MPS PA Compact Workstation

Process Automation

User Guide

Festo Didactic
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By the staff of Festo Didactic

Internet: www.festo.com
e-mail: services.didactic@festo.com

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Table of Contents

Introduction to the MPS PA Compact Workstation

The Festo Didactic Learning System for process automation and technology supports a range of training and vocational needs. The systems and stations of the MPS PA Compact Workstation enable industry-oriented vocational and continuing education, and the hardware uses didactically appropriate industrial components.

Training can also build team spirit, cooperation, and organizational skills. Project phases can be taught through training projects, such as:

- Planning
- Assembly
- Programming
- Commissioning
- Operation
- Maintenance
- Trouble shooting

Training contents

Training contents covering the following subjects can be taught:

- Mechanics
  - Mechanical construction and piping of a station
- Process Engineering
  - Reading and drawing of function charts and documentation
  - Pneumatics in process automation
  - Piping connections of process control components
- Electrical technology
  - Correct wiring of electrical components
  - Sensors, design and function, correct use of sensors
  - Measuring of non-electrical, process and control variables

- PLC
  - Programming and use of a PLC
  - Programming of alternative (OR) branches
  - Fieldbus technology

- Closed-loop control technology
  - Basics of closed-loop control technology
  - Analyze and optimize a closed-loop system
  - P, I, D control
  - Closed-loop controller
  - Configuration, assigning operation parameters and optimization of a closed-loop controller

- Commissioning
  - Commissioning of a closed-loop system
  - Commissioning of a process engineering system

- Fault finding
  - Systematic fault finding on a process engineering system
  - Examination and maintenance of a process engineering system
  - Operation and observation of a process

- Topics for project work
  - Selection of electrical components, e.g., level sensor
  - Safety check of a tank, how to use a float sensor

Important notes

Safe and trouble-free operation of the MPS PA Compact Workstation requires compliance with fundamental safety recommendations and regulations. These operating instructions contain essential information for safe operation.

All persons working on the MPS PA Compact Workstation must observe these safety recommendations. The applicable accident-prevention rules and regulations at the place of use must also be followed.

Duty of the operating authority

The operating authority must ensure that the MPS PA Compact Workstation is used only by persons who:

- are familiar with basic operational safety and accident-prevention regulations and have been instructed in the handling of the MPS PA Compact Workstation,
- have read and understood the safety chapter and cautionary notes in these operating instructions and confirmed this by signing,
- are regularly assessed to ensure safe working.

Duty of trainees

Before starting work, all persons assigned to the MPS PA Compact Workstation must:

- observe basic regulations for operational safety and accident prevention,
- read the safety chapter and cautionary notes in these operating instructions and confirm understanding by signing.

Risks involved in dealing with the MPS PA Compact Workstation

The MPS PA Compact Workstation is designed according to state-of-the-art technology and recognized safety regulations. Nevertheless, its use can still pose a risk of injury or death to users or third parties and can cause damage to the system or other property.

The MPS PA Compact Workstation is to be used only:

- for its intended purpose and
- in an absolutely safe conditions.

⚠ WARNING

Faults impairing safety must be rectified immediately!

Warranty and liability

All applicable Terms and Conditions of Sale apply. They are provided to the operating authority no later than upon contract conclusion. Warranty and liability claims for personal injury or material damage are excluded if they can be attributed to one or more of the following causes:

- Use of the machine not in accordance with its intended purpose
- Incorrect assembly, commissioning, operation, and maintenance of the machine
- Operation of the machine using faulty safety equipment or incorrectly fitted or non-operational safety or protective devices
- Non observance of notes in the operating instructions regarding transport, storage, assembly, commissioning, operation, maintenance, and setting up of the machine

- Unlawful constructional modifications on the machine
- Inadequate monitoring of machine components subject to wear
- Incorrectly carried out repairs
- Catastrophes as a result of foreign objects and acts of force major.

Festo Didactic excludes liability for damage or injury to trainees, the training company, or third parties arising from use or operation of the system outside a purely training context, unless such damage is caused by intent or gross negligence on the part of Festo Didactic.

Use for intended purpose

This system is designed exclusively for vocational and continuing training in automation and communication. The training authority and instructors must ensure that trainees follow the safety precautions described in the provided manual.

The use of the system for its intended purpose also includes:

- following all advice in the operating instructions and
- carrying out inspection and maintenance work.

Notes on Safety

General

⚠ WARNING

- Trainees may work on the station only under the supervision of an instructor.
- Observe the information in the data sheets for the individual components, especially all safety notes.

Electrics

⚠ WARNING

- Electrical connections may be wired or disconnected only when the power supply is switched off.
- Use only low voltages up to 24 V DC.
- The heating system operates at 230 V AC. Work on components with 230 V AC electrical connections must be carried out by qualified personnel. Observe the safety regulations for commissioning (DIN VDE 0113, EN 60204).

Pneumatics

⚠ WARNING

- Do not exceed the permissible pressure of 8 bar (800 kPa).
- Do not switch on compressed air until all tubing connections are established and secured.
- Do not disconnect pressurized air hoses while they are under pressure.
- Take particular care when switching on the compressed air. Cylinders may extend or retract immediately.

Mechanics

⚠ WARNING

- Securely mount all components on the mounting plate.
- Do not perform manual intervention unless the machine is at rest.
- The pump can be mounted horizontally or vertically. When mounted, the pump outlet must point upward. The pump must be installed in a flooded condition (see the data sheet).

Process engineering

⚠ WARNING

- Before filling the tanks with water, switch off the power supply.
- Switch off the 24 VDC and 230 VAC (110 VAC) power supplies.
- Use drinking-quality tap water (recommended) to ensure prolonged maintenance-free operation of the system (proportional valve and pump).
- The maximum operating temperature of the tanks must not exceed 65 °C.
- Do not operate the heating unit unless the heating element is fully immersed in fluid.
- Do not operate the piping system at a system pressure higher than 0.5 bar.
- Do not operate the pump without fluid, allow it to run dry, or use it with seawater or contaminated fluids.
- Before making changes to the piping system, drain all fluids from the system (tanks and piping) and close the valves.
- You can drain the fluids from the MPS PA Compact Workstation by opening hand valve V105.
- Do not leave water in the tanks for extended periods. Bacteria, such as Legionella, may grow and cause disease.

Cyber security

Festo Didactic provides products with security functions that support the safe operation of plants, systems, machines, and networks. Protecting these assets from cyber threats, however, requires a comprehensive and regularly updated security concept. Festo's products and services form only part of such a strategy.

The customer is responsible for preventing unauthorized access to equipment and networks. Connections to company networks or the Internet should be made only when necessary and only with appropriate security measures, such as firewalls, network segmentation, defense-in-depth strategies, etc.

Without these measures, connecting products to a network can expose vulnerabilities that allow unauthorized remote access, potentially affecting the entire system. This access can be exploited for data theft, manipulation, or sabotage. Common threats include Denial-of-Service attacks, remote code execution, privilege escalation, ransomware, and other malicious activities. In industrial environments, such attacks can create unsafe conditions, endangering both people and equipment.

Customers should follow Festo's security guidelines and keep their products up to date. Festo continuously improves its products for greater security and strongly recommends installing updates promptly. Using outdated or unsupported versions increases exposure to cyber threats.

Report security issues to the Festo Product Security Incident Response Team (PSIRT) in German or English by email at psirt@festo.com or through the online form at https://www.festo.com/psirt.

⚠ WARNING

Unsecure operating conditions due to software tampering

- Software tampering (e.g., viruses, Trojans, malware, worms) can cause unsafe system conditions, potentially leading to serious injury or property damage.
- Keep all software up to date.
- Integrate all automation and actuator components into a comprehensive industrial security concept aligned with current technological standards.
- Ensure all installed products are included in your security concept.
- Use protective tools, such as antivirus software, to scan files on removable storage media for malware.

⚠ WARNING

Firmware Update Security

This warning applies only to products with updatable firmware. To protect the security and integrity of your system, follow these guidelines during the firmware update process:

- **Download source.** Obtain firmware updates only from the official manufacturer's website.
- **Do not tamper.** Do not modify or interfere with the firmware update process.
- **Update process.** Strictly follow the firmware update instructions provided in the user guide.

Technical Data

Table 1: Main specifications of the MPS PA Compact Workstation.

Parameter	Subparameter	Value
Max. operating pressure piping system		50 kPa (0.5 bar)
Power supply for station		24 V DC
Profile plate		700 x 700 x 32 mm
Dimensions		700 x 700 x 907 mm
Weight		49 kg
(Volumetric) flow rate of the pump		About 5 l/min
Tank volume		Max. 10 l
Flexible piping system		DN10 ($Ø_a$ 15 mm)
Digital inputs		7
Digital outputs		5
Analog inputs		4
Analog outputs		2
Amount of tanks		3
Output range control element	Pump (0-24 V DC)	Voltage 0-10 V
	2/2W-proportional valve	Voltage 0-10 V
	Heating element, 230 V AC load supply	On/Off (control 24 V DC)

Parameter	Subparameter	Value
Level control	Working range closed-loop system for level control	0-10 l
	Measuring range level sensor	0-9 l
	Signal range level sensor	Current 4-20 mA
Flow rate control	Working range closed-loop system for flow rate control	0-5 l/min
	Measuring range flow sensor	0.3-9.0 l/min
	Signal range flow sensor	Frequency 0-1200 Hz
Pressure control	Working range closed-loop system for pressure control	0-30 kPa (0-300 mbar)
	Measuring range pressure sensor	0-40 kPa (0-400 mbar) 0-58 PSI
	Signal range pressure sensor	Voltage 0-10 V
Temperature control	Working range closed-loop system for temperature control	0-60°C
	Measuring range temperature sensor	-50°C to 150°C
	Signal range temperature sensor	Resistance PT100

Transport, Unpacking, and Scope of Delivery

Transport

The MPS PA Compact Workstation is supplied in a container with a pallet base. The container must always be transported using a suitable forklift truck and secured against tipping or falling.

Any transport damage must be reported immediately to the carrier and to Festo Didactic.

Unpacking

When unpacking the station, carefully remove the padding material and ensure that no station assemblies are damaged.

After unpacking, inspect the station for damage. Any damage must be reported immediately to the carrier and to Festo Didactic.

Scope of delivery

Check the scope of delivery against the delivery note and the order. Notify Festo Didactic immediately of any discrepancies.

Design and Function

The MPS PA Compact Workstation is available in different designs to suit individual training outcomes:

- Basic design
- Process instrumentation (PI)
- Energy
- And many other customized solutions

Figure 1: MPS PA Compact Workstation – basic design.

The MPS PA Compact Workstation combines 4 closed-loops with digital and analog sensors and actuators. With a PLC or a controller, it is possible to use them individually or cascaded:

- level controlled system
- flow rate controlled system
- pressure controlled system
- temperature controlled system

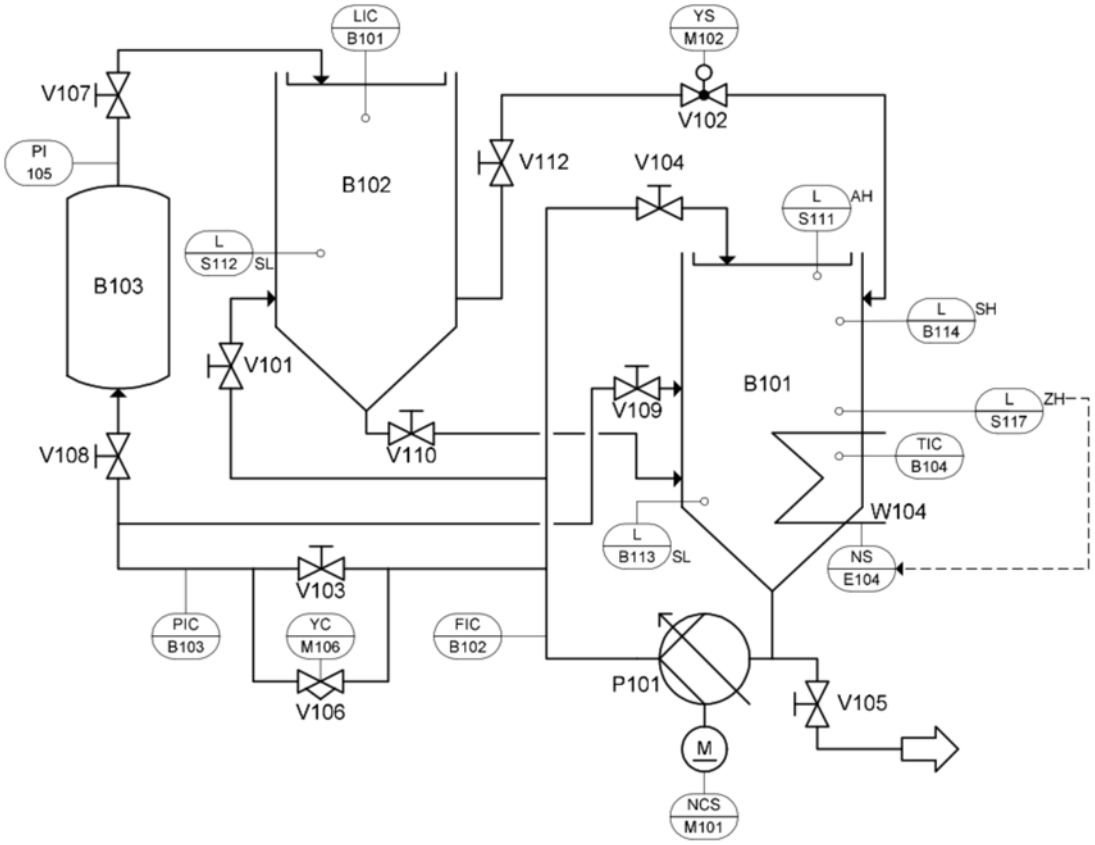


Figure 2: P&I diagram MPS PA Compact Workstation in standards DIN EN 62424 and ISO 10628.

