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

Three Phases Diode Clamped Inverter Using SVPWM Method for Induction Motor Fed Electric Vehicle Application

BENNESIVA
M-tech Scholar
Department of Electrical & Electronics Engineering,
K.V.SUBBAREDDY Engineering College, DHUPADU;
Kurnool (Dt); Andhra pradesh, India.
Email:bennesiva208@gmail.com

M.DILIP KUMAR M.TECH (P.HD)
Assistant Professor
Department of Electrical & Electronics Engineering,
k.v subbareddy Engineering College, dhupadu;
kurnool (Dt); andhrapradesh, India.
Email:manaikadilip@gmail.com

Abstract—to improve air quality in heavily populated urban communities have rekindled interest in the development of electric vehicle technology. Solar electric vehicles (SEV) are considered the future vehicles to solve the issues of air pollution, global warming, and the rapid decreases of the petroleum resources facing the current transportation technology. However, SEV are still facing important technical obstacles to overcome. They include batteries energy storage capacity, charging times, efficiency of the solar panels and electrical propulsion systems. In this paper, a hybrid Photovoltaic (PV)-fuel cell generation system employing electrolyze for hydrogen generation is designed and simulated. The system is applicable for remote areas or isolated loads. Fuzzy regression model (FRM) is applied for maximum power point tracking to extract maximum available solar power from PV arrays under variable isolation conditions. The system incorporates a controller designed to achieve permanent power supply to the load via the PV array or the fuel cell, or both according to the power available from the sun. The IM is fed from three phase inverter operated by a constant V/F control method and Space Vector Pulse Width Modulation (SVPWM) algorithm. The electric vehicle is propelled by three phase cage induction motor and powered by batteries which are charged by solar energy station. Due to its low cost, robustness, high reliability and free from maintenance, automobile industry will certainly select cage induction motor as the most appropriate candidate for EVs. Hence, it is believed that the work carried out will contribute in development of future electric vehicles based on the use of squirrel cage induction motor. This concept can be extended by applying Three phase Diode clamped Inverter at source side to apply for Induction Motor fed Electric Vehicles, i.e, Three phase Diode clamped Inverter Using SVPWM Method for Induction Motor fed Electric Vehicle Application. by using Matlab/Simulink software

Keywords—Electric Vehicle; Squirrel Cage Induction Motor; SVPWM method; V/F control.

I. INTRODUCTION

Sinceits introduction in 1980, early interest in multilevel power conversion technology was triggered by the work of Nabae, etal, who introduced the neutral-point clamped (NPC) inverter topology. It was immediately recognized that this new converter had many advantages over the more conventionaltwo-level inverter. Later, in the early nineties the concept of the three-level converter was extended further and some new multilevel topologies were proposed [1]. Newly, improvements in power electronics and semiconductor technology have lead developments in power electronic systems. Multilevel inverters have gained much attention for the next generation medium voltage and high power applications. Three-level diode-clamped inverter also known as neutral point clamped (NPC).The three-level NPC inverter is used in this paper [2]. Problems due to neutral-point voltage unbalance and narrow pulse width modulation its various balance control methods are discussed at length. The output voltage waveforms in multilevel inverters can be generated at low switching frequencies with high efficiency and low distortion [3].

In recent years, nearby multilevel inverters various pulse width modulation (PWM) techniques have been also developed. Space vector PWM (SVPWM) technique is one of the most popular techniques gained interest recently. This technique results in higher magnitude of fundamental output voltage available as compared to sinusoidal PWM. But, SVPWM procedure used in three-level inverters is more complex because of large number of inverter switching states. Multilevel inverters are that the voltage stress on each switching device is reduced. In addition, multilevel waveforms feature have less harmonic content compared to two level waveforms operating at the same switching frequency [4-5].

This paper presents simplified method for the implementation of the Neutral point clamped inverter combined with a new space vector pulse width modulation technique using Matlab/Simulink. The operation of the electric system is performed in both cases considering the neutral point clamped (NPC) and not considering the neutral point clamped (NPC).

