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DC-DC Converters Deliver Fast Response and High Efficiency

With the introduction of three new EcoSpeed dc-dc converters, Semtech extends the benefits of its adaptive on-time (AOT) control architecture to point-of-load (POL) applications and products with complex power management needs requiring digital control. The 3-A SC173 and 4-A SC174 are monolithic buck regulators targeting POL applications (Fig. 1); while the SC493 is a digitally programmable synchronous buck controller that can be configured and monitored via an I^2C interface (Fig 2.). All three devices deliver the benefits associated with AOT control—very fast transient response, high efficiency over the load range, and the elimination of external compensation components. Figure 3 shows load transient response for the SC174.

Adaptive on time control is a derivation of constant on time control, which in turn is based on hysteretic control. Hysteretic control is known for its simplicity (it requires no compensation) and its fast transient response. Unfortunately, switching frequency is variable under hysteretic control making EMI more unpredictable and difficult to filter. With AOT control, the switching frequency is held within a ±15% range, which is comparable to conventional voltage-mode and current-mode control methods. The table shows a comparison of AOT with other control methods.

To further aid EMI control, EcoSpeed converters feature SmartDrive, a two-step, high-side FET turn-on technology that reduces EMI in noise-sensitive applications. In addition, the switching frequency is programmable from 200 kHz (250 kHz in the '493) to 1 MHz, allowing designers to trade off efficiency and design size.

EcoSpeed converters also address the often-conflicting requirements for very low power during standby mode and fast "wake-up" capability, which demands fast recovery from low-power standby to full-power steady-state mode. The EcoSpeed converters solve this challenge with an ultrasonic power-save (UPSAVE) mode. UPSAVE lowers the switching frequency to cater to low-power standby requirements, thereby by reducing the switching losses associated with the power FET gate charge. This results in up to 95% peak standby efficiency.

Then, when the load changes from standby to steady state, EcoSpeed's cycle-by-cycle response quickly exits UPSAVE mode, providing very fast power-up response time. Additionally, UPSAVE ensures that the device switching frequency stays above a 25-kHz threshold, thereby eliminating audible resonance.

The EcoSpeed architecture allows the SC173, SC174, and SC493 to work with ceramic input and output capacitors, providing design flexibility and reliability. Other specifications and features for the SC173 and SC174 include a 3-V to 5.5-V input range and protection against output overvoltage, undervoltage and short circuits. The SC173 and SC174 are packaged in 10-pad, 3.0 x 3.0 x 1.0 mm, lead-free, halogen-free MLPD packages, and are priced at $1.80 and $1.90 respectively per unit in 3,000-piece lots.

The SC493 addresses today's increasingly complex power management requirements by enabling users to digitally configure and interrogate the status of the controller via an I^2C bus. The I^2C interface can be used to fine adjust the output voltage and implement margining, as well as to program device functions including output enable/disable, switching frequency, power-on delay time, soft-start time, power-save mode and ultrasonic power-save frequency. The I^2C status register bits can be used for diagnostics, including current limit, overtemperature, over/undervoltage, brown out and power good.

"Most controllers today are analog, which can achieve high performance but lack flexibility," says Alan Burchfield, senior product marketing manager for Semtech's Power Management Group. "Some controllers now provide digital flexibility, but it is typically achieved via totally digital topologies. This requires the addition of high-speed data converters and power-hungry DSPs. Semtech's approach takes our best-in-class, adaptive on-time EcoSpeed controller core, and wraps it with a digital interface to provide the benefits of an efficient, high-performance analog core and the flexibility of digital control."

The SC493, which supports output currents up to 25 A, targets distributed main power supply rails in embedded applications for networking, communications, industrial, and office automation equipment. The SC493 is packaged in a 20-pad, 3.0 x 3.0 x 0.6 mm, lead-free, halogen-free MLPQ package. The SC493 is priced at $1.06 each in 3,000-piece lots.

