A new implementation of FUZZY-MPPT based DC-DC converter topology of photovoltaic systems

Khaja Shujath Ali[1], M.Shasikanth[2]
P.G Student (Dept.Of.EEE) [1], Assoc. Professor (Dept.Of.EEE)[2]
Joginpally B.R.Engineering college

Abstract - A fuzzy-logic-control (FLC) based maximum power point tracking (MPPT) algorithm for photovoltaic (PV) systems is proposed. The power variation and output voltage variation are chosen as inputs of the proposed FLC, which simplifies the calculation. Compared with the conventional perturb and observe (P&O) method, the proposed FLC-based MPPT can simultaneously improve the dynamic and steady state performance of the PV system. To further improve the performance of the proposed method, an asymmetrical membership function (MF) concept is also proposed. Two design procedures are proposed to determine the universe of discourse (UOD) of the input MF. Comparing with the proposed symmetrical FLC-based MPPT method, the transient time and the MPPT tracking accuracy are further improved by 42.8% and 0.06%, respectively.

Keywords: *Cuk- SEPIC Converter, MPPT, PV Panel, Fuzzy logic Controller*

I. INTRODUCTION

Nowadays, world is focusing in on the utilization of manageable force in power region in light of essential condition of present day empowers, for instance, oil, gases and coal. A country like India has an extra obligation of offering capacity to the removed spots which are so far not associated with the public organization system. Along these lines, to destruction such energy crisis, the best course is to pick naturally inviting force resources that can be realized with fast effect. Fortunately, sun based energy is plentiful in most bit of India in light of its territory on the earth. That is the explanation, the sun fueled cell development are ending up being well known bit by bit for the force age. As we presumably am mindful, sun situated energy is unpredictable in nature and depends upon the atmosphere conditions, along these lines, to work the close by planetary gathering gainfully we need some worldwide situating system. The best power for the given common conditions can be trailed by using a couple of techniques known as Maximum Power Point Tracking (MPPT) procedures [3]. There are various MPPT methodology that can be used for such explanation. In this paper, we are using an Incremental Conductance (INC) MPPT methodology [2]. It is better than various available MPPT in light of the fact that it gives more definite results in changing biological conditions which diminishes influencing near most noteworthy point.

The basic operating principle of these kinds of methods is that when operating point is far from the MPP, larger perturbation step will be used to improve tracking speed. On the other hand, when operating point is close to the MPP, smaller perturbation step will be used to improve steady-state efficiency. However, since PV system is a nonlinear system, how to determine the scaling factor of the perturbation step becomes significant when realizing these variable-step size MPPT algorithms. On the other hand, FLC has advantages that its parameters can be determined without precise and complicate mathematical model and it is capable of operating under highly nonlinear system. As a result, the FLC-based MPPT algorithm attracts many research interests. Recently, numerous MPPT techniques based on FLC have been proposed in the literatures [14–34]. In comparison with conventional P&O algorithm, FLC-based MPPT provides superior tracking performance. However, the design consideration and realization complexity for different kinds of FLC-based MPPT techniques vary greatly.

The fundamental disasters in DC-DC converters are trading incidents, copper mishaps (inductor windings), diode conduction adversities, MOSFET conduction setbacks, and inductor focus hardships (whirlpool current and hysteresis). The converters in Table I all have an equal switch count so the trading setbacks will be relative. The inductor hardships are lower for the proposed converter in light of the fact that the lessened data current wave reduces the zenith inductor current, in any case the converter has more inductors. For this PV application, it is furthermore basic to perceive the DCDC converter's viability and the overall system capability. The low data current wave in the proposed converter will keep the PV structure nearer to its MPP, further improving the overall power removed.

Capacitor control conditioners full oversight change by electronic trading exchange of capacitors in the data control wellspring of the structure and the store. SEPIC converters are commonly utilized for dc-dc converter. The huge piece of room for SEPIC converter is that it has a non-disturbing (yield voltage has a comparable near limit as the data voltage). SEPIC converter is fundamentally uphold converter and is same as the customary buck-help converter. Production of controlling investigate, control structures, topographies limit issues and inspiration driving SEPIC converters are commonly used on endeavor where it is dc-dc converter.

The most express bit of SEPIC converter where it has one mosfet switch which accepts a huge capacity in the model and provoking high power voltage showed up diversely in relationship with standard dc-dc converters. SEPIC converter where it usually same as old style buck help converter in proposed system where SEPIC converter go probably as lift converter. To get PV voltage extended. PV module is joined with SEPIC converter where it can support the yield of PV voltage and it is given to inverter where it changes dc voltage over to ac voltage. The made sine yield is given to ac load or to cross section related applications.

