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Smart MPPT Solar Monitoring & Load Balancing

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ABSTRACT

Nowadays the most advance solar charge controller available in the market is Maximum Power Point Tracking (MPPT). The MPPT controller is more sophisticated and more expensive. It has several advantages over the earlier charge controller. It is 30 to 40 % more efficient at low temperatures. But making an MPPT charge controller is little bit complex in comparison to the PWM charge controller.

This paper presents design, analysis of MPPT charge controller for improving efficiency of the system using Atmega328p.

Keywords— MPPT, PWM, Solar Monitoring

I. INTRODUCTION

The microcontroller used is in this controller is Atmega 328. This design is suitable for a 50W solar panel to charge a commonly used 12V lead-acid battery. You can also use other Arduino board like Pro Mini, Micro and UNO. Nowadays the most advance solar charge controller available in the market is Maximum Power Point Tracking (MPPT). The MPPT controller is more sophisticated and more expensive. It has several advantages over the earlier charge controller. It is 30 to 40 % more efficient at low temperatures. But making an MPPT charge controller is little bit complex in comparison to the PWM charge controller. It requires some basic knowledge of power electronics. We put a lot of effort to make it simple, so that anyone can understand it easily. If you are aware about the basics of MPPT charge controller then skip the first few steps. The Maximum Power Point Tracker (MPPT) circuit is based around a synchronous buck converter circuit. It steps the higher solar panel voltage down to the charging voltage of the battery. The Arduino tries to maximize the watts input from the solar panel by controlling the duty cycle to keep the solar panel operating at its Maximum Power Point. During my prototyping, we have faced a critical issue. The issue was that when we connect the battery to the controller, the connection between the battery and the switching (buck converter) becomes very hot and then MOSFET Q3 burns out. It was due to the shorting of MOSFET-Q3. So Current flows from Battery - MOSFET Q3- GND which is unexpected.

A solar panel will generate different voltages depending on the different parameters like:

1. The amount of sunlight
2. The connected load
3. The temperature of the solar panel.

Throughout the day, as the weather changes, the voltage produced by the solar panel will be constantly varying. Now, for any given voltage, the solar panel will also produce a current (Amps). The number of Amps that are produced for any given voltage is determined by a graph called an VI curve, which can be found on any solar panel's specification sheet and typically looks like it. We know that Power = V x I lies at the knee of the current and voltage curve.

A 12V solar panel is not really a 12V panel at all. It is really somewhere in between 12V and 21V panel depending on what load is connected to it and how bright the sunlight is. The panel has an internal resistance which changes dynamically with differing irradiance levels. Solar panels will only deliver their rated power at one specific voltage and load, and this voltage and load move around as the sunlight intensity changes.

II. LITERATURE REVIEW

These Literature Review the MPPT system can be classified based on the algorithms & flow chart used; power converter in the system just like Thyristor and application of the system (Standalone or grid interconnection). Classification based on algorithms Many methods to track Maximum Power Point (MPP) for PV arrays have been discussed by Trishan Esram et al. It

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comprises of all the techniques implied in this field. It was shown that at least 19 distinct methods have been already introduced [1]. A high-frequency photovoltaic pulse charger (PV-PC) for lead-acid battery (LAB) guided by a power- increment-aided incremental-conductance maximum power point tracking (PIINCMPPT) was proposed by Hung-I Hsieh et al [2]. The PV-PC implemented by a boost current converter (BCC) is to eliminate sulphating crystallization on the electrode plates of the LAB and to prolong the battery life. The BCC associated with the PV module is modeled to maximize the energy charging to battery under maximum power transfer. A duty-control guided by the PI-INC MPPT is designed to drive the BCC operating at MPP against the random insulation. A design example of a PV-PC system for a four-in-series LAB battery. (48 VCC) was examined. The charging behavior of the PV PC system in comparison with that of CC-CV charger was studied. Four scenarios of solar insulation changes to describe tracking behavior of PI-INC MPPT in PV-BC system were investigated, which is also compared with that of INC MPPT. K.H. Hussein et al [3] have developed a new Maximum Power Tracking (MPT) algorithm to track Maximum Power Operating Point (MPOP) by comparing the incremental and instantaneous conductance of the PV array [4]-[6]The drawbacks of Perturb and Observe method were analyzed and it showed that the Incremental Conductance algorithm has successfully tracked the MPOP even when atmospheric conditions change rapidly C. S. Chin [7]. The work was carried out by both simulation and graphs. A new method for MPPT named CVT (Constant Voltage Tracking) is proposed by Zheng Shicheng et al with the analysis of characteristic curve and operation theory of PV array [8]-[10]. A lower power photovoltaic (PV) system with simple structure has been designed. This method has been verified by PV charging system and it showed that MPP of PV array can be tracked well by applying the charger controller. An adjustable Self-Organizing Fuzzy Logic Controller (SOFLC) for a solar powered Traffic Light Equipment (SPTLE) with an integrated MPPT system on a low-cost microcontroller has been presented by Noppadol Khaehintung et al [11]-[12]. It comprises of boost converter for high performance SPTLE

III. METHODOLOGY

The base of this project is depend upon the solar system in which base on MPPT which is maximum Power Point tracking.

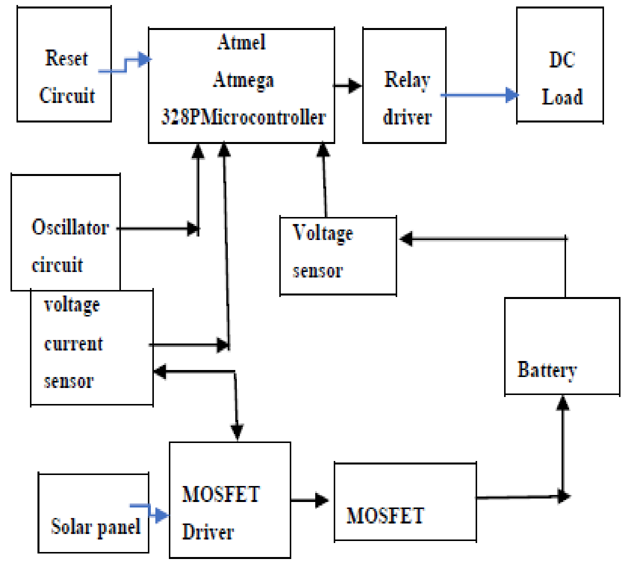

Figure 1: Block Diagram

The base of this project is depend upon the solar system in which base on MPPT which is maximum Power Point tracking system in which that the input is capture from sun and is given to the battery through MOSFET from the solar plate two sensor is connected which is current sensor and voltage sensors the current sensors are connected in series and voltage sensors are connected in parallel. The voltage sensors are made up of current divider circuit in which current sensors are connected to A1 pin of Microcontroller and voltage sensor is connected to A2 pin of Microcontroller. the MOSFET is connected between solar plate and battery MOSFET is continuously on and off the switch of load which is milli of second the MOSFET is connected to D8 and D9 pin of microcontrollers two MOSFET to be used. IRFZ 44 in MOSFET is used and the MOSFET driver is IIR2104 the battery voltage is 12 volt to store the Solar Energy during mppt period if greater capacity is 14 volt if the voltage is increases after exceeding limit.the battery is cut off with the help of zener diode which is 1N5818 may be used in which all the DC load is connected through battery so that only DC load is Run relay may be used for sensing the voltage. In which that 20 * 4 display is used for this project in future we use alternator for running the AC load.

