

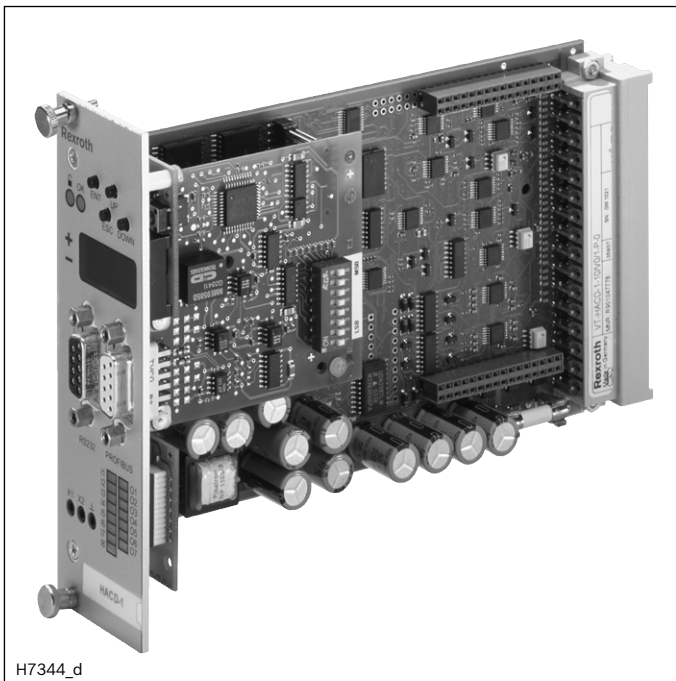
Digital command value and controller card

Type VT-HACD-1

RE 30143

Edition: 2013-10

Replaces: 04.12



- ▶ Component series 1X
- ▶ Use as **command value card** for generating, linking and standardizing signals
- ▶ Use as **controller card** for control loops with PIDT1 controller and optional state feedback

Features

- ▶ Substitutional closed-loop control (e.g. position control with superimposed pressure/force control) possible
- ▶ Input for digital measurement system SSI and incremental
- ▶ 6 analog inputs, voltage (± 10 V, 0...10 V) and current (4...20 mA) selectable
- ▶ 3 analog outputs, 1x switchable voltage (± 10 V, 0...10 V) or current (0...20 mA, 4...20 mA), 1x voltage (± 10 V)
- ▶ Various possible signal linking and switch-over options
- ▶ Enable input and OK output
- ▶ 8 digital inputs
- ▶ 7 digital outputs, configurable
- ▶ Parameterizable ramp function
- ▶ 32 blocks with command values, speeds and controller parameters

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Features (continued)

- ▶ Adjustment to hydraulic drive by means of area adjustment, characteristic curve correction, overlap compensation, residual velocity logic and zero point correction.
- ▶ ±10 V reference voltage output
- ▶ Front display with keys for parameter display and modification as well as diagnosis
- ▶ Serial interface RS232
- ▶ Up to 32 cards can be interconnected for parameterization and diagnosis via the local bus
- ▶ Configurable analog output (A03) led onto connector strip
- ▶ PROFIBUS DP, PROFIBUS DP in Motorola format, DeviceNet or CANopen for the communication with a superior control (For CANopen, there is no standard EDS file available as the data is transmitted by the CANopen PDOs.)

Ordering code

01	02	03	04	05	06	07
VT-HACD	-	1	-	1X	/	V0
				/		1
						-
						-

01	Digital command value and controller card	VT-HACD
02	Standard command value and controller card	1
03	Component series 10 ... 19 (10 to 19: Unchanged technical data and pin assignment)	1X
04	Basic device	V0
05	With display	1
06	Without bus connection	0
	PROFIBUS DPV0	P
	DeviceNet	D
	CANopen	C
07	Without valve output stage	0
	With valve output stage for 4WRE, component series 2X with two solenoids (only in connection with PROFIBUS)	1

Required accessories:

- ▶ BODAC PC program, CD ordering information: 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 standard 1:1 cable
- ▶ Optionally available USB adapter VT-ZKO-USB/S-1-1X/V0/0
- ▶ Connector type 6ES7972-0BA42-0XA0 for PROFIBUS DP, mat. no. R901312863

Suitable card holders:

- ▶ Open card holder VT 3002-1-2X/64G (see data sheet 29928), mat. no. R900991843 (Only for control cabinet installation)
- ▶ Connection adapter VT 10812-2X/64G (see data sheet 30105), mat. no. R900713826

Software project planning

Project planning

The creation of a parameter file forms the basis for the function of the HACD. The parameter file contains the block structure of the HACD in which the links of the variables will be created. The parameter files are created in BODAC. The parameter file can be created offline and transferred to the HACD by means of a PC.

