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SOLAR FED PMSM DRIVE USING ARDUINO

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ABSTRACT: Electricity is an essential commodity for modern and technologically developed world and it is very important for the future development of the society. Electricity must be supplied on a continuous basis in order to cover daily requirements. Power plants are the only way to ensure the daily production of electricity, however they contribute significantly in environmental pollution since they consume fossil fuels. This project investigates a way to operate "Solar hybrid PMSM drive" to lower the dependency on conventional power sources. Thus the use of renewable sources we can reduce the CO2 emissions. In this project we are using solar panel to generate 12V output to charge the lead acid battery through "Solar hybrid charger" also the battery can be charge using 12V DC source. Then the charged battery can be used to run the "Permanent magnet synchronous motor" by PMSM drive. The PMSM along with the Solar hybrid charger can be use in multipurpose way. e.g. It can drive the emergency fans, motor pumps, some household loads, etc.

INDEX TERM **– Arduino UNO, Battery, PMSM Drive, Solar Hybrid Charger, Solar photovoltaic System.**

I. INTRODUCTION

The global population increase has created the need of more energy, it is major threat of concern amongst developing nations. These nations are investing huge capital in the construction of new power plants or extending the operation of the existing ones. These all results in increase of CO2 emission in atmosphere, this later becomes major concern of global warning. The developing countries should invest their capital in renewable sources of energy to counter global warming and increasing power needs.

The moto of the project is to produce the energy in an ecofriendly way by using renewable sources of energy and to use energy for various applications. As we all know that solar energy is optimistic renewable resource to produce electrical energy, but this resource is not much efficient as compare to other conventional energy sources. So various researches have been carried out for utilization of solar energy in the best way.

This project's objective is to develop an optimal design of "Solar hybrid PMSM drive" for use in multipurpose application. In rural India the farmers get electricity for few hours a day to run their motor pump, sometimes due to large demand in industrial sector the energy supply in farming sector get affected. To overcome this situation, we have introduced our project, the water pump coupled with PMSM drive can efficiently work as a conventional motor pump. Due to compact and light weight the PMSM drive can be use in multipurpose way. This all just need solar energy to charge in a day and in unfavorable weather conditions this can be charge directly by electric power supply.

