Application Of PWM Rectifiertechnology For Harmonic Reduction In Smart Grid.

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Abstract

The present focus of every power system is theadoption of renewable energy.But this generated output from renewable energy is difficult to control and may cause frequency and local voltage fluctuations which calls for grid modernization.Smart grid is a systemthat reduces effect of mass adoption of renewable energy. This calls for methods to improve quality of power being transmitted and hence a major concern of harmonic reduction comes to play. The three phase thyristerized rectifiers are used for AC to DC conversion which results in harmonics being produced. This study shows the variation of power factor and output voltage with respect to firing angle for three phase thyristerized rectifier. Calculations are made to predict that the level of disturbance in power factor is considerable and must be mitigated. So are the harmonics produced which needs to be controlled. It's hence a proposed theory that PWM rectifier technology is one way of reducing harmonics in smart grid system.

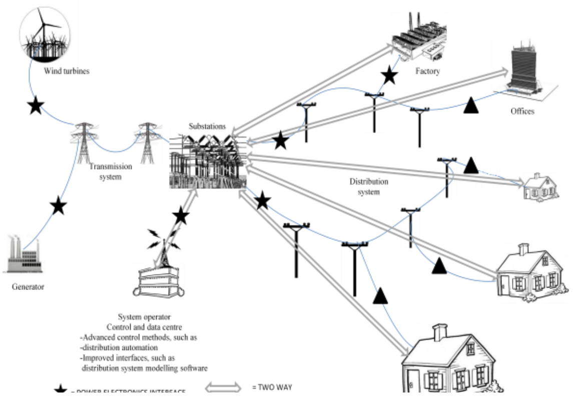
***Keywords*:** Smart grid, Harmonic reduction, Three Phase Thyristerized Rectifiers, PowerFactorPWM Rectifier Technology.

1.Introduction

The concept of Smart grid is based on bidirectional communication between utility and consumers, and sensing along the transmission lines resulting in efficient transmission and distribution of power. In this system all the grid components are able to communicate thereby making an otherwise passive grid as active. Unlike traditional power delivery method, smart grid provides a link between distributed generators and efficient consumption and a new interconnected energy value chain is created. Smart grids represent the most efficient way of integrating renewable energy generation inthe main grid. This requires a high-speed high-accuracy power supply system to connect to renewable energy source and hence the need of power electronics. PWM converter technology allows controlled bidirectional power flow and control of active and reactive power. The operation of different grids varies according to different technologies like AC, DC, single-phase and multi-phase which is possible to combine using PWM converters. In this paper it is proposed to study theoretically the requirement of PWM rectifier circuits for power quality improvement. Like traditional grids, power quality in smart grids is determined by factors such as:

- Uninterrupted service
- Transient voltages and currents
- Magnitude of voltage level
- Harmonic content in waveform etc.

Supporting power from DG (distributed generation) and intermittent power sources in smart grid helps in healing power degradation during transients or voltage fluctuations. The present technology for harmonic reduction is the use of passive filters, diode rectifiers, multi pulse rectifiers, active filters, PWM rectifiers etc.(Figure 1.1 Topology of smart grid. (Enlarged view) -Appendix A)



Φιγυρε 1.1 Τοπολογψ οφ σμαρτ γριδ

2. Need of harmonic reduction:

A nonlinear load is a source of current harmonics, which produces increase of reactive power, power losses in transmission lines, electromagnetic interference and, sometimes, dangerous resonances. It has a negative influence on the control and automatic equipment, protection systems, and electrical loads, resulting in reduced reliability. Also, nonlinear loads and non-sinusoidal currents produce non-sinusoidal voltage drops across the network impedances resulting in overheating of line, transformers and generators. Restrictions on current and voltage harmonics are maintained in many countries through IEEE 519-1992 in the USA and IEC 61000-3-2/IEC 61000-3-4 in Europe standards demanding a need for effective methods of harmonic reduction.

3. Most suitable harmonic reduction technique for smart grid:

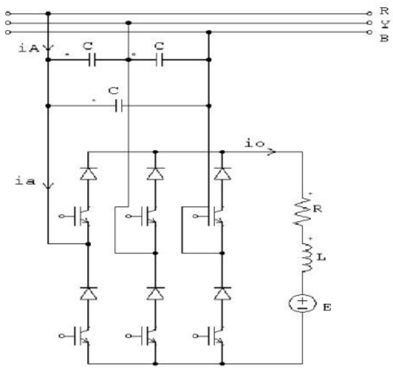
It can be categorizes as:
a. Harmonic reduction of already installed non-linear load;
b.Harmonic reduction through linear power electronics load installation.
Taking into account the advantages of PWM rectifier over passive filters,diode rectifiers, multi pulse rectifiers and active filters, it can be inferred that smart grids can utilize PWM rectifiers for harmonic reduction.(Figure 3.1.1. Classification of techniques of harmonic reduction -Appendix B)

3.1 Characteristics of PWM rectifier:

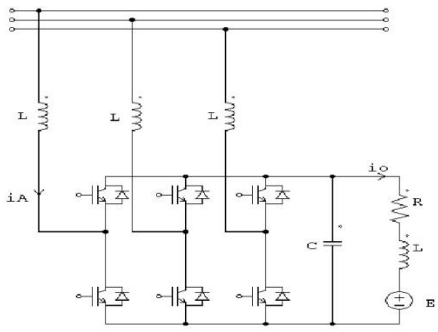
3.1.1 Bi-directional power flow,
3.1.2 Unity input power factor,
3.1.3 Approximate sinusoidal input current,
3.1.4 Low harmonic distortion;*THD*< 5%,
3.1.5 Stabilization of DC-linkvoltage/ current.