Proceed as follows for this software project planning:

1. Selection of the HACD.
2. Application is defined by means of the block structure.
3. Setting of the parameter values (sensors, controllers...).
4. The data is sent to the HACD.
5. Storage of the data in the flash.
6. The setting and the machine sequence are optimized at the machine.

PC program BODAC

The user can use the BODAC PC program for the implementation of project planning tasks. BODAC can be used for the programming, setting and diagnosis of the HACD.

Scope of services

- ▶ Convenient dialog functions for the online or offline setting of the machine data
- ▶ Dialog window for the online setting of the parameter values
- ▶ Comprehensive options for displaying process variables, digital inputs, outputs, and flags
- ▶ Recording and graphical representation of up to eight process variables with great selection of trigger options

PC system requirements

- ▶ Windows XP, Windows Vista, Windows 7
- ▶ Memory usage 64 MB typical
- ▶ 250 MB of available hard disk capacity

Notice:

The BODAC PC program is not included in the scope of delivery. It can be downloaded on the Internet free of charge.

Download on the Internet: www.boschrexroth.com/hacd
Enquiries: support.hacd@boschrexroth.de

Service interface

- ▶ RS 232

Process connection

- ▶ PROFIBUS DP, PROFIBUS DP in Motorola format, CANopen for the communication with a superior control (for CANopen, there is no standard EDS file available)

More information

www.boschrexroth.com/hacd

Functional description

The command value and controller card VT-HACD-1 is set up as printed circuit board in Europe format 100 x 160 mm, fitted on both sides.

A microcontroller controls the entire process, makes adjustments, establishes links and realizes the closed control loops. Data for configuration, command values and parameters are stored in a FLASH in a non-volatile form.

The complete configuration is made by means of software, the card does not comprise jumpers or the like. For the configuration, the VT-HACD has to be connected to a PC via a serial interface (RS 232, 1:1 cable). The BODAC user interface is used for the entire configuration and also for the parameterization and diagnosis.

The configuration and thus the creation of applications are very simple - you just have to link pre-defined functional components. For this purpose, no programming knowledge is necessary.

2 different modes are available:

- ▶ Mode 1 (not bus-enabled) – Block calls (condition as supplied)
The 32 blocks can be called via the binary combination of the digital inputs DI1...DI5 + DI6 as "binary enable". This mode is functionally compatible with VT-SWKD.
- ▶ Mode 3 (bus-enabled) – Structural editor
The structural editor is unlocked. Own motion sequences can be established. For this purpose, 32 blocks are available.

Each block contains: Command value, ramp times, (velocity +, velocity –, S share) and controller parameters.

Blocks are activated by setting trigger conditions: Setting digital inputs, comparing signals with freely definable thresholds or expiry of waiting periods.

You can change to another mode by simply saving a corresponding parameter set which is included in the BODAC scope of delivery.

Signal linking

The VT-HACD has various signal linking options both for the input and the output side, whereas 2 signals each can be linked. These are functions such as addition, subtraction, multiplication, division as well as minimum/maximum value generator, 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 generator: $Z = \text{MIN}(X, Y)$
MAX	= maximum value generator: $Z = \text{MAX}(X, Y)$
RATIO	= ratio input: for RATIO >1: $Z = X * \text{RATIO} - Y$ for RATIO <1: $Z = X - Y / \text{RATIO}$ (e.g. area ratio for pressure differential measurement)
LIMIT	= signal limiter: $Z = \text{MIN}(X , Y) * X / X $
JUMP	= jump generator: $Z = \text{MAX}(X , Y) * X / X $ with Z ... result X ... 1st signal Y ... 2nd signal

Analog I/O

For the 6 analog inputs, you can switch between ± 10 V, 0...10 V, 0...20 mA and 4...20 mA by means of the software. For the analog output AO1, you can switch between ± 10 V, 0...10 V, 0...20 mA and 4...20 mA by means of the software. AO2 is fixedly set to ± 10 V. AO3 can be configured by means of software and is e.g. suitable for diagnosis purposes.

The output is switched so that the whole range of the analog-digital connector is used.

Both working range and error identification can be defined for all analog inputs.

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

Digital I/O

The VT-HACD has 9 digital inputs and 8 digital outputs. An input has the fixed functionality Enable, a digital output the fixed functionality OK.

