IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 11, Issue 6, June 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.18

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

Solar Fed Sensorless BLDC Motor Drive for Water Pumping Application

R.Preethi[1] , V.Divya[2], T.Abinaya[3]

UG Student, Dept. of EEE, Krishnasamy College of Engineering & Technology, Cuddalore, Tamilnadu, India[1,2,3]

ABSTRACT: This paper proposes the exact time of commutation and detects the position of rotor angle easily from the Sensorless Brushless Direct Motor (BLDC) suitable for water pumping applications using a PV panel. Brushless direct current motors (BLDC) are prominent due to their high efficiency and less maintenance. However, BLDC motor applications are limited due to the requirement of a complex controller, the existence of torque ripple, and high cost. Sensorless brushless DC (BLDC) motor control is one of today's industry's requirements. The quality of this control is strongly dependent on the exact identification of the rotor angle for switching. In this study, a new sensorless BLDC motor control is introduced that could determine the exact time of the commutation. The effectiveness of the proposed motor can be verified using MATLAB/SIMULINK.

KEYWORDS: Converter, Inverter, Photovoltaic.

I.INTRODUCTION

Power is one of the most critical components for the economic growth and welfare of nations. Electricity demand in the country has increased rapidly and is expected to rise further in the years to come. In order to meet the increasing demand for electricity in the country, massive addition to the installed generating capacity is required. PV energy source is most efficient alternate energy source for solar pumping system. Permanent magnet brushless DC (BLDC) motor drive has more benefits over traditional brushed motor drives for PV pumping applications. In this work, Sensorless BLDC motor drive for solar pump applications is carried out.

Brushless DC (BLDC) motors are preferred as small horsepower control motors due to their high efficiency, silent operation, compact form, reliability, and low maintenance. However, the problems are encountered in these motors for variable speed operation over the last decades continuing technology development in power semiconductors, microprocessors, adjustable speed drivers control schemes and permanent-magnet brushless electric motor production have been combined to enable reliable, cost-effective solutions for a broad range of adjustable speed applications.

Household appliances are expected to be one of the fastest-growing end-product markets for electronic motor drivers over the next five years. The major appliances include clothes washers room air conditioners, refrigerators, vacuum cleaners, freezers, etc. The household appliance has traditionally relied on historical classic electric motor technologies such as single-phase AC induction, including split-phase, capacitor-start, capacitor–run types, and universal motor. These classic motors typically are operated at constant speed directly from the main AC power without regarding the efficiency. Consumers now demand lower energy costs, better performance, reduced acoustic noise, and more convenient features. Those traditional technologies cannot provide the solutions.

BLDC motor drives, systems in which a permanent magnet excited synchronous motor is fed with a variable frequency inverter controlled by a shaft position sensor. There appears a lack of commercial simulation packages for the design of controller for such BLDC motor drives. One main reason has been that the high software development cost incurred is not justified for their typical low cost fractional/integral kW application areas such as NC machine tools and robot drives, even it could imply the possibility of demagnetizing the rotor magnets during commissioning or tuning stages.

Nevertheless, recursive prototyping of both the motor and inverter may be involved in novel drive configurations for advance and specialized applications, resulting in high developmental cost of the drive system. Improved magnet material with high (B.H), product also helps push the BLDC motors market to tens of kW application areas where commissioning errors become prohibitively costly. A brushless dc motor is a dc motor turned inside out, so that the field is on the rotor and the armature is on the stator. The brushless dc motor is actually a permanent magnet ac motor whose torque-current characteristics mimic the dc motor. Instead of commutating the armature current using brushes, electronic commutation is used.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

II.LITERATURE SURVEY RELATED TO SENSORLESS BLDC MOTOR

- Dubey (2020) preferred a single-stage Sliding Mode Control-based solar PV power-driven position sensor-less control of PMBLDCM coupled with a variable-speed compressor unit of a refrigeration system. As a result, It provides cost-effective variable-speed compressor with longer service life and less maintenance needs for the cooling system. Reduced switching loss due to less device count and eliminates use of additional filter inductor and capacitor, therefore improves the conversion efficiency.

- Rajesh Kuttappan Achary (2019) presented a simple dc-link voltage modulation scheme to minimize the commutation torque ripple in a Permanent Magnet Brushless DC Motor (PMBLDCM). It provides a significant diminution in torque ripple and a smooth and noise free operation of the PMBLDC machine. PWM control of inverter at low speed range and PWM control along with dc-link voltage modulation at high speed range (proposed scheme) ensure a low torque ripple.

- K.Vanchinathan (2018) surveyed a novel method for Bat Algorithm (BA) based on optimal tuning of Fractional-Order Proportional Integral Derivative (FOPID) controller. It is found that Reduces the feedback required to implement the proposed control method, High accuracy in detecting the parameters and less sensitivity to noise, Reduction of torque ripple due to commutation operations and the commutation time in this method is specified more accurately in the fixed and variable modes.

- Wei Chen (2016) presented a output modes (buck-boost mode and boost mode) of the Cuk converter during commutation period and normal conduction period are altered by designing a mode selection circuit, which can reduce commutation torque ripple over the entire speed range. It reduces the commutation torque ripple effectively and utilization of the Cuk converter is enhanced.

