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IMPROVING THE PERFORMANCE OF SOLAR PV SYSTEM WITH SEPIC

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ABSTRACT
In this paper a PSO algorithm with SEPI converter is presented for maximum power point tracking (MPPT) with PI controller to improve the performance of PV system. SEPI converter is proposed as interface between load and PV module array as DC-DC converter. Whichis more advantageous over boost converter for step up and step down operations. The 1-phase inverter is proposed in order to convert the power for AC 1-phase applications. The PSO algorithm and SEPIC converter proposed are main key factors for high efficiency output at foul weather conditions. The MATLAB/SIMULINK power system tool box will be used to stimulate the proposed system.

INTRODUCTION
Solar energy is the one of the best renewable energy for future applications .So the use of photo voltaic (PV) systems increased with reduced costs and increased efficiency. But the generation of electricity from photo voltaic (PV) system is more expensive than the other non- renewable energy sources. We know that non-conventional sources which are also known as renewable energy resources are becoming more popular now a days as they are available nature free. Renewable energy sources are defined as the sources which can be reproduced from nature again and again once even they used.

There are many advantages with renewable energy resources comparing to non-renewable energy source. Some of the advantages are renewable energy sources are cost free and also pollution free compared to non-renewable resources. Some of the main examples for this renewable resources are solar, wind, tidal etc. Here in this project work we are considering solar as the source and obtaining maximum power from the sun by using maximum power point tracking algorithms (MPPT's). There are many algorithms are used for extracting maximum power such as perturb and observe, incremental conductance, fuzzy control etc. Among these algorithms, in this project work we are considering particle swarm optimization (PSO) algorithm for tracking maximum power. Comparing to all the other algorithms PSO algorithm gives better output with less harmonic contentPSO algorithm tracks maximum power under variable atmospheric conditions and at different irradiation levels.Along with PSO algorithm a DC-DC converter is proposed for tracking maximum power. Named as Single ended primary inductor converter (SEPIC) is used in PV system to track maximum power.

DC-DC CONVERTER
BOOST CONVERTER
A boost converter is one of the DC-DC converter. Which is used for increasing the output voltage? The name itself says that its main function is boosting operation. Boosting means stepping up i.e. increasing the output. Buck-Boost converter also one of the type of Boost converter but it is the combination of both Buck and Boost means it is capable of doing both step up and step down operations. But there are some disadvantages of these converters those are, Buck-Boost converters suffer from high amount of input ripple. These ripples create harmonics. The CUK and Buck-Boost converters operation causes large amount of electrical stress on components this can lead to device failure or overheating. The diagrammatic representation of Boost type converter is shown in the figure which contains semiconductor devices, and inductor, capacitors which acts as filters to reduce the amount of ripples at the output side.

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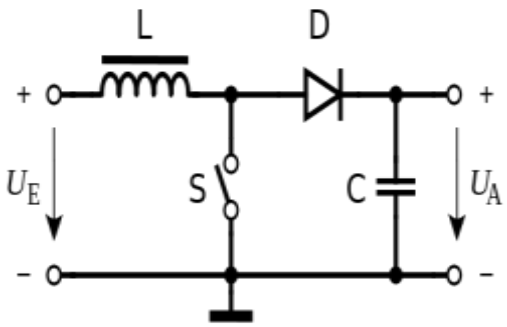

Fig: 1 The basic schematic diagram of a boost converter.

B.SEPI CONVERTER

SEPI stands for Single ended-primary inductor converter (SEPIC) is a type of DC-DC converter which is more advantageous to the Boost, Buck and CUK converters. It also performs the same operation of Buck-Boost converter that is step up and step down of input. But it will give non-inverted output unlike Boost and Buck-Boost converters so there will be no need to have extra circuit for non inverted output. Comparatively there are more advantages over other converters.

SEPI Converter circuit diagram is shown in the below figure which looks similar to the boost converter but has more elements compared to Boost. It has two inductors and two capacitors for step up and step down operations. It has switch i.e. MOSFET, IGBT, or BJT can be used as switch. The duty cycle of the switch is controlled by MPPT algorithm so that the output of the converter increases. It operates under fixed frequency and there will be less amount of harmonics. And also it gives high transient performance.

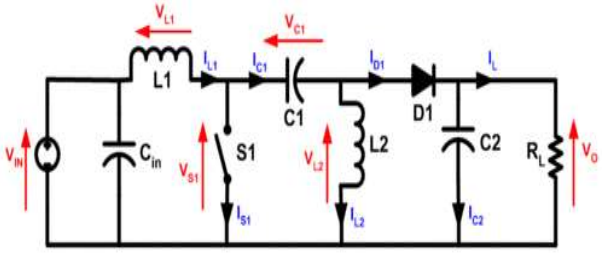

Fig:2 Shows the circuit design of SEPI converter

The circuit diagram for a SEPI converter is shown in above Figure. S1 acts as switch that is it can be replaced by MOSFET or IGBT or BJT. There are two modes of operations of SEPI converter those are (a). When switch is closed. (b) When switch is open. When switch is closed the capacitor C1 stores the energy. When switch is opened capacitor C2 gives the output. So in this way the operation of SEPI converter occurs. The capacitor. C1 also acts as isolation capacitor between input and output. The main function of converter is controlled by duty cycle of the switch. So that duty cycle is controlled by MPPT algorithms which are given below.

