

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
- Three independent CAN bus interfaces (one of which useable for ISOBUS and one 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
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Version

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

03	Series 4, index 0	40
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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/x0 speed sensors with integrated diagnosis function can be acquired.

Six inputs can be used for measuring analog voltages via the ADC in the μ C. 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.

Three independent CAN bus interfaces are available in the RC5-6/40 controller. Two of these CAN interfaces can be used as CAN FD interfaces. One CAN interface can be used to wake up the controller. Another one complies with the ISOBUS specification for ECUs. An external termination bias circuit (TBC) is required for ISOBUS compliance. 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 download 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.

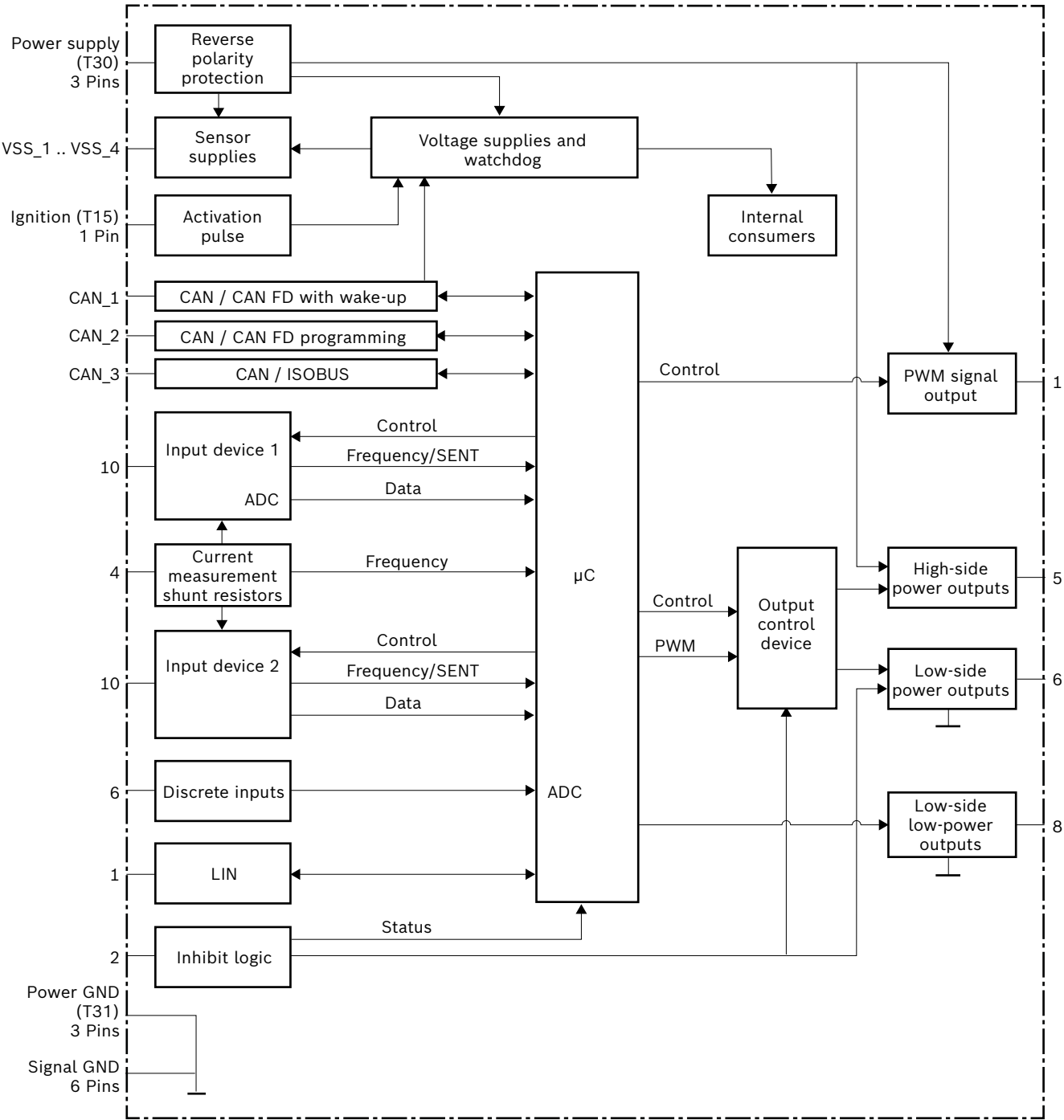
The hardware configuration is no longer required as part of the application software but can be done via a tool available on the internet. The configurable properties of inputs, outputs and CAN data bases can be defined. The tool returns a configured base software that can be linked with the actual application 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 ingress, 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 EN ISO 13849. The safety-relevant project planning instruction 95453-01-B has to be observed if such safety functions shall be implemented. These instructions are available on request.

