International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056
Volume: 06 Issue: 05 | May 2020 www.irjet.net p-ISSN:2395-0072

DEVELOPMENT OF SIMO DC-DC CONVERTER FOR PV APPLICATION

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Abstract – *This paper describes the design of single-input multi-output DC-DC converter for PV applications. This paper deals with the designing of an efficient SIMO DC-DC converter for solar PV applications via, an isolated transformer. The utilization of the output of the PV array is high as multiple loads of different voltages are drives from the single input of a PV array. The software MATLAB simulation corresponds to the effective utilization of this converter. As the variation in the duty cycle of the IGBT's (or MOSFET) corresponds to the variation of the output voltage that are supplied to the multiple loads. The hardware results corresponds to the effectiveness of the output voltage obtained by varying the input duty cycle. In this paper we have scrutinized a progressive increment and decrement of the output. This SIMO Converter suits for Hybrid vehicles and so on.*

Key Words: MATLAB Software, Percentage Defect, Percentage Quality, Efficiency and Age, Solar PV.

1. INTRODUCTION

DC-DC Power converter has occupied a great place in industrial telecommunication and renewable energy source application. It is that the demand for high quality DC voltage regulation is high and so, the use of this converter is high. For considering the solar PV application, the single input for a solar PV array can be utilized for the multiple loads of different voltage levels. As an additional advancement in this technology, the isolated transformer is used to increase the conversion efficiency.

The different regulated levels of DC voltage for multiple loads can be obtained by varying the duty cycle of the respective IGBT's (or MOSFET). The isolated transformer is used so as to avoid the short circuit of the load, due to the supply, whereas the isolated of the load and supply can be done. The study of MATLAB simulation output results that the variation of the duty cycle of the converter leads to the variation in the output of the multiple loads.

2. BLOCKDIAGRAM

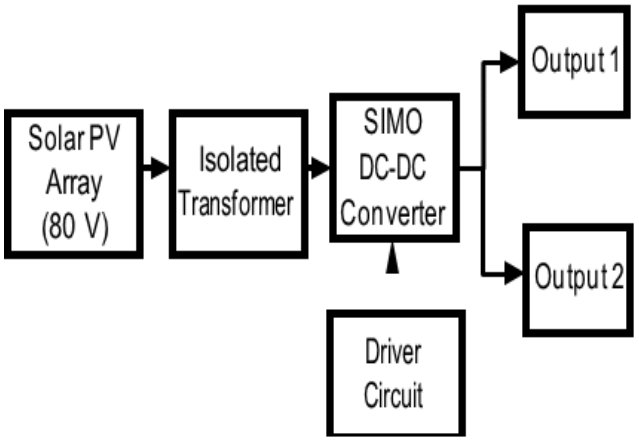


Figure – 1: Block Diagram.

3. BLOCK DIAGRAMDESCRIPTION

The figure: 1 shows the block diagram of the proposed work. The first block corresponds to the solar PV array of output voltage 80 V. The isolated transformer is connected between the solar PV array and the SIMO DC-DC converter in order to avoid the short circuit of the solar PV array and SIMO DC-DC converter. In case of using a non-isolated transformer it leads to the short circuit between the negative terminal of the multi output and the source. The variation in the duty cycle of the respective switches corresponds to this kind of disadvantage.

In order to overcome the disadvantage, an isolated transformer is used. The SIMO DC-DC converter block is driven by the driver circuit which is used to provide the various duty cycles to the respective switches. The variation in the duty cycle results in the variation in the output of the SIMO DC-DC converter. Thus, the required output can be obtained by the varying the duty cycle.

