Rexroth
Bosch Group

BODAS
Controller RC
Series 30

RE 95204/02.12 1/24
Replaces: 03.11

Data sheet

RC28-14/30 ■
RC20-10/30 ■
RC12-10/30 □

For the closed and open loop control of hydraulic components

Contents

Features

- High performance thanks to ultra-modern 32-TriCore technology with 180 MHz
- Component of BODAS system for mobile applications
- Robust design meeting specifications for mobile applications
- High electromagnetic compatibility (EMC)
- Inputs and outputs with fault detection
- Central deactivation of 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

Main components

- Fused Watchdog supervised processor for program run monitoring
- Hardware based RAM memory supervision
- CPU internal Flash with ECC error-correcting code
- Three independent sensor power supplies
- Four independent CAN bus interfaces
- Two-channel stop function

Ordering code

RC		/	30
01	02		03

Type

01	BODAS controller	**RC**

Version

02	1. Position: number of proportional outputs	**28-14**
	2. Position: number of switched outputs	**20-10**
		12-10

Series

03	Series 3, index 0	**30**

Notes:

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

If there is a sample label on the name plate, it is a prototype or sample, i.e., components not released for series production.

Possible sample labels are:

– SC: A

– SC: B

– SC: C

– SC: S (Software prototypes)

Optional accessories

– **BODAS-design software**
The windows-based BODAS-design PC software (RE 95112) is used for programming the BODAS RC controllers. All graphical and textual programming languages specified according to IEC 61131-3 are available for the programming.

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

– **C programming interface C-API**
The C-API (RE 95115) programming interface is used for programming the BODAS RC controllers in the C programming language. All required functions that are needed for the configuration and the reading of the inputs, the control of the outputs, the use of the communication interfaces and the creation of the diagnostics information for BODAS-service are available to the user.
Additionally, the user needs a C-compiler, with which the created program is translated into a machine code that is readable for the BODAS controller.

– **BODAS measuring adapter MA6**
The BODAS measuring adapter MA6 (RE 95090) is used for measuring all electrical signals at the inputs, outputs and interfaces of the BODAS controller. For testing purposes, it is connected in series between the controller and the vehicle or device wiring.

– **BODAS TB3 test box** (2 pieces) and adapter kit (1 piece)
The BODAS TB3 test box (RE 95092) is used for simulation of vehicle and device functions for development and testing purposes with BODAS controllers. The BODAS TB3 test boxes are connected to the controller via the adapter cable TAK4/10.

– **BODAS CAN I/O extension module RCE12-4/22**
The BODAS CAN I/O extension module RCE12-4/22 (RE 95220) is used for the I/O extension of a controller if the number of inputs and outputs of the controller is not sufficient 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

These BODAS controllers are designed as universal central controllers for complex mobile working machines. Thanks to the ultra-modern 32-bit TriCore technology, a clock frequency of 180 MHz and parallel processing, these controllers push into completely new performance dimensions that were previously reserved for larger PLC systems. The fields of application extend from the programmable control of proportional solenoids and additional switching functions to travel drives and gear shiftings as well as coordination of highly complex control circuits in mobile working machines. With 75 input channels, up to 42 output stages, four voltage outputs 25 % * U_{bat} to 75 % * U_{bat} and an additional output (4 to 20 mA), as well as four CAN buses for communication in the vehicle, these controllers provide a high-performance platform for all functions of mobile working machines.

Internally, the series 30 BODAS RC controllers contain a high-performance 32-bit TriCore microprocessor and all input and output circuits. Analog voltages in the range from 0 to 10 V and 0 to 32 V, currents from 0 to 20 mA, frequencies from 0 Hz to 10 kHz and switching information are processed as input signals. As well, these controllers offer special inputs for intelligent Bosch Rexroth sensors, like the speed sensor DSM1-10 with integrated diagnostics function or resistor inputs from 10 to 2000 Ω, for example for the direct connection of temperature sensors. The inputs are protected against overvoltage and electrical interference. The voltage inputs can be monitored for the detection of a cable break or short circuit. The current-controlled proportional solenoid outputs are pulse-width-modulated (PWM) and are compensated for temperature and voltage for high accuracy and minimum hysteresis. They are optimally harmonized with the electrical proportional control of the axial piston units and valves of Bosch Rexroth. The switched outputs are designed for direct switching of relays and switching solenoids. Moreover, the outputs have integrated voltage and current monitoring.

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, diesel engine injection, display). Four independent CAN bus interfaces, each of which can be operated with various protocols, are available in these BODAS controllers for communication. Communication with the BODAS-design and BODAS-service software is likewise done via CAN bus and is based on the Standard Key Word Protocol 2000 (KWP 2000).

Simple and flexible programming of the BODAS controller according to the industry standard IEC 61131-3, which enables a very convenient and rapid introduction to the programming of the RC28-14, is possible with the BODAS-design software. Comprehensive and complex applications can be conveniently developed and clearly represented with BODAS-design.

An application interface in the form of a C-API interface is available for the development of the full performance capability of these BODAS controllers when the C programming language is used. By using it, the software developer can concentrate on the important functions of his machine with-out having to become immersed in the details of the TriCore technology.

With the BODAS-service software, the programs can be quickly and simply downloaded to the controller via the Flash module. Extensive service functions, such as diagnostics, parameter setting or display of process variables are available via the graphical Windows interface of BODAS-service. This enables simple parameter setting and diagnostics in order to place the machine in service quickly and safely.