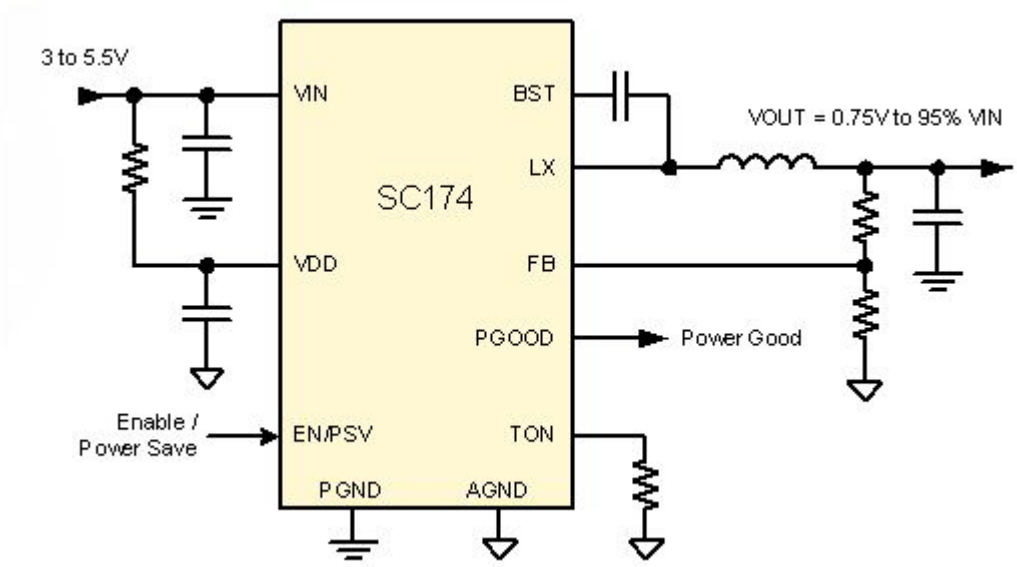

Fig. 1. Housed in a 3-mm x 3-mm MLPD package and requiring no external compensation components, the SC174 enables a compact 4-A buck regulator.

