

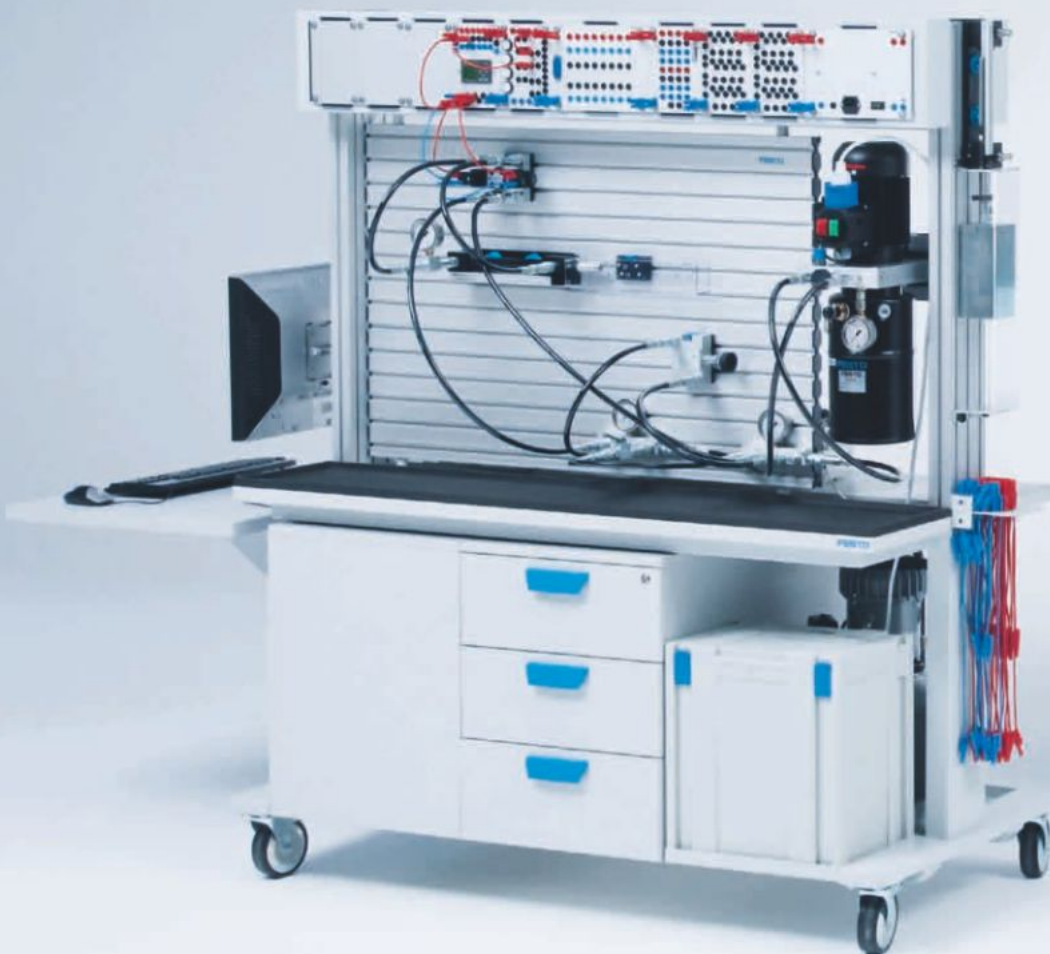
# Hydraulics

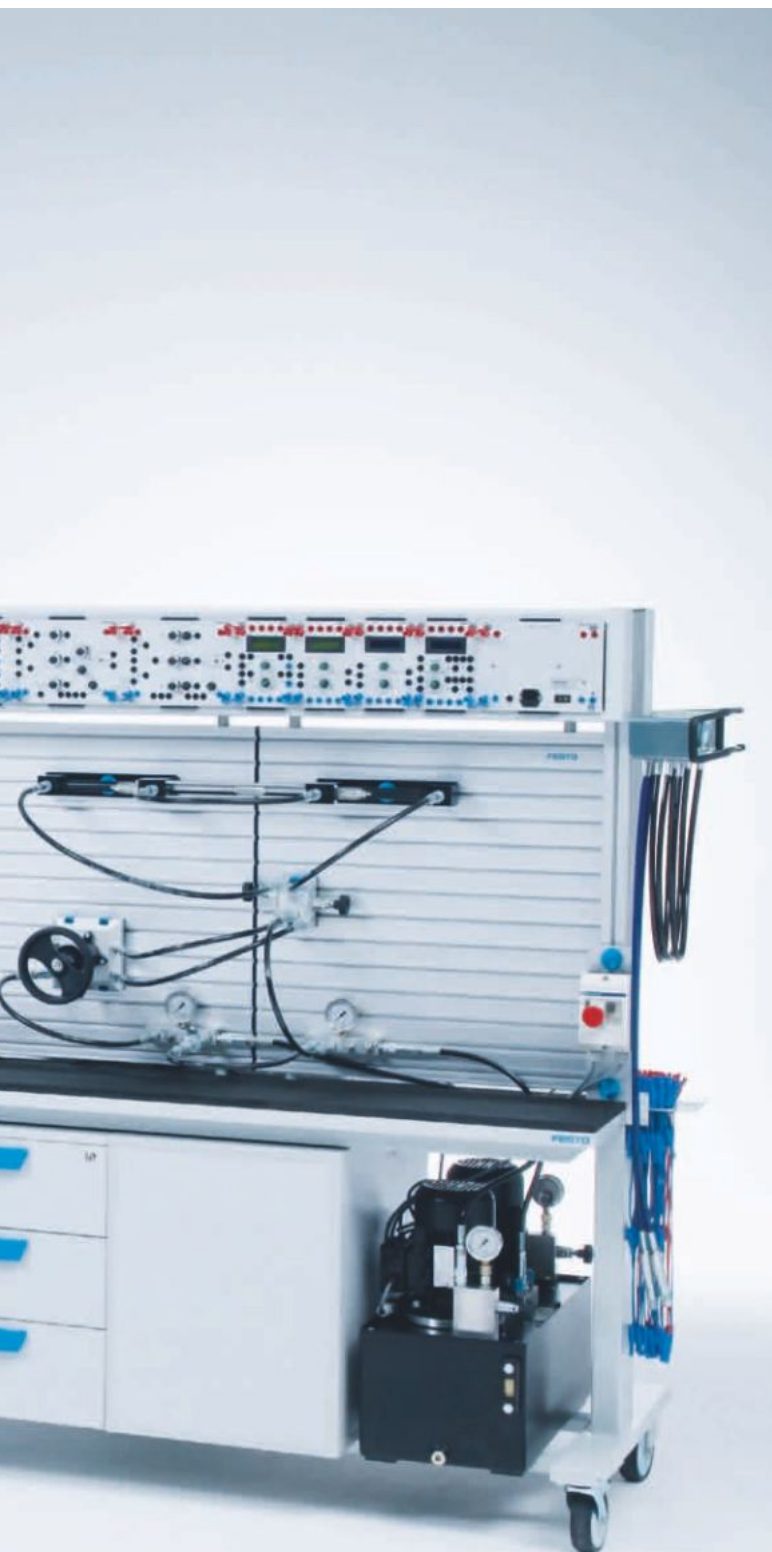
Vocational and further training with Festo Didactic

**FESTO**



## Hydraulics training packages





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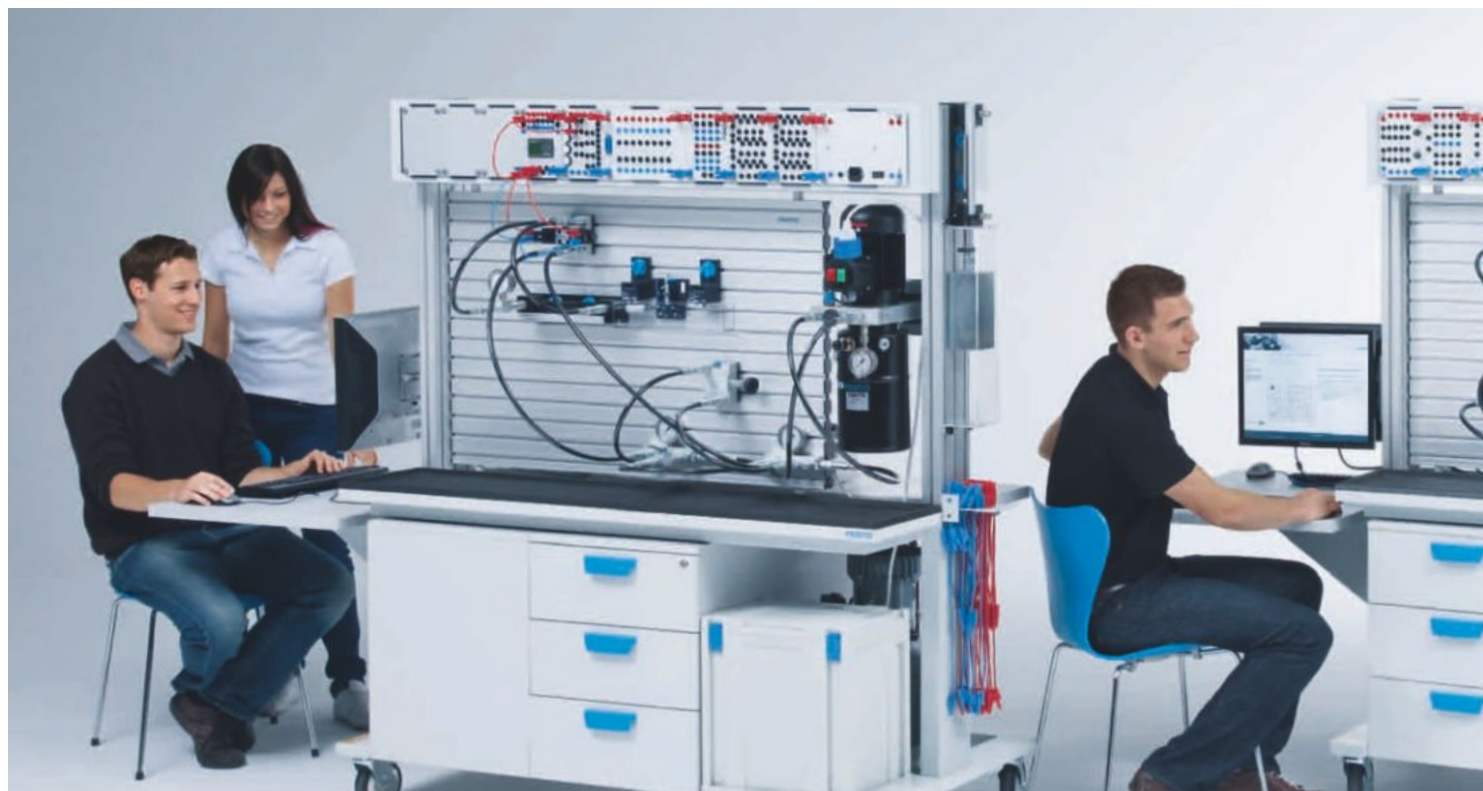
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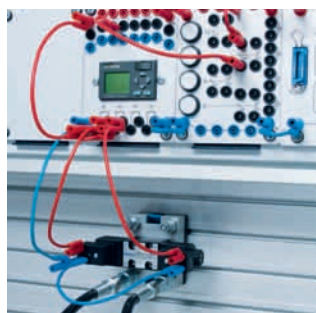
# Hydraulics training packages

## Tailored training in industrial and mobile hydraulics



### Modular for flexible expansion

Festo Didactic's training packages are modular in structure. For example, you could start with the basic level of electrohydraulics and then move onto the advanced level. Or are you more interested in electropneumatics? The choice is yours. You'd like to explore a particular specialised topic? All equipment set components can also be ordered separately, so you can turn your own ideas into reality.



### Position it – clamp it – done!

With the Quick-Fix® mounting system, you can mount all components easily and securely on the profile plate or on the profile column of a Learnline workstation. The electrical units are clamped into the ER frame and sequenced individually. The supports and the electrical units are the same for both hydraulics and pneumatics – a single investment, with double the functionality.



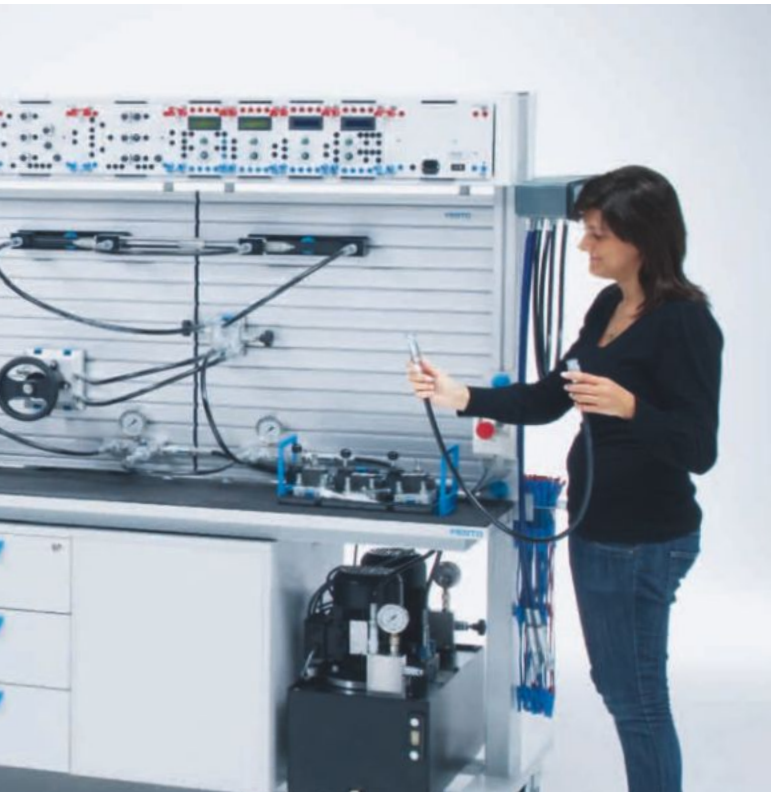
### Everything where you want it – systematic storage

Most equipment sets are supplied with an equipment tray or drawer insert in a Systainer. This equipment tray fits in the drawers of the workstations. The large pictogram on the components, designed in accordance with the latest standards, provides clear instructions for connecting the components and ensures short preparation and follow-up times. When dismantling circuits, you can quickly and easily locate where the component goes in the equipment tray.



### Connect it – power!

Hydraulic power is supplied by the tool-free connection of low-leakage couplings – the latest generation in high-grade stainless steel. The coupling is self-sealing when uncoupled. During the low-friction coupling procedure, only the front surface is coated with oil, which saves resources, is easy on the environment, and reduces contamination.



### Didactic plus

The workbooks accompanying the training packages contain project-oriented exercises of increasing complexity. There are also positional sketches, illustrations, videos, animations and cross-sectional drawings, which explain how things look in the real world. For a complete and expert treatment of the topic of hydraulics, the training also covers basic physics, technical calculations, safety, efficiency, analytical fault-finding and professional documentation.

Practical basic and further training using industrial components provides the confidence to apply the acquired knowledge in the workplace. The components are specially selected for the exercises in the workbook. Note: nearly all hydraulic and electrical connections are located on the easily accessible upper side of the components.



### Your choice of training environment

User-friendly training environments for specific topic areas:

- Self-study phases with the training programs
- Designing and documentation with FluidSIM®
- Practical implementation with the training packages and the exercises in the workbooks
- Functional testing and optimisation with measurement technology and FluidLab®



### Quality not quantity!

Bigger is not necessarily better. Volumetric flow rates and pressures should be chosen with care and in co-ordination with the system as a whole. This applies especially to hydraulic training systems. High forces and cylinder speeds not only increase the danger for the user, but also require a larger hydraulic power pack with higher power consumption. So our offer is: as large as necessary and as small as possible, without compromising on teaching effectiveness.



### New technologies – new skills needed

Modern measurement and diagnostic technology and cartridge valves are among the international trends in hydraulics. So you'll find those technologies in our learning systems as well. Benefit from the compact, integrated design, the low weight, ease of handling, and easy-to-read symbol system.



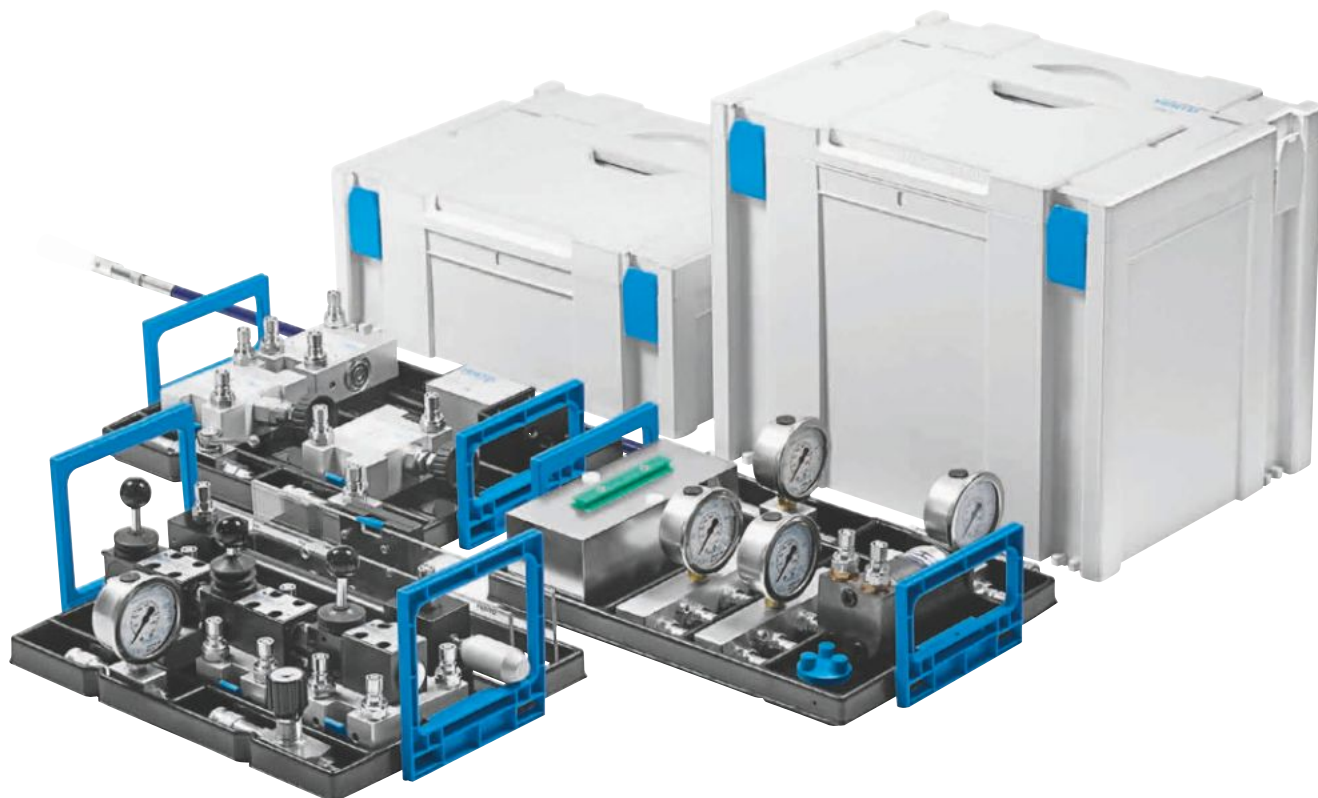
### Mobile hydraulics

The new training packages for mobile hydraulics systematically and informatively explore complex topics and systems, such as work hydraulics, hydrostatic steering and drive systems for the agricultural, forestry and construction vehicle sectors and warehouse and municipal vehicles.

# Equipment set TP 501 – Basic Level

## Basic training in hydraulics

New



### The classic reissued

The solid basis for practical basic and further education. Training package TP 501 contains only purely hydraulic control systems.

The number and version of the components are specifically adapted to the projects in the workbook. This is a cost-effective way of achieving the important training objectives.

TP 501, Basic Level is suitable for basic training in hydraulic control technology and imparts knowledge of the basic physical principles of hydraulics, as well as the function and use of hydraulic components.

### Pure convenience

- Easy and exact switching of hand lever valves
- Simple and precise setting of the flow and pressure valves thanks to the ergonomic handwheels and the fine resolution
- Tool-free, single-hand operation with quick action mounting system Quick-Fix®
- Easy and secure plugging and releasing of the new, low-leakage, self-sealing quick connection couplings

The training package is delivered in practical trays, packaged in a Systemainer. The trays, in turn, fit exactly into the drawers in Learnline workstations.

### Training content

#### Power packs and components:

- Design, function and most important characteristics of a hydraulic power unit
- Design and function of pressure-relief valves, cylinders and directional control valves
- Design and function of the non-return valve, one-way flow control valve and piloted non-return valve
- Design and function of flow control valves

#### Measurements and calculations:

- Recording and interpreting the characteristic curve of a hydraulic pump
- Measuring the volume flow of a hydraulic control system
- Recording the characteristic curve of a pressure-relief valve
- Identifying and calculating times, pressures and forces during advancing and retracting of a cylinder
- Recording the characteristic curve of a flow control valve
- Calculating performance ratios when using 4/3-way valves with different mid-positions

#### Hydraulic circuits:

- Commissioning hydraulic circuits safely
- Using the flow control valve in the inflow and outflow and adjusting the drive speed
- Difference between a flow control valve and one-way flow control valve in hydraulic control systems
- Design and mode of operation of a differential circuit
- Effect of the piston surfaces on pressures, forces, speeds and travel times
- Proper use of piloted non-return valves
- Circuits with different types of counter pressure
- Operating cylinders with varying loads



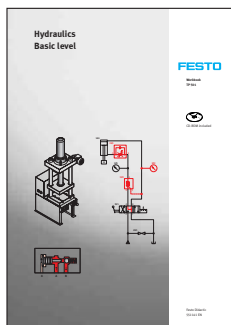
**Complete equipment set TP 501 in Systainer****573035**

The most important components at a glance:

1	1x Pressure relief valve	544335
2	1x 2-way flow control valve	544338
3	1x One-way flow control valve	152843
4	1x Non-return valve, delockable	544339
5	1x Non-return valve, 0,6 MPa opening pressure	548618
6	1x 4/2-way hand lever valve, spring return	544342
7	1x 4/3-way hand lever valve, relieving mid-position (AB-T), detenting	544344
8	1x 4/3-way hand lever valve, closed mid-position, detenting	544343
9	1x Shut-off valve	152844
10	1x Differential cylinder 16/10/200 with cover	572746
11	1x Weight, 9 kg for cylinder	152972
12	1x Hydraulic motor	152858
13	1x T-distributor	152847
14	2x 4-way distributor with pressure gauge	159395
15	3x Pressure gauge	152841
16	1x Flow sensor	567191

Necessary accessories, also order:

7x	Hose line with quick release couplings, 600 mm	152960
3x	Hose line with quick release couplings, 1000 mm	152970
2x	Hose line with quick release couplings, 1500 mm	159386
	Multimeter	571832
	Aluminium profile plate → Internet	
	Hydraulic power pack → Pages 48 – 49	
	Protective cover for weight → Page 45	
	Power supply unit for mounting frame → Page 52	

**The media on offer for TP 501****Training course documents**

The basic circuits for hydraulics are presented in 17 exercises. The symbols used in the circuit diagrams are according to DIN/ISO 1219. In order to carry out the exercises, students require the equipment set for TP 501 Hydraulics, Basic Level.