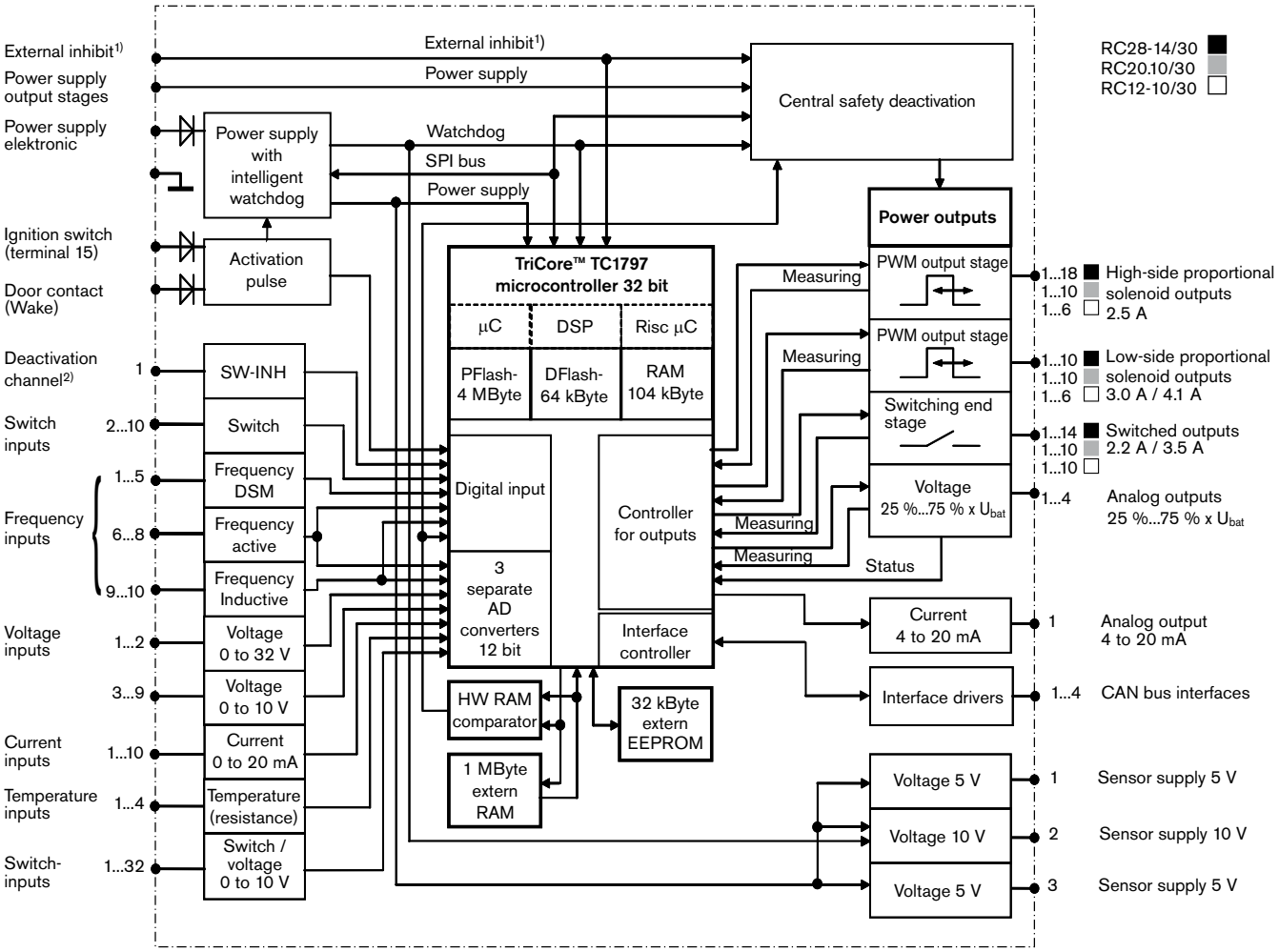
The BODAS RC controllers were developed specifically for use in mobile working machines and satisfy corresponding safety requirements regarding ambient temperatures, water and dust ingression, shock and vibration as well as electromagnetic compatibility (EMC).

BODAS RC controllers and corresponding software in combination with pumps, motors, valves, sensors, input devices and actuators from Bosch Rexroth make for complete system solutions.

Safety-relevant project planning instructions (RE 95451-01-B) have to be observed for the planning and implementation of safety functions and the two-channel stop function. These are available from Bosch Rexroth on request.

Block circuit diagram

Controller



1) Input that is independent of the microcontroller, for the central enabling/deactivation of the power outputs.
2) Input for the central enabling/deactivation of the power outputs in software.

Abbreviations:

µC = micro controller
DSP = digital signal processing
RISC = reduced instruction set computer

Notes

Technical data

Controllers RC		28-14	20-10	12-10
		■	▣	□
Nominal voltage	12 and 24 V		✓	
Residual ripple (DIN 40839, part 1)	max. ± 2 V		✓	
Supply voltage, permissible range	8 to 32 V		(✓)[5]	
Current consumption				
standby, in the 12 V vehicle electrical system	380 mA		✓	
standby, in the 24 V vehicle electrical system	290 mA		✓	
loaded, in the 12 V vehicle electrical system	max. 40 A		✓	
loaded, in the 24 V vehicle electrical system	max. 40 A		✓	
Fuses				
internal:			–	
external: in the supply path[4]	Electronics, max. 35 A power outputs		✓	
Controllers enabling pin	Terminal 15 / Wake		✓	
Constant voltage sources[3]				
e.g. for setpoint potentiometer				
150 mA	5 V ± 150 mV		✓	
250 mA	5 V ± 150 mV		✓	
1000 mA	10 V ± 350 mV		✓	
Digital inputs			9	
Digital voltage inputs, diagnostics-capable			32	
Analog voltage inputs, pulldown	0 to 10 V		7	
	0 to 32 V		2	
Analog current inputs, diagnostics-capable	0 to 20 mA		10	
Resistor inputs				
e.g. for temperature sensors resistance measuring range	10 to 2000 Ω		4	
Frequency inputs total			10	
DSM	0 to 9 kHz level 7 mA/14 mA		5	
Inductive sensors	0 to 10 kHz level > 1 V_{eff}		2	
Active sensors	0 to 10 kHz level low < 1 V level high > 6 V		3	
Analog signal outputs			5	
for 200 Ω load (burden)	4 to 20 mA or		1	
for 150 Ω load (burden)	0 V (off), 0.1 V to 5.0 V			
for 12 kΩ load (burden)	0 V (off), 0 % * U_{bat} to 90 % * U_{bat} (typical 25 % * U_{bat} to 75 % * U_{bat})		4	
Proportional solenoid outputs (PWM)		28	20	12
High side current range	0 to 2.5 A	18	10	6
Pulsation frequency	0; 50 to 250 Hz			
Low side current range	0 to 3.0 A	8	8	4
	0 to 4.1 A	2	2	2
Pulsation frequency	0; 50 to 250 and 1000 Hz			
Digital output stages total		14	10	10
High side current range	max 2.2 A	10	6	6
High side current range	max 3.5 A[2]		4	
Interfaces CAN 2.0 B, ISO 11898			4	
Fault detection in the event of cable break and short circuit				
Analog inputs			✓	
Proportional solenoid outputs			✓	
Switching solenoid outputs			✓	
Short circuit resistance when energized to supply voltage and ground for all inputs and outputs[1] [3]			✓	