Photovoltaic System Configurations

Domestic PV systems are usually connected to single-phase, earthed AC grids. Thus, in addition to voltage change ratios and input current waveforms, another important factor to consider is the impact of leakage currents These stem from the high frequency common mode voltages introduced at the DC side of many inverter topologies (e.g. H-bridge), which cause leakage currents to flow through the significant panel-to groundparasitic capacitances inherent in PV systems [10, 11], as shown in Fig. 1. The downside of using an isolated DC-DC converter is that they have an increased number of switches and diodes [14], and they still rely on transformers which negatively impact the overall efficiency of the PV system. The leakage current decoupling method has been investigated in recent years to reduce the leakage currents in converters such as the HERIC, H5, and H6, however additional switching devices must be employedwhich increases the losses, cost and complexity of the system

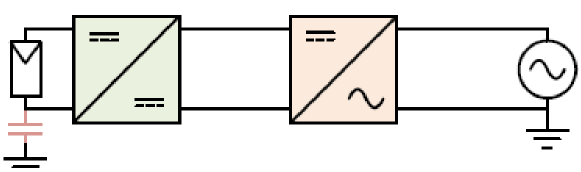


Fig 1:Unipolar DC output without transformer causing leakage currents.

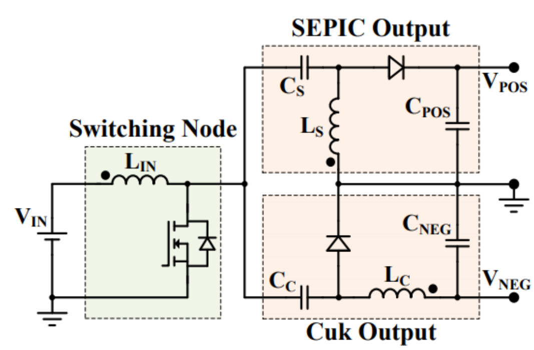
II. THE COMBINED CUK-SEPIC (CCS) CONVERTER

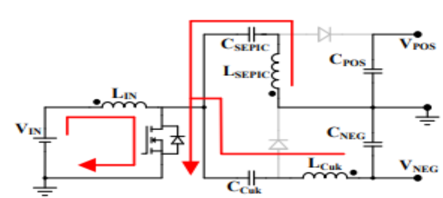
The Combined Cuk-SEPIC (CCS) converter, appeared in Fig. 2a, is an arising DC-DC converter geography that is appropriate for this application and has consequently been researched as of late . It utilizes a solitary exchanging hub, which is normal to both Cuk and SEPIC energy move stages, to give coordinating ground-referred to positive and negative yields. During the switch 'on' state (Fig. 2b), all inductors are charging and the capacitors are releasing. At the point when the switch kills (Fig. 2c), the inductor flows divert into the two diodes and the capacitors charge while the inductors release. In ceaseless conduction mode (CCM) activity considered in this paper, the switch turns on again preceding the total release of any inductor.

The CCS converter can give huge advance up, just as step-down voltage change proportions. The converter has a yield/input proportion of D/(1 − D) for every one of the positive and negative DC yield terminals, giving advance up change to obligation proportions more prominent than 1/2, and working in sync down mode for obligation proportions under 1/2. The converter's general increase (for example thinking about the yield voltage as the positive-to-negative voltage) is 2D/(1 − D). This particular yield/input voltage proportion permits guideline of bigger info voltage varieties with a similar obligation cycle range, or then again permits the converter to deal with a similar information voltage variety with a smaller obligation cycle range, taking into consideration more modest inductors to be utilized. Fig. 3 shows the increase gave by various converter types to a scope of obligation cycles.

Inductor Magnetic Coupling

The advantages of inductor coupling in Cuk converters and SEPIC converters has been depicted in the writing . Regardless of late interest in the CCS converter be that as it may, research





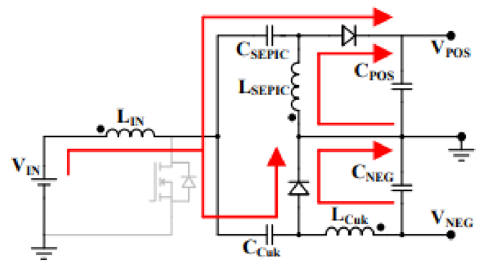
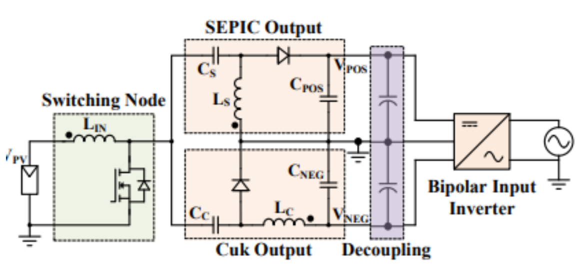


