to 1.0 p.u. The remunerated system currents stay sinusoidal regardless of the change in the load current extent. At long last, at t = t3, a single-phase load step change is presented in phase u from 1.0 to 1.3 p.u., which is equal to a 11% current unevenness. Not surprisingly on the load side, an unbiased current courses through the nonpartisan conductor (iLn), however on the source side, no impartial current is watched (isn). Recreated results show that the proposed control scheme viably kills uneven currents. Also, Fig. 8 shows that the dc-voltage stays stable throughout the whole active power filter operation.

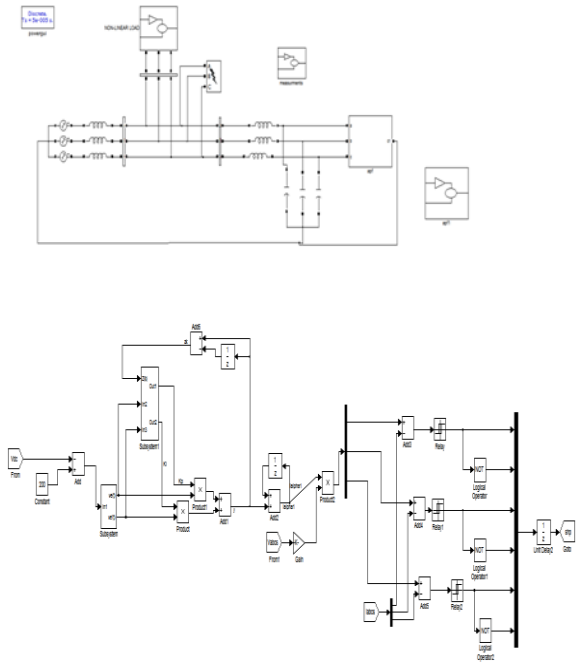
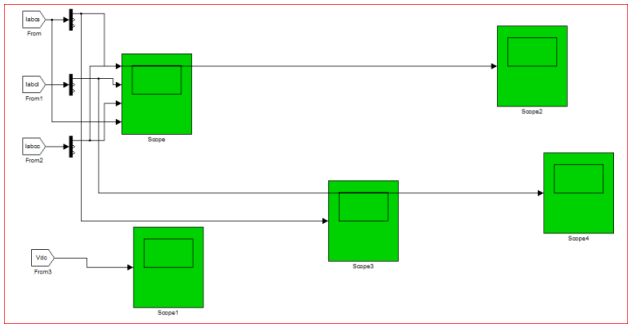


