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Solar Powered Induction Motor for EVs with Flexible Energy Control Functions

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ABSTRACT

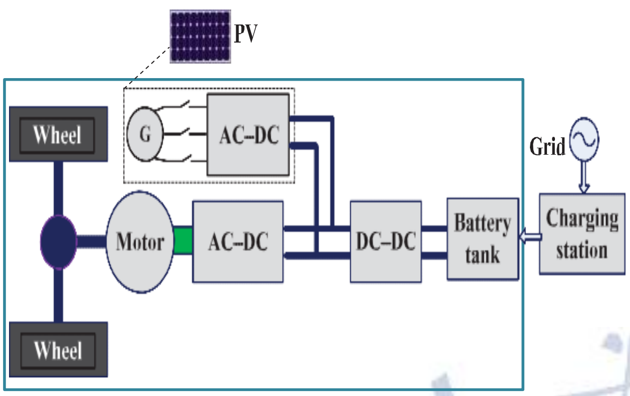
Electric vehicles (EVs) give an achievable answer for diminish nursery gas emanations and along these lines turn into an intriguing issue for innovative work. Enlistment MOTOR (IM) is one of the guaranteed engines for EV applications. Keeping in mind the end goal to broaden the EVs' driving miles, the utilization of photovoltaic (PV) boards on the vehicle diminishes the dependence on vehicle batteries. In light of the stage twisting attributes of SRMs, a tri-port converter is proposed in this paper to control the vitality stream among the PV board, battery, and INDUCTION MOTOR. Most extreme power point following (MPPT) of the PV board and speed control of the IM are figured it out. In the stop charging modes, a framework associated charging topology is produced without a requirement for outside equipment. At the point when the PV board straightforwardly charges the battery, a multisession charging control procedure is utilized to upgrade vitality usage.

KEYWORDS: *Electric vehicles (EVs), photovoltaic's (PVs), control stream control, INDUCTION MOTOR (IM), converter organize.*

I. INTRODUCTION

Electric vehicles (EVs) have taken a significant leap forward by advances in motor drives, power converters, batteries, and energy management systems. However, due to the limitation of current battery technologies, the driving miles are relatively short that restricts the wide application of EVs. In terms of motor drives, high-performance permanent-magnet (PM) machines are widely used while rare- earth materials are needed in large quantities, limiting the wide application of EVs.

To conquer these issues, a photovoltaic (PV) board and an Induction Motor (IM) are acquainted with expert vide control supply and engine drive, individually. To begin with, by including the PV board top of the EV, a reasonable vitality source is accomplished. These days, a common traveler auto has a sur-confront enough to introduce a 250-W PV board Second, an IM is likewise vigorous with the goal that it gets expanding consideration in EV applications. While PV boards have low-control thickness for footing drives, they can be utilized to charge batteries the majority of time.

