Evolution of Grid Connected Solar Based Water Pumping by usage of PMSM Drive

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***Abstract*— The work proposes the design and experimental investigation and the topology applies a photovoltaic array to change form solar energy to electrical energy, that is in terms of power. The obtained energy forms the solar array is utilized to rotate the permanent magnet synchronous motor (PMSM) using 3 phase voltage sources inverter. An intermediated stage boost converter is attached in between the solar panel and voltage source inverter to extract optimum power for solar PV array under variable insolation. The necessary of sustained water supply is not possible with single system, due to the infrequent corporated with photovoltaic solar system. A grid integrated solar water pumping is proposing here in order to overcome this problem here the battery is used as utility grid and it is attached to voltage source inverted and PMSM control respectively and the pump is attached by PMSM. Which performs the water pumping., irrespective of solar isolation level, a constant water pumping is done due to the utility grid.**

***Keywords*— PMSM, Solar PV array, PWM, 3 Phase Inverter, Optocoupler, Arduino and Battery**

I. INTRODUCTION

Non-conventional energy generation and well-organized use of obtainable energy resources be revealed as a flawless universal remedy for enlarging the carbon cost draining nonrenewable fuel sources, increasing global warming and changing climatic condition [4]. The demand for energy saving estimation has been rapidly expanding as the energy stipulation has increased. In this trend, the PMSM motor plays a critical role as a high effect energy motor [1]. When compared to an induction motor, which is commonly utilized in solar-powered water pumping. Low torque repulsion, smooth torque with increased efficiency, low noise, high performance at both high and low speeds, low inertia, and superior performance factor are all features of PMSM motors. [5].

The development of solar technology is at its advanced and sophisticated stage among the most favorable and noteworthy non-conventional energy sources. This technique is becoming increasingly relevant in terms of energy conservation. As a result, the solar offered for PMSM motor drive has proven to be a worthwhile combination of source and drive for a water pumping application. Despite various positive qualities, the intermittent nature of solar power producing technology is a severe issue. With a solar-powered water pumping system, this flaw results in deceptive water pumping. Water pumping is severely disrupted as a result of changing climatic conditions. In addition, the system is underutilized since the pump is not operating at maximum capacity. Furthermore, the inability to obtain sunlight (during the night) results in the complete shutdown of a water pumping system. To control this problem, a PMSM motor pumping system includes an external power backup in the form of a battery store [2]. An incremental conductance technique is applied for array using a boost [3]

The goal of this project is to provide continuous water pumping using solar and utility grid technology. Although a constant high energy is obtained from the sum the outcome of the voltage output fluctuates as the intensity of the solar radiation fluctuates in climate. In this work the boost converter is used to converter to minimize the pulsating voltage in a 3-phase inverter which is fed form solar energy.

This Paper is organized as follows: Section II presents the System Configuration and Operation; Section III presents the System Hardware Validation and Section IV presents the Conclusion.

