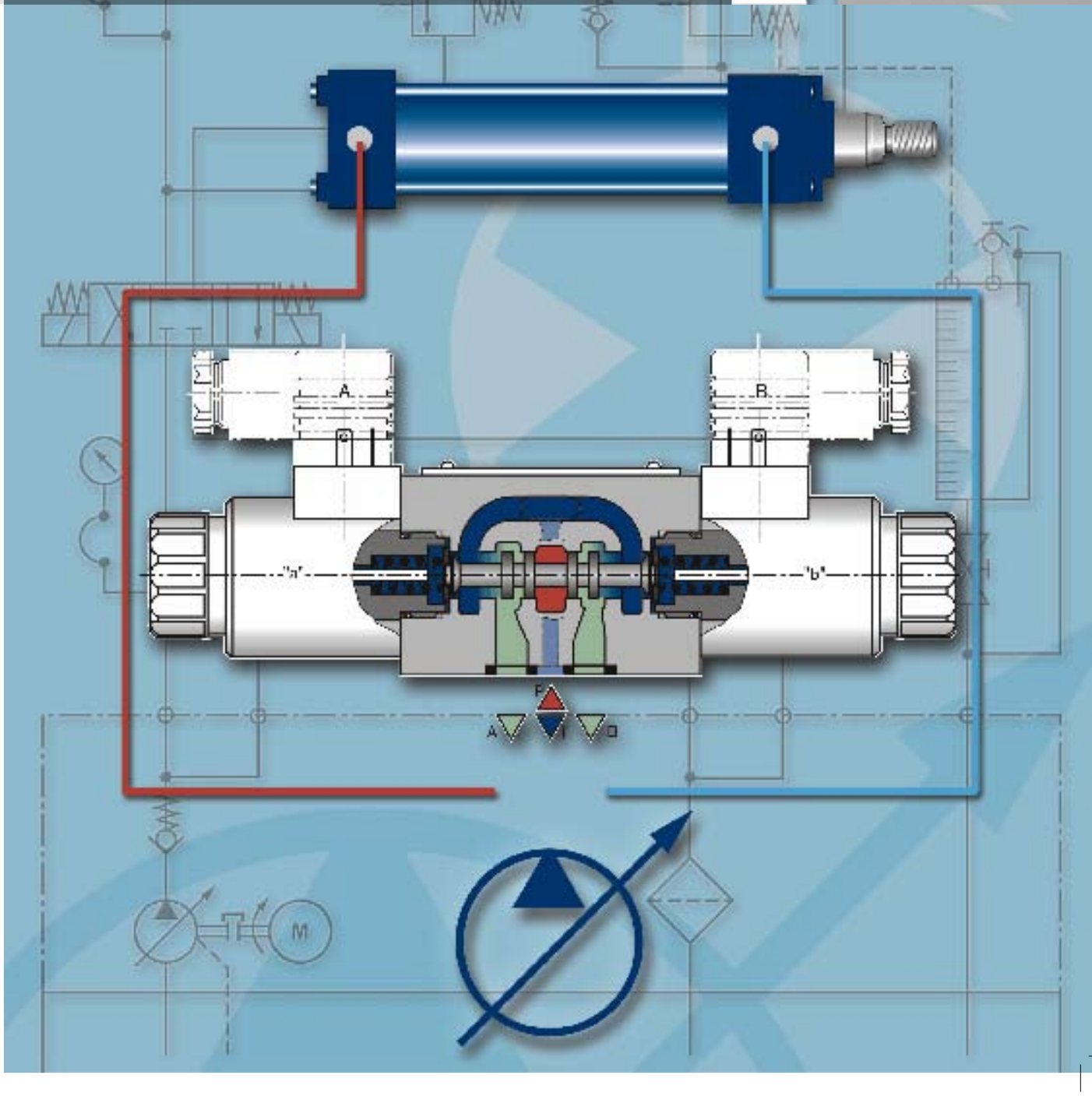
Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth
Bosch Group

Project Manual
Industrial Hydraulics

RE 00845/04.07

Trainer‘s manual



A

Introduction

Imparting knowledge through project work • Project designation with short description of the industrial application • Comparison of project exercises Bosch Rexroth AG/BIBB • Component matrix • Overview of components • Safety aspects

