MANNESMANN REXROTH

Digital Amplifier for Position and Pressure/Force Control Model DPR, Series 1X

RA 29 894/06.98

Replaces: 04.97

- Achievable position accuracy of ±0.05% with analog feedback*
- Achievable steady state, pressure accuracy of ±0.1%*
  * (typical, but not guaranteed)
- High resolution analog input for 10 VDC position transducer
- Fine Positioning integration for superior accuracy
- Active Damping for low natural frequency cylinders
- Gain matching for differential area cylinders
- Pressure limiting
- Accepts 2 pressure transducers or load cell as force feedback
- Digital platform
- Programmed by pushbuttons and front display
- RS485 communication
- Password protection available
- 24 VDC power
- Optimizes hydraulic axis for closed loop control
- Configurable for any valve family
- Proportional valve with closed center spool is normally preferred

DPR.tiff

Digital Amplifier Card, Model DPR

Ordering code

DPR	–1X	(valve type)

Digital Amplifier for Position and Pressure Regulation

Series
(10 to 19 externally interchangeable)

Valve Type (partial list)
Specify valve to series number or abbreviate as follows:

4WRAB6 E12 - 1X	or	WRAB6-E
4WRA6 E20 - 1X	or	WRA6-E
4WRA6 E30 - 2X	or	WRA6-E-2X
4WRA10 E40 - 1X	or	WRA10-E
4WRD10 E100L - 5X**	or	WRD10-E-5X
4WRE6 E32 - 1X	or	WRE6-E
4WRE10 E64 - 1X	or	WRE10-E
4WRSE10 E80 - 3X	or	WRSE-E
4WRTE10 E100L - 3X**	or	WRTE-E
4WRZ10 E85 - 3X	or	WRZ-E
4WS2EM6 - 1X/..E	or	WS2EM6-E
4WS2EM10 - 1X/..D	or	WS2EM10-D

**Linear L-flow type recommended.

Example: DPR -1X/ 4WRE10-E32/1X or DPR - 1X/ WRE10-E

Ordering information

Every DPR card includes a valve amplifier or driver board. From the valve model, Rexroth determines which driver board to install and how to configure the valve parameters. The valve model can be abbreviated. In most cases, it is best to always include the valve type, valve size, spool type and design series.

Technical data

Power supply voltage:	V_{DC}	21 V to 35 V
Power requirement: (depends on valve)	P	10 to 60 W
Input control signal:	V_{IN}	0 to 10 V (±10 V)
Input impedances:		
Analog Voltages	R_{IN}	200 kΩ or higher
Discrete (10–35 V) inputs	R_D	1 kΩ or higher
Internal reference voltage:	V_{REF}	±10 V
Minimum load on ±10 V: from card ±10 V @ ±25 mA	R_L	400 Ω
Fuse (5 mm x 20 mm):		3 A
Connector type: (DIN 41612, type C)		32-pin, rows “a” and “c”
Card dimension: (DIN 41494)		Euro card 100 mm x 160 mm
Space requirements:		
Height	3U	5.05 in. (128 mm)
Conductor side		1 division 0.20" (5.08 mm)
Component side		7 divisions
Face plate	8HP	8 divisions
Ambient temperature range:	T	32 to 122 °F (0 to 50 °C)
Storage temperature:		–4 to 158 °F (–20 to 70 °C)
Weight (approx.):	W	0.6 lb (0.27 kg)

Description

The Rexroth DPR digital amplifier optimizes the hydraulic axis for analog position, pressure or force control. All analog inputs are 10 VDC. All card settings can be accessed with the onboard pushbuttons and a digital display. The valve amplifier or driver board is included and optimized by Rexroth.

Configuration for the application and commissioning are the responsibility of the user. This includes the correct mechanical, hydraulic and electrical installation.

While the DPR contains advanced control options that can deliver impressive performance, it can only work within the limits of the given system. Note that proportional valves with closed center spools are normally preferred, except when only using Force Regulation. Consult Rexroth for further analysis to determine the best valve and system configuration for the desired performance.

Applications - Selections for the application are made in the Setup menu. Some common examples include:

- Direct drive, only (no feedback)
- Position regulation, only (analog position feedback, 10 VDC)
- Pressure regulation, only (1 pressure transducer, 10 VDC)
- Force regulation, only (2 pressure transducers or 1 load cell)
- CNC drive, only (feedback to CNC)
- Direct drive or Position regulation or CNC drive
  - with pressure limiting, either side
  - with pressure limiting, both sides; or force limiting
  - with clamp control on +side only
  - with clamp on +side, pressure limiting on –side

Direct Drive does not use position feedback. This is an open loop velocity control. It can also be combined with pressure control functions. New cards are normally configured as Direct Drive, only.

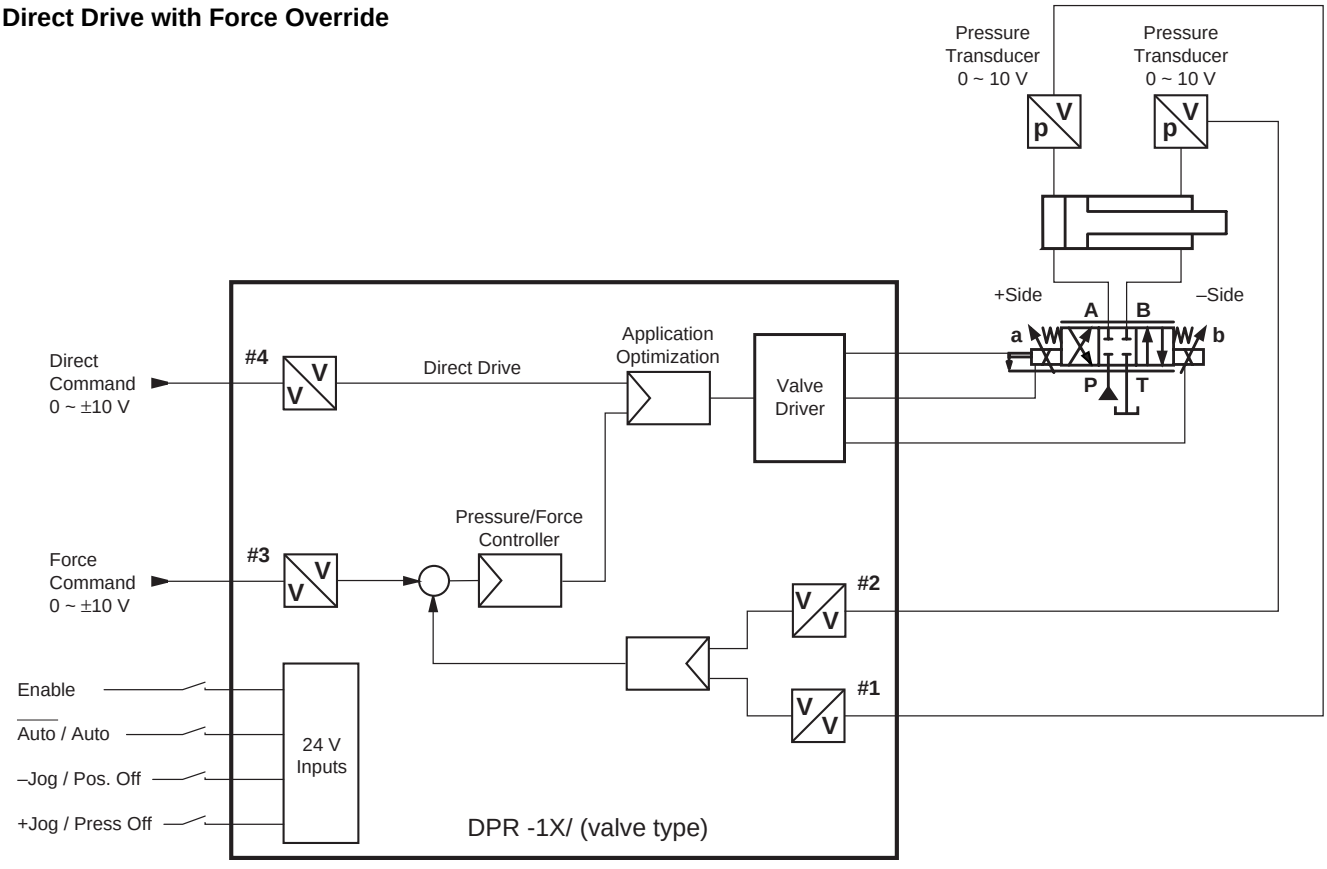
Position Control requires 10 V feedback. Position control may be used alone or with pressure control functions. The transition between position and pressure control is shock free, depending on the valve and system. For example, if a low dynamic valve like 4WRZ is wide open, some pressure overshoot is expected when the cylinder suddenly stops. The position controller can also be externally disabled by a discrete input. This override is immediate. It does not permanently alter the internal configuration.