- Bhim Singh (2009) preferred a state of the art of Permanent magnet Brushless DC motor (PMBLDC) drives with an emphasis on sensorless control. As a result, It provides a clear perspective on various aspects such as classification, construction, controllers, sensorless position control and Applications of BLDC motor.

III. PROPOSED SENSORLESS BLDC MOTOR DRIVE

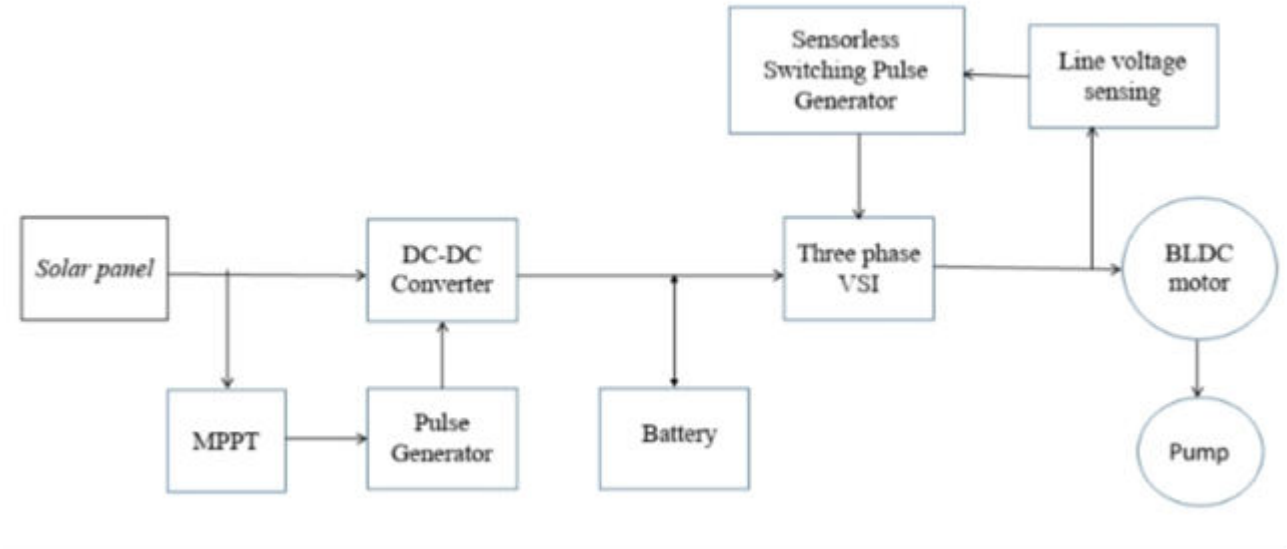


Fig. 1 Block diagram of the proposed Sensorless BLDC Motor Drive

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

Fig.1 shows the proposed system consists of solar panel, MPPT board, PWM generation board, three phase VSI and BLDC motor. The DC input source from the solar panel is given to the DC-DC converter through the MPPT based pulse generator and it maximize the voltage. This maximum DC voltage is given to the three phase VSI by DC-DC converter. The three phase VSI converts a DC input into the three phase output voltage. Its three arms are normally delayed by an angle 4r53e87of 120 degree, so as to generate three phase AC supply and it also stored in a battery for using night time purpose. This AC supply is given to the BLDC motor and the motor runs which is coupled to the pump.