II. BLOCK DIAGRAM

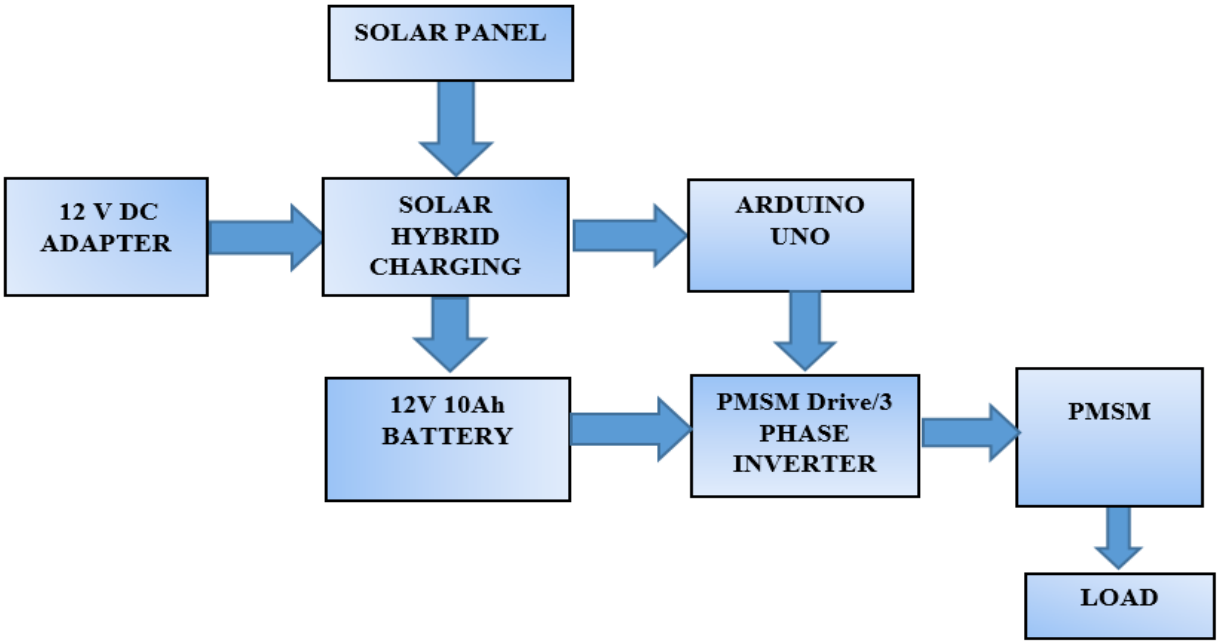


Fig 1- Block Diagram Of Solar Fed PMSM Drive

III. SOLAR HYBRID CHARGER

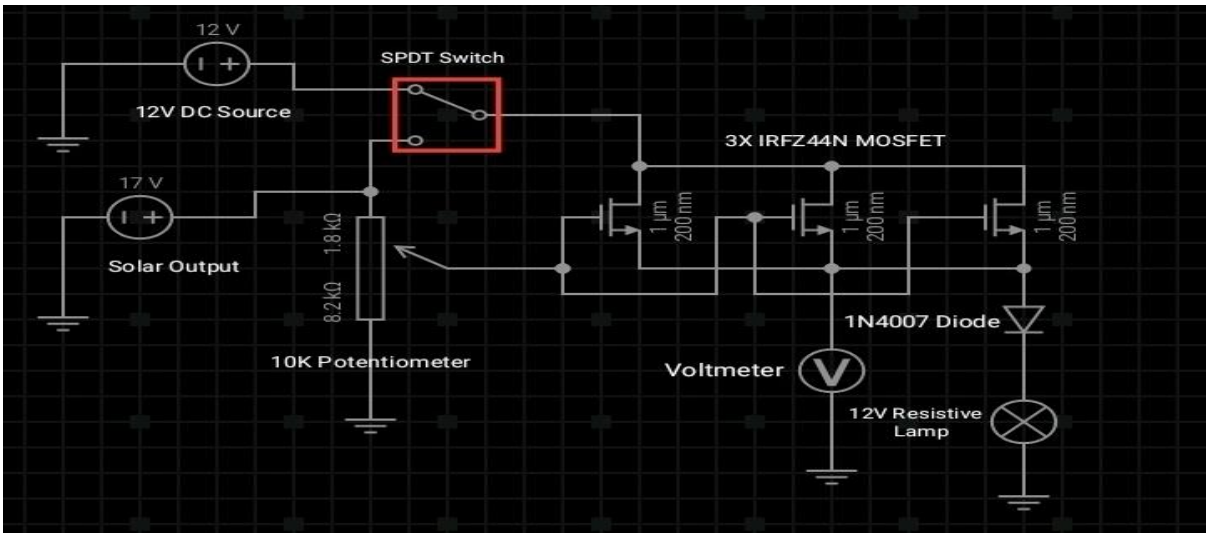


Fig 2- Solar Hybrid Charger Circuit

A. Construction

The solar hybrid charger consists of two power sources for charging the battery, the first one is solar panel which is the primary source and 12V adapter which is secondary source. The positive terminal of both the sources are connected at 1st and 3rd pin of the SPDT switch, the 2nd terminal of SPDT switch is delivering power to the MOSFETs. Here 3 MOSFETs are connected in parallel combination to deliver maximum charging current. The solar panel output is given to the 10k ohm potentiometer, also the middle terminal of potentiometer is connected to common gate terminals of MOSFETs. As we know that gate terminal of N channel MOSFET is controlling terminal. When solar panel is delivering power to the circuit we need to adjust the charging voltage up-to 12V, by using the gate terminal we can adjust the potentiometer in such a way that we get 12V output. The digital voltmeter shows the real-time output voltage or charging voltage, the diode connected at the last is to prevent the reverse current from the battery. In practically the lead acid battery is connected at the end instead of resistive load.

B. Working

During day period the battery will charge through solar energy, to achieve this the position of SPDT switch is shifted such that it delivers power to the circuit. To get exact 12V output we need to adjust the potentiometer, the output voltage from solar panel is depend on the intensity of solar radiation in the atmosphere, so the potentiometer should be adjusted throughout the day to maintain 12V output, the digital voltmeter is used to show the real-time output voltage it is very important while adjusting the charging voltage to 12V. During night or unfavorable weather conditions we need to charge battery through 12V adapter, to achieve this SPDT switch is shifted such that the adapter is delivering power to the circuit. In this condition there is no need to adjust the charging voltage as the adapter is continuously giving 12V output. The MOSFETs are carrying the charging current and deliver the current to charger the battery through diode, the main function of diode is to prevent current from battery to enter the circuit back.

