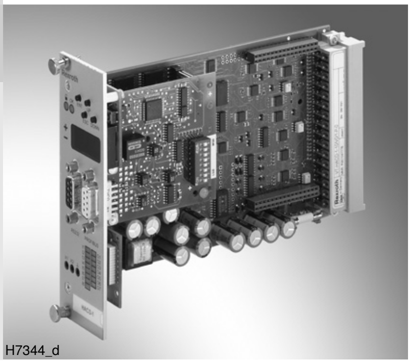
Rexroth
Bosch Group

Digital command value and controller card

RE 30143/06.08
Replaces: 09.07

Type VT-HACD-1

Component series 1X



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Features

- Use as **command value card** for generating, linking and normalizing signals
- Use as **controller card** for closed control loops with PIDT1-controller and optional state feedback
- Alternating control (e.g. closed-loop position control with superimposed closed-loop control of pressure / force) possible
- Input for digital measuring system, SSI and incremental
- 6 analog inputs, can be switched between voltage (±10 V, 0…10 V) and current (4…20 mA)
- 3 analog outputs, 1x switchable, voltage (±10 V, 0…10 V) or current (0…20 mA, 4…20 mA), 1x voltage (±10 V)
- Versatile options of logic operations of signals and change-over
- Enable input and OK output
- 8 digital inputs
- 7 digital outputs, configurable
- Parameterizable ramp function
- 32 blocks with command values, velocities and controller parameters
- Adaptation to hydraulic actuators by means of area adjustment, characteristic curve correction and overlap compensation, residual speed logic and zero point correction
- ±10 V reference voltage output
- Front display with keys for viewing and changing parameters as well as for diagnostics
- Serial interface RS232
- Up to 32 cards can be interconnected via local bus for parameterization and diagnostics
- Configurable analog output (A03) connected to strip connector

Ordering code

VT-HACD – 1 – 1X / V0 / 1 – – –

Digital command value and controller card

Standard command value and controller card **= 1**

Component series 10 to 19 **= 1X**
(10 to 19: unchanged technical data and pin assignment)

0 = Without valve output stage
1 = With valve output stage for 4WRE, component series 2X with two solenoids (only in conjunction with PROFIBUS)

0 = Without bus interface
P = PROFIBUS DPV0
D = DeviceNet
C = CANopen

1 = With display

V0 = Basic device

Standard types	Material number
VT-HACD-1-1X/V0/1-0-0	R900745354
VT-HACD-1-1X/V0/1-D-0	R901040277
VT-HACD-1-1X/V0/1-P-0	R901047778
VT-HACD-1-1X/V0/1-C-0	R901119881
VT-HACD-1-1X/V0/1-P-1	R901151005

Required accessories:
- PC program BODAC: Ordering code of CD: SYS-HACD-BODAC-01 (R900777335) or free download on the Internet at www.boschrexroth.com/hacd
- Interface cable: Cable set VT-HACD-1X/03.0/ HACD-PC (R900776897) or commercial 1:1 cable
- Optional USB adapter VT-ZKO-USB/S-1-1X/V0/0

Suitable card holders:
- 19“ racks VT 19101, VT 19102, VT 19103 and VT 19110 (see RE 29768)
- Enclosed card holder VT 12302 (see RE 30103) (standard), Mat. no. R900784153
- Open card holder VT 3002-2X/64G (see RE 29928), Mat. no. R900991843 (only for installation into control cabinet!)
- Connection adapter VT 10812-2X/64G (see RE 30105), Mat. no. R900713826

Suitable power supply unit:
- Compact power supply unit VT-NE30, see RE 29929

Functional description

VT-HACD-1 command value and controller cards are designed as double-sided printed-circuit boards in Euro-format 100 x 160 mm.

A microcontroller controls the entire sequence, executes adjustments and logic operations and realizes closed control loops. Data for configuration, command values and parameters are saved in a non-volatile FLASH memory.

The entire configuration is carried out by means of software; the card is not provided with jumpers, etc. For configuration purposes, the VT-HACD must be connected to a PC via a serial interface (RS 232, 1:1 cable). The complete configuration as well as parameterization and diagnosis are performed with the help of the operator interface BODAC.

The configuration and hence the implementation of applications is easy to accomplish by linking pre-defined function blocks. This requires no programming knowledge.

