iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** XI **Month of publication:** November 2015

DOI:

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Grid Connected Multi Level Inverter Interfacing With Solar Power Generation

B.Sridhar[1], M.Karthik[2], S.Venkatesh Kumar[3]
[1,2,3]Assistant Professor , Department Of EEE

***Abstract*—This paper proposes a new solar power generation system, which is composed of a DC/DC power converter and a new multi-level inverter. The DC/DC power converter integrates a DC-DC boost converter and a transformer to convert the output voltage of the solar cell array into two independent voltage sources with multiple relationships. This new seven-level inverter is configured using a capacitor selection circuit and a full-bridge power converter, connected in cascade. The capacitor selection circuit converts the two output voltage sources of DC-DC power converter into a three-level DC voltage and the full-bridge power converter further converts this three-level DC voltage into a seven-level AC voltage. In this way, the proposed solar power generation system generates a sinusoidal output current that is in phase with the utility voltage and is fed into the utility. The salient features of the proposed seven-level inverter are that only six power electronic switches are used and only one power electronic switch is switched at high frequency at any time. A prototype is developed and tested to verify the performance of this proposed solar power generation system.**
***Keywords*—multilevel inverter, grid-connected, pulse width modulated (PWM) inverter**

I. INTRODUCTION

The extensive use of fossil fuels has resulted in the global problem of greenhouse emissions. Moreover, as the supplies of fossil fuels are depleted in the future, they will become increasingly expensive. Thus solar energy is becoming more important since it produces less pollution and the cost of fossil fuel energy is rising, while the cost of solar arrays is decreasing. In particular, small-capacity distributed power generation systems using solar energy may be widely used in residential applications in the near future. There has been an increasing interest in electrical power generation from renewable energy, and solar energy has been one of the most attractive research areas. Photovoltaic (PV) systems are ideally distributed generation (DG) units, and they offer many advantages such as no fuel costs, no pollution, no noise, and little maintenance. Solar photovoltaic panels have been among the fastest growing energy sources in the world, and the growth is mostly in grid-connected applications.

In 2010, more than 78% of the global market was for grid-connected applications. Most solar cell installations involve the use of multiple solar panels or modules, which are connected in series or parallel. The cascaded H-bridge multilevel converter topology requires a separate DC source for each H-bridge, so the combination of the multiple modules with a multilevel converter makes it one of the suitable options for this type of application. Traditional multilevel converters include the cascaded H-bridge converter, diode clamped converter, and flying capacitors converter. This paper presents a single-phase multi-level (H-bridge) cascaded multilevel converter.

II. EXISTING SYSTEM

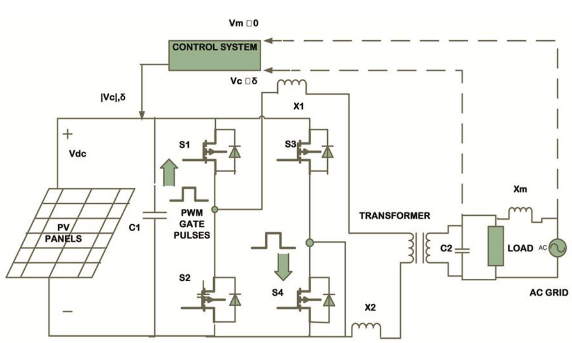


Fig. 1 Existing solar power generation System

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The power conversion efficiency of the power generation system is less. The proposed solar power generation system is composed of a solar cell array, a DC-DC power converter and a new Multi-level inverter. The solar cell array is connected to the DC-DC power converter, and the DC-DC power converter is a boost converter that incorporates a transformer with a turn ratio of 2:1.
The DC-DC power converter converts the output power of the solar cell array into two independent voltage sources with multiple relationships, which supply the seven-level inverter. This new seven-level inverter is composed of a capacitor selection circuit and a full-bridge power converter, connected in cascade. The power electronic switches of capacitor selection circuit determine the discharge of the two capacitors while the two capacitors are being discharged individually or in series. Because of the multiple relationships between the voltages of the DC capacitors, the capacitor selection circuit outputs a three-level DC voltage. The full-bridge power converter further converts this three-level DC voltage to a seven-level AC voltage that is synchronized with the utility voltage.