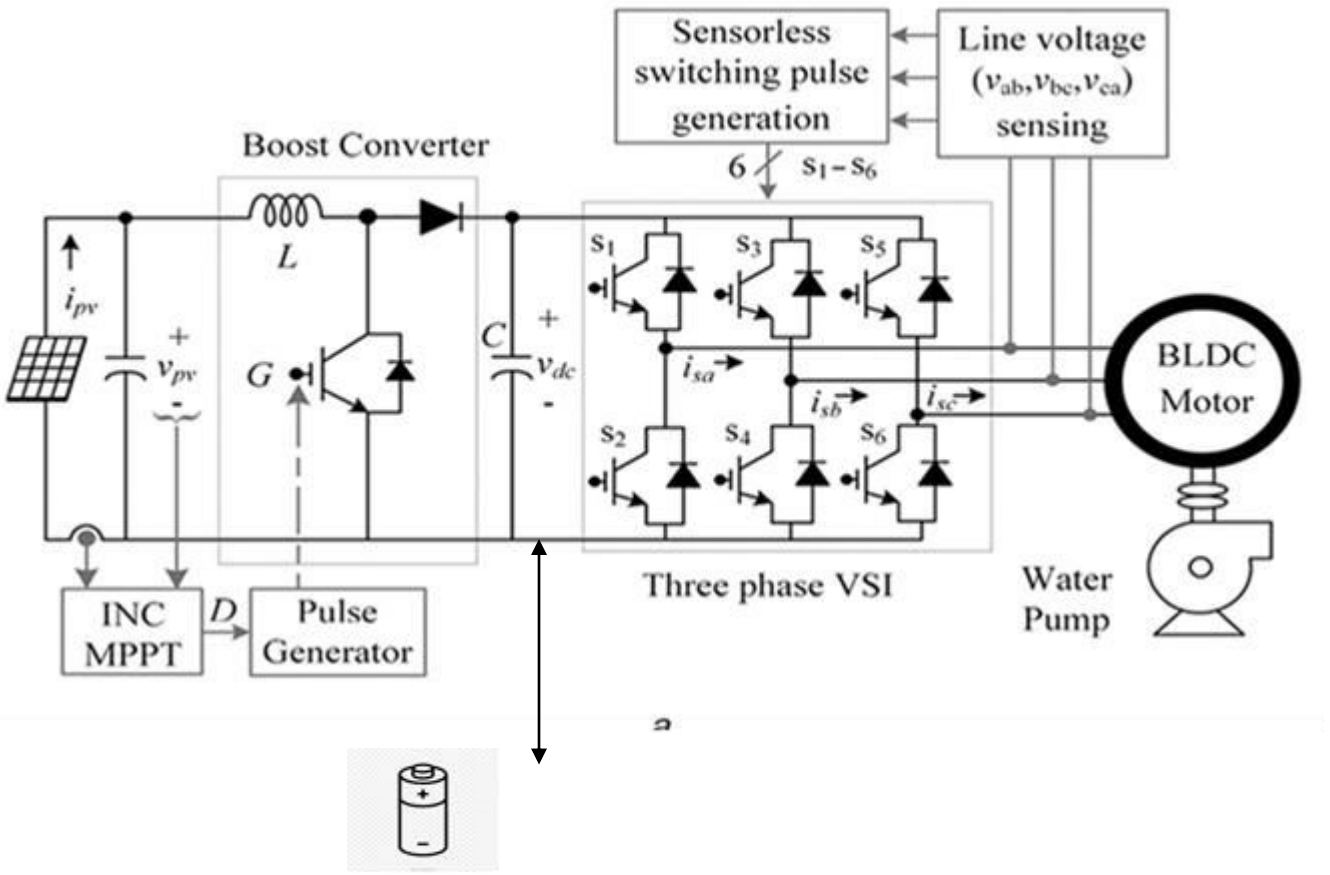


Fig.2 Equivalent circuit of Sensorless BLDC Motor Drive

Fig.2 shows the circuit diagram of design of Solar fed sensorless brushless dc motor drive for water pumping application. The components used are solar panel, MPPT board, PWM generation board, three phase VSI and BLDC motor works as a main function. The DC input source from the solar panel is given to the DC-DC converter through the MPPT based pulse generator and it maximize the voltage. This maximum DC voltage is given to the three phase VSI by DC-DC converter. The three phase VSI converts a DC input into the three phase output voltage. Its three arms are normally delayed by an angle of 120 degree, so as to generate three phase AC supply because this inverter consists of six inverter switches each has a ratio of 50% and switching occurs after every T/6 of the time T in a inverval of a angle 60 degree and the AC output is stored in a battery for using night time purpose. This AC supply is given to the BLDC motor. The inverter produce a trapezoidal waveform because sensing existing winding is carried out which is connected to the BLDC motor and the motor runs which is used to be pumping.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

IV. SIMULATION RESULTS OF PROPOSED SYSTEM

1. PERFORMANCE WITH PI CONTROLLER

The simulation of speed control characteristics PI speed control is based on the system configuration.The inverter output terminal voltages are generated according to the PWM switching algorithm.

The simulation result for speed reference input of 700 rpm with a load torque of 0.7 N-m are shown Fig 3. The controller gains are KP =0.8, KI = 0.02 and current controller bandwidth is 0.3A.The rotor is standstill at time zero with onset of the speed reference, the speed error, torque reference, and attains maximum value. The current is made to follow the reference by the current controller. Therefore electromagnetic follows the reference value.