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

The function of each digital output can be determined by the selection from a predefined list:

- ▶ Command value = actual value
- ▶ Actual value higher or lower than the adjustable threshold
- ▶ Waiting time completed
- ▶ Ramp active
- ▶ Internal flag set
- ▶ Error flag set

Functional description (continued)

Digital position measurement system

If you use the VT-HACD as controller card, digital position measurement systems of type SSI or incremental can be used for actual value collection.

Limitations of use for the incremental encoder

The maximum frequency of the VT-HACD incremental encoder input (f_G) is 100 kHz. The maximum travel velocity of the drive, the resolution (res) of the encoder system used and the possible signal evaluation by EXE (interpolation and digitalizing electronics) determine the frequency.

Determination formulas

Encoder resolution at given maximum velocity:

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

Velocity at specified encoder resolution:

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

Controller

If the VT-HACD is used as controller card, you must select "Controller" for the signal connection [8].

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

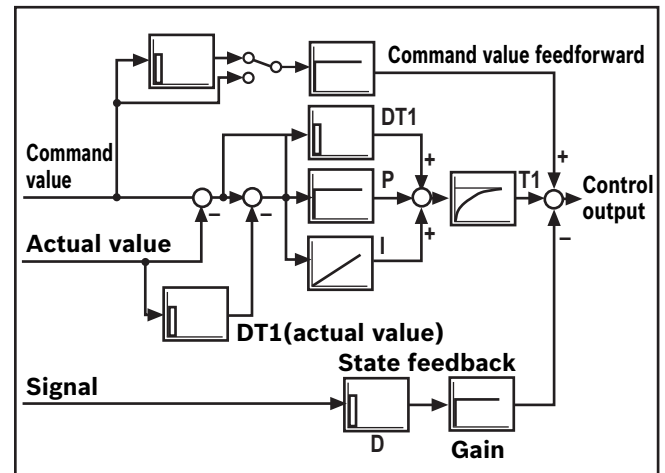
Both SSI encoder or incremental encoder [2] (digital measuring system) and one or more analog sensors can be used as actual value signal.

The controller structure is designed as PIDT1 controller, whereas each share can be activated or deactivated individually. Thus, also a P or PT1 controller can be implemented for example. The I share can additionally be controlled via a window (upper and lower limit).

Control parameters can be set in blocks or independently of blocks.

In mode 3, a state feedback can be used for dampening the controller output.

Controller structure:



Adjustment to hydraulic system

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

- ▶ Direction-dependent gain [10]

For positive and negative values, the amplification can be set separately. In this way, adjustment to the area ratio of a differential cylinder is possible.
- ▶ Characteristic curve correction [11]

In this way, the progressive flow characteristics of proportional directional valves are compensated or an inflected characteristic curve is realized.
- ▶ Overlap jump/residual velocity [12]

When using valves with positive overlap, a fine positioning can be used in case of a PDT1 controller in order to increase the static accuracy. This fine positioning can be selected according to the residual voltage principle and as overlap jump.
- ▶ Zero point correction (offset) [13]

Serves the correction of the zero point of the connected proportional servo valve.

Functional description (continued)

Error detection and treatment

The VT-HACD supports numerous error monitoring possibilities:

- ▶ Monitoring of analog inputs for lower deviation or exceedance of the range
- ▶ Monitoring the position sensors for cable break
- ▶ Control error monitoring when configuring the HACD as controller
- ▶ Monitoring of the supply voltage, any internal voltage as well as the 10 V reference voltage
- ▶ Monitoring the microcontroller (watchdog) as well as the memory (checksum)

The error monitoring as well as its reaction can be configured as well.

Front operation

In connection with the four keys, the front display is used to display and change parameters as well as for diagnosis purposes.

The VT-HACD parameters are accessed via a corresponding menu structure. The parameter values can be displayed and changed.

The following parameters can be accessed:

- ▶ Command value and ramp parameters
- ▶ Actual values
- ▶ Control parameters
- ▶ Output parameters
- ▶ Analog I/O
- ▶ Position sensors

Changes in the configuration, i.e. changes in the signal linking, trigger conditions, error monitoring, etc. are not possible via the front operation.

The display of command and actual values as well as the output of error messages are available as diagnosis options.

Valve output stage [18] (optional)

The following applies to the valve output stage:

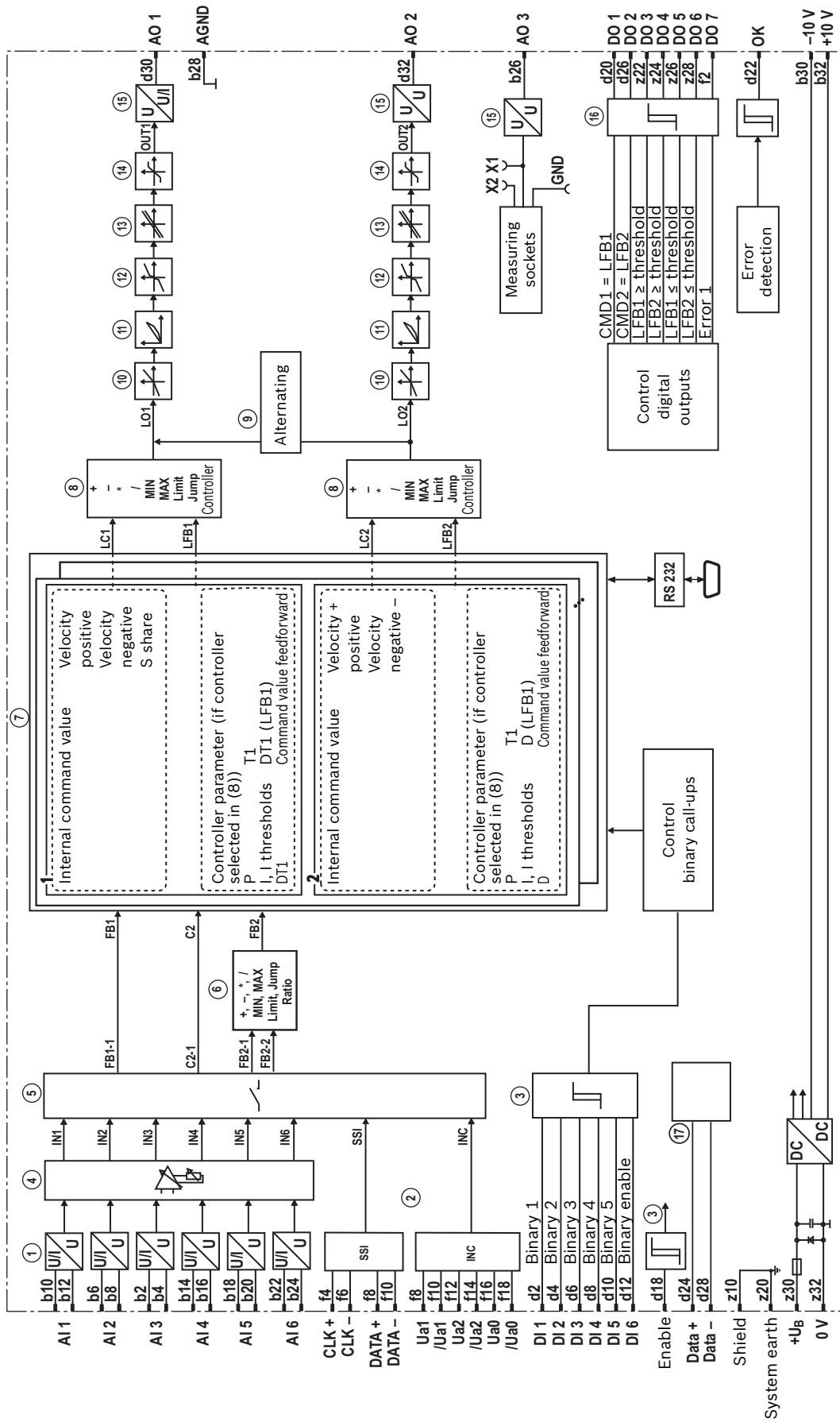
- ▶ Only available in connection with PROFIBUS
- ▶ Only for valves of type 4WRE...2X with two solenoids
- ▶ Can only be activated in mode 3

Error logics identify a cable break of the actual value cable of the valve position sensor. Readiness for operation is removed, a low signal is output at port d22 and the "OK" LED on the front plate goes out.

