International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Power Quality Improvement by Reduction of Total Harmonic Distortion (THD) using PWM Inverter

Chitralekha Jena, Srikanta Mohapatra, Sanhita Mishra,Babita Panda, Anwesha Majumdar

Abstract - In this paper, a PWM inverter is proposed for improvement of power quality i.e., reduction of total harmonic distortion (THD). The power quality problems reduce the lifetime and performance of equipments. The proposed system reduces the THD which is generated from the nonlinear loads. Because presence of harmonics leads to problems like overheating, failure of insulation etc.

Here the simulation results of the proposed system is studied using MATLAB SIMULINK. Using the system, a lower THD is achieved which shows the effectiveness of the system.

Index Terms - Power Quality, Total harmonic distortion(THD), PWM.

I. INTRODUCTION

Electrical energy is one of the most productive forms of energy and is totally dependent on electric supply. Hence the power quality is a significant factor which is quite important for the effective operation for handling user side equipment. It depends upon voltage and frequency ranges of power. If the range deviates from the standard range the quality of power gets effected [3]-[7].

With the evolution in technology, there is a radical enhancement in semi conductor devices. Semi conductor devices plays a vital role in the energy sector as they help to alleviate the control of a system. But the semi conductor devices are nonlinear and draws nonlinear current from the source. Use of nonlinear loads generates harmonics and reactive power. Harmonics is considered as a critical problem of power quality. Therefore, it is very important to eliminate the harmonics in order to maintain the power quality and reduce the THD below 5% based on IEEE 519 harmonics standard[2]. So a PWM Inverter is used in this paper to serve the purpose in order to facilitate 230V or 110V steady output voltage whether it's a constant load or variable.

Compared to the conventional inverters, PWM inverters are unrivaled as they have various protection circuits and voltage control circuits.

Revised Manuscript Received on December 30, 2019.
***** Correspondence Author
Chitralekha Jena*, Assistant Professor in School of Electrical Engineering,KIIT Deemed University, Bhubaneswar, India.
Srikanta Mohapatra, Associate Professor in the School of Electrical Engineering, KIIT Deemed University, Bhubaneswar, India.
Sanhita Mishra, Assistant Professor ,KIIT Deemed University, Bhubaneswar, India.
Babita Panda, Assistant Professor in the department of Electrical Engineering at KIIT, deemed university Bhubaneswar, India.

II. SYSTEM UNDER STUDY

Fig. 1 is showing the configuration of the proposed system for reducing THD. A three phase source is connected to a nonlinear load. Here a 3 phase full wave rectifier with resistive load is connected as a non linear load. It consists of six diodes D1, D2, D3, D4, D5 and D6.

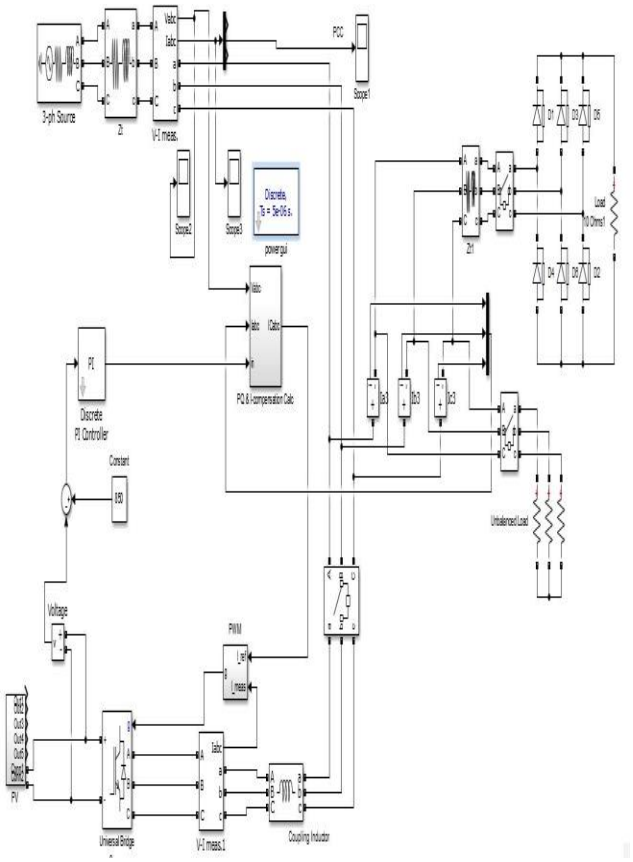

Fig 1. Configuration of the proposed system

A. PV Module

For a Photo Voltaic module solar cell is the primary component. Basically its size varies from 4-6 inches for a small cell generation about 3 watts. Basically the cells are connected in series-parallel manner in order to track maximum power[1].

