New S-Class Mercedes: Pioneering Electronics

Introduced at the Frankfurt Auto Show in September, the redesigned 2007 S-Class exemplifies the future of automotive electronics. Usually carmakers introduce new electronics features first in luxury vehicles and over the course of a decade or more those improvements trickle down to more affordable vehicles. Given the S-Class starting price in Germany of about €71,000 ($86,800), Mercedes engineers had a huge budget for embedded electronics and a unique opportunity to push the electronics design envelope.

Of all the challenging new and improved features created for the new S-Class, Mercedes vice president, Stephan Wolsfried, said the two he is most proud of are short-range radar and active IR night vision. Other new S-Class features include an eye-pleasing new instrument cluster, electric parking brake, enhanced Pre-Safe (an occupant protection system that anticipates a crash), crash sensors in the doors and HDD navigation, all standard.

Short-Range Radar

Mercedes equipped the 2007 S-Class with six short-range, 24 GHz ultra-wideband radar sensors, four in the front and two in the back. Four of the radar sensors (two facing forward and the two aimed to the rear) are used for the Park Assist feature. The other two forward-mounted short-range sensors complement one 77 GHz, forward-looking long-range sensor to provide autonomous cruise control (ACC) that works even in stop and go traffic. Without the short-range sensors, Mercedes’ Distronic Plus option could only work at speeds from 200 km/h down to 30 km/h. With them, it operates all the way down to zero. The system automatically brings the S-Class to a standstill and accelerates as soon as traffic gets moving again. It adjusts vehicle speed to maintain a safe driving distance to the vehicle ahead, while not exceeding a predetermined speed. With both the short-range and long-range sensors, the ACC system “sees” clearly from 0.2 meters out to 150 meters.

According to Mr. Wolsfried, the greatest challenge with the 24 GHz radar sensors was getting governments to allow their use. "Ultra-wideband radar sensors had not been regulated before," he said. “That was done first in the U.S. and then in Europe. Now we're struggling to get the Japanese to regulate their use." Mercedes is getting its 24 GHz sensors from M/A-Com, a division of Tyco Electronics, which also pioneered with Mercedes in the development of long-range radar sensors starting in 1996.

The short-range radar sensors also improve Mercedes' Brake Assist system, first introduced into series production in 1996. Brake Assist detects a panic stop by measuring the speed with which the brakes are depressed and automatically applies emergency braking pressure. Without Brake Assist, a majority of drivers do not apply sufficient brake force.

The new Brake Assist Plus system installed on the S-Class registers the distance to vehicles ahead, gives the driver an audible warning if the gap is too small and calculates the necessary brake forces needed to avoid a collision. When the driver steps on the brake pedal, the system automatically applies sufficient brake pressure to stop the car. The system doesn’t operate unless the driver’s foot is on the brake pedal. “That’s an important point, because no one has good enough sensors to recognize an emergency braking situation automatically,” noted Mr. Wolsfried.
Active Night Vision

An optional feature, active night vision will Premiere on the S-Class, the first such application in Europe, according to Mercedes. The term active refers to an infrared lighting source in each headlight that throws IR light on the road ahead of the vehicle. Passive night-vision systems don’t use an IR light source.

Since IR light is invisible, it can be aimed beyond the reach of the low beams without dazzling drivers in oncoming lanes. The IR camera picks up objects that are relatively warm, for example, pedestrians and animals. A camera can see even “cool” objects as long as they reflect IR light. The image is displayed on an eight-inch LCD screen situated in the middle of the instrument cluster within an easy glance of the driver.

According to Mr. Wolfsried, some carmakers have stopped using passive night-vision systems because the performance is so poor.

The IR camera is from SMaL Camera Technologies of Cambridge, Massachusetts in the U.S. “We tested a lot of other cameras including some from Hitachi and National Semiconductor, but we liked the SMaL camera the best,” said Mr. Wolfsried. “We brought SMaL together with Bosch to build the system. That was a breakthrough.”

New Instrument Cluster

When sitting at the wheel of the new S-Class, it’s impossible not to notice the attractive, easy-to-read instrument cluster with bright, white-on-black pointers and dial markings. What’s especially cool is the large, 8-inch color LCD located between the stepper-motor-driven mechanical gauges situated on either side for tachometer, fuel-level and engine temperature. When the relatively large LCD is not being used for navigation or night vision monitoring, for warnings or menu display, a circular analog-appearing speedometer gauge fills the digital display and, impressively, looks exactly like the cluster’s mechanical displays. I had to look hard to see a faint line showing the outline of the 8-inch display. When the monitor is otherwise engaged, the speedometer appears as a linear bar at the bottom of the display.

