ISSN 2348 – 8034
Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

REVIEW LITERATURE OF PERFORMANCE ANALYSIS OF A FOUR-SWITCH THREE-PHASE INVERTER FED INDUCTION MOTOR DRIVE

Sweta Kumari*[1]& Ashish Bhargava[2]
*[1]Department of Electrical Engineering, Bhabha Engineering and Research Institute, Bhopal
[2]Department of Electrical Engineering, Bhabha Engineering and Research Institute, Bhopal

ABSTRACT

This paper presents an extensive review of the performance analysis, design, testing and other aspects of a Four-Switch Three-Phase Inverter Fed Induction Motor Drive. The assumptions made and a brief description of the solution methods is presented. This paper describes step by step development in the area of switches used in Three-Phase Inverter fed IM Drives which provides helpful information and resources for the future studies for those interested in the problem or intending to do additional research in the area of IM Drive.

Keywords- *Four-Switch Three-Phase, Inverter Fed, Induction Motor*

1. INTRODUCTION

Over the years induction motor (IM) has been utilized as **a** workhorse in the industry due to its easy build, high robustness, and generally satisfactory efficiency. With the invent of high speed power semiconductor devices three-phase inverters play the key role for variable speed ac motor drives. Traditionally, 6-switch, 3-phase (6S3P) inverters have been widely utilized for variable speed IM drives. This involves the losses of the six switches as well as the complexity of the control algorithms and interface circuits to generate six PWM logic signals. In the past, researchers mainly concentrated on the development of the efficient control algorithms for high performance variable speed IM drives**.** However, the cost, simplicity and flexibility of the overall drive system which become some of the most important factors did not get that much attention to the researchers. That's is why, despite tremendous research in this area most of the developed control system failed to attract the industry. Thus, the main issue of this paper is to develop a cost effective, simple and efficient high performance IM drive. Most of the reported works on 4S3P inverter for machine drives did not consider the closed loop vector control scheme, which is essential for high performance drives. Usually, high performance motor drives used in robotics, rolling mills, machine tools, etc. require fast and accurate response, quick recovery of speed from any disturbances and insensitivity to parameter variations. The dynamic behavior of an ac motor can be significantly improved using vector control theory where motor variables are transformed into an orthogonal set of d-q axes such that speed and torque can be controlled separately**.** This gives the IM machine the highly desirable dynamic performance capabilities of a separately excited dc machine, while retaining the general advantages of the ac over dc motors. Various switching techniques are used such as six switch, four switch, eight switch for three phase inverter fed Induction Motor Drives. Various methodologies such as space vector techniques, Digital Signal Processing, Pulse Width Modulation are implemented.

The main aim is to achieve a cost efficient, simple, robust set up to solve the purpose of getting efficient output of an Induction Motor

2. REVIEW OF LITRATURE

This paper gives general backgrounds of research and development in the field of deign, modeling, testing and performance analysis in of Inverter Fed Induction Motor based on various published articles. The following open literature presents the summary and application of each method for several aspects of IM Drive. The related assumptions made, strengths and weaknesses of each solution methods are
highlighted.

In 2004, M. Nasir Uddin and M .A. Rahman investigated the performance of a 4-switch, 3-phase inverter (4S3P) fed cost effective induction motor drive system for high performance industrial drive systems. In their proposed approach, instead of a conventional 6-switch, 3- phase inverter (6S3P) a 4-switch, 3-phase inverter was utilized. This reduced the cost of the inverter, the switching losses, and thecomplexity of the control algorithms and interface circuits to generate ***6*** PWM logic signals. Furthermore, the proposed control approach reduced the computation for real-time implementation. The complete vector control scheme for the IM drive fed from the proposed 4S3P inverter is implemented in real-time using digital signal processor (DSP) TI TMS320C31 for a prototype 1 hp motor. Theoretical and experimental results of the proposed drive verified the robustness of the drive. A performance comparison of the proposed 4S3P inverter fed drive with a conventional 6S3P inverter fed drive was also made in terms of speed response and total harmonic distortion of the stator current. The proposed inverter fed IM drive was found

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In December 2007, K. Srinivasan and S.S. Dash did their research work in performance analysis and MATLAB simulation of A fuzzy logic controller based cost effective drive system of a induction motor for high performance industrial drive systems was presented . In the paper the FLC was used as a speed controller and the motor was fed from a four-switch three-phase (4S3Ph) pulse width-modulation (PWM) inverter instead of a conventional six-switch three-phase (6S3Ph) inverter. That reduced the cost of the inverter, the switching losses, and the complexity of the control algorithms and interface circuits to generate six PWM logic signals. Furthermore, the proposed control approach reduced the computation for real-time implementation. The robustness of the proposed FLC-based 4S3Ph-inverter-fed IM drive was verified theoretically. A comparison of the proposed 4S3Ph-inverter-fed IM drive with a conventional 6S3Ph inverter system was also made in terms of performance and harmonic analysis of the stator current

