Rexroth
Bosch Group

BODAS Controller RC Series 21

RE 95201/11.07 1/16
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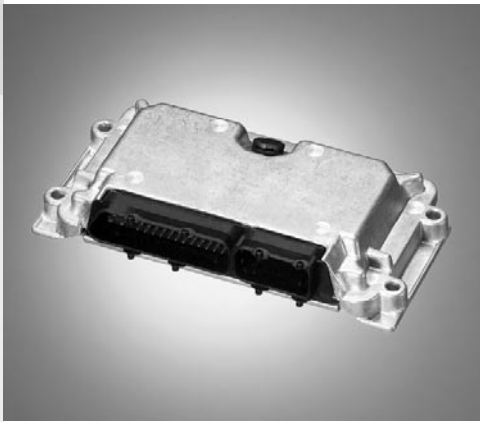
Technical Data Sheet



For closed- and open-loop control of hydraulic components

Contents

Features

- Component of BODAS system for mobile applications
- Robust design meeting specifications for mobile applications
- High electromagnetic compatibility (EMC)
- Inputs and outputs with fault detection
- Safety features such as redundant inputs and central safety cut-off for all outputs
- Pulse-width-modulated (PWM) solenoid currents for minimum hysteresis
- Closed-loop control of solenoid currents, i.e. not dependent on voltage and temperature
- Sturdy, sealed aluminum housing

Main components

- Powerful 16-bit microcontroller module
- Protected watchdog processor for program run monitoring
- Serial data interface and CAN-bus interface for diagnostics, parameter setting and display of process variables
- Supply voltage and ground connections for potentiometers and sensors

Ordering Code

RC	2-2	/	21
01	02		03

Type

01	BODAS controller	**RC**

Version

02	1st digit = no. of proportional outputs	**2-2**
	2nd digit = no. of switched outputs	

Series

03	Series 2, index 1	**21**

Note:

The BODAS controllers are not functional without software.

In order to use the BODAS controllers, you also need:

– BODAS standard software or
– Application-specific software

Optional accessories

– **BODAS-design software**
The Windows-based PC software BODAS-design (RE 95110) is used for programming the BODAS controller RC. All graphic and text-based programming languages specified in the IEC 61131-3 standard are available for programming.

– **BODAS-service software**
The Windows-based PC software BODAS-service (RE 95086) is used for displaying functions, errors and system variables as well as for setting parameters via a PC.

– **BODAS measuring adapter MA**
The BODAS measuring adapter MA (RE 95090) is used for measuring all electric signals at the inputs, outputs and interfaces of the BODAS controller. For test purposes, it is connected in series between the controller and the vehicle or device wiring.

– **BODAS TB3 test box**
The BODAS TB3 test box (RE 95092) is used for simulating vehicle and equipment functions for development and test purposes with BODAS controllers. The BODAS TB3 test box is connected to the controller with the adapter cable TAK1/10.

– **BODAS CAN I/O extension module RCE12-4/22**
The BODAS CAN I/O extension module RCE12-4/22 (RE 95220) is used for I/O extension of a controller in the event that the number of controller inputs and outputs is insufficient for the specified application.

All products mentioned here are available from Rexroth.
Further information can be found on the Internet at:
www.boschrexroth.com/mobile-electronics

Description

The BODAS controllers RC are used for the programmable control of proportional solenoids and additional switching functions. They can therefore be used for both simple and complex open- or closed-loop controls, e.g. for hydrostatic travel drives, working hydraulics or transmission control in mobile working machines.

BODAS controllers RC were specially developed for use in mobile working machines, and satisfy the relevant safety requirements with regard to ambient temperature, tightness, resistance to shock and vibration, as well as electromagnetic compatibility (EMC). Internally, BODAS controller RC consist of a powerful 16-bit microcontroller and all input and output circuitry.

Analog voltages, resistances, frequencies and switching information are processed as input signals. The inputs are protected against overvoltage and electrical interference. The voltage inputs can be monitored to detect any cable breaks or short circuits.

The proportional solenoid outputs are pulse-width-modulated (PWM) and optimally adapted for electric proportional control of axial piston units and valves to ensure high accuracy and minimum hysteresis.

The switched outputs are designed for the direct switching of relays, lamps and switching solenoids.

The RS232 serial interface enables the connection of a laptop to the BODAS-service PC software for service functions, such as diagnostics, parameter setting or display of process variables.