Along with Mercedes engineers, cluster-maker Blaupunkt worked hard to match the colors. The cold-cathode fluorescent tubes that illuminate the pointers and dial markings had to be carefully chosen, and special software was used to perfectly match the color of the LCD’s graphical image. Helping to integrate the look, the black-colored front screen transmits only about 30% of the light to the viewer. The LCD is made by Sharp. According to Blaupunkt, the cluster is just a little more expensive than clusters on competing German luxury cars.

Significant Quality Improvements Expected

Mercedes’ estimable reputation for quality has been damaged in recent years as electronics complexity has risen sharply. The new S-Class employs seven communication buses plus a CAN backbone and as many as 72 microcontrollers compared with 40 to 45 microcontrollers in the prior S-Class. Despite the substantial addition of new electronics capability, Mr. Wolfsried is confident that the new S-Class will perform very reliably.

“We tested to an extent we have never done before,” he noted. “From the beginning we produced clear, professional specifications not only for our suppliers, but also to establish the way we test what they design.” Mercedes uses definition and special software was used to perform complete HIL system test of malfunctions. “In former times we had a lot of open issues, because we had difficulties reproducing them,” he said. “[With the S-Class] we spent a lot less time analyzing what went wrong and could concentrate on debugging at the suppliers, testing and verifying.”

Mr. Wolfsried is so confident that his tools and processes will yield sufficiently mature software that he now expects to focus not on software development, but on improving the reliability of hardware. For example, he would like to replace CD and DVD playback mechanisms with non-volatile memories that work reliably throughout the automotive temperature range.

---

Other New S-Class Standard Features

- Direct Select shift buttons and electronic shift lever on the steering wheel
- Adaptive brake lights

Optional Features

- Bi-xenon headlamps with cornering light function
- Rear camera for reverse
- HDD navigation
- DVD drive and PCMCIA slot
- DVD changer
- Harman Kardon surround sound

---

Online Help for Industry Researchers

Remember, if you are looking for a concise, in-depth look at any of the major automotive electronics suppliers, be sure to consult the Index of Company Profiles at The Hansen Report website, www.hansenreport.com. Back issues from 1996 to the present can be purchased and downloaded for $50 each.

The Hansen Report on Automotive Electronics

© 2005 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 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/ Brianne Wolfe
Circulation Manager

ISSN 1040-1105
Siemens VDO engineers recently took me for a test drive around Frankfurt, Germany, in a BMW 5 Series that was equipped with a fully-functional cockpit module based on CESA R— for Cockpit Electromechanical System Architecture—Siemens' new modular approach to custom-designed cockpit electronics. Siemens says that by using CESA R processes it can fully design an all-new cockpit including instrument cluster, head-up display, center stack with radio head unit and HVAC controls, multifunction displays and switches, and perform crash testing in as little as 10 months. Ordinarily that kind of custom design and testing takes 24 to 36 months. Further, CESA R can reduce the cost of cockpits by as much as 30% by using integrated components, optimized E/E architecture, modular sourcing and preassembly. Without CESA R, cockpit modules including electronics and software typically cost carmakers between $1,000 and $2,000.

A custom design implemented within the CESA R platform encompasses not only the electronics hardware and software but also the light-weight magnesium frame that supports the cockpit electronics and wiring. The engineer starts working on the design process using a computer-aided engineering tool, which graphically captures the design requirements and automatically generates software code. The CESA R architecture employs a modular approach to software similar to Autosar, the standard being developed globally that will let carmakers reuse software modules across models. The trend by carmakers to outsource fully engineered and instrumented cockpit modules has run hot and cold. One of the pioneers of cockpit/instrument panel module sourcing in the mid-1990s, Volkswagen, later cooled to the idea. But according to Siemens VDO, Volkswagen is again keen on the approach. After VW, the hottest customers for cockpit modules are in North America, where Ford and DaimlerChrysler are interested, and in China, where Siemens cockpit engineers have been spending a lot of time recently. Siemens VDO expects to receive its first order for a CESA R cockpit module this December, and to start shipping completed modules in 2008 or 2009.