II. SPACE VECTOR PULSE WIDTH MODULATION TECHNIQUE

A number of Pulse width modulation (PWM) schemes are used to control the magnitude and frequency of AC output voltage of the inverter. The most widely used PWM schemes for three phase voltage source inverters [7] are sine wave sinusoidal SPWM and space vector PWM (SVPWM).Since SVPWM is easily implement digitally, enable more efficient utilization of DC bus voltage, and generate sine wave with lower total harmonic distortion, it is most frequently preferable technique used in modern AC machines drives fed by inverters.

The performance of an induction motor is improved when SVPWM technique is applied [6]. Details

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

explanation of the SVPWM and SPWM techniques can be found in [7].Although SVPWM is more complicated than sinusoidal PWM, it is easily implemented using modern DSP based control systems. The SVPWM technique implemented into the existing TI Digital Motor Control (DMC) library reduces computation time and the number of transistor commutations [9, 10]. It therefore improves Electro Magnetic Interference (EMI) behavior.

III. V/F CONTROL METHOD

The best way to vary the speed of the induction motor is by varying the supply frequency and voltage level simultaneously. It can be shown that the torque developed by the induction motor is directly proportional to the ratio of the applied voltage and the frequency of the supply [4]. By varying the voltage and frequency, but keeping their ratio constant, the maximum torque developed can be kept constant throughout the speed range. In summary, using the V/F control method the following can be achieved: 1) the induction motor can be run typically from 5% of the synchronous speed up to the base speed (maximum vehicle speed), and the maximum torque generated by the motor can be kept constant throughout this range; 2) the starting current is lower; 3) the acceleration and deceleration can be controlled by controlling the change of the supply frequency.

IV. DESIGN OBJECTIVES

The mechanical structure of the electric vehicle prototype manufactured locally and used in this study is shown in figure.1. The weight, volume and aerodynamic drag and rolling resistance effects have been carefully considered in the design of the body of the vehicle [8]. The design objectives are to attain maximum speed of 60 km/h with a total weight of 500 kg and acceleration time 0 to 60 km/h below 30 sec. 2015 6th International Renewable Energy Congress (IREC) is used to derive the desired driving power to ensure vehicle operation.

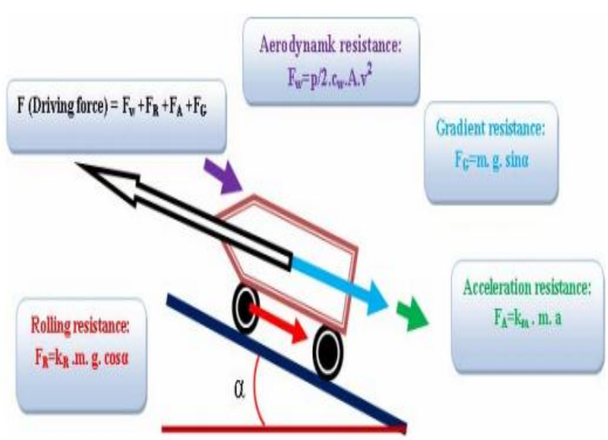

Fig.1. Representation of all forces acting on EV.

The road slope torque T is defined by:

$$T = T_w + T_R + T_A + T_G \quad (1)$$

Where

$T_w = p/2.c_w.A.v^2$: Aerodynamic torque

$T_R = k_R.m.g.\cos(\alpha)$: Rolling torque

$T_A = k_m.m.a$: Acceleration torque

$T_G = m.g.\sin(\alpha)$: Gradient torque

m, α : Vehicle mass and road angle

Torque evaluation of the power flow occurring into a vehicle is in strong relation with its mass and a total torque will be expressed as:

$$C_t = T_A + T_p \quad (2)$$

For this study, we selected for the EVs propulsion a cage three phase induction motor of 4.7kW, 220/380V, 11/19A, 4 poles with maximum speed of 1500rpm.