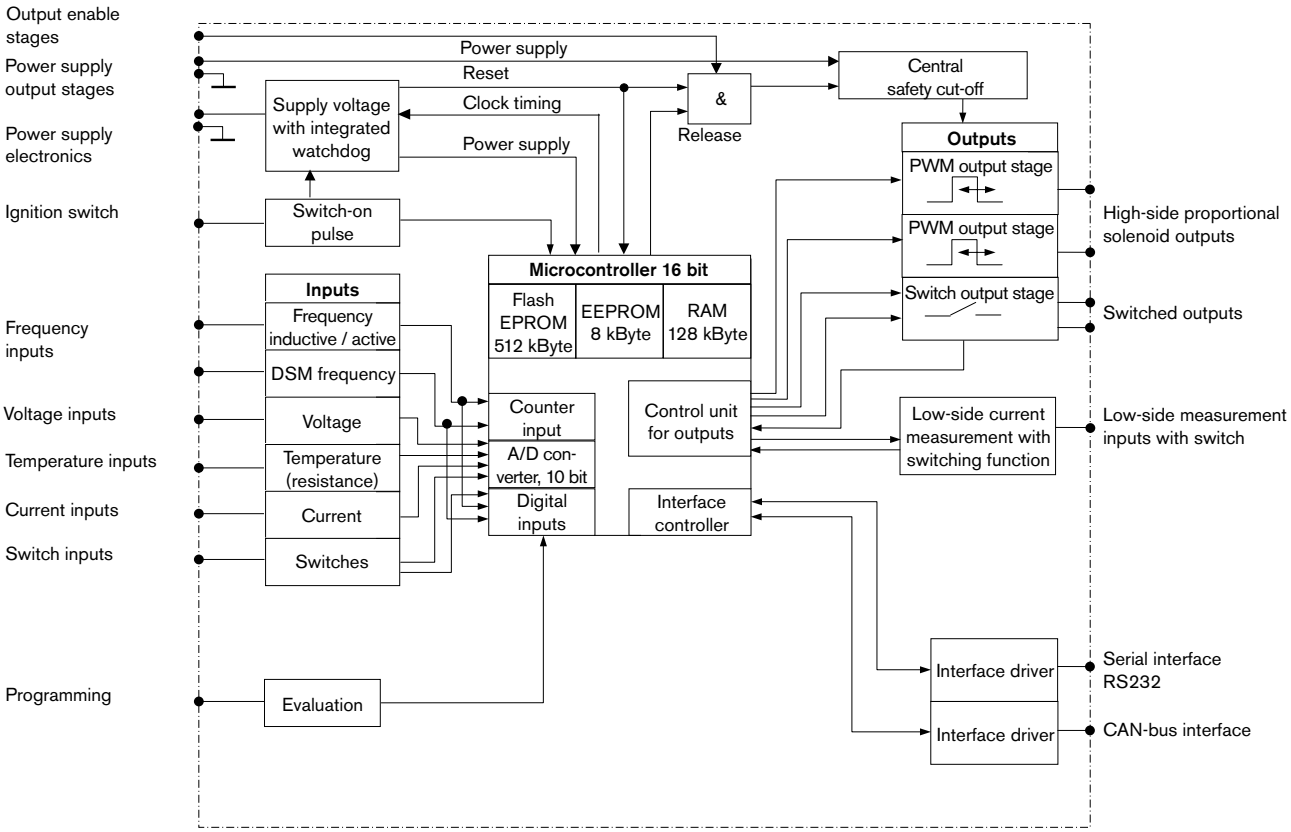
CAN-bus interfaces are available with all BODAS controller RC for exchanging data with other bus users or electronic systems (e.g. RC or RCE, joystick valves, diesel engine injection, display). The CAN-bus interfaces can each be operated with different protocols.

BODAS standard programs are available for the BODAS controller RC software. If more extensive functions are required, special program packages for specific applications can also be compiled using a program library and adapted to the application in question with the aid of service tools. Programming with BODAS-design is also possible.

Combined with pumps, motors, valves, sensors, input devices and actuators from Rexroth, BODAS controllers RC and corresponding software can be used to create complete system solutions.

