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DESIGN AND DEVELOPMENT OF HIGH GAIN DC-DC BOOST CONVERTER FOR SOLAR PV APPLICATIONS

S.Frieda Angelin[1], P.Hemamalini[2], V.Rithi Andal Pooja[3], S.Dhivya Priya[4], Dr. D. Prince Winston[5]

[1,2,3,4]UG Students, Dept. of EEE, Kamaraj College of Engineering & Technology, Madurai, Tamil Nadu, India.
[5]Professor, Dept. of EEE, Kamaraj College of Engineering & Technology, Madurai, Tamil Nadu, India.

Abstract - *Due to the of size, cost, and large mass of transformer which is considered as the main burden in grid-connected solar photo-voltaic system that also reduces the entire system efficiency and to avoid the utilization of a transformer, a high step-up gain DC to DC boost converter is designed by using limited number of switches. Within the classical type boost converters, the converter's stress like usage of multiple components. Therefore the losses are associated with the converter are high and that will sometime end in lower efficiency and low voltage gain. The converter also gets dominated with the ripple, which helps to elongate the reliability of devices and suppress the parameter of electromagnetic interference. This paper also compares with the classical converters characteristics. Under research, the traditional converter provides gain up to 20 and the proposed model increases gain quite 25 with limited usage of switches.*

Key Words: MATLAB Software, Arduino, Boost converter, Solar PV.

1. INTRODUCTION

Solar energy is the renewable source of energy obtained from sun which converts heat energy to light energy then to the electricity. The process of obtaining electricity from sunlight is taken into account to be as photo-voltaic method using solar panels. This is often achieved by employing a semiconductor material within the panel.
Photo voltaic cells converts light onto DC electrical energy. Initially energy obtained from sun through solar array is given to high step-up converter. The power from the panel may have low voltage due to some kind of partial shading in panel, hence after reducing the shading low voltage readings are obtained which is then given to the high gain boost converter respectively. Then it'll be fed to both the AC as also as DC grid by inverter and converter respectively. This will be the proposed method of high gain DC-DC boost converter.

Simultaneously the software simulation results were also taken using minimum number of switches by varying the pulse width and duty cycle of switches with reference to the supply voltage. As a result high gain is obtained which also increases efficiency.

BLOCK DIAGRAM

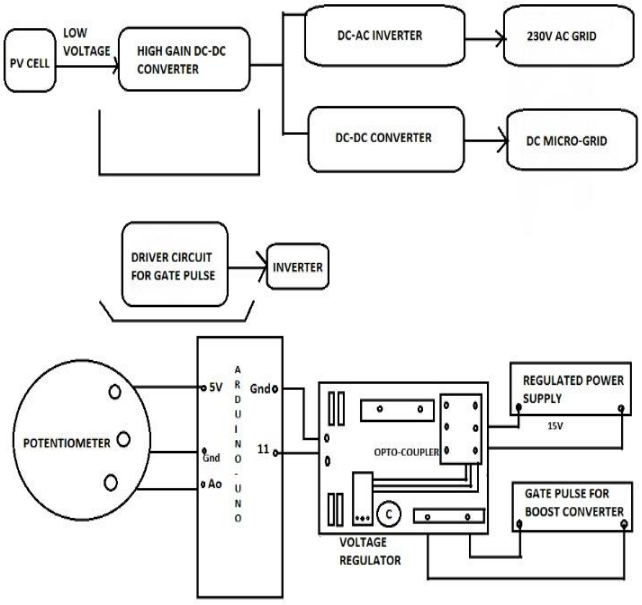

Fig – 1: Block Diagram representation of the high gain boost converter.

2. BLOCK DIAGRAM DESCRIPTION

From the above block diagram the brief explanation on the proposed method has been described and for the driver circuit, a detailed block is shown where the potentiometer is employed to vary the voltage and variation is given to the arduino as a input of 5V which should increase to 15V. Hence voltage regulator is used. Opto-coupler enhances the contact between the driver circuit, boost converter and therefore the regulated power supply which regulates 15V to boost converter.

3. COMPARISION WITH THE EXISTING SYSTEM:

In the conventional converter, regenerative boost converter operations and the switched capacitor takes place simultaneously by the lossless passive components and a minimum number of the semiconductor devices.

Thereby, it drastically increases the DC-voltage gain and enhances efficiency.

Based on the literature review the gap identified for our proposed work is concentrated on cascaded converter simulation. By applying values to duty cycle in pulse generator by splitting up values according to increase the output voltage. Hence the gain of our designed model will increase more than 25 by using limited number of switches which is our proposed methodology. But from the literature survey taken the gain has increased only up to 20.