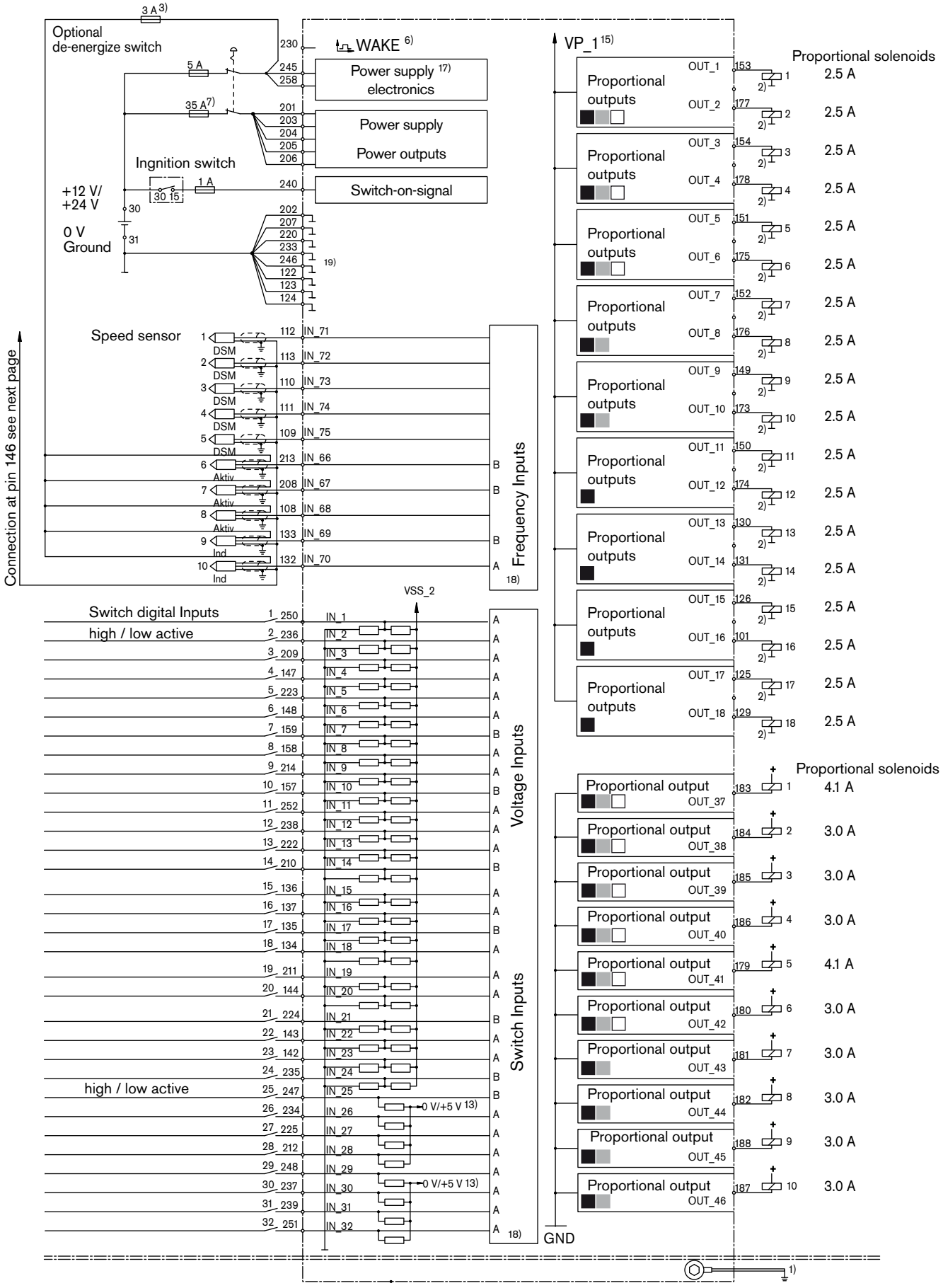
[1] Exception: GND, sensor GND, sensor supplies and CAN interfaces to battery
[2] Max. total current per group: 5 A
[3] Sensor voltage inputs are raised when there is a short circuit to battery. A correct reading of sensor signals is no longer ensured.
[4] Cable protection. The wiring has to be rated according to the fuse protection.
[5] Some functions do not comply fully with the respective specification at supply voltage < 11 V. See overview of functions, too.

Technical data

Controllers RC			28-14 ■	20-10 ▣	12-10 □
Reverse-connect protection[1]					
Power supply/battery				✓	
Microcontroller				SAK-TC1797	
Clock frequency		MHz		180	
Memory capacities					
RAM		MByte		1	
Flash EPROM		MByte		4	
EEPROM		kByte		32	
Software installation Download in Flash memory				✓	
Electromagnetic compatibility					
Spurious interference (ISO 11452-2)		200 V_{RMS}/m;		✓	
Spurious interference (ISO 11452-5)		100 V_{RMS}/m;		✓	
Electrostatic discharge ESD (according to ISO 10605)					
Out of service		8 kV		✓	
In service		15 kV		✓	
Max. dissipation power					
Electronics		W at 32 V		8.5	
Output stages		W at 32 V		60	
Operating temperature, case with mounting point on cooling surface		-40 to +85 °C (-40 to +185 °F)		✓	
Storage temperature, case		Maximum permissible case temperature in the short-term passive: -40 to +105 °C (-40 to +221 °F)		✓	
Vibration resistance					
Broadband noise vibration (ISO 16750-3)		34 m/s^2, 10 to 1000 Hz, 32 h per axis 10 Hz: 18 $(m/s^2)^2/Hz$ 20 Hz: 36 $(m/s^2)^2/Hz$ 30 Hz: 36 $(m/s^2)^2/Hz$ 180 Hz: 1 $(m/s^2)^2/Hz$ 2000 Hz: 1 $(m/s^2)^2/Hz$		✓	
Shock resistance Transport shock (IEC 60068-2-27)		$a = 400\ m/s^2$; $t = 6$ ms per spatial axis x, y, z and in each direction (pos./neg.)		✓	
Type of protection (DIN/EN 60529)[2] with assembled mating connector		IP65		✓	
Resistance to moisture (IEC 60068-2-30Db; variant 2)		95 % (+25 °C to +55 °C)		✓	
Resistance to salt spray (IEC 60068-2-52, part 2, test Kb)		4x 2 h salt spray (5 % NaCl) 22 h 40 °C / 93 % RH constant climate 72 h storage at room temperature		✓	
Case material	Upper shell: Base:	Diecast aluminum Deep-drawing aluminium		✓	
Mass		approx. kg		1.0 kg	
Outer dimensions		Length (in mm)		204.5	
		Width (in mm)		203	
		Height (in mm)		40.5	
Mating connector		96-pin		1	
		58-pin		1	

[1] In conjunction with external fuse
[2] While following the installation instructions

