International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 4th Aug 2019. Link :http://www.ijiemr.org/downloads.php?vol=Volume-08&issue=ISSUE-08

Title **FUZZY-CONTROLLER-DESIGNED-PV-BASED CUSTOM POWER DEVICE FOR POWER QUALITY ENHANCEMENT**

Volume 08, Issue 08, Pages: 242–247.

Paper Authors

MR. VADDESWARAM SURESH BABU, MR. DASARI RAMU

NOVA College of engineering and Technology,(A.P),INDIA

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

FUZZY-CONTROLLER-DESIGNED-PV-BASED CUSTOM POWER DEVICE FOR POWER QUALITY ENHANCEMENT

[1]MR. VADDESWARAM SURESH BABU, [2]MR. DASARI RAMU
[1]M.Tech in dept of EEE at NOVA College of engineering and Technology,(A.P),INDIA,
[2]Associate Professor in dept of EEE at NOVA College of engineering and Technology,(A.P),INDIA
[1]Sureshsriram219@gmail.com,[2]ramu230@gmail.com

ABSTRACT: In this paper, a three-phase series hybrid active filter (SEHAF) interconnected with photovoltaic (PV) system and dc–dc boost converter is proposed to minimize sag, swell, and harmonics caused due to nonlinear power electronic loads. The SEHAF consists of a voltage source inverter (VSI) with a capacitor connected across it to provide consistency in managing and compensating the reactive power. This minimizes the sag, swell, and harmonics present in the source and load voltages. With the integration of PV, the voltage across the dc-link capacitor of VSI is controlled effectively, which helps in better compensation. Reference current generation is done using the proposed robust extended complex Kalman filter (RECKF) technique. The performance of the PV-integrated-HAF is analyzed using a synchronous reference frame with proportional-integral (PI) as well as fuzzy logic controller (FLC) and is compared with the proposed RECKF technique. The PV-integrated hybrid power system is developed using MATLAB/SIMULINK. Further, real-time digital simulation using OPAL-RT OP5142 is also carried out to support the simulation results. It is observed that the proposed control scheme provides better harmonic compensation compared to conventional PI and FLC.
Fuzzy logic controller, photovoltaic array, robust extended complex Kalman filter, series hybrid active filter, synchronous reference frame.

I INTRODUCTION

POWER quality (PQ) is an important issue in commercial and industrial establishments for delivering its clients a consistent and cost-effective supply. Problems associated with power quality are highly spawned using switch mode power supply (SMPS) devices. These loads uphold non-linearity, generate harmonics [1], [2] and affect the efficiency of the utility network. PQ depends upon the supply system and the category of loads in the distribution system [3], [4]. Distortions and harmonics in voltage and current are treated as serious issues in PQ analysis. Harmonics in the utility network can be decreased by compensating techniques so that the total harmonic distortion (THD) remains within the specified limit [5].Recently, many researchers have proposed numerous techniques and theories to improve the quality of power. PQ can be

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

improved by suppressing the harmonics using active filters (AFs) [6]. But, AFs cannot compensate current or voltage harmonics beyond 25th order because of the existence of distortions of high frequencies. The configurations of hybrid AF (HAF) [7]–[9] overcome the limitations of AFs and also provide better performance and cost effective solutions [10], [11]. Different configurations of HAF, typically series and shunt types are respectively used for compensating voltage and current harmonics in the utility system. HAF effectively improves the compensating efficiency of the passive filter along with reduction in the rating. In recent days, it has been marked that grid integrated PV system has proved to be remarkable in providing continuity of power supply under fault scenarios. But, the challenges lie in extracting maximum power output from PV system under uncertainty in the input solar radiation because of varying environmental conditions.

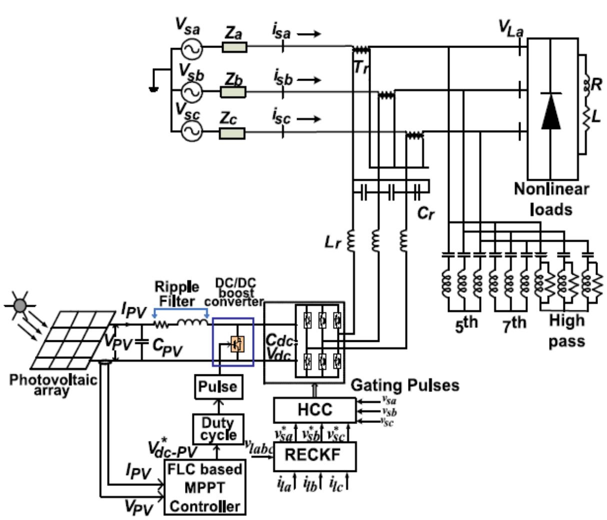

Fig. 1.1. Proposed configuration of the power system integrated with solar PV.