PC program BODAC

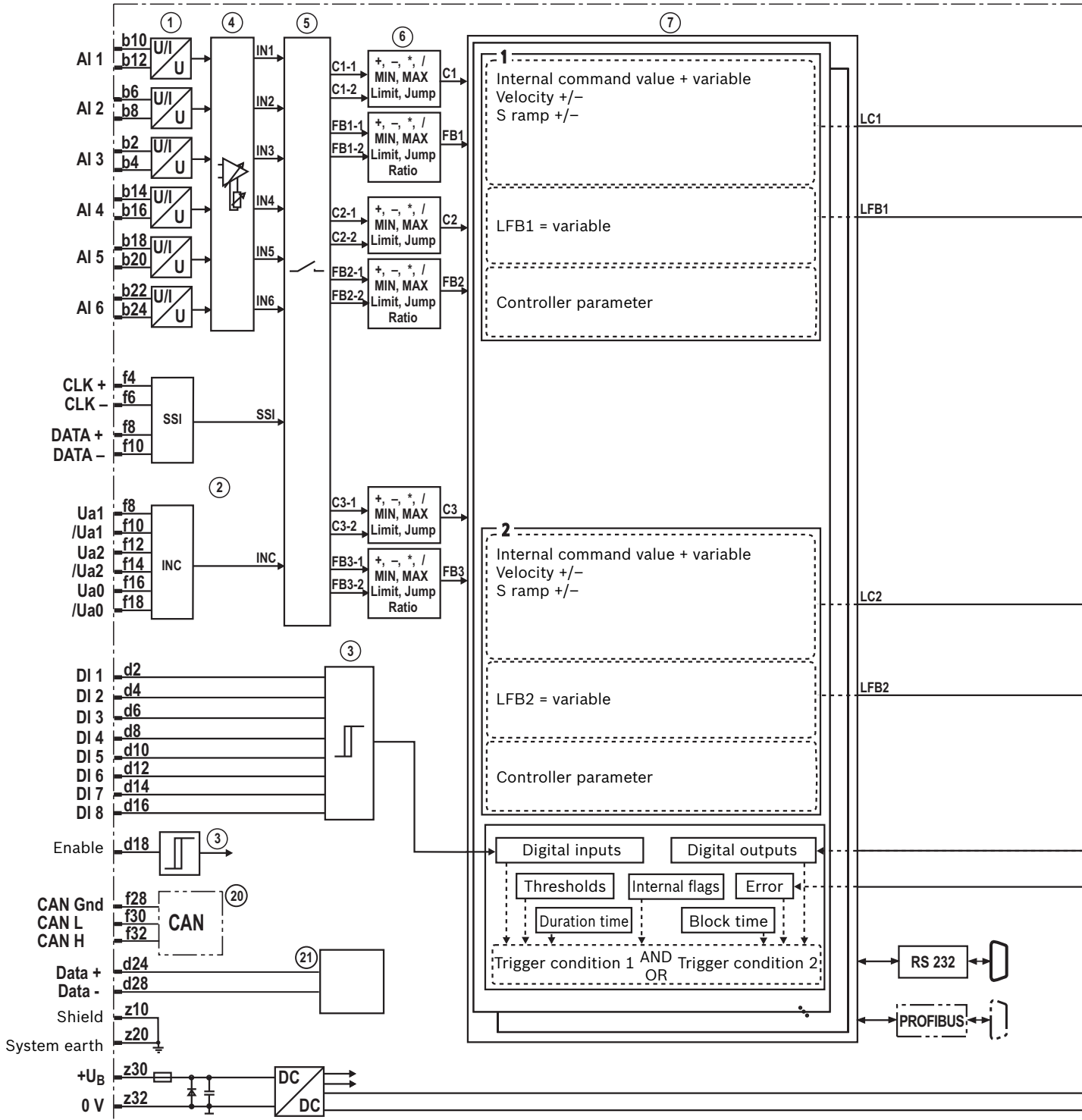
The BODAC PC program is used to configure, parameterize and diagnose the VT-HACD via a serial interface (RS 232). Via the local bus, up to 32 control electronics can be connected. Via BODAC, every control electronics is assigned a bus address. Reconnection of the serial interface cable is omitted. More information in document 30143-01-B.

