Process Automation and Water Management

Learning solutions for basic and advanced training

FESTO

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Festo Didactic

At your side to prepare a skilled workforce

Dear educators and instructors,

Thank you for your interest in our learning solutions and for considering Festo Didactic as a partner for your technical education and training projects.

Your commitment to imparting knowledge and fostering skills in process automation is paramount, equipping the workforce of today and tomorrow with the expertise needed to thrive in the dynamic process industry.

We strive to optimize your educational investments in vocational or technical schools, universities, and industrial training centers with world-class solutions and services.

I encourage you to browse this catalog and explore the wealth of resources at your disposal to facilitate learning and teaching. It is divided into two sections:

The “Magazine” section offers a collection of articles on current trend topics that influence skill requirements, along with details about the breadth of our services.

The “Products” section introduces our extensive range of learning solutions encompassing ready-to-use learning content, training equipment, and software tools.

Should you have any questions or require further assistance, simply reach out to us at **services.didactic@festo.com**. We are here to support you every step of the way.

Wishing you a fruitful reading and many rewarding learning experiences ahead!

Stéphane Casse, Professional Engineer
Product Manager, Process Automation Learning Solutions
Festo Didactic

Current trend topics
Impact on skills requirements

„In the dynamic process industry, digitalization, technology, and sustainability drive demand for cutting-edge automation solutions and highly skilled workers."

01

Alexander Vargas
Head of Industry Segment and Key Account Process Industries, Festo SE

Process industry

Key challenges

The process industry exhibits significant diversity. Companies within various segments of this industry are involved in unique activities and processes, yet they encounter common challenges. Understanding these challenges helps technical education teachers stay abreast of industrial realities and skill requirements. Improving technical education in process automation and related fields cultivates essential skills, both technical and transversal, necessary to meet the evolving demands of the industry.

- **Safety:** The high potential for accidents, leaks, and chemical hazards necessitates unwavering attention. Ensuring the well-being of employees, safeguarding the environment, and protecting local communities constitute an enduring challenge.

- **Operational and energy efficiency:** Achieving optimal operational efficiency involves streamlining production processes, minimizing waste, and maximizing resource utilization. Escalating energy costs and growing environmental consciousness underline the imperative for enhanced energy efficiency in production processes.

- **Technological advancements:** Staying attuned to rapid technological advancements, including automation, artificial intelligence, and data analytics, is an ongoing challenge. The integration of new technologies into existing systems presents complexities and necessitates a commitment to innovation.

- **Cybersecurity:** With increasing interconnectivity and reliance on IT, the industry confronts heightened cyber threats. Safeguarding critical infrastructure and sensitive data against cyberattacks represents a perpetual challenge.

- **Talent acquisition and retention:** Attracting and retaining skilled labor and experienced personnel with the necessary technical expertise and adaptability to navigate industry changes present a common industry-wide challenge. The demand for specialized knowledge accentuates skills gaps in the labor pool.

- **Global competition:** Intense competition from international companies necessitates continuous improvements in efficiency and quality to maintain competitiveness on a global scale.

- **Market volatility:** Fluctuations in demand, commodity prices, and economic conditions exert significant influence on the profitability and stability of process industry companies.

- **Sustainability:** Companies face increasing pressure to align with sustainability objectives and meet Environmental, Social, and Governance (ESG) criteria. Embracing cleaner and more sustainable practices to reduce emissions and waste and conserve resources is imperative.

- **Regulatory compliance:** Beyond environmental regulations, the industry contends with a diverse array of regulatory requirements encompassing safety, product quality, and more. Ensuring compliance across diverse regions and markets introduces intricate complexities.

Essential tools for

Sustainability

Sensors, meters, transmitters, controllers, actuators, and more are essential tools for improving production efficiency, reducing waste, minimizing environmental impact, enhancing safety, and ensuring compliance with regulations. By continuously monitoring and optimizing processes, these technologies enable industries to operate more sustainably while also improving their economic performance. They contribute to sustainability in several key areas:

Energy efficiency
Precise control of equipment and processes through instrumentation helps optimize energy consumption, reducing waste and greenhouse gas emissions. Real-time monitoring and control allow operators to identify and rectify energy inefficiencies promptly.

Resource conservation
Process control systems can help minimize raw material wastage and reduce resource consumption by ensuring that processes operate within specified limits. Monitoring and controlling equipment can extend their lifespan, reducing the need for frequent replacements and conserving resources.

Product quality and yield improvement
Process control ensures consistent product quality, reducing the likelihood of producing defective or substandard products that may lead to waste. Optimization of processes can increase product yield, reducing the need for additional resources and energy to produce the same quantity of output.

Safety enhancement
Instrumentation and control systems play a crucial role in maintaining the safety of industrial operations, preventing accidents, and reducing the environmental impact of incidents. Early detection of safety issues allows for swift responses, minimizing damage and the associated environmental consequences.

Water management
Many process operations are water-intensive, need highly pure water, or produce gray water that needs to be treated. Precise control of water usage and treatment processes can reduce water wastage and pollution. Monitoring and control of wastewater treatment can help ensure compliance with environmental standards.

Regulatory compliance
Instrumentation and control systems help industries meet regulatory requirements related to environmental standards, emissions, and safety, avoiding fines and reputational damage, and minimizing companies' environmental footprint. Continuous monitoring can detect and address leaks or emissions anomalies quickly. Process control systems can also optimize dosing and usage of chemicals.

Data analytics and decision support
Digitalization in the process industry means that advanced data analytics and artificial intelligence can be integrated into instrumentation and control systems to provide insights for optimizing processes further and identifying opportunities for sustainability improvements.

Predictive maintenance
Predictive maintenance, enabled by instrumentation and control systems, can help prevent equipment breakdowns and reduce unplanned downtime, minimizing resource wastage and energy consumption, while also extending the operational life of industrial systems and machinery.

Raising awareness and expertise in process automation is crucial moving forward. A robust integration of these topics into education and industry training programs at all levels will empower workers, enabling them to lead sustainability efforts and foster a greener, more responsible industrial landscape.

A significant contribution
Process industries play an integral role in sustainability efforts, both through the products they produce and the technologies and operations they employ to reduce environmental impacts. Examples include hydrogen production, battery manufacturing, renewable energy generation, biofuels, water treatment, waste-to-energy, recycling, and more.

Left image: An overview of the Blue World approach from Festo

Understanding

Distributed control systems

A DCS for training purposes

First-hand experience with a DCS is key for thorough understanding. How to provide such experimentation opportunities?

Discover our DCS demonstrator:

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Distributed Control Systems (DCS) are computer-based systems that enable real-time management and automation of processes. They consist of interconnected controllers, input/output devices, and operator stations, offering centralized control. From enhancing safety and efficiency, reducing waste, to enabling data-driven decision-making and integration with emerging technologies like the Industrial Internet of Things (IIoT), DCS systems are a critical tool for companies seeking to remain competitive and sustainable.

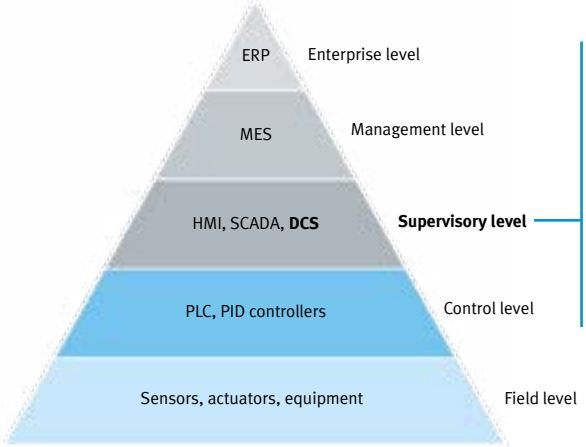
New skills requirements
Working with DCS requires a new set of skills that go beyond the traditional mechanical or electrical skills. These skills include computer literacy, knowledge of programming languages, data analysis, networking, cybersecurity, and a deeper understanding of process automation. Workers must be able to work with computers, software, and networks, and be able to diagnose and troubleshoot complex issues. In addition to these technical skills, workers using DCS must also have strong problem-solving and critical thinking abilities to make quick and accurate decisions in the event of a failure or emergency. Good communication skills enable effective collaboration with other departments for efficient operation.

Relevant for many occupations
DCS knowledge is becoming a necessary skill for all process industry workers. Process operators and technicians need a basic understanding of DCS software, alarm management, and control strategies for monitoring and controlling industrial processes, and for adjusting process variables as needed. Instrumentation and control technicians install, configure, and maintain DCS equipment and systems. They need in-depth knowledge of DCS hardware and software, as well as strong troubleshooting skills. Engineers and system integrators design and optimize industrial processes using DCS, thus requiring advanced knowledge of DCS software, control strategies, and data analysis to ensure processes run efficiently and meet performance objectives.

A well-rounded foundation
In an introductory course, the emphasis should be on building a solid knowledge base and practical skills to understand DCS and their applications. Here is a non-exhaustive list of foundational learning outcomes:

- Understand the concept of a DCS and its role in industrial process control.
- Explain the architecture and core components of a DCS.
- Navigate a DCS software program and know its basic functions.
- Define the concept of control loops.
- Understand PID control in DCS.
- Configure and tune controllers to monitor and adjust process variables using DCS.
- Create simple control strategies for processes using DCS software.
- Understand alarms and how to manage them effectively.
- Diagnose and troubleshoot common issues in DCS systems.
- Apply safety practices to prevent accidents and protect personnel.
- Interpret process data and create trends, charts, and graphics.
- Use DCS tools to improve process efficiency, reduce energy consumption, and minimize waste.
- Explore communication protocols.
- Know relevant industry standards and guidelines related to DCS.
- Use condition monitoring techniques and data analytics for predictive maintenance.
- Explore methods and protocols for integrating IIoT devices and sensors.
- Implement strategies for asset lifecycle management, tracking, and monitoring.

Other outcomes can be added, such as understanding how DCS can contribute to sustainability goals, or be aware of best practices for cybersecurity, including security protocols, risk management, and more. With a right balance between theory and practice, students will be well prepared for the workplace.



Training shifts in the age of IIoT devices

The growing importance of intelligent field devices marks a turning point in the process industry: streamlined processes, informed data-driven decisions, improved efficiency and safety, and reduced operational disruption. This underscores the need for parallel investment in improving workforce skills to take full advantage of the benefits of smart and Industrial Internet of Things (IIoT) and smart field devices. How to address this new topic in training programs? We turned to our process automation specialists for insights.

What's the main difference between IoT and analog or basic electronic field devices?
The difference lies in their connectivity, communication, and the advanced features they provide, aligning with the latest advancements in industrial automation and Industry 4.0.

Overview of the technological progression of industrial devices:

	Functionality	**Communication**	**Data processing**
Traditional devices	Basic instruments that perform specific measurement or control functions. They typically provide analog signals, such as 4-20 mA signals.	Limited communication capabilities. They may use simple protocols for basic two-way communication.	Minimal or no data processing capabilities. They usually transmit raw data to a central control system for processing and decision-making.
Smart devices	They come with more advanced features beyond basic measurement and control. They often have built-in microprocessors, enabling them to perform local data processing and make decisions.	Enhanced communication capabilities. Smart devices can communicate digitally using protocols like FOUNDATION Fieldbus, PROFIBUS PA, HART, PROFINET, or EtherNet/IP, allowing for more efficient data exchange and diagnostics.	Some level of data processing capabilities. They can perform local calculations and transmit processed information to the control system and provide diagnostic information.
IIoT devices	Part of the broader trend of Industry 4.0, where devices are highly interconnected and capable of sharing and utilizing data in real-time. They often have advanced sensors and may support multiple functionalities.	Designed for seamless connectivity to the Internet and other devices. They use standard Internet protocols, such as MQTT or CoAP, for communication with other IoT devices and cloud platforms.	Significant data processing and asset management capabilities. They can analyze data locally, make complex decisions, and send relevant information to the central control system or cloud platforms.

What new skills are required to effectively work with smart and IoT devices?
Given their characteristics, advanced devices require a broader skill set that encompasses IT and analytical skills. In practical terms, workers should demonstrate proficiency in digital communication protocols and the utilization of software tools for configuration, monitoring, control, and troubleshooting. Additionally, they must address potential security risks, interpret maintenance alerts, and utilize data to optimize reliability, particularly with predictive maintenance features.

Is it worth upgrading the training equipment in technical schools with IIoT devices?
Absolutely, it is a strategic move with several benefits. Students will encounter these advanced technologies in the workplace, making the training environment more reflective of real-world scenarios. Starting small, such as replacing one or two traditional transmitters in a process loop with smart ones, provides a manageable entry point. Taking small initial steps allows teachers and instructors to become familiar with the technologies and progressively update course content.

Are there "user-friendly" technologies for teachers and learners?
Yes, there are user-friendly technologies and straightforward introduction setups. Take IO-Link, for instance, known for its simplicity in industrial automation. Teachers can opt for IO-Link ready sensors, which are simpler than transmitters. Choose a sensor for flow, level, temperature, or pressure, and install it in the process loop on the lab training equipment, along with an IO-Link master module. Then download free configuration software like PACTware. Students can integrate and configure the sensor into the communication network. Another uncomplicated option is to replace a transmitter with an equivalent one equipped with Bluetooth connectivity and use a free app for remote configuration, diagnosis, and maintenance.

What should companies do to upskill their existing workforce?
Our top recommendation is to familiarize workers with upcoming technologies and devices well in advance of their implementation. Offering hands-on training opportunities beforehand allows workers to experiment, make mistakes, and learn in a controlled environment, away from production systems. This was the approach adopted by one of our mining clients, who purchased one of our industrial process control learning systems and asked us to integrate specific IoT devices that would soon be implemented into their operations.

What learning solutions can be used to introduce the industrial internet of things?

- IoT Kit for MPS PA systems
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- New components for the industrial process learning systems
  → Page 73
- Smart sensors TP 1312
  → Page 118

Digitalization

Water 4.0

What is Water 4.0?
Water 1.0 through 4.0 are conceptual frameworks used to delineate the historical and evolving paradigms within water management. These frameworks were initially articulated by David Sedlak, a professor of environmental engineering at the University 4.0: The Past, Present, and Future of the World's Most Vital Resource," first published in 2014.

Water 1.0: The earliest and most basic form of water management focused on collecting, storing, and distributing water for fundamental human needs, such as drinking and sanitation, with limited water treatment.
Water 2.0: With a focus on delivering safe and clean water to growing urban populations, this phase marks a significant advancement in water management with centralized, modern water treatment facilities.
Water 3.0: This phase introduced concepts like wastewater treatment and recycling to preserve aquatic ecosystems and minimize the environmental impact of water use.
Water 4.0: Echoing the concept of Industry 4.0, cyber-physical systems enable the networking of virtual and real water systems and users (agriculture, industry, and households) in a sustainable, efficient, and responsive water infrastructure through the seamless integration of digitalization, automation, and smart technologies.

Digitalization serves as a powerful modernization driver for water and wastewater operations, revolutionizing traditional approaches to water management and treatment. In this context, digitalization involves integrating advanced technologies, data-driven strategies, and automation to enhance efficiency, sustainability, and overall effectiveness. The success of digitalization depends on qualified workers capable of optimizing and managing water resources diligently. Therefore, education and training in process automation play a key role.

Characteristics of modern water operations

- Real-time monitoring of water systems, facilitated by the deployment of sensors and monitoring devices, allows operators to receive instant updates on water quality, pressure, and distribution. This capability enhances proactive decision-making and enables a rapid response to emerging issues.
- Automated control systems optimize various water treatment and distribution processes, overseeing tasks such as automated chemical dosing, pump control, and valve adjustments, ensuring precise and efficient operations while minimizing the need for manual intervention.
- The analysis of data generated by sensors and monitoring systems provides valuable insights into performance trends, empowering operators to make data-driven, informed decisions regarding resource allocation, maintenance scheduling, and overall system optimization.
- Continuous monitoring of equipment health and performance facilitates predictive maintenance, reducing downtime and enhancing operational efficiency.
- Modern water operations integrate technologies like IoT devices and communication networks. This interconnected and smart infrastructure enables efficient asset management, allowing for remote monitoring and management of equipment and infrastructure components.
- Many pumping, heating, and cooling systems and equipment are energy-intensive. Aeration stands out as the most energy-consuming process, as it facilitates the growth and activity of aerobic bacteria responsible for digesting organic matter in wastewater. Digitalization contributes to energy optimization in water operations by enabling the intelligent control of such equipment, thereby reducing energy consumption and operational costs. Additionally, integrating on-site renewable energy production helps offset energy costs and reduces the carbon footprint.
- Water utilities can implement more sustainable practices, including optimizing chemical usage, minimizing water wastage, and adopting energy-efficient technologies. These efforts align with broader environmental conservation goals.

Impacts on occupations

Digitalization significantly impacts various occupations within the water industry. Plant operators utilize digital tools to adjust chemical dosages, monitor equipment performance, and respond promptly to alarms and alerts. Automation engineers are responsible for programming and maintaining PLCs and SCADA systems, optimizing processes in treatment plants and distribution networks. Remote monitoring and control technicians oversee operations and address issues from a centralized location. Digital, real-time instruments and automated sampling systems have revolutionized water quality analysis and chemistry. Maintenance technicians employ digital tools for predictive maintenance. Data analysts process and interpret data collected from sensors and systems to make informed decisions concerning water quality, distribution, and treatment. Digitalization has also heightened the demand for cybersecurity specialists.

New skill requirements

To prepare for their evolving roles, both current and future workers must enhance their digital literacy to properly use digital tools and understand how data is collected, processed, and utilized. Knowledge of programming languages and automation systems is essential to design and implement automated control solutions for water treatment processes. Proficiency in data analytics is critical to extract meaningful insights from vast datasets and optimize water treatment processes.

A strong environmental awareness and understanding of environmental impact and conservation practices in water management are imperative. Additionally, workers need problem-solving skills and the ability to adapt to rapidly changing technology and environmental conditions. Given the complexity and interconnectivity of systems, workers should be prepared to collaborate within multidisciplinary teams.

Optimization of the

Water-energy nexus

When delving into water management within industrial operations, it is essential to recognize the inseparable connection with energy. Addressing the so-called “water-energy nexus” in technical education helps to prepare students to be conscientious, adaptable, and innovative professionals who can contribute to sustainable and responsible technological advancements.

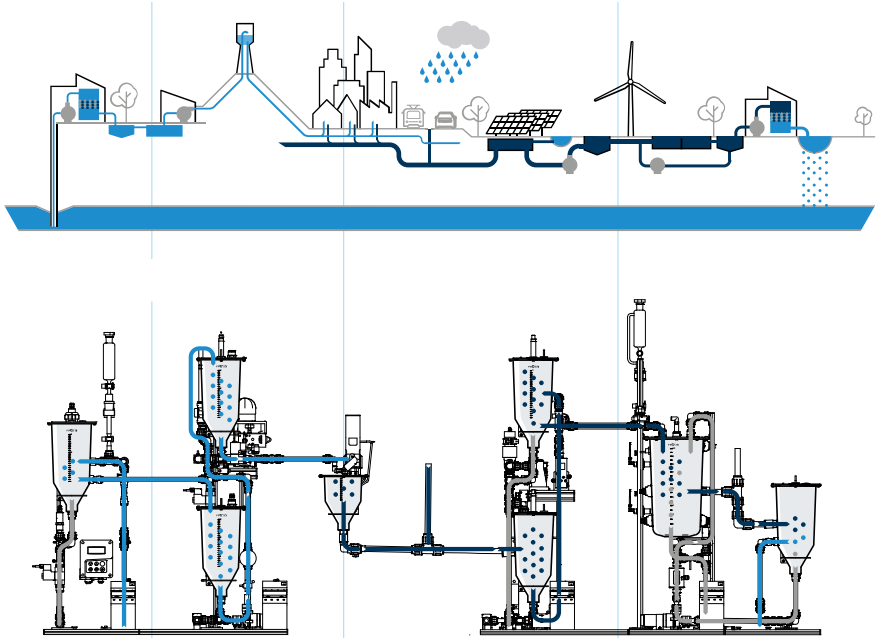
Water for energy, energy for water
The intricate interplay between energy and water forms a multifaceted relationship that underscores the interdependence of these two critical resources. Energy choices impact water resource quality and availability, and vice versa.

Energy production relies heavily on water resources, as various methods such as hydropower, nuclear, and thermal power generation require substantial water inputs.

Conversely, water treatment and distribution necessitate significant energy inputs. This intricate nexus becomes even more pronounced in the face of climate change, as altered precipitation patterns and rising temperatures impact both water availability and energy demand. Striking a delicate balance between these two vital elements is imperative for sustainable development and social acceptability.

Renewable energy availability
There is growing interest in integrating renewable energy sources into water tech operations to reduce reliance on fossil fuels and decrease greenhouse gas emissions. Solar, wind, and hydroelectric power can be used to power water treatment and distribution facilities, making them more sustainable and resilient.

However, decarbonizing electricity generation with renewables presents the challenge of energy storage during periods of low wind and sunlight. A solution involves utilizing surplus renewable electricity to pump water into reservoirs, enabling indirect energy storage through a smart grid. Students should be empowered or sensitized directly at school to identify these interconnections and develop innovative solutions.



The EDS Water Management helps to explore the water-energy nexus.
→ Page 44

Cross-disciplinary skills
To optimize the energy-water nexus, individuals need a diverse set of skills spanning technical knowledge, analytical prowess, interdisciplinary understanding, environmental awareness, policy and regulatory insight, effective communication, collaboration, project management proficiency, innovation, adaptability, and system thinking.

Optimization tools
Instrumentation and process control, in conjunction with automation technologies, plays a vital role in improving the efficiency of the energy-water relationship in industrial operations. Various instruments and control systems are used to monitor and manage water and energy consumption efficiently:

- Differential pressure meters, electromagnetic flow meters, ultrasonic flow meters measure the rate of water flow in pipes or channels. They monitor water consumption, detect leaks, and optimize water usage in processes.

- Piezoelectric, strain gauge, and capacitance pressure sensors measure the pressure of fluids in pipes or vessels. They optimize pump efficiency, detect leaks, and ensure proper pressure in water distribution systems.

- Ultrasonic level sensors, radar level sensors, float level sensors measure the level of liquids in tanks or containers. They control water levels, prevent overflow, and manage storage in water treatment facilities.

- Thermocouples, resistance temperature detectors (RTDs), infrared temperature sensors measure the temperature of water or other fluids. They optimize energy consumption in heating and cooling processes, monitor water quality.

- Analytical instruments (pH/conductivity/turbidity/dissolved oxygen meters) measure and analyze the composition of water and wastewater. They monitor water quality and ensure compliance with regulatory standards.

- Programmable logic controllers (PLCs) control and automate various processes based on programmed logic. They are key to sequence control, data acquisition, and process automation in water and energy management.

- Supervisory control and data acquisition (SCADA) Systems and distributed control systems (DCS) monitor, control, and gather data from industrial processes. Cloud data offer centralized control of water treatment plants, energy management, remote monitoring, and transparent communication with stakeholders.

- Variable frequency drives (VFDs) control the speed and power consumption of electric motors to optimize pump and fan operations, and overall energy efficiency.

- Smart sensors and IoT devices provide real-time data and enable communication between devices, enabling continuous monitoring, predictive maintenance, and data-driven decision-making.

- Energy management systems monitor and manage energy consumption in industrial processes to identify energy-saving opportunities and track energy usage patterns.

The mastery of these technologies enables real-time monitoring, control, and optimization of processes, contributing to increased efficiency, reduced resource consumption, and overall sustainability in industrial operations.

Instrumentation and control for

Battery manufacturing

Battery manufacturing plants are mushrooming to support the acceleration of electric mobility and the expansion of renewable energy storage options. What characterizes battery manufacturing facilities? What skills are required? How can students be prepared to onboard the industry and how to enhance workers' productivity? What is the contribution of process automation to operations? Let's find out.

Advanced manufacturing skills
Battery manufacturing plants are modern, high-volume facilities that seamlessly integrate factory and process automation. Automation ensures precision, uniformity, and stability, meeting stringent safety and performance requirements. However, the introduction of innovative technologies impacts skills requirements, leading to skills deficits among workers.

To thrive in an Industry 4.0 environment, workers need a broader range of skills, including digital literacy, troubleshooting, critical thinking, communication, collaboration, and creativity. Lifelong learning skills are also essential due to rapid changes in the industry. Therefore, teachers and industry training managers must invest in adapting or creating training programs aligned with industrial skills requirements.

Process technology: a key expertise area
The battery industry's value chain spans from raw material extraction to battery cell assembly, distribution, integration, services, recycling, and research. Process technology integration ensures efficiency and quality throughout. Skilled production workers require expertise in process technology and automation for safety and productivity in manufacturing.

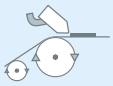
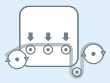
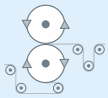
To prepare skilled workers in process automation, a comprehensive training program covering flow, level, pressure, temperature, pH, and conductivity processes, as well as industrial control technologies like PLCs, SCADA, and DCS, is essential. This program should also include specific knowledge of battery processes and technologies.

Essential battery fundamentals
Technical workers require a solid understanding of fundamental battery principles to effectively contribute to the production process. Here are a few important areas of battery fundamental knowledge:

- Battery chemistry (lithium-ion, lead-acid, nickel-metal hydride…) and materials (including electrodes, electrolytes, and separators).
- Battery design principles (including cell arrangement, electrode configurations, and packaging considerations) and structural components of batteries and their functions (such as current collectors, terminals, and casing materials).
- Electrochemical processes (charge/discharge reactions, ion migration, and electron flow) and electrochemical parameters (voltage, current, capacity, and energy density).
- Battery testing methods and characterization techniques, including performance metrics such as capacity, voltage, cycle life, and impedance.
- Safety protocols and hazard awareness (flammability, toxicity, and chemical reactivity).
- Quality control measures and standards (ISO quality management systems, industry-specific regulations, and product certification requirements).
- Batch processing techniques, production workflows, and optimization strategies.

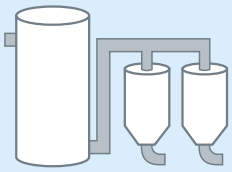
Learning solutions for battery and electric vehicle production
We can assist schools and industrial companies in developing comprehensive learning environments and training programs to build skills that help onboard new hires and enhance expertise of current employees.

→ **Click here or scan the code:**

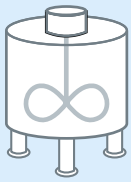
	Process	Description	Controlled variables	Field devices
	**Mixing**	Blending materials to form a uniform mixture, including slurry production.	Mixing speed, temperature, viscosity, concentration of materials	Speed, torque, and temperature sensors, viscosity meters, concentration analyzers
	**Coating**	Applying a thin layer of slurry onto current collectors to create battery electrodes.	Coating thickness and uniformity, temperature, solvent concentration	Thickness gauges, temperature sensors, gas analyzers
	**Drying**	Removing solvents from coated electrodes to enhance structure and prevent defects.	Temperature, humidity, residual solvent concentration	Temperature and humidity sensors, gas analyzers, heaters and fans
	**Calendering**	Compressing, shaping coated electrodes to improve density and mechanical properties.	Thickness of coated materials, density of materials, temperature	Thickness gauges, density meters, temperature sensors
	**Filling**	Injecting electrolyte into battery cells for proper volume and concentration.	Electrolyte volume, seal integrity, electrolyte concentration	Level sensors, leak detection systems, electrolyte analyzers
	**Aging**	Allowing batteries to stabilize and activate for optimal performance.	Rest time, temperature, self-discharge rate	Timers, temperature sensors, self-discharge measurement devices
	**Degassing**	Removing gases enhances battery safety and longevity.	Gas concentration, temperature, pressure	Gas analyzers, temperature and pressure sensors
	**Testing**	Evaluating capacity, voltage, resistance, and safety characteristics.	Capacity degradation, thermal stability, voltage drop, internal resistance	Battery testers, voltage and internal resistance meters, safety testing equipment

Typical battery production process

Raw material handling

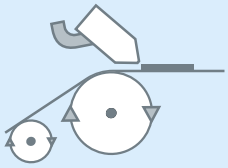


Raw material distribution

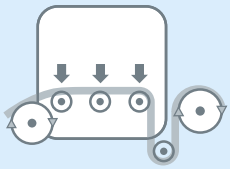


Mixing

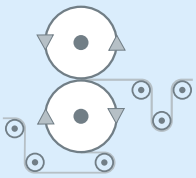
Material preparation



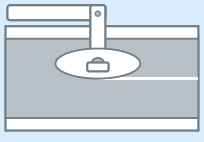
Coating



Drying

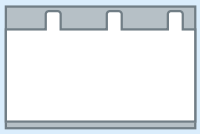


Calendering

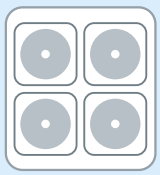


Slitting

Electrode manufacturing



Notching



Vacuum drying

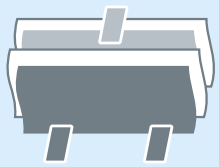
Cell assembly Front end

Cylindrical cell

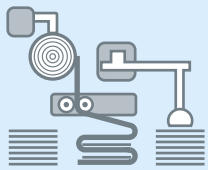
Stacked cell

Wound cell

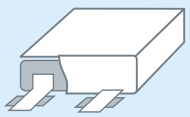
Cell assembly Back end



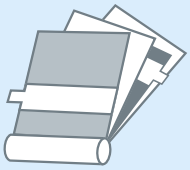
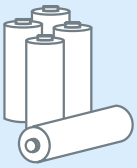
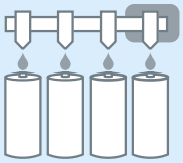
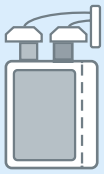
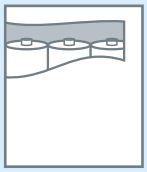
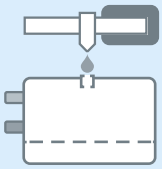
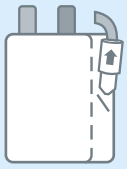
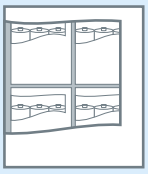
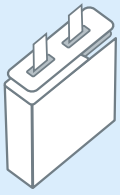
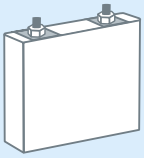
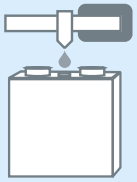
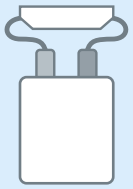
Tab welding



Z-folding



Tab assembly

Assembled cell		Filling	Formation	Module and pack assembly
 Cylindrical winding	 Cylindrical cell	 Cylindrical cell filling	 Aging	 Module assembly
 Tab welding	 Stacked cell	 Pouch cell filling	 Degassing	 Pack assembly
 Canning	 Prismatic cell	 Prismatic cell filling	 EOL testing	

Process technology in

Mining

Technical training for the mining and metals workforce

Explore our learning solutions that prepare operators and technicians for the mining industry.

Download our brochure.

→ **Click here or scan the code:**

With the increasing demand for technology minerals essential for various applications in renewable energy, electric vehicles, electronics, and telecommunications, the mining industry once again holds a pivotal position in modern society. Industrial mining operations heavily rely on process technology to optimize extraction processes, improve efficiency, ensure safety standards, and minimize environmental impact.

Process automation enhances safety by minimizing human exposure to hazardous conditions, improves efficiency by streamlining workflows and reducing downtime, and boosts productivity by maximizing resource utilization. Moreover, process automation facilitates real-time monitoring and control of critical parameters, ensuring optimal operation of equipment and processes. Additionally, automation contributes to environmental sustainability.

The processing of tech minerals differs significantly from that of traditional minerals, primarily due to their unique properties and characteristics and the specific requirements of modern technological applications.

Tech minerals often occur in complex ore bodies containing multiple elements, necessitating specialized extraction and processing techniques such as hydrometallurgy, ion exchange, and solvent extraction. Moreover, tech minerals used in high-tech applications require high levels of purity, leading to additional purification steps not typically needed for traditional minerals. Additionally, the processing of tech minerals may involve environmentally sensitive processes, prompting heightened environmental regulations and sustainability considerations compared to traditional minerals.

Picture: Flotation cells in a mineral processing facility

Key skills areas for production workers:

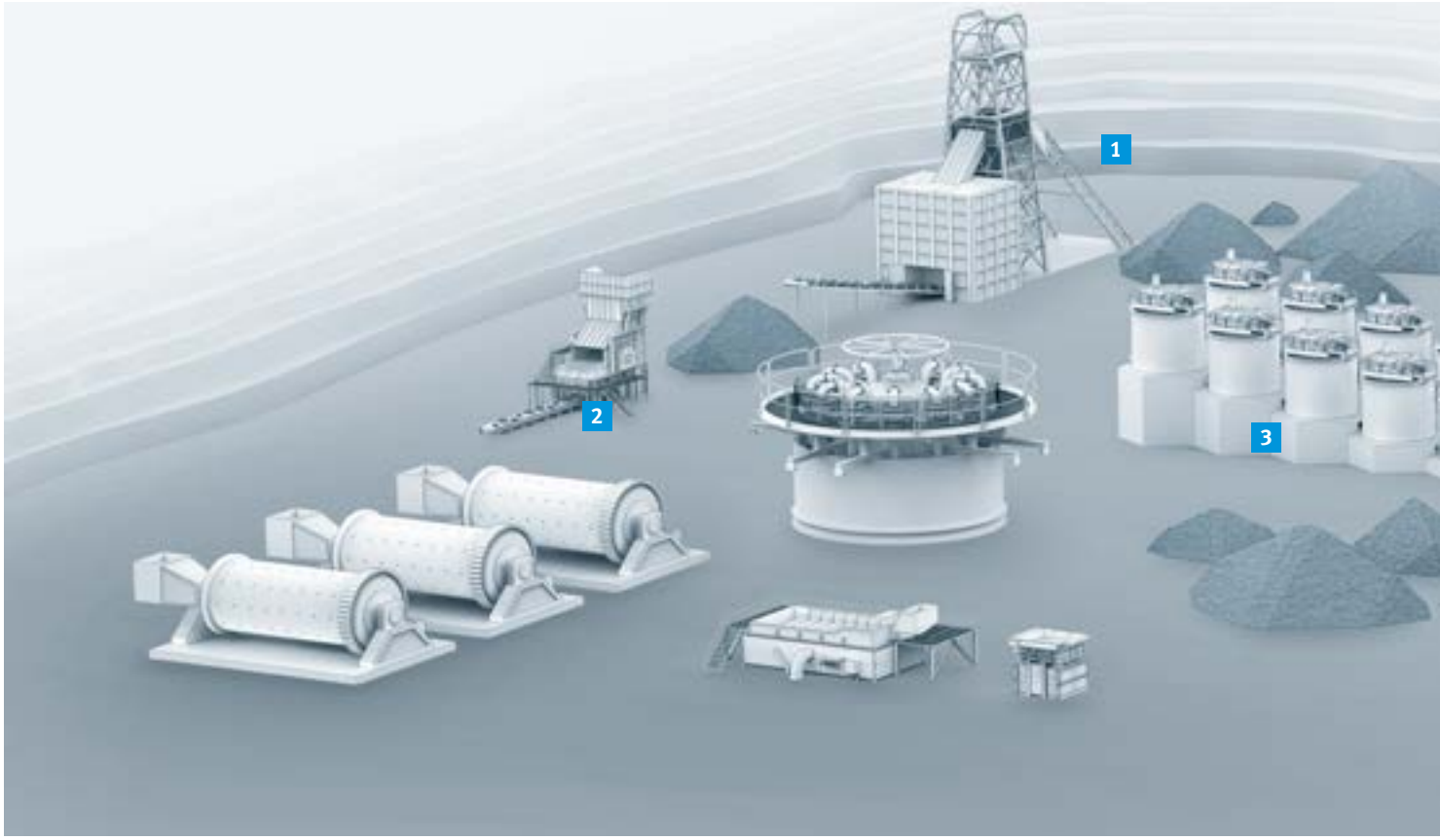
Instrumentation and process control
Managing the efficiency of the wide and diverse range of mining processes can be challenging, especially due to the variety of equipment that often operates using different interfaces and formats. Instrumentation enables real-time equipment monitoring for numerous mining operation processes simultaneously, increasing efficiency through automation, improving quality control, reducing waste and contamination, and creating a safe work environment.

Water technology
Water serves various purposes throughout the production processes, including extraction and processing, dust suppression, cooling, transportation and slurry handling, washing and cleaning, mineral separation and concentration, and more. Water technology relies on automation and control systems to precisely manage and optimize water and wastewater treatment processes.

Renewable energy production
By transitioning to renewable energy sources, mining companies can reduce their energy costs, particularly in remote locations with limited grid access, while mitigating environmental impacts such as greenhouse gas emissions and pollution.

Industrial trades
Industrial trade skills, particularly in machine mechanics and industrial pumps maintenance, are vital to ensure machinery and equipment reliability, minimize downtime, and optimize productivity.

Typical mining processes



1

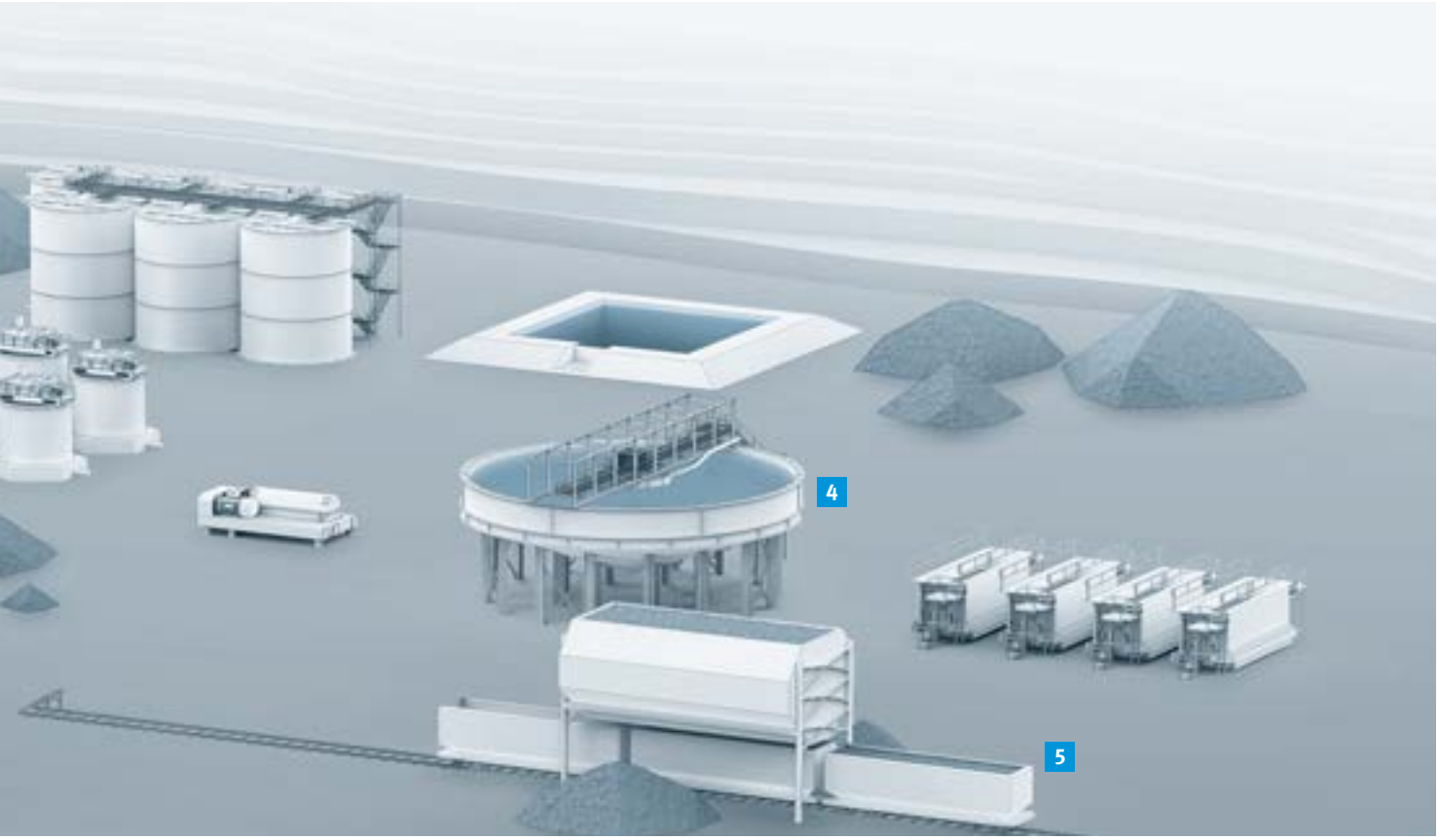
Mining
With deep mining or open-pit mining, the rock is drilled and blasted and then transported or conveyed to the surface.

2

Crushing
- Breaker
  A breaker station crushes the rock, often to rock dust.
- Ball mills
  The wet milling of minerals like copper ore crushes the material.
- Screening plant
  Screening separates granulated ore material into different grades based on particle size.
- Jigger
  The separating machine has a deep tank in which water is used to separate out the materials since they have a specific weight that is different to the gangue.
- Hydrocyclone
  Cyclones are one of the most frequently used plant components for separating solid particles from the liquid flows.

3

Processing and extraction
- Flotation
  Froth flotation selectively separates high-value, hydrophobic minerals from hydrophilic waste product. In its simplest form, the minerals are skimmed from the surface of a “slurry” of specific chemicals, water and air bubbles.
- Leaching
  This is the process by which precious metals, copper and other compounds are extracted from ores. Because of the chemical reactions, certain materials are absorbed and then separated again from other earth materials.
- Precipitation
  A precipitating agent is added to a batch of metal-containing solution, causing the target metal ions to form insoluble precipitates, which can be separated by filtration or sedimentation.



- Smelting
  The process involves feeding a batch of ore or concentrate into a furnace or smelter, along with fluxes and reducing agents, and heating it to high temperatures to separate the metal from the gangue materials. The molten metal is then tapped off and further refined.
- Electrorefining/Electrowinning
  In electrorefining, a batch of impure metal is used as the anode in an electrolytic cell, where it is dissolved and deposited onto a cathode, resulting in purified metal. In batch electrowinning, metal ions in solution are reduced and deposited onto an electrode to recover the metal in pure form.

4

Thickener and filtration

- Thickener
  The froth concentrate from the flotation cells is pumped to the concentrate thickener. The gravitational force causes the particles to form a thick slurry, which contains most of the solids. The overflow consists of liquids and caustic solution.
- Filtration
  Filter presses are used to dewater the concentrate and waste material. The minerals that are extracted from the sludge are processed further in follow-up processes and the water used is returned to the process.

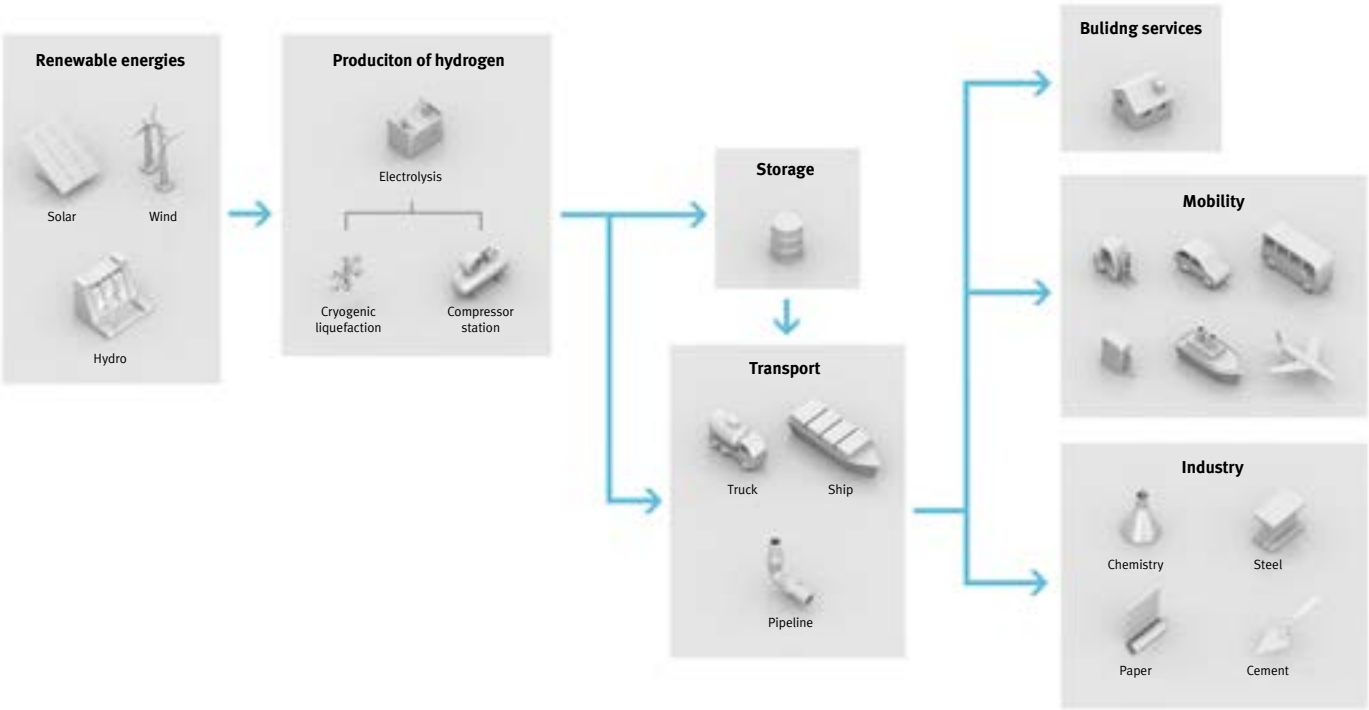
5

Onward transport

The finished mineral concentrate is transported to primary production plants like smelting works or refineries. In fully integrated plants, the internal transport is handled by conveyors.

Preparing for

Green hydrogen



Green hydrogen production is a burgeoning topic, yet still unfamiliar to many. As a technical education teacher specializing in process automation, instrumentation, and process control, it is crucial to grasp green hydrogen technology's growing significance in sustainable energy systems. Let's delve into a few fundamental aspects.

Numerous uses
Green hydrogen is primarily utilized as a clean energy source for transportation, industry, and power generation. It is a renewable alternative to fossil fuels, helping to reduce greenhouse gas emissions and mitigate climate change. It can also be used for energy storage and grid balancing, contributing to the integration of renewable energy sources. It also holds potential for applications in sectors requiring high-temperature heat.

The colors of hydrogen
- Grey hydrogen is produced from fossil fuels, usually through a process called steam methane reforming (SMR): methane is reacted with steam at high temperatures to produce hydrogen and carbon monoxide. It is the most common form of hydrogen produced today but is associated with significant greenhouse gas emissions.
- Blue hydrogen is also produced from natural gas, but with the additional step of carbon capture and storage (CCS) to mitigate greenhouse gas emissions.
- Turquoise hydrogen is produced using methane pyrolysis, a process that involves breaking down methane into hydrogen and solid carbon without producing CO2 emissions.
- Green hydrogen is produced through the electrolysis of water using renewable energy sources. Electrolysis splits water molecules into hydrogen and oxygen, with the hydrogen collected as a clean fuel source. Its production is entirely emissions-free.

Green ammonia
Ammonia is a versatile compound primarily used in the production of fertilizers, but also in industrial processes, chemical synthesis, and more. Green ammonia is produced using green hydrogen as a primary feedstock. This is typically achieved through the Haber- Bosch process, where hydrogen is combined with nitrogen extracted from the air or from nitrogen-rich sources like biogas or wastewater treatment plants.

Electrolysis technologies
Electrolysis is a fundamental process for green hydrogen production. There are currently three main technologies:
- Alkaline electrolysis: Uses alkaline electrolyte solution (e.g., KOH or NaOH) to split water into hydrogen and oxygen using direct current. Commercially available for decades, known for reliability and cost-effectiveness. Operates at higher temperatures and pressures, impacting energy efficiency and requiring additional heat management.
- PEM electrolysis: Utilizes solid polymer electrolyte membrane (e.g., Nafion) to split water into hydrogen and oxygen with an electric current. Offers high efficiency, fast response times, and lower operating temperatures and pressures.
- Solid Oxide Electrolysis Cells (SOECs): Operate at high temperatures (700-900°C) using a solid ceramic electrolyte to split water vapor into hydrogen and oxygen. Offers high efficiency and potential for co-electrolysis of steam and carbon dioxide.

Water-intensive process
While electrolysis relies on water as a feedstock, actual water usage varies based on several factors. Efficiency in electrolysis technology plays a significant role. Water usage is influenced by the purity of the hydrogen output, as additional water may be needed for purification to meet specific quality standards. The source of water utilized also affects consumption, with freshwater sources posing environmental concerns compared to alternative sources like seawater or wastewater.

Instrumentation for hydrogen production
Instrumentation measures and monitors key process variables and ensuring operational efficiency and safety:
- Pressure transmitters for various components of production system, flow meters (for gases and liquids), and sensors for monitoring electrolyte pH, temperature, pressure, gas purity, and levels.
- Various electrical instruments, including voltmeters, ammeters, and power meters, measure electrical parameters such as voltage, current, power consumption, and electrical efficiency within electrolysis systems.
- Safety instruments such as gas detectors, flame sensors, and pressure relief valves detect and mitigate potential safety hazards, including gas leaks, combustion risks, and overpressure situations.

Hydrogen production provides interdisciplinary insights into energy, sustainability, technology, economics, and policy.

Left image: An overview of the green hydrogen value chain

Biologization

Bioreactors

Biologization harnesses the potential of biological processes and materials. As this trend continues to gain momentum, bioreactors are emerging as crucial enabling technologies in the process industry. They serve as essential tools for cultivating, controlling, and optimizing biological processes at a commercial and industrial scale.

New knowledge and skills requirements
The introduction of these specialized chemical reactors necessitates process operators, technicians, and engineers to acquire a range of specialized competencies. These encompass an understanding of biology and microbiology, proficiency in aseptic techniques to ensure sterility, familiarity with bioreactor-specific instrumentation and control systems, knowledge of bioprocess engineering principles, and the ability to analyze and interpret data using analytical techniques.

Increased complexity
Standard reactors typically employ simpler control systems primarily geared toward ensuring the safety and basic stability of chemical reactions. In contrast, automation and control systems in bioreactors are notably more sophisticated and customized to meet the unique demands of biological processes. These systems prioritize the maintenance of precision and stability, with a strong emphasis on optimizing productivity through the application of advanced control strategies and data-driven decision-making.

Typical field devices in bioreactors
Various sensors and measurement devices monitor key parameters to ensure the proper functioning of the bioreactor and maintaining optimal conditions for the bioreaction.

- Temperature sensors measure and maintain the temperature of the culture medium and provide feedback to the control system.
- pH sensors continuously monitor the acidity or alkalinity of the culture medium, which can have a significant impact on cell growth and product formation.
- Dissolved oxygen sensors measure the concentration of oxygen dissolved in the culture medium to ensure an adequate oxygen supply.
- Pressure sensors ensure that the vessel operates within safe pressure limits and detect pressure fluctuations.
- Level sensors monitor the liquid level in the bioreactor to ensure that the culture medium remains at the desired volume and prevent overflow or dry-out.
- Biomass sensors measure the density or concentration of cells or microorganisms in the culture.
- Gas sensors monitor the concentration of gases like oxygen, carbon dioxide, and other gases in the headspace or exhaust.
- Conductivity sensors measure the electrical conductivity of the culture medium, which can be related to the concentration of ions and solutes in the medium.
- Turbidity sensors measure the cloudiness or turbidity of the culture medium, which can indicate cell density or the presence of particles.
- Redox potential (ORP) sensors measure the oxidation-reduction potential of the culture medium, an important parameter for some types of microbial processes.
- Flow meters measure the flow rate of gases or liquids entering or exiting the bioreactor. They are important for controlling nutrient addition and waste removal.

Essential input to the control systems
Data is collected and processed by a data acquisition and control system (PLC, SCADA, DCS, or other) that allows workers to set and adjust parameters, receive real-time data, and make automated decisions to maintain optimal conditions, and troubleshoot any issues that may arise during the processes.

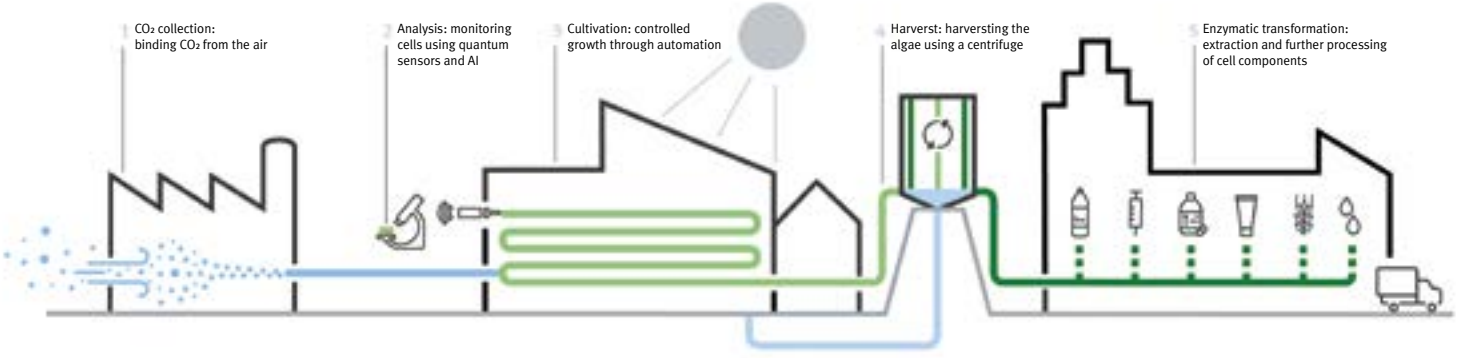
Cultivation of biomass on an industrial scale
Climate and resource protection are two of the great challenges of our time. How can we extract CO2 from the atmosphere and actively contribute to climate protection? How can we reduce our material consumption, recycle more materials and at the same time access alternative raw materials?

The cell as a factory
Living cells are the smallest factories in the world. Algae's chloroplast cells photosynthesize to convert sunlight, carbon dioxide and water into oxygen and chemical energy sources – or valuable organic matter.

Automation optimizes growth conditions
With automation technology, biomass can be cultivated in a closed cycle in a highly efficient, resource-saving way and on a large scale. Everything that we currently produce from crude oil creating immense CO2 emissions can also be obtained sustainably from algae. They are small planet protectors because they absorb ten times more CO2 than land plants. This value can be increased by a factor of ten through automated cultivation in bioreactors. The biomass obtained can be used in the chemical, food or pharmaceutical industries.