II. SYSTEM CONFIGURATION AND OPERATION

A. SCHEMATIC DIAGRAM OF 3 PHASE INVERTER

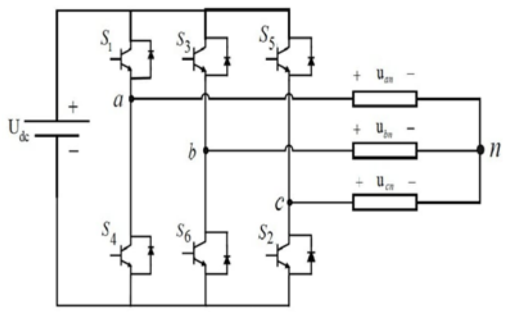


Fig. 1 3 Phase Inverter Schematic Diagram

B. POWER SUPPLY

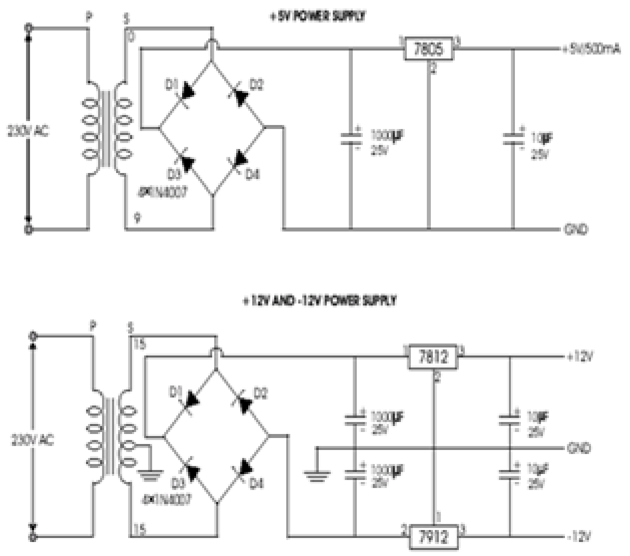


Fig. 2 Circuit Diagram of Power Supply

Block Diagram

The AC voltage, which is normally 220 V rms, is linked to a transformer, which decreases the AC voltage to the Yearning DC O/p level. A Rectifier diode then produces a full-wave rectified voltages, which is initially filtered by a filter of simple capacitor to generate a DC voltage. The resulting DC voltage frequently contain wavelet or ac voltage fluctuation.

Anyway, of whether the DC voltage alters or the load connected with the output DC voltage changes, a circuit of controller removes the wavelet and continues as before DC voltage. One of the voltage controller IC devices is usually used to achieve this voltage regulation.

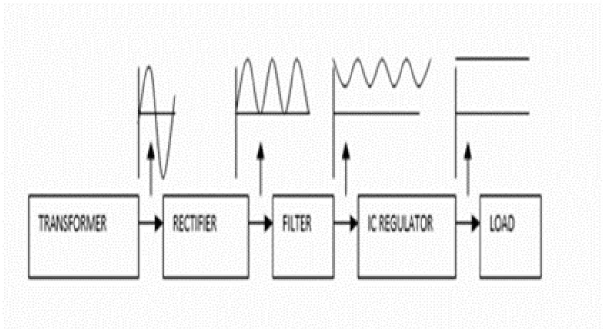


Fig. 3 Block Diagram of Power supply

C. WORKING PRINCIPLE

Transformer

The transformer is connected primary winding and secondary winding. The primary is suitable supply voltage is given and the secondary is center topped. And it is an autotransformer. The PT reduces the supply voltage of power from (0-230 V) to (0-6 V). The Accurateness rectifier, which is generated with the assistance of the op– amp, will next be connected to the PT's auxiliary. The advantage of using an accurateness rectifier is that it will provide a DC crest voltage yield while the rest of the circuit will only provide RMS output. Low price and a compact package.

Table 1: Specification and Ranges of Transformer

Specification	**Values**
I/P Voltage	230V AC
O/P Voltage	12V RMS or 24V RMS
O/P Current	1A
Mounting	Vertically Mount Type
Core	Soft Iron Core

Bridge rectifier

A Rectifier of bridge when 4 diodes are connected. The circuit's input is connected to the system's obliquely opposing corners, while the O/P is taken from the other two.

Allow to assume that transformer is operating properly and that the potential of point A is positive, while the potential of point B is negative. D3 will forward bias and D4 will reverse bias due to the positive potential at point A.

D1 will be forward biased and D2 will be reversed as a result of the negative potential at point B. D3 and D1 are currently forward biased, allowing current to flow through them; D4 and D2 are reverse biased, preventing current from flowing through them.

Current flows from point B through D1, up through RL, through D3, and back to point B via the transformer's secondary.

Similarly, for the other half cycle the other two diodes D2 and D4 will be forward biased to provide the same positive voltage at the output load.

One advantage of a Rectifier bridge over a regular rectifier that converts AC to pulsating DC is that it provides roughly twice the voltage of the traditional full-wave circuit using the same transformer.

