Car Makers Speak About Electronics Standards

Convergence Panelists Indicate Which Standards OEMs Will Adopt

As car makers around the world begin to reap the benefits of common electronics standards, they are getting faster at finding agreement on which standards to adopt. The top electrical engineers who participated in the Car Makers Speak panel discussion during last month’s Convergence conference in Detroit were unanimous on two standards that have found broad application very quickly. All six panelists indicated that iPod and USB connectivity would find high volume application within the next five to seven years at their companies. A number of OEMs already provide an audio jack for iPod, and some even offer the proprietary iPod connector, which allows drivers to use the vehicle’s embedded display and switches to more safely control their iPods while driving. In contrast, it took well over a decade for CAN (controller area network) to find such wide adoption, though it should be said that implementing an in-vehicle CAN data bus for the first time is a far more complicated matter than providing connectivity for MP3 players.

There was also general agreement, with only one exception each, on three other standards: the AUTOSAR software architecture standard, and the FlexRay and LIN networking protocols. The slowest communications network, LIN, is used in sub-buses, for example in door modules to connect switches to motor actuators. FlexRay is a high-speed networking protocol suitable for safety-critical applications that will begin to replace CAN once costs come down.

There was less agreement, however, about MOST, the multimedia network standard that German carmakers have been promoting at least since 1998. Only two of our panelists indicated the adoption of MOST in high volume applications: DaimlerChrysler has been using MOST in Mercedes vehicles since the 2002 model year, and Hyundai’s panelist, Woong-chul Yang, said MOST would find limited application. The other four panelists indicated they do not expect to use MOST in high volume.

Panelists responded yes (Y) or no (N) when asked if these standards would find high volume production (more than 200,000 units per year) at their companies in the next five to seven years.

<table>
<thead>
<tr>
<th>Panelist</th>
<th>AUTOSAR</th>
<th>FlexRay</th>
<th>Java</th>
<th>iPod</th>
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<tr>
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New Features Must Depend on Cost Reductions of Existing Features

Ever since automotive engineers first applied silicon to engine controls, electronics parts have accounted for an increasing percentage of the cost of building an automobile. Over the years, electronics rapidly enabled new features and at the same time replaced or were integrated into mechanical parts. This fueled annual double-digit growth rates of the automotive electronics industry throughout the 1980s and into the 1990s. Engine control systems grew more sophisticated, ABS and airbags proliferated and audio systems improved. Throughout the late 1990s and into the new millennium, electronics continued to grow as a percentage of the vehicle’s cost but at a slower pace, and the average growth rate of the automotive electronics market slowed to approximately 7% per year.

But now it appears that the penetration of electronics in cars has plateaued, according to the Car Makers Speak panelists at Convergence 2006. Bill Mattingly, top electrical engineer at Chrysler, put it this way, and the other panelists seemed to agree: “I don’t believe, unless there is a fundamental shift in the powertrain such as fuel cells or a high penetration of hybrids, there is going to be a significant jump again. The percentage of vehicle costs devoted to electronics has leveled out.” According to the panelists, electronics account for 15% to 30% of the total cost, depending on the vehicle’s price tag. MOST vehicles are produced with 20% to 25% of their cost from electronics.

With electronics penetration leveling, market growth can come only from cost reductions of existing features.
Hella D emos A utomatic P arking

Hella, the privately held German auto parts supplier, branching out further from its lighting roots, was at Convergence in Detroit last month showing a Volkswagen Touran equipped with a new automatic parking system. Hella’s system measures potential parking places as the car passes them and indicates if the space is big enough. The driver puts the vehicle in reverse, lets go of the steering wheel, and the system steers itself toward the curb. Throw the car into drive and the steering wheel turns the other way, bringing the car parallel to — and in my demo, within a foot of — the curb. Hella’s parking assistant can accurately size up the parking space from as far away as five meters at vehicle speeds as high as 40 km/h. If the parking space measures at least 1.3 car lengths, the system can park with just one reverse and one forward motion. The driver can override the system at any time.

