Implementation of hybrid model Converter for Photovoltaic Applications

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Abstract. The increase in the use of non-conventional energy sources in our day to day life is to save our earth. The hybrid wind and photovoltaic power generation system allow supplying the load either individually or at the same time. This technique includes the Cuk and Sepic converters together and this eliminates the accessibility for extra input filters having high-frequency harmonics. The rapid changes in the atmospheric conditions can be control by using the Maximum Power Point Tracking technique because of its high tracking accuracy. To increase the output power and efficiency the Buck Boost and Sepic converters are used. Converters output ripple voltage can be reduced by the photovoltaic array voltage which can vary from 0 to 600V. The thin-film PV panels and the MPPT methodology is produced with the help of converters by reducing the stress occurred in voltage due to inverters and to work at 230V DC-bus voltage reducing Simulation is carried out MATLAB Simulink.

Keywords—Photovoltaic, Maximum Power Point Tracking (MPPT), Buck boost, Sepic converter, non-conventional energy, dc-dc converter

1. Introduction

The increases in power need increases in daily basics due to the increase in population and industrial growth. So, power production is not sufficient for us. To overcome this problem, technology based on renewable energy (or) non-conventional energy which was developed for future power development. The energy source using conventional methods depends on the non-conventional energy methods. It is the merely an easy way to meet the need of global energy requirement in order to save our earth for the upcoming generations. The solar and wind energy are natural one. The renewable energy sources like Solar, wind have become the inexpensive tools in survival for the production of energy, which attracts scientists and educators over the world to show interest using the newer technology. It is always available in our earth. The photovoltaic panels convert the light energy from sunlight into DC current. These renewable energy sources are advantageous over other such technology because no noise signals, which require less maintenance and reduction in greenhouse emission. The environmental has limited amount of fossil resources that cannot able to satisfy the demand of increasing renewable energy usage. This growing demand can be satisfied by using the photovoltaic fuel cell and wind turbine systems. The existence of solar and wind is unpredictable since they depend on the weather conditions like incident solar radiation levels, shadows by birds, clouds and temperature. Individual solar photovoltaic and standalone wind systems have been promoted around the globe on a comparatively larger scale. These independent systems cannot provide continuous source of energy, as they are seasonal.

The PV system provides a long-term with high efficiency and resist the pollution free power generation[1]. The low output voltage photovoltaic arrays are allied in series to realize high voltage DC and DC to AC inverter. It is used to interface with the grid. This advance technique needs high voltage rated equipment for the inverter. To overcome this issue, the step-up transformer is necessary[2]. This system provides a low voltage rated equipment which enables the use of inverter and then transformer is used for boost up the voltage. In this it provides more harmonics because of the ripple content[3]. The efficiency is reduced because of the high switching losses.
2. Methodology

In general DC-DC converters can be used as switching mode regulators system. It can able to convert an unregulated DC voltage to a regulated DC output voltage. This DC regulation is generally achieved by Pulse Width Modulation at a predetermined frequency using the various switching devices like BJT, MOSFET or IGBT. Now-a-days, mainly low voltage and high current applications based switching devices like MOSFETs are used. It may be distinguished that, as the turn-on and turn-off time of MOSFETs are small as compared to other switching devices. The frequency used for the DC-DC converters in MOSFET is high that can be used to reduce the size of filters. It may be understood the basic group to DC-DC converters are BUCK, BOOST and BUCK-BOOST converters. The Cuk, effectively a BOOST-BUCK converter along with the different types as SEPIC and the zeta converters.

![Fig 1: Block diagram of Operational system](image1)

![Fig 2: Circuit diagram of converter system](image2)

In the methodology, a new DC to DC converter having a hybrid topology by mixing up the wind and solar energy source was developed. In this topology, a combination of Cuk and Sepic converters having
corporate both wind and solar energy sources together as a combined circuit. If any one of the source is unavailable, then the other source can compensate for energy production. The source input from Solar energy is given to the Cuk converter and source from wind energy is given as an input to the Sepic converter. The average output voltage produced by the system will be the sum of the inputs of these two systems. The fused Cuk-Sepic converters have the capacity to remove the HF current harmonics in the wind generator. To eliminate such effect there is a need of additional passive input filters in the system. It can step-ups or step-downs the input voltage during startup and overload conditions. Due to this input current ripple can be reduced and provides low electromagnetic interference (EMI) linked with the DCM.

