Electrical Engineering and Electronics

Learning Solutions Catalog 2025/2026

FESTO

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Magazine

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 electrical engineering and electronics is paramount, equipping the workforce of today and tomorrow with the electrical expertise needed to thrive in a wide range of occupations.

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

We 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 provides information on a selection of 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. We are here to support you every step of the way.

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

Your Festo Didactic Team

Trending topics
Impact on skills requirements

> From powering machines to enabling digital networks, electricity is everywhere, making electrical competence a core requirement for today's workforce.

Mathieu Plourde, P. Eng.
Head of Electrical Engineering Product Management, Festo Didactic

01

Trends

Current topics in electrical engineering education

The applications of electrical engineering are evolving rapidly, driven by technological innovation, digitalization, and the global shift toward sustainability.

These changes have a direct impact on the skills students will need in the workplace.

As a teacher, you play a pivotal role in equipping students with both strong foundational knowledge and the ability to work with emerging technologies.

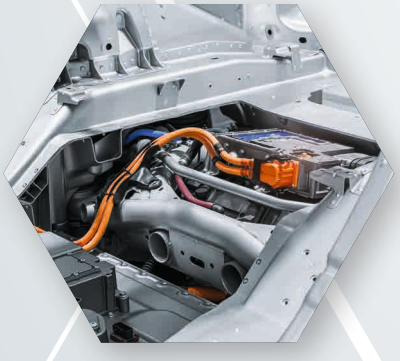
Our learning solutions help you address major trends, preparing students with the skills and experience that enhance their employability.

Renewable Energy

→ Page M12

Grid Modernization

→ Page M14



Energy Conversion and Storage

→ Page M16

Industrial Electric Machines

→ Page M18

Embedded Electronics

→ **Page M20**

Smart Buildings

→ **Page M22**

Other trends shape electrical engineering and electronics education, such as:

Modular programs: Stackable microcredentials and task-oriented modules.

Lifelong learning: Online courses, short-term certifications, and industry partnerships.

Digital learning: Simulations, virtual labs, and online resources.

Soft skills: Mainly collaboration, communication, creativity, and problem-solving.

Interdisciplinary learning: Combining electrical engineering with mechanical systems, automation, cybersecurity, and software.

Electric Automation

→ **Page M24**

Festo helps you advance your training programs and stay at the forefront of industry and educational trends.

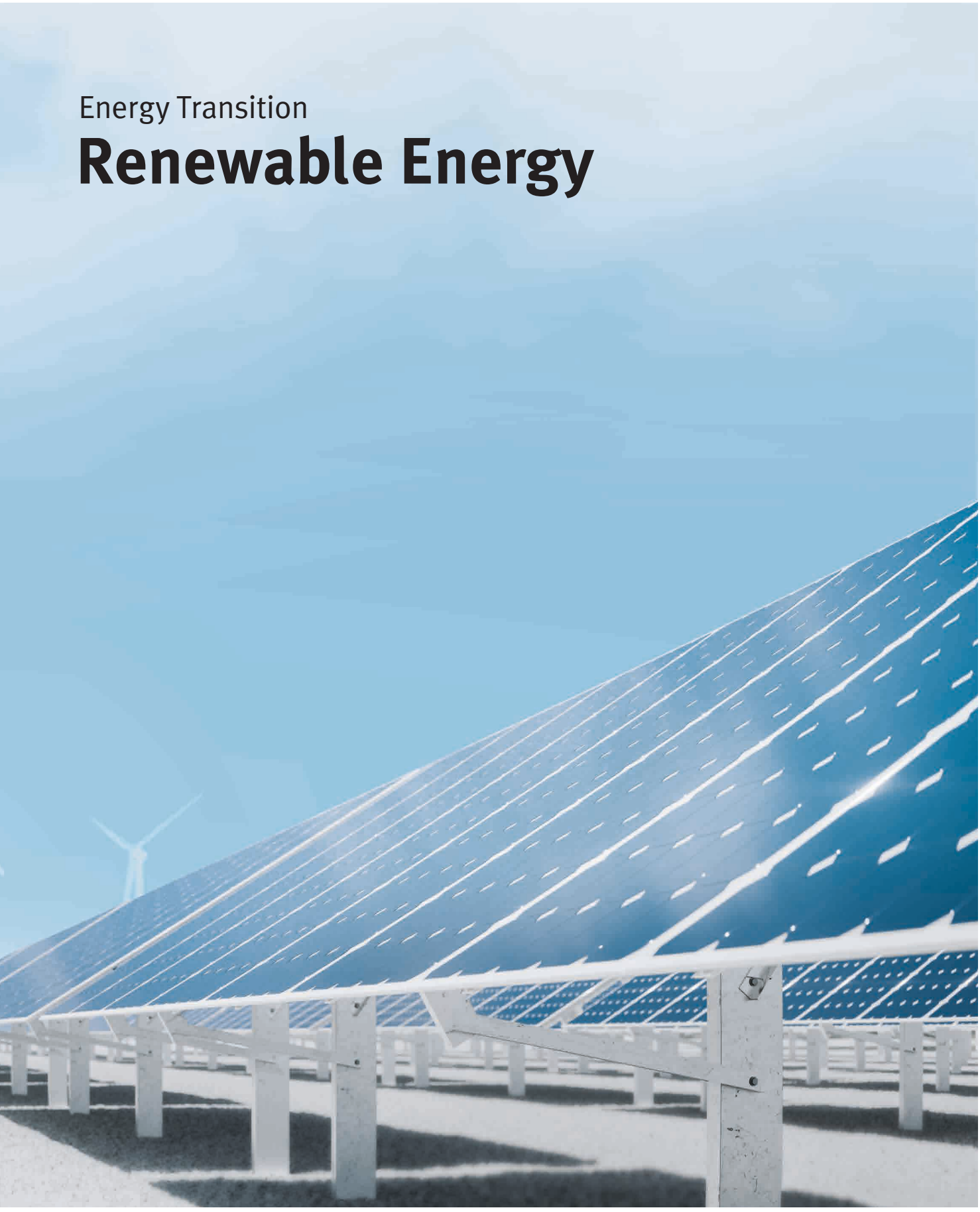
The shift to renewable energy sources, such as solar and wind power, is transforming the way electricity is generated, distributed, and utilized. For those interested in clean energy, efficiency, and sustainability, it is essential to understand these technologies. Exploring solar panels, wind turbines, and energy conversion systems provides a foundation for designing, analyzing, and optimizing renewable energy installations. Hands-on training shows how theoretical concepts apply in real-world settings.

Renewable energy education also emphasizes environmental and economic impacts, preparing learners for careers in the growing green sector. As they explore different technologies, learners develop skills in system integration, performance evaluation, and troubleshooting. These skills will equip them to tackle challenges in a low-carbon future with technical expertise and critical thinking.

Explore the following relevant learning solutions:
Wind Power Electricity Generation Learning Systems 8010-3 → Page 102
Home Energy Production Learning System 8010-7 → Page 106
Solar and Wind Power Training Packages TP 8012 → Page 143
Solar/Wind Energy Learning Systems → Page 216
Solar Thermal Learning System → Page 214
Nacelle Wind Power Learning System → Page 246

Energy Transition

Renewable Energy



Modern power grids are becoming smarter, more decentralized, and more sustainable. These improvements increase flexibility, reliability, and efficiency. They handle diverse energy sources, variable demand, and real-time monitoring more effectively. Studying grid modernization involves learning about digital control systems, protective relays, and automation technologies that ensure reliable electricity distribution. It is also essential to understand transmission and distribution networks, voltage management, and system reliability.

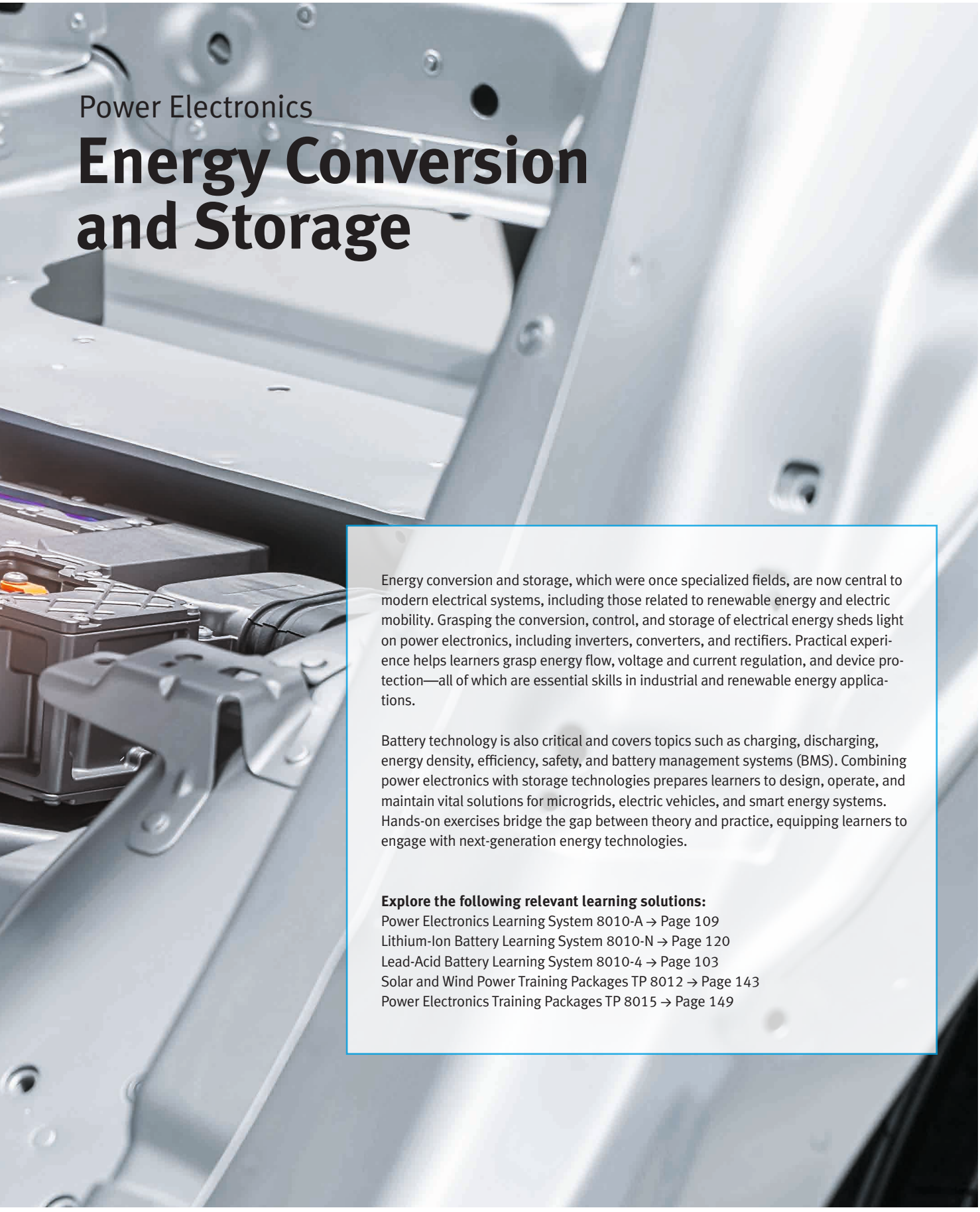
Hands-on exercises allow learners to apply theoretical knowledge to practical scenarios, such as analyzing network performance, implementing protective measures, and optimizing energy flow. This combination of knowledge and practice prepares learners to contribute to resilient, intelligent, and sustainable electrical networks.

Explore the following relevant learning solutions:

Microgrid Learning System 8010-M → Page 121
Power Transmission Smart Grid Technologies Learning System 8010-E → Page 113
Smart Grid Learning System 8010-F → Page 114
Electric Power Substation Learning System 8010-K → Page 117
0.2-kW Protective Relaying Learning System LV 8007 → Page 182
2-kW Electromechanical Learning Systems LV 8013 → Page 172
2-kW Electric Power Transmission Learning Systems LV 8059 → Page 184
Numerical Protective Relays → Page 119
Power Factor Correction TP 8016-3 → Page 159
Power Electronics TP 8015 → Page 149

Energy Transition

Grid Modernization



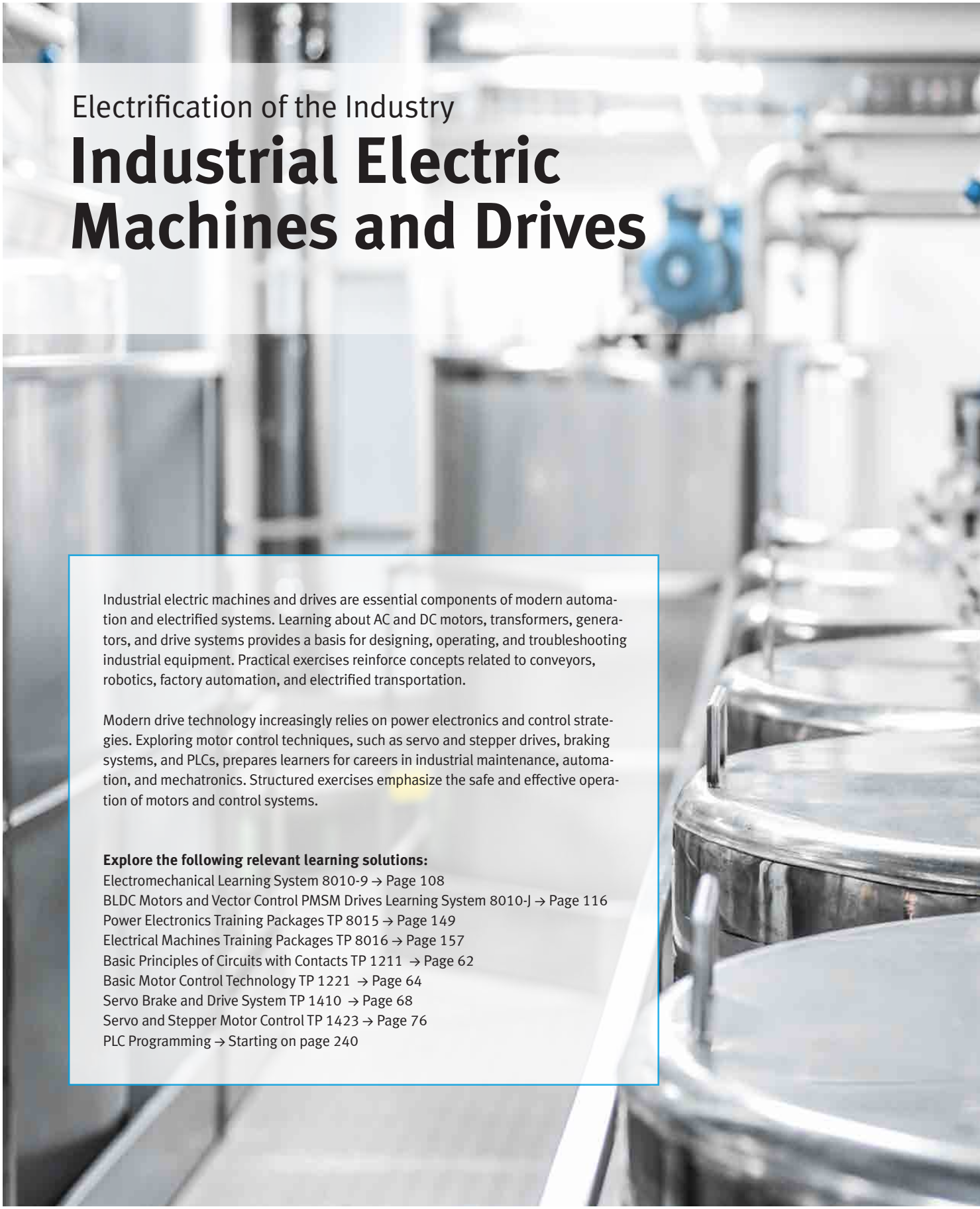
Power Electronics

Energy Conversion and Storage

Energy conversion and storage, which were once specialized fields, are now central to modern electrical systems, including those related to renewable energy and electric mobility. Grasping the conversion, control, and storage of electrical energy sheds light on power electronics, including inverters, converters, and rectifiers. Practical experience helps learners grasp energy flow, voltage and current regulation, and device protection—all of which are essential skills in industrial and renewable energy applications.

Battery technology is also critical and covers topics such as charging, discharging, energy density, efficiency, safety, and battery management systems (BMS). Combining power electronics with storage technologies prepares learners to design, operate, and maintain vital solutions for microgrids, electric vehicles, and smart energy systems. Hands-on exercises bridge the gap between theory and practice, equipping learners to engage with next-generation energy technologies.

Explore the following relevant learning solutions:
Power Electronics Learning System 8010-A → Page 109
Lithium-Ion Battery Learning System 8010-N → Page 120
Lead-Acid Battery Learning System 8010-4 → Page 103
Solar and Wind Power Training Packages TP 8012 → Page 143
Power Electronics Training Packages TP 8015 → Page 149



Electrification of the Industry

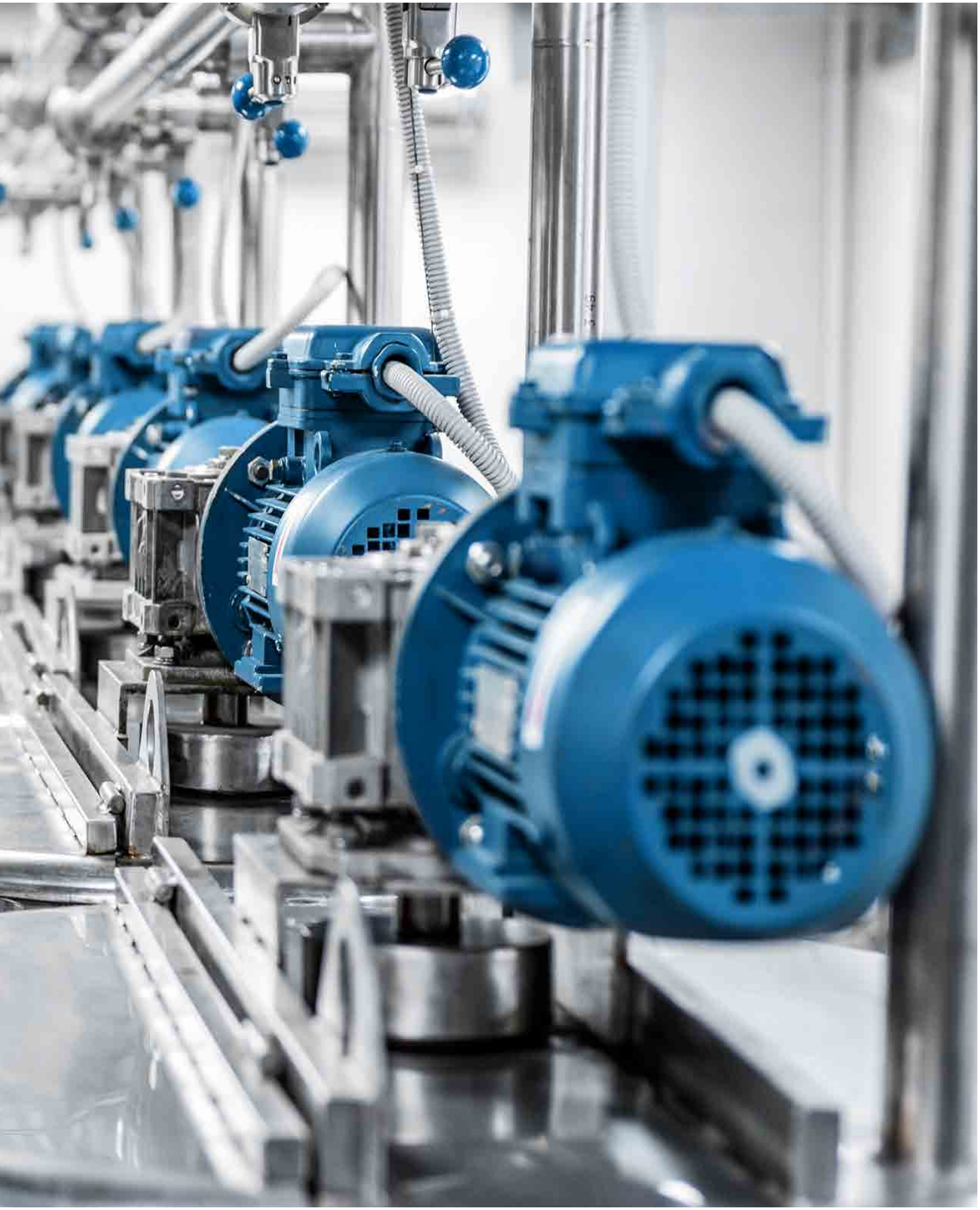
Industrial Electric Machines and Drives

Industrial electric machines and drives are essential components of modern automation and electrified systems. Learning about AC and DC motors, transformers, generators, and drive systems provides a basis for designing, operating, and troubleshooting industrial equipment. Practical exercises reinforce concepts related to conveyors, robotics, factory automation, and electrified transportation.

Modern drive technology increasingly relies on power electronics and control strategies. Exploring motor control techniques, such as servo and stepper drives, braking systems, and PLCs, prepares learners for careers in industrial maintenance, automation, and mechatronics. Structured exercises emphasize the safe and effective operation of motors and control systems.

Explore the following relevant learning solutions:

Electromechanical Learning System 8010-9 → Page 108
BLDC Motors and Vector Control PMSM Drives Learning System 8010-J → Page 116
Power Electronics Training Packages TP 8015 → Page 149
Electrical Machines Training Packages TP 8016 → Page 157
Basic Principles of Circuits with Contacts TP 1211 → Page 62
Basic Motor Control Technology TP 1221 → Page 64
Servo Brake and Drive System TP 1410 → Page 68
Servo and Stepper Motor Control TP 1423 → Page 76
PLC Programming → Starting on page 240



Digitalization

Embedded Electronics

Embedded electronics are central to smart devices, industrial automation, and Internet of Things (IoT) applications. Key topics include microcontrollers, sensors, actuators, communication protocols, and hardware-software integration. Relevant competencies include programming, component interfacing, data acquisition, and system troubleshooting. Working with development kits and simulation tools helps learners apply theory to practical robotics, home automation, and industrial control solutions.

Project-based exercises develop problem-solving and design skills, ensuring that learners can create reliable, efficient, and scalable embedded systems. Learning about real-time processing, signal conditioning, power management, and safety considerations prepares learners for careers in electronics, automation, and the IoT.

Explore the following relevant learning solutions:

Electeo → Page 4
FACET → Page 10
Fundamentals of Electrical Engineering/Electronics TP 1011 → Page 36
Basic Principles of Digital Technology TP 1012 → Page 40
Microcontroller Learning System TP 1515/1516 → Page 44

Building System Technology

Smart Buildings

Smart buildings integrate electrical, mechanical, and digital systems to improve energy efficiency, safety, and comfort. Learners explore automated lighting, HVAC, security, and energy management systems that use sensors, actuators, and embedded electronics. By understanding building automation protocols and energy monitoring, learners can design, operate, and maintain modern smart infrastructures. Hands-on exercises with real components bridge the gap between theory and practice.

In addition to technical skills, learners gain insight into sustainability and energy optimization. Topics include efficient HVAC operation, smart lighting, automated shading, and renewable energy integration. Through project-based learning, learners prepare for careers in building automation, facilities engineering, and energy management, while developing problem-solving, interoperability, and troubleshooting skills.

Explore the following relevant learning solutions:

Power Supply Systems and Protective Measures TP 1111 → Page 196
Basic Principles of Electrical Installation TP 1121 → Page 200
Smart Home TP 1135 → Page 203
KNX / Smart Home Training Kit → Page 202
DALI Lighting Control TP 1145 → Page 208
Building HVAC Controls Learning System → Page 210
Electric Vehicle AC Charging Station → Page 212

See the latest technologies in electric automation

Explore state-of-the-art technologies from Festo and stay up to date with trends you can share with your learners.

→ Visit our dedicated pages

Industry 4.0

Electric Automation

Electric automation combines electrical engineering, electronics, and digital technologies to control and optimize industrial processes, thereby making them safer, more efficient, and smarter. The growth of this field is fueled by Industry 4.0 technologies, including the Industrial Internet of Things (IIoT), digital twins, and predictive maintenance. The foundation of electric automation is provided by electrical engineering, which includes power distribution, motor drives, sensors, actuators, PLCs, and industrial networks.

Designing, programming, and troubleshooting automated systems requires a broad set of interdisciplinary skills. Learners engage with motors, drives, PLCs, sensors, actuators, and industrial communication protocols while developing problem-solving, system integration, and project-based engineering abilities. Robotics and mechatronics build on this knowledge by merging mechanical and electrical systems to create autonomous and semi-autonomous machines. Hands-on projects reinforce the application of electrical engineering concepts in real-world industrial scenarios.

Explore the following relevant learning solutions:

Smart Sensors TP 1312 → Page 230
SkillsConveyor → Page 234
Learning Factories → Page 236
PLC Programming → Starting on page 240

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
VP Global Education

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.

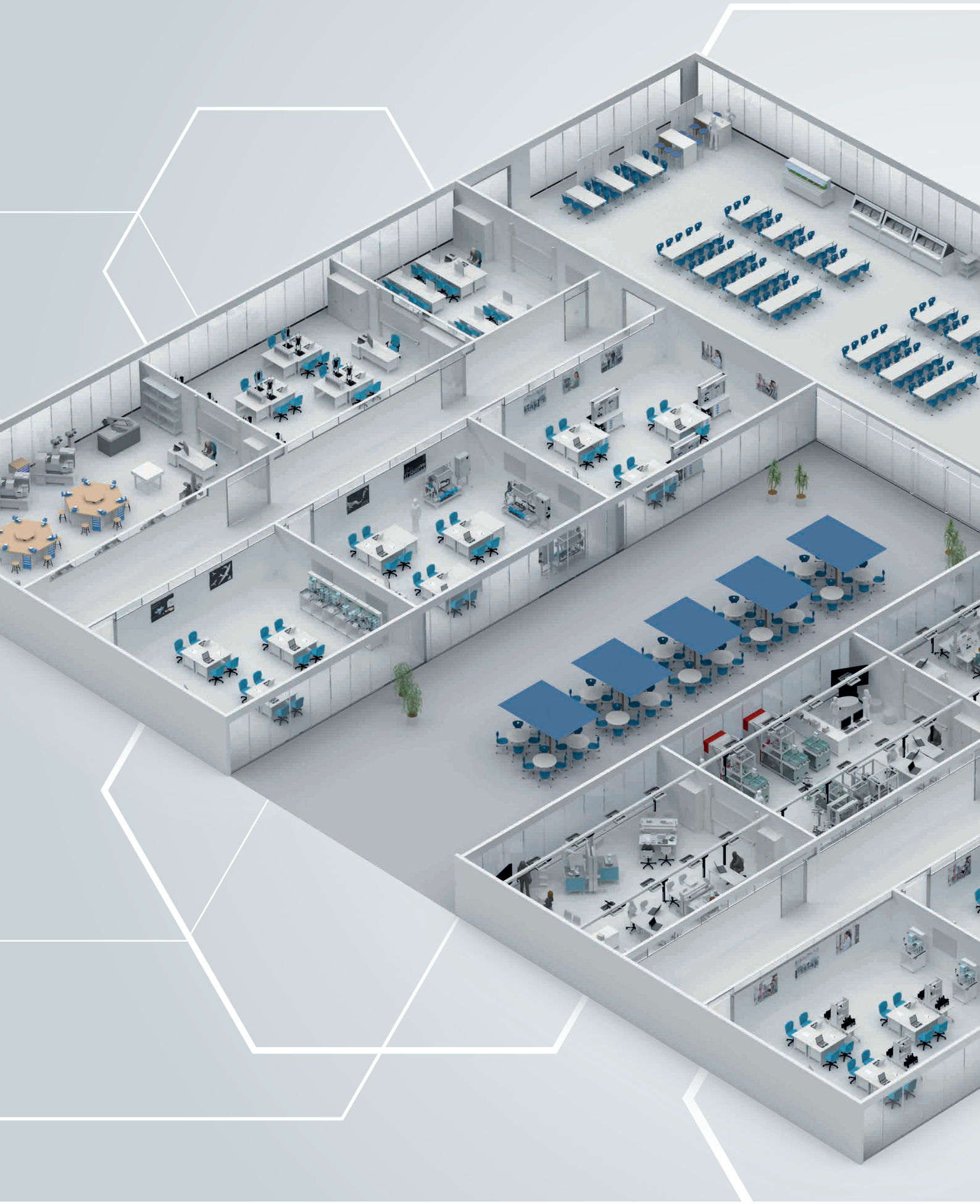
While these needs may differ, they share a common goal: to deliver exceptional training experiences for learners, whether they are students or working professionals.

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
Building systems technology
Environmental technology
Renewable energy
Fluid power



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:

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

Take advantage of our expertise!

→ **Click here or scan the code**

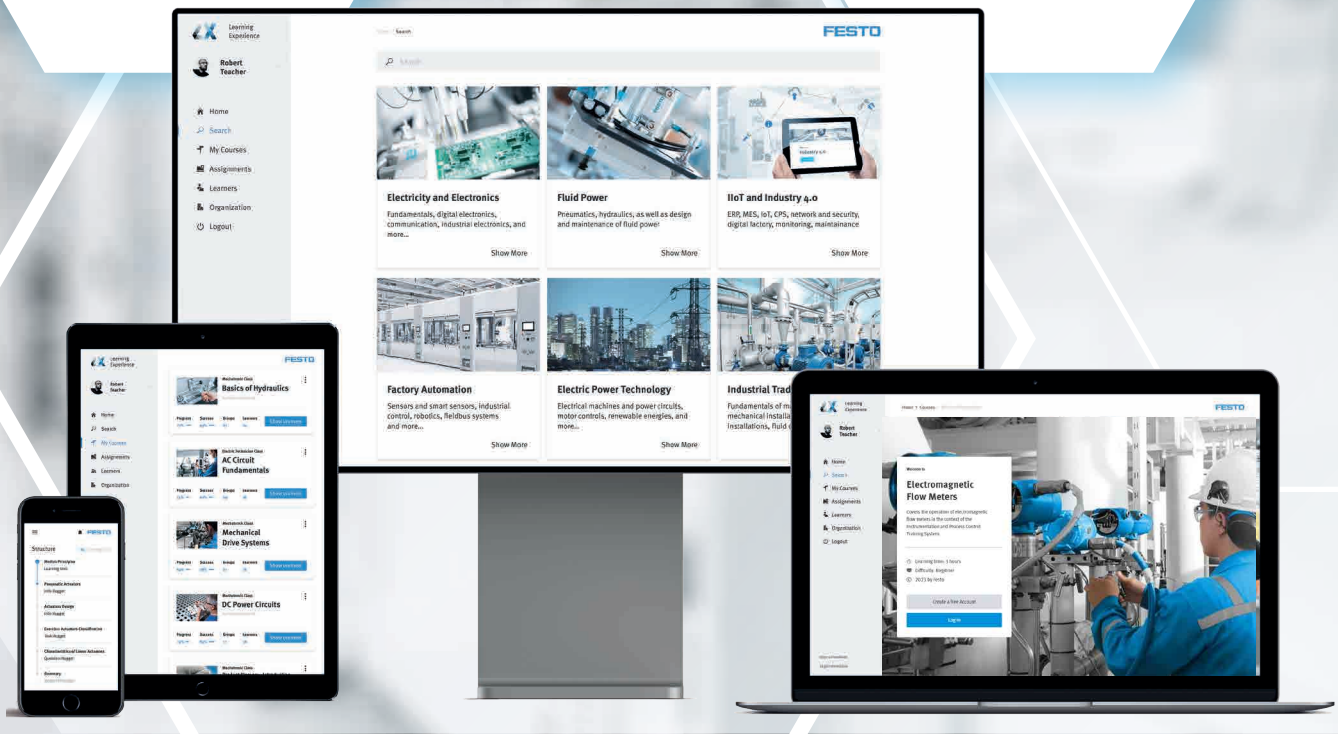
Festo Learning Experience

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 251

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:**

Festo Learning Experience Portal

New features that take learning to a new level

LX Creator AI

helps tailor content to specific needs by enabling the creation and editing of learning nuggets, courses, or paths – with AI support to streamline your work.

FluidSIM 365

is fully integrated into Festo LX, enabling online simulation in electrical engineering, hydraulics, and pneumatics directly within the learning portal.

→ Page 258

Learning paths

guide learners through suggested sequences to address specific topics in a structured way. Teachers can create their own paths or choose from pre-set paths.

LX Tutor

is an AI-powered companion designed to enhance the user experience with Festo LX, supporting both learners and teachers through interactive, educational conversations.

Electeo's instruments

are accessible directly through the Festo LX interface, providing a seamless electronics learning experience with real-time display of electrical values.

→ Page 4

Have questions about Festo LX?

How does Festo LX work? What makes it unique? How does it support personalized learning? What content is available? What are the subscription models? How to get a free trial period?

→ **Visit our web page**

Electrical Technology Curriculum

Learning paths to build solid electrical skills

Adaptable qualification plans

The Electrical Technology Curriculum is a flexible, modular training program designed to equip a wide range of professionals—including electrical engineers, technicians, operators, and maintenance personnel—with the essential skills to operate, maintain, and troubleshoot electrical systems across diverse industries and applications.

It features ready-to-use, fully customizable learning paths and courses that combine digital content, hands-on equipment, and software tools, providing learners with practical experience and preparing them for real-world challenges.

Your benefits

- Discover ready-made learning paths and courses that fit right into your program.
- Speed up lesson prep with turnkey materials and activities.
- Easily see how each topic connects—with clear prerequisites and follow-ups.
- Inspire students with engaging, modern resources and learning tools.
- Measure progress with assessments.
- Develop learners' real-world electrical skills.
- Stay ahead with up-to-date, industry-aligned teaching.

dustrial Wiring
Show More
Basic Motor Control Technology
Show More
Learning Experience
Back
Home
Search
My Learning
Assignments
Organization
Learners
Capacitors and Inductors
Version 3.0
Teaches the fundamentals of capacitors and inductors in dc and ac circuits.
Learning Time: 10 hours
Difficulty: Beginner
Language: English
Category: Electricity and Electronics
eLab Course
Public
2024 all rights reserved to Festo Didactic SE
Add to Favorites
Show Course
Frequently Asked Questions
Contact us
Equipment
Structure
Capacitors and Inductors
Course Preliminaries
Exercise 1: Capacitors
Exercise 2: Inductors
Exercise 3: Project – Car's Interior LED Light Control Circuit
Exercise 4: Capacitors in AC Circuits
Exercise 5: Inductors in AC Circuits
Edit the Course
Learning Outcomes

Electrical Technology Curriculum

Topic overview

Basic skills

Learning paths cover areas such as:

- Electrical and industrial safety
- Fundamentals of electricity and electronics
- Introduction to automated systems

| Learning time: over 230 hours

Electrical and automation skills

Learning paths cover areas such as:

- Electrical motor control
- Industrial electrical installations
- Automation technologies
- Pneumatics and electropneumatics
- Building system technology

| Learning time: over 280 hours

The curriculum is a curated collection of learning paths.

What is a learning path?

It is a structured sequence of activities—such as eLearning courses, videos, hands-on training on learning systems, simulations, and assessments—that guides learners toward specific outcomes and targeted competencies.

How to apply the curriculum?

The curriculum is a toolset with resources that can be selected and adapted to fit different training programs and objectives. Based on the requirements of industrial electricians, it provides a solid foundation for multiple career paths that require electrical expertise.

→ **Get a detailed overview of the curriculum and direct links to learning paths in Festo LX**

Advanced electrical and automation skills

Learning paths cover areas such as:

- Condition monitoring and maintenance
- Advanced electrical motors and drives
- Power electronics
- Power supply quality
- Advanced industrial automation

Learning time: over 210 hours

Specialized skills

Learning paths cover areas such as:

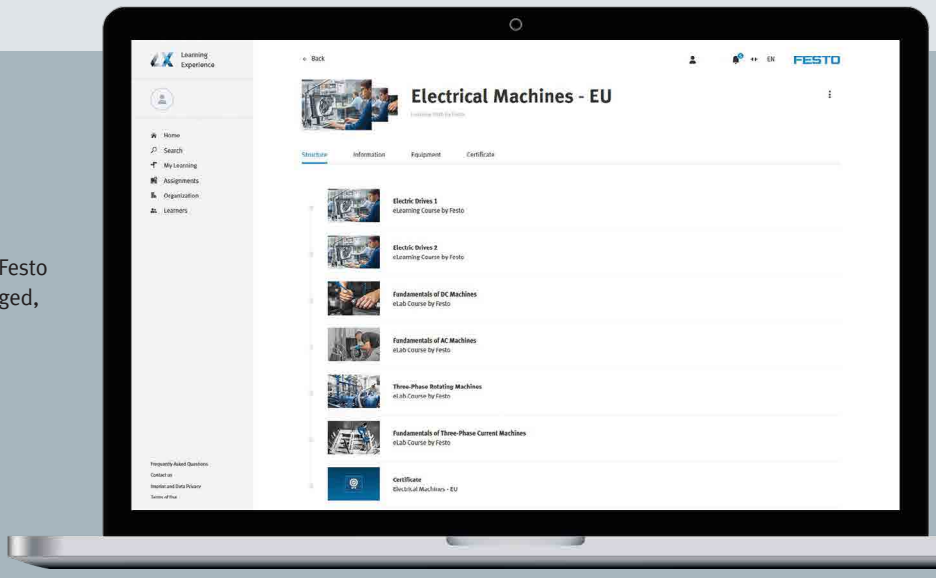
- Power generation, transmission, and distribution
- Renewable energy systems
- Process automation

Learning time: over 270 hours

How to access and customize the learning paths?

All curriculum content is available on the digital learning portal Festo LX, where learning paths and courses can be customized, arranged, and combined to create personalized learning experiences.

Festo LX features over 5,000 – and counting – hours of learning activities to choose from.



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 renewable energy technicians

A strong wind has been blowing in favor of renewable energy since the skill first appeared at WorldSkills. Skill 62 – Renewable Energy was introduced at the 2022 Special Edition in Kyoto, Japan, with three pioneering competitors. Due to strong interest, it became an official competition at WorldSkills Lyon 2024, where six teams from around the world showcased their expertise using state-of-the-art wind power equipment provided by Festo Didactic—highlighting the global demand for skilled renewable energy technicians.

Meaningful, invigorating experiences
Young people enrolled in training programs related to renewable energy 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
The competition features four modules—Design, Installation, Testing, and Maintenance—reflecting real-world tasks of renewable energy technicians. Competitors design and document small-scale solar or wind systems, install and configure components, commission and test system performance, and troubleshoot faults. Emphasis is placed on safety, sustainability, communication, and efficient work practices in line with the WorldSkills Occupational Standard.

Assessing skills
Competitors in the renewable energy competition are objectively assessed based on the established WorldSkills Occupational Standard, which outlines the essential skills and knowledge required for renewable energy technicians. Key skills areas include work organization and management, communication, interpreting technical documentation, applying electrotechnology and control systems, performing installation and maintenance of renewable energy components, ensuring environmental sustainability, following health and safety regulations, and using modern measurement and diagnostic tools effectively.

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.

→ **Visit the website for more info**

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.

FESTO

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

Electricity and Electronics

Electronics Learning System – Electeo
System Description 4
Base Unit 6
Learning Boards 8

Electronics Learning System – FACET
System Description 10
Base Units 14
Circuit Boards and Workbooks 16
Accessories 30

Training Packages
System Description 32
Fundamentals of Electrical Engineering TP 1010 34
Fundamentals of Electrical Engineering and Electronics TP 1011 36
Basic Principles of Digital Technology TP 1012 40
Basic Principles of Control Technology TP 1013 42
Microcontrollers TP 1515/1516 44
AC/DC Learning System 51

Accessories 52

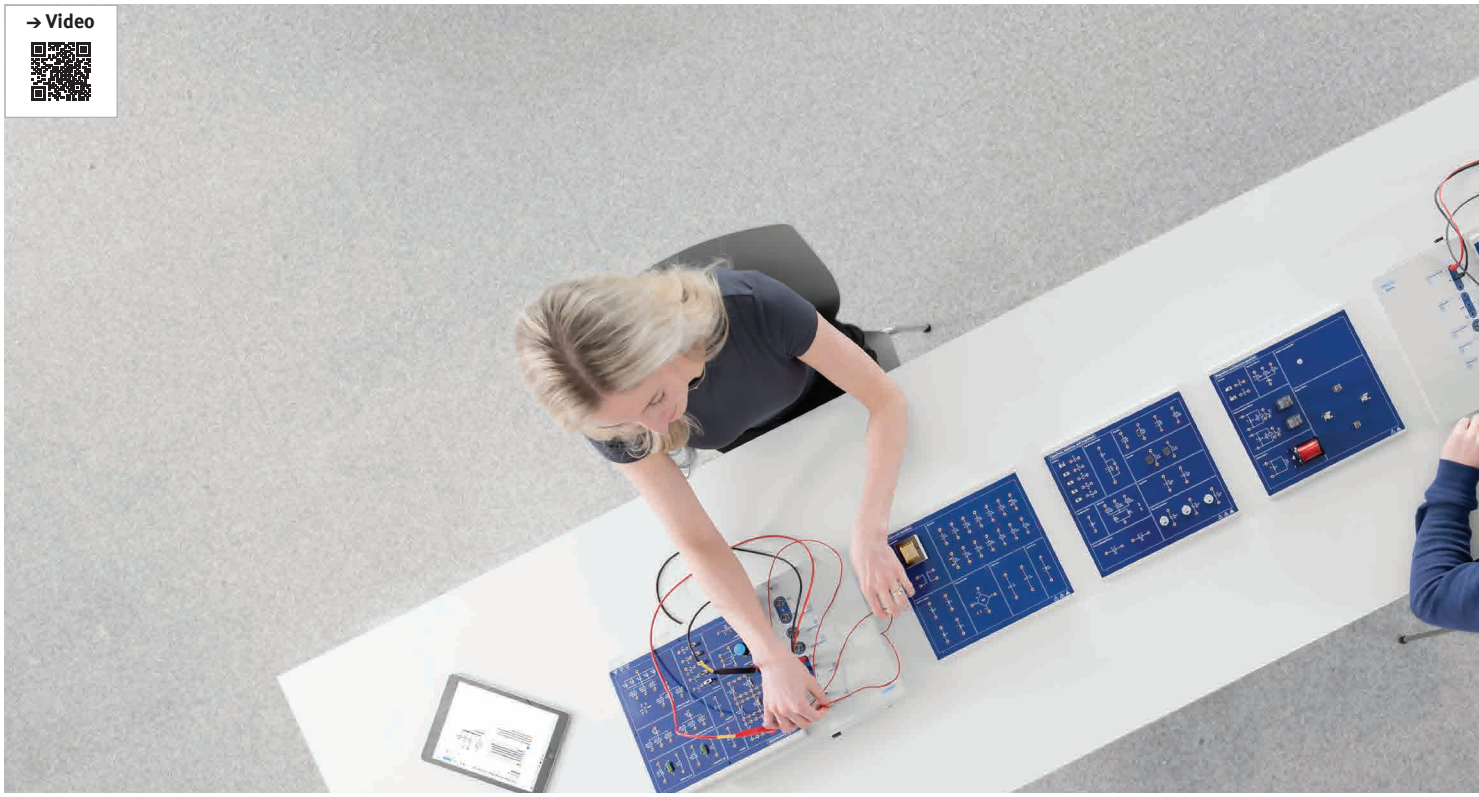
CE

Some of the learning solutions in this catalog do not carry the CE mark and cannot be ordered for delivery to Europe. If you are located in a country where this marking is required, please contact your local Festo sales representative before placing an order.

Electronics Learning System – Electeo

A Blended Solution to Teach and Learn Electronics

→ Video



A modern learning solution with complete course materials to allow users to harness the power of electronics

Electronics has become an integral part of our digitally-driven world, offering unprecedented levels of convenience and efficiency in the industry and beyond. Why not harness the power of electronics to optimize the process of teaching and learning this vital subject? Advance your electronics training programs and laboratories with Electeo!

Step into the world of Electeo
Electeo is a web-based, blended learning solution designed for the practical study of electricity fundamentals, analog and digital electronics, as well as programmable and industrial electronics.

Ideal for vocational and technical schools, universities, and industrial training centers, Electeo develops professional skills in the analysis, design, testing, and troubleshooting of electronic circuits. Thoughtfully crafted for seamless integration into classrooms, it meets the evolving needs of diverse learners and training programs.

100% digital
Electeo unlocks its full potential when used in combination with the digital portal Festo LX (subscription required) for a completely online solution. Festo LX allows teachers to create, plan, customize, and assign courses, and track and report on learners' progress. Virtual instruments are accessible directly within the interface of Festo LX for efficient hands-on sessions. The FluidSIM 365 online simulation software (subscription required) enables electronics circuit simulation.

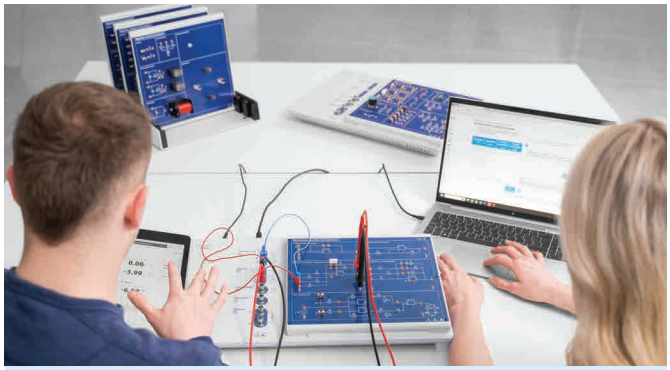
- Multimedia learning content in a digital platform
- Circuit simulation software available in Electeo's web environment
- Seamless data acquisition and transfer between the hardware and the virtual instruments

Note: Courses are also available as PDF and printed workbooks.

Electeo is a new learning solution in constant development.

Currently, a select range of courses and learning boards is offered.

However, product development is ongoing, and new topics, such as digital electronics and motors, will be added to the collection over time.



The Electeo system at a glance

A typical Electeo work setup consists of:
- A Base Unit with built-in digital data acquisition
- One or more Learning Boards
- Courses corresponding to the Learning Boards; courses are available in digital format on Festo LX (subscription required) or in PDF format (campus license)
- Storage Unit for Learning Boards

Electrically safe
Safety is of utmost importance when dealing with electricity. Electeo operates at low voltage and is protected against short-circuits, eliminating the risk of electric shock. The platform's design and component ratings ensure that large and potentially dangerous voltages are not generated. Electeo complies with major electrical safety standards.

Universally connected
Every minute spent in the laboratory should be dedicated to learning, not wasted on troubleshooting or configuring equipment. Electeo is powered by a unique electronic core that ensures hassle-free operation and compatibility with a wide range of devices – laptops, tablets, and smartphones. Electeo's open technology enables easy implementation of future enhancements. It also allows advanced users to develop custom applications using software tools such as LabVIEW, MATLAB, and C#.

- Compatible with most computers and mobile devices
- No software programs to install locally
- Over-the-air hardware updates
- Open, secure technology
- Embedded web server to work independently from an IT infrastructure or without an Internet connection

Electeo's promise: reliable performance for everyone
Learners enjoy a straightforward learning experience that encourages hands-on learning and meets professional standards.

Teachers benefit from an easy-to-use system with updated content and methods, allowing them to spend more time with students and improve lab sessions.

School administrators make a future-proof investment that modernizes labs, boosts teacher productivity, and ensures graduates have the skills for jobs.

All workbooks included in a single campus license

All PDF workbooks, including student and instructor versions, are conveniently bundled in a single campus license with order no. 8131442 (EN) and no. 8233375 (DE).

Printed workbooks remain available upon requests.

Electeo Base Unit

Electeo base unit with Wi-Fi	**8141686**
Electeo base unit without Wi-Fi	**8208409**

The base unit with Wi-Fi includes the TP-Link ARCHER T2U AC600 USB Wi-Fi adapter, which complies with FCC (USA), IC (Canada), CE DoC (EU), and UKCA (UK) regulations. For other regions, the base unit without Wi-Fi is available, and a compatible USB dongle can be sourced locally. For more information, please contact your Festo representative.

Necessary accessory, also order:

Power cable with IEC connector at one end and country-specific plug at other end.

Connector as per...

CEE 7 for DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID	**582146**
NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP	**582145**
BS 1363 for GB, IE, MY, SG, UA, HK, AE	**582148**
AS-3112 for AU, NZ, CN, AR	**582147**
SEV 1011 for CH	**582150**
CEI 23-50 for IT	**582151**
NBR 14136 for BR	**582152**

Other plug types are available on request.

Thanks to its connectivity and data acquisition capabilities, this laboratory device allows learners to perform practical activities outlined in the Electeo courses. Learners clip a learning board and analyze circuits in a web-based environment.

The Electeo base unit provides a self-contained work environment: portable, lightweight, and ergonomically designed, ensuring user comfort. Made of durable plastic, it operates on low voltage, prioritizing user safety and longevity. It incorporates protection against short circuits and features hardware status lights for both instruments and the unit itself.

With secure learning board fixation using magnets, it accommodates one full-size board or two half-size boards. Connectors power and control boards equipped with active components. Data acquisition terminals provide access to the virtual instruments. These instruments include DC voltage sources, a digital multimeter (voltmeter, ammeter, ohmmeter, and power meter), signal and clock generators, and a dual-channel oscilloscope, meeting the most demanding training needs.

Virtual instruments can be accessed through a web browser or the Festo LX interface. They are as accurate as traditional instruments. Adaptive displays enhance user convenience, with measured values easily transmitted directly to the Festo LX course.

Connectivity options include USB type B for virtual network connection, RJ45 for standard network connection, and built-in Wi-Fi supporting access point or client network connections. Future-ready expansion possibilities comprise USB type A 2.0 and optical link for high-speed data transfer. Network interfaces like 10Base-T, 100Base-TX, and IEEE 802.11 a/b/g/n wireless capabilities augment connectivity.

Powered by a unique electronics core, the base unit enables seamless communication with various devices. Firmware updates are automatic and there are no software or drivers to install. The Electeo base unit is meticulously designed for convenience and hassle-free operation.

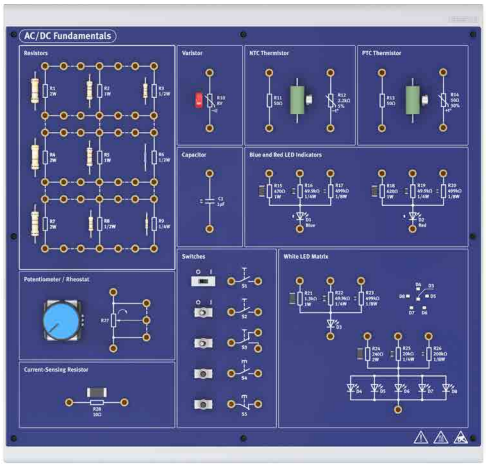
The Electeo base unit is provided with three oscilloscope probes, multimeter cables, 2 mm safety laboratory cables, and jumpers.

Storage Unit for Learning Boards

Compact, portable rack tray that holds up to 8 learning boards in an upright position for easy access and visibility. Made from lightweight aluminum, this open-frame rack tray features two handles for easy manipulation. The integrated plastic inserts stabilize and hold learning boards.

Order no.	**8205343**

AC/DC Fundamentals Learning Board



This board allows learners to conduct practical experiments with basic electrical circuits and learn the fundamental laws of electricity.

The basic principles and concepts associated with alternating current (AC) and direct current (DC) in electrical systems are foundational knowledge needed to understand, design, analyze, and troubleshoot a wide range of electrical and electronic systems.

This full-size board enables learners to engage in learning exercises and projects outlined in the courses “Electeo – AC Fundamentals” and “Electeo – DC Fundamentals.”

The board features a network of resistors, a potentiometer/rheostat, a current-sensing resistor, a varistor, a capacitor, a NTC thermistor, a PTC thermistor, blue and red LED indicators, a set of switches, and a white LED matrix.

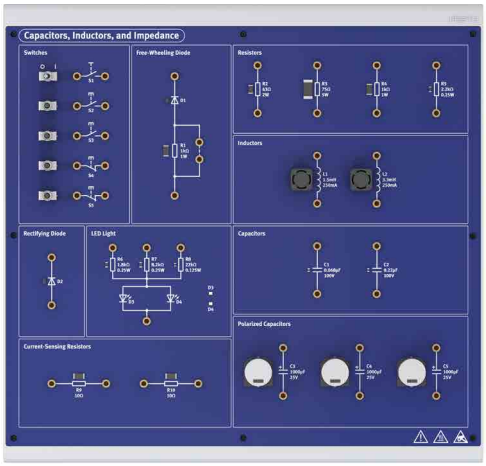
Once installed on the Electeo base unit, learners connect the components to create various electrical circuits and use test-and-measurement virtual instruments to explore subjects such as:
- DC voltage sources
- Electric circuits and current
- Ohm’s law
- Series, parallel, and series-parallel resistive circuits
- Power in circuits
- Switching concepts
- AC waveform measuring techniques using the oscilloscope
- Time constant, phase angle, and phase shift
- Power and effective values of voltage and current in resistive AC circuits
- Solving resistive AC circuits
- RC circuits
- And more

en **8141693**

Recommended workbooks: “DC Fundamentals” and “AC Fundamentals” (→ page 260)

Courses on Festo LX:
→ DC Fundamentals
→ AC Fundamentals

Capacitors, Inductors, and Impedance Learning Board



This board allows learners to conduct practical experiments with time-dependent components and understand how they change the electrical characteristics of circuits.

Time-dependent components are electronic devices whose characteristics influence the time response of circuits. Understanding the influence of time-dependent components in the behavior of circuits is crucial in designing reliable electronic systems and circuits.

This full-size board enables learners to engage in learning exercises and projects outlined in the course “Electeo – Capacitors, Inductors, and Impedance”.

The board features an array of switches, current-sensing resistors, a free-wheeling diode, a rectifying diode, resistors, inductors, capacitors, polarized capacitors, and a LED light.

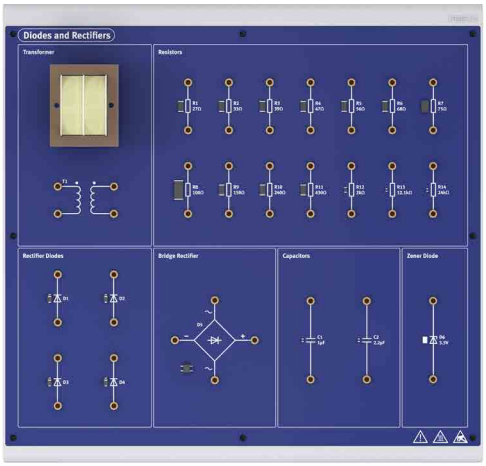
Once installed on the Electeo base unit, learners connect the components to create various electrical circuits and use test-and-measurement virtual instruments to explore subjects such as:
- Charging and discharging time of a capacitor
- Capacitors in series and in parallel
- Transient response of a RC circuit
- Capacitance
- Current and phase in a capacitive circuit
- Magnetic field and electromagnetic inductance
- Faraday’s and Lenz’s laws
- Self-induction
- Transient response of a RL circuit
- Inductor in series and in parallel
- Inductance
- Current and phase in an inductive circuit
- Impedance of resistors, capacitors and inductors
- Phasor diagrams
- Impedance of series and parallel circuits

en **8172968**

Recommended workbooks: “Capacitors and Inductors” and “Impedance” (→ pages 260 and 261)

Courses on Festo LX:
→ Capacitors and Inductors
→ Impedance

Diodes and Rectifiers Learning Board



This board allows learners to conduct practical experiments with rectifiers and voltage regulators using diodes and Zener diodes.

Diodes are fundamental semiconductors devices with diverse applications. They enable the control of current flow, signal modulation and demodulation, logic operations, power supply conversion, and protection of electronic circuits.

This full-size board enables learners to engage in learning exercises and projects outlined in the course "Electeo – Diodes and Rectifier Circuit".

The board features a transformer, an array of resistors, rectifer diodes, a bridge rectifier, capacitors, and a Zener diode.

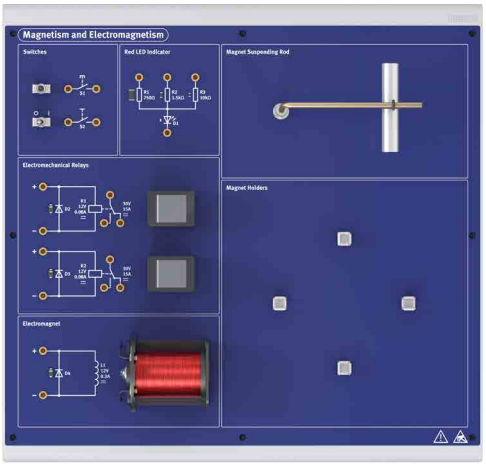
Once installed on the Electeo base unit, learners connect the components to create various electrical circuits and use test-and-measurement virtual instruments to explore subjects such as:
– Diodes
– Half-wave rectifiers
– Full-wave rectifiers
– Ripple reduction
– Zener diodes

en **8195357**

Recommended workbook: “Diodes and Rectifier Circuits” (→ page 261)

Course on Festo LX:
→ Diodes and Rectifier Circuits

Magnetism and Electro-magnetism Learning Board



This board allows learners to conduct practical experiments with basic electromagnetic devices and understand the phenomena of magnetic fields applied to electricity.

Magnetism and electricity are interconnected through the principle of electromagnetic induction, and their relationship is harnessed in numerous technologies, ranging from power generation and distribution to transportation, communication, and medical diagnostics.

This full-size board enables learners to engage in learning exercises and projects centered around basic electrical circuits outlined in the course “Electeo – Magnetism and Electromagnetism”.

The board features switches, electromagnetic relays, an electromagnet, a red LED indicator, as well as a magnet suspending rod and magnet holders.

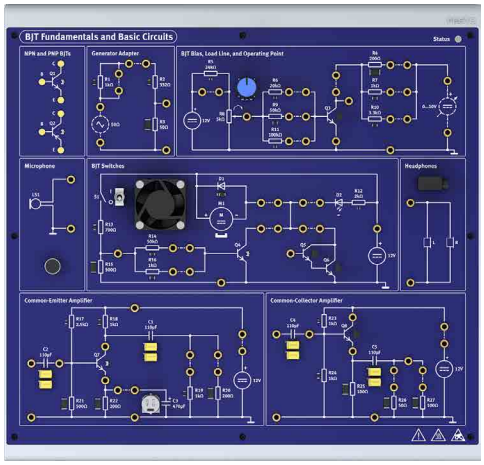
Once installed on the Electeo base unit, learners connect the components to create various electrical circuits and use test-and-measurement virtual instruments to explore subjects such as:
– Magnetism, magnets, and compass
– Magnetic field patterns and attractive/repulsive forces
– Direction and intensity of electromagnetism fields
– Right-hand rule
– The electromagnet
– The linear solenoid actuator
– The electromechanical relay
– Basic relay circuits
– Solenoid and relay construction
– And more

en **8172969**

Recommended workbook: “Magnetism and Electromagnetism” (→ page 260)

Course on Festo LX:
→ Magnetism and Electromagnetism

Bipolar Junction Transistor (BJT) Learning Board



This board allows students to understand, analyze, apply, and troubleshoot NPN and PNP bipolar junction transistors (BJTs) in electronic circuits through hands-on experimentation.

Bipolar junction transistors are key semiconductor devices for their ability to amplify signals and act as switches, enabling efficient control and operation of electronic circuits.

This full-size board allows students to engage in the study and hands-on experimentation outlined in the BJT Fundamentals and Basic Circuits course.

The board includes NPN and PNP BJTs, a voltage adapter circuit, a load line and operating point test circuit, a transistor switching circuit, common emitter and common collector amplifier circuits, a microphone, and a headphone jack. A light indicates the power and operating status of the board.

Once installed on the Electeo base unit, students connect the components to create various electrical circuits and use virtual test and measurement instruments to explore topics such as:
- BJT types (NPN and PNP transistors) and working principles
- BJT operating modes, characteristics, and curves
- Load line and operating point Q of a BJT circuit
- BJT as a switch
- BJT as common-emitter and common-collector amplifiers
- Biasing techniques
- Troubleshooting

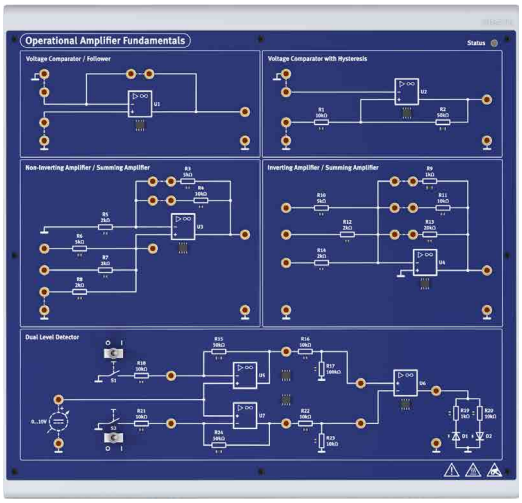
en **8217999**

Recommended workbook: “BJT Fundamentals and Basic Circuits” (→ page 261)

Course on Festo LX:

→ BJT Fundamentals and Basic Circuits

Operational Amplifiers (Op-Amp) Learning Board



This board enables learners to explore the key concepts and practical uses of operational amplifiers (op amps), with a focus on their characteristics, common configurations, and troubleshooting methods.

Operational amplifiers are versatile building blocks in analog electronics, used for signal amplification, comparison, and mathematical operations. Mastering their fundamental properties and configurations is essential for designing effective electronic circuits.

This full-size board enables learners to engage in learning exercises and projects outlined in the course Operational Amplifier Fundamentals.

The board features five sections: a voltage comparator/follower, a voltage comparator with hysteresis, a non-inverting amplifier/summing amplifier, an inverting amplifier/summing amplifier, and a dual-level detector.

Once installed on the Electeo base unit, learners connect the components to create various electrical circuits and use test-and-measurement virtual instruments to explore subjects such as:
- Fundamentals of op amps and parameter designations
- Ideal vs non-ideal behavior and operation with and without feedback
- Use of op amps as comparators (with and without hysteresis)
- Inverting/non-inverting voltage amplifiers
- Summing amplifiers

en **8216836**

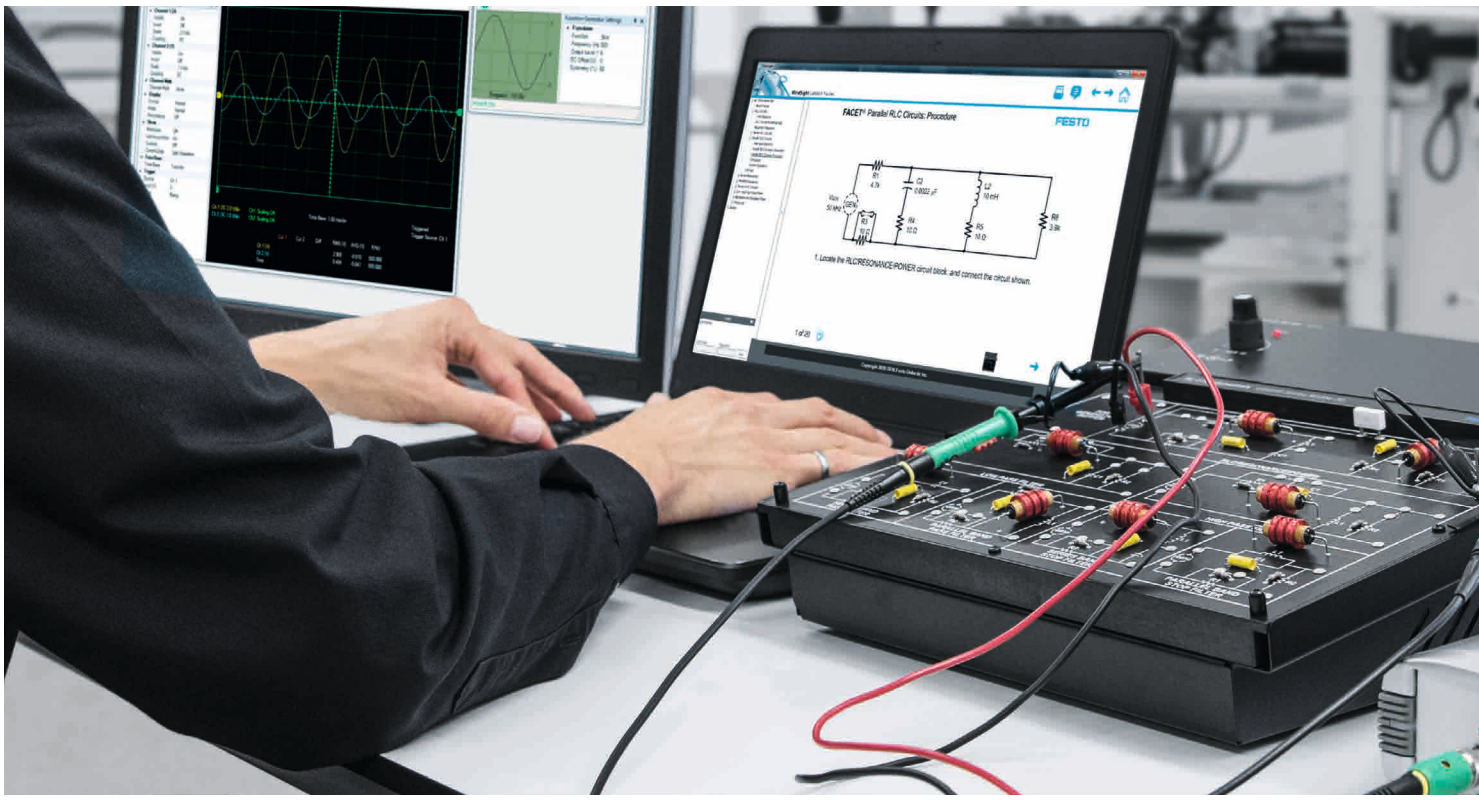
Recommended workbook: “Operational Amplifiers Fundamentals” (→ page 261)

Course on Festo LX:

→ Operational Amplifiers Fundamentals

Electronics Learning System – FACET

Fault-Assisted Circuits for Electronics Training



FACET with Festo LX –
A completely integrated system

The FACET with Festo LX training system is a unique combination of hardware and software, providing a complete learning solution for Electronics training.

This modular training system encompasses four areas of electronics:
– Basic principles of Electricity and Electronics
– Digital and Microprocessor Electronics
– Industrial Electronics
– Communications

System overview
The FACET training workstation consists of a base unit and your choice in a series of 30 boards to choose from, covering a wide range of electronics topics.

Each board comes with comprehensive, hands-on instruction with theory and practice. A collection of 30 courses is available as connected learning courses on Festo LX, our online portal for individualized learning experiences. Courseware is also available in print or PDF format.

Festo LX allows for individualized learning, learner management, learning analytics, equipment management, competency management, course edition, connected and mobile learning, evaluation, and more.

Conventional or virtual instrumentation is required to complete the training set up.

Flexibility in delivery
To accommodate a variety of training situations, the system offers multiple configurations. Whichever you plan to use, FACET workstation can be ordered as a stand-alone or USB-connected version.

When combined with Festo LX, FACET becomes a totally connected learning system for electronics that enhances learning speed and retention.

FACET is suitable for a multitude of training purposes in educational, industrial, R&D and training laboratories.

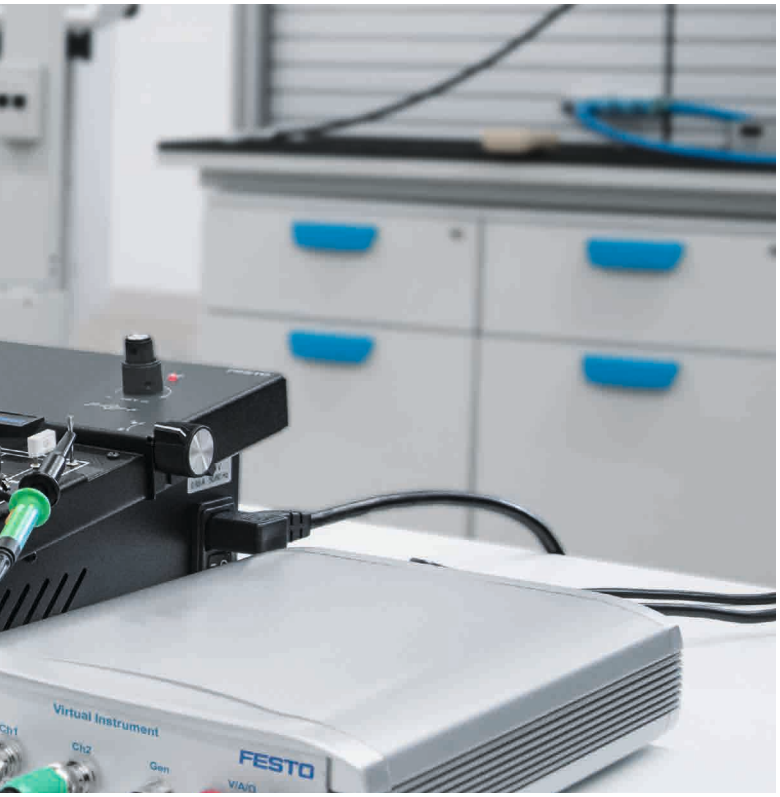
Rugged construction for durability
The hardware components of the FACET system are highly safe and designed for durability.

A complete electronic workstation is formed when a training board is inserted into the base unit. The built-in guide and stopper protects the unit from damage.

The unique zero insertion force (ZIF) connector with a lockable knob insures the integrity of the connection. The connector is gold-plated for added durability.

Power is distributed to the board by the base unit, which is fully protected against short circuits, reverse voltage and overcurrent.

The fact that there is no high voltage makes the system completely safe for students.



The FACET system at a glance

A complete FACET training station consists of:
- FACET Base Unit:
  Manual or USB
- FACET Circuit Boards:
  Choice of 30 topics
- Instrumentation:
  The Virtual Instrument Package
  or
  Conventional instrumentation that includes: multimeter, dual-trace oscilloscope, and signal generator
- Courseware:
  available as digital learning courses on Festo LX, or in print or PDF formats
- Accessory kit

The boards – learning optimization
The Boards are made of quality grade PCB mounted on a sturdy polystyrene tray for added rigidity. Durable, industrial-grade components are capable of withstanding millions of cycles of operation. Prewired circuits minimize wiring time.

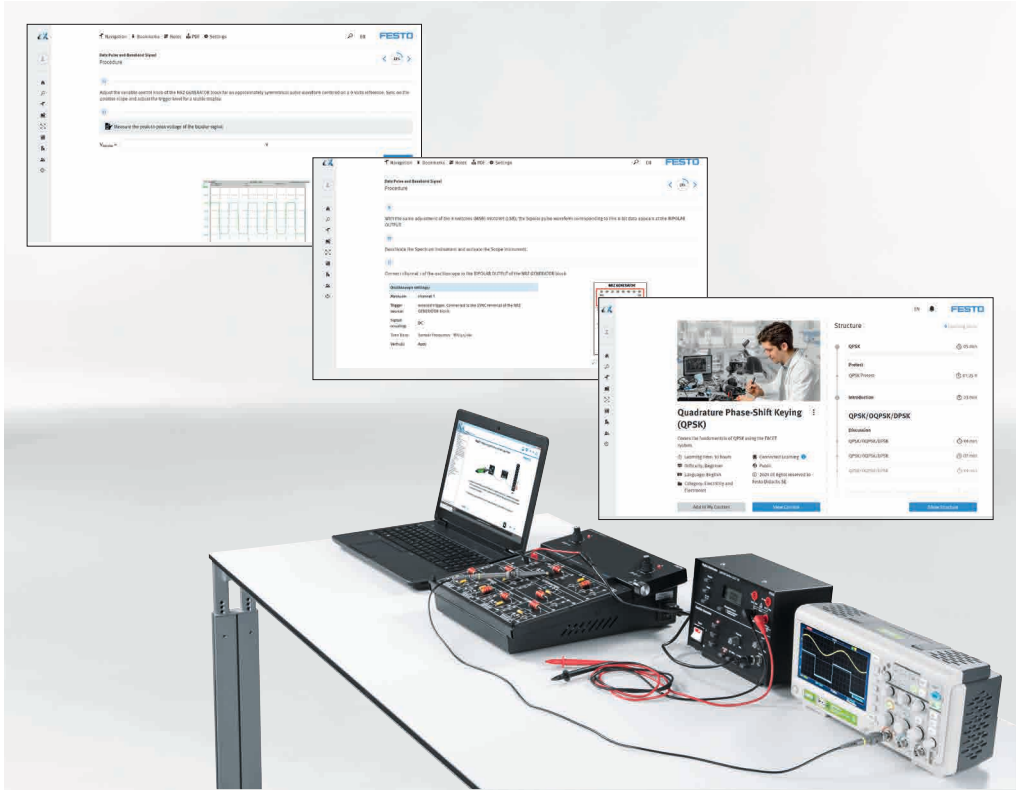
The components are clearly identified with silk-screened circuits. Active components are mounted on sockets for easy replacement.

Learning with hands-on
FACET incorporates built-in circuit modification and fault insertion capabilities. Circuits can be faulted to teach real-world troubleshooting. Students must then locate, isolate, and troubleshoot the malfunction through a series of troubleshooting steps, including the use of test instruments. Up to twenty circuit modifications and twelve faults are introduced from the base unit, reducing the need for connecting leads and allowing practical assessment of a student's understanding of a circuit.

Features
- Durable construction where mechanical components are capable of millions of cycles of operation
- Voltage regulation and protection against over-voltage and short circuit conditions for safety in training
- Gold-plated zero insertion force (ZIF) connector technology
- Silk-screened circuit and component identification
- Circuit boards mounted in sturdy trays for easy handling and connection to base unit
- Minimal wiring required saves lab time
- Variety of industrial-grade components provide broad, hands-on, real-world training experience
- Student-controlled circuit modification capability
- Instructor-controlled fault insertion capability
- Computer-activated circuit modification and fault insertion capability (computer-controlled system)

The FACET Curriculum

Digital Learning Courses



The FACET curriculum consists of 30 courses, each carefully designed to foster recognition, understanding, experimentation, troubleshooting, application, and evaluation of analog and digital electronics circuitry.

Rich in comprehensive content and competency-based, hands-on learning activities, each course gives students critical skills in one or more of the key areas of electronics study

Courses are designed to be self-paced, autonomous training.

Available topics:

Basic electricity and electronics
- DC Fundamentals
- DC Network Theorems
- AC 1 Fundamentals
- AC 2 Fundamentals
- Semiconductor Devices
- Transistor Amplifier Circuits
- Transistor Power Amplifiers
- Transistor Feedback Circuits
- Power Supply Regulation Circuits
- Operational Amplifier Fundamentals
- Operational Amplifier Applications

Digital and microprocessor electronics
- Digital Logic Fundamentals
- Digital Circuit Fundamentals 1
- Digital Circuit Fundamentals 2
- 32-Bit Microprocessor
- Digital Signal Processor
- Microprocessor Application Board

Industrial electronics
- Transducer Fundamentals
- Magnetism/Electromagnetism
- Motors, Generators, and Controls
- Power Transistors and GTO Thyristors
- FET Fundamentals
- Thyristor and Power Control Circuits
- Breadboard

Communications systems
- Analog Communications
- Digital Communications 1
- Digital Communications 2
- Fiber Optic Communications
- Transmission Lines
- QPSK/OQPSK/DPSK

All workbooks included in a single campus license

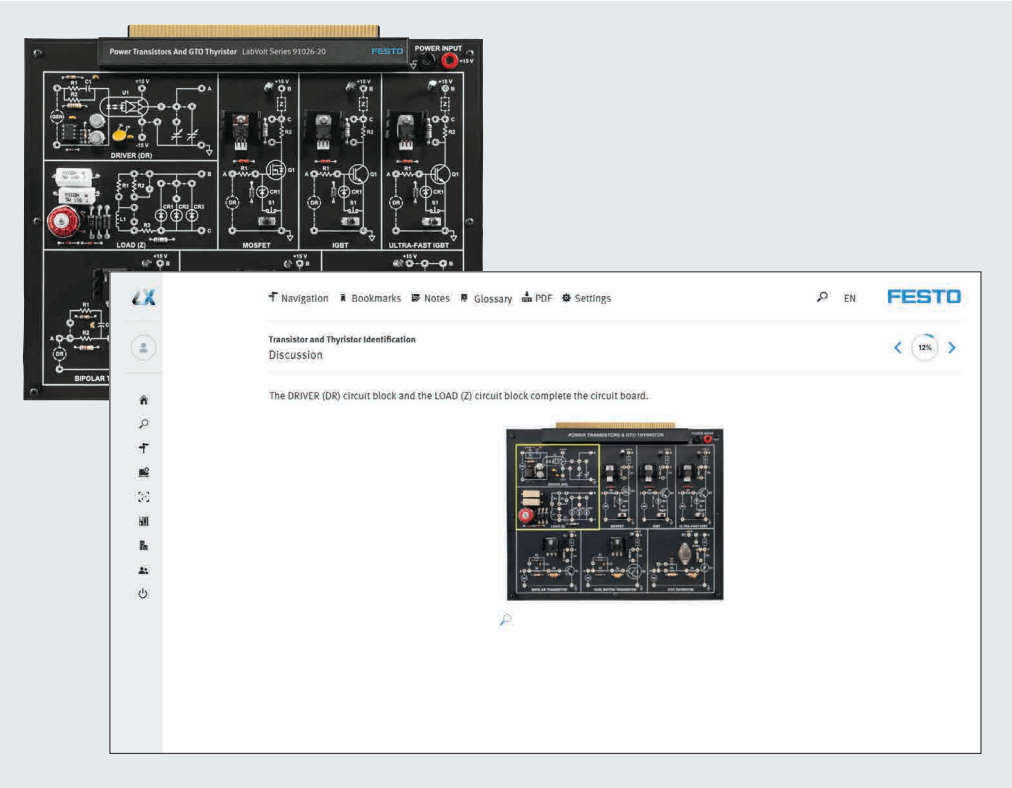
All PDF workbooks, including student and instructor versions, are conveniently bundled in a single campus license with order no. 585330.

Printed workbooks remain available upon requests.

A program designed for student achievement

Conforming to the highest measures of educational quality, the FACET curriculum is designed to facilitate and reinforce progressive mastery of the course material. The courseware provides an extensive array of instructional benefits, including:

– An outline of the principles and concepts covered in each course helps to clarify course content and focus.
– General and specific objectives stated in each unit help define learning outcomes and expectations for students.
– Topic discussions help to foster thorough comprehension.
– Hands-on activities engender dynamic and retentive learning.
– Emphasis on, and definition of new words and phrases throughout the text, helps students to develop comfort and familiarity with highly technical terms.
– Equipment lists support students' efforts to efficiently organize time and materials.
– Students receive constant feedback with a review test and competency ratings with each exercise, comprehensive unit tests, and additional questions on new material.
– Online data collection of exercise results, quizzes, and unit tests facilitates instant feedback to students.
– Troubleshooting skills development is facilitated through 12 instructor-or computer-activated fault switches and 20 circuit-modification switches.



Connected learning

The courses enhances learning speed and retention by featuring interactive multimedia courseware with hand-on exercises on pre-wired circuit boards.

For circuit comprehension and analysis

Students perform experiments on a wide range of electronics and electricity training modules that combine theory and application with live connection to base unit and board. This provides practical skills training over a full curriculum on electronic/electricity subjects.

Supportive resources

The instructor guide and supportive pre- and post-tests provide both instructors and students with an extensive overview and working knowledge of electricity, analog, and digital electronics.

The FACET Base Units

1 Computerized Base Unit 91000-5x **580867**

2 Manual Base Unit 91000-3x **580866**

1 **Computerized Base Unit**
The computerized base unit is linked to the computer automatically by the courseware when needed, and can also be activated via a USB port by the teacher through password-protected software.

The computerized base unit contains 32 relays controlled by commands from the student's computer. **C**ircuit **M**odifications (CM) and faults are switched in and out automatically by the software.

A message on the student's computer screen indicates that a CM or fault is activated. In the troubleshooting exercises, faults are also inserted automatically by the computer, thereby freeing the instructor to assist students with individual activities.

2 **Manual Base Unit**
The Manual Base Unit contains a total of 32 **C**ircuit **M**odification (CM) and fault switches. Students manually select CM switches as the course progresses, while the protected fault switches are reserved for Instructor use by means of an integrated, locking-cover assembly.

The FACET base units provide voltage supply with protection and conditioning circuitry to run each FACET board.

Specific features of all FACET base units include:
- Distributed +15 and -15 V DC, and variable ±10 V DC power to the various circuit training boards. Coarse and fine controls are provided to adjust the variable DC supplies.
- Self-protection against short circuit, reverse voltage, and overcurrent conditions.
- Long-life ZIF connector, with a rotary knob that locks the training board into the base unit. The ZIF connector itself is protected from damage by built-in stops.
- The fingers on the connectors are gold-plated for added durability.
- Included is an accessory kit containing terminal posts, connectors, adapters, and patch cords required to perform experiments on the FACET training board.

Necessary accessory, also order:

Power cable with IEC connector at one end and country-specific plug at other end.

Connector as per CEE 7 for DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID
Order no. **582146**

Connector as per NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP
Order no. **582145**

Connector as per BS 1363 for GB, IE, MY, SG, UA, HK, AE
Order no. **582148**

Connector as per AS-3112 for AU, NZ, CN, AR
Order no. **582147**

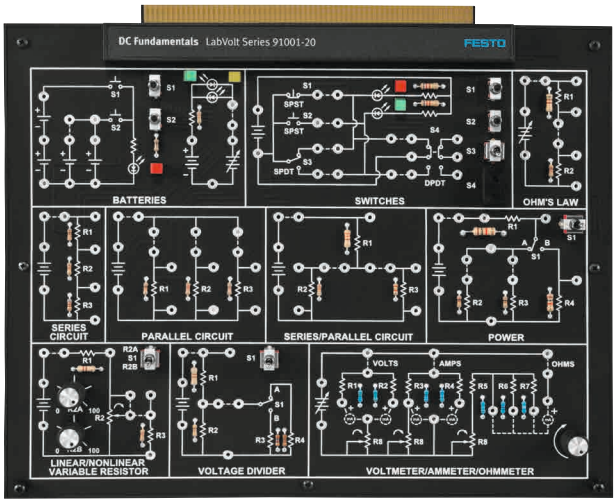
Connector as per SEV 1011 for CH
Order no. **582150**

Connector as per CEI 23-50 for IT
Order no. **582151**

Connector as per NBR 14136 for BR
Order no. **582152**

Other plug types are available on request.

DC Fundamentals
Circuit Board 91001



The DC Fundamentals Training Circuit Board is used by students to perform practical exercises that demonstrate DC principles. Students will become familiar with all the components to be able to successfully identify and isolate the circuit blocks on the training board and perform trouble-shooting exercises.

Course structure::
- Instrument Familiarization
- FACET Base Unit Familiarization
- DC Fundamentals Circuit Board Familiarization
- Symbols and Schematics
- Basic Safety Rules
- Electrical Safety Rules
- Circuit Resistance, Circuit Current, Circuit Voltage
- DC Power Sources in Series and in Parallel Series
- Opposing DC Sources
- Identify Types of Switches
- Switching Concepts
- Ohm's Law: Circuit Resistance, Circuit Current, Circuit Voltage
- Resistance, Current, and Voltage in a Series Resistive Circuit
- Resistance, Voltage, and Current in a Parallel Resistive Circuit
- Resistance, Voltage, and Current in a Series-Parallel Resistive Circuit
- Power in a Series, Parallel, and Series-Parallel Resistive Circuit
- The Rheostat
- The Potentiometer
- Voltage and Current Dividers
- The DC Ammeter/ Ohmmeter/ Voltmeter
- Troubleshooting DC Circuits 1

en	**580877**
fr	**580878**
es	**580879**

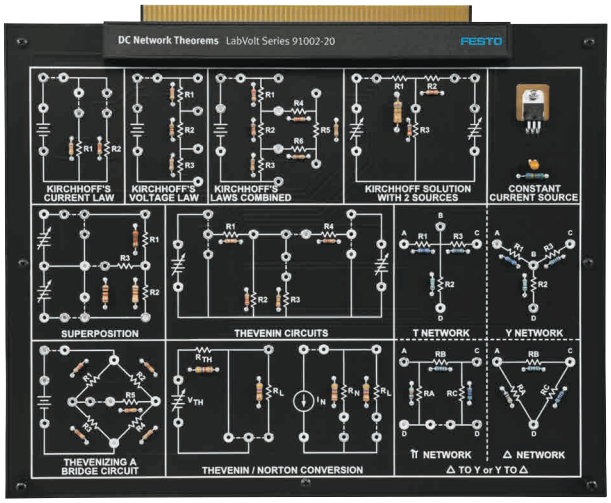
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ DC Fundamentals

DC Network Theorems
Circuit Board 91002



Consisting of nine training circuit blocks and a constant-source current block, the DC Network Theorems Circuit Board enables students to perform practical exercises that demonstrate theoretical DC principles. When a circuit has two voltage sources in different branches, theorems are used to solve for voltage and/or current in these circuits where Ohm's Law cannot be applied.

Course structure:
- Component Location and Identification
- Circuit Board Operation
- Currents and Node Currents in a Two-Element Branch Circuit
- Voltages in a Three-Element Series Circuit
- Algebraic Sum of Voltages in a Series Circuit
- Generating Loop Equations
- Generating Node Equations
- Kirchhoff's Voltage and Current Law with a Two-Source Circuit
- Mesh Solutions of a Two-Source Circuit
- Superposition Solution for a Two-Source Circuit
- Millman's Theorem Solution for Two-Source Circuit
- Thevenizing a Single-Source and a Dual-Source Network
- Thevenin Resistance (Rth) and Thevenin Voltage (Vth) of a Bridge Circuit
- Thevenin to Norton Conversion
- Norton to Thevenin Conversion
- Tee and Wye or Pi and Delta Networks
- Transformation of Delta and Wye Networks
- Troubleshooting Basics
- Troubleshooting DC Networks

en	**580889**
fr	**580890**
es	**580891**

Workbook, also order:

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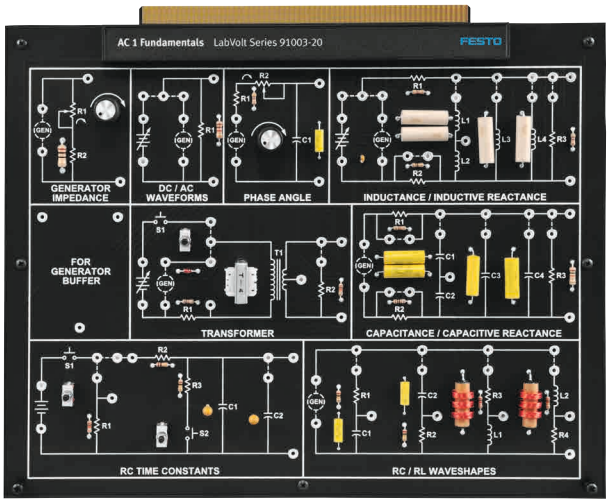
AC 1 Fundamentals
Circuit Board 91003



The AC 1 Fundamentals Circuit Board contains nine circuit blocks on which students perform varied troubleshooting exercises in the AC 1 Fundamentals program. Students identify and isolate the following circuits: Generator Impedance, AC/DC Waveforms, Phase Angle, Inductance/Inductive Reactance, Transformer, Capacitance/Capacitive Reactance, RC Time Constants, and RC/RL Wave Shapes.

Course structure:
- The Oscilloscope
- The AC Waveform Generator
- AC Amplitude Measurement
- Measuring AC Voltage, Current, and Impedance with an Oscilloscope
- Measuring and Setting Frequency
- Inductors
- Phase Angle
- Inductors in Series and in Parallel
- Fundamentals of Inductive Reactance
- Inductive Reactance and Impedance
- Series and Parallel RL Circuits
- What is an Electromagnet?
- Transformer Windings
- Mutual Inductance
- Transformer Turns and Voltage Ratios
- Transformer Secondary Loading
- Capacitors
- Capacitors in Series and in Parallel
- Fundamentals of Capacitive Reactance
- Series and Parallel RC Circuits
- RC Time Constants
- RC/RL Waveshapes
- Troubleshooting Basics
- Troubleshooting the AC 1 Fundamentals Circuit Board

en	**580901**
fr	**580902**
es	**580903**

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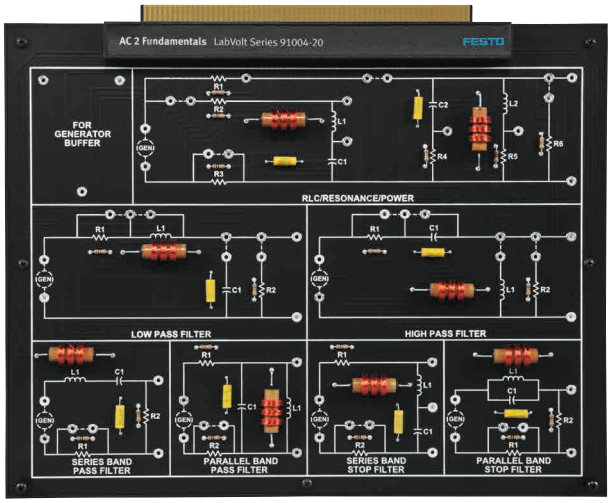
Course on Festo LX:
→ AC 1 Fundamentals

AC 2 Fundamentals
Circuit Board 91004



The AC 2 Fundamentals Circuit Board is designed as a continuation of the AC 1 Fundamentals program.

Course structure:
- Series RLC Circuits
- Parallel RLC Circuits
- Series Resonant Circuits
- Q and Bandwidth of a Series RLC Circuit
- Resonant Frequency in a Parallel LC Circuit
- Q and Bandwidth
- Power Division
- Power Factor
- Low-Pass Filters
- High-Pass Filters
- Band-Pass Filters
- Band-Stop Filters
- Troubleshooting Basics
- Troubleshooting the AC 2 Fundamentals Circuit Board

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fr	**580914**
es	**580915**

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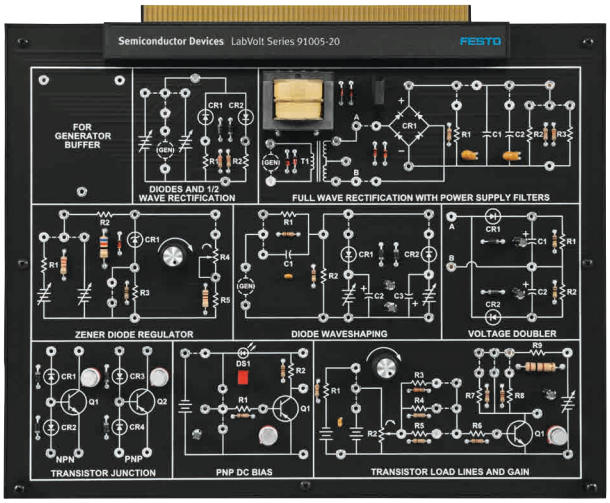
Course on Festo LX:
→ AC 2 Fundamentals

Semiconductor Devices
Circuit Board 91005



The Semiconductor Devices Circuit Board contains nine circuit blocks pertaining to skills training in semiconductor circuits.

