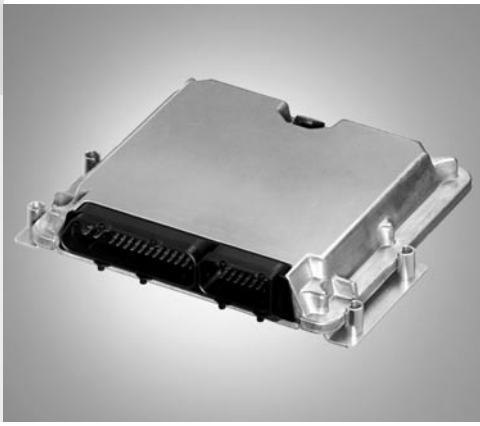
Rexroth
Bosch Group

BODAS
Controller RC
Series 22

RE 95202/02.12 **1**/18
Replaces: 03.09

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
- CAN-bus interface for diagnostics, parameter setting and display of process variables
- Supply voltage and ground connections for potentiometers and sensors

Ordering code

RC		/	22
01	02		03

Type

01	BODAS controller	**RC**

Version

02	1st digit = no. of proportional outputs 2nd digit = no. of switched outputs	**4-6** **8-8** **12-8**

Series

03	Series 2, index 2	**22**

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 TAK2/10.

– **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.

CAN channel 1 can be used for all CAN protocols except for CANopen. For regular CAN communication in the vehicle, e.g. for diesel via J1939, the diagnostics and service functions always run on this channel via BODAS-design and BODAS-service. CAN channel 2 is the CANopen channel, which can also be used for all CAN protocols except for diagnostics.

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.

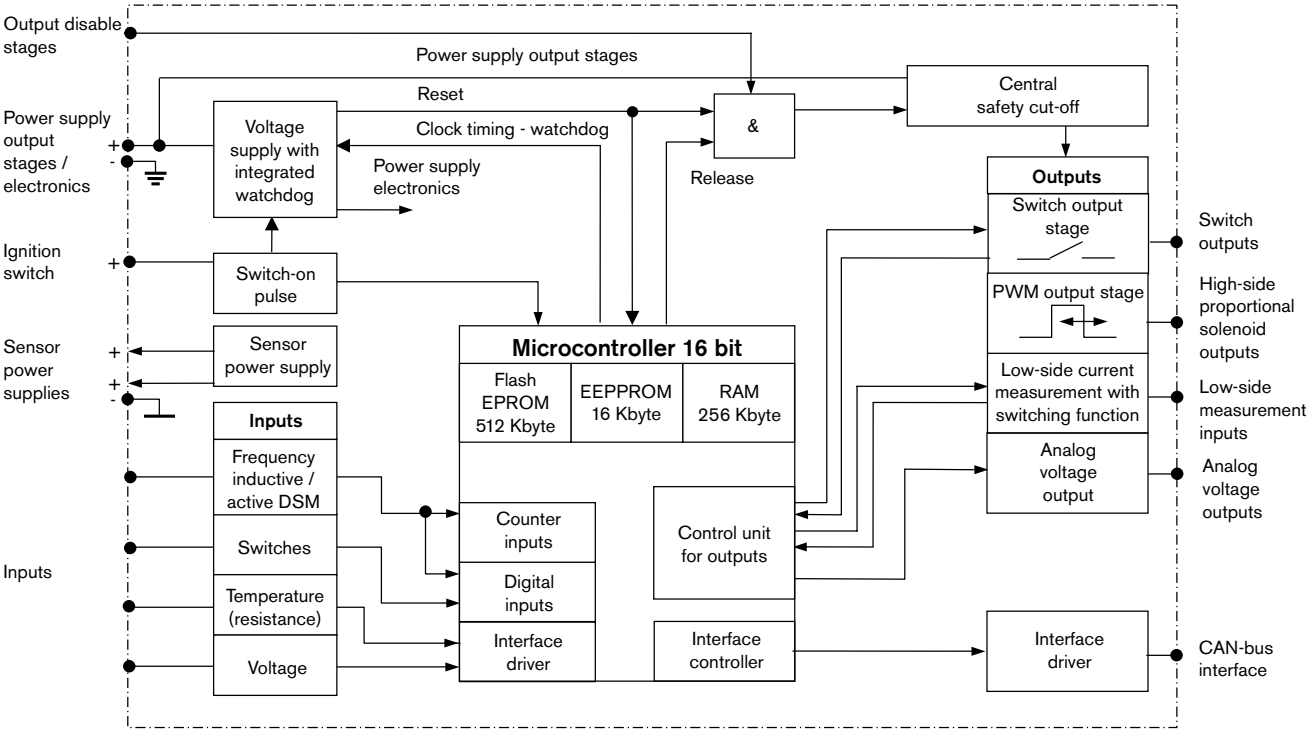
BODAS standard programs are available for the BODAS controller RC software. If more extensive functions are required, special program packages for specific applications can also be compiled using a program library and adapted to the application in question with the aid of service tools. Programming with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

Note:
The block circuit diagram applies for controllers RC4-6, RC8-8, RC12-8.



