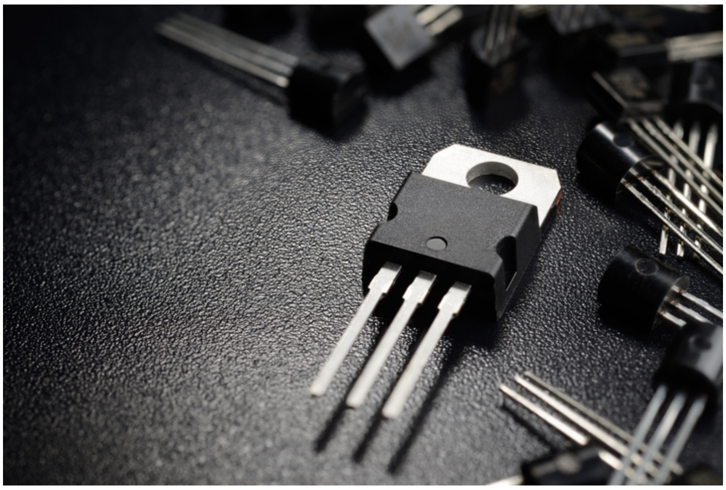
Analog-Digital Hybrid Controller Architecture for Load-Adaptive Power Transistor Scaling in PWM Switching Power Converter

TECHNOLOGY NUMBER: 6734



OVERVIEW

Efficient PWM buck converter for energy-constrained implantable biomedical devices

- Improves power conversion efficiency for wide load ranges in implant devices
- Used in biomedical implants for sensing, stimulation, and data transmission

BACKGROUND

Implantable biomedical systems, such as pacemakers and neural interfaces, operate in environments with limited energy resources. These devices experience fluctuating power demands—from low power for sensing biological signals to higher power for stimulation or data transmission. Historically, power conversion for these systems relied on pulse frequency modulation (PFM) converters, which though efficient, create unpredictable switching noise that affects signal quality. Pulse-width modulation (PWM) converters offer more predictable outputs but struggle with efficiency at light loads, which most implantable systems depend on. Advances in reducing power losses and improving conversion efficiency at low current levels remain essential for the growth and sustainability of these devices. Hence, an innovative strategy to bridge this efficiency gap without compromising power supply integrity is crucial for the evolution of energy-efficient biomedical implants.

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Category

Hardware
Engineering & Physical Sciences
Semiconductor, MEMS, and Electronics

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INNOVATION

Researchers at the University of Michigan have developed a discontinuous-conduction-mode (DCM) PWM buck converter, which achieves over 80% power conversion efficiency (PCE) for a broad range of load currents, from 45μA to 4mA. Utilizing a novel adaptive power gating mechanism paired with an analog-digital hybrid control system, it reduces switching power overhead, thus improving efficiency across load conditions. This hybrid control combines the robustness of digital control with the precision of analog adjustments, making it adaptable for real-time changes in power demand. Applications extend to various implantable biomedical systems, supporting a variety of functions such as signal sensing, stimulation, and data transmission. The innovation not only enhances device longevity by conserving battery life but also maintains signal integrity, thereby ensuring reliability and safety in medical applications.

ADDITIONAL INFORMATION

REFERENCES

S. -Y. Park, J. Cho, K. Lee and E. Yoon, "12.3 PWM buck converter with >80% PCE in 45μA-to-4mA loads using analog-digital hybrid control for impiantale biomedical systems," 2015 IEEE International Solid-State Circuits Conference - (ISSCC) Digest of Technical Papers, San Francisco, CA, USA, 2015, pp. 1-3, doi: 10.1109/ISSCC.2015.7063004

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US9929649 "Hybrid control architecture for load-adaptive power converter"