

# VT-HACD-3-2X

Digital control electronics

**Operating instructions**  
**RE 30543-B/09.12**

Replaces: 12.10  
English



The data specified only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

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An example configuration is shown on the title page. The delivered product may, therefore, differ from the product which is pictured.

The original operating instructions were created in the German language.

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# 1 About this documentation

## 1.1 Validity of the documentation

This documentation is valid for the following products:


- VT-HACD-3-2X/0-I-00/000, material number R901239533
- VT-HACD-3-2X/E-I-00/000, material number R901239535
- VT-HACD-3-2X/N-I-00/000, material number R901276379
- VT-HACD-3-2X/P-I-00/000, material number R901227616

This documentation is intended for fitters, operators, plant operators and machine and plant builders.

This documentation contains important information on the safe and appropriate installation, transport, commissioning, maintenance, operation, removal and simple troubleshooting of the product.




- ▶ Read this documentation thoroughly, especially Chapter 2 “Safety instructions“ and Chapter 3 “General notes on damage to material and the product“, before working with the digital control electronics.

## 1.2 Required and supplementary documentation

- ▶ Only commission the product when you have the documents identified with the book symbol  at hand and have understood and observed them. You can find operating instructions and data sheets on our website

[www.boschrexroth.com/mediadirectory](http://www.boschrexroth.com/mediadirectory).

**Table 1: Required and supplementary documentation**

| Title   | Document no.  | Document type                           |
|---|---------------|---|
|  Digital closed-loop control electronics, type VT-HACD-3, component series 2X                      | RE 30543      | Data sheet                              |
|  Declaration on the environmental compatibility for EMC, climate and mechanical load, VT-HACD-3-2X | RE 30543-U    | Declaration on environmental compliance |
| Digital controller for electromechanical and electrohydraulic drives - software description/BODAC online help   | RE 30543-01-B | Software description and online help    |
| Digital controller for electromechanical and electrohydraulic drives, start-up PROFINET RT interface, VT-HACD-3-2X  | RE 30543-05-Z | Instructions                            |
| Digital controller for electromechanical and electrohydraulic drives, start-up Ethernet/IP interface, VT-HACD-3-2X  | RE 30543-04-Z | Instructions                            |
| Digital controller for electromechanical and electrohydraulic drives, start-up PROFIBUS interface, VT-HACD-3-2X   | RE 30543-01-Z | Instructions                            |
| Installation, commissioning and maintenance of proportional valves  | RE 07800      | Data sheet                              |
| Installation, commissioning and maintenance of hydraulic systems  | RE 07900      | Data sheet                              |
|  System documentation of the system manufacturer   |               |   |


### 1.3 Representation of information

In order to allow you to work directly and safely with your product, standardized safety notes, symbols, terms and abbreviations are used. For a better understanding, these are explained in the following sections.

#### 1.3.1 Safety notes




This documentation contains safety notes in Chapter 2.6 “Product-specific safety instructions“ and Chapter 3 “General notes on damage to material and the product“ as well as before a sequence of activities or instructions for action, which involve the risk of personal injury or damage to equipment. The measures described for averting the hazard must be observed.

Safety notes are structured as follows:

|  <b>SIGNAL WORD</b>   |
|--|
| <p><b>Type and source of hazard!</b><br/>Consequences in the case of non-observance</p> <ul style="list-style-type: none"> <li>▶ Measures to avert the hazard</li> <li>▶ &lt;List&gt;</li> </ul> |

- **Warning symbol:** draws attention to a hazard
- **Signal word:** identifies the degree of hazard
- **Type and source of hazard:** identifies the type or source of the hazard
- **Consequences:** describes the consequences in the case of non-observance
- **Precautions:** states, how the hazard can be avoided


**Table 2: Hazard classes according to ANSI Z535.6-2006**

| Warning sign, signal word  | Meaning  |
|--|--|
|  <b>DANGER</b>  | Indicates a hazardous situation which, if not avoided, will certainly result in death or serious injury. |
|  <b>WARNING</b> | Indicates a hazardous situation which, if not avoided, could result in death or serious injury.          |
|  <b>CAUTION</b> | Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.         |
| <b>NOTICE</b>  | Damage to property: The product or the environment can be damaged.                                       |

#### 1.3.2 Symbols

The following symbols refer to notes, which are not relevant to safety, but increase the legibility of the documentation.

**Table 3: Meaning of symbols**

| Symbol  | Meaning  |
|---|--|
|  | If this information is disregarded, the product cannot be used or operated in an optimum manner. |
| ▶   | Individual, independent step of action   |
| 1.  | Numbered instructions for action:  |
| 2.  | The numbers indicate that the activities are to be carried out consecutively.                    |
| 3.  |  |

### 1.3.3 Terms used

The following terms are used in this documentation:

**Table 4: Terms**

| Term  | Meaning   |
|-------|---|
| BODAC | Bosch Rexroth <b>O</b> perator Interface for <b>D</b> igital <b>A</b> xis <b>C</b> ontrollers |
| HACD  | <b>H</b> ydraulic <b>A</b> xis <b>C</b> ontrol <b>D</b> igital                                |
| UB    | Operating voltage   |

### 1.3.4 Abbreviations

The following abbreviations are used in this documentation:

**Table 5: Abbreviations**

| Abbreviation | Meaning  |
|--------------|--|
| AGND         | Analog Ground  |
| AIx          | Analog Input   |
| AOx          | Analog Output  |
| CAN          | Controller Area Network                                      |
| CLK          | Clock (SSI encoder)  |
| D/A          | Digital/analog   |
| DIx          | Digital Input  |
| DOx          | Digital Output   |
| EMC          | Electromagnetic compatibility                                |
| GND          | Ground   |
| I/O          | Input/outputs  |
| L            | Link   |
| NS           | Network status   |
| PELV         | <b>P</b> rotective <b>E</b> xtra <b>L</b> ow <b>V</b> oltage |
| PWR          | Power supply   |
| Res          | Resolution   |
| S            | Status   |

## 2 Safety instructions

### 2.1 About this chapter

The product has been manufactured according to the generally accepted rules of current technology. There is, however, still a risk of personal injury or damage to equipment if you do not observe this Chapter and the safety instructions contained in this documentation.

- ▶ Read these instructions completely and thoroughly before working with the product.
- ▶ Keep this documentation in a location where it is accessible to all users at all times.
- ▶ Always pass the product together with the required documentation to third parties.

### 2.2 Intended use

The product is an electrical component.

You may use the product as follows:

- as component for installation in a control cabinet for use in conjunction with machine tools, plastics processing and special-purpose machinery as well as presses and transfer systems
- as command value electronics for the generation, linking and normalization of signals or
- as control electronics for control loops with PIDT1 controller and optional state feedback
- only together with a higher-level control electronics with suitable I/O components, which, in conjunction with the VT-HACD-3-2X, holistically controls the motion sequence of the machine and also monitors it in terms of safety
- under the operating conditions and within the performance limits specified in data sheet RE 30543

The product is intended exclusively for professional use and not for private usage.

Operation according to the intended use also implies that you have read and understood this documentation completely, especially Chapter 2 “Safety instructions“.

### 2.3 Improper use

Any use other than described in the section “Intended use” is considered as improper and is therefore not permitted.

For damage resulting from improper use, Bosch Rexroth AG will not bear liability. The risks arising from improper use lie exclusively with the user.

### 2.4 Personnel qualifications

The activities described in this documentation require basic knowledge of electrics and hydraulics as well as knowledge of the associated technical terms. To ensure safe usage, these activities may therefore only be carried out by qualified personnel or under the direction and supervision of qualified personnel.



Qualified personnel are those who, due to their professional training, knowledge and experience as well as their knowledge of relevant regulations, can assess work assigned to them, recognize potential hazards and institute appropriate safety measures. Qualified personnel must observe relevant specialist rules and have the required expertise. With regard to hydraulic products, specialist knowledge means, for example:

- Ability to read and completely understand hydraulic circuit diagrams,
- complete understanding in particular of interrelationships with regard to safety equipment and
- knowledge of the function and structure of hydraulic components.



Bosch Rexroth offers qualifying training courses in specific fields. You can find an overview of training contents on the Internet at:

<http://www.boschrexroth.de/didactic>

## 2.5 General safety instructions

- Observe valid regulations for accident prevention and environmental protection.
- Observe the safety regulations and rules of the country where the product is used/operated.
- Use Rexroth products only in technically perfect condition.
- Observe all notes given on the product.
- Persons who install, commission, operate, demount or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- Only use accessory and spare parts approved by the manufacturer in order to rule out personnel hazards arising from unsuitable spare parts.
- Adhere to the technical data and ambient conditions provided in the product documentation.
- If unsuitable products are installed or used in safety-relevant applications, unintended operational states can occur in these applications, which can cause personal injury and damage to property. Therefore, use the product only in safety-relevant applications such as in explosion protection areas or in safety-related parts of a control (functional safety), if this use is expressly specified and permitted in the documentation.
- You may commission the product only when it has been established that the final product (for example, a machine or system), in which the Rexroth products are installed, complies with national regulations, safety regulations and standards relevant for the application.