B

Basic principles of hydraulics

System technologies/energy conversion • Simple hydraulic circuit • Symbols according to DIN ISO 1219-1 • Circuit systems in the field of hydraulics • Demands placed on drive elements • Physical basic principles • Hydraulic fluids • Filtration

C

Project tasks

Fundamental safety notes • 01 Hydraulic power unit • 02 Hydraulic pump/variable displacement pump characteristic curve • 03 Single-rod cylinder/pressure intensification • 04 Single-rod cylinder/flow • 05 Hydraulic motor • 06 4/3 directional valve • 07 Check valve • 08 Check valve, pilot operated • 09 Throttle valve, adjustable • 10 Throttle check valve • 11 Flow control valve • 12 Pressure relief valve, direct operated • 13 Pressure relief valve controls • 14 Pressure reducing valve • 15 Pressure switch • 16 Pressure switch/hysteresis • 17 Hydraulic accumulator • 18 Regenerative circuit • 19 Rapid speed/creep speed control • 20 Valve circulation control • 21 Commissioning, inspection, maintenance, troubleshooting, repair

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Annex

RE 07008 General product information about hydraulic products from Bosch Rexroth AG

Project 03: Single-rod cylinder/pressure intensification

Project/trainer information

If in a hydraulic system the hydraulic force, which is converted into mechanical energy, is to be transmitted to an actuator in the form of a linear (straight) movement, a **hydraulic cylinder** is used. We distinguish hydraulic cylinders by their design principles:

Plunger, **single-rod** and **double-rod cylinders**.

The hydraulic cylinder as output element forms the link between the hydraulic circuit and the working element/tool in a technological system. Lifting, lowering, locking and transporting loads are typical applications of hydraulic cylinders.
Neglecting friction, the possible maximum **cylinder force** F in kN depends on the possible maximum system pressure p and the effective piston area A of the hydraulic cylinder, i.e.

$F = p \bullet A$ in dN $\quad p$ in bar; A in cm^2

The **piston velocity** v in m/s of the hydraulic cylinder is determined by the pump flow supplied. Flow control valves are used to change, i.e. reduce, the piston velocity. When throttling, for example, the piston extension velocity, important physical laws must be taken into account.

In the following *Project 03* knowledge can be imparted with regard to the use of single-rod cylinders as machine elements.

In the project order, the trainee is to work out the physical basic principles of pressure intensification with single-rod cylinders. On the basis of this project task, he/she is to understand the following:

- The hydraulic cylinder performs a straight movement and transmits the supplied piston pressure in the form of force.
- Double-acting hydraulic cylinders with different piston areas are pressure intensifiers.
- Due to adhesive friction in the hydraulic cylinder the pressure actually transmitted via the piston area or through the differences in areas is reduced.
- Forces and velocities can be kept constant over the entire stroke.

Biased on the control set up on the training system the trainee is to learn that the use of a meter-out throttle on the piston rod side involves a risk of pressure intensification. When the hydraulic pump is switched on, the piston of the single-rod cylinder extends. The extension velocity can be varied by means of a throttle valve. Retracting of the single-rod cylinder is accomplished with the help of a 4/2 directional valve.

Notes on detailed technical information about hydraulic cylinders:

- *The Hydraulic Trainer Volume 1/Bosch Rexroth AG*
  Basic principles and components, Chapter 7
- *Technical data sheet RE 17039*
  Hydraulic cylinders of tie rod design

Project definition

A workpiece is to be shifted by a horizontally installed single-rod cylinder to the working range of a simple fixture when the hydraulic pump is switched on. To this end, the extension velocity of the cylinder must be adjustable. Retracting is to be achieved by means of a 4/2 directional valve.

The customer installed a throttle valve on the piston rod side and, while adjusting the extension velocity, recognizes that the pressure upstream of the throttle becomes higher than the set system pressure. Apart from the technical documentation he wishes to get an explanation of the pressure intensification of the single-rod cylinder.

