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Charge Controller Operated Dc Motor Circuitry for Solar Panel Using Parallel Regulation Technique

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Abstract: - **In a world of increasing energy demand, it is imperative to come up with innovative solutions to reduce and conserve energy use. So the solar energy comes across a good option. Solar power generation has emerged as one of the most rapidly growing renewable sources of electricity. Solar-powered systems consist of solar panel, charge controller, battery, and load. Solar charge controller plays an important role as the system's overall success depends mainly on it. It is considered as an important link between the solar panel, battery and load. The series type of regulation 'wastes' a lot of energy while charging the battery which is used to operate DC motor, as the control circuitry is always active. So in this paper parallel regulation technique is used but instead of wasting the charging current it is used to keep battery topped-up.**

Keywords— **Solar energy, Charge controller, Parallel regulation.**

I. INTRODUCTION

In recent years, the growing concern over environmental issues has brought about great interest and remarkable investments in photovoltaic (PV) technology. Solar cells produce direct current electricity from sunlight which can be used to power equipment or to recharge a battery. Solar power is pollution-free during use, which enables it to cut down on pollution when it is substituted for other energy source. There is a significant interest in creating an environmentally friendly system that will save money on electricity and maximize the cost return on investment for solar panels. The photovoltaic industry continues to strive to create efficient and inexpensive systems that can be competitive with other energy sources [2]. In the solar-powered systems, the solar charge controller plays an important role as the system's overall success depends mainly on it. It is considered as an indispensable link between the solar panel, battery and load. As it serves following objectives 1) to monitor voltage as the input of the rechargeable battery and display on the Liquid Crystal Display 2) To protect the battery from overcharging 3) to protect the battery from discharging.

II. LITERATURE REVIEW

In 1988The Dye-sensitized solar cell is created by Michael Gratzel and Brian O'Regan (chemist). These photo electrochemical cells work from an organic dye compound inside the cell and cost half as much as silicon solar cells.Hoffman Electronics (1959) creates a 10% efficient commercial solar cell, and introduces the use of a grid contact, reducing the cell's resistance. Rattankumar (2012), aimed to develop a prototype for a car run by solar energy. Here they are using a special type of motor Brushless Permanent Magnet D.C. Motor and a microprocessor based controller to run the car. [7] Perreault (2013), explored the benefits of distributed power electronics in solar photovoltaic applications [2] Barrit et al. (2011), developed a study that includes an overview on the electrical and mechanical system [3]. El Sayed. (2102), proposed an efficient solar green energy scheme to interface the PV array with the DC load [9]. Vorobiev 2010), stated technical and economical aspects of application of solar electric systems in city transport with the possible use of sun tracking in application of stationary and moving platforms with photovoltaic solar panels [4]. Chen (2012), proposed a power management system to improve performance of an electric vehicle. Solar panel and battery are combined together as the power system of electric vehicle [1].

III. BLOCK DIAGRAM

A charge controller is needed in photovoltaic system to safely charge sealed lead acid battery. The most basic function of a charge controller is to prevent battery overcharging. If battery is allowed to routinely overcharge, their life expectancy will be dramatically reduced. A charge controller will sense the battery voltage, and reduce or stop

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the charging current when the voltage gets high enough. Here, as shown in Fig. 1 the voltage generated by solar panel is given to the charging circuitry. But the charging circuit operation is controlled by the microcontroller. Sensor connected to solar panel sense the voltage and gives it to the microcontroller so that it can operate charging circuitry.

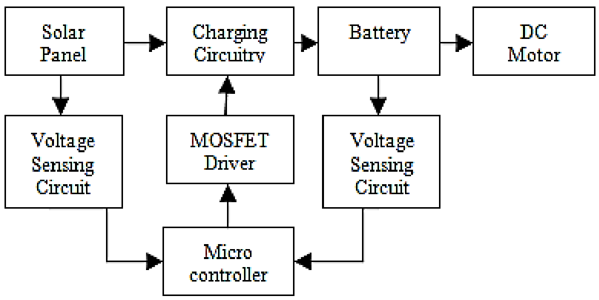

Fig. 1 Block Diagram

When the voltage of panel is less than required then it starts charging and when voltage reaches required value, it stops charging. PIC 16F877A microcontroller is selected to monitor voltage in PV charge controller. After power-on, the microcontroller reads the battery voltage with the help of the ADC and displays the values on the LCD. It monitors the input signal from the dusk-to-dawn sensor and activates the load or charging relay accordingly.