"M-modules are very hard to sell unless carmakers can organize themselves into project teams with representatives from each of the functional areas [including interior and HMI design, infotainment, instrument cluster and climate-control engineering]," noted director of cockpit module systems integration for Siemens VDO, Jörg Kiefer. According to Siemens, no more than 5% of the vehicles built worldwide use fully-engineered, outsourced modules.

Continental benefitted from growth in the ESC market in 2004 with a 37% increase in ESC sales, to 4.3 million systems.

While Europe currently leads the way in ESC penetration, by 2008 more than half of all new light vehicles in both North America and Europe will be equipped with the feature. ESC installation in Japan will not reach 50% until 2010, according to Continental’s estimates.

One particularly impressive feature of the CESA R-enabled system design was the ability of some of the switches to recognize which occupant was using them and as a result perform differently. As the passenger, I could input a new destination into the navigation system while the car was underway, using a rotary, haptic, multifunction switch located on the center console. If the driver activated that multifunction switch destination input was not allowed. The single set of climate control switches could also recognize who was using them and make temperature and fan adjustments accordingly.

The switch recognizes it has been touched by sensing a change in capacitance; it immediately transfers an exceedingly low current (micro-amps), low voltage (3- to 5-volt) sinusoidal signal to the person who touched it. That signal is detected inductively by seat warmer coils, which are integrated into the seat. By determining which seat has picked up the signal, the switch knows who is operating it, the driver or the passenger.

Conti Teves Forecasts ESC Penetration Through 2010

Continental benefitted from growth in the ESC market in 2004 with a 37% increase in ESC sales, to 4.3 million systems.

While Europe currently leads the way in ESC penetration, by 2008 more than half of all new light vehicles in both North America and Europe will be equipped with the feature. ESC installation in Japan will not reach 50% until 2010, according to Continental’s estimates.
IEE International Electronics & Engineering
Zone Industrielle – Findel, 2b route de Trèves,
L-2632 Luxembourg; Telephone: 352 42 47 37 1; Fax: 352 42 47 37 200; www.iee.lu

1994, IEE began pursuing the automotive market starting in 1994, IEE product sales. With shipments to customers in the automotive market starting in 1994, IEE began pursuing the automotive market globally in 1998. By the end of December 2005, IEE will own full rights to manufacture products based on FSR technology in any market it chooses. IEE’s rights to FSR technology will be equal to Interlink’s.

In July 2004, SNCI and Arcelor sold their position in IEE to Apax Partners, a private equity investment firm based in London, which now holds 70% of the company. The remaining 30% is held equally by top IEE managers and by investment firms BGI Investment Partners and Luxempart. On the basis of those transactions, IEE was valued at €125 million ($155 million).

Since 1997 sales have grown at roughly 20% per year through 2004, and that level of growth is projected through 2009. While not a matter of public record, IEE says it has been profitable at least for the last five years.

IEE operates two facilities in Luxembourg: Headquarters are located near Luxembourg International Airport (Findel); a 6,150-square-meter production plant, which came on stream in 1999, is located on the outskirts of Echternach, in Eastern Luxembourg near the German border. IEE maintains offices in Seoul, Korea, with 22 employees, and in Auburn Hills, Michigan, with 56 employees. Employees at the offices work in program management, sales, quality and application engineering. IEE products are manufactured in-house in Luxembourg and some of its simpler products are contract-manufactured in Slovakia. Because each IEE seat sensor is customized for a particular seat, production runs are relatively small and labor content relatively high. In 2004 sales per employee were just €132,519 ($164,334). IEE will likely move some assembly operations to Asia in the near future.

IEE’s two fastest-growing products are those that function as occupant classification sensors (and qualify under FMVSS 208) and seat belt reminders.

**FMVSS 208 Market in the United States**

<table>
<thead>
<tr>
<th>Application</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupant classification</td>
<td>53%</td>
</tr>
</tbody>
</table>

**For Vehicles Sold in Europe and Asia**

<table>
<thead>
<tr>
<th>Application</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger presence detection</td>
<td>12%</td>
</tr>
<tr>
<td>Passenger presence detection with electronics</td>
<td>6%</td>
</tr>
<tr>
<td>Child presence and orientation detection</td>
<td>12%</td>
</tr>
<tr>
<td>Occupant classification/child presence and orientation detection</td>
<td>16%</td>
</tr>
<tr>
<td>Seat belt reminder</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Most sales are for vehicles sold in Europe.