After completion of the FACET programs in AC and DC Fundamentals and AC and DC Circuits and Analysis, students are ready to train on the Semiconductor Board.

Students in this program will be responsible for analyzing and troubleshooting the following circuits: Diodes and Half-wave Rectification, Full-wave Rectification with Power Supply Filters, Zener Diode Regulator, Diode Waveshaping, Voltage Doubler, Transistor Junction, PNP DC Bias, and Transistor Load Lines and Gain.

Course structure:
- Semiconductor Component Identification
- Control of a Semiconductor Switch
- Diode and DC Characteristics
- Half-Wave Rectification
- Full-Wave Diode Bridge Rectification
- Power Supply Filtering
- Voltage Doubler
- Diode Waveshaping
- The Zener Diode
- Zener Diode Voltage Regulation
- Testing the Junctions of a Transistor
- PNP Transistor Current Control Circuit
- Emitter-Base Bias Potentials
- Collector Current vs. Base Bias
- Transistor DC Circuit Voltages
- Transistor Load Lines
- Troubleshooting Basics
- Troubleshooting the Semiconductor Devices Circuit Board

en	**580925**
fr	**580926**
es	**580927**

Workbook, also order:

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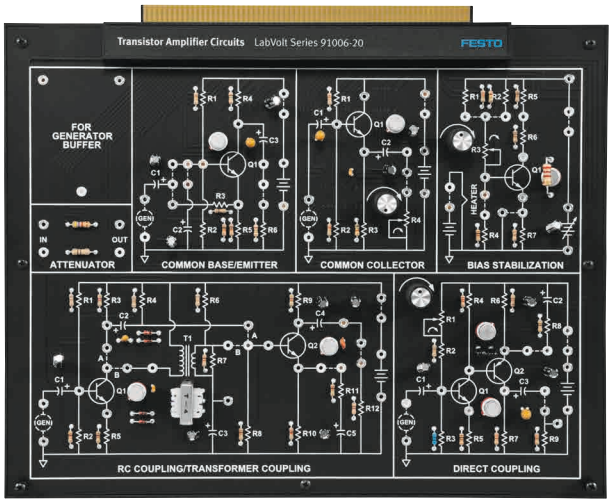
Course on Festo LX:

→ Semiconductor Fundamentals

Transistor Amplifier Circuits
Circuit Board 91006



The Transistor Amplifier Circuits Board allows students to perform practical exercises that demonstrate transistor amplifier principles.

Students will identify and isolate faults within the following six circuit blocks: Attenuator, Common Base/Emitter, Common Collector, Bias Stabilization, RC Coupling/Transformer Coupling, and Direct Coupling.

Course structure:
- Circuit Location and Identification
- Multistage Amplifier Introduction
- Common Base Circuit DC Operation
- Common Base Circuit AC Operation
- Common Emitter Circuit DC Operation/AC Operation
- Common Collector Circuit DC Operation/AC Operation
- Temperature Effect on Fixed Bias Circuit and Voltage Divider Bias Circuit
- Transistor Parameters Familiarization
- Using the Transistor Specification Sheet
- RC Coupled Amplifier DC Operation
- RC Coupled Amplifier AC Voltage Gain and Phase Relationship
- RC Coupled Amplifier Frequency Response
- Transformer Coupled Amplifier DC Operation/ AC Operation/ Frequency Response
- Direct Coupled Amplifier DC Operation/AC Operation
- Direct Coupled Amplifier Frequency Response
- Troubleshooting Basics
- Troubleshooting Transistor Amplifier Circuits

en	**580937**
fr	**580938**
es	**580939**

Workbook, also order:

Campus license, en	585330

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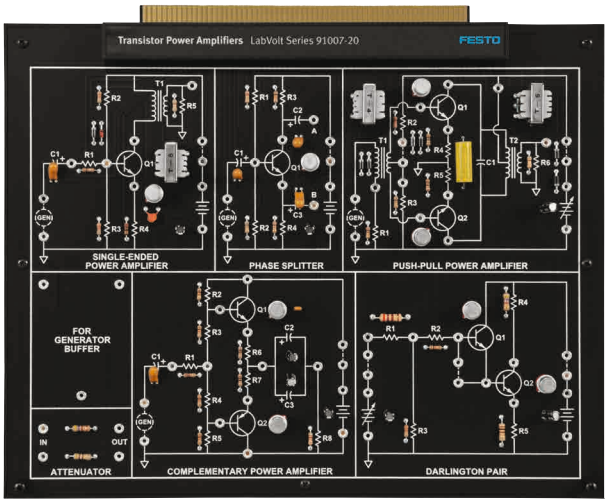
Course on Festo LX:

→ Transistor Amplifier Circuits

Transistor Power Amplifiers
Circuit Board 91007



The Transistor Power Amplifiers Circuit Board is designed to teach troubleshooting of transistor power amplifier circuitry.

Training on this Circuit Board includes identifying and isolating the following circuits: Single-Ended Power Amplifier, Phase Splitter, Push-Pull Power Amplifier, Attenuator, Complementary Power Amplifier, and Darlington Pair.

Course structure:
- Circuit Location and Identification
- Transistor Power Amplifier Introduction
- Single-Ended Power Amplifier DC Operation
- Single-Ended Power Amplifier AC Voltage Gain and Power Gain
- Phase Splitter DC Operation
- Voltage Gain and Input/Output Signal Phase Relationship
- Push-Pull Power Amplifier DC Operation
- Push-Pull Power Amplifier AC Voltage and Power Gain
- Complementary Power Amplifier DC Operation
- Complementary Power Amplifier AC Voltage Gain and Power Gain
- Darlington Pair Current Gain Characteristics
- Darlington Pair Input and Output Impedance
- Troubleshooting Basics
- Troubleshooting Transistor Power Amplifiers

en	**580949**
fr	**580950**
es	**580951**

Workbook, also order:

Campus license, en	585330

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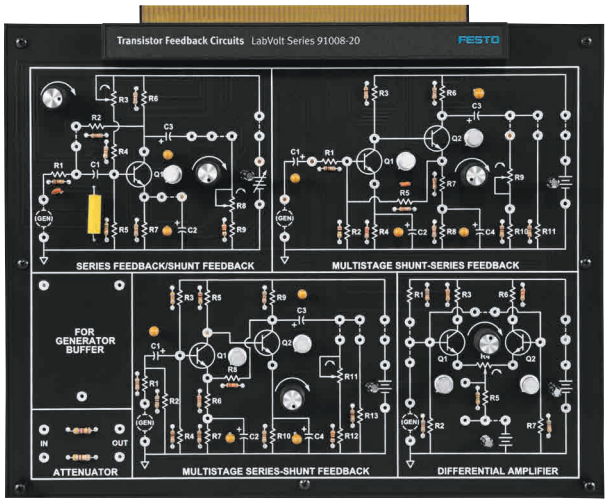
Course on Festo LX:
→ Transistor Power Amplifiers

Transistor Feedback Circuits
Circuit Board 91008



The Transistor Feedback Circuit Board enables students to perform practical exercises that demonstrate Transistor Feedback principles.

The circuits found on this board include: Series Feedback/Shunt Feedback, Multistage Shunt-Series Feedback, Attenuator, Multistage Series-Shunt Feedback, and the Differential Amplifier.

Course structure:
- Component Location and Identification
- Series Feedback Amplifier Operation
- The Effect of Feedback on AC Gain
- The Effect of Negative Series Feedback on Bandwidth
- The Effect of Series Feedback on Input and Output Impedance
- The Effect of Shunt Feedback on AC Gain
- The Effect of Shunt Feedback on Bandwidth
- The Effect of Shunt Feedback on Input and Output Impedance
- Shunt-Series Multistage Amplifier Current Gain
- Shunt-Series Multistage Amplifier Output Gain
- Shunt-Series Multistage Amplifier Voltage Gain
- Shunt-Series Multistage Amplifier Output Impedance
- Differential Amplifier Operation
- Single-Ended and Differential Gain Characteristics
- Common Mode Gain and Rejection Ratio
- Troubleshooting Basics
- Troubleshooting Feedback Amplifier Circuits

en	**580961**
fr	**580962**
es	**580963**

Workbook, also order:

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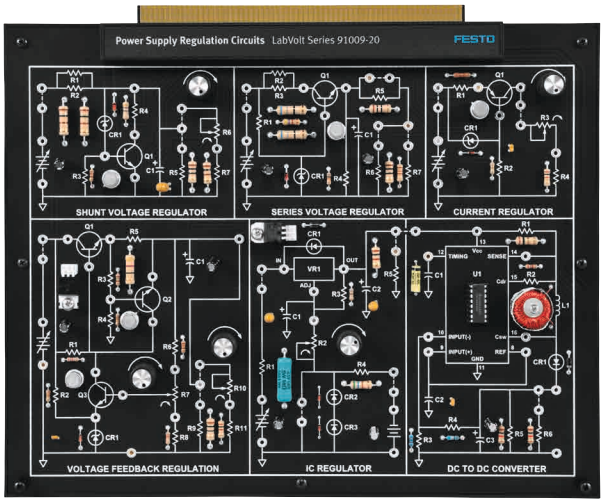
Course on Festo LX:
→ Transistor Feedback Circuits

Power Supply Regulation Circuits
Circuit Board 91009



The Power Supply Regulation Circuits Board provides comprehensive, hands-on instruction in the terminology, principles, and applications of power supply regulation circuits.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Circuit Location and Identification
- Power Supply Regulator Introduction
- Shunt Regulator Operation
- Line Regulation
- Load Regulation
- Series Regulator Operation
- Voltage Feedback Regulator Operation
- Voltage Feedback Load Regulation
- Foldback Current Limiting Active Protection Circuit
- Current Regulator Operation
- Current Regulator Line Regulation
- Current Regulator Load Regulation
- Three-Pin IC Regulator Operation and Voltage Regulation
- Three-Pin IC Current Regulation and Power Efficiency
- DC-to-DC Converter Operating Characteristics
- DC-to-DC Converter Voltage Regulation and Efficiency
- Troubleshooting Basics
- Troubleshooting Power Supply Regulation Circuits

en	**580973**
fr	**580974**
es	**580975**

Workbook, also order:

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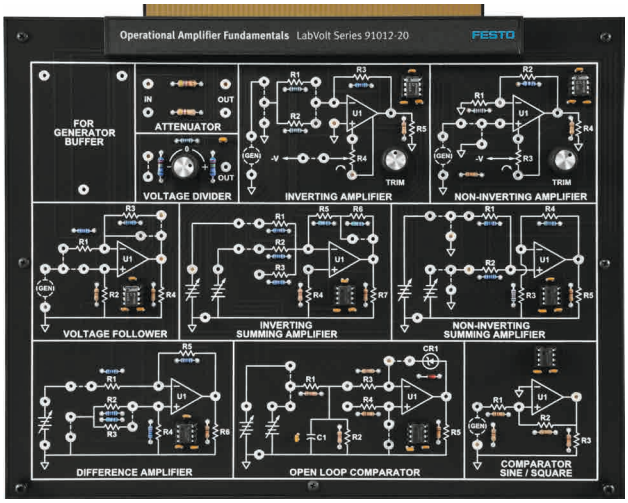
Course on Festo LX:
→ Power Supply Regulators

Operational Amplifier Fundamentals
Circuit Board 91012



The Operational Amplifier Fundamentals Circuit Board provides comprehensive, hands-on instruction in the terminology, principles, and applications of the circuitry used in analog applications.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Operational Amplifier Types and Packages
- Circuit Board Recognition and Description
- Basic Operational Amplifier Characteristics and Parameters
- DC, AC, and other Characteristics of the Inverting Amplifier
- DC, AC, and other Characteristics of the Non-inverting Amplifier
- The Voltage Follower DC Operation
- The Inverting Gain-of-One Amplifier
- The Voltage Follower AC Operation
- Inverting Summing Amplifier Operation
- Summing, Scaling, and Averaging
- Non-Inverting Summing Amplifier Operation
- Summing Amplifier Configurations
- Difference Amplifier DC Operation
- Difference Amplifier AC Operation
- Open-Loop Operation
- Zener-Clamped Operation
- The Sine Wave to Square Wave Converter
- Troubleshooting Basics
- Troubleshooting Operational Amplifier Circuits

en	**581009**
fr	**581010**
es	**581011**

Workbook, also order:

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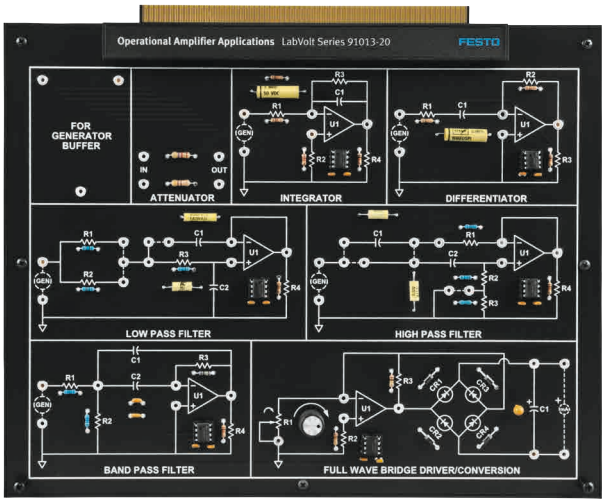
Course on Festo LX:
→ Operational Amplifier Fundamentals

Operational Amplifier Applications
Circuit Board 91013



The Operational Amplifier Applications course provides comprehensive, hands-on instruction in the terminology, principles, and applications of operational amplifiers.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Component Location and Identification
- Band-Pass Filter Operation
- The Integrator
- The Differentiator
- Low-Pass Filter Frequency Response
- Low-Pass Filter Phase and Transient Response
- High-Pass Filter Frequency Response
- High-Pass Filter Phase and Transient Response
- Band-Pass Filter Frequency Response
- Band-Pass Filter Phase Response
- DC Characteristics of an Active Voltage-to-Current Converter
- AC Characteristics of an Active
- RMS or Average Calibrated Voltage-to-Current Converter
- Troubleshooting Basics
- Troubleshooting Operational Amplifier Circuits

en	**581021**
fr	**581022**
es	**581023**

Workbook, also order:

Campus license, en	585330

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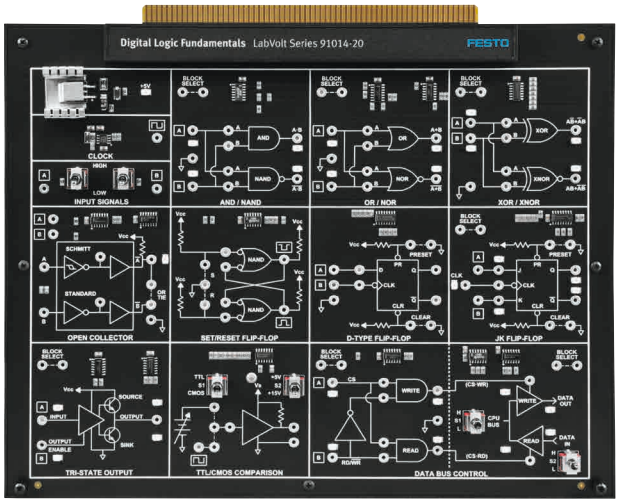
Course on Festo LX:
→ Operational Amplifier Applications

Digital Logic Fundamentals
Circuit Board 91014



The Digital Logic Fundamentals course provides comprehensive, hands-on instruction in the terminology, principles, and applications of digital logic circuits.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Component Location and Identification
- Operation of General Circuits
- IC Package Fundamentals
- AND/NAND Logic Functions
- OR/NOR Logic Functions
- Exclusive OR and NOR Gates
- Dynamic Response of XOR/XNOR Logic Gates
- DC Operation of a NOT and an OR-TIE
- Transfer Characteristics of a Schmitt and a Standard LS TTL Gate
- Set/Reset Flip-Flop
- D-Type Flip-Flop
- Static JK Flip-Flop Operation
- Dynamic Operation of a JK Flip-Flop
- Output Enable Control of a Tri-State Gate
- Sink and Source Control of a Tri-State Gate
- Static Trigger Levels of a TTL and CMOS
- Dynamic Transfer Characteristics of TTL and CMOS
- Static Control of a Data Bus
- Dynamic Control of a Data Bus
- Troubleshooting Basics
- Troubleshooting Digital Circuits

en	**581033**
fr	**581034**
es	**581035**

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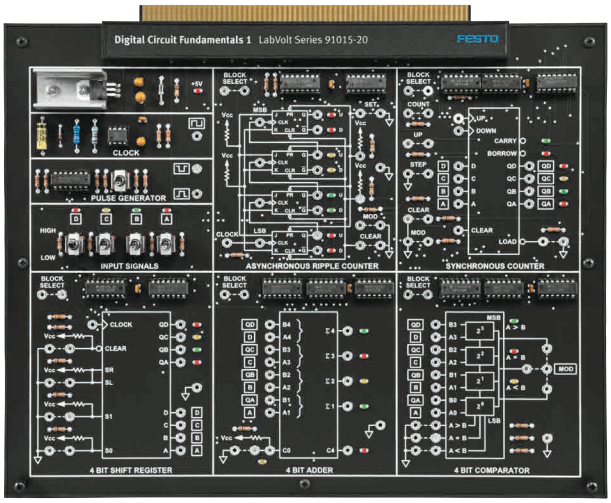
Course on Festo LX:
→ Digital Logic Fundamentals

Digital Circuit Fundamentals 1
Circuit Board 91015



The Digital Circuit Fundamentals 1 course provides comprehensive, hands-on instruction in the terminology, principles, and applications of digital circuits.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Component Location and Identification
- Operation of General Circuits
- IC Package Fundamentals
- Basic Counter Control Functions
- Ripple Counter Waveforms
- Synchronous Counter Circuit Waveforms
- Synchronous Counter Circuit Glue Logic
- Basic Operating Modes of the Shift Register
- Shift Register Circuit Waveforms
- Fundamental Binary Addition
- Binary Addition with Input and Output Carry
- Fundamental Binary Comparisons
- Comparators and Counter Modulus Control
- Troubleshooting Basics
- Troubleshooting Digital Circuits
- The 74LS193 Counter
- The 74LS283 4-Bit Adder
- The 74LS194 Shift Register
- The 74LS285 Comparator

en	**581045**
fr	**581046**
es	**581047**

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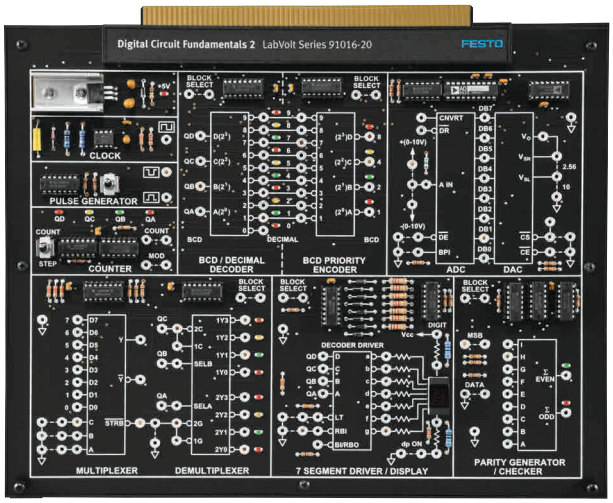
Course on Festo LX:

→ Digital Circuit Fundamentals 1

Digital Circuit Fundamentals 2
Circuit Board 91016



The Digital Circuit Fundamentals 2 course provides comprehensive, hands-on instruction in the terminology, principles, and applications of digital circuits.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Component Location and Identification
- Operation of General Circuits
- IC Package Fundamentals
- Fundamental BCD Decoder Operation
- Fundamental Priority Encoder Operation
- Fundamental ADC Operation
- Fundamental DAC Operation
- Data Selector and Multiplexer
- The LS151 Multiplexer and LS155 Demultiplexer
- 1-Line-to-8-Line Demultiplexer
- LED Decoder/Driver
- 7-Segment LED Display
- ODD and EVEN Parity
- Parity Generator/Checker Glue Logic
- Troubleshooting MSI IC Circuits
- Troubleshooting Basics
- Troubleshooting Digital Circuits

en	**581057**
fr	**581058**
es	**581059**

Workbook, also order:

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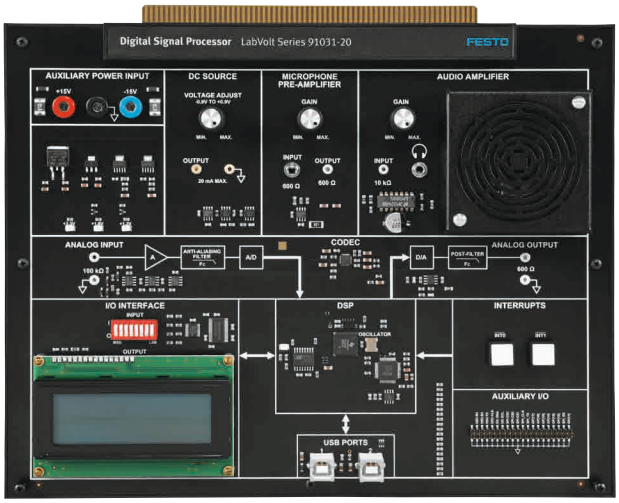
Course on Festo LX:

→ Digital Circuit Fundamentals 2

Digital Signal Processor
Circuit Board 91031



The Digital Signal Processor circuit board introduces students to the vast field of digital signal processing and applications.

The courseware covers the basic concepts of digital signal processing, as well as DSP architectures, memory, addressing, I/O, and peripherals. It also presents several essential aspects of real-time DSP processing, such as sampling, A/D and D/A conversion, and the Fast- Fourier Transform.

A version of Code Composer Studio, a typical Integrated Development Environment (IDE) used to develop, debug, and compile DSP applications, is bundled with the board. The source code for the applications used in the courseware is also included.

Practical techniques such as the use of library functions, DSP application optimization, and digital filtering algorithms, are also covered in the courseware.

Course structure:
- Familiarization with DSPs and DSP programming, overview of the DSP Circuit Board, the Integrated Development Environment (IDE) and Project Structure
- DSP Architecture, Processor Arithmetic, the Data Computation Unit, Memory, and Addressing
- I/O and Peripherals, an Application Using I/Os and Peripherals
- DSP Real-time Processing, Sampling and Analog-to-Digital/ Digital-to-Analog Conversion, the Fast Fourier transform (FFT), Optimizing DSP applications
- Signal Processing Applications, FIR and IIR Filters

en	**585736**
fr	**585737**

Workbook, also order:

Campus license, en	585330

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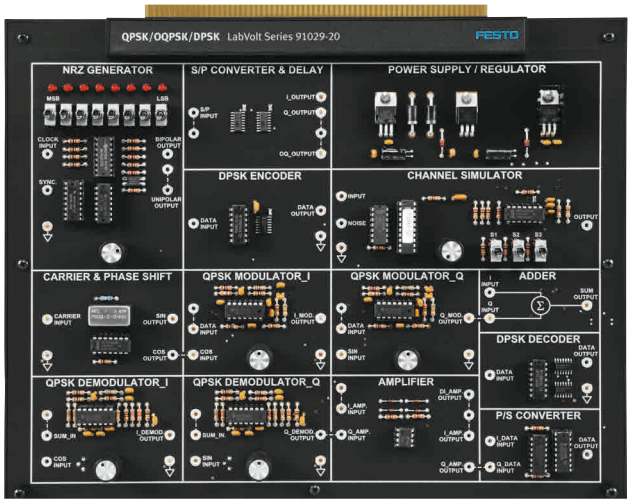
Course on Festo LX:
→ Digital Signal Processor

QPSK/OQPSK/DPSK
Circuit Board 91029



Phase-shift keying (PSK) is a method of digital communication in which the phase of a transmitted signal is varied to convey information. The QPSK/ OQPSK/DPSK board provides students with the theory and measurement skills required to implement and test different types of PSK modulation and demodulation techniques used in pulse-coded modulation (PCM) schemes.

Courseware covers the principles and operational characteristics of unipolar and bipolar signals in a baseband transmission, measurement and comparison of BPSK, QPSK, OQPSK, and DPSK signals in the time and frequency domains using an oscilloscope and spectrum analyzer, respectively, and familiarization with all components of the board, including isolation, identification, and testing of a series of circuits.

Students will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Digital modulation
- Baseband and Passband signals
- Partitioning of pulse streams
- Signal constellations for MPSK
- General MPSK equations
- Heterodyning baseband signals with a carrier
- Unipolar and bipolar signals in time and frequency domains
- Binary PSK (BPSK), Quadratic PSK (QPSK), and Offset QPSK (OQPSK) modulation and demodulation
- Differential PSK (DPSK) encoding and decoding

en	**581201**
es	**581202**

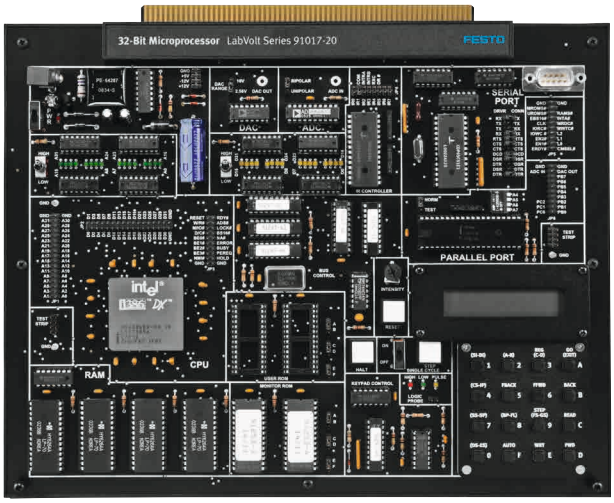
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Quadrature Phase-Shift Keying

32-Bit Microprocessor
Circuit Board 91017



This board provide comprehensive, hands-on instruction in the terminology, principles and applications of 32-bit µC microprocessor systems.

The 80386DX CPU is used to demonstrate microprocessor, memory, I/O concepts, analog systems via converters, as well as serial and parallel protocols.

A keypad and a LCD display allow direct user interaction with the CPU. An on-board logic probe, single bus cycle execution mode, and the practical, hands-on approach of the courseware guide students.

This board can be interfaced with higher-level FACET boards, such as Transducer Fundamentals; Motors, Generators and Controls; and Fiber Optic Communications. It can also interface with Application board 91062 for additional exercises.

Course structure:
- Circuit Board Introduction and Operation
- Bus States
- 32-Bit Bus Transfers
- Read and Write Cycles
- CPU Initialization
- Memory Control Signals
- Memory Address Decoding
- Memory Data Transfers
- DAC and ADC Ports
- PPI and Keypad Interface
- Display and Serial Ports
- Maskable and Non-Maskable Interrupts
- Exceptions
- Immediate, Register, and Memory Addressing Modes
- Instruction formats
- 80386 CPU Instructions

en	**581069**
fr	**581070**
es	**581071**

Workbook, also order:

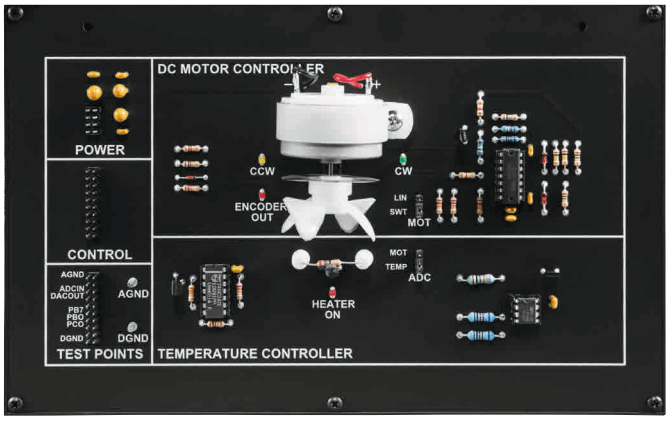
Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:

→ 32-Bit Microprocessor

Microprocessor Application
Circuit Board 91602



This Circuit Board is an add-on to the 32-Bit Microprocessor (Model 91017). It allows students to study how microprocessors can control and communicate with external devices. The Application Board has two application circuits: a DC Motor Controller, and a Temperature Controller.

The DC Motor Controller has a motor whose speed and direction of rotation can be controlled by the microprocessor. Mounted on the motor's shaft is a fan blade that makes it easier for students to see the direction of rotation. The motor's shaft also has an encoder disk with optical interrupter that provides feedback on the motor speed to the microprocessor, allowing closed-loop control of the motor speed.

The Temperature Controller uses two temperature transducers whose output current is a function of their temperature. One transducer is thermally bonded to a resistor that is used as a heater. The microprocessor controls the turning on and turning off of the heater, whose status is indicated by an LED indicator. The other transducer is used as a room temperature reference, allowing the microprocessor to perform closed-loop control of the temperature.

Course structure:
- Motor Speed and Direction Control
- Switched Mode Motor Control
- Open Loop Heater Control
- Closed Loop Temperature Control

en	**581224**

Workbook, also order:

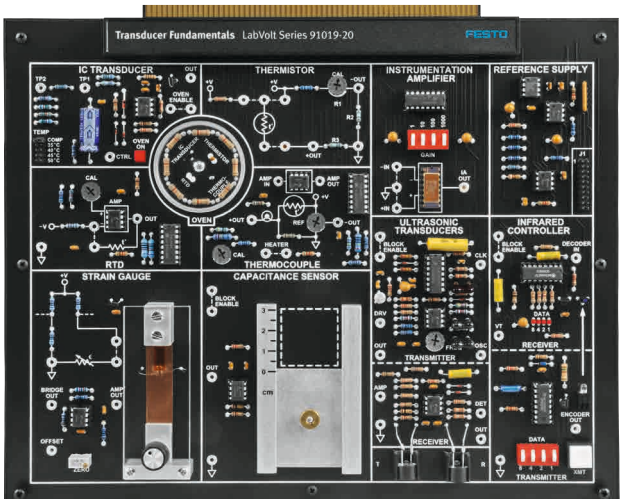
Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:

→ Microprocessor Applications Board

Transducer Fundamentals
Circuit Board 91019



The Transducer Fundamentals course guides students through the circuits and devices used to interface computer and control circuits. Students learn the principles of input and output transducers and how physical quantities, such as heat, position, proximity, and force, are converted to electrical signals for detection and processing.

This circuit board can be interfaced with the 32-Bit Microprocessor circuit board to demonstrate the principles of data acquisition and microprocessor control.

Course structure:
- Introduction to Transducers
- Introduction to the Circuit Board
- Temperature Measurement
- Temperature Control
- Thermistor Characteristics
- Resistance Temperature Detector (RTD) Characteristics
- Thermocouple Characteristics
- Capacitance Sensor
- Touch and Position Sensing
- Strain Gauge Characteristics
- Bending Beam Load Cell (Strain Gauge)
- Ultrasonic Principles
- Distance Measurement
- Infrared Transmission/Reception
- IR Remote Control
- Force Measurement
- Computerized Temperature Control and Measurement and Computerized Force Measurement:These exercises and computer interface require the optional 32-Bit Microprocessor board (91017) plus, accessories: 9 V Power Supply (91730), and Flat Ribbon Cable (91627)
- Troubleshooting Transducer Circuits

en	**581096**
fr	**581097**
es	**581098**

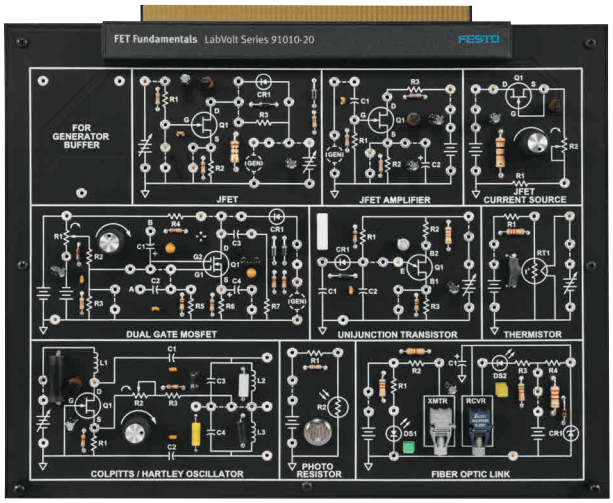
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Transducer Fundamentals

FET Fundamentals
Circuit Board 91010



The FET Fundamentals course provides comprehensive, hands-on instruction in the terminology, principles and applications of JFET, MOSFET, and UJT. Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Component Location and Identification
- Unijunction Oscillator Operation
- JFET Operating Characteristics
- The Effect of Gate Bias on Pinch-off
- JFET Dynamic Characteristic Curves
- JFET Amplifier DC Operation
- JFET Amplifier Voltage Gain
- JFET Current Source DC Operation
- JFET Current Source Power and Load Voltage Variation
- Zero Bias Characteristic of a MOSFET
- MOSFET Modes of Operation
- MOSFET Voltage Amplifier
- Dual Gate MOSFET Mixer
- UJT Operating Characteristics
- UJT Waveform Generation
- Hartley Oscillator Operation
- Colpitts Oscillator Operation
- Thermistor Operation
- Photoresistor Operation
- Fiber Optic Light Transfer
- Troubleshooting Basics
- Troubleshooting FET Circuits
- FET Specification Sheets
- Unijunction Transistor Specification Sheets
- Transducer Specification Sheets

en	**580985**
fr	**580986**
es	**580987**

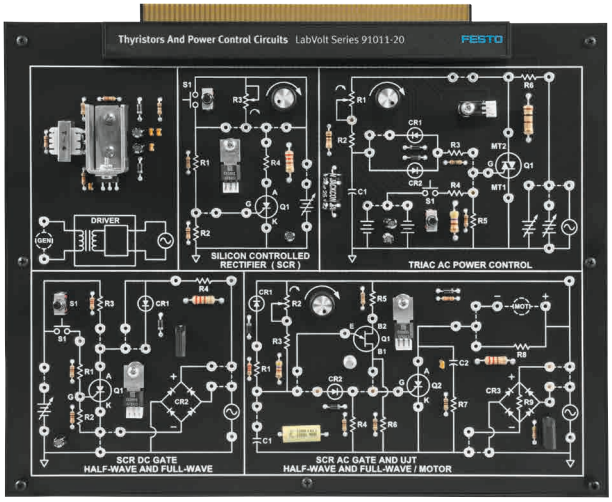
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ FET Fundamentals

Thyristor and Power Control Circuits
Circuit Board 91011



The Thyristor and Power Control Circuits course provides comprehensive, hands-on instruction in the fundamental terminology, principles, and applications of thyristor and power control circuits.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Thyristor Component Familiarization
- Thyristor Circuit Fundamentals
- Test a Silicon-Controlled Rectifier (SCR)
- SCR DC Operation
- Gate Trigger Voltage and Holding Current
- SCR Half-Wave Rectifier
- SCR Control of a Half-Wave Rectifier
- SCR Control of a Full-Wave Rectifier
- Half-Wave Phase Control
- Full-Wave Phase Control
- UJT Characteristics
- UJT Half-Wave and Full-Wave Phase Control
- Bidirectional Conduction
- The Four Triggering Modes
- Half-Wave Phase Control
- Full-Wave Phase Control
- Troubleshooting Basics
- Troubleshooting Thyristor and Power Control Circuits

en	**580997**
fr	**580998**
es	**580999**

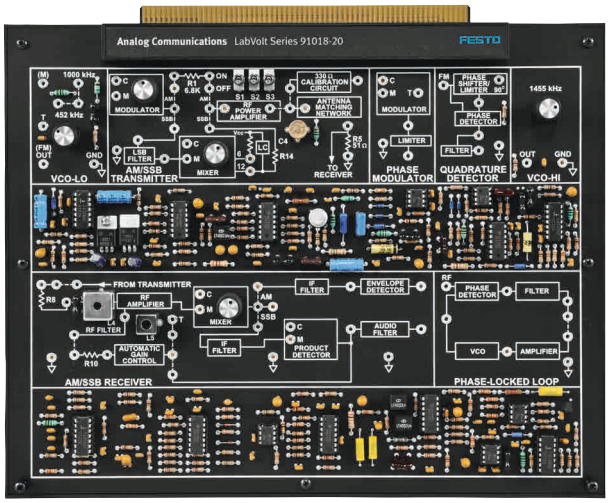
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Thyristor and Power Control Circuits

Analog Communications
Circuit Board 91018



The Analog Communications course provides comprehensive, hands-on instruction in the terminology, principles, and applications of analog communications.

In this course, students receive hands-on circuit training and acquire skills to measure radio signals with an oscilloscope. Students also learn the functions of oscillators, filters, amplifiers, LC networks, modulators, limiters, mixers, and detectors in communication circuits.

Course structure:
- Analog Communications Concepts
- Circuit Board Familiarization
- Amplitude Modulation (AM)
- RF Power Amplifier
- Balanced Modulator
- RF Stage
- Mixer, IF Filter, and Envelope Detector
- Balanced Modulator and LSB Filter
- Mixer and RF Power Amplifier
- RF Stage, Mixer, and IF Filter
- Product Detector and Automatic Gain Control
- Frequency Modulation (FM) and Phase Modulation (PM)
- Demodulation (Quadrature Detector)
- PLL (Phase-Locked Loop) Circuit and Operation
- FM Detection with a PLL
- Troubleshooting Basics
- Troubleshooting Analog Communications Circuits

en	**581084**
fr	**581085**
es	**581086**

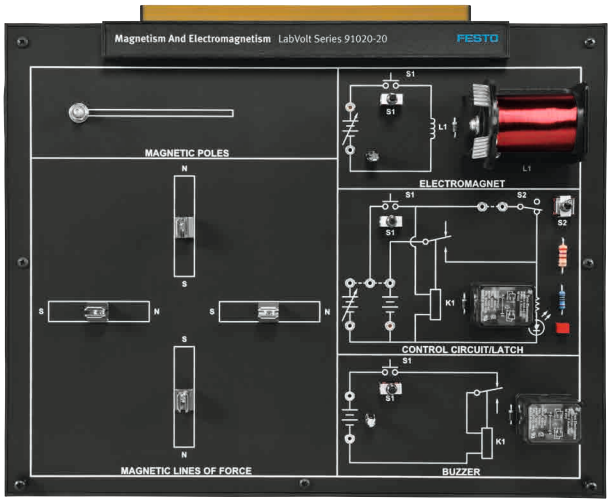
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Analog Communications

Magnetism/Electromagnetism
Circuit Board 91020



The Magnetism/Electromagnetism course is an extension of the AC 1 Fundamentals training board that provides comprehensive, hands-on instruction in the terminology, principles, and applications of magnetism and electromagnetism.

Following a carefully designed instructional program, students will become familiar with all components of the board; and will be able to isolate, identify, and test a series of circuits.

Course structure:
- What is Magnetism?
- Magnetic Fields
- Making a Magnet
- What is an Electromagnet?
- The Solenoid
- The Relay

en	**581108**
fr	**581109**
es	**581110**

Workbook, also order:

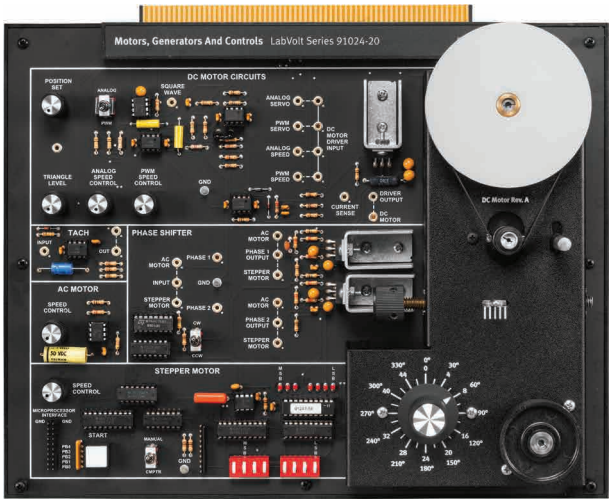
Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:

→ Magnetism and Electromagnetism

Motors, Generators, and Controls
Circuit Board 91024



The Motors, Generators, and Controls course provides comprehensive, hands-on instruction in the terminology, principles, and applications of the DC motor, AC synchronous motor, phase shifter, and stepper motor.

Following a carefully designed instructional program, students are able to perform troubleshooting exercises on analog and pulse-width modulated (PWM) DC motor positioning, analog and PWM DC motor speed control, variable frequency speed control of an AC synchronous motor, operation of a tachogenerator circuit, and speed and position control of a stepper motor with optional computer interface.

Course structure:
- DC Motor Circuits Familiarization
- Stepper Motor and AC Motor Circuits
- Analog DC Motor Positioning
- PWM DC Motor Positioning
- Analog and Pulsed Speed Control of a DC Motor
- Variable Frequency Control
- The Tachometer Generator
- The Stepper Motor
- The Stepper Motor Controller
- Troubleshooting
- Microprocessor Interface: This exercise and computer interface require the optional 32-Bit Microprocessor board (91017) plus accessories: 9 V Power Supply (91730), and Flat Ribbon Cable (91627).

en	**581147**
fr	**581148**
es	**581149**

Workbook, also order:

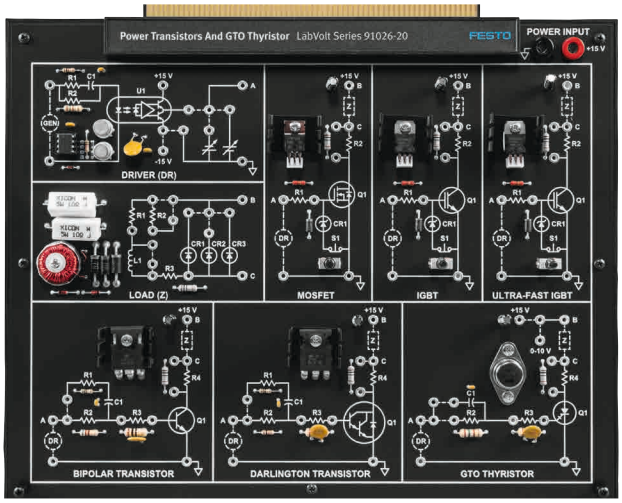
Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:

→ Motors, Generators, and Controls

Power Transistors and GTO Thyristors
Circuit Board 91026



In the Power Transistors and GTO Thyristors course, students perform practical exercises that demonstrate the use of several power electronic, self-commutated switches. The course contains six types of switches that are implemented with a MOSFET, an isolated-gate bipolar transistor (IGBT), a fast IGBT, a bipolar resistor, a Darlington resistor, and a GTO thyristor. Learning of switches is expanded with a Driver section, consisting of an opto-isolator and driver for power thyristors; a Load section, consisting of resistive and inductive components; and general-purpose, fast, and ultra-fast free-wheeling diodes.

Course structure:
- Power Transistors and GTO Thyristor Identification
- Overview of the Circuit Blocks
- Familiarization with the Driver Circuit Block
- Familiarization with the Load Circuit Block
  Basic Operations of Power Bipolar Transistors
- Basic Operation of Power MOSFETs and IGBTs
- Basic Operation of GTO Thyristors
- Switching Time and Conduction Voltage Drop
- Switching Power in an Inductive Load
- Free-Wheeling Diode Recovery Time
- Losses in Electronic Power Switches
- The Bipolar Power Transistor
- The Darlington Power Transistor
- The GTO Thyristor
- The Power MOSFET
- The IGBT
- The Ultra-Fast IGBT

en	**581171**
fr	**581172**
es	**581173**

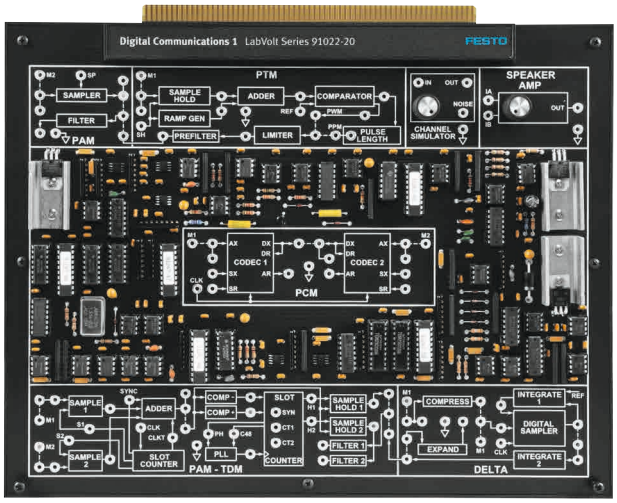
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Power Transistors and GTO Thyristors

Digital Communications 1
Circuit Board 91022



The Digital Communications 1 course provides comprehensive, hands-on instruction in the terminology, principles, and applications of digital circuits, including: Sampler, Sample/Hold, Adder, Ramp Generator, Comparator, Limiter, Filter, CODEC, PLL, Compressor, Expander, Integrator, Differentiator, Latched Comparator, Speaker Amplifier, and Channel Simulator.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Concepts of Digital Communications
- Circuit Board Familiarization
- Pulse Amplitude Modulation (PAM) Signal Generation
- PAM Signal Demodulation
- PAM Time-Division Multiplexing (TDM) Transmission
- PAM TDM Reception
- Pulse-Time Modulation (PTM) Signal Demodulation
- PTM Signal Generation
- Pulse-Code Modulation (PCM) Signal Generation and Demodulation
- PCM Signal TDM
- Delta Modulation (DM) Transmitter
- DM Receiver and Noise
- Channel Bandwidth
- Channel Noise
- Troubleshooting Basics
- Troubleshooting Digital Communications 1 Circuits

en	**581123**
fr	**581124**
es	**581125**

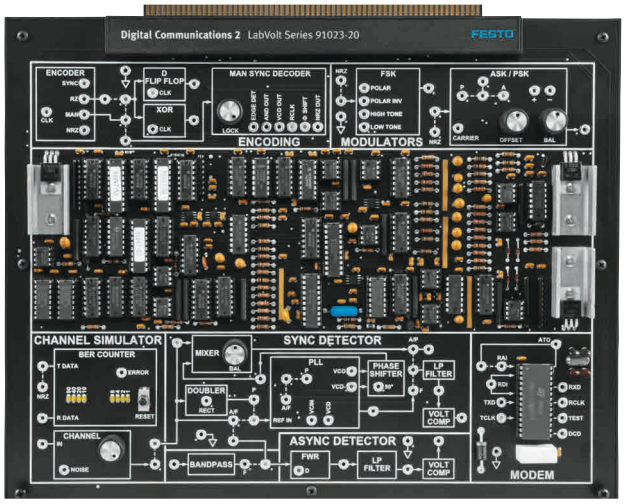
Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Digital Communications 1

Digital Communications 2
Circuit Board 91023



The Digital Communications 2 course provides further comprehensive, hands-on instruction in the terminology, principles, and applications of digital circuits, including: NRZ, RZ, Manchester Encoding and Decoding, Clock Synchronizer, Frequency-Shift Keying (FSK) Generation, FSK Asynchronous and Synchronous Detection, Phase-Shift Keying (PSK) Generation, PSK Synchronous Detection, Amplitude-Shift Keying (ASK) Generation, ASK Asynchronous and Synchronous Detection, Channel Effects, and FSK/DPSK (Differential Phase-Shift Keying) Modem.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Circuit Board Familiarization
- Introduction to Digital Transmission
- Encoding and Decoding
- FSK Signal Generation
- FSK Asynchronous Detection
- FSK Synchronous Detection
- PSK Signal Generation
- PSK Synchronous Detection
- ASK Signal Generation
- ASK Asynchronous Detection
- The Channel Simulator
- Effects of Noise on ASK and PSK Signals
- Effects of Noise on Asynchronously and Synchronously Detected FSK Signals
- Operation of an FSK Modem
- Operation of a DPSK Modem
- Troubleshooting Basics
- Troubleshooting Digital Communications 2 Circuits

en	**581135**
fr	**581136**
es	**581137**

Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Digital Communications 2

Fiber Optic Communications
Circuit Board 91025

The Fiber Optic Communications course provides comprehensive, hands-on instruction in the theory and practice of fiber optic communications technology.

Following a carefully designed instructional program, students will become familiar with all components of the board; will be able to isolate, identify, and test a series of circuits; and will perform troubleshooting exercises to demonstrate mastery of the course objectives.

Course structure:
- Circuit Board Familiarization
- Introduction to Fiber Optic Communications
- Scattering and Absorption Losses
- Connectors and Polishing
- Numerical Aperture and Core Area
- Bending Loss and Modal Dispersion
- Light Source
- Driver Circuit
- Source-to-Fiber Connection
- Light Detector
- Output Circuit
- Fiber Optic Test Equipment
- Optical Power Budgets
- Analog Communications
- Digital Communications: This exercise and computer interface require the optional 32-Bit Microprocessor plus accessories: 9 V power supply, and Adapter. Additional option includes Polishing Kit
- Troubleshooting

en	**581159**
fr	**581160**
es	**581161**

Workbook, also order:

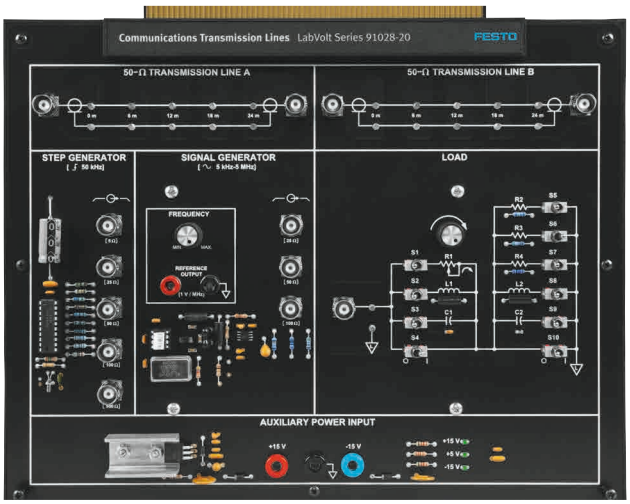
Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

Course on Festo LX:
→ Fiber Optic Communications

Communications Transmission Lines

Circuit Board 91028



The Communications Transmission Lines circuit board provides students with the theory and measurement skills required to implement and test communications transmission lines. Courseware covers the principles and operational characteristics of transmission lines, conducting transmission line measurements under transient (step testing) and sinusoidal steady-state conditions, and valuable foundational information on the theory and practice of time-domain reflectometry (TDR), as well as impedance matching and transformation.

The circuit board uses two 24-meter (78.7 feet) RG-174 coaxial cables which can be used separately or connected end-to-end. Each line has five probing points that permit observation and measurements of signals along the line, using an oscilloscope. Two generators are provided to study the transmission line behavior: a step generator that produces a 50-kHz square-wave voltage for transient behavior testing, and a signal generator that produces a sinusoidal voltage of variable frequency (5 kHz – 5 MHz) for steady-state behavior testing. Each generator has several BNC outputs providing different output impedances. A load section, consisting of a configurable network of resistors, inductors, and capacitors, permits connection of different load impedances to the receiving end of each line.

Course structure:

– Characteristics of Transmission Lines
– Transmission Line Measurements Under Transient (Step Testing) and Sinusoidal Steady-State Conditions

en	**581192**
fr	**581193**
es	**581194**

Workbook, also order:

Campus license, en	585330

The campus license includes all FACET workbooks in PDF, including the student and instructor manuals. Printed workbooks available upon request.

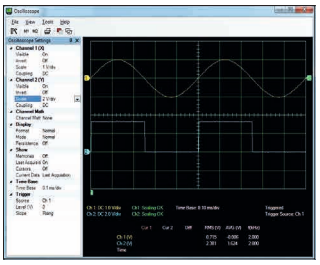
Course on Festo LX:

→ Communications Transmission Lines

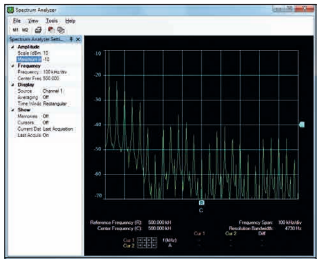
Accessories

Virtual Instrument Package

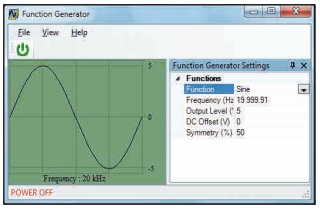
Multimeter



Oscilloscope



Spectrum Analyzer



Arbitrary Waveform Generator (AWG)

A powerful package
The Virtual Instrument Package, LabVolt Series 1250, replaces conventional desktop test equipment with a powerful, space-saving, virtual instrumentation package that gives students state-of-the-art tools to measure, analyze, observe, and display the results of electronic circuit tests.

Fully integrated with the FACET Electronics Training program, the Virtual Instrument Package enables students to conduct all experiments of the FACET curriculum.

Complete software suite
The complete Virtual Instrument Package consists of an interface unit for data acquisition connections, and a Windows-based software. The interface is connected to the computer via a USB connection.

The software displays the various instruments in separate windows and includes the following virtual instruments and signal source:
– Dual-Channel Oscilloscope
– Multimeter
– Spectrum Analyzer
– Waveform Generator

This package operates under any one of the following Microsoft Windows operating systems:
Windows 7, Windows 8,
and Windows 10.

It is also possible to interface the unit with MATLAB® and LabVIEW® software for advanced control and analysis.

The interface unit
The Virtual Instrument unit is a lightweight, compact interface module powered from a standard AC power wall outlet.

On the front panel of the Virtual Instrument unit, two BNC connectors and a pair of safety banana sockets provide access to the various virtual instruments. A third BNC connector provides the signal generator output. A BNC connector on the back panel of the Virtual Instrument unit is the access to the external trigger input of the virtual oscilloscope.

The Virtual Instrument unit samples the signals applied to its various inputs to provide raw signal data that is used by the virtual instrument software to measure, filter, and display the input signals. The high sampling rate of 1 GS/s provides the Virtual Instrument unit a 250 MHz bandwidth that is amply sufficient for the observation and analysis of the various signals in the FACET Electronics Training program.

The Virtual Instrument unit also generates signal samples (data) that are converted to analog format to produce the output signal.

Data exchange between the Virtual Instrument unit and the host computer that runs the virtual instrument software is through a USB link (USB 1.1 and 2.0 compatible).

Order no.	**8098535**

1 **Digital Multimeter/Function Generator**

The Digital Multimeter/Function Generator, designed as a general-purpose instrumentation module, provides the necessary test equipment (except oscilloscope) to perform the lessons in the FACET program. This instrument consists of a sine/square/triangle waveshape function generator and an auto-ranging digital multimeter. The instrumentation shares a common power input and is housed in a portable enclosure. All components, switches, and terminals are mounted in a tamper-resistant manner. The system's design protects the instruments from inadvertent short circuits and overloads within the FACET system.

with NEMA 5-15 cord line

en	**580851**
es	**580852**

with CEE 7 cord line

en	**580853**
es	**580854**

with AS-3112 cord line

en	**580855**

2 **FACET Storage Enclosure**

The FACET Storage Enclosure is a portable and sturdy metal enclosure that can house up to ten boards of the FACET program. The enclosure includes a locking cover and a carrying handle.

Order no.	**585728**

2 **Dual-Trace Digital Storage Oscilloscope**

The Dual-Trace Digital Storage Oscilloscope is a low-cost oscilloscope that is ideally suited for general purpose use in any classroom laboratory. Two low-capacitance probes are included with the unit.

Features and Benefits:
– Color, 7-inch LCD
– Multilingual, on-display menu
– 40 MHz bandwidth
– 1 GSa/s maximum sampling rate
– USB and RS 232 ports
– Compact design

with NEMA 5-15 power cord

en	**585695**

with CEE 7 cord line

en	**585696**

with AS-3112 cord line

en	**585694**

4 **Accessory Kit**

The Accessory Kit is a replacement kit that contains the same accessories as those provided with any of the FACET base units. The kit consists of miniature banana-jack jumpers and leads, alligator clips, and test point pins.

Order no.	**581215**

1

3

2

4

Electricity and Electronics Training Packages

Build Basic Skills and Knowledge

Expertise in electronics
Electronics skills are critical for implementing automation, monitoring, communication, safety, and sustainability. This is why 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.

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 include modular, customized, and complete solutions to meet 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 offers room 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.

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.

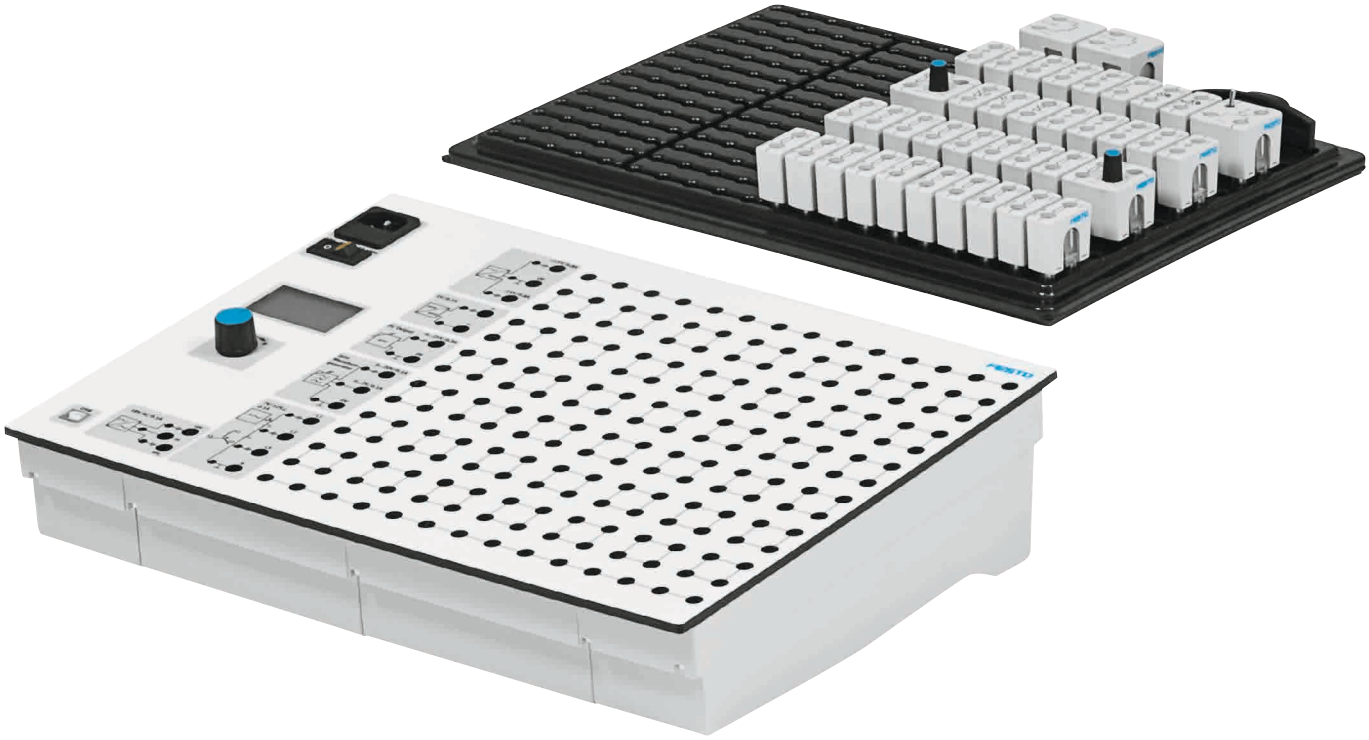
Safe connection technology
When dealing with electricity, safety and protective measures are especially in focus. Of course, all electrical connections are equipped with safety sockets or plugs.
– The plug-in modules of the equipment set for the basic principles of electrical engineering/electronics
– Power supply outlets
– Patch panel and EduTrainer

Combination with self-study
Education in schools, companies or university cannot be successful without a willingness to do self-study. That is why the appropriate courses are available for all topics. Our range of learning materials provides exciting learning scenarios and supplements the classroom-based parts of a course. The courses are particularly well suited for teaching the basic principles and thus provide the optimum supplement to practical experiments.

Mobile solution
Anyone who wants to design diverse teaching and individualized learning concepts needs flexible, modular training systems. That's why Festo Didactic offers mobile solutions for most equipment sets — making storage and transport easier while supporting flexible work.

Fundamentals of Electrical Engineering

TP 1010



Basic electrical engineering
Can you limit your training to DC and AC technology now and in the future? Then this equipment set, with the small Combiboard Fundamentals EduTrainer and a reduced range of components, is an economical alternative to TP 1011.

A basic knowledge of circuits is becoming more important for many of occupations to understand functions and processes in complex systems.

The examples used by the training package Fundamentals of Electrical Engineering are taken from this field. The learning objectives include the electrical variables and their relationships with each other. With the project-based exercises, the content can be clearly taught through theory and practical tests. Measurements illustrate relationships, and promote understanding and in-depth learning.

The component set contains all of the components for carrying out basic exercises for DC and AC technology. The clearly labeled slots of the storage panel provide order and structure.

Training content

- **Direct current technology**
  Voltage, current, resistance, conductance, Ohm's law, using measuring devices, energy and capacity, series and parallel connections, voltage dividers, non-linear resistors, bridge circuit, voltage source
- **Alternating current technology**
  Electric field, induction, capacitor and coil in DC and AC circuit, series and parallel connection, active resistance, reactance and impedance, phase shift of current and voltage

On the safe side!
The system is completely equipped with safety plugs and sockets based on state-of-the-art technology.

This applies for all electrical connections - whether on the components or on the Combiboard. The equipment set is therefore ideal for use in any laboratory, even if there are high voltages present. Safety first!

Complete equipment set TP 1010	**8023958**

The most important components at a glance:

1	1x Combiboard Fundamentals EduTrainer	571810
2	1x Set of components for electrical engineering	8005374
3	1x Safety jumper plugs, 28 pieces, grey-black	571809

Necessary accessories, also order:

IEC power cable (→ page 14)	
4 mm Safety laboratory cables (→ page 167)	
2x Digital multimeter (→ page 58)	
Digital storage oscilloscope (→ page 57)	

Possibilities of expansion:

Equipment Set TP 1022 Installation and Relay Technology (→ page 38)	
Equipment Set TP 1025 Motor Vehicle Mechatronics (→ page 39)	
A4 Transport and Storage Case (→ page 55)	8197368
PSU Remote Software	574179

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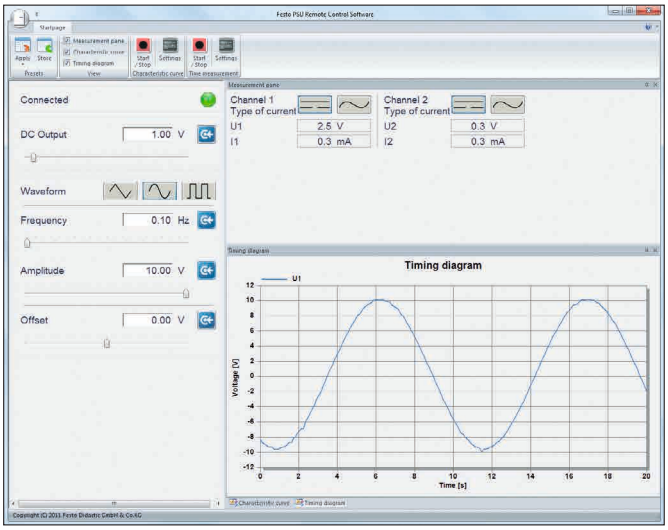
PSU Remote Software

The setting and measurement software for TP 1010, TP 1011 and TP 1011 M

Basic functions:
- Setting the variable DC output
- Setting the signal shape, frequency, amplitude and offset of the frequency generator
- Saving and recalling parameter sets

Also with the built-in measuring module on the power supply unit:
- Direct measured value indicator for voltage and current inputs
- Recording of measured values over time
- X-Y comparison of measured values
- Automatic curve recording with configurable DC voltage output

USB cable with angled USB plug on power supply side, length: 2 m



Recommended Learning Material

Workbooks (→ page 262)

Fundamentals of Direct Current Technology

Campus license:

de	567207
en	567209
es	567211
fr	567213

Fundamentals of Alternating Current Technology

Campus license:

de	567215
en	567217
es	567219
fr	567221

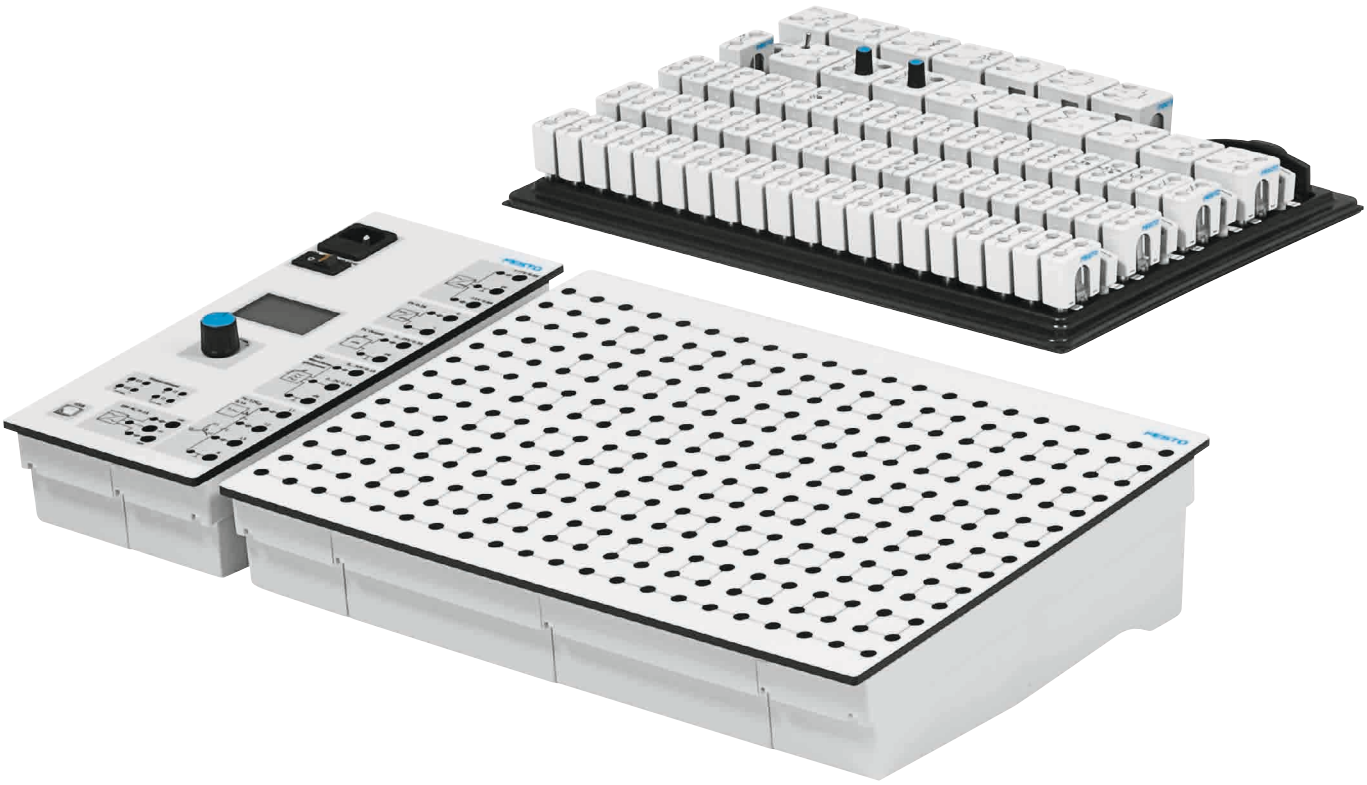
Note: Campus licenses include the PDF version of sample solutions, educational instructions, and worksheets for learners.

Courses on Festo LX

→ Fundamentals of DC Technology
→ Fundamentals of AC Technology

Fundamentals of Electrical Engineering and Electronics

TP 1011



The basis of everything
The universal patch panel of this training package uses the proven 19 mm grid. The universal patch panel and basic power supply unit, which includes a function generator, form the basis on which the digital and control technology component sets can also be used.

With the component set, all basic exercises of DC, AC and semiconductor technology can be performed and basic electronic circuits can be examined. The storage panel, with its clearly labeled slots, provides order and structure.

The equipment set variant TP 1011 M additionally contains a measuring module integrated in the power supply unit and the necessary measuring leads, adapters, and the PSU Remote software.

Training content

- **Direct current**
  Voltage, current, resistance, conductance, Ohm's law, using measuring devices, energy and capacity, series and parallel connections, voltage dividers, non-linear resistors, bridge circuit, voltage source
- **Alternating current**
  Electric field, induction, capacitor and coil in DC and AC circuit, series and parallel circuits, active resistance, reactance and impedance, phase shift of current and voltage
- **Semiconductors**
  Semiconductor diode, Zener diode, LED, bipolar transistors, unipolar transistors, diac, triac, thyristor
- **Basic electronics circuits**
  Transistors and basic circuits, multi-level amplifiers, power amplification, differential and direct current amplifier, impulse and saw tooth generators, sine wave generators, power supply unit circuits

On the safe side!
The system is completely equipped with safety plugs and sockets based on state-of-the-art technology.

This applies to all electrical connections – whether on the components or devices. The equipment set is therefore ideal for use in any laboratory, even if there are high voltages present. Safety first!

Easy to connect!
Safety plugs at the bottom, safety sockets at the top – each component has double the connections.

As a result, measurements can be taken at any time without having to modify the circuit, and parallel connections are easy to establish.

Complete equipment set TP 1011	**571780**

The most important components at a glance:

1	1x EduTrainer basic power supply unit without integr. measuring module	576624
2	1x Universal patch panel EduTrainer	567322
3	1x Component set for electrical engineering/electronics	567306
4	1x Safety jumper plugs, 28 pieces, grey-black	571809
5	FluidSIM-Electrical Engineering (→ page 258)	

Complete equipment set TP 1011 M	**8029635**

The most important components at a glance:

1	1x EduTrainer basic power supply unit with integrated measuring module	567321
2	1x Universal patch panel EduTrainer	567322
3	1x Component set for electrical engineering/electronics	567306
4	1x Safety jumper plugs, 28 pieces, grey-black	571809
	4x 2 mm Safety laboratory cables, 500 mm, red	576295
	4x 2 mm Safety laboratory cables, 500 mm, blue	576296
	8x 4 mm – 2 mm safety measuring adapter	8023960
	1x PSU Remote Software (→ page 35)	

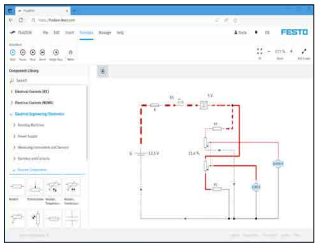
Necessary accessories, also order:

IEC power cable (→ page 14)	
4 mm Safety laboratory cables (→ page 167)	
2x Digital multimeter (→ page 58)	
Digital storage oscilloscope (→ page 57)	

Possibilities of expansion:

Set of Components for Digital Technology (→ page 41)	
Set of Components for Control Technology (→ page 43)	
Equipment Set TP 1022 Installation and Relay Technology (→ page 38)	
Equipment Set TP 1023 Optoelectronics (→ page 38)	
Equipment Set TP 1024 Analog Technology (→ page 39)	
Equipment Set TP 1025 Motor Vehicle Mechatronics (→ page 39)	
Operational Amplifier (→ page 56)	576621
A4 Transport and Storage Case (→ page 55)	8197368

Simulation software FluidSIM
The schematics of the workbooks are included in the library of the simulation software FluidSIM, which allows learners to gain hands-on experience by simulating, testing, and troubleshooting circuits at their own pace, bridging the gap between theory and application while fostering independent learning. More about FluidSIM on page 258.



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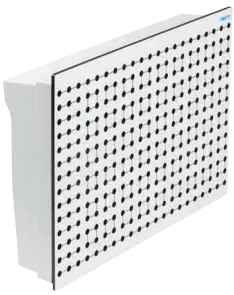

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Recommended Learning Material

Workbooks (→ page 262)

Fundamentals of Direct Current Technology
Campus license:

de	567207
en	567209
es	567211
fr	567213

Fundamentals of Alternating Current Technology
Campus license:

de	567215
en	567217
es	567219
fr	567221

Fundamentals of Semiconductors
Campus license:

de	567281
en	567283
es	567285
fr	567287

Basic Electronics Circuits
Campus license:

de	567289
en	567291
es	567293
fr	567295

Note: Campus licenses include the PDF version of sample solutions, educational instructions, and worksheets for learners. Printed workbooks available upon request.

Courses on Festo LX
- → Fundamentals of DC Technology
- → Fundamentals of AC Technology
- → Fundamentals of Semiconductors
- → Basic Electronics Circuits

Extension Component Sets for
TP 1010 and TP 1011

Installation and Relay Technology
TP 1022

This expansion component set is used for introducing students to electrical installation and industrial control technology.

Students work with practical learning scenarios in realistic projects. This includes planning, constructing and testing a variety of basic circuits.

The extension component set consists of plug-in components on a storage panel. The plug-in components fit on the EduTrainer patch panel in a 19 mm grid.

Symbols and electrical values are printed on the top of each plug-in component. In the event of malfunctions, the plug-in components can be easily opened and repaired.

Training content
- Basic circuits for electrical installation (switching-off, series connection, two-way connection, cross connection)
- Control circuits for relay technology

Components included
- 2x Relay, NO/NC
- 1x Relay, NO/NO
- 2x Toggle switch
- 1x Crossover switch
- 2x Pushbutton, two-pin, NO/NC
- 2x Pushbutton, single-pin, NO
- 1x Pushbutton, single pin, NC
- 2x Lamp, 12 V/3 W
- 1x Fuse, 1 A

Extension component set TP 1022	**8111819**

Necessary accessory, also order:

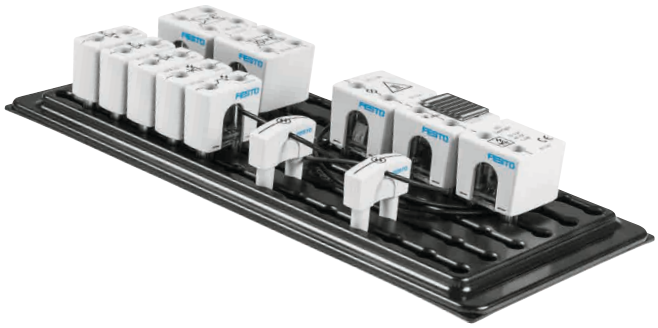
Complete equipment set TP 1011 **or**	571780
Complete equipment set TP 1011 M or	8029635
Complete equipment set TP 1010	8023958

Recommended learning material: → Courses on Festo LX coming soon
Basic Circuits for Electrical Installation, campus license (page 263)

de, en	**On request**

Control Circuits for Relay Technology, campus license (page 263)

de, en	**On request**



Optoelectronics
TP 1023

The training package Optoelectronics expands on TP 1011 or TP 1011 M to provide a comprehensive introduction to optical electronics. The kit enables students to explore the combined use of electronics and light. They will learn about optical semiconductor behavior, construction, and characteristics.

Using an EduTrainer patch panel and the components of TP 1011 or TP 1011 M, students easily build complete working circuits thanks to the flexibility and modularity of our training concept. They perform multiple project-oriented exercises and can also measure how they performed.

The plug-in components fit on the EduTrainer patch panel in a 19 mm grid. The equipment set ensures user safety, as it operates at low voltage and does not rely on laser technology. A convenient storage plate is included.

Training content
- Light-emitting diodes characteristic data and curves
- Infrared LED
- Control of LED (gate drive)
- Solar cell, Photodiode
- Phototransistor
- Optical signal transmission (with photodiode and phototransistor)
- Optocoupler
- Fiber optic cable

List of components
- 1x Photo transistor
- 1x Light diode (IR)
- 1x Photo diode (BPW 46)
- 1x Light diode (HLMP)
- 1x Light diode (BL)
- 1x Solar cell (AM 5610)
- 1x Lamp (12 V – 5 W)
- 1x LED lamp (15 V – 1 W5)
- 1x Isolation optocoupler (SFH618A)
- 1x Isolation optocoupler (MOC3051M)
- 1x Optical fiber

Extension component set TP 1023	**8077920**

Necessary accessory, also order:

Complete equipment set TP 1011 **or**	571780
Complete equipment set TP 1011 M	8029635

Recommended learning material: → Course on Festo LX
Fundamentals of Optoelectronics, campus license (→ page 263)

de	**8023586**
en	**8023587**

Analog Technology
TP 1024

The Analog Technology set of components extends the equipment sets TP 1011 and TP 1011 M with analog technology components. It provides information on the structure, function, and behavior of operational amplifiers and their application in different circuits.

The students set up complete, fully functional circuits by means of an EduTrainer patch panel and the components from TP 1011 or TP 1011 M. This enables the students to acquire the skills required to recognize the properties and characteristics of operational amplifiers and use them in analog circuits. Symbols and component values are printed on the top of the components. The housing of the set of components can be opened to renew the components in the event of a malfunction. The components are installed on a patch panel with a 19 mm grid.

Training content
- No load difference
- Output limits of the output voltage
- Use of the output current limiter of an OPA
- Limits of the usable input voltage common mode range
- Mode of operation of a warning for low operating voltage
- Mode of operation of a twilight switch
- Principle of a timer with RC element
- Structure and function of a window comparator
- Measurement of the slew rate of an operational amplifier
- Mode of operation and application of pulse-width modulation

Components included:
- 2x Operational amplifier
- 2x 2 mm safety laboratory cables, 300 mm, red
- 2x 2 mm safety laboratory cables, 300 mm, blue

Extension component set TP 1024	**8115716**

Necessary accessory, also order:

Complete equipment set TP 1011 **or**	571780
Complete equipment set TP 1011 M	8029635

Recommended learning material: → Course on Festo LX
Fundamentals of Analog Technology, campus license (→ page 263)

de	**8023586**
en	**8023587**
es	**8023588**
fr	**8023589**

Motor Vehicle Mechatronics
TP 1025

The students set up simple motor vehicle-specific basic circuits using an EduTrainer patch panel and the components from TP 1011 or TP 1011 M. Guided by action-oriented learning scenarios, they identify and eliminate malfunctions.

Symbols and component values are printed on the top of the components. The housing of the set of components can be opened to renew the components in the event of a malfunction. The components are installed on a patch panel with a 19 mm grid.

Built-in fault switches can be used to selectively manipulate components to enable realistic troubleshooting in the circuits.

All components are included in the electrical engineering library of FluidSIM. This library also contains extensive teaching material, adapted to the first year of training of automotive mechatronics technicians.

Training content
- Troubleshooting: rear fog light, reversing light, dashboard lighting, trailer lighting, low beam, tail and brake lights
- Diagnostics: instrument and dashboard lighting, fog lights, low beam, high beam and fog lights, right tail light, indicator system

Components included
- 1x 12 V Voltage regulator
- 2x Bulb, 12 V/20 mA
- 1x Key switch
- 1x Pulse oscillator
- 2x Lamp, 12 V/3 W
- 2x Lamp LED, 12 V
- 1x Normally open relay, 12 V
- 1x Fuse, 1 A
- 1x Fuse, 2 A
- 2x Switch

Extension component set TP 1025	**8106705**

Necessary accessory, also order:

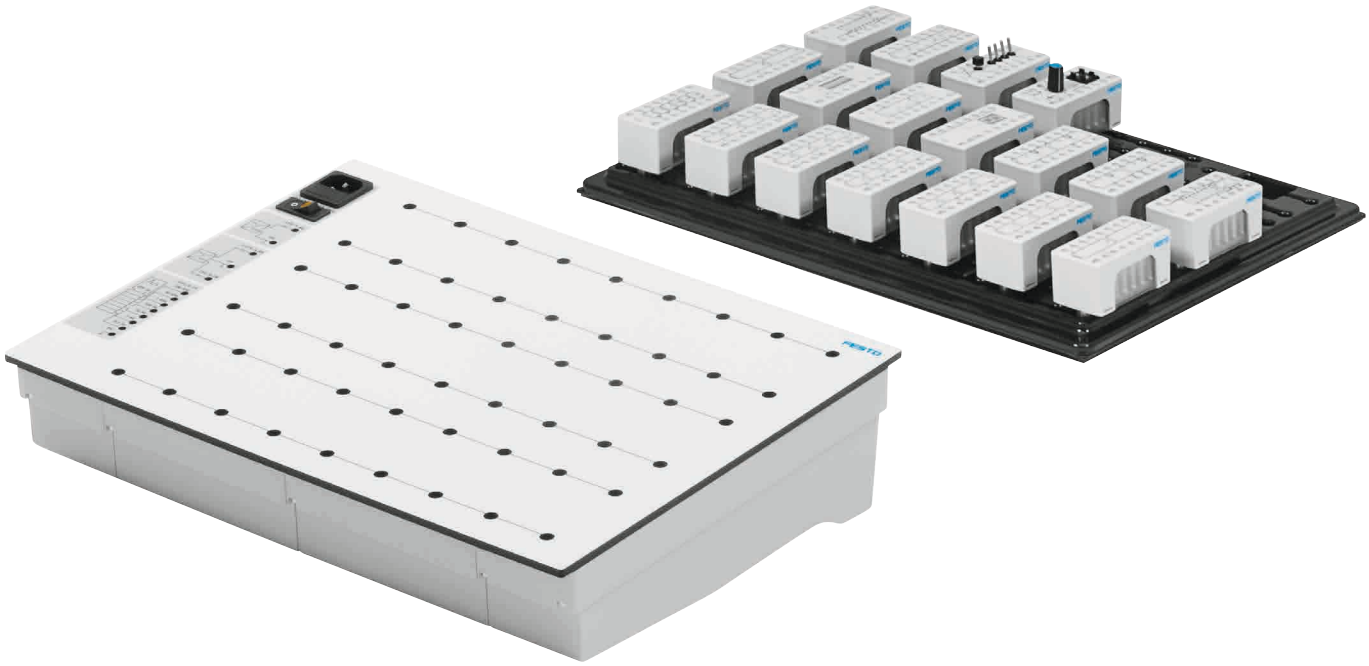
FluidSIM-Electrical Engineering (→ page 258)	
Complete equipment set TP 1011 **or**	571780
Complete equipment set TP 1011 M	8029635
Complete equipment set TP 1010	8023958

Recommended learning material:
Motor Vehicle Mechatronics, campus license (→ page 39)

de	**8212231**
en	**8245162**

Basic Principles of Digital Technology

TP 1012



The perfect introduction to digital technology

The training package Basic Principles of Digital Technology provides the optimum introduction to the world of digital signal processing. Those who learn and understand digital technology can easily and quickly learn any automation programming language.

The basic principles of digital technology include logical operations, signal flow and data formats. The curriculum also includes structured procedures for problem solving.

Special characteristics
- The components of the training package are constructed with real logic gates. They permit realistic examinations of their behavior.
- The ICs contained in the components are socketed and can be exchanged in only a few steps.
- All parts of the equipment set are completely equipped with safety plug connections.
- The Combiboard Digital and Control Technology EduTrainer included with this training package provides the required supply voltages for all tests and also contains a square-wave generator with 7 different output frequencies.
- This Combiboard EduTrainer can also be used as a patch panel for the Basic Principles of Control Technology components set.

Components included
- 1 inverter
- 2 AND
- 2 OR
- 1 NAND
- 1 NOR
- 1 XOR
- 1 hex switch and analog source 0 – 5 V
- 1 LED bar graph
- 1 counter
- 1 7-segment display
- 1 RS flip-flop
- 2 JK flip-flops
- 2 shift registers
- 1 full adder
- 1 signal input

Training content
- Elementary logic modules
- Important symbols
- Designing and optimizing logical circuits
- Logic algebra
- Conjunctive and disjunctive standard format
- Switching matrix diagrams
- Schmitt trigger
- Hysteresis
- Types of trigger circuits
- Using flip-flops
- Counting circuits
- Converting and transferring data
- Shift register
- Data conversion
- Arithmetic circuits

Complete equipment set TP 1012	**8023961**

The most important components at a glance:

1	1x Combiboard Digital and control technology EduTrainer	8023962
2	1x Set of components for digital technology	574193

Necessary accessories, also order:

IEC power cable (→ page 14)	
2 mm Safety laboratory cables (→ page 167)	

Possibilities of expansion:

Set of components for control technology (→ page 43)	8023963
I/O level converter 5 V ‹–› 24 V	576622
I/O level converter 5 V ‹–› 24 V with Sub-D HD15	8042619
IC zero insertion force socket	576623

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Recommended Learning Material

Workbooks (→ page 262)

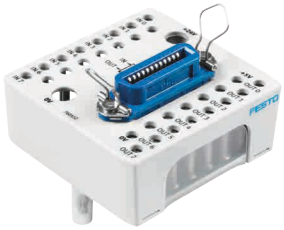
Campus license:

de	8023432
en	8023433
es	8023434
fr	8023435

Note: The campus license includes the PDF version of sample solutions, educational instructions, and worksheets for learners.

Course on Festo LX

→ Basic Principles of Digital Technology



I/O Level Converter 5 V ‹–› 24 V with SysLink Socket

Description on → page 56

Order no.	576622

I/O Level Converter 5 V ‹–› 24 V with SysLink Socket

Description on → page 56

Order no.	8042619

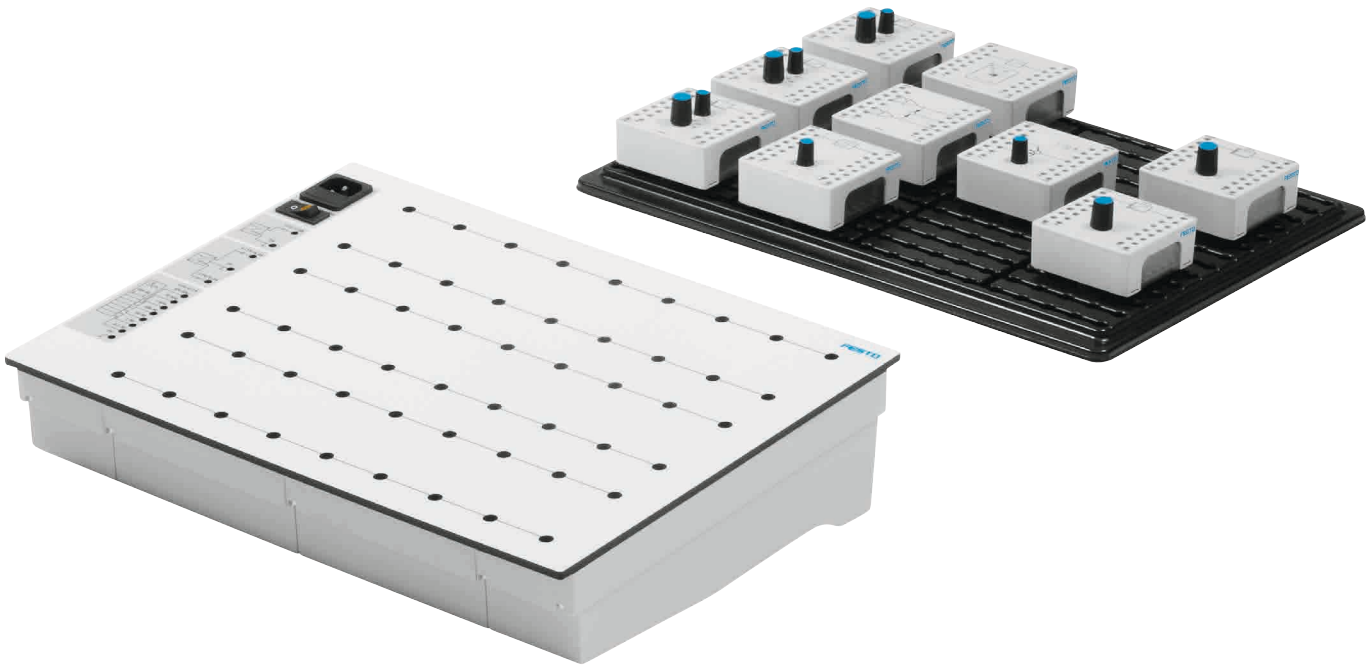
IC Zero Insertion Force Socket

Description on → page 56

Order no.	576623

Basic Principles of Control Technology

TP 1013



Control technology explained simply and comprehensibly

The training package Basic Principles of Control Technology provides a fast and easy-to-understand introduction to the topic of controllers and controlled systems.

The basic terminology of control technology, the behavior of various controllers and the structured analysis of requirements for controlled systems are particularly important here.

Ways and means of analyzing and solving control problems are shown and looked at in depth through experiments during the projects.

The equipment set permits fast and flexible construction of different controllers and thus allows simple inspections of behavior based on the interaction with controlled systems of different types.

All parts of the equipment set are completely equipped with safety plug connections. The Combiboard Digital and Control Technology EduTrainer contained in the equipment set provides the required supply voltages for all tests and also contains a square-wave generator with 7 different output frequencies. This Combiboard EduTrainer is also used in the training package Basic Principles of Digital Technology.

Components included
- 1x 2 differential inputs with subtracter
- 1x P element
- 1x I element
- 1x D element
- 1x summer with adjustable offset
- 1x limiter with level adaptation of the output signals
- 1x comparator with hysteresis and switching output
- 2x controlled system

Training content
- Structure of a control circuit
- Step response, dynamic behavior
- Standardizing physical variables
- Bode diagram
- Modeling a controlled system
- Positive and negative feedback
- Two and three-point controller
- P, I and PID controllers
- Stable and unstable behavior
- Controller gain
- Delay behavior according to Ziegler and Nichols

Complete equipment set TP 1013	**8023964**

The most important components at a glance:

1	1x Combiboard Digital and control technology EduTrainer	8023962
2	1x Set of components for control technology	8023963

Necessary accessories, also order:

IEC power cable (→ page 14)	
2 mm Safety laboratory cables (→ page 167)	
Digital storage oscilloscope (→ page 57)	

Possibilities of expansion:

Set of Components for Digital Technology (→ page 41)		574193
3	Application Module Level Control	8133444
4	Application Module Speed Control	8152965
5	Application Module Linear Position Control	8133202
6	Application Module Light and Temperature Control	8155732

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Optional application modules enable learners to explore typical industrial applications within a closed-loop system:

3 **Application Module Level Control**
With a control signal of ±10 volts, the application module behaves like a typical level curve and returns a control voltage. The level is displayed by means of a row of LEDs.

Order no.	8133444

4 **Application Module Speed Control**
The module consists of 2 units. On the first unit, there is a DC electric motor. The motor is coupled to a tachometer, which outputs the rotational speed as a voltage signal. The voltage signal is used for feedback in a closed control loop. On the second unit a generator serves as a load. A lamp activated via a switch loads the generator, changing its behavior.

Order no.	8152965

5 **Application Module Linear Position Control**
The module controls a positioning unit depending on the control signals from the components of the equipment set TP 1013. The module returns a voltage value as a control variable. The closed control loop behaves like a typical industrial application.

Order no.	8133202

6 **Application Module Light and Temperature Control**
A halogen lamp generates light and heat in a tunnel. Two sensors detect the light intensity and the temperature. A fan and a flap allow the air flow in the tunnel to change and thus also the temperature behavior of the application module.

