

Arduino Based Solar Powered Battery Charging System for Rural Solar Residence

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Abstract-Solar Energy is a smooth and RE Strength aid and is on its manner to high stage penetration inside the global strength basket. However, there are several demanding situations related to Solar Energy, like intermittency, restricted dispatch capacity and non-storability. Non-storability in a standalone PV device can be mitigated by using incorporating strength garage gadgets like battery to store the electric strength produced with the aid of solar panel while the solar is shining and to supply energy when the sun isn't shining. Batteries are, therefore, one of the essential aspect in the standalone PV system. And regularly the weakest link in PV systems because it impacts the maintenance price and reliability of the system. This paper includes designing and development of a low fee, microcontroller based totally, sun powered battery charging device. The developed system includes (i) MPPT (ii) Arduino Uno interface for battery control capabilities Arduino Uno interface, (iii) LCD show for statistics to the consumer approximately the system regarding the structures normal capacity to fee at any given time, (iv) information storage and carries Wi-Fi module for far off surveillance and uploading live records which can similarly be used for studying the fitness of the battery and help in maintenance of battery. The developed sun powered battery charging device for DC hundreds has been designed for use in Solar Home Systems (SHS). The character SHS can be linked to shape a low voltage DC micro grid for the remotely positioned rural populace for sustainable provision of electrical electricity offerings.

Key Words: Battery, Charge controller, Arduino Uno, Solar PV Panel.

I. INTRODUCTION

Increasing power call for, depleting fossil fuels, new load types, rural electrification, electricity protection are a number of the drivers for power place to embark directly to an adventure of sustainable energies. Renewable energies will play a key feature on this journey. Solar Energy is expected to contribute to the power blend in a big degree because it is considerable and easy. Solar PV systems include no fuel value, are silent in operation, require less renovation and have lengthy existence.

In India the Solar Mission is supported via the usage of MNRE and MoP. A hundred GW of sun power is envisaged through 2022. Out of this 40 GW of Rooftop PV and 60 GW of Solar Thermal might be generated in line with report of JNNSM (Jawaharlal Nehru National Solar Mission) MNRE, India. Decentralized Distributed Generation (DDG) scheme envisage provision of power to villages from conventional or renewable resources on a standalone foundation [1]. In order to provide get entry to to electricity to rural populace with low electricity intake in far off and off grid areas, a low,

Voltage DC distribution network, wherein in man or woman Solar Home Systems (SHS) may be interconnected, is an appealing opportunity [2]. However such standalone renewable electricity solutions need strength storage devices for making the energy available without interruption over some of days. Lead acid batteries presently offer the great price

to gain ratio among numerous electricity storage technology [3]. In this paper a low price Arduino Uno based totally solar powered battery charging device for SHS has been designed and advanced.

The fundamental components in standalone Solar PV tool Solar PV panels, batteries and electricity conditioning gadgets .The solar PV panels produce DC power which turned into afterward transformed to AC the usage of converter gadgets.

The use of strength Electronics converters boom the complexity and reduce performance of the strength gadget [4]. Nowadays, growing variety of gadgets which use DC, such as laptops, cellular telephones and exclusive power digital devices utilized in our each day existence are being incorporated. Such packages want to convert AC once more to DC. This conversion will boom the losses and complexity of the electricity device. This idea is especially useful for rural and moderately populated regions wherein in low voltage DC community can supply electricity generated through sun PV to cater to the load constituting of LED lamps, DC fan, TV and mobile charging stations. To decorate the overall performance of this kind of strength network, in preference to the use of a couple of conversions, the entire power device may be represented in figure 1. The DC based power device facilitates to remove the requirement of converters structures, lowering converter fee, energy system complexity, enhance efficiency and reliability. The batteries are used to save the electricity from sun panels as an power economic organization for emergency and night time hour utilization in home and enterprise programs. To price these batteries from the solar light rated quantity of contemporary for rated time duration is required. If extra current is provided, the battery may be damaged. If battery is overcharged or discharged for a long length of time, batteries life span will come down. The traditional battery chargers available in marketplace have restrained capabilities. And some time they do now not screen the battery health properly, and can allow the battery to go through deep discharge or overcharge. If a battery goes into deep discharge, it is very tough to recharge it the usage of battery charger because the electrode plates of battery maybe sincerely sulphated, resisting the charging.