**IEE Sales by Year in € millions ($ millions)**

- 1997 to 2004 Annual Growth Rate: 20.9%
- 2004 to 2009 Forecasted Annual Growth Rate: 21.0%

**IEE Sales by Product and by Region in Which Vehicles Are Sold**

2005 Sales: €124.7 million ($154.6 million)

<table>
<thead>
<tr>
<th>Market</th>
<th>Sales Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbag applications</td>
<td>1%</td>
</tr>
<tr>
<td>Passenger presence detection</td>
<td>12%</td>
</tr>
<tr>
<td>Child presence and orientation detection</td>
<td>6%</td>
</tr>
<tr>
<td>Occupant classification/child presence and orientation detection</td>
<td>12%</td>
</tr>
<tr>
<td>Seat belt reminder</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Most sales are for vehicles sold in Europe.

**IEE 2004 Served Market**

About €2 billion ($2.5 billion)

**IEE Central Region Sales, € millions ($ millions)**

- 1997: (31.7)
- 1998: (51.0)
- 1999: (62.2)
- 2000: (69.5)
- 2001: (79.7)
- 2002: (81.1)
- 2003: (80.5)
- 2004: (96.8)
- 2005: (148.8)
- 2006: (185.7)
- 2007: (232.3)
- 2008: (251.5)
- 2009: (311.9)

*Most sales are for vehicles sold in Europe.

**IEE 2004 R&D**

€2.5 billion ($154.6 million)

**IEE 2005 Sales per Employee**

€132,519 ($164,334).

**IEE Ownership**

IEE top managers own 10%. 

**IEE Employment**

IEE employees were just 12% of total employment (315 employees). In 2005, total employment was 941 as of July 2005, 12% of whom work in R&D.

**IEE 2005 Sales**

€124.7 million ($154.6 million)

**IEE Top End-Use Customers**

Hyundai/Kia with 35.2% of sales; BMW with 19.6% of sales; PSA with 11.5% of sales; Audi with 7.5% of sales; the remaining 5% of sales are generated by other car manufacturers.

**IEE markets**

Markets Automotive customers account for 97% of sales.

**IEE Background**

IEE came to life in 1989 when the government of Luxembourg helped finance a new joint venture with U.S. startup Interlink Electronics, now of Camarillo, California. The joint venture was formed to pursue the European market for products based on Interlink’s force sensing resistor (FSR) technology. Together, the Société Nationale de Crédit et d’Investissement (SNCI), a venture capital bank of the Luxembourg government, and Arcelor, a Luxembourg steel company, purchased 50% of the company. Interlink Electronics held the remaining 50%.

Today the basic FSR technology licensed from Interlink underpins 96% of IEE product sales. With shipments to customers in the automotive market starting in 1994, IEE began pursuing the automotive market globally in 1998. By the end of December 2005, IEE will own full rights to manufacture products based on FSR technology in any market it chooses. IEE’s rights to FSR technology will be equal to Interlink’s.

In July 2004, SNCI and Arcelor sold their position in IEE to Apax Partners, a private equity investment firm based in London, which now holds 70% of the company. The remaining 30% is held equally by top IEE managers and by investment firms BGI Investment Partners and Luxempart. On the basis of those transactions, IEE was valued at €125 million ($155 million)

Since 1997 sales have grown at roughly 20% per year through 2004, and that level of growth is projected through 2009. While not a matter of public record, IEE says it has been profitable at least for the last five years.

IEE operates two facilities in Luxembourg: Headquarters are located near Luxembourg International Airport (Findel); a 6,150-square-meter production plant, which came on stream in 1999, is located on the outskirts of Echternach, in Eastern Luxembourg near the German border. IEE maintains offices in Seoul, Korea, with 22 employees, and in Auburn Hills, Michigan, with 56 employees. Employees at the offices work in program management, sales, quality and application engineering. IEE products are manufactured in-house in Luxembourg and some of its simpler products are contract-manufactured in Slovakia. Because each IEE seat sensor is customized for a particular seat, production runs are relatively small and labor content relatively high. In 2004 sales per employee were just €132,519 ($164,334). IEE will likely move some assembly operations to Asia in the near future.

**IEE’s Key Automotive Products**

Occupant presence and occupant classification sensing systems

**IEE’s Key Technology**

Force sensing resistor (FSR) technology supports 96% of IEE sales.
Why do customers buy from IEE rather than from its competitors? A relatively small company, IEE is focused almost exclusively on the automotive market. Said Rod Holmes, president of IEE Automotive Electronics, Inc., “Over the years we have gained manufacturing knowledge that enables us to manufacture products to automotive specification with high integrity and reliability.”