Position applications can also include a velocity limit. The maximum velocity is limited by a ramp which changes the position command over time $\Delta v = \Delta x/\Delta t$. However, acceleration and deceleration are still determined by the closed loop system. Velocity is not regulated.

Note that true synchronizing is not possible within the DPR. External control would be required to monitor feedbacks and correct the relative position command for each axis.

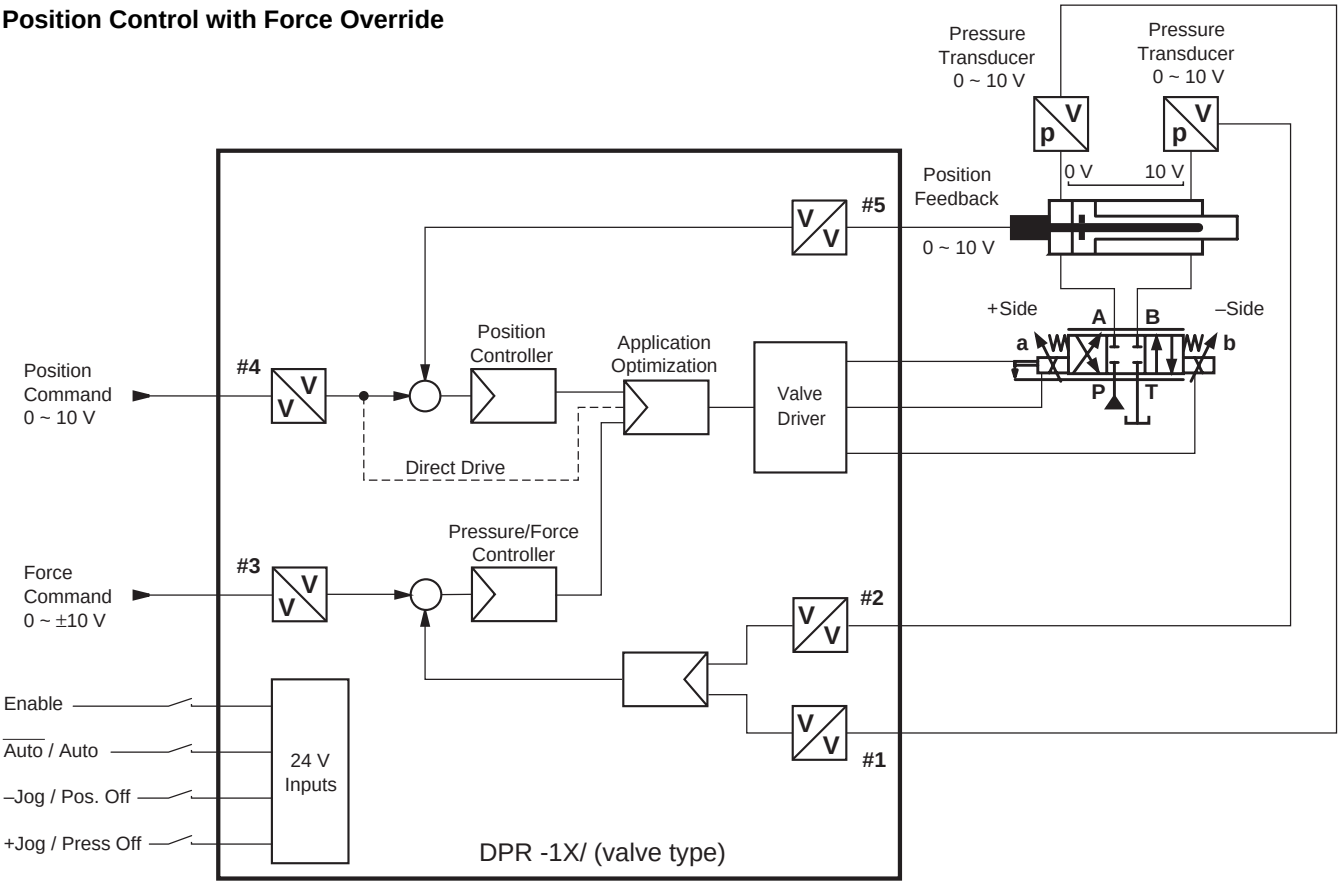
CNC Drive is a special DPR configuration for interfacing to a motion controller or computer numerical controller. The DPR optimizes the hydraulic axis and drives the valve. The CNC or controller accepts the axis feedback. For high accuracy, digital feedback is required. A typical hydraulic axis uses a Rexroth cylinder with an integral absolute SSD (serial synchronous data) feedback and a CLM 4-axis or 2-axis controller. Other controllers should use a simple position gain or Proportional gain for regulation. The CNC error of ±10 V connects to Input #5. The DPR compensates for valve symmetry, throttle characteristics and spool overlap. It also provides gain matching for differential area cylinders.