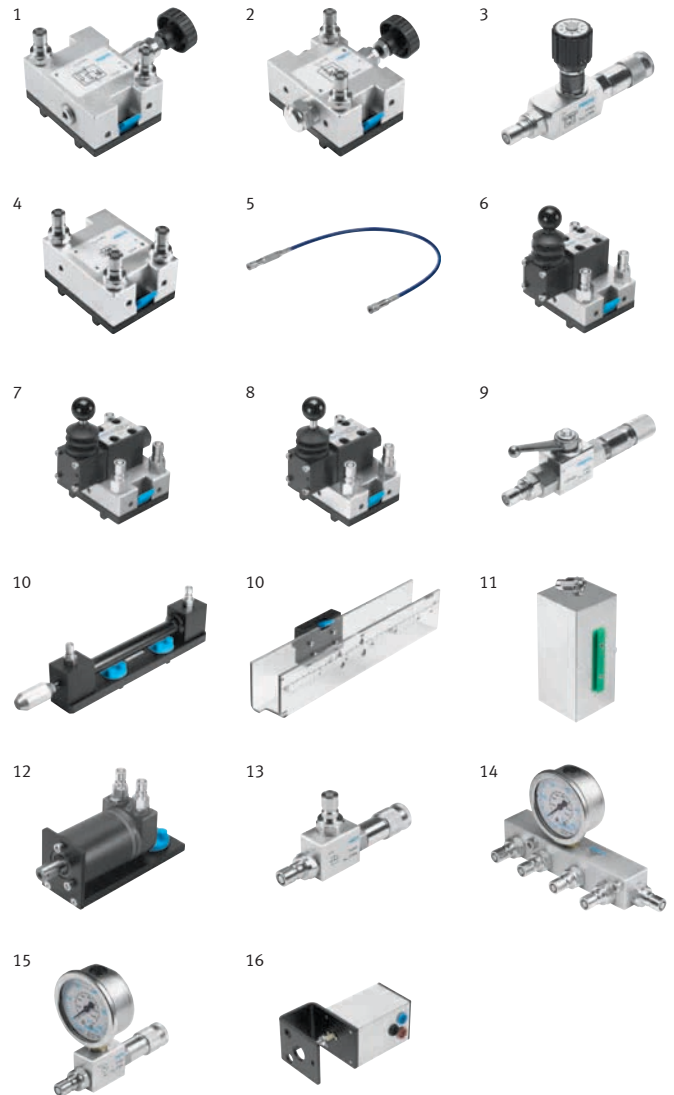
The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	550141
EN	551141
ES	551145
FR	551146

**Supplementary media**

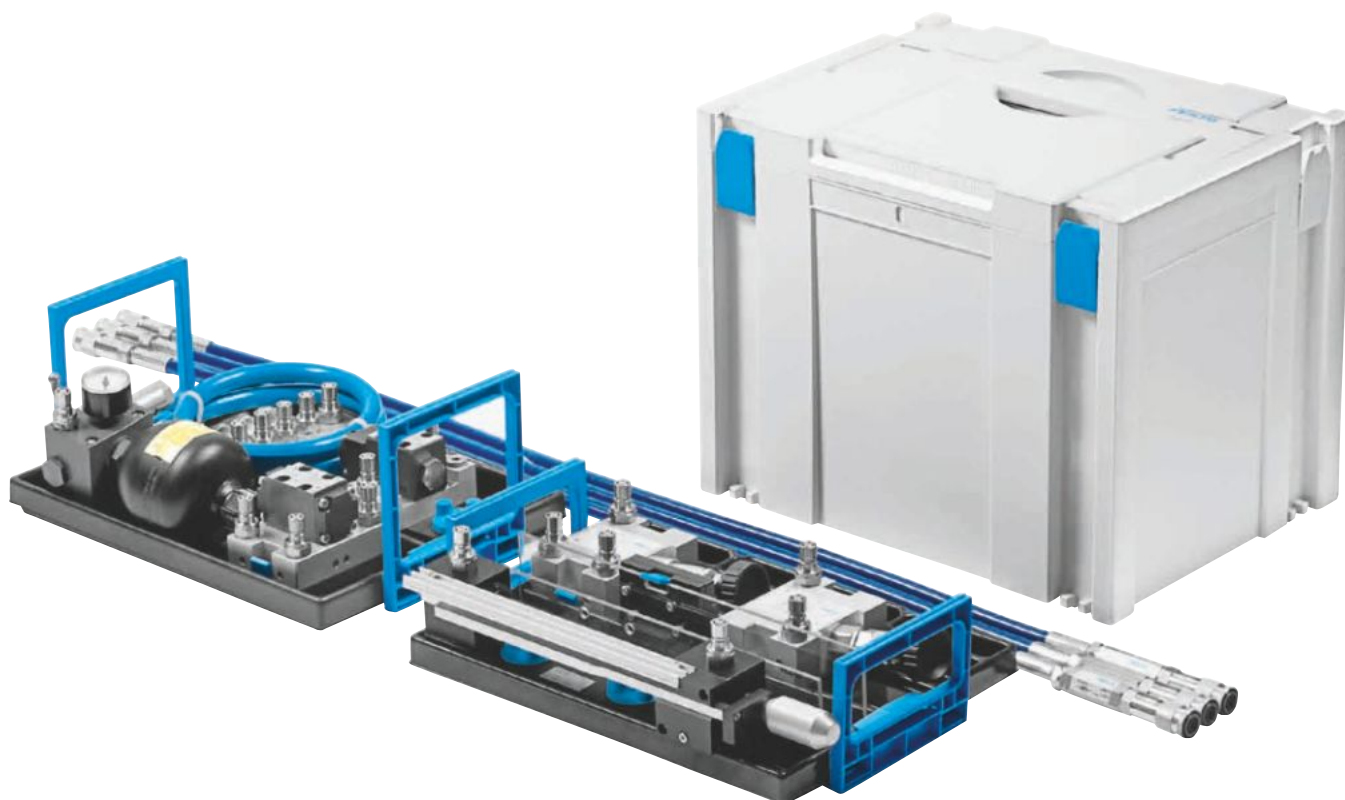
- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics
- Textbook Hydraulics – Basic Level
- Hydraulics poster set



# Equipment set TP 502 – Advanced Level

## Hydraulics for advanced students

New



### The new advanced level

The training package TP 502 builds on the material covered in training package TP 501 – Basic Level, and adds 15 new projects to it.

The course expands students' knowledge about the basic physical principles of hydraulics and the function and use of further hydraulic components.

In order to carry out the projects, users require the components and the necessary accessories from equipment set TP 501.

### Hydraulics plus!

The new components provide added training value and relevant project tasks form the basis for advanced training in fundamental principles.

The training package is delivered in practical trays, packaged in a Systainer. These trays, in turn, fit exactly into the drawers in Learnline workstations.

### Training content

Power packs and components:

- Design and function of a hydraulic motor
- Setting the direction and speed of rotation of a hydraulic motor
- Design, function and use of a flow divider
- Using a hydraulic reservoir as a volume and pressure accumulator
- Design, function and use of a pressure regulator
- Specifying the cylinder pressure
- Difference between pressure-relief valves and pressure regulators

Measurements and calculations:

- Calculating performance ratios of hydraulic circuits from measured values
- Calculating forces on the cylinder
- Creating procedure descriptions

Hydraulic circuits:

- Implementing bypass circuits
- Ensuring synchronised forward and return strokes
- Getting to know the bypass circuit
- Getting to know the rapid traverse feed circuit
- Advancing and retracting of a cylinder after the pump from the reservoir is switched off
- Use of a hydraulic reservoir for a rapid traverse circuit
- Getting to know the rectifier circuit
- Configuration and description of a sequence control with two cylinders
- Getting to know the pressure sequence and pressure stage circuit
- Getting to know the fuse protection for tensile loads



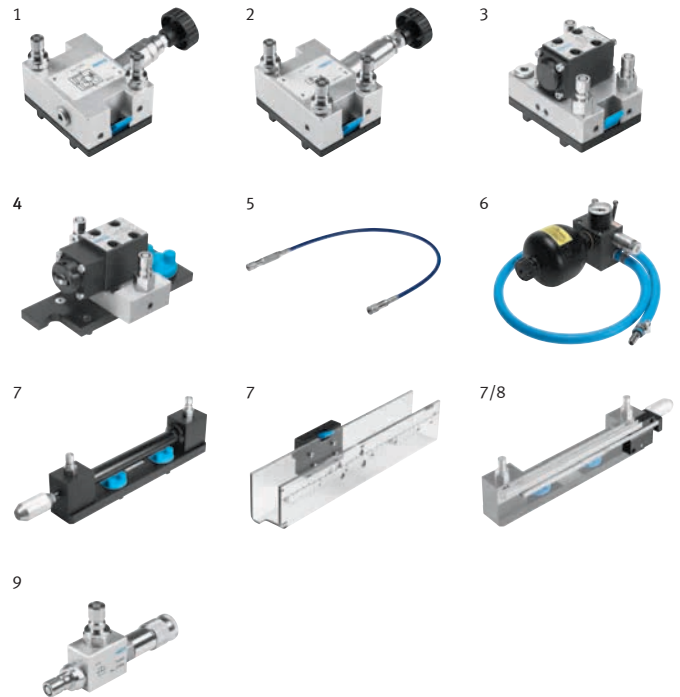
Complete equipment set TP 502 in the Systainer	<b>573036</b>
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The most important components at a glance:

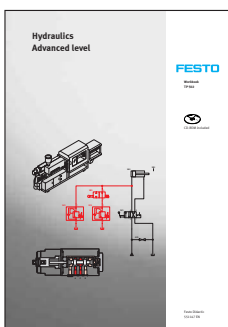
1	1x Pressure relief valve, compensated	567237
2	1x 3-way pressure reducing valve	544337
3	1x Flow dividing valve	544340
4	1x 2/2-way stem actuated valve, convertible	544353
5	3x Non-return valve, 0,6 MPa opening pressure	548618
6	1x Diaphragm accumulator with shut-off block	152859
7	1x Differential cylinder 16/10/200 with cover	572746
8	1x Mounting kit for cylinders	544371
9	5x T-distributor	152847

Necessary accessories, also order:

7x	Hose line with quick release couplings, 600 mm	152960
4x	Hose line with quick release couplings, 1000 mm	152970
2x	Hose line with quick release couplings, 1500 mm	159386
Safety laboratory cables → Page 52		
Multimeter		571832
Aluminium profile plate → Internet		
Hydraulic power pack → Pages 48 – 49		
Protective cover for weight → Page 45		
Power supply unit for mounting frame → Page 52		



### The media on offer for TP 502



### Training course documents

The tasks explain further hydraulic circuits. The equipment set of package TP 501 – Hydraulics Basic Level and TP 502 – Advanced Level equipment set are needed to carry out the tasks.

The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	<b>550142</b>
EN	<b>551147</b>
ES	<b>551148</b>
FR	<b>551149</b>

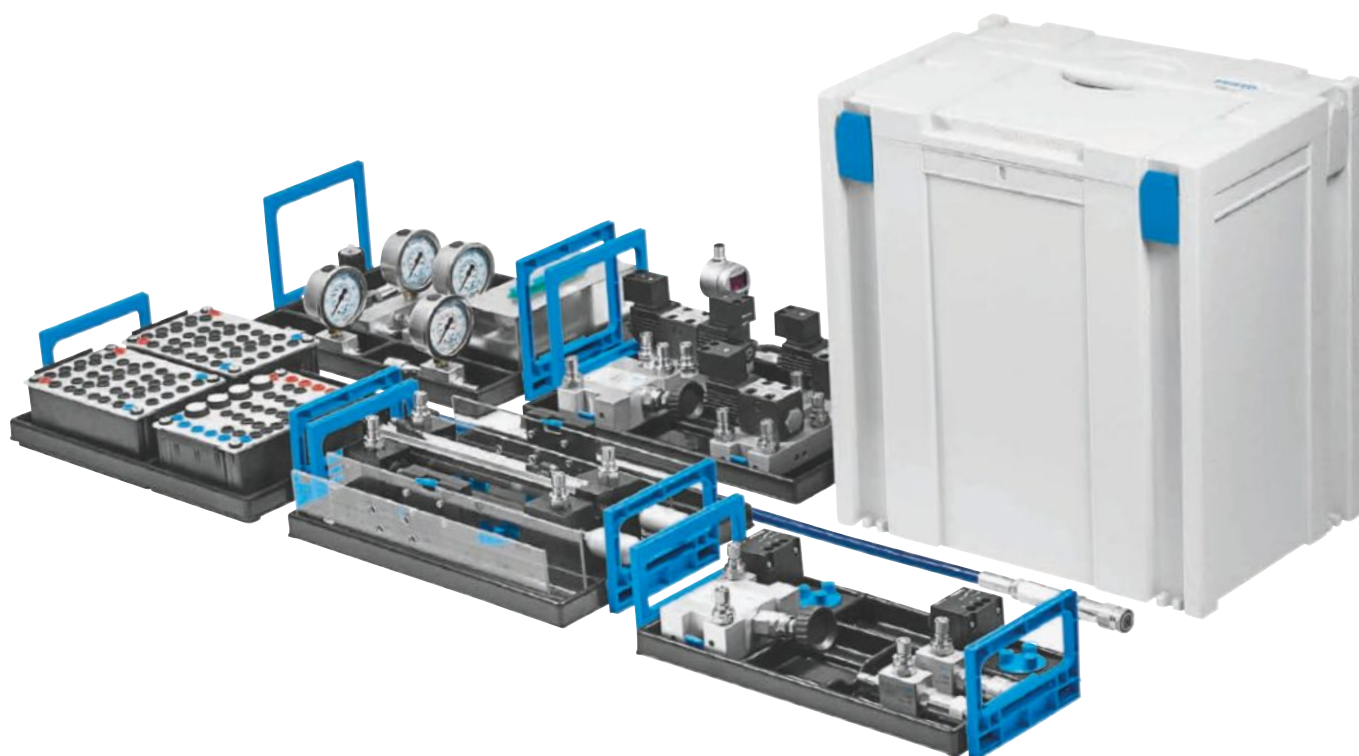
### Supplementary media

- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics
- Textbook Hydraulics – Basic Level
- Hydraulics poster set

# Equipment set TP 601 – Basic Level

## Basic training in electrohydraulics

New



### New edition of electrohydraulics!

TP 601 is a logical further development of electrohydraulics for training and further education. The equipment set contains only electrohydraulic circuits and control systems.

The number and version of the components are specifically adapted to the projects in the workbook. This is a cost-effective way of teaching the important training objectives.

This equipment set provides students with knowledge about the basic physical principles of electrical engineering and electrohydraulics, as well as how electrohydraulic and control technology components function and are used.

### Training content

#### Power packs and components:

- Design, mode of operation and areas of application of 2/2, 3/2, 4/2 and 4/3-way solenoid valves, as well as 4/2-way double solenoid valves
- Design and mode of operation of electrical pushbuttons, switches and limit switches
- Design and mode of operation of a relay
- Knowing and accounting for the contact load capacity of electrical signal transmitters
- Selecting and using hydraulic and electrical components according to economic criteria
- Design and mode of operation of a pressure switch
- Knowing different ways of sensing a cylinder's end position and selecting the right one

#### Hydraulic circuits:

- Commissioning hydraulic circuits safely
- Explaining and designing direct and indirect actuation
- Creating and using a sequence table
- Explaining and designing signal storage in the hydraulic power section
- Selecting solenoid valves according to the technical control requirements
- Using and designing basic logic functions
- Explaining and designing an electric latching circuit with a dominant switch-off signal
- Designing and arranging pressure-dependent control systems
- Knowing simple operating modes and accounting for them in the circuit

- Electrically and mechanically locking of signals in a relay control system
- Expanding existing control systems and adjusting the documentation accordingly Implementing sequence control with two cylinders
- Getting to know and creating a procedure description as GRAFCET and as a function diagram
- Analysing circuits and carrying out systematic fault finding and error elimination with restart

#### Measurements and calculations:

- Measuring and calculating the flow in an electrohydraulic installation
- Calculating electrical characteristic values

## Complete equipment set TP 601 in the Systainer

573037

The most important components at a glance:

1	1x Pressure relief valve	544335
2	1x 2-way flow control valve	544338
3	1x One-way flow control valve	152843
4	1x Non-return valve, 0,6 MPa opening pressure	548618
5	1x 4/2-way solenoid valve, spring return	544346
6	1x 4/3-way solenoid valve, closed mid-position	544347
7	1x 4/2-way double solenoid valve, detenting	544352
8	1x Shut-off valve	152844
9	1x Weight, 9 kg for cylinder	152972
10	2x Differential cylinder 16/10/200 with cover	572746
11	1x Mounting kit for cylinders	544371
12	2x T-distributor	152847
13	2x 4-way distributor with pressure gauge	159395
14	2x Pressure gauge	152841
15	1x Pressure switch, electronic	548612
16	2x Relay, three-fold	162241
17	1x Signal input, electrical	162242
18	1x Limit switch, electrical, left-actuated	183322
19	1x Limit switch, electrical, right-actuated	183345
20	2x Proximity sensor, electronic	548589

Necessary accessories, also order:

7x	Hose line with quick release couplings, 600 mm	152960
2x	Hose line with quick release couplings, 1000 mm	152970
4x	Hose line with quick release couplings, 1500 mm	159386
Safety laboratory cables → Page 52		
Multimeter		571832
Aluminium profile plate → Internet		
Hydraulic power pack → Pages 48 – 49		
Protective cover for weight → Page 45		
Tabletop power supply unit → Internet		
Power supply unit for mounting frame → Page 52		

## The media on offer for TP 601



## Training course documents

The basic electric circuits for hydraulic control technology are presented in 15 exercises. In order to carry out the exercises, students require the equipment set of TP 601 Electrohydraulics, Basic Level.

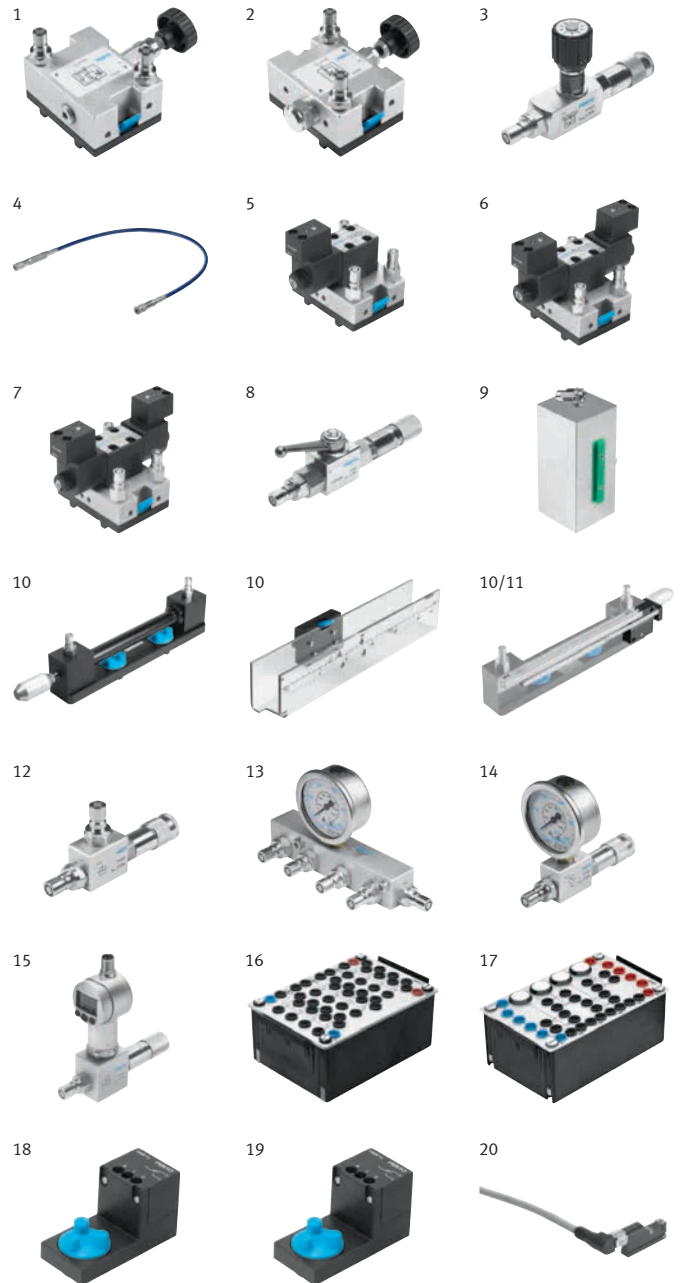
The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	550143
EN	551150
ES	551151
FR	551152

## Supplementary media

- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics
- Textbook Electrohydraulics – Basic Level
- Hydraulics poster set

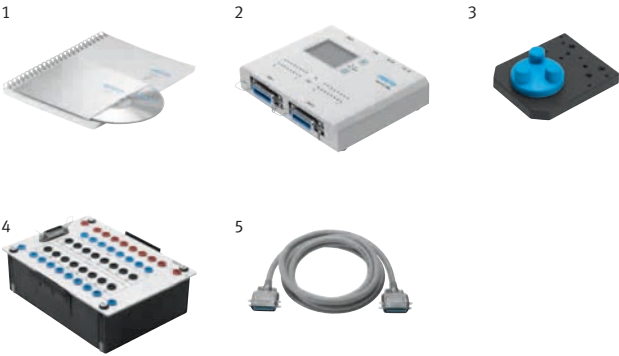




# Supplementary equipment sets

## Controllers for electrohydraulics

New



**Supplementary equipment set Controlling using FluidSIM®/ EasyPort USB**

The FluidSIM® software can be used to control training packages. FluidSIM® controls via EasyPort USB and processes the inputs and outputs connected to the universal connection unit according to their programming, e.g. using the digital module contained in FluidSIM®.

The Controlling using FluidSIM® package contains everything you need to control training packages TP 201 and TP 601. FluidSIM® Pneumatics is required for TP 201 and FluidSIM® Hydraulics for TP 601. A set of brief instructions provides information on the individual steps.

The sample solutions are included on a data storage medium as FluidSIM® CT programs.

Complete supplementary equipment set in the Systainer 556270

The most important components at a glance:		
1	1x Brief instructions for FluidSIM, DE/EN/FR/ES	556267
2	1x EasyPort USB	548687
3	1x EasyPort adapter for profile plate	549806
4	1x Universal connection unit, digital (SysLink)	162231
5	1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031

Prerequisite:

Equipment set TP 601 – Basic level → Pages 10 – 11

FluidSIM Hydraulics (from version 4) → Pages 34 – 35



**Supplementary equipment set Controlling using LOGO! EduTrainer® Compact TP/ LOGO! Soft Comfort**

The quick, uncomplicated and inexpensive introduction to logical signal processing. With its extensive basic and special control technology functions, LOGO! replaces a variety of conventional switchgears and control devices.

The LOGO! EduTrainer® Compact TP package contains everything you need to control training packages TP 201 and TP 601. A set of brief instructions provides information on the individual steps. Programming is carried out using the programming software LOGO! Soft Comfort.

The sample solutions are included on a data storage medium as LOGO! Soft Comfort programs.

Complete supplementary equipment set in the Systainer 556271

The most important components at a glance:		
1	1x Brief instructions for LOGO!, DE/EN/FR/ES	556268
2	1x LOGO! EduTrainer Compact TP	535250
3	1x LOGO! Soft Comfort, DE/EN/FR/ES/IT/PT	526505
4	1x LOGO! Programming cable	526504

Prerequisite:

Equipment set TP 601 – Basic Level → Pages 10 – 11

Necessary accessories, also order:

Aluminium profile plate → Internet

Hydraulic power pack → Pages 48 – 49

Power supply unit for mounting frame → Page 52

Safety laboratory cables → Page 52

# Supplementary equipment sets

## Electrohydraulics

New

### Supplementary equipment set from Hydraulics, Basic level TP 501 to Electrohydraulics, Basic level TP 601

For training aims see Electrohydraulics, Basic level TP 601 equipment set.

Complete supplementary equipment set TP 501 – TP 601 **573039**

The most important components at a glance:

1	2x Relay, three-fold	162241
2	1x Signal input, electrical	162242
3	1x Limit switch, electrical, left-actuated	183322
4	1x Limit switch, electrical, right-actuated	183345
5	1x 4/2-way double solenoid valve, detenting	544352
6	1x 4/2-way solenoid valve, spring return	544346
7	1x 4/3-way solenoid valve, closed mid-position	544347
8	1x Differential cylinder 16/10/200 with cover	572746
9	1x Mounting kit for cylinders	544371
10	1x Pressure switch, electronic	548612
11	2x Proximity sensor, electronic	548589
12	1x T-distributor	152847

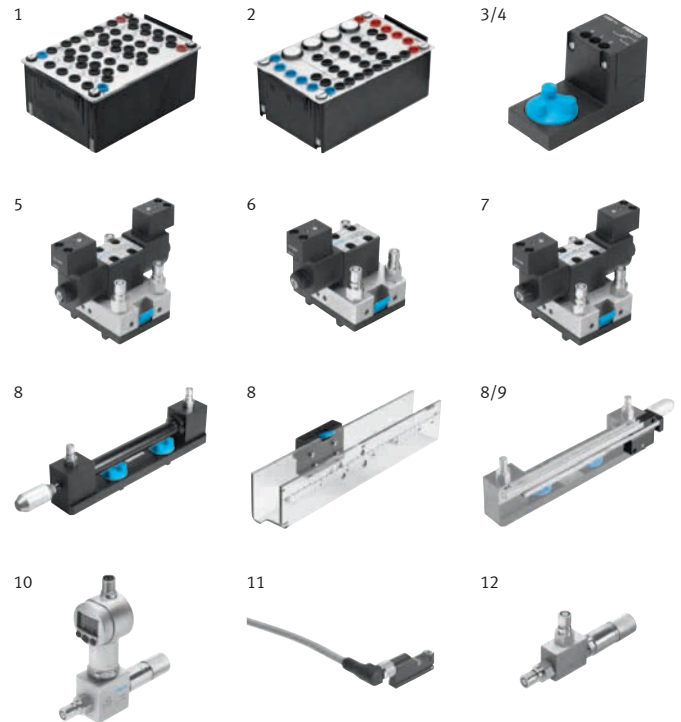
### Supplementary equipment set from Hydraulics, Basic level TP 501 and Advanced level TP 502 to Electrohydraulics, Basic level TP 601

For training aims see Electrohydraulics, Basic level TP 601 equipment set.