The PV Array block is a five parameter model using a current source IL (light-generated current), diode (I0 and nI parameters), series resistance Rs, and shunt resistance Rsh to represent the irradiance- and temperature-dependent I-V characteristics of the modules.

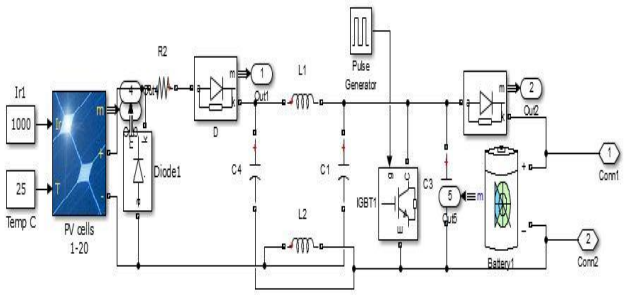

Fig. 2 Subsystem of the PV module

Here the inputs of the PV module are irradiance and Temperature. DC voltage is being generated from the PV module. A boost converter is used to step up the voltage from its input. The DC voltage is being saved in the battery.

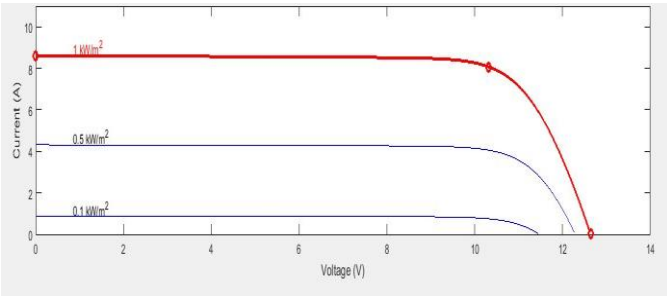

Fig. 3 V-I curve

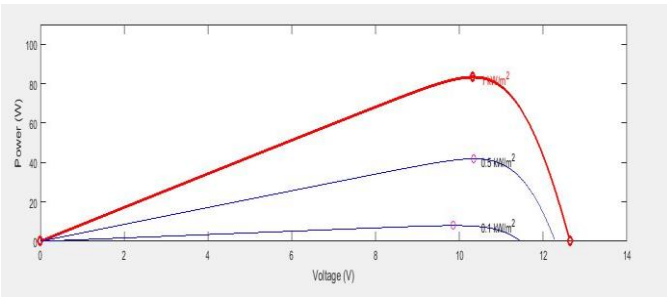

Fig. 4 P-V curve

B. PQ and I compensation calculation

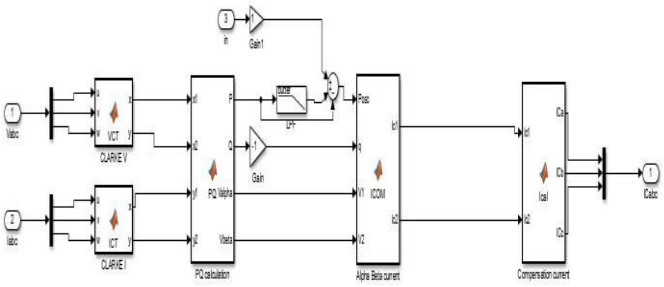

Fig. 5 PQ and I compensation calculation block

Inside this block the voltage Vabc from source and current Iabc from load is being converted into PQ using Clarke's Transformation. Then it is converting into Alpha Beta and then into compensation current Icabc.

C. PWM

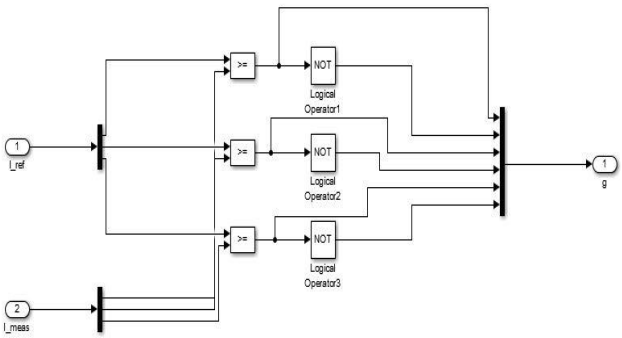

Fig. 6 PWM inverter block

Both the currents Icabc (I_ref) and Iabc (I_meas) are compared by the PWM block. And the difference between both the currents is injected into the universal bridge as we can see in Fig. 1.

