

BODAS Controller RC Series 21

RE 95201/02.12 1/16
Replaces: 03.09

Data sheet

For closed- and open-loop control
of hydraulic components



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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
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Version

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

Series

03	Series 2, index 1	21
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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 95112) 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 test box TB3

The BODAS test box TB3 (RE 95092) is used for simulating vehicle and equipment functions for development and test purposes with BODAS controllers. The BODAS test box TB3 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 Bosch 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.

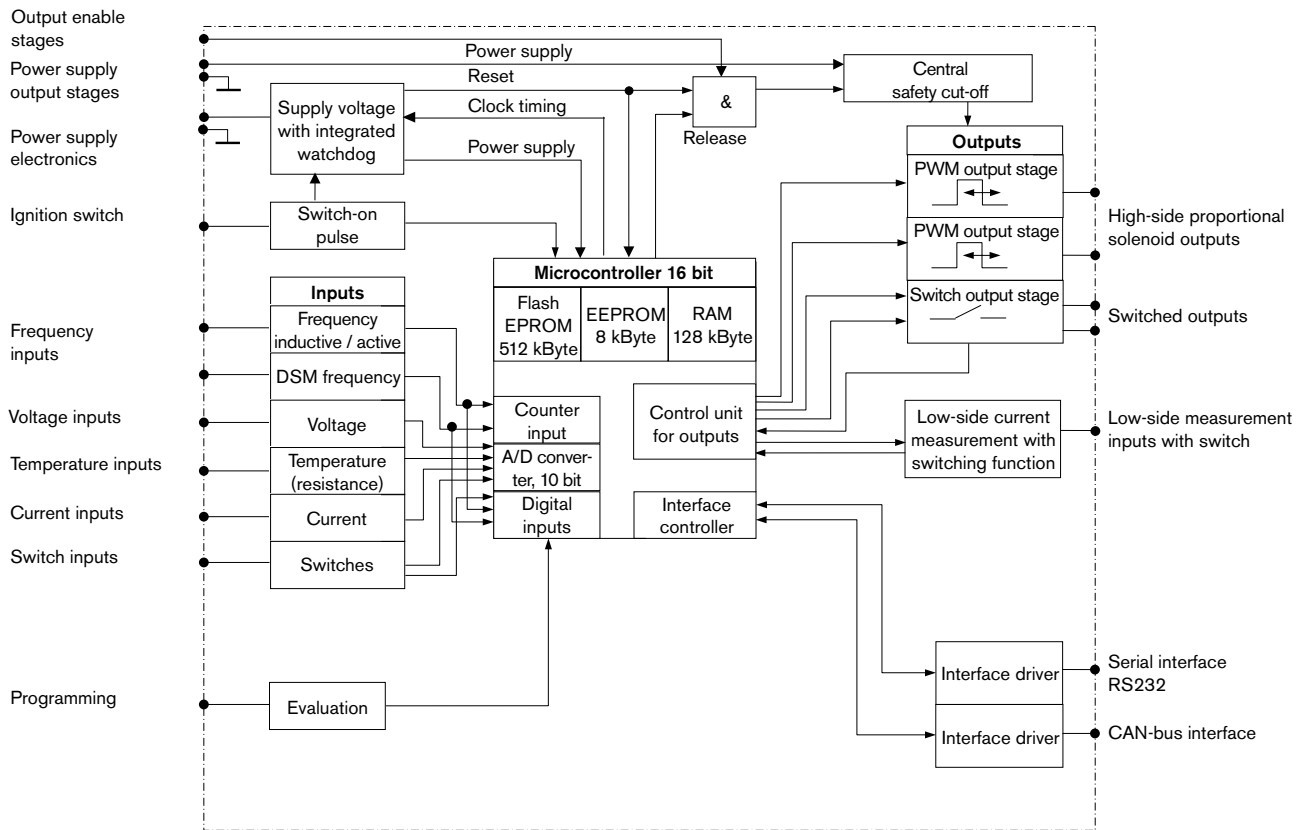
CAN-bus interfaces are available with all BODAS controller RC for exchanging data with other bus users or electronic systems (e.g. RC or RCE, joystick valves, diesel engine injection, display). The CAN-bus interfaces can each be operated with different protocols.