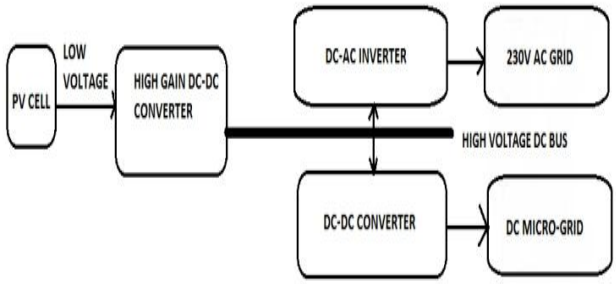

Fig – 2: Simple block diagram representation of boost converter from the proposed method

The design of such high gain boost converter using limited number of switches has specialized components like MOSFET IR640, opto-coupler MCT2E in the hardware section. The below pictorial represents the driver circuit of the high gain boost converter by using EAGLE software.

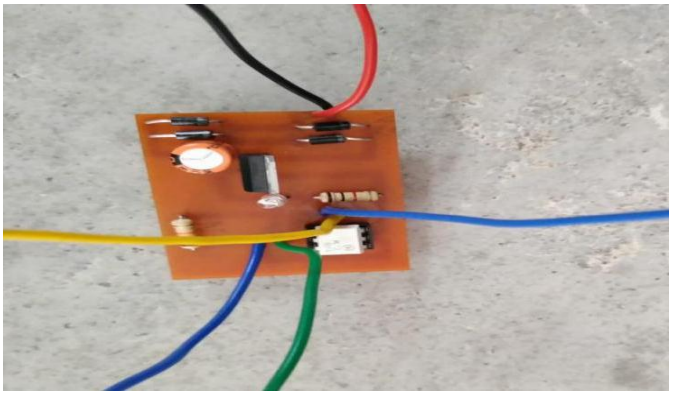

Fig – 3: Hardware PCB model of the driver circuit

The purpose of the printed circuit board here is to form a driver circuit for a high gain boost converter which needs gate pulse, hence PCB board is an interface between arduino connected with the potentiometer variations and to output.

In the below drawn PCB model is designed using EAGLE software which consists of four diodes D1, D2, D3, D4, a voltage regulator , a LED , a six pin opto-coupler MCT2E and passive components respectively where the major aim is to convert 5V to 15V from input to output by making variations in potentiometer which shows a rise in output voltage.

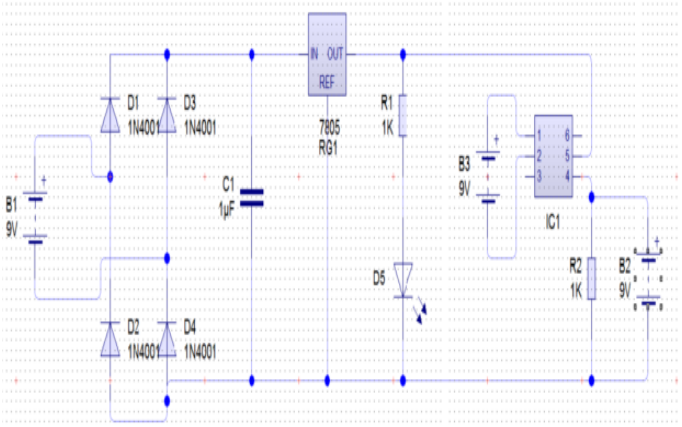

Fig – 4: Circuit diagram representation of the PCB design

The supply to the opto-coupler is taken from 11th pin of arduino and output from opto-coupler is given to RPS.

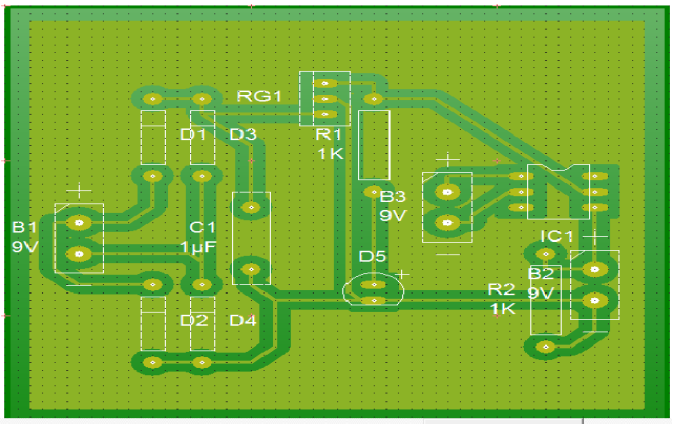

Fig – 5: Software representation of the PCB design

The above PCB work represents the model of proposed driver circuit using EAGLE software. Hence by increasing a gain enhances an rise in efficiency. Various duty cycle ratios are simultaneously varied consistent with the graph obtained from an increasing gain.