Technical data

Controller RC		4-6	8-8	12-8
Nominal voltage	12 and 24 V	✓	✓	✓
Residual ripple (DIN 40839, Part 1)	max. ± 2 V	✓	✓	✓
Supply voltage, permitted range	8 - 32 V	✓	✓	✓
Current consumption				
Without load, maximum	mA	500	500	500
With load, maximum	A	16	18	18
Fuse				
Internal:		–	–	–
External:	AT	20	20	20
Constant voltage sources				
E.g. for setpoint potentiometer 1 - 5 kΩ	5 V ± 0.1 V			
With voltage monitoring:	200 mA	1	1	1
Constant voltage sources				
E.g. for setpoint potentiometer 1 - 5 kΩ	8 V ± 0.4 V			
With voltage monitoring:	200 mA	1	1	1
Analog voltage inputs				
(May also be used as a switch input)[1]	0 - 5 V	8	10	11
	0 - 8 V	2	2	4
Resistor inputs[6]				
E.g. for temperature sensors	900 Ω - 1800 Ω	2	2	2
Switch inputs				
High active	low < 1.5 V; high > 4.5 V	6	8	9
Input resistance to GND	10 kΩ			
Low active	low < 1.5 V; high > 4.5 V	–	–	2
Input resistance to V_CC	10 kΩ			
Frequency inputs				
Inductive	0 - 10 kHz 1 - 100 V_{RMS}	1	1	1
DSM[5]	0 - 13.5 kHz	2	4	4
Proportional solenoid outputs (PWM)				
Current range	0 - 2.3 A			
Adjustable dither frequency	66 - 250 Hz	4	8	12
Control frequency	1 kHz	4	6	6
	500 Hz	–	2	6
Low-side measurement inputs[4]	0 - 2.5 A	3	4	6
Switched outputs				
Low-side switch	max. 3 A	0	2	2
High-side switch	max. 2 A	4	4	4
Low-side switch	max. 0.2 A	2	2	2
Signal outputs				
High-side switch	max. 10 mA	1	2	2
Analog voltage outputs	0 - 5 V I_OUT_max = 5 mA Ripple max. ± 100 mV	1	1	1
	0 - 10 V I_OUT_max = 5 mA Ripple max. ± 100 mV	–	1	1
Interfaces				
CAN 2.0 B	ISO 11898	2	2	2
Fault detection for cable break and short circuit				
Analog inputs		✓	✓	✓
Proportional solenoid outputs		✓	✓	✓
Protection against short circuit of the inputs and outputs				
Against supply voltage and ground[2]		✓	✓	✓
Reverse-connect protection				
Power supply / battery[3]		✓	✓	✓

