Carmakers are developing new, high-load electrical features such as electromechanical valves, electric power steering and electric heating. Given existing vehicle electrical power demands, these features would exhaust the power output of conventional 14-volt power supplies. Therefore, carmakers around the world are developing 42-volt systems that can generate electricity more efficiently, particularly at idle.

One of the many difficulties in bringing 42-volt systems to market has been finding an inexpensive and reliable alternator that is not too heavy. A further constraint is the large investment in place to manufacture conventional alternators, made today at low cost in high volume. The relative cost of manufacturing special 42-volt alternators in low volumes is prohibitively expensive for most applications. MIT researchers may have found a way to change all that—a way to make the ubiquitous Lundell, or Claflin-Pole, alternator well-suited to 42-volt applications.

At the May 23-24, 2000, meeting of the MIT 42-Volt Consortium, held in Vancouver, British Columbia, Canada, MIT’s David Perreault presented and won praise for a simple control scheme that requires only minimum and inexpensive modifications to existing 14-volt alternators. The proposed architecture fits a conventional Lundell alternator with a simple, inexpensive switched-mode rectifier (SMR) in the output circuit. The SMR is used as a second control handle to properly match the constant voltage load to the alternator and achieve high power. (Please see figure 1, page 8.) The switched-mode rectifier would need only two widely-used components: a controlled switch (such as a MOSFET) and a diode.

Enormous technical complexities, as well as fierce competitive and legal wrangling, have dogged but not deterred AMI-C’s efforts to establish open global standards. With plug-and-play standards for vehicle communication, information and entertainment systems, carmakers and their dealers will be better able to provide customers with wireless services and up-to-date, appealing and affordable electronics, something they can’t easily do today.

G M, Ford, Toyota, DaimlerC hrysler and Renaul t founded A M I-C in October 1998; today, the organization counts all 12 major carmakers worldwide as members.

AMI-C (A utomotive M ultimedia I nterface C ollaboration) is changing its legal status from a collaboration to a nonprofit corporation that will be headquartered in southeastern Michigan. The change will allow a few AMI-C executives representing the corporation to sign documents, whereas, in legal terms, a collaboration requires that all 12 member carmakers sign all documents. Moreover, as a corporation, AMI-C will be able to own a trademark and copyrights, which it can license to suppliers. After a great deal of effort in complex legal negotiations, AMI-C management committee members have signed the final incorporating agreement, and it has been sent off to each of the carmakers for approval by their top management.

Goals

With protection for normal vehicle operating functions an important consideration, AMI-C is creating specifications for hardware and software interfaces for information, communication and entertainment systems in light vehicles. AMI-C will develop, test, demonstrate and validate reference applications of the specs. The hardware specs will cover the physical configuration, mounting, electrical connections, signals, data rates and communications protocols. The software interface, or application programming interface (A PI), will specify variable names, units, scale factors and refresh rates. Finally, AMI-C will continuously maintain and update the standard as an open one that meets the business and technical needs of the automotive industry.

The carmakers want to ensure safe applications and protect the vehicle’s systems from incompatible equipment. Once AMI-C’s goals are realized, carmakers will have a mechanism to control which aftermarket equipment is installed in their vehicles. Carmakers want to approve which aftermarket equipment gains access through AMI-C connectors to vehicle systems and data. AMI-C likely will issue licenses to specific suppliers in return for royalties or other considerations on the equipment installed.

Predict Future Features

To comprehend all possible uses of the specs, AMI-C tried to develop a complete list of features and functions that carmakers expect to see in the next ten years. Essentially, it is a vision of what carmakers worldwide see as the future for multimedia, telematics and information systems in the vehicle. Below is a selection of features and functions—some not at all obvious:

◆ Road toll payment
◆ Smart card access
◆ Interactive payment authorization of goods and services
◆ DVD movie rental and download while fueling
◆ Commercial information sent from car dealer to customer
◆ Shared information and/or function among family’s and friends’ vehicles
◆ A virtual pet that could be moved from vehicle to vehicle
◆ Home automation of lights, doors, security systems and other devices from the vehicle
◆ Downloads of new application software to the vehicle