MAXIMUM POWER POINT TRACKING ALGORITHMS

These are the mostly used MPPT algorithms in PV systems for maximum power point tracker to improve the performance of the system.

A. Perturb and Observe MPPT algorithm
B. Incremental ConductanceMPPT algorithm.
C. Particle swarm optimization MPPT algorithm.

PERTURB AND OBSERVE MPPT ALGORITHM

In this type of MPPT algorithm requires external circuit to repeatedly perturb the array voltage and subsequently measure the resulting change in the output power. The main disadvantage of this algorithm is it forces the system to oscillate around MPP instead of continuously tracking it. This algorithm fails under rapidly changing

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environment. The major disadvantage of P&O algorithm is during rapid fluctuations of insolation the algorithm is likely to lose its direction while tracking true MPP. So that is this algorithm is not preferable under rapidly changing environmental conditions. The advanced version P&O is incremental conductance algorithm it is designed to overcome the drawbacks of P&O algorithm under rapidly changing environmental conditions in this algorithm the increase and decrease operations are performed continuously to achieve maximum power point in one direction. The output is continuously compared with previous to have better output.

INCREMENTAL CONDUCTANCE MPPT ALGORITHM

The name of algorithm says that it is incremental conductance in nature. Conductance is the opposite of resistance i.e. I/V so based on this function it can be given as, it computes the maximum power by comparing the incremental conductance to the array conductance when these two are same then output voltage is MPP voltage.

(dP/dV) MPP =d(VI)/dV

So when above equation satisfies then the maximum power point attains.

PARTICLE SWARM OPTIMIZATION (PSO) MPPT ALGORITHM

PSO is a bio inspiring computing tool. It is developed based on the activities of birds, fishes, and other animals. The behavior of these creatures are observed and developed by two persons James Kennedy and Russell Eberhart. Who are psychiatrist and electrical engineer. It is a robust stochastic optimization technique based on the movement and intelligence of swarms. PSO applies the concept of social interaction for problem solving.There are a number of particles in this algorithm which move around in space to search for the best or optimum value. These particles are provided with initial velocities and certain constants and values at the beginning.Each particle of the system has a certain velocity and learning constants. It then moves in the space, randomly and then adjusts according to the experience collected from other particles.

BASIC PSO FUNCTION

- **Velocity function**
- Vi(k+1) = Vi(k) + t1i(Pi – Xi(k)) + t2i(G – Xi(k))
- **Position function**
- Xi(k + 1) = Xi(k) + Vi(k + 1)
- i – particle
- k – discrete time
- Vi – velocity variable
- Xi – position variable
- Pi – personal best
- Gi –global best, best of personal bests
- g(1,2)i – random numbers on the interval [0,1] applied to ith particle.

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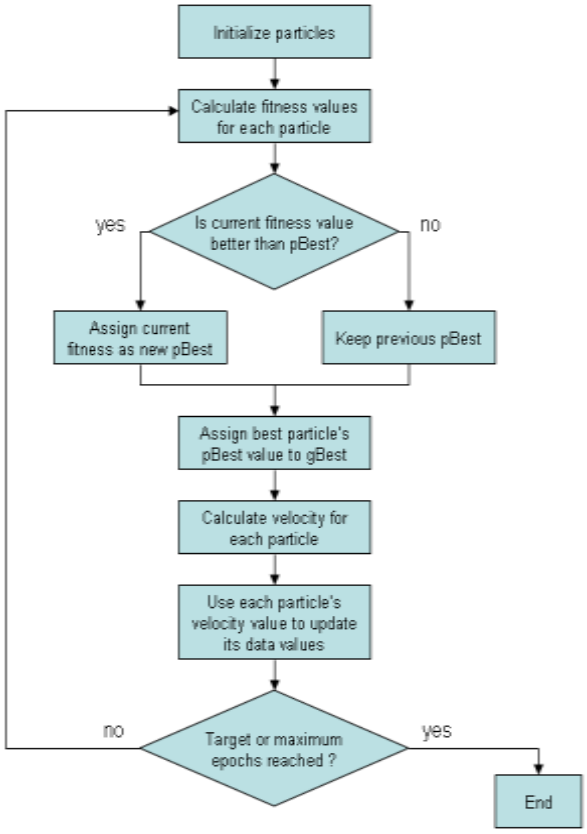
FLOW CHART OF PSO ALGORITHM



SIMULATION RESULTS

Here in this project work a real time organisation was taken for analysis and comparison of different MPPT techniques. A 150KW off-grid solar power plant is taken for case study and a sample of 1.2KW panels are implemented in MATLAB/SIMULINK software. All the three MPPT techniques are compared with different converters in SIMULINK.