Curious to learn more?
Read more about the PhotoBionicCell and the BionicCellFactory on the Bionics Learning Network web page.

→ **Click here or scan the code:**



Excellence in technical education
The key to progress

”

Stimulating learning environments and programs are investments in our future. Education drives innovation and supports sustainable development across the globe.

“

Dr. Nader Imani
Head of Global Education Overlay

02

Our holistic approach

Technical education thought through


Formal education
Workforce development
Continuing education

Concept for every challenge

Complete solutions from planning to installation

Customized solutions from a single source

Every training facility has different requirements in terms of budget, space, performance level, and technology orientation.

While these needs may differ, they share a common goal: to deliver exceptional training experiences for learners, whether they are students or working professionals.

Are you looking to enhance existing training programs or create new ones related to process automation? Are you interested in digitalization and hands-on experimentation? Do you require new pedagogical resources aligned with industry requirements?

For over 60 years, Festo Didactic has been addressing the inquiries of customers worldwide and developing tailor-made solutions for every challenge.

You receive a coherent and future-proof concept from a single source. And learners receive the exact technical qualifications currently in demand in the job market.


Industry 4.0
Industrial trades
Electrotechnology and electronics
Factory automation
Process automation
Fluid power
Environmental technology
Renewable energy
Building systems technology

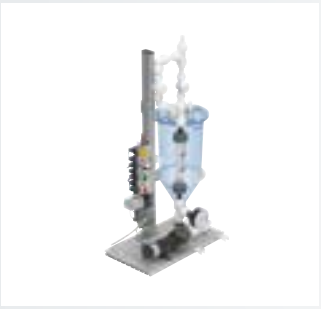
Overview of our

Learning solutions in process automation

From basic to advanced topics

Our learning systems are specifically designed for training purposes. They expose learners to the techniques, systems, and components they will encounter in the workplace, thereby offering realistic training opportunities.

Learners can experiment in a safe environment and make mistakes without facing consequences on live production systems.



EduKit PA
Small, expandable project kit that introduces the basics of process technology and open- and closed-loop control. Ideal for STEM education and beginners in process automation.
→ Page 4

MPS PA Compact Workstation
Four process loops with a fixed layout enable the study of closed-loop control of level, flow, pressure, and temperature. Ideal to grasp the fundamentals of process automation and instrumentation.
→ Page 8

EDS Water Management
Modular training system that represents the core processes of a water and wastewater treatment plant in the form of a water cycle, from source to wastewater treatment plant and back again.
→ Page 44

MPS PA 204
Four typical industrial process automation applications, combined in one system. Teach the fundamentals of filtration, mixing, reactor, and bottling processes, just like in the industry. Each station is available separately. → Page 26

Process Control Learning System*
Compact system for flexible circuit assembly to study measurement and control of pressure, flow, level, temperature, pH, and various process control techniques. Faultable components for troubleshooting exercises. → Page 28

Industrial Process Learning Systems*
Real-world, large-scale industrial process loops in a space-efficient work environment. Ideal for studying basic to advanced measurement and control of pressure, flow, level, temperature, pH, conductivity, and air flow and pressure. Fully customizable, faultable components, extensive course program, several IIoT options and industry configurations. → Page 70

PlantPAx DCS Demonstrator*
Practical training on instruments that control or monitor temperature, pressure, flow, and level process variables. → Page 90

Three-Phase Separator
Oil separation fundamentals taught with a realistic system that builds skills in operation, troubleshooting, and maintenance. → Page 92

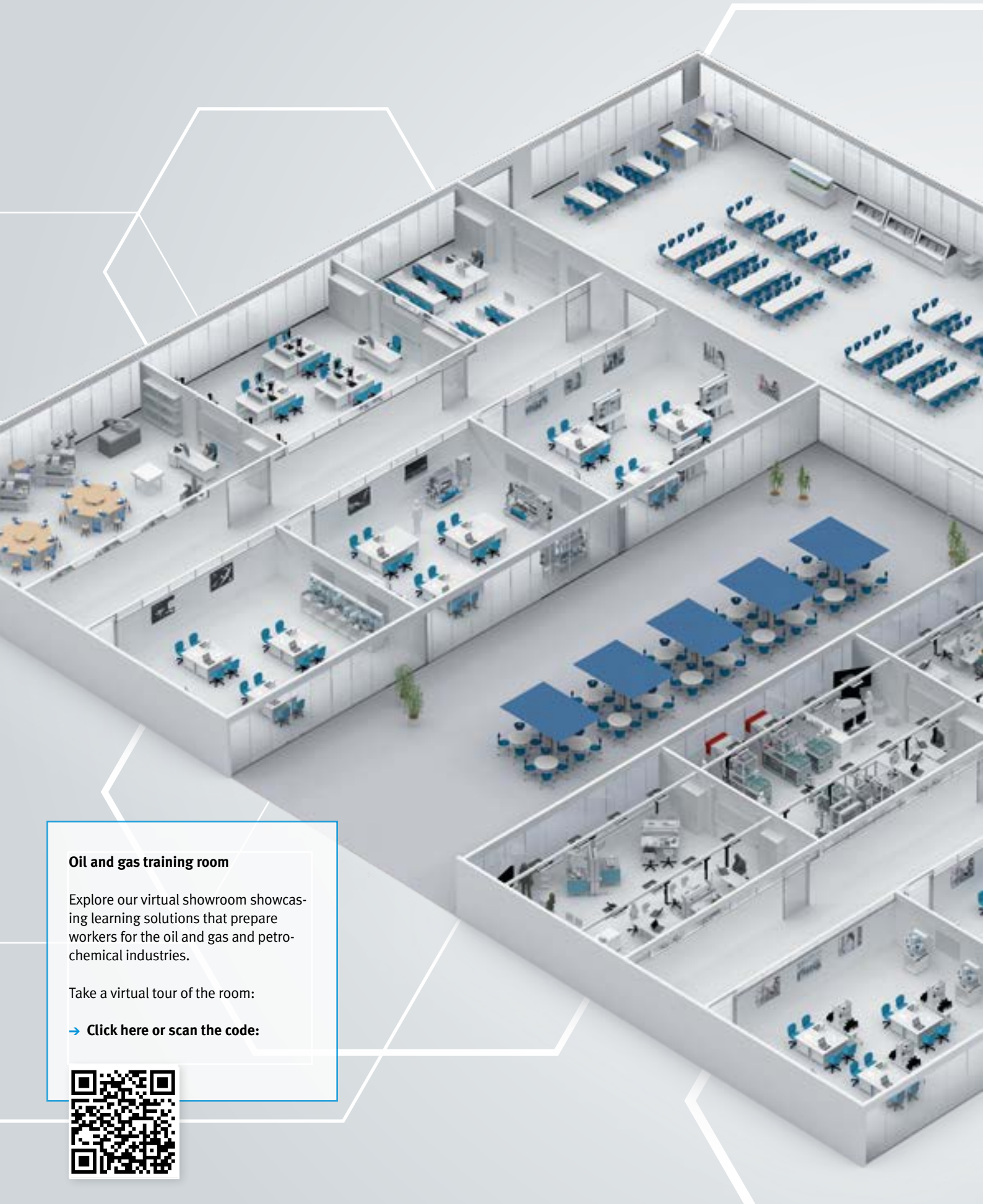
Curriculum available

Learning material focusing on hands-on experimentation is generally available as multimedia courses on the digital portal Festo LX.

Industrial components

Components and technologies from leading industrial suppliers are integrated into the training equipment for a realistic learning experience.

Note: Systems marked with a * cannot be sold or delivered in countries that require compliance to CE regulations.



Oil and gas training room

Explore our virtual showroom showcasing learning solutions that prepare workers for the oil and gas and petrochemical industries.

Take a virtual tour of the room:

→ **Click here or scan the code:**

Customized solutions

Design of workshops and laboratories

Bringing your ideas to life

Our extensive experience and leadership in the industry enable us to accurately pinpoint your qualification requirements.

We assist you in achieving optimal market alignment by providing support for your middle and long-term strategies. Utilizing the 2D space concept and 3D planning, we ensure that your laboratory design is both practical and compelling.

As seasoned automation specialists across various industries, we excel in transferring didactic knowledge of technologies.

Equipped with state-of-the-art learning systems, we offer a comprehensive range of laboratories catering to almost all technical professional fields, including:

- Process automation
- Automation technology
- Renewable energy
- Industry 4.0
- Electricity and electronics
- Industrial drive technology
- And more

Take a virtual tour of sample labs:

→ **Click here or scan the code:**

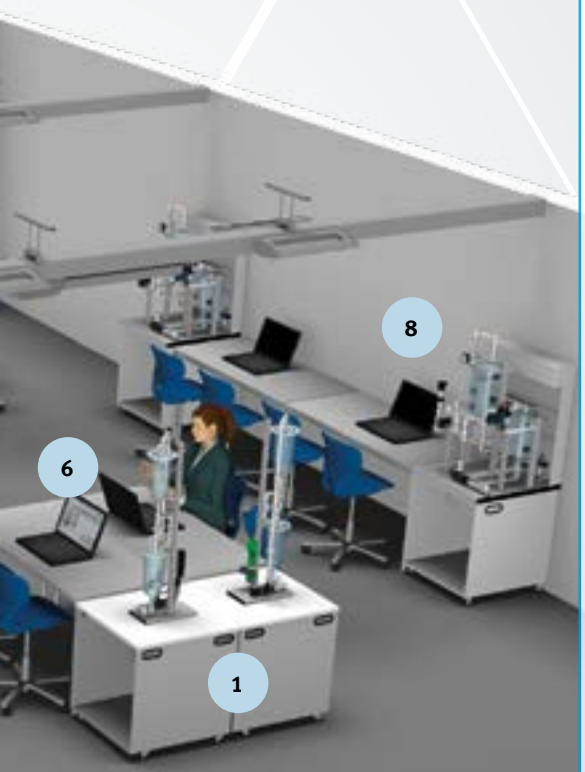
Inspiration

Process technology learning room

1 Introduce process and control engineering in a user-friendly way with the EduKit PA ➔ Page 4

2 Familiarize learners with filtering, mixing, reacting, and bottling processes with the MPS PA stations ➔ page 18

3 Stimulate creativity and exchanges in the multimedia/creativity zone



Reflecting industry trends in a learning environment

If we examine the trending topics in the process industry, we observe the dynamic nature of production plants, the demand for personalized products, fluctuating production volumes, the pursuit of maximum availability, and the ongoing digitalization of all business processes.

This dedicated process technology classroom is alleviates the workload of teachers while empowering students to cultivate independent learning and action.

Through a comprehensive integration of hardware, software, and courseware, many facets of process technology are realistically simulated. The learning systems elucidate the common principles of process technology.

Key elements such as measurement and control technology, including filling levels, flow rates, pressures, and temperatures, hold significant importance.

Limitless possibilities

The above picture depicts the hybrid learning factory laboratory of the FACT Center in Montevideo, Uruguay. It aims to enhance employability in the region by cultivating skills in flexible manufacturing through industrial and process automation. Four MPS PA stations are linked to the mechatronics modular production system (MPS) to create a seamless learning factory.

Learn more about FACT Centers
→ **Click here or scan the code:**

4 Find digital learning material aligned to professional requirements on our portal Festo LX → Page 148

5 Introduce PLC programming → Pages 112 – 115 and sensor technology → Page 118

6 Allow learners to grasp the fundamentals of control engineering with the software FluidLab-PA → Page 170

7 Introduce the Internet of Things and a batch size 1 bottling process with the IoT Kit → Page 11

8 Build complete skills in closed-loop control with the MPS PA Compact Workstation → Page 14

Extension idea: Introduce water technology with the EDS Water Management → Page 44

Massachusetts Maritime Academy (MMA)

Instrumentation and controls for facilities management and the life sciences industry

The customer

Massachusetts Maritime Academy (MMA) is a top-ranked university in Buzzards Bay, MA in the USA. The Academy's undergraduate programs prepare students for careers in the Maritime industry as well as Life Sciences through engineering planning, design, and installation of technical equipment systems required for power generation and management. These systems assist in the distribution of electrical power with the ability to engage in all facets of energy engineering.

The fast-growing Life Sciences industry has a high demand for graduates with technical problem-solving skills.

The challenge

MMA's undergraduate engineering curriculum needed an update. It provided traditional classroom training in fundamental instrumentation and operational controls, however, the Academy's engineering advisory board – in recognition of emerging advancements in instrumentation and control technologies – recognized the need for modern, state-of-the-art instrumentation and control laboratory spaces and curriculum.

Read the full story
→ **Click here or scan the code:**

The solution

Given a referral from AET Labs, a local reseller and education consultant, MMA selected Festo Didactic to provide their cadets with more effective hands-on training and equip them with the practical skills needed to work successfully in plant and facility management - particularly those supporting the growing Life Sciences industry in the Boston area.

"In consultation with the Academy's Engineering Advisory board, which includes industry experts, the Festo equipment was selected as it allows for precise training and practice on pressure, flow, level, and temperature process learning systems, while introducing students to a wide range of industrial processes that include instruments and control devices such as PLC plus control logics such as PID and On/Off," explained Dr. Ashraf Omran, Associate Professor of Facilities Engineering at MMA.

The new learning systems feature process and instrumentation workstations that allow instructors to select specific equipment as a function of the training objectives. The energy efficient units allow for several configurations regarding pressure, flow, level, and temperature. The learning systems also include complex control loop strategies that simulate controlling a level in a boiler, advanced controls such as cascade and feed-forward loops.

"The new training systems definitely enhanced our existing Instrumentation and Operational Controls curriculum. Using state-of-the-art equipment like Didactic's 3531 series is ideal to train students in facilities management and the growing process control industry. Modern technology-driven facilities require personnel experienced in complex operational controls, which these learning systems are specifically designed to provide," Dr. Omran added.

Pictures: Courtesy of Dr. Ashraf Omran

Festo Learning Experience

The digital portal for individual learning experiences

Festo LX combines
industry expertise with didactic know-how to create unique learning experiences that match industry requirements.

Festo LX offers
didactically prepared learning content for many technical areas.

Festo LX is based on
multimedia learning nuggets that can be processed in a modular fashion and combined to form individual learning paths.

Festo LX combines

digital courses and practical exercises performed on industry-aligned learning systems for increased employability.

→ Page 148

Find your learning content

Browse our growing collection of pedagogical materials designed to support learning and teaching across a wide range of technologies and topics.

Create your free account today!

→ **Click here or scan the code:**

Learning through competition
Making winners

> Skills competitions spark passion for technical jobs while celebrating the innovation and talent needed to shape our future.

Elfi Klumpp
Head of Partnership Development Global Education

03

WorldSkills

Inspiring future water technology specialists

"Water nurtures life and peace. Our commitment to WorldSkills is fueled by the urgent need for smart, skilled individuals to build, operate, and optimize water supply and wastewater plants worldwide."

Klaus Kronberger, CEO
Adiro Automatisierungstechnik GmbH

A lot of water has passed under the bridge since the appearance of water technology skills at WorldSkills competitions! Initially introduced as a demonstration skill in the 2013 Leipzig edition, it made the transition to an official competition in the 2019 Kazan edition, reflecting the rising importance of water technology specialists to support access to potable water and ensure the sustainability of our scarce water resources.

Meaningful, invigorating experiences
Young people enrolled in training programs related water technology are invited to seize the opportunity offered by skills competitions, big or small. Competitions enable young people to showcase their abilities in a competitive setting. They receive constructive feedback from industry experts, enhance their understanding and refine their skills. Exposure to real-world challenges contributes to students' professional growth and stimulates soft skills development, thus increasing their employability. Not to mention the excitement, pride, and sense of achievement of being part of such grand events!

A multifaceted competition
This competition unfolds through four distinct modules: Laboratory, Process Control and Automation, Maintenance, and Report Writing. Each module simulates the daily activities within municipal or industrial water supply and wastewater treatment plants. Participants engage in tasks mirroring real-world routines, encompassing daily checks, water quality measurements, chemical and biological analyses. The competition also emphasizes process control parameterization with a focus on troubleshooting, maintenance, and overseeing equipment such as pumps, valves, and sensors.

Assessing skills
Competitors in the water technology competition are objectively assessed based on the established WorldSkills Occupational Standard, which outlines the essential skills and knowledge required for water technology professionals. Key skills areas include work organization and management, communication, electrotechnology, industrial mechanics, environmental protection, chemical and biological analysis, quality assurance, process automation technology, and application of health and safety measures.

Strong partnerships
The WorldSkills Association organizes national and international vocational competitions since 1950. Thousands of young skilled workers around the world demonstrate their skills in over 60 vocational occupations year after year. Festo and WorldSkills International have enjoyed a close partnership since 1991. As a Global Industry Partner (GIP), Festo contributes the latest technology trends from industry to the competitions in Mechatronics, Industry 4.0, Water Technology and Renewable Energy. Since 2008, WorldSkills Europe and Festo have been working together to promote training in technical professions. In recognition Festo received the award of Premium Sponsor from WorldSkills Europe.

Images: Courtesy of WorldSkills International

Services
We are here for you

”

We invest in the professional development of our team members to ensure they can deliver an optimal and valuable experience to all our customers.

“

Markus Bellenberg
Head of Global Technical Customer Service

Workforce development

New skills for education and industry

Addressing skills gaps

Lifelong learning and competency development for employees are crucial for keeping pace with industry challenges. We are your perfect partner when it comes to specialized employee training for mastering technological, organizational, or interpersonal challenges and preparing for digital transformation.

Industrial DNA
We help bridge the gap between industrial skill requirements and individual competencies. Our solutions contribute to two main objectives: fostering employability and solving skills shortages by equipping people with the necessary industrial skills, as well as by closing existing skills gaps through proven qualification solutions for their workforce, thereby improving productivity.

As part of the Festo Group, we have first-hand experience and deep insights into industry demands. Moreover, our engineers are in close contact with other industries and provide us with valuable input on skills requirements for technological developments today and in the future. This industrial DNA enables us to constantly improve our equipment and service portfolio and to develop training programs that are in phase with current practices.

Curriculum and training content development
Festo Didactic develops curricula and provides consulting services for training content development and vocational and academic skills standards and programs. We deliver training solutions focused on measurable business outcomes with a wide range of standardized and customized trainings. Our learning solutions do not only aim at delivering single qualification courses – we also develop job-role-specific programs and curricula, focusing on competencies for a particular position.

Contact the Festo office nearest you to discover the full scope of local workforce development services and courses.

Customer assistance

Service and support

Optimal returns on your investments

We view our customers as long-term partners, which is why we consistently provide extensive support before and after delivery.

Worldwide presence, local service – With representatives in 60 countries, there is always someone who speaks your language.

Services tailored to your needs will enable you to make the most of your learning solutions. Our many years of productive exchanges with industry will help you define the exact training requirements for your situation. We offer support from project definition, to room planning and project implementation. Our expertise is derived from our vast international experience in training and education projects of all scopes and a network of partners and customers.

Train-the-trainer sessions, online or on-site, allow you to optimize investments and focus on what is most important: foster skills and support learners.

Installation, commissioning and maintenance can be carried out by our qualified team in order to guarantee safe, efficient setup and make sure you can use your new products straight away.

Technical assistance is provided in-house by our employees from customer assistance, sales, product management or development. Our ticket system guarantees maximum transparency of the processes. Remote access to your computer is another effective and cost-efficient way to support you.

A robust warranty backs our products for your peace of mind. Furthermore, our company prides itself on providing high-quality products designed for longevity, featuring repairability.

Contact us to discover the full scope of our assistance services and start planning your project.

Products

Process Automation and Water Management

Introduction and Fundamentals

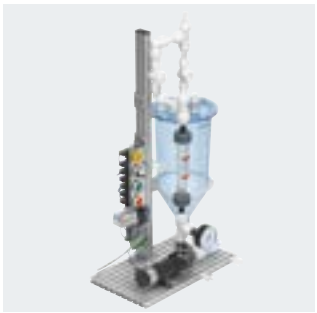
EduKit PA

Introduction to Process Engineering and Closed-Loop Control

Mobile and Practical for Beginners

The learning concept of the EduKit PA supports experimental learning, as well as teaching supported by the learning material. The projects provide a simple and safe introduction to process engineering and closed-loop control.

Closed-loop control systems are becoming increasingly vital across various sectors due to their ability to conserve energy and resources. As industries strive for efficient production, meticulous planning of individual steps, comprehensive understanding of processes, and thorough verification become imperative.



Two Versions
The EduKit PA Basic provides a step-by-step introduction to manual measurement and open- and closed-loop control, using the example of a simple system with level, flow, and pressure control.

The EduKit PA Advanced adds the automation technology, with pressure, flow, and ultrasonic sensors and an I/O connecting board for a controller of your choice. A 2/2 way solenoid valve controls the filling into the lower tank.

Control Options
The SysLink interface guarantees problem-free connection to various controllers:
– The SimBox for initial familiarization and commissioning
– The EasyPort USB, the interface to the PC. Control the system with FluidLab-PA Process, FluidLab-PA Closed-Loop, LabVIEW, MATLAB or FluidSIM (Grafcet/Digital blocks) for example
– An EduTrainer Universal or any other PLC

Ready to Use
Unpack, set up, and use! Setting up the first EduKit PA subsystem is the first activity of the project.

The EduKit PA offers suitable projects designed for technical training in both school and professional settings. Its modular concept caters to the need for diverse exercises, allowing tailored training for various skill levels.

Software Support

FluidLab-PA Process provides students with a step-by-step guide to the field of measuring and control engineering. What is displayed on the screen accurately mirrors the real-time activities in the physical system or simulation.

Learners are immersed in a virtual control station, creating a highly motivating and engaging learning experience.

Hot Topic:
Energy Efficiency

In the chemical, pharmaceutical, and food industries, state-of-the-art technologies help to prevent waste of energy and resources. The EduKit PA features scenarios that illustrate hot topics such as energy efficiency and environmental protection.

Two optional components allow for further practical experiments:
– A DC Wattmeter for energy measurement
– A modern pinch valve for flow optimization

Energy Monitoring
When and how can I save power? Which equipment is power-intensive? These questions are crucial to ensuring efficient management of energy in the domestic sphere and in production. Identifying potential savings first involves measuring current consumption. The DC Wattmeter is used as a smart meter for learning systems.

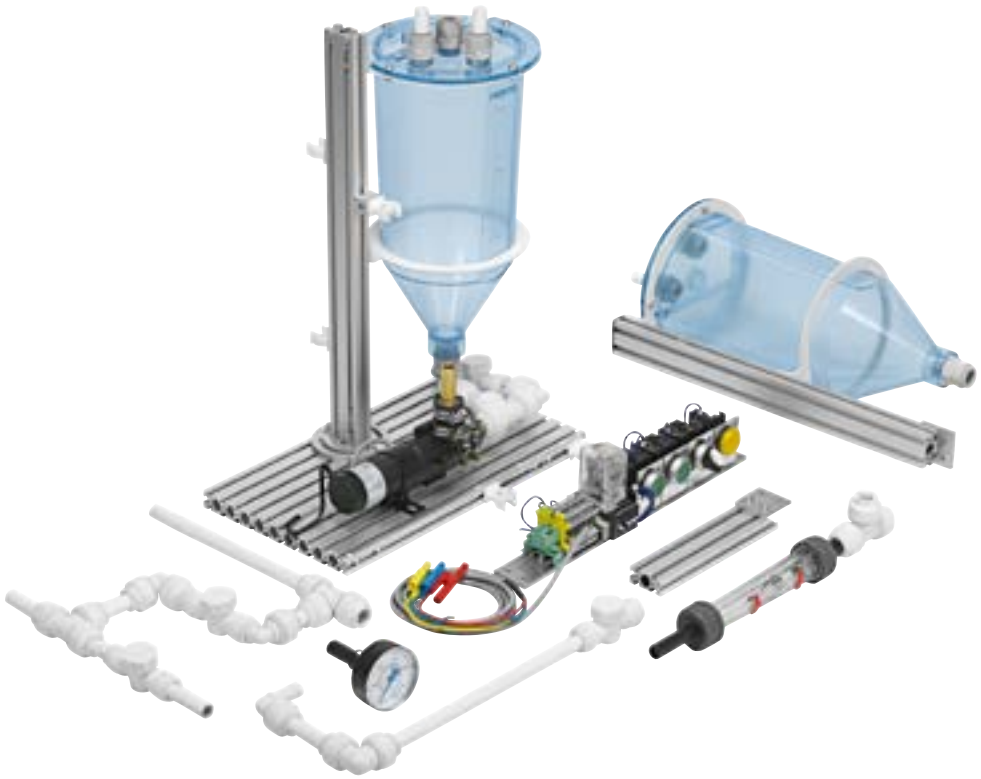
Pinch Valve
An increasing number of valves and drives are being operated pneumatically in process engineering. This is often safer, more economical, and energy-efficient.

The optional pinch valve seals the production flow gas tight with 2 to 3 bar differential pressure supply. Thanks to its rebound resilience, it returns to the open position with no drive after venting, guaranteeing an almost friction-free flow of material.

worldskills

Official Competition Equipment for Skill #55 Water Technology

EduKit PA Basic



Unpack and Start Working

Description
The EduKit PA Basic teaches the basic principles of project work and the fundamentals of closed-loop control – manual measurement, open- and closed-loop control – without a PC or sophisticated control technology.

Your Benefits
– Handy, easy to transport and simple to set up
– Step by step construction of a functional system: start with a small setup – a tank – and finish the project with a level control system.
– Training documents available
– Easy to use and expandable
– Water acts as a non-hazardous teaching medium ideally suited for closed-loop control
– Consistent with other Festo Didactic systems

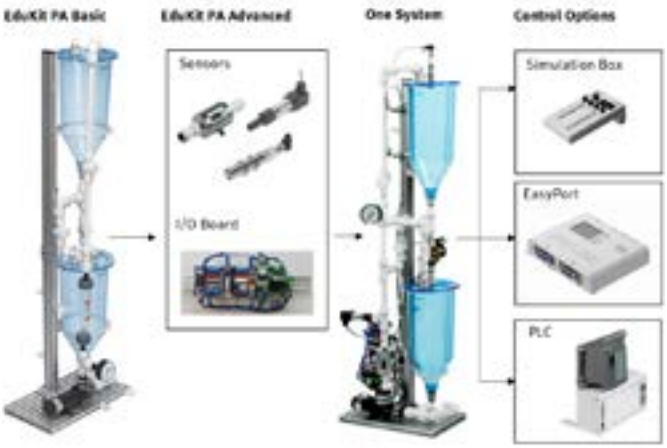
EduKit PA Basic	**549822**

The most important components at a glance:

Pump	170712
Tank, round	548596
Flow meter (rotameter)	548604

Required accessories, also order:

Tabletop power supply unit ➔ page 64	
Pipe and tubing cutter	7658
Tool set	539767



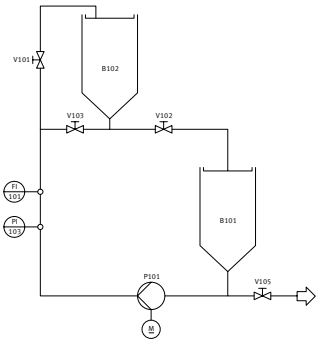
Learning Content for Project Work

Planning a project:
– Allocating tasks in teams
– Creating a project plan with different steps

Construction, assembly, connection:
– Creating sketches for the pipe connection system
– Producing an assembly diagram
– Mechanical assembly
– Electrical connection of pump to 24 V supply
– Checking activities
– Creating test logs

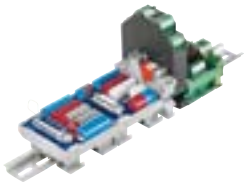
Commissioning and measured data acquisition:
– System start-up
– Recording measured values with changed valve position, changed voltage on the pump or different fill heights
– Observation of level, pressure, and flow, as well as time response

Presentation and Documentation:
– Creating assembly instructions
– Documenting measured values
– Graphical analysis
– Presenting project process



In addition to electrical pneumatic diagrams, you will also learn how to understand and describe a piping and instrumentation diagram.

EduKit PA Advanced

1


2


3


4


5


6


Description
The EduKit PA Advanced supplements the EduKit PA Basic modular product system with the topics of automated measurement, open and closed-loop control, sensors, and electrical interfaces. The EduKit PA Basic is required when using the components of the EduKit PA Advanced.

EduKit PA Advanced	**564631**

The most important components at a glance:

1 I/O board for EduKit PA	549823
2 Sensor, capacitive	549824
3 Sensor, ultrasonic	548689
4 Flow sensor, magnetic-inductive	8079872
5 Pressure sensor 0 – 400 mbar	549826
6 2/2-way solenoid valve	549827

Recommended accessories for control:

EasyPort USB	548687
I/O data cable with SysLink connectors (IEEE 488), 2.5 m	34031
Analog cable, parallel, 2 m	529141

The open interface provides various actuation options, e.g. controllers from Siemens, Festo, and Allen-Bradley.

Recommended software:

FluidLab-PA Closed-Loop → page 171
FluidLab-PA Process → page 170

Possibilities of expansion:

2-way ball valve	549828
Pinch valve, normally closed	8201244
Pinch valve, normally open	8201243
Float switch sensor, top	548597
DC wattmeter	8216170
IoT Kit for MPS PA	8162599

Recommended Learning Material

Workbooks
→ page 155

Campus license:

de	563969
en	563971
es	563973
fr	563975

Courses on Festo LX
→ Process Automation

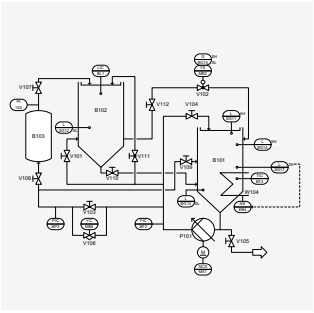
→ Open- and Closed-Loop Control
→ Basic Principles of Closed-Loop Control Technology
→ Basics of Production Control

Pinch Valves
The two optional valves are 2/2 directional valves with stainless steel bodies. The valve assemblies include a tube plug-in fitting (15 mm) and a pneumatic plug-in connection tube (6 mm).

2-Way Ball Valve
2-way ball valve for EduKit PA with DFPD quarter-turn actuator, sensor box, Namur valve, solenoid coil and mounting.

MPS PA Compact Workstation

The Fundamentals of Closed-Loop Control in Minimal Space



The Core: The P&ID
As the flowchart shows, the individual control loops can be activated simply by adjusting the ball valves. The flexible piping system allows quick changes to the flow pattern or integration of additional components.

Software Support
FluidLab-PA is designed for data acquisition and control. FluidLab-PA Process introduces users to process engineering. FluidLab-PA Closed-Loop enables basic control functions (such as two-point or continuous PID control) using the four closed loops. FluidLab-PA Multi-Loop supports advanced control strategies, including cascade, override, feed-forward, and ratio control. FluidLab-PA Energy enables energy monitoring.

Control Options
The MPS PA Compact Workstation offers various control options to suit the focus of your training. Controllers and operating units are not permanently installed on the workstation: PLCs are simply clicked into place in the ER mounting frame or placed on the lower shelf of the trolley.

Option: Refrigeration
All variants of the MPS PA Compact Workstation include a water/air cooler as standard equipment. For more temperature control options, like quicker cooling, an optional cooling unit with heat exchanger can be added.

Foundational Knowledge

Closed-loop control increases the efficiency, quality, and safety of modern process plants.

The “Fundamentals of closed-loop control” course offers a user-friendly introduction to this topic. Practical experimentation is performed on the MPS PA Compact Workstation. Learners build universal skills required in the process industry:

- Learn the basics of closed-loop control and process automation
- Commission and test a basic closed-loop system
- Read and design technical drawings
- Perform analog signal processing

- Operate and analyze flow, level, pressure, and temperature control systems
- Select and use optimization methods for loop tuning
- Monitor, analyze, and optimize energy consumption of a pump
- And more

After this course, learners will be prepared for advancing to the study of more complex topics in process automation.

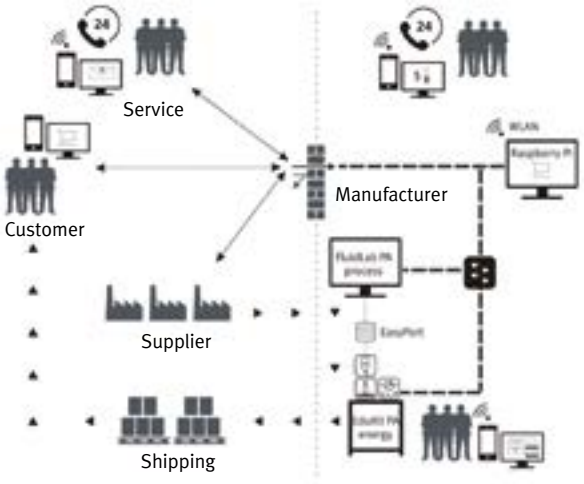
Option: Internet of Things (IoT)
As IT integration in business operations grows, demand for interdisciplinary experts rises. The IoT Kit for MPS PA meets this demand, enabling networked processes in a compact tabletop format.

Learners use the MPS PA Compact Workstation and FluidLab-PA Process software for hands-on learning scenarios without the need for an existing IT structure.

The kit breaks down a production process into key stages. This includes the customer order process in the web store, production and bottling, sensor-controlled stock transfer to the supplier, and automated service notification.

By exploring these interconnected processes, learners develop the ability to identify and analyze potential issues.

FluidLab-PA Process allows for full simulation of the production and filling processes. Alternatively, the MPS PA Compact Workstation can run the production process, while the bottling process can be simulated using FluidLab-PA Process.



MPS PA Compact Workstation

→ Video

Function
The four controlled systems can be operated individually. By using a corresponding controller, the level and flow rate controlled system can be configured into a cascade control system (FluidLab-PA Multi-Loop required).

The sensors and valve actuators support various types of controllers, including continuous ones like P, I, PI, PID, and discontinuous ones like two-point controllers. The pumps can be controlled through direct actuation or speed adjustment.

In the flow rate and pressure controlled systems, the manipulated variable of the controller can also operate a proportional directional control valve. A two-way ball valve with a pneumatic quarter-turn actuator is installed in the return between the elevated tank and the lower reservoir. This valve simulates a “load” for disturbance variable compensation in the level controlled system.

The workstation features IO-Link components (level, temperature, and magnetic flow sensors) to address digital communication between devices.

Learning Outcomes
– Introduction to process automation
– Learn the fundamentals of closed-loop control
– Read and design technical drawings for process engineering
– Learn the different methods used for control loop tuning
– Operate, identify, and analyze different control systems for pressure, flow, level, and temperature
– Operate, identify, and analyze different control systems for pressure, flow, level, and temperature with industrial instrumentation (Process instrumentation workstation)
– Operate, identify, and analyze a control system for energy management (Energy workstation)

Note: When ordering a complete compact workstation, it is delivered preassembled and preprogrammed. Individual components can be ordered separately to create a custom solution, but the system will not come preassembled nor preprogrammed.

MPS PA Compact Workstation – Basic

The basic workstation contains the mechanical and electrical components, sensors, and actuators that form the process system. The corresponding workbook is entitled “Fundamentals of Closed-Loop Control”, sold separately ➔ page 155.

	120 V	220 – 240 V
Without an additional controller and operator unit	**8164437**	**8164438**
With Festo controller and operator unit	**8162573**	**8162574**
With Siemens controller and operator unit	**8162582**	**8162583**
With Rockwell Automation controller and operator unit	**8162589**	**8162590**

Scope of delivery:

1x MPS PA Compact Workstation, basic (120 V, 60 Hz) **or**	8162603
1x MPS PA Compact Workstation, basic (220 – 240 V, 50/60 Hz)	8162604

Main components at a glance:

Mechanical components: 2 tanks, stainless steel pressure tank, plug-in tube system, filter regulating valve, mounting frame, aluminum profile plate

Sensors: 2 capacitive sensors, 2 float switches, IO-Link ultrasound level sensor (0 – 10V), IO-Link magnetic flow sensor with display (0,1...25 l/min), pressure sensor with display (0...400 mbar), IO-Link temperature sensor PT100 (-50...+150°C/-58...+302°F)

Actuators: pump with a separate motor controller for varying the pump speed with analog signals, proportional directional control valve, 2-way ball valve with pneumatic quarter turn actuator and end-position sensing, double-acting, heating

Electrical components: I/O connection board with measuring transducer, motor controller, I/O terminal, SysLink, 8I/8O, analog terminal, SysLink, 15-pin, power supply 24 V DC

And:

1x Trolley	8106686
1x EasyPort USB 19’’	8021637
1x Control panel	195766
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x Water-air cooler	8080632
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817
1x Ethernet/USB Interface	8079873

Note: The control components are added to this scope of delivery, depending on the selected workstation variant. A compressor (order no. 91030/565440) is also required.

Recommended extensions:

Simulation box	526863
IoT kit for MPS PA	8162599
Air Control System AirCS equipment set ➔ page 14	8023858
Cooling unit with heat exchanger ➔ page 13	
FluidLab-PA Multi-Loop ➔ page 171	
FluidLab-PA Process ➔ page 170	

MPS PA Compact Workstation – Process Instrumentation

The process instrumentation workstation is equipped with parameterizable sensors to allow a deep-dive into typical control devices and the HART communication protocol. The corresponding workbook is entitled “Fundamentals of Closed-Loop Control”, sold separately ➔ page 155.

	120 V	220 – 240 V
Without an additional controller	**8164439**	**8164440**
With Festo controller (CDPX and Codsys incl. I/O)	**8162575**	**8162577**
With Siemens controller (PLC S7-1512 and MTP700)	**8162584**	**8162585**
With Rockwell Automation controller (L24 and PanelView 7)	**8162591**	**8162592**

Scope of delivery:

1x MPS PA Compact Workstation, instrumentation (120 V, 60 Hz) **or**	8162605
1x MPS PA Compact Workstation, instrumentation (220 – 240 V, 50/60 Hz)	8162606

Main components at a glance (different than the basic station):

Sensors: capacitive level measurement, two-rod probe for continuous level measurement, magnetic-inductive flow meter with evaluation unit, on-site indicator and HART interface, pressure sensor, configurable with on-site indicator, temperature sensor PT100, configurable with on-site indicator, level vibration limit switch for fluids

Electrical engineering: signal conversion with parameterizable measured-value transducers, includes parameterization software and programming cable

And:

1x Trolley	8106686
1x EasyPort USB 19’’	8021637
1x Control panel	195766
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x Water-air cooler	8080632
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817
1x Ethernet/USB Interface	8079873

Note: The control components are added to this scope of delivery, depending on the selected workstation variant. A compressor (order no. 91030/565440) is also required.

Recommended extensions:

Simulation box	526863
IoT kit for MPS PA	8162599
Air Control System AirCS equipment set ➔ page 14	8023858
Cooling unit with heat exchanger ➔ page 13	
FluidLab-PA Multi-Loop ➔ page 171	
FluidLab-PA Process ➔ page 170	

MPS PA Compact Workstation

MPS PA Compact Workstation – Energy
The energy workstation is equipped with current and power meters to study energy consumption and efficiency. The corresponding workbook is entitled "Fundamentals of Closed-Loop Control", sold separately ➔ page 155.

	120 V	220 – 240 V
Without an additional controller	**8164441**	**8164442**
With Festo controller (CDPX and Codsys incl. I/O)	**8162578**	**8162579**
With Siemens controller (PLC S7-1512 and MTP700)	**8162587**	**8162588**
With Rockwell Automation controller (L24 and PanelView 7)	**8162593**	**8162594**

Scope of delivery:

1x MPS PA Compact Workstation, energy (120 V, 60 Hz) **or**	8162607
1x MPS PA Compact Workstation, energy (220 – 240 V, 50/60 Hz)	8162608

Main components at a glance (different than the basic station):
Electrical engineering: DC Wattmeter, power meter up to 5 A/24 V DC, incl. Ethernet interface, mounted on mounting bracket, AC multi-function meter PAC 3200 for measuring total output incl. Ethernet interface, built into 19" front panel
Software: FluidLab-PA Energy

And:

1x Trolley	8106686
1x EasyPort USB 19"	8021637
1x Control panel	195766
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x Water-air cooler	8080632
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817
1x Ethernet/USB Interface	8079873

Notes: The control components are added to this scope of delivery, depending on the selected workstation variant. A compressor (order no. 91030/565440) is also required.

Recommended extensions:

Simulation box	526863
IoT kit for MPS PA	8162599
Air Control System AirCS equipment set ➔ page 14	8023858
Cooling unit with heat exchanger ➔ page 13	
FluidLab-PA Multi-Loop ➔ page 171	
FluidLab-PA Process ➔ page 170	
EiSLab Software	8050112

Controller Options for the MPS PA Compact Workstation

Notes: All options include a sample application with control functions for the level, flow, pressure, and temperature. For details about the components ➔ pages 112 – 113

Festo Controller/Operator Unit

Scope of delivery
– Touch Panel Operator unit CDPX 7" (order no. 8162595)
– Integrated Soft PLC Codesys V3.5
– I/O module 16 DI/DO, 4 AI/2 AO, directly to 2x SysLink/1x analog cable
– Connecting cable 24 V dc
– Ethernet cable RJ45, length 5 m
– Software license Codesys V3 Runtime for CDPX
– Codesys V3.5 development environment
– Designer Studio V1.9x with HMI client

Siemens Controller/Operator Unit

Scope of delivery:
– EduTrainer Universal S7-1512C-1PN (order no. 8065600)
– SIMATIC HMI MTP700 Unified Comfort with mounting frame (order no. 8189570)
– IEC power cable 90°
– Connecting cable 24 V dc
– Ethernet cable RJ45, length 5 m
– Programming software STEP 7 TIA portal, single license

Rockwell Automation Controller/ Operator Unit

Scope of delivery:
– EduTrainer Universal A4 rack with Allen-Bradley 1769 L24 (order no. 8034583)
– 7-inch PanelView Operator unit with mounting frame (order no. 8162597)
– Connecting cable 24 V dc
– Ethernet cable RJ45, length 5 m

Note: RSLogix 5000 and FactoryTalk Studio ME software are not included ➔ pages 172 – 173

Recommended Learning Material

Workbook
➔ page 155

Campus licenses:

en/de	8190412

Note: The campus license includes the student and the instructor PDF versions of the workbook "Fundamentals of Closed-Loop Control" as well as other relevant documentation, such as user guides.

Courses on Festo LX
➔ Fundamentals of Closed-Loop Control

➔ Process Automation

1 **IoT Kit for MPS PA**
Create a learning scenario to introduce students to the Internet of Things. The IoT Kit provides a practical, all-in-one solution for networked processes in a compact tabletop size. Its use of open-source software and the availability of source data enable easy customization and do-it-yourself projects.

The different services run on the Raspberry PI such as an Apache Webserver / PHP Server (Website with shopping cart) and a MySQL-Server (Database). The components use a Siemens Scalance 5-port switch to communicate with each other's and a tablet preconfigured with the DC Wattmeter App.

Possible uses with:
– EduKit PA
– MPS PA Compact Workstation
– MPS PA Bottling Station
– EDS Water Management (Water Supply Station)

Scope of delivery
– Raspberry Pi 4 Wireless LAN
– Top-hat rail housing
– Power supply,
– SD Card with
– Raspbian operating system Services
– MySQL-Server (Database)
– Siemens Scalance 5-Port Switch
– Adapter for connecting Tablet to Ethernet via cable
– 7-inch tablet preconfigured with DC Wattmeter App
– Network cable set

Order no.	8162599

2 **Water-Air Cooler**
– Aluminum heat exchanger with copper line and flexible plug-in fittings
– 2x 24 V dc axial fans with 0 – 10 V adjustable speed input and encoder speed feedback
– Profile foot for mounting
– Connecting cable for I/O connection board
– 1x digital output, optional:
– 1x analog input 0 – 10 V

Order no.	8080632

3 **Cooling Unit with Heat Exchanger**
Hermetically sealed refrigerant circuit that is air-cooled with an axial fan that can be added to a MPS PA station for faster cooling. The heat exchanger is made of non-ferrous metal and has one 3/4" filling port as well as two 1/4" threaded female connections. Suitable for continuous operation and does not require any maintenance. The heat exchanger builds into the circulation pipe for tank-to-tank process with pump. Separated media circles: cooling and heating. Manual control of the cooling circuit by a temperature controller and a 2-way valve.

Technical data:
– Temperature range -10 °C to +40 °C
– Ambient temperature +12 °C to +30 °C
– Cooling capacity at +30 °C: 380 W
– Control accuracy +/- 1 K
– 4 liter/min 0,15 bar max. pressure
– Coolant tank volume: 4 Liter, filling port 3/4", inlet/outlet: 1/4"
– Refrigerant R134a
– Dimensions 260 x 370 x 405 mm (width x length x depth)

220 – 240 V, 50/60 Hz	8164444
120 V, 60 Hz	8162598

4 **Trolley**
Through-holes enable orderly routing of cables. The front side is equipped with mountings for panels.
– Height (including casters): 750 mm
– Width: 700 mm
– Depth: 700 mm

Order no.	8106686

5 **DC Wattmeter**
The DC wattmeter is a smart meter for training facilities with a 24 V DC power supply and up to 120 W power consumption. All measured values can be read out via data transmission with the integrated Ethernet port. Power consumption is read out as an analog signal within a range of either 0 to 10 V DC. Product picture for illustrative purposes only; actual product may vary.

Order no.	8216170

1

3

4

2

5

Energy-Efficient Compressed Air Management
Equipment set AirCS

An Expansion Option for the MPS PA Compact Workstation or the MPS PA 204 Complete System

Compressed air energy monitoring and compressor control are taught in a practical and comprehensive manner.

As part of a continuous learning project, the tasks are divided into the areas of condition monitoring, load management, long-term monitoring, flow resistance and nominal flow measurement.

Results can be measured with measuring points, and the software also includes the entire collection of exercises as a PDF file.

A Look at the Overall System
Before compressed air can be used, it must be generated, processed and distributed through to the respective application. Compressed air is a valuable form of energy. The AirCS EduTrainer is integrated between the generation of compressed air (compressor) and the process. The integrated measurement technology, together with the FluidLab-AirCS software, enables innovative condition monitoring for measuring compressed air and power consumption.

Generation and Load Management
Different compressors can be compared and changes can be noticed at an early stage. A calculation aid supports the calculation of the total variable and fixed costs of compressed air generation. With load management, the energy consumption of the compressor and another consumer is visualized.

Distribution and Monitoring
With long-term monitoring, it is possible to visualize the consumption of individual applications. Elements of the compressed air distribution can be examined in the Flow resistance menu. A calculation aid is available to determine the ideal pipe crosssection.

Learning Goals
- Generation, preparation and distribution of compressed air
- Condition monitoring
- Flow measurement and flow resistance
- Effect of leakage
- Pressure losses in distribution networks

Benefits
- Efficient compressed air applications
- Recording pneumatic and electrical consumption values
- FluidLab-AirCS license included
- Industrial quality components
- Can be used in the A4 mounting frame or on the lab table

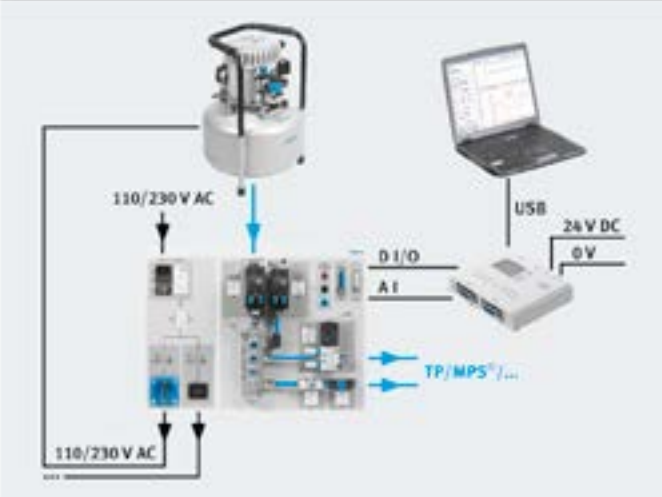
Complete equipment set AirCS	**8023858**

The most important components at a glance:

1x AirCS EduTrainer	8023859
1x AirCS accessory kit	8023860
1x FluidLab-AirCS 1.0 single license	8023861
1x EasyPort USB	548687
1x Analog cable, parallel, 2 m	529141
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Pressure sensor with display	572745

Necessary accessories, also order:

Compressor → Page 67
Tabletop power supply unit → Page 64
Power supply unit for mounting frame → festo.com/didactic
4 mm Safety laboratory cables → festo.com/didactic



FluidLab-AirCS and Training Documentation Included
The FluidLab-AirCS software is an important component of the AirCS equipment set. Just a few simple steps are needed to configure the interface and select the user language (German/English). Then the exercises can be started.

The measurement process is software-controlled. Results can be measured with measuring points, printed out, or exported to a spreadsheet program.

Exercises are supported by connection diagrams, descriptions, and sample solutions taken from the AirCS workbook in PDF format.

The workbook in German and English constitutes the accompanying documentation for the AirCS training project.

The workbook contains:
– Definition of task
– Sample solutions
– Training notes

Up to two electric consuming devices (e.g. compressor and power supply unit) are needed to perform the load management exercises.

MPS PA Process Automation Applications

Understanding Common Real-Life Operations

Filtering Station
Aquarium, vacuum cleaner, atomizer, sewage plant, waterworks – filters are of critical importance in many areas and the key question is: how can I ensure a constant flow with any level of filter contamination? And how can the filter be cleaned more effectively? Using compressed air?

The learning objectives of the filtration station cover these questions. By the end of the training, learners will grasp the appropriate open- and closed-loop control principles and technologies.

Mixing Station
Food and confectionery, paints, construction materials, pharmaceutical products – the correct proportions of different materials are crucial to the quality of the end product. Constant metering and mixing of the components makes high demands on the controller and the equipment involved in the process.

The mixing station provides state of the art equipment for demanding, motivating projects on one of the most common control loops in process automation – flow control.

Reactor Station
To extend the shelf life of foods, improve the mixing capacity of liquids or allow them to be mixed, there are a large number of optimized heating processes in the chemical industry.

Temperature control imposes significant demands on electronics components, as managing heat presents its own set of challenges. The realism of the reactor station becomes evident when coupled with the operational and monitoring software.

Bottling Station
Customers get annoyed if there is less in a drinks bottle than it says on the label. For drinks producers, a consistent and guaranteed fill quantity is a crucial quality feature.

The bottling station represents a realistic industrial environment, in which all aspects of a quality optimized filling process can be learned and experienced. The projects focus on level monitoring and positioning of the containers to be filled.

Continuous and Discrete: MPS PA Across Boundaries

Each of the MPS PA stations represents a closed process, such as can be found in an identical or similar form in many industry sectors.

Their control loops provide content for designing demanding courses in measuring and control engineering. They represent the most important continuous processes.

All stations can be combined with one another. The MPS PA stations can be linked to the mechatronic MPS stations and the discrete processes they represent with no problems at all.

The SysLink interface is the basis for this. This means that you can move into the industrial reality of hybrid production with minimal investment.

The interface concept opens a wide range of options for directly combining the individual MPS PA stations. Deciding on one combination or another depends on various factors:
– Training content
– Existing equipment
– Your budget

All Four in One
Anyone who wants to use all four stations in a network should order them as a complete MPS PA 204 system. The advantage: we commission and test the system before it is shipped. All you have to do is supply fresh water.

Commissioning services allow for the combination of on-site commissioning with instruction for the responsible trainers.

Standard with EduTrainer
All stations of the MPS PA will be delivered fully assembled. The stations will come the SIMATIC S7-1500 controller generation in the TIA portal. It delivers maximum performance and user-friendliness for medium and high-end applications in plant automation.

Touch Panel MTP700
Stations also include a preprogrammed touch panel SIMATIC HMI MTP700 Unified Comfort from Siemens, a 7" widescreen touch panel for advanced applications.

– Multiple interfaces for process communication
– Integrated PROFINET switch
– Programming from WinCC Unified Comfort V16 (TIA portal)

MPS PA Filtration Learning System

Station with optional equipment

Function
The filtration station filters liquids. The filtrate is pumped from the first tank into the second tank through the filter using a knife gate valve. The filtered liquid reaches the second tank via the butterfly valve. It can be pumped onwards to the next station using a separate pump. The filter can be rinsed using a rinse program. Regulated compressed air is blown through the filter to loosen deposits.

Measurement and Control
Sensors detect the filling level of the container. This allows for simple control exercises for monitoring the pumps right up to complete control projects involving complex processes.

Pressure control ensures constant high filter quality during flushing. The pressure sensor with LCD display, analog output and switching output always supplies the correct measurement variable. The controller with P, PI or PID control algorithm ensures constant high filter quality during rinsing via the proportional pressure regulator. Control technology is thus clearly explained.

Shutting off, Opening, Closing
The right selection of process valve, drive, drive accessories and control valve plays an important role in complex process sequences. The filtration station uses a wide range of process components. All the valve actuators are actuated via a directly connected NAMUR valve.

Knife gate valve with linear actuator.

Butterfly valve with sturdy rack and pinion rotary actuator and large visual display.

Three-way ball valve with rack and pinion combination with a constant torque characteristic across the entire swivel range, with large visual display.

MPS PA Filtration Learning System	**8079862**

The most important components at a glance:

1x Filtration station	701291
1x Trolley	541139
1x EasyPort USB 19"	8021637
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x EduTrainer Universal A4 rack with SIMATIC S7-1512C-1PN	8065600
1x SIMATIC HMI MTP700 Unified Comfort	8189570
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039

Recommended accessories:

IEC power cable → festo.com/didactic	
Replacement filter cartridge	544303
Compressor → see below	

Recommended software:

FluidLab-PA Process → Page 170	

Training Aims for Project Work

- Set-up, wiring, and commissioning of a system for process technology
- Selection, application and actuation of process valves
- Measurement of electrical and process-related variables such as level and pressure
- Set-up and commissioning of control circuits
- Analysis of control processes and control circuits
- Parameterization and optimization of P, PI or PID controllers
- Drafting of open-loop and closed-loop control programs
- Process operation and monitoring
- Inspection, maintenance, and servicing

Recommended Learning Material

Workbook

→ page 155

Campus license:

de	8131019
en	8131020

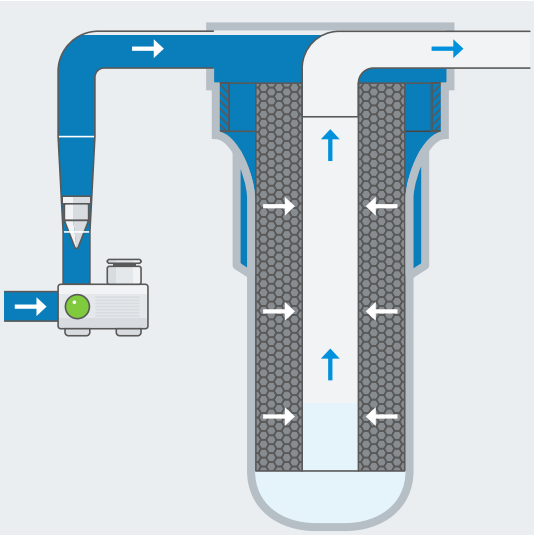
Courses on Festo LX

→ Process Automation

→ Open- and Closed-Loop Control

→ Basics of Production Control

→ Basics of Production Control



Possibility of Expansion: Compressor

Oil-lubricated, very quiet (45 dB (A)) compressor with pressure reducer and water separator.