III. PROPOSED SYSTEM

As seen in Fig. 1, the DC-DC power converter incorporates a boost converter and a current-fed forward converter. The boost converter is composed of an inductor, LD, a power electronic switch, SD1, and a diode, DD3. The boost converter charges capacitor C2 of the seven-level inverter. The current-fed forward converter is composed of an inductor, LD, power electronic switches, SD1 and SD2, a transformer and diodes, DD1 and DD2. The current-fed forward converter charges capacitor C1 of the seven-level inverter.

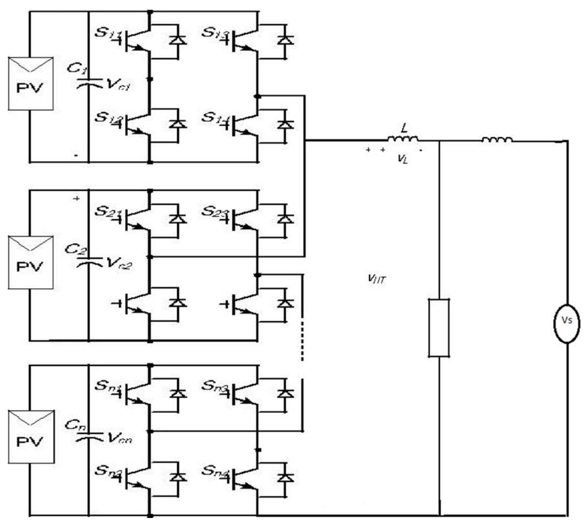


Fig. 2 Proposed multi level inverter using solar power

The inductor, LD, and the power electronic switch, SD1, of the current-fed forward converter are also used in the boost converter. Figure 2 shows the operating circuit of the DC-DC power converter when SD1 is turned on. The solar cell array supplies energy to the inductor LD. When SD1 is turned off and SD2 is turned on, its operating circuit is shown. Accordingly, capacitor C1 is connected to capacitor C2 in parallel through the transformer, so the energy of inductor LD and the solar cell array charge capacitor C2 through DD3 and charge capacitor C1 through the transformer and DD1 during the off-state of SD1. Since capacitors C1 and C2 are charged in parallel by using the transformer, the voltage ratio of capacitors C1 and C2 is the same as the turn ratio (2:1) of the transformer.

IV. MULTI-LEVEL INVERTER

As seen in Fig. 2, the multi level inverter is composed of a capacitor selection circuit and a full-bridge power converter, which are connected in cascade. Operation of the seven-level inverter can be divided into the positive half cycle and the negative half cycle of the utility. For ease of analysis, the power electronic switches and diodes are assumed to be ideal, while the voltages of both capacitors C1 and C2 in the capacitor selection circuit are constant and equal to Vdc/3 and 2Vdc/3, respectively. Since the output

Volume 3 Issue XI, November 2015
ISSN: 2321-9653

current of the solar power generation system will be controlled to be sinusoidal and in phase with the utility voltage, the output current of the seven-level inverter is also positive in the positive half cycle of the utility. In grid-connected systems, the panels needed to reach the required power levels are usually arranged in strings. The cascaded multilevel inverter requires a separate DC source for each bridge thus, the high power and/or high voltage from the combination of the multiple modules would favor this topology in grid-connected PV applications. The multilevel inverter also presents the advantages of reducing the device voltage stress, reducing output filters, and being high efficiency.

V. RESULTS

Simulation and experimental tests are carried out to validate the proposed ideas. In both cases, an Multi- level cascaded H-bridge inverter is considered. Each of the bridges has its own 195 W PV panel connected as an independent source. To verify the performance of the proposed solar power generation system, a prototype was developed with a controller based on the DSP chip TMS320F28035.
The power rating of the prototype is 500W, and the prototype was used for a single-phase utility with 110V and 60Hz. Table II shows the main parameters of the prototype.

