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Improved high step-up converter with high efficiency for renewable energy applications

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Abstract
A new super-boost convertor, that is acceptable for renewable energy applications, is projected during this paper. The proposed convertor consists of switched capacitors and 2coupled inductors. This mixture will offer a comparatively high voltage boost gain whereas in operation with little duty cycle. The converter is often supercharged either by one individual DC voltage supply in associate interleaved manner or 2 freelance DC voltage sources as a multiport convertor. The configuration of the proposed convertor has blessings like low power losses, longer period of input sources owing to non-pulsating input current, low voltage stress across the most switches and slight output voltage fluctuation. victimization this convertor, a 22.5 times gain can be reached with zero.6 duty magnitude relation and turns magnitude relation adequate to two that makes it potential to attach a 20Y PY system to a 450Y DC bus. Theoretical analysis and simulation results square measure bestowed to demonstrate the genuineness of the projected convertor.

Keywords: DC-DC converter, step-up converter, incremental conductance, maximum power point tracking, continuous physical phenomenon

Introduction
Today thanks to the restricted resources of fossil fuels and conjointly their serious environmental impacts together with greenhouse emission emissions, heating and environmental pollution, the renewable technologies like electrical phenomenon CPY systems, fuel cells and wind energy systems have received intensive attention as property and clean sources of energy .Among renewable energy sources, PY systems expected to become the biggest target for energy investment by year 2040 thanks to the clean, efficient, and environmentally friendly performance. Since PY cells generate low output voltage, a high change of magnitude DC/DC convertor is critical to spice up the PV voltage to level of DC load/micro-grid voltage or required level of electrical converter DC-link voltage activity Associate in Nursing AC load/utility. A typical electrical phenomenon systems including PV array, a change of magnitude convertor Associate in nursing an electrical converter for converting the DC voltage for AC applications. Generally, high voltage boost gain cannot be achieved victimization conventional change of magnitude converters since the parasitic parameters will set Associate in nursing higher limit on the duty quantitative relation at that the convertor can efficiently operate. In recent years several high change of magnitude DC-DC converters are projected. Among the developed converters, the high change of magnitude single switch converters exhibit input current ripple that build them unsuitable to operate at significant load thanks to high conductivity losses. An alternative resolution for prime power applications conventional two-switch interleaved change of magnitude convertor. Although the traditional interleaved convertor alleviates the input current ripple, like the traditional boost converter it's not been developed for handling high voltage boost gain. The restricted change of magnitude gain might be overcome by integrating the coupled-inductor into the interleaved convertor. The switch voltage stress is additionally reduced by the transformer perform of the coupled-inductor [1]. However, in order to realize Associate in nursing extreme voltage gain, it's needed to increase the turns quantitative relation of the coupled inductance that affects the transformer dimensionality and increase the discharge inductance causing the voltage spike across the switches throughout the off state. Extreme voltage gain can even be completed through diode-capacitor voltage multiplier factor. This resolution has

allowed the DC-DC convertor to work with low input current ripple that is appropriate for prime power application. Nevertheless, several cascaded diode-capacitor voltage multipliers is required to extend the voltage gain, thus, the converter efficiency would be affected for prime voltage gain. In this paper, a replacement high change of magnitude DC-DC convertor is proposed. The projected convertor may be steam-powered either by one individual DC voltage supply in Associate in Nursing interleaved manner or two freelance DC voltage sources as a multiport convertor [2]. This convertor combines the benefits of the coupled inductors with the diode-capacitor multipliers and thence a super change of magnitude gain may be simply achieved with minimum number of multipliers and low turns quantitative relation of the coupled inductors whereas the convertor operates at low duty quantitative relation. The proposed convertor exhibits high efficiency in a very wide selection of operation [3, 4]. It conjointly presents low current ripples and low conduction losses that build it appropriate for prime power applications. Additionally, the voltage stress across the switches and diodes is far not up to the output voltage [5].