Complete supplementary equipment set TP 501 and TP 502 – TP 601 **573040**

The most important components at a glance:

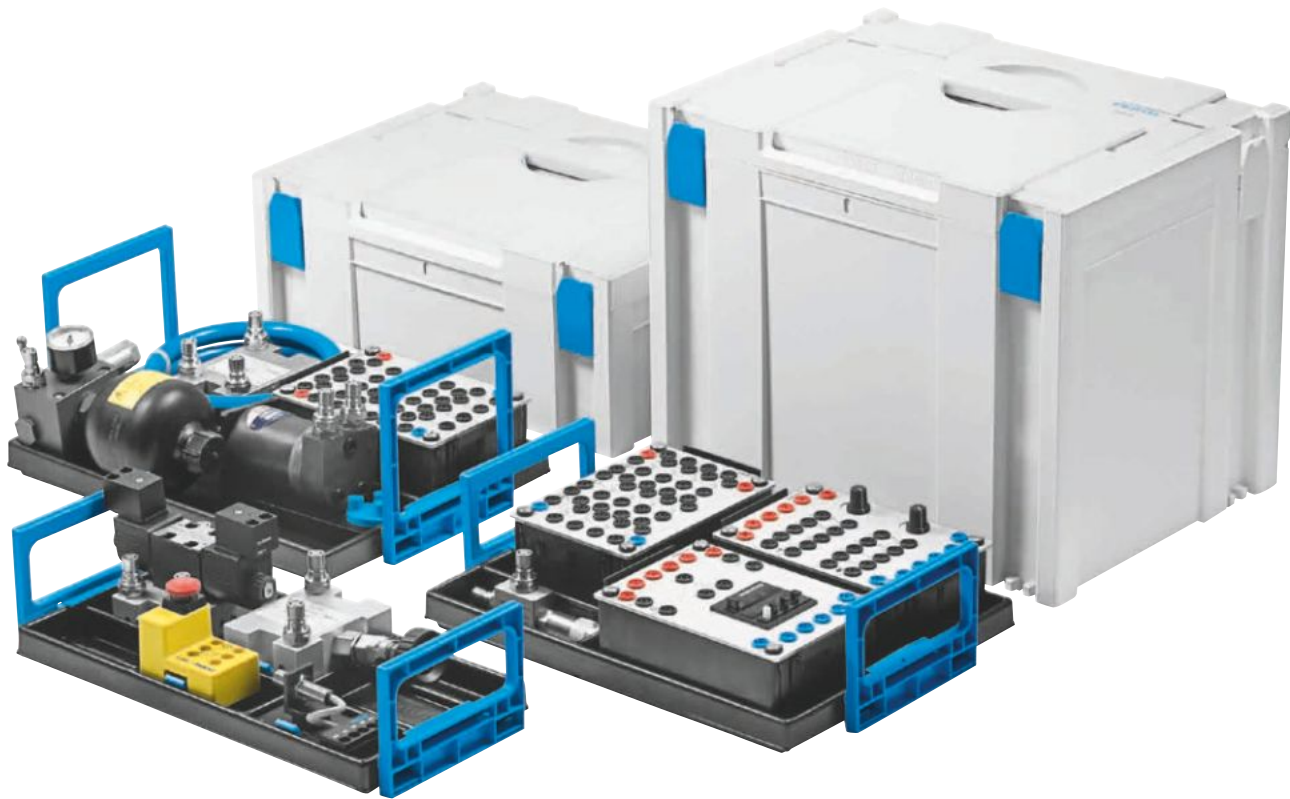
1	2x Relay, three-fold	162241
2	1x Signal input, electrical	162242
3	1x Limit switch, electrical, left-actuated	183322
4	1x Limit switch, electrical, right-actuated	183345
5	1x 4/2-way double solenoid valve, detenting	544352
6	1x 4/2-way solenoid valve, spring return	544346
7	1x 4/3-way solenoid valve, closed mid-position	544347
10	1x Pressure switch, electronic	548612
11	2x Proximity sensor, electronic	548589



# Equipment set TP 602 – Advanced Level

## Electrohydraulics for advanced students

New



### The new advanced level

The training package TP 602 builds directly on the material covered in basic principles package TP 601, and adds more in-depth projects to it.

It provides students with advanced knowledge about the basic physical principles of electrical engineering and electrohydraulics, as well as how electrohydraulic and control technology components function and are used.

In order to carry out the projects, users require the components and the necessary accessories from TP 601.

The number and version of the components are specifically adapted to the projects in the workbook. This makes it possible to achieve many important training objectives at little cost.

### Training content

Power packs and components:

- Design and mode of operation of different proximity sensors
- Function and possible applications of a time relay with switch-on and switch-off delay
- Design and use of an electrical predetermining counter

Learning objectives for hydraulic circuits:

- Selecting proximity sensors according to the technical control requirements
- Expanding electrohydraulic control systems and adjusting the documentation
- Designing and arranging path- and pressure-dependent sequence controls
- Identifying signal overlaps in a sequence control and taking the appropriate action
- Designing and arranging sequence control as a standing sequencer

- Using memory to implement an emergency operation
- Implementing control systems with the operating modes single cycle and continuous cycle
- Querying time in electrohydraulic control systems
- Getting to know and using further logical connections
- Designing and arranging pressure sequence control
- Knowing safety-related conditions that could be needed for a drive
- Designing and arranging safety functions with a predefined motion sequence for a control system
- Implementing control systems with the operating modes inching and aligning
- Systematically identifying and eliminating errors in complex electrohydraulic control systems
- Creating sequence control as a displacement-step diagram
- Representing procedure descriptions with GRAFCET

### Hydraulics plus!

The training package is delivered in practical trays, packaged in a Systainer. The trays fit into the drawers in Learnline workstations. The new components, with added training value and relevant project tasks, form the basis for advanced training in fundamental principles.



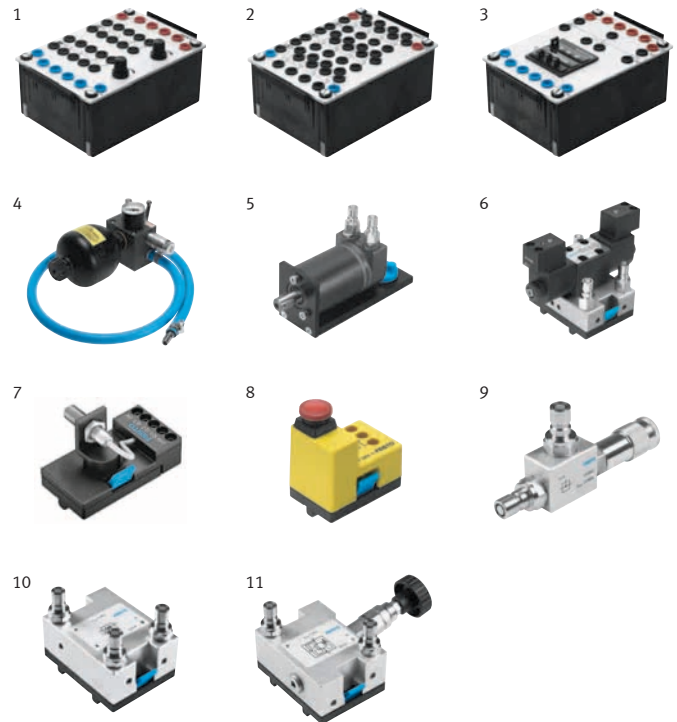
# Complete equipment set TP 602 in the Systainer **573038**

The most important components at a glance:

1	1x Time relay, two-fold	162243
2	2x Relay, three-fold	162241
3	1x Preset counter, electrical, incrementing	162355
4	1x Diaphragm accumulator with shut-off block	152859
5	1x Hydraulic motor	152858
6	1x 4/3-way solenoid valve, relieving mid-position (AB→T)	544348
7	1x Proximity sensor, inductive, M12	548643
8	1x Emergency stop pushbutton, electrical	183347
9	1x T-distributor	152847
10	1x Non-return valve, delockable	544339
11	1x Pressure relief valve, compensated	567237

Necessary accessories, also order:

8x	Hose line with quick release couplings, 600 mm	152960
4x	Hose line with quick release couplings, 1000 mm	152970
2x	Hose line with quick release couplings, 1500 mm	159386
Safety laboratory cables → Page 52		
Multimeter		571832
Aluminium profile plate → Internet		
Hydraulic power pack → Pages 48 – 49		
Protective cover for weight → Page 45		
Tabletop power supply unit → Internet		
Power supply unit for mounting frame → Page 52		



## The strong blended learning range for TP 602



### Training course documents

The basic practical circuits in electrohydraulics are presented in 12 exercises. In order to carry out the exercises, students require the equipment set of TP 601 Electrohydraulics, Basic Level and Advanced Level TP 602.

The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	<b>550144</b>
EN	<b>551153</b>
ES	<b>551154</b>
FR	<b>551155</b>

### Supplementary media

- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics
- Textbook: Basic level – Electrohydraulics
- Hydraulics poster set

# Equipment set TP 610 – Advanced level

## Measurement and control in Hydraulics with FluidLab®-H

New



### Fit for tomorrow?

The equipment set for TP 610 expands the training content of TP 501 and TP 601 to include the topic of hydraulics measurement and control. The material covered ranges from recording simple characteristic curves of individual hydraulic valves through to the basic principles of cylinder control. In addition, awareness is raised in a clear and striking manner about the effective use of hydraulic energy, e.g. with resistance experiments.

New features of FluidLab®-H include the measurement experiments for proportional technology with recording characteristic curves and applications such as pressure stages and rapid traverse feed circuits, as well as control technology with position, sequence and pressure control.

Exercises for the measurement and analysis of system and control behaviour point to a future in which diagnostics, preventative maintenance and saving energy are becoming more and more important.

### Something extra special

In order to complete the exercises, sensors (e.g. pressure, flow and position) are connected to the inputs and control signals are transmitted to the EasyPort USB outputs. The FluidLab®-H software included in the scope of delivery interprets and visualises the signals. Analogue values are displayed as measurement curves.

Each exercise includes notes on its implementation, with positional sketches and block circuit diagrams. Students are guided step by step through the experiments. Measured results are then interpreted, compared with sample solutions and questions are asked to check students' understanding.

### Training content

- Basic principles of analogue processing
- Using and adjusting sensors
- Interpreting measurement results
- Reading and understanding technical data and measurement curves
- Getting to know fluid engineering components and their influence and function
- Demonstrating fluid engineering effects and special features
- Analytical fault finding
- Hydraulic energy
- Evaluating changes of state
- Proportional technology
- Control technology with position, sequence and pressure control

### Your advantages

- Fast, PC-supported recording of measured values
- Greater training success through measurement of components and interpretation of results
- Sensors that enable students “to look into” the circuit and components
- Suppositions regarding system behaviour can be easily proven
- Learning the principles of measurement and analysis and applying them directly in other circuits
- Demonstrate and understand the principles of fluid engineering faster
- System analysis via a PC: State-of-the-art diagnostic method
- Better understanding of fluid engineering components and processes and thus better training outcomes

# Complete equipment set TP 610 in Systainer 567194

The most important components at a glance:

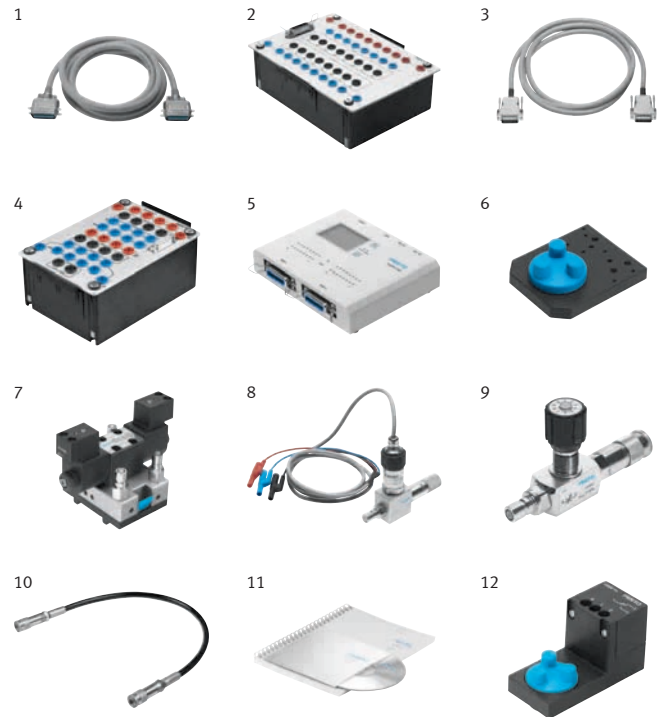
1	1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
2	1x Universal connection unit, digital (SysLink)	162231
3	1x Analogue cable, parallel, 2 m	529141
4	1x Connection unit, analogue	567232
5	1x EasyPort USB	548687
6	1x EasyPort adapter for profile plate	549806
7	1x 4/3-way solenoid valve, relieving mid-position (AB→T)	544348
8	2x Pressure sensor	525964
9	1x Flow control valve	152842
10	1x Resistance hose line with quick release couplings, 1000 mm	549858
11	1x FluidLab-H Single licence	573286
12	1x Limit switch, electrical, left-actuated	183322

The exercises for proportional and control hydraulics also require

Proportional amplifier	162255
Displacement encoder for cylinder, 200 mm stroke	167090
Mounting kit for cylinders	544371
4/3-way proportional valve	167086
Proportional pressure relief valve	544351
Pressure filter	548609

Optionally, the regulating valve can be used instead of the proportional amplifier with the proportional valves for the control technology exercises.

4/3-way regulating valve	167088
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## Includes FluidLab®-H measurement software

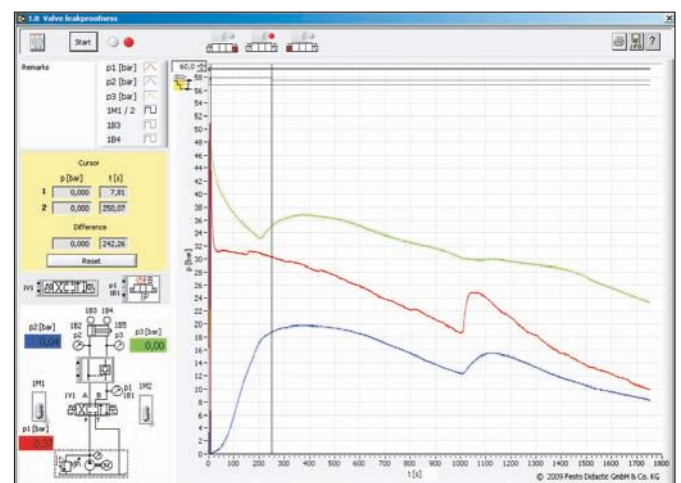
The FluidLab®-H software is an important component of the training package TP 610. Just a few simple steps are needed to configure the interface, adapt the sensors and select the language (DE/EN/ES/FR). Then the exercises can begin. These are divided into the areas: basic experiments, cylinder controls, proportional technology and control engineering. Connection diagrams, descriptions and sample solutions support students during the exercises. The software also controls the measurement sequence. Diagrams can be dimensioned and printed out using the cursors. The software also includes the complete book of exercises, with sample solutions, in PDF format.

## System requirements

- PC with Windows XP/Vista/7
- At least Pentium 1 GHz
- 2 GB RAM
- CD-ROM drive
- USB 2.0 or serial interface
- 1280 x 1024 pixels

NI LabView 8.2.1 Runtime  
(included in the scope of delivery)

To carry out the exercises, students require the components and appropriate accessories from training packages 501 and 601.





# Equipment set TP 701 – Basic level

## Basic proportional hydraulics training



### Proportional hydraulics, Basic Level

Proportional valves are continuous valves that, thanks to proportional magnets, not only permit simple switching positions, but also enable a continuous transition in the valve opening.

These valves are specifically used in hydraulics where variable volumetric flows (proportional directional control valve or proportional throttle) are needed together with load compensation (proportional flow control valve) or variable pressures (proportional pressure-relief valve). The equipment set provides information about proportional valves, how they function and how they are activated using proportional amplifiers and a setpoint value card. The set can be used to design, set and commission simply proportional control systems.

### Training content

#### Components:

- Design and function of different proportional valves
- Characteristic curves and characteristics of proportional valves
- Design and function of amplifiers and setpoint specification
- Getting to know the characteristics of the 1 and 2-channel amplifier
- Completely setting the 1-channel amplifier
- Setting the basic current, step current and maximum current
- Getting to know the characteristics of the 4/3-way proportional valve and the proportional pressure-relief valve
- Deriving the settings for the 2 channel amplifier
- Setting ramps
- Deriving the ramp settings from the function diagram

#### Measurements and calculations:

- Determining characteristic curves and characteristics of valves and equipment
- Measuring parameters such as pressure, volumetric flow and time
- Calculating the flow for proportional directional control valves
- Calculating speeds for double-acting cylinders with varying load
- Calculating the natural frequency of a cylinder drive
- Calculating times for acceleration and braking

#### Hydraulic circuits:

- Controlling pressure and speed
- Reading and creating hydraulic and electric circuit diagrams
- Creating a function diagram
- Designing and commissioning control systems, including fault finding

- Basic circuits for proportional hydraulics, such as pressure stage circuit, rapid traverse feed circuit, pump bypass, approaching positions, controlled acceleration and braking, logically connecting setpoint values, load-independent speeds
- Getting to know the pressure stage control system
- Braking a cylinder feed
- Reversing a hydraulic motor
- Setting process-dependent pressure stages
- Externally and logically interconnecting setpoint values
- Approaching a position with braking
- Creating a load-independent feed speed

### Complete equipment set TP 701

**184465**

The most important components at a glance:

1	1x Relay, three-fold	162241
2	1x Proportional amplifier	162255
3	1x Setpoint value card	162256
4	1x Signal input, electrical	162242
5	2x Proximity sensor, inductive, M12	548643
6	1x 4/3-way proportional valve	167086
7	1x 4/2-way solenoid valve	167082
8	1x Proportional pressure relief valve	544351
9	1x Pressure filter	548609
10	1x Pressure balance (proportional flow control valve)	159351
11	1x Pressure relief valve/Pressure sequence valve	152848
12	1x Differential cylinder 16/10/200	152857
13	1x Hydraulic motor	152858
14	1x Flow control valve	152842
15	1x One-way flow control valve	152843
16	2x Pressure gauge	152841
17	2x T-distributor	152847
18	1x Weight, 9 kg for cylinder	152972

Necessary accessories, also order:

5x	Hose line with quick release couplings, 1000 mm	152970
2x	Hose line with quick release couplings, 1500 mm	159386
	Measuring case	177468
	Pressure relief unit	152971
	Safety laboratory cables → Page 52	
	Aluminium profile plate → Internet	
	Hydraulic power pack → Pages 48 – 49	
	Protective cover for weight → Page 45	
	Tabletop power supply unit → Internet	
	Power supply unit for mounting frame → Page 52	

### The strong blended learning range for TP 701



### Training course documents

Ten exercises provide an introduction to the equipment and circuits for proportional hydraulics. First of all, individual items of equipment are presented and their settings are tested. The graduated exercises then provide a complete solution.

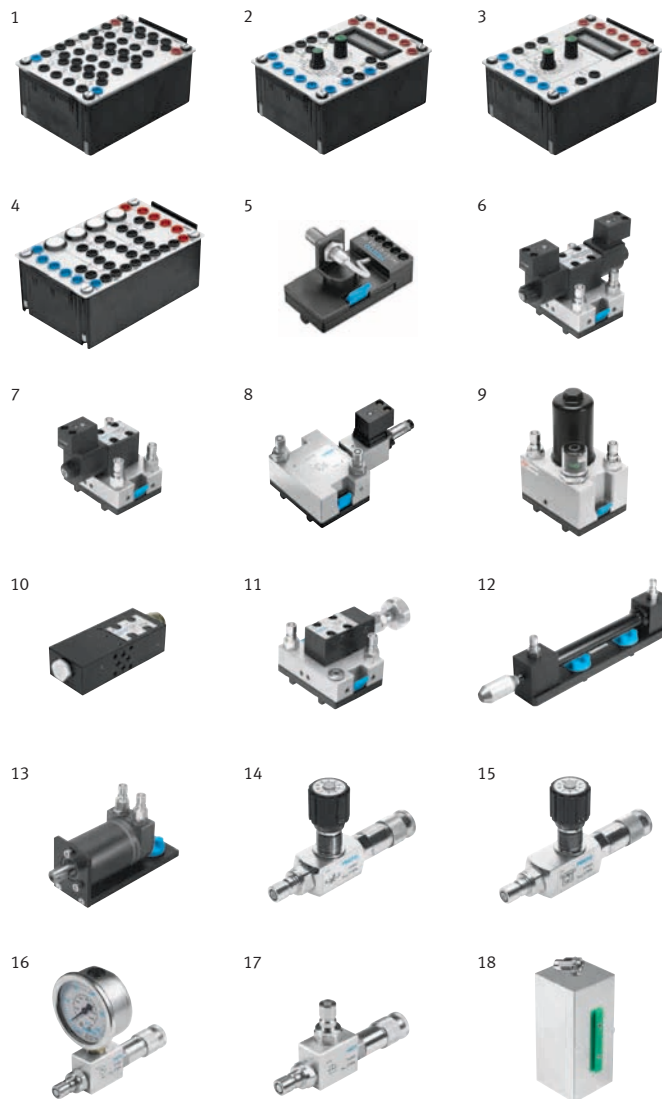
The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	<b>94457</b>
EN	<b>94472</b>
ES	<b>94404</b>
FR	<b>94352</b>

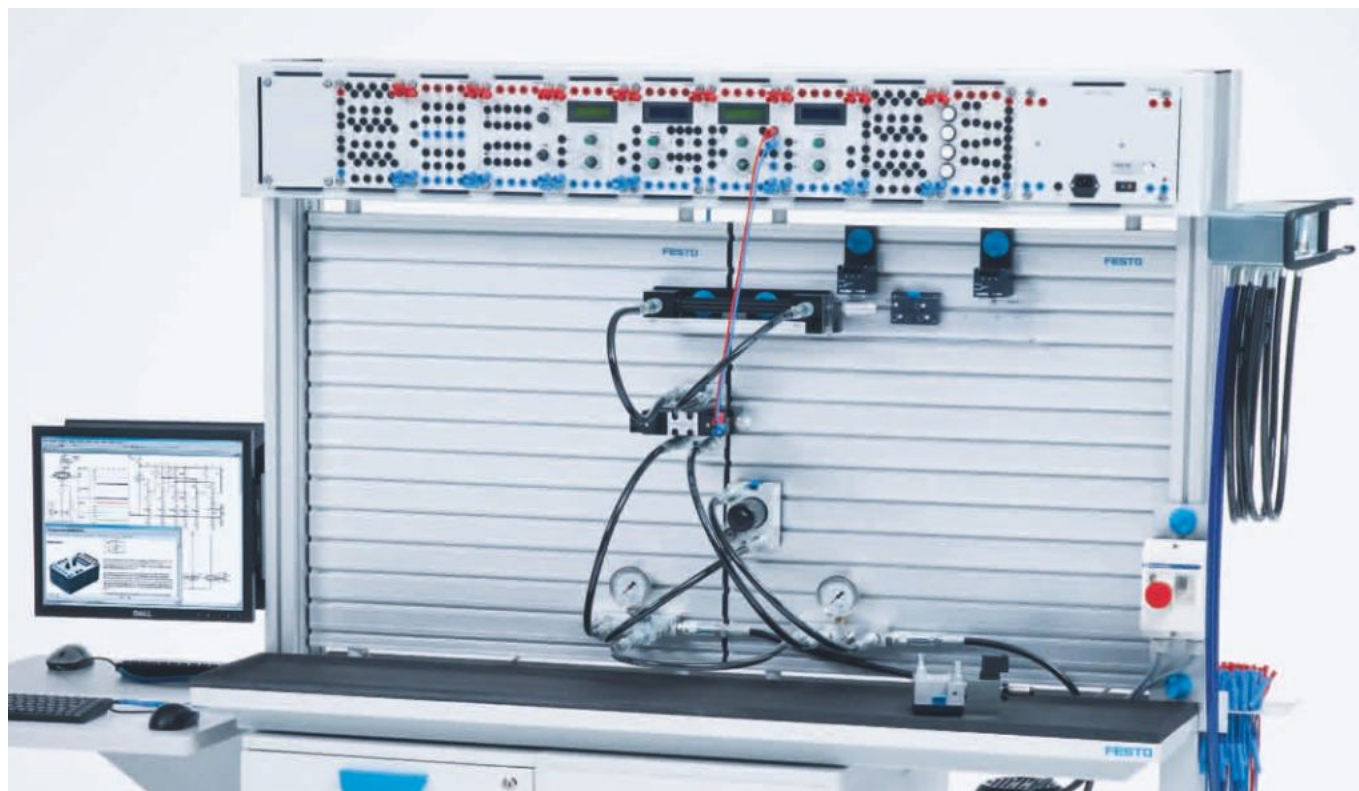
### Supplementary media

- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics/ Open- and closed-loop control
- Textbook: Proportional hydraulics
  - Basic level
- Hydraulics poster set



# Equipment set TP 702 – Advanced level

## Advanced proportional hydraulics training



### Proportional hydraulics Advanced Level

The training package TP 702 builds directly on the material covered in package TP 701, Basic Level, and adds nine further, more in-depth and real-life case studies.