Block diagram: VT-HACD-1, mode 1 - block calls



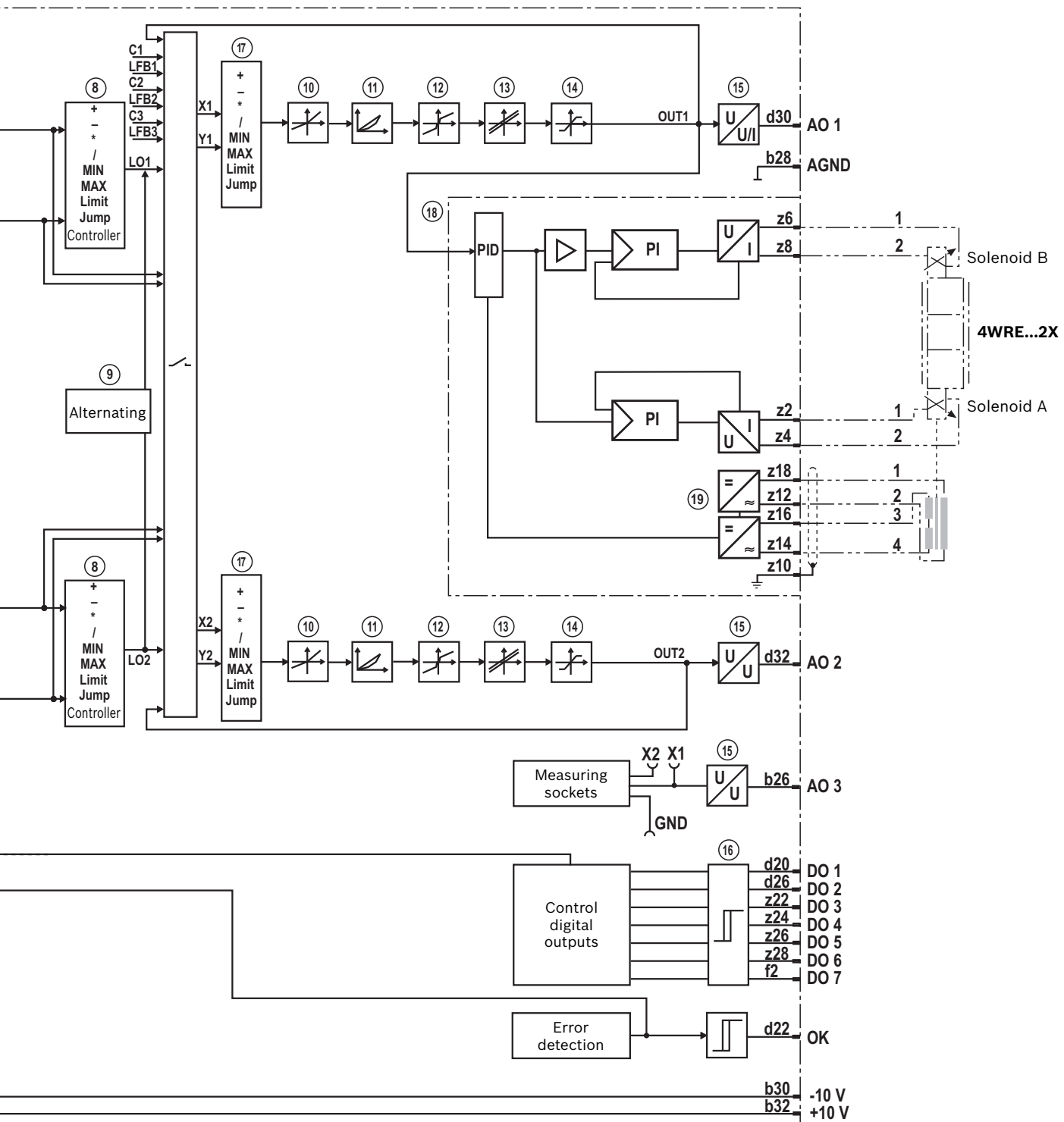
- 1 Analog voltage or current inputs
- 2 SSI or incremental
- 3 Enable input and digital inputs
- 4 Analog input adjustment
- 5 Switching matrix
- 6 Math. connection of the inputs
- 7 32 blocks for command value generation, controller parameter switching
- 8 Math. connection and/or controller
- 9 Substitutional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

Block diagram: VT-HACD-1, mode 3 - structural editor



- 1 Analog voltage or current inputs
- 2 SSI or incremental
- 3 Enable input and digital inputs
- 4 Analog input adjustment
- 8 Math. connection and/or controller

- 9 Substitutional control
- 10 Direction-dependent gain
- 11 Adjustment of the characteristic curve
- 12 Residual velocity and overlap jump
- 13 Offset