Block circuit diagram



Abbreviations	
µC	Micro controller
PWM	Pulse Width Modulation
GND	Ground
ADC	Analog to Digital Converter
CAN	Controller Area Network
CAN FD	CAN with Flexible Data Rate

Technical data

BODAS controller		RC5-6 Series 40
Supply Voltage		
Nominal battery voltage		12 V and 24 V
Supply voltage ranges		
No function: μ C 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 μ A
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		3
10 V 150 mA		1
Inputs, total count		30
Digital voltage, analog voltage		6
Digital voltage, analog voltage, alternative use as 0 – 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/x0 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 – 10 V analog voltage output (alternative use of an input pin)		1
Communication interfaces, total count		4
CAN 2.0 B / CAN FD with wake-up capability		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 13309:2010, 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)

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 details see RE95453-01-B.

Humidity cycling test

EN 60068-2-30:2005, Test Db variant 2, 6 cycles with 24 h each, $T_{\max} = 55\text{ °C}$, $rH = 98\%$
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, $T = 35\text{ °C}$, 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); $T = \text{room temperature}$
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 2007, vibration
4.1.2.7 Test VII – Commercial vehicle, sprung masses
Duration = 32 h each axis, temperature overlaid $T_i = -40\text{ °C}$ up to 105 °C , soak time = 30 min, frequency band: 10 - 2,000 Hz,
 $a_{\text{eff}} = 57.9\text{ m/s}^2$; see table 12

Frequency	PSD
10 Hz	$18\text{ (m/s}^2\text{)}^2 / \text{Hz}$
20 Hz	$36\text{ (m/s}^2\text{)}^2 / \text{Hz}$
30 Hz	$36\text{ (m/s}^2\text{)}^2 / \text{Hz}$
180 Hz	$1\text{ (m/s}^2\text{)}^2 / \text{Hz}$
2000 Hz	$1\text{ (m/s}^2\text{)}^2 / \text{Hz}$

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 10605:2008, 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 10605:2008, 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 10605:2008, 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 10605:2008, 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, $t_r = 3 + 0 / -0.5$ μ s, $t_2 = 200$ ms, $t_3 = < 100$ μ s, 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, $t_r = 1$ μ s, 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, $t_1 = 100$ μ s, $t_4 = 10$ 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, $t_1 = 100$ μ s, $t_4 = 10$ 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

$U_{s6} = 4.5 \text{ V}$, $U_s = 6.5 \text{ V}$, $t_f = 5 \pm 0.5 \text{ ms}$, $t_6 = 15 \pm 1.5 \text{ ms}$, $t_7 = 50 \pm 1.5 \text{ ms}$, $t_8 = 10,000 \pm 1,000 \text{ ms}$, voltage ripple during $t_8 = U_s + 2 \text{ V}$ with $f = 2 \text{ Hz}$, $t_r = 100 \pm 10 \text{ ms}$,

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)

$U_s = -6 \text{ V}$, $U_a = -4 \text{ V}$, $R_i = 0 \Omega \dots 0.02 \Omega$, $t_7 = 15 \text{ ms} \dots 40 \text{ ms}$, $t_8 < 50 \text{ ms}$, $t_9 = 0.5 \text{ s} \dots 20 \text{ s}$, $t_{10} = 5 \text{ ms}$, $t_{11} = 5 \text{ ms} \dots 100 \text{ ms}$

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

$U_{s6} = 6 \text{ V}$, $U_s = 10 \text{ V}$, $t_f = 10 \pm 1 \text{ ms}$, $t_6 = 50 \pm 5 \text{ ms}$, $t_7 = 50 \pm 5 \text{ ms}$, $t_8 = 1,000 \pm 100 \text{ ms}$,

voltage ripple during $t_8 = U_s + 2 \text{ V}$ with $f = 2 \text{ Hz}$, $t_r = 40 \pm 10 \text{ ms}$, 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