## 2.6 Product-specific safety instructions

### **WARNING**

#### **Hazardous movement!**

Risk of injury due to incorrect activation by the control electronics and resulting unforeseeable machine movements.

- ▶ If persons have to enter the hazard zone while the control is active, provide superordinate monitoring functions or measures for personal safety on the system side. The plant manufacturer/user must rate and dimension these measures on the basis of a risk and failure analysis according to the specific situation on site. The safety regulations valid for the system must be taken into account for this.

The control electronics emits interference to other electronics within the permitted limit values. This can cause malfunction in the control process.

- ▶ Only use electronics below the EMC limit values or provide appropriate shielding.

The control electronics VT-HACD-3-2X responds to electromagnetic interference from non-shielded, improperly installed or wrongly connected cables. If the limit values given in the data sheet are exceeded, malfunction or uncontrolled movements are possible.

- ▶ Adhere to the limit values specified in the data sheet, use only electronics below the EMC limit values or provide proper shielding.

Electrostatic processes, an inadequate grounding concept or missing equipotential bonding can lead to damage to the electronics and hence cause malfunction or uncontrolled movements of the machine.

- ▶ Ensure proper grounding and provide equipotential bonding.

Using the product outside the given IP protection class can result in short-circuit and malfunction and can therefore cause uncontrolled machine movements.

- ▶ Only use the product within the IP protection class and under ambient conditions as specified in the data sheet.
- ▶ Provide safety functions for personal safety separately. The control electronics VT-HACD-3-2X itself does not include safety functions for personal safety and is therefore no safety-relevant component.
- ▶ Avoid contact with salt-containing environments and adhere to the ambient conditions specified in the data sheet.
- ▶ Before carrying out any work on the control electronics VT-HACD-3-2X, depressurize the relevant system section and disconnect it from the power supply.
- ▶ Switch the system off and secure it against restarting in the event of an emergency, malfunction or other irregularities.

#### **High pressure!**

Risk of injury!

- ▶ Depressurize the relevant system section before carrying out any work on the control electronics.

## WARNING

### **High voltage!**

Risk of injury.

- ▶ Wire or plug in the control electronics VT-HACD-3-2X only when it is disconnected from the power supply.

### **High electric voltage due to incorrect connection!**

Danger to life, risk of injury through electric shock.

- ▶ Only connect devices, electrical components and lines which feature protective extra low voltage (PELV) to connections or terminals having voltages from 0 to 50 Volt.
- ▶ Only connect voltages and power circuits that feature safe isolation from dangerous voltages. Safe electrical isolation can be achieved for example with isolating transformers, safe optocouplers or mains-free battery operation.

### **Lightning!**

Risk of uncontrolled machine movements. An inadequate grounding concept or missing equipotential bonding can lead to damage to the electronics.

- ▶ Ensure equipotential bonding for the device.

### **Failures and defects in the control current circuits or the energy supply!**

Risk of uncontrolled machine movements.

- ▶ Ensure safety in accordance with EN ISO 13849 or IEC 62061.

## CAUTION

### **Hot surfaces!**

Risk of burning. System parts can heat up during operation.

- ▶ Let system parts cool down before touching them or wear protective gloves.

### **Fault currents and short-circuits!**

Reduced safety and malfunction.

- ▶ The environment must be free from conductive contamination (acids, lyes, anti-corrosion agents, salts, metal vapors, etc.) and the device must not be exposed to them. Generally, rule out deposits according to the IP protection class.

### 3 General notes on damage to material and the product

#### **NOTICE**

**High voltage!**

Possible damage to the control electronics.

- ▶ Wire the control electronics only when it is disconnected from the power supply.

**Overheating!**

Risk of damage to the control electronics.

- ▶ Adhere to the ambient conditions according to the data sheet.
- ▶ Do not use free-wheeling diodes in the solenoid cables.
- ▶ Ensure sufficient ventilation of air.

**Overloading!**

Risk of overloading and damage to supply cables in the case of insufficient dimensioning and/or operation with several electrical devices.

- ▶ Provide current limitation by overload protection.
- ▶ Select an appropriate rating of power supply unit and cables.

**Wrong cables! Voltage loss, scorching of cable!**

Risk of damage to the product.

- ▶ For solenoid cables up to 50 m long, use cable type LiYCY 1.5 mm<sup>2</sup>, for position transducer cables, cable type LiYCY 0.5 mm<sup>2</sup> shielded. For greater lengths, please consult us.

**Cables lying around!**

Risk of stumbling!

- ▶ Install cables and lines so that they cannot be damaged and nobody can stumble over them.

The warranty is valid exclusively for the configuration delivered.

Warranty claims will be rejected in the case of improper installation, commissioning and operation as well as in the case of use not in accordance with the intended purpose and/or improper handling.

## 4 Scope of delivery

The scope of delivery includes

- The digital control electronics VT-HACD-3-2X.
- Mating connectors for
  - Connection X1S (Phoenix Mini Combicon 3-pin)
  - Connection X2A1 (Weidmüller, type designation B2L 3.5/18 LH SN SW)
  - Connection X2M1 (Weidmüller, type designation B2L 3.5/30 LH SN SW)

Accessories such as interface cables and USB converters are not included in the scope of delivery, but can be ordered separately. See Chapter 13.1 “Optional accessories“ on page 37.

The configuration software “BODAC“ can be ordered from Rexroth as CD stating the ordering designation SYS-HACD-BODAC-01 (material number R900777335) or be downloaded free of charge on the Internet. Here, you can also find the “WinView” software required for diagnostics purposes.

Download: [www.boschrexroth.com/hacd](http://www.boschrexroth.com/hacd)

Enquiries: [support.hacd@boschrexroth.com](mailto:support.hacd@boschrexroth.com)



Inspect the scope of delivery for completeness and damage in transit. In the case of defects, please get in touch with your contact in the sales organization.

## 5 About this product

### 5.1 Performance description

The digital VT-HACD-3-2X serves as control electronics for up to three control loops (position, pressure, force and velocity control) with PIDT1 controller and optional state feedback in conjunction with electrohydraulic axes. It is also possible to realize an overriding control (position, pressure or force, e.g. closed-loop position control with overriding pressure/force control).

In addition, the control electronics can be used for generating, linking and normalizing signals.

The control electronics VT-HACD-3-2X offers numerous options for linking signals or implementing changeovers. Moreover, it features a parameterizable ramp function. Configuration, parameterization and diagnostics of the VT-HACD-3-2X can be carried out using the software BODAC. For the graphical representation of recorded variables, this software works in conjunction with the visualization software WinView.

The fields of application comprise electrohydraulic axes in machine tools, plastics processing machines, special-purpose machines, presses and transfer systems. The functions realized in these machines include sequence parameterization, positioning, pressure control, force controls and tables.

### 5.2 Product description

The control electronics VT-HACD-3-2X is designed for mounting on 35-mm mounting rails and complies with EMC Directive 2004/108/EC.

The micro-controller of the VT-HACD-3-2 X controls the entire process, makes adjustments and arithmetic operations and implements closed control loops. Data for configuration, command values and parameters are stored in a non-volatile flash memory

The entire configuration as well as parameterization and diagnostics are carried out using the PC program BODAC. This program can also be used for conveniently administrating machine and measurement data. Apart from the switches for address setting, the control electronics VT-HACD-3-2X does not include any additional hardware switches. The VT-HACD-3-2X must therefore be connected via a serial interface (RS232, 1:1 cable) with a PC. For parameterization and diagnostics, up to 32 electronics can be interconnected over a local bus. The configuration and consequently the creation of applications can be accomplished very easily by linking pre-defined function blocks. To this end, 32 blocks with command values, velocities and controllers are available.