Order no.	8155732

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

de	8023436
en	8023437
es	8023438
fr	8023439

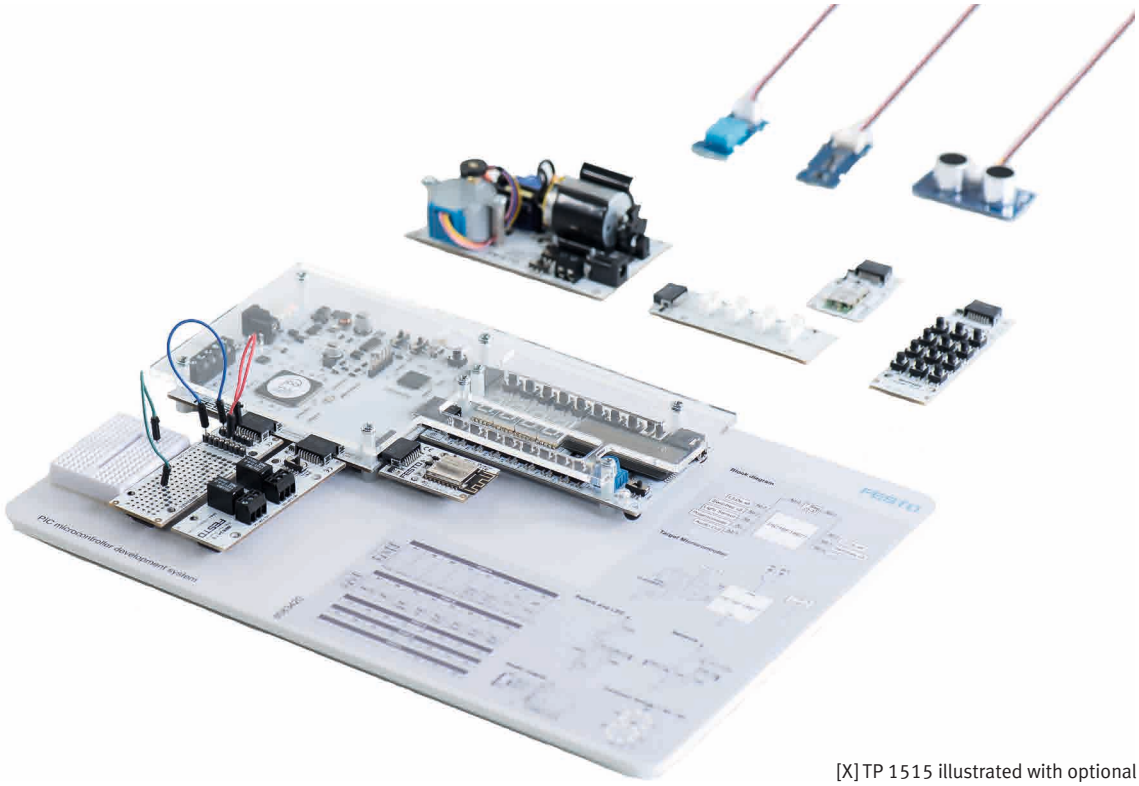
Note: The campus license includes the PDF version of sample solutions, educational instructions, and worksheets for learners.

Courses on Festo LX

- → Basic Principles of Closed-Loop Control Technology
- → Level Control System
- → Speed Control System
- → Llght and Temperature Control System

Microcontroller Development Systems

TP 1515 (PIC) / TP 1516 (Arduino)



[X] TP 1515 illustrated with optional components

Flexibility through modularity
The equipment sets TP 1515/1516 offer an affordable introduction to microcontroller systems and programming. They are ideal for learning about embedded electronic systems, programmable electronics, and for rapid prototyping.

Each set consists of a mounting panel, with a choice of upstream programmer board technology – PIC or Arduino – and a standard downstream board.

The sets can be used by students in educational environments, up to engineers in the industrial world. The technology is real, up-to-date, and provides a great base for Learning the next generation of engineers and technicians.

Flexible expansion
A wide selection of optional expansion boards is available, allowing coverage of specific topics to perfectly match Learning needs: input/output boards, wired/ wireless boards, motors/actuators boards, sensor boards, prototype boards, and graphical displays.

Boards can be snapped together using the rugged Har-flex® connectors to form a wide variety of systems for teaching or learning and for the rapid prototyping of complex electronic systems.

Students develop, simulate, test, and debug a microcontroller program to control embedded systems or mechatronics applications. The optional MecLab Interface connects TP 1515 to any MecLab Station.

Rugged design for education
The boards fit together in a flat 2D layout manner allowing the entire system to be easily seen and understood.

The sets have been designed to be electrically and mechanically rugged to withstand the pressures of the lab: downstream board interfaces include damage protection resistors and cannot be damaged by programming errors. Plastic covers protect panel-based boards and prevent chips from being removed.

Non-programmer friendly
The equipment sets are supported by Flowcode – a graphical, advanced integrated development environment (IDE) for electronic and electromechanical system development. Flowcode allows students to design, simulate, and test a wide variety of microcontroller-based systems with ease.

Topic coverage:
– Intro to microcontrollers
– Using E-blocks
– Flowcode – first program
– Flowcode – examples
– Programming exercises
– Arduino adjustments

1 Complete equipment set TP 1515	**8085562**

The package includes:
– 1x 8-bit PIC programmer board
– 1x Combo board
– 1x Mounting panel
– 1x Power supply
– 1x USB cable
– 1x Storage tray

2 Complete equipment set TP 1516	**8085563**

The package includes:
– 1x Arduino programmer board
– 1x Combo board
– 1x Mounting panel
– 1x Power supply
– 1x USB cable
– 1x Storage tray

Necessary accessory, please order:

Flowcode	→ page 48

Possibilities of expansion

Expansion boards	→ page 46
MecLab Interface	→ page 46

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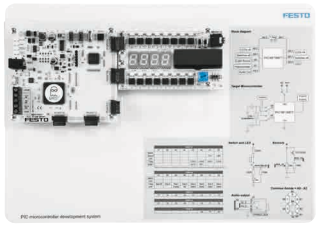

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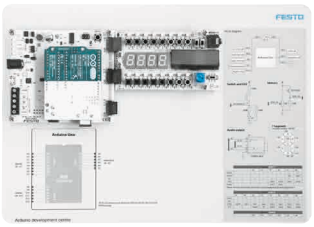


Technical characteristics

8-bit PIC Programmer Board
– PIC16F18877 microcontroller
– Voltage selector 5V/3.3V
– Powered via USB port or external supply
– Power output via screw terminal
– Adjustable clock frequencies
– Programmable via micro USB
– 5 ports; 35 I/O
– Reset button
– Chip features: 32 MHz, 56 kb flash memory

Arduino UNO Programmer Board
– Arduino UNO R3 PDIP
– Powered via USB port or external supply
– Power output via screw terminal
– Adjustable clock frequencies
– Programmable via micro USB
– 3 ports; 20 I/O
– Reset button
– Chip features:16 MHz, 32 kb flash memory

Introduce electronics students to the Internet of Things!

The Internet of Things, a network in which smart devices connect, communicate, and exchange data, is a key concept underlying the Industry 4.0. Several boards tackle communication technologies, such as Wi-Fi, Ethernet, and Bluetooth.

Recommended Learning Material

Workbooks

Campus license:

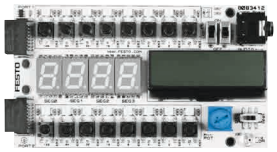
en	8094009
de	8128594

Printed workbooks available upon request.

Course on Festo LX
→ Microcontroller Programming

Expansion Boards and MecLab Interface

1



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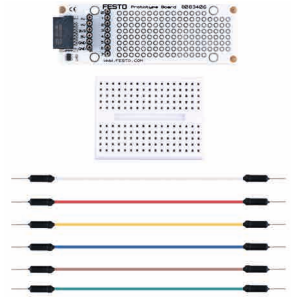

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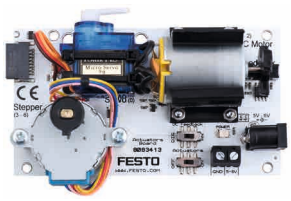

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8

1 **Combo Board**
The Combo Board works with any upstream programmer board, allowing multiple technologies to be explored using a single downstream board. The board includes 16 individual LEDs, 16 individual switches, a quad 7-segment display, a 20 x 4-character alphanumeric LCD, onboards sensors (light / potentiometer), and an audio output socket. . The graphical LCD is driven via an intelligent conversion module (macro) to allow it to be treated as a standard Alphanumeric HD44780 compatible device.

Order no. **8083412**

2 **Prototype Board**
The Prototype Board allows for easy addition of custom circuitry into the system. It connects the I/O lines of a port to an array of standard pitch holes. The board is supplied with a small a solderless breadboard and leads.

Order no. **8083406**

3 **Keypad 3x4 Board**
The Keypad Board allows for simple data entry using an array of switch inputs. Switches are push to make.

Order no. **8083408**

4 **Color Graphical LCD Board**
The Color Graphical LCD Board provides a 160 x 128 pixel TFT color graphical display capable of drawing text, displaying images and symbols in 16-bit color. Featuring a Flowcode compatible ILI9163C display driver IC the display can be programmed and fully simulated within the Flowcode environment. The board also features a dimmable backlight to provide maximum display visibility even in the dark.

Order no. **8089821**

5 **Actuators Board**
The Actuators Board includes a DC motor with both analogue and digital feedback, a servo motor and a stepper motor with gearbox, plus the circuitry to drive the motors. A DC socket allows the various drivers to be powered from a secondary power supply.

Order no. **8083413**

6 **LED Board**
The LED Board allows a bank of eight LED indicators to be added to the system. LEDs can be driven in a digital way using on or off output states or in an analogue way using pulse width modulation (PWM) techniques. Each LED is in the active high configuration.

Order no. **8083404**

7 **LCD Board**
The LCD Board provides a 20 x 4 character alphanumeric display compatible with the standard HD44780 type displays. An onboard microcontroller listens for HD44780 compatible commands and converts the incoming commands into SPI packets that drive the modern chip on glass (COG) graphical display.

Order no. **8083407**

8 **SD card Board**
The micro SD card Board allows a large amount of data storage to be added to the system. The board provides a means of reading and writing data to the SD card as well as providing level shifting to allow 5V and 3V3 systems to be compatible. The board also provides a means of detecting if the card is present via a switch built into the card socket.

Order no. **8083409**

1 **Grove Sensor Board***
The Grove sensor board allows for the addition of many peripherals and sensors from the Seeed Studio range of Grove modules (sold separately). The board can use up to four Grove sensors at a time.

Order no.	**8083414**

2 **Relay Board**
The Relay Board provides two electrically controllable relays which act as isolated switches. The external connections to the relays are screw terminals; normally open (NO) and normally closed (NC) connections allow for maximum flexibility. Each relay features a LED.

Order no.	**8083419**

3 **Bluetooth Board**
The Bluetooth Board contains a Microchip RN4677 module which provides certified Bluetooth 4.0 functionality to the system. The module allows for exploration of both Bluetooth classic (BR/EDR) and Low Energy (LE) protocols.

Order no.	**8089815**

4 **Wi-Fi Board**
The Wi-Fi Board allows connection and communication with an existing Wi-Fi network. It can also be used to create a data access point. It is provided with a fully certified and ruggedized ESP12F module.

Order no.	**8089816**

5 **MecLab Interface**
MecLab Interface is a component that bridges a Microcontroller Development System TP 1515 with any MecLab Station. It allows control of the station by the microcontroller located on TP 1515. Using the visual programming software Flowcode, students can quickly and easily code a microcontroller to perform a sequence of actions on the station. The program is uploaded to the microcontroller and test run on the station. Two variants are available, depending if your MecLab Stations are equipped or not with the EasyPort Mini EasyKit with Power supply and Connecting cables.

Complete version	**8136430**
Add-on version	**8127367**

Additional expansion boards

Switch board	8083405
Terminals board	8083410
Servo motor board	8083411
Manual patch board	8083415
Splitter board	8083416
ZigBee board router	8083417
Upstream link board	8083418
ZigBee board coordinator	8084231
Ethernet board	8089822
Click board**	8089817
Mono gLCD board	8089818
CAN bus board	8089819
I/O expander board	8089820

*Compatible with Grove™ products
**Compatible with MikroElektronika products

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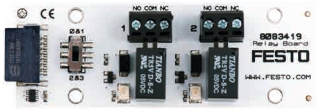

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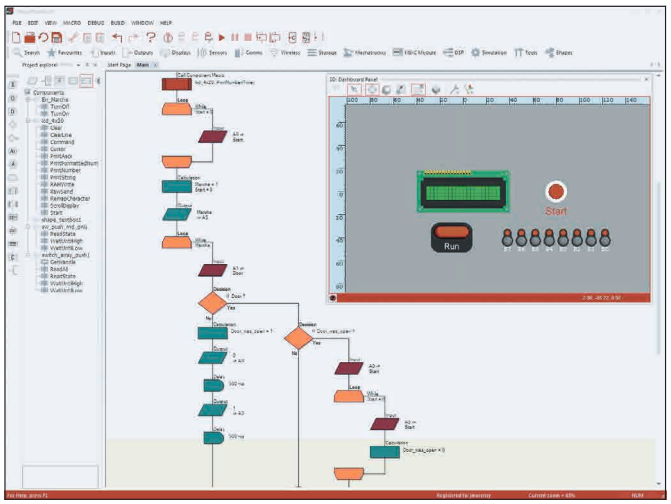
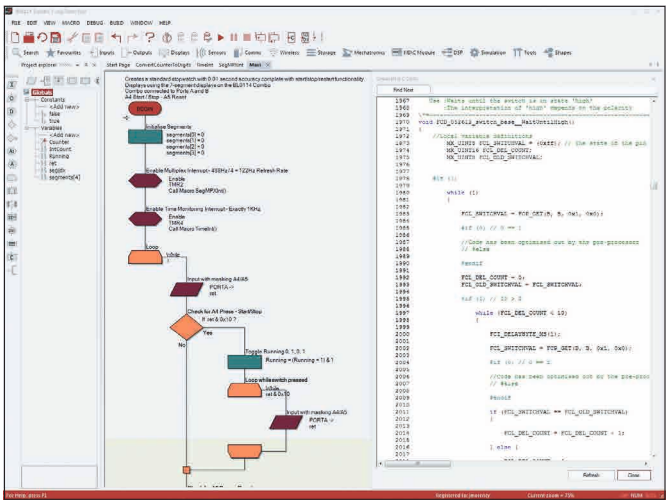
Flowcode

A Visual Programming Environment





Flowcode enables quick and easy development of complex electronic and electromechanical systems. The graphical programming tool allows those with little experience to develop systems in minutes.

Flowcode is an advanced integrated development environment (IDE) for electronic and electromechanical system development. Engineers—both professional and academic – use Flowcode to develop systems for control and measurement based on microcontrollers or on rugged industrial interfaces using Windows compatible personal computers.

Furthermore, Flowcode allows full simulation (including simulation of C code), with users also being able to convert C code to flowcharts and other programming languages.

Other features included the ability to Auto ID downstream boards that are connected, improved compatibility with Arduino hardware, to give a more streamlined and smooth approach to programming this popular family, and SCADA mode – meaning users can now control external hardware from their PC using this impressive feature.

Graphical programming
The graphical icons which are used to develop systems within Flowcode are easy-to-use. It enables first-time developers to pick up the fundamentals and run with their designs. Using graphical icons allows users to view and learn code side-by-side for easier learning.

For more advanced users with a good understanding of programming, Flowcode allows integration of pre-written codes.

Microcontroller flexibility
Flowcode gives you the ability to work with multiple chip variants in an easy and flexible way. When learning and developing designs using 8-bit PIC or Arduino microcontrollers, Flowcode is perfect for students and makes code-porting simple, meaning that users can switch target devices with ease.

Testing and debugging
Ghost Technology embedded on upstream boards provides a real-time log of the status of all the pins on the microcontroller whilst a Flowcode program is running on the device. Built into Flowcode is a data recorder and oscilloscope which makes test and debugging procedures straightforward. Flowcode is also compatible with external hardware including oscilloscopes, power supplies, signal generators and more.

Component library
The library contains a vast collection of components that can be used to create systems, from simple switches and LED's to more complex communications modules.

Electronic communications
Communications developments form a large part of modern day electronic education and understanding. Communications including CAN bus, Bluetooth, USB, Ethernet and WIFI are available within the Flowcode environment.

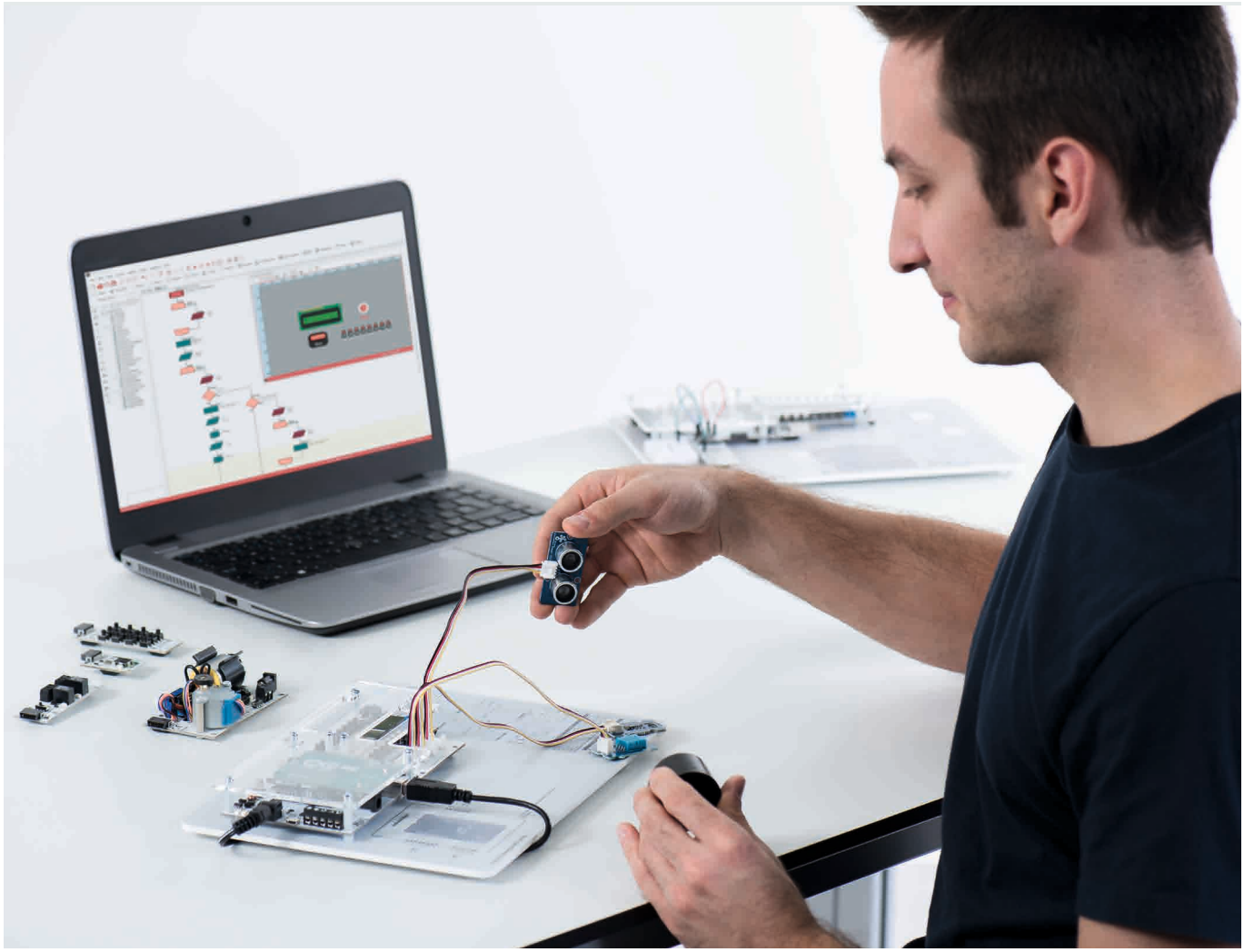
New in version 10
- New 2D panels provide clearer graphics and customization option of all panels with your own drawings and notes.
- All 2D components have been redesigned with clearer graphics. Backwards compatible with V9 panels. 3D still supported. New primitive components with nesting properties.
- Code for any component can be viewed, edited, and customized.
- Improved simulation display and speed.
- Create web-based applications. HTML export allows you to create control and data gathering projects that function on any browser on any platform. Javascript based components allow simple web based applications to be produced.
- Facilitated project documentation and export.

Flowcode 10 licenses

1 user	**8194089**
10 users	**8194090**
50 users	**8194091**

Contact us for more licensing options.

Program a mechatronic application!
The PIC microcontroller on the TP 1515 programmer board controls the MecLab Station conveyor via the MecLab Interface. The microcontroller operates a flowchart-based program developed using Flowcode.



Build core skills.
A solid foundation in electricity and electronics is becoming essential for an increasing number of professions. Blending digital tools with hands-on experimentation equips learners with the skills needed for tomorrow's workforce.

AC/DC Learning System

Basic Principles of Electrical Circuits

120 V, 60 Hz	**587589**
220 V, 50 Hz	**587590**

These products cannot be ordered or delivered in countries that require compliance to CE regulations. For other country voltage and frequency configurations, please contact your local sales representative.

Most important components:
- Fixed to the front panel: protected DC and AC power sources, resistors, an inductor, two capacitors, a transformer, switches (SPST, SPDT, DPDT, NO push button, NC push button, selector and knife switches, AC and DC relays, indicator lights, a potentiometer, a DC motor, a solenoid, a buzzer, a circuit breaker with test components, a fuse.
- Individual components that can be fixed to or stored in the case lid: two multimeters, a connection leads set, compass, an iron rod (for electromagnetism experiments)
- Six built-in faults can be individually inserted using a toggle switch. These faults are designed to test and improve troubleshooting skills.

LabVolt Series 3351
The AC/DC Learning System is a state-of-the-art learning system that is specifically designed to introduce students to the basic principles of electrical circuits, both in direct current (DC) and alternating current (AC). It provides a comprehensive, high-quality, and cost-effective solution to rapidly build student knowledge in electricity and electrical circuits.

The AC/DC Learning System comprises the most common electrical components in modern electrical circuits, easy to access and safe for student experimentation. Two 24 V power supplies provide DC power and AC power. The learning system itself can be powered from a standard AC wall outlet.

Highlights
- Full introduction to important concepts in AC/DC circuits
- Comprises the most common electrical components
- Operates at a low voltage for student safety
- Built-in faults
- Comprehensive courseware
- Rugged transportation and storage case

Topic Coverage
- Basic concepts of electrical circuits, both in direct current (DC) and alternating current (AC)
- Ohm's law
- Kirchhoff's voltage and current laws
- Using measuring instruments (voltmeters, ammeters, ohmmeters, etc.)
- Solving series and parallel circuits
- Electromagnetism
- Electrical distribution
- Troubleshooting electrical circuits
- Exploration of the most common electrical components: power sources, resistors, inductors, capacitors, transformers, switches, relays, motors

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	583853
es	8176723

Notes: The campus license includes the PDF of the student and instructor manuals "AC Circuits Fundamentals" and "DC Circuits Fundamentals". Printed workbooks available upon request.

Courses on Festo LX:
- → AC Circuits Fundamentals
- → DC Circuits Fundamentals

Accessories

Power Supplies and Cables

1

2

3

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1 **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, with:
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**

2 **EduTrainer 24 V Power Supply Unit**
– Input voltage: 1 AC/110 – 230 V (47 – 63 Hz)
– Output voltage: 24 V DC, short-circuit-proof
– Output current: Max. 4.5 A
– Front plate: 133 x 297 mm
– Console housing with rubber feet for use in an A4 frame or on tabletop
– Connection via 4 mm safety plugs
– Feedtrough for 3AC/400V
Order no. **571813**

3 **Power Supply Unit for Mounting Frame**
– Input voltage: 85 – 265 V AC (47 – 63 Hz)
– Output voltage: 24 V DC, short-circuit-proof
– Output current: max. 4.5 A
– Dimensions: 170 x 240 x 92 mm
Without power cable
Order no. **8049382**
With IEC power cable, 1.3 m, with:
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. **159396**
Connector as per NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP
Order no. **162411**
Connector as per BS 1363 for GB, IE, MY, SG, UA, HK, AE
Order no. **162412**
Connector as per AS 3112 for AU, NZ, CN, AR
Order no. **162413**
Connector as per SEV 1011 for CH
Order no. **162414**
Connector as per SANS 164-1 for ZA, IN, PT, SG, HK, (GB), (AE)
Order no. **162415**

4 **5-Fold plug Socket Strip with Switch**
Impact and shatter resistant plug socket strip with tamper-proof cover, 4 mounting points and mounting attachments.
With power supply plug suitable for: DE, FR, NO, SE, FI, PT, ES, AT, NL, BE, GR, TR, IT, DK, IR, ID
Order no. **380707**

CEE 7/VII

AS 3112

NEMA 5-15

SEV 1011

BS 1363

SANS 164-1

5 **IEC Power Cable**
One end fitted with a straight IEC C13 connector and the other fitted with a country-specific connector.
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. **247661**
Connector as per NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP
Order no. **350362**
Connector as per BS 1363 for GB, IE, MY, SG, UA, HK, AE
Order no. **350363**
Connector as per AS 3112 for AU, NZ, CN, AR
Order no. **350364**
Connector as per SEV 1011 for CH
Order no. **350366**
Connector as per SANS 164-1 for ZA, IN, PT, SG, HK, (GB), (AE)
Order no. **350367**

6 **IEC Power Cable 90°**
One end fitted with a 90° IEC C13 connector and the other fitted with a country-specific connector. Preferred version for EduTrainer Universal.
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. **549860**
Connector as per NEMA 5-15 for US, CA, Central America, BR, CO, EC, KR, TW, TH, PH, JP
Order no. **549861**
Connector as per BS 1363 for GB, IE, MY, SG, UA, HK, AE
Order no. **549862**
Connector as per AS 3112 for AU, NZ, CN, AR
Order no. **549863**
Connector as per SEV 1011 for CH
Order no. **549864**
Connector as per SANS 164-1 for ZA, IN, PT, SG, HK, (GB), (AE)
Order no. **549865**

Accessories

Safety Laboratory Cables (4 mm)

4 mm Safety Laboratory Cables
– Plugs with rigid protective sleeve and axial socket
– Conductor cross section: 1 mm²
– 1000 V CAT II
– Rated current: 16 A

4 mm Safety Laboratory Cables, 98 Pieces, Red and Blue
Complete set, consisting of 98 safety laboratory cables with 4 mm safety plugs in the colors red and blue:
– 10x red 50 mm
– 10x blue 50 mm
– 26x red 300 mm
– 11x blue 300 mm
– 21x red 500 mm
– 12x blue 500 mm
– 3x red 1000 mm
– 3x blue 1000 mm
– 1x red 1500 mm
– 1x blue 1500 mm
For the third cable color, safety laboratory cables, 47 pieces, black, are suitable (order no. 8092667)

Order no.	**8092666**

4 mm Safety Laboratory Cables, 47 Pieces, Black
Complete set, consisting of 47 safety laboratory cables with 4 mm safety plugs in the color black:
– 8x black 50 mm
– 18x black 300 mm
– 18x black 500 mm
– 2x black 1000 mm
– 1x black 1500 mm

Order no.	**8092667**

4 mm Safety Laboratory Cables, 106 Pieces, Red, Blue and Black
Complete set, consisting of 106 safety laboratory cables with 4 mm safety plugs in the colors red, blue and black:
– 10x red 50 mm
– 10x blue 50 mm
– 8x black 50 mm
– 8x red 300 mm
– 8x blue 300 mm
– 18x black 300 mm
– 8x red 500 mm
– 8x blue 500 mm
– 18x black 500 mm
– 2x red 1000 mm
– 3x blue 1000 mm
– 2x black 1000 mm
– 1x red 1500 mm
– 1x blue 1500 mm
– 1x black 1500 mm

Order no.	**8092668**

4 mm Safety Laboratory Cables, 58 Pieces, Brown, Black, Gray, and Blue, with Gray Plugs
Complete set, consisting of 58 safety laboratory cables with 4 mm safety plugs in brown, black, gray, and blue, with gray plugs:
– 6x gray 50 mm
– 5x gray 300 mm
– 5x brown 300 mm
– 5x black 300 mm
– 5x blue 300 mm
– 4x gray 500 mm
– 4x brown 500 mm
– 4x black 500 mm
– 4x blue 500 mm
– 2x gray 1000 mm
– 2x brown 1000 mm
– 2x black 1000 mm
– 2x blue 1000 mm
– 2x gray 1500 mm
– 2x brown 1500 mm
– 2x black 1500 mm
– 2x blue 1500 mm

Order no.	**8092669**

4 mm Safety Laboratory Cables and Safety Jumper Plugs, 14 Pieces, Green-Yellow
Complete set, consisting of 8x 4 mm safety laboratory cables and 6x safety jumper plugs in the color green-yellow:
4 mm Safety laboratory cables:
– 2x 300 mm
– 2x 500 mm
– 2x 1000 mm
– 2x 1500 mm
4 mm Safety jumper plugs:
– 6x 19 mm

Order no.	**8092672**

4 mm Safety Laboratory Cables, 50 mm

red	**8092626**
blue	**8092627**
black	**8092628**
gray-gray	**8092629**

4 mm Safety Laboratory Cables, 300 mm

red	**8092630**
blue	**8092631**
black	**8092632**
gray-gray	**8092633**
brown-gray	**8092634**
black-gray	**8092635**
blue-gray	**8092636**
yellow	**8092637**
green/yellow-yellow	**8092638**

4 mm Safety Laboratory Cables, 500 mm

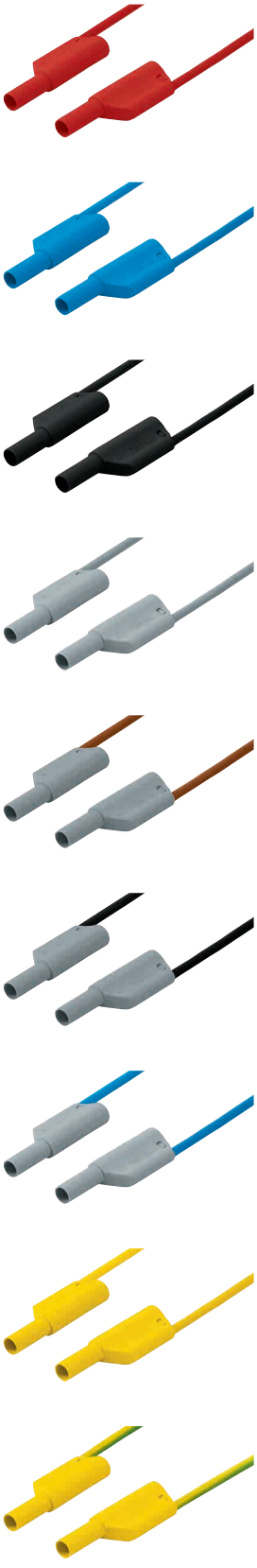
red	**8092639**
blue	**8092640**
black	**8092641**
gray-gray	**8092642**
brown-gray	**8092643**
black-gray	**8092644**
blue-gray	**8092645**
yellow	**8092646**
green/yellow-yellow	**8092647**

4 mm Safety Laboratory Cables, 1000 mm

red	**8092648**
blue	**8092649**
black	**8092650**
gray-gray	**8092651**
brown-gray	**8092652**
black-gray	**8092653**
blue-gray	**8092654**
yellow	**8092655**
green/yellow-yellow	**8092656**

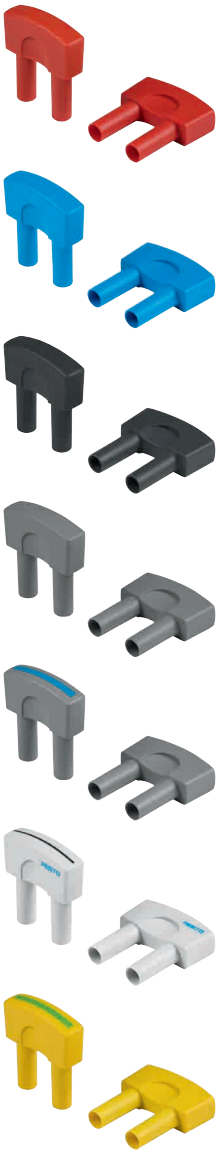
4 mm Safety Laboratory Cables, 1500 mm

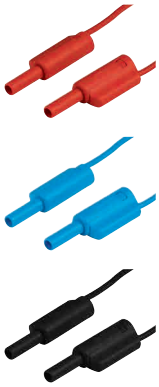
red	**8092657**
blue	**8092658**
black	**8092659**
gray-gray	**8092660**
brown-gray	**8092661**
black-gray	**8092662**
blue-gray	**8092663**
yellow	**8092664**
green/yellow-yellow	**8092665**



Accessories

Jumper Plugs (4 mm) and Safety Laboratory Cables (2 mm)





Safety Jumper Plugs
– Plugs with rigid protective sleeve
– Plug spacing: 19 mm
– 1000 V CAT II
– Rated current: 16 A

Safety Jumper Plugs, 36 Pieces, Red, Blue, Gray, Gray-Blue
Complete set, consisting of 36 safety jumper plugs in the colors red, blue, gray, gray-blue:
– 8x red
– 8x blue
– 16x gray
– 4x gray-blue

Order no.	**8092677**

Safety Jumper Plugs, 28 Pieces, Gray-Black
Complete set, consisting of 28 gray-black safety jumper plugs. Suitable for the universal patch panel EduTrainer, the jumper plugs are used to clearly establish connections when designing circuits:
– 28x gray-black

Order no.	**571809**

Safety Jumper Plugs, 19 mm

red	**572097**
blue	**572098**
black	**572099**
gray	**572100**
gray-blue	**572120**
gray-black	**572121**
green-yellow	**572101**

2 mm Safety Laboratory Cables
– Plugs with rigid protective sleeve and axial socket
– Conductor cross section: 0,5 mm²
– 500 V CAT II
– Rated current: 5 A

2 mm Safety Laboratory Cables, 60 Pieces, Red, Blue and Black
Complete set, consisting of 60 safety laboratory cables with 2 mm safety plugs in the colors red, blue and black:
– 11x red 100 mm
– 11x blue 100 mm
– 20x black 100 mm
– 2x red 200 mm
– 2x blue 200 mm
– 10x black 200 mm
– 2x black 300 mm
– 2x black 500 mm

Order no.	**574206**

2 mm Safety Laboratory Cables, 100 mm

red	**574198**
blue	**574199**
black	**574200**

2 mm Safety Laboratory Cables, 200 mm

red	**574201**
blue	**574202**
black	**574203**

2 mm Safety Laboratory Cables, 300 mm

red	**576297**
blue	**576298**
black	**574204**

2 mm Safety Laboratory Cables, 500 mm

red	**576295**
blue	**576296**
black	**574205**

Measuring lad holder
Mobile measuring lead holder with storage box.
– Dimensions (W x H x D)
  54 x 135 x 54 cm
– Storage dimensions (W x D)
  42 x 51 cm

Order no.	**8043430**

Accessories

Protective Conductor Cables, Adapters

Protective Conductor Cables with Special Connector
– Special sockets 6 mm
– Conductor cross section: 4 mm²
– Both sides are equipped with a special socket
– Special connectors are unmistakable with 4 mm safety cables
– Easy to recognize, allows simple checking of safety-relevant connections at the workplace

1 **Protective Conductor Cables with Special Connector, 14 Pieces**
Complete set, consisting of 14 preassembled cables with 6 mm special socket for protective earth connection:
– 8x 100 mm
– 3x 400 mm
– 3x 1500 mm

Order no.	**8067503**

Protective Earth Cable with Special Connector

100 mm	**8067504**
400 mm	**8067505**
1500 mm	**8067506**

2 **Adapter from 4 mm Safety Socket Plug to Special Connector, 20 Pieces**
– Connector pin: 6 mm
– To insert into a 4 mm safety socket
– Special connectors are unmistakable with 4 mm safety cables
– Simple to mount with the assembly tool
– Permanent retention and conversion
– 20x adapters
– 1x assembly tool
– 1x assembly instructions

Order no.	**8067500**

A4 Transport and Storage Case
Practical and robust case with handle for storing and transporting EduTrainers (A4 modules with a width of up to 535 mm (permissible device height of console housing 66/95 mm)). Up to 200 plug-in components with 4 mm safety plugs can be stored in the cover of the case. Both the EduTrainer and the plug-in components can be used directly when installed. Approx. dimensions: 450 x 650 x 280 mm

Order no.	**8197368**

3 **BNC – 4 mm Safety Measuring Adapter**
Measuring lead for BNC plug on 4 mm safety plug
– BNC plug insulated
– 4 mm plug with rigid protective sleeve and axial socket
– 600 V CAT II
– Length: 1600 mm

Order no.	**8023959**

4 **4 mm – 2 mm Safety Measuring Adapter**
Measuring adapter 4 mm safety plug on 2 mm safety socket
– With rigid protective sleeve and axial socket
– 600 V CAT II
– Load capacity: 5 A

Order no.	**8023960**

5 **Set of 4 mm Angled Safety Adapters, 20 Pieces, Clevis**
Set comprising 20 angled adapters with rigid protective sleeve and open clevis end for the bonding of devices.
– Clevis width: 7.5 mm
– Clevis length: 12 mm
– Suitable for M4 screws
– 1000 V CAT II
– Load capacity: 16 A

gray	**576287**
black	**576288**

6 **Set of 4 mm Angled Safety Adapters, 20 Pieces, Pin**
Set comprising 20 angled adapters with rigid protective sleeve and open pin end for the bonding of devices.
– Pin width: 2 mm
– Pin length: 12 mm
– 1000 V CAT II
– Load capacity: 16 A

gray	**576285**
black	**576286**

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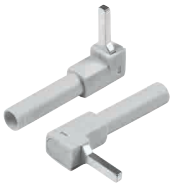

Accessories

Optional Components, Housings

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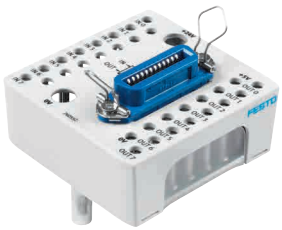

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1 **Set of Empty Component Housings, 2-Pin**
Set of ten 2-pole empty housings, suitable for the equipment sets Fundamentals of Electrical Engineering and Electronics. Consisting of:
– Housing top part, gray, blank
– Housing bottom part, transparent
– Printed circuit board with universal layout and pressed-in 4 mm connectors
For standard components with 2 terminals.

Order no.	**576289**

2 **Set of Empty Component Housings, 3-Pin**
Set of ten 3-pole empty housings, suitable for the equipment sets Fundamentals of Electrical Engineering and Electronics. Consisting of:
– Housing top part, gray, blank
– Housing bottom part, transparent
– Printed circuit board with universal layout and pressed-in 4 mm connectors
For standard components with 2 terminals.

Order no.	**576290**

3 **Operational Amplifier**
For constructing amplifier circuits.
– Supply voltage +/-15 V DC via 2 mm safety plug
– Output short circuit proof
– Offset compensation possible with potentiometer
– OP type LM741

Order no.	**576621**

4 **IC Zero Insertion Force Socket**
High-quality IC socket for tool-free adaptation of ICs, compatible with digital technology.
– 16 pins in a 2.54 mm grid
– Tool-free assembly using clamping lever
– Contacting with 2 mm safety plug

Order no.	**576623**

5 **I/O Level Converter 5 V ‹–› 24 V**
I/O level converter for the implementation of digital inputs and outputs for digital technology or microcontrollers on functional models.
– Supply voltage DC/24 V via 4 mm safety plug
– 8 inputs 5 V via 2 mm safety plug
– 8 outputs 5 V via 2 mm safety plug
– SysLink connection with 8 inputs and 8 outputs 24 V
– Acceptable current load per DC/24 V output 300 mA, protected against short circuits and overloads
– Sum of the output currents: max. 2 A

Order no.	**576622**

6 **I/O level Converter 5 V-24 V with Sub-D HD Socket**
I/O level converter for the implementation of digital and analog inputs and outputs for digital technology, control technology or microcontrollers on functional models.
– Supply voltage 24 V DC via 4 mm safety plug
– 4 inputs 5 V DC via 2 mm safety plug
– 4 outputs 5 V DC via 2 mm safety plug
– 2 analog inputs ±10 V DC via 2 mm safety plug
– 1 analog output ±10 V via 2 mm safety plug
– Sub-D HD plug with 4 inputs, 4 outputs 24 V DC and 2 analog inputs, 1 analog output ±10 V
– Current rating per 24 V DC output 300 mA, short-circuit and overload protected
– Current rating per 5 V DC output: 25 mA

Order no.	**8042619**

7 **KNX Cable Set**
Complete set comprising 6 KNX cables. Pre-assembled with KNX system plugs to fit KNX EduTrainers.
– Conductor cross section: 2 x 2 x 0.8 mm²
– 4x 100 mm
– 1x 200 mm
– 1x 1000 mm

Order no.	**8023965**

8 **A4 Empty Housing**
Medium-grey front panel with removable protective sheet, rear cover, rubber feet and screws fully mounted.
– Front panel: variable
– Depth: 90 mm

133 x 297 mm	**8023974**
266 x 297 mm	**8023975**
399 x 297 mm	**8023976**

Accessories
Oscilloscopes

1 **Tektronix TBS2074 Digital Storage Oscilloscope**
– Display: Color WVGA, 9” W, resolution 800 x 480
– Bandwidth: 70 MHz
– Channels: 4
– Sampling rate: 1.0 GS/s
– Resolution: 8 bits
– Interface: 2x USB2.0, Wifi, Ethernet port
– Record length : 20 Mpoints
– 32 automated measurement mode
– CE, UL, CSA

Order no.	**8068879**

Also necessary, please order:

4x	BNC - 4 mm Safety Measuring Adapter (page 55)	8023959

2 **Keysight EDUX52A-EDU Digital Oscilloscope**
Standard oscilloscope for visualizing relationships during basic training in electrical engineering. Curves can be traced and evaluated on a PC.
– Display: color
– Bandwidth: 50 MHz
– Channels: 2
– Time base: 2,5 ns – 50 s/div
– Sampling rate: 1.0 GS/s
– Resolution: 8 bits
– Interface: USB / LAN
– Additional functions: digital voltmeter, frequency meter

Order no.	**571845**

Also necessary, please order:

2x	BNC - 4 mm Safety Measuring Adapter (page 55)	8023959

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Accessories

Multimeters, Testers

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1 **GW Instek GDM-533 Digital Multimeter**
The universal digital multimeter for basic training. Offers True RMS measurement, automatic and manual range selection, illuminated LCD display with 6000 counts, display hold, bar graph display, USB interface.
– Voltage: 0.01 mV ... 1000 V
– Current: 0.1 µA ... 20 A
– Resistance: 0.1 Ω ... 60 MΩ
– Capacitance: 0.01 nF ... 60 mF
– Frequency: 1 Hz ... 10 MHz
– Measuring circuit category: CAT III/1000 V

Order no. **8217596**

2 **Fluke 179 Digital Multimeter**
Meter for higher requirements in basic training. Automatic and manual range selection, 4-digit illuminated LCD display for measuring direct and alternating voltage, direct and alternating current, resistance, continuity, frequency, capacitance, diode test, temperature measurement, min./max./mean value, display hold, bar graph, true effective value measurement (TRMS).
– Voltage: 0.1 mV – 1,000 V
– Current: 0.01 mA – 10 A
– Resistance: 0.1 Ω – 50 MΩ
– Frequency: 0.01 Hz – 100 kHz
– Capacitance: 1 nF – 10,000 µF
– Measuring circuit category CAT III/1000 V
– Measuring circuit category CAT IV/600 V

Order no. **571831**

3 **Fluke 1664 FC Installation Tester for VDE 0100**
Installation tester for testing and accepting stationary installations as per VDE 0100/0413 and the international standard IEC 60364. Perfect for the practical demonstration of electrical protective measures in combination with our EduTrainers for power supply systems and protective measures, and particularly for testing type B RCDs. For all basic installation tests including continuity, insulation, loop impedance, trigger time and trigger current of the residual current protective devices (RCDs), measuring ground resistance and phase sequence, including insulation pre-test to protect connected devices from damage. Internal memory, PC interface or Fluke Connect for documentation and reporting.

Order no. **8064024**

4 **Beha-Amprobe Telaris ProInstall-0100 Installation Meter**
Low-cost installation tester with a good range of functions for testing the safety of electrical systems and work with our EduTrainern for power supply systems and protective measures, without test options for RCDs Type B. For testing and acceptance of fixed electrical installations in accordance with: DIN VDE 0100,ÖVE E 8001, NIV/NIN 2010, BS 7671, IEC 60364. Light and compact portable device with a clear user interface, a large backlit LCD display and a data logging function with a PC download. For all fundamental installation tests including insulation resistance, loop impedance and short circuit measurement, triggering time and tripping current of RCDs/quick-acting protective devices, low-ohm measurement and rotary field testing.

Order no. **8040008**

Software for Beha-Amprobe Telaris ProInstall-0100
Convenient, extensible software for logging measurement data per DIN VDE 0100/0105. Log design per ZVEH protocol. Includes interface adapter TL USB.

Order no. **8040009**

1 **Amprobe AC50A**
Digital Leakage Current Clamp
This current clamp is ideally suited to measuring discharge currents (leakage currents) and differential currents (to BGV A3). In addition to the current clamp function, this current clamp also includes the most common multimeter functions via measuring cables such as voltage measurement, resistance and continuity.
– Voltage AC: 0.1 – 400 V
– Current AC: 0.01 mA – 60 A
– Resistance: 0.1 – 400 Ω
– Frequency range: 40 Hz – 1 kHz
– Measuring circuit category CAT IV/600 V

Order no.	**571848**

2 **Amprobe Rotary Field and Motor Direction-of-Rotation Indicator PRM-6-EUR**
Phase sequence checker for basic training in three-phase technology and drive technology.
– Rotary field display
– Display of a missing or incorrectly connected external conductor
– Contactless motor direction-of-rotation indicator with running motors
– Voltage-free determination of motor connections (U, V, W) using a manual drive

Device information
– Voltage range from 40 to 700 V
– Frequency range 16 to 400 Hz
– Measurement category CAT IV, 600 V
– Sturdy housing with protective rubber cover
– Removable measuring cables
– Background lighting
– Rotary field direction check also possible if battery is low or missing

Order no.	**8081205**

3 **T110 VDE Voltage and Continuity Tester**
Ideally suited for basic training in electrical engineering. VDE-tested and EN 61243-3:2010-compliant, with measurement probes per the safety regulation HSE GS 38. With its robust and ergonomic plastic housing and the thicker measuring lead with a wear indicator, T110 is ideal for mobile use. Equipped with a direction of rotation indicator for three-phase systems and functions for testing RCDs via loads which can be switched with two-button operation. Also includes a special electric flashlight function for working in dark environments.
– Voltage: 12 – 690 V
– Rotary field: 100 – 690 V
– Flow: 0 – 400 kΩ
– Frequency: 0/40 – 400 Hz
– Measuring circuit category CAT III/690 V
– Measuring circuit category CAT IV/600 V

Order no.	**8040007**

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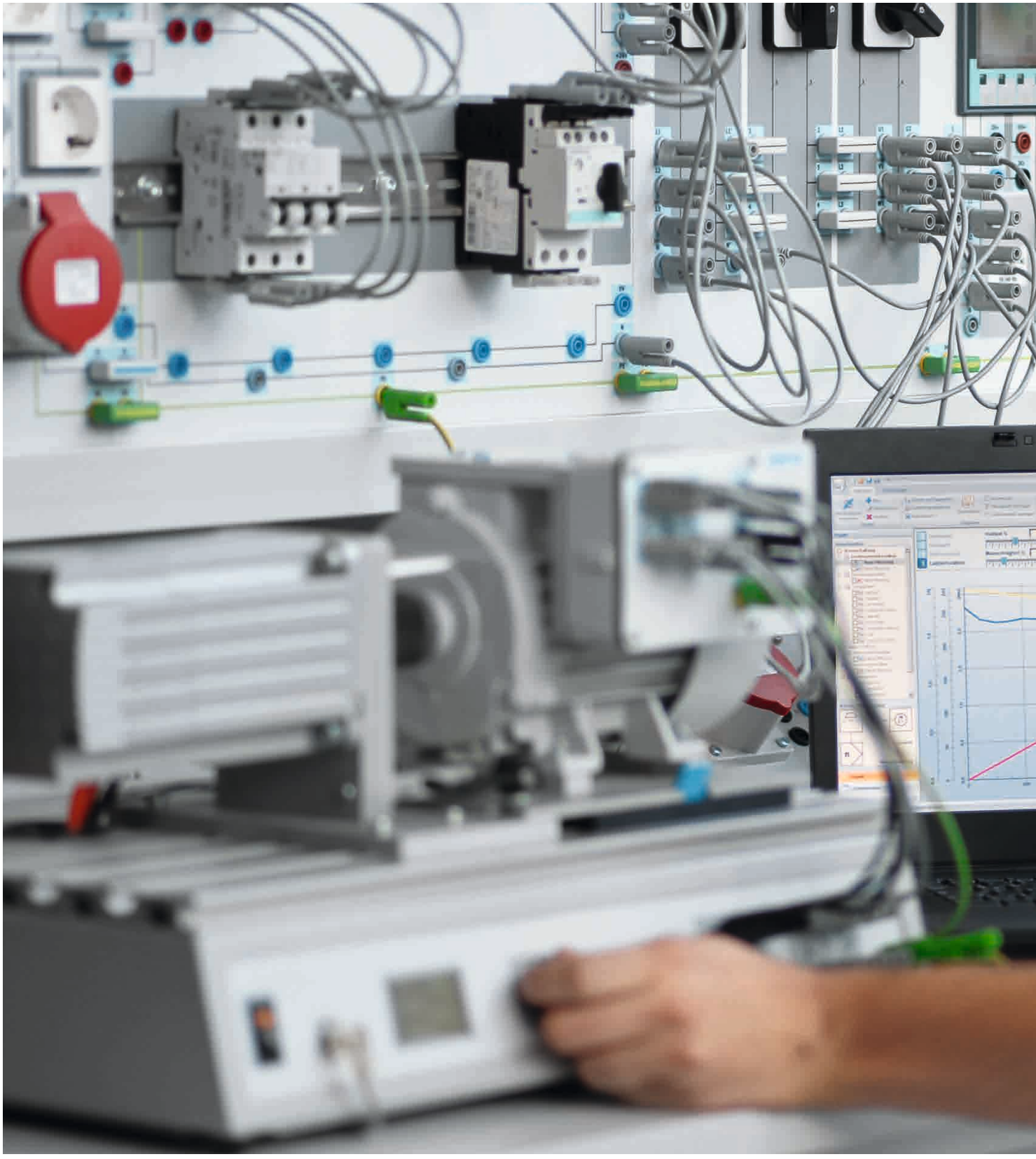
Drive Technology and Motor Control



Training Packages

Circuits with Contacts TP 1211 62
Basic Motor Control Technology TP 1221 64
Servo Brake and Drive System TP 1410 68
Stepper and Servo Motor Control Technology TP 1423 76

Project Kits

Electrical Drive Technology 78

Learning Systems

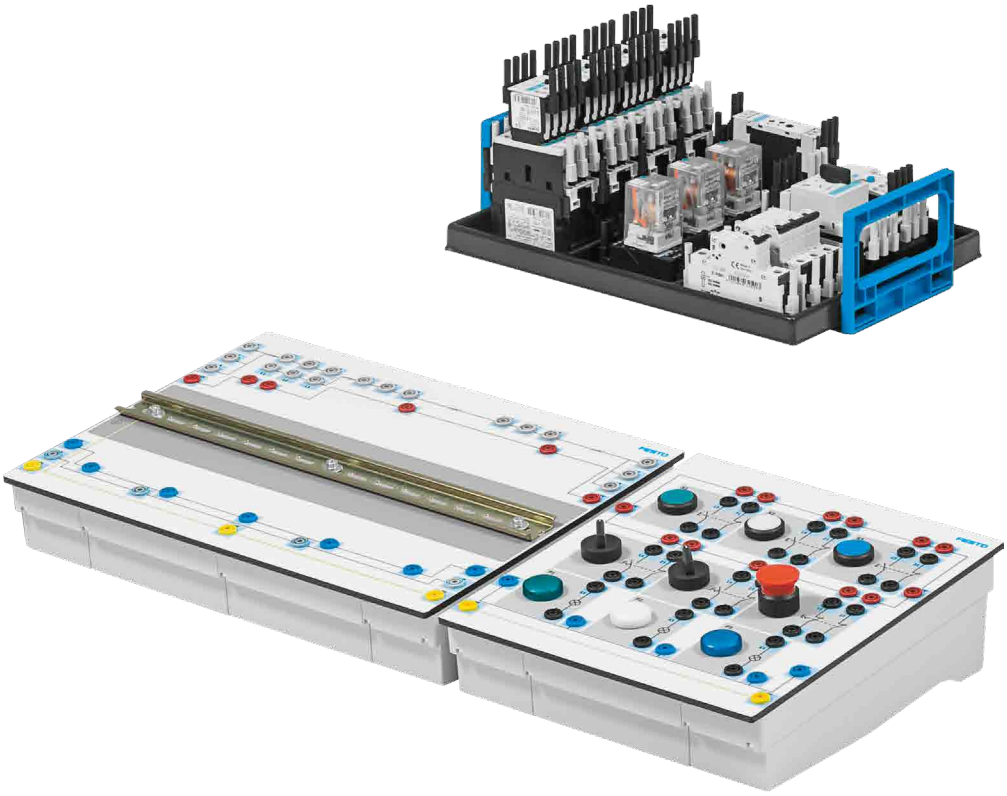
Industrial Wiring 80
Industrial Controls 82
Digital Servo 92
Variable-Frequency Drives 93

CE

Some of the learning solutions in this catalog do not carry the CE mark and cannot be ordered for delivery to Europe. If you are located in a country where this marking is required, please contact your local Festo sales representative before placing an order.

Basic Principles of Circuits with Contacts

TP 1211



The fundamentals of control technology

Basic control circuits also have their place in modern automation technology, as simple automation tasks are still set up with low-cost contactor circuits.

Realistic projects are executed using the equipment set and practical exercises. The design, function and areas of application of the components are explained along with their use.

Selecting the correct switching elements and equipment is just as important as the correct use and adjustment of protective devices.

The general operating principles are explained using examples and the basic knowledge of the control technology with contacts is explained comprehensively.

Training content

- Pushbuttons and switches
- N/O and N/C contacts
- Jog mode
- Self-latching loop
- Pushbutton lock
- Multiple control points
- Indicator lamps
- Design and function of a contactor
- Electronic time relays
- Overcurrent trigger and motor protection switch
- Equipment designations
- Connecting and testing a three-phase socket
- Main and control circuit
- Protective interlocking
- Reversing contactor circuit
- Star-delta starting up
- Reversing contactor circuit with automatic star-delta starting up

Advantages

- Extremely compact equipment
- Flexible thanks to the use of industrial components
- Easily expandable
- Jumper plugs for connecting the boards improve clarity
- Stable angled screw-in sockets for contacting
- The optional mobile solution combines work, transport and storage requirements perfectly, thus reducing the amount of work required before and after lessons

Complete equipment set TP 1211	**8208247**

The most important components at a glance:

1	1x EduTrainer Contactor Board	571814
2	1x EduTrainer Operator and Signaling Unit	571815
3	1x Motor Technology Contactor Set	571816

Necessary accessories, also order:

Soft Starter	8126037
4 mm Safety Laboratory Cables, 106 Pieces, Red, Blue and Black	8092668
4 mm Safety Laboratory Cables, 58 Pieces, Brown, Black, Gray, and Blue, with Gray Plugs	8092669
Safety Jumper Plugs (page 37)	
Protective Conductor Connecting Cables with Special Socket, 14 Pieces	8067503
Amprobe PRM-6-EUR Phase Sequence Indicator	8081205

Possiblities of expansion:

Three-Phase AC Power Supply and Safety Unit	594826
EduTrainer 24 V Power Supply Unit	571813
Three-phase AC Asynchronous Motor 400/690 V IE3	8226654
Stand-Alone Guard for Electric Machines	8118117
Electric Machines (page 70)	
Motor Protection Switch (page 69)	

Note: This training package comes disassembled. The safety connectors have to be assembled by the end user.

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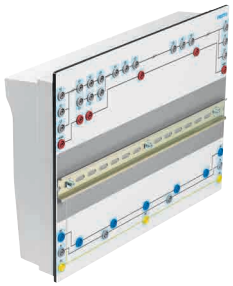

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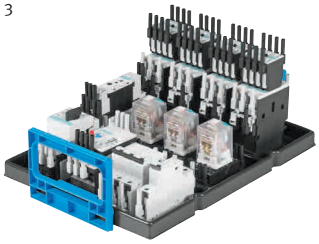


Recommended Learning Media

Workbooks (→ page 262)

Campus license:

de	570901
en	567315
es	567317
fr	567319

Printed workbooks available upon request.

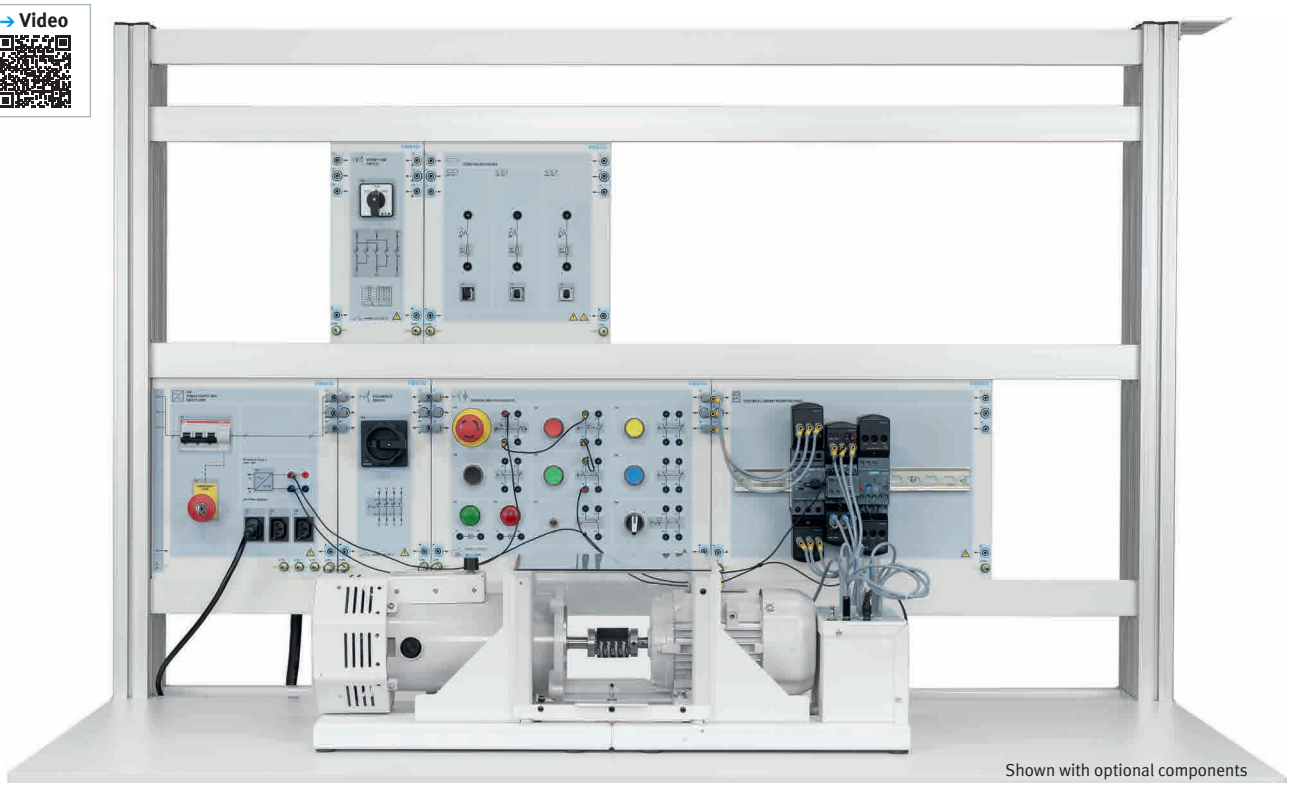
Course on Festo LX

→ Fundamentals of Circuits With Contacts

Basic Motor Control Technology

TP 1221

→ Video



Shown with optional components

The fundamentals of electric motor controllers

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 troubleshoot 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

Learning objectives

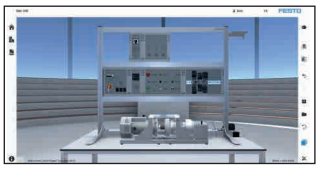
– Lockout/tagout procedures
– Symbols and schematics
– Troubleshooting components and circuits
– Control and pilot devices
– Protections (breakers, overloads)
– Manual starters
– Two- and three-wire control
– Reversing starters
– Jogging control
– Time-delay relays
– Primary resistors starters
– Star-delta starters
– Motor testing and troubleshooting

BMC SIM:
Basic Motor Control Simulator

BMCSIM enables the study of basic motor control technology in an easy-to-use 3D digital environment that can be accessed anytime, anywhere.

This online simulation software faithfully reproduces the characteristics and behaviors of the two equipment sets, enabling remote virtual lab sessions without the need for physical hardware.

Students can use BMCSIM to complete most of the exercises in the Basic Motor Control Technology student workbook.



– Interactive tool that allows remote study or lab preparation
– User-friendly interface and easy license management
– Hands-on learning activities with electrical schematics included in PDF format
– Fault-injection feature to develop troubleshooting skills

Free trial version:
→ bmcsim.festo.com

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:

7 Three-phase induction motor, 120 V, 60 Hz or	8143697
Three-phase induction motor, 230 V, 50/60 Hz	8143698
8 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 extensions:

EduTrainer soft starter	8121090
BMC SIM (1 user, 1 year)	8219723
BMC SIM (1 user, 3 year)	8219724
BMC SIM (1 user, 5 year)	8219725
SkillsConveyor *	8184210

Note: When using the SkillsConveyor in combination with the TP 1221, suitable additional motor protection devices are required and must be ordered separately: Manual Starter (order no. 8229017) and Overload Relay (order no. 8229231).

By connecting TP 1221 with the SkillsConveyor, students gain a deeper understanding of how basic motor controls integrate into modern automated processes.

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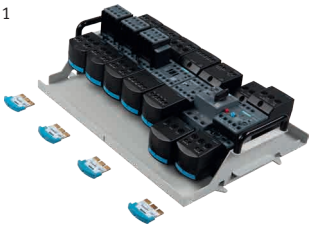

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Recommended Learning Material

Workbooks (→ page 262)

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”. Printed workbooks available upon request.

Course on Festo LX

→ Basic Motor Control Technology

Basic Motor Control Technology

TP 1221-P

→ Video

By connecting TP 1221 with the SkillsConveyor, students gain a deeper understanding of how basic motor controls integrate into modern automated processes.

The fundamentals of electric motor controllers

The training package Basic Motor Control Technology builds knowledge and skills in the fundamentals of industrial electric motor controllers.

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.

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
- Safe grounding method PE+

All the equipment required to perform the practical exercises is contained in the rugged suitcase for convenient storage and transportation.

Complete Equipment Set TP 1221-P	**8145472**

Notes: Measuring instruments sold separately. Also, three-phase power (120 – 208 V or 230 – 400 V, 5 wires including neutral and ground) is required for operation.

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
- Tabletop mounting plate with DIN rail
- Safety laboratory cables
- Three-phase power cord

Recommended extensions:

BMC SIM (1 user, 1 year)	8219723
BMC SIM (1 user, 3 year)	8219724
BMC SIM (1 user, 5 year)	8219725
SkillsConveyor *	8184210

Note: When using the SkillsConveyor in combination with the TP 1221, suitable additional motor protection devices are required and must be ordered separately: Manual Starter (order no. 8229017) and Overload Relay (order no. 8229231).

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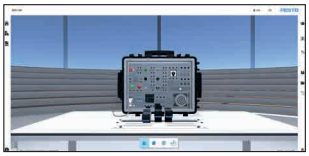


- Interactive tool that allows remote study or lab preparation
- User-friendly interface and easy license management
- Hands-on learning activities with electrical schematics included in PDF format
- Fault-injection feature to develop troubleshooting skills

Free trial version:
→ bmcsim.festo.com

Recommended Learning Material

Workbooks (→ page 262)

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". Printed workbooks available upon request.

Course on Festo LX
→ Basic Motor Control Technology

Servo Brake and Drive System

TP 1410

A compact and powerful motor testing platform

Modern drives are characterized by the integration of electrical and mechanical components into complete systems.

In addition to the fundamentals of the rotating electrical machines, the system approach and practical relevance play a decisive role in an effective learning concept.

Enclosed in a compact housing, this equipment set incorporates a complete, flexible and convenient load and drive system, which is used to analyze the systems to be examined in different load situations.

The unique didactic concept makes a clear distinction between the unit under test and the load. The practical quick-change system makes it easy to set up and change the machines to be examined. The unit under test circuits are created using reliable and flexible A4 EduTrainer modules.

Simple tests such as the recording of a characteristic curve can be performed manually with the brake system, with no need for a PC and software. Measured values, characteristics and function mode are shown on the integrated display.

The convenient DriveLab software provides a wide range of options.

With the electric teaching machines, virtually all electric circuits and drives that exist in industry, in trade and in the home can be explained practically and effectively.

The range of drives includes systems of varying degrees of complexity, including single-phase and three-phase drives, DC drives and modern servo drives.

Training content
- Electric drive technology components
- DC drives
- AC drives
- Three-phase drives
- Special purpose machines
- Actuation with contact
- Frequency converters
- Communication technology

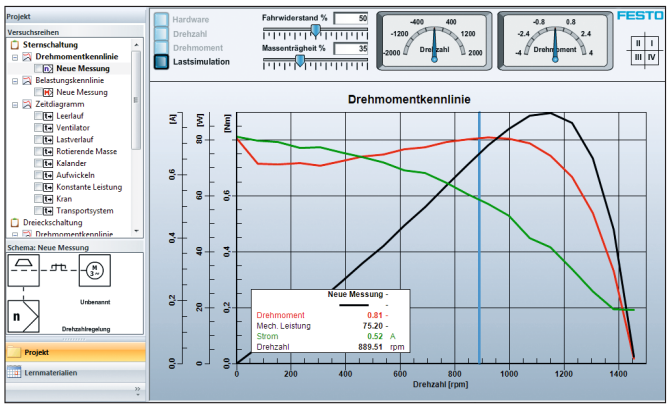
Technical data
- Input voltage: 1 AC/110 – 230 V, 50 – 60 Hz
- Control console housing with rubber feet for use in the desk
- Connection via 4 mm safety connector
- Integrated EMC filter
- Integrated braking resistor

Complete equipment set TP 1410	**8121044**

The most important components at a glance:
– 1x Servo brake and drive system
– 1x Transparent shaft cover
– 1x Coupling sleeve
– 1x DriveLab software
– 1x USB connecting cable

Possibilities of expansion:

Electric machines (next page)
Motor protection switch (see below)
Control units for electric machines (page 71)
Basic Principles of Circuits with Contacts TP 1211 (page 62)
Sinamics G120 EduTrainer TP 1410 (page 73)
IGBT Training Package for TP 1410 (page 74)
FluidSIM-Electrical Engineering (→ page 258)



The convenient and intuitive **DriveLab** software supports the automatic recording of machine characteristic curves, the parameterization of a static load and the simulation of load models for the examination of drives under realistic conditions.

The comparison and optimization of different drive concepts can be carried out in the form of project exercises.

Sample configurations provide a quick and easy-to-understand introduction.

Different load models:
– Inert load
– Pump/fan
– Hoist drive
– Calendar
– Winder drive
– Lathe
– Traversing drive

Motor Protection Switch
High-quality, industrial switching device from Siemens with 4 mm safety elbow adapters for professional protection of rotating electric machines. Mounting on 35 mm H-rail. Auxiliary contacts 1 N/O contact + 1 N/C contact.

0.35 – 0.5 A	**576284**
0.55 – 0.8 A	**573266**
1.1 – 1.6 A	**573267**
1.8 – 2.5 A	**573268**
2.2 – 3.2 A	**573269**

Recommended Learning Material

Workbooks (→ page 262)

Fundamentals of DC Machines
Campus license:

de	571781
en	571783
es	571785

Fundamentals of AC Machines
Campus license:

de	571789
en	571791
es	571793

Fundamentals of Three-Phase Current Machines
Campus license:

de	571797
en	571799
es	571801
fr	571803

Printed workbooks available upon request.

Courses on Festo LX:
→ Fundamentals of DC Machines
→ Fundamentals of AC Machines
→ Fundamentals of Three-Phase Current Machines
→ Speed Control of Three-Phase Asynchronous Motors with Frequency Converters

Optional Electric Machines for TP 1410

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– Sturdy special design for training purposes
– Neutral rating plate
– Over-temperature protection (NC contact) in the winding
– Fully assembled and aligned on support plate
– One shaft end, equipped with coupling piece suitable for the servo brake and drive system
– Support plate with clamping slot and quick action mounting system for profile plate
– All connections on safety sockets
– Other machines are available on request, for example a Three-Phase Reluctance Motor and a Three-Phase Motor Pole-Switchable.

1 **DC Shunt Machine**
– Power rating: 0.3 kW
– Speed: 2,000 rpm
– Armature: 220 V/1.8 A
– Field: 220 V/0.3 A

Order no. **571868**

2 **DC Series Machine**
– Power rating: 0.3 kW
– Speed: 2,000 rpm
– 220 V/1.9 A

Order no. **571869**

3 **Universal Motor**
– Power rating: 0.2 kW
– Speed: 3,000 rpm
– AC 230 V/3.0 A
– DC 140 V/2.5 A

Order no. **571871**

4 **Capacitor Motor**
– Power rating: 0.25 kW
– Speed: 1,400 rpm
– cos φ: 0.99
– AC 230 V/1.86 A
– Running/starting capacitor: 25 µF/10 µF

Order no. **8203026**

5 **Three-Phase Current Asynchronous Motor 230/400 V IE3**
– Power rating: 0.25 kW
– Speed: 1,395 rpm
– cos φ: 0,72
– Star circuit: 400 V/0,68 A
– Delta circuit: 230 V/1,19 A

Order no. **8226794**

Three-Phase Current Asynchronous Motor 400/690 V IE3
– Power rating: 0.25 kW
– Speed: 1,395 rpm
– cos φ: 0,72
– Star circuit: 690 V/0,40 A
– Delta circuit: 400 V/0,68 A

Order no. **8226654**

6 **Synchronous Machine**
– Power rating: 0.3 kW
– Speed: 1,500 rpm
– cos φ: 0,97
– Exciter: 150 V/0.95 A
– Star circuit: 400 V/0.66 A
– Delta circuit: 230 V/1.14 A

Order no. **572095**

DC Compound Machine
– Output: 0.3 kW
– Speed: 2000 r.p.m
– Armature: 220 V/1.8 A
– Field: 205 V/0.25 A

Order no. **8023977**

Three-Phase AC Multifunction Machine (AC slip ring rotor, can be synchronized)
– Output: 0.27 kW
– Speed: 1360/1500 r.p.m. 50 Hz
– cos φ: 0.7/1.0
– Star connection: 400 V/0.83 A
– Delta connection: 230 V/1.44 A
– U2: AC 107 V/1.7 A; DC 20 V/4.0 A

Order no. **8023978**

Dahlander
– Output: 0.3/0.43 kW
– Speed: 1390/2800 r.p.m 50 Hz
– cos φ: 0.73/0.8
– Double star circuit: 400 V/1.2 A
– Delta connection: 440 V/0.89 A

Order no. **8023979**

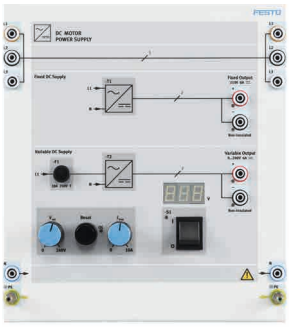
7 **Slip Ring Rotor**
– Output: 0.27 kW
– Speed: 1360 r.p.m 50 Hz
– cos φ: 0.72
– Star connection: 400 V/1.16 A
– Delta connection: 230 V/2 A
– U2: 95V

Order no. **8023980**

8 **Stand-Alone Guard for Electrical Machines**
Transparent protective cover for mounting over the rotating shafts of our electrical machines for protection against contact and for safe operation of machines in standalone mode.

Order no. **8118117**

Control Units for the Electric Machines of TP 1410



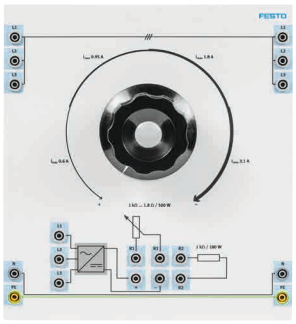
DC Motor Power Supply

The module provides electrical supplies for electrical machines where DC power is required. It provides a fixed 210 V DC power source and a variable DC power source from 0 to 240 V.

The variable DC power source voltage can be easily adjusted using the front panel knob and digital display. A second front-panel knob allows the current to be limited for certain applications.

Technical data
– Input voltage: 3 AC/400 V/50 Hz
– Fixed DC output: 210 V/8 A
– Variable DC output: 0 – 240 V/6 A, short-circuit and overload protected
– Peak current limit on the variable DC output: 0 – 10 A
– Suitable for use in A4 mounting frames
– Dimensions (H x W x D): 297 x 266 x 140 mm
– Weight: 6.1 kg

Order no. **8111319**



EduTrainer Load Resistance

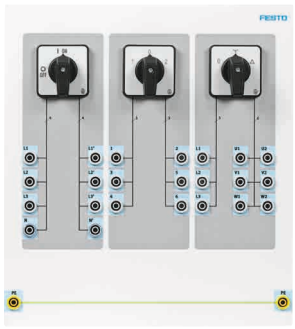
The Load Resistance is used to load electrical machinery for use as generators or as starting resistors for slip ring rotors. It consists of a rheostat with an upstream protecting resistor. An additional fixed resistor can extend the load range. The rheostat is infinitely adjustable; the multi-level winding allows different maximum peak currents to be set as loads.

The 3-phase rectifier allows the load resistance to be used as a load for alternating and 3-phase current sources.

All connection locations are standardized and are laid out as safety sockets.

Technical data
– Maximum input voltage: 230 V DC, 3x 400 V AC
– Load capacity: 500 W
– Setting range: 1.8 – 1 kΩ
– Maximum current:
  1.8 – 30 Ω, 3.1 A
  30 – 56 Ω, 1.8 A
  56 – 140 Ω, 0.95 A
  140 – 1 kΩ, 0.6 A
– Protecting resistance: 1.8 Ω
– Extension resistance: 1 kΩ/180 W
– Front panel: 266 x 297 mm
– For use in an A4 frame
– Connection via 4 mm safety plugs
– Through-feed for 3 x 400 V AC

Order no. **8037136**



Motor Switches

The Motor Switches are designed for direct switch activation of electric machines. Equipped with on/off switch, polarity reversal switch and star/delta switch.

All connection locations are standardized and are routed to safety sockets or system plugs.

Technical data
– Input voltage: 3 AC/400 V
– Output voltage: 3 AC/400 V
– Load capacity: Maximum 16 A
– Front panel: 266 x 297 mm
– Desk housing with rubber feet, also suitable for use in A4 mounting frames
– Connection via 4 mm safety plug

Order no. **576309**

EduTrainer Field Rheostat

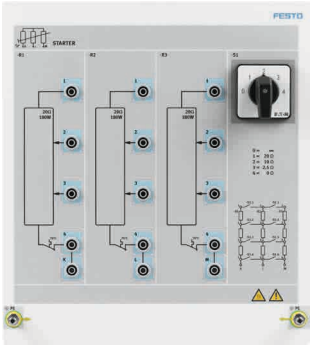
The Field Rheostat allows the field voltage of motors and generators to be reduced if a set direct voltage is used. By connecting a variable resistor upstream, an exciter field can be set. The resistor is infinitely adjustable.

All connection locations are standardized and are laid out as safety sockets.

Technical data
– Maximum input voltage: 230 V DC
– Maximum load capacity: 100 W
– Setting range 0 – 1.5 kΩ
– Maximum current:
  0 – 450 Ω, 0.5 A
  450 – 1.5k Ω, 0.25 A
– Front panel: 133 x 297 mm
– For use in an A4 frame
– Connection via 4 mm safety plugs
– Through-feed for 3 x 400 V AC

Order no. **8036772**

Control Units for the TP 1410 Electric Machines



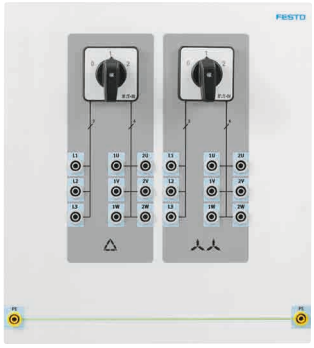
Slip Ring Starting Resistors

The module houses three identical power resistors, each with three different taps for various resistance values used for starting slip-ring motors.

Using a four-position rotary switch, resistors can be used independently or connected together in a star configuration for different resistance values. Power resistors can then be connected in steps to the rotor of a slip-ring motor. Turning the switch to a different position reduces the resistance at each tap until it reaches zero and the rotor windings are fully connected together in a resistance-free star configuration. Using 4 mm safety sockets, all taps of the resistors can be accessed to guarantee flexibility for different applications.

Technical data
– Three identical power resistors with three taps for various resistance values
– Resistance values (for each resistor): 20/10/2.5 Ω
– Rated load (for each resistor): 180 W at 20 Ω
– Dimensions (H x W x D): 297 x 266 x 140 mm

Order no.	**8109369**



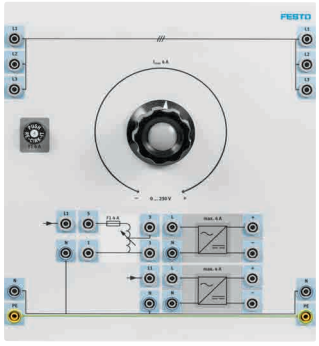
EduTrainer Dahlander Switch

The motor switches are designed for direct switch activation of electric machines.

Fitted with a Dahlander switch and switches for asynchronous motors with separate windings. The locations of all connections are standardized and are routed to safety sockets or system plugs.

Technical data
– Input voltage: 3 AC/400 V
– Output voltage: 3 AC/400 V
– Load capacity: Maximum 16 A
– Front panel: 266 x 297 mm
– Desk housing with rubber feet, also suitable for use in A4 mounting frames
– Connection via 4 mm safety plug

Order no.	**8040011**



EduTrainer Variable Transformer

Single-phase variable transformer for providing a variable alternating current. Alternatively, the device can be used via the integrated rectifier as an unsmoothed direct current source with a variable and a fixed output, e.g. for supplying electrical machinery. The integrated device circuit breaker deactivates the variable output voltage in the event of an overload or short circuit.

The locations of all connections are standardized and are routed to safety sockets or system plugs.

Technical data
– Input voltage: 1 x 230 V AC
– Output voltage: 1 AC/0 – 230 V, short-circuit and overload protected
– Max. output current: 4 A
– Rectifier load capacity: 4 A
– Front panel 266 x 297 mm
– For use in an A4 frame
– Connection via 4 mm safety plugs
– Through-feed for 3 x 400 V AC

Order no.	**8037127**

Soft Starter EduTrainer

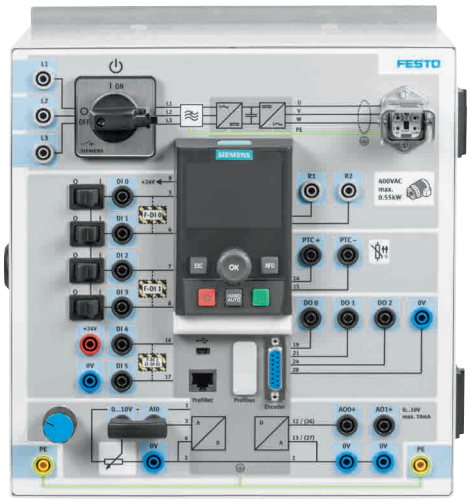
The soft starter is an electronic motor control unit for optimizing the start and stop phases of asynchronous three-phase induction motors (soft starts and soft stops). The motor controller increases or decreases the voltage delivered to the motor during the start and stop phases in order to optimize the torque generated by the motor (acceleration torque) and the current demand (switch-on current).

This version of the EduTrainer is designed for use in the A4 mounting frame and the use of 4 mm safety lab cables. The Softstarter EduTrainer is part of learning systems described in the workbook for equipment set TP 1211.

Technical data
– Input/output power: 200 - 480 V AC (L1 – L3), 3 A, 50 – 60 Hz
– Control voltage (terminals A1-A2, 1): 24 V AC/DC
– Auxiliary contact (1 NO/NO): 24 V DC, 1 A (utilization category DC-13), 230 V AC, 3 A (utilization category AC-15)
– Compatible with devices up to 350 W
– Designed for use in the A4 mounting frame
– Dimensions (H x W x D): 297 mm x 133 mm x 140 mm

Order no.	**8121090**

Sinamics G120 EduTrainer



A safe variable-frequency drive learning solution

The next generation of the Sinamics G120 frequency converter – Optimized even further for training. Now in a completely new housing and EMC-compliant for use in laboratories without heeding installation instructions – just like that!

The G120 is well-suited as a beginner device, however its comprehensive functions offer plenty of potential for advanced users who want to implement complex drive tasks. Various bus systems, advanced safety functions and an optional encoder input permit perfect adjustment to the requirements and integration in control systems. All relevant ports are accessible on the front of the device and installed in 4 mm safety sockets or system connectors.

The motor is connected via the cable sold separately which permits EMC-compliant operation. The devices can be used flexibly – suspended in an A4 frame or on a table, and are equipped with an EMC filter with low leakage current. The corresponding control panels (BOP-2, IOP) are available as accessories.

Characteristics
- Simple parameterization via STARTER and the BOP-2 or IOP control panels
- Versatile, programmable inputs/outputs voltage/frequency characteristic curves for constant, square torque
- Encoder-free vector regulation brake functions (resistance, DC, motor holding, compound brake)
- Integrated protection/overload functions

Technical data
- 6 digital inputs, depending on the variant, 2 of which can be parameterized as failsafe inputs
- 3 digital outputs
- 1 analog input
- 2 analog outputs
- 3m USB cable included
- Connections for temperature sensor and for external braking resistor
- Input:
  1x 200-240 V AC (Order no. 8105137)
  3x 380-480 V AC (Order no. 8037819 and 8105421)
- Output:
  3x 400 V AC, 0.55 kW (Order no. 8037819) or 0.75 kW (Order no. 8105421 and 8105137)

1 **Intelligent Operator Panel (IOP-2)**
Powerful operator panel with large plain text display and menu navigation. The application wizard guides you through the startup procedure for important applications. The general startup procedure is performed with quick-startup wizards. Up to two percentages can be displayed graphically or numerically. Updatable and extendable via USB interface.
Order no. **8022476**

1

2 **Basic Operator Panel (BOP-2)**
Operator panel with 2-line display and basic startup menu navigation. Two percentages can be numerically displayed at the same time for frequency converter diagnostics.
Order no. **8022475**

2

3 **EMC Motor Cable**
Pre-assembled cable, prepared to connect the asynchronous machine and frequency converter with one another with EMC compliance. The shielded cable has a system plug for connecting to the converter; on the motor side, it is equipped with a shielded terminal and individual 4 mm safety plugs. Set including shield connection adapter for motor. Length: 2 m.
Order no. **8038849**

3

4 **Set of Feet and Device Handle**
Using the frequency converter on a table is more convenient with the optional conversion set. The set comprises 2 fixed and 2 fold-out device feet, a folding device handle and the required mounting material.
Order no. **8036788**

4

5 **Startdrive Software**
Software program for parameterization, startup, optimization, diagnostics and control
Order no. **8105776**

5

Sinamics G120 EduTrainer - DP	**8037819**
Sinamics G120 EduTrainer - PN-F with encoder port (1 AC input)	**8105137**
Sinamics G120 EduTrainer - PN-F with encoder port (3 AC input)	**8105421**

Fundamentals of Frequency Converters with IGBT

Extension Package for TP 1410

[X] Shown with TP 1410 and optional components

Order no.	**8246149**

The most important components at a glance:

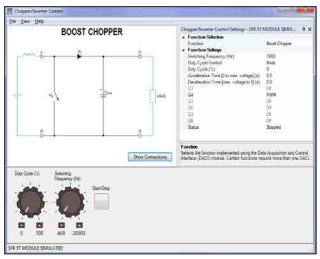
IGBT Chopper/Inverter	**8167609**
Rectifier and Filtering Inductors/Capacitors	**8243905**
Three-Phase AC Filter	**8166653**
Three-Phase AC 400V / DC 230V / Power Supply	**594825**
24 V AC Power Supply	**793290**
Data Acquisition and Control Interface DACI-1	**595912**
Chopper/Inverter Control Function Set 9069-2	**581453**

Note: The modules are components of the training packages in electric power technology shown on pages 94 – 187. Refer to these pages for the technical descriptions of all modules.

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4)	8153360

Note: A computer with a Windows 10/11 operating system is also required.



The **chopper/inverter control function** enables students to adjust switching patterns, pulse width modulation (PWM), and duty cycles, gaining practical skills in power electronics control strategies. Students develop a system-level understanding of how IGBTs influence the performance of converters and inverters.

Explore the fundamentals of frequency converters based on Insulated Gate Bipolar Transistor (IGBT) technology.

Designed to be used in conjunction with the Servo Brake and Drive System TP 1410, the IGBT Training Package provides the basis for studying the operating principles of variable-frequency drives.

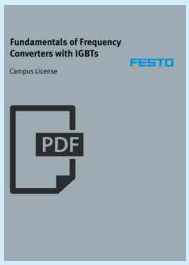
This product combination gives students hands-on experience with the principles of modern power electronics and motor control. They learn how AC power is converted, filtered, and inverted using IGBT technology, and how variable-frequency drives control motor speed and torque.

By analyzing rectification and three-phase variable-frequency induction-motor with or without constant V/F ratio, students develop a deep understanding of the conversion chain from power supply to motor. Real-time monitoring and analysis strengthen the link between theory and practice, preparing learners to apply their knowledge of frequency converters and drive systems in real-world applications.

The free LVDAC-EMS software streamlines lab work and boosts system understanding. Learners can use a complete set of **software-based instruments** – including an oscilloscope, meters, and analyzers – to measure, record, and analyze electrical and mechanical parameters such as speed, torque, power, and energy in real time.

Recommended Learning Material

Workbook (→ page 262)



Campus license:

en	8244290

Note: The campus license includes the student and the instructor PDF versions of the workbook “Fundamentals of Frequency Converters with IGBTs”. Printed workbooks available upon request.

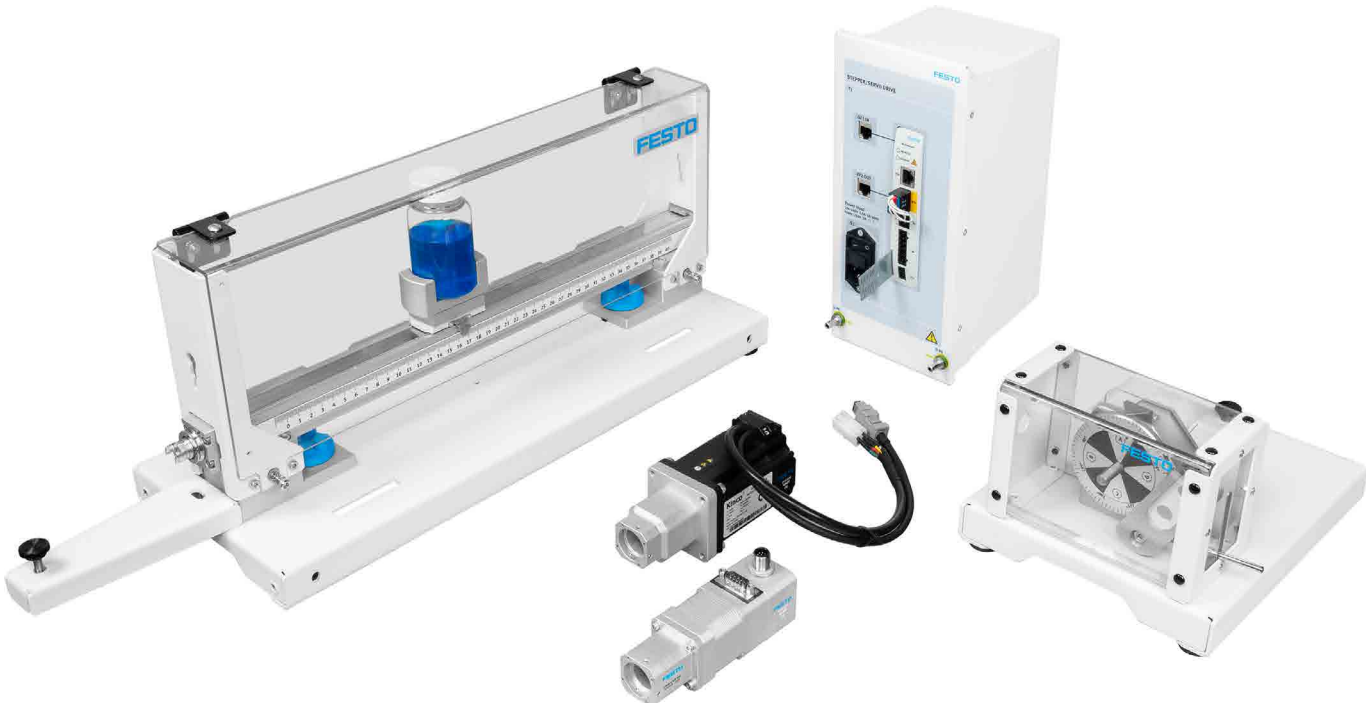
Course on Festo LX

Coming soon

A versatile, efficient setup
With the TP 1410 and its various options, including different types of electric motors, control modules, and frequency converters, learners can gain hands-on experience operating and understanding industrial electric motor technology.

Stepper and Servo Motor Control Technology

TP 1423



Position, speed, and torque control essentials

This flexible training package offers a secure and controlled environment for developing skills in the installation, commissioning, configuration, maintenance, and troubleshooting of servo and stepper motor-driven systems.

Learners gain essential hands-on experience in stepper motor and servo motor control technology, focusing on position, speed, and torque control. Learning activities are designed to develop technical and soft skills of automation specialists, industrial electricians, or electrical and maintenance technicians.

The course covers fundamental topics: operating principles of stepper and servo motors, drive configuration and commissioning, wiring, motor sizing techniques, homing, motion profiles creation, troubleshooting, power transmission methods, PID control, and more.