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World’s Carmakers Predict Future Features

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◆ Home automation of lights, doors, security systems and other devices from the vehicle
◆ Downloads of new application software to the vehicle

List continued on page 2
Lots of Work, Plenty of Help

In addition to the monumental task of getting all of the carmakers’ attorneys to agree on the correct legal formulation, AMI-C has been moving ahead on the specification itself. In the summer of 1999, after signing an initial agreement, the collaboration asked Sun Microsystems and IBM to consult. With much experience in establishing industry standards, these consultants instructed AMI-C’s steering committee on technical, legal and political issues. For about six months, Sun and IBM helped lay the architectural framework for the specification and helped figure out how much work would be required to finish them.

By January 2000, six engineers were working full time on AMI-C specs; currently there are 25 engineers and by October 2000, 80 engineers will be onboard—40 from carmakers and 40 from suppliers. At the end of May, AMI-C asked suppliers if they would be willing to assign experts to help create the specification. Since suppliers will gain early access to the developing specification and therefore, a head start on any new products, AMI-C expects to receive offers for many more than the 40 engineers it needs. AMI-C lawyers have been very careful to create a selection process that is fair and transparent, so it can pick the best suppliers and not violate antitrust laws in the U.S., Europe or Japan.

Specifications Release 1

Release 1 will specify the initial architecture, network and gateway. This initial information will allow development of network tools and hardware to begin. Sent out at the end of May 2000 as part of the solicitation for help from suppliers, were drafts of the Functional Requirements and Architecture Outline, two of the documents that will be part of the AMI-C Specifications. Release 1. Functional Requirements, a 227-page document, comprehends all of the potential uses envisioned for multimedia and telematics equipment for the next 10 years. The 85-page Architecture Outline details what the specifications include, why they are required and how they will evolve along with AMI-C’s life cycle.

In Release 1, AMI-C is endorsing IDB-C (Intelligent Transportation System Data Bus-Low Cost), the standard pioneered by Motorola and GM that includes physical and link layers from CAN (Controller Area Network), developed by Robert Bosch GmbH. IDB-C is the low-speed plug-and-play open network that allows connections to other networks in the vehicle through a gateway. AMI-C has selected two candidates for the high-speed network: MOST and IEEE 1394

World’s Carmakers Predict Future Features (continued from page one)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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<tbody>
<tr>
<td>Wireless, Bluetooth enabled headset</td>
<td>Video media players, Video games, Integrated two-player game console using two remotes and separate monitors</td>
</tr>
<tr>
<td>Parking garage fee payment with Bluetooth wireless interface</td>
<td>Vehicle probe data via short-range communications, Various fleet management systems</td>
</tr>
<tr>
<td>Move personal data and functions from old car to new car</td>
<td>Vehicle probe data via short-range communications, Various fleet management systems</td>
</tr>
<tr>
<td>Look for a stolen vehicle</td>
<td>Navigation, on- or off-board, with or without communications (for example, to comprehend traffic congestion)</td>
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<tr>
<td>Commercials aimed at vehicles in a specific area</td>
<td>Traffic information using multiplex broadcasts, Obtaining roadside information</td>
</tr>
<tr>
<td>Emergency calls for diagnostics</td>
<td>(\text{Laptop access to vehicle devices (for example, the vehicle's display)})</td>
</tr>
<tr>
<td>Continuous feed</td>
<td>Information from service providers, Internet or mobile video phone (using non-real time video)</td>
</tr>
<tr>
<td>Internet audio and/or video with or without voice input</td>
<td>Paging, receive or send fax, E-mail</td>
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<tr>
<td>Web browsing</td>
<td>Interactive audio chat over the Internet, Voice mail access over phone or Internet</td>
</tr>
<tr>
<td>Analog or digital TV</td>
<td>Portable phone docking for voice or data call, Mobile device messaging “read” via the vehicle's text to speech</td>
</tr>
<tr>
<td>World’s Carmakers Predict Future Features (continued from page one)</td>
<td>Mobile device sharing: enhancing capabilities of one or both devices</td>
</tr>
</tbody>
</table>

Standards

One of the precepts guiding AMI-C planners is that, rather than invent specifications to the auto industry, the industry should try to adopt standards that already have wide support. WP, OSGi, HAVi, Bluetooth and IEEE 1394 are such standards. To date, Bluetooth is the only one of these to have its specifications chosen for inclusion in Release 2. Developed by leading companies in the telecommunications and computing industries, Bluetooth allows portable/mobile phones, computers and PDAs to make short-range wireless connections with onboard systems, and it has been demonstrated in automotive applications.