In 2011, Tang Aihong, Guo Fang, Liu Furong, Chen Yuepeng and Jiang Desheng, in there paper stated the voltage regulating principle of the STATCOM and analyzed the switch characteristics of the voltage source converter controlled by the SPWM, then deduced the duty ratio of each switches based on the switching function. Then, introduced the switching system concept in the modeling of the STATCOM, the mathematical model of STATCOM, which included four sub-system in one switching period, each one corresponding to the specified switching duty ratio, each duty ratio corresponds with the concept of switching function, was deduced. The model described the physics concept of the STATCOM in detail and deliverd the static and dynamic characteristics exactly.

In 2012, Shun Saito, Haruki Tanaka, Akitoshi Nakajima proposed the system for independent drive of three-phase Induction Motor (IM) and Permanent Magnet Synchronous Motor (PMSM) fed by a four-leg inverter (4LI) with vector control method. The 4LI is a single inverter that could drive two AC motors independently. The proposed system could drive IM and PMSM independently, 4LI enlarged the range of its use. The inverter consisted of four legs and two capacitors connected in each leg, respectively, whereas the W phase of both motors was connected in the neutral point of two-sprit capacitors. The neutral point voltage was needed to maintain half magnitude of DC-bus voltage for stable driving two ac motors. So the compensation method restraining the drift phenomenon was shown. It confirmed that the proposed system with vector control method and compensation method for drift phenomenon could drive IM and PMSM

In July 2013, Bassem El Badsi, Badii Bouzidi, and Ahmed Masmoudi proposed a novel direct torque control (DTC) strategy for induction motor (IM) drives fed by a four switch three-phase inverter (FSTPI). The introduced strategy was based on the emulation of the operation of the conventional six switch three-phase inverter (SSTPI). That was achieved with the help of suitable combination of the four unbalanced voltage vectors intrinsically generated by the FSTPI, leading to the synthesis of the six balanced voltage vectors of the SSTPI. This approach was adopted in the design of the vector selection table of the proposed DTC strategy which considered a subdivision of the *Clarke* plane into six sectors. the proposed DTC strategy, FSTPI-fed IM drives exhibit interesting

In 2014, Upama Bosel, K. Divyal, Vallathur Jyothil, Sreejith.S studied the performance evaluation of an induction motor fed from a four-switch three-phase inverter. In their research, instead of using six-switch three-phase inverter (SSTPI), a four-switch three-phase inverter (FSTPI) was used. This reduced the cost of the inverter, the switching losses, the complexity of the control algorithms and the interface circuits to generate six PWM logic signals. Both PWM and SPWM techniques were implemented for switching. The performance of the motor and the Total Harmonic Distortion (THD) were compared in both of the techniques. Eventually a comparison between the performance of induction motor fed from three phase six-switch based inverter and three phase four-switch based inverter was carried out.

In 2016, Imen Nouira El Badsi, Bassem El Badsi and Ahmed Masmoudi investigated two space vector pulse width modulation (SVM) techniques dedicated to the control of an open-loop induction motor (IM) drives fed by a three-switch three-phase inverter (TSTPI), also known as delta- or B3-voltage source inverter (B3-VSI). The B3-VSI performs a DC to three-phase AC conversion by employing only three power switch devices rather than six ones as in the classical six-switch three-phase inverter (B6-VSI). The reduction of the number of switch devices involved a potential increase in reliability and lifetime of the power conversion system. Though the B3-VSI generated only three active voltage vectors and one zero voltage vector, which made the development of various relevant SVM techniques a complicated task. The two proposed SVM methods allowed the application of three voltage vectors for each switching period considering different vector switching sequences.
In 2016, Qidi Tang, Xinglai Ge1, Yong-Chao Liu, compared two different space-vector modulation (SVM) methods which could be named SVM-1 dividing the two-phase stationary coordinate plane into eight sectors and SVM-2 dividing the two-phase stationary coordinate plane into six sectors for eight-switch three-phase inverters (ESTPIs), which are the post-fault reconfigured topologies for the three-level neutral-point-clamped (3L-NPC) inverter with failure of a power switch or a leg were introduced. This two different SVM-based field-oriented control (FOC) schemes

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Impact Factor- 4.022

for the ESTPI-fed induction motor drive system were also presented. The performance of this two different FOC schemes were subsequently analyzed based on the dynamic response, the ripple of the torque and the offset and fluctuation of the DC-link two capacitor voltage.

