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# IMPLEMENTATION OF MODIFIED SEPIC CONVERTER FOR RENEWABLE ENERGY BASEDDC MICRO GRIDS

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***Abstract*: Generally renewable energy sources are getting integrated with DC micro grids to deliver reliable power supply with enhancing system efficiency and essential cost reduction in the best way. The implementation of PV-driven DC micro grids technology is inexpensive, harmless, simple, flexible, and energy effective to the end-users. Here the proposed Modified SEPIC converter is designed based on the traditional SEPIC with a boost-up module. While related to the conventional or traditional SEPIC converter, the proposed MSC produces higher voltage gain and continuous current to the DC micro grids. Moreover, this MSC is operated with a single controlled switch. Here MSC with PV system-based DC micro grids are implemented to effectively satisfy DC loads requirements and moreover entire this work is carried out in PSIM software. And also in this research work, closed loop control of Modified SEPIC Converter for DC micro grid is also analysed and obtained simulation results of continuous output current, output voltage stability in improved manner with reducing the peak over shoot of output voltage wave form comparing with the open loop control of Modified SEPIC Converter by the application of PSIM software.**

**Key words: DC micro grids, SEPIC, MSC, PSIM software**

## I INTRODUCTION

Nowadays usage of electricity demand is increased by utility grids. To meet the fast- growing energy demand and at the same time, tackle the ecological concerns producing from the conservative energy sources, then research persons are moving towards the non- conservative (or) renewable energy sources integrated with DC micro grids to deliver power supply with improving system efficiency and especially cost reduction in distribution systemsin a superior way. In non-conservative sources, solar energy is the cleanest and abundant green energy source available in nature. So, implementation of solar PV based DC micro grids technology is inexpensive flexible, and energy-efficient to the end-users.

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But solar PV panels generate a low DC voltage. By using this low DC voltage as an input to the DC micro grids, this grid does not serve any dc load properly. So, erect this problem with the help of DC-DC converters. The main motto of these DC-DC converters is properly produced output voltage and ripple free output current to the dc load requirements.

## II OBJECTIVE OF THE PROJECT

Following objectives are achieved by this Thesis work, those are

1 To analyse best PWM technique for the MSC (Modified SEPIC Converter)

2 To integrate MSC with DC micro grids

3 To integrate a PV system with the MSC

4 To analyse various performance parameters for the PV based DC micro grid withMSC.

5 To Implement Closed loop control of MSC for DC loads in DC micro grids.

## III SELECTION OF DC-DC CONVERTERS

Conventional SEPIC converter is also termed as a single ended primary inductor converter. Generally, conventional SEPIC converters normally used in the high-voltage renewable energy applications and shown in figure 1. But problem associated with this converter is listed as follows:

1 This converter produces less voltage gain.

2 This converter generate ripples at output side (load side) when this converter takes input voltage with some noise signals.

3 This converter does not utilize input resources in maximum.

4 This converter does not satisfy the variable DC loads.

All the problems associated with this conventional SEPIC converter are overcome with the MSC discussed in latter section. Moreover conventional SEPIC converter requires maximum duty ratio to operate a converter in a boost mode. So, finally this conventional SEPIC converter is affects the functionality and efficiency of the system when this conventional SEPIC converter is operated at maximum duty ratio. But MSC does not require any maximum duty ratio operating points and then this converter operate in boost mode in the duty ratio of 0.55 to 1 in efficient manner with producing any unwanted disturbing signals. The following circuit diagram of the conventional SEPIC converter normally operate like a buck-boost DC-DC converter but this conventional SEPIC converter continuously generates output current in continuous way.

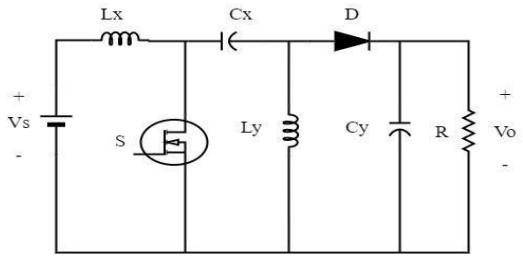



Fig 1. Conventional SEPIC Converter

*a. Proposed Modified SEPIC Converter*

In this thesis work non-isolated Modified SEPIC Converter (MSC) is presented for high voltage applications (ex: - renewable energy applications) showed in figure 3.2. This MSC containing the single input-output terminals and derivative by changing the conventional SEPIC converter as exposed in figures 3.3 & 3.4 demonstrations the circuit diagram of the MSC containing 3 diodes ($D_x$, $D_y$ and $D_z$), 3 inductors ($L_x$, $L_y$ and $L_z$), and 3 capacitors ($C_x$, $C_y$, and $C_z$), these elements are operated with a single switch S with switching frequency ($f_s$). The capacitor $C_1$ and inductor $L_1$ attend as the voltage-boosting component in adding with$D_x$, $D_y$ diodes in MSC.

