Novel High-Conversion-Ratio High Efficiency Isolated Bidirectional DC–DC Converter

Abstract
In addition to improvements in the conversion efficiency of green energy, the storage and reuse of excess energy have become important research topics. Thus, high-step-up/step-down converters have become important research subjects. Converters with high conversion ratios can be used in energy storage systems, high-intensity discharge lamps, high power applications, communication power, solar power, and uninterruptible power supplies. These converters are designed by combining switched-capacitor cells, coupled inductor techniques, and Z source techniques.

The distributed generation system indicates that the bidirectional dc–dc converter plays a very important role between energy storage device (Battery) and voltage bus. The function of the bidirectional converter is to transfer energy between the battery and the dc bus. The energy generated from the renewable source(s) will be transferred to the dc voltage bus. Load(s) may be connected with dc voltage bus and ac utility grid. Battery is used to provide energy to dc voltage bus when the grid voltage outage and renewable energy sources cannot
provide enough energy to the load connected with dc voltage bus.

**Existing system:**

In bidirectional DC-DC converter topology, the energy flow from the low to the high voltage side, the boost converter (L) is controlled and the high side converter (H) is not controlled but operates as a rectifier. To the energy flow into the opposite side the buck converter (H) is controlled and the low side converter (L) operates as a rectifier. The main problem of this solution is the use of the same resonant circuit elements for the both directions of the energy flow. An additional capacitor must be used when the system operates in the buck mode.

**Proposed system:**

The circuit includes high voltage VHV; high-voltage capacitor C1 and dc-blocking capacitor C2; four active switches S1, S2, S3, and S4; a transformer T1; two inductors L1 and L2; a low-voltage capacitor C3; and low voltage VLV. The gate signals of S1 and S2 in the high-step-down stage are interlaced by a phase shift of 180°, and S3 and S4 are synchronous rectifiers. In the high-step-up mode, the gate signals of S3 and S4 are greater than 50% and are controlled by a phase shift of 180°. The gate signals of S1 and S2 are smaller than 50% and
are controlled by a phase shift of 180° with synchronous rectifiers. The function of the proposed bidirectional converter is like the “double voltage step-down” instead of mode. (When $S_1$ is turned on, the voltage on the primary winding is reduced by half because of the capacitor $C_2$. Thus, the voltage gain can be reduced by half by adding $C_2$ in series with the half-bridge converter.) This converter is controlled with duty control on frequency control so that the effect of leakage inductance can be neglected. The proposed cannot achieve zero-voltage switching (ZVS) on the high voltage side power switches but the low voltage side synchronous rectifier can achieve ZVS.

Advantages:
- It meets the safety standards of galvanic isolation.
- The size of the transformer can be reduced.
• The energy in the leakage inductance of the transformer can be recycled.
• It has a high conversion ratio.

**Block diagram:**

[Diagram showing the flow of the circuit with blocks labeled as:
- Filter
- Half bridge converter
- High frequency transformer
- Synchronous rectifier
- OPTO coupler circuit
- 12 V DC
- 5 V DC
- BUFFER circuit
- PIC controller circuit
- Load
- Filter
- INPUT DC supply]
Tools and software used:

- MPLAB – microcontroller programming.
- ORCAD – circuit layout.
- MATLAB/Simulink – Simulation.