iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: VII Month of publication: July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45563

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

PV FED Interleaved Boost Converter for BLDC Motor

Daniya P[1], Surabhi K. C[2]
[1]M Tech Power Electronics Scholar, Department of Electrical and Electronics Engineering, Vedavyasa institute of technology
[2]Asst.Professor, Department of Electrical and Electronics Engineering, Vedavyasa institute of technology

***Abstract:** The generation of solar energy and its conversion techniques gained greater importance due to increase use of electricity. The power generation scheme is more striking due to its advantages among all the Renewable Energy Sources. This project introduces a PV fed interleaved boost converter for BLDC motor, which is a simple, cost effective and efficient brushless DC (BLDC) motor drive for solar photovoltaic (SPV) array system. A interleaved boost converter is used in order to extract the maximum available power from the SPV array. This control algorithm eliminates phase current sensors and adapts a fundamental frequency switching of the voltage source inverter (VSI) hence avoids the power losses due to high frequency switching. In speed control of BLDC motor no additional circuitry or control is used. An appropriate control of interleaved boost converter is done by the incremental conductance maximum power point tracking (INC-MPPT) algorithm which offers soft starting of the BLDC motor. The proposed system is designed and modelled at steady state conditions of practical operating conditions is demonstrated through simulation results using MATLAB/ Simulink.*
***Keywords:** Incremetal conductance, Interleaved boost converter, Maximum power point tracker (MPPT), solar photo voltaic (SPV)*

I. INTRODUCTION

The use of electricity is increasing day by day, So we may have to move over to renewable sources of energy. The increase in cost of fossil fuel and environmental pollution are the problem of fossil fuel. The renewable energy resources like solar energy have no emission during its working so it have minimum pollution. Solar power is varying with climate condition it depend on solar irradiance and temperature. The P and O algorithm, artificial neural network, fuzzy logic control gives better performance but they are complex and time consuming so, here use incremental conductance algorithm which is simple and accurate.The generation of voltage for renewable energy like solar and fuel cell generate low voltage which need to be stepped up.

The stepping up of voltage is done by using DC-DC converters. The boost converter have reduce efficiency and voltage gain with large duty cycle due to losses of switch and diode and equivalent series resistance of inductor and capacitor makes high stress on main switch leads high conduction loss. In switched-capacitor they are connected in series and supply energy to load hence the voltage is multiplied so the voltage is improved. But it increases the circuit complexity and high voltage stress on switches makes high conduction loss and increase the cost of converter. The coupled inductor have high voltage gain but it increases the voltage stress on switch due to leakage inductance. Converter using voltage multiplier cell technique have high voltage conversion but overall system size and cost are increased with several cell multiplier cell technique. In a transformerless buck- boost converter have high voltage gain but stress in switch and diode in this converter is high. So, the losses in converter is high. In high step-up transformer less converters is presented. Here one main switch is used with the switched- capacitor technique. In the multi phase transformer less converter with high voltage gain is proposed. The voltage stress is low So the losses can be reduced. In transformerless converter based on diode-capacitor cell is introduced. It have high voltage gain, low diodes-switches stresses and low ripple which increases efficienc.In interleaved converters with transformer are presented. In these converters, active and passive clamps used to reduce the switching voltage stress. In a zero voltage switching (ZVS) ZETA converter with active clamp is presented. The ZETA and fly back converters utilize the same active switches to reduce the switch. In transformer less buck-boost converter the voltage gain of converter is triple large as buck-boost converter. In two ZETA dc-dc converters are used for reducing the output voltage ripple. In a high step-up converter with the coupled inductor has only one main switch and stress across this switch is reduced.But the voltage stresses of the three diodes of the converter are high. In this converter the leakage inductance energy can be recycled. In a high step-up interleaved converter is presented.Here the interleaved boost converter and the voltage-double module has two main switches and the stresses of the diodes are high. In a high step-up DC-DC converter have two main switches and the diodes and switches stresses are also high.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

In transformer has three main switches the voltage stress of the switch is equal to the output voltage. The converters switching losses and conduction are high. The use of interleaved boost converter step up low voltage DC pv voltage in to high DC voltage with high efficiency. Because the interleaving split the output current in to two paths. Which reduces the conduction losses ie, I^2R losses hence reduces the ripple current in both input and output circuit and increases the efficiency and also have faster transient response, reduced electromagnetic emission and improve reliability.

