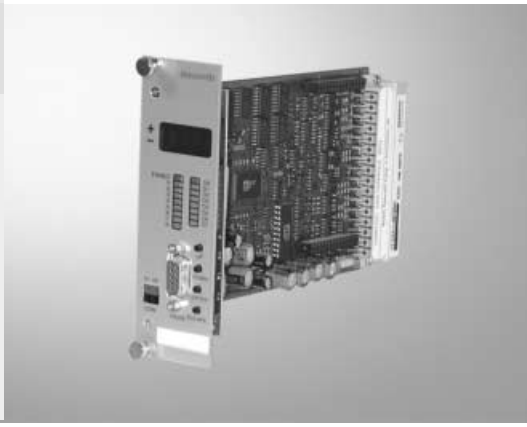
Rexroth
Bosch Group

Digital Clamp Axis Control for Hydraulic Molding Machines

RA 08 499/09.03 **1/**08
Replaces:
RA 08 499/06.03

Model VT-HACD-DPC-1X



Series 1X

Features

- Accepts digital SSI position feedback devices
- Six analog inputs predefined, voltage (±10V, 0..10V)
- Three analog outputs predefined
- Enable input and Card OK output
- Eight predefined digital inputs
- Seven predefined digital outputs
- Optimization of the hydraulic axis. Valve configuration parameters are available to adapt the output for a wide range of hydraulic valve types
- ±10V output
- Front display for parameter display and 4 pushbuttons to access various parameters
- Serial interface RS232
- DeviceNet™ communication

Available accessories:

- PC program BODAC available on CD-ROM or internet download.
- Interface cable: Cable set VT-HACD-1X/03.0/HACD-PC or standard 1:1 cable

Further information:

- Product information see RA 08 499-P
- Installation instructions see RA 08 499-B

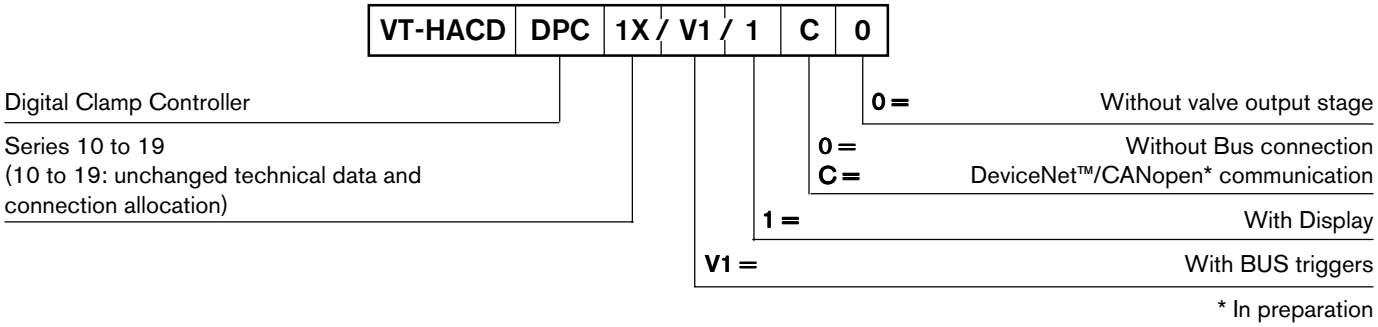
Suitable card holders:

- 19” rack VT 19101, VT 19102, VT 19103 or VT 19110 (see RE 29 768)
- Open card holder CH64G-1X (RA 29 921)

suitable for cabinet mounting only

- Connection adapter VT 10812-2x/64G (see RE 30 105)

Model code



Functional description

The DPC is a digital control card for clamp control type applications. It includes proven control techniques and advanced options for controlling the hydraulic axis. Ultimately, the control system is bound to the mechanical and hydraulic limits of the machine. The DPC is a tool for closed loop control that can define the performance limits of the machine. Results are a function of proper machine design, installation, environment and laws of physics.

Overview

The DPC is a digital platform, industrial clamp controller. It optimizes the control of a hydraulic axis for velocity and force control.

