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Three Phase Inverter Using SVPWM Technique for Solar Electric Vehicle

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ABSTRACT: Solar electric vehicles are deliberated as the future vehicles to solve the issues of air pollution, global warming, and the fast reductions of the petroleum resources facing the current transportation technology. However, SEV are still tackling important technical problems to overcome. They include batteries energy storage capacity, charging times, effectiveness of the solar panels and electrical propulsion systems. In the present work, we propose an electrical propulsion system initiated on three phase IM so as to attain the desired speed and torque with less power loss. The induction motor is served from three phase inverter functioned by a constant V/F control method and Space Vector Pulse Width Modulation (SVPWM) algorithm. The planned control strategy has been implemented on the microcontroller to generate SVPWM signal needed to trigger the gates of MOSFET-based inverter.

KEYWORDS: Electric vehicle, Squirrel Cage Induction Motor, SVPWM method, V/F control.

I.INTRODUCTION

Efforts to recover air quality in highly populated urban communities have renewed interest in the growth of electric vehicle technology. However, the key issues which are challenging in the scheme of electric vehicles are the electric propulsion system, energy sources and battery management system. This paper will emphasis in design and functioning of electric propulsion system alternative. The emerging technology in switching semiconductors and digital signal processors at reasonable cost led to more interest in using AC induction motors instead of DC motors. The AC induction motors particularly the cage type, have less weight, small volume, low cost, less maintenance, no commutation, high torque at low speed and high efficiency.

In electrical vehicle’s propulsion, an AC induction motor drive is served from a DC source (battery), which has roughly fixed terminal voltage, through a DC/AC inverter. The DC/AC inverter is embraced by a active switching power electronic switches and power diodes. Insulated gate bipolar transistors and MOSFET are usually used in the inverters.Since the output AC voltage of the inverter has more frequency square wave forms, a high speed processor is required to create the proper switching sequence. Various switching methods are used to produce pulse width modulation signal which is used to govern the amplitude and the frequency of the output voltage. From the several pulse width modulation methods, Space Vector Pulse Width Modulation (SVPWM) has benefits that made it the most switching methods suitable for electric vehicles. The exciting features of this type of modulation is that it offersbetter DC-link utilization, efficient use of direct current supply voltage, create less ripples and improve life time of drive .

In this paper an electric propulsion system is examined. The EP system consists of a three phase squirrel cage IM, insulated gate bipolar transistor based three phase inverter and advanced processor, such as digital signal processor, implementing SVPWM algorithm for open loop speed regulation using V/F method of electric vehicle. The V/F is selected, as it tries to reachsome features which are fit for electric vehicles. These include wide speed span with fixed motor torque, small starting current, acceleration and deceleration of the vehicle.

II.SPACE VECTOR PULSE WIDTH MODULATION TECHNIQUE

A number of Pulse width modulation methods are used to control the magnitude and frequency of alternating current output voltage of the inverter. The most commonly used PWM methods for three-phase voltage source inverters are sine wave sinusoidal SPWM and space vector PWM .Since SVPWM is simply implemented digitally, enable more

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efficient utilization of direct current bus voltage, and produce sine wave with lower THD, it is most frequently preferable technique used in modern AC machines drives served by inverters.

The functioning of an induction motor is improved when SVPWM technique is applied.Although SVPWM is more complicated than sinusoidal PWM, it is easily incurred using modern digital signal processor based control systems. The SVPWM method implemented into the present TI Digital Motor Control library decreases computation time and the number of transistor commutations. It therefore improves Electro Magnetic Interference (EMI) behaviour.

III. V/F CONTROL METHOD

The finest way to change the speed of the induction motor is by changing the supply frequency and voltage level concurrently. It is found that the torque produced by the IM is directly proportional to the ratio of the supplied voltage and the frequency of the supply. By changing the voltage and frequency, but keeping their ratio fixed, the maximum torque produced can be kept fixed throughout the speed range. In this system, using the V/F control method the succeeding can be attained: 1) the induction motor can be run typically from 5% of the synchronous speed up to the base speed, and the maximum torque produced by the motor can be kept fixed throughout this range; 2) the starting current is less; 3) the acceleration and deceleration can be structured by controlling the change of the supply frequency.

IV. DESIGN OBJECTIVES

The weight, volume and aerodynamic drag and rolling resistance effects have been carefully considered in the design of the body of the vehicle. The design goals are to attain maximum speed of 60 km/h with a complete weight of 500 kg and acceleration time 0 to 60 km/h under 30 sec.

Fig 1:Snapshot of system model

V. PRACTICAL RESULTS

The figure shows, the two PWM pulses which are complementary and used to generate the gates of one leg of the IGBT Bridge of the inverter.

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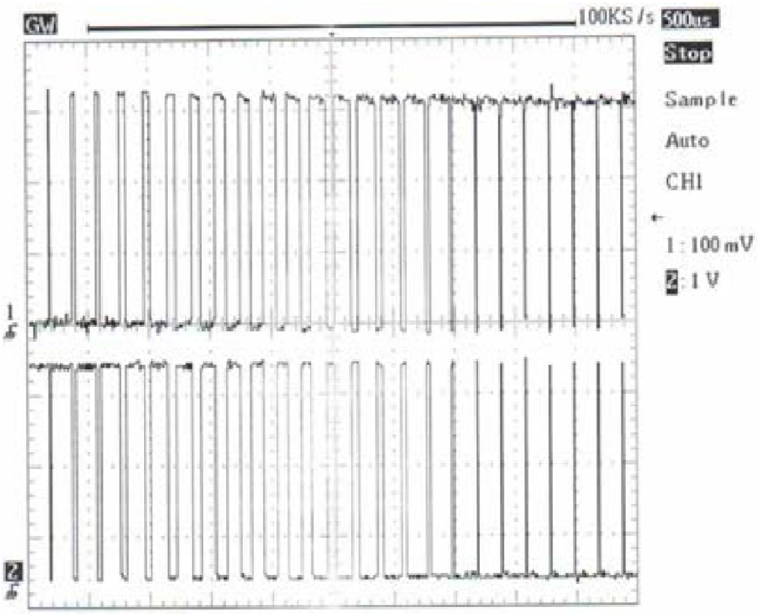

Fig 2: PWM signal and its complement

In order to elude the short circuit of inverter power supply, we introduced a time delay of 0.5µs between the two complementary pulses.