Direct Drive with Force Override

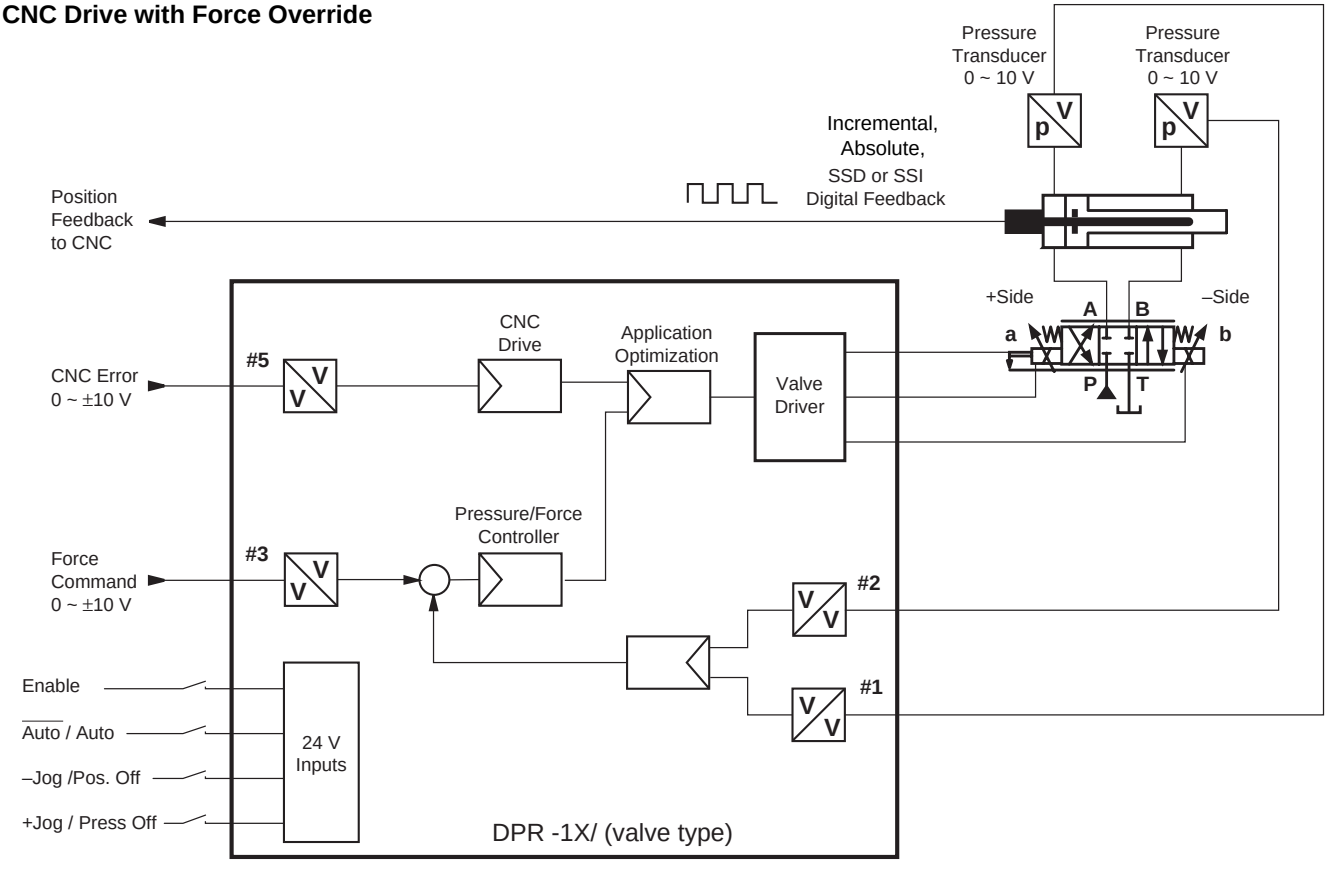


Description

Position Control with Force Override



CNC Drive with Force Override



Description

The DPR can include both passive and active damping. It also uses Fine Positioning for superior accuracy. Of course, CNC Drive can also be combined with DPR pressure control functions. Note that the CNC must accept the greater following error of a typical hydraulic axis, especially while pressure is being limited. Refer to the DPR Setup Instructions regarding, moving J3 to the "A" position.

Pressure regulation is essentially the same as pressure limiting. It may be used alone or combined with Direct Drive, Position Control or CNC Drive. If pressure must be limited on both sides of a cylinder, a shuttle valve may be used with a single pressure transducer. The DPR can also accept two pressure transducers.

Clamp Control is a form of pressure control suitable for some clamping applications. Clamp control is only available on the +side. The only difference between Clamp Control and Pressure Limiting is that the valve spool is not allowed to shift over-center, while commanded to move in this +direction. Maximum pressure relief protection for the +side of the cylinder may be advisable. The load induced pressure could exceed the commanded pressure limit! Normal pressure limiting is still available for the –side. One example of Clamp Control is for an injection molding machine where the clamp must not open during injection. This could occur if a sufficient external force acted against the clamp direction. Clamp Control limits pressure on the +side while moving or clamped. To prevent the mold pressure from opening the mold, this spool can not shift through center. The position command must remain greater than the actual clamp position, to stay in this pressure mode.

An internal preset for pressure command is available when a fixed pressure settings is desired. Each side or direction has a separate preset for this command. These presets can eliminate the need for the analog connection to input #3 when the DPR is also used for Direct Drive, Position Control or CNC Drive. The preset goes through the pressure ramp function to control the rate of change when enabled or disabled by the corresponding discrete input.

The Counterbalance parameter provides a fixed offset to pressure. Unlike the presets, this is located after the pressure ramp. This parameter is similar to using a counterbalance valve. Note that the DPR can not hold this offset under all conditions, as during a power failure. This may not be a problem for all applications or when using directional proportional valves with closed center spools. The situation may be quite different when using a servo valve or proportional pressure relief valve.

The pressure or force controller can be externally disabled by a discrete input. Like the position control option, the override is immediate. For example, you may want to disable the pressure limit for a short time to assure maximum acceleration, then release the override before approaching the final position with the pressure limit operating.

Force regulation requires a load cell, two pressure transducers or a differential pressure transducer. When selecting this menu option, it is not necessary to configure Force Limiter options in the Setup menu. The DPR will automatically be set to external analog controller for both sides. Input #1 is normally used as the ±10V Force feedback input.