4. CIRCUIT DIAGRAM

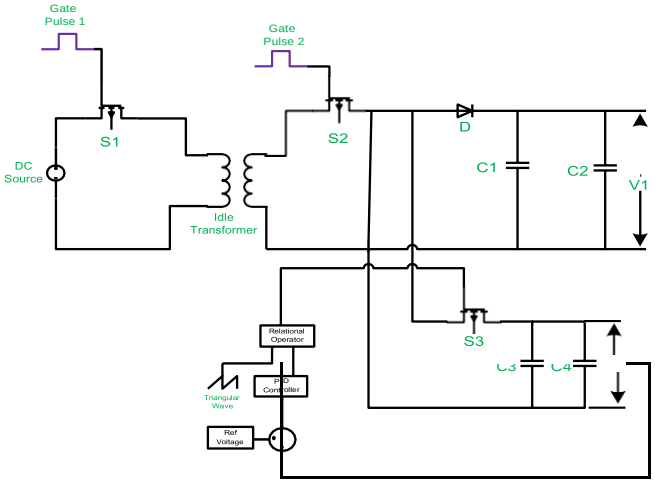


Figure: 2 Circuit diagram of the proposed work

The figure 2 shows the circuit diagram of the proposed work. The DC supply in the figure corresponds to the 80 V solar PV array. The isolated transformer is connected between the supply and the multi outputs. It is that the loads of different voltages are to be supplied from the single input of 80 V solar PV array. The gate pulse of the switches are varied respectively in order to supply the multiple loads of different voltages. The short circuit between the supply and the loads is avoided by the isolated transformer. For some applications such as hybrid electric vehicle, various circuits of different voltages can be supplied from the single input of the solar panel. In order to improve the effectiveness of the converter, The PID controller is placed in which the proportional gain and the integral gain are varied such that the percentage error can be reduced. This correspondingly increase the effectiveness of the converter. The relational operator and the summer block are used in this circuit along with the PID controller. Thus, the different voltages are obtained and supplied to the multiple loads.

PRINTED CIRCUIT BOARD (PCB) DESIGN

The figure 3 shows the circuit diagram of the proposed work that has been designed by using software. Initially the circuit diagram is designed then figure 4 shows the PCB design. The circuit diagram initially designed is converted to a PCB design. This PCB design is then printed on a PCB circuit board. The printed circuit board plays an important role for the development of hardware design in this project. General inputs of Arduino are connected to the printed circuit board.

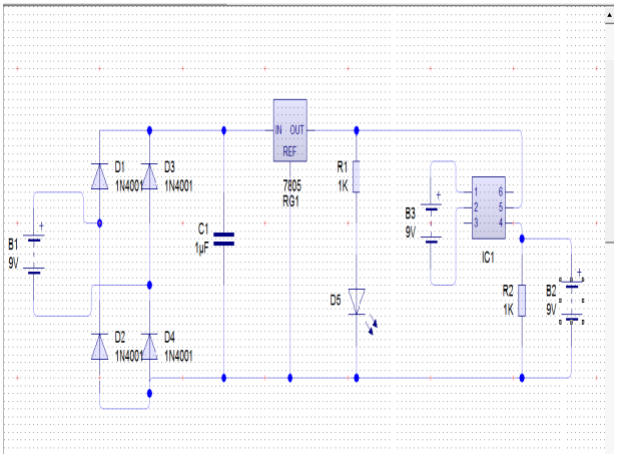


Figure: 3 PCB-Circuit Diagrams

TO

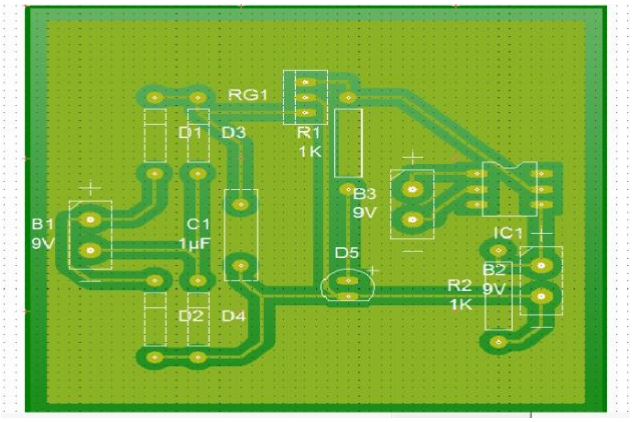
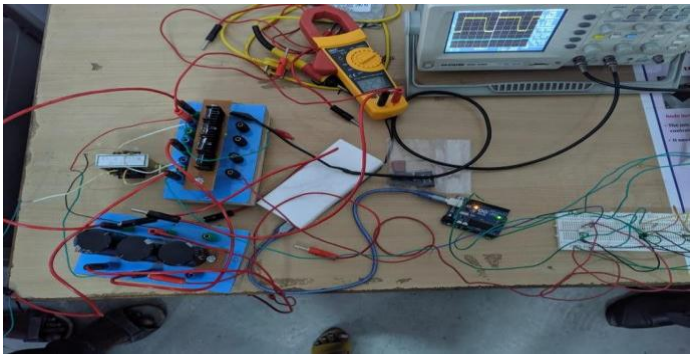


Figure: 4 PCB- Design

HARDWARE CIRCUIT DESCRIPTION

Figure 5 shows the hardware connection of the components as per the circuit connection of the proposed work.

Figure5 : Proposed hardware



The different regulated levels of DC voltage for multiple loads can be obtained by varying the duty cycle of the switches.Their outputs are controlled by pulse width modulation (PWM) of the gate signals. We can see the corresponding output through digital waveform. By the help of changing the potentiometer the value of output voltage can be changed.