WP P protocol is a developing standard for the transmission of data across wireless networks. The HAVi (Home Audio/Video Interoperability) standard will connect TVs, VCRs, DVD players and stereo components in the home using IEEE 1394 specifications (FireWire/Sony iLink). OSGi (Open Services Gateway Initiative) is also for the home networking market, but for connecting wide area networks like that of the cable company. OSGi is an open standard that allows software services to run on a services gateway, such as a set top box, cable modem or DSL modem. It would allow communication from outside the home to networks within the home.

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**MP3 Audio Onboard**

The remarkable influence of the Internet is changing the way automotive audio systems are made. Young consumers have been using CD burner-equipped PCs to download MP3 music files from the Web, as well as to record their own MP3 formatted CD collections on CD-R. In the next several months, the automotive aftermarket and OEM suppliers will start bringing to market audio systems with CD players that play CD-Rs (CD-R recordables) and CD-RWs (CD-R rewritables) used to store MP3 data files. By 2006, shipments of in-car CD players capable of playing CD-R and CD-RW discs with Internet audio files will grow to 4.8 billion—about 15% of the total in-car CD market, expected to be 32 million units, according to an April 2000 report, “In-Car Entertainment Systems Market” by Strategy Analytics Ltd. (Luton, UK; USA telephone 781-235-6550).

Once music is compressed into MP3 files, a CD-R can hold 9 to 11 times more music than a conventional 74-minute CD. MP3 is the most widely-used of several audio-compression formats for so-called CD-quality. “In a car environment, most people can’t tell the difference between CD-quality and a CD,” suggested Hugh Fiennes, co-founder of Empeg (Cambridge, England), a small manufacturer of transportable audio players that use hard drives to store MP3 files. “MP3 is a perceptual audio coding format, which means the algorithm removes stuff the brain doesn’t notice.”

By year’s end, Visteen says it will introduce a CD player capable of playing MP3 files. Delphi has also developed an MP3-capable CD player, demonstrated in January 2000 at the Consumer Electronics Show, but the company is not saying when it will be introduced. Ken Erickson, Delphi product line manager for audio systems, noted that new electronics must be added to conventional CD players to uncompress MP3 data. Further the man-machine interface has to be improved. “Instead of 12 tracks you have 120, and you don’t really want to scroll through them all. So what is your menu system and how do you present it in a mobile environment?”

In the next few years, car audio systems that use solid-state memory to store compressed music files will be introduced. General Motors and Sony have made an alliance to bring Sony’s Memory Stick into GM vehicles. About the size of a stick of gum, Memory Stick is solid-state flash memory capable of storing up to 64 megabytes—80 minutes of music—and as flash memory prices decline, Sony will double and quadruple capacity. And filling up all that capacity will be easy. Numerous websites already provide free downloadable MP3 music. Search engines can locate MP3 audio files anywhere on the Web. For more on MP3, go to www.mpeg.org for lists of audio and video interfaces including display, sound and control devices at a later date. ◆

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**Specifications Release 2**

Beginning work in November 2000, AMI-C hopes to finalize and publish Release 2 by January 2003. (See chart “Project Timeline for Release 2” above.) Release 2 will address the complete AMI-C architecture, including technical specifications for navigation, telematics and information devices through physical, network, gateway and API specifications. AMI-C will release specifications for user interfaces including display, sound and control devices at a later date. ◆

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**Project Timeline for Release 2**