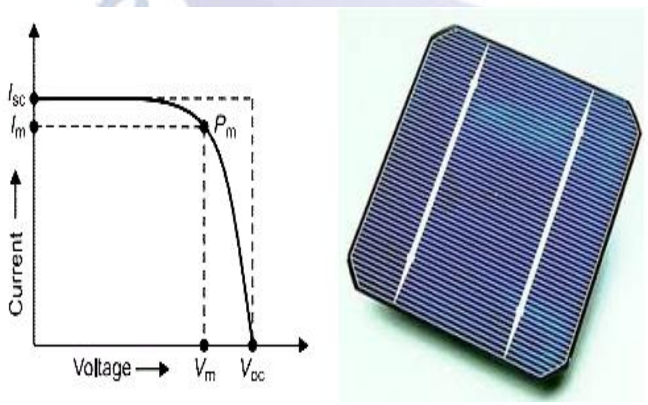


Fig(1.0):Block Diagram Of Electrical Vehicle

II. COMPONENTS

A.Solar panel

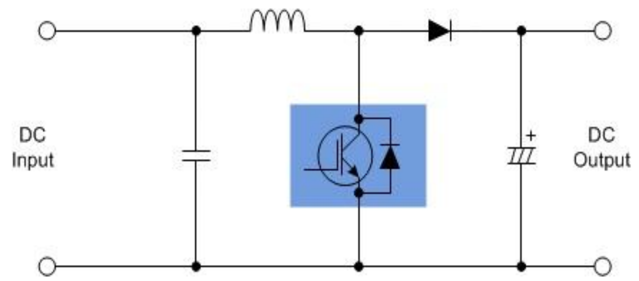
Sun oriented Cell converts light energy into the electrical energy. A sun powered cell is essentially a p-n junction diode. It uses photovoltaic effect to convert light energy into electrical energy. In spite of the fact that this is fundamentally a junction diode, however constructionally it is little bit different frame conventional p - n junction diode. A thin layer of p - type semiconductor is grown on a generally thicker n - type semiconductor. We provide couple of finer electrodes on the top of the p - type semiconductor layer. These electrodes do not obstruct light to reach the thin p - type layer. Just underneath the p - type layer there is a p - n junction. We likewise provide a current collecting cathode at the bottom of the n - type layer. We encapsulate the entire gathering by thin glass to protect the sun oriented cell from any mechanical stun. Main advantage of this is No pollution related with it and it should keep going for a long time.



Fig(2.1): V-I characteristics of solar cell

B.Boost converter

Step up chopper or boost converter is utilized to increase the input voltage level of its output side. Its circuit outlines and waveforms are shown beneath in figure.



Fig(2.2): Line Diagram Of Boost Converter

The chopper circuit is, as mentioned, fundamentally a DC step-down transformer. Another circuit generally utilizing IGBTs is the boost converter or bootstrap circuit. This circuit can increase the DC source voltage and to generate high voltage from a low-voltage source. When the IGBT is gated, the inductor is accused of current. Then, when the IGBT is turned off, the induced voltage from the inductor di/dt charges the capacitor to a higher voltage. Using inductor voltage steady state average voltage is zero in DC Steady state. Equations of converter is below (1,2,3)

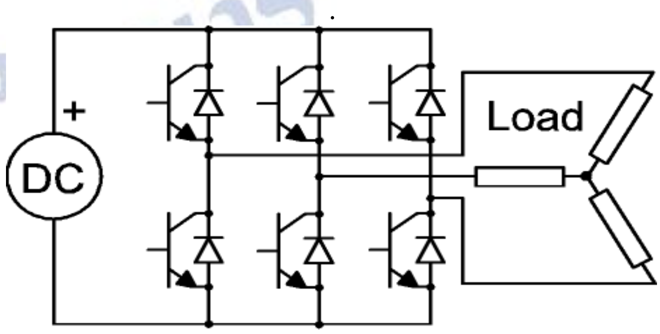
$$V_{in}(DT_s) = (V_0 - V_{in})(1-D)_{T_s} \ldots\ldots(1)$$

$$\frac{V_0}{V_{in}} = \frac{1}{1-D} \qquad (V_0 > V_{in}) \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$C\frac{dVc}{dt} \Rightarrow V_c(t) = \frac{1}{c}\int_{\tau} i_c . dT \ldots\ldots\ldots\ldots\ldots (3)$$

C.Inverter

Three-phase inverters are utilized for variable-frequency drive applications and for high power applications, for example, HVDC power transmission. An essential three-phase inverter consists of three single-phase inverter changes each connected to one of the three load terminals. For the most essential control plot, the operation of the three switches is coordinated with the goal that one switch operates at every 60 degree point of the fundamental output waveform. This makes a line-to-line output waveform that has six steps. Inverter operates in six modes (mode 1, 2, 3, 4, 5, 6)