$U_s = 202 \text{ V}$, $R_i = 8 \Omega$, $t_d = 350 \text{ ms}$, $t_r = 10 +0 / -5 \text{ ms}$, 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

$U_a = 28 \text{ V}$, $U_s = 151 \text{ V}$, $U_s^* = 41 \text{ V}$, $R_i = 1 \text{ Ohm}$, $t_d = 350 \text{ ms}$, $t_r = 10 \text{ ms}$, $t_1 = 60 \text{ s}$, 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: $U_s = -150 \text{ V} / +150 \text{ V}$

$t_r = 5 \text{ ns}$, $t_d = 0.15 \pm 0.045 \mu\text{s}$, $t_1 = 100 \mu\text{s}$, $t_4 = 10 \text{ ms}$, $t_5 = 90 \text{ ms}$, $R_i = 50 \Omega$, 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: $U_s = +10 \text{ V} / -10 \text{ V}$

$t_r = 1 \mu\text{s} + 0 / -0.5 \mu\text{s}$, $t_d = 0.05 \text{ ms}$, $t_1 = 1 \text{ s}$, $R_i = 2 \Omega$

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

$U_{Smax} = 32 \text{ V}$, $U_{PP} = 4 \text{ V}$ (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

$U_{Smax} = 32 \text{ V}$, duration = 60 s \pm 10 %

Operating state: C

ISO 16750-2:2012, overvoltage, chapter 4.3.2

$U_{sup} = 36 \text{ V}$

$T = 65^\circ\text{C}$ (= T_{max} minus 20°C)

Duration: 60 min

Power stages are not active as these are intentionally shut off by diagnosis software above 32 V.