High starting torque of DC Series motor makes it a suitable for traction application so, it can withstand a sudden increase in load and easy speed control. But they have high maintenance and loss due to brushes and commutators. SRM are appropriate for the high speed application ith also offers high power density but it is difficult to control with increase in the switching circuit and have some noise issues. The permanent magnet motors have high efficiency compared to DC (brushed) motors IMs. These become unwarrantable for PV powered BLDC motor due to their high cost. BLDC motors have characteristics like high starting torque, high efficiency around 95- 98%,high power density, long service life and motor reduces cost and size of pv panel due to electronic commutation.

II. SYSTEM CONFIGURATION

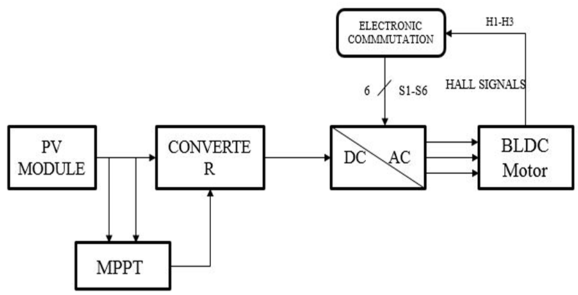


Fig. 1. Block diagram of the system

The figure 1 shows the Block diagram of PV fed interleaved boost converter for BLDC motor. The PV array feed the BLDC motor via the interleaved boost converter and voltage source inverter (VSI). Output from solar connected to a converter Output of PV panel is low voltage which need to be stepped up for stepping up of voltage from low to high is done by using converter. The maximum power point tracking (MPPT) control generate PV voltage and PV current to generate duty cycle. The Pulse generator generate the pulses for interleaved boost converter by generating pv voltage and pv current to generate the duty cycle. Stepping of voltage is done by using interleaved boost converter Convertor convert low voltage DC in to high voltage DC. Inverter convert DC to AC here inverter used is voltage source inverter Motor is supplies from a voltage source inverter and this inverter switches are turn on and off in a sequence to ensure proper electronic commutation of BLDC motor and inbuilt encoder to generate three hall effect signal to carry out an electronic commutation. Here two phases are energized at an instant the permanent magnet create the rotor flux and energies the stator winding create electromagnetic poles. Here the hall element are used to detect the rotor position signal and feed the data back to the voltage source inverter.

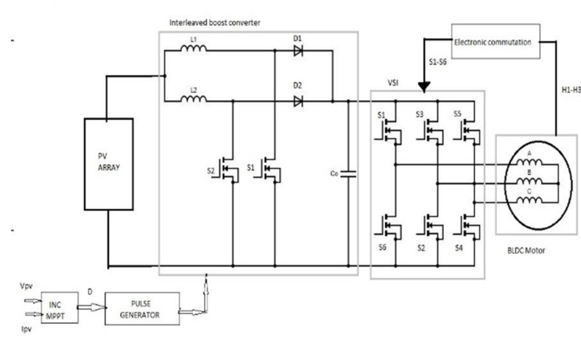


Fig. 2. Schematic diagram of the system

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

A. Operation of Interleaved Boost Conveter

The circuit of interleaved boost converter is shown in Figure 3. The low voltage DC is fed to interleaved boost DC-DC converter to step-up the level of voltage. The operating principle of Interleaved DC-DC converter is have two modes. A two-phase interleaved boost converter is used to achieve high gain voltage. It consist of two inductors L1 and L2, Two switches S1and S2, two diode D1 and D2 and filter capacitor C. S1 and S2 are switched with 180 degree phase difference by pulse width modulation (PWM).