Table 2: Specifications and Ranges of Bridge Rectifier

Specification	**Values**
O/ P DC Current	1.5A
Max. Peak Reverse Voltage	600V
O/P Voltage	2V
Max. O/P Voltage	560V

Characteristics

- wavelet factor
- Peak reverse voltage
- Efficiency

IC voltage regulators

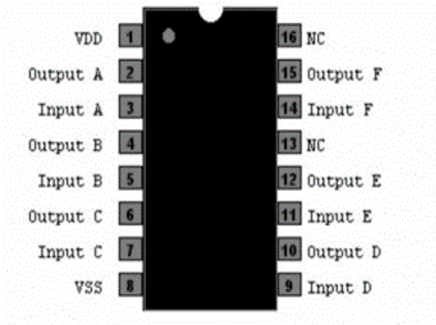
Voltage regulators are a common type of integrated circuit. Single ICs are safeguarded by regulator IC units, which include hardware for a comparator amplifier, source, control device, and over-load protection. A constant positive voltage, a settled negative voltage, or a flexibly set voltage can all be regulated by an IC unit. The controllers can handle load currents ranging from a few milliamps to several amps, with power ratings ranging from milliwatts to several watts.

A 3 terminal voltage regulator has an unregulated DC I/P voltage (Vi) linked to one terminal, a regulated DC voltage (Vo) attached to another, and the third terminal connected to ground.

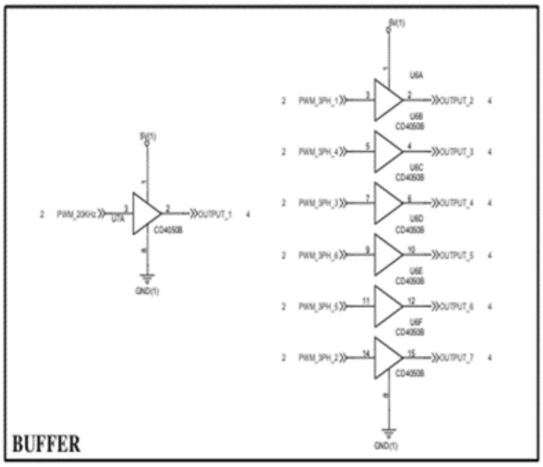
The 78 series regulator give settled positive (+ve) and the 79 series regulator give settled negative(-ve). And both series of positive and negative the DC voltages from 5 to 24 volts.

CD4050BE

The CD4049UB and CD4050B ICs are inverting and non-inverting hex buffers, respectively, that may alter logical levels with just a single supply voltage (VCC). When these ICs are used for logic level adjustments, the voltage input (VIH) can exceed the VCC supply voltage.



(a)



(b)

Fig. 4 (a) Pin Diagram and (b) Buffer

These ICs are proposed for use as CMOS to DTL or TTL converters and can drive specifically 2 DTL or TTL loads. (VCC = 5V, VOL ≤ 0.4 V, and IOL ≥ 3.3 mA.)

EL817(Opto Isolator)

Description:

The EL8179IC series each comprise of an infrared radiating diode, optically coupled to a phototransistor indicator. They are bundled in a 4-pin DIP bundle and accessible in wide-lead separating and SMD choice.

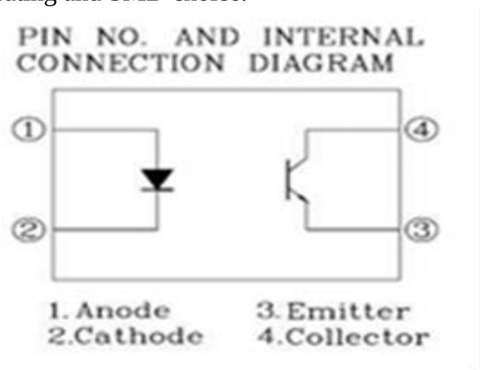


Fig (a) Internal Connection Diagram of Opto isolator

Features:

• Ratio of current ratio with collector emitter voltage of 5V and current 5mA is between 50 to 600%