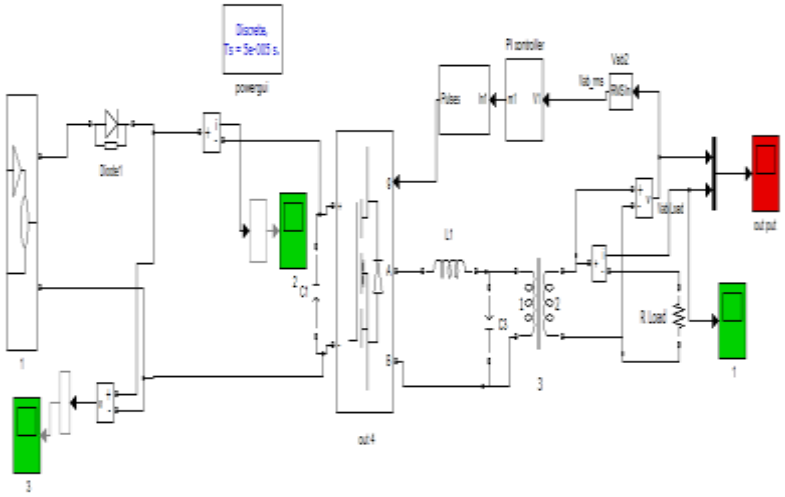


FIG: 4 SIMULINK diagram.

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SIMULATION RESULTS OF PSO ALGORITHM WITH SEPIC.

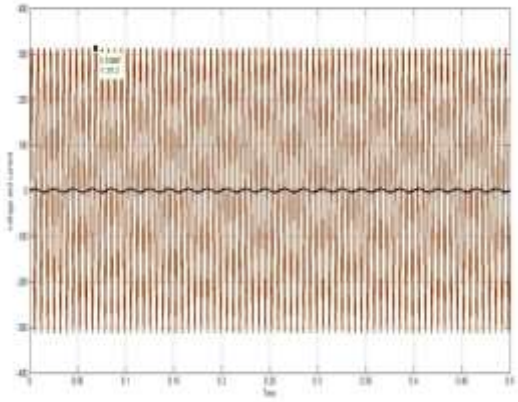

FIG: 5 OUTPUT OF PSO WITH SEPIC

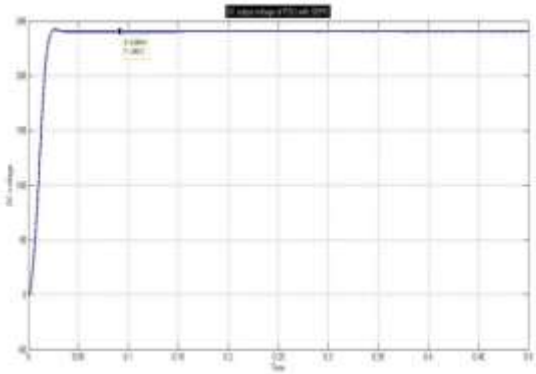

FIG: 6 DC OUTPUT VOLTAGE OF PSO WITH SEPIC

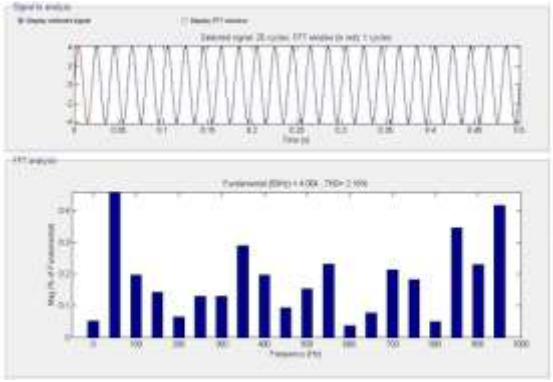

FIG: 7 THD ANALYSIS

FIG : THD CALUCULATION

TABLE-1

SNO	MPPT	CONVERTER	DC (W)	AC (W)	EFFICIENCY(%)	THD(%)
1	P&O	BOOST	689.5	560W	46.6	3.32
2	INC	BOOST	717.7	581.8W	48.4	2.81
3	PSO	BOOST	726.2	612.9W	51.7	2.56

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TABLE-2

SNO	MPPT	CONVERTER	DC (W)	AC (W)	EFFICIENCY(%)	THD(%)
1	P&O	SEPIC	703.3	570.9	47.5	3.14
2	INC	SEPIC	732.2	589	49.1	2.73
3	PSO	SEPIC	744	639	53.5	2.16

CONCLUSION

By observing above table the SEPI converter with PSO MPPT technique gives increased output compared to other MPPT techniques like P&O and INC with combination of BOOST converter. The harmonic quantity also reduced with PSO and SEPIC combination compared other combinations. The efficiency of the system also improved with combination of PSO and SEPI converter. Hence the PV generation system is more advantageous with PSO and SEPI converter.

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