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rexroth
A Bosch Company

BODAS Controller RC18-12 series 40 RC27-18 series 40

- For closed- and open-loop control of hydraulic components

Features

- 32-bit multi-core processor with 300 MHz clock frequency and hardware security module (HSM)
- Suitable for safety-relevant applications
- Component of the BODAS system for mobile applications
- Robust and compact design meeting specifications for mobile applications
- High Electromagnetic Compatibility (EMC)
- Inputs and outputs with fault detection
- Inhibit logic for safety-relevant outputs
- Pulse-Width-Modulated (PWM) solenoid currents
- Closed-loop control of solenoid currents, i.e. not dependent on supply voltage and temperature

Main components

- 30 or 45 power outputs, 18 or 27 of which are current-controlled
- 8 low power switch outputs
- 58 multi-functional Inputs
- Program sequence monitoring with watchdog
- Four independent sensor voltage supplies
- Four independent CAN bus interfaces (one of which useable for ISOBUS and two with wake-up function)
- One LIN master interface

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Ordering code

01	02	03		04
RC			**/**	**40**

Type

01	BODAS controller	**RC**

Version

02	1st number: Number of current-controlled power outputs	**18-12**
	2nd number: Power switching outputs	**27-18**

Option

03	Without Ethernet interface 100Base-T1	
	With Ethernet interface 100Base-T1	**E**

Series

04	Series 4, index 0	**40**

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 (prototype software)

Optional accessories

- **BODAS-service software**
  The windows-based PC software BODAS-service 4.x (see data sheet 95087) is used for displaying functions, errors and system variables as well as for setting parameters via a PC. It is also used for flashing programs from a PC onto the controller.
  BODAS-service 4.x is based on the UDS standard.

- **C Programming environment**
  The BODAS BSW software provides the basic software functionality for series 40 RC controllers. The project specific BSW is configured regarding inputs, outputs, communication channels and tasks as well as diagnostics, network and communication channels with the easyConfig online tool. A comprehensive application programming interface (API) is provided for programming the actual application software, which is linked with the BSW. The user needs a C Compiler for compiling and linking the program code in order to get an executable hex file. For details consult the BODAS-BSW manual for RC series 40 and the easyConfig manual.

- **BODAS measuring adapter MA8**
  The BODAS measuring adapter MA8 (see data sheet 95090) facilitates measuring all electrical signals at the inputs, outputs and interfaces of the BODAS controller. For testing purposes, it is connected in series between the RC controller and the vehicle or device wiring.

- **BODAS testbox TB3**
  The BODAS testbox TB3 is used with BODAS controllers to simulate vehicle and device functions for development and test purposes. Two BODAS testboxes TB3 are connected to the controller via the TAK8/11 and TAK9/10 adapter cables. The channel designations for the controller are marked by stencils. See data sheet 95092 for more details.

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 RC18-12/40 and RC27-18/40 are designed as universal controllers for mobile working machines. The two variants are only distinguished by the number of available power outputs. They are fully pin-compatible with each other and the smaller RC5-6/40. RC18-12/40 and RC27-18/40 are based on a 32-bit micro controller with two lock-step cores and two single-cores operating at a clock frequency of 300 MHz. The micro controller features an integrated hardware safety module offering procedures for information security like secure storage of keys and generation of random figures.
The controllers are used for the programmable control of proportional and switching solenoid and of additional electrical switching functions. Typical applications are electrohydraulically actuated work functions, travel drives and transmission controls.
The micro controller, all input and output circuits, communication interfaces, voltage supplies for the sensors and a power supply unit for operation with 12 or 24 V supply voltages are integrated in a compact housing.
Depending on the type, the power outputs have a maximum current capacity of three, four or five amperes. High-side power outputs for switching of battery voltage and low-side power outputs for ground switching are available. Depending on the type, the power outputs can be operated current-controlled, by open-loop controlled pulse width modulation or switched ON/OFF. Loads that are used to realize a safety function must be operated between a high-side and a low-side power output. Loads switched on the low side must be supplied by a high-side output stage, even if the load is not critical for safety.
Current-controlled power outputs are used in particular for the activation of proportional solenoids. The closed-loop current control guarantees that the set-point current is kept even if the supply voltage or the temperature of the solenoid changes and it is characterized by minimal hysteresis.
Eight low-side outputs are provided to control low-power consumers such as relays. Four of those outputs are PWM-capable and can also be used for generation of PWM signals.

Most of the input functions are realized by three input devices (ASIC) that are highly configurable with own A/D converters. They can be used to read digital voltage, analog voltage or electrical resistance. Partly, the inputs are also suitable for measurement of analog currents (4 to 20 mA), acquisition of frequency signals or connection of sensors via SAE J2716 SENT interface.
Six conventional inputs are available for analog voltage measurement of up to 5V. These work with the A/D converter of the microcontroller and have a short latency. Voltages of up to 32V can be measured by 15 additional discrete inputs which are particularly suitable as switching inputs. For this purpose, the voltages are compared with switching thresholds in software. These inputs are all equipped with pull-down and partly with pull-up resistors to battery voltage. CAN bus interfaces are available with all BODAS controllers for exchanging data with other controllers RC, I/O extension modules, joysticks, engine control units, displays, etc.
RC18-12/40 and RC27-18/40 offer a total of four independent CAN bus interfaces. Three of these CAN interfaces can be used as high-speed or CAN FD interfaces. Two of these offer a wake-up function. One CAN interface complies with the ISOBUS specification for ECUs. An external termination bias circuit (TBC) is required for ISOBUS compliance.
For CAN, the basic software offers various communication protocols. These include XCP, J1939, CANopen, CANopen Safety and signal-based communication configured via a DBC file.
Communication with a service tool is also realized via one of the CAN interfaces. The Rexroth service tool BODAS-service 4.x is based on the UDS standard. This tool is used in application development, commissioning and service. It can be used to download programs to the controller. Using application-specific apps, errors and process variables can also be displayed and parameters set. The controllers of series 40 can also be adapted for other service tools.

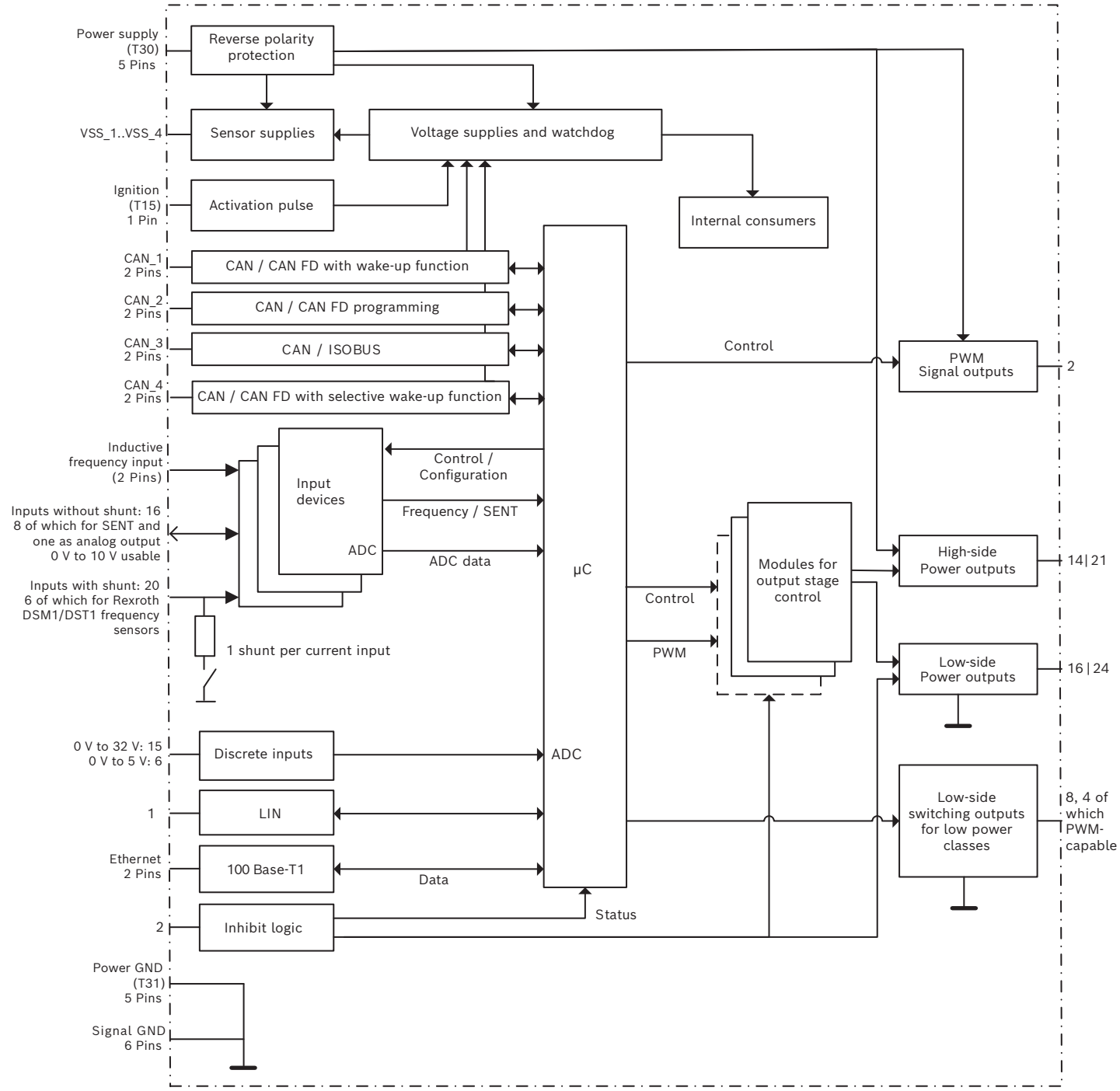
The controllers with Ethernet option (see ordering code) feature a 100Base-T1 interface. By means of a twisted and unshielded pair of wires, data can be transmitted at 100 Mbit/s. The interface does not require any separate connector and uses two pins of the multipole system connector.
An API is available for programming the controller in high level language C. This allows the software developer to concentrate on the important functions of the machine without having to become immersed in the details of the processor, ECU circuitry of controllers and base software. The API also offers functions required for diagnosis by customer-specific service tools. Customer-specific bootblocks for adaptation of the controller to other flash tools can be developed by means of a Customer Loader API (CLAPI). On one CAN channel, a connection to development tools like ETAS-INCA and Vector Tools can be established via the XCP protocol.
At series 40, the hardware configuration is no longer required as part of the application software but can be done via the easyConfig tool available on the internet. The tool returns a configured base software that can be linked with the actual application software.
Besides configuration of I/Os and tasks, the tool also enables import of DBC and LDF files as well as DIDs and DTCs for diagnosis.

The BODAS controllers RC were developed specifically for use in mobile working machines and satisfy corresponding protection requirements regarding ambient temperatures, water and dust ingression, shock and vibration as well as electromagnetic compatibility (EMC). BODAS controllers RC and corresponding software in combination with pumps, motors, valves, sensors, input devices and actuators from Bosch Rexroth make for complete system solutions.

Attention

The controllers RC18-12/40 and RC27-18/40 can be used for safety functions according to ISO 25119 up to AgPL d or up to PL d according to ISO 13849.
The safety manual has to be observed if such safety functions are to be implemented. The safety manual is part of the customer manual for RC18-12/40 and RC27-18/40, which is online available for registered users.

Block circuit diagram



Abbreviations	
µC	Micro controller
PWM	Pulse width modulation
ADC	A/D converter
GND	Ground
CAN	Controller Area Network
CAN FD	CAN with Flexible Data Rate
LIN	Local Interconnect Network
SENT	Single Edge Nibble Transmission
VSS	Voltage Sensor Supply

Technical data

BODAS controller			RC18-12/40 RC18-12E/40	RC27-18/40 RC27-18E/40
Supply voltage				
	Nominal battery voltage		12 V and 24 V	
	Supply voltage ranges			
		No function: µC is reset, outputs are off	< 6 V	
		Very low voltage mode: only CAN communication is ensured At low temperatures, 7 V are required to start the controller.	6 V .. 8 V	
		Undervoltage mode: restrictions on 10 V sensor supplies (VSS_4) and outputs apply, CAN wake-up is not guaranteed with supply voltages below 9 V	8 V .. 11 V	
		Normal operation: Controller is fully operational	11 V .. 32 V	
		Extended voltage supply range: the controller is partially operational	32 V .. 36 V	
		Absolute maximum rating: Controller is not operational, risk of damage at higher voltage	36 V	
Current consumption				
	Standby current at room temperature and 13.5 V supply voltage additional quiescence current if wake-up by frame (WUF) function is activated on CAN_4		< 500 µA + 1 mA	
	Without load in a 12 V battery supply voltage		~ 300 mA	
	Without load in a 24 V battery supply voltage		~ 250 mA	
Fuses				
	Internal		none	
	An external fuse in the supply path (common supply line for internal electronics and high-side outputs) is mandatory		40 A	
Constant voltage sources, total count			**4**	
	5 V	150 mA, 150 mA, 300 mA, all ratiometric	3	
	10 V	500 mA, non-ratiometric	1	
Inputs, total count			**58**	
	Digital voltage, analog voltage 0 V .. 5 V		6	
	Digital voltage, analog voltage 0 V .. 32 V		15	
	Digital voltage, analog voltage, alternative use as 0 V .. 10 V output		1	
	Digital voltage, analog voltage, resistance		3	
	Digital voltage, analog voltage, resistance, analog current		14	
	Digital voltage, analog voltage, resistance, frequency		4	
	Digital voltage, analog voltage, resistance, frequency, SENT		8	
	Digital voltage, analog voltage, analog current, active frequency sensor signals from active frequency sensors, Rexroth DSM1/DST1 speed sensors		6	
	Input for inductive frequency sensors (2 pins)		1	
Cluster with 7 high-side and 8 low-side power outputs each			**2**	**3**
Power outputs, total count			**30**	**45**
	High-side (battery-switching) in total		14	21
		Current-controlled 4 A power outputs, with current measurement	5	5
		Current-controlled 3 A power outputs, with current measurement	7	13
		Switching power output 5 A, without current feedback	2	3
	Low-side (ground-switching) in total		16	24
		Current-controlled 4 A power outputs, with current measurement	3	3
		Current-controlled 3 A power outputs, with current measurement	3	6
		PWM-capable 4 A power outputs, with current sensing	2	2
		PWM-capable 3 A power outputs, with current sensing	2	4
		Switching power output 4 A, with current sensing	1	1
		Switching power outputs 3 A, with current sensing	1	2
		Switching power outputs 3 A, without current feedback	4	6

BODAS controller	**RC18-12/40 RC18-12E/40**	**RC27-18/40 RC27-18E/40**
Low power outputs, total count	**11**	
200 mA PWM-capable switching outputs, low-side	4	
200 mA switching outputs low-side	4	
PWM signal output (can be used as analog output, external capacitance provided)	2	
0 V .. 10 V analog voltage output (alternative use of an input pin)	1	
Communication interfaces, total count	**6**	
CAN 2.0 B / CAN FD with non-selective wake-up function	1	
CAN 2.0 B / CAN FD with selective wake-up function	1	
CAN 2.0 B / CAN FD (standard interface for diagnosis and flashing)	1	
ISOBUS interface	1	
LIN	1	
Ethernet (option E only)	1	
Fault detection in the event of cable break and short circuit		
Inputs (depending on sensor type and input configuration the failure mode can be ambiguous)	•	
Outputs	•	
CAN	•	
LIN	•	
Ethernet (option E only)	•	
Protection against short circuits to supply voltage and ground (Requirement: controller is powered and running, i.e. T30 and T15 are connected to supply voltage, power ground pins are connected to T31, processor runs valid software)		
Inputs	•	
Outputs	•	
CAN	•	
LIN	•	
Ethernet (option E only)	•	
Reverse polarity protection	•	
Multicore processor with lockstep functionality	Infineon TC389	
Clock frequency (processor clock)	300 MHz	
Internal memory capacity in micro controller		
SRAM	1 MB	
DFlash	128 kB EEPROM-equivalent	
PFlash	10 MB	
Software installation		
Download in PFlash	•	
E1 Mark		
Type approval with regards to ECE regulation No. 10 revision 6	•	
CE Mark		
Compliance with EMC Directive 2014/30/EU. The harmonized standards EN ISO 13766-1:2018, EN 12895:2015 and EN ISO 14982:2009 have been applied.	•	
Compliance with RoHS2 directive 2011/65/EU on the restriction of the use of certain hazardous substances.	•	
Operating temperature		
Housing temperature, housing mounted on cooling surface	–40 to +85 °C (–40 to +185 °F)	
Max. permissible temperature of cooling surface	+60 °C (+140 °F)	
Weight	930 g, ± 5 %	

Qualification testing

Durability testing

Thermal testing has been conducted to simulate typical aging processes in mobile machines. The failure rates that have to be considered in safety-relevant applications depend on temperature and temperature change profiles. For more details see safety manual.

Humidity cycling test with ice

EN 60068-2-38:2010, 10 cycles with 5 cooling subcycles within the initial 9 cycles (chap. 6.4.1 to 6.4.4), supply voltage = 14 V, operating mode: intermittent (active in heating phase, passive in cooling phase), operating state: A in active cycles

Salt spray test

EN 60068-2-11:2000, Test Ka, T = 35 °C, NaCl solution = 5 %, pH = 6.5 – 7.2, duration = 144 h
Operating mode: passive, operating state: A after test

Chemical resistance test

ISO 16750-5:2010, tested media: engine oil, fertilizer, AdBlue, RME (rapeseed methyl ester), battery acid, gear oil, steering gear oil, anti-freeze, brake fluid, hydraulic oil, fuel, Diesel, cold cleaner, contact spray (WD 40)
Operating mode: passive, operating state: A after test

Protection class tests

ISO 20653:2013, protection class IP6kx
Operating mode: passive, with dummy sealed connector

ISO 20653:2013, protection class IPx9k and IPx6k
Operating mode: passive, the pressure compensation element PCE is not part of the test
IPx5 can be achieved with unprotected PCE

Mechanical tests

ISO 16750-3:2023, vibration
4.1.2.7 Test VII — Commercial vehicle, sprung masses
Duration = 32 h each axis, temperature overlaid T_i = -40 °C up to 105 °C, soak time = 30 min, frequency band: 10 - 2,000 Hz, a_{eff} = 57.9 m/s^2; see table 12

Frequency	PSD
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

Operating mode: active in heating phase, passive in cooling phase

EN 60068-2-27:2010, mechanical shock
Shock profile: half-sine, shock duration: 18 ms, acceleration: 30 *g*, cycles each direction = 1,000 (6,000 in total)
Operating mode: passive

EN 60068-2-27:2010, mechanical shock
Shock profile: half-sine, shock duration: 6 ms, acceleration: 100 *g*, cycles each direction = 3 (18 in total)
Operating mode: passive

Susceptibility EMC tests

ISO11452-2:2019, absorber-lined shielded enclosure method
complies with UN ECE 10 Rev. 6
24V system: Supply voltage = 27 V. This test covers the 12 V system as this is the more demanding test.

CW 200 MHz – 3 GHz, 100 V/m
AM 200 MHz – 800 MHz, 150 V/m
PM 800 MHz – 3 GHz, 150 V/m

ISO11452-4:2011, BCI test method
complies with UN ECE 10 Rev. 6
24V system: Supply voltage = 27 V, This test covers the 12 V system as this is the more demanding test.
1 MHz – 20 MHz: 100 mA
20 MHz – 400 MHz: 150 mA
Method: open loop, common mode (complete harness in current probe)

Emission EMC test

UN ECE 10 Rev. 6, broadband emitted interference
Chapter 6.5, appendix 6
Supply voltage = 13.5 V and 27 V

Frequency range in MHz	**peak value**
30 .. 75	62 - 25.13 log (f/730) dB(µV/m)
75 .. 400	52 + 15.13 log (f/75) dB(µV/m)
400 .. 1000	63 dB(µV/m)

Appendix 7: procedure according CISPR 25:2002 chapter 6.4 ALSE-method
Measuring distance 1 m peak detector, 120 kHz bandwidth

UN ECE 10 Rev. 6, narrowband emitted interference
Chapter 6.6, appendix 7
Supply voltage = 13.5 V and 27 V

Frequency range in MHz	**peak value**
30 .. 75	52 - 25.13 log (f/730) dB (µV/m)
75 .. 400	42 + 15.13 log (f/75) dB (µV/m)
400 .. 1000	53 dB (µV/m)

Appendix 8: Procedure according CISPR 25:2002 chapter 6.4 ALSE-method
Measuring distance 1 m average detector, 120 kHz bandwidth

CISPR25:2016, radiated emission
Chapter 6.5.4, table 7
Supply voltage = 13.5 V and 27 V
Class 3: LW, MW, CB, other frequency bands class 4

CISPR25:2016, conducted emission
Chapter 6.3.4, table 5
Supply voltage = 13.5 V and 27 V
Class 2: FM, class 3: MW, TV1, VHF, other frequency bands class 4

UN ECE 10 Rev. 6, ISO 7637-2:2011, ISO 7637-2:2004, voltage transient emission test
Supply voltage = 13.5 V
Table B.2, level III
slow pulses: + 37 V / - 75 V
fast pulses: + 75 V / - 112 V
This test covers the 24 V system as this is the more demanding test

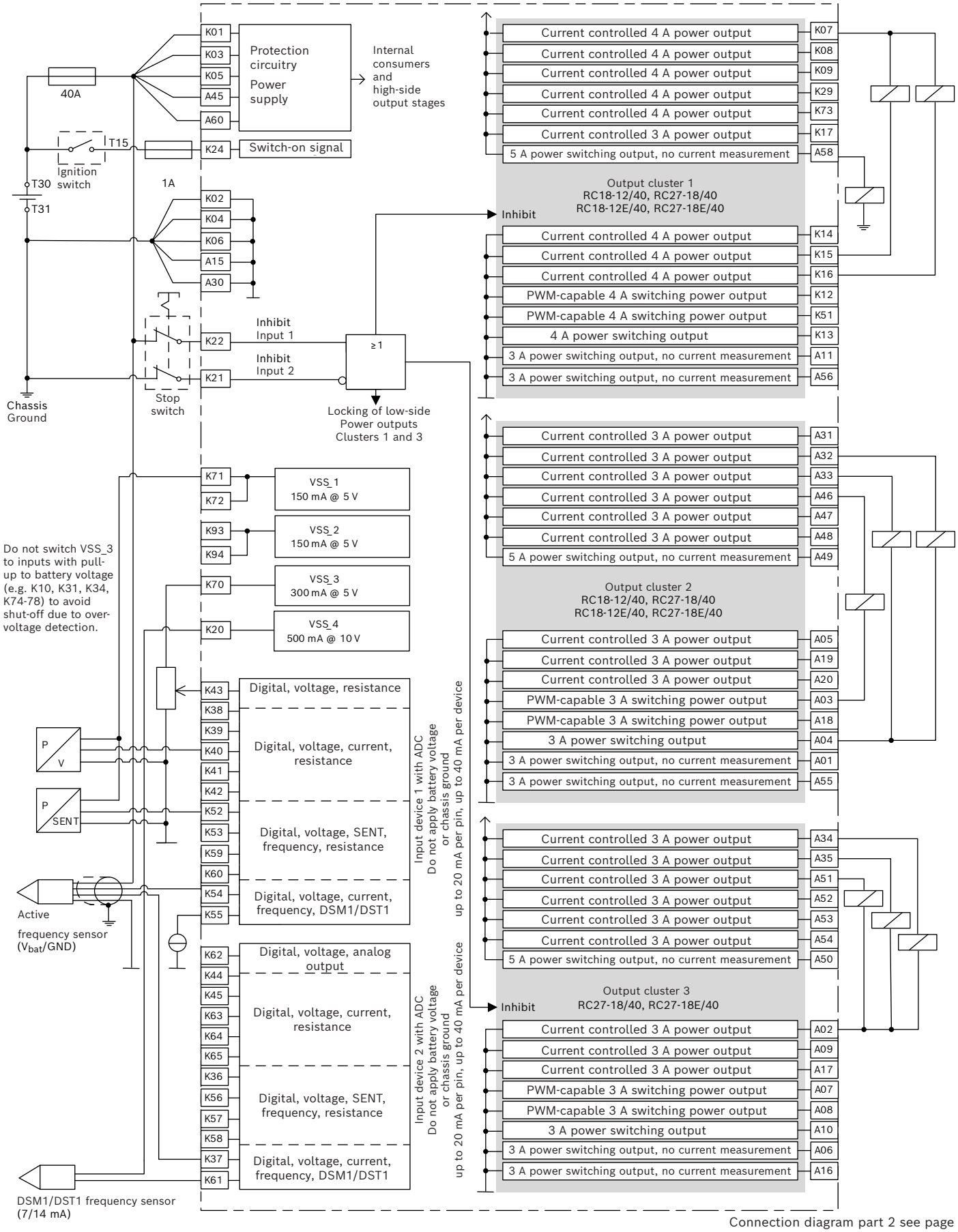
Electrostatic discharge (ESD) tests
ISO 10605:2023, direct contact discharge Supply voltage = 27 V Setup as chapter 8, figure 4 Test voltage: table C.1, category 1, L1 to L4 (max. ± 8 kV) 50 discharges distributed on connector and housing Operating mode: active, operating state: C
ISO 10605:2023, direct air discharge Supply voltage = 27 V Setup as chapter 8, figure 4 Test voltage: Table C.2, category 1, L1 to L4 (max. ± 15 kV) 50 discharges distributed on connector and housing Operating mode: active, operating state: C
ISO 10605:2023, contact discharge, not powered Setup as chapter 9, figure 6 Test voltage: table C.1, category 1, L1 to L4 (max. ± 8 kV) ISOBUS pins (K68, K90) are tested with ± 15 kV 3 discharges each pin, 5 discharges distributed on connector and housing Operating mode: passive, operating state: A after reset
ISO 10605:2023, air discharge, not powered Setup as chapter 9, figure 6 Test voltage: Table C.2, category 1, L1 to L4, max. ± 15 kV 3 discharges each pin, 5 discharges distributed on connector and housing Operating mode: passive, operating state: A after reset