2 different modes are available:

- **Mode 1** (not bus-capable) **– Block call-ups (factory setting)**
  The 32 blocks can be called up via the binary combination of digital inputs DI1…DI5 + DI6 as "binary enable". In terms of function, this mode is compatible with the VT-SWKD.
- **Mode 3** (bus-capable) **– Structure editor**
  The Structure editor is enabled. It is possible to create own motion sequences. 32 blocks are available to this end. Each block includes: Command value, ramp times (velocity +, velocity –, S-component) and controller parameters.

  The blocks are activated by setting trigger conditions: Setting of digital inputs, comparison of signals with freely definable threshold or elapsing of wait times.

Changing over to another mode is easily possible by saving a corresponding parameter set, which is included in the scope of supply of BODAC.

Logic operation of signals

The VT-HACD offers a multitude of options for linking signals on both, the input and output side, with logic operations being possible for 2 signals at a time. The operations are addition, subtraction, multiplication as well as minimum/maximum value comparators, area ratio and limiter:

+ = Addition: Z = X + Y

– = Subtraction: Z = X – Y

* = Multiplication: Z = X * Y / 100

/ = Division: Z = X / Y * 100

MIN = Minimum value comparator: Z = MIN (X, Y)

MAX = Maximum value comparator: Z = MAX (X, Y)

RATIO = Input for a ratio:
for RATIO >1: Z = X * RATIO – Y
for RATIO <1: Z = X – Y / RATIO
(e.g. area ratio for differential pressure measurement)

LIMIT = Signal limitation: Z = MIN (|X|, |Y|) * X / |X|

JUMP = Jump function generator: Z = MAX (|X|, |Y|) * X / |X|

with Z … result
X … 1st signal
Y … 2nd signal

Analog I/O

The 6 analog inputs can be software-switched between ±10 V, 0…10 V, 0…20 mA and 4…20 mA.

Analog output AO1 can be software-switched between ±10 V, 0…10 V, 0…20 mA and 4…20 mA. AO2 is firmly set to ±10 V. A03 can be configured by means of software and used for, e.g. diagnosis purposes.

Changing over takes place in a way that the entire range of the analog/digital converter is utilized.

The operating range and fault recognition can be defined for all analog inputs.

The analog outputs can be adjusted by means of gain and offset.

Digital I/O

The VT-HACD is provided with 9 digital inputs and 8 digital outputs.

One digital input has the fixed functionality "enable", one digital output the fixed functionality "OK".

Further digital inputs are used for triggering blocks (see blocks and triggering).

The function of each digital output can be determined through selections from a pre-defined list:

- Command value = actual value
- Actual value greater or less than an adjustable threshold
- Wait time completed
- Ramp active
- Internal flag set
- Fault flag set

Functional description (continued)

Digital position measuring system

If the VT-HACD is used as controller card, type SSI or incremental digital position measuring systems can be used for the acquisition of actual value.

Application limits of incremental encoders

The maximum frequency of the incremental encoder input (f_G) of the VT-HACD is 100 kHz. Determining factors for the frequency are the maximum traversing velocity of the drive, the resolution (Res) of the encoder used and possible signal evaluation by EXE (interpolation and digitizing electronics).

Calculation formulas

Encoder resolution with given maximum velocity:

$$\text{Res}\,[\mu\text{m}] \geq \frac{v\left[\frac{m}{s}\right] \times 10^3}{f_G\,[\text{kHz}] \times \text{EXE}}$$

Velocity with given encoder resolution:

$$v\left[\frac{m}{s}\right] \leq \frac{\text{Res}\,[\mu\text{m}] \times \text{EXE} \times f_G\,[\text{kHz}]}{10^3}$$

Controller

If the VT-HACD is used as controller card, the entry “controller” must be selected in signal linking [8].

LCx signals represent the command value branch, LFBx signals the actual value branch. [8]

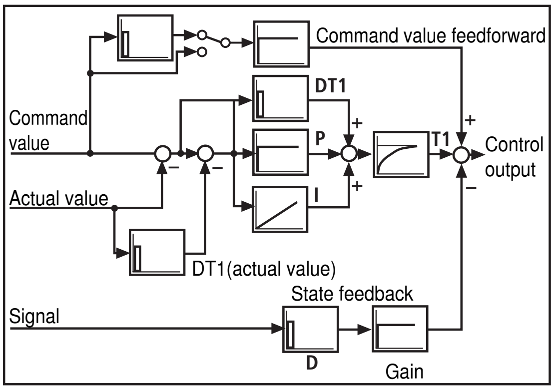
An SSI encoder or incremental encoder [2] (digital measuring system) or one or several analog sensors can be used as actual value signal.

