A DOUBLE INPUT BUCK BOOST CONVERTER FOR WIND ENERGY SYSTEM WITH POWER SHARING CONTROL

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Abstract--The simulation of a nonlinear controller with power sharing control capabilities for a wind energy system double input buck boost–buck boost converter is presented. A multiple-input DC–DC converter is useful to obtain the regulated output voltage from input power source such as a wind array. Double input DC-DC buck boost converter principle of operation and the equations describing the converter circuit are reviewed. Wind energy system combining two Photo Voltaic (PV) panels based double input buck boost – buck boost converter is simulated. Finally, various simulation results for a buck boost– buck boost converter operating under the proposed controller are reported to verify the operation of the designed controller.

Index Terms—Buck boost–buck boost converter, wind energy System, double-input converter, power sharing.

I. INTRODUCTION:

The double-input DC–DC converter is useful to get regulated output voltage for the desired load[1]. From the wind array power supply system, the maximum power point of a wind array can be easily tracked.

Advantages of utilizing a double input DC-DC converter [4] are reduced component count, potential weight reduction, source integration flexibility and power sharing management capability [5]. This double input DC-DC buck boost converter is a circuit which converts of direct current from one voltage to another which is a class of power converter. This double input DC-DC buck boost converter is used for renewable energy applications. Power sharing management is the ability of the double-input converter to vary the ratio of the power drawn from the two input sources while keeping the total output power as constant.

A basic block diagram of a system with wind source connected to a double-input withload arrangement is shown in fig. 1
II. SYSTEM BLOCK DIAGRAM

The block diagram shown in fig. 2 consists of PV cell, double input DC-DC buck boost converter, controlled rectifier, voltage source inverter, micro controller, driver circuit, power supply circuits and load. The description of various blocks is as follows.

Wind Generator: A wind generator is a device that converts kinetic energy from the wind into electrical energy. Thus electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical power. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system (WECS).

Buck Boost - Buck Boost Converter: The buckboost-buckboost converter is a multiport (multi-input, single-output) converter with two input sources and one output port. Regulated output voltage that drives inverter is obtained with this converter.

Power Converter: Electrical power converter has both inverter and controlled rectifier that convert direct current to alternating current and alternating current to direct current respectively. Inverters are commonly used to supply AC power from DC sources such as wind panels or batteries.

Controller: Less instruction and low cost Peripheral Interface Controller (PIC) is used as power controller. It performs the function of controlling the input voltage and produces the gate pulse for the power electronic switches of converter.

III. WIND ENERGY SYSTEM

A wind turbine is a rotating machine which converts the kinetic energy into mechanical energy. If the mechanical energy is converted to electricity, the machine is called a wind generator, wind power unit (WPU), wind energy converter (WEC), or aero generator. Wind is the continuous movement of atmospheric air masses and is determined by its
speed and its orientation [14]. This movement derives from the changes and the different values of the atmospheric pressure while these values are the result of the solar heating of different parts of the earth’s surface. Despite the fact that the atmospheric air moves horizontally and vertically as well, only its horizontal movement is actually considered as wind. The wind energy is derived from the air as a result of its movement. Wind energy is the conversion of a small percentage, about 0.2%, of the solar radiation that reaches the surface of the earth.

Wind Power is energy extracted from the wind, passing through a machine known as the windmill. Electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical energy. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system (WECS).

![Wind Power Vs Wind Speed Characteristic](image)

**Fig. 5 Power Vs speed characteristic**

The wind power Vs wind speed characteristic is shown in fig.5. Power is directly proportional to wind speed, as the wind speed increases the power delivered by a wind turbine also increases. If wind speed is between the rated wind speed and the furling speed of the wind turbine, the power output will be equal to the rated power of the turbine. Finally, if the wind speed is less than the cut-in speed or greater than the furling speed there will be no output power from the turbine.

IV.DOUBLE-INPUT BUCKBOOST–BUCKBOOST CONVERTER

The main purpose of these topologies is to provide a three phase voltage source, where the amplitude, phase, and frequency of the voltages should always be controllable. The buck boost–buck boost converter is a multiport (double-input, single-output) converter with two input sources $V_1$ and $V_2$, three controllable switches $S_1$, $S_2$ and $S_3$ and one output port. Two of the controllable switches $S_1$ and $S_2$ can be turned ON and OFF independently, while the conduction status of $S_3$ depend on that of $S_1$ and $S_2$. Switch $S_3$ should be turned ON only when $S_1$ is ON and $S_2$ is OFF.