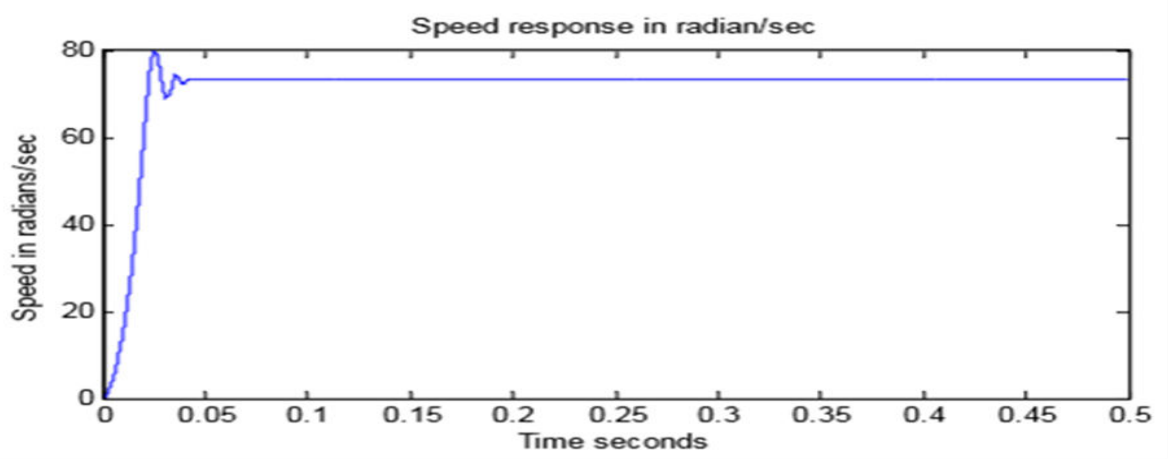


Fig.3 Speed response radians /seconds versus time

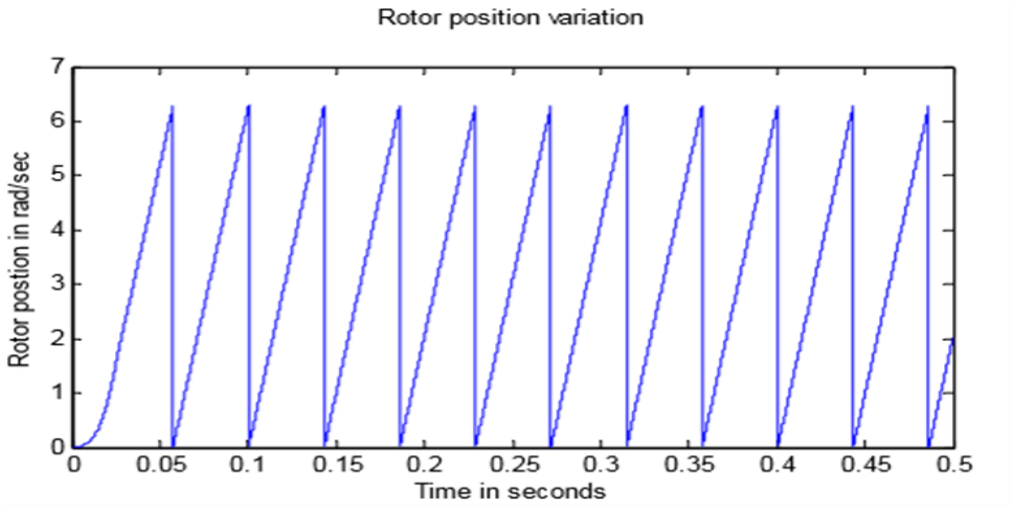


Fig.4 Rotor position in radians

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

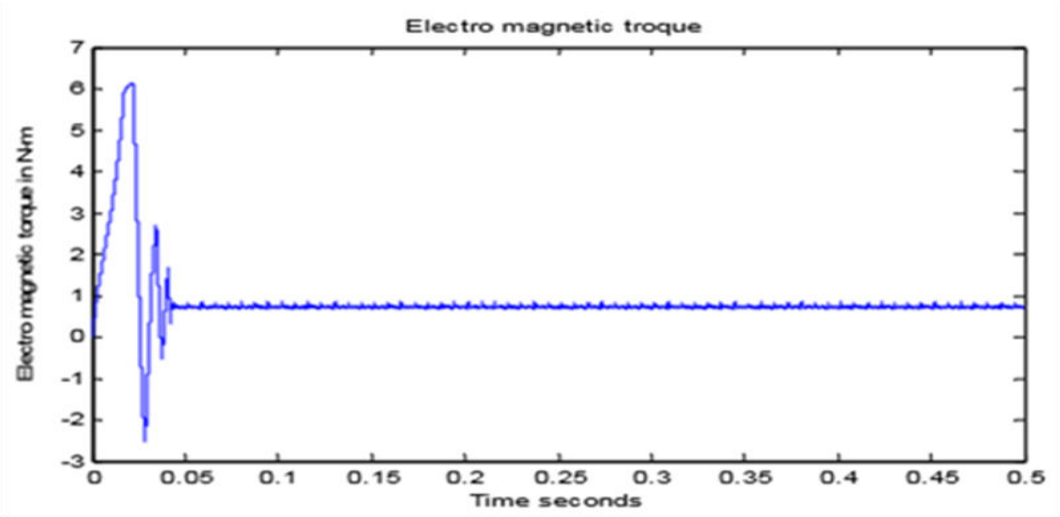
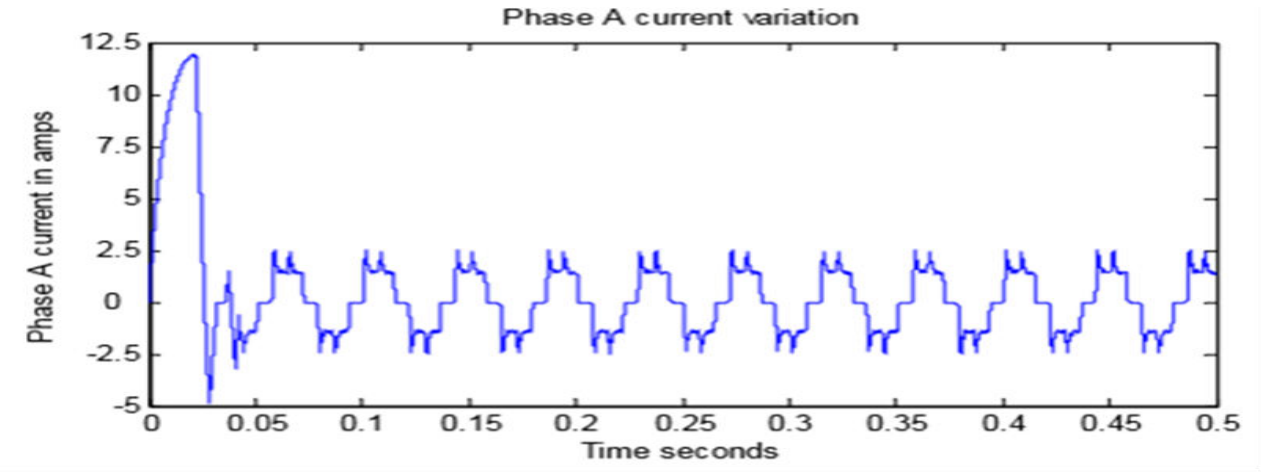