3. Results and discussion

The implementation can be achieved by using the simulation technique which has developed into a very powerful tool in industry application. The academician and research develop a newer technique to reduce power loss with high efficient and essential for an electrical engineer to understand the concept of operation. Simulation is one of the best traditions to learn the system or circuit performance without harmful it. Many industrial researchers are spent valuable time and money to develop the simulation results before manufacturing and implementation of their product. In these converters with open loop simulation and filter design to reduce ripples were developed with inverter and converter R, R-L and RLE loads using MATLAB tool.

3.1 Open loop system

The PFC boost converter without EMI filters for R load with C filter as shown in Fig.3.

![Fig 3: PFC boost converter with C filter using R load](image)

The input voltage are shown in Fig.4 and the switching pulses are shown in Fig.5. The Output Voltage, output current and output power are shown in Fig 6, Fig 7, and Fig 8 respectively. The total harmonic distortion is 33.81%.

![Fig 4: Input Voltage](image)
The PFC boost converter without EMI filters for R load with T filter as shown in Fig.10. The input voltage is shown in Fig.11 and the switching pulses are shown in Fig.12. The Output Voltage, output current and output power are shown in Fig13, 14 and 15 respectively. The total harmonic distortion is 12.73%.
Fig 10: PFC boost converter with T filter using R load

Fig 11: Output Voltage

Fig 12: Output Current

Fig 13: Output Power
The PFC boost converter with EMI filter for MOTOR load with T filters as shown in Fig.17. The input voltage and the switching pulses are shown in Fig.18 and Fig.19. The speed and torque waveform are shown in Figs.20 and 21.
Table 1: Types of filters vs ripple

| S no | Type of filters | Ripple |
|------|-----------------|--------|
| 1    | C filter        | 0.25 V |
| 2    | T filter        | 0.1 V  |

Table 2: THD

| TYPE    | THD    |
|---------|--------|
| Without EMI | 33.33% |
| With EMI   | 12.73% |

3.2 Closed PFC Boost Converter with PI controller

Fig. 18 Simulated diagram of Closed PFC Boost Converter with PI controller

Fig 19: Input voltage

Fig 20: Output voltage of Wind
3.3 Closed PFC Boost Converter with FLC controller

Fig 21: Output voltage of converter

Fig 22: Output voltage of inverter

Fig 23: Closed PFC Boost Converter with FLC controller

Fig 24: Input voltage
Fig 25: Output voltage of converter

Fig 26: Output voltage of inverter

Fig 27: Output current

Table 3: Simulink results

| Converter - buck-boost & sepic | Tr | Ts | Tp | Vp | Ess |
|-------------------------------|----|----|----|----|-----|
| PI controller                 | 0.26 | 6  | 4.2 | 25 | 8.2 |
| Fuzzy                         | 0.15 | 1.2| 0  | 0  | 0.3 |

Fig 28: Hardware Layout
The fused CUK-SEPIC converter technique provides various stages for hybrid wind and solar energy systems that makes continuous power generation. It is achievable to meet the demand of power requirement based on the load by connecting the hybrid sources to supply the load either individually by both the energy process or simultaneously used by them. The main advantage of this type of converter model is that it eliminates the need of extra input filters to remove the high frequency harmonics. It can supports broad range of PV and wind input voltages, small input current distortion, low amount of conduction losses and improves the conversion efficiency using Maximum Power Point Tracking algorithm. MATLAB Simulation has been presented to verify the characteristics of the converter topology using open loop and closed loop system. The advantage of this system is it has lower operating cost and used for various applications like power generation in remote areas,
provides constant speed and variable speed, conversion of energy, implemented in industries like aerospace, electric vehicles, communication equipment manufacturing and rural electrification purposes.

4. Conclusion
A Single-Phase Inverter with Buck Boost and Sepic converter with open loop and closed loop system is used with maximum power point trackers (MPPTs) for DC-distribution applications. In an converter closed loop controller technique using Proportional integral and Fuzzy was analysed using the MATLAB simulink. It is essential to control the speed of the induction motor and to regulate the DC bus voltages to a certain range. A Buck Boost and Sepic converters helps to increase the output power and also its efficiency. The simulation results states that the converter outputs ripple voltage can be reduced because the photovoltaic (PV) array voltage is varied from 0 to 600V. It is applicable with thin-film PV panels having the topology of MPPT method combined with the buck and boost converters to operate at the 230V DC-bus voltage which reduce the voltage stress.

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