Maximum Utilization of Power from Solar PV under Partial Shading Condition using Luo Converter

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Abstract— This project mainly aims in maximum utilization of power from solar panel array under the partial shading condition. However, the performance of the PV system gets affected by the environmental conditions such as change in solar radiation and temperature. When one(or many) of the module in a solar panel comes under the effect of shading(which can be due to trees, neighboring buildings, clouds and many more circumstances can be there), its voltage drops, so, it works as a load instead of working as a generator. If the solar array is subjected to shading condition, its output power level decreases. In order to utilize maximum of the power generated we have designed a Luo converter (a boost converter).

Key words: PV, Luo Converter, Solar Panel

I. INTRODUCTION

Conventional electrical power generation based on coal-fired power plants introduces carbon emissions which cause air pollution to be released into the Earth's atmosphere. To tackle this problem, renewable energy is employed as an alternative mode of electrical power generation. Among the renewable energy options, photovoltaic solar power is getting more and more popular nowadays due to its abundantly available and inexhaustible nature.

Photovoltaic modules or solar panels are the most fundamental components in a photovoltaic power system which is used to convert solar energy to electrical power. When a photovoltaic module is connected to a piece of measurement equipment, P-V characteristics will be obtained. The P-V characteristics demonstrate the electrical power delivered by the photovoltaic module at different voltages. During a uniform irradiance condition, the P-V characteristics of a photovoltaic string exhibit open peak characteristics. The peak acts as the global peak which represents the maximum power of the photovoltaic string.

When partial shading takes place, multiple peaks appear on the P-V characteristics due to the use of a bypass diode. The P-V characteristics of a photovoltaic string during a partial shading condition. The highest peak is the global peak which represents the maximum power of the photovoltaic string, while the others are the local peaks.

The efficiency of a photovoltaic(PV) array is greatly influenced by shading conditions. The PV arrays get shadowed, completely or partially, by the passing clouds, neighboring buildings and towers, trees, and utility and telephone poles.

During partial shading, the maximum power of a photovoltaic system can drop drastically, which significantly reduces the energy yield of the photovoltaic system. However, the susceptibility of partial shading to a photovoltaic system is not constant. The susceptibility of partial shading to a photovoltaic system can be varied due to the partial shading pattern and the connection employed to connect the photovoltaic modules in the photovoltaic system. The aim of this project is the maximum utilization of power from the solar panel under partial shading condition. Here we use Luo converter for this process, which will boost the output power. We designed this project for the common household usage, where 50W panel is used to power up dc sources. The major objective is to bring out a product to solve the problem of fluctuation in generation of power from the photovoltaic array during shading condition.

II. OBJECTIVE OF PROPOSED WORK

To design a Luo converter for 50W panel to utilize the maximum power generated under partial shading condition.
To bring out a product for the AMMA THOGUPPU VEEDU scheme. This would sort out the problem of decrease in generation of power under partial shading condition.

Fig. 1: Solar panel of amma Thoguppuveedu scheme

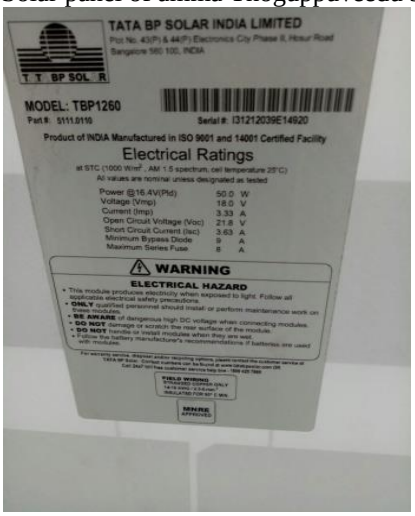

Fig. 2: Specifications of Amma ThooguppuVeedu panel

The maximum load connected to the panel of Amma Thooguppu Veedu Scheme is about 45W, whose output decreases under the partial shading condition. Our Luo converter's design will get rid of this problem.