The package includes the following steps:

- Understanding the task using a positional sketch, diagram and problem description
- Designing the hydraulic circuit diagram
- Determining the necessary signal transmitters
- Compiling the sequence table
- Designing the electric signal control system
- Structuring and commissioning the proportional hydraulic control system
- Settings and evaluating the result

### Training content

#### Components:

- Determining characteristics curves and characteristics of different sensors
- Coordinating electrical and hydraulic equipment
- Creating characteristic curves for displacement, pressure and temperature sensors

#### Measurements and calculations:

- Measuring and processing parameters such as displacement, time, pressure and temperature
- Further signal processing of analogue signals

#### Hydraulic circuits:

- Controlling pressure, speed, acceleration, delay and position
- Reading and creating proportional hydraulic and electric circuit diagrams
- Reading motion diagrams
- Designing and commissioning proportional hydraulic control systems, including fault finding
- Adjusting and coordinating as per the specified procedure description
- Using basic circuits for proportional hydraulics such as: speed, rotational speed, stage, acceleration, braking and differential circuits, as well as positioning
- Implementing specific displacement-time and positioning programs
- Setting precise switch-off positions
- Implementing drive acceleration with a proportional pressure-relief valve

- Implementing oscillating movements for a cylinder with a proportional hydraulic control system
- Implementing the specified speed profile by means of an additional bypass circuit and slow retraction to the end positions
- Implementing a travel process with a 2/2-way proportional valve and a proportional pressure-relief valve

### Complete equipment set TP 702

**184466**

The most important components at a glance:

1	1x Setpoint value card	162256
2	1x Comparator	162257
3	1x Time relay, two-fold	162243
4	1x Indicator unit and distributor, electrical	162244
5	3x Relay, three-fold	162241
6	1x Limit switch, electrical, left-actuated	183322
7	1x Limit switch, electrical, right-actuated	183345
8	1x Proximity sensor, capacitive, M12	548651
9	1x Proximity sensor, optical, M12	572744
10	1x Non-return valve, delockable	152852
11	1x T-distributor	152847
12	1x Non-return valve	152845
13	1x Displacement encoder for cylinder	167090
14	1x Mounting kit for cylinders	544371

Necessary accessories, also order:

5x	Hose line with quick release couplings, 600 mm	152960
2x	Hose line with quick release couplings, 1500 mm	159386
	Measuring case	177468
	Pressure relief unit	152971
	Safety laboratory cables → Page 52	
	Aluminium profile plate → Internet	
	Hydraulic power pack → Pages 48 – 49	
	Protective cover for weight → Page 45	
	Tabletop power supply unit → Internet	
	Power supply unit for mounting frame → Page 52	

### The strong blended learning range for TP 702



### Training course documents

Nine exercises illustrate the most important circuits and equipment in proportional hydraulics. To carry out the exercises, the equipment sets for proportional hydraulics TP 701 (Basic Level) and TP 702 (Advanced Level) are required.

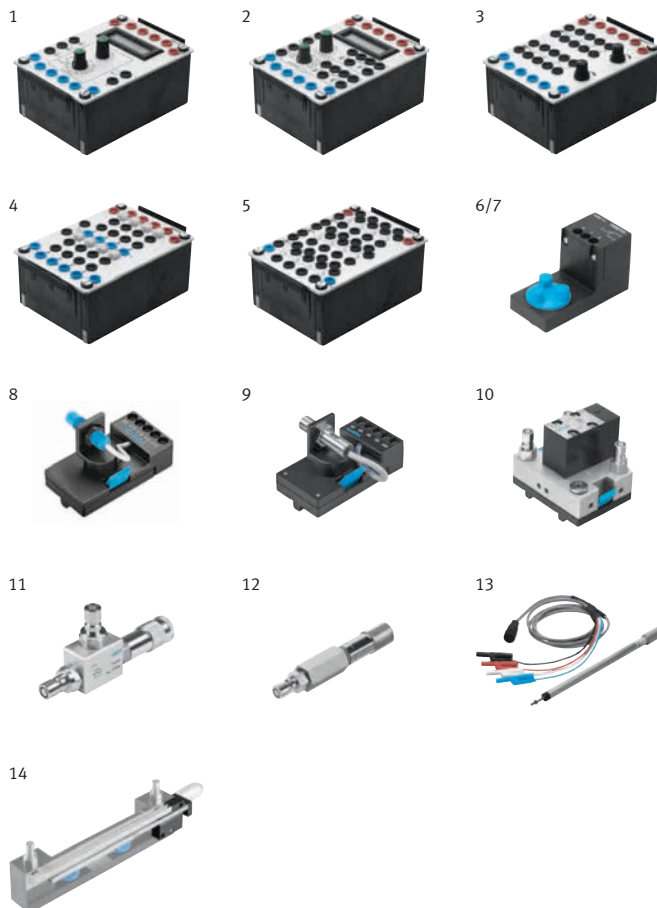
The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	<b>94458</b>
EN	<b>94473</b>
ES	<b>94450</b>

### Supplementary media

- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics/ Open- and closed-loop control
- Textbook: Proportional hydraulics
  - Basic level
- Hydraulics poster set





# Equipment set TP 511

## Basic closed-loop hydraulics training



### Closed-loop hydraulics, Basic Level

Hydraulic closed-loop control circuits are normally operated with continuous valves. A control valve with integrated electronics, linear characteristic curve (volumetric flow to control piston position) and zero overlap makes commissioning easy and provides good results in the closed-loop control circuit.

### Training content

#### Position control circuits:

- Characteristic curve of a displacement sensor
- Flow rate characteristics of a continuous directional control valve
- Linear unit as a controlled system for position control
- Designing and commissioning a position control circuit
- Lag errors in the position control circuit
- Position control with a changed controlled system
- Commissioning a position control circuit with disturbances
- Characteristics and transition functions of a status controller
- Parameterising a status controller

#### Pressure control circuits:

- Characteristic curve of a pressure sensor
- Controlled system for pressure control
- Characteristics of a PID controller board

- Transition function of a P controller
- Control performance of a pressure control circuit with P controller
- Transition functions of I and PI controllers
- Transition functions of D, PD and PID controllers
- Empirical parameterisation of a PID controller
- Parameterising using the Ziegler-Nichols method
- Changed controlled system with disturbances

#### Controllers in hydraulics:

- Controlled systems with and without compensation
- Low-delay hydraulic controlled systems
- First, second and third order hydraulic controlled systems
- Classifying controlled systems according to their step response
- Operating point and controller amplification
- Discontinuous controllers
- Block diagrams for discontinuous and continuous controllers
- P, I, D, PI, PD and PID controllers
- Status controllers

- Selecting the controller structure
- Disturbance reaction and control factor
- Designing control circuits
- Hydraulic, mechanical and electrical controllers
- Analogue and digital controllers
- Selection criteria for controllers

#### Valves and measuring systems:

- Designation, circuit symbols and function of continuous directional control valves
- Stationary characteristics and dynamic behaviour of continuous directional control valves
- Function, design and mode of operation of a pressure regulating valve
- Pressure control with a directional control valve
- Mode of operation and interface of a measuring system

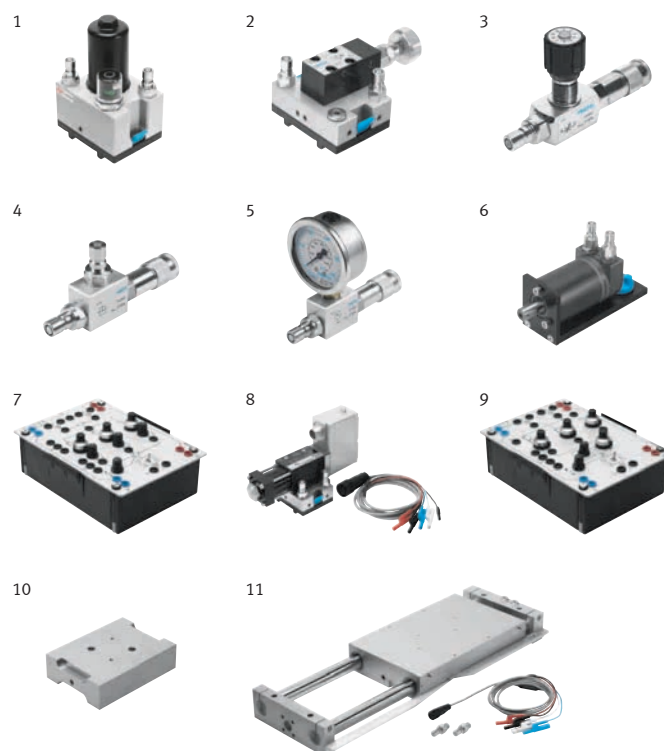
# Complete equipment set TP 511 184471

The most important components at a glance:

1	1x Pressure filter	548609
2	1x Pressure relief valve/Pressure sequence valve	152848
3	1x Flow control valve	152842
4	4x T-distributor	152847
5	1x Pressure gauge	152841
6	1x Hydraulic motor	152858
7	1x PID controller	162254
8	1x 4/3-way regulating valve	167088
9	1x Status controller	162253
10	2x Weight, 5 kg for linear drive	34065
11	1x Linear drive	167089

Necessary accessories, also order:

7x	Hose line with quick release couplings, 1000 mm	152970
4x	Hose line with quick release couplings, 1500 mm	159386
2x	Hose line with quick release couplings, 3000 mm	158352
	Measuring case	177468
	Pressure relief unit	152971
	Cushioning cylinder for linear drive	152295
	Function generator	152918
	Cable BNC – 4 mm	152919
	Cable BNC – BNC	158357
	T-connector BNC	159298
	Oscilloscope → Internet	
	Hydraulic power pack → Pages 48 – 49	
	Power supply unit for mounting frame → Page 52	



## The strong blended learning range for TP 511



### Training course documents

Twenty exercises cover the most important principles of analogue closed-loop control: pressure and position control with PID controller and position control with status controller.

The workbook contains:

- Sample solutions
- Training notes
- Multimedia CD-ROM with photos and videos of industrial applications and circuit diagrams
- Worksheets for students

DE	94460
EN	94469
ES	94368
FR	94348

### Supplementary media

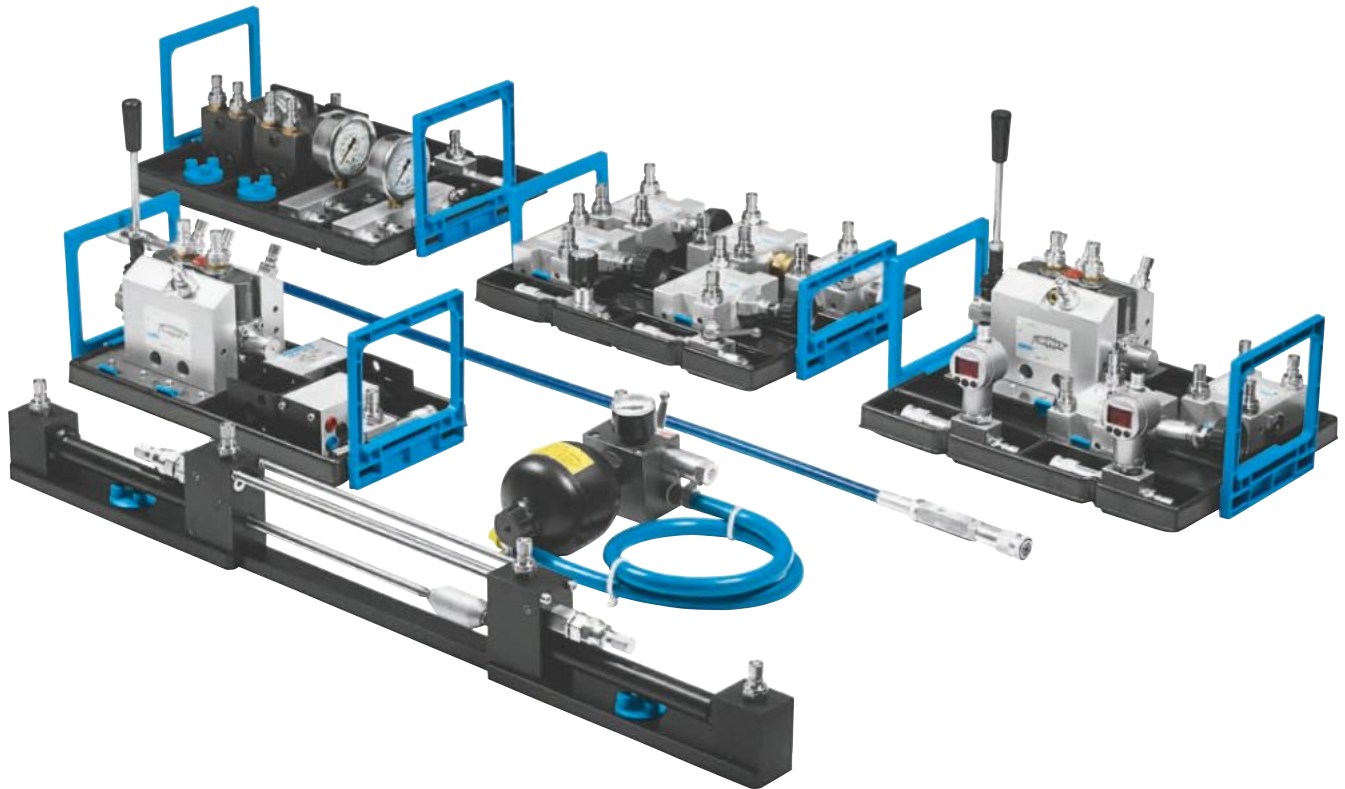
- Designing and simulating with FluidSIM®
- Measuring and controlling with FluidLab®
- Digital learning program Hydraulics/Electrohydraulics/ Open- and closed-loop control
- Textbook: Proportional hydraulics
  - Basic level
- Hydraulics poster set

Partial equipment sets for controlling pressure and position on request.

# Equipment set TP 801 – Basic level

## Mobile hydraulics – Working hydraulics 1

New



### Mobile hydraulics from Festo Didactic

Mobile hydraulics has a range of specific features compared to conventional industrial hydraulics. Training content is therefore usually explained and demonstrated directly on the vehicle.

But what if the hydraulic components being explained or the vehicle are not accessible or the system is too complex for teaching purposes?

Festo Didactic's new training system closes the gap between the basic principles of hydraulics and the hydraulic systems on a vehicle.

### Complexity clarified

The new training packages for mobile hydraulics take components which often appear in vehicles as highly integrated functional modules and present them as separate, individual elements with unique symbols and clear terminal identification codes.

The teaching principle behind this is that of guiding students step by step from a simple component to a complex complete picture, with practical demonstrations. The universal compatibility of the single elements allows them to be used for other function units, making this equipment set highly flexible.

### Fully compatible

With uniform interfaces and a modular structure, it is possible to put together even quite complex entire systems. All mobile hydraulics elements are compatible with the current Festo Didactic equipment sets for hydraulics fundamentals, electrohydraulics, proportional and closed-loop hydraulics.

However, it is the double pump power unit with a pressure-limited constant displacement pump and variable displacement pump with load sensing control which forms the basis for the perfect training station and workstation. It also allows assembly of the load sensing system with TP 803.

Alternatively, it is possible to use a hydraulic power unit with a constant displacement pump and a volumetric flow rate of about 4 l/min for TP 801 and TP 802.

### TP 801 – training content

Many vehicles and applications make use of constant displacement pumps which continue to provide volumetric flow even when no hydraulic power is required. In TP 801, the energy usage of different systems – also when under load – is compared and assessed. Systems with multiple consuming devices are set up, connected in parallel, tandem and series, and examined in terms of characteristics such as priority, flow rate distribution, and pressure dependency.

The training also looks into the basics of holding the load with poppet valves and lowering the load with counter pressure and a counterbalancing valve.

### Complete equipment set TP 801 in equipment tray

**574161**

The most important components at a glance:

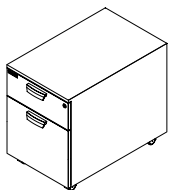
1	1x Counterbalance valve	572149
2	1x Pressure compensator for open centre load sensing	572123
3	1x 3-way pressure reducing valve	544337
4	2x Pressure relief valve	544335
5	1x Flow control valve	152842
6	1x Non-return valve, 0,6 MPa opening pressure	548618
7	1x Shuttle valve	572122
8	1x Double non-return valve, delockable	572151
9	1x Shut-off valve	152844
10	2x Proportional 6/3-way hand lever valve	572141
11	1x Loading unit/cylinder load simulator	572145
12	1x Diaphragm accumulator with shut-off block	152859
13	2x Hydraulic motor	152858
14	2x 4-way distributor with pressure gauge	159395
15	3x T-distributor	152847
16	2x Pressure switch, electronic	548612
17	2x Flow sensor	567191

Necessary accessories, also order:

10x	Hose line with quick release couplings, 600 mm	152960
4x	Hose line with quick release couplings, 1000 mm	152970
2x	Hose line with quick release couplings, 1500 mm	159386
2x	Multimeter	571832
Safety laboratory cables → Page 52		
Hydraulic power pack → Pages 48 – 49		
Power supply unit for mounting frame → Page 52		

### The equipment tray

The training package is supplied with an equipment tray. This equipment tray fits in the drawers of the workstations. A fixed drawer unit for mobile hydraulics with two drawers is recommended for particularly large components.



Wheeled drawer unit for mobile hydraulics  
(2 drawers)

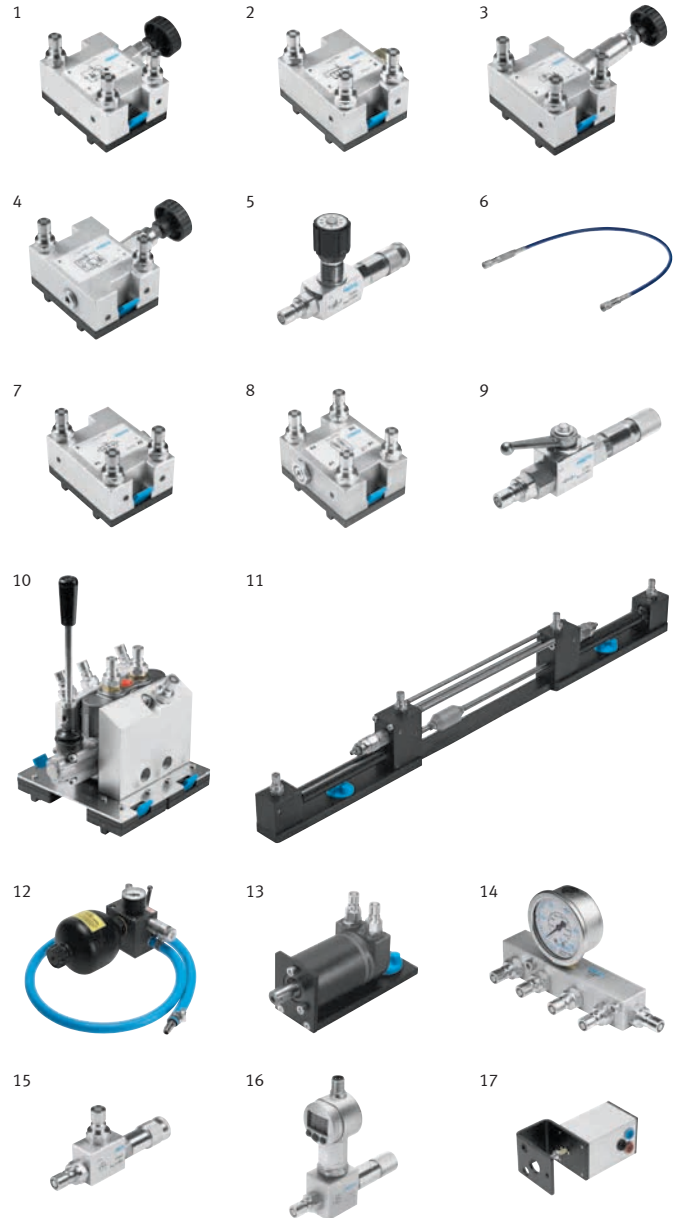
Order no. **574152**

Fixed drawer unit for mobile hydraulics  
(2 drawers)

Order no. **574153**

### The media on offer for TP 801

- Training course documents for mobile hydraulics TP 800
- Diagnostic system TP 810 with FluidLab®-M
- Designing and simulating with FluidSIM®
- Digital learning program, Hydraulics
- Digital learning program, Electrohydraulics
- Hydraulics poster set

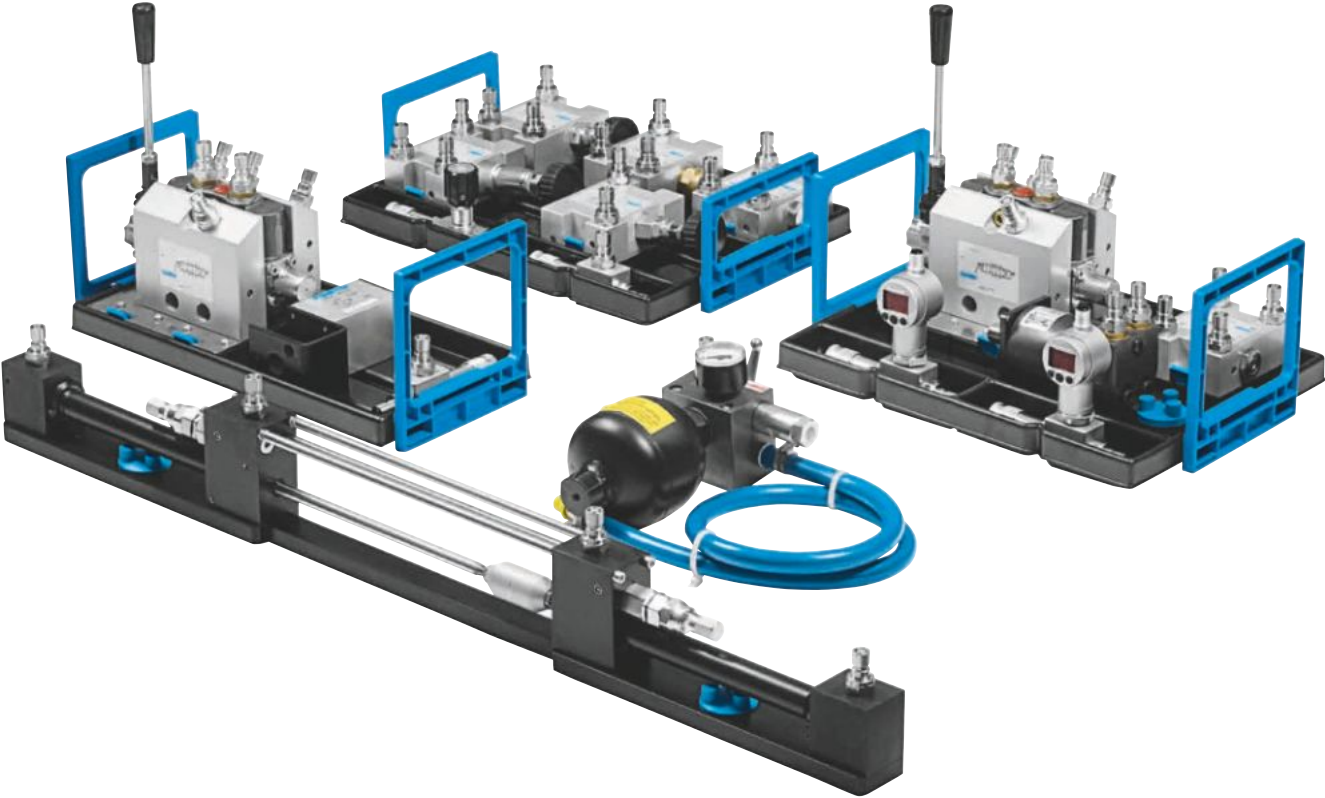




# Supplementary equipment set

## Mobile hydraulics

New



### Supplementary equipment set to upgrade Hydraulics, Basic level TP 501 to Mobile hydraulics, Working hydraulics 1 TP 801

The supplementary equipment set extends TP 501 (order no. 573035) to form TP 801. The necessary accessories from TP 801 are required in order to carry out the exercises. Supplements are available on request for other/older equipment sets.