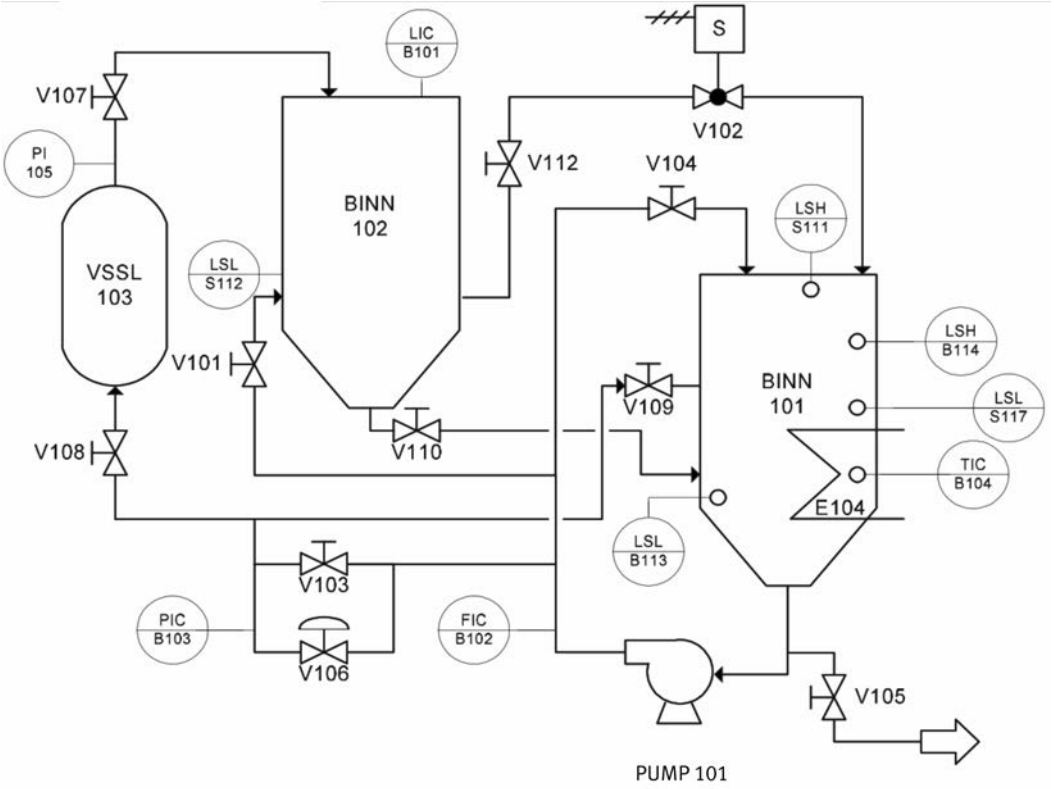


Figure 3: PI diagram MPS PA Compact Workstation in ISA 5.5 / ISA 5.1 standard.

It is possible to work with following functions by using the 4 closed-loop systems:

- two point control of a level control system with an analog standard signal
- continuous control of a level control system with an analog standard signal
- continuous control of a flow rate control system with a pump as controlled system and an impulse signal for frequency measurement
- continuous control of a flow rate control system with a proportional valve (controlled system) and an impulse signal for frequency measurement
- continuous control of a flow rate control system with a pump as controlled system and with an analog standard signal
- continuous control of a flow rate control system with a proportional valve as controlled system and with an analog standard signal
- continuous control of a pressure control system with a pump as controlled system and with an analog standard signal
- continuous control of a pressure control system with a proportional valve as controlled system and with an analog standard signal
- two point control of a temperature control system with an analog standard signal

The basic design components of the MPS PA Compact Workstation are:

- Analog ultrasonic sensor
- Flow sensor with frequency signal
- Pressure sensor, piezoresistive
- Pressure gauge for 0-1 bar
- PT100 temperature sensor
- 2x Capacitive proximity switch for min/max level in lower tank
- Float switch for threshold function (electromechanical) in upper tank
- Float switch for overflow alarm monitoring in lower tank
- Float switch as a protection for the heating system
- Centrifugal pump
- Motor Controller for pump
- Proportional valve with electronic control module
- Heating system with integrated micro controller
- 2W ball valve with pneumatic rotary drive (SYPAR) with sensor box
- I/O Terminal
- Terminal for analog signals
- Signal converter: current to voltage, frequency to voltage, PT100 to voltage
- Piping system incl. 4 transparent segments
- Pressure tank (reactor), 2L, stainless steel
- 2x Water tanks, 10L, square
- Manual valve
- Service Unit
- Cable ducts
- Aluminum profiles
- Profile plate
- 19" mounting frame
- Mounting frame for ER units or A4 EduTrainers

Additional accessories should be used:

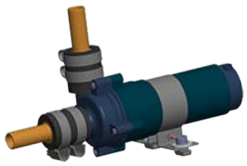
- 24 V DC power suppl for 19" frame
- PLC or closed-loop controller, e.g., EasyPortUSB, EduTrainer Universal with PLC
- Trolley
- Basic control panel for 19" frame
- Touch panel (HMI)

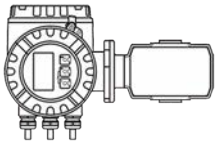
The functions of each closed-loop system result in the specified combination of the (manual-) valves. Also, they depend on the programming, configuration, or parametrizing of the PLC/ controlling system. For the usage of the station a control kit and a power supply for 24 V DC is required.

Overview of components

The following table shows all electric devices of the MPS PA Compact Workstation in every design, which are included (✓) or not included (blank). The components and functions in this operating instruction are explained for the basic design.

Table 2: Electric devices of the MPS PA Compact Workstation.

Description	Component	Basic design	Process instrumentation (PI)	Energy
Pump		✓	✓	✓
Proportional valve		✓	✓	✓
Heating		✓	✓	✓
Ultrasonic sensor		✓		✓

Description	Component	Basic design	Process instrumentation (PI)	Energy
Flow rate sensor		✓		✓
Pressure sensor		✓		✓
Temperature sensor		✓		✓
Level probe, capacitive			✓	
Magnetic-inductive flow meter			✓	
Pressure sensor			✓	
Temperature sensor			✓	

Description	Component	Basic design	Process instrumentation (PI)	Energy
Level switch, vibronic		✓	✓	✓
2way ball valve with pneumatic rotary drive		✓	✓	✓
DC-wattmeter				✓
PAC4200 AC power meter				✓

Level monitoring

The following technical examples for level monitoring are integrated into the MPS PA Compact Workstation:

- Proximity switches
- Float switch for overflow safety
- Float switch for threshold function
- Float switch as switch-on protection for heating

Proximity switches

Two capacitive proximity switches, B113 (1) and B114 (2), are mounted on a profile plate on the side of lower tank B101. The switches are mechanically adjustable. The sensing distance through the tank wall is set using an adjustment screw. The 24 V binary input signals are connected to the I/O terminal XMA1.

The minimum level of tank B101 is detected by the lower sensor B113. At the minimum level, the heating element E104 must be fully immersed in the liquid.

The maximum level of tank B101 is detected by the upper sensor B114. In the system reset state, both sensors must be active.

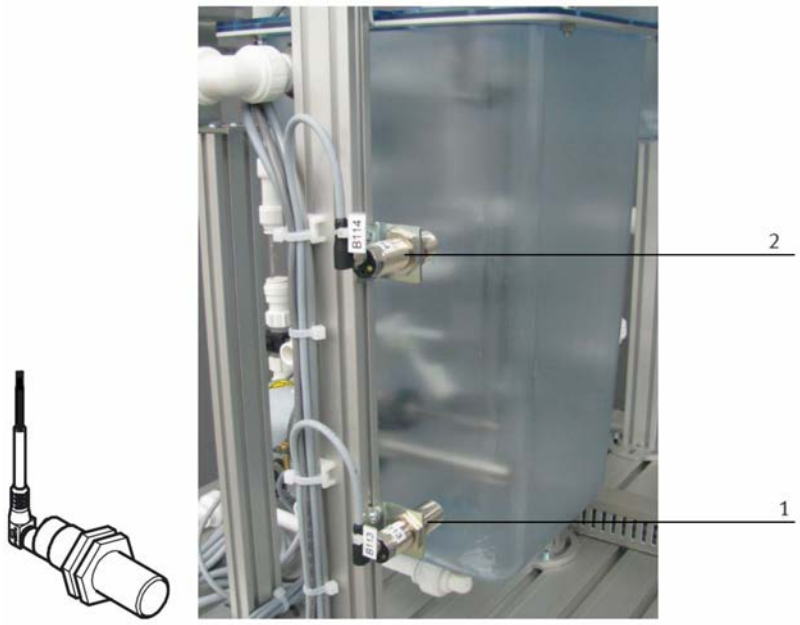


Figure 4: Level monitoring with capacitive proximity switches B113 and B114.

Overflow safety

The overflow of tank B101 is monitored by float switch S111 (1). If the tank level exceeds the maximum level, the transparent float cylinder moves upward. Magnets inside the float cylinder activate a reed contact.

The normally open 24 V binary input signal is connected to the I/O terminal XMA1. The overflow signal should trigger an alarm function in the PLC program and affect ball valve V102 and pump P101. With appropriate electrical modification, the overflow switch can also be used to switch off the pump or valve via a relay circuit or to provide a signal to an emergency relay.

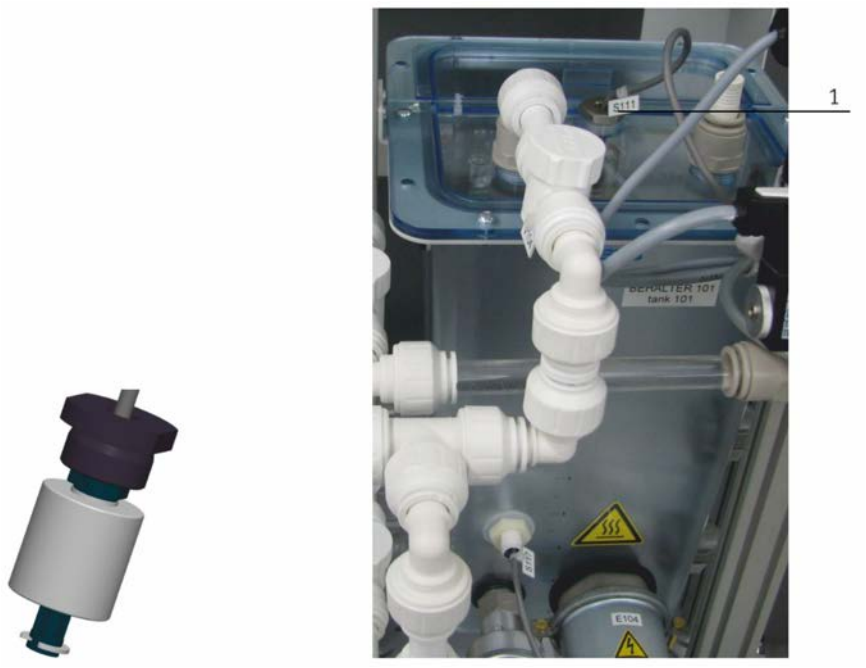


Figure 5: Level monitoring with float switch for overflow safety S111.

Threshold function

The rising fluid level in upper tank B102 is monitored at a defined minimum level by float switch S112 (1). By changing the mounting position, the switch can also be used to detect a falling level.

The normally closed 24 V binary input signal is connected to the I/O terminal XMA1. The switch cable has a plug connection to allow easy connection and disconnection when the mounting position is changed.

Figure 6: Level monitoring with float switch for threshold function S112.

Switch-on protection for heating

The float switch monitors the decreasing fill level in the tank. It prevents continued heating if the level falls below the critical point. The heating element must always be fully immersed in the fluid.

The switch cable has a plug connection and is connected directly to the heating element and to the connection cable for the I/O connection board.

Figure 7: Float switch as switch-on protection for heating.

Pump

The centrifugal pump P101 (1) is the main actuator used in all control systems. It delivers fluid from the reservoir tank B101 through the piping system.

Do not operate the pump dry. Before commissioning, fill the reservoir tank and the piping system connected to the pump with fluid.

The pump is driven by motor controller A4 and relay K1. Using digital output O2 at XMA1, the control mode can be switched between binary digital control and analog control. In binary control (O2 = 0), the pump is switched on and off using output O3 at XMA1. In analog control (O2 = 1), the pump speed is set by the analog output signal channel O (UA1 at X2) with a control voltage from 0 to 10 V.

	⚠ WARNING
	Refer to the pump data sheet for additional safety instructions.

Figure 8: Controlling equipment – Pump P101 (1).

Proportional valve

The proportional valve V106 (1) is a directly actuated 2/2-way valve for fluid flow control. It can be used as an adjustable remote element in open- or closed-loop systems. The valve piston lifts from its seat as a function of the solenoid coil current, allowing flow through the valve.

The valve control electronics are enabled by a binary output (O4 at XMA1). An analog signal from channel 1 (UA2 at X2) drives the valve input with a standard 0–10 V analog signal.

This analog signal is converted into a pulse-width modulation (PWM) signal, enabling continuous adjustment of the valve opening. The PWM frequency can be adapted for different valve types.

Figure 9: Controlling element proportional valve V106.

Heating

The heating element is controlled by an internal microcontroller activation of a binary output (Q1 at XMA1).

NOTICE

Notes on safety

- The maximum operating temperature of the tanks must not exceed 65°C.
- Do not operate the heating unit unless the heating element is fully immersed in the fluid.
- Critical temperature at the heating element: at approximately 50–60°C, the heating switches off automatically. When the temperature drops below 45°C, the heating switches on again.
- Critical temperature at the heating microcontroller: at a semiconductor temperature of approximately 90°C, the heating switches off automatically. When the temperature drops below 85°C, the heating switches on again.

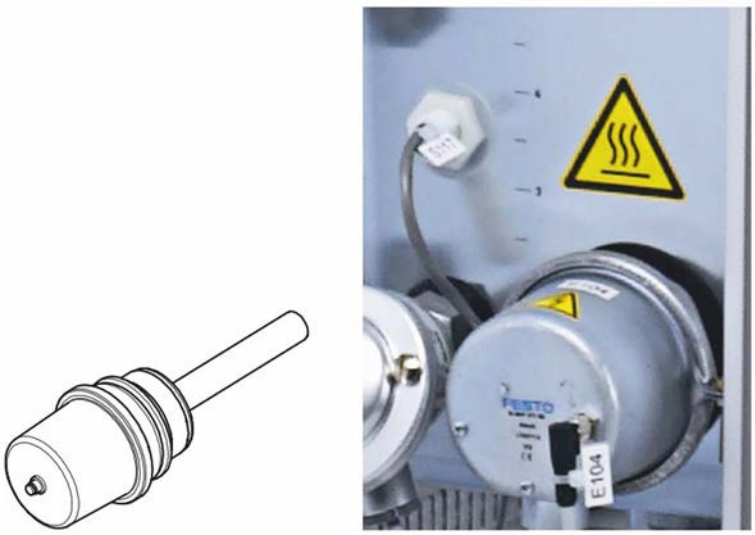


Figure 10: Heating.

Controlling the heat element

The heating can be controlled in binary or analog (continuous) mode. In the MPS PA Compact Workstation, the heating is controlled **binary only**. Continuous control is achieved using pulse-width modulation (PWM). The controller switches the heating on and off with a constant period T (for example, 10 s). By increasing the on-time t1, the thermal power Q increases accordingly.

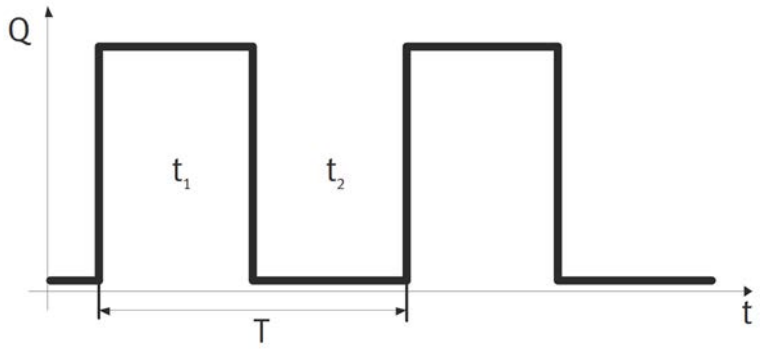


Figure 11: PWM with a pulse-width ratio of 50%.