Ramps - The +Ramp and –Ramp limits acceleration and deceleration in Direct Drive. Acceleration is the same in both directions. Deceleration is independently adjusted. These ramp times range from 0 to 100 seconds. The +/–Ramp function can be used for Position Control. In this mode, the traverse velocity is limited by changing position over time. The +Ramp works as the +Velocity parameter. The –Ramp works as the –Velocity parameter. No ramp is used with the CNC Error input. The Pressurization Ramp and Decompression Ramp are available for pressure and force commands. The range of these ramp times is 0 to 30 seconds. The Jog Ramp limits acceleration and deceleration when moving with Jog commands. The Jog ramp is the same for both directions. Jog Ramp has a range from 0 to 30 seconds.

Fine Positioning - This can greatly improve position accuracy. Without this advanced option, accuracy is a direct function of the optimized Proportional gain alone. Additional Proportional gain can cause over-shoot. With Fine Positioning enabled, a switching integrator reduces the position error without requiring increased Proportional gain. An overlapped spool is preferred for this option. For greatest accuracy, proper shielding, grounding and wiring practices must be observed.

Active Damping - This is an advanced feature that can improve position accuracy. The active compensation can allow higher Proportional gain for greater performance. Active Damping requires two pressure transducers or a load cell, even if force or pressure control is not desired. Cylinders with low natural frequencies that use high response valves normally benefit the most from active damping.

Valves - Typical proportional valves include: 4WRAB, 4WRA, 4WRE, 4WRSE, 4WRD, 4WRKE, 4WRTE, 4WRZ. For position control with DPR, use the proportional valve with an E-spool or positive overlap for best results! This includes position applications with force regulation, CNC applications with pressure limiting, and direct drive with pressure limiting. For pressure or force regulation only, use a zero or underlap spool design, like the V-spool. A more dynamic proportional valve is preferred when pressure or force control is involved. Although servos can be used in any case, they may only be required for very small flows or special applications. The DPR could be used with proportional relief valves in some pressure applications.

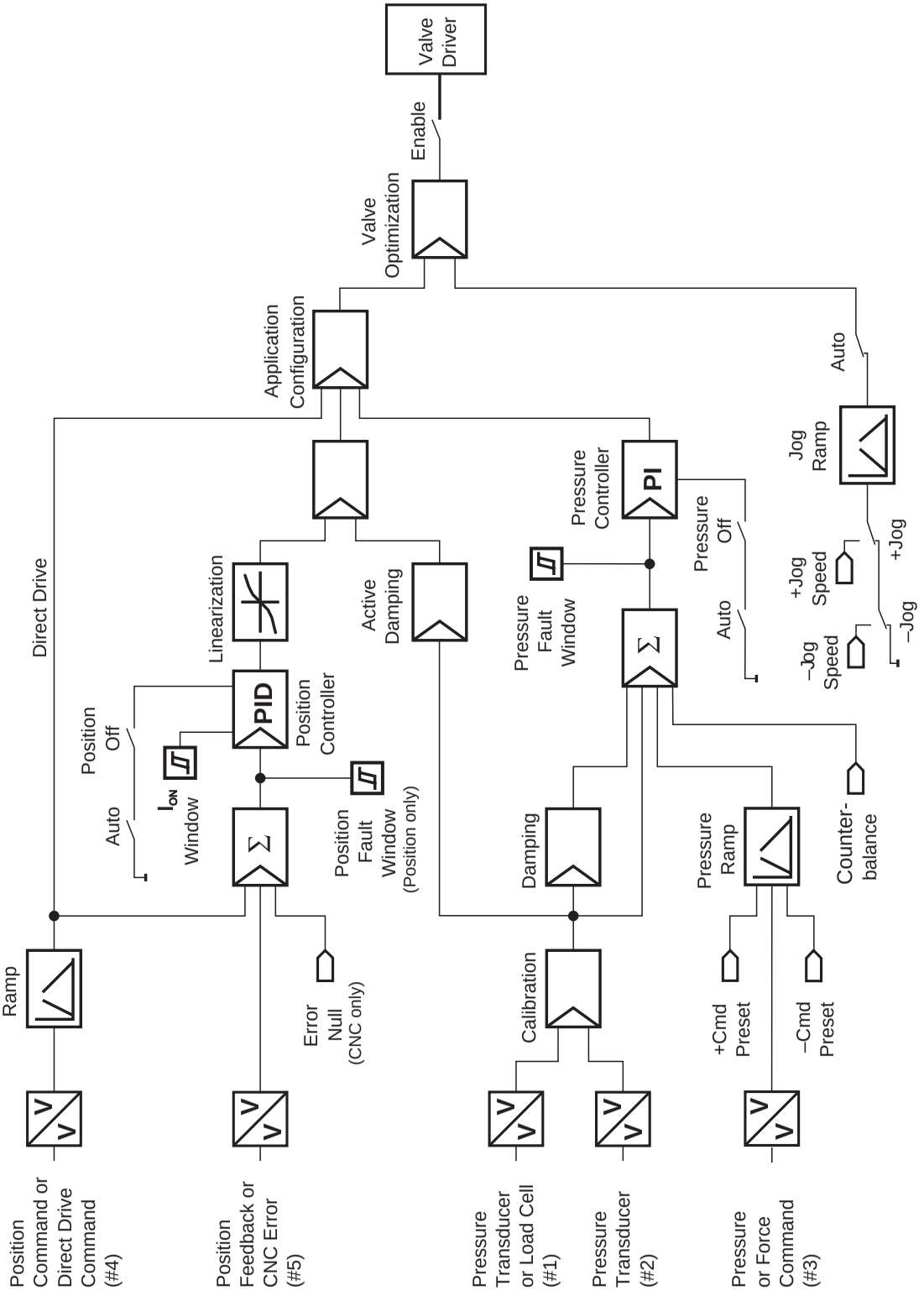
Position Feedback - The position transducer should be 0 to 10 VDC. The DPR has excitation voltage for potentiometer feedback. Most single rod cylinders for position control are fitted with a magnostrictive feedback device. This has many advantages and normally works well. Special considerations may be required for critical applications where high acceleration or sudden temperature changes are expected.

Pressure Feedback - Pressure transducers should be 0 to 10 VDC. A 0 to 5 VDC transducer can be used, but resolution is reduced. There are two pressure transducer inputs. The unused transducer input can be disabled. For pressure regulation only, select "Force Only" under the menu for application and enable the desired feedback input. For Direct Drive, Position Control or CNC Drive with Pressure control, first select "Direct Drive", "Position Ctrl" or "CNC Drive" then enable the desired transducer input.

Force Feedback - Most force control applications will use two pressure transducers that output 0 to 10 VDC. The DPR sets the pressure ratio for Inputs #1/#2, to accommodate differential cylinders. Load cells should be 0 to ±10 VDC.

Analog Inputs - All analog inputs are bipolar, 0 to ±10 VDC differential type. The position feedback is a special high resolution design. For greater accuracy with 0 to 10 VDC devices, force inputs #1 and #2, and position inputs #4 and #5, can be re-configured as uni-polar. Refer to DPR Setup Instructions regarding jumpers J5, J6, J7, J8.