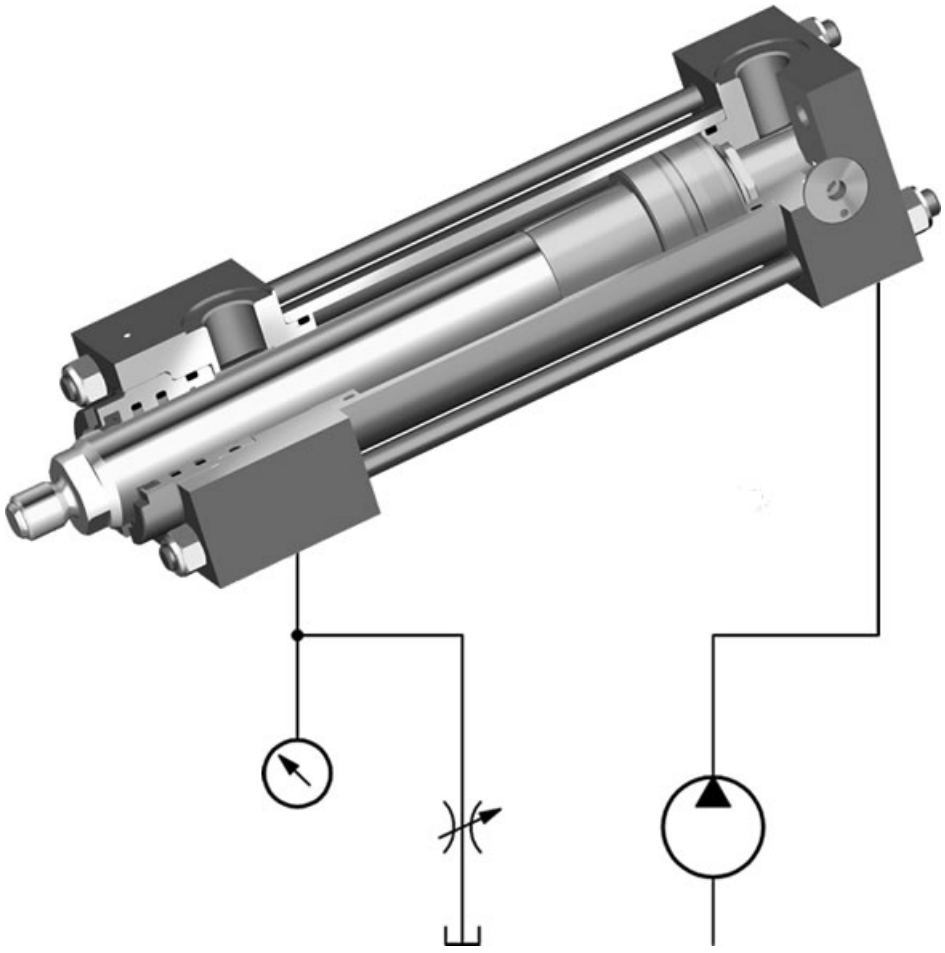


Fig. 03.1 Practical example: Hydraulic cylinder of tie rod design

Project tasks

- Independent **understanding** and execution of the task set through application of hydraulic control technology
- **Planning** and organizing the customer requirement (core qualification)
- **Analyzing** the technical data sheet of a hydraulic cylinder (specialist qualification)
- **Handling** of hydraulic components in line with functional needs

Project steps

- **Informing:** Accepting and understanding the order, among others, through discussions with the customer.

- **Planning:** Planning and organizing the execution of the customer order; among others, through the selection of hydraulic components from the data sheet collection (RE 17039 Hydraulic cylinders, tie rod design).

- **Deciding:** Preparation of a schematic diagram sketch and selection of components.

- **Executing:** Set-up of the hydraulic control on the training system. Working out and documenting the system parameters required by the customer and explanations with regard to pressure intensification on the basis of a calculation example.

- **Checking:** Are all customer requirements met?

- **Evaluating:** Are there further possibilities of meeting the customer requirement or simpler ways of project execution? Have unforeseeable problems occurred?