230 V	91030
100 V – 120 V	565440

MPS PA Mixing Learning System

Station with optional equipment

Function
The mixing station mixes different recipes from three reservoir tanks. The liquid from one of the three reservoir tanks is pumped into the main tank in a controlled manner by opening the respective two-way ball valve. The finished mixture can be pumped to the next station via a second pump or pumped back to the reservoir tank.

Measurement and Control
The mixing station blends three raw materials according to a set recipe using a constant flow rate. An electro-magnetic flow sensor records the flow rate, which is displayed using a variable-area flowmeter. The output signal from the flow sensor is converted to a standard signal from 0 – 10 V. The mixing station can also be actuated through binary means using the integrated comparator. The controller adjusts the necessary flow rate via the pump with analog control using a simple two-point controller or various dynamic controllers such as P, PI or PID. This permits a clear explanation of control technology.

Always the Right Mixture
The mixing station includes pumps, valves, sensors, and electronic modules for signal conversion, providing a versatile selection from process engineering.

Sensors detect container levels and prevent overflow using extra sensors, eliminating overflow risks.

Signal converters convert all analog signals to standard signals from 0 – 10 V. Practical for the purpose of experimentation: integrated comparators also supply purely binary signals.

Two-way ball valve with rack and pinion combination with a constant torque characteristic across the entire swivel range and directly connected NAMUR valve.

MPS PA Mixing Learning System	**8079863**

The most important components at a glance:

1x Mixing station	701292
1x Trolley	541139
1x EasyPort USB 19"	8021637
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x EduTrainer Universal A4 rack with SIMATIC S7-1512C-1PN	8065600
1x SIMATIC HMI MTP700 Unified Comfort	8189570
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039

Recommended accessories:

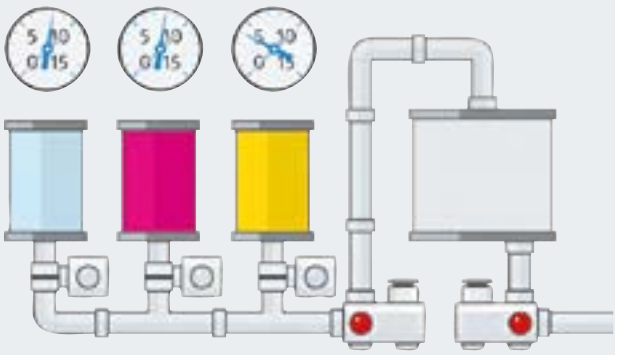
IEC power cable → festo.com/didactic	

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039
Compressor → see below	

Recommended software:

FluidLab-PA Process → Page 170	



Training Aims for Project Work

– Construction, wiring, and commissioning of a system for process technology
– Selection, application, and connection of various flow sensors
– Measurement of electrical and process-related variables such as level and flow rate
– Design and commissioning of control circuits
– Analysis of control processes and control circuits
– Parameterization and optimization of P, PI or PID controllers
– Drafting of open-loop and closed-loop control programs
– Process operation and monitoring
– Inspection, maintenance, and servicing

Possibility of Expansion: Simulation Box

Commission a station and test its components easily → page 111

Compressor

Oil-lubricated, very quiet (45 dB (A)) compressor with pressure reducer and water separator.

230 V	91030
100 V – 120 V	565440

Recommended Learning Material

Workbook

→ page 155

Campus license:

de	8131019
en	8131020

Courses on Festo LX

→ Process Automation
→ Open- and Closed-Loop Control

→ Basic Principles of Closed-Loop Control Technology
→ Basics of Production Control

MPS PA Reactor Learning System

Station with optional equipment

Function
The reactor station brings liquid to the right temperature. Depending on the recipe selected, different temperature profiles with different stirring times are activated. A cooling pump cools the liquid. The tempered liquid can be pumped onwards to the next station using a separate pump.

Measurement and Control
Sensors detect the filling level of the reservoir in the reactor station. This facilitates lessons on simple control exercises for monitoring the pumps right up to complete control projects involving complex processes.

Exact adherence to the various temperature profiles when activating the recipes is achieved by means of temperature control. The temperature sensor (PT100 resistance thermometer) supplies a unit signal of 0 – 10 V via the measuring transducer. The controller with P, PI or PID control algorithm can approach the setpoint temperature values via the dynamically controlled heating unit and keep the values constant. Simple control exercises, for example control using the two-point controller, can be realized .

Heating and Stirring
Key basic operations in many process engineering systems involve heating and stirring. The reactor station permits experiments in this area.

Infinitely adjustable **heating** with control signal from 0 – 10 V. A safe experimental environment permits integrated linking of the heater with the float switch – thus ruling out the possibility of “running dry” in a practical way.

Stirrer with DC motor

Signal converters convert analog signals from the station to standard signals from 0 – 10 V. Practical for the purpose of experimentation: integrated comparators also supply purely binary signals.

The **water-air cooler** cools down the temperature.

MPS PA Reactor Learning System, 220 V	**8079865**
MPS PA Reactor Learning System, 120 V	**8079864**

The most important components at a glance:

1x Reactor station, 220 V **or**	701293
1x Reactor station, 120 V	8079871

These components apply for both stations:

1x Trolley	541139
1x EasyPort USB 19"	8021637
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x EduTrainer Universal A4 rack with SIMATIC S7-1512C-1PN	8065600
1x SIMATIC HMI MTP700 Unified Comfort	8189570
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817
1x Water-air cooler	8080632

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039

Recommended accessories:

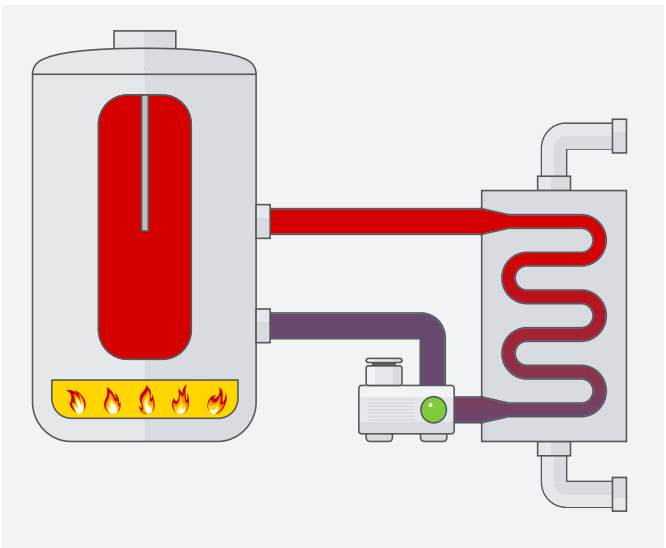
IEC power cable → festo.com/didactic

Recommended software:

FluidLab-PA Process → Page 170
FluidLab-PA Multi-Loop → Page 171

Training Aims for Project Work

- Construction, wiring, and commissioning of a system for process technology
- Selection, application, and connection of temperature sensors
- Measurement of electrical and process-related variables such as level and temperature
- Use and connection of measuring transducers
- Design and commissioning of control circuits
- Analysis of control processes and control circuits
- Parameterization and optimization of P, PI or PID controllers
- Drafting of open-loop and closed-loop control programs
- Process operation and monitoring
- Inspection, maintenance, and servicing



Possibility of Expansion: Cooling Unit with Heat Exchanger

For more options in temperature control experimentation

220 – 240 V, 50/60 Hz	8164444
120 V, 60 Hz	8162598

Recommended Learning Material

Workbook

→ page 155

Campus license:

de	8131019
en	8131020

Courses on Festo LX

→ Process Automation

→ Open- and Closed-Loop Control

→ Basic Principles of Closed-Loop Control Technology

→ Basics of Production Control

MPS PA Bottling Learning System

Station with optional equipment

Function
The bottling station fills bottles with liquid. The liquid is pumped into the dosing tank from the reservoir. These bottles are transported to the filling position via conveyors. A pneumatic separator separates the bottles. The bottles are filled with different filling quantities from the dosing tank in accordance with the recipe selected.

Measurement and Control
The filling level of the dosing tank is detected in the filling station using an analog filling level sensor. The controller regulates the filling level to the required setpoint value via the dynamically controlled pump (0 – 10 V).

The filling level in the dosing tank is kept constant during filling, which optimizes process quality of the filling process. Various control algorithms such as P, PI or PID can be applied and optimized during experiments. The characteristics of the control process can be modified using hand valves already integrated. Control technology is clearly and practically explained in this way.

Transporting, Separating, Filling
Few segments of the diversified process industry are associated with such a wide range of end products as the food industry. All foodstuffs, whether dairy products, baked goods, juice, beer or wine have their own requirements with regard to the handling and production of the corresponding end products. Transporting, separating, proportioning and filling play an important role here.

Optical sensors, adjustable using background suppression, monitor transportation on the conveyors of the bottling station.

The pneumatic separator ensures that there is never more than one bottle at the filling position.

The filling quantity can be easily adjusted by selecting different recipes.

MPS PA Bottling Learning System	**8079866**

The most important components at a glance:

Bottling station	701294
Bottle set	567202
1x Trolley	541139
1x EasyPort USB 19”	8021637
1x FluidLab-PA Closed-Loop (perpetual license, 1 user)	8208217
1x EduTrainer Universal A4 rack with SIMATIC S7-1512C-1PN	8065600
1x SIMATIC HMI MTP700 Unified Comfort	8189570
1x I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
1x Analog cable, parallel, 2 m	529141
1x Safety laboratory cable, 3 m	571817

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039

Recommended accessories:

IEC power cable → festo.com/didactic	
Compressor → see below	
IoT Kit for MPS PA	8162599

Recommended software:

FluidLab-PA Process → Page 170	

Training Aims for Project Work

– Construction, wiring, and commissioning of a system for process technology
– Selection and application of filling level sensors
– Measurement of electrical and process-related variables such as level
– Design and commissioning of control circuits
– Analysis of control processes and control circuits
– Parameterization and optimization of P, PI or PID controllers
– Drafting of open-loop and closed-loop control programs
– Process operation and monitoring
– Inspection, maintenance, and servicing

Recommended Learning Material

Workbook

→ page 155

Campus license:

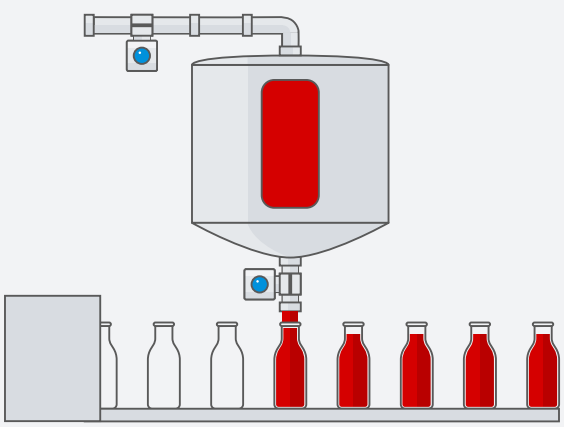
de	8131019
en	8131020

Courses on Festo LX

→ Process Automation

→ Open- and Closed-Loop Control

→ Basic Principles of Closed-Loop Control Technology
→ Basics of Production Control



Possibility of Expansion:
IoT Kit for MPS PA

Create a learning scenario to introduce learners to the Internet of Things

Order no.	8162599

Compressor

Oil-lubricated, very quiet (45 dB (A)) compressor with pressure reducer and water separator.

230 V	91030
100 V – 120 V	565440

MPS PA 204 Learning System

Four Typical Industrial Processes in One System

Function
The system consists of the Filtration, Mixing, Reactor and Bottling stations. The Filtration station filters a fluid. The filtrate is pumped out of the first tank via process valves through the filter into the second tank. The filtered fluid is added to the first tank in the Mixing station.

The Mixing station mixes different recipes from three storage tanks. The finished mixture is pumped to the Reactor station. The Reactor station regulates the temperature of the fluid. Different temperature profiles, with different mixing times, are run depending on the selected recipe. The Bottling station bottles the fluid.

The bottles are carried on conveyor belts to the bottling position. A pneumatic separator separates the bottles. The bottles are filled with different quantities from the dosing tank, depending on the selected recipe.

With a P, PI or PID control algorithm, (closed-loop) control technology is taught in a demonstrative and practical manner. The **temperature** sensor – for the Reactor station a PT100 resistance thermometer is used – delivers a uniform signal of 0 – 10 V via the measuring transducer. By way of the continuously controllable heater the controller sets the nominal temperatures and keeps them constant.

At a constant **flow rate**, the three input materials are mixed into a recipe on the Mixing station. The flow rate is recorded by an electronic flow sensor with an impeller, and is additionally displayed with a float-type flow meter. The controller sets the required flow rate by way of the analog controlled pump.

The **pressure regulation** ensures a constant high filtering quality by means of back-flushing. The pressure sensor features an LCD display, analog output and switching output, always delivering the correct value. A constant high quality is maintained by means of the proportional-pressure regulator.

In the Bottling Station the level of the dosing tank is recorded with an analog **level sensor**. By way of the continuously controllable pump the controller regulates the level to the appropriate control value. During bottling, the level in the dosing tank is kept constant, thereby optimizing the bottling quality.

MPS PA 204 Learning System, 220 – 240 V, 50/60 Hz	**8079868**
MPS PA 204 Learning System, 120 V, 60 Hz	**8079867**

The PLC control packages includes SIMATIC S7-1500
4x EduTrainer Universal with SIMATIC S7-1512C, 4x SIMATIC Touch Panel MTP700 Operator unit, 1x Ethernet switch XB005 EduTrainer Compact

The MPS PA 204 system contains everything you need for training:
- **Stations:** Filtration, mixing, reactor, bottling with trolley, mounting frame and power supply unit
- **Control technology:** 1x PLC control package, 1x EMERGENCY-STOP board, 2x EMERGENCY-STOP control panel, 4x EasyPort
- **Software:** 4x FluidLab-PA Closed-Loop (perpetual license, 1 user)

For simple commissioning, simulation and display using the simulation box:

Simulation box, digital/analog	526863
I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
Analog cable, crossover, 2 m	533039

Recommended accessories:

IEC power cable → festo.com/didactic	
Replacement filter cartridge	544303
Compressor → see below	
Cooling unit with heat exchanger → see below	
IoT Kit for MPS PA	8162599
Air Control System AirCS equipment set → Page 15	8023858

Recommended software:

FluidLab-PA Process → Page 170	
FluidLab-PA Multi-Loop → Page 171	

Included in the Scope of Delivery: Various Facilities for Measuring, Controlling and Regulating

- Simplifies commissioning, simulation and display using the simulation box
- Multimedia measuring, controlling, regulating, operating, monitoring and commissioning using EasyPort and FluidLab-PA Closed-Loop.
- Start processes in the PLC or operate and monitor them with the touch panel
- The control task is handled by the PLC. The controller parameters are set on the touch panel. All process variables are displayed in a user-friendly way – including trend graphs on the touch panel.

The MPS PA complete system provides everything needed for an efficient start in measurement and control technology.

Successful Project Work Based on Modular Construction

Learning by doing – the MPS PA system offers accessible, hands-on process technology. Project ideas can be implemented in a flash, and risk-free.

Special Training Aims

- Set-up, wiring, and commissioning of a system for process technology
- Measurement of electrical and process engineering variables such as level, flow rate, pressure, and temperature
- Set-up and commissioning of control circuits
- Assessment of control response
- Networking of process engineering systems
- Process operation and monitoring, system management
- Selection, deployment, and control of process fittings
- Analysis of controlled systems and control circuits
- Parameter setting and optimization of P, PI, or PID controllers
- Writing open-loop and closed-loop control programs
- Process operation and monitoring
- Inspection, maintenance, and servicing

Possibility of Expansion: Cooling Unit with Heat Exchanger

For more options in temperature control experimentation

220 – 240 V, 50/60 Hz	8164444
120 V, 60 Hz	8162598

Compressor

Oil-lubricated, very quiet (45 dB (A)) compressor with pressure reducer and water separator.

230 V	91030
100 V – 120 V	565440

Recommended Learning Material

Workbook
→ page 155

Campus license:

de	8131019
en	8131020

Courses on Festo LX
→ Process Automation

→ Open- and Closed-Loop Control
→ Basic Principles of Closed-Loop Control Technology

→ Basics of Production Control

Process Control Learning Systems

All the Fundamentals in a Flexible Workstation

Highlights
- Cost-effective, compact industrial system with turnkey courses
- Many equipment options
- Stainless-steel drip tray
- Bench offers lockable storage
- Fault switches to develop troubleshooting skills
- HART communication protocol (optional)
- Environmentally-friendly temperature training system (no cooling water required)
- Data acquisition interface compatible with LVProSim, MATLAB, NI LabVIEW, and Linux

Easy Assembly
Mounting and removing components is especially easy using quick-lock fixations and knobs that enable components to be locked in the perforations of the work surface. This enables learners to create circuits that mimic industry-specific applications.

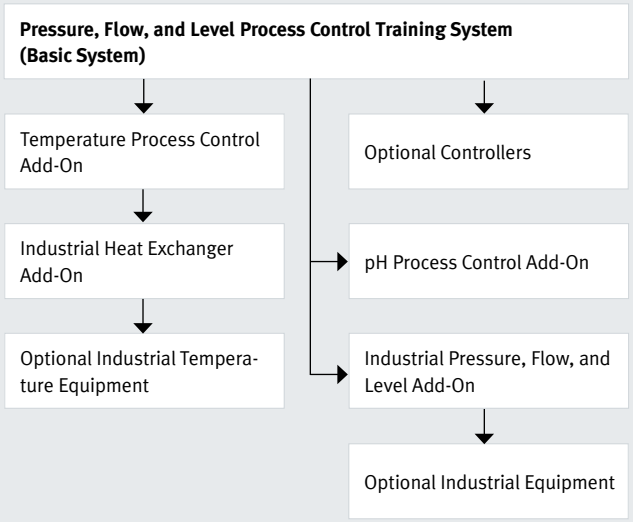
The components can be interconnected by means of flexible hoses equipped with garden-type fittings that permit easy and fast component connections without the use of tools. The hose fittings contain check valves to prevent water from running out of the hoses when they are disconnected.

Flexible Workstation
Although the equipment is designed to operate atop a regular work table, an optional bench is available to provide mobility and storage space for components. Optional dressing panels and lockable doors are also available to fully enclose and lock the bench.

The work surface consisting of a solid perforated plate hinged to a drip tray provides a large area on which components can be mounted. Additional work area can be added.

Industrial Realism
Several equipment packages allow teachers to recreate current industrial practices. The workstation can be configured to accommodate a wide variety of space and teaching needs with different benches, work surfaces, and optional equipment.

System Structure



A Cost-Efficient Solution

Teach the fundamentals of PID (proportional, integral, derivative) control of flow, pressure, and level processes to vocational school or college students at a lower cost than systems using industrial-grade components.

This learning solution demonstrates the control of pressure, flow, level, temperature, and pH processes.

It can also demonstrate advanced process control techniques, such as feed-forward control, second-order control, and cascade control when used with a controller featuring these functions.

Turnkey courses, available as digital courses or PDF workbooks, guide students through study and experimentation.

Topic Coverage Overview
- Pressure, flow and level processes
- PID controller and process control
- Temperature processes and measurement
- pH control and measurement
- Process dynamics
- Proportional plus integral/ derivative control mode
- Cascade control mode
- Second-order process control
- Industrial centrifugal pumps

Computer Data Acquisition
The learning solution includes the I/O interface, a module used for computer data acquisition and PID control of a real process.

The I/O interface provides interconnection between the process devices and the computer. It performs analog signal and digital signal conversions and sends the information to software program LVProSim. The I/O interface is also compatible with MATLAB, NI LabVIEW, and Linux.

Process Control Training Systems

Basic system with a bench and panels illustrated

Also required, please order:

1x Rust inhibitor solution	777198
1x Antibacterial solution	8060736

Optional workstation for the basic system without a bench:

Bench (unassembled, without dressing panels and doors)	587933
Dressing panels (with lockable front door)	587927
Bench (assembled, without dressing panels and front doors)	587928
Bench (assembled, with dressing panels and lockable front door)	587929
Bench (with dressing panels and lockable doors, unassembled)	587931

Optional equipment:

Signal tower	582351
Indicator-light/push-button station	587871
Emergency switch station	582352

Optional measurement equipment:

Pressure gauge (digital, high range)	582375
Digital pressure gauge (analog output)	588234
Pressure gauge (analog, medium range)	588235
Pressure gauge (digital, medium range)	588236
Pressure switch (with analog output)	588328
Calibration kit	588416
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419

Process, Flow, and Level Process Control Learning System
LV Series 6090-1 and 6090-B, Basic system.
The corresponding workbook is entitled “Pressure, Flow, and Level Processes”, sold separately ➔ page 158

Basic system without a bench	en	fr	es
120 V, 60 Hz	**588661**	**588662**	**588663**
220 – 240 V, 50/60 Hz	**588664**		**588665**

Note: These systems cannot be sold or delivered in countries that require CE compliance.

Basic system with a bench and panels	en	fr	es
120 V, 60 Hz	**588655**	**588656**	**588657**
220 – 240 V, 50/60 Hz	**588658**	**589866**	**588659**

Note: These systems and their components cannot be sold or delivered in countries that require CE compliance.

Main components at a glance:
- 1x Work surface (stainless steel)
- 1x Expanding work Surface (large)
- 1x DC power supply
- 1x Multimeter
- 1x Pumping unit
- 1x Column
- 2x Hand-operated two-way valve
- 1x Solenoid-operated two-way valve
- 1x Pressure transmitter
- 1x Paddle wheel flow transmitter
- 1x Rotameter
- 1x Venturi tube
- 1x Orifice plate
- 2x Pressure gauge (analog, low range)
- 1x Float switch
- 1x Hose set and accessory kit
- 1x I/O interface with LVProSim

Only provided with the basic system with bench and panels:
- 1x Bench (unassembled, without dressing panels and doors)
- 1x Dressing panels (with lockable front door)
- 2x Storage/work surface

Shown with optional components

Process, Flow, and Level Process Control Learning System (Entry-Level) LV Series 6090-8

This entry-level solution is a variant of the Basic Process, Flow, and Level process Control Learning System that allows performance of most, but not all, experiments that can be done with the basic system. To perform all experiments, additional equipment is required. The corresponding workbook is entitled “Pressure, Flow, and Level Processes”, sold separately ➔ chapter “Learning Media” page 158.

	en	es
120 V, 60 Hz	**589633**	**589634**
220 – 240 V, 50/60 Hz	**589635**	**589636**

Note: These systems cannot be sold or delivered in countries that require CE compliance.

Main components at a glance:
- 1x Work surface (stainless steel)
- 1x Expanding work surface (large)
- 1x DC power supply
- 1x Multimeter
- 1x Pumping unit
- 1x Column
- 1x Hand-operated two-way valve
- 1x Pressure transmitter
- 1x Rotameter
- 1x Venturi tube
- 2x Pressure gauge (analog, low range)
- 1x Hose set and accessory kit
- 1x I/O interface with LVProSim

Also required, please order:

1x Rust inhibitor solution	777198
1x Antibacterial solution	8060736

Optional measurement equipment:

Pressure gauge (digital, high range)	582375
Digital pressure gauge (analog output)	588234
Pressure gauge (analog, medium range)	588235
Pressure gauge (digital, medium range)	588236
Calibration kit	588416
Calibration kit with pressure modules	588417

Shown with optional components

Process, Flow, Level and Temperature Process Control Learning System (Entry-Level) LV Series 6090-9

This entry-level solution is a variant of the Basic Process, Flow, and Level process Control Learning System that allows performance of most, but not all, experiments that can be done with the basic system equipped with the Temperature Process Control Add-on Package. To perform all experiments, additional equipment is required. The corresponding workbooks are entitled “Pressure, Flow, and Level Processes” and “Temperature Process and Heat Exchanger”, sold separately ➔ chapter “Learning Media” page 158.

	en	es
120 V, 60 Hz	**589638**	**589639**
220 – 240 V, 50/60 Hz	**589640**	**589641**

Note: These systems cannot be sold or delivered in countries that require CE compliance.

Main components at a glance:
- All components of the Process, Flow, and Level Process Control Training System (Entry-Level)
- 1x Heating unit
- 1x Radiator
- 1x Pressure transmitter
- 1x RTD temperature transmitter

Also required, please order:

1x Rust inhibitor solution	777198
1x Antibacterial solution	8060736

Optional workstation for the two Entry-Level Learning systems:

Bench (unassembled, without dressing panels and doors)	587933
Dressing Panels (with lockable front door)	587927
Bench (assembled, without dressing panels and front doors)	587928
Bench (assembled, with dressing panels and lockable front door)	587929
Bench (with dressing panels and lockable doors, unassembled)	587931

Process Control Learning Systems

Shown with optional components

Temperature Process Control Add-On
LV Series 6090-2
This package provides additional components to the Pressure, Flow, and Level Process Control Learning System in order to demonstrate PID control of temperature. The corresponding workbook is entitled “Temperature Process and Heat Exchanger”, sold separately ➔ chapter “Learning Media” page 158.

	en	es
120 V, 60 Hz	**588674**	**588675**
220 – 230 V, 50/60 Hz	**588670**	**588671**
240 V, 50 Hz	**588673**	

Note: These systems cannot be sold or delivered in countries that require CE compliance.

Main components at a glance:
– 1x Heating unit
– 1x Radiator
– 4x Thermocouple temperature transmitters
– 1x RTD temperature transmitter

Shown with optional components

Industrial Heat Exchanger Add-On
LV Series 6090-4
This package adds a heat Exchanger and an additional pump to the Pressure, Flow, and Level Process Control Learning System to study the exchange of heat between two flows of water at different temperatures. For operation, it requires the Temperature Process Control Add-On to be installed on the Pressure, Flow, and Level Process Control Training System. The corresponding workbook is entitled “Temperature Process and Heat Exchanger”, sold separately ➔ chapter “Learning Media” page 158.

	en
120 V, 60 Hz	**588678**
220 – 240 V, 50/60 Hz	**588679**

Note: These systems cannot be sold or delivered in countries that require CE compliance.

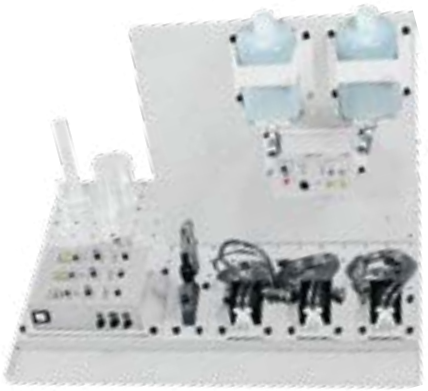
Main components at a glance:
– 1x Expanding work surface (small)
– 1x Pumping unit
– 1x Heat exchanger
– 1x Rotameter

Also required, please order:

1x Instrumentation pipe	588245

Optional equipment:

HART software configurator	588420



Shown with optional components

pH Process Control Add-On
LV Series 6090-3
This package provides additional components to the Pressure, Flow, and Level Process Control Learning System in order to demonstrate PID control of pH processes. The corresponding workbook is entitled “pH Process Control”, sold separately ➔ chapter “Learning Media” page 158.

	en	es
120 V, 60 Hz	**588674**	**588675**
220 – 230 V, 50/60 Hz	**588676**	**588677**
240 V, 50 Hz	**588673**	

Note: These systems cannot be sold or delivered in countries that require CE compliance.

Main components at a glance:
– 3x Metering pump
– 2x Chemical tank
– 1x pH transmitter
– 1x Metering pump drive
– 1x Set point device
– 1x pH process control accessories
– 1x pH process control consumables

Also required, please order:

1x pH process control consumables	588246

Optional measurement equipment:

pH transmitter (HART)	588353
Water analyzer	588424

Recommended Learning Material

Workbooks
➔ page 158

Campus license:

en	585247
es	594144

Note: The campus license includes the student and the instructor PDF versions of the following workbooks: Pressure, Flow, and Level Processes; Temperature Process and Heat Exchanger; and pH Process Control.

Courses on Festo LX
➔ Pressure, Flow, and Level Processes

➔ Industrial Safety in the Workplace

Process Control Learning Systems

Shown with optional components

Industrial Pressure, Flow, and Level Add-On (HART)
LV Series 6090-5
This package is an add-on to the Pressure, Flow, and Level Process Control Learning System. The level transmitter allows students to continuously monitor the level in the column while the pitot tube and the differential-pressure transmitter measure the flow rate with accuracy. A pneumatic control valve completes this add-on and allows students to exert control over different processes. The two transmitters use a 4 – 20 mA signal as their output. This allows the use of either a programmable logic controller or a PID controller on the training system.

This package requires a reliable source of compressed air from either a central air supply or a portable unit which can deliver air at a minimal flow rate of 28 L/min (1 SCFM) with a pressure of 207 kPa (30 PSI).

	en
120 – 240 V, 50/60 Hz	**588680**

Note: This system cannot be sold or delivered in countries that require CE compliance.

Optional equipment:

Pneumatic control valve (with digital positioner, HART) – DVC 2000	588357
Pneumatic control valve (with positioner, Fisher 3660)	588358
Electric control valve	588360
Pneumatic control valve (with digital positioner, HART) – DVC 6200	588363

Optional measurement equipment:

Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Vortex flow transmitter (HART)	588320
Coriolis flow transmitter (HART)	588323
Pressure transmitter (HART)	588333
HART software configurator	588420

Optional controller*:

ControlLogix PLC bundle – educational	588519
MicroLogix PLC bundle – educational	588521
CompactLogix PLC bundle – educational	588522
ControlLogix PLC bundle – commercial	588513
CompactLogix PLC bundle – commercial	588515
S7-1500 PLC bundle HART – educational	589669
S7-1500 PLC bundle – Educational	589670
Touch-screen computer mount	589678
Touch screen graphic terminal – 14.5 cm (5.7 in)	8165911
Touch screen graphic terminal (Allen-Bradley) – 26.4 cm (10.4 in)	8103425
Industrial PC HMI (Siemens)	589672
Touch-Screen Computer for SCADA	588440
Unmanaged switch (Allen-Bradley)	765575
Unmanaged switch (Siemens)	780054

* Optional dual-sided instrumentation workstation (order no. 589003) required. Other requirements might apply: Please check with your sales representative for details.

Note: When you order a PLC bundle, make sure you also order an appropriate HMI or touch-screen terminal.

Optional software:

FactoryTalk View ME Studio ➔ page 173	
Step 7 professional and WinCC Advanced* ➔ page 173	
RSLogix 5000* ➔ page 172	

* A single license is usually included with the PLC bundles. If you require additional licenses, order these supplementary licenses separately.

Process Control Learning Systems
Components

1 **Table**
Designed to support a workstation and its equipment, and provides enough space for additional small items such as a laptop computer.
Order no. **587645**

2 **Work Surface**
Stainless steel universal drip-tray hinged to a perforated, tiltable work surface on which components can be mounted. It can be placed on top of a regular table or on an optional bench.
Size: 80 x 900 x 700 mm
Order no. **587925**

3 **Expanding Work Surface**
Perforated plate that can be mounted on the Work Surface to increase the work area.
Large (30 x 590 x 590 mm) **763446**
Small (30 x 290 x 590 mm) **582356**

4 **Storage/Work Surface**
Perforated metal plate (30 x 590 x 590 mm) on which the equipment is placed. Two work surfaces can be joined using spacers.
Order no. **582357**

Bench
Mobile workstation on which the large or small work surfaces can be mounted. It has three pairs of side supports over which three storage/work surfaces can be slid, providing shelving for component storage.

5 **Assembled, Without Dressing Panels and Front Doors**
Order no. **587928**

6 **Assembled, With Dressing Panels and Lockable Front Doors**
Order no. **587929**

Unassembled Without Dressing Panels and Doors
Order no. **587933**

7 **Dressing Panels (with Lockable Front Door)**
Designed to fully enclose the bench. Front and side doors are lockable to secure components.
Order no. **587927**

8 **Dual-Sided Instrumentation Workstation**
Designed to house devices such as controllers, PLCs, color paperless recorders, and touch screen graphic Terminals. The workstation allows two student groups to work simultaneously. It features two mounting pipes to install instruments.
Order no. **589003**

9 **Touch-Screen Computer Mount**
Allows the installation of a touch-screen computer on the side of either the Dual-Sided Instrumentation Workstation.
Order no. **587644**

Controller Support Panel
Allows the installation of a PLC or PID controller to the side of the mobile workstation.
Order no. **687932**

10 **Storage Station**
Designed to store the accessories and the various optional models which are not required for the particular process taking place on the workstation. It includes space to store up to four flange tops, many flow meters and control valves on six galvanized struts (three on each side), a few devices on two instrumentation mounting pipes, and miscellaneous pieces of equipment in the three painted stainless-steel storage boxes at the bottom of the station.
Order no. **588301**

11 **Controller Support Panel**
Metal support plate required to install the controller on the side of a bench.
Order no. **587932**

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Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

Process Control Learning Systems
Components

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1 **Pressure Transmitter**
This transmitter has output signals of 4 – 20 mA, a zero adjustment of 90% of the calibrated span, a span adjustment of 2.5 – 103 kPa (10 – 414 in H2O), a proof pressure of 310 kPa, gauge (45 psig), an operating temperature of 5 – 70 °C (41 – 158 °F), and a compensated temperature of 0 – 50 °C (32 – 122 °F). Linearity: 1% of the full scale. Hysteresis: 0.2% of the full scale. Supply voltage: 24 V dc.

Order no. **588216**

2 **Thermocouple Temperature Transmitter**
This transmitter has four J-type thermocouple probes with cold-junction compensation and a built-in calibration source. Its outputs are controlled using 0 – 5 V dc or 4 – 20 mA signals and are calibrated at 100 mV/°C (56 mV/°F). Supply voltage: 24 V dc.

Order no. **588219**

3 **Paddle Wheel Flow Transmitter**
This transmitter with two outputs controlled using 0 – 5 V dc or 4 – 20 mA signals. The first output is a voltage output calibrated at 1 V per l/min (3.85 V per gal US/min). The second output is a frequency output calibrated at 22.1 Hz per l/min (85 Hz per gal US/min). Supply voltage: 24 V dc.

Order no. **588222**

4 **RTD Temperature Transmitter**
Transmitter with a single three-wire 100 Ω platinum probe and a built-in calibration source. Its outputs are controlled using 0 – 5 V dc or 4 – 20 mA signals and are calibrated at 100 mV/°C (56 mV/°F). Supply voltage: 24 V dc.

Order no. **588225**

5 **pH Transmitter**
Transmitter with a single pH probe and a built-in calibration source. Its outputs are controlled using 0 – 5 V dc or 4 – 20 mA signals and are calibrated at 1 V/pH unit. Supply voltage: 24 V dc.

Order no. **588228**

6 **Ultrasonic Level Transmitter**
Transmitter with output signals controlled using 4 – 20 mA inputs and two switches. Its optimum range is 64 mm – 2 m (2.5 – 80 in), its maximum range is 3 m (10 feet). It has a digital resolution of 0.086 mm (0.0034 in) and an analog resolution of 4099 steps over the 4 – 20 mA signal. It has a repeatability greater than ± 0.76 mm (0.03 in) or 0.1% of the target distance. Its operating temperature is -40 to 70 °C (-40 to 158 °F) and it is temperature compensated. Update rate: 50 ms.

Order no. **588231**

7 **Paddle Wheel Flow Transmitter**
Device that provides a accurate measurement of the flow rate by inserting a paddle wheel into the flow stream. A sensor measures the velocity of the paddle wheel which is converted into a direct reading of the flow rate displayed on a remote digital display. It features a 4 – 20 mA output signal.

Order no. **588326**

8 **Pressure Switch (with Analog Output)**
Digital pressure gauge ranging from 0 kPa (0 psi) to 1000 kPa (145 psi). It features a 4 – 20 mA output signal proportional to a user-defined upper value. A relay can be configured so as to become activated when the measured pressure rises above a threshold value. IO-Link supported.

Order no. **611537**

Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

1 **Pressure Gauge**
Provides a direct reading of the pressure in one of many convenient measurement units. It features two interconnected pressure ports, and is equipped with a mounting bracket for simple installation on the workstation. The pressure gauge is available in four versions with different operating ranges:

Analog, Low Range, 0 – 100 kPa (0 – 15 psig)

Order no.	**582374**

Digital, High Range, 0 – 690 kPa (0 – 100 psig)

Order no.	**588234**

Analog, Medium Range, 0 – 200 kPa (0 – 30 psig)

Order no.	**588235**

Digital, Medium Range, 0 – 200 kPa (0 – 30 psig)

Order no.	**588236**

2 **Float Switch**
Reed-relay float switch with magnet-equipped float. Its mounting is vertical and inside the level column. The reed contact is hermetically sealed and normally closed, with a positioning range of 25 cm (10 in). It operates at atmospheric pressure.

Order no.	**588242**

3 **Conditioning Unit (Single Port)**
Conditions and regulates the pressure of the air supplied to the pneumatic circuits. It consists of a main shutoff valve, filter, a pressure regulator, pressure gauge, sleeve valve, and a muffler. It requires compressed air from a central air supply or a portable unit.

Order no.	**588111**

4 **Pumping Unit**
Consists of a centrifugal variable-speed pump having a flow of 0 – 12 l/min (0 – 3.2 gal US/min) and a maximum pressure of 100 kPa, gauge (14.5 psig). The pump motor has a rated speed of 3600 rpm at 60 Hz and 3000 rpm at 50 Hz, with a power of 0.37 kW (0.5 hp) at 60 Hz and 0.25 kW (0.33 hp) at 50 Hz. The Pumping Unit includes a built-in Powerflex 525 ac drive from Allen-Bradley. This ac motor drive has an output voltage of 0 – 230 V ac, an output frequency of 0 – 240 Hz, and is controlled using either 4 – 20 mA signals or an Ethernet/IP digital communication with Allen-Bradley PLC's. The Pumping Unit also features a convenient communication interface to configure and monitor all the drive's parameters. The nominal current of the Pumping Unit is 3 A at 120 V 60 Hz and 1.5 A at 220 – 240 V 50 Hz.

120 V, 60 Hz	**595991**
220 – 240 V, 50/60 Hz	**595992**

5 **Metering Pump**
Device whose pump motor has an excitation voltage of 0 – 12 V dc and a nominal current of 2 A. The pump has a flow of 0 – 2.52 L/min (0 – 0.67 gal US/min), a maximum pressure of 145 kPa (21 psi), and a maximum temperature of 93 °C (200 °F).

Order no.	**588212**

6 **Metering Pump Drive**
Device with three 0 – 5 V dc or 4 – 20 mA inputs and an output voltage of 0 – 10 V dc. It is controlled using three 0 – 5 V dc or 4 – 20 mA control inputs. It can operate in either continuous mode or pulsed mode.

Order no.	**588238**

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Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

Process Control Learning Systems
Components

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1 **Hand-Operated Two-Way Valve**
Device that controls fluid flow in an on or off fashion and also helps when necessary to ensure that a system component is safely isolated from other parts of the system.
Order no. **582368**

2 **Solenoid-Operated Two-Way Valve**
Device that controls fluid flow in an ON or OFF fashion and also helps to ensure that a system component is safely isolated from other parts of the system, when necessary.
Order no. **588214**

3 **Rotameter**
Analog device that measures the flow rate of a fluid as the material pushes on a floating indicator. It is calibrated in both liters per minute (L/min) and gallons per minute (gal/min), and the clear-tapered tube permits visual inspection of the internal fluid and observation of trapped air bubbles, dirt, and debris within a system loop.
Order no. **582373**

4 **Heat Exchanger**
Device consisting of a brazed plate heat exchanger, with a nominal surface of 0.21 m^2 (2.3 ft^2) and 4 channels for side A and 3 for side B, for a total of 8 plates.
Order no. **588215**

5 **Venturi Tube**
Device with an inlet and outlet diameter of 1.3 cm (0.5 in), a β ratio of 0.37, a flow range of 1.9 – 18.9 l/min (0.5 – 5.0 gal US/min), and a pressure drop of 0.25 – 65 kPa (1 – 260 in H2O). It has two pressure taps, one at the inlet and one at the outlet, with quick-connect ball check sockets.
Order no. **588232**

6 **Orifice Plate**
Device with an inlet and outlet diameter of 1.3 cm (0.5 in), a β ratio of 0.43, an orifice diameter of 6.53 mm (0.257 in), a flow range of 1.9 – 18.9 l/min (0.5 – 5.0 gal US/min), and a pressure drop of 0.25 – 65 kPa (1 – 260 in H2O). The Orifice Plate has two pressure taps, one at the inlet and one at the outlet, with quick-connect ball check sockets.
Order no. **588233**

7 **Pitot Tube**
Device with a nominal pipe size of 1.27 cm (0.5 in), schedule 40. Its instrument connection size is 0.635 cm (0.25 in) FNPT, and its maximal pressure differential is 400 in H2O (99.6 kPa, 14.45 psi).
Order no. **588237**

Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

1 **Column**
Column with a height of 68 cm (26.8 in), a diameter of 11.5 cm (4.5 in), and a capacity of 3.8 l (1 gal US). It has two pressure taps: one at the bottom and one at the top of the column, with quick-connect ball check sockets. It is fitted with an integrated bubbler tube, a level measurement ruler graduated in both centimeters and inches, and a removable cap allowing the insertion of level measuring instruments into the column.

Order no.	**588211**

2 **Chemical Tank**
Tank with a capacity of 2 L (0.53 gal). The cap check-valve of the tank has a closing pressure of 97 Pa (0.014 psi). The tank has a quick-connect coupling.

Order no.	**588213**

3 **Set Point Device**
Device with a supply voltage of 24 V dc and three 0 – 5 V dc outputs. It is controlled using two built-in adjustment knobs and one toggle switch.

Order no.	**588241**

4 **DC Power Supply**
Converts the ac line voltage into a 24 V dc voltage. The power supply is protected against short circuits by an automatic current/limit circuit.

120 V, 60 Hz	**587962**
220 – 240 V, 50/60 Hz	**587962**

5 **Multimeter**
Used for ac/dc voltage, dc current, and resistance measurements.

Order no.	**582365**

6 **Radiator**
Device containing a 1.06 m² (11.41 ft²) radiator element that acts as a heat exchanger to transfer thermal energy from water to air. The unit allows manual blower-speed control using either a built-in adjustment knob or external signals (0 – 5 V or 4 – 20 mA). The maximum air flow rate is 3060 L/min (106 ft³/min). The dual blower consists of two electric motors with fan blades that are powered by a 24 V dc, 2.4 A power supply output.

Order no.	**582372**

7 **Heating Unit**
Heating unit with a maximum power of 1.2 kW (1.14 Btu/s) that is controlled manually using a built-in adjustment knob or externally using 0 – 5 V or 4 – 20 mA signals. It has two temperature measurement ports (inlet/outlet). It is protected using two high-temperature cutout switches: one with an automatic reset and one with a manual reset. Also protected using a current breaker.

120 V, 60 Hz	**582369**
230 V, 50/60 Hz	**582370**
240 V, 50 Hz	**582371**

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Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

Process Control Learning Systems
Components

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1 **Air Compressor**
Quiet device well suited for classroom and school laboratories. It is provided with a tank, pressure regulator, pressure gauge, and a hose.

120 V, 60 Hz	**588105**
220 – 240 V, 50/60 Hz	**588104**

2 **Emergency Switch**
Mushroom-type push-button that opens its circuit when the button is pressed in order to cut the power to some of the 24 V dc outputs of the electrical unit, the pneumatic unit, and the pump drive.

Order no.	**582352**

3 **Signal Tower**
Three lights providing visual signals of the equipment states. Lights are stacked one upon another. Each module is easily programmable without any special wiring or tools. An acoustic alarm is available as an option.

Order no.	**582351**

Indicator-Light/Push-Button Station
Three industrial push-buttons, one normally closed and two normally open, used to operate the Pressure, Flow, Level, and Temperature Process Learning systems. It also features three indicator lights. Both the push-buttons and the indicator lights operate at a voltage of 24 V dc. Four switches allow the instructor to insert faults. A Rail Workstation (order no. 581242) is required to install this device on the system.

Order no.	**587871**

4 **Compressor**
Quiet device well suited for classroom and school laboratories that provides compressed air to different components. A conditioning unit (order no. 588111) must be connected to the compressor for certain applications.

120 V, 60 Hz	**588108**
220 – 240 V, 50/60 Hz	**588107**

5 Instrumentation Pipe
Vertical pipe used to install instruments at the appropriate height and close to the point of measurement. It replicates the common industrial practice of installing a measuring instrument directly on the process pipe or on an adjacent one. It must be installed on a perforated work surface.

Order no.	**588245**

Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

1 **Unmanaged Switch (Allen-Bradley)**
Allen-Bradley STRATIX 2000 that permits to connect devices using Industrial Ethernet communication protocol. It features 10/100MBIT/S speeds with 5 ports X 10/100MBIT/S twisted-pair ports with RJ45-sockets. It permits configuring small Star and Line Topographies and offer led-diagnosis for fast network troubleshooting.
Order no. **765575**

Unmanaged Switch (Siemens)
Siemens SCALANCE XB008 that permits to connect devices using Industrial Ethernet communication protocol. It features 10/100MBIT/S speeds with 8 ports X 10/100MBIT/S twisted-pair ports with RJ45-sockets. It permits configuring small Star and Line Topographies and offer led-diagnosis for fast network troubleshooting.
Order no. **780054**

Personal Computer
Desktop computer running under Windows 10. A monitor, keyboard, and mouse are included.
Order no. **579785**

2 **Touch-Screen Computer**
Features a large 23-inch touchscreen and a high-speed processor. It can be installed on a full-motion mount (order no. 587644) on the Instrumentation Workstation to maximize desk space.
Order no. **589677**

Rust Inhibitor
Industrial-grade solution used to prevent the formation of rust.
Order no. **777198**

Antibacterial Solution
Solution specially designed for time-released protection of the water.
Order no. **8060736**

3 **Hose Set and Accessory Kit**
– Six PVC hoses, 1.3 cm (0.5 in) inside diameter, garden-type, quick-connect fittings, 303 kPa, gauge (44 psig) maximum pressure
– 6 mm (0.25 in) tubing
– Tube cutter
– Electrical leads
– Quick-connect fittings
Order no. **588243**

4 **Hose Set and Accessory Kit**
– Laboratory glassware
– Two beakers, one with 100 ml (3.4-oz) capacity and one with 600 ml (20.3-oz) capacity
– Two graduated cylinders, one with 100 ml (3.4-oz) capacity and one with 10 ml (0.3oz) capacity
– Volumetric flask with a 2000 ml (67.63-oz) capacity
– Two chemical splash goggles
– Tubing and hoses connectors
– Spatula
– Column cap
Order no. **588244**

5 **pH Process Control Consumables**
– 1 L (33.8 oz) of: sodium hydroxide standard solution 1.0 N (x 2), hydrochloric acid solution 1.0 N, phenol red aqueous solution 0.05%, phosphoric acid 1.0 N solution
– 500 ml (16.9 oz) of: potassium chloride solution, buffer solutions (pH 4.0, pH 7.0, pH 10.0), acetic acid 5% (vinegar)
– 500 g (1.1 lb) of sodium bicarbonate (baking soda)
Order no. **588246**

1

2

3

4

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Note: Some of these components may not be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

Water Technology

Picture: Courtesy of WorldSkills International

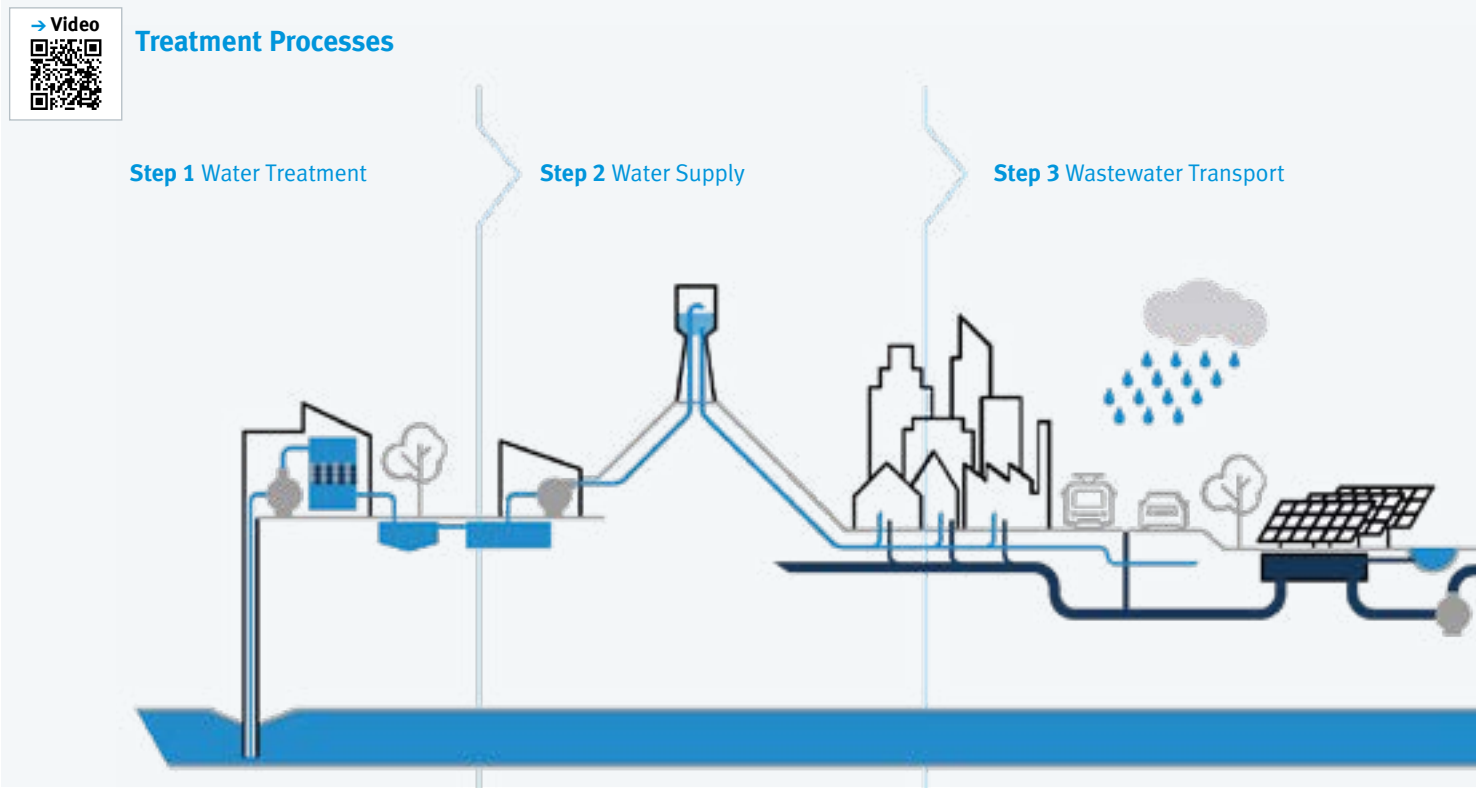
EDS Water Management

EDS Water Management

Discovering the Water Circuit

→ Video

Treatment Processes



Clean Water for Everyone with Modern Technology
Complex systems require responsible operation, as the applications have far-reaching effects on humans, the plant and the environment.

The EDS Water Management stations prepare users optimally for these varied tasks and systems with state-of-the-art technology.

Teaching the Water Circuit in a Small Space
Experience the complexity of corporate working processes from administration, technology and science with mobile and compact tabletop stations.

Experience Process Control Engineering
One click in the control room needs to be thought through, as a switching signal changes the system functions invisibly to the operator. The effects often appear hours later. In the worst case, they can result in water pollution or wasted energy and resources.

The EDS Water Management allows you to experience the effects directly and rapidly.

Setup Times and Operating Costs – Less is More
Add water, start PCs and software – and you're ready to start water circuit training.

Plastic granules are used as the soiled load and can be air-dried and re-used after utilization – reducing the operating costs of the training system to water and electricity.

Basic Water Circuit System
With the four main stations of the basic system, you are ideally equipped to get to know the world of process command, measurement and control technology.

If you operate the stations individually, up to three learners can work on the following learning areas:
– Plant engineering, process and laboratory technology
– Electrical engineering
– Automation/process control engineering and administration

Control Test in the Laboratory
Laboratory control tests are required to verify the in-line measurement technology of process engineering systems.

The EDS Water Management is the ideal addition for combining your new knowledge directly with your laboratory, applying scientific skills.

General Training Content
– Controlling, regulating and monitoring physical variables such as levels, flows and pressure
– Technical/physical functions of sensors and actuators as well as wiring, adjustment and parameterization
– Analyzing controlled systems, parameterizing and optimizing regulators
– System operation, maintenance, troubleshooting and repair
– Plant engineering
– Optimization and energy monitoring
– Electronic data processing
– Reading and interpreting process flowcharts, electrical and pneumatic circuit diagrams

Hardware, Software, Courseware
For ideal training – the workbooks with theory sections and exercise scenarios are perfectly customized for the stations. There are digital training programs on many topics for presentation or self-learning phases. A wide range of training courses is available for training staff.

The EDS Water Management offers the required planning documents, e.g. electric and pneumatic circuit diagrams, process flowcharts, data sheets and operating instructions. All documents comply with European standards.

The EDS Water Management equipment is used in WorldSkills competitions for Skill 55 Water Technology.

worldskills

DWA Mitglied

Member of German Water Partnership

Water Purification Station

Function
The water purification station represents a basic logic function of water treatment in the form of a water storage system with an overflow rim. A groundwater tank with a submersible pump is required for operation.

Focal points include:
– Setting flow rate values for volume control
– Level measurement via analog pressure measurement
– Level sensing via capacitive proximity sensors

The training documents reveal how a flocculation reaction is implemented by adding a flocculant, and how sedimentation can occur in spite of the flow.