II. POWER QUALITY PROBLEM

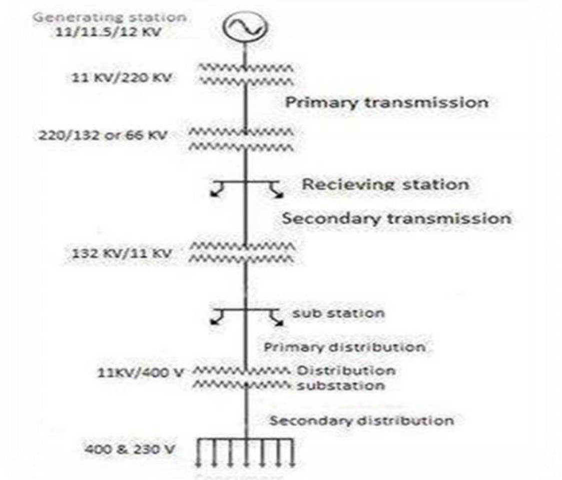

Fig. 2.1 Single line diagram of power supply system

Power distribution system s, ideally, should provide their customers with an uninterrupted flow of energy at smooth sinusoidal voltage at the contracted magnitude level and frequency. However, in practice, power systems, especially the distribution systems, have numerous nonlinear loads, which significantly affect the quality of power supplies. A s a result of the nonlinear loads, the purity of the waveform of supplies is lost. This ends up producing many power quality problems.

While power disturbances occur on all electrical systems, the sensitivity of today's sophisticated electronic devices makes them more susceptible to the quality of power supply. For some sensitive devices, a momentary disturbance can cause scrambled data, interrupted communications, a frozen mouse, system crashes and equipment failure etc.A power voltage spike can damage valuable components. Power Quality problems encompass a wide range of disturbances such as voltage sags/swells,

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

flicker, harmonics distortion, impulse transient, and interruptions.

- Voltage dip: A voltage dip is used to refer to short-term reduction in voltage of less than half a second.
- Voltage sag: Voltage sags can occur at any instant of time, with amplitudes ranging from 10 – 90% and a duration lasting for half a cycle to one minute.
- Voltage swell: Voltage swell is defined as an increase in rms voltage or current at the power frequency for durations from 0.5 cycles to 1 min.
- Voltage 'spikes', 'impulses' or 'surges': These are terms used to describe abrupt, very brief increases in voltage value.
- Voltage transients: They are temporary, undesirable voltages that appear on the power supply line. Transients are high over-voltage disturbances (up to 20KV) that last for a very short time.
- Harmonics: The fundamental frequency of the AC electric power distribution system is 50 Hz. A harmonic frequency is any sinusoidal frequency, which is a multiple of the fundamental frequency. Harmonic frequencies can be even or odd multiples of the sinusoidal fundamental frequency.
- Flickers: Visual irritation and introduction of many harmonic components in the supply power and their associated ill effects.

III SYSTEM CONFIGURATION

The proposed configuration consists of solar PV, DC-DC boost converter, VSI with non-linear loads. The input to DC-DC boost converter is given by PV in which fuzzy logic is used to track MPP and improve the output voltage of PV. In general, the boost converter with FLC defines a suitable duty cycle which regulates the voltage and power output. Usually, the input voltage is variable with the voltage output while maintaining constant duty cycle. So, to maintain constant output voltage, the duty cycle is varied by the help of voltage input and condition of the load. The dc link bus voltage of VSI is controlled by the integration of solar PV along with a PI/ FLC. VSI are employed along with SEHAF configuration with PI/FLC/proposed RECKF for better reactive power compensation, improvement in power factor and suppression of harmonics. The details of the parameters used in the proposed system are provided in Table IA.