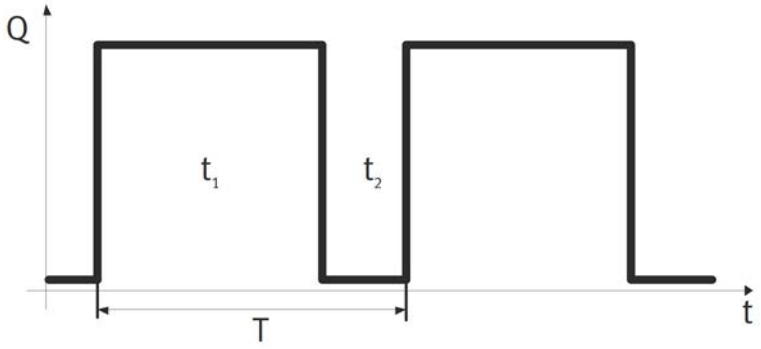


Figure 12: PWM with a pulse-width ratio of 75%.

Legend

t1: ON-time

t2: OFF-time

T: time period

Q: thermal power

2W ball valve with pneumatic rotary drive

The 2-way ball valve V102 is opened and closed by a pneumatic rotary actuator. The assembly consists of a brass ball valve (1) with a type 5YPAR rotary actuator (4) operating on the scotch yoke principle. A 5/2-way solenoid valve (2, 3) with a NAMUR interface and a sensor box (5) are flange-mounted on the actuator. The rotary drive ball valve controls the fluid flow from upper tank B102 to lower tank B101.

Legend

1. Brass ball valve
2. Solenoid
3. 5/2 way valve with port pattern to NAMUR
4. Rotary drive type SYPAR, scotch yoke principle

5. Sensor box

The end-position sensing unit (5) consists of two electrical microswitches with roller levers. The two 24 VDC binary signals (5115 and 5116) are connected as inputs to the I/O terminal XMA1. The unit also provides a visual indication of the actuator position for the operator.

Figure 13: 2-way ball valve V102 with pneumatical rotary drive.

Level control function

The function of the level controlled system is to regulate the filling level of a fluid in a reservoir tank. The controlled filling level system can be used as I- or PT1 controlled system.

The pump P101 delivers a fluid from a storage tank B101 to a reservoir tank B102 (1) via a piping system. The level of the fluid inside tank B102 is monitored with an analog sensor B101 (2) at measuring point "UC B101" and read as actual value. The actual value should be kept on a certain level also if disturbances or set point changes occur.

In the basic design of the station a ultrasonic sensor B101 (measuring point "UC B102") is measuring the distance between sensor and water surface. The sensor has a fixed programmed measuring range.

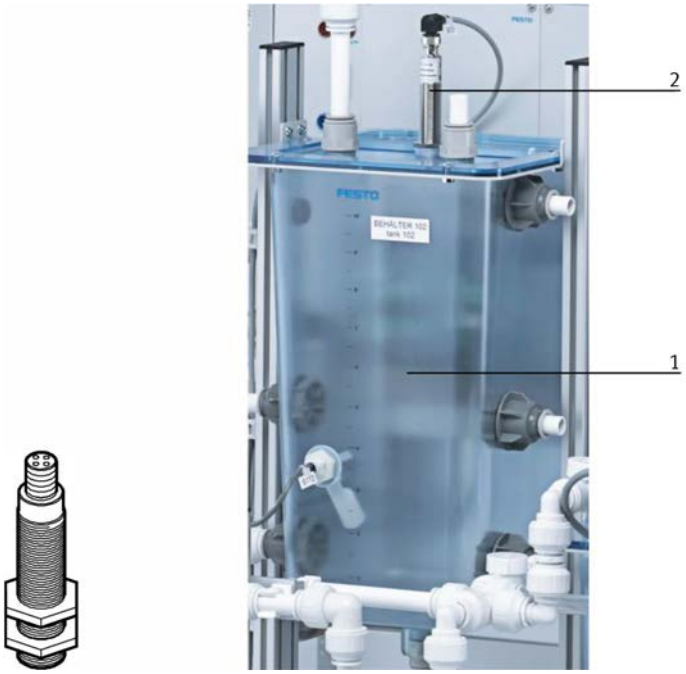


Figure 14: Controlled level system – ultrasonic sensor B101 (measuring point "LIC B102") for basic design.

The analog current signal (4-20 mA) of the ultrasonic sensor is connected to the measuring transformer A1. The transformer changes the analog current signal into a standard voltage signal (0-10 V). The standard voltage signal is connected to the analog terminal X2 (UE1).

For function and characteristic curve of the ultrasonic sensor please see data sheet.

The fluid quantity of the pump P101 can be a binary or manipulated value. For controlling a system, a twoposition or a continuous element can be used (see also EMCS block diagrams).

For disturbance it is possible to partly or totally open/close the ball valve V102 to drain the upper into the lower tank or open/close hand valve V104.

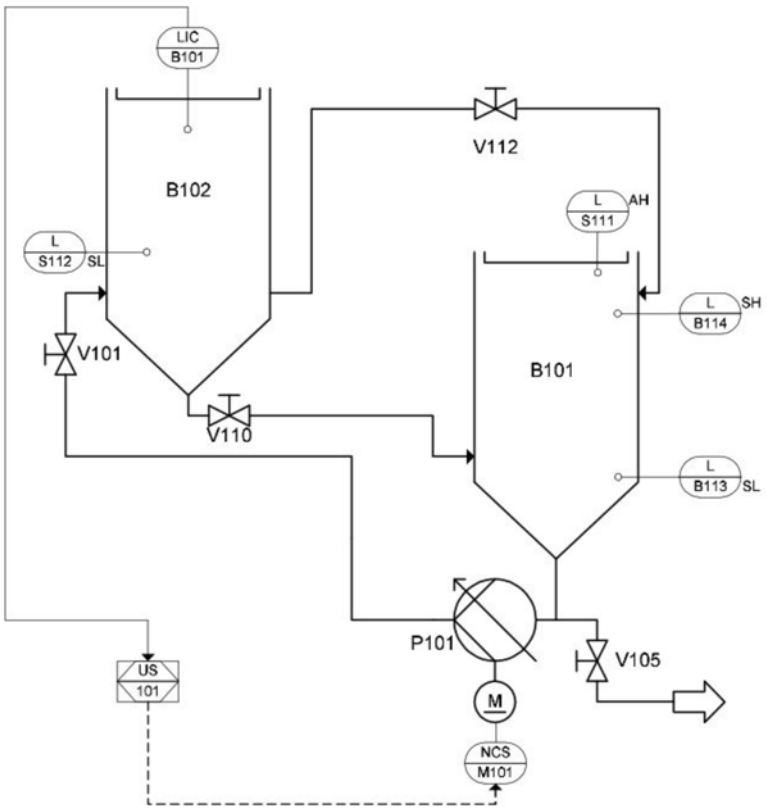


Figure 15: PI diagram of the closed-loop level control system (EN62424/ISO10628).

Flow rate control function

In a piping system or filter unit, the fluid flow velocity must be regulated.

The system used is a self-regulating controlled system (P-controlled system) without time delay. The control loop, combined with the pump (PT1 behavior), results in an easily controllable system.

The pump delivers fluid from the reservoir through a piping system. The measured actual value (2) must be maintained at a specified flow rate, even in the presence of disturbances or setpoint changes. Continuous control elements can be used. Two operating modes are available:

- Flow rate control using pump P101 as the controlled system. The manipulated variable is the pump voltage, which sets the rotational speed.
- Flow rate control using proportional valve V106 as the controlled system. The manipulated variable is the valve coil voltage, which sets the valve piston stroke. Pump P101 operates at constant speed.

Disturbances can be introduced by partially or fully opening or closing hand valves V104 or V109.

Figure 16: Controlled flow rate system – pump P101 with e.g., flow sensor B102 (measuring point "FIC B101").

The flow rate is measured as an actual value using the optoelectronic vane sensor B102 (turbine sensor). The sensor outputs a square-wave signal that is connected to a binary input at I/O terminal XMA1 (I0). Refer to the PLC manual for the maximum permissible input frequency of binary inputs.

The signal level depends on the applied supply voltage (8–24 V). The pulse signal can be processed by a PLC with integrated counter inputs. The frequency signal is also connected to measuring transducer A2, which converts it into a standard voltage signal (0–10 V). This voltage signal is connected to analog terminal X2 (UE2).

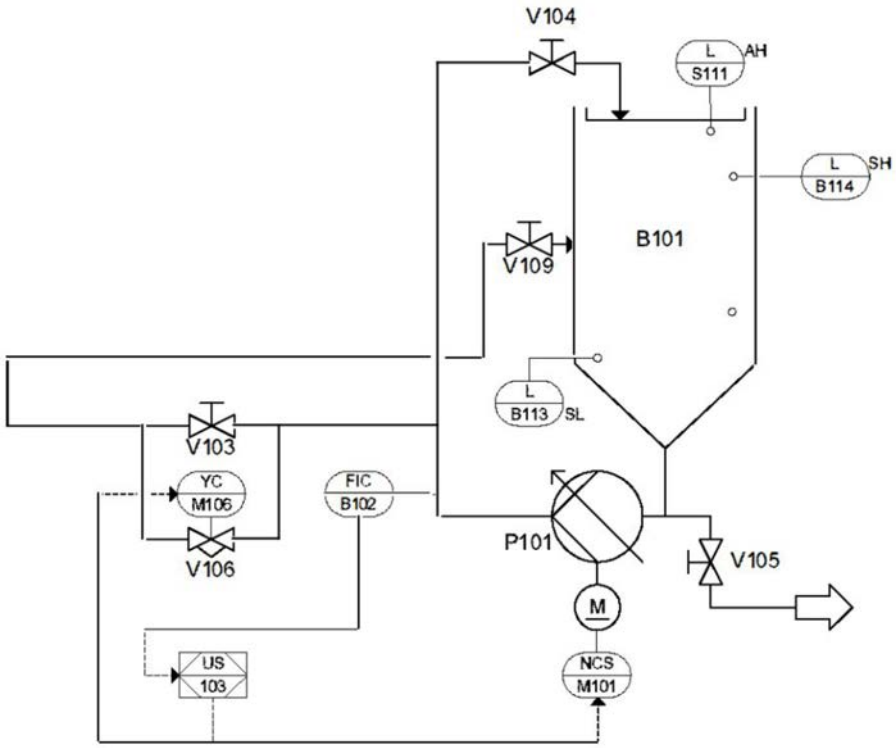


Figure 17: PI-diagram of the closed-loop flow rate control system (EN62424/IS010628).

Pressure control function

The process pressure of a fluid in a pressure tank or piping system must be regulated. The pressure control system used is a self-regulating controlled system (PT1-controlled system). Because the pressure tank is partially filled with gas (air), it acts as an energy storage system.

Through a piping system, pump P101 delivers fluid from a reservoir into the gas-precharged pressure tank B103 (1). The gas (air) pressure in the tank is measured by a relative pressure sensor as the actual value. This actual value must be maintained at a specified pressure, even when disturbances or setpoint changes occur.

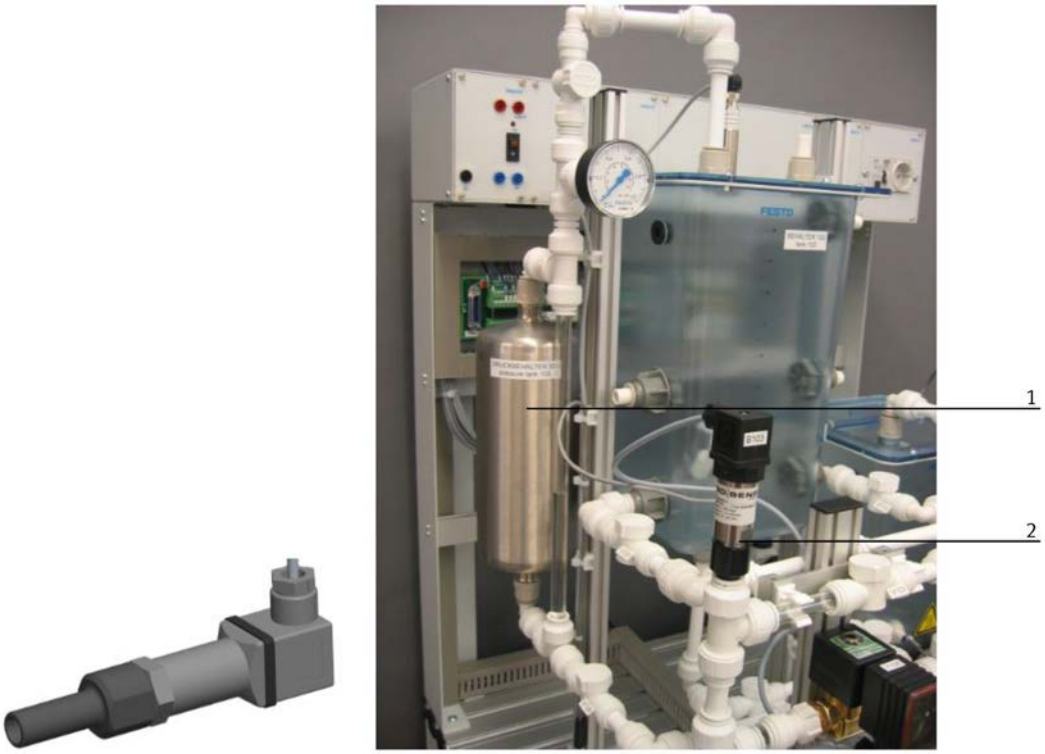


Figure 18: Controlled pressure system – pressure tank B103 with pressure sensor B103 (measuring point "PIC B103").

Setup for controlling

A continuous control element can be used as the control system. During operation, pressure is built up and controlled between the liquid and gaseous media in pressure tank B103. Before closed-loop control, the liquid level in the pressure tank can be adjusted by opening or closing exhaust valve V107 while pump P101 is running. For optimal operating range during closed-loop control, it is recommended to set the tank water level to approximately half full using valve V107.

The medium pressure is measured as an actual value using the relative piezoresistive sensor B103. The sensor's standard voltage output is connected directly to analog terminal X2 (UE3); a measuring transformer is not required. The sensor can be easily unplugged from the piping system. Be aware that residual or trapped pressure may be present in the piping.