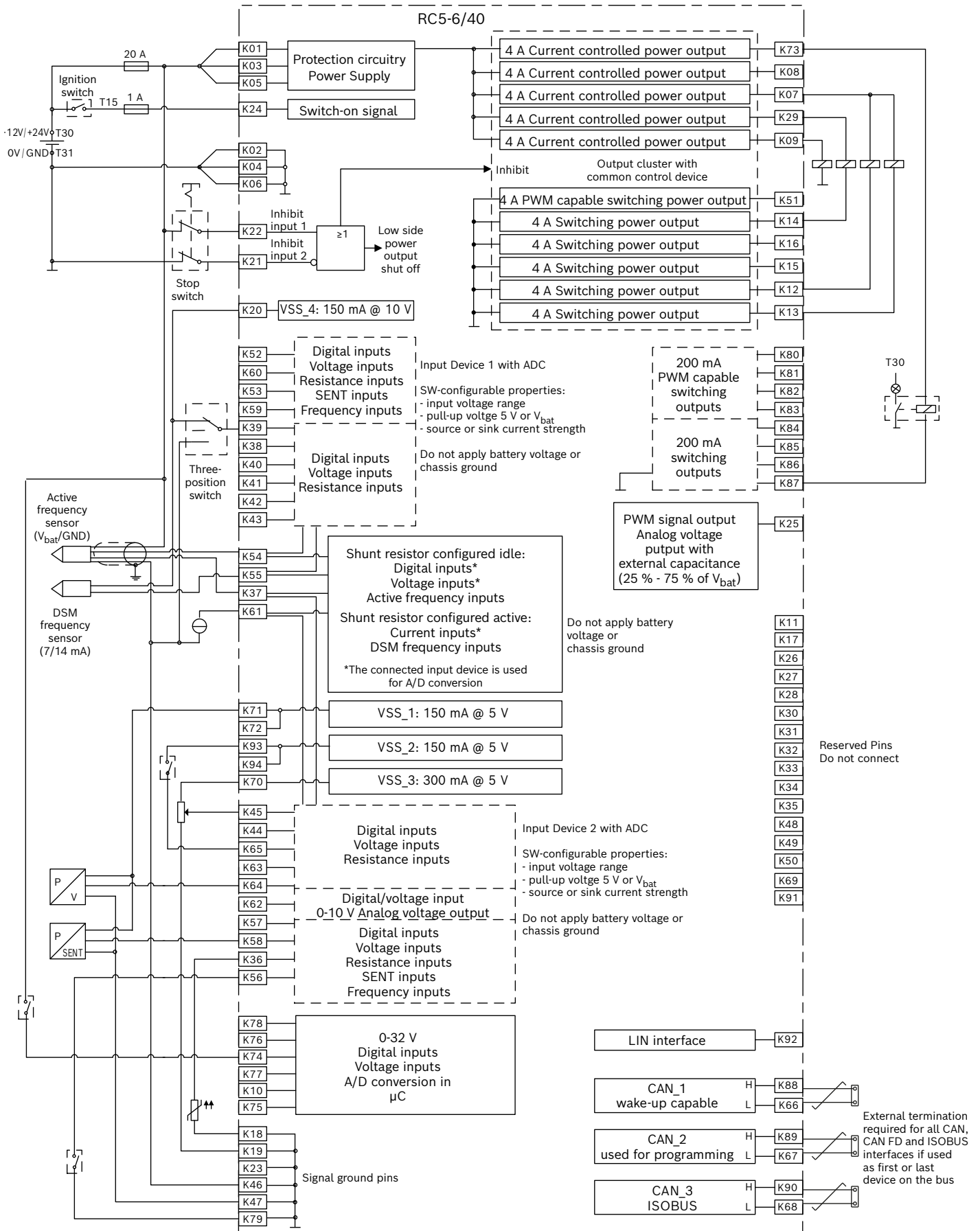
Operating state: C

ISO 16750-2:2012, reversed polarity, chapter 4.7.2

Case 2, $U_A = 28 \text{ V}$ (see ISO 16750-1 and Table 7), duration = 60 \pm 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: < 50mA ≤ 1.2 μ F < 100mA ≤ 0.9 μ F < 150mA ≤ 0.33 μ F		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 during start-up not active Admissible capacitive load ≤ 100 μ F		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 during start-up and reset not active Admissible capacitive load ≤ 100 μ F		Can be used for Bosch Rexroth speed sensor DSM1/x0 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	DI	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 <table><tr><td></td><td>Low</td><td>High</td></tr><tr><td>Automotive logic</td><td>< 2.2 V</td><td>> 3.5 V</td></tr><tr><td>TTL logic</td><td>< 0.8 V</td><td>> 2.2 V</td></tr><tr><td>High voltage logic</td><td>< 3.5 V</td><td>> 6.0 V</td></tr></table> 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 Accuracy 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) Resistance measurement Pull-Up voltage 5 V Three configurable measurement ranges 20 Ω .. 2 kΩ 475 Ω pull-up resistor 2 kΩ .. 30 kΩ 5.62 kΩ pull-up resistor 30 kΩ .. 400 kΩ 46.4 kΩ pull-up resistor 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.				Low	High	Automotive logic	< 2.2 V	> 3.5 V	TTL logic	< 0.8 V	> 2.2 V	High voltage logic
	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												
			AI AIV AID											
			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	FI SENT	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 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		
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	AOV	Do not apply battery voltage or chassis ground Resistance measurement is not possible

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 $\pm 7.5\%$ for battery voltage measurement $\pm 10\%$ Resolution 12 bits Pull-Down resistor 80 k Ω Pull-Up resistor 14.7 k Ω Pull-Up voltage is the battery voltage (reverse polarity protection via diode in the pull-up path) Filter limit frequency ≥ 279 Hz 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 $\pm 7.5\%$ at 32 V Serial resistor (output current limiter) 3.5 k Ω Pull-Down resistor in analog feedback 55 k Ω Ripple dependent on external capacitance. ≥ 100 μ F 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.
K80, K81, K82, K83	Low side, low power digital outputs	PWM capable switching outputs Max. current rating per output 200 mA Max. PWM frequency 3 kHz with constant duty cycle of 50 % ($\pm 5\%$) Max. PWM frequency 250 Hz with adjustable duty cycle of 0 .. 100 % For full diagnosis capability a minimal pulse length of 250 μ s is required.	PO POD	
				Loads connected to a low side output must be powered from a high side output. Load Dump protected up to $U_s^* = 41$ V

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 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 detection) 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	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, K13, K14, K15, K16	Low side power output stage	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 detection) 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	DO	Loads connected to a low side output must be powered from a high side output. Freewheeling diode included
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

