AlixPartners’ 2006 Automotive Benchmarking Survey

“Consolidation in the automotive industry is going to be with us for the foreseeable future,” warned John F. Hoffecker, managing director of AlixPartners, the global corporate advisory firm. “We’re seeing significant, strong competition building in China and India, which will surface over the next five to 10 years, and that will drive consolidation globally, just as the great competitors in Japan and Korea drove consolidation before.”

We recently spoke with Mr. Hoffecker, who gave us some of the highlights of AlixPartners’ influential 2006 financial survey of 22 carmakers, 18 heavy truck OEMs and 104 suppliers.

According to the survey, severe price pressures are here to stay. Despite this reality, a number of carmakers and suppliers performed quite well in 2005 as measured by return on capital employed (ROCE) and compound average growth rate (CAGR). For example, “Porsche is doing a nice job with quality, and they’re bringing in new vehicles. As a result they’ve grown sales at 19% CAGR for the last two years and have the highest return on capital of any carmaker in the world, including the Asians: nearly 14%.”

Why measure return on capital? “Because it takes both the balance sheet and income statement into account,” explained Mr. Hoffecker. AlixPartners takes returns (EBIT, or earnings before interest and taxes) and divides that by what debt and equity holders have into the company (total assets minus current liabilities).

Among suppliers, Continental is one of the top performers. “They were predominately a tire maker, but their major acquisition several years ago of [brake system maker] ITT Teves has paid off very strongly,” said Mr. Hoffecker. He noted:

I & T Makes Inroads with Extruded Flexible Flat Cable

Innovation & Technology, a small Austrian wiring harness maker, has been picking up some important production orders for its extruded flexible flat cable (FFC e). Five FFC e projects are presently in production at I&T: three are for customers in Europe, including Mercedes, and two are for customers in the United States. More production orders are in the works on both sides of the Atlantic. As a result the company, under the leadership of founder and CEO Dr. Harald Reiszner, has taken on major equity partners: Magna Europe came aboard in 2004 and now owns a controlling interest in the company; 3M came aboard in 2005. Founded in 1999, I&T has 130 employees, most of whom work in Siegendorf, Austria.

Formed into what looks like ribbon, FFC e is made from flattened copper wire over which the insulation—TPU (thermoplastic urethane), PVC (polyvinyl chloride) or PBT (polybutylene terephthalate)—is extruded. The technology has been around for several years. In 2004 the German wiring system maker Leoni claimed to be the first company in the world to make extruded flexible flat cables for high volume production applications in vehicles. Flat cable is light, has a very low profile and has fewer buzz, squeak and rattle issues compared with round cable, but it has been significantly more expensive. I&T developed and built an automated production facility in Austria that brings the cost of FFC more in line with round cable. “It is a technology whose time has come, based on I&T’s unique processing of the extruded approach,” declared Steve Polakowski, in charge of E/E systems for Intier, a division of Magna.

One of the things that attracted 3M to I&T is the advantages that FFC e brings to modular panel assemblies that include wiring. “You don’t have a gangly harness anymore. You can use a variety of transfer adhesives or hot melts to neatly bond the wiring to the headliner,” explained Brian Pospy, 3M automotive business development manager. “Attachment technology is one of 3M’s core capabilities,” he added.

Mr. Pospy, who spent eight years with Sheldahl developing flexible printed circuit (FPC) applications before coming to 3M three years ago, championed the hookup between 3M and I&T.

“Flexible printed circuits are made using a subtractive process, where you etch away circuits, similar to making a traditional rigid circuit board, so it is an expensive process compared to this extruded approach,” said Mr. Pospy.

A major advantage extruded flexible flat cable has over round wire is the ease with which FFC e can be integrated with simple electronics devices, for example LEDs, drivers and resettable fuses. Small surface-mountable LED light sources can be pick-and-place mounted directly onto the cable, saving space and part counts.

With round wire you would have to come off the wires with some kind of terminals to a circuit board,” noted Mr. Pospy.

At least one of I&T’s customers uses FFC e for clocksprings that connect an airbag attached to the steering wheel.

Advantages of Flexible Flat Cables Compared with Round

- Smaller
- Lighter
- Fewer buzzes and squeaks
- Electronics can be integrated
- Attached easily to modular panels

FFC Applications

- Headliners
- Seats
- Doors
- Visors

A total of 630 words.
**New XM Satellite Services in the Wings**

We recently checked in with XM Satellite Radio's Paul Kirsch, vice president for OEM activities, to see how XM was progressing with its plans to implement new data services. With a data pipeline to more than 6.9 million current subscribers, XM Radio sees revenue-building opportunity in allocating a portion of its assigned satellite radio spectrum to providing supplemental information and entertainment options such as real-time traffic advisories, weather data, parking availability and video programming.

