Digital control electronics for electro-hydraulic injection molding machines

Type VT-HACD-DPQ

RE 30146
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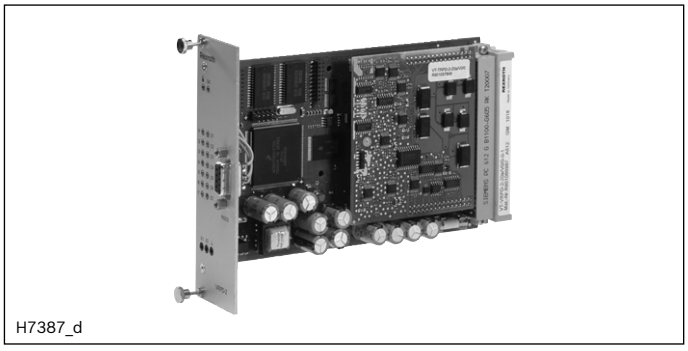

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- Component series 2X

Features

- Actual value recording via SSI encoder, incremental or analog position measurement system possible
- Free configuration of the valve control spool
- Control loop adjustment
- Jog mode controlled
- Separate menus for injection, holding pressure and back pressure
- Pressure transition via:
  - Position
  - Internal mold pressure
  - Hydraulic pressure via position
  - Discrete input
- Enable input and OK output
- ±10 V reference voltage output
- Front display with keys to display and change parameters as well as for diagnosis purposes
- RS232 serial interface
- Up to 32 controller cards can be interconnected for parameterization and diagnosis via the local bus
- Internal or analog profile
- I/O configuration

Contents

Ordering code

01	02	03	04	05	06	07
VT-HACD-DPQ	**– 1 –**	**2X**	**/ V0 /**	**1**	**–**	**– 0**

01	Digital controller card	**VT-HACD-DPQ**
02	One axis	**1**
03	Component series 20 ... 29 (20 ... 29: Unchanged installation and connection dimensions)	**2X**
04	Basic unit	**V0**
05	With display	**1**
06	Without bus connection	**0**
	CANopen	**C**
	DeviceNet	**D**
07	without valve output stage	**0**

Required accessories:

- PC program BODAC: 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

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

Functional description: Overview

Overview

The VT-HACD-DPQ is a digital controller card. It optimizes the control of hydraulic injection axes.

- The rate of injection profiles are completely realized by a position control system. A position command value profile is automatically created on the basis of the velocity profile entered by the operator.
- As the VT-HACD-DPQ controls the position, a position transducer is required. Both analog (0...10 V; ±10 V, 0...20 ad 4...20 mA) and digital position transducers (SSI; INCR) are supported by the VT-HACD-DPQ.
- The VT-HACD-DPQ comprises limitation of the injection force. For the limitation, 1 or 2 pressure transducers or one load cell can be used.
- The rate of injection and the pressure profiles can be regulated using a proportional directional valve or separate valves for flow and pressure.
- The command values for the motion profile can be (analogously) transmitted by the PLC to the VT-HACD-DPQ. The profiles can, however, also be input into the VT-HACD-DPQ using the Bosch Rexroth BODAC software.

Function

The VT-HACD-DPQ is a complete solution for controlling hydraulic injection axes. The injection profile is created by different parameters which are entered by the machine operator. All process parameters for the injection cylinder are stored on the card. Parameter changes can be loaded onto the VT-HACD-DPQ individually or as complete profile. The VT-HACD-DPQ keeps the last stored profile in a non-volatile flash (memory). On the card, one single injection profile is stored. To enable the VT-HACD-DPQ, a discrete input (enable) is required.

Functional description: Injection control

Injection profile

In order to fill the mold, a velocity profile with up to 10 steps is provided.
For every profile step, a maximum pressure/force limit can be set. The injection cylinder is moved in a regulated form using the velocity profile (position control).
At the beginning of the injection, the internal position command value is set equal to the current actual position value and then moved forward by means of a ramp which corresponds to the relevant step in the velocity profile.
The steps are run through one after the other. Switch-over to the next step is effected as soon as the position command value has been reached. The repetition accuracy of the profile is determined by the highest setting of the proportional gain possible so that the injection cylinder follows the internal position command value as closely as possible, also under varying load conditions. This system is used as changes in the material properties of the plastic and in the temperature have hardly any influence. As the position control is a ramp of the position command value over the time, variations of velocity between the profile steps take place smoothly and do not require any special ramp adjustment.