DPR functional diagram



Description

Before connecting the PLC analog or external analog source to the DPR differential inputs, determine if the analog common is isolated. An isolated or floating analog common should be grounded at one point. It is recommended to connect an isolated analog common to 0 VDC or to the ground bus, at one point.

Discrete Inputs - These are 24 V (10 to 35 V) inputs.

ENABLE input (pin-22a) must be selected or high to allow motion from analog inputs. In most installations, this is activated by a PLC permissive. After a DPR fault is cleared, the ENABLE input will reset the card.

AUTO (pin-24a) is energized for normal operation and is de-energized to allow jog functions.

–JOG inputs (pin-26a) and +JOG (pin-28a) move the valve with the corresponding internal jog speeds. The AUTO input must be off to allow jog.

These same inputs (pin-26a and pin-28a) have another function after the AUTO input has been selected. Input pin-26a or "Pos. Off", disables the Position Controller, if AUTO is selected. Input pin-28a or "Press Off", disables the Pressure Controller, if AUTO is selected.

When AUTO is "off",
Input (pin-26a) is energized for -JOG
Input (pin-28a) is energized for +JOG

When AUTO is "on",
Input (pin-26a) is energized to disable Position Control
Input (pin-28a) is energized to disable Pressure Control

Both pin 26a and pin 28a are energized to allow external manual control on Input #4 (Version ≥1.04.) Does not affect CNC drive. Force limiting is disabled.

DPR Menu

Pushbuttons on the front of the DPR select menu items or adjust values. Text can continuously scroll across the 4 digit display. Parameter values include the decimal point, as needed. When negative values are displayed, the minus sign toggles with the number. Display values that are positive will not toggle with the plus sign. Units, like [%], [V], [mV] and [sec] are listed behind the parameter name. The display automatically adjusts for range. In some cases, the voltage range below 1 volt will be displayed as 0 to 999 mV. Over 1 volt the range changes to 1.00 to 10.0 V, which includes the decimal point.

UP	Increases displayed value, next option at this level
DOWN	Decreases displayed value, previous option at this level
ENTER	Accept this value or option, move into this parameter
ESC	Cancel any change, exit to previous level in menu

Note that some "force" terms in the DPR menu may represent pressure, and vice versa, depending on the specific application. If a pressure transducer was replaced by a current transducer sensing the electric motor, the "force" terms would represent power.

Parameters that optimize the application are grouped under the Main menu. Press ENTER to see this menu. Some parameters will not appear, depending on the software configuration. Configuration and calibration parameters are hidden under the Setup menu. To call the Setup menu, press both ENTER and ESC for 5 seconds. Then press ENTER to access these options. Password protection is available.

When power is applied, the display shows the configuration: **Rexroth DPR**, firmware version, valve type, driver board required. Then a default display value can appear, like **Valve Command [%].** Units are indicated with the option name. The display eventually returns to the default value, unless the buttons are touched. Access the "Display.." option under the main menu. The default can be changed to other options like: Valve Feedback [%], Direct Command [V], CNC Error [mV or V], Position Command [V], Position Feedback [V], Position Error [mV or V], Force Command [V], Force Feedback [%], Force Error [%], Transducer #1 [V], Transducer #2 [V]. Only the available options for the application will appear. The DPR can also continuously scroll the text during startup by selecting "Configuration". After an idle time, the display may dim. Press any key to restore the display to full brightness. This feature can be disabled.

Faults - When a fault is detected, the valve driver is disabled. FAIL will flash on the display until ENTER is pressed. The detected fault is continuously scrolled across the display in clear text, until ENTER is pressed again. Cycle power or lower the ENABLE input to reset the DPR, after clearing a fault. Some faults are related to the application and user settings, like Position Fault or Pressure Fault. Other faults are related to the valve, like Solenoid Fault, Driver LVDT or Driver Loop. The DPR verifies internal calibration and EEPROM memory during power up. It also continuously monitors the internal reference voltages.

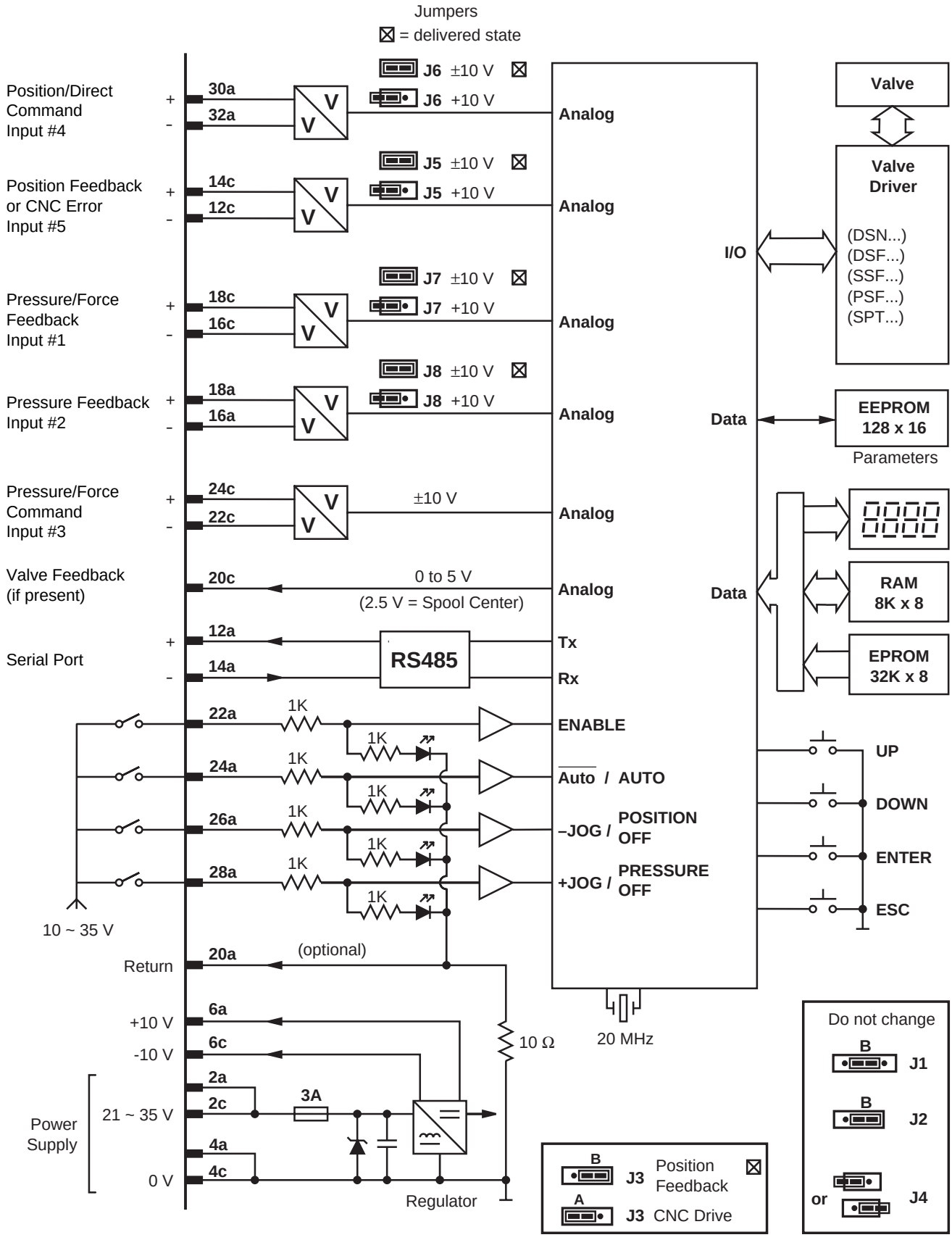
Communications - An RS485 serial port is available for programming and diagnostics. RS485 allows multiple DPR cards to communicate to a host computer, over a single twisted pair cable. The Rexroth DPR host program runs on a personal computer or PC. The DPR host program will automatically detect the baud rate and find all available DPR stations. Baud rates of 9600, 19200 and 38400 are supported. An RS232 to RS485 converter for COM1 or COM2 is normally required. A serial converter can be ordered separately, Rexroth COM485 Kit (US00 888 281).