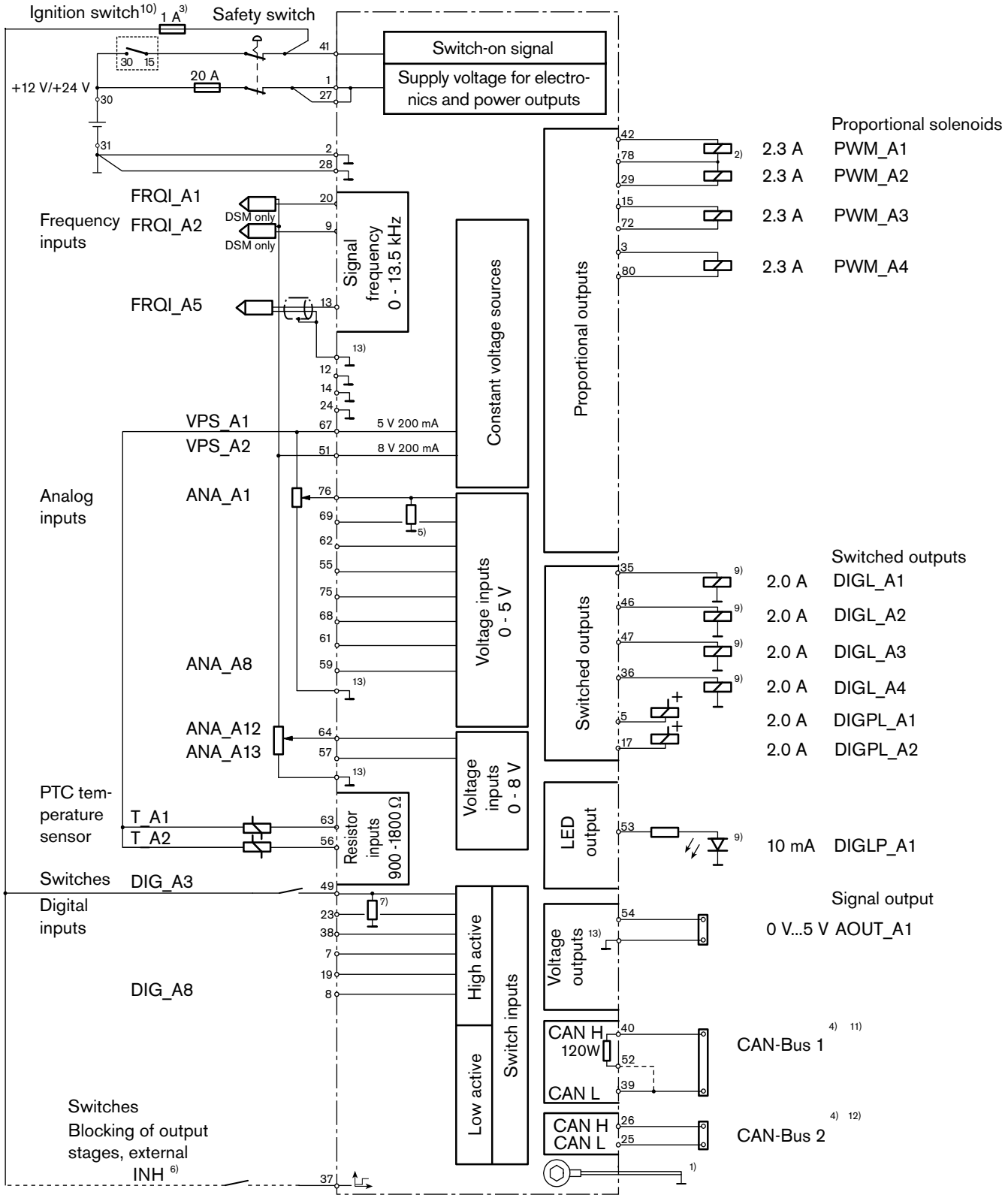
1) Switchable with supply voltage
2) Voltages greater than those applied to supply pins 1, 27, 41 must not be applied to the outputs. Except GND, sensor GND, constant voltage sources, resistance (temperature) inputs and CAN interfaces against battery voltage.
3) The external fuse trips in the event of voltage reversa
4) When using as a switching function, the notes in the respective, applicable software description (API) are to be observed.
5) Signal frequency corresponds to twice the tooth pulsation frequency on the DSM sensor
6) The resistor inputs are not continuously protected against short circuits to a battery voltage > 12 V.

Technical data

Controller RC		4-6	8-8	12-8
Microcontroller		C167CS	C167CS	C167CS
Clock frequency	MHz	40	40	40
Memory capacities				
RAM	Kbyte	256	256	256
Flash EPROM	Kbyte	512	512	512
EEPROM	Kbyte	16	16	16
Software installation Download to flash memory		✓	✓	✓
Electromagnetic compatibility				
Spurious interference (motor vehicles directive 2004/104/EC)	100 V_{RMS}/m; (details on request)	✓	✓	✓
Line-bound interference (ISO 7637-1/-2/-3)	Values on request	✓	✓	✓
Load dump	70 V	✓	✓	✓
Max. dissipation power	W at 32 V	8.0	8.25	8.25
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)	Values on request	✓	✓	✓
Random-shaped vibration (IEC 60068-2-64, ISO 16750-3)	Values on request	✓	✓	✓
Shock resistance:				
Transport shock (IEC 60068-2-27)	15 *g*; 11 ms per spatial axis x, y, z and 6 x 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 / IP65	✓	✓	✓
Case material	Diecast aluminum	✓	✓	✓
Weight	Approx. kg	0.7	0.7	0.7
Outer dimensions	Length (in mm)	187	187	187
	Width (in mm)	202	202	202
	Height (in mm)	45	45	45
Mating Connector	52-pin	1	1	1
	28-pin	1	1	1