• The 5000Vrms isolation between the LED and photodiode

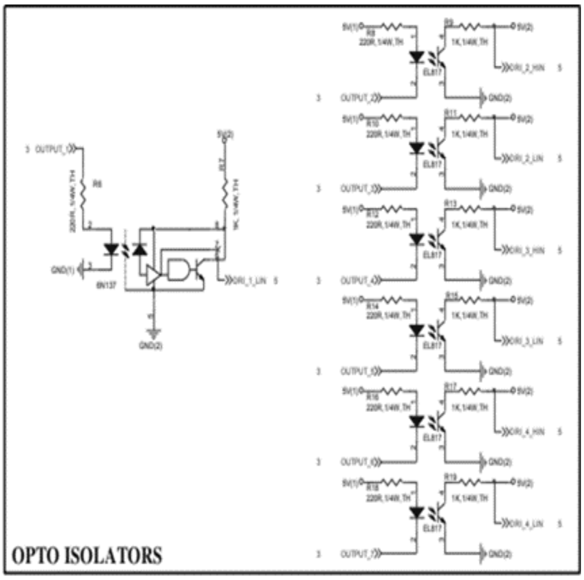


Fig. 5 (a) and (b) OPTO ISOLATOR

Driver 2110:

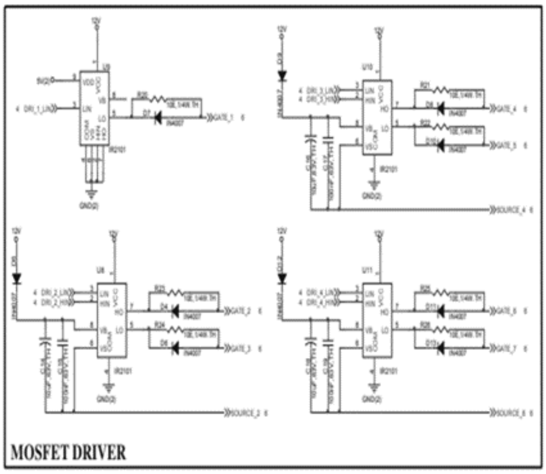
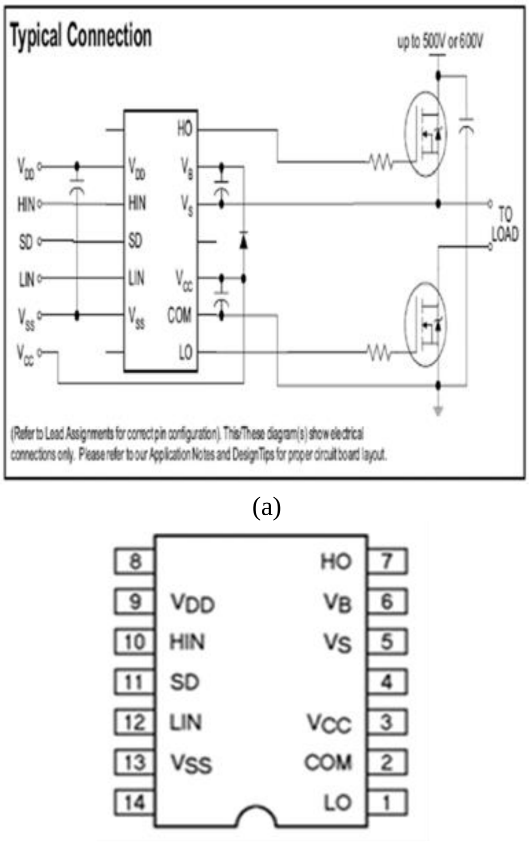


Fig. 6 MOSFET DRIVER

Floating circuits are used to drive high-side MOSFETs in a variety of applications. 2 MOSFETs are used as high side MOSFETs and two MOSFETs are used as low side MOSFETs in the H bridge used as part of the sine wave inverter. The IR2110 MOSFET driver can work on both the high and low sides of the MOSFET. To deal with the bootstrapping activity, it has a floating circuit. With a stand voltage of up to 500 volts, the IR2110 can be used (counterbalance voltage). Its output pins can deliver 2 amps of electricity. It's also a good IGBT driver. The IR2110 skimming circuit can drive MOSFETs up to 500 volts on the high side. Below is a list of pin configurations and their usefulness.