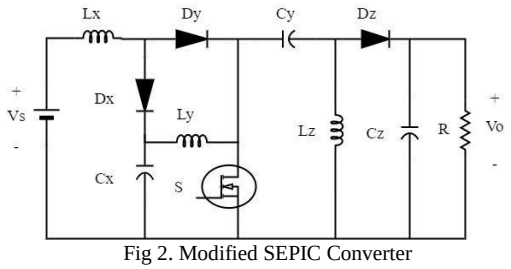



Fig 2. Modified SEPIC Converter

*b. Selection of MSC as a best DC-DC converter for Solar PV Panels based Dc micro grids*

In this section selection of non-isolated DC-DC converter is conversed for solar PV panels based DC micro grids. As based on the above discussion regarding the different types of non-isolated DC-DC converters, MSC is preferable for solar PV based DC micro grid applications. The requirements of the non-conservative energy-based DC micro grids as like that primarily every dc load is served by the continuous ripple-free current with preferred voltage level and secondarily DC micro grids are must be served by the high voltage gain andhigh voltage level without containing any fluctuations in DC voltage.

In general non-conservative sources are always generates low voltage to the DC gridsystems so enhance this voltage level to higher level with the help of a DC-DC converter with high voltage gain and maximum utilization of sources. Hence based on the requirements of this solar PV panels based DC micro grids MSC is preferred rather than the other non- isolated DC-DC converters.

## VI RESULTS AND DISCUSSIONS

In order to simulate the PV system based DC micro grid with a MSC in software simply called as PSIM software. PSIM software is specially designed for power conversion systems, power electronics, and motor drives.

Generally, PSIM takes less run time to simulate any power electronic circuit. But in MATLAB whereas numbers of circuits are going to increase run time of the solver is also makes some delay to generate an output plot in Simulink browser. Moreover, MATLAB is applicable especially for power system and mechanical drive applications.

When working with the power electronic devices, one can easily simulate these powerelectronic circuits in PSIM with less run time and generate accurate results. So, all power electronics based micro grid designs are effectively simulate in this PSIM software.

So, that ‘s the reason PV system-based DC micro grid with MSC is simulated in this software.

*a. Operational strategy*

Regarding the operation of the PV system based DC micro grid with MSC can operate in following stages:

Stage.1:- In this stage PV system totally generate power supply to the DC loads in a DC micro grid effectively with the help of a MSC. Here three DC loads are viewed in this stage namely termed as 12V 100W DC load, 24V 100W DC load, and 24V 100W half-bridge BDCoperated in a buck mode will consume power like a DC load.

Stage.2:- In this stage PV system partially generate power supply to the DC loads in a DC micro grid effectively with the help of a MSC. If partially shaded conditions are held in a PV system. Here two DC loads are viewed in this stage namely termed as 12V 100W DC load, 24V 100W DC load, and 24V 100W half-bridge BDC operated in a boost mode will produce power to the DC loads. Here one point is noticed that half-bridge BDC with battery supply acts like a backup provider to the PV system.

Here in this stage PV and Battery both are acts as supply systems for the DC loads in DC micro grids.

One of the main advantage of the BDC_s are they are operate in buck and boost modes with the controlling action presented by the controller. In both stages PV system is effectively operate with a P&O MPPT controller to track a maximum power point. And supply this power to MSC and effectively produce output voltage and current at DC loads ina DC micro grid without generating any ripples. This two stages are simply explains the working operation of this PV system based DC micro grid with a MSC.

### *b. PSIM operation of the system*

Table.5.1 Performance parameters are considered to the MSC, Buck converters, andhalf-bridge BDC

| Parameters | Values |
|---|---|
| Input voltage | 24V |
| Power | 100W |
| Inductors | 1mH |
| Capacitors | 220uF |
| Switching frequency | 50,000Hz |
| Duty ratio | 0.7 |
| Input current | 4A |

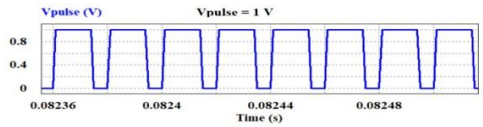



Fig 2. Voltage pulse of MOSFET switch

These are the different gate pulses to the MSC, buck converters and half-bridge BDC‘s MOSFET switch regarding these converters operated in the environment of PV systemintegration with a DC micro grids. So, effectively generate a voltage pulses to the MOSFET switches in these converters are produces a output voltage in an efficient manner.