Proposed System

The convertor consists of 2 coupled-inductors and four diode-capacitor voltage number (DCVM) stages. Each DCVM stage consists of 1 diode and one electrical condenser [6, 7]. The DVCM stages ar inserted between the input and output stages of the convertor to boost the voltage conversion ratio. By increasing the quantity of DCVM stages, it's attainable to reach the next voltage gain at constant duty quantitative relation. However, for simplicity and higher understanding, four DCVM stages are used. The coupled inductors are resided within the proposed convertor in order that a modified fly back-forward interleaved structure is created. the first windings of the coupled inductors with np1 and np2 turns are used within the input stage to decrease the input current ripple, whereas the secondary windings with nsl and n/ turns are connected in series with the output stage to enlarge the voltage gain. Within the coupled inductors have identical turns quantitative relation [8, 9]. The coupled electrical device are often sculptures que because the combination of a magnetizing electrical device, a perfect electrical device and series leakage inductors in every winding. The equivalent circuit of the projected convertor wherever Lmi and L2 are the magnetizing inductances, Lipi and Llp2 ar the first windings outflow inductances, Lis is that the summation of secondary windings outflow inductances, S1 and S2 are power switches, Cout1, Cout2 and Cout3 are the output capacitors, CI toC4 and DI to D, severally, indicate the capacitors and therefore the diodes of DCVM stages, D (I and Df are the output diodes of the fly back-forward structure and n denotes turns quantitative relation np/ns.

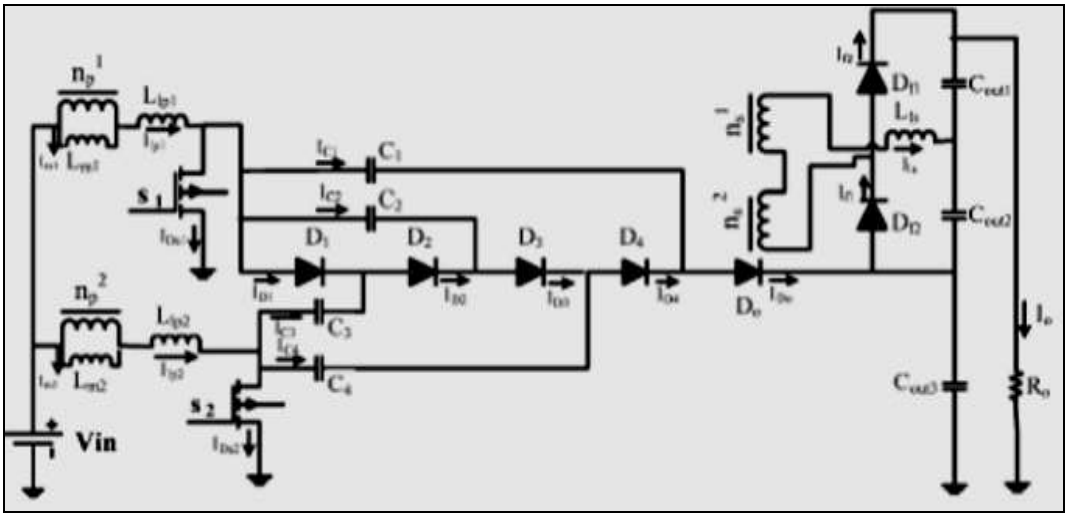


Fig 1: Proposed high step-up converter

In the circuit analysis, it's assumed that the convertor operates in continuous physical phenomenon mode (CCM) and therefore the duty ratio of the switches is larger than zero.5. The operational waveforms of the projected convertor in CCM during one switch cycle. Proposed high step-up converter is shown figure 1, there are some overlapping time once 2 switches are ON and also it slow intervals once only 1 of the switches is ON. According to six operation modes exist in every switching cycle for the projected convertor.