When The Hansen Report last profiled XM Radio in June 2005, XM NavTraffic had just been launched, first in the Acura RL in the fall of 2004, followed by the Cadillac CTS in March 2005. At the time, traffic data was available in only 20 metropolitan markets and not all the roads and highways in those cities were covered. NavTraffic uses the vehicle's navigation display to show traffic flow rates, accidents, construction zones and other incidents relevant to the vehicle's location and chosen route.

NavTraffic has since expanded to include 31 markets and, according to Mr. Kirsch, road coverage is getting better and more comprehensive. The feature will be offered on the 2007 model year Acura RDX and TL models as well as on the Infiniti G35, Lexus LS 460L and LS 600h L. Mr. Kirsch said more rollouts are coming in 2007 but have not yet been announced. XM Radio estimates that 200,000 NavTraffic-capable vehicles will be on the road in the next two years.

XM has been delivering weather data to marine and aviation customers since 2003, and now plans to offer automotive subscribers a similar service, which would work with a vehicle's navigation system to provide weather advisories along a selected route.

XM's market research has shown that traffic, weather and parking are the three services people care most about in their cars. ParkingLink is XM's proposed solution for providing drivers with real-time, time-saving parking availability. As a driver nears his destination, colored icons pop up on the navigation screen indicating availability at nearby parking facilities. For example, if 15% or fewer spaces are available in one garage, the red icon would appear; a facility at mid-capacity would show yellow, and one with low occupancy would be designated with a green symbol. XM could have ParkingLink ready for the 2009 model year, but as Mr. Kirsch cautioned, "This all depends, almost exclusively, on how fast the infrastructure can be completed, if it stays on schedule, and if we can get an OEM to sign up for it and integrate it into their navigation system." XM has been working with Standard Parking Corp., a large parking facilities operator, and Quixote Corp., maker of traffic flow sensors, both based in Chicago, Illinois, in developing ParkingLink.

Cached video programming is another area where XM sees opportunity. According to Mr. Kirsch, the "overwhelming majority" of XM's OEM customers are, or soon will be, installing hard drives in their cars for infotainment, with a major ramp up coming in the 2008 to 2010 model year timeframe. Using data transport technology licensed from Digital Fountain (Fremont, California), XM will be ready to deliver video programming to subscribers, with no loss of quality in its music broadcasts. Digital Fountain technology also enables XM to deliver text-to-speech features such as reading newspapers, email or driving directions.

Targeting future vehicles that will not have navigation displays, XM has also been working with VoiceBox Technologies (Bellevue, Washington) on an exclusive, conversational voice interface to XM programming. Carmakers can tailor the voice interface to control additional features such as stored MP3 files. XM has signed a deal with a carmaker who will launch the feature in a MY 2008 vehicle. (For more on VoiceBox, please refer to the April 2006 issue of The Hansen Report.)

---

**FFC e...**

The biggest application to date, however, is in the headliner in the Mercedes M-class. I&T has been working closely with Mercedes, and FFC e will also be used in the new C-class, due at the end of 2007. Other promising applications include door panels and seats.

The M-class headliner is a particularly fitting application for FFC e, says Delphi Packard engineering director, Nick Cassudakis, because it is a long overhead system where you can take advantage of the long extruded cable run. “In ten years maybe half of all the headliners in luxury vehicles could be fitted with flexible flat extruded cables,” Mr. Cassudakis said. “They're perfect when you need a low profile headliner to get more head room, particularly when there is a lot of electronics content.” Delphi Packard has overall responsibility for the M-class wiring system.

One downside of using FFC e, according to Mr. Cassudakis, is that it is more difficult to accommodate last-minute changes to the electrical system design and assembly, since FFC e requires a significant fixed investment in manufacturing tools. A nother issue is the limited availability of hybrid connectors that mate a flat wire cable to the vehicle's round wire cable and to an electronic control unit. Delphi Packard says they will tool up new connectors for flexible flat cables as required. “Tooling new connectors is something we do all the time,” said Mr. Cassudakis.

Yazaki makes a flexible flat cable assembly for the headliner of the Toyota Prius that uses insulation displacement connectors to connect the dome light and control unit. Delphi Packard says they are making a flexible flat cable as required. “Tooling new connectors is something we do all the time,” said Mr. Cassudakis.

Yazaki makes a flexible flat cable assembly for the headliner of the Toyota Prius that uses insulation displacement connectors to connect the dome light and control unit. Delphi Packard says they are making a flexible flat cable as required. “Tooling new connectors is something we do all the time,” said Mr. Cassudakis.

Yazaki makes a flexible flat cable assembly for the headliner of the Toyota Prius that uses insulation displacement connectors to connect the dome light and control unit. Delphi Packard says they are making a flexible flat cable as required. “Tooling new connectors is something we do all the time,” said Mr. Cassudakis.