Block Circuit Diagram

RC



Technical Data

Controller		RC2-2/21
Nominal voltage	12 and 24 V	✓
Residual ripple (DIN 40839, Part 1)	max. ± 2 V	✓
Supply voltage, permitted range	9 - 32 V	✓
Current consumption		
Without load, max.	mA	150
With load, max.	A	8
Fuse		
Internal:		–
External: for switch and proportional solenoid outputs	AT	8
For electronics	AT	3
For sensors	AT	1
Constant voltage source		
E.g. for setpoint potentiometer 1 - 5 kΩ	5 V ± 0.1 V, 30 mA	2
Analog voltage inputs		
(may also be used as switch input)[1)]	0 - 5 V	2
Analog current inputs		
(may also be used as switch input as well as analog voltage input)[1)5)]	0 - 20 mA and 0 - 8 V	2
Switch inputs		
May be switched between high/low active (may also be used as an analog voltage input as well as a frequency input)	low < 1.5 V; high > 4.5 V	4
Frequency inputs for inductive and active sensors		
(may also be used as switch input)[1)]	0 - 10 kHz; > 1 V_{RMS}	2
Frequency inputs for DSM+HDD1 sensors		
(may also be used as switch input)[2)]	0 - 13.5 kHz	2
Resistor inputs for temperature sensors		
(may also be used as switch input)[2)]	800 Ω - 1800 Ω	4
Proportional solenoid outputs (PWM)		
Current range	0 - 2.3 A	2
Adjustable dither frequency	100 - 250 Hz	✓
Control frequency	1 kHz	✓
Switched outputs (MOSFET)		
(may also be used as PWM outputs)	max. 2 A	2
Low-side measurement input[5)]		
Additional PWM output stage when used in combination with one or both switched outputs		
Current range	0 - 2.0 A	1
Adjustable dither frequency	100 - 250 Hz	✓
Control frequency	0.5 kHz	✓
Interfaces		
RS232 C		1
CAN 2.0 B	ISO 11898	1
Fault detection for cable break and short circuit		
Analog inputs		✓
Proportional solenoid outputs and switched outputs		✓
Protection against short circuit of the inputs and outputs		
Against supply voltage and ground[3)]		✓
Reverse-connect protection		
Power supply / battery[4)]		✓

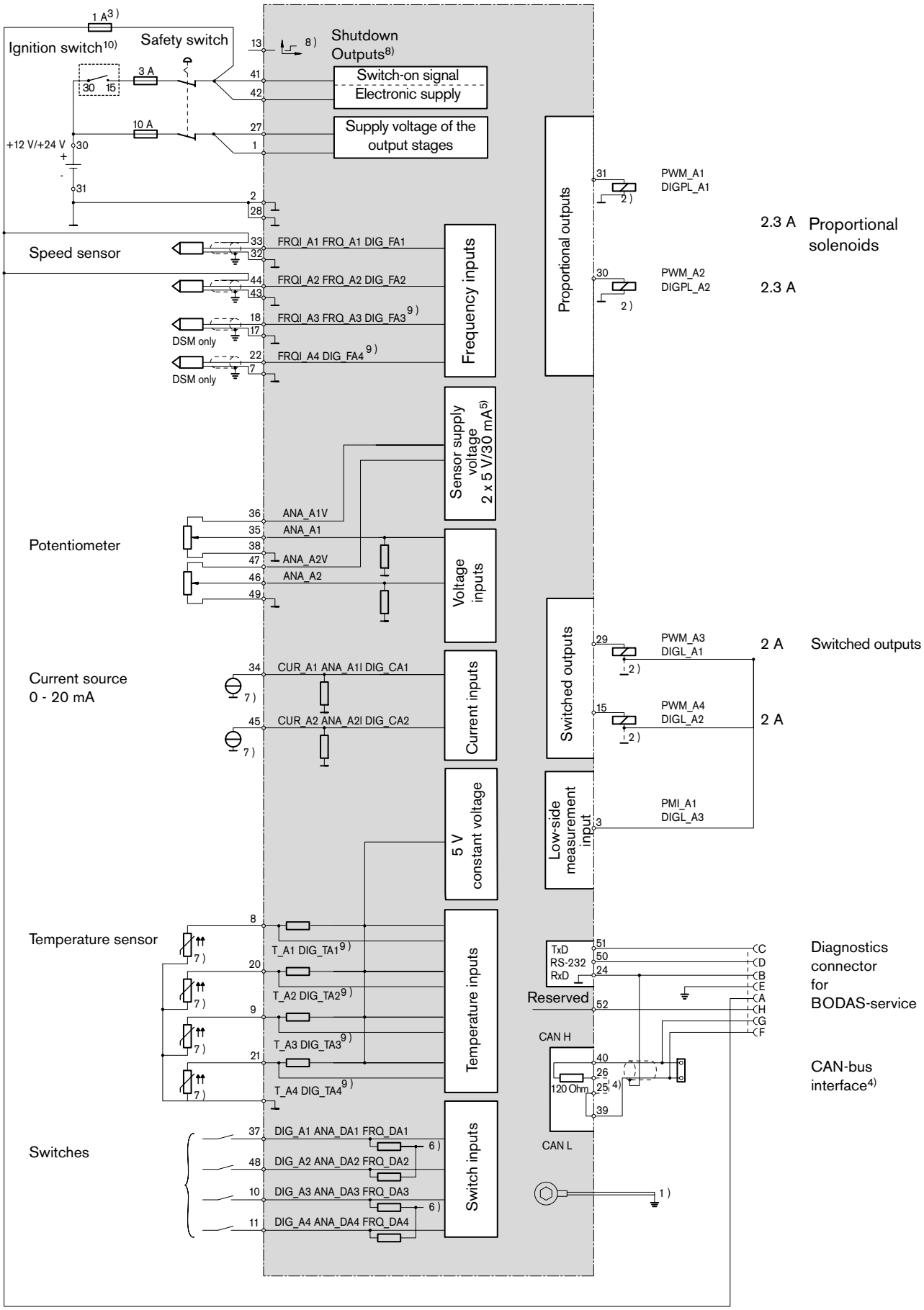
1) Switchable with supply voltage.
2) Can be used as switch inputs if externally connected to GND.
3) Voltages greater than those applied to supply pins 1, 27, 41, 42 must not be applied to the outputs.
4) The external fuse trips in the event of voltage reversal.
5) When using as a switching function, the notes in the respective, applicable software description (API) are to be observed.
6) Load 484 Ω. Can be switched by means of software to 22 kΩ.

Technical Data

Controller		RC2-2/21
Microcontroller		C167CR
Clock frequency	MHz	30
Memory capacities		
RAM	kByte	128
Flash EPROM	kByte	512
EEPROM	kByte	8
Software installation Download via RS-232		✓
Download via CAN		✓
Electromagnetic compatibility		
Spurious interference (directive 2004/104/EC)	100 V_{RMS}/m; (details on request)	✓
Line-bound interference (ISO 7637-1/-2/-3)	Values on request	✓
Load dump	123 V at 27.0 V supply voltage 87 V at 13.5 V supply voltage	✓
Electrostatic discharge ESD (acc. to ISO 10605)		
Not in operation	8 kV	✓
In operation	15 kV	✓
Max. dissipation power	W at 32 V	**5**
Operating temperature, case	-40 to +85°C (-40 to +185°F)	✓
Storage temperature, case	-40 to +85°C (-40 to +185°F)	✓
Vibration resistance		
Sinusoidal vibration (IEC 60068-2-6)	10 *g*; 57 - 2000 Hz 20 cycles per axis	✓
Random-shaped vibration (IEC 60068-2-36)	0.05 g^2 / Hz 30 min per axis	✓
Shock resistance		
Transport shock (IEC 60068-2-27)	15 *g*; 11 ms per spatial axis x, y, z and in each direction (pos./neg.)	✓
Continuous shock (IEC 60068-2-29)	25 *g*; 6 ms per spatial axis x, y, z and 1000x in each direction (pos./neg.)	✓
Resistance to moisture (IEC 60068-2-30Db; Variant 2)	95% (+25 to +55°C)	✓
Resistance to salt spray (IEC 60068-2-11)	72 h, 35°C, 5% NaCl	✓
Type of protection (DIN / EN 60529)[1] Without / with mounted mating connector	IP54k / IP 65	✓
Case material	Diecast aluminum	✓
Weight	Approx. kg	0.5
Outer dimensions	Length (in mm)	114
	Width (in mm)	204
	Height (in mm)	45
Mating Connector	52-pin	1
	28-pin	–

[1]) Taking installation notes into account

Connection diagram RC2-2/21



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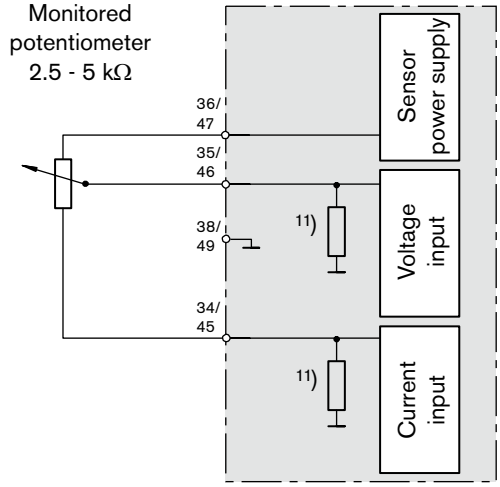
Connection Variants



1) Short, low-resistance connection from a case screw to the device ground or vehicle ground
2) Separate ground connection from solenoid return line to battery (chassis possible)
3) Separate fuses for switches and sensors necessary
4) CAN bus: termination resistor 120 Ω necessary
5) Sensor supply voltage for potentiometers and active sensors
6) Can be switched together between high / low active by means of software - pull-up or pull-down for these inputs
7) Separate ground connection for current source to battery, controller GND possible (pins 38/49)
8) If ≥ 5 V is applied to the input, all power outputs are off
9) Can be used as switch inputs if externally switched to GND
10) The terminals are labeled according to DIN 72 552. This does not apply for the controller.
11) Internal pull-down resistor

Overview of Functions

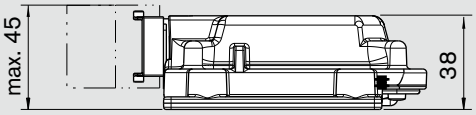
Pin	Description	Main function	Alternative functions
37, 48, 10, 11	**Digital input** with selectable pull-up/ pull-down after 5 V / GND Pull-up/pull-down switched in 2 groups: DI_1 - DI_2, DI_3 - DI_4	**Digital input** Threshold, programmable via software Pull-up / pull-down resistance switchable by means of software	**Analog voltage input** Measuring range 0 - 5 V Resolution 10 bit (5.93 mV/Bit) Input resistance DC to GND 18.3 kΩ Limit frequency filter 9 kHz Basic setting with open GND terminal
33, 44	**Inductive frequency input** FIV_1 - FIV_2	**Frequency input for inductive sensors** Frequency evaluation up to 10 kHz Input resistance 115 kΩ	**Digital input** Evaluation options • Threshold programmable via software
18, 22	**DSM frequency input** FIC_3 - FIC_4	**Frequency input for Rexroth DSM sensors** Frequency evaluation including additional information such as direction of rotation and error monitoring up to 13.5 kHz (max. tooth pulsation frequency 6.5 kHz)	**Frequency input for type PNP sensors** (e.g. HDD1) Frequency evaluation of active speed sensors switched to ground. **Caution**: Short circuit current up to 40 mA
			Digital input switching to GND Evaluation options • Threshold programmable via software • Digital current threshold 10 mA +3 mA
35, 46	**Analog voltage input** AIV_1 - AIV_2	**Analog voltage input** Measuring range 0 - 5 V Resolution 10 bit (5.37 mV/bit) Input resistance DC to GND 110 kΩ Limit frequency filter 17.5 kHz	**Digital input** Evaluation options • Threshold programmable via software
34, 45	**Analog current input** with selectable load (input resistance) AIC_1 - AIC_2	**Analog current measurement** Measuring range 0 - 20 mA Load 484 Ω Resolution 10 bit (10.8 mV/Bit) Input resistance Limit frequency filter 2.9 kHz	**Analog voltage input** Measuring range 0 - 10 V Resolution 10 bit (10.8 mV/bit) Input resistance DC to GND 11.02 kΩ Limit frequency filter 2.9 kHz
			Digital input Evaluation options • Threshold programmable via software
			LED output Can be used as LED output with external protective resistor to battery voltage.
8, 20, 9, 21	**Temperature input** AIT_1 - AIT_4	**Temperature measurement by means of resistance measurement in connected temperature sensors** Evaluation of passive temperature sensors with PTC measuring resistors	**Digital input switching to GND** Evaluation options • Switching thresholds < 1.6 V low > 1.8 V high