V. ELECTRICAL PROPULSION SYSTEM

Figure 2 shows the block diagram of the open loop control system used to adjust the speed of the vehicle. The hardware includes squirrel cage induction motor, bridge inverter, isolation card, Digital Signal Processor (DSP), speed sensor, potentiometer for desired speed adjustment, and switches for user interface. The desired speed is entered by the user via the potentiometer and then entered to DSP via analog to digital converter (ADC). The speed of the motor (i.e. vehicle) is monitored using a tachometer setup.

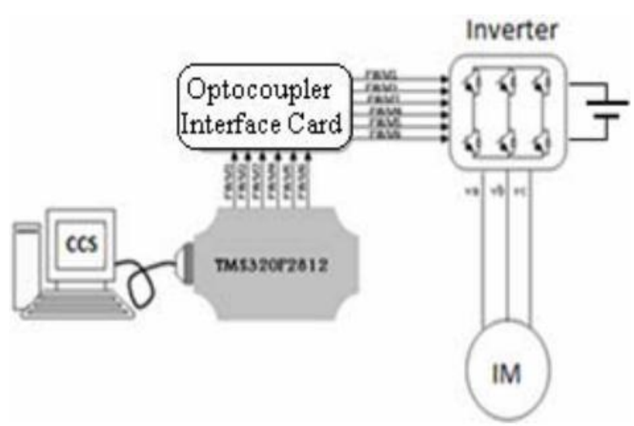

Fig. 2. The block diagram of the open loop control system.

VI. OPEN LOOP CONTROL STRATEGY

The user adjusts the desired speed using a potentiometer and this latter converts it to its analogous voltage. The output of the potentiometer is sensed by the ADC which is integrated on the DSP and then converted to desired frequency Fs. The open loop control program consists of several stages as shown in the flow chart depicted in figure 2. Based on the figure, the open loop system can be summarized as follows:

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

- Initialization DMC modules and declare variables;
- Determine Vs voltages with constant V/F profile based on desired frequency (Fs) using VHz_PROF module;
- Determine the time durations Ta, Tb and Tc based on Vs and Fs using SVGEN_MF module;
- Generate the signal PWM based on the time durations Ta, Tb and Tc using PWMGEN module.

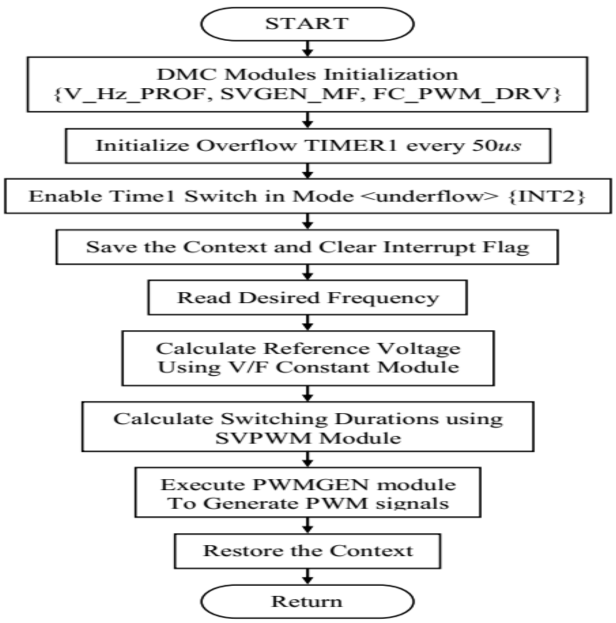

Fig.3. Program Flow Chart.

VII PHOTOVOLTAIC SYSTEM

A Photovoltaic (PV) system directly converts solar energy into electrical energy. The basic device of a PV system is the PV cell. Cells may be grouped to form arrays. The voltage and current available at the terminals of a PV device may directly feed small loads such as lighting systems and DC motors or connect to a grid by using proper energy conversion devices this photovoltaic system consists of three main parts which are PV module, balance of system and load. The major balance of system components in this systems are charger, battery and inverter.