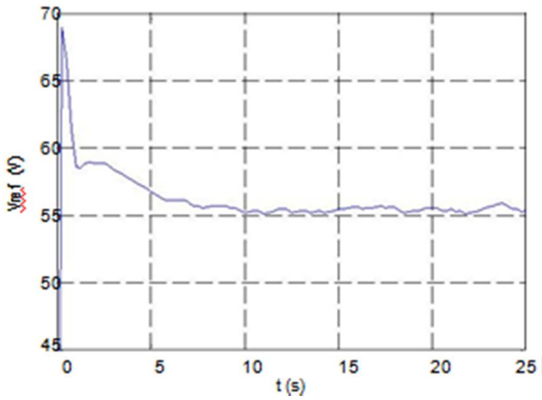


Fig. 4 Reference voltage loop

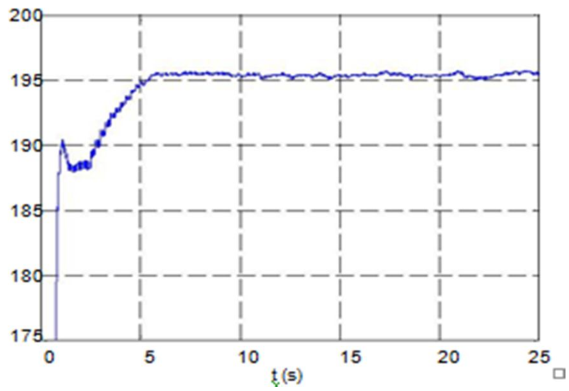


Fig. 5 Output power of the PV panel

The experimental results are presented in Fig. The experimental results also show that the grid current has the same phase as the grid voltage and has unity power factor. In this case, the grid receives power from the PV system.

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

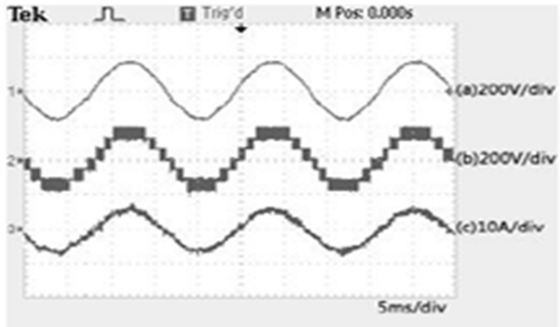
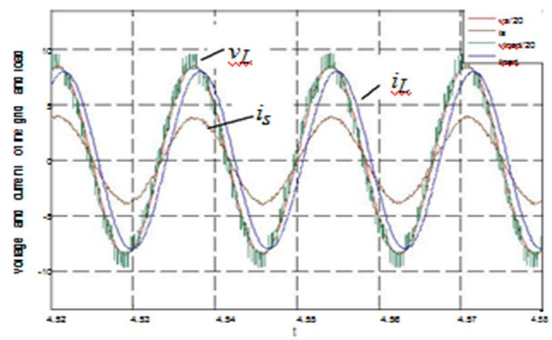
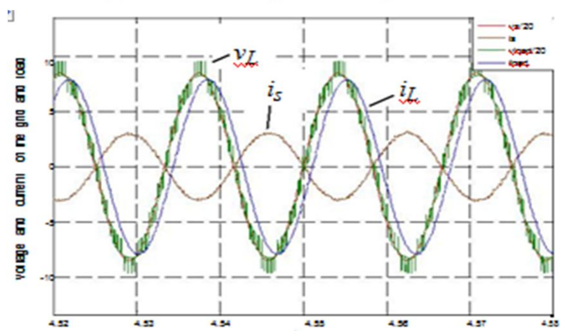


Fig. 6 Experimental result for inverter

To verify the performance of the proposed solar power generation system, a prototype was developed with a controller based on the DSP chip TMS320F28035. The power rating of the prototype is 500W, and the prototype was used for a single-phase utility with 110V and 60Hz.