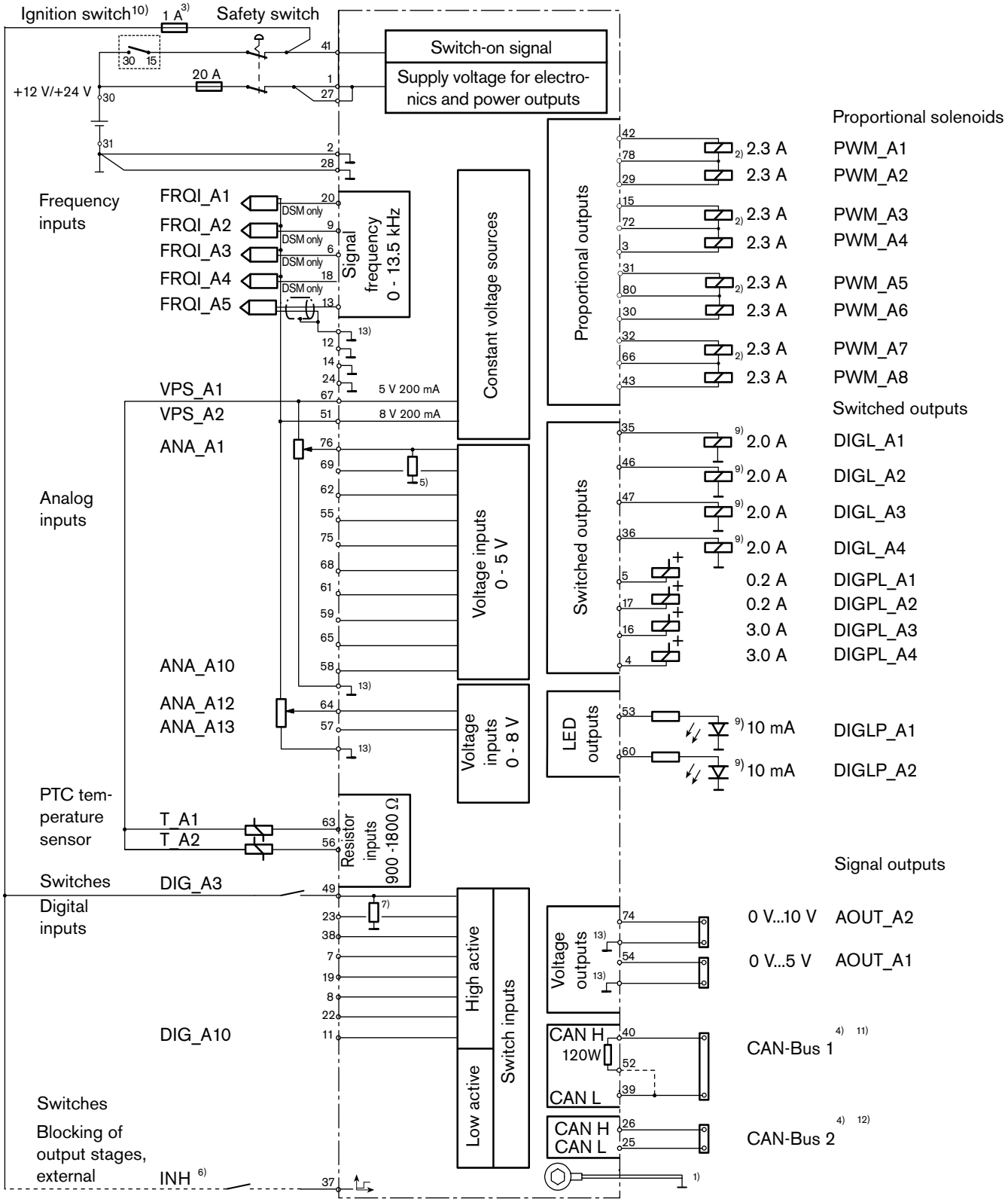
1) Taking installation notes into account

