International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-9, December 2015
ISSN: 2395-3470
www.ijseas.com

A Resounding Converter Topology for Bidirectional DC-DC Converter

Punit Kumar Chandra[1], Tikeshwar Gajpal[2]
[1] Raipur Institute of Technology, Raipur, India
[2] Raipur Institute of Technology, Raipur, India

Abstract

Another bidirectional DC–DC converter made out of two class-E resounding converters is exhibited in this paper. Bidirectional converters are fundamental sorts of DC-DC converter right now utilized as a part of the business today. Bidirectional DC-DC converter may be segregated or non detached relying upon its application. Bidirectional DC-DC converters are being progressively used to accomplish force exchange between two dc force sources in either bearing without evolving extremity. It diminishes the expense and enhances the framework effectiveness, furthermore enhances the execution of the framework. They are utilized as a part of numerous application, for example, dc un-intruded on force supplies, aviation power frameworks, electric vehicles and battery chargers. The point of this task is to utilize class E full method in bidirectional dc converter. Bidirectional force stream is controlled by transistor control beat recurrence changes, with a steady break between the succeeding heartbeats as in semi thunderous converters. The support or buck mode converter operation relies on upon the common connection between the control beats of the transistor sets which are found corner to corner in the converter scaffold. Because of the zero voltage exchanging of the transistor with high recurrence, this converter topology have essential components like low size, low weight. Simulation of existing converter with full scaffold circuit furthermore, changed half extension circuit is done utilizing MATLAB.

Keywords: *Bidirectional DC-DC converter, Class E resonant converter*

1. Introduction

DC-DC power converters are utilized in an assortment of utilizations, counting force supplies for PCs, office types of gear, rocket power frameworks, smart phones, supplies, power device vehicles, renewable vitality frameworks and so forth. In electric vehicle applications, an assistant vitality stockpiling battery retains the recovered vitality sustained back by the electric machine. Bidirectional dc-dc converter is required to draw power from the assistant battery to support the high-voltage transport amid vehicle beginning, speeding up and slope climbing. With its capacity to switch the bearing of the present stream, and along these lines control, the bidirectional dc-dc converters are as a rule progressively used to accomplish power exchange between two dc force sources in either bearing. The greater part of the current bidirectional dc-dc converters fall into the bland circuit structure outlined in figure1.Based on the situation of the helper vitality stockpiling, the bidirectional DC-DC converter can be sorted into buck and support sort. To understand the twofold sided force stream in bidirectional dc-dc converters, the switch cell ought to convey the current on both headings. It is generally executed with a unidirectional semiconductor force switch, for example, power MOSFET (Metal-Oxide-Semiconductor-Field-Impact Transistor) or IGBT (Protected Door Bipolar Transistor) in parallel with a diode; on the grounds that the two-fold sided current stream force switch is not accessible.

Writing gives numerous arrangements here, the primary of which can be ordered into a few trademark sorts. The primary sort is, named as, a double dynamic extension (Spot) converter [6]. The primary downside of this arrangement is that the converter can't accomplish zero voltage exchanging (ZVS) in an extensive variety of burden varieties while data or yield voltage rises. To take out this issue in control framework, the stage movement was also improved with a beat width adjustment [7], [8]. A three-port dynamic scaffold (TAB) was presented as an augmentation of the Touch topology [9]. Another kind of BDC is described by a present bolstered inverter/rectifier on the low-voltage (LV) side of the transformer and a voltage-nourished inverter/rectifier on the high-voltage (HV) side. The disadvantage of this framework is the high voltage spikes incited by the transformer spillage inductance when the support converter is exchanged transformer spillage inductance can be utilized as a valuable component as a part of the resounding converters. Utilizing high changing frequencies prompts a critical diminishment of size of detached parts. Semiconductor gadgets are presented to high di/dt amid replacements as a result of the vitality put away in their parasitic which expand exchanging misfortunes and electromagnetic impedance and may bring about breakdown of the gadget. Parasitic inductances and capacitances cause critical issues as the recurrence of the circuit is expanded. To address these issues in the configuration of high-recurrence working DC-DC converters topologies that consolidates these parasitic into circuit components are to be utilized. The class-E thunderous inverter topology, addresses these issues which permit its operation in the request of megahertz frequencies with zero-voltage exchanging and zero-voltage incline at turn-on if the exchanging conditions are met. The class-E topology additionally assimilates the power MOSFETs parasitic capacitors into the circuit components and can be actualized with couple of parts. These qualities of class E converter permit accomplishing high power densities, high productivity and it will bring about diminishment in the size and weight of the converter.

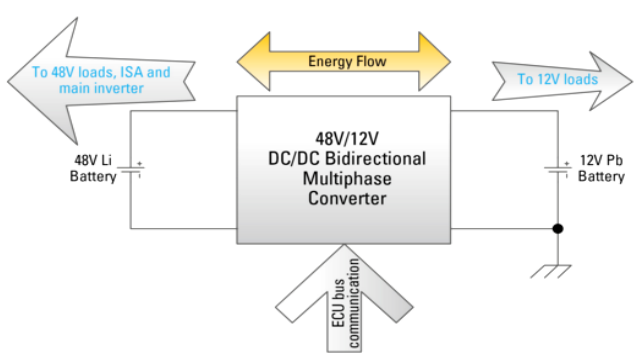

Fig. 1 Illustration of Bidirectional Power Flow

Since class-E inverter can operate at very high frequencies, it can be used in designing resonant dc-dc converters.

2. Class E Inverter

A Class E inverter is an understood resounding converter that can work at frequencies from several kHz to many MHz and force levels from watts to kilowatts with high effectiveness. Its fundamental circuit is appeared in Fig. 2. It comprises of a gag inductor L1, a shunt capacitor C1, an arrangement thunderous circuit C1, L1, a heap resistor R, and a transistor Tr. The shunt capacitance C1 incorporates the yield transistor capacitance. The transistor Tr is typically exchanged intermittently at a obligation cycle of 0.5. The best possible decision of circuit parameters ensures the transistor Tr is exchanged on for ZVS (zero-voltage exchanging) and ZdVS (zero-voltage slant exchanging) conditions that decide the ideal operation of Class E inverter.

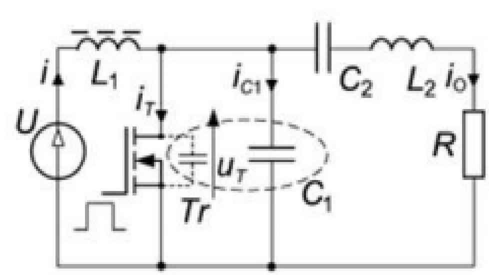

Fig. 2 Class E inverter

A Class E inverter is a surely understood thunderous converter that can work at frequencies from many kHz to several MHz and force levels from watts to kilowatts with high proficiency. Its fundamental circuit is appeared in Fig. 2. It comprises of a gag inductor L1, a shunt capacitor C1, an arrangement resounding circuit C1, L1, a heap resistor R, and a transistor Tr. The shunt capacitance C1 incorporates the yield transistor capacitance. The transistor Tr is generally exchanged occasionally at a obligation cycle of 0.5. The best possible decision of circuit parameters ensures the transistor Tr is exchanged on for ZVS (zero-voltage exchanging) and ZdVS (zero-voltage slant exchanging) conditions that decide the ideal operation of Class E inverter. The voltage and current waveforms of Fig.3.are standardized to the dc supply voltage U and the normal worth I of the supply current i, separately, and the time hub is standardized to the exchanging period T. Amid the off interim of the transistor, the present iT stays at zero while the voltage uT increments to a greatest of 3.6 times the dc voltage U. Toward the end of the off interim, when the voltage uT has diminished to zero, the transistor is exchanged on and the present iT increments toward a most extreme of 2.9 times the dc current I. Toward the end of the on-interim, the transistor is exchanged off and the present iT drops to zero preceding the voltage uT starts to rise. Amid exchanging moves, both transistor voltage and current have zero hybrid qualities and, as an outcome, the main force misfortunes remaining are the conduction misfortunes. Efficiencies of Class E inverters can essentially surpass 90 rate. Expanded proficiency means lower data power, as well as less warmth scattering in the transistor.