Drinking Water and Chlorine
Chlorine is used worldwide to preserve drinking water. Overmetering not only increases the plant operator's costs unnecessarily, it also pollutes the environment and endangers the consumers. The additional chlorine measurement package with manual metering technology is a 1:1 training scenario for online chlorine measurement. This allows you to learn how to operate a chlorine metering system, and react to malfunctions and optimize the system.

worldskills

Official Competition Equipment for Skill #55 Water Technology

Water Purification Station	**8024504**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, including an overflow rim, capacitive proximity sensor, float switch, impeller flow sensor, pressure sensor, 2/2-way solenoid valve, non-return valve, electric connection board, aluminum profile plate.

For single operation, a water supply tank/ground water is required.

Required accessories, also order:

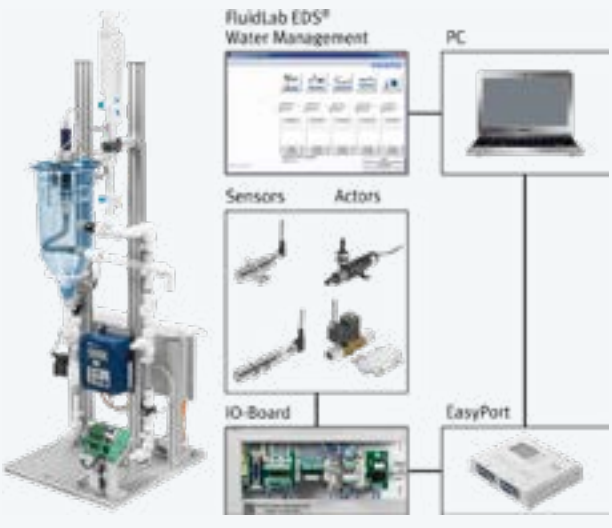
1x Water supply tank/ground water	8024503
1x Tabletop power supply unit ➔ page 64	

Recommended accessories ➔ page 64

1x Additional chlorine measurement package	8025419
1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Water supply technology training set	8038315

Recommended software:

FluidLab-PA Closed-Loop ➔ page 171



General Training Content

See the workbook “Water Purification” ➔ page 156

Learning Content for Project Work

– Function of an overflow rim
– Analog level measurement via a pressure sensor
– Capacitive proximity sensor for level querying
– Basic processes of precipitation, flocculation and sedimentation

Training Content with Water Supply Tank

– Activation of a pump for flow control
– Regulation variants with capacitive sensors for level control

Training Content with Additional Chlorine Measurement Package

– Measuring chlorine content
– Effects of excessive or insufficient chlorine metering

Technical Data

– Water (10 – 15 l)
– Power supply: 24 V DC
– 3 digital inputs
– 3 digital outputs
– 4 analog inputs
– 1 analog output
– Dimensions (H x W x D): 1100 x 355 x 400 mm

Recommended Learning Material

Workbooks

➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

➔ Water Purification

➔ Introduction to Water Cycle and Water Management
➔ Water Supply
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Sand filtration for Water Purification
➔ Membrane Filter Process in Water Management
➔ Mechanical Pre-Treatment for Wastewater
➔ Adsorption in Water Management

Water Supply Station

Function
The water supply station deals with water storage and distribution via an elevated container, e.g. a water tower. The elevated container is filled via a pump, which can be operated in open- or closed-loop control mode. Water is withdrawn via valves. The process command software configures its switching characteristics. Depending on the withdrawal characteristics, feedback to the pump controller and shock loads for wastewater transport can result.

Balancing the water quantity provided with the water quantity delivered is another focus. In many water supply systems, leakages are a significant waste, and elimination by trained personnel is highly important.

Training by simulating a leakage using a valve, and subsequent location of the leakage are useful exercises.

 For tailored advice and product selection/configuration assistance, please contact a sales representative.

Water Supply Station	**8024505**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, capacitive proximity sensor, float switch, impeller flow sensor, ultrasound sensor, centrifugal pump, 2/2-way solenoid valve, 2-way ball valve with pneumatic semi-rotary drive, electric connection board, aluminum profile plate.

Note

For single operation, a water supply tank/ground water (order no. 8024503) is required.

Required accessories, also order:

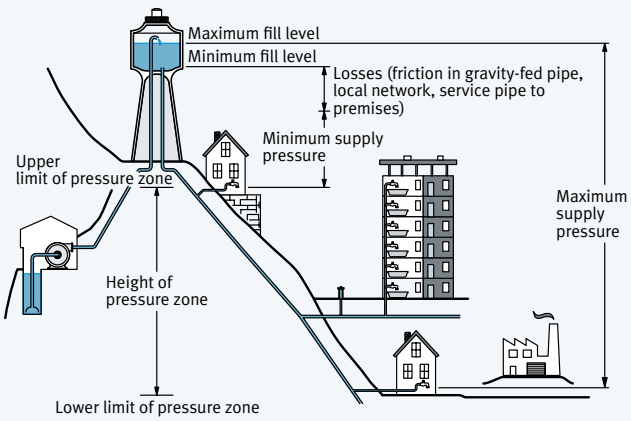
1x Tabletop power supply unit → page 64	
1x Compressor → page 67	
1x Compressor accessories	102725

Recommended accessories → page 64

1x Water supply tank/ground water	8024503
1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Water supply technology training set	8038315

Recommended software:

FluidLab-PA Process → page 170
FluidLab-PA Closed-Loop → page 171



General Training Content

See the workbook “Water Supply” → page 156

Learning Content for Project Work

– Setting the pump to open- and closed-loop control mode and determining the effect on the delivery rate
– Determining the interaction between pressure and flow rate in a piping system
– Controlling the water supply via various valve types and showing the effects of shock loads
– Finding water losses in distribution networks and showing problems in leakage detection
– Measuring/controlling levels with ultrasound sensors
– Understanding and applying the function of pneumatically driven valves and fittings

Technical Data

– Operating pressure: 4 – 6 bar (50 l/min)
– Water (10 – 15 l)
– Power supply: 24 V DC
– 5 digital inputs
– 7 digital outputs
– 4 analog inputs
– 1 analog output
– Dimensions (H x W x D): 1200 x 355 x 400 mm

Recommended Learning Material

Workbooks

→ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

→ Water Supply

→ Introduction to Water Cycle and Water Management
→ Water Purification
→ Wastewater Transport
→ Wastewater Treatment
→ Sand filtration for Water Purification
→ Membrane Filter Process in Water Management
→ Mechanical Pre-Treatment for Wastewater
→ Adsorption in Water Management

Wastewater Transport Station

Function
The wastewater transport station teaches control technology for wastewater disposal and the associated processes. It comprises four sub-areas:
– Feeding device for supplying a soiled load
– Sewage pipe section with branch
– Tank with overflow rim as a rain retention and sedimentation basin
– Tank as a primary settlement tank for the biological stage and the option of starting sludge removal via a pneumatically automated fitting.

Plastic granules are used as the soiled load and can be air-dried and re-used after utilization. Flooding due to rainfall or problems transporting solids can be simulated realistically.

The fluids are supplied to the primary settlement tank via a pump. A flow meter records the flow rate, which is configured via a motor control system of the pump or a proportional media valve.

The media valve functions based on the principle of a pneumatically activated constriction-hose valve. The throttle opening can be configured via air pressure with a proportional pressure regulator valve. That allows the effects on energy efficiency and the flow control quality to be shown clearly.

Wastewater Transport Station	**8024506**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, including overflow rim, 1 l tank, gravity duct, capacitive proximity sensor, float switch, magnetic-inductive flow sensor, ultrasound sensor, centrifugal pump, proportional media valve, proportional pressure regulator valve, pneumatic slide, metering screw for metering solids, electric connection board, aluminum profile plate.

Note

For single operation, a water supply tank/ground water (order no. 8024503) is required.

Required accessories, also order:

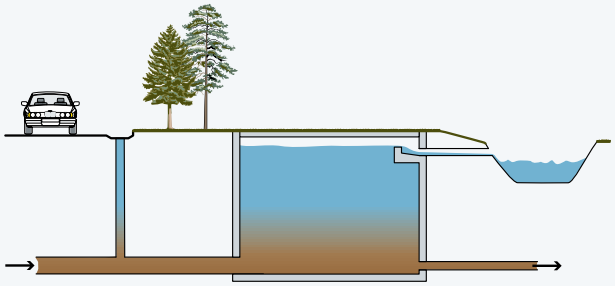
1x Tabletop power supply unit → page 64	
1x Compressor → page 67	
1x Compressor accessories	102725

Recommended accessories → page 64

1x Water supply tank/ground water	8024503
1x Sedimentation granules	8037688
1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Sewage technology training set	8174093

Recommended software:

FluidLab-PA Closed-Loop → page 171



General Training Content

See the workbook “Wastewater Transport” → page 156

Learning Content for Project Work

– Transporting solid matter in a sewer system using different flow velocities
– Effects of exceeding the hydraulic capacity
– Naming the basic mechanisms that make flushing necessary
– Functions of a rain overflow basin
– Basic functions of sedimentation in a flow basin
– Level measurement with an “ultrasound sensor
– Functions of pneumatically driven valves and fittings

Technical Data

– Operating pressure: 4 – 6 bar (50 l/min)
– Water (10 – 15 l)
– Power supply: 24 V DC
– 5 digital inputs
– 5 digital outputs
– 4 analog inputs
– 2 analog outputs
– Dimensions (H x W x D): 1200 x 1200 x 400 mm

Recommended Learning Material

Workbooks

→ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

→ Wastewater Transport

→ Introduction to Water Cycle and Water Management
→ Water Supply
→ Water Purification
→ Wastewater Transport
→ Sand filtration for Water Purification
→ Membrane Filter Process in Water Management
→ Mechanical Pre-Treatment for Wastewater
→ Adsorption in Water Management

Wastewater Treatment Station

Function
The wastewater treatment station maps the physical functions of wastewater treatment after the sludge treatment and contains an aeration tank and a secondary settlement tank. Plastic granules are used as the soiled load and can be air-dried and re-used after utilization. The sludge return has a flow measurement system with an adjustable pump for setting and monitoring the sludge return ratio.

The oxygen feeding on the station functions using an electrically adjustable compressed air diaphragm pump. Combined with the available oxygen sensor, there is also an option of extending the oxygen feeding system to a control circuit.

Economical Oxygen Regulation
Adding oxygen to water is not only relevant in the wastewater sector, but also in fish breeding or bioreactors.

In order to guarantee energy-optimized oxygen feeding, in-line oxygen measurement is required and must be combined with the oxygen feeding actuator in a control circuit. That avoids unnecessary energy use and possible biochemical malfunction.

The EDS Water Management forms a neutral learning environment on the subject of oxygen feeding regulation. Periodic addition of sodium sulphite (Na_2SO_3) to the upstream supply water causes a continuous oxygen consumption, thus simulating the oxygen demand of bacteria eating up organic substances in a real biological treatment of wastewater.

Handling with real wastewater is too complex and therefore not planned.

Wastewater Treatment Station	**8024507**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, including an overflow rim, 10 l tank, ventilation system, capacitive proximity sensor, float switch, magnetic-inductive flow sensor, centrifugal pump, 2/2-way solenoid valve, electric connection board, aluminum profile plate.

Note

For single operation, a water supply tank/ground water (order no. 8024503) is required.

Required accessories, also order:

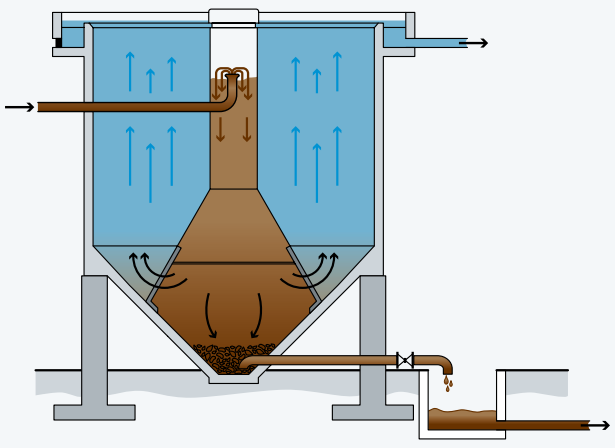
1x Tabletop power supply unit → page 64	

Recommended accessories → page 64

1x Additional oxygen measurement package	8025418
1x Water supply tank/ground water	8024503
1x Sedimentation granules	8037688
1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Sewage technology training set	8174093

Recommended software:

FluidLab-PA Closed-Loop → page 171	



General Training Content

See the workbook “Wastewater Treatment” → page 156

Learning Content for Project Work

– Behavior of flakes at different flow velocities and different solid loads
– Hydraulic overloading of a wastewater treatment plant and the consequences
– Basic function of aerobic water treatment
– Function of sludge return
– Analog level measurement via a pressure sensor

Training Content with Additional Oxygen Measurement Package

– Measuring the quantity of dissolved oxygen
– Showing the advantages of continuous measurement/ control of the oxygen content

Technical Data

– Water (10 – 15 l)
– Power supply: 24 V DC
– 5 digital inputs
– 5 digital outputs
– 4 analog inputs
– 2 analog outputs
– Dimensions (H x W x D): 900 x 710 x 400 mm

Recommended Learning Material

Workbooks

→ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

→ Wastewater Treatment

→ Introduction to Water Cycle and Water Management
→ Water Supply
→ Water Purification
→ Wastewater Transport
→ Sand filtration for Water Purification
→ Membrane Filter Process in Water Management
→ Mechanical Pre-Treatment for Wastewater
→ Adsorption in Water Management

Sand Filtration Station

Function
This sand filtration station focuses on the filtration processes for separating solids frequently used in drinking and sewage technology. As in nature, the sand layers are used to retain the undissolved and suspended pollutants via deep-bed filtration as it trickles through. The pollutants are trapped in the sand layer and are deposited as filter cake. With time, the permeability decreases, the water level above the sand layer rises and is recorded via sensing. The sensor signal shuts off the inlet and starts the backwash process.

Parametrization of the filtration process is configured on the PC via the enclosed software, such as the change of the backwash time or the pressure adjustment of the purge air to break up the filter cake.

The structure of the different filter layers with quartz sand and quartz gravel in different grain sizes and corresponding monitoring of the cleaning performance through the transparent filter housing is a special aspect.

Sand Filtration Station	**8024508**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, including overflow rim, capacitive proximity sensor, float switch, magnetic-inductive flow sensor, centrifugal pump, 4.75 l sand filter unit, proportional media valve, proportional pressure regulator valve, pneumatic valve terminal with 5/2-way solenoid valves, non-return valve, pressure sensor, electric connection board, aluminum profile plate, 1x quartz sand and quartz gravel.

Required accessories, also order:

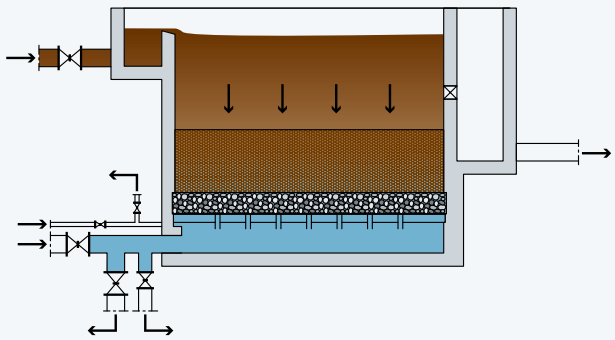
1x Tabletop power supply unit ➔ page 64	
1x Compressor ➔ page 67	
1x Compressor accessories	102725

Recommended accessories ➔ page 64

1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Quartz and quartz gravel	8039989
1x Sewage technology training set	8174093
1x Water supply technology training set	8038315

Recommended software:

FluidLab-PA Process ➔ page 170
FluidLab-PA Closed-Loop ➔ page 171



General Training Content

See the workbook “Sand Filtration”
➔ page 157

Learning Content for Project Work

– Separation of pollutants via a quartz sand and quartz gravel layer
– Deep-bed filtration and structure of a filter cake
– Measurement of pressure loss via the sand filter
– Automated filter process and sand filter backwashing
– Parameterizing the process steps
– Functions of pneumatically driven valves and fittings
– Creating a Micheau diagram

Technical Data

– Operating pressure: 4 – 6 bar (50 l/min)
– Water (10 – 15 l)
– Power supply: 24 V DC
– 6 digital inputs
– 8 digital outputs
– 4 analog inputs
– Dimensions (H x W x D): 1350 x 355 x 400 mm

Recommended Learning Material

Workbooks

➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

➔ Sand filtration for Water Purification

➔ Introduction to Water Cycle and Water Management
➔ Water Supply
➔ Water Purification
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Membrane Filter Process in Water Management
➔ Mechanical Pre-Treatment for Wastewater
➔ Adsorption in Water Management

Membrane Filtration Station

Function
Membrane filtration is highly topical in modern water treatment. Depending on the pore size, the principle is used in water treatment.

Drinking water and wastewater treatment in the form of microfiltration and ultrafiltration is another area of application. The objective of both methods is retaining pathogenic germs, for example. The differences between the cross-flow and dead-end filtration operating modes are covered.

The membrane filtration station maps both processes. In cross-flow operation, the trans-membrane pressure is set for optimal filter performance. The inflows to and outflows from membrane filters can be measured and thus the performance of the membrane can be determined.

The backwash process takes place automatically if the filter performance is insufficient. Backwashing uses system filtrate created previously. The pressure resistance test checks the functionality of the membrane.

Other typical applications include:
– Reverse osmosis for seawater desalination
– Process water treatment in the pharmaceutical industry
– Steam generation in power stations

Membrane Filtration Station	**8024509**

The station is fully assembled, wired and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, including overflow rim, 3/2-way ball valve, membrane filter unit, capacitive proximity sensor, float switch, magnetic-inductive flow sensor, pneumatic valve terminal with 3/2-way solenoid valves, 5/2-way solenoid valve, membrane pump, proportional media valve, proportional pressure regulator valve, pressure sensor, electric connection board, aluminum profile plate.

Note

For single operation, a water supply tank/ground water (order no. 8024503) is required.

Required accessories, also order:

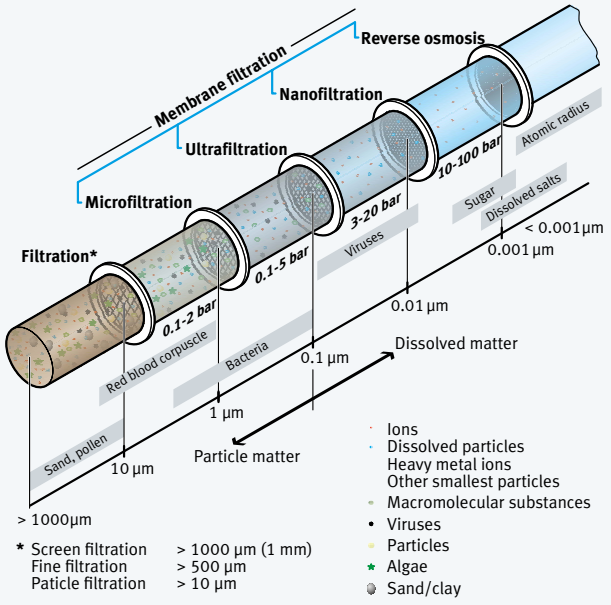
1x Tabletop power supply unit ➔ page 64	
1x Compressor ➔ page 67	
1x Compressor accessories	102725

Recommended accessories ➔ page 64

1x Water supply tank/ground water	8024503
1x DC wattmeter	8216170
1x Membrane filter unit	8024510
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Sewage technology training set	8174093
1x Water supply technology training set	8038315

Recommended software:

FluidLab-PA Process ➔ page 170
FluidLab-PA Closed-Loop ➔ page 171



General Training Content

See the workbook “Membrane Filtration” ➔ page 157

Learning Content for Project Work

– Membrane filtration operating modes like filtration and backwashing
– Presentation of the theoretical basic principles of various membrane filtration (micro-, ultra-, nanofiltration and reverse osmosis)
– Process engineering differences between the cross-flow and dead-end filtration
– Automated integrity test for quality testing the membrane via pneumatic actuation and monitoring
– Effect of the transmembrane pressure on the filter performance
– Functions of pneumatically driven valves and fittings

Technical Data

– Operating pressure: 4 – 6 bar (50 l/min)
– Water (10 – 15 l)
– Power supply: 24 V DC
– 8 digital inputs
– 8 digital outputs
– 4 analog inputs
– 2 analog outputs
– Dimensions (H x W x D): 1250 x 710 x 400 mm

Recommended Learning Material

Workbooks

➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

➔ Membrane Filter Process in Water Management

➔ Introduction to Water Cycle and Water Management
➔ Water Supply
➔ Water Purification
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Sand filtration for Water Purification
➔ Mechanical Pre-Treatment for Wastewater
➔ Adsorption in Water Management

Adsorption Station

New

Function
Adsorption processes are extensively employed, particularly in industrial wastewater treatment for various sectors such as food, textile, pharmaceutical, and petroleum refineries. Activated carbon is also employed in municipal wastewater treatment plants as a fourth purification stage to remove trace substances like drug residues and microplastics, thereby enhancing water pollution control.

At the adsorption station, clear tap water is dyed and introduced into the wastewater tank for illustrative purposes. A second tank receives the purified water. For operational convenience, the colored water can be continuously pumped through the activated carbon filter within the circuit of the first tank, under observation, until the desired level of decolorization is achieved. Subsequently, a solenoid valve can be activated to redirect the flow of water to the clear water tank.

For automated operation, the piping system is equipped with a flow meter, a pressure sensor, and a smart arti:sens photometer. Signal processing of the photometer is employed to control the solenoid valve automatically.

The station comprises two filter modules and additional piping materials, allowing flexibility for various operational modes. It can function either with the filter modules in series, which increases the filtration capacity but necessitates plant shutdown for filter replacement, or in parallel, where one of the two filters can be removed during operation, for instance, to replace the activated carbon. The remaining filter can continue to operate at a reduced flow rate.

Adsorption Station	**8133701**

The station is fully assembled, wired, and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

3 l tank, ultrasound sensor, capacitive proximity sensor, float switch, magnetic-inductive flow sensor, centrifugal pump, 2/2-way solenoid valve, filter unit, inline photometer Arti:sens, analysis unit for the photometer, electric connection board, aluminum profile plate.

Required accessories, also order:

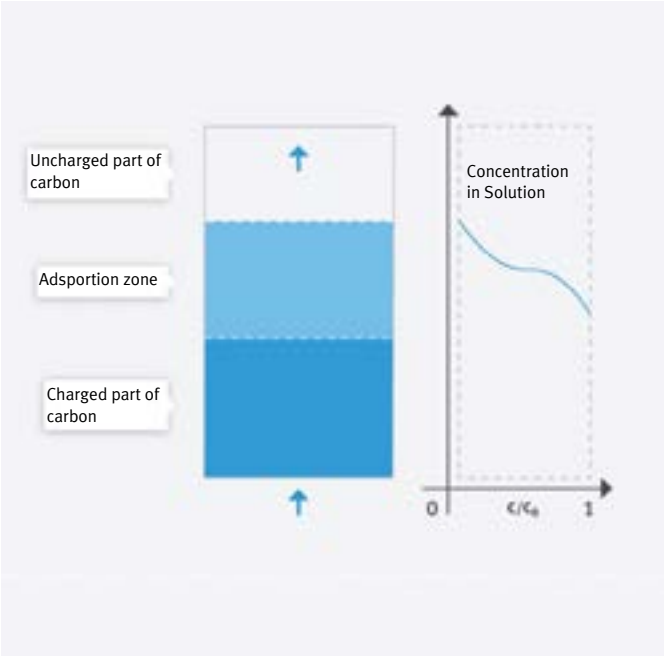
1x Tabletop power supply unit ➔ page 64	

Recommended accessories ➔ page 64

1x Water supply tank/ground water	8024503
1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Sewage technology training set	8174093
1x Water supply technology training set	8038315

Recommended software:

FluidLab-PA Closed-Loop ➔ page 171	



Learning Objectives

– In-depth understanding of the adsorption process.
– Learn the fundamentals of closed-loop control in the station adsorption.
– Read and design technical drawings for a adsorption engineering system.
– Learn the various methods used for control loop tuning in a adsorption.
– Operate, identify, and analyze different control systems for flow, pressure, and a adsorption process.

Technical Data

– Water (10 – 15 l)
– Power supply: 24 V DC
– 4 digital inputs
– 6 digital outputs
– 3 analog inputs
– 1 analog output
– Dimensions (W x H x D): 355 x 1200 x 400 mm

Recommended Learning Material

Workbooks

➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

➔ Adsorption in Water Management

➔ Introduction to Water Cycle and Water Management
➔ Water Supply
➔ Water Purification
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Sand filtration for Water Purification
➔ Membrane Filter Process in Water Management
➔ Mechanical Pre-Treatment for Wastewater

Mechanical Pre-Treatment Station

New

Function
Mechanical cleaning, also known as screening systems raking, serves as the initial cleaning stage to remove coarse materials, such as wood, hygiene articles, and more, from the inlet. Its purpose is to protect downstream machinery from clogging and damage.

Various applications include:
– Wastewater pre-cleaning in the inlet structures of sewage treatment plants.
– Water extraction from flowing water sources.
– Placement in front of water turbines at weirs.

In all three cases, the goal is to maintain a steady water flow while collecting coarse materials for further use. Ultrasonic sensors are employed for level measurement both upstream and downstream of the rake to enable remote plant status monitoring and automatic scraper activation.

As a demonstration, plastic balls are introduced into the water flow to simulate contaminants. The scraper captures solid materials at the rake, and the electro-pneumatically driven scraper conveys them either to a collection tank or a water return trough. If the water return trough is utilized, the balls remain in the system as contaminants, enabling continuous operation without manual intervention.

This station can be seamlessly integrated into the EDS Water Management System. An overflow connection is included to demonstrate potential flooding scenarios. The channels are constructed from sturdy stainless steel sheets.

 For tailored advice and product selection/configuration assistance, please contact a sales representative.

Mechanical Pre-Treatment Station	**8133700**

The station is fully assembled, wired, and tested.

Including control system with FluidLab Water Management, EasyPort, connecting cables, accessory set and “Getting Started” technical documentation.

Main components

Drain channel, screen, ultrasonic sensor, pneumatic cylinder, pneumatic solenoid valve, electric connection board, aluminum profile plate, LED lamp, water supply tank/ground water.

Required accessories, also order:

1x Tabletop power supply unit ➔ page 64	
1x Compressor ➔ page 67	
1x Compressor accessories	102725

Recommended accessories ➔ page 64

1x DC wattmeter	8216170
1x Trolley with plate	8039990
1x Tool set	538767
1x Pipe and tubing cutter	7658
1x Sewage technology training set	8174093
1x Water supply technology training set	8038315
1x Wastewater transport station	8024506

Recommended software:

FluidLab-PA Closed-Loop ➔ page 171

Learning Objectives

– Gain a deep understanding of the water pre-treatment process
– Read and design technical drawings for water pre-treatment engineering
– Know the functions of pneumatically cylinder
– Parameter the process steps

Technical Data

– Operation pressure: 4 – 6 bar (50l/min)
– Water (10 – 15 l)
– Power supply: 24 V DC
– 6 digital inputs
– 5 digital outputs
– 2 analog inputs
– Dimensions (W x H x D): 580 x 900 x 400 mm

Recommended Learning Material

Workbooks

➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX

➔ Mechanical Pre-Treatment for Wastewater

➔ Introduction to Water Cycle and Water Management
➔ Water Supply
➔ Water Purification
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Sand filtration for Water Purification
➔ Adsorption in Water Management
➔ Membrane Filter Process in Water Management

Basic Water Circuit System

Fully Equipped – Four Stations Become One

Shown with optional equipment

Function
Efficiency and economy are not only in demand in the water sector – Save time and money with the basic system. The basic water circuit system, comprising all necessary water supply and disposal stations which also function independently of one another.

Use in a Control Room
The learners initially control the individual stations in manual over-ride using a simulation box.

The included EasyPort devices are then used to control and observe the stations via the control software.

One PC, to which all four EasyPort devices are connected, controls the complete system.

For Perfect Classes
The workbooks with theory sections and exercise scenarios are perfectly customized for the stations and guarantee ideal class preparation.

The learning system components map real processes, making the exercises interesting and informative.

General Training Content
- Controlling, regulating and monitoring physical variables such as levels, flows and pressure
- Technical/physical functions of sensors and actuators as well as wiring, adjustment and parameterization
- Analyzing controlled systems, parameterizing and optimizing regulators
- System operation, maintenance, troubleshooting and repair
- Plant engineering
- Optimization and energy monitoring
- Electronic data processing

Basic Water Circuit System	**8024501**

The basic system stations are fully assembled, wired and tested. For single operation, a water supply tank/ground water (order no. 8024503) is required.

The water circuit basic system contains:
1x Water treatment station
1x Water supply station
1x Wastewater transport station
1x Wastewater treatment station
1x Water supply tank/ground water including cables
1x Additional chlorine measurement package
1x Additional oxygen measurement package
1x Digital/analog simulation box, including cables
4x EasyPort including cables
4x DC wattmeter
4x FluidLab Water Management

Necessary accessories, also order:

4x Tabletop power supply unit➔ page 64	
1x Compressor ➔ page 67	
1x Compressor accessories	102725

Recommended accessories ➔ page 64

3x Water supply tank/ground water	8024503
5x Trolley with plate	8039990
1x Tool set	539767
1x Pipe and tubing cutter	7658
1x Water supply technology training set	8038315
1x Sewage technology training set	8174093
Commissioning service	On request

Recommended software:

FluidLab-PA Process ➔ page 170
FluidLab-PA Closed-Loop ➔ page 171

Learning Content for Project Work
All training content of the individual stations apply. It is supplemented with the following training content:
– Showing dependences in a water circuit
– Increasing the degree of complexity by networking systems
– Identifying interactions of hydraulic flow and delivery rate beyond the limits of the station
– Getting to know the importance of different pressure zones in a water supply network

Technical Data
– Operating pressure: 4 – 6 bar (50 l/min)
– Water (30 – 40 l)
– Power supply: 24 V DC
– Dimensions (H x W x D): 1150 x 2760 x 400 mm

Recommended Learning Material

Workbooks
➔ page 156

Campus license:

en/de	8208239

Note: The campus license includes both the student and instructor versions of all PDF workbooks related to EDS Water Management: “Water Purification”, “Water Supply”, “Wastewater Transport”, Wastewater Treatment”, “Sand Filtration”, “Membrane Filtration”, “Monitoring, Controlling, and Optimizing Operations”, and “Energy Optimization in Water and Wastewater Treatment Plants”.

Courses on Festo LX
➔ Introduction to Water Cycle and Water Management

➔ Water Purification
➔ Water Supply
➔ Wastewater Transport
➔ Wastewater Treatment
➔ Sand filtration for Water Purification
➔ Membrane Filter Process in Water Management
➔ Mechanical Pre-Treatment for Wastewater
➔ Adsorption in Water Management

EDS Water Management
Accessories

Tabletop Power Supply Unit
– Input voltage:
85 – 265 V AC (47 – 63 Hz)
– Output voltage:
24 V DC, short-circuit-proof
– Output current: max. 4.5 A
– Dimensions: 75 x 155 x 235 mm

Without power cable
Order no. **8049633**

With IEC power cable, 1.3 m
Connector as per CEE 7/VII for DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID
Order no. **162417**
Connector as per NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP
Order no. **162418**
Connector as per BS 1363 for GB, IE, MY, SG, UA, HK, AE
Order no. **162419**
Connector as per AS 3112 for AU, NZ, CN, AR
Order no. **162380**
Connector as per SEV 1011 for CH
Order no. **162381**
Connector as per SANS 164-1 for ZA, IN, PT, SG, HK, (GB), (AE)
Order no. **162382**

Water Supply Tank/Ground Water
Main components
– Systainer with T-LOC system, 30 l
– Adapter for piping connectors
– Submersible pump
– Pre-filter
– Float switch
– Water sieve
– Mobile roller system
Order no. **8024503**

Trolley with Plate
Stable sheet steel construction with table plate. Dimensions (W x H x D including rollers to bottom edge of profile plate): 700 x 770 x 700 mm
Order no. **8039990**

Additional Oxygen Measurement Package
Optional extension for the waste-water treatment station. Measuring cell for dissolved oxygen with integrated optoelectronics. Measuring principle: Oxygen-dependent luminescence.
Order no. **8025418**

 For tailored advice and product selection/configuration assistance, please contact a sales representative.

Sewage Technology Training Set
How does a wastewater treatment plant work? Explains and demonstrates sewage technology with didactically designed magnet cards, etc.
– Plastic case
– 60 DIN A7 magnet cards
– 44 learning cards in a set (playing card-size)
– 130 questions on a USB stick for instructors

Order no. **8174093**

Water Supply Technology Training Set
Water, waste, energy: Showing connections on whiteboards or flipcharts with didactically designed magnet cards. All important stations/structures in the water and energy circuit are shown as color pictograms.
– Plastic case
– 62 DIN A7 magnet cards

Order no. **8038315**

Sedimentation Granules
For demonstrating the sedimentation process:
– Plastic granules, red
– Volume content 0.5 l (corresponds to approx. 340 g)
– Packaged in a PVC wide-neck container

Order no. **8037688**

Quartz and Quartz Gravel
Used in treating drinking and wastewater as a natural filter material. The filter medium is delivered in various grain sizes to optimize sand filtration.

Order no. **8039989**

EDS Water Management
Accessories

Additional Chlorine Measurement Package
Optional extension for the water treatment station: Measurement of free chlorine. This package is equipped with a dropping funnel, a membrane-covered, amperometric measuring cell and an indicator that can be parametrized. The measuring cell functions within an operating range of 4 to 9 pH.

Order no.	**8025419**

Membrane Filter Unit
Interchangeable filter unit with a pore size of 0.02 µm. Including connections to the pipe system and blanking plug.

Order no.	**8024510**

DC Wattmeter
The DC wattmeter is a smart meter for training facilities with a 24 V DC power supply and up to 120 W power consumption. All measured values can be read out via data transmission with the integrated Ethernet port. Power consumption is read out as an analog signal within a range of either 0 to 10 V DC. Product picture for illustrative purposes only; actual product may vary.

Order no.	**8216170**

Tool Set
The tool set contains basic tools for practical work on mechatronic systems such as MPS stations and modules.

Order no.	**539767**

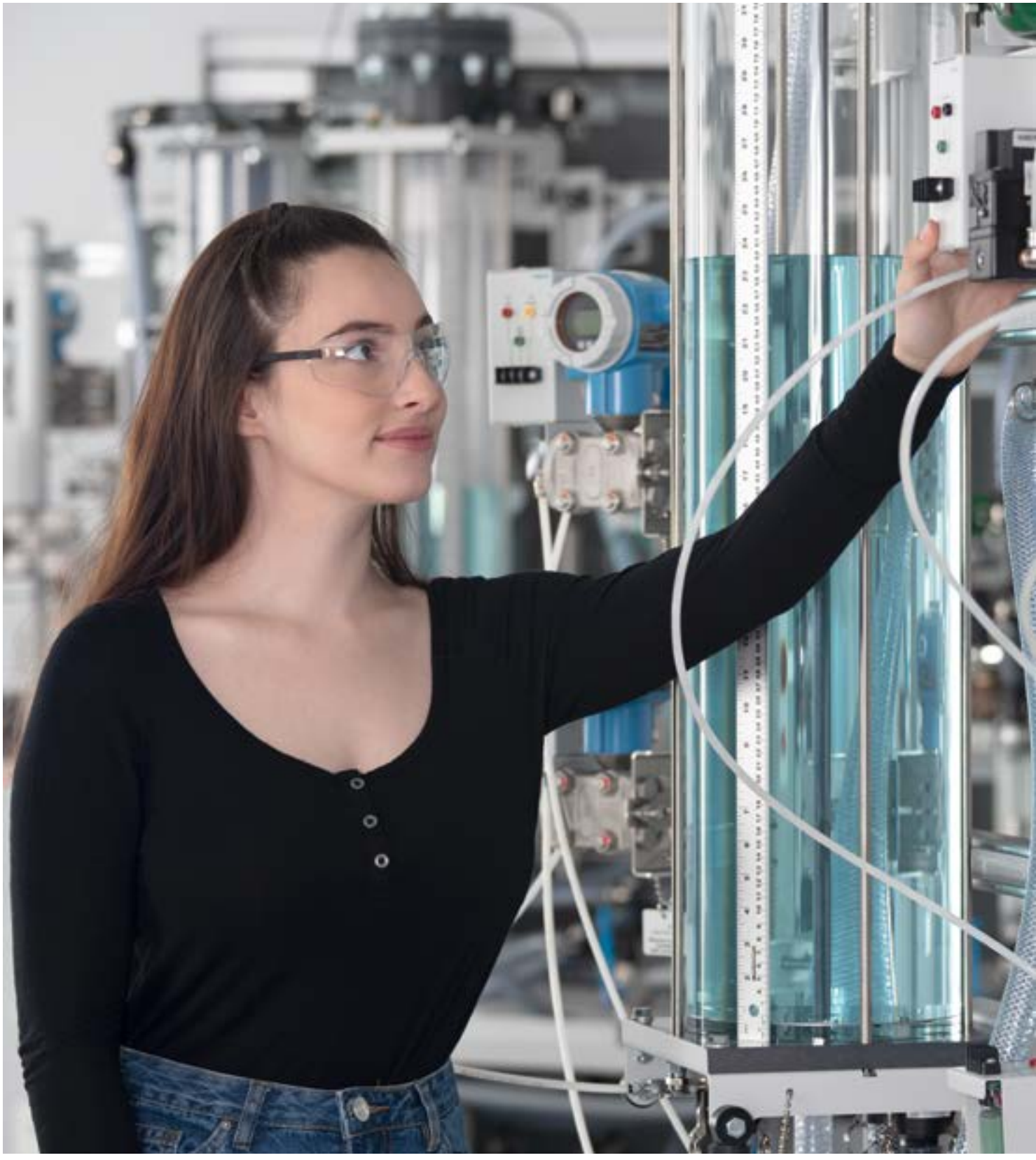
Pipe and Tubing Cutter
For pneumatic tubing made of plastic and Perbunan with and without textile insert up to 20 mm outside diameter. Right-angled, burr-free cut due to positive support of the tubing in the cutter. It also has an integrated retaining clip to prevent unintentional opening. Delivery includes two replacement blades.

Order no.	**7658**

Compressor
Oil-lubricated, very quiet (45 dB (A)) compressor. This makes it ideal for use in classrooms. With pressure reducer and water separator.
– Pressure: 800 kPa (8 bar) P_{max}
– Suction capacity: 50 l/min
– Tank volume: 24 l
– Compressed air outlet: ¼“ or KD4
– Noise level: 45 dB (A)/1 m
– Duty cycle: max. 50%
– Pressure regulator with gauge

230 V	**91030**
100 V – 120 V	**565440**

Industrial Instrumentation and Process Control



Note: Several products in this chapter cannot be sold or delivered in countries that require CE compliance; please check with a sales representative for details.

Industrial Process Learning Systems

A Process Plant in Your Classroom

→ Video

Real-world, large-scale process loops are implemented in a safe and practical environment to develop universal skills for the process industry.

Two workstations recreate the widespread industrial practice of separating the process environment from the instruments and controllers

The **process workstation** is the hub of the different process circuits to be created by the students. It consists of a mobile workstation equipped with two tanks, up to four centrifugal pumps, a rotameter, a drip tray, an instrumentation mounting pipe, ball valves, and process supports. To configure the system for hands-on training, students have to install the appropriate industrial components and devices.

The **instrumentation workstation** houses the electrical and the pneumatic units as well as other electrical equipment such as the variable speed drives, controllers, PLCs, and touch screens. It includes a lockable power switch and a 24 V dc power supply. An emergency button allows cutoff of both the electric and pneumatic power. The teaching material includes a lockout/tagout procedure explaining how to lock the power switch.

Industrial Technologies and Devices
The training systems feature technologies and industrial components from leading manufacturers that students will encounter in the workplace. A wide selection of components (transmitters, valves, level switches, heat exchangers, controllers, calibration kits...) allows instructors to easily replicate specific industry processes.

Technologies and brands:
– Siemens
– Rockwell Automation
– Endress + Hauser
– ABB
– Emerson
– HART Protocol
– EtherNet/IP
– Profibus PA
– And more

Industrial Realism

To plan, monitor, maintain, and improve continuous production processes, instrumentation and process technicians and engineers need an in-depth understanding of basic industrial processes as well as their instruments and control devices.

To prepare students for the workplace or to upskill current industry workers, practical experience with industrial components and communication protocols is important during their studies. Our industrial process training systems are a **cost- and space-savvy way to bring the plant into your classroom**.

Designed for training purposes, these modular systems enable teachers to create a wide variety of configurations to mimic real-life control loops. Extensive courseware guides students through the configuration, wiring, calibration, and troubleshooting of various instruments and devices.

Focus on Troubleshooting
The learning systems feature many tools to help instructors develop essential troubleshooting skills. There are three different methods to insert faults:
– Local fault insertion is done by accessing the fault panel on a particular device to activate faults as required.
– Remote calibration fault insertion is performed by changing the calibration parameters of a device from the instructor's computer over either the HART communication protocol (requires the appropriate modules).
– Remote fault insertion is achieved by remotely modifying the state of I/O relays on a PLC from a computer or from a touch screen terminal.

Complete Courseware
A complete course program underpins the training systems. Over 40 illustrated courses guide students step by step through self-paced, autonomous practical experimentation. They cover theory and practice of measurement, control, and troubleshooting of temperature, pressure, flow, and level processes and their devices.

Topic Coverage
– Fluid mechanics and chemistry
– Safety
– P&I diagrams
– Centrifugal pumps
– Measurement of pressure, flow, level, temperature, pH, conductivity
– Real-time energy calculations to study four types of heat exchangers
– Smart instrumentation
– Communication protocols
– PID, cascade control
– First/second order processes (interacting and non-interacting)
– Loop tuning
– Advanced control strategies (ratio, feed-forward, and split-range)
– Boiler three-element control loops
– Troubleshooting

Industrial Process Learning Systems

Create a System Tailored to Your Needs

Safe Boiler Simulation

Students can study boiling processes thanks to an unpressurized boiler simulator that works with water at room temperature. The key features of a boiling process are replicated with a controlled flow of air injected at the base of a process column containing a controllable level of water. Up to three elements and three control loops (2 PID loops and 1 calibrator) are involved in the control of the level of water in the drum of the boiler.

The boiling process is recreated by regulating the flow of air injected in the column while operating a second pump drains the column to simulate evaporation of water. The Boiler Simulation system is a synthesis of many industrial control notions and involves multiple control loops as well as feed-forward and cascade control.

Your Ideal Configuration

To select and/or create a training system tailored to your training requirements and budget, our experts will guide you through the selection of components:

– Types of process variables
– Communication protocols
– Controllers and HMI
– Optional transmitters and control valves, traditional or smart
– Programming/configuration software
– Calibration kits

Industry-Specific Training

System configurations tailored to specific industry segments are also available, incorporating the instrumentation typical of each segment.

– Mining
– Power generation
– Water and wastewater
– Food and beverage
– Pharmaceuticals
– Oil and gas
– Chemicals
– Pulp and paper

Such a configuration is especially interesting if your process automation-related courses aim to prepare workers for a specific industry.

Total Flexibility

The strength of the learning systems lies in the customization potential and expansion options enabled by an extensive array of industrial devices. Instructors can also integrate other devices as needed.

Serving as blank canvases, the workstations provide an ideal platform for creating process loops.

For convenience, popular system configurations are available, but they can all be customized.

 For tailored advice and product selection or configuration assistance, please contact a sales representative.

Introduce the Internet of Things for Process Automation

Introduce learners to the growing importance of the Industrial Internet of Things (IIoT) in the process industry.

The increasing integration of new technologies in process operations require new skills. Future and current workers need to become familiar with smart field devices and acquire the essential skills and knowledge required for effective utilization, such as networking and connectivity proficiency, remote device configuration expertise, as well as diagnostic and troubleshooting capabilities.

The modular design of the process control learning systems facilitates the integration of new components to complement or replace existing equipment. Learners get familiar with the configuration and operation of smart devices using software tools.

– For Bluetooth devices, use the SmartBlue App
– For Heartbeat devices, use FieldCare or DeviceCare
– For WLAN devices, use FieldCare or DeviceCare and connect to the device's web server
– For IO-Link devices, add an IO-Link master module* and use the PACTware software

Procedures are explained in the courseware. Learners can then perform practical experimentation in pressure, flow, level, or pH control. Most components feature fault switches that teachers can utilize to develop troubleshooting skills.

* The IO-Link master module is included in the training package TP 1312 Smart Sensors, sold separately ➔ Page 118. By using this training package, learners can delve into the study of other IO-Link sensors.

Available Smart Devices for the Industrial Process Learning Systems (from Endress+Hauser):

Pressure
– High-Range Differential Pressure Transmitter with Bluetooth and Heartbeat (order no. 611539)
– Low-Range Differential Pressure Transmitter with Bluetooth and Heartbeat (order no. 611544)
– Pressure Switch with IO-Link (order no. 611537)
– Differential Pressure Transmitter with Bluetooth and Heartbeat (order no. 611538)

Level
– Guided-Radar Level Transmitter with Bluetooth and Heartbeat (order no. 611545)
– Radar Level Transmitter with Bluetooth and Heartbeat (order no. 611541)

Flow
– Magnetic Flow Transmitter with WLAN and Heartbeat (order no. 611542)
– Vortex Flow Transmitter with Heartbeat (order no. 611543)
– Coriolis Flow Transmitter with WLAN and Heartbeat (order no. 611540)
– Picomag Electromagnetic Flow Transmitter with Bluetooth and IO-Link (order no. 611547)

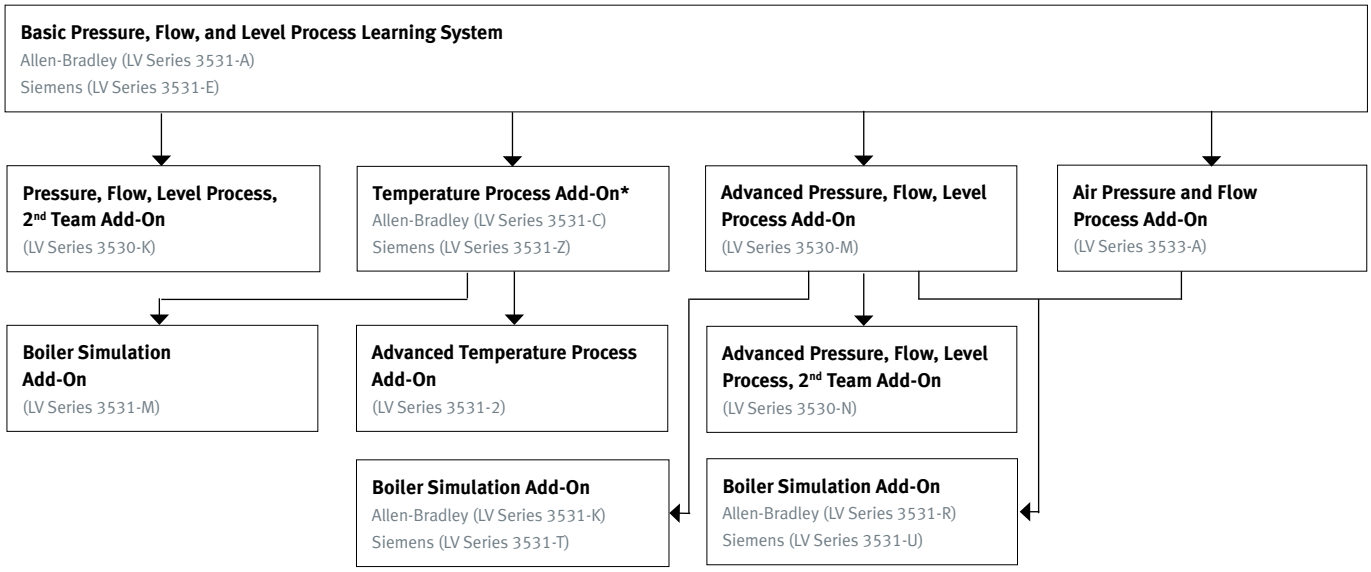
pH
– pH Transmitter with Heartbeat (order no. 611546)

All devices are detailed on ➔ Pages 94 – 97

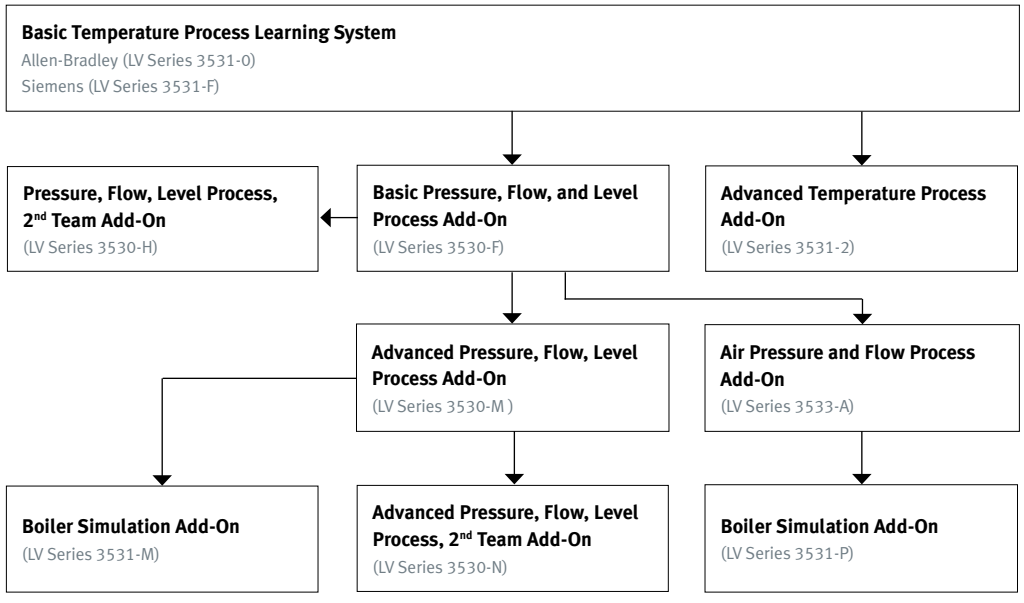
Industrial Process Learning Systems

Standard System Configurations

To study pressure, flow, level, and temperature processes, you can use the following systems and add-on packages:

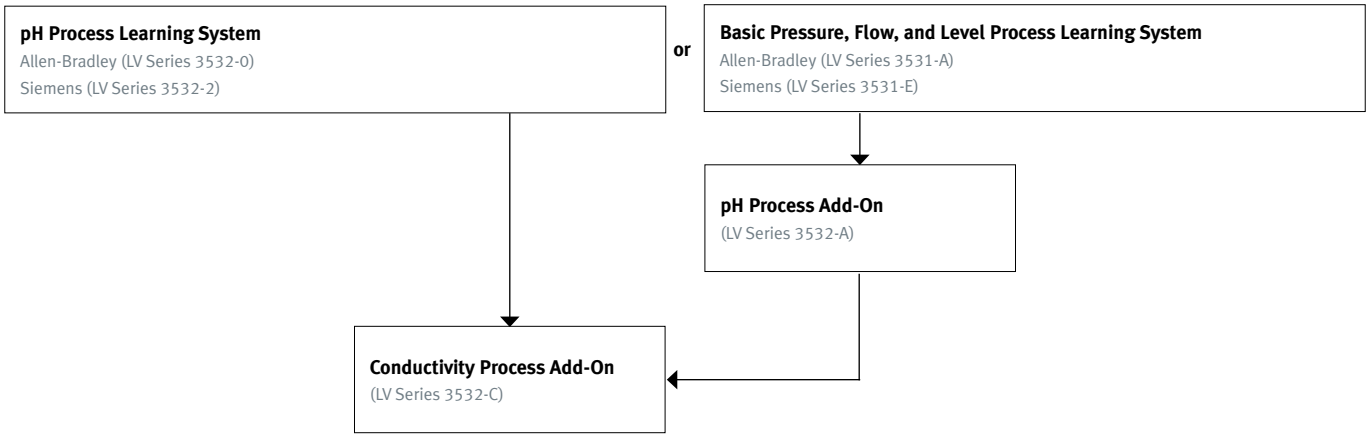


or

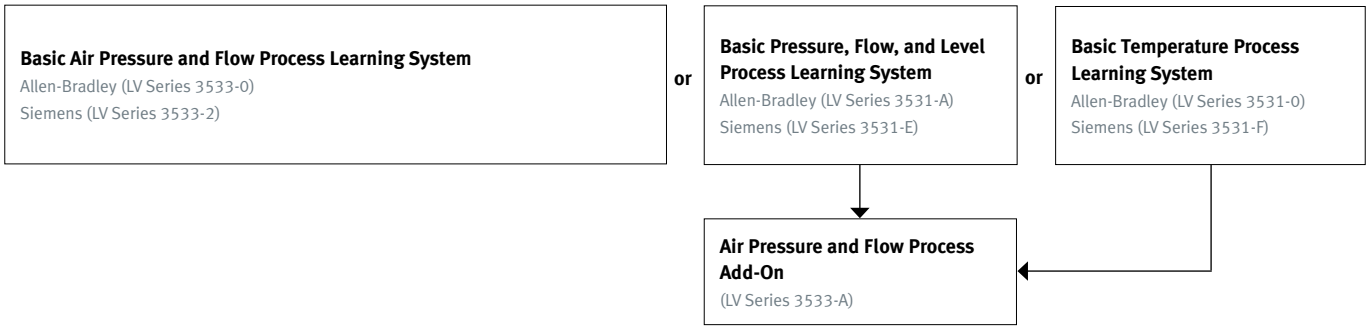


* Note: This add-on system is intended for customers looking to extend a basic pressure, flow, or level system (3531-A or -F). If you want to start with a temperature system, please choose the “Basic Temperature Process Learning System” (3531-0 or 3531-F).

To study pH and conductivity processes, you can use the following systems and add-on packages:



To study air pressure and flow processes, you can use the following systems and add-on packages:



General notes
- Arrows show system prerequisites and expansion options.
- All standard system configurations can be customized.
- Learning systems utilize the HART communication protocol.
- The learning systems and add-on packages cannot be ordered or delivered in countries that require compliance with CE regulations.
- Second team add-on packages provide the necessary materials for a second team of students to work on the back side of the workstation.

Pressure, Flow, Level, and Temperature Process Learning Systems

Pressure, Flow, Level Process Learning System (Allen-Bradley, HART)
LabVolt Series 3531-A

This learning system is equipped with components from Allen-Bradley and introduces learners to pressure, flow, and level processes along with their associated instruments and controls. It includes two HART differential pressure transmitters, one high-range, and one low-range. Additionally, it features an Ethernet/IP Allen-Bradley variable frequency drive. It requires a PLC bundle for operation.

120 V, 60 Hz, en	**582464**
120 V, 60 Hz, es	**582465**
220 – 240 V, 50 – 60 Hz, en	**582466**
220 – 240 V, 50 – 60 Hz, es	**582467**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
- 1x Emergency switch station (order no. 582352)
- 1x Digital pressure gauge (high range) (order no. 582387)
- 1x Process workstation (pressure, flow, and level) (order no. 582390)
- 1x Instrumentation workstation (assembled) (order no. 588306)
- 1x Column (large diameter) (order no. 582394)
- 1x Rotameter (order no. 582402)
- 1x Venturi tube (order no. 582403)
- 1x Differential-pressure transmitter (high range) (order no. 582408)
- 1x Differential-pressure transmitter (low range) (order no. 582410)
- 1x Pneumatic control valve (order no. 582424)
- 1x Solenoid valve (order no. 582426)
- 1x Electrical unit ➔ Page 105
- 1x Pneumatic unit (order no. 582433)
- 1x Color paperless recorder (order no. 595185)
- 1x AC variable frequency drive (Ethernet) ➔ Page 102
- 1x Instrumentation mounting pipe (order no. 582444)
- 1x Process supports (P/F/L/T) (order no. 582445)
- 1x Drip tray (front) (order no. 582447)
- 1x Piping and accessories (P/F/L, Allen-Bradley – basic system) (order no. 582451)

Recommended learning material, also order:
- Familiarization with the Training System – Pressure, Flow, and Level ➔ Page 159
- Measurement ➔ Page 159
- Process Control ➔ Page 160

Additional equipment required to perform the exercises, also order:
- 1x CompactLogix PLC bundle ➔ Page 114
- 1x Compressor (order no. 588108)
- 1x Touch screen graphic terminal (Allen-Bradley) – 26.4 cm (10.4 in) ➔ Page 116 (order no. 8103425), or a Large Touch-Screen Computer (order no. 589677) with FactoryTalk View ME ➔ Page 116
- 1x Calibration kit (order no. 588416)

Optional controller

ControlLogix PLC bundle ➔ Page 114	
MicroLogix PLC bundle ➔ Page 114	
CompactLogix PLC bundle ➔ Page 114	
Siemens S7-1500 PLC bundle ➔ Page 114	
ABB CM30 PID controller bundle ➔ Page 115	
I/O Interface with LVProSim (9065-B) ➔ Page 111	

Optional equipment

Pressure, flow, level, second team add-on	588488
Touch screen graphic terminal, 14.5 cm (5.7 in)	8165911
Process control signal tower	587869
Indicator-light/push-button station	587871
Storage station	588301
Second pump add-on	582398
Pneumatic control valve with Digital Positioner, HART, DVC 2000	588357
Pneumatic control valve with Positioner, Fisher 3660	588358
Electric control Valve	588360
Pneumatic control valve with digital positioner, HART, DVC 6200	588363
Solenoid valve	582426
Ball valve	588365
Pneumatic control valve for air with a positioner Fisher 3660	588367
Pneumatic control valve for air with digital positioner, HART, DVC 6200	588368
Touch-Screen Computer for SCADA ➔ Page 116	

Optional measurement

Digital pressure gauge (low range)	588300
Orifice plate	588315
Pitot tube	588316
Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Electromagnetic flow transmitter (HART, transmitter on the left)	582419
Vortex flow transmitter (HART)	588320
Coriolis flow transmitter (HART)	588323
Paddle wheel flow transmitter	588326
Pressure switch (with analog output)	588328
Ultrasonic flow transmitter (HART)	588330
Pressure transmitter (HART)	588333
Ultrasonic level transmitter (HART)	588337
Guided-radar level transmitter (HART)	589127
Vibrating fork level switch	588344
Conductivity level switch	588346
Float switch	588348
Capacitive level transmitter (HART)	588350
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419
HART software configurator	588420

Software

Studio 5000 Logix Designer Lite Edition ➔ Page 172	
Studio 5000 Logix Designer Full Edition ➔ Page 172	
FactoryTalk View ME Studio ➔ Page 173	
Fuzzy Logic Software Add-on to RSLogix 5000 ➔ Page 172	

Spare Parts

Spare Parts Kit 1 for 3531	763511

Pressure, Flow, Level Process Learning System (Siemens, HART)
LabVolt Series 3531-E

This learning system is equipped with components from Siemens and introduces learners to pressure, flow, and level processes along with their associated instruments and controls. It includes two HART differential pressure transmitters, one high-range, and one low-range. Additionally, it features a PROFINET Siemens variable frequency drive. It requires a PLC bundle for operation.

120 V, 60 Hz, en	**589668**
220 – 240 V, 50 – 60 Hz, en	**592691**

Note: These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Emergency switch station (order no. 582352)
– 1x Digital pressure gauge (high range) (order no. 582387)
– 1x Process workstation (pressure, flow, and level) (order no. 582390)
– 1x Instrumentation workstation (assembled) (order no. 588306)
– 1x Column (large diameter) (order no. 582394)
– 1x Rotameter (order no. 582402)
– 1x Venturi tube (order no. 582403)
– 1x Differential-pressure transmitter (HART, high range) (order no. 582408)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x Pneumatic control valve (order no. 582424)
– 1x Solenoid valve (order no. 582426)
– 1x Electrical unit ➔ Page 105
– 1x Pneumatic unit (order no. 582433)
– 1x Color paperless recorder (order no. 595185)
– 1x AC drive (Ethernet/IP) – single-phase AC supply ➔ Page 102
– 1x Instrumentation mounting pipe (order no. 582444)
– 1x Process supports (P/F/L/T) (order no. 582445)
– 1x Drip tray (front) (order no. 582447)
– 1x Piping and accessories (P/F/L, Siemens) – basic system (order no. 592689)

Recommended learning material, also order:
– Familiarization with the Training System – Pressure, Flow, and Level ➔ Page 159
– Measurement ➔ Page 159
– Process Control ➔ Page 160
– SIMATIC Manual Collection on DVD (order no. 192883)

Additional equipment required to perform the exercises, also order:
– 1x S7-1500 PLC bundle ➔ Page 114
– 1x Compressor (order no. 588108)
– 1x Calibration kit (order no. 588416)
– 1x Industrial PC HMI (Siemens) (order no. 589672) or a Large Touch-Screen Computer ➔ Page 116

Optional controller

ControlLogix PLC bundle ➔ Page 114	
MicroLogix PLC bundle ➔ Page 114	
CompactLogix PLC bundle ➔ Page 114	
ABB CM30 PID controller bundle ➔ Page 115	
I/O Interface with LVProSim (9065-B) ➔ Page 111	

Optional equipment

Pressure, flow, level, second team add-on (LabVolt Series 3530-K0 ➔ Page 78)	
Touch screen graphic terminal - 14.5 cm (5.7 in)	8165911
Process control signal tower	587869
Indicator-light/push-button station	587871
Storage station	588301
Second pump add-on ➔ Page 102	
Pneumatic control valve (with digital positioner, HART) - DVC 2000	588357
Pneumatic control valve (with positioner, Fisher 3660) (46950-A0)	588358
Pneumatic control valve	582424
Electric control valve	588360
Pneumatic control valve (with digital positioner, HART) - DVC 6200	588363
Solenoid valve	582426
Ball valve	588365
Pneumatic control valve for air with a positioner - Fisher 3660	588367
Pneumatic control valve for air with digital positioner (HART) - DVC 6200	588368
AC variable frequency drive (PROFINET) ➔ Page 102	
Touch-Screen Computer for SCADA ➔ Page 116	
Spare parts Kit 1 for 3531	763511

Optional measurement

Digital pressure gauge (low range)	588300
Orifice plate	588315
Pitot tube	588316
Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Electromagnetic flow transmitter (HART, transmitter on the left)	582419
Vortex flow transmitter (HART)	588320
Coriolis flow transmitter (HART)	588323
Paddle wheel flow transmitter	588326
Pressure switch (with analog output)	588328
Ultrasonic flow transmitter (HART)	588330
Pressure transmitter (HART)	588333
Ultrasonic level transmitter (HART)	588337
Guided-Radar level transmitter (HART)	589127
Vibrating Fork level switch	588344
Conductivity level switch	588346
Float switch	588348
Capacitive level transmitter (HART)	588350
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419

Software

Fuzzy Logic Software Add-on to RSLogix 5000 ➔ Page 172	
HART Software Configurator	588420
Step 7 professional and WinCC Advanced ➔ Page 173	
Studio 5000 Logix Designer Lite Edition ➔ Page 172	
Studio 5000 Logix Designer Full Edition ➔ Page 172	
FactoryTalk View ME Studio ➔ Page 173	

Pressure, Flow, Level, and Temperature Process Learning Systems

Pressure, Flow, Level Process, Second-Team Add-On
LabVolt Series 3530-K

Add-on package designed for the Pressure, flow, and level process learning system (3531-A or -E). It allows a second group of students to work at the same time, one group on each side of the workstation. It includes all the equipment required to complete the measurement, control, and troubleshooting exercises for the pressure, flow, and level processes, and features two differential pressure transmitters supporting the HART communication protocol.

en	**588488**
es	**589034**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Emergency switch station (order no. 582352)
– 1x Digital pressure gauge (high range) (order no. 582387)
– 1x Column (large diameter) (order no. 582394)
– 1x Rotameter (order no. 582402)
– 1x Venturi tube (order no. 582403)
– 1x Differential-pressure transmitter (HART, high range) (order no. 582408)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x Pneumatic control valve (order no. 582424)
– 1x Solenoid valve (order no. 582426)
– 1x Color paperless recorder (order no. 595185)
– 1x Instrumentation mounting pipe (order no. 582444)
– 1x Process supports (P/F/L) - add-on, second team (order no. 588427)
– 1x Drip tray (back) (order no. 582448)
– 1x Piping and accessories, second team (order no. 588429)

Recommended components, also order:
– Second pump add-on ➔ Page 102
– AC variable-frequency drive ➔ Page 102

Recommended learning material, also order:
– Measurement, Workbook ➔ Page 159
– Process Control, Workbook ➔ Page 158
– Control Valves, User Guide ➔ Page 163
– Familiarization with the Training System, User Guide ➔ Page 159

Advanced Pressure, Flow, Level Process Add-On
LabVolt Series 3530-M

Add-on package designed for the Pressure, flow, and level process learning system (3531-A or -E). It allows students to perform a set of advanced process control experiments, including feedforward control, ratio control, split-range control, and the control of second-order processes.

en	**588490**
es	**588491**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Column (small diameter) (order no. 582395)
– 1x Upper tank (order no. 588307)
– 1x Orifice plate (order no. 588315)
– 1x Pneumatic control valve (order no. 582424)
– 1x Ball valve (order no. 588365)
– 1x Piping and accessories, advanced (order no. 588432)

Recommended learning material, also order:
– Flow Primary Elements, Workbook ➔ Page 163
– Control Valves, User Guide ➔ Page 163
– Advanced Process Control, Workbook ➔ Page 160

Advanced Pressure, Flow, Level Process, Second-Team Add-On
LabVolt Series 3530-N

Add-on package designed for the Pressure, flow, and level process learning system (3531-A or -E) equipped with the Advanced pressure, flow, and level add-on (3530-M). It allows a second groups of students to work at the same time, one group on each side of the workstation, and perform a set of advanced process control experiments. The experiments include feed-forward control, ratio control, split-range control, and the control of second-order processes.

en	**588492**

Notes: This system is not voltage-sensitive. It cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Column (small diameter) (order no. 582395)
– 1x Orifice plate (order no. 588315)
– 1x Pneumatic control valve (order no. 582424)
– 1x Ball valve (order no. 588365)
– 1x Piping and accessories, advanced (order no. 588432)

Recommended learning material, also order:
– Advanced Process Control, Workbook ➔ Page 160

Pressure, Flow, Level, and Temperature Process Learning Systems

Pressure, Flow, Level Process Add-On (HART)
LabVolt Series 3530-F

Add-on package designed for the Temperature process learning system (3531-0 or -F). The add-on comprises two differential pressure transmitters supporting the HART communication protocol. The add-on includes all the equipment required to complete the measurement, control, and troubleshooting exercises for the pressure, flow, and level processes.

en	**588481**
es	**588482**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Digital pressure gauge (high range) (order no. 582387)
– 1x Column (large diameter) (order no. 582394)
– 1x Rotameter (order no. 582402)
– 1x Venturi tube (order no. 582403)
– 1x Differential-pressure transmitter (HART, high range) (order no. 582408)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x Pneumatic control valve (order no. 582424)
– 1x Solenoid valve (order no. 582426)
– 1x Process supports (P/F/L) - Add-on (order no. 588425)
– 1x Piping and accessories (P/F/L) - add-on (order no. 588431)

Recommended learning material, also order:
– Measurement, Workbook ➔ Page 159
– Process Control, Workbook ➔ Page 158
– Control Valves, User Guide ➔ Page 163
– Familiarization with the Training System, User Guide ➔ Page 159

Advanced Pressure, Flow, Level Process, Second Team Add-On
LabVolt Series 3530-H

Add-on designed for the Temperature process learning system (3531-0 or -F) equipped with the Pressure, flow, and level process add-on (3530-F). It allows a second groups of students to work at the same time, one group on each side of the process workstation. It comprises two differential pressure transmitters supporting the HART communication protocol. It includes the equipment required to complete the measurement, control, and troubleshooting exercises for the pressure, flow, and level processes.

en	**588485**
es	**588486**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Emergency switch station (order no. 582352)
– 1x Digital pressure gauge (high range) (order no. 582387)
– 1x Column (large diameter) (order no. 582394)
– 1x Rotameter (order no. 582402)
– 1x Venturi tube (order no. 582403)
– 1x Differential-pressure transmitter (HART, high range) (order no. 582408)
– 1x Differential-pressure transmitter (HART, low range)(order no. 582410)
– 1x Pneumatic control valve (order no. 582424)
– 1x Solenoid valve (order no. 582426)
– 1x Color paperless recorder (order no. 595185)
– 1x Instrumentation mounting pipe (order no. 582444)
– 1x Process supports (P/F/L), add-on, second team (order no. 588427)
– 1x Piping and accessories, second team (order no.588429)

Recommended learning material, also order:
– Flow Primary Elements, Workbook ➔ Page 163
– Control Valves, User Guide ➔ Page 163
– Advanced Process Control, Workbook ➔ Page 160

Temperature Process Add-On
LabVolt Series 3531-C (Allen-Bradley) or 3531-Z (Siemens)

Add-on package designed for the Pressure, flow, and level Flow/Level process learning system (3531-A or -E). It includes all the equipment required to perform the measurement, control, and troubleshooting exercises for temperature processes. It includes a HART temperature transmitter and three Allen-Bradley or Siemens variable-frequency drives. A variety of optional heat exchangers are available for advanced training in temperature process control.

Allen-Bradley, 120 – 208 V, 60 Hz, en	**582470**
Allen-Bradley, 230 – 380 V, 50 Hz, en	**582471**
Allen-Bradley, 230 – 380 V, 60 Hz, en	**595188**
Allen-Bradley, 230 – 380 V, 60 Hz, es	**595189**
Siemens, 120 – 208 V, 60 Hz, en	**8176740**
Siemens, 230 – 380 V, 50 Hz, en	**8176741**
Siemens, 230 – 380 V, 60 Hz, en	**8176742**
Siemens, 230 – 380 V, 60 Hz, es	**8176743**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Pumps add-on (temperature) ➔ Page 102
– 1x Second pump add-on ➔ Page 102
– 1x Brazed plate heat exchanger (order no. 582400)
– 1x Heating/cooling unit ➔ Page 102
– 1x J-type thermocouple (order no. 582406)
– 1x Platinum RTD 100 (order no. 582407)
– 1x Temperature transmitter (HART)(order no. 582422)
– 1x Three-way pneumatic control valve (order no. 582430)
– 3x AC VFD (Ethernet) (Siemens or Allen-Bradley) ➔ Page 102
– 1x Drip tray (back) (order no. 582448)
– 1x Piping and accessories (temperature) – Add-on (order no. 582452)
– 1x Electrical distribution box (order no. 582453)

Recommended learning material, also order:
– Measurement, Workbook ➔ Page 159
– Process Control, Workbook ➔ Page 158
– Control Valves, User Guide ➔ Page 163
– Familiarization with the Training System, User Guide ➔ Page 159

Advanced Temperature Process Add-On
LabVolt Series 3531-2

Add-on package designed for the Temperature process learning system (3531-0 or -F) or the Pressure, flow, and level process learning system (3531-A or -E) equipped with the Temperature process add-on (3531-C or -Z). It offers the possibility to perform a set of advanced temperature control experiments. The main feature of the add-on resides in the use of electromagnetic flowmeters and RTDs coupled to the energy manager to obtain precise, real-time energy balances.

en	**582461**
es	**589037**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 3x Platinum RTD 100 (order no. 582407)
– 1x Electromagnetic flow transmitter (HART, transmitter on the right) (order no. 582413)
– 1x Electromagnetic flow transmitter (HART, transmitter on the left) (order no. 582419)
– 1x Energy manager (order no. 582435)
– 1x Accessories (temperature) - advanced (order no. 582450)

Recommended learning material, also order:
– Electromagnetic Flow Meters, Workbook ➔ Page 164
– Heat Exchangers and Advanced Temperature Measurement, Workbook ➔ Page 161

Pressure, Flow, Level, and Temperature Process Learning Systems

Temperature Process Training System (Allen-Bradley)
LabVolt Series 3531-0

Standalone system that introduces students to temperature processes and their associated instruments and control. It features a HART temperature transmitter and variable-frequency drives from Allen-Bradley.

120 V, 60 Hz, en	**582455**
120 V, 60 Hz, es	**582456**
240 V, 50 Hz, en	**582457**
240 V, 60, en	**588971**
240 V, 60, es	**589036**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Emergency switch station (order no. 582352)
– 1x Process workstation (temperature, pressure, flow, and level) (order no. 582388)
– 1x Instrumentation workstation (with heating/cooling unit) ➔ Page 104
– 1x Brazed plate heat exchanger (order no. 582400)
– 1x J-type thermocouple (order no. 582406)
– 1x Platinum RTD 100 (order no. 582407)
– 1x Temperature transmitter (HART) (order no. 582422)
– 1x Three-way pneumatic control valve (order no. 582430)
– 1x Electrical unit ➔ Page 105
– 1x Pneumatic unit (order no. 582433)
– 1x Color paperless recorder (order no. 595185)
– 4x AC VFD (Ethernet) ➔ Page 102
– 1x Instrumentation mounting pipe (order no. 582444)
– 1x Process supports (temperature) (order no. 582446)
– 1x Drip tray (front) (order no. 582447)
– 1x Drip tray (back) (order no. 582448)
– 1x Piping and accessories (temperature) - basic system (order no. 582449)
– 1x Electrical distribution box ➔ Page 102

Recommended learning material, also order:
– Measurement, Workbook ➔ Page 159
– Process Control, Workbook ➔ Page 158
– Control Valves, User Guide ➔ Page 163
– Familiarization with the Training System, User Guide ➔ Page 160

Additional equipment required to perform the exercises, also order:
– 1x CompactLogix PLC Bundle ➔ Page 114
– 1x Compressor ➔ Page 102
– 1x Touch Screen Graphic Terminal (Allen-Bradley) ➔ Page 116
– 1x Calibration Kit (order no. 588416)

Optional controller

ControlLogix PLC Bundle – Educational ➔ Page 114	
MicroLogix PLC bundle ➔ Page 114	
CompactLogix PLC bundle ➔ Page 114	
Siemens S7-1500 PLC bundle ➔ Page 114	
ABB CM30 PID controller bundle ➔ Page 115	
I/O Interface with LVProSim (9065-B) ➔ Page 111	

Software

Fuzzy Logic Software Add-on to RSLogix 5000 ➔ Page 172	
HART Software Configurator	588420
Step 7 professional and WinCC Advanced ➔ Page 173	
Studio 5000 Logix Designer Lite Edition ➔ Page 172	
Studio 5000 Logix Designer Full Edition ➔ Page 172	
FactoryTalk View ME Studio ➔ Page 173	

Optional equipment

Process control signal tower	587869
Indicator-light/push-button station	587871
Gasketed plate heat exchanger	588309
Shell and tube heat exchanger (1 pass)	588310
Shell and tube heat exchanger (4 pass)	588311
Pneumatic control valve (with digital positioner, HART) - DVC 2000	588357
Pneumatic control valve (with positioner, Fisher 3660)	588358
Pneumatic control valve	582424
Electric control valve	588360
Pneumatic control valve with digital positioner (HART) - DVC 6200	588363
Solenoid valve	582426
Ball valve	588365
Pneumatic control valve for air with a positioner - Fisher 3660	588367
Pneumatic control valve for air with digital positioner (HART) - DVC 6200	588368
Three-way pneumatic control valve with digital positioner (HART) - DVC 2000	588372
Three-way pneumatic control valve with positioner (Fisher 3660)	588373
Three-way pneumatic control valve	582430
Three-way pneumatic control valve with digital positioner (HART) - DVC 6200	588376
Touch-Screen Computer for SCADA ➔ Page 116	
Spare parts kit 1 for 3531	763511
Storage station	588301

Optional measurement

Digital pressure gauge (low range)	588300
Orifice plate	588315
Pitot tube	588316
Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Electromagnetic flow transmitter (HART, transmitter on the left)	582419
Vortex flow transmitter (HART)	588320
Coriolis flow transmitter (HART)	588323
Paddle wheel flow transmitter	588326
Pressure switch (with analog output)	588328
Ultrasonic flow transmitter (HART)	588330
Pressure transmitter (HART)	588333
Ultrasonic level transmitter (HART)	588337
Guided-radar level transmitter (HART)	589127
Vibrating fork level switch	588344
Conductivity level switch	588346
Float switch	588348
Capacitive level transmitter (HART)	588350
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419
HART software configurator	588420

Temperature Process Training System (Siemens)
LabVolt Series 3531-F

Standalone system that introduces students to temperature processes and their associated instruments and control. It features a HART temperature transmitter and variable-frequency drives from Siemens.

120 V, 60 Hz, en	**594539**
240 V, 50 Hz, en	**594540**
240 V, 60, en	**595850**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Emergency switch station (order no. 582352)
– 1x Process workstation (temperature, pressure, flow, and level) (order no. 582388)
– 1x Instrumentation workstation (with heating/cooling unit) ➔ Page 104
– 1x Brazed plate heat exchanger (order no. 582400)
– 1x J-type thermocouple (order no. 582406)
– 1x Platinum RTD 100 (order no. 582407)
– 1x Temperature transmitter (HART) (order no. 582422)
– 1x Three-way pneumatic control valve (order no. 582430)
– 1x Electrical unit ➔ Page 105
– 1x Pneumatic unit (order no. 582433)
– 1x Color paperless recorder (order no. 595185)
– 4x AC VFD (Ethernet) ➔ Page 102
– 1x Instrumentation mounting pipe (order no. 582444)
– 1x Process supports (temperature) (order no. 582446)
– 1x Drip tray (front) (order no. 582447)
– 1x Drip tray (back) (order no. 582448)
– 1x Piping and accessories (temperature) - basic system (order no. 582449)
– 1x Electrical distribution box ➔ Page 102

Recommended learning material, also order:
– Measurement, Workbook ➔ Page 159
– Process Control, Workbook ➔ Page 158
– Control Valves, User Guide ➔ Page 163
– Familiarization with the Training System, User Guide ➔ Page 160

Additional equipment required to perform the exercises, also order:
– 1x Compressor ➔ Page 102
– 1x Calibration kit (order no. 588416)
– 1x Industrial PC HMI (Siemens) (order no. 589672) or a Large Touch-Screen Computer ➔ Page 41 with PLC Software Step 7 ➔ Page 173

Optional controller

ControlLogix PLC Bundle – Educational ➔ Page 114	
MicroLogix PLC bundle ➔ Page 114	
CompactLogix PLC bundle ➔ Page 114	
ABB CM30 PID controller bundle ➔ Page 115	
I/O Interface with LVProSim (9065-B) ➔ Page 111	

Software

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HART Software Configurator	588420
Step 7 professional and WinCC Advanced ➔ Page 173	
Studio 5000 Logix Designer Lite Edition ➔ Page 172	
Studio 5000 Logix Designer Full Edition ➔ Page 172	
FactoryTalk View ME Studio ➔ Page 173	

Optional equipment

Process control signal tower	587869
Indicator-light/push-button station	587871
Gasketed plate heat exchanger	588309
Shell and tube heat exchanger (1 pass)	588310
Shell and tube heat exchanger (4 pass)	588311
Pneumatic control valve (with digital positioner, HART) - DVC 2000	588357
Pneumatic control valve (with positioner, Fisher 3660)	588358
Pneumatic control valve	582424
Electric control valve	588360
Pneumatic control valve with digital positioner (HART) - DVC 6200	588363
Solenoid valve	582426
Ball valve	588365
Pneumatic control valve for air with a positioner - Fisher 3660	588367
Pneumatic control valve for air with digital positioner (HART) - DVC 6200	588368
Three-way pneumatic control valve with digital positioner (HART) - DVC 2000	588372
Three-way pneumatic control valve with positioner (Fisher 3660)	588373
Three-way pneumatic control valve	582430
Three-way pneumatic control valve with digital positioner (HART) - DVC 6200	588376
Touch-Screen Computer for SCADA ➔ Page 116	
Spare parts kit 1 for 3531	763511
Storage station	588301

Optional measurement

Digital pressure gauge (low range)	588300
Orifice plate	588315
Pitot tube	588316
Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Electromagnetic flow transmitter (HART, transmitter on the left)	582419
Vortex flow transmitter (HART)	588320
Coriolis flow transmitter (HART)	588323
Paddle wheel flow transmitter	588326
Pressure switch (with analog output)	588328
Ultrasonic flow transmitter (HART)	588330
Pressure transmitter (HART)	588333
Ultrasonic level transmitter (HART)	588337
Guided-radar level transmitter (HART)	589127
Vibrating fork level switch	588344
Conductivity level switch	588346
Float switch	588348
Capacitive level transmitter (HART)	588350
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419
HART software configurator	588420

Pressure, Flow, Level, and Temperature Process Learning Systems

Boiler Simulation Add-On
LabVolt Series 3531-M

Add-on package designed for the Basic temperature process learning system (3531-0 or -F) or for the Basic pressure, flow, and level process learning system (3531-A or -E) equipped with the Temperature process add-on (3531-C or -Z). It utilizes the HART communication protocol. The boiler system can only be used by one team at a time.

A controller with a minimum of three inputs and two PID loops capable of both cascade and feedforward control and a 4-20 mA calibrator are also necessary. As both cascade and feedforward control schemes are used, the Advanced pressure, flow, and level process add-on (3530-M), is required.

en	**582478**
es	**582479**

Notes: These systems are not voltage-sensitive. They cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Orifice plate (air, high flow) (order no. 582404)
– 1x Rotameter (air) (order no. 582405)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x Solenoid valve (air) (order no. 582427)
– 1x Pneumatic control valve (air) (order no. 582428)

Recommended learning material, also order:
– Boiler Control, Workbook ➔ Page 161
– Control Valves, User Guide ➔ Page 163

Boiler Simulation Add-On
LabVolt Series 3531-P

Add-on package designed for the Basic temperature process learning system (3531-0 or -F) or the Basic pressure, flow, and level process learning system (3531-A or -E) equipped with the Air pressure and flow process add-on (3533-A).

A controller with a minimum of three inputs and two PID loops capable of both cascade and feedforward control and a 4-20 mA calibrator are also necessary. As both cascade and feedforward control schemes are used, the Advanced pressure, flow, and level process add-on (3530-M), is required.

en	**582482**

Notes: This system is not voltage-sensitive. It cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)

Recommended learning material, also order:
– Boiler Control, Workbook ➔ Page 161

Boiler Simulation (Water/Air) Add-on
LabVolt Series 3531-K (Allen-Bradley) or 3531-T (Siemens)

Add-on package designed for the Basic pressure, flow, and level process learning system (3531-A or -E) equipped with the Advanced pressure, flow and level process add-on (3530-M). It utilizes the HART communication protocol.

A controller with a minimum of three inputs and two PID loops capable of both cascade and feedforward control and a 4-20 mA calibrator are also necessary. As both cascade and feedforward control schemes are used, the Advanced pressure, flow, and level process add-on (3530-M), is required.

Allen-Bradley, 120 V, 60 Hz, en	**582474**
Allen-Bradley, 220 – 240 V, 50/60 Hz, en	**582475**
Allen-Bradley, 220 – 240 V, 50/60 Hz, es	**589035**
Siemens, 120 V, 60 Hz, en	**589883**
Siemens, 220 – 240 V, 50/60 Hz, en	**8176738**
Siemens, 220 – 240 V, 50/60 Hz, es	**8176739**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x 2nd Pump add-on (order no. 582398)
– 1x Orifice plate (air, high flow) (order no. 582404)
– 1x Rotameter (air) (order no. 582405)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x Solenoid valve (air) (order no. 582427)
– 1x Pneumatic control valve (air) (order no. 582428)
– 1x AC VFD (Ethernet) (Allen-Bradley or Siemens) ➔ Page 102

Recommended learning material, also order:
– Boiler Control, Workbook ➔ Page 161
– Control Valves, User Guide ➔ Page 163

Boiler Simulation (Water/Air) Add-On
LabVolt Series 3531-R (Allen-Bradley) or 3531-U (Siemens)

Add-on package designed for the Basic pressure, flow, and level process learning system (3531-A or -E) equipped with the Advanced pressure, flow and level process add-on (3530-M) and the Air pressure and flow process add-on (3533-A). It utilizes the HART communication protocol.

A controller with a minimum of three inputs and two PID loops capable of both cascade and feedforward control and a 4-20 mA calibrator are also necessary. As both cascade and feedforward control schemes are used, the Advanced pressure, flow, and level process add-on (3530-M), is required.

Allen-Bradley, 120 V, 60 Hz, en	**582484**
Allen-Bradley, 220 – 240 V, 50/60 Hz, en	**582485**
Allen-Bradley, 220 – 240 V, 50/60 Hz, es	**8176735**
Siemens, 120 V, 60 Hz, en	**589884**
Siemens, 220 – 240 V, 50/60 Hz, en	**8176736**
Siemens, 220 – 240 V, 50/60 Hz, es	**8176737**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
– 1x 2nd pump add-on (order no. 582398)
– 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
– 1x AC VFD (Ethernet) (Siemens or Allen-Bradley) ➔ Page 102

Recommended learning material, also order:
– Boiler Control, Workbook ➔ Page 161

pH and Conductivity Process Learning System

Calibration Instrumentation
A calibration device is an essential addition to allow calibration and maintenance of the transmitters, current-to-pressure converter, gauges, and control valves.

Fault Insertion
There are three different methods to insert faults: by accessing the component's fault panel, by changing the calibration parameters of a device from the instructor's computer, or by remotely modifying the state of I/O relays on a PLC from a computer or from a touch screen terminal.

Smart Devices
A few components feature a transmitter that can communicate via the HART communication protocol, which enables communication between devices by superimposing digital signals on top of the existing 4-20 mA outputs. Most of these devices can be configured via their alphanumeric display and/or push-buttons, or via a HART software configurator (strongly suggested).

Critical Parameters of Liquids and Solutions

These systems and their corresponding courses offer an introduction to measurement, control, and troubleshooting of pH and conductivity processes.

Two Workstations
The process workstation is the hub of the different processes to be investigated by learners. They install the appropriate instruments as described in the courses, which cover both the theory and practical learning activities.

The instrumentation workstation houses the electrical unit, which powers the equipment, as well as other electrical equipment. A controller (sold separately) is required to have a fully functional system. The instrumentation workstation is equipped with wiring ducts to organize wires and features a handy pull-out work surface.

Lockable, swiveling casters allow movement of the two workstations. A hitch mechanism links the workstations. Various optional components are available to customize the workstation.

Main Learning Objectives
- pH measurement, pH probes and smart transmitters
- Titration of strong acids, weak acids, and buffer solutions
- Feedback control and batch processes
- PID control of a batch pH process
- Feedback control of continuous pH processes
- Conductivity measurement, probes and smart transmitters
- Water deionization
- Ion-exchange resins applications
- Ion-exchange resins regeneration
- On-off conductivity control

Recommended Learning Material

Workbooks
→ Page 161

Campus license:

Order no.	585124

Courses/User Guides on Festo LX
- → Familiarization with the Training System - pH and conductivity
- → Process Control (pH and Conductivity)
- → Measurement (pH and Conductivity)

pH Process Learning System
LabVolt Series 3532-0 (Allen-Bradley) or 3532-2 (Siemens)

Standalone system that features all the equipment required to perform measurement, control, and troubleshooting exercises related to pH processes. It utilizes the HART communication protocol. It features an Allen-Bradley or Siemens AC drive and unmanaged switch.

Allen-Bradley, 120 V, 60 Hz	**588494**
Allen-Bradley, 220 – 240 V, 50/60 Hz	**588495**
Siemens, 120 V, 60 Hz	**589885**
Siemens, 220 – 240 V, 50/60 Hz	**8176734**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
- 1x Emergency switch station (order no. 582352)
- 1x Process workstation (order no. 588302)
- 1x Instrumentation workstation, assembled (order no. 588306)
- 1x Column (large diameter) (order no. 582394)
- 1x Upper tank (order no. 588307)
- 1x pH transmitter (HART) (order no. 588353)
- 1x Solenoid valve (order no. 582426)
- 1x Ball valve (order no. 588365)
- 3x Metering pump ➔ Page 102
- 1x Electrical unit ➔ Page 105
- 1x Color paperless recorder (order no. 595185)
- 1x AC drive (Ethernet) (Siemens or Allen-Bradley) ➔ Page 102
- 1x Water analyzer (order no. 588424)
- 1x Process supports (pH) (order no. 588428)
- 1x Piping and accessories, pH (Siemens or Allen-Bradley) ➔ Page 106
- 2x Chemical tank (order no. 588436)
- 1x Consumables kit 1 for 3532 (pH) (order no. 588438)
- 1x GFCI electrical distribution box ➔ Page 102

pH Process, Add-On
LabVolt Series 3532-A

Add-on package designed to be used in combination with a Basic pressure, flow, and level process learning system (3531-A or -E). It allows pH measurement and control experiments. It utilizes the HART communication protocol. It can be complemented by the Conductivity add-on.

120 V, 60 Hz	**588496**
220 – 240 V, 50/60 Hz	**588497**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
- 1x Upper tank (order no. 588307)
- 1x pH transmitter (HART) (order no. 588353)
- 1x Ball valve (order no. 588365)
- 3x Metering pump ➔ Page 102
- 1x Water analyzer (order no. 588424)
- 1x Process supports (pH) (order no. 588428)
- 1x Piping and accessories, pH ➔ Page 106
- 2x Chemical tank (order no. 588436)
- 1x Consumables kit 1 for 3532 (pH) (order no. 588438)
- 1x GFCI electrical distribution box ➔ Page 102

Conductivity Process, Add-On
LabVolt Series 3532-C

Add-on package designed to be used in combination with a pH process learning system (3532-0 or -2) or a Basic pressure, flow, and level process learning system (3531-A or -E) equipped with the pH Process add-on (3532-A). It allows conductivity measurement and control experiments. It utilizes the HART communication protocol.

Order no.	**588501**

Note: This system cannot be ordered or delivered in countries that require compliance to CE regulations. It is not voltage-sensitive.

Main components at a glance
- 1x Conductivity transmitter (HART) (order no. 588355)
- 1x Chemical tank (order no. 588436)
- 1x Deionization unit (order no. 588437)
- 1x Consumables kit 2 for 3532 (conductivity) (order no. 763510)

For all systems 3532-0, 3532-2, and 3532-C:

Required controller, please choose:

ControlLogix PLC bundle ➔ Page 114	
MicroLogix PLC bundle ➔ Page 114	
CompactLogix PLC bundle ➔ Page 114	
Siemens S7-1500 PLC bundle HART ➔ Page 114	
ABB CM30 PID controller bundle ➔ Page115	
I/O Interface with LVProSim ➔ Page 111	

Note: PLC bundles require the purchase of a corresponding HMI or touch-screen computer.

Optional equipment

Pressure

Pressure switch (with analog output)	611537
Pressure transmitter (HART)	588333
Digital pressure gauge (low range)	588300

Pneumatic control valves for air

With a positioner - Fisher 3660	588367
With digital positioner (HART) - DVC 6200	588368

Calibration kits

Calibration kit	588416
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART, FOUNDATION Fieldbus, Profibus PA)	588419

Software

FactoryTalk View ME Studio or ME Station➔ Page 173	
Fuzzy Logic Software Add-on to RSLogix 5000 ➔ Page 172	
HART software configurator	588420
HART/FOUNDATION Fieldbus software configurator	588422
PLC Software (Step 7 Professional) ➔ Page 173	

Additional optional accessories

Air Compressor ➔ Page 40	
Spare parts kit 1 for 3532	763512
Spare parts kit 2 for 3532	763513
Storage station	588301
Touch-screen computer mount	589678
Process control signal tower	587869
Indicator-light/push-button station	587871

Air Pressure and Flow Process Learning System

Calibration Instrumentation
An accurate calibration device is an essential addition to allow calibration and maintenance of the transmitters, current-to-pressure converter, gauges, and control valves.

Fault Insertion
There are three different methods to insert faults and develop troubleshooting skills: by accessing the component's fault panel, by changing the calibration parameters of a device from the instructor's computer, or by remotely modifying the state of I/O relays on a PLC from a computer or from a touch screen terminal.

Smart Devices
A few components feature a transmitter that can communicate via the HART communication protocol, which enables communication between devices by superimposing digital signals on top of the existing 4-20 mA outputs. Most of these devices can be configured via their alphanumeric display and/or push-buttons, or via a HART software configurator (strongly suggested).

Essential Knowledge for Gas Processing Plants

This system and its corresponding courses cover both the theory and practice of measurement, control, and troubleshooting of pressure and flow air processes.

The workstation houses the electrical and the pneumatic units, as well as the other components used in the experiments. A controller (sold separately) is required to have a fully functional system.

Because air process components and instrumentation can be mounted on the same workstation, this system is compact in size. Although some of the system components are pre-configured, the installation, wiring, and configuration of many devices must be done by the learners as part of the course.

The workstation is equipped with wiring ducts to organize wires and features a handy pull-out work surface. Lockable, swiveling casters allow movement of the workstation. Various optional components are available to customize the workstation.

Main Learning Objectives
- Pressure measurement with a smart transmitter
- Flow measurement using a rotameter and a smart transmitter
- Tuning a pressure control loop using Ziegler-Nichols and ultimate-cycle methods
- Tuning a flow control loop with the trial-and-error method
- Troubleshooting a process or control system

Recommended Learning Material

Workbooks
→ Page 162

Campus license:
Order no. 585124

Courses on Festo LX

→ Measurement (Air, Pressure, and Flow)
→ Process Control (Air, Pressure, and Flow)
→ Control Valves

Air Pressure and Flow Process Learning System
LabVolt Series 3533-0 (Allen-Bradley) or 3533-2 (Siemens)

Standalone system that features all the equipment required to perform measurement, control, and troubleshooting exercises related to air flow and pressure processes. It utilizes the HART communication protocol. The piping and accessories package includes an unmanaged switch from either Allen-Bradley or Siemens.

Allen-Bradley, 120 V, 60 Hz	**588505**
Allen-Bradley, 220 –240 V, 50/60 Hz	**588506**
Siemens, 120 V, 60 Hz	**589886**
Siemens, 220 –240 V, 50/60 Hz	**8165802**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance
- 1x Instrumentation workstation (assembled) (order no. 588306)
- 1x Emergency switch station (order no. 582352)
- 1x Digital pressure gauge (high range) (order no. 582387)
- 1x Air tank (large) (order no. 588312)
- 1x Air tank (small) (order no. 588313)
- 1x Muffler assembly (order no. 588314)
- 1x Orifice plate (air, high flow) (order no. 582404)
- 1x Rotameter (air) (order no. 582405)
- 1x Differential-pressure transmitter (HART, low range) (order no. 582410)
- 1x Solenoid valve (air) (order no. 582427)
- 1x Pneumatic control valve (air) (order no. 582428)
- 1x Electrical unit → Page 105
- 1x Pneumatic unit (order no. 582433)
- 1x Color paperless recorder (order no. 595185)
- 1x Instrumentation mounting pipe (order no. 582444)
- 1x Piping and accessories, air (Allen-Bradley or Siemens) → Pag→e 106

Air Pressure and Flow Process, Add-On
LabVolt Series 3533-A

Add-on package designed to be used in combination with a Basic pressure, flow, and level process learning system (3531-A or -E) or a Basic temperature process learning system (3531-0 or -F). It allows measurement and control experiments related to pressure and flow of compressed air.

Order no.	**588507**

Note: This system cannot be ordered or delivered in countries that require compliance to CE regulations. It is not voltage-sensitive.

Main components at a glance
- 1x Air tank (large) (order no. 588312)
- 1x Air tank (small) (order no. 588313)
- 1x Muffler assembly (order no. 588314)
- 1x Orifice plate (air, high flow) (order no. 582404)
- 1x Rotameter (air) (order no. 582405)
- 1x Solenoid valve (air) (order no. 582427)
- 1x Pneumatic control valve (air) (order no. 582428)
- 1x Instrumentation mounting pipe (order no. 582444)
- 1x Piping and accessories, air (order no. 588430)

Requirements for all Air Pressure/Flow Process systems:
- A reliable source of compressed air from a central air supply or portable unit able to deliver air at a minimal flow of 110 L/min (4 CFM), with a pressure of 620 kPa (90 PSI). Compressed air units are also available in the optional accessories.
- A personal computer
- The stand-alone system requires a controller from the selection of available PLCs.

Required controller, please choose:

ControlLogix PLC Bundle → Page 114	
MicroLogix PLC Bundle → Page 114	
CompactLogix PLC Bundle → Page 114	
Siemens S7-1500 PLC Bundle HART → Page 114	
ABB CM30 PID controller bundle → Page 115	
I/O Interface with LVProSim → Page 111	

Note: PLC bundles require the purchase of a corresponding HMI or touch-screen computer.

Optional equipment

Pressure

Pressure transmitter (HART)	588333
Digital pressure gauge (low range)	588300

Pneumatic control valves for air

With a positioner - Fisher 3660	588367
With digital positioner (HART) - DVC 6200	588368

Calibration kits

Calibration kit	588416
Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419

Software

FactoryTalk View ME Studio or Studio → Page 173	
Fuzzy Logic Software Add-on to RSLogix 5000 → Page 172	
HART software configurator	588420
HART/FOUNDATION Fieldbus software configurator	588422
PLC Software (Step 7 Professional) → Page 173	

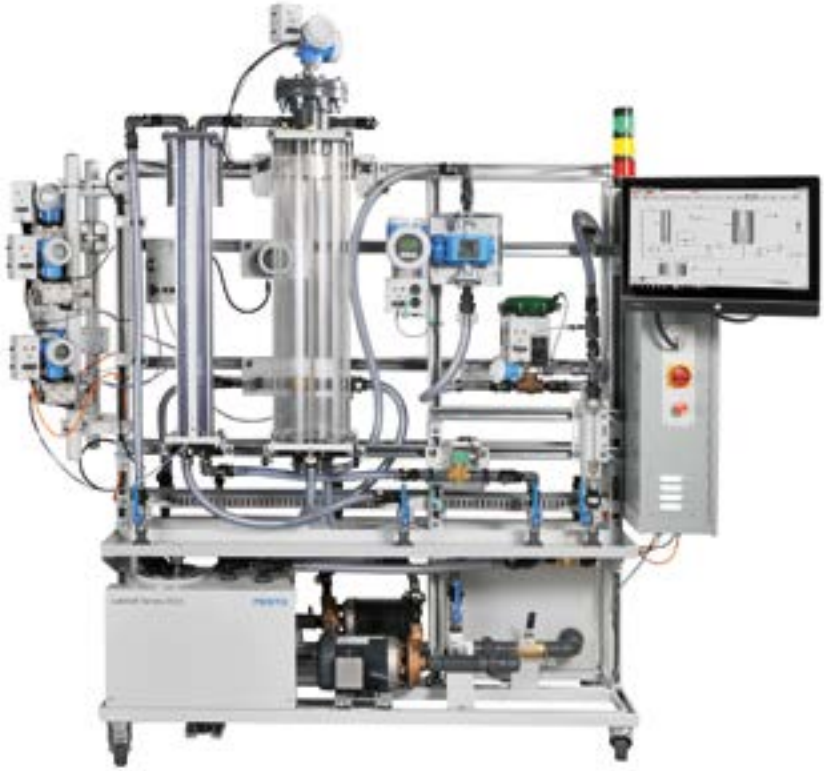
Additional optional accessories

Air Compressor → Page 40	
Compressor → Page 102	
Storage station	588301
Touch-screen computer mount	589678
Process control signal tower	587869
Indicator-light/push-button station	587871
Spare parts kit for 3533	763514
Touch-Screen Computer for SCADA → Page 116	
Industrial PC HMI (Siemens) → Page 116	
Touch-screen computer → Page 116	
Touch-screen graphic terminal, Allen-Bradley → Page 116	

PlantPAx Distributed Control System Demonstrator

PID Process Control and Control Strategies

→ **Video**



The Nerve Center of the Industry
Designed for training purposes, the PlantPAx Distributed Control System (DCS) Demonstrator replicates a DCS showing real-life process applications across a wide range of industries, including water and wastewater, oil refining, petrochemical, and food processing.

It conveys essential skills for instrumentation and process technicians and engineers learn who operate DCS systems, manage alarms, and install, configure, and troubleshoot equipment.

A user guide introduces students to the configuration and use of instruments that control and monitor industrial processes, including temperature, pressure, flow, and level process variables.

PID Control
The demonstrator is configured to teach different types of PID process control and types of control strategies.

Two level PID control loops work simultaneously to maintain a stable level in each column even when disturbance occurs. The PID level control loop of the large column works in Cascade mode with the flow rate and use a pneumatic control valve as the final element. A pressure control loop maintains a stable pressure at the inlet of the large column. The pressure control loop uses the centrifugal pump with an industrial variable frequency drive to maintain the desired pressure.

Batch Sequencer
The system also features a sequencer performing an automatic start-up sequence to facilitate operation. A batch sequencer allows fill-up of the small column with four different amounts of water. Running the batches allows students to see the impact on the process stability. For safety purposes and damage prevention, the system includes interlocks similar to the ones in the process industry.

Industrial Communication Protocols
The demonstrator uses four different communication protocols between smart devices and smart transmitters. The HART protocol enables communication between devices by superimposing digital signals on top of the existing 4-20 mA outputs. The FOUNDATION Fieldbus, Profibus PA and EtherNet/IP protocols work in the same manner as a Local Area Network (LAN) for smart devices.

Each smart transmitter has the option to be configured manually or through a computer using either a DCS system or an optional configuration software. It is also possible to edit the HMI interface and the PLC program to change the control strategies using two optional software such as FactoryTalk Site Edition Studio and RSLogix 5000 Full Edition.

PlantPAx DCS Demonstrator

120 V, 60 Hz	**589631**
220 – 240 V, 50/60 Hz	**8095450**

Note: These systems cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:
Instrumentation mounting pipes, differential-pressure and temperature transmitters, three-valve manifold, small- and large-diameter columns, radar level transmitter with remote display, electromagnetic flow transmitter, J-type thermocouple, signal tower, touchscreen, high-speed computer, pneumatic control valve, rotameter, solenoid valve, venturi tube, disconnect switch and emergency push-button, two 60-liter (16 gallons) tanks, two pumps, each coupled to a three-phase motor, control panel (two AC drives, EtherNet/IP to Profibus-PA bridge, EtherNet/IP to FOUNDATION Fieldbus bridge, PLC, Ethernet managed switch)

Required accessories, also order:

Compressor (60L/min)	On request
FactoryTalk View SE station ➔ Page 173	
Calibration kit	588416

Recommended accessories:

Calibration kit with pressure modules	588417
Calibration kit (HART)	588418
Calibration kit (HART and FOUNDATION Fieldbus)	588419
Studio 5000 Logix Designer Full Edition, commercial or education ➔ Page 172	
HART Software Configurator	588420
HART/FOUNDATION Fieldbus software configurator	588422

Topic Coverage
The user guide of the demonstrator covers the following topics:
– Familiarization with the demonstrator (electric control valve, process control demonstrator, control panel, disconnect switch and emergency push-button, AC drives, PLC fundamentals, HMI, process columns)
– Fundamentals of radar level transmitters
– Fundamentals of the electromagnetic flow meters
– Basic control valve theory
– Pneumatic control valve with I/P converter
– Control valve




Three-Phase Separator

Practical Training in the Crude Oil Separation Process

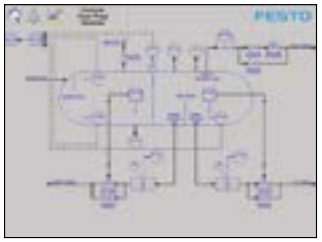
→ **Video**

System with instrumentation shown with optional temperature transmitter and thermocouple

Industry-Relevant Skills
The Three-Phase Separator demonstrates the fundamentals of oil separation, such as the effect of gravity, the effect of layer thickness, viscosity, retention time, density difference, vessel pressure, and oil/water/gas ratio.

This helps operators, instrumentation technicians, and process engineers to develop industry-relevant skills for successfully performing operation, troubleshooting, and maintenance tasks in the oil and gas industry.

Observable Flow and Processes
The vessel features standard zones of three-phase separators: inlet, flow distribution, gravity separation, and outlet. An inline mixer emulates crude oil by creating an emulsion with water, air, and oil. The separation process itself then begins.



The large, clear acrylic vessel and clear PVC piping allow for observation of flows and of internal components (diverter plate, perforated baffle plate, coalescing plates, weir plate, demister pad, etc.) during operation. This boosts student understanding of the process itself and the role of each component. Safety is ensured with an industrial pressure relief valve and a rupture disc.

System Configurations
Two configurations are available:
– Three-Phase Separator with basic pneumatic control for training operators;
– Three-Phase Separator with Instrumentation, including smart devices, for training instrumentation technicians as well as process engineers.

It is also possible to upgrade the basic pneumatic control system to a system with instrumentation using the instrumentation add-on.

Festo Didactic is part of the Rockwell Automation Machine Builder Partner Program and has contributed to its University Partnership Program.

Three-Phase Separator with Basic Pneumatic Control
Three-phase separator workstation with a back pressure valve, a pneumatic float level controller, a pneumatic displacer level controller, a safety pressure valve, and a pneumatic control valve. The Instrumentation add-on can be added.

120 V, 60 Hz	**8094286**
220 – 240 V, 50/60 Hz	**8094287**

Three-Phase Separator with Instrumentation
Three-phase separator workstation with a back pressure valve, a pneumatic float level controller, a pneumatic displacer level controller, a safety pressure valve, an orifice plate (air-high flow), a differential-pressure transmitter (HART, low range), a turbine flow transmitter, a pressure transmitter (HART), a vibrating fork level switch, a multi-parameter guided-radar level transmitter, a pneumatic control valve, and a touch screen graphic terminal (Allen-Bradley).

120 V, 60 Hz	**8094289**
220 – 240 V, 50/60 Hz	**8094290**

Recommended accessories:

Three-phase separator, instrumentation add-on (120 V, 60 Hz)	8094292
Three-phase separator, instrumentation add-on (220 – 240 V, 50 /60 Hz)	8110644
J-type thermocouple	582406
Electromagnetic flow transmitter (HART, transmitter on the right)	582413
Coriolis flow transmitter (HART)	588323
Temperature transmitter (HART)	582422
HART software configurator	588420
Calibration kit	588416
Calibration kit with pressure modules	588417
FactoryTalk View Studio ME ➔ Page 173	

Interactive Measurement and Control Experience
Smart instrumentation is used not only for measurement, but also for optimization of the separation process, which reduces operation cost and maximizes operator and asset safety.

The Three-Phase Separator allows students to perform experiments with measurement devices and control components commonly found in industry. Students get first-hand experience with Rockwell Automation and Endress+Hauser technologies, both of which are used on a large scale in the oil and gas industry.

The system is monitored using PlantPAx, as is usually the case in real world scenarios.

An Allen-Bradley CompactLogix PLC monitors processes. Two Allen-Bradley variable frequency drives allow the user to change operating flow rates, as well as water and oil pressure. Gas flow measurement is possible thanks to a differential pressure transmitter.

The HMI for data acquisition and alarm management – a large PanelView Plus 7 touch panel – uses the standard PlantPAx library. It also allows for fault insertion during troubleshooting exercises.

Learning Objectives
Basic control system:
– Become familiar with three-phase separation mechanisms and design of separator vessels
– Experiment with the effect of various parameters on separation efficiency
– Adjust pneumatic level controllers
– Configure and operate specific instrumentation used with three-phase separators
– Read piping and instrumentation diagrams
– Practice troubleshooting

Additional objectives with the system with instrumentation:
– Use an HMI and manage alarms efficiently
– Learn about PLCs
– Install and use different types of smart instrumentation
– Get acquainted with the HART communication protocol (optional)

Recommended Learning Material

Workbook

Campus license:

Order no.	8099622

Notes: The campus license is currently offered in English only, but other languages will be added as they become available. Campus licenses include the student and the instructor PDF versions of the workbooks “Three-Phase Separator Basic Control” and “Three-Phase Separator Instrumentation”.

Courses on Festo LX

➔ Three-Phase Separator – Basic Control

➔ Three-Phase Separator – Instrumentation

Transmitters and Primary Flow Elements

Pressure

1

2

3

4

5

6

1 **Pressure Transmitter**
Rugged and reliable gauge pressure measurement device for the fluids in the Pressure, Flow, Level, and Temperature Process Learning Systems as well as for the Three-Phase Separator. Available in two versions:

HART	**588333**
Bluetooth, Heartbeat, HART	**611544**

2 **Differential-Pressure Transmitter (Low Range)**
Device designed to operate in a range going from a difference of 0 kPa (0 psi) to an absolute difference of 50 kPa (7.3 psi).

HART	**582410**
Bluetooth, Heartbeat, HART	**611539**
Profibus-PA	**582412**

3 **Differential-Pressure Transmitter (Medium Range)**
Device designed to operate in a range going from a difference of 0 kPa (0 psi) to an absolute difference of 300 kPa (45 psi). It is compatible with the HART communication protocol.