3.2 Types of PWM rectifier:

3.2.1 Voltage source output (Fig.3.2.1) called a *boost*rectifierand
3.2.2 A current source output (Fig.3.2.2) called a *buck* rectifier.



Φιγυρε 3.2.1. Βοοστ ρεχτιφιερ



Φιγ3.2.2: Βυχκ ρεχτιφιερ

4. Harmonics observed in three phase thyristerized bridge rectifier.

Three-phase thyristerized bridge rectifier simulation results are shown below. From the simulation we observed that, with the increase in the firing angle, power factor decreases and harmonics increases in both input current and the output voltage. Power factor improvement and lower order harmonics elimination can be done by the PWM technique. Putting simple filters at the input side and the output side of the rectifier can reduce higher order harmonics. This justifies the need of PWM technology in reduction of harmonics.

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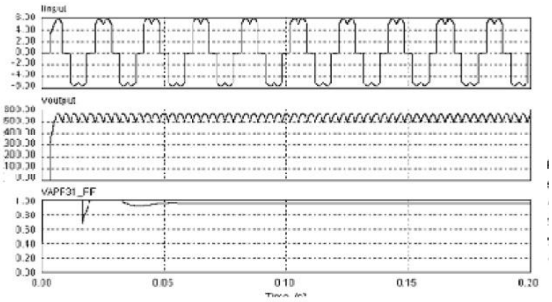
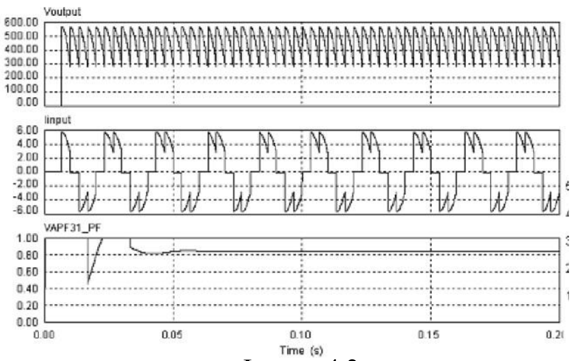
4.1 Simulation results:



Φιγυρε 4.1.



Φιγυρε 4.2.

1. Fig 4.1: Input current, output voltage and power factor of three phase rectifier with firing angle 30°.
2. Fig 4.2:Output voltage, input current and power factor of three phase rectifier with firing angle 60°.

4.2 Observations*:*

4.2.1 The output dc voltage consists of a lot of ripples.
4.2.2 Thyristor bridge rectifier produce the harmonic of 6P±1 order in the input current.
4.2.3 Thyristor bridge rectifiers input PF decreases with the increase in the firing angle.

Power factor improvement and lower order harmonics elimination can be done by the PWM technique. Putting simple filters at the input side and the output side of the rectifier can reduce higher order harmonics. This justifies the need of PWM technology in reduction of harmonics.

5. Conclusion

The undesirable effects of these harmonicsareoverheating of the capacitors and generators, instability of the converter control, and interference with the telecommunication systems, These effects are not only confined to the vicinity of the converter station but are propagated over a great distances. International organizations have introduced new standards (in United States, IEEE 519, and in Europe IEC 6100-3) which limit the harmonic content of the current drawn from the power lines drawn by the rectifiers. As a consequence requirement of PWM technique arises. With microprocessor developments in recent times, the space vector modulation (SVM) becomes a basic power processing technique in three phase PWM converters. Hence it is observed from that the harmonics are produced during AC/DC conversion in a rectifier and the same can be minimized by using PWM rectifiers and its modified circuits.

6. References

1.) Wilson E. Kazibwe and Mucoke H. Senduala : Electric Power Quality Control Techniques. New York: Van Nostrand Reinhold, c1993.

