OPTIMAL DESIGN OF AN INTERLEAVED DC-DC SWITCH MODE CONVERTER

Presented By
Prasanna Kumar. C
Dept. of Electrical and Electronics Engineering
PES Institute of Technology, Bangalore
INDIA
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Objective of the present work

- Design, simulation and hardware implementation of the proposed two stage interleaved converter topology with reduced inductor volume.
The voltage levels obtained from renewable energy sources are low and unregulated.

These renewable energy systems require a suitable converter to increase and regulate their output voltage level.

Most commonly used converter to accomplish this is a Boost converter.
Certain disadvantages observed in conventional Boost Converters are:

* The output voltage significantly decreases with increase in the load and the DC bus voltage is not regulated.

* Normal boost topologies are no more favourable as the power line pollution because harmonics have reached a critical level.

* For high power applications, there exists issues such as high stresses on the power semiconductor switches, high input and output current ripples, and low power density of the converter.

These issues have been reduced by Boost converters called the Interleaved Boost Converter (IBC).
Interleaved Boost Converter

* Interleaved Boost Converters are specialized boost converter topologies.

* The converter components are paralleled into number of stages, with the paralleled stages having common source and load.

* Interleaved Boost Converter consist of two parallel-connected boost power trains operated with a phase difference of 180°.
Unlike the continuous conduction mode (CCM) technique, BCM offers inherent zero current switching of the boost diodes.

This permits the use of less expensive diodes without sacrificing efficiency.

For efficient switching of the two MOSFETS and to ensure that there is no extra heat generated, IC SG3525 has been used to drive MOSFETS.
Advantages of IBC over traditional single stage boost converters include:

- Substantial reduction in input & output current ripple
- Higher power density
- Higher current handling capacity
- Improved efficiency
- Faster response
Block diagram of the proposed system

AC Source → Bridge Rectifier → Interleaved Boost Converter → Filters and Load

Trigger unit → Switching devices

Block diagram of the Power Electronic System
Circuit Diagram of IBC

Circuit diagram of Interleaved Boost Converter
Design and Development

- IBC has been designed using standard steady – state equations, to a power level of 60W PFC application.

- The input considered is 15V, and the switching frequency in the neighborhood of 15kHz
## Component Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>15V</td>
</tr>
<tr>
<td>Inductance (Boost)</td>
<td>71µH</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>16kHz</td>
</tr>
<tr>
<td>Switching device</td>
<td>FDP18N50/DPF18N50; 500V, 18A</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>0.5</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>1000µF/50V</td>
</tr>
</tbody>
</table>
Simulation Results

Simulated output gating pulses for the two MOSFETS
Input voltage and input current waveforms which are in phase
Simulated inductor current with and without interleaving
## Summary of hardware results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>15.05V</td>
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<tr>
<td>Input current</td>
<td>4.55A</td>
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<tr>
<td>Output voltage</td>
<td>29.82A</td>
</tr>
<tr>
<td>Output current</td>
<td>1.99A</td>
</tr>
</tbody>
</table>
Hardware Implementation

Laboratory set up for the hardware prototype
The designed IBC has been implemented under laboratory set – up and tested up to 60W successfully.

For closed loop control, PWM control IC SG3525 has been used.

Switching device used is FDP18N50/DPF18N50 (500V, 18A)
Hardware implementation of the Interleaved Boost Converter
Hardware Results

Waveform across the two switches & output voltage obtained from hardware circuit implementation with a level of about 30V
Conclusion

* A power level of 60W was achievable with the realised hardware setup.

* The design was been able to support a load of 1.99 A and could achieve an efficiency of above 86.66%.

* The input and output filters can be smaller due to ripple current cancellation and effective doubling of the switching frequency.

* It has been seen that the efficiency, size, and cost can be minimized with the proposed topology.
Future Work

- The topology can be modified to drive multiple loads of higher ratings using an appropriate power switch and suitable heat sink.

- The converter can be suitably modified to make use of solar energy as a source with minimum number of battery to drive high rated load.
References


Thank You!