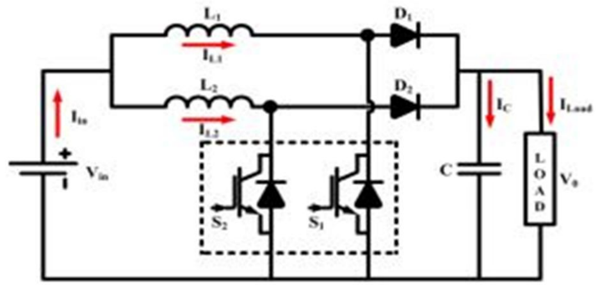
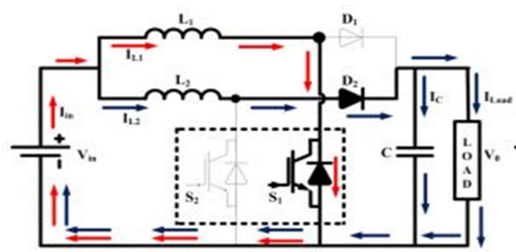


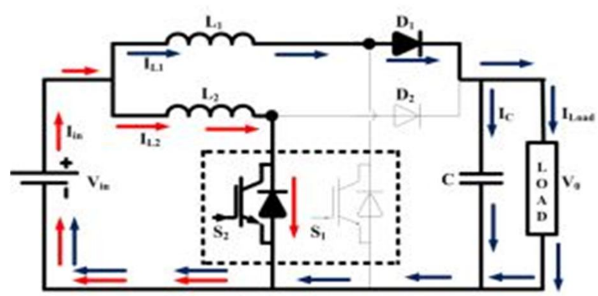
Fig. 3 interleaved boost converter

In mode 1 the switch S1 is in ON-state and S2 is in off state. The diode D2 is forward biased and diode D1 is reverse biased.The current at the inductor L1 linearly rising and strores energy in it. The energy stored in inductor L2 is moved to load through D2



(a) Mode-1 Operation

In mode 2 the switch S1 is in off-state and S2 is in on state. The diode D1 is forward biased and diode D2 is reverse biased.The current at the inductor L2 linearly rising and strores energy in it. The energy stored in inductor L1 is moved to load through D1.



(b) Mode-II Operation

The voltage gain of thi converter is

$$\frac{V_O}{V_{IN}} = \frac{1}{1-D} \qquad (1)$$

III. DESIGN OF THE SYSTEM

The developmentof 1kw, 310v BLDC motor system requires 1.2 kw of pv array. The design values are shown here.

A . Design value of pv array

The selected pv module ratng are,
Open circuit pv module voltage (V_{om}) = 31.7 V
Short circuit pv module voltage (I_{sm}) = 8.25 A

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

The voltage and current at MPP is

V_{mpp} = 26.5 V

I_{mpp}= 7 A

The maximum power of solar pv array is

I = $\frac{P_o}{V_{BLDC}}$ = 3.22 A

$P_{mpp} = (n_{ss} * V_{mpp})(n_{ps} * I_{mpp}) = 1.2\ kW$

P_{mpp} is the power of module at MPP, n_{ss} and n_{ps} are the number of series and parallel module selected as 2 and 3 respectively.

PV array voltage $V_A = n_{ss} * V_{mpp}$ = 53 V

B . Design of converter

The interleaved boost converter is designed to step up pv voltage of 53 V to 310 V required for the operation of BLDC motor.

$L_1 = L_2 = \frac{DV_{IN}}{f_s * N * \Delta I_{IN}}$ = 80 mH

$C_O = \frac{DI_O}{f_s * N * \Delta V_O}$ = 6000µF

L_1 and L_2 are inductor, C_O is output capacitor, V_{IN} is input voltage, V_O is output voltage,N is number of phase,f_s is switching frequency of 25khz, ΔI_{IN} is inductor current ripple of 5% and ΔV_O is capacitor ripple of 1%.

