MOBILE 2021

Explore more.

New challenges –
Let´s start today

Transforming Mobile Machines

Now. Next. Beyond.

Content

Transforming Mobile Machines. Let’s start today.

Dear Readers,

Mobile working machines will soon be very different from what we’re used to today. After all, their transformation into more intelligent and efficient systems is well under way. The development work is focusing on reliable interaction with people – especially when it comes to semi and full automation –, connectivity and the increasing demands for “zero emissions”. These are all ways of dealing with increasing pressure as regards productivity and energy efficiency.

The presentations at MOBILE 2021 will therefore focus on a wide range of topics with a view to encouraging the transformation of mobile working machines – and giving you an overview of our areas of expertise. The presentations are subdivided into five main topic clusters:

Easy Operation
Automation and Comfort

Electrification
Emissions and Efficiency

More Performance
Increased Work Power and Speed

Smart Simplicity
Less Complexity, More Features

Always Connected
Telematics and Data Management

In addition to these clusters, you can also find interesting discussions on more general topics such as digitalization, the IoT or alternative power sources.

We’d like to invite you to discuss all these topics with us. After all, our aim is to work together with you to develop solutions – from the initial idea through to mass production. We invite you to explore and shape the future of mobile machines together.

Explore more.
Now. Next. Beyond.

Best wishes

Holger von Hebel
Bosch Rexroth AG
Senior Vice President
Business Unit Mobile Hydraulics

Bernd Schunk
Bosch Rexroth AG
Senior Vice President
Sales Business Unit Mobile Hydraulics

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Easy Operation

Automation and Comfort

Alexander Mark
& Dr. Frank Bender

TOUGH PERFORMANCE.
EASY HANDLING.
Smart functions for operator assistance

The machine becomes an active support for the operators so they can focus on the essentials. Easily integrate intelligent assistance functions to reduce stress and increase safety for operators, machines and the surrounding.

Automation and assistance functions open up new opportunities for mobile machines. Make higher precision, repeatability, and safety native characteristics of your machine – independent from the operators‘ skill and experience levels.

Patrick Glasbrenner

EVERYTHING UNDER CONTROL.

New human machine interface for an enhanced operator experience

More safety – more assistance – more distraction? Our new control elements for mobile machines increase ergonomics and provide innovative functions. This makes the machine control safer and more comfortable, so the operaters can fully concentrate on their job.

Diego Cornolti

(TELE)HANDLING NEW CHALLENGES.

The holistic solution to control telehandlers

What is the control concept for the telehandler of the future? We combine electrohydraulics, power management and assistance functions to a holistic machine solution. This enables new functions, reduced consumption and increased machine safety.

Andreas Fladée & Camille Marbach

NEVER LET IT GET TOO CLOSE.

Assistance systems for narrow environments

The safety of men and machines is always and everywhere of highest priority – and especially relevant where space is limited or the situation is unclear, like in warehouses or on construction sites. Surround sensing systems from Bosch are the basis both for safer operation and ongoing automation of mobile machines.

Tough performance. Easy handling.

Smart functions for operator assistance

Authors

Alexander Mark
Director Sales Wheel Loader Implements and Automation

Dr. Frank Bender
Team Manager Automation, Systems Engineering

At a glance

Bosch Rexroth presents ready-to-apply operator assistance functions that help OEMs adding value to their off-highway machines. Smart software running on BODAS controllers can solve all the mathematical problems in the background and provide the right command signals to electro-hydraulic core components, while intuitive, customized user interfaces ensure safe and Easy Operation.

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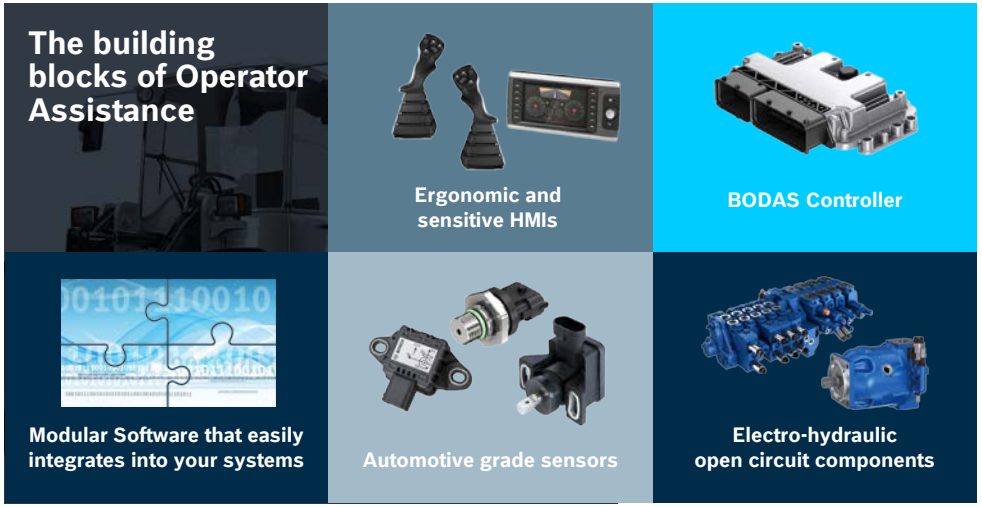
WHY THIS INNOVATION?

Rough terrain, narrow and crowded working spaces, heavy equipment, demanding tasks – operating mobile machines requires skilled operators and permanent concentration. Automation has already become part of our daily life (e.g. home and garden) as well as our daily business (e.g. factory automation), intelligent assistance systems are rapidly evolving to support humans in doing their jobs best. Bosch Rexroth follows this trend and offers OEMs ready-to-apply solutions – which can help them to create a new and attractive selling point.

WHAT'S NEW?

Bosch Rexroth presents a complete ecosystem of hardware and software building blocks for operator assistance – from Electronic Open Circuit components to HMIs, electronic control units, sensors and modular application software for various mobile applications. Our solutions combine knowledge of hydraulics and machine dynamics with Bosch's highly reliable mass production sensors and ECUs in automotive quality. The result: application-specific functions with superior performance. They help to reduce operator stress and sources of error, enhance accuracy and productivity, minimize equipment wear and tear, and make operations safer for everyone.



Smart functions for operator assistance are based on five main elements. These range from the HMI devices to the core electro-hydraulic components.

HOW DOES IT WORK?

Understanding the kinematics. Bosch Rexroth has developed algorithms to handle multiple base types of kinematics in real-time on BODAS controllers. The functions can be easily adapted to the specific geometry of your machine structure.

Having the sensors. Position sensing is a crucial element for assisted movements. Our 6D inertial measurement unit MM7.10 offers great freedom for positioning them in an available space, protected from external impact. Or would you prefer another sensor solution? Our assistance software flexibly supports different sensor types; whatever is best for the integration into your machine.

Knowing the actuators. Control engineering is a key competence of our systems engineering and automation teams. Combining the expertise in controls with the deep knowledge about our components translates into robust, fast, accurate, predictable, and stable performance.

HOW DO YOU BENEFIT?

- **Easy handling boosts performance.** Simplify repetitive tasks with teach-in functions. Help less experienced operators to perform better and faster. Increase working precision with ergonomic and sensitive HMIs.

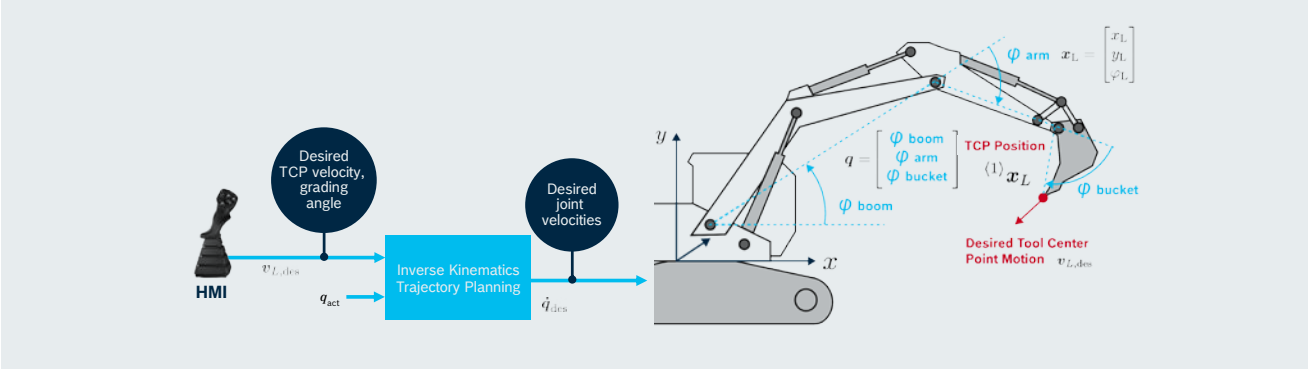
- **Optimized performance.** Deep knowledge about hydraulic component design and their dynamic characteristics combined with the expertise in robotics and control engineering translates into outstanding and reliable performance.

- **Complete bundles.** Bosch Rexroth is offering all building blocks required to integrate operator assistance functions in proven Bosch Rexroth quality into your machines. Ergonomic HMI devices, BODAS controllers, sensors, application and assistance software, and optimized electro-hydraulic components are the key ingredients.

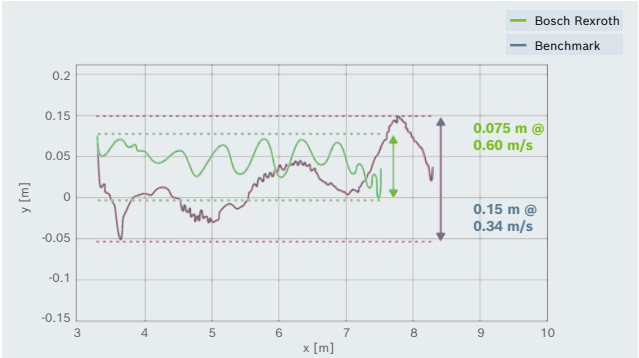
- **Adaptable and modular.** Assistance functions can easily be adapted to customer machines. Customers can select the desired combination of features from our BODAS portfolio.

- **Enhanced safety.** Operator assistance functions and adaptive machine controls can help to avoid unsafe operations, restrict them to a predefined safe area, and to reduce operator fatigue. This goes beyond the legal requirements of functional safety.

- **Bosch factor.** Proven electronic control units and sensors produced in high volumes in automotive quality offer a robust basis for automation technology.



Easy Grade is an example of how to intelligently assist the operator in complex tasks. Understanding the kinematics is crucial to developing a solution that can handle the 3 degrees of freedom offered by the structure in real-time to follow the grading trajectory.



Easy Grade – performance measured in practice: Our holistic solution outperforms the serial benchmark system in speed and accuracy. It's twice as precise and almost twice as fast.

Everything under control.

New multifunctional joystick with haptic feedback element

Author

Patrick Glasbrenner
Sales and Product Management
Human Machine Interface

At a glance

Human machine interface, or “HMI”, is key in the perception of machine behavior and operator experience. With the new multifunctional, ergonomic joystick Sense+, mobile working machines remain easily controllable despite a rising number of machine functions and attachment tools. The integrated haptic vibration feedback element enables an intuitive interaction between the driver and the machine in combination with operator assistance and semi-automation functions.

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WHY THIS INNOVATION?

The implementation of assistance functions, semi-automation functions and addition of attachment tool options is fundamentally impacting HMI requirements. Operators are dealing with a high number of control elements and need to master the shift between manual and automatic operation. In addition, the risk of overstimulation and distraction is rising, as drivers are continuously confronted with a veritable onslaught of information and alerts in the form of acoustic signals and displayed information.

WHAT’S NEW?

Bosch Rexroth has developed the new multifunctional, ergonomic joystick Sense+. The unique grip design, available in both left- and right-hand version, has been created based on the experience and preferences of end users around the world to reach the ultimate ergonomics, improving comfort and supporting an easy controllability.
On top of that, the grip can be optionally equipped with a haptic vibration feedback element.

The optional haptic vibration feedback can be used to warn and guide operators intuitively

This haptic element can guide and warn operators with different vibration patterns, enabling an interaction between the machine and the driver in an intuitive and comfortable way.

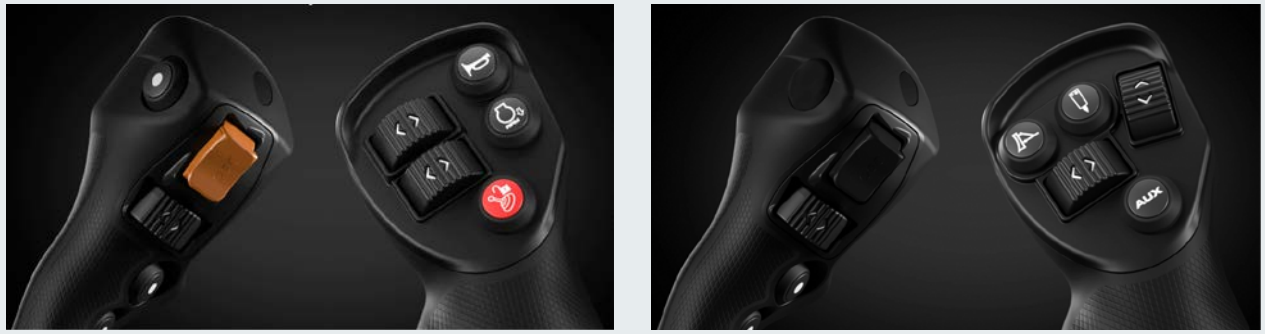
New multifunctional joystick Sense+ with ultimate ergonomics

HOW DOES IT WORK?

The Sense+ consists of a comfortable thumb and hand rest, soft touch textures and ergonomically integrated push buttons, rollers and rockers. The grip components are optionally available with LED backlighting, allowing for excellent accessibility and comfort to reduce fatigue and increase productivity. In total, the new grip is available in 156 different configurations to suit multiple applications and various machine models.

In order to enable a high degree of flexibility and adaptability without changing the electronic hardware architecture on the machine, Bosch Rexroth joysticks offer the possibility to process the signals from the grip within the joystick base and transform the analogue signals into CAN messages. This results in only one standardized CAN connection from the joystick to the machine ECU, which significantly reduces wiring effort and saves costs.

The integrated vibration function can be used to guide and warn the driver or provide feedback about the quality and progress of the work results. By using different vibration patterns and increasing the vibration frequency, distances from a target surface, a virtual wall, approaching obstacles, or simply the mechanical end positions of the machine movements can be indicated in an intuitive way.



The modular front and back faces enable 156 different configurations

HOW DO YOU BENEFIT?

- **Easy controllability.** The new Sense+ enables an easy controllability, despite the rising number of machine functions, thanks to an ergonomic grip shape, excellent component integration, and accessibility.

- **Increased intuitiveness.** The integrated haptic vibration feedback element increases the intuitiveness, especially in combination with automation and assistance functions.

- **Individual adaptions.** The modular front and back faces of the grip can be individually configured, enabling an easy adaption to different applications, machine models or individual operator preferences.

- **Low wiring effort.** A low wiring effort is guaranteed as only one single CAN connector is required to connect the joystick to the machine ECU. All analogue grip signals are converted to CAN signals in the joystick base.

Everything under control.

New modular dual circuit power brake

Author

Patrick Glasbrenner
Sales and Product Management
Human Machine Interface

At a glance

As a basis for the automation of mobile working machines, hydraulic power brakes are changing from pure mechanical actuation to electro-hydraulics. The new modular dual circuit power brake platform “Gemini” allows an easy and step by step transition to brake by wire. Thanks to the dual channel design, safety performance levels PLd or PLe according to ISO 13849 can be reached.

WHY THIS INNOVATION?

The usage of brake systems offering the option of electric activation is the foundation to enabling autonomous, semi-automated and remote-controlled machines.
This is causing a shift in the design of hydraulic power brake architectures from purely mechanical to electro-hydraulics.
Nonetheless, not all the machines will be equipped with full brake by wire at once.
For this reason, a scalable brake solution allowing different actuation options is key in order to reduce the validation and homologation effort and ease the transition to brake by wire.

WHAT’S NEW?

The new modular dual circuit power brake platform Gemini from Bosch Rexroth makes the transition from purely mechanical brake systems to electro-hydraulic override or even full brake by wire feasible and easy, without changing the hydraulic hardware architecture. The dual channel design, with the two brake spools arranged in parallel, ensures in case of a failure that one brake circuit always remains fully operational.

Floor mounted version of Gemini with electric solenoid valve for electro-hydraulic override

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HOW DOES IT WORK?