Sturdy equipment provides a safe work environment. Protective guards ensure learners' safety during experimentation. Industrial components from Festo increase realism and durability. The drive can be configured and commissioned using the free software Festo Automation Suite. Both servo and stepper motor can be controlled by the same controller and drive the linear- and angular single-axis applications.

Benefits
- Development of universal skills required for many professional occupations
- Compact solution that can be tailored to various training needs
- Ready-to-use course material to expedite lesson planning
- Alignment with industry requirements, facilitating swift skills transfer to the workplace
- Diverse learning activities encompassing real-life applications for industrial relevance

Highlights
- Modern, industrial components from Festo
- One controller for both motors
- Linear- and angular-axis, and gantry applications
- Free, professional configuration software: Festo Automation Suite

Learning goals
- Understand the working principles of stepper and servo motors, including their construction, operation, and applications
- Learn the process of drive commissioning and diagnostics, including parameter settings and troubleshooting techniques
- Learn the principles of open- and closed-loop control, including the use of encoders and feedback devices for accurate positioning and speed control
- Explore the concepts of PID control for position, speed, and torque control in stepper and servo motor applications
- Develop the skills to control and coordinate multiple axes independently, enabling complex motion sequences with a PLC

Stepper and Servo Motor Control Technology TP 1423	**8200387**

The most important components at a glance:

1 Stepper and servo motor controller	8179953
2 Rotative-axis application	8180132
3 Linear-axis application	8191671
4 Stepper motor kit	8180475
5 Servo motor kit	8191670

Stepper Motor Control Technology TP 1422	**8200389**

The most important components at a glance:

Stepper and servo motor controller	8179953
Linear-axis application	8191671
Rotative-axis application	8180132
Stepper motor kit	8180475

Servo Motor Control Technology TP 1421	**8200388**

The most important components at a glance:

Stepper and servo motor controller	8179953
Linear-axis application	8191671
Rotative-axis application	8180132
Servo motor kit	8191670

To expand, also consider:

6 Adapter kit for TP 1410	8196774
Gantry application update kit	8197527
EduTrainer Universal with SIMATIC S7-1500 (S7-1512C-1PN) **or**	8065595
TP700, HMI Rack	8022729

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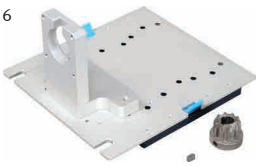


Recommended Learning Material

Workbooks (→ page 262)

Campus licenses:

en	8200982

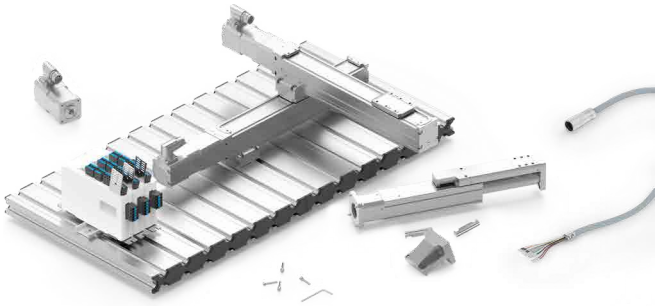
Notes:The campus license includes the student and instructor versions of the workbooks “Stepper and Servo Motor Control”, “Stepper Motor Control”, and “Servo Motor Control”. Printed workbooks available upon request.

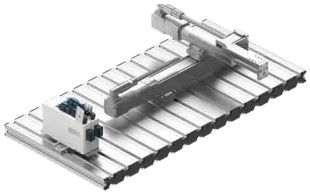
Courses on Festo LX

- → Stepper and Servo Motor Control
- → Stepper Motor Control
- → Servo Motor Control

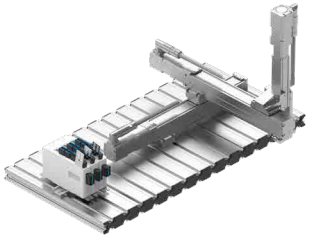
Electrical Drive Technology Project Kits

Practical Training with Industrial Components





Configuration example:
2-axis handling with
– 2x Drive Kit
– 1x Spindle Axis Kit
– 1x Linear Slide Kit
– And a profile plate, if necessary



Configuration example:
3-axis handling with
– 3x Drive Kit
– 2x Spindle Axis Kit
– 1x Linear Slide Kit
– And a profile plate, if necessary

A new concept
Vocational training should be as practice-oriented as possible and always include projects carried out by the learners.

Projects are defined by open outcomes and require independent planning, implementation, and control — aspects that are not always fully achievable with traditional learning systems.

Moreover, apprentices should have the opportunity to engage with the latest industrial technologies during their training.

The new Project Kits from Festo Didactic, offered for the first time, address both of these needs.

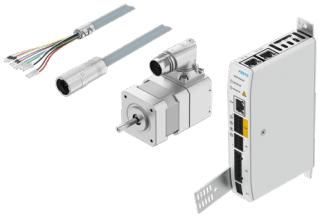
Highlights
– State-of-the-art industrial drive components from Festo
– Suitable for project work
– High accuracy
– Affordable price for training

Exciting projects
The first project kits focus on electrical drive technology and currently include the three packages listed below.

The drive can be mounted on either axle using the included attachment kits, and the axles can be combined to create a variety of applications—such as two- or three-axis handling systems, sorting units, or lifting mechanisms. The only limit is your imagination!

The inverters can directly control simple motion sequences. Thanks to their multi-protocol capability (EtherCAT, EtherNet/IP, Modbus/TCP, PROFINET), they are compatible with all common industrial controllers.

Learners have access to extensive original documentation for their projects, as well as a wide selection of tutorial videos on YouTube—explaining, for example, how to parameterize the inverter. This allows them to practice workflows exactly as they would in an industrial setting. In addition, numerous courses on our LX learning platform can help prepare learners for successful project work.



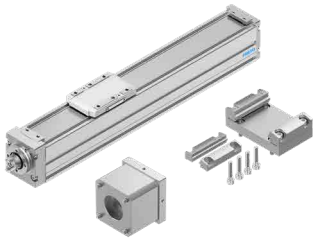
Drive Project Kit

This project kit consists of:
– Servo drive CMMT-ST-C8-1C-MP-S0 for stepper and BLDC motors, which can control simple motion blocks directly, but can also be controlled via a PLC using the EtherCAT – EtherNet/IP – Modbus/TCP – PROFINET protocols. Protection class IP 20, for DIN rail mounting, nominal current per phase 8 A
– Stepper motor EMMT-ST-42-S-RS size 42, according to IEC 60034, nominal torque 0.24 Nm, nominal rotational speed 600 rpm, absolute encoder single turn with 65536 position values per revolution, operating voltage 48 V, nominal power 17 W, nominal current 1.8 A
– Suitable connecting cable NEBM-M17G12-EH-2.5-Q6N-LE12 for stepper and BLDC motors, 12 cores, 2.5 m long, energy chain-compatible, max. 48 V, 7.6 A
– Commissioning with the free Festo Automation Suite software

The kit is compatible with the electrical linear drive and linear slide project kits.

No course materials are provided for the project kits, but full component documentation is available online.

Order no. **8228012**



Spindle Axis Project Kit

This project kit consists of:
– Ball screw axis ELGC-BS-KF-45-200-10P, size 45 with ball screw and recirculating ball bearing guide, 200 mm stroke, 100 N max. feed force, 0.15 mm reversing backlash, max. speed 0.6 m/s and lifetime lubrication
– Axial mounting kit EAMM-A-V32-42A for mounting a size 42 stepper motor
– Adapter kit EHAA-D-L2-45-L2-45 for mounting the axis on a flat surface or slide

The kit is compatible with the motor and controller project kit.

No course materials are provided for the project kits, but full component documentation is available online.

Order no. **8228014**

Linear Slide Project Kit

This project kit consists of:
– Mini slide EGSC-BS-KF-32-100-8P, size 32, stroke 100 mm, recirculating ball bearing guide and recirculating ball screw, reversing backlash 0.15 mm, max. speed 0.5 m/s, max. feed force 60 N, materials aluminium, steel, mounting option for limit switch
– Axial kit EAMM-A-V25-42A for mounting a size 42 stepper motor
– Angle kit EHAA-D-L2-45-L2-32-AP for mounting the slide at right angles to a slide or flat surface.

The kit is compatible with the motor and controller and electrical linear drive project kits.

No course materials are provided for the project kits, but full component documentation is available online.

Order no. **8228015**

Power Supply Unit

This project kit consists of:
- Fixed power supply CACN-3A-1-10-G2, output current 24V, max. 10 A, protection class IP20, cooling via free convection, for DIN rail mounting, approval according to EMC and Low Voltage Directive, UL.

The kit is compatible with the motor and controller, electrical linear drive and linear slide project kits.

No course materials are provided for the project kits, but full component documentation is available online.

Order no. **8228013**

Industrial Wiring

Proficiency with Electrical Installations

→ Video

[X] 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

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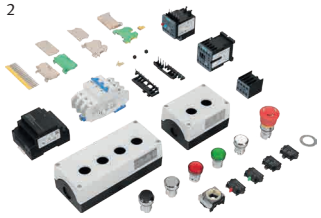

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Recommended Learning Material

Workbooks (→ page 262)

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”. Printed workbooks available upon request.

Courses on Festo LX

- → Industrial Wiring
- → Crimping Tool – How Tool
- → Insulation-Stripping Plier – How Tool

Industrial Controls Learning Systems

Theory and Techniques of Electric Motor Controllers

LabVolt Series 8036

The Industrial Controls Learning Systems are designed to teach the theory and techniques of electric motor controllers. They allow students to select and mount control devices to form typical control circuits, and to troubleshoot them once a fault is inserted. The modularity of the systems offers unique controls learning possibilities.

The Industrial Controls Learning Systems comprise four basic systems, each covering a specific topic that deals with various aspects of industrial controls equipment operation.

- Basic Controls (8036-1) provides students with a complete basic learning in motor controls.
- Programmable Logic Controller (8036-2) introduces students to PLCs for motor operation control.
- Motor Drives (8036-3) introduces students to dc and ac drives.
- Sensors (8036-4) introduces students to photoelectric and proximity switches.

The control devices and motors in the 8036 Series are of standard industrial quality. Device designations can be added to each module with magnetic labels. Each module is equipped with up to four faults that can be inserted by the instructor using switches hidden behind the faceplate. Typical faults include open coils and contacts, dirty contacts, shorted connection, and crossed wires.

Courseware

The Industrial Controls Learning Systems courseware consists of student manuals and instructor guides. The student manuals are divided into several units, each consisting of a series of hands-on exercises dealing with a particular topic of industrial controls. Each exercise provides a clearly stated objective, a discussion, an exercise procedure, a summary, and a set of review questions.

An additional ten-question test at the end of each unit allows the student to verify what was learned in the unit. The instructor guides contain the practical results and the answers for each hands-on exercise in the student manuals. They also contain the answers to the unit test questions

Integration into Electromechanical Learning Systems

The Industrial Controls Learning Systems can be integrated into the 0.2-kW Electromechanical Learning Systems using the workstation and power supply provided with these systems.

All workbooks included in a single campus license

All PDF workbooks, including student and instructor versions, are conveniently bundled in a single campus license with order no. 580468 (EN) or 580469 (ES).

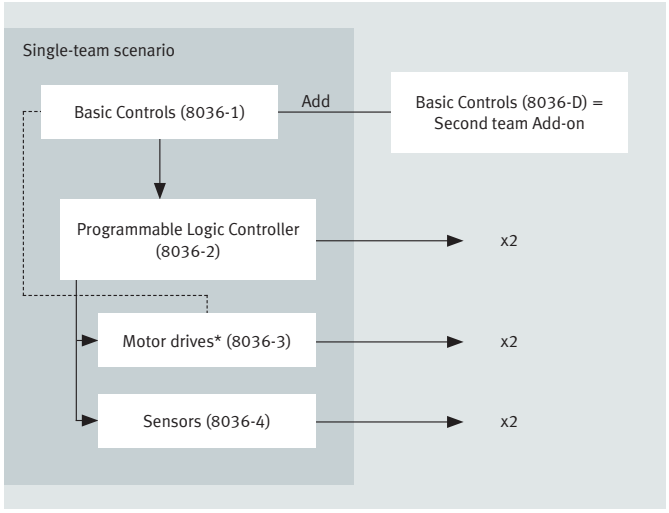
Printed workbooks remain available upon requests.

Highlights
- Extensive array of modules makes it possible to create setups filling many learning needs
- Wide variety of modules representative of control components found in the industry
- Electrical connections between the modules mirror real-life connections
- Comprehensive curriculum
- Safety features such as a lockable cut-out switch, a tag-out device, and banana plug leads
- Insertion of faults to teach troubleshooting
- Sturdy, mobile, two-sided workstation
- Simulation software available

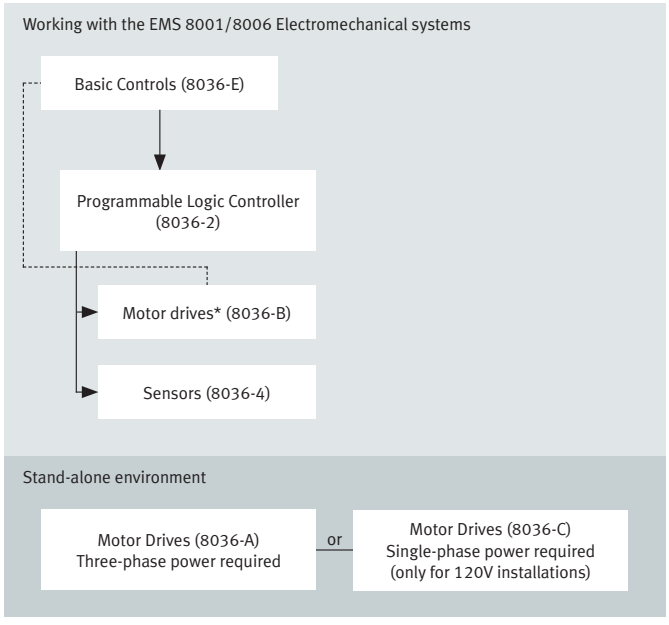
General learning content
- Electric Motor Controls
- Circuit Layout and Specifications
- Basic Control Circuits
- Jogging Control Circuits
- Reduced AC Voltage Starters
- Controls with Electronic Devices
- AC and DC Drive Controls
- Programmable Logic Controllers
- Sensors
- Troubleshooting

Different learning scenarios
The modularity of the Industrial Controls Learning Systems allows instructors to build a customized solution. The flowcharts describe different possible learning scenarios and how they supplement each other for one or two teams of students, with several options.

Two-team scenario (standard environment)



Other possible scenarios



* Notes:
These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations.
Please check with your sales representative if you want to use Motor Drives as a direct add-on to Basic Controls, or if you want to order a system independent of its prerequisite system(s).

Basic Systems

Basic Industrial Controls Learning System

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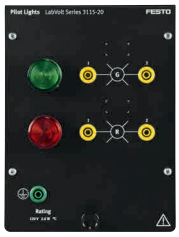

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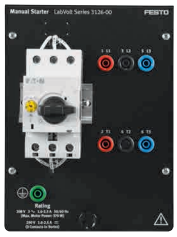

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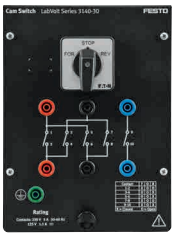

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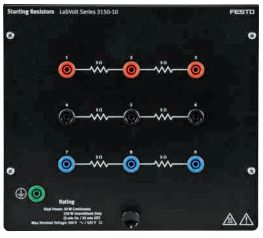

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LabVolt Series 8036-1

Topic Coverage

– Basic Principles of Electric Motor Control (Lockout/tag-out, control devices, starters, relays and contactors, protection)
– Circuit Layout and Specifications
– Basic Control Circuits (Two- and three-wire control, manual starter, reversing starters, multiple push buttons)
– Jogging Control Circuits
– Reduced AC Voltage Starters (Starting resistors, soft starters)
– Time Relay Circuits (Time relays, plugging circuits, starting resistors)
– Troubleshooting

	en	es	fr
120 V, 60 Hz	**581502**	**581503**	
220 V, 50 Hz	**581504**		**581505**
240 V, 50 Hz	**581506**		
220 V, 60 Hz	**581507**	**581508**	

These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations. If your country's voltage and frequency configuration, does not appear here, please contact your sales representative to check if available.

Main components at a glance:*	en	es	fr
1x Industrial Controls Mobile Workstation	581240	581240	
2x Push Buttons	581244	581246	
1x Selector Switches	581247	581249	
1x Emergency Button	581252	581254	
1 2x Pilot Lights	581255	581257	
2 1x Dual Contactors	581263	581265	
1x Lockout Module	581267	581269	
3 1x Three-Phase Manual Starter	581271	581273	
4 1x Contactor	581278	581280	
5 1x Control Relay	581289	581291	
6 1x Overload Relay	581295	581297	
7 1x Time-Delay Relay	595976	595978	
8 1x Three-Pole Fuse Holder	581305	581307	
9 1x Control Transformer	581309	581311	
10 1x Cam Switch	581320	581322	
1x Inertia Wheel	581327	581327	
11 1x Starting Resistors	581329	581331	
12 1x Brake Motor	581341	581341	
1x Soft Starter	581361	581363	
1x AC Power Supply	581365	581367	
1x Connection Lead and Accessory Set	581429	581429	
1x Fuses	582126	582126	
1x Magnetic Labels	582140	582140	

* Order numbers provided for 120 V, 60 Hz. For other configurations, please contact us.

Recommended workbooks: "Basic Controls", "Troubleshooting" (page 286)

Required equipment

1x Digital tachometer	581427
1x Stopwatch	781371
1x Multimeter	579782

Optional equipment

1x Basic Controls Learning System, Second Team, Add-On (8036-D)	see page 88

Programmable Logic Controller Learning System

LabVolt Series 8036-2

Topic Coverage
– Programmable Logic Controller – PLC
Control relay functions, boolean logic, timing relays, counter, comparator)
– PLC Control Circuits
(Interfacing voltages, motor starters with jogging, reversing starters)
– Troubleshooting

	en	es	fr
Order no.	**581509**	**581510**	

For all country voltage and frequency configurations. These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:*	en	es	fr
1 2x Switches	581250	581251	
2 1x Pilot Lights 24 V DC	581261	581262	
3 1x Programmable Logic Controller	581285	581286	
4 1x Interposing Relays	581287	581288	
5 1x DC Power Supply	581318	581319	
1x Connection Lead Set	581430	581430	581430

* Order numbers provided for 120V, 60Hz. For other configurations, please contact us.

Required equipment
Refer to flowchart on page 99 for prerequisites depending on the working environment

Recommended workbooks: “PLC”, “Troubleshooting” (page 286)

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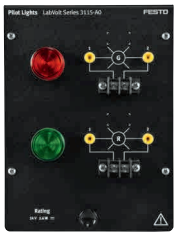

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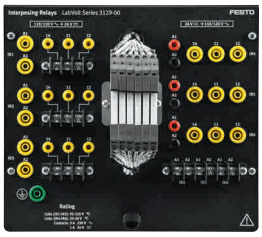

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Motor Drives Learning System

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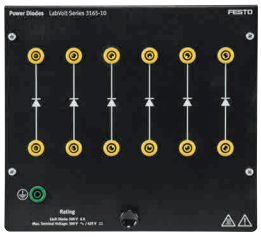

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LabVolt Series 8036-3

Topic Coverage
– AC Drive
(overview, Volts per Hertz characteristics, ramp and torque boost, protection, braking, jogging, remote controls)
– DC Drive
(overview, speed control, current limiting, IR compensation)
– Troubleshooting

	en	es	fr
120V, 60Hz	**581511**	**581512**	
220V, 50/60Hz	**581513**	**581514**	
240V, 50Hz	**581515**		

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

Main components at a glance:

1	1x Power Diodes	581337	581339
2	1x DC Motor (for 120V, 60Hz networks)	581346	581346
	1x DC Motor (for 220–240V, 50/60Hz networks)	581347	581347
3	1x AC Drive (for 120V, 60Hz networks)	592522	
	1x AC Drive (for 220–230V, 50/60Hz networks)	592523	581347
4	1x DC Drive (for 120V, 60Hz networks)	581356	581347
	1x AC Drive (for 240V, 50Hz networks)		592524

Required equipment
Refer to flowchart on page 99 for prerequisites depending on the working environment

Recommended workbooks: “Motor Drives”, “Troubleshooting” (page 283)

Sensors Learning System

LabVolt Series 8036-4

Topic Coverage
– Photoelectric Sensors
(Background suppression, polarize retro-reflective)
– Proximity Switches
(Capacitive and inductive)
– Mechanical Limit Switches

	en	es	fr
Order no.	**581516**	**581517**	

For all country voltage and frequency configurations. These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:

1	1x Limit Switch	581328
2	1x Background Suppression Photoelectric Switch	582361
3	1x Polarized Retro-reflective Photoelectric Switch	582362
4	1x Inductive Proximity Switch	582363
5	1x Capacitive Proximity Switch	582364
	1x Reflective Block	582366
	1x Plastic Bottle	764073
	1x Tool Rotating Knob	582164

Required equipment
Refer to flowchart on page 99 for prerequisites depending on the working environment

Recommended workbook: “Sensors” (page 273, 287)

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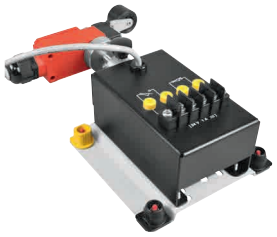

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Variants of Basic Systems

Motor Drives Learning System Stand-Alone

LabVolt Series 8036- A

The Motor Drives Learning System is a complete stand-alone system that allows students to perform the same exercises as in the Motor Drives Learning System. The system is designed to be used directly on a tabletop.

	en	es	fr
120 V, 60 Hz	**581518**	**592562**	
220 V, 50 Hz	**581519**		
220 V, 60 Hz	**581521**		
240 V, 60 Hz	**581520**		

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

Main components at a glance:
- 1x Industrial Controls Tabletop Workstation
- 2x Switches
- 1x Emergency Button
- 1x Pilot Lights 24 V dc
- 1x Three-Phase Manual Starter
- 1x Control Relay
- 1x Control Transformer
- 1x Cam Switch
- 1x Inertia Wheel
- 1x Starting Resistors
- 1x Power Diodes
- 1x Machine Mounting Plate
- 1x Brake Motor
- 1x DC Motor
- 1x AC Drive
- 1x DC Drive
- 1x AC Power Supply
- 1x Connection Lead and Accessory Set
- 1x Magnetic Labels

Recommended workbook: "Motor Drives" (page 273)

Motor Drives Learning System Second Team Add-On

LabVolt Series 8036-B

The Motor Drives Learning System is an add-on to the Electromechanical Learning System, LabVolt Series 8001 or 8006, that allows students to perform the same exercises as in the Motor Drives Learning System (8036-3).

	en	es	fr
120 V, 60 Hz	**581522**		
220 V, 50/60 Hz	**581523**	**581524**	
240 V, 50 Hz	**581525**		

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

Main components at a glance:
- 1x Industrial Controls Single-Rail Workstation
- 1x Switches
- 1x Pilot Lights 24 V dc
- 1x AC Drive
- 1x DC Drive
- 1x Connection Lead Set
- 1x Magnetic Labels

Recommended workbook: "Motor Drives" (page 273)

Motor Drives Learning System Stand-Alone

LabVolt Series 8036-C

The Motor Drives Learning System is an alternative version of the Motor Drives Learning System (8036-A) that is designed to operate at a voltage and frequency of 120 V and 60 Hz. Both the DC and the AC drives are connected directly to a wall outlet.

	en	es	fr
120 V, 60 Hz	**581526**	**587370**	

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

Main components at a glance:
- 1x Industrial Controls Tabletop Workstation
- 2x Switches
- 1x Emergency Button
- 1x Pilot Lights 24 V DC
- 1x Three-Phase Manual Starter
- 1x Control Relay
- 1x Control Transformer
- 1x Cam Switch
- 1x Inertia Wheel
- 1x Starting Resistors
- 1x Power Diodes
- 1x Machine Mounting Plate
- 1x Brake Motor
- 1x DC Motor
- 1x AC Drive
- 1x DC Drive
- 1x Connection Lead and Accessory Set
- 1x Magnetic Labels
- 2x Power Cord

Required equipment
Refer to flowchart on page 99 for prerequisites depending on the working environment

Recommended workbook: “Motor Drives” (page 273)

Motor Drives Learning System Second Team Add-On

LabVolt Series 8036-D

The Basic Controls Learning System is designed to be used with the Industrial Controls Mobile Workstation. It contains all the equipment necessary for a second team to perform the exercises in the Basic Controls Learning System, without unnecessary duplication of the equipment that can be shared by the first team.

	en	es	fr
120 V, 60 Hz	**581527**		
220 V, 50 Hz	**581528**		
240 V, 50 Hz	**587371**		
220 V, 60 Hz	**581529**		

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

Main components at a glance:
- 2x Push Buttons
- 1x Selector Switches
- 1x Emergency Button
- 2x Pilot Lights
- 1x Dual Contactors
- 1x Lockout Module
- 1x Three-Phase Manual Starter
- 1x Contactor
- 1x Control Relay
- 1x Overload Relay
- 1x Time-Delay Relay
- 1x Three-Pole Fuse Holder
- 1x Control Transformer
- 1x Cam Switch
- 1x Inertia Wheel
- 1x Starting Resistors
- 1x Brake Motor
- 1x Soft Starter
- 1x Connection Lead and Accessory Set
- 1x Fuses
- 1x Magnetic Labels

Recommended workbooks: “Basic Controls”, “Troubleshooting” (page 286)

Variants of Basic Systems

Basic Controls Learning System Add-On

LabVolt Series 8036-E

The Basic Controls Learning System is an add-on to systems 8001 or 8006 that allows students to perform the same exercises in the Basic Controls Learning System (8036-1) using the power supply, motors, and additional equipment provided with systems 8001 or 8006.

	en	es	fr
120 V, 60 Hz	**581530**	**592563**	
220 V, 50 Hz	**581531**	**581532**	
240 V, 50 Hz	**581533**		
220 V, 60 Hz	**581534**		

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

Main components at a glance:
- 1x Industrial Controls Double-Rail Workstation
- 2x Push Buttons
- 1x Selector Switches
- 1x Emergency Button
- 2x Pilot Lights
- 1x Dual Contactors
- 1x Lockout Module
- 1x Three-Phase Manual Starter
- 1x Contactor
- 1x Control Relay
- 1x Overload Relay
- 1x Time-Delay Relay
- 1x Three-Pole Fuse Holder
- 1x Control Transformer
- 1x Cam Switch
- 1x Starting Resistors
- 1x Brake Motor (EMS version)
- 1x Soft Starter
- 1x Connection Lead Set
- 1x Zero Friction Machine
- 1x Inertia Wheel

Recommended workbooks: “Basic Controls”, “Troubleshooting” (page 286)

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	580468
es	580469

Notes: The campus license include the PDF of the all student and instructor manuals related to the LV 8036, such as “Basic Motor Controls”, “Motor Drives”, “Sensors”, “Programmable Logic Controllers”, and “Troubleshooting”. Printed workbooks available upon request.

Courses on Festo LX:
- → Basic Motor Controls
- → Motor Drives
- → Sensors
- → PLC
- → Troubleshooting

Workstations, Software

1 **Industrial Controls Mobile Workstation**

The Industrial Controls Mobile Workstation is a double-sided, mobile workstation on casters. It has an A-frame configuration, is constructed of steel, and can accommodate two student groups simultaneously. Four pairs of mounting rails hold the control modules firmly in place. Additional mounting rails underneath the work surface increase the workstation storage capability. The work surface and storage shelf are protected against scratches by a rubber carpet. Safety bars are attached to each rail of the Industrial Controls Mobile Workstation. These bars prevent students from removing modules during laboratory exercises. Padlocks are provided to lock the safety bars in place once all modules are inserted in the workstation.

Order no.	**581240**

2 **Industrial Controls Tabletop Workstation**

This Industrial Controls Tabletop Workstation consists of an inclined mounting rail designed to be placed on top of a regular table. One pair of mounting rails holds the control modules firmly in place. A safety bar is attached to the rail of the Industrial Controls Tabletop Workstation. This bar prevents students from removing modules during laboratory exercises. A padlock is provided to lock the safety bar in place once all modules are inserted in the workstation.

Order no.	**581242**

3 **Industrial Controls Single- or Double-rail Workstation**

The Industrial Controls Single- or Double-Rail Workstation consists of one or two mounting rails designed to be installed on top of the Workstation or the Mobile Workstation to facilitate interconnection between the Industrial Controls Learning Systems and the Electric Power Technology Learning Systems. A safety bar is attached to the rail of the Industrial Controls Single Rail Workstation. This bar prevents students from removing modules during laboratory exercises. A padlock is provided to lock the safety bar in place once all modules are inserted in the workstation.

Single rail	**581243**
Double rail	**585964**

11

2

3

Digital Servo Learning System

The Fundamentals of Servo Motion Control

120 V, 60 Hz, en	**581535**
120 V, 60 Hz, es	**581536**

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:
- 1x Servo controller
- 1x Linear axis

LabVolt Series 8063

The Digital Servo Learning System is a compact trainer designed to familiarize students with the fundamentals of digital servo motion control. The learning system features a single-axis belt driven positioning system, a digital servo controller, and powerful software tools.

Motor control can be achieved in several ways: by using the included hardware controller, LABVIEW or MATLAB/SIMULINK, or an optional analog controller.

Open-source firmware and software controls are provided to allow the user to create his own control strategies by modifying the existing ones or by developing new ones.

Main features
- Servo controller and linear axis
- Position and speed control, friction break, belt tensioning and backsplash, dual encoders, transferable inertia load
- Observation and control can be performed simultaneously
- State-of-the-art 32-bit microcontroller coupled to a power amplifier
- Straps can be easily disengaged from the motor shaft to study the motor

Topic coverage
- Open loop servo motor static characteristics
- Open loop servo motor transient characteristics
- Servo closed loop speed control – steady state characteristics
- Servo closed loop speed control – transient characteristics and disturbances
- Motor shaft angular position control
- Linear position sensing and Control
- Following error in a linear position control system

Recommended Learning Material

Workbooks (→ page 262)

Student manual, PDF, en	591794
Instructor guide, PDF, en	591796

Notes: The campus license include the PDF of the all student and instructor manuals “Servo Motion Control”. Printed workbooks available upon request.

Course on Festo LX

→ Digital Servo Motor Control

Variable-Frequency Drives Learning System

Basic Principles of VFDs and their Motor Applications

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

LabVolt Series 3356

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)

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8175839

Notes: The campus license include the PDF of the all student and instructor manuals “Variable-Frequency Drives”. Printed workbooks available upon request.

Course on Festo LX

→ Motor Control Using Variable-Frequency Drives

Electric Power Technology

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CE

Some of the learning solutions in this catalog do not carry the CE mark and cannot be ordered for delivery to Europe. If you are located in a country where this marking is required, please contact your local Festo sales representative before placing an order.

Electric Power Technology Learning Systems

Emulate Simple to Complex Electrical Systems in the Lab

Note to institutions located in CE countries: The Electric Power Technology Training Packages with DIN A4 modules (see page 135) are available as CE-compliant alternatives to the Learning Systems.

Modular and customizable
Pre-set learning systems represent popular configurations designed to cover logical bundles of related topics. These systems are fully customizable and expandable to meet specific program needs.

Modular hardware and curriculum can easily be extended to teach a wide range of subjects. Instructors can build their electrical energy lab by selecting only the components they need. This flexible approach allows new courses and equipment to be added over time without duplication—ensuring cost-efficient investments.

The system's wide selection of modules—motors, loads, filters, batteries, power supplies, inverters, transformers, controllers, and more—enables the emulation of a variety of system topologies, from simple setups to complex applications, for both training and research purposes.

Safe and durable
Live parts of connection leads are concealed and insulated to prevent electric shock. Lockable workstations integrate a grounding rail system to ensure complete electrical safety. Safety procedures outlined in the workbooks help reinforce proper working habits. Most modules are protected against overcurrent, overheating, and/or overvoltage.

The sturdy, enamel-coated steel hardware is built to withstand years of lab use. Open-frame construction allows for easy observation and repair of components. Silk-screened electrical symbols provide clear identification, test points are accessible throughout the system, and motors are oversized to enhance instructional value.

A versatile, complete platform with a unique training program

The Electric Power Technology Training Systems combine courses, training equipment, and software tools to teach and learn a wide range of topics in the wide field of electrical energy.

Versatility is key, and it is what makes our electric power technology training systems the backbone of countless laboratories in technical schools, colleges, universities, research centers, and utility and industrial companies worldwide, all with differing requirements.

The concept behind the learning systems was initiated in the 1960s by Dr Theodor Wildi, an electrical engineering teacher in a Canadian university.

Computerized modules
The Data Acquisition andControl 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.

Software tools
Enhance lab efficiency and flexibility with digital tools that support hands-on learning, as well as data collection and analysis.

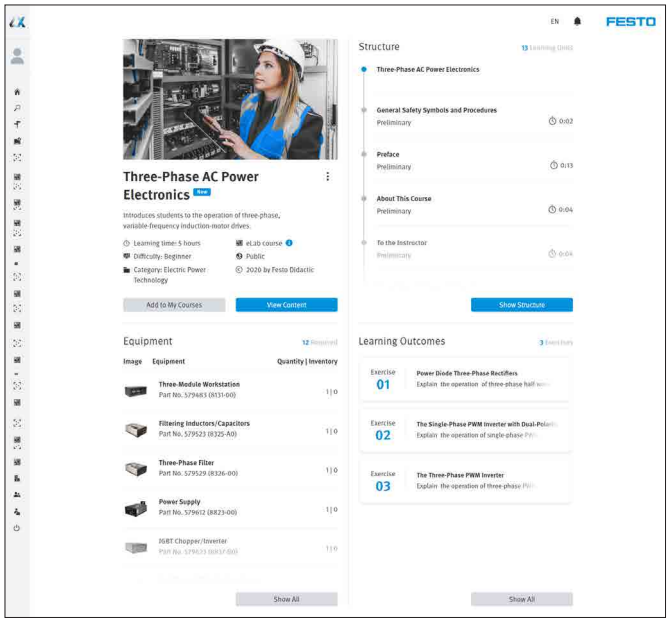
LVDAC-EMS is a free program that gives students access to computerized control of the DACI and four-quadrant dynamometer. It includes virtual instruments to measure, observe, analyze, and control key electrical and mechanical parameters—reducing the need for physical instruments.

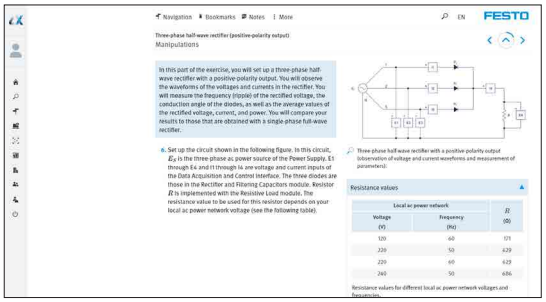
SCADA for LVDAC-EMS enables centralized monitoring and control of multiple workstations over a local network from a supervisory computer.

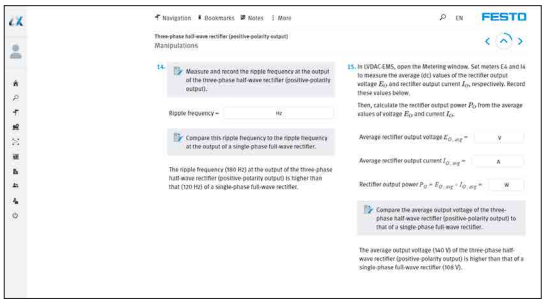
LVSIM-EMS (lvsim.labvolt.com) is a web-based simulation tool that replicates the hardware for remote learning and lab preparation.

Electric Power Technology Training Program

A Complete Curriculum for Progressive Learning Paths







A unique course program
The Electric Power Technology Training Program was developed to answer the increasingly diversified training needs in the wide field of electrical energy. Carefully elaborated courses around core technology topics combine theory with practical exercises.

The program starts with a variety of courses providing in-depth topic coverage of the fundamentals related to the field of electrical energy. It then builds on the knowledge gained by the student through these basic courses to provide training in more advanced subjects.

New courses are added regularly to keep pace with technological advances.

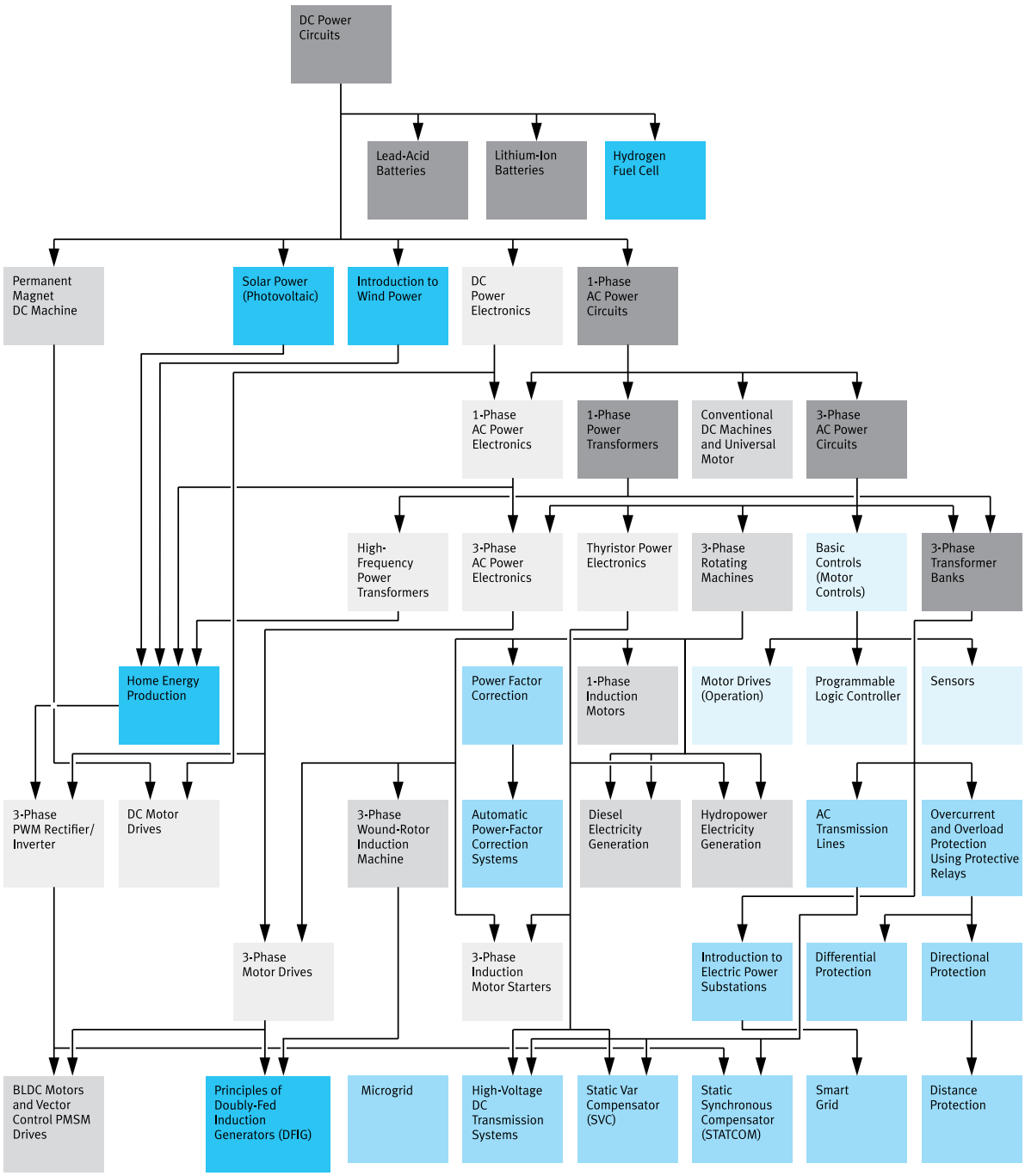
Customizable learning experiences
Courses are organized in a gradual learning path: from the basics to advanced topics. New courses are regularly added to the program to keep up with emerging needs and topics.

The modular philosophy of the program gives instructors full flexibility over the integration of content into their lesson plans: they can choose pre-defined learning paths with complete courses, customize courses, or even create their own path, exercise by exercise.

Online or offline
Each course represents one workbook (available in PDF, print, or as an eLab course on Festo LX) that features practical exercises accompanied by theoretical notions.

Students are guided through practical experimentation with step-by-step, illustrated laboratory procedures and questions, followed by review quizzes. Instructors have access to lab results, answers, and didactic notes.

More about the courses can be found in the Learning Media chapter (page 250) or viewed online on Festo LX (lx.festo.com).



Basic Electric Power | **Rotating Machines** | **Power Electronics** | **Renewable Energies** | **Smart Grid** | **Industrial Controls**

DC and AC Power Circuits
Learning System

LabVolt Series 8010-1

	en	es	fr
120 V, 60 Hz	**579281**		
220 V, 50 Hz	**579282**		
240 V, 50 Hz	**579283**		
220 V, 60 Hz	**589056**		

Note: These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations. If CE compliance is needed, please see the electric power technology training packages (page 136).

Main components at a glance:
– 1x Three-Module Workstation
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control and Computer-Based Control Function Sets
– 1x Data Acquisition and Control Interface
– 1x Connection Lead Set
– 1x AC 24 V Wall Mount Power Supply

Additional required equipment:
– 1x Digital Multimeter

Teach the fundamentals of electric power technology on a versatile, expandable platform

The DC and AC Power Circuits Learning System combines a modular design approach with computer-based data acquisition and control to introduce students to the fundamentals of electricity, such as direct current (DC), alternating current (AC), voltage, resistance, and Ohm's Law. The Learning System is designed to operate at a low voltage to ensure the safety of students beginning their training in electric power technology.

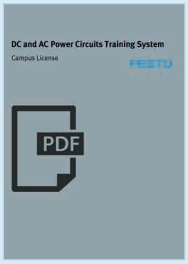
This learning system contains the necessary equipment to perform the practical learning activities of the "DC Power Circuits" and "Single-Phase AC Power Circuits" courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– Introduction to Ohm's Law
– DC circuits concepts: resistance, voltage, current, power, series vs parallel
– AC circuits concepts: sine wave, phase angle, phase shift, power, reactance, impedance
– Concepts of power in AC circuits: active power, reactive power, apparent power and the power triangle
– Learning how to solve DC and AC circuits with the right methods such as impedance calculation and the power triangle method

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	579716

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "DC Power Circuits" and "Single-Phase AC Power Circuits". Printed workbooks available upon request.

Courses on Festo LX:
→ DC Power Circuits
→ Single-Phase AC Power Circuits

Solar Power
Learning System

LabVolt Series 8010-2

	en	es	fr
120 V, 60 Hz	**579284**		
220 V, 50 Hz	**579285**		
240 V, 50 Hz	**579286**		

Note: These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations. If CE compliance is needed, please see the electric power technology training packages (page 136).

Main components at a glance:
– 1x Three-Module Workstation
– 1x Resistive Load
– 1x Lead-Acid Batteries
– 1x Solar Panel Test Bench
– 1x Monocrystalline Silicon Solar Panel
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control Function Set

Additional required equipment:
– 1x Digital Multimeter
– 1x Pyranometer
– 1x Heavy-Duty Tripod

Teach students all they need to know to turn sunlight into electricity

The Solar Power Learning System introduces students to the production of electrical energy from solar power, with emphasis on the use and operation of photovoltaic panels, as well as storage of electrical energy in batteries. The system consists of a solar panel test bench and a monocrystalline silicon solar panel. Students can conduct indoor or outdoor experiments on solar panel operation and performance.

This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits” and “Solar Power” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– DC circuits concepts: resistance, voltage, current, power, series vs parallel, diodes
– Construction of solar panels and properties
– Storing energy from solar panels into batteries
– Performances based on temperature, shading, orientation and insolation

Recommended Learning Material

Workbooks (→ page 262)

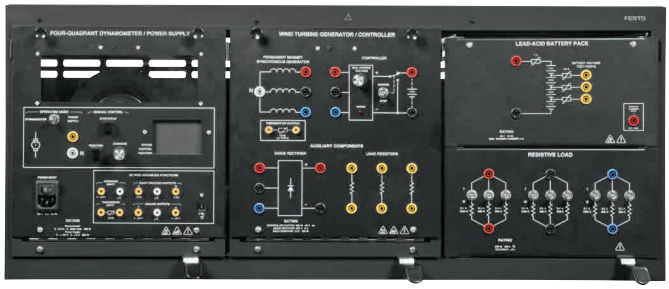
Campus license:

en, 120 V, 60 Hz	579703
fr, 120 V, 60 Hz	8233235
es, 120 V, 60 Hz	8233237
en, 240 V, 50 Hz	585176

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Circuits” and “Solar Power”. Printed workbooks available upon request.

Courses on Festo LX:
→ DC Power Circuits
→ Solar Power

Small-Scale Wind Power Electricity Generation
Learning System



LabVolt Series 8010-3

	en	es	fr
120 V, 60 Hz	**579287**		
220 V, 50 Hz	**579288**	**595187**	
240 V, 50 Hz	**579289**		

Note: These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations. If CE compliance is needed, please see the electric power technology training packages (page 136).

Main components at a glance:
– 1x Three-Module Workstation
– 1x Wind Turbine Generator/Controller
– 1x Resistive Load
– 1x Lead-Acid Batteries
– 1x Lead-Acid Battery Pack
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control, Computer-Based Control, Turbine Emulator and Lead-Acid Battery Charger Function Sets

Additional required equipment:
– 1x Digital Multimeter

Teach students how to turn wind into electricity.

The Small-Scale Wind Power Electricity Generation Learning System enables students to study the complete process of wind power electricity generation directly in the classroom. Wind speed and air density are simulated using a user-friendly and configurable wind emulator. The learning system also covers the storage of electrical energy in batteries to ensure that it is available when there is no wind or during low wind periods.

This learning system contains the necessary equipment to perform the practical learning activities of the "DC Power Circuits", "Lead-Acid Batteries" and "Introduction to Wind Power" courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
– DC circuits concepts: resistance, voltage, current, power, series vs parallel, diodes
– Fundamental concepts of batteries: construction, discharging characteristics, charging methods
– Characteristics of a wind turbine generator: voltage vs speed, torque vs current, power vs speed
– Connection and operation of a wind turbine generator with charging controller and batteries to store and use the energy

Recommended Learning Material

Workbooks (→ page 262)

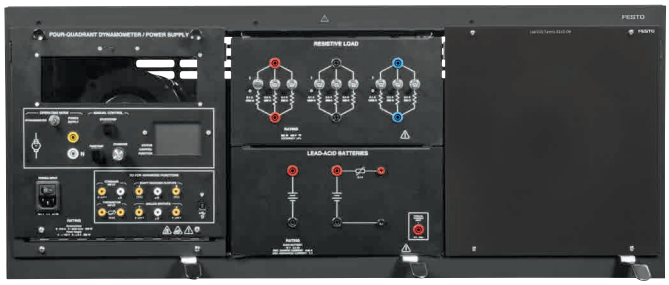
Campus license:

en, 120 V, 60 Hz	579704
fr, 120 V, 60 Hz	8233251
es, 120 V, 60 Hz	8233252
en, 240 V, 50 Hz	585177

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "DC Power Circuits", "Lead-Acid Batteries" and "Introduction to Wind Power". Printed workbooks available upon request.

Courses on Festo LX:
→ DC Power Circuits
→ Lead-Acid Batteries
→ Introduction to Wind Power

Lead-Acid Batteries
Learning System



LabVolt Series 8010-4

	en	es	fr
120 V, 60 Hz	**579290**	**579291**	
220 V, 50 Hz	**579292**		
240 V, 50 Hz	**579293**		

Note: These systems and their components cannot be ordered or delivered in countries that require compliance to CE regulations. If CE compliance is needed, please see the electric power technology training packages (page 136).

Main components:
– 1x Three-Module Workstation
– 1x Resistive Load
– 1x Lead-Acid Batteries
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control, Computer-Based Control, and Lead-Acid Battery Charger Function Sets

Additional required equipment:
– 1x Digital Multimeter

Familiarize students with basic concepts of lead-acid batteries

The Lead-Acid Batteries Learning System teaches the principles of lead-acid battery operation during both charge and discharge. It introduces students to the operation of lead-acid batteries and covers voltage regulation, internal resistance, capacity, depth of discharge, and cycle life of lead-acid batteries. Hands-on experiments cover the discharge characteristics and the most popular charging methods of lead-acid batteries.

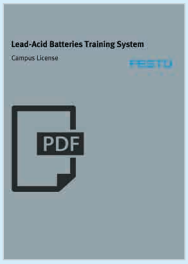
This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits” and “Lead-Acid Batteries” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– DC circuits concepts: resistance, voltage, current, power, series vs parallel, diodes
– Battery fundamentals: construction, materials, energy flow, discharging characteristics
– Charging methods: float charging, fast charging

Recommended Learning Material

Workbooks (→ page 262)

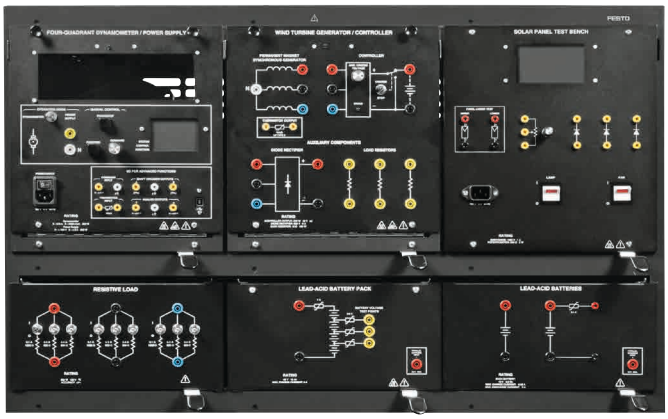


Campus license:

en, 120 V, 60 Hz	579701
fr, 120 V, 60 Hz	8233253
es, 120 V, 60 Hz	579702
en, 240 V, 50 Hz	585175

Courses on Festo LX:
→ DC Power Circuits
→ Lead-Acid Batteries

Basic Renewable Energy
Learning System



LabVolt Series 8010-5

	en	es	fr
120 V, 60 Hz	**579294**	**579295**	
220 V, 50 Hz	**579296**	**594501**	
240 V, 50 Hz	**579297**		

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 Three-Module Workstation
– 1x Wind Turbine Generator/Controller
– 1x Resistive Load
– 1x Lead-Acid Batteries
– 1x Lead-Acid Battery Pack
– 1x Solar Panel Test Bench
– 1x Monocrystalline Silicon Solar Panel
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control, Computer-Based Control, Turbine Emulator, and Lead-Acid Battery Charger Function Sets

Additional required equipment:
– 1x Digital Multimeter

Introduce students to essential concepts of renewable energy

The Basic Renewable Energy Learning System provides in-depth coverage of foundational renewable energy systems. It provides an introduction to DC power circuits, and covers in detail the principles behind the production of electrical energy from both solar power and wind power. The students are then introduced to the storage of electrical energy produced from renewable resources into lead-acid batteries for future consumption.

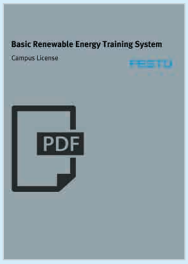
This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits”, “Lead-Acid Batteries”, “Introduction to Wind Power”, and “Solar Power” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– DC circuits concepts: resistance, voltage, current, power, series vs parallel, diodes
– Battery fundamentals: construction, materials, energy flow, discharging characteristics
– Characteristics of a wind turbine generator: voltage vs speed, torque vs current, power vs speed
– Connection and operation of a wind turbine generator with charging controller and batteries to store and use the energy
– Introduction to solar power: construction, properties, storing energy in batteries, performance-based factors

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en, 120 V, 60 Hz	579753
fr, 120 V, 60 Hz	8233449
es, 120 V, 60 Hz	579754
en, 240 V, 50 Hz	585310

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Circuits”, “Lead-Acid Batteries” and “Introduction to Wind Power”. Printed workbooks available upon request.

Courses on Festo LX:
→ DC Power Circuits
→ Lead-Acid Batteries
→ Introduction to Wind Power
→ Solar Power

DC Power Electronics
Learning System

LabVolt Series 8010-6

	en	es	fr
120 V, 60 Hz	**579298**		
220 V, 50 Hz	**579299**		
240 V, 50 Hz	**579300**		

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 Three-Module Workstation
– 1x Resistive Load
– 1x Filtering Inductors/Capacitors
– 1x Lead-Acid Battery Pack
– 1x IGBT Chopper/Inverter
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control, Computer-Based Control, and Lead-Acid Battery Charger Function Sets
– 1x Data Acquisition and Control Interface
– 1x AC 24 V Wall Mount Power Supply

Teach the fundamentals of DC power electronics

The DC Power Electronics Learning System provides a comprehensive study of the diode and switching transistor, two semiconductor components that are widely used in power electronics circuits. The Learning System also provides in-depth coverage of various types of choppers, a power electronics device used in many DC power circuits. The operation of these modules is controlled via the LVDAC-EMS software, which also provides the instrumentation required to measure and record the experimental data.

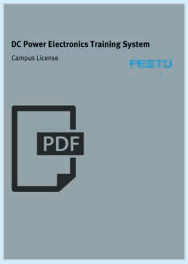
This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits” and “DC Power Electronics” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– DC circuits concepts: resistance, voltage, current, power, series vs parallel, diodes
– DC power electronics basic concepts: diode, switching transistor, high-speed power switching, Ripples
– Choppers: boost, buck, buck/boost, four-quadrant, battery Chargers

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	579706

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Circuits” and “DC Power Electronics”. Printed workbooks available upon request.

Courses on Festo LX:
→ DC Power Circuits
→ DC Power Electronics

Home Energy Production
Learning System

LabVolt Series 8010-7

	en	es	fr
120 V, 60 Hz	**579301**	**579302**	
220 V, 50 Hz	**579303**	**579304**	
240 V, 50 Hz	**579305**		
220 V, 60 Hz	**579306**	**588988**	

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 Tabletop Workstation
- 1x Wind Turbine Generator/Controller
- 1x Resistive Load
- 1x Inductive Load
- 1x Filtering Inductors/Capacitors
- 1x Capacitive Load
- 1x Transformer
- 1x AC Power Network Interface
- 1x Lead-Acid Batteries
- 1x Lead-Acid Battery Pack
- 1x Solar Panel Test Bench
- 1x Monocrystalline Silicon Solar Panel
- 1x IGBT Chopper/Inverter
- 1x Rectifier and Filtering Capacitors
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer/Power Supply with the Manual and Computer-Based Control, as well as the Turbine and Solar Panel Emulators and the Lead-Acid Battery Charger Function Sets
- 1x Data Acquisition and Control Interface
- 1x AC 24 V Wall Mount Power Supply

Teach students to power homes using renewable energy sources

The Home Energy Production Learning System is a comprehensive and flexible program related to home energy production systems including all the prerequisites in renewable energies and power electronics. It provides in-depth training in renewable energies production using solar and wind, and battery storage to power stand-alone network or perform in grid-tied operation.

This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits”, “Lead-Acid Batteries”, “Solar Power”, “Introduction to Wind Power”, “Single-Phase power circuits”, “Single-Phase Power Transformers”, “DC Power Electronics”, “Single-Phase AC Power Electronics”, and “High-Frequency Power Transformers” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
- AC & DC circuits concepts: resistance, Ohm’s Law, active and reactive power, phase angle, solving circuits, transformers
- DC & AC power electronics: diode, transistor, choppers, rectifier, inverters
- Wind turbine generation: voltage vs speed, torque vs current, power vs speed, storing energy in batteries
- Introduction to solar power: construction, properties, storing energy in batteries, performances based different factors
- Home energy production: PWM rectifier/inverter, DC-to-DC converter, stand-alone operation, grid-tied operation

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	579747
fr, 120 V, 60 Hz	579748
es, 120 V, 60 Hz	579749
en, 240 V, 50 Hz	585208

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Circuits”, “Lead-Acid Batteries”, “Solar Power”, “Introduction to Wind Power”, “Single-Phase power Power Circuits”, “Single-Phase Power Transformers”, “DC Power Electronics”, “Single-Phase AC Power Electronics”, and “High-Frequency Power Transformers”. Printed workbooks available upon request.

Courses on Festo LX:
- → DC Power Circuits
- → Lead-Acid Batteries
- → Introduction to Wind Power
- → Solar Power
- → Single-Phase Power Circuits
- → Single-Phase Power Transformers
- → DC Power Electronics
- → Single-Phase AC Power Electronics
- → High-Frequency Power Transformers

Hydrogen Fuel Cell
Learning System

LabVolt Series 8010-8

	en	es	fr
120 V, 60 Hz	**579307**		

Note: This system and its components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:
– 1x Three-Module Workstation
– 1x Traffic Lights
– 1x Electronic Load
– 1x Hydrogen Fuel Cell
– 1x Hydrogen Cylinder Connection Kit
– 1x Hydrogen Storage Canister

Provide complete and efficient training on hydrogen fuel cell systems

The Hydrogen Fuel Cell Learning System realistically demonstrates the basic functions of a 50 W hydrogen fuel cell system and is ideal for teaching the basic engineering principles of fuel cell systems. The modular design of the system enables flexibility in setup complexity — from simple experiments for teaching basic principles to complex experiments for experienced students. The course covers the structure and functioning principles of thermodynamics theory, and characteristics of a real fuel cell system.

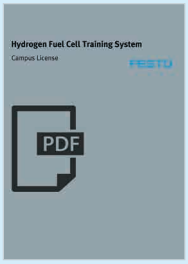
This learning system contains the necessary equipment to perform the practical learning activities of the “Hydrogen Fuel Cell” course available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– Fuel cell applications: remote traffic light, fuel cell car
– Basic functions of fuel cell systems
– Characteristic curves of a fuel cell and parameters influencing it
– Efficiency in a fuel cell stack and its power supply
– Setting up a fuel cell power supply

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	579705

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Circuits”, “Hydrogen Fuel Cell”. Printed workbooks available upon request.

Courses on Festo LX:
→ Hydrogen Fuel Cell

Electromechanical
Learning System

LabVolt Series 8010-9

	en	es	fr
120 V, 60 Hz	**579308**	**579309**	
220 V, 50 Hz	**579310**	**594502**	
240 V, 50 Hz	**579311**		
220 V, 60 Hz	**579312**	**579313**	

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 Tabletop Workstation
- 1x Permanent Magnet DC Motor
- 1x Four-Pole Squirrel Cage Motor
- 1x Three-Phase Synchronous Motor/Generator
- 1x Resistive Load
- 1x Inductive Load
- 1x Capacitive Load
- 1x Three-Phase Transformer Bank
- 1x Transformer
- 1x Synchronizing Module / Three-Phase Contactor
- 1x Lead-Acid Battery Pack
- 1x Three-Phase Power Supply
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
- 1x Data Acquisition and Control Interface
- 1x AC 24 V Wall Mount Power Supply

Get a complete training concept in electromechanical systems for your laboratory

The Electromechanical Learning System combines a modular design approach with computer-based data acquisition to provide unrivaled training in basic electric power technology. Training is oriented toward today's competency requirements.

This learning system contains the necessary equipment to perform the practical learning activities of the "DC Power Circuits", "Permanent Magnet DC Motor", "Single-Phase AC Power Circuits", "Three-Phase AC Power Circuits", "Single-Phase Power Transformers", "Three-Phase Transformer Banks", "Three-Phase Rotating Machines", and "Power Factor Correction" courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
- AC & DC Circuits concepts: resistance, Ohm's Law, active and reactive Power, phase angle, solving circuits, transformers
- Single and three-phase transformers: ratios, windings, polarity, regulation, interconnections, configurations
- DC permanent magnet motor: characteristics, operation as a motor, operation as a generator
- Asynchronous machines: characteristics, operation as an eddy-current brake/motor/generator, high-efficiency motors
- Synchronous machines: characteristics, operation as a motor/generator, synchronization, voltage regulation, stress

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	579707
fr, 120 V, 60 Hz	8233943
es, 120 V, 60 Hz	579708
en, 240 V, 50 Hz	579709

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "DC Power Circuits", "Permanent Magnet DC Motor", "Single-Phase AC Power Circuits", "Three-Phase AC Power Circuits", "Single-Phase Transformers", "Three-Phase Transformer Banks", "Three-Phase Rotating Machines", and "Power Factor Correction". Printed workbooks available upon request.

Courses on Festo LX:
- → DC Power Circuits
- → Single-Phase AC Power Circuits
- → Three-Phase AC Power Circuits
- → Single-Phase Power Transformers
- → Three-Phase Transformers Banks
- → Three-Phase Rotating Machines
- → Power Factor Correction

Power Electronics
Learning System

LabVolt Series 8010-A

	en	es	fr
120 V, 60 Hz	**579314**	**579315**	
220 V, 50 Hz	**579316**		
240 V, 50 Hz	**579317**		
220 V, 60 Hz	**579318**	**579319**	

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 Tabletop Workstation
- 1x Permanent Magnet DC Motor
- 1x Four-Pole Squirrel Cage Motor
- 1x Resistive Load
- 1x Filtering Inductors/Capacitors
- 1x Three-Phase Filter
- 1x Capacitive Load
- 1x Three-Phase Transformer Bank
- 1x Synchronizing Module / Three-Phase Contactor
- 1x Lead-Acid Battery Pack
- 1x Three-Phase Power Supply
- 1x IGBT Chopper/Inverter
- 1x Power Thyristors
- 1x Rectifier and Filtering Capacitors
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control and Lead-Acid Battery Charger Function Sets.
- 1x Data Acquisition and Control Interface
- 1x AC 24 V Wall Mount Power Supply

Provide students with a professional, stimulating learning experience in power electronics

The Power Electronics Learning System is a comprehensive introduction to the most common power electronic components and devices used in numerous industrial applications today. It provides unrivaled training in power electronics to students already having a sound knowledge of basic electric power technology.

This learning system contains the necessary equipment to perform the practical learning activities of the “DC Power Electronics”, “Single-Phase AC power electronics”, “Three-Phase AC power electronics”, “Thyristor Power Electronics”, “DC Motor Drives”, “Three-Phase Motor Drives”, and “Three-Phase Induction Motor Starters” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
- DC power electronics basic concepts: diode, switching transistor, buck/boost chopppers, four-quadrant choppers, chargers
- AC power electronics: single- and three-phase diode rectifiers, single- and three-phase PWM inverter, dual polarity DC bus
- Thyristor circuits: rectifiers, solid state relay, single- and three-phase AC power control, three-phase rectifier/inverter
- DC motor drives: unidirectional and bidirectional PWM DC drive, regenerative braking, speed feedback, current control
- Three-phase motor drives and starters: variable frequency drives, constant V/f characteristics, soft starters

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	579717
fr, 120 V, 60 Hz	8150309
es, 120 V, 60 Hz	579718
en, 240 V, 50 Hz	585184

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “DC Power Electronics”, “Single-Phase AC power electronics”, “Three-Phase AC power electronics”, “Thyristor Power Electronics”, “DC Motor Drives”, “Three-Phase Motor Drives”, and “Three-Phase Induction Motor Starters”. Printed workbooks available upon request.

Courses on Festo LX:
- → DC Power Electronics
- → Single-Phase AC Power Electronics
- → Three-Phase AC Power Electronics
- → Thyristor Power Electronics
- → DC Motor Drives
- → Three-Phase Motor Drives
- → Three-Phase Induction Motor Starters

AC Power Transmission
Learning System

LabVolt Series 8010-B

	en	es	fr
120 V, 60 Hz	**579320**		
220 V, 50 Hz	**579321**		
240 V, 50 Hz	**579322**		
220 V, 60 Hz	**579323**	**579324**	

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 Tabletop Workstation
– 1x Resistive Load
– 2x Inductive Load
– 1x Three-Phase Transmission Line
– 3x Capacitive Load
– 1x Three-Phase Transformer Bank
– 1x Three-Phase Regulating Autotransformer
– 1x Three-Phase Power Supply
– 1x Connection Lead Set
– 1x Data Acquisition and Control Interface
– 1x AC 24 V Wall Mount Power Supply

Provide experimentation opportunities in power transmission fundamentals

The AC power transmission Learning System is a comprehensive introduction to the basic principles of AC power transmission lines. computerized controls provide better understanding, monitoring, and control compared to conventional measuring instruments.

This learning system contains the necessary equipment to perform the practical learning activities of the "Three-Phase AC Power Circuits", "Three-Phase Transformer Banks", and "AC Transmission Lines" courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– Understand basic concepts of three-phase power circuits, power measurements, phase sequence, and more
– Being able to setup and use three-phase transformers
– Understand AC power transmission lines fundamental characteristics
– Being able to compensate voltage in AC power transmission lines and define power transmission capacity
– Being able to control the active and reactive power flow in a AC power transmission line

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	580209
fr, 120 V, 60 Hz	8232430
es, 120 V, 60 Hz	580210
en, 240 V, 50 Hz	580211

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "Three-Phase AC Power Circuits", "Three-Phase Transformer Banks", and "AC Transmission Lines". Printed workbooks available upon request.

Courses on Festo LX:
→ Three-Phase AC Power Circuits
→ Three-Phase Transformers Banks
→ AC Transmission Lines

Smart Grid Technologies
Learning System

LabVolt Series 8010-C

	en	es	fr
120 V, 60 Hz	**579325**		
220 V, 50 Hz	**579326**		
240 V, 50 Hz	**579327**		
220 V, 60 Hz	**589057**		

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 Tabletop Workstation
- 1x Resistive Load
- 1x Inductive Load
- 1x Filtering Inductors/Capacitors
- 1x Three-Phase Filter
- 1x Line Inductors
- 2x Three-Phase Transmission Line
- 1x Capacitive Load
- 1x SVC Reactors / Thyristor-Switched Capacitors
- 2x Three-Phase Transformer Bank
- 2x Three-Phase Regulating Autotransformer
- 1x Transformer
- 1x Three-Phase Transformer
- 1x AC Power Network Interface
- 1x Lead-Acid Battery Pack
- 1x Variable Three-Phase Power Supply
- 1x Insulated DC-to-DC Converter
- 1x IGBT Chopper/Inverter
- 2x Power Thyristors
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer/Power Supply with Manual and Computer-Based Control
- 2x Data Acquisition and Control Interface

Cover fundalemental aspects of power grid modernization

The Smart Grid technologies Learning System provides a turn-key solution dealing with smart grid technologies. Real-world, complex applications, normally found in large power stations, can now be recreated within this training platform. Computerized controls provide better monitoring and control compared to conventional measuring instruments.

This learning system contains the necessary equipment to perform the practical learning activities of the “Home Energy Production”, “Static Var Compensator (SVC)”, “Static Synchronous Compensator (STATCOM)”, and “High-Voltage DC Transmission Systems” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
- Understand home energy production: PWM rectifier/inverter, DC-to-DC converter, stand-alone operation, grid-tied operation
- Benefit from using static var compensators in power transmission systems to regulate voltage or reactive power dynamically
- Understand the usage of static synchronous compensators to regulate voltage dynamically in transmission applications
- Understand basic concepts of DC power transmission in high voltage systems
- Regulate current and power flow in DC power transmission systems and deal with commutation failure and harmonic reduction

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	579724
fr, 120 V, 60 Hz	579725
es, 120 V, 60 Hz	579726
en, 240 V, 50 Hz	585187

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “Home Energy Production”, “Static Var Compensator (SVC)”, “Static Synchronous Compensator (STATCOM)”, and “High-Voltage DC Transmission Systems”. Printed workbooks available upon request.

Courses on Festo LX:
- → Home Energy Production
- → Static Var Compensator
- → Static Synchronous Compensator
- → High-Voltage DC Transmission Systems

DFIG Principles
Learning System

LabVolt Series 8010-D

	en	es	fr
120 V, 60 Hz	**579328**		
220 V, 50 Hz	**579329**		
240 V, 50 Hz	**579330**		
220 V, 60 Hz	**581466**		

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 Tabletop Workstation
- 1x Three-Phase Wound-Rotor Induction Machine (DFIG)
- 1x Resistive Load
- 1x Three-Phase Transformer Bank
- 1x Three-Phase Power Supply
- 1x IGBT Chopper/Inverter
- 1x Rectifier and Filtering Capacitors
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
- 1x Data Acquisition and Control Interface
- 1x AC 24 V Wall Mount Power Supply

Explain and demonstrate the concepts of doubly-fed induction generators

The Doubly-Fed Induction Generators (DFIG) Learning System combines a unique, modular design approach with computer-based data acquisition and control to provide unrivaled training in the basic principles of the doubly-fed induction generator to students that already have a sound knowledge of three-phase AC power circuits, rotating machines, and motor drives.

This learning system contains the necessary equipment to perform the practical learning activities of the "Three-Phase Wound-Rotor Induction Machine" and "Doubly-Fed Induction Generators" courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
- Understand the basic concepts of wound-rotor machines which then can be used as doubly-fed induction generator
- Operate a three-phase wound-rotor induction machine with rotor resistance
- Operate a three-phase wound-rotor induction machine as a synchronous machine
- Understand doubly-fed induction motor and generator and its characteristics
- Learn the benefits of doubly-fed induction generators in wind turbine applications

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V , 60 Hz	579738
fr, 120 V, 60 Hz	8239186
es, 120 V, 60 Hz	585198
en, 220 V, 50 Hz	579739
en, 240 V, 50 Hz	579740
en, 202 V, 60 Hz	579741

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "Three-Phase Wound-Rotor Induction Machine" and "Doubly-Fed Induction Generators". Printed workbooks available upon request.

Courses on Festo LX:
- → Three-Phase Wound-Rotor Induction Machine
- → Doubly-Fed Induction Generators

Power Transmission Smart Grid Technologies
Learning System

LabVolt Series 8010-E

	en	es	fr
120 V, 60 Hz	**579331**		
220 V, 50 Hz	**579332**		
240 V, 50 Hz	**579333**		
220 V, 60 Hz	**589058**		

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 Tabletop Workstation
- 1x Resistive Load
- 2x Inductive Load
- 1x Three-Phase Filter
- 1x Line Inductors
- 2x Three-Phase Transmission Line
- 3x Capacitive Load
- 1x SVC Reactors / Thyristor-Switched Capacitors
- 2x Three-Phase Transformer Bank
- 2x Three-Phase Regulating Autotransformer
- 1x Three-Phase Transformer
- 1x Variable Three-Phase Power Supply
- 1x IGBT Chopper/Inverter
- 2x Power Thyristors
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
- 2x Data Acquisition and Control Interface

Allow your students to master SVC, STATCOM, and HVDC in the context of power transmission

The Power Transmission Smart Grid Technologies Learning System provides a turn-key solution related to power transmission of smart grids. Students learn that SVCs and STATCOMs can be used in conjunction with HVDC transmission systems to greatly enhance the controllability and power transfer capability of a power network, and are thus essential tools to the implementation of a smart grid.

This learning system contains the necessary equipment to perform the practical learning activities of the “AC Transmission Line”, “Static Var Compensator (SVC)”, “Static Synchronous Compensator (STATCOM)”, and “High-Voltage DC Transmission Systems” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The system’s modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
- Know the fundamental concepts of AC power transmission: characteristics, voltage compensation, capacity, power flow control
- Benefit from using Static Var Compensators in power transmission systems to regulate voltage or reactive power dynamically
- Understand the usage of Static Synchronous Compensators to regulate voltage dynamically in transmission applications
- Being able to understand basic concepts of DC power transmission in high voltage systems
- Regulate current and power flow in DC power transmission systems and deal with commutation failure and harmonic reduction

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en, 120 V, 60 Hz	579744
en, 240 V, 50 Hz	579745

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of “AC Transmission Line”, “Static Var Compensator (SVC)”, “Static Synchronous Compensator (STATCOM)”, and “High-Voltage DC Transmission Systems”. Printed workbooks available upon request.

Courses on Festo LX:
- → AC Transmission Line
- → Static Var Compensator
- → Static Synchronous Compensator
- → High-Voltage DC Transmission Systems

Smart Grid
Learning System

LabVolt Series 8010-F

	en	es	fr
120 V, 60 Hz	**8117310**		
220 V,50 Hz	**8117311**		
240 V, 50 Hz	**8117312**		

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 Circuit Breakers and Disconnecting Switches 1
– 1x Circuit Breakers and Disconnecting Switches 2
– 1x Fault Module
– 1x Three-Module Workstation
– 1x Tabletop Workstation
– 1x Four-Pole Squirrel Cage Motor
– 2x Resistive Load
– 1x Capacitive Load
– 2x Three-Phase Transformer Bank
– 1x Three-Phase Power Supply
– 1x Ethernet Switch
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
– 1x Data Acquisition and Control Interface

Evolution towards the smart grid in substations

The Smart Grid Learning System introduces students to the concept of upgrading and operating an electric power substation in today's smart grid. To demonstrate this in a concrete way, the course shows how an aging distribution substation can be upgraded to improve its reliability, maintainability, flexibility of operation, and power efficiency. The course also shows that proper control of the operations in electric power substations is as important as upgrading the infrastructures.

This learning system contains the necessary equipment to perform the practical learning activities of the "Smart Grid" course available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
– Reducing power losses in electric power substations
– Upgrading a substation for operation in the smart grid
– Operating a substation in the smart grid

Recommended Learning Material

Workbooks (→ page 262)

Workbook

en, student manual	8107698
en, instructor guide	8107696

Notes: Workbooks (student and instructor manuals) are provided in PDF format. Printed workbooks available upon request.

Courses on Festo LX:
→ Smart Grid

Hydropower Electricity Generation
Learning System

LabVolt Series 8010-G

	en	es	fr
120 V, 60 Hz	**8108668**		
220 V, 50 Hz	**8108669**		
240 V, 50 Hz	**8108670**		

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 Tabletop Workstation
- 1x Three-Phase Synchronous Motor/Generator
- 1x Resistive Load
- 1x Inductive Load
- 1x Synchronizing Module / Three-Phase Contactor
- 1x Three-Phase Power Supply
- 1x Power Thyristors
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
- 1x Turbine/Engine Emulator Function Set
- 1x Data Acquisition and Control Interface
- 1x Synchronous Generator Control Function Set
- 1x AC 24 V Wall Mount Power Supply

Replicate a full electric power generation plant in your lab

The Hydropower Electricity Generation Learning System examines the large-scale production of electricity from hydro power using a synchronous generator. The students learn how to adjust the voltage and frequency of the synchronous generator in a hydropower plant, as well as how to synchronize the generator using a synchro-check relay. The system concludes with a study of the automatic speed (frequency) and voltage regulation systems used in a hydropower plant.

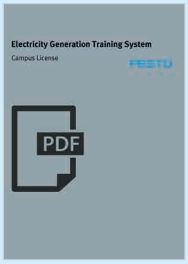
This learning system contains the necessary equipment to perform the practical learning activities of the "Hydropower Electricity Generation" course available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
- Understand fundamentals of these power plants: types of power plants, main components, pros and cons, ...
- Control the voltage and frequency of a generator
- Perform generator synchronization with a synchro-check relay
- Operate a generator and regulate the speed and voltage with and without droop
- Operate two generators in parallel and perform load sharing (2 systems required)

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en, 120 V, 60 Hz	8197022

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "Hydropower Electricity Generation" and "Diesel Electricity Generation".. Printed workbooks available upon request.

Courses on Festo LX:
→ Hydropower Electricity Generation

BLDC Motors and Vector Control PMSM Drives
Learning System

LabVolt Series 8010-J

	en	es	fr
120 V, 60 Hz	**8108674**		
220 V, 50 Hz	**8108675**		
240 V, 50 Hz	**8108676**		

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 Tabletop Workstation
- 1x Permanent Magnet Synchronous Machine
- 1x Resistive Load
- 3x Lead-Acid Battery Pack
- 1x IGBT Chopper/Inverter
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
- 1x Data Acquisition and Control Interface
- 1x BLDC Motor/PMSM Control Function Set
- 1x AC 24 V Wall Mount Power Supply

BLDC and PMSM technology made easy

The BLDC Motor and Vector Control PMSM Drives Learning System introduces students to the permanent magnet synchronous machine (PMSM). It covers the operation and characteristics of two types of motor that use PMSM technology: the brushless dc (BLDC) motor and the PMSM drive. It also deals with the most common types of modulation used to implement BLDC motors (six-step 120° modulation and six-step PWM) and PMSM drives (vector control).

This learning system contains the necessary equipment to perform the practical learning activities of the "BLDC Motors and Vector Control PMSM Drives" course available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals:
- Understand fundamentals of permanent magnet synchronous machines
- Control a PMSM using a three-phase, six-step 120 degrees modulation inverter
- Understand BLDC motors main characteristics and operation: encoder, torque ripple, control methods, and more
- Control a PMSM with a vector control drive: V/f ratio, speed control, torque control, vector control in the four quadrants

Recommended Learning Material

Workbooks (→ page 262)

Workbooks:

en, student manual	591945
en, instructor guide	591947
es, student manual	591946
es, instructor guide	591948

Notes: The workbooks of "BLDC Motors and Vector Control PMSM Drives" are provided in PDF format. Printed workbooks available upon request.

Course on Festo LX:
→ BLDC Motors and Vector Control PMSM Drives

Electric Power Substations
Learning System

LabVolt Series 8010-K

	en	es	fr
120 V, 60 Hz	**8108677**		
220 V, 50 Hz	**8108678**		
240 V, 50 Hz	**8108679**		

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 Tabletop Workstation
– 1x Circuit Breakers and Disconnecting Switches 1
– 1x Circuit Breakers and Disconnecting Switches 2
– 1x Fault Module
– 1x Resistive Load
– 1x Line Inductors
– 1x Three-Phase Power Supply
– 1x Ethernet Switch
– 1x Connection Lead Set
– 1x Data Acquisition and Control Interface
– 1x AC 24 V Wall Mount Power Supply
– 1x Software Development Kit (SDK)
– 1x License TIA Portal PLC Software (Step 7 Professional/WinCC Advanced) for education

Study the fundamentals of power distribution

The Electric Power Substations Learning System introduces students to the operation of electric power substations. It begins by covering the main components of substations. The system then fully describes and presents both advantages and disadvantages of two switching schemes commonly implemented in substations: the single-bus scheme and the double-bus, single-breaker scheme.

This learning system contains the necessary equipment to perform the practical learning activities of the "Introduction to Electric Power Substations" course available on Festo LX (subscription required) or as a campus license (sold separately).

The system's modular approach allows teachers to easily expand to teach other subjects within the program by adding individual modules and/or unlocking control functions.

Learning goals
– Understand design characteristics of electric power substations
– Understand the main components of a substations such as high-voltage disconnecting switches and circuit breakers
– Operate a substation in the single-bus scheme: reliability, components, operation, interlocking, and more
– Operate a substation in the double bus, single breaker scheme: reliability, components, operation, interlocking, and more

Recommended Learning Material

Workbooks (→ page 262)

Workbooks:

en, student manual	590302
en, instructor guide	590303
fr, student manual	8222458
fr, instructor guide	8222456
es, student manual	8114738
es, instructor guide	8114736

Notes: The workbooks of "Introduction to Electric Power Substations" are provided in PDF format. Printed workbooks available upon request.

Course on Festo LX:
→ Introduction to Electric Power Substations

Power Factor Correction
Learning System

LabVolt Series 8010-H

	en	es	fr
120 V, 60 Hz	**8108671**		
220 V, 50 Hz	**8108672**		
240 V, 50 Hz	**8108673**		

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

Main components at a glance:
– 1x Power Factor Correction Capacitor Banks
– 1x Power Factor Controller
– 1x Tabletop Workstation
– 1x Four-Pole Squirrel Cage Motor
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 1x Three-Phase Power Supply
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer / Power Supply with Manual and Computer-Based Control
– 1x Data Acquisition and Control Interface
– 1x AC 24 V Wall Mount Power Supply

Emulate a distributed energy network in your classroom to build skills in microgrid design and operation

This learning system contains the necessary equipment to perform the practical learning activities of the “Power Factor Correction” and “Automatic Power Factor Correction” courses available on Festo LX (subscription required) or as a campus license (sold separately).

The Power Factor Correction Learning System familiarizes the student with the reasons for correcting the power factor in industrial applications, as well as with the different means to do so.

The learning begins by discussing the problematic of having a low power factor in industrial applications, for both the electrical power provider and the customer. It then covers how power factor correction is usually implemented in industrial applications with variable inductive loads (e.g., induction motors that start and stop). It also introduces learners to the two main types of power factor correction available: plant-wide and distributed. Finally, the principles of power factor correction are applied to both single-phase and three-phase ac power circuits.

Learning goals:
– Explain the problem of low power factor in industrial applications.
– Demonstrate how to correct the power factor using banks of switched capacitors.
– Differentiate between plant-wide and distributed power factor correction.
– Apply plant-wide and distributed power factor correction methods to industrial scenarios.

Recommended Learning Material

Workbooks (→ page 262)

Workbooks

en	On request

Courses on Festo LX:
→ Power Factor Correction
→ Automatic Power Factor Correction

Numerical Protective Relays
Learning System

LabVolt Series 8010-L

	en	es	fr
120 V, 60 Hz	**8108680**		

Note: This system and its components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:
– 1x Numerical Distance Relay
– 1x Numerical Differential Relay

Also necessary, please order:
– License for DIGSI 5 Premium Software

Optional component
– 1x Mounting Frame (DIN A4) for EMS Workstations
– 1x Numerical Directional Overcurrent Relay

More numerical protective relays and variants are available:
See the complete offering on page 180

Protecting the electrical grid

The Numerical Protective Relays Learning System covers the theoretical background, as well as practical application, of protective devices and their protection functions. The system uses power-utility-grade equipment, Siemens' newest generation the SIPROTEC 5 series. Example scenarios are created in the accompanying professional programming tool, DIGSI 5, which allows users to create different setups and simulate possible faults using the built-in relay testing unit. The response of the relay is then analyzed with the relay display and the fault record.

This learning system contains the necessary equipment to perform the practical learning activities of the "Overcurrent/Overload Protection", "Directional Protection", "Differential Protection, and "Distance Protection" courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learning goals:
– Overcurrent and overload protection of AC machines and power transformers, overcurrent protection of radial feeders
– Directional protection: parallel power lines, overcurrent, comparison and power
– Differential protection: current measuring error, sensitivity and percentage restrained differential protection
– Distance protection: fault vs. load impedance, line protection, generator loss-of-excitation protection

Recommended Learning Material

Workbooks (→ page 262)

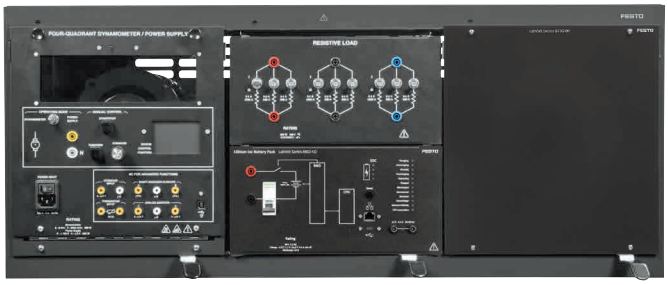
Campus license:

en, 120 V, 60 Hz	8157298

Notes: The campus license includes all workbooks (student and instructor manuals) in PDF format of "Overcurrent/Overload Protection", "Directional Protection", "Differential Protection, and "Distance Protection". Printed workbooks available upon request.

Courses on Festo LX:
→ Overcurrent/Overload Protection
→ Directional Protection
→ Differential Protection
→ Distance Protection

Lithium-Ion Battery
Learning System



LabVolt Series 8010-N

	en	es	fr
120 V, 60 Hz	**8243597**	**8243598**	
220 V, 50 Hz	**8243599**		
240 V, 50 Hz	**8243600**		

Note: This system and its components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components:
– 1x Three-Module Workstation
– 1x Resistive Load
– 1x 48 V Lithium-Ion Battery Pack
– 1x Connection Lead Set
– 1x Four-Quadrant Dynamometer/Power Supply With the Manual Control, Computer-Based Control, and Lithium-Ion Battery Charger Function Sets

Also necessary, please order:
– License for DIGSI 5 Premium Software
– 1 x Three-Phase AC Power Supply and Safety Unit

Gain insights into Li-Ion battery technology through interactive learning and real-time analysis

The learning system contains the necessary equipment to perform the practical learning activities of the “Lithium-Ion Batteries” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore topics such as voltage regulation, internal resistance, capacity, cycle life, discharging characteristics, balancing and charging methods of Lithium-Ion (Li-Ion) batteries.

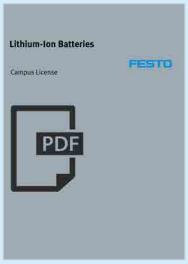
The four-quadrant power supply and dynamometer controller regulate variable DC power to provide the required voltage and current for discharging or charging the lithium-ion battery. The LVDAC-EMS software enables users to monitor and visualize the battery’s operation, allowing for the measurement, observation, analysis, and control of the system’s electrical and mechanical parameters.

The training modules of this learning system are designed to fit into a compact tabletop workstation, which is equipped with a built-in grounding mechanism for enhanced safety. For durability, the equipment is constructed from steel, and sensitive components are protected against overcurrent, overheating, and overvoltage.

Learning goals:
– Become familiar with the operation of lithium-ion batteries.
– Understand the charging and discharging characteristics.
– Control various parameters that influence the charger characteristics.
– Use the four-quadrant method to balance lithium-ion cells.

Recommended Learning Material

Workbook



Order no. 8243459

Note: The campus license contains the student manual and the instructor guide in PDF format. Printed workbooks are available upon request.

Courses on Festo LX:
→ Lithium-Ion Batteries

Microgrid
Learning System

LabVolt Series 8010-M

	en	es	fr
120 V, 60 Hz	**8198895**		

Note: This system and its components cannot be ordered or delivered in countries that require compliance to CE regulations.

Main components at a glance:
– 2x Resistive Load (TTL / 24V Controlled)
– 1x Inductive Load (TTL / 24V Controlled)
– 3x Three-Phase AC Filter
– 3x Lithium-Ion Battery Module
– 1x Variable Three-Phase Power Supply
– 6x IGBT Chopper/Inverter
– 3x 24 V AC Power Supply (Wall Mount)
– 3x Four-Quadrant Power Supply and Dynamometer Controller
– 6x Data Acquisition and Control Interface
– 5x Synchronizing Module / Three-Phase Contactor
– 3x Three-Phase Transformer
– 2x Filtering Inductors/Capacitors
– 1x Power Supply and Ethernet Switch 8 Ports
– 1x Permanent Magnet Synchronous Machine
– 1x Power Thyristors
– 1x Three-Phase Synchronous Motor/Generator
– 1x Digital Output Interface
– 1x Lithium-Ion Battery Charger Function Set
– 2x Three-Phase PWM Rectifier/Inverter Control Function Set
– 1x BLDC Motor/PMSM Control Function Set
– 1x Solar Panel Emulator Function Set
– 2x Turbine Emulator Function Set
– 1x Synchronous Generator Control Function Set

Also necessary, please order:
– 4x Mobile workstations
– 5x Mini PC running windows 7 or later
– 1x Monitor (LCD) Screen
– 1x KVM Switch for 5 PCs
– 1x USB Mouse and Key board

Emulate a distributed energy network in your classroom to build skills in microgrid design and operation

This learning system contains the necessary equipment to perform the practical learning activities of the “Microgrid” course available on Festo LX (subscription required) or as a campus license (sold separately).

This learning system offers hands-on experience in designing and implementing a microgrid that integrates three key renewable energy sources: solar power, wind power, and a diesel generator, along with a battery energy storage system.

Learners follow step-by-step instructions to connect modules and explore topics such as active and reactive power transfer, microgrid startup after a power outage, network reconnection, and the operation of the diesel generator in islanding mode.

Emulated wind turbines and photovoltaic panels generate three-phase AC power and synchronize with the microgrid system. The diesel generator can serve as an emergency power source or as the primary energy source when the microgrid is in islanding mode. The Battery Energy Storage System (BESS) can function as both energy storage and generation, synchronized with the microgrid system. Additionally, all these energy sources can be connected to the utility grid (main grid).

Learning goals:
– Become familiar with the implementation of a microgrid
– Understand the operation of active and reactive power transfer
– Control the diesel generator in islanding mode
– Establish synchronization with the utility grid
– Operate the microgrid in different modes

Recommended Learning Material

Workbook

Campus license:

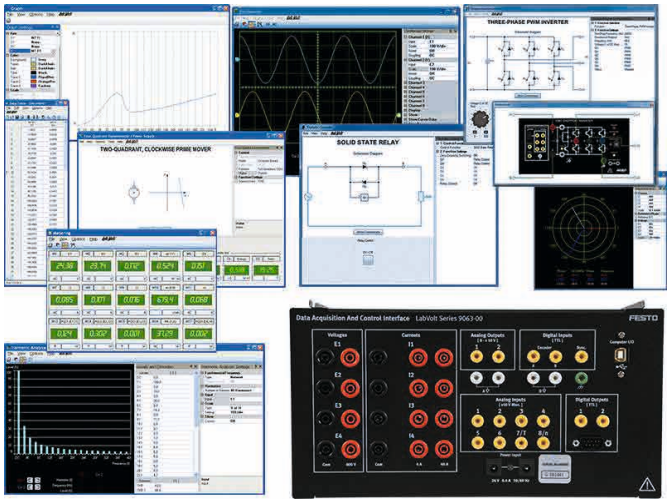
en	8245246

Note: The campus license contains the student manual and the instructor guide in PDF format. Printed workbooks are available upon request.

Course on Festo LX:
→ Microgrid

LVDAC-EMS

Computer-Assisted Data Acquisition



Highlights

– Affordable compared to conventional equipment, as virtual tools lower the cost of acquisition and replacement of accessories
– Several instrumentation functions and control function sets available
– SCADA windows available for several applications
– Software development kit (SDK) for customization
– Free software and updates

Free download on our → website.

The LVDAC-EMS software is a user-friendly tool that facilitates the use of the various functions which can be implemented with USB peripherals, such as the Data Acquisition and Control Interface (DACI) and the Four-Quadrant Dynamometer/Power Supply.

Together, the DACI and LVDAC EMS provide a complete set of modern computer-based instruments to measure, observe, analyze, and control electrical and mechanical parameters. The provided instruments include voltmeters, ammeters, power meters, frequency meters, efficiency meters, impedance meters, power factor meters, energy meters, torque and speed meters, an oscilloscope, a phasor analyzer, a harmonic analyzer, and a spectrum analyzer.

The DACI and LVDAC-EMS also allow manual and timed data recording. The recorded data can be saved to files in any specified location, graphically represented with the provided graph plotting tool, and exported into a spreadsheet application.

The DACI and LVDAC-EMS can also be used with the Four-Quadrant Dynamometer/Power Supply, Model 8960, to implement a variety of control functions for advanced training in various fields of electricity and new energy, including electric power technology, ac/dc rotating machines, renewable energy, transmission lines, and power electronics.