---

**The Hansen Report on Automotive Electronics**

© 2006 Paul Hansen Associates, 150 Pinehurst Rd., Portsmouth, NH 03801, USA. Telephone: 603-431-5859, Fax: 603-431-5791. Email: info@hansenreport.com. All rights reserved. Materials may not be reproduced in any form without written permission. The Hansen Report on Automotive Electronics is published 10 times a year, monthly; July/August and December/January issues are combined issues. The annual subscription rate is $717 (North America), $747 (elsewhere). Back issues are available for $50 each; see our online index at www.hansenreport.com. Paul Hansen Associates is a strategy and market research firm consulting to the electronics industry.

Publisher/Editor Paul Hansen Managing Editor/ Brieanne Wolfe Circulation Manager

ISSN 1040-1105
Survey...

that over the last couple of years Continental has moved straight up the graph from the standpoint of return on capital, to about 20% in 2005. (Please see chart.)

“Ten years ago Bosch was not a strong return on capital performer. They have also moved up the graph to be one of the better ROCE performers at about 11%.

Two companies that have done a good job differentiating themselves in electronics and safety would be TRW and Autoliv,” M r. Hoffecker observed.

According to the survey, the bottom 26 suppliers averaged just 2.3% ROCE. Investors in those companies would have been better off investing in 5% certificates of deposit, which carry no risk. A verage ROCE for all suppliers in the survey was 7.4%, with the top 25% of companies getting 13.6%.

The survey shows that 24% of suppliers are in fiscal danger based on their 2005 Altman Z-scores. The Altman Z-score is derived from a predictive model that combines five different financial ratios to determine the likelihood of bankruptcy. The highest percentage of troubled suppliers are companies based in the Americas: 38% of them are in fiscal danger, compared with 20% of Asian and 13% of European suppliers, according to Alix Partners. The 2005 survey did not include Delphi, which is already in bankruptcy.

Among the suppliers surveyed, Denso invested the largest percentage of sales in R&D, 8.5%. Next was Akebono Brake at 7.2%, Valeo at 6.7% and Alps Electric at 6.6%.

But large investments in R&D aren’t necessarily the answer to financial success. “There is zero correlation between profitability and R&D,” said M r. Hoffecker.

“Take Magna as an example. They are in all kinds of automotive businesses, some that require heavy R&D, some that don’t. But you will never find them on top of the list in R&D spending. Rather, their R&D spending is appropriate and effectively focused.” Magna earned more money in 2005 than all but six suppliers. And they had nearly 10% ROCE in 2005, while growing sales 22% per year from 2003 through 2005.

“There are a lot of companies out there that aren’t as sophisticated as they need to be in targeting their R&D investments for the highest return,” noted M r. Hoffecker.

“This is an area where AlixPartners does a fair amount of work, helping people sort that out.”

There is a correlation between ROCE performance and the type of products the company produces. Companies making transmissions and/or steering systems did the best in 2005, about 9.3% ROCE. Next were safety systems makers at 7.2%. Companies devoted to electrical equipment, wiring for example, did the worst: about 2% ROCE. There were no data for electronics parts makers, since none of the companies analyzed make only electronics.
Sensata Technologies

The Company Profile

Background

Sensata Technologies, formerly the Sensors and Controls division of Texas Instruments, was purchased by Bain Capital from Texas Instruments for $3 billion in April 2006. Sensata produced just over $1 billion in sales in 2005. After the spin-off from TI, the stand-alone company was named Sensata, a Latin word meaning “those things gifted with sense.”

The business was founded in Attleboro, Massachusetts in 1916 as General Plate Company, to provide gold plate for the jewelry industry in nearby Rhode Island. Following a 1931 merger with a Massachusetts thermostat manufacturer, the company, then named Metals & Controls Corporation, began making room thermostats. Its experience in temperature sensing and controls led to a merger with Texas Instruments in 1959. TI started making automotive sensors in 1989 and introduced its popular line of micro-fused silicon strain gauge sensors in 1999. It expanded its automotive product line with the acquisition of Pierburg’s mass airflow sensor business in 2005.

Sensata maintains business and technology centers in Attleboro, Massachusetts in the United States; in Almelo, the Netherlands; and in Oyama, Japan. Primary manufacturing is based in Ajacalientes, Mexico; Baoying and Changzhou, China; and Kuala Lumpur, Malaysia. The Attleboro facility also does limited manufacturing for aircraft and military customers.

The company’s individually tailored sensors and controls product portfolio today includes more than 18,000 different products, with no single product accounting for more than 2.3% of 2005 sales.

Sensata’s new owner, Bain Capital LLC, is an investment firm with headquarters in Boston. Leveraged buyout firms such as Bain Capital leverage their own cash by using mostly borrowed funds to acquire companies. Another recent Bain acquisition with roots in the auto industry is the French connector terminal company FCI (Framatome Connectors International), purchased in November 2005. One of the founders of Bain Capital is Mitt Romney, governor of Massachusetts and aspiring president of the United States.

