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Power Quality Improved Single Stage High Gain DC to DC Converter

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ABSTRACT

This project presents a single-switch single power-conversion (S3PC) power factor correction (PFC) converter. The control algorithm derived from feedback linearization enables the S3PC converter to obtain good controllability. The proposed converter performs both PFC control and output power control through single power-conversion. The S3PC converter provides high efficiency and high power factor in excess of 0.994.. The proposed converter is able to offer low cost and high power density in step up application due to the following features: ZCS turn-on and ZVS turn-off of switch and ZCS turn-off of diodes regardless of voltage and load variation; low rated lossless snubber; reduced transformer volume compared to fly back based converters due to low magnetizing current. The proposed converter is able to offer high power density in step-up application because of its simple structure; low rated lossless snubber; reduced transformer volume compared to isolation based converters due to low magnetizing current. The proposed converter is capable to stabilize the output efficiency. Experimental results are provided to validate the proposed concept. The Simulation is done with the help of MATLAB Software using Simulink.

Keywords : Fly-back converter, Soft switching, ZCS, ZVS.

I. INTRODUCTION

Isolated step-up dc-dc converters are used in many applications, such as photovoltaic module-integrated converter (MIC) systems, portable fuel cell systems and vehicle inverters where high efficiency, high power density and low cost are required. Owing to smaller input current ripple, lower diode voltage rating and lower transformer turns ratio, the current-fed isolated converter is better suited for step-up applications. The current-fed isolated converter has two types: passive-clamped and active-clamped. The passive-clamped current-fed converter has simple structure and small switch count, but suffers from excessive power losses dissipated in the RCD snubber and associated with hard switching of main switch. Active-clamped current-fed converters have actively been developed based on three basic topologies: push-pull , full-bridge and half-bridge. They achieve not only lossless clamping of voltage spikes caused by transformer leakage inductance but also zero-voltage switching (ZVS)turn on of switches. However, they may not be expected to achieve high efficiency and low cost in relatively low power application since they need at least four switches and gate driver circuits.

A number of isolated boost converters using two switches have been proposed recently. However, some of them have certain limitations. For example, the duty cycle should be set larger than 0.5 even in the start-up stage. Converters with four switches have also been proposed, which consists the isolated buck-boost converter, full-bridge isolated boost converter and full-bridge resonant boost converter. These converters are capable of achieving higher efficiency with either a phase shift control technology or a resonant circuit. But, these converters use more than two or even four switches, which increase the cost of the converters. This paper proposes a single-switch isolated DCDC converter, which has less number of switches than other isolated converters which decrease the cost. The number of switches of the proposed converter is the same as that of a forward or flybackconverter.

Isolated converters with reduced switch count have been proposed for low power application. isolated dc-dc converters with one main switch and one clamp switch achieves ZVS turn on of switches, but switches are turned off with hard switching. Isolated single switch dc-dc converters are more attractive to achieve low cost. Z-source converter. And fly back converter are hard switched at both turn-on and turn-off instants. Frequency-controlled fly back converter and series-connected forward-fly back converter achieve zero-current switching (ZCS) turn-on of switch, but the switch is hard switched at turn-off instant. The above mentioned single switch topologies have increased transformer volume since magnetizing inductor is used for energy transfer. An isolated single-switch resonant converter achieves both ZCS turn-on and ZCS turn-off of switch, but need high transformer turn ratio for step-up application due to low voltage gain and hence is not suited to step-up application.

II. EXISTING METHOD

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Conventional PFC converters are based on a two-stage configuration comprising a PFC converter stage and a dc-dc converter stage. The PFC stage interfaces the utility grid and achieves high power quality, while the dc-dc stage provides a well-regulated output with high dynamic performance.

Drawbacks:

- ☐ Two-stage PFC converters have some well-known drawbacks such as poor price competitiveness and low power efficiency.
- ☐ The cost will always be high due to the two-stage architecture with their respective control circuits High harmonics.

III. PROPOSED METHOD

In an effort to overcome these drawbacks, many single-stage PFC converters have been introduced. A single stage converter combines the PFC and the dc-dc stages by sharing a common switch. So that the PFC switches and its gate driver and controller can be eliminated.

Advantages:

- ☐ Simple structure and low cost compared with two-stage PFC converters.

- The single-stage converters have an intermediate dc-bus capacitor, and because it is left uncontrolled, the dc-bus voltage can be more than double the peak value of the input voltage.
- Using the series-resonant circuit, the S3PC converter provides bidirectional core excitation for the transformer and obtains higher power capability compared with the conventional single-switch PFC converters

Block diagram:

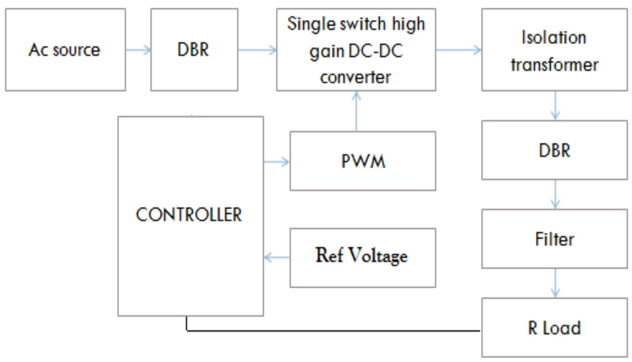
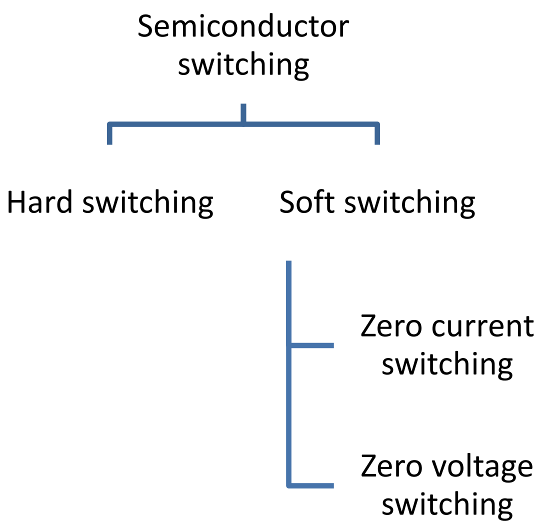


FIG.1.Block Diagram

In this diagram represents for input AC supply is converted into DC supply using DBR then the DC supply is passed through boost converter. This boost converter is used to boost the applied voltage. This signal is applied to the snubber circuit which removes the noise. This signal is applied to step up transformer. The output from transformer is applied to the rectifier and resonant circuit; this block converts the AC to DC and filters out the unwanted noise. This rectified DC output is applied to the load.
The proposed converter has the following features:
1) ZCS turn-on and ZVS turn-off of switch regardless of voltage and load variation
2) ZCS turn-off of all diodes leading to negligible voltage surge associated with the diode reverse recovery
3) small input current ripple due to CCM operation
4) reduced transformer volume due to low magnetizing current
5) low rated lossless snubber, which makes it possible to achieve high efficiency and low cost for step-up application.

IV. SWITCHING

The switching is the phenomenon in which one of the parameters [voltage and current] is put to zero or both of the parameters put to zero. This involves mostly turning on and turning off of a device or a line. The major types are mechanical switching and semiconductor switching. Mechanical switching is the process of turn on and turning off using mechanical devices like SPST and DPST, circuit breakers. Semiconductor switching named because using the semiconductor devices.



FID.2. Switching techniques

SOFT SWITCHING

Soft switching the voltage and currents are to be varied at different times. In turning on of a device, first voltage decreased to zero and then current is increased. In turning off of a device, first current decreased to zero and then voltage is increased.

So in soft switching the power loss can be reduced because there is no presence of voltage and current at the same time during the switching operation.

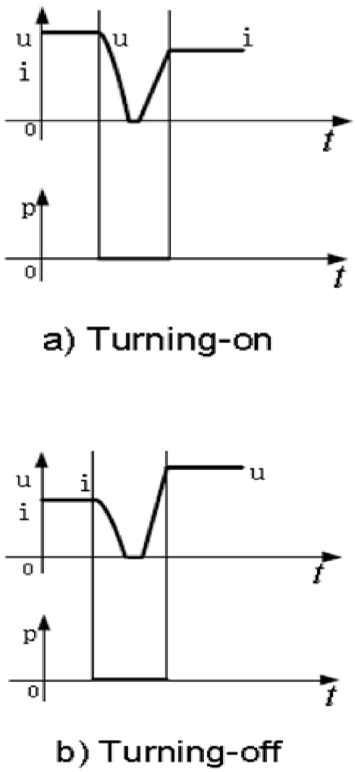


FIG.3. TYPES OF SOFT SWITCHING

ZVS—Zero-voltage switching, Specifically means zero-voltage turn-on, i.e., the voltage across the device is reduced to zero before the current increases.

ZCS—Zero-current switching, Specifically means zero-current turn-off, i.e., the current flowing through the device is reduced to zero before the voltage increases.

Due to the presence of discontinuous current mode across the inductors, we can make use of zero current switching.

Software used:

Simulink is a software package for modeling, simulating, and analyzing dynamical systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams, using click-and-drag mouse operations. Models are hierarchical, so we can build models using both top-down and bottom-up approaches. We can view the system at a high level, then double-click on blocks to go down through the levels to see increasing levels of model detail. This approach provides insight into how a model is organized and how its parts interact. After we define a model, we can simulate it, using a choice of integration methods, either from the Simulink menus or by entering commands in MATLAB's command window. Using scopes and other display blocks, we can see the simulation results while the simulation is running. In addition, we can change parameters and immediately see what happens, for "what if" exploration.

The simulation results can be put in the MATLAB workspace for post processing and visualization. Simulink can be used to explore the behavior of a wide range of real-world dynamic systems, including electrical circuits, shock absorbers, braking systems, and many other electrical, mechanical, and thermodynamic systems.