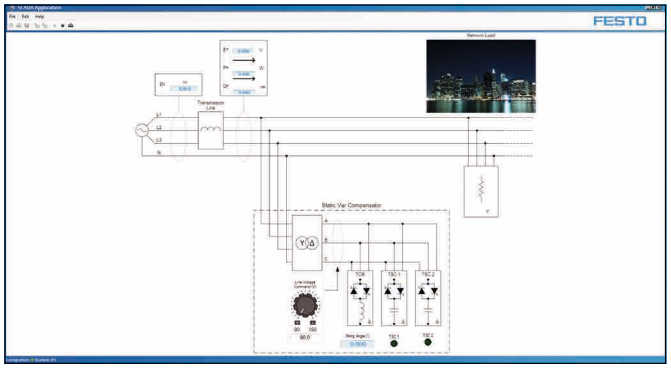
The LVDAC-EMS software and the Data Acquisition and Control Interface allow complex power system applications such as hydropower generators, large-scale wind turbines (PMSG and DFIG), high-voltage direct current (HVDC) transmission systems, static var compensators (SVCs), and static synchronous compensators (STATCOMs) to be implemented. SCADA windows are available in the LVDAC-EMS software for these complex applications to ease system control and monitoring, as well as to allow students to quickly understand what is going on in these applications.

Computer-based instruments replace a multitude of actual data acquisition devices:

– The Metering window displays up to eighteen meters that can be configured to measure a multitude of parameters.
– The Oscilloscope displays up to eight waveforms simultaneously. Each waveform is of a different color for easy identification.
– The Phasor Analyzer displays the phasors related to measured voltages and currents instead of the values and waveforms related to these voltages and currents.
– The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents.
– The recorded values of all meters and indicators in the Data Table can be saved to a file and used to plot graphs.
– Several sets of computer-based functions can be activated in the DACI and controlled directly in LVDAC-EMS.

SCADA for LVDAC-EMS

Supervisory Control and Data Acquisition (SCADA)



SCADA for LVDAC-EMS is a software program designed to run in combination with LVDAC-EMS. It transforms LVDAC-EMS software and the workstation's computer into a local workstation that can be monitored and controlled over a local network from a supervisory computer.

Using the OPC Server protocols, SCADA-EMS enables users to design their own interfaces by calling the different applications running on the local workstations.

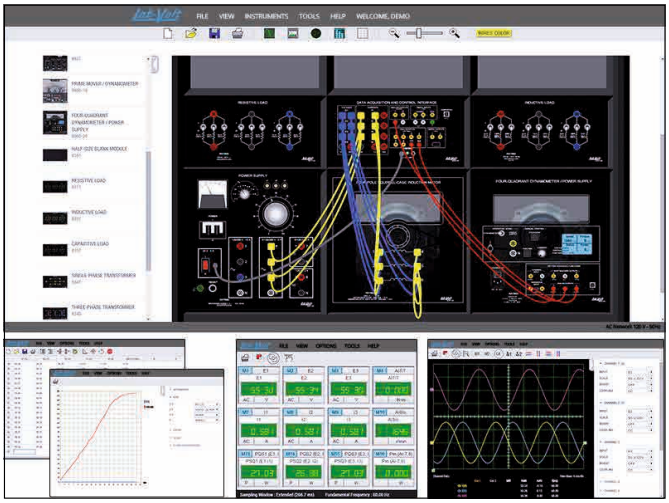
SCADA-EMS enhances LVDAC-EMS by adding several new features:
- Collect data from local workstations.
- Observe and control one or multiple stations from one or multiple supervisory stations.
- Remotely control several applications in a lab.
- Use a workstation in a different room to present actual demonstrations over the network in your classroom without having to bring a workstation to class.
- Introduce students to the fundamentals of SCADA in a grid context.
- Recreate a complete grid with several different applications running.

A locked version of the SCADA-EMS software program can be downloaded from our website and can be unlocked by a USB dongle.
A dongle unlocks five workstations; order as many dongles as required.
LVDAC-EMS is required to run SCADA-EMS.

Order no.	**8094377**

LVSIM-EMS

Simulation Software



Electromechanical Systems Simulation Software (LVSIM-EMS) is a simulation software that enables students to perform actual experiments using virtual equipment

It covers the same courseware as the following systems: the computer-assisted 0.2 kW electromechanical Learning System, the DC and AC power circuits Learning System, the electromechanical Learning System, and the AC power transmission Learning System.

LVSIM-EMS is a web-browser based application available in three different configurations. The simulation software can either be installed locally on a Windows personal computer (local version), on a Windows server (network version), or accessed directly online through our website.

Highlights
- Replicates the electromechanical Learning System
- Students prepare for laboratories in advance using virtual equipment, thereby decreasing the time they require to perform the exercises using actual equipment
- Decreases the quantity of actual equipment required per student
- Allows students to practice with EMS equipment operation and connection at home on a personal computer

LVSIM-EMS

Local installation with USB dongle

1 user	**586920**
5 users	**586923**
15 users	**586929**
25 users	**586935**

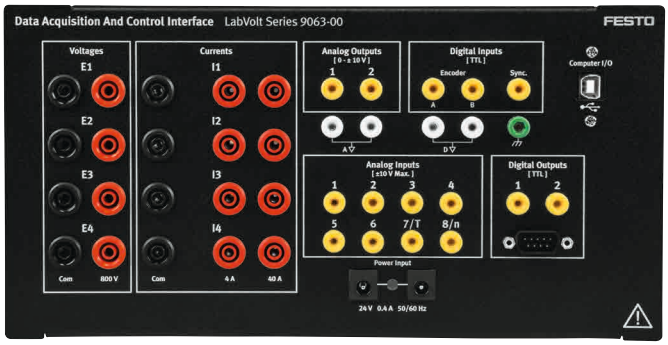
Online version, annual subscription

1 user	**586971**
5 users	**586974**
15 users	**586980**
25 users	**586986**

Note: Several other license options are available.

Modules

Data Acquisition and Control Interface (DACI)



Most popular packages

DACI with Computer-Based Instrumentation

	en	es	fr
Order no.	**579680**	**579682**	**579681**

DACI with Computer-Based Instrumentation and Chopper/Inverter Control

	en	es	fr
Order no.	**579683**	**579685**	**579684**

Note: For reference numbers of other variants DACI control functions or specific packages based on your needs, please contact your Festo sales representative.

LabVolt Series 9063

Measuring, observing, analyzing, and controlling electrical and mechanical parameters in electric power systems and power electronics circuits represent an important part of the training in various areas, such as electric power technology, AC/DC machines, renewable energy, and power electronics.

For these purposes, the Data Acquisition and Control Interface (DACI) is a versatile USB peripheral that features a set of computer-based instruments and instrumentation tools, which can be accessed through Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS) software.

The DACI and the LVDAC-EMS software are standard features in the Electric Power Technology Learning Systems and in the Computer-Assisted 0.2-kW Electromechanical Learning System.

Highlights

- Computer-based tools increase student knowledge and understanding of electric power systems and power electronics circuits
- Customizable DACI with several control functions available to fit specific training needs
- Pre-built SCADA interface facilitates an understanding of the process taking place
- Several inputs/outputs for easy connection with other modules
- Optically isolated inputs
- Includes free software (LVDAC-EMS)
- Software Development Kit for third-party programming tools
- Short set-up time
- Safe and affordable

Control function sets

Several sets of computer-based functions allowing control of power electronics modules can be activated in the DACI. Instructors can select and combine the functions they need.

- Computer-Based Instrumentation
- Chopper/Inverter Control
- Thyristor Control
- Home Energy Production Control
- Three-Phase PWM Rectifier/ Inverter Control
- BLDC Motor/PMSM Control
- High-Voltage DC (HVDC) Transmission System Control
- Static Var Compensator (SVC) Control
- 9063 Software Development Kit
- Synchronous Generator Control
- Static Synchronous Compensator (STATCOM) Control
- Synchroscope
- SCADA

Four-Quadrant Dynamometer/Power Supply

LabVolt Series 8960

The Four-Quadrant Dynamometer/power Supply is a highly versatile USB peripheral designed to be used in the Electric Power Technology Learning Systems. Two operating modes are available: Dynamometer and Power Supply. A wide variety of user-selectable functions is available in each operating mode.

In the Dynamometer mode, the unit becomes a four-quadrant dynamometer that can act as either a fully configurable brake or a fully configurable prime mover. In the power supply mode, the unit becomes a four-quadrant power supply that can act as a DC voltage source, DC current source, ac power source, etc.

In each operating mode, key parameters related to the selected function are displayed and can be monitored using the computer-based instruments in the software LVDAC-EMS. Speed, torque, mechanical power, and energy are displayed in the Dynamometer mode while voltage, current, electrical power, and energy are displayed in the Power Supply mode. Optional functions, such as a small wind-turbine emulator, a hydraulic turbine emulator, a solar panel emulator, battery chargers, an SDK (Software Development Kit) etc., can be added to the standard functions to further enhance the training possibilities of the Four-Quadrant Dynamometer/Power Supply.

Highlights
- Multipurpose device combining power supply, prime mover, dynamometer, metering, and emulator properties
- Manual or computer-based control mode
- Green device: it returns the power produced directly on the grid
- Emulation of multiple load types
- Optional functions can be added to the standard functions to further the training possibilities

Topic coverage
- Speed and Torque
- Voltage and Current
- Mechanical and Electrical Power
- Energy

Function sets
- Standard Functions (Manual Control)
- Standard Functions (Computer-Based Control)
- Turbine Emulator and Diesel Generator
- Lead-Acid Battery Charger
- Ni-MH Battery Chargers
- Solar Panel Emulator
- LabVolt Series 8960 Software Development Kit

Most popular packages

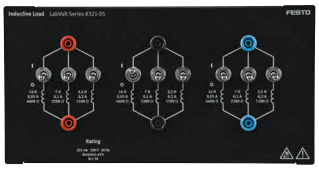
Four-Quadrant Dynamometer/Power Supply with Manual and Computer-Based Control

	en	es	fr
120 V, 60 Hz	**579648**	**579650**	**579649**
220 V, 50 Hz	**579651**	**579653**	**579652**
240 V, 50 Hz	**579654**		

Note: For reference numbers of other variants Dynamometer/Power Supply control functions or specific packages based on your needs, please contact your Festo sales representative:

Modules
Loads, Filters

1



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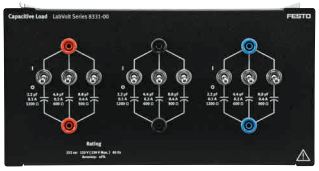

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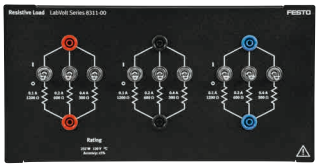

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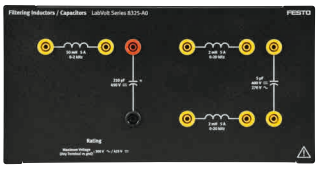

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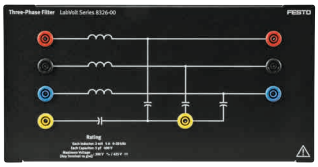

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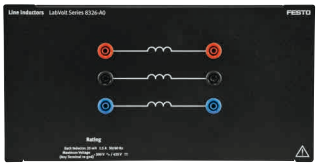

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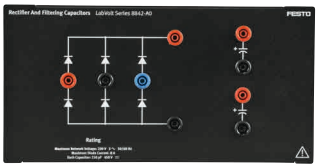

1 Inductive Load
Nine iron-core power inductors arranged in three identical banks.

	en	es	fr
120 – 208 V, 60 Hz	763362	763363	579516
220 – 380 V, 50 Hz	579517	579519	579518
240 – 415 V, 50 Hz	579520		
220 – 380 V, 60 Hz	579521	579522	

2 Capacitive Load
Nine capacitors arranged in three identical banks.

	en	es	fr
120 – 208 V, 60 Hz	763366	763367	579544
220 – 380 V, 50 Hz	579545	579547	579546
240 – 415 V, 50 Hz	579548		
220 – 380 V, 60 Hz	579549	579550	

3 Resistive Load
Nine wire-wound power resistors arranged in three identical banks.

	en	es	fr
120 – 208 V, 60 Hz	763359	763360	579511
220 – 380 V, 50 Hz	579512	579514	579513
240 – 415 V, 50 Hz	579515		

4 Electronic Load
Provides manual or computer-assisted adjustment of constant rated currents that can be used to record the characteristic curves of a fuel cell system.

	en	es	fr
120 – 208 V, 60 Hz	579575	579575	579575

5 Filtering Inductors/Capacitors
Two separate filters (low- and high-frequency) enclosed in a half-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz	579523	579525	579524
220 – 380 V, 50 Hz	579526	579528	579527

6 Three-Phase Filter
Three inductors and four capacitors enclosed in a half-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz	579529	579530	586454

7 Line Inductors
Three separate inductors enclosed in a half-size EMS module to be connected in series in a three-phase circuit.

	en	es	fr
120 – 208 V, 60 Hz	763364	594487	586455

8 Rectifier and Filtering Capacitors
Three-phase bridge rectifier and two separate capacitors enclosed in a half-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz	579630	579632	579631
220 – 380 V, 50 Hz	579633	579635	579634
240 – 415 V, 50 Hz	579636		

Batteries, Renewable Energy Sources

1 **Traffic Lights**
Simulates a real-world traffic light application that can be used as a load for a fuel cell system.

	en	es	fr
120 – 208 V, 60Hz			
	579574	579574	579574

2 **Lead-Acid Batteries**
Two 12 V valve-regulated, lead-acid (VRLA) batteries enclosed in a half-size EMS module. Batteries can be connected in series or parallel.

	en	es	fr
120 – 208 V, 60 Hz			
	763374	763375	579590

3 **Solar Panel Test Bench**
Full-size EMS module in which a Solar Panel can be installed.

	en	es	fr
120 – 208 V, 60 Hz			
	579594	579596	579595
220 – 380 V, 50 Hz			
	579597	579598	
240 – 415 V, 50 Hz			
	579599		

4 **Smart Meter**
Compact device designed for basic metering and energy monitoring and featuring a SENTRON PAC3200 from Siemens.

	en	es	fr
120V, 60 Hz			
	8093902		

5 **Lead-Acid Battery Pack**
Half-size EMS module housing four 12 V lead-acid batteries connected in series.

	en	es	fr
120 – 208 V, 60Hz			
	579591	579592	

6 **Li-Ion Battery Pack**
48V, 3.4Ah battery pack with 13 re-chargeable 18650 lithium-Ion cells with a nominal voltage of 3.6V. The battery pack is made up of one group of 13 series of cells. (13S1P)

	en	es	fr
120 – 208 V, 60Hz			
	8144107		

7 **Hydrogen Fuel Cell**
A fuel cell stack comprising a fuel cell controller, a hydrogen flow meter, a dc-to-dc converter, an air supply, and seven LED displays for visualizing all essential system parameters.

	en	es	fr
120 – 208 V, 60 Hz			
	579593	579593	579593

8 **Monocrystalline Silicon Solar Panel**
Two independent photovoltaic modules mounted on a common metal chassis that can be installed in the Solar Panel Test Bench or on a tripod.

	en	es	fr
120 – 208 V, 60 Hz			
	579600	579602	579601

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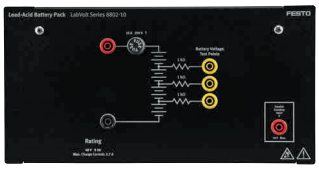

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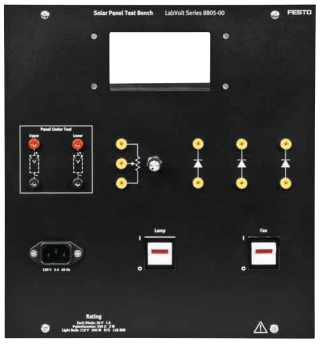

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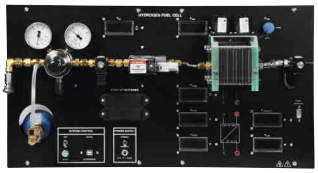

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Modules

Transformers, Power Transmission

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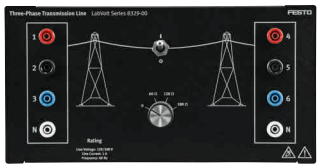

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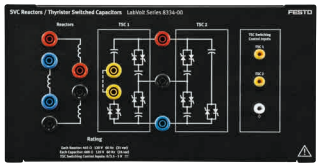

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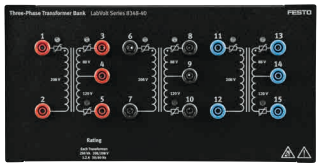

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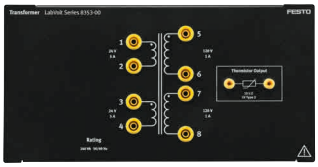

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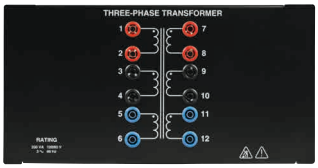

1 Three-Phase Transmission Line
Three iron-core inductors enclose in a half-size EMS module.
The inductors are specifically designed to simulate a high-voltage ac transmission line.

	en	es	fr
120 – 208 V, 60 Hz			
	579535	579537	579536
220 – 380V, 50 Hz			
	579538	579540	579539
240 – 415 V, 50 Hz			
	579541		
220 – 380 V, 60 Hz			
	579542	579543	

2 SVC Reactors/Thyristor Switched Capacitors
Module consisting of a set of three identical inductors to implement thyristor-controlled reactors (TCRs) using the Power Thyristors.

	en	es	fr
120 – 208 V, 60 Hz			
	763368		
220 – 380V, 50 Hz			
	579556		
240 – 415 V, 50 Hz			
	579557		
220 – 380 V, 60 Hz			
	579558	594488	

3 Three-Phase Transformer Bank
Three independent power transformers enclosed in a module.

	en	es	fr
120 – 208 V, 60 Hz			
	579559	579561	579560
220 – 380 V, 50 Hz			
	579562	579564	579563
240 – 415 V, 50 Hz			
	579565		

4 Regulating Autotransformer
Three-phase autotransformer enclosed in a half-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz			
	763369	763370	579566
220 – 380 V, 50 Hz			
	579567	579569	579568
240 – 415 V, 50 Hz			
	579570		

5 Transformer
Power transformer enclosed in a module. Both the primary and secondary sides are made of two identical separate windings.

	en	es	fr
120 – 208 V, 60 Hz			
	763371	763372	579571

6 Three-Phase Transformer
Transformer made up of a single magnetic core with three branches, enclosed in a half-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz			
	763373	592542	586468
220 – 380 V, 50 Hz			
	579572	594489	
240 – 415 V, 50 Hz			
	579573		

Motors, Generators

1 **DC Motor/Generator**
DC machine mounted in a full-size EMS module, that can operate independently as a DC motor or a DC generator.

	en	es	fr
120 – 208 V, 60 Hz			
	579759	**579761**	**579760**
220 – 380 V, 50 Hz			
	579762	**579764**	**579763**
240 – 415 V, 50 Hz			
	579765		

2 **Permanent Magnet DC Motor**
High-speed, brushed DC motor mounted in a full-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz			
	579485	**579486**	

3 **Wind Turbine Demonstrator**
Actual small-scale wind turbine modified to display the main internal components. The wind turbine has a fixed-pitch, three blade rotor that is directly coupled to the generator.

	en	es	fr
120 – 208 V, 60 Hz			
	579766	**579766**	**579766**

4 **Wind Turbine Generator/ Controller**
Three-phase permanent-magnet synchronous and a controller (converts the 3-phase power into DC power) of an actual small-scale wind turbine, mounted in a full-size EMS module.

	en	es	fr
120 – 208 V, 60Hz			
	579487	**579489**	

5 **Four-Pole Squirrel Cage Motor**
A squirrel-cage induction machine mounted in a full-size EMS module. The machine stator windings allow connection in either wye or delta configuration.

	en	es	fr
120 – 208 V, 60Hz			
	586267	**586268**	
220 – 380V, 50Hz			
	586269	**586270**	
240 – 415V, 50Hz			
	586266		

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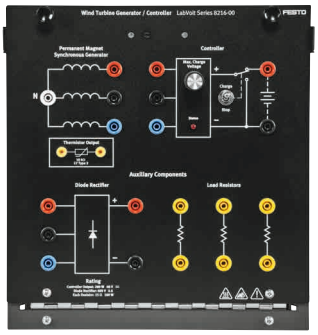

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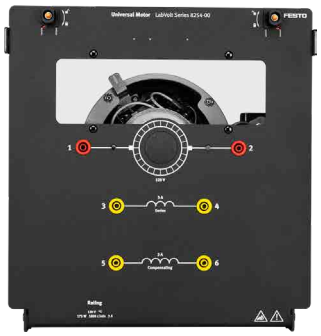
Modules

Motors, Generators

1



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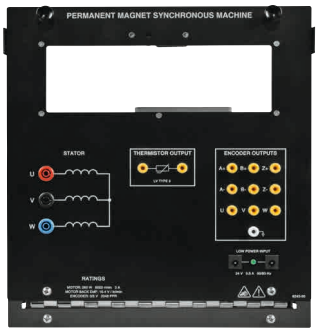

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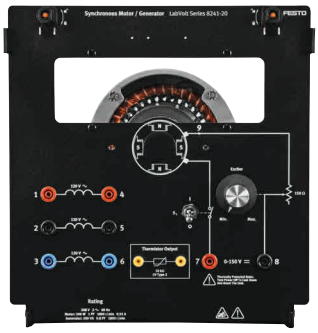

1 Universal Motor
Universal machine mounted in a full-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz			
	579774	579776	579775
220 – 380 V, 50 Hz			
	579777	579779	579778
240 – 415 V, 50 Hz			
	579780		

2 Three-Phase Wound Rotor Induction Machine
Induction machine with a wound rotor mounted in a full-size EMS module.

	en	es	fr
120 – 208 V, 60 Hz			
	579497	592532	579498
220 – 380 V, 50 Hz			
	579499	594484	
240 – 415 V, 50 Hz			
	579500		
220 – 380 V, 60 Hz			
	579501	594483	

3 Three-Phase Synchronous Motor/ Generator
0.2 kW three-phase synchronous machine mounted in a full-size EMS module that can be operated either as a three-phase motor or a three-phase generator.

	en	es	fr
120 – 208 V, 60 Hz			
	579502	579504	579503
220 – 380 V, 50 Hz			
	579505	579507	579506
240 – 415V, 50 Hz			
	579508		
220 – 380 V, 60 Hz			
	579509	579510	

4 Permanent Magnet Synchronous Machine
Permanent magnet synchronous machine encased in a full-size module. The stator windings of the machine are connected in a wye configuration.

	en	es	fr
120 – 208 V, 60 Hz			
	586378	594485	

5 Capacitor-Start Motor
Capacitor-start machine mounted in a full-size EMS module. The centrifugal switch and contact points of the machine are mounted externally.

	en	es	fr
120 – 208 V, 60 Hz			
	579767	579769	579768
220 – 380 V, 50 Hz			
	579770	579772	579771
240 – 415 V, 50 Hz			
	579773		
220 – 380 V, 60 Hz			
	581389	581390	

Switching Devices, Power Electronics

1 **Insulated DC-to-DC Converter**
Used to convert a low-voltage DC source, such as the Battery Pack, into a high-voltage DC output suitable for AC conversion.

	en	es	fr
120 – 208 V, 60 Hz			
	579618	**579620**	**579619**
220 – 380 V, 50 Hz			
	579621	**579622**	

2 **IGBT Chopper/Inverter**
Consists of seven insulated-gate bipolar transistors (IGBT) mounted in a half-size EMS module. Six IGBTs are used to implement choppers and inverters. The seventh IGBT and a dumping resistor allow smooth dissipation of excess energy at the DC bus.

	en	es	fr
120 – 208 V, 60 Hz			
	579623	**579625**	**579624**
220 – 380 V, 50 Hz			
	579626	**579628**	**579627**
240 – 415 V, 50 Hz			
	579629		

3 **Power Thyristors**
Six power thyristors (SCRs) mounted in a half-size EMS enclosure. A firing control section allows six 0-5 V pulse signals from either the Data Acquisition and Control Interface, Model 9063, the Thyristor Firing Unit, Model 9030, or any compatible 0-5 V control unit, to be applied to the gating circuits of the thyristors.

	en	es	fr
120 – 208 V, 60 Hz			
	763376	**763378**	**763377**
220 – 380 V, 50 Hz			
	763379	**763381**	**763380**
240 – 415 V, 50 Hz			
	763382		

4 **Synchronizing Module/ Three-Phase Contactor**
Half-size EMS module used to control various electric devices, or synchronize two ac power sources like a synchronous generator with an AC power network. It consists of a three-phase contactor whose coil can be energized either manually with a toggle switch, or automatically with a thyristor.

	en	es	fr
120 – 208 V, 60 Hz			
	579576	**579577**	
220 – 380 V, 50 Hz			
	579578	**579579**	
240 – 415 V, 50 Hz			
	579580		

5 **Fault Module**
Consists of a three-phase normally open contactor enclosed in a half-size EMS module. Each phase of the contactor can be used to insert different types of faults in an electric power circuit, such as ground faults and phase-to-phase faults.

	en	es	fr
120 – 208 V, 60 Hz			
	588972		
220 – 380 V, 50 Hz			
	589055		
240 – 415 V, 50 Hz			
	589054		

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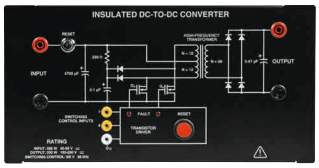

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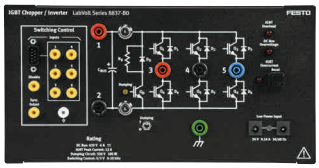

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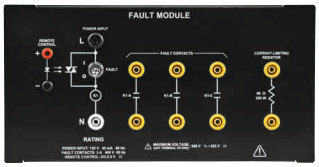

3

Modules

Protective Relaying, Power Supplies

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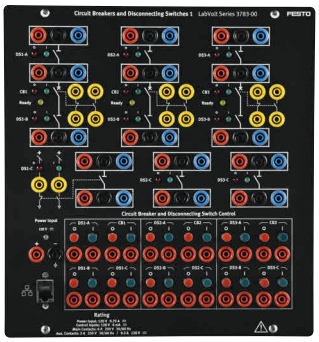

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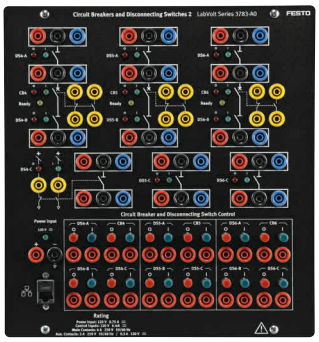

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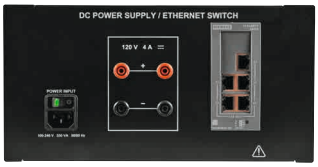


1 **Circuit Breakers and Disconnecting Switches 1**
Module that can be operated independently using dedicated I/O (open/close) switches or open/close control inputs on the front panel. An Ethernet port on the module front panel allows all circuit breakers and disconnecting switches to be controlled independently using a SCADA system.

en	es	fr
120 – 208 V, 60 Hz		
588952		

2 **Circuit Breakers and Disconnecting Switches 2**
Consists of 3 three-phase circuit breakers and 9 three-phase disconnecting switches, enclosed in a full-size EMS module, that can be used to implement electric power substations with different switching schemes. An Ethernet port on the module front panel allows all circuit breakers and disconnecting switches to be controlled independently using a SCADA system.

en	es	fr
120 – 208 V, 60 Hz		
588953		

Numerical Distance Relay
See page 133

Numerical Directional Overcurrent Relay
See page 133

Numerical Differential Protective Relay
See page 133

3 **AC power Network Interface**
Module used to interface the ac power network with EMS modules. It consists of an AC Power Inlet section comprising a C14 power cord inlet with 4 mm color-coded safety sockets for each terminal (line, neutral, and ground).

en	es	fr
120 – 208 V, 60 Hz		
579581	**579583**	**579582**
220 – 380 V, 50 Hz		
579584	**579586**	**579585**
240 – 415 V, 50 Hz		
579587		
220 – 380 V, 60 Hz		
579588	**579589**	

24V AC Power Supply
Enclosed in a full-size EMS module, it provides DC power and AC power, both fixed and variable, single-phase and three-phase.

en	es	fr
120 – 208 V, 60 Hz		
579696	**579696**	**579696**
220 – 380 V, 50 Hz		
579697	**579697**	**579697**
240 – 415 V, 50 Hz		
579698		
220 – 380 V, 60 Hz		
579697	**579697**	

4 **Three-Phase Power Supply**
Consists of a fixed-voltage three-phase ac power source and a fixed-voltage DC power source enclosed in a half-size EMS module.

en	es	fr
120 – 208 V, 60Hz		
579612	579613	
220 – 380 V, 50Hz		
579614	**594495**	
240 – 415 V, 50 Hz		
579615		
220 – 380 V, 60 Hz		
579616	**579617**	

5 **Power Supply/Ethernet Switch**
Consists of a 120 V DC power supply and an industrial-grade, five-port Ethernet switch enclosed in a half-size EMS module. The 120 V DC power supply is designed to power Circuit Breakers and Disconnect Switches modules.

en	es	fr
120 – 208 V, 60 Hz		
588954		

Numerical Directional Overcurrent Relay
ANSI protection functions: Directional phase overcurrent (67), Directional ground overcurrent (67N), Directional power (32), Instantaneous phase overcurrent (50), Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N). Other possible functions: 27, 37, 38, 46, 59, 74, 81, 86, and 87N

Standard version
Order no. **589061**
With safety jacks and connectors
Order no. **589110**

Numerical Distance Relay
ANSI protection functions: Phase distance (21), Ground distance (21N), Directional phase overcurrent (67), Directional ground overcurrent (67N), Directional power (32), Instantaneous phase overcurrent (50). Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N). Other possible functions: 27, 37, 38, 46, 59, 68, 74, 81, 86, and 87N.

Standard version
Order no. **589062**
With safety jacks and connectors
Order no. **589111**

Numerical Differential Protective Relay
ANSI protection functions: Transformer differential (87T), Instantaneous phase overcurrent (50), Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N).

Standard version
Order no. **589891**
With safety jacks and connectors
Order no. **592529**

Required accessories for all numerical protective relays, also order:
– IEC Power Cable (page 14)
– Siemens DIGSI 5 (page 181)

Electric Power Technology Training Modules
Workstations and Accessories

Hydrogen Generator
HG 30 Heliocentris hydrogen generator that produces high-purity hydrogen (99.9999% vol) for laboratory and research use. It is ideal both for the direct operation of fuel cell systems and for filling low-pressure metal hydride canisters.

Order no	**579781**

Hydrogen Canister

Order no	**579699**

Hydrogen connection kit from 200 Bar

Order no	**780548**

Timing Belt
The Timing Belt is a high-quality industrial synchro-cog timing belt made of rubber whose teeth exactly mesh with the geared pulley fitted on the shaft of all 0.2 kW EMS machines. The Timing Belt is supplied in a fixed length appropriate for coupling two adjacent EMS machines together without slippage between them.

Order no	**579637**

Heavy-Duty Tripod
Compact, heavy-duty unit that is perfectly suited to hold a solar panel when performing outdoor exercises.

Order no	**583216**

Pyranometer
The Pyranometer is a high-quality instrument for measuring solar irradiance. The thermopile sensor construction measures the solar energy that is received from the total solar spectrum and the whole hemisphere (180° field of view). The output signal of the Pyranometer is a voltage proportional to the measured solar irradiance, expressed in Watts/m². The Pyranometer is a useful instrument when measuring the performance of solar panels versus .

Order no	**579784**

Connection Leads
Extra-flexible leads terminated with stacking 4 mm safety banana plugs. The leads are supplied in different lengths and are color-coded according to length.
– 16x red, 600 mm
– 8x blue, 900 mm
– 16x yellow, 300 mm

Order no	**586891**

Connection Leads
Extra-flexible leads terminated with stacking 4 mm safety banana plugs. In addition, the set includes stacking 2 mm banana plug leads of the same length and color.
– 4x red, 600 mm (2 mm plug)
– 10x red, 600 mm (4 mm plug)
– 4x blue, 900 mm (4 mm plug)
– 20x yellow, 300 mm (4 mm plug)

Order no	**579638**

Connection Leads
Extra-flexible leads terminated with stacking 4 mm safety banana plugs. The leads are supplied in different lengths and are color-coded according to length. The set also includes three-phase leads, which are made of three color-coded leads bundled together along their length to simplify the connection of three-phase circuits.
– 4x 3-phase cable, 600 mm
– 8x red, 600 mm
– 4x blue, 900 mm
– 14x yellow, 300 mm

Order no	**579639**

Connection Leads (Shielded)
Set consisting of two three-phase shielded cables terminated with stacking 4 mm safety banana plugs as well as two shielded cables terminated with 2 mm banana plugs.

Order no	**586897**

Multimeter
An Amprobe AM-510 Tool Kit Digital Multimeter with Battery Test, ideal to perform voltage, current, and resistance measurements in exercises.

Order no	**579782**

EMS Blank Module
Used to fill unused locations in a workstation, preventing students from accessing electrical or moving parts inside the other modules. Combined with the use of safety bars to prevent students from removing modules, blank EMS modules ensure student safety during lab exercises.

Full-size	**579757**
Half-size	**579758**

1 **Storage Shelves**
Module with five shelves, each of which can accommodate four full-size EMS modules or eight half-size EMS modules.
Order no. **579756**

3 **Three-Module Workstation**
Workstation consisting of a single row of three full-height compartments that can accommodate up to three full-size EMS modules or six half-size EMS modules. Intended for use on a bench (not supplied) and is fitted with wooden feet to protect the bench top.
Order no. **579483**

4 **Tabletop Workstation**
Workstation intended for use on a bench (not supplied) and is fitted with rubber feet to protect the bench top. Three rows of compartments are designed to house EMS modules. Two of these rows have full-height compartments while the other row has half-height compartments.
Order no. **579484**

5 **Mobile Workstation**
Workstation mounted on a Mobile Storage Cabinet. Swivel casters allow easy movement. Immediately above the storage cabinet is a pullout work surface. The upper portion of the workstation consists of three rows of compartments designed to house EMS modules.
Order no. **579755**

6 Mounting Frame (DIN A4) for EMS Workstations
Frame is designed to integrate DIN A4 modules within the EMS LabVolt 8010 work environment. It consists of a set of rails and feet that can be installed on top of an EMS workstation. It accommodates up to three DIN A4 modules. This frame comes disassembled.
Order no. **8138160**

1

3

4

5

Training Packages in Electric Power Technology

TP 801X Series

The building blocks
Training packages include workstations, robust training modules, and practical digital tools for teaching and studying electrical topics in vocational and technical schools, colleges, and universities, as well as for workforce development programs in industrial companies and training providers.

Each training package is matched with one or more courses from our collection and provides all the essential equipment needed to carry out the hands-on experiments described in these courses.

Emulate electric power systems in the classroom
Learners can insert a variety of modules—such as motors, loads, filters, batteries, power supplies, inverters, transformers, and controllers—into compact workstations. This flexibility allows them to replicate a broad spectrum of system topologies, ranging from simple configurations to complex applications for study or research.

Students wire these modules to create electrical circuits and engage in experiments outlined in the courseware. During lab sessions, they utilize digital data acquisition and control tools, along with virtual instruments, to understand and analyze circuit behavior effectively.

A proven concept
The training packages are the CE-marked version of the EMS Lab-Volt Series 8010 product line, used for hands-on electrical labs in vocational schools, universities, and training centers worldwide. This concept was originally developed in the 1960s by Canadian electrical engineering teacher, Dr. Theodore Wildi.

Highlights
- Turnkey curriculum focused on hands-on experimentation.
- Computerized hardware for advanced control and power management functions.
- Unparalleled data acquisition and control interface designed specifically for learning purposes.
- Modular design to meet and evolve with current and future training needs and budgets.
- Real-time measurement and display of electrical and mechanical values with a free virtual instrumentation suite.
- Safe grounding methods and embedded electrical protections against overcurrent, overheating, and/or overvoltage.
- High durability and repairability.

Essential electrical expertise

As industries move toward electrification and strive to maximize efficiency while reducing their environmental footprint, the demand for professionals who can design, operate, and maintain basic to complex electrical systems continues to grow.

Building a strong foundation in electrical engineering is a prerequisite for innovation, competitiveness, and sustainability.

Our range of training packages provide a balanced mix of theory and hands-on experimentation, equipping instructors and learners with the tools to effectively teach and study essential topics such as **basic electrical principles, renewable energy, power electronics, and rotating machines.**

Your benefits
- Tailor a solution to your current-needs, while keeping expansion options open.
- Teach multiple classes with the same hardware and reduce accessories costs.
- Speed up course preparation thanks to pre-designed courses.
- Digital tools deepen student understanding and make lab sessions more efficient and impactful.
- Students work in a safe environment.
- Enjoy a high return on investment and a long service life.

List of training packages

Renewable energy:
- Introduction to Wind Power TP 8012-0
- Wind Power Systems TP 8012-1
- Wind Power, Complete TP 8012-2
- Introduction to Solar Power TP 8012-3
- Photovoltaic Systems TP 8012-4
- Solar Power, Complete TP 8012-5

Basics of electric power:
- AC/DC Power Circuits TP 8015-1
- Transformers TP 8015-2
- AC/DC Power Circuits and Transformers TP 8015-3

Power electronics:
- IGBT Power Conversion Circuits TP 8015-4
- Thyristor Power Conversion Circuits TP 8015-5
- AC Variable-Speed Drives TP 8015-6
- DC Variable-Speed Drives TP 8015-7
- Three-Phase Motor Starters TP 8015-8

Electrical machines:
- Three-Phase Rotating Machines TP 8016-1
- Permanent Magnet DC Motors TP 8016-2
- Power Factor Correction TP 8016-3

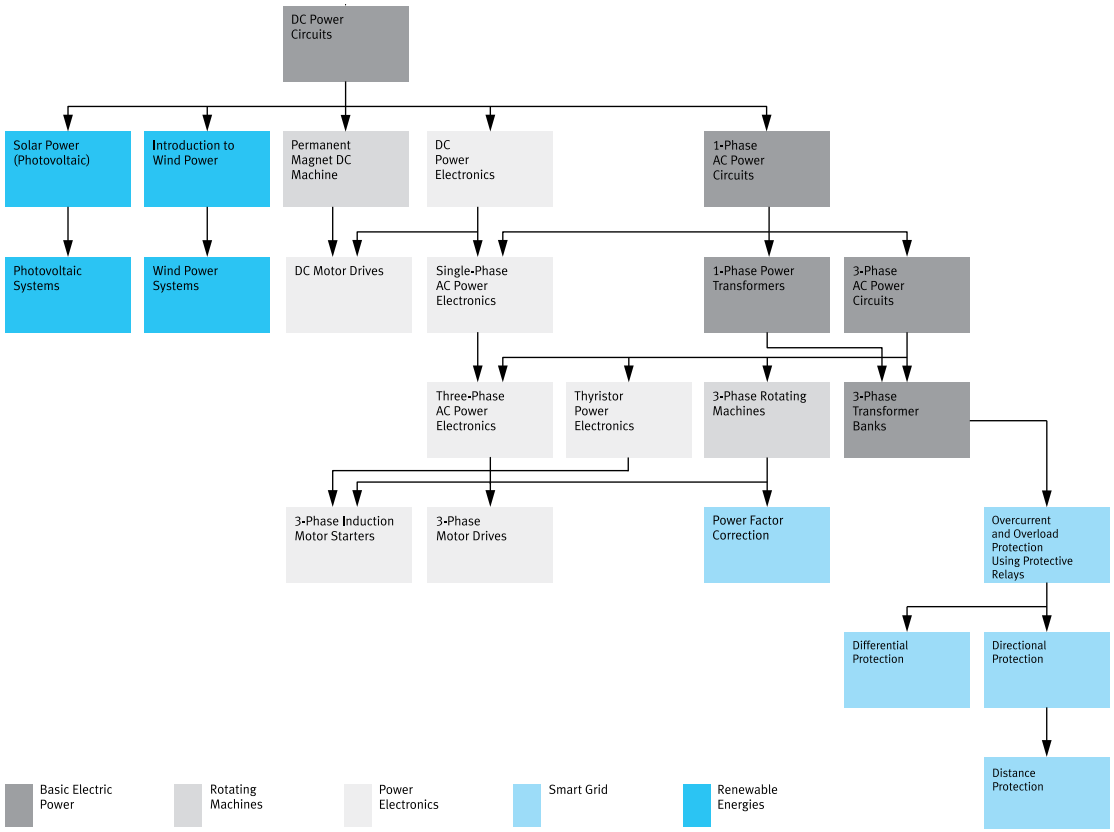
New training packages, modules, and courses are currently under development to expand the topic coverage of the product line.

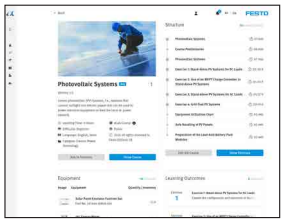
Where to start?
Explore the selection of courses and training packages to choose the ones that meet your goals. The modular design lets you mix and match packages, add individual modules, and unlock firmware functions—either at the time of purchase or later.

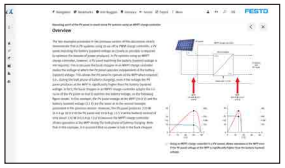
Build your lab, your way.

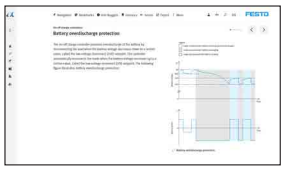
Training Packages in Electric Power Technology

Course Program









Ready-to-use course materials

The electric power technology training packages are supported by a comprehensive collection of ready-to-use courses. The program flowchart outlines the variety of topics available and indicates the necessary prerequisites for each course.

Each course is designed to cover specific subjects, featuring clear learning objectives, concise theoretical content, and practical exercises that have been rigorously tested for effectiveness. Step-by-step instructions assist students during lab sessions, while review questions help reinforce the knowledge acquired. Instructors have access to all lab results and answers for efficient teaching.

Educators can easily adopt these courses in their entirety, select individual units or exercises to enhance their existing curriculum, or customize the content to meet their specific instructional needs.

Courses are available on Festo LX in digital format (subscription required) or as PDF workbooks (campus licenses sold separately).

This course collection is continuously evolving, with new courses added regularly to ensure up-to-date content and relevance in the field.

The table below shows which courses are supported by each training package.
Keep in mind: Once you've purchased one or more training packages with their corresponding courses, you can easily expand your setup by adding individual modules to support additional courses. Whether you're purchasing electric power technology training packages for the first time or expanding an existing setup, your Festo representative will help you get exactly what you need.

● Course suitable for the training package	TP 8012-0	TP 8012-1	TP 8012-2	TP 8012-3	TP 8012-4	TP 8012-5	TP 8015-1	TP 8015-2	TP 8015-3	TP 8015-4	TP 8015-5	TP 8015-6	TP 8015-7	TP 8015-8	TP 8016-1	TP 8016-2	TP 8016-3	Protective Relays *
Solar Power	●		●															
Photovoltaic Systems		●	●															
Intro to Wind Power				●		●												
Wind Power Systems					●	●												
DC Power Circuits							●		●									
Permanent Magnet DC Machine																●		
DC Motor Drives													●					
DC Power Electronics										●								
Single-Phase AC Power Electronics										●								
Three-Phase AC Power Electronics										●								
Three-Phase Motor Drives												●						
Thyristors Power Electronics											●							
Three-Phase Induction Motor Starters														●				
Single-Phase AC Power Circuits							●		●									
Single-Phase Power Transformers								●	●									
Three-Phase Rotating Machines															●			
Power Factor Correction																	●	
Three-Phase AC Power Circuits							●		●									
Three-Phase Transformer Banks								●	●									
Overcurrent/Overload Protection																		●
Differential Protection																		●
Directional Protection																		●
Distance Protection																		●

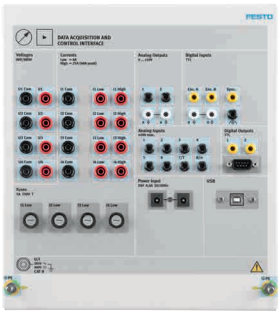
* See the numerical protective relays on page Seite 180.

Training Packages in Electric Power Technology
Computerized Modules

Optimize learning and lab sessions

Digitalization transforms electrical engineering laboratories. New technologies offer more ways to increase the efficiency of hands-on sessions, facilitate data collection and analysis, decrease the need for accessories, make hardware more flexible, and allow for remote learning and training.

Two computerized modules–the Data Acquisition and Control Interface (DACI) and the Four-Quadrant Power Supply and Controller–are unparalleled allies for teaching and conducting experiments in electromechanics, power electronics, renewable energies, and power management.



Data Acquisition and Control Interface (DACI)

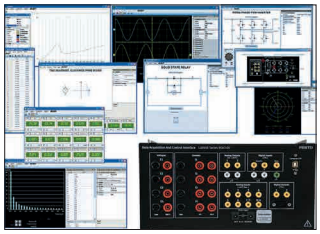
This module efficiently measures and analyzes electrical and mechanical parameters in power systems and electronics. It features computer-based instruments and control functions, accessible via LVDAC-EMS software, and supports applications like choppers, inverters, and drives.

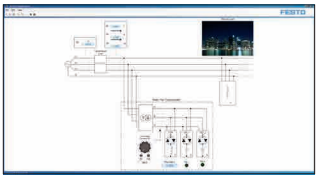
Four-Quadrant Power Supply and Dynamometer Controller

This module is easily configurable as a prime mover or brake, a flexible AC/DC power supply, or a load emulator for applications ranging from simple mechanical systems to more complex applications such as wind and hydraulic turbines and solar panels. These functions are accessible via LVDAC-EMS software."

Training Packages in Electric Power Technology

Software Programs





The **LVDAC-EMS** software is a user-friendly tool that facilitates the use of the various functions which can be implemented with USB peripherals, such as the Data Acquisition and Control Interface (DACI) and the Four-Quadrant Dynamometer/Power Supply. Together, the DACI and LVDAC EMS provide a complete set of modern computer-based instruments to measure, observe, analyze, and control electrical and mechanical parameters.

The provided instruments eplace a multitude of actual data acquisition devices and include voltmeters, ammeters, power meters, frequency meters, efficiency meters, impedance meters, power factor meters, energy meters, torque and speed meters, an oscilloscope, a phasor analyzer, a harmonic analyzer, and a spectrum analyzer.

- The Metering window displays up to eighteen meters that can be configured to measure a multitude of parameters.
- The Oscilloscope displays up to eight waveforms simultaneously. Each waveform is of a different color for easy identification.
- The Phasor Analyzer displays the phasors related to measured voltages and currents instead of the values and waveforms related to these voltages and currents.
- The Harmonic Analyzer allows observation and analysis of the harmonic components in the measured voltages and currents.

The DACI and LVDAC-EMS also allow manual and timed data recording. The recorded data can be saved to files in any specified location, graphically represented with the provided graph plotting tool, and exported into a spreadsheet application.

The DACI and LVDAC-EMS can also be used with the Four-Quadrant Dynamometer/Power Supply to implement a variety of control functions for advanced training in various fields of electricity and new energy, including electric power technology, AC/DC rotating machines, renewable energy, transmission lines, and power electronics.

The LVDAC-EMS software and the Data Acquisition and Control Interface allow complex power system applications such as hydropower generators, large-scale wind turbines (PMSG and DFIG), high-voltage direct current (HVDC) transmission systems, static var compensators (SVCs), and static synchronous compensators (STATCOMs) to be implemented. SCADA windows are available in the LVDAC-EMS software for these complex applications to ease system control and monitoring, as well as to allow students to quickly understand what is going on in these applications.

Free download on our → website.

The **SCADA for LVDAC-EMS program** is designed to run in combination with LVDAC-EMS. It transforms LVDAC-EMS software and the workstation's computer into a local workstation that can be monitored and controlled over a local network from a supervisory computer.

Using the OPC Server protocols, SCADA-EMS enables users to design their own interfaces by calling the different applications running on the local workstations.

SCADA-EMS enhances LVDAC-EMS by adding several new features:
- Collect data from local workstations.
- Observe and control one or multiple stations from one or multiple supervisory stations.
- Remotely control several applications in a lab.
- Use a workstation in a different room to present actual demonstrations over the network in your classroom without having to bring a workstation to class.
- Introduce students to the fundamentals of SCADA in a grid context.
- Recreate a complete grid with several different applications running.

A locked version of the SCADA-EMS software program can be downloaded from our website and can be unlocked by a USB dongle. A dongle unlocks five workstations; order as many dongles as required. LVDAC-EMS is required to run SCADA-EMS.

Order no.	**8094377**

Using Festo LX in combination with the training packages empowers teachers to design personalized learning paths, monitor student progress, and tailor course materials—all within a central hub.

The lab's flexible design, built on electric power technology training packages, functions like building blocks—everything, from courses and modules to control functions, is designed for easy customization. This adaptability allows the lab to evolve seamlessly over time in the most cost-effective way.

Introduction to Wind Power

TP 8012-0

Equipment Set TP 8012-0

220 – 240 V, 50 Hz	**596083**

Note: This package complies to CE regulations. If you need another electrical configuration, or do not need CE compliance, please see the electric power technology learning systems (page 96).

The most important components at a glance:

1x Wind Turbine Generator/Controller	595061
1x Wind Turbine Load Resistors	594819
1x Resistive Load	594820
1x 48 V Lead-Acid Battery Pack	8174051
1x 4-Quadrant Power Supply and Dynamometer Controller	596127
1x 4-Quadrant Dynamometer Motor	595062
1x AC 24 V Power Supply	772050
1x Timing Belt	793141
1x Protective Guard – Side-by-side	794195

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Frameline Table on Wheels	8087149
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

Teach the fundamentals of wind power production.

This training package provides hands-on experience with wind power production. It integrates real wind turbine parts to build essential knowledge and skills to turn wind into electrical energy, with emphasis on the use and operation of wind turbines.

The training package contains the necessary equipment to perform the practical learning activities of the “Introduction to Wind Power” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules to study topics such as the basic principles of power systems that convert wind energy into electrical power.

The four-quadrant dynamometer motor simulates the mechanical behavior of a wind turbine under various wind conditions, while the four-quadrant power supply and dynamometer controller emulate these wind conditions and provide both manual and computer-based control of turbine operation. This includes the management of battery charging cycles through the integrated lead-acid battery charger function.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	596126
de	798369
fr	8096504

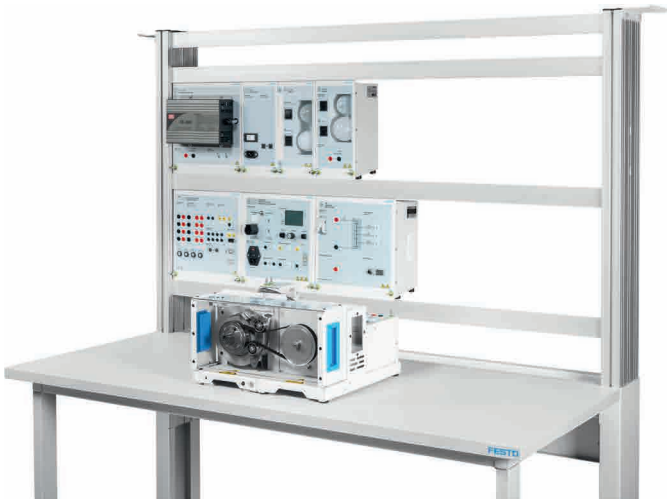
Notes: The campus license “Wind Power” includes the student and instructor manuals of the following workbooks: “Intro to Wind Power”, and “Wind Power Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Intro to Wind Power
→ Wind Power Systems

Wind Power Systems

TP 8012-1



Equipment Set TP 8012-1

220 – 240 V, 50 Hz	**596084**

The most important components at a glance:

1x Wind Turbine Generator/Controller	595061
1x DC 48 V Lamps	595055
1x AC 230 V Lamps	8165858
1x 48 V Lead-Acid Battery Pack	8174051
1x AC 24 V Power Supply	772050
1x 1 AC 230 V Stand-Alone Inverter	595052
1x 4-Quadrant Power Supply and Dynamometer Controller	596127
1x 4-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-1	595912
1x Timing Belt	793141
1x Protective Guard – Side-by-side	794195

Necessary accessory, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Frameline Table on Wheels	8087149
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

Facilitate the study of wind power production systems.

This training package provides hands-on experience with stand-alone power systems for AC or DC loads.

The training package contains the necessary equipment to perform the practical learning activities of the “Wind Power Systems” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners connect modules following step-by-step instructions to study topics such as the voltage-speed and torque-current characteristics of a wind turbine generator, the relationship between power and wind speed, and the basics of battery energy storage.

The four-quadrant dynamometer motor simulates the mechanical behavior of a wind turbine under various wind conditions, while the four-quadrant power supply and dynamometer controller emulate these conditions and provide both manual and computer-based control of turbine operation—including battery charging cycles via the integrated lead-acid battery charger.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	596126
de	798369
fr	8096504

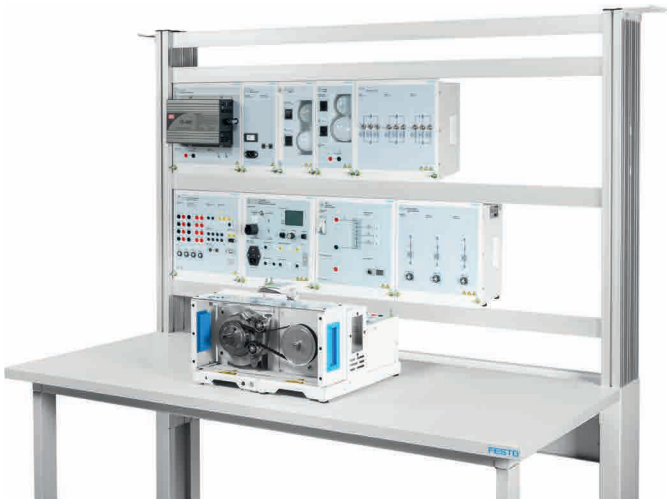
Notes: The campus license includes the student and instructor manuals of the following workbooks: “Intro to Wind Power”, and “Wind Power Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Intro to Wind Power
→ Wind Power Systems

Wind Power, Complete

TP 8012-2



Equipment Set TP 8012-2

220 – 240 V, 50 Hz	**596085**

The most important components at a glance:

1x Wind Turbine Generator/Controller	595061
1x Wind Turbine Load Resistors	594819
1x Resistive Load	594820
1x DC 48 V Lamps	595055
1x AC 230 V Lamps	8165858
1x 48 V Lead-Acid Battery Pack	8174051
1x AC 24 V Power Supply	772050
1x 1 AC 230 V Stand-Alone Inverter	595052
1x 4-Quadrant Power Supply and Dynamometer Controller	596127
1x 4-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-1	595912
1x Timing Belt	793141
1x Protective Guard – Side-by-side	794195

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Frameline Table on Wheels	8087149
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

Provide a complete learning experience in wind power production.

This training package provides hands-on experience with the basic principles of wind power generation and wind power systems. It combines TP 8012-0 and TP 8012-1 without duplication of hardware components. It enables teachers to train qualified workers who can operate and maintain wind power systems based on small-scale wind turbines.

The training package contains the necessary equipment to perform the practical learning activities of the “Introduction to Wind Power” and “Wind Power Systems” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and learn the basic principles of power systems that convert wind energy into electricity. They then move on to topics such as wind turbines and small-scale wind power generation, voltage-speed and torque-current characteristics of a wind turbine generator, wind power variation with wind speed, battery energy storage, and stand-alone wind power systems for AC and DC loads.

The four-quadrant dynamometer motor simulates the mechanical behavior of a wind turbine under varying wind conditions, while the four-quadrant power supply and dynamometer controller emulate these conditions and provide both manual and computer-based control of turbine operation. This includes management of battery charging cycles through the integrated lead-acid battery charger function.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	596126
de	798369
fr	8096504

Notes: The campus license includes the student and instructor manuals of the following workbooks: “Intro to Wind Power”, and “Wind Power Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Intro to Wind Power
→ Wind Power Systems

Introduction to Solar Power

TP 8012-3

Equipment Set TP 8012-3

220 – 240 V, 50 Hz	**596086**

The most important components at a glance:

1x 12 V Lead-Acid Batteries*	595060
1x Solar Panel Test Bench	595057
1x Monocrystalline Silicon Solar Panel	595058

*A 12 V DC battery charger is required for this module. Users can use their own charger with 4 mm safety plugs or order the 4-Quadrant Power Supply and Dynamometer Controller, including manual and computer-based control (order no. 595028).

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Frameline Table on Wheels	8087149
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

Teach the fundamentals of solar power production.

This training package provides hands-on experience with basic solar power energy concepts, solar panel construction, operating characteristics and performance factors.

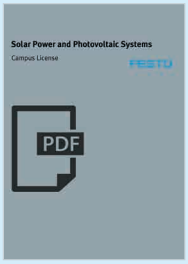
The training package contains the necessary equipment to perform the practical learning activities of the “Solar Power” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore topics such as solar panel characteristics, battery energy storage, and performance under varying conditions such as temperature, shading, orientation, and irradiance.

The tabletop solar panel test bench provides a controlled environment for hands-on experimentation with irradiance control, temperature monitoring, and shading capabilities. Experiments can be conducted indoors with the bench’s built-in light source or outdoors with natural sunlight. This versatile setup allows a monocrystalline silicon solar panel to be safely and efficiently connected to measure key parameters such as voltage, current, and power output under different lighting conditions.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	596125
de	798367
fr	8096492

Notes: The campus license includes the student and instructor manuals of the following workbooks: “Solar Power”, and “Photovoltaic Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Solar Power
→ Photovoltaic Systems

Photovoltaic Systems

TP 8012-4

Equipment Set TP 8012-4

220 – 240 V, 50 Hz	**596087**

The most important components at a glance:

1x DC 48 V Lamps	595055
1x AC 230 V Lamps	8165858
2x 1 AC Energy Meter	594904
1x 48 V Lead-Acid Battery Pack	8174051
1x DC 48 V PWM Charge Controller	8241563
1x DC 48 V MPPT Charge Controller	595050
1x AC 230 V Power Supply	595930
1x AC 24 V Power Supply	772050
1x 1 AC 230 V Stand-Alone Inverter	595052
1x 1 AC 230 V Grid-Tied Inverter	595053
1x 4-Quadrant Power Supply and Dynamometer Controller	595028
1x Solar Power Emulator Function for the 4Q Power Supply/Dynamometer	581440
1x Data Acquisition and Control Interface DACI-1	595912

Necessary accessories, also order:

1x Communications Gateway*	595054
1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Frameline Table on Wheels	8087149
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

* Only one per lab is necessary

Facilitate the study of solar power production systems.

This training package provides hands-on experience with photovoltaic energy production systems operating in stand-alone or grid-tied operation.

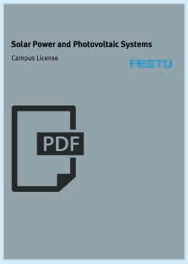
The training package contains the necessary equipment to perform the practical learning activities of the “Photovoltaic Systems” course available on Festo LX (subscription required) or as a campus license (sold separately).

Students connect modules following step-by-step instructions to explore topics such as selecting the appropriate components for stand-alone or grid-tied applications, setting up systems for DC and AC loads, improving energy efficiency, applying metering techniques, and understanding different types of charge controllers (MPPT or PWM) and inverters.

The solar panel emulator firmware feature of the four-quadrant power supply and dynamometer simulates the behavior of a solar panel under varying environmental conditions. This provides a controlled environment to study solar power system performance and analyze how different charge controllers (MPPT or PWM) affect energy efficiency and power output in both stand-alone and grid-tied systems. The tabletop solar panel test stand further supports experimentation with irradiance control, temperature monitoring, and shading capabilities.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	596125
de	798367
fr	8096492

Notes: The campus license includes the student and instructor manuals of the following workbooks: “Solar Power”, and “Photovoltaic Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Solar Power
→ Photovoltaic Systems

Solar Power, Complete

TP 8012-5

Equipment Set TP 8012-5

220 – 240 V, 50 Hz	**596088**

The most important components at a glance:

1x 12 V Lead-Acid Batteries *	595060
1x Solar Panel Test Bench	595057
1x Monocrystalline Silicon Solar Panel	595058
2x 1 AC Energy Meter	594904
1x DC 48 V PWM Charge Controller	8241563
1x DC 48 V MPPT Charge Controller	595050
1x AC 230 V Power Supply	595930
1x 1 AC 230 V Grid-Tied Inverter	595053
1x DC 48 V Lamps	595055
1x AC 230 V Lamps	8165858
1x 48 V Lead-Acid Battery Pack	8174051
1x AC 24 V Power Supply	772050
1x 1 AC 230 V Stand-Alone Inverter	595052
1x 4-Quadrant Power Supply and Dynamometer Controller	595028
1x Data Acquisition and Control Interface DACI-1	595912
1x Solar Panel Emulator Function for the 4Q Power Supply/Dynamometer	581440

*A 12 V DC battery charger is required for this module. Users can use their own charger with 4 mm safety plugs or use the 4-Quadrant Power Supply and Dynamometer Controller.

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Communications Gateway*	595054
1x Connection Lead Set and Grounding Kit	595916
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation (DIN A4)	8158409

* Only one per lab is necessary

Provide a complete learning experience in solar power production.

This training package provides hands-on experience with basic solar power energy concepts, solar panel construction, operating characteristics and performance factors, before moving on to the operation and maintenance of photovoltaic systems in stand-alone or grid-tied scenarios. It combines TP 8012-3 and TP 8012-4 without duplication of hardware components.

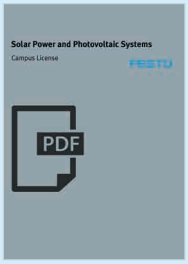
The training package contains the necessary equipment to perform the practical learning activities of the “Solar Power” and “Photovoltaic Systems” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore topics such as solar panel characteristics, battery energy storage, and system performance under varying conditions such as temperature, shading, orientation, and insolation. They also explore component selection for stand-alone or grid-tied applications, system setup for DC and AC loads, energy efficiency, metering techniques, and the differences between MPPT and PWM charge controllers and inverters.

The four-quadrant power supply and test stand’s solar panel emulator firmware feature simulates solar panel behavior under changing environmental conditions, providing a controlled environment to study system performance and compare the impact of MPPT and PWM charge controllers on energy efficiency and power output in both stand-alone and grid-tied systems. The tabletop solar panel tester also provides a controlled environment for hands-on experimentation with irradiance control, temperature monitoring, and shading simulation.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	596125
de	798367
fr	8096492

Notes: The campus license includes the student and instructor manuals of the following workbooks: “Solar Power”, and “Photovoltaic Systems”. Printed workbooks available upon request.

Courses on Festo LX:

→ Solar Power
→ Photovoltaic Systems

AC/DC Power Circuits

TP 8015-1

Equipment Set TP 8015-1

220 – 240 V, 50 Hz	**8093319**

The most important components at a glance:

1x Resistive Load	594820
1x Inductive Load	594821
1x Capacitive Load	594822
1x Three-Phase 400 V DC 230V Power Supply	594825
1x 24V AC Power Supply (Wall Mount)	793290
1x AC 230V DC 325V Variable Power Supply	* 8089266
1x Data Acquisition and Control Interface DACI-2	594499

* Can be replaced by the 4-Quadrant Power Supply and Dynamometer Controller

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase Power Supply and Safety Unit	594826
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is required.

Convey fundamental knowledge of electric power circuits.

This training package provides hands-on experience with the basics of electricity and electric power, measurements, electrical values, DC circuits (series, parallel, mixed) and single- and three-phase AC circuits.

The training package contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits”, “Single-Phase AC Power Circuits, and “Three-Phase AC Power Circuits” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore DC circuit principles such as resistance, voltage, current, and power, as well as series and parallel configurations. They also study AC circuit concepts, including sine waves, phase angles, phase shifts, reactance, and impedance.

The four-quadrant dynamometer/power supply features built-in meters, an oscilloscope, phasor analyzer, data tables, graphs, and harmonic analyzer—enabling comprehensive analysis while minimizing time lost switching connections or consulting multiple instruments. It can simultaneously measure up to four high-voltage and four high-current inputs, providing accurate, real-time data for studying complex electrical and mechanical interactions.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8093410
de	8147580
fr	8231072

Notes: The campus license “AC/DC and Transformers” includes the student and instructor manuals in PDF of the following workbooks: “DC Power Circuits”, “Single-Phase AC Power Circuits”, “Single-Phase Power Transformers”, “Three-Phase AC Power Circuits”, and “Three-Phase Transformer Banks”. Printed workbooks available upon request.

Courses on Festo LX:

- → DC Power Circuits
- → Single-Phase AC Power Circuits
- → Single-Phase Power Transformers
- → Three-Phase AC Power Circuits
- → Three-Phase Transformer Banks

Transformers

TP 8015-2

Equipment Set TP 8015-2

220 – 240 V, 50 Hz	**8093320**

The most important components at a glance:

1x Resistive Load	594820
1x Three-Phase Transformer Bank	594823
1x Single-Phase Transformer	594824
1x Three-Phase 400 V DC 230V Power Supply	594825
1x 24V AC Power Supply (Wall Mount)	793290
1x AC 230V DC 325V Variable Power Supply	* 8089266
1x Data Acquisition and Control Interface DACI-2	594499

* Can be replaced by the 4-Quadrant Power Supply and Dynamometer Controller

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase Power Supply and Safety Unit	594826
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is required.

Facilitate the study of power transformers, in a safe environment.

This training package provides hands-on experience with single- and three-phase transformers are built, as well as magnetism principles, losses, regulations, efficiency, configuration and more.

The training package contains the necessary equipment to perform the practical learning activities of the “Single-Phase Transformer Banks” and “Three-Phase Transformer Banks” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore topics such as transformer design, polarity, regulation and losses, the effect of frequency on transformer rating, autotransformers, and three-phase transformer configuration in various setups.

The data acquisition and control interface features built-in meters, an oscilloscope, phasor analyzer, data tables, graphs, and harmonic analyzer, enabling comprehensive analysis while minimizing the time spent switching connections or consulting multiple instruments. It can simultaneously measure up to four high-voltage and four high-current inputs, providing accurate, real-time data for studying complex electrical and mechanical interactions.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8093410
de	8147580
fr	8231072

Notes: The campus license “AC/DC and Transformers” includes the student and instructor manuals in PDF of the following workbooks: “DC Power Circuits”, “Single-Phase AC Power Circuits”, “Single-Phase Power Transformers”, “Three-Phase AC Power Circuits”, and “Three-Phase Transformer Banks”. Printed workbooks available upon request.

Courses on Festo LX:

- → Single-Phase Power Transformers
- → DC Power Circuits
- → Three-Phase AC Power Circuits
- → Single-Phase AC Power Circuits
- → Three-Phase Transformer Banks

AC/DC Power Circuits and Transformers

TP 8015-3

Equipment Set TP 8015-3

220 – 240 V, 50 Hz	**8093321**

The most important components at a glance:

1x Resistive Load	594820
1x Inductive Load	594821
1x Capacitive Load	594822
1x Three-Phase Transformer Bank	594823
1x Single-Phase Transformer	594824
1x Three-Phase 400 V DC 230V Power Supply	594825
1x 24V AC Power Supply (Wall Mount)	793290
1x AC 230V DC 325V Variable Power Supply	* 8089266
1x Data Acquisition and Control Interface DACI-2	594499

* Can be replaced by the 4-Quadrant Power Supply and Dynamometer Controller

Necessary accessories, also order:

2x Digital Multimeter	579782
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase Power Supply and Safety Unit	594826
1x Mobile Frameline, Complete Model Without Energy Duct	8075133
1x Tabletop Workstation (DIN A4)	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is required.

Provide a complete learning experience in power circuits and transformers.

This training package provides hands-on experience with the basics of DC power circuits and single- and three-phase AC power circuits and transformers. It combines TP 8015-1 and TP 8015-2 without duplication of hardware components.

The training package contains the necessary equipment to perform the practical learning activities of the “DC Power Circuits”, “Single-Phase AC Power Circuits, and “Three-Phase AC Power CIrcuits”, “Single-Phase Transformer Banks”, and “Three-Phase Transformer Banks” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore DC circuit principles, such as resistance, voltage, current, and power, as well as series and parallel configurations. They also study AC circuit concepts, including sine waves, phase angles, phase shifts, reactance, and impedance. The program then moves on to transformer topics, covering design, polarity, regulation and losses, the effect of frequency on transformer rating, autotransformers, and various three-phase transformer configurations.

The data acquisition and control interface features built-in meters, an oscilloscope, a phasor analyzer, data tables, graphs and a harmonic analyzer—enabling comprehensive analysis while minimizing time spent switching connections or reading different instruments. It can simultaneously measure up to four high-voltage and four high-current inputs, providing accurate, real-time data for studying complex electrical and mechanical interactions.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8093410
de	8147580
fr	8231072

Notes: The campus license “AC/DC and Transformers” includes the student and instructor manuals in PDF of the following workbooks: “DC Power Circuits”, “Single-Phase AC Power Circuits”, “Single-Phase Power Transformers”, “Three-Phase AC Power Circuits”, and “Three-Phase Transformer Banks”. Printed workbooks available upon request.

Courses on Festo LX:

- → Single-Phase Power Transformers
- → DC Power Circuits
- → Three-Phase AC Power Circuits
- → Single-Phase AC Power Circuits
- → Three-Phase Transformer Banks

IGBT Power Conversion Circuits

TP 8015-4

Equipment Set TP 8015-4

220 – 240 V, 50 Hz	**8223523**

The most important components at a glance:

1x Resistive Load	594820
1x Rectifier and Filtering Inductors Capacitors	8136516
1x Three-Phase AC Filter	8166653
1x 48 V Lead-Acid Battery Pack	8174051
1x IGBT Chopper/Inverter	8167609
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x 24 V AC Power Supply (Wall Mount)	793290
1x 4-Quadrant Power Supply and Dynamometer Controller (note 1)	595028
1x Data Acquisition and Control Interface DACI-2 (note 2)	594499

Notes:

(1) The Lead-Acid Battery Charger function set must also be activated (sold separately, order no. 581438).

(2) The Chopper/Inverter function set must also be activated (sold separately, order no. 581453)

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Explore the fundamentals of power electronics and DC power conversion and control.

This training package provides hands-on experience with rectifiers, inverters, and various types of choppers using IGBTs as switching elements in single- and three-phase circuits.

The training package contains the necessary equipment to perform the practical learning activities of the “Single-Phase AC Power Electronics”, and “Three-Phase AC Power Electronics” courses available on Festo LX (subscription required) or as a campus license (sold separately).

Learners follow step-by-step instructions to connect modules and explore topics such as power diode rectifiers, switching transistors, ripple in choppers, buck/boost choppers, single- and three-phase rectifiers/inverters, and single-phase PWM inverters with a dual-polarity DC bus.

The four-quadrant power supply and dynamometer controller regulates the variable DC power supplied to the IGBT. In other scenarios include three-phase AC power supplied to the rectifier and filtering inductors capacitors to produce DC for the IGBT. The IGBT chopper/inverter either converts the DC to AC or boosts the DC voltage to the desired output level. The Data Acquisition and Control Interface (DACI) allows users to monitor and adjust parameters for chopper/inverter operation.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8212870

Notes: The campus license “Power Electronics Fundamentals” includes the student and instructor manuals of the following workbooks: “DC Power Electronics”, “Single-Phase AC Power Electronics”, “Three-Phase AC Power Electronics”, and “Thyristor Power Electronics”. Printed workbooks are available upon request.

Courses on Festo LX:

- → DC Power Electronics
- → Single-Phase AC Power Electronics
- → Three-Phase AC Power Electronics
- → Thyristor Power Electronics

Thyristor Power Conversion Circuits

TP 8015-5

Equipment Set TP 8015-5

220 – 240 V, 50 Hz	**8223526**

The most important components at a glance:

1x Resistive Load	594820
1x Rectifier and Filtering Inductors Capacitors	8136516
1x Capacitive Load	594822
1x Three-Phase AC Filter	8166653
1x Three-Phase AC Transformer Bank	594823
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x Power Thyristors	8167245
1x 24 V AC Power Supply (Wall Mount)	793290
1x 4-Quadrant Power Supply and Dynamometer Controller	595028
1x Data Acquisition and Control Interface DACI-2 (note 1)	594499

Notes:

(1) The Thyristor control function set must also be activated (sold separately, order no. 581454)

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Achieve efficient control of power management with power electronics semiconductors.

This training package provides hands-on experience with power diodes, power thyristors, solid state relays, zero-voltage switching, and various types of power control using thyristor circuits.

The training package contains the necessary equipment to perform the practical learning activities of the “Thyristor Power Electronics” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners connect modules following step-by-step instructions to study topics such as power diodes, single- and three-phase rectifiers, power thyristors, solid state relays, single- and three-phase AC power control, three-phase thyristor rectifiers/inverters, and more.

The four-quadrant power supply and dynamometer controller manages the AC power that goes to various components based on exercises. The Data Acquisition and Control Interface (DACI) allows users to monitor and adjust parameters that control the power thyristor module.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8212870

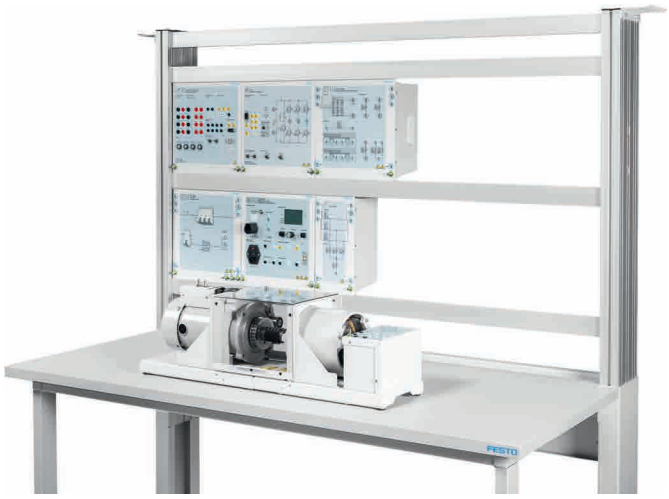
Notes: The campus license “Power Electronics Fundamentals” includes the student and instructor manuals of the following workbooks: “DC Power Electronics”, “Single-Phase AC Power Electronics”, “Three-Phase AC Power Electronics”, and “Thyristor Power Electronics”. Printed workbooks are available upon request.

Courses on Festo LX:

- → DC Power Electronics
- → Single-Phase AC Power Electronics
- → Three-Phase AC Power Electronics
- → Thyristor Power Electronics

AC Variable-Speed Drives

TP 8015-6



Equipment Set TP 8015-6

220 – 240 V, 50 Hz	**8223527**

The most important components at a glance:

1x Squirrel-Cage Induction Machine	595064
1x Rectifier and Filtering Inductors Capacitors	8136516
1x Three-Phase AC Filter	8166653
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x IGBT Chopper/Inverter	8167609
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Dynamometer Motor	595062
1x 4-Quadrant Power Supply and Dynamometer Controller	595028
1x Data Acquisition and Control Interface DACI-2 (note 1)	594499
1x Protective Guard – Face-to-Face	794194

Notes:

(1) The Chopper/Inverter function set must also be activated (sold separately, order no. 581453)

Necessary accessories, also order:

1x Coupling Face-to-Face	792271
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Use power electronics to control the speed and torque, as well as the frequency and voltage supplied to induction motors.

This training package provides hands-on experience with three-phase, variable-frequency induction-motor drives that use IGBTs as switching elements to improve power efficiency and reduce power consumption.

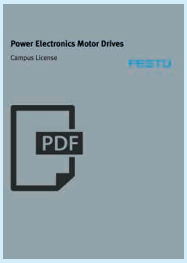
The training package contains the necessary equipment to perform the practical learning activities of the “Three-Phase Motor Drives” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners connect modules following step-by-step instruction to study topics such as three-phase motor drive, variable-frequency induction-motor drive, motor drive with constant V/F ratio, and more.

The four-quadrant power supply and dynamometer controller apply braking to the four-pole squirrel-cage induction motor while rectifying the 3-phase AC supply to provide DC for the IGBT. The IGBT chopper/inverter then converts the DC into power for the induction motor and manages the speed at the required torque level. The Data Acquisition and Control Interface (DACI) allows users to monitor and adjust parameters for the chopper/inverter functions.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8228874

Notes: The campus license “Power Electronics Motor Drives” includes the student and instructor manuals of the following workbooks: “Three-Phase Motor Drives”, “DC Motor Drives”, and “Three-Phase Induction Motor Starters”, Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Motor Drives
- → DC Motor Drives
- → Three-Phase Induction Motor Starters

DC Variable-Speed Drives

TP 8015-7

Equipment Set TP 8015-7

220 – 240 V, 50 Hz	**8223528**

The most important components at a glance:

1x Permanent Magnet DC Machine	8100085
1x 48 V Lead-Acid Battery Pack	8174051
1x IGBT Chopper/Inverter	8167609
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Power Supply and Dynamometer Controller	595028
1x Four-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-2 (note 1)	594499
1x Protective Guard – Side-by-side	794195
1x Timing Belt 62 Tooth (for side-by-side mounting)	8106423

Notes:
(1) The Chopper/Inverter function set must also be activated (sold separately, order no. 581453)

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Use IGBT-based power electronics and PWM techniques to precisely control the speed and torque of DC motors.

This training package provides practical experience with DC drives and PWM DC motor drives.

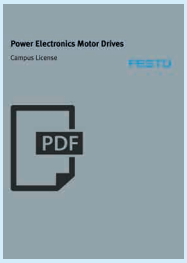
The training package contains the necessary equipment to perform the practical learning activities of the “DC Motor Drives” course available on Festo LX (subscription required) or as a campus license (sold separately).

Learners connect modules by following step-by-step instructions to study topics such as PWM DC motor drives, bi-directional PWM DC motors with regenerative braking, speed feedback, current control, and more.

The four-quadrant power supply and dynamometer controller manage the mechanical load applied to the permanent magnet DC motor, while the lead-acid battery supplies power to the IGBT-based DC input. The IGBT chopper/inverter uses either a buck or buck-boost converter to supply the required voltage to the permanent magnet DC motor. The Data Acquisition and Control Interface (DACI) enables users to monitor and adjust parameters for the chopper/inverter functions.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8228874

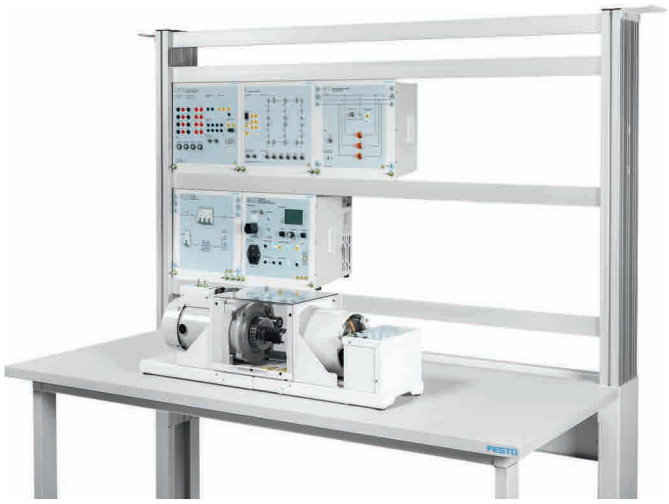
Notes: The campus license “Power Electronics Motor Drives” includes the student and instructor manuals of the following workbooks: “Three-Phase Motor Drives”, “DC Motor Drives”, and “Three-Phase Induction Motor Starters”, Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Motor Drives
- → DC Motor Drives
- → Three-Phase Induction Motor Starters

Three-Phase Motor Starters

TP 8015-8



Equipment Set TP 8015-8

220 – 240 V, 50 Hz	**8223529**

The most important components at a glance:

1x Squirrel-Cage Induction Machine	595064
1x Synchronization Lamps and Contactor	8208627
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x Power Thyristors	8167245
1x Three-Phase AC Filter	8166653
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Power Supply and Dynamometer Controller (note 1)	595028
1x Four-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-2	594499
1x Protective Guard – Face-to-Face	794194

Notes:
The Thyristor function set must also be activated (sold separately, order no. 581454)

Necessary accessories, also order:

1x Coupling Face-to-Face	792271
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Explore the basics of three-phase motor starters and power electronics drives to ensure safe and efficient motor operation.

This training package provides hands-on experience with motor starters, soft starters, and their advanced features. It also address important phenomena associated with motor starting.

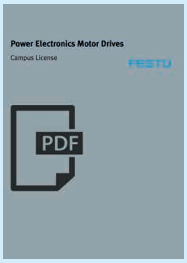
The training package includes the necessary equipment to perform the hands-on learning activities of the “Three-Phase Induction Motors Starters” course, available on Festo LX (subscription required) or as a campus license (sold separately).

Learners connect modules following step-by-step instructions to study topics such as DOL starters and soft starters, advanced features of soft starters such as kick start, soft stop, etc. DC bus, and more.

The four-quadrant power supply and dynamometer controller emulates a flywheel connected to the four-pole squirrel-cage induction motor. The thyristors are managed by the Data Acquisition and Control Interface (DACI), which controls the power delivered to the induction motor. The DACI allows the user to monitor and manipulate parameters, as well as observe the motor’s starting current, torque, and speed.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8228874

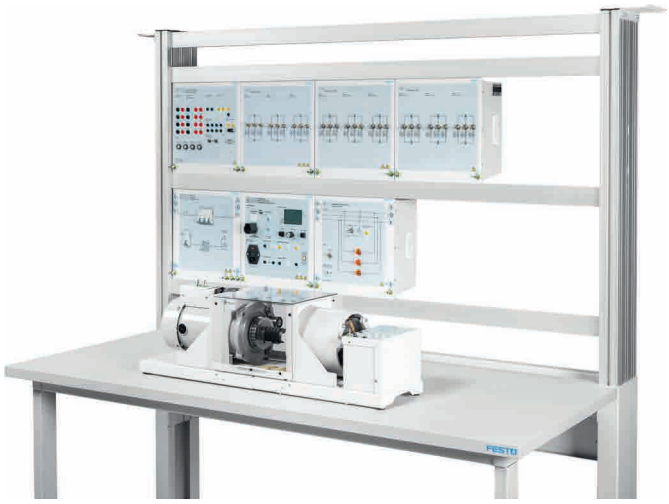
Notes: The campus license “Power Electronics Motor Drives” includes the student and instructor manuals of the following workbooks: “Three-Phase Motor Drives”, “DC Motor Drives”, and “Three-Phase Induction Motor Starters”, Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Motor Drives
- → DC Motor Drives
- → Three-Phase Induction Motor Starters

Three-Phase Rotating Machines

TP 8016-1



Equipment Set TP 8016-1

220 – 240 V, 50 Hz	**8223530**

The most important components at a glance:

1x Resistive Load	594820
1x Inductive Load	594821
1x Capacitive Load	594822
1x Squirrel-Cage Induction Machine	595064
1x Synchronous Machine	595802
1x Synchronization Lamps and Contactor	8208627
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Power Supply and Dynamometer Controller	595028
1x Four-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-2 (note 1)	594499
1x Protective Guard – Face-to-Face	794194

Notes:
(1) The Synchroscope function set must also be activated (sold separately, order no. 579789)

Necessary accessories, also order:

1x Coupling Face-to-Face	792271
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Master the basics of motors and generators to convert between mechanical and three-phase AC electrical power.

This training package provides hands-on experience with three-phase induction machines, torque, efficiency, and more.

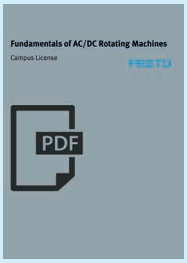
The training package includes the necessary equipment to perform the practical learning activities for the “Three-Phase Rotating Machines” course available on Festo LX (subscription required) or through a campus license (sold separately).

Learners connect modules following step-by-step instructions to study topics such as prime mover and brake, three-phase squirrel cage induction motors, eddy-current brakes, asynchronous generators, and more.

The induction motor is powered by a three-phase power supply. The four-quadrant power supply and dynamometer controller monitor and control the torque and speed of the induction motor. The Data Acquisition and Control Interface (DACI) allows users to monitor and manipulate parameters for the chopper and inverter functions.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8201321

Notes: The campus license “Fundamentals of AC and DC Rotating Machines” includes the student and instructor manuals of the following workbooks: “Three-Phase Rotating Machines”, “Permanent Magnet DC Machines”, and “Power Factor Correction”. Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Rotating Machines
- → Permanent Magnet DC Machines
- → Power Factor Correction

Permanent Magnet DC Motors

TP 8016-2

Equipment Set TP 8016-2

220 – 240 V, 50 Hz	**8223531**

The most important components at a glance:

1x Permanent Magnet DC Machine	8100085
1x 48 V Lead-Acid Battery Pack	8174051
1x Data Acquisition and Control Interface DACI-2	594499
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Dynamometer Motor	595062
1x Four-Quadrant Power Supply and Dynamometer Controller	595028
1x Timing Belt	793141
1x Protective Guard – Side-by-side	794195

Necessary accessories, also order:

1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Gain valuable insights into the design, operation, and control of energy-efficient motors and performant advanced systems.

This training package provides practical experience with the operating principles and characteristics of permanent magnet DC motor operation.

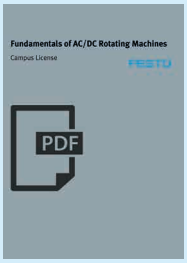
The training solution includes the necessary equipment to conduct practical learning activities for the “Permanent Magnet DC Machines” course available on Festo LX (subscription required) or through a campus license (sold separately).

Learners connect modules according to step-by-step instructions to study topics such as prime mover and brake, as well as the operation of the motor and generator.

The permanent magnet DC motor is powered by a lead-acid battery. The four-quadrant power supply and dynamometer controller monitor and control the torque and speed of the permanent magnet DC motor. The Data Acquisition and Control Interface (DACI) allows users to monitor and adjust parameters for the chopper and inverter functions.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8201321

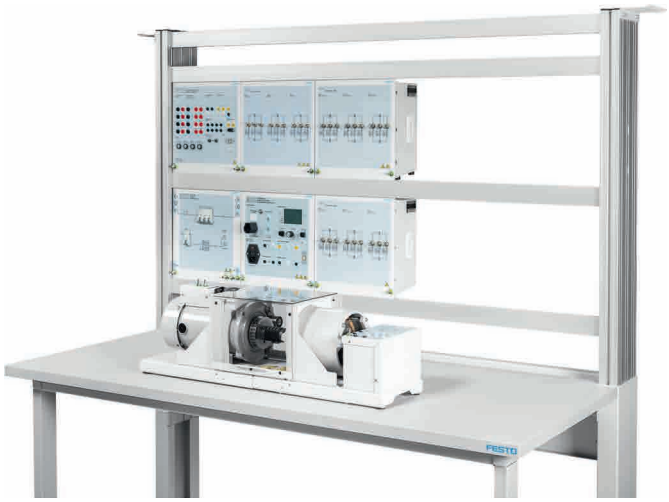
Notes: The campus license “Fundamentals of AC and DC Rotating Machines” includes the student and instructor manuals of the following workbooks: “Three-Phase Rotating Machines”, “Permanent Magnet DC Machines”, and “Power Factor Correction”. Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Rotating Machines
- → Permanent Magnet DC Machines
- → Power Factor Correction

Power Factor Correction

TP 8016-3



Equipment Set TP 8016-3

220 – 240 V, 50 Hz	**8223532**

The most important components at a glance:

1x Resistive Load	594820
1x Inductive Load	594821
1x Capacitive Load	594822
1x Squirrel-Cage Induction Machine	595064
1x Three-Phase AC 400 V DC 230 V Power Supply	594825
1x 24V AC Power Supply (Wall Mount)	793290
1x Four-Quadrant Power Supply and Dynamometer Controller	595028
1x Four-Quadrant Dynamometer Motor	595062
1x Data Acquisition and Control Interface DACI-2	594499
1x Protective Guard Face-to-Face	794194

Necessary accessories, also order:

1x Coupling Face-to-Face	792271
1x Connection Lead Set and Grounding Kit	595916
1x Three-Phase AC Power Supply and Safety Unit	594826
1x Mobile Frameline, complete model without energy duct **or**	8075133
1x Tabletop Workstation (DIN A4) **or**	8153360
1x Tabletop Double-Sided Workstation	8158409

Note: A computer with a Windows 7/8/10 operating system is also required.

Learn to master power factor correction to create more efficient, cost-effective, and sustainable electrical systems.

This training package provides practical experience to perform power factor correction for induction machines, both in electrical substation and in large industrial applications.

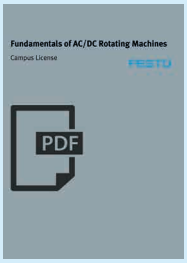
The training package includes the necessary equipment to facilitate the practical learning activities for the “Power Factor Correction” course available on Festo LX (subscription required) or through a campus license (sold separately).

Learners connect modules following step-by-step instructions to study topics such as power factor correction.

The resistive, inductive, and capacitive loads allow users to study different types of load behaviors and how they impact power factor. The squirrel-cage induction machine is used to explore motor operations and is powered by a three-phase power supply. The four-quadrant power supply and dynamometer controller monitor and control the torque and speed of the induction motor. The Data Acquisition and Control Interface (DACI) allows users to better observe or analyze power factor correction.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	8201321

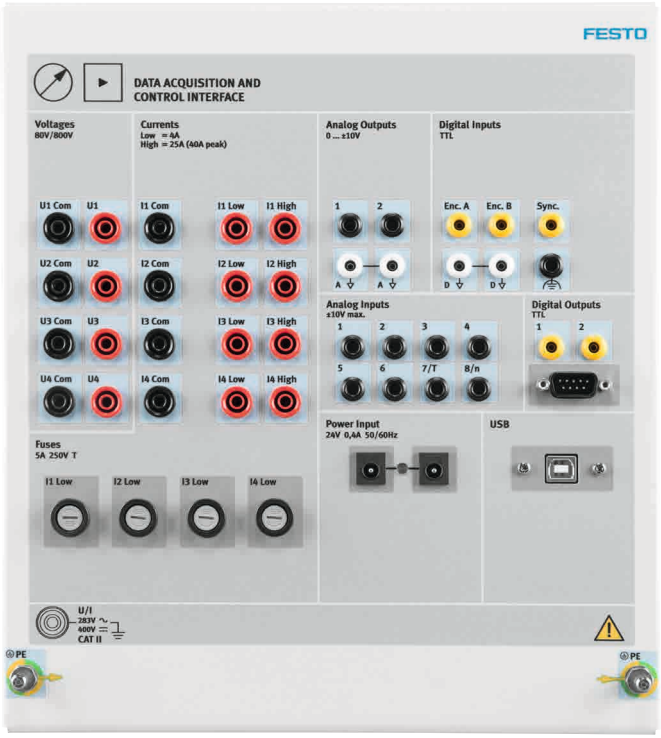
Notes: The campus license “Fundamentals of AC and DC Rotating Machines” includes the student and instructor manuals of the following workbooks: “Three-Phase Rotating Machines”, “Permanent Magnet DC Machines”, and “Power Factor Correction”. Printed workbooks are available upon request.

