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Development of full-Bridge Cascade Dual-Buck Electrical inverter With Phase Shift management And PWM

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Abstract

Cascade H-bridge inverter has been widely used in various applications, especially where separate DC sources naturally exist in the places, such as Photovoltaic, fuel cells, battery energy storage, and electric vehicle drives. The proposed cascade dual buck inverter with phase-shift MANAGEMENT inherits all the merits of dual buck type inverters and overcomes some of their drawbacks. Compare to traditional cascade inverters, it has much enhanced system reliability thanks to no shoot-through problems and lower switching loss with the help of using power MOSFETs.With phase-shift MANAGEMENT, it theoretically eliminates the inherent current zero-crossing distortion of the single-unit dual buck type inverter. In addition, phase-shift MANAGEMENT and cascade topology can greatly reduce the ripple current or cut down the size of passive components by increasing the equivalent switching frequency.

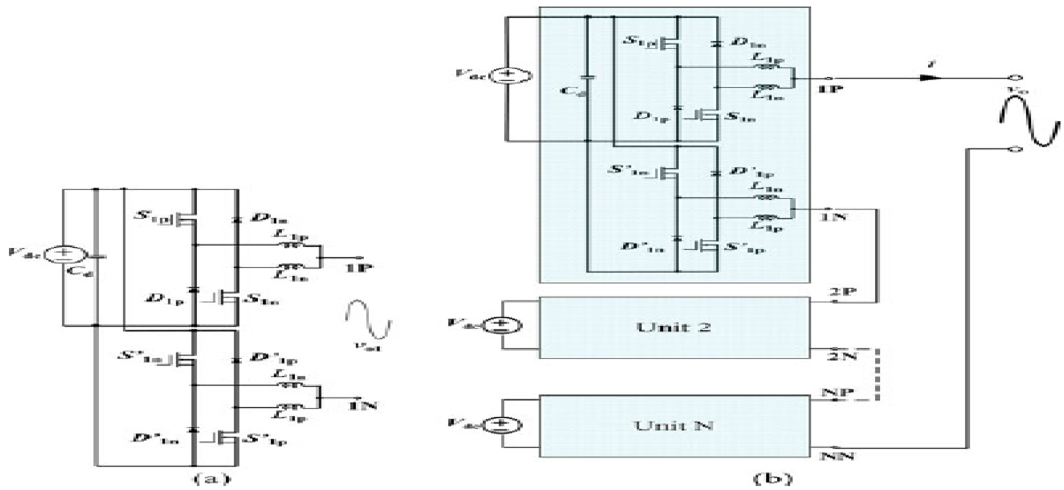
Keywords: Cascade, Inverter, Full Bridge, Phase Shift

Introduction

Numerous industrial applications have begun to require higher power apparatus recent years. Some medium voltage motor drives and utility applications require medium voltage and megawatt power level. For a medium voltage grid, it is troublesome to connect only one power semiconductor switch directly. As a result, a multilevel power converter structure has been introduced as an alternative in high power and medium voltage situations. A multilevel converter not only achieves high power ratings, but also enables the use of renewable energy sources. Renewable energy sources such as photovoltaic, wind, and fuel cells can be easily interfaced to a multilevel converter system for a high power application.

The concept of multilevel converters has been introduced since 1975. The term multilevel began with the three-level converter . Subsequently, several multilevelconverter topologies have been developed . However, the elementary concept of a multilevel converter to achieve higher power is to use a series of power semiconductor switches with several lower voltage dc sources to perform the power conversion by synthesizing a staircase voltage waveform. Capacitors, batteries, and renewable energy voltage sources can be used as the multiple dc voltage sources. The commutation of the power switches aggregate these multiple dc sources in order to achieve high voltage at the output; however, the rated voltage of the power semiconductor switches depends only upon the rating of the dc voltage sources to which they are connected.

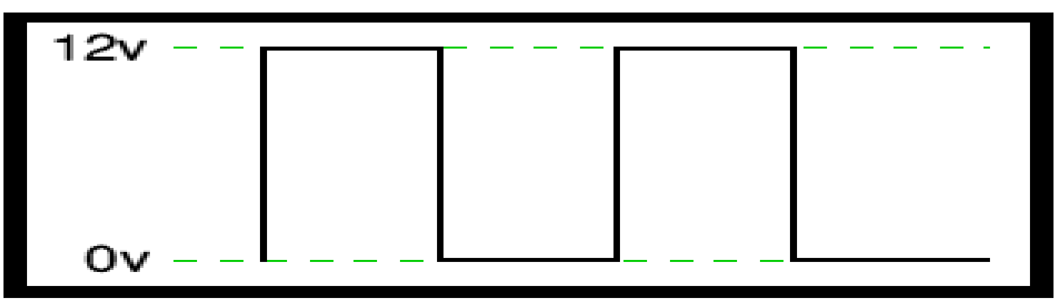
Circuit Diagram



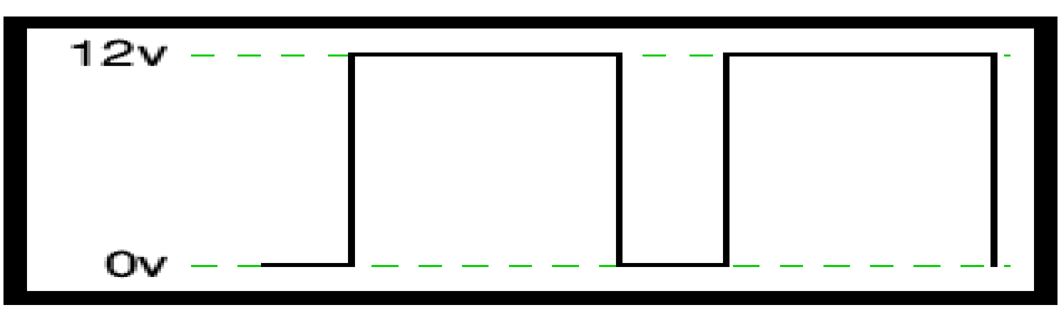
Single-unit dual buck full-bridge inverter serving as one cell for cascade dual buck full-bridge inverter. (a) Single-unit dual buck full-bridge inverter.(b) Cascade dual buck full-bridge inverter.

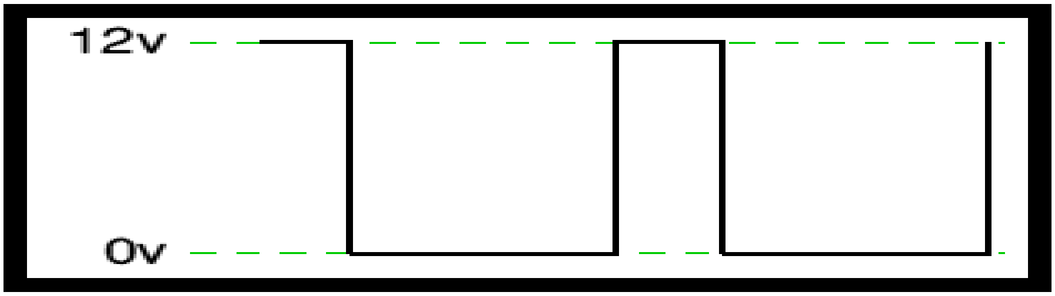
Pulse Width Modulation (PWM)

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by switching the solar system management power devices. When in PWM regulation, the current from the solar array tapers according to the battery's condition and recharging needs Consider a waveform such as this: it is a voltage switching between 0v and 12v. It is fairly obvious that, since the voltage is at 12v for exactly as long as it is at 0v, then a 'suitable device' connected to its output will see the average voltage and think it is being fed 6v - exactly half of 12v. So by varying the width of the positive pulse - we can vary the 'average' voltage.



Similarly, if the switches keep the voltage at 12 for 3 times as long as at 0v, the average will be 3/4 of 12v - or 9v, as shown below and if the output pulse of 12v lasts only 25% of the overall time, then the average is





By varying - or 'modulating' - the time that the output is at 12v (i.e. the width of the positive pulse) we can alter the average voltage. So we are doing 'pulse width modulation'. I said earlier that the output had to feed 'a suitable device'. A radio would not work from this: the radio would see 12v then 0v, and would probably not work properly. However a device such as a motor will respond to the average, so PWM is a natural for motor management.

Phase-Shift Management Analysis

One of the significant characteristics of a single-unit dual buck type inverter is that the switch is selectively working based on the direction of output current. From the operation modes of single-unit half-bridge dual buck inverter in Fig. 2, we can clearly see that when *i*1 is positive, *S*1p and*D*1p are the working pair, and when *i*1 is negative, *S*1n and *D*1n are the working pair. However, this distinctive operation leads to its inherent drawback, current zero-crossing distortion, which will be explained in detail below. This issue can be passively mitigated by turning on both *S*1p and *S*1n near zero-crossing period. However, this remedy is against the operating principle and the best feature of the dual buck type inverter, which is high reliability by avoiding turning on both active switches at the same time. In addition, this passive measure results in higher switching losses because at zero-crossing period two switches are switching while the original goal of dual buck inverter is to have only one switch operating at any given time.

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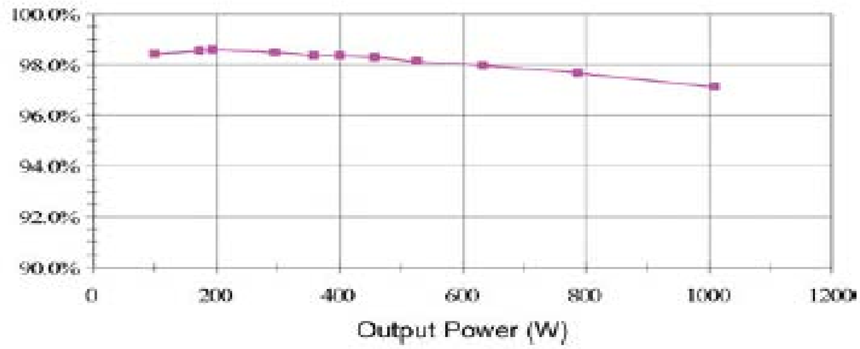
Thankfully, cascade topology solves the issue of zero crossing distortion by using phase-shift management scheme. With phase shifted PWM fed to different cascade units, current zero crossing distortion is theoretically eliminated. In addition, the phase-shift management greatly increases the equivalent switching frequency by *N* times that of single-unit inverter, which leads to significantly lower current ripple or smaller passive filter components.

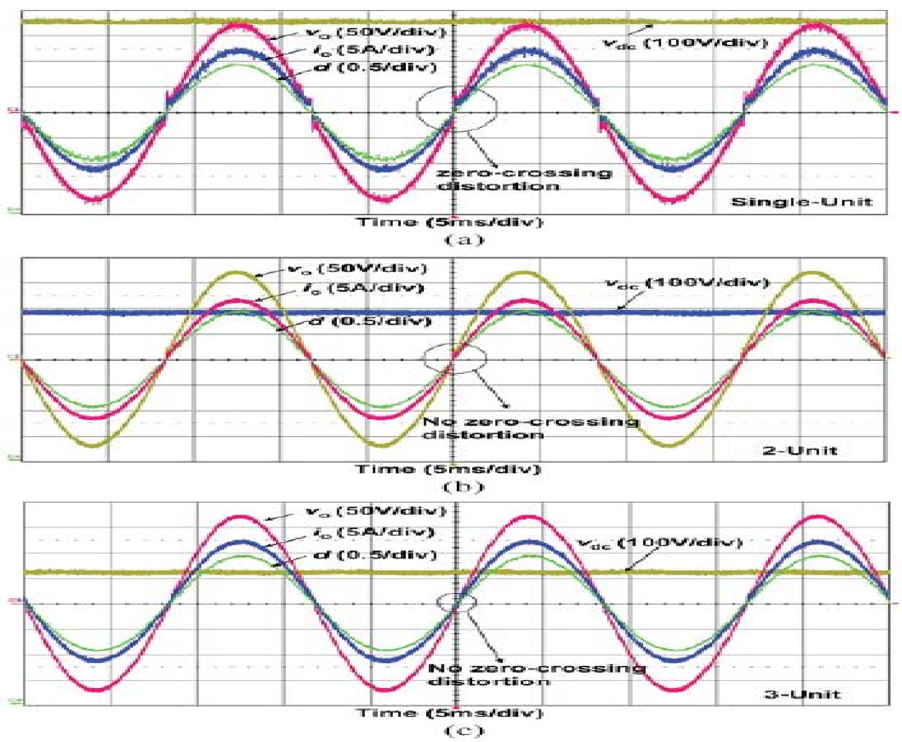
Results

To prove the viability and merits of the proposed cascade dual buck inverter with phase-shift management, a 1 kW, 120 V ac output cascade dual buck half-bridge inverter system in standalone operation was designed and tested. The system structure of the experiment is the same as in Fig.1, and the management scheme applied is shown in Figs. 13 and 15.

The system managementler and PWM generation are conducted by TI floating point DSP TMS320F28335. The switching frequency of the devices is set to be 20 kHz. Because the cascade dual buck inverter adopts phase-shifted PWM management, the equivalent switching frequency of the inverter is 40 kHz for 2-unit and 60 kHz for 3-unit cascade inverters, respectively. The MOSFET is selected as STY80NM60 N with on-resistance 35 mΩ, and the diode is

RURG3060 with reverse recovery time 55 ns. The passive components are selected as follows: *Lj p* = *Lj n* = 250 μH, *Lf* = 1 mH, *Cf* = 2.4 μF, and *Cd* = 1.2 mF. The system has the ability of serving as single-unit, 2-unit, and 3-unit systems. For comparison, tests were conducted with single-unit, 2-unit, as well as 3-unit systems. All the output power of three tests is 1 kW, and output ac voltage is 120 V RMS. For single-unit system, *V*dc is 360 V, and for 2-unit cascade system, *V*dc is 180 V, and for 3-unit cascade system, *V*dc is 120 V.





Output current *io* , ac and dc voltage waveforms for single-unit, 2-unit cascade, and 3-unit cascade inverter system at 1 kW. (a) Single-unit inverter. (b) 2-unit cascade inverter. (c) 3-unit cascade inverter.

Conclusion

A new series of cascade dual buck inverters has been proposed based on single-unit dual buck inverters. The cascade dual buck inverter has all the merits of traditional cascade inverters, and improves on its reliability by eliminating shoot-through worries and dead-time concerns. With the adoption of phase-shift management, the cascade dual buck inverter solves the inherent current zero-crossing distortion problem of single-unit dual buck inverter.

References

[1] J. S. Lai and F. Peng, “Multilevel converters—A new breed of power converter,” IEEE Trans. Ind. Electron., vol. 32, no. 3, pp. 509–517, May/Jun. 1996.

[2] J. Rodriguez, J. S. Lai, and F. Peng, “Multilevel inverters: A survey of topologies, MANAGEMENTs, and applications,” IEEE Trans. Ind. Electron., vol. 49, no. 4, pp. 724–738, Aug. 2002.

[3] M. Malinowski, K. Gopakumar, J. Rodriguez, and M. A. P´erez, “A survey on cascaded multilevel inverters,” IEEE Trans. Ind. Electron., vol. 57, no. 7, pp. 2196–2206, Jul. 2010.

[4] L. G. Franquelo, J. Rodriguez, J. I. Leon, S. Kouro, R. Portillo, and M. A. M. Prats, “The age of multilevel converters arrives,” IEEE Ind. Electron.Mag., vol. 2, no. 2, pp. 28–39, Jun. 2008.

[5] F. Z. Peng and J. S. Lai, “A multilevel voltage-source inverter with separate dc sources for static VAR generation,” in Proc. Conf. Rec. IEEE-IAS Annu.Meeting, Lake Buena Vista, FL, Oct. 8–12, 1995, pp. 2541–2548.

