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Grid Solar Hybrid Speed Controller For Electric Vehicle

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Abstract: In the future a significant shift in focus will occur towards electric vehicles as fossils decrease and fuel prices become extremely high. Also use of renewable energy sources will be required in electric vehicles, so as not to depend on thermal or nuclear power indirectly. Characteristic of a IC engine (Internal Combustion Engine) such as higher torque on demand, rapid acceleration and row power are often a hindrance in acceptance of Electric vehicles by mass public. This Research work emphasis's on a design of a grid solar hybrid electric vehicle Which addresses the above issues effectively and efficiently. The proposed system uses a higher power 3 q induction motor with FOC (Field Oriented control) or vector control to deliver IC Engine vehicles like performance in terms of row power, acceleration, torque etc. with highest energy efficiency achievable. Also the system comprises of an intelligent electronic PWM switching system which facilitates use of Root solar energy in priority and energy deficit to be derived from battery when the vehicle is running. The switching system also provides for priority to on board Root top solar panels for vehicle battery charging and tabs deficit power from grid.

Keywords: Electric vehicle, Grid-Solar Hybrid, Field Oriented Control, Vector Control, Intelligent Electronic Switching.

INTRODUCTION

The petroleum derivative, for example, oil and diesel are exceptionally costly approach to be separated and utilized. The utilization of petroleum derivative based vehicles is one of the real reasons that has quickened the extraction of these non-sustainable assets in an unsustainable way. Facilitate, transportation of these fuel to country regions itself has turned into a issue. The real issue is green house impact created because of this consuming of non-renewable energy source where vast sum of CO2 will be transmitted which causes loads of issue. Sun oriented vehicles rely on upon PV cells to change over daylight into power to drive the PMDC engines. Not at all like sun based warm vitality which changes over sun based vitality to warm, PV cells specifically change over daylight into power. As per late overviews the petroleum products are exhausting at a quick rate where in and around 50 years the entire petroleum product on the planet must be totally drained. In this manner it is the need of an opportunity to make another investigation of characteristic assets of vitality and power among the common assets accessible daylight is the most encouraging one [1]. Daylight is thought to be a wellspring of vitality which is executed in different everyday applications. The Solar/Electric Powered Hybrid Vehicle (SEPHV) contains the sun based board, Permanent Magnet DC (PMDC) engine, charge controller, batteries, solenoid control, venture down transformer, extra brushes and diode rectifier unit. Diode Rectifier can be utilized to charge the batteries in typical AC supply amid sunless conditions. A zero discharge sun based/electric vehicle is fueled by Photovoltaic/Electric Supply vitality by means of sun powered boards and AC supply with capacity of electric vitality in batteries.The PV exhibit has a specific working point that can supply the greatest energy to the heap which is for the most part called Maximum Power Point (MPP). The most extreme power point has a non direct locus where it differs as per the sunlight based irradiance what's more, the cell temperature. To support the effectiveness of the PV framework, the MPP must be followed and taken after by directing the PV board to work at MPP working voltage point, accordingly advancing the creation of the power . A standout amongst the most essential focuses is the development of the vehicle is that, [2] it is firmly identified with the suspension outline, with the motivation behind accomplishing a basic upgraded work. In this way, keeping in mind the end goal to make the vehicle move under low power utilization and the overhaul of frame must be finished. The outline was considered from perspective of a high proficiency, light weight and stable transport with lessened expenses and zero outflow in its operation and in the acquiring of the vitality [3].Solar Energy is being utilized to create power with the offer assistance of these innovation our mean to make sun oriented vitality controlled Vehicle in our paper. Primary weaknesses of sunlight based vitality is with the end goal that it is not a consistent wellspring of energy and the measure of sun based vitality accessible continues changing for the duration of the day and during the evening time it is totally inaccessible. So to control our vehicle amid the nonattendance of sunlight based vitality we outlined as option technique for acquiring energy to run the vehicle from the Electric supply. Sun powered/Electric Powered Hybrid Vehicle (SEPHV) can charge itself from both sunlight based and electric power. The vehicle is changed out of a 'Maruti Omni' by supplanting its motor with a 1.2HP, 24V Permanent Magnet DC [3].