Courses on Festo LX:

- → Three-Phase Rotating Machines
- → Permanent Magnet DC Machines
- → Power Factor Correction

Modules

Data Acquisition and Control Interface (DACI)



Most popular packages

DACI-1: With computer-based instrumentation for 2x current inputs and 2x voltage inputs

Order no.	**595912**

DACI-2: With computer-based instrumentation and synchroscope function set

Order no.	**594499**

Other variants are available. Contact your sales representative for details.

LabVolt Series 9063

Measuring, observing, analyzing, and controlling electrical and mechanical parameters in electric power systems and power electronics circuits represent an important part of the training in various areas, such as electric power technology, AC/DC machines, renewable energy, and power electronics.

For these purposes, the Data Acquisition and Control Interface (DACI) is a versatile USB peripheral that features a set of computer-based instruments and instrumentation tools, which can be accessed through Data Acquisition and Control for Electromechanical Systems (LVDAC-EMS) software.

The DACI and the LVDAC-EMS software are standard features in the Electric Power Technology Learning Systems and in the Computer-Assisted 0.2-kW Electromechanical Learning System.

Highlights

- Computer-based tools increase student knowledge and understanding of electric power systems and power electronics circuits
- Customizable DACI with several control functions available to fit specific training needs
- Pre-built SCADA interface facilitates an understanding of the process taking place
- Several inputs/outputs for easy connection with other modules
- Optically isolated inputs
- Includes free software (LVDAC-EMS)
- Software Development Kit for third-party programming tools
- Short set-up time
- Safe and affordable

Control function sets

Several sets of computer-based functions allowing control of power electronics modules can be activated in the DACI. Instructors can select and combine the functions they need.

- Computer-Based Instrumentation
- Chopper/Inverter Control
- Thyristor Control
- Home Energy Production Control
- Three-Phase PWM Rectifier/ Inverter Control
- BLDC Motor/PMSM Control
- High-Voltage DC (HVDC) Transmission System Control
- Static Var Compensator (SVC) Control
- Synchronous Generator Control
- Static Synchronous Compensator (STATCOM) Control
- Synchroscope
- SCADA
- 9063 Software Development Kit

Modules

Four-Quadrant Dynamometer/Power Supply

LabVolt Series 8960

The Four-Quadrant Dynamometer/power Supply is a highly versatile USB peripheral designed to be used in the Electric Power Technology Learning Systems. Two operating modes are available: Dynamometer and Power Supply. A wide variety of user-selectable functions is available in each operating mode.

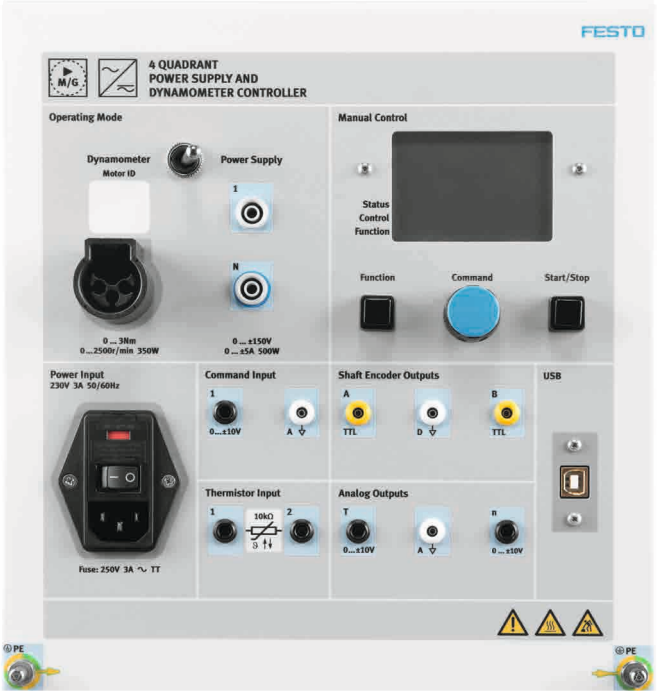
In the Dynamometer mode, the unit becomes a four-quadrant dynamometer that can act as either a fully configurable brake or a fully configurable prime mover. In the power supply mode, the unit becomes a four-quadrant power supply that can act as a DC voltage source, DC current source, ac power source, etc.

In each operating mode, key parameters related to the selected function are displayed and can be monitored using the computer-based instruments in the software LVDAC-EMS. Speed, torque, mechanical power, and energy are displayed in the Dynamometer mode while voltage, current, electrical power, and energy are displayed in the Power Supply mode. Optional functions, such as a small wind-turbine emulator, a hydraulic turbine emulator, a solar panel emulator, battery chargers, an SDK (Software Development Kit) etc., can be added to the standard functions to further enhance the training possibilities of the Four-Quadrant Dynamometer/Power Supply.

Highlights
- Multipurpose device combining power supply, prime mover, dynamometer, metering, and emulator properties
- Manual or computer-based control mode
- Green device: it returns the power produced directly on the grid
- Emulation of multiple load types
- Optional functions can be added to the standard functions to further the training possibilities

Topic coverage
- Speed and Torque
- Voltage and Current
- Mechanical and Electrical Power
- Energy

Function sets
- Standard Functions (Manual Control)
- Standard Functions (Computer-Based Control)
- Turbine Emulator and diesel generator
- Lead-Acid Battery Charger
- Ni-MH Battery Chargers
- Solar Panel Emulator
- 8960 Software Development Kit



Most popular packages

With manual and computer-based control

Order no.	**595028**

With manual and computer-based control, lead-acid battery charger and turbine emulator functions

Order no.	**596127**

Other variants are available. Contact your sales representative for details.

Modules

Dynamometer, Power Supplies

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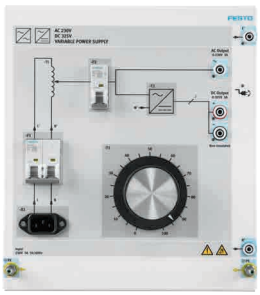

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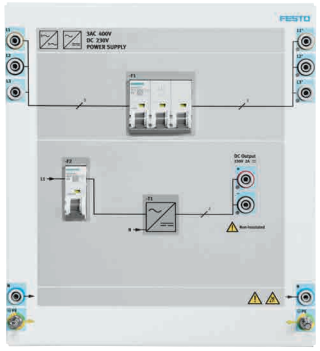

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1 **4-Quadrant Dynamometer Motor**
Tabletop motor that is used as a complete 4-quadrant dynamometer in conjunction with the 4-Quadrant Power Supply and Dynamometer Controller. This dynamometer can then act as a prime mover, a brake, or a motor test bench, and can also emulate various types of predefined or custom loads.

Order no. **595062**

2 **Three-Phase AC 400 V DC 230V Power Supply**
Module that provides electrical supplies for a wide range of experiments on a workstation.

Order no. **594825**

3 **AC 24V Power Supply**
Module that provides auxiliary power for various system components.

Order no. **772050**

4 **AC 230V DC 325V Variable Power Supply**
Module that provides two source outputs: one variable from 0 to 230 V AC single-phase and the other from 0 – 325 V DC.

Order no. **8089266**

5 **AC 230 V Power Supply**
Single-phase power supply which, connected to the AC line voltage, supplies the necessary power for single-phase experiments. This power supply is mounted in an A4 module.

Order no. **595930**

6 **Three-Phase AC Power Supply and Safety Unit**
Fixed-voltage three-phase AC power source with an integrated circuit breaker providing protection against overload and short circuit and switches off when a voltage failure occurs.

Order no. **594826**

Modules

Solar and Wind Energy

1 **Wind Turbine Generator/ Controller**
Tabletop module that provides a wind turbine for experimentation. It can be coupled to a dynamometer motor to be externally driven.
Order no. **595061**

2 **Wind Turbine Load Resistors**
Module that provides a resistive electrical load for wind turbine experiments.
Order no. **594819**

3 **Solar Panel Test Bench**
Tabletop module that houses the solar panel (sold separately) so that it can be illuminated, and experiments can be conducted.
Order no. **595057**

4 **Monocrystalline Silicon Solar Panel**
Solar panel mounted on a common metal chassis that can be installed in the Solar Panel Test Bench when performing exercises indoors, or on a tripod when performing exercises outdoors.
Order no. **595058**

5 **DC 48 V Lamps**
Half-size A4 module that houses two lamps: one LED and one incandescent.
Order no. **595055**

6 **AC 230 V Lamps**
Half-size A4 modules that houses three lamps: one incandescent, one CFL, and one LED.
Order no. **595056**

7 **Pyranometer**
High-quality instrument for measuring solar irradiance.
Order no. **579784**

8 **Single-Phase Energy Meter**
Half-sized module that includes a single-phase energy meter.
Order no. **594904**

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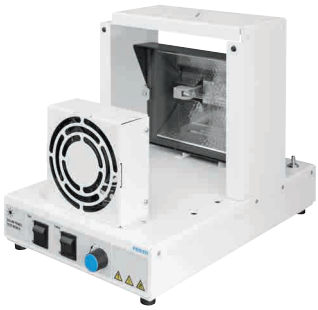

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Modules

Loads, Batteries, Transformers, Inverters, Controllers

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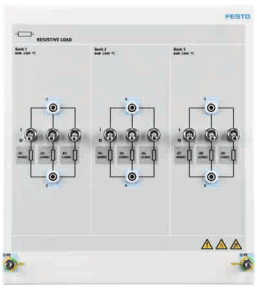

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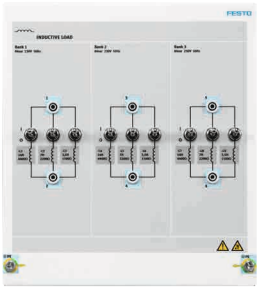

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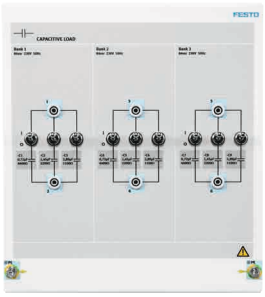

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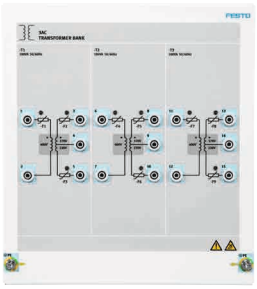

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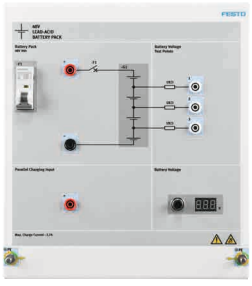

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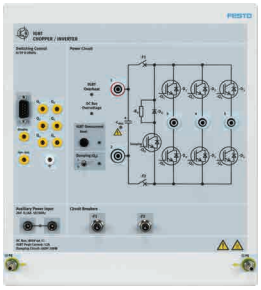

1 **Resistive Load**
Module that provides a universal resistive electrical load for a wide range of experiments.
Order no. **594820**

2 **Inductive Load**
Module that provides a universal inductive electrical load for a wide range of experiments.
Order no. **594821**

3 **Capacitive Load**
Module that provides a universal capacitive electrical load for a wide range of experiments.
Order no. **594822**

4 **Single-Phase Transformer**
Module that includes a single-phase transformer with both primary and secondary sides made of two identical, separate windings.
Order no. **594824**

5 **Three-Phase Transformer Bank**
Module that includes three independent power transformers.
Order no. **594823**

6 **12 V Lead-Acid Batteries**
Half-size A4 module that contains two VRLA batteries.
Order no. **595060**

7 **48 V Lead-Acid Battery Pack**
Module that contains four 12V lead-acid batteries.
Order no. **595059**

8 **IGBT Chopper/Inverter**
Module that consists of seven insulated-gate bipolar transistors (IGBT) mounted in an A4 module. Six IGBTs are used to implement choppers and inverters and one for the dumping circuit.
Order no. **8167609**

1 **DC 48 V PWM Charge Controller**
Module used to perform charge-controlling experiments with batteries and DC energy sources, such as solar.
Order no. **8241563**

2 **DC 48 V MPPT Charge Controller**
Module that is used to control the charge of batteries with DC energy sources, such as solar panels. It uses MPPT technology, which adjusts its input voltage and finds the maximum power operating point from the solar array, transferring this power to the battery and load.
Order no. **595050**

3 **1 AC 230 V Stand-Alone Inverter**
Converts a DC power source, such as batteries, into an AC power source for “off-the-grid” applications.
Order no. **595052**

4 **Single-Phase 230 V Grid-Tied Inverter**
Returns power from a DC power source such as batteries directly to the grid and it is mounted in an A4 module.
Order no. **595053**

5 **Communications Gateway**
Module that communicates and sets grid-tied inverters over the AC line voltage directly.
Order no. 595054

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Modules

Motors, Filters, Contactors

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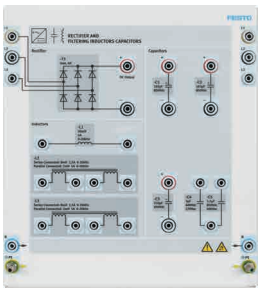

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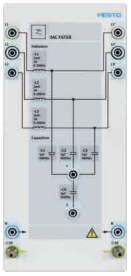

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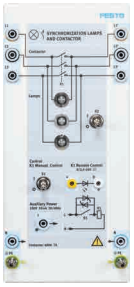

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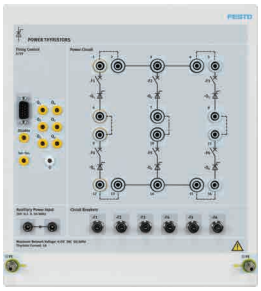


1 **Squirrel-Cage Induction Machine**
Designed to be used with the Four-Quadrant Dynamometer Motor. The machine stator windings are independently connected, allowing connection in either wye or delta configuration.

Order no.	**595064**

2 **Synchronous Machine**
Designed to be used with the Four-Quadrant Dynamometer Motor. This machine can be operated either as a three-phase motor or a three-phase generator.

Order no.	**595802**

3 **Power Thyristors**
Module that consists of six power thyristors (SCRs).

Order no.	**8167245**

4 **Permanent Magnet DC Machine**
High-speed, brushed DC motor designed to be used with the Four-Quadrant Dynamometer Motor.

Order no.	**8100085**

5 **Rectifier and Filtering Inductors Capacitors**
Module that consists of a series of inductors and capacitors to implement different types of filters plus a three-phase rectifier bridge for power electronics applications.

Order no.	**8136516**

6 **Three-Phase AC Filter**
Module that consists of three inductors to be put in series in a three-phase circuits and four capacitors in star connection with the neutral.

Order no.	**8166653**

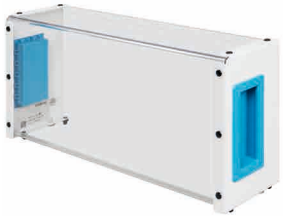
7 **Synchronization Lamps and Contactor**
Module that consists of a three-phase contactor whose coil can be energized either manually with a toggle switch, or automatically with a thyristor fired by applying to the Remote Control input of the module, a low-level (TTL) signal from the Data Acquisition and Control Interface. Six safety connectors (one pair per phase) allow connection of electric devices or ac power sources across the contacts of the contactor. Three indicator lamps indicate the relative level of the voltage across their corresponding contact terminals.

Order no.	**8208627**

Modules

Accessories and Workstations

1



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1 **Protective Guard, Side-by-Side**
Must be used when coupling two electrical machines side-by-side with a timing belt in order to provide a safe working environment. It is made of see-through glass in a heavy-duty case.
Order no. **794195**

2 **Protective Guard, Face-to-Face**
Must be used when coupling two electrical machines face-to-face in order to provide a safe working environment. It is made of see-through glass in a heavy-duty case.
Dimensions (H x W x D): 197 x 244 x 208 mm
Order no. **794194**

3 **AC 24 V Wall Mount Power Supply**
Powers specific modules of the Electric Power Technology Training Packages. IEC Power Cable, straight, AS 3112 (Type I)
Order no. **793290**

Safety Laboratory Cables Set and Grounding Kit for TP 801X (51 pieces)
4 mm safety laboratory cables:
– 15x grey-yellow 300 mm
– 10x grey-red 600 mm
– 4x grey-blue 900 mm
2 mm safety laboratory cables:
– 4x black 500 mm
– 6x black 200 mm
Grounding cables:
– 5x 100 mm
– 3x 400 mm
– 4x grey jumper plugs
Order no. **595916**

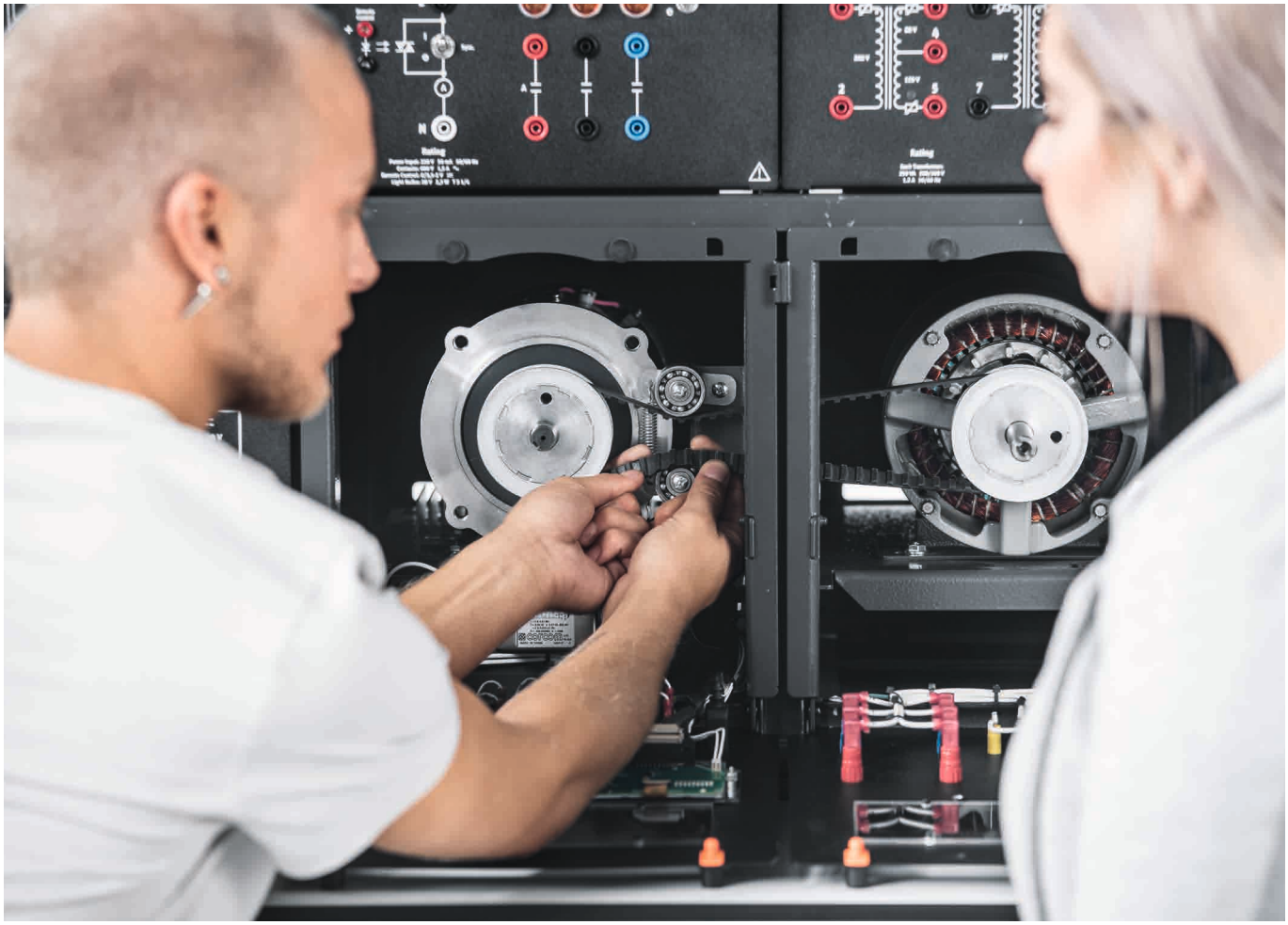
4 **Mobile Frameline, Complete Model Without Energy Duct**
Basic frame with 3 holding frames (2x A4 lines and 1x ER line) for individual laboratory and workshop design. Highly flexible and universal for technical education and training.
Order no. **8075133**

5 **Tabletop Workstation (DIN A4)**
Designed to safely house the DIN A4 modules. It consists of a mounting frame with 3 rows and lead holder on the side. The bottom row can be removed to place other laboratory equipment without compromising stability.
Order no. **8153360**

6 **Tabletop Double-Sided Workstation**
Designed to safely house the DIN A4 modules. It consists of a mounting frame with 2 rows and a lead holder on each side .
Order no. **8158409**

Timing Belt 72 Tooth
High-quality industrial synchro-cog timing belt made of rubber whose teeth exactly mesh with the geared pulley fitted electrical machines working with the 4-Q power supply and dynamometer controller and the 4-Q dynamometer motor.
Order no. **793141**

Timing Belt 62 Tooth (for Side-by-Side Mounting)
High-quality industrial synchro-cog timing belt made of rubber whose teeth exactly mesh with the geared pulley fitted electrical machines working with the 4-Q dynamometer motor.
Order no. **8106423**



Electromechanical Skills

Hands-on training systems develop a broad range of electric motor-related skills—from understanding motor construction and winding principles to operation, troubleshooting, maintenance, and system integration. This training prepares students to work safely and efficiently with the electromechanical systems that power manufacturing, transportation, energy, and many other industries.

Motor Winding Kit

Construction Techniques for Electrical Machines

	en	es	fr
120 V, 60 Hz	**587332**	**587334**	**587333**
220 V, 50 Hz	**587335**	**587337**	**587336**
240 V, 50 Hz	**587338**		
220 V, 60 Hz	**589232**	**588990**	

The most important components, at a glance:
- 1x Work bench for the Motor Winding Kit
- 1x Assembly Housing Module
- 1x Manual Coil Winder
- 1x Motor Winding Kit Parts

Highlights
- High-quality components designed for hands-on training purposes
- Complete assembly kit that can be reused many times
- Nominal rating and the winding schematics are silk-screened on the overlay to facilitate learning
- Complete curriculum

LabVolt Series 8022

The Motor Winding Kit offers a new approach to teaching construction techniques for electrical machines. Starting with basic components such as laminations, motor ends, and magnet wire, the Motor Winding Kit allows the assembly of a squirrel-cage induction motor, a wound-rotor induction motor, a three-phase synchronous machine, and a split-phase capacitor-start motor. All parts necessary for assembly of the four machines are included in the kit. Two types of stator laminations are included for winding a three-phase stator and a single-phase stator.

Three types of rotors are included in the kit: a squirrel-cage rotor (fully assembled), a rotor with open slot laminations allowing the winding of a wound rotor, and a rotor with cruciform laminations and a damper assembly, allowing the winding of a four-pole synchronous machine rotor. The rotors are made of a double ended stainless-steel shaft on which the ball bearings and laminations are permanently assembled.

There is enough material supplied with the kit to wind each type of machine at least five times. All the necessary materials and tools are included. A hand-operated coil winder fitted with an adjustable mandrel and a turn counter facilitates the assembly of the different windings according to the specifications described in the instruction manual.

The rotating machines assembled using the Motor Winding Kit can be operated just like any preassembled machine in the EMS LabVolt 8010. To do so, optional equipment is necessary. Contact your sales representative for details.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

120 V, 60 Hz, en	580232
220 V, 50 Hz, en	580233

Notes: The campus license includes the student and instructor manuals of the workbook “Magnetic Circuits and Transformers” in PDF. Printed workbooks available upon request.

Course on Festo LX:
→ Motor Winding

Dissectible Machines Learning System

Construction and Operation of Rotating Machines

	en	es	fr
120 V, 60Hz	**581467**	**581469**	**581468**
220 V, 50Hz	**581470**	**581472**	**581471**
240 V, 50Hz	**581473**		
220 V, 60Hz	**592561**	**588989**	

The most important components, at a glance:
- 1x Work bench for the Dissectible Machines Learning System
- 2x Assembly Housing Modules
- 1x Dissectible Machine Parts
- 1x Timing Belt

Highlights
- Rugged, high-quality components designed for hands-on training purposes
- Complete assembly drawing (exploded view) for each machine
- No tools required for machine assembly
- Two machines can be assembled at the same time
- Fourteen different machines can be constructed

LabVolt Series 8020-2

The Dissectible Machines Learning System is an electromechanical Learning System that provides hands-on training in the construction and operation of rotating machines. The system fulfills educational requirements that include industrial applications of electric power technology and employs training equipment that has characteristics similar to industrial equipment.

The dissectible machines are assembled with the use of tools from a complete set of components, including stators, rotors, armatures, rheostats, and capacitors. Once assembled, they can be mounted on basic modules that lock into place on any EMS workstation. To do so, optional equipment is necessary. Please contact your sales representative for details. The components allow students to construct two different machines at the same time. Fourteen different machines can be constructed with these components.

Machine windings are connected to the faceplate of the module with polarized plugs, allowing for the correct interconnection of different types of machines. Schematic connections are silkscreened on the interchangeable face on the basic module. Once assembled, machines can be inserted into an EMS workstation and operated just like any preassembled machine. The workstation and equipment required to operate the assembled rotating machines are optional equipment.

All machines that can be built with the Dissectible Machines Learning System can be ordered separately as fully assembled machines that can be disassembled and re-assembled by students.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	580227

Notes: The campus license includes the student and instructor manuals of the workbook “Dissectible Machines” in PDF. Printed workbooks available upon request.

Course on Festo LX:
→ Dissectible Machines

MagTran Learning Systems

Magnetic Circuit Principles Applied to Basic Transformers

Complete System	en	es	fr
120 V, 60 Hz	**581481**	**581483**	**581482**
220 V, 50 Hz	**581484**	**581486**	**581485**
240 V, 50 Hz	**581487**		
220 V, 60 Hz	**581488**		

The most important components, at a glance:
- 1x Three-Module Workstation
- 1x Resistive Load
- 1x Inductive Load
- 1x Capacitive Load
- 1x Fully Protected Transformer
- 1x MagTran Parts
- 1x DC Voltmeter/Ammeter
- 1x AC Ammeter
- 1x AC Voltmeter
- 1x Flux Meter
- 1x Power Supply
- 1x Connection Lead Set

Add-On to LV 8001	en	es	fr
120 V, 60 Hz	**581489**	**581491**	**581490**
220 V, 50 Hz	**581492**	**581494**	**581493**
240 V, 50 Hz	**581495**		
220 V, 60 Hz	**581496**	**581497**	

The most important components, at a glance:
- 1x MagTran Parts
- 1x Flux Meter

LabVolt Series 8024

The MagTran Learning System is designed to teach magnetic circuit principles and the application of these principles to basic single- and three-phase transformers. It is suitable for a broad range of teaching programs – from vocational schools to universities.

It consists of a set of laminated iron bars, a vise-type non-magnetic base that holds the bars in place, coils, and other related components that can be assembled in many ways. Correlated courseware contains an extensive set of laboratory experiments that illustrate basic principles of magnetism and electromagnetic induction.

The MagTran Learning System is designed to operate at a power 0.2 kW using standard EMS instrumentation. The Learning System includes all the equipment required to perform the exercises contained in the courseware, except for an oscilloscope. The equipment is packaged in a rugged carrying case.

Highlights
- An incandescent lamp enables the observation and study of magnetic coupling.
- Enables measurement of magnetic fluxes as low as 10 µWb to demonstrate leakage flux, saturation, and magnetic shunts.
- A low-cost flux meter with a special built-in circuit enables the observation of hysteresis loops on an oscilloscope (not included).

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	580280
es	8174177

Notes: The campus license includes the student and instructor manuals of the workbook "Magnetic Circuits and Transformers" in PDF. Printed workbooks available upon request.

Course on Festo LX:
→ Magnetic Circuits and Transformers

2-kW Electromechanical Learning Systems (EMS)

Simulation of High-Power Machines

LabVolt Series 8013

The 2-kW Electromechanical Learning Systems deal with the different techniques associated with the generation and use of electrical energy.

The Learning Systems simulate large power machines, yet are very safe for student experimentation. They incorporate heavy-duty components and machines that can be combined to create different configurations tailored to technical or university courses.

The systems satisfy educational requirements for industrial applications of electric power technology, using industrial-like equipment to provide easy-to-understand laboratory results and easily observed data values.

Highlights

- Modular design
- Extreme ease-of-use, safety, and durability
- The rotating machines have a specifically high inertia to simulate large-power machines
- Machine Motor frames equipped with transparent, shatter-proof shields for inspection of the interior
- Protection of vulnerable meter components without fuses
- Metering modules cover the complete range of measurements required with a minimum number of meters
- Machines may be joined with a hard rubber coupling device and patented locking fastener designed to eliminate vibrations
- Several combinations of machines can be studied simultaneously

Simulation of high-power machines

The rotating machines have a specifically high inertia to simulate high-power machines. In addition, all machines are equipped with search coils through which the magnetic flux distribution at various locations in the machine can be observed using an oscilloscope. Each 2-kW rotating machine in the Learning Systems is permanently mounted on a mobile cart, and includes a double-extension shaft terminated with geared-type flanges. Different machines may be joined with a hard rubber coupling device and patented locking fastener designed to eliminate vibrations. Any combination of machines may be studied simultaneously.

Comprehensive courseware

The courseware consists of student manuals that guide students through the experiments and provide the necessary theoretical background to successfully complete the educational objectives. The instructor can select the experiments that will satisfy the objectives of technical courses or university programs. The flexibility of this system allows students to act on their own initiative during laboratory sessions.

Optional modules

In addition to the included hardware with the systems, optional modules and devices are available to expand learning possibilities:

- 2-kW Four-Quadrant Dynamometer
- 2-kW IGBT Chopper/Inverter
- 2-kW Power Thyristors
- Data Acquisition and Control Interface (page 124)

2-kW EMS – Modularized
LabVolt Series 8013-1

Complete Learning System that covers the principles of power circuits, DC machines, and Transformers and AC machines.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x AC Voltmeter
– 1x DC Motor/Generator
– 1x Wiring Module for DC Motor/ Generator
– 1x Four-Pole Squirrel-Cage Induction Motor, 2 kW
– 1x Wiring Module for Squirrel-Cage Induction Motor
– 1x Three-Phase Wound-Rotor Induction Motor, 2 kW
– 1x Wiring Module for Wound-Rotor Induction Motor
– 1x Synchronous Motor/Generator
– 1x Wiring Module for Synchronous Motor/Generator
– 3x Resistive Load, 2 kW
– 3x Inductive Load, 2 kW
– 3x Capacitive Load, 2 kW
– 3x Single-Phase Transformer, 2 kW
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter Module, 2 kW
– 1x Wattmeter/Varmeter
– 1x DC Breaker, 2 kW
– 1x Synchronizing Module, 2 kW
– 1x Manual DC Motor Starter
– 1x Synchronous Motor Starter, 2 kW
– 1x Three-Phase Full-Voltage Starter, 2 kW
– 1x Three-Phase Rheostat, 2kW
– 1x Three-Phase Power-Factor Meter, 2kW
– 2x Field Rheostat, 2 kW
– 1x Variable Power Supply
– 1x Automatic DC Motor Starter
– 1x Digital Tachometer
– 1x Speed Sensor/Tachometer
– 2x Couplers
– 1x Digital Multimeter
– 1x Connection lead set

Recommended workbook (page 276, 289): Power Circuits, DC Machines, Transformers and AC Machines

2-kW EMS – Power Circuits
LabVolt Series 8013-2

Learning System that covers the principles of power circuits.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x AC Voltmeter
– 3x Resistive Load, 2 kW
– 3x Inductive Load, 2 kW
– 3x Capacitive Load, 2 kW
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter Module, 2 kW
– 1x Wattmeter / Varmeter
– 1x Synchronizing Module, 2 kW
– 1x Variable Power Supply
– 1x Digital Multimeter
– 1x Connection lead set

Workbook – Power Circuits
The exercises in the workbooks contain the theory and lab exercises covering the following topic coverage:
– Series and Parallel Equivalent Resistances
– Resistances in Parallel
– Resistances in Series and in Series-Parallel
– Safety and the Power Supply
– Ohm's Law
– Circuit Solution
– Power in DC Circuits
– The Transmission Line
– AC Voltage and Current Measurement
– The Wattmeter
– Phase Angle, Real and Apparent Power Capacitive Reactance
– Inductive Reactance
– Watt, Var, Volt-Ampere and Power Factor
– Vectors and Phasors – Series Circuits
– Vectors and Phasors – Parallel Circuits
– Impedance
– Three-Phase Circuits
– Active, Reactive and Apparent Power in Three-Phase Circuits
– Three-Phase Power Measurement
– Phase Sequence

Recommended workbook (page 276): Power Circuits

	en	es	fr
120 V, 60 Hz	**587305**	**587307**	**587306**
220 V, 50 Hz	**587308**	**587310**	**587309**
240 V, 50 Hz	**587304**		

	en	es	fr
120 V, 60 Hz	**587312**	**587314**	**587313**
220 V, 50 Hz	**587315**	**587317**	**587316**
240 V, 50 Hz	**587311**		

2-kW EMS – DC Machines
LabVolt Series 8013-3

Learning System that covers the principles of DC machines.

Main components:
– 1 x Mobile Workstation
– 1 x Storage Shelves
– 1 x AC Voltmeter
– 1 x DC Motor/Generator
– 1 x Wiring Module for DC Motor/ Generator
– 1 x Synchronous Motor/Generator
– 1 x Wiring Module for Synchronous Motor/Generator
– 3 x Resistive Load, 2 kW
– 1 x DC Voltmeter/Ammeter
– 1 x AC Ammeter Module, 2 kW
– 1 x Manual DC Motor Starter
– 1 x Synchronous Motor Starter, 2 kW
– 2 x Field Rheostat, 2 kW
– 1 x Variable Power Supply
– 1 x Coupler
– 1 x Connection lead set

Workbook – DC Machines
The exercises in the workbooks contain the theory and lab exercises covering the following topic coverage:
– Prime Mover Torque Measurement
– The Direct Current Motor
– The DC Shunt Motor
– The DC Series Motor
– The DC Compound Motor
– The Separately-Excited DC Shunt Generator
– The Self-Excited DC Shunt Generator
– The DC Compound Generator
– DC Motor Starter

Recommended workbook (page 289): DC Machines

2-kW EMS – Transformers and AC Machines
LabVolt Series 8013-4

Learning System that covers the principles of transformers and AC machines

Main components:
Please refer to the list of hardware included with the 2-kW EMS – Modularized.

Workbook – Transformers and AC Machines
The exercises in the workbooks contain the theory and lab exercises covering the following topic coverage:
– The Single-Phase Transformer
– Transformer Polarity
– Transformer Regulation
– The Autotransformer
– Transformers in Parallel
– The Distribution Transformer
– Three-Phase Transformer Connections
– Prime Mover and Torque Measurement
– The Wound-Rotor Induction Motor
– The Squirrel Cage Induction Motor
– The Synchronous Motor
– The Three-Phase Alternator
– The Alternator Under Load
– Alternator Synchronization
– Alternator Power
– Three-Phase Motor Starters
– Frequency Conversion
– Reactance and Frequency
– Selsyn Control

Recommended workbook (page 289) Transformers and AC Machines

	en	es	fr
120 V, 60Hz	**587319**	**587321**	**587320**
220 V, 50Hz	**587322**	**587324**	**587323**
240 V, 50Hz	**587318**		

	en	es	fr
120 V, 60 Hz	**587326**	**587328**	**587327**
220 V, 50 Hz	**587329**	**587331**	**587330**
240 V, 50 Hz	**587325**		

Optional Modules

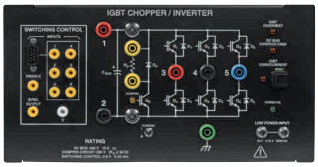
2-kW Four-Quadrant Dynamometer

This device can act as a prime mover or as a dynamometer, depending on user preference, and it can easily be coupled to any motor and generator from the 2-kW product line.

The Four-Quadrant Dynamometer consists of a squirrel-cage induction motor with an encoder feedback. The motor is driven by a closed-loop vector drive which is coupled to a touch-screen Human-Machine Interface (HMI). This interface enables the user to select the mode of operation (speed or torque) and to set either the speed (r/min) and direction or the output torque (N·m or lb·ft) of the machine. The interface displays the main parameters of operation in real-time (voltage, current, torque, speed, and frequency). Open-source software drivers are available to integrate it in specific research setups.

Electrical connections between the vector drive and the motor are made through jumpers on the front panel. This makes the separation of both components simple and allows the motor or the vector drive to be used independently in other experimentations.

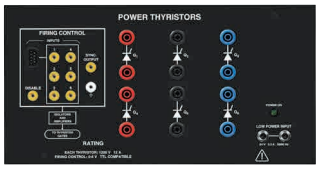
	en	es	fr
120 V, 60 Hz			
	586731	**586732**	
220 V, 50 Hz			
	586733		
240 V, 50 Hz			
	586734		



2-kW IGBT Chopper/Inverter

This module consists of 7 insulated-gate bipolar transistors (IGBT) mounted in a half-size EMS module. Six IGBTs are used to implement choppers and inverters. These IGBTs are protected against a variety of severe operating conditions, such as short-circuits, overvoltage, overcurrent, and overheat. The seventh IGBT and an external dumping resistor allow smooth dissipation of excess energy at the DC bus. The module switching control section allows 0/5 V pulse signals from either the Data Acquisition and Control Interface, LabVolt Series 9063, the Chopper / Inverter Control Unit, LabVolt Series 9029, or any compatible 0/5 V control unit, to be applied to the gating circuits of the IGBTs.

	en	es	fr
120 V, 60 Hz			
	586829	**586831**	**586830**
220 V, 50 Hz			
	586832		
240 V, 50 Hz			
	586828		



2-kW Power Thyristors

This module consists of six power thyristors (SCRs) mounted in a half-size EMS enclosure. Each individual thyristor is protected against overcurrents and short-circuits. All the anodes and cathodes of the thyristors are terminated on the front panel by color-coded, 4 mm safety banana jacks. To reduce the number of external connections, the most typical thyristor configurations can be achieved using two toggle switches on the front panel.

A firing control section allows six 0-5 V pulse signals from either the Data Acquisition and Control Interface, LabVolt Series 9063, the Thyristor Firing Unit, LabVolt Series 9030, or any compatible 0-5 V control unit, to be applied to the gating circuits of the thyristors.

	en	es	fr
120 V, 60 Hz			
	586833	**586834**	
220 V, 50 Hz			
	586835		
240 V, 50 Hz			
	586836		

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

120 V, 60 Hz, en	583936
220 – 240 V, 50 Hz, en	595932

Notes: The campus license includes the student and instructor manuals of the following workbooks in PDF: “Power Circuits”, “DC Machines”, and “Transformers and AC Machines”. Printed workbooks available upon request.

Courses on Festo LX:

- → Power Circuits
- → DC Machines
- → Transformers and AC Machines

0.2-kW Electromechanical Learning Systems (EMS)

Electric power technology through laboratory observations using analog meters

LabVolt Series 8001

The 0.2-kW Electromechanical Learning System (EMS) is based on an approach to teaching electric power technology through laboratory observations. The program, presented in four subsystems, deals with the different techniques associated with the generation and use of electrical energy. The subsystems cover the common machines, and each subsystem is offered with its courseware presented in a student manual.

Each subsystem is available as a package that consists of the equipment necessary to perform the laboratory exercises presented in the correlated student manual.

Highlights

- Cutaway bell housings to permit visual inspection of the internal construction and observation of the machine during operation
- The shaft of each machine has a concave and slotted end to facilitate the use of tachometers, holding brakes, plugging switches, or inertia wheels
- Metering modules are designed to cover the complete range of required measurements with a minimum number of meters
- System conception and load components simplify calculations required in the learning process
- Safe: all live parts of the plugs are concealed and insulated

Carefully designed

The systems give instructors complete versatility. They were developed by educators to satisfy educational requirements that include industrial applications of electric power technology. The design objective was to develop a low-power (0.2 kW or ¼ hp) educational system with equipment that operates like industrial equipment.

Through careful attention to engineering detail, the systems provide laboratory results that are easy to understand, with data values that are easily observed. The data, when applied to formulas, provides results that verify electrical laws rather than deny them because of large operational tolerance errors.

Comprehensive courseware

Laboratory manuals guide students step-by-step through the experiments and provide the necessary theoretical background to allow students to successfully complete the educational objectives. These manuals contain experiments that correlate with the training equipment for hands-on involvement with the subject matter.

The instructor can select the experiments that will satisfy the objectives of technical courses or university programs. The flexibility of the Learning Systems allows students to use their own initiative during the laboratory sessions. Under the direction of an instructor, students can gain the required competencies for successful employment.

0.2-kW EMS – Modular with Motor Starters
LabVolt Series 8001-1

This complete system provides comprehensive training in electromechanical systems and convey the techniques associated with the generation and use of electrical energy. It integrates all four subsystems: Power Circuits, DC Machines, Single-Phase Transformer and AC Machines, and Three-Phase Transformer and AC Machines.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x DC Motor/Generator
– 1x Four-Pole Squirrel-Cage Induction Motor
– 1x Three-Phase Wound-Rotor Induction Machine
– 1x Synchronous Motor/Generator
– 1x Capacitor-Start Motor
– 1x Capacitor-Run Motor
– 1x Universal Motor
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 3x Fully Protected Transformer
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Single-Phase Wattmeter
– 1x Three-Phase Wattmeter
– 1x Synchronizing Module
– 1x Manual DC Motor Starter
– 1x Synchronous Motor Starter
– 1x Three-Phase Full-Voltage Starter
– 1x Three-Phase Rheostat
– 1x Power Supply
– 1x Electrodynamometer, Imperial Units
– 1x Digital Tachometer
– 1x Timing Belt
– 1x Digital Multimeter
– 1x Connection Lead Set
– 1x Thyristor Speed Controller

	en	es	fr
120 V, 60 Hz	**587243**	**587245**	**587244**
220 V, 50 Hz	**587246**	**587248**	**587247**
240 V, 50 Hz	**587242**		

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

0.2 kW EMS – Power Circuits
LabVolt Series 8001-2

This learning system features the necessary subsystem to study power circuits.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Single-Phase Wattmeter
– 1x Three-Phase Wattmeter
– 1x Synchronizing Module
– 1x Power Supply
– 1x Digital Multimeter
– 1x Connection Lead Set

	en	es	fr
120 V, 60 Hz	**587250**	**587252**	**587251**
220 V, 50 Hz	**587253**	**587255**	**587254**
240 V, 50 Hz	**587249**		

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

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

120 V, 60 Hz, en	583903
120 V, 60 Hz, es	583904
120 V, 60 Hz, fr	8174175
220 V, 60 Hz, en	583905
240 V, 50 Hz, en	583902

Notes: The campus license includes the student and instructor manuals of the following workbooks in PDF: “Power Circuits”, “DC Machines”, “Single-Phase Transformers and AC Machines”, and “Three-Phase Transformers and AC Machines”. Printed workbooks available upon request.

Courses on Festo LX
→ Power Circuits
→ DC Machines
→ Single-Phase Transformers and AC Machines
→ Three-Phase Transformers and AC Machines

0.2-kW EMS – DC Machines
LabVolt Series 8001-3

Partial Learning System that covers the principles of DC machines.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x DC Motor/Generator
– 1x Synchronous Motor/Generator
– 1x Resistive Load
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Manual DC Motor Starter
– 1x Power Supply
– 1x Electrodynamometer,

Imperial Units
– 1x Digital Tachometer
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Thyristor Speed Controller

Recommended manual page 289:
DC Machines

	en	es	fr
120 V, 60 Hz	**587257**	**587259**	**587258**
220 V, 50 Hz	**587260**	**587262**	**587261**
240 V, 50 Hz	**587256**		

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

0.2-kW EMS – Single-Phase Transformers and AC Machines
LabVolt Series 8001-4

Learning System that covers the principles of transformers and AC machines

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x Capacitor-Start Motor
– 1x Capacitor-Run Motor
– 1x Universal Motor
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 2x Fully Protected Transformer
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Single-Phase Wattmeter
– 1x Power Supply
– 1x Electrodynamometer,

Imperial Units
– 1x Digital Tachometer
– 1x Timing Belt
– 1x Digital Multimeter
– 1x Connection Lead Set

Recommended manual page 290:
Single-Phase Transformers and AC Machines

	en	es	fr
120 V, 60 Hz	**587264**	**587266**	**587265**
220 V, 50 Hz	**587267**	**587269**	**587268**
240 V, 50 Hz	**587263**		

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

0.2-kW EMS – Three-Phase Transformers and AC Machines
LabVolt Series 8001-5

Learning System that covers the principles of transformers and AC machines:

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x DC Motor/Generator
– 1x Four-Pole Squirrel-Cage Induction Motor
– 1x Three-Phase Wound-Rotor Induction Machine
– 1x Synchronous Motor/Generator
– 1x Resistive Load
– 1x Inductive Load
– 1x Capacitive Load
– 3x Fully Protected Transformer
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Three-Phase Wattmeter
– 1x Synchronizing Module
– 1x Synchronous Motor Starter
– 1x Three-Phase Full-Voltage Starter
– 1x Three-Phase Rheostat
– 1x Power Supply
– 1x Electrodynamometer,

Imperial Units
– 1x Digital Tachometer
– 1x Timing Belt
– 1x Connection Lead Set

	en	es	fr
120 V, 60 Hz	**587271**	**587273**	**587272**
220 V, 50 Hz	**587274**	**587276**	**587275**
240 V, 50 Hz	**587270**		

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

0.2-kW EMS – Electromechanical Learning System
LabVolt Series 8001-6

Modular instructional program designed to teach electric power technology through laboratory observations.

Main components:
– 1x Mobile Workstation
– 1x Storage Shelves
– 1x DC Motor/Generator
– 1x Four-Pole Squirrel-Cage Induction Motor
– 1x Three-Phase Wound-Rotor Induction Machine
– 1x Synchronous Motor/Generator
– 1x Capacitor-Start Motor
– 1x Capacitor-Run Motor
– 1x Universal Motor
– 2x Resistive Load
– 1x Inductive Load
– 2x Capacitive Load
– 3x Fully Protected Transformer
– 1x DC Voltmeter/Ammeter
– 1x AC Ammeter
– 1x AC Voltmeter
– 1x Single-Phase Wattmeter
– 1x Three-Phase Wattmeter
– 1x Synchronizing Module
– 1x Three-Phase Rheostat
– 1x Power Supply
– 1x Electrodynamometer,

Imperial Units
– 1x Digital Tachometer
– 1x Timing Belt
– 1x Connection Lead Set
– 1x Thyristor Speed Controller

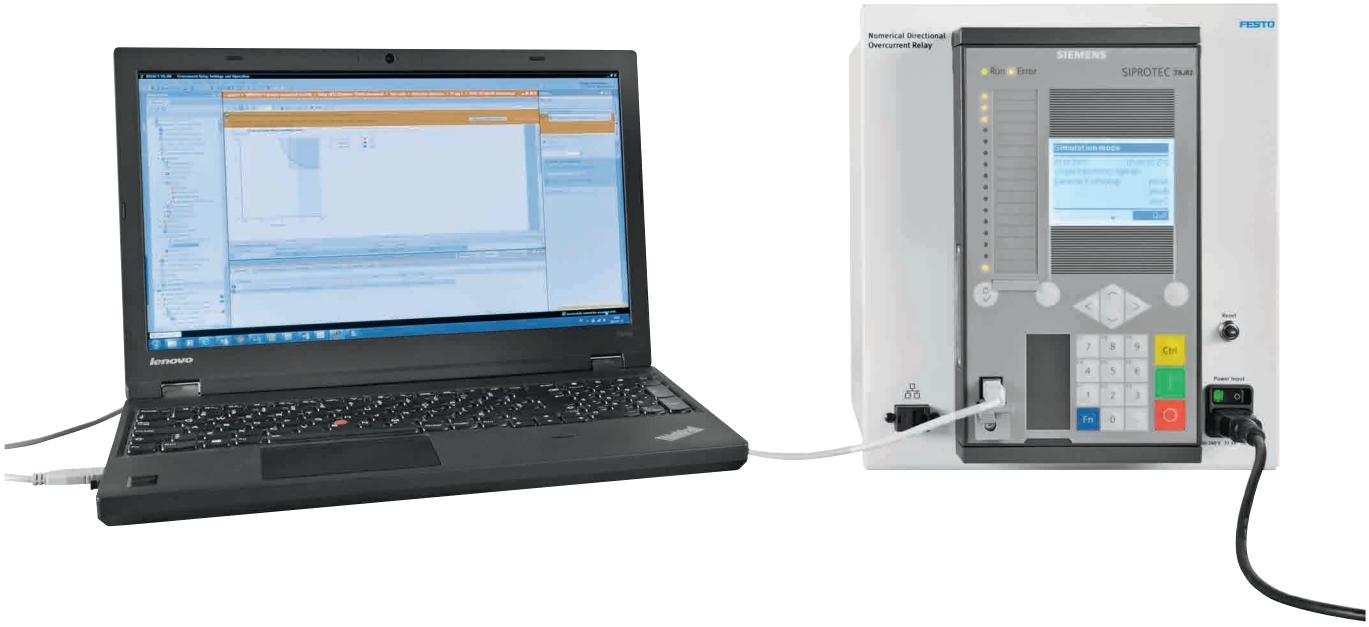
	en	es	fr
120 V, 60 Hz	**587278**	**587280**	**587279**
220 V, 50 Hz	**587281**	**587283**	**587282**
240 V, 50 Hz	**587277**		

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

Protective Relaying

Based on the SIPROTEC 5 Series from Siemens

→ Video



Variant with external connectors

Modern, time-efficient, and interactive hands-on training

Protective relaying provides detection of abnormal operating conditions in electrical systems and is needed in order to act quickly to protect circuits, equipment, and the general public.

The theoretical background, as well as practical application, of these protective devices and their protection functions are an important part of the education of power systems for electrical engineers.

Power-utility-grade equipment, Siemens' newest generation the SIPROTEC 5 series, is used in this innovative teaching approach.

State-of-the-art hardware

Three relays are available and must be selected in accordance with the desired learning path. Each features a display that can provide information about the relay protection functions, indicate numerous currently measured values such as the line voltages, line currents, phase power, three-phase power, and power factor, and show information about trip events that have been recorded. A keypad, also on the front panel of the relay, allows users to select the information displayed. The front panel of the relay also features a set of 16 LEDs that allows quick monitoring of the status of various relay functions.

Relay programming

Relay programming (e.g., protection function selection, function settings) is achieved via the Siemens DIGSI 5 software via a USB connection or using the keypad and display located on the front panel of the relay. Once programmed, the relays can be tested using a built-in relay testing unit to ensure it is programmed to operate as expected. This eliminates the need for users to purchase a costly external relay tester to perform relay testing.

Access to the voltage and current inputs, Ethernet port, binary inputs, and binary outputs (e.g., trip contacts) of the relay is through a removable panel located at the back of the relay enclosure. A variant of each relay with safety jacks and connectors mounted on the front panel to provide access to all relay inputs, outputs, and ports is also available.

Numerical Directional Overcurrent Relay
ANSI protection functions: Directional phase overcurrent (67), Directional ground overcurrent (67N), Directional power (32), Instantaneous phase overcurrent (50), Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N). Other possible functions: 27, 37, 38, 46, 59, 74, 81, 86, and 87N

Standard version	**589061**
With safety jacks and connectors	**589110**

Numerical Distance Relay
ANSI protection functions: Phase distance (21), Ground distance (21N), Directional phase overcurrent (67), Directional ground overcurrent (67N), Directional power (32), Instantaneous phase overcurrent (50). Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N). Other possible functions: 27, 37, 38, 46, 59, 68, 74, 81, 86, and 87N.

Standard version	**589062**
With safety jacks and connectors	**589111**

Numerical Differential Protective Relay
ANSI protection functions: Transformer differential (87T), Instantaneous phase overcurrent (50), Instantaneous ground overcurrent (50N), Phase overcurrent (51), Ground overcurrent (51N).

Standard version	**589891**
With safety jacks and connectors	**592529**

Required accessories, also order:

IEC Power Cable (page 14)	
Siemens DIGSI 5 (license for one non-educational user)	779959

* Note: The license for educational users is free.

Topic coverage

Overcurrent/Overload Protection
– Evolution of protective relays
– Overcurrent protection
– Overcurrent and overload protection of AC machines and power transformers
– Overcurrent protection of radial feeders

Directional Protection
– Protection of parallel power lines using overcurrent relays
– Directional overcurrent protection
– Directional comparison protection
– Directional power protection

Differential Protection
– Effect of the current measuring error on the sensitivity of current differential protection
– Percentage restrained differential protection
– Application of differential protection3

Distance Protection
– Simplified diagram of a power system
– Conventional time-stepped distance protection
– Distance relay impedance characteristic
– Fault impedance vs. load impedance
– Line protection
– Generator loss-of-excitation protection
– Distance protection using communication-assisted tripping schemes

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	8157298

Notes: The campus license includes the student and instructor manuals of the following workbooks: “Overcurrent and Overload Protection”, “Directional Protection”, “Differential Protection”, and “Distance Protection”. Printed workbooks available upon request.

Courses on Festo LX
→ Overcurrent and Overload Protection
→ Using Protective Relays
→ Directional Protection
→ Differential Protection
→ Distance Protection

0.2-kW Protective Relaying Learning System

LabVolt Series 8007

The 0.2-kW Protective Relaying Learning System is a complete program that extends training in protective relaying beyond the operation and calibrations of individual relays into broader circuit applications.

The program provides hands-on training at the system level in generator protection, transformer protection, and induction motor protection.

The 0.2-kW Protective Relaying Learning System consists of several modules, which can be divided into five groups: common electrical modules, power system modules, protective relaying control station, protective relays, and additional and optional equipment.

The prerequisites include: completion of a course in relay operation and calibration, and completion of a course in electric power technology that covers electric power generation, power transformers, and induction motors.

The modular structure of the 0.2-kW Protective Relaying Learning System, together with the subdivision of student manuals into topical units, enables instructors to choose equipment that matches their budgets while progressively enhancing their systems over time.

For power utility users, it is possible to combine their own protective relays with a selection of modules from the 0.2-kW Protective Relaying Learning System to obtain equipment setups that correspond to existing one-line and three-line diagrams.

Highlights

- Modular approach allowing selection of areas of interest for study, and tailoring to special training needs equipment selection to match budgets setup of complete power systems/generators feeding various devices such as transformers, transmission lines, and others progressive system enhancement with no replication of equipment
- Use of many modules from other well-known Electromechanical System (EMS)
- Wide range of protective relays
- Fault insertion capability for troubleshooting at the system level
- Very safe operation and experimentation
- Comprehensive curriculum with detailed lab procedures, exercises, theory, tests, etc.

Topic coverage
- Differential protection
- Reverse power protection
- Rotor earth fault protection
- Loss-of-excitation protection
- Overvoltage protection
- Overspeed protection
- Overcurrent protection
- Generator synchronization
- Synchronous generator protection scheme
- Transformer magnetizing inrush
- Differential protection
- Restricted earth fault protection
- Overcurrent protection
- Three-phase power transformer protection scheme
- Stator-winding fault protection
- Overcurrent protection
- Phase reversal protection
- Phase unbalance and undervoltage protection
- Stall protection
- Mechanical overload/underload protection

0.2-kW Protective Relaying Learning System
LabVolt Series 8007

	en	es
120 V, 60 Hz	**587292**	**587293**
220 V, 50 Hz	**587294**	
240 V, 50 Hz	**587299**	

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

Main components
- 1x Source Impedance
- 1x Current Transformers
- 1x Voltage Transformers
- 1x Faultable Transformers
- 1x Transmission Grid 'A'
- 1x Interconnection Module
- 1x Universal Fault Module
- 1x Protective Relaying Control Station
- 1x Three-Phase Over Current Relay
- 1x AC/DC Current Sensitive Relay
- 1x Three-Phase Under/ Over Voltage Relay
- 1x AC/DC Voltage Sensitive Relay
- 1x Synchro-Check Relay
- 1x Under/Over Frequency Relay
- 1x Phase Balance/Sequence Relay
- 1x Reverse Power Relay
- 1x Motor Power-Factor Relay
- 1x Mobile Workstation
- 1x Three-Module Workstation
- 1x Storage Shelves
- 1x Four-Pole Squirrel-Cage Induction Motor
- 1x Synchronous Motor/Generator
- 2x Resistive Load
- 1x DC Voltmeter/Ammeter
- 1x AC Ammeter
- 1x AC Voltmeter
- 1x Wattmeter / Varmeter
- 1x Synchronizing Module
- 1x Power Supply
- 1x Power Diodes
- 1x Timing Belt
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer/ Power Supply
- 1x Inertia Wheel

Protective Relaying Learning System Add-On to LV 8001
LabVolt Series 8007-A

This equipment is an add-on to the 0.2 kW Electromechanical Learning System LV 8001 which supplements the necessary components to teach Protective Relaying in conjunction with the standard EMS platform.

	en	es
120 V, 60 Hz	**587296**	**587297**
220 V, 50 Hz	**587298**	
240 V, 50 Hz	**587295**	

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

Main components
- 1x Source Impedance
- 1x Current Transformers
- 1x Voltage Transformers
- 1x Faultable Transformers
- 1x Transmission Grid 'A'
- 1x Interconnection Module
- 1x Universal Fault Module
- 1x Protective Relaying Control Station
- 1x Three-Phase Over Current Relay
- 1x AC/DC Current Sensitive Relay
- 1x Three-Phase Under/ Over Voltage Relay
- 1x AC/DC Voltage Sensitive Relay
- 1x Synchro-Check Relay
- 1x Under/Over Frequency Relay
- 1x Phase Balance/Sequence Relay
- 1x Reverse Power Relay
- 1x Motor Power-Factor Relay
- 1x Three-Module Workstation
- 1x Resistive Load
- 1x Wattmeter / Varmeter
- 1x Power Diodes
- 1x Connection Lead Set
- 1x Four-Quadrant Dynamometer/ Power Supply
- 1x Inertia Wheel

Additional required accessories for both systems:

- 1 x Dual-Trace Digital Storage Oscilloscope (page 31)
- 1 x Digital Multimeter (page 134)

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	584220

Notes: The campus license include the PDF of the student and instructor manuals of "Introduction to Protective Relaying". Printed workbooks available upon request.

Courses on Festo LX:
→ Introduction to Protective Relaying

2-kW Electric Power Transmission Learning Systems

LabVolt Series 8059

The 2-kW Electric Power Transmission Learning Systems are designed to teach through hands-on exercises the principles of transmission of electric power – a subject which is usually taught in a strictly theoretical manner.

The exercises show how changes in the source, the load, and the transmission line affect the overall performance of the system. They illustrate the meaning of active and reactive power, how the voltage at the end of a line can be lowered or raised, how power can be forced to flow over one transmission line instead of another, and how a system behaves when subjected to disturbances.

The tests relating to switching transients, sudden overloads, and momentary short-circuits dramatically demonstrate the mechanical swing of generator poles and the concurrent surges of power over the transmission line. More than any amount of theory could show, these exercises convey the meaning of power stability and the limits to power flow.

Alternator, motor, capacitors, reactors, resistors, regulating autotransformer, series compensator, and transmission lines are employed. Despite their small size, these components are designed to act in the same way under steady-state and transient conditions, as their larger counterparts in industry. This practical, hands-on course is presented in a way that is readily understandable by anyone who has foundational knowledge of electricity.

Three exclusive modules:
– Three-Phase Transmission Line
– Power Line Series Compensator
– Three-Phase Regulating Autotransformer

Topic coverage
- Power measurements
- Voltage regulation and power transmission capability of a transmission line
- Shunt capacitors and phase angle between sender and receiver
- Parameters affecting active and reactive power flow
- Power-handling capability and parallel lines
- Effects of series compensation on the power transfer capability and system stability
- Effect of series compensation on the voltage regulation and power factor
- The alternator
- The synchronous motor
- The synchronous compensator and long high voltage lines
- Transmission line networks and the three-phase regulating autotransformer
- The synchronous motor under load
- Hunting and system oscillation
- Power system transients

2-kW Electric Power Transmission Learning System – Analog Meters
LabVolt Series 8059-2

Complete system that uses analog meters to perform electrical measurements.

220 V, 50 Hz **587414**
This system cannot be ordered or delivered in countries that require compliance to CE regulations.

Most important components
- 1x Mobile Workstation
- 1x Three-Module Workstation
- 2x Three-Phase Transmission Line
- 1x Three-Phase Regulating Autotransformer
- 1x Power Line Series Compensator
- 1x AC Voltmeter, 1x Phase Meter
- 1x DC Motor/Generator
- 1x Wiring Module for DC Motor/Generator
- 1x Three-Phase Synchronous Motor/Generator
- 1x Wiring Module for Synchronous Motor/Generato
- 3x Resistive Load
- 3x Inductive Load
- 3x Capacitive Load
- 1x DC Voltmeter/Ammeter
- 1x AC Ammeter
- 2x Three-Phase Wattmeter/Varmeter
- 2x Field Rheostat
- 1x Power Supply
- 1x Phase-Shift Indicator
- 1x Stroboscope
- 1x Coupler
- 1x Connection Leads

2-kW Electric Power Transmission Learning System – Add-on to LabVolt Series 8013 with Analog Meters
LabVolt Series 8059-3

Add-on to the 2-kW Electromechanical Learning System, LabVolt Series 8013. It provides the equipment required to perform the exercises using LabVolt Series 8013 and analog meters.

220 V, 50 Hz **587415**
This system cannot be ordered or delivered in countries that require compliance to CE regulations.

2-kW Electric Power Transmission Learning System – with Data Acquisition Interface
LabVolt Series 8059-4

Complete system that uses a Data Acquisition Interface to perform electrical measurements.

220 V, 50 Hz **587416**
This system cannot be ordered or delivered in countries that require compliance to CE regulations.

2-kW Electric Power Transmission Learning System – Add-on to LabVolt Series 8013 with Data acquisition interface
LabVolt Series 8059-5

Add-on system to the 2-kW Electromechanical Learning System. It provides the equipment required to perform the exercises using LabVolt Series 8013 and a Data Acquisition Interface, LabVolt Series 9063.

220 V, 50 Hz **587417**
This system cannot be ordered or delivered in countries that require compliance to CE regulations.

Recommended Learning Material

Workbooks (→ page 262)

Student manual, en (PDF) 591675
Instructor manual, en (PDF) 591676
Note: Printed workbooks available upon request.

Courses on Festo LX:
→ 2-kW Electric Power Transmission System

Distribution Transformer Trainer

Connect Single- and Three-Phase Transformers

	en	es
120 V, 60 Hz	**586469**	**586470**
220 V, 50 Hz	**586471**	**586472**
240 V, 50 Hz	**586473**	

These products cannot be ordered or delivered in countries that require compliance to CE regulations. For other country voltage and frequency configurations, please contact your local sales representative.

Necessary accessories, also order:

Connection Lead Set	586903
Multimeter	780874

LabVolt Series 8361

The Distribution Transformer Trainer is a portable, hands-on trainer designed to allow students to develop the skills required to connect single- and three-phase transformers similar to those found in North American ac power networks.

The trainer contains two sets of three single-phase transformers to demonstrate three-phase transformer bank configurations such as wye-wye, delta-delta, closed delta-wye, closed wye-delta, open-wye, open-delta, etc. Each individual transformer winding is protected by a thermal-magnetic circuit breaker and designed to accept multiple faults.

Faults can be inserted to develop sound techniques for troubleshooting single-phase and three-phase transformer banks.

Targeted skills

– Identify different types of transformers
– Identify faulted transformers
– Test for proper no-load voltage
– Show how a three-phase transformer produces correct and incorrect motor rotation
– Show how the ratio of the transformer windings affects the secondary output voltage
– Show how to simulate parallel single-phase and three-phase transformers
– Simulate a burned-out transformer in a three-phase bank, as well as the connection of the remaining transformers in open-wye and open-delta configurations to produce the correct voltage

Topic coverage

– Distribution Transformer Trainer
– Transformer Polarity and Terminal Markings
– Single-Phase Transformers Supplying Single-Phase Loads
– Single-Phase Paralleling
– Three-Phase Banking of Single-Phase Transformers

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en	584075

Notes: The campus license include the PDF of the student and instructor manuals of "Distributed Transformer Trainer". Printed workbooks available upon request.

Courses on Festo LX:

→ Distribution Transformer Trainer

Power transmission and distribution is also covered by 0.2 kW Electric Power Technology learning systems (LabVolt Series 8010), especially in the context of the smart grid. Please check chapter 94 for details.

Building System Technology

Introduction 190

Introduction to Building System Technology
Fundamental Electrical Protective Measures TP 1100 194
Power Supply Systems and Protective Grounding TP 1110 195
Power Supply Systems and Protective Measures TP 1111 196
Basic Principles of Electrical Installations TP 1121 200

Building Automation
KNX Building Automation Training Kit 202
Smart Home TP 1135 203

Lighting Systems
High-Power LEDs TP 1144 206
DALI Lighting Control TP 1145 208

HVAC Systems
Building HVAC Controls 210

Electric Vehicles Infrastructure
Electric Vehicle AC Charging Stations 212

Renewable Energy Systems
Solar Thermal Learning System 214
Solar/Wind Learning Systems 216

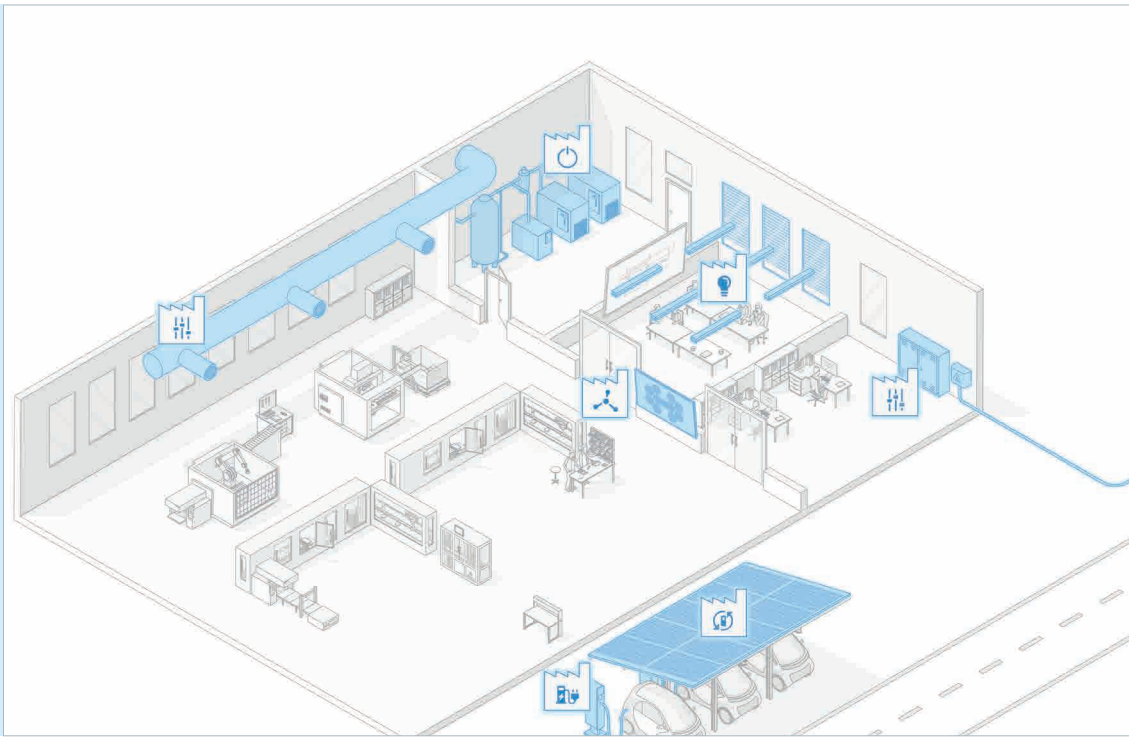
CE

Some of the learning solutions in this catalog do not carry the CE mark and cannot be ordered for delivery to Europe. If you are located in a country where this marking is required, please contact your local Festo sales representative before placing an order.

Building System Technology

The Rise of Automation and Connectivity

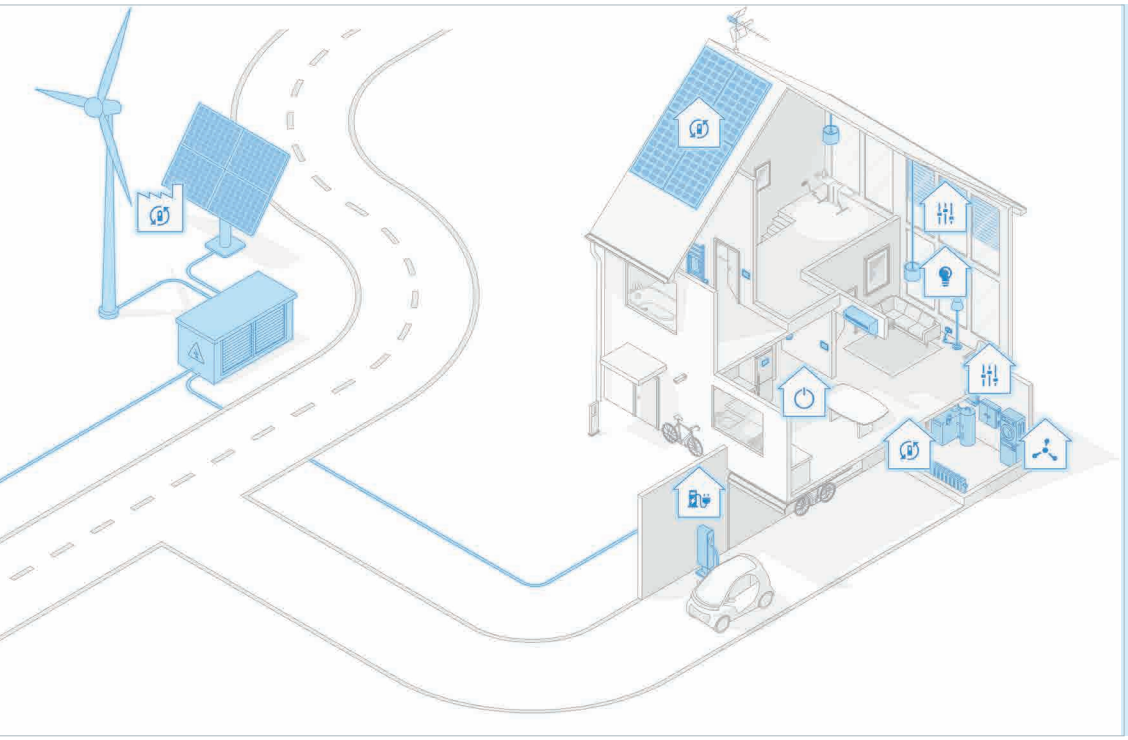
Smart industry buildings provide numerous benefits, improving efficiency, convenience, and sustainability. Automated systems optimize production processes and energy consumption, while real-time data analytics help minimize downtime, waste, and emissions.



Introduction to building systems
Our learning solutions provide a comprehensive foundation in the fundamental knowledge required for various building technologies and industry requirements. The training packages introduce electrical protective measures, explaining where risks arise, why they occur, and how to prevent them. An additional module covers the basic principles of electrical installation.

Energy-efficient lighting systems
Building lighting systems consume a significant amount of energy, making energy-efficient solutions increasingly important. Our training packages focus on advanced lighting technologies, particularly high-power LEDs.

Building automation
Modern buildings integrate intelligent solutions, particularly in lighting and climate control. Building system technology and bus systems play a key role in optimizing these functions.



Smart home systems enable homeowners to remotely control and automate lighting, heating, and appliances, enhancing energy efficiency, comfort, security, and convenience. By optimizing resource use, these technologies contribute to a safer, greener, and more sustainable future.

Building management systems
Effective climate control in buildings requires a complex monitoring system. Our learning solutions provide a strong foundation for teaching these concepts through hands-on training with real-world components. The system covers Direct Digital Control (DDC-GA) building automation and introduces network architecture concepts, including BACnet MS/TP.

Renewable energy
These learning solutions offer practical experiments in photovoltaic energy, wind power, grid supply, and smart grid scenarios. Various training packages are available to meet different learning needs. More details can be found in the Electric power technology chapter (page 94).

Electric vehicles
The growing adoption of electric vehicles presents new challenges for building installations, requiring updated infrastructure and integration solutions, especially charging stations.

Building System Technology Training Packages

From Basic Circuits to Intelligent Buildings

Proven training concept
Explore a comprehensive range of learning solutions designed to develop essential building technology skills, with a strong emphasis on system integration and interoperability. Our learning systems include modular, customized, and complete setups to meet diverse training needs and budgets across industry and education. Each solution is supported by high-quality learning content to maximize skills development.

Designed for training
The modular structure of our training packages allows instructors to create learning environments that align with both training objectives and budgetary constraints. This flexibility enables gradual expansion. Built to withstand daily use, our equipment ensures long-lasting, cost-effective training solutions.

Rapid skill transfer
Whether for introductory training or advanced courses, the ability to recall and apply learned concepts is essential. This is most effective when learning environments closely resemble real-world work settings. Our training packages for building system technology include industrial components, and the exercises in our course materials are based on real professional scenarios.

Expertise in building technologies
Building system expertise is essential for automation, monitoring, communication, safety, and sustainability. Our specialized learning solutions cover fundamental circuits, protective measures, and building automation systems, as well as communication standards and the integration of various systems and components. Hands-on courses complement the training to ensure practical understanding.

Modular learning systems: Step by step to success

The digitalization and integration of building control technology, along with the growing demand for reliable, energy-efficient, and cross-system solutions, present new challenges for both teachers and students.

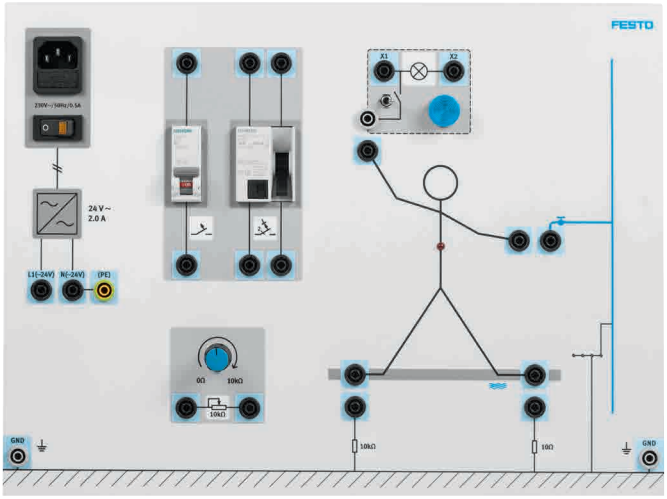
Various systems—including lighting, heating, renewable energy, blinds, and alarm systems—must seamlessly communicate across different industries. Installers, technicians, and users alike need the skills to operate and manage these interconnected technologies effectively.

Safe connection technology
When working with electricity, safety and protective measures are paramount. All our electrical connections feature safety sockets or plugs.

Digital learning
Successful education – whether in schools, companies, or universities – requires self-directed study. Our digital learning platform, Festo LX, offers engaging learning scenarios that complement classroom instruction. These courses are particularly effective for teaching fundamental concepts and serve as an ideal supplement to hands-on training.

Fundamental Electrical Protective Measures

TP 1100



People are primarily at risk from the magnitude of the current that flows through them.

The EduTrainer raises awareness of and teaches about the dangers of electric current—an essential safety topic that every worker, regardless of industry, should understand.

This device covers the difference between a miniature circuit-breaker to protect the system and a fault-current circuit breaker to protect people.

Due to the built-in transformer, all training content is explained at a non-hazardous voltage level of 24 V.

Technical data
- Input voltage: 1 AC/240 V cold device connection
- Output voltage: 1 AC/24 V
- Line circuit breaker: 1 A
- Fault current protective circuit: 30 mA
- Fault simulation via potentiometer and fixed resistances
- Equipment: LED lamp with toggle switch for simulating housing faults
- Front panel: 266 mm x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plug

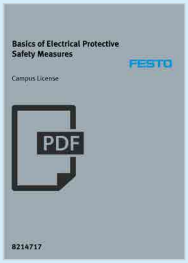
Order no.	**8048616**

Also necessary, also order:

IEC power cable (→ page page 14)
Digital multimeter (→ page 58)

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

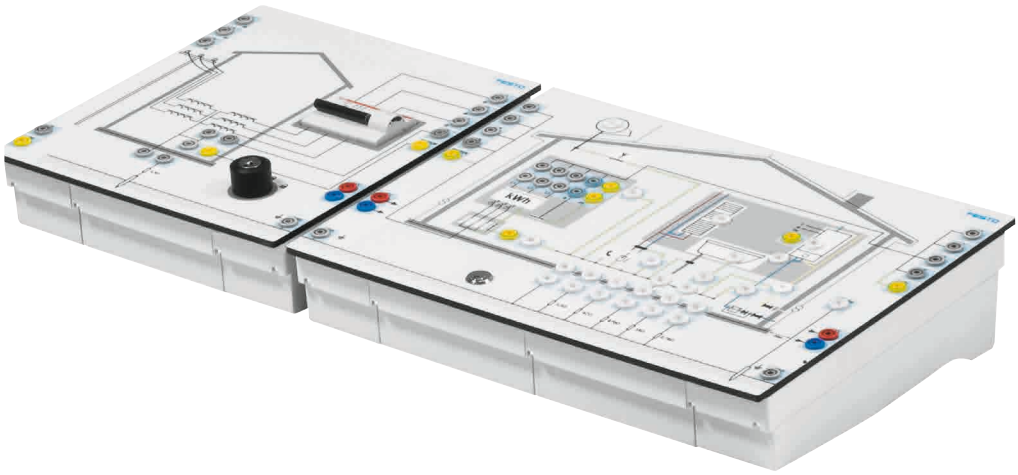
de	8214716
en	8214717

Course on Festo LX:

→ Electrical Protective Measures - EduTrainer

Power Supply Systems and Protective Grounding

TP 1110



This training package provides an introduction to electrical protective measures, designed especially for students in in occupations that are installing equipment that amognst others also has an electrical connection. It explains where and why electrical hazards can arise— even within a mechanic's or plumber's typical range of activities—and how they can be prevented.

TP 1110 covers the fundamentals, while TP 1111 (see next page) provides a more comprehensive overview of electrical protective measures.

Training content

Power supply:
- Power supply systems (TN, TT, IT system)
- Safety measures in the different networks

Service connection:
- Components of a service connection system
- Additional designations in the TN system (TN-C, TN-S, TN-C-S)
- Selection of the safety measure and protective devices
- Safety measure measuring devices
- Initial tests acc. DIN VDE 0100-600 and repeat tests acc. DIN VDE 0105 and BGV A3

Learning goals

- Define and wire TN-C, TN-C-S and TT earthing arrangements and explain when they are used in practice.
- Operate an installation tester to measure and evaluate voltages and loop impedances.
- Explain faults and examine applicable protection methods.
- Define SELV and PELV systems and explain when they are used in practice.

Complete Equipment Set TP 1110	**8023971**

The most important components at a glance:

1x EduTrainer Net Board	571825
1x EduTrainer House Installation	571826

Necessary accessories, also order:

4 mm Safety Laboratory Cables (page 53)	
Safety Jumper Plugs (page 54)	
Installation Tester for VDE 0100	8064024

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

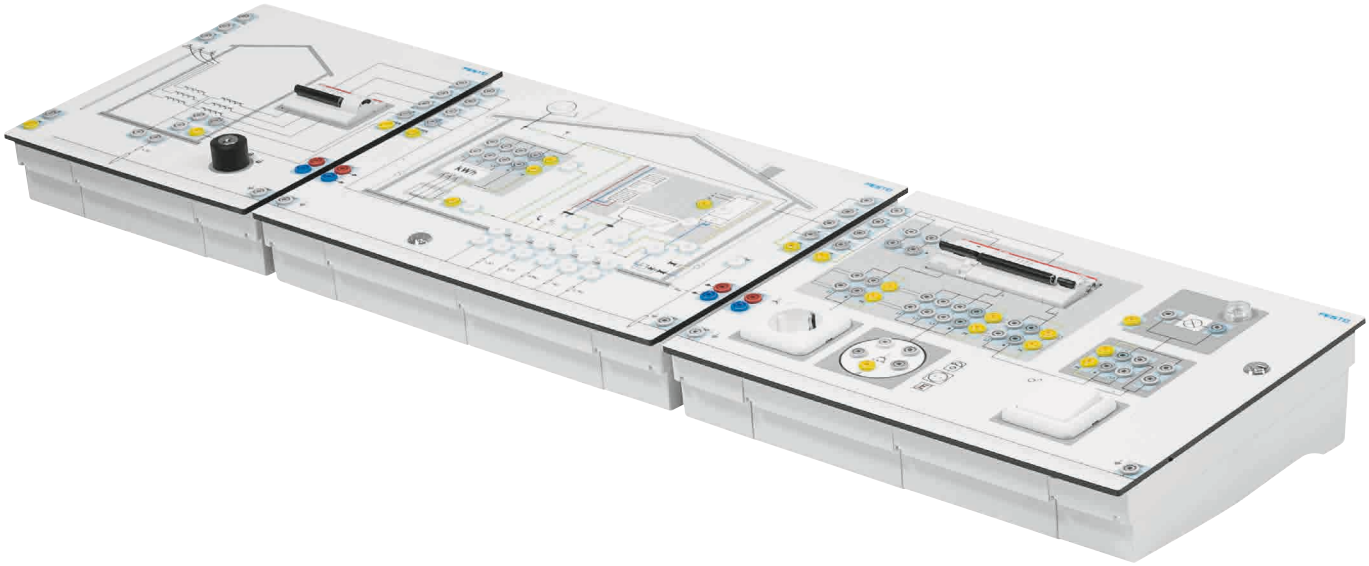
de	8023440
en	8023441
es	8023442
fr	8023443

Course on Festo LX:

→ Power Supply Systems and Protective Grounding

Power Supply Systems and Protective Measures

TP 1111



The fundamentals of electrical protective measures

Protecting people plays an important role when using electrical energy, as it is not visible and is recognizable only by its effects. Possible risks must therefore be minimized through suitable safety measures.

Examples provide an introduction to the problems associated with electrical safety measures. Current conditions are examined and the risks resulting from the relevant situation are demonstrated by means of measurements. The subsequent analysis and interpretation of the measurement results show the relationships and identify measures

Training content

Power supply:
– Power supply systems (TN, TT, IT system)
– Protective measures in the different networks

Service connection:
– Components of a service connection system
– Additional designations in the TN system (TN-C, TN-S, TN-C-S)
– Selection of the protective measure and protective devices
– Protective measure measuring devices
– Planning and execution of initial tests in accordance with DIN VDE 0100-600 and repeat tests in accordance with DIN VDE 0105 and BGV A3
– Creating test reports
– Safety and availability advice for customers

Sub-distribution:
– Using protective measures and measuring devices
– Planning and execution of initial and repeat tests
– Evaluation of the measurement results
– Creating test reports
– Identifying, describing and measuring risks due to errors
– Systematic troubleshooting

General:
Conducting customer dialogues
– for system commissioning
– for repeat testing
– for errors/malfunctions in the electrical system
– following successful repair

Complete Equipment Set TP 1111	**571824**

The most important components at a glance:

1	1x EduTrainer Net Board	571825
2	1x EduTrainer House Installation	571826
3	1x EduTrainer Subdistributor	571827

Necessary accessories, also order:

4 mm Safety Laboratory Cables (page 53)	
Safety Jumper Plugs (page 54)	
Installation Tester for VDE 0100	8064024

Possibilities of expansion:

Selective RCD EduTrainer (page 198)	574173
RCD A/B EduTrainer (page 198)	574174
IT Network EduTrainer (page 199)	574178
RCD-F Edutrainer	8190121
3AC Power Supply and Safety Unit	594826

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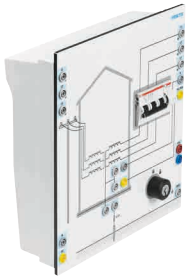

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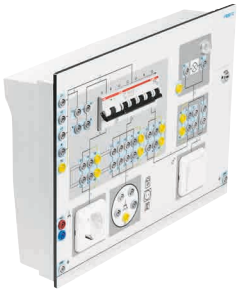

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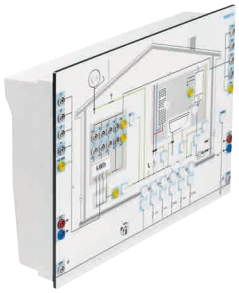


Advantages

- Lockable error switches integrated in the housing facilitate realistic fault finding
- No additional power supply required
- For a practical explanation of the protective measures, measurements and tests are carried out using conventional test and measuring devices.
- The optionally available mobile solution meets work, transport and storage requirements efficiently.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

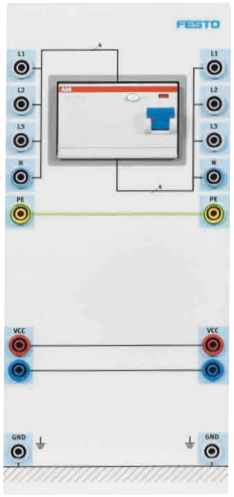
de	567307
en	567309
es	567311
fr	567313

Course on Festo LX:

→ Power Supply Systems and Electrical Safety Measures

Power Supply Systems and Protective Measures TP 1111

Possibilities of Expansion



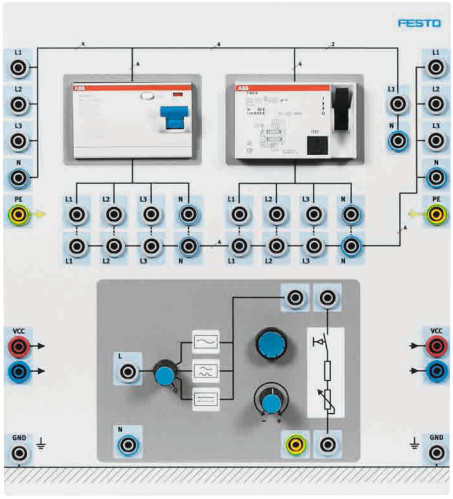
Selective RCD EduTrainer

The Selective RCD EduTrainer allows for treatment of the topic of selectivity for residual current circuit breakers in mains systems and protective measures. The selective RCCB ideally supplements the RCD A/B EduTrainer, so that it can be easily integrated and its essential characteristics can be elaborated.

The locations of all connections are standardised and are laid out as safety sockets.

Technical data
- Input voltage: 3 x 400 V AC
- Output voltage: 3 x 400 V AC
- Front panel: 133 mm x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs

Order no. **574173**



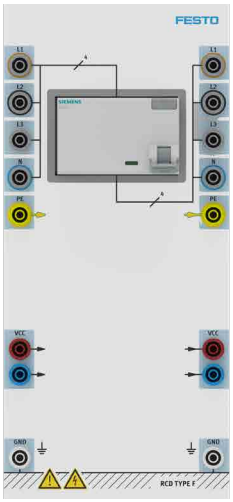
RCD A/B EduTrainer

The RCD A/B EduTrainer covers the topic of residual current circuit breakers in mains systems and protective measures. The two basic types of RCD, type A and type B, are compared with each other and their essential characteristics can be elaborated. The board is equipped with a fault simulator at which various types of voltage can be selected for the simulation of leakage current including alternating voltage, pulsed direct voltage and smoothed direct voltage. An additional voltage tap for expansion circuit breakers/RCCBs enables optimal integration into the equipment set for mains systems and protective measure.

The locations of all connections are standardised and are laid out as safety sockets.

Technical data
- Input voltage: 3 x 400 V AC (50 Hz)
- Output voltage: 3 x 400 V AC
- Tap for expansion circuit breakers/RCCBs
- Pushbutton and adjustment potentiometer for fault simulation
- Voltage type for leakage current can be set to alternating voltage, pulsed direct voltage or smoothed direct voltage
- Max. leakage current: approx. 40 mA, option for looping in an ammeter
- Front panel: 266 mm x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs

Order no. **574174**

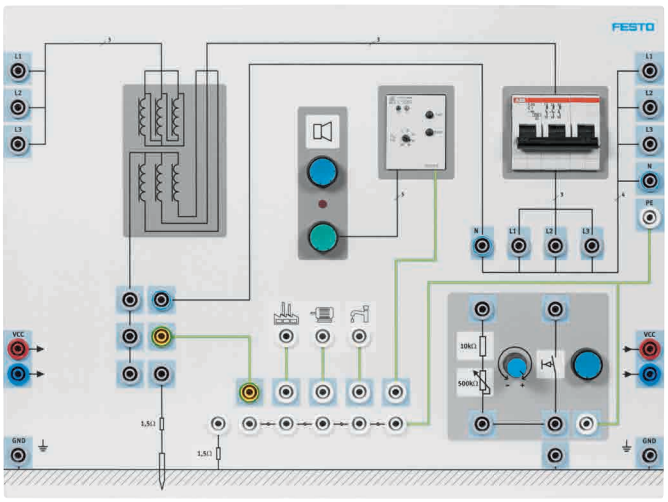


RCD F EduTrainer

The RCD Type F EduTrainer enables focused training on the operation and application of Type F residual current devices in electrical installations and protective systems. This trainer complements the existing RCD EduTrainer series perfectly, allowing easy integration and detailed examination of the specific features and response characteristics of Type F RCDs. All connection points are standardized and designed as safety sockets for secure and convenient use.

Technical data
– Input voltage: 3 x 400 V AC
– Output voltage: 3 x 400 V AC
– Front panel: 133 mm x 297 mm
– Console housing with rubber feet for use in an A4 frame or on a table
– Connection via 4 mm safety plugs

Order no. **8190934**



IT Network EduTrainer

The IT network EduTrainer expands the equipment set for mains systems and protective measures to include the topic of IT systems. The integrated fault simulator allows simulation of insulation faults which are detected and displayed by the insulation monitor. If the adjustable value is fallen short of, this is indicated by a lamp, as well as a buzzer which can be acknowledged.