To finance the acquisition Sensata has borrowed heavily. On April 6, 2006, the company signed up for $1.35 billion worth of secured bank financing, after which, Sensata was assigned junk credit ratings: B+ by Standard & Poor’s and B2 by Moody’s. Both ratings suggest that Sensata’s credit worthiness is vulnerable to adverse business, financial and economic conditions. Given this level of risk, Sensata must pay relatively high interest on the money it borrows.

Distinctions Claimed by Sensata

◆ More than one billion sensors and control devices are produced each year
◆ Sensata’s sensors and controls business is supported by more than 415 patents
◆ Number-one or number-two supplier in every one of its automotive pressure sensor applications

Note: Sensata’s second quarter financials will be its first reporting as a stand-alone company. Scheduled to be released on August 15, 2006, they will show a very different financial picture, including significantly reduced margins, largely a result of increased interest expenses due to borrowing.

Headquarters: 529 Pleasant Street, Attleboro, Massachusetts 02703-0964; Telephone: 508-236-3800; Web site: www.sensata.com
2005 Sales: $1,061 million
2005 Sales by Division: Sensors, 58%; Controls, 42%
Working Capital: $169 million as of March 31, 2006
Products: Sensors and electromechanical switches
Employees: 5,400
Sales per Employee: $196,000
Sensors Division
2005 Sales: $618 million
Products: Mostly pressure sensors and pressure switches for auto applications

Distinctions Claimed by Sensata
◆ More than one billion sensors and control devices are produced each year
◆ Sensata’s sensors and controls business is supported by more than 415 patents
◆ Number-one or number-two supplier in every one of its automotive pressure sensor applications

Sensata Technologies

Background

Sensata Technologies, formerly the Sensors and Controls division of Texas Instruments, was purchased by Bain Capital from Texas Instruments for $3 billion in April 2006. Sensata produced just over $1 billion in sales in 2005. After the spin-off from TI, the stand-alone company was named Sensata, a Latin word meaning “those things gifted with sense.”

The business was founded in Attleboro, Massachusetts in 1916 as General Plate Company, to provide gold plate for the jewelry industry in nearby Rhode Island. Following a 1931 merger with a Massachusetts thermostat manufacturer, the company, then named Metals & Controls Corporation, began making room thermostats. Its experience in temperature sensing and controls led to a merger with Texas Instruments in 1959. TI started making automotive sensors in 1989 and introduced its popular line of micro-fused silicon strain gauge sensors in 1999. It expanded its automotive product line with the acquisition of Pierburg’s mass airflow sensor business in 2005.

Sensata maintains business and technology centers in Attleboro, Massachusetts in the United States; in Almelo, the Netherlands; and in Oyama, Japan. Primary manufacturing is based in Ajacalientes, Mexico; Baoying and Changzhou, China; and Kuala Lumpur, Malaysia. The Attleboro facility also does limited manufacturing for aircraft and military customers.

The company’s individually tailored sensors and controls product portfolio today includes more than 18,000 different products, with no single product accounting for more than 2.3% of 2005 sales.

Sensata’s new owner, Bain Capital LLC, is an investment firm with headquarters in Boston. Leveraged buyout firms such as Bain Capital leverage their own cash by using mostly borrowed funds to acquire companies. Another recent Bain acquisition with roots in the auto industry is the French connector terminal company FCI (Framatome Connectors International), purchased in November 2005. One of the founders of Bain Capital is Mitt Romney, governor of Massachusetts and aspiring president of the United States.

To finance the acquisition Sensata has borrowed heavily. On April 6, 2006, the company signed up for $1.35 billion worth of secured bank financing, after which, Sensata was assigned junk credit ratings: B+ by Standard & Poor’s and B2 by Moody’s. Both ratings suggest that Sensata’s credit worthiness is vulnerable to adverse business, financial and economic conditions. Given this level of risk, Sensata must pay relatively high interest on the money it borrows.

Distinctions Claimed by Sensata
◆ More than one billion sensors and control devices are produced each year
◆ Sensata’s sensors and controls business is supported by more than 415 patents
◆ Number-one or number-two supplier in every one of its automotive pressure sensor applications

Sensata Technologies

Background

Sensata Technologies, formerly the Sensors and Controls division of Texas Instruments, was purchased by Bain Capital from Texas Instruments for $3 billion in April 2006. Sensata produced just over $1 billion in sales in 2005. After the spin-off from TI, the stand-alone company was named Sensata, a Latin word meaning “those things gifted with sense.”