Transient tests
ISO 7637-2:2011, test pulse 1 Supply voltage = 27 V U_s = -600 V, R_i = 50 Ω, t_d = 1 ms, t_r = 3 +0 / -0,5 µs, t_2 = 200 ms, t_3 = < 100 µs, 4,500 cycles with t_1 = 0.5 s and additional 500 cycles with t_1 = initialization time (> 1 s), operating state: C Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2011, test pulse 2a Supply voltage = 27 V U_s = +112 V, R_i = 2 Ω, t_d = 0.05 ms, t_1 = 200 ms, t_r = 1 µs, 5,000 pulses, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2011, test pulse 2b Supply voltage = 27 V U_s = +20 V, R_i = 0.05 Ω, t_d = 0.2 s to 2 s, t_{12} = 1 ms ± 0.5 ms, t_r = 1 ms ± 0,5 ms, t_6 = 1 ms ± 0.5 ms, 20 pulses, operating state: C Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2011, test pulse 3a Supply voltage = 27 V U_s = -300 V, R_i = 50 Ω, t_d = 150 ns ± 45 ns, t_r = 5 ns ± 1.5 ns, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, duration = 1 h, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2011, test pulse 3b Supply voltage = 27 V U_s = +300 V, R_i = 50 Ω, t_d = 150 ns ± 45 ns, t_r = 5 ns ± 1.5 ns, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, duration = 1 h, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test

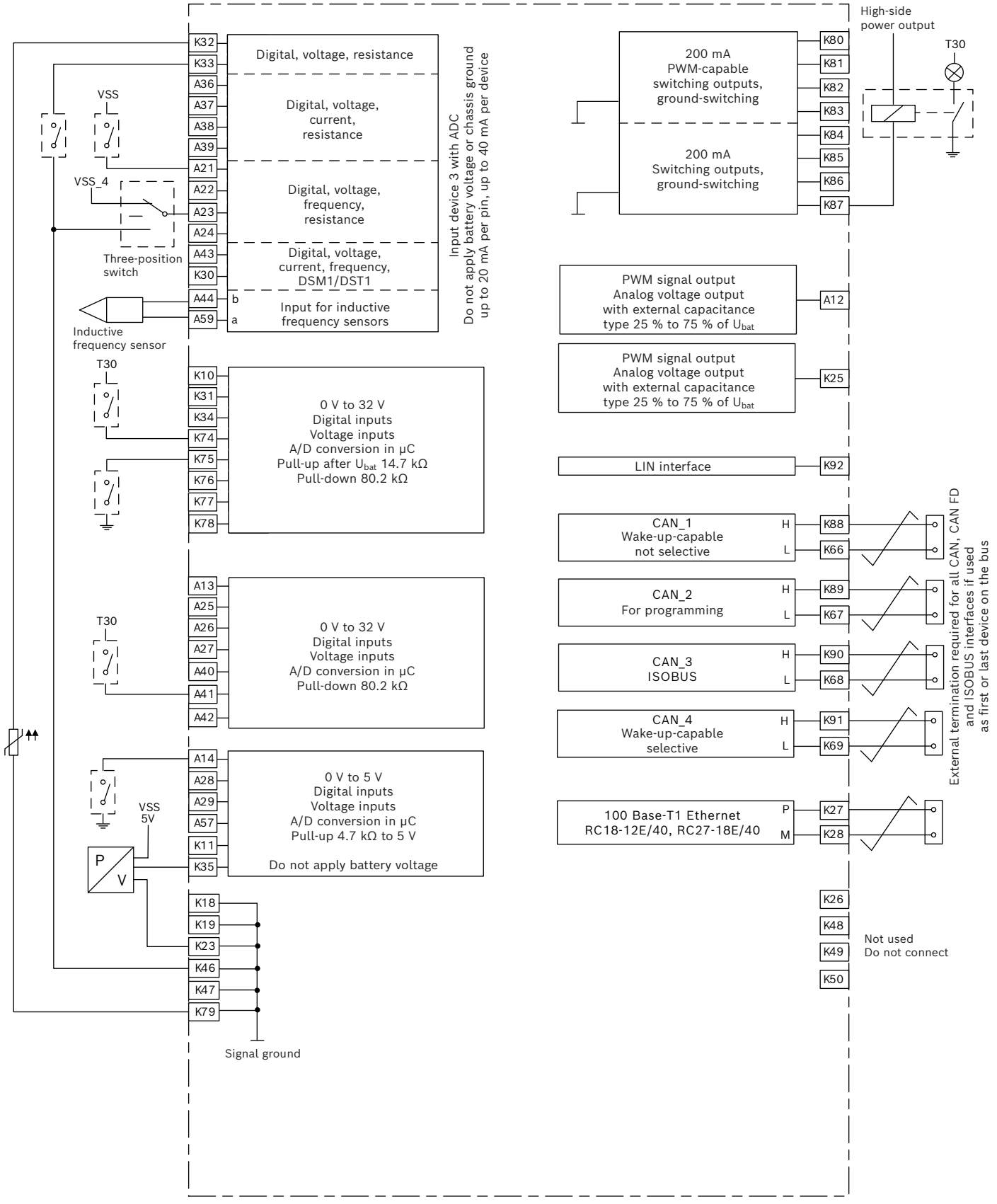
Transient tests
ISO 7637-2:2011 (ISO 16750-2:2012), starting profile (pulse 4) Supply voltage = 13.5 V U_{s6} = 4.5 V, U_s = 6.5 V, t_f = 5 ± 0.5 ms, t_6 = 15 ± 1.5 ms, t_7 = 50 ± 1.5 ms, t_8 = 10,000 ± 1,000 ms, voltage ripple during t_8 = Us + 2 V with f = 2 Hz, t_r = 100 ± 10 ms, 10 pulses, 1 s break between each pulse Operating state: C for components that are not relevant for starting phase. FS permissible for safety functions activated by inhibit.
ISO 7637-2:2004, starting profile (pulse 4) U_s = -6V, U_a = -4 V, R_i = 0 Ω .. 0.02 Ω, t_7 = 15 ms .. 40 ms, t_8 < 50 ms, t_9 = 0.5 s .. 20 s, t_{10} = 5 ms, t_{11} = 5 ms .. 100 ms No. of pulses: 1 Operating state: C for components that are not relevant for starting phase. FS permissible for safety functions activated by inhibit.
ISO 7637-2:2011 (ISO 16750-2:2012), starting profile (pulse 4) Supply voltage = 24 V U_{s6} = 6 V, U_s = 10 V, t_f = 10 ± 1 ms, t_6 = 50 ± 5 ms, t_7 = 50 ± 5 ms, t_8 = 1,000 ± 100 ms, Voltage ripple during t_8 = U_s + 2 V with f = 2 Hz, t_r = 40 ± 10 ms, 10 pulses, 1 s break between each pulse Operating state: C for components that are not relevant for starting phase. FS permissible for safety functions activated by inhibit.
ISO 16750-2:2012, table 5 (pulse 5a) Supply voltage = 24 V U_s = 202 V, R_i = 8 Ω, t_d = 350 ms, t_r = 10 +0 / -5 ms, 10 pulses at 1 min intervals Pins tested: Supply (A45, A60, K01, K03, K05, Ignition (K24), Inhibit (K 22), all pins connected and tested together Operating state: C
ISO 16750-2:2012, table 6 (pulse 5b) Supply voltage = 24 V U_a = 24 V, U_s = 151 V, U_s* = 41 V, R_i = 1 Ohm, t_d = 350 ms, t_r = 10 ms, t_1 = 60 s, 10 pulses at 1 min intervals Pins tested: low-side low power outputs (K80 .. K87) and discrete analog inputs 0 V .. 32 V (K10, K31, K34, K74 .. K78, A13, A25 .. A27, A40 .. A42) Operating state: C
ISO 7637-3:2016, fast pulses 3a and 3b Supply voltage = 24 V Method CCC, Level IV: U_s = - 150 V / + 150 V t_r = 5 ns, t_d = 0.15 ± 0.045 µs, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, R_i = 50 Ω, test duration: 10 min Operating state: A This test covers the 12 V system as this is the more demanding test
ISO 7637-3:2016, slow pulses 2a positive and negative Supply voltage = 24 V Method ICC, Level IV: U_s = + 10 V / - 10 V t_r = 1 µs + 0 / - 0.5 µs, t_d = 0.05 ms, t_1 = 1 s, R_i = 2 Ω Operating state: A This test covers the 12 V system as this is the more demanding test

General electrical tests
ISO 16750-2:2012, superimposed alternating voltage, chapter 4.4 Supply voltage = 24 V U_{Smax} = 32 V, U_{PP}: 4 V (severity level 2), frequency range = 50 Hz to 25 kHz, number of sweeps = 5, sweep duration = 120 s Operating state: A Operating mode: active
ISO 16750-2:2012, short circuit of signals, chapter 4.10.2 U_{Smax} = 32 V, duration = 60 s ± 10 % Operating state: C
ISO 16750-2:2012, overvoltage, chapter 4.3.2 U_{sup} = 36 V T = 65°C (= T_{max} minus 20°C) Duration: 60 min Power outputs are not active as these are intentionally shut off by diagnosis software above 32 V. Operating state: C
ISO 16750-2:2012, reversed polarity, chapter 4.7.2 Case 2, U_A = 28 V (see ISO 16750-1 and Table 7), duration = 60 ± 6 s, room temperature Operating state: A after reset

Connection diagram



Connection diagram part 2 see page 14



Connection diagram part 1 see page 13

Overview of functions

Pin	Description	Main function	Software modes	Comments
A45, A60, **K01, K03, K05**	**Power supply** Terminal 30	**Power supply for internal electronics and high-side output stages** Nominal supply voltage: 12 V or 24 V Normal operation: 11 V .. 32 V For other voltage ranges see technical data above These pins must not be used as current output, e.g. for supply of other devices.		A fuse in the supply line with max. 40 A is required. All five pins shall be used for an even current distribution.
A15, A30, **K02, K04, K06**	**Power Ground** Terminal 31	**Ground for power supply** Internally connected to signal ground pins		All five pins shall be used for an even current distribution.
K24	**Ignition switch** Terminal 15 Internal Pull-Down resistor 10 kΩ	**Switch-on signal** Switching to high level wakes-up the controller Switching to low level or opening the key switch terminates normal operation and the controller enters into POSTRUN and then into SHUTDOWN status. Finally the controller goes into SLEEP status. In POSTRUN, cyclic processes are possible. In SHUTDOWN, one more non-cyclic process is possible. High-level > 4.5 V Low-level < 2.9 V or open pin		
K22	**Inhibit input 1** Internal 5 kΩ pull-down resistor when controller energized	**Stop switch input** The power output stages are deactivated if this pin is not switched to high level High-level ≥ 7 V Low-level ≤ 2 V or open pin Quiescence current max. 275 µA (ECU is off and inhibit 1 is connected to 13.5 V) If the inhibit function is not used, this pin has to be connected to battery voltage so that the output stages can be activated. Once the inhibit function is activated the output stages remain off even if this signal returns to high level until the output stages are unlocked by the application software (prevention of restart). Switching current ≥ 2 mA (disabled when the controller is in standby)		The inhibit function acts on the power outputs of output cluster 1 and additionally on output cluster 3 at RC27-18x/40. Respectively, output cluster 2 is not shut down. If the power outputs of output cluster 2 shall also be switched off by the activation of an inhibit input, this can be realized with the ASW application software. The inhibit function is a pure hardware function independent from BSW and ASW. Only release of the output stages after deactivation of the inhibit function is realized in software.
K21	**Inhibit input 2** Internal 2 kΩ pull-up resistor to 5 V	**Stop switch input** The power output stages are deactivated if this pin is not switched to low level High-level ≥ 4 V or open pin Low-level ≤ 2 V If the inhibit function is not used, this pin has to be connected to ground so that the output stages can be activated. Once the inhibit function is activated the output stages remain off even if this signal returns to low level until the output stages are unlocked by the application software. Switching current ≥ 2 mA (disabled when the controller is in standby)		

Pin	Description	Main function	Software modes	Comments
K71, K72	**Sensor Supply 1**	**Sensor supply VSS_1** Ratiometric to ADC reference voltage Maximum output current (for the two pins in total) 150 mA Output voltage 5 V Output voltage tolerance ± 105 mV State during start-up active The admissible capacitive load depends on the load current: < 50 mA ≤ 1.2 µF < 100 mA ≤ 0.9 µF < 150 mA ≤ 0.33 µF		Two pins are provided for the ease of wiring Do not connect to another VSS_x
K93, K94	**Sensor Supply 2**	**Sensor supply VSS_2** Same as VSS_1		Same as VSS_1
K70	**Sensor Supply 3**	**Sensor supply VSS_3** Ratiometric to ADC reference voltage Max. output current 300 mA Output voltage 5 V Output voltage tolerance ± 150 mV State after start-up active Admissible capacitive load ≤ 100 µF		Do not connect to another VSS_x
K20	**Sensor Supply 4**	**Sensor supply VSS_4** Non-ratiometric to ADC reference voltage Min. output current required 5 mA Max. output current 500 mA Output voltage (battery voltage > 11 V provided) 10 V Output voltage tolerance ± 1 V State after start-up active Admissible capacitive load ≤ 100 µF		Can be used for Bosch Rexroth speed sensor DSM1/DST1 Do not connect to another VSS_x
K18, K19, K23, K46, K47, K79	**Signal ground pins**	**Ground connection for sensors** Internally connected to ground pins of power supply These pins must be used for the ground connection of sensors or potentiometers that provide signals to the controller		Six pins are provided for the ease of wiring

Pin	Description	Main function	Software modes	Comments
	Multi-functional inputs Input device 1 **Multi-functional inputs** Input device 2 **Multi-functional inputs** Input device 3	**Common properties for inputs at input devices** A switching current of 5 mA is activated for 1024 ms after a voltage level change on switched inputs Constant current source or sink configurable in pre-defined steps (the function is similar to a pull-up and pull-down resistors): Pull-Up current 7.5 µA .. 20 mA Pull-Down current 20 µA .. 20 mA Configurable pull-up voltage 5V or battery voltage **Digital inputs** Digital inputs with configurable pre-defined hardware thresholds Low High Automotive logic < 2.2 V > 3.5 V TTL logic < 0.8 V > 2.2 V Logics for higher voltages < 3.5 V > 6.0 V **Analog voltage inputs** Can be used as digital inputs with thresholds defined by the application software Three configurable voltage measurement ranges up to 5 V, 20 V, 40 V If the pull-up voltage 5 V is combined with the measurement range 20 V or 40 V, then voltage overshoot at the input can occur. Thus, these combinations are not recommended. Accuracy within the defined measurement range 5 V range 0.05 .. 4.95 V ± 2 % of full scale 20 V range 0.45 .. 18.3 V ± 4 % of full scale 40 V range 0.80 .. 38.9 V ± 4 % of full scale Resolution 12 bit Filter limit frequency: ≥ 25 kHz (first order filter) **Resistance measurement (not at K62)** Measurement range 20 Ω .. 400 kΩ Pull-Up voltage 5 V Accuracy (in % of highest value in range) 20 Ω .. 50 Ω 19 % 50 Ω .. 2 kΩ 3.5 % 2 kΩ .. 30 kΩ 3.5 % 30 kΩ .. 350 kΩ 3.5 % 350 kΩ .. 400 kΩ 10 % Resolution 15 bits Conversion to °C for the Bosch Rexroth PTC temperature sensors TSA and TSF and the Bosch NTC sensor TF-W is provided by the base software. The temperature characteristic of other temperature sensors can be filed in a custom look-up table.	DI AI AIV AID	Do not apply battery voltage or chassis ground

Pin	Description	Main function	Software modes	Comments
K43 K32, K33	**Multi-functional inputs** Input device 1 **Multi-functional inputs** Input device 3	**Digital, analog voltage inputs and resistance measurement, see page 17**		Do not apply battery voltage or chassis ground
K38, K39, K40, K41, K42	**Multi-functional inputs** Input device 1	**Digital, analog voltage inputs and resistance measurement, see page 17** additionally:		
K44, K45, K63, K64, K65 A36, A37, A38, A39	**Multi-functional inputs** Input device 2 **Multi-functional inputs** Input device 3	**Analog current inputs** Switchable shunt 200 Ω Nominal measurement range 4 mA .. 20 mA Full measurement range 0 mA .. 24 mA Accuracy ± 3.6 % of full range Filter limit frequency ≥ 11 kHz	AIC	
A21, A22, A23, A24	**Multi-functional inputs** Input device 3	**Digital, analog voltage inputs and resistance measurement, see page 17** additionally: **Frequency inputs for active frequency sensors that switch between battery voltage and ground** Low-level < 2.2 V High-level > 3.5 V Frequency range 1 Hz .. 20 kHz Filter limit frequency ≥ 25 kHz Phase measurement and pulse counter possible	FI	
K52, K53, K59, K60	**Multi-functional inputs** Input device 1	**Digital, analog voltage inputs and resistance measurement, see page 17** additionally:		
K36, K56, K57, K58	**Multi-functional inputs** Input device 2	**Frequency inputs for active frequency sensors that switch between battery voltage and ground** Low-level < 2.2 V High-level > 3.5 V Frequency range 1 Hz .. 20 kHz Filter limit frequency ≥ 25 kHz Phase measurement and pulse counter possible	FI	
		SENT inputs (Single edge nibble transmission) Digital sensor signal input according to the SAE J2716 Rev. 4 201604 protocol Pull-Up (current source) 250 µA Pull-Up voltage 5 V The base software provides decoding of the bit-streams of fast channels and slow channel	SENT	

Pin	Description	Main function	Software modes	Comments
K54, K55	**Multi-functional, inputs** Input device 1	**Digital inputs, see page 17** **Analog voltage inputs** Filter limit frequency ≥ 11 kHz, other specifications, see page 17 (no resistance measurement) additionally:		Do not apply battery voltage or chassis ground
K37, K61	**Multi-functional, inputs** Input device 2		FI	
A43, K30	**Multi-functional, inputs** Input device 3	**Frequency inputs for active frequency sensors that switch between battery voltage and ground** Low-level < 1.7 V High-level > 2.2 V Frequency range 1 Hz .. 20 kHz Filter limit frequency ≥ 34 kHz Phase measurement and pulse counter possible		
		Analog current inputs Switchable shunt 200 Ω Nominal measurement range 4 mA .. 20 mA Full measurement range 0 mA .. 24 mA Accuracy ± 3.6 % of full range Filter limit frequency ≥ 11 kHz	AIC	
		Frequency inputs for Bosch Rexroth speed sensors DSM1/DST1 Switchable shunt 200 Ω Low-level < 8.4 mA High-level > 11.2 mA Frequency range 1 Hz .. 10 kHz Filter limit frequency ≥ 34 kHz	FI	
K62	**Multi-functional input or analog output** Input device 2	**Digital and analog voltage inputs, see page 17** (no resistance measurement) **Analog output** Voltage output range 0 V .. 10 V Minimum external ohmic resistance: 3 kΩ This I/O Pin has a 2 µF smoothing capacitor. A short charging current pulse occurs when used as a switching input. This may cause a feedback in the voltage source, e.g. short circuit might be detected erroneously. This pin has a 78 kΩ pull-down resistance. This is a voltage divider for the analog feedback when used as an output. If the pin is configured as analog input with a current source, then the pull-up current will cause a voltage drop at the resistance that is measured with an open terminal (e.g. 1.56 V at 20 µA).	AOV	
A44, A59	**Multi-functional input** Input device 3	**Frequency input for inductive speed sensors** Frequency range 10 Hz .. 20 kHz Input sensitivity 1 V_{RMS} Max. input voltage ± 80 V_{AC} (56 V_{RMS}) Pulse counter possible	FI	

Note on the use of the phase measurement for direction of rotation and pulse-counter

The base software of the controller facilitates the detection of the rotational direction by means of the phase measurement between two frequency outputs of a speed sensor. The two frequency signals (primary signal and secondary signal) have to be acquired via predefined pairs of inputs. The following pairs can be selected in the online tool:

K52 and K57	K59 and K56	K54_VI and K37_VI
K60 and K58	A21 and A22	K55_VI and K61_VI
K53 and K36	A23 and A24	A43_VI and K30_VI

Use of frequency input pairs with primary and secondary inputs realized by different input devices enables realization of ADC redundancy for analog read back.

The Rexroth speed sensors DSM1/DST1 provide both the frequency and rotational direction information on a single line. Thus, only one of the inputs A43_VI, K30_VI, K37_VI, K54_VI, K55_VI and K61_VI is required for one sensor.

The phase pairs can be used for counting pulses, too. The pulses of the primary signal are counted. The counter is incremented or decremented depending on the phase of the secondary signal, i.e. the state of the signal at the rising edge of the primary signal.