Order no.	**588335**

4 **Differential-Pressure Transmitter (High Range)**
Device designed to operate in a range going from a difference of 0 kPa (0 psi) to an absolute difference of 1.6 MPa (240 psi).

Hart	**582408**
Profibus-PA *	**588318**
Bluetooth, Heartbeat, HART	**611538**

* Can only be used with the PlantPAx demonstrator.

5 **Digital Pressure Gauge**
Device that provides a direct reading of the pressure in one of many convenient measurement units. It features two interconnected pressure ports, an LCD display, and is equipped with a mounting bracket for simple installation on the workstation. Available in two versions: high range (0-100 psi or 0-690 kPa) and low range (0-30 psi or 0-200 kPa).

Low range	**582387**
High range	**588300**

6 **Pressure Switch With Analog Output**
Digital pressure gauge ranging from 0 kPa (0 psi) to 1000 kPa (145 psi). It features a 4-20 mA output signal proportional to a user-defined upper value. A relay can be configured so as to become activated when the measured pressure rises above a threshold value. Recommended learning material, also order: “Pressure and Level Switches” ➔ Page 165

IO-Link	**611537**

Note: An IO-Link master module is required; one is included in the training package TP 1312 Smart Sensors, sold separately ➔ Page 118.

Transmitters and Primary Flow Elements

Flow

1 **Ultrasonic Flow Transmitter**
Device that infers the flow rate by measuring the transit-time differential between an ultrasonic pulse traveling upstream with one traveling downstream. The ultrasonic pulses are emitted by two clamp-on sensors installed on a clear PVC pipe. Recommended learning material, also order: "Ultrasonic Flow Transmitter" ➔ Page 165

Order no.	**588330**

2 **Electromagnetic Flow Transmitter**
Device that relies on the conductive properties of liquids traveling across a magnetic field to measure the flow in a pipe. It is insensitive to vibrations and causes almost no pressure loss. Temperature variations of the fluid are automatically compensated by the device for accurate flow rate measurement. The variant "transmitter on the left" must be used if the transmitter is to be installed on the second team side of the Process Workstation. Recommended learning material, also order: "Electromagnetic Flow Meters" ➔ Page 164

Transmitter on the right

HART	**582413**
Ethernet	**588319**
WLAN, Heartbeat	**611542**

Transmitter on the left

HART	**582419**
Ethernet	**582418**
WLAN, Heartbeat	**8184574**

3 **Paddle Wheel Flow Transmitter**
Device that provides an accurate measurement of the flow rate by inserting a paddle wheel into the flow stream. A sensor measures the velocity of the paddle wheel which is converted into a direct reading of the flow rate displayed on a remote digital display. Also features a 4 – 20 mA output signal. Recommended learning material, also order: "Paddle Wheel Flow Transmitter" ➔ Page 165

Order no.	**588326**

4 **Vortex Flow Transmitter**
Device that uses the dynamic properties of fluids to create small vortexes whose frequency of detection is proportional to the flow in a pipe. This device is typically used in the industry to measure the flow of high or low temperature fluids. Recommended learning material, sold separately: "Vortex Flow Transmitter" ➔ Page 164

Hart	**588320**
Hart, Heartbeat	**611543**

5 **Coriolis Flow Transmitter**
Flow measurement device that uses the Coriolis forces generated when a fluid goes through the flow meter to measure the mass flow of liquid in a pipe. Since it measures the mass flow, the measurement is not affected by changes in the temperature, viscosity, and density of the fluid. Recommended learning material, also order: "Coriolis Flow Transmitter" ➔ Page 164

HART	**588323**
WLAN, Heartbeat	**611540**

6 **Pitot Tube**
Flow measurement device relying on a small tube inserted in the flow stream to measure the dynamic pressure of a fluid from which the flow rate can be inferred. It presents a low pressure-loss and clearly illustrates the working principles of such a device. It requires the use of a differential-pressure transmitter to transform the pressure drop into a usable flowrate value. Recommended learning material, also order: "Flow Primary Elements" ➔ Page 163

Order no.	**588316**

7 **Picomag Electromagnetic Flow Meter**
Magnetic-inductive flow meter Picomag. Operation and maintenance via the SmartBlue app. Recommended learning material, also order: "Electromagnetic Flow Meters" ➔ Page 164

Bluetooth, IO-Link	**611547**

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Transmitters and Primary Flow Elements

Flow, Level

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1 **Orifice Plate**
Flow measurement device using the Venturi effect to produce a pressure drop from which the flow rate can be inferred. This primary element consists of a thin metal plate with a sharp-edged upstream aperture (orifice) inserted between two flanges at the location where the flow must be determined. β ratio: 0.55, 0.65, 0.75. Provided with three different plates. It requires the use of a differential-pressure transmitter to transform the pressure drop into a usable flow rate value.

Order no. **588315**

2 **Orifice Plate (Air)**
Flow measurement device designed for air applications. It uses the Venturi effect to produce a pressure drop from which the flow rate can be inferred. This primary element consists of an orifice precisely machined in a brass tube. It requires the use of a differential-pressure transmitter to directly convert the pressure drop into a usable flow rate value.

Order no. **582404**

3 **Venturi Tube**
Flow measurement device that relies on the Venturi effect to produce a pressure drop from which the flow rate can be inferred. This apparatus provides a clear picture of the phenomena and offers a low permanent pressure-loss. It requires the use of a differential-pressure transmitter to transform the pressure drop into a usable flow.

Order no. **582403**

4 **Rotameter**
Variable area flow meter calibrated to measure the flow of water in the process loop. It provides a direct visual reading of the flow rate by observing the position of the float inside the transparent graduated tube.

Order no. **582402**

5 **Rotameter (Air)**
Variable area flow meter specifically calibrated to measure the air flow in a compressed air setup. It provides a direct visual reading of the flow by simply observing the position of a float inside the transparent graduated tube.

Order no. **582405**

6 **Conductivity Level Switch**
Level limit switch made of three probe rods of different lengths. When two of the probe rods come in contact with the conductive liquid, a measurable current flows between the two rods which allows the student to detect that a certain level has been reached. The three-rod configuration allows the detection and the monitoring of a low and a high level of liquid in the column of the Pressure, Flow, Level, and Temperature Process Learning Systems. With two output relays. Recommended learning material, also order: “Pressure and Level Switches” ➔ Page 165

Order no. **588346**

7 **Float Switch**
Level limit switch triggered when a float is raised by buoyancy forces as the level of liquid in the column reaches the float. The device has one contact which can be configured to be either normally closed or normally open. Its length can also be adjusted to accommodate the detection of different levels. Recommended learning material, also order: “Pressure and Level Switches” ➔ Page 165

Order no. **588348**

1 **Ultrasonic Level Transmitter**
Measurement device that uses sound waves to detect the level of liquid in the column of the Pressure, Flow, Level, and Temperature Process Learning Systems. This transmitter includes an ultrasonic sensor/emitter installed on the flange of the column and a transmitter supporting the HART communication protocol. The device can be configured manually, but it is strongly recommended to use an optional Software Configurator. Recommended learning material, also order: "Ultrasonic Level Transmitter (HART)" ➔ Page 165

Order no.	**588337**

2 **Guided-Radar Level Transmitter**
Measurement device that uses electromagnetic waves to detect the level of liquid in the column of the Pressure, Flow, Level, and Temperature Process Learning Systems. Changes in the density, conductivity, and composition of the process fluid do not affect this sensor. This transmitter includes a rod probe to guide the signal in the column and a transmitter. It can be configured manually via its alphanumeric display and push-buttons, a software configurator is required to efficiently program advanced functions. Recommended learning material, also order: "Radar Level Transmitters" ➔ Page 166

Hart*	**589127**
Bluetooth, Heartbeat, HART	**611545**

* Software configurator required
➔ Page 101

3 **Radar Level Transmitter**
Device that uses electromagnetic waves to detect the level of liquid in the column of the Pressure, Flow, Level, and Temperature Process Learning Systems. It includes a horn antenna to direct the signal and a transmitter. It can be configured manually via its alphanumeric display and push-buttons, a software configurator is required to efficiently program advanced functions.

HART*	**589125**
Bluetooth, Heartbeat, HART	**589125**

* Software configurator required
➔ Page 101

4 **Capacitive Level Transmitter**
Level measurement device based on the change in the capacitance of a capacitor as the level of fluid constituting the capacitor varies. It includes a 4–20 mA output to monitor the level in the column and is compatible with the HART communication protocol. The device can also be configured manually via its alphanumeric display and push-buttons. Recommended learning material, also order: "Capacitive Level Transmitter" ➔ Page 165

Order no.	**588350**

5 **Vibrating Fork Level Switch**
Level limit switch that detects whether or not the level of water in the column has reached a set level. The fork of the switch is continuously excited at its natural resonance frequency. When the level of liquid reaches the fork, the frequency of oscillation changes. This is detected by the device which triggers a relay. The device allows continuous monitoring and is suitable for overspill-protection setups. Recommended learning material, also order: "Pressure and Level Switches" ➔ Page 165

Order no.	**588344**

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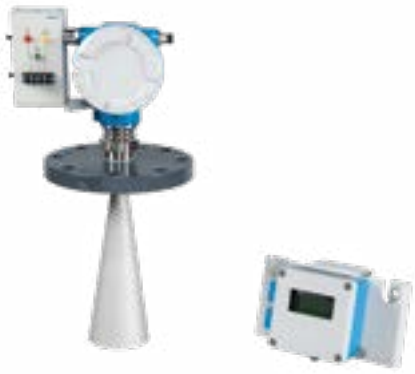

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Transmitters and Primary Flow Elements

pH, Conductivity, Temperature, Heat Exchangers

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1 **Temperature Transmitter**
Device that displays the temperature measured by up to two devices such as RTDs or thermocouples. It also outputs either a 4-20 mA signal compatible with the HART communication protocol. The configuration of this transmitter can only be modified using a software configurator.

Order no. **582422**

2 **Platinum RTD 100**
Resistive thermal device which uses the change of electrical resistance of platinum with changing temperature to determine the temperature. The model is provided with a T-shaped connector and a thermowell for inclusion in the process loop.

Order no. **582407**

3 **J-Type Thermocouple**
Device that uses the thermoelectric effect to perform precise measurement of temperature. The model is provided with a T-shaped connector and a thermowell for inclusion in the process loop.

Order no. **582406**

4 **Brazed Plate Heat Exchanger**
Compact type of exchanger made of a series of thin, usually corrugated plates which create cavities in which the process fluids flow. Each plate has four corner ports (one inlet, and one outlet for each of the two fluids). When the plates are assembled, the ports line up to give access to the cavities. For each cavity, a pair of gaskets or restrictions alternately blocks the access to one of the two fluids and lets the other one flow from the inlet to the outlet.

Order no. **582400**

5 **Gasketed Plate Heat Exchanger**
Device that features a series of thin, thermally conductive plates that create cavities or channels for the two fluids. By alternating the fluid that circulates in each channel between fluids 1 and 2, a multi-layered and compact structure is created and allows an efficient heat transfer to take place. Plates can be added or removed to change the surface area of the where the heat exchange takes place.

Order no. **588309**

1/2 **Shell and Tube Heat Exchanger**
Made of a series of tubes around which a watertight shell is built. A given fluid flows in the tubes while another one flows in the shell around the tubes.

1 1-pass	**588310**
2 4-pass	**588311**

3 **pH Transmitter (HART)**
Features a one-channel Liquiline M CM42 transmitter from Endress+Hauser for pH, conductivity or oxygen measurement. A pH probe measures the electrochemical potential of a solution to determine its pH. The device displays the pH measured by the probe and has a 4-20 mA output to transmit the measurement to a controller. It uses the HART protocol, 4–20 mA.

Order no.	**588353**

4 **pH Transmitter (HART)**
Features a 4-channel Liquiline CM444 transmitter from Endress + Hauser for pH, ORP, conductivity, oxygen, chlorine, turbidity, and sludge level measurement, and more. It uses the HART protocol, 4–20 mA.

Heartbeat	**611546**

5 **Conductivity Transmitter**
Device that features a probe which measures the conductivity of a solution. The probe has a large measurement range and a high durability. The device displays the conductivity measured by the probe and has an output to transmit the measurement to a controller. Supports the HART protocol.

Order no.	**588355**

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Valves

Pressure, Flow, Level, Temperature, Air

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1 **Pneumatic Control Valve**
Industrial bronze control globe valve of the equal percentage type and is normally open. It includes a current-to-pressure converter which transforms a 4-20 mA input signal into a pneumatic output signal sent to the actuator of the control valve. Recommended learning material, also order: “Control Valves” ➔ Page 163

Order no.	**582424**

2 **Electric Control Valve**
Industrial bronze control globe valve of the equal percentage type and is normally open. This device transforms a 4-20 mA input signal directly into a specific opening of the control valve. A 0-10 V dc output is used as a feedback signal to monitor the position of the valve.

Order no.	**588360**

3 **Pneumatic Control Valve with Digital Positioner**
Industrial bronze control globe valve of the equal percentage type and is normally open. It includes a digital valve controller which transforms a 4-20 mA input signal into a pneumatic output signal sent to the actuator of the control valve. The controller has a high-performance positioner. Recommended learning material, also order: “Control Valves” ➔ Page 163

HART, DVC 2000	**588357**
HART, DVC 6200	**588363**

4 **Pneumatic Control Valve (with Positioner, Fisher 3660)**
Industrial bronze control globe valve of the equal percentage type and is normally open. It includes a current-to-pressure converter which transforms a 4-20 mA input signal into a pneumatic output signal sent to the actuator of the control valve. A pneumatic positioner provides a valve position proportional to the pneumatic signal. Recommended learning material, also order: “Control Valves” ➔ Page 163

Order no.	**588358**

5 **Solenoid Valve**
A simple unidirectional, direct-acting, normally closed valve made of brass which can be used to effect on/off control on a process. It is fully open when a 24 V dc signal is applied to the electrical connectors wired to the solenoid.

Order no.	**582426**

6 **Ball Valve**
Device used for on/off control of ports in the Pressure, Flow, Level, and Temperature Process Learning Systems. It can also be used to throttle and manually regulate the flow in a process loop.

Order no.	**588365**

7 **Three-Way Pneumatic Control Valve**
Industrial bronze control globe valve of the equal-percentage type designed to be used in mixing mode (two inlets, one outlet). Normally open on the lower port.

Pneumatic control	**582430**
Positioner (Fisher 3660)	**588373**
With dig. pos. (HART) DVC 6200	**588376**
With dig. pos. (HART) DVC 2000	**588372**

Pneumatic Control Valve (Air)
Normally closed stainless steel valve with 1/4 inch connectors. It features a rugged construction and good control characteristics over the air flow. It includes a current-to-pressure converter which transforms a 4-20 mA input signal into a pneumatic signal sent to the actuator of the valve.

8 Pneumatic control	**582428**
Positioner (Fisher 3660)	**588367**
HART, with dig. pos. DVC 6200	**588368**

9 **Muffler Assembly**
Device composed of two air inlet ports connected to a muffler to reduce exhaust noise. A graduated hand valve for each air inlet restricts the access to the muffler while a third one is used to link the two input lines.

Order no.	**588314**

Components
Calibrators, Configurators

1 **Calibration Kit**
This kit includes the equipment required to precisely adjust the control valves and to perform diagnostic tests on electrical devices. The kit contains a Fluke 725 multifunction process calibrator which can act as a source and measure different parameters. A calibration pump completes the kit and is used to calibrate pressure devices.

Order no.	**588416**

Calibration Kit with Pressure Modules
This kit is a variant of the Calibration Kit that also includes a Fluke 725 multifunction process calibrator and pressure modules (a test pump and two pressure gauges) for reliable measurement of pressure directly on the Fluke calibrator.

Order no.	**588417**

2 **Calibration Kit (HART)**
This kit includes the equipment required to precisely adjust the control valves, perform diagnostic tests, and interface with smart devices. It contains a Fluke 754 documenting process calibrator with HART capabilities to calibrate, maintain, and troubleshoot HART devices. The Fluke calibrator acts as a source and measures pressure, temperature, and electrical signals. It also include a test pump used to generate a wide range of pressures from vacuums at -95 kPa (-13.9 psi) to pressures up to 410 kPa (600 psi). Two pressure gauges, a low-range version (up to 34 kPa (5 psi)) and a high-range version (up to 690 kPa (100 psi)), are included and can be used with the Fluke calibrator for direct measurement of pressure. Recommended learning material, also order: “Device Configuration (HART)” → Page 167

Order no.	**588418**

3 **Calibration Kit (HART and FOUNDATION Fieldbus)**
This kit includes the equipment required to precisely adjust the control valves, perform diagnostic tests, and interface with smart devices. This version of the kit is compatible with both HART and FOUNDATION Fieldbus. It includes the Emerson AMS Trex™Device Communicator: a universal HART and FOUNDATION Fieldbus communicator. The kit also contains a Fluke 725 multifunction process calibrator which can act as a source and measure different parameters. It also include a test pump used to generate a wide range of pressures from vacuums at -95 kPa (-13.9 psi) to pressures up to 410 kPa (600 psi). Two pressure gauges, a low-range version (up to 34 kPa (5 psi)) and a high-range version (up to 690 kPa (100 psi)), are included and can be used with the Fluke calibrator for direct measurement of pressure. Recommended learning material, also order: “Device Configuration (HART)” → Page 167

Order no.	**588419**

4 **Software Configurators**
The Software Configurators include the FieldCare software necessary to interpret the data related to the different smart devices and to configure their parameters. The HART versions also include a communication box for data transfer between a HART device and a PC with a USB port, while the FOUNDATION Fieldbus version makes use of the FOUNDATION Fieldbus Bridge.

HART	**588420**
FOUNDATION Fieldbus	**588421**
HART/FOUNDATION Fieldbus	**588422**

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Components

Pumps, VFDs, Heating, Cooling, Compressors

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1 **Second Pump Add-On**
Additional pump to be used by a second team or to drain a Process Column in advanced control experiments. It requires an AC VFD (EtherNet/IP or PROFINET). This model includes the tubing and equipment required to install the pump on the Process Workstation and to connect it to the system.

Order no.	**582396**

2 **Pumps Add-On (Temperature)**
Two additional pumps used to circulate the warm and cold water to the Heating/Cooling Unit while performing temperature process experiments. Each pump requires an AC VFD (EtherNet/IP or PROFINET). The kit includes the tubing and equipment required to install the pumps on the Process Workstation and to connect them to the system.

Order no.	**582396**

3 **Metering Pump**
Devices that dispenses chemicals to the process at an adjustable and precise rate. It features an LCD, a stroke length adjustment knob and a six-button touch pad. The pump can operate in a fixed rate mode or it can be commanded by an external 4-20 mA signal. A contact relay is also featured.

120 V, 60 Hz	**588377**
220 – 240 V, 50/60 Hz	**588378**

4 **Heating/Cooling Unit**
Unit that warms the contents of one of the two water tanks of the Process Workstation while it cools the contents of the other one. This creates and maintains the temperature differential required for heat transfer experiments. Designed with enough capacity to ensure efficient and continuous operation. Typical capacity: 2 tons, 24000 BTU/hour, or 7 kW.

120 V, 60 Hz	**763447**
220 V, 50/60 Hz	**582401**

5 **GFCI Electrical Distribution Box**
Designed to power the metering pumps. Features an added electrical protection (ground fault interrupter) and four power outlets.

120 V, 60 Hz	**588439**
220 V, 50 Hz	**763515**

6 **AC Variable Frequency Drive (EtherNet/IP)**
Comprises an industrial Allen-Bradley Power Flex 525 1.0-HP AC Drive that controls the pump(s) of the system. It features control inputs and outputs and can optionally communicate via an Ethernet link. The three-phase drive requires a GFCI Electrical Distribution Box.

Single-phase power	**8122680**
Three-phase power	**8122682**

7 **AC Variable Frequency Drive – Single-Phase AC Supply (PROFINET)**
Comprises an industrial Siemens G120 1.0-HP AC Drive used to control the pump(s) of the system. It features control inputs and outputs and can optionally communicate via a PROFINET link. Four switches allow the instructors to insert faults for troubleshooting exercises.

120 V, 60 Hz	**589673**
220 – 240 V, 50/60 Hz	**592685**

8 **Compressor**
Quiet device that provides compressed air to different components. A conditioning unit must be connected to the compressor for certain applications. Available in different variants depending on ac power network voltages and frequencies.

120 V, 60 Hz	**588108**
Other	**On request**

Components
Monitoring

1 **Distributed I/O Module (HART)**
Interface module ET200M from Siemens. Allows the connection of analog I/Os using HART communication protocol to a Siemens PLC through PROFINET communication. Features eight 4-20 mA HART analog inputs and eight 4-20 mA HART analog outputs. With six fault insertion switches.
Order no. **589674**

2 **Emergency Switch Station**
Mushroom-type push-button that opens its circuit when the button is pressed in order to cut the power to some of the 24 V dc outputs of the electrical unit, the pneumatic unit, and the pump drive.
Order no. **582352**

Indicator-Light/Push-Button Station
Three industrial push-buttons, one normally closed and two normally open, to operate the Pressure, Flow, Level, and Temperature Process Learning Systems. With three indicator lights. Operates at a voltage of 24 V DC.
Order no. **587871**

3 **Process Control Signal Tower**
Three lights providing visual signals for various states of the pressure, flow, level, and temperature processes. Lights are stacked one upon another, up to five modules. Each module is easily programmable without any special wiring or tools.
Order no. **587869**

4 **Energy Manager**
Device that records the temperatures measured at different points in the system. It can use the flow rate signals coming from optional transmitters to calculate energy balances in real time. It features an alphanumeric display with eight buttons and is powered by a 24 V dc signal. Up to four Platinum RTDs (Model 46917) can be connected to the inputs of the Energy Manager. Output relays and 4-20 mA outputs are also part of the device. The device can be programmed using a computer and a serial cable.
Order no. **582435**

5 **Deionization Unit**
Designed to filter the process fluid and capture the ions it contains. Composed of two cartridge holders and their associated filters. The prefilter cartridge contains a filter which removes many impurities from the water. The deionization cartridge captures ions from the fluid in its resin.
Order no. **588437**

6 **Water Analyzer**
Multifunction device which allows the simple and accurate measurement of the pH, conductivity, resistivity, oxidation reduction potential, total dissolved solids and Langelier saturation index of a test solution.
Order no. **588424**

7 **Paperless Recorder**
Device that acquires, displays, records, and archives analog input signals. Four high-speed 4-20 mA inputs with a scan time of 100 ms can be displayed on the thin-film-transistor (TFT) 17.8 cm (7 in) color display. It can be configured using push-buttons and a shuttle dial, and it can be programmed to activate one of four output relays. Data can be recorded in the internal memory or transferred to a USB stick. An Ethernet port enables recorder integration into a PC network (TCP/IP).
Order no. **595185**

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Components
Workstations

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P/F/L/T

1 **Process Workstation (Temperature, Pressure, Flow, and Level)**
Features two 60 L (16 gal) tanks and four centrifugal pumps. Designed for performing experiments with temperature, pressure, flow, and level processes. Delivered partly-assembled.

Order no.	**582388**

2 **Process Workstation (Pressure, Flow, and Level)**
Features two 60 L (16 gal) tanks and four centrifugal pumps. Designed for pressure, flow, and level processes, but can be upgraded for temperature processes. Delivered partly-assembled.

Order no.	**582388**

3 **Process Workstation**
Features a tank and a centrifugal pump. Delivered partly-assembled. Designed for pH/conductivity or air pressure/flow processes.

Order no.	**588302**

Instrumentation Workstation (Without Heating/Cooling Unit)
Houses the Electrical and Pneumatic Units and other electrical components. Can be linked to a Process Workstation with a hitch mechanism, part of the Piping and Accessories Kit.

4 **Without Heating/Cooling Unit**

Partly assembled	**582393**
Fully assembled	**588306**

5 With Heating/Cooling Unit

Order no.	**582391**

6 **Storage Station**
Stores up to four flange tops, many flow meters and control valves on six galvanized struts, a few devices on two instrumentation mounting pipes, and various pieces of equipment in the three stainless-steel storage boxes.

Order no.	**588301**

7 **Instrumentation Mounting Pipe**
Vertical pipe used to install instruments at the appropriate height and close to the point of measurement. Can be mounted on both sides of the workstations.

Order no.	**582444**

8 **Drip Tray**
Large painted stainless steel drip tray to collect the water. Hand valves and a drain tube included with associated parts.

Front side	**582447**
Back side	**582448**

9 **Process Supports (pH)**
Package that contains various process struts, a long wire duct, a hose storage rack, and more.

Order no.	**588428**

Package that avoids equipment redundancy if the pH and Conductivity Process Learning System is acquired as an add-on to a Process, Flow, Level, and Temperature Process Learning System.

Order no.	**588426**

10 **Process Supports**
Packages containing a subset of the following elements: process struts, a storage rack to store up to four optional flange tops, a long wire duct, a hose storage rack, and other assorted items. Designed to address the possibility of two teams sharing the same station and to prevent equipment redundancy.

P/F/L/T	**582445**
Temperature	**5**82446
P/F/L	**588425**
P/F/L (second team)	**588427**

Notes about workstations:
– Most workstations are double-sided to allow two teams of two students to work at the same time, one team on each side.
– Steel frames ensure reliability and durability.
– All are equipped with lockable casters for mobility.

Components

Air and Electrical Supply, Columns, Tanks

1/2 **Column**
Watertight process column made of clear acrylic plastic. Three ports at the top and bottom of the column can be connected to the process loop or sealed off with a cap. A ruler allows simple visual level measurements. Pressure ports allow for the measurement of the pressure at the bottom and at the top of the column. A safety valve prevents the pressure from exceeding a safe limit. The column features an industrial flange that can house an optional level sensors and it contains a stainless steel baffle plate to reduce turbulence at the bottom water intake. Equipped with a bubbler tube to infer the level of fluid in the column. The large-diameter column has a capacity of 30.4 liters (8.0 gal).The small-diameter column has a capacity of 7.6 liters (2.0 gal) and can be used to create interacting second-order processes when connected to the large-diameter column.

1 Large diameter	**582394**
2 Small diameter	**582395**

3 **Upper Tank**
Tank made of heavy-duty polyethylene that is used to create non-interacting second-order processes and is designed to be installed on the top of the Process Workstation. It features five connection ports. It can be used by a single team of students at a time.

Order no.	**588307**

4 **Chemical Tank**
Rectangular carboy designed to contain solutions and dispense chemicals to the process. It is equipped with dripless, quick connectors, a check valve and a faucet.

Order no.	**588436**

5 **Air Tank (Small)**
Robust pressure vessel designed to contain pressurized air. It features two pressure ports each equipped with a quick-connect fitting (1/4 inch) and a graduated hand-operated valve. The tank is coated to resist corrosion and is tested to SAE J10 compliance.

Order no.	**588313**

6 **Air Tank (Large)**
Robust ASME-compliant pressure vessel designed to contain pressurized air. It features two pressure ports equipped with a quick-connect fitting (1/4 inch) and a graduated hand-operated valve.

Order no.	**588312**

7 **Electrical Unit**
Module that features a lockable safety switch, a power transformer from line level to 24 V dc, and all the necessary inputs and outputs in both a safety cable version and in a terminal block version.

120 V, 60 Hz	**592680**
220 – 240 V, 50 – 60 Hz	**592681**

8 **Pneumatic Unit**
Module that features an activation switch to quickly turn on or off the air supplied, an adjustable low-range pressure regulator (0 to 200 kPa (0 to 30 psi)) with its output air port, and an adjustable high-range pressure regulator (0 to 700 kPa (0 to 100 psi)) with its output air port.

Order no.	**582433**

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Components

Piping, Accessories, Consumables

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1 **Piping and Accessories (pH)**
Kit that contains many of the components needed to perform the exercises in the pH and Conductivity Process Training System. It includes an Allen-Bradley or Siemens unmanaged switch.

Allen-Bradley	**588435**
Siemens	**589881**

2 **Piping and Accessories Add-On (pH)**
Kit that contains many of the components needed to perform the exercises in the pH and Conductivity Process Training System. It avoids redundancy of equipment if the pH and Conductivity Process Training System is acquired as an add-on to a Pressure, Flow, Level, and Temperature Process Training System.

Order no.	**588434**

3 **Piping and Accessories (Air)**
This kit includes a reel of tubing, a tube cutter, connectors, and other items required to use the air workstation. A manual needle valve is included to control the flow of air in the process. It includes an Allen-Bradley or Siemens unmanaged switch.

Siemens	**589882**
Allen-Bradley	**588433**

4 **Piping and Accessories (Air)**
This kit is designed to be used with the Air Pressure and Flow Process Add-On. It includes a reel of tubing, a tube cutter, connectors, and other items required to use the air workstation. A manual needle valve is also included to control the flow of air in the process.

Order no.	**588430**

Piping and Accessories
Packages that contain the components required to operate the Pressure, Flow, Level, and Temperature Process Training Systems and to perform the suggested experiments: hoses, elbows, and pressure ports, a wet leg, a three-valve manifold, a small ladder, wires, pressure tubes, tools, and an attach bracket to link the Instrumentation Workstation to the Process Workstation. The variants are designed to allow two teams on the same station while avoiding equipment duplication.

5 Second team	**588429**
Temperature, basic system	**582449**
P/F/L, basic system, A-B	**582451**
P/F/L, basic system, Siemens	**592689**
Temperature, add-on	**588431**

Accessories, Temperature (Advanced)
Includes an infrared thermometer.

Order no.	**582450**

Piping and Accessories, Advanced
Includes the short hose and a three-valve manifold required for some of the advanced experiments on process control.

Order no.	**588432**

Components

Spare Parts Kits, Consumables

Spare Parts Kit 1 for 3531 systems
Set of spare parts for the pH and Conductivity Process Training System.
Order no. **763511**

Spare Parts Kit 1 for 3532 systems
Set of spare parts for the pH and Conductivity Process Training System.
Order no. **763512**

Spare Parts Kit 2 for 3532 systems
Second set of spare parts for the pH and Conductivity Process Training System.
Order no. **763513**

1 **Spare Parts Kit for 3533 systems**
Set of spare parts for the Air Pressure and Flow Process Training Systems.
Order no. **589882**

2 **Consumables Kit 1 for 3532 (pH) systems**
Contains a supply of chemicals (acids, bases, buffers, marker, etc.) required to perform pH experiments using the pH and Conductivity Process Training Systems. It also includes the associated Material Safety Data Sheets (MSDS), a box of plastic gloves, and 1 oz. plastic cups.
Order no. **588438**

3 **Consumables Kit 2 for 3532 systems (Conductivity)**
Includes the consumables required to perform conductivity experiments using the pH and Conductivity Process Training Systems. It includes distilled water, iodized table salt (NaCl) and a conductivity calibration solution.
Order no. **763510**

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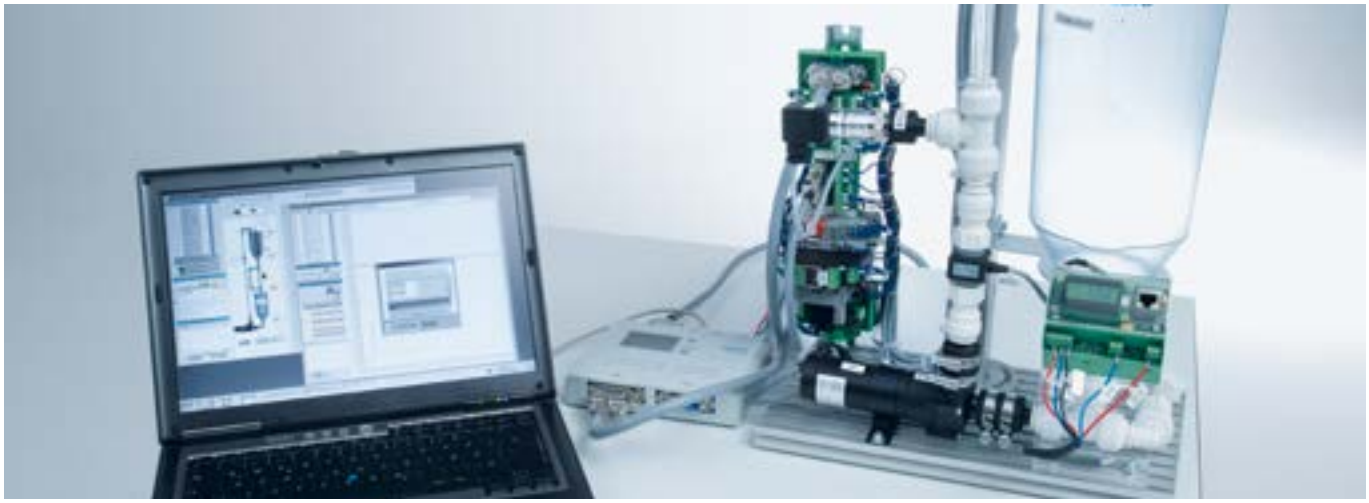
Industrial Control Technology

EasyPort USB

Interface for Measuring, Open- and Closed-Loop Control



Connection of software/simulation with actual training equipment/ all PLCs

The EasyPort USB is used for bidirectional transmission of process signals between a real low-voltage control process and a PC. The connection to the automation equipment is via standard SysLink connectors. Input and output signals can thus be read into and output from a PC. So that EasyPort can adapt to different situations, we have developed software for the device drivers with a graphical user interface, through which connections can be made.

The possible uses of EasyPort USB are diverse:

- Controlling a real process with a controller running on the PC
- Controlling a simulated process model with a real PLC
- Control of a real process, the control runs on the PC
- Recording and evaluating measured values from a real process

A maximum of 8 EasyPort USB modules can be interconnected via a USB hub or via USB ports on a PC. It should be noted that the addresses of the modules are different.

Numerous practical process models can be controlled using any PLC using EasyPort and the EasyVeep simulation software included in scope of delivery.

Technical data

- 24 V power supply via separate screw terminals or via SysLink connectors
- Interface to PC (galvanically isolated): USB 2.0, RS 232. Up to 4 modules can be connected via a USB hub. Transmission speed: 115 kbaud
- Analog interface: sub-D 15-pin socket, 12 bit resolution, 4 analog inputs, 2 analog outputs, sample frequency 0.5 kHz
- Digital interface: 16 digital inputs, 16 digital outputs on 2 x 24-pin Centronics sockets with 8 digital inputs each (24 V), 8 digital outputs (24 V). 24 V power supply. Digital signals represented by LEDs.
- Large LCD display, display of channel, unit, trend and measured value (4 digits). Selection of the channel to be displayed and the units via keys.
- Controllable via FluidSIM, FluidLab PA (Closed-Loop, Process, Water Management...), CIROS, Festo Didactic EzOPC, LabVIEW, C++, Visual Basic, Matlab.

EasyPort USB	**548687**

EasyPort USB 19"	**8021637**

Scope of delivery

- EasyPort USB/EasyPort USB 19"
- 24 V connecting cable on 4 mm safety plugs
- USB cable
- CD-ROM: EasyVeep, EasyOPC driver, datasheet, ActiveX control, examples of control using LabVIEW

Also order:

For EasyPort with a real process or SimuBox:

I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
Analog cable, parallel, 2 m	529141

For EasyPort with a real process or SimuBox:

I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106

For EasyPort, freely wireable, with any PLC:

I/O data cable with SysLink connector IEEE 488 and bare cable-end sleeves	167122

For EasyPort with an EduTrainer:

I/O data cable, crossover, with terminal socket, 0.3 m	167197

For EasyPort with a real PLC or SimuBox:

Analog cable, crossover, 2 m	533039

CODESYS starter kit with CECC-LK and EasyPort USB	8024001
Universal connection unit, digital (SysLink)	162231
Quick-Fix screw adapter	549806

Simulation Box Digital/Analog

The simulation box (SimBox) is used to generate and visualize digital 24 V DC and analog 0 – 10 V DC signals, as are common in PLC control technology. The device has 8 momentary/latching switches for generating output signals. Another switch serves as a release switch. The status is displayed by 9 LEDs. With 4 potentiometers, up to 2 output voltages or 4 input voltages in the range from 0 ... 10 V DC can be set. A selector switch enables the selection of the voltages shown on the display. The connection between the simulation box and the process or the PLC for digital signals is made via a standard plug connection (SysLink). Analog signals are connected via a D-Sub connector.

The simulation box is used to display the input and outputs signals of an MPS station or PLC. Two modes of application are possible:
– Simulation of inputs for testing of a PLC program. Use I/O data cable (SysLink) (order no. 34031) for this purpose.
– Setting of outputs (with separate 24 V supply) in order to operate an MPS station. The cable (order no. 167106, 2.5 m) required for this purpose is included in the scope of delivery.

SimBox, analog/digital	**526863**

Also order:

I/O data cable with SysLink connectors (IEEE 488) on both ends, crossover	167106
I/O data cable with SysLink connectors (IEEE 488) at both ends, 2.5 m	34031
Analog cable, crossover, 2 m	533039
Analog cable, parallel, 2 m	529141

I/O Interface with LVProSim

The I/O Interface is a module that interfaces with a computer for data acquisition and PID control of a real process. The I/O Interface provides interconnection between the process devices and the computer. It performs analog signal and digital signal conversions and sends the information to LVProSim, a process control software included with the interface.

The I/O Interface has four 4-20 mA analog inputs, two 4-20 mA analog outputs, four 24 V digital inputs, two 24 V digital outputs, and two 30 V dc relays. It connects to a computer through a USB cable and must be powered using a 24 V dc power supply.

The I/O Interface requires LVProSim, a free process control software specially designed to connect to the interface and collect data at a fast sampling rate (100 ms). LVProSim has two main features: it can operate as a process controller and a generic process simulator.

The I/O Interface can be used with the Process Control Learning Systems and the Industrial Process Learning Systems.

Note that, although the I/O Interface is designed to be used with LVProSim, its data acquisition interface is compatible with Linux, MATLAB, and NI LabVIEW. Raw data can be acquired using these software/platform, given the appropriate drivers are installed.

I/O Interface	**763509**

Note: This product cannot be ordered or delivered in countries that require compliance to CE regulations.

EduTrainer Universal Preferred Versions for MPS PA

PLCs, Operator Units

Universal Shape and Size
Do you use PLCs from global market leaders or less well-known but innovative control concepts? Does your training tend to focus on mastering processes and technologies rather than safe handling of wires and screwdrivers? If so, the EduTrainer Universal is the right solution for you!

The EduTrainer Universal deserves its name: it fits in A4 mounting frames or an MPS PA station; it can also stand on a table or lie flat; and it comes as a fully configured preferred version or you can customize it.

Universal Design
There are many manufacturers of programmable logic controllers worldwide.

The EduTrainer is available with PLCs from Siemens, Allen-Bradley, Festo and other manufacturers, and with or without power supply, 4 mm safety sockets, and a SysLink system interface.

The EduTrainer Universal is designed for different H-rails so that it can be fitted with any PLC. Below the PLC, the 19" plug-in format ensures that the EduTrainer can be equipped with any conceivable combination of connecting plates and simulation modules. A range of simulation modules allows for many different processes to be connected and simulated during the training.

We recommend the "Preferred versions". The benefits?
– Cost-effective solution
– Harmonized technology
– Quick delivery

All EduTrainers can be found on
→ festo.com/didactic

To find the EduTrainer configuration tool, search for "edutrainer 500000"

EduTrainer Universal with SIMATIC S7-1500
The controller family SIMATIC S7-1500 is a new controller generation in the TIA portal and a milestone in automation. It delivers maximum performance and user-friendliness for medium- and high-end applications in machine and plant automation.

CPU S7-1512C-1PN (MPS)
– Main memory: 250 kB for programs and 1 MB for data
– Memory card included
– Interface: PROFINET IRT with 2-port switch
– 32x digital inputs (24V dc)
– 32x digital outputs (24V dc, 0.5A)
– 5x analog inputs, 4x U/I, 1x R/RTD, 16-bit resolution
– 2x analog outputs, 2x U/I, 16-bit resolution

Notes:
Order no. 8065600 is based on Siemens SCE trainer packages and each contain an EduTrainer including programming cable (Ethernet cable) and programming software STEP 7 WinCC (TIA Portal). When the trainer packages are updated by Siemens, the controllers are replaced by successor models, subject to technical feasibility. Special licensing rules apply to schools and training centers in the commercial sector.

Order no.	**8065600**

Recommended accessories:

I/O data cable with SysLink connectors (IEEE 488), 2.5 m	**34031**
Analog cable, parallel, 2 m	**529141**
Safety laboratory cable, 3 m	**571817**
IEC power cable 90° → festo.com/didactic	

EduTrainer Universal with Allen-Bradley CompactLogix
Allen-Bradley CompactLogix controllers of the series 1769 are ideal for small to compact control applications that do not require axis control or safety functions. These controllers offer integrated serial EtherNet/IP or ControlNet channels and modular DeviceNet communications.

AB CL 1769-L24ER-QB1B (MPS)
– Main memory: 0.75 MB
– 1 GB SD memory card included
– Interfaces: 2x EtherNet/IP, 1x USB
– 16x digital inputs
– 16x digital outputs
– 4x universal analog inputs
– 2x universal analog outputs
– 4x high-speed counters

Order no.	**8034583**

Necessary accessories:

I/O data cable with SysLink connectors (IEEE 488), 2.5 m	**34031**
Analog cable, parallel	**529141**
RSLogix5000	**8034585**

Recommended accessories:

Safety laboratory cable, 3 m	**571817**
IEC power cable 90° → festo.com/didactic	

[X]

Festo Touch Panel CDPX 7”
Operator Unit
Festo CDPX panels are high-performance processors combined with wide-screen technology. They provide more functions at a higher resolution for man-machine interfaces.

Features:
– Set up on a metal sheet housing
– Open for web and multimedia applications
– Incorporation of standard documents
– Multiple interfaces for process communication
– Programming with Designer Studio

Technical data:
– Control unit CDPX 7”
– Display resolution: 800x480 pixels
– Number of colors: 16M
– CPU Data: 1 GB RAM
– Supply: 24 V DC 0.7 A
– Battery backup: Rechargeable lithium battery
– SD card slot
– Integrated switch with 2x RJ 45 port
– Integrated Soft-PLC Codesys V3.5
– Integrated and wired I/O-Module 16DI/DO, 4AI/2AO
– Connection cable24 VDC
– Network cable RJ45, 5 m
– Software license Codesys V3 Runtime for CDPX
– Codesys p.b.F V3.5 development environment
– Designer Studio V1.9x with HMI client

Order no.	**8162595**

[X] The picture shows the device itself for illustrative purposes only; it comes integrated into a module that can be installed on a MPS PA station.

Allen-Bradley PanelView
Operator Unit
Touch screen for flexibly displaying processes and data as a desktop device. The PanelView standard panels monitor, and control devices connected to CompactLogix controllers in an Ethernet/IP network.

Features:
– Ethernet/IP communication that supports networks with linear and star topologies.
– Easy to mount on aluminum profile
– Set up on a metal sheet housing
– Embedded FactoryTalk runtime software
– Programming with optional FactoryTalk Studio software
➔ page 173

Technical data:
– Screen size : 7”
– Communication port : Ethernet/IP (2x)
– USB Port : 1x
– Supply : 24 V DC
– SD Card reader

Order no.	**8162597**

SIMATIC Touch Panel MTP700
Operator Unit

State-of-the-art Unified Comfort Panel, 7-inch touchscreen interface for industrial control and monitoring. Its high-resolution display provides clear visuals, facilitating seamless interaction with automation systems.

With advanced features like Ethernet connectivity and multiple communication ports, the MTP700 ensures reliable and versatile operation. The user-friendly interface and customization options make it adaptable to diverse applications.

Features:
– 7” widescreen TFT display
– 16 million colors
– PROFINET interface
– Configurable from WinCC Unified Comfort V16, contains open-source software provided free of charge.

Order no.	**8189570**

Recommended Learning Material

Course on Festo LX
➔ PLC Programming

Controllers for Industrial Process Learning Systems

PLC Bundles

Allen-Bradley ControlLogix PLC

Powerful PLC with sixteen 24 V dc inputs, eight 4-20 mA HART inputs, eight 24 V dc output relays and eight 4-20 mA HART outputs hardwired to both safety connectors and terminal blocks on the module front panel. EtherNet/IP communication ports are located on the PLC processor. A USB port can be used to transfer a program into the PLC. The PLC can be programmed using Rockwell's RSLogix 5000 Full Edition software in four languages: relay ladder, structured text, sequential function chart, and function block diagram. Ten switches allow instructor to insert faults.

This PLC can be purchased separately or as part of a bundle.

Scope of delivery of the bundle:
– 1x PLC Allen-Bradley ControlLogix (order no. 589122)
– 1x Studio 5000 Logix Designer Full Edition (educational version order no. 587895 **or** commercial version, order no. 587894)
– 1x ControlLogix and CompactLogix Programmable Logic Controllers (User Guide) (order no. 585159)

Additional required equipment, please also order: Touch panel or Touch-Screen Computer - Large with a HMI software (➔ page 116)

PLC Only	**589122**
PLC Bundle (Educational)	**588519**
PLC Bundle (Commercial)	**588513**

Allen-Bradley MicroLogix PLC

Ideal for small to mid-sized applications. With ten digital inputs, two analog inputs, six digital outputs, and two analog outputs. Can be programmed using Rockwell's RSLogix Micro software and can be used to implement various control procedures, including PID routines. It includes an Ethernet communication port, a DF1 Full-Duplex Serial link (RS-232-C) port, an embedded LCD and control keys, and many more advanced features. Eight switches allow instructors to insert faults.

This PLC can be purchased separately or as part of a bundle.

Scope of delivery of the bundle:
– 1x PLC AB MicroLogix 1400 (order no. 8203776)
– 1x PLC Software, RSLogix Micro (educational version order no. 587552 **or** commercial version order no. 587555)
– 1x Communication Cable, Allen-Bradley (order no. 587566)
– 1x MicroLogix Programmable Logic Controller (User Guide)

Additional required equipment, please also order: Touch panel or Touch-Screen Computer - Large with a HMI software (➔ page 116)

PLC Only	**588381**
PLC Bundle (Educational)	**588521**
PLC Bundle (Commercial)	**588514**

Allen-Bradly CompactLogix PLC

Cost-effective PLC with a L24 CPU. Features sixteen 24 V dc digital inputs and sixteen 24 V dc digital output relays hardwired to both safety connectors and terminal blocks on the module front panel. Eight 4-20 mA analog inputs and eight 4-20 mA analog outputs are also included. Two Ethernet/IP ports are located on the front panel. Can be programmed with Rockwell's RSLogix 5000 Lite Edition software in relay ladder, structured text, sequential function chart, and function block diagram. Ten switches allow instructors to insert faults.

This PLC can be purchased separately or as part of a bundle.

Scope of delivery of the bundle:
– 1x PLC AB CompactLogix (order no. 589123)
– 1x Studio 5000 Logix Designer Lite Edition (educational version order no. 587890 **or** commercial version order no. 587892)
– 1x ControlLogix and CompactLogix Programmable Logic Controllers (User Guide) (order no. 585159)

Additional required equipment, please also order: Touch panel or Touch-Screen Computer - Large with a HMI software (➔ page 116)

PLC Only	**589123**
PLC Bundle (Educational)	**588522**
PLC Bundle (Commercial)	**588515**

Siemens S7-1500 PLC

S7-1516 PLC. Features sixteen 24 V dc inputs, eight 4-20 mA inputs, eight 24 V dc output relays and eight 4-20 mA outputs hardwired to both safety connectors and terminal blocks on the module front panel. One PROFIBUS port and three PROFINET ports. Can be programmed using Siemens SIMANTIC STEP 7 Pro software in TIA Portal environment using Ladder (LAD), Function Block Diagram (FBD), Instruction List (IL). Ten switches allow instructors to insert faults.

This PLC can be purchased separately or as part of a bundle.

Scope of delivery of the bundle:
– 1x PLC S7-1516 (order no. 589671)
1x TIA Portal PLC Software (Step 7 Professional) (order no. 592687)

Scope of delivery of the bundle HART:
– 1x PLC S7-1516 (order no. 589671)
– 1x Distributed I/O Module (HART) (order no. 589674)
– 1x TIA Portal PLC Software (Step 7 Professional) with Process Device Manager (PDM) (order no. 589676)

Additional required equipment, please also order: Touch panel or Touch-Screen Computer - Large with a HMI software (➔ page 116)

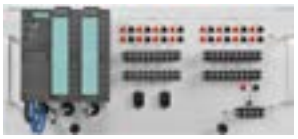
PLC Only	**589671**
PLC Bundle (Educational)	**589670**
PLC Bundle HART (Educational)	**589669**

ABB CM30 PID Controller

Powerful and versatile device for industrial process control. Its advanced features, flexibility, and ease of use make it an ideal choice for optimizing operations, enhancing productivity, and achieving superior control performance in various industries.

Its compact design and modular architecture allow for seamless integration into existing control systems. It has powerful control functionality including cascade, feed-forward, ratio, predictive and adaptive control strategies.

Order no.	**8187460**



Distributed I/O Interface

Interface module (ET 200M) from Siemens that permits to connect analog I/O's using HART communication protocol to a Siemens PLC through PROFINET communication. This I/O module features eight 4-20 mA HART analog inputs and eight 4-20 mA HART analog outputs.

All the I/O'S can be hardwired to both banana jacks and terminal blocks on the module front panel. Safety laboratory cables provide an easy and fast way to wire a setup, while terminal blocks allow students to wire their setup in a way much closer to what is commonly found in the industry.

This module has six switches that the instructor can use to insert faults.

Order no.	**589674**

Controllers for Industrial Process Learning Systems

Touch-Screens, HMI, Graphic Terminals

Touch-Screen Graphic Terminal (Allen-Bradley)

Allen-Bradley PanelView Plus 7 1000 with a 26.4 cm (10.4 in) color display. It features an integrated EtherNet/IP communication port and one USB port. It requires a 24V dc power supply that can be connected using either a terminal block or a M12 quick connector.

Preprogrammed graphic terminal that monitors and control many devices of the Pressure, Flow, Level, and Temperature Process Training Systems. The optional FactoryTalk software can be used to modify the interface or develop a custom one.

Order no.	**8103425**

Touch-Screen Graphic Terminal (Allen-Bradley)

Allen-Bradley PanelView Plus 7 with a 14.5 cm (5.7 in) color display. The terminal also features an integrated USB port, an EtherNet/IP communication port and an RS-232 serial port. A Rail Workstation is required to install the Touch Screen Graphic Terminal on the systems.

Preprogrammed graphic terminal that monitors and control many devices of the Pressure, Flow, Level, and Temperature Process Training Systems. The optional FactoryTalk software can be used to modify the interface or develop a custom one.

Order no.	**8165911**

Industrial PC HMI (Siemens)

Consists of a Siemens 477D Industrial PC with a 48.2 cm (19 in) color display. This touch-screen interface allows monitoring and control of some features of the Pressure, Flow, Level, and Temperature Process Training Systems.

The Touch Screen Graphic Terminal is preprogrammed with a control interface developed with the various components of the system in mind. It features an integrated PROFINET communication port, three USB ports and DVI port to connect an extra large monitor for presenting demonstrations to a large student group. The Industrial PC includes Windows 7 Ultimate and WinCC Runtime software. The WinCC Advanced development software is optional and can be used to design your own control interface.

120 V, 60 Hz	**589672**
220 – 240 V, 50 Hz	**592683**

Touch-Screen Computer

Computer that features a large 23-inch touch-screen and a high-speed processor. It can be installed on an optional computer mount (order no. 589678) on the Instrumentation Workstation of the Industrial Process Learning Systems.

Order no.	**589677**

Touch-Screen Computer for SCADA

Computer that features a large 23-inch touch-screen and a high-speed processor. It can be installed on an optional computer mount (order no. 589678) on the Instrumentation Workstation of the Industrial Process Learning Systems.

Designed to ensure full compatibility with the SCADA system and long term reliability and efficiency. The optional preferred software for SCADA such as FactoryTalk View, WinCC is preinstalled along with the other optional PLC programming software ordered at the same time, such as RSLogix Micro, RSLogix 5000 or Step7 TIA Portal. All the software are registered to the training facility.

Order no.	**588440**

Advanced PLC Training System

Programming High-End PLCs and HMIs

Siemens version illustrated

Advanced PLC Training System - Rockwell Automation (120 – 240 V, 60 Hz)	588969
Advanced PLC Training System - Siemens (120 – 240 V, 60 Hz)	595849

Notes: These products cannot be sold or delivered in countries that require CE compliance. For other country voltage/frequency configurations, please contact your local sales representative for availability.

Also required, please order
For the Rockwell Automation version: Studio 5000 Logix Designer ➔ page 172
For the Siemens version: FactoryTalk View Studio ➔ page 173

Hardware Description

– Rockwell Automation version: CompactLogix 5370 controller, PanelView Plus 7 graphic terminal, Stratix 2000 industrial Ethernet switch, several inputs (16 digital and 4 analog inputs) and outputs (16 digital and 2 analog outputs).
– Siemens version: Siemens S7-1200 controller, 7-inch widescreen TP700 Comfort Panel with PROFINET, MPI/PROFIBUS DP, and USB interfaces, and a SCALANCE XB005 unmanaged industrial Ethernet switch, several inputs (16 digital inputs, including 6 high-speed counters, and 4 universal analog inputs) and outputs (14 digital outputs, including 4 high-speed outputs, and 2 configurable analog outputs).
– Common to both versions: Inputs and outputs are accessible from the front panel using 2-mm test leads. Controls and lights can also be connected. Eight switches allow the addition of electrical faults during troubleshooting exercises. A SysLink interface allows connection to Modular Production System (MPS) stations from Festo.

Programming a PLC efficiently requires a strong familiarity with the specifics of the programming environment and languages. This training system allows students to acquire hands-on experience with industrial control equipment. Realistic examples are used to motivate students. These examples are displayed on the graphic terminal, and correspond to real PLC applications that can be interfaced with the trainer.

A complete course introduces the necessary theory and guides the students step-by-step through the practical activities to be performed with the learning system.

Benefits

– Industrial hardware and software for realistic training
– Easy access to components
– Communication between devices using either an industrial Ethernet switch, Sys-Link connectors, or 2 mm jacks.
– Rugged transportation and storage case
– Eight fault switches for troubleshooting exercises

Learning Objectives

– Familiarization to WinCC (TIA Portal) for the Siemens system **or** to Studio 5000 and FactoryTalk View Studio for the Rockwell Automation system
– Understanding PLC operation and addressing
– Programming in four different IEC 61131 languages: ladder, sequential function chart, function block, and structured text.
– Designing HMIs
– Troubleshooting

Recommended Learning Material

Workbook

Campus license:

Rockwell Automation	589148
Siemens	8096774

Notes: Campus licenses are offered in English only. They include the student and the instructor PDF versions of the workbooks.

