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DC-DC Solar Regulator

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Abstract: **In solar energy systems, the solar irradiance variations limit the converter's transformation rate for a certain input amount, leaving the rest of the energy unconverted. In order to utilize the maximum energy provided by Photo-Voltaic system, this project suggest the use of a boost converter whose duty pulses are controlled using Arduino as per input variation. Also, this project eliminates change in input and gives a constant output. MATLAB simulations for a certain input variation is provided and practical implementation of the circuit is discussed in this project.**

Keywords: **solar energy systems, boost converter, Arduino, duty pulses**

1. Introduction

Today, Photovoltaic (PV) or solar energy represents a small portion of the total generated energy, even though this kind of resource is enormous (the average intensity of light is about 1353W/m2 and the earth receives more energy from the sun in 1h than the global population uses in an entire year). The total energy from sun given to earth every 1hr is more than the energy produced by entire human population in one year. The energy produced from solar has increased by 8 times in the last four years. Solar power plants equipped with battery storage system is used for grid stabilization. The MPPT charge control technique of charging a battery and then obtaining constant output power has greater losses and very bulky apparatus. In applications where the solar energy need not be stored, using ideal DC – DC converters is the optimal method of obtaining constant output power.

The output power of a solar panel depends on the amount of light falling on the panel. Time of the day, season, panel position and orientation are the factors behind the output power. The present scenario used to convert variable output current from solar panel to a constant power makes use of MPPT charge control technique coupled to a battery which gives out constant DC power. The main advantage of the above method lies in the fact that once charged, the battery can supply equipment as and when needed. However, in applications where the solar energy is to be used directly without storing in the battery, DC – DC converters can be used which will convert the variable input to constant output. This will reduce losses and also the cost of setup.
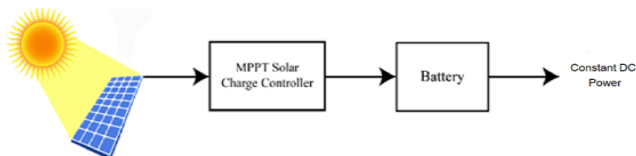

Fig. 1. Block diagram representation of extracting constant power using MPPT charge control technique
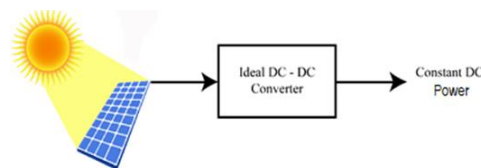

Fig. 2. Block diagram representation of extracting constant output using DC – DC converter
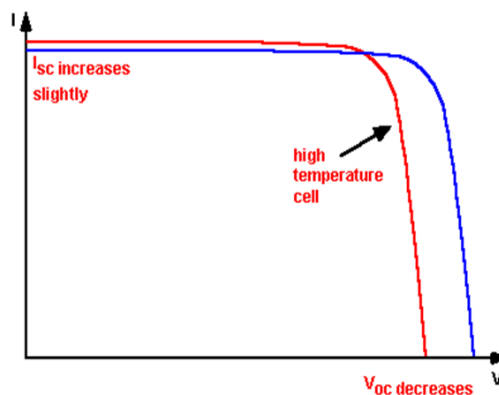

Fig. 3. V-I Graph for solar panel exposed to temperature change

When the solar panel is exposed to temperature change, the output voltage is affected more compared to the output current as shown in figure 3.
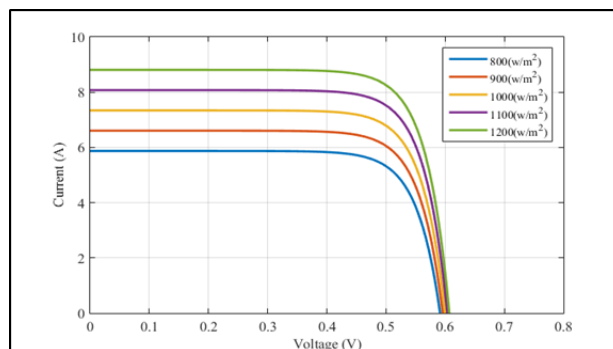