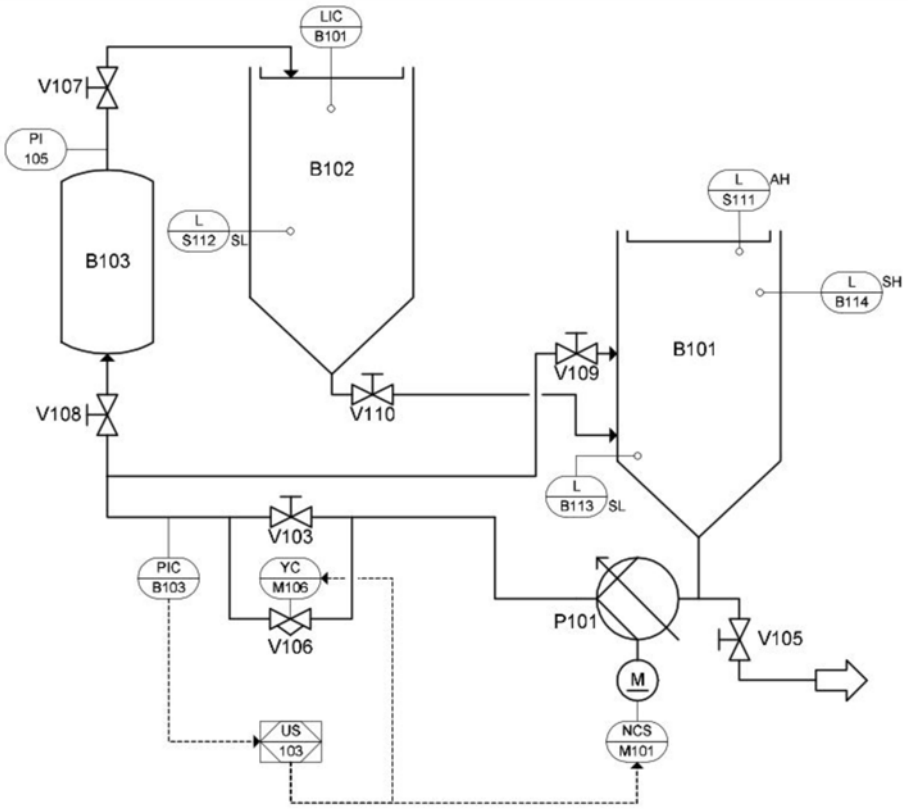


Figure 19: PI diagram of the closed-loop pressure control system (EN62424/ISO10628).

Two operating modes are available:

- Pressure control using pump P101 as the controlled system. The manipulated variable is the pump voltage, which sets the rotational speed.
- Pressure control using proportional valve V106 as the controlled system. The manipulated variable is the valve coil voltage, which sets the valve piston stroke. Pump P101 operates at constant speed.

Disturbances can be introduced by partially or fully opening or closing hand valve V109. To empty the pressure tank, open hand valves V109, V108, and V107 and switch off pump P101. Note that the water level in the pressure tank cannot drop below the level of lower tank B101. It may be necessary to pump water from the lower tank to the upper tank B102.

The tank pressure can also be read on a pressure gauge.

Figure 20: Pressure gauge at PCE-task "PI 105".

Temperature control system

The process fluid temperature of a heat exchanger must be regulated. The temperature control system used is a self-regulating controlled system (PT1-controlled system). Because energy conversion occurs slowly, these systems have a high time constant.

The water in reactor tank B101 of heat exchanger E104 is heated by a heating element and recirculated by pump P101.

A PT100 sensor B104 (2) measures the system temperature at measuring point “TIC B104” as the actual value. This value must be maintained at a specified temperature, even in the presence of disturbances or setpoint changes.

The medium temperature is measured as an actual value using the temperature-resistive sensor B103 mounted in the lower tank. The sensor resistance is connected to measuring transformer A3, which converts it into a standard voltage signal of 0 to 10 V. This voltage signal is connected to analog terminal X2 (UE4).

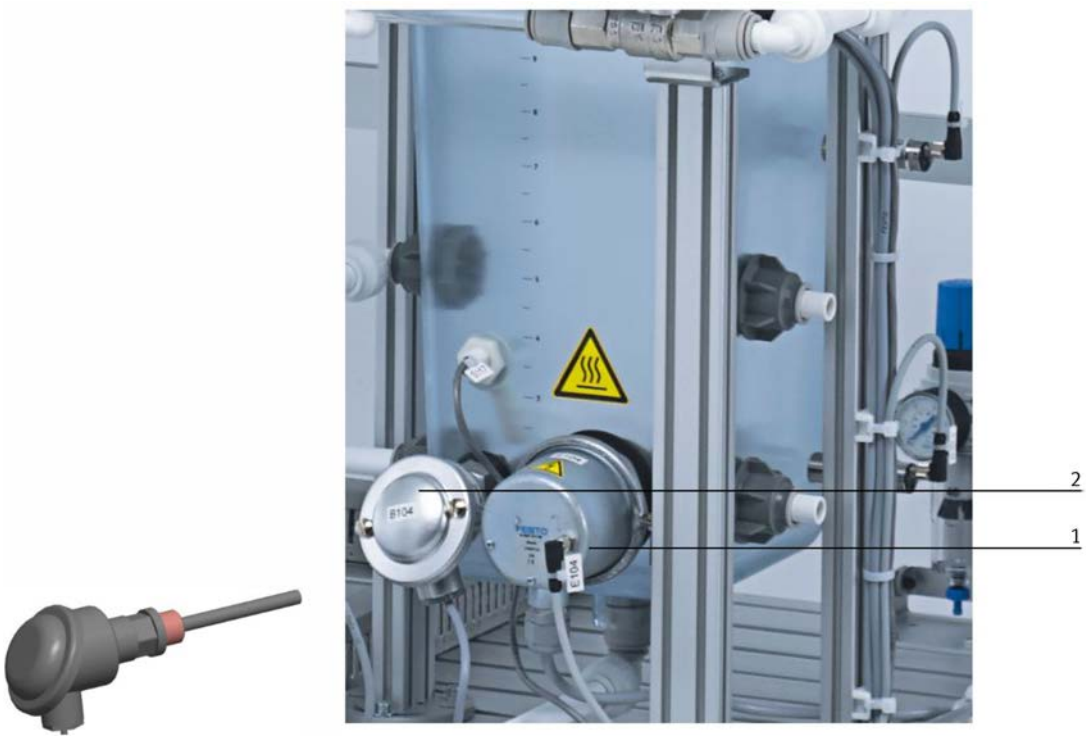


Figure 21: Controlled temperature system – reactor container B101 with temperature sensor B104 (measuring point “TIC B104”).

The on/off switching period of heating element E104, which is the manipulated variable, determines the heat output of the heat exchanger. A two-point control element can be used for control. Disturbances can be introduced by adding cold fluid (for example, ice cubes) or by mixing with water from the upper tank. The heating is controlled by an internal microcontroller. Using binary output O1 at XMA1, the heating can be switched on or off.

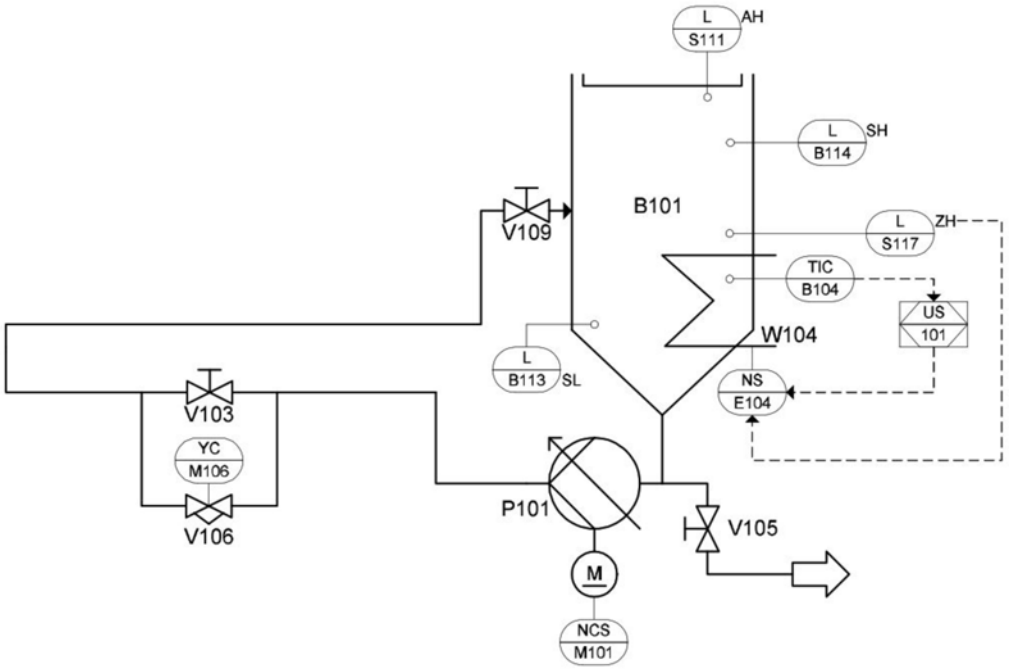


Figure 22: PI diagram of the temperature control system.

I/O board

The connection board provides an interface for analog and digital input and output signals. All analog signals are converted to 0–10 V and routed to the analog terminal. Binary signals, up to eight inputs and eight outputs per station, are routed to the I/O terminal. This ensures compatibility with EasyPort, SimuBox, EduTrainer, and PLC boards.

Legend

1. Mounting plate
2. XMA1 I/O terminal (SysLink station): connection of inputs, for example capacitive proximity sensors, and outputs, for example pumps, proportional valve, and 2-way ball valve.
3. X2 analog terminal: actual values for level, flow rate, pressure, and temperature, and manipulated variable y for the pump and proportional valve.
4. Relay K1: pump control. When K1 is active, the pump can be controlled with a continuous 0–10 V manipulation voltage.
5. Power relay K106: activates the power electronics for the proportional valve.
6. A4 motor controller: binary and analog control of the pump.
7. A1 measuring transducer I/U: converts the 4–20 mA current signal of the ultrasonic level sensor into a 0–10 V standard voltage signal.
8. A2 measuring transducer f/U: converts the frequency pulse signal of the flow sensor into a 0–10 V standard voltage signal.

9. A3 measuring transducer PT100/U: converts the resistance signal for temperature measurement into a 0–10 V standard voltage signal.
10. A5 starting current limiter: limits the maximum motor controller starting current to prevent voltage drops at the controller.
11. DIN rail
12. Housing

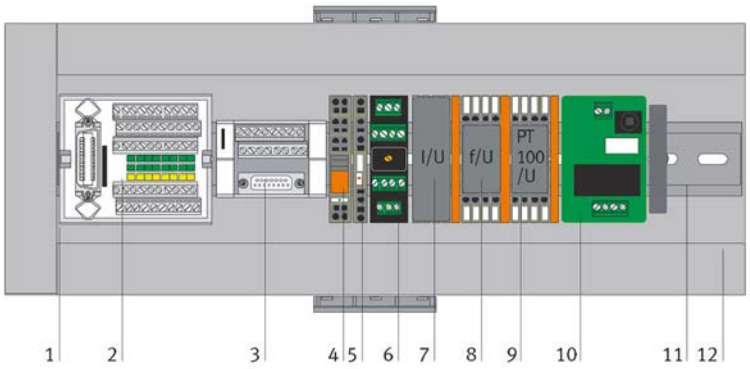


Figure 23: I/O board of basic design.

Mounting frame

The mounting frame of the MPS PA Compact Workstation consists of a two-row ER frame for Edu Trainers and a 19" base frame for 19" units.

1. ER frame for Edu Trainers
2. 19" base frame for 19" units

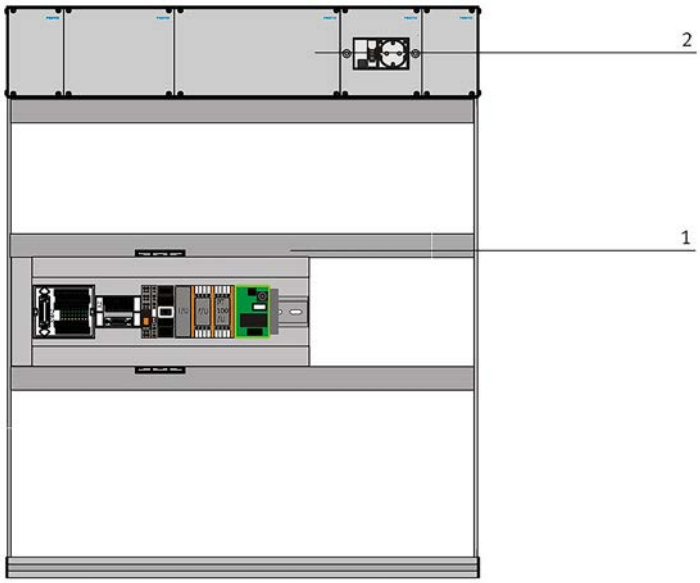


Figure 24: Mounting frame.

The 19" control panel supports the following operating and indication units:

- 19" 24 V DC power supply, 4.5 A
- 19" control panel with three pushbuttons, one key switch, and four indicator lights
- 19" communication panel with four inputs and four outputs on 4 mm safety sockets (use only with the 19" control panel)
- 19" EMERGENCY STOP panel

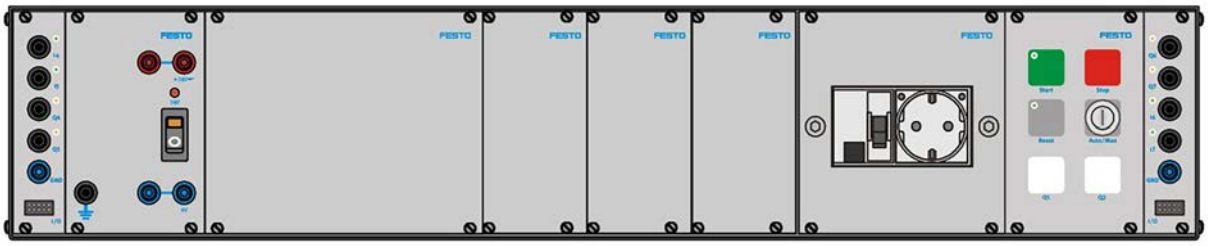


Figure 25: 19"-frame example assembly.

Additional accessories

The common functions of the station can be extended and customized with modular components. Following components are not included to the delivery of the MPS-PA Compact Workstation basic design and should be ordered additionally.

Directly controlled 2-way solenoid valve, brass

Directly controlled solenoid valves automate the manual valve functions of the MPS PA Compact Workstation. The solenoid valves are integrated into the piping and are switched by a load relay.

The 2-way solenoid valves are used for the following functions:

- Inlet feed tank B102 (supplement for V101)
- Tank-to-tank process with pump P101 (supplement for V101)
- Drain valve for tank B101

Figure 26: Directly controlled 2way solenoid valve, brass.

Directly controlled 2-way solenoid valve, plastic

A plastic 2-way solenoid valve is used in the MPS PA Compact Workstation to control the cooling circuit. It is supplied with the cooling unit with heat exchanger (C44001) and is switched by a load relay.

Figure 27: Directly controlled 2way solenoid valve, plastic.

Pilot-operated 2-way solenoid valve, brass

A 2-way solenoid valve is servo- or pilot-operated, allowing it to open with low magnetic force at a minimum medium supply pressure. It is installed in the piping or at a T-connector. Due to its low power consumption, the solenoid can be switched directly by a binary PLC output.

A pilot-operated solenoid valve supplies fresh water from the drinking water line to station tank B101.

⚠ WARNING

Refer to the data sheet for the 2/2-way solenoid valve and the applicable safety regulations.