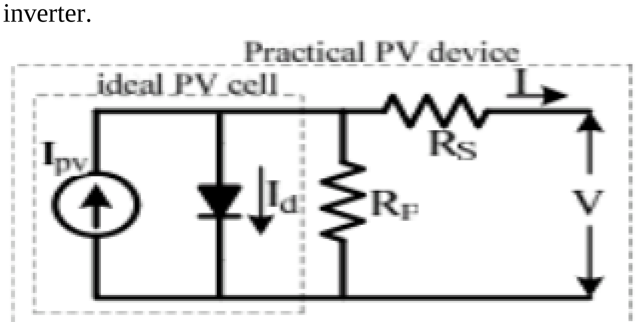

Fig.4. Practical PV device.

A photovoltaic cell is basically a semiconductor diode whose p–n junction is exposed to light. Photovoltaic cells are made of several types of semiconductors using different manufacturing processes. The incidence of light on the cell generates charge carriers that originate an electric current if the cell is short circuited1

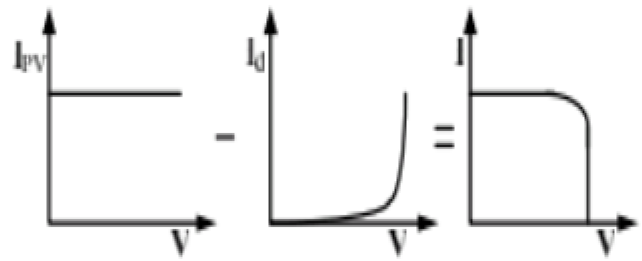

Fig.6. Characteristics I-V curve of the PV cell.

The equivalent circuit of PV cell is shown in the fig.5. In the above figure the PV cell is represented by a current source in parallel with diode. Rs and Rp represent series and parallel resistance respectively. The output current and voltage form PV cell are represented by I and V. The I-Characteristics of PV cell are shown in fig.6. The net cell current I is composed of the light generated current IPV and the diode current ID

Fuel Cell Operation

Pressurized hydrogen gas (H_2) enters cell on anode side. Gas is forced through catalyst by pressure. When H_2 molecule comes contacts platinum catalyst, it splits into two H+ ions and two electrons (e-). Electrons are conducted through the anode. Make their way through the external circuit (doing useful work such as turning a motor) and return to the cathode side of the fuel cell. On the cathode side, oxygen gas (O_2) is forced through the catalyst Forms two oxygen atoms, each with a strong negative charge. Negative charge attracts the two H+ ions through the membrane, Combine with an oxygen atom and two electrons from the external circuit to form a water molecule (H_2O).

How a fuel cell works: In the polymer electrolyte membrane (PEM) fuel cell, also known as a proton-exchange membrane cell, a catalyst in the anode separates hydrogen atoms into protons and electrons. The membrane in the center transports the protons to the cathode, leaving the electrons behind. The electrons flow through a circuit to the cathode, forming an electric current to do useful work. In the cathode, another catalyst helps the electrons, hydrogen nuclei and oxygen from the air recombine. When the input is pure hydrogen, the exhaust consists of water vapor. In fuel cells using hydrocarbon fuels the exhaust is water and carbon dioxide. Cornell's new research is aimed at finding lighter, cheaper and more efficient materials for the catalysts and membranes.

Fuel Cells Working

A single fuel cell consists of an electrolyte sandwiched between two electrodes, an anode and a cathode. Bipolar plates on either side of the cell help distribute gases and

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

serve as current collectors. In a Polymer Electrolyte Membrane (PEM) fuel cell, which is widely regarded as the most promising for light-duty transportation, hydrogen gas flows through channels to the anode, where a catalyst causes the hydrogen molecules to separate into protons and electrons. The membrane allows only the protons to pass through it. While the protons are conducted through the membrane to the other side of the cell, the stream of negatively-charged electrons follows an external circuit to the cathode. This flow of electrons is electricity that can be used to do work, such as power a motor. On the other side of the cell, air flows through channels to the cathode. When the electrons return from doing work, they react with oxygen in the air and the hydrogen protons (which have moved through the membrane) at the cathode to form water. This union is an exothermic reaction, generating heat that can be used outside the fuel cell.

