

# Energy-Efficient Analog Devices Fit Auto Applications

By Sam Davis, Senior Technical Editor

National Semiconductor has introduced a series of energy-efficient ICs that enable emerging automotive applications in light-emitting-diode (LED) lighting, powertrain, safety and infotainment systems. The company's temperature sensors, data converters, audio and op amps, as well as power management and interface circuits, address the need for reliability and precision with high-temperature environments and wide operating-voltage ranges. Many of these devices, identified by the letter Q in the device name, conform to the Automotive Electronics Council's AEC-Q100 reliability specification, a special manufacturing flow that requires extended testing and screening.

To prevent severe battery drain when a car is parked for extended periods of time, the LM26003 switching regulator features a quiescent current of 10.8  $\mu\text{A}$  in shutdown mode (typical) and less than 40  $\mu\text{A}$  in sleep mode. A forced pulse-width-modulation (PWM) mode is also available to disable the sleep mode.

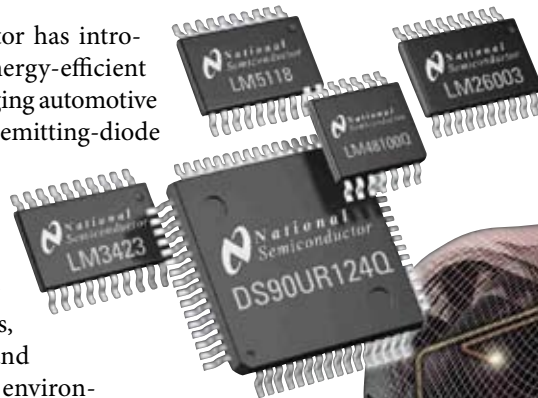
The LM26003 can deliver up to 3 A of continuous load current with a fixed-current limit, through its internal n-channel switch. The IC has a 4-V to 38-V input range and can operate with input voltages as low as 3 V during line transients. The operating frequency is adjustable from 150 kHz to 500 kHz using a single resistor, and it can be synchronized to an external clock.

Other features include power good, adjustable soft-start, enable pin, input undervoltage protection, thermal shutdown and an internal bootstrap diode for reduced component count.

In addition, the LM26003 has a reference with 1.5% accuracy and cycle-by-cycle current limit, and it is housed in a TSSOP-20 exposed pad package.

## Buck-Boost

The PowerWise LM5118 controller IC is intended for powering automotive systems where the battery can vary both above and below its nominal voltage. It is a 3-V to 75-V input-range buck-boost switching regulator controller with the functions necessary to implement a high-performance,

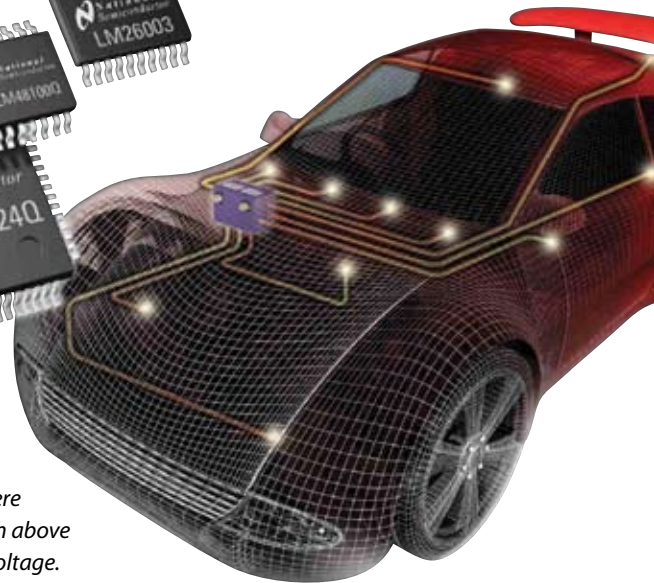


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cost-efficient buck-boost regulator using a minimum of external components. It features a switching frequency programmable to 500 kHz, with oscillator synchronization capability, programmable soft-start, thermal shutdown, low shutdown current and a power-enhanced TSSOP-20 package with an exposed die attach pad to aid thermal dissipation.

The buck-boost topology maintains output-voltage regulation when the input voltage is either less than or greater than the output voltage, making it especially suitable for automotive applications. It operates as a buck regulator while the input voltage is sufficiently greater than the regulated output voltage and gradually transitions to the buck-boost mode as the input voltage approaches the output. This dual-mode approach maintains regulation over a wide range of input voltages, with optimal conversion efficiency in the buck mode and a glitch-free output during mode transitions.

The controller IC includes drivers for the high-side buck MOSFET and the low-side boost MOSFET. Emulated current-mode control reduces noise sensitivity of the PWM circuit, allowing reliable control of the very small duty cycles necessary in high input-voltage applications. Protection features include current limit, thermal shutdown and an enable input.



LED lighting in the car is becoming widespread, improving fuel economy due to better luminous efficiency than incandescent and fluorescent bulbs. LEDs are environmentally friendly due to fewer hazardous materials and they last longer.

A family of PowerWise LED drivers power 1-W to 5-W high-brightness LEDs. These LED drivers provide a wide input-voltage range, constant current to regulate LED brightness, a low-feedback voltage to minimize power dissipation and zero shutdown current to maximize efficiency. Dimming, protection and thermal control features are suitable for a wide range of lighting applications.

