

## BODAS – Intelligent Electronics for Mobile Hydraulics



The Drive & Control Company



## A Single Source: Hydraulics, Gearboxes and Electronics for Mobile Equipment

Over the years Rexroth Mobile Electronics have always served me well. Electronics matched to the hydraulics of mobile machines make things so much easier. Rexroth mobile electronics also make it far simpler to optimize hydraulic systems – parameters are all altered on the PC, so there is no need to keep changing oily throttles. The electronics also include lots of useful features. For example, electronic joystick settings can be varied according to the application. And, just as importantly, electronic eco-modes reduce fuel consumption considerably. I have to say, Rexroth mobile electronics make my life easier."

Experienced professionals have long understood that Rexroth makes their job much easier. Our mobile electronics are perfectly matched to hydraulic components and systems. Why not find out for yourself?

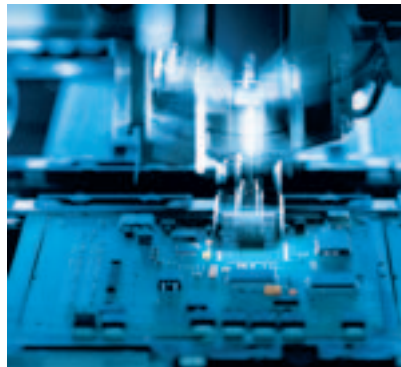




### Functional synergy

Rexroth offers an incredible range of components and systems for drives and controls, in which electronics are becoming increasingly important. For years we have been developing electronic components and systems for many different requirements – tailored precisely to our hydraulics and gear technology. That is what makes us unique.

Rexroth has the ideal solution for almost any type of mobile equipment, especially construction machinery, utility vehicles, agricultural and forestry machines and material handling equipment. In every field we stand as proof of what has made Rexroth the world market leader: reliability, cost-effectiveness, robustness and extreme ease of use.



### The Bosch factor

Extremely high demands are placed on the electronics in mobile equipment. Vibration, shock, cold, heat and electromagnetic radiation are sources of interference to which a system has to be resistant. That is why we only use components that satisfy Bosch's strict quality requirements.

Our attention extends to far more than just the components, however. As part of the Bosch Group, we also have access to the very best skills in automotive electronics. Our electronics are produced on the same production lines as Bosch vehicle electronics. In the development phase every component is subjected to stringent testing: on vibration devices, in cold and heat chambers, in interference field laboratories and salt spray chambers. That is why you can always rely on our electronics, even under the most extreme conditions. Quality made by Bosch.

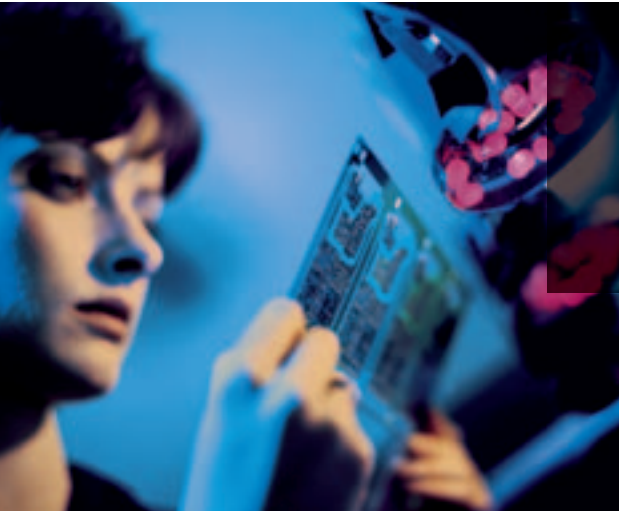


### Concentrated knowledge

Consulting is our strength. Rexroth Application Centers provide a comprehensive, vehicle-specific development partnership for the optimum choice and integration of electronics, hydraulics and transmission systems. Specialist engineers are on hand to support you all the way, from component selection through programming to simulation. Our experts are there at your side for the design, development, construction and optimization of your system. We work closely with you to create system solutions which are optimized for your own applications and which, thanks to fully coordinated components, require a minimum of interfaces. This saves time and money.



## BODAS – the System for Mobile Electronics



BODAS provides the perfect and unique solution for your needs. Due to the close cooperation between Rexroth and Bosch in development, testing and production, BODAS is suitable for a wide variety of applications.

### Modular architecture

The consistent and configurable modular architecture saves you a lot of development time. Perfectly coordinated hardware and software components reduce your costs.

### Reliability

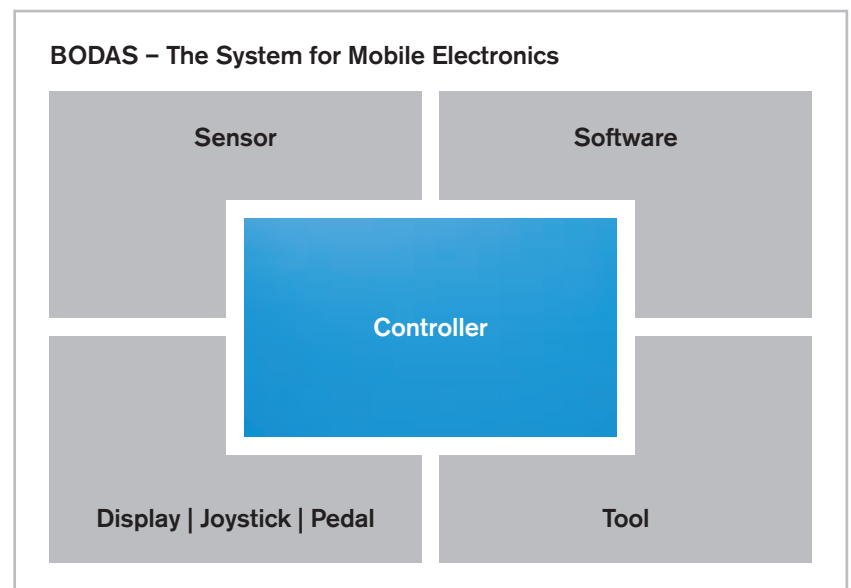
Thanks to the BODAS controllers and peripheral devices, proven in mobile equipment in the daily grind, BODAS ensures your machine electronics will be highly reliable and accessible.

### Flexibility

The new BODAS software concept enables an unequalled degree of flexibility. Through open and complementary software modules, the solution can be easily and individually adapted to growing demands. Thus, your machine design and performance can be one decisive step ahead of competition.

### Service

BODAS tools offer you flexibility and freedom – from software development and simulation to evaluation and optimizing your current system. Thus you can build up your control system yourself, and access the extensive Rexroth know-how at the same time.



# BODAS – the Hardware Modules

## Robust Controllers for rough mobile use



BODAS controllers are the powerful backbone to the BODAS system. On the one hand they receive and process signals from operator panels and sensors. On the other they calculate and generate the output signals to pumps, motors, valves and auxiliary devices. In the BODAS hardware building set, several robust variations of the controllers and one extension module are available. This makes your machine reliable and efficient.

### Our controllers stand up to the mobile environment

- Sealed diecast aluminum housing free from potting compound, from Bosch automotive development – proven in vehicle systems a million times over
- Robust construction: resistant to salt and dirt, watertight housing and connector with IP 65 (optionally IP 69k) under IEC 60068-2 and EN 60528

- High temperature resistance for use in alpine winter or tropical conditions (-40°C to +85°C/ -40°F to 185°F) without reduction in performance
- Vibration- and shock-resistant to 25 g in accordance with IEC 60068-2
- Interference immunity through high electromagnetic compatibility (EMC) to 100 V/m in accordance with the Automotive Directive 95/54/EC and ISO 7637

### Application safety with BODAS controllers

- Integral Bosch watchdog for processor monitoring
- Integral potentiometer monitoring to prevent broken lines and short-circuit faults
- All inputs and outputs are short-circuit proof and protected against polarity reversal
- Integral output protective diodes

### Flexibility in use

- Inputs are freely definable as analog, digital or frequency input
- All outputs can be used simultaneously and independently
- High clock frequency up to 40 MHz for time-critical applications
- Enough RAM even for complex applications
- Easy to wire, since no solenoid return line is needed
- External programs can be downloaded via flash without changing the EPROM
- CAN-Bus interface is standard

### Controllers and Extension module

#### Properties and Applications

	RC2-2	RC4-4	RC6-9	RC12-18	RCE12-4
Proportional solenoid outputs	2	4	6	12	12
Switch outputs	2	4	9	18	4
Supply voltage	12 to 24 V				
Voltage inputs 0-5 V	2	5	8	16	15
Current inputs 0-20 mA	2	4	4	8	0
Frequency inputs	2	3	5	10	2
Switch inputs	4	6	8	14	14
RS 232 interfaces	1	1	1	2	0
CAN interfaces	1	2	2	4	1
Operating temperature	-40 to +85°C/-40°F to + 185°F				

Detailed data sheets for controllers and accessories can be downloaded from our website at: [www.boschrexroth-us.com/brm](http://www.boschrexroth-us.com/brm)

## BODAS – the Hardware Modules

### Versatile, harmonized peripheral devices

The BODAS hardware building set is complimented with approved, high-quality and versatile applicable peripheral devices. The significantly expanded BODAS sensor family as well as joysticks and displays are perfectly harmonized to the controllers and the Rexroth hydraulic components. So you will get your product onto the market more quickly by increased functional security and shortened development and testing time.



Speed sensor DSM for rotary speed detection, direction and standstill detection with integrated diagnosis and IP 69 k protection



Pressure sensor PR 2 with measuring range up to 600 bar (8600 psi) and IP 69 k protection



Speed sensors HDD and ID with and without rotational direction detection and redundancy for safety functions with IP 69 k protection



Temperature sensors TSA for air (up to 160 °C/320°F) and TSF for fluids (up to 130 °C/266°F) with broad temperature range



Angle of rotation sensor WS1 with 90° swivel angle, redundant, contact-free measuring system for safety functions and IP 69 k protection



Contamination switch VS for the detection of abraded ferretic matter in hydraulic fluids to prevent consequential damage



Position sensor PO with measuring range up to 10 mm, temperature compensation and IP 66 protection



Joystick EJC with 2 axis, redundant position determination via hall-effect sensors, signal output via voltage, current, PWM or CAN



Draft sensor KMB to measure loads and forces up to 11kNm, extremely robust, detection of cable break and short-circuit and IP 66 protection



Display DI2 for exterior use with IP 69 k protection, operable also with gloves, full graphics and CAN bus capable

Through standardized interfaces and the open system architecture, BODAS enables the integration of additional machine components (such as e.g. own sensors, actuators) and the communication to the diesel engine via SAE J 1939 for lower fuel consumption and optimized performance.

Detailed data sheets regarding the BODAS hardware modules can be downloaded from our website at: [www.boschrexroth-us.com/brm](http://www.boschrexroth-us.com/brm)

# BODAS – the Software Modules

## How would you like it?

The configurable BODAS software concept provides the perfect solution for all applications. From ready-to-use standard application software packages to adapted modules (customizing) up to customer specific solutions, you can access the extensive application know-how of Rexroth.



### Standard Application Software

Are you looking for turnkey, coordinated machine software components, easy to use and proven in the field? BODAS offers complete software packages that you can configure yourself with very little effort. With the help of BODAS tools and the user-friendly documentation, you can start up your machine step by step.

### Customizing and add-on modules

Or perhaps your requirement is more specific? Customizing, in other words the adaption of the basic modules is quick and cost-effective. Using the BODAS tools or via a C-application interface, you can even carry out these expansions yourself or you can integrate complete BODAS add-on modules in your concept.

### Customer-specific solutions

Are you looking for a concept that is tailored precisely to your individual specifications? Here, BODAS provides you the opportunity to program your own solution completely and independently also. Certainly you can also rely on Rexroth as a proven service provider to develop your individual solution.

Application software packages, basic modules	Optional add-on modules
<b>SPC Speed control</b> Defined output speed of hydraulic motors at variable pump speed	<b>ADC Automotive drive control</b> Direct linking of vehicle speed to engine speed
<b>VAC Electronic valve control</b> Conditioning and setting of joystick signals for valve control	<b>AFC Automatic fan control</b> Temperature-dependent control of fan speed
<b>LLC Load limiting control</b> Intelligent power management between diesel motor and hydraulics, with safety functions	<b>AGS Automatic gear shifting</b> Control of a power shift gear
<b>DRC Drive control</b> Comprehensive drive management, including reversing, speed control and safety functions	<b>ASR Anti slip control</b> Traction control for slippery terrain
<b>DPC Dual path control</b> Drive management for tracked vehicles	<b>ECO Ecodrive</b> Reduction in engine speed in part-load operation to reduce fuel consumption, noise and wear
<b>CEM CAN bus extension module</b> Reading of digital and analog signals and control of switch and proportional outputs via CAN bus	<b>EDP Electronic drive pedal</b> Engine control via CAN bus
	<b>CBC Coordinated boom control</b> Coordinated control of two work functions
	<b>DDI Display-data interface</b> Provision of display data for DI2 display via CAN bus

# Excavator

## With Load Limiting Control LLC



Lift the filled bucket, extend the boom and slew the superstructure, all at 40 °C/100 °F in the shade? That's a lot to ask of a diesel engine and hydraulic system. It's just as well that the load limiting control ensures an intelligent power distribution between the diesel engine and the hydraulics. The electronics protect the diesel engine against overload and reduce fuel consumption, emissions and wear. They also make it easier to operate the excavator.

The BODAS controller monitors the current operating status of the diesel engine, either by means of speed and angle of rotation sensors or directly, via CAN bus data. In the event of a potential overload, for example due to too great a divergence between the rated speed and the actual speed or too high a cooling water temperature, the electronics automatically reduce the power consumption of the coordinated Rexroth hydraulic pumps. This ensures that the diesel engine is always within the optimum operating range.

The BODAS software module also has an auto-idle function, which automatically reduces the speed - and hence the fuel consumption - if the engine is under light load for any length of time. Various mode shifts offer a choice between precision control, e.g. for sewage pipe installation, and dynamic loading and unloading. That's enough to make any excavator driver happy.

### Hardware in this example

Controller	RC2-2
Speed sensor	ID
Pressure sensor	DS
Angle sensor	WS
Coordinated hydraulics	A8VO.LA or A11VO.LE

### Software package in this example

Load limiting control	LLC
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## Forage Harvester With Anti Slip Control ASR



Optimum traction on heavy, wet farmland without getting the harvester bogged down, moving smoothly across the grass to pick up windrow without damaging the turf. Forage harvesters have to cope with all sorts of requirements. Electronically controlled all-wheel drive from Rexroth brings even the most difficult situation under control. Our technology prevents rear wheel spin when driving or braking on a slope – on any terrain, in any weather. This gives a forage harvester optimum traction, even under the harshest conditions.

With anti slip control, integral speed sensors continuously monitor the wheel speeds of the Rexroth hydraulic motors. If the speed differential between the front and rear axle becomes too great, it is immediately corrected by means of a special algorithm. This prevents the wheels from spinning uncontrollably.

But the BODAS controller also has another function. It receives information via CAN bus about the selected gear and the diesel engine speed – and uses this to control pumps, motors and valves on the travel drive.

### Hardware in this example

Controller	RC2-2
Speed sensor	HDD in A6VM hydraulic motor

### Software packages in this example

Drive control	DRC
Anti slip control	ASR

# Paver

## With Synchronous Dual Path Control

A road is meant to run straight or in a clearly defined curve. It should also be completely level of course, whether up or downhill. The synchronous dual path control with add-on modules BODAS ensures that optimum road surfaces are produced, and makes it easy to operate the paver from the control console. Our software package controls speed, synchronization between the right and left track drive, as well as braking and acceleration. The result, the level surface, is something you experience every day for yourself.



### Hardware in this example

Controller	RC6-9
Speed sensor	HDD built into A6VE plug-in motor
Display	DI2

### Software packages in this example

Dual path control	DPC
Speed control	SPC
Display-data interface	DDI

At the heart of the drive control system on the paver is the BODAS controller with the dual path control software module, which keeps the drives for the left and right tracks at defined speeds in order to follow the planned course of the road precisely. The drive control, with integral reversing, load-neutral speed

control and inching, ensures simplicity of use and consistent road surface quality.

The necessary input signals come from the weather-resistant BODAS display with integral function keys and from other potentiometers and switches on the control console. Integral speed sensors in the travel

motors also supply the signals for travel speed and travel direction. Curve radius, speed, delivery rate, screed temperature – everything the driver needs to know appears on the BODAS display in the form of pictograms, numerical values or bar charts. After all, operation has to be easy even if the technology is complex.

## Road Roller

### With Drive Control DRC and Vibration Drive

Behind the paver, road rollers carry out their difficult job. A tough, level road covering calls for precision work, and BODAS electronics can really help with this. They control smooth starting, braking and reversing to ensure that the roller leaves no impressions in the road surface as it turns. After all, with road rollers it's the quality of the road surface that really counts.



With its smart choice of software packages, the BODAS controller has everything a road roller needs to carry out its job. The drive control with integral reversing functions and hydrostatic braking provides the all-important, finish-specific soft accelerating and reversing operations. The anti slip control stops wheels from spinning on slopes and on smooth surfaces. Speed sensors built into the Rexroth drive motors provide continuous speed feedback to the controller. This means that any signs of slipping can immediately be corrected before the road surface is damaged.

BODAS also takes care of the load limiting control between the diesel engine and the hydraulics, when negotiating steep slopes for example. The hydraulic power reduction is adjusted according to the diesel engine load signaled via CAN bus. There are also additional functions, including spray and vibration control.

The driver is kept fully informed about all of this by the robust BODAS display built into the driver's console, which provides a graphical overview of all relevant data. After all, technology is meant to help people.

#### Hardware in this example

Controller	RC4-4
Speed sensor	HDD in A6VM hydraulic motor
Display	DI2

#### Software packages in this example

Drive control	DRC
Anti slip control	ASR
Load limiting control	LLC
Display-data interface	DDI



## Fork Lift With Drive Control DRC



The BODAS software controls the hydraulic pump on the basis of the electronic gas pedal position, current diesel engine output and hydraulic pressure. The all-important dynamic response can be switched according to specific circumstances to favor good handling performance or sensitive positioning. The electronics also ensure that the travel speed is unaffected when the working hydraulics are actuated. Smooth, jolt-free reversing thanks to BODAS greatly improves transport safety. The optional software packages that complete the Rexroth control system for fork lifts include fan, parking brake and brake valve control.

A busy period in the aircraft hangar: the Boeing has to be ready for takeoff shortly. But before it can leave, the electronic engineers need some sensitive avionics from the warehouse, and the cabin crew have to change the covers and half the galley. This is a real challenge for the transport vehicles. They have to drive and lift pallets at the same time, without jolting or changing speed; accelerate without their wheels spinning on the hangar floors; brake accurately without damaging the goods; and all this with minimum fuel consumption. Every day, perfectly coordinated Rexroth components control thousands of fork lift trips.