Pin	Description	Main function	Software modes	Comments
K10, K31, K34, K74, K75, K76, K77, K78	**Analog inputs** (discrete)	**Analog voltage inputs** Measuring range 0 V .. 32 V Accuracy at 32 V for sensor signal measurement ± 7.5 % for battery voltage measurement ± 10 % Resolution 12 bits Pull-Down resistor 80 kΩ Pull-Up resistor 14.7 kΩ Filter limit frequency ≥ 279 Hz Open terminal voltage: Min. U_{bat} * 0.83 – 0.6 V Typ. U_{bat} * 0.85 – 0.4 V Max. U_{bat} * 0.86 – 0.15 V Pull-Up voltage is the battery voltage (reverse polarity protection via diode in the pull-up path) Voltage with open terminal approx. 85% of U_{bat} These inputs can be used as digital inputs with thresholds defined by the application software. These inputs can be switched to ground, battery voltage or VSS_x. The reading of analog sensor signals is not recommended due to the limited accuracy and filter characteristic.	AI AID AIV	Load Dump protected up to U_s* = 41 V
A13, A25, A26, A27, A40, A41, A42	**Analog inputs** (discrete)	**Analog voltage inputs** Measuring range 0 V .. 32 V As above, however, without pull-up, for this reason, only active high and voltage at open terminal 0 V		
A14, A28, A29, A57, K11, K35	**Analog inputs** (discrete)	**Analog voltage inputs** Measuring range 0 V .. 5 V Accuracy for non-ratiometric Signals ± 2.2 % at 5 V Resolution 12 bits Pull-Up resistor after 5 V 4.7 kΩ Filter limit frequency ≥ 1950 Hz Active low and voltage at open terminal 5 V These inputs are suitable for sensors with analog voltage output. A/D conversion is realized in the µC.		Do not switch to voltages higher than 5 V, particularly not to battery voltage

Pin	Description	Main function	Software modes	Comments
A12, K25	**PWM / Analog output**	**PWM signal output** PWM frequency 5 kHz Duty cycle 0 % .. 100 % Supply voltage Battery voltage Output voltage 0% or 25 % .. 75 % of battery voltage Accuracy ± 7.5 % at 32 V Serial resistor (output current limiter) 3.5 kΩ Pull-Down resistor in analog feedback 55 kΩ Ripple dependent on external capacitance. ≥ 100 µF recommended.	AOV	
K84, K85, K86, K87	**Low-side, low power digital outputs**	**Switching outputs** Max. current rating per output 200 mA Typically used for relays	DO	The total current of all eight low-side, low-power outputs must not exceed 1200 mA. Loads connected to a low-side output must be powered from a high-side output. Load Dump protected up to U_s* = 41 V
K80, K81, K82, K83	**Low-side, low power digital outputs**	**PWM-capable switching outputs** Max. current rating per output 200 mA Frequency adjustable in software from 32 Hz to 3.3 kHz Duty cycle adjustable in software in 1000 steps Can be used to generate a frequency or PWM signal if an external pull-up resistor (e.g. to VSS_4) is used. To ensure a sufficient slew rate, small duty cycles should not be used at high frequencies. Indicative value for PWM control: max. 250 Hz. For full diagnosis capability a minimal pulse length of 250 µs is required.	PO POD	
K07, K08, K09, *K29*, *K73*	**High-side power output stages**	**Current controlled power outputs** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1.1 s PWM duty cycle adjustable from 0 % to 100 % in 1000 steps in open-loop controlled operation. PWM frequency configurable in defined steps from 10 Hz to 1 kHz Repetition current measurement accuracy under static conditions: from 0.1 A .. 1 A ± 10 mA from 1 A .. 4 A ±1 % of set-point At 1 kHz PWM frequency, a dither frequency can be superimposed: Dither frequency 83 Hz .. 250 Hz in 10 steps Dither amplitude 0 .. 500 mA Threshold for short circuit detection 6.5 A .. 25 A	PO POD POC	The total current of all high side and the internal electronics must not exceed 40 A. Spark suppression diode in the controller Loads controlled with PWM current must not be switched with spark suppression diodes as these have an impact on current measurement. For diagnosis functions, see BSW manual The voltage at open terminal or high-resistance load is 5 V. The 5 V source can drive a diagnosis current of up to 15 mA.
K17 *A31, A32, A33, A46, A47, A48* *A34, A35,* A51, A52, A53, A54		**Current controlled power outputs** Continuous max. current per output 3 A Permissible single current overshoot 5 A for max. 100 ms within 1.1 s For further details, see above.		
A58, *A49, A50*		**Switched power outputs** Continuous max. current per output 5 A Permissible single current overshoot 7 A for max. 100 ms within 1 s Without current feedback but with detection of short circuit to battery, short circuit to ground and cable break. Threshold for short circuit detection 7.4 A .. 16 A	DO	

Pin	Description	Main function	Software modes	Comments
K14, K15, K16	**Low-side power output stage**	**Current controlled power outputs** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1.1 s PWM duty cycle adjustable from 0 % to 100 % in 1000 steps in open-loop controlled operation. PWM frequency configurable in defined steps from 10 Hz to 250 Hz Repetition current measurement accuracy under static conditions: from 0.1 A .. 1 A ± 10 mA from 1 A .. 4 A ± 1 % of set-point Threshold for short circuit detection 6.5 A .. 25 A	PO POD POC	Loads connected to a low-side output must be powered from a high-side output. Spark suppression diode in the controller Loads controlled with PWM current must not be switched with spark suppression diodes as these have an impact on current measurement. For diagnosis functions, see BSW manual The voltage at open terminal or high-resistance load is 5 V. The 5 V source can support a diagnosis current of up to 15 mA.
A05, A19, A20 *A02,* A09, *A17*		**Current controlled power outputs** Continuous max. current per output 3 A Permissible single current overshoot 5 A for max. 100 ms within 1.1 s For further details, see above.		
K12, *K51*		**PWM-capable switching power outputs** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1.1 s PWM duty cycle adjustable from 0 % to 100 % in 1000 steps in open-loop controlled operation. PWM frequency configurable in defined steps from 10 Hz to 250 Hz Max. fault at current feedback ± 400 mA within a range of 100 mA .. 4 A. For HS/LS current deviation, see Safety Manual. Threshold for short circuit detection 10 A .. 17.2 A	PO POD	
A03, A18 A07, A08		**PWM-capable switching power outputs** Continuous max. current per output 3 A Permissible single current overshoot 5 A for max. 100 ms within 1.1 s For further details, see above.		
K13	**Low-side power output stage**	**Power switching output** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1 s Max. fault at current feedback ± 400 mA within a range of 100 mA .. 4 A. For HS/LS current deviation, see Safety Manual. Threshold for short circuit detection 10 A .. 17.2 A	DO	
A04 A10		**Power switching output** Continuous max. current per output 3 A Permissible single current overshoot 5 A for max. 100 ms within 1 s Max. fault at current feedback ± 400 mA within a range of 100 mA .. 4 A. For HS/LS current deviation, see Safety Manual. Threshold for short circuit detection 6.5 A .. 25 A		
A11, A56 *A01,* A55 A06, *A16*		**Power switching output** Continuous max. current per output 3 A Permissible single current overshoot 5 A for max. 100 ms within 1 s Without current feedback but with diagnosis functions: Detection of short circuit to battery, short circuit to ground and cable break Threshold for short circuit detection 6.5 A .. 25 A		

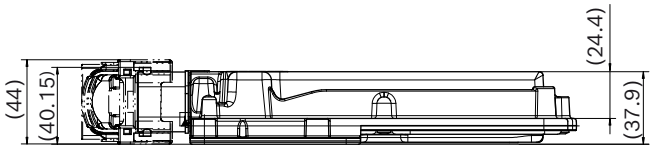
Pin	Description	Main function	Software modes	Comments
K88 K66	**CAN_1 High** **CAN_1 Low**	**CAN bus interface** High speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Wake-up by pattern (WUP) can be enabled for this CAN interface in the easyConfig tool. Any data traffic wakes-up the controller if WUP is enabled. The wake-up function is lost if the controller is disconnected from the voltage supply and must be reconfigured by the BSW, i.e. one re-start via T15 is required.		When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K89 K67	**CAN_2 High** **CAN_2 Low**	**CAN bus interface** High speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Standard CAN interface for flashing and diagnosis		
K90 K68	**CAN_3 High** **CAN_3 Low**	**ISOBUS interface** Implementation of ISOBUS interface for ECUs according to ISO 11783-2 Can be used as high speed CAN 2.0 b up to 1 Mbaud Standard CAN interface for XCP access.		When used as the first or last node of an ISOBUS, an active terminating bias circuit (TBC) has to be applied. When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K91 K69	**CAN_4 High** **CAN_4 Low**	**CAN bus interface** High speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Wake-up by pattern (WUP) or wake-up by frame (WUF) can be enabled for this CAN interface in the easyConfig tool. Any data traffic wakes-up the controller if WUP is enabled. If WUF is enabled, the controller wakes-up, when a message with a configurable ID and data is received. The wake-up function is lost if the controller is disconnected from the voltage supply and must be reconfigured by the BSW, i.e. one re-start via T15 is required.		When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K92	**LIN**	**LIN Bus interface** Master interface according to ISO 17987-4 Maximum baud rate 20 kBaud		Normative requirements are only complied with in the 12 V system.
K27 K28	**Ethernet Plus** **Ethernet Minus**	**100Base-T1 Ethernet interface** Interface according to IEEE 802.3bw for 100 Mbit/s transmission rate. Connection with unshielded twisted-pair line (unshielded twisted-pair automotive Ethernet). On physical level not compatible with 4 and 8-wire IT-Ethernet.		Only for RC18-12**E**/40 and RC27-18**E**/40 For optimum impedance matching, it must be ensured that the untwisted cable ends have the same length and that they are as short as possible.
Other	**Reserved Pins**	**No function** These pins cannot be used and must not be connected		

PIN sizes
Bold pin numbers are for contact type BDK 2.8
Italic pin numbers in are for contact type MQS 1.5 CB
All other pins are for contact type BCB 0.6

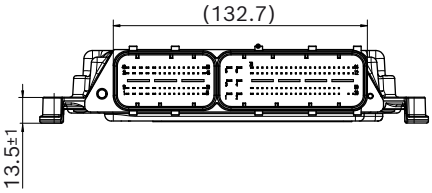
Software modes	
DI	Digital input (state)
AI	Analog input (raw value in digits)
AIV	Analog input voltage in mV
AID	State level dependent of software defined thresholds
AIC	Analog input current in µA
RI	Resistance input in Ω, optional conversion to °C by means of look-up tables supported by BSW
FI	Frequency input in 0.1 Hz
SENT	SAE J2716 input
DO	Digital Output (on/off)
PO	Proportional output (duty cycle in 0.1 %)
POD	Proportional output digital (0 % / 100 %)
POC	Proportional output current controlled (set current in mA)
AOV	Analog output set point in mV (range 0 .. 10 V) or Set point in 0.1 % of battery voltage (range 25 % .. 75 %)

Dimensions

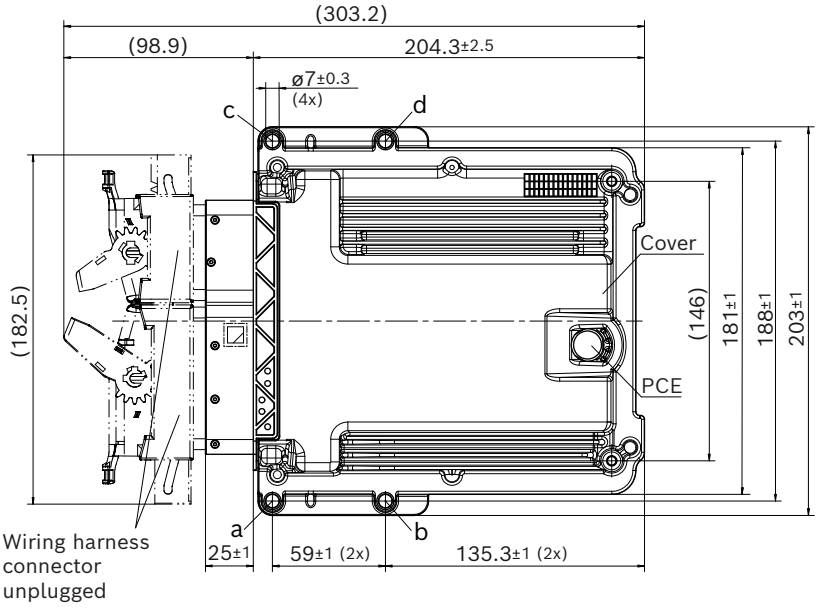
Long-side view



Side view with pulled connector



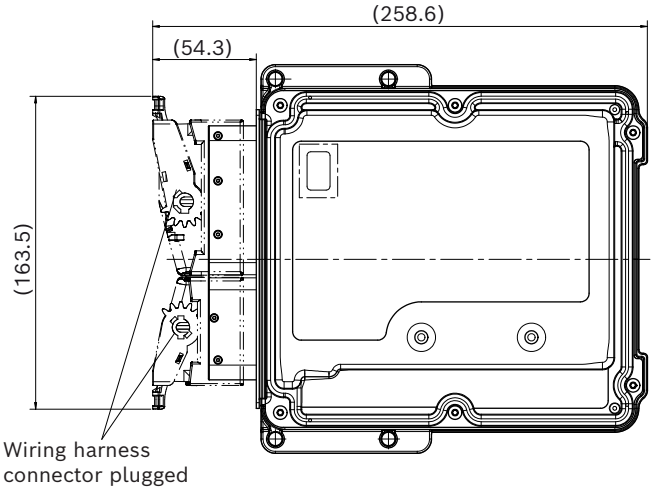
Top view



Fixing:

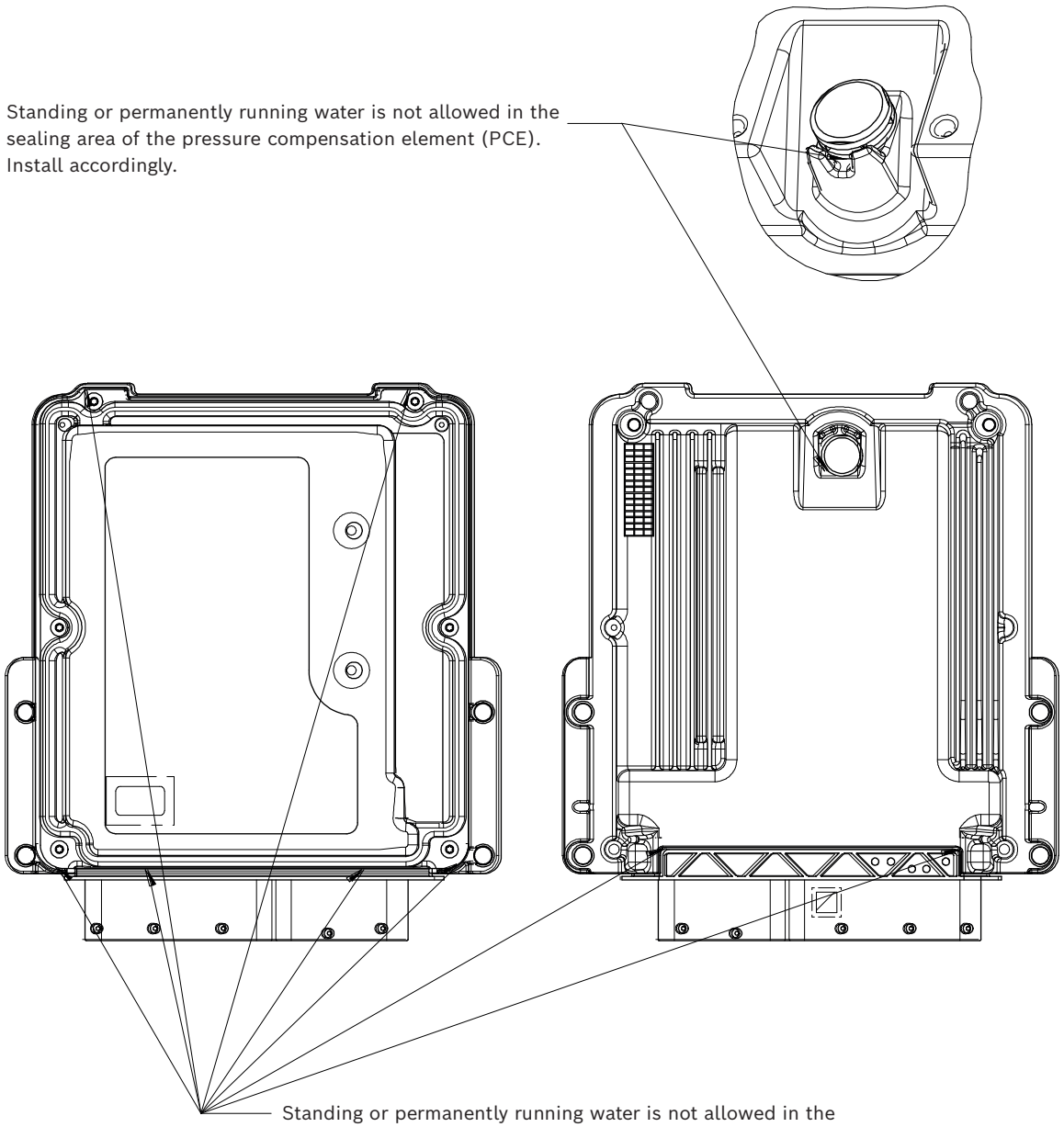
- The BODAS controller must be fixed at 4 positions (a, b, c and d).
- The BODAS controller has to be fastened in the vehicle so as to avoid bouncing against other vehicle parts and additional fastening elements of the controller.
- The maximum tightening torque for fastening the BODAS controller with M6 screws is 10 Nm.
- This 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.
- The minimum gap between the bottom and the screw on surface of the vehicle is 1 mm.
- The evenness of the mounting surface between points a, b, c and d is ▱ 0.5.
- The wiring harness should be fixated in the area in which the control unit is installed (spacing < 150 mm) in such a way that in-phase excitation with the control unit occurs (e.g. at the control unit tightening point).
- The wiring harness should be fixed such that the assembly has sufficient room to exit the BODAS controller without putting too much force on the mating connector.
- If the mounting surface is not sufficiently even, place flexible compensating elements between the fixing points of the BODAS controller and the mounting surface
- The housing must have a low ohmic electrical connection to the chassis ground. If this is not ensured by the mounting bolts, the connection must be established in a different way, e.g. via an earth strap.

Bottom view



Display without scale

Installation position



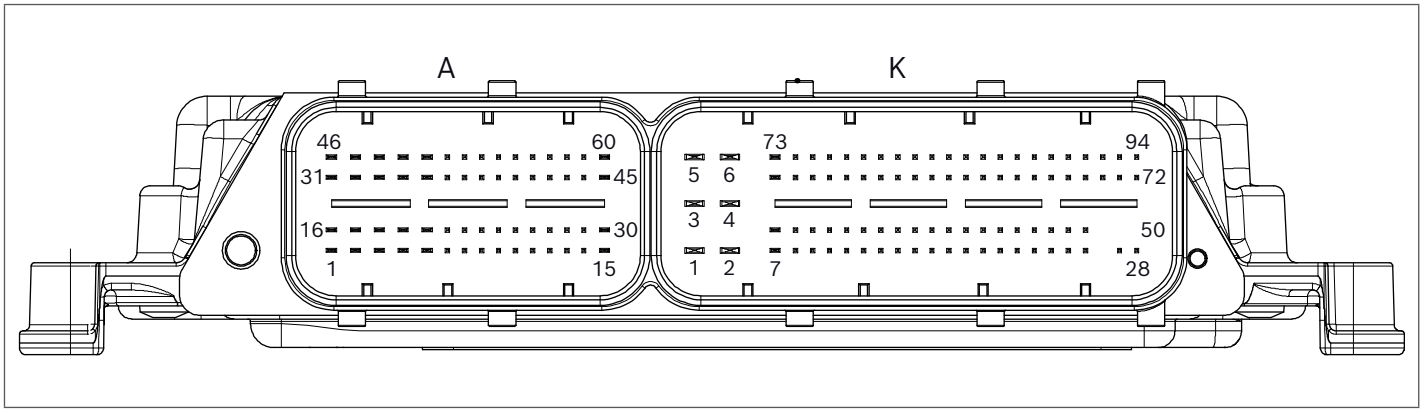
This drawing is for illustration of the sealing areas only. The controller can be mounted horizontally, vertically or at an angle to three the main axis. Mounting up-side-down is permissible. However, when installed on a machine, the connectors must not face upwards.

Mating connector

The 154-way plug connector is divided in two chambers. The larger chamber has 94 pins with the designation K. The smaller chamber has 60 pins with the designation A.
The 1 928 xxx numbers stated below are Bosch designations. Technical details about these documents and part numbers are available at www.bosch-connectors.com.
The numbers prefixed with "TE" are designations of TE Connectivity (previously Tyco Electronics).
Visit www.te.com for information on these items.

Assembly instruction	1 928 A01 09M
Technical customer documentation	1 928 A01 00T
Offer drawing (assembly)	1 928 A00 325
Offer drawing (carrier)	1 928 A00 326
Final check instruction	1 928 A00 05E

View of connector strip



Terminal designation

Contact BCB 0.6	Contact MQS 1.5 CB	Contact BDK 2.8
Row 1: Pins A6 to A14, K8 to K28	Row 1: Pins A1 to A5, A15, K7	Pins K1 to K6
Row 2: Pins A21 to A29, K30 to K50	Row 2: Pins A16 to A20, A30, K29	
Row 3: Pins A36 to A44, K52 to K72	Row 3: Pins A31 to A35, A45, K51	
Row 4: Pins A51 to A59, K74 to K94	Row 4: Pins A46 to A50, A60, K73	

Notice: Pins 26, 48, 49 and 50 are not present on the connector of the Ethernet variant (see figure above).
The variant without Ethernet does include these pins, but they are not used.

Tools

Contact Type	Line cross section in mm^2	Hand crimping tool	Wear part set	Automatic crimping	Extraction tool	Process specification contact
BCB 0.6	0.35 to 0.5	1 928 498 753	1 928 498 749	1 928 498 751	1 928 498 755	1 928 A00 70M
BCB 0.6	0.75	1 928 498 753	1 928 498 750	1 928 498 752	1 928 498 755	1 928 A00 70M
MQS 1.5 CB	0.75 to 1.5	TE 539635-1 with insert TE 539692-2	TE 541662		TE 6-1579007-0	TE 114-18286
BDK 2.8	0.5 to 1.0	1 928 498 161	1 928 498 163	1 928 498 165	1 928 498 167	1 928 F00 025
BDK 2.8	1.5 to 2.5	1 928 498 162	1 928 498 164	1 928 498 166	1 928 498 167	1 928 F00 025

Cable
Use FLKr Type "B" cables.

Mating connector

The following parts are required for assembling a wiring harness connector. Alternatives are listed if applicable.

Designation	Version	Part number	Manufacturer	Number
Contact carrier, 94-pin, Code C		1 928 405 063	Bosch	1
Contact carrier, 60-pin, Code C		1 928 405 064	Bosch	1
Cover, 94-pin	Outlet up Outlet left Outlet right	1 928 405 247 1 928 405 071 1 928 405 069	Bosch	1
Cover, 60-pin	Outlet up Outlet left Outlet right	1 928 405 248 1 928 405 072 1 928 405 070	Bosch	1
Secondary lock, 94-pin, power		1 928 405 074	Bosch	1
Secondary lock, 94-pin, signal		1 928 405 073	Bosch	1
Secondary lock, 60-pin		1 928 405 075	Bosch	1
Holding plate, 94-pin		1 928 405 067	Bosch	1
Holding plate, 60-pin		1 928 405 068	Bosch	1
Fixing strap		1 928 401 713	Bosch	2
Contact BCB 0.6	Line cross section 0.35 - 0.5 mm² Insulation diameter 1.2 – 1.6 mm Not allowed for power output pins, recommended for CAN and Ethernet	1 928 492 555	Bosch	up to 120
	Line cross section 0.75 mm²: Insulation diameter 1.7 – 1.9 mm Not recommended for Ethernet	1 928 492 556	Bosch	
Contact MQS 1.5 CB	Line cross section 0.75 – 1.5 mm² Insulation diameter 1.7 – 2.4 mm	TE 1 241 608-1	TE Connectivity	up to 28
Contact BDK 2.8	Line cross section 0.5 – 1.0 mm² Insulation diameter 1.2 – 2.1 mm	1 928 498 056	Bosch	up to 6
	Line cross section 1.5 – 2.5 mm² Insulation diameter 2.2 – 3.0 mm	1 928 498 057	Bosch	
Dummy contact BCB 0.6		1 928 405 077	Bosch	[1]
Dummy contact MQS 1.5-CB		1 928 405 076	Bosch	[1]
Single wire seal for BDK 2.8	For insulation diameter 1.2 – 2.1 mm (blue)	1 928 300 599	Bosch	up to 6
	For insulation diameter 2.2 – 3.0 mm (white)	1 928 300 600		
Cavity / dummy plug BDK 2.8	(clear)	1 928 300 601	Bosch	[1]

1) Free contact chambers are to be sealed with dummy contacts to ensure water tightness.