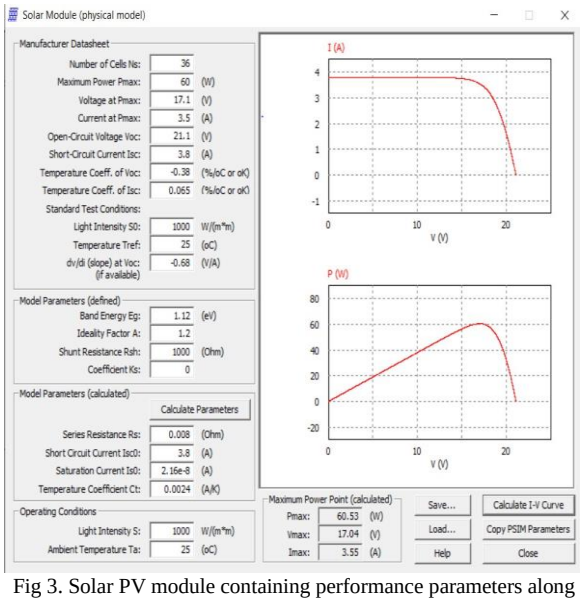
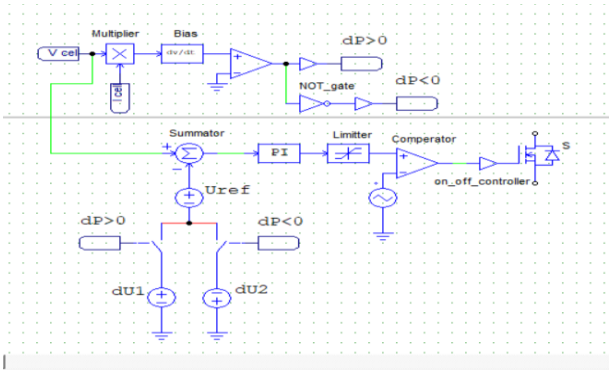



Fig 3. Solar PV module containing performance parameters along with the I-V & P-Vcharacteristics

In figure 3. $V_{cell}$, $I_{cell}$ are the voltage and current producing from the PV cell and considering this voltage and current as input to the P&O MPPT controller. Finally P&O MPPT algorithm develops a controlling duty pulses to the switch which can connected by an on-off controller. So, this functional block regarding the P&O MPPT controller can effectively control the MSC in a DC micro grid integrated with the PV system. Mainly all MPPT techniques are focus on the implementation of the controlling duty pulses for DC-DC converters and finally develop a constant power with maximum track point. While considering the factor of easy implementation with less cost MPPT technique is a P&OMPPT technique. So, most of the researchers are working with this P&O MPPT technique and then obtain an effective controlled duty pulses and maximum power to the DC-DC converters (MSC).

Fig 3. Simulation of P&O MPPT controller




### c. PSIM based simulation results and discussions

Describe the supply voltage, output voltage and output current simulation result waveforms of the MSC with values of 24V, 186.3V, 0.5A. These three waveforms are periodically DC in nature. Here MSC can‘t generate any ripple content in the output voltage and current. So that‘s the reason MSC always generate continuous current to the DC loads.

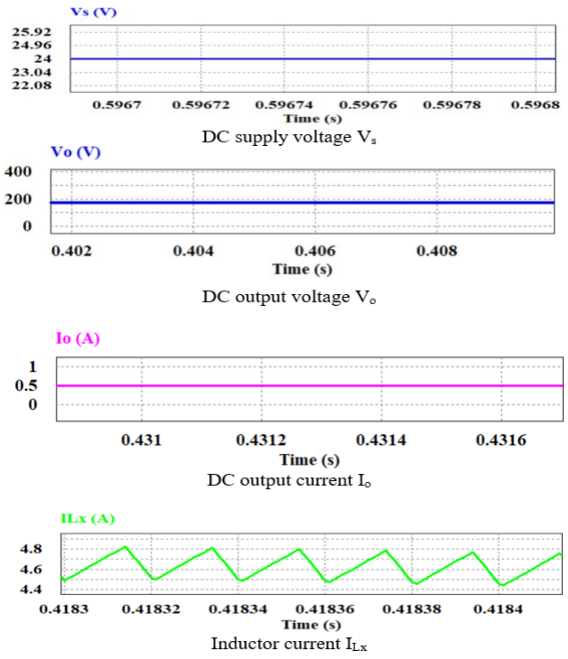



Fig 4. PSIM based simulation

From figures 4. describes simulation result waveforms of

the inductor $L_x$ , $L_y$ and $L_z$ current regarding the MSC with values of 4.2 A, 1.4 A and 0.5 A (average) current. In mode-I, currents flowing in three inductors are increasing with positive slope and vice versain mode-II operation.