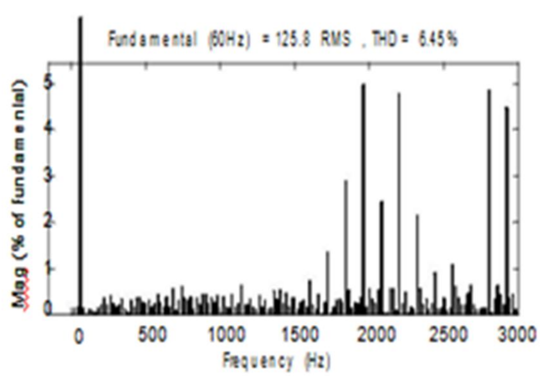


(a) S=1000 W/m^2, grid receives power from PV.



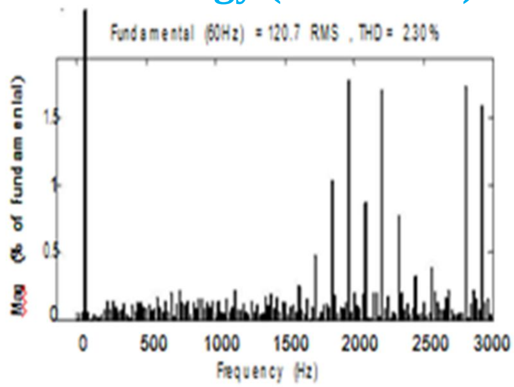
(b) S=400 W/m^2, local load receives power from grid.

Fig.7 Voltage and current waveform of grid and load

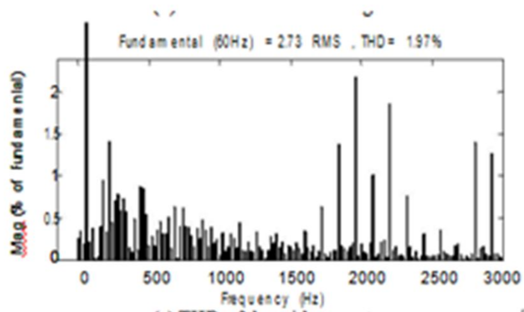


a.THD of the Inverter OutputVoltage

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

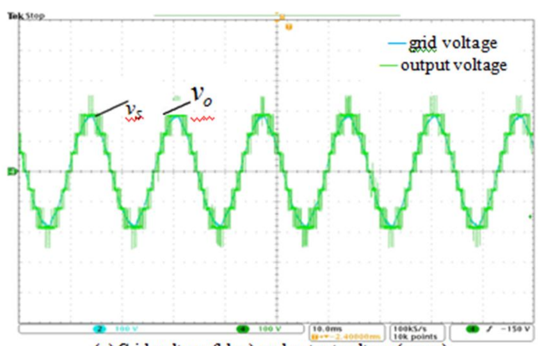


b.THD of the Load Voltage

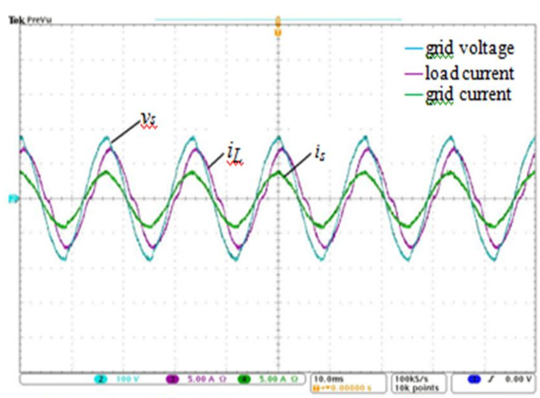


c.THD of the grid current.

Fig.8 THD output Voltage



(a) Grid voltage (blue) and output voltage (green).



(b) Grid voltage (blue), load current (purple) and grid current (green).