Notes

Hydraulic circuit diagram

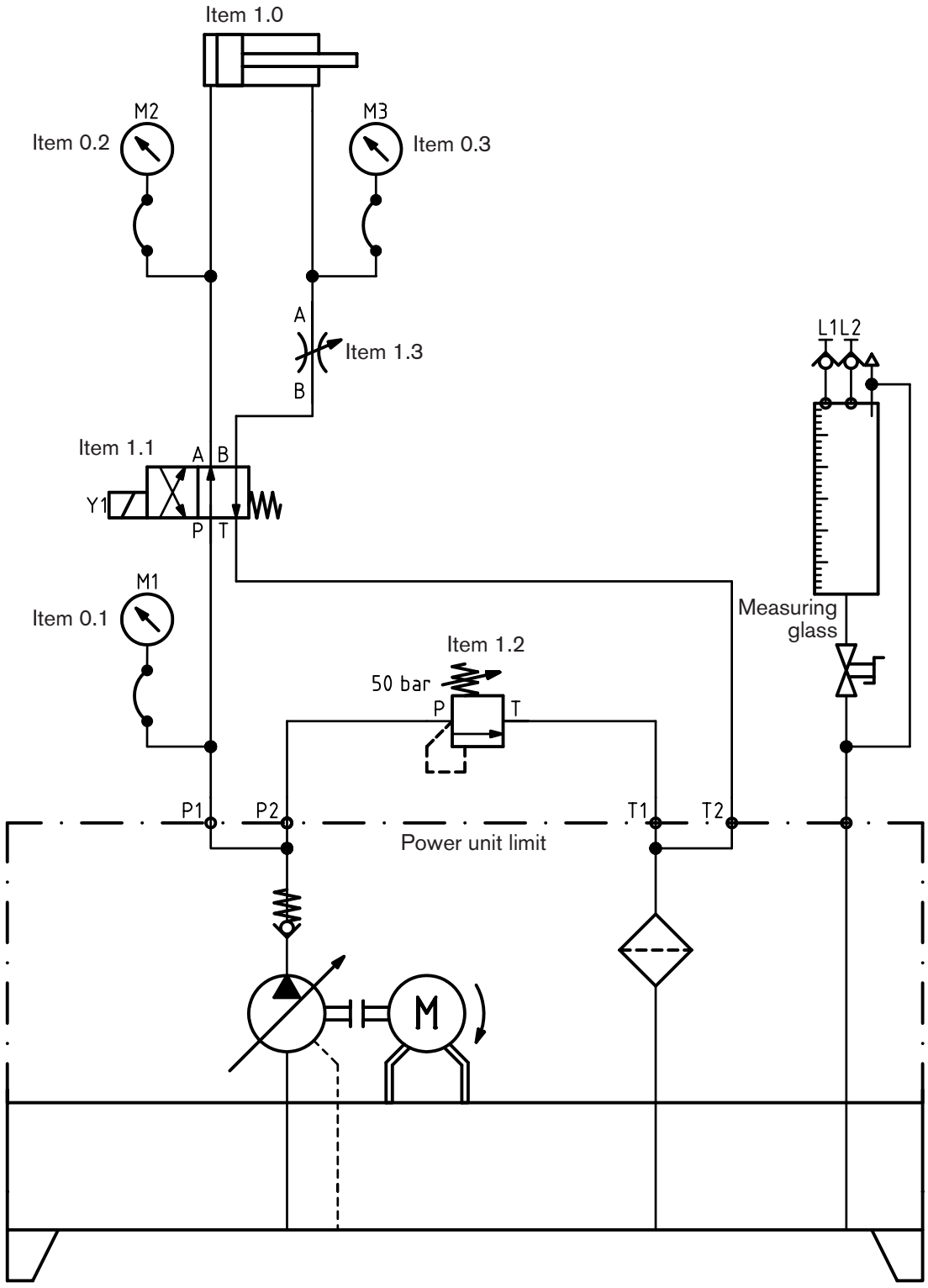


Fig. 03.2 Hydraulic circuit diagram: Feeding cylinder

Electrical circuit diagram

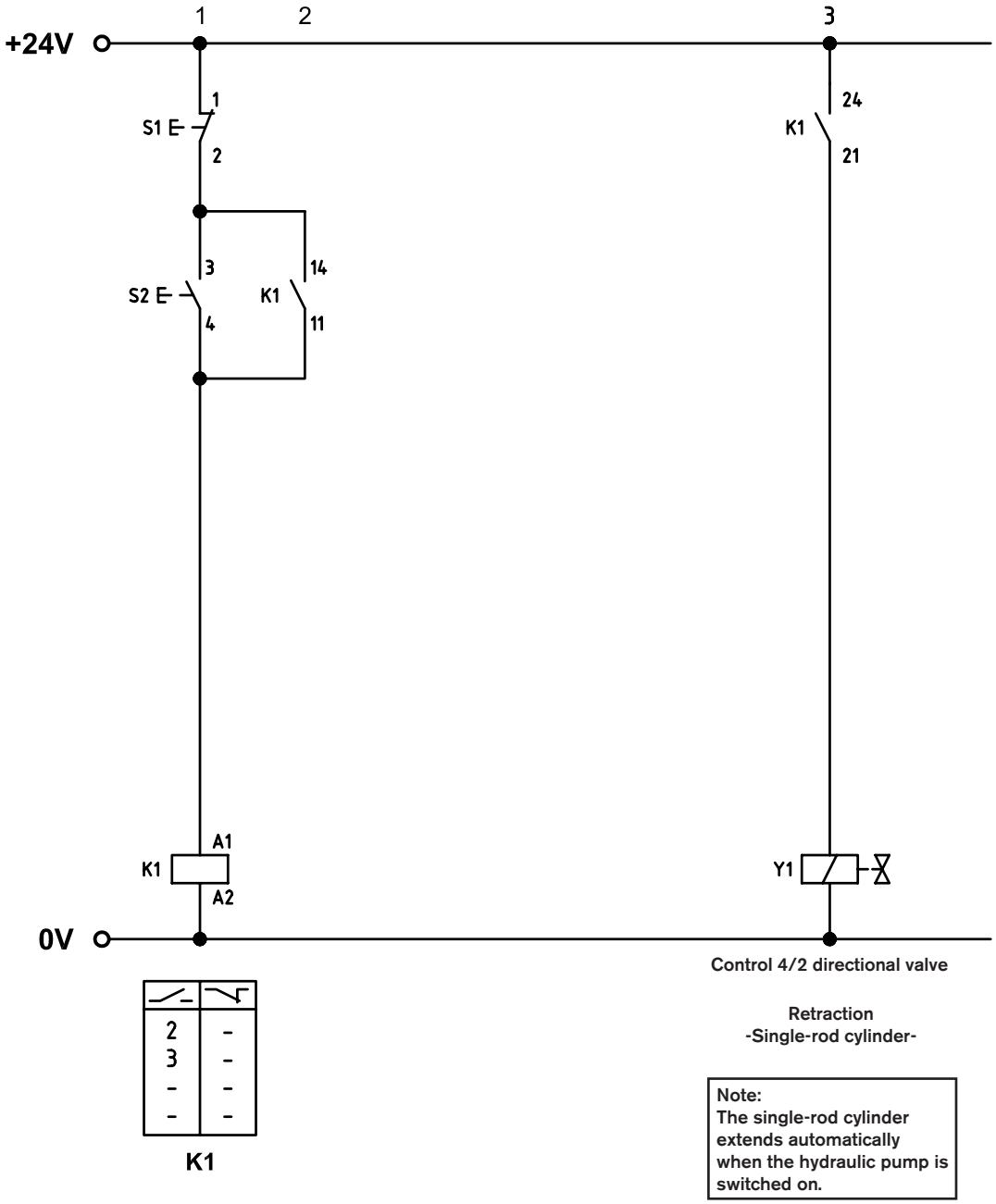


Fig. 03.3 Wiring diagram re hydraulic circuit diagram Fig. 03.2

Component selection with parts list

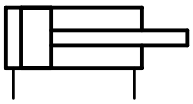
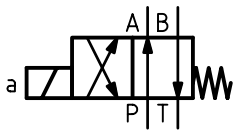
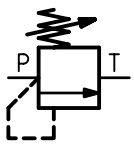
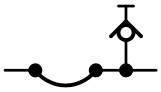
Item	Qty	Component designation	Type designation	Symbol
1.0	1	Double-acting cylinder with single-sided piston rod	**ZY 1.3**	
1.1	1	4/2 directional valve with solenoid actuation, spring return	**DW 3 E**	
1.2	1	Direct operated pressure relief valve, the cracking pressure can be adjusted by means of a spring	**DD 1.1**	
1.3	1	Throttle valve, adjustable	**DF 1.2**	
	1	Distributor plate with four ports	**DZ 4.1**	
0.1 - 0.3	3	Pressure gauge with hose and quick release coupling without check valve	**DZ 1.4**	
	3	Hose with quick release coupling with check valve	**DZ 25.1**	
		Hose	**VSK 1**	