Fuel cells directly convert the chemical energy in hydrogen to electricity, with pure water and potentially useful heat as the only byproducts. Hydrogen-powered fuel cells are not only pollution-free, but also can have more than two times the efficiency of traditional combustion technologies. The power produced by a fuel cell depends on several factors, including the fuel cell type, size, temperature at which it operates, and pressure at which gases are supplied. A single fuel cell produces barely enough voltage for even the smallest applications. To increase the voltage, individual fuel cells are combined in series to form a stack. (The term "fuel cell" is often used to refer to the entire stack, as well as to the individual cell.) Depending on the application, a fuel cell stack may contain only a few or as many as hundreds of individual cells layered together.

VIII .MATLAB/SIMULATION RESULTS

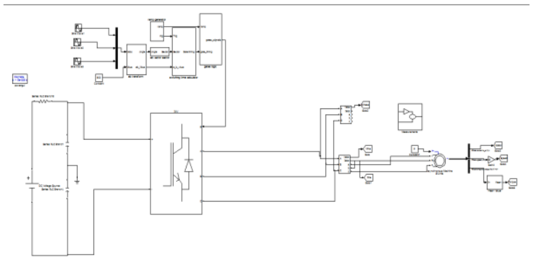

Fig 5 Matlab/simulation circuit of the open loop control system with Induction Motor

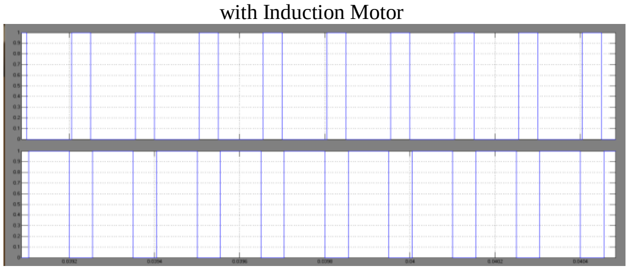

Fig 6simulation wave form of PWM signal and its complement

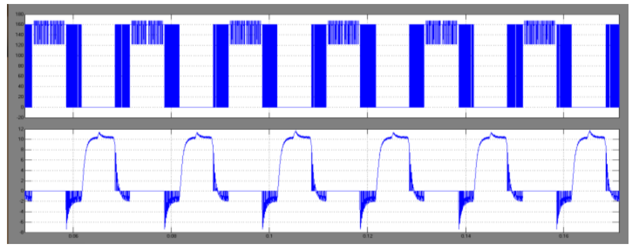

Fig 8 simulation wave form of Dead time between two complementary pulses

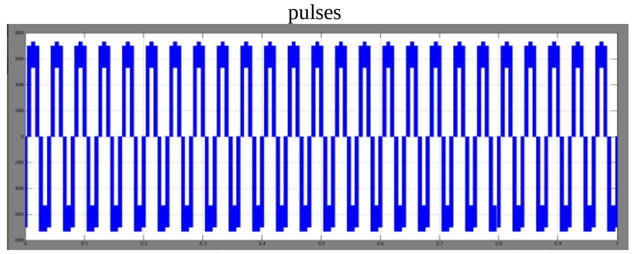

Fig 9 simulation wave form the phase voltage and current for *f* =25Hz with a load torque