Transition to the holding pressure

The VT-HACD-DPQ starts with the holding pressure profile as soon as one of the specified transition criteria is met. The transition criteria available in the stored profile are hydraulic pressure and cylinder position, internal mold pressure or digital input 3 (DI3). All transition criteria are monitored on a permanent basis. Transition criteria which are not used are to be set to values which cannot be reached during the travel profile. The hydraulic pressure command value is only activated if the cylinder position is smaller than the set hydraulic transition position parameter. So acceleration pressures higher than the set hydraulic transition pressure are also possible without triggering of the holding pressure profile. The machine control can start the transition by means of a digital input (DI3).
Via the digital output DO1, the machine control is signaled that the process has been completed.

Holding pressure phase

For the holding pressure, a pressure/force profile with up to five steps is available.
As soon as the holding pressure phase is activated, the VT-HACD-DPQ switches to pressure/force control with superimposed velocity control. All other steps in the velocity profile are ignored. In every step, pressure, (force)

Functional description: Injection control (continued)

time, and velocity limitation can be set in the holding pressure profile.
Step 1 in the profile is started at the time of transition. Every subsequent step in the holding pressure profile is initiated when the previous step timer has been completed.

The velocity limitation in step 1 of the holding pressure profile is usually used in order to avoid an early pressure/force build-up in the injection cylinder if transition on the basis of the position is selected. Apart from that, the DPQ allows for faster reaction if transition is initiated based on the internal mold pressure by reducing the command value for the flow control valve to a smaller opening within 2 msec in order to thus avoid pressure/force overshoots. In the following steps of the holding pressure profile, the velocity limit is usually set higher so that it does not limit the dynamics of the pressure/force control circuit.

Pre-retraction (pre-decompression)
After the last timer in the holding pressure profile has been completed, the VT-HACD-DPQ will automatically unload the worm. Pre-retraction is active if the position parameter for the pre-decompression is larger than the actual position of the injection cylinder at the end of the holding pressure phase. The velocity parameter for the pre-retraction is a valve control command. Pre-retraction is complete as soon as the position of the injection cylinder is equal to or larger than the pre-retraction position parameter. At the end of the pre-retraction, the VT-HACD-DPQ will send a signal to the machine control and signal completion of the retraction. At the end of the pre-retraction, the valve outputs will be set to 0 V.

Back pressure
Starting of the back pressure requires activation by the machine control via the discrete input DI. The VT-HACD-DPQ will then control the retraction of the injection unit on the basis of position and pressure and/or force parameters in a 3-stage retraction profile.
The back pressure is changed in a regulated manner; it does moreover have a subordinate controlled velocity limitation. The next step in the retraction profile is triggered during the ongoing retraction by a higher cylinder position. In applications with hydraulic circuit with only one injection valve, the velocity parameter is set for every back pressure step as limitation of the valve pre-opening. In a circuit with a separate proportional pressure relief valve for the back pressure, the velocity parameter can be set to any valve value which is necessary for the proportional directional valve for the injection, for some hydraulic systems, this is e.g. the worm motor speed.
The worm retraction phase is completed if the injection cylinder position is equal to or larger than the injection position. The VT-HACD-DPQ signals reaching of the injection position to the machine control. The back pressure control is maintained until post-decompression starts.

Post-retraction (post-decompression)
If the discrete input (DI6) for the post-retraction is activated by the machine control, the post-decompression phase starts when injection cylinder position is equal to or larger than the the injection position. The velocity parameter for the post-decompression is a valve control command. Post-decompression is completed when the injection cylinder position is equal to or larger than the post-decompression position value. When post-decompression is reached, the VT-HACD-DPQ will set the valve outputs to 0 V and signal this to the machine control.

Injection configuration options
Depending on the hydraulic system, the VT-HACD-DPQ can be used with one of the two injection configurations.

1. Preferred configuration: Velocity control profile and pressure control with one proportional injection valve and one analog valve output. This system type controls the rate of injection profile, the pressure profile, the back pressure and the worm decompression by means of a proportional directional valve. With this system type, the available response dynamics are better than with systems with separate valves for flow and pressure control; this means that the control loop can be adjusted for faster and exacter control.
2. Velocity control profile and open-loop or closed-loop pressure control with one proportional directional valve or flow control valve for the velocity profile and one proportional pressure control valve for the injection pressure control. For this configuration, two analog valve outputs are available. This configuration does not require the same degree of dynamic response from the proportional flow control valve as the configuration with a separate valve. Due to the limitations caused by the distribution of current and pressure control functions to several valves and the design-inherent dynamic limitations of proportional pressure valves, the control of the overall system is not as dynamic and repeatable.

Functional description: Injection control (continued)

In addition, the VT-HACD-DPQ can be configured so that the second valve output is directly controlled via the machine control and not by the internal pressure profile.

Applications

The VT-HACD-DPQ has been configured to control injection applications and all parameters will be recognized in injection applications. There are, however, many other applications that may benefit from the VT-HACD-DPQ control quality:

- Injection machines
- Extrusion
- Reaming
- Rubber processing
- Blow molding in the battery head

Front panel operation

The front display is used in connection with 4 pushbuttons to display and change the parameters.
The following operator parameters can be accessed:

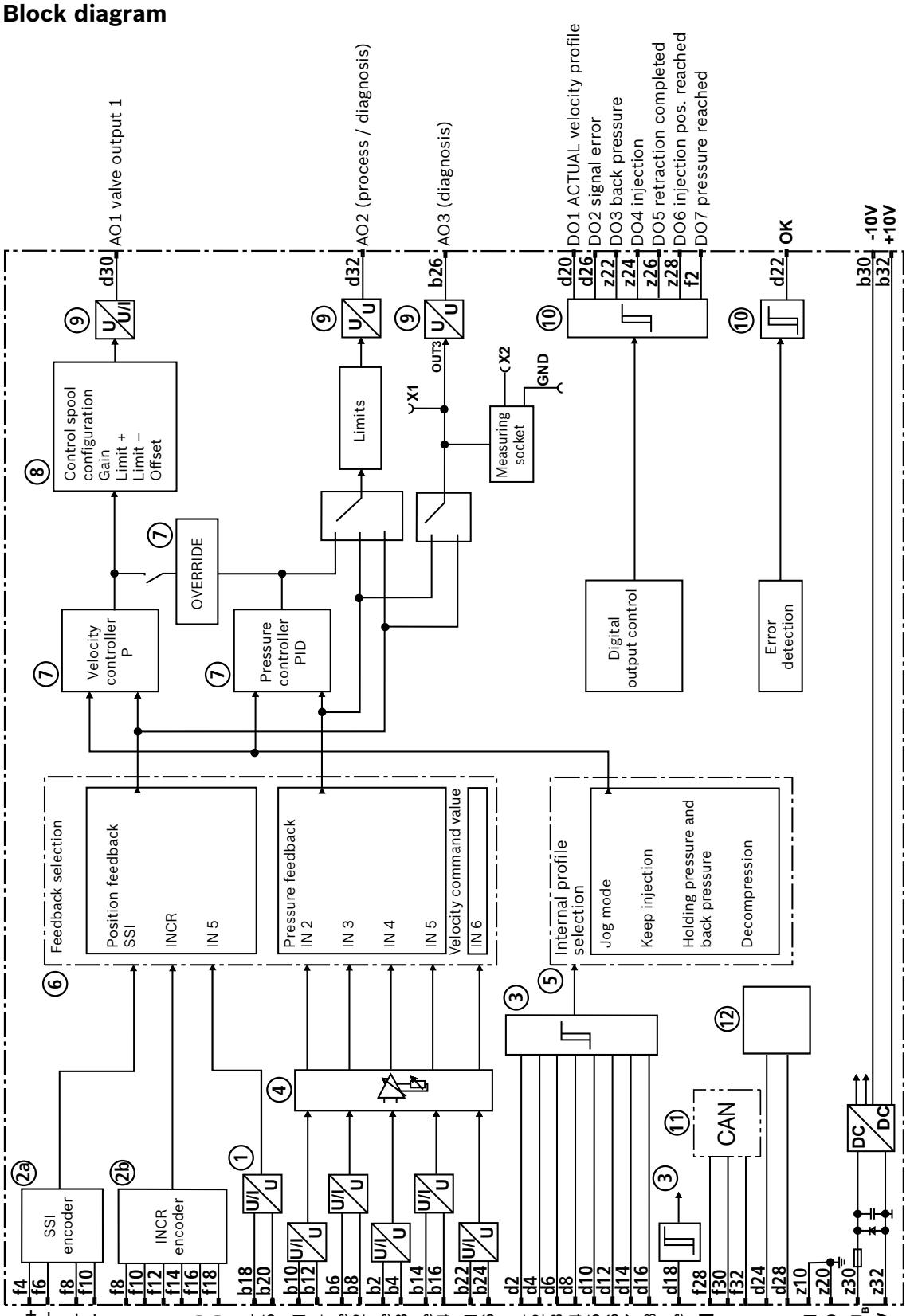
- Injection profile
- Transition parameters
- Holding pressure profile
- Worm retraction
- Decompression parameters

For safety reasons, set-up and configuration parameters are not accessible via the front panel.
If errors occur, error messages will be displayed.