Maximum power point tracking algorithms

As was previously explained, MPPT algorithms are necessary in PV applications because the MPP of a solar panel varies with the irradiation and temperature, so the use of MPPT algorithms is required in order to obtain the maximum power from a solar array. Over the past decades many methods to find the MPP have been developed and published. These techniques differ in many aspects such as required sensors, complexity, cost, range of effectiveness, convergence speed, correct tracking when irradiation and/or temperature change, hardware needed for the implementation or popularity, among others. A complete review of 19 different MPPT algorithms can be found. Among these techniques, the P&O and the observer algorithms are the most common. These techniques have the advantage of an easy implementation but they also have drawbacks, as will be shown later. Other techniques based on different principles are fuzzy logic control, neural network, fractional open circuit voltage or short circuit current, current sweep, etc. Most of these methods yield a local maximum and some, like the fractional open circuit voltage or short circuit current, give an approximated MPP, not the exact one. In normal conditions the V-P curve has

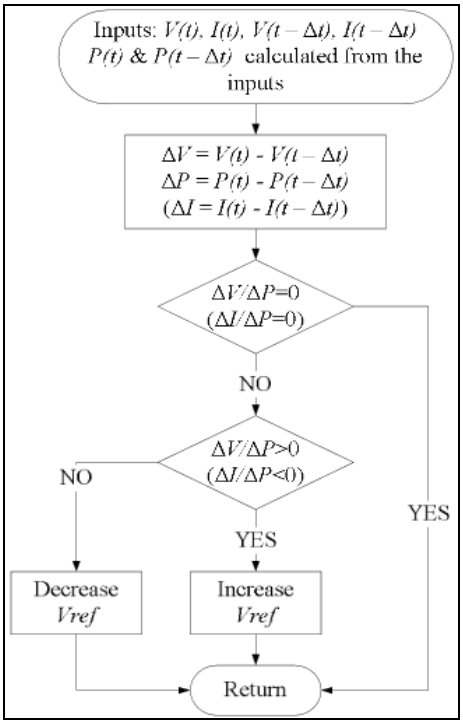
only one maximum, so it is not a problem. However, if the PV array is partially shaded, there are multiple maxima in these curves. In order to relieve this problem, some algorithms have been implemented.

Incremental conductance

The incremental conductance algorithm is based on the fact that the slope of the curve power vs. voltage (current) of the PV module is zero at the MPP, positive (negative) on the left of it and negative (positive) on the right.

- $\Delta V/\Delta P = 0$ ($\Delta V/\Delta P = 0$) at the MPP.
- $\Delta V/\Delta P = 0$ ($\Delta V/\Delta P = 0$) at the left.
- $\Delta V/\Delta P = 0$ ($\Delta V/\Delta P = 0$) at the right.

By comparing the increment of the power vs. the increment of the voltage (current) between two consecutives samples, the change in the MPP voltage can be determined.



In both P&O and In Cond schemes, how fast the MPP is reached depends on the size of the increment of the reference voltage. The drawbacks of these techniques are mainly two. The first and main one is that they can easily lose track of the MPP if the irradiation changes rapidly. In case of step changes they track the MPP very well, because the change is instantaneous and the curve does not keep on changing. However, when the irradiation changes following a slope, the curve in which the algorithms are based changes continuously with the irradiation, so the changes in the voltage and current are not only due to the perturbation of the voltage. As a consequence, it is not possible for the algorithms to determine whether the change in the power is due to its own voltage increment or due to the change in the irradiation. Figure 2 shows the Maximum Power Point Conditions with respect to voltages.