IV. CHARGE CONTROL USING PARALLEL REGULATION

When a lead acid battery is kept for charging its voltage rises. When current is first turned on, the internal resistance of the battery resists the current and voltage immediately rises above open circuit voltage. If this continues for long period of time, the battery is overcharged, resulting in accelerated corrosion of battery plates. So overcharging should be limited. The Flowchart for program of battery charge system is shown in Fig 2. The voltage sensor senses the voltage and displays it on LCD. It checks whether voltage is below 11 V, if so it makes load off and charging on. Before that it also checks whether voltage is between 11 to 13 V, if yes then it switches to charging and if voltage is greater than 13V it stops charging, and checks whether timer of 10 sec is on. If timer of 10 sec is on, it makes charging off for that time. For voltage between 11V to 13V microcontroller checks whether it is daytime or nighttime. If it is daytimes it makes charging on and load on or off as per requirement. But at nighttime charging mode is completely off and load can be on or off. The programming is done with the help of MPLAB software. An embedded C program can be used for this purpose. Circuit is implemented first on Proteus tool and the Simulation is done. The load connected here is 12 V DC motor. Relay RL1 connects the solar panel to the battery through diode. Under normal conditions, it allows the charging current from the panel to flow into the battery. When the battery is at full charge, the charging current becomes ‘pulsed’.