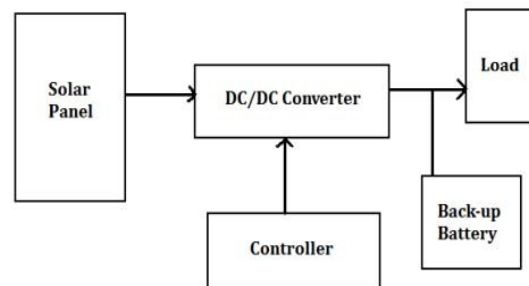


Fig. 1. Block diagram of the solar energy storage system

To fee a deep discharge battery, a large cutting-edge to opposite the chemical reactions which came about at some stage in discharging is required.

II. PROPOSED SYSTEM

If we supply large modern to a deep discharged battery, battery gets broken. And if we permit a battery to be in charging manner for a protracted length (over charging), gassing of hydrogen and oxygen occurs at the electrode plates and wash away the energetic material coated at the plates this once more leads failure of battery because of this an practical battery charging system is vital to take care of those troubles. In this paintings, a low fee sun powered battery charger for DC hundreds (DC lighting fixtures i.e. LEDs, DC devices like laptops, telephones, satellite TV for pc television for computer TV controllers and so forth.) has been designed and advanced.

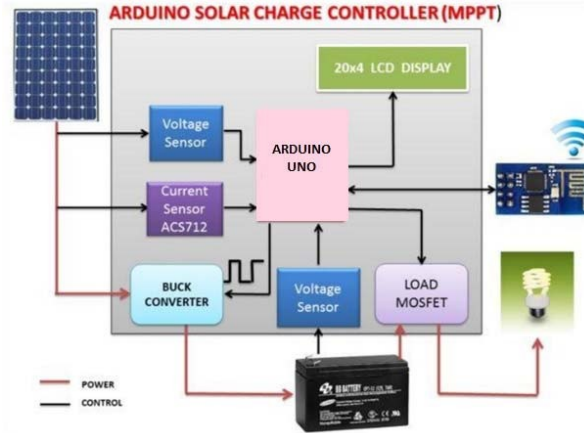


Fig. 2. Block diagram of the proposed solar system

The advanced machine has the functionality of logging and storing data for some distance off surveillance, primary to better safety of the battery, thereby developing the life of the battery. Figure 2 gives the block diagram of the proposed system. The standard solar PV standalone device encompass a solar panel, Arduino interfaced MPPT charge controller, Wi-Fi module battery financial institution, and load to deliver usable strength to the stop person [5,8].

III. BASIC DESCRIPTION OF THE SYSTEM

A. PV Cell Chemistries

The solar panel include some of Si based PV cells combined in collection and in parallel depending on the specified voltage and the current. Presently the usually used one of a kind sorts of PV cells are polycrystalline Silicon, mono crystalline Silicon, copper-indium selenide and amorphous silicon. The efficiencies range from 6% to 25%. A Mono crystalline silicon PV cellular has higher conversion overall performance (approx. 22%) in addition to better price. In this art work mono crystalline Silicon panel is used.

Electrical traits of the PV Panel (Values at STC (AM1.5, 1000W/m², 25°C))

- Max Power Pmax: 50Wp +/-three%
- Panel Voltage: 12 V
- Nominal Current Imp: 2.77A
- Nominal Voltage Vamp: 17.20V
- Cell Efficiency: 17%
- Open-Circuit Voltage Voc: 21.6 V
- Module Efficiency: 14.6%
- Short-Circuit Current Isc: three.23 A

The I-V characteristic of solar cellular beneath numerous daylight is verified in Figure three. The knee factor where the dropping voltage line meets the vertical electricity line indicates the most high quality energy available.

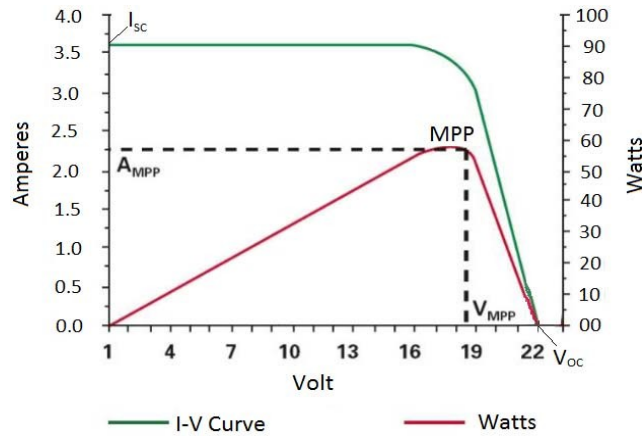


Fig. 3. Standard I-V Characteristics of PV Cell

B. Batteries for Energy Storage

Energy storage devices are required for 'power programs' and 'electricity applications'. In strength programs, the discharging manner of electricity is gradual as compared to power programs and generally takes ten minutes to hours. In case of electricity packages discharging of the stored energy take place at very immoderate rate, from seconds to minutes [7]. In power applications the energy storage medium is flywheel, battery, hydrogen and electrochemical capacitors (ECs). Most not unusual used energy storage generation is lead-acid battery due to its essential gain over the other rechargeable batteries is that energy ratio is advanced. Generally there are categories of lead-acid batteries flooded lead acid (FLA) batteries and valve regulated lead-acid (VRLA). VRLA is similarly classified as Absorbed Glass Mat (AGM) and Gel. VRLA batteries are also called sealed batteries. Sealed batteries, even though steeply-priced, have the gain of less safety and longer life span. In the prevailing work AGM battery is used.

C. Charge Controller

A battery charging tool isn't always complete without a rate. Mainly it's the shape of regulator that prevents the batteries from overcharging. The rate controller converts the incoming DC voltage from the sun panels to the precise voltage range appropriate for battery charging. The price controller unit ought to work for the given variety of the voltage and must reduce robotically if SPV voltage falls underneath preference rate [13]. As the intensity of light is slightly reduced, the charge controller mechanically turns off and switches on while adequate quantity of energy is restored again. Most of the available charge controllers can feature handiest on best light conditions. Due to this shortcoming, the use of such rate controllers is limited. The superior rate controller uses maximum power point tracking (MPPT) to monitor and modify the voltage and cutting-edge to take a look at the most energy with winning light situations. However, MPPT controllers are steeply-priced [8]. Figure 4 depicts the Tracking Algorithm of Maximum Power Point Tracker used.

Pulse width modulation (PWM) controller uses high frequency pulses to manipulate the modern-day from the supply depending upon the condition of the battery. Pulse width modulation controller examines the significance and time of pulse to reduce battery overcharging. During peak while the batteries are discharged a sign is obtained with the aid of using the PWM charger and whole cutting-edge pulses continue to be non-forestall, as it turns into charged and this degree is referred to as bulk degree of charging. Absorption is the following step of charging which takes region while batteries are close to the whole state of rate (SOC). The battery bank voltage is held every day via the controller for high quality period of time. Further, the off time of the pulses prolonged to slowly lower the contemporary-day degree at the same time as electricity financial institution is crowned off.

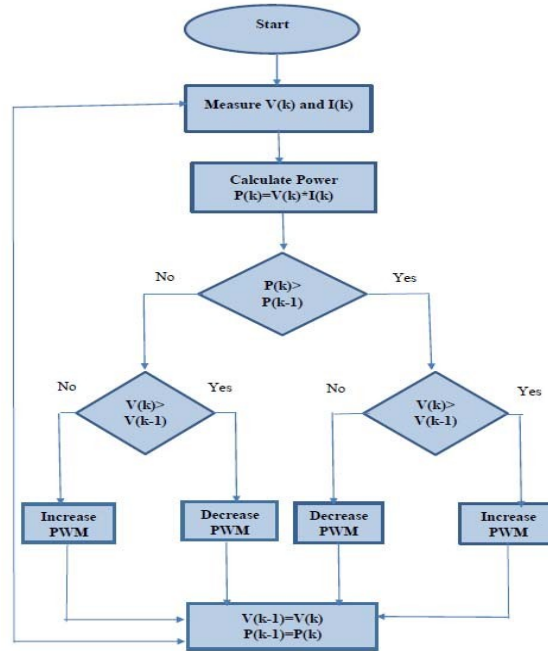


Fig. 4. Tracking Algorithm of Maximum Power Point Tracker

The complete potential of the batteries is referred to as float charging stage.

