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Maximum Power Point Tracking for efficient working of PV arrays

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Abstract — *Solar energy is one of the most important renewable energy which can be made completely useful, if a well-engineered remote energy system is attached along with the solar arrays. In the case where solar cells are used for conversion of solar energy into electricity, maximum efficiency is possible when solar panels are held perpendicular to the sun's rays where tracking comes into picture. Trackers are devices used to change the orientation of the PV panels towards the sun to capture maximum energy. The arrays should operate at their maximum power point (MPP) to give maximum efficiency. The principal of maximum power point tracking gives a higher reliability to the photo voltaic arrays along with very high efficiency. It can improve quality of life in remote areas and also help in cost effectiveness. Therefore an MPPT connection is made between the PV array and the load in order to obtain maximum power. An Arduino-based tracker was chosen for ease of use and access. This base also allowed for easy modification and repair, and provided a stable supply chain. Simulations showed maximum power point tracking was effective in providing necessary power to load batteries. Once built, voltage and efficiency tests of the tracker showed that it increased solar panel efficiency and output.*

Keywords- *Arduino NANO, Solar Panel, Tracker, Battery, Wifi module, Jumper wires, Acrylic sheet, Printed circuit board (PCB), Buck convertor, Current and voltage sensor*

I. INTRODUCTION

Photovoltaic energy is an effective alternative source of power one that is going to serve us for long. PV cells use sunlight and directly convert to electricity without leaving any residual element which pollute environment.
Thus solar energy systems as a renewable energy source, is of particular interest due to lower maintenance, less pollution.
For the generation of electricity in remote areas at a moderate price, sizing of the power supply is of the utmost importance. Photovoltaic systems and some other renewable energy systems, are therefore excellent choices in remote areas for low to medium power levels, because of the easy scaling of the input power source.
So it can be used very efficiently through solar arrays. But the panel alone cannot utilize the solar energy to its fullest. So when it connected directly with the load the potential power that could be extracted from the panel is wasted as it mainly depends on the characteristics of the load.
To fix the problem of price and complexity, a low cost, easy to use electronic system can be created to better provide solar power. Making this system simple to modify, economical, and repairable is a necessity, especially if it is to be deployed in rural or developing areas. By creating a streamlined, hardy device, solar power can be made more readily available and affordable than conventional energy use.
So to maximize the power of the arrays and to utilize the energy of the sun, a maximum power point tracker is inserted between the panel and the load to make sure that the system operating point is adjusted to be located at the MPP.

II. COMPONENTS OF MPPT

2.1 PROPOSED SYSTEM OF MAXIMUM POWER POINT TRACKING

(a) Arduino NANO: Arduino NANO is a small, complete and breadboard friendly board based on ATmega328. The Arduino can be powered via Mini-B USB connection, 6-20V unregulated power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

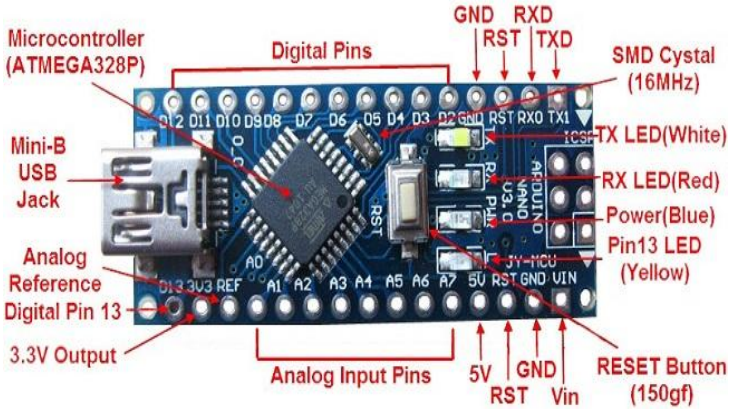

Figure 1: Arduino NANO

(b) Current Sensor: A Current Sensor is a device that senses the electric current in a wire and generates a signal proportional to that current. The generated signal can then be used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control.