The controller structure is designed as PIDT1-controller, in which every component can be individually activated or deactivated. In this way, it is also possible to realize, for example, a P- or PT1-controller. The I-component can additionally be controlled via a window (upper and lower limit).

Controller parameters can be set block-wise or independently of blocks.

In Mode 3, a state feedback can be used for damping the controller output.

Controller structure:



Adjustment to the hydraulic system

For the optimum adjustment to the special requirements of hydraulic drives, the following functions are implemented upstream of the analog output:

- Direction-dependent gain [10]

  The gain can be adjusted separately for positive and negative values. Adjustments to the area ratio of a single-rod cylinder are therefore possible.
- Characteristic curve correction [11]

  This allows progressive flow characteristics of proportional directional valves to be compensated for or the realization of an inflected characteristic curve.
- Overlap jump/residual speed [12]

  When valves with positive overlap are employed in conjunction with a PDT1-controller, fine positioning can be used to increase the steady-state accuracy. This can be selected according to the residual voltage principle or as overlap jump.
- Zero point correction (offset) [13]

  Serves to correct the zero point of the connected servo, proportional or high-response valve.

Recognition and handling of errors

The VT-HACD supports a multitude of options for fault monitoring:

- Monitoring of analog inputs for values above or below ranges
- Monitoring of the position sensors for cable break
- Monitoring of system deviations, if the HACD is configured as controller
- Monitoring of the supply voltage, of all internal voltages and of the ±10 V reference voltage
- Monitoring of the microcontroller itself (watchdog) and of the memory (checksum)

Error monitoring and the related response can also be configured.

Functional description (continued)

Front panel operation

In conjunction with the four keys the front display is used for displaying and changing parameters as well as for diagnosis purposes.

The parameters of the VT-HACD can be accessed via a corresponding menu structure. The parameter values can be viewed and changed.

Access is possible to the following parameters:

- Command value and ramp parameters
- Actual values
- Controller parameters
- Output adjustment
- Analog I/O
- Position sensors

Changes in the configuration, i.e. changes to logic operations of signals, trigger conditions, fault monitoring, etc. are not possible via front panel operation.

The diagnosis options offered are the display of command and actual values and the output of fault messages.

Valve output stage [18] (optional)

The following is valid for the valve output stage:

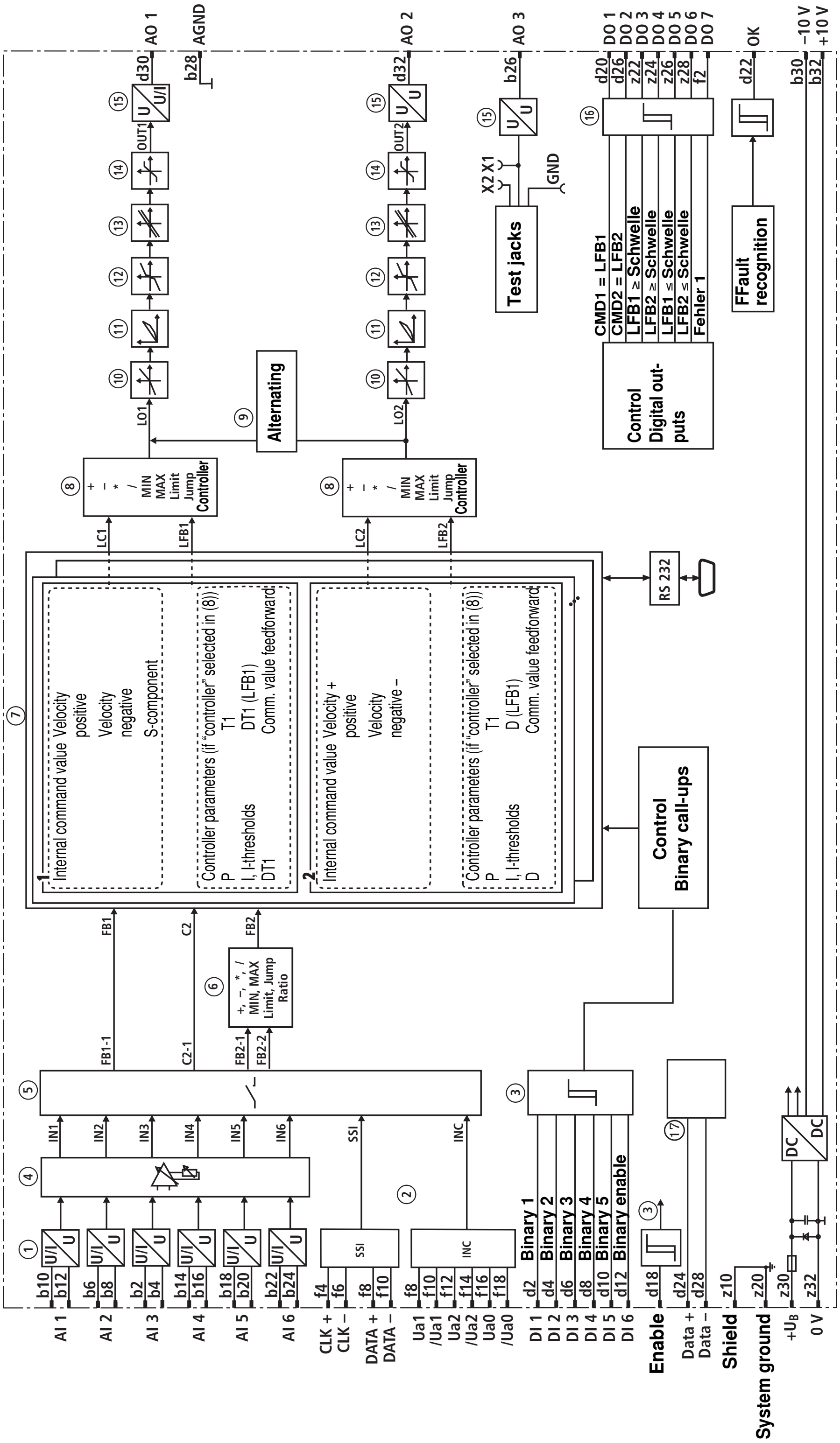
- Available only in conjunction with PROFIBUS
- Only for valves of type 4WRE…2X with two solenoids
- Can only be activated in Mode 3

A fault logic recognizes a cable break of the actual value cable of the valve position transducer. The ready-for-operation signal is withdrawn, a Low signal is output at connection d22 and the “OK” LED on the front panel goes out.

PC program BODAC

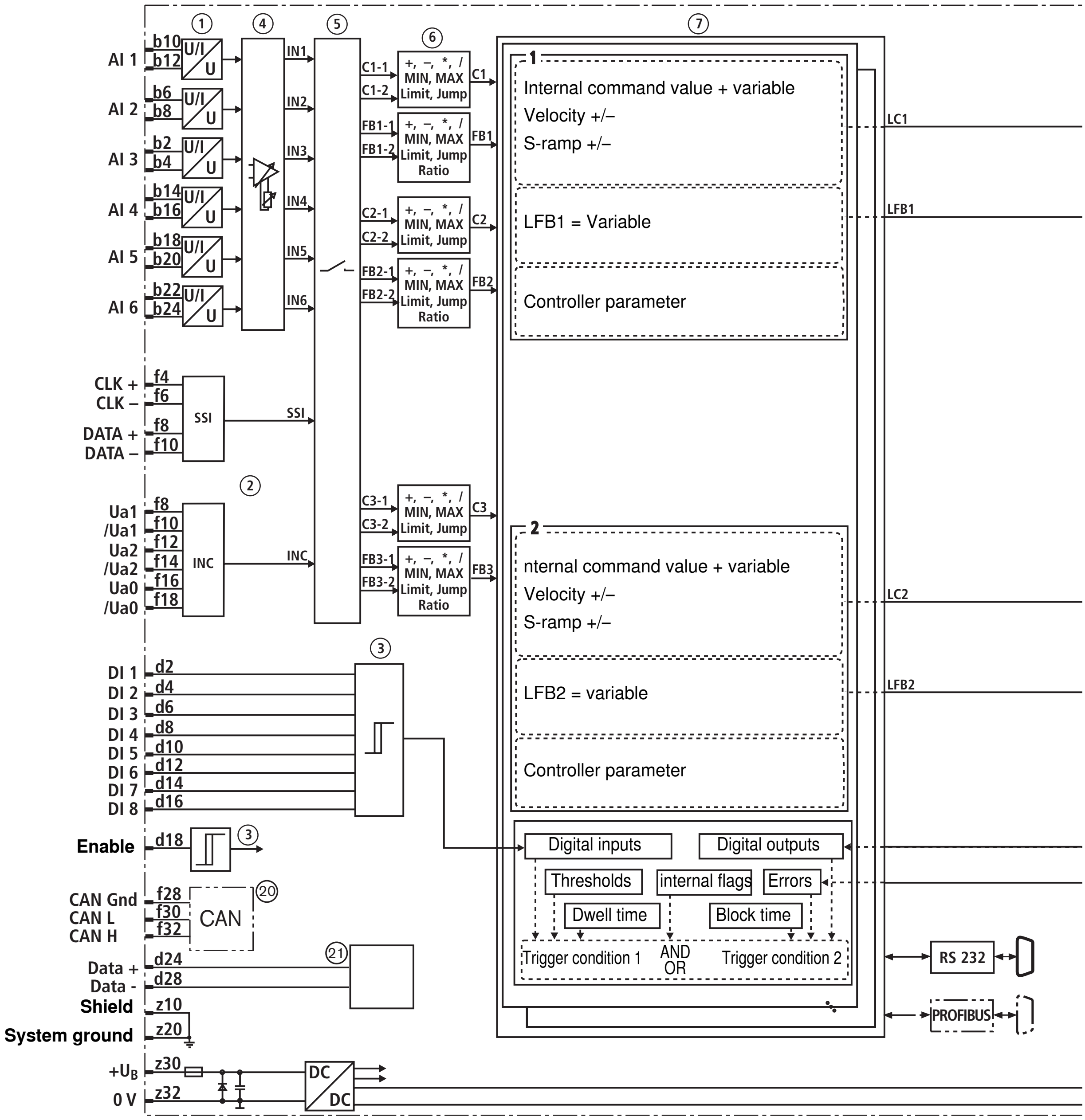
The PC program BODAC is used for the configuration, parameterization and diagnosis of the VT-HACD via a serial interface (RS 232). Up to 32 control electronics can be interconnected via the local bus. Each control electronics is assigned a bus address via BODAC. Re-plugging of the serial interface cable is not required. For further information, see RE 30143-01-B.

Block circuit diagram: VT-HACD-1, Mode 1 - Block call-ups

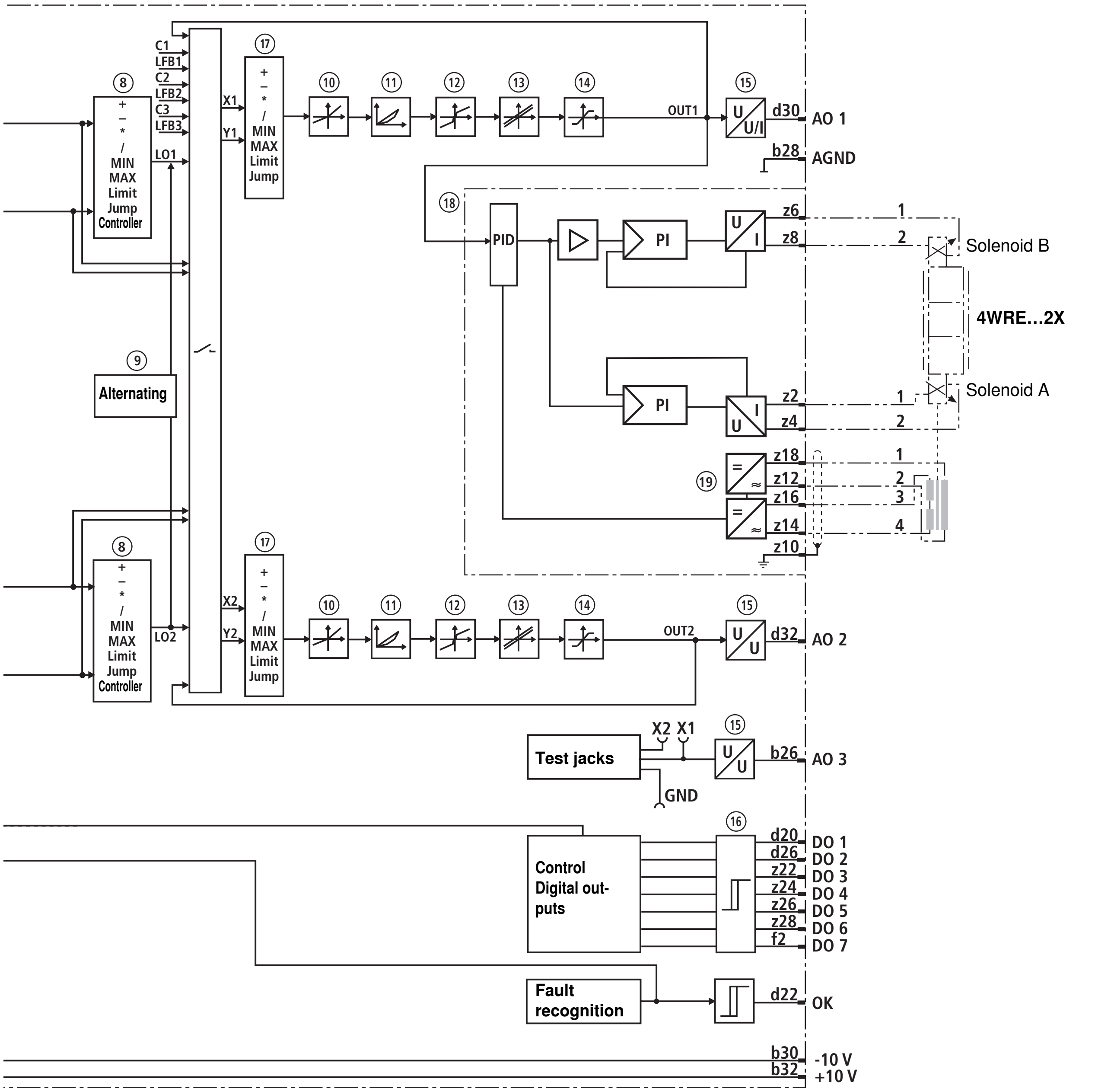


1 Analog voltage or current inputs
2 SSI or incremental
3 Enable input and digital inputs
4 Adjustment of analog inputs
5 Switching matrix
6 Math. operation of inputs
7 32 blocks for command value generation, controller parameter changeover
8 Math. operation or controller
9 Alternating control
10 Direction-dependent gain
11 Characteristic curve adjustment
12 Residual speed and overlap jump
13 Offset
14 Limitation
15 Analog outputs, voltage or current
16 OK output and digital outputs
17 Local bus

Block circuit diagram: VT-HACD-1, Mode 3 - Structure editor



1 Analog inputs, voltage or current
2 SSI or incremental
3 Enable input and digital inputs
4 Adjustment of analog inputs
8 Math. operation or controller
9 Alternating control
10 Direction-dependent gain
11 Characteristic curve adjustment
12 Residual speed and overlap jump
13 Offset
14 Limitation
15 Analog voltage or current outputs



16 OK output and digital outputs
17 Math. operation of outputs
18 Optional output stage
19 Oscillator/demodulator
20 CAN interface, optional
21 Local bus

Technical data (for applications outside these parameters, please consult us!)

Operating voltage	U_B	24 VDC
Operating range:		
Upper limit value	$u_B(t)_{max}$	35 V
Lower limit value	$u_B(t)_{min}$	21 V
Current consumption	I_{max}	Stand-by current 250 mA
Fuse	I_S	4 A slow-blowing
Digital inputs	Signal	log 0 = 0 to 5 V log 1 = 16 V to U_B
Digital outputs	Signal	log 0 = 0 to 5 V log 1 = 16 V to (U_B – 3 V) I_{max} = 30 mA
Analog inputs AI 1…6		
Configuration as voltage input		
Range	U	0 to 10 V or ±10 V (configurable)
Input resistance	R_e	100 kΩ, > 10 MΩ for input AI 1
Resolution		5 mV for range ±10 V 2.5 mV for range 0…10 V
Non-linearity		< 10 mV
Configuration as current input		
Range	I	0…20 mA or 4…20 mA
Input resistance	R_e	100 Ω
Current loss		0.15 % (at 500 Ω between Pin AI x– and 0 V)
Resolution		5 μA
Analog outputs		
AO 1 configuration as voltage output		
Output voltage	U	0…10V or ±10 V (configurable)
Output current	I_{max}	10 mA
Load	R_{Lmin}	1 kΩ
Resolution		1.25 mV (14 bit)
Residual ripple content		±15 mV (without noise)
AO 1 configuration as current output		
Output current	I	0…20 mA or 4…20 mA (configurable)
Load	R_{max}	500 Ω
Resolution		1.25 μA
Residual ripple content		±15 μA (without noise)
AO 2 / AO 3		
Output voltage	U	±10 V
Output current	I_{max}	10 mA
Load	R_{min}	1 kΩ
Resolution		10 mV (11 bit)
Residual ripple content		± 25 mV (without noise)
Reference voltage	U	±10 V
Load	I_{max}	30 mA
Residual ripple content		< 20 mV
Scan time	t	2 ms