Hella has already booked an order for its electronic parking assistant with a European carmaker with production starting in 2009; the company is also talking to North American carmakers who, it says, are asking for the feature. One appeal of Hella’s system is its price, which is about €300 ($384) retail, not including electric power steering, a display and ABS wheel-speed sensors, all necessary components of automatic parking.

The Hella system uses one ultrasonic sensor on each side of the vehicle. The sensors must be installed with their surface exposed to the outside air, which carries the acoustic signal. Positioned near the A-pillar, each sensor measures about three-fourths of an inch by one-half inch. Hella will purchase the ultrasonic sensor elements from an outside supplier.

A late entrant into the market for automatic parking systems, Hella had only a year to develop a working prototype, including the control algorithm, electronics and system human machine interface. Hella says that its seamless simulation tool chain, including tools from The Math-Works, was essential to meeting its tight schedule.

An automatic parking system from Valeo called Park4U is scheduled for production on the Touran in 2007. Valeo’s system, which uses ten ultrasonic sensors, can identify a parking spot while cruising at 30 km/h. A system with the Hella system, the driver is responsible for accelerating and braking. Toyota first introduced automatic parking, developed in cooperation with Aisin Seiki, on the 2003 Prius in Japan. A similar system comes to the United States on the 2007 Lexus LS 460. Continental A utomotive S ystems is also developing an automatic parking product. ◆

Semiconductor Industry Ripe for Major Consolidation

Its Interest in Acquiring Philips Semiconductors Led to Freescale’s Acquisition by Blackstone

“Consolidation is a sign of a maturing industry and a necessity for semiconductor makers when building the next wafer fab costs three, four or five billion dollars in addition to what we have to spend on R&D to stay competitive,” explained Paul Grimme, senior VP and general manager of Freescale’s Transportation and Standard Product Group. Shortly after announcing on September 15, 2006 its decision to be acquired by the private equity firm The Blackstone Group, Freescale’s board of directors identified six potential strategic partners. Freescale believes these companies, based on their size and business focus, might be interested in merging with Freescale.

In fact, Freescale’s interest in acquiring the semiconductor business of Philips Electronics is what led to the discussions begun nearly a year ago with Blackstone, who could potentially financially support the acquisitions being considered by Freescale. At that time, Freescale was also having discussions with an unnamed, large company in the semiconductor business about a potential merger.

Well aware that a merger between semiconductor companies would lead to synergies, on June 4, 2006, Blackstone formerly expressed its interest in acquiring Freescale for a possible price of $37 to $38 per share of common stock, which at the time represented at least a 28% premium over Freescale’s market price.

Later that month, Philips Electronics announced to the public that it was considering a possible sale of its semiconductor company, which led to a bidding process in which Blackstone participated. On June 13 the unnamed, large company pulled out of discussions with Freescale.

By August 3, 2006 it was clear that Blackstone’s bid for Philips was too low when Philips Electronics announced an agreement to sell its semiconductor business to a consortium of private equity firms led by Kohlberg Kravis, Roberts & Co. (KKR), Silver Lake Partners and AlpInvest Partners.

Realizing that Freescale might now have more strategic value to KKR than continued on following page
Sellers Beware: LBOs Can Hurt

A wash with funds from private investors, leveraged buyout firms have recently purchased a number of companies with major involvement in automotive electronics including TRW, Freescale, Philips Semiconductors, and the Sensors and Controls Division of Texas Instruments. Several more such deals are reportedly in the works including leveraged buyouts of STMicroelectronics and portions of Delphi and Visteon. This past September Continental AG issued a statement saying that it had been at an “early stage” in a conversation with a private equity investor, but those discussions were “terminated by mutual agreement.”

Private equity firms have attracted large amounts of capital because they have profited greatly by acquiring companies and selling them a few years later for a higher price than they paid. They buy companies with as little of their own money as possible and leverage those funds by borrowing heavily in the name of the acquired firm. Along the way they quickly extract large management fees and can pay themselves huge dividends by borrowing even more money in the name of the acquired firm. According to Thomson Financial, leveraged buyout firms earned 24% annual returns in 2004 and 2005.