Courses on Festo LX

➔ PLC and HMI Programming (Siemens S7-1200)
➔ PLC and HMI Programming (CompactLogix AB)

Smart Sensors TP 1312

Sensor Techology With IO-Link

→ Video

Understanding Smart Sensors
TP 1312 combines industrial components with project-oriented learning activities to efficiently build proficiency in smart sensor technology for Industry 4.0.

A Complete Learning Concept
Comprehensive courseware guides students through detailed project-oriented learning activities. Starting with the basics of each sensor, students perform practical exercises in a simplified work environment, allowing them to focus on smart sensors.

Students can also connect these sensors to a PLC over PROFINET, EtherNet/IP or Modbus, just like in industry.

Industrial Relevance
Smart sensors play a crucial role in the process automation. Several sensors from TP 1312, including flow, pressure, and temperature sensors, monitor process variables. Furthermore, the equipment and software of TP 1312 can be utilized to configure IO-Link devices specifically designed for Industrial Process Learning Systems.

Quick Assembly
All components are based on the Quick-Fix mounting system, which allows for quick mounting and alignment of sensors and test objects without any tools. Components can be installed on a profile plate or on the optional Sensor Workstation.

Complete Equipment Set TP 1312		**8116358**

The most important components at a glance:

1	Diffuse photoelectric sensor with IO-Link	8110725
2	Inductive proximity sensor with IO-Link	8110726
3	Ultrasonic sensor with IO-Link	8110727
4	IO-Link master module with 4 ports	8110729
	Accessory kit for equipment set TP 1312	8112723

Necessary accessories, also order:

5	Sensor workstation*	8110723
6	Set of test objects	549830
	Slide unit	572740

* Please order the main cables separately. If the Sensor workstation is not ordered with the training package, be sure to have a profile plate to hold the sensors and a tabletop 24V DC power supply. A PLC is necessary for the last portion of the course. Several options are available. Please check with your sales representative for further details.

Recommended accessories:

IO-Link Bluetooth Interface	8132947
RFID sensor with IO-Link	8110728
Laser distance sensor with IO-Link	8115140
Temperature sensor with IO-Link	8115033
Code reader with Ethernet	8121748
Flow sensor with IO-Link	8115026
Pressure sensor with IO-Link	8115027
EduTrainer Universal with SIMATIC S7-1500	8065452
EduTrainer Universal with Allen-Bradley CompactLogix	8034582
EduTrainer Universal with Festo CECC-LK CODESYS V3.5	8043320
Equipment set TP 1311 – Sensors for object detection	8150804

Data Monitoring

The software PACTware provides the interface to parameterize, adjust, and operate smart sensors. Monitoring real-time data prepares students to perform predictive maintenance and troubleshooting. An optional Smart IO-Link Interface seamlessly integrates mobile devices (iOS or Android) through Bluetooth for remote monitoring and operation.

Learning Objectives

- Understanding the benefits of smart sensors in the context of Industry 4.0
- Selecting, parameterizing, monitoring, and adjusting sensors
- Setting up IO-Link communication
- Integrating sensors into different manufacturing communication layers
- Performing predictive maintenance
- Replacing sensors and uploading settings automatically
- Troubleshooting sensors

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Recommended Learning Material

Workbooks

Campus license:

de	8148168
en	8122694
fr	8148172

Note: Campus licenses include the student and the instructor PDF versions of the workbooks “Fundamental Principles of Smart Sensors”, “Smart IO-Link Interface”, and “PLC Integration of Smart Sensors”.

Courses on Festo LX

→ Fundamental Principles of Smart Sensors

→ Smart IO-Link Interface (P&F SmartBridge)
→ PLC Integration of Smart Sensors
→ Smart IO-Link Interface

Networks and IT Security TP 1333

IT security plays an ever-increasing role in more and more professions. Mechatronic engineers, industrial electronic engineers and IT specialists need sound professional qualifications. Training package TP 1333 offers this over a range of subjects based on a wide range of training scenarios.

Equipment set TP 1333 contains components for the setup of example networks that serve to communicate all important fundamentals of IT security.

The equipment is configured for two workstations. The individual modules can be adapted to the spatial situation in the classroom or laboratory. The modules can be positioned flexibly to solve the exercises: on worktables or in an A4 mounting frame. The two EduTrainers with Siemens router and switch form the core of equipment set TP 1333.

The enclosed Festo NetLab Toolkit (NLTK) configuration software enables the configuration of network and safety functions. Examples of such functions include setting an IP address, clearing the ARP address memory, and importing and deleting NetLab hierarchy certificates. The NLTK requires one-off admin rights when launched, and makes the necessary functions available to the students. During the teaching unit, there is no further need to enter the administrator password.

Equipment Set TP 1333
with workbook and software

de	**8127828**
en	**8127829**
es	**8127830**
fr	**8127831**

The most important components at a glance:
– 2x EduTrainers with integrated electricity supply, a S615 router and a XC208 switch
– 1x Inductive proximity sensor with IO-Link
– 1x Ethernet cable set
– 1x Festo NetLab Toolkit configuration software
– 1x Configuration files for the exercises with S615 router and XC208 switch
– 1x Workbook, in printed form and on a USB data carrier

The enclosed workbook contains detailed practical exercises on applications that are becoming increasingly important in the industry. Theoretical foundations supplement the exercises perfectly. Pre-configured software setups and sample solutions optimize laboratory-based learning. Exercises 1 to 4 can be carried out separately at one workstation. Exercises 5 and 6 are carried out jointly at neighboring workstations. The workbook covers the following key cybersecurity topics in everyday industrial situations:
– switching and monitoring
– address allocation in production networks
– routing and firewall functions
– VLAN-separated manufacturing networks
– Network Address Translation (NAT)
– Virtual Private Networks (VPN)

To complete the exercises in their entirety, two PLCs and two PCs with a Windows 10 operating system are required. The PLC must allow external adjustment of IP address e.g. project with the “IP address is set directly at the device” setting. Alternatively, control with factory settings should be possible.

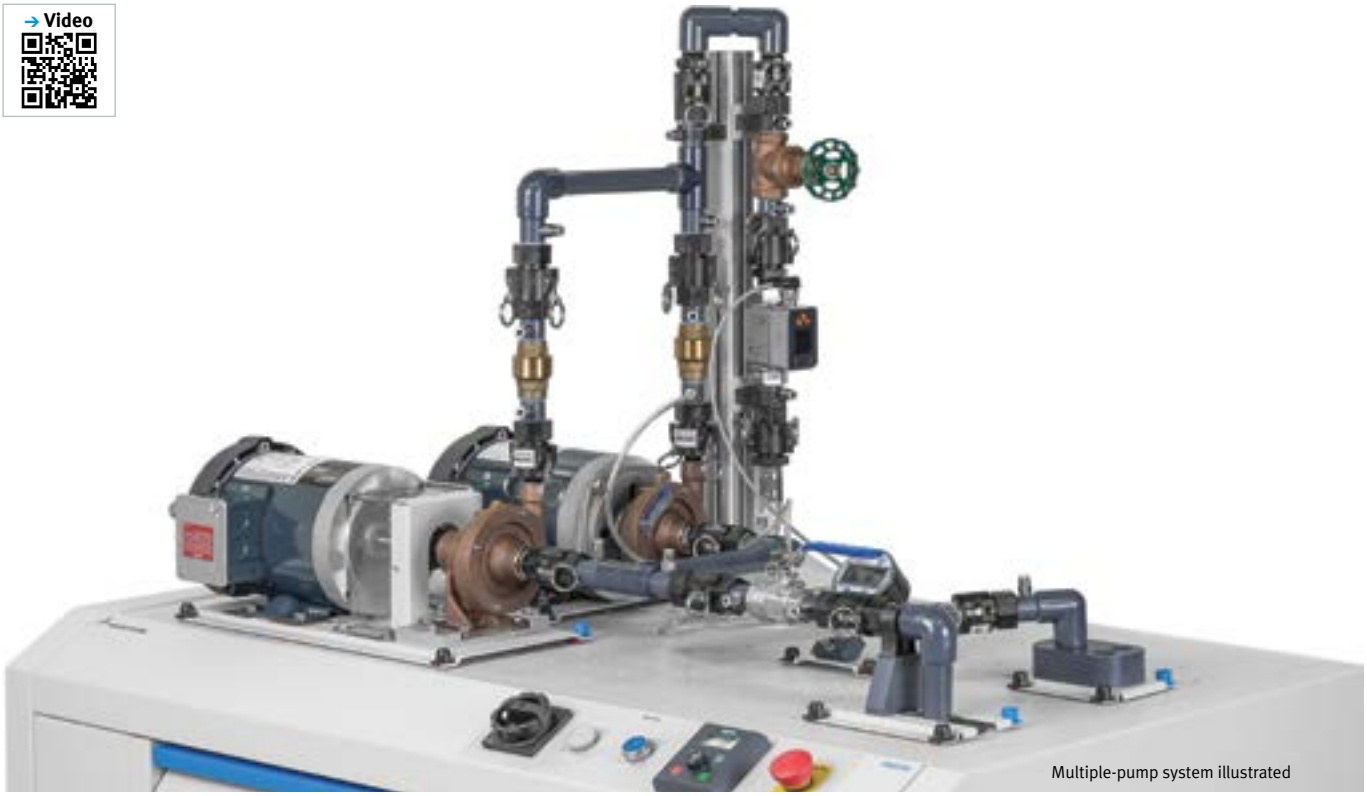
Special license rules apply for schools and educational institutes in the commercial sector.

Foundational Areas of Expertise

Industrial Pumps

The Flexibility Needed to Master Pumping Circuits

→ Video



Multiple-pump system illustrated

Project-Based Approach
Pumps move fluids through a wide variety of industrial applications and systems. Proper selection, installation, commissioning, operation, maintenance, troubleshooting, and repair skills are necessary to ensure efficiency and safety.

Hands-on courses allow maintenance and process technicians, as well as industrial mechanics, to develop this expertise.

Pedagogical objectives are aligned to professional requirements. Emphasis is placed on critical topics such as troubleshooting and efficiency. The project-based approach enables learners to apply their skills in a real-world setting.

Versatile Workspace
Practical experimentation is conducted on the ergonomic and rugged pumping circuit bench. It is designed to withstand the rigors of the workshop environment while providing a comfortable workspace for building circuits.

The bench is designed following the 5S principles to promote a tidy and organized workplace. Water conveniently circulates in a closed loop and naturally drains back to the tank through a drainage system.

Main Features of the Bench
- Lockable drawers featuring outline of components for storage and inventory
- IP54 control panel to prevent electrical hazards and breakdowns
- Tank and perforated work surface can be easily removed for cleaning
- Stainless steel used in key areas to prevent corrosion
- Electrical and control components housed inside the bench
- Compact and mounted on casters

Quick Circuit Assembly
To optimize lab sessions, several features facilitate circuit assembly and disassembly:
- Large, perforated work surface for various circuit layouts
- Single rotating knob for quick installation of components
- Flexible hoses for enhanced durability
- Quick-connect cam lever couplings and push-in fittings for easy pipe and tubing connections

Teachers can insert faults to put learners' troubleshooting skills to the test.

The Industrial Pumps learning solution is composed of four systems:

Single-Pump Systems, 120 V, 60 Hz **or**	**8180033**
Single-Pump Systems, 220-240 V, 50/60 Hz	**8180034**
Pump Performance*	**8180035**
Multiple-Pump Systems** (see picture)	**8180036**
Positive-Displacement Pump Systems**	**8180037**

* Requires “Single-Pump Systems”

** Requires “Pump Performance”

Main components for **Single-Pump Systems**:

Pumping circuit bench, 120 V, 60 Hz **or**	8180039
Pumping circuit bench, 220-240 V, 50/60 Hz	8180040

and

Motor and pump assembly (single-pump)	8180041
Ball valve assembly	8180043
Globe valve assembly	8180044
Manometer assembly	8180045
Rotameter assembly	8180046
Single-pump systems accessories	8180047

Main components for **Pump Performance**:

Magnetic-inductive flowmeter assembly	8180048
Digital pressure gauge assembly	8180049
Pump performance accessories	8180050

Main components for **Multiple-Pump Systems**:

Motor and pump assembly (multiple-pump)	8180051
Check valve assembly	8180053
Multiple-pump systems accessories	8180054

Main components for **Positive-Displacement Pump Systems**:

Positive-displacement pump accessories	8180055
External gear pump	8180056

Soon available: Optional pumps

Learning Objectives

Single-Pump Systems
- Learn the fundamentals of pump operation and their main parts.
- Inspect a pumping circuit, identify its main components, and safely start it.
- Understand fluid dynamics concepts that regulate the behavior of liquids inside a pump.
- Perform preventive maintenance and part replacement procedures.
- Detect symptoms of common pumping circuit failures and take corrective actions.

Pump Performance
- Trace, read and compare pump curves at various speeds.
- Evaluate the efficiency of a pump after changing its impeller.
- Compare major pump output control methods.
- Describe what causes cavitation and air ingestion and observe their effects.

Multiple-Pump Systems
- Measure pressure losses and understand their causes and consequences.
- Install pumps in parallel or in series, and compare their pressure and flow characteristics to a single-pump setup.
- Choose a pump for a specific application.
- Present solutions for a tank replacement and identify the consequences on an existing pumping circuit.

Positive-Displacement Pumps
- Explain the basic operating principles of an external gear pump and its main parts.
- Set up a circuit and start it.
- Draw the pumps curve under various conditions.
- Perform inspection, lubrication, and maintenance tasks.
- Disassemble and re-assemble an external gear pump.

Recommended Learning Material

Workbooks

Campus licenses:

Single-Pump Systems	8195948
Pump Performance	8195827
Multiple-Pump Systems	8195946
Positive-Displ. Pumps	8193210

Notes: Campus licenses are currently offered in English only, but other languages will be added as they become available. Campus licenses include the student and the instructor PDF versions of the workbook.

Courses on Festo LX

→ Single-Pump Systems

→ Pump Performance

→ Multiple-Pump Systems
→ External Gear Pumps

Mechanical Drives

All the Basics of Industrial Mechanics

→ Video

Shown with optional components

Machinery Maintenance
Skilled industrial mechanics are in demand worldwide. We rely on them to install, maintain, repair, and replace a vast array of mechanical equipment.

Manual skills involving a variety of machine elements are most valued. With this in mind, we have designed a training system that exposes learners to the hardware, tools, and methods used by industrial mechanics to keep plants running.

Versatile Workstation
A workstation equipped with movable T-slotted extrusions is included and is the foundation of the system. Learners use it to assemble a variety of mechanical drive set-ups. They test them with the included variable frequency drive and prony brake to control the motor speed and load, creating various usage scenarios.

Safety You Can Rely On
Safety is maintained with a detection circuit that cuts power when the polycarbonate cover of the workstation is opened. Learners are asked to perform a lockout/tagout procedure on the main switch to prevent accidental activation of the motor while they are working. The cover can also be locked when closed to further improve safety during operation and allow instructors to control access to the components.

Complete Coverage
Instructors can rely on a turnkey learning solution that includes suggested experiments to teach the fundamentals every industrial mechanic must master. Most topics are combined in packages called "Levels" and cover:
– Belt, chain and gear drives
– Couplings and shaft alignment methods
– Bearings and seals
– Linear slides
– Gearboxes and clutch-brake units
– Vibration metering

Mechanical Drives, Workstation Package

Familiarization and Introduction

Workstation Package **230 V, 50/60 Hz**	**de**	**en**	**es**	**fr**
	594831	**594776**	**594833**	**594832**
The most important components at a glance:				
1 Workstation	593739	593737	593741	593740
2 Couplings and shafts panel	593745	593742	593744	593743
3 Pillow block bearings panel	593749	593746	593748	593747
Workstation accessories	593750	593750	593750	593750
Optional components:				
5 Wall-mounted support for 5 panels	594985	594985	594985	594985
4 Work bench	593855	593855	593855	593855

Workstation Package **120 V, 50/60 Hz**		**594775**	**594830**	**594829**
The most important components at a glance:				
1 Workstation		593733	593735	593734
2 Couplings and shafts panel		593742	593744	593743
3 Pillow block bearings panel		593746	593748	593747
Workstation accessories		593750	593750	593750
Optional components:				
Wall-mounted support for 5 panels		594985	594985	594985
4 Work bench	593855	593855	593855	593855

Foundation of the System
The workstation package includes, besides the workstation itself, elements common to most experiments of the mechanical drives training system. Shafts, basic couplings, pillow block bearings, most required fasteners, basic tools, and measuring apparatus are part of this package. A three-phase motor and an adjustable-height motor mounting base are also included.

Topics
The job sheets offer exercises involving components commonly found in mechanical drives. Topics include:
– Introduction to mechanical drives
– Familiarization with the workstation
– Safety
– Pillow blocks bearings and shafts
– Motor, variable frequency drive, and tachometer
– Shaft alignment and couplings
– Torque, power, and efficiency

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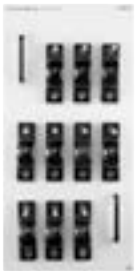

4

Recommended Learning Material

Workbook

Campus license:

de	793116
en	793115
es	793118
fr	793117

Notes: Campus licenses include the student and the instructor PDF versions of the workbooks of the Workstation Package and Level 1: “Introduction to Mechanical Drives”, “Belt Drives I”, “Chain Drives I”, “Gear Drives I”, and the “Mechanical Drive Training System User Guide”.

Course on Festo LX

→ Introduction to Mechanical Drive Systems

Mechanical Drives, Level 1

Belt, Chain, and Gear Drives 1

Mechanical Drives Training System – Level 1

	de	en	es	fr
	594834	**594777**	**594836**	**594835**

Note: Level 1 requires the Workstation Package.

The most important components at a glance:

1 Belt drives 1	593762	593759	593761	593760
2 Chain drives 1	593766	593763	593765	593764
3 Gear drives 1	593770	593767	593769	593768

Properly aligned pulleys, sprockets, and gears as well as adjustment of belt tension, chain slack and gear backlash are essential to minimize vibration, maximize power transmission, and meet the expected service-life of mechanical drives. Industrial mechanics must be trained to master the fundamental skills related to the identification, installation, and maintenance of belt, chain, and gear drives.

The Level 1 includes all the hardware and tools to teach these skills. Pulleys, sprockets and gears are stored on a panel for quick identification and inventory control.

Topics

Belt Drives 1:
– Introduction to belt drives
– Installation of belt drives
– Adjustment of belt tension
– Speed and torque ratios

Chain Drives 1:
– Introduction to chain drives
– Installation of chain drives
– Adjustment of chain slack
– Speed and torque ratios

Gear Drives 1:
– Introduction to gear drives
– Spur gear installation
– Gear alignment
– Backlash adjustment
– Speed, torque, and gear ratios
– Gear trains

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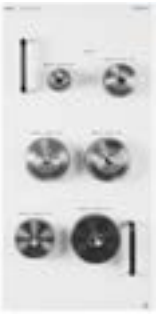

Recommended Learning Material

Workbooks

Campus license:

de	793116
en	793115
es	793118
fr	793117

Notes: Campus licenses include the student and the instructor PDF versions of the workbooks of the Workstation Package and Level 1: “Introduction to Mechanical Drives”, “Belt Drives 1”, “Chain Drives 1”, “Gear Drives 1”, and the “Mechanical Drive Training System User Guide”.

Courses on Festo LX

→ Chain Drives 1

→ Belt Drives 1
→ Gear Drives 1

Mechanical Drives, Level 2

Belt, Chain, and Gear Drives 2

Mechanical Drives Training System – Level 2

	de	en	es	fr
	594837	**594778**	**594839**	**594838**

Note: Level 2 requires Level 1.

The most important components at a glance:

1 Belt drives 2	593781	593778	593780	593779
2 Chain drives 2	593785	593782	593784	593783
3 Gear drives 2	593789	593786	593788	593787
Level 2 accessories	593790	593790	593790	593790

Building on the knowledge acquired in Level 1, Level 2 provides learners with more learning possibilities in installation procedures of hardware commonly used in a variety of belt drives, chain drives, and gear drives. There are several types of belts, pulleys, chain, sprockets, and gears suited for specific applications; industrial maintenance learners need to be able to identify and install them according to specifications. A selection of the most common components is included in Level 2.

Level 2 also includes new hardware and tools to teach these skills. Pulleys, sprockets, and gears are conveniently stored on panels.

Topics

Belt Drives 2:
– Wedge and notched wedge V-belts
– Idler pulleys
– Variable-speed belt drives
– Multiple-speed belt drives
– Multiple-belt drives
– Synchronous belt drives
– High torque synchronous belt drives

Chain Drives 2:
– Multiple-strand chain drives
– Idler sprockets

Gear Drives 2:
– Helical gears
– Worms and worm gears
– Miter gears
– Gearboxes

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Recommended Learning Material

Workbooks

Campus licenses:

de	595111
en	595110
es	595113
fr	595112

Notes: Campus licenses include the student and the instructor PDF versions of the workbooks “Belt Drives 2”, “Chain Drives 2”, and “Gear Drives 2”.

Courses on Festo LX

→ Gear Drives 2

→ Belt Drives 2
→ Chain Drives 2

Mechanical Drives, Level 3

Shaft Alignment, Couplings, Bearing, Seals

Mechanical Drives Training System – Level 3

	de	en	es	fr
230 V, 50/60 H	**594840**	**594779**	**594842**	**594841**
120 V, 50/60 Hz		**594780**	**594844**	**594843**

Note: Level 3 requires the Workstation Package.

The most important components at a glance:

1 Shaft alignment and couplings	593800	593797	593799	593798
2 Bearings and seals	593804	593801	593803	593802
Level 3 accessories, 230 V	595670	595670	595670	595670
Level 3 accessories, 120 V		593809	593809	593809
Spare parts for bearings and seals	593805	593805	593805	593805

Optional component:

3 Laser alignment of shafts*	593819	593816	593818	593817

* Add-on to Shaft alignment and Couplings

A fundamental aspect of mechanical drives is the axial transmission of torque from a driving machine to a driven machine. This is achieved by joining the shafts of each machine through a device called the coupling. A key requirement of any coupling is the alignment of the shafts.

The topic “Shaft alignment and couplings” introduces those aspects and presents couplings and shaft alignment methods suitable for various operating conditions. An optional Laser alignment of shafts add-on is available.

The topic “Bearings and seals” deals with the inner components of a machine. Using real applications such as a gearbox, a pump and a wheel hub, learners learn industry-proven methods for installing and removing bearings and seals in housings and on shafts. Essential concepts of bearings lubrication are also covered.

Topics

Shaft Alignment and Couplings:
– Shaft alignment: straight-edge and feeler gauge method, rim and face method, reverse dial indicator method, laser method (optional)
– Flange couplings
– Flexible sleeve couplings
– Chain/gear/grid couplings
– Universal joints

Bearings and Seals:
– Removal/installation of gaskets, and seals
– Use of an arbor press and a hammer for installation/removal of bearings
– Use of a splitter/puller
– Installation of a bearing by heating the inner raceway
– Removal/installation of shaft lock nuts, lock washers, and snap rings
– Introduction to cleaning and lubrication of bearings

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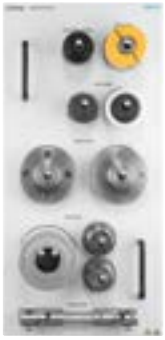

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Recommended Learning Material

Workbooks

Campus licenses:

de	596178
en	596177
es	596180
fr	596179

Notes: Campus licenses include the student and the instructor PDF versions of the workbooks “Shaft Alignment and Couplings”, “Bearing and Seals”, “Vibration Metering”, and “Vibration Analysis”

Courses on Festo LX

→ Bearing and Seals

→ Shaft Alignment and Couplings
→ Vibration Metering
→ Vibration Analysis

Mechanical Drives, Level 4

Clutches, Brakes, Ball Screws, Linear Bearings

Mechanical Drives Training System – Level 4

	de	en	es	fr
	594845	**594781**	**594847**	**594846**

Note: Level 4 requires the Workstation Package.

The most important components at a glance:

1 Clutches and brakes	593823	593820	593822	593821
Electromagnetic clutch-brake unit*	593834	593834	593834	593834
2 Ball screws and linear bearings	593789	593786	593788	593787

* Shown with item 1

Several industrial applications, such as some conveyors, may require a load to be engaged/disengaged or braked while the motor keeps running. Other applications require the torque to be limited to protect mechanical equipment from overload caused by shock loads or machine jamming. The topic “Clutches and brakes” introduces those aspects and presents clutches for various operating conditions along with their proper installation procedure.

In modern industry, ball screws and linear bearings are commonly used to transform rotational movement into linear movement, and vice versa. Typical applications include many types of machine tools, such as CNC mills and CNC drills. The topic “Ball screws and linear bearings” introduces the main components and proper assembly steps of a linear slide. Essential concepts of maintenance and lubrication of linear bearings, ball screws, and ball nuts are also covered.

Topics

Clutches and Brakes:
– Freewheel clutches
– Torque limiters
– Electromagnetic clutches and brakes

Ball Screws and Linear Bearings:
– Linear bearings
– Ball nuts and ball screws
– Backlash
– Pitch, lead, start, and speed

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Recommended Learning Material

Workbooks

Campus licenses:

de	596182
en	596181
es	596184
fr	596183

Notes: Campus licenses include the student and the instructor PDF versions of the workbooks “Clutches and Brakes” and “Ball Screws and Linear Bearings”.

Courses on Festo LX

→ Clutches and Brakes

→ Ball Screws and Linear Bearings

Industrial Wiring

Proficiency with Electrical Installations

→ Video

Shown with optional components

Developing proficiency in industrial wiring is especially important for panel builders, industrial electricians, and electrical and maintenance technicians.

The Industrial Wiring learning solution imparts all wiring essential competencies in a compact and safe environment.

Learners gain wiring expertise to build, commission, modify, and troubleshoot a typical industrial electrical installation.

The project approach is stimulating and allows for the development of soft skills, such as work organization and communication.

The course guides learners in the installation of a three-phase induction motor control system. Learners hone their skills through varied hands-on tasks.

Using industry-standard drawings, learners learn metalworking skills and geometry bending techniques (optional). They install all components and wire the installation from the electrical panel through the deported operator panel.

Upon the completion of this course, learners will have the necessary skills to build and modify most industrial electrical installations.

Learning Objectives

- Technical drawings and electrical enclosures
- Pull boxes, junction boxes, and conduit bodies
- Electrical conduits
- Fittings and cable trays
- Electrical schematics and wiring tables
- DIN rails, wiring ducts, and electrical panel components
- Wiring of an industrial installation
- Running wires through conduits
- Commissioning
- Troubleshooting
- Maintenance
- Modification of an existing installation
- Written and oral report

Industrial Wiring Learning System, NEMA, 120 – 208 V, 60 Hz		**8176019**

Main components at a glance:

1	Electrical installation package (120/208 V)	8167918
2	Control component package (120/208 V)	8175086
	Metalworking component package	8169080
3	Wiring components package (NEMA)	8169079
	Wire marking component package	8169083
	Flexible conduit component package	8169082

Industrial Wiring Learning System, IEC, 230 – 240 V, 50/60 Hz		**8176020**

Main components at a glance:

1	Electrical installation package (230/400 V)	8167919
2	Control component package (230/400 V)	8175087
	Metalworking component package	8169080
3	Wiring components package (IEC)	8169084
	Wire marking component package	8169083
	Flexible conduit component package	8169082

Applicable to the two variants:

Necessary tools, also order:

4	Metalworking tool kit	8169078
	Wires and cables tool kit	8169077

Rigid conduit (EMT) option, also order:

Bending tool kit	8180051
Rigid conduit component package (EMT)	8169081

Workstation and storage options:

5	Tabletop workstation with white plywood panel	8167878
	Systainer storage package	8174658
	Dolly truck for Systainers	8186152
	EMT conduit rack	8176027
	Wire spool support package (NEMA)	8174183
	Wire spool support package (IEC)	8186153

Additional consumables:

Wiring components package (NEMA)	8169079
Wiring components package (IEC)	8169084
Rigid conduit component package (EMT)	8169081
Metalworking component package	8169080
Wire marking component package	8169083
EMT conduit consumables	8169134
Flexible conduit consumables	8169135

Note: The wiring project can be built five times using the material provided in the rigid and flexible conduit component packages.

Optional equipment:

4-mm safety connectors interface plate	8176024
Harting interface plate	8176025
Factory automation project components	8176026

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Recommended Learning Material

Workbook

Campus licenses:

en	8190364

Notes: The campus license is currently offered in English only, but other languages will be added as they become available. Campus licenses include the student and the instructor PDF versions of the workbook “Industrial Wiring”.

Courses on Festo LX

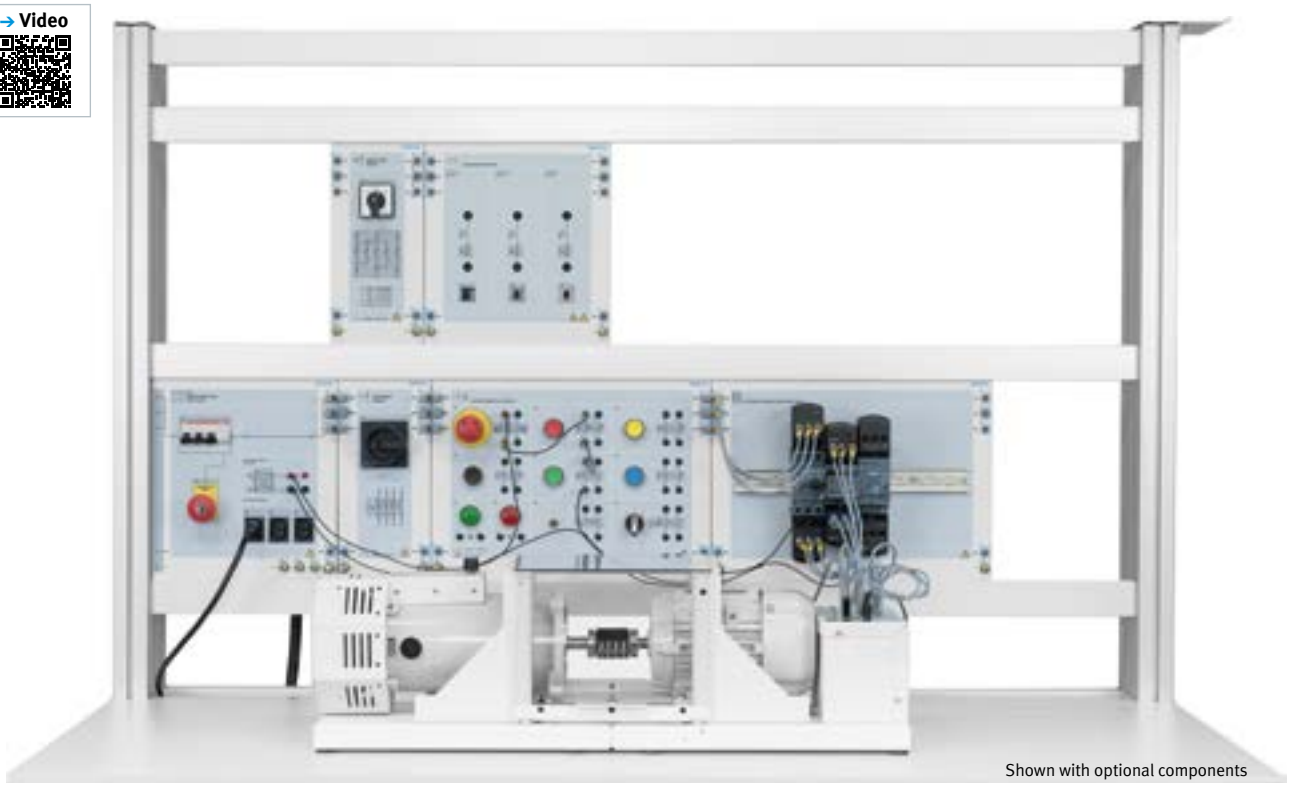
→ Industrial Wiring

→ Crimping Tool – How Tool
→ Insulation-Stripping Plier – How Tool

Basic Motor Control Technology TP 1221

The Fundamentals of Electric Motor Controllers

→ Video



Shown with optional components

Many types of technical workers, primarily industrial electricians, industrial maintenance technicians, and mechatronics technicians, need to understand, install, maintain, and troubleshoot control circuits and their main controllers such as manual starters, automatic starters, reversing starters, reduced voltage starters.

The equipment set Basic Motor Control Technology builds knowledge and skills in the fundamentals of industrial electric motor controllers. The curriculum is specially designed to develop soft skills in addition to technical skills. Equipment allows teachers to insert various faults to develop troubleshooting skills – a must for a good preparation for the workplace.

The course first familiarizes learners with the operation of individual components, then provides hands-on application opportunities to use them in realistic, industrial motor control circuits. Upon completion of this course, learners will be able to install, commission and trouble-shoot the most common electric motor controllers using contactors and relays.

Benefits

– Innovative design for power switchgear from Siemens with safe and faultable connection boxes
– Faultable components to develop troubleshooting skills
– Curriculum with high focus on soft skills development along with technical skills
– Realistic training using industrial-grade equipment
– Safe grounding method PE+

This training package is also available as a portable version in a rugged suitcase (120 V, 60 Hz): Basic Motor Control Technology TP 1221-P.

Learning Objectives

– Lockout/tagout procedures
– Symbols and schematics
– Troubleshooting components and circuits
– Control and pilot devices
– Protections (breakers, overloads)
– Manual starters
– Two- and three-wire control
– Reversing starters
– Jogging control
– Time-delay relays
– Primary resistors starters
– Star-delta starters
– Motor testing and troubleshooting

Complete Equipment Set TP 1221, 120 V, 60 Hz	**8158355**
Complete Equipment Set TP 1221, 230 V, 50/60 Hz	**8158356**

The most important components at a glance:

1 Basic motor controls component set	On request
2 Electrical cabinet mounting panel	8141608
3 Control and pilot devices	8140123
4 Disconnect switch	8140373
5 Cam switch	8140444
6 Starting resistors, 120 V, 60 Hz **or**	8142976
6 Starting resistors, 230 V, 50/60 Hz	8144625

Note: Make sure you have the required accessories and recommended workstations listed below, or suitable equivalents, in your laboratory.

Required accessories, also order:

Three-phase induction motor, 120 V, 60 Hz **or**	8143697
Three-phase induction motor, 230 V, 50/60 Hz	8143698
Mechanical load for electrical machines	8147352
Inertia wheel for Basic Motor Control	8156783
Protective guard – face-to-face	794194
Coupling	792271
Safety laboratory cables for Basic Motor Control	8150799
Digital multimeter	579782
Amprobe AMP-220 clamp meter	8158976
Klein tools ET600 insulation resistance tester	8158399
AC 24 V wall mount power supply, 120 V, 60 Hz **or**	579696
AC 24 V wall mount power supply, 230 V, 50/60 Hz	793290
Three-phase AC Power supply and safety unit, 120 V, 60 Hz **or**	8143154
Three-phase AC Power supply and safety unit, 230 V, 50/60 Hz	8143155
or	
Three-phase AC Power supply and safety unit, Type B RCD, 230 V, 50/60 Hz	8162950

Recommended workstations:

Tabletop workstation (DIN A4)	8153360
Tabletop double-sided workstation (DIN A4)	8158409
Mobile Frameline, complete model without energy duct	8075133
Frameline mobile table	8087149

Recommended extension:

EduTrainer soft starter	8121090

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Recommended Learning Material

Workbook

Campus license:

en	8174636

Note: The campus license is currently offered in English only, but other languages will be added as they become available. Campus licenses include the student and the instructor PDF versions of the workbook “Basic Motor Control Technology”.

Course on Festo LX

→ Basic Motor Control Technology

Basic Motor Control Technology TP 1221-P

The Fundamentals of Electric Motor Controllers in a Suitcase

→ Video

Complete Equipment Set TP 1221-P (120 V, 60 Hz)	**8145472**

Note: This product cannot be sold or delivered in countries that require CE compliance.

The most important components at a glance:
- Pushbuttons, switches and emergency buttons
- Pilot lights
- Circuit breaker
- Disconnect switch
- Cam switch
- High-power resistors
- Three-phase induction motor (star/delta) with inertia load
- Contactors
- Control relay
- Overload relay
- Motor protective switch
- Time-delay relay
- Fault keys for power components and fault switches
- Power supplies (120/208 V AC and 24 V DC)
- Tabletop mounting plate with DIN rail
- Safety laboratory cables
- Three-phase power cord

Notes: Measuring instruments sold separately. Also, three-phase power (120 – 208 V, 5 wires including neutral and ground) is required for operation.

All the equipment required to perform the practical exercises is contained in the rugged suitcase for convenient storage and transportation.

The course first familiarizes learners with the operation of individual components, then provides hands-on application opportunities to use them in realistic, industrial motor control circuits. Upon completion of this course, learners will be able to install, commission and troubleshoot the most common electric motor controllers using contactors and relays.

Recommended Learning Material
See TP 1221 (previous page)

The equipment set Basic Motor Control Technology builds knowledge and skills in the fundamentals of industrial electric motor controllers. The curriculum is specially designed to develop soft skills in addition to technical skills. Equipment allows teachers to insert various faults to develop troubleshooting skills – a must for a good preparation for the workplace.

Learning Objectives
- Lockout/tagout procedures
- Symbols and schematics (understanding and implementing)
- Troubleshooting components and circuits
- Control and pilot devices
- Protections (breakers, overloads)
- Manual starters
- Two- and three-wire control
- Reversing starters
- Jogging control
- Time-delay relays
- Primary resistors starters
- Star-delta starters
- Motor testing and troubleshooting

Benefits
- Innovative design for power switchgear from Siemens with safe and faultable connection boxes
- Faultable components to develop troubleshooting skills
- Curriculum with high focus on soft skills development along with technical skills
- Realistic training using industrial-grade equipment
- Safe grounding method PE+

Variable-Frequency Drives

Basic Principles of VFDs and their Motor Applications

This training system specifically designed to introduce learners to the basic principles of variable-frequency drives (VFDs). It provides a comprehensive, high-quality, and cost-effective solution to rapidly build student knowledge in VFDs and their motor applications. It is designed for portability and powered using a standard single-phase AC outlet.

Courseware

Seven exercises progressively introduce learners to variable-frequency drives and their more advanced functions. These experimentations reinforce the theoretical concepts and help learners develop the skills necessary to work in the field of electricity.

Benefits

– Introduction to all the important concepts of VFDs and three-phase induction motors
– Allen-Bradley PowerFlex 525 drive
– Easy access to components
– Six built-in faults (toggle switches)
– Rugged transportation and storage case

Learning Objectives

– Motor drives
– Three-phase induction motor characteristics and operation
– VFD characteristics and operation
– VFD control circuits and advanced functions, such as acceleration and deceleration, motor braking, jogging, and protection
– VFD load types/control methods
– VFD installation, maintenance, and troubleshooting
– Optional exercise about VFD operation with programmable logic controllers (PLCs) and human-machine interfaces (HMIs)

Variable-Frequency Drive Training System (120 V, 60 Hz)	592614

Note: This product cannot be sold or delivered in countries that require CE compliance. For other country voltage/frequency configurations, please contact your local sales representative for availability.

The most important components at a glance:

– Variable-frequency drive (Allen-Bradley Powerflex 525)
– Fourteen inputs outputs for the variable-frequency drive
– AC induction motor
– Padlockable circuit breaker controlling main supply
– 24 V DC power source
– Load pulley/brake disk
– Optical incremental encoder
– Magnetic brake
– Emergency stop and reset switch
– Four push-button switches
– Two selector switches
– Two indicator lights
– Variable DC signal source
– Ethernet/IP coupler

Recommended Learning Material

Workbook

Campus license:

en	8175839

Notes: The campus license is currently offered in English only, but other languages will be added as they become available. Campus licenses include the student and the instructor PDF versions of the workbook “Motor Control Using Variable-Frequency Drives”.

Course on Festo LX

→ Motor Control Using Variable-Frequency Drives

Electricity and Electronics

Build Basic Skills and Knowledge

Proven Training Concept
Discover a comprehensive range of learning solutions that develop universal electrotechnology skills, with a strong emphasis on electrical safety. Our learning systems encompass modular, customized, and complete setups to cater to diverse training requirements and budgets in both industry and education. These solutions are always accompanied by outstanding learning content, ensuring maximum skills development.

Designed for Training
The modular structure of the training packages enables instructors to set up a training and learning environment that matches training and budgetary requirements. This flexibility provides scope for gradual expansion. Equipment is built to withstand daily use in training. All in all, this results in versatile, cost-efficient sets of equipment.

Rapid Transfer
Whether in initial professional training or more advanced courses: It is essential to be able to recall what has been learned and apply it immediately. This is easier to do if the worlds of learning and work are as similar as possible. That is why the training packages for electrical engineering only contain industrial components, and the exercises in the course documents come from a typical, professional environment.

Expertise in Electronics
Electronics skills are critical for implementing automation, monitoring, communication, safety, and sustainability. This is we offer specialized electronics learning solutions accompanied by a collection of hands-on courses that covers the fundamentals, as well as digital, communication, and industrial electronics, including programmable electronics.

Everything from a Single Source – Equipment for Electrical Engineering Laboratories

No matter what your training focuses on, electrical engineering and electronics are part of the basic knowledge for all areas of production, process and automation technology.

With learning systems from Festo Didactic, learning laboratories – be they modular, customized or complete – can be equipped for any application and budget, whether for industry or trades, for teaching basic principles, for building systems or control or drive technology.

A Sample of Training Packages
- Fundamentals of electricity and electronics TP 1011, with extensions to relay technology, optoelectronics, analog technology, and motor vehicle mechatronics
- Basic principles of digital technology TP 1012
- Basic principles of control technology TP 1013
- Power supply systems and protective measures TP 1111
- Servo brake and drive system TP 1410, with a selection of electrical machines, compatible with the SINAMICS G120 frequency converter

More training packages are available: Refer to our website or to the product catalogs.

Product Catalogs Electronics and Electrical Engineering

In the Electronics and Electrical Engineering product catalogs, you will find our complete range of learning solutions for basic and advanced training in:

- Electrical engineering
- Electricity and electronics
- Communications
- And more

Visit our website to browse and download the catalog:
→ To the catalog download page

Electric Power Technology Training Systems

A Single Platform for a Complete Coverage

Extensive Program
Learners install and connect various electrical modules to create a wide range of electrical systems and circuits and study a wide range of topics: rotating machines, electrical power transmission, power electronics, home energy production from renewable resources (wind and sunlight), large-scale electricity production from hydropower and wind power, smart-grid technologies (SVC, STATCOM, HVDC transmission, etc.), storage of electrical energy in batteries, drive systems for small electric vehicles, and more.

Modular Design Approach
The program is highly flexible and allows a multitude of different customized training solutions. Modular hardware equipment and curriculum can be easily expanded to teach other subjects within the program. Instructors build their electrical-energy laboratory selecting what they need. This ensures that new courses and equipment can be added over time without unnecessary duplication, ensuring investment is cost-efficient.

Sturdy and Safe
All workstations, modules, and components are very sturdy, ensuring a prolonged service life in a demanding training laboratory environment. The systems are designed to ensure user safety. Modules are grounded using a railing system enclosed in the workstation. Safety jacks are used for connections to electric power circuits. Inputs and outputs are protected against improper connections and overvoltage or overcurrent conditions. Exercises cover safety procedures.

Computer-Based Tools
Networkable, smart hardware
Two computerized modules – the Data Acquisition and Control Interface (DACI) and the Four-Quadrant Dynamometer/Power Supply – form the cornerstone of a digital electrical engineering lab based on our electric power technology training systems. These two modules are unparalleled allies for teaching and conducting experiments in electromechanics, power electronics, renewable energies, and power management.

Note: The products on these pages cannot be sold or delivered in countries that require CE compliance.
See TP 8012 for CE-compliant equivalent products.

A Flexible, Complete Training Platform, Based on a Unique Training Program

The Electric Power Technology Training Program from Festo Didactic answers the increasingly diversified needs for training in the wide field of electrical energy in:
– Basic electric power
– Rotating machines
– Power electronics
– Renewable energies
– Smart grid
– Industrial controls

The program combines hardware, software, and courseware content aimed at maximizing learning and experimentation. Courses and pre-set systems offer predefined learning paths, but modularity enables instructors to create a tailored solution that matches specific requirements.

Instrumentation, Data Acquisition and Control
Computer-based instrumentation decreases the need for physical measuring instruments and speeds up data processing. LVDAC-EMS, our free, multipurpose software, assists learners during the experiments, providing access to the computer-ized control functions of the DACI and four-quadrant dynamometer, and offering a set of virtual instru-ments to measure, observe, analyze, and control electrical and mechanical parameters of a workstation.

Also available:
– Software program SCADA for LVDAC-EMS
– LVSIM-EMS, a simulation software

Pre-Set Training Systems
Pre-set learning systems are also available to show popular config-urations among customers. Each pre-set system includes necessary modules and selected courses of the Electric Power Technology Training Program. These turnkey systems are also expandable to answer evolving needs.

Available systems:
– DC and AC Power Circuits
– Lead-Acid Batteries
– Basic Renewable Energy
– Electromechanics
– Power Electronics
– Smart Grid Technologies
– DFIG Principles
– Power Transmission
– Smart Grid
– Hydropower Electricity Generation
– BLDC Motors and Vector Control PMSM Drives
– Electric Power Substations
– And more

A Popular Choice
The Electromechanical Training System combines a modular design approach with computer-based data acquisition to provide unrivaled training in basic electric power tech-nology. Training is oriented toward today's competency requirements.

Training content:
– DC power circuits
– Permanent magnet DC motor
– Single-phase and three-phase
– AC power circuits
– Single-phase transformers
– Three-phase transformer banks
– Three-phase rotating machines
– Power factor correction

See our website for details:
→ To the electric power technology learning solutions page

Electric Power Technology TP 8012

Modular Training Packages for Key Topics

Versatile Equipment Sets
The electric power technology equipment sets constitute a unique, modular pedagogical concept – a combination of turnkey courseware, practical software, and rugged hardware designed for instructional purposes. This methodically and efficiently builds student knowledge and skills in electric power technology.

Modular Design Approach
The program is highly flexible and allows a multitude of different customized training solutions. Festo Didactic provides a wide array of equipment to perform the practical exercises. Equipment sets suggest a learning path linking hardware and courseware, yet the modularity allows instructors to create divergent paths for customized solutions.

A variety of electrical loads, power supplies, motors and generators, inverters, power electronics components, transformers, mechanical loads, and other devices are available to ensure that student training builds the relevant skills for the future.

Sturdy and Safe
All workstations, modules, and components are very sturdy, ensuring a prolonged service life in a demanding training laboratory environment. The systems are designed to ensure user safety. Modules are grounded using a railing system enclosed in the workstation. Safety jacks are used for connections to electric power circuits. Inputs and outputs are protected against improper connections and overvoltage or overcurrent conditions. Exercises cover safety procedures.

Computer-Based Tools
Networkable, smart hardware
Two computerized modules – the Data Acquisition and Control Interface (DACI) and the Four-Quadrant Dynamometer/ Power Supply – form the cornerstone of a digital electrical engineering lab based on our electric power technology training systems. These two modules are unparalleled allies for teaching and conducting experiments in electromechanics, power electronics, renewable energies, and power management.

Note: The training packages mentioned on these pages are designed for 230V/50Hz electrical configurations.

The modular structure of the electric power technology training packages enables instructors to set up a training and learning environment that matches training and budgetary requirements.

This flexibility provides scope for gradual expansion of the equipment sets as required.

The devices are built to withstand daily use in training. All in all, this results in a versatile, cost-efficient set of equipment.

Complete courses are available for each training package in digital format on Festo LX or as PDF workbooks.

We are constantly developing new devices and workbooks to ensure that our electric power technology training packages always provide a modern, up-to-date learning platform.

Instrumentation, Data Acquisition and Control
Computerized instrumentation decreases the need for physical measuring instruments and speeds up data processing. LVDAC-EMS, our free, multipurpose software, assists learners during the experiments, providing access to the computerized control functions of the DACI and four-quadrant dynamometer, and offering a set of virtual instruments to measure, observe, analyze, and control electrical and mechanical parameters of a workstation.

Practical Equipment Sets
Equipment sets includes necessary modules to cover a specific topic. They can be combined and/or customized to answer evolving needs.

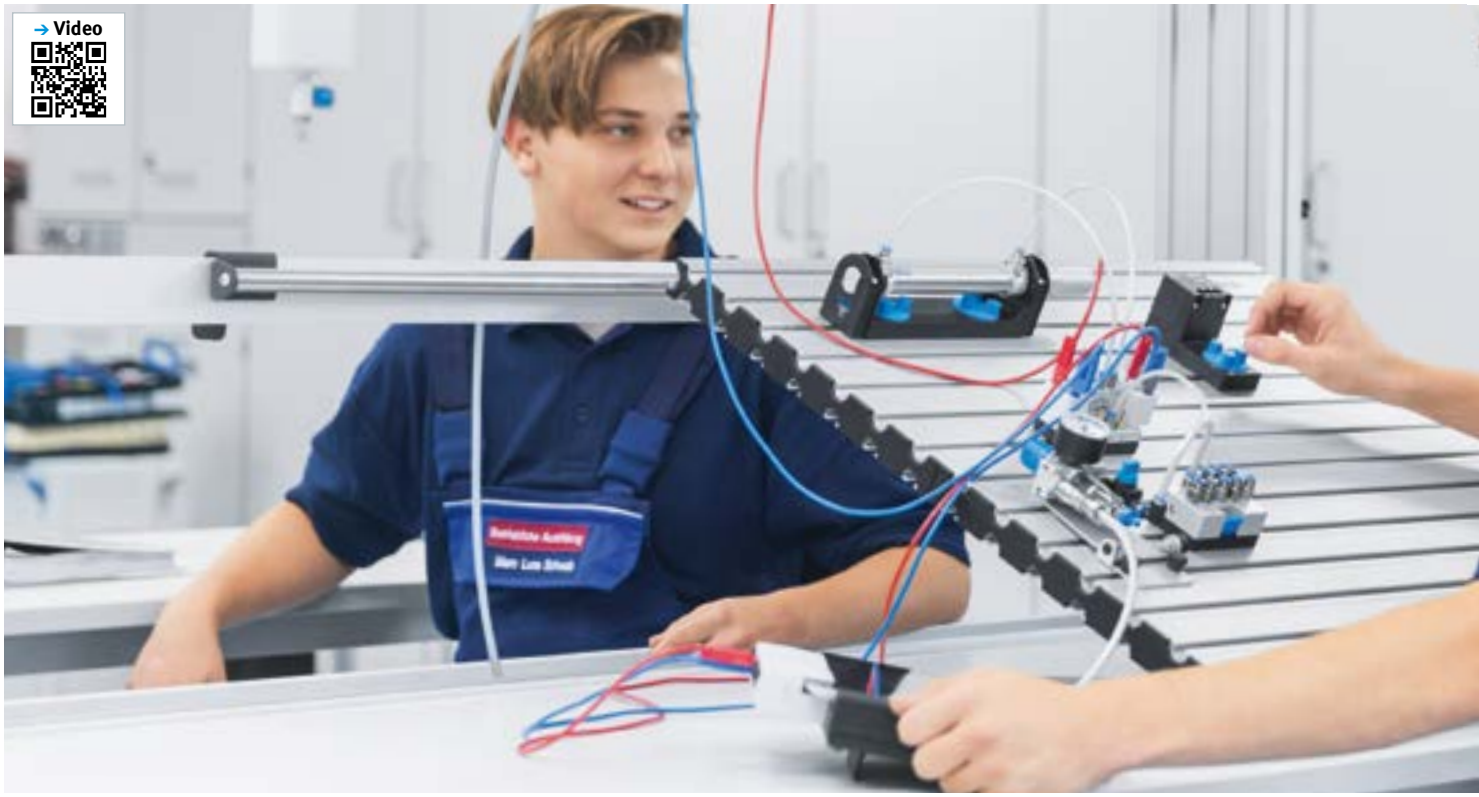
Available equipment sets:
– Intro to Wind Power 8012-0
– Wind Power Systems TP 8012-1
– Wind Power, Complete TP 8012-2
– Intro to Solar Power TP 8012-3
– Photovoltaic Systems TP 8012-4
– Solar Power, Complete TP 8012-5
– AC/DC Power Circuits TP 8015-1
– Transformers TP 8015-2
– AC/DC Power Circuits and Transformers TP 8015-3

Soon available:
– Power electronics
– Electrical machines

See our website for details:
→ To the electric power technology learning solutions page

Fluid Power

From the Basics to Advanced Topics



Essential Technologies
Fluid power is an essential part of contemporary industrial reality. Air is available everywhere, easy-to-transfer and store – to cite just a few of the many benefits of pneumatics. Hydraulics offers a solution wherever high pressures and forces are required in industry.

Modular for Flexible Expansion
The training packages from Festo Didactic are modular in structure. For example, you could start with the basic level of electropneumatics and then move onto the advanced level, or start with the subject of electro-hydraulics – the choice is yours. You want to explore a particular specialized 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 and the profile column of a Learnline workstation. The electrical units are clamped into the ER mounting frame and sequenced individually. The profile slots on the workstations are the same for all pneumatic, hydraulic and electrical units – a single investment, with triple functionality.

Systematic Storage
Most equipment sets are delivered in practical, Systainer-compatible equipment trays. 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.

Connect – And Energy Is There!
The pneumatic power supply is provided by connecting highly flexible plastic tubing to the push-in fitting QS. The hydraulic energy supply is provided by the tool-free connection of low-leakage couplings. The couplings are self-sealing when decoupled. All electrical components and units are connected by 4 mm safety sockets or 4 mm safety plugs.

Didactic Plus

The practical courses 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 pneumatics, the training also covers basic physics, technical calculations, safety, economic efficiency, analytical fault-finding, and professional documentation.

Practical basic and specialized 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 courses.

Customized Training Environments
User-friendly training environments for specific topic areas:
– Self-study phases with the training programs
– Designing, simulation, and documentation with FluidSIM
– Hands-on experimentation with the training packages and the exercises in the workbooks
– Functional testing and optimization with measurement technology and FluidLab

Advanced Courses Made Easy
New developments and trends in fluid engineering can be incorporated directly into our learning systems. New control systems can be integrated into the learning system using the EduTrainer concept. Basic packages can be easily expanded to include the subjects “Pneumatics measurement and control TP 210” or “Vacuum technology TP 230.”

Product Catalog Fluid Power

In the Fluid Power product catalog you will find our complete range of learning solutions for basic and advanced training in this area.

