

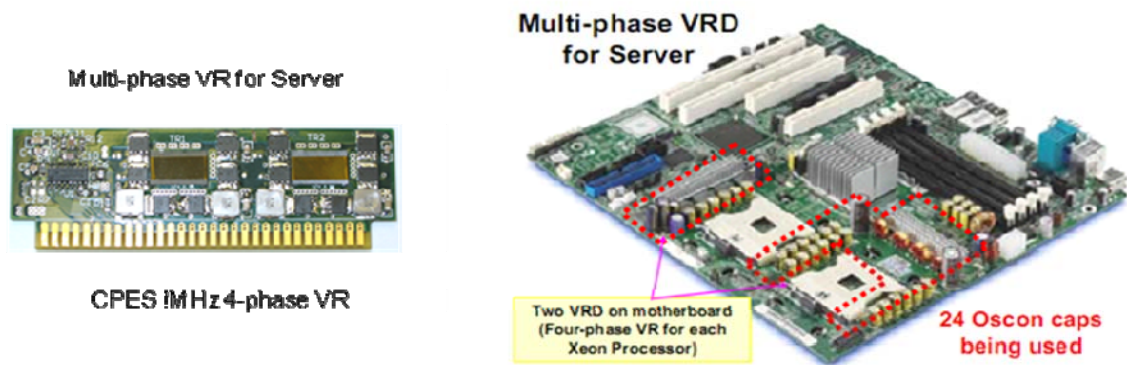
An ERC's Multiphase Voltage Regulator Module Revolutionized Microprocessor Power Management

Intel microprocessors operate at very low voltage and high current, and with ever-increasing speed, requiring a fast dynamic response to switch the microprocessor from sleep to power mode and vice versa. This operating mode is necessary to conserve energy, as well as to extend the operation time for any battery-operated equipment. The challenge for the voltage regulator module (VRM) is to provide tightly regulated output voltage with fast dynamic response in order to transfer energy as quickly as possible to the microprocessor. The first generation of VRMs, developed for the Pentium II processor, was too slow to respond to the power demand of subsequent generations of microprocessors, which included the Pentium III and Pentium 4. As a result, a large number of capacitors had to be placed adjacent to the microprocessor in order to provide the required fast power transfer. This solution became costly and bulky.

Responding to Intel's microprocessor challenges, the Center for Power Electronics Systems (CPES), an ERC headquartered at Virginia Tech, established a mini-consortium of companies in 1997 with a keen interest in the development of VRMs for future generations of high-speed microprocessors. Since CPES first developed the multiphase buck converter as a VRM for Intel processors (in 1998), this has become standard practice throughout the entire industry.

Today, every computer containing Intel microprocessors uses the multiphase VRM approach developed at CPES. Besides all the computer manufacturers, other companies impacted by this CPES-developed technology include Texas Instruments, National Semiconductors, Analog Devices, Intersil, Semtech, STMicroelectronics, Linear Technology, Vishay Siliconix, Infineon, Maxim, International Rectifier, ON Semiconductor, Microsemi, Fairchild Semiconductor, Primarion, and Volterra.

This particular technology has developed into a multi-billion-dollar industry, and has given U.S. industry the leadership role in both technology and market position. It has also enabled new job creation and job retention in the U.S. Without this technology infusion from CPES, U.S. industry would have lost its market position in providing power management solutions to the new generation of microprocessors to overseas low-cost providers.



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