Fig: Combined CUK-SEPIC Converter Topology i) CCS Converter Topology ii) CCS Operation during 'ON 'state iii) CCS operation during off state.is yet to be directed into the impacts of coupling its info and yield inductors and the advantages this has for PV frameworks. This paper looks at the effect of coupling between LIN , LS, and LC , as appeared in Fig. 2a. This converter is consequently alluded to as the Coupled Inductors Combined Cuk-SEPIC (CI-CCS) converter. A multi-variable enhancement has been directed to decide the ideal coupling levels in Section II, which additionally incorporates reproduction and test results. The outcomes show that this coupling can essentially decrease the information current wave, which permits the general inductance – and subsequently volume and weight – to be diminished. Area III presents a conversation of the advantages this decreased current wave has on sunlight based PV execution - explicitly tending to MPPT and a high data transfer capacity current regulator - alongside an assessment of the more extensive matrix incorporation of this converter.

III. CONVERTER DESIGN AND MAGNETICS OPTIMIZATION

The pinnacle power appraisals of both the DC-DC converter and inverter for single-stage network associated PV frameworks are significant contemplations. Fig. 4 shows the CI-CCS converter taking care of a bipolar info inverter, with some energy stockpiling present on the DC transport to decouple the 100 Hz power changes brought about by the single-stage framework. For a 1 kW normal ACoutput power, the peak instantaneous power will be 2 kW, since the instantaneous power is given by √Pac (t) =2Vrms sin (ωt) √2Irms sin (ωt) = 2VrmsIrms sin2(ωt).



In the event that there is no capacity present on the DC transport, at that point the CICCS converter should be equipped for providing this 2-kW top force on both of its positive and negative yields (since this pinnacle happens in both the positive and negative patterns of the lattice voltage). In the event that there is no repeating power de-rating of the CI-CCS converter (for example its ceaseless rating is moderately set to the transitory pinnacle power prerequisites) and on the off chance that we negatively guarantee that it can gracefully this pinnacle power on the two yields all the while, at that point the converter must be evaluated to a sum of 4 kW (for example 2 kW for each yield). For this situation, the force provided to the DC contribution of the CI-CCS converter won't be steady, but instead follow a similar shape as

the immediate AC yield power. Hence, in this most dire outcome imaginable the force rating proportion of the CI-CCS to inverter will be

Truly, enough capacitance should be remembered for between the CI-CCS converter and the inverter to decouple the 100 Hz swell from the PV exhibit, permitting it to create a steady force yield and keep up activity at its MPP. In this situation, with a similar 1 kW normal AC yield power, the contribution to the CI-CCS converter will be a nonstop 1 kW. This is provided then again to the positive and negative yields in every framework half cycle. Once more, without repetitive force de-rating and guaranteeing the converter can flexibly 1 kW on the two yields at the same time, the converter should be evaluated to a sum of 2 kW (for example 1 kW for each yield). Consequently, in this situation the force rating proportion of the CI-CCS to inverter will be 2:1.

In the event that the converter's evaluating is acclimated to represent the recurrent idea of the force provided, at that point the force rating proportion of the CI-CCS to inverter will be 1:1, since the normal force provided by the CI-CCS converter is 1 kW, in spite of this coming then again from each yield. Along these lines, the CI-CCS converter's evaluating must be somewhere in the range of 1x and 4x the inverter's normal yield power, contingent upon the capacity present between the converters, and the degree of de-rating applied. In this paper, the converter model is moderately intended for the most dire outcome imaginable (for example 4 kW top force), yet tried at 2 kW since adequate capacitance is given to guarantee 100 Hz decoupling between the PV exhibit and the matrix. A more itemized examination concerning the effects of these decoupling DC connect capacitors and inverter geography choice is left for different papers, centering in the matrix coordination part of the proposed DC-DC converter.

FUZZY MPPT:

There is numerous MPPT techniques have been developed. The MPPT techniques have been based using fuzzy logic controller. The implementation of the fuzzy logic mppt controller to reduce the voltage oscillation. Fuzzy logic control compromises the optimization and defuzzification. The inputs of FLC deviation of the power((ΔPV) deviation of the current (ΔI and change in voltageΔV

Fuzzification interface:

Membership functions are selected for Fuzzy logic controller are triangular membership functions due to its simplicity for the input membership functions five triangular variables are selected as NB (negative big) NS (negative small) zero PS (Positive small) and PB (Positive Big).The fuzzy subset separation shape and the membership function shape which can adjust the membership function shape.