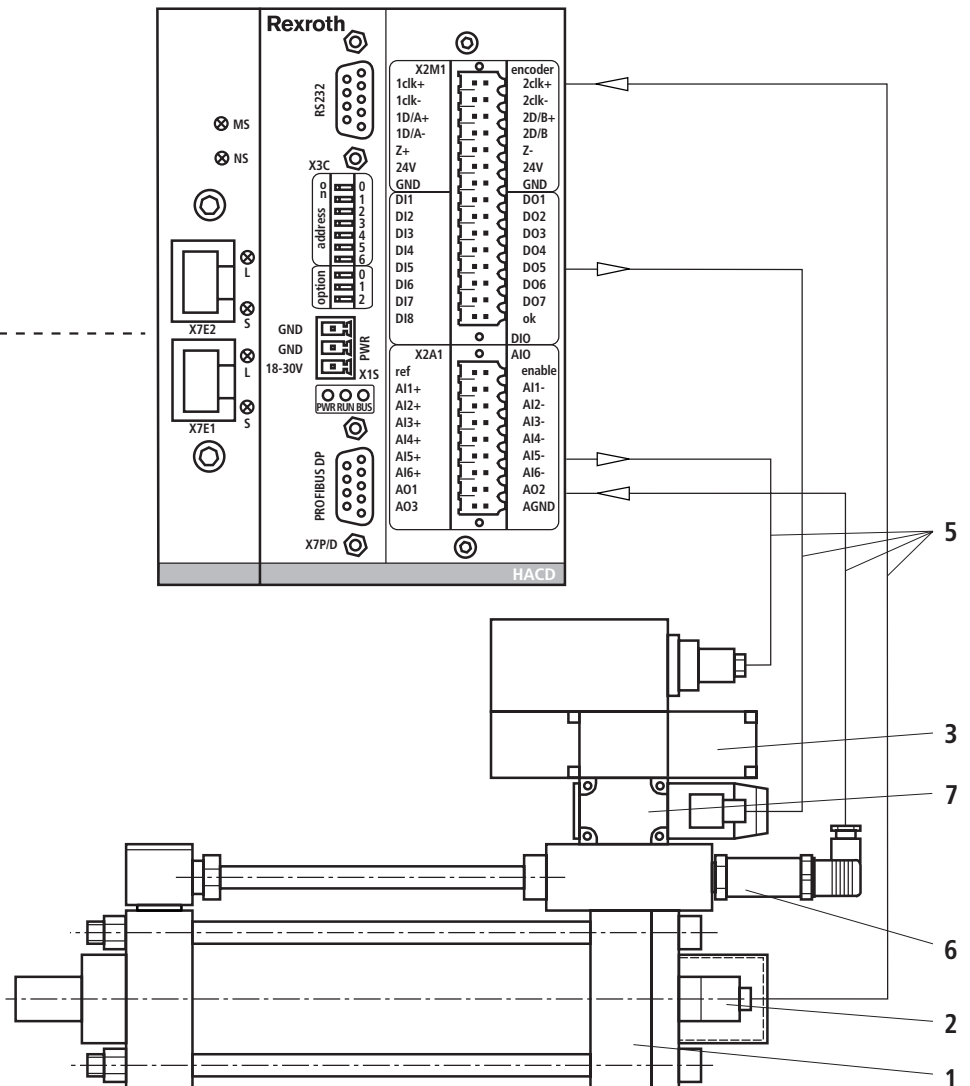
Adjustments to the hydraulic drive at hand can be made in the form of area ratio adjustment, characteristic curve correction, overlap compensation, residual speed logic and zero point correction.

### 5.2.1 System overview, interfaces

The Figure below shows as an **example** a VT-HACD-3-2X/E or .../N with a hydraulic cylinder axis.

**Higher-level control**  
Possible interfaces with the VT-HACD-3-2X:

- Analog signals
- Digital inputs/outputs
- Serial interface
- Bus systems



**Fig. 1: System overview of interfaces**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1 Single-rod cylinder</li> <li>3 Proportional valve with integrated control electronics</li> <li>5 Connection cable</li> <li>7 Sandwich plate shut-off valve (with plug-in switching amplifier)</li> </ul> | <ul style="list-style-type: none"> <li>2 Integrated position measuring system</li> <li>4 VT-HACD</li> <li>6 Pressure transducer</li> </ul> |
|---|--|

The following interfaces are possible between a higher-level control and the VT-HACD-3-2X:

- Analog signals
- Digital inputs/outputs
- Serial interface
- Bus systems (PROFIBUS DP/V0; Ethernet/IP or PROFINET RT)

### 5.2.2 Inputs and outputs

The control electronics VT-HACD-3-2X comprises an input for two digital measuring systems SSI (binary or Gray code) or one incremental position measuring system. You can use only SSI encoders of the same type (resolution). In addition, the control electronics features a +10 V reference voltage output as well as a serial interface RS232.

**Analog I/O** The 6 analog inputs can be software-switched between  $\pm 10$  V, 0...10 V, 0...20 mA and 4...20 mA.

For the voltage inputs, the input resistance is 300 kOhm  $\pm 5$  %. For all analog inputs, the operating range as well as error detection can be defined.

The VT-HACD-3-2X comprises a total of 3 analog outputs. Analog output AO1 is software-switchable between  $\pm 10$  V, 0...10 V, 0...20 mA and 4...20 mA. The changeover is accomplished so that in each case the entire range of the analog/digital converter is utilized. AO2 and AO3 are firmly set to  $\pm 10$  V.

The analog outputs can be adjusted in terms of gain and offset.

**Digital I/O** The VT-HACD-3-2X has 9 digital inputs and 8 digital outputs. One input has the fixed functionality "Enable" (X2A1, enable), one digital output (X2M1, ok) the fixed functionality "OK".

The other digital inputs are used for triggering blocks.

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

- Command value = actual value
- Actual value higher or lower than a settable threshold
- Wait time completed
- Ramp completed
- Error flag
- Controller active
- Error flag set
- Table completed
- Absolute value higher or lower than window
- Error status
- Block timeout

**Process connectivity** For integration into the process, digital/analog inputs and outputs are available as well as optionally PROFIBUS DP, PROFINET RT or Ethernet/IP for communication with a higher-level control. For the individual bus systems, separate instructions are available, see Table 1 "Required and supplementary documentation" on page 5.



### 5.2.3 Controllers

The numbers in brackets refer to the items in the block circuit diagram of Fig. 5 on page 22.

If the VT-HACD-3-2X is used as controller module, the entry "Controller" must be selected in linking [8].

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

Both, an SSI 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, with each component being able to be activated individually. It is, for example, also possible to realize a P or a PT1 controller, The I-component can additionally be controlled via a window (upper and lower limit).

Control parameters can be set in blocks or independently of blocks. In this case, referencing is done to the controller data of block 1.

In the structure editor, a state feedback can be used to dampen the controller output.

#### Controller functions

##### Position controller:

- PDT1 controller
- Linear gain characteristic curve
- Direction-dependent gain adjustment
- Gain modification possible using the program
- Valve characteristic curve adjustment
- Fine positioning via I-component
- Residual voltage principle
- Compensation of zero point errors
- State feedback via
  - Pressure
  - Differential pressure
  - Position
- Command value feedforward

##### Pressure/force controller:

- PIDT1 controller
- I-component can be cut in via window
- Differential pressure evaluation
- Command value feedforward

##### Velocity controller:

- PI controller
- I-component can be cut in via window

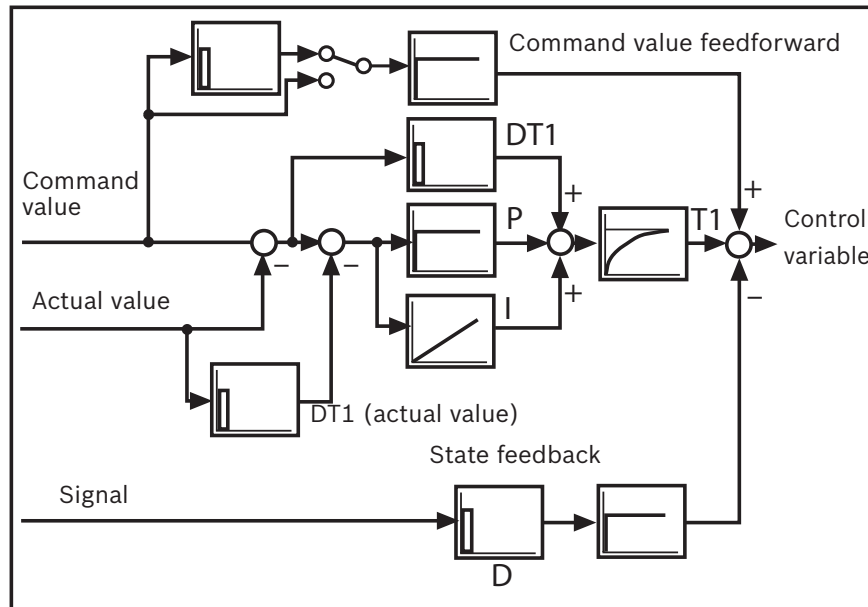


Fig. 2: Controller structure

#### 5.2.4 Adjustment to hydraulic system

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

- Direction-dependent gain [10]  
The gain can be set separately for positive and negative values. In this way, adjustments to the area ratio of a single-rod cylinder are possible.
- Characteristic curve correction [11]  
Can be used for compensating for progressive flow characteristics of proportional directional valves or for realizing an inflected characteristic curve.
- Overlap jump/residual speed [12]  
If valves with positive overlap are used in conjunction with a PDT1 controller, fine positioning can be activated 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]  
Is used for correcting the zero point of the connected valve.

#### 5.2.5 Signal linking/arithmetic operations

The VT-HACD-3-2X features a multitude of options of linking signals on the input or output side. It is possible to realize arithmetic operations for 2 signals.

These are functions like addition, subtraction, multiplication, division as well as minimum/maximum value comparator, 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:  $Z = \text{MIN} (X, Y)$
- MAX = maximum value comparator:  $Z = \text{MAX} (X, Y)$

- RATIO = entry of 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 limiter:  $Z = MIN (|X|, |Y|) * X / |X|$
- JUMP = jump generator:  $Z = MAX (|X|, |Y|) * X / |X|$
- With Z ... result
- X ... 1<sup>st</sup> signal
- Y ... 2<sup>nd</sup> signal

### 5.2.6 Digital position measuring system

When the VT-HACD-3-2X is used as controller module, digital position measuring systems of type SSI or incremental can be employed for the acquisition of actual values.