<table>
<thead>
<tr>
<th>2000</th>
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<th>2002</th>
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- Assemble Team
- Alpha Arch/System Specification
- Beta Spec
- Workstation Reference Implementation
- Test and Validation of Specifications
- Physical and Network Specifications
- Verification Approach
- Outreach: WAP, Bluetooth, OSGi, 1394, HAVi and others

**Verification Approach**

- Physical and Network Specifications
- Final Spec
Corporation Background

Omron was founded in 1933 in Kyoto, Japan, as a manufacturer of timers. With revenues of ¥555 billion ($5.1 billion) in FY 1999, Omron Corporation currently consists of 115 companies. In addition to more than 40 manufacturing facilities with ISO 9000 certification, the company has 1,500 offices worldwide for sales, service and technical support. Key markets include consumer electronics, automotive, appliances, computer peripherals, office automation products and telecom applications.

The world's leading supplier of relays, Omron makes some of the world's smallest relays—the smallest in the automotive market—and is using micromachining technology to develop semiconductor-sized relays and sensors. Omron has already applied micromachining in sensors to develop products such as acceleration sensors, pressure sensors and micro lens arrays. The corporation aims to strengthen its competitiveness in sensing technologies, from simple on-off recognition to image and voice recognition as well as wireless, and the emphasis is on efforts to build alliances with U.S. venture businesses. Omron is marketing its engineering and consulting services within the continental United States, where 24-hour, 7-day-a-week customer service is available.

Automotive Electronics

Worldwide automotive electronics sales represent about 7% of total corporate sales, with North America contributing about a third of total automotive sales. Omron's Automotive Electronics Group supplies electronic and electromechanical components mainly to first- and second-tier OEM suppliers, and manages operations from North America, Europe, Japan and Korea, although the world is divided into five regional sales and marketing centers. R&D is based solely in Japan, but is performed in five regional sales and marketing centers from North America, Europe, Japan and Korea.

The company entered the automotive industry in 1975, selling timing relays. Still a key product area, relays make up 71% of Omron's sales to the North American auto electronics industry today. Worldwide, relays account for only 14% of total sales; ECUs represent 44%. Established in 1985, the North American Automotive Electronics Group currently has 738 employees at three manufacturing facilities: one in the United States and two in Canada. Only 3% of products sold in the United States come from Japan, with 57% from Canadian facilities and the remaining 40% from the U.S. In fall 2000, a new North American headquarters will open in Michigan.

Omron Automotive Electronics Components Division Headquarters:


Auto Electronics Sales FY 1999: ¥40.3 billion ($373 million)

Automotive Products: Electronic control units and switches make up 76.5%.

Largest Automotive Customer: Mitsubishi Motors

Employees: 1,600

open in Novi, Michigan. The 12,000-square-foot facility will house sales and administrative offices as well as applications engineering facilities.

Three years ago, about two-thirds of global auto electronics sales went to Japan/Asia and one-third to North and South America. To build up its business outside of Japan, Omron initially focused on North America, but one and a half years ago, the company began penetrating the European market. Now, global auto electronics sales to Japan/Asia (mostly to Japan) have dropped to about 61% of total sales. About 37% go to North America and 2% to Europe. Omron currently has $7 million in auto electronics sales in Europe and expects revenues to grow to $24 million in two years.

While continued recession in Japan has kept Omron Corporation sales growth flat, sales of Omron’s automotive components have grown worldwide, from $318 million in FY 1998 to $373 million in FY 1999. Recent sales growth has come from demand for keyless entry systems and power-window switches. Omron has also benefited from economic recovery in the Korean automotive market and continued favorable economic conditions in North America. Omron’s sales in North America grew faster than the market: from $59 million in FY 1996 to $151 million in FY 2000, a 26.5% annual rate. The company estimates annual revenues will exceed $200 million by 2002 in the U.S.

According to Mr. Bricker, Omron stands out from its competitors because “We have very high quality at a competitive price.” While its products are shipped to tier-one suppliers, its components are often specified by the carmaker, so Omron maintains close relationships with both carmakers and tier-one suppliers. A high level of engineering support is maintained with a total of 10 to 15 resident engineers at customer facilities including GM and Ford in the States and Mitsubishi and Honda in Japan.