The automotive market today accounts for 97% of IEE sales. IEE expects that number to decline to about 88% as it picks up business in other markets, including communications. The company is currently developing combination electroluminescent-force sensing resistor panels for cell phones, which could go into production in a few years.

IEE’s Force Sensing Resistor

Force Sensing Resistor and FSR are registered trademarks of Interlink Electronics, Inc., which licenses the technology to IEE. After December 2005, FSR will also be registered to IEE. IEE’s occupant sensing applications use arrays of 10, 20 or 100 or more FSR cells. FSR cells are made by gluing two non-conducting polymer substrates together with a spacer in between. On one substrate silver conductive ink is screen printed with an open space along the lead, so no current can flow. On the other substrate, a resistive layer is printed from carbon particles (graphite) that line up with the open space. A 10-mm diameter hole is cut out of the spacer allowing the two halves of the sensor to touch. A pressure is applied that squeezes the substrates together, the circuit is closed and current can flow but with resistance. As the pressure increases, the resistance to current flow decreases. FSR arrays are flexible, which makes them well-suited to measuring the interface pressure between two soft objects, for example, a passenger and the seat upholstery. They can easily be adapted to any passenger seat. A typical flat execution of an FSR array measures just 500 microns thick. While FSRs are not suited to exact pressure measurement—FSR technology provides only qualitative pressure measurements—they are sufficiently accurate for occupant sensing and passenger classification systems in airbag applications. To make the sensors, IEE prints the carbon particles and electrodes on a variety of polyvinyl materials. IEE force sensing arrays measure temperature to compensate for the variation in resistance caused by changes in ambient temperature.

Occupant Classification Systems

By far IEE’s biggest application of FSR arrays is occupant classification (OC) sensors, which are used to classify what’s in the passenger seat. The airbag system can use that information to determine whether and how aggressively to inflate the airbag, thus minimizing the risk to restrained and unrestrained infants, children and small stature adults, while still providing full protection to average stature and large adults. Occupant classification sensors accounted for 69% of company sales in 2004.

continued on following page
IEE’s OC system classifies occupants according to the pattern created by mapping the resistance of all the FSR cells in a seat array. That resistance pattern indicates what’s in the seat. “We look at the weight and the pattern created by pressure peaks, which match the two bones in a person’s bottom. That pattern tells us whether it’s a large or small person,” explained Michel Witte, executive vice president responsible for global sales and marketing, program management and advanced product engineering. It can also indicate the bottom of a child safety seat.

IEE’s second-generation OC system can provide information to multi-stage seatbelt pretensioners and multi-stage/variable airbag inflators. The output can also be fed to the climate control system to turn the passenger side of the system off when no one is present.

The market for OC sensors can be divided into two segments: the European high-end, luxury car market, which IEE has served since the mid-1990s, and the mandated U.S. market. The U.S. market, about $15 billion in MY 2006, is IEE’s fastest-growing market segment, developed as a result of FMVSS (Federal Motor Vehicle Safety Standard) 208, also known as the Advanced Airbag mandate. “Prior to FMVSS 208, our biggest customers were Mercedes and BMW. We had no business in North America,” said Tom Kowalski, vice president of sales and marketing for IEE Automotive USA. One sensor per vehicle is required to comply with the mandate. Ranging in price from about $70 to $80 each today, as the market expands the price of these sensors will drop by about $5 to $6 per year.

NHTSA Advanced Airbag Ruling

In May 2000, NHTSA amended FMVSS 208 to address the risk of death and injury to children, people of small stature and out-of-position passengers caused by airbag deployment. While NHTSA maintains that children should never ride in the front seat, it acknowledges the reality that sometimes they do and adopted more rigorous testing requirements to minimize their risk of injury from airbags. These include tests with rear-facing child seats holding a one-year-old dummy, for three- and six-year-old dummies, and for fifth-percentile adult female dummies. To comply with the test requirements carmakers could choose either to suppress the airbag in the presence of any of those three types of occupants or deploy the airbag less forcefully, in a way that would not harm the occupant, a so-called low-risk deployment.

Beginning September 1, 2003, 20% of each manufacturer’s vehicles intended for sale in the United States had to meet NHTSA’s advanced frontal airbag requirements. The percentage increased to 65% by September 1, 2004 for 2005 model year vehicles. All passenger cars and light trucks produced after September 1, 2005 must have advanced frontal airbags.