#### Operating limits of incremental encoder

The maximum frequency of the incremental encoder input ( $f_G$ ) of the VT-HACD-3-2X is 250 kHz. Factors determining the frequency are the maximum travel speed of the drive, the resolution (Res) of the encoder system used and the evaluation of signals, if used, by an EXE (interpolation and digitization electronics).

#### Formula

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 given encoder resolution:

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

### 5.2.7 Detection and treatment of errors

The VT-HACD-3-2X supports numerous possibilities of error monitoring:

- Dynamic following error monitoring
- Cable break monitoring for incremental and SSI encoders
- Cable break monitoring for sensors
- Cable break monitoring for analog signals
- Monitoring of analog inputs for falling below or exceeding a certain range
- Control error monitoring when the VT-HACD-3-2X is configured as controller
- Monitoring of the supply voltage, all internal voltages and the +10 V reference voltage
- Monitoring of the microcontroller itself (watchdog) as well as of the memory (checksum)

Error monitoring functions as well as the response in the event of an error can be configured as well. Error monitoring must be activated by the customer in the parameter file.

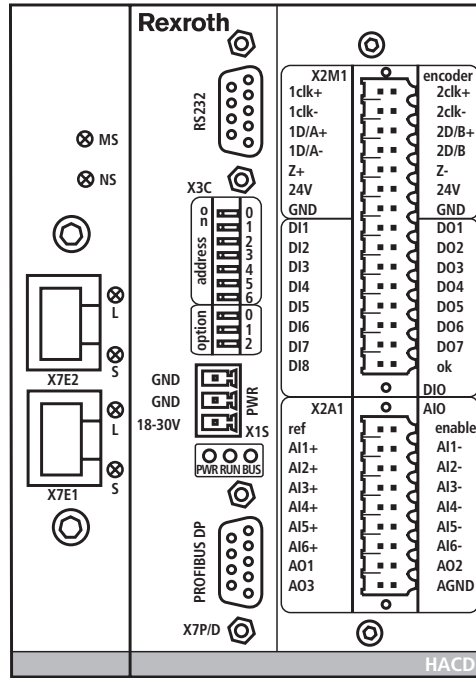
### 5.2.8 Pinout VT-HACD-3-2X

| X3C RS 232 |          |
|------------|----------|
| Pin        |          |
| 1          | LCAN_H   |
| 2          | TxD      |
| 3          | RxD      |
| 4          | reserved |
| 5          | GND      |
| 6          | reserved |
| 7          | reserved |
| 8          | reserved |
| 9          | LCAN_L   |

| X1S Power |           |
|-----------|-----------|
| Pin       |           |
| 1         | GND       |
| 2         | GND       |
| 3         | 18 – 30 V |

| X7P PROFIBUS DP |           |
|-----------------|-----------|
| Pin             |           |
| 1               | reserved  |
| 2               | reserved  |
| 3               | RxD/TxD-P |
| 4               | CNTR-P    |
| 5               | DGND      |
| 6               | VP        |
| 7               | reserved  |
| 8               | RxD/TxD-N |
| 9               | reserved  |

| X7E1, X7E2     |  |
|----------------|--|
| Ethernet ports |  |



| X2M1  | DIO (digital) |
|-------|---------------|
| 1clk+ | 2clk+         |
| 1clk- | 2clk-         |
| 1D/A+ | 2D/B+         |
| 1D/A- | 2D/B-         |
| Z+    | Z-            |
| 24V   | 24V           |
| GND   | GND           |
| D11   | DO1           |
| D12   | DO2           |
| D13   | DO3           |
| D14   | DO4           |
| D15   | DO5           |
| D16   | DO6           |
| D17   | DO7           |
| D18   | ok            |

| X2A1 | AIO (analog) |
|------|--------------|
| ref  | enable       |
| AI1+ | AI1-         |
| AI2+ | AI2-         |
| AI3+ | AI3-         |
| AI4+ | AI4-         |
| AI5+ | AI5-         |
| AI6+ | AI6-         |
| AO1  | AO2          |
| AO3  | AGND         |

The address DIL switches are used for setting the IP address for connection to bus systems.

The option DIL switches are provided only on Ethernet-capable variants.

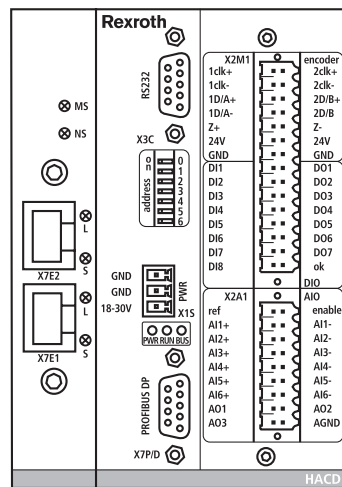
Note:

The pins marked with “reserved“ must not be connected!

Fig. 3: Pinout

### 5.3 Indicator lamps

The following LED indicator lamps are provided on the front panel of the VT-HACD-3-2X:



**Fig. 4: LEDs**

- PWR** Voltage supply applied
- RUN** VT-HACD-3-2X is initialized and in the “RUN“ mode.  
The LED flashes, if the VT-HACD-3-2X has not been initialized.
- BUS** Bus signal is present
- NS** Network status  
LED off = no IP address  
LED green (flashing) = configuration  
LED green = connection established  
LED red (flashing) = connection interrupted  
LED red = double IP addresses
- MS** HACD status  
LED green (flashing) = configuration  
LED green = HACD OK  
LED red (flashing) = HACD error
- L** Link: On = active; Off = no connection with a communication partner
- S** Transmission status of data (flashing = receiving/sending Ethernet telegrams)