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IV. PERFORMANCE ANALYSIS

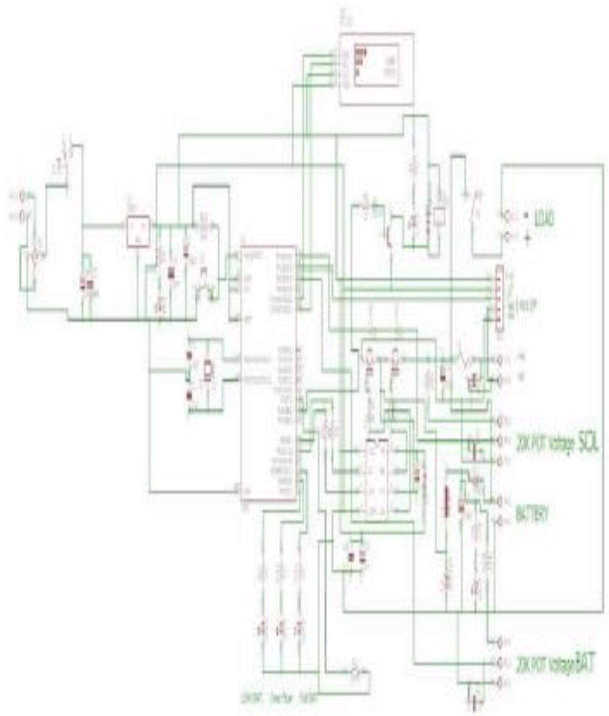

Figure 2: Circuit Diagram of Proposed System

Step 1: Design and Output: circuit boards should be rigorously compatible with, the designer creates a PCB layout using PCB design software. Commonly-used PCB design software includes Altium Designer, OrCAD, Pads, KiCad, Eagleetc. NOTE: Before PCB fabrication, designers should inform their contract manufacturer about the PCB design software version used to design the circuit, it helps avoid issues caused by discrepancies. Once the PCB design is approved for production, designers export the design into format their manufacturers support.

Step 2: From File to Film:- PCB printing begins after designers output the PCB schematic files and manufacturers c: From File to Film:- PCB printing begins after designers output the PCB schematic files and manufacturers conduct a DFM check. Manufacturers use a special printer called a plotter, which makes photo films of the PCBs, to print circuit boards. Manufacturers will use the films to image the PCBs. Although it's a laser printer, it isn't a standard laser jet printer. Plotters use incredibly precise printing technology to provide a highly detailed film of the PCB design

Step 3: Printing the Inner layers: Where Will the Copper Go. Now it's time to print the figure on the film onto a copper foil. This step in PCB manufacturing prepares to make actual PCB. The basic form of PCB comprises a laminate board whose core material is epoxy resin and glass fiber that are also called substrate material. Laminate serves as an ideal body for receiving the copper that structures the PCB. Substrate material provides a sturdy and dust- resistant starting point for the PCB. Copper is preboned on both sides. The process involves whittling away the copper to reveal the design from the films.

Step 4: Removing the Unwanted Copper: With the photo resist removed and the hardened resist covering the copper we wish to keep, the board proceeds to the next stage: unwanted copper removal. Just as the alkaline solution removed the resist, a more powerful chemical preparation eats away the excess copper. The copper solvent solution bath removes all of the exposed copper.

Step 5: Layer Alignment and Optical Inspection: With all the layers clean and ready, the layers require alignment punches to ensure they all line up. The registration holes align the inner layers to the outer ones. The technician places the layers into a machine called the optical punch, which permits an exact correspondence so the registration holes are accurately punched. Once the layers are placed together, it's impossible to correct any errors occurring on the inner layers.

Step 6: Layer-up and Bond: In this stage, the circuit board takes shape. All the separate layers await their union. With the layers ready and confirmed, they simply need to fuse together. Outer layers must join with the substrate. The process happens in two steps: layer-up and bonding. The outer layer material consists of sheets of fiber glass, pre- impregnated with epoxy resin. The shorthand for this is called prepare.

Step 7: Drill: Finally, holes are bored into the stack board. All components slated to come later, such as copper linking via holes and leaded aspects, rely on the exactness of precision drill holes. The holes are drilled to a hairs-width - the drill achieves 100 microns in diameter, while hair averages at 150 microns

Step 8: Plating and Copper Deposition: After drilling, the panel moves onto plating. The process fuses the different layers together using chemical deposition. After a thorough cleaning, the panel undergoes a series of chemical baths. During the baths, a chemical deposition process deposits a thin layer - about one micron thick - of copper over the surface of the panel. The copper goes into the recently drilled holes. Prior to this step, the interior surface of the holes simply exposes the fiber glass material that comprises the interior of the panel. The copper baths completely cover, or plate, the walls of the holes. Incidentally, the entire panel receives a new layer of copper. Most importantly, the new holes are covered. Computers control the entire process of dipping, removal and procession.

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Step 9: Outer Layer Imaging: In Step 3, we applied photo resist to the panel. In this step, we do it again – except this time, we image the outer layers of the panel with PCB design. We begin with the layers in a sterile room to prevent any contaminants from sticking to the layer surface, then apply a layer of photo resist to the panel. The prepped panel passes into the yellow room. UV lights affect photo resist. Yellow light wavelengths don't carry UV levels sufficient to affect the photo resist.

Step 10: Plating: We return to the plating room. As we did in Step 8, we electroplate the panel with a thin layer of copper. The exposed sections of the panel from the outer layer photo resist stage receive the copper electroplating. Following the initial copper plating baths, the panel usually receives tin plating, which permits the removal of all the copper left on the board slated for removal. The tin guards the section of the panel meant to remain covered with copper during the next etching stage. Etching removes the unwanted copper foil from the panel.

Step 11: Final Etching: The tin protects the desired copper during this stage. The unwanted exposed copper and copper beneath the remaining resist layer undergo removal. Again, chemical solutions are applied to remove the excess copper. Meanwhile, the tin protects the valued copper during this stage. The conducting areas and connections are now properly established.

Step 12: Solder Mask Application: Before the solder mask is applied to both sides of the board, the panels are cleaned and covered with an epoxy solder mask ink. The boards receive a blast of UV light, which passes through a solder mask photo film. The covered portions remain unhardened and will undergo removal. Finally, the board passes into an oven to cure the solder mask.

Step 13: Surface Finish: To add extra solder-ability to the PCB, we chemically plate them with gold or silver. Some PCBs also receive hot air-leveled pads during this stage. The hot air leveling results in uniform pads. That process leads to the generation of surface finish. PCB Cart can process multiple types of surface finish according to customers' specific demands.

Step 14: Silkscreen: The nearly completed board receives ink-jet writing on its surface, used to indicate all vital information pertaining to the PCB. The PCB finally passes onto the last coating and curing stage.

Step 15: Electrical Test: As a final precaution, a technician performs electrical tests on the PCB. The automated procedure confirms the functionality of the PCB and its conformity to the original design. At PCB Cart, we offer an advanced version of electrical testing called Flying Probe Testing, which depends on moving probes to test electrical performance of each component.

IV. RESULT AND DISCUSSION

These Smart MPPT solar Monitoring & Load balancing methods mainly include Incremental Conductance, Perturb and Observe and Fuzzy Logic. Here we also mention advantages and disadvantages of different method. With a well-designed system including a proper converter and selecting an efficient and proven algorithm, the implementation of MPPTis simple and can be easily constructed to achieve an acceptable efficiency level of the PV modules. From the comparison of 3 most popular MPPT technique -Incremental Conductance best MPPT technique. This Proposed controller provides superior output values for buck, boost, and converter operations. It has been noted that Perturbation and Observation and Incremental Conductance methods are commonly utilised by researchers because to their simplicity. However, these methods suffer from slow tracking and low utilisation efficiency. In order to address the limitations, contemporary approaches employ fuzzy and neural network techniques to enhance efficiency. In order to increase the voltage, several DC-DC converters are utilised in conjunction with battery storage systems to store extra energy generated by solar PV panels. The DC link voltage oscillations in the grid connected PV system can be measured by employing Cuk converters, SEPIC converters, and Zeta converters, which effectively minimise the current ripple introduced to the PV array and load. Filter circuits are employed to diminish the harmonic content in the output of DC-DC converters. Passive filters such as LC, LCL, and LLCC are employed to mitigate harmonic distortion and enhance power quality. Filter capacitors are employed to mitigate the effects of high frequency current ripple.

V. CONCLUSION

As This paper focus on comparison of three different converter which will connected with the controller. This controller gives a better output value for buck, boost and converter. It is observed that Perturbation and Observation and Incremental Conductance methods are simple and used by many researches, but they have the slow tracking and low utilization efficiency. To overcome the drawbacks, fuzzy and neural network techniques are used in the present days by which the efficiency is increased. To boost up the voltage various DC- DC converters are used along with battery storage systems in order to store the excessive energy from solar PV panel. The DC link voltage oscillations in the grid connected PV system can be obtained by using Cuk converters, SEPIC converters, and Zeta converters with reducing current ripple injected in the PV array and load. The harmonic content is reduced from the output of DC- DC converters using the filter circuits. The passive filters as LC, LCL, and LLCC are used for harmonic distortion as well as to improve the power quality. Filter capacitors are used to reduce high frequency current ripple.

REFERENCES

[1] Trishan Esram & Patrick L.Chapman. (2007). Comparison of photovoltaic array maximum power point tracking techniques. *IEEE Transactions on Energy Conversion, 22*(2).

[2] Hung-I Hsieh & Jen-Hao Hsieh, et al. *A study of high-frequency photovoltaic pulse charger for lead-acid battery guided by PI-INC MPPT*.

[3] K.H. Hussein, I. Muta, T. Hoshino & M. Osakada. (1955). Maximum photovoltaic power tracking:an algorithm for rapidly changing atmospheric conditions. *IEEE Ploc.- Gener. Transmission and Distribution, 142*(1).

[4] C.Thulasiyammal & S Sutha. (2011). An efficient method of mppt tracking system of a solar powered uninterruptible power supply application. *1st International Conference on Electrical Energy Systems*.

[5] Chaudhari, A. P., Patil, A. J. & Patil, G. B. (2022). A review on grid integration challenges of wind energy systems. *International Journal of Engineering and Management Research, 12*(4), 154-161.

[6] C. S. Chin & P. Neelakantan, et al. (2011). Fuzzy logic based mppt for photovoltaic modules influenced by solar irradiation and cell temperature. *13th International Conference on Modelling and Simulation*.

[7] S. Ushkewar, N. Ahire & G. Patil. (2022). Enhancing capabilities of wireless transmission for electric vehicle. *Global Energy Conference (GEC), Batman, Turkey*, pp. 278-281

[8] Shweta Baviskar, Gaurav B. Patil, Yash Patil, Yogita Solanki & Sandeep Ushkewar. (2024). An evaluation of solar photovoltaic system depreciation using PVSOL. *International Journal of Engineering and Management Research, 14*(3), 15–20.

[9] Baviskar, S., Patil, G. B. & Beldar, R. (2024). Predictive analysis of 50 kw solar photovoltaic system using pvsyst. In: *International Conference on Intelligent and Innovative Technologies in Computing, Electrical and Electronics (IITCEE)*, pp. 1-4. IEEE.

[10] Chavan, K., Patil & More, R. (2024, February). Transient stability analysis of IEEE test system. In: *IEEE International Conference for Women in Innovation, Technology & Entrepreneurship (ICWITE)*, pp. 691-695. IEEE.

[11] Ashwini Patil, G. B. Patil & Nikhil Borse. (2023). A state of art of smart grid and their smart solutions. *International Journal of Research in Engineering and Science (IJRES), 11*(5), 648-652.

[12] Patil, G. B. & Shah, P. *Comprehensive study of forward and fly back converter for improvement in performance*.

[13] S. G. Tesfahunegn & O. Ulleberg, et al. (2011). A simplified battery charge controller for safety and increased utilization in standalone PV applications. *IEEE*.

[14] Thakur, M., Patil, A. & Patil, G. (2022, November). The current state of the art for pv grid connected system issues with power quality. In: *International Interdisciplinary Humanitarian Conference for Sustainability (IIHC)*, pp. 1515-1520. IEEE.