Fig.9 Experimental voltage and current waveforms of grid and load

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

VI. CONCLUSIONS

This paper proposes a solar power generation system to convert the DC energy generated by a solar cell array into AC energy that is fed into the utility. The proposed solar power generation system is composed of a DC/DC power converter and a seven-level inverter. The seven-level inverter contains only six power electronic switches, which simplifies the circuit configuration. Furthermore, only one power electronic switch is switched at high frequency at any time to generate the seven-level output voltage. This reduces the switching power loss and improves the power efficiency. The voltages of the two DC capacitors in the proposed seven-level inverter are balanced automatically, so the control circuit is simplified. Experimental results show that the proposed solar power generation system generates a seven-level output voltage and outputs a sinusoidal current that is in phase with the utility voltage, yielding a power factor of unity. In addition, the proposed solar power generation system can effectively trace the maximum power of solar cell array. A hybrid controller is applied to current control to restrain harmonics and achieve zero error tracking. Even without output filters, the THD of the load voltage and grid current are low. The simulation and experimental results confirmed the proposed ideas.

REFERENCES

[1] L. M. Tolbert, F. Z. Peng, “Multilevel converters as a utility interface for renewable energy systems,” IEEE Power Engineering Society Summer Meeting, Seattle, Washington, Jul. 2000, pp. 1271-1274.

[2] H. Ertl, J. Kolar, and F. Zach, “A novel multicell DC-AC converter for applications in renewable energy systems,” IEEE Trans. Ind. Electron., vol. 49, no. 5, pp. 1048-1057, Oct. 2002.

[3] F. Filho, Y. Cao, and L. M. Tolbert, “11-level cascaded H-bridge grid-tied inverter interface with solar panels,” in Proc. 2010 Applied Power Electronics Conference and Exposition (APEC), Feb. 2010, pp.968-972.

[4] J. Rodriguez, J. S. Lai, and F. Z. Peng, “Multilevel inverters: A survey of topologies, controls, and applications,” IEEE Trans. Ind. Electron., vol. 49, no. 4, pp. 724-738, Aug. 2002.

[5] J. Negroni, F. Guinjoan, C. Meza, D. Biel, and P. Sanchis, “Energy-sampled data modeling of a cascade H-bridge multilevel converter for grid-connected PV systems,” in Proc. 10th IEEE Int. Power Electron. Congr., Oct. 2006, pp. 1-6.

[6] S. Khajehoddin, A. Bakhshai, and P. Jain, “The application of the cascaded multilevel converters in grid connected photovoltaic systems,” in Proc. IEEE EPC, Montreal, QC, Canada, Oct. 2007, pp. 296-301.

[7] E. Villanueva, P. Correa, J. Rodriguez, and M. Pacas, “Control of a single-phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic systems,” IEEE Trans. Ind. Electron., vol. 56, no. 11, pp.4399-4406,Nov.2009.

[8] T. Esram and P. L. Chapman, “Comparison of photovoltaic array maximum power point tracking techniques,” IEEE Trans. Energy Convers., vol. 22, no. 2, pp. 439-449, Jun. 2007.