Connection diagram RC4-6



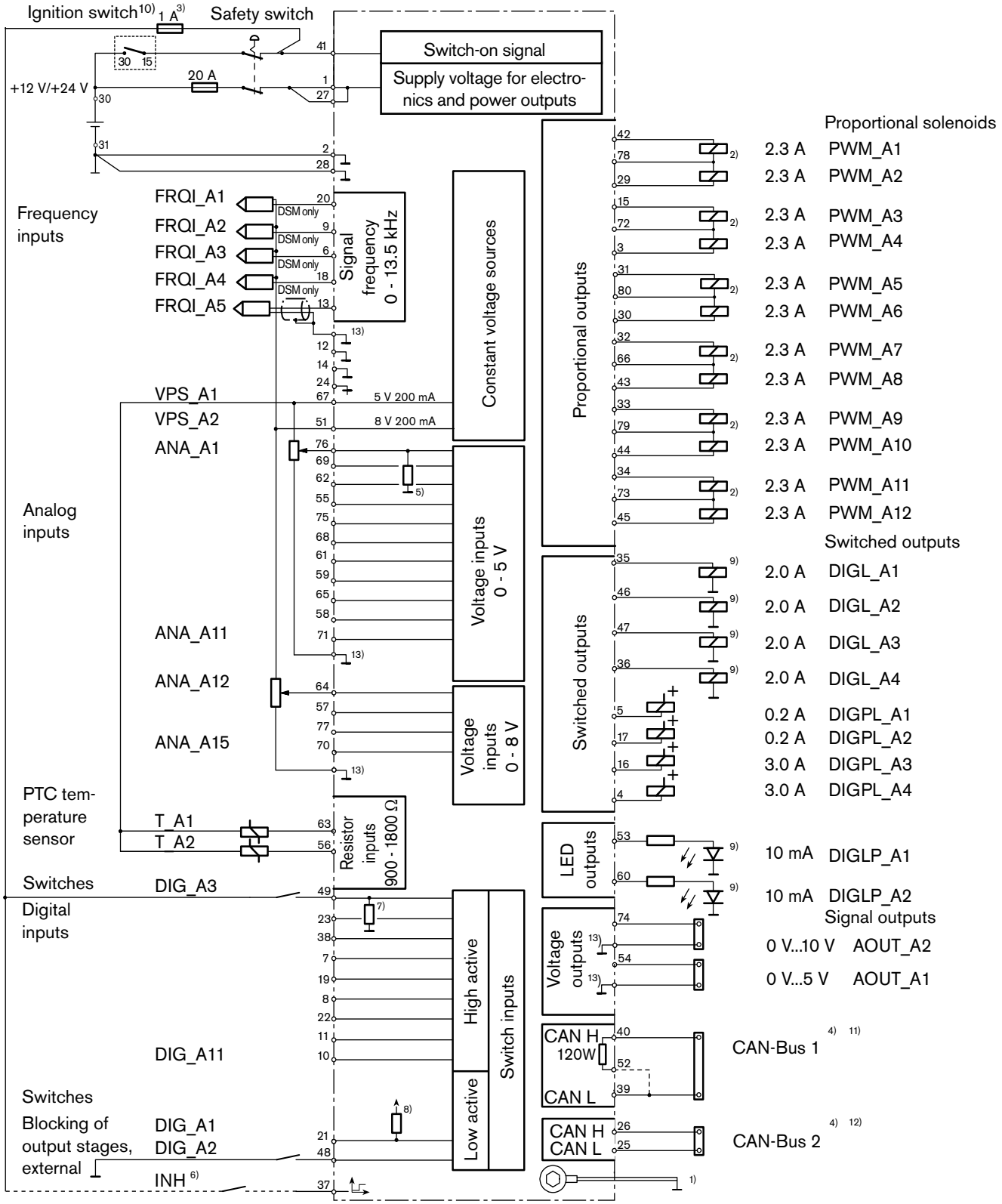
1) Short, low-resistance connection from a case screw to the device ground or vehicle ground
2) Common return line to controller for each pair of solenoids
3) Separate fuses for switches and sensors necessary
4) CAN bus: termination resistor 120 Ω necessary
5) All voltage inputs with pull-down as shown for pin 76
6) Block the output stages levels ≥ 5 V (proportional and switched outputs); R_IN_GND = 10 kΩ, I_OUT_max = 7.5 mA
7) All high-active switch inputs with internal pull-down as shown for pin 49
8) All low-active switch inputs with internal pull-up as shown for pin 21
9) Separate ground connection from solenoid return line to battery (chassis possible)
10) The terminals are labeled according to DIN 72 552. This does not apply for the controller.
11) Diagnostic port, any CAN protocols possible with exception of CANopen
12) CANopen port, any CAN protocols possible with exception of KWP and diagnostics.
13) Use pins 12, 14 or 24 as signal ground for analog and frequency signals.

Connection diagram RC8-8



1) Short, low-resistance connection from a case screw to the device ground or vehicle ground
2) Common return line to controller for each pair of solenoids
3) Separate fuses for switches and sensors necessary
4) CAN bus: termination resistor 120 Ω necessary
5) All voltage inputs with pull-down as shown for pin 76
6) Block the output stages levels ≥ 5 V (proportional and switched outputs)
7) All high-active switch inputs with internal pull-down as shown for pin 49.
8) All low-active switch inputs with internal pull-up as shown for pin 21.
9) Separate ground connection from solenoid return line to battery (chassis possible)
10) The terminals are labeled according to DIN 72 552. This does not apply for the controller.
11) Diagnostic port, any CAN protocols possible with exception of CANopen
12) CANopen port, any CAN protocols possible with exception of KWP and diagnostics.
13) Use pins 12, 14 or 24 as signal ground for analog and frequency signals.