Connector Kit

Mating connector sets with the following content are available under Rexroth part number R917013307 for the manual assembly of wiring harness connectors for laboratory or small-series requirements. Machined assembly is recommended for larger quantities.

Designation	Version	Part number	Manufacturer	Number
Contact carrier, 94-pin, Code C		1 928 405 063	Bosch	1
Contact carrier, 60-pin, Code C		1 928 405 064	Bosch	1
Cover, 94-pin	Outlet right	1 928 405 069	Bosch	1
Cover, 60-pin	Outlet right	1 928 405 070	Bosch	1
Secondary lock, 94-pin, power		1 928 405 074	Bosch	1
Secondary lock, 94-pin, signal		1 928 405 073	Bosch	1
Secondary lock, 60-pin		1 928 405 075	Bosch	1
Holding plate, 94-pin		1 928 405 067	Bosch	1
Holding plate, 60-pin		1 928 405 068	Bosch	1
Fixing strap		1 928 401 713	Bosch	2
Contact BCB 0.6	Line cross section 0.35 – 0.5 mm² Insulation diameter 1.2 – 1.6 mm Not allowed for power output pins, recommended for CAN and Ethernet	1 928 492 555	Bosch	12
	Line cross section 0.75 mm²: Insulation diameter 1.7 – 1.9 mm Not recommended for Ethernet	1 928 492 556	Bosch	120
Contact MQS 1.5 CB	Line cross section 0.75 – 1.5 mm² Insulation diameter 1.7 – 2.4 mm	TE 1 241 608-1	TE Connectivity	30
Contact BDK 2.8	Line cross section 1.5 – 2.5 mm² Insulation diameter 2.2 – 3.0 mm	1 928 498 057	Bosch	8
Dummy contact BCB 0.6		1 928 405 077	Bosch	90
Dummy contact MQS 1.5-CB		1 928 405 076	Bosch	28
Single wire seal for BDK 2.8	Insulation diameter 2.2 – 3.0 mm (white)	1 928 300 600	Bosch	6
Cavity / dummy plug BDK 2.8	(clear)	1 928 300 601	Bosch	4[1)]

1) Free contact chambers are to be sealed with dummy contacts to ensure water tightness.

Safety instructions

General instructions

- Reliable operation cannot be guaranteed if samples or prototypes are used in series production machines.
- The possible circuits for the system do not imply any technical liability for 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 is not liable for any hazards of this kind.
- The component firmware/software must be installed and removed by Bosch Rexroth or the responsible authorized partner in order to ensure that the warranty does not expire.
- 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 control unit may only be performed by Bosch Rexroth or by an authorized partner.
- The stop switch (two-channel deactivation) can be used for deactivation in emergency situations. The switch must be installed 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.
- 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.
- Whilst commissioning and maintenance of the controller, the machine may pose unforeseen hazards. Therefore the vehicle and the hydraulic system have to be in a safe condition during such operations.
- Therefore, make sure that nobody is in the machine's danger zone.
- Do not use defective components or components which are configured incorrectly. Failed or incorrectly operating components must be repaired immediately.
- Control units used to develop software must not be installed in series production machines as the number of flash cycles is limited and may have been reached or exceeded.
- The control units are to be used in applications for intermittent operations. The maximum uninterrupted operating time is defined as 24 hours. The controller must be switched off or reset at least once within 24 hours.

Information on installation location and position

- Do not install the control unit near parts which 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 transmission 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 control unit must not be electrostatically charged, e.g. during painting.
- 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 not facing upwards. 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 compensation element (PCE).
- The control unit must be fastened with metal screws in order to establish a good thermal connection between the housing and the cooling surface (heat sink).

Notices 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.
- Store control units at an average relative humidity of 60% and at a temperature between -10°C and +30°C. Momentary, a storage temperature of -20 °C to +40 °C is 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

- Connections to systems with a different electrical ground or power source require galvanic isolation.
- Lines to the speed sensors are to be shielded and kept as short as possible and be shielded. The shielding must be connected to the electronics or to the machine or vehicle ground via a low-resistance connection (one side only).
- Twisted-pair wires have to be used for CAN, ISOBUS and 100Base-T1.
- 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 connected to one another or bridged.
- The outputs must not be used to operate incandescent lamps due to the inrush current properties of these loads. Exceptions are permitted for signal lamps with low power if it is ensured that the inrush current does not exceed the limit values of this data sheet.
- The sensor supplies can be „pulled up” by an 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.
- Restrictions apply for the operation of LEDs with internal electronics at the outputs. The in-rush current must be below diagnosis thresholds.
- If LEDs are operated at power outputs, the diagnostic current may cause the LEDs to flash.
- The "high-side" outputs may not be externally connected to battery.
- Loads connected to low side outputs (both power and low power) must be powered from a high side output and not directly from battery.

Note on proportional and switching solenoids and other wired inductive consumers

- Proportional solenoids used in current-controlled mode must not be wired with spark-suppression diodes.
- Switching solenoids at the outputs of the control unit do not need to be connected to free-wheeling 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 free-wheeling 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 the use in mobile working machines provided no limitations / restrictions are made to certain application areas in this data sheet.
- Operation of the control unit must generally occur within the operating ranges specified and released in this data sheet. This applies in particular 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.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and for 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 by the application software to detect faults and to activate specially programmed reactions.
- Special measures may be initiated if the plausibility check shows deviations between the set-point values and the values read back by the micro controller.
- 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 in the ECU customer manual must be observed.

Safety features in the BODAS controller

- Independent circuitry is provided for certain groups of inputs (e.g. two input devices with separate A/D converters). Through appropriate input connections, the micro controller 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 micro controller with the appropriate software.
- The controllers can be operated with all power outputs de-energized for service purposes.
- A watchdog module is provided to detect malfunctions in the program run. The power outputs are shut off in such a case.

Disposal

- The BODAS controller and its packaging must be disposed of according to the national environmental regulations of the country in which the controller is used.

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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rexroth
A Bosch Company

BODAS controller RC4-5 series 30

- For the closed and open loop control of hydraulic components

Features

- High performance thanks to 32-bit TriCore processor with 80 MHz clock frequency
- Component of BODAS system for mobile applications
- Robust and compact design meeting specifications for mobile applications
- High Electromagnetic Compatibility (EMC)
- Inputs and outputs with fault detection
- Central output deactivation
- Pulse-Width-Modulated (PWM) solenoid currents for minimum hysteresis
- Closed-loop control of solenoid currents, i.e. not dependent on supply voltage and temperature

Main components

- Nine power outputs, 4 of which current-controlled
- Program sequence monitoring with watchdog
- CPU-internal flash memory with ECC fault detection
- Four independent sensor voltage supplies
- Two independent CAN bus interfaces

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Ordering code

01	02		03
RC	**4-5**	**/**	**30**

Type

01	BODAS controller	**RC**

Version

02	1. Position: Number of proportional power outputs 2. Position: Number of power switching outputs	**4-5**

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 (prototype software)

Optional accessories

- **BODAS-service software**
  The windows-based PC software BODAS-service (see data sheet 95086) is used for displaying functions, errors, and system variables as well as for setting parameters via a PC. It is also used for flashing programs from a PC to the control unit.

- **C-programming interface C-API**
  The programming interface C-API (see data sheet 95115) is used for programming the BODAS controllers RC in the programming language C. 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 diagnostic information for BODAS-service are available to the user in the form of a software library. 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 MA7**
  The BODAS measuring adapter MA7 (see data sheet 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.

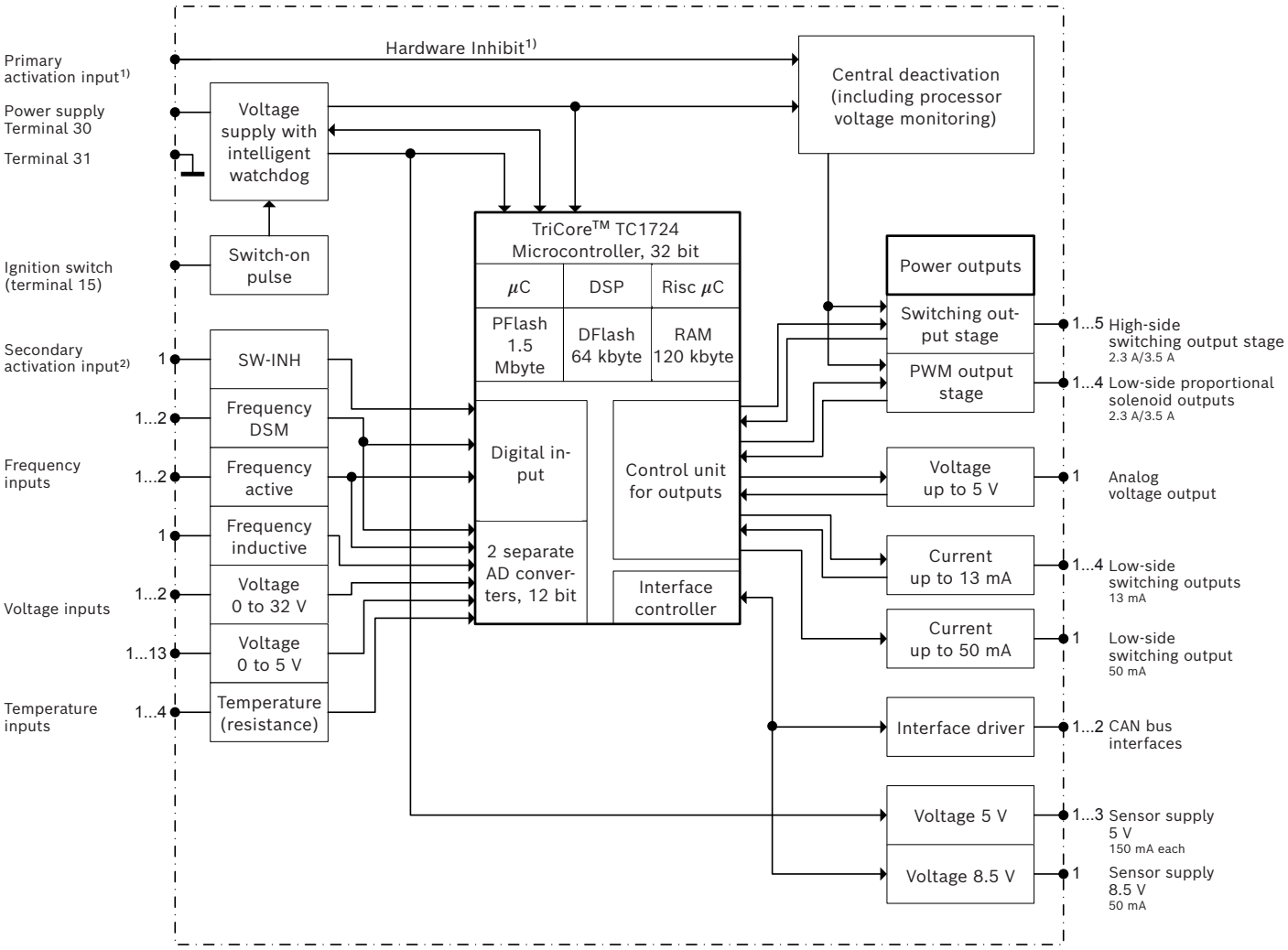
- **BODAS testbox TB3**
  The BODAS testbox TB3 is used to simulate vehicle and device functions for development and test purposes with BODAS controllers. The BODAS testbox TB3 is connected to the control unit via an adapter cable TAK7. A stencil provides specific channel designations for this control unit. See data sheet 95092 for more details.

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 controller RC4-5/30 is a universal controller for mobile working machines.
State-of-the-art 32-bit TriCore technology, a clock frequency of 80 MHz and numerous I/O functions give the controller a high power density in a very compact housing.
The controller is used for the programmable control of proportional and switching solenoids and of additional electrical switching functions. Typical applications are electrohydraulically actuated work functions, travel drives and transmission controls.
Internally the BODAS controller RC4-5/30 contains a powerful 32-bit TriCore microprocessor TC1724, all input and output circuitry, and a power supply unit for operation in mobile machines with 12 or 24 volt nominal supply voltages.
With 9 power outputs, 6 small signal outputs, a total of 30 input channels, 4 constant voltage sources and two CAN buses for communication in the vehicle, the RC4-5/30 controllers form a powerful platform for controlling mobile working machines.
The four current-controlled, pulse-width-modulated (PWM) outputs are used in particular for controlling proportional solenoids. The current control keeps the set-point current constant without hysteresis even if the supply voltage or temperature of the solenoid changes.
The PWM outputs match the electrical proportional control of Rexroth axial piston units and valves.
Five switching outputs can be used for switching solenoids, relays or other electrical consumers.
Of the input channels, five are used to measure frequency signals. Two of these inputs are configured for active frequency sensors. Two other frequency inputs are specified for the intelligent Rexroth DSM1-10 speed sensors with integrated diagnosis function. An inductive speed sensor can be connected at the fifth frequency input.
Four resistance inputs are used, for example, to directly connect temperature sensors.
The other inputs can be used for measuring analog voltages or as switching inputs.
The inputs are protected against overvoltage and electrical interference. The voltage inputs can be monitored to detect cable breaks or short circuits.
CAN bus interfaces are available with all BODAS controllers RC for exchanging data with other bus users or electronic systems (e.g. controller RC, joystick, engine control unit, display).
Two independent CAN bus interfaces, each of which can be operated with various protocols, are available in the RC4-5/30 BODAS controller. Communication with a service tool is also conducted via one of the two CAN interfaces. The RC4-5/30 controller is supported as standard by the Rexroth tool BODAS-service.
An application interface in the form of a C-API is available for programming the controller. This allows the software developer to concentrate on the important functions of his machine without having to become immersed in the details of the TriCore technology and the hardware of the controller.
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 diagnosis in order to place the machine in service quickly and safely.
The BODAS controllers RC were developed specifically for use in mobile working machines and satisfy corresponding protection requirements regarding ambient temperatures, water and dust ingression, shock and vibration as well as Electromagnetic Compatibility (EMC). BODAS controllers RC and corresponding software in combination with pumps, motors, valves, sensors, input devices and actuators from Rexroth make for complete system solutions.

Block circuit diagram



Abbreviations	
µC	Microcontroller
DSP	Digital signal processor
RISC	Reduced instruction set computer
PFlash	Program flash
DFlash	Data flash (e.g. for parameter storage)
RAM	Random Access Memory

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

Technical data

Nominal voltage		**RC4-5 series 30**
Nominal battery voltage		12 V or 24 V
Supply voltage, permissible range		8 V to 29 V temporarily up to 32 V
Current consumption		
in the 12 V vehicle electrical system, without load		150 mA
in the 24 V vehicle electrical system, without load		90 mA
Fuses		
internal		none
External in supply path		max. 15 A
Constant voltage source		
150 mA	5 V ±4 %	3
50 mA	8.5 V ±10 %	1
Analog voltage inputs, total (can be used as a switching input, partly as alternative function)		28
0 to 5 V		18
0 to 32 V		10
Digital switching inputs		1
Resistance inputs		
	10 Ω to 20 kΩ	4
Frequency inputs total		5
Active sensors	from 0 to 20 kHz,	2
DSM	from 0 to 20 kHz	2
Inductive sensors	from 500 Hz to 10 kHz	1
Analog voltage output		
	0.05 V to 5 V	1
Proportional solenoid output, total		4
Current-controlled low-side PWM output stage	0 to 2.3 A, PWM to 1 kHz	2
	0 to 3.5 A, PWM to 1 kHz	2
Digital output stages total		5
Non-current-controlled high-side PWM output stage	max. 2.3 A, PWM to 250 Hz	1
	max. 3.5 A, PWM to 250 Hz	4
Low-side driver output		5
Low-side driver output, current-limited	up to 13 mA	4
	up to 50 mA	1
Interfaces		
CAN 2.0 B, ISO 11898, max. 500 kBaud		2
Fault detection in the event of cable break and short circuit		
Inputs		*
Outputs		*
CAN		*
Protection against short circuits[1] **to supply voltage and ground** (Requirement: controller is powered and switch-on signal at terminal 15 is on High is active)		
Inputs		*
Outputs, except OUT_14[1]		*
CAN[1]		**to ground only**

1) The output OUT_14 and the CAN interfaces are not permanently protected against short circuit to battery voltage.

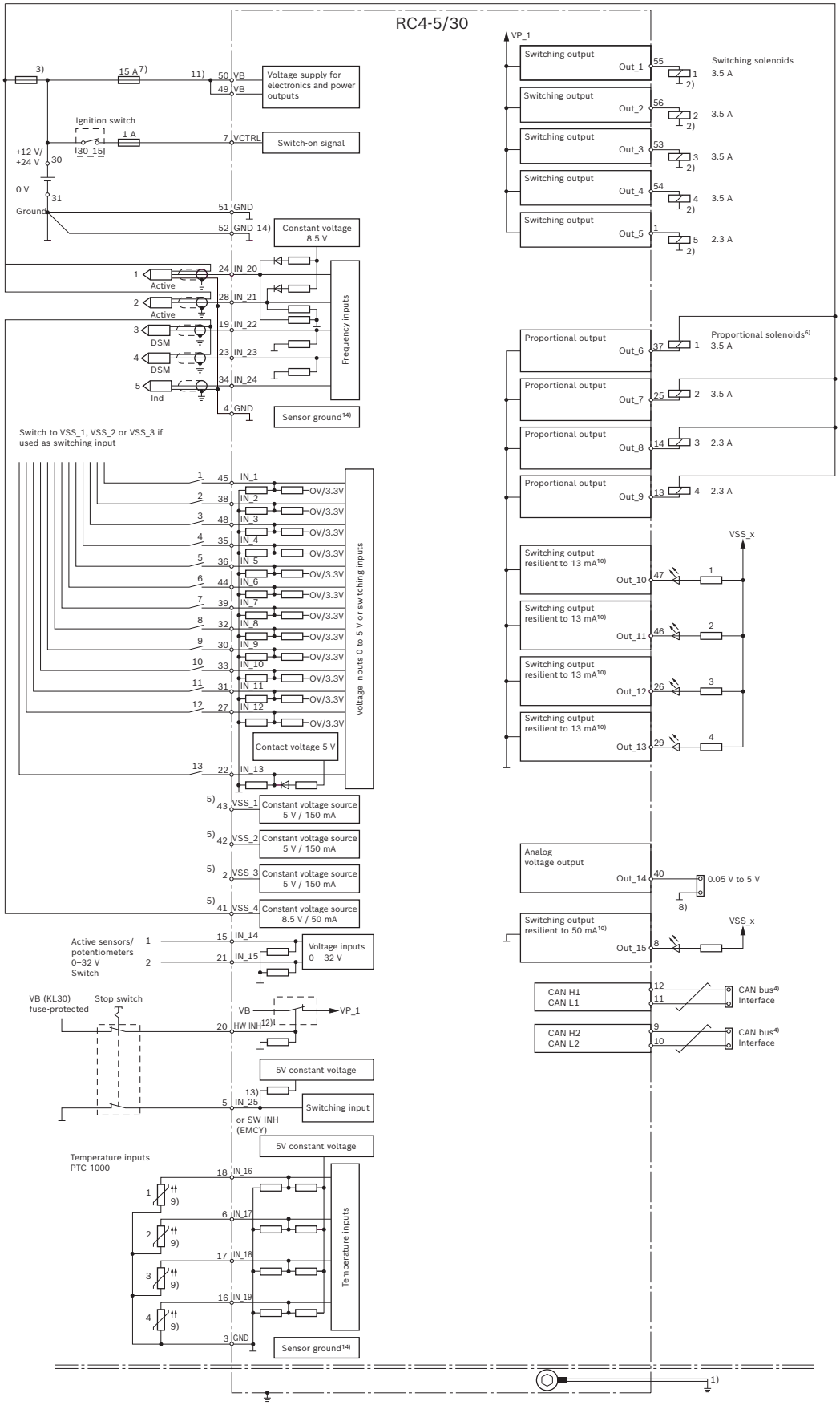
Reverse polarity protection		**RC4-5 series 30**
Power supply / battery[1)]		–
Microcontroller		
		SAK-TC1724
Clock frequency		
	MHz	80
Internal memory capacity in microcontroller		
RAM	kB	120 kByte
DFlash	kB	64 kByte
PFlash	kB	1.5 MByte
Software installation		
Download in PFlash		✓
Electromagnetic compatibility		
Spurious interference (ISO 11452-2)	200 MHz to 2 GHz: 140 V/m	*
Spurious interference (ISO 11452-4)	BCI 20 MHz to 400 MHz: 100 mA	*
Load dump with 12 V battery voltage		*
Load dump with 24 V battery voltage (ISO 7637-2: 2004)	Us = +123 V	*
Electrostatic Discharge ESD (DIN EN 60068-2-30Db; version 2)		
Out of service, class C	Contact and air	8 kV
In service, class C	Contact / air	6 kV / 8 kV
Maximum power dissipation		
Electronics		approx. 3 W
Outout stages		approx. 15 W
Permissible operating temperature, housing		
With mounting point on cooling surface <= +60 °C (+140 °F)		–40 to +85 °C (–40 to +185 °F)
Storage temperature, housing		
Maximum permissible housing temperature momentary, passive:		–40 to +105 °C (–40 to +221 °F)
Vibration resistance, broadband noise oscillations (ISO 16750-3: 2007)		
	57.9 m/s^2, 10 bis 2000 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: 2010)		
	a = 30 *g*; t = 11 ms per spatial axis x, y, z and in each direction (pos./neg.)	*
Moisture resistance (DIN EN 60068-2-30Db; version 2)		
	90–96 % (+25 °C to +55 °C)	*

1) Reverse polarity protection can be realized by the external fuse

Combined salt spray and moisture test (DIN EN 60068-2-52Kb)		**RC4-5 series 30**
	Salt spray 4x 2 h, 5 % NaCl	*
	Followed by 22 h storage at 40 °C and 93% humidity	
	72 h storage at room temperature	
Type of protection (ISO 20653) with installed mating connector[1)]	IP65, IP66 with protected pressure equalizing element	*
Housing material		
Cover	Aluminium sheet AlMg3	*
Base	Aluminium sheet AlMg3	*
Weight		approx. 0.2 kg
Outer dimensions Without mating connector, with multipoint connector	Length (in mm)	140
	Width (in mm)	123
	Height (in mm)	43
Mating connector	56-pin	1[2)]

1) While following the installation instructions
2) Second connector chamber not used

Connection diagram



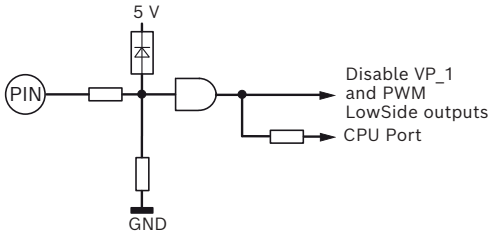
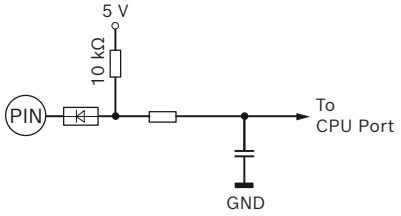
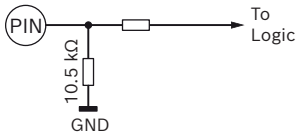
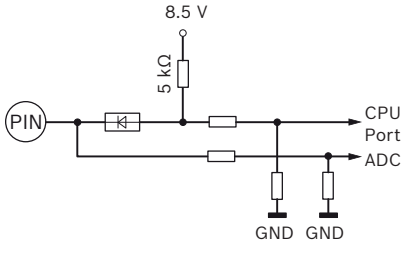
For footnotes, see page 9

Note

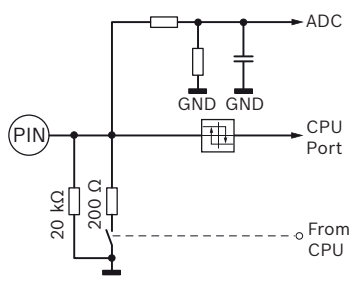
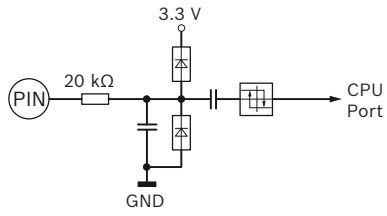
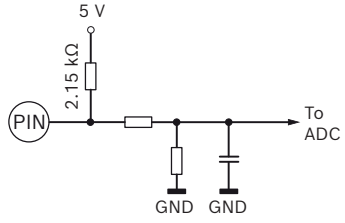
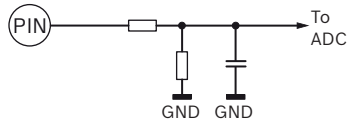
- To switch off the system in emergencies, the power supply to the controller must be disconnected by an emergency-stop switch.
  The emergency-stop switch must be installed in an easily accessible position for the operator.
  Safe braking must be ensured when the emergency stop function is activated.
- All GND pins are connected together on the printed circuit board. Maximum permissible currents depend on the contacts used (pins 51 and 52: MQS 1.5 CB; pins 3 and 4: BCB 0.6) and on the lines used.
- Lines to the controller must not be routed close to other power-conducting lines in the device.
- The proportional solenoids must not be wired with spark-suppression diodes.
  Switching solenoids at the outputs of the controller do not need to be connected to spark-suppression diodes.
  Other switched inductive consumers in the system must be equipped with spark-suppression diodes.
- For information about mating connectors and contacts, please refer to Bosch offer drawing 1 928 A00 443.
- The illustrated fuses act as line protection.

1) Short, low-resistance connection from a case screw to the vehicle ground.
2) Own ground connection to battery (chassis possible).
3) Separate fuse protection for sensors supplied from UBat, and solenoids switched to ground. Fuse configuration specific to application (in particular current needed and line cross section).
4) CAN bus: 120 Ω termination resistor and twisted line necessary.
5) Constant voltage sources can be used as sensor supply or switching voltage for switches/push-buttons.
6) The power line to consumers switched to ground must be fused, see 3.
7) Can be adjusted to the actual current consumption of the consumers and must be adjusted to the permissible rating of the lines and pins.
8) Independent ground connection of the current source to the battery, controller ground possible.
9) Can be used as switching inputs.
10) Alternatively, can be used as input.
11) If deactivated during operation, data will not be saved in the non-volatile memory and there will be no after run.
12) First deactivation channel:
    In deactivation state, the main switch for the power supply to the high-side output stages is opened by the hardware and the low-side output stages are deactivated.
13) Second deactivation channel:
    If used as SW-INH, main switch opened and low-side output stages deactivated by the software.
14) Terminal 31 (ground supply) and sensor ground are joined at a star point in the controller and are connected to the housing.

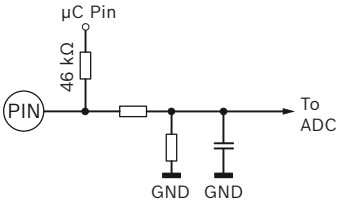
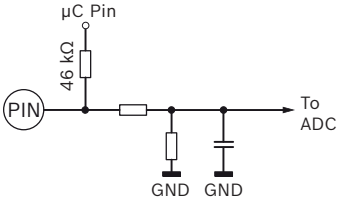
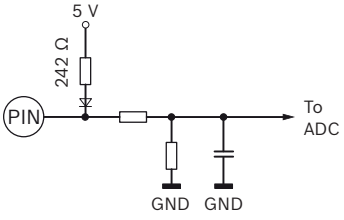
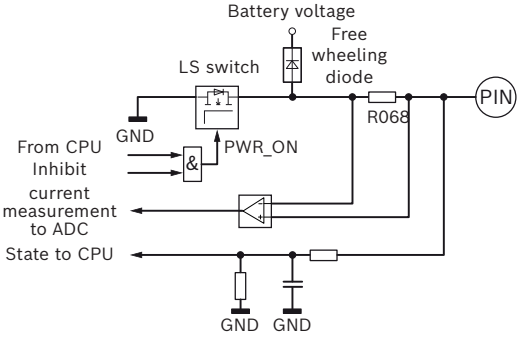
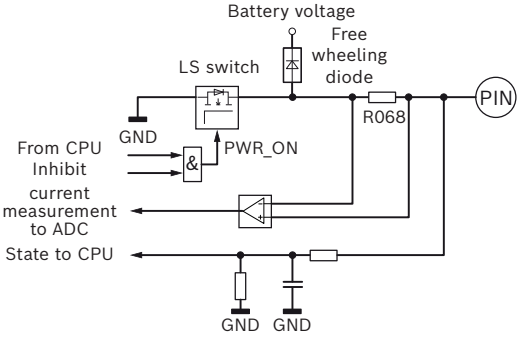
Overview of the functions

Pin[1)]	Description	Main function	Alternative function
49, 50	**Voltage supply** VB (terminal 30)	**Power supply for electronics and output stages** Nominal battery voltage 12 V DC or 24 V Operating range 8 V to 29 V, temporarily permissible 32 V	
51, 52	**Vehicle ground** GND (terminal 31)	**Supply ground** (internally connected to pins 3 and 4)	
3, 4	**Internal sensor ground** GND	**Sensor ground** (internally connected to pins 51 and 52)	
20 	**Hardware Inhibit** HW-INH	**Primärer activation input** Hardware deactivation function for all power output stages Activation level > 7.9 V Deactivation level < 2.8 V	
5 	**Software Inhibit** SW-INH or switching input IN_25	**Secondary activation input** Activation with low level Deactivation with high level	**Digital switching input** High level > 2.0 V Low level < 0.5 V Pull-up 10 kΩ to 5 V
7 	**Ignition switch** VCTRL (terminal 15)	**Digital input** Switch on controller with level > 8 V up to supply voltage VB Pull-down 10.5 kΩ	
24, 28 	**Active frequency input** IN_20, IN_21	**Frequency input for active sensors** Cut-off frequency filter 22 kHz Frequency measurement up to 20 kHz Level low < 1.5 V Level high > 4 V, ≦ VB Pull-up 5 kΩ to 8.5 V Pull-down 40 kΩ	**Analog input** Measuring range: 0 to 32 V Resolution: 12 bit Digital input Level configurable in software up to 32 V Pulse counter input Pulse width measurement Measurement of pulse/ pause ratio

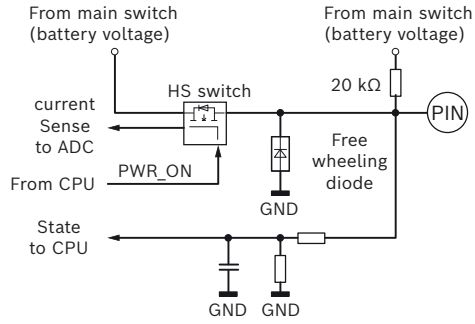
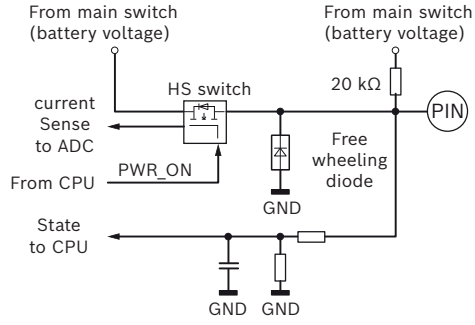
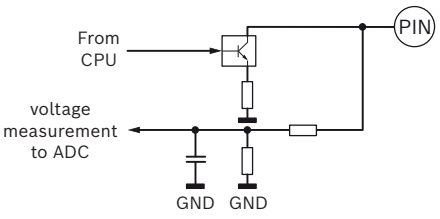
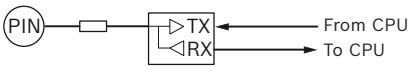
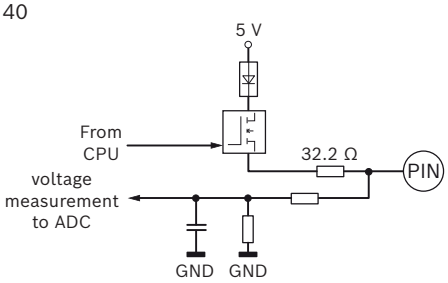
1) Pin numbers in bold type are for MQS 1.5-CB contacts; others are for BCB 0.6 contacts

Pin[1)]	Description	Main function	Alternative function
19, 23 	**DSM frequency input** IN_22, IN_23	**Frequency input** **for Rexroth DSM sensors** Cut-off frequency filter 26 kHz Frequency measurement up to 20 kHz Evaluation of additional information such as direction of rotation and fault monitoring possible Switching thresholds 7 mA / 14 mA Internal resistance 200 Ω to ground VSS_4 can be used as power supply for DSM frequency sensors.	**Frequency input** for active sensors that switch to High (type PNP) Level Low < 1.7 V Level High > 2.2 Pull-down 10 kΩ Analog input Measuring range: 0 to 32 V Resolution: 12 bit Digital input Level configurable in software up to 32 V Pulse counter input Pulse width measurement Measurement of pulse/pause ratio
34 	**Induktive frequency input** IN_24	**Frequency input** **for inductive frequency sensors** Frequency measurement from 500 Hz to 10 kHz to 1 V_{RMS} AC	**Pulse counter input** Pulse width measurement Measurement of pulse/pause ratio
18, 6, 17, 16 	**Resistance input** IN_16, IN_17, IN_18, IN_19	**Temperature measurement** via resistance measurement of connected NTC/PTC temperature sensors from 10 Ω to 20 kΩ Support from Rexroth Temperature sensors TSF and TSA Pull-up 2.15 kΩ to 5 V Pull-down 120 kΩ Frequency limit 230 Hz	**Analog input** Measuring range: 0 to 5 V Resolution: 12 Bit Digital input Level configurable in software up to 5 V
15, 21 	**Analog input** IN_14, IN_15	**Analog input** Measuring range: 0 to 32 V Resolution: 12 bit Pull-down 50 kΩ Frequency limit 500 Hz	**Digital input** Level configurable in software up to 32 V

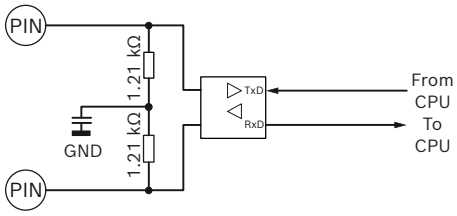
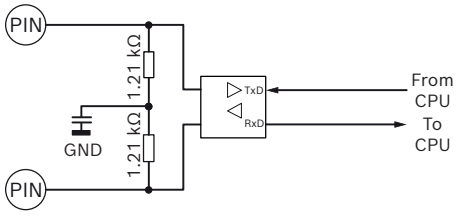
1) Pin numbers in bold type are for MQS 1.5-CB contacts; others are for BCB 0.6 contacts

Pin[1)]	Description	Main funktion	Alternative function
45, 38, 48, 35, 36, 44 	**Analog Input** IN_1 bis IN_6	**Analog Input** Measuring range: 0 to 5 V Resolution: 12 bit If µC pin is switched to 3.3 V: Pull-up 46 kΩ Pull-down 129 kΩ If µC pin is switched to ground: Pull-down 33 kΩ Frequency limit 230 Hz	**Digital input** Level configurable in software up to 5 V
39, 32, 30, 33, 31, 27 	**Analog Input** IN_7 bis IN_12	**Analog Input** Measuring range: 0 to 5 V Resolution: 12 bit If µC pin is switched to 3.3 V: Pull-up 46 kΩ Pull-down 250 kΩ If µC pin is switched to ground: Pull-down 39 kΩ Frequency limit 120 Hz	**Digital input** Level configurable in software up to 5 V
22 	**Analog Input** IN_13	**Analog Input** Measuring range: 0 to 5 V Resolution: 12 bit Pull-up 242 Ω via diode to 5 V Pull-down 230 kΩ Frequency limit 200 Hz	**Digital input** Level configurable in software up to 5 V
37, 25 	**PWM output stage** OUT_6, OUT_7	**Closed-loop current controlled Low side** PWM output stage Pulse frequency configurable in software in defined steps from 50 Hz to 1 kHz Duty cycle 0 % to 100 % Max. current 3.5 A Can only be operated if the main switch VP_1 is activated	
14, 13 	**PWM output stage** OUT_8, OUT_9	**Closed-loop current controlled Low side** PWM output stage Pulse frequency configurable in software in defined steps from 50 Hz to 1 kHz Duty cycle 0 % to 100 % Max. current 2.3 A Can only be operated if the main switch VP_1 is activated	

1) Pin numbers in bold type are for MQS 1.5-CB contacts; others are for BCB 0.6 contacts

Pin[1)]	Description	Main function	Alternative function
55, 56, 53, 54 	**Switching output stage** OUT_1, OUT_2, OUT_3, OUT_4	**High-side switching output stage** with current sensing max. 3.5 A Central power supply via VP_1	**Open-loop controlled PWM output stage** with current sensing Duty cycle 0 % to 100 % Pulse frequency configurable in software in defined steps up to 250 Hz max. 3.5 A Central power supply via VP_1
1 	**Switching output stage** OUT_5	**High-side switching output stage** with current sensing max. 2.3 A Central power supply via VP_1	**Open-loop controlled PWM output stage** with current sensing Duty cycle 0 % to 100 % Pulse frequency configurable in software in defined steps up to 250 Hz max. 2.3 A Central power supply via VP_1
47, 46, 26, 29 	**Small signal-switching output** OUT_10, OUT_11, OUT_12, OUT_13	**Low-side driver output** Limited to 13 mA (current limitation in case of overload) e.g. for LED with external resistor	**Analog input** (when driver output is deactivated) Measuring range: 0 to 30 V Resolution: 12 Bit Pull-down 31 kΩ Frequency limit 860 Hz
8 	**Small signal-switching output** OUT_15	**Low-side driver output** Limited to 50 mA (current limitation in case of overload) e.g. for LED with external resistor	
40 	**Analog output** OUT_14	**Analog voltage output** Output signal 0.05 V to 5 V Minimum 5 kΩ external ohmic resistance required (<= 1 mA)	**Analog input** (when driver output is deactivated) Measuring range: 0 to 5 V Resolution: 12 Bit Pull-down ~20 kΩ Frequency limit 550 Hz

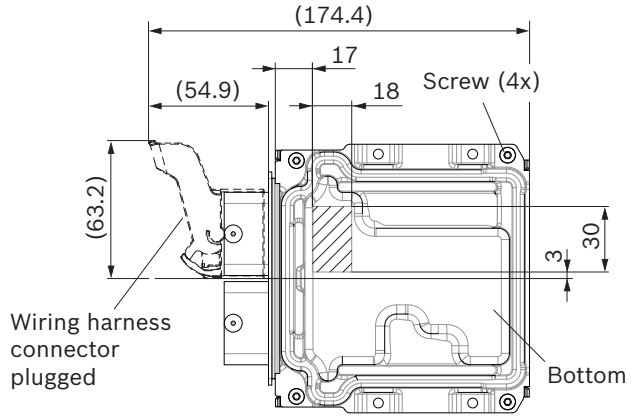
1) Pin numbers in bold type are for MQS 1.5-CB contacts; others are for BCB 0.6 contacts

Pin[1)]	Description	Main function	Alternative function
43, 42, 2	**Sensor supply** VSS_1, VSS_2, VSS_3	**Power supply for external sensors** Output voltage 5 V Accuracy ±4 % Load capacity 150 mA The sensor supplies must not be operated or bridged in parallel.	
41	**Sensor supply** VSS_4	**Power supply for external sensors** Output voltage 8.5 V at supply voltage of at minimum 9.5 V Accuracy ±10 % Load capacity 50 mA In particular used as power supply for DSM frequency sensors	
12, 11 	**CAN interface** CAN1_H, CAN1_L	**CAN interface** CAN 2.0 B, up to 500 kBaud External termination resistor 120 Ω in the CAN bus required Standard diagnosis interface with 250 kBaud factory setting	
9, 10 	**CAN interface** CAN2_H, CAN2_L	**CAN interface** CAN 2.0 B, up to 500 kBaud External termination resistor 120 Ω in the CAN bus required	

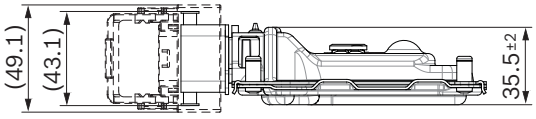
1) Pin numbers in bold type are for MQS 1.5-CB contacts; others are for BCB 0.6 contacts

Dimensions

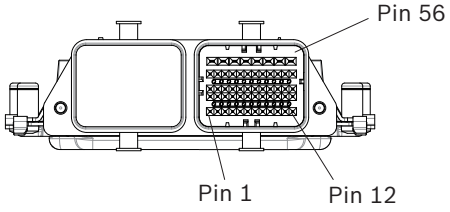
View from below



Long-side side view



Side view of connector side with pulled connector



Plan view

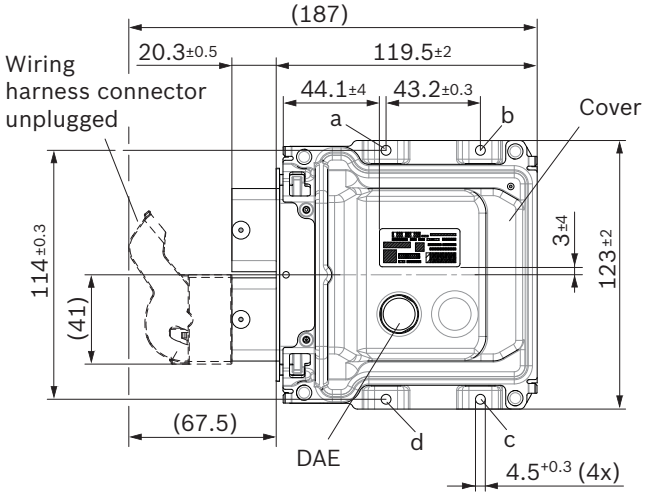


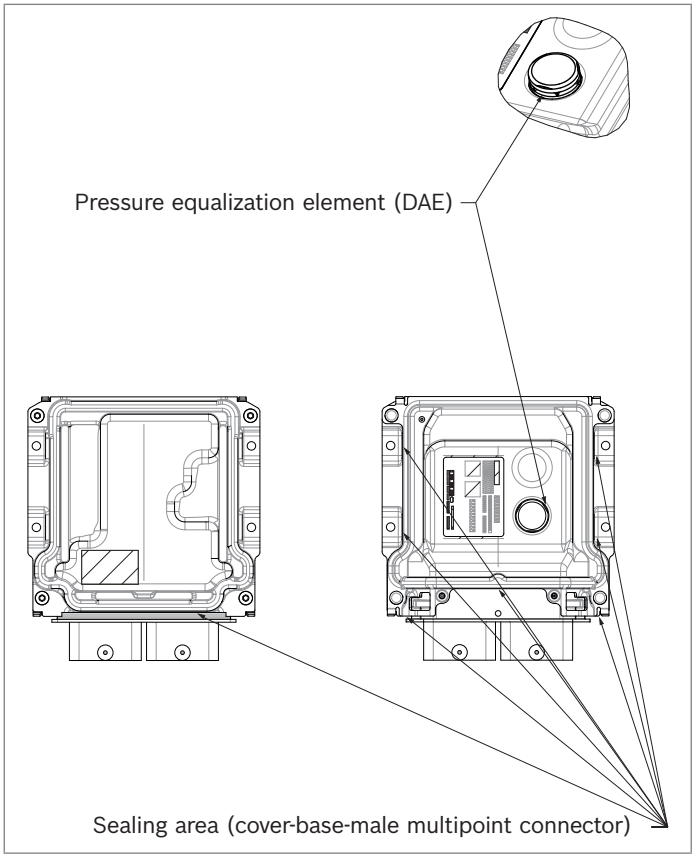
Illustration not to scale

Mounting

- The BODAS controller must be fastened at 4 points (a, b, c and d).
- The 4 mounting points must have an evenness of 0.5 mm.
- The upper limit for surface pressure on the screwing areas of the controller is 140 N/mm².
- Recommended screws M4 with head diameter ≥ 7 mm
- Tightening torque with washer 3.0 Nm, without washer 2.5 Nm
- The BODAS controller must be mounted in the vehicle in such a way that it does not bounce against other vehicle parts and additional fastening elements of the controller.
- A distance of at least 1 mm over the entire surface must be maintained between the bottom of the controller and the mounting surface. The distance should be less than 10 mm. If the control unit is not mounted with a bracket, it should be mounted with four distance bolts that guarantee this distance and prevent the bottom plate from bending in the area of the screw holes.
- It must be ensured that the screw fitting cannot come loose unexpectedly.
- The wiring harness should be fixated mechanically in the area in which the controller is installed (spacing < 100 mm).
- The wiring harness should be fixated so that in-phase excitation with the controller occurs.
- The wiring harness connector is not included in the scope of supply.
- Bosch Rexroth's consent is required if fixing is different from above.

Installation position

The installation position must be chosen such that no standing or continuously flowing water can occur in the area of the pressure equalization element (DAE) and the sealings.
The pressure equalization element (DAE) and the sealing area must not be immersed in water.
The controller must not bounce when mounted in the vehicle.



Mating connector

A 56-pin module from Bosch is used as wiring harness connector. The 1928xxx numbers stated below are Bosch designations. Technical details about these document and part numbers are available at www.bosch-connectors.com.

Installation specification	1928 A01 41M
Technical customer documentation	1928 A01 40T
Offer drawing (assembly)	1928 A00 443

The following parts are required for assembling a wiring harness connector:

Designation	Version	Part number	Manufacturer	Number
Contact carrier, code 13	Wire outlet left	1928 405 161	Bosch	1
	Wire outlet right	1928 405 217	Bosch	
Cover	Outlet up	1928 405 164	Bosch	1
	Outlet straight	1928 405 163	Bosch	
Secondary lock		1928 405 165	Bosch	1
Holding plate		1928 405 162	Bosch	1
Wire tie		1928 401 713	Bosch	1
Contact BCB 0.6	Line cross section in mm^2 0.35 mm^2 – 0.5 mm^2 Insulation diameter in mm 1.2 – 1.6 (FLR-B)	1928 492 555	Bosch	up to 48[1)]
	Line cross section in mm^2 0.75 Insulation diameter in mm 1.7 – 1.9 (FLR-B)	1928 492 556	Bosch	
Contact MQS 1.5-CB	Line cross section in mm^2 0.75 – 1.5 Insulation diameter in mm 1.7 – 2.4 (FLR)	1241608-1	TE connectivity (www.te.com)	up to 8[1)]
Dummy contact BCB 0.6 blue		1928 405 239	Bosch	[1)]
Dummy contact MQS 1.5-CB green		1928 405 240	Bosch	[1)]

For part numbers of tools (crimping tongs, contact removal tools, etc.), see Bosch offer drawing.

1) Free contact chambers are to be sealed with dummy contacts to ensure water-tightness.