Connection diagram part 1

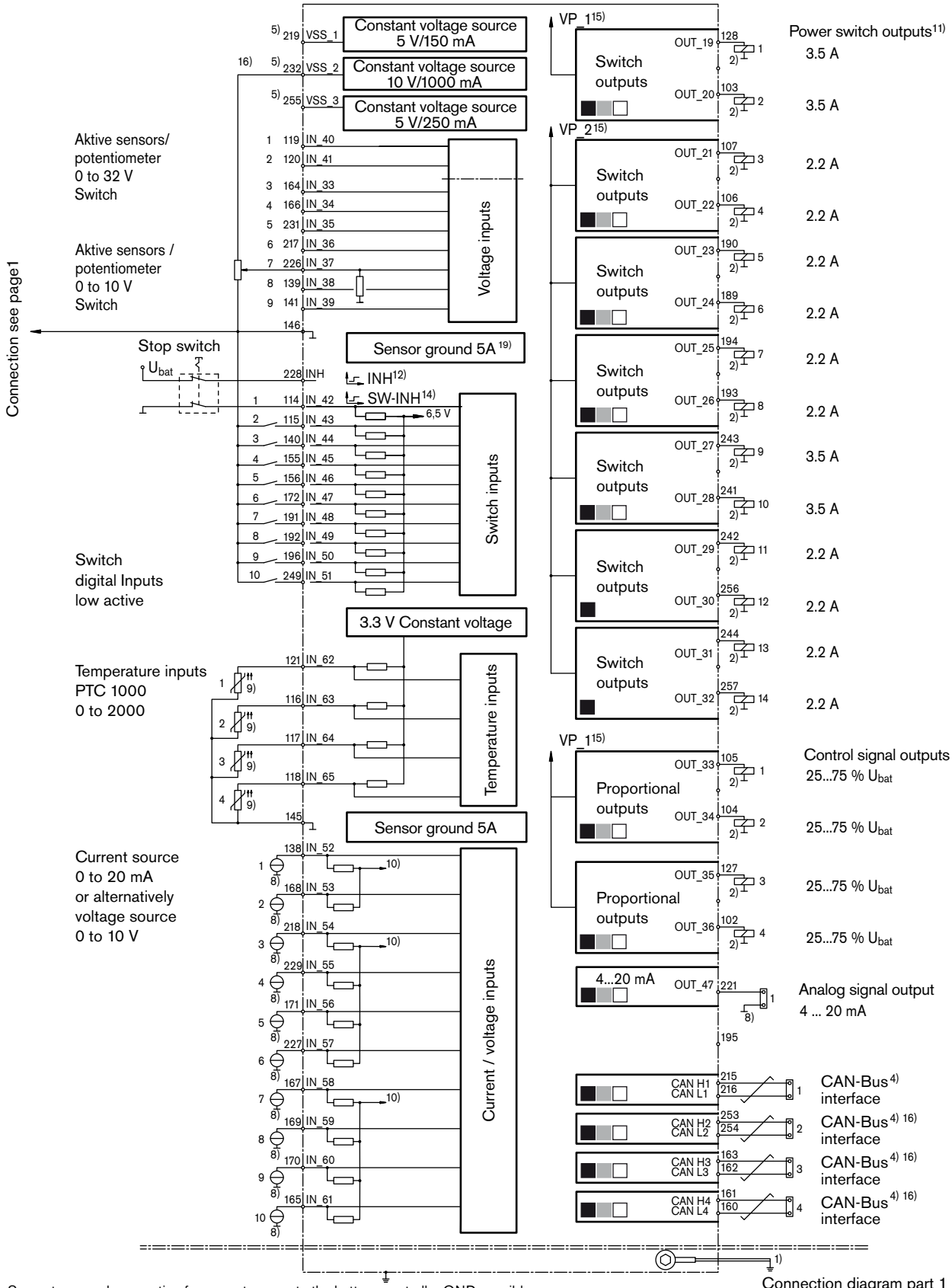


Connection diagram part 2
see next page

1) Short, low-resistance connection from a case screw to the vehicle ground.
2) Separate ground connection to battery (chassis possible).
3) Separate fuses for switches and sensors necessary. Sensor supply application specific.
4) CAN bus: termination resistor 120 Ω and twisted pair wire necessary.
5) Outputs 5 V/10 V can also be used as sensor supply alternatively.
6) Temporary wake up of the controller when a signal > 8 V is applied for more than 1 sec.
7) Note max. current consumption with simultaneous actuation of proportional solenoids and switched outputs.

For additional footnotes, see next page

Connection diagram part 2



8) Separate ground connection for current source to the battery, controller GND possible.
9) Can be used as switch inputs if externally switched to GND.
10) For use as voltage inputs (0 to 10 V), the load can be switched by the software in groups for these inputs.
Groups: inputs 1 to 2, inputs 3 to 6, inputs 7 to 10.
11) Outputs arranged in groups, each witch 2 output stages. Maximum permissible output current of a group: 5 A.
12) Primary deactivation channel for proportional- and switch outputs: enabling with level > 4.5 V, deactivation with level < 1 V, cable break leads to deactivation.
13) Input groups may be switched to pull down or pull up in software.
14) Secondary deactivaton channel for proportinal- and switch outputs: enabling with level < 0.8 V, deactivation with level > 1.7 V, cable break leads to deactivation.
15) Supply can be switched by the software.
16) in switched off when the watchdog triggers. Is switched off shortly for diagnosis purpuses when a main switch is initially activated.
17) If power is disconnected during operation no data can be saved to non-volatile memory and no after-run.
18) A and B indicate different A/D converters which may be selected for redundancy reasons.
19) Terminal 31 (supply ground) and sensor ground are bridged at a star point in the control unit and connected to the housing.

Connection variants

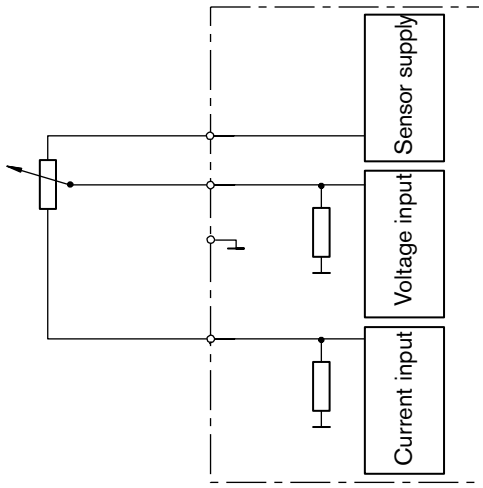
Monitored potentiometer 2.5 to 5 kΩ

Error monitoring of the potentiometer

– Internal measurements of the sensor voltage (5 V)

– Connection of the potentiometer to a current input, via which the current of the potentiometer is checked.

– Checking the loop voltage. It must be within a valid range (software).

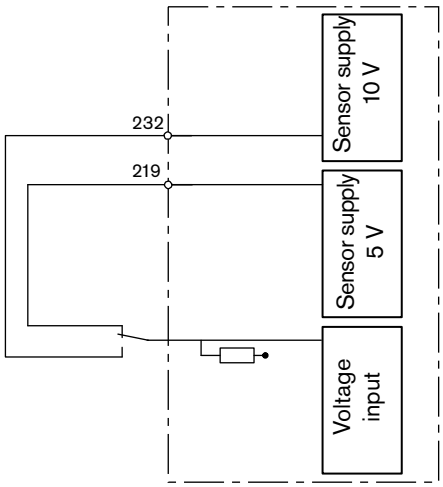


Switch input with fault detection

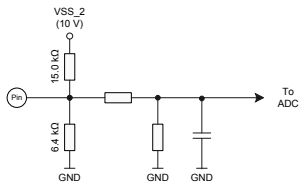
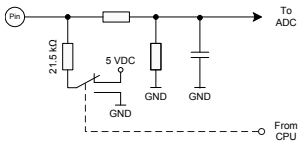
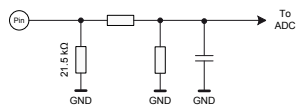
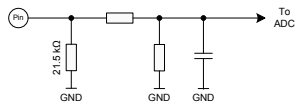
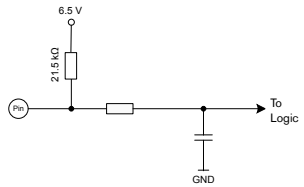
Error monitoring of the switch inputs

– Switching of the input voltage between 10 V and 5 V

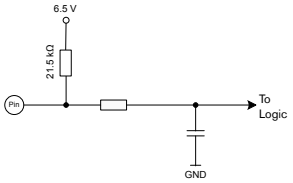
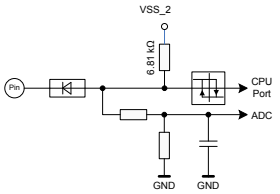
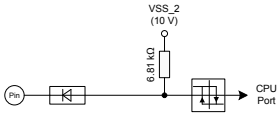
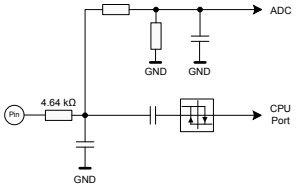
– Reading the switching level and checking the valid range (software)



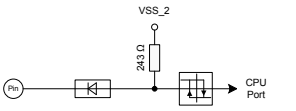
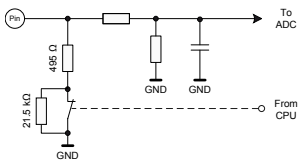
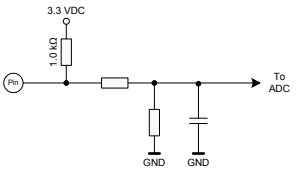
Overview of functions

