Contents

A stronger, Sounder Sauer-Danfoss 2
Sven Ruder gives his view on the future of Sauer-Danfoss

Meet the New Business 3
HIC/Cartridge, Gear Products, and Inverters go their own way

Leading Technology at the Core 4
Presentation of Propel and Electronic Components businesses

A Complete Approach to Vehicle Control 5
News from PLUS+1™ and Electronic competencies

The Widest, Deepest Cut 6
Customer story with Astec Underground - PLUS+1 controlled

Efficient H1 Pumps and Motors Lead the Way 8
News from the H1 product range, best in efficiency tests!

New Standards in Safety 10
Introduction to the European safety legislations

Short News from Sauer-Danfoss 12
Exhibition Calendar 2011 and more

the circuit

Sven Ruder, President
and Chief Executive Officer:

Shaped to Your Needs

Sauer-Danfoss has faced tough challenges over the past two years. Today, through our efforts to overcome the hurdles, our organization is in better shape than ever – confirming our position as a leading strategic partner for customers in the mobile equipment industry.

In this issue of The Circuit, we tell you more about what you can expect from us. Our core product focus; the establishment of three new specialist businesses; solutions that meet stringent emissions and safety regulations – our realigned approach is a keen response to the needs you have expressed.

We have singled out two of our core product areas – propel and electronic controls – for detailed description. In our customer case story from Astec Underground, you can learn about our leading PLUS+1™ electronic controls platform in action.

I hope you will enjoy the read, as I am confident that you over the coming months will see and experience the gains of a new and reshaped Sauer-Danfoss:

Your Strongest Partner in Mobile Hydraulics!

SAUER DANFOSS

A Stronger, Sounder S

When Sven Ruder joined Sauer-Danfoss as president and CEO on January 1, 2009, he could not have foreseen the year the company was about to embark upon. As with the rest of the industry, 2009 brought a lot of pain, angst, and downsizing. But, just as the phoenix rises from the ashes, Sauer-Danfoss has emerged from the global economic meltdown stronger, more focused and more customer-driven than ever.

Of course, the worldwide economic outlook was already not-so-sunny on that January day in 2009. However, by February, it became clear that the deepening crisis was having a very dramatic effect on customers all across the globe and would soon resonate to Sauer-Danfoss itself. Indeed, the impact of the downturn was acutely felt throughout the rest of the year: a shrinking order book, budget cuts, financial woes, and painful reductions of a very good workforce.

Sauer-Danfoss was certainly not the only company facing such challenges and agonizing times. Yet Ruder, amid the crisis, began to see an opportunity. While the company had enjoyed a market leader position and tremendous growth since the merger of Sauer-Sundstrand and Danfoss Fluid Power in 2000, Ruder and his leadership team began to focus on apparent inconsistencies in growth and financial performance among the 14 Sauer-Danfoss product lines. They sensed tangible differences in terms of customer needs and vehicle project timelines.

"Some of our products were simply not thriving under the Sauer-Danfoss business model, and more importantly, they were not being marketed in a way that met our customers' needs," says Ruder. The leadership team quickly resolved to turn anecdotal information into concrete research from which decisions could be made; and they started a cross-functional, seven-month project to create the roadmap for the future of Sauer-Danfoss.

Targeted Research, Customer Focus

A project team was appointed to discover – in no uncertain terms – what customers liked best about working with Sauer-Danfoss, their most finite expectations of sales and technical support, and how each and every product in the portfolio was positioned to meet those expectations. The information gathering was conducted via two channels: first, targeted research of the industry and market segments, and more importantly, through direct conversations with customers.

The research confirmed Ruder's speculation in some areas and gave a new perspective in others. Customers gave Sauer-Danfoss high marks in areas such as technical support, quality, relationships, product value, and application expertise. According to Ruder, "It was positive for our leadership team to know that we are looked on very favorably in areas where we strive to be best-in-class."

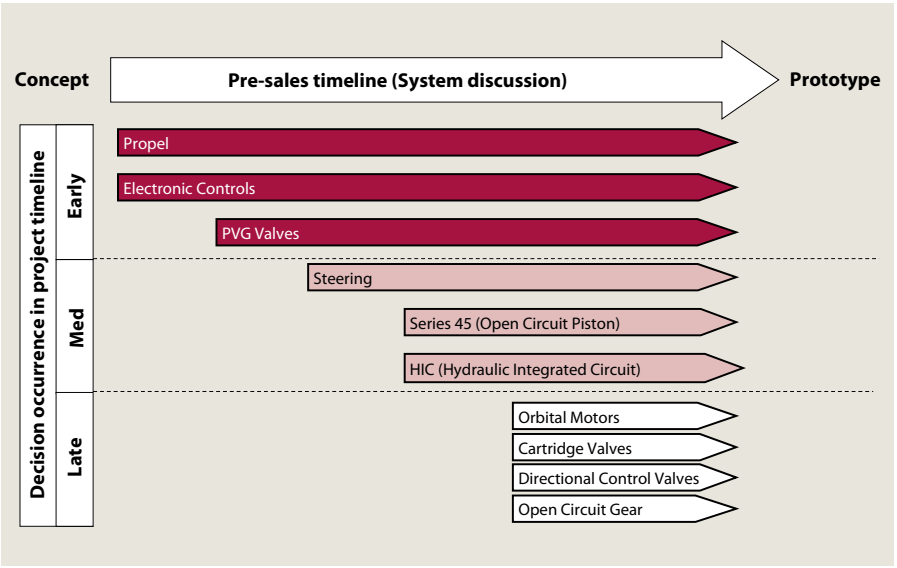
However, the feedback also exposed areas where customer needs were not being met, and that the company wasn't as 'easy to do business with' as it was striving to become. "It became clear that, while most of our products lend themselves to a system approach, some would be more successful in the market if we adopted a different way of doing business," says Ruder.

Keeping What Works, Changing What Doesn't

With concrete market research and customer feedback at their disposal, Ruder and his management team were ready to make equally concrete decisions about the destiny of the Sauer-Danfoss organization – decisions that the organization was ready for. "We not only had room for improvement," says Ruder, "But we believed it was within our ability to make these improvements. It became clear that the time for change had come."

The most compelling organizational changes were the creation of three new, separate businesses: Comatrol® designs, manufactures, and sells cartridge valves and hydraulic integrated circuits (HICs); Turolla OpenCircuitGear™ designs, manufactures, and sells open circuit gear pumps and motors, and Schwarzmüller-Inverter™ likewise manages electric inverter products. All three new organizations are members of the Sauer-Danfoss Group, fully owned by Sauer-Danfoss Inc., and were launched as stand-alone organizations on July 1, 2010.

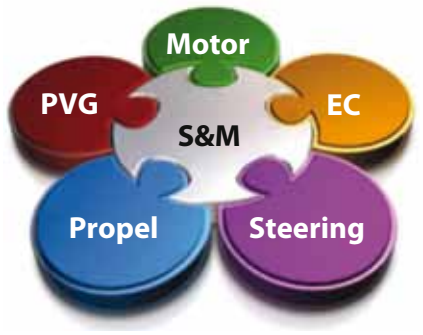
According to Ruder, "These new businesses will



auer-Danfoss

operate as smaller, more agile entities. This enables them to become more responsive – exactly what our customers told us they want and need."

Sauer-Danfoss will continue to design, manufacture, and sell products in hydrostatic propel products, orbital motors, electronic components, steering, and PVG spool valves. These core product lines will get even more focus in order to ensure and strengthen the company's position as a world-wide leader in technology, product performance, and innovation.



Likewise, exciting changes are being implemented within the sales organization – again, to position the company to be more aligned with customer needs and market demands. The 'one face to the customer' approach is still important – not least to customers – and account managers will remain responsible for coordinating activities of individual accounts.

In addition, the Sauer-Danfoss Business Areas (BAs), representing each of the core product lines, will establish their own sales development managers and product application engineering teams. "These BA teams will work closely with the account managers, bringing deep technical expertise closer to our customer," says Ruder.

System application engineering teams, clearly of value to the customer, will remain unchanged.

Strength in the Core

Best Customer Connect

Unique Customer Experience

Just the Beginning

Ruder and Sauer-Danfoss are now in the juxtaposition of looking back and looking forward. For Ruder, it's a state of satisfaction for what has been done, and anticipation for what the future holds. "Of course, I'm extremely satisfied with how far we've come since last year, and I'm more confident than I've ever been in the people and culture of Sauer-Danfoss.

"We are on course to create a stronger and more vibrant company, fit for the future and ready to be a decisive factor in our customers' success," he affirms.

Meet the New Businesses

Three new businesses were launched on 1 July 2010 to provide customers with improved service and support. All three are under the leadership of Domenico Traverso, Vice President, Stand-Alone Businesses, and will operate with their own strategy, manufacturing, and business plans. They are fully owned by Sauer-Danfoss and members of the Sauer-Danfoss Group.

Comatrol
RESPONSIVENESS IN MOTION
MEMBER OF THE SAUER-DANFOSS GROUP

Product Focus:	Cartridge Valves and Hydraulic Integrated Circuits (HICs)
General Manager:	Dave Duvall
Global Locations:	China; Italy; and USA
Web site:	www.comatrol.com

Turolla™
OpenCircuitGear
MEMBER OF THE SAUER-DANFOSS GROUP

Product Focus:	Gear Pumps & Motors and Fan Drives solutions
General Manager:	Gunnar Dæhlin
Global Locations:	Italy; Slovakia; and USA
Web site:	www.turollaOCG.com

SCHWARZMÜLLER INVERTER
MEMBER OF THE SAUER-DANFOSS GROUP

Product Focus:	Electric Inverters
Director:	Thomas Schwarzmüller
Location:	Germany (Kaiserslautern)
Web site:	www.schwarzmueller-inverter.com

Leading Technology at the Core

The identification of core product areas at Sauer-Danfoss unites technological leadership with what matters most to customers. Before long, customers will feel the benefit of the reinforced focus on hydrostatic propel systems, electronic components, orbital motors, steering and PVG spool valves.

Here, we take a look at the driving role of propel and electronic components in our new strategy for the future.

It's easy to explain why hydrostatic propel and electronic control systems will be even more central to the Sauer-Danfoss business from now on. Their ability to bring a high degree of efficiency and differentiating benefits to mobile machinery makes them a clear priority for many global manufacturers.

Considered from a very early stage in the vehicle design cycle, their performance is critical to the machine overall. Here, in particular, manufacturers expect finely-tuned specialist support and fast response times for a shorter time to market.

"What we have done is look at our customers' priorities and make sure they are our priorities," says Dave Wohlsdorf, Propel Sales Vice-President.

"Our aim is to focus more resources on continuing to develop the products that give our customers the most value and sharpen our ability to provide responsive services."

Leading the Market

In the design phase, decisions regarding propel and control systems are secondary only to the choice of engine. Involvement of Sauer-Danfoss from this stage gives customers the full benefit of high-level hydraulic expertise and some of the market's most innovative product lines.

The propel product line, including H1, Series 40 and 42, Series 51 and 90, Series 45 and transit mixer pumps and motors, is widely known for efficient performance, ease of control and high durability. Within electronic controls, Sauer-Danfoss has set the standard with its PLUS+1™ hardware and software, PLUS+1 GUIDE graphic programming tool and a broad range of PLUS+1 Compliant components.

"Our customer's know us as a technological leader in these areas. And we have always done a good job at passing on the benefits of our application knowhow", Wohlsdorf remarks.

The Brain and Nerves

Riccardo Carra, Electronic Components Sales Director, highlights the electronic trend, which continues to gather pace.

"Electronic controllers are the brain and nerves of our customers' machines. We will see electronics used more and more as an integral part of machine control systems – a trend driven by the need to improve vehicle productivity, address regulations, such as, TIER 4, and increase the user information available to the machine operator," he says.

"Our PLUS+1 GUIDE platform addresses the need to reduce time to market and provides flexibility, scalabililty and maintainability."

Opportunities to Differentiate

The reinforced product focus will create further opportunities for manufacturers to simplify their development process and differentiate their machines in terms of functionality and efficiency. Sauer-Danfoss' strong application know-how will also help manufacturers meet challenging performance goals related to the increasingly tougher legislation on emissions and functional safety.

In-house, Sauer-Danfoss has dedicated additional resources to developing concepts for machine designs that live up to the new regulations.

More Know-How to Share

"To pass the functional safety regulations in Europe, we have, for example, designed a pump with an integrated electronic controller. Customers should experience that we have a lot of technological knowhow we can share with them as we combine more electronic software with our pumps and motors," Wohlsdorf explains.

Carra agrees, adding that early involvement of Sauer-Danfoss in design projects gives manufacturers the greatest benefits.

"With our strong core product portfolio, we are equipped to work with our customers from the very beginning of their design projects. The earlier we are involved in a project, the better we can help our customers design an integrated hydraulic system for efficient power distribution and control in their machine," he states.

Read more about PLUS+1, H1 and functional safety in the articles on pages 5, 8-9, and 10-11.

***Article 1**. For further information: TheCircuit@Sauer-Danfoss.com*

A Complete Approach to Vehicle Control

In an increasingly challenging development environment, vehicle design engineers are expected to accomplish more with fewer resources. Sauer-Danfoss continues to develop an ever expanding portfolio of electronic hardware and software products to help address these demands.

Customized vehicle control solutions entered a new phase when Sauer-Danfoss in 2004 launched the PLUS+1™ Control Platform. Today the many options bring endless opportunities to maximize the performance and efficiency of mobile machines.

The PLUS+1 portfolio includes position controls and sensors, graphical displays, joysticks, foot pedals, and the PLUS+1 GUIDE development software – supported by a growing range of PLUS+1 Compliant products.

Your Strongest Partner for Electronic Solutions

"We would like our customers to think of us as their strategic electronics partner," says Joseph P. Maher, Product Marketing Manager. "Our PLUS+1 hardware and GUIDE software are designed to integrate seamlessly with our PLUS+1 Compliant electrohydraulic, human machine interface (HMI), and sensor products. This enables us to offer complete solutions, which combine our electronics, hydraulics, and vehicle control expertise. It's this comprehensive approach that makes us a strong partner for our customers."

From basic software components, function blocks, and compliance blocks through complete pre-programmed vehicle and system control software, Sauer-Danfoss provides the tools to help OEMs develop control solutions and get to market faster. Software packages, such as the new subsystem application blocks (SSA), are thoroughly tested on operating vehicles. As a result, OEMs are able to significantly reduce the time and expense of vehicle control design and qualification.

In-house Testing and Manufacturing

Another reason to consider Sauer-Danfoss as a strong electronics partner is the exceptional in-house product development and manufacturing facilities. Located in North America and Europe, these state-of-the-art facilities enable a complete range of hardware tests, for example, temperature, vibration, water ingression, and electromagnetic compatibility (EMC).

"Being able to design, qualify, and manufacture our electronic products ourselves provides a significant advantage," states Maher. "With these competencies in-house, we gain a greater understanding of our electronic components and their capabilities. This knowledge is then used to ensure continuous improvement, not only in the products themselves, but also in the already rigorous product development process. These in-house capabilities help speed up the process of developing new product variants."

Microcontrollers and Graphical Displays Offer Additional Functionality

The latest PLUS+1 MC012-016, MC038-010 and MC050-055 microcontrollers are designed to address all aspects of electronic vehicle control. This enables OEMs to control other electrical functions on their vehicles, without having to source a separate electronics supplier.

"In addition to the essentials of hydraulic control, we're now able to offer options for control of small DC motors, lighting and other electrical functions plus expanded input functionalities," says Dan Ricklefs, Director Global Marketing. "The bottom line is that the new microcontrollers help address productivity and the effect of emission requirements on vehicle design – so that vehicles will work faster, longer and with lower fuel consumption."

Supporting Tier IV fuel savings solutions, the new MC012-016 is designed for engine compartment operating temperatures up to 105 degrees Celsius.

Available for all controllers are PLUS+1 GUIDE and C-code application development tools. PLUS+1 GUIDE users enjoy a graphical drag and drop approach to developing machine control software from an extensive library of application software blocks. Sauer-Danfoss further supports PLUS+1 users with basic and advanced classroom training, e-learning, web, e-mail and help desk telephone support.

(Continued...)

Product News:

High Current Microcontroller

With the highest output current capability in the PLUS+1 family, the 38-pin controller, MC038-010, is suitable for night lighting, emergency vehicle flashers and lightbars, control of variable speed DC electric motors and high current solenoids. It is also the first PLUS+1 controller to feature a sleep mode. When in sleep mode, outputs are disabled and the microcontroller enters a low power consumption condition. When one or more inputs change state, the microcontroller wakes up. This ultimately enables the designer to power certain functions without the vehicle running, opening the possibility for more automotive style features.

PLUS+1 Microcontrollers and I/Os	Controllers	I/O Modules
12-pin	MC012-010/12	IX012-010
	MC012-016	OX012-010
	-	IOX012-010
24-pin	MC024-010/12	IX024-010
	MC024-11/14	OX024-010
	MC024-020/22	IOX024-020
	MC024-21/24	-
38-pin	MC038-010	-
50-pin	MC050-010/12	-
	MC050-020/22	-
	MC050-055/05B	-
88-pin	MC088-015	-

New DP250 Color Display

This innovative 3.5" display product family provides state of the art 240x320 pixel resolution with 15 bit color support, dual CAN and USB connectivity. Complementing the product is a new color version of the popular EIC (Engine Information Center) software, which allows OEMs to monitor and control engine functions straight out of the box.

More info at www.sauer-danfoss.com/PLUS1

***Article 2**. For further information: TheCircuit@Sauer-Danfoss.com*

The Widest, Dee

Hard rock is no obstacle to Astec Underground's new Trencor 1760. Fitted out with an intelligent Sauer-Danfoss system, this is one of the world's largest and most powerful trenchers.

Tough terrain is a sure thing when digging a trench for a new gas or oil pipeline. Whether cutting through the limestone shelf in Texas or the permafrost north of the Arctic Circle, it takes a machine of colossal power and dimensions to do the job — a machine like the new Trencor 1760 chain trencher from Astec Underground.

The Trencor 1760 is a true giant. At 950HP and built to dig trenches 6 feet wide and 24 feet deep, it dwarfs all other trenchers on the market. And, with a Sauer-Danfoss hydraulic and control system, it gives a performance to match its size.

Claudio Verzilli, Director of Engineering at Astec Underground, is confident that the improved productivity, serviceability and comfort make the machine a worthy successor to the Trencor 1660 Magnum.

"This machine is 30% bigger than the next size down. We believe customers will be amazed by the higher horsepower. Compared to the Trencor 1660M, we are looking at a 15% improvement in production.

"Another main benefit is the integrated controls, which are easier to operate, service and troubleshoot in the field," he says.

In-house Programming

The Trencor 1760 is the first of Astec Underground's mechanical drive chain trenchers to have a Sauer-Danfoss PLUS+1™ control system. Because PLUS+1 is already featured on a number of other machines in the company range, Astec Underground has its own trained PLUS+1 programmers to develop customized controls using the software programming environment, PLUS+1 GUIDE.

"Nothing comes close to PLUS+1," Verzilli remarks. "Compared to other control systems, where you have to go back and forth to the supplier during programming, the ability to train our own engineers and do our own customized programming is a key feature. Our intention is to take the same control system down the line to our smaller machines."

The PLUS+1 hardware used on the Trencor 1760 consists of two MC50 microcontrollers, two DP600 graphic displays and three JS6000 joysticks. Like the displays and joysticks, the microcontrollers are located in the cab, securing them maximum protection from the rugged outdoors. Control signals to the machine functions are transmitted via CAN bus.

Of the three joysticks, one is allocated to each of

pest Cut

the two Caterpillar track drives. The third controls the speed of the conveyor that carries rock and dirt out of the trench. Customized joystick buttons include left/right shift controls and a lockout switch that prevents involuntary conveyor movement.

Taking the Load

Cutting through hard rock places big demands on the transmission system. Here, two Sauer-Danfoss Series 90 100ccm closed circuit axial piston variable pumps take the load, driven by one of the Trencor 1760's two transmission power take off (PTO) shafts.

The other PTO drives the Series 90 100ccm pump that supplies flow to the large, robust OMT motor at each end of the conveyor. This PTO also distributes power to the auxiliary system, which elevates the boom and cab and powers the crumber and burn scrapers that keep the trench and trench sides clean. In addition, the Trencor 1760 has a Sauer-Danfoss Series 45 E-Frame 147ccm open circuit pump in the auxiliary system.

Impressive resilience

Claudio Verzilli describes the sheer resilience of the Sauer-Danfoss components as impressive.

"The biggest challenge to the hydraulic system is the high pressures on the track drives. Sometimes we push the pumps up to a pressure of 5000psi [345 bar]," he says.

"We expect components to perform under the most rigorous trenching conditions where it may be hot or cold, wet or dusty. So they have to be robust. And, because the machines typically operate far from cities and service centers, they must perform flawlessly."

The self-diagnostic program integrated in the control system supports the consistently high functionality, reporting performance information to service technicians via the graphic displays.

Altogether the system reconfirms all the reasons why Astec Underground has come to rely on Sauer-Danfoss as one of its main suppliers.

"We chose a Sauer-Danfoss solution because of the quality, technical support and availability," says Verzilli. "Sauer-Danfoss is extremely helpful to us when we have unexpected orders, sometimes coming up with the parts we need much faster than the standard lead times. They really go out of their way to help us out. That commitment to us is behind our commitment to using their products."

***Article 3** . For further information: TheCircuit@Sauer-Danfoss.com*

Efficient H1 Pumps and Motors

For off-highway vehicle designer engineers facing the demands of new engine emission and machine safety regulations, H1 axial piston pumps and motors should be the first choice on their list of key components.

OEMs have a lot to consider with the arrival of the Tier 3 & 4/Euro Stage III & IV engine emissions regulations and the revised European Machinery Directive 2006/42/EC.

With a range of H1 transmission solutions to choose from, Sauer-Danfoss is able to help OEMs through the transition – speeding up system development and qualification, increasing overall vehicle efficiency and performance, and reducing installation and life-cycle costs.

The H1 Family includes both single and tandem pumps, now available with embedded, SIL 2 certified (Safety Integrity Level 2 according to IEC 61508), electronic automotive control, and a growing range of exceptionally efficient bent axis motors.

Improve Fuel Economy

"To meet increasingly stringent global engine emissions regulations, OEMs will require more effective systems that maximize available engine power," says Branko Horvat, Product Marketing Manager. "The H1 bent axis motor is a core component that will help ensure the success of these new systems."
Test results* have shown that, at 2000rpm and 200-300 bar system pressure,

* H1 efficiency data has been measured using the same test stand and equipment, at the same time and compared with the newest comparable products on the market.

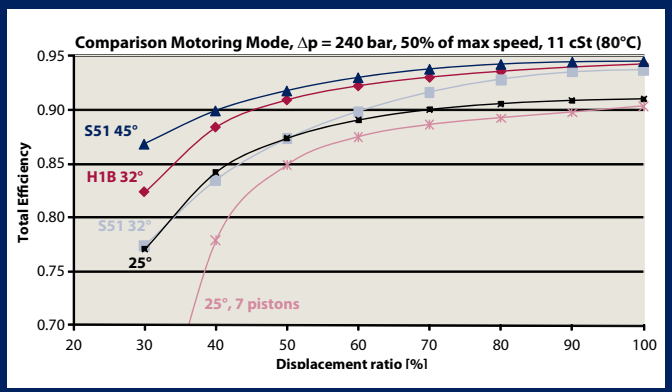


Figure 1: Bent axis motor comparisons, measured on the same test stand, with the same equipment. The graph shows the measured total efficiency advantage of Sauer-Danfoss bent axis motors (S51 32°/45° as well as the H1B motor 32°) compared to new, comparable products on the market with a lower angle range (25°). Note that both a reduced angle range and seven pistons instead of nine have a similarly negative effect on motor efficiency.

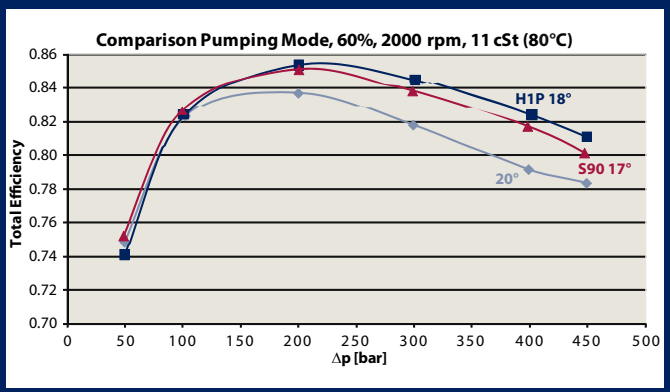


Figure 2: Swash-plate pump comparisons, measured on the same test stand, with the same equipment. The graph shows the measured total efficiency advantages of Sauer-Danfoss swash-plate pumps (S90 and H1P) compared to new, comparable products on the market with solid pistons and standard slippers (20°).

Lead the Way

the H1 bent axis motor has a six percent efficiency gain at maximum displacement (high torque working cycle) compared to the nearest comparable product. That's a gain of 5.5 kW (7.4 HP) to the ground. The result is not only improved fuel economy, but also a reduction in power losses, which can be utilized either to increase vehicle productivity or reduce the heat load placed upon the vehicle cooling system.

Two examples of the potential savings:

- 5.5 kW (7.4 HP) of power loss reduction over at 1000 working hours equates to a fuel cost saving of €1,600 per year (US$2,000) at current prices and a 3.5 ton reduction in CO_2.
- In the case of multiple hydrostatic units in the drive train, for example a typical dual path or multi-motor system, operating cost savings can easily reach the €5,000 (US$ 6,500) per year range.

The fuel-saving effect will certainly increase with a higher number of working hours, not to mention the inevitable rising cost of fuel in the future.

Maximize Vehicle Performance

In addition to the efficiency advantages of the H1 bent axis motor, the H1 pump is designed to reduce rotating group, control and charge pump losses, which also help to save fuel consumption and free power for other vehicle functions.

"By making hydraulic components more efficient, such as reducing unit power loss in pumps, we are in effect restoring some vehicle efficiency and, in many cases, improving overall performance by maximizing the transmission performance without compromise," states Horvat.

Save Development Time and Costs

H1 AC features robust electronics mounted directly on the H1 pump. The embedded controller incorporates additional "watch dog" circuitry, which provides real time fault monitoring of the electronic hardware. Combined with optional software to monitor redundant Human Machine Interface input channels, H1 AC provides single fault tolerance for AC vehicle transmission systems, with programming to bring the H1 pump to a defined 'safe state' in the event of signal loss or interruption.

The H1 AC solution is also SIL 2 certified by TÜV Nord (Technischer Überwachungs-Verein). This helps OEMs comply with the new safety legislation and reduces the cost and time required for system qualification and vehicle certification.

Faced with increasingly stringent global engine emissions regulations and new European safety legislation, OEMs require solutions that can help reduce vehicles emissions, improve safety, enhance fuel economy and increase productivity. The H1 Family offers a range of options that enable OEMs to meet these challenges head-on.

For Further Information about H1 Pumps and Motors visit:
www.sauer-danfoss.com/Products/PistonPumpsandMotors

***Article 4**. For further information: TheCircuit@Sauer-Danfoss.com*

The H1 family

PUMPS

- Frame 45/53 single and tandem pumps: 45 cm³ and 53 cm³
- Frame 60/68 single pumps: 60 cm³ and 68 cm³ *(Coming soon)*
- Frame 78 single pump: 78 cm³
- Frame 89/100 single pumps: 89 cm³ and 100 cm³
- Frame 115/130 single pumps: 115 cm³ and 130 cm³
- Frame 147/165 single pumps: 147 cm³ and 165 cm³

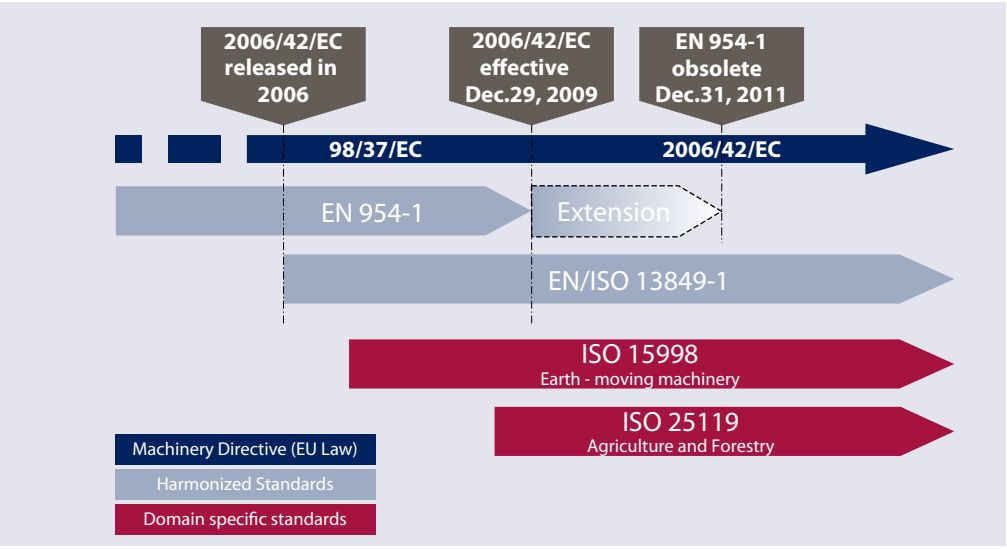
MOTORS

- Frame 60 bent axis motor: 60 cm³
- Frame 80 bent axis motor: 80 cm³
- Frame 110 bent axis motor: 110 cm³
- Frame 160 bent axis motor: 160 cm³ *(Coming soon)*

COMPLIANT

On Top of the new Safety

New European safety legislation will impact the design and development of all off-highway vehicles destined for the European market. Sauer-Danfoss expertise is helping OEMs meet the challenge.



On December 29, 2009, the long awaited revision to the European Machinery Directive 2006/42/EC came into force. For OEMs that manufacture or sell off-highway vehicles in Europe, the revised directive demands a more rigorous process of risk analysis and vehicle function verification.

Sauer-Danfoss is prepared to help OEMs meet these new safety requirements. Standard products today come with key safety data, such as Mean Time To dangerous Failure (MTTFd). At the same time, new products are being designed to speed up system development and verification, reduce total installed costs, and ultimately bring vehicles to market faster. These include the OSPE Electrohydraulic Steering Unit and SIL 2 certified H1 Automotive Control.

New International Safety Standards

Together with the revised Machinery Directive, international safety standards have been updated, such as the harmonized EN ISO 13849-1 standard. A significant change is the introduction of a probabilistic approach to vehicle function verification. The challenge for OEMs is to design and verify that vehicle functions meet a specific performance level (PLr), determined by a hazard and risk analysis. Verification involves gathering MTTFd data from individual component suppliers and checking diagnostic coverage (DCavg) and common cause failures (CCF) in order to ensure the required PL has been achieved. Only then can OEMs establish an EC Declaration of Conformity (DoC) and CE mark their vehicles.

To help with this process, Sauer-Danfoss is developing new products, in some cases prequalified, that meet the demands of specific safety standards.

SIL 2 Certified H1 Automotive Control

H1 Automotive Control (AC) is a complete SIL 2 (Safety Integrity Level 2, according to International Electrotechnical Commission (IEC) standard 61508) certified solution that significantly reduces OEM vehicle development and qualification expenses.

"Our H1 Automotive Control is the first solution on the market to offer the precision and consistent performance of intelligent electronics, combined with complete drive system functionality, system qualification and SIL 2 certification," says Joseph P. Maher, Product Marketing Manager. "OEMs will be able to reduce time to market for new vehicles and model variants while still customizing vehicle behavior and providing differentiation for their products."

Both the H1 AC hardware and software have been designed to be SIL compliant. The embedded controller incorporates additional 'watch dog' circuitry, which provides real-time fault monitoring of the electronic hardware. Together with optional software used to monitor redundant HMI channels, it provides single fault tolerance for AC transmission systems. The controller is also programmed to bring the H1 pump to a defined safe state in the event of signal loss or interruption – SIL 2 certified by TÜV Nord (Technischer Überwachungs-Verein).

H1 AC software is easily configured to meet OEM requirements. Features include engine anti-stall and protection against engine over-speed, extreme high and low hydraulic oil temperature conditions, and hydraulic motor over-speed. In addition, there is automatic compensation for variations in hydraulic oil viscosity that affect control performance. The result is consistent, predictable vehicle performance irrespective of operating temperature.

A 'Safe State' Steering System Architecture

The OSPE electrohydraulic steering unit is another Sauer-Danfoss component designed to help OEMs meet the new safety legislation. In the event of an electronic or hydraulic system malfunction, a 'safe state' option, activated by an external 'watch dog' controller, can isolate the electrohydraulic section

Standard

of the steering valve in order to protect the steering system.

"The OSPE has been designed to provide the basis for a safe state system architecture – for example, Category 2 (ISO 25119)," says Tom Rudolph, Product Marketing Manager. "As a result, OEMs can speed up steering system development and certification."

Another safety feature ensures that the steering ports from the OSP are not blocked in electro-hydraulic steering (non-reactive) mode. This is achieved with an extra connection from the hydrostatic steering unit to the cylinder. In contrast to other systems, this keeps the steering wheel fully operational and the driver in complete control.