Mating connector sets with the following content are available under Rexroth part number R917008789 for the manual assembly of wiring harness connectors for laboratory or small-series requirements:

Designation	Version	Part number	Manufacturer	Number
Contact carrier, code 13	Wire outlet right	1928 405 217	Bosch	1
Cover	Outlet straight	1928 405 163	Bosch	1
Secondary lock		1928 405 165	Bosch	1
Holding plate		1928 405 162	Bosch	1
Contact BCB 0.6	Line cross section in mm^2 0.35 – 0.5 Insulation diameter in mm 1.2 – 1.6 (FLR-B)	1928 492 555	Bosch	48
Contact MQS 1.5-CB	Line cross section in mm^2 0.75 – 1.5 Insulation diameter in mm 1.7 – 2.4 (FLR)	1241608-1	TE connectivity (www.te.com)	8
Dummy contact BCB 0.6 blue		1928 405 239	Bosch	30
Dummy contact MQS 1.5-CB green		1928 405 240	Bosch	4

Delivered loose in a PE bag. Not suitable for processing by a machine.

Safety instructions

General instructions

- External measures in the vehicle are required to implement commonly used safety standards for mobile working machines with the RC4-5/30 controller. If necessary, please contact Bosch Rexroth in this regard.
- 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 dangers while the machine is in operation. It is the responsibility of the machine manufacturer to determine dangers of this type in a danger analysis and to bring them to the attention of the end user. Bosch Rexroth shall assume no liability for dangers of this kind.
- 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.
- A stop switch can be used for deactivation of the controller (refer to the connection diagram).
- 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 output stages 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 dangers. 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.
- Controllers 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. Controllers that have been programmed more than 1000 times are not to be installed in series production machines.

Notes on the installation location 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 controller in such a way that the connector is not pointing upwards. This ensures that any condensation water that may form can flow out.
- Standing or permanently running water is not permitted anywhere near the circumferential sealing (cover/base/connector) or the pressure equalizing element (DAE).
- The housing must be wired to vehicle ground in order to comply with EMC guidelines. Metallic screws must be used to create a connection to vehicle ground.
- The controller must be fixed with metallic screws to provide a good thermal connection between the housing and the cooling surface (heat sink)

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.
- Controllers must be stored at a temperature between –40 °C and +40 °C. Up to 1000 hrs are permissible between +40 °C and +85 °C. Up to 200 hrs are permissible between +85 °C and +105 °C. Air humidity up to 96% at 55 °C.
- 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.
- Lines to the speed sensors must be designed as short as possible and be shielded. The shielding must be connected on one side to the electronics or to the machine or vehicle ground via a low-resistance connection.
- The controller 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 < 100 mm). The wiring harness should be fixated so that in-phase excitation with the controller occurs (e.g. at the controller mounting points).
- 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 distance from hot or moving vehicle parts.
- PWM outputs (OUT_6 to OUT_9) must not be connected to each other or bridged. No light bulbs are to be operated at these outputs.
- None of the sensor supplies VSS_x is to be connected to one or more sensor supply VSS_x.
- The sensor supplies VSS_x 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" (OUT_1 to OUT_5) outputs must 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 controller do not need to be connected to spark-suppression diodes.
- The electronics may only be tested with the proportional solenoids connected.
- Other switched inductive loads that are in the system but not connected to the controller must be connected to spark-suppression diodes. The same applies to relays if these have the same power supply as the controller.

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.
- Damages which result from improper use and/or from unauthorized, interference in the component not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a 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 values (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.
- Please consult Bosch Rexroth if you require product data for a safety assessment of the machine.
  - Notes about all controllers in the API description (manual) must be observed.

Safety features in the BODAS controller

- Faults in the voltage supply are detected by internal monitoring.
- All output signals can be monitored by the microcontroller with the appropriate software.
- For service purposes, the controllers can be operated with all power outputs de-energized.
- The internal watchdog module centrally switches off the power supply of all proportional and switching outputs in the event of disturbances to the program execution.

Further information

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

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rexroth
A Bosch Company

BODAS Controller RC5-6 series 40

- For closed- and open-loop control of hydraulic components

Features

- 32-bit multi-core processor with 200 MHz clock frequency and Hardware Security Module (HSM)
- Suitable for safety-relevant applications
- Component of the BODAS system for mobile applications
- Robust and compact design meeting specifications for mobile applications
- High Electromagnetic Compatibility (EMC)
- Inputs and outputs with fault detection
- Inhibit logic for safety related outputs
- Pulse-Width-Modulated (PWM) solenoid currents
- Closed-loop control of solenoid currents, i.e. not dependent on supply voltage and temperature

Main components

- 11 power outputs, 5 of which current-controlled
- 8 low power switch outputs
- 30 multi-functional input pins
- Program sequence monitoring with watchdog
- Four independent sensor voltage supplies
- Four independent CAN bus interfaces (one of which useable for ISOBUS and two with wake-up function)
- One LIN master interface

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Ordering code

01	02		03
RC	**5-6**	**/**	**40**

Type

01	BODAS controller	**RC**

Version

02	1st number: number of current controlled power outputs 2nd number: number of switching power outputs[1)]	**5-6**

Series

03	Series 4, index 0	**40**

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 (prototype software)

Optional accessories

- **BODAS-service software**
  The windows-based PC software BODAS-service 4.x (see data sheet 95087) is used for displaying functions, errors and system variables as well as for setting parameters via a PC. It is also used for flashing programs from a PC onto the controller.

- **C Programming environment**
  The BODAS BSW software provides the basic software functionality for series 40 RC controllers. The project specific BSW is configured regarding inputs, outputs, communication channels and tasks by an online tool. A comprehensive application programming interface (API) is provided for programming the actual application software, which is linked with the BSW. The user needs a C Compiler for compiling and linking the program code in order to get an executable hex file. For details consult the BODAS-BSW manual for RC series 40.

- **BODAS measuring adapter MA8**
  The BODAS measuring adapter MA8 (see data sheet 95090) facilitates measuring all electrical signals at the inputs, outputs and interfaces of the BODAS controller. For testing purposes, it is connected in series between the RC controller and the vehicle or device wiring.

- **BODAS testbox TB3**
  The BODAS testbox TB3 is used with BODAS controllers to simulate vehicle and device functions for development and test purposes. The BODAS testbox TB3 is connected to the control unit via an adapter cable TAK8. A stencil provides specific channel designations for this control unit. See data sheet 95092 for more details.

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

1) Low-side outputs that must be used in combination with High-Side outputs.

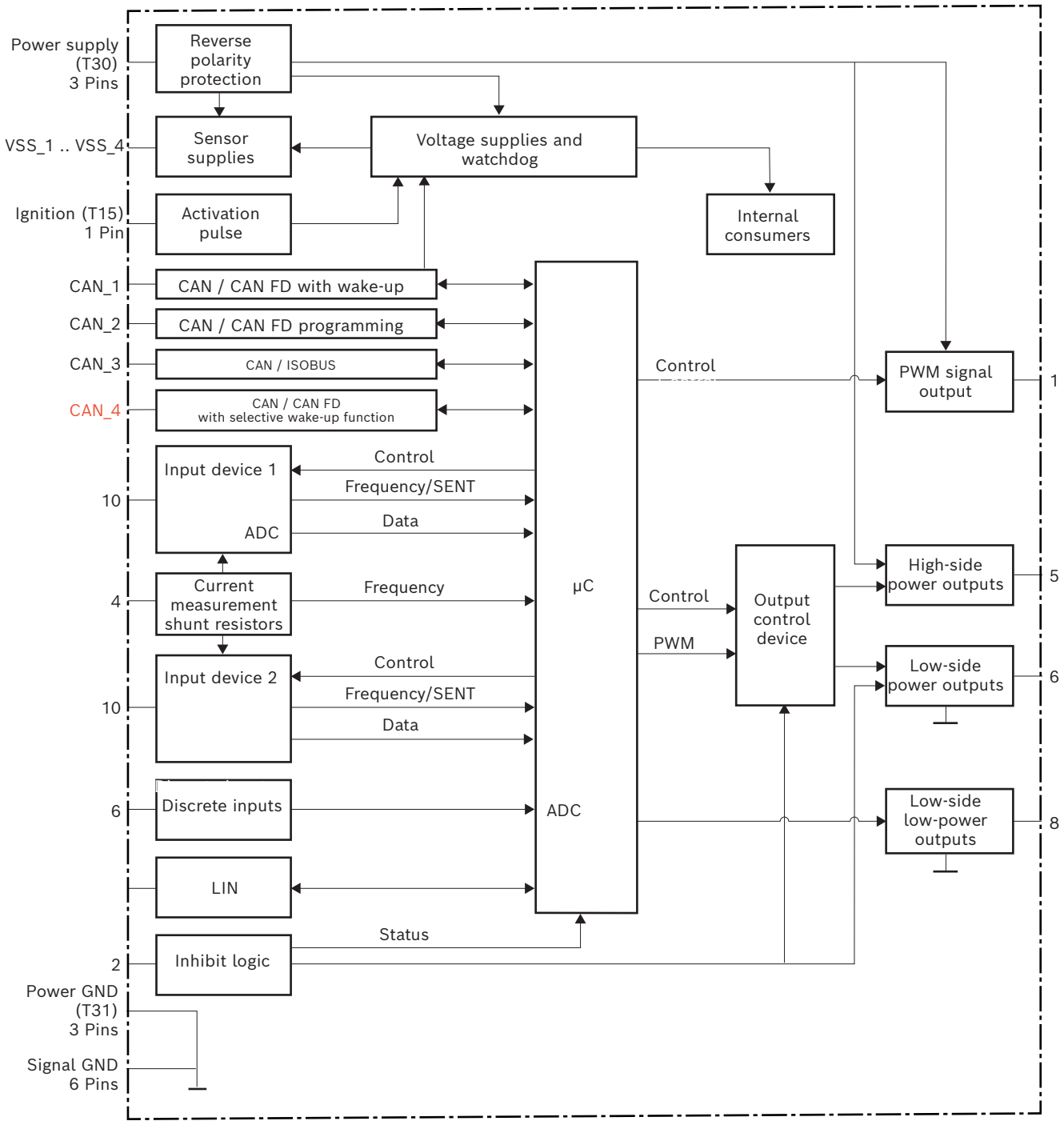
Description

The BODAS controller RC5-6/40 is designed as a universal ECU for mobile working machines. It is based on a 32-bit microcontroller with two lock-step cores and a single core operating at a clock frequency of 200 MHz. A hardware security module, that is integrated in the microcontroller, provides methods for data security such as secure key storage and random number generation.
The controller is used for the programmable control of proportional and switching solenoids as well as additional electrical switching functions. Typical applications are electrohydraulically actuated work functions, travel drives and transmission controls.
The microcontroller, all input and output circuitries, communications interfaces, sensor voltage supplies and a DC power supply unit for operation with 12 or 24 volt nominal supply voltages are integrated in a compact housing.
All eleven power outputs can drive current up to 4 A. The five high-side power outputs that switch battery voltage can be operated in closed loop current control mode. The six low-side power outputs that switch to ground can be used for loads that are powered from a high-side output. Loads that are used to realize a safety function must be operated between a high-side and a low-side power output. One of them acts as a safety-related shut-off path in that case.
The current-controlled, pulse-width-modulated (PWM) high-side outputs are used in particular for controlling proportional solenoids. The closed loop current control guarantees that the set-point current is kept even if the supply voltage or the temperature of the solenoid changes and it is characterized by minimal hysteresis. Eight low-side outputs are provided to control low power consumers such as relays.
Most of the input functions are realized by input devices (ASIC) that are highly configurable and provide their own A/D converters. They can be used to read digital voltage, analog voltage or resistance. Eight of these inputs can be used additionally for connecting sensors via the SAE J2716 SENT interface or to measure frequency signals.
Four more inputs are intended to be used particularly as frequency or analog current inputs. Signals from active frequency sensors and the Rexroth DSM1/DST1 speed sensors with integrated diagnosis function can be acquired.
Six inputs can be used for measuring analog voltages via the ADC in the µC. These can be used as battery voltage switching inputs.
The inputs are protected against overvoltage and electrical interference. The inputs can be monitored to detect cable breaks or short circuits.
CAN bus interfaces are available with all BODAS controllers for exchanging data with other controllers RC, I/O extension modules, joysticks, engine control units, displays, etc.
RC5-6/40 offer a total of four independent CAN bus interfaces. Three of these CAN interfaces can be used as high-speed or CAN FD interfaces. Two of these offer a wake-up function. One CAN interface complies with the ISOBUS specification for ECUs. An external termination bias circuit (TBC) is required for ISOBUS compliance.
For CAN, the basic software offers various communication protocols. These include XCP, J1939, CANopen, CANopen Safety and signal-based communication configured via a DBC file.
Communication with a service tool is also conducted via one of the CAN interfaces. The Rexroth service tool BODAS-service 4.x is based on the UDS standard. This tool is used in application development, commissioning and service. It can be used to downloaded programs to the RC5-6/40 controller. It also shows error codes and process variables and facilitates the setting of parameters.
An API is available for programming the controller in high level language C. This allows the software developer to concentrate on the important functions of the machine without having to become immersed in the details of the processor, ECU circuitry and base software. It also provides functions required for implementing the diagnosis by a custom service tool.
The hardware configuration is no longer required as part of the application software but can be done via a tool available on the internet. The configurable properties of inputs, outputs and CAN data bases can be defined. The tool returns a configured base software that can be linked with the actual application software.
The BODAS controllers RC were developed specifically for the use in mobile working machines and satisfy corresponding protection requirements regarding ambient temperatures, water and dust ingression, shock and vibration as well as electromagnetic compatibility (EMC). BODAS controllers RC and corresponding software in combination with pumps, motors, valves, sensors, input devices and actuators from Rexroth make for complete system solutions.

Note

The RC5-6/40 controller can be used for safety functions according to ISO 25119 up to AgPL d or up to PL d according to ISO 13849. The safety manual has to be observed if such safety functions shall be implemented. The safety manual is part of the RC5-6/40 ECU Customer Manual which is online available for registered users.

Block circuit diagram



Abbreviations	
µC	Micro controller
PWM	Pulse width modulation
ADC	A/D converter
GND	Ground
CAN	Controller Area Network
CAN FD	CAN with Flexible Data Rate
LIN	Local Interconnect Network
SENT	Single Edge Nibble Transmission
VSS	Voltage Sensor Supply

Technical data

BODAS controller			RC5-6 series 40
Supply Voltage			
	Nominal battery voltage		12 V and 24 V
	Supply voltage ranges		
		No function: µC is reset, outputs are off	< 6 V
		Very low voltage mode: only CAN communication is ensured At low temperatures 7 V are required to start-up the controller	6 V .. 8 V
		Under voltage mode: restrictions on sensor supplies and outputs apply, CAN wake-up is not guaranteed with supply voltages below 9 V	8 V .. 11 V
		Normal operation mode: ECU is fully operational	11 V .. 32 V
		Extended voltage supply range: ECU is partially operational	32 V .. 36 V
		Absolut maximum rating: ECU is not operational, risk of damage at higher voltages	36 V
Current consumption			
	Standby current at room temperature and 13.5 V supply voltage		< 500 µA
	Without load in a 12 V battery supply voltage		~ 250 mA
	Without load in a 24 V battery supply voltage		~ 200 mA
Fuses			
	Internal		none
	An external fuse in the supply path (common supply line for internal electronics and high-side outputs) is mandatory		20 A
Constant voltage sources, total count			**4**
	5 V	150 mA, 150 mA, 300 mA, all ratiometric	3
	10 V	150 mA, non-ratiometric	1
Inputs, total count			**30**
	Digital voltage, analog voltage 0 V .. 32 V		6
	Digital voltage, analog voltage, alternative use as 0 V .. 10 V output possible		1
	Digital voltage, analog voltage, resistance		11
	Digital voltage, analog voltage, resistance, frequency, SENT		8
	Digital voltage, analog voltage, analog current, active frequency sensor signals, Rexroth DSM1/DST1 speed sensor signals		4
Power outputs, total count			**11**
	4 A current controlled power outputs high-side		5
	4 A PWM capable switching power output low-side		1
	4 A switching power outputs low-side		5
Low power outputs, total count			**10**
	200 mA PWM capable switching outputs low-side		4
	200 mA switching outputs low-side		4
	PWM signal output (can be used as analog output, external capacitance provided)		1
	0 V .. 10 V analog voltage output (alternative use of an input pin)		1
Communication interfaces, total count			**5**
	CAN 2.0 B / CAN FD	with non-selective wake-up function	1
	CAN 2.0 B / CAN FD	with selective wake-up function introduced 2023 with change number 1039T68431	1
	CAN 2.0 B / CAN FD	(standard interface for diagnosis and flashing)	1
	ISOBUS interface		1
	LIN		1

BODAS controller	RC5-6 series 40
Fault detection in the event of cable break and short circuit	
Inputs (depending on sensor type and input configuration the failure mode can be ambiguous)	•
Outputs	•
LIN	•
CAN	•
Protection against short circuits to supply voltage and ground (Requirement: controller is powered and running, i.e. T30 and T15 are connected to supply voltage, power ground pins are connected to T31, processor runs valid software)	
Inputs	•
Outputs	•
LIN	•
CAN	•
Reverse polarity protection	•
Multicore processor with lockstep functionality	SPC58 E-Line MCU with e200z4 cores STMicroelectronics
Clock frequency (processor clock)	200 MHz
Internal memory capacity in microcontroller	
SRAM	608 kB
DFlash	64 kB EEPROM equivalent
PFlash	6 MB
Software installation	
Download in PFlash	•
E1 Mark	
Type approval with regards to ECE regulation No. 10 revision 5	•
CE Mark	
Compliance with EMC Directive 2014/30/EU. The harmonized norms EN ISO 13766-1:2018, EN 12895:2015 and EN ISO 14982:2009 have been applied.	•
Compliance with RoHS2 directive 2011/65/EU on the restriction of the use of certain hazardous substances.	•
Operating temperature	
Housing temperature, housing mounted on cooling surface	–40 to +85 °C (–40 to +185 °F)
Max. permissible temperature of cooling surface	+60 °C (+140 °F)
Weight	540 g ±5 %

Qualification testing

Durability testing
Thermal testing has been conducted to simulate typical aging processes in mobile machines. The failure rates that have to be considered in safety-relevant applications depend on temperature and temperature change profiles. For more details see safety manual.

Humidity cycling test
EN 60068-2-30:2005, Test Db variant 2, 6 cycles with 24 h each, T_{max} = 55 °C, rH = 98 % Operating mode: intermittent (1 h active, 1 h passive), operating state: A in active cycles

Salt spray test
EN 60068-2-11:1999, Test Ka, T = 35 °C, NaCl solution = 5 %, pH = 6.5 – 7.2, duration = 144 h Operating mode: passive, operating state: A after test

Chemical resistance test
ISO 16750-5, tested media: engine oil, fertilizer, AdBlue, RME (rapeseed methyl ester), battery acid, gear oil, steering gear oil, anti-freeze, brake fluid, hydraulic oil, fuel, Diesel, cold cleaner, contact spray (WD 40); T = room temperature Operating mode: passive, operating state: A after test

Protection class tests
ISO 20653, protection class IP6kx Operating mode: passive, with dummy sealed connector
ISO 20653, protection class IPx9k and IPx6k Operating mode: passive, the pressure compensation element PCE is not part of the test IPx5 can be achieved with unprotected PCE

Mechanical tests
ISO 16750-3 2023, vibration 4.1.2.7 Test VII — Commercial vehicle, sprung masses Duration = 32 h each axis, temperature overlaid T_i = -40 °C up to 105 °C, soak time = 30 min, frequency band: 10 - 2,000 Hz, a_{eff} = 57.9 m/s^2; see table 12

Frequency	**PSD**
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

Operating mode: active in heating phase, passive in cooling phase
EN 60068-2-27:2009, mechanical shock shock profile: half-sine, shock duration = 18 ms, acceleration: 30 *g*, cycles each direction = 1,000 (6,000 in total) Operating mode: passive
EN 60068-2-27:2009, mechanical shock shock profile: half-sine, shock duration = 6 ms, acceleration: 100 *g*, cycles each direction = 3 (18 in total) Operating mode: passive

Susceptibility EMC tests
ISO11452-2:2004, absorber-lined shielded enclosure method 12V System: supply voltage = 13.5 V 24V System: supply voltage = 27 V
CW 200 MHz – 3 GHz, 100 V/m
AM 200 MHz – 800 MHz, 150 V/m
PM 800 MHz – 3 GHz, 150 V/m
ISO11452-4:2005, BCI test method 12 V System: supply voltage = 13.5 V 24 V System: supply voltage = 27 V 1 MHz – 20 MHz: 100 mA 20 MHz – 400 MHz: 150 mA Method: open loop, common mode (complete harness in current probe)

Emission EMC test	
UN ECE 10 Rev. 5, broadband emitted interference Chapter 6.5, appendix 6 Supply voltage = 13.5 V and 27 V	
Frequency range in MHz	**peak value**
30 .. 75	62 - 25.13 log (f/730) dB(µV/m)
75 .. 400	52 + 15.13 log (f/75) dB(µV/m)
400 .. 1000	63 dB(µV/m)
Annex 7: procedure according CISPR 25:2002 chapter 6.4 ALSE-method Measuring distance 1 m peak detector, 120 kHz bandwidth	
UN ECE 10 Rev 5, narrowband emitted interference Chapter 6.6, appendix 7 Supply voltage = 13.5 V and 27 V	
Frequency range in MHz	**peak value**
30 .. 75	52 - 25.13 log (f/730) dB (µV/m)
75 .. 400	42 + 15.13 log (f/75) dB (µV/m)
400 .. 1000	53 dB (µV/m)
Annex 8: procedure according CISPR 25:2002 chapter 6.4 ALSE-method Measuring distance 1 m average detector, 120 kHz bandwidth	
CISPR25: 2008, radiated emission Chapter 6.4.4, tables 9 and 10 Supply voltage = 13.5 V LW, MW, CB, VHF class 3, other frequency bands class 4	
CISPR25: 2008, conducted emission Chapter 6.2.3, tables 5 and 6 Supply voltage = 13.5 V and 27 V MW, SW, CB, VHF, TV I class 3, other frequency bands class 4	
ISO 7637-2:2004, voltage transient emission test Supply voltage = 13.5 V Table B.2, Level III slow pulses: + 37 V / - 75 V fast pulses: + 75 V / - 112 V This test covers the 24 V system as this is the more demanding test	