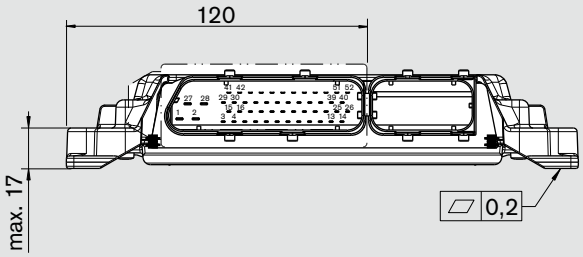
Overview of Functions

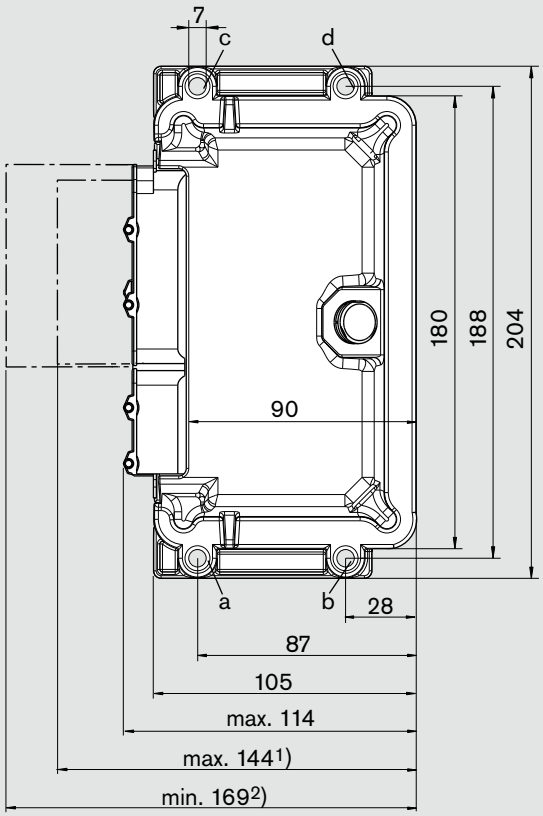
Pin	Description	Main function	Alternative functions
31, 30	**PWM output stage** POH_1 - POH_2	**PWM output stage** High-side switch Dither frequency programmable via software Integrated suppression diode for inductive kickback Max. current 2.3 A Pulse duty factor 5 - 95%	**Switch output stage** Diagnostics-compatible actuated time 0% / 95%
29, 15	**Power switch output stage** DOH_1 - DOH_2	**Switch output stage** High-side switch Max. current 2.0 A Integrated suppression diode for inductive kickback	**PWM output stage in combination with pin 3** High-side switch Dither frequency programmable via software Integrated suppression diode for inductive kickback Max. current 2.0 A Pulse duty factor 0 - 100%
3	**Low-side switch output stage** POL_1	**Switch output stage** Low-side switch with current measurement 0 - 2.65 A Max. current 4 A Limit frequency filter 246 Hz Integrated suppression diode for switching relay coils	**PWM output stage in combination with pins 29 or 15** Low-side switch Integrated suppression diode for inductive kickback
36	**Sensor supply** VSS_1	**Sensor supply** Output voltage 5.0 V Precision 5% Load capacity 30 mA	
47	**Sensor supply** VSS_2	**Sensor supply** Output voltage 5.0 V Precision 5% Load capacity 30 mA	
13	**Output enable**[1)] INH	**Digital input** Levels ≥ 5 V cause output stages to be blocked Input resistance DC to GND 20 kΩ	
40, 39	**CAN interface** CAN1_H, CAN1_L	**CAN interface** CAN 2.0B, 1 Mbaud	
25, 26	**CAN termination** CAN1_H_T, CAN1_L_T	**CAN termination** Termination resistor 120 Ω for CAN_1 by bridging contacts 25 and 26 in the plug	
51, 50	**RS232 interface** TxD, RxD	**RS232 C interface** Baudrate up to 56 kbaud	

[1)] Independent input for release/shutdown of the power outputs.