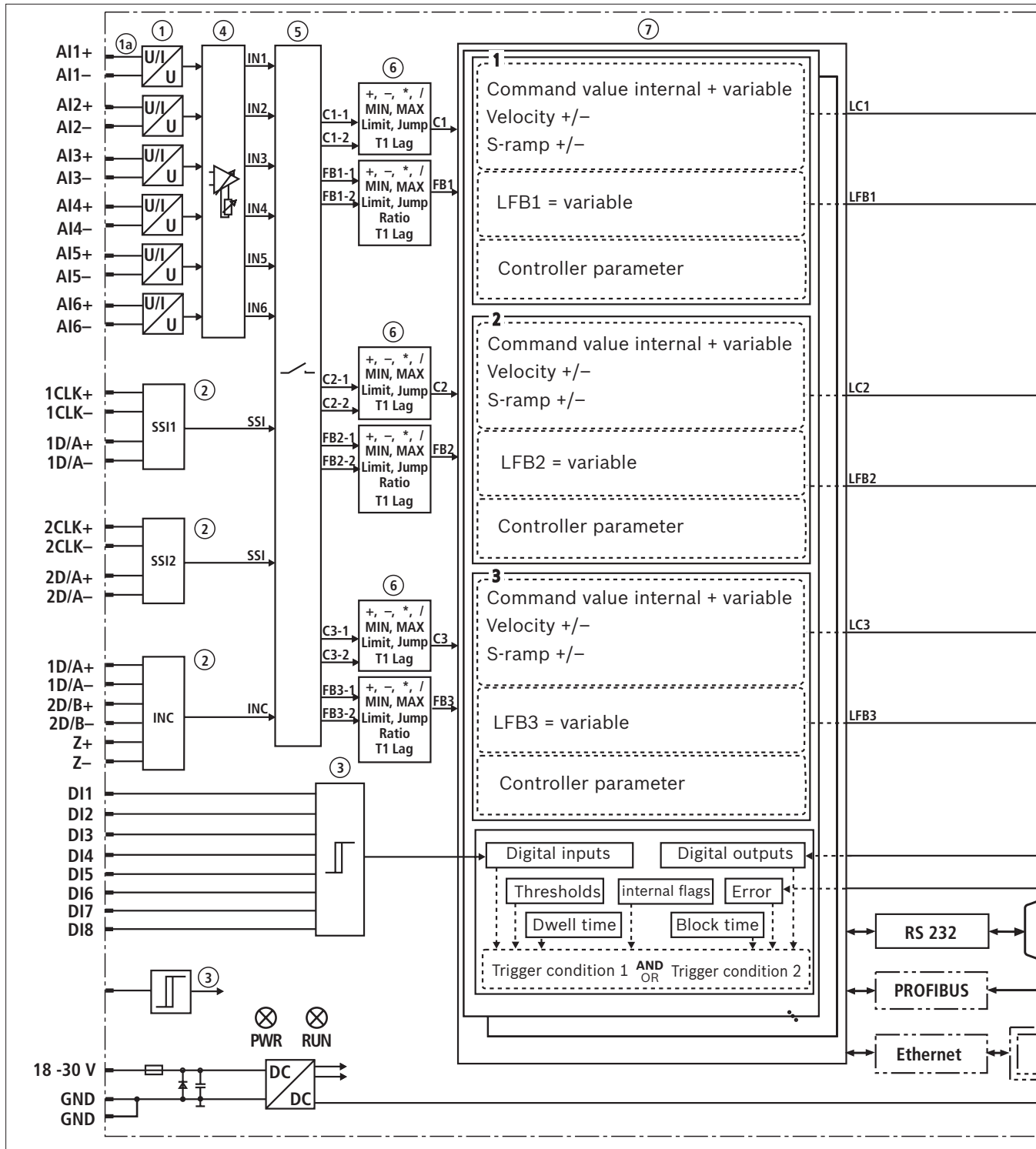
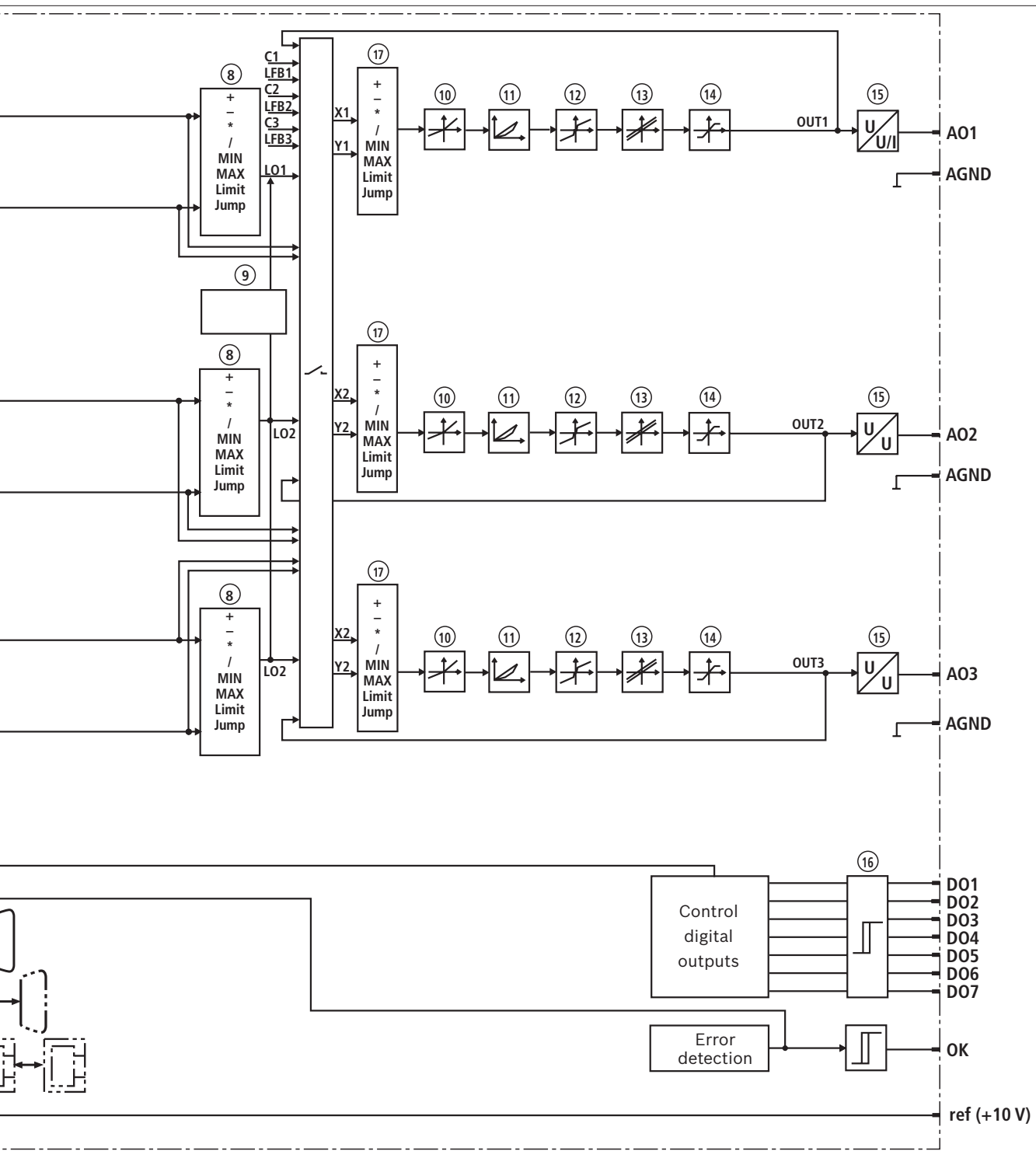


Fig. 5: Block circuit diagram VT-HACD-3-2X, structure editor

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li><b>1</b> Analog inputs, voltage or current (1a: High-resistance input AI1)</li> <li><b>6</b> Mathematical operation or inputs</li> <li><b>11</b> Characteristic curve correction</li> <li><b>16</b> OK output and digital outputs</li> </ul> | <ul style="list-style-type: none"> <li><b>2</b> SSI or incremental</li> <li><b>7</b> 32 blocks for command value generation, controller parameter changeover</li> <li><b>12</b> Residual speed and overlap jump</li> <li><b>17</b> Mathematical operations for outputs</li> </ul> | <ul style="list-style-type: none"> <li><b>3</b> Ena</li> <li><b>8</b> Mat</li> <li><b>13</b> Off</li> </ul> |
|---|---|---|



able input and digital inputs

hemathical operation or controller  
set

**4** Adjustment of analog inputs

**9** Overriding control  
**14** Limitation

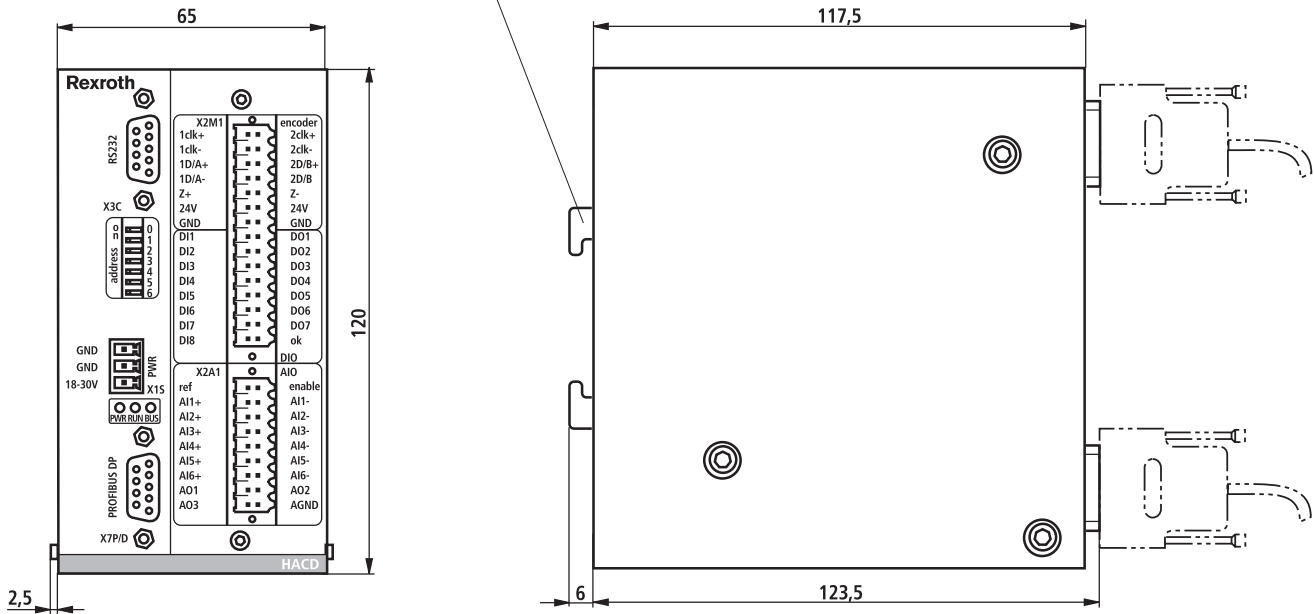
**5** Switching matrix

**10** Direction-dependent gain  
**15** Analog outputs or current

For further information, see online help in BODAC or RE 30543-01-B

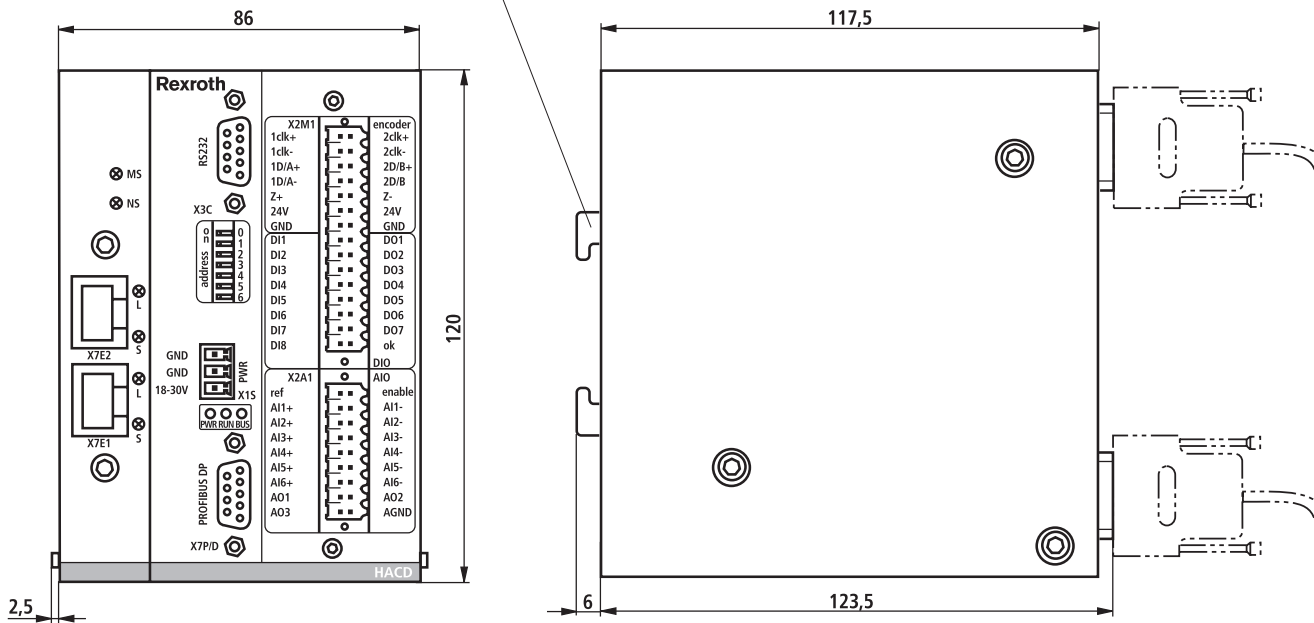
**5.3.1 Unit dimensions VT-HACD-3**  
(dimensions in mm)