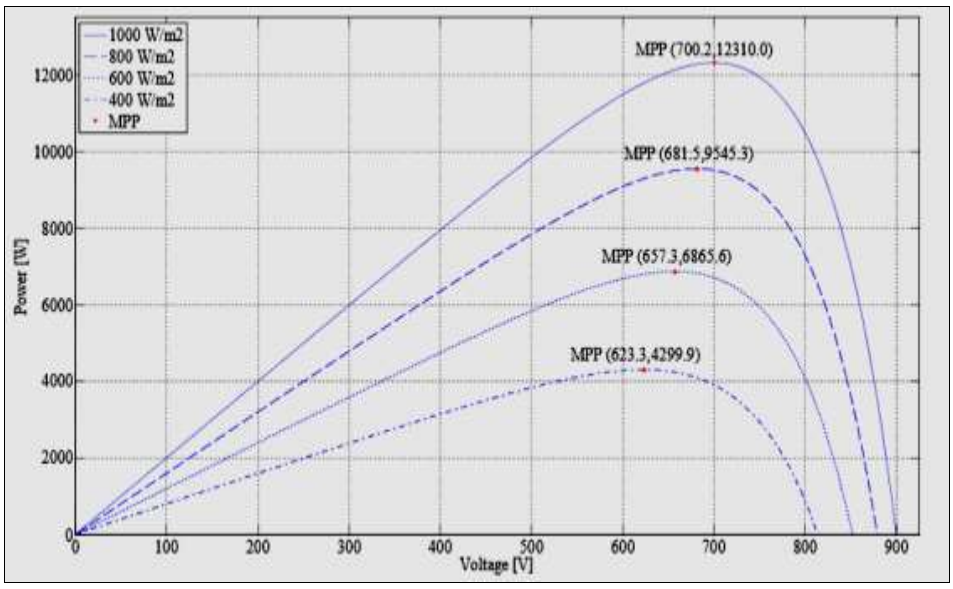


Fig 2: Maximum power point conditions

Modes of operation

Mode I [fo, fI]

At f = fo, whereas the facility switch S2 remains ON, the power switch SI is switched ON. The diodes DrD, Do and D are reverse biased. throughout this mode the energy keep within the series outflow inductance LIs is completely discharged into the output terminal through fly back-forward diode Dj and hs decreases to zero; therefore, the leakage electrical device current ilpl linearly will increase and therefore the out flow inductor current ilp2 reciprocally decreases.

Mode eleven [fI, f2]

At t = fl, the facility switches S and, are still ON and every one of the diodes are reverse biased as shown. Therefore, both the first outflow inductances and therefore the magnetizing inductances are charged by the input supply and therefore the currents hpJ, Ilp2, ImgI and Img2 linearly increase.

Mode TIT [f2, f3]

At f = f2, the facility switch S2 is turned OFF whereas the switch SI remains ON. As the diodes DI, D3, Do and Dj are reverse biased during this mode and Lml and Llpl ar still charged through the input supply. In contrast, the energy keep within the Llp2 releases into the capacitors CI to C and therefore the energy keep in L2 is transferred to the secondary facet of the coupled electrical device and charges the output electrical condenser through the diode D.

Mode IV [f3, f]

At f = f3, the facility switch SI remains ON whereas the power switch S2 is switched ON. The diodes DrD, Do and Dj are reverse biased during this mode. The energy keep in LmI is transferred to the secondary facet of the coupled electrical device and therefore the output capacitors are charged through Dfl.

Mode V [f4, f5]

At t = f, each of power switches SI and S2 stay ON. All of diodes are reverse biased during this mode. The present of the outflow inductances Lipi and Llp2 linearly will increase by the input supply.

Mode VI [t5, t6]

At f = f5, the facility switch S2 remains on-state whereas the power switch SI is turned off. The diodes D2, D4 and Df are still reverse biased, whereas the diodes DI, D3, Do and Dj are turned ON. The energy keep in Lipi and CI is free to the output electrical condenser Cout3 through Do. Moreover, a section of the energy keep in Lipi charges C2 and C3 and therefore the energy keep in Lmi is transferred to the secondary facet of the coupled inductor and charge emf2.

Conclusion

In this paper a replacement interleaved high increase convertor is proposed. The planned convertor combines the benefits of the coupled inductors with the diode-capacitor voltage multipliers and thence an excellent increase gain will be simply achieved with minimum range of multipliers and low turns ratio of the coupled inductance whereas the convertor operates at low duty quantitative relation with low current ripples and low physical phenomenon losses. Therefore, the planned convertor exhibits high efficiency in a very wide selection of operation that makes it appropriate for high power application. The simulations results verify the authenticity of the theoretical analysis and therefore the effectiveness of the planned system as an excellent high increase converter.

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