Plan and Execution of Solar Charge Controller with MPPT Algorithm Utilizing Arduino

R. Ganesan, C. Karuppasamy, S. Saravanan

Assistant Professor/EEE, AAA College of Engineering and Technology, Sivakasi, Tamil Nadu, India

***Abstract*: In an increasing energy demand, it is need to come up with innovative solutions to reduce and conserve energy use. The light and temperature are not steady for a PV board, along these lines the power ages of the PV board isn't steady. So the most Maximum power point Tracking (MPPT) systems are utilized to give the most noteworthy capacity to the heaps or batteries. The MPPT procedure with Perturb and Observe technique is performed with a power electronic circuit and it beats the issue of voltage confuses between the PV boards and the batteries/loads. In this an Arduino UNO (microcontroller) is employed to develop battery charge control system for PV panels. The proposed system is composed of an Arduino UNO, sensors, synchronous buck converter, PV panel and battery. MPPT is a strategy for extricating greatest power from PV module and furthermore to shield the battery from cheating. MPPT charge controller serves two main purpose battery protection and energy metering. This paper provides details of maximum power point tracking solar charge controller device and dc energy-meter.**

***Keywords:* Solar Charge control, MPPT Algorithm, Perturb and Observe, Arduino, Charge control, Automatic charge controller, Solar Energy**

I. INTRODUCTION

We have just a single planet that we can call home. However, we are gradually annihilating this home with each liter of non-renewable energy source that we consume each day. No alternative, you say? Obviously there's a choice. The Sun. India is one of the sunniest nations on the planet, with 250 – 300 bright days consistently. What's more, we let this awesome abundance of nature go to squander. Because of late improvements in photovoltaic innovation, one can undoubtedly change over sunlight based vitality to electrical power and store it for utilize at whatever point we require it. Sunlight based vitality is free, for all intents and purposes endless and does not contaminate the planet. Shockingly, it is additionally extremely sparing over the long haul. As individuals are tremendously worried about the petroleum derivative fatigue and the natural issues caused by the regular power age, sustainable power sources and among them photovoltaic boards and wind-generators are broadly utilized at this point. The productivity of a PV plant is influenced principally by three components:

- the proficiency of the PV board (in business PV boards it is between 8-15%)
- the proficiency of the inverter (95-98 %)
- the proficiency of the MPPT calculation (which is more than 98%)

Enhancing the proficiency of the PV board and the inverter isn't simple as it relies upon the innovation accessible, it might require better segments, which can increment radically the expense of the establishment. Rather, enhancing the following of the MaximumPower Point (MPP) with new control calculations is less demanding, not costly and should be possible even in plants which are now being used by refreshing their control calculations, which would prompt a quick increment in PV control age and subsequently a decrease in its cost. MPPT calculations are fundamental in light of the fact that PV exhibits have a nonlinear voltagecurrent trademark with an extraordinary point where the power created is most extreme. This point depends upon the temperature of the sheets and on the irradiance conditions. The two conditions change amid the day and are additionally extraordinary relying upon the period of the year. Besides, illumination can change quickly because of changing barometrical conditions, for example, mists. It is vital to track the MPP precisely under every conceivable condition with the goal that the most extreme accessible power is constantly acquired. In this venture, Perturb and Observe (P&O) and Incremental Conductance (InCond) calculations are dissected inside and out and tried by the standard conditions said above. From that point forward, upgrades to the P&O and the InCond calculations are recommended to prevail in the MPP following under states of evolving irradiance. To test the MPPT calculations as indicated by the illumination profiles proposed in the standard, a rearranged display was created, in light of the fact that the reproduction time required in a portion of the cases can't be come to with the point by point exchanging model of a power converter in an ordinary work station. The purpose behind that will be that the PC comes up short on memory in the wake of mimicking just a couple of moments with the total model. At last, every technique is assessed and their qualities and shortcoming are distinguished.

II. ARDUINO

The Arduino microcontroller is a simple to utilize yet ground-breaking single board PC that has increased impressive footing in the pastime and expert market. The Arduino is open-source, which implies equipment is sensibly estimated and advancement programming is free. This guide is for understudies in ME 2011, or understudies anyplace who are going up against the Arduino out of the blue. For cutting

edge Arduino clients, sneak the web; there are heaps of assets. The Arduino venture was begun in Italy to grow minimal effort equipment for association plan. A review is on the Wikipedia passage for Arduino. The Arduino equipment comes in a few flavors. In the United States, Spark fun (www.sparkfun.com) is a decent hotspot for Arduino equipment. This guide covers the Arduino Uno board (Spark fun DEV-09950, $29.95), an extraordinary choice for understudies and instructors. With the Arduino board, you can form projects and make interface circuits to scrutinize switches and distinctive sensors, and to control motors and lights with no effort. A considerable lot of the photos and illustrations in this guide were taken from the documentation on the Arduino site, the place to turn in the event that you require more data. The Arduino segment covers more on interfacing the Arduino to this present reality. This is the thing that the Arduino board resembles. 2 The board includes an Atmel ATmega328 microcontroller working at 5 V with 2 Kb of RAM, 32 Kb of glimmer memory for putting away projects and 1 Kb of EEPROM for putting away parameters. The clock speed is 16 MHz, which means about executing around 300,000 lines of C source code every second. The board has 14 computerized I/O pins and 6 simple information pins. There is a USB connector for conversing with the host PC and a DC control jack for interfacing an outer 6-20 V control source, for instance a 9 V battery, when running a program while not associated with the host PC. Headers are given to interfacing to the I/O pins utilizing 22 g strong wire or header connectors. For extra data on the equipment. The Arduino programming dialect is a disentangled form of C/C++. On the off chance that you know C, programming the Arduino will be recognizable. On the off chance that you don't know C, no compelling reason to stress as just a couple of directions are expected to perform helpful capacities. An essential component of the Arduino is that you can make a control program on the host PC, download it to the Arduino and it will run consequently. Expel the USB link association with the PC, and the program will even now keep running from the best each time you push the reset catch. Expel the battery and put the Arduino board in a storage room for a half year. When you reconnect the battery, the last program you put away will run. This implies you associate the board to the host PC to create and investigate your program, yet once that is done, you never again require the PC to run the program.

III. ARDUINO HARDWARE

The intensity of the Arduino isn't its capacity to crunch code, yet rather its capacity to associate with the outside world through its info yield (I/O) pins. The Arduino has 14 advanced I/O pins marked 0 to 13 that can be utilized to turn engines and lights on and off and read the condition of switches. Each advanced stick can sink or source around 40 mama of current. this is more than sufficient for interfacing to most gadgets, however means that interface circuits are expected to control gadgets other than straightforward led's. As such, you can't run an engine specifically utilizing the current accessible from an Arduino stick, but instead must have the stick drive an interface circuit that thusly drives the engine. A later segment of this record demonstrates to interface to a little engine. To cooperate with the outside world, the program sets advanced pins to a high or low esteem utilizing c code guidelines, which compares to +5 v or 0 v at the stick. The stick is associated with outer interface gadgets and a short time later to the gadget being turned on and off. The arrangement of occasions is appeared in this figure. To decide the condition of switches and different sensors, the Arduino can read the voltage esteem connected to its pins as a double number. The interface hardware makes an interpretation of the sensor motion into a 0 or +5 v flag connected to the computerized I/O stick. Through a program order, the Arduino investigates the condition of the stick. In case the stick is at 0 v, the program will read it as a 0 or low. In case it is at +5 v, the program will read it as a 1 or high. In case in excess of +5 v is connected, you may victory your board, so be cautious. The grouping of occasions to peruse a stick is appeared in this figure. program sets stick high/low (1/0) board stick set to +5v/0v interface gadgets utilize flag voltages and power supply to switch engine on/off computerized make (4,high); advanced write(4,low); +5v 0v tip120 1k stick 4 +12 v program sets stick high/low (1/0) board stick set to +5v/0v interface hardware utilize flag voltages and power supply to switch engine on/off computerized write(4,high); advanced write(4,low); +5v 0v tip120 1k stick 4 +12 v 13 collaborating with the world has opposite sides. To begin with, the planner must make electronic interface circuits that enable engines and different gadgets to be controlled by a low (1-10 mama) current flag that switches somewhere in the range of 0 and 5 v, and different circuits that believer sensor readings into an exchanged 0 or 5 v flag. Second, the fashioner must compose a program utilizing the arrangement of Arduino directions that set and read the I/O pins.

IV. PROGRAMMING CONCEPTS

A PC program is a succession of well-ordered guidelines for the PC to take after. The PC will do precisely what you instruct it to do, no more no less. The PC just comprehends what's in the program, not what you planned. In this way the beginning of the expression, "deny in, rubbish out". program peruses estimation of pins (1/0) board pins set to +5v/0v interface hardware change sensor signals into +5v/0v digital read(4); 10k stick 4 +5 v +5v 0v program peruses estimation of pins (1/0) board pins set to +5v/0v interface gadgets change sensor signals into +5v/0v digital read(4); 10k stick 4 +5 v +5v 0v 14 the arrangement of substantial directions originates from the specific programming dialect utilized. There are numerous dialects, including C, C++, JAVA, ADA, Stutter, FORTRAN, Fundamental, Pascal, Perl, and a thousand others. TheArduino utilizes a rearranged variety of the c programming dialect. For any programming dialect, the directions must be entered in a particular sentence structure. All together for the PC to

decipher them legitimately. Ordinarily, the understanding is a two stage process. A compiler takes the dialect particular content you enter for the program and changes over it into a machine lucid frame that is downloaded into the processor. Exactly when the program executes, the processor executes the machine code line by line.

V. PROGRAM STRUCTURE

All Arduino programs have two capacities, Setup () and loop (). The guidelines you put in the startup () work are executed once when the program starts and are utilized to instate. Use it to set headings of pins or to instate factors. The directions set in circle are executed over and again and frame the fundamental undertakings of the program. As needs be each program has this structure

```
Void Setup()
{/Commands To Initialize Go Here
}
Void Loop()
{/Commands To Run Your Machine Go Here
}
```

The Absolute, Bare-Minimum, Do-Nothing Program That You Can Compile And Run Is

```
Void Setup() {} Void Loop() {}
```

The program performs no function, but is useful for clearing out any old program. Note that the compiler does not care about line returns, which is why this program works if typed all on one line.

VI. MPPT BASED SOLAR CHARGE CONTROLLER

A Maximum power point tracker (or MPPT) based Solar Charge Controller is a high proficiency DC to DC converter which works as an ideal electrical load for a photovoltaic (PV) cell, most regularly for a sunlight based board or cluster, and changes over the ability to a voltage or current level which is more reasonable to whatever heap the framework is intended to drive.

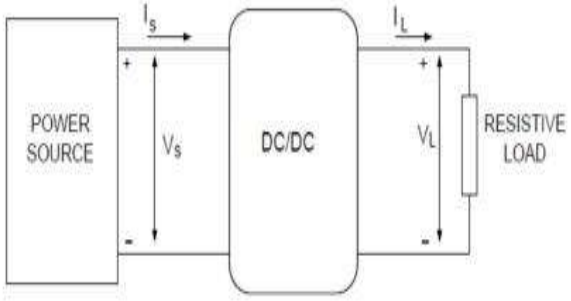

Figure 1: Schematic portrayal of MPPT charge Controller

Typically a charge controller plays out the accompanying fundamental capacities:

- Controls greatest power extraction from a board by following the MPP and guaranteeing that the board works at MPP.
- Controls battery charging as characterized in the battery charge cycle determination to enhance usable battery life and ensure it against turn around association, over charging and profound releasing
- Load insurance against over-burdens and shortcircuits
- Display (LED or LCD) Status signs

VI. MAXIMUM POWER POINT TRACKING ALGORITHM

The power yield from the sunlight based board is a component of insolation level and temperature. Be that as it may, for a given working condition, we have a bend which gives the voltage level kept up by the board for a specific estimation of current. This plot is known as the qualities of the cell. From the attributes plot, we will have the capacity to determine the power yield as for the yield current. We receive the strategy to observe the present which must be separated in order to settle the working purpose of the cell at its greatest power.