**Relays**

Omron Automotive Electronics is the number-one supplier of power relays in the North American market. Responding to the industry desire for ever smaller components, Omron Automotive has introduced the world’s smallest automotive relay, the G8N, rated to handle five amps of continuous current and up to 25 amps of in-rush current. Applied to control power-window motors, it is approximately one-half the size and two-thirds the weight of Omron’s current miniaturized relay, and it reduces power consumption by 50 percent. While not in production yet, Omron also offers a quiet relay, the G8TA. Designed to isolate the relay’s functioning from its housing in order to minimize noise, the relay is applied to windshield-wiper controls and reduces vibration to the PCB.

Solid-state relay production began in Japan about one year ago, and the company is the first Japanese supplier to make high-capacity, solid-state relays for automotive use. While all relay sales in North America are still electromechanical, the company introduced a line of solid-state relays for automotive applications at the SAE 2000 World Congress, March 6-9, in Detroit, Michigan. Its solid-state relays are continued on following page.

### Omron Automotive Electronics North American Customers, Ranked by Sales

1. Delphi/GM
2. AFL/Ford
3. Lear/GM
4. Yazaki/DaimlerChrysler
5. Honda/ICTC

### Omron Automotive Electronics North American Sales by Product

- PCB relays, 8%
- Electronic control units, 14%
- Switches, 14%
- Power relays, 64%

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fully EM I-compatible, meet specifications for Micro and Mini ISO-type applications and are easily applied to any 42-volt automotive system. Potential applications include daytime running lights, electronic fuel injector drives and ABS that requires PWM (pulse-width modulation) drives.

**Most New Revenues Expected From These Products:**
- Accessory switches
- Electric power steering modules
- Power window/power seat switches
- Remote keyless entry

**Accessory Switches:** Omron has recently booked an order with one of the Big Three for electromechanical accessory switches located in the cockpit. Applications include power mirrors, trunk release, fuel-door release and starter motor. While most automotive switches are still electromechanical, they are slowly evolving toward solid-state implementations.

**EPS (Electrically-Assisted Power Steering):** So far, Omron has built and shipped 1.4 million EPS modules for use in micro-mini vehicles in Japan, but EPS is beginning to migrate to heavier cars as well. In Japan, the company supplies controllers to one carmaker building a micro car, and to one company building an A-class car in Europe. Further, the company has a contract for a B-class car going into production in 2002 in Europe. Omron provides EPS control modules and software to NSK, a major Japanese tier-one supplier of steering mechanisms, and will soon supply NSK in the European market as well. Using bare chips mounted on aluminum circuit boards for improved heat dissipation, Omron's newest EPS modules can be integrated with the motor and installed in the engine compartment. Omron points to its core specialty in PW M (pulse width modulation) motor control to explain its success in electric power steering applications.

**Power-Window Switches:** Electronic control of power-window motors has advanced over the last few years, giving car manufacturers express-up and anti-pinch safety functions. PW M (pulse width modulation) has been very advantageous here also. Omron has developed an edge-mounted hybrid IC, (bare chips on a ceramic substrate) so that motor control functions can be packaged within the window-lift switch module. Omron will begin shipping to a Japanese manufacturer for a MY 2001 global application. In Japan, Omron has been making window-lift controls with pinch protection since 1994, although in the past, some were mounted in a separate housing.

Omron's anti-pinch control system combines electronic control and sensing to automatically stop the upward movement of a power window if the window comes in contact with an obstruction. The system prevents misdetection caused by voltage, by vibrations from a rough driving surface and environmental changes such as temperature, rain, snow, ice and debris, as well as variations of vehicle door assemblies. The system detects an object when it measures less than 100 N (Newtons) of pinch force. Recently, Omron demonstrated an anti-pinch rear sliding window controller for use on pickup trucks; the system integrates window actuator technology from a North American supplier.