III. MPPT ALGORITHM

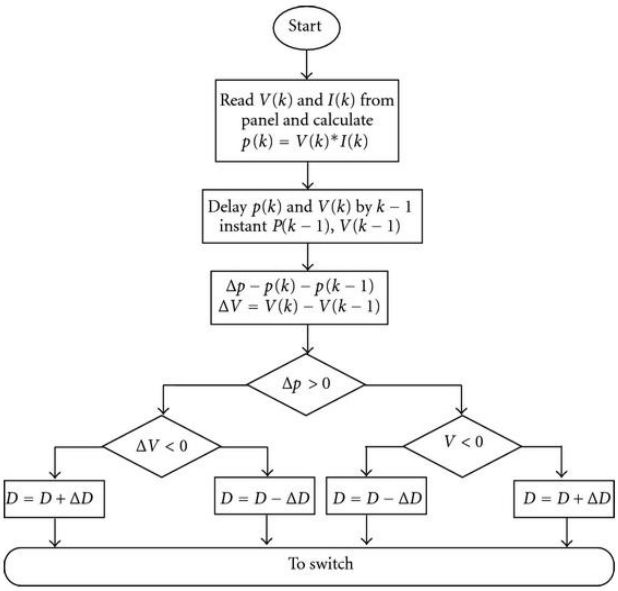

Fig. 3: Flow chart of P&O MPPT algorithm

A typical solar panel converts only 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel .According to Maximum Power Transfer theorem, the out power of a circuit is maximum when the venin impedance of the circuit (source impedance) matches with the load impedance. Hence problem of tracking the maximum power point reduces to an impedance matching problem.

Perturb & Observe (P&O) is the simplest method. The Perturb & Observe algorithm states that when the operating voltage of the PV panel is perturbed by a small increment, if the resulting change in power P is positive, then we are going in the direction of MPP and we keep on perturbing in the same direction. If P is negative, we are going away from the direction of MPP and the sign of perturbation supplied has to be changed.

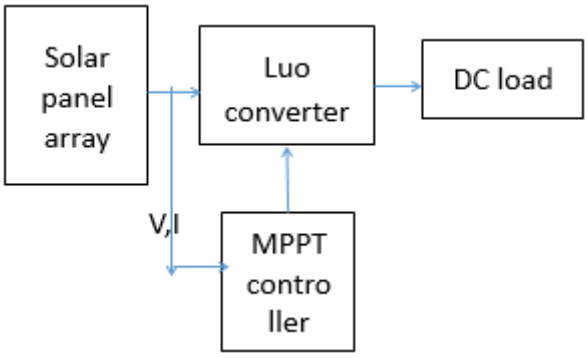

Fig. 4: Block diagram

The above proposed block diagram illustrates the following explanation. The power generated from the panel will be sent to the load through luo converter. This converter performs positive to positive DC-DC voltage increasing conversion. The output from the MPPT controller will also influence the output of the converter by tracking the maximum power point. The power generated will be supplied to the DC load.

IV. SIMULATION OF LUO CONVERTER

The below Figure 5. shows the simulation of Luo converter in MATLAB software tool.

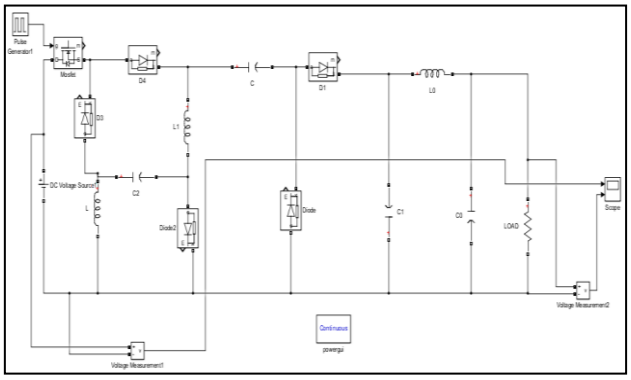

Fig. 5: Simulation of Luo converter

The above diagram showsthe circuit connection of the Luo converter with the pulse given manually to the switch by using the powergui.