IV. SIMULATION OF SOLAR HYBRID CHARGER CUERCUT

Fig 3 - When Solar Panel Is Powering the Circuit

We have successfully simulated the solar hybrid charger circuit on "Every Circuit" android application. The above result we get when the SPDT switch is shifted such that the solar panel is powering the circuit and eventually charging the battery. We have adjusted the charging voltage to 12V by adjusting potentiometer. At the end we have connected a lamp as a resistive load, the blue graph above the circuit shows voltage across the lamp and the green graph shows current consume by the lamp. We get the exact results as we expected

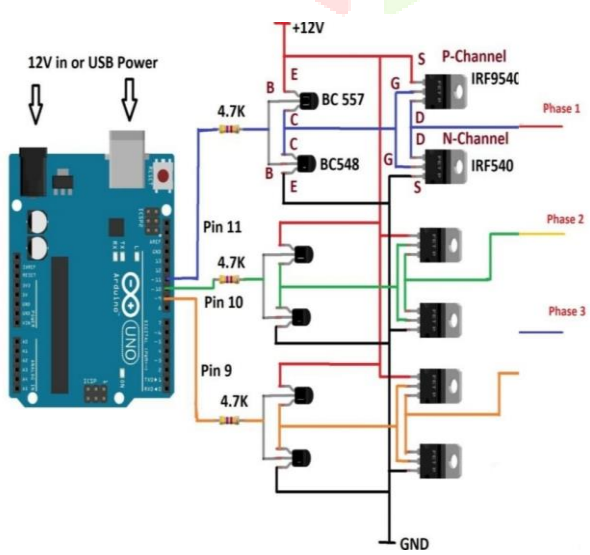
. We have practically implement the solar hybrid charger circuit when solar panel is powering the circuit on bread board. As shown in above picture we have consider 18.5V as open circuit voltage of solar panel and we have included the potentiometer to adjust the charging voltage. By adjusting the potentiometer, we successfully get 12V output.

Fig 4 - When Adapter is Powering the Circuit

The 12V DC adapter is the secondary source to power the circuit and eventually to charge the battery. The above result we get when SPDT switch is shifted such that the 12V DC adapter is powering the circuit. In this condition there is no need to drop down the charging voltage, so the potentiometer part is get bypassed. We get approximate 12V at the output and across the lamp, the blue graph above the circuit shows the output voltage and green shows the current consume by the lamp.

We have practically implement the solar hybrid charger circuit when adapter is powering the circuit on bread board. As shown in above picture the voltage of adapter in consider to be constant as 12V and there is no need to drop down the charging voltage. So we get as it is 12V output as charging voltage.

V. PMSM DRIVE/3 PHASE INVERTER



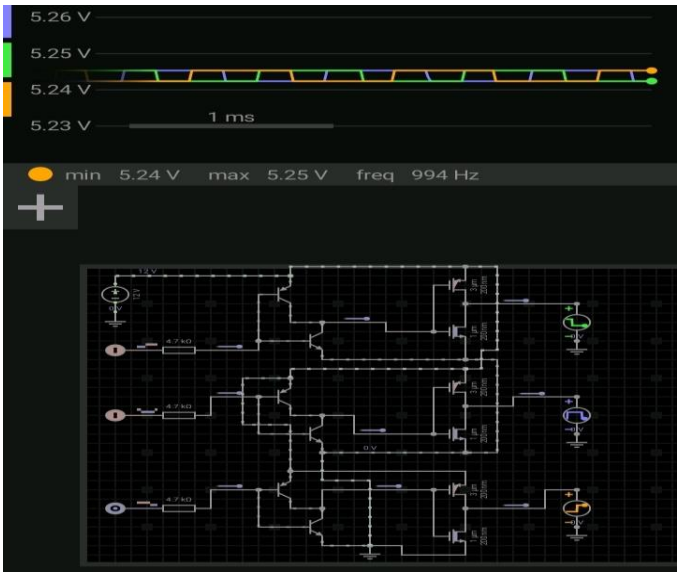


Fig 5 - PMSM Drive/3 Phase Inverter

We have successfully simulated the PMSM drive/3 phase inverter circuit in "Every Circuit" android application. The above result we get after the simulation, the three waveforms above the circuit shows the three phase output voltages. The nature of waveform is trapezoidal and the voltage amplitude is comparatively less to drive the permanent magnet synchronous motor. Although the phase shifting between two phases is 120 degrees. The results we get after the simulation is not as our expectations, so this circuit is not suitable for our project. We need to find other ways to get the expected results, and to drive the permanent magnet synchronous motor efficiently.