Fig.5 Electromagnetic torque developed in N-m



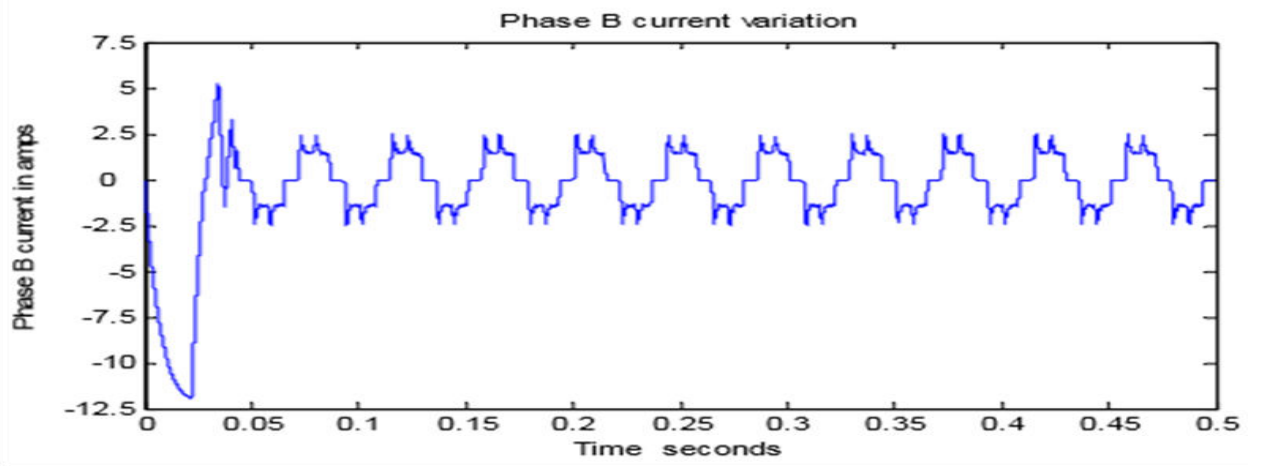


Fig.6 Phase currents variation of motor

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

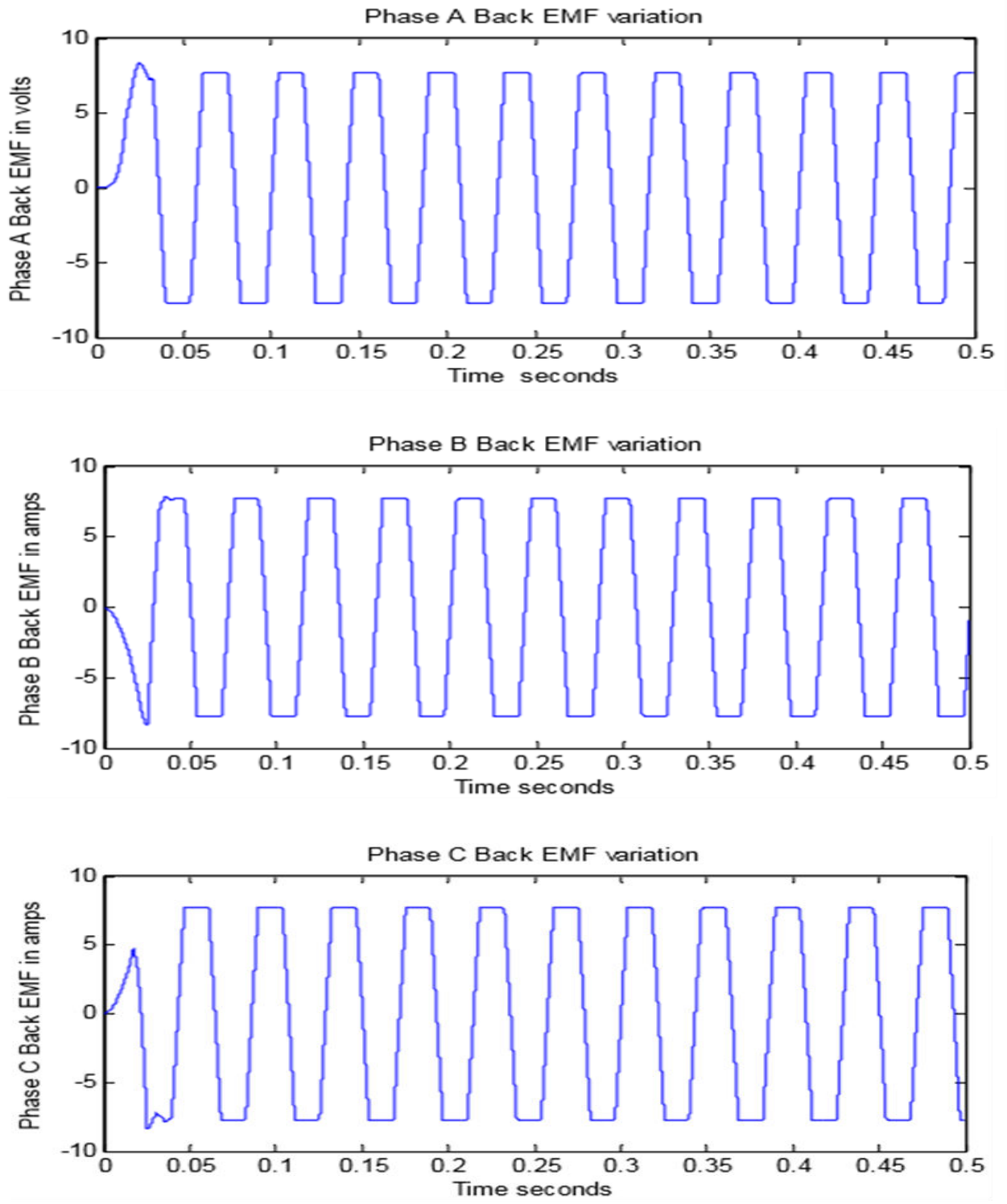


Fig.7 Back EMF of phase variations

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

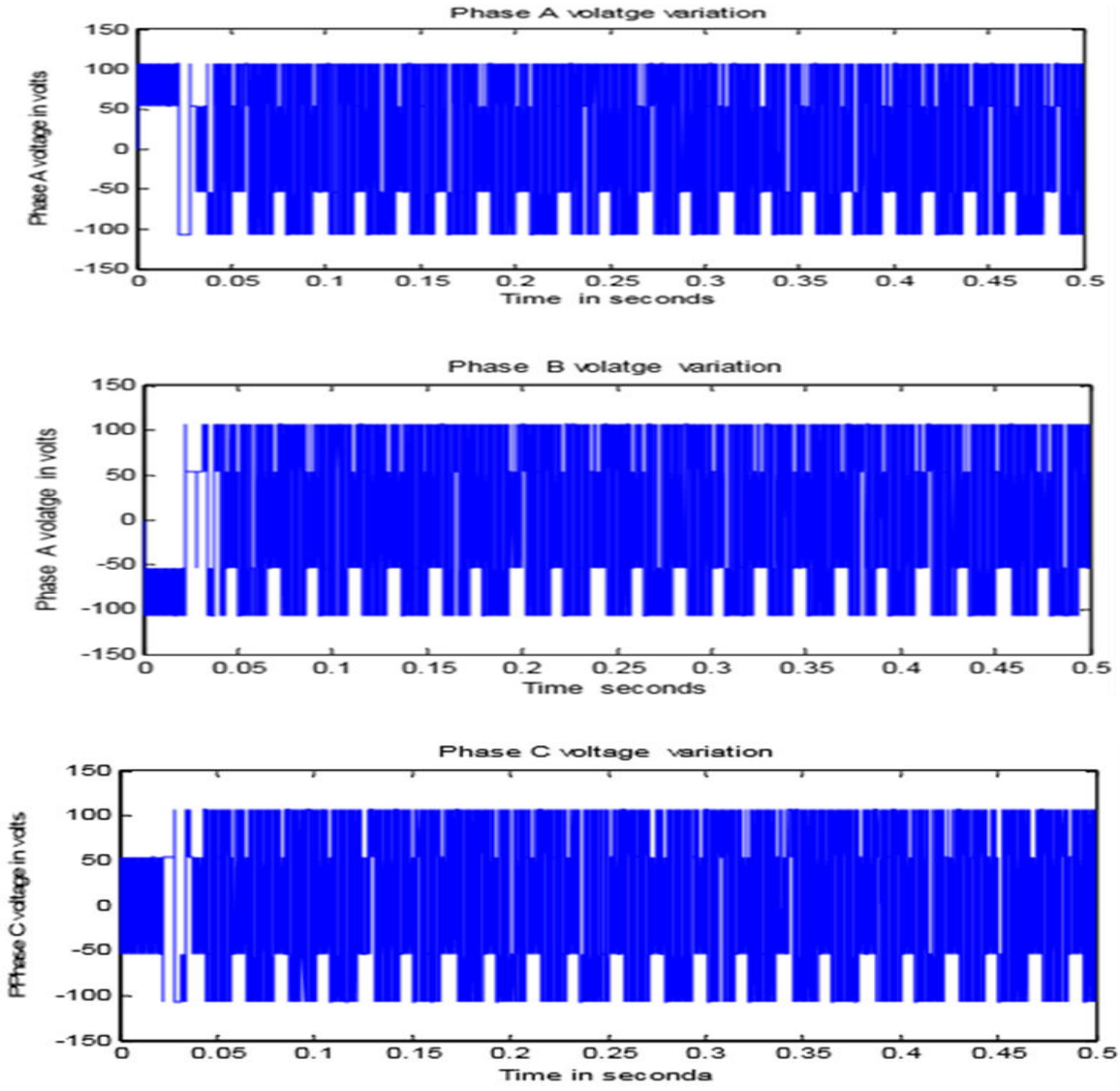


Fig.8 Phase voltages variation of motor

2. PERFORMANCE WITH FLC

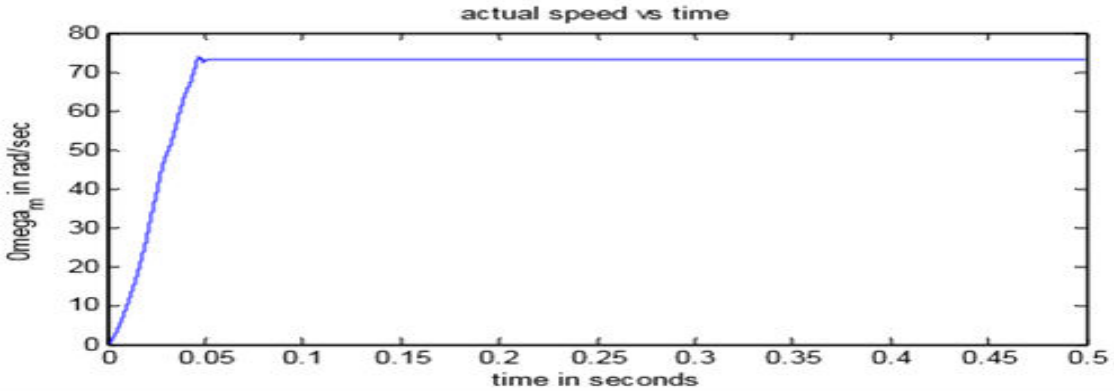


Fig.9 Speed response radians /seconds versus time

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 6, June 2022||

|DOI:10.15662/IJAREEIE.2022.1106013 |

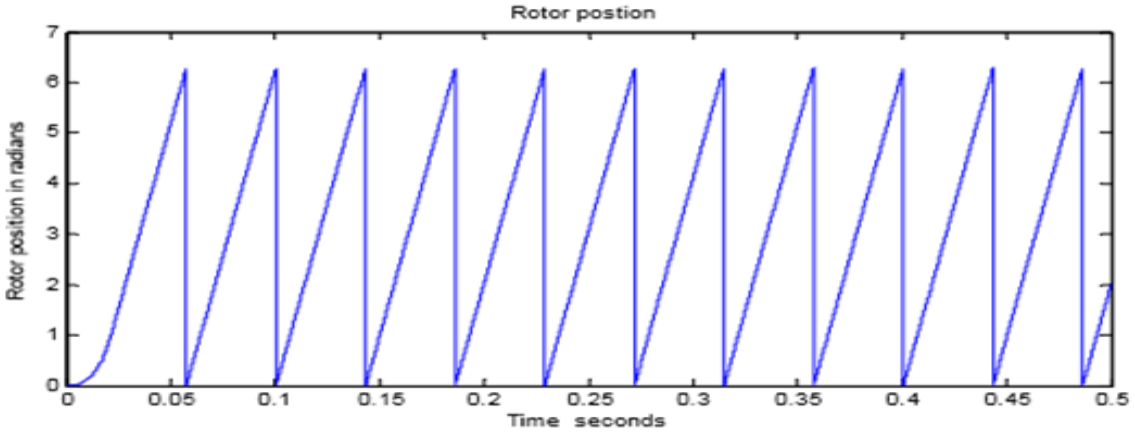


Fig.10 Rotor position in radians versus time

V. CONCLUSION