Of course some buyout firms earn the money they make fairly by turning troubled companies around; they are often more willing than previous owners to make the tough decisions to close unprofitable factories and exit unprofitable businesses. Or they add value to healthy companies by implementing good strategies. They can fund acquisitions of additional companies in order to create critical mass or they may make investments in technology or capital improvements that improve a company’s competitiveness. Three or four years later when the buyout firm sells out, they leave the company better off than they found it.

But some private equity firms over borrow, saddling the companies they sponsor with onerous interest payments that leave little for R&D and capital expenses, essentially borrowing from the future. While it’s not clear that private equity funding was the decisive factor in the half-dozen, or so recent automotive parts supplier bankruptcies in North America, two—Collins & Aikman and Meridian Systems—had private equity sponsors before they went bankrupt.

Automotive Electronics Companies and Their Leveraged-Buyout Sponsors

<table>
<thead>
<tr>
<th>Company</th>
<th>Sponsor</th>
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<tbody>
<tr>
<td>TRW Automotive</td>
<td>Blackstone Group</td>
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<tr>
<td>Freescale</td>
<td>Blackstone Group</td>
</tr>
<tr>
<td>Sensata Technologies*</td>
<td>Bain Capital</td>
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<tr>
<td>NXP Semiconductor**</td>
<td>A consortium including KKR, Silver Lake Partners and AlpInvest Partners NV</td>
</tr>
<tr>
<td>Preh GmbH</td>
<td>Deutche Beteiligungs AG</td>
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</table>

*Formerly the Sensors and Controls Division of Texas Instruments
**Formerly Philips Semiconductors

Semiconductor...

Continued from page 2

to Blackstone, Freescale chose to also explore what KKR had in mind for it. At that point Blackstone upped its offer for Freescale to $40 per share, which Freescale accepted in an announcement on September 15, 2006.

With Philips Semiconductor division (now known as NXP) and Freescale now in the hands of private equity, consolidation of the semiconductor industry through mergers is almost a certainty.

Even before these ownership changes, the industry was consolidating. In April of 2005 STMicroelectronics, Philips and Freescale reached agreement to cooperate on R&D in the creation of high-level System-on-Chip (SoC) intellectual property blocks, the so called Crolles2 Alliance.

Aiso in April 2005, Freescale and Phillips, who had been pioneering with Mercedes and BMW in the development of the FlexRay safety-critical high-speed network, agreed to share their technologies.

In March of 2006, STMicroelectronics and Freescale announced a major agreement aimed at the automotive industry to jointly develop a power-efficient, 32-bit microcontroller core based on the Power Architecture (PowerPC). The two companies have opened joint design centers that will be staffed with 120 engineers by the end of the year. Freescale and ST plan to manufacture the jointly designed MCUs products on mutually aligned 90-nanometer processes, with each company using its own fabs.

A nother alliance involving the automotive industry was announced this past September between Freescale and ELMOS Semiconductor, a German company closely aligned with BMW. The two companies plan to co-develop application specific semiconductor products combining Freescale’s 16-bit microcontroller architectures with ELMOS’ high-voltage CMOS A SSPs.

Another semiconductor company on the lookout for acquisitions is Infineon, who is reportedly interested in Japanese semiconductor companies serving the automotive or communications markets.

Semiconductor industry consolidation is not a brand new phenomenon. Indeed, one of the fastest growing semiconductor suppliers serving the auto industry is Renesas, which was brought to life in April 2003 with the merger of the semiconductor divisions of Hitachi and Mitsubishi Electric.
The Company Profile... Preh Gmbh

Thumbnail Sketch

Headquarters: An der Stadthalle, D-97616 Bad Neustadt/Saaale, Germany; Phone: 49 (0) 9771 92-0; Fax: 49 (0) 9771 92-300; www.preh.com; automotive@preh.de
2005 Sales: €248.4 million ($316 million)
R&D: 9.8%
Capital Expenses: 6.7% of sales
Products: Driver control systems and switches; sensors
Principal End Customers: BMW, VW/Audi and GM/Opel
Ownership: Deutsche Beteiligungs AG, more than 75%; Preh management, about 10%
Employees: 1,915; about 15% are engineers
Sales per Employee: €131,737 ($167,530)

Background

While Preh's roots go back to its founding in Germany in 1919, the company didn't begin serving the auto industry until 1988. Its present strategy to concentrate almost exclusively on the auto industry didn't fully emerge until 2003 with the management-led leveraged buyout of the company. Preh's financial sponsor, with a 75% stake in the company, is Deutsche Beteiligungs AG, of Frankfurt, Germany, a private-equity firm that specializes in mid-sized companies based in Germany. Shares of DBAG are traded on the DAX.