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 Bosch Rexroth, BODAS controllers RC and corresponding software can be used to create complete system solutions.

Block circuit diagram

Controller



Technical data

Controller RC		2-2
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, maximum	mA	150
With load, maximum	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 k Ω	5 V \pm 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 input⁵⁾		
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. Except GND, sensor GND, constant voltage sources, resistance (temperature) inputs and CAN interfaces against battery voltage.

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.

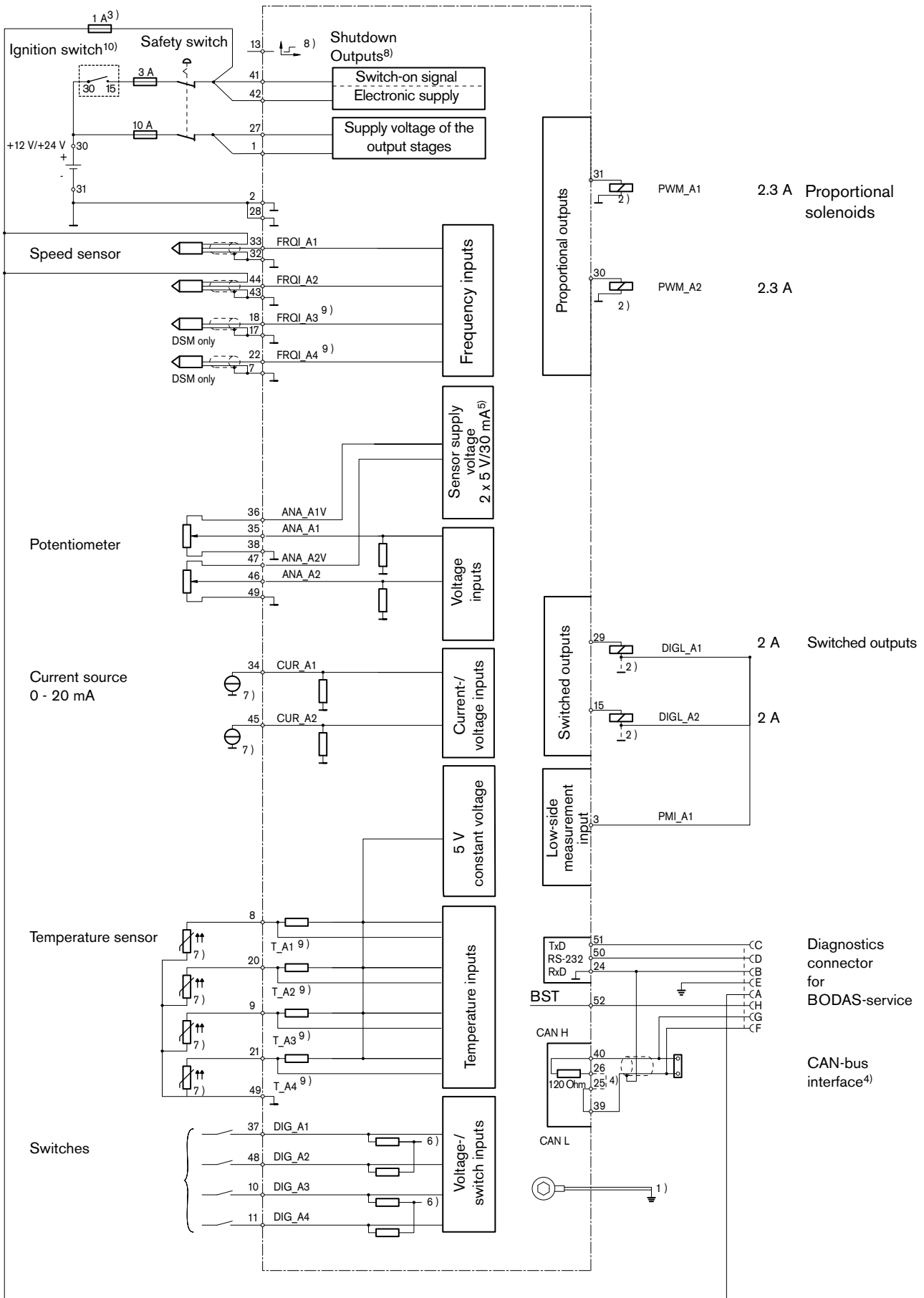
6) Load 484 Ω . Can be switched by means of software to 22 k Ω .