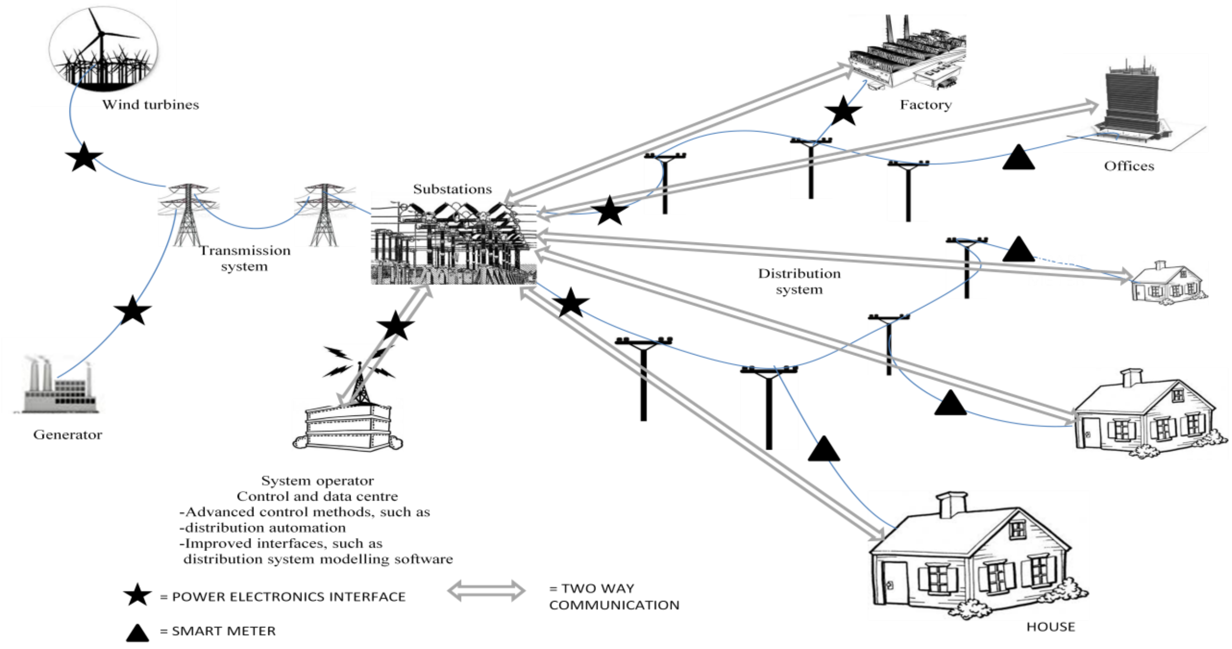
2.) J. W. Kolar, F.C. Zach, "'A Novel Three-Phase Utility Interface MinimizingLine Current Harmonics of High-Power Telecommunications Rectifier Modules", IEEE Transactions on Industrial Electronics, vol. 44, No.4 August 1997 pp. 456-467.

3.) E. Paal, Z. Tatai, "Grid Connected Inverters Influence on Power Quality of Smart Grid" , 14th International Power Electronics and Motion Control Conference, EPE-PEMC 2010, pp.35-39, 2010

4.) A. Mohamed, , and O. Mohammed, "Smart Power Flow Control in DC Distribution Systems Involving Sustainable Energy Sources", 2010 IEEE/PES Transmission and Distribution Conference and Exposition: Latin America pp.372-379, 8-10 Nov. 2010

5.) M.H. Rashid, Power Electronics Handbook, third edition, Academic Press, 2001.

Appendix A



Φιγυρε 1.1 Τοπολογψ οφ σμαρτ γριδ

APPENDIX B

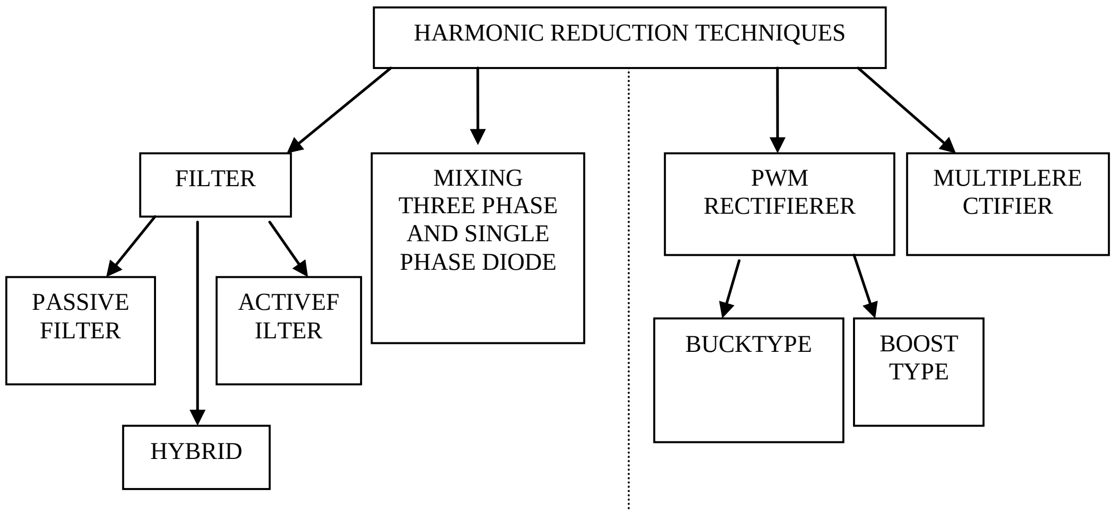


Figure 3.1.1. Classification of techniques of harmonic reduction