[PMDC] engine. The electric supply to the engine is acquired from a battery set of 12v, 150AH. Two sun oriented boards each with a rating of 230Watts are joined to the highest point of the vehicle to get the sun powered vitality and afterward it is controlled with the assistance of charge controller. This is utilized as a fundamental wellspring of vitality to charge the battery. The family electric supply of 230V is diminished with a stage down transformer to 24V and after that it is changed over it to DC with a correcting unit to charge the battery. This is utilized as a reinforcement source or helper of vitality to charge the battery. The Vehicle can be controlled and can matchup a speed of 45km/hr. The PV/Electric Powered Half and half Vehicle [SEPHV] is in this way a blast to the present world by furnishing us with fuel free method of transport.

Hybrid Grid System

Intended for use in remote range or islands, BenQ Solar crossover sun based vitality arrangement deals with the era, stockpiling, and use of sun based power alongside other power sources. In this paper, we propose the utilization of sun based power as a wellspring of energy for the sun based power framework. The small scale network framework diminishes dependence on open vitality matrices or diesel, and makes an eco-accommodating vitality hold that can be utilized for private utilize or a crisis emotionally supportive network [4, 5].

Why store the sunlight based vitality you create as opposed to nourish it to the matrix? Numerous legislatures and power organize administrators have diminished the sunlight based nourish in levy (FiT - cash or credit gotten for sun oriented vitality into the power lattice) which implies the less complex matrix encourage frameworks have turned out to be less efficient. This is on account of a great many people are working amid the day and are not home to utilize the sun oriented vitality as it is produced, so the vitality is bolstered into the lattice for almost no arrival. However for business organizations that for the most part work amid the day network sustain heavenly bodies are regularly the most sparing decision.

Mixture sun powered battery frameworks empower you to store the sun oriented vitality produced inside a battery which gives you the capacity to utilize it when you're home amid the night (when the cost of power is normally at pinnacle rate). Since the cost of pinnacle power in a few nations is four to five times the sunlight based sustain in rate to a half breed framework significantly diminishes your power costs [6].

The capacity to store and utilize your sun oriented vitality when craved is alluded to as self-utilize or self-utilization. It works in an indistinguishable path from an off-matrix control framework however the battery limit required is far less, normally recently enough to cover top night utilization (8 hours or less) instead of 3-5 days with a regular off-lattice framework

Solar Hybrid System Advantages:

- Stores & saves solar or cheaper off-peak energy.
- Allows use of solar energy during peak times (self-use or load-shifting)
- Power available during a grid outage or blackout – UPS
- Enables advanced energy management (ie. peak shaving)
- Enables energy independence
- Reduces power consumption

LITURATURE REVIEW

The nonlinear induction motor model is appropriately integrated by incorporating the dynamics of the electronic power converter in a manner that allows the design of stable field-oriented control (FOC) operating with minimum losses. As already proven, the challenging issue of operating the induction machine with minimum copper losses requires a varying rotor flux versus the standard FOC technique, which keeps the rotor field constant and tracks the electric torque to the desired level. To this end, exploiting the Hamiltonian structure of the developed motor / converter model, an innovated nonlinear controller is proposed that guarantees the technical limits of the converter (linear modulation) and simultaneously operates under FOC at steady state to achieve accurate speed regulation with varying rotor Flux according to the minimal losses requirements. Under these circumstances, the conventional FOC stability analysis does not hold anymore, and therefore for the first time, a new rigorous analysis is provided that provides stability and convergence to the desired equilibrium for the complete closed-loop motor converter system. Finally, the theoretical contribution is examined in comparison to the traditional FOC operation by simulations obtained for an industrial size induction motor, while it is further evaluated by real-time results of a motor with similar parameters. [7]

In this paper, a complete nonlinear system modeling of a VSC-fed induction motor was presented, and a nonlinear dynamic controller was proposed to achieve motor speed regulation with minimum losses. Taking into account the varying rotor flux theory, the relationship between the stator currents is obtained to minimize the power losses and to achieve field orientation at steady state. Both the current and speed regulation are implemented by a nonlinear controller that is fully independent of the system parameters and produces bounded duty-ratio signals always within the predefined limits as they are set by the linear modulation area of the converter. Based on the complete system dynamics and the controller structure, nonlinear closed-loop system stability is proven where the system states are guaranteed to remain bounded and converges to the desired equilibrium. Adding to the rigorous stability analysis the fact that the controller can be easily implemented with no measurements or estimation needed, this control scheme establishes a clearly innovated step in ac motor drives that decisively enhances the existing techniques. [8]