Pin	Description	Main function	Alternative functions
250, 236, 209, 147, 223, 148, 159, 158, 214, 157, 252, 238, 222, 210, 136, 137, 135, 134, 211, 144, 224, 143, 142, 235 	**Digital input** IN_1 to IN_24 This inputs have an internal pullup resistance of 15.0 kΩ to the sensor supply VSS_2 (10 V) and a 5.6 kΩ pulldown resistance to GND	**Digital input** Operating point, settable via software Switch externally to GND, VSS_x or Ubat. If Ubat = 24V then max. 10 of these inputs may be switched to 24 V simultaneously.	**Analog voltage input** Measuring range 0 to 10 V Resolution 12 bit (2.7 mV/bit) Input resistance DC to GND 5.6 kΩ DC to VSS_2 15.0 kΩ Filter limit frequency 330 Hz
247, 234, 225, 212 248, 237, 238, 251 	**Digital input** with switchable pullup/ down to 5V / GND switchable in 4 pullup/pulldown groups IN_25 to IN_28 IN_29 to IN_32	**Digital input** Switching threshold settable by software. Pullup/pulldown resistance, switchable via software Basic setting (Default): GND Switch externally to GND, VSS_x or U_{bat}.	**Analog voltage input** Measuring range 0 to 10 V Resolution 12 bit (2.7 mV/bit) Input resistance DC to 5 V 21.5 kΩ (pullup) DC to GND 49.5 kΩ (pulldown) Filter limit frequency 330 Hz Basic setting with open terminal 0 VDC
164, 166, 231, 217, 226, 139, 141 	**Analog voltage input** IN_33 to IN_39	**Analog voltage input** Measuring range 0 to 10 V Resolution 12 bit (2.71 mV/bit) Input resistance DC to GND 15.0 kΩ Filter limit frequency 330 Hz	**Digital input active high** Evaluation possibilities - Threshold adjustable via software - max. 10 V
119, 120 	**Analog voltage input** IN_40 to IN_41	**Analog voltage input** Measuring range 0 to 32 V Resolution 12 bit (8.8 mV/bit) Input resistance DC to GND: 15.13 kΩ Filter limit frequency 800 Hz	**Digital input active high** Evaluation possibilities - Threshold adjustable via software - max. 32 V
114 	**Digital input** IN_42 (SW-INH) This input has an internal pullup resistance of 21.5 kΩ to 6.5 V	**Secondary input enabling** Enabling of the outputs	**Digital input aktive low** Evaluation possibilities - Digital threshold: Level low < 0.8 V switch to GND with low resistance Levgel high > 1.7 V switch open Filter limit frequency 330 H

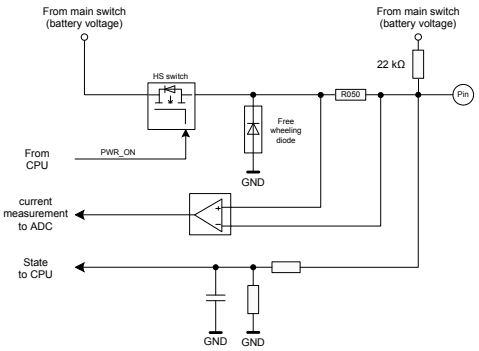
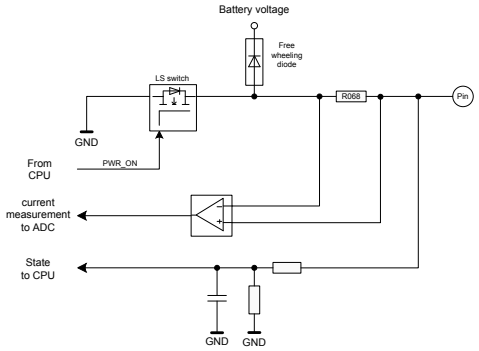
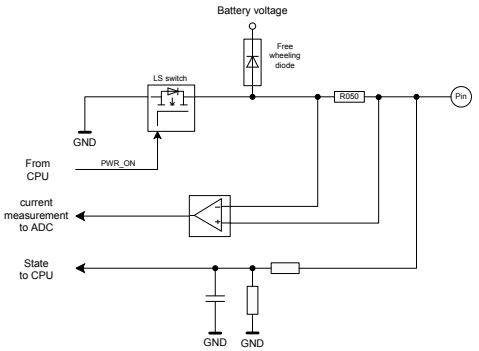
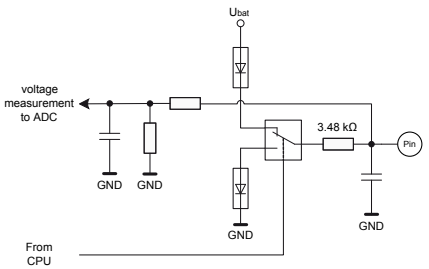
Overview of functions

Pin	Description	Main function	Alternative functions
115, 140, 155, 156, 172, 191, 192, 196, 249 	**Digital input** IN_43 to IN_51 This input has an internal pullup resistance of 21.5 kΩ gegen 6.5 V	**Digital input aktive low** Evaluation possibilities - Digital threshold: Level low < 0.8 V switch to GND with low resistance Levgel high > 1.7 V switch open Filter limit frequency: 330 H	
213, 208 	**Active frequency input** IN_66 to IN_67 This input has an internal pullup resistance of 6.81 kΩ to VSS_2 (10 V)	**Frequency input for inductive and active sensors type NPN** (z.B. HDD1) Frequency evaluation of active speed sensors, that switch to ground. Frequency evaluation up to 10 kHz Phase measurement between IN_66 (pin 213) and IN_67 (pin 208) Short circuit current up to 1.37 mA	**Digital input switching to GND** Evaluation possibilities - Threshold adjustable via software - Digital threshold: Level low < 1 V switch to GND with low resistance Level high > 6 V switch open Filter limit frequency: 13.21 kHz **Analog voltage input** Measuring range 0.5 to 5 V Resolution 12 bit (1.78 mV/bit) Filter limit frequency 510 Hz
108 	**Active frequency input** IN_68 This input has an internal pullup resistance of 6.81 kΩ to VSS_2 (10 V)	**Frequency input for inductive and active sensors type NPN** (z.B. HDD1) Frequency evaluation of active speed sensors, that switch to ground. Frequency evaluation up to 10 kHz Short circuit current up to 1.37 mA	
133, 132 	**Inductive frequency input** IN_69 to IN_70	**Frequency input for inductive and active sensors type PNP and NPN** Frequency evaluation up to 10 kHz Input resistance DC to GND 44 kΩ required signal amplitude min. 1 Veff (sinus) Phase measurement between IN_69 (pin 133) and IN_70 (pin 132)	**Digital input active high** Evaluation possibilities - Threshold adjustable via software - Limit frequency depends on amplitude - max. 32 V **Analog voltage input** Measuring range 0 to 30 V Resolution 12 bit (7.65 mV/bit) Input resistance DC to GND 44 kΩ

