BIPOLAR DC MICROGRID OPERATION USING SEPIC AND CUK CONVERTER

1SANDHYA RAI, 2MAHESHWARI.B

1Associate Professor, 2M. Tech (Power Electronics) Dept. of EEE, The oxford college of engineering, Bangalore-560068, Karnataka, India.

Abstract— This paper describes the DC-DC converter configuration based on combination of sepic and cuk converter. The same switching node is shared by two converters as they have same duty cycle. As the converters are sharing same switching node which is called bipolar microgrid. This topology allows the connection of renewable energy sources for the efficient and easily way. Simulation results shows that combining of two converters with appropriated modulations schemes are adequate for the voltage balance and current redistribution in bipolar microgrid. The output results are compared with the industrial load and unbalanced load.

Keywords— DC Microgrid, DC-DC Converters, Distribution Generation.

I. INTRODUCTION

Microgrid are the low voltage grids which are used in independently. MG are of three types
- Monopolar microgrid
- Bipolar microgrid
- Homopolar microgrid

Of all this topologies, bipolar microgrid is mostly used. DC microgrid is being used. Sepic and cuk converter have the same switching node and same result with different polarity.

Output is being compared with industrial load and unbalanced load.

II. SEPIC CONVERTER

Sepic converter can act as Buck and Boost converter depending on the duty cycle. Output is always positive
\[
\frac{V_{output}}{V_{input}} = 1 - \frac{D}{D}
\]

D = duty cycle
If duty cycle is below 50% Sepic converter acts as the Buck converter and if duty cycle is above 50% duty cycle acts as the boost converter.

III. CUK CONVERTER

Cuk converter can acts as Buck and Boost Converter depending on the duty cycle. The output voltage is always negative. Cuk converter has extra inductor and capacitor for ripple free output.

\[
\frac{V_{output}}{V_{input}} = \frac{D}{1 - D}
\]

IV. MICROGRID

Power grid is used for one way flow of power. The large central power station is being connected transmission lines which move power form power station to lower voltage distribution system and then power is reached to consumers. This project deals with microgrid in which electricity is moved form point of generation to the consumers by acting independently.
Microgrid enable local electricity generation, energy storage and load to operate independently. When the power flow through the microgrid. It will utilize the locally generated sources of energy to keep the local lights ON. Complexity of microgrid depends upon the energy capacity of the microgrid. It is vital to microgrid at a minimum and adequate generation is available to support all non-interruptible and critical electrical loads within the microgrid. Some microgrid will have sufficient energy to supply to the load but when electric load with microgrid within the microgrid changes to the macrogrid. This problem can be avoided if microgrid is being operated in parallel with macrogrid.

They are three types of microgrid which are used in this project

- Monopolar microgrid
- Bipolar microgrid
- Homopolar microgrid

Monopolar microgrid: Monopolar microgrid which has single voltage wire. The return conductor may be land or metallic. Monopolar DC link has advantage over economical point of view.

Bipolar microgrid: Bipolar dc link microgrid is mostly used. Its cost is more than Monopolar dc link. It has advantages in bipolar dc link the current which is return is half and if failure occurs in one of the line the other continuous to operate normally. In bipolar DC link supply voltage should be balanced and also the transmitted power.

Bipolar dc link has one positive polarity and one negative polarity and the values of result will be same.

Configurations which are widely used in bipolar DC link use two or four controlled switches half bridge type and full bridge type.

Homopolar microgrid: This microgrid has one or more wires. The return may be land or metallic. The cost of the microgrid is less.

Bipolar microgrid: In this project bipolar microgrid is formed by a combination of sepic and cuk converter in which only one input voltage is used for the operation of two converters

VI. DC MICROGRID AND AC MICROGRID

Microgrid is the large central power station connected to transmission lines that move power form one power station to distribution system and then to consumers.

Microgrid is the regionally limited energy of distribution energy resources, consumers and operational storage it optimizes power quality and reliability and it may continuously run in off and on grid as well as in dual mode by charging the grid connection status.

In this project DC microgrid is used which enable control of DC network resources for more operational performance and ability to operate independently of a primary AC system for enhanced reliability. The backbone of DC network is either powered by AC-DC rectifiers or DC-DC converters which are used to power individual native DC loads. AC loads are served by directly AC power supply.

The total power lost in DC microgrid depends on energy that passes through the different devices and also on the relative timing of the microgrid generation and load. The loss is due to a DC line losses and efficiency of the converters. The losses in DC microgrid is 70% to 90% less then the AC microgrid.

The cost of DC microgrid is less than the AC microgrid.

AC microgrid has the advantages over clearing the transient faults.