Mounting on top hat rails TH 35-7.5 or TH 35-15 to EN 60715



**Fig. 6: Unit dimensions VT-HACD-3-2X/... (without Ethernet)**

Mounting on rails TH 35-7.5 or TH 35-15 to EN 60715

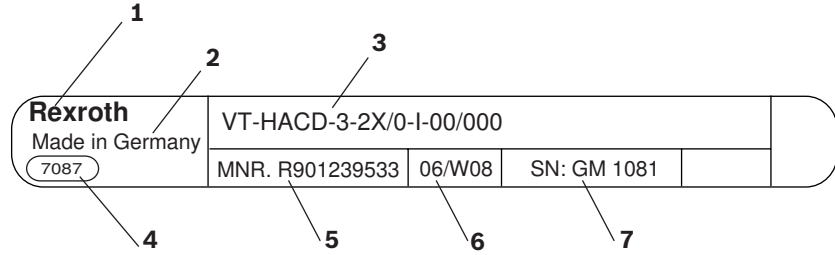


**Fig. 7: Unit dimensions VT-HACD-3-2X/... (with Ethernet)**



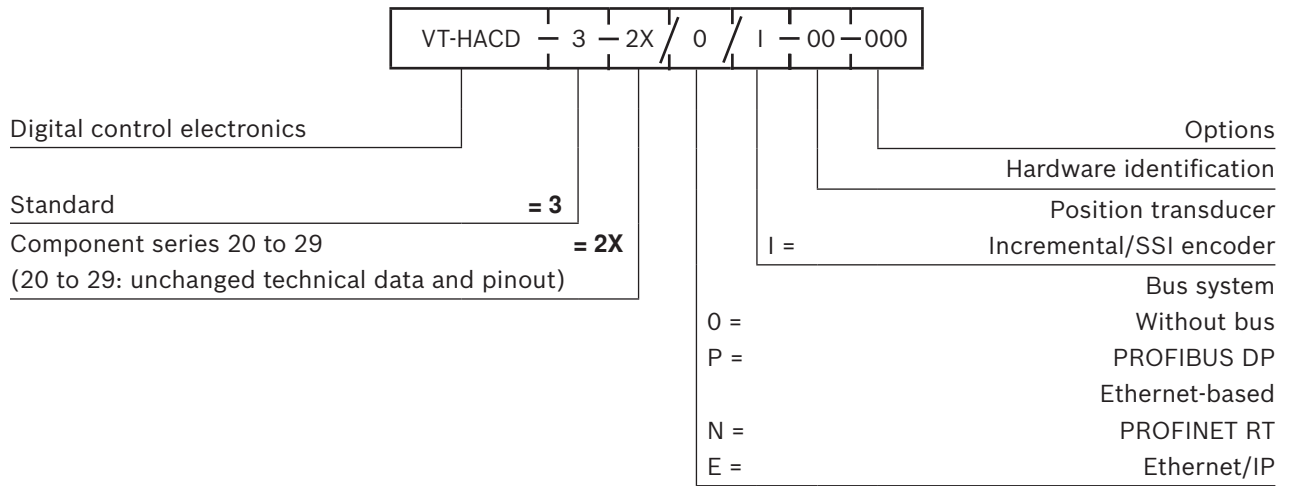
### 5.4 Identification of the product

A label indicating the most important details is provided at the side of the VT-HACD-3-2X.



- 1 Word mark
- 2 Country of origin
- 3 Material short text
- 4 Factory
- 5 Material number
- 6 Date of production
- 7 Serial number

#### 5.4.1 Ordering code



## 6 Transport and storage

There are no special transport instructions for this product. Please observe, however, the notes in Chapter 2 “Safety instructions“ and for transport and storage adhere in any case to the ambient conditions given in the technical data of data sheet 30543.

### **6.1 Storing the VT-HACD-3-2X**

For preparing the control electronics for storage and further use, proceed as follows:

- ▶ Use the original packaging for storage.
- ▶ Adhere to the permissible storage temperature range of -20 °C to +70 °C.
- ▶ Protect the VT-HACD-3-2X against dust and humidity.

## 7 Installation

### CAUTION

#### **Fault currents and short-circuits!**

Impaired safety and malfunction.

- ▶ The surroundings must be free from conductive contamination (acids, lyes, corrosive agents, salts, metal vapors, etc.), and the device must not be exposed to them. Generally, rule out deposits according to protection class IP 65.
- ▶ Prevent the ingress of dust and humidity into the control electronics VT-HACD-3-2X.

#### **Cables lying around!**

Risk of stumbling.

- ▶ Route cables and lines so that they cannot be damaged and nobody can stumble over them.

#### **Incorrect power supply!**

Uncontrolled drive behavior.

- ▶ Use exclusively a power supply unit with protective separation.
- ▶ Always observe specific national regulations.

### NOTICE

#### **Great differences in potential!**

Risk of destruction of the control electronics VT-HACD-3-2X by plugging in or removing the electronics while connected to the power supply.

- ▶ Disconnect the relevant system part from the power supply before you plug, remove or connect the electronics. Damage to the electronics caused by incorrect installation is not covered by the warranty!
- ▶ Observe the protection class, the voltage supply and ambient conditions as specified in data sheet RE 30543.

### 7.1 Unpacking

Dispose of the outer packaging in accordance with the regulations valid in your country.

### 7.2 Installation conditions

When installing the control electronics, adhere in any case to the ambient conditions specified in data sheet RE 30543.

### 7.3 Required tools

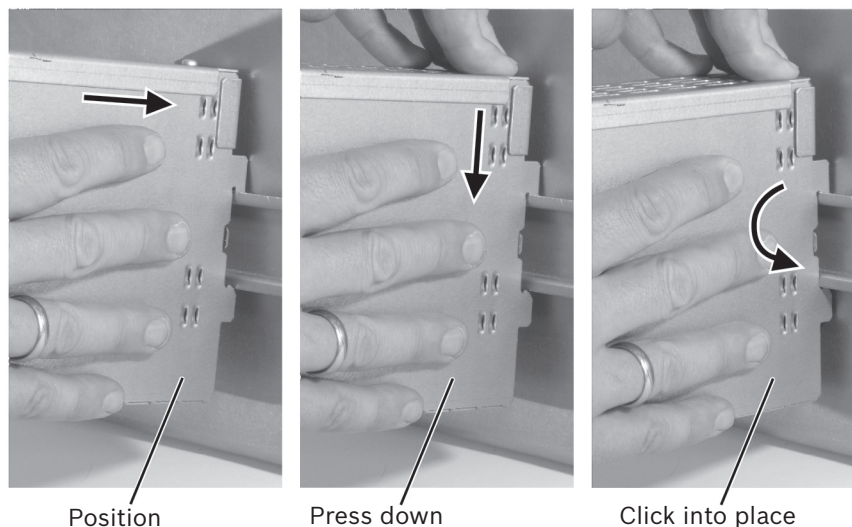
No special tools are required for installing the electronics.

### 7.4 Installing the VT-HACD-3-2X

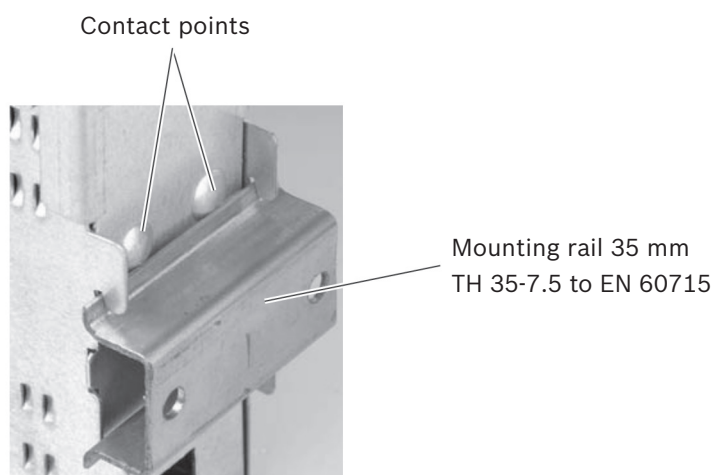
Mount the VT-HACD-3-2X on a mounting rail in the control cabinet as follows:

1. Disconnect the relevant system section from the power supply.
2. Carefully snap the backpanel of the VT-HACD-3-2X in on a mounting rail.  
Mechanical contact points on the elastic backpanel of the VT-HACD-3-2X ensure

proper fit on the mounting rail and connect the housing with the grounding system of the control cabinet.