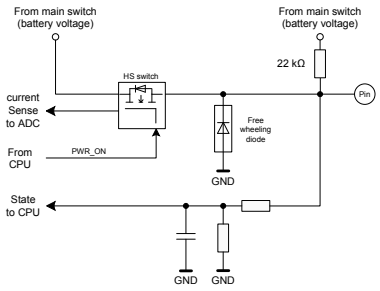
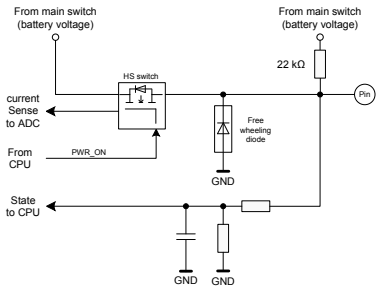
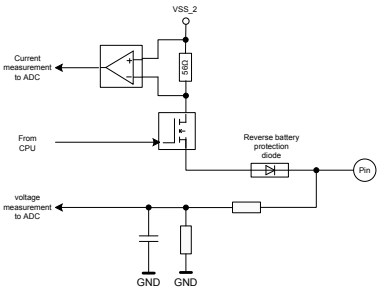
Overview of functions

Pin	Description	Main function	Alternative functions
112, 113, 110, 111, 109 	**DSM frequency input** IN_71 to IN_75 This input has an internal pullup resistance of 243 Ω to VSS_2 (10 V)	**Frequency input for Rexroth DSM sensors** Frequency evaluation up to maximum of 9 kHz. Evaluation of additional information such as direction of rotation and error monitoring.	**Frequency input for active sensors type NPN** (z.B. HDD1) Frequency evaluation of active speed sensors, that switch to ground. Level low < 5V (bzw. < 7 mA) Level high > 9V (bzw. > 13 mA) Phase measurement between IN_71 (pin 112) and IN_72 (pin 113) Phase measurement between IN_73 (pin 110) and IN_74 (pin 111) **Caution:** short circuit current up to 40 mA **Digital input switching to GND** Evaluation possibilities - Digital current threshold 10 mA ± 3 mA
138, 168 218, 229, 171, 227 167, 169, 170, 165  Over voltage protection only if ECU is energized	**Analog current input** with switchable load (input resistance) IN_ 52 to IN_61 Switchable in three groups between analog current and voltage input IN_52 and IN_53 IN_54 to IN_57 IN_58 to IN_61	**Analog current measurement input** Measuring range 0 to 20 mA Load 488 Ω Resolution 12 bit (2.71 mV/bit) Input resistance Filter limit frequency 330 Hz In 12 V applications two current inputs may be connected in parallel to halve the input resistance	**Analog voltage input** Measuring range 0 to 10 V Resolution 12 bit (2.71 mV/bit) Input resistance DC to GND: 12.38 kΩ Filter limit frequency 330 Hz **Digitale input** Threshold adjustable via software max. 10 V
121, 116, 117, 118 	**Temperature input** IN_62 to IN_65	**Temperature measurement via resistance measurement of connected temperature sensors** Evaluation of passive temperature sensors with PTC measuring shunts from 700 to 2000 Ω Support of BOSCH Rexroth sensors: TSF (RE 95180) TSA (RE 95181)	**Digital input switching to GND** Evaluation possibilities • Threshold adjustable via software • max. 3.3 V **Analog voltage input** Measuring range 0 to 3 V Resolution 12 bit (1.26 mV/bit) Input resistance DC to GND 156.2 kΩ Filter limit frequency 94 Hz

Overview of functions

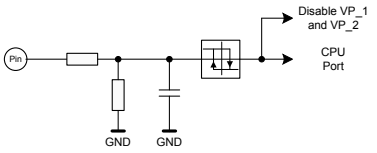
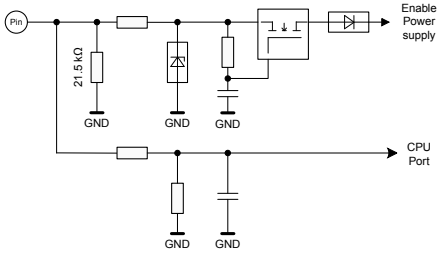
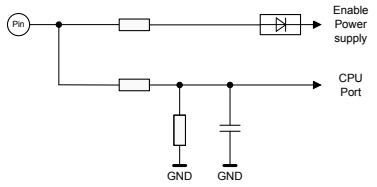
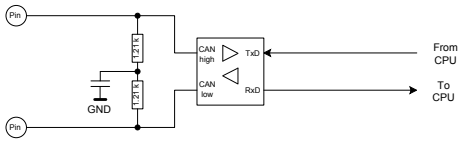
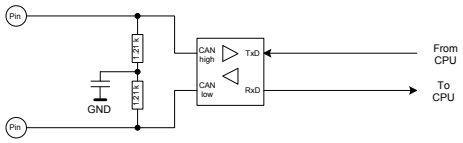
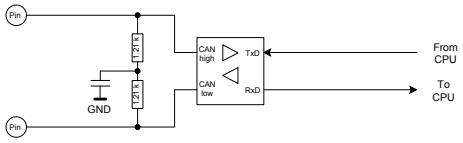
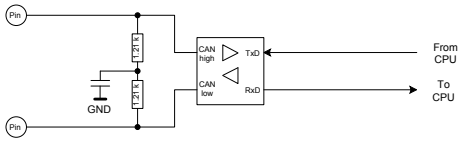
Pin	Description	Main function	Alternative functions
153, 177, 154, 178, 151, 175, 152, 176, 149, 173, 150, 174, 130, 131, 126, 101, 125, 129 	**PWM output stage** OUT_1 to OUT_18	**PWM output stage** High side switch clock frequency adjustable via software Free wheeling diode for switching of inductive loads integrated Max. current 2.5 A Pulse duty factor 0 to 100 % Power supply centrally switchable via VP_1	**Switching output stage** diagnostics-capable actuated time 100 %
184, 185, 186, 180, 181, 182, 188, 187 	**PWM output stage** OUT_38 to OUT_40 and OUT_42 to OUT_46	**PWM output stage** Low side switch clock frequency adjustable via software Free wheeling diode for switching of inductive loads integrated Max. current 3.0 A Pulse duty factor 0 to 100 %	**Switching output stage** diagnostics-capable actuated time 100 %
183, 179 	**PWM output stage** OUT_37 and OUT_41	**PWM output stage** Low side switch clock frequency adjustable via software Free wheeling diode for switching of inductive loads integrated Max. current 4.1 A Pulse duty factor 0 to 100 % Maximum current depends on duty cycle and load.	**Switching output stage** diagnostics-capable actuated time 100 %
105, 104, 127, 102 	**Analog voltage output** OUT_33 to OUT_36	**PWM control signal output** Output voltage 0 % * U_{bat} to 90 % * U_{bat} (typical 25 % * U_{bat} to 75 % * U_{bat}) 400 to 5000 Hz OUT_33 to OUT_36: Power supply centrally switchable via VP_1	

Overview of functions

Pin	Description	Main function	Alternative functions
107, 106, 190, 189, 194, 193, 242, 256, 244, 257 	**Switching output stage with current sensing** OUT_21 to OUT_26 and OUT_29 to OUT_32	**Switching output stage**[1)] High side switch max. current 2.2 A Spark suppression diode for switching of inductive loads integrated Power supply centrally switchable via VP_2 Current measurement via ‚current sensing'	
128, 103, 243, 241 	**Switching output stage with current sensing** OUT_19 tos OUT_20 and OUT_27 to OUT_28	**Switching output stage**[1)] High side switch max. current 3.5 A Spark suppression diode for switching of inductive loads integrated OUT_19 to OUT_20: Switchable via VP_1 OUT_27 to OUT_28: Switchable via VP_2	
221 	**Analog signal output** OUT_57	**Analog current output** Output signal 4…20 mA at 200 Ω load Output is supplied via VSS_2	**Analog voltage output** Output signal 0 V (off), 0.1 V to 5.0 V 150 Ω load required
219	**Sensor supply** VSS_1	**Sensor supply** Output voltage 5.0 V Accuracy ± 0.15 V Load capacity 150 mA	
232	**Sensor supply** VSS_2	**Sensor supply, deactivatable** Output voltage 10.0 V only up to U_{bat} -1 V Accuracy ± 0.35 V Load capacity 1000 mA	
255	**Sensor supply** VSS_3	**Sensor supply, deactivatable** Output voltage 5.0 V Accuracy ± 0.15 V Load capacity 250 mA	

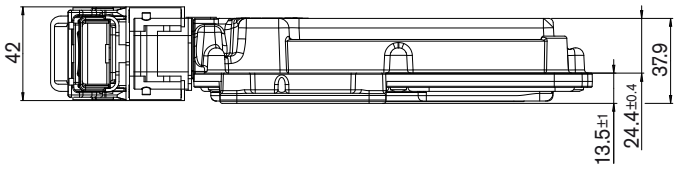
[1)] Software configuration as proportional output with 100 % duty cycle required.