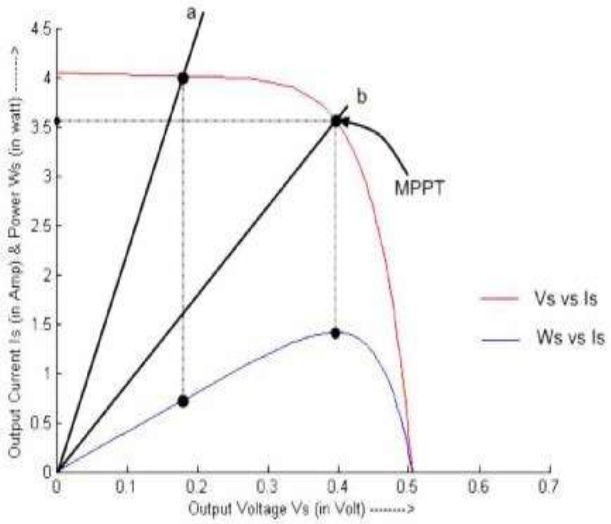

Figure 2: PV Panel Characteristic curves

The working purpose of any source sink component is the convergence purpose of load line with the source trademark plot appeared in fig 2. What we endeavor here to do is change the heap edge theta to converge the qualities at most extreme power point i.e., only the answer for impedance coordinating issue. The standard is portrayed underneath. PV modules have a low transformation productivity of around 15% for the fabricated ones. In addition, because of the temperature, radiation and load varieties, this effectiveness can be profoundly decreased.Truth be told, the productivity of

any semiconductor gadget drops steeply with the temperature. With a specific end goal to guarantee that the photovoltaic modules dependably act providing the most extreme power as would be prudent and directed by encompassing working conditions, a particular circuit known as MPPT is utilized.

In most basic applications, the MPPT is a DC-DC converter controlled through a methodology that permits forcing the photovoltaic module task point on the Maximum Power Point (MPP) or near it. On the writing, numerous investigations depicting procedures to enhance MPP calculations were distributed, allowing greater speed and exactness of following. Then again, there is no hypothesis to control the originator to pick, among the DC-DC converters family, the best one to work as MPPT, in this way, much of the time, the architects are entced to utilize the least complex DC-DC converters – to be specific buck converter or lift converter.

Different MPPT procedures

There are diverse procedures used to track the most extreme power point. Two of the most prevalent strategies are:

- Perturb and Observe Method
- Incremental Conductance Method

The decision of the calculation relies upon the time intricacy the calculation takes to track the MPP, usage cost and the simplicity of execution.

1. Perturb and Observe

Bother and Observe (P&O) is the most straightforward technique. Fig 3 demonstrates the algorithmic flowchart of Perturb and Observe technique for MPPT. In this we utilize just a single sensor, that is the voltage sensor, to detect the PV exhibit voltage thus the expense of execution is less and henceforth simple to actualize. The time many-sided quality of this calculation is less however on achieving near the MPP it doesn't stop at the MPP and continues annoying on both the headings. Figure demonstrates the Illustration of MPPT Algorithm When this happens the calculation has achieved near the MPP and we can set a fitting blunder restrain or can utilize a hold up work which

Winds up expanding the time multifaceted nature of the calculation. Anyway the technique does not assess the fast difference in illumination level (because of which MPPT changes) and considers it as a change in MPP because of bother and winds up computing the wrong MPP. To maintain a strategic distance from this issue we can utilize incremental conductance technique. The Perturb and Observe calculation expresses that when the working voltage of the PV board is irritated by a little augmentation, if the subsequent changes in control P is certain, at that point we are going toward MPP and we continue bothering a similar way. On the off chance that P is negative, we are leaving from the bearing of MPP and the indication of bother provided must be changed.

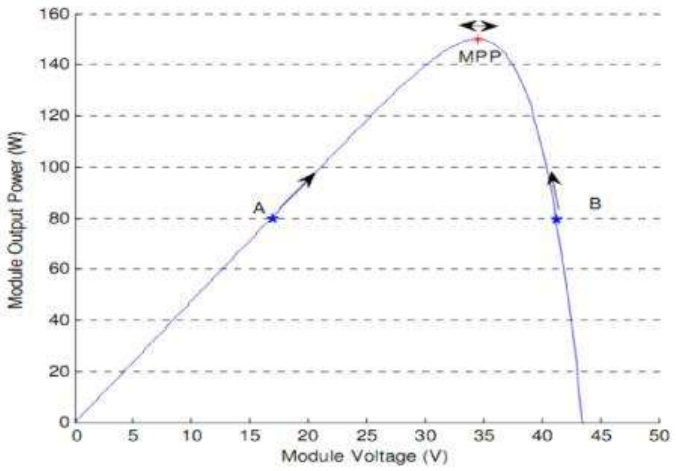

Figure 3: Illustration of P&O MPPT Algorithm

2. Incremental Conductance Method

The hypothesis of the incremental conductance technique is to decide the variety bearing of the terminal voltage for PV modules by estimating and contrasting the incremental conductance and prompt conductance of PV modules. On the off chance that the estimation of incremental conductance is equivalent to that of immediate conductance, it speaks to that the greatest power point is found. The fundamental hypothesis is shown with Fig. 4.

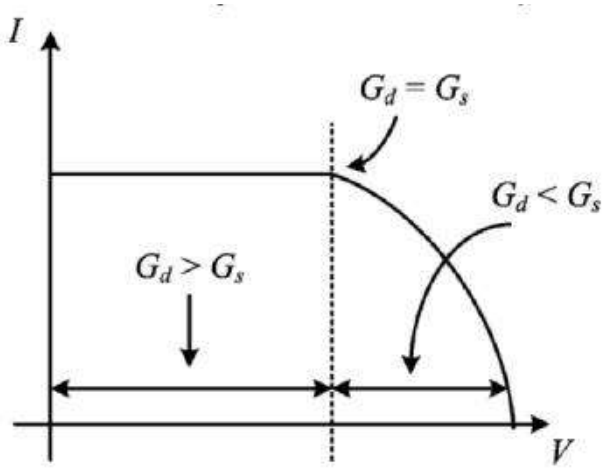

Figure 4: Illustration of InCond MPPT Algorithm

VII. CIRCUIT DIAGRAM

The MPPT control circuit is actualized in a MPPT controller that has IC LM324. The comparator is having 4 operation amps used to analyze voltage and current. It read the voltage and current of the sun based boards through the Optocoupler and computes the yield control. The control circuit analyzes the PV yield voltage and battery voltage and gives expected yield to the battery. It checks the sun powered board yield and if the battery voltage is less then it expands the voltage.