This paper presents a highly reliable, extended range power supply for an Electric Vehicle (EV). The power supply consists of solar PV source, a battery and Ultra capacitor (UC). This is the main source of power, and is supported by the Ultra capacitor during the transient phase such as starting and braking. Solar PV cell works during steady-state operation. The net effect of this arrangement is improved travel range, reduced battery size, enhanced battery life and excellent response during the dynamic condition. Improved dynamic performance results in smooth ride, optimal energy utilization and optimal sizing of energy sources. Most of the stand-alone photovoltaic systems require energy storage devices to supply continuous energy to the load when there is insufficient solar irradiation. Typically, Valve Regulated Lead Acid (VRLA) batteries are used for this application. However, providing a large burst of current, such as motor startup, degrades battery plates, resulting in devastation of the battery. An alternative way of supplying large bursts of current is to integrate VRLA batteries and super capacitors to form a hybrid storage system, where the battery can supply continuous energy and the ultra capacitor can supply the instant power to the load.

This paper work presents a pulse width modulation (PWM) speed control technique for a working model of grid solar hybrid electric vehicle. The integrated system consists of solar panel, charge controller, battery, step down transformer, diode rectifier, PMDC motor, speed controller and PIC Microcontroller 16F876A. The working model is able to run on dual mode - solar and electricity. It can also be driven either by solar or electricity. The battery can be charged from solar panel (10W) or by power supply. The household single phase A.C. Power supply of 230V is converted into 12V D.C. Using step down transformer and rectifying circuit. The working model can achieve energy saving, low carbon emission, environmental protection for the upcoming future of human life. The motor speed is controlled by PWM technique implementation using the programming burn in microcontroller. This technique is implemented on working model and its application results in reduced current consumption and removal of mechanical parts. The experimental result shows that the digital controller is able to follow the reference speed and hence, speed control is achieved as shown graphically. [9]

In this paper the working model for grid solar hybrid electric vehicle has been presented. The pulse width modulation speed control method is simple and inexpensive for D.C. Motor control, implemented with a microcontroller 16F876A having an inbuilt analog to digital controller. This experimental result shows that hardware implementation of working model prototype is Suitable for current designing of grid solar hybrid electric vehicle and this design is feasible and reliable for this kind of application. The aim of this project was to demonstrate that grid solar hybrid could be viable alternative to conventional vehicles and this could help to improve air quality in big cities, through the reduction in carbon dioxide emissions and by using renewable sources of energy (solar energy) We can reduce the world dependence on fossil fuel. The prototype realization is carried out successfully and the results have shown that the speed controller performs to stable and efficient motor control.

In world more than 60% petroleum is consumed by vehicles. Global warming, air pollution, rising price of gasoline fuel are the key issue of 21st century. Electric Vehicles (EVs) segment has gained importance in world. Every nation is looking for alternative energy efficient transportation solutions. Electric vehicles are the only alternative for clean, efficient and eco friendly urban transport system. Electric vehicles are being popular across the world but they are having some problems associated with driving range, energy storage system and stored energy management. This paper presents a new strategy of energy management between battery and supercapacitors, renewable approaches to generate electricity, new speed-torque control approach and an energy management system for electric vehicles. The main contribution of this paper is focused on improvement in performance and range of an electric vehicle. Torque and speed control circuit and energy management system has been introduced and implemented on the electric vehicle which extends the driving range and improving the efficiency of the propulsion system. Each mode of battery connection has its best range of speed, torque and efficiency. At the same time operation of electric vehicles will become like ICE vehicles driving smoothness and comfort. The test result shows that the driving range is increased by 30% over the same vehicle without torque and speed control circuit, energy management system. In the field of automobile sector, this kind of experiment is new. By implementing this system on an automobile, the fuel efficiency of an automobile increases without hampering environment. More research may be necessary for the determination of the number of modes, shift points and the actual road test on the driving range. [10]