Voltage gain of converter by equation 1 is 5.89 duty ratio value is 8.2.

IV. PERFORMANCE ANALYSIS OF THE SYSTEM

Fig 4. Shows closed loop simulation of interleaved boost converter to obtain accurate and steady output with input given from a dc source.

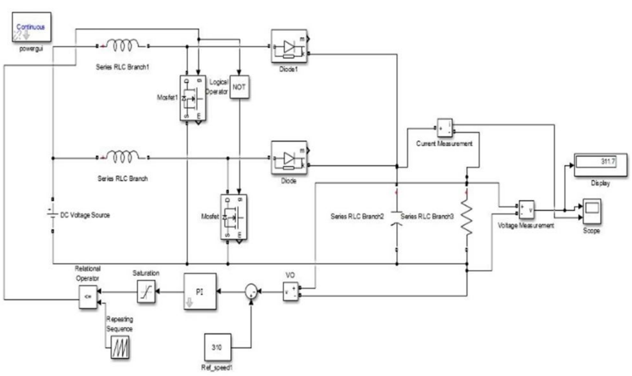


Fig 4. Closed loop operation of converter

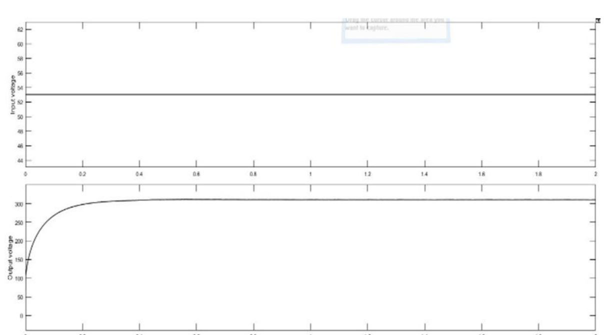


Fig 5. Input and output waveform of converter

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

The converter has been designed and simulated for a duty ratio D = 0.82 at a switching frequency of 25 kHz. It is operated to have an output voltage of 310 V at an input of 53 V at a load resistance of 120 Ω and the obtained waveforms of input voltage at 53 V, output voltage at 310 V, output current at 2.5 A.

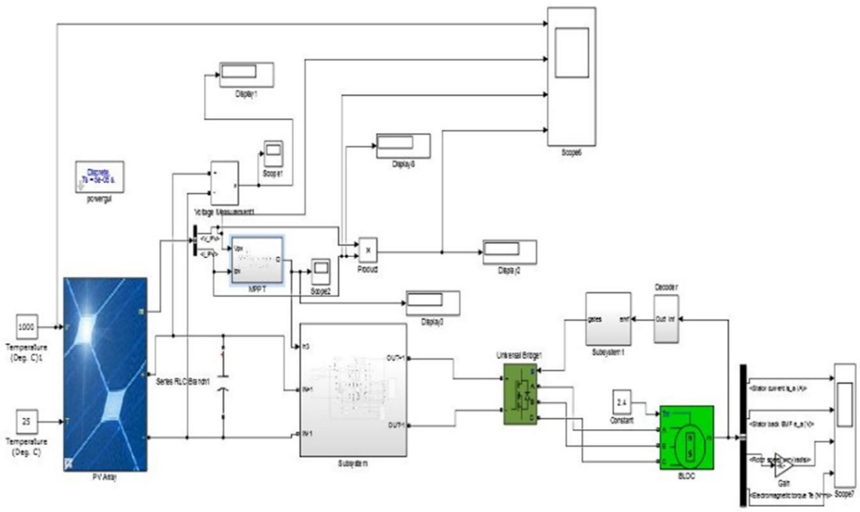


Fig 6. Steady state performance of system

The fig 7 shows steady state performance of system when full solar power is available at 1000w/m^2. Therefore, the BLDC motor is operated at its full capacity and it runs at its rated speed i.e. 3000 rpm. The various indices refer to back-EMF, ea , stator current, isa, speed, N and electromagnetic torque, Te . These results demonstrate a soft starting along with the successful steady state operation of the motor. The electronically commutated BLDC motor has a back EMF of trapezoidal in shape with a flat value of 120V and a current waveform of quasi rectangular shape.