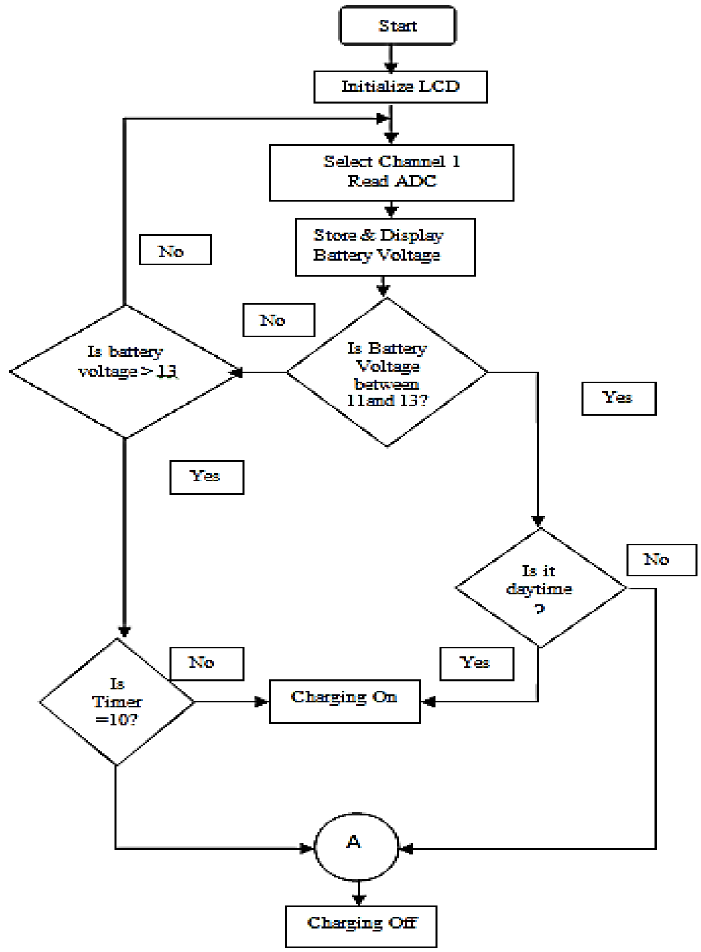

Fig.2 Flowchart of Charge Control

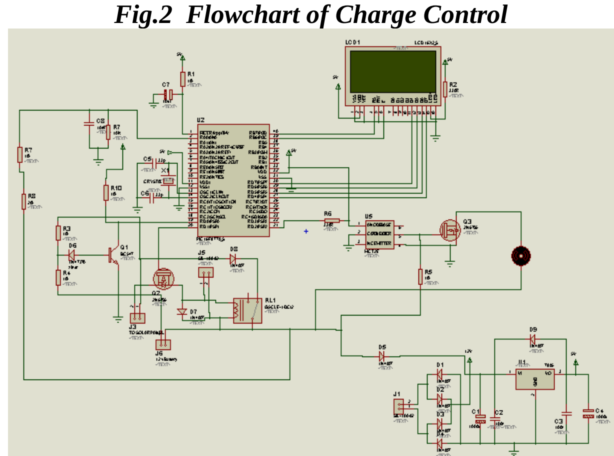

Fig.3 Circuit Simulations

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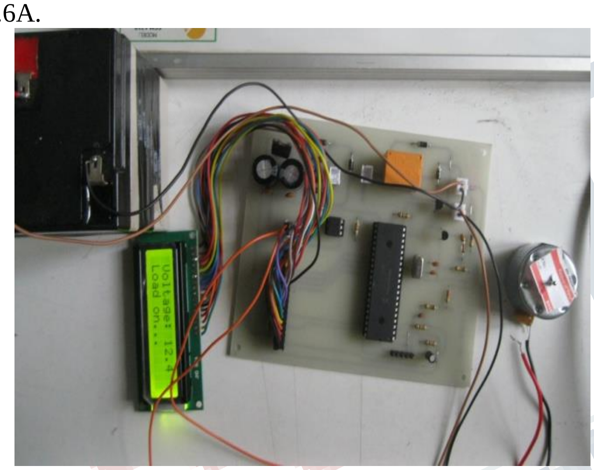
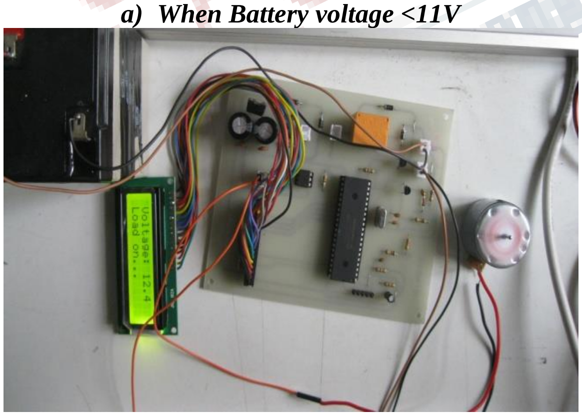
To keep the overall current consumption of the solar controller low, normally-closed contacts of the relay are used and the relay is normally in de-energized state. One terminal of the load is connected to the battery and another terminal of the load to an n-channel power MOSFET. These are voltage-driven devices that require virtually no drive current. The load current should be limited to 10A.

V. RESULTS

Hardware is implemented and the circuit of charge controller is connected to Solar panel, battery and Load. A 5V supply is generated using a voltage regulator. It is used as a supply for microcontroller, but supply of 5V from solar panel too can be used. A battery of 12V 7.5 A/h is connected to charge from solar panel. Solar panel of 12 V and 10 Watt power is used, which gives current of 0.5-0.6A.



a) When Battery voltage <11V



b) When Battery voltage is between 11V and 13V
Fig.4 Hardware Implementation

As shown in the Fig 4a the voltage sensor senses the voltage and displays on LCD. It checks whether voltage is below 11 V, if so it makes load off and charging on. When the panel voltage crosses 11V the microcontroller senses it and activates the load by switching on MOSFET via optocoupler and "load on" message is displayed as shown in the Fig 4b. Before that it also checks whether Voltage is between 11 and13 V, if yes then it starts charging, and if voltage is greater than 13V it stops charging, and checks whether timer of 10 sec is in on state. If timer of 10 sec is on, it makes charging off for that time and if timer of 5 sec is on, it makes charging on for that time. For voltage between 11V to 13V microcontroller checks whether it is daytime or not. If it is daytimes it makes charging on and load on or off as per requirement. Otherwise charging mode is completely off and load can be on or off. Table 1 shows the status of battery charging, voltage from solar panel and status of load when battery voltage is less than 11V. Table 2 shows the status of battery charging, voltage from solar panel and status of load when battery voltage is between 11V and 13V.

Voltage Of Battery (V)	Voltage from Solar Panel (V)	Battery Charging
7.9	12.1	On
8.4	12.3	On
8.8	12	On
8.7	12.6	On

Table 1 When Battery voltage <11V

Voltage Of Battery (V)	Voltage from Solar Panel (V)	Battery Charging
11	12.3	On
11.2	12.5	On
11.3	14	On
11.8	14.3	On
12.4	14.8	On

Table 2 When Battery voltage is between 11V and 13V

Normally, when the load is switched off, the battery voltage tends to rise back and the load oscillates between 'on' and 'off' states. To avoid this, the microcontroller employs a hysteresis control by entering into a 'lock' mode during low-battery state and comes out of the lock mode when the dusk-to-dawn sensor receives the panel voltage. During lock mode, the microcontroller keeps converting the ADC value and displays the battery voltage on the LCD.

VI. CONCLUSION

A system for battery charging is designed and implemented with solar charge controller. It is designed using highly efficient PIC microcontroller. It has features such as deep discharge protection as well as overcharge protection. It displays each time the status of battery on LCD by continuously monitoring the battery voltage. Thus it does full battery protection and status display. It can be used in robotic applications too.

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