Technical data

Controller RC		2-2
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	-

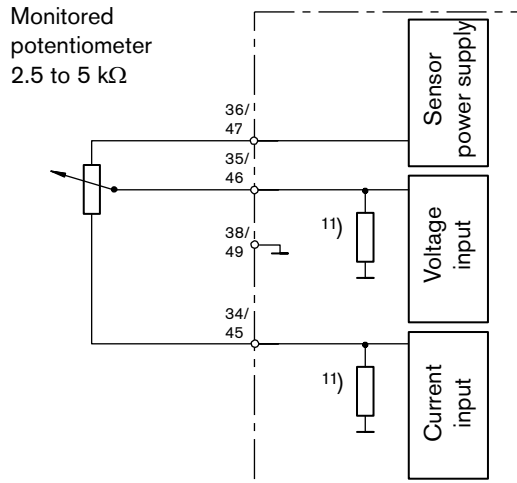
1) Taking installation notes into account

Connection diagram RC2-2



See next page for footnotes

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

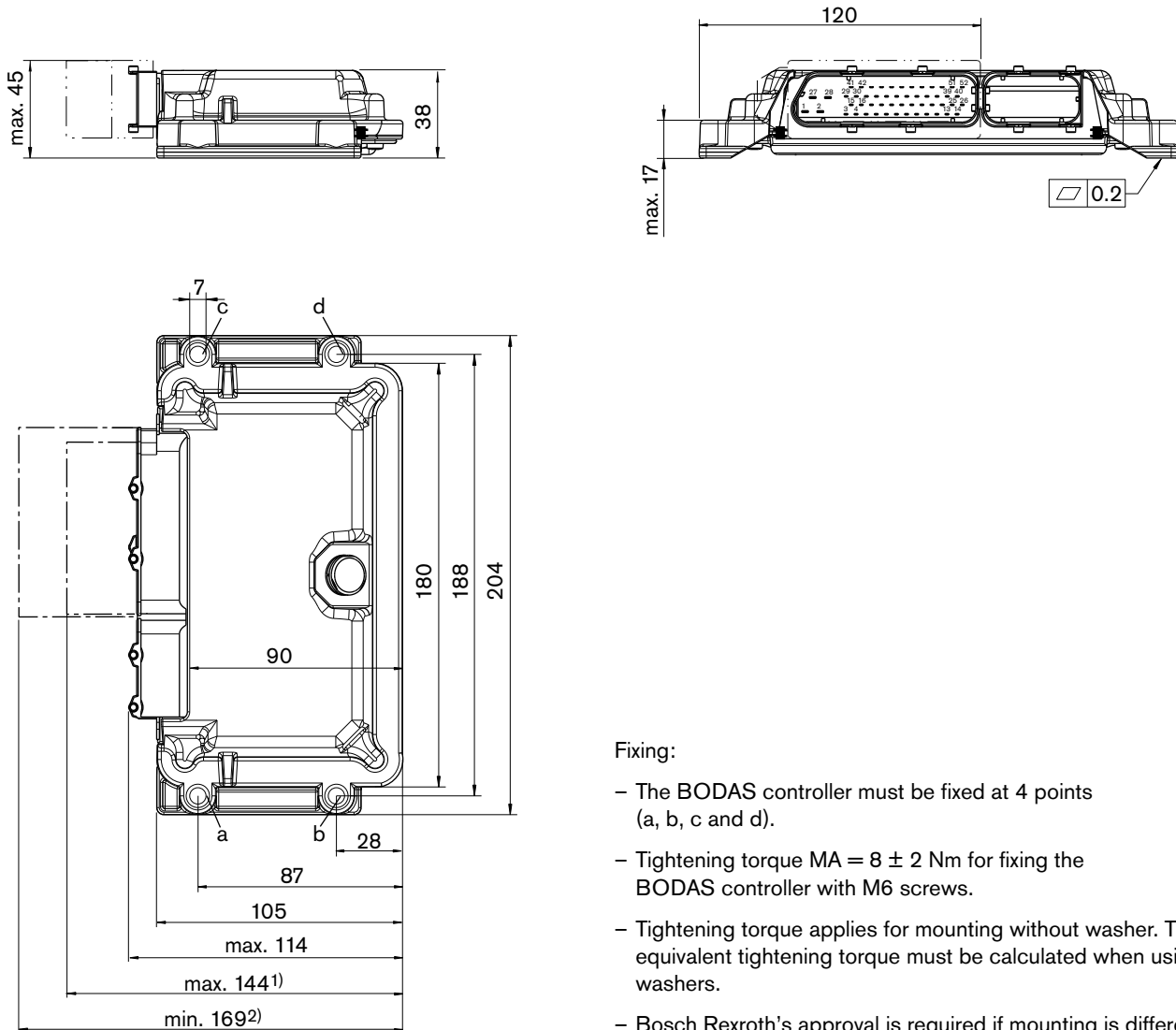
Pin	Description	Main function	Alternative functions
37, 48, 10, 11	Digital input with selectable pull-up/ pull-down after 5 V / GND Pull-up/pull-down swit- ched in 2 groups: DIG_A1... DIG_A2, DIG_A3... DIG_A4	Digital input Threshold, programmable via software Pull-up / pull-down resistance switchable 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 FRQI_A1 ... FRQI_A2	Frequency input for inductive and active sensors type PNP and NPN (e.g. HDD1) Frequency evaluation up to 10 kHz Input resistance 115 kΩ	Digital input Evaluation options • Threshold programmable via software
18, 22	DSM frequency input FRQI_A3 ... FRQI_A4	Frequency input for Bosch Rexroth DSM sensors Frequency evaluation including addi- tional 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 NPN sensors (e.g. HDD1) Frequency evaluation of active speed sen- sors 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 ANA_A1 ... ANA_A2	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) CUR_A1 ... CUR_A2	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 T_A1 ... T_A4	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 PWM_A1 ... PWM_A2	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 DIGL_A1 ... DIGL_A2	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 PMI_A1	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 ANA_A1V	Sensor supply Output voltage 5.0 V Precision 5% Load capacity 30 mA	
47	Sensor supply ANA_A2V	Sensor supply Output voltage 5.0 V Precision 5% Load capacity 30 mA	
13	Output enable¹⁾ INH	Digital input Levels ≥ 5 V cause output stages to be blocked Input resistance DC to GND 20 k Ω	
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	
52	BST	Boot strap for flashing via RS232 with BODAS Flash adapter FA1	