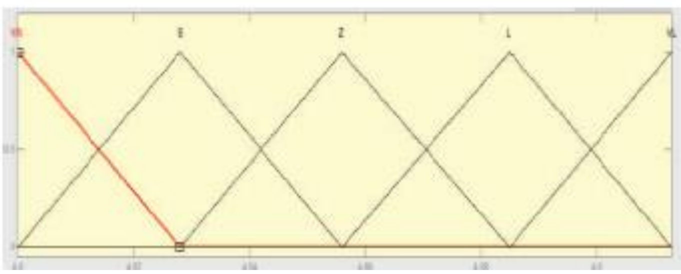
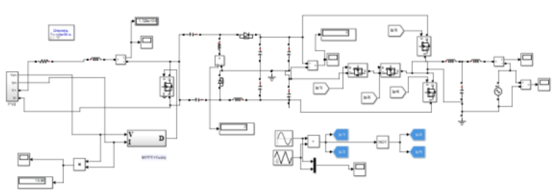
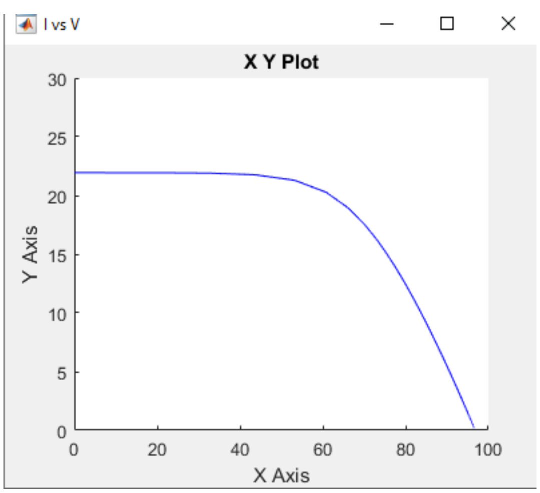
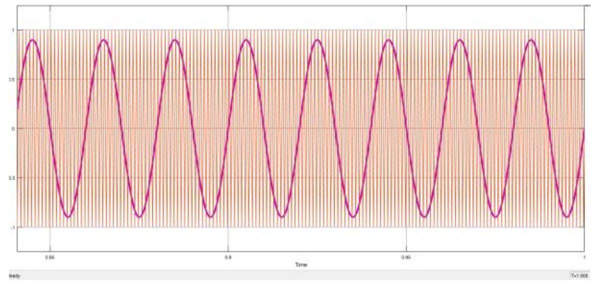


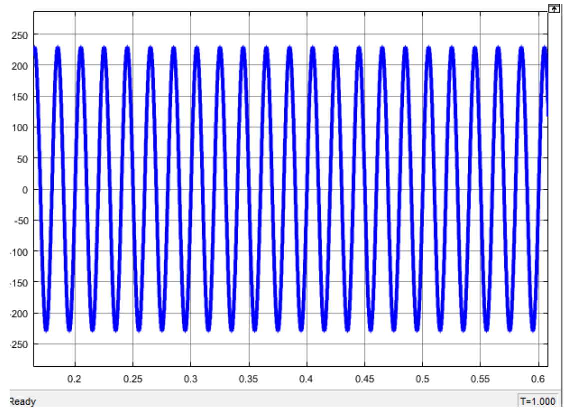
Fig : Input membership functions

IV. SIMULINK DESIGN AND RESULTS









V. CONCLUSION

Combining the input stages of the Cuk and SEPIC converters allows a bipolar DC output to be generated from a unipolar input, using only a single switch. This emerging converter topology shows many advantages for PV applications as its bipolar output structure allows the both the PV system and grid to be grounded without an isolation transformer the benefits that can be derived by magnetically coupling the converter's input and output inductors are investigated. SiC power devices and nanocrystalline powder cores are used in place of IGBTs and ferrite cores, enabling much higher switching frequencies. Together with the coupled inductors, minimal input current ripple has been realized, which enables high levels of PV utilization as the system can remain close to the power curve's peak. In addition to the lower input current ripple, a CCS converter with coupled inductors is smaller, lighter, and more efficient than its uncoupled equivalent. An inner-loop current controller has been designed to facilitate Fuzzy MPPT. A SiC-based T-type converter has perimentally been used to export the PV power from the CI-CCS converter to the AC grid.

VI. REFERENCES

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