As an example, let the input voltage be 72 V, output voltage is 400 V, switching frequency is 40 kHz and load R is 320 Ω. Then the design calculations would be

- D (Duty Ratio) = 0.64,
- M (Voltage transfer ratio) = 5.556,
- L = 165.86Mh,
- L1 = 165.86Mh,
- Leq = 165.88Mh,
- C = 47.63Nf,
- C1 = 14.06Nf,
- C2 = 0.217Mf,
- L0 = 1Mh,
- C0 = 9.76Nf.

V. OPERATION OF THE LUO CONVERTER

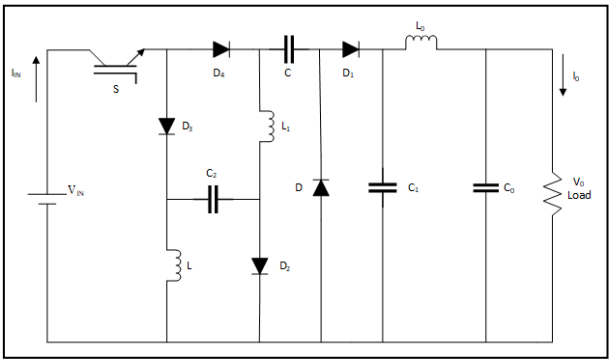

Fig. 6: Circuit diagram of Luo converter

The figure 7,shows the equivalent circuit of the luo converter when the switch S is in ON state. When the switch is closed, the current flows through inductors and capacitors. Due to the flow of current through these elements charging action takes place. The polarity of the charged elements are shown in the figure. Thus the load current flows through the load.

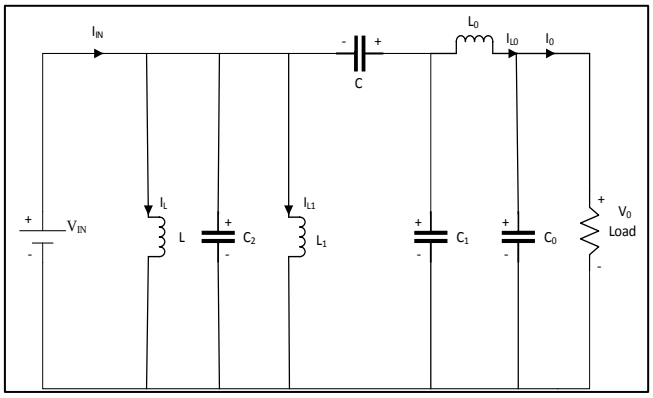

Fig. 7: Equivalent circuit when switch s is in ON state

The figure 8, shows the working of the converter, when the switch S is in OFF state. At this condition the source is isolated from the load. This condition makes the charged elements like inductors and conductors to discharge. This discharged current flows through the load.

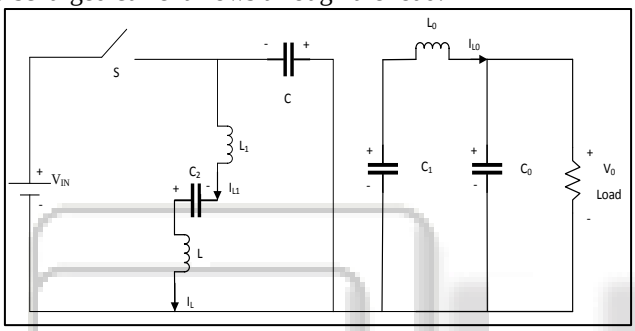

Fig. 8: Equivalent circuit when switch S is OFF state

VI. CIRCUIT IMPLEMENTATION

The figure 9, shows the circuit implementation of the project.