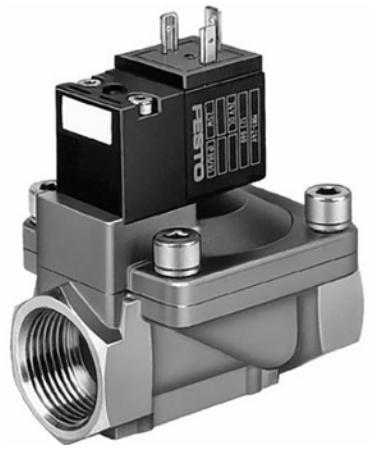


Figure 28: Pilot-operated 2-way solenoid valve.

Water-air cooler

The MPS PA Compact Workstation is extended with the following additional functions:

- Cooling using a heat exchanger
- Closed-loop speed control with variable-speed fans

The water-to-air cooler W120 is connected to the piping system using plug-in connectors. It cools the medium down to approximately room temperature using the pump in a flow-through configuration.

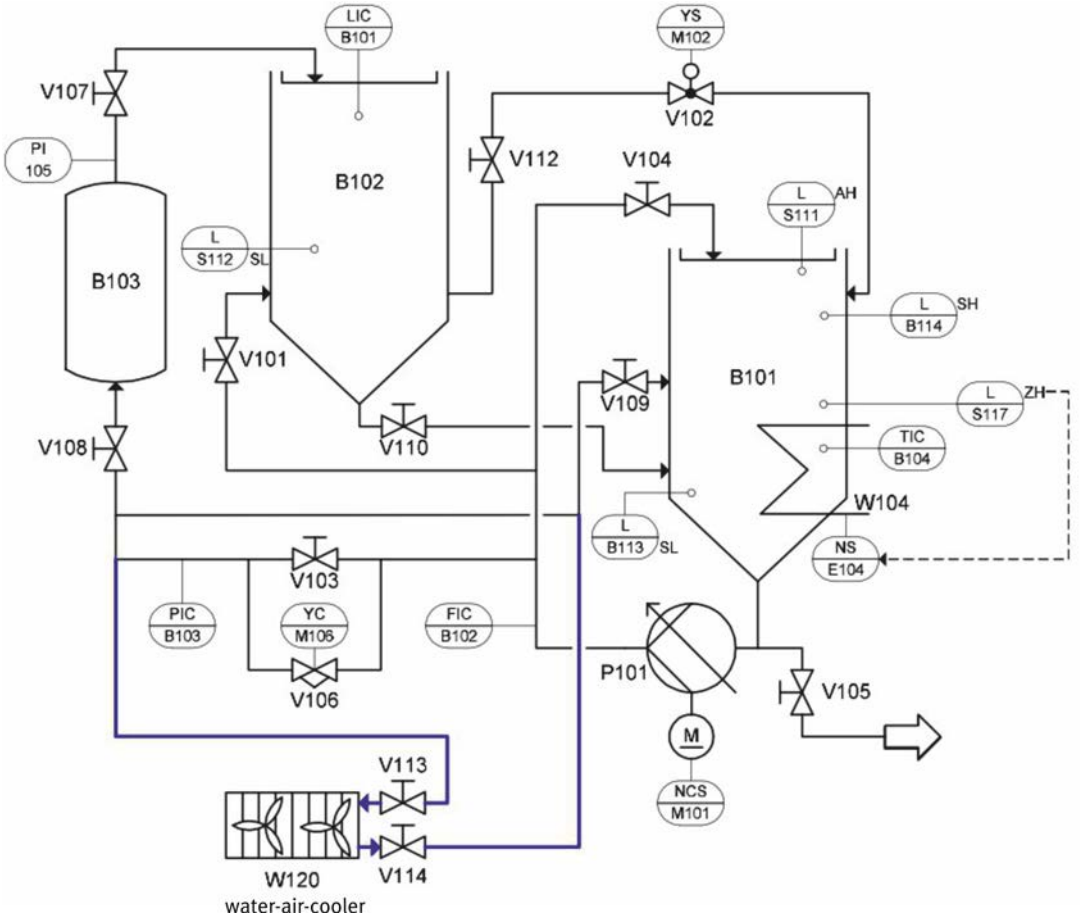


Figure 29: PI diagram of the station with water-air cooler (EN62424/ISO10628).

The process medium is pumped through the piping system by pump P101. Set the manual valves as described in Chapter 6.9 for “Pressure control with pump,” and open manual valves V113 and V114. Manual valves V113 and V114 are used to close the cooling circuit.

The water-air cooler is activated by relay K2. Relay K2 switches the following signals:

- Analog output CH1 from proportional valve V106 as the manipulated value for fan speed control, 0–10 V → 0–100%.
- Analog input CH2 from pressure sensor B102 as the measured value for fan speed feedback, 0–10 V → 0–6000 r/min.

Fan motor speed is continuously controlled by a 0–10 V DC control voltage. An encoder provides a feedback signal from the motors; only one motor encoder is connected. The speed-dependent square-wave signal is converted by a frequency transducer (0–200 Hz) into a voltage signal of 0–10 V. The water-air cooler is connected to the station IO board using a plug-in cable.

Cooling unit with heat exchanger

The process temperature of the process media inside the tank should be reduced.

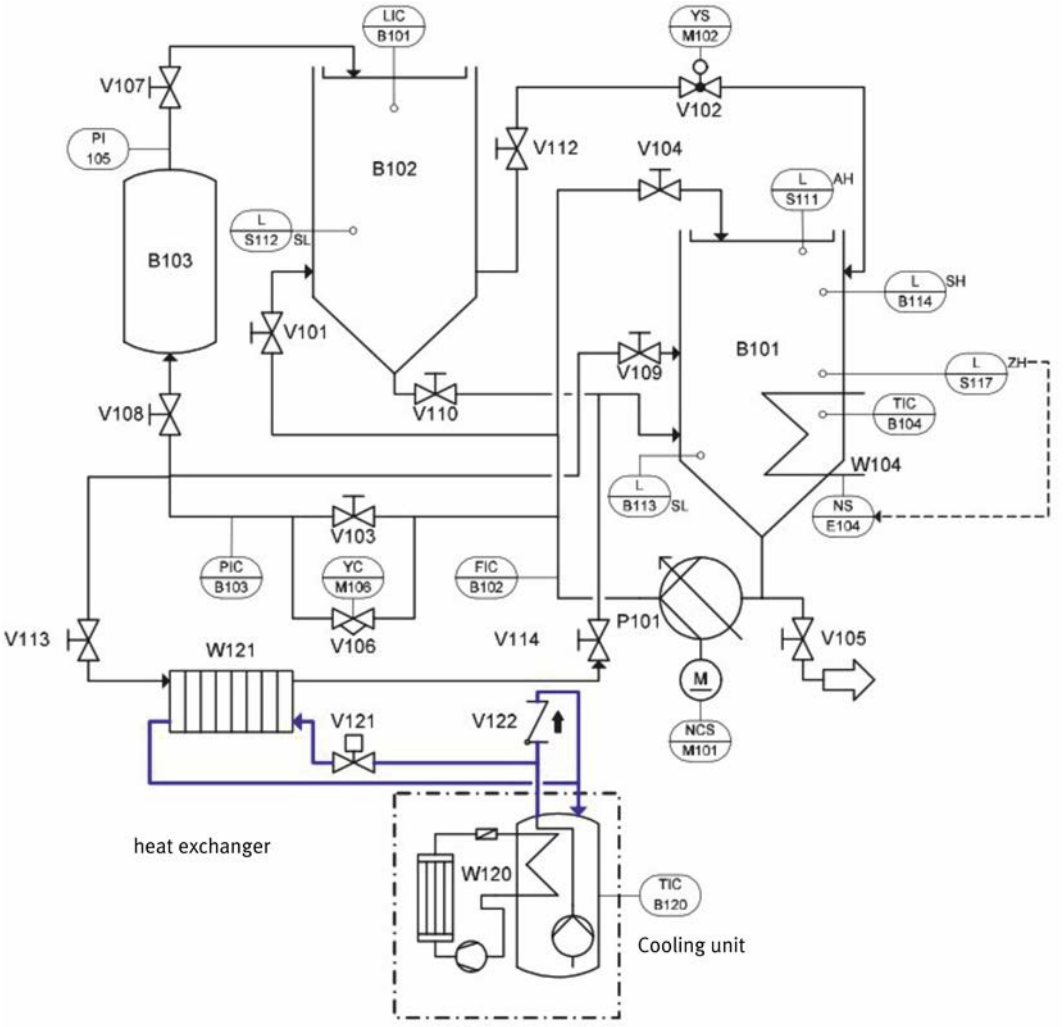


Figure 30: PI diagram for heat exchanger for cooling circuit W121 with cooling unit W120.

The liquid in tank B101 is pumped by P101 in a tank-to-tank circuit through a plate heat exchanger via valves V103 → V113 → V114. The tank temperature is measured by the PT100 temperature sensor and provided as the process value for the PCE task "TIC B104."

The cooling circuit is activated using the cooling unit in internal and external loops. Switch on the cooling unit, set the cooling setpoint to 10 °C, and start the pump. In the internal loop, the cooling unit precools the coolant via check valve V122; the supplied antifreeze liquid is recommended. When cooling solenoid valve V121 opens, the external cooling circuit through the plate heat exchanger operates to dissipate heat from the process medium. The circulating cooler uses a microprocessor-based temperature controller with an internal Pt100 sensor for thermostatic control.

⚠ WARNING

- The minimum operating temperature of the process or cooling medium must not fall below 5 °C to prevent freezing.
- Activate the cooling unit only after commissioning according to the specifications.

Stirrer

The stirrer R107 consists of a drive unit (motor), a compensating coupling, and a stirring rod. It is mounted to a profile using a mounting plate and mixes the process medium in tank B101. Activate the stirrer only when it is submerged in the process medium.

Figure 31: Stirrer module.

Connection technology. The stirrer is controlled by a motor controller that is activated via a digital output. In manual mode, the manipulated variable can be adjusted from 0 to 10 V using the adjustment screw on the motor controller.

Figure 32: Motor controller.

⚠ WARNING

Refer to the data sheets for the stirrer and motor controller for additional safety instructions.

Centrifugal pump with 3-phase AC-motor

Instead of the standard pump in basic design, a centrifugal pump with 3-phase AC-motor can be installed.

Figure 33: Centrifugal pump with 3-phase AC-motor - for illustration only.

Electrical cabinet with frequency convertor

A frequency converter (FC) installed in the electrical cabinet enables continuous control of the pump speed.

The pump is controlled by a frequency converter. Its parameters can be configured using the basic operator panel (BOP). Observe the instructions for the Micromaster M420 frequency converter. The configurable parameters for pump P101 are listed in the following section. Pump control with the FC is similar to standard pump control. The FC is enabled by digital output O3 at XMA1. Analog control is selected using digital output O2 at XMA1 and switch-over relay K1. In analog mode (O2 = 1), the pump speed is set by the analog output signal channel 0 (UA1 at X2) with a control voltage from 0 to 10 V.

An additional status signal indicates a configurable operating state to the control system. For safety reasons, the rotational speed or frequency is limited to 25 Hz.

Do not allow the pump to run dry. Before commissioning, fill the lower storage tank and the piping system connected to the pump with the liquid to be pumped. Refer to the data sheets for the pump and the frequency converter, and observe all safety regulations.

Figure 34: Electrical cabinet with frequency convertor.

Commissioning

To operate the MPS PA Compact Workstation, all commissioning steps must be performed in accordance with the operating rules shown in the following figure.

The MPS PA Compact Workstation is generally delivered:

- completely assembled,
- operationally adjusted,
- commissioned, and
- tested.

⚠ WARNING

Commissioning is normally limited to a visual inspection to verify correct tubing, piping, wiring, and the supply of operating voltage.

All components, tubing, and wiring are clearly labeled so that all connections can be easily reestablished.

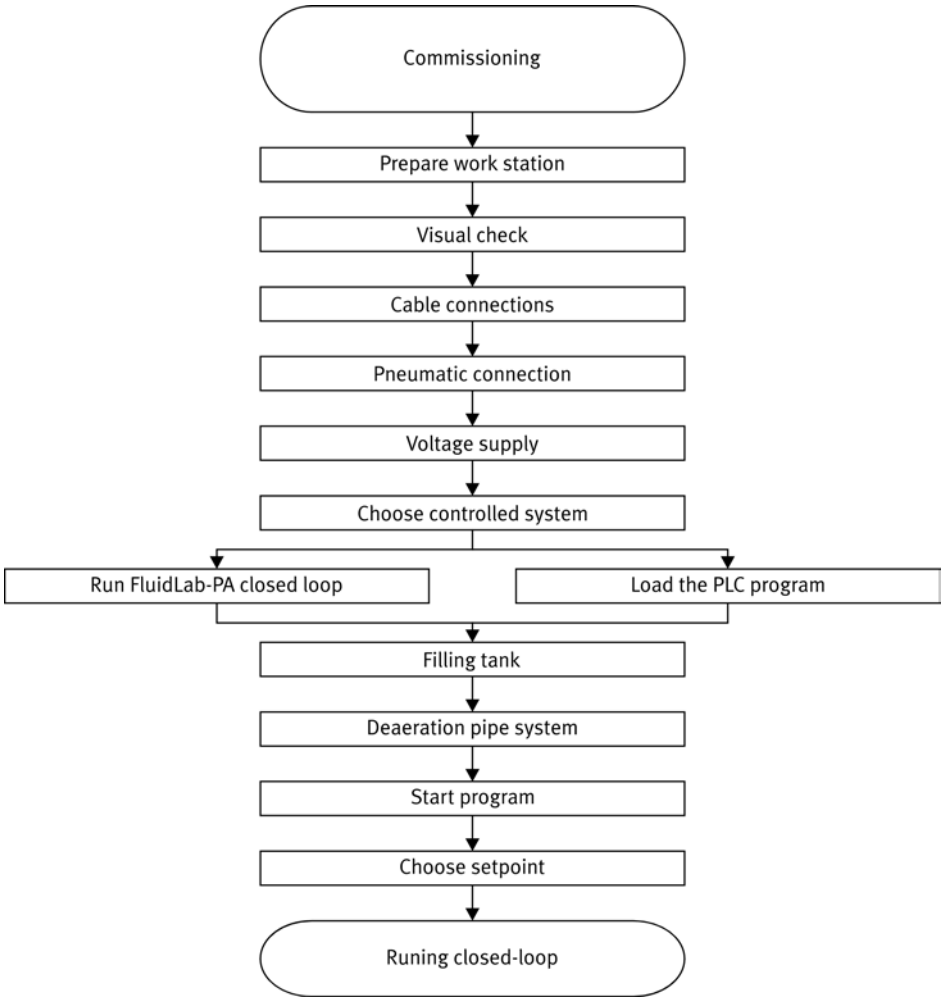


Figure 35: Flow chart for commissioning the MPS PA Compact Workstation.

Workstation

The following is required to commission the MPS PA Compact Workstation:

- The assembled and adjusted MPS PA Compact Workstation
- A control console
- An EduTrainer with PLC, EasyPort USB, or industrial controller
- A 24 V DC, 4.5 A power supply unit
- A compressed air supply of 6 bar (600 kPa), with an approximate suction capacity of 50 l/min
- A PC with installed PLC programming software or Fluid Lab-PA closed-loop software

Visual check

A visual inspection must be performed before each commissioning. Before starting the station, check the following:

- Electrical connections
- Correct installation and condition of pipes and pipe connections
- Correct installation and condition of compressed air connections
- Mechanical components for visible damage (cracks, loose connections, etc.)