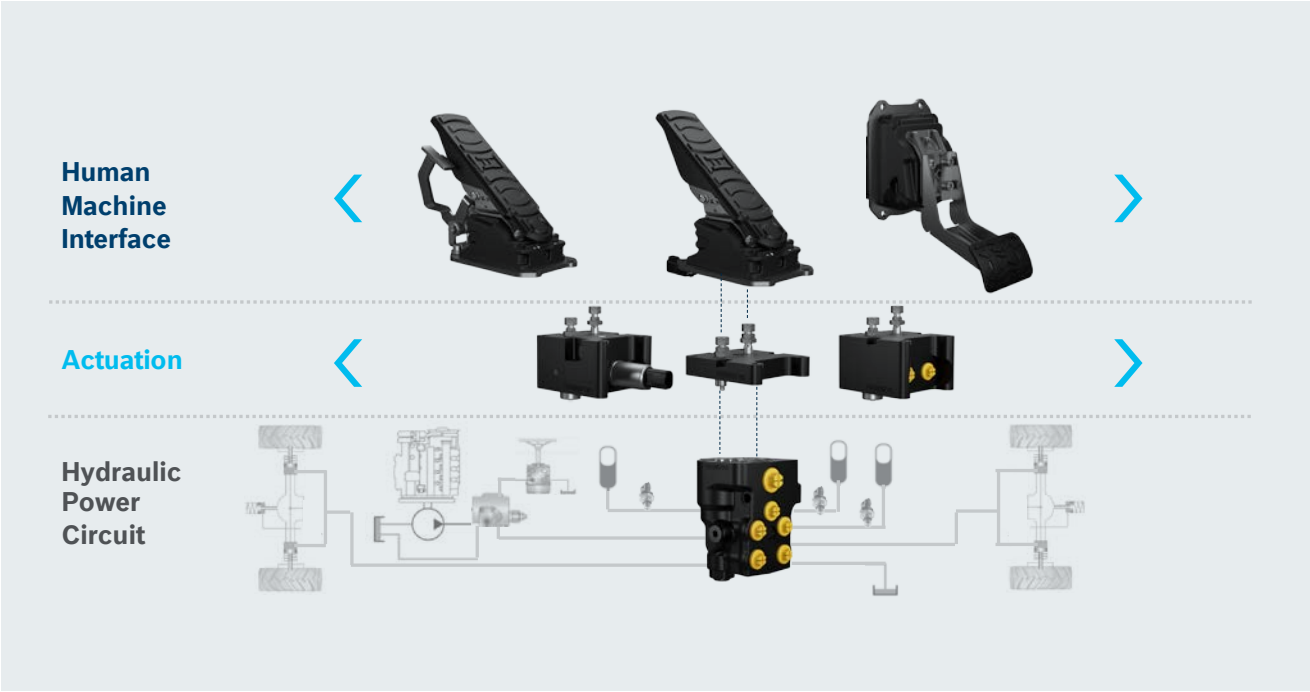
The new power brake platform is designed in modular building blocks. Regardless of the installed brake solution, e.g. pure mechanical, electro-hydraulic override or full brake by wire, the hydraulic power circuit section remains the same. No change of the brake components, such as the pump, the accumulator charging valve, the accumulators, the hoses, or the fittings is necessary. Unlike conventional brake valves with two tandem brake spools for the front and rear circuit, the regulation units for Gemini are arranged in parallel and are completely independent from each other. This dual channel design ensures – in the case of a pressure loss in one of the circuits or a mechanical issue in one of the regulation units – that the maximum brake pressure can still be reached in the second, operational circuit. This, in turn, enables safety performance levels up to PLd or PLe according to ISO 13849 to be achieved.

HOW DO YOU BENEFIT?

- **Easy transition.** The new power brake platform enables an easy transition from mechanical to electro-hydraulic override and up to full brake by wire.

- **High scalability.** The modular building blocks offer a high scalability from basic to advanced machines without changing the hydraulic hardware architecture.

- **High safety performance level.** Thanks to the dual channel design with the brake spools arranged in parallel, performance levels PLd or PLe can be achieved.



Modular design concept with fixed hydraulic power circuit section, flexible actuation options and different pedal versions

Electro-hydraulic brake valve with separate E-pedal for a full brake by wire system

(Tele)handling new challenges.

The holistic solution to control telehandlers

Author

Diego Cornolti
Director Sales and Industry Sector Management Telehandlers and Hydromechanics

At a glance

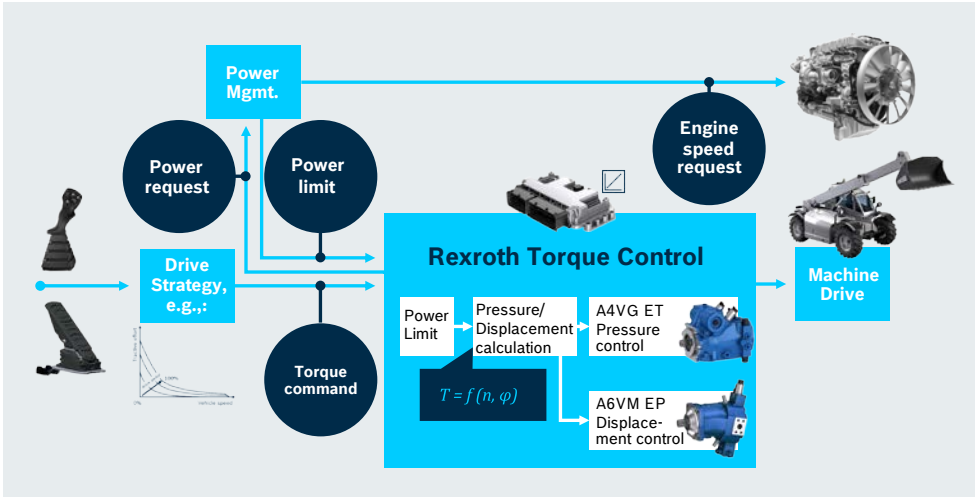
Telehandlers are a demanding application – from development to configuration and operation; good reasons to improve the entire value chain. Based on proven components and software, Bosch Rexroth introduces innovative drivetrain and implement control concepts, along with the openness for Advanced Assistance Functions and intelligent power management.

WHY THIS INNOVATION?

Telehandler OEMs are seeing diverging market trends: The complexity of the application and the decreasing availability of skilled operators require easy-to-control and easy-to-handle vehicles. At the same time, customers expect ever-more customized machines – developed and delivered faster. How can OEMs combine ease-of-use, differentiation, and short time-to-market?

WHAT'S NEW?

Bosch Rexroth offers new solutions to control the drivetrain, increase the load sensitivity of the implement, and enhance safety and productivity with Advanced Assistance Functions. Additionally, adjustable power management makes the operation of the machine smoother and reduces CO_2 emissions. Innovative software solutions help OEMs to adjust machine parameters to the specific needs of their customers and reduce the time-to-market. All solutions are based on proven components and software functions that are used successfully in mobile machines around the globe.



Next-generation drivetrain: The torque at the wheel is completely decoupled from the engine speed. The electronic torque control responds considerably quicker to driving commands.

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HOW DOES IT WORK?

Next-generation drivetrain. Traditionally, the control logic is based on the engine speed, which determines the necessary pump and motor control current. Now, with the new torque control, the operator simply determines the tractive effort as desired in any working and driving situation – while the Power Manager ensures the right engine speed.

Load-sensitive implement – the next stage. By combining the Electronic Open Circuit pump and electro-hydraulic main control valve with EHpQ software, pressure and flow are controlled independently. This allows for a high load sensitivity, soft but quick movements, easier control of the auxiliaries, and adaptive power limitation. Together with the E-motion Plus, Bosch Rexroth defines the next level of controllability for telehandlers.

Advanced Assistance Functions (AAF). The new control strategy and the “digitalization” of the hydraulic system make it easy to add intelligent assistance anytime. AAF from Bosch Rexroth increases safety and productivity no matter how narrow the working environment. Even less experienced operators can manage any task with ease while maintaining high productivity.

Power management. In addition to the precision control of vehicle motion via the torque, Bosch Rexroth offers power-oriented engine speed control with the Power Manager. Given that all main consumers in the vehicle share its physical interfaces, the Power Manager coordinates and optimizes the power flows from and to the power participants.

HOW DO YOU BENEFIT?

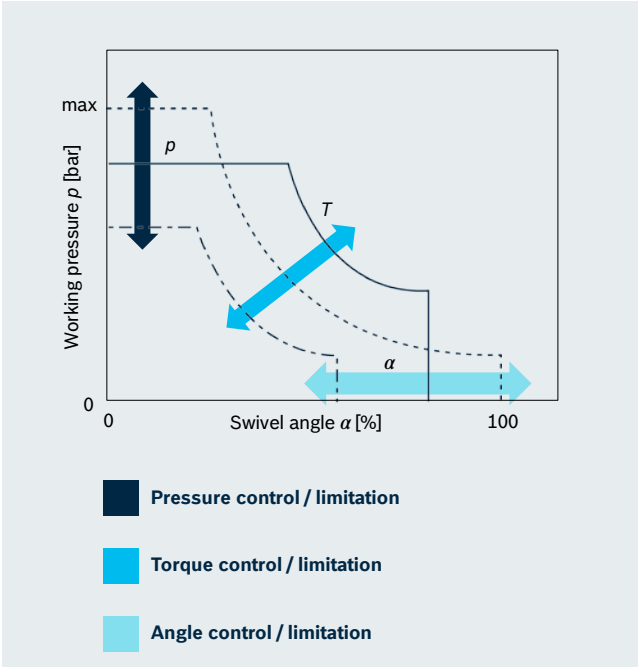
- **Everything under control.** All these new solutions enable even less experienced drivers to safely handle the drivetrain and the implement. Rental machine providers – and not only them – will appreciate the possibilites this opens for them.

- **Less fuel, less CO_2.** Sustainability as a selling point: With the adjustable power management, your customers can save up to 20% energy. The Electronic Open Circuit solution eOC with EHpQ software adds the capability of limiting power, which enables additional savings.

- **Customization at its best.** With the new drive control concept and eOC, you can easily configure machine characteristics in the software – perfectly adapted to different customer needs.

- **Faster than your competitors.** Thanks to open and common interfaces, you can save a great deal of time in function development and vehicle configuration.

The new implement solution Electronic Open Circuit eOC combines: eOC pump, electro-hydraulic main control and load-holding valves, RC controller, and BODAS EHpQ software.



Pressure and flow control for the implements can be controlled independently. This results in improved load sensitivity, easier control, and adaptive power management.

Never let it get too close.

Assistance systems for narrow environments

Authors

Andreas Fladée
Director Customer Team Sales Off-Road Customers

Camille Marbach
Product Management Surround Sensing

At a glance

On-Highway technology meets off-highway requirements – in this fascinating intersection of markets, automotive knowledge, experience, and high-quality products are made available for the Off-Highway market. Introducing a broad portfolio of surround-sensing solutions such as radar, ultrasonic, and a multi-camera systems adapted for the world of mobile machinery.

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WHY THIS INNOVATION?

The automotive sector enjoy various technological solutions for surround sensing developed for it. Many of these automotive innovations serve the driver in terms of efficiency, safety, and intuitive interactions. Why should operators of mobile machines not enjoy the benefits offered by those technologies, making the handling of loads and the driving of large machines much safer? Or a better question: how can we make machines safer, more efficient, and at the same time intuitive for the operator?

WHAT'S NEW?

The field of mobile machinery places entirely different requirements on sensor systems than automotive applications. In order to provide an answer for the different industries, customer needs and vehicle types, the products have been adapted to the relevant requirements.

The goal: Flexible, easy-to-install and configurable sensor systems that can be used in machines such as excavators, forklifts, tractors, municipal vehicles, and many other applications.

HOW DOES IT WORK?

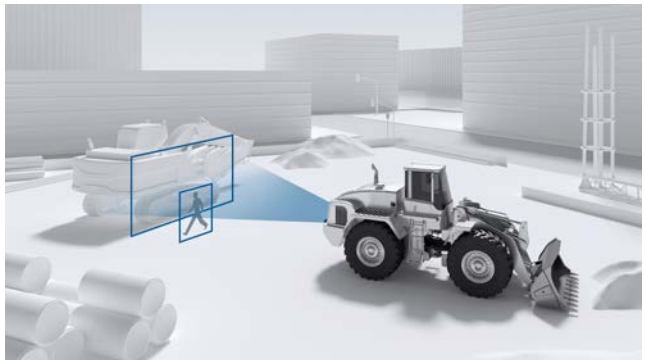
Ultrasonic Sensor System Off-Highway
Bosch offers different variants of Ultrasonic Sensor Systems based on the latest generation of automotive sensors with a sensor field of view of 140° by 70°. The Entry version provides precise information on distances to objects in a range of 15 cm to 5.5 m with an accuracy of up to 2 cm and a measurement rate of 120 ms. The system is scalable from 4 to 12 ultrasonic sensors allowing different configurations. It allows flexible, individual parameterization and is optimized for the use on mobile machines. The system also offers features like special distance filters for application in rough terrain and self-protection functions like the detection of sensor blindness caused by dirt or other deposit obstructing the sensor. In addition to the features offered by the Entry system, the Premium variant measures the distance and additionally

localizes the exact position of up to 20 objects. The main use case for ultrasonic sensor systems is the protection of zones with limited visibility around the machine.

Specific examples for ultrasonic sensors are the man basket or the blind side of the excavator.

Radar Off-Highway

Bosch radar sensors are state-of-the-art and work in a frequency-band of 76 to 77 GHz. This enables a detection range of 1 m to 40 m for typical objects with an accuracy of up to ± 0.1 m. The sensors are equipped with two freely selectable internal antennas, one optimized for near range (field of view ± 42.6°) and one for far range (field of view ± 10°). The sensor is one of the smallest on the market with dimensions of 7 x 6 x 3 cm. Our range of radar sensors offers two variants: The General Purpose Radar (GPR) OHW detects up to 48 target reflections. This makes, the GPR the ideal base for individual functional development. The second variant, Radar OHW, includes advanced Off-Highway specific object detection algorithms. It can detect up to 40 objects, also providing a lot of useful information about each object, such as distance, speed, reflectivity, and many other attributes. The radar sensor systems are developed according to ISO13849 and can be used for safety-related functions up to performance level PLd. The main use case for radar systems on mobile machines are collision warnings during front- or backwards movements, for example, on wheel loader.



In addition, the radar sensor enables object tracking for the assumption of object movements.

Multi-Camera System Off-Highway

The Multi-Camera System consists of an electronic control unit and four digital near range cameras. It provides a high resolution (1280x800 pixel), full 360° view around the vehicle. The different views can be displayed on a monitor in either full screen or split screen mode. An advanced stitching algorithm ensures that objects in overlapping areas do not “disapper” from the display or appear double. The surround view system includes a top view zoom function, depending on vehicle velocity and a driving lane indication. This surround view can be converted to a collision warning system using the same cameras. The collision warning function creates configurable alarms depending on static or dynamic objects around the vehicle. Fast and easy calibration for different vehicle variants is possible by using the related tools. This also enables service technicians to update or recalibrate the system in the field.

Multi-camera system provides 360° surround view and virtual camera movement depending on the steering angle.

HOW DO YOU BENEFIT?

- **High end surround sensing technology optimized for Off-Highway applications.** Latest sensor technology adapted for Off-Highway applications.

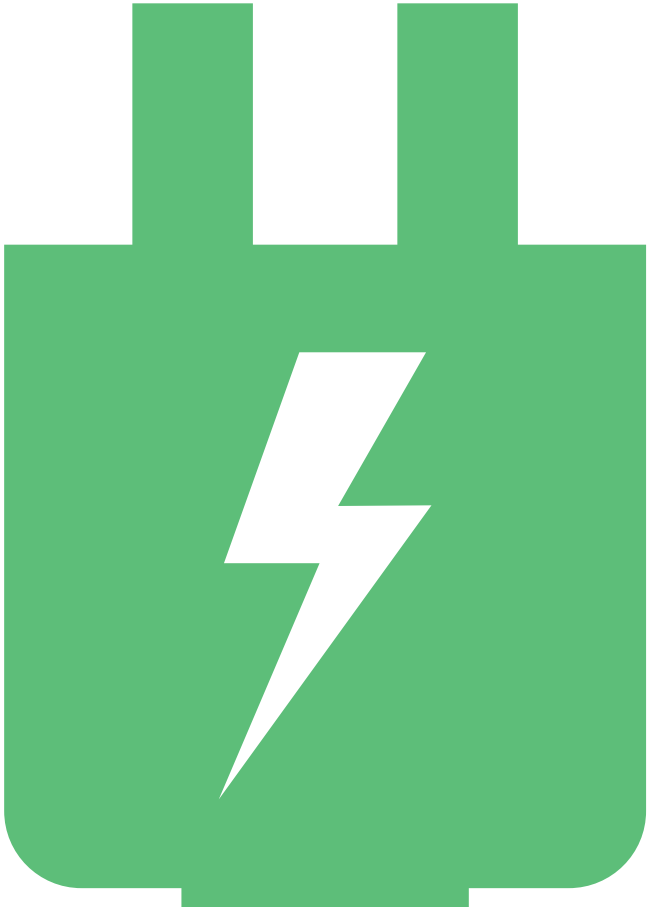
- **Tool-based application.** A special toolset supports the adaptation of the technology to your machine.

- **Enhanced safety and reduced operator stress.** Assistance systems support the operator by highlighting objects in the danger zone around the vehicle. This reduces the stress on the operator and ensures that they can focus 100% on their work.

- **Tailored support.** Bosch can integrate the presented assistance systems into your vehicle with full engineering support. Alternatively, the comprehensive documentation and tools provided enable you to carry out the integration yourself.