(a)

(b)

(a) Schematic of test circuit of the IR2110 driver, (b) Pin diagram

Low side MOSFET drive output is denoted in pin 1, while the return path for the low side is defined in pin2 which is connected to ground as pin 13. When the Lin input is high the LO output at pin 3 will become VCC, while Lin is low LO will become VSS which is zero. Similarly, Hin pin is the input for the high side MOSFET.

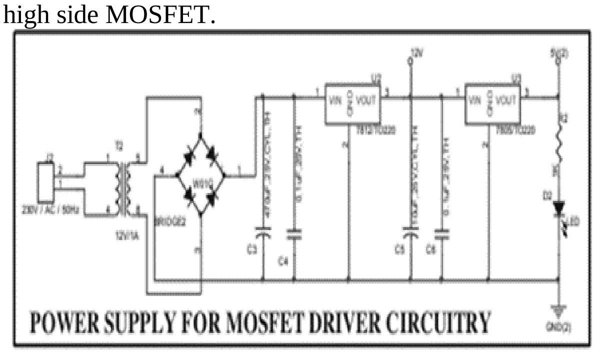


Fig. 7 POWER SUPPLY FOR MOSFET DRIVER CIRCUIT

3 PHASE INVERTERS

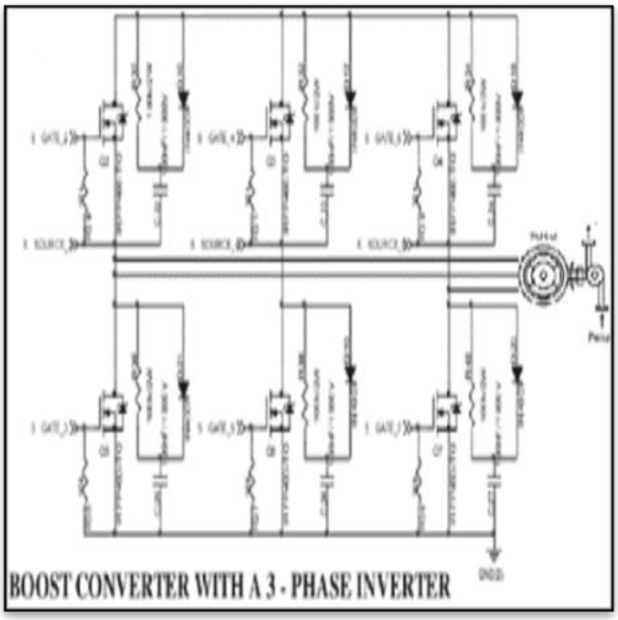


Fig. 8 3-PHASE INVERTER

An inverter is a type of power conversion circuit that takes a DC voltage or current and converts it to a symmetric AC voltage or current. It works in the opposite direction as ac-to-dc. A direct dc source or a dc source generated from an ac source is used as the inverter's input. The major source of input power, for example, could be a utility ac voltage supply that is transformed to dc by an ac - dc rectifier with filter capacitor and then back to ac by an inverter. The final ac output may have a different frequency and magnitude than the utility supply's input ac. The Inverter is a voltage source if the input dc is a voltage source. A battery bank or a stack of solar PV cells may be the simplest dc voltage source for a VSI. After rectification into dc, an AC voltage supply can also be used as a DC voltage source.

III. SYSTEM HARDWARE VALIDATION

The hardware setup for the system is as given in the Figure 9. The Three Phase Inverter, driver circuit for isolation from the Arduino processor and the Battery is as shown in the Figure.

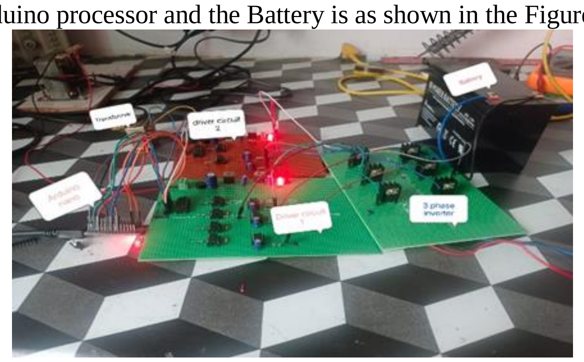
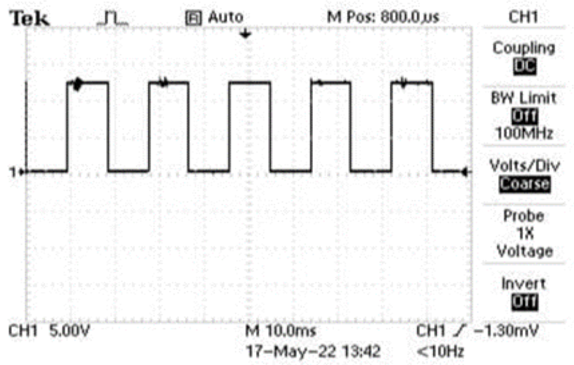
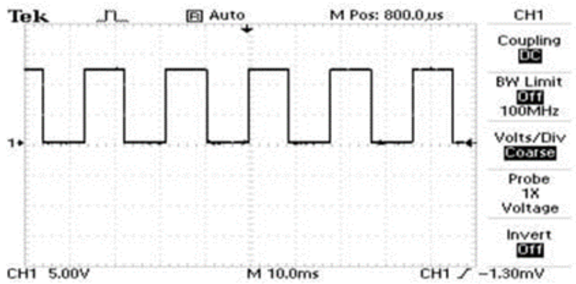


Fig. 9 COMPLETE HARDWARE SETUP THREE PHASE INVERTER DRIVE

The O/P from the Three phase inverter can be obtained from the PWM generated for each of the 6 switches. The switching sequence for all the six switches (three and NOT of three) are as given in Figure 10.



(a)



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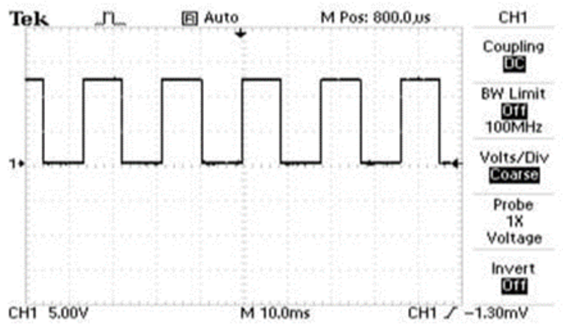

(c)

Fig. 10 (a) A phase PWM, (b) B phase PWM and (c) C phase PWMs

After pulses are given to the six switches of the three-phase inverter the output obtained from the inverter is as given in the Figure 11.

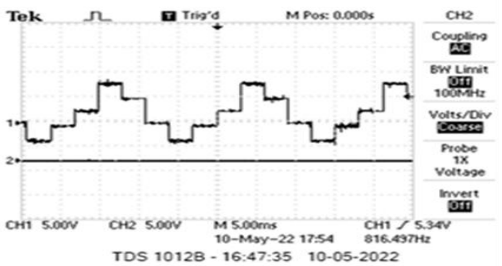

Fig. 11 THREE PHASE INVERTER OUTPUT

All the pulses and the 3 phase inverters are getting the output for the 50 Hz frequency

IV. CONCLUSION

Evolution of Grid Connected Solar Based Water Pumping by usage of PMSM Drive has been revealed and proposed through its evaluation of performance using hardware prototype. An external power backup in the form of a battery storage as a utility grid has been advocated for in a PMSM motor pumping system with full capacity of water supply, which has provided a financial benefit. As a result, the proposed topology has shown to be a dependable and well-organized water pumping system.

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