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METHODOLOGY

A simple control such as the V / Hz strategy has limitations on the performance. To achieve better dynamic performance, more complex control scheme needs to be applied, to control the induction motor. With the mathematical processing power offered by the microcontrollers, we can implement advanced control strategies, which use mathematical transformations in order to decouple the torque generation and the magnetization functions in an AC induction motor. Such decoupled torque and magnetization control is commonly referred to as rotor flux oriented control, or simply Field Oriented Control (FOC). Nonstationar control such as the "V / Hz" strategy has its limitations in terms of performance. The scalar control method for induction motors generates oscillations on the produced torque. Hence to achieve better dynamic performance, the more superior control scheme is needed for Induction Motor. With the mathematical processing capabilities offered by the micro-controllers, digital signal processors and FGPA, advanced control strategies can be implemented to decouple the torque generation and the magnetization functions in an AC induction motor. This decoupled torque and magnetization flux is commonly called Flux Oriented Control (FOC). Field Oriented Control describes the way in which the control of torque and speed are directly based on the electromagnetic state of the motor, similar to a DC motor. FOC is the first technology to control the "real" motor control variables of torque and flux. With decoupling between the stator current components (magnetizing flux and torque), the torque producing component of the stator flux can be controlled independently. Decoupled control, at low speeds, the magnetization state of motor can be maintained at the appropriate level, and the torque can be controlled to regulate the speed. "FOC has been only developed for high-performance motor applications which can operate smoothly over the wide speed range, can produce full torque at zero speed, and is capable of quick acceleration and deceleration"

In order to understand the spirit of the Field Oriented Control technique, let us start with an overview of the separately excited direct current (DC) motor. In this type of motor, the excitation for the stator and rotor is independently controlled. Electrical study of the DC motor shows that the produced torque and the flux can be independently tuned. The strength of the field excitation (i.e. the magnitude of the field excitation current) sets the value of the flux. The current through the rotor windings How much torque is produced. The commutator on the rotor plays an interesting part in the torque production. The commutator is in contact with the brushes, and the mechanical construction is designed to switch to the winding circuit that is mechanically aligned to produce the maximum torque. This arrangement then means that the torque production of the machine is fairly close to optimal all the time. The key point here is that the windings are managed to keep the flux produced by the rotor windings orthogonal to the stator field. [12]

Induction machines do not have the same key features as the DC motor. In both cases we have only one source that can be controlled which is the stator currents. On the synchronous machine, the rotor excitation is given by the permanent magnets mounted on the shaft. On the synchronous motor, the only source of power and magnetic field is the stator phase voltage. Obviously, as opposed to the DC motor, flux and torque depend on each other.

The goal of the FOC (also called vector control) on synchronous and asynchronous machine is to be able to separately control the torque producing and magnetizing flux components. The control technique goal is to (in a sense), imitate the DC motor's operation.

Induction Motors

Induction motors derive their name from the way the rotor magnetic field is created. The rotating stator magnetic field induces currents in the short circuit rotor. These currents produce the rotor magnetic field, which interacts with the magnetic field field, and produces torque, which is the useful mechanical output of the machine.

The three phase squirrel cage AC induction motor is the most widely used motor. The bars forming the conductors along the rotor axis are connected by a thick metal ring at the ends, resulting in a short circuit as shown in Fig. The sinusoidal stator phase currents fed into the stator coils create a magnetic field rotating at the speed of the stator frequency (ωs). The changing field induces current in the cage conductors, which results in the creation of a second magnetic field around the rotor wires. As a consequence of the forces created by the interaction of these two fields, the rotor experiences a torque and starts rotating in the direction of the stator field.

As the rotor begins to speed up and approach the synchronous speed of the stator magnetic field, the relative speed between the rotor and the stator flux decreases, decreasing the induced voltage in the stator and reducing the energy converted to torque. This causes the torque to drop off, and the engine will reach steady state at a point where the torque load is matched with the torque motor. This point is an equilibrium reached depending on the instantaneous loading of the engine.

Vector control (motor)

Vector control, also called field-oriented control (FOC), is a variable-frequency drive (VFD) control method in which the stator currents of a three-phase AC electric motor are identified as two orthogonal components that can be visualized with a vector . One component defines the magnetic flux of the motor, the other torque. The control system of the drive calculates the corresponding current component references from the flux and torque references given by the drive's speed control. Typically proportional-integral (PI) controllers are used to keep the measured current components at their reference values.

The pulse-width modulation of the variable-frequency drive defines the transistor switching according to the stator voltage references that are the output of the PI current controllers.