Overview of functions

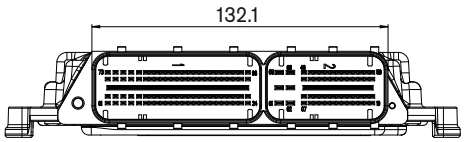
Pin	Description	Main function	Alternative functions
228 	**External inhibit** INH Enabling	**Digital input** Isolation of the output stages Level > 4.5 V, <= U_{bat} Deactivation of output stages Level < 1 V (Proportional and switched outputs), cable break leads to the deactivation of all output stages Input resistance DC to GND 33.6 kΩ	
230 	**Door contact** WAKE Enables temporary power up of the control unit	**Digital input** Switch on control unit Level > 8 V, <= U_{bat} Input resistance DC to GND 18.5 kΩ	
240 	**Ignition switch** KL15 Power on signal for the control unit	**Digital input** Switch on control unit Level > 8 V, <= U_{bat} Input resistance DC to GND 131.6 kΩ	
215, 216 	**CAN interface** CAN1_H, CAN1_L	**CAN interface** CAN 2.0 B, factor setting 250 kBaud, standard diagnosis interface up to 1 Mbaud, termination resistor in the cable harness required	
253, 254 	**CAN interface** CAN2_H, CAN2_L	**CAN interface** CAN 2.0 B, up to 1 Mbaud, termination resistor in the cable harness required	
163, 162 	**CAN interface** CAN3_H, CAN3_L	**CAN interface** CAN 2.0 B, up to 1 Mbaud, termination resistor in the cable harness required	
161, 160 	**CAN interface** CAN4_H, CAN4_L	**CAN interface** CAN 2.0 B, up to 1 Mbaud, termination resistor in the cable harness required	

Dimensions

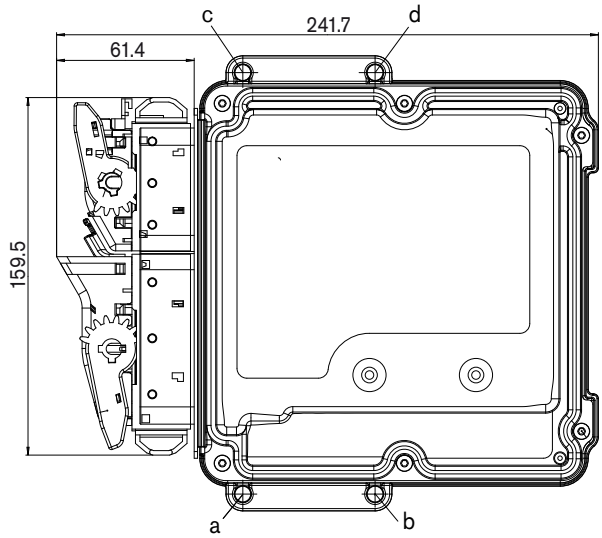
Long-side side view



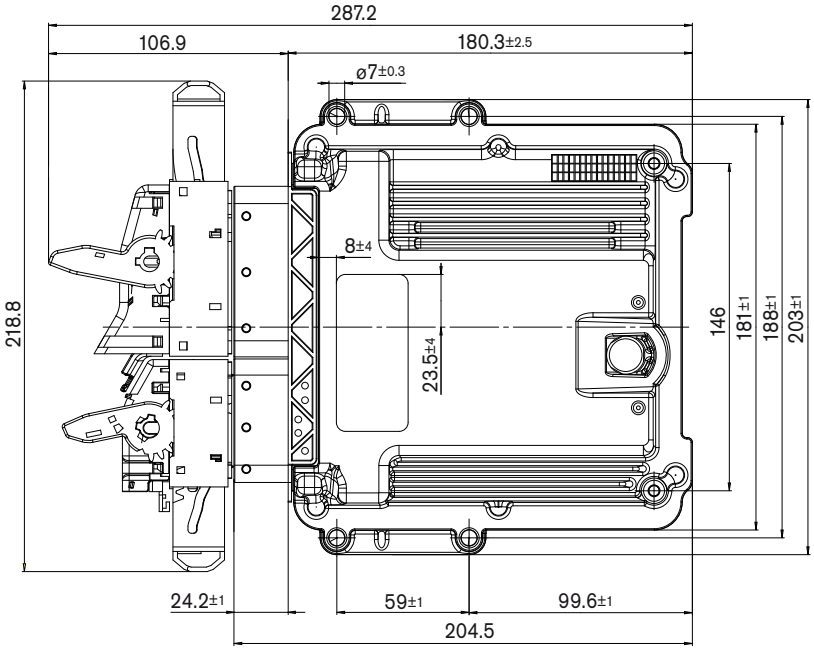
Side view of connector side with pulled connector



Plan view



View from below



Fixing:

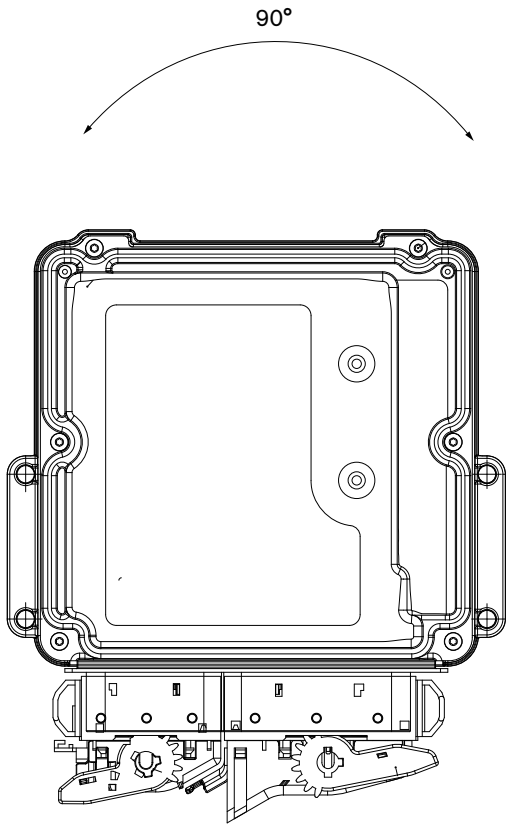
- The BODAS controller must be fixed at 4 positions (a, b, c and d).
- Tightening torque MA = 8 ± 2 Nm for fixing the BODAS controller with M6 screws.
- Tightening torque applies for fitting without washer. The equivalent tightening torque must be calculated when using washers.
- Rexroth's consent is required if fixing is different from above.
- Installation point: flatness of the mounting surface ▱ 0.5
- The cable harness should be mechanically fixed in the area in which the controller is installed (spacing < 150 mm).
  The cable harness should be fixed such that the assembly has sufficient room to exit the controller without putting too much force on the mating connectors.