**Switch Cells:** Omron patented the concept and design for switch cells in Japan about 10 years ago. Currently, between 10 million to 12 million per year are used in Japan, and they are gaining in popularity in North America, where approximately 7 million to 8 million switch cells are used annually by General Motors, Ford, Mazda and Mitsubishi. High-volume automated assembly to produce switch cells yields a high-quality, low-cost switching device. The switch cell is a self-contained, modular unit that has the switching mechanism packaged into it. A four-door car would require four switch cells just in the driver's door to control power windows and door locks. A 6-way power seat would require 3 switch cells. Each cell has a spring to maintain contact pressure and two sets of contacts. Current can be reversed, for example, to drive the window-lift motor up or down, so the basic electromechanical switch is used for both up and down.

**Keyless Entry Systems:** Within the electronic-control-module product area, Omron has had success in its keyless entry business. Omron says it has the largest market share in keyless entry in Japan, where it produces over 1 million units a year. Omron produces annually close to a half million RKE units in the West, where its market share is still growing. In Japan, the challenge has been to develop RKE systems that provide sufficient range, given the low RF power levels mandated by the Japanese government. Having overcome the Japanese challenge, Omron believes its RKE technology, though more costly, is superior to that found in the West. Since the West allows higher power levels, the Omron system would work that much better.

In the past, many RKE systems had their own separate receiver modules. In production in Japan now and coming to the West is a new, smaller generation of receivers that can be integrated into body electronics modules. Today's receiver measures roughly 25 mm by 35 mm; the new receiver will be roughly 25 mm by 10 mm. Omron builds the receivers using a proprietary hybrid process.

Omron is working on passive entry systems using two-way digital transceivers like those already made by Siemens Automotive. While Omron has demonstrated prototype systems on vehicles in Japan, Mr. Bricker estimates production is three years away. “We are expecting an order in the very near future.”

**Promising Products**
Not expected to provide as much revenue as the products above, these products are nevertheless promising:
- Laser radar for adaptive cruise control
- DC/AC power inverters
- Integrated flashers
- Fingerprint sensors
Laser Radar for ACC (Adaptive Cruise Control): Omron's laser radar technology detects vehicles ahead by using laser-beam scanning and a fuzzy-logic recognition algorithm. Optics and fuzzy logic are two of Omron's four core technologies. If the following distance of one's vehicle becomes too short, the vehicle's ACC automatically applies light braking and alerts the driver. Omron's laser radar sensor technology detects in high resolution the curvature of the road, as well as vehicle location and the relative speed of obstacles. The miniaturized lightweight system is capable of detecting multiple vehicles, different vehicle types and false objects caused by elements such as fog and heavy rain. It is accurate up to 130 meters.

In 1996, Omron began making laser radar sensors for heavy trucks manufactured in Japan by Isuzu. For two years the sensors were used as part of a forward-looking collision avoidance system. Last fall, Omron again began shipping laser sensors; this time they were part of a complete ACC system for Honda, for installation in the A vancer, sold in Japan. A supplier to Honda for 20 years, Omron was honored for its ACC system with the Honda R&D Japan. Omron's ACC system includes the laser front end, the vehicle location and the relative speed of obstacles. The miniaturized lightweight system is capable of detecting multiple vehicles, different vehicle types and false objects caused by elements such as fog and heavy rain. It is accurate up to 130 meters.

Omron's ACC system is already quite limited, and over-use of any power outlet could easily drain the battery of charge. Omron's new inverter, however, contains a battery-level warning function that features a warning buzzer to alert users that the battery is losing power. Designed to minimize EMI (electromagnetic interference), Omron's inverter has added protection against short circuits caused by over-current.

Flashers: The market for stand-alone flashers is declining as flashers are integrated into body controllers, yet Omron recently picked up two new orders for stand-alone flashers in North America, for the new Pontiac Bonneville and the SLS Cadillac.