Technical data (continued)

Valve output stage (optional)		
Solenoid current per solenoid	I_{max}	2.5 A
Valve position transducer		
Oscillator amplitude	U	13 Vss
Oscillator frequency	f	5.7 kHz
Coil resistance	R_{20}	Between coil connection 1 and 2: 130 to 164 Ω Between coil connection 3 and 4: 21 to 24 Ω
For further technical data for valve 4WRE…2X, see data sheet RE 29061		
Serial interface		RS 232 (front panel), D-Sub socket
Type of connection		64-pin multi-point connector, DIN 41612, form G
Local bus, distance to the most distant station	l	max. 280 m cable length
Card dimensions		Euro-card 100 x 160 mm, DIN 41494
Front panel dimensions:		
Height		3 HE (128.4 mm) *[5.06 inches]*
Width soldering side		1 TE (5.08 mm) *[0.20 inches]*
Width component side		7 TE
Permissible operating temperature range	ϑ	0 to 50 °C *[0 to 122 °F]*
Storage temperature range	ϑ	–20 to +70 ° *[0 to 158 °F]*
Weight	m	0.2 kg

Note:

For details with regard to **environment simulation testing** in the fields of EMC (electromagnetic compatibility), climate and mechanical stress, see RE 30143-U (declaration on environmental compatibility).

Pin assignment of multi-point connector

Pin	Row z		Row b		Row d		Row f	
2 5)	Solenoid A+	MA+	Analog input	AI 3+	Digital input	DI 1	Digital output	DO 7
4 5)	Solenoid A–	MA–	Analog input	AI 3–	Digital input	DI 2	SSI clock pulse +	
6 5)	Solenoid B+	MB+	Analog input	AI 2+ 1)	Digital input	DI 3	SSI clock pulse –	
8 5)	Solenoid B+	MB–	Analog input	AI 2– 1)	Digital input	DI 4	SSI data +; Inc Ua1	
10 5)	Shield		Analog input	AI 1+ 3)	Digital input	DI 5	SSI data –; Inc /Ua1	
12 5)	LVDT supply –	L1O–	Analog input	AI 1– 3)	Digital input	DI 6	Inc Ua2	
14 5)	LVDT signal –	L1I–	Analog input	AI 4+ 1)	Digital input	DI 7	Inc /Ua2	
16 5)	LVDT signal +	L1I+	Analog input	AI 4– 1)	Digital input	DI 8	Inc Ua0	
18 5)	LVDT supply +	L1O+	Analog input	AI 5+ 1)	Enable	DI 9	Inc /Ua0	
20	System ground		Analog input	AI 5– 1)	Digital output	DO 1	n.c.	
22	Digital output	DO 3	Analog input	AI 6+ 1)	OK		n.c.	
24	Digital output	DO 4	Analog input	AI 6– 1)	Local bus	Data+	n.c.	
26	Digital output	DO 5	Analog output AO 3, ±10 V		Digital output	DO 2	n.c.	
28	Digital output	DO 6	Analog GND 4)		Local bus	Data–	CAN Gnd	
30	U_B: +24 V		–10 V	REF–	Analog output	AO 1 2)	CAN L	
32	L0: 0 V		+10 V	REF+	Analog output AO 2, ±10 V		CAN H	

1) Inputs AI 2, 4, 5 and 6 can be software-set to 0…10 V, ±10 V, 0…20 mA or 4…20 mA.

2) Output AO 1 can be software-set to 0…10 V, ±10 V, 0…20 mA or 4…20 mA.

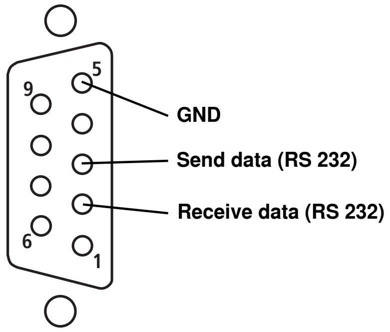
3) This input has an input resistance of R_i > 10 MΩ

4) Reference potential for AO 1, AO 2, AO 3, +10 V and –10 V

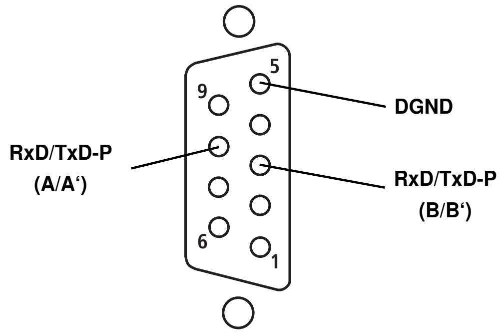
5) Only in conjunction with optional valve output stage

n.c. Not assigned in the basic version, but reserved for extensions.