The business was founded in Attleboro, Massachusetts in 1916 as General Plate Company, to provide gold plate for the jewelry industry in nearby Rhode Island. Following a 1931 merger with a Massachusetts thermostat manufacturer, the company, then named Metals & Controls Corporation, began making room thermostats. Its experience in temperature sensing and controls led to a merger with Texas Instruments in 1959. TI started making automotive sensors in 1989 and introduced its popular line of micro-fused silicon strain gauge sensors in 1999. It expanded its automotive product line with the acquisition of Pierburg’s mass airflow sensor business in 2005.

Sensata maintains business and technology centers in Attleboro, Massachusetts in the United States; in Almelo, the Netherlands; and in Oyama, Japan. Primary manufacturing is based in Ajacalientes, Mexico; Baoying and Changzhou, China; and Kuala Lumpur, Malaysia. The Attleboro facility also does limited manufacturing for aircraft and military customers.

The company’s individually tailored sensors and controls product portfolio today includes more than 18,000 different products, with no single product accounting for more than 2.3% of 2005 sales.

Sensata’s new owner, Bain Capital LLC, is an investment firm with headquarters in Boston. Leveraged buyout firms such as Bain Capital leverage their own cash by using mostly borrowed funds to acquire companies. Another recent Bain acquisition with roots in the auto industry is the French connector terminal company FCI (Framatome Connectors International), purchased in November 2005. One of the founders of Bain Capital is Mitt Romney, governor of Massachusetts and aspiring president of the United States.

To finance the acquisition Sensata has borrowed heavily. On April 6, 2006, the company signed up for $1.35 billion worth of secured bank financing, after which, Sensata was assigned junk credit ratings: B+ by Standard & Poor’s and B2 by Moody’s. Both ratings suggest that Sensata’s credit worthiness is vulnerable to adverse business, financial and economic conditions. Given this level of risk, Sensata must pay relatively high interest on the money it borrows.

Distinctions Claimed by Sensata
◆ More than one billion sensors and control devices are produced each year
◆ Sensata’s sensors and controls business is supported by more than 415 patents
◆ Number-one or number-two supplier in every one of its automotive pressure sensor applications
“What’s different is that now we have they bought our growth strategy,” she said. “When they bought us, that the Sensata strategy will not fundamental change. “When they bought us, that the Sensata strategy will not fundamental change. “When they bought us, that the Sensata strategy will not fundamental change. “When they bought us, that the Sensata strategy will not fundamental change. “When they bought us, that the Sensata strategy will not fundamental change.

Martha Sullivan, chief operating officer of Sensata, has responsibility for the entire operation, with the exception of the finance and human relations functions. Ms. Sullivan, who began working for Sensata in 1984 as a field sales engineer, has steadily risen through the ranks: to Detroit sales manager, to marketing manager of the controls business, to North American general manager of the automotive business, and to sensor product global business unit manager. She graduated from Michigan Technological University with a bachelor’s degree in mechanical engineering. Ms. Sullivan reports to Sensata CEO, Tom Wroe. Sensata management has been given modest equity stakes in the company.

A asked what will be different under Bain’s sponsorship compared with Texas Instruments’ Ms. Sullivan made it clear that the Sensata strategy will not fundamentally change. “When they bought us, they bought our growth strategy,” she said. “What’s different is that now we have more flexibility in how we implement that strategy.” Sensata will continue to self-fund its R&D and capital investments. Aquisitions will not be the means by which the strategy gets implemented, unless, as in the past, all other approaches to implement the strategy are exhausted.

If it were to make an acquisition, Sensata is more interested in acquiring quick access to a new market than it is in acquiring new sensor or control technologies. Sensata takes pride in its ability to apply the know-how it has gained in the automotive market to the other markets it serves, commercial and industrial. In the case of an acquisition outside the automotive industry it would try to transfer that technology back to the auto industry. While the company is naturally biased toward pressure sensors, it would indeed consider other measurement variables.

We asked Ms. Sullivan why customers buy from Sensata rather than from its competitors. “We start with credibility,” she said. “We’ve been in the [automotive sensor] business for 30-plus years and have demonstrated an ability to launch new products with proven technology and then consistently hit cost-reduction and quality targets beyond the launch period. We start with what the customer needs. Because we have a range of fundamental sensor technologies in our portfolio, we can deliver the best solution. We can be more competitive over time, because we’re not starting from scratch with every application.”

In addition, Sensata believes having a global footprint to support customers anytime, anywhere is imperative. The company is well-positioned with technical centers and manufacturing in Asia and North America, and a technical center in Europe. In a description of its business, Sensata writes:

“We believe that our global scale provides us with a cost advantage over our competitors, and this scale combined with our cost-focused approach has created what we believe is the most competitive cost position in the industry. We have achieved our current cost position through a continuous process of migration to lower-cost manufacturing locations, transformation of our supply chain to best-cost sourcing, and ongoing productivity-enhancing initiatives. Over the past ten years we have aggressively shifted our manufacturing base from higher-labor cost countries such as the U.S., Australia, Canada, Italy and The Netherlands to lower-cost countries including China, Mexico, and Malaysia and we continue to increase our use of local suppliers in these locations.”