Given the available technology, most carmakers initially opted for suppression over low-risk deployment, “In model year 2004 and 2005 low-risk deployment was not a factor ... it was 100% suppression,” said Mr. Kowalski. “A time has gone on, the airbag companies are seizing the opportunity to develop low-risk systems that deploy under all circumstances and still meet the injury criteria.”

In model year 2006-2007, carmakers will begin to introduce low-risk deployment airbags, which, depending on the occupant’s size and position, deploy with the appropriate force and size. Currently no data exists to support airbag deployment in the presence of a rear-facing infant seat, but in some circumstances it could be beneficial to deploy if a child is in a front-facing infant seat.

Child Seat Detection

IEE’s child seat presence and orientation detection (CPOD) system has been used in production vehicles since its introduction in 1996 on the Mercedes SLK. Since then, IEE has shipped more than five million CPOD systems. The CPOD system uses transponders, antennas and electronics. Two transponders are integrated with the child safety seat, one on the left side and one on the right. Three antennas are printed on top of an FSR array seat sensor, one for transmitting and two for receiving. The transmitting antenna’s electromagnetic field energizes the transponders, which transmit back a modulated signal according to their embedded data on the type of seat and the seat’s position relative to the receivers. The CPOD system determines if a child safety seat is present and determines its orientation and classification. If the child seat is rear facing or out-of-position, the system transmits this information to the airbag control unit which makes the decision to deploy or not deploy the airbag.

While IEE has developed a version of its CPOD system to meet the demands of FMVSS 208, it is not clear today whether the system will ultimately win U.S. government approval. So far, no carmakers producing in the U.S. have chosen IEE’s CPOD system. The problem with the CPOD approach is that there is no way to ensure that all child safety seats will be embedded with transponders the system can read. According to Mr. Witte, 40% to 50% of child car seats made in Europe have embedded tags manufactured by IEE, a number that is growing, but there is no such trend underway in the U.S.

IEE has developed an occupant classification product it calls BodySense, which combines an FSR array with capacitive sensing to more accurately determine what is in the seat. Not only does the capacitive sensor provide a signal that varies according to what is in the seat, an occupied child seat for example, it also provides information to confirm that a larger person is sitting in the seat. A capacitive sensor foamed into the floor carpet can confirm that a person tall enough to have his feet on the floor is occupying the seat. “BodySense is less expensive than other sensors because it provides information that is more robust, and that places fewer demands on the detection algorithm and the electronics required to process it,” explained Mr. Witte. In 2008 Mercedes will...
be the first carmaker to employ Body-Sense in a production vehicle. Body Sense is compliant with FMVSS 208 requirements for low-risk deployment in the presence of an occupied child seat.

New Products

While IEE expects its share of the market for FMVSS 208-compliant sensors to grow from 7% in MY 2006 to 11% or 12% in MY 2008, the company faces increasing competition in that market from larger, established players like Delphi, Aisin, Takata and TRW. The global proliferation of smart airbags and side airbag systems offer new opportunities for IEE’s occupant position sensing technology.

3D Camera System

With the help of CSEM (the Swiss Center for Electronics and Microtechnology Inc.), IEE developed a 3D video imager capable of producing complete information about what’s in the seat in order to reliably decide whether and how to deploy an airbag. To meet the FMVSS 208 requirements for an out-of-position front-seat passenger, only one camera is needed. That same camera could also provide information about the driver, depending on the systems specification. More sophisticated airbag systems would require two cameras.

"With the 3D camera you can measure the distances between the person and the dashboard, the person and the steering wheel and give a clear indication as to whether or not the person is in a safe position to be protected by the airbag," explained Mr. Witte. The visual image is also used to classify occupants by size. Further, the system is also able to detect child seats and determine their orientation to the airbag. The system combines static occupant classification with dynamic occupant out-of-position sensing. The IEE system gets a distance measurement by analyzing the phase-shift between emitted and reflected light, the intensity of which has been modulated at a known frequency.

The most challenging aspect of the 3D development was coming up with the imager itself, Mr. Witte told us. IEE developed the 3D image sensor IC with ZMD AG, an analog mixed-signal semiconductor maker headquartered in Dresden, Germany. IEE holds the exclusive worldwide rights to the technology. With an order, IEE could have the 3D imager ready for production in mid-2008. A B-sample of the 3D camera is presently available. (While not made using mass production tools, a B-sample demonstrates mass-production aspects.)