Today Preh is known mainly for driver interface controls—it is the exclusive manufacturer of Audi's MMI (multimedia interface) control panel—and for the driver interface panels of climate control systems. Preh's integrated HMI control-system solutions provide carmakers with a unique look and feel. Preh also manufactures potentiometric position sensors and a capacitive humidity sensor that detects when the windshield needs to be defogged.

Preh's products rely on in-house competencies in software, electronics, plastics engineering, and surface-finishing technology and sensors. Preh is qualified to SPICE (software process improvement and capability) level 2 development standards and says it will reach level 3 before the end of 2006.

Fifty percent of Preh's automotive revenue comes directly from orders placed by O EM s. A nother 25% comes from suppliers who have been directed by O EM s to work with Preh.

In 2005, 89% of Preh's shipments went to European customers, but Europe's share of Preh shipments will soon decline in favor of North America. The company intends to grow sales to North America by 35% per year through 2010—from $30 million worth of product in 2006 to $100 million by 2010. Today, 15 people are employed at Preh's sales and engineering facility in Novi, Michigan, a number that could grow to 40 people in three or four years.

Preh produces driver controls and sensors at its manufacturing facility in Novi, Michigan, a number that could grow to 40 people in three or four years.

In a step that will take it beyond driver controls and sensors, Preh will soon begin to produce electronic control units, including a chassis controller and a fuel tank controller, for some of the customers it already serves. By 2010, ECUs will account for 10% of Preh sales.

Under a product category the company refers to as “automotive engineering,” Preh develops production assembly lines for its own in-house requirements and also for a number of automotive customers. TRW, Takata, Kolbenschmidt Pierburg, and SDI account for 80% of engineering sales; Preh's in-house requirements account for 20%. The engineering business, which has, for example, specialized on the assembly of airbag modules, accounts for 5% of Preh sales and will remain at that level at least through 2010.

Driver Controls

Sixty percent of Preh's revenue comes from driver controls—which are essentially assemblies of hand-operated, single- and multipurpose buttons, sliders, rockers and dials used to control infotainment or climate control systems. Climate controls...
The Company Profile Continued

Preh Group Sales by Division and Product

<table>
<thead>
<tr>
<th>Division</th>
<th>2005 Sales</th>
<th>2010 Sales (€)</th>
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</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>€248.4 million</td>
<td>€400 million (€509 million)</td>
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<tr>
<td>Electronics</td>
<td>8%</td>
<td>10%</td>
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<tr>
<td>Engineering</td>
<td>4%</td>
<td>5%</td>
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<tr>
<td>Sensors</td>
<td>22%</td>
<td>20%</td>
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<tr>
<td>Driver controls</td>
<td>60%</td>
<td>55%</td>
</tr>
<tr>
<td>ECUs</td>
<td>10%</td>
<td>Non-automatic 10%</td>
</tr>
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</table>

Preh Group Core Competencies

- Electronics hardware and software
- In-house tooling shop
- Plastics technology
- PVD*
- Thick-film technology for sensors
- Surface finishing
- Electronics manufacturing
- Assembly
- Testing

*Physical vapor deposition gives plastic buttons and knobs a metallic surface that can be laser etched for backlit night illumination.

account for roughly 55% of Preh's sales of driver controls.

Preh designs and manufactures the entire assembly in house, including electro-mechanical and plastic parts and any electronics. Operator controls are implemented using a variety of technologies including optical, resistive and magnetic. The company believes its vertical integration provides competitive advantages.

"We have electronics know-how, software and haptics know-how, illumination and plastics know-how and surface [finishing] know-how; we even make many of our own production tools," said Michael Roesnick, president, CEO and owner of about 5% of Preh GmbH. "Because we are vertically integrated we are more flexible and can respond more quickly than some of our competitors who must bring a lot of partners to the table. We are more self reliant."