The PC interface is optional since the DPR can be commissioned exclusively by using the front display and pushbuttons.

Valve Code - All valve parameters are set by Rexroth. The more common valve settings will be assigned a specific 3-digit code number and stored in the DPR memory. The valve Code is a simple menu option that loads parameters for a valve. More than one code may exist for the same valve. As new designs are introduced, this table will expand without affecting codes for existing products. After power is applied, the display includes the abbreviated valve model and driver board that should be associated with these settings. The Valve Code should also appear on a label on the front panel.

All valve parameters are available under "Custom.. " in the Setup menu. If the default valve settings are changed, the original valve code will end with a "C". After power is applied, the display will show "Custom" instead of a valve model. If the DPR had a "C" when delivered, the original valve Code and custom values are noted on the Certificate of Conformance. Restore the default parameters by setting the desired Code number and removing the "C" with the UP or DOWN push-button. Then press ENTER.

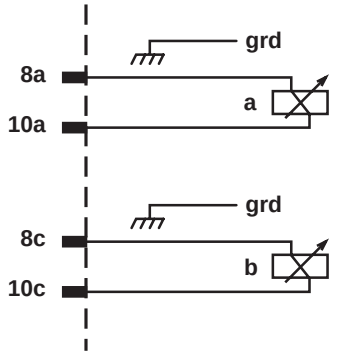
DPR Inputs



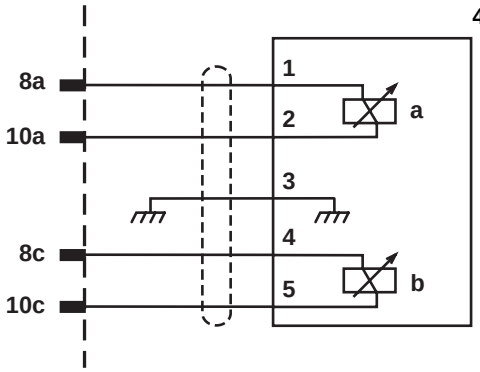
See next page for valve connections.