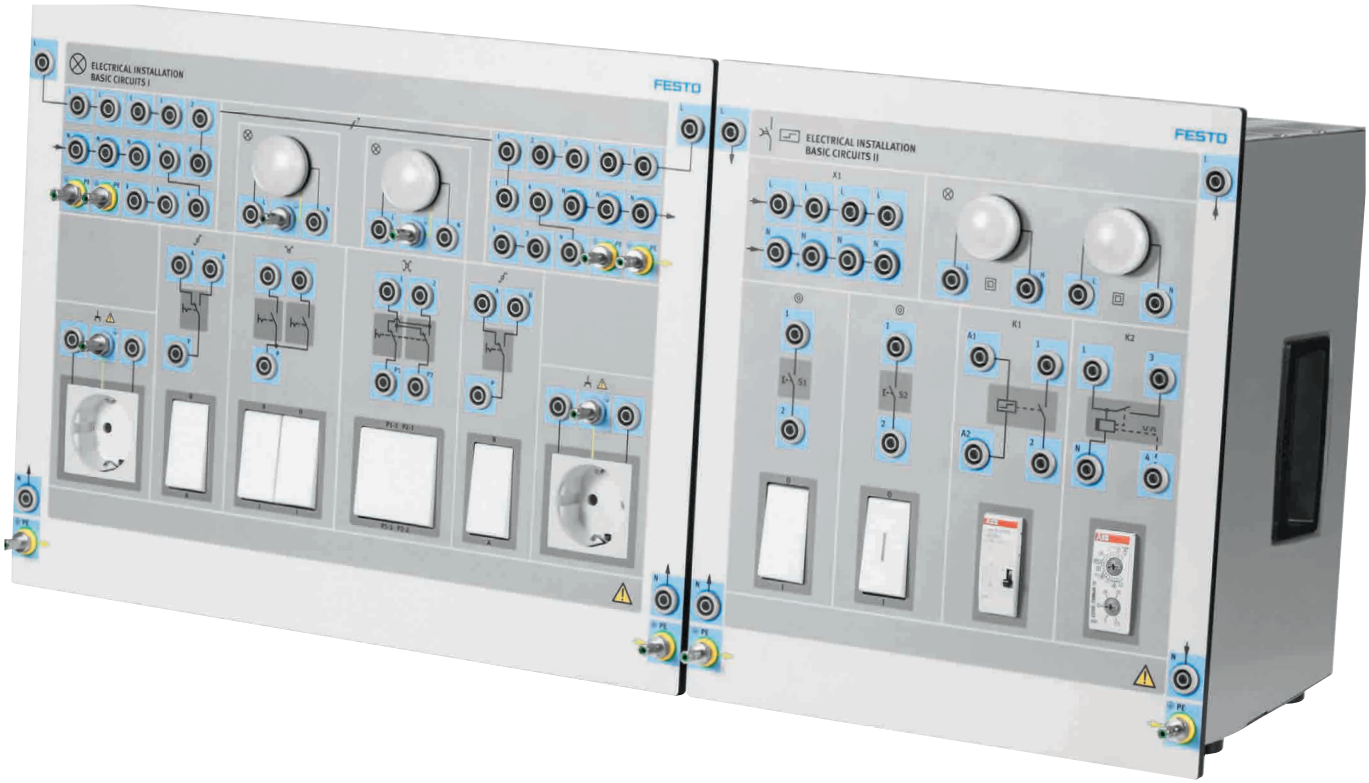
The locations of all connections are standardized and are laid out as safety sockets.

Technical data
– Input voltage: 3 x 400 V AC
– Output voltage: 3 x 400 V AC
– Output current: max. 1 A
– Front panel: 399 mm x 297 mm
– Console housing with rubber feet for use in an A4 frame or on a table
– Connection via 4 mm safety plugs

Order no. **574178**

Basic Principles of Electrical Installations TP 1121

Introduction to Planning and Implementation



The equipment set provides an introduction to the planning and implementation of electrical installations. The following circuits can be built for a variety of scenarios:
– Switch-off circuit
– Crossover circuit
– Series circuit
– Power surge circuit
– Staircase lighting timer circuits
– Various two-way circuits

All with and without junction box and plug socket circuits.

Training content
– Planning and normative principles
– Circuit diagrams and circuit symbols
– Basic circuits
– Teaching through practical project tasks

Advantages
– Complete function range
– Easy, fast and reliable setup
– Work book with theoretical part and project tasks

Features
– Front panel with multicolored, scratch-resistant front print
– Graphics with division into didactic function blocks
– Rear hood for use in A4 frame or as upright table unit
– All connections are equipped with 4 mm or 2 mm safety sockets
– PE conductor system which is unmistakable with 4 mm safety cables, adapters are removable

Complete Equipment Set TP 1121	**8105156**

The most important components at a glance:

1	1x	Basic Circuits in Installation Engineering I EduTrainer	8085468
2	1x	Basic Circuits in Installation Engineering II EduTrainer	8085560

Necessary accessories, also order:

4 mm Safety Laboratory Cables (page 53)
Safety Jumper Plugs (page 54)

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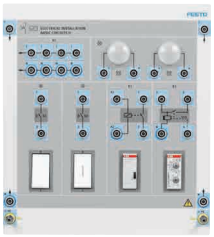


Basic Circuits in Installation Engineering I EduTrainer

Makes it possible to set up different basic circuits for electrical installation engineering.

Product features
- 2x Junction boxes with 7 multipole terminals
- 2x Lamps
- 2x Earth contact sockets
- 2x Toggle switch
- 1x Series switch
- 1x Crossover switch

Basic Circuits in Installation Engineering II EduTrainer
- Surge current and timer circuits (for stairwell lighting) with one or two actuation points and one or two lighting points
- Automatic stairwell lighting system with switch-off pre-warning
- The circuits can be set up with or without a junction box.

Product features
- 1x Junction box
- 2x Lamps
- 1x Pushbutton
- 1x Pushbutton, illuminated
- 1x Impulse relay
- 1x Automatic stairwell lighting system

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

de	8074437
en	8113396
es	8113397

Course on Festo LX:

→ Basic Principles of Electrical Installations

KNX Building Automation Training Kit New

KNK Suitcase	**8224190**

The most important components at a glance:
- KNX power supply
- KNX USB interface
- KNX IPsecure Router
- Switch actuator
- Binary input
- Blinds actuator
- Universal dimmer actuator
- Heating actuator
- Weather station
- Push button interface
- Tactile sensor
- Room controller with integrated temperature sensor

KNX, smart home and network: three learning topics in one system

The KNX Suitcase is a well-designed tool for training future KNX specialists.

The included KNX devices cover the content of the official EIB (European Installation Bus) courses while also supporting additional applications. All components come pre-wired to ensure safe and efficient training in schools and training centers.

With the integrated KNX IP Secure Router, multiple suitcases can be connected to simulate complex building scenarios.

Thanks to the open architecture, additional KNX devices from other manufacturers can be integrated into the system using the supplied adapter cable.

Learning goals
- Learn how to program and configure KNX/EIB
- Get to know the basics of network technology
- Learn the basics of automation with Smart Home
- Conduct handover meeting

Benefits
- Compact and mobile device, all components in view
- Component selection is based on the KNX certificate courses
- Versatile control
- Can be extended regardless of manufacturer

Smart Home New

TP 1135

Complete Equipment Set TP 1135	**8195654**

The most important components at a glance:
- Smart Home Control Unit
- Power Supply Raspberry Pi
- HDMI Cable (HDMI to Micro HDMI)
- Micro SD Card
- WLAN Schuko Socket
- EnOcean Button
- EnOcean Gateway
- USB Card Reader
- Access Point
- Systainer T-Loc Size 1

Building technology, smart and networked

The training package teaches how to connect intelligent devices to optimize energy efficiency and comfort in buildings across all technologies. It covers everything you need to know about Smart Home systems.

The program begins with an analysis of the building and the desired processes. From there, the necessary devices are selected, the processes are programmed, and the user interface is designed.

Data from various sources is collected and processed, and the open architecture allows for the integration of existing and future topics and concepts into your laboratory.

Learning goals
- Understand the basic structure of smart home systems
- Design data acquisition, transmission and processing with smart home components
- Select and integrate suitable smart home components
- Install a smart home system and linking different technologies
- Perform data backup and restore

Benefits
- Practical
- Open platform into which existing and future technologies can be integrated in the laboratory
- Supplied in a practical Systainer with organiser to protect the components

Recommended Learning Material

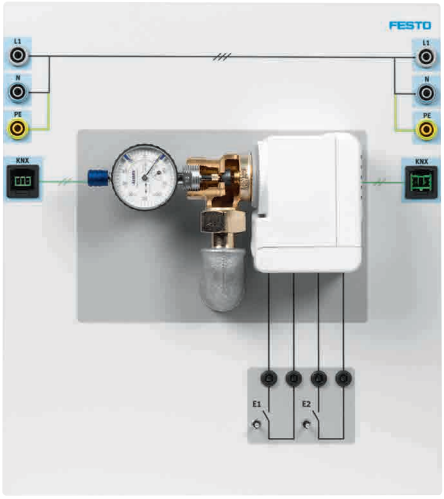
Workbook (→ page 262)

Campus license:

de	8224944
en	8224945

Course on Festo LX:
→ Smart Home

Complementary KNX Applications



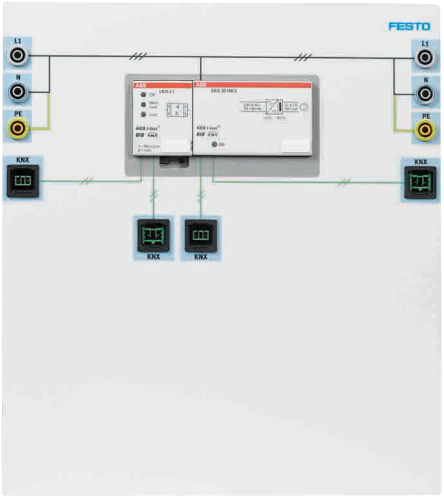
KNX EduTrainer Heating Actuator

The heating actuator controls the heating water circuits in heating systems. The interior of the valve is visible, and an integrated gauge shows the stroke of the plunger. The valve is supplied entirely via the KNX bus. Two binary inputs are available as presence and/or window contacts and can be controlled via switches or external signals. The plate also contains the KNX system distributor for 230 V.

The locations of all connections are standardised and are routed to safety sockets or system plugs.

Technical data
- Input voltage: 1 x 230 V AC
- Output voltage: 1 x 230 V AC
- Electric motor functional principle, automatic limit stop connection, controller stroke 6 mm, run-time < 20 s/mm, control force > 120 N
- Display of valve stroke via LEDs
- Gauge triggering: 0.01 mm
- Front panel: 266 mm x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs
- Connections for KNX bus via KNX bus plug connectors

Order no. **574175**



KNX EduTrainer Line Coupler

The line coupler connects the main and secondary line in a KNX systems. This also permits targeted filtering of signals. The main line is also equipped with a power supply. The plate also contains the KNX system distributor for 230 V.

The locations of all connections are standardised and are routed to safety sockets or system plugs.

Technical data
- Input voltage: 1 x 230 V AC
- Output voltage: 1 x 230 V AC
- Power supply EIB: 30 V DC, 160 mA
- Front panel: 266 mm x 297 mm
- Console housing with rubber feet for use in an A4 frame or on a table
- Connection via 4 mm safety plugs
- Connections for KNX bus via KNX bus plug connectors

Order no. **574176**

KNX Weather Station EduTrainer

The KNX Weather Station EduTrainer is an extension of the KNX learning system designed for capturing and processing four independent analog input signals from standard weather sensors measuring brightness, wind, temperature, and rain. Users can choose between real sensor signals, when connected to actual sensors, or simulated signals, with values adjustable via potentiometers. Programming and commissioning are carried out easily using the ETS software.

Features
- Integration of existing external sensors possible
- Covers all key building sensors with support for 0...10 V, 4...20 mA, PT100, and digital sensors
- Robust tabletop housing with rubber feet, also suitable for use in an A4 mounting frame

Technical data
- Input voltage: 115 V...230 V AC, 50/60 Hz
- Includes ABB WS/S4.1.1.2 KNX weather station module
- KNX bus connection
- Simulators for 0...10 V (brightness), 4...20 mA (wind), PT100 (temperature), and digital signals (rain)

Technical requirements
- Can only be used as an extension of an existing KNX installation
- Current ETS license required

Order no.	**8089827**

High-Power LEDs

TP 1144

The most modern and energy efficient way of lighting

Enables two different high-power LEDs to be connected in a circuit.

The high-power LED equipment set provides an introduction to high-power LEDs. It is possible to connect the lamps with LED driver for operation in photometric and energy investigations.

An 8-piece cable set for 2 mm connections and measurements is included with the equipment set.

Training content
- Method of operation of LEDs
- Industrial energy efficiency of LEDs
- Dimming LEDs
- Light and light temperature
- Taught using practical project exercises

Advantages
- Complete function range
- Easy, fast and reliable setup
- Work book with theoretical part and project tasks

Complete Equipment Set TP 1144	**8106866**

The most important components at a glance:

1	1x High-Power LED EduTrainer	8064069

Necessary accessories, also order:

4 mm Safety Laboratory Cables (page 53)	
Safety Jumper Plugs (page 54)	
Light Meter	8064082
Color Card Set	8087222

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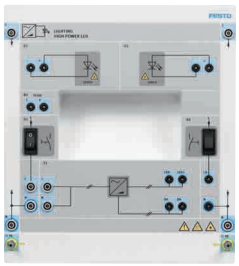


Product features
- 1x High-power LED warm white
- 1x High-power LED cold white
- 1x LED driver with DALI
- 1x Switches
- 1x Pushbutton

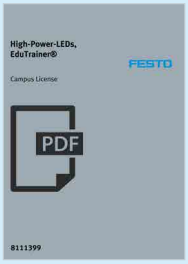
Features
- Front panel with multicolored, scratch-resistant front print
- Graphics with division into didactic function blocks
- Rear hood for use in A4 frame or as upright table unit
- All connections are equipped with 4 mm or 2 mm safety sockets
- Removable adapter for PE conductor plug-in system which cannot be swapped over

Color Card Set
The color cards allow subjective assessment of color rendering and legibility under different light sources.
- Set of 12
- Delivery in the storage system
- Easy to use
- For the subjective evaluation of light sources of different types

Light Meter
The device is used to record technical light quantities during experiments on lighting technology.
- Compact handheld measuring device
- Easy to use
- Various measurements of photometric parameters

Recommended Learning Material

Workbooks (→ page 262)



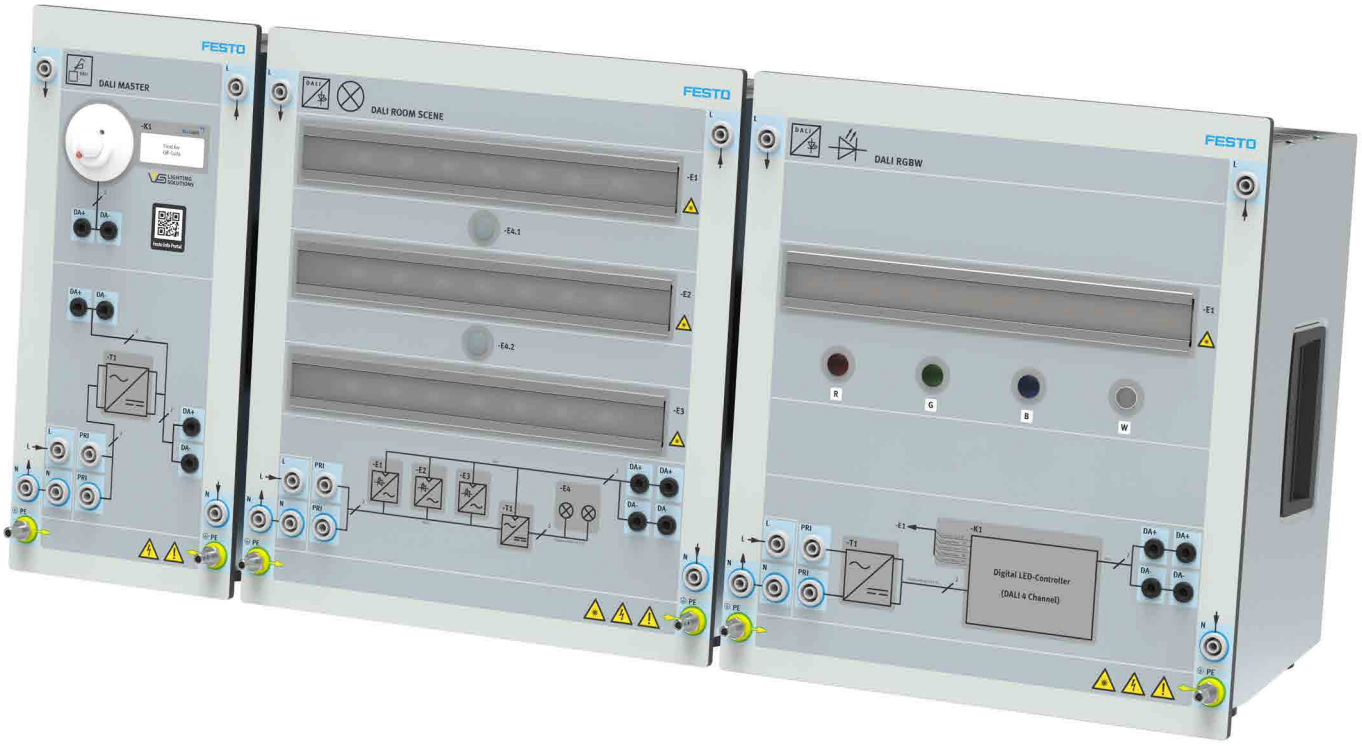
Campus license:

en	8111399
de	8074440
es	8111400

Course on Festo LX:
→ High-Power LEDs

DALI Lighting Control New

TP 1145



Intelligent and flexible digital control of lighting systems in commercial or industrial environments

With the DALI lighting control training package, topics such as lighting control with DALI, light scenes and color mixing can be taught in a compact and clear way.

The clearly arranged and compactly designed room lighting modules DALI Master, DALI Room Scene and DALI RGBW can be used to create light scenes as well as emergency lighting scenarios.

The system presents additive color mixing in an understandable way. The mixing ratio can be displayed directly thanks to the additional individual color LEDs. An integrated presence and light sensor expands the training content to include topics such as control through presence checks and light readjustment.

Training content
- Understand and implement the DALI bus system
- Design light scenes
- Set up scene controls
- Control light scenes with presence and motion sensor
- RGBW color control

Advantages
- Can be used in an A4 frame or as a desktop device
- Front plate prepared as a learning aid
- Many different light scenes in white or color
- Presence and motion sensor included

Complete Equipment Set TP 1145	**8204768**

The most important components at a glance:

1	1x DALI Master	8192081
2	1x DALI Room Scene	8191319
3	1x DALI RGBW	8192583

Necessary accessories, also order:

4 mm Safety Laboratory Cables (page 53)		
Safety Jumper Plugs (page 54)		
4	KNX/DALI Gateway	8194015

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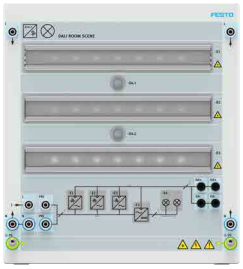

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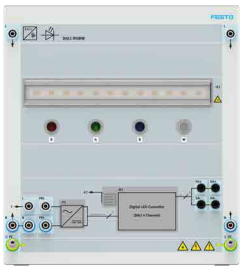

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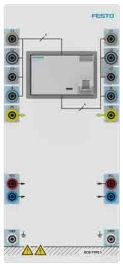


DALI Master
The A4 module DALI Master controls the entire DALI lighting system. It controls the DALI light scenes. The integrated fixed power supply supplies the DALI bus with power. The integrated presence and light sensor offers additional training content.

DALI Room Scene
The A4 DALI Room Scene module enables the implementation of different lighting scenarios in rooms with three LED light strips and emergency lighting with two LED light points. The LED light strips are controlled via three DALI LED drivers. The emergency lighting is operated with another DALI LED driver. The A4 module can be connected to a DALI bus via the DALI bus connector sockets. Control is via an external DALI master.

DALI RGBW
The A4 DALI RGBW module enables the lighting color to be adjusted to the lighting task using additive color mixing. Control is conducted via the DALI bus. An RGBW LED light strip is installed in the A4 module, which can reproduce the four colors R (red), G (green), B (blue) and W (white) individually or in combination. A 4-channel DALI LED controller is installed as the control unit, and is used to control the RGBW LED light strip as a multifunctional control unit. The device can be connected to a DALI bus via the DALI bus connector sockets. Control is via an external DALI master.

KNX/DALI Gateway
The A4 module KNX/DALI Gateway connects DALI lighting systems with KNX building automation. It can control up to 64 DALI or DALI-2 devices, and support up to 16 lighting groups and 16 scenes. The power supply for the DALI bus is already integrated.

Recommended Learning Material

Workbook (→ page 262)

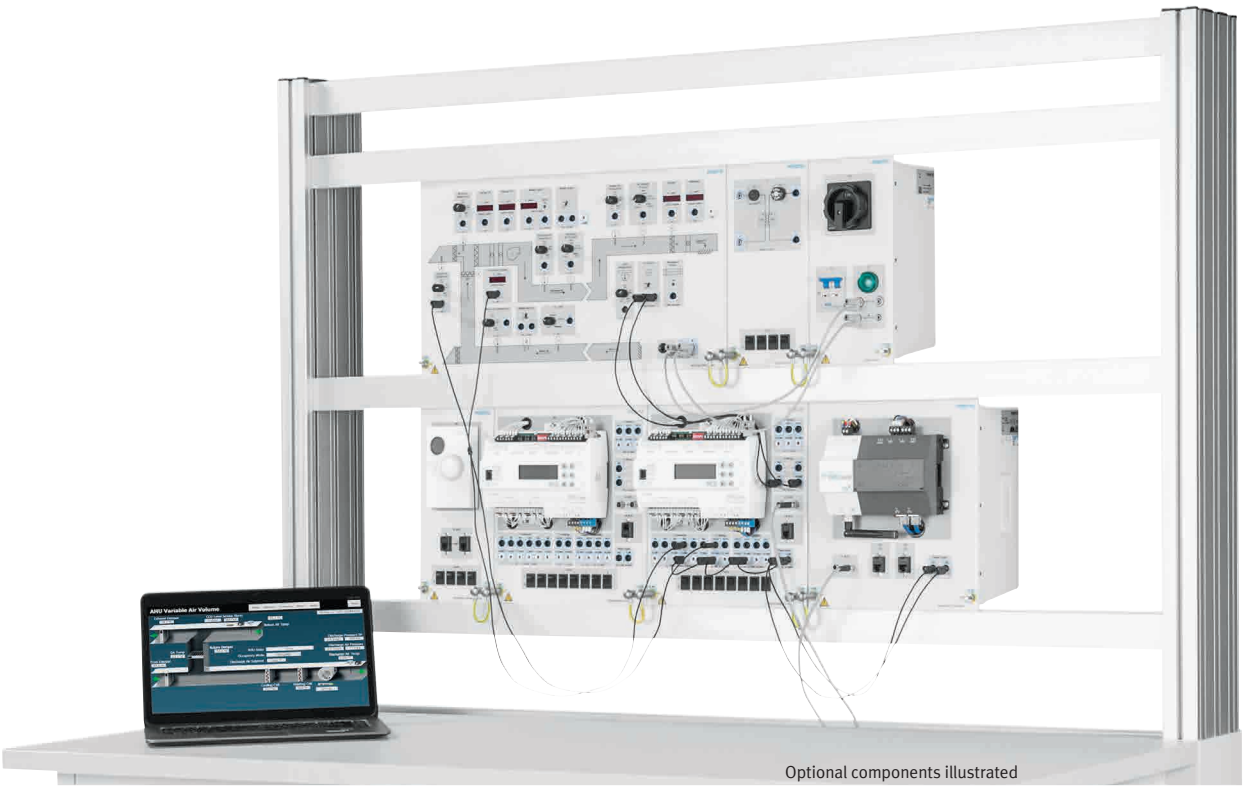
Campus license:

de	8224951
en	8224952

Course on Festo LX:
→ DALI

Building HVAC Controls

Building Management Systems in the Digital Age



Optional components illustrated

Building management systems in the digital age

Modern HVAC systems contain a wide range of technologies and complex control systems. In order to ensure smooth and efficient operation, installation and maintenance engineers must possess an in-depth understanding of how these systems work. Our learning system provides the perfect foundations for teaching this knowledge and providing practical training using real-life components.

Practical training

The Building management systems learning system is the ideal medium for teaching the basics of modern control systems to the level required for training in the field of HVAC. The system possesses industry-standard components provided by Johnson Controls, a world-renowned manufacturer.

Web-based supervisory controller

A built-in web server that acts as an HMI interface can be used to access all the system data in real time via LAN or WLAN. The graphic overview enables the students to keep an eye on the ventilation system and ventilation shafts at all times. Other special functions include time sequence control, forecast displays and alarm management.

Simulated signals, real control

The HVAC system plan module models a typical air conditioning system with simplified building ventilation shafts. This provides the foundation for the learning system. This module can be used to easily simulate change in temperature, pressure and carbon dioxide concentration. It also contains simulated flaps, cooling and heating equipment, fans and humidifiers.

The module's sensor and actuator simulations are connected to a real field controller. This gives the students practical experience of how an HVAC control system responds to changes in conditions. The field controller's control algorithm has been optimized to speed up the processes modeled in the system.

Topic coverage

- Structure of an HVAC system for a commercial building
- Components of the Direct Digital Control building automation system DDC-GA
- Introduction to network architecture (BACnet MS/TP)
- Field controllers
- Supervisory controller and HMI
- Temperature and humidity control of constant air volume systems (CAV)
- Pressure-dependent and pressure-independent variable air volume systems (VAV)

Building HVAC Control Learning System (230 V, 50 Hz)	**594538**

The most important components at a glance:

1	Building HVAC Layout	594518
2	Supervisory Controller	594519
3	2x Programmable Controller	8216205
4	Temperature Network Sensor	594517
5	Control Transformer	594515
	Programmable Controller Software	588274

Additional equipment required, also order:

Connection Leads for HVAC Controls	594520
Power Source	594513
Multimeter*	588288

* Or equivalent

Building HVAC Control Learning System (120 V, 60 Hz)	**594537**

The most important components at a glance:

1	Building HVAC Layout	594518
2	Supervisory Controller	594519
3	2x Programmable Controller	8216205
4	Temperature Network Sensor	594517
5	Control Transformer	594514
	Programmable Controller Software	588274
	Multimeter	588288
	Power Source	594512
	Connection Leads for HVAC Controls	594520

Necessary accessories* for both learning systems, also order:

1x	Table	587645
1x	Tabletop Workstation (DIN A4)	8153360
1x	Tabletop Double-Sided Workstation (DIN A4)	8158409

Also required: PC running Windows 10 Pro or more recent

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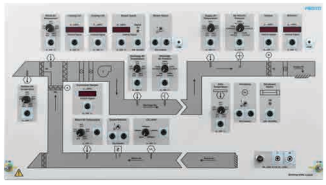

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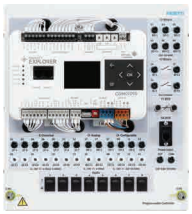

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Recommended Learning Material

Workbooks (→ page 262)

Campus license:

de	793120
en	793119
es	793122

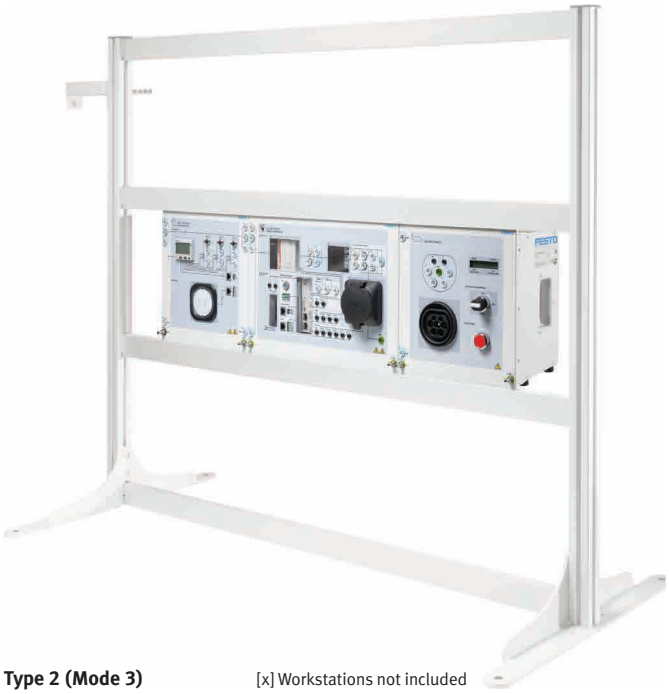
Course on Festo LX

→ Building HVAC - Direct Digital Control

Electric Vehicle AC Charging Stations New

→ Video

Type 1 (Level 2)



Type 2 (Mode 3)

[x] Workstations not included

Master the key skills required to keep AC charging stations operational.

The learning system is designed to train future EVSE technicians and electricians. It helps them develop skills in commissioning, troubleshooting, and maintaining charging stations through hands-on practice using industry-standard procedures and tools.

The hardware supports the "Electric Vehicle AC Charging Stations" course, with activities and learning objectives inspired by leading industry certifications from SAE International and EVITP.

The Electric Vehicle AC Charging Station features four modules, each representing essential components and systems found in typical Electric Vehicle Supply Equipment (EVSE). Learners interconnect, commission, and test components to ensure a thorough understanding of the system formed by the EV and the charging station.

The hardware meets key industry standards (SAE J1772 for Type 1 and IEC 61851-1 for Type 2) and OCPP 1.6J. The controller is compatible with the ISO 15118 standard. This opens the possibility for future integration of advanced features such as Vehicle-to-Grid, Smart Charging, and Plug and Charge.

Fault switches and multiple test points allow learners to experience various troubleshooting scenarios. The modules can be used on a tabletop or installed into a workstation equipped with standard DIN A4 rails. Several charging stations can be connected to emulate a charging network, allowing the study of load management strategies.

Benefits

- Realistic, industry-aligned training builds essential skills with a focus on problem solving.
- Ready-to-use course materials expedite lesson planning and facilitate topic integration into training programs.
- Intuitive hardware design and well-structured multimedia resources engage learners effectively.
- Modern, scalable laboratory equipment allows for flexible and advanced learning scenarios.
- Emphasis on EV-EVSE interactions fosters a solid understanding of the dynamics of EV charging systems.

Learning goals

- Identify key components of residential and commercial AC charging stations and understand their interactions.
- Follow a commissioning procedure and acquire systematic troubleshooting techniques to address common issues.
- Use specialized instruments to measure, observe communication signals, and test installations.
- Explore load management strategies when several charging stations are on the same electrical supply.
- Understand the scope and applications of ISO 15118 and the role of the Open Charge Point Protocol (OCPP).

Electric Vehicle AC Charging Station, Type 1	**8225433**

Designed for countries with Level 2 AC charging stations compatible with standard SAE J1772, mainly North America and Japan. Note that this learning system features an SAE J1772 connector, but the course's theory and experiments apply to both J1772 and NACS/ Tesla (SAE J3400) Level 2 charging.

The most important components at a glance:

1 Electric Vehicle Supply Equipment, Type 1	8218281
2 EVSE Metering and Authentication, Type 1	8218285
3 Electric Vehicle, Type 1	8218288
4 Split-Phase Power Supply	8234496
5 EVSE Tester, Type 1	8225208
Oscilloscope and Probes, Type 1	8225428

Necessary accessories for Type 1, also order:

Extech EX510 Digital Multimeter	579782

Electric Vehicle AC Charging Station, Type 2	**8225432**

Designed for countries with Mode 3 AC charging stations compatible with standard IEC 61851, mainly Europe, several countries in Asia, South Africa and Australia.

The most important components at a glance:

6 Electric Vehicle Supply Equipment, Type 2	8218283
7 EVSE Metering and Authentication, Type 2	8218286
8 Electric Vehicle, Type 2	8218289

Necessary accessories for Type 2, also order:

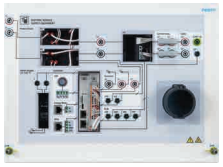
9 Module 3AC Power Supply and Safety Unit (or equivalent)	594826
10 EVSE Tester, Type 2	8160048
Oscilloscope and Probes, Type 2	8225429
Extech EX510 Digital Multimeter	579782
Safety Laboratory Cables (2 mm and 4 mm)	On request
Protective Conductor Connecting Cable with Special Socket	On request

Optional accessories for both types:

Table	587645
Tabletop Workstation (DIN A4)	8153360
Tabletop Double-Sided Workstation (DIN A4)	8158409

Note: The modules can also be used as tabletop devices.

1



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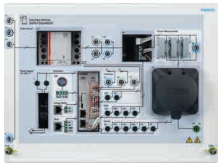

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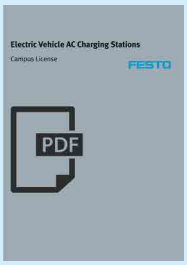
Recommended Learning Material

Workbook



Campus licenses:

Type 1, en	8236774
Type 1, de	On request
Type 2, en	On request
Type 2, de	On request

Note: Printed workbooks available upon request.

Course on Festo LX

→ Electric Vehicle AC Charging Stations

Solar Thermal Learning System

Electrical Panel (120 V and 230 V)

Back of the system

Expertise in building systems that convert solar power into heat

This didactic solar hot-water heating system teaches students the basic principles of thermal energy, and how it can be collected, stored, and supplied.

This learning system enables students to set up various realistic heating systems, such as radiant floor heaters, passive and active solar water heaters, space heaters, and hot water heat exchangers. They learn how to install the system components, operate the system, and measure different parameters, such as pressure, temperature, and flow rate.

The use of a small-scale hot water supply, a radiator, and a hydronic floor heating system, teaches students how solar radiant energy can be harnessed from the sun and converted to solar thermal energy in order to increase air, water, and surface temperatures in residential, commercial, and industrial buildings. It can be configured to exchange and store thermal energy. The system permits experimenting with open- and closed-loop heating systems. The main (primary) loop collects thermal energy while the secondary loop distributes and applies heat to a gas, liquid, or solid in order to dissipate the thermal energy.

Topic coverage
- Thermal Energy Fundamentals
- Trainer Familiarization and Safety
- Site Analysis
- System Sizing
- Solar Heating and Cooling Systems
- Collecting Thermal Energy
- Storing/Exchanging Thermal Energy
- Supplying/Controlling Thermal Energy
- Familiarization and Safety
- Closed-Loop Surface and Air Heating, Drain-Back Systems, and Combination Systems

Advantages
- Includes everything required to operate as a stand-alone, hands-on learning system
- Made with high-quality components currently used in residential, commercial, and industrial applications
- Easy and safe to use, durable, and manufactured to the highest quality standards
- A fixed-plate electrical panel allows all electrical devices to be securely fixed to the workstation side with a power
- Two control strategies: manual or digital thermostats
- Comprehensive curriculum consisting of fully illustrated student manuals and instructor guides

Solar Thermal Learning System, 120 V, 60 Hz	**8046647**
Solar Thermal Learning System, 230 V, 50 Hz	**8046646**

Main components, at a glance:
1x Solar Thermal Workstation with Electrical Panel
2x Analog Thermometer
2x Pressure Relief Valves
1x Plate Heat Exchanger
1x Check Valve Assembly with Two Drain Valves
2x Circulator Pump
1x Temperature Sensor
2x Expansion Tanks
1x Automatic Air Vent
1x Radiant Floor
2x Fill Bowl
1x Hoses and Accessories
1x Halogen Work Light
1x Multimeter
2x Hand-Operated Two-Way Valves
1x Radiator
2x Rotameter

Necessary accessories, also order:

IEC power cable (Page 14)	

Other accessories:

Evacuated Tube Solar Collector	8046648

Evacuated Tube Solar Collector
The Evacuated Tube Solar Collector is an add-on for the Solar Thermal Learning System that permits the heating of water through the tubes and the observation of the effects on the water temperatures. Its function is to replace the standard flat panel solar collector of the Solar Thermal Learning System.

Recommended Learning Material

Workbooks (→ page 262)

Campus license:

en (Imperial units)	8060788
en (SI units)	8060789
fr	8060790
es	8060791
de	8060792

Note: The campus license includes the student and instructor PDF versions of the following workbooks: “Introduction to Solar Thermal Energy”, “Solar Thermal Energy Systems”, and “Multi-Loop Systems”. Printed workbooks available upon request.

Courses on Festo LX
- → Introduction to Solar Thermal Energy
- → Solar Thermal Energy Systems
- → Multi-Loop Systems

Solar and Wind Energy Learning Systems

[X] Complete system illustrated with optional components

Provide hands-on experience in the installation, operation, maintenance, and servicing of solar and wind power systems

The Solar/Wind Energy Learning System is a modular program that covers the history, fundamentals, installation, operation, maintenance, and servicing of alternative energy systems.

Students learn how to install the system components, operate the systems, and measure the different parameters important to the production of energy from solar and wind power

The system features a stand-alone, hands-on learning workstation with solar and wind energy power-generating equipment, training modules with fault-insertion capabilities, as well as complete course material for students and teachers.

The learning systems explore sunlight and wind as energy sources that can be used to help reduce dependence on nonrenewable fuel sources. It helps students gain a complete perspective of the field by studying the economics, efficiency, and low-environmental impact of producing energy from non-polluting, renewable sources

Topic coverage
- History of solar and wind power
- Safety practices, lockout/Tagout procedure, and proper grounding
- Basics of energy, including energy sources, power, work, measurements, and units
- Operation of diversion loads, controllers, inverters, and hybrid generators
- Basic principles of power consumption, efficiency, transmission, and distribution
- Troubleshooting
- Solar module and wind turbine siting
- Loading, charge controllers, battery banks

Advantages
- Includes everything required to operate as a stand-alone, hands-on training system
- Made with high-quality components currently used in residential, commercial, and industrial applications
- Easy and safe to use, durable, and manufactured to the highest quality standards
- Perforated work surfaces to allow custom configurations
- Comprehensive curriculum consisting of fully illustrated student manuals and instructor guides
- CSA/UL certified version available
- Identified wires allow students to save time
- Networked data acquisition available as an option

Solar/Wind Energy Learning Systems (LabVolt 46120-0)

This learning system forms a complete, hybrid renewable energy production unit that teaches students how solar panels and wind turbines are used in today's domestic and industrial installations.

	en	es	fr
120 V, 60 Hz	**580181**	**580182**	
220 – 230 V, 50 Hz	**580183**	**580184**	**8123723**
240 V, 50 Hz	**580185**		

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

Main components, at a glance:
1x Solar/Wind Energy Mobile Workstation
1x Battery Bank
1x Battery Bank Junction Box
2x Electrical AC Outlet
3x Ammeter
1x DC Power Distribution Panel
2x Horizontal-Mount Disconnect Switch
2x Vertical-Mount Disconnect Switch
1x Diversion Load Controller
1x Dump Load
3x DC Circuit Breaker
2x kWh Meters with AC Circuit Breaker Box
4x AC/DC Wall Switch
1x Lockout/Tagout Module
1x Power Bus Bar
1x Power Inverter
1x Solar Charge Controller
1x Stop Switch
2x DC Lamp Socket
1x Photovoltaic Module Assembly
1x Wind Turbine Generator with DC Motor
1x Solar Array Junction Box
1x Sun Simulator Assembly
1x DC Motor Controller
1x Accessories Package
1x Connection Cables Kit
1x Power Usage Monitor
1x Multimeter

Recommended accessories:

Network Data Acquisition	580197
Outdoor Solar Module	580186
Outdoor Wind Turbine Module (page 219)	

Recommended learning material: Page 268

Solar Energy Learning Systems (LabVolt 46120-F)

This learning system is a variant of the complete Solar/Wind Energy Learning System. It features the equipment required for teaching the principles of electrical energy production from solar power.

	en	es	fr
120 V, 60 Hz	**580189**	**589109**	
220 – 230 V, 50 Hz	**580190**	**580191**	
240 V, 50 Hz	**589131**		

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

Main components, at a glance:
1x Solar/Wind Energy Mobile Workstation
1x Battery Bank
1x Battery Bank Junction Box
2x Electrical AC Outlet
3x Ammeter
1x DC Power Distribution Panel
2x Horizontal-Mount Disconnect Switch
2x Vertical-Mount Disconnect Switch
1x Diversion Load Controller
1x Dump Load
3x DC Circuit Breaker
2x kWh Meters with AC Circuit Breaker Box
4x AC/DC Wall Switch
1x Lockout/Tagout Module
1x Power Bus Bar
1x Power Inverter
1x Solar Charge Controller
2x DC Lamp Socket
1x Photovoltaic (PV) Module Assembly
1x Solar Array Junction Box
1x Sun Simulator Assembly
1x Accessories Package
1x Connection Cables Kit
1x Power Usage Monitor
1x Multimeter

Recommended accessories:

Network Data Acquisition	580197
Outdoor Solar Module	580186

Recommended learning material: Page 268

Solar and Wind Energy Learning Systems

Wind Energy Learning Systems (LabVolt 46120-G)

This learning system is a variant of the complete Solar/Wind Energy Learning System. It features the equipment required for teaching the principles of electrical energy production from wind power.

	en	es	fr
120 V, 60 Hz	**580193**	**589108**	
220 – 230V, 50 Hz	**580192**		
240 V, 50 Hz	**589130**		

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

Main components, at a glance:
1x Solar/Wind Energy Mobile Workstation
1x Battery Bank
1x Battery Bank Junction Box
2x Electrical AC Outlet
3x Ammeter
1x DC Power Distribution Panel
2x Horizontal-Mount Disconnect Switch
2x Vertical-Mount Disconnect Switch
1x Diversion Load Controller
1x Dump Load
3x DC Circuit Breaker
2x kWh Meters with AC Circuit Breaker Box
4x AC/DC Wall Switch
1x Lockout/Tagout Module
1x Power Bus Bar
1x Power Inverter
1x Stop Switch
2x DC Lamp Socket
1x Wind Turbine Generator with DC Motor
1x DC Motor Controller
1x Accessories Package
1x Connection Cables Kit
1x Power Usage Monitor
1x Multimeter

Recommended accessories:

Network Data Acquisition	580197
Outdoor Wind Turbine Module (page 219)	

Recommended learning material: Page 268

Solar/Wind Energy Learning Systems, UL/CSA Certified (LabVolt 46120-H)

This learning system forms a complete, hybrid renewable energy production unit fully UL/CSA certified that teaches students how solar panels and wind turbines are used in today's residential and industrial installations.

	en	es	fr
120 V, 60 Hz	**580195**	**589107**	

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

Main components, at a glance:
1x Solar/Wind Energy Mobile Workstation
1x Battery Bank
1x Battery Bank Junction Box
2x Electrical AC Outlet
3x Ammeter
1x DC Power Distribution Panel
2x Horizontal-Mount Disconnect Switch
2x Vertical-Mount Disconnect Switch
1x Diversion Load Controller
1x Dump Load
3x DC Circuit Breaker
2x kWh Meters with AC Circuit Breaker Box (UL/CSA Certified)
4x AC/DC Wall Switch
1x Lockout/Tagout Module
1x Power Bus Bar
1x Power Inverter
1x Solar Charge Controller
1x Stop Switch
2x DC Lamp Socket
1x Photovoltaic (PV) Module Assembly
1x Wind Turbine Generator with DC Motor
1x Solar Array Junction Box
1x Sun Simulator Assembly
1x DC Motor Controller
1x Accessories Package
1x Connection Cables Kit
1x Power Usage Monitor
1x Multimeter

Recommended accessories:

Network Data Acquisition	580197
Outdoor Solar Module	580186
Outdoor Wind Turbine Module (page 219)	

Recommended learning material: Page 268

Networked Data Acquisition System

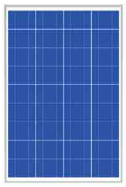
This optional component for the Solar/Wind Energy Learning Systems features the Networked Data Acquisition Interface (illustrated) allows remote monitoring of the power and energy levels measured in the learning systems. The measured data is transmitted using a wide area network (WAN) or a local area network (LAN).

Users can view in real time electrical, environmental, and ecological data via an internet or an intranet connection from most common web browsers. Up to 30 users can access the data simultaneously.

Additional sensors are provided to make environmental measurements: a silicon-cell photodiode pyranometer, a leveling plate, and an anemometer. Interconnection cables are also included.

Order no.	**580197**

This product cannot be ordered or delivered in countries that require compliance to CE regulations.



Outdoor Solar Module

This optional component for the Solar/Wind Energy Learning Systems features a photovoltaic panel being able to produce up to 90 W of electrical power at a nominal voltage of 12 V.

Order no.	**580186**

This product cannot be ordered or delivered in countries that require compliance to CE regulations.

Outdoor Wind Turbine Module

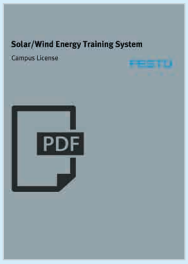
This optional component for the Solar/Wind Energy Learning Systems. It consists of a wind turbine generator and a 8.84 m (29 ft) EZ Tower Kit or a 8.23 m (27 ft) Air-Guyed Tower Kit. The tower kit comprises all the hardware required to erect the tower, such as pipes, anchors, and cables, except anchors, pipes, and concrete.

8.84 m (29 ft)	**580187**
8.23 m (27 ft)	**580188**

This product cannot be ordered or delivered in countries that require compliance to CE regulations.

Recommended Learning Material

Workbooks (→ page 262)



Campus license:

en	580560
es	8107373

Notes: The campus license includes the student and instructor PDF versions of the following workbooks: “Going green”, “Energy Fundamentals”, “Solar/Wind Systems”, “Solar Module”, and “Wind Turbine”. Printed workbooks available upon request.

Courses on Festo LX

- → Going Green
- → Energy Fundamentals
- → Solar/Wind Systems
- → Solar Module
- → Wind Turbine

Complementary Areas of Expertise

Industrial Trades
Mechanical Drives Learning System 222
Industrial Pumps Learning System 228

Factory Automation
Smart Sensors 230
Networks and IT Security 220
SkillsConveyor 234
Learning Factories 236

PLC Programming
EduTrainer 238
PLC Suitcase 240
Advanced PLC Learning System 241

Process Automation 242

Pneumatics and Hydraulics 244

Wind Power
Wind Turbine Nacelle Learning System 246
Pitch Hub Learning Systems 248

Mechanical Drives Learning System

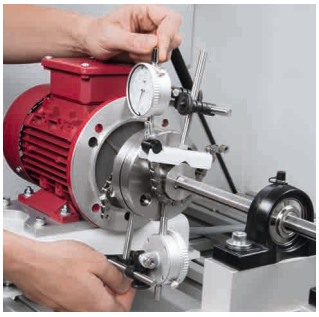
All the Basics of Industrial Mechanics

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

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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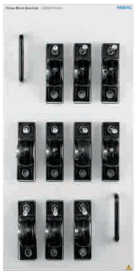

4

Recommended Learning Material

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 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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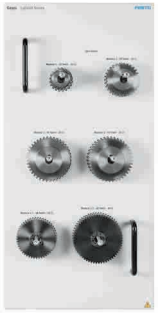

Recommended Learning Material

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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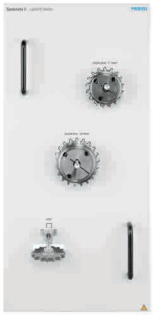


3

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.

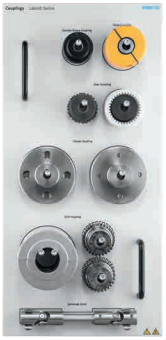
The topic “Bearings and seals” deals with the inner components of a machine. Using real applications such as a gearbox, a pump and a wheel hub, learners learn industry-proven methods for installing and removing bearings and seals in housings and on shafts. Essential concepts of bearings lubrication are 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

1



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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

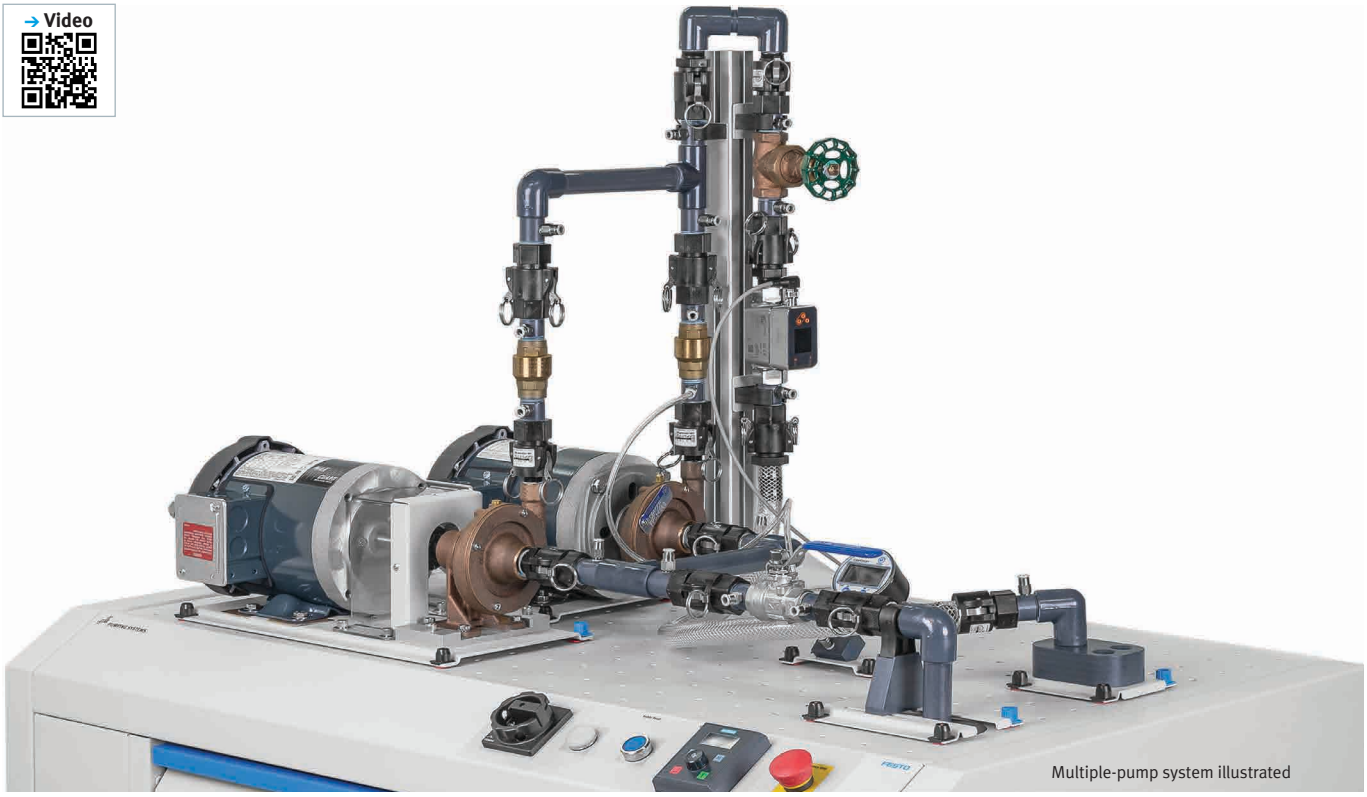
→ Clutches and Brakes

→ Ball Screws and Linear Bearings

Industrial 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

Optional pumps for Pump Performance:

Flexible impeller pump	8198312
Peristaltic pump	8198315
Magnetic-coupling centrifugal pump	8209796

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

Optional pumps for Positive-Displacement Pump Systems:

Progressive cavity pump	8198313
Pneumatic diaphragm pump	8198314
Multistage centrifugal pump	8209794
Vane pump	8209795

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
→ Flexible impeller pump
→ Progressive cavity pump
→ Pneumatic diaphragm pump
→ Peristaltic pump
→ Multistage centrifugal pump
→ Vane pump
→ Magnetic-coupling centrifugal pump

Smart Sensors TP 1312

Sensor Technology 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

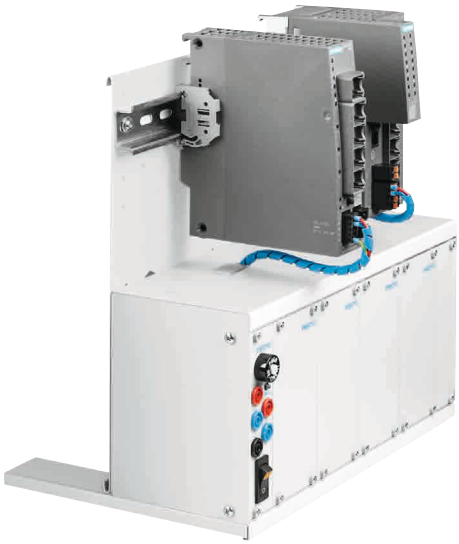
Note: Campus licenses include the student and the instructor PDF versions of the workbooks “Fundamental Principles of Smart Sensors”, “Smart IO-Link Interface”, and “PLC Integration of Smart Sensors”.

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 Festo NetLab Toolkit (NLTK) configuration software is available as part of the courseware and software package. It 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.

Complete Equipment Set TP 1333	**8106066**

The most important components at a glance:
– 2x EduTrainers with integrated electricity supply, a S615 router and a XC208 switch
– 1x Ethernet cable set

Also required, please order:

Downloadable courseware and software package, de	8075235
Downloadable courseware and software package, en	8084440
Downloadable courseware and software package, es	8107694
Downloadable courseware and software package, fr	8106097

The courseware and software package includes:
– 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

Also required: Two PLCs and two PCs

The 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)

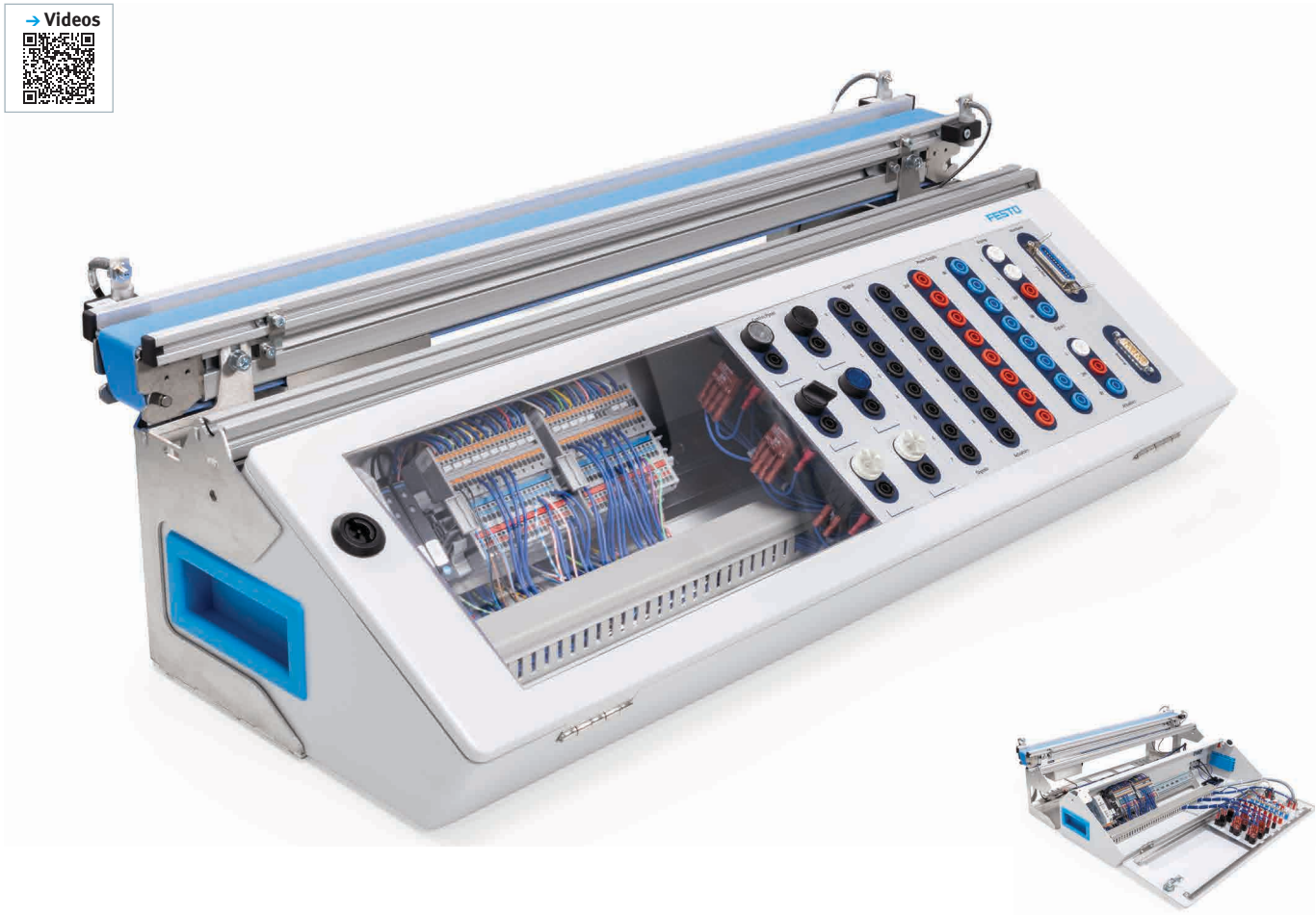
To complete the exercises in their entirety, two PLCs and two PCs are required. The PLC must allow external adjustment of IP address e.g. project with the “IP address is set directly at the device” setting. Alternatively, control with factory settings should be possible.

Special license rules apply for schools and educational institutes in the commercial sector.

SkillsConveyor

The Most Universal Training System for the Basics of Automation Technology

→ Videos



The SkillsConveyor is an integration-ready system, developed in close cooperation with customers. Its ergonomic belt is designed to support both single workpiece flow and pallet-based goods carrier flow.

Available pre-assembled or as a kit, the SkillsConveyor sets a new standard of modularity in terms of hardware, software, courseware and interfaces to other Festo Didactic learning systems.

It starts with the basics of installation and commissioning and continues up to hard-wired programmed control, PLC and LOGO! programming as well as DC and AC motor control technology. Other topics are taught.

Basic design
In its basic configuration, the SkillsConveyor consists of a 700 mm long conveyor belt driven by a DC motor. The motor controller is located next to a rail mounted terminal on a H-rail in the integrated control box. It can be flexibly removed from the front of the system – similar to a drawer. The front of the control box contains various operating elements and sockets which – depending on the training scenario – can be individually rewired by the students in the control box and labelled on the operator panel. At the beginning of the belt, there is a diffuse light sensor, at the end of the belt there is a light barrier, each for the detection of workpieces.

Learning kit
In the SkillsConveyor Kit version, the students build the SkillsConveyor step by step at the beginning of the learning process. In addition to the empty control box and the mounting rack for the belt, the mechanical and electrical components are supplied clearly sorted in reusable shadow boards. The mechanical construction is followed by the assembly and wiring of the control box and the sensors. Subsequently, the commissioning is carried out with a suitable controller.

Process
Incoming workpieces can be conveyed on the conveyor to various machining and measuring positions. An optional add-on package with sensors, actuator, and sensor bracket allows a variety of sensor types to be mounted for object detection, measurement and object classification.

Control box
The removable control box as an integrated control cabinet with control elements is the pivotal point of the learning environment. On a H-rail inside the control box are various rail mounted terminals for flexible wiring, the fibre-optic units for the diffuse light sensor and the light barrier as well as the motor controller.

SkillsConveyor

1 SkillsConveyor (pre-assembled/mounted)	**8184210**
2 SkillsConveyor Kit (unassembled/unmounted)	**8184211**

Expansion options

3 SkillsPackage Distributing and Sorting	8214783
4 Add-on SkillsPackage Stacking Magazine	8214782
AC Motor Package	8189526
AC Motor Package (North America)	8210443
EasyPort USB	548687
EduTrainer Compact LOGO!	8073774
EduTrainer S7-1512C	8065452
EduTrainer Compact Preferred Variant with SIMATIC S7-1215C	8096457
Sensors for Object Detection TP 1311	8150804
Smart Sensors TP 1312	8116358
Systainer for Shadow Boards	8193428
HMI MTP700	8222002
Basic Principles of Circuits with contacts TP 1211	8208247
Add-On Package SKC AC Motor Control (TP 1211)	8206252
Control Cabinet	8191357

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Wiring
The wiring of the system is flexibly achieved in the control box as an integrated control cabinet in free wiring via industrial terminals. This allows the greatest possible flexibility for rewiring within the learning process as well as the greatest possible degree of transparency and comprehensibility for the learner.

Extension options
Through various additional packages, the training system can be expanded step by step with targeted learning content.

Learning goals
- Mechanical construction, assembly, wiring and commissioning of a conveyor belt
- Basics of control cabinet technology and sensor technology and flexible use of industrial control elements
- Controlling a DC motor with a motor controller and wiring and controlling an AC motor (accessories required)
- GRAFCET basics, hard-wired programmed control (accessories required) and PLC programming basics (Siemens LOGO!, Siemens S7-1512) (accessories required)
- Integration and adjustment of digital and analog sensors and actuators, and advanced programming of mechatronic systems

Highlights
- Hands-on training and basic training on the topics of automation technology and mechatronics
- System ready to be integrated with other Festo Didactic learning systems
- Flexibly interchangeable actuators
- Reliable and safe system
- Extensive learning materials on Festo LX
- Available as a kit and as a pre-assembled version

Recommended Learning Material

Workbooks

Campus license
"Commissioning of the SkillsConveyor (unmounted)"

en	8191549
de	8191548
es	8193514
fr	8193515

Campus license
"Commissioning of the SkillsConveyor (mounted)"

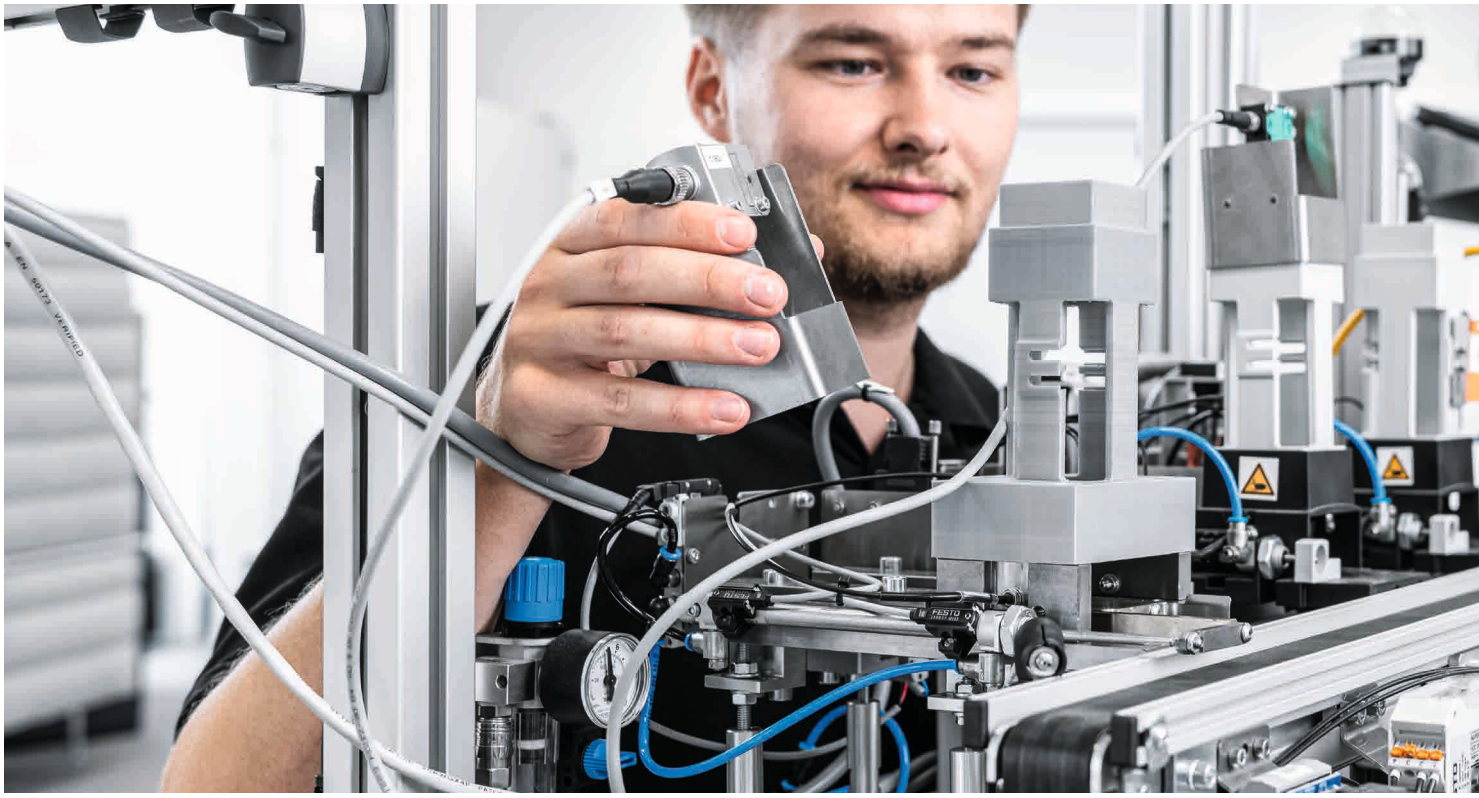
en	8188442
de	8188441
es	8193521
fr	8193522

Note: Campus licenses are available for most of the courses listed below. Contact your representative for details.

Courses on Festo LX
- → Commissioning of the SkillsConveyor (mounted)
- → Commissioning of the SkillsConveyor (unmounted)
- → Hard-Wired Programmed Control with SkillsConveyor and Control Cabinet
- → Wiring and Controlling an AC Motor
- → Basics of PLC Programming (Siemens LOGO!)
- → Basics of PLC Programming (Siemens S7-1512)
- → Applied PLC Programming and Sensor Technology
- → Basic Motor Control with SkillsConveyor and TP 1221
- → Hard-Wired Control with SkillsConveyor and TP 1211
- → Wiring and Control of an AC Motor with SkillsConveyor and TP 1211

Learning Factories

Practical Applications of Electrical Technology

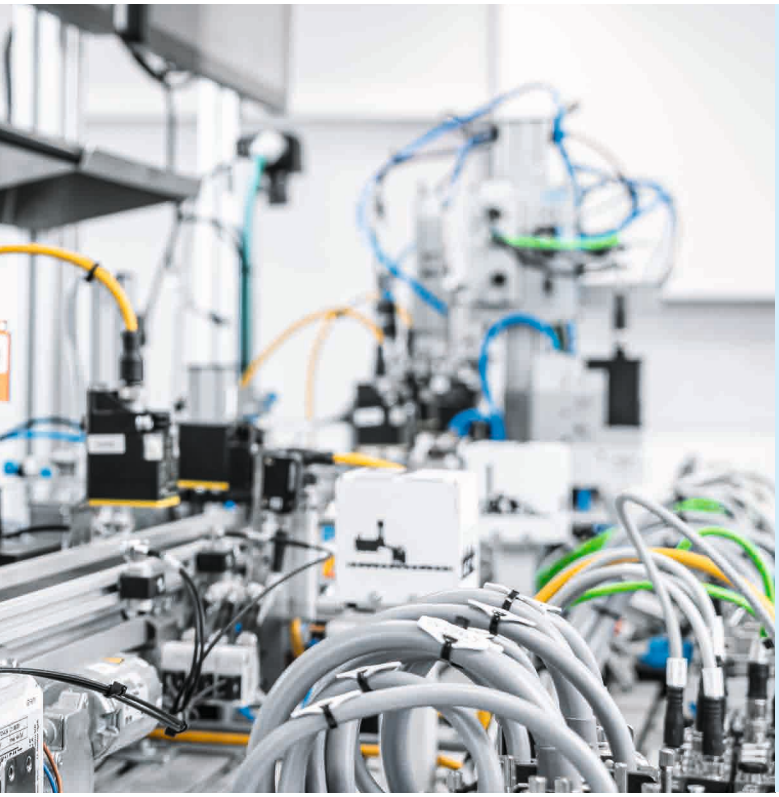


Learning factories give students in electrical technology and engineering programs the chance to experiment in a safe, controlled environment while engaging with real industrial equipment. This immersive experience also encourages collaboration, critical thinking, and a deeper understanding of how electrical technology drives modern manufacturing — preparing students for successful careers in evolving industrial environments.

Customization and expandability
The modularity of the learning factories offers unmatched flexibility and scalability. Educators can start small and expand step by step, choosing from several options to match their teaching goals, reconfiguring setups for different production scenarios, or combining them into complex lines. This adaptability makes them a future-proof investment that grows with evolving educational needs.

Real-life equipment
The learning factories incorporate industrial components and technologies from Festo and other leading manufacturers, providing a realistic learning experience. Most learning systems also offer hands-on practice with industry-standard communication protocols, Manufacturing Execution Systems (MES), PLC programming, smart sensors, and more.

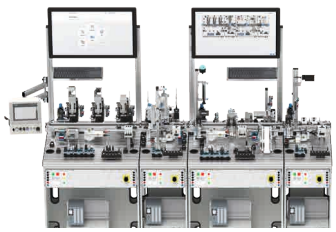
Learning support
Ready-to-use learning materials are available as multimedia courses on the Festo LX digital learning portal, or as printed or downloadable PDF workbooks. The courses emphasizes hands-on experimentation with the learning systems, while several purely digital eLearning courses complement practical training by deepening theoretical knowledge.



Electrical technology: the enabler of factory automation

Electrical technology is the backbone of factory automation, driving actuators, robots, and control systems that keep production lines efficient and reliable. It integrates sensors, circuits, and communication networks into seamless automated processes.

Thanks to learning factories, learners see how electrical knowledge applies directly to programming, troubleshooting, and maintaining automation. This hands-on experience builds expertise for optimizing production and contributing to smart factories and Industry 4.0.



Our **MPS 400** all-round training factories are based on an individual workpiece flow. They bring real-world production processes into the classroom. They combine mechatronics, robotics, and digitalization technologies to teach students how to plan, operate, and optimize smart manufacturing systems. They support hands-on learning in areas such as electrical engineering, automation, and Industry 4.0.

The CP Lab learning factories are based on a pallet transfer system and enable closed-loop layouts. They include all the technologies and components needed for conveying an in-depth knowledge of Industry 4.0. The modular and flexible design has a range of learning scenarios, from individual pallet transfer systems with integrated controller right up to a connected production system with cloud services.

Product Catalog Factory Automation

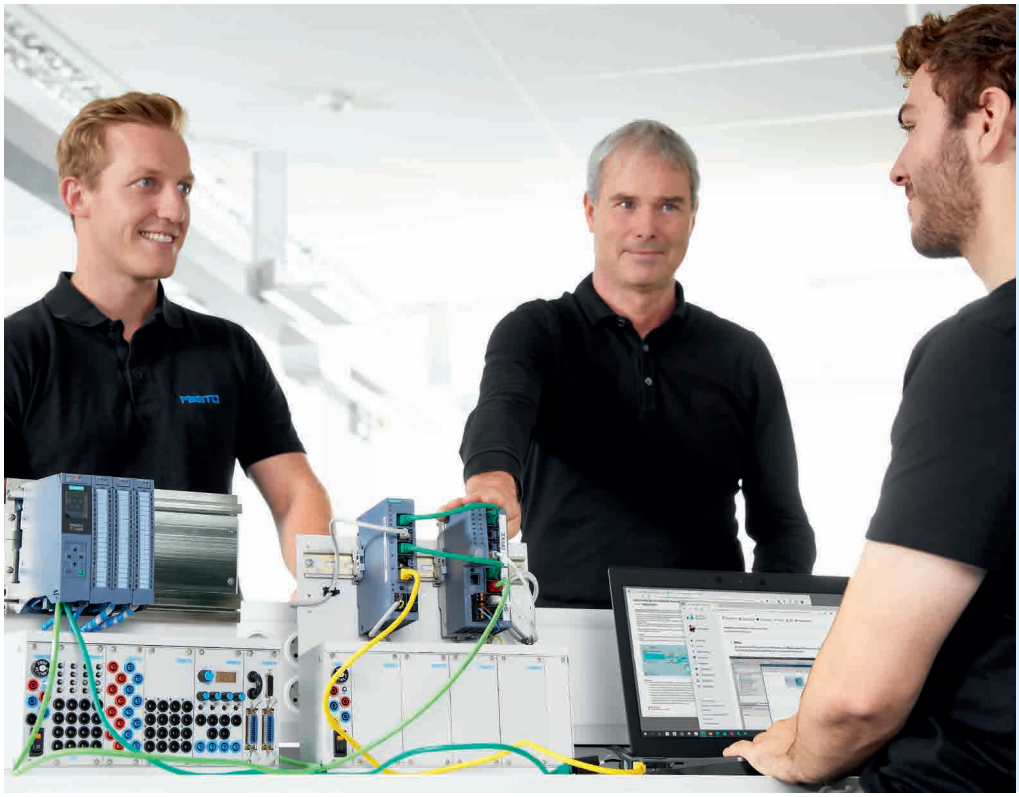
Find more information about the learning factories and our comprehensive offering of learning solutions in factory automation in our dedicated catalog.

In this catalog, you will find our complete range of learning solutions for basic and advanced training in:

– Mechatronics
– Robotics
– Industry 4.0 technologies
– Industrial control technology
– And more

Visit our website to browse and download the catalog:
→ To the catalog download page

EduTrainer Universal
PLC Programming



PLC programming: the brain of automated systems

PLC programming is at the heart of modern automation, controlling machines, processes, and industrial systems with precision and reliability. It links sensors, actuators, and control logic to ensure smooth, safe, and efficient operations.

Hands-on training with PLCs lets students apply electrical and electronics knowledge to real-world scenarios—designing programs, troubleshooting faults, and optimizing system performance. This practical experience prepares learners to contribute to smart factories and advanced industrial automation.

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, lie flat or stand on a table. 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
- 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. 8065595 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.	**8065595**

Necessary accessories, also order:

I/O data cable with SysLink connectors	
(IEEE 488), 2.5 m	34031
IEC power cable 90° → festo.com/didactic	

Recommended accessories:

Analog cable, parallel, 2 m	529141
Safety laboratory cable, 3 m	571817

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-QBFC1B
- 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.	**8022848**

Necessary accessories, also order:

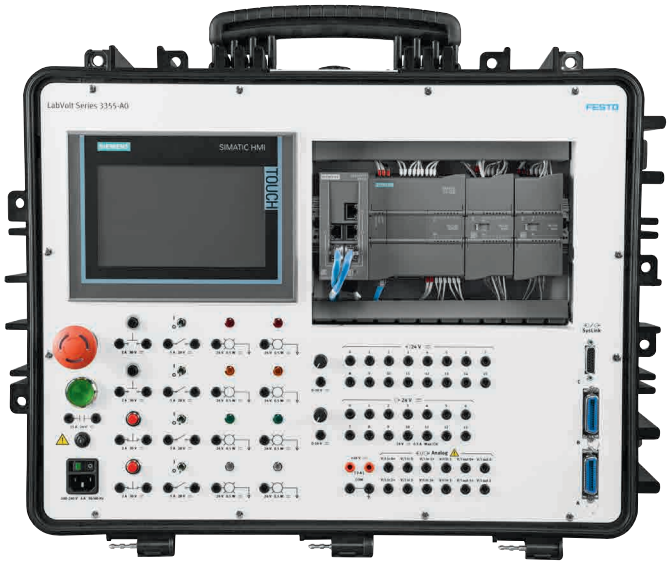
I/O data cable with SysLink connectors	
(IEEE 488), 2.5 m	34031
IEC power cable 90° → festo.com/didactic	
RSLogix5000	8034585

Recommended accessories:

Analog cable, parallel	529141
Safety laboratory cable, 3 m	571817

Advanced PLC Training System

Programming High-End PLCs and HMIs



Siemens version illustrated

Rockwell Automation version

LabVolt Series 3355

With the RA CompactLogix 5370 (120 – 240 V, 60 Hz)	**588969**
With the Siemens S7-1200 (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
Studio 5000 Logix Designer and FactoryTalk View Studio (for the CompactLobix PLC) or WinnCC (for the S7 PLC) → www.festo.com/didactic

Expansion options: PLC Applications (LabVolt Series 8075)

Electro-Pneumatic System (120 – 240 V, 60 Hz)	588682
Traffic Light (120 – 240 V, 60 Hz)	582533
Level Process (120 – 240 V, 60 Hz)	582544

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.

The PLC Applications are small-scale, realistic systems can be interconnected with the Advanced PLC Learning System or the PLC AB Micro-Logix 1400 with Case to develop student understanding of PLC programming.

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 trouble-shooting 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

Workbooks

Campus license:

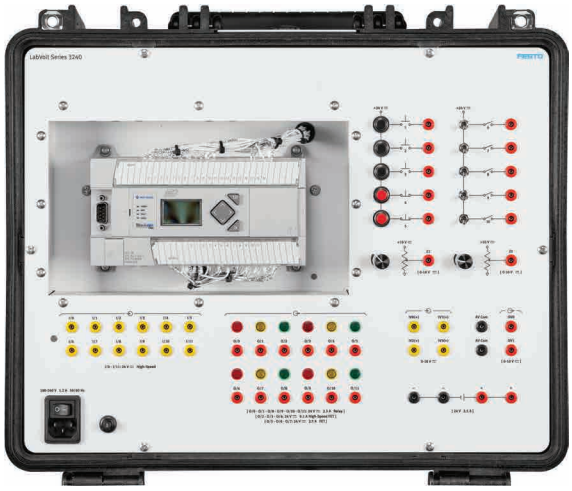
Rockwell Automation	589148
Siemens	8096774

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)

Programmable Logic Controller

AB MicroLogix 1400 with Case



LabVolt Series 3240-F

120 – 240 V, 60 Hz	**8208214**

Notes: 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.

Also required, please order
RSLogix Micro Software, Educational use (Order no. 587552)

The Programmable Logic Controller AB MicroLogix 1400 with Case is specially designed to help students develop skills in operating, programming, and troubleshooting modern PLC-controlled systems. Driven by an Allen-Bradley MicroLogix 1400 controller, the training module is fully supported by instructional material and is compatible with several didactic applications

Features and benefits
- Rugged suitcase for easy transportation and storage. Also include a storage compartment for cables and accessories
- Built-in 10/100 Mbps Ethernet/IP port for peer-to-peer messaging
- Eight fault switches
- Embedded Web server and LCD screen
- Possibility to navigate the web server pages to display levels of information
- Each controller supports 32 discrete I/O points (20 digital inputs, 12 discreet outputs) and 6 analog I/O points (4 analog inputs and 2 analog outputs)
- Input/Output data scaled for PID
- Five push-button and five toggle switches
- Compatibility with MicroLogix and SLC instruction set
- Programming the MicroLogix 1400 controller is done using RSLogix 500 / RSLogix Micro software

Learning topics
- Familiarization with the PLC Trainer and RSLogix Micro
- Online Operations and Monitoring I/O Data Files
- Relay Instructions
- Timer Instructions
- Counter Instructions
- Comparison Instructions
- Move Instructions
- Sequencer Instructions

Recommended Learning Material

Workbooks

Campus license

en	585276

Note: Campus licenses is offered in English only. They include the student and the instructor PDF versions of the workbook “Programmable Logic Controller”.

Course on Festo LX

→ Programmable Logic Controller – Basic Programming

Process Automation

Explore the Role of Electrical Technology in Instrumentation and Process Control

In batch processes, control and monitoring devices ensure each step of production runs safely and accurately. Sensors measure variables like temperature, pressure, flow, and level, while actuators—such as valves, pumps, and heaters—adjust the process as needed. Controllers, including PLCs and DCS systems, use this data to regulate operations, and monitoring tools like HMIs and SCADA systems let operators track progress and respond to issues. Together, these devices help students understand how electrical and control systems work in real industrial processes.

From basic to advanced topics
Our portfolio of learning systems in process automation are specifically designed for educational purposes, exposing learners to the techniques, systems, and components they will encounter in the workplace. This provides realistic, hands-on learning opportunities in a safe environment, where learners can experiment and make mistakes without affecting live production systems.

Depending on the scope of the learning systems chosen, learners can monitor and control flow, level, pressure, temperature, pH, and conductivity.

Industrial components
Training equipment incorporates components and technologies from leading industrial suppliers, including many smart devices that are increasingly part of modern systems, providing a realistic learning experience. Most systems also offer hands-on practice with industry-standard communication protocols, which are essential in today's connected industries.

Curriculum available
Ready-to-use learning materials are provided as multimedia courses on the Festo LX digital learning portal, or as printed and downloadable PDF workbooks.

The curriculum emphasizes hands-on experimentation with the learning systems, while several purely digital eLearning courses complement practical training by deepening theoretical knowledge.

Electrical technology: the backbone of process automation

Process control and industrial instrumentation bring electrical engineering and electronics to life by showing how electrical technology enables sensors, circuits, and control systems to measure, transmit, and regulate process variables safely, precisely, and automatically in real industrial processes.

Learners can apply their electrical expertise in these settings while learning to monitor, regulate, and optimize systems, gaining practical skills, solving real-world problems, and preparing for careers in industrial automation and Industry 4.0 technologies.

The MPS PA Compact Workstation provides the perfect introduction to the process automation world. In a small workstation features four process loops typical of the industry. It links electrical knowledge (circuits, signals, power) with control systems and process automation, showing how theory applies to real industrial processes. Three variants available : basic, energy, and industrial instrumentation.

New! The DCS Learning System – SIMATIC PCS neo equips learners with in-demand skills using IIoT-ready instrumentation and web-based DCS technology. t reflects the complexity of modern plants in an intuitive environment, allowing learners to control and optimize various process loops using SIMATIC PCS neo, like in today's advanced process plants.

Product Catalog Process Automation and Water Management

Find more information about the MPS PA Compact Workstation and the DCS Learning System in our catalog.

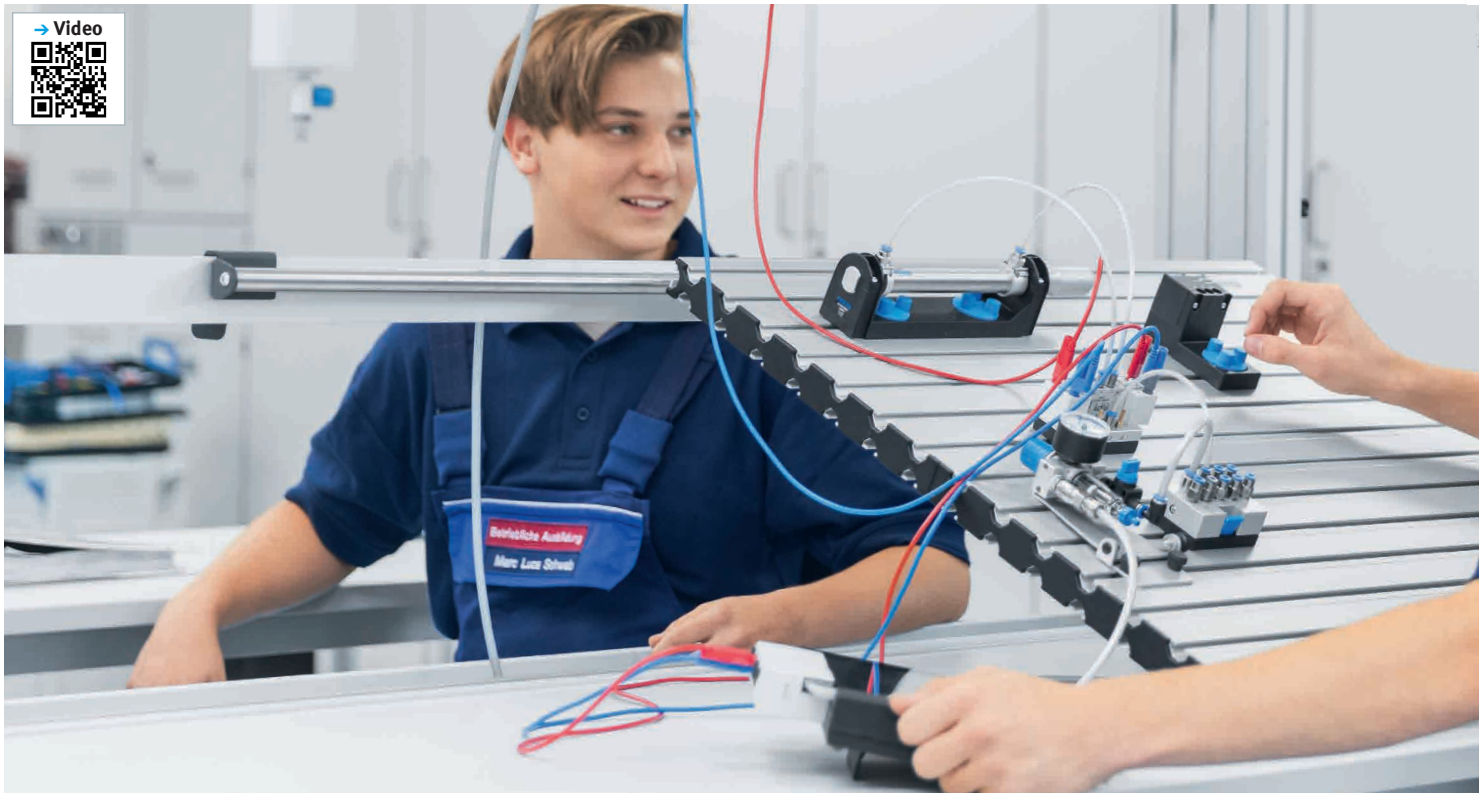
In this catalog, you will find our complete range of learning solutions for basic and advanced training in:

– Introduction and fundamentals
– Water technology
– Industrial instrumentation and process control
– And more

Visit our website to browse and download the catalog:
→ To the catalog download page

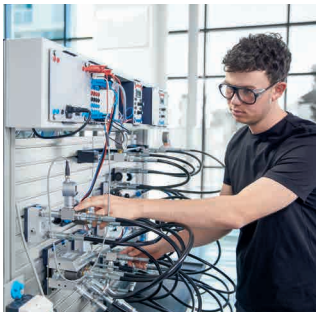
Pneumatics and Hydraulics Training Packages

Bridge Electrical Technology with Fluid Power Circuits



Modular for flexible expansion, from basic to advanced topics

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.

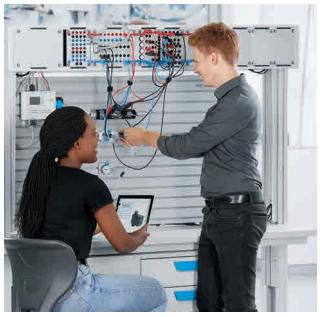
Connect – and energy is there!
The pneumatic power supply is provided by connecting highly flexible plastic tubing to the push-in fitting QS. The hydraulic energy supply is provided by the tool-free connection of low-leakage couplings. The couplings are self-sealing when decoupled. All electrical components and units are connected by 4 mm safety sockets or 4 mm safety plugs.

Prepare students for real-world control systems by integrating core fluid power concepts into your electrical engineering curriculum.

Our pneumatics and hydraulics learning solutions show how electrical signals drive mechanical motion—bridging control logic with actuators, sensors, and energy flow.

This fosters a systems-thinking mindset and equips students with industry-relevant skills for careers in automation, robotics, manufacturing, and beyond.

Designed for hands-on learning, the systems cover essential topics such as electropneumatic control, sensor integration, safety circuits, and energy efficiency—making them ideal for courses in control, automation, and mechatronics.



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 “Energy-efficient compressed air management, AirCS”, “Electropneumatics Advanced Level TP 202” or “Digitalization of pneumatics TP 260.”

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.

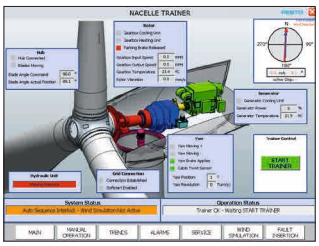
Visit our website to browse and download the catalog:
→ To the catalog download page

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

Nacelle – Wind Turbine Learning System

Operation and Maintenance of Wind Turbines

→ Video



From wind to electrical power

The Nacelle – Wind Turbine Learning System is a complete scaled-down version of commercial wind turbine nacelles, making it an excellent substitute for expensive actual equipment.

The learning system consists of a complete drive train that includes the main shaft, a gearbox with a transparent side cover, speed sensors, a hydraulic brake, and an asynchronous generator. The yaw system is fully operational and features a 61 cm (24 in) slewing bearing, a gear motor, a drive, a position sensor, and fail-safe hydraulic brakes. A manual hydraulic pump and an accumulator, as found in real-world wind turbines, are also included. A PLC controls the different functions of the nacelle and is located in an electrical enclosure together with all the other electrical components.

Simulating reality

A wind vane and an anemometer are located in a transparent enclosure on top of the training system to monitor wind speed and wind direction. Although they are not measuring actual wind, the control system managed by the user simulates the process, causing the weather sensors to react and send signals to the control system which take the simulated parameters into account.

An industrial electrical panel

The lockable electrical panel contains all the electrical supply, distribution, and control functionality for the learning system: contactors, variable-frequency drives, breakers, fuses, power supplies, and remote inputs/outputs for the PLC.

Grid-tied power generator

The generator allows the induction generator of the learning system to be connected to the grid and to return power proportional to the wind simulation in the system. It includes a soft starter, an overload, switchable compensation capacitors, and a power meter that allows the user to monitor several parameters of the power returned to the grid (VAR, W, VA, power factor, etc.).

Nacelle – Wind Turbine Learning System

120 V	**610873**
220 – 240 V	**610874**

Necessary accessory:

Isolation Transformer *	8064358

* This device is only required for specific systems: order no. 610874.

Nacelle – Wind Turbine Learning System with Power Generator

208 V, three-phase current	**610875**
400 V, three-phase current	**610876**

Expansion options for all Nacelle – Wind Turbine Learning Systems

Electrical Pitch Hub (next page)
Hydraulic Pitch Hub (next page)

Learning goals
- Wind Aerodynamics, Safety
- Hub and Low-Speed Shaft, Gearbox, Coupling, and Alignment
- Basic Hydraulic Circuit, Hydraulic Brakes
- Electrical Circuits and Control Systems
- Troubleshooting

Your advantages
- Demonstrates how a wind turbine nacelle, an electrical hub, and a hydraulic hub operate
- Helps practice maintenance and troubleshooting skills in a safe environment
- Faultable through the HMI
- Cost-effective, Full hands-on training with rugged equipment
- Comprehensive curriculum and lab exercises

Isolation Transformer 230V, 50 Hz
Device that eliminates high leakage currents and prevents undesired tripping of residual current devices (RCDs). A fuse protects this device and a thermal protection prevents overheating.

Recommended Learning Material

Workbooks

Campus license:

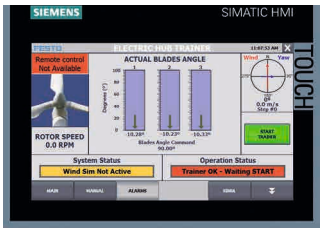
en	8166512
es	8233966

Note: The campus license includes the student and instructor PDF versions of the following workbooks: “Nacelle Operation and Maintenance” and “Grid-Tied Nacelle”. Printed workbooks available upon request.

Courses on Festo LX
- → Nacelle Operation and Maintenance
- → Grid-Tied Nacelle

Pitch Hubs – Wind Turbine Learning System

Electrical and Hydraulic Control of Blade Pitch Angle



Blade-angle optimization for harnessing wind power

Housed in the hub that supports the blades, the pitch system is a combination of components that monitor and manipulate blade angles to control rotation speed, as well as the area exposed to the wind.