Simulating a dynamic system is a two-step process with Simulink. First, we create a graphical model of the system to be simulated, using Simulink's model editor. The model depicts the time-dependent mathematical relationships among the system's inputs, states, and outputs. Then, we use Simulink to simulate the behavior of the system over a specified

Applications:

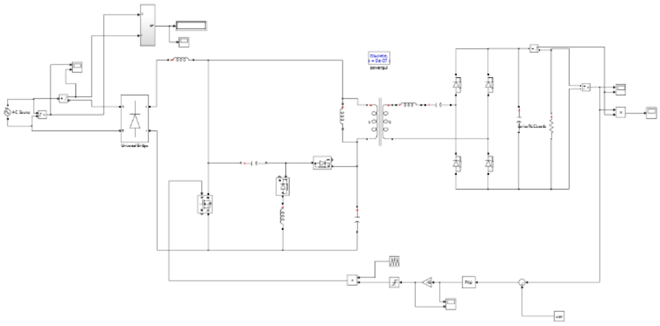
- ☐ These are only suitable for low-power applications because they provide unidirectional core excitation with one switch.
- ☐ PV voltage conditioners

V. SIMULATION RESULTS

The simulation circuit of the proposed system is as shown below, in which a DC signal is converted to an

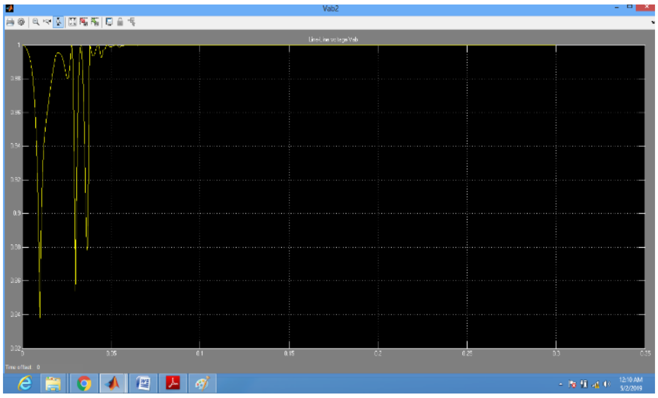
AC signal and applied to the step up transformer, this boosted signal is converted to a DC signal. The respective gate pulse, input and output waveform are as follows.

SIMULINK DESIGN:

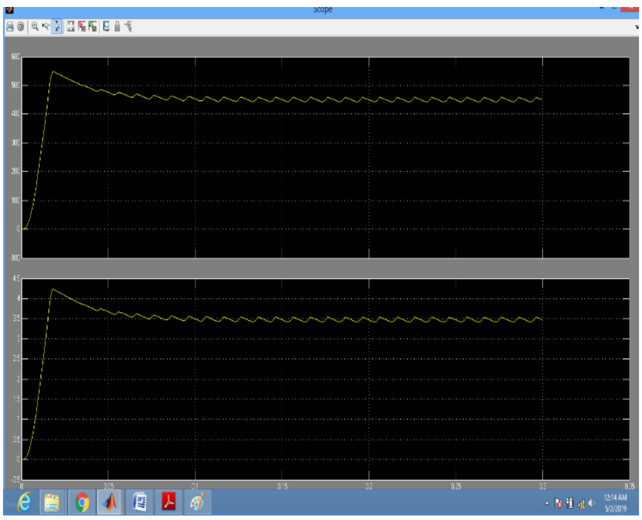


OUTPUT WAVEFORM:

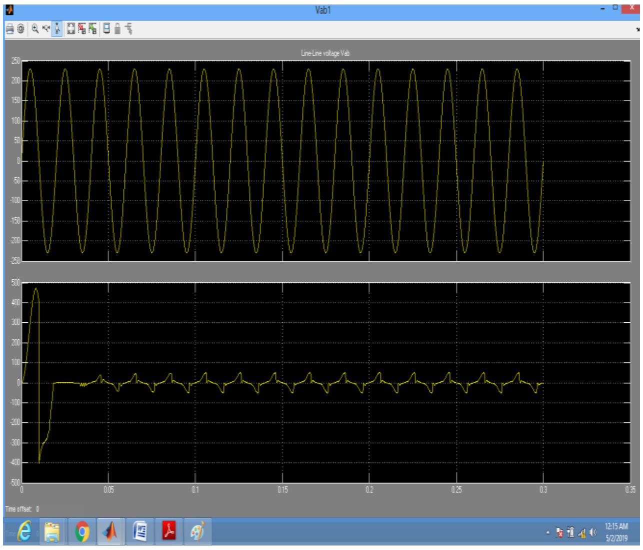
POWER FACTOR WAVEFORM:



OUTPUT VOLTAGE & CURRENT WAVEFORM:



INPUT VOLTAGE & CURRENT WAVEFORM:



VI. CONCLUSION

In this project, a single switch isolated DC-DC boost converter was proposed for step-up application such as portable fuel cell systems, and vehicle inverters. Improved features such as isolated switched characteristics of switch and diode, low rated lossless snubber, and reduced transformer volume makes the proposed converter achieve higher power density compared to the conventional non isolated converter. Experimental results and prototype are provided to validate the proposed concept.

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