**Sensors**

Just within the pressure variable, Sensata can apply disc pressure switch technology, capacitive ceramic, poly-silicon strain gauge, micro-fused strain gauge, or MEMS differential fundamentals.

To the fundamental measurement technology Sensata applies its estimable knowledge of the in-car environment, of signal conditioning and of packaging, which isolates the sensor electronics from the deleterious effects of the medium that is being measured.

continued on following page
Eighty-five percent of sensor revenues come from pressure sensors; 80% of sensor revenues come from sales to customers in the automotive industry. Sensata’s sensors are also used in HVAC and other industrial applications.

Sensata’s ceramic capacitive pressure sensors, also called automotive pressure transducers, produced the most sales in 2005, followed by micro-fused silicon strain gauge sensors (MSG) and electromechanical, snap-action pressure switches a close third. Sensata began producing pressure switches before it got into sensors. Almost all of Sensata’s sensor products are application specific, a result of close collaboration with customers.

Sensata’s main competitors in automotive pressure sensors include Bosch, Continental, Delphi, Denso, Freescale, Kavlico, HiStat, Honeywell and Nagano Keiki (in high pressure sensors only).

A acording to Strategy Analytics the global market for automotive pressure sensors will grow from $1.5 billion in 2005 to $2.2 billion by 2008, a 13% annual rate of growth. Part of the growth is fueled by demand for tire pressure sensors mandated by the U.S. government. Sensata makes no tire pressure sensors.

Automotive Pressure Transducers (APTs)

Sensata’s low-cost APTs, by far its best-selling sensors, employ a sensing element comprised of a pair of parallel ceramic plates that function as a variable capacitor. One plate of the capacitor is fashioned into a diaphragm that flexes in response to pressure changes; the other plate is rigid. Because it is made from ceramic materials, the element is compatible with most automotive fluids. Depending on the thickness of the diaphragm, the element can measure liquid pressures up to 5,000 psi. The capacitance of the element varies as a function of pressure. This is converted by a signal conditioning IC, packaged within the transducer, to a voltage that varies linearly over an operating temperature range from minus 40 to 135 degrees C.

Sensata’s APTs are broadly applied in automotive applications such as air conditioning, ABS, engine control, transmission, suspension and power steering.

Micro-Fused Silicon Strain Gauge (MSG) Sensors

Low-cost and highly reliable, Sensata’s MSG technology can be applied either to measure force or pressure. The technology can be used to sense brake hydraulic fluid pressure, for example in electronic stability control applications and diesel or gas fuel-rail injection pressure.

Configured to measure force, MSG sensors are used in passenger seats to detect the presence of an occupant heavy enough to withstand the deployment of the airbag without injury. The technology derives from the piezoresistive effect of silicon, which changes in resistance as a function of mechanical stress. A separate A SiC chip within the sensor package signals the sensor output. Sensata purchases its silicon strain-gauge sensing elements.

One of the fastest growing applications for Sensata’s MSG sensors has been stability control systems. Continental, a major player in stability control systems, is one of Sensata’s largest customers. Continental uses a Sensata pressure sensor in its stability control system to measure the hydraulic pressure of the brake fluid in the master cylinder. Brake pressure measures the force that the driver is placing on the brake pedal, a way to monitor the driver’s intentions.

In April 2006, Continental purchased Motorola’s automotive unit, which also makes sensors that monitor hydraulic brake pressure. It is reasonable to expect that at some point Continental will consider taking the Sensata business in-house. For now, however, the Continental business is safe, according to M. Sullivan.

“We’ve actually had a discussion about that with people at the highest level of Continental Systems and we’ve been assured that our position there will not see a major change,” she said.

In recent years, Sensata has seen significant growth in demand for its MSG elements as load sensors to indicate the weight of the front seat passenger. The demand for these sensors is almost exclusively based on the U.S. government mandate FMVSS 208, which has led most OEMs to suppress airbag deployment when a small passenger is in the front seat. Attached to the seat frame, as many as four MSG sensors have been used in each seat, one per corner.

The rule has been in effect for all light vehicles built for the U.S. market since September 2005, so the mandated market for seat occupant sensors has begun to mature as carmakers look to implement less costly systems. Sensata has a number of projects in the works that use anywhere from one to four sensors in each seat.

In another market development, airbag makers have begun to produce so-called...
low-risk deployment (LRD) airbags that are less dangerous to small passengers. As a result, one carmaker, Chrysler, under the Dodge brand, will put into production several 2007 vehicles that require no passenger classification sensors.