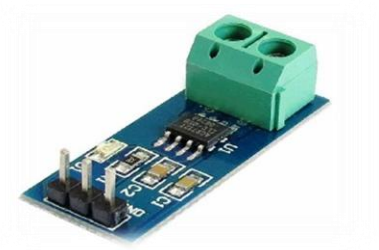

Figure 2: Current sensor

(c) Buck convertor (LM2596): The buck converter is a DC to DC power converter which steps down the voltage from its input (here solar panel or Arduino) to its output (here battery).

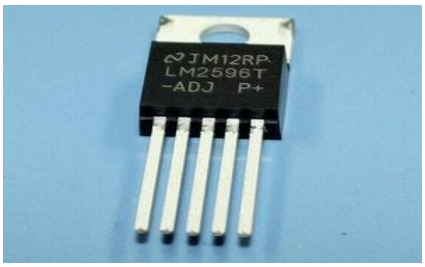

Figure 3: Buck Convertor

(d) Wi-Fi module: The ESP8266 is a self-contained SOC (System on Chip) with the integrated protocol that can give any microcontroller access to Wi-Fi network. The ESP is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processors.

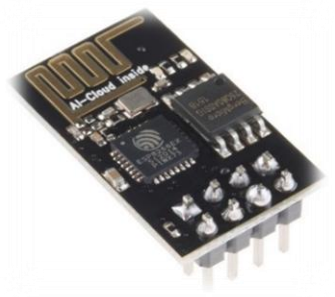

Figure 4: Wi-Fi module

(e) **3.3 Volt Linear Regulator:** The linear voltage regulator is a system used to maintain a steady voltage. The resistor of the regulator varies in accordance with the load resulting a constant output voltage.

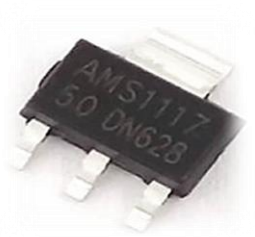

Figure 5: Linear Regulator

(f) LCD display (20x4): An LCD display is used to display the output voltage, current and other respective readings of the panel connection.

III. WORKING MECHANISM

The construction of the MPPT circuit is divided in following steps,

Step 1: Mount` all the components related to the construction. For this we divide the whole circuit into parts. Then we mount 1st part which is starting from solar supply and end to the inductor. Then we check the continuity for if there is any short circuit.

Step 2: Make the 2nd part which is, a separate bus for supply and ground. Then the 3rd part which is, the LED indicator circuit for battery charging. Then the 4th part is mounting components for connection of ESP8266 Wi-Fi module. Now comes the 5th part, which includes LCD display and output terminals.

Step 3: Now, after the circuit is ready, the next task is uploading the program for interfacing of Wifi module and Arduino Nano. For this only the connection for Wi-Fi module from Arduino is done. Give separate supply and common ground to Arduino and Wi-Fi module.

The interfacing of Wi-Fi module ESP8266 with the Arduino NANO is shown in figure 6:

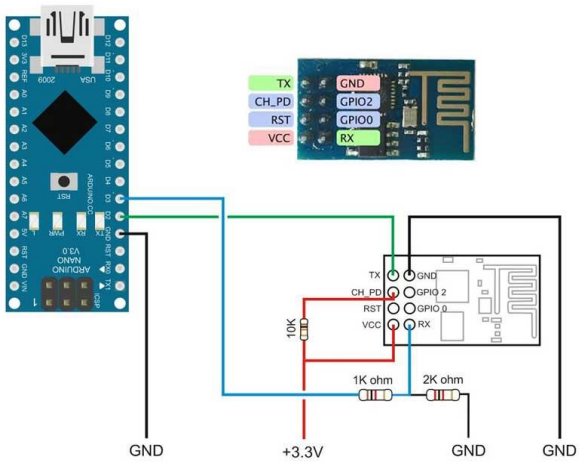

Figure 6: Interfacing Wifi with Arduino

Step 4: Wi-Fi module works on 3.3 volts and current more than 200 mA. So connect a linear regulator to step down the voltage from the Arduino which is done by giving the supply from 5V pin to Wi-Fi module.

Step 5: Arduino Nano works on 5V supply. So give supply to the bus through SMPS of 5V. Now once the program for Wi-Fi interfacing is done, connect the circuit again and upload the main program for the MPPT to the Arduino. Then give supply to the circuit board for testing the MPPT output.

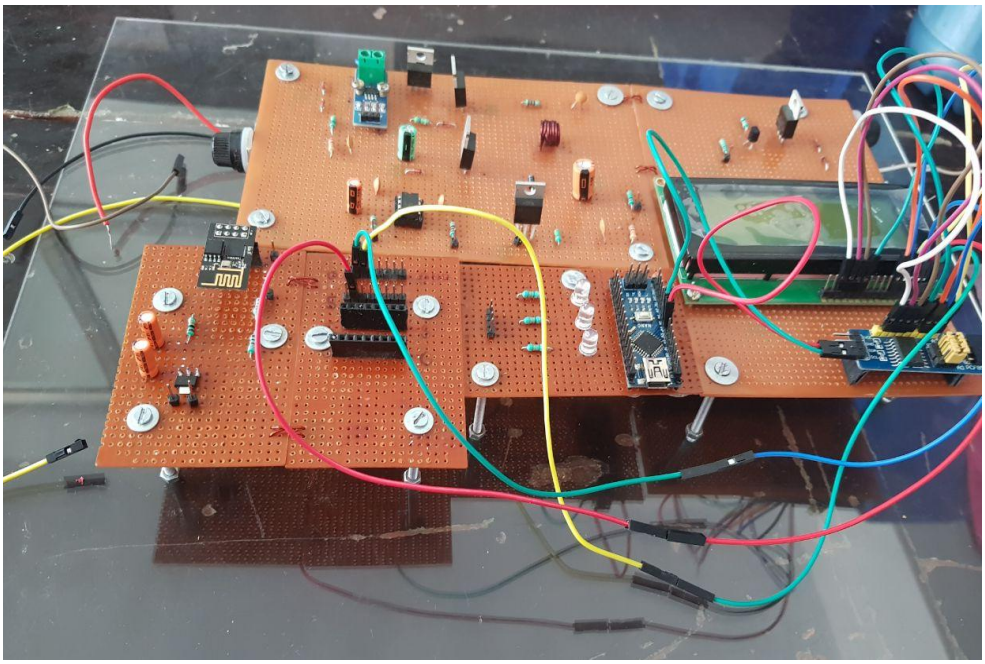

Figure 7: Connections for MPPT

IV. Advantages of Maximum Power Point Tracker

The principal of MPPT is applied in the solar charge controller, which is used to charge the battery connected to load

- An MPPT charge controller extracts the maximum power from PV module by forcing the PV module to operate at a voltage close to maximum power point.
- It causes to draw maximum available power from PV module.
- Another advantage of MPPT is its flexibility in using PV modules with higher voltage compared to the operating voltage of battery system.
- Using an MPPT solar charge controller, it is possible to wire the PV array for a higher voltage up to 140V (depending on charge controller and PV modules) and bring the full PV power for charging the battery.

Future Scope:

- Connecting MPPT to large number of solar arrays in remote locations and fields.
- Can be very useful for power supply in rural areas where one can use high sensitive solar panels which can work in mild sun light.

V. CONCLUSION

Renewable energy systems can be utilized in remote areas and compare cost competitive with other power supply systems. Furthermore, to implement renewable energy systems cost effectively, without losing reliability, it is necessary to use innovative techniques and appropriate high technology. To make the renewable energy system more efficient and reliable a maximum power point tracker principal. This paper described an MPPT solar charge controller, described the construction and working mechanism was explained.

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