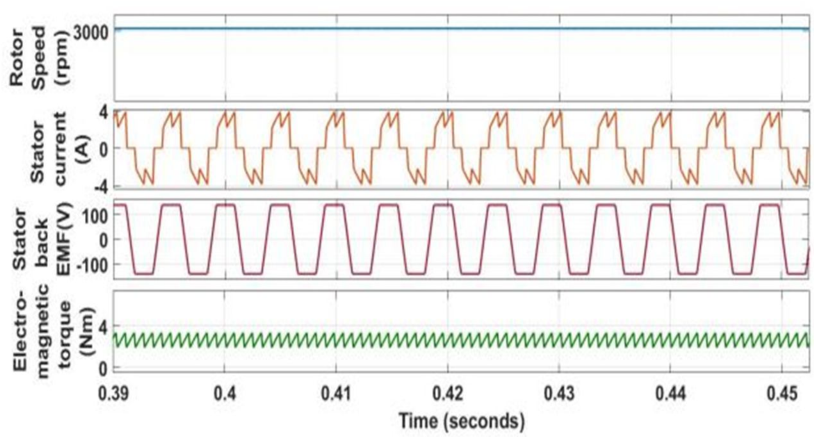


Fig . 7 BLDC motor output

V. CONCLUSION

Implemented Incremental based MPPT technique and regulated voltage of converter. The maximum power is tracked by using this MPPT technique of incremental conductance algorithm. The MPPT control works satisfactory for DC-DC converter. A interleaved boost converter to step up the voltage of PV to a higher level is investigated. The new converter topology is well suited to renewable energy applications with low dc input voltage. Without the need of an isolated transformer or connected inductors, this converter can convert high voltages. This converter has a substantially lower voltage stress across its power switch than conventional converters, which adds to its improved reliability.BLDC motor is electronically commutated it have high efficiency, high power density, long service life, less maintenance, and motor reduces sized and cost of pv panel. Simulation results in MATLAB Simulink verifies the theoretical concepts and derived equations and waveforms. Developed an efficient power transfer mechanism for a BLDC motor system between a solar photovoltaic array.

VI. ACKNOWLEDGEMENT

I take this opportunity to express my deepest gratitude and appreciation to all those people who made this project report work with words of encouragement, motivation, discipline and faith. First and foremost, I am grateful to the lord who gave me sufficient potential to make this project report a success. I would like to thank Dr. SANGEETHA S, Principal, Vedavyasa Institute of Technology for providing me with the best facilities and atmosphere for the Project report completion and presentation. I express our deep gratitude to Prof. BALAKRISHNA PILLAI, Head of the Department, Electrical and Electronics Engineering, Vedavyasa Institute of Technology, Malappuram for his immense support and guidance. I have great pleasure in expressing my deep sense of gratitude and indebtedness to our guide Ms. SURABHI K.C Asst. professor, Department of Electrical and Electronics Engineering, Vedavyasa Institute of Technology, Malappuram for her invaluable guidance through every stage of our work and timely advice. Finally, I take this opportunity to express my thanks to the teaching and non teaching staff in Department Electrical and Electronics Engineering, for their valuable help and support for making the project report a success, I am grateful to all my classmates for their help and encouragement.

REFERENCES

[1] Bhim Singh and Rajan Kumar(2019), “Grid interactive solar pv based water pumping using bldc motor drive,” IEEE 7th Power India International Conference (PIICON),Bikaner ,Rajasthan, vol. 51, no. 3, pp. 1–6, 2019.