Valve connections to DPR

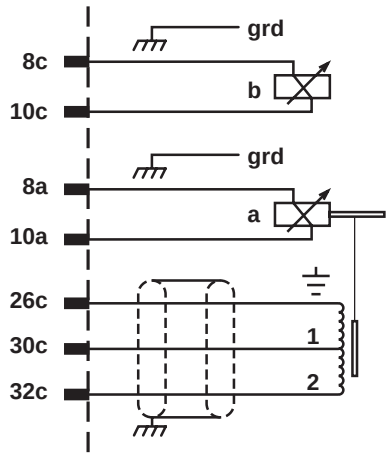
4WRA
4WRAB
4WRZ



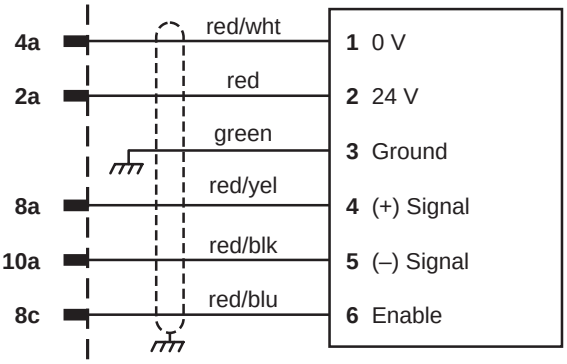
4WRAB…DK25



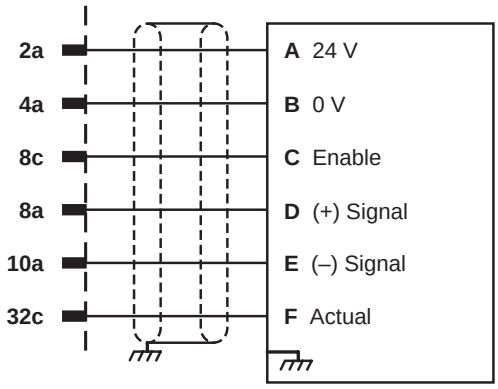
4WRE



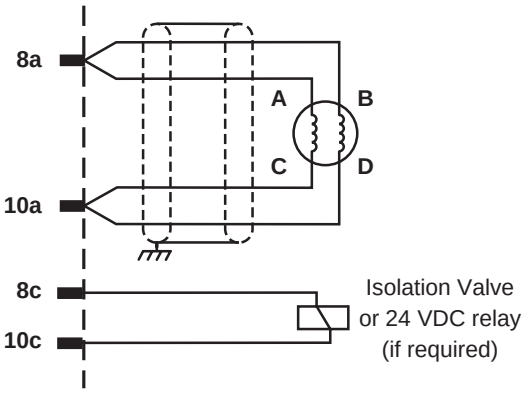
4WRAEB



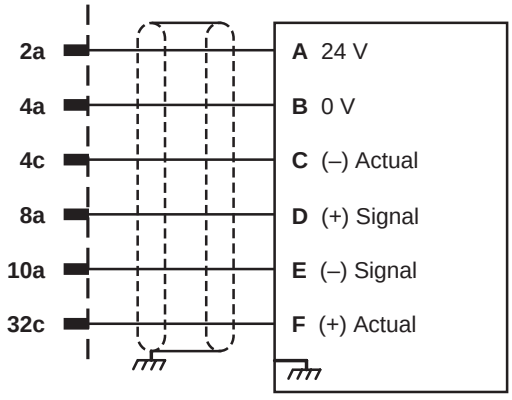
4WRTE



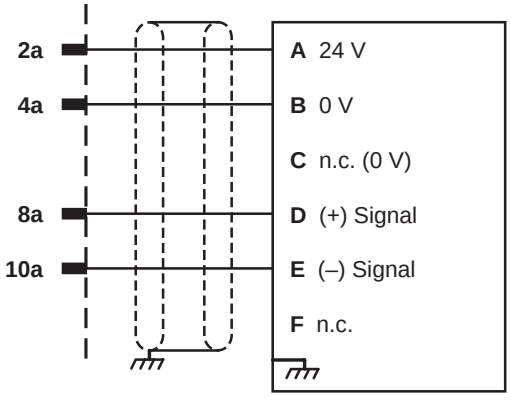
4WS2EM



4WREE
4WRSE



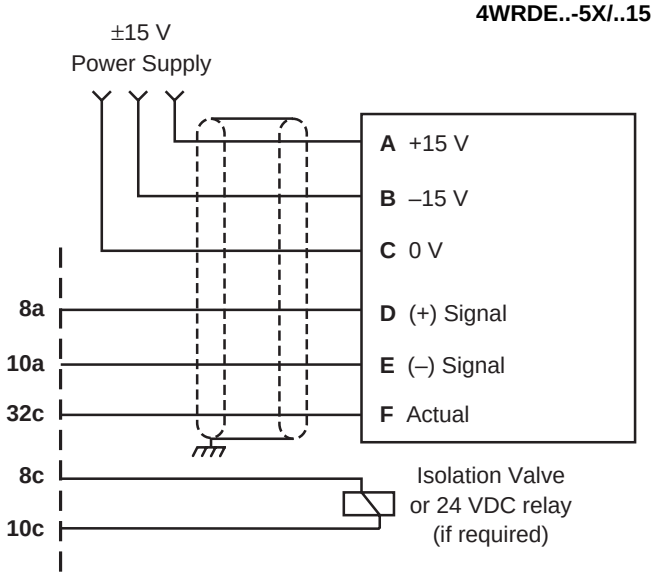
4WRAE
4WRZE



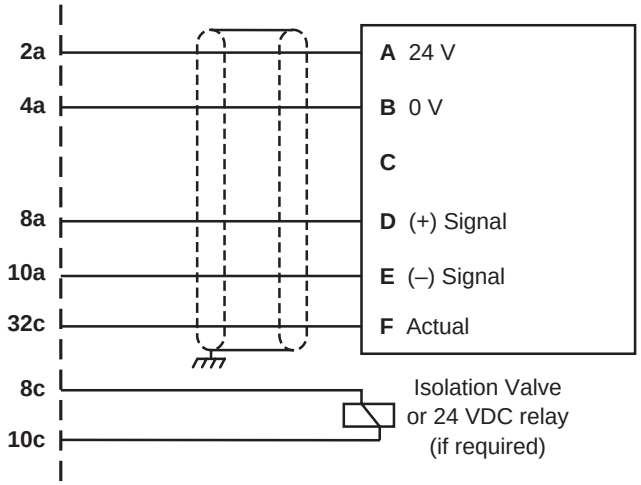
Do not connect to C or F.