Certified PLUS+1™ Software Development Environment

To help speed up the development and certification of safety critical software, and ultimately help customers achieve CE certification, Sauer-Danfoss PLUS+1™ software development tools have been certified by the SP Technical Research Institute of Sweden. Both the PLUS+1 GUIDE graphical design program and the PLUS+1 Service Tool program fulfill the requirements of the IEC 61508 standard for use as support tools in the development of SIL 2 application software. This will help customers develop safety functions according to the harmonized EN ISO 13849-1 standard.

"Our GUIDE program, application software development processes and user manuals are consistent with IEC 61508, which means they do not need to be completely re-assessed as part of the application software certification process" says Fred Bezat, Software Product Marketing Manager. "This helps to speed up software development, ensure higher quality, and reduce vehicle certification time and expense by reducing the complexity of the technical file that must be provided to the certifying organization."

"We have strong product offerings for propel, steering and work functionality, as well as the software to control these devices and their related safety functions," continues Steve Crow, Senior Engineer. "When used in combination, Sauer-Danfoss products can be assembled into strong architectures that satisfy the most stringent functional safety requirements demanded by our industry."

Article 5. *For further information:*
TheCircuit@Sauer-Danfoss.com

New Leadership Team in Place

Sven Ruder
President and Chief Executive Officer

Jesper Christensen
Executive Vice President and Chief Financial Officer

Marc Weston
Executive Vice President and Chief Marketing Officer

Kells Hall
Executive Vice President and President Propel Division

Wolfgang Schramm
Executive Vice President and President Controls Division

Anne Wilkinson
Executive Vice President Human Resources

The prospects for the mobile hydraulic market are vastly improved since financial crisis rocked much of the world two years ago. At Sauer-Danfoss, the Leadership Team is focused on firing up under the steady trend towards renewed growth.

One major step in that direction is the new business structure announced in July.

Following a series of changes in 2010, the Sauer-Danfoss Leadership Team now comprises Sven Ruder, President and Chief Executive Officer; Jesper Christensen, Executive Vice President and Chief Financial Officer; Marc Weston, Executive Vice President and Chief Marketing Officer; Kells Hall, Executive Vice President and President Propel Division; Wolfgang Schramm, Executive Vice President and President Controls Division and Anne Wilkinson, Executive Vice President Human Resources. Sauer-Danfoss is today 76% owned by Danfoss A/S.

Website Offers low Emissions Advice

How to optimize efficiency and performance are big questions for the mobile machine industry as the Tier IV and Stage IV low emissions regulations come into force over the next six years. Manufacturers will find many of the answers on the Emissions Solutions section on the Sauer-Danfoss website.

The resource is a step in Sauer-Danfoss' drive to support the mobile machine industry as the regulations are phased in. Up to 15,000 machine models are expected to need a makeover to maximize their efficiency with the new low emission engines.

In addition to information about research and solutions, the web pages describe a series of Sauer-Danfoss tools for identifying optimum systems and comparing the cost and efficiency of circuit designs.

Visit www.sauer-danfoss.com/Emissions, and read more about how Sauer-Danfoss can help you face the future with Tier IV and Stage IV in the next issue of The Circuit.

University Opens PLUS+1™ Lab

Engineering students get to grips with the latest programming technology in the new PLUS+1™ training lab at Osnabrück University of Applied Sciences in Germany.

The lab is equipped with PLUS+1 components, PLUS+1 GUIDE, PVG valves and orbital motors sponsored by Sauer-Danfoss. Following PLUS+1 training by Sauer-Danfoss staff, the engineering faculty began offering basic and advanced courses in mobile machine programming in 2009.

Stefan Eichler, System Application Engineering Manager at Sauer-Danfoss in Germany, reports on the highly positive feedback the lab has received.

"The courses are always fully booked. Three of the first students to participate have since founded a company that successfully offers PLUS+1 programming to OEMs," he says.

Over the years, Sauer-Danfoss has established a close relationship with Osnabrück University. The relationship has clear mutual benefits. "Using our PLUS+1 GUIDE graphical programming tool, students gain confidence in using electronic systems," Eichler explains. "It is also an opportunity for us to seek out new talents capable of taking our business forward."

Exhibition Calendar 2011

Attending the IFPE at ConExpo/ConAgg, March 23-26, Las Vegas, USA

Make sure to check out where to meet Sauer-Danfoss representatives at Exhibitions over 2011.

You will find our Exhibition Calendar on our website: www.sauer-danfoss.com/exhibitions

the circuit

"The Circuit" is published by Market Communications, Sauer-Danfoss Sales & Marketing, and has a circulation of approx. 11,000 copies in English, German, French, Spanish, Portuguese, Italian, Danish and Russian.

Editor: Lenette Nielsen, Manager Market Comm. Sauer-Danfoss, 6430 Nordborg, Denmark lenielsen@sauer-danfoss.com

Layout: Hanne Fabrin, Market Communication

Text: Cath Mersh, Rachel Martin, and Warren Joiner