![Circuit of Double-Input Buck-Boost Converter](image)

**Fig. 6 Circuit of Double-Input Buck-Boost Converter**

As per the power sharing management principle involved in the converter for constant load and constant power output, the double input converter can alternate the amount of power drawn from the energy source ($V_1$ and $V_2$) when needed and hold the voltage as constant.

V.MODES OF OPERATION

The principles of operation for double input buck boost–buck boost converter [2] are reviewed here to provide deeper insight into the proposed control method. The switching operation of three different switches is shown below in table-1.

<table>
<thead>
<tr>
<th>$S_1$</th>
<th>$S_2$</th>
<th>$S_2$</th>
<th>$S_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

**Table-1 Switching Operation of $S_1$,$S_2$and $S_3$**
Two of the controllable switches $S_1$ and $S_2$ can be turned ON and OFF independently, while the conduction status of $S_3$ depend on that of $S_1$ and $S_2$. Switch $S_3$ should be turned ON only when $S_1$ is ON and $S_2$ is OFF ($S_3 = S_1 \times \bar{S}_2$); thus, the modes of operation of this converter depend only on the status of conduction of $S_1$ and $S_2$ resulting in totally four modes of operation. The waveform of switches $S_1$ and $S_2$ are shown below in Fig. 8.

![Waveform of switch $S_1, S_2$](image)

**Fig. 7 Waveform of switch $S_1, S_2$**

**Mode 1 Operation:** In mode 1, $S_1$ and $S_3$ are ON and $S_2$ is OFF; $V_1$ energizes the inductor $L$.

![Circuit of Mode 1 Operation](image)

**Fig. 8 Circuit of Mode 1 Operation**

**Mode 2 Operation:** In mode 2, both $S_1$ and $S_2$ are ON, and $S_3$ is OFF and both sources energize the inductor $L$.

![Circuit of Mode 2 Operation](image)

**Mode 3 Operation:** In mode 3, only $S_2$ is ON and $S_3$ is OFF, and $V_2$ energizes the inductor $L$.

![Circuit of Mode 3 Operation](image)

**Mode 4 Operation:** In mode 4, $S_1, S_2$, and $S_3$ are OFF, and the inductor $L$ starts to discharge.

![Circuit of Mode 4 Operation](image)

**VI. SIMULATION RESULTS**
The simulink circuit of Wind Panels 1 and 2 circuit is shown in Fig 13. Fig 14 and Fig 15 show the Output voltage of Wind panels 1 and 2 respectively. The simulink circuit of double input Buck – boost converter is shown in fig.16. Fig.17 shows output voltage and current of double input Buck – boost converter and fig.18 shows the output voltage of single-phase inverter circuit that feeds an AC load. The various parameters involved in the design are tabulated in table-2.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Input Voltage 1 (V_w1)</td>
<td>12V</td>
</tr>
<tr>
<td>Wind Input Voltage 2 (V_w2)</td>
<td>24V</td>
</tr>
<tr>
<td>Double Input Buck-boost converter Output Voltage DC (V_O)</td>
<td>100V</td>
</tr>
<tr>
<td>Inverter Output Voltage AC (V_O)</td>
<td>100V</td>
</tr>
</tbody>
</table>

![Fig. 12 Simulation of Rectifier Circuit](image1)

![Fig. 13 Simulation of Double Buck-Boost Converter](image2)

![Fig. 14 Double Buck-Boost Converter Output](image3)

![Fig. 15 Simulation of Inverter circuit](image4)
VII. CONCLUSION

Wind energy system using double input Buck Boost – Buck Boost converter is simulated. The output voltage from wind is regulated using double input DC – DC buck-boost converter. In addition to regulation of output voltage, the converter also provides non-linear control with power sharing capability. The simulation is done with help of MATLAB software and the results are obtained. In future the same circuit can be extended for more than two sources.

REFERENCES:


