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Summary of our technologies

1. Active Diode

This is a type of synchronous rectifier mainly for converters with low voltage and high current output. Unlike generic synchronous rectifier which is a circuit design, the Active Diode is a separate module which can be used as a diode with very low loss. The Active Diode also solves the problems of sensitivity to transformer leakage inductance, input line voltage, parallel connection of power converters. Many converters have been built including a 200A 1.5V converter without fan cooling.

References

a. US patent on " Current driven synchronous rectifier with energy recovery" patent number 6,134,131
b. N.K. Poon, C.P. Liu, M.H. Pong, US patent on “Current driven synchronous rectifier with energy recovery using hysterisis driver”, patent number 6,597,587, 22 July 2003.
c. Xuefei Xie, C.P. Liu, Franki Ngai Kit Poon, Man Hay Pong “The Active Diode - Current-Driven Synchronous Rectifier” Invited paper at the China Beijing International Power Technology Forum, 13 May 2002, Beijing, China.
d. Xuefei Xie, Joe Chui Pong Liu, Franki Ngai Kit Poon, M. H. Pong "A Novel High Frequency Current-Driven Synchronous Rectifier Applicable To Most Switching Topologies", IEEE Transactions on Power Electronics, September 2001.
e. “Current Driven Synchronous Rectifier With Energy Recovery using Hysteresis Driver” Taiwan Patent no. 230497 , 1 April 2005 .

2. VRM converter using stepping inductor

Fast transient VRM is a critical component for microprocessors. Multiphase interleaved converters is the generic method used in most VRMs. A new VRM is introduced which uses a single phase buck converter only. This drastically cut down the number of power components required. The controller IC is greatly simplified because there is only one phase to drive and this eliminates issues like current sharing among multiple phases. The principle of operation is to make the output inductor of a buck converter to become a coupled inductor, and the effective inductance can be drastically cut down when there is a transient change in the load current. This new VRM converter using stepping inductor can cut down the cost of a VRM significantly.

References

a. N.K. Poon, Joe C.P. Liu, M.H. Pong "A Low Cost DC-DC Stepping Inductance Voltage Regulator with Fast Transient Response" APEC Proceedings, March 2001.
b. US patent on "Stepping Inductor for fast transient response of switching converter " patent number 6,188,209
c. Franki N.K. Poon, M.H. Pong, Joe C.P. Liu, US patent on “Stepping Inductor for fast Transient Response of Switching Converter” patent number 6,815,937 B2 9 Nov 2004.

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d. "Stepping inductor for fast transient response of switching converter" China Patent No. 01800175.0, 16 Mar 2005.

3. EMI reduction using cancellation technique

Electromagnetic Interference (EMI) has always been a time consuming process in the design of a switching power supply. Passive filter with capacitors and inductors are often used to reduce EMI emission. The increasing demand for small size and low cost power supplies make it more and more difficult to accommodate the EMI components. A new cancellation technique is introduced which can drastically cut down the EMI filter required in terms of component count and board space. No expensive component is required in the new cancellation technique and product competitiveness is not sacrificed.

References

a. US patent on "Noise Canceling Apparatus for a Power Converter" patent number 6,347,045
b. US patent on "Apparatus for Noise Current Reduction in Power Converters" patent number 6,490,181
c. N.K. Poon, J.C.P. Liu, C.K. Tse, M.H.Pong, "Techniques for Input Ripple Current Cancellation : Classification and Implementation", IEEE Trans on Power Electronics, Vol. 15, No.6, November 2000, pp.1144-1152.
d. N.K. Poon, M.H. Pong, C.P.Liu, C.K. Tse, "Essential-Coupling-Path Models for Non-Contact EMI in Switching Power Converters Using Lumped Circuit Elements" IEEE Trans. on Power Electronics, March 2003.
e. C.P. Liu, N.K. Poon, M.H. Pong, US patent on "Apparatus for Noise Current Reduction in Power Converters" patent number 6,879,500 B2 , 12 Apr 2005.

4. Zero ripple converter

Zero output ripple converter is always desirable for converters with DC output. It can eliminate electrolytic capacitor which is probably the most unreliable component in a power supply. A new converter using overlapping technique is introduced. It makes use of two converters with overlapping waveform at the output. This eliminates the square wave presented to the output and drastically cut down the ripple. Electrolytic capacitor can be eliminated.

References

a. US patent on "Method and System for Providing a DC voltage with Low Ripple by Overlaying a Plurality of AC Signals", patent number 6,697,266 B2.
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5. Asymmetric converter

Soft switching is a popular and useful technique to reduce switching loss especially when the voltage swing across semiconductor switches is high. This is often the case for off-line converters where the primary switches are subject to several hundred volts. Asymmetric switching converter is quite promising in the sense that a simple half bridge configuration is employed without extra soft switching circuitries. Families of this type of converters are introduced. Also, asymmetric converter is very difficult to control because of its complicated transfer characteristics. A new technique is introduced to stabilize the converter without complicated design.

References

a. US patent on "Double Modulation Converter" patent number 5,633,791
b. US patent on "Family of Zero Voltage Switching DC to DC Converters " patent number 5,748,457.
c. US patent on "Family of Zero Voltage Switching DC to DC Converters with Coupled Output Inductor" patent number 5,774,346.
d. US patent on “Apparatus for Improving Stability and Dynamic Response of Half-Bridge Converter” patent number 6,396,716

6. Capacitor coupled converter

Some converters such as battery chargers require converters with controlled output power without the need for feedback circuit for safe and reliable operation. A new converter with multiple features is introduced. It has automatic output power control without feedback circuit, it has soft switching and it has automatic power factor correction. It is ideal for high power battery chargers. The principle of operation is to place a capacitor in series with the primary side of a converter. The capacitor is charged and discharge in every switching cycle. Packets of energy are delivered to the load controlled by the switching frequency. Open circuit or short circuit at the load will inhibit the capacitor charging process and output power is cut down immediately.

References

a. US patent on " Capacitor Coupled Converter " patent number 5,657,212
b. M.H.Pong, W.C. Ho, N.K. Poon , "A Soft Switching Converter with Power Limiting Feature” IEE Proceedings - Electric Power Applications, January 1999, Vol.146, No.1, p.95-p.102.
c. N.K. Poon, B.M.H. Pong, C.K.Tse “A Constant-Power Battery Charger with Inherent Soft Switching and Power Factor Correction”, IEEE Transaction on Power Electronics, Nov 2003, Vol 18, No. 6 pp.1262-1269.

7. Power Factor Correction Circuit

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Power Factor Correction is an important requirement for AC/DC converters. Many researchers have been working on integration of the PFC front end and the DCDC converter with a hope to reduce component count and reduce cost. However, integration of the converters does not always cut cost because the burden of two converters is placed upon a few semiconductor switches. High performance and expensive devices are needed and this is contradicts the primary purpose. A new PFC converter is introduced. It makes use of resonant link circuits to provide soft switching to all major switching devices and allow low cost components to be used while maintaining high efficiency.

References

a. N.K. Poon, C.P. Liu, M.H. Pong "A ZVS approach for AC/DC converter with PFC" " paper presented at the APEC conference in Feb 2003, Miami, USA
b. US patent on "High Efficiency AC-DC Converter with Power Factor Corrector", patent number 6,580,259
c. Joe C.P. Liu, N.K. Poon, M.H. Pong, US patent on "A High Efficiency AC-DC Converter With Power Factor Corrector" patent number 6,812,679, 2 Nov 2004.
d. "A high efficiency AC-DC converter with power factor corrector" Hong Kong patent no. 1060448A, 6 Aug 2004.

8. High Frequency Ballast

High frequency ballast is becoming popular nowadays but the ballast circuit topology being used has been there for a long time with minor incremental improvements only. One of the drawbacks is reliability. The conventional circuit itself has no protection against variation in lamp characteristics. External monitoring circuits are used to shut down the converter in case of abnormal lamp behavior which is often too slow for protection of the converter. Here a new circuit topology is developed which provide automatic power limitation. In fact this is an extension of the Capacitor Coupled Converter mentioned earlier. The circuit topology itself automatically limits the output power through charging and discharging of a pair of capacitors. It needs no external monitors and presents reliable operation to both converter and the lamp. Dimmable ballast can also be realized by this technology.

References

a. N.K. Poon, M.H. Pong, C.P. Liu US patent on "Dimmable Ballast with Resistive Input and Low Electromagnetic Interference" patent number 7,122,972 B2, 17 Oct 2006.

9. LED lamp converter

LED lamps are emerging as a highly reliable and colorful light source. LEDs nowadays are able to produce the three primary colors which give numerous combinations of colors. The conventional way to produce a mix of colors is to use three separate power supplies and control the three primary colors separately. Here a converter circuit topology is developed whereby the three sets of primary color LEDs are produced by a single converter. This cuts down the number of converters needed from three to one. It also provides integrated control.

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a. M.H. Pong, N.K. Poon, C.P. Liu “High efficiency driver for color light emitting diodes (LED)” US Patent no. 7178971, 20 Feb 2007.

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Application of the technologies to product platforms

Product Platforms / Technologies	AC/DC Converter	DC/DC Converter	Power converters for automobiles	Integrated Circuits	Lamp Ballast	LED Lamps	Battery Chargers	Inverters
1. Active Diode	√	√	√	√			√	
2. VRM converter using stepping inductor		√						
3. EMI reduction using cancellation technique	√	√	√	√	√	√	√	√
4. Zero ripple converter	√	√	√	√				
5. Asymmetric converter	√		√	√				
6. Capacitor coupled converter	√			√	√		√	
7. Power Factor Correction Circuit	√			√			√	√
8. High Frequency Ballast					√			
9. LED lamp converter				√		√		

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