For training content, see Equipment set, Mobile hydraulics, Working hydraulics 1 TP 801.

Complete supplementary equipment set TP 501 – TP 801 in equipment tray
574160

The most important components at a glance:		
1x	Counterbalance valve	572149
1x	Pressure compensator for open centre load sensing	572123
1x	3-way pressure reducing valve	544337
1x	Pressure relief valve	544335
1x	Flow control valve	152842
1x	Shuttle valve	572122
1x	Double non-return valve, delockable	572151
2x	Proportional 6/3-way hand lever valve	572141
1x	Diaphragm accumulator with shut-off block	152859
1x	Loading unit/cylinder load simulator	572145
1x	Hydraulic motor	152858
2x	T-distributor	152847
2x	Pressure switch, electronic	548612
1x	Flow sensor	567191

# Mobile hydraulics TP 800

## Training course documents

New



### Mobile hydraulics TP 800

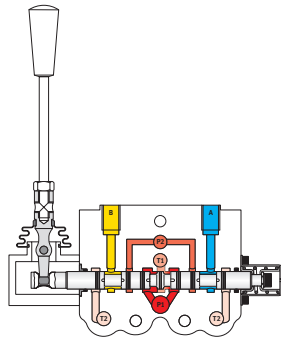
The workbook contains all the project exercises designed for equipment sets TP 801, TP 802 and TP 803 together with the corresponding exercise sheets and sample solutions. It thus provides a comprehensive course companion conveying the essential knowledge and basic principles of the hydraulic systems of mobile machines.

The basic level contains the following topics:

- Definition of terms and basic principles of hydraulics
- Closed hydraulic circuit
- Load-sensing systems and variable displacement pumps
- Flow divider
- Mobile control blocks
- 6/3-way proportional valves and valve configurations
- Pressure balances
- Holding and lowering loads
- Hydraulic pilot control (joystick)
- Priority valves
- Steering systems

The workbook contains:

- Basic information
- Exercise sections comprising project exercises and sample solutions for TP 801, TP 802 and TP 803
- Training notes
- Multimedia CD-ROM with supplementary media
- Worksheets for students



### Exercise section TP 801 Working hydraulics 1

This training section, made up of 11 project exercises, is designed for the equipment set TP 801.

Each project exercise begins by presenting the training objectives which can be achieved. Next, the vehicle or application under discussion is presented. Parameters are provided to ensure a uniform starting point, and the project goal ensures a structured approach.

#### Energy usage

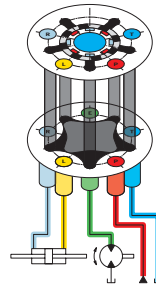
- Of flow control
- Of open centre load sensing
- Of a proportional valve (supply)
- Of a proportional valve (supply and discharge) with and without open centre load sensing
- Of a proportional valve with pump bypass with and without loaded cylinder

#### Holding load, lowering load

- Holding load (piloted non-return valves)
- Lowering load (counter pressure)
- Lowering load (counterbalancing valve)

#### Circuits with multiple loads

- Features of parallel connection
- Features of tandem connection
- Features of series connection



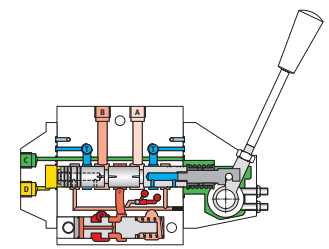
### Exercise section TP 802 Hydrostatic steering system

This training section, made up of 5 project exercises, is designed for the equipment set TP 802.

During all project exercises, trainees set up a circuit as per the instructions and the relevant circuit diagram, and carry out measurements and calculations. Each project exercise ends with a series of questions are asked to test trainees' understanding. The measurements, calculations and answers can then be compared with the sample solutions and discussed.

#### Basic principles of hydrostatic steering

- Structure of a steering system with through-rod cylinders
- Structure of a steering system with two differential cylinders
- Displacement of the steering valve
- Emergency steering characteristics of the steering valve
- Loads and overloads in the steering system
- Torque dependency of the steering valve
- Priorities of the steering system and secondary loads



### Exercise section TP 803 Working hydraulics 2

This training section, made up of 10 project exercises, is designed for the equipment set TP 803.

The content builds on the training content of TP 801, Working hydraulics 1 and expands it to include the complex topic of systems with a variable displacement pump with load sensing control. However, the complexity is kept to a manageable level because the project exercises are progressive, each building on the one before.

#### Load-sensing systems

- Design and function of a control block
- Control block with closed centre load sensing
- Control block with two loads
- Flow rate limitation on the control block
- Pilot control of a control block
- Dependencies of load and flow
- Functioning of an upstream pressure balance
- Pressure compensation for load sensing
- Characteristics of upstream pressure balances when there is more than one load
- Characteristics of downstream pressure balances when there is more than one load

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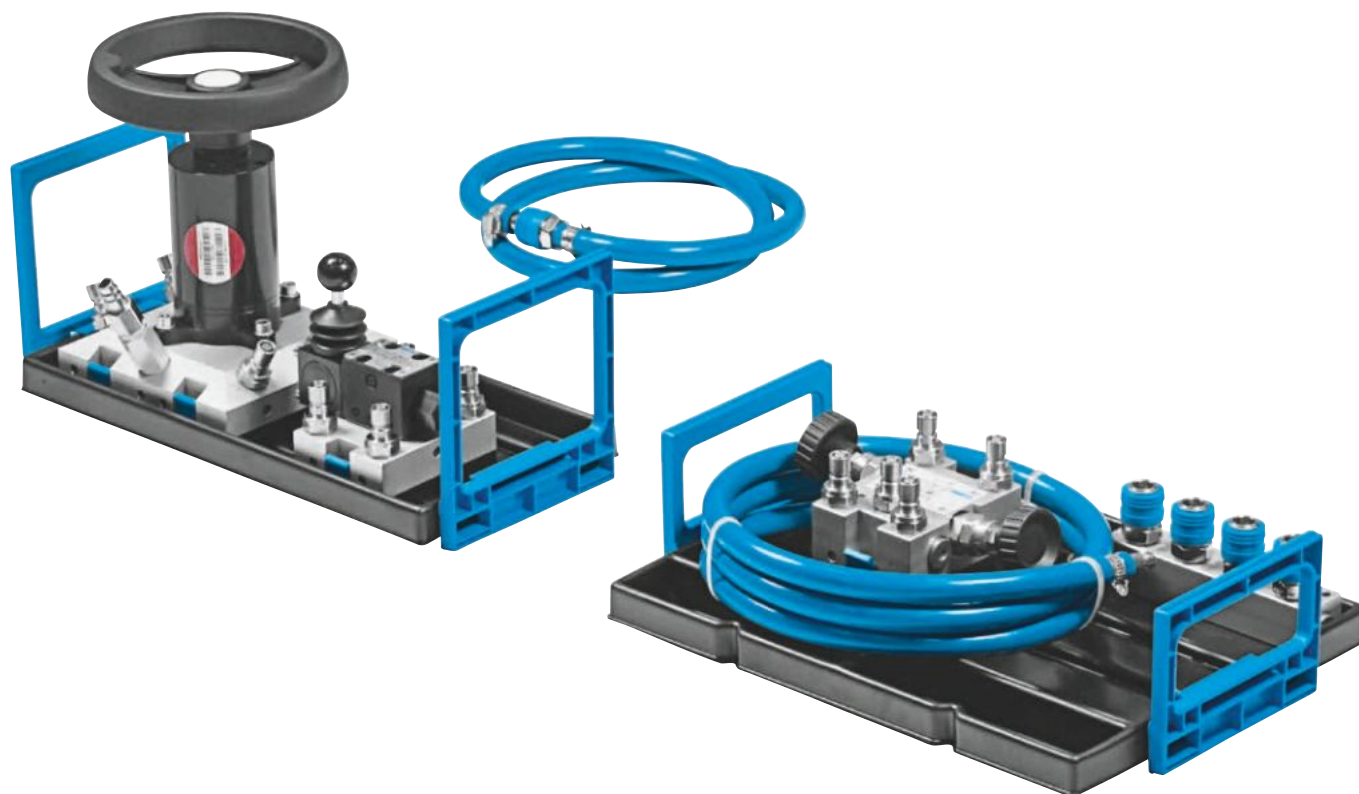
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de	574165
en	574166

# Equipment set TP 802 – Advanced level

## Mobile hydraulics – Hydrostatic steering system

New



### Hydrostatic steering system

Hydrostatic steering is an essential subsystem in many mobile machines and is especially well-suited to managing high steering forces.

The number and design of the components are specifically adapted to the projects in the workbook. This ensures a maximum return on the training with minimum effort.

### For multiple use

As with all Festo Didactic training packages, so too for mobile hydraulics: all components are designed to be used as parts of a single, compatible system. This means that many parts at basic level can also be used for experiments at advanced levels. Long-term maintenance of the interfaces is also an important part of the design, whether mechanical with Quick-Fix®, hydraulic with low-leakage couplings, or electrical with safety plug technology.

Components and accessories from the equipment set TP 801 are required to carry out the projects.

### Safety first!

Safety in the use of our training system is top priority. Many mobile hydraulics elements are not designed to be pressure resistant. This is why our oil return ports use an open coupling system. Students should nonetheless be made fully aware of safety matters. Making sure connections are correct will minimise impact on resources and the environment.

### TP 802 – training content

TP 802 promotes the practical testing and technical measurement of the structure and method of operation of a hydrostatic steering system, comprising a steering valve, anti-shock and anti-cavitation valves, steering cylinder(s), constant-displacement pump and (if needed) secondary loads.

The basics include the structure of different steering systems with through-rod and differential cylinders, and determining the displacement and the torque dependencies of the steering unit. In addition, emergency steering characteristics are explored and tested. An overload is applied to the system, its behaviour is analysed and anti-shock valves are set accordingly. The steering system's priority over a secondary load also forms part of this training package.

#### Complete equipment set TP 802 in equipment tray

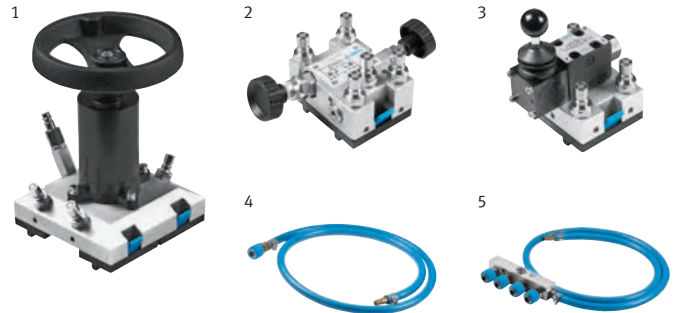
**574162**

The most important components at a glance:

1	1x Steering unit (Orbitrol)	572146
2	1x Shock and anti-cavitation valve	572148
3	1x 4/3-way hand lever valve, relieving mid-position (AB→T), detenting	544344
4	1x Tubing line for unpressurised return	573024
5	1x 4-way return header, unpressurised	573026

Necessary accessories, also order:

9x	Hose line with quick release couplings, 600 mm	152960
4x	Hose line with quick release couplings, 1000 mm	152970
3x	Hose line with quick release couplings, 1500 mm	159386
2x	Multimeter	571832
Safety laboratory cables → Page 52		
Hydraulic power pack → Pages 48 – 49		
Power supply unit for mounting frame → Page 52		



#### The media on offer for TP 802

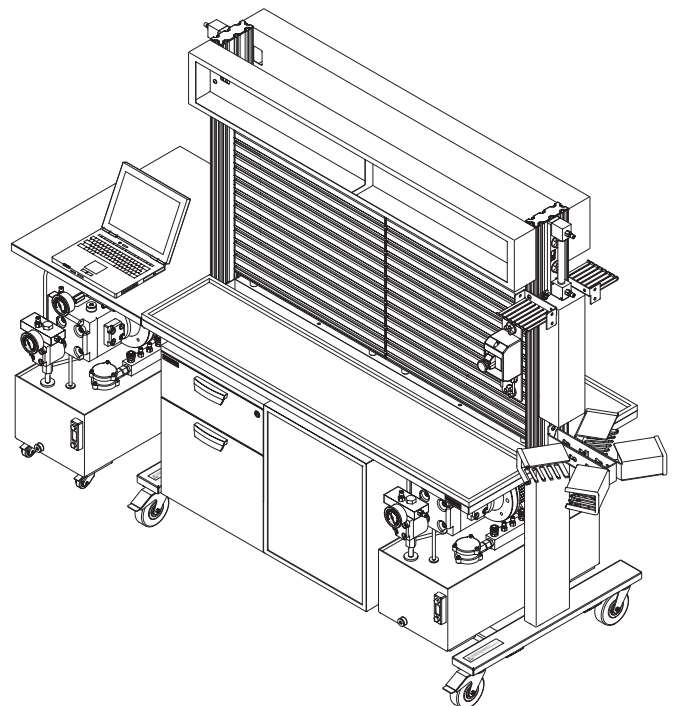
- Training course documents for mobile hydraulics TP 800
- Diagnostic system TP 810 with FluidLab®-M
- Designing and simulating with FluidSIM®
- Digital learning program, Hydraulics
- Digital learning program, Electrohydraulics
- Hydraulics poster set

#### The workstation system

Learnline has a modular design and offers an almost unlimited range of configuration possibilities for the Learnline workstation, such as the table extension for PC-assisted measurement with TP 810 and FluidLab®.

Learnline has a profile surface area of 1400 x 700 mm per side – lots of room for large components and complex circuits.

Quality isn't compromised as its construction and functionality are the very best. The torsionally rigid design and the high-quality coating on the work surface and frame guarantee a long service life despite high loads. Learnline can handle the hard daily lesson routine, as well as a vibrational load during the hydraulic position control.

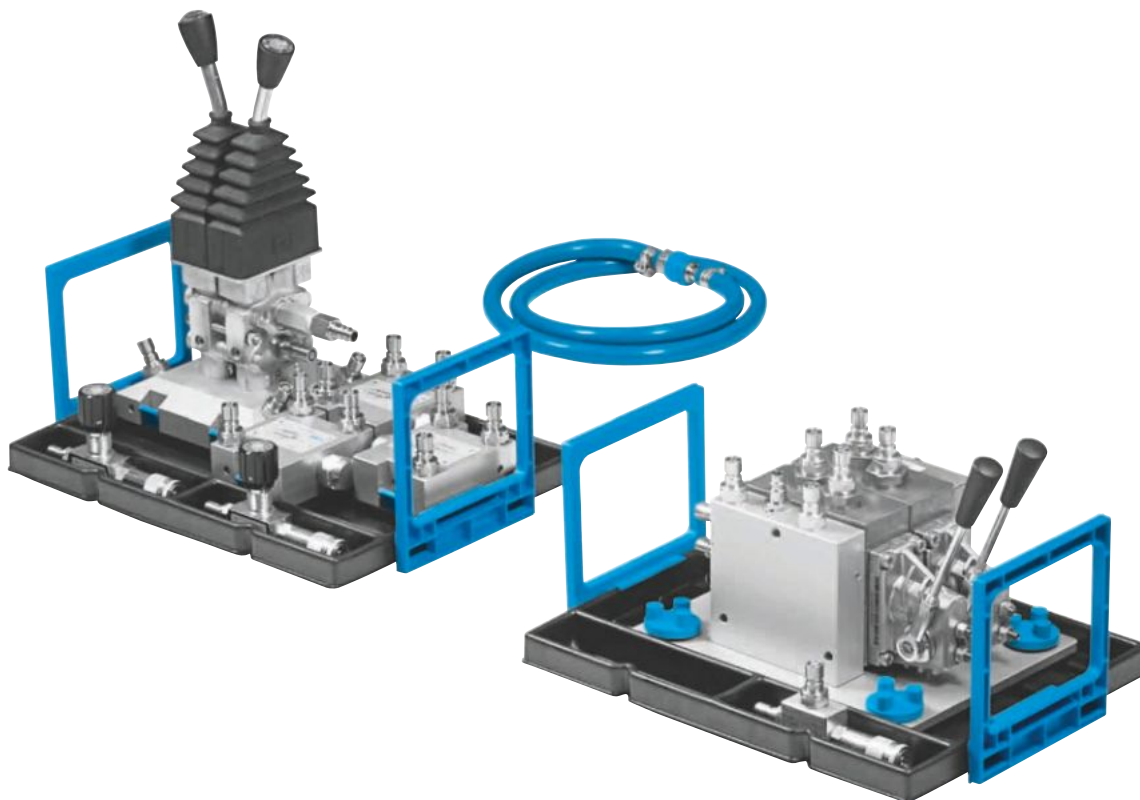




# Equipment set TP 803 – Advanced level

## Mobile hydraulics – Working hydraulics 2

New



### Working hydraulics 2

The challenge for the efficient operation of machines is how to handle frequently changing loads and fluctuating speeds during the operation cycle.

Constant displacement pump systems generally have a very poor degree of efficiency in such cases, as they are always designed for the highest, most likely pressure and flow rate.

Load-sensing systems are different. Both the pressure and the flow rate are adapted to the actual needs. This requires a variable displacement pump with a load-sensing (LS) controller, as well as valves with the right type of control paths for load feedback to the pump controller.

### System behaviour under load

In practical applications, the challenge is to handle continuously changing large loads reliably and efficiently. To reflect this challenge properly in the training system, we have developed a cylinder load simulator which allows an extremely wide range of load types even with the TP 801 set.

An active or passive hydraulic counteracting force is applied to a combination of two differential or through-rod cylinders.

By doing away with large working loads and integrating an overload safeguard, the cylinder load simulator is not just highly flexible, but also safe to use and extremely manageable.

### TP 803 – Working hydraulics advanced level training content

The advanced level focuses on the load-sensing system with variable displacement pump, control block, pilot control and up to two loads.

Components and accessories from the equipment sets TP 801 and TP 802 are required to carry out the projects.

### The content:

- Design, mode of operation and setting of a variable displacement pump with load sensing controller and control block.
- Comparing and assessing the energy usage of flow control, open centre load sensing and closed centre load sensing with a variable displacement pump.
- Remote control and hydraulic pilot control of control blocks.
- Characteristics of load sensing systems with upstream and downstream pressure balances (flow distribution independent of load pressures).

#### Complete equipment set TP 803 in equipment tray

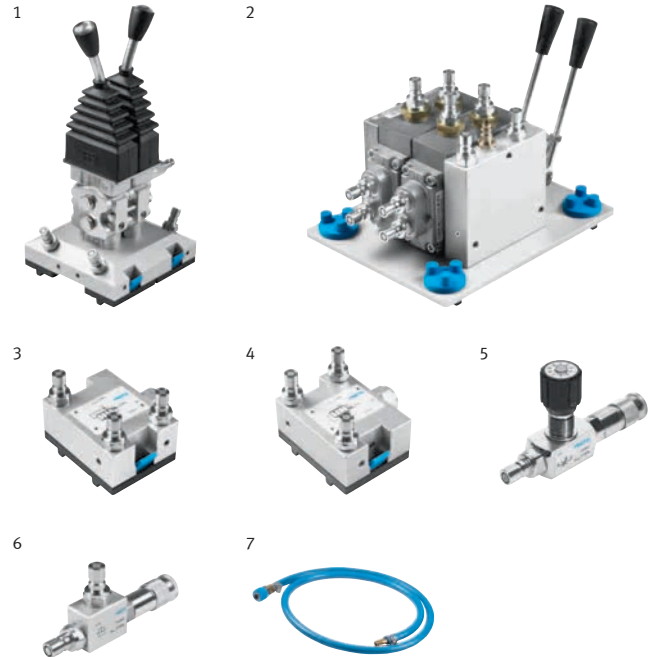
**574163**

The most important components at a glance:

1	1x Pilot valves (joystick), 2x2-channel	572147
2	1x Mobile valve block, Load sensing	572144
3	1x Pressure compensator, upstream (pre)	573023
4	2x Pressure compensator, downstream (post)	572741
5	2x Flow control valve	152842
6	1x T-distributor	152847
7	1x Tubing line for unpressurised return	573024

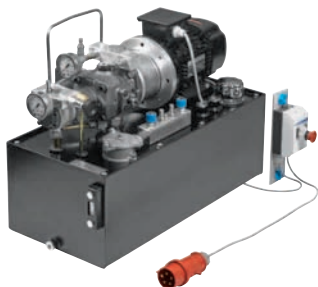
Necessary accessories, also order:

10x	Hose line with quick release couplings, 600 mm	152960
6x	Hose line with quick release couplings, 1000 mm	152970
3x	Hose line with quick release couplings, 1500 mm	159386
2x	Multimeter	571832
	Safety laboratory cables → Page 52	
	Hydraulic power pack → Pages 48 – 49	
	Power supply unit for mounting frame → Page 52	



#### The hydraulic power unit

The power unit used for the mobile hydraulics training packages is a variable and constant displacement pump combination. The constant displacement pump is ideal both for the basic principles of hydraulics and electrohydraulics and for the mobile hydraulics sets TP 801 and TP 802. With TP 803, the focus shifts to the variable displacement pump with LS controller, with the function of the constant-displacement pump now being applied to active hydraulic loads on the cylinder load simulator.



#### The media on offer for TP 803

- Training course documents for mobile hydraulics TP 800
- Diagnostic system TP 810 with FluidLab®-M
- Designing and simulating with FluidSIM®
- Digital learning program, Hydraulics
- Digital learning program, Electrohydraulics
- Hydraulics poster set

# Equipment set TP 810 – Advanced level

## Diagnostic system FluidLab®-M: Measurement – Visualisation – Analysis

New



### A greater understanding of diagnostic systems

System diagnostics, condition monitoring and energy efficiency are becoming more important all the time.

A fluid power system can only be optimally set if measurements are taken at the correct points. The correct conclusions must then be drawn from the measurement data. However, with dynamic system conditions, measuring techniques such as the use of a pressure gauge are pushed to their limits. That is why permanent measured data acquisition with visualisation of measurement curves is necessary. Servicing and maintenance personnel then have access to crucial information for the tasks at hand and settings required. FluidLab®-M is the universal measuring tool for all pneumatic and hydraulic training packages.

### The new FluidLab-M®

Do you want the measuring system for your fluid power circuits, processes or systems to be simple but high quality? To start with, any number of sensors with voltage output and connected to a PC via EasyPort, can be adapted to the measurement software in a few simple steps. Your sensor settings, designations and ranges of values are stored and immediately ready to use next time. FluidLab-M® can record up to four analogue and digital inputs simultaneously.

### Reproducible measurement processes

Simply start the measurement and record digital and analogue input and output signals. During the measurement, you can set and reset the digital outputs manually and control the analogue outputs. A reproducible, controlled measurement process is important if you want to be able to compare series of measurements. This is a particular strong point of FluidLab®-M. The measurement process can be programmed and saved directly in a text editor using a simple programming code. Delay times, jump or repeat commands, and periodic analogue output signals can all be programmed, for example.

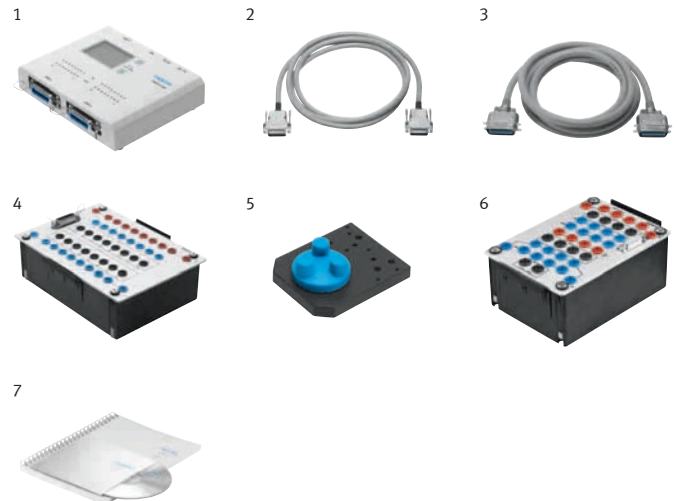
### Visualisation and analysis

Two display modes are available for measured data data acquisition. One is with up to two Y-axes over time (X-axis). For example, changes in pressure and flow rate over the course of a cycle can be recorded. The other is an XY graph to record e.g. a flow control or pump characteristic, in other words pressure over flow rate. The measured values can be saved and superimposed with other records within the software, or compared and analysed. There are two measuring cursor and zoom and detail functions available for the purpose of analysis. Alternatively, a spreadsheet program such as Microsoft Excel can be used to open and work with the measured values.