Fig(2.3): Inverter Circui Diagram

.The six-step waveform has a zero-voltage step between the positive and negative sections of the square-wave with the end goal that the harmonics that are multiples of three are eliminated as depicted previously. When bearer based PWM techniques are applied to six-step waveforms, the essential general shape, or envelope, of the waveform is retained so that the third harmonic and its multiples are canceled. From the late nineteenth century through the center of the twentieth century, DC-to-AC power conversion was accomplished using revolving converters or motor-generator sets (M-G sets). In the mid twentieth century, vacuum tubes and gas filled tubes began to be utilized as switches in inverter circuits. The most broadly utilized type of tube was the thyratron.The origins of electromechanical inverters explain the wellspring of the term inverter. Early AC-to-DC converters utilized an induction or synchronous AC motor direct-connected to a generator (dynamo) so that the generator's commutator turned around its connections at precisely the correct moments to produce DC. A later development is the synchronous converter, in which the motor and generator windings are combined into one armature, with slip rings at one end and a commutator at the other and only one field outline. The outcome with either is AC-in, DC-out. With a M-G set, the DC can be considered to be separately generated from the AC; with a synchronous converter, in a certain sense it can be considered to be "mechanically corrected AC". Given the correct assistant and control equipment, a M-G set or rotating converter can be "run in reverse", converting DC to AC. Hence an inverter is an inverted converter.

D.Induction motor

A standout amongst the most widely recognized electrical motor utilized as a part of most applications which is known as induction motor. This motor is additionally called as asynchronous motor since it keeps running at a speed not as much as its synchronous speed. Here we have to characterize what is synchronous speed. Synchronous speed is the speed of revolution of the attractive field in a turning machine and it relies on the recurrence and number posts of the machine. An induction motor dependably keeps running at a speed not as much as synchronous speed in light of the fact that the pivoting attractive field which is created in the stator will produce flux in the rotor which will make the rotor to turn, however because of the lagging of flux current in the rotor with flux current in the stator, the rotor will never reach to its pivoting attractive field speed i.e. the synchronous speed.

Fig(2.4): Induction Motor

There are essentially two sorts of induction motor that rely on the info supply - single stage induction motor and three stage induction motor. Single stage induction motor is not a self beginning motor which we will talk about later and three stage induction motor is a self-beginning motor.

Working Principle is we have to give twofold excitation to make a machine to pivot. For instance on the off chance that we consider a DC motor, we will give one supply to the stator and another to the rotor through brush plan. In any case, in induction motor we give just a single supply, so it is truly intriguing to realize that how it functions. It is extremely basic, from the name itself we can comprehend that induction procedure is included. Really when we are giving the supply to the stator winding, flux will produce in the loop because of stream of current in the curl. Presently the rotor winding is organized in a manner that it turns out to be short circuited in the rotor itself. The flux from the stator will cut the loop in the rotor and since the rotor curls are short circuited, as indicated by Faraday's law of electromagnetic induction, current will begin streaming in the loop of the rotor. At the point when the present will stream, another flux will get created in the rotor. Presently there will be two flux, one is stator flux and another is rotor flux and the rotor flux will slack concerning the stator flux. Because of this, the rotor will feel a torque which will make the rotor to pivot toward turning attractive flux. So the speed of the rotor will rely on the air conditioner supply and the speed can be controlled by differing the info supply. This is the working standard of an induction motor of either sort – single and three stage.The equation of induction motor is below with 4,5,6,7,8,9,10.

$$V_{TE} = \frac{X_m}{\sqrt{R_s^2+(X_s+X_m)^2}} V_s \quad \text{.........................} \quad (4)$$

$$Z_{TE}= R_{TE}+jX_{TE}= \frac{jX_m(R_s+jX_s)}{R_s+j(X_s+X_m)} \text{......... (5)}$$

For low value of slip

$$R_{TE}+R_r^{'}>>R_{TE}+X_r^{'} \quad \text{and} \quad R_r^{'}>>R_{TE} \text{.............(6)}$$

$$T_{em}\approx \frac{1}{w_s}\frac{3V_{TE}^2}{R_r^{'}}.s$$

(N-m).............................. (7)