- Velocity profiles are controlled completely by use of closed loop position control. An advanced position command profile is calculated automatically based on the operator input velocity profile.
- Because the DPC is a position control device it requires a position feedback transducer. Both 0 to 10 VDC analog and SSI digital types are supported.
- The DPC uses constant acceleration type ramping to allow smooth acceleration of the clamp.
- Position dependant braking technology is used so that even the most demanding systems can be decelerated in the shortest time possible, smoothly and with superb repeatability.
- The DPC includes force-limiting control that can be configured to work with 1 or 2 pressure transducers or a load cell.
- Advanced control techniques like Active Damping allow precise closed loop control of the most demanding low-natural-frequency systems.
- The velocity profile and force profiles may be controlled with one proportional directional type hydraulic flow control valve, or using separate valves for flow and pressure.
- The DPC includes DeviceNet™ communications protocol that allows access to all parameters directly from a PLC or computer. All sequence triggers are transmitted to the DPC over a DeviceNet™ bus system.
- Motion profile set points are normally transferred into the DPC from a PLC or computer. The profile set points may also be entered into the card using Bosch Rexroth BODAC software.
- Critical process data is acquired and stored during each cycle. The stored data is available for machine controller statistical process control functions through the DeviceNet™ communications link.

Operational description

The DPC controller is a complete hydraulic clamp axis control solution. A clamp motion profile is created from parameters that are entered by the machine operator into a machine sequential logic controller. Parameters are loaded from the machine sequential logic controller into the card through a DeviceNet™ communications interface. All clamp cylinder motion parameters are then stored on the card. Parameter changes may be individually loaded into the card, or the entire profile loaded at one time. The card maintains the last saved profile in non-volatile flash memory. A single clamp motion profile is stored on the card. Multiple profiles may be stored in the machine sequential logic controller and any one selected to load into the card. Handshaking to sequence the axis control is through the DeviceNet™ communications interface. A single discrete input is required to enable the card prior to any other commands, and three additional discrete inputs may be combined for additional safety functions.

The DPC controller includes the following control features and functionality.

Completely Closed Loop Control

All segments of the motion profile are controlled by implementation of closed loop position control of the clamp cylinder. Active damping technology allows stable and smooth closed loop control of even springy, low natural frequency systems. At the start of clamp motion the internal position command is set equal to the current cylinder position feedback and then ramped toward the next segment's start position. The rate of movement of the position command corresponds to the velocity command in the current profile segment. Each step in the profile is initiated when the internal position command reaches a segment start position as defined in the profile. Repeatability of the profile is insured because the internal position command is moved at a rate controlled by the internal DPC clock, and the cylinder follows the command profile. This type of system is used because it is relatively unaffected by changes in friction, oil temperature, and, other system variables. Smooth acceleration of the clamp to the selected traverse velocity is controlled by a constant acceleration ramp. Deceleration of the clamp to slow velocity is controlled by use of position dependant braking technique that assures fast, smooth, and repeatable slowdown.

Functional description (continued)

Mold Close Profile

A two-segment profile is provided to close the mold; the traverse segment and the mold protect segment. A maximum closed or open loop pressure limit may be set for each profile segment. A timer (start close delay) is available to delay the start of the mold close profile and allow the hydraulic pump system time to build pressure, which prevents undesirable initial windup of the closed loop control. There is a discrete output available to indicate when mold touch position is achieved.

The profile may optionally be adjusted to stop the clamp during the mold protect segment (before mold touch) using the pre close stop position. Two additional final close velocity segments are available to then complete the closing profile. Final close is triggered independently of the closing profile.

Tonnage Pressure Profile

A two-segment profile is provided for mold closed pressure control, the tonnage segment and the low-hold segment. The tonnage segment is started automatically when the tonnage start position is reached during the mold close or final close profile. Tonnage pressure control may be closed or open loop. For toggle clamp applications there is a discrete output available to indicate when tonnage position is achieved. The flow valve output may be limited to separate open loop values during the tonnage and low-hold pressure control segments.

Decompress

Prior to opening the mold the clamp cylinder(s) must be decompressed to prevent hydraulic shock. A decompress segment is provided with an adjustable pressure set point and decompress rate control. A discrete output is provided to indicate when the pressure has decreased below the decompress set point. The decompress complete discrete output is a permissive that is required to allow the clamp to begin the mold open profile or the jog open function.