**Fig. 8: Mounting the VT-HACD-3-2X on a mounting rail**



**Fig. 9: Contact points of the VT-HACD-3-2X for mounting on a mounting rail**

Please observe the following when mounting the control electronics VT-HACD-3-2X:

- ▶ Observe the notes on applicable standards and operating conditions in the data sheet when installing the control electronics.
- ▶ Use low-capacitance cables.
- ▶ Whenever possible, provide cable connections without intermediate terminals.
- ▶ Lay sensor cables separately.
- ▶ Do not install sources of electromagnetic interference (e.g. frequency converter) in the direct vicinity of the control electronics.
- ▶ The distance to aerial lines, radio sources and radar equipment must be at least 1 m.
- ▶ Do not install solenoid and signal cables near power cables.
- ▶ Use shielded cables (EMC-compliant) as valve cables.
- ▶ Execute the installation so that when the differential inputs are used both inputs are activated or deactivated simultaneously.

- ▶ Use relays with gold-plated contacts for switching command values (small voltages, small currents).
- ▶ Do not use adhesives, sealants or insulating agents that contain silicone.
- ▶ The system ground is an essential integral part of EMC protection of the control electronics. Here, interference, which is transported to the control electronics via data and voltage supply cables, is dissipated. This function can only be ensured, if the system ground itself does not inject interference into the control electronics. Bosch Rexroth recommends that also solenoid cables be shielded.
- ▶ Ensure maintenance-friendly installation, i.e. ease of access to the connection cables. The connection side must be freely accessible. The cable ends should be sufficiently long in order that the control electronics can also be removed in the wired condition.
- ▶ Before installing the control electronics note down the details given on the nameplate. If nameplates are no longer visible or legible after the installation you have this data at hand at any time.

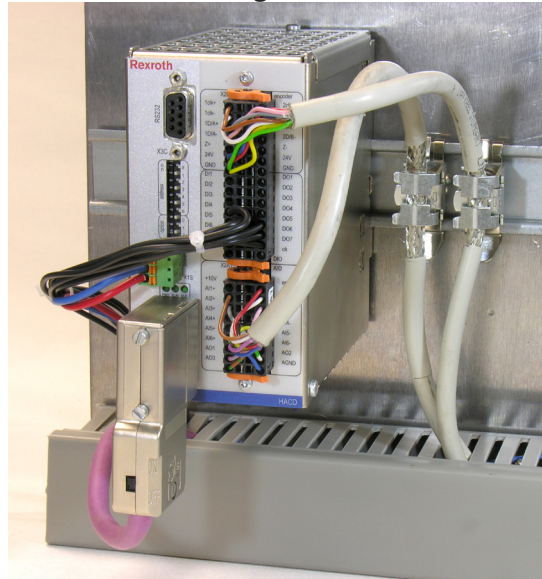
## 7.5 Connecting the power supply

To connect the electrical supply to the VT-HACD-3-2X proceed as follows:

1. Disconnect the relevant system section from the power supply.
2. Inspect all cables for intactness.
3. Establish the power supply to the VT-HACD-3-2X via the plug-in connection X1S "Power".
4. Establish the connections of the analog and/or digital inputs/outputs in accordance with the application at hand via the plug-in connections X2M1 "DIO" and X2A1 "AIO".
5. Switch the power supply on and make sure that voltage is applied to the VT-HACD-3-2X and the LED "PWR" is on and that the bus signal is present and the LED "BUS" is on.

The VT-HACD-3-2X is now connected to the electrical supply.

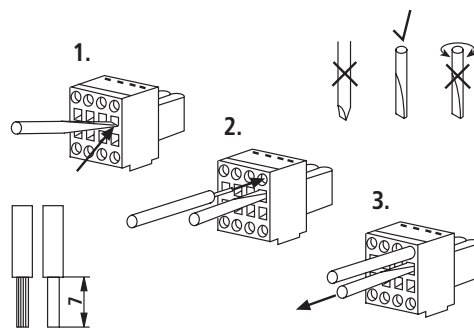
### 7.5.1 Notes on wiring



**Fig. 10: Proper wiring**

1. Engage the VT-HACD-3-2X on an appropriate C section.
2. Ground the electronics housing and the filter elements on the electronic boards via the conductive connection between the housing and the C section → rear wall of the control cabinet.
3. Connect the cable shields of the encoder and AD/DA connections conductively to the C section using shield clamps. This connection of the shields to the C section at the rear control cabinet wall must be made close to the VT-HACD-3-2X. To establish the connection, strip the cable sheath end and then clamp the wire beneath the shield clamp (see Figure). (Shield clamps, e.g. from Murrplastik SK 3-8 shield terminal 3-8 mm, Art. no.: 87201060 or SK 4-13.5, Art. no.: 87201062).
4. Connect both GND to X1S (Power).

### 7.5.2 Notes on the connection of tension spring clamps



**Fig. 11: Tension spring clamps**

Litz wires must not be visible from outside.

## 8 Commissioning

With regard to commissioning in conjunction with bus systems, also observe the following instructions:

PROFINET RT RE 30543-05-Z  
 Ethernet/IP RE 30543-04-Z  
 PROFIBUS RE 30543-01-Z

### 8.1 Configuration software “BODAC”

To solve project planning tasks, the user can utilize the PC program “BODAC”. It serves for programming, setting and diagnostics of the VT-HACD-3-2X.

Scope of performance:

- Convenient dialog functions for online or offline setting of machine data
- Dialog window for online setting of parameter values
- Comprehensive options for displaying process variables of digital inputs, outputs and flags
- in conjunction with WinView, recording and visualization of up to eight process variables with a great choice of trigger options



The PC program “BODAC” is not included in the scope of delivery. It can be downloaded on the Internet free of charge at: [www.boschrexroth.com/hacd](http://www.boschrexroth.com/hacd)  
 Queries: [support.hacd@boschrexroth.de](mailto:support.hacd@boschrexroth.de)

#### 8.1.1 PC installation requirements

The following system requirements must be met for the PC program “BODAC”:

- IBM PC or compatible system
- Windows XP, Windows Vista, Windows 7
- RAM (recommended: 256 MB)
- 250 MB free hard drive capacity
- RS232 interface or USB converter

#### 8.1.2 Installation of “BODAC”

For the installation of “BODAC” proceed as follows:

- ▶ Download the file “BodacSetup\*.exe” from the [www.boschrexroth.com/hacd](http://www.boschrexroth.com/hacd) web page to your PC.
- ▶ Execute the “BodacSetup\*.exe” file.

The file will be unpacked.

- ▶ Select the desired language.
- ▶ Follow the installation instructions. After having installed the program, you can start it by clicking on the file “BODAC\*.exe”.

“BODAC” is now completely installed on your PC.

### 8.1.3 Configuration of the VT-HACD-3-2X with BODAC

The required parameter file can be created offline and transmitted to the VT-HACD-3-2X from the PC. Software-assisted project planning is carried out according to the following steps:

1. Start "BODAC".
2. Select the relevant VT-HACD-3-2X from the selection window.
3. Define the desired application using the block structure.
4. Set the desired parameter values (sensorics, controllers, ...). Follow the instructions given in the "BODAC" online help.
5. Transmit the data to the VT-HACD-3-2X.
6. Save the data in the flash.

The generation of the parameter file is now completed.

The settings and the operating sequence of the machine are optimized on the machine.



#### Structure editor

It is possible to load parameter files of the VT-HACD-3-1X to the VT-HACD-3-2X.

In conjunction with the VT-HACD-3-2X, BODAC offers the structure editor. The structure editor is enabled and can be used for creating own motion sequences. For this purpose, 32 blocks are available.

Parameter set name: **HACD2\_Mode3\_Editor.param**

Each block contains: Command value, acceleration, deceleration (velocity +, velocity -) and controller parameters.

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

In addition, observe the following instructions: BODAC online help RE 30543-01-B.

## 8.2 Initial commissioning of the VT-HACD-3-2X

To commission the VT-HACD-3-2X, proceed as follows:

1. Inspect all cables for intactness.
2. Make sure that voltage is applied to the VT-HACD-3-2X and the "PWR" LED is on.
3. Make sure that the bus signal is present and the "BUS" LED is on.
4. Install the commissioning and configuration software "BODAC" on your PC.
5. Connect your PC to your VT-HACD-3-2X by means of an RS232 interface cable.
6. Configure the VT-HACD-3-2X with the help of BODAC. In this connection, follow the instructions given in Chapter 8.1.3 "Configuration of the VT-HACD-3-2X with BODAC" above.
7. Optimize the settings of the parameter file and the operating sequence on the machine.
8. After having finalized the settings, save the parameter file of the VT-HACD-3-2X to your PC.