Eliminate any detected damage before starting the station.

Cable connections

There are different ways to control the MPS PA Compact Workstation. The following sections describe the different control variants.

Simulation box digital/analog and MPS PA Compact Workstation

All cable connections are described for an MPS PA Compact Workstation with simulation box.

- Connect the SysLink plug of the simulation box to the XMA1 socket of the station I/O terminal (2) using a SysLink cable (3).
- Connect the analog plug of the simulation box to the X2 socket of the station analog terminal (4) using an analog cable (5).
- Connect the 4 mm safety plugs (red and blue) of the simulation box and the power supply unit using a 4 mm safety plug cable (red = +, blue = –).

When using the crossover analog cable with the simulation box, only the first two analog channels (0 = level, 1 = flow) can be displayed.

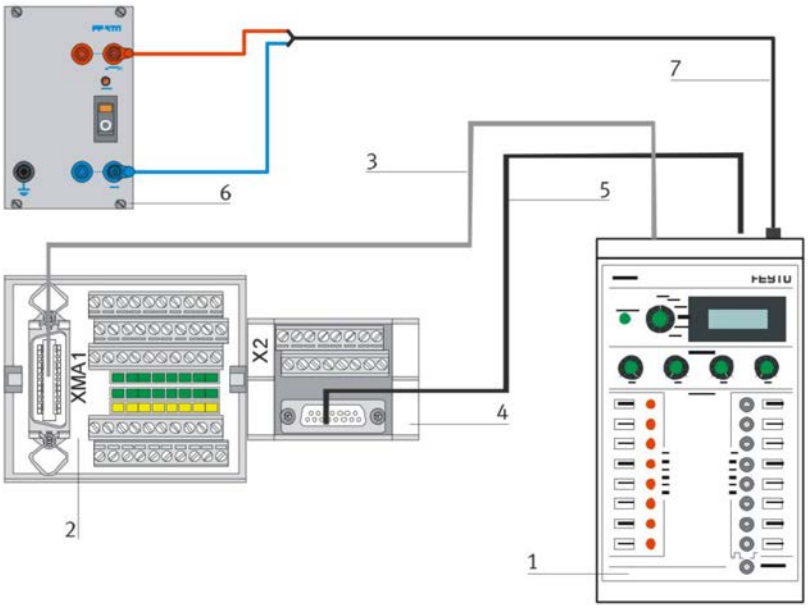


Figure 36: Cable connections MPS PA Compact Workstation - Simulation box, digital/analog.

Legend

1. SimBox digital/analog
2. I/O terminal SysLink
3. SysLink-cable, I/O- data cable with SysLink, 20 pin (black endings, Order No. 167197)
4. Analog terminal
5. Analog cable, 15-pin, cross over (red endings, Order No. 533039)
6. 24 V DC power supply
7. Connector cable 24 V DC for simbox power supply

EasyPort USB and MPS PA Compact Workstation

All cable connections are described as an example for a MPS PA Compact Workstation with the EasyPort USB.

- Connect 4 mm safety plugs cable (7, red and blue) to the EasyPort USB screw terminals (24V/0V).
- Connect port 1 (Digital I/O) of the EasyPort USB with the XMA1 socket of the I/O terminal (2) of the station with a SysLink cable (3).
- Connect port 3 (Analog I/O) of the EasyPort USB with the X2 socket of the analog terminal (4) of the station with analog cable (5).
- Connect your PC to the EasyPort USB by means of a USB data cable (8).
- Connect EasyPort USB to 24 V DC power supply unit with 4 mm safety plugs cable (red =+/blue= -).

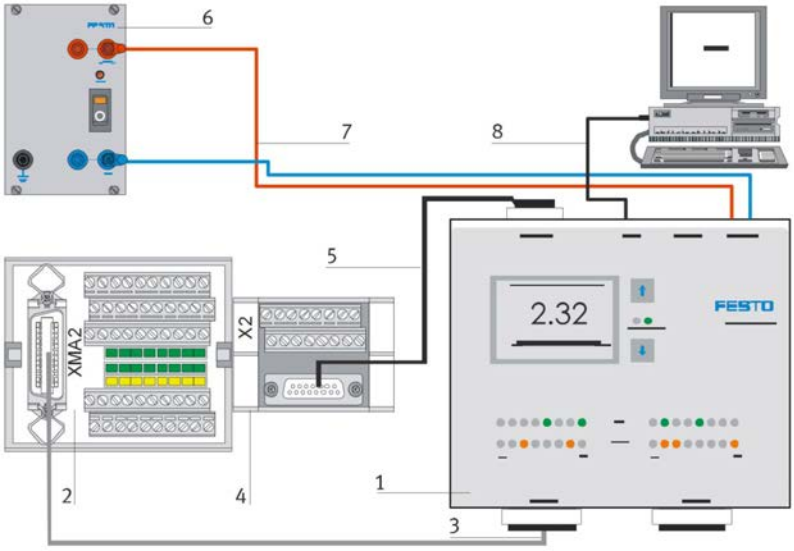


Figure 37: Cable connections MPS PA Compact Workstation - EasyPort USB.

Legend

1. Easyport USB
2. I/O terminal SysLink
3. SysLink-cable, I/O data cable with SysLink, 20 poles (black endings, order No. 167197)
4. Analog terminal
5. Analog cable, 15 poles, parallel (Order-N o. 529141)
6. 24 V DC power supply
7. Universal cable set with 4 mm safety plugs (red/blue)
8. USB data cable

EduTrainer Universal with PLC – without power supply

All cable connections are described as an example for a MPS PA Compact Workstation with a PLC EduTrainer Universal **without power supply** inside the EduTrainer:

- Connect Sys link plug A of the EduTrainer (3) with the XMA1 socket of the I/O terminal of the station with a SysLink cable (7).
- Connect the analog plug C (8) of the PLC / controller with the X2 socket of the analog terminal (4) of the station with analog cable (5).
- Connect SysLink B (1/C) with the XMA plug of the control panel.
- Connect 4 mm safety plugs (red and blue) of the EduTrainer and power supply unit with 4 mm safety plugs cable (red = +/blue = -).
- Connect your PC to the PLC by means of a programming or network cable (no illustration).

Legend

1. I/O board MPS-PA Compact Workstation
2. Power supply 24 V DC, 4.5 A
3. EduTrainer Universal with PLC 4 19" Control panel
4. 19" Control panel
5. I/O terminal SysLink
6. Analog terminal
7. I/O data cable SysLink, parallel (034031)
8. Analog cable, 15-PIN, parallel (529141)
9. 24 V connecting cable on 4 mm safety plugs

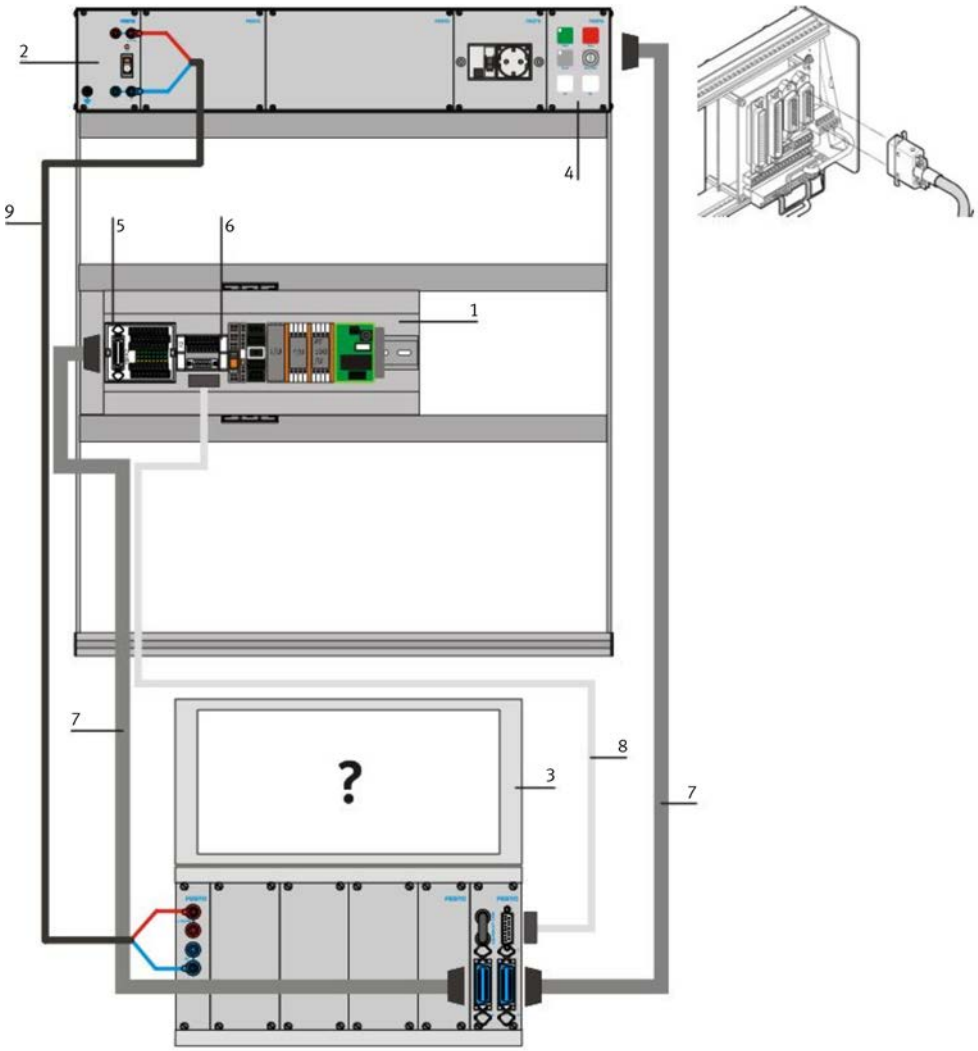


Figure 38: Cable connections MPS PA Compact Workstation – EduTrainer Universal without power supply 24 V DC.

EduTrainer Universal with PLC – with power supply

All cable connections are described as an example for a MPS PA Compact Workstation with a PLC EduTrainer Universal with power supply inside the EduTrainer:

- Connect SysLink plug A of the EduTrainer (3) with the XMA1 socket of the I/O terminal of the station with a SysLink cable (7).
- Connect the analog plug C (8) of the PLC / controller with the X2 socket of the analog terminal (4) of the station with analog cable (5).
- Connect SysLink B (1/C) with the XMA plug of the control panel.
- Connect your PC to the PLC by means of a programming or network cable (no illustration).

Legend

1. I/O board MPS-PA Compact Workstation
2. Power supply 24 V DC, 4.5 A
3. EduTrainer Universal with PLC
4. 19" Control panel
5. I/O terminal SysLink
6. Analog terminal
7. I/O data cable SysLink, parallel (034031)
8. Analog cable, 15-PIN, parallel (529141)

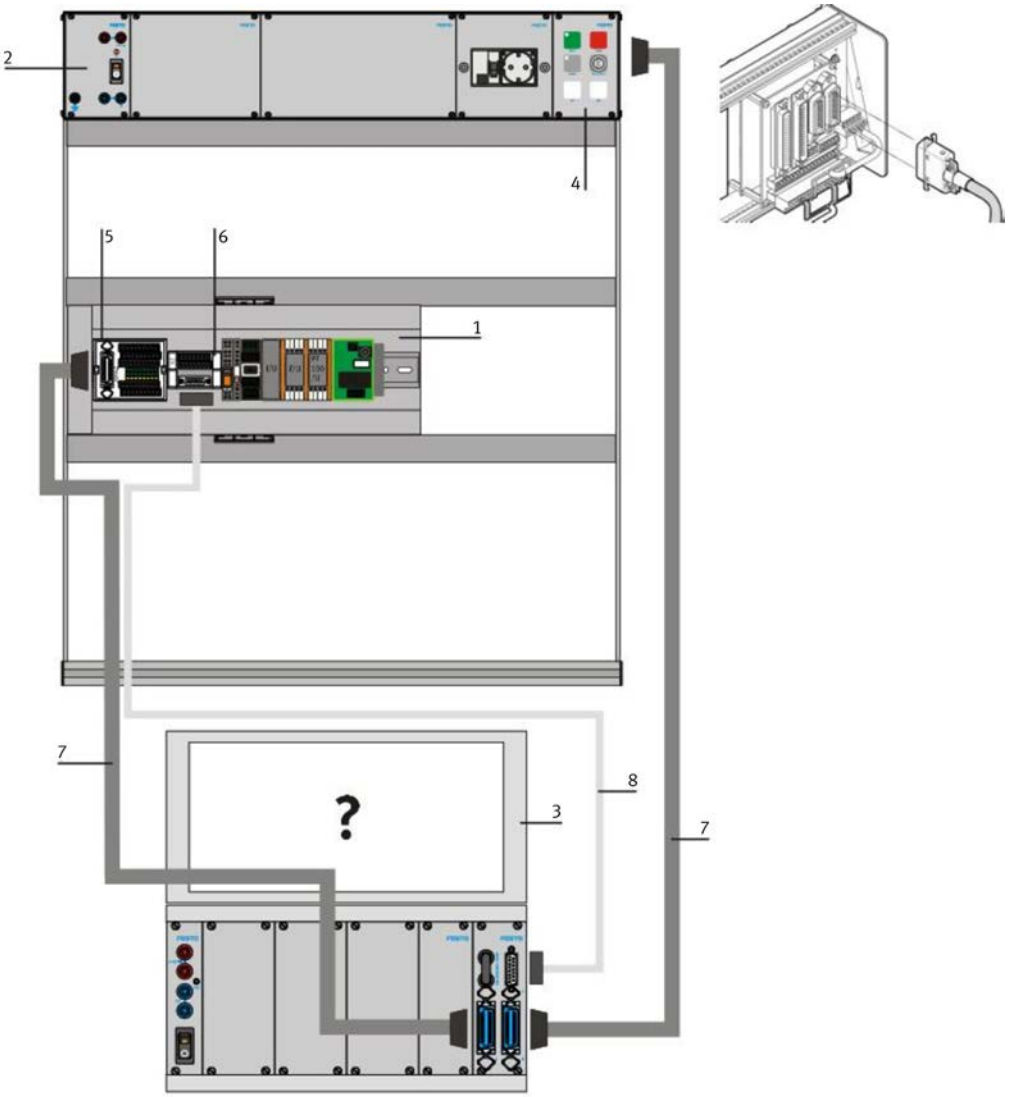


Figure 39: Cable connections MPS PA Compact Workstation – EduTrainer Universal with power supply 24 V DC.

Visualization project for touch panel

There are several options to operate the MPS PA Compact Workstation with an EduTrainer-Universal PLC (Control Kit) through a touch panel (HMI = human-machine interface). Example visualization projects are available for the illustrated PLC types.

In general, the physical connection between the PLC and the touch panel is established with a network cable using RJ45 plugs.

EduTrainers with Siemens S7-300 CPUs without an Ethernet interface are connected via MPI protocol. Then the physical connection is made with a bus cable (RS485).

Table 3: Options to operate the MPS-PA Compact Workstation.