Electrification

Emissions and Efficiency



Matthias Kielbassa

GET ELECTRIFIED.
Our new solution portfolio for mobile machines

Innovation is where imagination meets ambition. Explore our new 700 V electric portfolio of motors, inverters, gear units and complementary components to realize robust, scalable and safe solutions for mobile applications.

Reconciling mobile machinery with urban life and a healthy environment: This is both a challenge and an opportunity! Certainly, this is driving the technology shift towards electrification. We combine our new electric drives with hydraulics, transmissions and our application expertise to help you successfully manage the transformation of your machines.

Matthias Kielbassa & Federico Perelli

FULL FORCE.
ZERO LOCAL EMISSIONS.
Electrifying mobile machines – we're ready

How to realize local zero emission without performance trade-off? A real use case to discover 700 V electric solutions for mobile applications.

Jochen Reinhard

LIFTING PLATFORMS.
NOT COMPLEXITY.
Optimized hydraulics for electrified compact machines

Does electrification drive complexity? Our hydraulic systems for electric drives demonstrate the opposite. We use optimized pumps and decentralized valves to increase efficiency and reduce noise and complexity, on the example of a Mobile Elevating Work Platform.

Get electrified.

Our new solution portfolio for mobile machines

Author

Matthias Kielbassa
Vice President Electrification
Off-Highway Mobile Machines

At a glance

Bosch Rexroth is extending its capabilities in the off-highway sector by driving forward the electrification of mobile machines. Our end-to-end high-voltage portfolio – the Rexroth eLION platform – supports OEMs in realizing both partially and fully electric off-highway machines. Electrification combined with intelligent software creates attractive new options by providing increased efficiency, powerful perfomance, and full compliance with functional and electrical safety requirements.

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WHY THIS INNOVATION?

Electrification has evolved to become one of the megatrends in the automotive industry – and it's about to conquer the off-highway market too. Legislation is a main driver for local zero emissions and reduced noise. But also from an economic perspective, electric drivetrains and implement functions are becoming more and more interesting. The remaining question: Can electrification really succeed in this tough industry?

WHAT'S NEW?

In our new high-voltage eLION portfolio, OEMs find the complete spectrum of electric motor-generators, inverters, electric accessories as well as corresponding gear units, hydraulics and software – all made for seamless interoperability.

The power range from 20 to 200 kW nominal with a peak performance of up to 400 kW allows platform developments for all applications from compact to heavy machines, and all machine functions from traction to implement.

HOW DOES IT WORK?

The eLION portfolio is specifically designed for the off-highway sector and provides an answer for the main challenges in that industry, such as:

Harsh environmental conditions. The motor-generators, inverters and gear units have a robust off-highway design, i.e. high ingress protection (IP) class and high shock and vibration resistance. Additionally, they can be operated without any derating at a broad temperature interval.

Wide range of applications and functions. eLION is a scalable portfolio. The motor-generators are available in different diameter, length, and stator winding configurations, with inverters also available in different power classes. As a result, the flexible portfolio offers solutions for a variety of different applications which meet the specific requirements in terms of power, torque, and speed. These solutions are always optimized according to the customer's duty cycles to achieve the ideal operating conditions and provide both the highest efficiency and low noise.

Safe operation. Always work safely with your machine by minimizing the risk in all operating situations, whether on construction sites, in warehouses, or in public places. In addition to reliable electrically safe components, the eLION inverter portfolio provides functional safety for mobile machines with Rexroth safety on board solutions according to ISO 13849.

HOW DO YOU BENEFIT?

- **Electrification à la carte.** eLION offers a wide range of motor and inverter variants to provide the perfect characteristics for your application. Realize any electrified machine type based on any power source that matches your need, from diesel-electric solutions to fully electrified machines.
- **Sustainability as a part of your brand.** Zero local emissions, low noise emissions, and significant energy savings add up to an improved environmental footprint of your off-highway machines.
- **Interoperability guaranteed.** eLION covers the electrics, gear units, hydraulics, and software – everything under one roof. The proven interoperability of all components facilitates engineering, commissioning, and service.
- **Collaboration.** We combine your application know-how with our experience in electrics, hydraulics, electronics, and software to realize together the best solution for your machine.

eLION product portfolio – highlights

eLION implement and drivetrain solutions

Full force.
Zero local emissions.

Electrifying mobile machines – we’re ready

Authors

Matthias Kielbassa
Vice President Electrification
Off-Highway Mobile Machines

Federico Perelli
Project Leader
Electric Telehandler

At a glance

Rexroth eLION, the new end-to-end high-voltage portfolio, perfectly combines state-of-the-art technologies with deep application know-how in the off-highway sector. This is demonstrated by the set-up of a battery-electric telehandler using 700 V electrics as well as the full engineering expertise of Rexroth.

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WHY THIS INNOVATION?

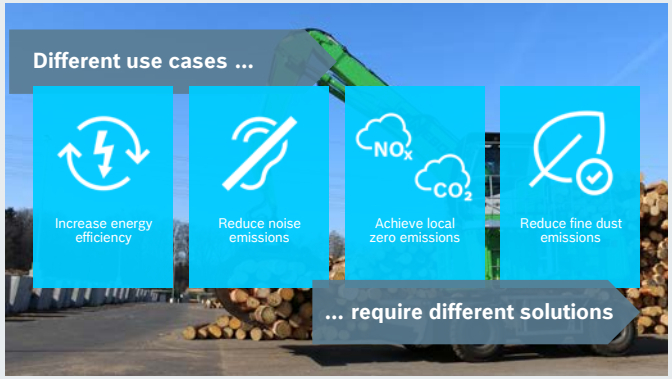
Different requirements call for innovative solution approaches. Partnering with the OEM, we are analyzing typical use cases and supporting the implementation by integrating eLION into new electrified machine architectures. Two examples:

Hybrid architectures. Electrified machines with internal combustion engines as the primary energy supply can be an attractive option for increasing energy efficiency and reducing TCO. Smaller diesel engines and fuel savings are contributing as well as productivity improvements by a better machine handling. This is thanks to the highly efficient eLION components and software for the drivetrain and the power management.

Electric architectures. These combine zero local emission and silent operation. Regardless of the energy supply, regardless of whether battery or fuel cell, with eLION from Rexroth, you can realize consistent and future-proof solutions with no compromises on machine performance. Whether driving or working, Rexroth latest innovations in hydraulics and gear units seamlessly interact with the new high-voltage electric portfolio.

WHAT’S NEW?

Rexroth eLION is a new high-voltage portfolio designed specifically for the off-highway sector, it is scalable to meet the OEM´s requirements and is electrically and functionally safe. But a state-of-the-art product portfolio is not enough on its own. eLION is more. It is solutions! Combining new electric motor-generators and inverters with gear units, hydraulics and a broad range of electric accessories and controlled by Rexroth software.



Electrification use cases

HOW DOES IT WORK?

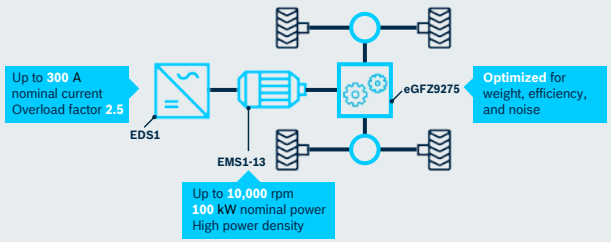
The Rexroth capabilities in the field of electrified mobile machines are demonstrated with a battery-electric telehandler.

eDrivetrain. The new high-speed EMS1 electric motor features a high power density and offers, combined with the eGFZ 2-speed central gear unit, a powerful and compact solution. This combination enables you to easily achieve performance according to the required tractive effort and a driving speed of up to 40 km/h.

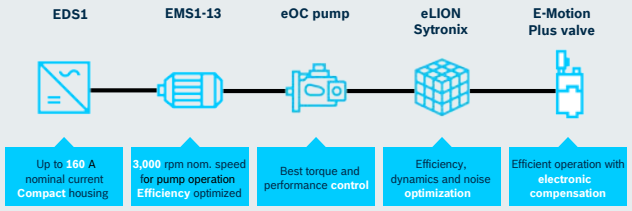
eImplement. The direct coupling between the new eOC pump and the electric motor, the smooth operation of the hydraulic pump by a standard-speed EMS1 motor with a nominal speed of 3,000 rpm, but, especially, Rexroth's long-term experience in electric-hydraulic solutions are supporting the OEM. Whether flow control or pressure control, whether position control or speed control, efficiency and noise of the implement are optimized.

eAccessories. eLION is more than just electric core components like motor-generator or inverter. It is about combining them and further electric components in the machine by offering high-voltage cabling and power distribution units for different electric architectures.

eSoftware. Whether it is the power management, the vehicle coordinator for electric control units, the transmission control unit, or the control of the hydraulic pump with an electric motor: it is software that enables a complete solution. That is exactly where Rexroth with its eLION software suite come in.



Fully electrified: Drivetrain



Fully electrified: Implement

Example of a fully electrified architecture: Drivetrain and implement.

HOW DO YOU BENEFIT?

- **Developed for off-highway applications.** Taking the harsh conditions in off-highway operation into consideration, we developed a completely new application-specific portfolio. Designed for durability.

- **Fulfillment of your market requirements.** No matter whether you would like to develop zero local emmissions machines or improve the TCO for your customer – we develop the right solution together.

- **Scalability.** With the eLION portfolio, we cover a nominal power range from 20 kW to 200 kW in 80 variants. With one technical solution you can cover your complete machine range and thus reduce your engineering efforts.

- **Complete solutions.** Combine our electric components with matching Rexroth eAccessories, hydraulics, and gear units. With BODAS Connect, the machine subsystems are coordinated and the data of your electric machine are always available via telematics in the BODAS data management.

Battery-electric telehandler

Lifting platforms. Not complexity.

Optimized hydraulics for electrified compact machines

Author

Jochen Reinhard
Sales and Industry Sector Management Mobile Elevating Work Platforms

At a glance

When compact mobile machines go electric, this has an impact on the hydraulic solution. We have assessed a range of new questions and developed solutions to optimally leverage the speed variability of the e-drive, including new challenges such as increased pump wear in case of frequent start/stop switching. A new decentralized architecture drastically reduces hardware and engineering effort – and it's applicable not only to electrified machines.

WHY THIS INNOVATION?

Particularly (but not exclusively) in cities, the electrification of compact mobile machines is the method of choice to reduce noise and exhaust emissions, and to achieve local zero CO_2 emissions. What does this imply for hydraulics? To what degree do OEMs have to rethink architectures? What components do optimally interact with fully electric or hybrid vehicles? Bosch Rexroth has examined future hydraulic platforms.

WHAT'S NEW?

Electrification not only creates a new power source but also new requirements for hydraulics. Questions such as the impact of variable speed drives on the pump, noise-optimized pump layouts, and the reaction of the pump to the standby mode of the drive have to be considered. We work together with OEMs to find the right answer considering multiple criteria from load requirements to component TCO. With combinations of e-machines and Bosch Rexroth's hydraulic components, OEMs can expect benefits in performance, cost, and efficiency. Moreover, such innovations open up additional possibilities on the system side, e.g. so-called gravity lowering. Aiming at reducing complexity as a whole, we have explored a decentralized and drastically simplified hydraulic architecture – independently of the power supply yet well prepared for electrification.

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Bosch Rexroth's hydraulic portfolio provides a wide range of pumps optimized for different noise reduction levels. One example ist the external gear pump, SILENCE PLUS, that allows operation at 10-20 dBA below the standard.

HOW DOES IT WORK?

The right pump for speed variable drives.
Interacting with e-machines, fixed displacement pumps deliver excellent results with high and relatively consistent volume flows. Requirements like load holding, operation below minimum speed, or high demands on the hydraulic response time could speak for variable axial piston pumps. In the end, it's about weighing up the delta cost of the pump and the battery.

The right pump for the standby mode.
Variable speed e-machines can be switched to standby to save energy when it's not needed, e.g. when lowering the basket of mobile elevated working platforms by gravity. Bosch Rexroth has extensive expertise from industrial applications where high-frequency start/stop switching is normal. With the proven A10VZ pump portfolio, we make sure that the standby mode and gravity lowering don't result in extensive pump wear and reduced lifetime.

The right pump for noise reduction.
Noise reduction is an important aspect for electrification, an aspect for which Bosch Rexroth offers solutions. The external gear pump silence plus boasts a noise level up to 20 dB(A) below the standard. This significant reduction is achieved thanks to the continuous meshing prinicipal of the gear profile. In the axial piston pump range, our PCV (Pre Compression Volume) solution offers 30-50% less pressure ripples, resulting in very low fluid acoustic.

The right platform to reduce complexity.
Independently of the power source, Bosch Rexroth is pioneering a new decentralized approach for different kinds of boom applications. The central main manifold will be replaced by smaller, customized manifolds which are directly located on cylinders – reducing the number of hoses from eight to two. Our Decentralized Boom Control (DBC) solution is a holistic approach with a focus on high efficiency and reduced complexity.

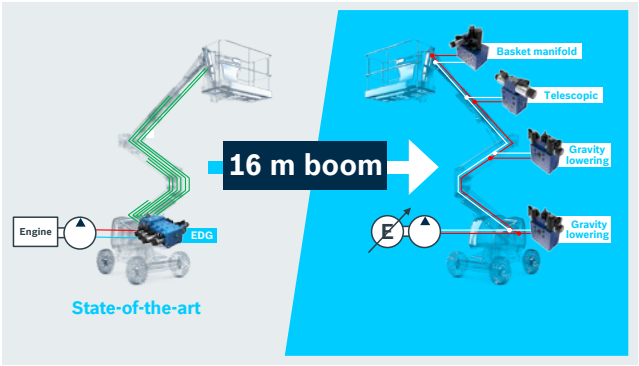
Frequent start/stop switching is normal when using variable-speed e-machines. The A10 "Z" pump has proven its worth in our servo-hydraulic actuators and is resilient to low- or no-flow operation, minimizing wear and tear.

HOW DO YOU BENEFIT?

- **Readiness for new regulations.**
Legislation drives the need to electrify compact machines – and to reconsider the hydraulics solution. With Bosch Rexroth as an innovation driver, you're well prepared for this new era.

- **Increased efficiency.**
The gravity lowering solution with a control valve directly mounted on the cylinder enables us to realize the lowering function of the boom by gravity without additional energy demand. This leads to a smaller battery and therefore lower machine costs.

- **More flexibility.**
The new decentralized architecture allows for customer-specific machine layouts at reduced hardware, engineering, and commissioning effort.



Bosch Rexroth is pioneering a new decentralized approach for boom applications. Replacing the central main manifold with smaller, customized manifolds allows to drastically reduce the number of hoses.

More Performance

Increased Work Power and Speed

Jiying Yuan
& Christian Michl

SHIFT THE LIMIT.
Faster and stronger with the new A36VM based drivetrain

Higher speed and higher tractive effort – but at what cost? The new drivetrain solutions with A36VM motors overcome the limitations of the past. They boost the speed range by up to 50% – without disturbing gear changes.

Hydraulics, electronics and software are merging towards holistic solutions. The result: Huge advances for small and large machine sizes in drive and process speed, productivity, and energy efficiency.

Gary Whitelaw

SIMPLE BUT POWERFUL.
No compromise with the new adaptive quad drive solution

High speed travel mode and high tractive effort – can this be combined in a cost-effective quad drive? It can. With its automatic traction control and smart differential function, the new Quad Drive Solution QDS paves the way.

Alex Glavak & Michael Mast

SPEED OR TORQUE CONTROL? FORGET THE "OR".
The right drive characteristics in all situations

Fast and dynamic driving to the work site – or precise speed control when working? Get both! It's all in the software: Easily realize the full variance of drive characteristics at minimum component variance.

Edwin Heemskerk & Johannes Leimeister

THE HYDRAULIC SUCCESS STORY – WITH NEW CHAPTERS.
Enabling innovative architectures for efficient machines

Getting more efficiency out of hydraulics with innovative common rail and multi-rail architectures: Let's take a look into the future together based on our current innovations.

Shift the limit.

Faster and stronger with the new A36VM based drivetrain

Authors

Jiying Yuan
Sales and Industry Sector Management Wheeled Loaders

Christian Michl
Sales and Industry Sector Management Wheeled Loaders

At a glance

While smaller diesel engines are gaining importance, OEMs don't have to compromise on speed and tractive effort. Bosch Rexroth has managed to boost the overall ratio of the hydrostatic transmission by achieving a higher pressure level and introducing the new A36VM motor – in conjunction with innovative electronic controls.

EXPLORE MORE
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WHY THIS INNOVATION?

Environmental regulations such as Tier 4 and EU Stage V call for OEMs to equip off-highway machines with smaller diesel engines. To ensure equal machine productivity, Bosch Rexroth has improved the key parameters of the hydraulic drivetrain system: the pressure level and the motor swivel angles.

WHAT'S NEW?

Bosch Rexroth has improved two key factors of high performance: First, the tractive effort, which is determined by the pressure level. Based on long-term experience with load profiles, our engineers were able to increase the maximum pressure of two proven variable axial piston pumps by a significant amount: the A10VG from 350 to 470 bar; and the A4VG from 450 to 530 bar. The new pressure level is related to the pump displacement and operation time. Second, to enable a higher hydraulic ratio, Bosch Rexroth introduces a new motor generation, the A36VM. Its main advantage is an extended swivel angle. To optimize efficiency and achieve the widest effective motor angle, the motor has been developed in three sizes for different machine classes:

- The A36VM60 is based on the robust and well-known design of the A6VM, but comes with an extended swivel angle from 0° to 32°, aiming at operation at higher angles, leading to higher system efficiency.
- The A36VM125 allows for swiveling the motor from 5° to 38°, optimized for the combination with small pump sizes.
- The A36VM255 features a swivel angle that extends from 5° to 36°. This angle range is optimal for higher pump volumes with corresponding higher flow losses.

Furthermore, the geometry of the A36VM – including external dimensions, contour design, valve mounting and position of the sensors – is optimized to fit into the limited installation space in mobile working machines.

The results open a door to a faster and stronger drivetrain and set a new standard in the off-highway market.

HOW DOES IT WORK?

The right combination for any customer need.
A typical use case is the downsizing of a 25 kW engine to 19 kW due the Stage V emission regulation. Despite the power reduction by >20%, the A10VG28 pump with an A36VM60 motor ensures uncompromised tractive effort and machine velocity. For a machine with a 55 kW engine, the A4VG56 + A36VM125 combination ensures a new speed of 40 km/h at a high efficiency – a competitive advantage in this class. In the 70-90 kW class, the A4VG90 pump with a A36VM255 motor allows for driving up to 40 km/h without shifting.

On top of this, the electronic control eDA enables a dynamically optimized engine operation and various operational modes for high productivity, energy saving, or attachment operation. With the A36VM, OEMs can extend the usage range of a single-stage gearbox. Plus, they are able to realize cost-effective compact machines that can be driven at less machine complexity. Nevertheless, the A36VM can also be combined with various gearbox solutions.

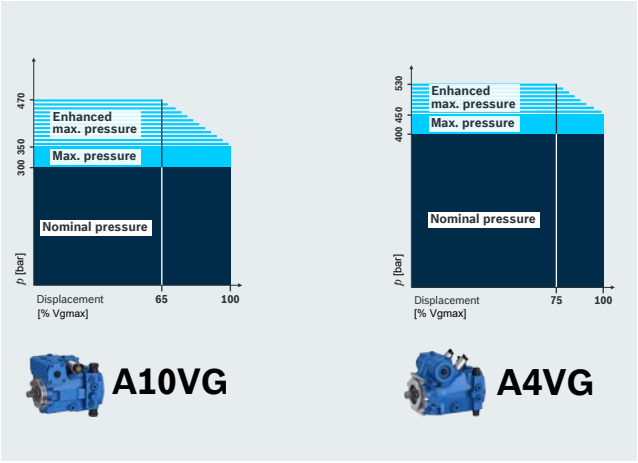
HOW DO YOU BENEFIT?

- **Wider overall hydraulic ratio.** With the increased pressure level and the extended swivel angle of the A36VM, machines can achieve a significantly wider hydraulic ratio and thus higher speed and higher tractive effort.

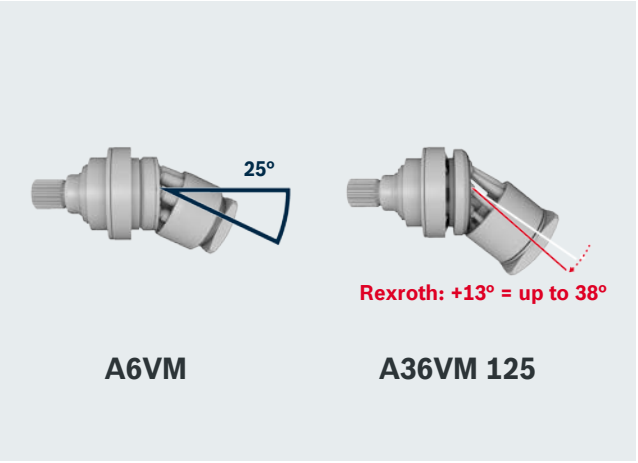
- **Comfortable driving.** The drivetrain with wider hydraulic ratio allows the driver to operate machines without shifting over the entire speed and working range.

- **Efficiency increase.** The optimized hardware and the electronic control improve the system efficiency and productivity.

- **Attractive machine cost.** All combinations are based on Bosch Rexroth standard products. The system complexity is reduced because a two-speed gearbox is often not needed. Our intelligent software helps minimize hardware variants. All of this results in solutions with lower machine costs.



Pressure increase according to load profile of A10VG and A4VG



Example: rotary group A6VM vs. A36VM 125

Machine class	Driving speed	A36VM size	Your benefit
19 kW - 3.0 t	20 km/h	60 cc	Same performance with less diesel power
55 kW - 5.0 t	40 km/h	125 cc	Higher velocity at high efficiency
90 kW - 8.0 t	40 km/h	255 cc	Easier driving / no shifting

Different examples for typical machine classes

Simple but powerful.

No compromise with the new adaptive quad drive solution

Author

Gary Whitelaw
Director Sales Product Management Radial Piston Motors

At a glance

The latest all-terrain drive solution from Bosch Rexroth – QDS

- Productive
- Intuitive
- Efficient

To achieve cycle reductions, energy saving, reduced system complexity and ease of use – Bosch Rexroth introduces a simple yet powerful drive system.

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WHY THIS INNOVATION?

Traditionally, all-terrain drive systems had to compromise on five major performance aspects in particular:

- manual control of drive modes
- manual control of locking differential function
- speed control (two-step only)
- top speed
- tractive effort

Bosch Rextroth has a better solution: QDS eliminates the need to compromise and in doing so maximizes productivity, increases controllability and optimizes TCO (total cost of ownership).

WHAT'S NEW?

The next generation BODAS controller is configured with new dedicated QDS software. This software controls the well-established A4VG pump with integrated pressure sensors and the proportional control valve (QDS valve) integrated in the radial piston motor. Thus, the required torque and speed are always available.

At the heart of this innovation is the MCR motor. It is designed to meet all high-pressure requirements in the market based on its robust and compact configuration.

The new QDS-equipped motor offers the following enhancements and features:

The rotary group

- 12% increase in starting efficiency
- 30% reduction in torque ripple
- 100% increase in expected lifetime

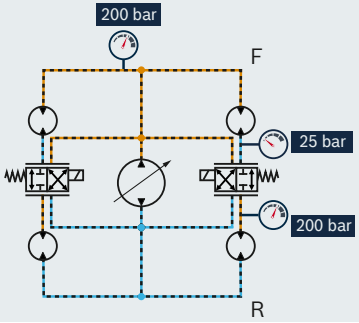
QDS valve

- This new valve type is the key to realizing QDS. It is integrated into the motor housing and therefore provides a simple, compact installation.
- The proportional characteristic of this valve has been developed to optimize performance, particularly for all-terrain use.
- The latest pressure and angle sensor technology combined with new software on the controller enables the system to deliver an intelligent adaptive limited slip differential.

HOW DOES IT WORK?

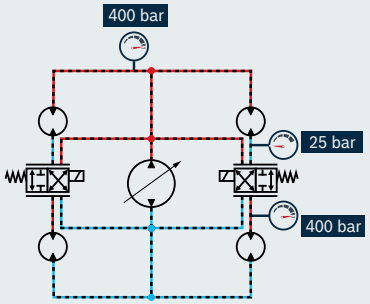
The operation of the QDS spool for a single operation describes the fundamental function.
When a machine is travelling on even ground in good conditions, the torque requirements are low and traction control is not required. Therefore, the BODAS controller keeps the spool in high speed mode. Pressure and torque are split between the two axles.

Once the machine encounters an obstacle, the integrated pressure sensor detects the increase in pressure caused by the higher torque requirements. The pressure sensor sends a signal to the BODAS controller which initiates the shift of the QDS spool. The spool enters the metering zone, where an infinitely variable transmission ratio provides the optimal performance. Pressure on the rear motors increases to provide the machine with more tractive effort. The pump automatically increases the swivel angle to provide a transition so smooth it is imperceptible to the operator.



Situation: Machine starts climbing.
The pressure sensor sends a signal to BODAS controller initiating to shift the spool. The pump automatically increases the swivel angle.

As the machine climbs the slope, the increasing torque requirement increases the pressure. Again, the pressure sensor signals the BODAS controller to shift the spool progressively and increase the available tractive effort further. To get the maximum torque, the spool shifts fully to low speed/high torque mode. Each motor can now deliver full torque utilizing 100% of the differential pressure provided by the pump.



Situation: Machine on steep slope. The BODAS controller recognizes high pressure and shifts the QDS valve fully. Full differential pressure is achieved across all 4 motors.
The pump automatically adjusts the swivel angle accordingly.

For machines working under extreme conditions, traction control is critical. To better explain how this works we take as an example of a machine working on a muddy slope. Initally, all wheels have traction, so the torque is evenly split between front and rear wheels. As the pressure sensor continues to read high pressure, the BODAS controller maintains the spool position in high torque mode.

On a muddy slope with poor traction it is common for the front wheels to lose their grip and spin. QDS prevents this wheel spin, responding to the drop in torque at the front motors. Once the wheels begin to slip the pressure transducer recognises the reduction of pressure and the BODAS controller signals the spool to move into the metering zone, which creates a back pressure on the motors with lower traction preventing the spin, maximizing the available torque and maintaining high pressure supply to rear the wheels.

HOW DO YOU BENEFIT?

- **Maximizing productivity.** With the increased travel speed and adaptive drive modes, cycle times are reduced and an increase up to 30% in productivity can be achieved.

- **Optimized TCO.** OEMs enjoy the benefits of an easy installation thanks to the simplicity of the system. Consequently, the elimination of now superfluous components, such as flow dividers and bypass check valves, helps achieve costs savings whilst reducing the complexity of pipe work and pipework fittings. With its higher efficiency, a QDS-equipped machine consumes up to 9% less fuel over a typical work cycle, thereby also enabling savings in term of CO_2 emissions and overall costs. This not only reduces production costs, but the end-user TCO is significantly improved.

- **Ease of use.** Thanks to the QDS automatic traction control, the operator can travel safely over difficult terrains whilst the machine proportionately shifts between high and low speed drive modes. QDS furthermore reduces machine-operator interactions significantly because it is a fully automated solution.

Speed or torque control? Forget the “or”.

The right drive characteristics in all situations

Authors

Alex Glavak
Sales and Industry Sector Management Municipal Vehicles

Michael Mast
Product Owner Functions Drive Components

At a glance

With the BODAS pump driver, Bosch Rexroth introduces a new electronic closed-circuit software driver concept for compact mobile machines. It strips hydraulic hardware down to its essentials and transfers key functions like pressure cut-off and diverse control modules to the software. This enables load-dependent, as well as load-independent pump control with the exact same component, resulting in extended flexibility during operation.

EXPLORE MORE
www.boschrexroth.com/mobile-2021

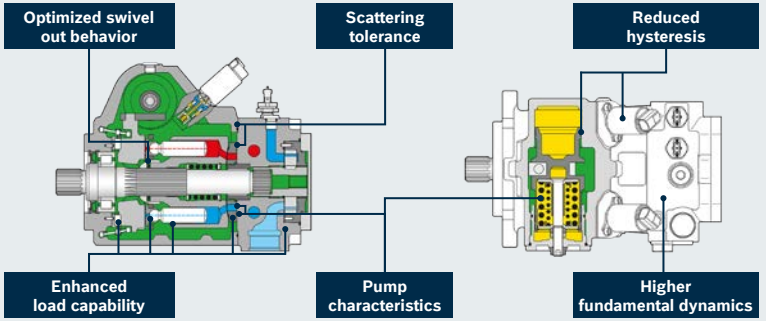
WHY THIS INNOVATION?

OEMs in the mobile machinery market are always looking for new ways to deliver new machine concepts faster. One way to achieve this is to reduce complexity. At Bosch Rexroth, we react to their needs with a dedicated strategy to introduce electronic controls. We leverage our profound knowledge of the physical processes to solve complex control tasks using software and thereby simplify the hardware. As a result, OEMs can streamline their entire value chain from purchase, logistics, and engineering to maintenance and spare parts management.

WHAT’S NEW?

The successful A4VG pump takes an evolutionary step toward electronic controls. With the new series 35, most hydraulic functions are transferred from hardware to software control – allowing for a great simplification of the pump hardware, to make it more compact, and significantly reduce hardware variants. In addition to making the pump smarter, we’ve also enhanced the fine controllability and increased the load capability to up to 530 bar.

Thanks to the new BODAS pump drivers, OEMs can completely focus on the machine’s driving and working strategy rather than dealing with the complexities of pump physics. This also enables OEMs to offer their customers greater flexibility: Vehicle operators can easily switch between speed control and torque control to achieve the desired machine behavior in every driving and working situation.



Hydraulic knowledge is the basis for control functions in electronics. With the A4VG series 35, many important aspects have been improved, as shown in the overview – enabling a significant leap in performance.

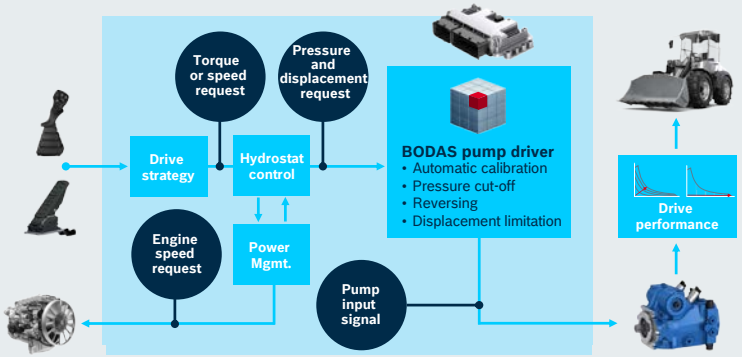
HOW DOES IT WORK?

Simpler, smaller, smarter
The BODAS pump driver now features pressure cut-off, a range of hydraulic-mechanical controllers, and displacement limitation. The corresponding hardware has been optimized with the entire lifecycle in mind. For example, service is facilitated through easier maintenance, fewer parts needing replacement, and a lower risk of leakage due to reduced sealing points.

Control functionalities – not complexity
OEMs can easily integrate the controls into any kind of machine management software – thanks to the new BODAS pump driver. Those modules play a key role in transforming the control commands into the required machine behavior. Invisible below the software surface, they use the given mechanical, hydraulic, and sensor input to calculate the appropriate electrical pump control current according to the selected operation mode.

Use-case-dependent drive characteristics
The BODAS pump driver allow to emulate different control concepts on the same hardware. OEMs can implement switchable drive characteristics – torque, speed, and power control – into their machine control software to offer their customers maximum flexibility.

The driver's request is transmitted from the accelerator pedal or joystick to the OEM's functional software. This passes a pressure and displacement request on to the BODAS pump driver, which calculates the pump input signal according to the selected operation mode. There, it activates exactly the motion or implement behavior required.



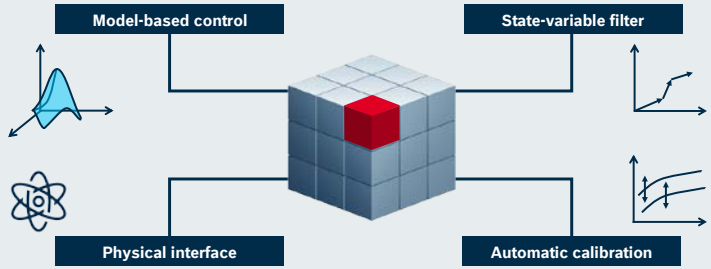
HOW DO YOU BENEFIT?

▶ **Simplicity.** Reduce your hardware complexity – by using the same hardware for load-dependent and proportional load-independent pump control. The BODAS pump driver help you control the pumps via commands, thus massively reducing complexity.

▶ **Application scalability.** Realize a fleet-wide approach across different vehicle types and, within the same application, different sizes and configurations. Save on effort and costs – from purchase, logistics, assembly, and installation to life-cycle services. And set an individual focus to meet application-specific and regional customer needs.

▶ **Flexibility in usage.** The physical interfaces and modular concept of the BODAS pump driver allow to implement a wide range of machine characteristics without changing the basic structure of the hardware and software. You can fully focus on the driving strategy and performance – thus creating a competitive advantage.

The BODAS pump driver combines optimized pump characteristics with methods of control engineering, as shown in the overview. This allows to push the performance boundaries even further.



The hydraulic success story – with new chapters.

Enabling innovative architectures for efficient machines

Authors

Edwin Heemskerk
Sales and Industry Sector Management Excavators – Application Support Innovative Concepts

Johannes Leimeister
Sales and Industry Sector Management Excavators

At a glance

The need for climate protection, the reduction of CO_2 emissions, steadily increasing energy costs, and the rise of electrification are strong drivers for the need to increase the efficiency of mobile machines. New solutions are required that support innovative, more energy-efficient hydraulic architectures while maintaining the same performance as today's machines or even surpassing them.

EXPLORE MORE
www.boschrexroth.com/mobile-2021

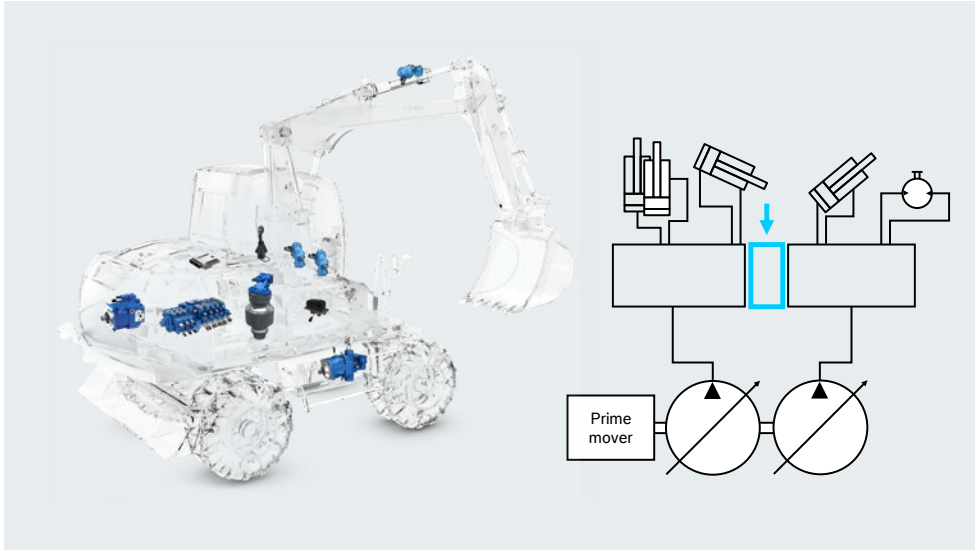
WHY THIS INNOVATION?

As drivers vary from market to market, OEMs are facing the need to build different versions of the same machine to best support their customers. This is challenging, especially for the OEMs´ design and service departments. To reduce this complexity, we offer modular upgrade solutions for the well-proven LUDV flow sharing technology to improve the energy efficiency of your system.

These solutions can be used individually or in combination, enabling ideal solutions to reduce the fuel consumption and CO_2 emissions or to significantly increase the uptime of battery driven machines.

WHAT'S NEW?

At Mobile 2021, Bosch Rexroth presents five modular upgrades of the LUDV flow sharing technology. Many of the the innovations can be realized already today with existing pump, motor, and valve products and software on the BODAS controller. For applications that need to maximize the energy efficiency, we offer a solution that might be radical in its approach but is based on proven components, too.



Two-loop LUDV flow sharing solution for improved controllability and reduced energy consumption.

HOW DOES IT WORK?

Common-rail applications. Mobile excavators, wheel loaders, telehandlers, etc. are versatile machines that serve many purposes on today´s construction sites or farms. Common-rail, or 1-loop, flow sharing LUDV solutions are well-established solutions for these machines, enabling excellent controllability, flexible attachments handling and energy efficiency.

Electronic Open Circuit eOC is the new state-of-art flow sharing solution and consists of an eOC pump, a RS control valve and a BODAS controller with eOC BODAS control software. Higher efficiency, better dynamics and individual machine behavior are just some of the benefits, which are discussed in more detail in “Your machine – the most versatile actor” by Simon Dreher.

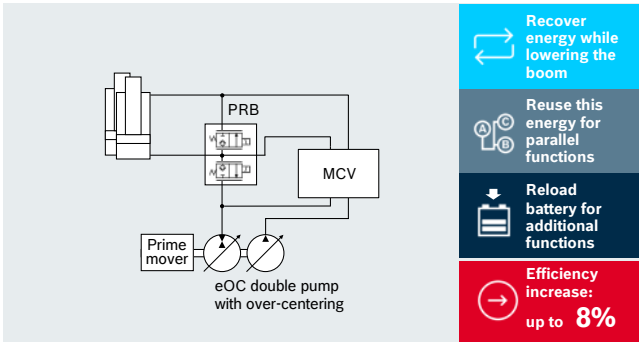
From there you can enhance the efficiency with the use of electro-hydraulic hose burst valves. Serving as an independent meter-out from the main control valve, the valve can react to the current working conditions and loads of the machine for improved performance or better energy efficiency.

In the future, secondary control of the slew or the open loop driving will reduce throttle losses, support efficient acceleration, and allow for energy recovery. Further information can be found in “Change the way it is” by Jonas Meyer.

Multi-rail applications. Another big step to improve the energy efficiency is to upgrade to a two-loop LUDV solution with intelligent summation. Separating functions, reducing throttle losses, and optimizing pump swash angles not only lead to less fuel consumption but also improve the controllability. Adding a Power Regenerative Boom (PRB) valve and utilizing the over-centering function of the eOC pump in such architectures allows recovering energy while lowering the boom, and reusing it for parallel functions, or recharging the battery for additional functions.

Moreover, we are pioneering the electro-hydraulic hose burst valves with a “ghost mode”. They only become active when needed, ensuring that we can maximize the recovery potential from lowering the boom.

Battery-driven machines and applications with high-energy consumption, can benefit from the additional potential offered by multi rail solutions using 3-loops. Based on the proven components, the closed-center RCS control block and eOC pumps, in combination with 3 hydraulic accumulators and new control strategies, the so called multi-pressure network (MPN) allows for significant energy savings.



Recovering energy when lowering the boom with the help of the power regenerative boom (PRB) valve and the over-centering function of the eOC pump.

To develop this new technology further, Bosch Rexroth also supports publicly initiated research projects in Germany and the USA.

HOW DO YOU BENEFIT?

- **Efficient.**

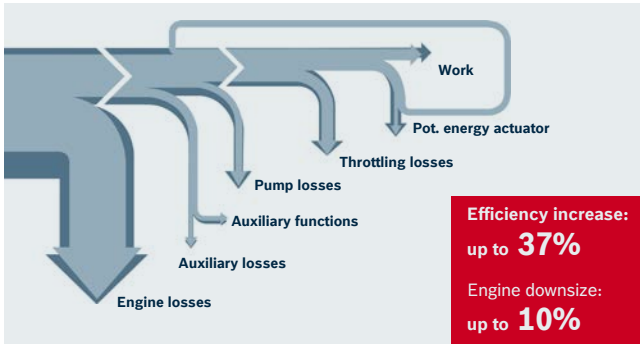
Depending on your application and machine class, you will find the optimum solution for energy savings between 8 and up to 37% and hence reduce CO_2 emissions.

- **Modular.**

Building on the well proven LUDV flow sharing technology you can upgrade your fleet using our modular building blocks.

- **Ready for the Future.**

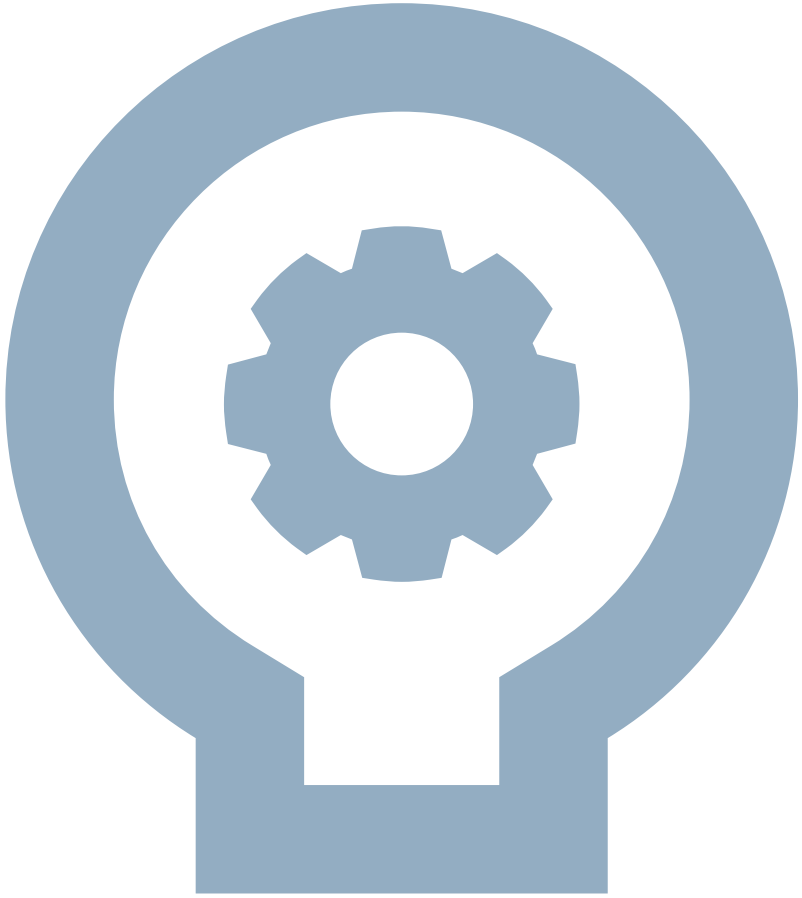
Our solutions can help you to stepwise upgrade your machines in the future, in order to keep track with machine electrification and further market trends.



Beyond today‘s architectures, new multi-pressure networks will enable huge energy efficiency gains for battery-driven machines and applications with high energy consumption. Another advanage will be the downsizing of the engine.

Smart Simplicity

Less Complexity, More Features



Simon Dreher

YOUR MACHINE – THE MOST VERSATILE ACTOR.

Gain flexibility and performance with our new electrohydraulic solutions

Are you fed up with fixed machine dynamics and limited variations? That's over. The Electronic Open Circuit – eOC – maps all the capabilities of your machine in software. Whether you want it smooth or dynamic – you can adopt the characteristics to any customer's requirement.

The great age of hydraulics has only just begun. With software, you can explore its full capabilities with unprecedented flexibility. Our smart and simple electro-hydraulic solutions do not only reduce costs, they also allow you to simplify machine architectures and adapt to any new requirement. Isn't this the kind of flexibility your customers demand?

Jonas Meyer
& Salih Tetik

CHANGE THE WAY IT IS!
Let's rethink your machine with a new drivetrain concept

Great performance, reduced complexity. The new Electronic Open Circuit eOC enables cost-effective solutions for all rotary drives in small machines. From travel drive to slew drive – anything you can imagine!

Stefan Hüber
& Michael Schütte

DRILLING IT DOWN TO THE ESSENCE.
Reduce complexity and increase efficiency in cranes and drilling machines

Our electrohydraulic solutions in combination with modern software algorithms reduce complexity, increase efficiency and improve machine control. For cranes, drilling machines and beyond.

Your machine – the most versatile actor.

Gain flexibility and performance with our new electrohydraulic solutions

Author

Simon Dreher
Sales and Industry Sector Management Mining Excavators and Construction Machinery

At a glance

The requirements for hydraulic systems are steadily rising. With the Electronic Open Circuit eOC, machine manufacturers gain an unprecedented degree of freedom to react to any customer demand and preference. Machine control, operator feeling and dynamics, along with other parameters, can be set and switched individually anytime. This comes in conjunction with more efficient engineering, safer machine operation, and future readiness, for example for Advanced Assistance Functions (AAF).

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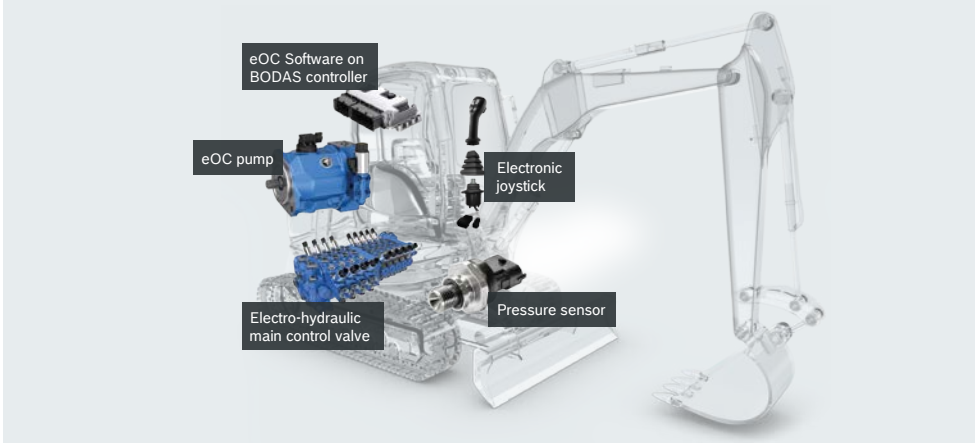
WHY THIS INNOVATION?

Individual customer preferences and operational situations require differentiated solutions from mobile machine OEMs. However, in a conventional hydro-mechanically controlled system, parameters are set on the hardware side through combinations of orifices and springs. This often results in poor flexibility and a huge effort when manually switching the parameters and individually fine-tuning the machine behavior. Furthermore, it results in a lot of compromises regarding performance, and the need to offer a vast range of machines.

WHAT'S NEW?

Bosch Rexroth's new electro-hydraulic solution enables greater flexibility and engineering efficiency. The full range of functions and variability are now available when transferring the control functions from the hydro-mechanical controller to the software. In the software control, different control parameters can be flexibly set with digital CAN bus communication. The scalable solution also enables a step-by-step implementation. You can start with just the electro-hydraulic eOC pump and then extend the eOC control to include the electro-hydraulic main control valve. Eventually, even the entire hydraulic system can be included. It can be realized with fixed coded individual parameters, as well as a wide range of adjustable digital CAN bus parameters, depending on the operator's preference.



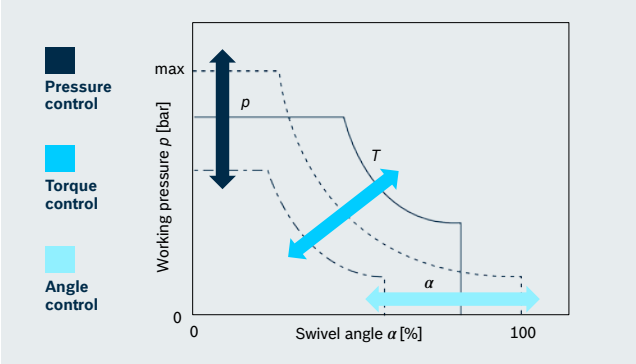
HOW DOES IT WORK?

eOC pump

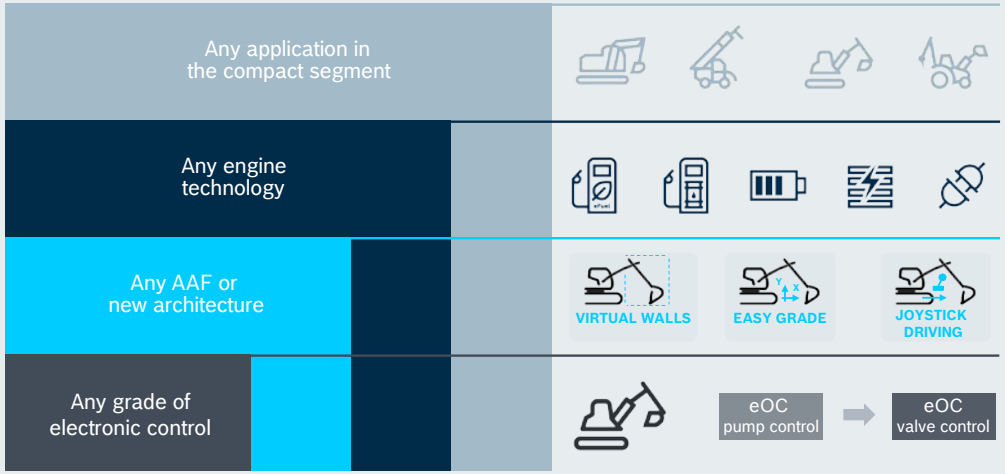
As a central component providing hydraulic power, the pump is paramount to the control of the required set values for torque, pressure, or flow in an electronic closed loop. In conjunction with our eOC BODAS pump control software and relevant sensors for pressure and pump displacement, this helps to achieve the desired machine behavior. Transferring the control combinations into software allows to set, change, and even combine key characteristics, such as dynamics and power control. It also enables customizable control modes. Machines can thus behave both dynamically and precisely without compromises.

Electronic Open Circuit eOC

The electro-hydraulic pressure and flow software (EHpQ) controls flow and pressure independently. This allows to freely adapt all known machine characteristics depending on the type of operation and the operator's machine feeling preferences. Electronic joysticks greatly simplify the installation, help reduce costs, and avoid the risk of oil spillage or leakage in the cabin. Additionally, the machine is ready for the integration of Advanced Assistance Functions (AAF).



OEMs can define the scope of electronic control – from the pump up to the entire system. The same hydraulic and electronic components can cover a wide range of applications, engine technologies, and features.



HOW DO YOU BENEFIT?

▸ **Flexibility.** OEMs and even operators can simply switch between different machine operability: By controlling the pressure, they can merge the load feeling – usually only achieved with an open-center system – with the controllability and multi-functional operation which are only provided in a flow sharing system. With EHpQ, the benefits of both solutions can be combined: Feel free to create your own preferred system – with one machine for all markets, all preferences, and all tasks.

▸ **Optimally controlled movements.** The new solution allows for superb load sensitivity – in particular for soft load pick-up and smooth slewing operation, combined with a stable but dynamic control of the tracks. This comes with improved fine control at the start and soft but quick movements. Machine stability and controllability are excellent even at maximum speeds of operation.

▸ **Energy savings.** With the electro-hydraulic controls and smart and dynamically adjustable software, OEMs can use settings that will enable energy optimization or maximum productivity, depending on the type of works and operations.

Change the way it is!

Let’s rethink your machine with a new drivetrain concept

Authors

Jonas Meyer
Sales and Industry Sector Management Excavators

Salih Tetik
Development Engineer Systems

At a glance

Electronic open circuit driving is a radically innovative approach to realize travel drives in compact mobile machines following the concept of secondary control. Challenging the status quo of drive concepts, this new architecture combines the functionality of a closed-circuit drivetrain solution, with the physical set-up of an open-circuit drive, empowered by the the Electronic Open Circuit (eOC) pump.

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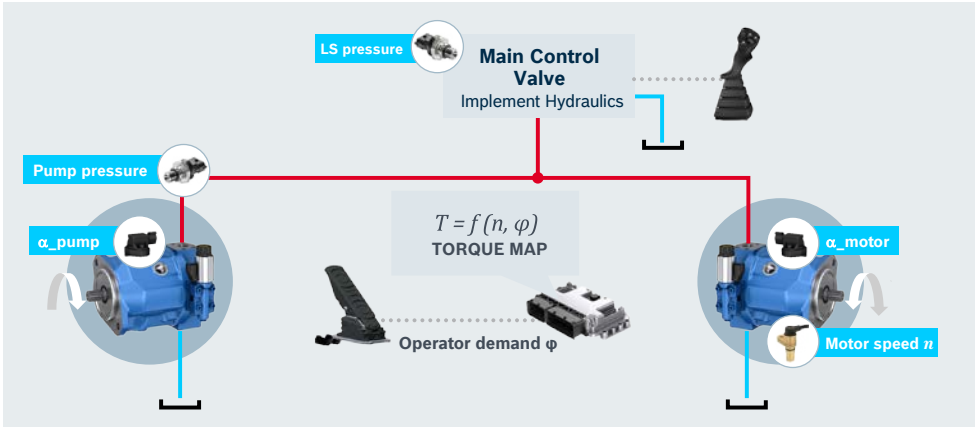
WHY THIS INNOVATION?

Today, hydrostatic drives are realized in either closed or open circuit applications. Both have their specific strengths and limitations: With a closed circuit, a highly dynamic and powerful drive behavior can be combined with advanced drive functions. However, a separate hydraulic circuit is required for the implement functions of the machine. With an open circuit we only need one pump for the travel drive and the implements – at the cost of very limited drive performance. We don’t want to limit the choice for our customers to just these alternatives. Instead, we want to motivate you to explore the benefits that can be achieved with secondary controlled drives.

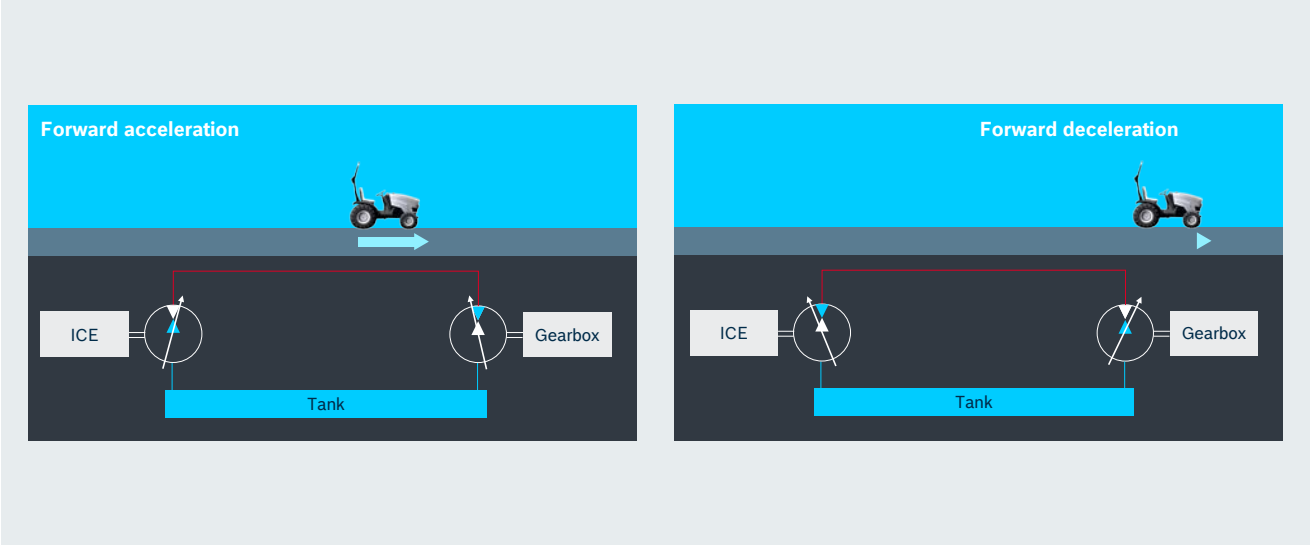
WHAT’S NEW?

The concept of secondary control was first introduced into industrial applications as a high-precision solution with the Rexroth axial piston unit A4VSG. Due to the high cost of the component, the high effort on the hydraulic system and lacking mobile electronics, the concept was not suitable for the majority of mobile applications.

Now, with the new eOC pump control and the mooring-capability of our well-established A10VO axial piston units, secondary control is adapted for the mobile machinery market. The very compact setup is ideally suited for small mobile machines and can be scaled to any number of axial piston motors in a single hydraulic open circuit.



Intelligent hydraulics and secondary control: All drive and implement functions are integrated into one hydraulic circuit. All rotary consumers are directly connected to the pressure rail.



Operation of the secondary-controlled drive: Both the pump and the motor operate in positive and negative displacements – the machine accelerates and decelerates forward and backward.

HOW DOES IT WORK?

Intelligent hydraulics and secondary control
The basic idea of this concept is to combine all drive and implement functions of a machine into one hydraulic circuit and having all rotary consumers directly connected to the pressure rail. That means that each hydraulic component, such as the main control valve or travel motors, are working with the same pump pressure. In order to achieve the desired rotational speed of the hydraulic motors, the displacement – respectively the output torque – of the motor is controlled in a secondary logic without any additional directional valves. For this, the axial piston units are equipped with an angle sensor, a pressure sensor (at the pump), and a speed sensor (at the motor). Both the pump and the motor operate in positive and negative displacement, allowing acceleration and deceleration in forward and backward direction.

HOW DO YOU BENEFIT?

- **Simplified hydraulic architectures.**
Secondary control in combination with eOC allows to rethink hydraulic architectures as the complexity of the hydraulic system is transferred into software.

- **Less hydraulic components.**
Integration of multiple hydraulic circuits into one reduces the number of installed components and, therefore, the overall cost of the machine.

- **Improved controllability and ease of use.**
The acceleration and deceleration of rotational consumers, such as slew or track drives, is controlled in a secondary logic – allowing for high operation comfort, improved controllability, and ease of use.

- **Concepts for electrified compact machines.**
Combining work and drive functions into one hydraulic circuit allows to regenerate hydraulic energy from braking or lowering functions and leads to an optimized utilization of battery power.

Drilling it down to the essence.

Reduce complexity and increase efficiency in cranes and drilling machines

Authors

Michael Schütte
Sales and Industry Sector Management Drilling and Mining Machines

Stefan Hüber
Sales and Industry Sector Management Drilling and Mining Machines

At a glance

We innovate the hydraulics of cranes and drilling machines. The first pillar in our innovation is the electronic controlled valve with software drivers, which include complex hydraulic knowledge at minimized effort for the OEM: engineering, commissioning, and customer-individual machine settings made easy. The second pillar is the closed loop solution for the winch as the single most demanding application of these machines – enabling superb fine control as well as energy savings of up to 30%.

WHY THIS INNOVATION?

The control of today's cranes and drilling rigs is becoming more and more complex. OEMs would largely benefit from a simpler hydraulic approach to reduce their development effort and complexity along the entire value chain. At the same time, end users expect OEMs to provide new answers to rising energy prices. Machines should incorporate solutions for significantly lower flow losses and energy recovery to decrease overall fuel consumption and to reduce CO_2 emission.

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WHAT'S NEW?

With two major innovations, we respond to the challenges facing both OEMs and end users. First, we are introducing the new RCS-Drilling control block with its newly designed inlet element. The RCS-Drilling control block is part of our general strategy of transferring mechanical-hydraulic knowledge into software, combined with modular software drivers. The primary goal is to simplify machine controls, and to allow OEMs and even end users to realize flexible and individual control strategies. With only one valve size, they can cover all applications that require maximum flows of up to 550 l/min per pump. Second, we are advancing controllability and energy efficiency with a separate closed loop for the winch. The BODAS winch drive eWD consists of the BODAS winch driver, the motor controller, and monitoring functions which can be installed on a BODAS controller. By using a closed-loop pump in combination with eWD it enables energy recovery and savings when lowering the load.

The new control block RCS-Drilling combines the benefits of the proven RCS excavator valve with the special needs of drilling machines.

HOW DOES IT WORK?

Control block RCS-Drilling
Compared to conventional solutions, the RCS-Drilling control block focuses on energy savings in drilling machines.

Thanks to its modular design, the RCS range enables individual platform concepts for optimum fit with customer requirements. It also offers improved efficiency, in particular due to the optimized design of the galleries and thus reduced pressure losses. The RCS is protected against pressure peaks with a full flow pressure relief valve. The RCS-Drilling control block is suitable for single- or double-circuit solutions. In combination with our BODAS RCS driver you can realize special features such as heating up procedure, unloading, cooling, flushing, and remote pressure limitation.

Our BODAS RCS driver allows specific functionalities and a wide range of core functions, from flow demand determination to pump pressure limitation to power management. Add-ons include, among others, an anti-jamming function that prevents the rotary head from jamming when it hits hard rock.

Closed-loop winch drive solution
In a winch drive with a closed loop system, the pump can act as a motor-generator and feed the kinetic energy back to the drivetrain when loads are being lowered. The diesel engine can thus be operated with reduced fuel consumption and drive other functions in the remaining open loop. In addition to these advantages, there are also challenges, such as load transfer during brake opening. With the new Rexroth winch drive software we have an excellent solution concerning performance and accuracy in closed winch drives. The interaction of our winch drive software and the ET controlled pump enables the possibility to operate in pressure control or angle control to the exact value. With this new possibilities we can pre-pressurize the system to the excat value before opening the winch brake. Another advantage is that this solution adapts to all permissible operating conditions and calibrates itself.

ET controlled pump
The ET controlled pump consist of an electric control with two directly-operated pressure reducing valves which pressurize the stroking cylinder.
The output flow of the pump is infinitely variable between −100% and +100%. The pump displacement that arises at a certain control current depends on the speed and working pressure of the pump. To close an electric control loop there are two pressure sensors in the working ports of the pump and a swivel angle sensor. Together with the smart BODAS winch driver we have a perfect winch solution.

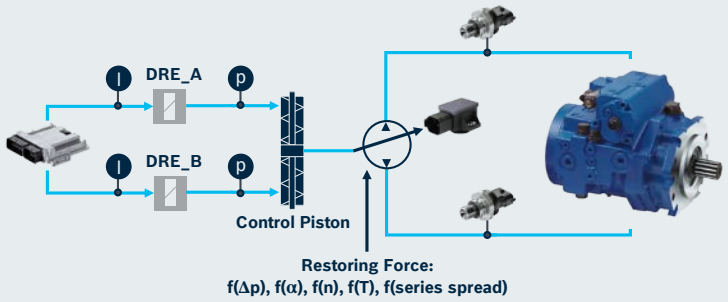
HOW DO YOU BENEFIT?

- **Efficiency.** The new RCS-Drilling control block reduces the inevitable flow losses to a minimum and enables energy savings of up to 10%. There are no valves in the closed loop and almost no losses between the pump and the motor. This and the energy recovery can lead to energy savings of up to 30%.

- **Flexibility.** With the electronically controlled RCS-Drilling valve block and its special features in the inlet element you have several possibilities to realize the right solutions for your needs. BODAS winch drive eWD offers tremendous fine control and successfully solves two challenges for customers: holding the load in its position when the mechanical brake is released and maintaining the same speed when the pressure increases.

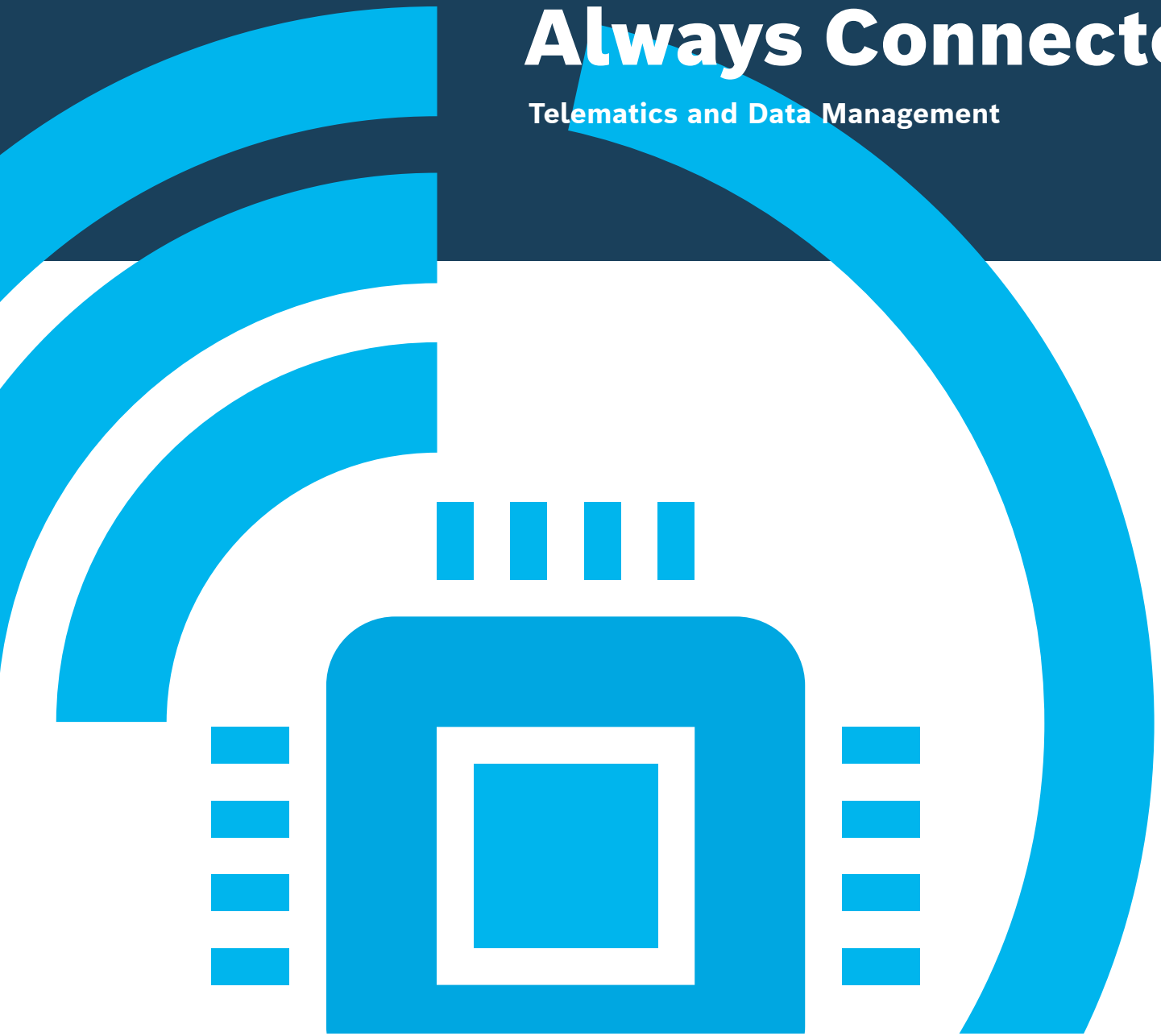
- **Simplicity.** You won't see the complexity behind the BODAS drivers – you will only see faster and easier engineering, assembly, and commissioning. You can realize all function for your customers. You reduce the hardware variants by taking the next step towards digital control.

The winch solution consists of a BODAS controller with BODAS pump driver software and the ET controlled pump. This makes the system simple and intelligent.



Always Connected

Telematics and Data Management



Josef Matty

FROM BUCKET TO BOOK.
The telematics basis starts on the edge

Your vehicles generate data every second – and that's it? Help your customers make more of it. They can reuse this treasure to create complete digital workflows – far beyond the data's original purpose of machine control.

Data opens up new opportunities to enhance mobile workflows. From planning to operation, to maintenance, and further, to documentation and billing. Explore how you can increase productivity and workflow efficiency with our telematics and data management solutions.

Dr. Christian Grabe

DON'T LET THE SKY BE THE LIMIT!