Connection diagram RC12-8



1) Short, low-resistance connection from a case screw to the device ground or vehicle ground
2) Common return line to controller for each pair of solenoids
3) Separate fuses for switches and sensors necessary
4) CAN bus: termination resistor 120 Ω necessary
5) All voltage inputs with pull-down as shown for pin 76
6) Block the output stages levels ≥ 5 V (proportional and switched outputs)
7) All high-active switch inputs with internal pull-down as shown for pin 49.
8) All low-active switch inputs with internal pull-up as shown for pin 21.
9) Separate ground connection from solenoid return line to battery (chassis possible)
10) The terminals are labeled according to DIN 72 552. This does not apply for the controller.
11) Diagnostic port, any CAN protocols possible with the exception of CANopen
12) CANopen port, any CAN protocols possible with the exception of KWP and diagnostics
13) Use pins 12, 14 or 24 as signal ground for analog and frequency signals.

Overview of functions

Pin	Description	Main function	Alternative functions
21, 48[1)]	**Digital input** DIG_A1, DIG_A2	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to V_CC 10 kΩ	
49, 23, 38, 7, 8	**Digital input** DIG_A3 - DIG_A6, DIG_A8	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to GND 10 kΩ	**Frequency input for active sensors of type PNP** Frequency evaluation of active speed sensors which switch to plus. Limit frequency filter 7.4 kHz **Pulse/pause measurement** (pulse duty factor) of a PWM signal. **Pulse counter measurement** with detection of count direction (does not apply to DIG_A8)
19, 22, 11, 10[1)]	**Digital input** DIG_A7, DIG_A9 - DIG_A11	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to GND 10 kΩ	
20, 9, 6, 18[1)]	**DSM frequency input** FRQI_A1 - FRQI_A4	**Frequency input for Bosch Rexroth DSM sensors** Frequency evaluation including additional information such as direction of rotation and error monitoring up to signal frequency 13.5 kHz (max. tooth pulsation frequency 6.5 kHz) Short-circuit resistant. In the event of overload (U_in > 6 V) the inputs are switched off.	
13	**Inductive frequency input** FRQI_A5	**Frequency input for inductive sensors** Frequency evaluation up to 10 kHz 1…100 V_{RMS}	**Digital input switching to GND** Switching thresholds ´0.7 V / 4.5 V Input resistance DC to battery voltage 10 - 40 kΩ
76, 69, 62, 55, 75, 68, 61, 59, 65, 58, 71[1)]	**Analog voltage input** ANA_A1 - ANA_A11	**Analog voltage input** Measuring range 0 - 5 V Resolution 10 bit (5.4 mV) Input resistance DC to GND 110 kΩ Limit frequency filter 300 Hz	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to GND 110 kΩ
64, 57, 77, 70[1)]	**Analog voltage input** ANA_A12 - ANA_A15	**Analog voltage input** Measuring range 0 - 8 V Resolution 10 bit (8.6 mV) Input resistance DC to GND 119 kΩ Limit frequency filter 35 Hz	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to GND 119 kΩ
63, 56	**Temperature input** T_A1, T_A2	**Temperature measurement by means of resistance measurement of connected Bosch temperature sensors** Evaluation of passive temperature sensors with PTC measuring resistors 900 - 1800 Ω	

1) Pins not available on all controllers

Overview of functions

Pin	Description	Main function	Alternative functions
42, 29, 15, 3, 31, 30[1]	**PWM output stage** PWM_A1 - PWM_A6	**PWM output stage** High-side switch, PWM frequency 1 kHz, dither frequency programmable via software Integrated suppression diode for inductive kickback Max. current 2.3 A Pulse duty factor 0 - 95% Current measurement accuracy, approx. 3 %	**Switch output stage** Diagnostics-compatible Actuated time 95%
32, 43, 33, 44, 34, 45[1]	**PWM output stage** PWM_A7 - PWM_A12	**PWM output stage** High-side switch, PWM frequency 500 Hz, dither frequency programmable via software Integrated suppression diode for inductive kickback Max. current 2.3 A Pulse duty factor 0 - 100%	**Switch output stage** Diagnostics-compatible Actuated time 100%
35, 46, 47, 36	**Switch output stage** DIGL_A1 - DIGL_A4	**Switch output stage** High-side switch Integrated suppression diode for inductive kickback Max. current 2.0 A	
78, 72	**Analog current input** PWMMI_A1, PWMMI_A2	**Analog current measurement input** Measuring range 0 - 2.5 A Load 100 mΩ Resolution 10 bit (2.6 mA) Limit frequency filter 250 Hz	**Digital input** Switching thresholds 0.5 V / 4.5 V Input resistance DC to GND 193 kΩ
80, 66, 79, 73[1]	**Analog current input** PWMMI_A3 - PWMMI_A6	**Analog current measurement input** Measuring range 0 - 2.5 A Load 100 mΩ Resolution 10 bit (2.6 mA) Limit frequency filter 250 Hz	**Digital input** Switching thresholds 0.5 V / 4.5 V Input resistance DC to GND 157 kΩ **Switch output stage**[2] Low-side switch Integrated spark-suppression diode for switching inductivity Max. current 2.5 A
54	**Analog voltage output** AOUT_A1	**Analog voltage output** Voltage range 0 - 5 V Resolution 10 bit (4.9 mV) Load capacity 5 mA	
74[1]	**Analog voltage output** AOUT_A2	**Analog voltage output** Voltage range 0 - 10 V Resolution 10 bit (9.8 mV) Load capacity 5 mA	

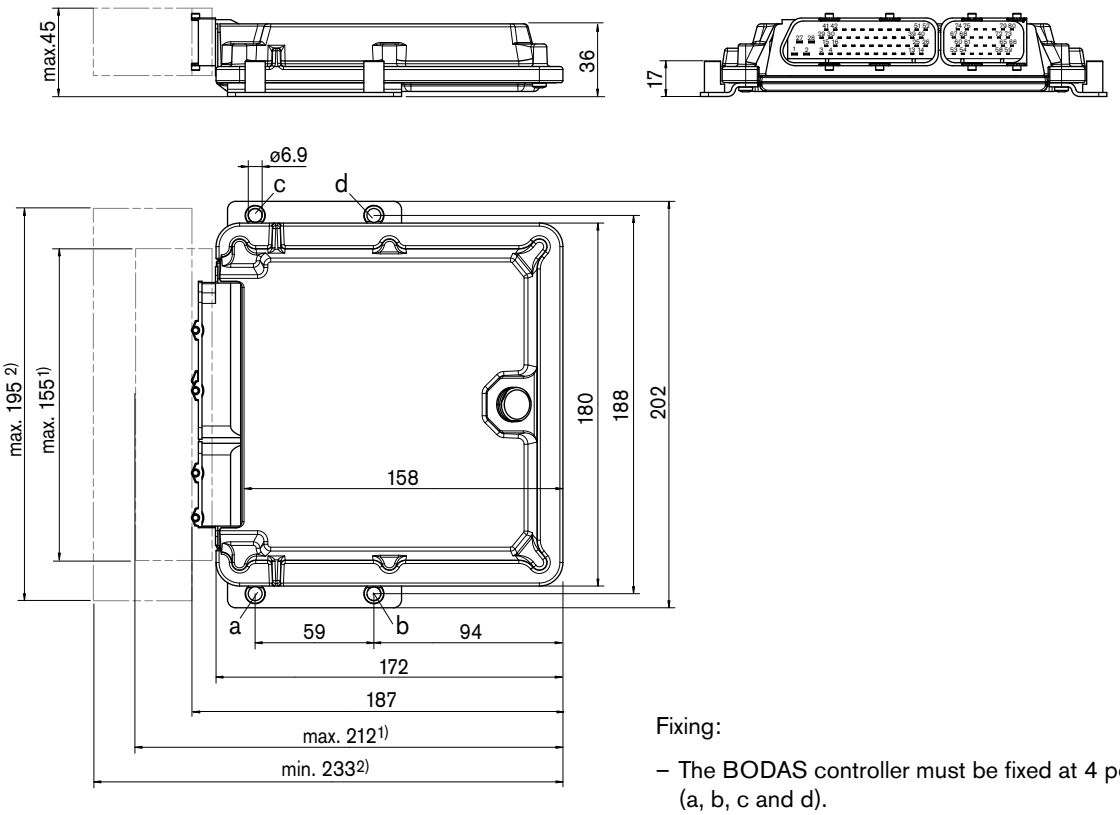
1) Pins not available on all controllers
2) The switch output stage is not suitable for the connection of glow lamps.