For exterior lighting such as headlights, daytime running lights, fog lights and rear-combination lamps, as well as interior lighting such as dome lighting and instrumentation, the PowerWise LM3421 and LM3423 high-voltage LED drivers drive three or more LEDs per string, and are offered in a small TSSOP package.

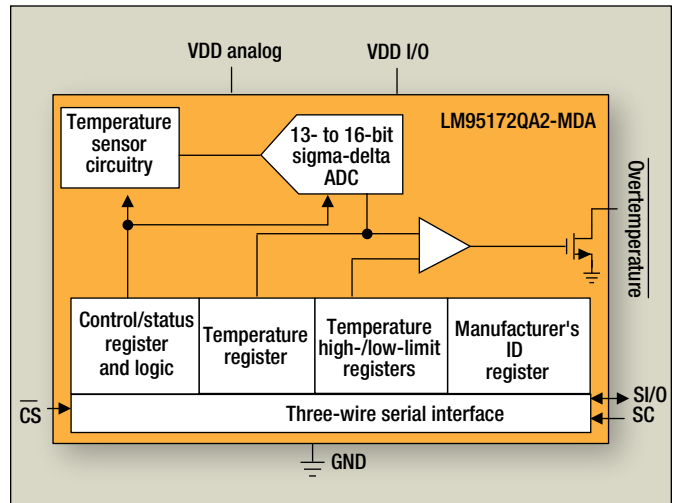
For space-critical infotainment backlighting, National's PowerWise LM3431 three-channel, constant-current LED driver includes an integrated boost controller and features dimming frequencies up to 25 kHz with a contrast ratio of 100:1. The LM3431 is housed in a 28-pin TSSOP package.

National also offers a range of op amps and thermal-management solutions that monitor lighting systems to ensure reliability and robustness. Under-the-hood automotive electronic control systems demand the highest thermal performance from electronic systems at temperatures beyond 150°C.

The PowerWise LM95172Q-MDA is a digital output temperature sensor (Fig. 1) with both a serial peripheral interface and a MICROWIRE interface. It monitors the automotive system temperature up to 175°C and delivers  $\pm 1^\circ\text{C}$  accuracy between 130°C and 160°C. The device meets AEC-Q100 Grade 0 qualification requirements. The LM95172Q-MDA's pinpoint accuracy at high temperatures permits lower system guard bands. This IC allows system engineers to develop a reliable electronic control unit that consistently runs at higher temperatures, allowing for optimal oil viscosity, smaller system form factor and lower weight. These elements enable increased fuel efficiency.

The LM95172QA2-MDA includes a very linear sigma-delta ADC, high accuracy, a conversion rate of 35 ms and extremely low output noise. Its overtemperature alarm output asserts when the die temperature exceeds a programmed  $T_{\text{HIGH}}$  limit. The user-programmed  $T_{\text{LOW}}$  limit creates a temperature-stabilizing hysteresis when the ambient temperature is near the trip point.

The LM95172QA2-MDA can be programmed to operate from 13-bit (0.0625°C/LSB) to 16-bit (0.0078125°C/LSB) resolution. When in the 13-, 14- or 15-bit resolution mode, the least-significant bit in the 16-bit temperature register toggles after the completion of each conversion. This bit may be monitored to verify that the conversion is complete.



Meeting the AEC-Q100 Grade 0 standard, the low-noise digital output makes the LM95172QA2-MDA temperature sensor ideal for low-voltage, high-sensitivity applications. Its operating temperature range is  $-40^\circ\text{C}$  to  $175^\circ\text{C}$ .

## Infotainment Systems

Infotainment systems continue to evolve with the convergence of multiple audio and video streams, camera imaging systems and navigation into a single sophisticated system that includes real-time road and driver alerts. Keeping audio and video crisp despite multiple sources and multiple streams presents unique challenges.

National's DS90UR124Q and DS90UR241Q serializers/deserializers and low-jitter crosspoint switches provide an efficient and cost-effective way to route and switch video content to single or multiple displays in the driver and passenger compartments. Combined with National's LM49350 and LM49370 Boomer audio-amplifier subsystems, the DS90UR124Q and DS90UR241Q deliver audio and video over a single high-speed low-voltage differential signaling lane, thereby minimizing cables and weight while improving the ease of design and the ability to drive cables up to 10 m. The DS90UR124Q and DS90UR241Q are available now in a 64-pin and 48-pin TQFP package. They are AEC-Q100 Grade 2 qualified for operation between  $-40^\circ\text{C}$  and  $105^\circ\text{C}$ .

Safety combined with convenience are emerging as a top feature among automotive customers. Today, multiple systems work together to actively alert the driver of potential road hazards. National's LM48100Q single-supply, mono bridge-tied load amplifier with I<sup>2</sup>C-compatible volume control amplifies warning and alert tones in these automobile driver-warning systems. This Boomer audio power amplifier is AEC-Q100 Grade 2 qualified and includes a comprehensive output fault-detection system that senses the load conditions, protecting the device during short-circuit events, as well as detecting open-circuit conditions. Operating from a single 5-V supply, the LM48100Q delivers 1.3 W of continuous output power to an 8- $\Omega$  load with less than 1% total harmonic distortion plus noise. It is available in a 14-pin TSSOP package.

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