### Hardware in this example

Controller	RC6-9
Pressure sensor	DS
Speed sensor	ID
Angle sensor	WS
Temperature sensor	TSA
Hydraulic pump	A4VG.EP
Radial piston motor	MCR with integral speed sensor and brake

### Software packages in this example

Drive control	DRC
Anti slip control	ASR
Electronic drive pedal	EDP
Automotive drive control	ADC
Automatic fan control	AFC



## Wheel Loader With Drive Control DRC

Move into the pile, fill the bucket and lift. Back up and turn at the same time. Then accelerate, brake again in front of the dump truck and empty the bucket – that's the daily routine of a wheel loader. BODAS shifts the gears for maximum acceleration and controls the travel drive to minimize fuel consumption. After all, unloading and reloading has to be as fast and efficient as possible.



In order to carry out these functions, a whole series of software packages work together in the BODAS controller. They include control of switching operations on the mechanical power shift gear with no interruption of tractive force, based on the gas pedal position and direction selection. The input variables for this are supplied by BODAS angle and speed sensors.

The drive control and load limiting control modules ensure that the hydraulics provide optimum conversion of the diesel engine output. The coordinated hydraulic pumps and motors are adjusted for travel drive and additional functions. As soon as the loader drops to part-load operation, the eco-drive reduces the diesel engine speed to save fuel. BODAS temperature

### Hardware in this example

Controller	RC6-9 and RC2-2
Speed sensor	HDD built into A6VM hydraulic motor
Temperature sensor TSA	
Angle sensor	WS

### Software packages in this example

Drive control	DRC
Automatic gear shifting	AGS
Anti slip control	ASR
Electronic drive pedal	EDP
Automotive drive control	ADC
Ecodrive	ECO
Load limiting control	LLC
Automatic fan control	AFC
Coordinated boom control	CBC

sensors working alongside the fan control software module provide optimum engine cooling. The electronic boom control makes moving a full bucket much easier. This ensures that the bucket position remains horizontal, regardless of the height of lift.

## From Vision to Result: We Contribute Ideas

Do you have an idea and want to know how we can help you? Then discuss your sketches and plans with our engineers, who have experience of your own area of application and will be glad to work alongside you all the way from development to commissioning. Full immersion in the technology and requirements of our customers – that's the guiding principle of our engineers. Because together we are strong. To find your local Rexroth contact, go to [www.boschrexroth-us.com](http://www.boschrexroth-us.com)





### Commissioning and fine tuning

Our range of services in the electronics area goes far beyond controllers and sensors. It also includes service tools in the form of hand-held equipment, software for laptops, test adapters and flash tools, and specific commissioning instructions and software specifications. With our BODAS tools you can connect straight to the electronics via the diagnostic connector, allowing you to change software parameters – and the characteristics of your equipment – quickly and easily. All modifications can be viewed and analyzed instantly in the integral data log. For more complex applications our commissioning and application engineers are happy to help.



### Software development with BODAS-design

Would you like to design your own software for your equipment? No problem. With the BODAS-design graphical programming interface you can develop, simulate and debug your program on a PC and then transfer it onto the controller. The programming interface is based on the standard IEC 6 1131-3 and is comparable to industrial control systems such as PLC. Programming is made easier with BODAS software modules from the software library. And the whole process is carried out in a modern, user-friendly Windows interface. Interested? Ask your Rexroth contact for a free demo version.

To kick-start the process we also offer professional support for the BODAS-design programming system with training at Rexroth. Forthcoming dates can be found at [www.boschrexroth.com/mobile-training](http://www.boschrexroth.com/mobile-training)



### Documentation and support

All relevant facts, figures and data are available in the form of detailed information sheets or catalogs for each product. Just ask. Your Rexroth contact will be glad to provide you with all the information you need. Alternatively, take a look at our website, where you can download technical information about our products and services.

If you need more information, just ask your Rexroth contacts. They know the experts in development and project planning, worldwide, to get you mobile faster.

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