

## Amps complete digital sound chain

Manufacturers of powerful stereo systems may soon be able to produce much smaller systems without sacrificing sound quality. A growing number of manufacturers are supplying amplifiers that use what is called Class D technology, which generates far less heat than Class A and B amps that have been used for years in conjunction with voluminous heat sinks.

The market is still small, hitting only \$84 million in 2003, according to **Forward Concepts**. And that represents a 200% increase over 2002. But Class D sales should soar to \$200 million this year, climbing to \$823 million by 2008, the research company predicts.

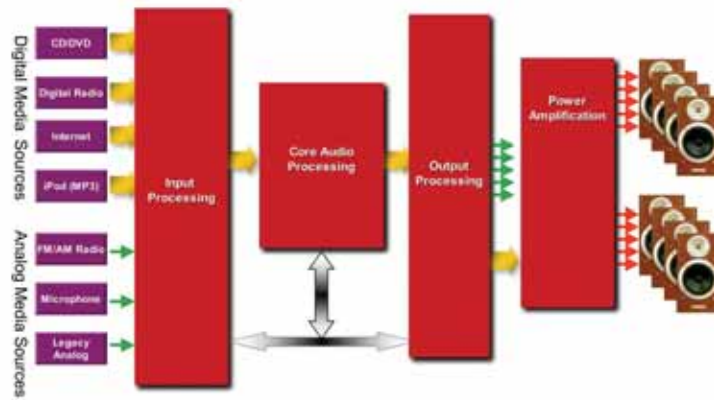
Class D amps replace the last analog part in the signal chain for vehicle radios, eliminating the need for a digital to analog converter before the speaker. Beyond that, their central benefit is higher efficiency. That reduces heat generation, so there is less need for the bulky heat sinks that expand the size of today's high-powered sound systems.

That decrease is typified by **Philips Semiconductors**, which classifies its Class D amplifiers at 80-95% efficiency, compared with 25% for conventional Class A and B amplifiers. That means the new amps can produce eight times the power in the same space. They also run much cooler, so lower-cost plastic chip packages and system housings can be employed.

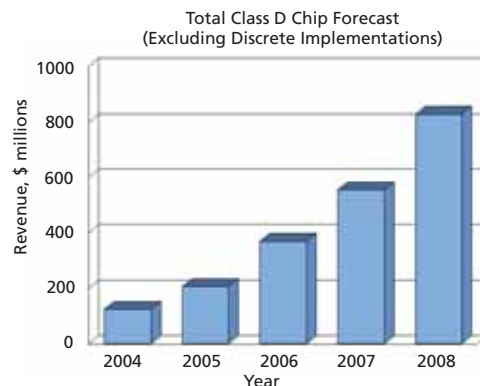
"One of the biggest problems with Class A and B amps is that they get so hot that plastic housings can melt," said Bill Slattery, Product Line Manager at the Analog Semiconductor Components division of **Analog Devices (ADI)**.

ADI entered the market late last year with the AD1991 having a sigma-delta modulator that provides feedback. Its chip provides total harmonic distortion down to 0.005%, well below the 0.1% of competing packages. "We've focused on audiophile-style performance," Slattery said.

In vehicles, low power consumption is attractive since 12-V batteries are challenged to power their growing electronics content. The lower power requirements can help decrease the cost of cabling, which can grow as users want more pow-



ADI's Class D amplifiers provide the last link in the digital audio chain.



Forward Concepts expects the Class D amps to gain rapid acceptance.

erful sound systems. Voltage in a car is limited, so there are not many variables to adjust.

"One of the few choices is to decrease the impedance of the speakers, but then the amount of current they draw means low impedance cables, which are big and expensive," Slattery said.

EMI (electromagnetic interference) has also been a limiting factor for autos since it can impact AM radio reception. However, ADI has removed spikes in AM wavelengths, making it easier to filter out interference. "Our signal has no spikes, it's got better spectral purity, and it's easier to filter out EMI in the AM bands," Slattery said.

Costs could come down as more high-volume markets adopt Class D technology. ADI is also focusing on flat-panel TVs, which have limited space.