PC program BODAC

The BODAC PC program is used to configure, parameterize and diagnose the VT-HACD-DPQ via a serial interface (RS 232). Via the local bus, up to 32 controller cards can be connected. Via BODAC, every controller card is assigned a bus address. Reconnection of the serial interface cable is not required. Further information in the instructions 30146-01-B.

Block diagram



1 Analog inputs, voltage or current
2a SSI encoder
2b Incremental encoder
3 Enable and digital input
4 Setting analog inputs
5 Internal profile
6 Feedback selection
7 Controller
8 Control spool configuration
9 Analog outputs (voltage or current)
10 OK output and digital outputs
11 CAN interface, optional
12 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}	150 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
		I_{max} = 30 mA
Analog inputs AI1...AI6		
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 (configurable)
Input resistance	R_e	100 Ω
Leakage current		0.15 % (with 500 Ω between pin AI x– and 0 V)
Resolution	I	5 µA
Analog outputs		
AO1 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		±15 mV (without noise)
AO1 configuration as current output		
Output current	U	0...20 mA or 4...20 mA (configurable)
Load	R_{max}	500 Ω
Resolution		1.25 µA
Residual ripple		±15 µA (without noise)
AO2 / AO3 configuration as voltage output		
Output voltage	U	±10 V
Output current	I_{max}	10 mA
Load	R_{Lmin}	1 kΩ
Resolution		10 mV (11 bit)
Residual ripple		±25 mV (without noise)
Digital position transducers (encoders):		
SSI transducer		
Line receiver / line driver		RS485
Reference voltage	U	±10 V
	I_{max}	30 mA
Residual ripple		< 20 mV
Scan velocity	t	2 ms
Serial interface		RS232 (front plate), D-Sub socket
Type of connection		64-pole male multipoint connector, DIN 41612, design G
Local bus, distance to the furthermost device	l	Max. 280 m line length

Technical data (continued)

Card dimensions		Euro-card 100 x 160 mm, DIN 41494
Front plate dimensions:		
Height		3 HE (128.4 mm)
Width soldering side		1 TE (5.08 mm)
Width component side		7 TE
Admissible operating temperature range	ϑ	0 to 50 °C
Storage temperature range	ϑ	–20 to +70 °C
Weight	*m*	0.2 kg

Pin assignment of the male multipoint connector

Pin	Row z	Row b	Row d	Row f
2	n.c.	AI3+: Internal mold pressure [1]	DI1: Back pressure	DO7: Pressure
4	n.c.	AI3–: Internal mold pressure [1]	DI2: Auto	SSI clock+
6	n.c.	AI2+: Actual pressure value FB 1 [1]	DI3: Start holding pressure	SSI clock–
8	n.c.	AI2–: Actual pressure value FB 1 [1]	DI4: Injection/jog+	SSI data+; inc. Ua1
10	n.c.	AI1+: Pressure command value [1] [3]	DI5: Incremental home	SSI data–; inc. /Ua1
12	Shield	AI1–: Pressure command value [1] [3]	DI6: Post-retraction/jog-	Inc. Ua2
14	n.c.	AI4+: Actual pressure value FB 2 [1]	DI7: Analog injection	/inc. Ua2
16	n.c.	AI4–: Actual pressure value FB 2 [1]	DI8: Analog command value	Inc. Ua0
18	n.c.	AI5+: Analog cyl. position [1]	Enable	/inc. Ua0
20	System earth	AI5–: Analog cyl. position [1]	DO1: Actual velocity profile	n.c.
22	DO3: Back pressure	AI6+: Velocity command value [1]	Card OK.	n.c.
24	DO4: Injection	AI6–: Velocity command value [1]	Data+: Local bus	n.c.
26	DO5: Retraction completed	AO3: Valve output	DO2: Signal error	n.c.
28	DO6: Injection position	Analog GND	Data-: Local bus	CAN Gnd
30	UB: +24 V	–10 V	AO1: Valve output 1 [2]	CAN L
32	LO: 0 V	+10 V	AO2: Valve output 2	CAN H

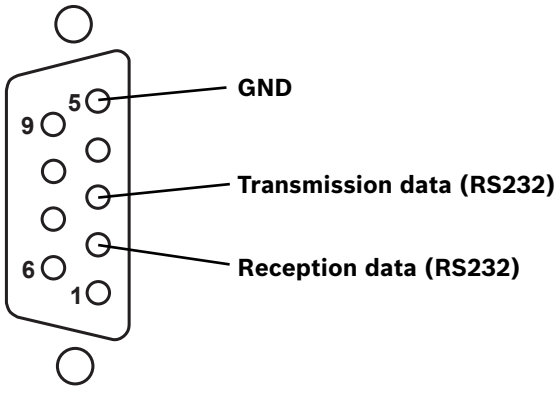
[1] By means of software, the inputs can be set to 0...10 V, ±10 V, 0...20 mA or 4...20 mA.