Still, according to M. Sullivan, numerous carmakers will continue to use sensors “in combination with LRD bags.” A nd some carmakers will use occupant detection sensors for purposes other than fulfilling the mandate. For example, some want to go “beyond compliance” and come up with even safer systems that almost completely eliminate the risk of bag injury. According to Sensata, its seat sensors will also be used to trigger the seat belt alert, not only in the front seat but the back as well.

Automotive Pressure Switches

Sensata’s third-best selling products are electromechanical pressure switches, which are based on snap-action discs, technology that was first invented in the 1930s. Th e snap-action disc reacts to changing pressure by reversing its curvature at a pre-designed set point, an action which produces linear motion sufficient to activate an electrical switch, turning it off and on.

Typical pressure switch applications are in air conditioning, for functions such as high pressure cut-out, fan control, compressor control and loss of charge; in transmissions, for hydraulic clutch engagement detection; in power steering, for engine load management; and in low-engine-oil indicators.

New Sensor Products

Generally, Sensata’s new product strategy in the auto industry is driven by the need to improve fuel economy, reduce emissions and improve safety. While the company continues to invest in its pressure portfolio, it has recently started to invest significantly in other parameters.

MEMS Differential Pressure Sensors: A new product, Sensata recently began shipments of a micro-electromechanical system (MEMS) sensor designed to measure back pressure caused by the build-up of soot in particulate filters used in diesel engine exhaust systems. MEMS technology was chosen because of its ability to measure low pressure differences. Sensata expects this technology to mature into a $50 million per year product line in the next several years. While the sensor assembly is designed by Sensata, the MEMS sensing element is purchased from an outside foundry.

Chemical Sensors: In three to four years Sensata expects to see its line of chemical sensors emerge into another $50 million product line. Sensata has been developing a NOx sensor that will be applied to engine emission control systems. Sensata is planning to leverage this technology platform to expand into other engine emission sensors. The output of these sensors will be used to develop core engine control variables and in diagnostics.

In October 2003, Sensata (TI) announced that it would work with AppliedSensors (Linköping, Sweden), a provider of chemical sensor components, to develop an HVAC air intake control module for the automotive industry. Using MEMS technology, the module will detect the presence of NOx, CO and volatile organic compounds and send a signal to the HVAC system to shut off air intake to the passenger compartment.

Humidity Sensors: This year Sensata will launch its new relative humidity sensor into volume production. Used in automotive climate control systems to automatically control windshield defogging and the relative humidity of the cabin, the sensor will lead to improved fuel economy since humidity control optimizes the performance of the A/C compressor and the electric heater.

Sensata’s capacitive sensor responds to changes in relative humidity with changes in permittivity, which is the ability of a nonconducting material to retain energy storage capability. That affects its capacitance. Signal conditioning electronics convert the change in capacitance to a voltage output that’s proportional to the relative humidity. The capacitor is built from porous electrodes arranged inter-digitally with a polymer dielectric in between.

Occupant Seat Sensors: Sensata has a development contract to work on a new sensing approach (new technology to Sensata) that detects a front seat passenger and whether or not it’s safe to deploy a low-risk deployment airbag. More cost effective than existing occupant classification technologies on the market, according to Sensata, this technology can be scaled down for front and/or rear seatbelt alert-only functions.

Controls

A counting for 42% of sales in 2005, Sensata’s controls are customized, application-specific electromechanical devices used to protect systems from excessive heat and electrical current. Most of the Controls division revenue comes from motor controls including motor protectors, thermostats and lighting protectors.

Sensata’s motor controls business serves a diverse group of end markets including commercial and residential HVAC systems, lighting, refrigeration, industrial motors and household appliances.

Sensata attributes its success in the controls business to the breadth and quality of the product portfolio, its competitive costs, and the strength of the Klixon brand of snap-acting bimetal disc devices. Klixon devices include circuit protectors, motor protectors and thermostats.

Employee Moves

To reduce manufacturing costs, in 2003 Sensata announced a plan to move certain production lines out of Attleboro, Massachusetts, and The Netherlands. The restructuring affected a total of about 930 manufacturing jobs and cost $72 million. A s of December 31, 2006, 911 employees were terminated. The restructuring is expected to yield $40 million in benefits and payroll savings each year.

Since the acquisition there have been no new employee reduction initiatives, and none are planned. To support its growth strategy, Sensata has been hiring engineers at its headquarters in Attleboro, in China and in Europe for the last two years and at a slightly faster rate in 2006.

In the first quarter of 2006, Sensata’s capital expenditures were $10 million compared with $12.3 million for the fourth quarter of 2005 and $10.7 million for the first quarter of 2005. •
Chrysler Deploys Low-Risk Airbags That Require No Occupant Sensors

Several Dodge models—Avenger, Magnum, Charger, Nitro, Dakota and Durango—will come equipped in the 2007 model year with low-risk deployment airbags that do not require a weight sensor in the seat. According to DaimlerChrysler, its low-risk deployment front-passerenger airbags use a unique shape, venting, folding patterns, advanced inflators or a combination of these to position and inflate the restraint properly for a belted passenger including out-of-position passengers, small occupants or rear-facing infant seats.