Maintenance over the air with BODAS Connect

Maintenance in the cloud – just hot air? Or is it getting real? BODAS connects you to the machine and enables error analysis, software flashing and parameter changes "over the air" – thus substantially increasing maintenance efficiency.

Adrien Mouaffo

SAFE ROADS. GUARANTEED.

Remote monitoring and documentation for road maintenance

From snow plowing to grass mowing – how can your customers document road maintenance? Reuse existing vehicle data to generate integrated data streams with BODAS Connect – including operations reporting for billing and legal documentation.

Martin Sykora

MANAGE YOUR TRANSFORMATION!

BODAS – a holistic solution in hardware, software, and connectivity

Tomorrow is now! With BODAS, the Bosch Rexroth Digital Application Solution, we fulfil your needs for the digital transformation. Discover BODAS and its modular, scalable, open, and secure approach that transforms your pains into gains.

Matthias Miller

BETTER TOGETHER. FASTER TO MARKET.

Shared software development in our open digital ecosystem

How fast can one company innovate alone? How many capabilities can you really develop inhouse? Let's discuss ways to collaborate as partners in our open digital ecosystem. The future-oriented path to accelerate innovation.

From bucket to book.

The telematics basis starts on the edge

Author

Josef Matty
Business Development and Sales Telematics

At a glance

BODAS Connect is Bosch Rexroth's telematics platform for mobile machines. It allows to process existing vehicle data in many ways and provide additional value for machine workflows during operation. Typical applications include work documentation for legal and billing requirements and fleet management for route planning and dispatch optimization. As an open solution, BODAS Connect supports the fast implementation of new ideas and unique business models. Starting on the edge, customers can use off-the-shelf features on the Rexroth Connectivity Unit and easily add customer-specific features and algorithms thanks to the containerized software architecture.

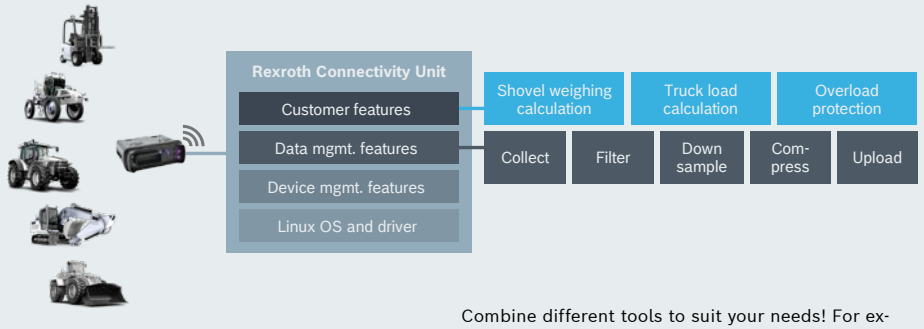
For most use cases, data processing and analysis is also necessary for the whole machine fleet in the cloud. Therefore, BODAS Connect offers customer-individual processing pipelines. With this, customers are able to run their own algorithms and calculations without further involvement by Bosch Rexroth. They can also deliver raw or processed data to third-party cloud and ERP systems. It has never been easier to turn dark data – for example, hidden in bucket movements – into useful data, e.g., on the payload.

WHY THIS INNOVATION?

Data can be a powerful lever when it comes to increasing productivity in the off-highway industry. Each second of operation, mobile machines generate vast amounts of data. However, this potential is mostly limited to enhancing machine control, and does not yet contribute to higher-value processes like fleet assessment and enterprise resource planning.

WHAT'S NEW?

Digitalization is not about data – it's about what you make of it. BODAS Connect bridges the way from vehicle motion data to higher-value data that allows for significant process improvements. Rather few of the functions and features themselves are completely new. The innovation lies in activating "forgotten" sensor data, transforming it for strategic purposes like fleet performance measuring, and unlocking the potential of connected workflows. End customers and rental machine providers can create additional value, while OEMs can render their machines ready for the future.



Combine different tools to suit your needs! For example, you can use our off-the-shelf data handling features (horizontal gray boxes) and supplement them with custom software features (upper blue boxes).

HOW DOES IT WORK?

Consider an exemplary workflow that starts with a wheel loader dumping onto a truck. The rise of electronic controls has led to permanent position and pressure measurement being widely established in the industry. The data generated this way can be re-used to help protect the truck from overloads, increase safety, and calculate the payload. Data processing can be done on the edge, by using BODAS Connect off-the-shelf features on the Rexroth Connectivity Unit and easily add customer-specific features and algorithms without impacting the vehicle software.

With BODAS Connect, big data becomes smart data beyond the vehicle. Fleet managers can analyze the aggregated loading and driving data with our reporting features, and they can assess the fleet performance for potential improvement.

To unlock even greater value, Bosch Rexroth makes the data accessible in the customer's existing ERP system – based on the general data standard ISO 15143 or via specific application programming interfaces (API) for automatic and continuous data exchange. Now, fleet managers can turn data into action. Examples range from automated documentation and booking to optimized dispatch and more efficient route planning.

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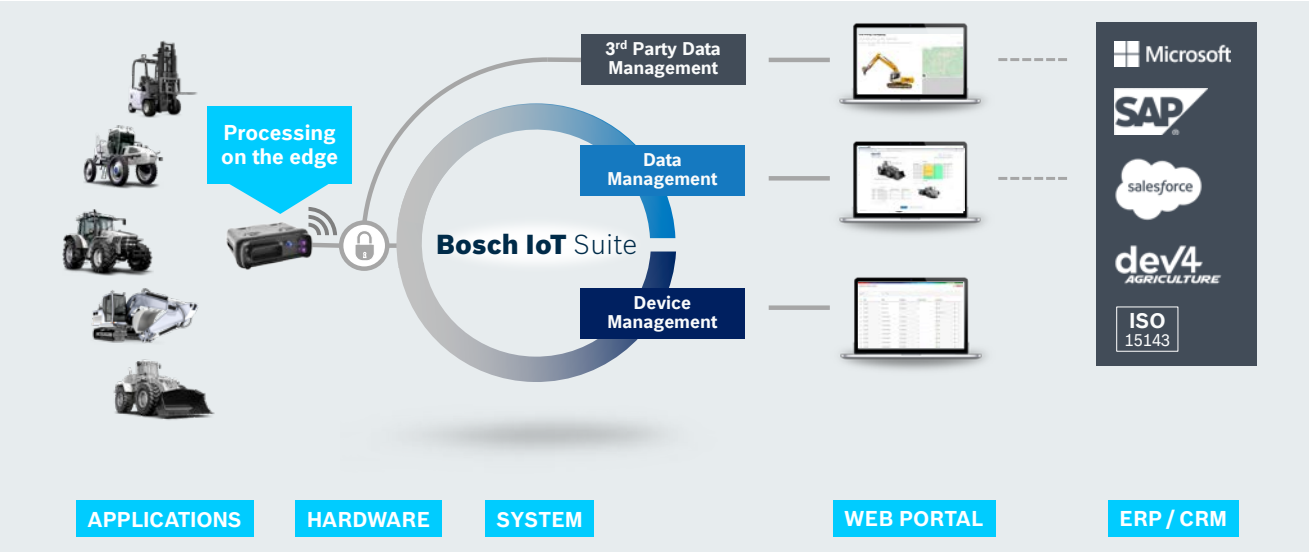
HOW DO YOU BENEFIT?

- **The telematics basis starts on the edge.** The Rexroth Connectivity Unit RCU enables flexible data acquisition and data processing on the edge with its open Linux operating system. The RCU comes with off-the-shelf features that you can use, based on the containerized software architecture. On top of this, you can process machine data with customer-specific algorithms on the RCU, without having to change the E/E architecture or safety-relevant ECU software on the machine.

- **Productivity gains.** Use the power of data to improve transparency and efficiency throughout your fleet – anytime, anywhere. You probably already have the data you need, albeit hidden in the deep, dark regions of your system.

- **Openness for your existing solutions.** No matter what solution you have in place to process your vehicle data – BODAS Connect understands any "language". The same applies for your ERP system. Within BODAS Connect, you can define and program the processing pipelines on your own – fully open.

- **Security from end to end.** This includes our device management, the Bosch IoT Suite, data handover to your own IoT solution, and the transfer into your ERP – security with no compromise.



Turn data into action – with an open end-to-end telematics ecosystem: Build your own apps for data processing on the edge with the open Rexroth Connectivity Unit (blue box on the left). Use the Rexroth cloud or your own cloud solutions to transfer processed vehicle data to your customer's ERP system (gray box on the right).

Don’t let the sky be the limit!

Maintenance over the air with BODAS Connect

Author

Dr. Christian Grabe
Business Owner Telematics

At a glance

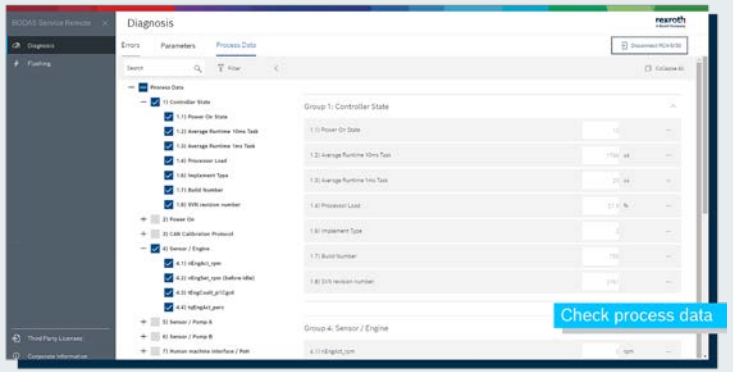
High reliability, availability, performance, and sought-after functions – they all depend on software. BODAS Connect, Bosch Rexroth’s comprehensive telematics IoT system, ensures fast over-the-air device management to keep off-highway machines both up and running and up to date – anytime.

WHY THIS INNOVATION?

Off-highway machines are seeing a strong trend toward electronic controls with more and more functions being transferred to software. This opens up never-before-seen possibilities for remote diagnostics, maintenance, and even changes and extensions of the vehicle software and firmware throughout the entire lifecycle. But telematics alone isn’t the key. It takes a secure, proven, and integrated device management and software deployment environment to fulfill the requirements of OEMs and their customers.

WHAT’S NEW?

Within BODAS Connect, Bosch Rexroth’s professional and secure end-to-end telematics solution also offers diverse over-the-air services – status indication, diagnosis, parameters, and flashing over the air. On the one hand, this sets the basis for fast root cause analysis and error correction during operation. At the same time, over-the-air services enable great freedom to adapt vehicles to the operator’s individual requirements and keeps the vehicle fit for new functions and implements. Contrary to conventional solutions, BODAS Connect can be scaled limitlessly for any fleet size. Furthermore, it provides professional software distribution campaign management for entire fleets around the globe, including all safety and security requirements.



Status and diagnosis over the air: Getting an overview – a quick check of the operational data, and a deeper dive into process data and error messages.

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HOW DOES IT WORK?

Status and diagnosis over the air.
Service technicians can log onto the machine, check the general vehicle operations data, but also dive more deeply into the process data and error messages. In many cases, this enables them to take the right action for getting the vehicle back to work.

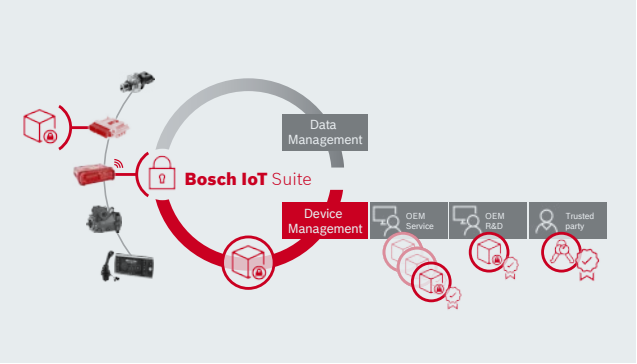
Parameters over the air.
This service allows to change and save software parameters, such as the machine dynamics, anytime, according to the operator's individual skills and preferences.

Flashing over the air.
Vehicles may find themselves needing to meet completely new demands over the course of their lifecycles – from new vehicle attachments entering the market to upcoming work documentation requirements within BIM. Such new demands may mean that legacy machines fall behind and become obsolete. Flashing over the air minimizes this risk by deploying new software onto the vehicle, no matter whether the software is located on the connectivity device or in domain controllers within the vehicle network. The 1:X principle ensures high-performance software distribution. In all of these tasks, Bosch Rexroth customers can rely on comprehensive IT security, including public and private certificates, whitelisting of the software source, and encryption. Since the over-the-air services are part of BODAS Connect's device management stack, they are completely independent from any data management and data analytics services OEMs may already be using.

Due to the openness of both BODAS domain controllers and connectivity devices, software may be developed independently by the OEMs based on standard programming environments.

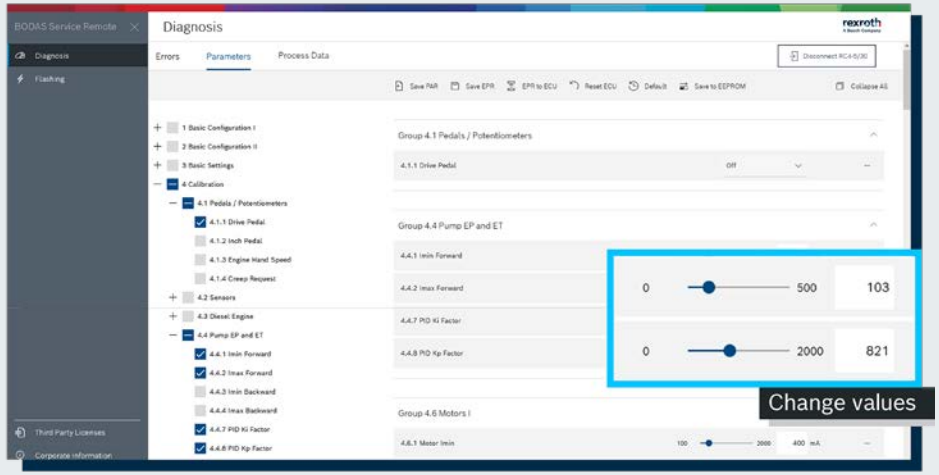
HOW DO YOU BENEFIT?

- **Faster recovery.** Increase the availability of your machines with fast and remote error analysis and repair.
- **Fit for any requirement.** Whatever vehicle behavior and characteristics your customers prefer – you can satisfy them by simply changing parameters.
- **Lower obsolescence risk.** Update and upgrade your vehicles anytime to keep pace with the rapid technological development.



1:x Flashing over the air: OEM software can be distributed to the Rexroth Connectivity Unit, and from there flashed onto the vehicle when the time is right – backed by comprehensive IT security.

- **Scalable to any fleet size.** You can count on 1:X software distribution – the professional way to deliver software to nearly any size vehicle fleet.
- **Reliable and secure.** BODAS Connect includes a large number of future-proof state-of-the-art IT security mechanisms and processes.



Parameters over the air: Changing and saving software parameters anytime – e.g. to achieve the machine dynamics the operator prefers.

Safe roads. Guaranteed.

Remote monitoring and documentation for road maintenance

Author

Adrien Mouaffo
Product Owner Telematic Data Management

At a glance

BODAS Connect, Bosch Rexroth's comprehensive telematics IoT system, takes road maintenance to the next level – by reusing vehicle data for monitoring, documentation, and billing. Municipal service providers gain a new level of transparency and legal security. By choosing from pre-configured dashboards, configurable widgets, or even programming their own algorithms supported by BODAS Connect, OEMs can offer their customers any function and application needed. Moreover, they can use the data to improve current machine characteristics as well as future product generations.

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WHY THIS INNOVATION?

Municipal services have an important role to play in ensuring both environmental protection and safety. Road maintenance providers are required to properly document that – and how – they've accomplished the tasks and responsibilities incumbent upon them. Today, this often suffers from media breaks that hinder information from being exchanged and processed. BODAS Connect bridges this gap.

WHAT'S NEW?

BODAS Connect makes intelligent use of the existing vehicle data to enable vehicle tracking, planning, and productivity analyses. Moreover, it generates operations reporting for legal and billing documentation, as required by municipal authorities. OEMs can thus offer their customers attractive added value, be it with pre-configured dashboards, with individualized functions based on BODAS Connect widgets, or even with freely programmable applications supported by the BODAS Connect ecosystem. Also, OEMs can leverage the anonymized data for their own purposes. One example is statistical data about the most-used speed and tractive effort range. Why not use this data when developing the next vehicle generation? Or to enhance the current vehicle characteristics with BODAS parameters over the air?

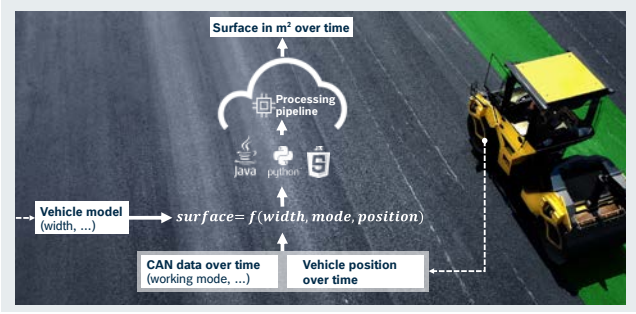
State-of-the-art: Municipal service providers can visualize data from their mobile machines with pre-configured dashboards, e.g. for reporting of work cycles and material used.