Dimensions RC2-2/21







Fixing:

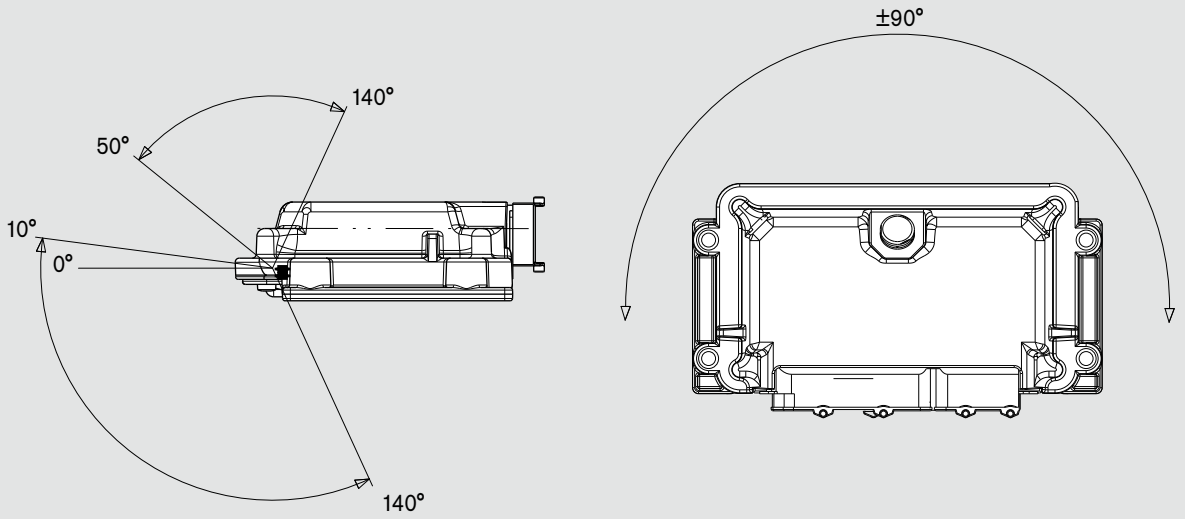
- The BODAS controller must be fixed at 4 points (a, b, c and d).
- Tightening torque MA = 8 ± 2 Nm for fixing the BODAS controller with M6 screws.
- Tightening torque applies for mounting without washer. The equivalent tightening torque must be calculated when using washers.
- Rexroth's approval is required if mounting is different from above.
- Installation point: evenness of mounting surface ▱ 0.5
- The wiring harness should be fixated mechanically in the area in which the controller is installed (spacing < 150 mm). The wiring harness should be fixated such that a phase excitation with the controller occurs (e.g. at the controller mounting point).

If the mounting surface is not sufficiently even, place flexible compensating elements (e.g. rubber washers) between the fixing points of the BODAS controller and the mounting surface.

¹) Space required for mating connector

²) Space required for plugging and unplugging the mating connector

Installation Position



Note:

Installation position only permissible with specified angular range.

Mating Connector

Order designations for mating connector, consisting of:

Designation	AMP No.	Number for AMP-Tyco MT2/JPT 52-pin ID No R902602414
Junior-Power-Timer-contacts	0-0964285-2	4
Single-wire seals JPT	0-0963293-1	4
Micro-Timer-2 contacts	0-0964275-2	48
Single-wire seals MT2	0-0964972-1	48
Basic unit MT2/JPT; 52-pin	0-1393450-3	1
Cover	0-1393454-7	1
Leakage dummy plugs F.D3,6-MT2	0-0963531-1	40

The mating connector is not included in supply.

The mating connector is available from Rexroth as a kit with all materials under the following material number:

– Mating connector kit 52-pin: Mat. no. R902602414

Recommended line

Recommended connection lines for contacts 1, 2, 27 and 28:

– Cross section 1.0 mm² (16 AWG with thin insulation)

– Outer diameter: 2.0 mm - 2.7 mm

Recommended connection lines for the other contacts (except for 1, 2, 27 and 28):

– Cross section 0.5 mm² (20 AWG)