Fig. 4. Output Current change with Irradiance

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The output current gets affected more by Solar Irradiance as compared to output voltage as shown in figure 4.
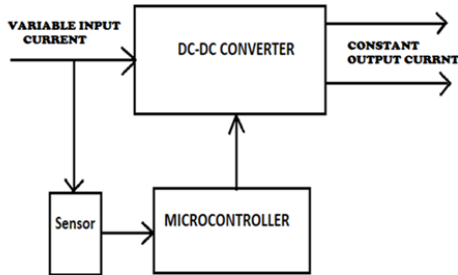
2. Basic block diagram

Fig. 5. Basic block diagram

3. Arduino

Arduino is an open-source platform used for building electronics projects. It has a physical programmable circuit board and a piece of software, that runs on your computer, used to write and upload computer code to the physical board. The Arduino IDE uses a simplified version of C++. the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn. users have contributed code and released instructions for a variety of Arduino-based projects.
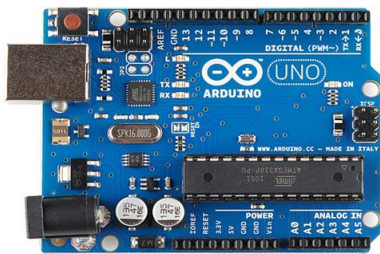

Fig. 6. Arduino

4. Boost converter

DC-to-DC power converter that increases voltage (while decreasing current) from its input (supply) to its output. It is classified in a class of switched-mode power supply containing a diode and a transistor and a capacitor, inductor, or the two in combination.
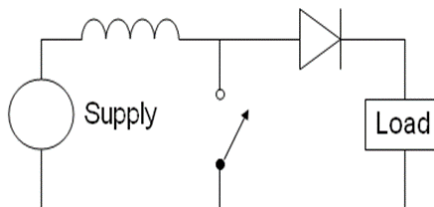

Fig. 7. The basic schematic of a boost converter

The switch is typically a MOSFET, IGBT, or BJT. In a boost converter an inductor tries to resist changes in current by creating and destroying a magnetic field. the output voltage is always higher than the input voltage. A schematic of a boost power stage is shown in Figure 7.

5. MATLAB circuit diagram

The fig. 8 is the MATLAB circuit is a software circuit to test the practical circuit component working properly or not and also to get a proper output. If the MATLAB circuit correct then only we can move on practical hardware circuit
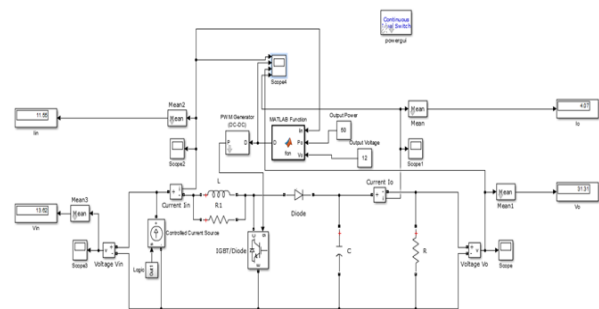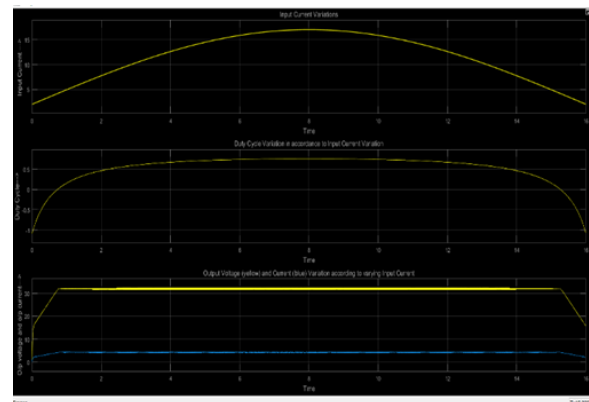

Fig. 8. MATLAB Simulink diagram

Fig. 9. MATLAB Circuit Output

6. MATLAB function

function D = fcn(Iin,Po,Vo)
D=((Iin-(Po/Vo))/Iin);
Here,
Value of Iin will be provided by the input current from the solar panel (Controlled Current Source in the MATLAB Simulation)
Value of Po and Vo will be provided according to the power and voltage ratings of the load used.
Accordingly, Duty Cycle, D of the MOSFET is calculated.

