International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 17
November 2016

The three phase inverter for Optimal load & voltage control Using THD & UPS

E MANOJ KUMAR[1] & T. CHANDRUDU[2]

[1]M-TECH, Dept. of EEE Geethanjali College of Engineering &Technology, Kurnool, AP

[2]Associate Professor Dept. of EEE Geethanjali College of Engineering & Technology, Kurnool,

Abstract: -

This paper proposes a simple optimal voltage control method for three-phase uninterruptible-power-supply systems. The proposed voltage controller is composed of a feedback control term and a compensating control term. The former term is designed to make the system errors converge to zero, whereas the latter term is applied to compensate for the system uncertainties. Moreover, the optimal load current observer is utilized to optimize system cost and reliability. Concretely, the closed-loop stability of an observer-predicated optimal voltage control law is mathematically proven by exhibiting that the whole states of the augmented observer-predicated control system errors exponentially converge to zero. Unlike anterior algorithms, the proposed method can make a tradeoff between control input magnitude and tracking error by simply culling opportune performance indexes. The efficacy of the proposed controller is validated through simulations on MATLAB/Simu link and experiments on a prototype 600-VA testbed with a TMS320LF28335 DSP. Determinately, the comparative results for the proposed scheme and the conventional feedback linearization control scheme are presented to demonstrate that the proposed algorithm achieves an excellent performance such as expeditious transient replication, minute steady-state error, and low total harmonic distortion under load step change, unbalanced load, and nonlinear load with the parameter variations.

Keywords - uninterruptible power supply, Optimal load current observer, optimal voltage control, three phase inverter, total harmonic distortion (THD).

1. INTRODUCTION

Uninterruptible power supply (UPS) systems supply emergency power in case of utility power failures. Recently, the consequentiality of the UPS systems has been intensified more and more due to the incrementation of sensitive and critical applications such as communication systems, medical equipment, semiconductor manufacturing systems, and data processing systems. These applications require clean power and high reliability regardless of the electric power failures and distorted utility supply voltage. Thus, the performance of the UPS systems is customarily evaluated in terms of the total harmonic distortion (THD)

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 17
November 2016

of the output voltage and the transient/steady state replications regardless of the load conditions: load step change, linear load, and nonlinear load. To ameliorate the aforementioned performance indexes, a number of control algorithms have been proposed such as proportional–integral (PI) control, Hloop-shaping control, model predictive control, deadbeat control, sliding-mode control, perpetual control, adaptive control, and feedback linearization control (FLC). The conventional PI control suggested in and is facile to implement; however, the THD value of the output voltage is not low under a nonlinear-load condition. In, the Hloop-shaping control scheme is described and implemented on a single-phase inverter, which has a simple structure and is robust against model uncertainties. A model predictive control method for UPS applications is described in. By utilizing a load current observer in lieu of current sensors, the authors claimed a reduced system cost. However, the simulation and experimental results do not reveal an exceptional performance in terms of THD and steadystate error. In, the deadbeat control method utilizes the state feedback information to compensate for the voltage drop across the inductor. However, this method exhibits sensitivity to parameter mismatches, and the harmonics of the inverter output voltage are not very well compensated.Inand , the sliding-mode control technique reflectsrobustness to the system noise, and still, the control system has a well-kenned chattering quandary. In, perpetual control is applied to achieve a high-quality sinusoidal output voltage of a three-phase UPS system. Generally, this control techniquehasa slow replication time. In, the adaptive control method with low THD is proposed; nevertheless, there is still a peril of divergence if the controller gains are not congruously culled. Multivariable FLC is presented in. In this control technique, the nonlinearity of the system is considered to achieve low THD under nonlinear load. However, it is not facile to carryout due to the computation involutions. As a result, the aforementioned linear controllers are simple, but the performance is not copacetic under nonlinear load. In contrast, the nonlinear controllers have an outstanding performance, but the implementations not facile due to the relatively perplexed controllers.