An electrical engineer, Dr. Roesnick has a PhD from Hamburg Aplied Technical University in control theory. He joined Preh in 1999 when the company was controlled by Rheinmetall Berlin, for whom he was a general director and then a member of the board of the electronics branch that included Preh. He participated in the management-led leveraged buyout of Preh in 2003.

In Europe, Preh's main competitors in driver controls are Behr, Hella, Thermo, Delphi, Kostal, Mangle, Siemens VDO, TRW and AIPS. In North America, Preh competes with AIPS, TRW, Visteon, Delphi and Siemens VDO.

While Preh does not fabricate metal parts, the company is particularly proud of its ability to apply metallic finishes to plastic surfaces by using a physical vapor deposition (PVD) process. Metallic surfaces can be applied to plastics by galvanizing, but galvanized plastic parts can't be laser etched with identifying icons or labels. Backlit laser-etched icons or labels make the switches easy to operate in the dark.

Preh uses a low-temperature (70 degrees C) PVD procedure whereby the base material used to coat the plastic is brought to a gaseous state using ion bombardment or magnetron sputtering. By keeping the process temperature low, the plastic keeps its shape and doesn't become brittle. A multitude of metallic colors are possible including aluminum, chrome, stainless steel, copper, red or gold. According to Preh, its approach to PVD is environmentally friendly. The first high-volume production application for Preh's PVD process was the climate control head on the BMW 6 series. The innovation is one of 23 finalists for Automotive News' 2007 PA CE award.

Center Stack Controls

Preh has solid experience supplying the user interface control panels located in the center stack. The company has been a development partner with BMW for more than ten years and supplies BMW with climate control heads for the 5, 6 and 7 series, the X5 SUV and for Rolls-Royce. For the last three years Preh has been manufacturing the user interface controls for the entertainment system and climate control system in the Lancia center stack. Preh also makes the user controls for the Mercedes E class and the Chrysler Sebring.

Preh's control panels connect to the continued on following page
Preh GmbH

radio head unit and the climate control ECU by means of a multiplexed link, usually CAN or LIN.

**Multifunction User Interface**

After BMW introduced its iDrive multifunction user interface in 2001, to widespread criticism, Audi came out in 2004 with its Multimedia Interface (MMI), to critical acclaim. Preh, which does not make the iDrive unit, initially made only the MMI used in the Audi A6; Preh is today the sole supplier of Audi MMIs.

Audi's MMI has the look and feel of high quality, and it is robust enough to withstand the rigors of the automotive environment, including coffee spills. For safe operation while driving, MMI switches provide tactile and audible feedback, and they are illuminated with red light for nighttime operation. The MMI control panel is located on the center console between the gearshift lever and the center armrest. In the middle of the panel is a round metal dial that can be turned or pushed. Four soft (multifunction) switches surround the dial, one at each corner. In the Audi A6, the interface also includes 11 hard switches. MMI is used to control the radio, CD, TV, telephone and navigation.

Besides the Audi MMI, Preh also makes the multifunction infotainment interface used in the rear seat of the Mercedes S class and has booked an important order with another German Mercedes S class and has booked an important order with another German carmaker to supply a multifunction driver port.

**Driver Interface Prototype**

Building on its experience supplying the Audi MMI driver interface, Preh has been demonstrating a working prototype that impressively combines four different control elements: programmable buttons, touch pad, central control element and proximity buttons. While it is unlikely that a carmaker would choose to build a driver interface using all four elements, the prototype gives designers a good sense of what is possible.

**Programmable buttons** – A tiny LCD is built into each push-button switch so the switch can be labeled variably according to the function it is meant to perform. For example, in climate control mode the button might display a symbol indicating that pushing it will turn on the window defroster. But in phone mode the button might be part of a keypad, bearing the number zero. Illuminated by LEDs, the LCD-generated image is projected onto the back face of the button.

**Touch pad** – Touch pads are widely used in laptop computers to position the cursor. In a vehicle the driver could enter a destination by writing words onto the key pad with his finger while keeping his eyes on the road.