FOC is used to control AC synchronous and induction motors. It was originally developed for high-performance motor applications that are required to operate smoothly over the full speed range, generate full torque at zero speed, and have high dynamic performance including fast acceleration and deceleration. However, it is becoming increasingly attractive for lower performance applications as well as FOC's engine size, cost and power consumption reduction superiority. It is expected that with increasing computational power of the microprocessors it will eventually universally displace single-variable scalar volts-per-Hertz (V / f) control.

The motor control industry is a strong, aggressive sector. To remain competitive new products must address several design constraints including cost reduction, power consumption reduction, power factor correction, and reduced EMI radiation. In order to meet these challenges, advanced control algorithms are necessary. Embedded control technology allows both a high level of performance and system cost reduction to be achieved. According to market analysis, the majority of industrial motor applications use AC induction motors. The reasons for this are higher robustness, higher reliability, lower prices and higher efficiency (up to 80%) on comparison with other engine types. However, the use of induction motors is challenging because of its complex mathematical model, its non linear behavior during saturation and the electrical parameter oscillation which depends on the physical influence of the temperature. These factors make the control of motor induction complex and call for use of high-performance control algorithms such as "vector control" and a powerful microcontroller to perform this algorithm. [13, 14]

During the last few decades the field of controlled electrical drives has undergone rapid expansion due to the benefits of micro-controllers. These technological improvements have enabled the development of very effective AC drive control with lower power dissipation hardware and more accurate control structures. The electrical drive controls become more accurate in the sense that they are not only DC quantities controlled but also the three phase AC currents and voltages are managed by so-called vector controls. This document describes the implementation of the most efficient form of a vector control scheme: the Field Orientated Control method. It is based on three major points: the current machine and voltage space vectors, the transformation of a three phase speed and time dependent system into two coordinate time invariant system and effective Space Vector Pulse Width Modulation pattern generation. Thanks to these factors, the control of AC machine acquires every advantage of DC machine control and frees itself from the mechanical commutation drawbacks. Moreover, this control structure, by achieving a very steady state and transient control, leads to high dynamic performance in terms of response times and power conversion. [15]