- 14 Limitation
- 15 Analog voltage or current outputs
- 16 OK output and digital outputs
- 17 Math. connection of the 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
Upper limit value	$u_B(t)_{\max}$	30 V
Lower limit value	$u_B(t)_{\min}$	21 V
Current consumption	I_{\max}	Standby current consumption 250 mA
Fuse	I_S	4 A time-lag
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 k Ω , > 10 M Ω 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
Leakage current		0.15 % (with 500 Ω between pin AI x- and 0 V)
Resolution		5 μ A
Analog outputs		
AO 1 configuration as voltage output		
Output voltage	U	0...10V or ± 10 V (configurable)
Output current	I_{\max}	10 mA
Load	$R_{L\min}$	1 k Ω
Resolution		1.25 mV (14 bit)
Residual ripple		± 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 μ A
Residual ripple		± 15 μ A (without noise)
AO 2 / AO 3		
Output voltage	U	± 10 V
Output current	I_{\max}	10 mA
Load	R_{\min}	1 k Ω
Resolution		10 mV (11 bit)
Residual ripple		± 25 mV (without noise)
Digital position transducers (encoders):		
SSI transducer		
Line receiver / line driver		RS485
Incremental sensor		
Signal level	U	5...24 V
Reference voltage	U	± 10 V
Load	I_{\max}	30 mA
Residual ripple		< 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 sensor			
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 more technical data for valve 4WRE...2X see data sheet 29061			
Serial interface		RS 232 (front plate), D-Sub socket	
Type of connection		64-pole male multipoint connector, DIN 41612, design G	
Local bus, distance to the furthest device	l	Max. 280 m line length	
Card dimensions		Euro-card 100 x 160 mm, DIN 41494	
Front plate 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	
Admissible operating temperature range	ϑ	0 to 50 °C [0 to 122 °F]	
Storage temperature range	ϑ	-20 to +70 °C [0 to 158 °F]	
Weight	m	0.2 kg	

Notice:

For information on the **environment simulation testing** for the areas EMC (electromagnetic compatibility), climate and mechanical load, see data sheet 30143-U.

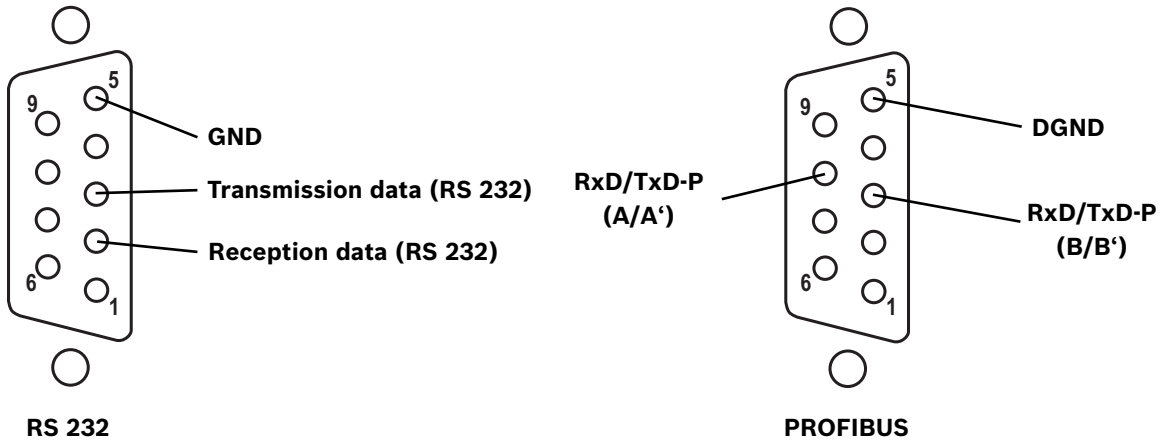
Pin assignment of the male multipoint connector

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 +
6 ⁵⁾	Solenoid B+ MB+	Analog input AI 2+ ¹⁾	Digital input DI 3	SSI clock -
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⁾	Position transducer of valve feed - L10-	Analog input AI 1- ³⁾	Digital input DI 6	Inc Ua2
14 ⁵⁾	Position transducer of valve actual value - L11-	Analog input AI 4+ ¹⁾	Digital input DI 7	Inc /Ua2
16 ⁵⁾	Position transducer of valve actual value + L11+	Analog input AI 4- ¹⁾	Digital input DI 8	Inc Ua0
18 ⁵⁾	Position transducer of valve feed + L10+	Analog input AI 5+ ¹⁾	Enable DI 9	Inc /Ua0
20	System earth	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