Overview of functions

Pin	Description	Main function	Alternative functions
5, 17	**Switch output stage** DIGPL_A1, DIGPL_A2	**Switch output stage** Low-side switch Integrated suppression diode for inductive kickback Max. current 200 mA	**PWM output stage** Low-side switch Integrated suppression diode for inductive kickback PWM frequency programmable via software Pulse duty factor 0 - 100% **Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to battery voltage 4.64 kΩ
16, 4[1)]	**Switch output stage** DIGPL_A3, DIGPL_A4	**Switch output stage** Low-side switch Integrated suppression diode for inductive kickback Max. current 3.0 A	**PWM output stage** Low-side switch Integrated suppression diode for inductive kickback PWM frequency programmable via software Pulse duty factor 0 - 100% **Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to battery voltage 4.64 kΩ
53, 60[1)]	**Signal output** DIGLP_A1, DIGLP_A2	**Signal output** High-side switch Max. current 10 mA	**Digital input** Switching thresholds 1.5 V / 4.5 V Input resistance DC to GND: 10 kΩ
67	**Sensor supply** VPS_A1	**Sensor supply** Output voltage 5.0 V Precision 2% Load capacity 200 mA	
51	**Sensor supply** VPS_A2	**Sensor supply, can be switched off** Output voltage 8.0 V Precision 5% Load capacity 200 mA	
37	**Output enable**[2)] DIG_INH	**Digital input** Levels ≥ 5 V cause output stages to be blocked Input resistance DC to GND 10 kΩ	
40, 39, 52	**CAN interface** CAN1_H, CAN1_T, CAN1_L	**CAN interface** CAN 2.0B, 1 Mbaud Termination resistor 120 Ω (through connection of CAN1_T and CAN1_L)	
26, 25	**CAN interface** CAN2_H, CAN2_L	**CAN interface** CAN 2.0B, 1 Mbaud Internal termination resistor not present	

1) Pins not available on all controllers
2) Independent input for release/shutdown of power outputs.

Dimensions RC4-6, RC8-8, RC12-8



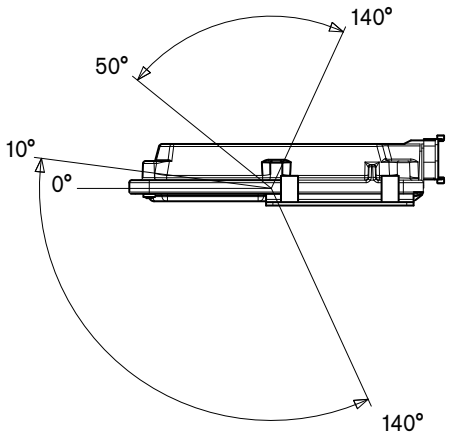
Fixing:

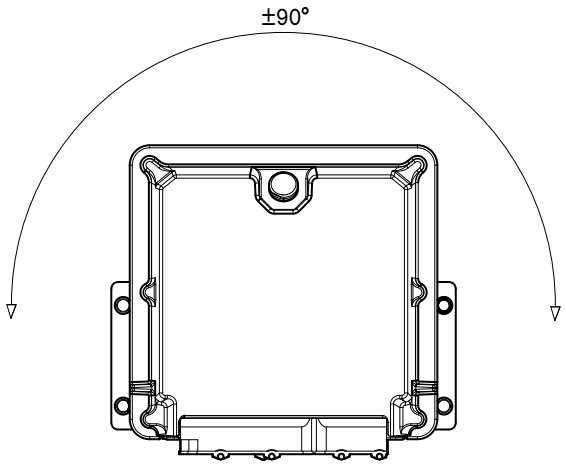
- The BODAS controller must be fixed at 4 points (a, b, c and d).
- Tightening torque MA = 8 ± 2 Nm for fixing the BODAS controller with M6 screws.
- Tightening torque applies for mounting without washer. The equivalent tightening torque must be calculated when using washers.
- Bosch Rexroth's approval 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	Number for AMP-Tyco MT2/JPT 28-pin ID No R902602415
Junior-Power-Timer-contacts	0-0964285-2	4	–
Single-wire seals JPT	0-0963293-1	4	–
Micro-Timer-2 contacts	0-0964275-2	48	28
Single-wire seals MT2	0-0964972-1	48	28
Basic unit MT2/JPT; 52-pin	0-1393450-3	1	–
Basic unit MT2; 28-pin	0-1393436-2	–	1
Cover	0-1393454-7	1	–
Cover	0-1393454-2	–	1
Leakage dummy plugs F.D3,6-MT2	0-0963531-1	40	–

The mating connectors are not included in supply.

The mating connectors are available from Bosch Rexroth as a kit with all materials under the following material numbers.

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

– Mating connector kit 28-pin: Mat. no. R902602415

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 should 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.
- Analog current measurement inputs respectively low side switch outputs with current measurement (PWMMI_Ax) 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-engergizing 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 design 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 controller may be found at www.boschrexroth.com/mobile-electronics.

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