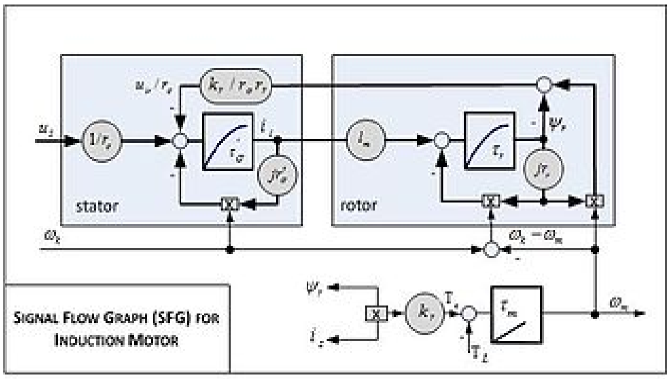
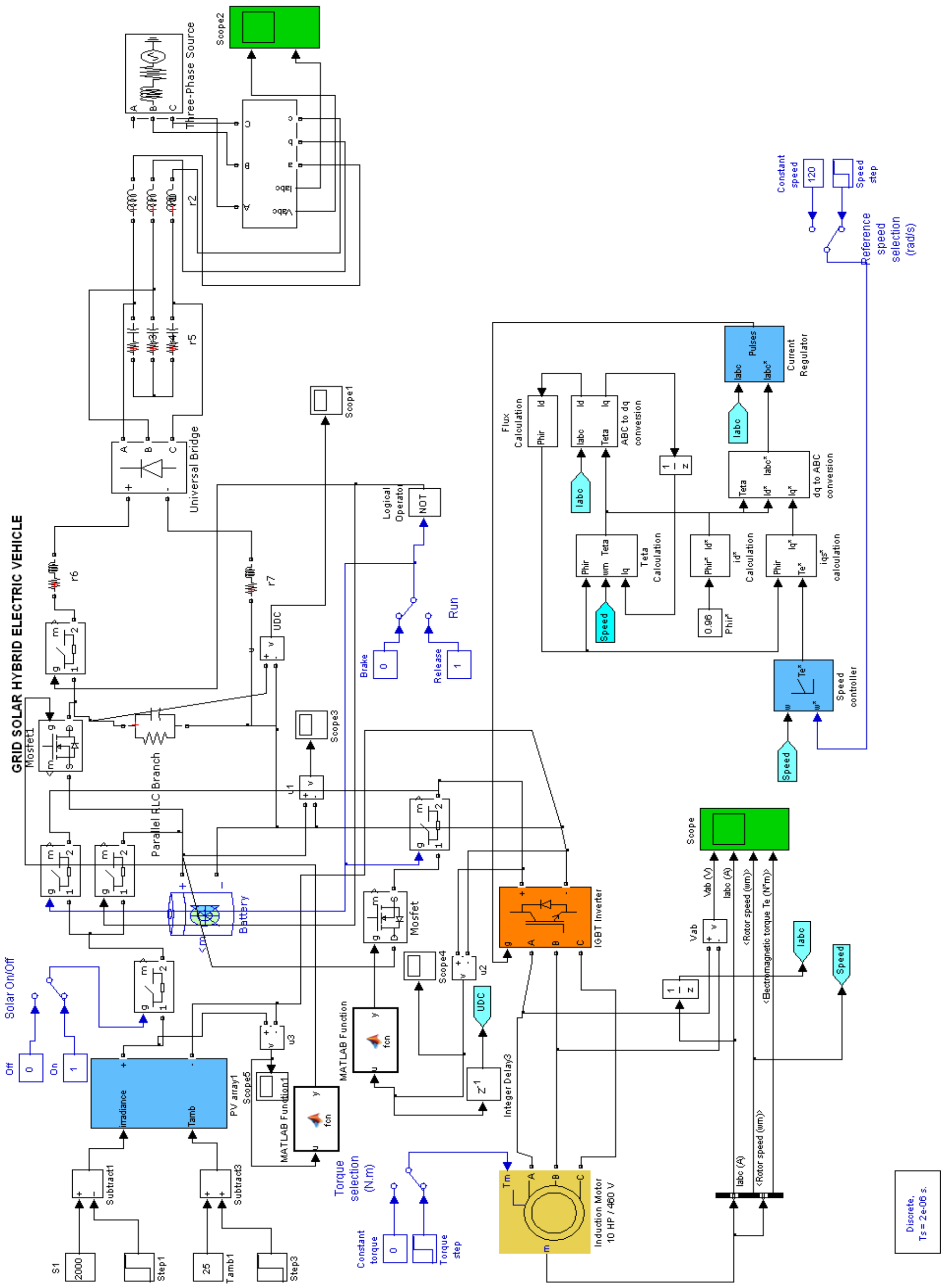


Fig 1 Signal flow Diagram of Induction Motor

VI SYSTEM DESIGN



VII. RESULT

Simulation parameter

S. No.	Parameter	Value
1	Simulation Type	Discrete
2	Solve Type	Tustin
3	Sample Timer	Ts
4	Simulation Timer	3 sec

Motor Parameter

S. No.	Parameter	Value
1	Power	10HP
2	Voltage	460 V
3	Frequency	60 Hz
4	Type	3 Phase Asynchronous Machine Squirrel cage
5	Stator Resistance	0.087 Ohm
6	Stator Inductance	0.8 mH
7	Rotor Resistance	0.228 Ohm
8	Rotor Inductance	0.8 mH
9	Mutual Inductance	34.7 mH
10	Inertia	1.662 J(Kg.M^2)
11	Friction Factor	0.12 F(N.M.S)

Initial Switch Settings

S. No.	Switch Name	Position (OFF)	Position (ON)	Initial Condition
1	Solar On/Off	Solar Panel Disconnect	Solar Panel Connect	ON
2	Break/Release	Break	Release	OFF
3	Reference Speed Select red/sec	Constant Speed (120)	Speed step	Speed Step(120rad/ sec, 160rad / sec)
4	Torque Salection (N-M)	Constant Torque	Costume Torque	Torque (0,200@1.85)

Solar Panel Parameter Change

S. NO.	Parameter	Time	Value
1	Irradiance	0 sec	2000
2	Irradiance	3 sec	1800
3	Ambition Temperature	0 sec	25 degree Celsius
4	Ambition Temperature	2 sec	20 degree celsius