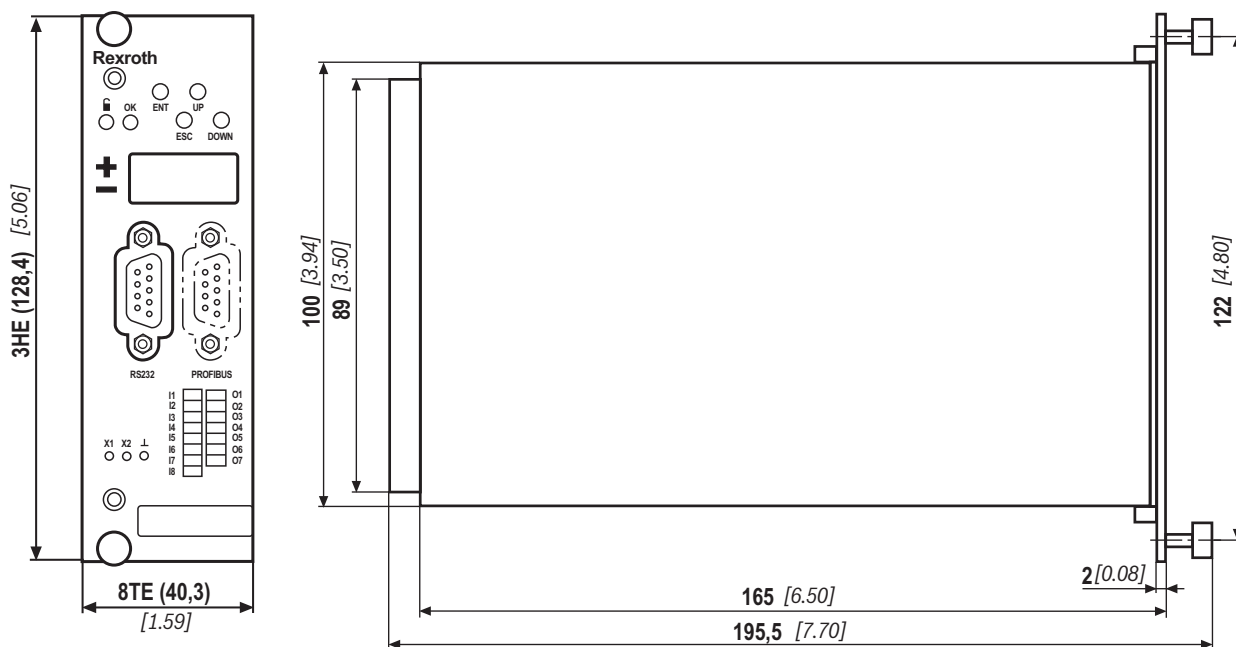
- 1) By means of software, the inputs AI 2, 4, 5 and 6 can be set to 0...10 V, ±10 V, 0...20 mA or 4...20 mA.
- 2) By means of software, the output AO 1 can be set to 0...10 V, ±10 V, 0...20 mA or 4...20 mA.
- 3) This input has an input resistance $R_e > 10 \text{ M}\Omega$

- 4) Reference potential for AO 1, AO 2, AO 3, +10 V and -10 V
- 5) Only for option with valve output stage
- n.c. Not used in basic version, however reserved for extensions.

Pin assignment of the D-Sub sockets on the front plate



Dimensions (dimensions in mm [*inch*])



Project planning / maintenance instructions / additional information**Product documentation for VT-HACD-1**

30143	Technical data sheet (this document)
30143-B	Installation and operating instructions
30143-01-B	Commissioning and operating instructions
30143-U	Environmental compatibility statement
30143-01-Z	Commissioning instructions PROFIBUS DP interface
30143-02-Z	Commissioning instructions CANopen interface
30143-03-Z	Commissioning instructions DeviceNet interface
30143-Z	Additional information for replacing the VT-SWKD by VT-HACD-1

- ▶ Use low-capacitance cables. If possible, design the cable connections without intermediate terminals.
 - ▶ Electro-magnetic sources of interference (e.g. frequency converters) must not be arranged in the immediate vicinity of the control electronics.
 - ▶ Power cables must not be laid in the immediate vicinity of the controller card.
 - ▶ Lines of the control electronics must not be laid in the immediate vicinity of power cables.
 - ▶ Pass the sensor lines separately.
 - ▶ The distance to aerial lines, radios, and radar systems has to be 1 meter at least.
 - ▶ Design the installation so that when the differential inputs are used, both inputs are always connected or disconnected at the same time.
 - ▶ For switching command values, relays with gold-plated contacts have to be used. (Low voltages, low currents)
 - ▶ Always shield command value lines and actual value cables. Connect the shield to "Shield" on the card side and leave the other side open as otherwise, there is the risk of ground loops.
 - ▶ Use highly flexible CU conductors (at least 2.5 mm²) in order to connect the system earth
- The system earth is a main part of the EMC protection of the controller card. Here, interference is eliminated which is transported to the controller card via the data and supply voltage lines. This function is only ensured if the system earth itself does not introduce interference into the controller card. Rexroth recommends screening the solenoid conductors as well.

Notes

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It must be remembered that our products are subject to a natural process of wear and aging.

Notes

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