EduTrainer Universal with PLC	Touch panel (HMI)	Communication	Software for visualization project
Siemens S7-300 (PN) 	Siemens TP700 Comfort 	Industrial Ethernet/ Profinet 	Siemens Simatic TIA-Portal WinCC Advanced V13
Siemens S7-1200 	Siemens KTP700 Basic 	Industrial Ethernet/ Profinet 	Siemens Simatic TIA-Portal WinCC Basic V13
Siemens S7-1500 	Siemens TP700 Comfort 	Industrial Ethernet/ Profinet 	Siemens Simatic TIA-Portal WinCC Advanced V13

EduTrainer Universal with PLC	Touch panel (HMI)	Communication	Software for visualization project
Festo CPX-CEC 	Festo FED550/ CDPX 7" 	Industrial Ethernet Modbus	Festo Designer Studio V1.90
AB Compactlogix 	Allen Bradley PanelView +600 	EtherNet/IP EtherNet/IP	Rockwell Automation Factory Talk View V7.0 Machine Edition

Visualization project

The touch panel visualization project starts with the main page. As an example, the visualization project for a Siemens touch panel TP700 Comfort is illustrated.

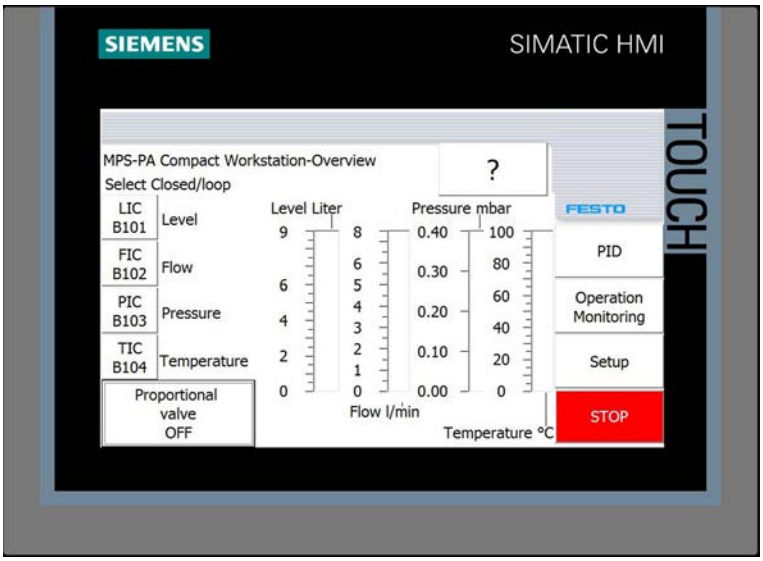


Figure 40: Visualization project example TP700 Comfort – Main page.

Choose subordinate pages from the main page (starting picture) with functions for:

- Manual operation or after selection of the control-loop: PID controller
- Monitoring
- Setup - select language for DE, EN, ES, FR, and parameter
- STOP: abort all active functions
- Selection of the control-loop: Level-Flow-Pressure-Temperature
- Select proportional valve for control-loops flow or pressure
- Bar graph of analog process values

- **Manual operation**

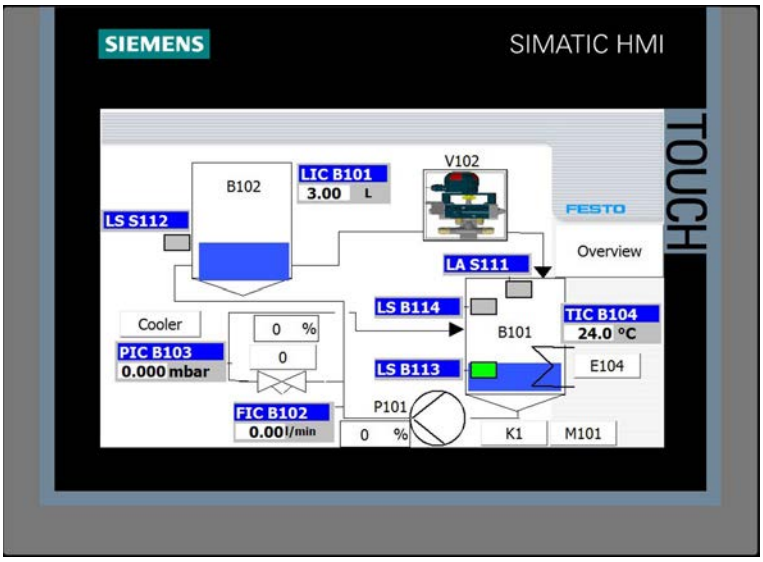


Figure 41: Visualization project example TP700 Comfort – Manual operation.

Functions:

- Display sensor signals
- Operating actuators, switching and continuous
- Station overview of PCE-task and final control elements

- **Monitoring**

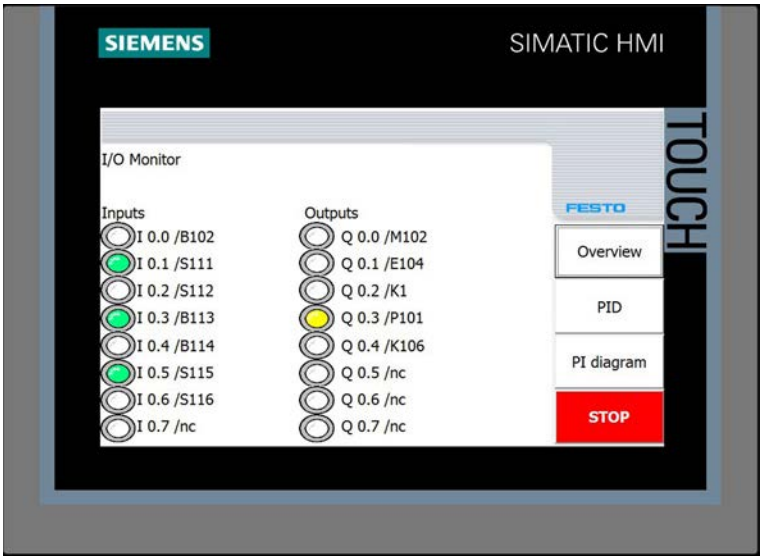


Figure 42: Visualization project example TP700 Comfort – Monitoring.

Functions:

- Display signals of binary inputs and outputs.
- STOP: abort all active functions

- **Setup**

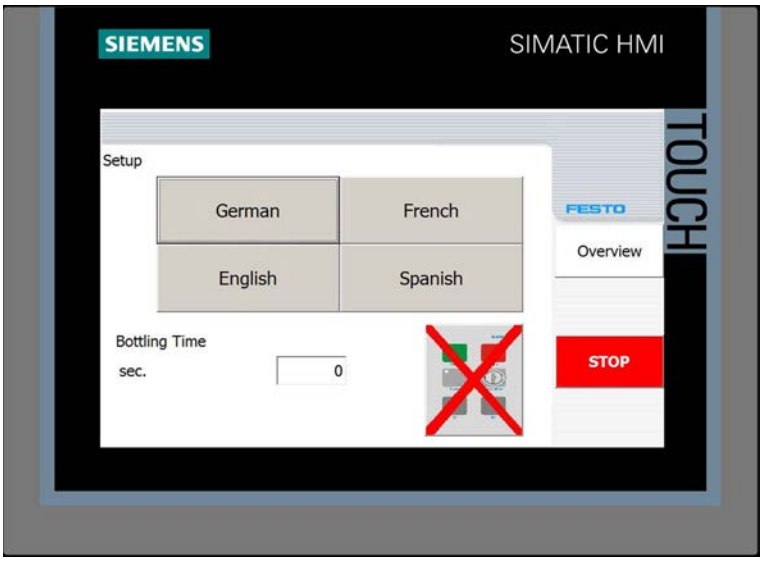


Figure 43: Visualization project example TP700 Comfort – Setup.

Functions:

- Select language for DE, EN, ES, FR
- Setting parameters for bottling time, when bottling function is switched on for level control
- Setting 19" control panel connected: activated/ deactivated (see illustration).

If activated and the control panel is not truly connected than the STOP-input (normally closed) aborts all functions!

- **PID controller in manual mode**

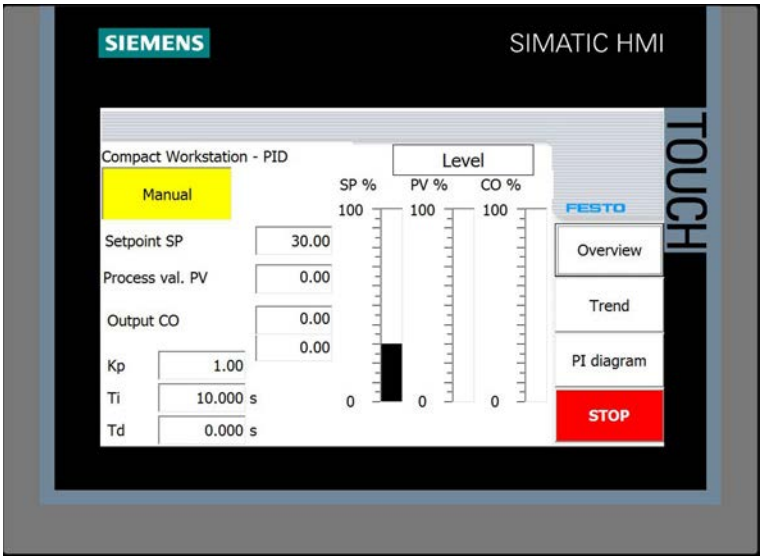


Figure 44: Visualization project example TP700 Comfort – PID controller in manual mode.

Functions:

- Display and operation of controller values and parameters.
- Operation of Manual and Automatic Mode of the controller. If Manual is selected the manual manipulated value is active.

- **PID controller in automatic mode**

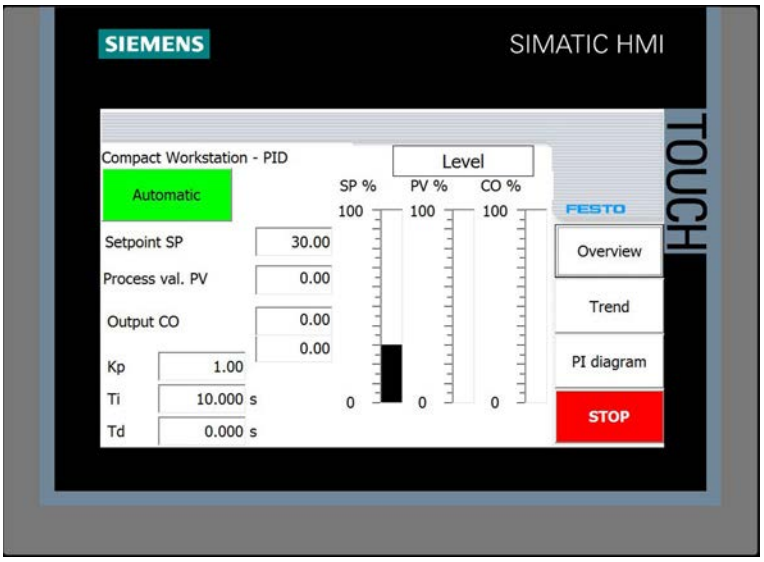


Figure 45: Visualization project example TP700 Comfort – PID controller in automatic mode.

Functions:

- Display and operation of controller values and parameters.
- Operation of Manual and Automatic Mode of the controller. If Automatic is selected, the controller constitutes the manipulated value.
- STOP: abort all active functions

- **P&I diagram**

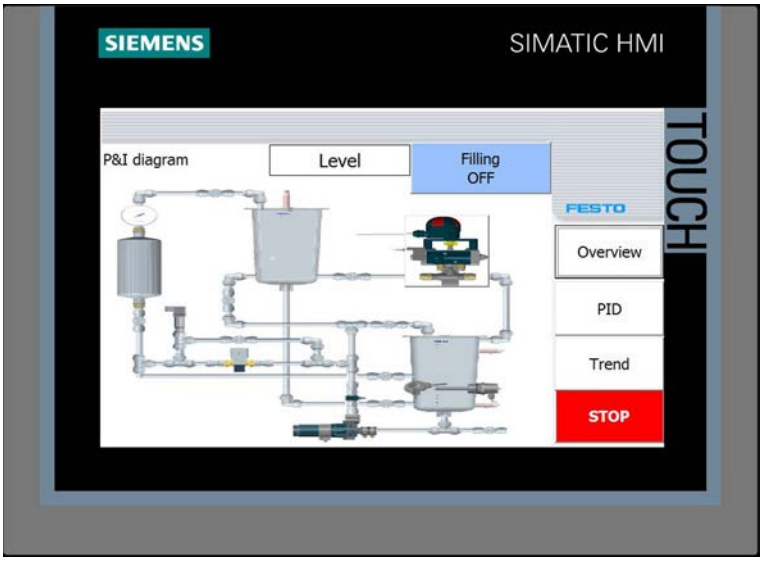


Figure 46: Visualization project example TP700 Comfort – P&I diagram.

Functions:

- Activate bottling process for level control
- STOP: abort all active functions

Adjusting the capacitive proximity sensor B113/B114

The two capacitive proximity sensors are used to determine liquid level in the lower tank and are to be adjusted such as to enable the contactless sensing of the liquid in the container, but not the wall of the container. The liquid changes the capacity of a capacitor integrated into the proximity sensor.

The capacitive proximity sensors are used to sense the liquid level of both the lower and upper liquid levels of the tanks.

Prerequisites

- The tank and a profile for the attachment of the mounting bracket are assembled.
- The electrical connection of the capacitive proximity sensor is established.
- The power supply is switched on.

Procedure

1. Mount the proximity sensors onto the mounting bracket so that they do not touch the tank, each at a distance of 5 mm from the tank.

2. Fill the tank with liquid.

3. Set the proximity sensors at the following values:

   - 2 l (bottom); 6 l (top)
   - Move the switches up or down until the switching status display (LED) switches on at the respective volume level.

The proximity sensors must be triggered by the liquid in the tank. If there is no liquid in the tank, there must be no signal available. Check the positioning and setting of the proximity sensor by repeatedly filling and emptying the tank.

Adjusting the float switch 5111/5112/5117

The float switch is to be fitted into the tank. The float switch opens if the maximum level of liquid in the tank is exceeded and switches off the pumps via the relay.

Prerequisites

- The tank is mounted.
- Electrical connection of the float switch is established.
- The power supply is switched on.

Procedure

1. The float switch is to be fed from the inside of the tank through the opening in the tank cover and the screw tightened externally.

2. Connect the float switch. The switch must emit a signal without any liquid.

3. Fill the tank and establish whether the float switch interrupts the signal if the maximum liquid level is exceeded. The float must turn upwards.

4. Check the positioning and setting of the sensor by repeated filling and emptying.

Make sure that the flow always moves freely and is not stuck due to dirt.

Adjusting the ultrasonic sensor B101

The ultrasonic sensor is fitted into the tank cover. It emits an inaudible ultrasonic signal, which bounces back to the receiver in the sensor housing after reflection on an object, e.g., the liquid. The ultrasonic sensor supplies an analog signal (4-20 mA) in relation to the fill level.

The ultrasonic sensor can be used both for rising liquid levels and falling levels.