[2] By means of software, output AO1 can be set to 0...10 V, ±10 V or 4...20 mA.

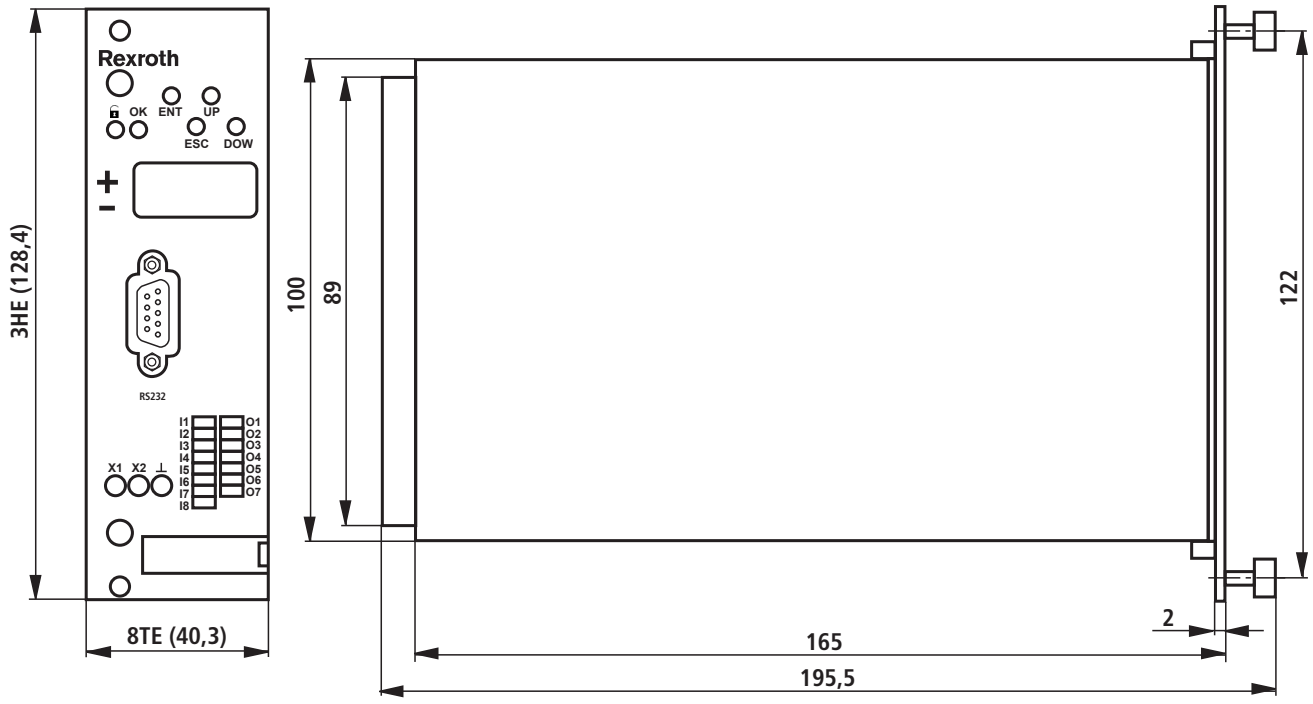
[3] This input has an input resistance of R_i > 10 MΩ

n.c. ... not used in basic version, however reserved for extensions.

Pin assignment of the D-Sub socket on the front panel



Dimensions (dimensions in mm)



Project planning / maintenance instructions / additional information

Product documentation for VT-HACD-DPQ

- 30146
  Technical data sheet (this document)
- 30146-B
  Installation and operating instructions
- 30146-01-B
  Commissioning and operating instructions
- 30146-U
  Environmental compatibility statement
- 30146-02-Z
  Commissioning instructions CANopen interface
- 30146-03-Z
  Commissioning instructions DeviceNet interface

- 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 controller card.
- Power cables must not be laid in the immediate vicinity of the controller card.
- Lines of the controller card 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 mm^2) 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.

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Notes

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