– Outer diameter: 1.9 mm - 2.1 mm

Safety Notes

• General instructions:
- Reliable operation cannot be guaranteed if samples or prototypes are used in series production machines.
- The suggested circuits do not imply any technical liability for the system on the part of Rexroth.
- Incorrect connections could cause unexpected signals at the outputs of the controller.
- Dangerous malfunctions may result if the control electronics are opened or modified or the wiring repaired without authorization.
- In addition, the application-specific documents (connection diagrams, software descriptions, etc.) are to be observed.
- To switch off the system in emergencies, the power supply to the electronics must be disconnected with a safety switch. The safety switch must be installed in an easily accessible position for the operator. The system must be designed in such a way that actuating the safety switch ensures safe braking.
- System developments, installations and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with the components used and with the complete system.
- Unexpected dangers may be present at the machine during commissioning of the RC. For this reason, before commissioning the system, you must ensure that the vehicle and the hydraulic system are in a safe condition. Make certain that no persons are present in the danger zone of the machine.
- No components that are defective or not working properly should be used. If components fail and/or exhibit malfunction, repair must be carried out immediately.
- The controller RC warms up above regular ambient temperature during operation. To prevent risks due to high temperatures, it should be attached and protected before it is touched.
- Incorrect programming of the RC may create potential sources of danger while the machine is in operation. It is the responsibility of the machine manufacturer to determine dangers of this type in a risk assessment and to bring them to the attention of the end user. Rexroth assumes no liability for risks of this type.
- Make sure that the controller configuration does not lead to safety-critical malfunctions of the complete system in the event of failure or malfunction. This type of system behavior may lead to danger to life and/or cause much damage to property.

• Conventional use:
- The controller RC is designed for use in mobile working machines provided no limitations / restrictions are made to certain application areas in this data sheet.
- Operation of the controller RC must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences. Use outside of the specified and released boundary conditions may result in danger to life and/or cause damage to components which could result in consequential damage to the complete system.
- Damages which result from improper use and/or from unauthorized, unintended interventions in the device not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

• Notes on the installation point and position:
- Do not install the controller near parts which generate considerable heat (e.g. exhaust).
- Install the controller in such a way that the connector is pointing downwards. This ensures that any condensation water can drain.
- A sufficiently large distance to radio systems must be maintained.
- All connectors must be unplugged from the electronics during electrical welding operations.
- The controller must not be electrostatically charged, e.g. during painting operations.
- Radio equipment and mobile telephones must not be used in the driver's cab without a suitable antenna or near the control electronics.
- Cables/wires must be sealed individually to prevent water from entering the controller.

• Notes on transport and storage:
- Controllers must be stored in mean relative humidity of 60% at a temperature between -10°C and +30°C. Briefly, for 100 hours, a storage temperature range of -20°C to +40°C is permissible.
- After a storage time of more than 5 years, the controller must be examined by the manufacturer before it is used.
- The controller must not be used if it has been dropped, as damage that is not visible could still affect its reliability.

Safety Notes

• Notes on circuitry and on wiring:
  – The lines used for speed sensors are to be shielded. The shield must be connected to the electronics on one side or to the machine or vehicle ground via a low-resistance connection.
  – Cables to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
  – The electronics and the power outputs of a controller must be fed from the same power source.
  – The wiring harness should be fixated mechanically in the area in which the controller is installed (spacing < 150 mm). The wiring harness should be fixated such that a phase excitation with the controller occurs (e.g. at the controller mounting point).
  – When wiring the output stages, the maximum cumulative output current for each output stage group should be noted. The cumulative output current means a permanent, simultaneous actuation of the output stages.

• Notes on proportional solenoids and switching solenoids and other switched inductive consumers:
  – The electronics may only be tested with the proportional solenoids connected.
  – The proportional solenoids must not be wired with suppression diodes.
  – Switching solenoids at the outputs of the controller RC do not need to be connected to suppression diodes.
  – Other inductive loads that are in the system but not connected to the controller RC must be connected to suppression diodes.

Safety features in the BODAS controller

– The input circuits for speed and analog signals partially feature circuits that are mutually electrically isolated. Through appropriate input connections, the microcontroller and, when used, the software diagnostic function can detect faults.

– Faults in the supply voltage are detected by internal monitoring.

– All output signals can be monitored by the microcontroller with the appropriate software.

– For service purposes, the controllers can be operated with all power outputs de-energized.

– The internal watchdog module centrally switches off all proportional and switched outputs in the event of disturbances to the program execution.

Product-specific notes

– By means of appropriate circuitry and through the use of the software diagnostic function, it is possible to detect cable breaks or short circuits on the potentiometers by circuit logic. (See circuit version: Monitored potentiometers)

– Via the release input, the output stages (proportional and switched outputs) are switched off independent of the CAN bus.

Safety measures during use of the BODAS controller

– Faults can be detected and specially programmed safety functions activated by means of appropriate input variable assignments (e.g. connection of the acceleration pedal signal to two independent analog inputs).

– Special safety functions can be initiated if the plausibility check reveals discrepancies between the setpoints and the values read back by the microcontroller.

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