Prerequisites

- The tank is assembled.
- The electrical connection of the ultrasonic sensor is established.
- The sensor is screwed into the tank cover such that the LED is not illuminated if the container is empty.
- The power supply is switched on.

Procedure

The LED must be illuminated even if the level of liquid is minimal. The sensor must be re-adjusted via the securing nuts if this is not the case.

Make sure that the emitter side of the sensor is always clean.

Choosing controlled system

For using a specific controlled system integrated in the MPS PA Compact Workstation see to following table for setup of the manual valves and actuators.

Programming, configuration or parameterizing of the PLC or closed-loop controller depends on the chosen controlled system and used signal type. E.g., at controlled level system the ultrasonic sensor is used with a signal range of 4 to 20 mA. This signal is converted into a standard voltage signal of 0 to 10 V.

Therefore, the signal input at the controlling system has to be configured. Configuration of the PLC or closed-loop controller depends on the used device. For the Compact Workstation, the following control types can be used:

- PLC, e.g., Simatic S7-300 CPU 313C
- Industrial close-loop controller
- EasyPort USB with educational software Fluid Lab-PA
- Simulation box digital/analog

Table 4: Choosing the controlled system of MPS PA Compact Workstation.

Component	Level-controlled system	Flow-controlled system	Component	Level-controlled system	Flow-controlled system	Component
Measuring point of the sensor	LIC102 B101	FIC101 B102		PIC103 B103		TIC104 B104
Pump P101	Controlling element	Controlling element	Digital on	Controlling element	Pump P101	Controlling element
Prop. valve V106	Off	Off	Controlling element	Off	Prop. valve V106	Off
Heating element E104	Off	Off	Off	Off	Heating element E104	Off
Hand valve V101	Open	Closed	Closed	Closed	Hand valve V101	Open
Ball valve V102	Open/ Closed	Closed	Closed	Closed	Ball valve V102	Open/ Closed
Hand valve V103	Closed	Closed	Closed	Open	Hand valve V103	Closed
Hand valve V104	Closed	Open	Closed	Closed	Hand valve V104	Closed
Drainage valve V105	Closed	Closed	Closed	Closed	Drainage valve V105	Closed

Component	Level-controlled system	Flow-controlled system	Component	Level-controlled system	Flow-controlled system	Component
Hand valve V107	Closed	Closed	Closed	Closed	Hand valve V107	Closed
Hand valve V108	Closed	Closed	Closed	Open	Hand valve V108	Closed
Hand valve V109	Closed	Closed	Open	Open/ Closed	Hand valve V109	Closed
Hand valve V110	Closed	Closed	Closed	Closed	Hand valve V110	Closed
Hand valve V112	Open/ Closed	Closed	Closed	Closed	Hand valve V112	Open/ Closed

Allocation list of inputs and outputs

Table 5: Binary inputs (XMA1).

Symbol	PIN assignment	EasyPort/ Simbox address	PLC address	Description
B102	I0	I0	%I0.0	Flow rate sensor (frequence 0-1000 Hz)
S111	I1	I1	%I0.1	Float switch, oveflowtank B101
S112	I2	I2	%I0.2	Float switch tank B102
B113	I3	I3	%I0.3	Capacitive sensor min. level tank B101
B114	I4	I4	%I0.4	Capacitive sensor max. level tank 101
S115	I5	I5	%I0.5	Micro switch 2-way ball valve V102 closed
S116	I6	I6	%I0.6	Micro switch 2-way ball valve V102 opened
–	I7	I7	%I0.7	Not used

Table 6: Binary outputs (XMA1).

Symbol	PIN assignment	EasyPort/ Simbox address	PLC address	Description
M102	O0	O0	%Q0.0	Solenoid 0111, open 2-way ball valve V102
E104	O1	O1	%Q0.1	Switch on heating E104 in tank B101
K1	O2	O2	%Q0.2	Relay, select pump O = binary/1 = analog
M1	O3	O3	%Q0.3	Switch on pump P101 binary
M106	O4	O4	%Q0.4	Switch on proportional valve V106
(K2)	O5	O5	%Q0.5	Optional: Switch-over relay K2 water-air cooler
–	O6	O6	%Q0.6	Not used
(M121)	O7	O7	%Q0.7	Optional: 2way solenoid valve V121 open cooling circuit

Table 7: Analog inputs (X2).

Symbol	PIN assignment	EasyPort/ Simbox address	PLC address	Description
LIC B101	UE1	AI0 (analog input channel)	(P) IW256	Process value PV, level in tank B102
FIC B102	UE2	AI1	(P) IW258	Process value PV, flow rate in pipe system
PIC B103	UE3	AI2	(P) IW260	Process value PV, pressure in pipe system
TIC B104	UE4	AI3	(P) IW262	Process value PV, temperature in tank B101

Table 8: Analog outputs (X2).

Symbol	PIN assignment	EasyPort/ Simbox address	PLC address	Description
P101	UA1	AQO (analog output channel)	(P)QW256	Manipulated output CO, pump P101
V106	UA2	AQ1	(P)QW258	Manip. output CO, proportional valve V106

Fluid Lab-PA closed-loop settings

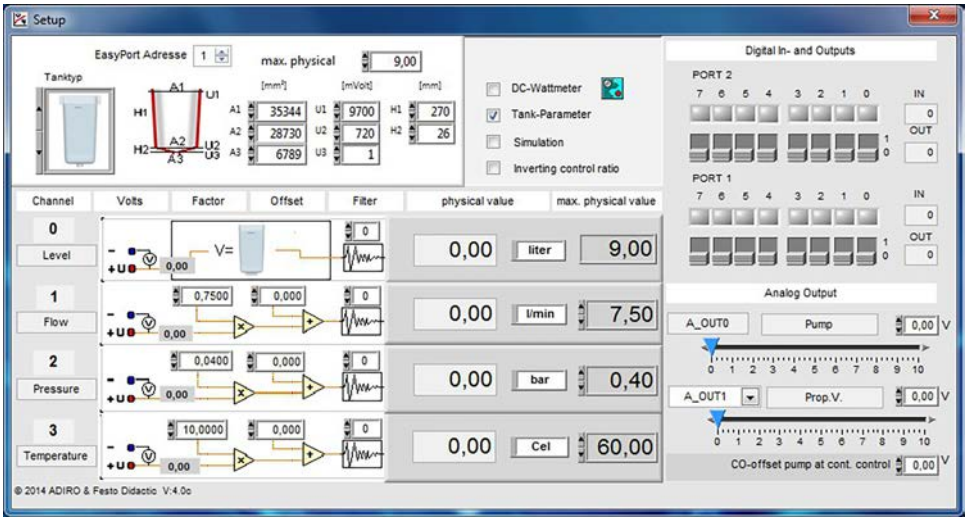


Figure 47: Fluid Lab-PA closed-loop settings.

Adapt tank parameters U1, U2 and U3 individually.

Loading the PLC program

PLC: Siemens S7-300 CPU 313C

Programming software: Siemens STEP7 Version 5.1 (SP6) or higher

1. Connect PC and PLC using the programming cable.
2. Switch on the power supply unit.
3. Switch on the compressed air supply.

4. Release the EMERGENCY-STOP switch (if available).

5. Overall reset PLC memory (delete online MMC).

6. CPU switch in STOP position.

7. Start the PLC programming software.

8. De-archive the file **CWS_Level_CPU313C_314C-2DP _314C2PNDP.zip** from the directory ... \Sources_Quellen\ Step7 _PLC_Program\ of the supplied CD-ROM.

9. Select the project for your PLC hardware and the s7-program "Level" and load it to the PLC.

10. CPU switch in RUN position

Festo FEC-CPX

Controller: Festo FEC CPX

Programming software: Festo FST Version 4.10

1. Connect the PC and controller using the programming cable TTL-RS232.

2. Switch on the power pack.

3. Switch on compressed air supply.

4. Release EMERGENCY-STOP pushbutton (if available).

5. Wait until the PLC has completed its test routine.

6. Start the programming software.

7. De-archive the file e.g., CWSLevel_FST41_ CPX_FE(_V4_FED.zip in the directory ... \Sources\PLC\FEC\ of the CD-ROM provided (the screenshot shows an example).

8. Compile the project.

9. Download the project to the controller.

Filling and deaeration

During commissioning, it is recommended to use Fluid Lab-PA closed-loop with EasyPort USB or a Simulation box to control the following outputs:

- 2-way ball valve V102
- Pump P101
- Proportional valve V106

It is also possible to deaerate the system by using the PLC example program "Level".

1. Before filling the system with water close drainage valve V105.
2. Before filling the system with water close all hand valves.
3. Switch off the power supply.
4. Fill the container only if the power supply is switched off.
5. Water spray can cause short circuits.
6. Turn off the compressed air supply.
7. Fill the lower tank B101 up to a water level of 10 l in quality of drinking water. Fill up lower tank B101 with water until the upper capacitive sensor B114 is activated. Float switch S111 for overflow safety function must not be activated.
8. Clear of water spray.
9. Switch on power supply 24 VDC.
10. Switch on pump P101 and pump water to the upper tank B102. Then, open hand valve V101 (or RESET and START program).
11. Close hand valve V101 and open hand valve V103 and prop. valve V106.
12. Close hand valve V103 and prop. valve V106.
13. Switch off pump P101 (or stop the program).
14. After deaeration, water loss in the piping system will be visible in the lower tank. Refill the lower tank and compensate for the water loss (as described in step 5).

Start sequence PLC example program "Level"

A PLC program for closed-loop level control is provided on the CD included with the technical documentation. The following describes how to start the sequence.

1. Check the power supply voltage and the compressed air supply.

2. Select the controlled system and set the hand valves according to the commissioning table.

3. Activate RESET sequence. The RESET sequence is prompted by the illuminated RESET pushbutton and executed when the pushbutton has been pressed.

   The normal position of the station is defined if the water level in the lower tank is filled and the following digital sensors are activated:

   - Float switch S111 for overflow safety: not activated
   - Upper limit switch B114: activated
   - Lower limit switch B113: activated
   - Float switch S112 for threshold (upper tank): not activated

4. Start the sequence of the MPS PA Compact Workstation. The start is prompted by the illuminated START pushbutton and executed when the push button has been actuated.

5. When the program starts, operating mode “logic control” runs and is indicated by indicator light Q1.

6. Pump P101 delivers process fluid from lower storage tank B101 to upper reservoir tank B102. When the level reaches float switch B112, the PLC switches from logic control to closed-loop control. Indicator light Q2 signals closed-loop control mode. Ultrasonic sensor B102 measures the filling level (actual value), which is controlled to the setpoint fixed at PLC startup. After the setpoint is reached and steady-state conditions (for example, bottling pressure) are achieved, ball valve V102 opens for a time-controlled interval. After bottling time t, ball valve V102 closes and the level is controlled again to the setpoint. When the setpoint is reached again, the next bottling cycle starts.

7. The program stops automatically if the water level in the lower storage tank falls below limit switch B113 (deactivated).

Pressing the STOP pushbutton closes ball valve V102 and switches off pump P101. The sequence program stops.

Notice

- Pressing the STOP or Emergency pushbutton stops the sequence program.

- Warning: If valve V101 is open, fluid flows from the upper tank to the lower tank through the deactivated pump.
- Reset sequence: If the system is not in the normal position after STOP or startup, the illuminated RESET pushbutton prompts the reset sequence and starts it when pressed. During the reset sequence, fluid is drained from upper tank B102 to lower tank B101; therefore, ball valve V102 remains open until the normal position is reached.
- The setpoint and control parameters can be selected in Step 7 of the online table “Closed-Loop Parameter,” on the touch panel, or via the SCADA system. If the setpoint is too high and the water level in the lower tank falls below limit switch B113, the sequence stops automatically. Reset the system and select a lower setpoint.

Maintenance

Maintenance The MPS PA Compact Workstation is largely maintenance-free. Clean the following components at regular intervals using a soft, lint-free cloth or brush:

- Optical sensor lenses, fiber optics, and reflectors
- The active surface of the proximity sensor
- The entire station, including the profile plate, trolley, and frames

Do not use aggressive or abrasive cleaning agents.

Use drinking-quality water only. If the MPS PA Compact Workstation is not used for an extended period, drain all water from the system. Remove any remaining water from the piping and tanks using a liquid vacuum cleaner, then wipe dry with a soft, lint-free cloth.

Consult the safety information in the data sheets.

Appendix

MPS PA resource files

The resources for the MPS PA courses are included in the following files:

MPS PA Compact Fundamentals of Closed-Loop Control resources.

https://lx.festo.com/media/8cfcb079f5064683a188e16b0f3cffcc

MPS PA Compact Workstation Process Instrumentation resources.

https://lx.festo.com/media/55d89f96839942d89638c64562673dce

MPS PA 204 resources.

https://lx.festo.com/media/77ef6c5e35d6400d859853ffb44f2e19

Parts lists

- MPS PA Compact Workstation part list

Pl-diagrams

- MPS PA Compact Workstation, basic design
- MPS PA Compact Workstation, basic design, with water-air cooler
- MPS PA Compact Workstation, basic design, with cooling unit

Loop lists

- Continuous control of a level control system using an analog standard signal
- Continuous control of a flow-rate control system with a pump as the controlled system using an analog standard signal
- Continuous control of a flow-rate control system with a proportional valve as the controlled system using an analog standard signal
- Continuous control of a pressure control system with a pump as the controlled system using an analog standard signal
- Continuous control of a pressure control system with a proportional valve as the controlled system using an analog standard signal
- Two-point control of a temperature control system using an analog standard signal

Loop diagrams

- Continuous control of a level control system using an analog standard signal
- Continuous control of a flow-rate control system with a pump as the controlled system using an analog standard signal
- Continuous control of a flow-rate control system with a proportional valve as the controlled system using an analog standard signal
- Continuous control of a pressure control system with a pump as the controlled system using an analog standard signal
- Continuous control of a pressure control system with a proportional valve as the controlled system using an analog standard signal
- Two-point control of a temperature control system using an analog standard signal

Electrical circuit diagrams

- MPS PA Compact Workstation, basic design
- MPS PA Compact Workstation, basic design, with water-air cooler
- MPS PA Compact Workstation, basic design, with cooling unit
- Control panel
- DR19

Pneumatic circuit diagrams

- MPS PA Compact Workstation, basic design

Data sheets

Collection of MPS PA data sheets

FESTO

CE Importer:
Festo Didactic SE
Rechbergstr. 3
73770 Denkendorf
Germany
Tel.: +49 711 3467-0
did@festo.com

US Importer:
Festo Didactic Inc.
607 Industrial Way West
Eatontown, NJ 07724
United States
Tel.: +1 732 938-2000
Toll Free: +1-800-522-8658
services.didactic@festo.com

CA Manufacturer:
Festo Didactic Ltée/Ltd
675, rue du Carbone
Québec (Québec) G2N 2K7
Canada
Tel.: +1 418 849-1000
Toll Free: +1-800-522-8658
services.didactic@festo.com

UK Importer:
Festo Ltd
Applied Automation Centre
Brackmills
Northampton, NN4 7PY
United Kingdom
T +44 800 626 422
info_gb@festo.com

www.festo.com

User Guide

MPS PA Compact Workstation

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