Modeling of SEHAF

The SEHAF is connected to the grid through an interfacing transformer as shown in Fig. 1. The SEHAF acts as an isolator between the supply and the load. The mathematical model [10], [11] of series active filter (SAF) of SEHAF can be expressed below as:

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

$$L_c \frac{di_{ca}}{dt} = v_{ca} - v_{an} \quad (1)$$

$$L_c \frac{di_{cb}}{dt} = v_{cb} - v_{bn} \quad (2)$$

$$L_c \frac{di_{cc}}{dt} = v_{cc} - v_{cn} \quad (3)$$

$$C \frac{dv_{ca}}{dt} = i_{sa} - i_{ca} \quad (4)$$

$$C \frac{dv_{cb}}{dt} = i_{sb} - i_{cb} \quad (5)$$

$$C \frac{dv_{cc}}{dt} = i_{sc} - i_{cc} \quad (6)$$

IV SIMULATION RESULTS

It is evident that the proposed controller minimizes the harmonics much effectively in comparison to that of FLC and conventional PI controllers. This is achieved by an accurate estimation of the reference currents using RECKF which helps the SEHAF to manage the reactive power in more effective way. A comparative analysis of the THD values with the above controllers is presented in Table II which displays the minimum THD value of 0.4% in case of the proposed controller.

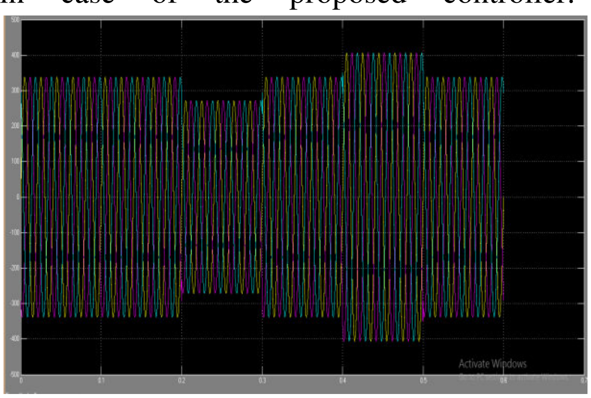

Fig 4.1 : Simulation result: Voltage sags and swells without using DVR

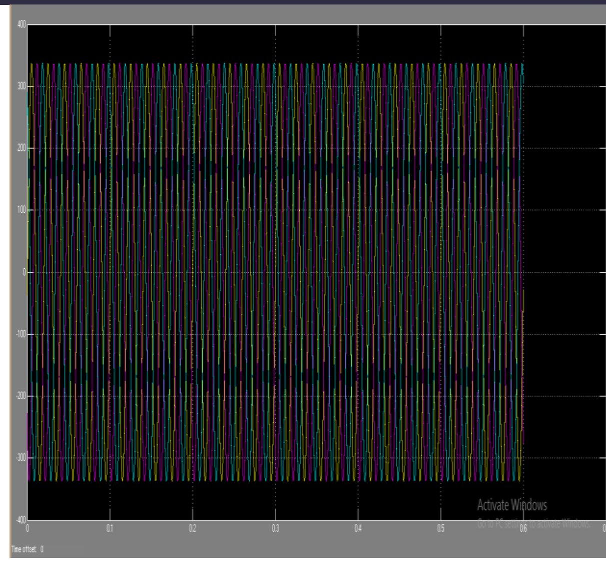

Fig 4.2: Simulation result: 3-Phase Voltage output using DVR

V CONCLUSION

It is observed from the power quality analysis that in case of FLC based SEHAF, the THD value is improved significantly as compared to that of the conventional PI controller. But, with incorporation of RECKF, the reactive power management as well as improvements in THD value is much better in comparison to that of FLC and PI controller. In addition, real-time digital simulation in OPAL-RT OP5142 is also carried out to support the simulation results. Based on the simulation and real-time results, it is analyzed that the proposed SEHAF with RECKF control scheme provides much better harmonics compensation as compared to the conventional controllers. In the future study, the MPPT can be designed with grid interactive DC–AC inverter to achieve further improvements in the power quality and reactive power compensation. In addition, real-time hardware based power

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

quality improvement will be carried out in our future study under different operating scenarios.