[2] P.P.Bezrukikh, P.P.Bezrukikh and S.M.Karabanov (2016), “Renewable energy efficiency,” IEEE 16th International Conference on Environment and Electrical Engineering (EEEIC),Florence,Italy, vol. 51, no. 3, pp. 1–5, 2016.

[3] Anjanee Kumar Mishra and Bhim Singh(2020), “Performance optimization of gridinteractive switched reluctance motor-driven spwps utilizing a new structure of boost converter,” IEEE 9th Power India International Conference (PIICON), Sonepat, India, vol. 65, no. 3, pp. 1–6, 2020.

[4] Nirmal Mukundan C.M. and P.Jayaprakash(2017), “Isolated sepic converter fed trinary hybrid cascaded h-bridge multilevel inverter for solar pv system,” IEEE Region 10 Symposium (TENSYMP), Cochin, India,, pp. 1–5, 2017.

[5] Ahmad Ali Nazeri and Sakda Somkun(2019), “Design of proportional-resonant controller with zero steady-state error for a single-phase grid-connected voltage source inverter with an lcl output filter,” IEEE Milan Power Tech, Milan Italy, pp. 1–6, 2019.

[6] Teena George and P.Jayaprakash(2020), “Maximum power tracking and power sharing in grid connected wecs using modified pfc rectifier and pr controlled inverter,” Electric Power Components and System Taylor and Francis Group,LLC, pp. 1–4, 2020.

[7] S.Guoqiao, Z.Xuancai, Z.Jun and X.Dehong(2010), “A new feedback method for pr current control of lcl-filter-based grid-connected inverter,” IEEE transactions on Industrial Electronics, vol. 57, no. 6, pp. 2033–2041, 2010.

[8] Lakshmanan S.A, B.S.Rajpourhit and Amit Jain(2014), “A novel current controlled technique with feed forward dc voltage regulator for grid connected solar pv system,” 18th National Power Sys. Conference (NPSC),Guwahati, India, pp. 1–6, 2014.

[9] S Saravanan, and N Ramesh Babu(2017), “Design and development of single switch high step-up dc-dc converter,” IEEE journal of emerged and selected topics in power electronics, vol. 10, no. 3, pp. 2168–6777, 2017.

[10] A.S.Anees(2016), “Grid integration of renewable energy sources: Challenges,issues and possible solutions,” IEEE 5th India International Conference on Power Electronucs (IICPE),Delhi,India, vol. 62, no. 5, pp. 1–6, 2016.

[11] Martyanov, and D.Korobatov(2018), “Performance assessment of perturbation and observation algorithm for wind turbine,” International Conference on Industrial Engineering Applications and Manufacturing (ICIEAM), pp. 1–5, 2018.