Valve connections to DPR

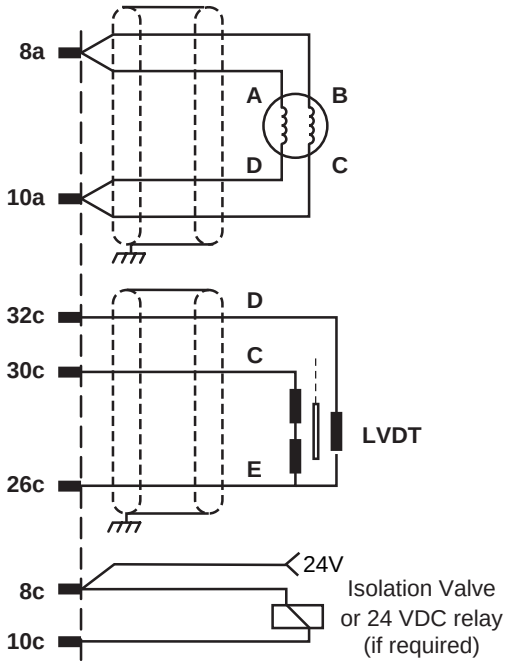
4WRDE..-5X/..15



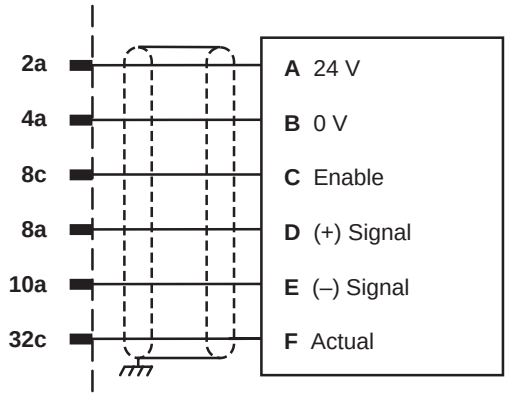
4WRDE..-5X/..24



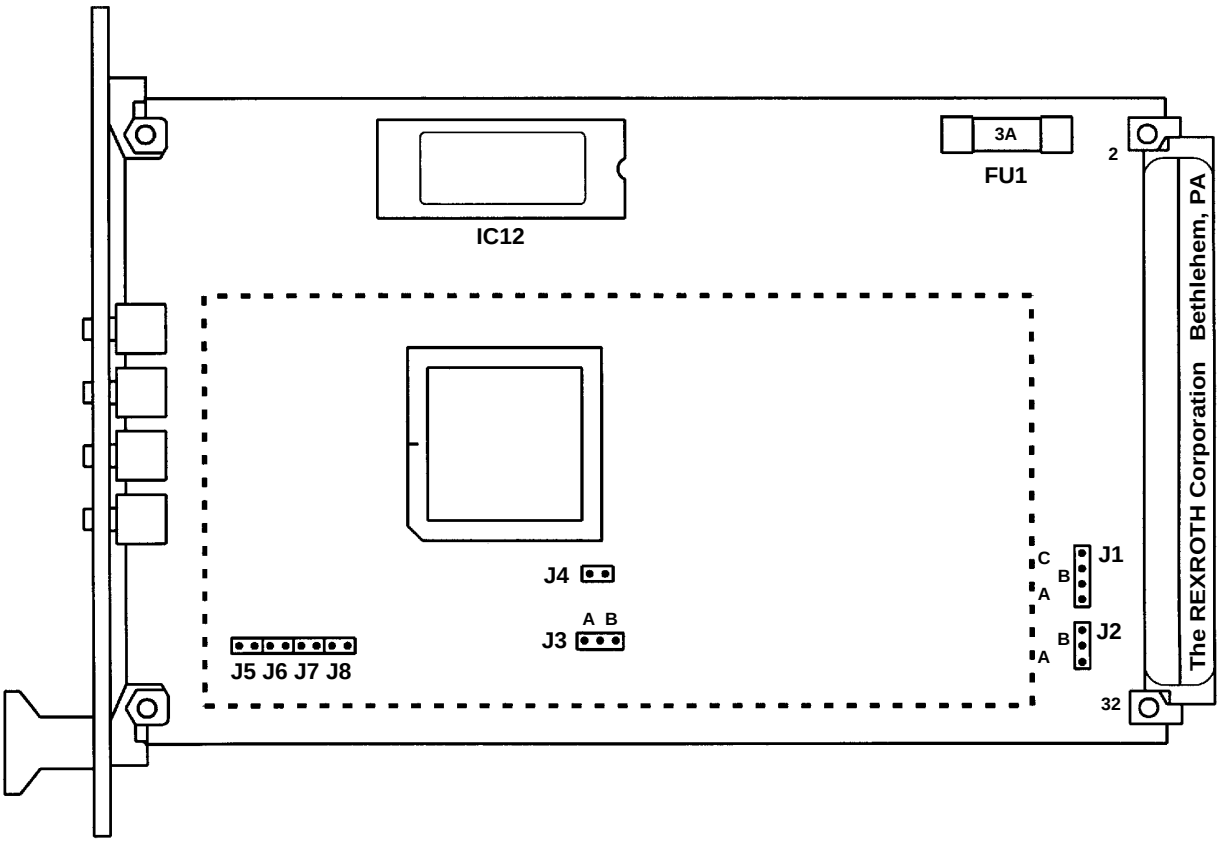
4WRD



4WRKE



Display / adjustment elements

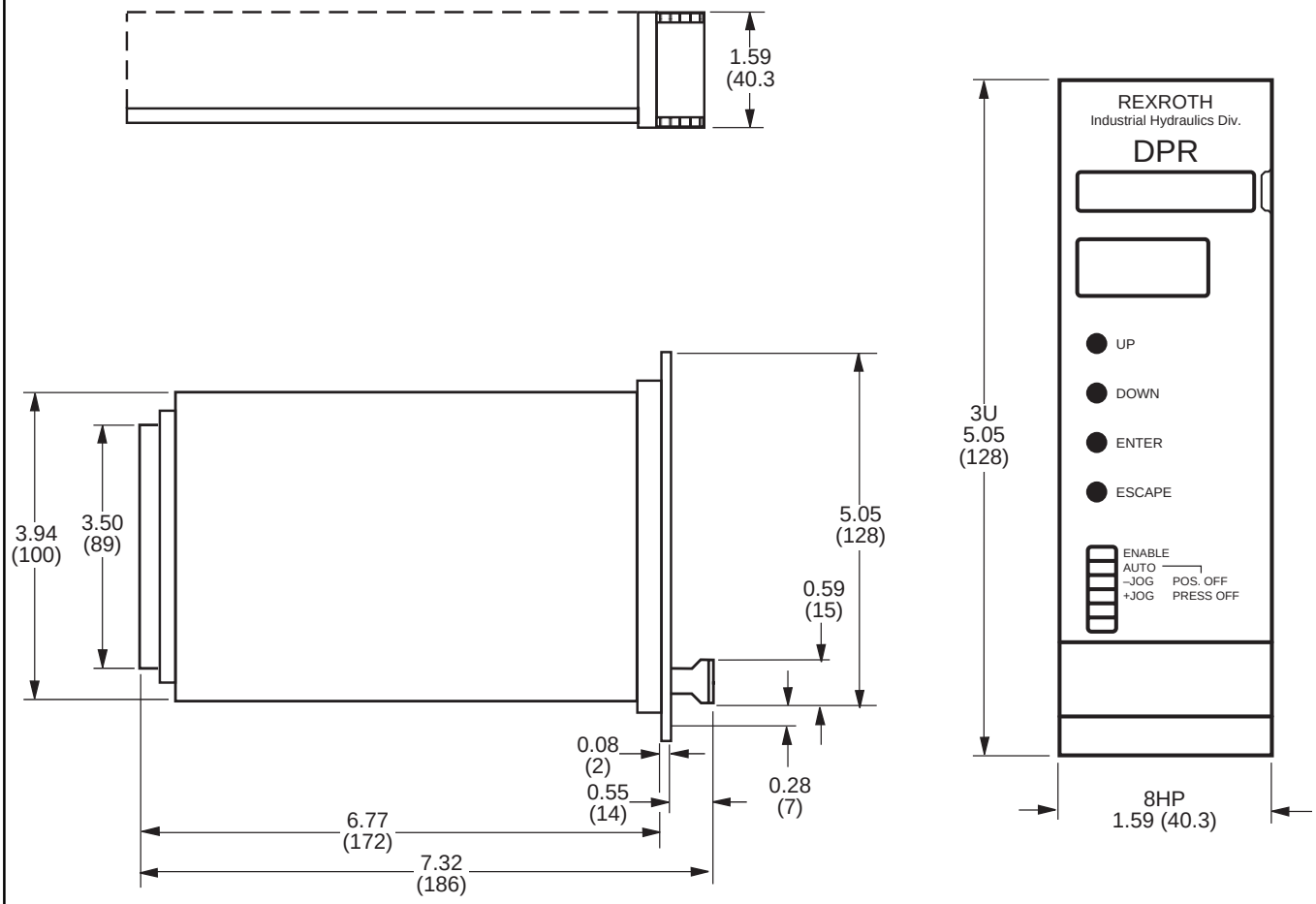


Additional information

- Do not unplug the card while power is being supplied.
- Shield analog inputs and valve feedback cables; connect the shield to 0 V or earth ground on one end, leave the other end of shield open.
- The mimimum distance to antenna cables, radio sources, and radar systems is 3 ft. (1 meter).
- Solenoid and signal cables must not be laid in the vicinity of power cables. Avoid close, parallel runs with AC field wiring, even where separate condiut and shields are used.
- The RS485 converter (COM485 Kit US00 888 281) includes a 9/25 pin adapter and 120 V AC wall cube.

Unit dimensions: dimensions in inches (millimeters)

DPR



Notes

Mannesmann Rexroth Corporation
***Rexroth Hydraulics Div., Industrial,* 2315 City Line Road, Bethlehem, PA 18017-2131 Tel. (610) 694-8300 Fax: (610) 694-8467**
***Rexroth Hydraulics Div., Mobile,* 1700 Old Mansfield Road, Wooster, OH 44691-0394 Tel. (330) 263-3400 Fax: (330) 263-3333**

All rights reserved – Subject to revision
Printed in U.S.A.