## Briefs

**General Motors** announced in late January that **OnStar** and electronic stability control will eventually become standard for its retail customers in the United States and Canada, covering all segments except for some commercial vehicles. The expansion of OnStar begins this year and will be completed in 2007. Electronic stability control, sold as StabiliTrak, is standard on many GM full-size SUVs, will expand to midsize SUVs this year, and remaining SUVs and vans will get it by the end of 2007. It will be standard on all cars and trucks by the end of 2010. In making the decision, GM cited recent studies by the **National Highway Traffic Safety Administration** and the **Insurance Institute for Highway Safety** indicating that the widespread application of electronic stability control could result in a significant safety benefit. As enablers of electronic stability control, antilock brakes and traction control will also become standard.

A recent report from **IMS Research** concluded that **Bosch** overtook **Delphi** to lead the global Tier 1 automotive electronics supplier rankings in 2004. Its 2004 market share is estimated at 12%, fractionally ahead of Delphi. **Denso**, **Siemens VDO**, and **Visteon** completed the Top 5. Just 15 suppliers accounted for three-quarters of the total market, showing the consolidated nature of the automotive electronics supply chain. The market shares of Delphi and Visteon were affected by the unusually weak U.S. dollar.

**Fujitsu Microelectronics Europe** is licensing Robert **Bosch** GmbH's FlexRay Communication Controller IP-Module for embedding into its automotive microcontroller units (MCUs). Fujitsu currently offers MCUs with CAN (Controller Area Network) and LIN (Local Interconnect Network) protocols, but it says control systems of the future will require faster and more reliable data transfer as data volume increases and systems continue to become more complicated. Fujitsu plans to offer an FPGA (Field Programmable Gate Array) prototype board incorporating FlexRay, FlexRay as an application-specific standard product solution, and in early 2006 its first MCU with an embedded FlexRay IP based on the 32-bit Fujitsu FR core.

Many large systems put amplifiers in the trunk, but there's a push to integrate them into radios. Though radios are becoming central hubs for many applications, there is not much space in most dashboards for larger gear.

"When people are designing infotainment head units, they want to put more and more of the audio chain in less and less space," Slattery said.

*Terry Costlow*

## Ceramics sense the pressure

New automotive engine control innovations such as cylinder deactivation and returnless fuel systems, which meet more stringent emissions and fuel economy requirements, use advanced pressure-sensing technology to communicate vital real-time data to automotive systems. The challenge for automotive engineers is to find lighter, more durable sensors that are capable of enduring harsher conditions and more rugged performance demands—all at a price point that meets manufacturing requirements. Understanding new automotive pressure transducer (APT) technologies, as well as their role in advanced engine and transmission control and regulating HVAC systems, is key to harnessing the new pressure-sensing technologies.

Automotive engineers deploy high-performance APTs across the engine and transmission to perform functions such as monitoring fuel-rail pressure to improve fuel delivery and optimizing engine calibration. Transducers also monitor exhaust pressure for new exhaust-gas-recirculation systems.

APTs are at the core of the latest cylinder-deactivation technology, for which monitoring oil pressure activates controls that shift engine operation from eight to four or from six to three cylinders to improve fuel economy. Transmission engineers use transducers to monitor transmission fluid pressure to optimize shifting and improve fuel consumption and performance.

Design engineers also employ APTs to protect air-conditioning systems. The transducers are used in high-pressure cut-out systems and controls that manage both cooling fans and engine load to ensure that air-conditioning operates at peak performance with a minimal impact on fuel consumption.

Transducer manufacturers such as **Texas Instruments (TI)** have made several advances in APT performance and packaging through refining manufacturing processes and materials. Central to the performance of this new generation



*Texas Instruments has developed new automotive pressure transducer technologies through refining manufacturing processes and materials.*

of transducers are improvements in ceramic sensing element (CSE) technology.