4. SIMULATION DIAGRAM AND DESCRIPTION

Three switches S_1, S_2, S_3 are the main component which requires gate pulse for its operation. For varying the gate pulse, duty ratio and pulse width values have to be varied.

For the requirement of gate pulse, pulse generator is used in simulation initially switch S_1 and S_2 operates, only 80% and 90% of the duty cycle will be given. Next switch S_1 and S_3 will operate whereas the switch S_2 will not have any gate pulse. Capacitor C_2 and inductor L_3 near S_3 will discharge to output. Here the value of duty cycle will have 80% and 20% respectively.

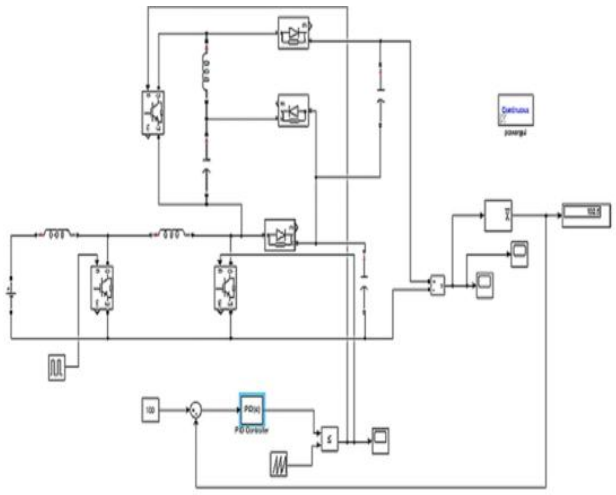

Fig – 6: Simulation representation of the proposed system

Since high gain should also be obtained even when the gain varies. And vice verse the operation continues again from the switch S_1 and S_2 and process will occur which leads to increase in gain finally with minimum number of switches.

5. SIMULATION GRAPH

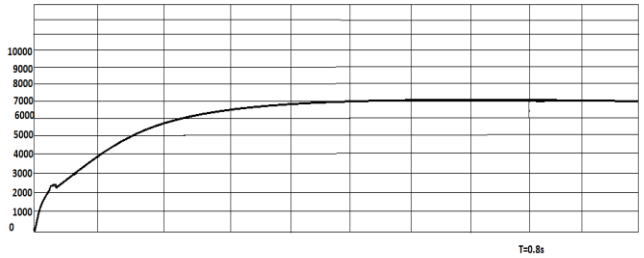

Fig – 7: Output graph taken from simulation

5.1 SIMULATION RESULTS FOR THREE PHASE

The variation in bar graph is obtained by varying the integral and proportional values in the Ramp generator which provides absolute variation with minute changes for the three phase.

ERROR = 508 - MEASURED VALUE for three phase

$$V_{in} = \frac{415V * 3}{\sqrt{6}} = 508.06V$$

here V_{in} is supply voltage

Input	Set Value	P	I	Measured value
30	508	30	15	463
30	508	10	5	450
30	508	80	15	105
30	508	60	60	520
30	508	20	30	507
30	508	90	10	675
30	508	40	45	512
30	508	41	20	508
30	508	25	21	509
30	508	30	13	510
30	508	30	21	507
30	508	34	24	646
30	508	32	16	508

Table -1: Readings taken for three phase system with different P and I values.

The table above represents the different values of proportional (P) and integral (I) for three phase, where each value of p and I, the output may increase or decrease according to a change in input which may be low voltage since the input to panel may get reduced due for shading which can be recovered by many techniques like image processing.

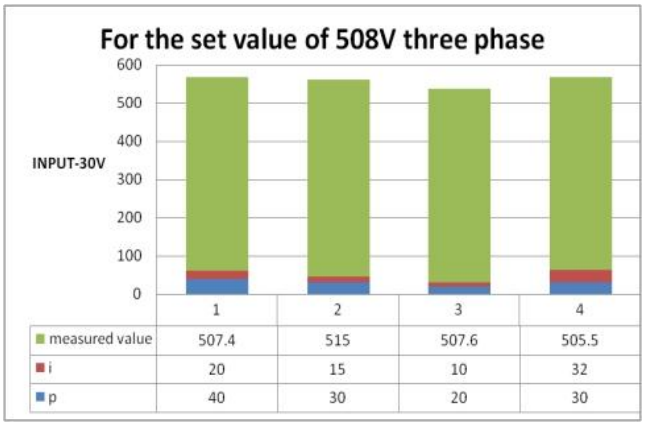

Fig – 8 Representation of bar graph model of output values with minimum error in three phase

5.2 SIMULATION RESULTS FOR SINGLE PHASE

The variation in bar graph is obtained by varying the integral and proportional values in the Ramp generator which provides absolute variation with minute changes for both the single phase.