Visit our website to browse and download the catalog:
→ To the catalog download page

We offer training packages for the following topics:
– Pneumatics
– Electropneumatics
– Closed-loop pneumatics
– Vacuum technology
– Sensor technology
– Measurement and control
– Hydraulics
– Electrohydraulics
– Closed-loop hydraulics
– Proportional hydraulics
– Mobile hydraulics
– Digitalization

Learning Media

Digital Learning with Festo Learning Experience

The Backbone of the Process Automation Learning Content

What Makes Festo LX Unique
With Festo LX, we have created a digital learning portal that offers a high degree of flexibility, personalization and hardware integration.

Included in Festo LX is an extensive library of course content. Different learning formats are combined to make learning as varied and interactive as possible. The existing content is created on the basis of individual learning nuggets and can thus be quickly and easily adapted to the specific needs of the learners.

Combining theory and practice is easy with Festo LX. Matching the connected learning systems, Festo LX shows suitable courses to perform practical exercises.

Individual Learning with Festo LX
Festo LX offers a high degree of individualization so that learners are taught exactly the knowledge they need.

Festo LX follows the so-called nugget concept with its courses. Nuggets are small, self-contained learning contents that offer the opportunity to learn in a targeted and effective manner. Nuggets are usually designed with a combination of text, images, videos, animations, links and other interactive elements. Several nuggets can be combined to form a specific course and thus convey content on a specific topic.

LX Creator
The LX Creator makes individual learning even easier. Existing learning nuggets and courses can be edited quickly and easily. It is also possible to create own content and link it to the existing teaching materials. The LX Creator offers the same look and feel of Festo Didactic content. For learners, this creates a consistent learning experience without any visual disruption and makes it much easier for teachers to create content.

Learning Paths
Learning paths are made up of a combination of different courses on a specific topic or professional field. They provide structures and recommendation for the ideal order in which courses should be completed. Our learning paths are based on our didactic expertise as well as on national occupational profiles and curriculum frameworks. The learning paths can be revised and created in the same way as courses using the LX Creator.

Festo LX
The Advantages at a Glance

– Individual and goal-oriented design of the lessons
– Flexible to use
– Supports many different teaching and learning scenarios
  – traditional or flipped classroom
  – distance learning
  – self-paced learning
  – and more
– Existing course materials can be linked with the appropriate learning systems from Festo Didactic in order to combine theory with practice and ensure a steep earning curve

– The learning content on Festo LX can be personalized using the online authoring tool LX Creator in order to meet the needs of teachers and students
– Existing learning content can be enhanced with own materials

Course Content in Festo LX
Festo LX offers a wide range of different learning contents for many areas of technical education and training. The Festo LX learning library includes more than 600 courses on factory automation,fluid power, Industrial Internet of Things (IIoT) and Industry 4.0, as well as electrical engineering, process automation, renewable energy and STEM. The learning content available on Festo LX is constantly revised and expanded to meet educational needs.

Course Formats in Festo LX
In order to make lessons as effective and varied as possible, it is necessary to use different learning formats. Festo LX offers a wide range of options for presenting and conveying learning content.

These include:
– eLearning courses
– eLab courses
– eTheory courses
– Evaluations
– Simulations and
– Learning videos

Partnerships
Together with partners, we are constantly developing and improving the content available on Festo LX. In this way, we ensure that the learning content on Festo LX meets the requirements of the industry and that learners are trained in the necessary skills.

Easy Access
Festo LX is a cloud-based learning portal. This eliminates the need for local installations and gives you access to the latest updates on functionalities and learning content at all times. Festo LX is used via license packages that are tailored to the number of users and the period of use.

Festo Learning Experience
Course Formats

Festo Learning Experience

Having a range of different learning formats is crucial in order to make the lessons as effective and varied as possible. Festo LX provides a wide choice of options for presenting and transferring training content.

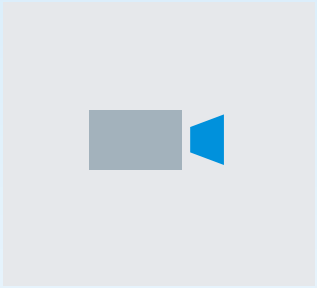
Course Formats

eLearning Courses
Our eLearning courses are interactively designed learning content, usually with a storytelling approach and with a narrator guiding through the course. These courses are particularly suitable as an introduction to new topics and provide a high-level overview. Best of all, all you need is a tablet, laptop, or smartphone with an Internet connection to complete the courses.

eLab Courses
Our eLab courses offer a wide range of hardware-related learning content, taught either through the use of Festo Didactic equipment or simulation software. Our associated learning systems are required to complete the courses. Our eLab courses are designed to test previously learned theoretical knowledge with practical tasks.

eTheory Courses
Our eTheory courses offer a wide range of hardware-independent learning content on technical topics. Compared to eLearning courses, they generally impart broader knowledge.

Simulations
Our simulations guide learners to perform hands-on, safe experiments that have no impact on real-world processes. The simulations provide a cost-effective learning extension, saving the need to purchase additional learning equipment.



Learning Videos
In our learning videos, experts present complex topics in a simple way. In the videos, current topics within the scope of technical training are explained in an easy-to-understand and practical manner, which enables fast and effective learning.

Evaluations
Thanks to the integrated evaluations in Festo LX, knowledge tests can be automatically carried out and evaluated.

User Manuals
Our user guides serve as digital manuals that support getting started with a new learning system or software in an interactive and engaging way.

eBooks
We make courses that are not yet digitally optimized available as eBooks on Festo LX. We are continuously working on new interactive content.

Campus Licenses Available For Offline Usage
Printable versions are available for selected learning materials, catering to those who prefer offline solutions or need additional resources. Campus licenses allow schools and small companies to use the licensed educational material at a single location, providing users with modification and reproduction rights as outlined in the license agreement. Delivery options (downloads, printed documents, USB keys...) and formats, as well as language variations, depend on the specific educational material.

Digital Learning with Festo LX
Featured Content

Expand knowledge and skills, no equipment required!

In addition to eLab courses that provide hands-on learning content and activities with physical learning systems, Festo LX offers a wealth of resources to learn without the need of a physical learning solution.

They can be used to expand knowledge and skills of current and future workers in a wide range of topics and technologies.

Browse our ever-growing collection on
→ lx.festo.com

1. Process Automation

This course deals with the basics of process automation including the handling of substances, system planning and engineering processes in practice.

→ eLearning course 12069 on **Festo LX**

2. Open and Closed Loop Control

This course uses practical examples to show the difference between open- and closed-loop control in automation. This includes types of control, signal processing, and regulators.

→ eLearning course 6775 on **Festo LX**

3. PLC Programming

PLCs play a central role in automation. These devices are used to control machines and systems. This course offers an ideal introduction to IEC-compliant programming.

→ eLearning course 5094 on **Festo LX**

4. Industrial Safety in the Workplace

This course covers the basic principles of safety in an industrial workplace setting.

→ eTheory course 10057 on **Festo LX**

5. Biologization – Explained in 5 minutes

This video describes the topic of biologization and the necessary steps to drive the biological transformation of the industry.

→ Video 17530 on **Festo LX**

6. Safety Technology

This course focuses on the design aspects of safety engineering and helps to understand safety engineering equipment and hazard analysis methods.

→ eLearning course 10313 on **Festo LX**









Water Management Series

A series of nine eLearning modules for people who need to know about water and wastewater management. No equipment required.

1. Intro to the Water Cycle and Water Management

This course teaches you the basics of water, creates awareness for energy and resources and introduces you to the field of water management.

→ eLearning course 9746 on **Festo LX**

2. Water Purification

This course will introduce you to the water purification process, including the topics of precipitation, flocculation and the need for water disinfection.

→ eLearning course 9747 on **Festo LX**

3. Water Supply

This course teaches you how drinking water is supplied from the source to the consumer, how operating pumps work and how water losses occur and how they can be avoided.

→ eLearning course 9748 on **Festo LX**

4. Wastewater Transport

In this course you will focus on wastewater transport, especially sewer systems. Learn about the components of a sewer system and important things to consider for the transport and regulation of wastewater.

→ eLearning course 9749 on **Festo LX**

5. Wastewater Treatment

This course will introduce you to wastewater treatment, including the topics of sedimentation, secondary or biological treatment as well as sludge treatment.

→ eLearning course 9750 on **Festo LX**

6. Sand Filtration for Water Purification

Learn what sand filtration is used for, what the different existing types of sand filtration are and how filters can be operated and maintained.

→ eLearning course 9751 on **Festo LX**

7. Membrane Filter Process in Water Management

Learn what membranes are, about the technology of membranes and the different membrane types, and how to operate membrane filtration processes.

→ eLearning course 9752 on **Festo LX**

8. Mechanical Pre-Treatment for Wastewater

In this course you will learn why wastewater needs to be pre-treated mechanically. We will focus on treatments using screens and grit chambers.

→ eLearning course 9753 on **Festo LX**

9. Adsorption in Water Management

Learn more about adsorption in general and especially in water management with the help of a practical example.

→ eLearning course 9754 on **Festo LX**

Digital Learning with Festo LX
Featured Content

1. How Tool Series

A series of eLearning courses that teach how to use basic tools and techniques common in industrial workplaces, such as:
– Drill
– Soldering
– Scribing
– Wrenches
– Files
– Knife Edge Square
– Hexagonal Key
– Crimping Tool
– Center Punching
– Vernier Caliper
– Pneumatic Hammer Drill
– Cutting Threads (external, internal)
– Insulation-Stripping Plier
– Tightening with a Torque Wrench
– Measurement of a Circuit with a Multimeter
– Pressing on Ball Bearings
– And more

Search for “How Tool” on Festo LX.

2. Fieldbus Technology

This course covers the basics of Fieldbus technology including the advantages of Fieldbus systems, design of Fieldbus systems, and topology.

→ eLearning course 12748 on **Festo LX**

3. Renewable Energies
This course provides an overview of the different sources of energy with a detailed focus on renewable energy sources and how they are used

→ eLearning course 14440 on **Festo LX**

4. Sustainability – What is it All About?

This course introduces the topic of sustainability, provides an overview of the different dimensions and facets of sustainable development, and shows which measures can be used to promote sustainability in industry and in everyday life.

→ eLearning course 21577 on **Festo LX**

5. ISO Geometrical Product Specifications (GPS) Series

This learning program has been jointly developed by Festo Didactic SE and Mahr GmbH to build skills in ISO geometrical product specification. Courses:
– Fundamentals of ISO/GPS
– Dimensional Tolerancing According to ISO 14405
– Form Tolerances According to ISO 1101
– Datums, Orientation, Location, and Run-Out
– Material Conditions According to ISO 2692
– Standards for Zones, Edges, and Measurement Uncertainties
– Compendium ISO/GPS – Size, Form and Location

Search for “ISO/GPS” on Festo LX.

6. Total Productive Maintenance

It is always better to act than to react. Bearing this in mind, many businesses strive to stabilize plant performance, and to introduce preventive maintenance.

→ eLearning course 2139 on **Festo LX**

7. Basics of Production Control

In this course, you will explore the relationship between Lean Production, Just in Time philosophy, and production systems control.

→ eTheory course 21321 on **Festo LX**

8. 5S – Workstation Organization

The objective of the 5S is to become familiar with methods for creating ideal, exemplary, well-organized workstations (both in industrial and administrative areas).

→ eLearning course 1509 on **Festo LX**








Discover more digital content:
Visit → lx.festo.com and open your free account to browse the library.

Courseware
EduKit PA and MPS PA

EduKit PA

This workbook explains the basic principles of process technology and provides an introduction to the subject. It covers manual and automated measurement, open and closed-loop control and system design topics such as planning, installation, commissioning, marketing and sales. You will be provided with exercises including all necessary worksheets as well as didactic information and solutions as support for trainers. The workbook contains detailed descriptions of the problems and parameters. The worksheets guide students through the required steps of planning, execution and function testing.

The measurement and open- and closed-loop control exercises relate to flow, level and pressure technology.

The workbook includes the worksheets, data sheets, and solutions in digital format.

Campus license

de	**563969**
en	**563971**
es	**563973**
fr	**563975**

MPS PA Process Applications

This workbook includes tables that allocate training aims with exercises and components with exercises, together with the fundamentals of closed-loop control technology, exercises with all necessary worksheets and didactic instructions about analyzing and inspecting a system, measuring, open and closed-loop control, as well as the solutions for the instructors. The workbook provides detailed descriptions of the problem definition and parameters. The worksheets support the students through the required steps of planning, execution and function testing.

The exercises refer to the filtering, mixing, temperature maintenance and bottling processes. The trainees acquire the ability to inspect systems, to describe components and functions as well as the operation of systems.

The workbook includes the worksheets, and the solutions in digital format.

Campus license

de	**8131019**
en	**8131020**

MPS PA Compact Workstation

The workbook “Fundamentals of Closed-Loop Control” includes learning activities to be performed with the MPS PA Compact Workstation.

Content:
– Introduction to process automation
– Commissioning a basic closed-loop control system
– Read and design technical drawings
– Analog signal processing
– Fundamentals of closed-loop technology
– Operating, identifying and analyzing a level control system
– Operating, identifying and analyzing a flow control system
– Operating, identifying and analyzing a pressure control system
– Operating, identifying and analyzing a temperature
– Loop tuning
– Energy monitoring, analyzing, and optimizing a pump (optional)

The campus license also includes the user guides of the MPS PA Compact Workstation (basic and instrumentation workstations).

→ eLab course 16423 on **Festo LX**

Campus license (PDF format)

en/de	**8190412**

Courseware

EDS Water Management

Water Purification

After having worked through the exercises in the “Water purification” workbook, learners will be able to:
– Control the basic processes of precipitation, flocculation and sedimentation
– Measure the chlorine content and deal with chlorine dosage in the system
– Name problems caused by too high or too low a chlorine dosage

Campus license (PDF format)
en/de/es/fr **8208239**

Water Supply

After having worked through the exercises in the “Water Supply” workbook, learners will be able to:
– Highlight special features of different pump types
– Understand the influences on pump performance during water supply
– Identify the interaction between pressure and flow rate in a piping system
– Control water supply using different valve types
– Describe the meaning of different pressure zones in a water distribution network
– Detect water losses in distribution networks and highlight problems in leak detection

Campus license (PDF format)
en/de/es/fr **8208239**

Wastewater Transport

After having worked through the exercises in the “Wastewater Transport” workbook, learners will be able to:
– Transport solid matter in a sewer system using different flow speeds
– Name the effects of exceeding the hydraulic capacity
– Name the basic mechanisms that make flushing necessary
– Describe the functions of a rain overflow basin
– Explain the functional principle of a flow basin for solid matter retention

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Wastewater Treatment

After having worked through the exercises in the “Wastewater Treatment” workbook, learners will be able to:
– Simulate central processes related to the sedimentation of sludge
– Analyze the behavior of floc with different flow rates and solid matter content
– Name the consequences of hydraulic overload of a wastewater treatment plant
– Describe the basic function of aerobic water treatment and the role of sludge recirculation
– Measure the amount of dissolved oxygen and highlight the advantages of continuous measurement

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Membrane Filtration

After having worked through the exercises in the “Membrane filtration” workbook, learners will be able to:
– Describe the operating modes of membrane filtration and backwashing processes
– Understand the fundamental principles of various membrane techniques
– Describe differences between the cross-flow and dead-end filtration
– Check the functionality of the membrane via pneumatic actuation and monitoring
– Identify and understand the relationship between trans-membrane pressure and filtering efficiency

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Sand Filtration

After having worked through the exercises in the “Sand filtration” workbook, learners will be able to:
– Explain how rapid sand filtration works
– Understand the relationship between the feed to the filter and the filtrate rate
– Differentiate between dry and wet filtration
– Explain how deep bed filtration works
– Explain how backwashing has to be carried out and the steps involved
– Optimize the backwashing process for different sand beds

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Monitoring, Controlling and Optimizing Operations

After having worked through the exercises in the “Monitoring, controlling and optimizing operations” workbook, learners will be able to:
– Control the level using a two-point controller and a linear controller
– Control the flow rate using a proportional-integral controller
– Understand the features of different controller types and reliably implement the controllers
– Identify the impacts of different controller settings on energy consumption
– Find the best control strategy for ventilation

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Energy Optimization in Water and Wastewater Treatment Plants

After having worked through the exercises in the “Energy optimization in water and wastewater treatment plants” workbook, learners will be able to:
– Recognize the difference in energy consumption between a free and narrow piping system
– Identify potential for energy savings and energy conversion in water and wastewater treatment plants
– Compare different control strategies with regard to their energy requirements in order to optimize the efficiency of plant components
– Calculate the costs of different control strategies
– Implement energy management processes and methods

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Courseware

Process Control Learning Systems (LabVolt 6090)

Course Bundle "Process Control Learning Systems"

This bundle includes workbooks (student and instructor versions) and user guides in PDF format, for the optional devices available for the Process Control Learning Systems (LabVolt Series 6090) → chapter "Introduction and Fundamentals" page 2.

Included workbooks:
– Pressure, Flow, and Level Processes
– Temperature Process and Heat Exchanger
– pH Process Control

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Pressure, Flow, and Level Processes

This workbook covers the fundamental principles of pressure, flow, and level processes using the Process Control Learning System.

Topic coverage:
– Familiarization with the system
– Pressure measurement
– Pressure losses
– Centrifugal pumps in series and in parallel
– Rotameters and paddle wheel flow meters
– Orifice plates
– Venturi tubes
– Pitot tubes and industrial DP transmitters
– Float switches
– Differential pressure level meters
– Zero suppression and zero elevation
– Wet reference legs
– Bubblers
– Ultrasonic level transmitters
– Determining the dynamic characteristics of a process
– Pressure process control
– Flow process control
– Level process control
– Cascade process control
– Second-order process control

→ eLab course 13112 on **Festo LX**

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Temperature Process and Heat Exchanger

This workbook covers the fundamental principles of temperature process control using the Process Control Learning System equipped with the temperature process control add-on.

Topic coverage:
– Familiarization with the system
– Resistance temperature detectors (RTDs)
– Thermocouples
– Thermal energy transfer in temperature processes
– Heat exchangers
– Characterization of a temperature process in the heating mode
– Characterization of a temperature process in the cooling mode
– PI control of a temperature process in the heating mode and in the cooling mode

→ eLab course 9939 on **Festo LX**

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pH Process Control

This workbook guides learners through study of theory and practical experimentation using the Process Control Learning System equipped with the pH process control add-on.

Topic coverage:
– Familiarization with the system
– pH electrodes
– Titration of a strong acid
– Titration of weak acids
– Titration of a buffer solution
– Characterization of a strong-acid pH process
– Characterization of a weak-acid pH process
– PID and on-off control of a batch pH process
– PID control of a continuous pH process

→ eBook 11126 on **Festo LX**

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Courseware

Industrial Process Learning Systems (LabVolt 353X)

Course Bundle "Industrial Process Control Learning Systems"

This bundle includes workbooks (student and instructor versions) and user guides in PDF format related to the Industrial Process Learning Systems (LV 353X) for pressure, flow, level, temperature, pH, conductivity, and air pressure and flow, as well as PlantPAx Distributed Control System Demonstrator.

The bundle includes:
- Familiarization with the Training System (Flow, Level, Pressure)
- Measurement (Pressure, flow, level)
- Process Control (Pressure, Flow, Level)
- Advanced Process Control (Pressure, Flow, Level)
- Familiarization with the Training System (Temperature)
- Measurement (Temperature)
- Process Control (Temperature)
- Boiler Control
- Heat Exchangers and Advanced Temperature Measurement
- Familiarization with the Training System (pH and Conductivity)
- Measurement (pH and Conductivity)
- Process Control (pH and Conductivity)
- Familiarization with the Training System (Air Pressure/Flow)
- Measurement (Air pressure and flow)
- Process Control (Air pressure and flow)
- Familiarization with the Process Control Demonstrator
- Control Valves
- Flow Primary Elements
- Electromagnetic Flow Meters
- Vortex Flow Transmitter
- Coriolis Flow Transmitter
- Ultrasonic Flow Transmitter
- Paddle Wheel Flow Transmitter
- Capacitive Level Transmitter
- Pressure and Level Switches
- Ultrasonic Level Transmitter (HART)
- Radar Level Transmitter (FMR51and FMP50)
- Radar Level Transmitter (FMR240 and FMP40)
- Human-Machine Interface (FactoryTalk View)
- Human-Machine Interface (Wonderware InTouch) HART Device Configuration
- ControlLogix and CompactLogix Programmable Logic Controllers
- MicroLogix Programmable Logic Controller

Courses are described in the following pages.

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en	**585124**
es	**585125**

Familiarization with the Training System – Pressure, Flow, and Level

This user guide covers the basic operating principles of the pressure-, flow-, and level-related equipment in the Industrial Process Learning Systems.

Content:
- Process workstation
- Instrumentation workstation
- Electrical unit
- AC drive - Allen-Bradley
- AC drive - Siemens
- Emergency push-button
- Pneumatic unit
- Paperless recorder
- Process column, wet reference leg, and bubbler
- Digital pressure gauge
- Differential-pressure transmitter
- Three-valve manifold
- Solenoid valve
- Control valve
- Venturi tubes
- Rotameter
- Accessories
- Basic setup
- Configuring a transmitter with SmartBlue via a Bluetooth connection

→ User Guide 13331 on **Festo LX**

Campus license (PDF format)

en	**585124**

Measurement – Pressure, Flow, and Level

This workbook guides learners through the study of the theory of pressure, flow, and level measurement, as well as practical experimentation using the Industrial Process Learning Systems.

Content:
- Pressure measurement
- Pressure loss
- Flow meters
- Centrifugal pumps
- Differential pressure level meters
- Bubblers
- Wet reference leg

→ eLab course 12836 on **Festo LX**

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Courseware

Industrial Process Learning Systems (LabVolt 353X)

Process Control – Pressure, Flow, and Level

This workbook guides learners through study of theory of the fundamental principles of process control, in the context of pressure, flow, and level control, as well as practical experimentation using the Industrial Process Learning Systems.

Content:
– Determining the dynamic characteristics of a process
– Tuning and control of a pressure loop
– Tuning and control of a flow loop
– Tuning and control of a level loop
– Cascade control of a level/flow process
– Guided process control troubleshooting
– Non-guided process control troubleshooting

→ eLab course 9757 on **Festo LX**

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Advanced Process Control

This workbook covers advanced principles of process control in the context of the Industrial Process Learning Systems.

Content:
– Feedforward control
– Ratio control
– Split-range control
– Second-order non-interacting processes
– Second-order interacting processes

→ eLab course 13344 on **Festo LX**

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Familiarization with the Learning System – Temperature

This user guide covers the basic operating principles of the temperature-related equipment in the Industrial Process Learning Systems for temperature control.

Content:
– Process workstation
– Basic setup
– Instrumentation workstation
– Electrical unit
– Emergency push-button
– Electrical distribution box
– AC drive - Allen-Bradley
– AC drive - Siemens
– Heating-cooling unit
– Temperature probes and transmitter
– Paperless recorder
– Brazed plate heat exchanger
– Pneumatic unit
– Three-way pneumatic control valve
– Accessories

→ User Guide 13005 on **Festo LX**

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Measurement – Temperature

This workbook guides learners through study of theory of the fundamental principles of temperature measurement and practical experimentation using the Industrial Process Learning Systems for temperature control.

Content:
– Resistance temperature detectors (RTDs)
– Thermocouples
– Heat exchanges
– Basic thermal energy transfer with a heat exchanger

→ eLab course 12864 on **Festo LX**

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Process Control – Temperature

This workbook guides learners through study of theory of the fundamental principles of process control, as well practical experimentation using the Industrial Process Learning Systems for temperature control.

Content:
– Determining the dynamic characteristics of a process
– Tuning and control of a temperature loop
– Guided process control troubleshooting

→ eLab course 10153 on **Festo LX**

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Boiler Control

This workbook covers the operation of boilers in the context of the Industrial Process Learning Systems.

Content:
– Single-element control
– Two-element control
– Three-element control

→ eLab course 13777 on **Festo LX**

Campus license (PDF format)

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Heat Exchangers and Advanced Temperature Measurement

This workbook covers the operating principles of heat exchangers and the advanced principles of temperature measurement, in the context of the Industrial Process Learning Systems equipped with the advanced temperature process add-on.

Content:
– Familiarization with the energy manager
– Brazed plate exchanger
– Gasketed plate heat exchanger
– Shell-and-tube heat exchanger (one pass)
– Shell-and-tube heat exchanger (four passes)

→ eLab course 14219 on **Festo LX**

Campus license (PDF format)

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Familiarization with the Training System – pH and Conductivity

This user guide covers the basic operating principles of the pH and conductivity-related equipment in the pH and Conductivity Process Learning Systems (LV 3532).

Content:
– Process workstation
– Basic setup
– Instrumentation workstation
– Electrical unit
– Emergency push-button
– GFI electrical distribution box
– AC drive - Allen-Bradley
– AC drive - Siemens
– Solenoid valve
– Process column
– Chemical tanks, upper tank, and injection ports
– Metering pumps
– pH transmitter
– Deonization filter (optional)
– Conductivity transmitter (optional)
– Water analyzer
– Paperless recorder
– Accessories
– Chemical products and safety
– How to make solutions
– Neutralizing and draining the system
– Configuring a transmitter via EtherNet/IP or WLAN

→ User Guide 17614 on **Festo LX**

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Courseware

Industrial Process Learning Systems (LabVolt 353X)

Measurement (pH and Conductivity)

This workbook guides learners through study of theory and practical experimentation using the pH Process Learning System (LV 3532).

Content:
– Chemical solutions
– pH probes
– Titration of a strong acid
– Titration of weak acids
– Titration of a buffer solution
– Water deionization

→ eBook 11241 on **Festo LX**

Campus license (PDF format)

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Process Control (pH and Conductivity)

This workbook guides learners through study of theory and practical experimentation using the pH Process Learning System (LV 3532).

Content:
– PID control of a batch pH process with a strong acid
– PID control of a batch pH process with a weak acid
– On-off conductivity control (optional)
– Continuous process control

→ eBook 11242 on **Festo LX**

Campus license (PDF format)

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Familiarization with the Learning System (Air Pressure/Flow)

This user guide covers the basic operating principles of the equipment related to Air Pressure and Flow Process Learning Systems (LV 3533).

Content:
– Introduction
– Electrical unit
– Emergency push-button
– Pneumatic unit
– Paperless recorder
– Rotameter
– Digital pressure gauge
– Differential-pressure transmitters
– Orifice (air)
– Solenoid valve
– Pneumatic control valve
– Air tanks
– Muffler assembly
– Accessories

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Measurement (Air Pressure and Flow)

This workbook guides learners through study of theory and practical experimentation using the Air Pressure and Flow Process Learning Systems (LV 3533).

Content:
– Measuring instruments (characteristics, errors, accuracy)
– Pressure measurement (fundamentals, fluids characteristics, hydrostatic pressure, types of measurement and devices)
– Pressure loss
– Flow measurement (fundamentals)
– Flow meters (rotameter, orifice)

→ eBook 11226 on **Festo LX**

Campus license (PDF format)

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Process Control (Air Pressure and Flow)

This workbook guides learners through study of theory and practical experimentation using the Air Pressure and Flow Process Learning Systems (LV 3533).

Content:
– Process characteristics
– Determining the dynamic characteristics of an air process open-loop method, response curve, safety
– Tuning and control of a pressure loop (control schemes, open-loop Ziegler-Nichols and ultimate-cycle methods)
– Feedback control (on-off and PID control, structure of controllers)
– Tuning and control of a flow loop
– Process control troubleshooting

→ eBook 11227 on **Festo LX**

Campus license (PDF format)

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Familiarization with the Process Control Demonstrator

This user guide covers the operation of the PlantPAx Distributed Control System Demonstrator.

Content:
– Process Control Demonstrator
– Control panel
– Disconnect switch and emergency push-button
– AC drives
– PLC fundamentals
– The human-machine interface
– Process columns
– Differential-pressure transmitter
– Radar level transmitters
– Electromagnetic flow transmitter
– Temperature probes and transmitter
– Three-valve manifold
– Solenoid valve
– Control valve
– Venturi tube
– Rotameter

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Control Valves

This user guide explains how to operate specific control valves of the Process Control Learning Systems (LV 6090) or Industrial Process Learning Systems (LV 353X).

Content:
– Basic control valve theory
– Basic control valve
– Pneumatic control valve with a positioner
– Control valve with DVC2000
– Control valve with DVC6000 – HART/FF
– Control valve with DVC6200 – HART/FF
– Electric control valve
– Air control valves
– Three-way control valves
– Using Fieldcare via the HART protocol

→ User Guide 9847 on **Festo LX**

Campus license (PDF format)

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Flow Primary Elements

This workbook covers the operation of two flow primary elements, orifice plates and pitot tubes, in the context of the Industrial Process Learning Systems.

Content:
– Orifice plate
– Pitot tube
– Inspection, maintenance, and storage

→ eLab course 13788 on **Festo LX**

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Courseware

Industrial Process Learning Systems (LabVolt 353X)

Electromagnetic Flow Meters

This workbook covers the operation of electromagnetic flow meters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of electromagnetic flow meters
– Maintenance and storage
– Configuring a transmitter via EtherNet/IP or WLAN

→ eLab course 13985 on **Festo LX**

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Vortex Flow Transmitter

This workbook covers the operation of vortex flow transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of vortex flow transmitters
– FieldCare Configuration - HART

→ eLab course 14322 on **Festo LX**

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Coriolis Flow Transmitter

This workbook covers the operation of Coriolis flow transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of Coriolis flow meters
– Configuring a transmitter via EtherNet/IP or WLAN

→ eLab course 20835 on **Festo LX**

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Ultrasonic Flow Transmitter

This workbook covers the operation of ultrasonic flow transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of ultrasonic flow meters
– Common error codes
– FieldCare Configuration - HART

→ eLab course 14224 on **Festo LX**

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Paddle Wheel Flow Transmitter

This workbook covers the operation of paddle wheel flow transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of paddle wheel flow meters: description, commissioning, how to calculate the scale factor from the K factor

→ eLab course 14242 on **Festo LX**

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Capacitive Level Transmitter

This workbook covers the operation of capacitive level transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of paddle wheel flow meters: description, installation
– Using FieldCare via the HART protocol
– Fault on the capacitive level transmitter

→ eLab course 15226 on **Festo LX**

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Pressure and Level Switches

This workbook covers the operation of pressure and level switches in the context of the Industrial Process Learning Systems.

Content:
– Pressure switches
– Float switches
– Vibrating level switches
– Conductivity level switches
– Pressure switch functions
– Pressure switch errors, warnings, and diagnostic events
– Pressure switch faults
– Float switch faults
– Vibrating level switch faults
– Conductivity level switch faults

→ eLab course 13978 on **Festo LX**

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Ultrasonic Level Transmitter (HART)

This workbook covers the operation of ultrasonic level transmitters in the context of the Industrial Process Learning Systems.

Content:
– Familiarization and basic level measurement
– Troubleshooting
– FieldCare configuration (HART)

→ eLab course 13986 on **Festo LX**

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Courseware

Industrial Process Learning Systems (LabVolt 353X)

Radar Level Transmitters (FMR51 and FMP50)

This workbook covers the operation of radar level transmitters Endress+Hauser FMR51 and FMP50 in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of radar level transmitters FMR51 and FMP50
– Installation and commissioning
– Configuration using FieldCare

→ eLab course 20417 on **Festo LX**

Campus license (PDF format)

en	**585124**

Radar Level Transmitters (FMR240 and FMP40)

This workbook covers the operation of radar level transmitters Endress+Hauser FMR240 and FMP40 transmitters in the context of the Industrial Process Learning Systems.

Content:
– Fundamentals of radar level transmitters FMR240 and FMP40)
– Configuration and setup using FieldCare
– Configuration and setup using DeviceCare
– Configuring a transmitter with SmartBlue via a Bluetooth connection

→ eLab course 14265 on **Festo LX**

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Human-Machine Interfaces (FactoryTalk View)

This user guide covers human-machine interfaces developed under the Rockwell Automation (FactoryTalk View ME) architecture. It explains how to use the PanelView Plus 600, PanelView Plus 1000, or PC version of the interface with a ControlLogix, CompactLogix, MicroLogix, or Foxboro controller.

Content:
– Introduction to hardware and software
– Screen types overview
– Familiarization with the MicroLogix, CompactLogix, ControlLogix, and Foxboro interfaces
– On-off control
– PID control
– Cascade control
– Rockwell software installation and network configuration
– Common operations with FactoryTalk View Studio

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Human-Machine Interfaces (Wonderware InTouch)

This user guide covers human-machine interfaces developed by Festo Didactic under Wonderware InTouch architecture for Foxboro controllers.

Content:
– System setup
– Software installation
– Familiarization with the interface
– PID control
– Solving OPC server communication problems

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ControlLogix and CompactLogix Programmable Logic Controllers

This user guide covers how to use ControlLogix and CompactLogix PLC in the context of the Industrial Process Learning Systems.

Content:
– PLC fundamentals
– Familiarization with the PLC
– On-off control
– PID control
– Cascade control
– Split-range control
– Characteristics
– Installation and configuration
– PID control and cascade PID control
– PID ratio control and PID split-range control
– Use of trends
– List of faults

→ User Guide 12838 on **Festo LX**

Campus license (PDF format)

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MicroLogix Programmable Logic Controller

This user guide covers the operation of the MicroLogix PLC in the context of the Industrial Process Learning Systems.

Content:
– PLC fundamentals
– Familiarization with the PLC
– On-off control
– PID control
– Cascade control
– Ratio control
– Split-range control
– Installation and configuration
– List of faults

→ User Guide 9920 on **Festo LX**

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HART Device Configuration

This workbook introduces the HART communication protocol in the context of the Industrial Process Learning Systems.

Content:
– HART protocol overview
– HART point-to-point (fundamentals, two-wire transmitter, four-wire transmitter (optional), output device (optional)
– HART multidrop
– HART multidrop with multiple transmitters
– Installation and configuration

→ eBook 11243 on **Festo LX**

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Courseware

Three-Phase Separator Learning System

Three-Phase Separator

This bundle includes workbooks (student and instructor versions) and user guides in PDF format for the Three-Phase Separator.

Included workbooks:
– Three-Phase Separator: Basic Control
– Three-Phase Separator: Instrumentation
– Three-Phase Separator: User guide

Campus license (PDF format)

en	**8099622**

Three-Phase Separator - Basic Control

This workbook covers the principles of three-phase separation in the oil industry. This is achieved through theory presentations and hands-on manipulations using the basic version of the Three-Phase Separator Learning System.

Content:
– Fundamentals of three-phase separation, types of separators, main components, pumps, fluids and emulsions
– Separation process, treating methods, effect of heat, by-product disposal, secondary treatments, additional equipment
– Horizontal separators (vessel, measurement, safety mechanisms and procedures, components, start-up, purge procedure)
– Performance (influencing parameters, impediments, effect of the input flow rate, of the water cut, of the inline mixer)
– Basics of process control, level/flow/pressure/temperature control, displacer level controller
– Troubleshooting

→ eLab course 1423 on **Festo LX**

Campus license (PDF format)

en	**8099622**

Three-Phase Separator - Instrumentation

This workbook covers several instruments commonly used on three-phase separators in the oil industry. They include five types of flow meters (rotameters, turbine, differential pressure, electromagnetic, and Coriolis flow meters), level switches, radar level meters, pressure meters and temperature meters, using the Three-Phase Separator Learning System equipped with instrumentation.

Content:
– Human-machine interfaces
– Measurement and instrumentation (units, characteristics, precision and accuracy)
– Rotameters, turbine flow meters, differential-pressure flow meters, orifice plates
– Electromagnetic and Coriolis flow meters (optional)
– Tuning fork level switches, radar level sensors and meters
– Pressure meters
– Thermocouples and temperature transmitters (optional)
– Troubleshooting

→ eLab course 1413 on **Festo LX**

Campus license (PDF format)

en	**8099622**

Three-Phase Separator Learning System

This user guide covers the installation, operation, and components of the Three-Phase Separator.

Content:
– Technical specifications
– Quick-start guide
– Basic operation
– HMI and fault switches
– Flow, level, pressure, and temperature instrumentation
– Maintenance and inspection
– Shutdown and purge guide

→ User guide 13379 on **Festo LX**

Campus license (PDF format)

en	**8099622**

LVProSim

LVProSim is a process control software specially designed to connect to the I/O Interface and collect data at a fast sampling rate (100 ms). LVProSim has two main features: it can operate as a process controller and a generic process simulator. The web interface makes it easy to use, helping students focus on learning process control.

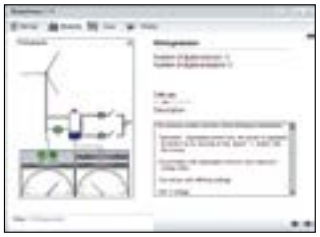
When used as a controller, LVProSim monitors data from the I/O Interface and applies a standard PID algorithm to determine the appropriate response. LVProSim can either control two processes simultaneously or use its two controllers in cascade mode. LVProSim also offers a set of mathematical functions to treat inputs and outputs signals.

The simulation mode allows students to model first-order or second-order processes. This mode encourages students to explore the various characteristics of a process such as its time constants, gain, and dead time. Once a generic process simulation is running, students can connect the simulated process to a controller and test different control schemes. Contrary to the data acquisition mode, the simulation mode does not require the I/O Interface. Therefore, students can experiment with the software on their own computer.

LVProSim is free and can be downloaded from our website.

EasyVeep

PLC Simulation



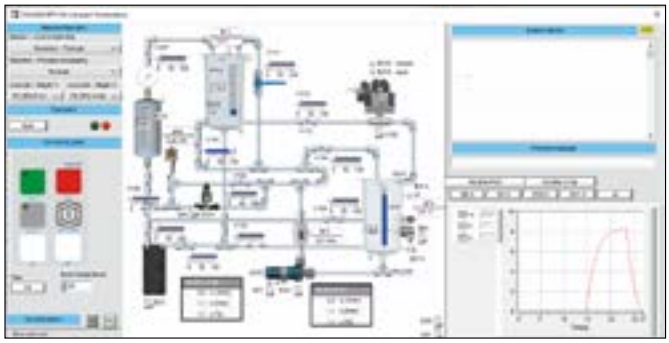
EasyVeep is a graphic 2D process simulation software that facilitates PLC training.

Numerous practical process models can be controlled using any PLC using EasyPort and the EasyVeep simulation software included in scope of delivery. The models are documented and meet a broad range of requirements.

EasyVeep is easy to install and offers exciting fields of application. The topics covered include the following:
– 7-segment display
– Alarm systems
– Level crossings
– Lifts
– Garage doors
– Multi-level car parks
– Sluice gates
– Sorting systems
– Hot water tanks
– Washing machines
– Wind generators
– And more.

EasyVeep is provided with the EasyPort USB.

FluidLab-PA Process
Getting Started in Process Engineering



The clear menu structure of FluidLab-PA Process makes it easy to understand complex process engineering systems in a simple application, used in combination with the EduKit PA, the MPS PA Compact Workstation, the MPS PA 204 System, and the EDS Water Management.

Various Applications, One Interface
Whether the system is real or simulated, you can seamlessly switch between the two with a simple toggle. Whether you are controlling the system directly using the switching elements or programming independent sequences via the Festo Didactic EzOPC interface, both are easily implemented through intuitive menu navigation.

Operating Concept
A consistent and unified operating concept applies to all systems, whether you're managing the EduKit PA, the MPS PA Compact Workstation, MPS PA 204 Mixing, or, for instance, EDS Water Management Sand Filtration. The system diagram facilitates the selection between the simulated and real systems, addressed through the EasyPort. The inclusion of real components in the system diagram provides a quick reference to the actual system.

Switching states
The switching states are not only depicted in the system diagram but are also displayed and recorded in curve diagrams.

Programming
To create your own PLC program or describe Grafcet sequences, the EzOPC interface enables control over both simulations and the real system using FluidSIM, CoDeSys simulation mode, and PLCSIM Advanced software.

Supplementary Topics
– Filling process with the IoT kit extension package
– Direct storage of simple and fixed programmed processes directly from the software.
– Integration of hidden errors in signal states

Simulated Systems:
EduKit PA, MPS PA Compact Workstation, MPS PA 204 with mixing and filtering; EDS Water Management System (water supply, sand filtration, membrane filtration). Additional stations will be introduced through updates/upgrades and can be accessed on the Internet.

Downloadable license, en/de/es/fr

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1 year, 10 users	**8208222**
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Perpetual, 10 users	**8208224**
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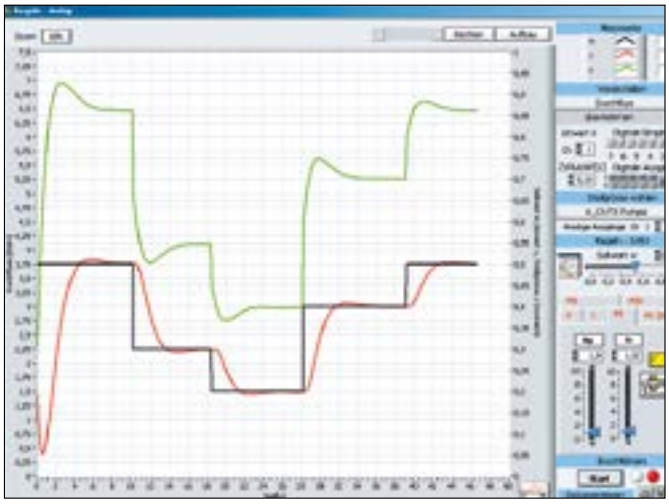
FluidLab-PA Closed-Loop
Control Engineering in Focus



Learn and work through the basics of control technology step by step with FluidLab-PA. The EasyPort connects the PC and real hardware, e.g., the EduKit PA, the MPS PA Compact Workstation, or the MPS PA Stations.

Settings
Parameterize sensor values with factor and offset to display the physical values as well as signal attenuation via mean value filter for the analogue input signals. Display of the physical value in the variable unit field. Further setting options are the inversion of the controller sense, Y-offset for continuous control and the selection of the simulation mode.

Menu: Measure
All binary and analogue process data, for example the signal states of the sensors, process fittings and the pump, can be displayed graphically and evaluated directly. Functions such as selecting the measuring channels, adjusting the test time or cursor evaluation with zoom function are available for recording the sensor characteristic curve and determining a step response.

Menu: Characteristic Curve
The characteristic curve of an actuator (e.g. pump or proportional valve) is examined from different points of view (voltage on flow, flow on pressure, pressure on voltage).

Menu: 2-point Controller
Typical applications are level and temperature control systems.

Menu: Continuous Control
Experiment, configure and optimize control processes (P, PI, PD or PID controllers) with immediate effect in the process. Controlled systems can be operated at the click of a mouse. Easy documentation of the control parameter is possible. The measured values and curve progressions can be comprehensively documented. The block diagram can be displayed as a function menu for all continuous controllers with current numerical values.

Industrial Controller Functions
Plant operation as in a process control system. Setpoints can be specified and manual/automatic controller switching is possible.

Simulation
A simulated process model illustrates the process identically to the operation of the real hardware.

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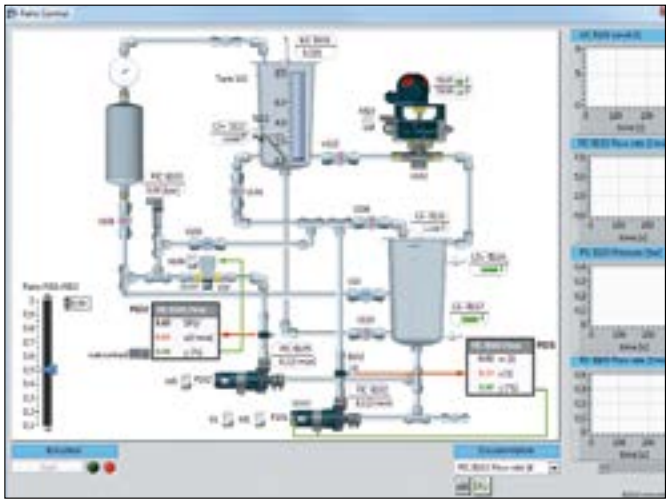
FluidLab-PA Multi-Loop
Multivariable Control



The FluidLab-PA Multi-Loop software used with the EasyPort interface permit to control four types of process variable such as level, flow, pressure, or temperature.

The FluidLab-PA Multi-Loop main screen offer a quick overview of the process and an easy configuration of the PID parameters.

The following control strategies can be performed with the software:
– PID cascade control.
– Level and flow control circuits with disturbance variable forwarding for a constant final control element.
– PID ratio controller for two flow control circuits and a constant final control element.
– PID limiting controller for flow and pressure control circuits and a constant final control element.
– PID controller with disturbance variable forwarding for pressure control with flow disturbance variable by means of a proportional valve.
– PID controller with disturbance variable forwarding for temperature control with non-constant heating/cooling final control element.
– PID selecting controller for temperature control with non-constant heating final control element.

To carry out the tests, different hardware variants with additional components are required:
– MPS PA Compact Workstation
– MPS PA Reactor Station

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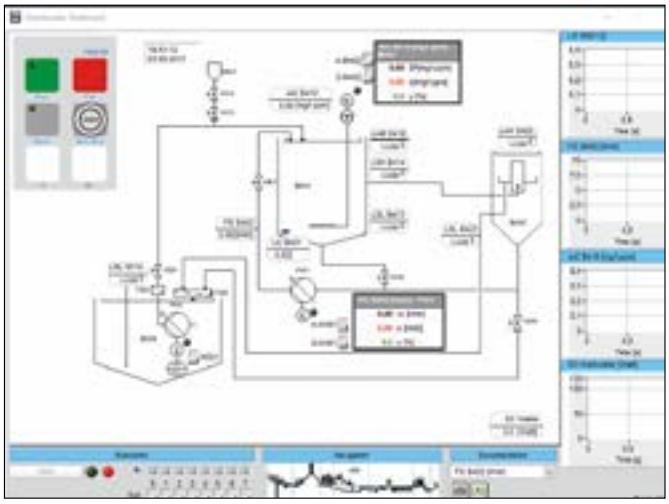
FluidLab-PA is compatible with Windows 10 and 11.

FluidLab Water Management
Simple Hardware Operation



The FluidLab Water Management software, when paired with the EasyPort Interface, enables convenient operation of EDS Water Management stations, functioning as a simplified process control system.

Operating Concept
The Windows-based PC software illustrates equipment modules and processes. The clear menu structure and intuitive graphical interface satisfy the didactic requirements of instructors and trainers. All exercises are adaptable for different skill levels, ranging from beginner to expert. For instance, determining the optimal combination of controller and closed-loop controller parameters for a given process.

Eight EDS Water Management stations can be concurrently controlled through a PC or individually combined based on the PC availability. Enable users to individually switch the language of menu and station labels, providing them with the flexibility to incorporate their own additional options.

The software is included in the scope of delivery of each EDS Water Management station.

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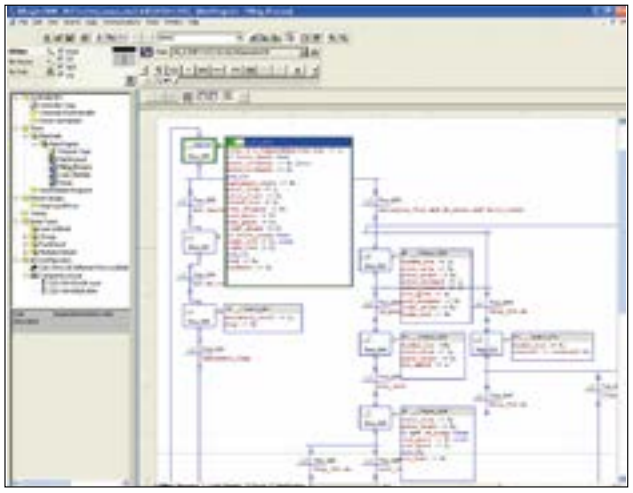
Studio 5000 Logix Designer



Studio 5000 Logix Designer is a Windows-based application produced by Rockwell Software. The full version can be used to build programs for PLCs, whereas the lite version can be used to build programs for CompactLogix PLCs.

Studio 5000 Logix Designer provides a powerful integrated interface allowing users to easily build programs using four programming languages: relay ladder, structured text, sequential function chart, and function block diagram. The software allows students to concentrate on the logic aspects of PLC programming instead of spending time on complex syntax. It also features drag-and-drop editing, search-and-replace functions, and tools for verifying programs before running them on a PLC.

Studio 5000 Logix Designer can be used to program a PLC via the built-in RS-232 port or via an Ethernet link. The software comes with RSLinx lite which provides the functionality required to support RSLogix and RSNetWorx.

Studio 5000 Logix Designer Lite Edition

Single license on CD-ROM

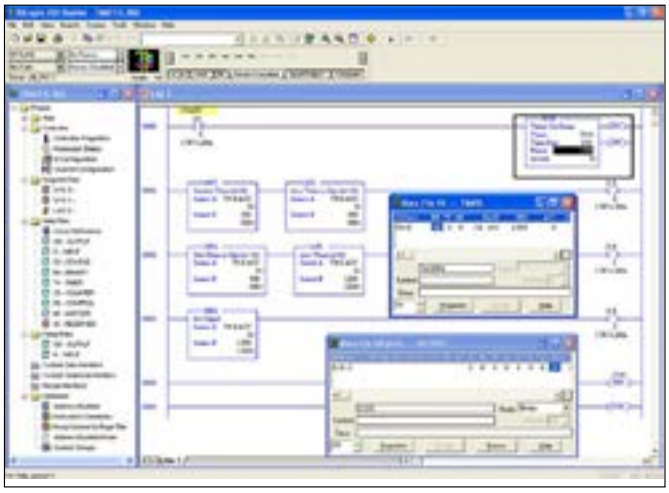
Educational	**587890**
Commercial	**587892**

Studio 5000 Logix Designer Full Edition

Single license on CD-ROM

Educational	**587895**
Commercial	**587894**

RSLogix Micro, Fuzzy Logic Add-On



The RSLogix Micro software is a tool to design and implement ladder programs for the Allen-Bradley MicroLogix family of processors (it cannot be used with SLC 500 controllers). It is a Windows-based application produced by Rockwell Software that allows PLC programming using a personal computer.

The free-form ladder of RSLogix Micro lets students concentrate on the application logic rather than using the proper syntax when editing programs. Several other features of RSLogix Micro greatly facilitate PLC programming, such as a project verifier, drag-and-drop editing, and search-and-replace functions. The PLC can be programmed via either an RS-232 port or an Ethernet port on the PLC processor. This software comes with RSLinx, which provides connectivity between the PLC and the computer.

RSLogix Micro

Single license on CD-ROM

Educational	**587552**
Commercial	**587555**

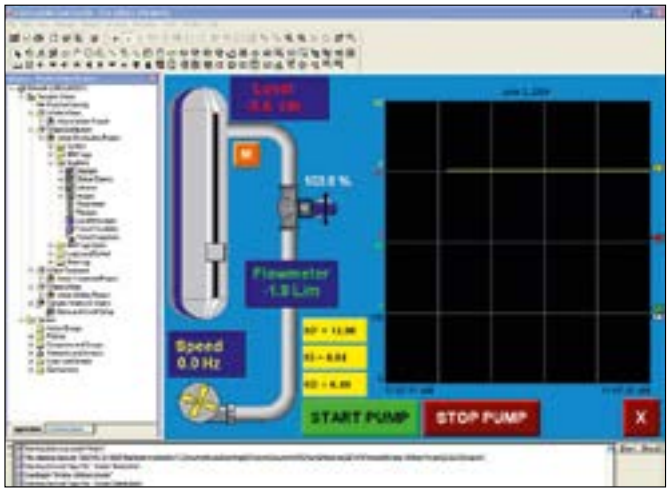
The Fuzzy Logic Software Add-On features Fuzzy Designer, an add-on to RSLogix 5000 which lets the user design and implement fuzzy logic algorithms on a controller of the Logix 5000 family. Fuzzy Designer includes an extensive component library to help the user quickly build algorithms that can be used in any RSLogix 5000 program.

Fuzzy Logic Software Add-On

Single license on CD-ROM

Educational	**587902**
Commercial	**587903**

FactoryTalk View



FactoryTalk View is a Windows-based application suite, introduced by Rockwell Software, which simplifies the creation of graphic human-machine interfaces (HMI), such as operator interface solutions, to monitor and control machines and small processes.

This versatile suite is compatible with a wide array of devices, including PLCs and Foxboro controllers, and constitutes a distributed control system development solution of choice.

HMI applications are developed and edited using FactoryTalk View Studio, which also has limited two-hour runtime capabilities to test your interface. A completed application can be loaded directly on a Touch Screen Graphic Terminal, as it includes a built-in runtime software. Your applications can also be designed to run on a computer, but doing so requires the purchase of FactoryTalk View Machine Edition Station Runtime.

FactoryTalk View ME Studio

Single license on CD-ROM

Educational	**588384**
Commercial	**588385**

FactoryTalk View ME Station

Single license on CD-ROM

Educational	**588397**
Commercial	**588390**

FactoryTalk View SE Station

Single license on CD-ROM (46968-5)

Educational	**588400**
Commercial	**588401**

TIA Portal PLC Software Step 7, WinCC

The PLC Software (Step 7 Professional) is a programming software that is required for programming Siemens programmable logic controllers.

The WinCC Advanced development software is a Windows-based application suite, produced by Siemens, which simplifies the creation of graphic human-machine interfaces (HMI), such as operator interface solutions, to monitor and control machines and industrial processes.

A complete application provided with WinCC can be used with a S7-1500 Siemens PLC and a Industrial Process Learning System (LV 353X) to perform process control experiments.

The HMI database can be loaded directly on an Industrial PC. Your applications can also be designed to run on a computer.

The course “Human-Machine Interface (Siemens SIMATIC)” (order no. 590101)” is available and must be purchased separately.

License, 1 user (perpetual)

Order no.	**592686**

For the configuration of SIMATIC S7-1500/1200/300/400/WinAC, SIMATIC Panels:

Trainer Package V17 STEP 7 Professional, Safety, WinCC Advanced and Unified Engineering

– STEP 7 Professional, Safety, WinCC Advanced and Unified Engineering, RT and Options, CFC, DCC, SiVArc, Test Suite, SIRIUS, Multiuser, Teamcenter Gateway, Cloud Connector; Target, ODK, PRODIAG, OPC UA, PLCSIM Advanced, Startdrive Advanced
– 6 x software license unlimited
– 20 x trial license for 365 days
– Software on DVD or download
– License key on USB flash drive
– Executable in Windows 10

6 users (perpetual) + 20 Students (1 year), Educational

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