**Complete equipment set TP 810 in the Systainer 574164**

The most important components at a glance:

1	1x EasyPort USB	548687
2	1x Analogue cable, parallel, 2 m	529141
3	1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
4	1x Universal connection unit, digital (SysLink)	162231
5	1x EasyPort adapter for profile plate	549806
6	1x Connection unit, analogue	567232
7	1x FluidLab-M Single license	573029


**System requirements**

- PC with Windows XP/Vista/7
- At least Pentium 1 GHz
- 2 GB RAM
- CD-ROM drive
- USB 2.0 or serial interface
- 1280 x 1024 pixels
- NI LabView 8.2.1 Runtime (included in the scope of delivery)

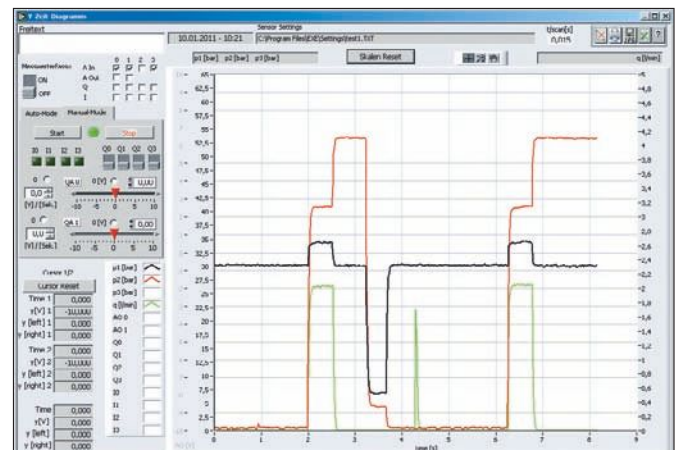
Measurements can be carried out with any sensor with voltage output and 4 mm safety plug. Sensors are not included in scope of delivery.

**The equipment trays**

The training package is delivered in practical trays, packaged in a Systainer. The trays, in turn, fit exactly into the drawers of the Learnline workstations.

**The media on offer for TP 810**

- Training course documents for mobile hydraulics TP 800
- Designing and simulating with FluidSIM®
- Digital learning program, Hydraulics
- Digital learning program, Electrohydraulics
- Hydraulics poster set





# FluidSIM® 4 Pneumatics/Hydraulics

## Individual and multiple licenses



### It doesn't get much faster than this:

GRAFSET – the new graphical description language that describes the logical behaviour and operation of a control system or process – regardless of the technical software/hardware implementation.

The new FluidSIM® Version lets you create GRAFSET plans according to the standard DIN EN 60848 standard. In simulation mode, you can observe and control the result step by step.

If you already use FluidSIM® 4.x, you can download the update for free from the download area of our website.

### The versatile software package

FluidSIM® can be used to perform experiments, carry out simulations in real time and prepare lessons. It can also be used as a virtual modular control system and integrated into blended learning concepts. Version 4 features outstanding dynamic simulation, many new components and enhanced didactic material.

### The lesson preparation tool

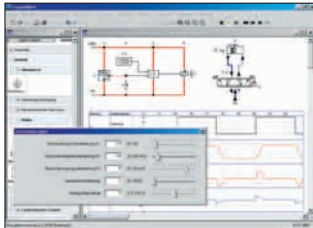
- Windows functionality: drag & drop, copy & paste, context-sensitive menus
- Copying of text and graphics to Word and PowerPoint
- Print preview, scaling and printing in all formats
- Integrated slide show: basic circuits, animated sectional views, instructional units, support for many Windows-compatible image and multimedia file formats
- Integrated fundamentals for pneumatics and hydraulics on video CD

### Realistic simulations in real time

- Calculation of pressure build-up and flow rate, current and voltage
- Consideration of characteristic data for calculating the pressure drop in valves
- Realistic switching times
- Calculation of piston acceleration and speed taking into consideration inertia, stiction and sliding friction, leakage and end position cushioning
- Proportional and closed-loop-control technology
- Digital technology in accordance with Siemens LOGO! Soft
- Cylinder and directional control valve configurator

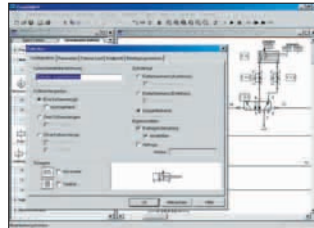
### Learn – simulate – apply: FluidSIM® in blended learning concepts

- User-friendly project administration
- Detailed description of all components, in most cases with colour illustrations
- Application examples in video CD format
- Standard-compliant symbol libraries according to DIN ISO 1219
- Integrated learning training program as the ideal complement to Festo's other learning training programs
- Variable network licenses or software activation via Internet



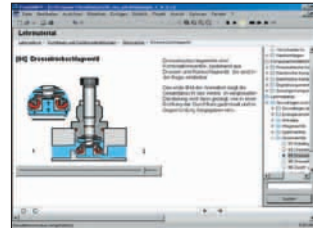
### Dynamic simulation

The new simulator, which rivals those found in much more expensive professional programs, permits the simulation of dynamic effects such as pressure build-up, inertia, acceleration, stiction and sliding friction. Systems with open-loop and closed-loop control can be simulated.



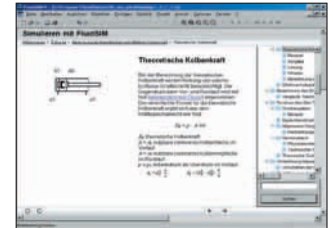
### Circuit diagram creation

The component library has been greatly extended in comparison with Version 3.6. All the components are shown in clearly structured trees. In addition to the enhanced valve configurator, a flexible cylinder configurator is now also available.



### Documentation

Flexible, highly detailed diagrams with automatic optimum scaling. Automatic current path numbering, logic element tables, terminal designations and terminal allocation lists in electrical circuits. Function diagram editor and parts list generator.



### Didactic material

Extended and updated didactic material. Comprehensive descriptions of the physical/-mathematical models of the components used in FluidSIM®. A detailed learning training program makes it easier to get started with simulation using FluidSIM®.

### OPC and EasyPort – open the gateway to the world of 24 volts systems

FluidSIM® can also communicate with other applications. This makes it extremely easy to use FluidSIM® for process simulation.

### Mini control system with 16 I/O

Complete mini control system as a logic module with up to 16 inputs and outputs that can access the EasyPort via OPC or directly.

### FluidSIM® 4 Pneumatics

E.g. single licence on CD-ROM/DVD with online activation

DE	544145
EN	544153
ES	556939
FR	556930

with network licence connector

DE	544146
EN	544154
ES	556940
FR	556931

Student version

DE	544143
EN	544151
ES	556937
FR	556928

### FluidSIM® 4 Hydraulics

E.g. single licence on CD-ROM/DVD with online activation

DE	544149
EN	544157
ES	556943
FR	556934

with network licence connector

DE	544150
EN	544158
ES	556944
FR	556935

Student version

DE	544147
EN	544155
ES	556941
FR	556932

### System requirements

- PC with Windows 98/ME/NT/2000/XP/Vista/Windows 7
- At least Pentium II 500 MHz
- At least 128 MB RAM
- Sound card
- 4-speed CD-ROM drive

### Further information

Multiple licences for local installation or network installation, with as many licences as you need and in numerous other languages.

### Visit us on the Internet

Here you will find all the information you need on currently available versions and updates.

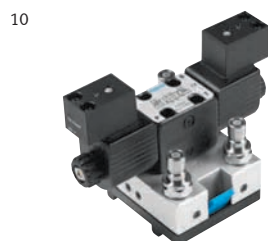
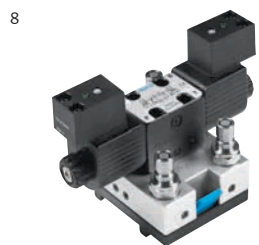
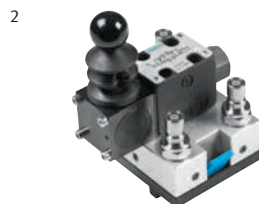
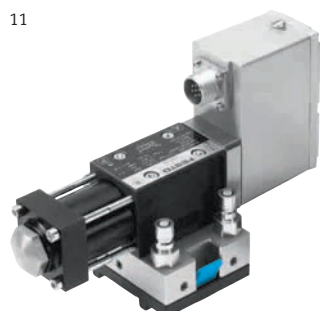
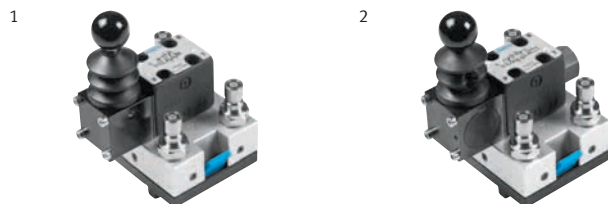
### Network license:

#### Mobile and flexible

One individual network licence allows you to install and use FluidSIM® on any number of computers. The number of users who can simultaneously work with FluidSIM® is limited only by the number of licences purchased.

# Hydraulics

## Directional valves



### 1/2/3/4 Hand lever valves

- Actuation: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

### 4/2-way hand lever valve, spring return

1 Order no. 544342

### 4/3-way hand lever valve, closed mid-position, detenting

2 Order no. 544343

### 4/3-way hand lever valve, relieving mid-position (AB→T), detenting

3 Order no. 544344

### 4/3-way hand lever valve, bypass mid-position (P→T), detenting

4 Order no. 544345

### 5 2/2-way stem actuated valve, convertible

- Manual actuation, by means of the guide bar of a cylinder with mounting kit, spring return
- Normal position P→A, can be converted
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. 544353

### 6/7/8/9/10 Solenoid valves

- Actuation: switching solenoid
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- 24 V DC power
- 6.5 W output
- Electrical connection: 4 mm safety socket
- Quick action mounting system Quick-Fix®

### 4/2-way solenoid valve, spring return

6 Order no. 544346

### 4/2-way double solenoid valve, detenting

7 Order no. 544352

### 4/3-way solenoid valve, closed mid-position

8 Order no. 544347

### 4/3-way solenoid valve, relieving mid-position (AB→T)

9 Order no. 544348

### 4/3-way solenoid valve, bypass mid-position (P→T)

10 Order no. 544349

### 11 4/3-way regulating valve

- Directly actuated servo valve with electrical, closed-loop position control of the control piston.
- Zero overlap and linear characteristic curve (flow rate to control piston position)
- Mid-position closed, de-energised
- Actuation: permanent magnet, adjustment by linear motor
- Integrated position, driver and amplifier electronics
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar) on T 5 MPa (50 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 03
- Low-leakage, self-sealing coupling nipples
- 24 V DC power
- Current consumption: maximum 1.2 A
- Setpoint signal ± 10 V DC
- Electrical connection: cable with 4 mm safety socket
- Quick action mounting system Quick-Fix®

Order no. 567269

# Hydraulics

## Directional valves

### 1 4/3-way proportional valve

This valve is used for controlling both the direction and rate of hydraulic volumetric flow.

- Mid-position closed, de-energised
- Actuation: proportional solenoid
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- 24 V DC power
- Nominal current 800 mA
- Electrical connection: 4 mm safety socket
- Quick action mounting system Quick-Fix®

Order no. **544350**

### 2 Pressure balance (proportional flow control valve)

The pressure balance expands the 4/3-way proportional valve (order no. 544350) to form a proportional flow control valve. This vertical stacking valve is installed between the sub-base and the proportional directional control valve.

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02

Order no. **159351**

### 3 Proportional 6/3-way hand lever valve

This valve is used for controlling both the direction and rate of hydraulic volumetric flow rates. Serial, parallel and tandem circuits can be created by linking several valves.

- Mid-position, spring centred, P1→T1, P2T2AB blocked
- Actuation: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar), T2 for brief periods only 6 MPa (60 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572141**

### 4 Mobile valve block, Load sensing

Two proportional directional control valves with supply pressure balance for load sensing controls (adaptation of pressure and volumetric flow). Suitable for pilot control device, 2x2-channel (order no. 572147).

- Mid-position closed, spring centred ("closed centre")
- Actuation: hydraulic and manual (hand lever)
- Operating pressure 6 MPa (60 bar)
- Pilot pressure up to 3.5 MPa (35 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Open connection fitting for pressureless return (T)
- Quick action mounting system Quick-Fix®

Order no. **572144**

### 5 Steering unit (Orbitrol)

This rotary slide valve is used for hydrostatic steering. When the steering wheel is turned, the steering unit dispenses a quantity of oil to the right or left which is proportional to the turning of the steering wheel. The excess volumetric flow is diverted through E and can be supplied to another consumer ("power beyond").

- No load feedback (non-reaction)
- Open centre (for constant-displacement pump)
- Actuation: manual (steering wheel)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Open connecting plug for pressureless return (T)
- Quick action mounting system Quick-Fix®

Order no. **572146**

1



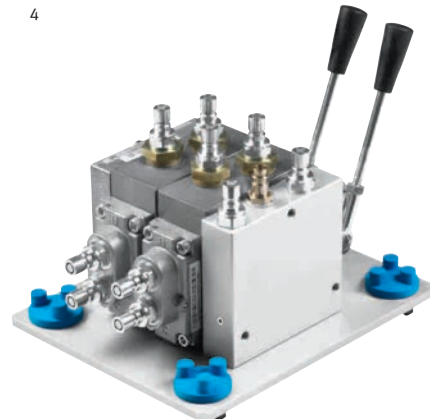
2



3



4



5





# Hydraulics

## Pressure control valves



### 1 Pressure relief valve

The valve limits the pressure at port P relative to the pressure at T to the set value.

- Adjustment: manual
- Includes non-return valve
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544335**



### 2 Pressure relief valve, compensated

The valve limits the pressure at port P relative to the pressure at T to the set value. Pressure on T has no effect on this value because the spring chamber of the pressure relief is compensated.

- Adjustment: manual
- Includes non-return valve
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **567237**



### 3 Pressure relief valve, piloted

The valve limits the pressure at port P relative to the pressure at T to the set value. The main flow of the pressure relief valve is controlled with a small volumetric flow in the pilot stage.

- Adjustment: manual
- Hydraulically piloted
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544336**



### 4 3-way pressure reducing valve

The valve keeps the set pressure at port A constant, compensating for fluctuations in supply pressures and loads from consumers. If the pressure at A rises above the set value, a connection opens from A to T.

- Adjustment: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544337**



### 5 Pressure sequence valve

The valve connects P with T if the pressure at X is larger than the sum of the spring force and the pressure in port T.

- Adjustment: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544341**



### 6 Proportional pressure relief valve

The valve is used for pressure limitation. The limit pressure is adjusted with the proportional solenoid.

- Actuation: proportional solenoid
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- 24 V DC power
- Nominal current 800 mA
- Electrical connection: 4 mm safety socket
- Quick action mounting system Quick-Fix®

Order no. **544351**



### 7 Counterbalance valve

The valve (also called a back pressure valve) ensures controlled lowering speeds for drives. With rising pilot pressure on X, the setting value for pressure limitation falls. The pressure relief valve is bypassed by a non-return valve from T to P.

- Adjustment: manual (with tool)
- Surface area ratio of X to P is 1:3
- Includes non-return valve
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572149**

# Hydraulics

## Pressure control valves

### 1 Pilot valves (Joystick), 2x2-channel

Each channel has two pressure regulators which control the pressure from P to A or B. A and B are pressureless in the spring-centred neutral position. The hydraulic joysticks are used for functions such as remote or pilot control of the load sensing mobile block.

- Adjustment: manual (2x joystick)
- Operating pressure 3.5 MPa (35 bar)
- Maximum permissible pressure 3.5 MPa (35 bar)
- Low-leakage, self-sealing coupling nipples
- Open connection fitting for pressureless return (T)
- Quick action mounting system Quick-Fix®

Order no. **572147**

### 2 Pressure compensator for open centre load sensing

The valve is required for load sensing applications with a fixed displacement pump (open centre).

- Adjustment: hydraulic
- Differential pressure 0.055 MPa (5.5 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572123**

### 3 Pressure compensator, upstream (pre)

This pressure compensator ensures a volumetric flow rate regardless of the load pressure.

- Adjustment: hydraulic
- Differential pressure 0.055 MPa (5.5 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **573023**

### 4 Pressure compensator, downstream (post)

The pressure compensator ensures a volumetric flow rate regardless of the load pressure. If the total volumetric flow rate demanded by all consumers together is more than that which can be supplied by the pump, the individual volumetric flow rates are reduced proportionally. The valve is used in load sensing applications with an LS variable displacement pump (closed centre).

- Adjustment: hydraulic
- Differential pressure 35 kPa (0.35 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572741**

### 5 Flush valve with pressure relief valve

The valve is used for feeding out oil in a closed hydraulic circuit.

- Adjustment: hydraulic, with fixed setting on pressure relief valve
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

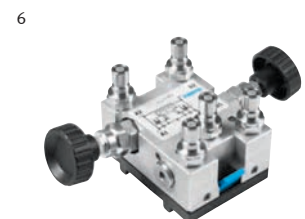
Order no. **572126**

### 6 Shock and anti-cavitation valve

The valve manifold has two pressure relief valves (shock valves) to dissipate pressure peaks away to T and two replenishing valves to ensure supply to the consumer line even in the event of low pressure, e.g. during load changes.

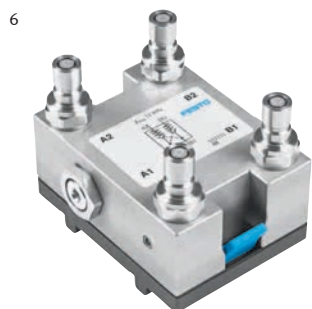
- Adjustment: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572148**



# Hydraulics

## Flow control valves/Stop valves



### 1 Flow control valve

The valve is used to influence the volumetric flow rate through an adjustable throttle point, in both directions.

- Actuation: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples/quick coupling socket

Order no. 152842

### 2 One-way flow control valve

The valve is used to influence the volumetric flow rate through an adjustable throttle point, in one direction. In the opposite direction, the throttle is bypassed using the non-return valve.

- Actuation: manual
- Integrated non-return valve
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples/quick coupling socket

Order no. 152843

### 3 Non-return valve

The valve is closed by a locking cone which is pressed against the seat by a spring. When the opening pressure on the seat side is exceeded, the valve opens and fluid can flow through it. When the pressure on the spring side is greater, the valve remains closed.

- Actuation: hydraulic
- Tube length 1000 mm
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing quick coupling sockets

0.05 MPa opening pressure

Order no. 548617

0.6 MPa opening pressure

Order no. 548618

### 4 Shut-off valve

The valve can be closed by turning the lever. This presses a ball onto the seal on the non-pressurized side, sealing off the flow without any leakage.

- Actuation: manual
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples/quick coupling socket

Order no. 152844

### 5 Non-return valve, delockable

The valve is closed by a locking cone which is pressed against the seat by a spring. The locking cone does not open until X is activated. When the opening pressure on the seat side is exceeded, the valve opens and fluid can flow through it.

- Actuation: hydraulic
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. 544339

### 6 Double non-return valve, delockable

The two non-return valves are each unlocked from the opposite side.

- Surface area ratio of opening piston to non-return valve 3.3:1
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. 572151

# Hydraulics

## Flow control valves/Stop valves

### 1 2-way flow control valve

The valve ensures a constant volumetric flow rate in the flow direction from A to B, regardless of the load pressure on B. The oil can flow from B to A via the non-return valve which opens.

- Actuation: manual
- Differential pressure of the pressure balance 0.55 MPa (5.5 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544338**

### 2 3-way flow control valve

The valve ensures a constant volumetric flow rate in the flow direction from P to A, regardless of the load pressure on A. The excess volumetric flow is diverted through B and can be supplied to another consumer.

- Actuation: manual
- Differential pressure of the pressure balance 0.55 MPa (5.5 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **572150**

### 3 Flow dividing valve

The valve divides the volumetric flow rate from P between A and B in a 50:50 ratio, regardless of load.

- Actuation: hydraulic
- Minimum volumetric flow rate 0.5 l/min
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Valve port pattern, hydraulic ISO/DIN 4401 size 02
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **544340**

### 4 Shuttle valve

The flow to the outlet of the shuttle valve is opened by pressurization at one of the two inlets (OR function). If pressure is applied at both inlets, the flow is opened between the outlet and the inlet with the higher pressure.

- Actuation: hydraulic
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

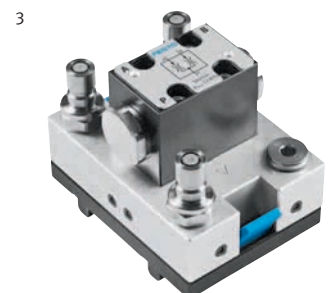
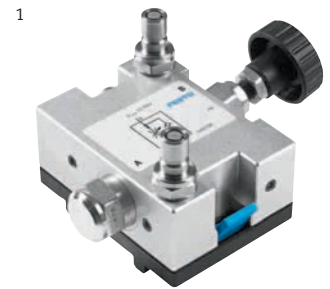
Order no. **572122**

### 5 Priority valve LS, dynamic

The preferential flow direction supplied by the valve is from P to CF and independent of the load pressure on CF. The excess volumetric flow is diverted through EF and can be supplied to another consumer.

- Actuation: hydraulic
- Differential pressure of the pressure balance 1.03 MPa (10.3 bar)
- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **573022**





# Hydraulics

## Hosing, distributing/Additional components



### 1 Hose line with quick release couplings

The high-pressure hose consists of three layers: The innermost layer is synthetic rubber, followed by a wire mesh and sheath of abrasion-resistant synthetic rubber. The quick coupling sockets are self-sealing when decoupled. Used with a coupling nipple, the coupling sockets form a tightly sealed connection. Only the face of the coupling is coated with oil during the coupling process. Coupling and decoupling are only permissible when the hose is de-pressurised.

- Operating pressure 6 MPa (60 bar)
- Max. permissible pressure 12 MPa (120 bar)
- Temperature range -40 – + 125 °C
- Min. bending radius 100 mm
- DN 06 (Ø 6,3 mm)

600 mm	152960
1000 mm	152970
1500 mm	159386
3000 mm	158352



### 2/3 Coupling socket

- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing quick coupling socket
- G 1/4" thread

Internal thread	567223
External thread	548610



### 4 Coupling nipple

- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipple
- G 1/4" male thread

Order no.	342047
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### Blanking plug

To seal off connecting threads that are not needed.

- Maximum permissible pressure 12 MPa (120 bar)
- G 1/4" male thread

Order no.	205284
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### Resistance hose line with quick release couplings

DN 04 (Ø 4 mm)

1000 mm	549858
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### Hose line without quick release couplings

With G 1/4" external thread and spanner flat (AF19).

Please observe the following safety rules: Hoses should not be used for longer than 6 years, including a storage period of 2 years.

600 mm	337617
1000 mm	337618
1500 mm	350337
3000 mm	343616



### 5 T-distributor

The distributor can be inserted at any point.

- Ports: 2x coupling nipples and 1x quick coupling socket
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing couplings

Order no.	152847
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### 6 4-way distributor

Distributor with five ports.

- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no.	184455
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### 7 4-way distributor with pressure gauge

The distributor with five ports is equipped with a pressure gauge and is firmly screwed to the profile plate.

- Effective range and maximum permissible pressure 10 MPa (100 bar)
- Quality class 1.6% of the full scale value
- Operating pressure, static: 3/4 of the full scale value
- Operating pressure, dynamic: 2/3 of the full scale value
- Cushioning: glycerine
- Low-leakage, self-sealing coupling nipples

Order no.	159395
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# Hydraulics

## Hosing, distributing/Additional components

### 1 4-way return header, unpressurised

Plate with five ports to bring together multiple safety-oriented return lines. The open quick coupling plug is routed back to the tank of the hydraulic power unit.