7. DC-DC Solar regulator

Using boost convertor principle operation, we design our project. According to desire output of device the circuit maintain a constant output. The desire output value V0 is set in Arduino programming code due to these the Arduino gives signal to TLP circuit. The TLP circuit generate pulses (duty cycles) which is then given to gate of MOSFET according to pulses the gate switch on and off the MOSFET the pulses

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control switching time of MOSFET and then the boost convertor operation starts.

8. Arduino coding

```
#include <avr/io.h>
#include <util/delay.h>
int main(void)
{
float D;
pinMode(3, OUTPUT); // Output pin for OCR2B
//pinMode(5, OUTPUT); // Output pin for OCR0B
void loop();
{
Vo =
// read the input on analog pin 0:
int sensorValue = analogRead(A0);
// Convert the analog reading (which goes from 0 - 1023) to
a voltage (0 - 5V):
float Iin = (sensorValue * (30.0 / 1023.0));
// print out the value you read:
Serial.println(Iin);
//Serial.println(sensorValue);
if(Iin<1.0)
{
D=0.95;
}
else if(Iin>10.0)
{
D=0.9;
}
Else
{
D = 1 - (Po/Vo)/Iin ;
}
TCCR2A = bit(COM2A1) | bit(COM2B1) | bit(WGM21) |
bit(WGM20);
TCCR2B = bit(WGM22) | bit(CS20);
TCCR2B = (TCCR2B & 0b11111000) | 0x04;
OCR2A = 120; // change this for changing frequency
OCR2B = D * 100; // change this for changing duty cycle
}
}
```
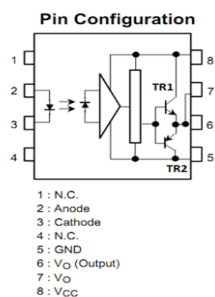
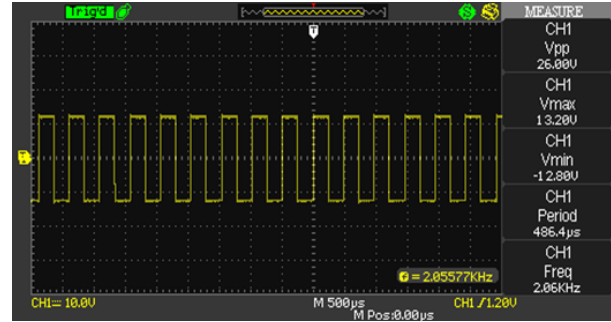## 9. TLP pin configuration

Fig. 10. TLP pin configuration
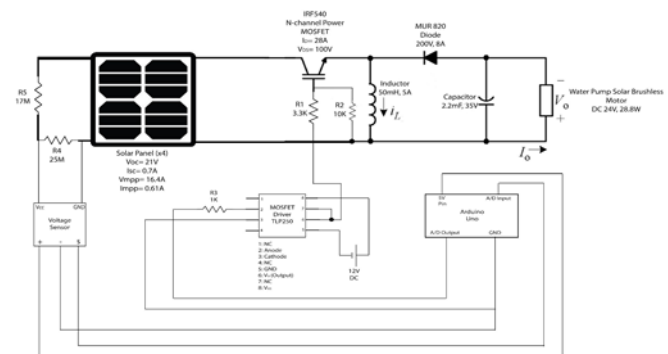

Fig. 11. Input to TLP

Fig. 12. TLP output

Fig. 13. Project circuit diagram

10. Conclusions

It was observed that solar panel when exposed to various environmental conditions such as temperature changes and solar irradiance, i.e. the variation in the amount of solar energy received by the panel due to weather changes, dust accumulation on the panel, shade falling on panel etc. leads to variation in the input power, which in turn causes fluctuations or variations in the desired output power. In order to find a solution to this problem a DC-DC Boost Converter was designed using MATLAB Simulation. We were able to successfully obtain a constant desired output on MATLAB Simulation even when the input current was varied. we are able to get the desired results from software point of view, and also hardware implementation of the solar regulator we have designed gives a desired constant output even when variation occur in output of solar panel. The main advantage of this project is the simple components and cost required is low.

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