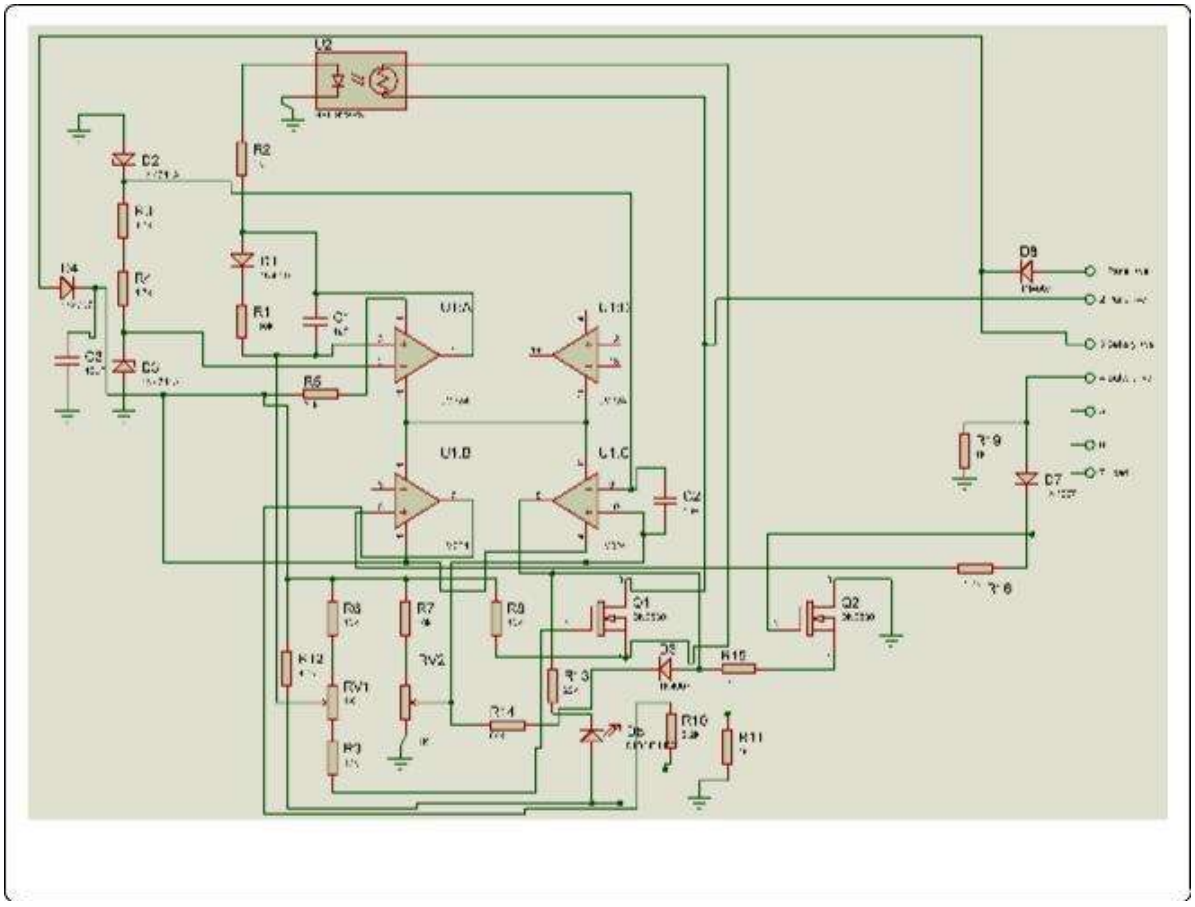

Figure 5: Circuit Diagram

The charger energizes battery to 12.9 volt and after that it charges gradually. On the off chance that the battery is completely charged the Optocoupler faculties, it and remove the supply. Info voltage and Battery voltages are looked at by comparators

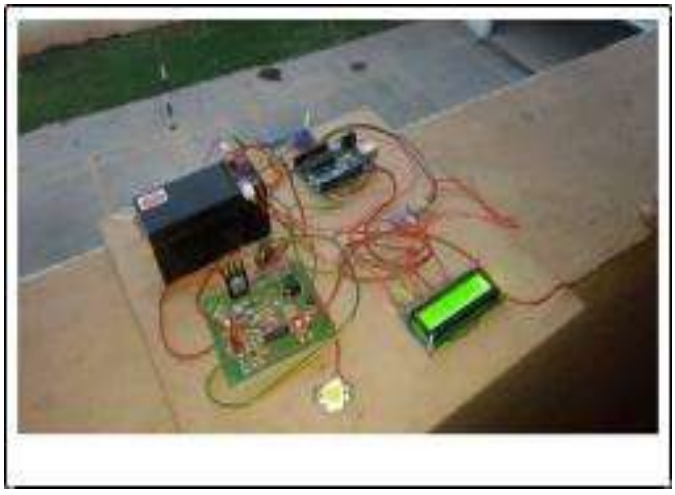

Figure 6: Complete Circuit

VIII. RESULTS

The continuous outcomes taken are appeared in Table 1 and Figure 6.

Time	Output Voltage (Volt)	Current (Ampere)
10 AM	13	0.36
11 AM	13.7	0.59
12 Noon	13.9	0.95
1 PM	13.6	0.91
2 PM	13.7	0.71
3 PM	13.2	0.70
4 PM	13.01	0.60
5 PM	12.59	0.50
6 PM	12.01	0.39

Table 1: Continuous Outcome

IX. CONCLUSION

A MPPT based charge controller hardware demonstrate is recommended that can effectively track the most maximum power point (MPP) at various irradiance esteems. A short time later, the most extreme power extricated from the board at that specificirradiance and temperature condition is nourished to a dc-dc Buck-Boost converter circuit to direct it as indicated by a settled dc voltage lastly encouraged to a 12 volt battery.

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