- Maximum permissible pressure 1 MPa (10 bar)
- Four self-sealing quick coupling sockets
- A tube (2 m) with open quick coupling plug

Order no. **573026**

### 2 Tubing line for unpressurised return

For connecting open connection fittings to the return header or the plug socket on the hydraulic power unit.

- Maximum permissible pressure 1 MPa (10 bar)
- One side with open quick coupling plug, one side with quick coupling socket
- Length 1200 mm

Order no. **573024**

### 3 Pressure relief unit

The pressure relief unit is attached to the low-leakage, self-sealing coupling nipple so it can be forced open without requiring much power. This allows trapped hydraulic pressures to be relieved.

Order no. **152971**

### 4 Base plate

Base plates with four G1/4" threaded connections and valve port patterns to ISO/DIN 4401. For the adaptation of any valves. Quick action mounting system Quick-Fix®.

Size 02 (NG4) port pattern

Order no. **572152**

Size 02 (NG4) port pattern, AB rotated

Order no. **572153**

Size 03 (NG6) port pattern

Order no. **669198**

### 5 Diaphragm accumulator with shut-off block

With the three-way ball valve integrated in the shut-off block the following functions are possible:

1. Open connection between P and the diaphragm accumulator
  2. Closed connection between P and the diaphragm accumulator
  3. Open connection between T and the diaphragm accumulator (relief)
- Safety valve against overload
  - Pressure gauge for working pressure
  - Rated volume 0.32 dm<sup>3</sup>
  - Medium, gas side: nitrogen (N)
  - Gas charging pressure when delivered p 1 MPa (10 bar)
  - Operating pressure 6 MPa (60 bar)
  - Maximum permissible pressure 12 MPa (120 bar)
  - Low-leakage, self-sealing coupling nipple for P
  - Tube with open quick coupling plug for T
  - Material for mounting on the profile plate

Order no. **152859**

### Accumulator filling device

For filling or topping up the gas side of the diaphragm accumulator (order no. 152859) with nitrogen (N). The accumulator filling device can be operated directly using a standard commercially available nitrogen bottle. If a pressure reducer is used, manufacturer-specific adapters may be required.

Order no. **92491**

### 6 Pressure filter

Placed directly downstream of the pump, the pressure filter reliably protects the following hydraulic elements from solids suspended in the oil. The required purity class is determined by the most sensitive element in the system.

- Pore size of the filter: 5 µm
- Contamination indicator
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **548609**

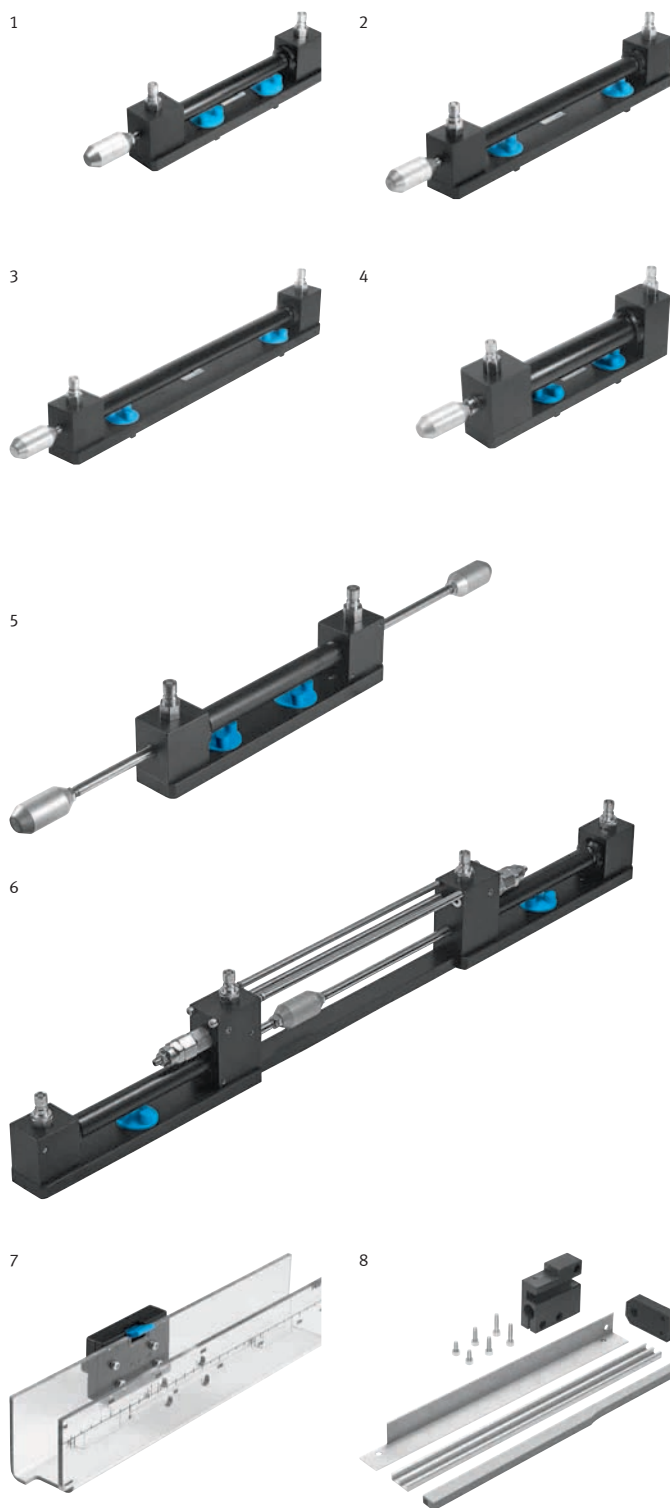
### Replacement filter cartridge for the pressure filter

Order no. **236302**



# Hydraulics

## Drives



### 1 Differential cylinder 16/10/200 with cover

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Double-acting
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

- Piston Ø: 16 mm
- Piston rod Ø: 10 mm
- Stroke: 200 mm
- Surface area ratio 1 : 1.6

Order no. 572746

### 2 Differential cylinder 16/10/300 with cover

- Piston Ø: 16 mm
- Piston rod Ø: 10 mm
- Stroke: 300 mm
- Surface area ratio 1 : 1.6

Order no. 572748

### 3 Differential cylinder 16/10/400 with cover

- Piston Ø: 16 mm
- Piston rod Ø: 10 mm
- Stroke: 400 mm
- Surface area ratio 1 : 1.6

Order no. 572749

### 4 Differential cylinder 25/18/200 with cover

- Piston Ø: 25 mm
- Piston rod Ø: 18 mm
- Stroke: 200 mm
- Surface area ratio 1 : 2

Order no. 572747

### 5 Steady-speed cylinder with covers

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Double-acting
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

- Piston Ø: 16 mm
- Piston rod Ø: 2 x 10 mm
- Stroke: 200 mm
- Surface area ratio 1 : 1

Order no. 572750

### 6 Loading unit/cylinder load simulator

With this combination, a hydraulic counteracting force can be applied to a differential or steady-speed cylinder, allowing a wide range of load situations to be set up and investigated. Available options include differential against differential (2 x 1 : 1.6), small steady-speed against large steady-speed, or large steady-speed against small steady-speed cylinder.

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Integrated safety valve
- Double-acting (2 x)
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®
- Piston Ø: 2 x 16 mm
- Piston rod Ø: 10 mm
- Stroke: 200 mm
- Surface area ratio 1 : 1 or 1 : 1.6

Order no. 572145

### 7 Cover for cylinder

Reduces the risk of injury. With a guide for easy positioning of limit switches and proximity sensors. Also suitable for cylinders with mounting kit. Use two covers for cylinders with a stroke of more than 200 mm. Quick action mounting system Quick-Fix®. For all differential and double rod cylinders.

Order no. 556290

### 8 Mounting kit for cylinders

Fitting a mounting kit on a cylinder makes the following possible:

- Actuation of the stem actuated valve by the guide bar
- Actuation of proximity sensors (order no. 548589) by the permanent magnet of the guide bar
- Use of a displacement encoder

For cylinder 572746, 572750, 572145

Order no. 544371

For cylinder 572748

Order no. 544372

For cylinder 572747

Order no. 544373

# Hydraulics

## Drives

### 1/2 Displacement encoder for cylinder

Linear potentiometer for installing on cylinders using a mounting kit.

- Connecting cable with 4 mm safety plug
- Output: 0 – 10 V (DC)

### Linear potentiometer with 200 mm measuring stroke, order no. 167090

- for cylinders order no. 572746 and 572750 with mounting kit order no. 544371

or

- for cylinders order no. 572747 with mounting kit order no. 544373

1 200 mm stroke **167090**

### Linear potentiometer with 300 mm measuring stroke, order no. 525953

- for cylinders order no. 572748 with mounting kit order no. 544372

1 300 mm stroke **525953**

### Linear potentiometer with 450 mm measuring stroke, order no. 525954

- for direct mounting on cylinders order no. 184488 and aluminium profile plate

2 450 mm stroke **525954**

### 3 Weight, 9 kg for cylinder

Weight for mounting on a Learnline profile column. Can be used as the driving or tractive load of a hydraulic cylinder. With clevis and plain-bearing guide.

Weight for cylinder: order no. 152857, 572746, 572750

Order no. **152972**

### 4/5 Protective cover for weight, 9 kg

Protects reliably against injury. Only in combination with cylinder, order no. 152857, 572746, 572750 and weight, order no. 152972.

For the Learntop-S mounting kit

Order no. **152973**

For Learnline profile column

Order no. **541135**

### 6 Linear drive

Comprising a slide, double-acting cylinder, guide rods, guide, yoke and displacement encoder.

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Low-leakage, self-sealing coupling nipples
- Mounting accessories
- Piston Ø: 16 mm
- Piston rod Ø: 10 mm
- Stroke: 200 mm
- Surface area ratio 1 : 1.6

Order no. **167089**

### 7 Weight, 5 kg for linear drive

Weight for mounting on a linear drive (order no. 167089), to be used as additional load.

Order no. **34065**

### 8 Cushioning cylinder for linear drive

Load/cushioning cylinder for a linear drive unit (order no. 167089).

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Double-acting
- Low-leakage, self-sealing coupling nipples
- Piston Ø: 16 mm
- Piston rod Ø: 10 mm
- Stroke: 200 mm
- Surface area ratio 1 : 1.6

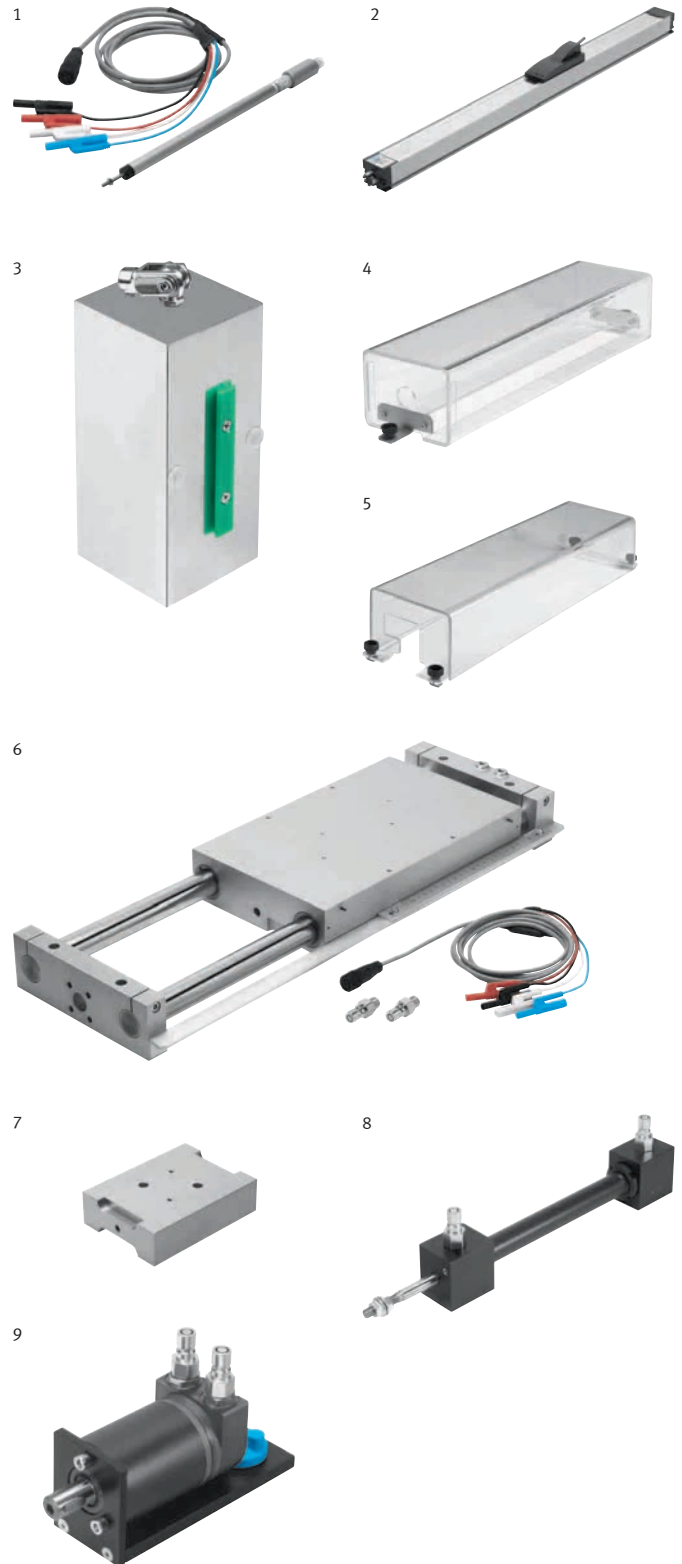
Order no. **152295**

### 9 Hydraulic motor

The motor rotates because of the flow passing through it. When the direction of flow is changed, the direction of rotation changes as well. Leakage in the motor is conveyed to the lower-pressure side via the shuttle valve.

- Operating pressure 6 MPa (60 bar)
- Maximum permissible pressure 12 MPa (120 bar)
- Maximum permissible pressure in the return line 5 MPa (50 bar)
- Displacement: 8.2 cm³ per revolution, 0 – 10 l/min equates to 0 – 1220 r.p.m.
- Design: orbit
- Low-leakage, self-sealing coupling nipples
- Quick action mounting system Quick-Fix®

Order no. **152858**





# Hydraulics

## Sensor technology/Measurement technology

1



2



### 1 Pressure gauge

The pressure gauge can be inserted at any point for pressure measurement.

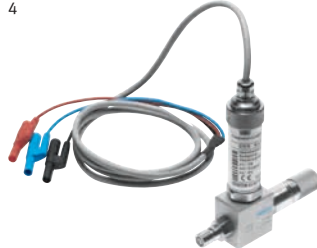
- Effective range and maximum permissible pressure 10 MPa (100 bar)
- Quality class 1.6% of the full scale value
- Operating pressure, static: 3/4 of full scale value
- Operating pressure, dynamic: 2/3 of full scale value
- Cushioning: glycerine
- Low-leakage, self-sealing couplings

Order no. **152841**

3



4



### 2 Pressure sensor

The pressure sensor can be inserted at any point for pressure measurement and has an analogue output.

- Operating voltage 15 – 30 V DC
- Effective range and maximum permissible pressure 10 MPa (100 bar)
- Analogue output 0 – 10 V
- Electrical connection on 4 mm safety plug
- Low-leakage, self-sealing couplings

Order no. **525964**

5



6



### 3 Pressure switch, electronic

The pressure switch can be inserted at any point for pressure measurement and has two switching outputs and an analogue output.

- Operating voltage 18 – 35 V DC
- Switching outputs 2 x PNP, maximum 1.2 A
- Effective range and maximum permissible pressure 10 MPa (100 bar)
- Analogue output 0 – 10 V
- 4-digit digital display, can be rotated along 2 axes
- Electrical connection M12, 5-pin on 4 mm safety plug
- Low-leakage, self-sealing couplings

Order no. **548612**

### 4 Temperature sensor

The sensor can be inserted at any point for temperature measurement and has an analogue output.

- Maximum permissible pressure 12 MPa (120 bar)
- Operating voltage 20 – 30 V DC
- Measuring range 0 – 100 °C
- Analogue output 0 – 10 V
- Electrical connection on 4 mm safety plug
- Low-leakage, self-sealing couplings

Order no. **525963**

### 5 Measuring container for hydraulic oil

The transparent measuring container is equipped with a stabilised inlet, a normal inlet and an inlet for unpressurised return. There is also a scale, protection against overflow, and a manually opened outflow. For mounting on Learnline, the universal bracket (order no. 539736) is required. Measuring range up to 2 litres.

Order no. **541134**

### 6 Flow sensor

The sensor is connected to the hydraulic motor (order no. 152858). A tachometer generator transforms the rotational speed of the hydraulic motor into DC voltage. The speed of the hydraulic motor from 0 – 1220 r.p.m. equates to a voltage of 0 – 10 V and a flow rate of 0 – 10 l/min.

- Clockwise/anti-clockwise rotation: output as analogue value from 0 – 10 V
- Operating voltage 24 V DC
- Measuring range 0 – 10 l/min
- Analogue output 0 – 10 V
- Electrical connection on 4 mm safety sockets

Order no. **567191**

**Displacement encoder**  
→ Hydraulics, Drives

**PC-supported measured data acquisition**  
→ Equipment sets TP 610 and TP 810

# Hydraulics

## Sensor technology/Measurement technology

### 1 Amprobe 30XR-A digital multimeter

Simple entry-level device for basic training.

Automatic and manual range selection, 3¾-digit LCD display for measuring direct and alternating voltage, direct and alternating current, resistance, continuity, diode test, min./max./mean value, data hold.

- Voltage: 0.1 mV – 600 V
- Current: 0.1 µA – 10 A
- Resistance: 0.1 Ω – 20 MΩ
- Tested with 600 V CAT II

#### Scope of delivery

- Measuring cables
- Magnet holder
- Protective covering
- 9 V battery
- Manual

Order no. **571832**

### 2 Measuring case

The complete measuring set is packaged in the practical and sturdy Systainer. It can be used for commissioning, maintenance, troubleshooting and optimisation of hydraulic circuits.

Complete measuring case, consisting of:

- Flow rate measuring device, electronic: 0 – 10 V analogue output corresponds to 0 – 10 litres per minute or 0 – 1220 RPM.
- Can only be operated with a hydraulic motor (Order no. 152858). Order no. 567191
- Measuring line, 500 mm, red: Order no. 376937
- Measuring line, 500 mm, blue: Order no. 376936
- Digital multimeter: Order no. 571832
- Pressure sensor, measuring range 0 – 10 MPa (0 – 100 bar), nominal size 4: Order no. 525964
- Temperature sensor, measuring range 0 – 100 °C, nominal size 4: Order no. 525963

Order no. **177468**

### 3 Limit switch, electrical, left-actuated

The micro switch is actuated mechanically when the roller lever is pressed, for example by the trip cam of a cylinder. The micro switch can be wired as a N/O contact, N/C contact or a changeover switch, using the 4 mm safety sockets integrated in the quick action mounting system Quick-Fix®. Possible contact load: maximum 5 A

Order no. **183322**

### Limit switch, electrical, right-actuated

Order no. **183345**

### 4 Proximity sensor, electronic

Contactless proximity sensor for mounting on drives with T-slot, with connecting cable and LED operating status indicator. Protected against polarity reversal, overload and short circuit.

- Power supply: 10 – 30 V DC
- Switching output, N/O contact (PNP): maximum 200 mA
- Electrical connection M8, 3-pin on 4 mm safety plug

Order no. **548589**

### 5/6/7 Proximity sensors

Proximity sensors with protection against polarity reversal, overload and short circuit.

- M12 design
- 360° rotatable, detenting every 15°
- Connection via the 4 mm safety connectors integrated in the Quick-Fix® quick connector system
- Power supply 10 – 30 V DC
- N/O contact (PNP) starting function
- Quick-Fix® quick connector system

### Proximity sensor, optical, M12

Adjustable sensing distance of 70 – 300 mm, with LED

5 Order no. **572744**

### Proximity sensor, inductive, M12

Sensing distance of 0 – 4 mm

6 Order no. **548643**

### Proximity sensor, capacitive, M12

Sensing distance of 0 – 4 mm

7 Order no. **548651**

1



2



3



4



5



6



7



# Hydraulics

## Power packs



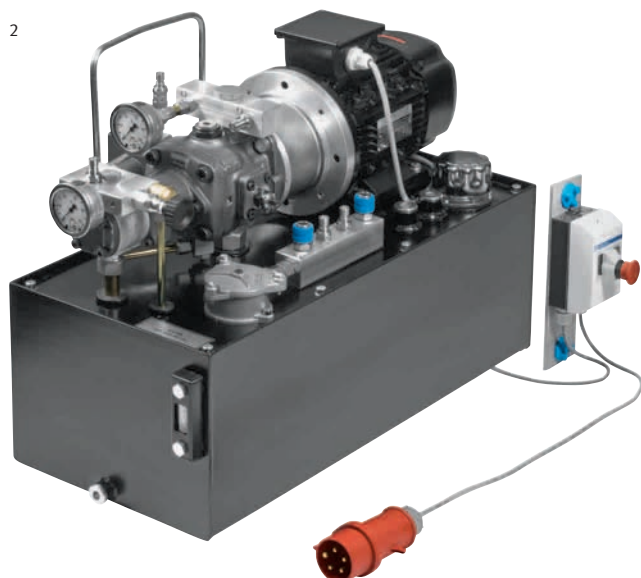
### 1 Hydraulic power pack with two constant-displacement pumps and two motors, AC

Especially suitable for separate supply of two hydraulic circuits each with its own ON/OFF switch e.g. on a mobile Learnline workstation. Equally recommended for reaching higher speeds in cylinders and motors. Also ideal for producing valve characteristic curves.

- Can be integrated into mobile Learnline workstation systems from 2005 onwards
- Pump design: 2 x external gear motor each with pressure relief valve adjustable from 0 – 6 MPa (0 – 60 bar)
- Operating pressure 6 MPa (60 bar)
- Two motors with overload protection, and each with an ON/OFF switch on the Quick-Fix® mounting system
- Tank: 40 l volume, sight glass, temperature display, drain screw
- Tank lid with air filter and return filter
- Low-leakage, self-sealing coupling nipples for P and T
- Plug socket for unpressurised return
- Connecting flange for measuring container return
- Dimensions: 700 x 320 x 550 mm (W x D x H)
- Weight: 72 kg

- Power pack with AC motors
- Single-phase and start capacitors
- Nominal voltage: 230 V
- Rated output: 2 x 550 W
- Frequency: 50 Hz
- Delivery rate (rated speed): each 3.7 l/min/1400 r.p.m.

Order no. **541114**



### 2 Hydraulic power pack with LS variable and constant-displacement pump combination

Especially well-suited to all tests with the TP 800 standard equipment sets and other mobile hydraulics applications, especially processes controlled with load sensing (LS).

- Can be integrated into mobile Learnline workstation systems from 2005 onwards
- Pumps: vane pump with hydraulic load-sensing controller limited to 4 l/min delivery rate and external gear pump with pressure-relief valve adjustable to 0 – 6 MPa (0 – 60 bar)
- Operating pressure 6 MPa (60 bar)
- Motor with overload protection and an ON/OFF switch on quick action mounting system Quick-Fix®
- Tank: 40 l, sight glass, temperature display, drain screw
- Tank lid with air filter and return filter
- Low-leakage, self-sealing coupling nipples for P and T
- Plug socket for unpressurised return
- Connecting flange for measuring container return
- Dimensions: 700 x 320 x 550 mm (W x D x H)
- Weight: 75 kg

- Power pack with three-phase AC motor
- Nominal voltage: 400 – 460 V
- Rated output: 1.1 kW
- Frequency: 50 – 60 Hz
- Delivery rate (rated speed) of the constant-displacement pump: 4 – 4.8 l/min at 1000 – 1200 rpm

Order no. **572128**



### 3 Wheel set for mounting on the tank

- Suitable for hydraulic power units with 40 l tank
- Four guide rollers, of which two with locking brake
- Mounting material included

Order no. **539734**

### Hydraulic power pack with two fixed displacement pumps and two three-phase AC motors

- Power pack with three-phase AC motor
- Nominal voltage: 400 – 460 V
- Rated output: 2 x 550 W
- Frequency: 50 – 60 Hz
- Delivery rate (rated speed): each 3.7 – 4.5 l/min at 1400 – 1740 r.p.m.

Order no. **541116**

All 230 V power packs with power plug CEE 7, suitable for: DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID.

Note:

For safety reasons, hydraulic power packs are delivered without oil. Please order hydraulic oil separately.

# Hydraulics

## Power packs

### 1 Hydraulic power pack with two constant-displacement pumps and one motor, AC

Recommended for reaching higher speeds in cylinders and motors. Also ideal for producing valve characteristic curves.