This paper is a simple design of sensorless brushless DC motor where PV cell and PWM inverter are serves the main functions for solar pumping applications. The modelling and simulation of the complete drive system is described in this thesis. Effectiveness of the model is established by performance prediction over a wide range of operating condition. A performance comparison between the sensor and sensorless operation for BLDC motor has been carried out by simulation and evaluate the performance of solar PV fed sensorless BLDC motor for water pumping applications. The simulation results validates that the BLDC has a exact time of commutation and without using the sensor its detect the position of the rotor angle for switching.

REFERENCES

[1] Shikai Sun,Hu Guo,Yimeng Zhang,Yupeng Jia,Hongliang Lv,Qingwen Song,Xiaoyan Tang, Yuming Zhang "Novel modulation method for torque ripple suppression of brushless DC motors based on SIMO DC–DC converter", Journal of Power Electronics, Springer,2020.

[2] Parag Karekar, C. Shrutika, B. B. Pimple "Torque Ripple Minimization of BLDC motor Drive using DC Link Current Control with Low Pass Compensator", IEEE, 2020.

[3] Zicheng Li , Qingyao Kong, Shanmei Cheng, Jiang Liu "Torque ripple suppression of brushless DC motor drives using an alternating two-phase and three-phase conduction mode", IET Power Electronic,2020.

[4] S.-H. Kim, "Brushless direct current motors", Electr. Mot. Control, no. Dc, pp. 389–416, 2017, doi: 10.1016/b978-0-12-8121382.00010-6.