Mold Open Profile

A three-segment profile is provided to open the mold; the breakaway segment, the traverse segment and the open slow segment. A maximum open loop pressure limit may be set for each profile segment when using a separate pressure control valve. A timer (start open delay) is available to delay the start of the mold open profile and allow the hydraulic pump system time to build pressure, which prevents undesirable initial windup of the closed loop control.

Jog Functions

In addition to the closed loop profile control there are two open loop jog modes, open and close. The valve outputs may be preset to an independent value for each jog mode. There are separate increasing and decreasing ramp adjustments for each output in jog mode. Typical applications of these modes are for manual operation of the clamp (setup function). The machine sequential logic controller triggers each jog mode through the DeviceNet™ interface.

Applications

The DPC is configured to control clamp type applications and all parameters are labeled to be recognizable in clamp applications. There is, however, many other applications that could benefit from the quality of control afforded by the DPC.

Typical applications include:

- Mechanical handling devices
- Lift and Transfer machines
- Powder metal presses
- Angular position for rotary axis
- Shuttle and Transport axis

Configuration Options

The card can be applied in one of two basic configurations depending on the hydraulic system.

1. Closed loop velocity profile and closed loop pressure control using one proportional directional valve and one analog valve output. This type of system will control the clamp velocity profile and closing pressure limit using one proportional directional control valve. The available dynamic response using this type of system is higher than systems that use separate valves for flow and pressure control. Mold protect pressure typically can be a lower value using a single control valve system.

2. Closed loop velocity profile and either closed loop or open loop pressure control using one proportional directional or flow control valve for the velocity profile and one proportional pressure control valve for the pressure control. There are two analog valve outputs available for this configuration. This configuration does not require as high dynamic response from the proportional directional control valve as the single valve configuration. Mold protect pressure control will not be as dynamic due to limitations of separating flow and pressure functions into multiple valves, and inherent dynamic limitations of proportional pressure control valves.

Alternatively, the DPC may be configured so that the second valve output is controlled directly by the machine logic controller instead of the internal pressure profile

Front panel operation

The front display is used in conjunction with the 4 push buttons to display and change operator parameters.

Access is given to the following operator parameters:

- Mold close profile
- Tonnage pressure profile
- Decompress
- Mold open profile

For safety reasons, set-up and configuration parameters are not accessible through the front panel.