IEE’s 3D imager technology is also applicable to side-impact sensors that indicate at what angle and how fast an object is traveling relative to the vehicle to better activate the protection system.

Pedestrian Protection

Responding to directives from Europe and Asia, IEE has developed an active pedestrian protection system that helps to lessen the degree of injury to pedestrians hit by a moving vehicle. The system consists of an FSR impact detector integrated into the front bumper, an electronics processing unit to run the IEE-developed detection algorithm and an actuator that lifts the hood away from the engine block so it can deform, absorbing much of the impact from the collision, softening the blow to the pedestrian.

According to Mr. Witte, Opel recently completed an engineering project that benchmarks the IEE system along with systems from competing manufacturers. While the Opel division is leaning toward a passive pedestrian protection system, Opel conducted the tests on behalf of other GM divisions including Cadillac, which are considering active approaches like IEE’s. “Our system is inexpensive and ready for manufacture, but what really distinguishes us is our force sensing resistor technology,” declared Mr. Witte.

Built into the hood’s hinges, the actuator is spring-loaded to propel the hood from 8 to 12 cm away from the engine block upon actuation. The hinge is reloaded simply by opening and closing the hood.

European Directive to Reduce Injuries to Pedestrians

A 2003 Directive passed by the European Union was designed to reduce injuries to pedestrians struck by cars.

Beginning in October 2005 all new light vehicle types (platforms) sold in Europe weighing up to 2,500 kg must conform to impact thresholds for head and lower leg injuries specified in phase one of the Directive. Among the solutions developed by the market for meeting the test parameters are: reshaping the front of the vehicle, installing active hoods with hinges that release on impact, external airbags and foam-padded bumpers. Starting in 2012, any new vehicle must comply with phase one requirements.

Phase two of the Directive, effective from 2010 for new vehicle types and from 2015 for all new vehicles, called for stricter test requirements: two tests for head injuries and two tests for leg injuries. Carmakers contended that the phase two requirements were not technically feasible and proposed modified passive requirements combined with crash avoidance technology, specifically brake assist, as an alternative approach to protecting pedestrians. An amendment to the regulation reflecting these changes has been proposed and will require legislative approval.

Flat Illuminated Switches

IEE is developing inexpensive, thin, flexible switch panels made from electroluminescent (EL) lamps combined with switches based on IEE’s force sensing resistor (FSR) technology. Only 200 to 300 microns thick and flexible enough to conform to complex shapes, the lighted switches are especially suited to non-flat surfaces where there is too little depth behind the switch for mechanical components.

At least three years from high-volume production, IEE’s challenge is to find the best way to provide feedback so the user knows his switch action was processed. Both the EL lamp and FSR switches are manufactured using screen-printing processes. IEE has been working on EL technology with the Durel division of Rogers Corp., Chandler, Arizona, a high-volume manufacturer of EL backlighting and integrated circuit EL drivers. EL displays require 110 volts of alternating current at 400 Hz. ◆
BMW had hoped to employ Autosar in its most advanced vehicle yet, the redesigned 7 Series, due in the fall of 2008, but bench tests last spring uncovered some issues. For example, Autosar software was slowing down computer processing more than expected. That was one of the factors that forced BMW to scale back its implementation of Autosar to only some control systems on the new 7 Series.

Dr. Scharnhorst cautioned, “Anybody who takes our specification right now and tries to implement it in time for 2008 production is taking some risk that there might be changes in the future, although any changes would be minor.”

Among the initial supporters of Autosar—Volkswagen, DaimlerChrysler and BMW—BMW has been the most outspoken about making sure that Autosar works and gets done as soon as possible. One of BMW’s concerns is that when the Autosar partnership grew to include more of the world’s carmakers, those carmakers’ individual requirements have made the specification unwieldy. “The standard is huge, and sometimes if a standard is too big it is not effective,” noted Karl-Heinz Gaubatz, general manager of chassis electronics development at BMW. “The Autosar operating system takes up 256K of flash memory in an ECU. If you want to add Autosar to the microcontroller for a door opener, which only uses, say, 64K of flash, you have to take 512K of flash. That isn’t cost effective,” he said.