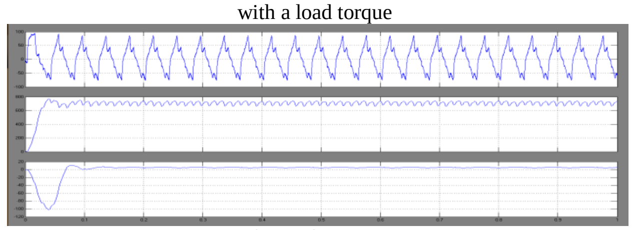

Fig 10 simulation wave form of stator current speed and torque

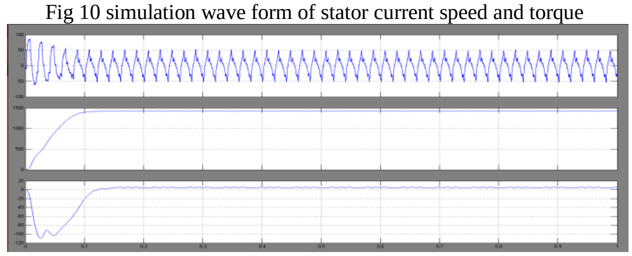

Fig 11 simulation wave form of stator current, speed and torque

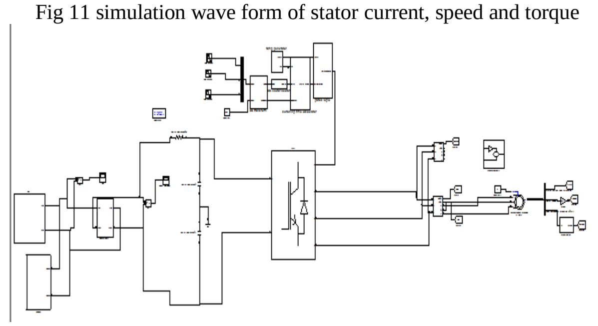

Fig 12 Matlab/simulation circuit of the open loop control system of renewable energy source with Induction Motor

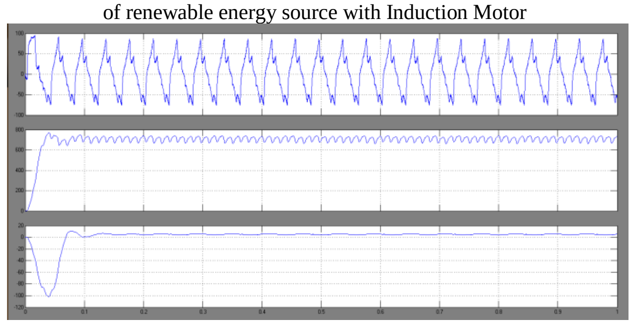

Fig 13 simulation wave form of stator current, speed and torque with RES

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

VIII.CONCLUSION

The present paper has presented an induction motor drive based on v/f controller with hybrid energy source This controller determinates the desired amplitude of torque in terms of voltage and speed in terms of frequency. By using 3-level inverter, ripples in speed and torque will reduce. The main advantage in this proposed method is incorporated V/F based induction motor control with SVPWM based 3-level inverter. So that the advantages in 3-level with SVPWM as increased the performance and life time of drive. These advantages allow implementing controllers for electric vehicles; because, mainly electric vehicles need high starting torque so this is produce the required torque with minimum torque ripples and in electric vehicles, operation of drive is depends on variable torque with constant speed applications as well as variable speed with constant torque application

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, “Commandedirectede couple à fréquence demodulation constant e 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.

[7] M.A.A. Badran, A.M. Tahir, W.F. Faris, “Digital Implementation of Space Vector Pulse Width Modulation Technique Using 8-bit Microcontroller”, World Applied Sciences Journal 21, pp. 21-28, 2013.

[8] http://www.alldatasheet.com/datasheetpdf/pdf/82578/TI/TMS320F2812.html

[9] V.M. Yashasvi, B. Amarapur, “Digital Signal Processing Based Speed Control of Induction Motor Drive System”, International Journal on Advanced Electrical and Electronics Engineering, (IJAEEE), Vol. 1, No.1, 2012.

[10] S. Soni, A. Gupta, “Analysis of SVPWM Based Speed Control of Induction Motor Drive with using V/F Control Based 3 Level Inverter”, IJSET, Vol. 2, No. 9, 2013.