Table 03.1 Parts list for hydraulic circuit diagram Fig. 03.2

Component arrangement

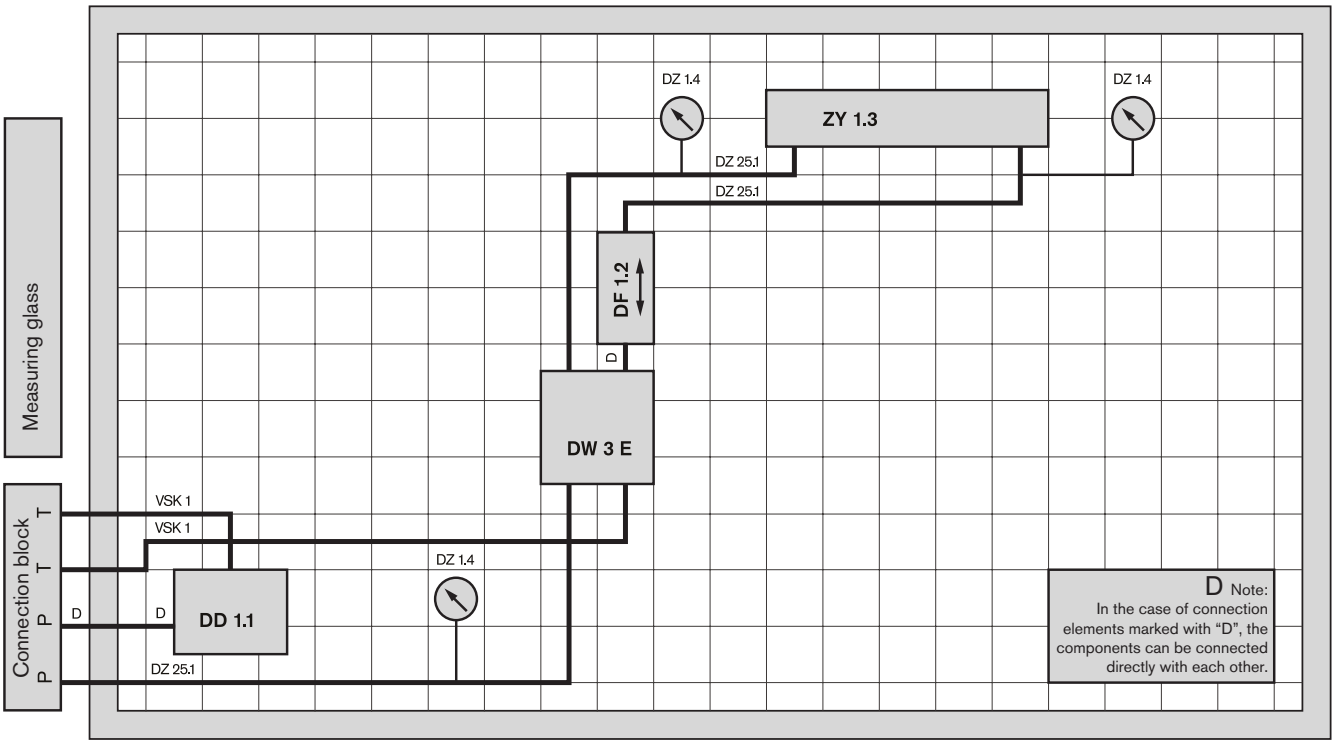


Fig. 03.4 Recommended component arrangement with component designations for parts list Table 03.1 and hydraulic circuit diagram Fig. 03.2

Note:

The designations of components in the parts list and the component arrangement are Rexroth-specific designations. Also the grid arrangement is Rexroth-specific and adapted for use on the training system.

Notes

Safety notes

To ensure the operability of plant and machinery, and consequently to allow the recognition of potential risks, safety regulations must be observed before and during the execution of the order. Relevant sources of regulations are given in the introduction of the present manual.

Warning

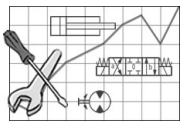
If work on electrohydraulic components is carried out improperly, risks of injury and a safety risk can arise during operation of the system, including danger to life.

Caution

Before starting work on the training stand, check that the electrical ON/OFF switch on the hydraulic power unit is pressed in, i.e. that the system is switched off. Use the system pressure gauges to check that the system is depressurized.

Hydraulic systems can store pressure energy when at rest. It can cause injury when the system is opened.

Execution of the order



Set up the control as described below:

1. Mount the components required according to *Table 03.1* in a clearly arranged form on the training system according to the prepared circuit diagram.

   Connect the hydraulic control according to *hydraulic circuit diagram Fig. 03.2* by means of hoses.