In ups system when connected to AC distribution system the efficiency is less due to more number of power conversion stages like converter AC to DC and then DC to AC and while discharging it is backwards but for DC distribution a single stage bi-directional is used. Number of wires needed will be reduced by using DC distribution which eliminates the 60Hz transformer and the number of wires needed.

VII. APPLICATION OF DC MICROGRID

Industrial loads can use the microgrid such as motors and pumps could play significant role in enabling economical development.

It is used in dynamos that produce a AC current by as they convert mechanical energy into electrical energy. Almost all the processes that use AC uses DC which is produced in battery.

DC microgrid distribute the energy throughout building or campus.

VIII. BIPOLAR MICROGRID

Bipolar microgrid which supply single power supply to the two converters which are connected.

In this project the combination of sepic and cuk converter is used with single power supply which results in two output voltage with different polarity and same values.
CONTROL BLOCK
The control block consists of trigger pulses of switch supply input to the converters. The supply voltage given is 96V. Input is being compared with the control block, which is connected to the MOSFET.

BIPOLAR BLOCK
Bipolar block consists of combination of sepic and cuk converter, which have same duty cycle.

LOAD BLOCK
The output voltage is present in load block. The output voltage of sepic and cuk converter is same with different polarity. The reference value is given 200V. The loop continues till the output voltage is equal to 200V. The output voltage of sepic converter is +200V and for cuk converter it is -200V. The error is applied to the PI control block to get the suitable response. The output of PI control is adapted to a digital signal through a relay.

Sepic and cuk converter have same duty cycle so the output voltage is also similar. This converters acts as Buck or Boost converter depending on the duty cycle. If the duty cycle is greater than 50% then the converters acts as boost converter sepic response will be positive and cuk response will be negative. When duty cycle is less than 50% this converters acts as the buck converter the response will be respective to the polarities of sepic and cuk converter.

Sepic converter has a capacitor to store the energy and cuk converter has two inductor and two capacitor which is due the continuous current flow and also to store the energy. They are two modes of operation.

MODE1:- when the input supply is given the diode becomes reverse biased and there is flow of energy and store energy in the capacitor. The output result is obtained.

MODE2:- when supply is off the stored energy in the capacitor is passed to the diode and the result is obtained.

IX. SIMULATION
The supply voltage is given above 50, which is 96 to the sepic and cuk converter. Response of sepic and cuk converter is 140V, when the closed loop is placed with reference voltage 200V. The output voltage of sepic converter is given to the sum of sepic output and reference voltage. The voltage is then supplied to the PI controller and then again the voltage is compared with the error voltage and input voltage. The resulted voltage is sent to the operational relator which is set to be equal or less than 200V. This resulted pulse is given to the MOSFET which acts as the switch. The loop continues till the output voltage of sepic and cuk converter is 200V.

X. BIPOLAR MICROGRID
The open loop circuit of bipolar converter with pulse given to MOSFET.

Fig 5:-open loop circuit

The circuit diagram is as shown in below figure 2.

Fig 5:-BIPOLAR MICROGRID

Parameter values which are used in the converters are shown in table 1

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<th>Table 1:-parameters</th>
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<tr>
<td>Parameters</td>
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<tr>
<td>Input voltage</td>
</tr>
<tr>
<td>Inductor L1</td>
</tr>
<tr>
<td>Capacitor C1</td>
</tr>
<tr>
<td>Inductor L2</td>
</tr>
<tr>
<td>Capacitor C2</td>
</tr>
<tr>
<td>Sepic result</td>
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<tr>
<td>Cuk result</td>
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Industrial load is being connected to the load to check and the results are same as the without the load. The output with resistor values of 100Ω is being added. The circuit is also checked for unbalanced load which is same as the circuit without the load the fig is shown below.

CONCLUSION

Microgrid which is used for transmission of power is given above. sepic and cuk converter combination is shown which have same duty cycle so the output of sepic waveform is as shown in figure and cuk output waveform is same as the sepic converter but with the negative polarity. AC and DC microgrid is being compared which shows the DC microgrid is mostly used and application of DC microgrid. Simulation results shows the value of output current, output voltage of the converters. The industrial load is being compared which shows the DC microgrid is mostly used and application of DC microgrid. Simulation results shows the value of output current, output voltage of the converters. The industrial load is being connected to check the output if it gets any error in the output which is also checked with the unbalanced load. The results shows the both loads are satisfied by the bipolar.

ACKNOWLEDGEMENT

Microgrid which is used in locally power supply. Groups of US has come forward of using a microgrid. The combination of both the converters made it easy to get both the polarity of the results. The power supply can be replaced by renewable sources. They may be increase supply power during using source renewable so the use of battery is taken. In which we can take the control of the power supply.
REFERENCES


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