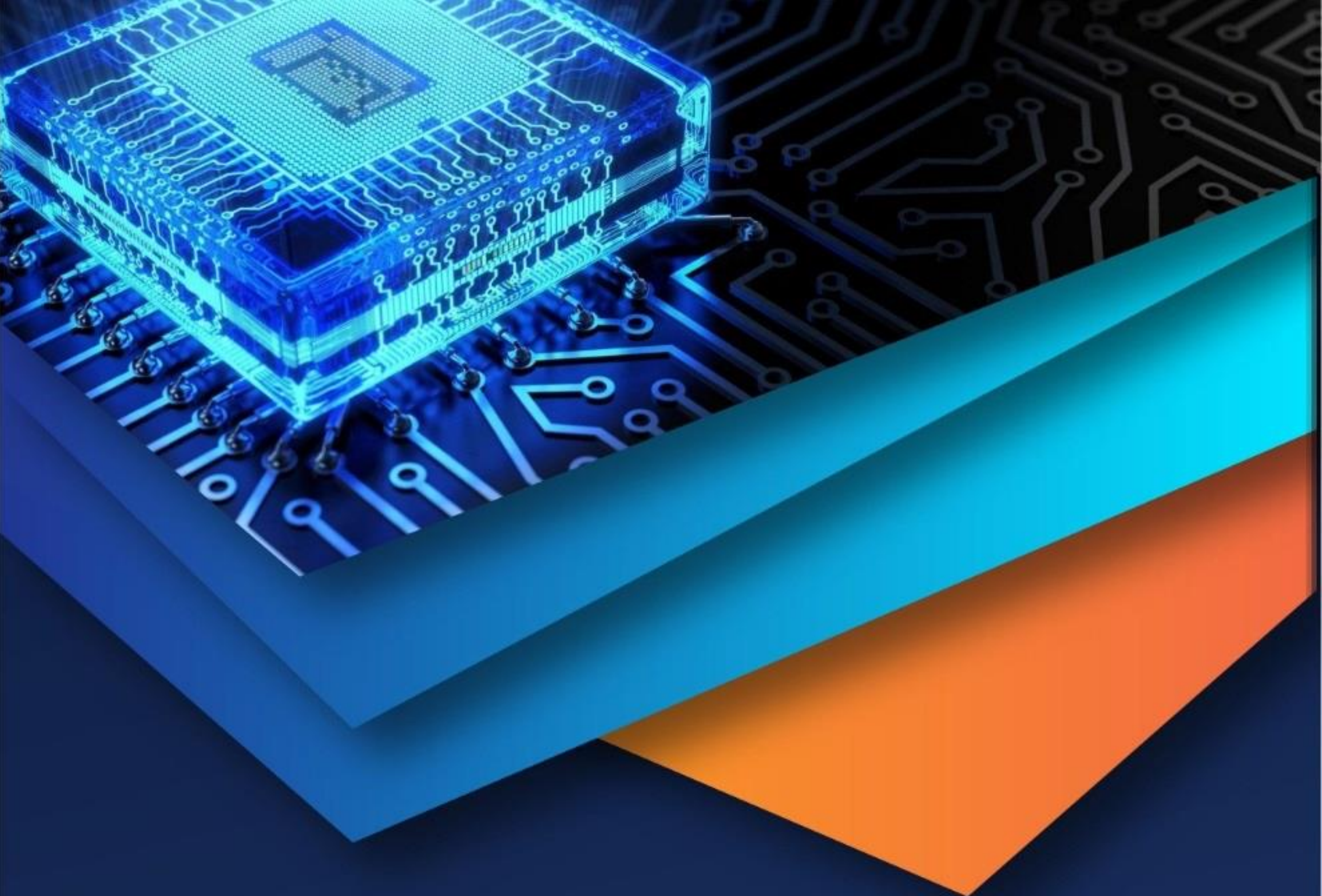
[9] D. P. Hohm, and M. E. Ropp, “Comparative study of maximum power point tracking algorithms,” Prog. Photovolt.: Res. Appl., vol. 11, no. 1, pp. 47-62, Jan. 2003.

[10] Y. Xu, L. M. Tolbert, J. N. Chiasson, F. Z. Peng, and J. B. Campbell, “Generalized instantaneous nonactive power theory for STATCOM,” IET Electric Power Applications, vol. 1, no. 6, Nov. 2007, pp. 853-861.

[11] Y. Liu, J. Bebic, B. Kroposki, J. de Bedout, and W. Ren, “Distribution system voltage performance analysis for high-penetration PV,” in Proc. Energy 2030 Conference, Nov. 2008.

[12] K. Turitsyn, P. Sulc, S. Backhaus, and M. Chertkov, “Use of reactive power flow for voltage stability control in radial circuit with photovoltaic generation,” in Proc. IEEE Power Engineering Society General Meeting, Jul. 2010.

[13] K. Zhou, and D. Wang, “Repetitive learning controller for CVCF PWM DC/AC converter,” in Proc. 39th IEEE Conf. Decision and Control, vol. 4, 2000, pp. 3733–3738.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY