Optimization for a Novel Single Switch Resonant Power Converter using GA to improve MPPT efficiency of PV Applications

M Siva Ram Kumar  
Assistant Professor, Department of EEE,  
Karpagam Academy of Higher Education, Coimbatore, India

Dr. A Amudha  
HOD, Department of EEE,  
Karpagam Academy of Higher Education, Coimbatore, India

R Rajeev  
Department of EEE,  
Karpagam Academy of Higher Education, Coimbatore, India

Abstract  
This paper develops a training data optimization for single switch resonant power converter using Genetic Algorithm for PV Applications. The circuit topology combines a novel single switch resonant inverter with Zero Voltage Switching (ZVS) with an energy blocking diode with Zero Current Switching (ZCS). This active switch is controlled by Pulse Width Modulation at fixed switching frequency and a constant duty cycle. When the resonant converter is operated at discontinuous conduction mode, the inductor current through the resonant tank circuit could achieve ZCS, of the diode, high energy conversion efficiency is obtained. The dynamics of a dc-to-dc converter is non linear, therefore, it is difficult to derive desirable performances. Hence GA is used to optimize the control parameters of the power converter. To obtain the fitness of an individual parameter, simulink model of the resonant converter is designed and GA is programmed to search optimal control parameters by manuscript file of the matlab. Given appropriately chosen circuit parameters using GA, the active power switch can be operated with ZVS, and a high energy conversion efficiency of the proposed topology can be achieved.

Index terms: Photovoltaic (PV), resonant power converter, zero-current switching (ZCS), zero-voltage switching (ZVS), Genetic Algorithm (GA).

INTRODUCTION  
While fossil fuels are used to meet our daily needs they may be exhausted in the near future. Therefore other systems based on non-conventional and renewable sources are being tried by many countries. Solar energy can be a major source of power. Its potential is about 178 billion MW which is about 20000 times the world’s demand. But so for it could be developed on a large scale. Sun’s energy can be utilized as thermal and photovoltaics. Our country, in particular, experiences strong sunshine in the summer. Consequently, the energy collected on PV arrays is utilized as the source of a renewable energy for reduction of fossil fuel energy. If the direct-current output of renewable energy generation systems is directly connected to a battery energy storage system (BESS), then the output voltage of the dc output source of the renewable energy generation system will be fixed to the voltage of the BESS, so the renewable energy generation system cannot always operate optimally. Hence, a dc/dc interface must be installed between the renewable energy generation system and the BESS to ensure that the renewable energy generation always operates at its optimum operating points. Resonant converters are widely utilized in the application of renewable energy generating systems. They require high efficiency in compact size. A high switching frequency is required to achieve small size. But it causes increase in switching loss. Two commonly used soft switching methods are ZVS and ZCS. In these methods, either current or voltage is zero during the switching transition, consequently reducing the switching loss and increasing the reliability of the resonant converters. Traditional ZCS converters operate with constant on time control. They must operate with a wide range of switching frequencies when the ranges of the input source and load are wide, making the filter design difficult to optimize. However, the traditional ZVS scheme eliminates capacitor turn on losses and decreases the turn off losses by decreases the rate of increase in voltage, reducing the overlap between the switch voltage and switch current. This work develops a novel single switch converter with ZVS topology based on the traditional ZVS concept for PV applications. It’s important features include a simple circuit structure, ease of control, soft switching, low switching losses, and high conversion efficiency. This can be considered as an extension of the traditional ZVS power converter. It utilizes a capacitor across the active power switch in the novel single switch power converter to generate a freewheeling stage with traditional ZVS power converter, enabling the novel converter to operate with a constant frequency and markedly much reduced circulating energy. The Genetic Algorithm based MPPT controller for solar system is implemented in MATLAB/SIMULINK software and its performance is compared with conventional techniques. The designed controller with GA has much faster response than conventional ones. In future GA based converters will be implemented in grid connected solar systems.
LITERATURE REVIEW
Most of the conventional resonant converters use traditional hard switching techniques. These techniques have a disadvantage of greater switching loss. In [6] soft switching techniques are discussed. The ZCS and ZVS are used in the system proposed by the authors in [2] pointing out the advantages of soft switching. These methods reduce the switching loss as well as increase the reliability of the circuit. Various resonant dc/dc converters discussed in [9]. In this paper a novel single switch resonant circuit is discussed as the authors specified in [2]. Although the resonant converter discussed in this paper is highly efficient, the features of Genetic Algorithm is also contribute the efficiency again high.[5’10]. GA is the most advanced and efficient MPPT technique of other methods. A training procedure is associated with GA which is time consuming. But it increases the overall efficiency of the system. In this paper training procedure for minutes, hours, days, months, and years taken for the climate change is observed. In [5, 8] the simulation with GA is discussed and give comparison with other methods. By means of GA optimization in the converter design, better results were obtained than those without using GA optimization.

PROBLEM STATEMENT
Solar energy is not constant throughout the day. It will vary with climate condition. This variation may be found in hourly, daily, monthly, half yearly and yearly manner. Moreover the output from the PV array is non linear in nature. Traditional converters also contribute switching losses which reduce efficiency of the power converter.

PROPOSED SYSTEM
This paper proposes GA based a novel single switch resonant converter that has only a single ended structure and is therefore unlike the traditional ZVS converter, which must have an isolated circuit to trigger the active power switch. The use of this converter in the dc/dc energy conversion stage in PV system provides many advantages, such as a low number of components, low cost, and high power density. MPPT with GA offers high efficiency and reliability in the system. These characteristics, as well as the fact that the novel ZVS resonant converter has only a single active power switch, cause it to have a simple structure, low switching losses, a small volume, and a low weight. In addition, since the commutations in the active power switch are performed at zero voltage, the switching losses are very low, resulting in very high efficiency. A genetic algorithm can be used to automatically select the important data among all the inputs, resulting in a smaller and more effective dataset. In our study, a genetic algorithm is used to improve the MPPT efficiency of a PV system by optimizing the input dataset for a novel resonant power converter model of PV modules.

IMPLEMENTATION OF GA BASED NOVEL SINGLE SWITCH POWER CONVERTER
In this proposed scheme an MPPT interface is provided with novel single switch power converter which is operated with ZVS and ZCS techniques [2]. Maximum power point tracking (MPPT) algorithms are used to force photovoltaic (PV) modules to operate at their maximum power points for all environmental conditions. Algorithms for MPPT are various types of schemes that are implemented for obtaining maximum power transfer. A genetic algorithm can be used to automatically select the important data among all the inputs, resulting in a smaller and more effective dataset.

The converter section is accomplished with only one active switch [2] which holding so many advantages. A battery is charged through the converter controlled by MPPT controller and the output of the converter is fed to an inverter which converts dc to ac which feeds the supply for the load.

CIRCUIT DESCRIPTION[2]
The aim of this work is to construct a high-efficiency power electronic converter that can be implemented in the renewable energy generation systems. This application of a power electronic converter depends on the effectiveness of its structure in minimizing switching losses in the energy transformation interval. Soft switching has potential to provide lossless switching and has become increasingly popular with researchers. This work develops a novel current-fed resonant converter with ZVS and ZCS operations of both the active power switch and the rectifying diode for energy conversion. Figure shows a basic circuit diagram of the proposed novel single-switch resonant converter for renewable energy generation applications. It comprises a choke inductor $L_m$, a metal–oxide–semiconductor field-effect transistor (MOSFET) that operates as a power switch $S$, a shunt capacitor $C$, a resonant inductor $L_r$, an energy-blocking diode $D$, and a filter capacitor $C_o$. The capacitor $C_o$ and the...
load resistance $R$ together form a first-order low-pass output filter, which reduces the ripple voltage below a specified level. The MOSFET is a favoured device because its body diode can be used as an ant parallel diode $DE$ for a bidirectional power switch. Notably, the shunt capacitance $C$ includes the power switch parasitic capacitance and any other stray capacitances (such as the winding capacitance of the choke $L_m$). Careful design of the circuit parameters guarantees that the power switch $S$ is switched by ZVS and the energy-blocking diode $D_e$ switched by ZCS, optimizing the operation of the converter.

**MAXIMUM POWER POINT TRACKING ALGORITHM**

The objective of MPPT controllers is to draw maximum power from PV modules for changing solar irradiance $(G)$ and temperature $(T)$ conditions. With that aim, PV modules are matched to the load and maximum power generation is ensured. In our research, PV module voltage was used as the control parameter and a MPPT controller was implemented based on the voltage. In order to ensure operation of the MPPT controller in a wide range of operating conditions, the training data must cover a large range.

**MPPT CONTROLLER USING GA FOR TRAINING DATA OPTIMIZATION**

The GA can be used to optimize the input dataset of the Novel single switch power converter to obtain a smaller and more effective input dataset. This method is particularly important if noisy and unimportant data, which reduce the generalization ability and effectiveness of the input, are present. The GA can be used to keep the most decisive data and remove insignificant data, and, when using the new dataset, a smaller error value may result at the end of training.

PV modules still have relatively low conversion efficiency therefore, controlling maximum power point tracking (MPPT) for the solar array is essential in a PV system. The amount of power generated by a PV depends on the operating voltage of the array. A PV's maximum power point (MPP) varies with solar irradiation and temperature. GAs are promising methods for solving difficult technological problems, and for machine learning. In this paper genetic algorithm is used to calculate the optimal control parameters of PID controller. Genetic algorithm is a computational procedure that mimics the natural process of evolution. It works by evolving a population of solutions over a number of generations. For each generation, solutions are selected from the population based on the fitness value. These solutions by crossover (merging previous solutions) and by mutation (modifying the solutions) generate new population. Since it searches many peaks in parallel, the trapping at local minima is avoided.

**SYSTEM CONFIGURATIONS**

Genetics algorithm is embedded in the feedback compensation circuit design and it is performed in the frequency domain and aided by Bode plots, the design essentially involves positioning of poles and zeros of the selected compensation circuit to compensate the undesirable characteristics of a power stage. The voltage reference $V_{ref}$ signal is generated from the MPPT controller. In the proposed method the resonant converter serves the purpose of transferring maximum power from the solar PV module to the load.

![Flow Chart Representation](image)

![Simulation Diagram](image)
GA SIMULATION RESULT
The proposed system was simulated and some experimental results from the laboratory prototype were obtained.

CONCLUSION
In this paper, a novel single-switch resonant power converter with an energy-blocking diode has been designed for use in solar energy generation system. The structure of the proposed converter is simpler and cheaper than other resonant power converters, which require numerous components. The novel resonant converter is analyzed, and performance characteristics are presented. The developed novel single-switch resonant power converter offers the advantages of soft switching, reduced switching losses, and increased energy conversion efficiency. The output power can be determined from the characteristic impedance of the resonant tank by adjusting the switching frequency of the converter. The novel single-switch resonant power converter is supplied by a solar energy generation system to yield the required output conditions. The novel single-switch resonant power converter topology yields higher energy conversion efficiency than conventional class-D resonant converters. Favorable performance is obtained at lower cost with fewer circuit components. Besides these features the optimization using Genetic Algorithm add remarkable properties in the performance of novel single switch resonant power converter. MPPT with GA helps the converter to perform according to the environmental conditions and explore the best output. Thus the proposed system is enable to provide overall efficiency nearing to 100 percent.

REFERENCES
[5] 1Erik ÖÖTVÖS, 2Marcel BODOR. “DC/DC resonant converter for PV system”