[6] F. Z. Peng and J. S. Lai, “Dynamic performance and MANAGEMENT of a static VAR compensator using cascade multilevel inverters,” in Proc. Conf. Rec.IEEE-IAS Annu. Meeting, San Diego, CA, Oct. 6–10, 1996, pp. 1009–1015.

[7] F. Z. Peng, J.W.Mc Keever, and D. J. Adams, “Cascade multilevel inverters for utility applications,” in Proc. Conf. Rec. IEEE-IECON Annu. Meeting, New Orleans, LA, Nov. 9–14, 1997, pp. 437–442.

[8] M. Hagiwara, K. Nishimura, and H. Akagis, “A medium-voltage motor drive with a modular multilevel PWM inverter,” IEEE Trans. PowerElectron., vol. 25, no. 7, pp. 1786–1799, Jul. 2010.

[9] R. Teodorescu, F. Blaabjerg, J. Pederson, E. Cengelci, and P. Enjeti, “Multilevel inverter by cascading industrial VSI,” IEEE Trans. Ind. Electron., vol. 49, no. 4, pp. 832–838, Aug. 2002.

[10] P. Lezana and G. Ortiz, “Extended operation of cascade multi-cell converters under fault condition,” IEEE Trans. Ind. Electron., vol. 56, no. 7, pp. 2697–2703, Jul. 2009.

[11] H. Ertl, J.W. Kolar, and F. C. Zach, “A novel multi-cell dc–ac converter for applications in renewable energy systems,” IEEE Trans. Ind. Electron., vol. 49, no. 5, pp. 1048–1057, Oct. 2002.

[12] O. Alonso, P. Sanchis, E. Gubia, and L. Marroyo, “Cascaded H-bridge multilevel converter for grid connected photovoltaic generators with independent maximum power point tracking of each solar array,” in Proc.34th IEEE Power Electron. Spec. Conf., 2003, vol. 2, pp. 731–735.

[13] E. Villanueva, P. Correa, J. Rodriguez, and M. Pacas, “MANAGEMENT of a single phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic systems,” IEEE Trans. Ind. Electron., vol. 56, no. 11, pp. 4399–4406, Nov. 2009.

[14] F. S. Kang, S. J. Park, S. E. Cho, C. U. Kim, and T. Ise, “Multilevel PWM inverters suitable for the use of stand-alone photovoltaic power grid-connected inverters for photovoltaic modules,” IEEE Trans. EnergyConvers., vol. 20, no. 4, pp. 906–915, Dec. 2005.

[15] L. M. Tolbert, F. Z. Peng, and T. G. Habetler, “Multilevel converters for large electric drives,” IEEE Trans. Ind. Appl., vol. 35, no. 1, pp. 36–44, Jan./Feb. 1999.

[16] L. M. Tolbert, F. Z. Peng, T. Cunnyngham, and J. N. Chiasson, "Charge balance MANAGEMENT schemes for cascade multilevel converter in hybrid electric vehicles," IEEE Trans. Ind. Electron., vol. 49, no. 5, pp. 1058–1064, Oct. 2002.

[17] L. Maharjan, T. Yamagishi, H. Akagi, and J. Asakura, "Fault-tolerant operation of a battery-energy-storage system based on a multilevel cascade PWM converter with star configuration," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2386–2396, Sep. 2010.

[18] L. Maharjan, S. Inoue, H. Akagi, and J. Asakura, "A transformer less battery energy storage system based on a multilevel cascade PWM converter," in Proc. IEEE Power Electron. Spec. Conf., 2008, pp. 4798–4804.

[19] Q. Song and W. H. Liu, "MANAGEMENT of a cascade STACOM with star configuration under unbalanced conditi ons," IEEE Trans. Power Electron., vol. 24, no. 1, pp. 45–58, Jan. 2009.

[20] L. Maharjan, S. Inoue, H. Akagi, and J. Asakura, "State-of-Charge (SOC)-balancing MANAGEMENT of a battery energy storage system based on a cascade PWM converter," IEEE Trans. Power Electron., vol. 24, no. 6, pp. 1628– 1636, Jun. 2009.