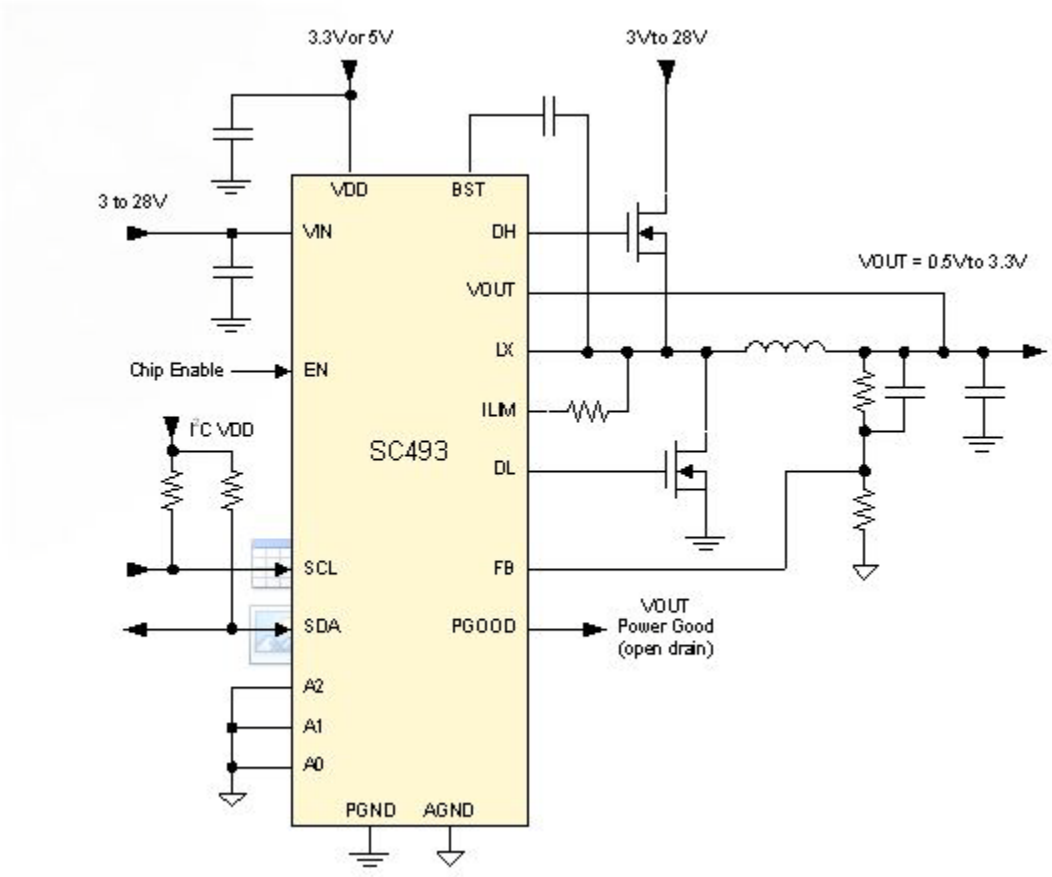

Fig. 2. Operating with inputs up to 28 V, the SC493 synchronous buck controller can be digitally programmed via its I^2C interface.

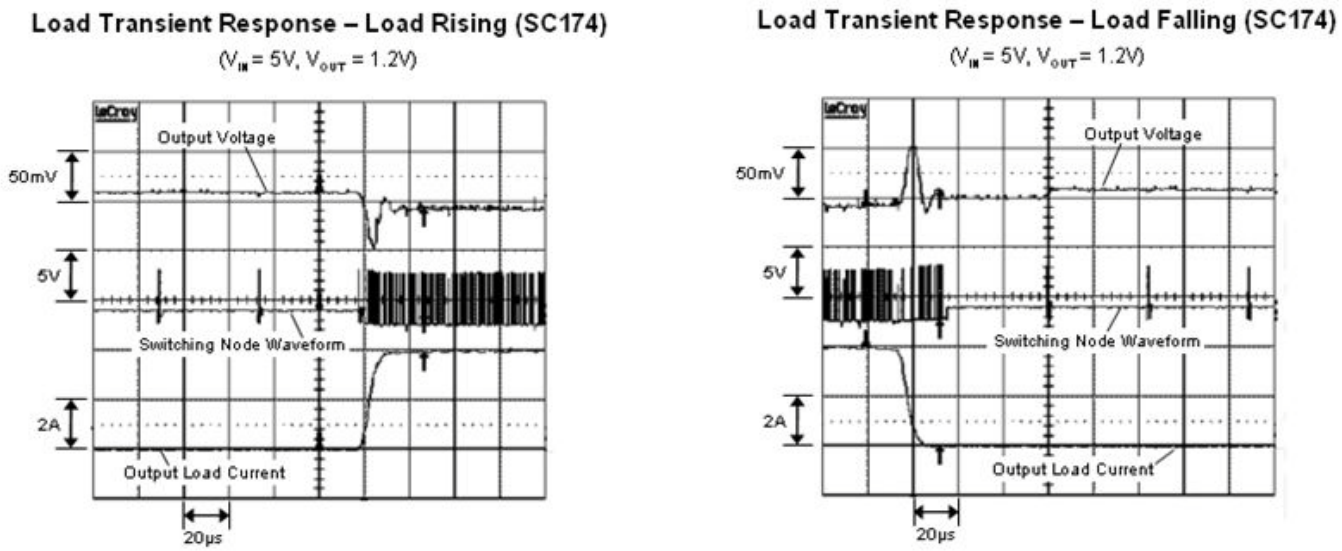

Figure 3. EcoSpeed dc-dc converters such as the SC174 4-A buck regulator exploit adaptive on-time control (an adaption of hysteretic control) to achieve very fast transient response.

Table. A comparison of Adaptive On-Time control with other control methods.

Function	Current Mode Control	Voltage Mode Control	Constant On-Time	*EcoSpeed*™ Adaptive On-Time
Line Regulation	Excellent	Good	Excellent	**Excellent**
Load Regulation	Excellent	Moderate	Excellent	**Excellent**
External Compensation	Single Pole	Double Pole	None	**None**
Stable Operation with Wide Range of Load Capacitance	Yes	No	No	**Yes**
Switching Frequency	Constant	Constant	Variable	**Pseudo-Constant**
Simple, Cost-Effective Architecture	No	No	Yes	**Yes**
Transient Response	Fast	Slow	Ultra-Fast	**Ultra-Fast**
C_{OUT}	Flexible	Somewhat Limited	Somewhat Limited	**Flexible**
PSAVE	Not Inherent	Not Inherent	Inherent	**Inherent**
PCB Layout Sensitivity	Yes	No	Yes	**Yes**