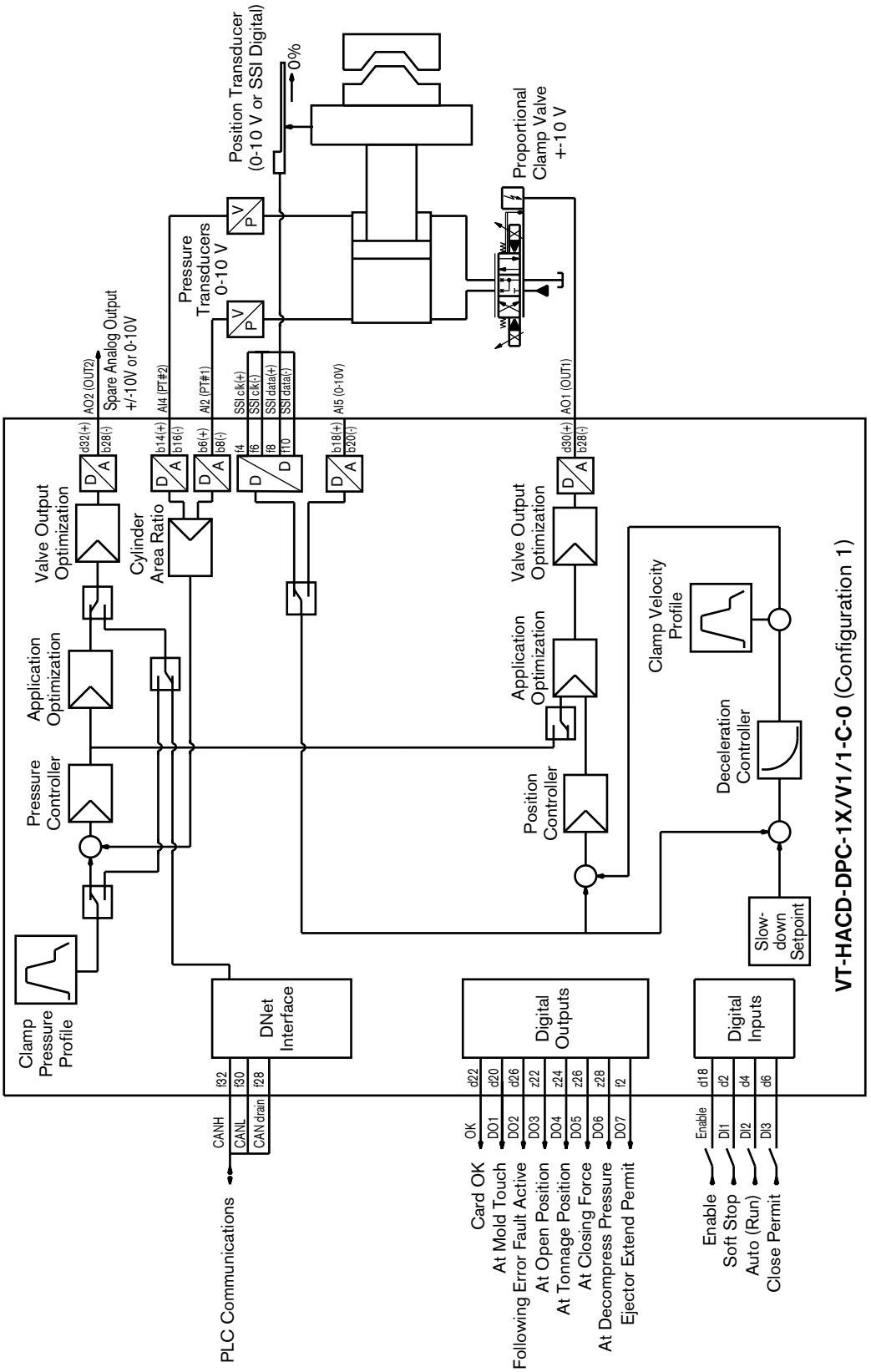
Fault messages will be displayed if they occur.

PC program BODAC

The PC program BODAC makes it possible to configure, parameterize and perform diagnostic functions on the VT-HACD-DPC-1X via a serial interface (RS232).

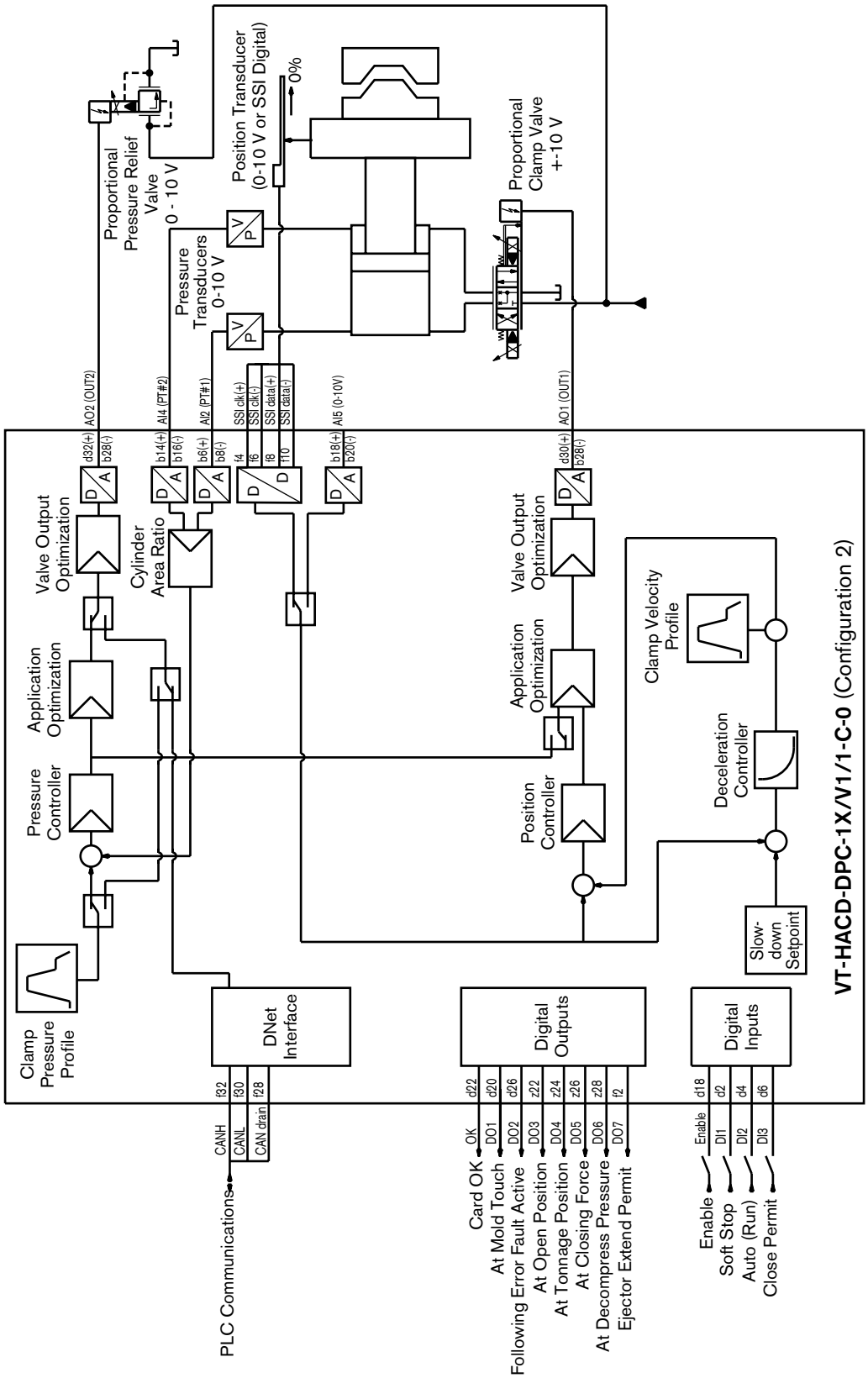
CD ordering code: SYS-HACD-BODAC-01 or download via the internet, address www.boschrexroth.com(Navigation: Industrial Hydraulics -> Products and Solutions -> Product Overview -> Digital open and closed loop controls -> HACD -> PC program BODAC

Block circuit diagram: VT-HACD-DPC-1X (Configuration 1)



Typical clamp circuit using one proportional control valve for velocity and pressure control and the PLC to control output AO2 (Out2) directly for additional functions if required.

Block circuit diagram: VT-HACD-DPC-1X (Configuration 2)



Typical clamp circuit using two proportional control valves, one for direction and velocity control and the second for clamp pressure control.

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

Operating voltage	U_B	24 VDC
Functional range:		
– Upper limiting value	$U_B(t)_{max}$	35 V
– Lower limiting value	$U_B(t)min$	21 V
Current consumption	I_{max}	150 mA
Fuse	I_s	4 AT
Digital inputs Voltage	*Log 0(low)*	0 to 5V
	Log 1 (high)	15V to U_B
Digital outputs Voltage	*Log 0(low)*	0 to 5V
	Log 1 (high)	15V to U_B
		I_{max} = 30 mA
Analog inputs		
Range	U	0 to 10V or ± 10V (configurable)
Input resistance	R_e	200 kΩ, > 10MΩ for AI1
Resolution		5 mV for range ± 10V
		2.5 mV for ranges 0…10V
Non linearity		< 10mV
Analog outputs		
AO1		
Output voltage	U	± 10V
Output current	I_{max}	20 mA
Load	R_{min}	500 Ω
Resolution		1.25 mV (14bit)
Residual ripple		± 15 mV (without noise)
AO2		
Output voltage	U	± 10V
Output current	I_{max}	10 mA
Load	R_{min}	1 kΩ
Resolution		10 mV (11bit)
Residual ripple		± 25 mV (without noise)
Sampling interval	T	2 ms
Serial interface		RS232 (front plate), D-sub socket
Connection type		64 pin blade connector, DIN 41 612, form G
Card dimensions		Eurocard 100 x 160 mm, DIN 41 494
Front plate dimensions		
– Height		3 U (128.4 mm)
– Width soldering side		1 HP (5.08 mm)
– Width component side		7 HP
Permissible operating temperature range	ϑ	0 to 122 °F (0 to 50 °C)
Storage temperature range	ϑ	4 to 158 °F (–20 to +70 °C)
Weight	m	0.2 kg

