RESEARCH ARTICLE OPEN ACCESS

Solar Charged Stand Alone Inverter

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ABSTRACT
This paper deals with solar powered stand alone inverter which converts the variable dc output of a photovoltaic solar panel into ac that can be fed to loads. Stand alone inverters are used in systems where the inverter get its energy from batteries charged by photo voltaic arrays. A charge controller limits the rate at which electric current is added to or drawn from electric batteries. This charge discharge controller is needed to prevent the battery from being overcharged or discharged thus prolonging its life. The charge/discharge control is necessary in order to achieve safety and increase the capacity of the battery. The project has been tested according its operational purposes. Maximum power rating of the experimented solar charge controller is 100W according battery capacities. Cost effective solar charge controller has been designed and implemented to have efficient system and much longer battery lifetime. The dc output is given to inverter and then it is supplied to loads. This method is very cheap and cost effective.
***Keywords* –** C/D Controller, MPPT, Photovoltaics, PWM Inverter, Trickle Charging

I. INTRODUCTION

Harnessing energy from the sun to perform useful work is becoming more and more urgent, perhaps one of the most important priorities for this century. Solar energy is the energy that is coming from the sun. It can be collected by human through photovoltaics systems. Photovoltaic systems composed of solar photovoltaic cells in modules, voltage control circuits and batteries for energy storage. The energy produced during the day time, which was not consumed by loads, is saved in batteries. Saved energy can be used at night or during the days with bad weather conditions. Batteries in photovoltaic systems [1] are often charged / discharged; therefore they must meet stronger requirements than ordinary batteries. So we need to go for charge discharge controller. A charge controller is an essential part of nearly all power systems that charge batteries, whether the power source is Photovoltaics, wind energy, hydro, fuel, or utility grid. Its purpose is to keep the batteries properly fed and safe for the long term. The basic functions of a charge discharge controller are quite simple. Charge controllers block reverse current and prevent battery overcharge. Some controllers also prevent battery over discharge, protect from electrical overload, and/or display battery status and the flow of the power. The main aim of doing this project is to develop cheap and better performance charge discharge controller. We will first proceed with block diagram followed by circuit diagram and some experimental results.

II. BLOCK DIAGRAM

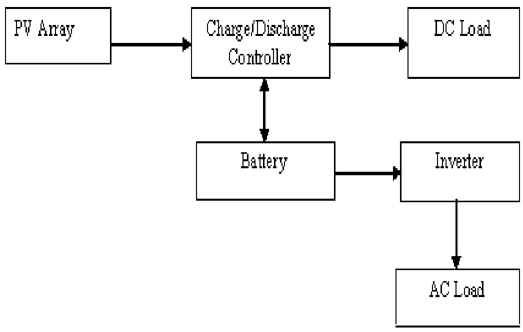

Fig.1 Photo voltaic solar energy system

III. DESCRIPTION

The block diagram [2] shows how the sun's radiation converted to dc and ac loads through charge discharge controller. The charge controller ensures that the battery is not over charged or discharged below a certain limit, thus preventing damage to the battery. An ideal charge controller will measure the battery voltage and when fully charged will reduce this duty cycle of an M.P.P.T to 100% to compensate for the inherent losses in the battery due to leakage. When the 12V battery is charged to 14V level, minimum charging is allowed to compensate for the losses in the battery. For this some minimum charging is given called Trickle Charging. For the MPPT, duty cycle is adjusted to 10 %(i.e.) the dc chopper is on for 10% or 0.1 times the complete duty cycle or on period. The minimum voltage below which the battery should not be discharged is 11.5 Volts. If the battery voltage drops to this value quick charging is affected by increasing the on time of the chopper to 100% until the battery voltage rises to 14 Volts. This charging is done from PV cell generating voltage. After attaining 14 or 14.5 volts, trickle charging is done for a 12 volts battery. This output is given to inverter for converting dc to ac and then supplied to consumer loads.

1.1 CIRCUIT DIAGRAM OF C/D CONTROLLER

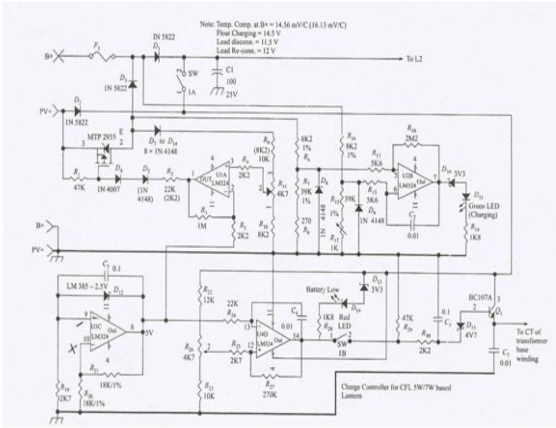

Fig.2 Circuit Diagram of charge discharge controller.