Various Switching of Parameters

S. NO.	Time (Sec.)	Solar Panel	Break/Release	Torque	Speed Select
1	0 sec	ON	Break	0 N-m	120 rad/ sec
2	0.2	ON	Break	0 N-m	160rad/sec
3	0.711	OFF	Break	0 N-m	160rad/sec
4	1.262	OFF	Release	0 N-m	160rad/sec
5	1.652	ON	Release	0 N-m	160rad/sec
6	1.85	ON	Release	200 N-m	160rad/sec
7	2.090	ON	Release	200 N-m	120rad/sec
8	2.536	ON	Break	200 N-m	120rad/sec
9	2.958	OFF	Break	200 N-m	120rad/sec

Induction Motor Running Parameters

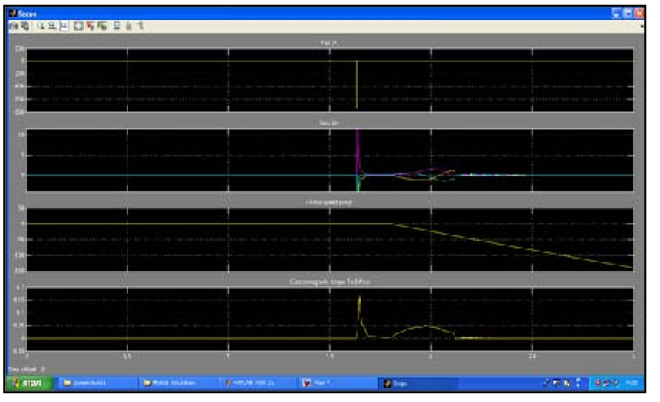


Fig. 2 Induction Motot Running Parameters

S. NO.	Time (Sec.)	Vab (V)	Iabc (Amp.)	Rotor Speed (WM)	Electrostatic Torque (N-m)
1	0 sec	0	0	0	0
2	0.2	0	0	0	0
3	0.711	0	0	0	0
4	1.262	0	0	0	0
5	1.652	0	10	0	0.17
6	1.85	0	2	-10	0.03
7	2.090	0	2.5	-25	0.05
8	2.536	0	0	-130	0
9	2.958	0	0	-150	0

Main Voltage and Current

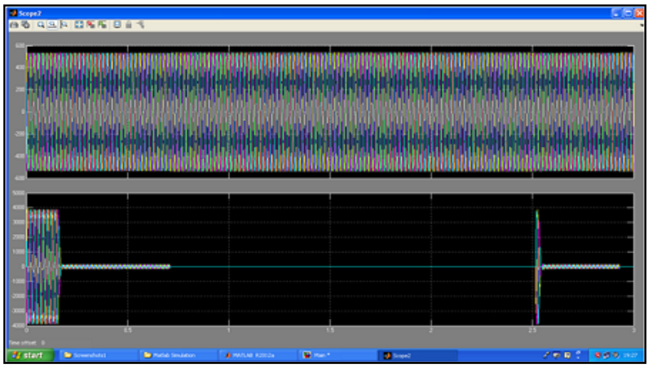


Fig.3 Current Iabc And Time Graph

CONCLUSION AND FUTURE SCOPE

Conclusion

Electric Vehicles are the only alternative for clean, efficient and environmental friendly urban transport system. In general, coordinated charging of vehicular generated. Hybrid EV's using vehicular generated Renewable energy and Grid power can lower power losses and voltage deviations by Flattening out peak power, and reduce major load on grid. Also the acceptance of EV's by mass public is improvised using FOC / vector control and employment of high power Induction motor in low power consumption mode in default states and high torque mode where burst power is required.

This technique improves the handling, maneuverability and power performance of proposed EV Significantly. Also a highly efficient mode of uses of solar energy in running vehicle energy compensation is demonstrated. The utilization of solar energy in subsidization of battery power for running EV can be a Game charger technology, which increased battery life a derive endurance per charging cycle.

Future Scope

Use of higher energy efficiency solar photovoltaic systems and power converter is emphasized to improve overall efficiency of grid solar hybrid EV's. Also efficient and intelligent electronic switching and control systems can be deployed on DSP's (Digital signal Processing) to obtain low cost electronic control cards/Boards for grid solar hybrid EV's. Also the systems can faciliate real time monitoring and diagnostic functionality and fall in conjunction with smart Grid / Smart city implementations.

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