The advanced battery charger can be in one of the following four states:

- On State: Is the charger United States for sun strength fee in among minimum solar strength value and coffee solar strength rate (minimal sun electricity < solar electricity < low sun power) [12]. In this country, for bulk charging state the solar watts input are very low however now not a lot low to enter the off kingdom. To get low amount of strength pulse width modulation is ready to be ninety nine. Nine%.
- Bulk State: Is the charger USA, Wherein sun electricity is more than the minimal solar power. In this nation, the Peak Power Tracking set of regulations is used for the bulk of the battery charging thru running the maximum amount of modern-day in the circuit that the solar panels are producing into the battery.
- Float State: In this degree, voltage is rise until maximum battery voltage is accomplished. So this country is known as drift kingdom. In this United States of America, through adjusting the PWM fee the battery voltage is maintained at its maximum. If PWM obtain its 100%, then the battery is being drawn down via some load because of the fact battery voltage can't be stored at maximum.
- Off State: When no power is generated with the useful resource of the sun panels the charger is going into off kingdom (solar power < minimal solar electricity). In this situation energy from the battery can replicate into the sun panel, so all the MOSFETs are became off to avoid this case. If the sun panel isn't generating power then it's possibly night time. Therefore, the weight country can be on because of this that the weight linked will take supply from the battery and there may be no deliver from the sun panel. The final code of the Arduino circuit used for MPPT changed into evolved.

D. DC to DC Converter

A DC-to-DC converter is needed to boom (Boost) or lower (Buck) the enter panel voltage to the preferred battery stage. The important parameters of the dollar circuit are the inductor, capacitor, and MOSFET. In this paintings IRFZ44N MOSFET is used as a transfer.

E. Micro controller

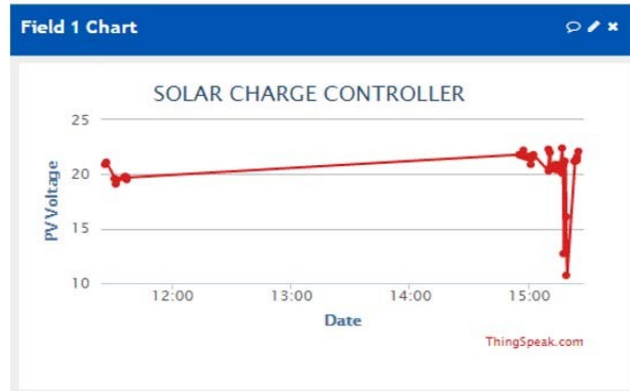


Fig. 7. Solar PV voltage Vs Time

The records also can be send to the places of the nearest solar tree system for the users' smart telephones. All this may lead to a designing of a better, efficient, IoT (Internet of Things) incorporated and higher related PV systems. Table 1 offers the listing of fundamental Components used.

Table 1. Listing of fundamental Components used.

Component	Specifications
Solar PV Panel	Rated Power – 50W; Cell Type – Monocrystalline; Open Circuit Voltage: 21.6V; Short Circuit Current: 3.23 A; Max. Power Voltage: 17.20 V
Battery	Absorbent Glass Mat (AGM) ; Nominal Voltage :12V; Internal Resistance- Fully Charged battery 770F- 30 mfi
Mosfet Driver	Gate drive supply - 10 to 20V; V_{OFFSET} - 600V (max) V_{OUT} - 10 - 20V; $I_{O+/-}$ - 130 mA / 270 mA
Buck Converter	Resistance–220fi; Inductance–33microHenry; Capacitance–0.1microFarads
Boost Converter	Inductance – 90 micro Henry Capacitance – 220 micro Farads
Load	Lamp; Voltage – 12 V; Rated Power - 6W
Microcontroller	Arduino Uno
WI Fi Module	ESP8266; Module operates at 3.3V; 240mA peak current; 100M for max transmitting distance ;+20Dbm power
Current and Voltage Sensors; LCD display	

V. CONCLUSIONS

In this paper, layout and improvement of a low fee Arduino based totally absolutely Advance Solar powered Battery Charge Controller is furnished. The charging of battery is completed using MPPT algorithm. Thus extra strength harvest is obtained by using using working at PV peak power point in preference to output voltage of PV at any given time. The fee controller has a battery control device in built along aspect LCD show and Wi Fi module for facts logging and storing. The outside and inside voltage and modern go with the flow within the battery, the nation of fee of battery and reduce off the battery while diverse limits are reached are indicated by means of way of display. The

developed battery charger will assist higher tracking of battery overall performance and reliability of the gadget. It additionally can be used for far off surveillance of battery related to PV standalone systems.

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