Fig.5 APF Control scheme



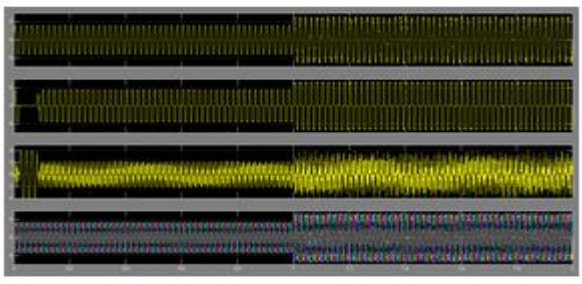


Fig. 6. APF load voltage, current, filter output current, load neutral current

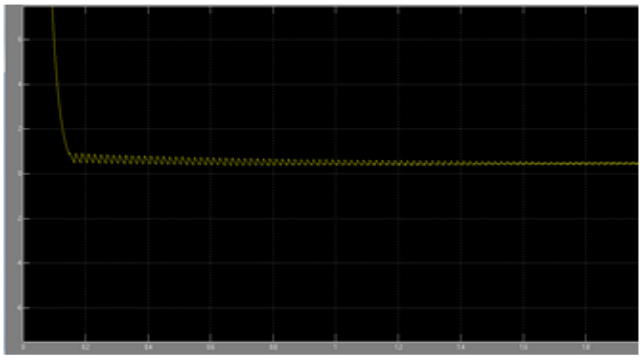


Fig. 7 Non linear Voltage

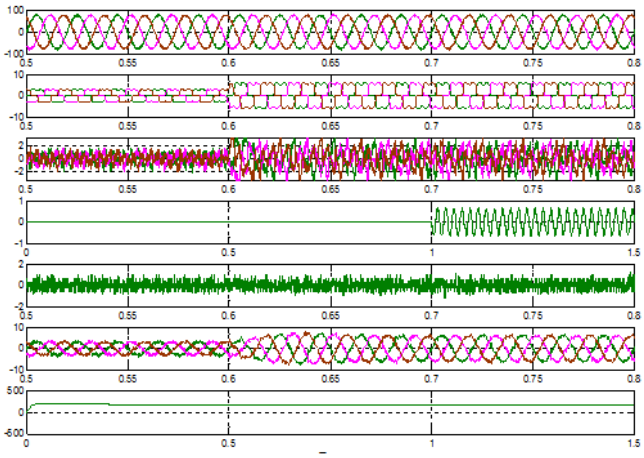


Fig. 8. Source voltage, Load current, Filter output currents, load neutral current, system neutral current, system currents, dclink voltage

6. CONCLUSION

Enhanced unique current harmonics and a reactive power compensation scheme for power distribution systems with generation from sustainable sources has been proposed to enhance the current quality of the distribution system. Favorable circumstances of the proposed scheme are identified with its straightforwardness, modeling, and usage. The utilization of a prescient control algorithm for the converter current loop turned out to be a successful answer for active power filter applications, enhancing current following ability, and transient reaction. Reproduced and experimental results have demonstrated that the proposed prescient control algorithm is a decent option in contrast to traditional direct control methods. The prescient current control algorithm is a steady and robust arrangement. Reenacted and experimental results have shown the compensation viability of the proposed active power filter.

FUTURE SCOPE

Power systems are developed from remote generators feed their loads to huge interconnected systems which are spread crosswise over numerous the nation. Interconnected systems are more dependable systems, since if there should be an occurrence of disruption in various parts like one a player in the system; power can spill out of substitute paths and thus can keep up coherence of the system. Though, harmonic distortions which are presented by the nonlinear loads will engender throughout. These issue might be fathomed by introducing specific sorts of filters of appropriately structured appraisals, best case scenario conceivable areas in the interconnected power system. The ideal assignment and rating of these shunt active filters can be resolved with help of developmental algorithms.

Supportable extension in the power system it is important to make utilization of the sustainable power source resources like Wind, Biomass, Hydal power, Co-generation, and so forth. The expansion of sustainable power source into the realistic power system additionally generates and influences power quality gives such as sudden voltage homeless people, precariousness, and so forth. Induction generator is helpful as wind power generator; it requires reactive power for charge. When the generated active power generated by APF of an induction generator is differed because of wind speed, the assimilated reactive powers and terminal voltages of an induction generator are hugely influenced. An appropriate controlled scheme in wind vitality generation system is fundamental under the typical working condition to let permit the right control over the active power creation. By and large Shunt Active Hybrid Filters are recommended for better enhancing of power quality issues, when generation quickly changes with wind speed.

REFERENCES

[1] D. D. Sabin and A. Sundaram, “Quality enhances reliability,” IEEE Spectr., vol. 33, no. 2, pp. 34–41, Feb. 1996.

[2] M. Rastogi, R. Naik, and N. Mohan, “A comparative evaluation of harmonic reduction techniques in three-phase utility interface of power electronic loads,” IEEE Trans. Ind. Appl., vol. 30, no. 5, pp. 1149–1155, Sep./Oct. 1994.

[3] F. Z. Peng, "Application issues of active power filters," IEEE Ind. Appl. Mag., vol. 4, no. 5, pp. 21–30, Sep../Oct. 1998.

AUTHORS:

1. **KADIKUNTA NAVEEN KUMAR,**

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

2. **J. MURALI KRISHNA,**

Assistant Professor, Department of EEE.

3. **P. NAGENDRA,**

Assistant Professor, Department of EEE.

4. **M. RAVI KUMAR.**

Assistant Professor, Department of EEE.