Initial commissioning of the VT-HACD-3-2X is now completed.



### 8.3 Recommissioning after repairs and reconditioning

After repair or reconditioning, the VT-HACD-3-2X is returned with the **default values**.

For recommissioning, proceed as follows :

1. Inspect all cables for intactness.
2. Make sure that voltage is applied to the VT-HACD-3-2X and the "PWR" LED is on.
3. Make sure that the bus signal is present and that the "BUS" LED is on.
4. Connect your PC to your VT-HACD-3-2X using the RS232 interface cable.
5. Transmit the saved parameter file from your PC to the VT-HACD-3-2X.
6. Save the parameter file in the flash of the VT-HACD-3-2X using the command "Set Parameter to Memory" from the "Controller" menu.

Recommissioning after repairs and reconditioning is now completed.

## 9 Operation

The operation of the VT-HACD-3-2X is based on a parameter file that is to be created during commissioning. The parameter file contains the block structure of the VT-HACD-3-2X, in which logic operations of the variables are created.

For monitoring and diagnosis of the VT-HACD-3-2X during operation you can use the optional diagnostic software “WinView” (which is not contained in the program BODAC). If you have not yet downloaded this software together with BODAC you can find the download section at the following Internet site:

[www.boschrexroth.com/winview](http://www.boschrexroth.com/winview)

### 9.1 Diagnostic software “WinView”

WinView is a program for the visualization of variables recorded during operation. The user program transfers the data to WinView for graphical representation. The data can be saved in the specific file format .GRA and reloaded.

#### 9.1.1 Installation of “WinView”

To install “WinView” proceed as follows:

1. Download the file “winview\*setup.exe” from the website [www.boschrexroth.com/winview](http://www.boschrexroth.com/winview) to your PC.
2. Execute the file “winview\*setup.exe”.

The file is going to be unpacked.

3. Select the desired language.
4. Follow the installation instructions. After completion of the installation you can start the program by clicking on the file “winview.exe”.

“WinView” is now completely installed on your PC.

# 10 Maintenance

## 10.1 Cleaning and care

### **NOTICE**

#### **Ingress of contamination and humidity!**

Malfunction!

- ▶ When carrying out any work on the VT-HACD-3-2X observe strictest cleanliness.
- ▶ Prevent the ingress of humidity and contamination into the perforated housing of the VT-HACD-3-2X.
- ▶ Use only a dry and dust-free cloth for cleaning.

#### **Solvents and aggressive detergents!**

Damage to the surface of the VT-HACD-3-2X and faster aging.

- ▶ Never use solvents or aggressive detergents.

For cleaning and care proceed as follows:

- ▶ Inspect all plug-in and clamping connections of the VT-HACD-3-2X for correct fit and damage at least once a year.
- ▶ Check cables for rupture and squeezing. Have damaged or defective cables immediately replaced!
- ▶ Clean the housing parts with a dry and dust-free cloth.

## 10.2 Repairs

The VT-HACD-3-2X can only be replaced as a whole unit.

Unauthorized modifications to the VT-HACD-3-2X are not permitted for safety reasons!

Repair and reconditioning work may only be carried out by Bosch Rexroth AG.

For repair and reconditioning work, send the device to the service address given in Chapter 16.1 "Address directory" on page 39.



After repairs and reconditioning, the VT-HACD-3-2X is returned with default values. User-specific settings are lost. The operator must re-transmit relevant user parameters and programs.

## 11 Removal and replacement

No tools are required for replacing the VT-HACD-3-2X.

### 11.1 Preparing the removal

Decommission the entire system as described in the general manual for the system. In any case, bring the system to a safe state, shut it down, depressurize it, disconnect it from the power supply and secure it against being restarted.

### 11.2 Carrying out the removal

#### **NOTICE**

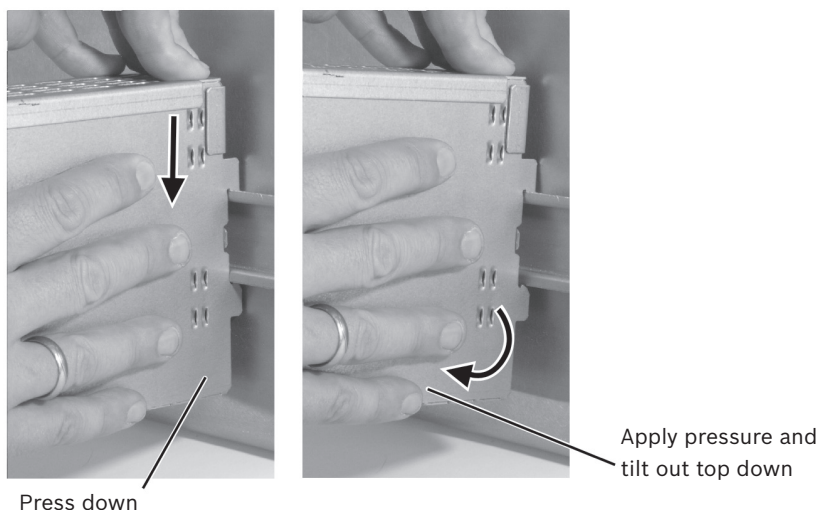
##### **Electric arcs and short-circuit!**

Risk of destruction of system components.

- ▶ Place down the plug-in connectors so that no short-circuits can occur.

To remove the VT-HACD-3-2X, proceed as follows:

1. Disconnect the connection cables and unplug plug-in connectors.
2. Remove the VT-HACD-3-2X from the mounting rail.



**Fig. 12: Removing the VT-HACD-3-2X from the mounting rail**

### 11.3 Preparing the components for storage/further use

To prepare the VT-HACD-3-2X for storage and further use, proceed as follows:

- ▶ Use the original packaging for storing.
- ▶ Adhere to the permissible storage temperature range specified in RE 30543.
- ▶ Protect the control electronics against dust and humidity.

## 12 Disposal

### 12.1 Environmental protection

Careless disposal of the VT-HACD-3-2X and the packaging material can lead to environmental pollution.

- ▶ Therefore, dispose of the VT-HACD-3-2X and the packaging material according to the national regulations of your country and recycle the material.

## 13 Extension and conversion

The control electronics VT-HACD-3-2X must neither be extended nor converted. If you modify the VT-HACD-3-2X the warranty will be rendered void.

Only the use of optional accessories is permitted.

### 13.1 Optional accessories

**Table 6: Accessories that can be ordered**

| Designation   | Material number |
|---|-----------------|
| PC program BODAC, CD, SYS-HACD-BODAC01                    | R900777335      |
| Interface cable, cable set RS232, length 3 m              | R900776897      |
| USB/RS232 converter                                       | R901066684      |
| Plug-in connector type 6ES7972-0BA41-0XA0 for PROFIBUS DP | R900050152      |
| CD with BODAC software SYS-HACD-BODAC-01/                 | R900777335      |

## 14 Troubleshooting

### 14.1 How to proceed with troubleshooting

Always act systematically and focused, even when under pressure of time. Random and imprudent disassembly and readjustment of settings might, in the worst-case scenario, result in the inability to ascertain the original cause of fault.

- First get a general idea of how your product works in conjunction with the entire system.
- Try to clarify whether the product worked properly in conjunction with the entire system before the troubles occurred.
- Try to determine any changes of the entire system in which the product is integrated:
  - Were there any changes to the product's operating conditions or operating range?
  - Were any changes made or repairs carried out on the complete system (machine/system, electrics, control) or on the product? If yes, which?
  - Was the product or machine used as intended?
  - How did the malfunction manifest itself?
  - Try to get a clear idea of the error cause. Directly ask the (machine) operator
- Make use of the diagnostic features for "BODAC" and "WinView" for troubleshooting:

If you cannot rectify the error, contact one of the contact addresses which can be found at: [www.boschrexroth.com/adressen](http://www.boschrexroth.com/adressen) or in the address directory in Chapter 16.1.

## 15 Technical data

For the technical data of control electronics VT-HACD-3 series 2X, please refer to the technical data sheet RE 30543.

# 16 Annex

## **16.1 Address directory**

### **16.1.1 Contacts for repairs**

Bosch Rexroth AG  
Service Industriehydraulik  
Bgm.-Dr.-Nebel-Str. 8  
97816 Lohr am Main  
Germany

<http://www.boschrexroth.com/service>

E-mail: [service@boschrexroth.de](mailto:service@boschrexroth.de)

### **16.1.2 Contacts for support**

Bosch Rexroth AG  
Zum Eisengießer 1  
97816 Lohr am Main  
Germany

Phone +49 (93 52) 18-11 32

Fax +49 (711) 811 517 1031

E-mail: [support.hacd@boschrexroth.com](mailto:support.hacd@boschrexroth.com)

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Bosch Rexroth AG  
Zum Eisengießer 1  
97816 Lohr a. Main  
Deutschland  
Tel. +49 (0) 9352 18-0  
info@boschrexroth.de  
www.boschrexroth.com