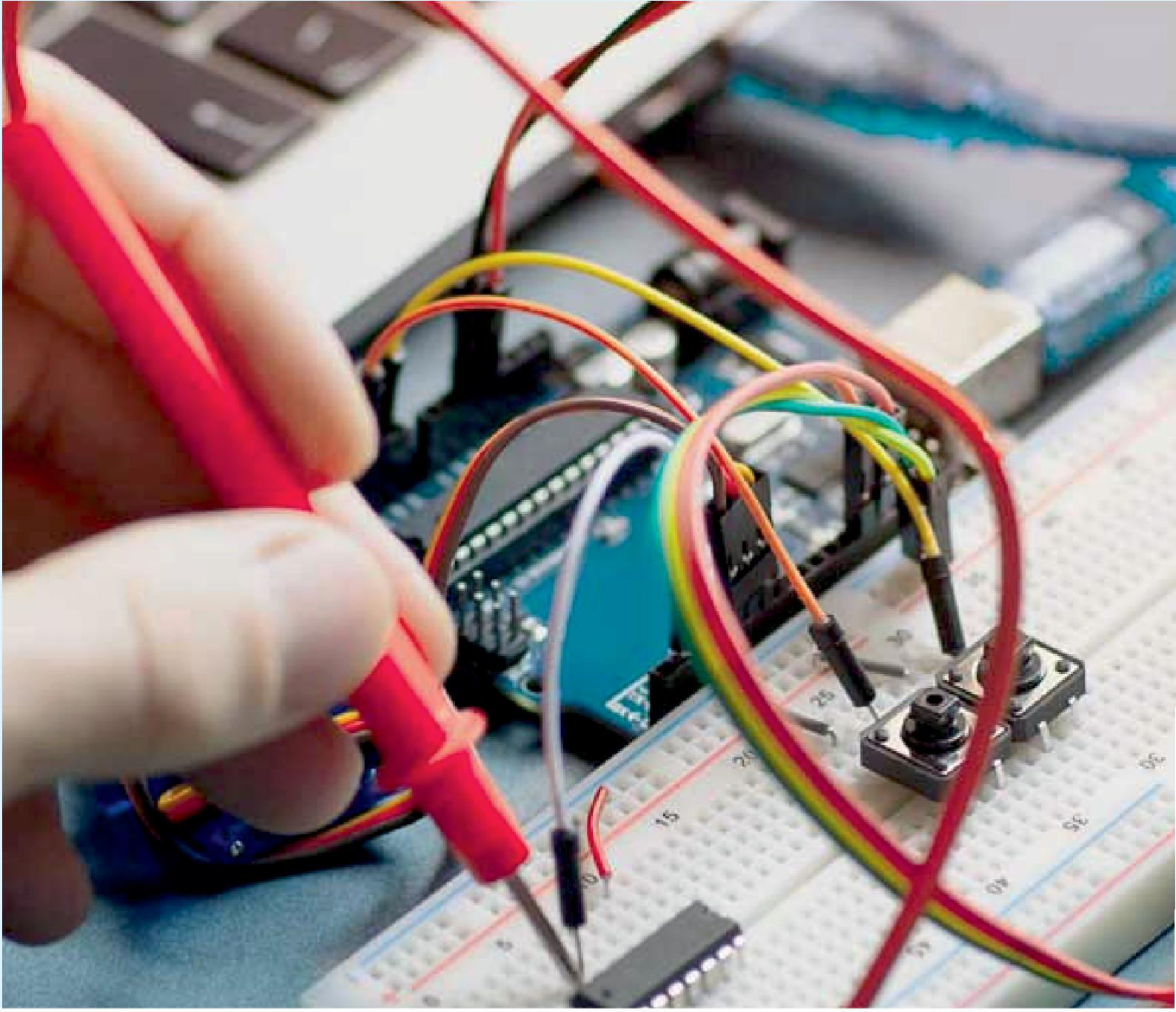
[5] B. Singh and S. Singh, "State of the art on permanent magnet brushless DC motor drives", J. Power Electron., vol. 9, no. 1, pp. 1–17, 2009, doi: 10.6113/JPE.2009.9.1.1.

[6] K. Y. Cheng and Y. Y. Tzou, "Design of a Sensorless Commutation IC for BLDC Motors", IEEE Trans. Power Electron., vol. 18, no. 6, pp. 1365–1375, 2003, doi: 10.1109/TPEL.2003.818867.

[7] B. H. Kang, C. J. Kim, H. S. Mok, and G. H. Choe, "Analysis of torque ripple in BLDC motor with commutation time", IEEE Int. Symp. Ind. Electron., vol. 2, no. 1, pp. 1044–1048, 2001, doi: 10.1109/isie.2001.931619.

[8] Chen, W., Liu, Y., Li, X., et al.: "A novel method of reducing commutation torque ripple for brushless DC motor based on Cuk converter", IEEE Trans. Power Electron, 2017, 32, (7), pp. 5497–5508.

[9] Lee, H.J., Chung, S.U., Hwang, S.M.: "Noise source identification of a BLDC motor", J. Mech. Sci. Technol., 2008, 22, pp. 708–713.



INNO SPACE
SJIF Scientific Journal Impact Factor

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

Impact Factor: 8.18

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com

www.ijareeie.com

Scan to save the contact details