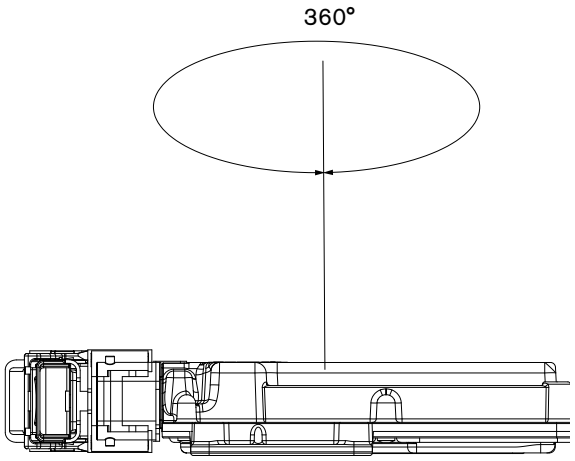
If the mounting surface is not sufficiently even, place flexible compensating elements (e.g. rubber washers) between the fixing points of the BODAS controller and the mounting surface.

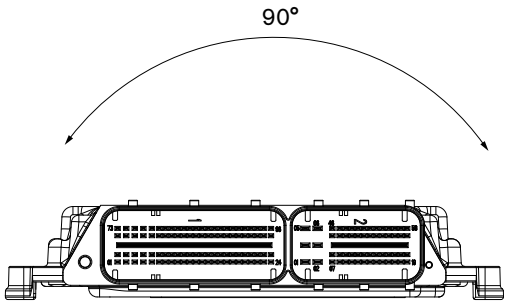
- Space required for mating connector
- Space required for plugging and unplugging the mating connector

Display without scale, dimensions in mm

Installation position







Note:

Installation position only permissible with specified angular range.

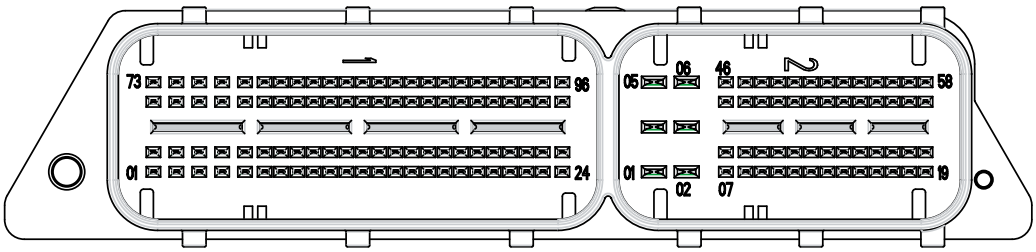
Mating connector

Order designations for the connector set with the Rexroth material number R902603622

Designation	Number	Bosch part numbers of the individual parts	
		Module 58-pin	Module 96-pin
Contact carrier code: A	1 per connector	1 928 404 780	1 928 404 781
Cover pre-assembled	1 per connector	1 928 404 774	1 928 404 773
Secondary lock 1.2	1 per connector	1 928 404 760	1 928 404 762
Secondary lock 2.8	1	1 928 404 761	–
Wire tie (cable tie)	1 per connector	1 928 401 713	
Contacts BDK 2.8 contact Surface: SN Insulation cross-section: 2.2 to 3.0 mm Line cross section: 1.5 to 2.5 mm	6 (8)*)	1 928 498 057	–
Matrix 1.2 contact Surface: SN Insulation cross-section: 1.2 to 1.6 mm Line cross section 0.35 to 0.5 mm	52 (55)*)	1 928 498 137	–
Matrix 1.2 contact Surface: SN Insulation cross section: 1.2 to 1.6 mm Line cross section: 0.35 to 0.5 mm	96 (100)*)	–	1 928 498 137
Individual cross-section White for BDK 2.8 Cross section: 2.2 to 3.0 mm	6 (8)*)	1 928 300 600	–

*) The number in the brackets indicates how many contacts or individual seals are included in the Rexroth connector set. The number without brackets indicates the requirement.

View of connector strip



Mating connector

Notes regarding assembly

In the assembly of the connectors, heed the assembly instructions for plug connections (1 928 A00 48M), BDK 2.8 contacts (1 928 F00 025) and Matrix 1.2 contacts (1 928 A00 47M).
These assembly instructions are available on request from Rexroth.

Caution:

In the installation of the connector in the vehicle, observe the following:

The fixation of the cable harness must be done at a distance ≤ 150 mm after the outgoing cable unit at the same vibration level of the controller.

Recommended lines

Recommended connection lines for contacts 201 to 206:

– Cross section 1.5 mm² to 2.5 mm² (16 to 14 AWG, 14 AWG with thin electric insulation)

– Outer diameter: 2.2 mm to 3.0 mm

Recommended connection lines for contacts 101-105, 124, 125-129, 148, 149-153, 172, 173-177, 196, 207, 220, 233, 246

– Cross section 1.0 mm² to 1.5 mm² (18 to 16 AWG)

– Outer diameter: 1.9 mm to 2.1 mm for 1.0 mm², 2.2 mm to 2.4 mm for 1.5 mm²

Lines with 0.35 mm² to 0.5 mm² cross section (see other contacts below) may be used for these contacts, too.
However, cross sections 1.0 mm² to 1.5 mm² can ease the insertion of these contacts into the connector.

Recommended connection lines for other contacts not mentioned above:

– Cross section 0.35 mm² to 0.5 mm² (22 AWG)

– Outer diameter: 1.2 mm to 1.6 mm

Required tools

Bosch part numbers for tools*)

	Line cross sections for cable type FLK-R			
	BDK 2.8 contacts	**Matrix 1.2 contacts**		
	1.5 to 2.5 mm²	**0.35 to 0.5 mm²**	**1.0 mm²**	**1.5 mm²**
Contact (terminal)	1 928 498 057	1 928 498 137	1 928 498 138	1 928 498 139
Crimping tool with matrix	1 928 498 162	1 928 498 212	1 928 498 213	1 928 498 214
Quick change tool	1 928 498 164	1 928 498 200	1 928 498 201	1 928 498 202
Wear part set	1 928 498 166	1 928 498 206	1 928 498 207	1 928 498 208
Disassembly extraction tool	1 928 498 167		1 928 498 218	
10 Replacement needles fort he extraction tool	1 928 498 168		1 928 498 219	

*) The tools may be purchased from Bosch dealers or Bosch Service (www.bosch-service.com)

Drawings and further information about Bosch connectors and tools can be found on the internet: www.bosch-connectors.com

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. 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 stop switch (two-channel stop function) or the optional de-energize 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.
- PMW outputs (OUT_1 to OUT_18 and OUT_37 to OUT_46) 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.
- If the stop function is used in an application, the contact 228 (INH) of the controller must be connected to the stop switch in the vehicle. For a dual channel switch off function the contact SW-INH has to be connected to the stop switch, too. Refer to the connection diagram.

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, in the online help section of BODAS design and in the „safety-relevant project planning instructions“ 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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