**Central control element** – While Preh's isn't the only control knob that can be rotated, tilted and pushed, this one provides remarkably good tactile feedback that can be varied according to which function it is meant to perform. For example, in audio mode, the rotating knob might be programmed with two stops to control volume. You turn it clockwise to the end, where it will turn no more; rotating counter clockwise brings you to the other end. The same knob can also function to adjust balance with a haptic detent programmed half-way between the two stops to indicate the center position. Likewise, the tilt function of the knob can be varied to have anywhere from four degrees of freedom, north, south, east and west, to just one to the north.

**Preh Automotive Sales by Major Customer**

2005 Total Automotive Sales: €213.6 million ($272 million)

- BMW, 27%
- Pierburg, 12%
- GM/Opel, 9%
- Behr, 8%
- Bosch, 3%
- Knorr-Bremse, 3%
- Harman Becker, 5%
- VW Group, 8%
- John Deere, 7%
- Others*, 18%

*Includes Dräxlmaier, Faurecia, Valeo, ZF, Hitachi, Takata, Air International, Denso, Same Deutz-Fahr

**Preh's Driver Interface Prototype**

**Central control element** – While Preh's isn't the only control knob that can be rotated, tilted and pushed, this one provides remarkably good tactile feedback that can be varied according to which function it is meant to perform. For example, in audio mode, the rotating knob might be programmed with two stops to control volume. You turn it clockwise to the end, where it will turn no more; rotating counter clockwise brings you to the other end. The same knob can also function to adjust balance with a haptic detent programmed half-way between the two stops to indicate the center position. Likewise, the tilt function of the knob can be varied to have anywhere from four degrees of freedom, north, south, east and west, to just one to the north.

**Automotive Production Facilities**

**Location: Bad Neustadt, Germany**
- Parts production volumes: from 20,000 to 3 million pieces per year
- Plant floor space: 46,000 square meters
- Number of employees: 750
- Products: Driver controls, ECUs, sensors
- Certifications: ISO 9001: 2000, since 2003
- ISO 14001: 1996, since 2001

**Location: Trofa, Portugal**
- Parts production volumes: from 10,000 to 1 million pieces per year
- Plant floor space: 14,500 square meters
- Number of employees: 480
- Products: Driver controls and sensors
- Certifications: ISO 9001: 2000, since 2003
- ISO 14001: 1996, since 2002

**Location: Monterey, Mexico**
- Parts production volumes: from 10,000 to 1 million pieces per year
- Plant floor space: 7,500 square meters
- Number of employees: 80
- Products: Driver controls and sensors

**Certifications:**
- ISO 9001: 2000, since 2003
- ISO 14001: 1996, since 2001

**Products:**
- Driver controls and sensors

**Number of employees:**
- 750

**Plant floor space:**
- 46,000 square meters

**Parts production volumes:**
- From 20,000 to 3 million pieces per year
Secretive about how the mechanism works to provide haptic feedback with so much variety, a Preh official would say only that the technology involves magnetics but not motors. Motors are used in the BMW iDrive.

**Proximity buttons** - Preh’s capacitance-sensing proximity button senses an approaching finger and indicates to the driver, via a visual display or voice announcement, the switch’s function. Proximity sensing helps the driver find which button to press without having to look away from the road.

**Sensors**

Sensors account for 22% of Preh revenues. Preh’s potentiometric sensors, which measure angular position, account for the greatest percentage of sensor sales. Preh’s biggest application for potentiometric sensors is with GM, for whom it makes 90% of the throttle-position sensors used in six- and eight-cylinder engines in North America.

While engineers have long considered replacing potentiometric sensors with noncontact sensors that use optical or magnetic sensing elements, Preh says its potentiometric sensors are sufficiently reliable for automotive applications. They can withstand more than 100 million cycles—well beyond the 30 million to 60 million cycles usually required by automakers. By using more than one thick-film resistor and a contact system with multiple wipers, Preh’s sensors have built-in redundancy. The resistive material is fabricated from glassy carbon paste, which combines glassy and ceramic properties with those of graphite. According to Ronald Schaare, director of product management and marketing, “It is very hard, but at the same time has a very good surface quality so that the sliding contact that moves over it does not wear out.” Preh’s throttle-position sensors cost as little as 3 Euros each and as much as 10 Euros if signal-conditioning electronics are included. These companies also make potentiometric position sensors: Bourns, CTS, Hella and A BElectronics. Preh’s potentiometric sensor customers include Pierburg, Bosch, Hitachi and Knorr-Bremse.