HOW DOES IT WORK?

Bosch Rexroth aggregates vehicle movement data and geo position data, most of which is automatically provided by electronic controls. BODAS Connect makes the essence of this data accessible with transparent monitoring and reporting solutions.

For municipal service providers: BODAS Connect includes end-customer features for operations monitoring, vehicle tracking, and reporting. The latter not only helps contractors to substantiate their billing, it also provides documented evidence of proper completion of their tasks in the case of lawsuits.

For OEMs: At the push of a button, OEMs can plot the existing data as load collectives to get better insights into the actual machine usage. At an aggregated and anonymized level, they can even break information down to vehicle-type-specific load cycles and operation points. The data can be further processed in 3rd-party environments like ERP tools for internal analyses.



Advanced applications: OEMs can use a rich toolbox of processors, combined with custom processing pipelines, to create their own processing code, e.g. for calculating the amount of surface rolled for billing purposes.

HOW DO YOU BENEFIT?

- **On the safe side.**

Just like municipal service providers and contractors, you gain a powerful solution that can be used for enabling multiple uses of existing data, such as legal documentation, billing, and to prevent liability, for example, for accidents due to difficult road conditions.

- **Future-proof with a great degree of freedom.**

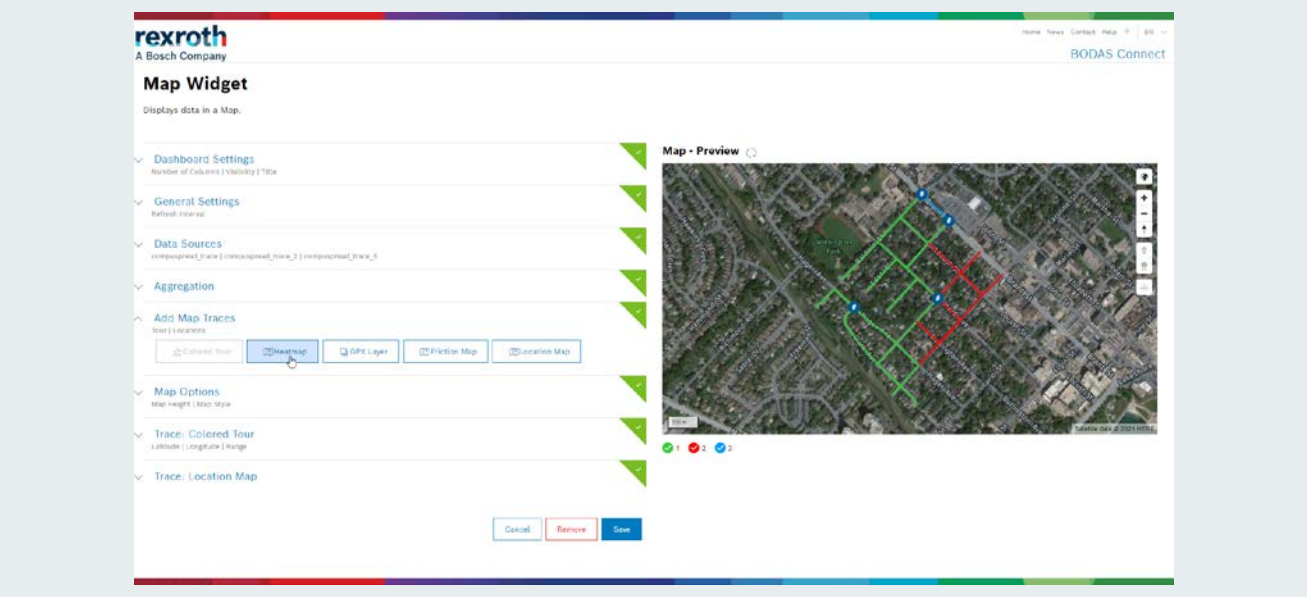
OEMs and their customers can prepare for possible future regulations that require ongoing documentation and reporting. With BODAS Connect as a completely open solution, OEMs and their dealers and customers can develop and implement data processing algorithms on their own – both on the connectivity device and in the cloud.

- **Better with every generation.**

OEMs can use load collectives and other anonymized data for optimized product development. The professional software-over-the-air and firmware-over-the-air features of BODAS Connect allow updates of the data processing algorithms even on vehicles that are scattered around the world – anytime.

- **Adapt to new use cases.**

OEMs can re-use and extend features by adapting the dashboard based on the rich set of widgets provided. Moreover, they can upload their own processing code (Python, JavaScript, or Java) in available processing pipelines.



The freedom of individualization: Using a wide range of widgets, OEMs can freely configure additional dashboard functions – e.g. by adding heatpoints to an existing trace map.

Manage your transformation!

BODAS – a holistic solution in hardware, software, and connectivity

Author

Martin Sykora
Head of Technical Sales Mobile Electronics

At a glance

Keeping pace with new market requirements demands making changes to systems, components and solutions. Every change means a digital transformation towards increasing efficiency, productivity and to provide even more functions and features. The challenge is to to do this while keeping the dynamics of digital transformation under control. With BODAS – Bosch Rexroth Digital Application Solutions – we support our customers in managing and balancing their digital transformation. We tackle this change together and ensure a better, stronger partnership. BODAS is open, scalable and provides easy access to put less strain on your resources, allowing you to increase your profitability.

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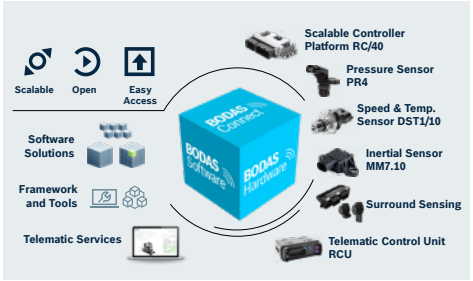
WHY THIS INNOVATION?

To master on the one hand the increasing automation and efficiency challenges while also considering the increasingly stringent legal regulations on the other hand, a holistic technological approach is necessary to synchronize electrification, digitalization and IoT. In fact, to create and engineer the solutions of tomorrow, OEMs need a powerful ecosystem and a partner they can trust with their mobile electronics. With its off-the-shelf offering, BODAS already covers market-specific requirements like security and safety, and is compliant with various qualification standards. Moreover, it includes solutions for surround sensing, assistance functions and automation. As a result, BODAS paves the way towards future technologies and can make the life of the OEM easier. It provides an answer for the digital transformation with its well-proven and future-oriented solution kit and and offers the chance to become better together, all the while enhancing profitability.

The dynamics of the digital transformation: New requirements lead to new solutions that bring new challenges. How are you keeping pace?



Product highlights 2021

WHAT'S NEW?

In 2021, BODAS is even more open, scalable, and provides easy access:

- Scalable, future-proof LINUX based IoT solution kit (hardware, device- and data management) open and all available from one source.
- Scalable RC/40 multicore automotive-based controller platform including FuSa, security, and versatility.
- Mobile machine-compliant ultra sonic system off-the-shelf for near surround sensing as a foundation for future automation.
- A new generation of sensors with highest measurement accuracy over lifetime: MM7.10, PR4, DST.
- Wide range of new software solu tions from drive to work up to semi-automated solutions as kinetic positioning control.

HOW DOES IT WORK?

BODAS Connect
BODAS Connect looks at the entire data stream from the source of the information to turning it into action. It is a modular end-to-end connectivity solution that transfer data from and to the mobile machine. The unbundled and freely selectable service consists of device management, data management, and ready-to-use apps for fleet management, vehicle health, remote R&D services, and vehicle operation workflows.

BODAS Software
BODAS Software is a software solution that covers a wide range of solutions to optimize machines: From standard, configurable, off-the-shelf application solutions for machine functions, to software libraries and modules as well as an integrated software development architecture. It includes tools for programming, parameterization and diagnosis of BODAS hardware and systems. Perfectly harmonized with Rexroth hydraulics, BODAS Software enables ideal machine control.

BODAS Hardware
BODAS Hardware is an open, scalable, and easily accessible mobile electronics platform consisting of control units, connectivity devices, sensors, and human-machine interfaces (joysticks, displays, pedals) for mobile machines. Individual BODAS Hardware controllers are freely programmable, available with a holistic control software, and ready for BODAS Connect.

HOW DO YOU BENEFIT?

In general: BODAS is your open, scalable, and easily-accessible mobile electronics ecosystem.

- **One stop shop**

BODAS is a holistic ecosystem – from IoT solutions to software and electronic hardware for the off-highway market – available off-the-shelf, to cover drive and control needs all from one source.

- **Openness and modularity**

Take it all or pick just the parts you need. OEMs can take the entire BODAS ecosystem and integrate it into the machine or, of course, take only the specific modules they need. BODAS makes it easier for the OEM to freely combine BODAS products according to their needs and requirements.

- **Functional safety**

The BODAS ecosystem design is flexible and easy to use when implementing safety functions that comply with the requirements of the EC Machinery Directive and the the safety standards EN ISO 13849, ISO 19014, and ISO 25119.

- **Cybersecurity**

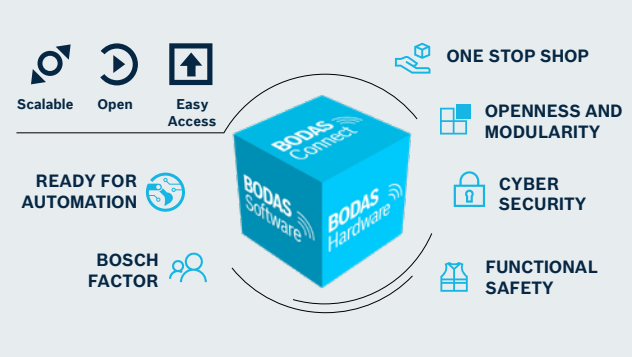
BODAS is protected against cyberattacks. By integration and use of automotive-based security solutions, the BODAS ecosystem addresses all relevant layers to reach a secure mobile machine control**.**

- **Ready for automation**

Automotive-based surround sensing technology turned mobile machine-compliant, high precession sensor technology, and automation modules such as kinematic position sensing logics or payload estimation offered as off-the-shelf solutions and more in development to meet the future technology needs.

- **Bosch factor**

Using Bosch automotive cutting-edge quality and technology, BODAS offers an outstanding portfolio designed and specified by Bosch Rexroth to specifically fulfill the mobile market requirements.



BODAS – Intelligent electronics for mobile applications

The BODAS ecosystem is open, scalable, and supports easy access for modification for your machine's specific needs.

Better together. Faster to market.

Shared software development in our open digital ecosystem

Author

Matthias Miller
Business Development

At a glance

Digital collaboration helps OEMs master the growing challenges and disruptions in the market of mobile machinery. Bosch Rexroth offers a comprehensive ecosystem for software development – containing proven construction kits for any task and application, comprehensive documentation and guidelines, and offerings for virtual and physical collaboration at the OEM's preferred location.

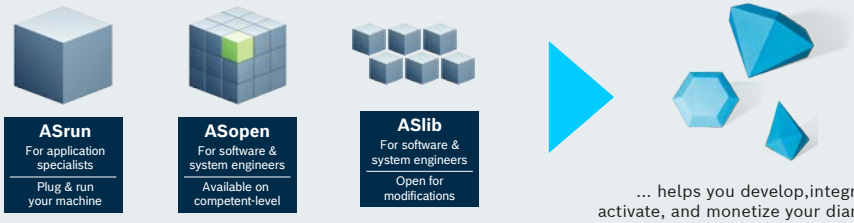
WHY THIS INNOVATION?

OEMs must explore new ways to secure future success in the rapidly changing mobile machinery market. Automation, connectivity, electrification, the need for sustainability, and the rise of disruptive technologies are creating new opportunities and new challenges. Software has become a centerpiece of machinery, but traditional software development has definitely reached its limits. How can OEMs master the growing complexity, focus on creating unique customer value – their diamonds – and accelerate time-to-market?

WHAT'S NEW?

At Bosch Rexroth, we offer OEMs a new kind of partnership: digital collaboration in an open ecosystem. Rather than building up their own tools and expert capacities for each and every topic, OEMs can benefit from the proven BODAS Application Software (AS) platform. AS helps them achieve more efficiency and reusability – no matter if it's about changing data settings in functional software like the drivetrain or the implement hydraulics, modifying the software itself, or developing new individual software modules altogether.

OEMs and Bosch Rexroth experts can collaborate by following state-of-the-art agile development processes to accelerate development and reduce risks and costs. Furthermore, they can team up virtually or face to face at the Bosch Rexroth Customer and Innovation Lab (Ulm/Germany), at any Bosch Rexroth location close to the customer, or at the OEM's site.



The right software for each target group and application ...

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BODAS Application Software product lines

Open ecosystem: BODAS Application Software (AS) comes in three product lines tailored for application specialists, software developers, and system experts. Using the same platform, they can add plug-and-play software modules to upgrade machines, modify software, or create completely new and unique modules.

HOW DOES IT WORK?

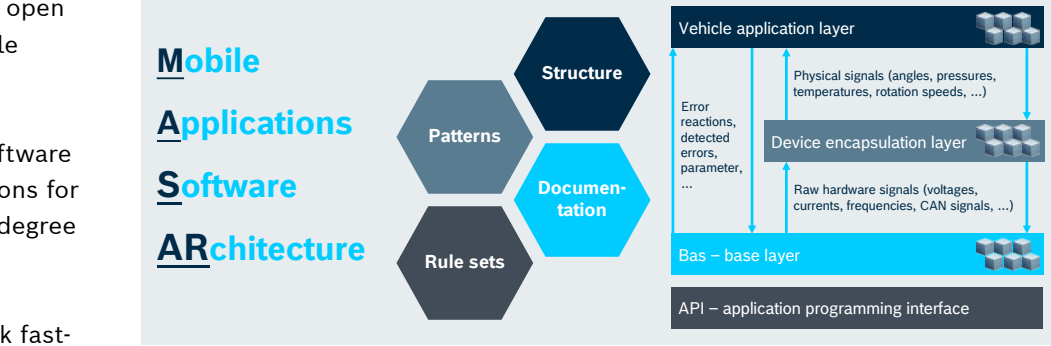
To make joint software development a full success, we've built three pillars of collaboration – an open ecosystem, a guiding architecture, and an agile workflow.

Open ecosystem: The BODAS Application Software (AS) product lines provide appropriate solutions for each target group, each application, and any degree of complexity.

- ASrun helps OEM application experts work faster and more efficiently. They can simply use our well-tested off-the-shelf packages and customize them, graphically guided via parameter settings, without any programming skills being required.
- ASopen intended software and system engineers – the experts when it comes to modifying existing or adding completely new machine features. It allows extending the BODAS software, for example, with on-demand features, which opens the door for the OEM to create new revenue streams.
- ASlib is for experts, too. It provides software components for extending existing packages as well as for creating individual solutions from scratch.

Guiding architecture: BODAS MASAR (Mobile Aplications Software Architecture) helps you manage your software development across multiple teams. Areas of responsibility are organized according to clear structures. Main principles include the decoupling of the machine functionality from the controller hardware, the encapsulation of device drivers, a well-defined layer concept and standardized interfaces.

Keep it manageable – clearly assigned responsibilities



Guiding architecture: BODAS MASAR (Mobile Applications Software Architecture) features clearly assigned responsibilities that facilitate collaboration even in decentralized teams and across organizations.

Agile workflow: The architecture and proven product lines provide a perfect starting point for collaboration at a high level of maturity. Valuable contributions from different partners can be efficiently combined while mastering the big picture. Wherever desired, our worldwide engineering team is ready to help you.

HOW DO YOU BENEFIT?

▶ **Focus on your diamonds.** Digital collaboration helps you develop, integrate, activate, and monetize the innovative functions and services your customers appreciate you for. Why invest immense resources in individual software development if our solutions are already available and well-proven?

▶ **Ready to go.** With BODAS Application Software, you have access to a comprehensive set of features, documentation, tools, and guidelines. All made, tested and optimized by experts for Rexroth components and beyond. No need to reinvent the wheel.

▶ **Stay on the safe side.** You can rely on many well-proven packages for driving, working, and auxiliary functions – all at system-level for your mobile machines. Safety and security are integral parts of our solutions. A comprehensive construction kit with more than 200 software components is waiting for you.

▶ **Get a holistic solution.** We provide more than just the right development tools. For example, when it comes to 3rd-party services like monetizing your on-demand features, you can count on the proven and open infrastructure of BODAS Connect. From a single machine to a whole fleet.

▶ **Scale your business.** With BODAS Hardware, BODAS Software, and BODAS Connect being widely used in mobile machines, you can use our solutions for a wide range of applications – worldwide and in close collaboration with our experts whenever you need them.

rexroth
A Bosch Company

Bosch Rexroth AG
Glockeraustrasse 2
89275 Elchingen, Germany
Tel. +49 7308 82-0
info.ma@boschrexroth.de
www.boschrexroth.com

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