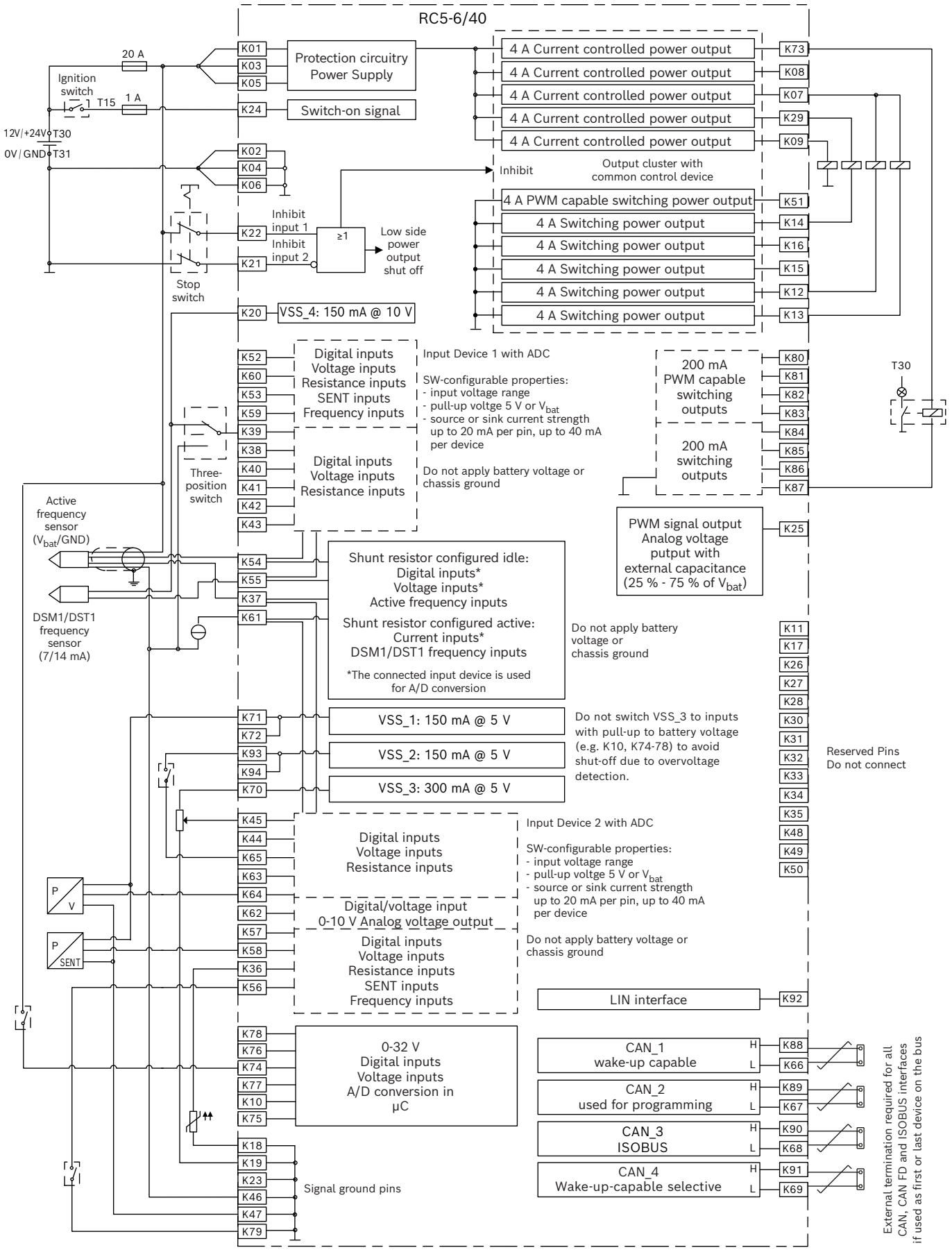
Electrostatic discharge (ESD) tests
ISO 10605:2023, direct contact discharge Supply voltage = 27 V Setup as chapter 8, figure 4 Test voltage: table C.1, category 1, L1 to L4 (max. ± 8 kV) 50 discharges distributed on connector and housing Operating mode: active, operating state: C
ISO 10605:2023, direct air discharge Supply voltage = 27 V Setup as chapter 8, figure 4 Test voltage: table C.2, category 1, L1 to L4 (max. ± 15 kV) 50 discharges distributed on connector and housing Operating mode: active, operating state: C
ISO 10605:2023, contact discharge, not powered Setup as chapter 9, figure 6 Test voltage: table C.1, category 1, L1 to L4 (max. ± 8 kV) ISOBUS pins (K68, K90) are tested with ± 15 kV 3 discharges each pin, 5 discharges distributed on connector and housing Operating mode: passive, operating state: A after reset
ISO 10605:2023, air discharge, not powered Setup as chapter 9, figure 6 Test voltage: table C.2, category 1, L1 to L4 (max. ± 12 kV for pins connected to an input device and the low power outputs, max. ± 15 kV for all other pins) 3 discharges each pin, 5 discharges distributed on connector and housing Operating mode: passive, operating state: A after reset

Transient tests
ISO 7637-2:2004, test pulse 1 Supply voltage = 27 V U_s = -600 V, R_i = 50 Ω, t_d = 1 ms, t_r = 3 +0 / -0.5 µs, t_2 = 200 ms, t_3 = < 100 µs, 5,000 cycles with t_1 = 0.5 s, operating state: C Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2004, test pulse 2a Supply voltage = 27 V U_s = +112 V, R_i = 2 Ω, t_d = 0.05 ms, t_1 = 200 ms, t_r = 1 µs, 5,000 pulses, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2004, test pulse 2b Supply voltage = 27 V U_s = +20 V, R_i = 0.05 Ω, t_d = 0.2 s to 2 s, t_{12} = 1 ms ± 0.5 ms, t_r = 1 ms ± 0,5 ms, t_6 = 1 ms ± 0.5 ms, 20 pulses, operating state: C Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2004, test pulse 3a Supply voltage = 27 V U_s = -300 V, R_i = 50 Ω, t_d = 150 ns ± 45 ns, t_r = 5 ns ± 1.5 ns, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, duration = 1 h, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test
ISO 7637-2:2004, test pulse 3b Supply voltage = 27 V U_s = +300 V, R_i = 50 Ω, t_d = 150 ns ± 45 ns, t_r = 5 ns ± 1.5 ns, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, duration = 1 h, operating state: A Operating mode: active This test covers the 12 V system as this is the more demanding test

Transient tests
ISO 16750-2:2012, starting profile (pulse 4) Supply voltage = 13.5 V U_{s6} = 4.5 V, U_s = 6.5 V, t_f = 5 ± 0.5 ms, t_6 = 15 ± 1.5 ms, t_7 = 50 ± 1.5 ms, t_8 = 10,000 ± 1,000 ms, voltage ripple during t_8 = Us + 2 V with f = 2 Hz, t_r = 100 ± 10 ms, 10 pulses, 1 s break between each pulse Operating state: C for components that are not relevant for starting phase
ISO 7637-2:2004, starting profile (pulse 4) U_s = -6V, U_a = -4 V, R_i = 0 Ω .. 0.02 Ω, t_7 = 15 ms .. 40 ms, t_8 < 50 ms, t_9 = 0.5 s .. 20 s, t_{10} = 5 ms, t_{11} = 5 ms .. 100 ms No. of pulses: 1 Operating state: C for components that are not relevant for starting phase
ISO 16750-2:2012, starting profile (pulse 4) Supply voltage = 24 V U_{s6} = 6 V, U_s = 10 V, t_f = 10 ± 1 ms, t_6 = 50 ± 5 ms, t_7 = 50 ± 5 ms, t_8 = 1,000 ± 100 ms, voltage ripple during t_8 = U_s + 2 V with f = 2 Hz, t_r = 40 ± 10 ms, 10 pulses, 1 s break between each pulse Operating state: C for components that are not relevant for starting phase
ISO 16750-2:2012, table 5 (pulse 5a) Supply voltage = 24 V U_s = 202 V, R_i = 8 Ω, t_d = 350 ms, t_r = 10 +0 / -5 ms, 10 pulses at 1 min intervals Pins tested: Supply (K01, K03, K05), Ignition (K24), Inhibit (K 22), all pins connected and tested together Operating state: C
ISO 16750-2:2012, table 6 (pulse 5b) Supply voltage = 12 V U_a = 28 V, U_s = 151 V, U_s* = 41 V, R_i = 1 Ohm, t_d = 350 ms, t_r = 10 ms, t_1 = 60 s, 10 pulses at 1 min intervals Pins tested: low side low power outputs (K80 .. K87) and discrete analog inputs (K10, K74 .. K78) Operating state: C
ISO 7637-3:2016, fast pulses 3a and 3b Supply voltage = 24 V Method CCC, Level IV: U_s = - 150 V / + 150 V t_r = 5 ns, t_d = 0.15 ± 0.045 µs, t_1 = 100 µs, t_4 = 10 ms, t_5 = 90 ms, R_i = 50 Ω, test duration: 10 min Operating state: A This test covers the 12 V system as this is the more demanding test
ISO 7637-3:2016, slow pulses 2a positive and negative Supply voltage = 24 V Method ICC, Level IV: U_s = + 10 V / - 10 V t_r = 1 µs + 0 / - 0.5 µs, t_d = 0.05 ms, t_1 = 1 s, R_i = 2 Ω Operating state: A This test covers the 12 V system as this is the more demanding test

General electrical tests
ISO 16750-2:2012, superimposed alternating voltage, chapter 4.4 Supply voltage = 24 V U_{Smax} = 32 V, U_{PP}: 4 V (severity level 2), frequency range = 50 Hz to 25 kHz, number of sweeps = 5, sweep duration = 120 s Operating state: A Operating mode: active
ISO 16750-2:2012, short circuit of signals, chapter 4.10.2 U_{Smax} = 32 V, duration = 60 s ± 10 % Operating state: C
ISO 16750-2:2012, overvoltage, chapter 4.3.2 U_{sup} = 36 V T = 65°C (= T_{max} minus 20°C) Duration: 60 min Power outputs are not active as these are intentionally shut off by diagnosis software above 32 V. Operating state: C
ISO 16750-2:2012, reversed polarity, chapter 4.7.2 Case 2, U_A = 28 V (see ISO 16750-1 and Table 7), duration = 60 ± 6 s, room temperature Operating state: A after reset

Connection diagram



Overview of functions

Pin	Description	Main function	Software modes	Remarks
K01, K03, K05	**Power Supply** Terminal 30	**Power supply for internal electronics and high side output stages** Nominal supply voltage: 12 V or 24 V Normal operation: 11 V .. 32 V For other voltage ranges see technical data above		A fuse in the supply line with max. 20 A is required. All three pins shall be used for an even current distribution.
K02, K04, K06	**Power Ground** Terminal 31	**Ground for power supply** Internally connected to signal ground pins		All three pins shall be used for an even current distribution.
K24	**Ignition** Terminal 15 Internal Pull-Down resistor 10 kΩ	**Switch-on signal** Switching to high level wakes-up the controller Switching to low level or opening the key switch terminates normal operation and the processor enters into the after-run procedure. Finally the controller goes into sleep mode. High level > 4.5 V Low level < 2.9 V or open pin		
K22	**Inhibit input 1** Internal 5 kΩ pull-down resistor if ECU is supplied	**Stop switch input** The power output stages are deactivated if this pin is not switched to high level High level ≥ 7 V Low level ≤ 2 V or open pin Quiescence current max. 275 µA (ECU is off and inhibit 1 is connected to 13.5 V) If the inhibit function is not used, this pin has to be wired to battery voltage so that the output stages can be activated. Once the inhibit function is activated the output stages remain off even if this signal returns to high level until the output stages are unlocked by the application software. Wetting current ≥ 2 mA (disabled when the ECU is in standby)		
K21	**Inhibit input 2** Internal 2 kΩ pull-up resistor to 5 V	**Stop switch input** The power output stages are deactivated if this pin is not switched to low level High level ≥ 4 V or open pin Low level ≤ 2 V If the inhibit function is not used, this pin has to be wired to ground so that the output stages can be activated. Once the inhibit function is activated the output stages remain off even if this signal returns to low level until the output stages are unlocked by the application software. Wetting current ≥ 2 mA (disabled when the ECU is in standby)		

Pin	Description	Main function	Software modes	Remarks
K71, K72	**Sensor Supply 1**	**Sensor supply VSS_1** Ratiometric to ADC reference voltage Max. current rating 150 mA (for the two pins in total) Output voltage 5 V Output voltage tolerance ± 105 mV State during start-up and reset active The admissible capacitive load depends on the load current: < 50 mA ≤ 1.2 µF < 100 mA ≤ 0.9 µF < 150 mA ≤ 0.33 µF		Two pins are provided for the ease of wiring Do not connect to another VSS_x
K93, K94	**Sensor Supply 2**	**Sensor supply VSS_2** Same as VSS_1		Same as VSS_1
K70	**Sensor Supply 3**	**Sensor supply VSS_3** Ratiometric to ADC reference voltage Max. output current 300 mA Output voltage 5 V Output voltage tolerance ± 150 mV State after start-up active Admissible capacitive load ≤ 100 µF		Do not connect to another VSS_x
K20	**Sensor Supply 4**	**Sensor supply VSS_4** Not ratiometric to ADC reference voltage Min. output current required 5 mA Max. output current 150 mA Output voltage 10 V (battery voltage > 11 V provided) Output voltage tolerance ± 1 V State after start-up active Admissible capacitive load ≤ 100 µF		Can be used for Bosch Rexroth speed sensor DSM1/DST1 Do not connect to another VSS_x
K18, K19, K23, K46, K47, K79	**Signal Ground Pins**	**Ground connection for sensors** Internally connected to power ground pins These pins must be used for the ground connection of sensors or potentiometers that provide signals to the controller		Six pins are provided for the ease of wiring

Pin	Description	Main function	Software modes	Remarks
K38, K39, K40, K41, K42, K43	**Multi-functional inputs** Input device 1	**Common properties for digital and analog voltage inputs on input devices** A wetting current of 5 mA is activated for 1024 ms after a voltage level change on switched inputs		Do not apply battery voltage or chassis ground
K44, K45, K63, K64, K65	**Multi-functional inputs** Input device 2	Constant current source or sink configurable in pre-defined steps (the function is similar to a pull-up and pull-down resistors): Pull-Up current 7.5 µA .. 20 mA Pull-Down current 20 µA .. 20 mA Configurable pull-up voltage 5 V or battery voltage		
		Digital inputs Digital inputs with configurable pre-defined hardware thresholds Low High Automotive logic < 2.2 V > 3.5 V TTL logic < 0.8 V > 2.2 V High voltage logic < 3.5 V > 6.0 V	DI	
		Analog voltage inputs Can be used as digital inputs with thresholds defined by the application software Three configurable voltage measurement ranges up to 5 V, 20 V, 40 V If the pull-up voltage 5 V is combined with the measurement range 20 V or 40 V, then voltage overshoot at the input can occur. Thus, these combinations are not recommended. Accuracy within the defined measurement range 5 V range 0.05 .. 4.95 V ± 2 % of full range 20 V range 0.45 .. 18.3 V ± 4 % of full range 40 V range 0.80 .. 38.9 V ± 4 % of full range Resolution 12 bits Cut-Off frequency: ≥ 25 kHz (first order filter)	AI AIV AID	
		Resistance measurement Measurement range 20 Ω .. 400 kΩ Pull-Up voltage 5 V Accuracy (in % of highest value in range) 20 Ω .. 50 Ω 19 % 50 Ω .. 2 kΩ 3.5 % 2 kΩ .. 30 kΩ 3.5 % 30 kΩ .. 350 kΩ 3.5 % 350 kΩ .. 400 kΩ 10 % Resolution 15 bits Conversion to °C for the Bosch Rexroth PTC temperature sensors TSA and TSF and the Bosch NTC sensor TF-W is provided by the base software. The temperature characteristic of other temperature sensors can be filed in a custom look-up table.	RI	

Pin	Description	Main function	Software modes	Remarks
K52, K53, K59, K60	**Multi-functional inputs** Input device 1	**Digital, analog voltage and resistance inputs** See above		Do not apply battery voltage or chassis ground
K36, K56, K57, K58	**Multi-functional inputs** Input device 2	**Frequency inputs** Frequency range 0 Hz .. 20 kHz Cut-Off frequency ≥ 25 kHz (first order filter) Low level < 2.2 V High level > 3.5 V Phase measurement and pulse counter possible	FI	
		SENT inputs (Single Edge Nibble Transmission) Digital sensor signal input according to the SAE J2716 Rev. 4 201604 protocol, BSW support currently limited to Rev. 3 (2010) Pull-Up (current source) 250 µA Pull-Up voltage 5 V The base software provides decoding of the bit-streams of fast channels and slow channel	SENT	
K62	**Multi-functional input or analog output** Input device 2	**Digital and analog voltage inputs** See above **Analog output** Voltage output range 0 V .. 10 V Min. external resistance 3 kΩ This I/O Pin has a 2 µF smoothing capacitor. A short charging current pulse occurs when used as a switching input. This may cause a feedback in the voltage source, e.g. short circuit might be detected erroneously. This pin has a 78 kΩ pull-down resistance. This is a voltage divider for the analog feedback when used as an output. If the pin is configured as analog input with a current source, then the pull-up current will cause a voltage drop at the resistance that is measured with an open terminal (e.g. 1.56 V at 20 µA).	AOV	Do not apply battery voltage or chassis ground Resistance measurement is not possible

Pin	Description	Main function	Software modes	Remarks
K54, K55 K37, K61	**Multi-functional, frequency and current inputs** Input device 1 **Digital, analog, frequency and current inputs** Input device 2	**Digital inputs** See above **Analog voltage inputs** See above with the following changes Current / source (PU/PD) configurable (as above) and 21.5 kΩ permanent pull down Filter limit frequency ≥ 11 kHz **Frequency inputs for active frequency speed sensors that switch between battery voltage and ground** Low Level < 1.7 V High Level > 2.2 V Frequency range 1.4 Hz .. 20 kHz (f < 1.4 Hz will be detected as 0 Hz) Filter limit frequency ≥ 34 kHz Phase measurement and pulse counter possible Current / source (PU/PD) configurable (see above) and 21.5 kΩ permanent pull down Each of these inputs can be configured with a 200 Ω Pull Down shunt resistor that enables the following functionality: **Frequency inputs for Bosch Rexroth speed sensors DSM1/DST1** Low Level < 8.4 mA High Level > 11.2 mA Frequency range 1.4 Hz .. 10 kHz Filter limit frequency ≥ 34 kHz **Analog current inputs** Nominal measurement range 4 mA .. 20 mA Full measurement range 0 mA .. 24 mA Accuracy ± 6 % of full range Filter limit frequency ≥ 11 kHz	FI (Shunt of) FI (Shunt on) AIC	Do not apply battery voltage or chassis ground

Note on the use of the phase measurement for direction of rotation and pulse-counter

The base software of the controller facilitates the detection of the rotational direction by means of the phase measurement between two frequency outputs of a speed sensor. The two frequency signals (primary signal and secondary signal) have to be acquired via predefined pairs of inputs. The following pairs can be selected in the online tool:

K52 and K57
K60 and K58
K53 and K36
K59 and K56

K54_VI and K37_VI
K55_VI and K61_VI

The pairs were chosen in a way that the analog read back of the signals for diagnosis purposes is performed by different input devices. The Rexroth speed sensors DSM1/DST1 provide both the frequency and rotational direction information on a single line. Thus, only one of the inputs K54_VI, K55_VI, K37_VI and K61_VI is required for one sensor.

The phase pairs can be used for counting pulses, too. The pulses of the primary signal are counted. The counter is incremented or decremented depending on the phase of the secondary signal, i.e. the state of the signal at the rising edge of the primary signal.

Pin	Description	Main function	Software modes	Remarks
K10, K74, K75, K76, K77, K78	**Analog inputs** (discrete)	**Analog voltage inputs** Measurement ranges 0 V .. 32 V Accuracy at 32 V for sensor signal measurement ± 7.5 % for battery voltage measurement ± 10 % Resolution 12 bits Pull-Down resistor 80 kΩ Pull-Up resistor 14.7 kΩ Pull-Up voltage is the battery voltage (reverse polarity protection via diode in the pull-up path) Filter limit frequency ≥ 279 Hz Open terminal voltage: Min. U_{bat} * 0.83 – 0.6 V Typ. U_{bat} * 0.85 – 0.4 V Max. U_{bat} * 0.86 – 0.15 V These inputs can be used as digital inputs with thresholds defined by the application software. These inputs can be switched to ground, battery voltage or VSS_x. The reading of analog voltage sensor signals is not recommended due to the limited accuracy and filter characteristic.	AI AID AIV	Load Dump protected up to U_s* = 41 V
K25	**PWM / Analog output**	**PWM signal output** PWM frequency 5 kHz Duty cycle 0 % .. 100 % Supply voltage battery voltage Output voltage 0% or 25 % .. 75 % of battery voltage Accuracy ± 7.5 % at 32 V Serial resistor (output current limiter) 3.5 kΩ Pull-Down resistor in analog feedback 55 kΩ Ripple dependent on external capacitance. ≥ 100 µF recommended.	AOV	
K84, K85, K86, K87	**Low side, low power digital outputs**	**Switching outputs** Max. current rating per output 200 mA Typically used for relays	DO	The total current of all eight low side, low power outputs must not exceed 1200 mA. Loads connected to a low side output must be powered from a high side output. Load Dump protected up to U_s* = 41 V
K80, K81, K82, K83	**Low side, low power digital outputs**	**PWM capable switching outputs** Max. current rating per output 200 mA Frequency adjustable in software from 32 Hz to 3.3 kHz Duty cycle adjustable in software in 1000 steps Can be used to generate a frequency or PWM signal if an external pull-up resistor (e.g. to VSS_4) is used. To ensure a sufficient slew rate, small duty cycles should not be used at high frequencies. Indicative value for PWM control: max. 250 Hz. For full diagnosis capability a minimal pulse length of 250 µs is required.	PO POD	

Pin	Description	Main function	Software modes	Remarks
K07, K08, K09, *K29*, *K73*	**High Side power output stages**	**Current controlled power outputs** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1.1 s PWM frequency configurable in defined steps from 10 Hz to 1 kHz Duty cycle 0 % (off), 0% .. 100% (minimal length of on or off pulses 5 µs), 100 % (on) For full diagnosis capability a minimal pulse length of 65 µs is required Diagnosis current up to 15 mA from 5 V source Current measurement range 0.1 A .. 6.8 A Repetition current measurement accuracy under static conditions: from 0.1 A .. 1 A 10 mA from 1 A .. 4 A 1 % of set-point At 1 kHz PWM-frequency a dither frequency can be superimposed. Dither frequency 83 Hz .. 250 Hz in 10 steps Dither amplitude 0 .. 500 mA	PO POD POC	The total current of all high side and the internal electronics must not exceed 20 A. Freewheeling diode included External freewheeling diode not allowed in PWM mode (open or closed loop control)
K51	**Low side power output stage**	**PWM capable switching power output** Continuous max. current per output 4 A Permissible single current overshoot 6 A for max. 100 ms within 1.1 s Overcurrent threshold (short circuit to battery voltage) 10 A .. 17 A PWM frequency configurable in defined steps from 10 Hz to 250 Hz Duty cycle 0 % (off), 0 .. 100 % (minimal length of on or off pulses 5 µs), 100 % (on) For full diagnosis capability a minimal pulse length of 65 µs is required Diagnosis current up to 15 mA from 5 V source Current sensing range 0.1 A .. 7 A Current sensing accuracy from 0.1 A .. 7 A 10 % of full scale For HS/LS current deviation, see Safety Manual.	PO POD	Loads connected to a low side output must be powered from a high side output. Freewheeling diode included External freewheeling diode not allowed in PWM mode (open loop control)
K12 and K13 in default configuration, K14, K15, K16	**Low side power output stages**	**Switching power output** Continuous max. current per output 4 A Permissible current overshoot 6 A for max. 100 ms Overcurrent threshold (short circuit to battery voltage) 10 A .. 17 A Diagnosis current up to 15 mA from 5 V source Current sensing range 0.1 A .. 7 A Current sensing accuracy from 0.1 A .. 7 A 10 % of full scale For HS/LS current deviation, see Safety Manual.	DO	Loads connected to a low side output must be powered from a high side output. Freewheeling diode included
K12, K13	**High side power output stages** These outputs can be reconfigured as high side outputs with the easyConfig tool in s170 and later workflows	**Switching power output** Continuous max. current per output 4 A Permissible current overshoot 6 A for max. 100 ms Overcurrent threshold (short circuit to battery voltage) 6.5 A .. 25 A Diagnosis current up to 15 mA from 5 V source	DO	No current feedback. Must not be used for safety functions. Freewheeling diode included