4.3 SIGNALS IN DIGITAL FORM(DSO)

Figure 6 and Figure 7 corresponds to the output Signals in the digital form that has been obtained In the Digital Storage Oscilloscope(DSO).

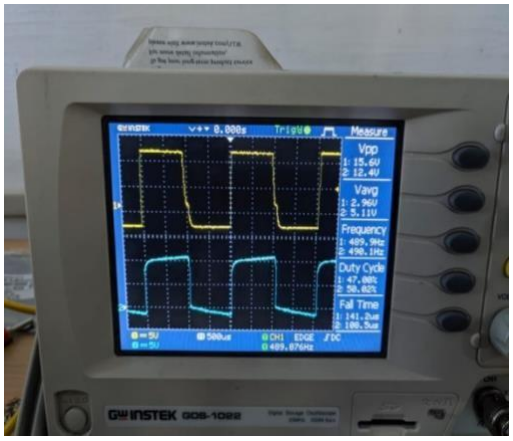


Figure: 6 Digital signal 1

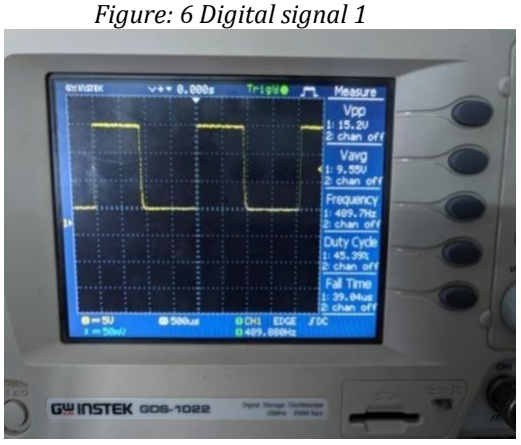


Figure: 7 Digital signal 2

5. RESULT AND DISCUSSION

The figure 8 shows the MATLAB simulation of the circuit diagram of the proposed work. The respective values that are obtained from the MATLAB simulink are obtained below.

The graphical representation also shown below.

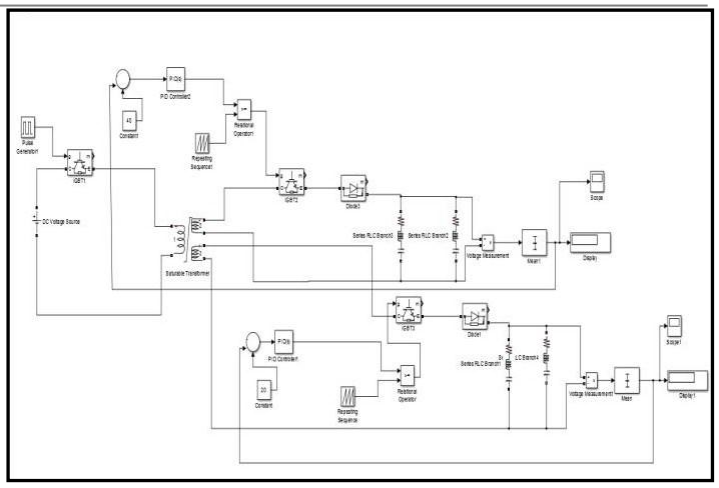


Figure 8: MATLAB SIMULINK-CIRCUIT DIAGRAM

RESPECTIVE VALUES FROM THE MATLAB SIMULINK ARE GIVEN BELOW:

Table1: Tablewithsetvalue1of60

SET VALUE 1=60			
P	I	MEASURED VALUE	%ERROR
53	29	60.36	0.6
73	69	59.49	0.85
26	29	59.49	-0.85
62	48	61.48	-2.47
56	49	60.81	-1.35
82	48	67.46	-12.42
69	29	62.11	-3.52

Figure: 9: Graph with set value 1 of 60.

The figure 9 shows the comparative gain analysis with respect to proportional gain and internal gain for the set value of 60. The

maximum gain will be obtained at the error value of -12.42. The maximum proportional gain is 82 and the internal gain is 48. The minimum internal gain obtained at the -0.85, 0.6 and -3.52 error values.