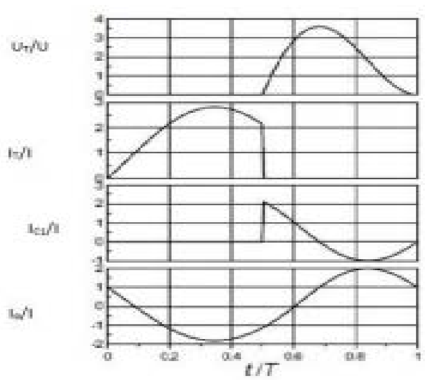

Fig. 3 Class E inverter waveform

3. Class E Resonant Bridge Bidirectional Converter

The class-E resounding extension BDC is appeared in Fig. 4. It comprises of two scaffold inverters sustained by current sources because of the information inductances LFL and. LFH. Inverter yields are associated by a transformer, which is portrayed by auxiliary to-essential turns proportion kT. Amid the force exchange from the LV source VL to the HV source VH, an extra capacitor Cadd is presented by shutting the key k. The LV converter transistors are controlled and the converter works as a class-E support converter while the HV converter transistors are not controlled and the converter works as a class-E rectifier made out of transistor body diodes. The thunderous circuit [(Cadd + 2CH)Lr] is shaped by the inductance Lr , capacitance Cadd (switch k is shut), and capacitances CH which are put parallel to the diode. Amid force stream the other way, from the (VH) source to the (VL) source, the HV converter transistors are controlled and the converter works as a class-E buck converter, while the LV converter transistors are not controlled and the converter works as a class-E rectifier made out of transistor body diodes. The switch k is opened, and the full circuit is shaped by the capacitances CL and the inductance Lr .To guarantee ZVS in a class-E resounding converter, it must be controlled by recurrence change, keeping a consistent break between the succeeding control beats of the transistor, as it is the situation with semi thunderous converters. The LV-help and HV buck mode operation is portrayed by a cover or a break of the control beat of the transistor sets which are found corner to corner in the scaffold. A. Help and Buck operation[2] This converter framework is without parasitic motions as all the parasitic capacitances and inductances are incorporated into the resounding tank circuit. The trademark highlight of full converters is that the transformer parasites don't bother the circuit, in light of the fact that they are utilized as thunderous circuit components. In a present bolstered full scaffold help converter sort the covering conduction time of the four converter switches is kept consistent and the yield voltage is directed by differing the exchanging recurrence. The conduction time is especially figured to guarantee ZVS operation under a wide load range. MOSFETs and body diodes are utilized as the converter switches without the requirement for any extra diodes in arrangement. The converter transistor turn-off time is steady and is equivalent to the season of the parallel associated capacitor cheat. Amid the ZCS switch off time, the L-C tank circuit resounds. This navigates the voltage over the change from zero to its crest, and withdraw again to zero. Right now the switch can be reactivated, and lossless zero voltage exchanging is encouraged. Hence the switch move misfortunes go to zero paying little heed to working recurrence and information voltage. This could bring about noteworthy reserve funds in force and change in productivity. This component of the converter makes it suitable for high recurrence and high voltage converter outline.

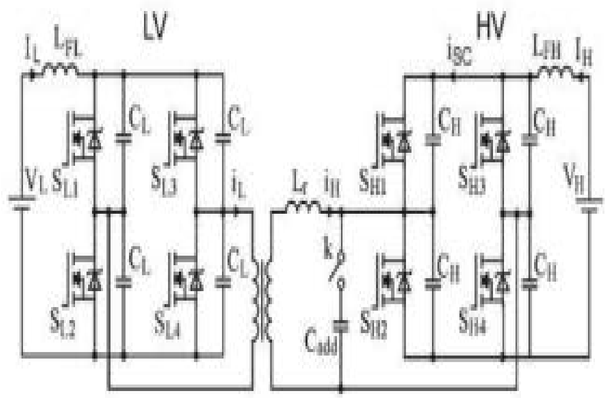

Fig. 4 Class-E resonant bridge Bidirectional converter

4. Conclusion

In this task work class E thunderous converter procedure is utilized as a part of bidirectional dc converter .This resounding method is utilized as a part of full scaffold and in addition half extension converter. The ZVS transistor exchanging procedure is apparent on the grounds that the transistor's present and voltage waveforms don't overlap. The transistor current wave structure has positive and negative esteem so the inside transistor body diodes take an interest in the present stream. Since the transistor current and voltage waveforms don't cover, the ZVS conditions are satisfied. So the class E thunderous bidirectional DC-DC converter is without the transistors exchanging force dissemination inside of the entire operation range, thusly it is checked by high effectiveness. The vital components of this converter topology are, low size, low weight and high motion in light of the transistors ZVS exchanging procedure with high recurrence. The converters utilized in the framework are present sourced. Subsequently, the association parasitic inductance are of no significance and framework is eco inviting. By utilizing class E resounding Innovation as a part of full extension converter circuit andhalf span converter circuit with same recurrence operation, same results are acquired. The half extension converter require just four switches however full scaffold converter require eight switches.