Integrated flashers are packaged with the turn-signal controls and located in the center of the dashboard, so either the driver or front-seat passenger can reach the flasher switch—a convention more common in Europe. The majority of flashers are implemented using electromechanical relay technology, but Omron recently demonstrated a solid-state flasher control that is integrated with the controls for daytime running lights, turn signals and parking lights. According to Mr. Bricker, daytime running lights, which are required in Canada and used on all GM vehicles in the States, are showing up on more vehicles in the U.S., for example, in Ford rental cars. Omron Dualtec Automotive Electronics, Ontario, Canada, supplies flashers to GM and to Toyota's assembly plant in Georgetown, Kentucky. Omron has received the Toyota North America Quality Achievement Award for Development from Honda for 20 years, Omron has won two production contracts for its laser ACC system, with a Japanese carmaker, for installation on a MY 2002 car to be sold in Europe.

DC/AC Power Inverters: Omron makes roughly 30,000 DC/AC inverters each year, the vast majority for Japanese domestic vehicles. Shown in March 2000 at SA E in Detroit, Michigan, Omron's new 500-watt DC/AC power inverter for in-vehicle features will power such devices as portable televisions, personal computers and other electrical appliances. Omron currently supplies the power inverter for the Mitsubishi Pajero in Japan.

Generally, a vehicle's battery/charging system is already quite limited, and over-use of any power outlet could easily drain the battery of charge. Omron's new inverter, however, contains a battery-level warning function that features a warning buzzer to alert users that the battery is losing power. Designed to minimize EMI (electromagnetic interference), Omron's inverter has added protection against short circuits caused by over-current.

Fingerprint Sensor: Using Omron optics capability, the fingerprint sensor employs a micro-lens array, laser light and photo detector. While Omron has not yet begun to develop the fingerprint sensing technology for automotive applications, Omron already ships roughly 10,000 fingerprint identification sensors per year to the PC market. Moreover, the company demonstrated a working prototype at the March SA E convention to gauge interest among automotive customers. That operational model had a false fingerprint rejection rate of less than 0.01 percent.

Potential automotive applications of Omron's fingerprint sensor include security systems, vehicle starting (only if authorized users' fingerprints are recognized by the system) and personalization of functions, such as seat position, steering wheel position and audio preferences.

Omron Automotive Electronics, Inc.: 30600 Northwestern Hwy, Suite 250, Farmington Hills, MI 48334 U.S.A.
(248) 539-4700; fax (248) 539-4710
Total U.S. employees: 303
Manufacturing & Engineering: 3709 Ohio Ave., St. Charles, IL 60174 U.S.A.
(630) 443-6800; fax (630) 443-6898
Manufacturing plant: 85,000 square feet
Products: Power/PCB and flasher relays, control modules, RKE, daytime running-light control units

Omron Dualtec Automotive Electronics, Inc.
Manufacturing plant: 165,000 square feet
Employees: 435

Switch/ECU Division: 2291 Winston Park Drive, Oakville, Ontario Canada L6H 6R7
(905) 829-0137; fax: (905) 829-1669
Plug-in, power and PCB relays

Switch/ECU Division: 2291 Winston Park Drive, Oakville, Ontario Canada L6H 6R7
(905) 829-0137; fax: (905) 829-5781
Highly automated facility; design and development capability
Products: Power window switches/assemblies, power seat switches/assemblies, I/P switches, sunroof limit switches, park pin switches, electronic (dual output) flashers, integrated hazard switches

Omron Automotive Electronics (Europe) Group
Manufacturing plant: 42,000 square feet
Employees: 55
Vantage Point, The Pensnett Estate, Kingswinford, West Midlands DY6 7FP U.K.
44 1384-405500; fax 44 1384-405508
Products: Keyless entry systems, sunroof tilt switches, A/C panel switches

Automotive Electronics (Europe) Group
Manufacturing plant: 42,000 square feet
Employees: 55
Vantage Point, The Pensnett Estate, Kingswinford, West Midlands DY6 7FP U.K.
44 1384-405500; fax 44 1384-405508
Products: Keyless entry systems, sunroof tilt switches, A/C panel switches

Automotive Electronic Components Division (Japan)
Manufacturing plant: 360,000 square feet
Employees: 554
2254-28 Kiribayashi, Iida, Nagano 399-25 J Japan
81 265 26 6007; fax 81 265 26 6034
Products: Power window switches, power seat switches, micro switches, keyless entry systems, relays, laser radar, sensors

Automotive Electronic Division (Korea)
Manufacturing plant: 83,000 square feet
Employees: 253
481-2 Kasan-dong, Gumchun-ku, Seoul 153-023
Korea
82 (2) 850-5850; fax 82 (2) 850-5809
Products: Keyless entry systems, power window switches, relays
The only modification to today's Lundell alternator, besides adding the SMR, would be rewinding with three times as many turns; wire for 42 volts would have one-third the cross section of wire for 14 volts.