   For connections, to which pressure gauges with minimess line **DZ 1.4** are to be connected, use hydraulic hoses **DZ 25**. Hand-tighten the pressure gauge measuring lines at the relevant minimess connection of the hydraulic hose.

   The correct and proper fit of the component connections with hoses can be checked by slightly turning the hoses.

   Warning

   Make sure that pipes or hoses are connected to all connections - in this case also to minimess lines, or that the connections are plugged by means of plug screws or protective caps. Leakage oil may drip through open connections and cause a slipping risk.

   Caution

   Before commissioning the hydraulic control, i.e. before switching the hydraulic pump on, check, whether all pressure control valves are set to minimum pressure (spring unloaded) and all throttle valves are open.

   Wire **the electrical contr**ol according *to wiring diagram Fig. 03.3*.

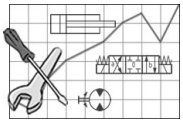
2. Switch the hydraulic pump on and inspect the set up control for leakage. No pressure gauge may indicate a pressure.
3. Check the pressure set on the **variable displacement pump** of the drive power unit (if required, correct to **50 bar**).
4. Set the **system pressure** on pressure relief valve **Item 1.2** to **50 bar plus one turn**; operate push-button **S2** to prevent the piston of hydraulic cylinder **Item 1.0** from extending.
5. Through operation of push-button **S1** the control voltage of solenoid **Y1** of the 4/2 directional valves **Item 1.1** drops, and the piston of the hydraulic cylinder extends due to the pump flow supplied directly to the piston side.

6. **Switch the hydraulic pump off** and wait until the system is **depressurized**. Close throttle valve **Item 1.3**. To this end, turn in the adjustment element counter-clockwise to the limit stop.
7. **Switch the hydraulic pump on**. The piston of the hydraulic cylinder cannot extend, because the **counterforce** on the piston rod side is greater than the force on the piston side, since the throttle valve is closed. Pressure gauge **M3** indicates the value of **pressure intensification**. Note the measured values and enter them in *Table 03.2*.

Caution

After having completed practical work on the training system switch the hydraulic pump off! Turn pressure relief valve Item 1.2 back to minimum pressure. No pressure gauge may indicate a pressure!

Measured values



Hydraulic cylinder	Measuring point M1 System pressure *p* in bar	M2 piston side *p* in bar	M3 piston rod side *p* in bar
Extending/ Y1 not operated	48	48	82

Table 03.2 Pressure intensification values measured

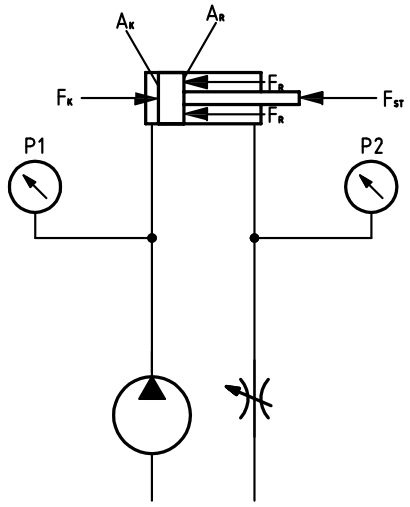
The values were measured at an oil temperature of approx. 20 °C.
The values measured by the trainees can deviate by 10 %.

Additional task in conjunction with the customer requirement:

Calculation of the pressure intensification on the basis of given hydraulic cylinder values.

Hydraulic cylinder of tie rod design: **Type CD T3...25/18...200**

Bore: 25 mm
Piston rod diameter: 18 mm



$$A_{piston} = 4{,}91\ cm^2$$
$$A_{rod} = 2{,}54\ cm^2$$
$$A_{annulus} = 2{,}37\ cm^2$$

$$\frac{4{,}91\ cm^2}{2{,}54\ cm^2} = 2{,}07 : 1$$

If the meter-out throttle is completely closed, then:

$$F_K = F_R$$
$$p_K \cdot A_K = p_R \cdot A_R$$
$$p_R = \frac{2{,}07}{1{,}00} \cdot 50\ bar = 103{,}5\ bar$$

Evaluating the work results with regard to the customer requirement

- Hydraulic cylinders perform linear movements and transmit the piston pressure in the form of force.
- Double-acting hydraulic cylinders with different areas are called single-rod cylinders.
- Single-rod cylinders are pressure intensifiers.
- Velocities can be kept constant over the entire stroke.