Table2:Tablewithsetvalue2of60

SET VALUE 2=60			
P	I	MEASURED VALUE	%ERROR
16	45	60.85	1.42
10	42	60.67	-1.12
12	24	60.52	-0.87
26	46	61.21	-2.02
20	45	61.02	-2
12	24	60.52	-0.87
10	42	60.67	-1.12

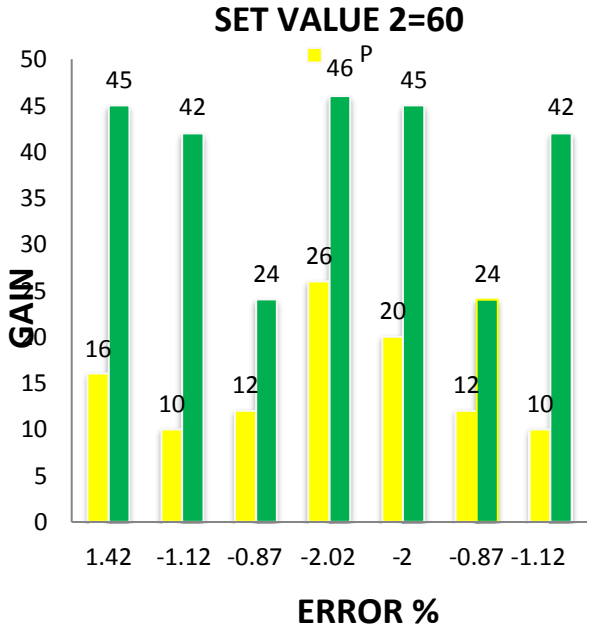


Figure: 10: Graph with set value 2 of 60.

The figure 10 shows the comparative gain analysis with respect to proportional gain and internal gain for the set value of 20.The maximum internal gain 46 obtained at -2.02 error. The internal gain of 45 obtained at the error values of 1.42 and -2. Higher proportional gain 26 will get at the -2.02 error value

Table3:Tablewithsetvalue3of40

		SET VALUE 3=40	-
P	I	MEASURED VALUE	%ERROR
16	25	40.32	-0.8
18	25	40.31	-0.78
15	52	40.22	0.37
48	52	41.77	4.42
48	52	41.71	-4.28

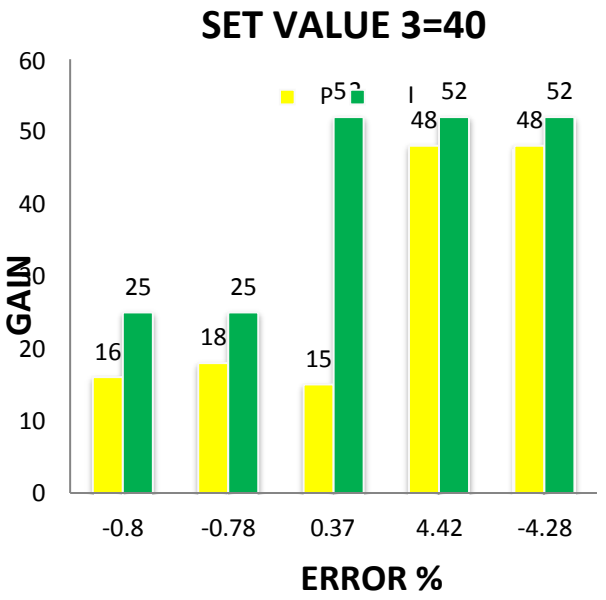


Figure :11: Graph with set value 3 of 40.

The figure 11shows the comparative gain analysis with respect to proportional gain and internal gain for the set value of 40. The maximum gain will be obtained at the error value of -4.28. The maximum proportional gain is 48 and the internal gain is 52. The minimum internal gain obtained at the -0.78, 0.8 and -0.37 error values.

Advantages

The following are the advantages of the proposed method,

- In our project, highly efficient SIMO DC –DC Converter can be designed at low cost.
- Many outputs can be obtained from a single input.
- It is highly beneficial for hybrid vehicles.
- The novel isolated transformer is used here to eliminate short circuit between the load and the supply.

- All the output's will be equally benefited based on their capacity.

Limitation

The variation of duty cycle for individual voltage is quite tedious and The SIMO DC-DC Converter has large ripple.

6. CONCLUSION

In this project, SIMO DC-DC Converter for PV application was designed. The isolated transformer was powered by 80V solar panel. In this work, the converter was designed with closed loop along with controller and performance was analyzed by using MATLAB tool, the graph was plotted with the respective readings and a prototype of the proposed converter was designed and the performance was tested by connecting the driver circuit. The different regulated levels of DC voltage for multiple loads can be obtained by varying the duty cycle of the switches. An efficient DC to DC Converter can be obtained. Therefore, SIMO DC to DC Converter is suitable choice for PV applications and also more output can be obtained.

ACKNOWLEDGEMENT

We would like to thank our guide Dr. D. Prince Winston, Professorofourdepartmentforguidingustocompleteour project.

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