VI. FURTHER RESEARCH ON PMSM DRIVE/3 PHASE INVERTER

In the simulation of PMSM drive/3 phase inverter the we get trapezoidal waveform instead of sinusoidal waveform, also the negative half cycle of the waveform was missing the amplitude of output voltage is small and not capable to run permanent magnet synchronous motor. To overcome these problems, we have to work more on construction and working of inverter. We have studied the construction and working of basic inverter, we construct a basic inverter from four semiconductor switches and simulate it. In the results we get complete positive as well as negative half cycle of the waveform, also we get nearly 50Hz frequency although the nature of the waveform is still trapezoidal.

By understanding the principle and working of basic inverter we have developed three phase inverter using six semiconductor switches. We have found reason behind the trapezoidal waveform obtained in simulation of basic inverter we conclude that the output voltage waveform obtained from any converter is totally depends upon the switching of semiconductor switches. To get sinusoidal waveform we studied the 120 degree switching scheme of three phase inverter. We constructed the three phase inverter on simulation app and give pulses to the semiconductor switches according to the switching scheme of three phase inverter. In the results we get quasi-sinusoidal three phase waveform, having 120-degree phase shift between two phases. The waveform is complete and consist of positive as well as negative half cycle with 50Hz frequency. The quasi-sinusoidal waveform is obtained from the three stage inverter to get complete sinusoidal waveform we have to increase the inverting stages of the inverter. By increasing stages, the inverter becomes bulky and expensive, the output obtained from the three phase inverter is capable to run the permanent magnet synchronous motor efficiently.

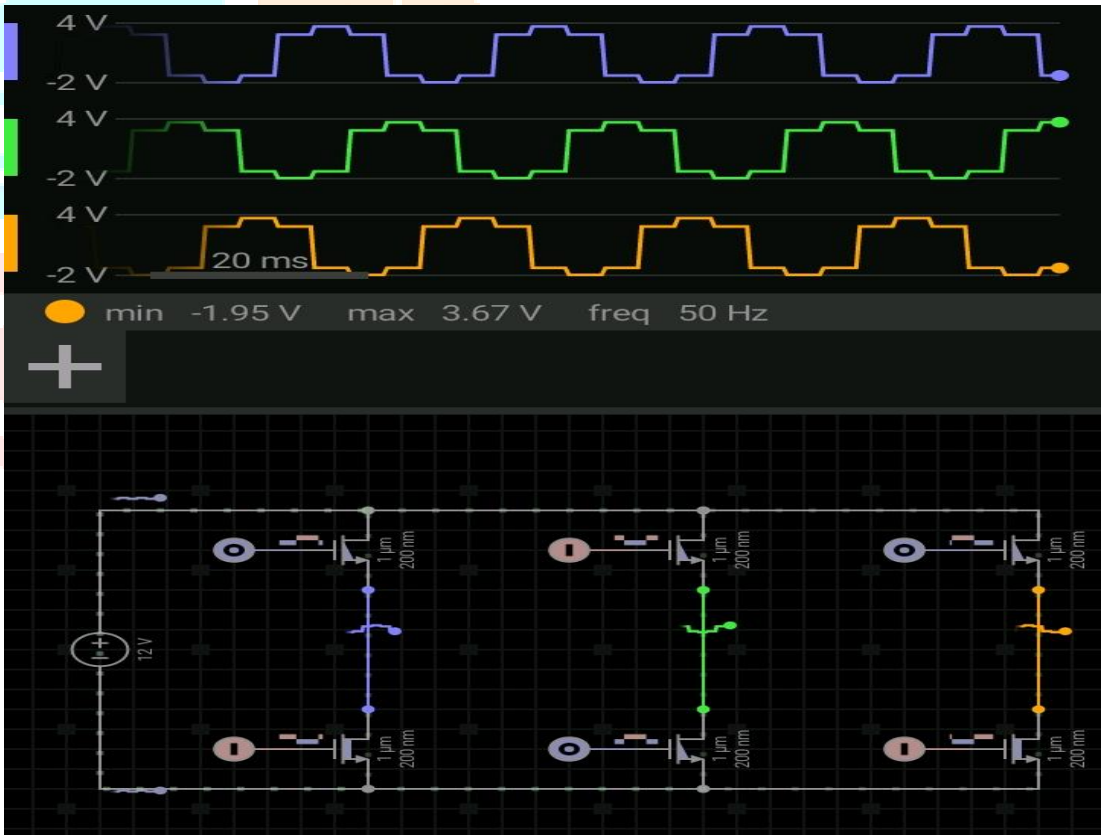
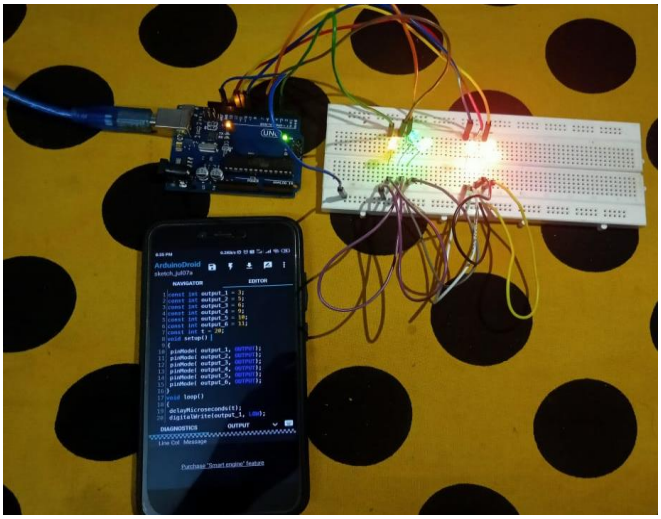