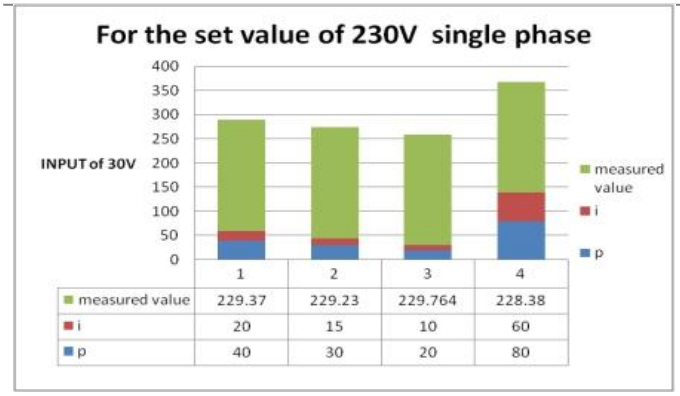

Fig – 9: Representation of bar graph model of output values with minimum error in single phase

Input	Set Value	P	I	Measured Value
30	230	34	16	234
30	230	40	20	400
30	230	10	5	401
30	230	10	15	221
30	230	30	15	230
30	230	24	12	306
30	230	32	16	227
30	230	44	22	230
30	230	22	11	228
30	230	80	60	240
30	230	20	10	229
30	230	50	25	228
30	230	26	13	229

Table -2: Readings taken for single phase system with different P and I values

ERROR = 230 - MEASURED VALUE for single phase

6. PROGRAM USED FOR ARDUINO

Program for the arduino is given below which is given as input of 5V to the driver circuit, made of PCB board. Arduino is verified initially if it works by using the simple program of LED.

```
const int analogPin = A0;
void setup()
{
  pinMode(11,OUTPUT);
  Serial.begin(9600);
}
void loop()
{
  analogWrite(11,230);
}
```

6.1 Advantages

The following are the benefits of the proposed method,

(1) Low Cost: Overall cost for testing the solar panel is low. This makes it much economical and reliable.

(2) High gain: Output voltage have been increased from 20 to quite 25.

(3) High Efficiency: Due to an increase in output voltage and gain leads to increase in efficiency.

7. LIMITATION

The operation of the proposed system of high gain dc -dc boost converter under closed loop is complex but it also can be verified by simulation.

8. RESULT AND CONCLUSION

From the analysis, it is concluded that our proposed converter has better merit than recently reported converters; thereby it is more suitable for solar PV applications. Moreover, it offers low losses due to the utilization of lower on-state resistance and lower duty cycle operations; it leads to high-efficiency.

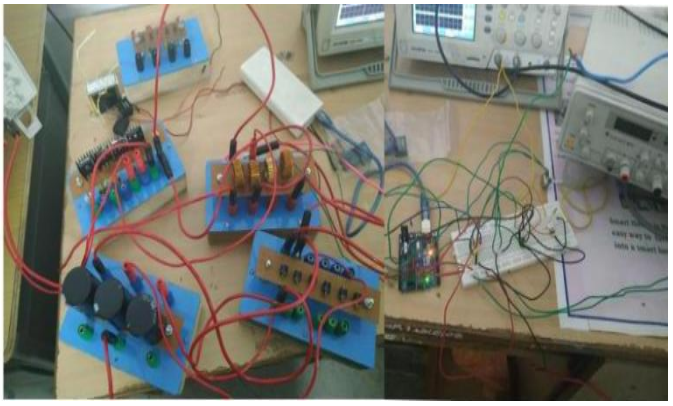

Fig – 10: HARDWARE CIRCUIT CONNECTIONS

The measured results have good agreement with the theoretical waveform and ensures the DC-voltage gain analysis. Furthermore, measured efficiency graph is discussed. It is noted that the utmost efficiency is obtained with the usage of minimum number of switches with reduced error.

Finally, by implementing the proposed high-gain dc dc converter, size and cost of the whole solar photo-voltaic system are often minimized that elongates the general efficiency. This will be useful for future research projects and references.

ACKNOWLEDGEMENT

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