Pin assignment of D-Sub sockets on the front panel



RS 232



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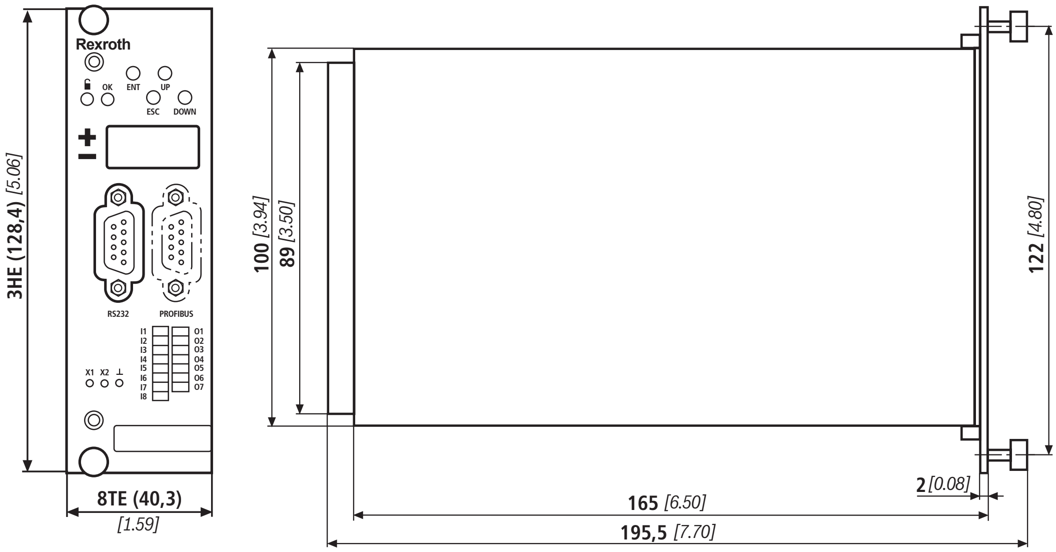
Unit dimensions (dimensions in mm *[inch]*)



Engineering / maintenance notes / supplementary information

Product documentation for VT-HACD-1

- RE 30143
  Technical data sheet (the present document)
- RE 30143-B
  Installation and operating instructions
- RE 30143-01-B
  Commissioning and operating instructions
- RE 30143-U
  Declaration on environmental compatibility
- RE 30143-01-Z
  Start-up PROFIBUS DP Interface
- RE 30143-02-Z
  Start-up CANopen Interface
- RE 30143-03-Z
  Start-up DeviceNet Interface
- RE 30143-Z
  Notes on the change-over of VT-SWKD to VT-HACD-1

– Use low-capacitance cables. Whenever possible, establish cable connections without intermediate terminals.
– The arrangement of sources of electromagnetic interference (e.g. frequency converter) is not permitted in the direct vicinity of the control electronics.
– Do not lay power cables in the direct vicinity of the controller card.
– Cables of the control electronics must not be installed in the direct vicinity of power cables.
– Install sensor cables separately.
– The distance to aerial lines, radio sources and radar equipment must be at least 1 meter.
– Set the installation so up that when differential inputs are used, both inputs are always switched on or off simultaneously.
– Use relays with gold-plated contacts for switching command values (small voltages, small currents).
– Always shield command value cables and actual value cables. Connect the shield to “shield” on the card side and leave the other end open; otherwise, there is a risk of earth loops.
– Use a highly flexible CU conductor (min 2.5 mm^2) for connecting the system ground!
The system ground is an essential part of the EMC protection of the controller card. It is used to discharge interference, which is transported to the controller card via data and supply voltage cables. This function can only be ensured, if the system ground itself cannot inject interference into the controller card. Rexroth recommends that also solenoid cables be shielded.
– Electrical signals brought out via control electronics (e.g. “OK“ signal) must not be used for switching safety-relevant machine functions!
(See also European standard “Safety requirements for fluid power systems and components - hydraulics” EN982:1996)

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