VI REFERENCES

[1] C. Fitzer, A. Arulampalam, M. Barnes, and R. Zurowski, "Mitigation of saturation in dynamic voltage restorer connection transformers," *IEEE Trans. Power Electron.*, vol. 17, no. 6, pp. 1058–1066, Nov. 2002.

[2] R. Omar and N. A. Rahim, "Voltage unbalanced compensation using dynamic voltage restorer based on super capacitor," *Int. J. Elect. Power Energy Syst.*, vol. 43, pp. 573–581, 2012.

[3] H. Akagi, "New trends in active filters for power conditioning," *IEEETrans. Ind. Appl.*, vol. 32, no. 6, pp. 1312–1322, Nov./Dec. 1996.

[4] B. Singh, K. A. Haddad, and A. Chandra, "A review of active filters for power quality improvement," *IEEE Trans. Ind. Electron.*, vol. 46, no. 5,pp. 960–971, Oct. 1999.

[5] P. Kumar, "Simulation of custom power electronic device DSTATCOM—
A case study," in *Proc. Int. Conf. Power Electron.*, 2011, pp. 1–4.

[6] L. Mor´an, J. Dixon, and M. Torres, "Active power filters," in *Power Electronics Handbook*, 4th ed. Oxford, U.K.: Butterworth-Heinemann, 2018, pp. 1341–1379.

[7] Z. Luo, M. Su, Y. Sun, W. Zhang, and Z. Lin, "Analysis and control of a reduced switch hybrid active power filter," *IET Power Electron.*, vol. 9, no. 7, pp, 1416–1425, Jun. 2016.

[8] R. B. Gonzatti, S. C. Ferreira, C. H. da Silva, R. R. Pereira, L. E. da Silva, and G. Lambert-Torres, "Smart impedance: A new way to look at hybrid filters," *IEEE Trans. Smart Grid*, vol. 7 no. 2, pp. 837–846, Mar. 2016.

[9] T. Demirdelen,M. Inci, andM. T¨umay, "A new control approach for shunt hybrid active power filter to compensate harmonics and dynamic reactive power with grid interconnection," in *Proc. IEEE Eur. Model. Symp.*, 2015, pp. 247–253.

[10] A. Hamadi, S. Rahmani, and K. A. Haddad, "A new hybrid series active filter configuration to compensate voltage sag, swell, voltage and current harmonics and reactive power," in *Proc. IEEE Int. Symp. Ind. Electron.*, 2009, pp. 286–291.

[11] S. D. Swain, P. K. Ray, and K. B. Mohanty, "Improvement of power quality using a robust hybrid series active power filter," *IEEE Trans. Power Electron.*, vol. 32 no. 5, pp. 3490–3498, May 2017.

[12] T. Esram and P. L. Chapman, "Comparison of photovoltaic array maximum power point tracking techniques," *IEEE Trans. Energy Convers.*, vol. 22, no. 2, pp. 439–449, Jun. 2007.

[13] Y. Jiang, J. A. A. Qahouqand, T. A. Haskew, "Adaptive step size with adaptive-perturbation-frequency digital MPPT controller for a singlesensor photovoltaic solar system," *IEEE Trans. Power Electron.*, vol. 28, no. 7, pp. 3195–3205, Jul. 2013.

[14] N. Altin and S. Ozdemir, "Three-phase three-level grid interactive inverter

with fuzzy logic based maximum power point tracking controller," *Energy Convers. Manage.*, vol. 69, pp. 17–26, 2013.

[15] A. El Khateb, N. A. Rahim, J. Selvaraj, and M. N. Uddin, "Fuzzy-logiccontroller-based SEPIC converter for maximum power point tracking," *IEEE Trans. Ind. Appl.*, vol. 50, no. 4, pp. 2349–2358, Jul./Aug. 2014.

AUTHORS:

Vaddeswaram Suresh Babu: is Pursuing M.Tech (Electrical and Electronic Engineering) in NOVA College of engineering and Technology, vegavaram, jangareddygudem, West Godavari Dist, Andhra Pradesh, India.

Dasari Ramu, is currently working as Associate. Professor in Nova college of engineering and technology, in the Department of Electrical and Electronic Engineering, vegavaram , jangareddygudem, West Godavari Dist, Andhra Pradesh, India.