Pin	Description	Main function	Software modes	Remarks
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 ¹⁾ Any traffic on this CAN bus wakes-up the controller ²⁾		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 ¹⁾ 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.
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 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)

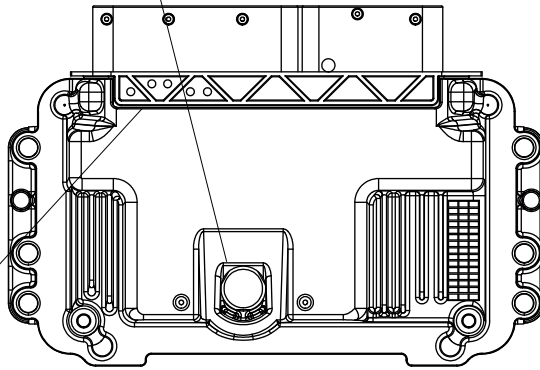
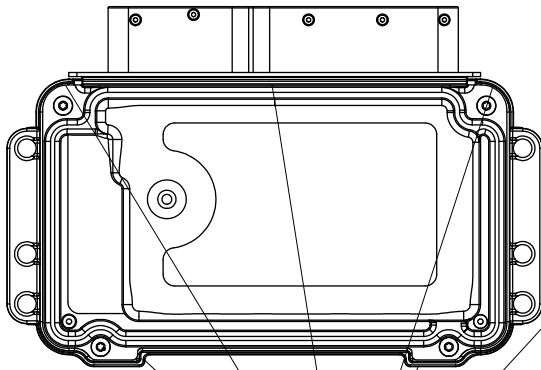
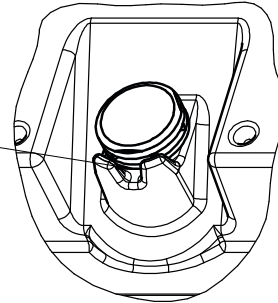
AOV Analog output set point in mV (range 0 .. 10 V) or
Set point in 0.1 % of battery voltage (range 25 % .. 75 %)

¹⁾ BSW support for CAN-FD under development

²⁾ BSW support for CAN wake-up under development

Installation position

Standing or permanently running water is not allowed in the sealing area of the pressure compensation element (PCE). Install accordingly.



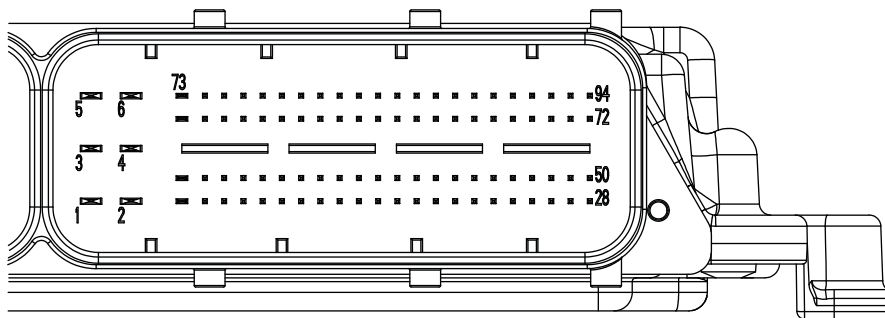
Standing or permanently running water is not allowed in the revolving groove area (cover-bottom-connector). Install accordingly.

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 mm ² 0.35 - 0.5 Insulation diameter in mm 1.2 – 1.6 Not allowed for power output pins. 0.75 mm ² has to be used for these pins.	1 928 492 555	Bosch	up to 84
	Line cross section in mm ² 0.75 Insulation diameter in mm 1.7 – 1.9	1 928 492 556	Bosch	
Contact MQS 1.5 CB	Line cross section in mm ² 0.75 – 1.5 Insulation diameter in mm 1.7 – 2.4	TE 1 241 608-1	TE connectivity	up to 4
Contact BDK 2.8	Line cross section in mm ² 0.5 – 1.0 Insulation diameter in mm 1.2 – 2.1	1 928 498 056	Bosch	up to 6
	Line cross section in mm ² 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 mm ² 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 mm ² 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 mm ² 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.

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 BODAS-BSW manual, in the BODAS-design manual (if applicable) and in the “safety-relevant project planning instructions” 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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