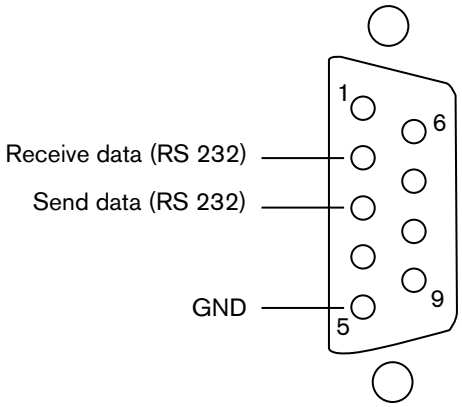
Note: For details regarding the **environmental simulation test** covering EMC (electro-magnetic compatibility), climate and mechanical loading see RE 30 143-U(declaration regarding environmental compatibility)

Connection diagram connector

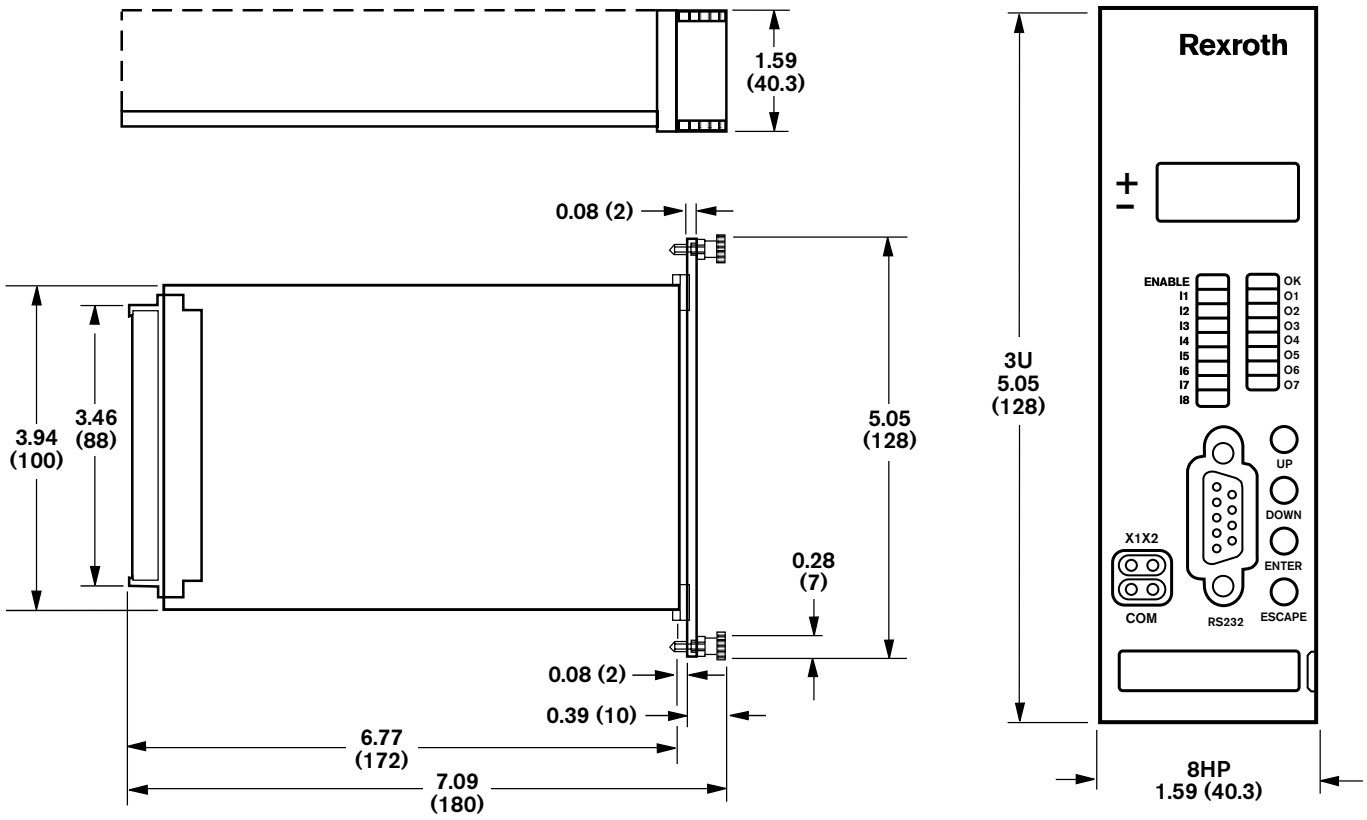
Pin	Row z	Row b	Row d	Row f
2	n.c.	AI3+: (Spare)	DI1: Soft Stop	DO7: Ejector Extend Permit
4	n.c.	AI3-: (Spare)	DI2: Auto (RUN)	SSI clock +: Clamp cylinder FB
6	n.c.	AI2+: Pressure FB#1	DI3: Close Permit	SSI clock -: Clamp cylinder FB
8	n.c.	AI2-: Pressure FB#1	DI4: (Spare)	SSI data +: Clamp cylinder FB
10	Shield	AI1+: Valve#1 spool position[1)]	DI5: (Spare)	SSI data -: Clamp cylinder FB
12	n.c.	AI1-: Valve#1 spool position	DI6: (Spare)	AI8+: Jumper to AO3 (Velocity Close)
14	n.c.	AI4+: Pressure FB#2	DI7: (Spare)	AI8-: Jumper to Analog GND
16	n.c.	AI4-: Pressure FB#2	n.c.	n.c.
18	n.c.	AI5+: Clamp cyl. FB (optional)	Enable (optional)	n.c.
20	n.c.	AI5-: Clamp cyl. FB (optional)	DO1: At Mold Touch (optional)	n.c.
22	DO3: At Open Position	AI6+: Jumper to AO3	Card OK (Velocity Close)	n.c.
24	DO4: At Tonnage Position	AI6-: Jumper to Analog GND	n.c.	n.c.
26	DO5: At Closing Force	AO3: Traverse Velocity	DO2: Following Error Fault Command Active	n.c.
28	DO6: At Decompress Pressure	Analog GND	n.c.	CAN drain
30	U_B: +24V	– 10 V	AO1: Valve CMD Single or Velocity	CANL
32	L0: 0V	+ 10 V	AO2: Valve CMD Clamp Pressure	CANH