According to A. utosar, the partnership has “unofficially” decided that the minimum requirement to accommodate Autosar’s run-time environment and middleware is a 16-bit processor with 128K for memory storage. Literally, BMW’s Mr. Gaubatz would like Autosar to develop three levels of Autosar: a premium class, middle class and a lower class. “For something small like a door-opening system, I want a very small operating system where I need only, say, 122K of flash, 1K of RAM and 10% of my CPU [for Autosar software]. The premium class of Autosar could require 256K of flash, 12K of RAM and 20% of my CPU performance.”

Another issue for Autosar developers is deciding just how finely to divide applications into separate functional modules that can plug and play within the Autosar architecture. Suppliers are concerned that if carmakers can divide functions like the brake system into small separate plug-and-play pieces, they would expose too much of suppliers’ proprietary intellectual property without financial compensation.

While he very much supports Autosar, Karl-Thomas Neumann, president of Continental Automotive Systems, told us recently that he wants to be sure the standard protects Continental’s intellectual property. “The question is how open we must be and to what degree should we dismantle our functional architecture. If you go down to a very low level of granularity, which is what some in Autosar want, then we think we give away too much of our IP. If you can see these little pieces, at some point you can understand how they work together.” A. utosar Dr. Neumann, the unit within Autosar that is dealing with the business model is not making much progress.

For now Autosar will keep its functional interfaces at a rudimentary level, for example, between the engine and the braking system. Dr. Scharnhorst noted, “We do not have to standardize the whole functional architecture in one step. Let’s wait a little bit.”

According to Dr. Scharnhorst, Volkswagen will begin migrating Autosar into production vehicles starting in 2009, only as new ECUs are introduced. Autosar won’t be applied to a whole Volkswagen vehicle at least until 2011 when the carmaker brings a new platform to market.◆

<table>
<thead>
<tr>
<th>Penetration of In-Dash Screens in New Vehicles</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Displays</td>
<td>2.5</td>
<td>2.9</td>
<td>3.2</td>
<td>3.7</td>
<td>4.0</td>
<td>4.3</td>
<td>4.6</td>
</tr>
<tr>
<td>New Vehicle Sales</td>
<td>5.7</td>
<td>5.7</td>
<td>5.8</td>
<td>5.9</td>
<td>6.0</td>
<td>6.0</td>
<td>6.1</td>
</tr>
<tr>
<td>Penetration</td>
<td>44%</td>
<td>51%</td>
<td>55%</td>
<td>63%</td>
<td>67%</td>
<td>72%</td>
<td>75%</td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Displays</td>
<td>1.5</td>
<td>1.8</td>
<td>2.2</td>
<td>2.9</td>
<td>3.7</td>
<td>4.6</td>
<td>5.1</td>
</tr>
<tr>
<td>New Vehicle Sales</td>
<td>16.9</td>
<td>16.9</td>
<td>17.1</td>
<td>17.3</td>
<td>17.5</td>
<td>17.8</td>
<td>17.9</td>
</tr>
<tr>
<td>Penetration</td>
<td>9%</td>
<td>11%</td>
<td>13%</td>
<td>17%</td>
<td>21%</td>
<td>26%</td>
<td>28%</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Displays</td>
<td>1.6</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>3.6</td>
<td>4.5</td>
<td>5.2</td>
</tr>
<tr>
<td>New Vehicle Sales</td>
<td>19.9</td>
<td>19.8</td>
<td>20.2</td>
<td>21.2</td>
<td>22.1</td>
<td>22.6</td>
<td>22.8</td>
</tr>
<tr>
<td>Penetration</td>
<td>8%</td>
<td>10%</td>
<td>12%</td>
<td>14%</td>
<td>16%</td>
<td>20%</td>
<td>23%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Displays</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.3</td>
<td>0.6</td>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>New Vehicle Sales</td>
<td>19.0</td>
<td>20.5</td>
<td>22.3</td>
<td>24.2</td>
<td>25.9</td>
<td>27.7</td>
<td>29.4</td>
</tr>
<tr>
<td>Penetration</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>5.6</td>
<td>6.7</td>
<td>8.0</td>
<td>9.9</td>
<td>11.9</td>
<td>14.2</td>
<td>16.4</td>
</tr>
<tr>
<td>New Vehicle Sales</td>
<td>61.5</td>
<td>62.9</td>
<td>65.4</td>
<td>68.6</td>
<td>71.5</td>
<td>74.1</td>
<td>76.2</td>
</tr>
<tr>
<td>Penetration</td>
<td>9%</td>
<td>11%</td>
<td>12%</td>
<td>14%</td>
<td>17%</td>
<td>19%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Data: Alpine Electronics