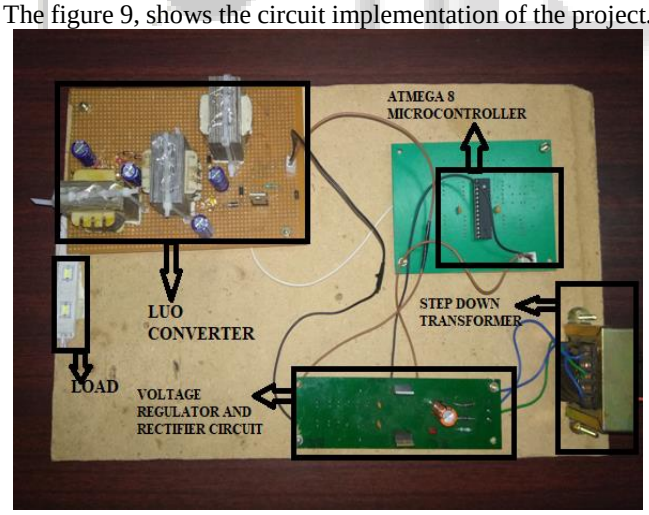

Fig. 9: Circuit implementation

VII. CONCLUSION

The proposed project has aimed for the low cost efficient converter circuit to utilize the maximum of the power generated during the partial shading condition. This circuit can be fitted in household solar panel to get benefited out of the renewable energy sources. This circuit will help in powering up the load for at least few minutes higher than the usual timing. Thus as an outcome, common people will get benefited out of it, and the awareness about the usage of renewable energy sources will boom among them.

REFERENCE

[1] Ren21,"Renewables2016globalstatusreport,"2016. [Online]. Available: http://www.ren21.net/. Accessed on: Jun. 2017.

[2] D. Teshome, C. Lee, Y. Lin, and K. L. Lian, "A modified firefly algorithm for photovoltaic maximum power point tracking control under partial shading, "IEEEJ. Emerg. Sel. Topics Power Electron., vol.5, no.2, pp. 661–671, Jun. 2017.

[3] K. Sundareswaran, V. Vigneshkumar, P. Sankar, S. P. Simon, P. S. R. Nayak, and S. Palani, "Development of an improved p&o algorithm assisted through a colony of foraging ants for mppt in pv system," IEEE Trans. Ind. Informat., vol. 12, no. 1, pp. 187–200, Feb. 2016.

[4] S. Mohanty, B. Subudhi, and P. K. Ray, "A new mppt design using grey wolf optimization technique for photovoltaic system under partial shading conditions," IEEE Trans. Sustain. Energy, vol. 7, no. 1, pp. 181–188, Jan. 2016.

[5] Luo, F. L. and Ye, H, "Modified positive output luo converters" in Proc. IEEE Intl. Conf. PEDS'99, Hong Kong, Jul. 1999, pp. 450–455.

[6] Pallavee Bhatnagar, R.K.Nema (2013), "Maximum power point tracking control techniques: State-of-the-art in photovoltaic applications", ELSEVIER Renewable and Sustainable Energy Reviews, vol. 23, pp. 224-241.

[7] S. Yu, L. Zhang, H. Iu, T. Fernando, and Kit Po Wong. "A DSE-Based Power System Frequency Restoration Strategy for PV-Integrated Power Systems Considering Solar Irradiance Variations." in IEEE Transactions on Industrial Informatics., vol. 13, no. 5, pp. 2511-2518 Oct. 2017.

[8] H. Renaudineau, F. Donatantonio, J. Fontchastagner, G. Petrone, G. Spagnuolo, J. P. Martin and S. Pierfederici, "A PSO-based global MPPT technique for distributed PV power generation." IEEE Trans. Ind. Electron., vol. 62, no. 2, pp. 1047-1058, Feb. 2015.