So far, the optimal control theory has been researched in sundry gelds such as aerospace, economics, physics, and so on, since it has a computable solution called a performance index that can quantitatively evaluate the system performance by contrast with other control theories. In additament, the optimal control design gives the optimality of the controller according to a quadratic performance criterion and enables the control system to have good properties such as enough gain and phase margin, robustness to uncertainties, good tolerance of nonlinearities, etc. Hence, a linear optimal controller has not only a simple structure in comparison with other controllers but additionally a remarkable control performance kindred to other nonlinear controllers. Consequently, this paper proposes an observer-predicated optimal voltage control scheme for three-phase UPS systems. This proposed voltage controller encapsulates two main components: feedback control term and a compensating control term. The former term is designed to make the system errors converge to zero, and the latter term is applied to estimate the system uncertainties. The Lyapunov theorem is utilized to analyze testability of the system. Specially, this paper proves the closedloopstability of an observer-predicated optimal voltage control law by exhibiting that the system errors exponentially convergetozero. Moreover, the proposed control law can be systematically designed taking into consideration a tradeoff between controlinputmagnitude and tracking error unlike precedent algorithms. The efficacy of the proposed control method is varied via simulations on MATLAB/Semolina and experiments on a prototype600-VA UPS inverter tested with a TMS320LF28335DSP. In this paper, a conventional FLC method unselected to demonstrate the comparative results because it has a good performance under a nonlinear-load condition, and its circuit model of a three-phase inverter in is kindred tour system model. Conclusively, the results limpidly show that the proposed scheme has a good voltage regulation capability such as expeditious transient demeanor, diminutive steadystate error, and loathed under sundry load conditions such as load step change, unbalanced load, and nonlinear load in the subsistence of the parameter variations.

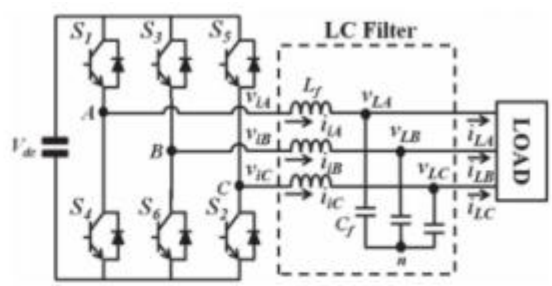


Fig:-1 Three-phase inverter with an LC alters for a UPS system

2.RELATED WORK

The main objective of static power converters is to engender an ac output waveform from a dc power supply. These are the types of waveforms required in adjustable speed drives (ASDs); uninterruptible power supplies (UPS), static vary compensators, active filters, flexible ac transmission systems (FACTS), and voltage compensators, which are only a few applications. For sinusoidal ac outputs, the magnitude, frequency, and phase should be controllable. According to the type of ac output waveform, these topologies can be considered as voltage source inverters (VSIs), where the independently controlled ac output is a voltage waveform. These structures are the most widely utilized because they naturally deport as voltage sources as required by many industrial applications, such as adjustable speed drives(ASDs), which are the most popular application of inverters; Similarly, these topologies can be found as current source inverters (CSIs), where the independently controlled ac output is a current waveform. These structures are still widely utilized in medium-voltage industrial applications, where highquality voltage waveforms are required. Static power converters, categorically inverters, are constructed from power switches and the ac output waveforms are consequently composed of discrete values This leads to the generation of waveforms that feature expeditious transitions rather than smooth ones. For instance, the ac output voltage engendered by the VSI of a standard ASD is a three-level

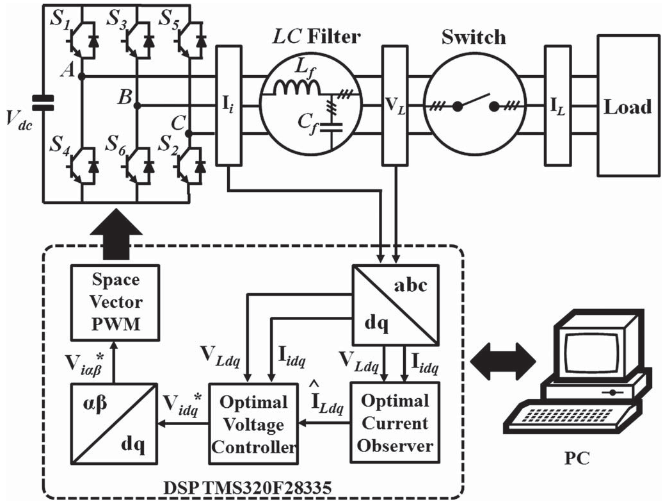


Fig:-2 Block diagram of the proposed observer-based optimal voltage controlsystem

