



**Innovative CPU Power Controller Architecture
Enables Significant Power System Cost Savings
for VR11 PC Motherboards**

ON Semiconductor has developed an innovative dual-edge pulse width modulation (PWM) controller, which enables power management subsystems for VR11 PC motherboard CPUs to respond to users' activation of high-performance computing functions. By enabling simultaneous switching of all phases in a multiphase power waveform, ON Semiconductor's new solution provides faster response compared to the industry's standard single-edge PWM controllers. This improved response enables the power management subsystem to operate at a lower frequency, and with fewer and smaller hold-up capacitors, resulting in a more compact physical design, fewer components required, and a more cost-effective overall solution.

The PC motherboard market today is hyper-competitive, with extremely thin margins. The biggest design challenge may be the hardest to achieve – system cost must be lower in each successive generation. In this environment, no cost reduction opportunity is too small to consider. A major component of motherboard cost, outside of the microprocessor and chipset silicon, is the power management subsystem for the CPU. While cost pressure remains intense, performance requirements continue to escalate - current levels increase, transitions are faster, and the voltage to the CPU must be immune to load changes.

Multiphase power systems supply today's CPU power requirements, which draw as much as 130 amperes (A). Dividing the 130 A current into four phases allows more manageable current levels of 32 A per phase. These systems require highly sophisticated controllers that must balance current sharing and transient response through four phases in a desktop system, and as many as six phases in server systems. One problem facing system designers is that only one phase at a time is clocked to immediately respond to transient events and supply the additional power required by the CPU when additional high-performance computing functions are activated. The initial power is supplied by energy stored in output capacitors, and after some time the PWM controller catches up and handles the power requirements.

PWM controllers today typically use single-edge (leading-edge or trailing-edge) modulation, both of which have a one-cycle delay when responding to a large-step current increase. ON Semiconductor's new dual-edge modulation PWM controller, the NCP5381, enables all power phases to respond to a large-step transient current increase with unprecedented speed, significantly reducing the output capacitance required for energy storage. Fewer capacitors may be used, and those remaining may be exchanged for smaller, less expensive devices. This results in a more cost-effective solution, developed with fewer components, and assembled into a smaller physical space.

Extensive testing at ON Semiconductor labs and in customers' VR11 applications has demonstrated the performance and cost-effectiveness of the dual-edge controller-based power subsystem. CPU power subsystem solutions used in today's PC motherboards vary depending on PWM controller and motherboard manufacturer, but comparisons demonstrate that NCP5381-based subsystems, utilizing dual-edge modulation, will reduce the number and size of required capacitors, versus subsystems based on single-edge modulation. These subsystem improvements result in significant cost savings to the manufacturer.

The table below summarizes the capacitor costs in the CPU power management subsystems used on two VR11 PC motherboards using traditional single-edge modulation, versus a NCP5381 dual-edge modulation based power subsystem. This built-and-tested example demonstrates the savings that can be realized by using the NCP5381, with fewer and less expensive capacitors in the supporting subsystem. The total savings are \$0.81 and \$1.03 respectively. Motherboard designers and manufacturers will be eager to realize the savings that can be realized by utilizing a dual-edge modulation based power management architecture.

Capacitor Value	Capacitor Cost (ea)	Single-edge Based Motherboard 1 (# used)	Single-edge Based Motherboard 2 (# used)	ON Semiconductor NCP5381 Based Motherboard (# used)
Polymer 560 uF	\$0.15	11	10	7
Poscap	\$0.16	0	1	0
Ceramic 22 uF	\$0.065	12	18	6
Ceramic 10 uF	\$0.03	6	0	12
Total Cost		\$2.61	\$2.83	\$1.80

ON Semiconductor's NCP5381 dual-edge modulation PWM controller enables this new CPU power subsystem architecture. The resulting VR11 PC motherboard designs leverage the simultaneous switching of all phases in a multiphase power waveform, enabled by dual-edge modulation, to provide faster response compared to design which use the industry's standard single-edge modulation PWM controllers. As tested, the NCP5381 based design results in a CPU power management subsystem that uses fewer and smaller capacitors, resulting in a more compact physical design, fewer components required, and a more cost-effective overall solution.