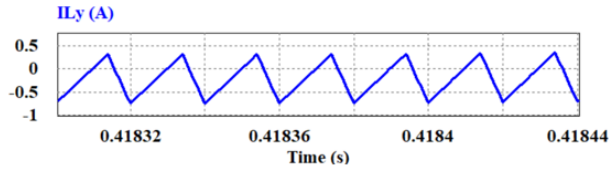



Fig 5 Inductor current $I_{Ly}$

From figures 6. illustrate the simulation results of capacitor voltages $V_{C1}$ and $V_{C2}$ with values of 78.71V, 76.75V. It is examined that, approximately +80 V is obtained

across the capacitors $C_1$ and $C_2$. It is analysed that the characteristic waveforms and this simulation results of capacitor voltages $V_{C1}$ and $V_{C2}$ are matched and steady state in nature.

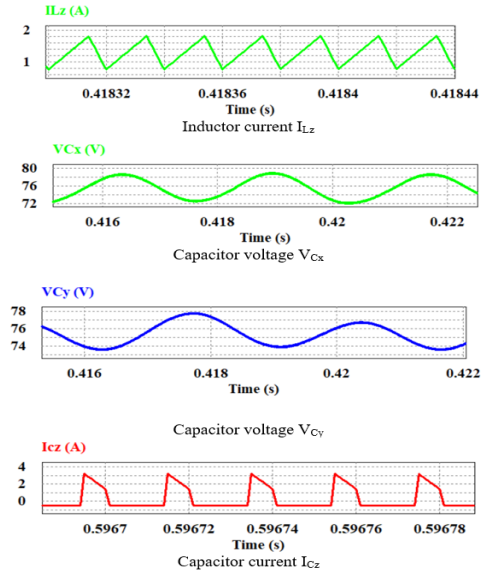



Fig 6. capacitor voltages

The figure 7. shows the simulation result waveform of the current flowing in the capacitor $C_z$ with the value of 0.5A [average value]. The average current of this capacitor is exactly equal to the output current flowing in the resistor R.

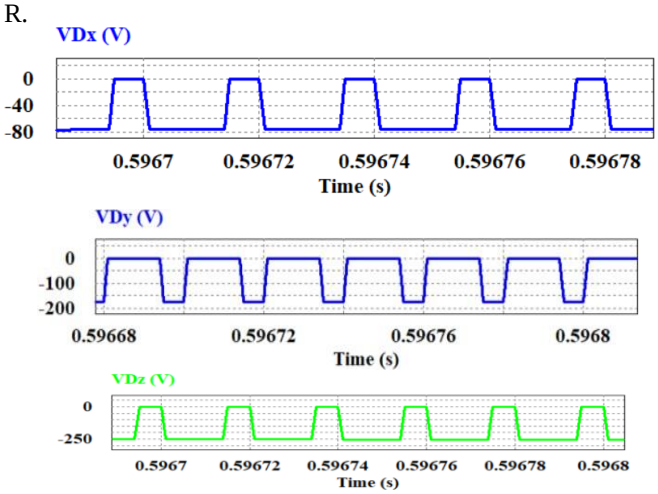



Fig 7. Diode voltage

## V CONCLUSIONS

The PV system-based DC micro grids with MSC topology is discussed and simulated using PSIM software. Moreover advantages of using MSC in this topology are addressed in the section of simulation results and discussion. So, PV system with a MSC configuration has continuously generates output current without producing any ripples. This configurationgives the output voltage with high gain and also deliver required amount of power supply demanded by the DC loads.

Based on the simulation results of the MSC for Photovoltaic based DC Micro Grids, MSC can effectively satisfies the DC load demand by generating continuous current, constant DC voltage without containing any ripples and high efficiency at 0.7 duty ratio. Moreover, proposed MSC topology has the novel capability of revoking the current ripple at supply side with greater than the duty cycle of 0.5. In accumulation, the MSC has feature of a high voltage gain with maximum utilization of input resources.

So this feature makes this converter suitable for the process low voltage coming from low power rating sources, like as renewable energy sources. Moreover, voltage stress acrossdiodes and switch is low for MSC, which is advantageous to the system cost and efficiency. Comparing with the conventional DC-DC converters MSC can capable to produce high efficiency, high voltage gain, continuous output current with negligible ripples at load side can prove this converter operated in between 0.7 to 0.8 duty ratio is well suitable for Photovoltaic based DC Micro Grids in residential loads. So that_s the reason MSC is suitable for high voltage renewable applications and DC Micro Grids in residential loads.

That‘s the reason this configuration is most probably well integrated with the DC micro grids to deliver a reliable power supply to the DC loads. Especially this topology well suited for domestic applications. Now a day‘s most of the houses are equipped with DC LED lamps, BLDCM based ceiling fans and etc. These applications require DC supply. And comparing with the open loop control through closed loop control of MSC for DC loads with varying in its voltage, closed loop control of MSC can easily produce constant DC voltage with 0.02 response time even if its input voltage suffering with external disturbances.

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