III. SIMULATION RESULT

The simulation result here demonstrates both the cases i.e., before applying PWM and after applying PWM. Here the current waveform and THD is displayed for both the cases.

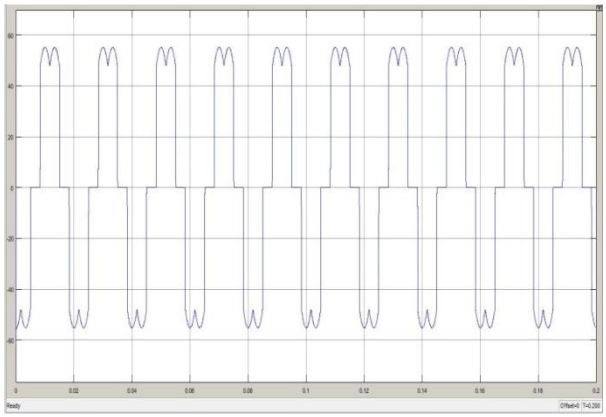

Fig. 7 Current waveform before applying PWM

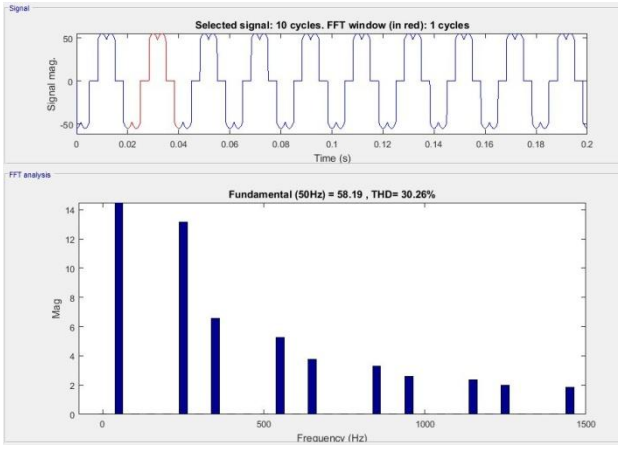

Fig. 8 Total harmonic distortion before applying PWM

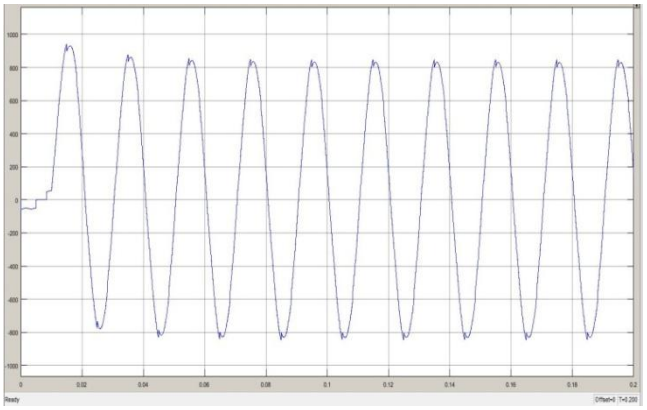

Fig. 9 Current waveform after applying PWM

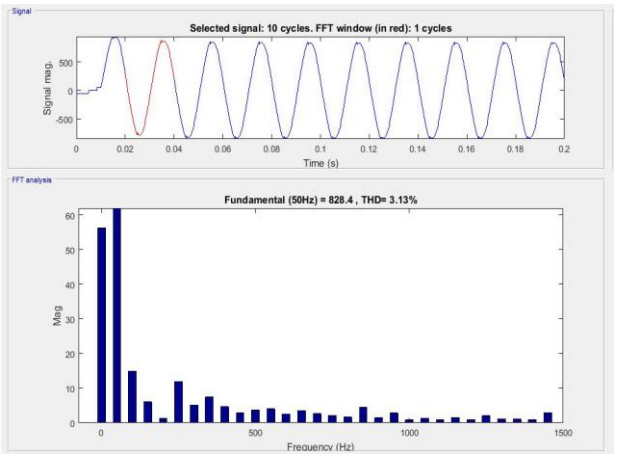

Fig. 10 Total harmonic distortion after applying PWM

Here the current waveforms and THD can be seen. Fig. 7 shows the waveform of current before applying PWM where distortion can be seen and Fig. 8 shows the THD which is 30.26%. In Fig. 9 current waveform is seen with less distortion which is after applying PWM and Fig. 10 shows the THD which is 3.13%.

IV. CONCLUSION

In this paper a three phase system with nonlinear load is analysed and simulated where a PWM inverter is used for reduction of THD. The simulation result shows that THD has been reduced from 30.26% to 3.13% after applying PWM. Since based on IEEE 519 harmonics standard THD should be below 5%, this method can be considered for improving the quality of power.

REFERENCES

1. R. Belaidi, M. Hatti, A. Haddouche and M. M. Larafi, "Shunt active power filter connected to a photovoltaic array for compensating harmonics and reactive power simultaneously," *4th International Conference on Power Engineering, Energy and Electrical Drives*, Istanbul, 2013, pp. 1482-1486.
2. Soumya Ranjan Das, Prakash K. Ray and Asit Mohanty, "Improvement in power quality using hybrid power filters based on RLS algorithm," *2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies*, Thailand, 2017, pp. 723-728.
3. Awad, H.; Bollen, M. H J, "Power electronics for power quality improvements," *Industrial Electronics, 2003. ISIE '03. 2003 IEEE International Symposium on* , vol.2, no.,pp.1129,1136 vol. 2, 9-11 June 2003 doi: 10.1109/ISIE.2003.1267983.
4. Singh, Bhim; Al-Haddad, K.; Chandra, A., "A review of active filters for power quality improvement," *Industrial Electronics, IEEE Transactions on* , vol.46, no.5, pp.960,971, Oct 1999 doi: 10.1109/41.793345.
5. Rivas, D.; Moran, L.; Dixon, J.W.; Espinoza, J.R., "Improving passive filter compensation performance with active techniques," *Industrial Electronics, IEEE Transactions on* , vol.50, no.1, pp.161,170, Feb. 2003 doi: 10.1109/TIE.2002.807658.
6. Herrera, R.S.; Salmeron, P., "Instantaneous Reactive Power Theory: A Comparative Evaluation of Different Formulations," *Power Delivery, IEEE Transactions on* , vol.22, no.1, pp.595,604, Jan. 2007 doi: 10.1109/TPWRD.2006.881468.
7. Salmeron, P.; Litran, S.P., "Improvement of the Electric Power Quality Using Series Active and Shunt Passive Filters," *Power Delivery, IEEE Transactions on* , vol.25, no.2,pp. 1058, 1067, April 2010 doi: 10.1109/TPWRD.2009.2034902.
8. H. Akagi, "Active harmonic filters," *Proc. IEEE*, vol. 93, no. 12, pp. 2128–2141, Dec. 2005.
9. B. Singh, K. Al-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
10. J. W. Dixon, G. Venegas, and L. A. Moran, "A series active power filter based on a sinusoidal current-controlled voltage-source inverter,"*IEEE Trans. Ind. Electron.*, vol. 44, no. 5, pp. 612–620, Oct. 1997.
11. Kneschke, T., "Distortion and power factor of nonlinear loads," *Power Engineering Society Summer Meeting, 1999.*

AUTHORS PROFILE

Chitralekha Jena, is currently working as Assistant professor in School of Electrical Engineering,KIIT Deemed to be University.She was awarded Ph.D from Jadavpur University in the year 2017.Her area of interest includes optimization of different power system problems,power management of solar PV system,load frequency control with integration of renewable sources,power quality improvement

Srikanta Mohapatra is currently working as Associate Professor in the School of Electrical Engineering, KIIT Deemed to be University, Bhubaneswar. He was awarded with PhD degree in 2014. His area of interest is harnessing electric energy from solar photovoltaic arrays, Power Electronics converters and FACTS & Power System Stability

Sanhita Mishra,Assistant Professor ,KIIT Deemed to be University has 8 years of experience in teaching and research published around 4 no of journal and 15 no of national and international conferences. She has research experience in optimisation technique, Solar PV system and AI technique, power system,Under ground cable. She is a member in IET. She has guided many number of B.Tech and M.Tech student for their research work. She has completed her M.Tech from VSSUT,Burla

Babita Panda received the B.Tech. degree in electrical engineering from the BIET,Bhadrak,M.Tech and Ph D degree from Kalinga Institute of Industrial Techonology deemed to be University. She is working as an Assistant Professor in the department of Electrical Engineering at KIIT , deemed to be university since 16th August 2012.Her research interests include distributed generation, renewable energy and power Electronics.

Anwesha Majumder was a M.Tech scholar in School of Electrical Engineering,KIIT University