- Can be integrated into mobile Learnline workstation systems from 2005 onwards
- Pump design: 2 x external gear motor each with pressure relief valve adjustable from 0 – 6 MPa (0 – 60 bar)
- Operating pressure 6 MPa (60 bar)
- Motor with overload protection, and ON/OFF switch on Quick-Fix® mounting system
- Tank: 40 l volume, sight glass, temperature display, drain screw
- Tank lid with air filter and return filter
- Low-leakage, self-sealing coupling nipples for P and T
- Plug socket for unpressurised return
- Connecting flange for measuring container return
- Dimensions: 700 x 320 x 550 mm (W x D x H)
- Weight: 65 kg

- Power pack with AC motor, single-phase and start capacitor
- Nominal voltage: 230 V
- Rated output: 1.1 kW
- Frequency: 50 Hz
- Delivery rate (rated speed): 2 x 3.7 l/min at 1400 r.p.m.

Order no. **539733**

### Hydraulic power pack with two fixed displacement pumps and one three-phase AC motor

- Power pack with three-phase AC motor
- Nominal voltage: 400 – 460 V
- Rated output: 1.1 kW
- Frequency: 50 – 60 Hz
- Delivery rate (rated speed): 2 x 3.7 – 4.5 l/min at 1400 – 1740 r.p.m.

Order no. **541115**

Additional hydraulic power units and configurations on request.

### 2 Hydraulic power pack with a constant-displacement pump, 230 V

Ideal for individual hydraulic workstations for all experiments using standard equipment sets TP 500, 600 and the MPS® punching station.

- Mounting on Learnline with universal bracket (order no. 539736)
- Mounting on Learntop-S: direct
- Pump design: external gear motor with pressure relief valve adjustable from 0 – 6 MPa (0 – 60 bar)
- Operating pressure 6 MPa (60 bar)
- Motor: AC, single-phase with overload protection, start capacitor and ON/OFF switch
- Tank: 5 l volume, sight glass, temperature display, drain screw
- Air filter and return filter
- Low-leakage, self-sealing coupling nipples for P and T
- Plug socket for unpressurised return
- Connecting flange for measuring container return
- Dimensions: 580 x 300 x 180 mm (W x D x H)
- Weight: 19 kg

- Nominal voltage: 230 V AC
- Rated output: 0.65 kW
- Frequency: 50 to 60 Hz
- Delivery rate (rated speed): 2.2 – 2.7 l/min at 1320 – 1680 r.p.m.

Order no. **152962**

### Hydraulic power pack with a fixed displacement pump, 110 V

- Nominal voltage: 110 V AC
- Rated output: 0.55 kW
- Frequency: 60 Hz
- Plug connector in accordance with US standard
- Delivery rate (rated speed): 2.7 l/min at 1680 r.p.m.

Order no. **159328**

### Hydraulic oil (DIN 51524)

Brand-name hydraulic oil for all Festo hydraulic power units.

HLP22, 10 Litres

Order no. **192215**

HLP22, 20 Litres

Order no. **14572**

### Funnel

Funnel for filling various devices with oil.

Order no. **374038**





# Hydraulics

## Control electronics/Electronic control



### 1 Signal input, electrical

The device contains an illuminated pushbutton switch (control switch) and three illuminated pushbuttons (momentary contact switches) with terminals and two buses for power supply.

- Contact set: 1 makes, 1 breaks
- Contact load: Maximum 2 A
- Power consumption (Miniature bulb): 0.48 W

Order no. **162242**

### 2 Indicator unit and distributor, electrical

The device contains an acoustic indicator and four lamps with terminals and three buses for power supply. Through-contact socket pairs per lamp allow the element to also be used as a distributor.

- Power consumption acoustic indicator: 0.04 W
- Power consumption indicator lamps: 1.2 W
- Frequency acoustic indicator: 420 Hz

Order no. **162244**

### 3 Relay, three-fold

The device has three relays with terminals and two buses for power supply.

- Contact load: max. 5 A
- Cut-off load: max. 90 W
- Pick-up time: 10 ms
- Drop-off time: 8 ms

Order no. **162241**

### 4 Time relay, two-fold

The element contains a release-delay and a pickup-delay time relay. Both relays are infinitely variable, using the rotary knob of the potentiometer.

- Contact set: 2 makes, 2 breaks
- Contact load: Maximum 5 A
- Cut-off load: Maximum 100 W
- Delay: 0.5 – 10 s adjustable

Order no. **162243**

### 5 Preset counter, electrical, incrementing

Electrical preset counter, with terminals and two buses for power supply.

- Contact set: 1 change-over
- Contact load: Maximum 1 A
- Power consumption: 2.4 W
- Counter pulse: Minimum 20 ms
- Display: 3-character

Order no. **162355**

### 6 Proportional amplifier

The amplifier allows control of proportional valves. It is designed so that it can either be driven by two independent solenoids (1 channel) or a valve with two solenoids (2 channel) such as a 4/3-way proportional valve. The proportional amplifier thus works either as a 1-channel amplifier or a 2-channel amplifier. The inputs are short-circuit protected or surge-proof up to 24 V.

- Setpoint values:  $\pm 10$  V DC in steps of 100 mV
- Switching signal for internal setpoint values: 15 – 30 V DC
- Solenoid outputs: PWM signal, 24 V, max. 1 A
- Enabling switching signal: 15 – 30 V DC
- Basic current: 0 – 250 mA, in steps of 1 mA
- Jump current: 0 – 250 mA, in steps of 1 mA
- Maximum current: 100 mA – 1 A, in steps of 5 mA
- Dither frequency: 100 – 250 Hz, in steps of 1 Hz

Order no. **162255**

# Hydraulics

## Control electronics/Electronic control

### 1 Setpoint value card

The setpoint value card has the following functions:

- Programmable setpoint generation
- Programmable ramp generation
- Cyclical sequencing of setpoints and ramps
- Stopwatch
- Number of setpoint values: 8
- Output voltage range: -10 – +10 V tol.  $\pm 5$  mV (adjustable in steps of 0.1 V)
- Number of ramps: 4
- Ramp times: 0 – 10.0 s/1 V (adjustable in steps of 50 ms/1 V)
- Activating voltage of inputs: Min. 15 V
- Output rate: 1 kHz
- Stop watch: Input 1, measuring time 0 – 100 hrs.

Order no. **162256**

### 2 Comparator

Positive switching comparator with hysteresis. The inputs are short-circuit-proof or surge-proof to 24 V. 2 separate inputs (IN A, IN B) each acting on two independent comparators. Each comparator can be set to:

- Reference voltage (-10 – +10 V), Hysteresis (0 – +5 V).
- Input voltage (inputs A and B): -10 – +10 V
- Input resistance (inputs A and B): > 10 k $\Omega$
- Display accuracy:  $\pm 30$  mV
- Outputs A and B: Floating relay contacts, changeover contacts
- Contact load: 24 V DC/2 A and 120 V AC/1 A

Order no. **162257**

### 3 PID controller

PID controller for pneumatic and hydraulic control circuits. The controller comprises the following:

- Voltage supply
- Differential inputs
- Comparators
- Final control elements: positional control elements, speed control elements, acceleration control elements (status controller), proportional control elements, integral control elements, differential control elements (PID controller)
- Overall gain (Status controller)
- Correcting variable offset
- Summing junction
- Limiter
- Output

Order no. **162254**

### 4 Status controller

The status controller is used as a regulator in pneumatic and hydraulic position control circuits. The controller comprises the following:

- Voltage supply
- Differential inputs
- Comparators
- Final control elements: positional control elements, speed control elements, acceleration control elements (status controller), proportional control elements, integral control elements, differential control elements (PID controller)
- Overall gain (Status controller)
- Correcting variable offset
- Summing junction, Limiter, Output

Order no. **162253**

### 5 FluidLab®-M Single license

Software for freely configurable data acquisition, visualisation and storage of analogue measured values from fluid engineering equipment and systems through the use of common industrial sensors with voltage output signal. Any desired sensors with voltage output can be set up and adapted with just a few simple steps. The measuring sequence can be controlled externally, as well as manually with the software, or it can be programmed as a sequencing program within the software. Recording and processing of up to 4 analogue inputs, 2 analogue outputs, 4 digital inputs and 4 digital outputs is possible. Results can be saved and compared with other measurements. Data can also be exported to a spreadsheet programme. Either German or English can be selected for the software.

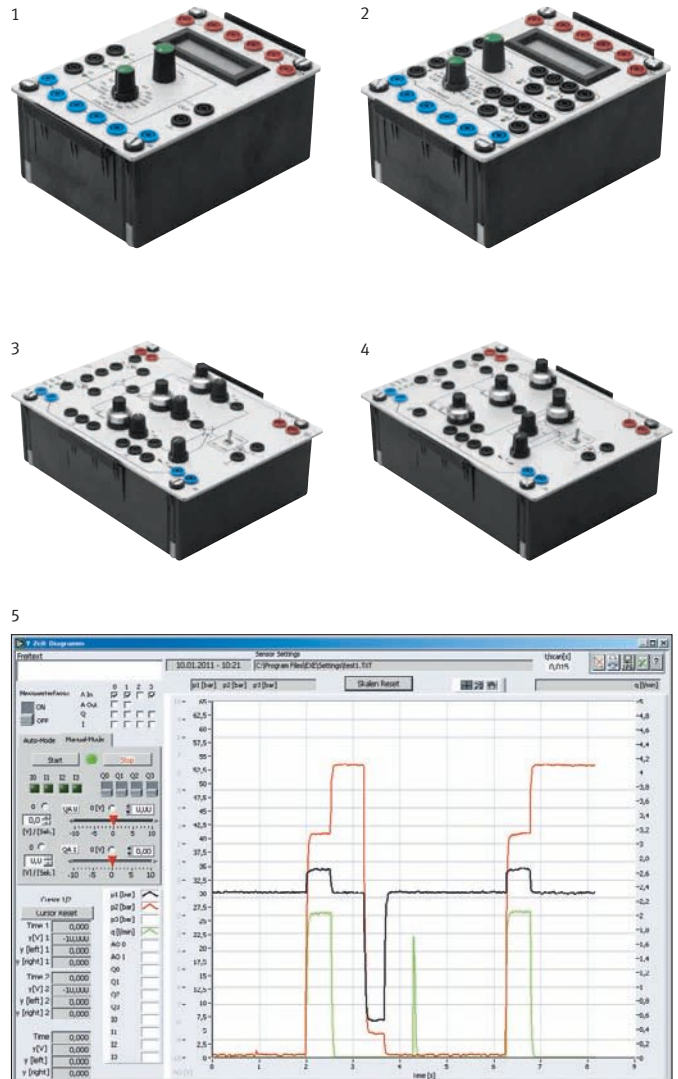
#### System requirements

- PC with Windows XP, Vista or 7
- At least Pentium 1 GHz
- 2 GB RAM
- CD-ROM drive
- USB 2 or serial port
- Resolution of 1280 x 1024 pixels
- NI LabView Runtime (included in scope of delivery)

Order no. **573029**

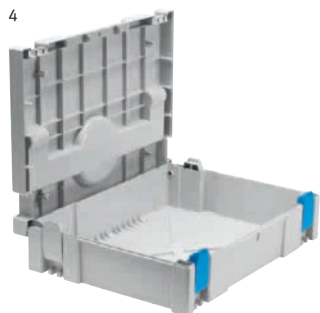
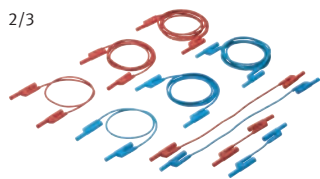
#### PC-supported measured data acquisition

→ Equipment sets TP 610 and TP 810



# Accessories

## Power supply/Order means



### 1 Power supply unit for mounting frame

- Input voltage: 85 – 265 V AC (47 – 63 Hz)
- Output voltage: 24 V DC, short-circuit-proof
- Output current: max. 4.5 A
- Dimensions: 170 x 240 x 92 mm

Without power cable

Order no. **159382**

With IEC power cable, 1.3 m, suitable for: DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID

Order no. **159396**

US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP

Order no. **162411**

GB, IE, MY, SG, UA, HK

Order no. **162412**

AU, NZ, CN, AR

Order no. **162413**

CH

Order no. **162414**

ZA, IN, PT, SG, AE, HK, (GB)

Order no. **162415**

### IEC power cable

One side designed as a connector and one side with a country-specific plug.

DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID

Order no. **247661**

US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP

Order no. **350362**

GB, IE, MY, SG, UA, HK

Order no. **350363**

AU, NZ, CN, AR

Order no. **350364**

CH

Order no. **350366**

ZA, IN, PT, SG, AE, HK, (GB)

Order no. **350367**

### 2 Safety laboratory cables, 98 pieces, red and blue

Complete set, consisting of 98 safety laboratory cables with 4 mm safety plugs in the colours red and blue:

- 10x red 50 mm
- 10x blue 50 mm
- 26x red 300 mm
- 11x blue 300 mm
- 21x red 500 mm
- 12x blue 500 mm
- 3x red 1000 mm
- 3x blue 1000 mm
- 1x red 1500 mm
- 1x blue 1500 mm

– Plugs with rigid protective sleeve and axial socket

– Conductor cross section: 1 mm<sup>2</sup>

– Tested with 1000 V CAT II

– Rated current: 16 A

For the third cable colour, safety laboratory cables, 47 pieces, black, are suitable (order no. 572096)

Order no. **167091**

### 3 Safety laboratory cables, 106 pieces, red, blue and black

Complete set, consisting of 106 safety laboratory cables with 4 mm safety plugs in the colours red, blue and black:

- 10x red 50 mm
- 10x blue 50 mm
- 8x black 50 mm
- 8x red 300 mm
- 8x blue 300 mm
- 18x black 300 mm
- 8x red 500 mm
- 8x blue 500 mm
- 18x black 500 mm
- 2x red 1000 mm
- 3x blue 1000 mm
- 2x black 1000 mm
- 1x red 1500 mm
- 1x blue 1500 mm
- 1x black 1500 mm

– Plugs with rigid protective sleeve and axial socket

– Conductor cross section: 1 mm<sup>2</sup>

– Tested with 1000 V CAT II

– Rated current: 16 A

Order no. **571806**

### 4 Systainer

Stackable interlocking case system, made of light grey plastic with light blue snap fasteners.

Size 0 (Mini-Systainer):

50 x 248 x 158 mm

Order no. **533014**

Size 1: 72 x 377 x 277 mm

Order no. **526714**

Size 2: 124 x 377 x 277 mm

Order no. **526715**

Size 3: 176 x 375 x 274 mm

Order no. **526716**

Size 4: 279 x 377 x 272 mm

Order no. **526717**

Size 5: 395 x 360 x 272 mm

Order no. **544375**

Soft foam insert for lid

(for Systainer sizes 1 – 5)

Order no. **526814**

(Interior dimensions W x H x D respectively)

### 5 Trolley for Systainer

Trolley for transporting Systainers sizes 1 to 5, can carry up to 5 Systainers.

With 2 adjustable heights:

height 1: 105 cm, height 2: 97.5 cm.

Tare weight 4 kg, load bearing

capacity 50 kg.

Order no. **549788**

### 6 Dolly truck for Systainer

Dolly truck for transporting Systainers sizes 1 to 5. 4 castors with a brake.

Order no. **549789**

# Accessories

## Order means

### Systainer/container inserts

Didactic components need to be stored in a clearly arranged and safe way. Simply clamp two handles onto the narrow side of the insert of your choice and stack the inserts in the Systainer. Note: Two large and one small insert exactly fill a Learnline container drawer.

#### 1 Systainer/container insert A

Dimensions (W x D): 351 x 172 mm.  
For Systainers sizes 1 – 4

Order no. **687927**

#### 2 Systainer/container insert B

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 4.

Order no. **687461**

#### 3 Systainer/container insert C

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 4.

Order no. **687929**

#### 4 Systainer/container insert D

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 4.

Order no. **689087**

#### 5 Systainer/container insert E

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **701309**

#### 6 Systainer/container insert F

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **709844**

#### 7 Systainer/container insert G

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **687943**

#### 8 Systainer/container insert H

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **687944**

#### 9 Systainer/container insert I

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **722009**

#### 10 Systainer/container insert J

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **754668**

#### 11 Systainer/container insert K

Dimensions (W x D): 351 x 264 mm.  
For Systainers sizes 1 – 5.

Order no. **754701**

#### 12 Systainer/container insert L

Dimensions (W x D): 351 x 172 mm.  
For Systainers sizes 1 – 4.

Order no. **754704**

#### 13/14/15 Handles for Systainer/container inserts

The handles are available in three different versions, suitable for Systainer sizes 2 – 5:

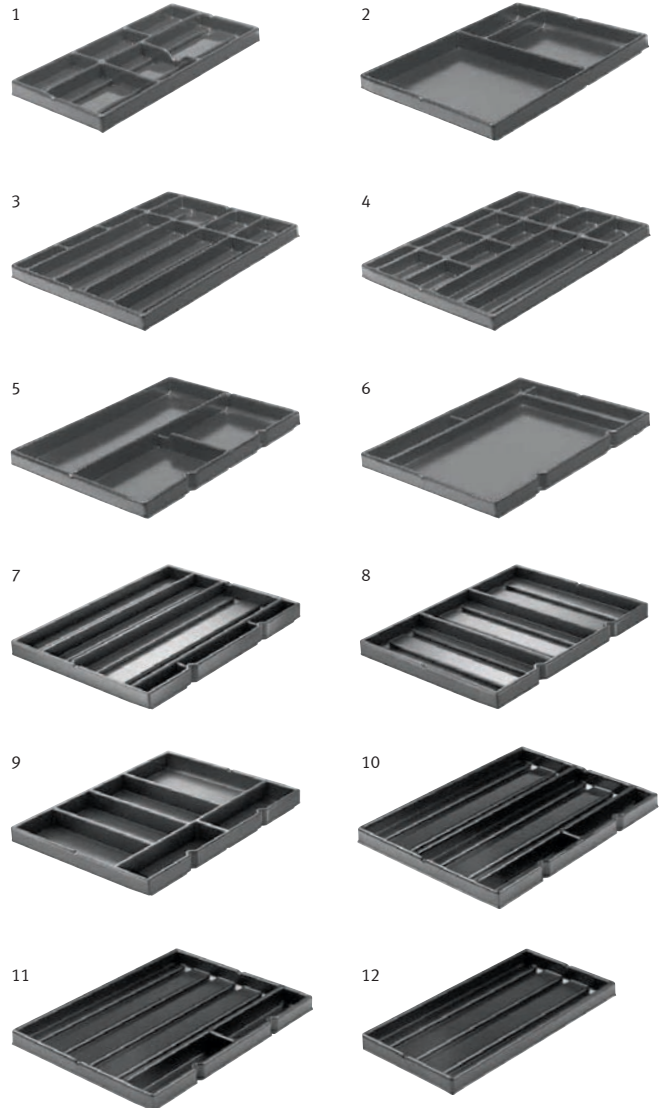
- Handle 80: 80 mm high version
- Handle 100: 100 mm high version
- Handle 150: 150 mm high version

When stacking the inserts in the Systainer the handle height determines the distance between the stacked inserts. The handles can be used for all Systainer/container inserts. Two handles are required per insert.

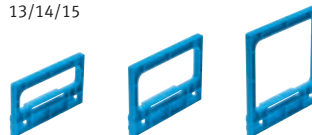
13 Handle 80 **683012**

14 Handle 100 **687455**

15 Handle 150 **683464**



13/14/15





# Modern industrial hydraulics

## HY511

This course provides you with an insight into hydraulic components and their functions. You will create and read circuit diagrams and set the pressure and position of hydraulic drives. You will also learn the basics of electrical drives, enabling you to commission electrohydraulic systems. As in all Festo Didactic training courses, there is an emphasis on practical exercises.

### Contents

- Equipment and circuit diagram symbols, reading and interpreting basic hydraulic circuit diagrams
- Physical principles
- Structure and mode of operation of basic components
- Volumetric flow and pressure
- Technology and characteristic data of valves and drive elements
- Intensive training for industrial practice: setting up systems in accordance with circuit diagrams, commissioning
- Fundamentals of proportional hydraulics
- Structure of simple relay controls

### Target groups

Maintenance, Engineering, Trainer

### Outcomes

The participants can:

- design, assemble and test basic hydraulic circuits
- maintain and troubleshoot basic hydraulic control systems
- identify and describe the construction, design features and operation of hydraulic components
- interpret technical specifications and data relating to hydraulic components and systems
- identify and explain graphical symbols for hydraulic components
- describe fundamentals of oil flow

### Duration

4 days

### Order number

559448

# Maintenance and troubleshooting industrial hydraulics

## HY521

Careful maintenance can almost double the operating times of hydraulic components. This course provides you with the relevant knowledge and necessary strategies and methods to tap these potential savings.

### Contents

- Special cylinders, hydraulic motors, piloted valves, synchronisation controls, valve fittings, power supply systems with hydraulic reservoir and variable displacement pumps
- Technical knowledge, communication and teamwork
- Maintenance: Increasing the operational reliability of production plants
- Inspection: Identification, measurement and evaluation of wear on systems

### Target groups

Operators, Maintenance, Trainer

### Outcomes

The participants:

- knows the features of piloted valves, special cylinders, hydraulic motors, valve fittings and power supply systems with hydraulic reservoir and variable displacement pumps
- understands how availability of production equipment can be improved
- can recognise and assess the degree of machine wear and carry out the relevant measurements
- can apply the principles of systematic troubleshooting to real applications
- can identify and analyse the weak points of a machine and initiate measures to eliminate them
- can safely recommission the system

### Prerequisites

HY511 – Modern industrial hydraulics

### Duration

5 days

### Order number

559449

# Proportional hydraulics

## HY132

In this course you will learn the function and control of proportional valves and the structure of basic circuits in industrial applications. An extensive practical part gives you the opportunity to set up circuits, set parameters and gain experience in commissioning and troubleshooting proportional hydraulic controls.

### Target groups

Maintenance, Design/Engineering, Trainer

### Contents

- Structure, function and characteristic data of proportional-, way-, pressure- and flow-control-valves
- Generation of setpoints (analog and digital)
- Adapting amplifier electronics to required conditions
- Development and interpretation of proportional hydraulics circuit diagrams
- Intensive practical training through setup of circuits according to circuit diagrams and setting parameters for optimal commissioning
- Proportional valves in open-loop controls and control valves in closed-loop controls
- Introduction to servo valve technology and control
- Current standards and safety regulations for industrial practice

### Outcomes

The participant:

- understands the principles of proportional hydraulics
- can explain the structure and mode of operation of proportional-, way-, pressure- and flow-control-valves
- can interpret the characteristic data of proportional valves
- can adapt amplifier electronics to the required conditions
- can develop, read, understand and interpret proportional hydraulics circuit diagrams
- can explain the principles of servo valve technology and control
- can explain the difference between open- and closed-loop controls
- can name current standards and safety regulations for industrial practice

### Prerequisites

HY511 – Modern industrial hydraulics

### Duration

3 days

### Order number

559451

# Mastering mobile hydraulics

<b>HY181</b>	<p>The know-how needed to design, maintain and operate mobile hydraulic systems is becoming more important each day. Due to the complexity of the systems, compared to industrial hydraulics, the skills needed for maintenance and design require strong mobile hydraulics fundamentals. In this course, you will learn every important detail related to mobile systems. And due to many interesting mobile hydraulics solutions and circuits, this course also enlarges your perspective of industrial hydraulics.</p>
Target groups	Maintenance, Design/Engineering, Trainer
Contents	<ul style="list-style-type: none"> <li>• Hydrostatic transmission and related components</li> <li>• Steering unit</li> <li>• Working hydraulics</li> <li>• Load holding</li> <li>• Load sensing in constant and variable displacement pumps</li> <li>• Pressure and flow control</li> <li>• Fundamentals of proportional control</li> <li>• Commissioning and maintaining mobile systems</li> </ul>
Outcomes	<p>The participants can:</p> <ul style="list-style-type: none"> <li>• identify the components and explain their functions in a given mobile hydraulic circuit</li> <li>• build and test hydrostatic transmissions, working hydraulics and steering circuits</li> <li>• explain load sensing functions and other efficiency components</li> <li>• make adjustments for the required control parameters of mobile hydraulics</li> <li>• measure the required parameters in a mobile hydraulic circuit</li> <li>• systematically troubleshoot and explain maintenance procedures</li> <li>• explain the safety measures in mobile equipments</li> </ul>
Prerequisites	HY511 – Modern industrial hydraulics
Duration	3 days
Order number	573359





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