1.1.1 OPERATION OF CHARGE DISCH
1.1.2 ARGE CONTROLLER

There are different types of charge and discharge controller exists [4]-[6]. But here we are developing the charge discharge controller using MOSFET. The input of charge/discharge controller [3] varies from (13-14) V to 20V and the standard battery voltage is 20V (lead-acid maintenance free battery). The voltage level of this battery is maintained between 11.5V and 14.5V for longevity of battery life i.e. maximum of 14.5V and the charge should not go below 11.5 V. In worst case, the battery should never be discharged below 10.8V. Therefore, it is necessary to design a suitable battery charge and discharge controller for solar compatible equipment. Example: solar inverter, solar lighting system, solar water pump, etc. The entire system is designed with a conventional feedback regulator with a p-channel MOSFET as the series element and a quad operational amplifier IC LM-324. The op-amp U3C is used as a reference voltage generator. This amplifier with the reference diode D12(LM-385-2.5V) is a band gap regulator situated in the feedback loop of this IC. It generates a constant 5V reference voltage for all the other op-amps which are used as comparators.Op-amp U1A is used as a charge controller which controls the series pass regulator MOSFET and maintain its output voltage constant at a set level by comparing its output voltage with the reference voltage. The charging limit (14.5V) is set by the preset R11 so that the battery receives a float change of 14.2V after a drop of nearly 0.3V across the diode D2. 8 silicon diodes (D7-D14) in the feedback loop of IC U1A offer the necessary thermal correction of 14.6mV/^{0} C at the battery terminal. Op-amp U4D is used as a comparator which compares the actual battery terminal voltage with the reference voltage and stop conduction of transistor Q1 so that supply to the load is cut-off when the terminal voltage of the battery goes below 10.5V. Therefore the potentiometer R26 is to be adjusted suitably. Hence U4D op-amp works as a discharge controller. Op-amp U2B is used to indicate that the charging process is going on. This comparator compares the voltage drop across diode D2.

IV. CIRCUIT DIAGRAM OF PWM INVERTER

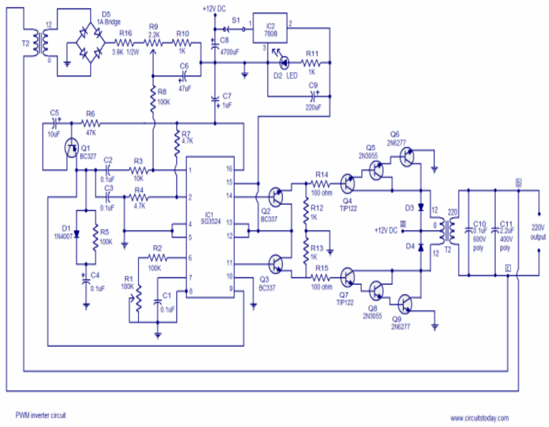

Fig.3 Circuit diagram of pwm inverter.

1.2 OPERATION OF PWM INVERTER

A PWM inverter circuit using IC SG3524 is shown here. This IC is an integrated switching regulator circuit that has all essential circuit required for making a switching regulator in Push-pull mode. This circuit consists of pulse width modulator, oscillator, voltage reference, error amplifier, overload protection circuit, output drivers etc., SG3524 plays main role in PWM inverter circuit which can change its output voltage against the variations in the output voltage. In this circuit resistor R2 and Capacitor C1 sets the frequency of the ICs internal oscillator. The preset switch R1 is used for fine tuning of the oscillator frequency. Pin 14 and Pin 11 are the emitter terminals of the internal driver transistor of the IC. The collector terminals (Pin 13 and Pin 12) of the driver transistors are connected to the +8V output pin of the IC 7808. Two 50 Hz pulse trains which are 180 degree out of phase are available at pin 14 and pin 15 of the IC 7808. These are the signals driving the subsequent transistor stages. When signal is high at pin 14, transistor Q2 is switched ON which turn makes transistor Q4,Q5,Q6 ON and the current flows from the +12V source(battery) connected at point a through the transistors Q4,Q5 and Q6. As a result a voltage is induced in the transformer secondary and this voltage contributes to the upper half cycle of the

220V output waveform. The working of voltage regulation section is as follows. The inverter output (output of T2) is tapped from point's labeled b, c and supplied to the primary of the transformer T2. The transformer T2 steps down this high voltage bridge D5 rectifies it and this voltage is supplied to the pin1 through R8, R9, R16 and this voltage is compared with the internal reference voltage. This error voltage will be proportional to the variation of the output voltage from the desired value and the IC adjust the duty cycle of the drive signals in order to bring back the output voltage to the desired value. Preset R9 can be used for adjusting the inverters output voltage as it directly controls the amount of voltage feedback from the inverter output to the error amplifier section.IC2 and its associated components produce an 8V supply from the 12V source for powering the IC and its related circuitries. Diode D3 and D4 are freewheeling diodes which protect the driver stage transistor from voltage spikes which are produced when the transformer primaries are switched. R14 and R15 limit the base current of Q4 and Q7 respectively. R12 and R13 are pull down resistors for Q4 and Q7 prevents their accidental switch ON. C10 and C11 are meant for bypassing noise from the inverter output. C8 is a filter capacitor for the voltage regulator IC 7808. R11 limits the current through the indicator LED D2.

V. CONTROLLER CIRCUIT

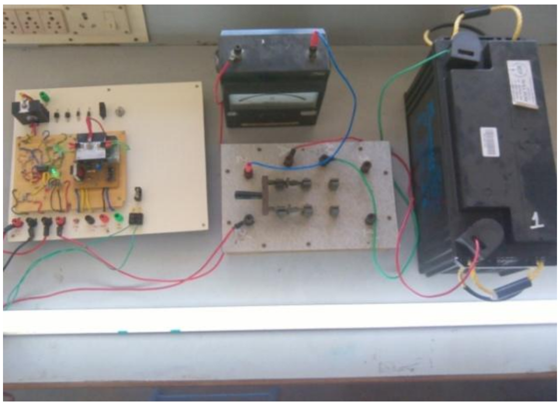

Fig.4. Assembled Prototype

1.3 OBSERVATION

Time	P.V Cell(open circuit voltage) (Volts)	P.V Cell(ON charging) (Volts)	Battery voltage (Volts)	Charging Current (Amps)	Battery Voltage on Load (Volts)	Output Load Voltage (Volts)	Load Current (Amps)
09:35	19.16	15.4	14.0	1.8	12.64	12.24	1.5
11:40	16.50	15.2	13.8	1.9	12.85	12.45	1.5
12.15	16.10	15.1	13.8	1.9	12.84	12.44	1.6
14.20	16.60	15.2	13.8	1.5	12.97	12.54	1.1
15.00	16.90	15.3	13.8	1.3	12.92	12.53	1.0

Fig.5. Voltage and Current rating

The output of charge discharge controller is 12V which is given to solar PWM inverter converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into an alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. Stand alone inverters used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays.

1.3.1 INVERTER CIRCUIT

Fig.6. Assembled Prototype of inverter circuit

1.3.2 OUTPUT WAVEFORM

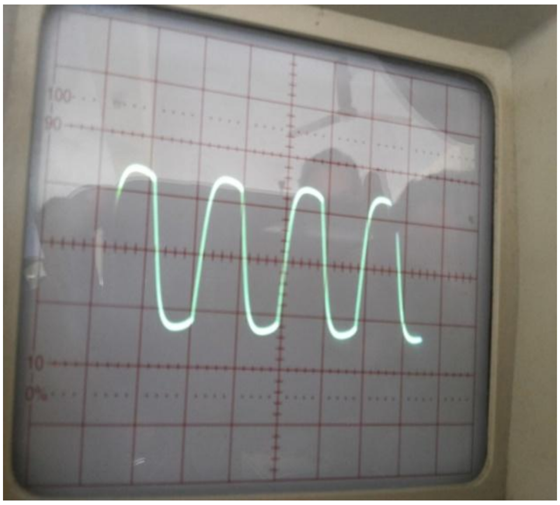

Fig.7. Waveform of inverter

VI. CONCLUSION

The solar energy is one of the important and major renewable sources of energy and has also proven it useful in functioning of applications like street lights. The charge/discharge control is necessary in order to achieve safety and increase the capacity of the battery. The project has been tested according its operational purposes. Maximum power rating of the experimented solar charge controller is 100W according to battery capacities. Cost effective solar charge controller has been designed and implemented to have efficient system and much longer battery life time.

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