Results from experiments on a prototype SMR alternator at MIT's Laboratory for Electromagnetic and Electronic Systems show the following:

- Output power improves by a factor of 2.5 (peak) and 1.9 (average).
- Significant increases in efficiency—the 42-volt SMR alternator is so efficient that it need not be liquid-cooled.
- Significantly more power without making the machine bigger or heavier.

**Load Dump and Jump Charging**

Given the simplicity of the proposed modifications to the conventional alternator, the improvements in performance are remarkable. In addition to increased output capability, as well as improvements in efficiency, the SMR design fulfills two more essential conditions for implementation of 42-volt systems: (1) Greater transient control (particularly for alternator load dump), and (2) recharging the high-voltage source from the low-voltage source (jump charging). Without transient suppression at the alternator, every component connected to the 42-volt supply would require circuitry to protect it from 240-volt transients. With today's 14-volt systems, every ECU connected to the 14-volt power supply must be protected from transients of up to 80 volts. Such transients can occur when a battery cable jiggles loose while the alternator is at full load.

In their paper, "A utomotive Power Generation and Control," David Perreault and Vahe Caliskan point out that the proposed SMR architecture improves upon the conventional diode-rectified alternator, which has a relatively flat power output over much of the speed range. The SMR alternator produces output that increases almost linearly with engine speed. The improvements result from utilizing an additional degree of control freedom to achieve load matching across the speed range. (Please see figure 2.)

The SMR alternator is particularly well-suited to electromechanical valves, which need significantly more electrical power as the engine speeds up— as much as 2 kW at cruising. The SMR alternator will also satisfy other electrical demands that rise with engine speed, such as from the electric water pump.

**More Power at Idle**

But the industry is also looking for a machine that will produce more power at or near idle for features such as electric climate control, electric power steering and electric engine cooling. If the conventional alternator were re-optimized—without significantly changing the manufacturing process—the MIT-proposed architecture could take full advantage of the SMR load-matching scheme. Early indications are that a re-optimized alternator would indeed produce more power at idle.

"We have done some calculations and we've convinced ourselves that you can get more power at idle... It won't be a factor of two, but we should be able to do better," revealed M r. Perreault. Research on creating more power at idle by re-optimizing the conventional alternator is being done at an MIT lab and could require one or two man-years of research.

For more information, have a look at "A utomotive Power Generation and Control," by David J. Perreault and Vahe Caliskan, Laboratory for Electromagnetic and Electronic Systems, MIT, Cambridge, Massachusetts, U.S.A.; phone 617-253-4631; fax 617-258-6774; or email Mr. Perreault at djperrea@mit.edu.

**A Special HANSEN REPORT Study: 42-Volt Power: An Opportunity to Redefine the Vehicle**

A transformation of the vehicle's electrical system is underway. Forty-two-volt applications will appear in production vehicles as early as 2002 or 2003, and they will begin to proliferate globally by 2008. Due in July, the new Hansen Report study details how this important trend goes well beyond satisfying the growing demands for power for new electrical features aboard the vehicle.

Study topics include "C armaker Plans A round the World," "K ey Drivers of the Trend," "Environmental Pressures," "Inte-grated Starter Alternators," "H ybrids vs. Soft H ybrids" and "Obstacles." Twelve to sixteen pages in length, the special study will go on sale in July, priced at $397. Order today: Log on to our website www.hansenreport.com; email hansen@nh.ultranet.com; phone 603-431-5859 or fax 603-431-5791.

For orders received before July 15, with payment, the report's price is just $337.