3. IMPLEMENTATION

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 sanction current to flow back to the DC source following two alternate paths through one terminus of the primary winding and then the other. The alternation of the direction of current in the primary winding of the transformer engenders alternating current (AC) in the secondary circuit. The electromechanical version of the switching contrivance includes two stationary contacts and a spring fortified moving contact. The spring holds the movable contact against one of the stationary contacts and an electromagnet pulls the movable contact to the antithesis 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 utilized in vacuum tube automobile radios. A homogeneous mechanism has been utilized in door bells, buzzers and tattoo. As they became available with adequate power ratings, transistors and sundry other types of semiconductor switches have been incorporated into inverter circuit designs.

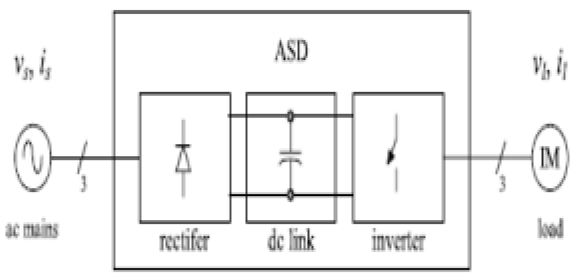


Fig:-3 Basic designs

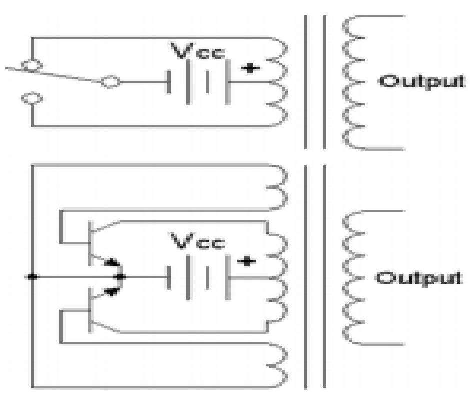


Fig:-4 Output waveforms

The switch in the simple inverter described above, when not coupled to an output transformer, engenders a square voltage waveform due to its simple off and on nature as opposed to the sinusoidal waveform that is the conventional waveform of an AC power supply. Utilizing Fourier analysis, periodic waveforms are represented as the sum of an illimitable series of sine waves. The sine wave that has the same frequency as the pristine waveform is called the fundamental component. The other sine waves, called harmonics that are included in the series have frequencies that are integral multiples of the fundamental frequency. The quality of the inverter output waveform can be expressed by utilizing the Fourier analysis data to calculate the total harmonic distortion (THD). The total harmonic distortion is the square root of the sum of the squares of the harmonic voltages divided by the fundamental voltage:

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

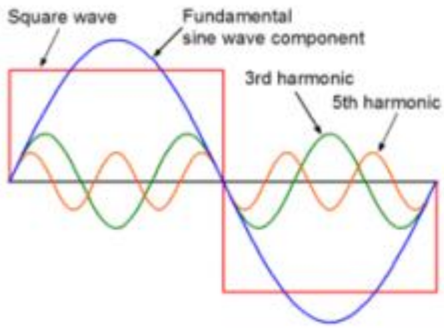
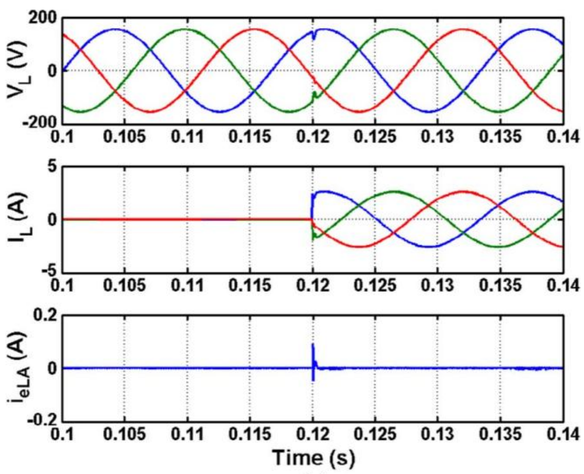
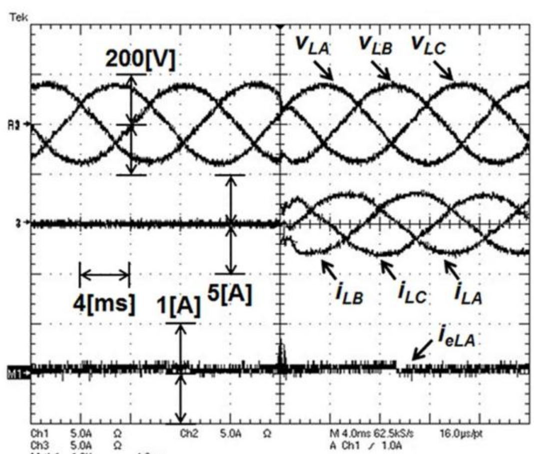