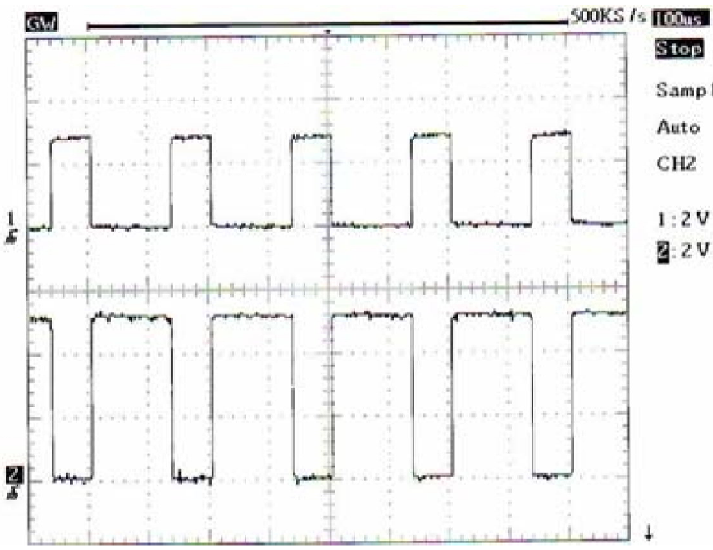

Fig 3: PWM signals before and after optocouplers

The inverter is tested to supply induction motor with rating 4.7kW with and without load. This motor is the one designed to be used in the propulsion system planned. The switching frequency of the IGBTs transistors and direct current power supply voltage are 10kHz and 200V respectively.

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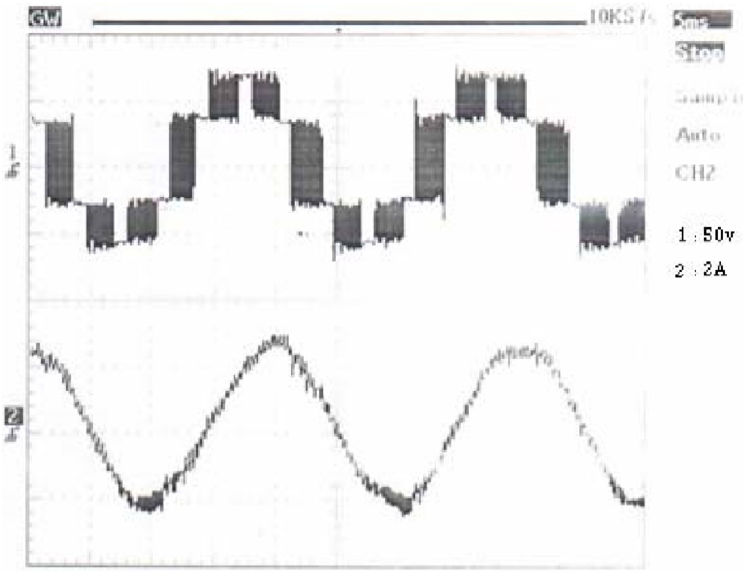

Fig 4: Wave form of the phase voltage and current for *f* =50Hz with a load torque

VI. CONCLUSIONS

This paper presented the design of a definite part of an electric vehicle. The EV is propelled by three phase cage induction motor and motorised by batteries which are charged by solar energy station. After many experiment done, the DSP-based control system planned and developed in this paper is able to operate the vehicle at various speeds under flat and uphill road circumstances. Though, during uphill condition the current needed was quite high compared to current applied to DC motor used on the same vehicle under the similar circumstances. Therefore, to be comparable to DC motor, more investigationwork is needed on control strategies in order to improve the performance of induction motor used in EV. Because of its less cost, robustness, more reliability and free from maintenance, automobile industry will certainly choose cage IM as the most suitable candidate for EVs. Hence, it is believed that the work carried out will subsidise in evolution of future EV based on the use of squirrel cage induction motor.

REFERENCES

[1] M. Ehsani, Y. Gao, S.E. Gay, A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design”. CRC press, 2004.
[2] H. Saidi, “Study and Realization of Solar Vehicle”, Europe University Edition, Germany, ISBN : 978-613-1-55909-9 9 (in french), 2014.
[3] H. Cheng, X. Gong, Y.F. HU, Q.F. LIU, B.Z. GAO, H.Y. GUO, “Automotive Control : The State of the Art and Perspective”, ActaAutomaticaSinica, Vol. 39, No. 4, pp. 322-346, 2013.
[4] M.H. Rashid, “Power Electronics : Circuits, Devices, and Applications”, 3rd Edition, 2004.
[5] M.A. Llor, “Commandedirecte de couple à fréquence de modulation constante des machines synchrones à aimants permanents”, Thèse de doctorat, université INSA, Lyon, France. 2003.
[6] G. El-Saady, E.A. Ibrahim, M. Elbesealy, “V/F Control of Three Phase Induction Motor Drive with Different PWM Techniques”, Innovative System Design and Engineering, IISTE, Vol. 4, No. 14, pp. 131-144, 2013.