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**Defogging Sensor**

Preh’s second best-selling sensor is a defogging sensor. With one electrode attached to the inside of the windshield and a moisture-sensitive dielectric, the sensor measures capacitance, which varies as a function of the humidity on the inside of windshield.

It is sensitive enough to engage the windshield defogger before it becomes visible to the driver. It is currently installed on all BMW models with fully automatic HVAC controls including the 1, 3, 5, 6 and 7 series, X3 and X5 SUVs. Preh has also received an order for the defogging sensor from a major Asian carmaker with production starting in 2007. In 2006 Preh received an automotive News PA CE award for the defogging sensor.

According to the SAE paper, “Design and Development of a Dual Integrated Windshield Defogging and Rain Sensor,” 2006-01-1323, authored by Hans-Michael Schmitt and Ronald Schaare of Preh, a similar capacitive sensing approach can also be applied to rain sensing by simply modifying the size of the capacitive plates so that the windshield glass and the air film directly in front of it act together as a dielectric. Since air has a much lower dielectric constant than water, the dielectric value of the sensor changes as a function of water droplets on the windshield. Since the defogging sensor and the rain sensor are so similar, the two sensors can be integrated into a single sensor comprising two capacitive sensors, each operating at a different frequency: defogging at 40 kHz and rain sensing at 220 kHz. •

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**Preh’s Integrated Windshield Defogging and Rain Sensor**

Preh's capacitive sensors and moisture susceptible dielectric2

Capacitive change through humidity

Preh's throttle-position sensors cost as little as 3 Euros each and as much as 10 Euros if signal-conditioning electronics are included. These companies also make potentiometric position sensors: Bourns, CTS, Hella and ABElectronics. Preh’s potentiometric sensor customers include Pierburg, Bosch, Hitachi and Knorr-Bremse.

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**Preh Uses These Software Development Tools**

DOORS for requirements management
MATLAB/Simulink/Stateflow, ASCET and Enterprise Architect for analysis and design
Structogram representation with XTools (for handwritten code)
QA-C and Misra static code analysis, dynamic tests with Tessy
Surround SCM for configuration management
TestTrackPro for change and error management
CANoe and LINspector or EmuLIN for bus simulation
CANape and DIAdem for measurement and application

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**Products**

**Driver Control Systems**

Intelligent switches for steering wheel and cockpit
HMI control systems for center stack
Special instrument clusters
HVAC interface controls
ECUs
Chassis
HVAC
Fuel system

**Position and Comfort Sensors**

Defogging
Rain
Light
Sun
Throttle valve
Exhaust gas management
Shifter position
Fuel level
Brake wear
Traction control
Accelerator pedal
Lexus LS 460 Employs 46-Volt EPS

Among the Lexus LS 460’s many distinctions is its 46-volt electric power steering (EPS) system, which according to the company, is the most powerful EPS ever installed in a car, anywhere in the world. Toyota’s Intelligent Parking Assist system on the LS 460 uses the electric power steering motor to automatically steer the vehicle into a parallel parking space; no steering input is required by the driver.

Electric power steering is a fast-growing feature, but no carmaker before Toyota had installed it in a full-sized vehicle, because at 14 volts the electric motor that actuates the steering, because it would draw so much current, would be too big and bulky. At 46 volts, the motor can be significantly more powerful than a 14-volt motor because less current is needed and therefore the number of motor windings can be increased without so much bulk, since smaller-gauge wire can be used. Toyota says it selected 46 volts so it can have a 2-volt margin beneath the “48-volt U.S. regulation.”

A according to Toyota, its selection of 46 volts to power EPS shouldn’t be construed as a departure from its participation with the MIT consortium working on a global 42-volt standard. For now, no other features will require 46 volts. A according to Toyota literature describing some of the LS 460’s features, the custom-built, high-output brushless motor gets its power from a DC-DC converter, which steps up to 46 volts from 27 volts.