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

Dimensions RC2-2



Fixing:

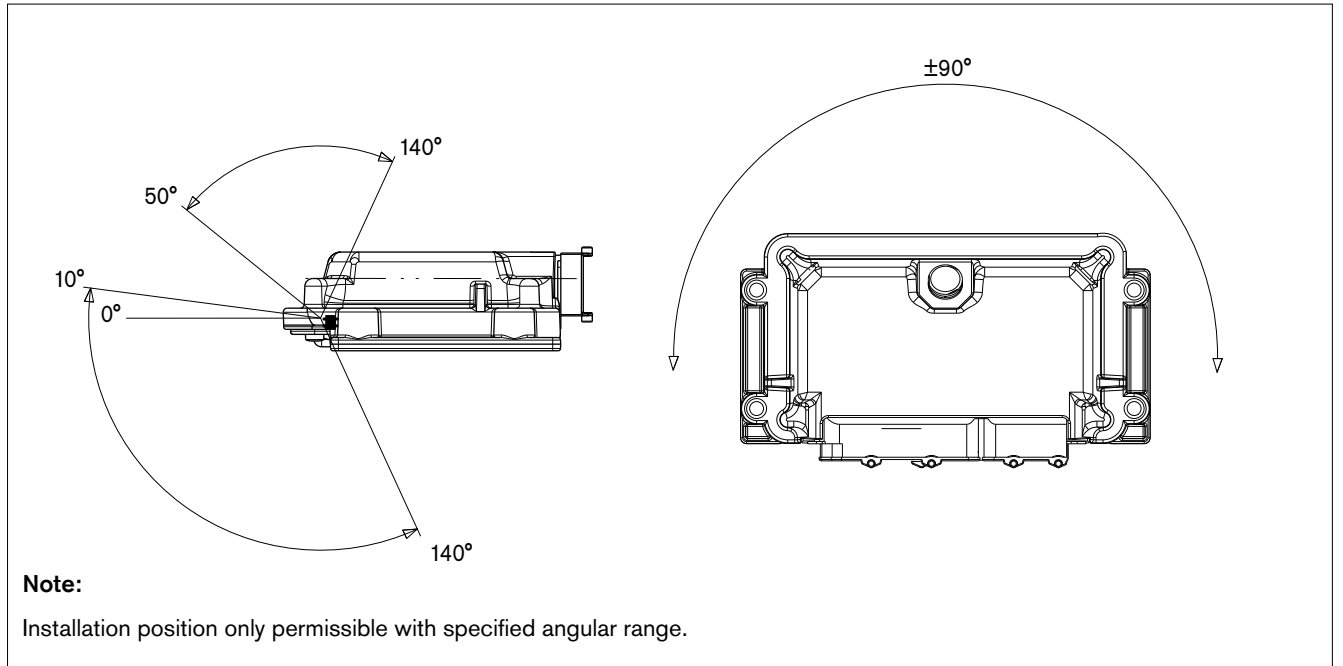
- The BODAS controller must be fixed at 4 points (a, b, c and d).
- Tightening torque $MA = 8 \pm 2$ Nm for fixing the BODAS controller with M6 screws.
- Tightening torque applies for mounting without washer. The equivalent tightening torque must be calculated when using washers.
- Bosch Rexroth's approval is required if mounting is different from above.
- Installation point: evenness of mounting surface $\nabla 0.5$
- 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



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 Bosch 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

Tools needed

Tyco AMP order numbers for crimping and extractor tools

For crimping

Description	Partlist number	For connection
Hand-held crimping tool	169 400-0	
Insert	539 612-1	MT-2 (Micro Timer)
Insert	539 614-1	JPT (Junior Power Timer)

For disassembly

Description	Partlist number	For connection
Extractor tool	539960-1	MT-2 (Micro Timer)
Extractor tool	1-1579007-6	JPT (Junior Power Timer)

Applicable documents

- Applicable Tyco AMP specification No.: 114-18081
This document contains the recommended crimping data and crimping tools for Micro Timer contacts, model MT2.
- Applicable Tyco AMP specification No.: 114-18050
This document contains the recommended crimping data and crimping tools for Junior Power Timer contacts, model JPT.

Safety instructions

General instructions

- Reliable operation cannot be guaranteed if samples or prototypes are used in series production machines.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- Incorrect connections could cause unexpected signals at the outputs of the controller.
- Incorrect programming or parameter settings on the controller may create potential hazards while the machine is in operation. It is the responsibility of the machine manufacturer to identify hazards of this type in a hazard analysis and to bring them to the attention of the end user. Bosch Rexroth assumes no liability for dangers of this type.
- The component firmware/software must be installed and removed by Bosch Rexroth or by the authorized partner concerned in order to uphold the warranty.
- It is not permissible to open the controller or to modify or repair the controller. Modification or repairs to the wiring could result in dangerous malfunctions.
Repairs to the controller may only be performed by Bosch Rexroth or by an authorized partner.
- To switch off the system in emergencies, the safety switch may be used. The switch must be in an easily accessible position for the operator. The system must be designed in such a way that safe braking is ensured when the outputs are switched off.
- When the electronics is not energized no pins must be connected to a voltage source. Thus, when the current supply is switched off, the supply for the electronics, the power outputs and the external sensor supply have to be switched off together.
- Make sure that the controller's 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.
- 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 both the components used and the complete system.
- While commissioning and maintenance the controller (with BODAS Tools) the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- No defective or incorrectly functioning components may be used. If the components should fail or demonstrate faulty operation, repairs must be performed immediately.
- Controller used to develop software may only be installed in series production machines if it can be guaranteed that these controller have not been flash-programmed with new software more than 500 times. Controller that have been programmed more than 1000 times are not to be installed in series production machines!