Airbags for sale in the United States are required to have airbags in the front seat. To minimize the risk of injuring small and out-of-position front-seat passengers, those airbags either must be turned off if sensors detect a child or child-sized person or they must deploy in a way that minimizes injury—so-called low-risk deployment. Chrysler is one of the first carmakers to take the low-risk deployment alternative for front passengers, and as a result, will save tens of dollars per vehicle by eliminating occupant classification sensors.

Many more such systems using low-risk deployment airbags to eliminate or minimize the need for passenger seat sensors are in the works from Chrysler and other carmakers. Every airbag supplier we talked to is either developing low-risk airbags or is already in production, including TRW, Autoliv, Delphi and Key Safety Systems.

TRW has been in production since late in the 2006 model year with a low-risk airbag, and Autoliv began producing one this summer for the 2007 model year. A Autoliv says it has “ten more systems coming right behind it. ... A II of our customers and all of our competitors are developing low-risk airbags,” noted Steve Fredin, vice president of automotive engineering for A Autoliv North America. He explained: “If Chrysler or other customers are successful, the market for occupant sensing will disappear fairly rapidly because of the cost and because of the warranty issues with the seat mat sensors or bladders. There have been a handful of recalls on them. You have customers who sit in their cars and the airbag warning light is going on and off and they’re not sure why.” A Autoliv does not produce airbag passenger sensors.

TRW is involved with numerous programs involving low-risk deployment airbags: “A lot of the programs are straight out, low-risk deployments, without sensors. Others will have scaled down, child-seat-only sensing, and very few will have full occupant sensing,” explained Doug Campbell, TRW vice president, occupant safety systems.

The mandate which led to the market for passenger weight and classification sensors, Federal Motor Vehicle Safety Standard 208, required the phase-in of advanced airbags to begin with the 2003 model year, reaching 100% compliance by the 2006 model year. “From a volume perspective, the market for occupant sensing systems in the U.S. has essentially reached its peak,” said Kevin Kincaid, product line architect for occupant sensing technologies at Delphi. “Future occupant sensing systems will be lower cost, not only because the technology is maturing, but also because low-risk deployment airbags put fewer constraints on system design. [Still] there is certainly an opportunity to apply these sensors in other regions of the world.”

While many carmakers will gravitate to low-risk deployment airbags that are designed to passively redirect the energy used to deploy the airbag away from the passenger, Key Safety Systems has developed its TickerTape airbag, an active airbag with a self-contained passenger sensor that actively controls the amount of gas that flows into the airbag. Available for a model year 2008 launch, the TickerTape airbag also does away with seat sensors.

GM’s Larry Burns Is Excited about Convergence 2006

“Convergence is especially relevant now as the DNA of the automobile is changing radically. Several technologies are converging: not just electronics but also fuel cells and better batteries, along with our ability to control the vehicle with by-wire steering and braking, and chassis control. Those things individually are profound, but when you combine them with the connectivity of the vehicle to everything around it—it’s amazing how much better the automobile will be in the future. That is why this is a very timely conference.”

Larry Burns, vice president, R&D and strategic planning for General Motors, is talking about Convergence 2006, the world’s most important automotive electronics conference, which will be held October 16–18, 2006, in Detroit. (For details, visit www.sae.org/convergence.)

We asked Mr. Burns, this year’s conference chair, why people should attend: “It is a good combination of exhibits and technical sessions. If you want to get a good dose of the state-of-the-art, what is going on in automotive electronics, it is a chance to hear from the best technical leaders in the field. A lot of papers are submitted but we have a very strict process for accepting papers, so what is presented is very good. Perhaps most important is the opportunity Convergence provides to network and renew friendships and to build new ones in our industry.”

Out front with leading-edge electronics itself, GM is well qualified to be the Convergence lead sponsor. “Over the last five years we’ve worked hard to create the right architectures for controls, software and electronics so we can get the benefit of scale and competition around the hardware, and be able to reuse software across a variety of suppliers’ hardware,” explained M. Burns. “We want as few architectures worldwide as possible.”

GM is also on the forefront in telecommunications with more than four million OnStar subscribers. According to M. Burns, “OnStar is a success from a business standpoint as the number of people who renew their subscription is consistently above our threshold. ... A s we go forward it becomes the brand foundation and the channel foundation for us to do a lot more things with convergence-like technology. Because the vehicle is connected we can do remote diagnostics and remote prognostics. We have opportunities to couple OnStar with stability control technology and do vehicle-to-vehicle communication and collision avoidance far more affordably than is done today.”