For high values of slip

$$R_{TE}+R_r^{'} \ll R_{TE}+X_r^{'} \text{ ....}$$

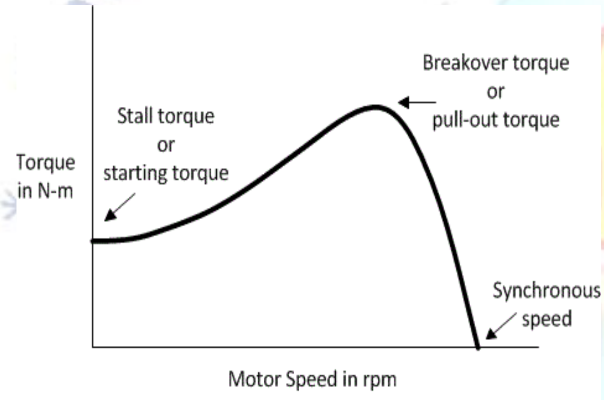
(8)

$$T_{em}\approx \frac{1}{w_s}\frac{3V_{TE}^2}{(X_s+X_r^{'})^2}\frac{R_r^{'2}}{s} \text{ (N-m)........................}$$

(9)

For maximum or breakdown torque, which is independent of rotor.

$$T_{max}=\frac{1}{2w_s}\frac{3V_{TE}^2}{R_{TE}+\sqrt{R_{TE}^2+(X_{TE}+X_r^{'})^2}} \text{(N-m).............(10)}$$



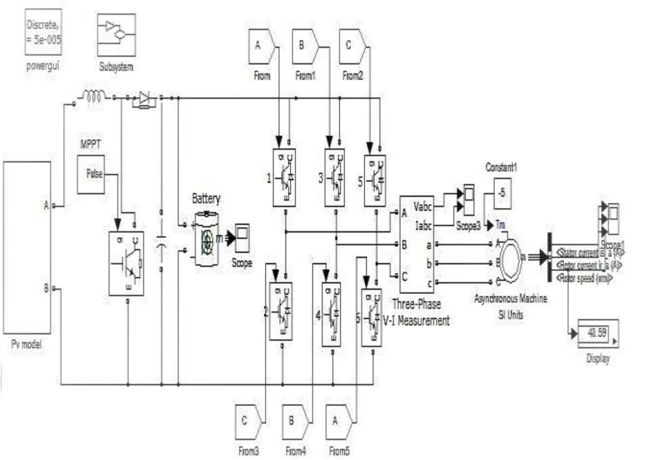
Fig(2.5):Speed Torque Characteristics

E.Battery

Li-ion battery (abridged as LIB) is a sort of rechargeable battery in which lithium ion move from the negative terminal to the positive cathode amid release and back while charging. Li-ion batteries utilize an intercalated lithium compound as one terminal material, contrasted with the metallic lithium utilized as a part of a non-rechargeable lithium battery. The electrolyte, which takes into account ionic development, and the two anodes are the constituent segments of a lithium-ion battery cell.

III. SIMULATION

Here we run the induction machine with the assistance of sunlight based board by utilizing the method MPPT (Maximum Power Point Tracking) with battery backup. For activating of inverter sinusoidal PWM (Pulse width Modulation) utilized and control the yield of inverter.