[1)] This input has an input resistance of R_e > 10 MΩ (For monitoring purposes only)
n.c. … is not connected

Connection diagram of the D-sub socket on the front plate



Unit dimensions: dimensions in inches (millimeters)



Engineering / maintenance guidelines / additional functions

- Use low-capacitance cables. Make cable connections without intermediate connections whenever possible.
- Control electronics should be isolated from electromagnetic noise sources (e.g. Variable frequency drives).
- Power wiring should not be routed in the vicinity of control electronics.
- Power wiring should not be routed in the vicinity of control wiring or cables.
- Route sensor lines separately.
- Maintain a distance of at least 1 meter from antenna lines, RF devices and radio equipment.
- When using differential inputs switch both inputs on and off at the same time.
- When switching signal inputs, use dry circuit rated relays with gold-plated contacts (low voltages, low currents)
- Always shield all analog signal lines. Connect shields at the card end only, connecting to the “Shield” terminal, and leave the other end open to prevent ground loops.
- Connect to an appropriate system ground using stranded copper wire (min 2.5mm2 / 12 AWG)!
The system ground is an essential component of the EMC protection for the controller card. The ground provides a path for noise that could otherwise enter the controller card through the signal and power supply lines. Noise is bypassed only if the system ground does not couple noise into the controller card. Rexroth also recommends shielding solenoid wiring.
- Do not use logical signals from the controller card (e.g. “OK” signal) for switching machine safety circuits
(see European Norm “Safety Requirements for Fluid Power Systems and Components” EN982:1996).

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