Notes on the installation point and position

- Do not install the controller close to parts that generate considerable heat (e.g. exhaust).
- Radio equipment and mobile telephones must not be used in the driver's cab without a suitable antenna or near the control electronics.
- A sufficiently large distance to radio systems must be maintained.
- All connectors must be unplugged from the electronics during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the device.
- The controller must not be electrostatically charged, e.g. during painting operations.
- The controller will heat up beyond normal ambient temperature during operation. To avoid danger caused by high temperatures, it should be protected against contact.
- Install the control unit in such a way that the electrical plug is facing downwards. This ensures that any condensation water that may form can flow out.
- Standing and permanently running water are not permitted anywhere near the circumferential groove (lid/base connector) or the pressure balance element (DAE).
- The case must be wired to vehicle ground in order to comply with EMC guidelines. Metallic screws are used to create a connection to vehicle ground.

Safety instructions

Notes on transport and storage

- If it is dropped, the controller must not be used any longer as invisible damage could have a negative impact on reliability.
- Control units must be stored with a mean relative humidity of 60% and at a temperature between -10 °C and +30 °C. Storage temperatures between -20 °C and +40 °C are briefly permissible, for up to 100 hours.
- After a storage time of more than 5 years, the controller must be examined by the manufacturer.

Notes on wiring and circuitry

- The electronics and the power outputs of a controller must be fed from the same power source.
- 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.
- Lines to the speed sensors are so short as possible and be shielded. The shielding must be connected to the electronics on one side or to the machine or vehicle ground via a low-resistance connection.
- The product may only be wired when it is de-energized.
- Lines to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- 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 so that in-phase excitation with the controller occurs (e.g. at the controller bolting point).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.
- Lines are to be routed with sufficient spacing to hot or moving vehicle parts.
- PWM outputs must not be linked or bridged.
- Proportional outputs (PWM_A1, PWM_A2, PMI_A1) must not be used to power lamps.
- The sensor supplies can be „pulled up“ by external connection, e.g., the application of a higher voltage, because they operate only as a voltage source but not as a voltage sink! Pulling up a sensor supply may result in unexpected malfunctions and damage of the controller in lasting operation.
- The „high side“ outputs may not be externally connected to battery.

Note on proportional and switching solenoids and other wired inductive consumers

- The proportional solenoids must not be wired with spark-suppression diodes.
- Switching solenoids at the outputs of the control unit do not need to be connected to spark-suppression diodes.
- The electronics may only be tested with the proportional solenoids connected.
- Other inductive loads that are in the system but not connected to the controller must be connected to spark-suppression diodes. This applies to relays (e.g. for de-energizing the controller) that have the same supply as the controller, too.

Intended use

- The controller 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 must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, current, 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 mobile working machine.

Improper use

- Any use of the controller other than that described in chapter „Intended use“ is considered to be improper.
- Use in explosive areas is not permissible.
- Damage resulting from improper use and/or from unauthorized interference in the component not described in this data sheet render all warranty and liability claims void with respect to the manufacturer.

Safety instructions

Use in functions relevant to safety

- The customer is responsible for performing risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking suitable measures for ensuring safety (sensor redundancy, plausibility check, emergency switch, etc.)
 - For example, a suitable assignment of input variables (e.g. by connecting the acceleration pedal signal to two independent analog inputs) can be used to detect faults and to activate specially programmed reactions.
 - Special measures may be initiated if the plausibility check shows deviations between the setpoint values and the values read back by the microcontroller.
- Product data that is necessary to assess the safety of the machine can be provided on request or are listed in this data sheet.
 - For all control units, the notes found in the API description and in the online help section of BODAS must be observed.

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 decentrally switches off the power supply of all proportional and switched outputs when there are malfunctions in the program run.

Further information

- In addition, the application-specific documents (connection diagrams, software descriptions, etc.) are to be observed.
- More detailed information on BODAS controllers may be found at www.boschrexroth.com/mobile-electronics.

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Subject to change.