Fig(3.1) : Simulation diagram

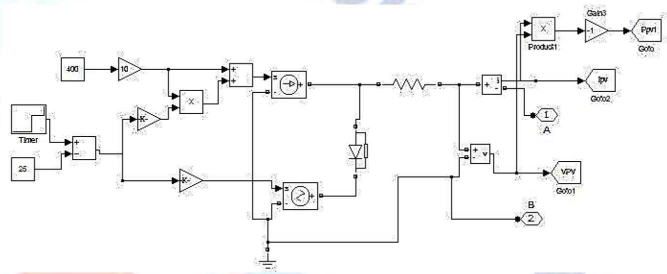
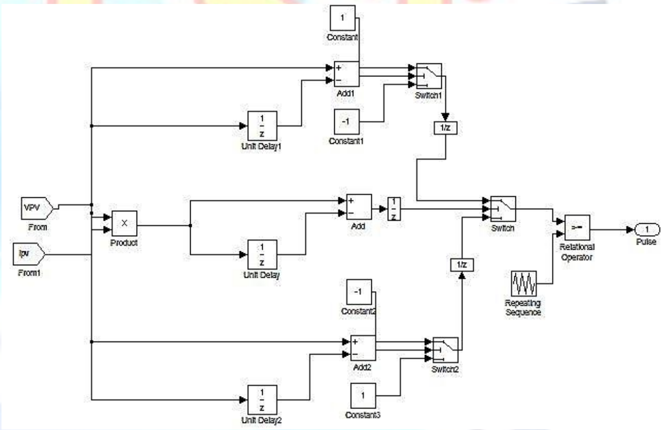


Fig (3.2): solar panel internal circuit



Fig(3.3): MPPT Technique of solar panel

This is the simulation figures of solar panel and its triggering. Further, control the inverter by triggering pulse for getting the efficient output. For rated capacity input of motor

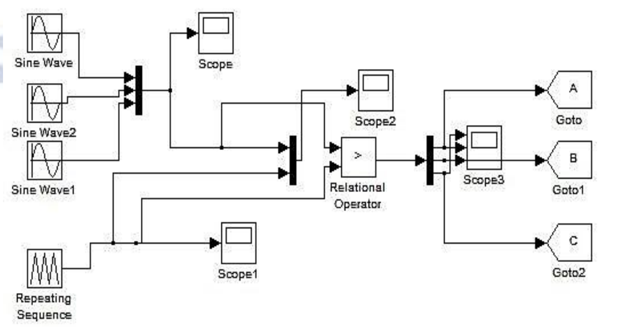


Fig (3.4): PWM Controller for inverter

IV. EXPERIMENTAL RESULTS

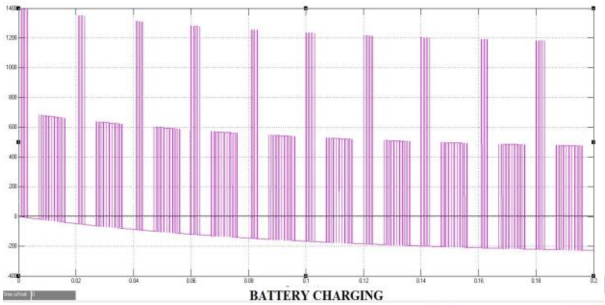
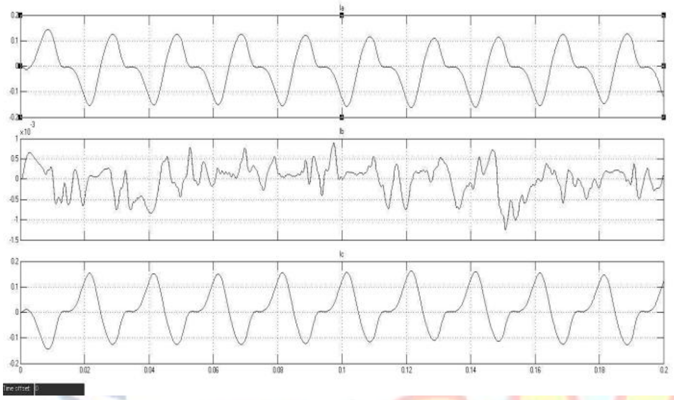