Fig 6 - 3 Phase Inverter Circuit and Simulation

VII. PROGRAMING WORK

The Arduino UNO we are using in our project consist of ATMEGA328P microcontroller, to programmed this microcontroller we are using an android application called "Arduino droid". We had codes for the old PMSM drive/3 phase inverter, but that circuit was rejected for the project due to the results. For the new PMSM drive/3 phase inverter circuit we need to change the codes. We successfully update the codes to produce six PWM pulses from pin no.3,5,6,9,10 and 11 of the Arduino UNO board.



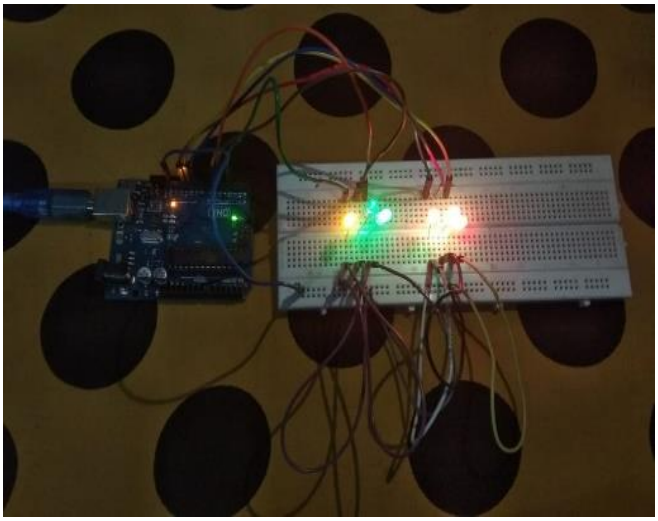


Fig 7 - Arduino Programming

VIII. DC MOTOR TO PMSM CONVERSION PROCESS

12V 775 DC MOTOR

To construct the PMSM we have taken a 12V 775 DC motor of above ratings. Our plan is to convert the DC motor to PMSM by doing some mechanical changes.

Rated voltage= 12V
Rated current= 0.32A
Rated maximum power= 60W
Rated maximum speed= 10000 rpm

Fig 8.1 - 12 V DC Motor

Fig 8.2 - PMSM Motor

The conversion process of DC motor to PMSM is quite simple, first we have to dissemble every part of the motor. We have to remove the rotor windings, brushes and commutator part also the rotor axle. We have to drill the motor armature with 6mm drill bit and mount the armature on metal support base now the rotor part of DC motor becomes the stator part of PMSM. Then we have to rewind the stator with 0.4mm insulated copper wire, the stator consists of three poles so three phase winding is not difficult to wind. We have winded three phase winding in delta connection, the PMSM become three phase three wire machine. We soldered heavy wires with the delta connected insulated copper wires, this all we need to do in construction of PMSM stator. For the construction rotor part of PMSM we have to take the body of DC motor and cut the excess part of the body by using hand grinder. Then we soldered the axle with the DC motor body permanently and mount this rotor setup on stator part of PMSM. We finally ensure that the rotor part of PMSM is fitted well on the stator this is how we have constructed PMSM by using 12V 775 DC motor.

IX. CONCLUSION

We have worked under the project titled as "Solar fed PMSM drive using Arduino", we have simulated Solar hybrid charger and PMSM drive/3 phase inverter circuits and get the proper expected results. We have converted DC motor to PMSM by doing some mechanical changes, we have published a review paper in a UGC approved journal and receive certificates. The hardware part of project is completed and the PMSM rotates with synchronous speed with water pump as a load. The software part consists of programing and simulation, the programing is completely by using "Arduino droid" android app and simulation is completed by using "Every Circuit" android app.

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