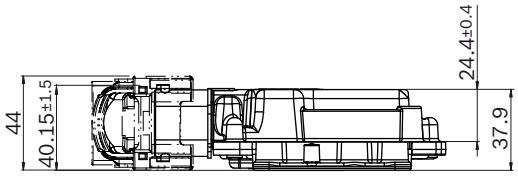
Pin	Description	Main function	Software modes	Remarks
K92	**LIN**	**LIN Bus interface** Master interface according to ISO 17987 4 Maximum baud rate 20 kBaud		Must be used for 12 V nominal battery voltage only
K88 K66	**CAN_1 High** **CAN_1 Low**	**CAN bus interface** High speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Wake-up by pattern (WUP) can be enabled for this CAN interface in the easyConfig tool. Any data traffic wakes-up the controller if WUP is enabled. The wake-up function is lost if the controller is disconnected from the voltage supply and must be reconfigured by the BSW, i.e. one re-start via T15 is required.		When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K89 K67	**CAN_2 High** **CAN_2 Low**	**CAN bus interface** High speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Standard CAN interface for flashing and diagnosis		When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K90 K68	**CAN_3 High** **CAN_3 Low**	**ISOBUS interface** ISOBUS interface ECU implementation as outlined in ISO 11783-2 Can be used as high speed CAN 2.0 b up to 1 Mbaud		When used as the first or last node of an ISOBUS, a terminating bias circuit (TBC) has to be applied. When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
K91 K69	**CAN_4 High** **CAN_4 Low**	**CAN bus interface** High Speed CAN 2.0 b interface up to 1 Mbaud CAN FD interface up to 2 Mbaud Wake-up by pattern (WUP) or wake-up by frame (WUF) can be enabled for this CAN interface in the easyConfig tool. Any data traffic wakes-up the controller if WUP is enabled. If WUF is enabled, the controller wakes-up, when a message with a configurable ID and data is received. The wake-up function is lost if the controller is disconnected from the voltage supply and must be reconfigured by the BSW, i.e. one re-start via T15 is required.		When used as the first or last node of the CAN bus, a termination resistor with 120 Ω has to be applied.
Other	**Reserved Pins**	**No function** These pins cannot be used and must not be connected		

PIN sizes
Pin numbers in **bold** are for contact type BDK 2.8
Pin numbers in *italic* are for contact type MQS 1.5 CB
All other pins are for contact type BCB 0.6

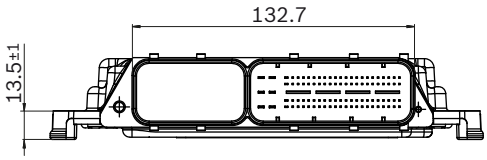
Software modes	
DI	Digital input (state)
AI	Analog input (raw value in digits)
AIV	Analog input voltage in mV
AID	State level dependent of software defined thresholds
AIC	Analog input current in µA
RI	Resistance input in Ω, optional conversion to °C by means of look-up tables supported by BSW
FI	Frequency input in 0.1 Hz
SENT	SAE J2716 input
DO	Digital Output (on/off)
PO	Proportional output (duty cycle in 0.1 %)
POD	Proportional output digital (0 % / 100 %)
POC	Proportional output current controlled (set current in mA)
AOV	Analog output set point in mV (range 0 .. 10 V) or Set point in 0.1 % of battery voltage (range 25 % .. 75 %)

Dimensions

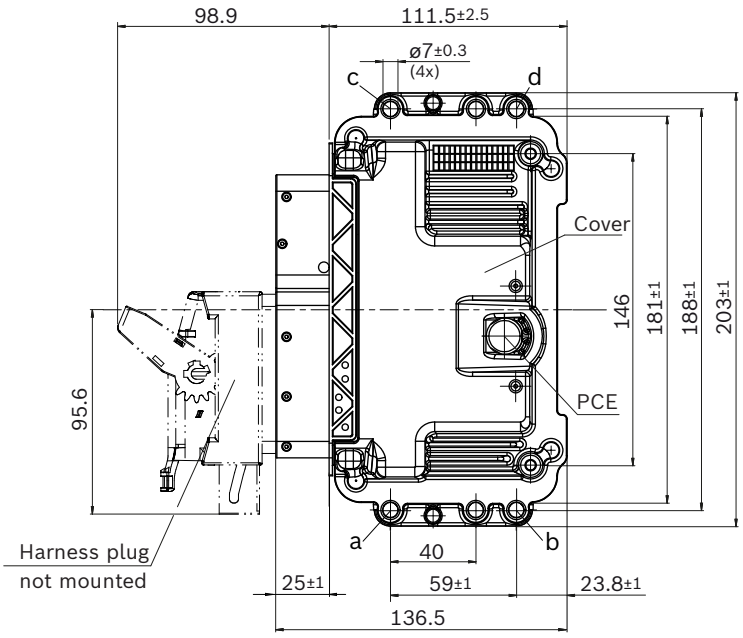
Long-side view



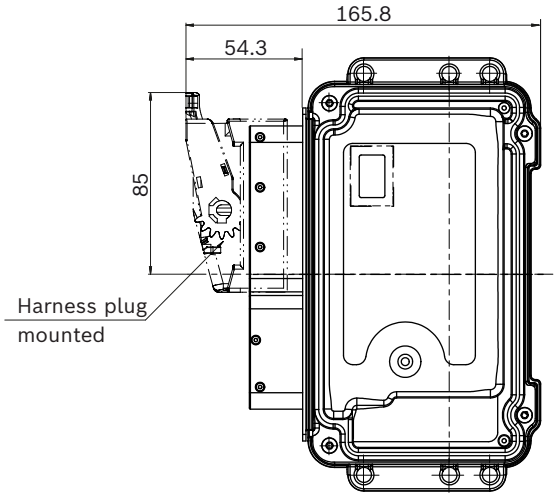
Side view with pulled connector



Top view



Bottom view



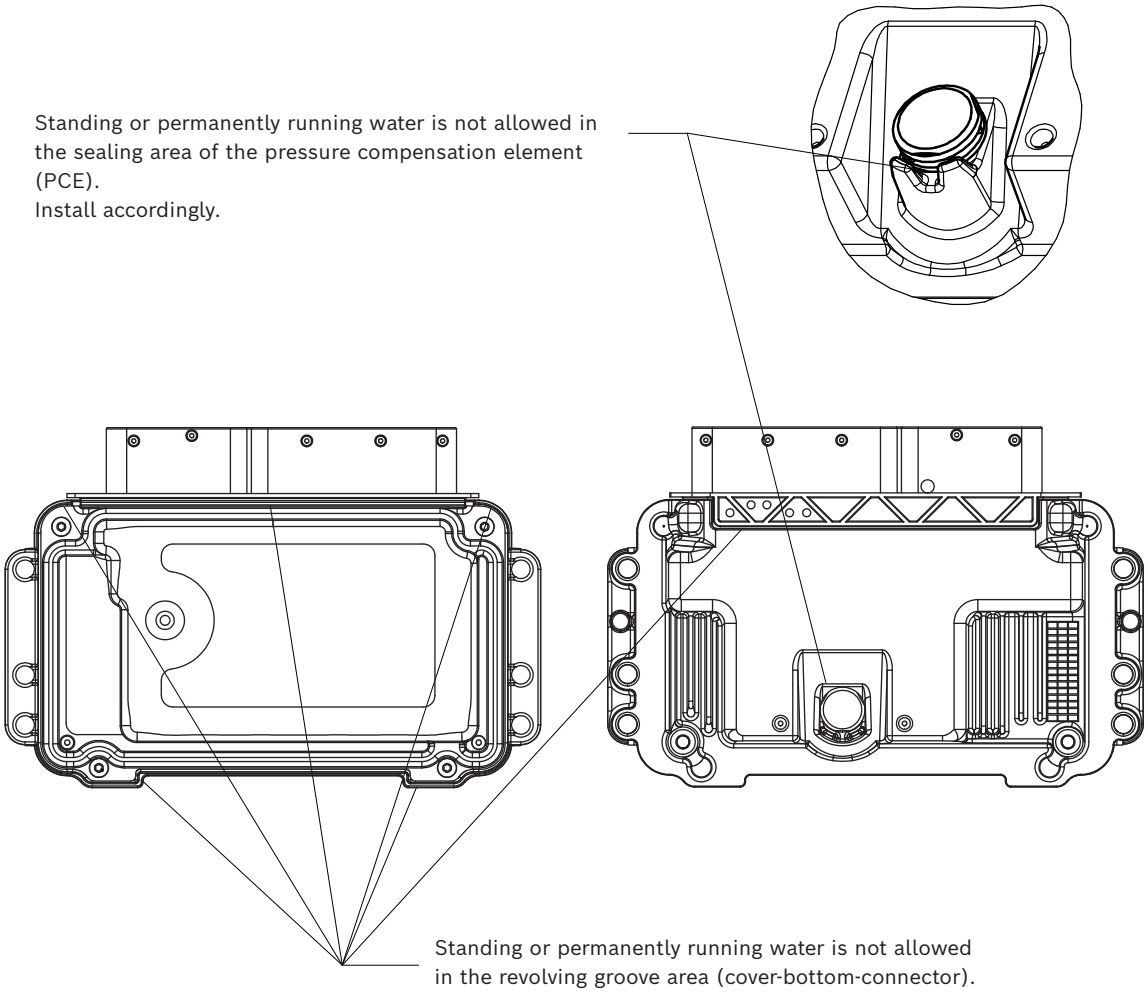
Fixing:

- The BODAS controller must be fixed at 4 positions (a, b, c and d).
- The BODAS controller has to be fastened in the vehicle so as to avoid bouncing against other vehicle parts and additional fastening elements of the controller.
- The maximum tightening torque for fastening the BODAS controller with M6 screws is 10 Nm.
- This tightening torque refers to a screw connection without washer. If washers are used, the equivalent tightening moment has to be determined.
- Rexroth's consent is required if fixing is different from above.
- The minimum gap between the bottom and the screw on surface of the vehicle is 1 mm.
- Even surface of customers screw on surface between the points a, b, c and d is ▱ 0.5
- The wiring harness must be supported mechanically at the controller mounting position (distance <150 mm) in a way that the excitation of the ECU is in phase (e.g. at the ECU screw on plate).
- The cable harness should be fixed such that the assembly has sufficient room to exit the BODAS controller without putting too much force on the mating connector.
- If the mounting surface is not sufficiently even, place flexible compensating elements between the fixing points of the BODAS controller and the mounting surface
- The housing must have a low ohmic electrical connection to the chassis ground. If this is not ensured by the mounting bolts, the connection must be established in a different way, e.g. via an earth strap.

Display without scale

Dimensions [mm]

Installation position



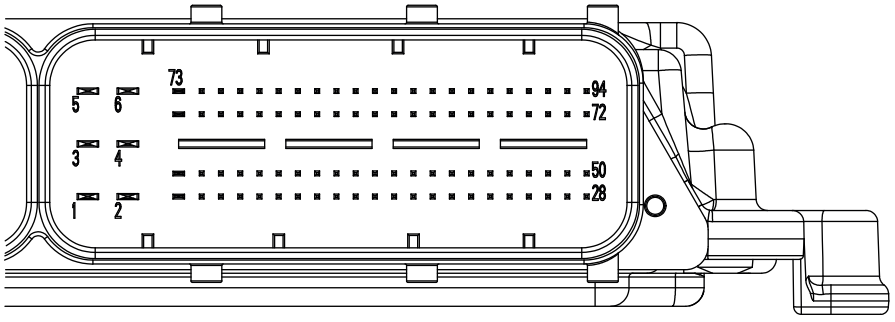
This drawing is for illustration of the sealing areas only. The controller can be mounted horizontally, vertically or at an angle to three the main axis. Mounting up-side-down is permissible. However, when installed on a machine, the connectors must not face upwards.

Mating connector

The 154-way plug connector is divided in 2 modules (94- and 60-way). Only the 94-pin module is used. The 60-pin module is closed and unused. The 1 928 xxx numbers stated below are Bosch designations. Technical details about these documents and part numbers are available at www.bosch-connectors.com. The numbers prefixed with “TE” are designations of TE connectivity (previously Tyco Electronics). Visit www.te.com for information on these items.

Assembly instruction	1 928 A01 09M
Technical customer documentation	1 928 A01 00T
Offer drawing (assembly)	1 928 A00 325
Offer drawing (carrier)	1 928 A00 326
Final check instruction	1 928 A00 05E

View of connector strip



Terminal designation

Contact BCB 0.6	Contact MQS 1.5 CB	Contact BDK 2.8
Row 1: Pins 8 to 28	Row 1: Pin 7	Pins 1 to 6
Row 2: Pins 30 to 50	Row 2: Pin 29	
Row 3: Pins 52 to 72	Row 3: Pin 51	
Row 4: Pins 74 to 94	Row 4: Pin 73	

Tools

Contact Type	Line cross section in mm^2	Hand Crimping	Wear part set	Automatic crimping	Extraction tool	Process specification contact
BCB 0.6	0.35 bis 0.5	1 928 498 753	1 928 498 749	1 928 498 751	1 928 498 755	1 928 A00 70M
BCB 0.6	0.75	1 928 498 753	1 928 498 750	1 928 498 752	1 928 498 755	1 928 A00 70M
MQS 1.5 CB	0.75 bis 1.5	TE 539635-1 with insert TE 539692-2	TE 541662		TE 6-1579007-0	TE 114-18286
BDK 2.8	0.5 bis 1.0	1 928 498 161	1 928 498 163	1 928 498 165	1 928 498 167	1 928 F00 025
BDK 2.8	1.5 bis 2.5	1 928 498 162	1 928 498 164	1 928 498 166	1 928 498 167	1 928 F00 025

Cables

Use FLKr Type “B” cables.

Connector components

The following parts are required for assembling a wiring harness connector. Alternatives are listed if applicable.

Designation	Version	Part number	Manufacturer	Number
Contact carrier, Code C		1 928 405 063	Bosch	1
Cover	Outlet up Outlet left Outlet right	1 928 405 247 1 928 405 071 1 928 405 069	Bosch Bosch Bosch	1
Secondary lock power		1 928 405 074	Bosch	1
Secondary lock signal		1 928 405 073	Bosch	1
Holding plate		1 928 405 067	Bosch	1
Fixing strap		1 928 401 713	Bosch	1
Contact BCB 0.6	Line cross section in mm² 0.35 - 0.5 Insulation diameter in mm 1.2 – 1.6 Not allowed for power output pins. 0.75 mm² has to be used for these pins.	1 928 492 555	Bosch	up to 84
	Line cross section in mm² 0.75 Insulation diameter in mm 1.7 – 1.9	1 928 492 556	Bosch	
Contact MQS 1.5 CB	Line cross section in mm² 0.75 – 1.5 Insulation diameter in mm 1.7 – 2.4	TE 1 241 608-1	TE connectivity	up to 4
Contact BDK 2.8	Line cross section in mm² 0.5 – 1.0 Insulation diameter in mm 1.2 – 2.1	1 928 498 056	Bosch	up to 6
	Line cross section in mm² 1.5 – 2.5 Insulation diameter in mm 2.2 – 3.0	1 928 498 057	Bosch	
Dummy contact BCB 0.6		1 928 405 077	Bosch	[1]
Dummy contact MQS 1.5-CB		1 928 405 076	Bosch	[1]
Single wire seal for BDK 2.8	For insulation diameter in mm 1.2 – 2.1 (blue)	1 928 300 599	Bosch	up to 6
Single wire seal for BDK 2.8	For insulation diameter in mm 2.2 – 3.0 (white)	1 928 300 600	Bosch	up to 6
Cavity / dummy plug BDK 2.8	(clear)	1 928 300 601	Bosch	[1]

1) Free contact chambers are to be sealed with dummy contacts to ensure water tightness.

Connector Kit

Mating connector sets with the following content are available under Rexroth part number R917010843 for the manual assembly of wiring harness connectors for laboratory or small-series requirements. Machined assembly is recommended for larger quantities.

Designation	Version	Part number	Manufacturer	Number
Contact carrier, Code C		1 928 405 063	Bosch	1
Cover	Outlet right	1 928 405 069	Bosch	1
Secondary lock power		1 928 405 074	Bosch	1
Secondary lock signal		1 928 405 073	Bosch	1
Holding plate		1 928 405 067	Bosch	1
Fixing strap		1 928 401 713	Bosch	1
Contact BCB 0.6	Line cross section in mm² 0.75 Insulation diameter in mm 1.7 – 1.9	1 928 492 556	Bosch	84
Contact MQS 1.5 CB	Line cross section in mm² 0.75 – 1.5 Insulation diameter in mm 1.7 – 2.4	TE 1 241 608-1	TE connectivity	6
Contact BDK 2.8	Line cross section in mm² 1.5 – 2.5 Insulation diameter in mm 2.2 – 3.0	1 928 498 057	Bosch	8
Dummy contact BCB 0.6		1 928 405 077	Bosch	60[1)]
Dummy contact MQS 1.5-CB		1 928 405 076	Bosch	6[1)]
Single wire seal for BDK 2.8	For insulation diameter in mm 2.2 – 3.0 (white)	1 928 300 600	Bosch	6
Cavity / dummy plug BDK 2.8	(clear)	1 928 300 601	Bosch	4[1)]

Delivered loose in a PE bag. Not suitable for processing by a machine.

1) Free contact chambers are to be sealed with dummy contacts to ensure water tightness.

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) 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.
- 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.
- Whilst commissioning and maintenance of the controller, the machine may pose unforeseen hazards. Therefore the vehicle and the hydraulic system have to be in a safe condition during such operations.
- 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.
- Controllers used to develop software must not be installed in series production machines since the number of flashing cycles is limited and may have been reached or exceeded.
- The control units are to be used in applications for intermittent operations. The maximum uninterrupted operating time is defined as 24 hours. The controller must be switched off or reset at least once within 24 hours.

Notes on the installation point and position

- Do not install the controller close to parts that generate considerable heat (e.g. exhaust).
- Radio transmitting 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 transmitting 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 not facing upwards. 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 compensation element (PCE).
- Metallic screws must be used for mounting the controller for a good thermal connection between the housing and the cooling surface (heat sink).

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 shall 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 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

- Connections to systems with a different electrical ground or power source require galvanic isolation.
- Lines to the speed sensors shall be as short as possible and shielded. The shielding must be connected to the electronics or to the machine or vehicle ground via a low-resistance connection (one side only).
- Twisted-pair wires have to be used for CAN and ISOBUS.
- 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.
- The outputs must not be used to energize light bulbs due to the inrush current characteristic of these loads. Exceptions are permissible for low power signal light bulbs if it is ensured that the inrush current does not exceed the limits of this data sheet.
- The sensor supplies can be „pulled up" by an 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.
- Restrictions apply for the operation of LEDs with internal electronics at the outputs. The in-rush current must be below diagnosis thresholds.
- When operating LEDs at power outputs the diagnosis current may lead to flashing of the LEDs.
- The high side outputs may not be externally connected to battery.
- Loads connected to low side outputs (both power and low power) must be powered from a high side output and not directly from battery.

Note on proportional and switching solenoids and other wired inductive consumers

- The proportional solenoids (operated in open- or closed loop current control mode) must not be wired with free-wheeling diodes.
- Switching solenoids at the outputs of the control unit do not need to be connected to free-wheeling 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 free-wheeling 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 the 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.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and for 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 by the application software to detect faults and to activate specially programmed reactions.
- Special measures may be initiated if the plausibility check shows deviations between the set-point 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 ECU customer manual must be observed.

Safety features in the BODAS controller

- Independent circuitry is provided for certain groups of inputs (e.g. two input devices with separate A/D converters). Faults can be detected by acquiring signals through independent circuitry and cross-checks in the application software.
- Faults in the supply voltage are detected by internal monitoring.
- All output signals can be monitored by the microcontroller with the appropriate software.
- The controllers can be operated with all power outputs de-energized for service purposes.
- A watchdog module is provided to detect malfunctions in the program run. The power outputs are shut off in such a case.

Disposal

- Disposal of the BODAS Controller and packaging must be in accordance with the national environmental regulations of the country in which the controller is used.

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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Starter kit RC/40

- Functional starter kit for BODAS controllers RC of series 40

Features

- Flashing and diagnosis by means of BODAS-service 4.x directly possible without further accessories
- Flexible use on several PCs through dongle license

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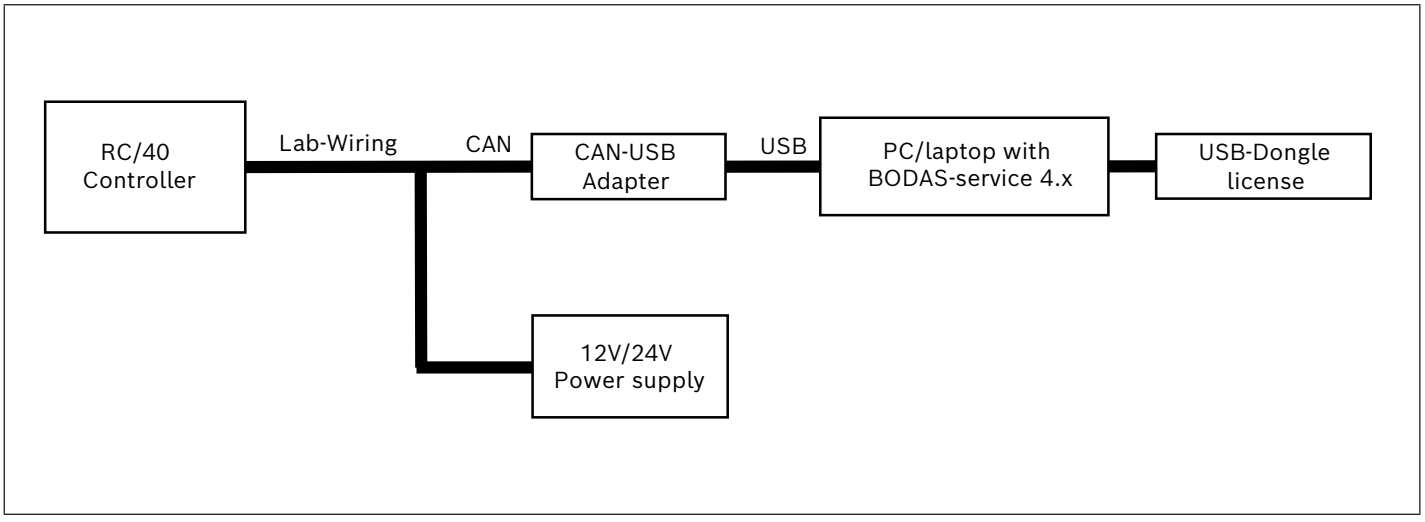
Description

The RC/40 starter kit includes the following components:

Component	Quantity
BODAS controller RC/40	1
USB dongle license for BODAS-service 4.x	1
Laboratory cable RC/40 for connecting the control unit to supply voltage and CAN bus or Ethernet	1
CAN-USB adapter (VCI)	1
Sub-D9 connector with CAN termination resistor	1

Port

The starter kit is connected as follows:



The PC/laptop and the voltage supply are not part of the starter kit.

Ordering codes

The RC/40 starter kit is available in two different variants:

Designation	Material number
Starter kit for RC5-6/40 (RC/40 small)	R917013288
Controller is programmable in C and CODESYS.	
Starter kit for RC18-12/40 and RC27-18/40 (RC/40 mid/large)	R917013289
Controller is also expected to be programmable in CODESYS from June 2023.	

Optional accessories

Pre-assembled cable

Pre-assembled cables are available for the two connector chambers A and K of BODAS controllers RC/40. With these cables, all pins are led to the outside and can be connected individually. The cable length is 1.5 m.

Designation	Material number
Cable for connector chamber K (large chamber)	R917013283
Cable for connector chamber A (small chamber)	R917013287

Safety instructions

Please observe the safety instructions for the individual components of this set when using them. These are available on the respective data sheets.

Disposal

- The products and their packaging must be disposed of according to the national environmental regulations of the country in which the products are used.

Further information

- More detailed information on the individual components may be found at www.boschrexroth.com/mobile-electronics
- Check our homepage regularly for the latest information on products and updates.

Related documentation

Title	Data sheet
BODAS controller RC5-6/40	95207
BODAS controller RC18-12/40	95208
BODAS controller RC27-18/40	95208
BODAS-service 4.x	95087

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