In 2016, Mohamed S. Zaky and Mohamed K. Metwaly presentd a speed controller using a fuzzy-logic controller (FLC) for indirect field oriented control (IFOC) of induction motor (IM) drives fed by a four-switch three-phase (FSTP) inverter. In their proposed approach, the IM drive system was fed by FSTP inverter instead of the traditional six-switch three-phase (SSTP) inverter for a cost-effective low power applications. The proposed FLC improved dynamic responses and, it was also designed with reduced computation burden. The complete IFOC scheme incorporating the FLC for IM drives fed by the proposed FSTP inverter was built in Matlab/Simulink and, it was also experimentally implemented in real-time. The dynamic performance, robustness, and insensitivity of the proposed FLC with FSTP inverter fed IM drive was examined and compared to a traditional PI controller under speed tracking, load disturbances, and parameters variation, particularly at low speeds. It was found that the proposed FLC was more robust than the PI controller under load disturbances, and parameters variation. And also the proposed FSTP IM drive was comparable with a traditional SSTP IM drive, considering its good dynamic performance, cost reduction and low THD.

3. DISCUSSION

This paper presents the extensive review of the work and the progress in the area of switching such as six, four, eight switch used in Inverter fed Induction Motor Drive and also various techniques used such as Space Vector Technique, Digital Signal Processing, Pulse Width Modulation, PI Controller and also Fuzzy logic. The THD is reduced to 63.24% by using PWM and SPWM in FSTP system. Using Fuzzy Logic t he Total harmonic distortion (THD) is found 4.49% where as the THD for traditional six switch three phase inverter is found 24.69%

4. CONCLUSION

This paper presents an overview and key issues of different research studies in the area of switching such as six, four, eight switch used in Inverter fed Induction Motor Drive. It is clear, from the existing literature, that there are different solution methods for switching techniques for Inverter fed Induction Motor Drive. This paper describes step by step development in the area of switching techinques which provides relevant guidelines and references for the researchers intending to do additional study in the area of Inverter fed Induction Motor Drive.

REFERENCES

1) *'Suraj R.Karpe and P.S.Phutane, "Perfonnance of a 4-switch, 3-phase inverter fed induction motor drive system", UAREEI , vol. 2,Issue 3, March 2013.*
2) *Jaehong Kim, Kwanghee Nam and Jinseok Hong, and, "A Current Distortion Compensation Scheme for Four-Switch Inverters, " IEEE Trans.*
Power Electronics, vol. 24, no. 4, pp. 1032- 1040, April 2009.
3) *C. W. Liu, C. T. Lin, and C. W. Hung, "Position sensorless control for four-switch three-phase brushless DC motor drives," IEEE Tran. Power Electro*
4) *M. Nasir Uddin, Zhi Rui Huang, and A. B. M. Siddique Hossain, "Development and Implementation of a Simplified Self-Tuned Neuro–Fuzzy-Based IM Drive, " IEEE Transactions on Industry Applications, Vol. 50, No. 1, pp. 51-59, January/February 2014 nics, vol. 23, no. I, pp. 438-444, Jan. 2008.*
5) *Elbadsi, B., Guermazi, A. and Masmoudi, A. (2005), "New space vector PWM strategy intended for a low-cost four-switch three-phase inverter-fed induction motor drive", paper presented at CD-ROM of the Third IEEE International Conference on Systems, Signals and Devices, Sousse*
6) *"Performance Analysis of Two Different SVM-Based Field-Oriented Control Schemes for Eight-Switch Three-Phase Inverter-fed Induction Motor Drives" by Qidi Tang1,2, Xinglai Ge1, Member, IEEE,*
Yong-Chao Liu1,2, Student Member, IEEE in 2016 IEEE 8th International Power Electronics and Motion Control Conference (IPEMC-ECCE Asia)
7) *B. -R. Lin, and T. -C. Wei, "Space vector modulation strategy for an eight-switch three-phase NPC converter," IEEE Transactions on Aerospace and Electronic Systems, vol. 40, no. 2, pp. 553–566, April 2004.*
8) *M. B. R. Correa, C. B. Jacobina, E. R. C. da Silva, and A. M. N. Lima, "A general PWM strategy for four-switch three-phase inverters," IEEE Trans. Power Electron., vol. 21, no. 6, pp. 1618–1627, Nov 2006*