New production techniques such as ceramic plate cutting bring enhanced quality, performance, and cost savings to each component. For example, replacing the traditional round CSEs with square elements reduces the time and steps required to manufacture the round elements, vastly improving quality and yield. Using U-shaped edge connections for electronic interfaces with the square CSE can further reduce cost while improving quality.

While traditional transducers have the capability of achieving a baseline accuracy of  $\pm 3\%$  Vcc, this new class of APTs has the capability of achieving an initial accuracy of  $\pm 1\%$  Vcc. Conditioning electronics can also be adapted to meet analog and pulse width modulated output signals.

Advances have also been made in component housing materials. Standard transducers are made from steel, lending strength to the component but adding unnecessary mass to the overall vehicle. New aluminum-cased APTs are four times more resilient to corrosion, and manufacturers such as TI have realized a 50% reduction in component mass. The temperature ranges that engines must perform at require that transducers be rated between  $-40$  and  $+150^\circ\text{C}$  ( $-40$  and  $+300^\circ\text{F}$ ), a demanding range for any

electronic sensor.

As vehicles get smarter, more and more electronics are being packed into them. Combine this with cell phone relay towers dotting our roadways, and electromagnetic compatibility (EMC) becomes a very important issue in ensuring the accuracy of transducers. Today's automotive engineers are demanding higher

EMC tolerances from 100 to 200 V/m. Newer APTs offer this additional level of protection through optimization of discrete circuit and application-specific integrated circuit design.

As automotive engineers well know, meeting the demand for better fuel efficiency and lowering emissions requires some novel and new approaches to en-

gine, transmission, and air-conditioning design. Advances in pressure-sensing technology are providing the automotive industry with low-cost precision measurement and control tools to meet these challenges.

This article was written for AEI by **Karl Abrahamson**, Design Engineering Manager for the Automotive Division of Texas Instruments Sensors & Controls.

## Four focuses for Denso

The President and CEO of **Denso** International America, Inc. stressed the importance of having vehicle makers and consumers trust the global supplier of thermal, powertrain, electronic, and electric products during Convergence 2004.

"Every constant improvement in engineering development, in manufacturing process, and in marketing and administration aims at nurturing our customers' trust," said Matt Matsushita, during a keynote speech at the conference. "It has been, is, and will be the customers who drive us to new products, new components, and new systems," he added.

Denso wants to continue making inroads in four key areas: environment, safety, comfort, and convenience. In the realm of environmental technology, the supplier has steadily worked toward realizing a cleaner world. Among the more recent accomplishments is Denso's devel-

opment of the first vehicle air-conditioning system using carbon dioxide as a refrigerant.

In the arena of safety, Denso engineers are now focused on preventive accident systems. The supplier's new Pre-Collision System, developed with **Lexus**, can identify potential collision dangers and respond by "automatically tightening seatbelts and activating a pre-collision brake system to avoid an accident," said Matsushita, noting that the system's components include a millimeter-wave radar sensor, pre-collision electronic control unit, and seatbelt electronic control unit.

The comfort side includes the development of an electric air conditioner for hybrid vehicles using a "newly developed electric compressor, which keeps the air-conditioning running even at idle stops when the engine shuts down to save fuel," he said. Convenience products

have included car navigation and multimedia systems.

Future products representing the four product categories include a 200-MPa (29,000-psi) diesel common-rail system for decreased emissions and reduced fuel consumption, sensing technology for accurate detection of obstacles and pedestrians, detecting and monitoring technology for human biochemical data (such as body temperature and heart rate) to facilitate an automatic air-conditioning system adjustment, and windshield navigation display technology.

"What I always tell my people at the office is, 'Let's go back to the basics.' The basics in marketing as well as in engineering remain, 'Listen to the voice of the customers, and in return, let us be listened to for the best solution,'" said Matsushita.

*Kami Buchholz*

## IC innovations from Austriamicrosystems

**Austriamicrosystems** AG, a designer and manufacturer of integrated analog intensive, mixed signal integrated circuits, has developed a multichannel, narrow-band, radio frequency transmitter that will debut on a 2006 model year European vehicle.

"This product, referred to as the AS3977, has extremely low power consumption (one micro-amp in standby mode), which is important for remote keyless entry and tire pressure monitoring," said Franz Faschinger, General Manager of Austriamicrosystems.

Unveiled during Convergence 2004, the product is said to be the first automotive-qualified, multichannel, narrow-band transmitter. "With the proliferation of radio and data transmission applications in today's automotive designs, the AS3977 offers designers a single transmitter option for worldwide usage, supporting various ISM (Industrial Scientific



*The bus and failure diagnostics, low-current standby operation, automatic thermal shutdown protection, and other key features make the AS8221 transceiver appropriate for various automotive applications.*

and Medical) bands according to international standards established by ETSI (European Telecommunications Standards Institute), ARIB (Association of Radio Industries and Businesses), and the FCC (Federal Communications Commission)," noted Bernhard Czar, Director of Automotive Marketing for Austriamicrosystems.

In other news, the company announced that it will deliver a high-bandwidth bus transceiver that is appropriate

for automotive bus systems, safety-critical applications, and X-by-wire systems "because in all these applications, you need immediate response times and reliable communications," said Faschinger.

The product, known as AS8221, operates at baud rates up to 10 megabits per second, and its bi-directional serial host interface is used to set the various low-power operation modes and to request the diagnostic status. AS8221 functions as the interface between a FlexRay or time-

triggered protocol communication controller and the copper wire physical bus.

"In the North American market, high-speed networking is one of the fastest growing segments for automotive electronics," said Faschinger, who noted that the AS8221 transceiver is a product for high-speed networking.

*Kami Buchholz*

## New tool for embedded design

Through the use of a new modeling and simulation software package from **Mirabilis Design**, an engineer can address in-vehicle electronic design at the start of a project.

"VisualSim does performance analysis and architectural exploration—those are the technical aspects. On the business side, it's conceptual engineering—and that means taking the business requirements and translating those needs to technical implementation specifications," said the founder and CEO of Mirabilis Design, Deepak Shankar.

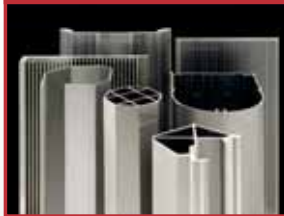
As a virtual system prototyping solution for abstract-to-detail modeling of electronic and embedded systems, VisualSim enables design, optimization, and validation of the target architecture of systems, subsystems, components, as well as the embedded software. The platform-independent VisualSim provides graphical and textural modeling software that supports digital electronics, embedded software, imaging, networking, protocols, analog, control systems, and digital signal processing (DSP) design combinations. "Because our environment is graphical, the user can change the parameters and try different experiments," said Shankar.

VisualSim interfaces with a number of tools—including STK, Excel, Java/C/C++, XML, MatLab, serial input/output, and URL addresses—to provide a comprehensive modeling environment. The software also integrates model- and language-based modeling with a native, multi-domain simulation kernel that supports all the required models of computation.

"VisualSim is the first product that can do performance analysis, algorithm development, and a vehicle's electronics architectural design in a single model," said Shankar. "What that means is a systems engineer can combine analog and digital

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electronics as well as protocols—such as CAN (controller area network), FlexRay, or TCP/IP (transmission control protocol/internet protocol)—and control systems. That is important because today's engineers have separate software design tools for each engineering domain. What we're doing with VisualSim is combining these engineering domains into one software application."

Kami Buchholz

## AUTOSAR gains support

The electronics industry has been built on standards, but many of the electronic modules used by the automotive industry have been designed for specific applications, using few if any common architectures. But automakers seem to be moving toward some standardization, seeing it as a way to simplify the growing complexity of electronic subsystems while cutting costs.

The Automotive Open System Architecture (AUTOSAR) standard is gaining support, although there does not appear to be a huge push to get the standard into production vehicles. The AUTOSAR partnership was formed last year to create a *de facto* standard for automotive electronics, providing more uniformity for both hardware and software.

It provides both hardware interfaces and software hooks that make it simpler for programmers to reuse software and move it from one vendor's hardware to another. The specification will also simplify certification, while helping suppliers reduce the

number of versions they must design as well as making development tools more universal.

**General Motors** recently committed to join the consortium, joining **Bosch, Volkswagen, Siemens VDO, BMW, DaimlerChrysler, Ford, Citroën, Toyota, and Continental** as core members. A number of other leading auto industry players such as **Delphi, Honda, and Freescale** are also members.

"They probably have enough key players to make it happen now," said Paul Hansen, publisher of The Hansen Report, who moderated a panel session during Convergence 2004. He noted that "automakers can save billions if they push forward with this."

"It is an effort that must, and will, work. We must move quickly to implement it," said Franz Fehrenbach, CEO of Bosch GmbH.

"AUTOSAR will be one of several standards we support. We love standards," said Jeff Owens, President of Delphi Delco Electronics Systems.

However, most observers do not expect the standard to have an immediate impact. During the Convergence panel with six leading industry managers, only a Volkswagen representative said he expected to see AUTOSAR used in a vehicle with at least 200,000 units within five to seven years.

Though AUTOSAR seems to have momentum now, its timeframe for achieving the volumes needed to make it a true standard stretch into the next decade. The optimism for its success is therefore somewhat tempered.

"I'd give it about a 60% chance of becoming a widely used standard," Hansen said.

Terry Costlow

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## Eclipse tools form base for design software

The open source movement is beginning to focus some effort on the auto market, and automakers including **BMW** are paying attention. The **Eclipse Foundation**, which manages the development of open source software that is used to create and integrate development tools for code writing, has begun focusing on automotive applications.

The Eclipse open source movement began in 2001 when **IBM**, **Red Hat**, **QNX Software**, and others formed the Eclipse group to develop common open source tools for engineers who develop programs. The Eclipse Foundation took over future oversight and development from program manager IBM early in 2004. The foundation, which now has more than 50 member companies, recently began a number of development projects.

"We're starting to focus on vertical markets with two projects. One is automotive, the other is health care," said Mike Milinkovich, Executive Director of the Eclipse Foundation.

The auto industry was picked because of its size and because a number of vendors have expressed interest. At the recent EclipseCon conference, BMW Car IT detailed how it is using Eclipse for prototyping of embedded, component-based software. Working with the AUTOSAR middleware standard, Eclipse is used for building models, managing modules, and for editing, debugging, and generating code for the OSEK target platform.

Benefits for automakers, Tier 1 suppliers, and others could be significant.

"There will be savings in software development and tool integration, where costs will be greatly reduced because modules are Eclipse plug-ins. Training for users will cost less and take less time because the tools will all share common interactions," said Ian Skerrett, Director of Marketing of the Eclipse Foundation.

Skerrett noted that OEMs who often integrate software from multiple vendors will be able to blend these programs together more easily if they're all built using Eclipse development tools.

"When all the projects have a common base for software, the cost of bringing the parts together will be reduced," Skerrett said.



*Mike Milinkovich, Executive Director of the Eclipse Foundation, is promoting open source design software for the automotive industry.*

The working committee had not been finalized at press time, so he gave no timeframe for completion of any programs. However, foundation members say industry support makes it quite likely that tools will emerge.

"There's adoption in embedded markets with support from the real-time operating system guys, so there's an opportunity to construct a tool chain based on Eclipse for developing the software that goes into the car," Milinkovich said.

The Eclipse automotive project coincides with other standardization efforts, particularly the AUTOSAR initiative. AUTOSAR shows solid signs of long-term success in becoming an open standard for functional interfaces between electronic components.

"We feel open source and open standards will work well together," said Milinkovich.

If and when the automotive project bears fruit, it could be used by many different companies. Eclipse licensing is "very user-friendly," so development tool vendors may use it as a base for their tools, as many have done with other aspects of Eclipse. Using Eclipse for a base reduces the time and money they must spend on product development, he added.

"Tier 1 suppliers and OEMs may build special-purpose tools and integrate them for things they want to do. That's what BMW Car IT is talking about," said Milinkovich.

*Terry Costlow*

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