Fig:- 5 Way Forms

4. EXPERIMENTAL RESULTS



(a)



(b)

Fig:-6 Simulation diagram and Results

5. CONCLUSION

This paper has proposed a simple observer-predicated optimal voltage control method of the three-phase UPS systems The proposed controller is composed of a feedback control term to stabilize the error dynamics of the system and a compensating control term to estimate the system uncertainties. Moreover, the optimal load current observer was acclimated to optimize system cost and reliability. This paper proved the closed-loop stability of an observer-predicated optimal voltage controller by utilizing theLyapunov theory. Furthermore, the proposed voltage control law can be methodically designed taking into account a tradeoff between control input magnitudes and tracking error unlike antecedent algorithms. The superior performance of the proposed control system was demonstrated through simulations and experiments. Under three load conditions (load step change, unbalanced load, and nonlinear load), the proposed control scheme revealed a better voltage tracking performance such as lower THD, more minuscule steady-state error, and more expeditious transientresponse than the conventional FLC scheme even if there subsist parameter variations.

REFERENCES

[1] A. Nasiri, "Digital control of three-phase series-parallel uninterruptible power supply systems," IEEE Trans. Power Electron., vol. 22, no. 4, pp. 1116–1127, Jul. 2007.

[2] Y. H. Chen and P. T. Cheng, "An inrush current mitigation technique for the line-interactive uninterruptible power supply systems," IEEE Trans. Ind. Appl., vol. 46, no. 4, pp. 1498–1508, May/Jun. 2010.

[3] K. S. Low and R.Cao, "Model predictive control of parallel-connected inverters for uninterruptible power supplies," IEEE Trans. Ind. Electron., vol. 55, no. 8, pp. 2884–2893, Aug. 2008.

[4] A. Mokhtarpour, H. A. Shayanfar, M. Bathaee, and M. R. Banaei, "Control ofa single phase unified power quality conditioner-distributed generation based input output feedback linearization," J. Elect. Eng. Technol., vol. 8, no. 6, pp. 1352–1364, Nov. 2013.

[5] J. H. Lee, H. G. Jeong, and K. B. Lee, "Performance improvement of grid connected inverter systems under unbalanced and distorted grid voltage by using a PR controller," J. Elect. Eng. Technol., vol. 7, no. 6, pp. 918–925, Nov. 2012.

[6] H. K. Kang, C. H. Yoo, I. Y. Chung, D. J. Won, and S. I. Moon, "Intelligent coordination method of multiple distributed resources for harmonic current compensation in a microgrid," J. Elect. Eng. Technol., vol. 7, no. 6, pp. 834– 844, Nov. 2012.

[7] C. Salim, B. M. Toufik, and G. Amar, "Harmonic current compensation based on three-phase three-level shunt active filter using fuzzy logic current controller," J. Elect. Eng. Technol., vol. 6, no. 5, pp. 595–604, Sep. 2011.

[8] U. Borup, P. N. Enjeti, and F. Blaabjerg, "A new space-vector-based control method for UPS systems powering nonlinear and unbalanced loads," IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1864–1870, Nov./Dec. 2001.

[9] H. Karimi, A. Yazdani, and R. Iravani, "Robust control of an autonomous four-wire electronically-coupled distributed generation unit," IEEE Trans. Power Del., vol. 26, no. 1, pp. 455–466, Jan. 2011.

[10] T. S. Lee, S. J. Chiang, and J. M. Chang, " H∞ loop-shaping controller designs for the single-phase UPS inverters," IEEE Trans. Power Electron., vol. 16, no. 4, pp. 473–481, Jul. 2001.