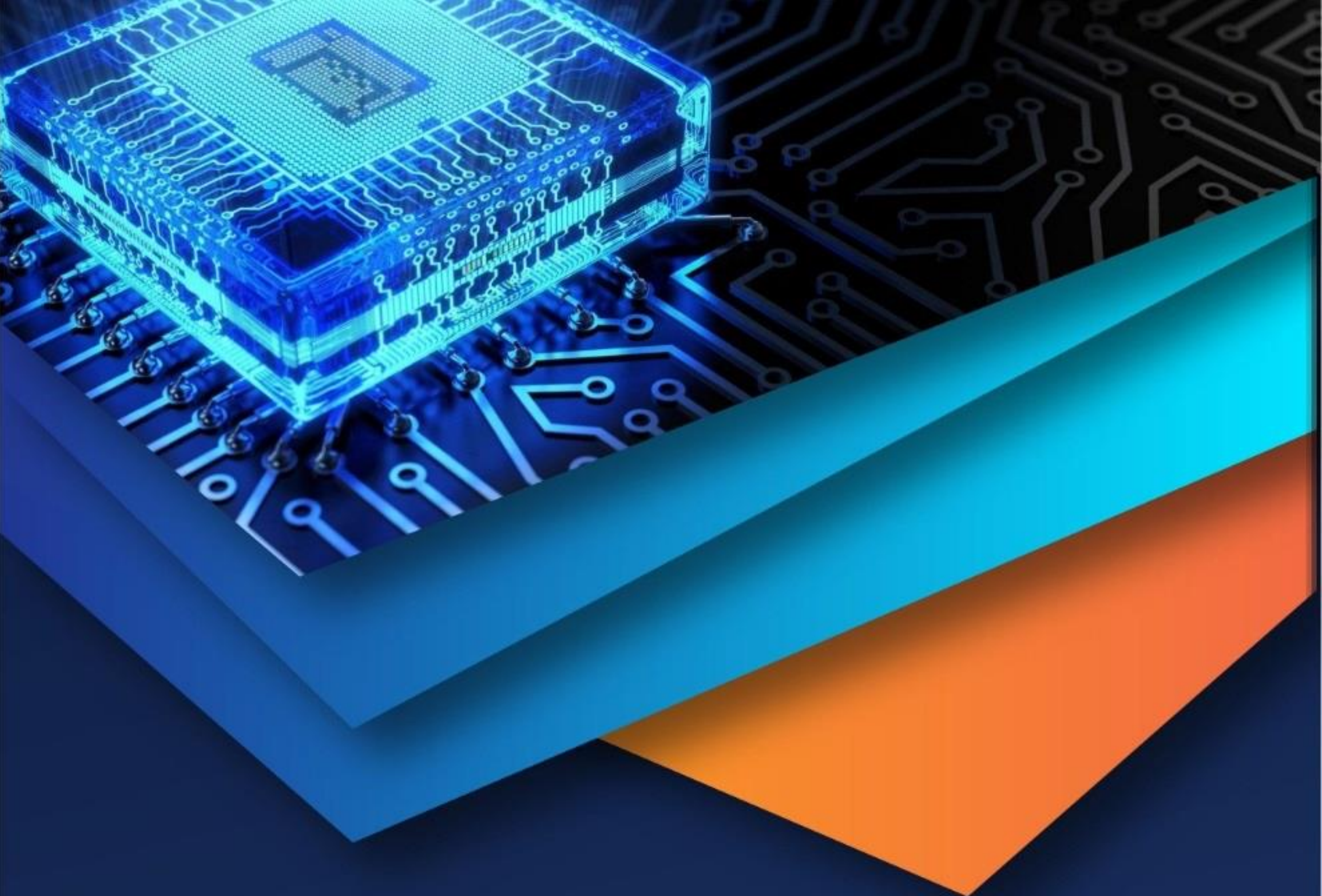
[12] T.Sweidan and M.S.Widyan(2017), “Perturbation and observation as mppt algorithm applied on the transient analysis of pv powered dc series motor,” 8th International Renewable Energy Congress(IREC), pp. 1–6, 2017.

[13] F. Blaabjerg, and K. Ma(2013), “Future on power electronics for wind turbine systems,” IEEE Journal of Emerged and Selected Topics in Power Electronics, vol. 1, no. 3, pp. 139– 152, 2013.

[14] A. Ajami and S.Farakhor(2015), “A novel high step-up dc/dc converter based on integrating coupled inductor and switched-capacitor techniques for renewable energy applications,” IEEE Transactions of Power Electronics, vol. 30, no. 8, pp. 4255–4263,, 2015.

[15] C.Silveria,F.L. Tofoli and Bezerra(2014), “A nonisolated dc-dc boost converter with high voltage gain and balanced output voltage,” IEEE Transactions on Industrial Electronics, vol. 61, no. 12, pp. 6739–6746, 2014.

[16] W.Li. and X. He(2011), “Non isolated high-step-up dc/dc converters in pv grid-connected applications,” IEEE Transactions on industrial Power Electronics, vol. 58, no. 4, pp. 1239–1250, 2011.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY