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Intelligent Grid Connected Solar Water Pumping Scheme, Using BLDC Drive

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Abstract

A Grid connected solar PV fed water pumping system run by a Brush Less DC motor is proposed in this paper. Present days, the energy supply in the world is flared day by day which the nonrenewable energy sources are not able to meet this energy demand. By using solar energy, wind energy etc., this energy demand can be fulfilled. Because of frequent power cuts Solar water pumping system has become a better option for irrigation purpose. The solar panel output power is not constant throughout the day. To optimize the generation of solar energy, a MPPT algorithm technique is utilized. The distribution system (grid) is used as external power backup integrated with Solar water pumping system. If the PV array is impotent to satisfy the necessary power need, the power is worn from the grid, other than the PV array is used rather. Via a PFC boost converter, a simplex power flow control for the same is generated and completed.The motor parameters can be controlled by using a VSI. A suitable configuration is planned for the PV array and BLDC motor-drive, providing efficient water pumping. The installation of the hardware is carried out to show the system's output.

Key words - VSI, BLDC Motor, Solar PV Array, Water Pump, Buck-boost Converter

1. Introduction

Because of the rapid decline of traditional fossil fuel supplies and the consistent cost reduction of PV panels, PE devices, and processors, the expected global energy crisis soon produced interest in the productive use of solar PV technology among researchers and industrialists. A PV powered water pumping scheme appears to be the most exciting and appealing in the numerous use of solar PV energy in various areas, such as rural street watering, agricultural supply, and fish farms[4]. Water pumping for irrigation has became a major problem for the farmers. In this scenario solar water pumping has became best alternative among all. The water pumping is highly intermittent because of bad climatic condition.In addition, as the pump is not running at its maximum potential, the system is underutilized. In comparison, the unavailability of sunshine (at night) allows the entire water pumping scheme to be shut down. To optimize the usage of solar power, online monitoring of the full power point of a PV array/module is therefore necessary. A number of methods of MPPT have been developed. The techniques differ in complexity of implementation, sensed parameters, sensor number needed, speed of convergence, and cost. Regardless of the working environments, whether day or night, the primary objective is to ensure a constant and maximum amount of water supply. In addition, the performance of the SPV panel varies with solar radiance. The SPV array's MPPT is not reached much of the time.This problem is minimized by using an MPPT which maintains the SPV arrays operating point nearer to MPPT. Online algorithms that are very common in terms of ease of execution and high monitoring performance are the Perturb and Observe and Incremental conductance (InC). The InC algorithm execute best than the P&O algorithm, however, with higher tracking performance under quickly changing region conditions. The human community's modernization and the evolving use of electric motors have exponentially expanded the demand for electrical resources. Engines account for more than 40 percent of gross electrical power spending. An engine therefore plays a prominent role in the realization of energy-efficient and cost-effective pumping of water based on solar PV. An powerful motor significantly decreases the number of solar modules and thus the cost of capital for the given power demand. In less-power solar PV water pumping, the DC motors are often used. . This translates to a smaller scale and greater motor power.This work aims to introduce efficient water pumping through a PV-utility grid interface based on the solar PV-fed BLDC motor drive. For the MPPT of the PV series, using a boost converter, an incremental conductance approach is implemented.For the speed control of the BLDC motor, current sensor-less control is acknowledged. Via an electronic commutation of the BLDC motor, the VSI is worked with simple frequency pulses, resulting in a decreased loss of switching and increased conversion efficiency. Hardware models have been formed for grid-interfaced solar PV-fed water pumping scheme.

For example, the remote agrarian needed water siphoning for the domestic animals. The water siphoning scheme that governs the sun-based controller comprises two important segments. There are PV boards and siphons. The littlest part of the PV board is the solar-based cell. The smallest component is the PV board component, which in turn relies on sunlight. “Direct flow generates power when each sun-powered cell provides light with a minimum of two layers arranged in a semiconductor material.It is then supplied either to a DC siphon, which then siphons water at whatever point the sun shines, or placed away by the siphon in batteries for later use, which in turn pumps water anytime the sun shines, or deposited by the pump in batteries for later use”[10].

2. Scheme Organization

The diagram of the planned PV fed BLDC motor-driven water pumping scheme for the grid interface is shown in Fig. 1. A 9W PV array supply a BLDC engine through a boost converter and a VSI with adequate power to work the water pump at its maximum capacity under normal climatic conditions. The MPPT of the PV collection and electronic motor switching was carried out by the DC-DC boost converter and the VSI severally. The switching signals are produced using 3 Hall Effect sensors. To power the water pump, the BLDC engine is used. A 1ph utility grid assist is offered on the popular VSI DC bus, through a bridge rectifier and a PFC boost converter. By running the PFC converter via a power flow control, the power transfer is controlled. If a PV-produce electricity is short to satisfy the power demand, the established control requires a power transfer from the service grid to the DC bus, otherwise no power is transmitted from the utility. The power flow is seen in Fig 2 in all three modes.

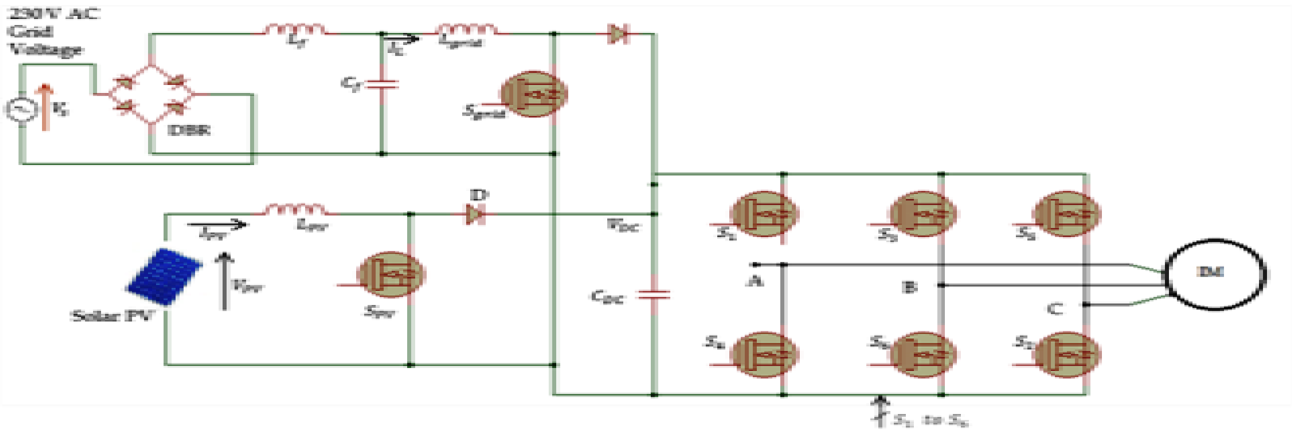

Fig. 1: Solar water pumping scheme with intelligent grid interface.

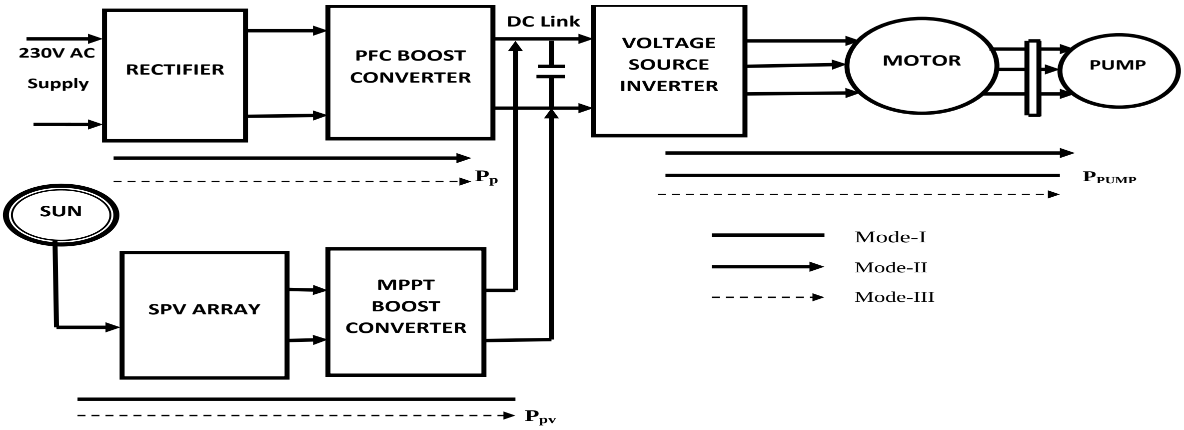

Fig. 2: Power flow in various modes of operation.

2.1 Mppt

To lead the optimal operating point of the solar PV array, an INC-MPPT approach is used. This algorithm's flow diagram is shown in Fig. 2. The new samples are V_{pv} and I_{pv}, while VP_{V0} and IP_{V0} are the old PV voltage and current samples. The additive PV voltage and current related to the two successive sampling instants are denoted by dV_{PV} and dI_{pv}. The power slope of the PV array characteristics is null. As a consequence, an incremental conductance is observed in the MPPT as,

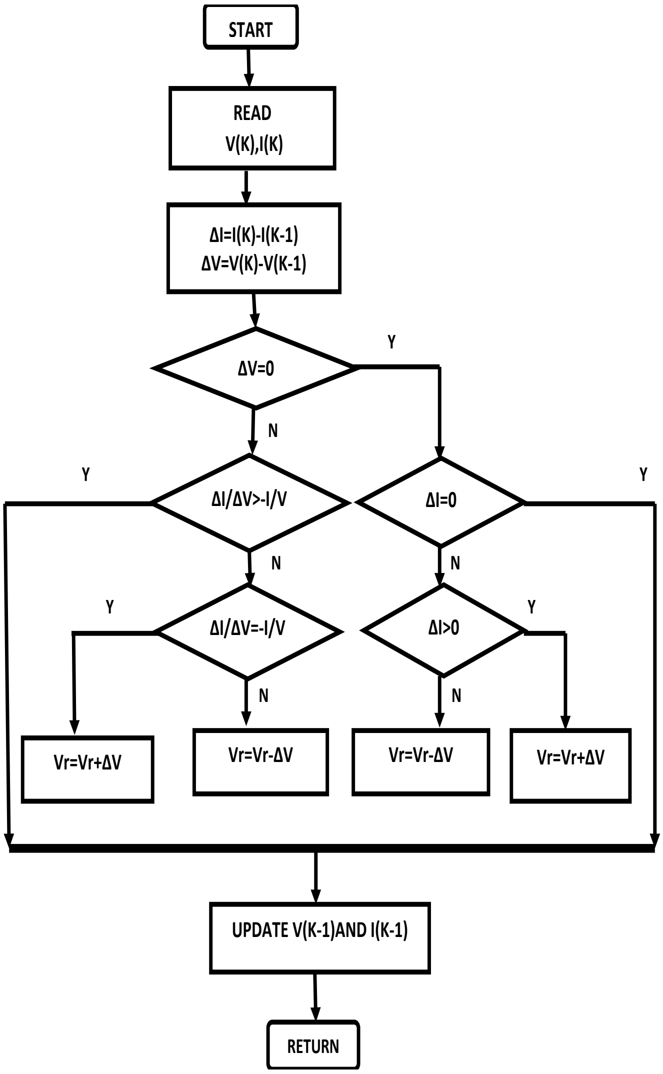

Fig.3: Flow chart of Incremental Conductance MPPT algorithm of proposed grid interfaced water pumping

2.2 Power Flow Various In Modes

Mode I: In this mode The solar-based force for solo operation persists. PV voltage from Vmp to the mention to the DC transport voltage that retains the PV working point at the MPP formed by the PV side lift converter.The reference speed or recurrence of IMD is set by the DC transport voltage is put up by the PI controller. The other way some remains fix and the excess power is advised into the siphon by speeding it up.

Mode II: In this mode Instead of having sufficient radiation, for example during the evening, the sun-powered boards were separated. "DC interface capacitor is connected with the current drawn by a diode connect rectifier by the current drawn which is profoundly not shaped properly.The framework can draw a sinusoidal current from the main AC with a PFC support converter and the evaluated water release also engine runs at the appraised speed" .

Mode III: With this mode, the force from both the SPV display and the scheme is triggered. The IMD separates the highly reachable force from the PV source thus eliminating the lack of power from the array supply. "In this mode the substructure expends consequently with less force from the lattice even at the appraisal release the weight of the network is diminished by this line .In addition to which the PFC converter helps for the utilization and underlies the THD of the main AC current within the preferred cut off points".

2.3 BLDC Motor

Asymmetrical DC is worn from the VSI DC bus for 120 ° using an electronic commutation and positioned at the middle of back-EMFF. A series of Hall signals (H1-H3) are generated by three Hall sensors at a rotor position interval of 60°. At every moment, the only 02 pulses are high, sequent in a low loss of conductivity.

2.4 Control Scheme of grid interfaced water pumping

The voltage of the DC interface is regulated by the PI controller utilization. The yield of PI controllers is applied to the use of the siphon rule by which the feed-forward term is calculated by the PV source. The reference velocity for appropriate IMD action along with the MPPT is the sum of the two numbers. With the feed-forward term, the weight on the PI controller decreases and it helps with the dynamic enhancement of the framework attributes. The VSI's exchange beats specify the scalar control square that is taken from the reference speed generated. At first, the velocity at a specific limit is sloped from the halt state.

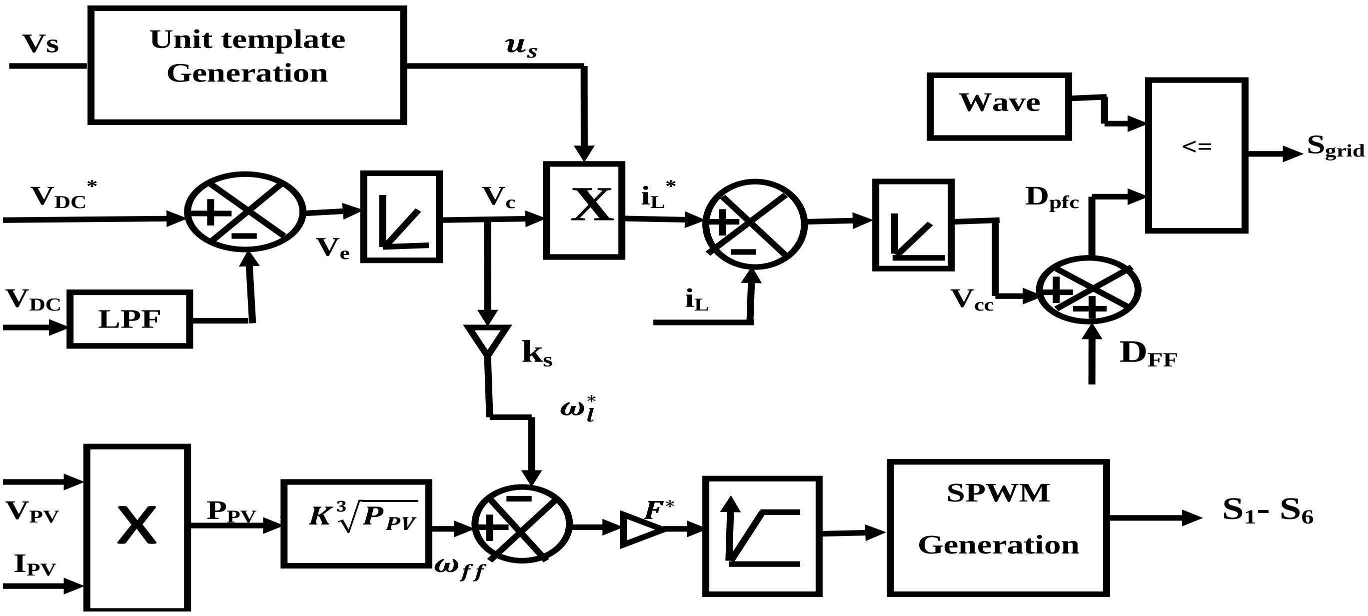

Fig.4: Control scheme of grid interfaced water pumping

Where the feed-forward expression is wff. It decreases the strain on the PI controller of the DC connection. Through subtracting the current DC bus voltage VDC from the reference DC bus voltage vdc, an error in DC bus voltage is obtained..

$$V_c(k) = V_c(k-1) + V_{pv}\{V_e(k) - V_e(k-1)\} + k_{iv}V_e(k) \quad \textbf{(1)}$$

$$\omega_1^* = V_c(k) * k_s \quad \textbf{(2)}$$

$$\omega^* = \omega_{ff} - \omega_1^* \quad \textbf{(3)}$$

Where k_{pv} and k_{iv} are the gains of the PI controller alluded to above. In addition, for an idea of signal wl^*, this control voltage is fed to a P controller. By subtracting the wl^* from w_{ff}, the sequent reference speed w* for the induction motor is measured.

3 .Hardware Implementation

To develop the prototype of the proposed scheme a 12V, 9W solar panel and 12V, 6A MPPT Boost converter are used. For the dynamic irradiation solar panel unable to supply the rated output, here MPPT Boost converter is in use to get the fix & rated output. This is given to the dc bus and then it is supplied as the input for 12V DC to 230V, 50HZ AC voltage source inverter. The converted output from VSI is given as input to the water pump. A 19W, 230V, 50 HZ Single phase induction motor is utilized to cause the water pump. This water pumping scheme is interconnected with grid to supply UPS to the load. Single phase 230V AC is given to the 230V/12V transformer & this can be converted into 12V, 2A DC by a diode bridge rectifier. Output of rectifier is connected to the dc bus.

Fig.5: Hardware setup for Proposed scheme

4. RESULT

This section would be provided with experimental findings obtained from the interleaved boost converter and the three-phase inverter with the planned DPD strategy. It should be remembered that the PV array displayed in Fig.8 for the hardware experiment setup represents the experimental setup. the hardware unit consists of Solar PV, Battery, step-down transformer (230V/12V), driver circuit with optocoupler, Arduino Mega, 8 MOSFET semiconductor switches with ac source, rectifier (in4007) and voltage regulator. The ac supply 230V is given to the step-down transformer to get the ac voltage of 12V from 230V ac source. 5V dc supply is necessary to run the pic microcontroller; hence with the help of bridge rectifier, 12V dc voltage is obtained. 12V dc source is given to the voltage regulator, which regulates the voltage from 12V DC supply to constant 5V DC supply; this voltage is given to the pic-microcontroller. the signals are generated from the driver circuit to turn on the MOSFET switches, according to the DPD have been generated Pulse as shown in Fig.8.

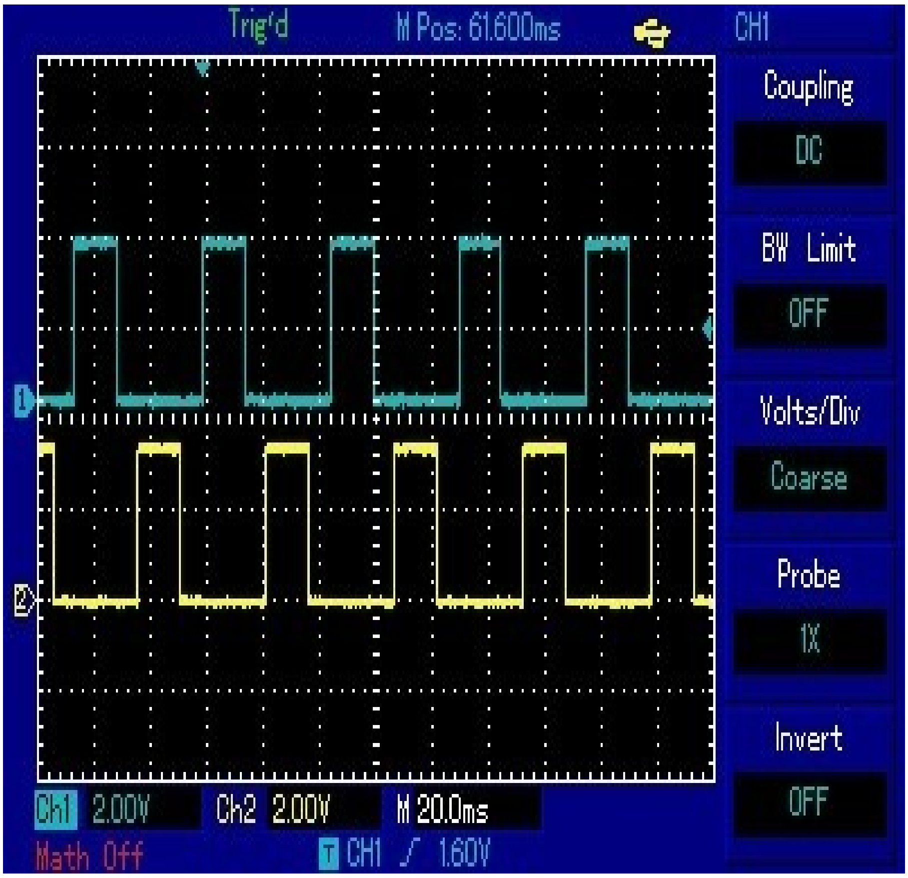

Fig.6: Result

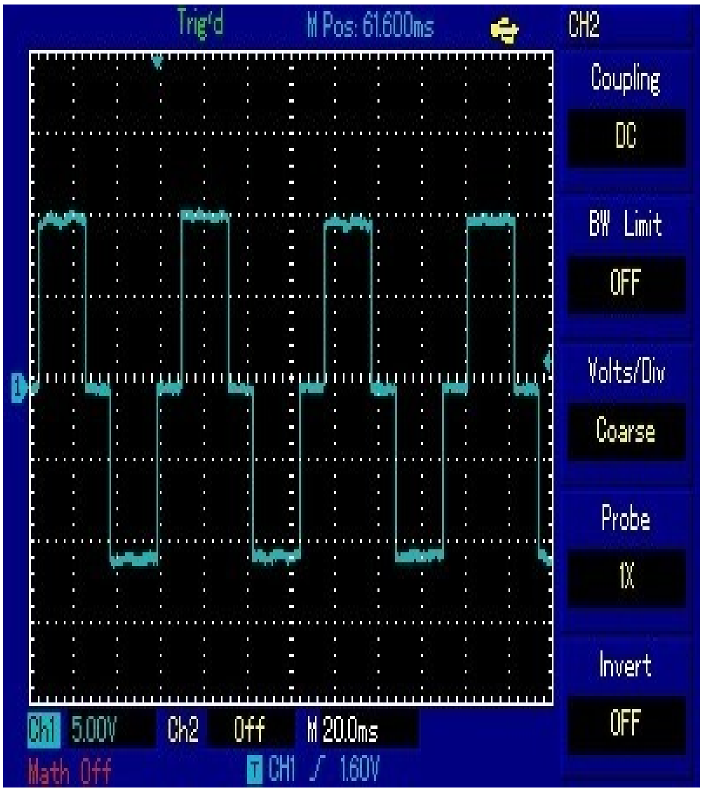

Fig.7 : Proposed scheme output

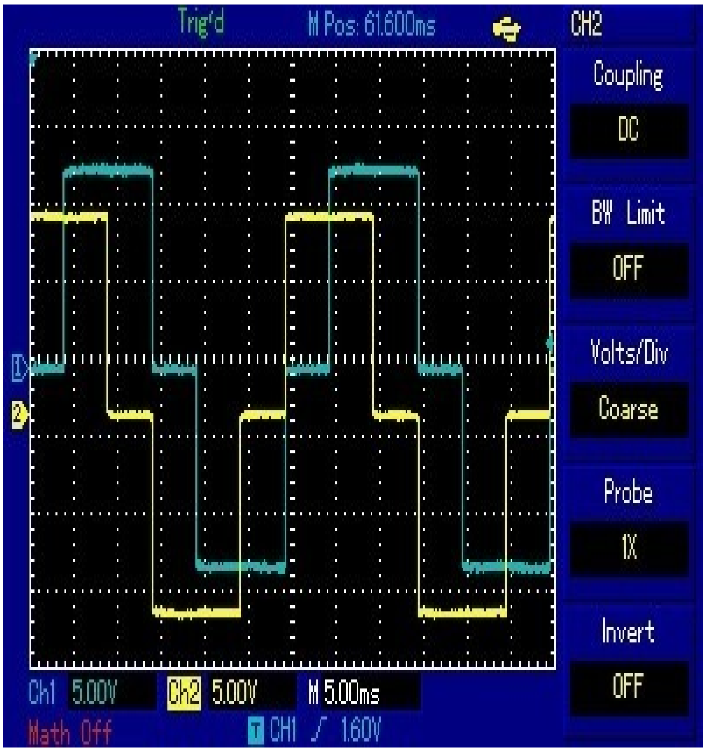

Fig. 8: Result

The single phase 230V, 50Hz AC supply is stepped down to 12V by using step-down transformer. After that the rectifier (DB107) converts AC voltage into DC voltage. Filter (1000μf/25V) is used for removing unwanted components from the scheme. The opto-isolator and driver circuit (TLP250) is used for amplifying the control signals to the levels requisite to drive the power switch and it also provides electrical isolation between power circuit and control circuits. The microcontroller (Arduino Mega) generates required gate pulses according to the code written. To evaluate the timing, the internal timer is used as a clock and a counter is used for counting the pulses.

5. CONCLUSION

Hardware model is implemented. MPPT optimizes solar power generation. Utility grid support has been given on the public DC bus as a power backup. In three controlled modes, power flow was improved and implemented with a PFC boost converter to allow conditional power transfer. This control has allowed continuous water pumping, regardless of the climatic conditions, with a maximum volume of water delivery. As per standard, the power quality specifications have been met. A basic BLDC motor speed control strategy was introduced that presented a cost-benefit. Thus, as a stable and effective water pumping method, the proposed topology has arisen.

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