Fig (4.1): Battery charging



Fig(4.2):Output Currents

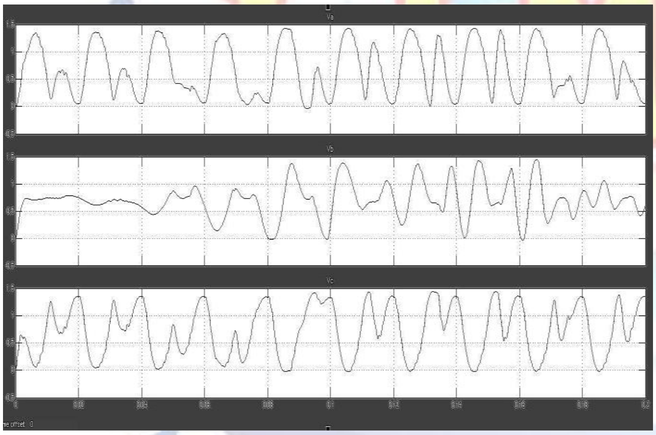
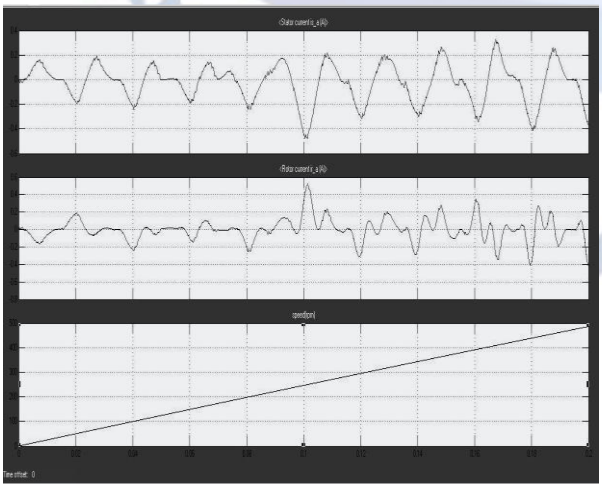
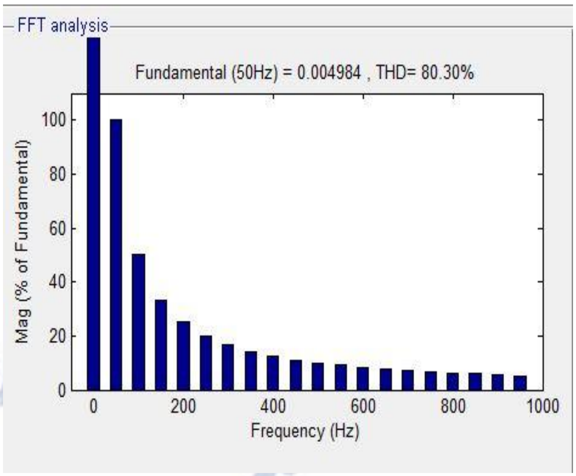


Fig (4.3): Output Voltage



Fig(4.4):Stator Current, Rotor Current, Speed



Fig(4.5):THD Analysis

These are obtained after the performing of the project under certain criteria.

PARAMETERS

PARAMETERS	VALUES
No of phases	3
No of poles	4
Speed(RPM)	1750
Rated voltage(v)	415
Line to line voltage(v)	460
Nominal power(w)	3730
Frequency(Hz)	60
Stator resistance(ohms)	1.115
Stator inductance(Henry)	0.005974
Rotor resistance(ohms)	1.083
Rotor inductance(Henry)	0.005974

V. CONCLUSION

Here we successfully run the induction motor with help of the solar energy as input and controlled by controlling circuits. 1) Six working modes are created to accomplish adaptable energy stream for driving control, driving/charging half breed control, and charging control.

2) A novel matrix charging topology is shaped without a requirement for outer power gadgets.

3)A PV-sustained battery charging control plan is created to enhance the solar energy use.

Since PV-encouraged EVs are a greener and more practical innovation than traditional vehicles, this work will give a plausible answer for lessen the aggregate expenses and CO2 emanations of electrified vehicles. Besides, the proposed innovation may likewise be connected to comparable applications, for example, energy component fueled EVs. Energy units have a much high-control thickness and are in this way more qualified for EV applications.

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