References

[1] Stanislaw Jalbrzykowski, Antoni Bogdan, and Tadeusz Citko, "A dual full-bridge resonant class E bidirectional dcdc converter", IEEE Transactions on Industrial Electronics , Vol. 58, No. 9, 2011.

[2] S. Jabrzykowski and T. Citko, "Transactions current-fed resonant fullbridge boost DC/AC/DC converter", IEEE Transactions on Industrial Electronics, Vol. 55, No. 3, 2008, pp. 1198-1205.

[3] B. Ray, "Bidirectional DCDC power conversion using quasiresonant topology", IEEE Transactions on Power Electronics, 1992, pp. 617-624.

[4] J. Marcos Alonso, Marina S. Perdigao, David Gacio Vaquero, "Analysis, Design, and Experimentation on Constant Frequency DC-DC Resonant Converters With Magnetic Control", IEEE Transactions on Power Electronics, Vol. 27, No. 3, 2012.

[5] G. Ma, W. Qu, G. Yu, Y. Liu, N. Liang, and W Li, "A zero voltage switching bidirectional dcdc converter with state analysis and soft switching-oriented design consideration", IEEE Transactions on Industrial Electronics, Vol. 56, No. 6, pp. 2174-2184, 2009.

[6] Mustansir H. Kheraluwala, Randal W. Gascoigne, Deepakraj M. Divan, "Performance Characterization of a High-Power Dual Active Bridge dc-to-dc Converter", IEEE Transactions on Industrial Electronics, Vol. 28,No. 6, 1992.

[7] D. Xu, C. Zhao, and H. Fan, "A PWM plus phase-shift control bidirectional dc–dc converter", IEEE Transactions on Industrial Electronics, Vol. 19, No. 3, pp. 666–675, 2004.

[8] G. Ma, W. Qu, G. Yu, Y. Liu, N. Liang, and W. Li, "A zero voltage switching bidirectional dc–dc converter with state analysis and soft switching oriented design consideration", IEEE Transactions on Industrial Electronics, Vol. 56, No. 6, pp. 2174–2184, 2009.

[9] H. Tao, J. L Duarte, and A. M. Hendrix, "Three-port triple half-bridge bidirectional converter with zero-voltage switching", IEEE Transactions on

Industrial Electronics, Vol. 23, No. 2, pp. 782–792, 2008.

[10] F. Zhang and Y. Yan, “Novel forward-back hybrid bidirectional DCDC converter”, IEEE Transactions on Industrial Electronics, Vol. 56, No. 5, pp. 1578-1584, 2009.

[11] S. Jabrzykowski and T. Citko, “Bridge configuration of class E converters”, IEEE Transactions on Industrial Electronics, Vol. 52, No. 2, pp. 221-237, 2003.

[12] M. K. Kazimierczuk, “Analysis and design of class-E dc/dc converter”, IEEE Transactions on Industrial Electronics, Vol. 37, No. 2, pp.173-183, 1990.

[13] G. Hua and F. C. Lee, “Soft-switching techniques in PWM converters”, IEEE Transactions on Industrial Electronics, Vol. 42, No. 6, pp. 595-603, 1995.

[14] A. K. S. Bhat and M. H. Swamy, “Loss calculations in transistorized parallel resonant converters operating above resonance”, IEEE Transactions on Industrial Electronics, Vol. 4, No. 4, pp. 391-400, 1989.

Mr. Punit Kumar Chandra is M.Tech scholar in Raipur Institute of Technology, Raipur, India. His current area of specialization is Power Electronics. He has completed his Bachelors degree from Chhattisgarh Swami Vivekanand Technical University, Raipur, India in 2012 from Electronics and Telecommunication branch of Engineering.

Mr. Tikeshwar Gajpal received his M.Tech degree from Chhattisgarh Swami Vivekanand Technical University, Raipur, India in 2013. His area of interest is Digital Electronics. Currently he is a professor in Electronics and Telecommunication Department in Raipur Institute of Technology, Raipur, India.