Pitch control is an important element of the overall wind turbine system that improves turbine efficiency by optimizing wind utilization. Pitch systems also stabilize rotational speed for uniform power generation and synchronization with the power grid. They protect the system by preventing turbine overspeed and reducing forces on the rotor during system idle or servicing.

Demonstrate realistic pitch adjustment

In the Nacelle – Wind Turbine Learning System, the rotor blades turn but cannot be pitched. Instead, the pitch angle is simulated and displayed on the main screen of the HMI.

To comprehensively demonstrate the pitch adjustment with wind conditions, a pitch hub can be connected to the Nacelle – Wind Turbine Learning System using a fiber-optic connector. Pitch hubs can also be operated independently.

Electrical or hydraulic

Two pitch hub learning systems are available: electrical and hydraulic. Both include all components of a typical commercial pitch hub and a representation of the wind turbine blade. The system reacts to simulated wind conditions, corresponding to the typical behavior of a real wind turbine.

Each hub addresses blade pitch control and emergency backup systems using the appropriate technologies typical of their respective electrical or hydraulic pitch control systems. The HMI controls and monitors the blade movement and the training system. It runs a SCADA interface that communicates directly with a Siemens PLC inside the electrical panel.

Electrical Pitch Hub – Wind Turbine Learning System
This system addresses blade pitch control and emergency back-up systems using technologies typically found in electrical pitch control systems, such as servo motor and gearbox.

120 V	**8091728**
220 – 240 V	**8091729**

Hydraulic Pitch Hub – Wind Turbine Learning System
The system addresses blade pitch control and emergency back-up systems using technologies typically found in hydraulic pitch control systems, such as cylinder, proportional valve and position sensor.

120 V	**8095227**
220 – 240 V	**8095228**

Learning content
– Introduction to energy production with wind power
– Machine safety
– Introduction to SCADA
– Rotor
– Hydraulic or electric pitch control
– Electrical system and back-up power
– Troubleshooting

Your advantages
– Fully-operational, single-blade positioning systems
– Blade movement actuated by a servo motor and a gearbox or by a hydraulic cylinder
– Industrial components
– Faults can be inserted through the HMI
– Emergency pushbutton and protective guard
– Turnkey, comprehensive course material

Recommended Learning Material

Workbooks

Campus licenses:

Electrical pitch hub, en	8098181
Hydraulic pitch hub, en	8098185

Printed workbooks available upon request.

Courses on Festo LX
→ Electrical Pitch Control
→ Hydraulic Pitch Control

Learning Media

Digital Learning with Festo LX
Introduction 252
Featured Courses 256
Featured Learning Paths 257

Software
FluidSIM 258

Courseware
Workbooks 262

Digital Learning with Festo Learning Experience

The Backbone for Building Electrical and Electronic Skills

→ Video

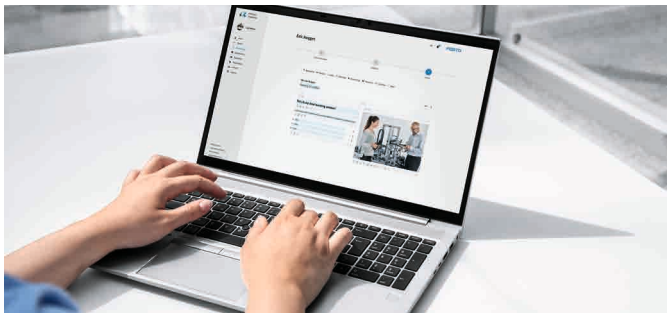
What makes Festo LX unique
With Festo LX, we have created a digital learning portal that offers a high degree of flexibility, personalization and hardware integration.

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, quizzes, 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
Thanks to our nugget concept, existing courses and learning paths can be updated quickly and easily. With the LX Creator, educators can also develop their own content using an intuitive tool supported by AI for generating texts and quizzes. The Creator ensures the same look and feel as Festo Didactic content, giving learners a consistent experience while making content creation simpler for teachers.

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

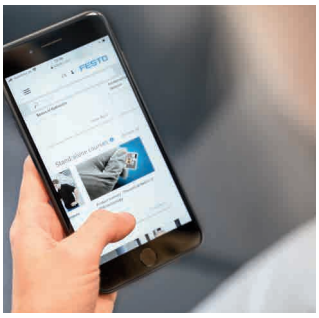
- Individual and goal-oriented design of the lessons
- Flexible to use
- Supports many different teaching and learning scenarios
  - traditional or flipped classroom
  - distance learning
  - self-paced learning
  - and more
- Existing course materials can be linked with the appropriate learning systems 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.

LX Tutor: an AI-based companion
The LX Tutor enhances the learning and teaching experience by supporting users through interactive, educational conversations. It answers questions related to Festo LX learning content with referenced sources and offers proactive guidance when learners struggle—for example, after incorrect quiz answers, extended learning times, or repeated access to the same material. The LX Tutor can be enabled or disabled at any time and is automatically deactivated during evaluations.

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 and Subscription Options

Festo LX provides a wide variety of learning materials covering many areas of technical education and training. These areas include factory automation, fluid technology, the Industrial Internet of Things (IIoT), Industry 4.0, electrical engineering, process automation, renewable energies, STEM, and many other technical fields. Additionally, we provide technology-independent, comprehensive learning content on lean management, project management, and soft skill development.

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.

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.

Festo LX for Education

1-year subscription	**8219584**
3-year subscription	**8219585**
5-year subscription	**8219586**

Note: Unlimited number of users with 100 concurrent users.

Festo LX for Industry

1-year subscription (single user)	**8219587**

Note: The number of users can be tailored to customer requirements.

Expansion option

Single Sign-On (SSO) Festo LX	8157218

Note: Please clarify the technical requirements with your IT before placing an order for Festo LX SSO. Establishing SSO for Festo LX is a one-time service fee and does not need to be ordered again when the subscription for Festo LX will be extended.

Campus licenses are available for offline usage.
PDF or 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.

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 guides
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.

Digital Learning with Festo LX
Featured eLearning 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.

Electrics 1

This course covers the basics of electrical engineering including closed circuits, electrical conductivity, Ohm's Law, voltage supplies and resistors.

→ eLearning course 28706 on **Festo LX**

Electrics 2

This course covers further topics in electrical engineering including electric charge, capacitors and coils.

→ eLearning course 4879 on Festo LX

Electronics 1

This course covers the basics of electronics including semiconductor technology, diodes, bipolar transistors and field-effect transistors.

→ eLearning course 28142 on Festo LX

Electronics 2

The "Electronics 2" training program is addressed at all those who wish to acquire electronics knowledge or consolidate already existing knowledge for training and professional use.

→ eLearning course 29172 on Festo LX

PLC Programming

Programmable logic controllers 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

Electrical Drives 1

This course covers the basic principles of electrical drives as well as the construction and function of DC and AC motors.

→ eLearning course 29338 on Festo LX

Electrical Drives 2

This course further expands the principles of electric drives including the controlling of DC and AC motors, energy efficiency as well as economic and environmental aspects.

→ eLearning course 30468 on Festo LX

Electrical Protective Measures

This course provides an introduction to the complex subject of safety measures. It explains what electrical safety measures are and how they are classified.

→ eLearning course 9921 on Festo LX

Actuators - DC Motor

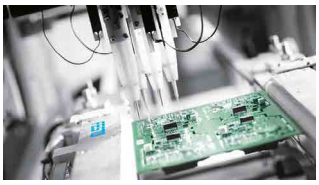
This course covers the function of actuators in mechatronic systems using the everyday example of a car park access control system.

→ eLearning course 12045 on Festo LX

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



Discover more digital courses:
Click here → **lx.festo.com** to browse the library.

Featured Learning Paths

Basic Electricity – Electeo

This learning path builds a foundation in electrical engineering concepts—including circuits, Ohm's Law, AC/DC principles, magnetism, and electromagnetism—using the Electeo electronics learning system.

→ Learning path on Festo LX

Basic Electronics – Electeo

This learning path helps learners build a foundation in electronics concepts—including diodes, rectifier circuits, and BJTs—using practical applications and structured troubleshooting techniques—using the Electeo electronics learning system.

→ Learning path on Festo LX

Industrial Power System

This learning path provides a structured approach to understanding industrial power systems, covering key concepts such as three-phase circuits, voltage calculations, power measurement, transformers, and common configurations.

→ Learning path on Festo LX

Power Electronics

This learning path offers a hands-on approach to Power Electronics, covering key topics such as DC, Single-Phase AC, and Three-Phase AC systems, power control with thyristors, motor operations, and more.

→ Learning path on Festo LX

Basic Motor Control

This learning path provides a foundation in motor control, covering essential topics such as control circuits, three-phase induction motors, protection methods, braking techniques, and reduced voltage starting approaches for various applications.

→ Learning path on Festo LX

Electrical Machines

These learning paths explore the foundational concepts of electrical machines, covering the principles of electric drives, DC and AC motor construction, control mechanisms, and more.

→ Learning path on LX (Europe)
→ Learning path on Festo LX

Stepper and Servo Control

This learning path provides an overview of stepper and servo motor control systems, covering installation, wiring, commissioning, and PLC integration.

→ Learning path on Festo LX

Sensor Technology

This learning path covers the fundamentals of sensors in pneumatics and object detection, explores smart sensor technology and PLC integration, and provides hands-on training in Smart IO-Link interfaces for advanced industrial applications.

→ Learning path on Festo LX

Smart Maintenance

This learning path provides an overview of maintenance practices, highlighting proactive strategies, the role of technology and data analytics in efficiency, and approaches for optimizing industrial performance.

→ Learning path on Festo LX

Building Systems

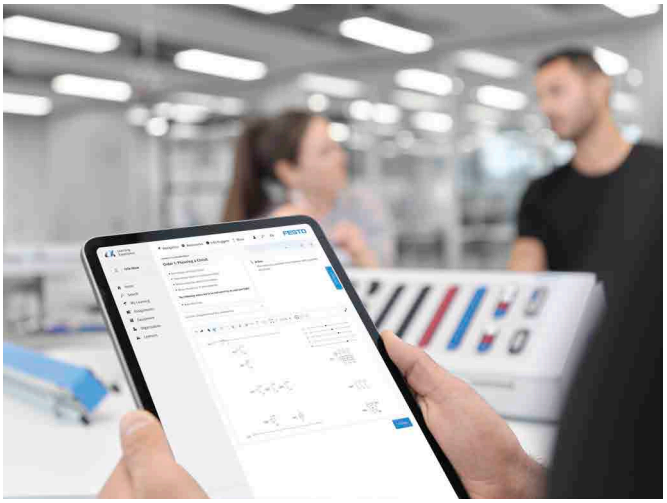
This learning path provides a foundation in building automation and HVAC systems, covering direct digital control (BACnet), smart home technology, and energy-efficient building management.

→ Learning path on Festo LX

Discover more learning paths:
Click here → **lx.festo.com** to see all learning paths.

FluidSIM

Interactive Electrical Circuit Simulations



For more than 25 years, FluidSIM has been the world's leading simulation software for creating and simulating circuit diagrams in pneumatics, hydraulics, and electrical engineering.

FluidSIM enables valuable technical skills to be acquired by designing circuits, bringing them to life through simulation, and optimizing them through interaction. The simulation of control systems and processes has long been an industrial standard that ensures errors are prevented, and efficiency and quality are increased.

Objectives
FluidSIM provides a practical way for students to develop their skills in automation technology and to master complex tasks.

The learning objectives of FluidSIM include:
– Creating circuit diagrams
– Identifying and preventing errors
– Optimizing solution circuit diagrams through interactive simulations
– Understanding how solutions are developed
– Observing effects through real-time simulations

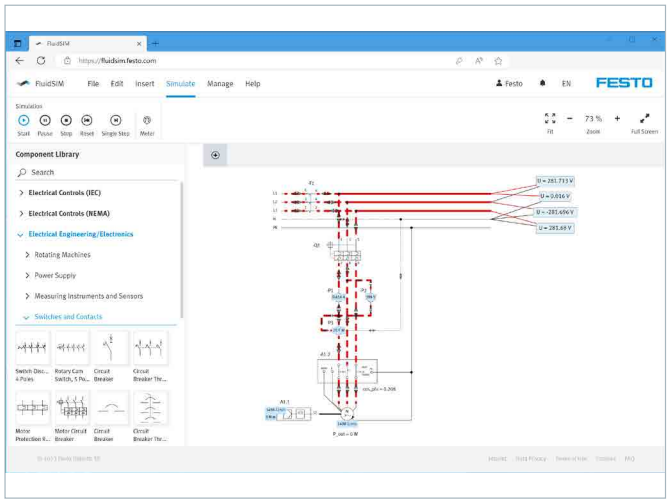
Component library
FluidSIM also has component libraries for pneumatics, hydraulics, and electrical engineering that can be used either separately or in combination. The component libraries include hundreds of pneumatic, hydraulic, electrotechnical, electric, and digital components, and are constantly expanded and revised.

GRAFCET
GRAFCET diagrams can be created and included in simulations in FluidSIM. These simulations comprise:
– GrafEdit: Standard-compliant creation of GRAFCETs
– GrafView: Visualization of the control sequence mapped as GRAFCET
– GrafControl: Controlling the process with GRAFCET, including fault simulation and process monitoring
– GrafPLC: Manufacturer-independent control of all fluid and electrical engineering systems

Virtual and real measuring devices
FluidSIM offers both real and virtual measuring devices that can be integrated into circuits. Before the simulation, real measuring devices are installed, while virtual measuring devices are used during or before the simulation to display the simulated values of the circuit. In contrast to real measuring devices, virtual measuring devices do not influence the circuits. They therefore show the pure values of the circuit simulated by FluidSIM. Virtual measuring devices can be used in electrical as well as pneumatic and hydraulic circuits.

Fault models and diagnostics
FluidSIM has an innovative diagnostic concept, which enables the readily available fault models for various components to be compiled. Before a simulation, a specific error configuration can be selected; this then has an impact on the subsequent simulation. During this simulation, defective components are identified with the help of virtual measuring devices and then virtually repaired.

Lesson preparation and learning materials
With the expert mode of FluidSIM, profiles can be created and lessons can be organized and then assigned to students. The profiles enable the functions, components, and error models to be narrowed down, for example so that students only deal with the functions and tasks that are relevant to them. Multimedia training content is also available on FluidSIM so that variety and interest can be added to the lessons.



FluidSIM at a glance

- Convenient creation of circuit diagrams and their interactive simulation
- Content tailored to Festo Didactic learning systems
- Various usage options: web, Windows, and via the Festo LX digital learning portal
- Can be used online and offline
- Fast learning preparation and individual learning
- Learn what effects changes in a technical set-up have and observe the immediate consequences by running real-time simulations
- Extensive library of pneumatic, hydraulic, control, electronic and digital components
- Virtual and real measuring devices
- Fault models for developing skills in troubleshooting and preventing errors

Interfaces to practical applications
With FluidSIM, students put the knowledge they have learned into practice straight away. Signals are transmitted either via the connected hardware or via interfaces from other programs. All parameters are identical to those of the training packages from Festo Didactic and additionally, they can be fully adapted to the characteristics of other components. The EasyPort hardware enables FluidSIM to be used both as a controller for real systems and as a replacement for them. The industry standard OPC-UA is also supported, bringing FluidSIM even closer to industrial applications.

Integration in Festo LX
By integrating FluidSIM in Festo LX, simulation tasks can be created directly in Festo LX by the tutors and then processed and simulated by the students. Users no longer have to switch between the two programs.

User versions
FluidSIM can be accessed in different ways. Depending on the license, users can choose between the Windows version, the web version, or they can opt to integrate FluidSIM into our digital learning portal Festo LX.

Web version
The web version of FluidSIM is a device-independent user application. It can be accessed anytime, anywhere, and from any device (e.g., iPad). The web version includes approximately 80% of the functionality of the Windows version, covering all the most important and frequently used features. It is continuously developed and enhanced, with additional functions available exclusively on the web.

Windows version
The Windows version includes all the functionalities and content of FluidSIM. Please note that this version can only be run on devices with a Windows operating system. This version can also be used offline.

Our licensing options
FluidSIM 365 and FluidSIM 6 are the two license versions available for FluidSIM.

The FluidSIM 365 license version gives users access to the web and Windows versions, as well as the FluidSIM functions within Festo LX. All updates and upgrades are included in the FluidSIM 365 license.

A pure FluidSIM 6 license includes all the updates for version 6. Upgrades to a higher version are not included, nor is the use of the web version and the functions of FluidSIM within Festo LX possible.

The licenses for all the versions provide users with maximum flexibility. As a result, some of the licenses can be used for the web version, some for the Windows version, and the rest for using FluidSIM in Festo LX. We have applied the floating principle: this means that as soon as a user no longer actively uses a license, it is available for the next user in the organization.

FluidSIM 365 – 1 year

Pneumatics	**8198195**
Hydraulics	**8198196**
Electrical Engineering	**8198197**

FluidSIM 365 – 3 years

Pneumatics	**8198198**
Hydraulics	**8198199**
Electrical Engineering	**8198200**

FluidSIM 365 – 5 years

Pneumatics	**8198201**
Hydraulics	**8198202**
Electrical Engineering	**8198203**

FluidSIM 6

Pneumatics	**8198189**
Hydraulics	**8198190**
Electrical Engineering	**8198191**

Workbooks

Electricity and Electronics – Electeo

DC Fundamentals

Teaches the fundamentals of electricity and how to calculate voltage, current, resistance, and power in dc circuits. Introduces basic electric components. Also introduces the use of basic instruments such as the variable-voltage dc source and the multimeter.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: DC voltage sources
- Exercise 2: Resistors
- Exercise 3: Electric circuit and current
- Exercise 4: Ohm's law
- Exercise 5: Series resistive circuits
- Exercise 6: Project - Power-on Indicator for USB Charger
- Exercise 7: Parallel resistive circuits
- Exercise 8: Series-parallel resistive circuits
- Exercise 9: Switches
- Exercise 10: Power in DC circuits
- Exercise 11: Project - Dual-intensity LED flashlight
- Exercise 12: Thermistors
- Exercise 13: Varistors
- Exercise 14: Project - Hot-surface indicator for glass-top stoves

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX

→ DC Fundamentals

AC Fundamentals

Teaches the fundamentals of electricity and how to calculate voltage, current, resistance, and power in dc circuits. Introduces basic electric components such as resistors, potentiometers, switches, light-emitting diodes (LEDs), thermistors, and varistors. Also introduces the use of basic instruments such as the variable-voltage dc source and the multimeter.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Basics of AC
- Exercise 2: AC waveform measuring techniques using the oscilloscope
- Exercise 3: Phase angle and phase shift
- Exercise 4: Power and effective values of voltage and current in resistive AC circuits
- Exercise 5: Solving resistive AC circuits
- Exercise 6: Project - AC-powered LED night light

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX

→ AC Fundamentals

Magnetism and Electromagnetism

Teaches the fundamentals of magnetism and electromagnetism. Introduces the operation of the following basic electromagnetic devices: the electromagnet, the linear and rotary solenoid actuators, and the electromechanical relay.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Magnetism, magnets, and compass
- Exercise 2: Magnetic field patterns and attractive/repulsive forces
- Exercise 3: Making a magnet
- Exercise 4: The electromagnet
- Exercise 5: The linear solenoid actuator
- Exercise 6: The electromechanical relay
- Exercise 7: Basic relay circuits
- Exercise 8: Project - Service request system

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX

→ Magnetism and Electromagnetism

Capacitors and Inductors

Teaches the fundamentals of capacitors and inductors in DC and AC circuits. Covers capacitor construction, charging and discharging behavior, capacitance, and transient responses in RC circuits. Explores capacitor types, specifications, and applications. Introduces inductors, their properties, and electromagnetic induction. Examines self-induction, inductance in series and parallel arrangements, and transient responses in RL circuits. Highlights practical applications to connect theoretical principles with real-world use.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Capacitors
- Exercise 2: Inductors
- Exercise 3: Project - Car's interior LED light control circuit
- Exercise 4: Capacitors in AC circuits
- Exercise 5: Inductors in AC circuits

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX

→ Capacitors and Inductors

Impedance

Teaches the fundamentals of impedance in DC and AC circuits, highlighting the contributions of capacitors and inductors through capacitive and inductive reactance. Covers how resistance, capacitance, and inductance interact to shape circuit behavior. Guides students in applying these concepts by designing a car's interior LED light control circuit, building skills for analyzing and designing complex electronic systems.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Impedance and parallel circuits
- Exercise 2: Impedance and series circuits

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX
→ Impedance

Diodes and Rectifier Circuits

Teaches the fundamentals of diodes and rectifier circuits, including their structure and key characteristics in forward and reverse bias. Covers the operation of half-wave rectifiers and their practical applications. Guides students in applying these concepts by designing a dual-heat, dual-speed hair dryer circuit.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Diodes
- Exercise 2: Half-wave rectifiers
- Exercise 3: Project - Heat and speed settings for a hair dryer
- Exercise 4: Full-wave rectifiers
- Exercise 5: Ripple reduction
- Exercise 6: Zener diodes
- Exercise 7: Project - modification of an alarm system

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX
→ Diodes and Rectifier Circuits

BJT and Basic Circuits

Teaches the fundamentals (construction, packages, symbol, basic characteristics, etc.) of the bipolar junction transistor (BJT). Shows how to correctly bias a BJT so that it can operate as a current-control device. Shows how to use a BJT as an electronic switch. Covers the operation of BJT circuits used for voltage and current amplification.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: The bipolar junction transistor
- Exercise 2: BJT operation and characteristics
- Exercise 3: Load line and operating point of a BJT circuit
- Exercise 4: The BJT switch
- Exercise 5: The common-emitter amplifier (concept and DC bias)
- Exercise 6: The common-emitter amplifier (AC operation)
- Exercise 7: The common-collector amplifier (concept and DC bias)
- Exercise 8: The common-collector amplifier (AC operation)
- Exercise 9: Project - Microphone audio amplifier
- Exercise 10: Troubleshooting

Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX
→ BJT Fundamentals and Basic Circuits

Operational Amplifier Fundamentals

Teaches the fundamentals of operational amplifiers (packages, symbol, basic characteristics), including ideal vs non-ideal behaviour and operation with and without feedback. Demonstrates the use of op amps as comparators (with and without hysteresis), inverting/non-inverting amplifiers, and summing amplifiers. Includes a dual-level detector project and introduces systematic troubleshooting techniques for op amp circuits.

The campus license includes the PDF versions of the student manual and instructor guide.

Structure:
- Exercise 1: Fundamentals of operational amplifiers
- Exercise 2: The voltage comparator
- Exercise 3: The non-inverting voltage amplifier
- Exercise 4: The voltage follower
- Exercise 5: The inverting voltage amplifier
- Exercise 6: The summing amplifier
- Exercise 7: Project - Dual-Level detector
- Exercise 8: Troubleshooting

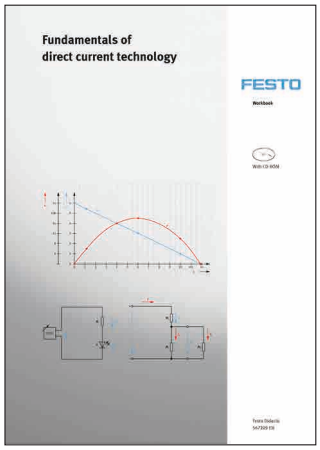
Campus license:

en	**8131442**
de	**8233375**

Course on Festo LX
→ Operational Amplifier Fundamentals

Workbooks

Electricity and Electronics – Training Packages



Fundamentals of Direct Current Technology

The fundamentals of direct current technology provide an introduction to the world of electrical engineering/electronics. The content is explained and elaborated in realistic projects. The primary focus is on the explanation of the basic variables, behavior and relationships and the recording of these using measurements.

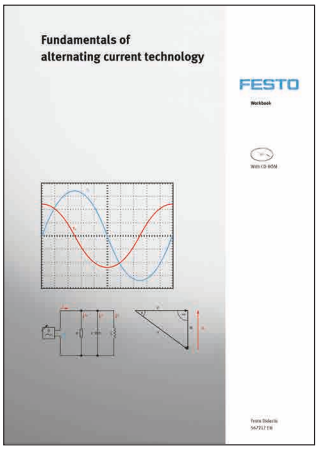
Among the variables covered are voltage, current, resistance and conductance as well as energy and capacity. Ohm's law is explained in detail. Particular emphasis is placed on the use of measuring devices. The circuit examples include series and parallel connection, voltage divider, bridge circuit and voltage sources.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**567207**
en	**567209**
es	**567211**
fr	**567213**

Course on Festo LX
→ Fundamentals of DC Technology



Fundamentals of Alternating Current Technology

The workbook for fundamentals of AC technology continues the introduction to electrical engineering/electronics components and systems with topics relating to AC technology. The main topics covered are the electric field and induction, and the resulting behavior of components in the AC circuit.

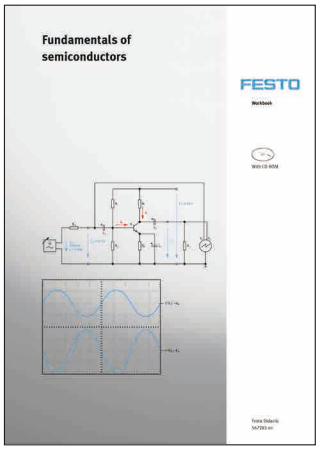
Topics such as the capacitor and coil in the DC and AC circuit, as well as the series and parallel connection of resistor, coil and capacitor are covered in project exercises. The variables and relationships of active resistance, reactance, and impedance, and the topic of phase shift of current and voltage are covered in detail.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**567215**
en	**567217**
es	**567219**
fr	**567221**

Course on Festo LX
→ Fundamentals of AC Technology



Fundamentals of Semiconductors

The third volume of the fundamentals of electrical engineering/electronics deals with semiconductors, covering the design and mode of operation of modern semiconductors, with their application demonstrated in project exercises.

As an introduction to the topic, different diodes, such as the semiconductor diode, Zener diode, and LED are considered and the basic concepts are worked out. Content including PN junction, reverse voltage, or conducting state current is demonstrated both theoretically and, where possible, using measurements. The topic of transistors is also explained using bipolar and unipolar transistors. The book also covers power electronics components, such as diac, triac, and thyristor.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**567281**
en	**567283**
es	**567285**
fr	**567287**

Course on Festo LX
→ Fundamentals of Semiconductors

Basic Electronics Circuits

The workbook for basic electronics circuits completes the series of workbooks for the fundamentals of electrical engineering/electronics. Particular emphasis is placed on the analytical examination of the interaction between the components already covered in the first three books on the fundamentals.

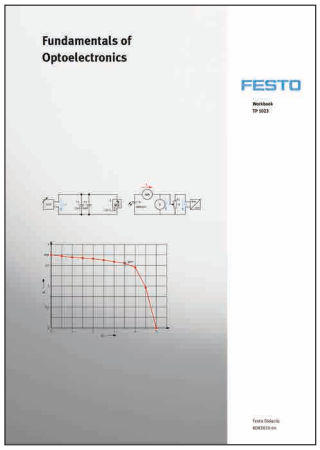
The content includes project exercises with selected basic circuits, in which the design is first developed and then analyzed on the basis of measurement technology. The circuits include power supply unit circuits, amplifier circuits, flip-flops, and power electronics circuits, as well as circuits commonly used in industrial practice.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**567289**
en	**567291**
es	**567293**
fr	**567295**

Course on Festo LX
→ Basic Electronics Circuits



Fundamentals of Optoelectronics

The primary objective of this workbook is the set-up and analysis of optoelectronic components, as well as a selection of basic circuits.

The circuits include twilight switches, light barriers, infrared remote controls, fiber-optic cables for data transmission, and power supply circuits. This direct interaction of theory and practice ensures fast progress and sustainable learning.

The workbook contains:
– Sample solutions
– Educational instructions
– Worksheets for learners

The worksheets support the learner in the information and planning phase as well as with execution, monitoring and documentation.

All exercises require independent performance, evaluation and documentation from the learner.

Campus license:

de	**8081038**
en	**8083810**

Course on Festo LX
→ Fundamentals of Optoelectronics

Fundamentals of Analog Technology

The workbook imparts knowledge about the structure, function and characteristics of operational amplifiers.

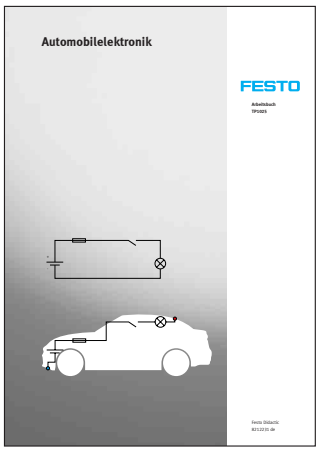
Five projects are specifically targeted at the topic of operational amplifiers and their application as impedance converters, computing amplifiers, sawtooth wave generators, voltage controllers and power amplifiers.

The workbook contains:
– Sample solutions
– Training notes
– Worksheets for the student

Campus license:

de	**8023586**
en	**8023587**
es	**8023588**
fr	**8023589**

Course on Festo LX
→ Fundamentals of Analog Technology



Automotive Electronics

This workbook contains learning activities using the Motor vehicle mechatronics extension component set TP 1025

Training content:
– Fundamentals of automotive electronics
– Diagnostics on lighting
– Diagnostics on coolant temperature display
– Diagnostics on brake pad wear indicator
– Diagnostics for direction indicator and hazard warning lights

The workbook contains:
– Sample solutions
– Training notes
– Worksheets for the student

Campus license

de	**8212231**

Basic Principles of Digital Technology

The workbook provides an introduction to the world of digital signals and their interconnection. The primary focus is on the explanation of the basic variables, behavior, and relationships.

The content is project exercises with selected basic circuits, in which the design is first developed and then analyzed on the basis of measurement technology. The contents include elementary logic modules and logic circuits, Schmitt triggers, trigger circuits, flipflops, counting circuits, data conversion, and arithmetic circuits.

The workbook contains:
– Sample solutions
– Training notes
– Worksheets for the student
– Graphics

Campus license:

de	**8023432**
en	**8023433**
es	**8023434**
fr	**8023435**

Course on Festo LX
→ Basic Principles of Digital Technology

Workbooks

Electricity and Electronics – Training Packages

Basic Principles of Closed-Loop Control Technology

The optimum introduction to the world of closed-loop systems. Basic terms are explained through examples, with the focus then shifting to behaviors, and relationships. Special focus is given to the topics of behavior, and analysis of control processes.

The content includes project exercises with selected basic circuits, in which the design is first developed and then analyzed on the basis of measurement technology. Training content, includes structure of a control circuit, spring responses and dynamic behavior, Bode diagram, controlled system modeling, positive and negative feedback, and two and three-step controllers as well as P, PI, and PID controllers.

The workbook contains:
– Sample solutions
– Training notes
– Worksheets for the student
– Graphics

Campus license:

de	**8023436**
en	**8023437**
es	**8023438**
fr	**8023439**

Course on Festo LX
→ Basic Principles of Closed-Loop Control Technology

Introduction to Microcontroller Programming

This 50-hour course teaches the basics of developing projects based on microcontrollers using Flowcode software.

The aim of this course is to introduce the concepts of developing electronic systems using microcontrollers.

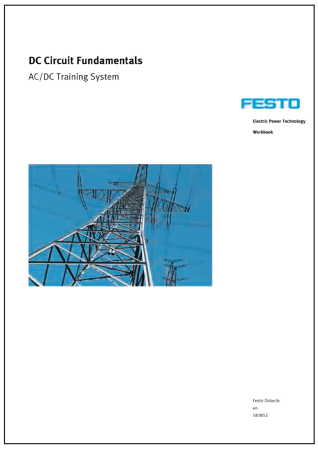
Students learn what a microcontroller is, how to construct circuits and systems based on microcontrollers, and how to program microcontrollers.

The course is suitable for BTEC National in Engineering unit 6, Microcontroller systems for engineers.

Table of contents:
– Introduction
– Intro to microcontrollers
– Using E-blocks
– Flowcode – first program
– Flowcode – examples
– Programming exercises
– Arduino adjustments

Campus license

de	**8128594**
en	**8094009**



DC Circuits Fundamentals

The learning exercises are designed to be performed with the AC/DC Learning System (LabVolt Series 3351).

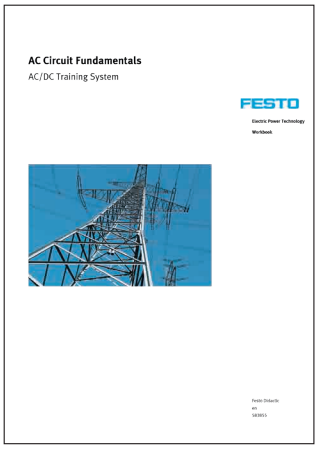
Topic coverage:
– Basic concepts of electricity
– Switches
– Series and parallel circuits
– Voltage, current, and measuring instruments
– Resistance and Ohm's Law
– Solving series circuits and Kirchhoff's voltage law
– Solving parallel and mixed circuits and Kirchhoff's current law
– DC capacitors
– Electromagnetism
– DC relays

The campus license includes the PDF versions of the student manual and instructor guide.

Campus license:

en	**583853**
es	**8176723**

Course on Festo LX
→ DC Circuits Fundamentals



AC Circuits Fundamentals

The learning exercises are designed to be performed with the AC/DC Learning System (LabVolt Series 3351).

Topic coverage:
– AC circuits and AC capacitors
– DC and AC inductors
– Transformers
– AC relays and contactors
– Electrical distribution
– Troubleshooting methods

The campus license includes the PDF versions of the student manual and instructor guide.

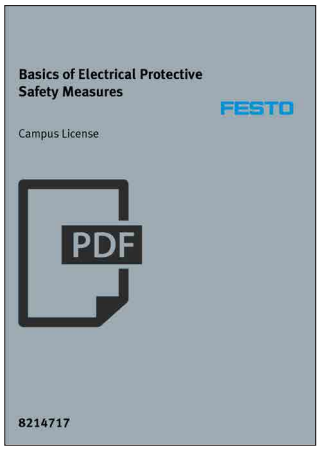
Campus license:

en	**583853**
es	**8176723**

Course on Festo LX
→ AC Circuits Fundamentals

Workbooks

Building System Technology – Training Packages



Basics of Electrical Protective Safety Measures

This workbook covers the basic principles of protective measures in the field of electricity using the EduTrainer Electrical Protective Measures.

Training content:
– RCDs
– Circuit-breakers
– Protective conductors

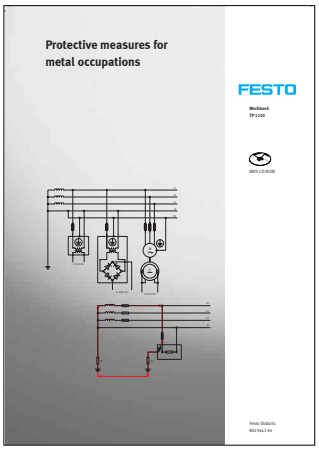
The workbook contains:
– Sample solutions
– Training notes
– Worksheets for students
– Graphics

Campus license:

de	**8214716**
en	**8214717**

Course on Festo LX

→ Electrical Protective Measures - EduTrainer



Power Supply Systems and Protective Grounding

This workbook deals with the topic of hazardous situations caused by electrical systems.

It addresses the emergence of hazards and the measures for preventing dangerous situations on the basis of realistic examples. It explains different mains systems as well as measures for protecting against direct and indirect contact and against electric shock (including in case of a fault).

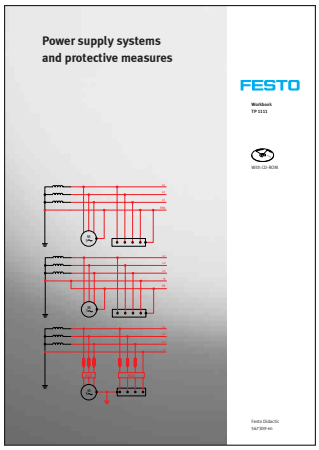
The workbook contains:
– Sample solutions
– Training notes
– Worksheets for students
– Graphics

Campus license:

de	**8023440**
en	**8023441**
es	**8023442**
fr	**8023443**

Course on Festo LX:

→ Power Supply Systems and Protective Grounding



Power Supply Systems and Protective Measures

The workbook for power supply systems and protective measures covers in detail the topic of the safety of electrical systems in accordance with DIN VDE.

The specific conditions and the measures for avoiding dangerous situations are explored using realistic situations. Different types of networks (TN-C, TN-CS, TT and IT network), protection against direct and indirect contact, protection against electric shock (including in the event of a fault), protection through RCD, and initial and repeat testing of electrical systems and devices are explained in project form.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**567307**
en	**567309**
es	**567311**
fr	**567313**

Course on Festo LX:

→ Power Supply Systems and Electrical Safety Measures

Basic Principles of Electrical Installation

The basics of electrical installation are taught using the example of practical projects with planning, setup and testing of different basic circuits.

Training content:
– Planning and normative principles
– Circuit diagrams and circuit symbols
– Basic circuits
– Taught using practical project exercises

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

The worksheets support the learner in the information and planning phase as well as with execution, monitoring and documentation.

All exercises require independent performance, evaluation and documentation from the learner.

Campus license:

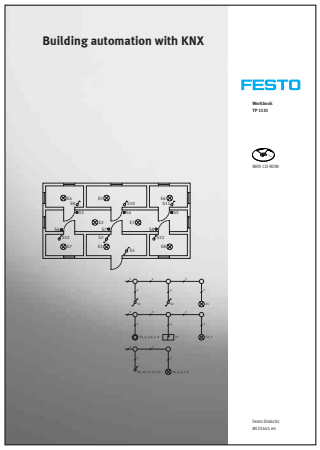
de	**8074437**
en	**8113396**
es	**8113397**

Course on Festo LX:

→ Basic Principles of Electrical Installations

Workbooks

Building System Technology – Training Packages



Building Automation with KNX

Modern buildings demand a wide variety of technologies, the most important being intelligent building automation, as a modern building cannot function without it.

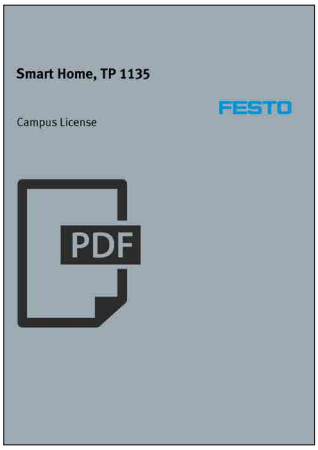
The workbook for the basic principles of building automation introduces the relevant topics in realistic projects. Focus is on the software tools, equipment, and configuration, as well as their interaction and extended options.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**8023444**
en	**8023445**
es	**8023446**
fr	**8023447**

Course on Festo LX:
➔ Building Automation with KNX



Smart Home

This workbook contains theoretical knowledge, practical exercises as well as evaluations, with answers included in the trainer's version.

The learning activities are designed to be carried out using TP 1135.

Training content:
– Understand the basic structure of smart home systems
– Design a method to gather, transmit and process data with smart home components
– Select and integrate smart home components
– Install a smart home system and connect different technologies
– Back up and restore data

Campus license:

de	**8224944**
en	**8224945**

Course on Festo LX:
➔ Smart Home

Building HVAC Controls

Course designed for use with the Building HVAC Control Learning System.

This workbook introduces students to the basic principles of heating, ventilation, and air conditioning (HVAC). It covers components used in HVAC systems, and teaches skills required to work in the HVAC field. Throughout the activities, students develop practical knowledge on how to install, maintain, and troubleshoot HVAC systems. They become familiar with a variety of HVAC systems.

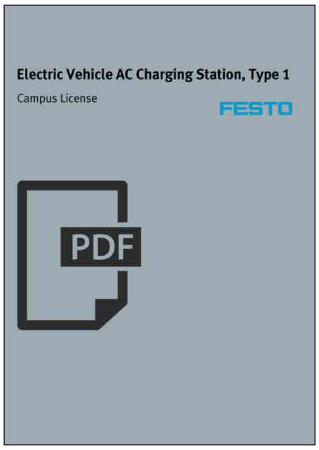
Training content:
– Describe the operation of HVAC systems, sub-systems, and components
– Wire HVAC control circuits
– Read and understand technical documents such as wiring diagrams
– Troubleshoot malfunctions and determine how to correct them

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

de	**793120**
en	**793119**
es	**793122**

Courses on Festo LX
➔ Building HVAC - Direct Digital Control (CGM Controllers)



Electric Vehicle AC Charging Stations

Course designed for use with the Electric Vehicle AC Charging Station Learning System, type 1 or type 2.

Training content:
– Introduction to electric vehicle AC charging stations
– Electric vehicle supply equipment familiarization and basics
– Electric vehicle basics
– Installation, commissioning, and testing
– Commercial functions (energy meter and RFID)
– Troubleshooting
– Load management
– Open Charge Point Protocol (OCPP)

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license (Type 1 charging stations):

en	**8236774**

Campus license (Type 2 charging stations):

en	**8244894**

Course on Festo LX
➔ Electric Vehicle AC Charging Stations

Energy-Efficient Lighting Engineering

Different lamps are compared in terms of mode of operation, light produced, industrial energy efficiency and dimming processes.

Training content:
– Method of operation of lamps
– Industrial energy efficiency of lamps
– Light and light temperature
– Dimming properties
– Taught using practical project exercises

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

The worksheets support the learner in the information and planning phase as well as with execution, monitoring and documentation.

Campus license:

de	**8074441**
en	**8113398**
es	**8113399**

Course on Festo LX:
→ Energy-Efficient Lighting Engineering

High-Power LEDs

The most modern and energy efficient way of lighting.

The workbook provides practical project exercises for an introduction to high-power LEDs. Particular attention is paid to the mode of operation of the LEDs, the light they produce as well as industrial energy efficiency.

The learning activities are designed to be carried out using TP 1144.

Training content:
– Method of operation of LEDs
– Industrial energy efficiency of LEDs
– Dimming LEDs
– Light and light temperature
– Taught using practical project exercises

Campus license:

de	**8074440**
en	**8111399**
es	**8111400**

Course on Festo LX:
→ High-Power LEDs

DALI LIghting Control

This workbook contains theoretical knowledge, practical exercises as well as evaluations, with answers included in the trainer's version.

The learning activities are designed to be carried out using TP 1145.

Training content:
– Understand and implement DALI bus systems
– Create light scenes
– Light scene control
– Control light scenes with sensors
– RGBW color control

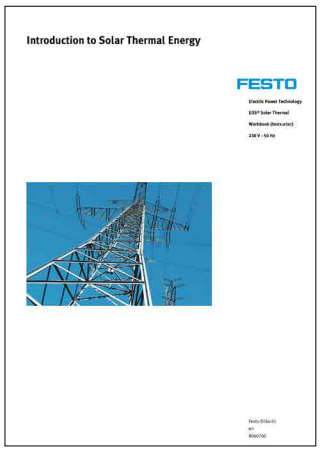
Campus license:

de	**8224951**
en	**8224952**

Course on Festo LX:
→ DALI

Workbooks

Building System Technology – Renewable Energy



Introduction to Solar Thermal Energy

Course designed for use with the Solar Thermal Learning System, LabVolt Series 46121.

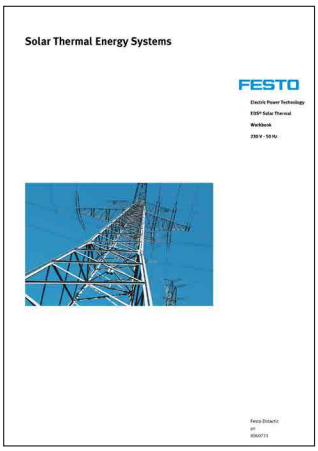
Training content:
– Thermal energy fundamentals
– Trainer familiarization and safety
– Site analysis
– System sizing

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en (Imperial units)	**8060788**
en (SI units)	**8060789**
fr	**8060790**
es	**8060791**
de	**8060792**

Course on Festo LX
→ Introduction to Solar Thermal Energy



Solar Thermal Energy Systems

Course designed for use with the Solar Thermal Learning System, LabVolt Series 46121.

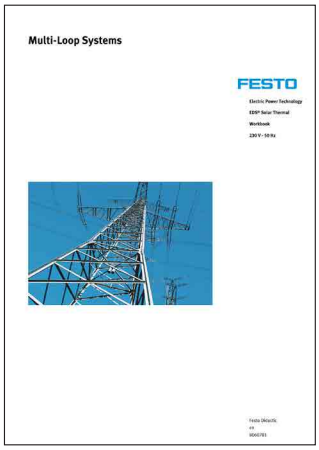
Training content:
– Solar heating and cooling systems
– Collecting thermal energy
– Storing and exchanging thermal energy
– Supplying and controlling thermal energy

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en (Imperial units)	**8060788**
en (SI units)	**8060789**
fr	**8060790**
es	**8060791**
de	**8060792**

Course on Festo LX
→ Solar Thermal Energy Systems



Multi-Loop Systems

Course designed for use with the Solar Thermal Learning System, LabVolt Series 46121.

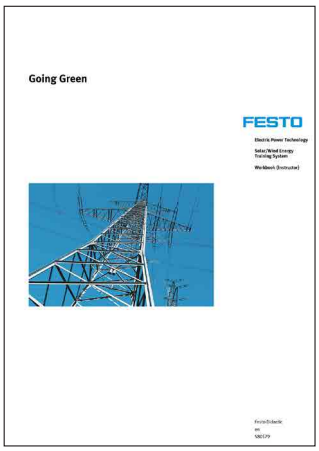
Training content:
– Closed-loop water heating
– Closed-loop surface heating
– Closed-loop air heating
– Closed-loop drainback systems
– Closed-loop combination systems
– Closed-loop combination systems
– System performance

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en (Imperial units)	**8060788**
en (SI units)	**8060789**
fr	**8060790**
es	**8060791**
de	**8060792**

Course on Festo LX
→ Multi-Loop Systems



Going Green

Course designed for use with the Solar/Wind Energy Learning Systems, LabVolt Series 46120.

Training content:
– Solar energy history
– Wind energy history
– Solar and wind energy careers

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en	**580560**
es	**8107373**

Course on Festo LX
→ Going Green

Energy Fundamentals

Course designed for use with the Solar/Wind Energy Learning Systems, LabVolt Series 46120.

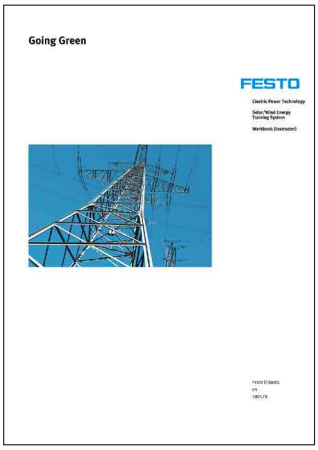
Training content:
– Sources of energy
– Power and work
– Measurements and units

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en, 120 V, 60 Hz	**8060788**
en, 230 V, 50 Hz	**8060789**
de, 230 V, 50 Hz	**8060792**
es, 230 V, 50 Hz	**8060791**
fr, 230 V, 50 Hz	**8060790**

Course on Festo LX
→ Energy Fundamentals



Solar/Wind Systems

Course designed for use with the Solar/Wind Energy Learning Systems, LabVolt Series 46120.

Training content:
– Diversion load and controller
– DC to AC inverter
– Power consumption
– Power efficiency
– Power transmission and distribution
– On/off grid operation
– Hybrid generator
– Troubleshooting

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en, 120 V, 60 Hz	**8060788**
en, 230 V, 50 Hz	**8060789**
de, 230 V, 50 Hz	**8060792**
es, 230 V, 50 Hz	**8060791**
fr, 230 V, 50 Hz	**8060790**

Course on Festo LX
→ Solar/Wind Systems

Solar Module

Course designed for use with the Solar/Wind Energy Learning Systems, LabVolt Series 46120.

Training content:
– Siting
– Photovoltaic module
– Charge controller
– Loading
– Battery bank

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en, 120 V, 60 Hz	**8060788**
en, 230 V, 50 Hz	**8060789**
de, 230 V, 50 Hz	**8060792**
es, 230 V, 50 Hz	**8060791**
fr, 230 V, 50 Hz	**8060790**

Course on Festo LX
→ Solar Module

Wind Turbine

Course designed for use with the Solar/Wind Energy Learning Systems, LabVolt Series 46120.

Training content:
– Siting
– Turbine generator
– Stop switch
– Loading
– Battery bank

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en	**580560**
es	**8107373**

Course on Festo LX
→ Wind Turbine

Workbooks

Drive Technology and Motor Control

Fundamentals of Circuits With Contacts

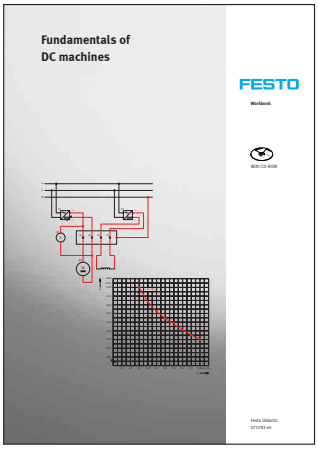
Contactor controls still have their place despite increasing automation and increasingly cost-effective control electronics. The workbook for the fundamentals of circuits with contacts covers the specific topics relating to relays and contactor controls in six realistic projects plus an additional project for soft starters. The control circuit with topics such as self-latching loop and locking plays just as important a role here as the primary circuit with the circuits for asynchronous three-phase motors, from simple starting to star-delta reversing circuit.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**570901**
en	**567315**
es	**567317**
fr	**567319**

Course on Festo LX:
→ Fundamentals of Circuits With Contacts



Fundamentals of DC Machines

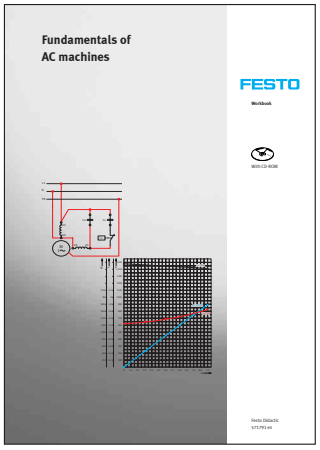
In drive technology, DC drives currently play a major role in mobile drive solutions. The workbook for the fundamentals of DC machines covers the specific topics relating to DC drives. The content is first elaborated theoretically and then consolidated in exercises. In addition to the design of the machines, their circuitry and areas of application are demonstrated in realistic projects.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**571781**
en	**571783**
es	**571785**

Course on Festo LX:
→ Fundamentals of DC Machines



Fundamentals of AC Machines

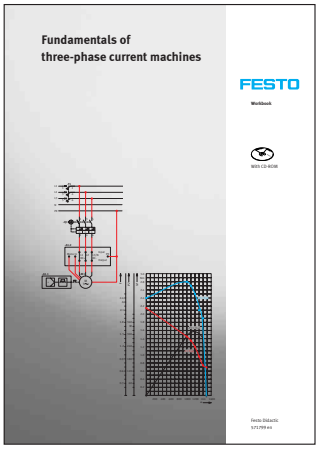
We come into contact with AC drives every day, as these motors are commonly used in household appliances and electric handheld tools in particular. The workbook for the fundamentals of AC machines introduces the topics relating to AC motors in realistic projects. Particular emphasis is placed on design, circuitry and areas of application. Control questions on the content facilitate the assessment of learning success.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**571789**
en	**571791**
es	**571793**

Course on Festo LX:
→ Fundamentals of AC Machines



Fundamentals of Three-Phase Current Machines

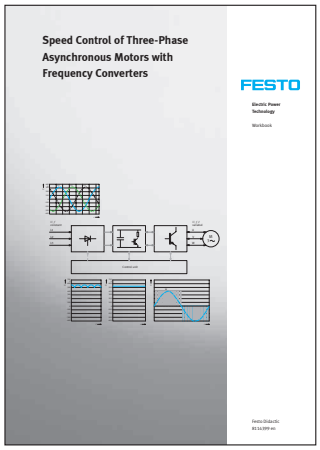
The sturdy design and wide range of applications thanks to modern power electronics have contributed to three-phase motors becoming the standard drives for industrial applications. In the workbook for the fundamentals of three-phase current machines, the design, connection and areas of application are explained on the basis of realistic project exercises. The machines are exposed to a wide range of simulated load situations in order to determine their options.

The workbook contains:
– Solutions
– Didactic notes
– Worksheets for the student
– Graphics

Campus license:

de	**571797**
en	**571799**
es	**571801**
fr	**571803**

Course on Festo LX:
→ Fundamentals of Three-Phase Current Machines



Speed Control of Three-Phase Asynchronous Motors With Frequency Converters

Frequency converters are power electronic devices. They convert the fixed mains voltage with a fixed frequency into a three-phase system with a variable voltage and frequency. This makes it possible to control or regulate the speed of three-phase motors infinitely variably.

Frequency converters with a DC voltage intermediate circuit are used most frequently. The descriptions in the work book are therefore restricted to frequency converters with this design principle.

The following contents are communicated in 12 application-oriented project exercises: function, applications, energy optimization and programming.

The workbook contains:
– Sample solutions
– Training notes
– Worksheets for students

Campus license:

de	**8114398**
en	**8114399**
es	**8114400**
fr	**8114401**

Course on Festo LX:

→ Speed Control of Three-Phase Asynchronous Motors With Frequency Converters

Glossary of Electrical Drive Technology

Modern drive technology is characterized by the increased integration of electrical and mechanical components into drive systems. New and improved drive capabilities can be achieved through the use of compact power electronics, innovative motor concepts, optimized mechanical components, new materials, and high-performance communication technology.

This book lists the main concepts in glossary format and provides brief explanations to facilitate a better understanding of these drives. However since there is more to an electrical drive that just the electric motor, it also touches on areas such as measurement systems, power electronics, gearboxes, controllers, and components for transmitting power.

Campus license:

de	**539265**

Industrial Wiring

This workbook covers the assembly, installation, startup, maintenance, and troubleshooting of electrical wiring systems for industrial applications. The learning activities are designed to be performed using the Industrial Wiring Learning System.

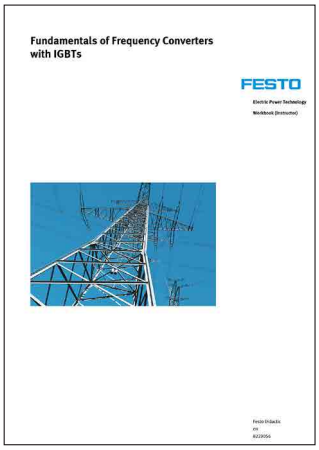
Structure:
– Exercise 1: Presentation
– Exercise 2: Technical Drawings and Electrical Enclosures
– Exercise 3: Pull Boxes, Junction Boxes, and Conduit Bodies
– Exercise 4: Electrical Conduits
– Exercise 5: Fittings and Cable Trays
– Exercise 6: Electrical Schematics and Wiring Tables
– Exercise 7: DIN Rails, Wiring Ducts, and Electrical Panel Components
– Exercise 8: Wiring of an industrial installation
– Exercise 9: Running Wires Through Conduits
– Exercise 10: Commissioning
– Exercise 11: Troubleshooting
– Exercise 12: Maintenance
– Exercise 13: Modification of an Existing Electrical Installation
– Exercise 14: Written and Oral Reports

Campus license:

en	**8190364**

Course on Festo LX:

→ Industrial Wiring



Fundamentals of Frequency Converters with IGBTs

This workbook introduces the operation of three-phase, variable-frequency induction-motor drives. The learning activities are designed to be performed using the IGBT Training Package for TP 1410.

Structure:
– Three-Phase, Variable-Frequency Induction Motor Drive
– Three-Phase, Variable-Frequency Induction Motor Drive with Constant V/f Ratio

Campus license:

en	**8244290**

Workbooks

Drive Technology and Motor Control

Basic Motor Control Technology

This workbook covers basic control circuits, three-phase induction motors, motor protection, reversible motor starters, braking, and reduced-voltage motor starting.

The learning activities are designed to be performed using TP 1221 or TP 1221-P.

Structure:
- Exercise 1: Fundamentals
- Exercise 2: Induction Motors
- Exercise 3: Motors Maintenance and Testing
- Exercise 4: Power Circuit and Manual Motor Starters
- Exercise 5: Control Circuit
- Exercise 6: Magnetic Starter
- Exercise 7: Jogging circuits
- Exercise 8: Automatic Starter
- Exercise 9: Timed Circuits
- Exercise 10: Reversible Motor Starters
- Exercise 11: Reduced Voltage Starters
- Exercise 12: Braking

Campus license :

en	**8174636**

Course on Festo LX:

→ Basic Motor Control Technology

Stepper and Servo Motor Control

This workbook covers the installation, wiring, and commissioning of a stepper and servo motor control system.

The learning activities are designed to be performed using TP 1423.

Structure:
- Exercise 1: Drive Commissioning and Manual Control
- Exercise 2: Open-Loop Position Control of a Rotative Axis
- Exercise 3: Closed-Loop Position Control of a Rotative Axis
- Exercise 4: Velocity Control of a Rotative Axis
- Exercise 5: Torque Control of a Linear Axis
- Exercise 6: Position Control of a Linear Axis
- Exercise 7: Single axis motion control with a PLC
- Exercise 8: Multi-axes motion control

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en	**8200982**

Course on Festo LX:

→ Stepper and Servo Motor Control

Stepper Motor Control

This workbook Covers the installation, wiring, and commissioning of a stepper motor control installation.

The learning activities are designed to be performed using TP 1423 or TP 1421.

Structure:
- Exercise 1: Drive Commissioning and Manual Control
- Exercise 2: Open-Loop Position Control of a Rotative Axis
- Exercise 3: Closed-Loop Position Control of a Rotative Axis
- Exercise 4: Velocity Control of a Rotative Axis
- Exercise 5: Torque Control of a Linear Axis
- Exercise 6: Position Control of a Linear Axis
- Exercise 7: Single axis motion control with a PLC
- Exercise 8: Multi-axes motion control

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en	**8200982**

Course on Festo LX:

→ Stepper Motor Control

Servo Motor Control

This workbook covers the installation, wiring, and commissioning of a servo motor control system.

The learning activities are designed to be performed using TP 1423 or TP 1422.

Structure:
- Exercise 1: Drive Commissioning and Manual Control
- Exercise 2: Introduction to Position Control of a Rotative Axis
- Exercise 3: Closed-Loop Position Control of a Rotative Axis
- Exercise 4: Velocity Control of a Rotative Axis
- Exercise 5: Torque Control of a Linear Axis
- Exercise 6: Position Control of a Linear Axis
- Exercise 7: Single axis motion control with a PLC
- Exercise 8: Multi-axes motion control

The campus license includes the PDF files of the student manuals and instructor guides.

Campus license:

en	**8200982**

Course on Festo LX:

→ Servo Motor Control

Basic Motor Controls

This workbook provides a foundation for further study in the industrial control branch of knowledge.

The learning activities are designed to be performed using Industrial Controls Learning Systems LabVolt Series 8036.

Structure:
- Lockout/Tagout Procedure
- Control Panel Devices
- Manual Starters
- Contactors and Control Relays
- Current Protection Devices
- Specifications Reading
- Symbols, Designations, and Diagrams
- Motor Starters
- Two-Wire and Three-Wire Controls
- Manual Reversing Starters
- Reversing Starters
- Multiple Push Buttons
- Friction Brakes
- Motor Starters with Jogging
- Reversing Starters with Jogging
- Primary Resistor Starters
- Soft Starters
- Time Relays
- Plugging with Time Relays
- Primary Resistor Starters with Time Relays

Campus license :

en	**580468**
es	**580469**

Course on Festo LX:
→ Basic Motor Controls

Motor Drives

This workbook provides the knowledge necessary to perform motor controls with the help of motor drives.

The learning activities are designed to be performed using Industrial Controls Learning Systems LabVolt Series 8036.

Structure:
- Exercise 1: Drive Commissioning and Manual Control
- Exercise 2: Open-Loop Position Control of a Rotative Axis
- Exercise 3: Closed-Loop Position Control of a Rotative Axis
- Exercise 4: Velocity Control of a Rotative Axis
- Exercise 5: Torque Control of a Linear Axis
- Exercise 6: Position Control of a Linear Axis
- Exercise 7: Single axis motion control with a PLC
- Exercise 8: Multi-axes motion control

Campus license :

en	**580468**
es	**580469**

Course on Festo LX:
→ Motor Drives

Sensors

This workbook covers the design and operation of the most common types of sensors in the industrial control branch of knowledge.

The learning activities are designed to be performed using Industrial Controls Learning Systems LabVolt Series 8036.

Structure:
- Introduction to Sensors
- Background Suppression Photoelectric Switch
- Polarized Retroreflective Photoelectric Switch
- Capacitive Proximity Switch
- Inductive Proximity Switch
- Limit Switch
- Motor-Operated Circuits Using Sensors
- PLC-Controlled Circuits Using Sensors

Campus license :

en	**580468**
es	**580469**

Course on Festo LX:
→ Sensors

Programmable Logic Controllers

This workbook provides the knowledge necessary to realize motor controls with the help of a PLC.

The learning activities are designed to be performed using Industrial Controls Learning Systems LabVolt Series 8036.

Structure:
- AC Drive Overview
- Volts per Hertz Characteristics
- Ramp and Torque Boost
- Protection
- Braking and Jogging
- Remote Controls
- DC Drive Overview
- Current Limiting and IR Compensation

Campus license :

en	**580468**
es	**580469**

Course on Festo LX:
→ Programmable Logic Controllers

Workbooks

Drive Technology and Motor Control

Troubleshooting Industrial Controls

This workbook introduces methods to develop skills in troubleshooting industrial control circuits.

The learning activities are designed to be performed using Industrial Controls Learning Systems LabVolt Series 8036.

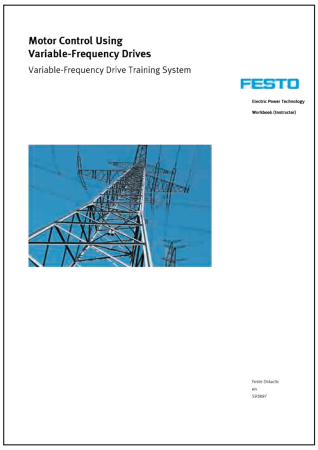
Structure:
- Voltmeter Method of Troubleshooting
- Ohmmeter Method of Troubleshooting
- Troubleshooting a Basic Electrical Circuit
- Troubleshooting a Manual Reversing Starter Circuit
- Troubleshooting a Motor Starter with Jogging Circuit
- Troubleshooting a Plugging with Time Relay Circuit
- Troubleshooting a PLC Circuit
- Troubleshooting a PLC Reversing Motor Starter with Jogging Circuit
- Troubleshooting a PLC Motor Starter with Jogging Circuit
- Troubleshooting an AC Drive Circuit
- Troubleshooting an AC Drive Braking and Jogging Circuit
- Troubleshooting a DC Drive Circuit

Campus license :

en	**580468**
es	**580469**

Course on Festo LX:

➔ Troubleshooting Industrial Controls



Motor Control Using VFDs

This workbook covers the basic principles of variable-frequency drives and their operation.

The learning activities are designed to be performed using the Variable-Frequency Drives Learning System LabVolt 3356.

Structure:
- Exercise 1: Drive Commissioning and Manual Control
- Exercise 2: Open-Loop Position Control of a Rotative Axis
- Exercise 3: Closed-Loop Position Control of a Rotative Axis
- Exercise 4: Velocity Control of a Rotative Axis
- Exercise 5: Torque Control of a Linear Axis
- Exercise 6: Position Control of a Linear Axis
- Exercise 7: Single axis motion control with a PLC
- Exercise 8: Multi-axes motion control

Campus license:

en	**8175839**

Course on Festo LX:

➔ Motor Control Using VFDs

Digital Servo Motor Control

This workbook familiarizes learners with the internal characteristics of a servo motor and allows them to experiment with different types of control loops.

The learning activities are designed to be performed using the Digital Servo Learning System, LabVolt 8063.

Structure:
- Open Loop Servo Motor Static Characteristics
- Open Loop Servo Motor Transient Characteristics
- Servo Closed Loop Speed Control – Steady State Characteristics
- Servo Closed Loop Speed Control – Transient Characteristics and Disturbances
- Motor Shaft Angular Position Control
- Linear Position Sensing
- Linear Position Control
- Following Error in a Linear Position Control System

Workbook:

Student manual, en	**580535**
Instructor guide, en	**580536**

Course on Festo LX:

➔ Digital Servo Motor Control

Workbooks

Digital Protective Relays

Overcurrent and Overload Protection Using Protective Relays

The learning activities in this workbook are designed to be performed using the Numerical Overcurrent Relay, the Numerical Distance Relay, or the Numerical Differential Relay.

Course structure:
– Exercise 1: Overcurrent Protection
– Exercise 2: Overcurrent and Overload Protection of AC Machines and Power Transformers
– Exercise 3: Overcurrent Protection of Radial Feeders
– Introduction to the DIGSI 5 Software from Siemens

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Overcurrent and Overload Protection Using Protective Relays

Directional Protection

The learning activities in this workbook are designed to be performed using the Numerical Overcurrent Relay or the Numerical Distance Relay.

Course structure:
– Exercise 1: Directional overcurrent protection
– Exercise 2: Directional comparison protection
– Exercise 3: Directional power protection
– Introduction to the DIGSI 5 Software from Siemens

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Directional Protection

Differential Protection

The learning activities in this workbook are designed to be performed using the Numerical Differential Relay.

Topic coverage:
– Exercise 1: Fundamentals of Differential Protection
– Exercise 2: Percentage Restrained Differential Protection
– Introduction to the DIGSI 5 Software from Siemens

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Differential Protection

Distance Protection

The learning activities in this workbook are designed to be performed using the Numerical Distance Relay.

Course structure:
– Exercise 1: Distance Relay Impedance Characteristic
– Exercise 2: Conventional Time-Stepped Distance Protection
– Exercise 3: Distance Protection Using Communication-Assisted Tripping Schemes
– Introduction to the DIGSI 5 Software from Siemens

Campus license:

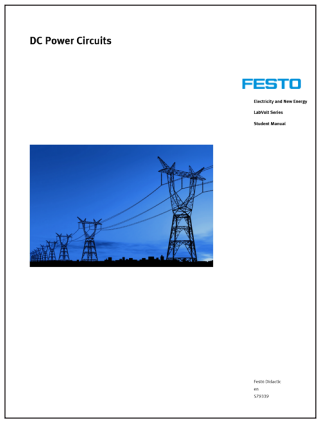
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Distance Protection

Workbooks

Electric Power Technology



DC Power Circuits

Training content
– Voltages and currents in electrical circuits
– Ohm's and Kirchhoff's laws
– Concept of equivalent resistance
– Equivalent resistance of a combination of resistors
– Power dissipated in a DC circuit
– Solution of complex series and parallel circuits using fundamental laws

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ DC Power Circuits

Lead-Acid Batteries

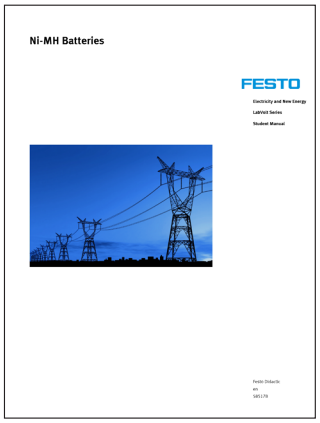
Training content
– Fundamental principles of batteries
– Types and features of lead-acid batteries
– Charge and discharge characteristics
– Experiments with various methods for charging lead-acid batteries (constant-current, constant-voltage, modified constant-voltage, float charging, trickle)

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Lead-Acid Batteries



Ni-MH Batteries

Training content
– Reactions occurring during charge and discharge cycles
– Battery characteristics during discharge
– Calculation of energy released during a discharge cycle
– Effects of charge input, charge rate, and ambient temperature on the voltage and temperature profiles during a charge cycle
– Charging methods and charge-control techniques

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Ni-MH Batteries

Lithium-Ion Batteries

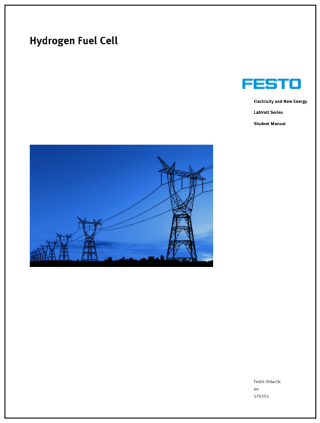
Training content
– Battery discharge and charge characteristics
– Battery balancing

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Lithium-Ion Batteries



Hydrogen Fuel Cell

Training content
– The basic functions of the fuel cell system
– The characteristic curve
– Parameters influencing the characteristic curve
– Determination of the hydrogen current curve
– Efficiency of the fuel cell stack
– Set-up of a fuel cell power supply
– Efficiency of a fuel cell power supply

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Hydrogen Fuel Cell

Home Energy Production

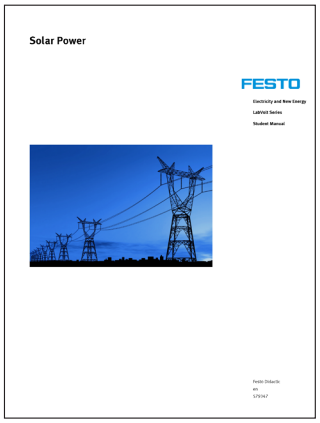
Training content
– Stand-alone home energy production
– Single-phase grid-tied inverter (PWM rectifier/onverter)
– Grid-tied home energy production using a solar or wind power inverter without DC-to-DC converter
– Large-scale energy storage: A step in the implementation of the smart grid

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Home Energy Production



Solar Power (Photovoltaic)

Training content
– Diode
– Solar panel
– Effect of temperature on solar panel performance
– Energy storage into lead-acid batteries
– Effect of shading on solar panel operation
– Solar panel orientation
– Insolation and performance

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Solar Power

Photovoltaic Systems

Training content
– Standalone PV systems for DC Loads
– Use of an MPPT charge controller in standalone PV systems
– Standalone PV systems for AC Loads
– Grid-Tied PV Systems

Campus license:

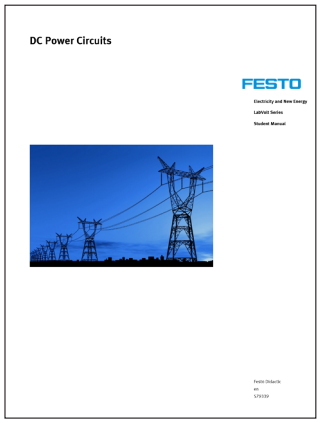
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Photovoltaic System

Workbooks

Electric Power Technology



Introduction to Wind Power

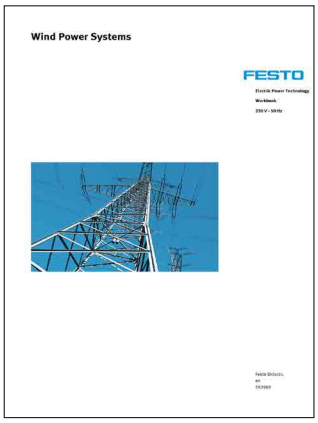
Training content
– Wind turbines and small-scale wind power
– Voltage-speed and torque-current characteristics of a wind turbine generator
– Wind power variation with wind speed
– Energy storage in batteries

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Introduction to Wind Power



Wind Power Systems

Training content
– Standalone wind power systems for DC loads
– Standalone wind power systems for AC loads

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Wind Power Systems

DC Power Electronics

Training content
– Operation and characteristics of diodes and switching transistors
– Buck, boost, buck/boost, and four-quadrant choppers
– Concept of voltage-type and current-type circuits, and free-wheeling diodes
– Ripple phenomenon in a chopper
– Implement a lead-acid battery charger using a buck chopper with feedback loop

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ DC Power Electronics

Single-Phase AC Power Circuits

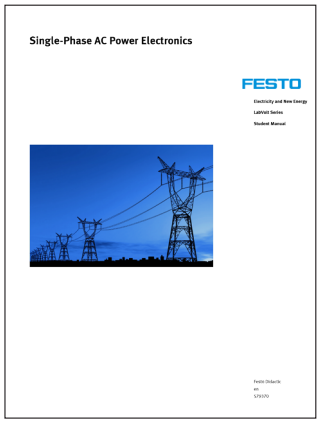
Training content
– Voltage and current sine waves
– Power dissipated in a resistive load
– Inductive reactance and capacitive reactance
– Relationship between the source frequency and the reactance of an inductor or a capacitor
– Active, reactive, and apparent power
– Impedance calculation method and the power triangle method

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Single-Phase AC Power Circuits



Single-Phase AC Power Electronics

Training content
– Operation of power diode
– Single-phase rectifiers
– Half-wave and full-wave rectifier
– Average DC voltage
– Operation of the single-phase PWM inverter

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Single-Phase AC Power Electronics

Three-Phase AC Power Electronics

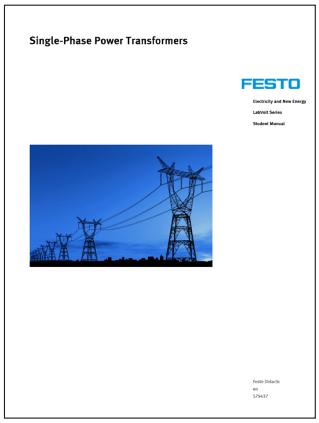
Training content
– Analysis of three-phase half-wave and full-wave rectifiers, as well as single- and three-phase PWM inverters
– Voltage and current waveforms
– Advantages of three-phase rectifiers over single-phase rectifiers
– Dual polarity DC power supply

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Three-Phase AC Power Electronics



Single-Phase Power Transformer

Training content
– Turns, voltage, and current ratios
– Characteristics of step-up and step-down power transformers
– Polarity of power transformer windings
– Equivalent diagram of a power transformer.
– Voltage, current, and power ratings
– Effect of saturation on the magnetizing current and no-load power losses of a power transformer

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Single-Phase Power Transformer

Conventional DC Machines and Universal Motor

Training content
– Fundamentals of rotating machines
– Prime mover and brake operation
– DC motors and generators
– Series, shunt, compound, separately-excited motors
– Shunt, separately-excited, and compound DC generators
– Armature reaction and saturation effect
– Universal motor

Campus license:

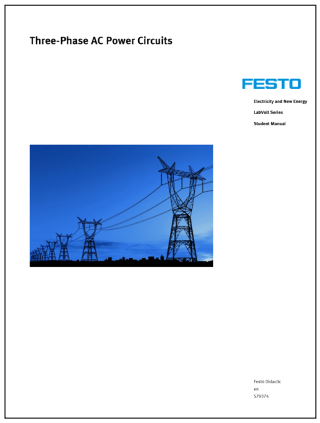
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Conventional DC Machines and Universal Motor

Workbooks

Electric Power Technology



Three-Phase AC Power Circuits

Training content
– Difference between line and phase voltages and currents
– Active power dissipated in each phase of a three-phase circuit and the total active power dissipated
– Phase sequence and wye and delta circuit configuration
– Active, reactive, and apparent power in balanced, wye- or delta-connected, three-phase circuits

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Three-Phase AC Power Circuits

High-Frequency Power Transformers

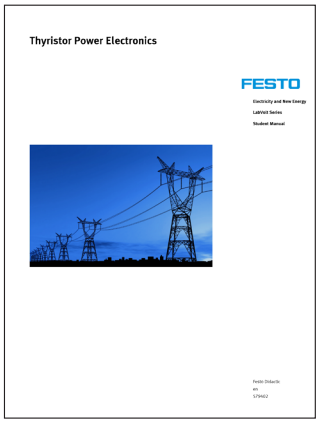
Training content
– High-frequency power transformers and their uses
– Effect of frequency on the power rating of transformers
– Analysis of high-frequency power transformers in switched-mode power supplies and insulated DC-to-DC converters

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ High-Frequency Power Transformers



Thyristor Power Electronics

Training content
– Diodes
– Single-phase half-wave rectifier and single-phase full-wave (bridge) rectifier
– Voltage and current waveforms
– Thyristor in AC circuits with loads
– Thyristor three-phase rectifier/ inverter

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Thyristor Power Electronics

Three-Phase Rotating Machines

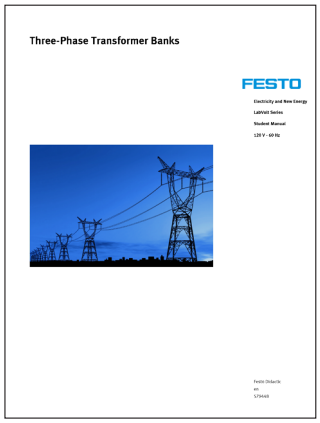
Training content
– Prime mover and brake operation
– Three-phase squirrel-cage induction machines
– Eddy-current braked and asynchronous generator
– Synchronous motor
– Synchronous generators (alternators)
– Voltage, torque
– Generator synchronization

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Three-Phase Rotating Machines



Three-Phase Transformer Banks

Training content
– Operation of three-phase transformer banks
– Connection of the windings of 3-phase transformer banks in wye, delta, wye-wye, delta-delta, wye-delta, or delta-wye configuration
– Voltage, current, and phase relationships between the primary and secondary windings
– Uses of three-phase transformer banks in 3-phase AC power circuits

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Three-Phase Transformer Banks

Three-Phase Induction Motor Starters

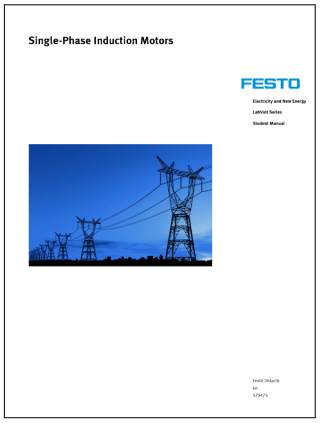
Training content
– Induction motor starters
– Direct on-line (DOL) starters and soft starters
– Advanced features of soft starters

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Three-Phase Induction Motor Starters



Single-Phase Induction Motors

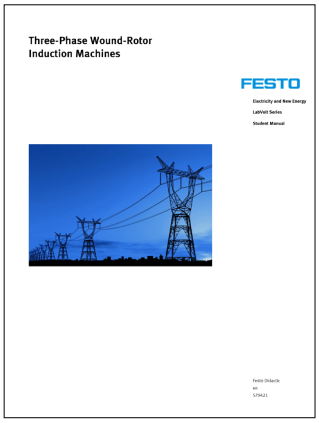
Training content
– AC induction motors
– Operation and characteristics of single-phase induction motors

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Single-Phase Induction Motors



Three-Phase Wound-Rotor Induction Machines

Training content
– Three-phase wound-rotor induction machine with a short-circuited rotor
– Three-phase wound-rotor induction machine with rotor resistance

Campus license:

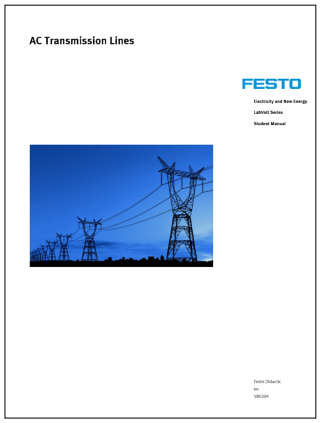
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Three-Phase Wound-Rotor Induction Machines

Workbooks

Electric Power Technology



AC Transmission Line

Training content
– Equivalent circuits and characteristics of AC transmission lines for resistive, inductive, and capacitive loads
– Voltage compensation
– Active power transmission
– Shunt-capacitor substations
– Control of the flow of active and reactive power

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ AC Transmission Lines

Permanent Magnet DC Motor

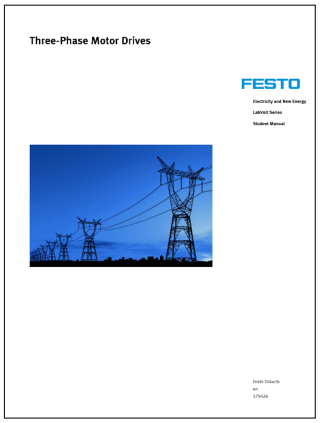
Training content
– Prime mover and brake operation
– Basic functions of the 4-quadrant dynamometer/power supply
– Polarity of speed, torque, and mechanical power
– Construction of permanent magnet DC machines and their operation as generators
– Voltage-speed and torque-current characteristics of a permanent magnet DC machine operating as a generator or as a motor

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Permanent Magnet DC Motor



Three-Phase Motor Drives

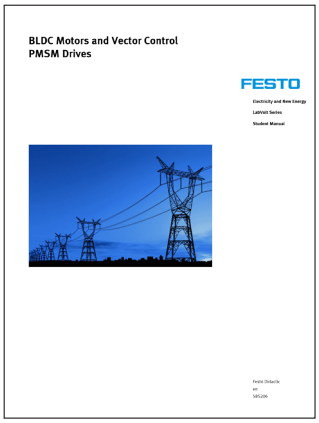
Training content
– Principles and operation of 3-phase variable-frequency induction motor drive
– Three-phase variable-frequency induction motor drive with a constant Volt-per-Hertz (V/f) ratio

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ Three-Phase Motor Drives



BLDC Motors and Vector Control PMSM Drives

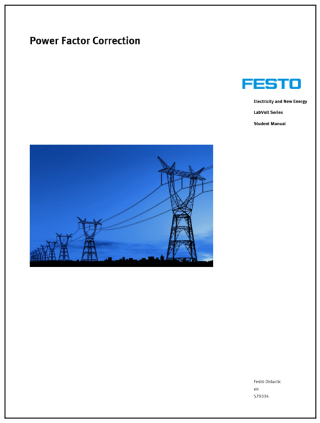
Training content
– Permanent magnet synchronous machines
– PMSM control using a three-phase, six-step 120° modulation inverter
– BDLC motor
– Vector control PMSM drive

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
➔ BLDC Motors and Vector Control PMSM Drives



Power Factor Correction

Training content
– Types of power corrections: plant-wide versus distributed
– Using banks of switched capacitors
– Correction in three-phase circuits

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Power Factor Correction

Three-Phase PWM Rectifier/Inverter

Training content
– Three-phase pulse-width modulation (PWM) rectifier/inverter
– Block diagram
– Most common applications
– Active current and reactive current command variation
– Active and reactive power control

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Three-Phase PWM Rectifier / Inverter

DC Motor Drives

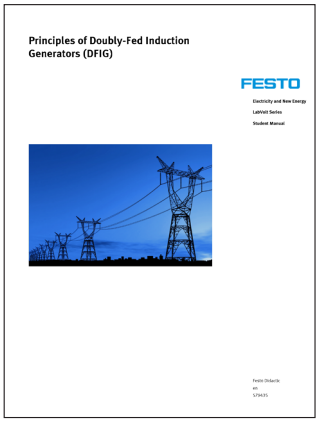
Training content
– Basic PWM DC motor drives
– Bidirectional PWM DC motor drives with regenerative braking
– Speed feedback and current control in PWM DC motor drives

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ DC Motor Drives



Principle of Doubly-Fed Induction Generators (DFIG)

Training content
– Three-phase wound-rotor induction machine used as a synchronous machine
– Doubly-fed induction motors and generators

Campus license:

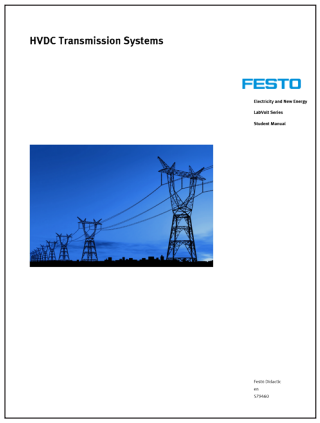
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Doubly-Fed Induction Generators

Workbooks

Electric Power Technology



High-Voltage DC Transmission Systems

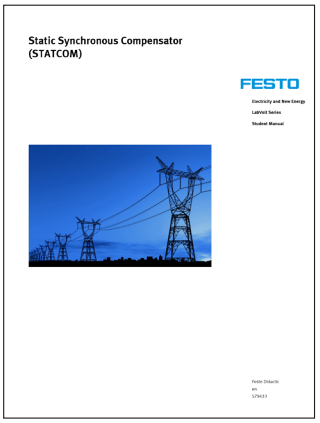
Training content
– Voltage regulation and displacement power factor (DPF) in thyristor three-phase bridges
– Basic operation of HVDC transmission systems
– DC current regulation and power flow control in HVDC transmission systems
– Commutation failure at the inverter bridge
– Harmonic reduction using thyristor 12-pulse converters

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ HVDC Transmission Systems



Static Synchronous Compensator (STATCOM)

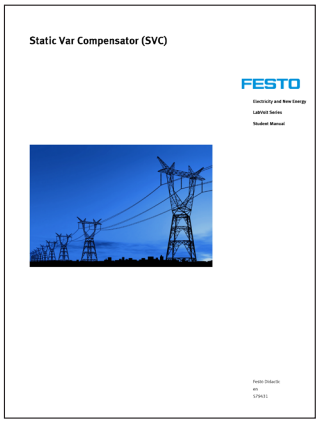
Training content
– Voltage compensation of AC transmission lines using a STATCOM
– Dynamic power factor correction using a STATCOM

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Static Synchronous Compensator



Static Var Compensator (SVC)

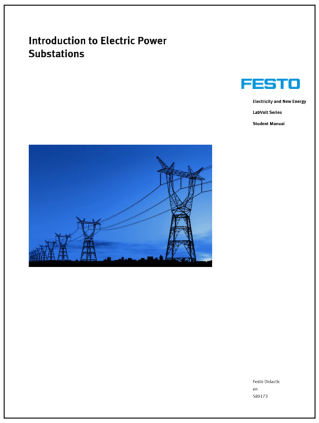
Training content
– Main components of a Static Var Compensator (SVC)
– Voltage compensation of AC transmission lines using an SVC
– Dynamic power factor correction using an SVC

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Static Var Compensator



Introduction to Electric Power Substations

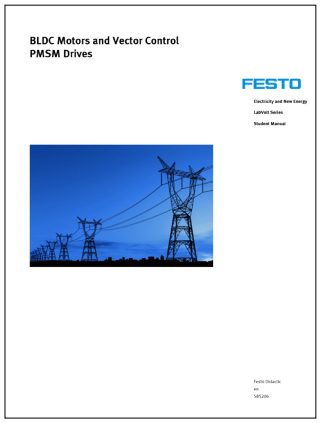
Training content
– Electric power substations
– High-voltage disconnecting switches and circuit breakers
– Single-bus scheme
– Double-bus, single breaker scheme

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Introduction to Electric Power Substations



BLDC Motors and Vector Control PMSM Drives

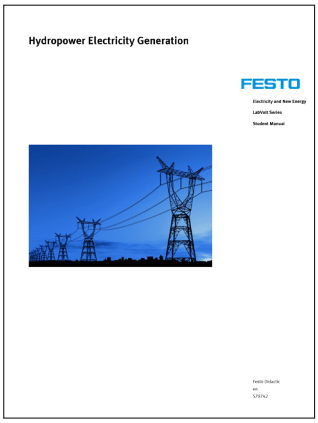
Training content
– Permanent magnet synchronous machines
– PMSM control using a three-phase, six-step 120° modulation inverter
– BDLC motor
– Vector control PMSM drive

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ BLDC Motors and Vector Control PMSM Drives



Hydropower Electricity Generation

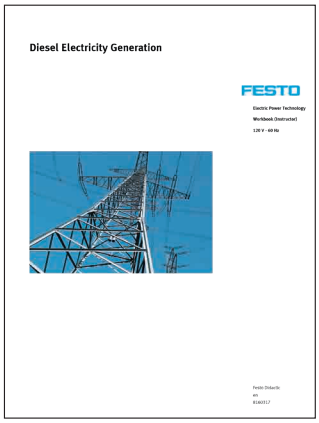
Training content
– Hydropower electricity generation
– Generator frequency and voltage control principles
– Generator synchronization using a synchro-check relay
– Generator operation with speed and voltage regulation
– Droop
– Generator parallel operation and load sharing

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Hydropower Electricity Generation



Diesel Electricity Generation

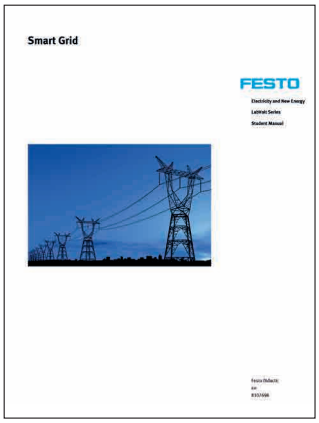
Training content
– Generator frequency and voltage control principles
– Generator synchronization using a synchro-check relay
– Generator operation with speed and voltage regulation
– Generator speed and voltage regulation with droop
– Generator parallel operation and load sharing

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Diesel Electricity Generation



Smart Grid

Training content
– Smart grid fundamentals
– Reducing power losses in electric power substations
– Upgrading a substation for operation in the smart grid
– Operating a substation in the smart grid

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Smart Grid

Workbooks

Electric Power Technology

Microgrid

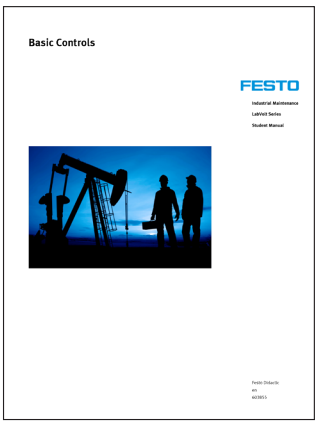
Training content
– Active power transfer
– Reactive power transfer
– Microgrid start-up after a power outage
– Network reconnection
– Addition of a diesel generator in islanding mode

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Microgrid



Basic Controls

Course designed for use with the Industrial Controls Learning System, LabVolt Series 8036.

Training content
– Basic principles
– Circuit layouts and specifications
– Basic control circuits
– Jogging control circuits
– Reversing/manual reversing starters
– Reduced AC voltage starters
– Time relay circuits

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Basic Controls

Motor Drives (Operation)

Course designed for use with the Industrial Controls Learning System, LabVolt Series 8036.

Training content
– AC drives
– Volts per Hertz characteristics
– Ramp and voltage boost
– Protection
– Braking and jogging
– Remote controls
– DC drives
– Current limiting and IR compensation

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Motor Drives

Programmable Logic Controllers

Course designed for use with the Industrial Controls Learning System, LabVolt Series 8036.

Training content
– PLC
– Control and timing relay functions
– Boolean logic and markers
– Counter and comparator functions
– PLC control circuits
– Interfacing voltages
– Motor and reversing motor starters with jogging

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Programmable Logic Controllers

Sensors

Course designed for use with the Industrial Controls Learning System, LabVolt Series 8036.

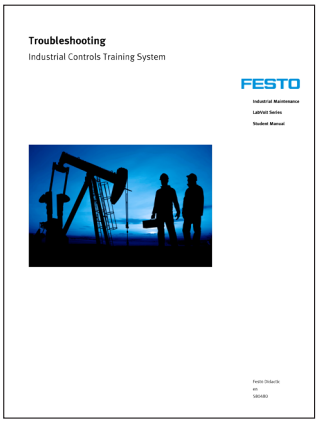
Training content
– Sensors
– Background suppression photoelectric switch
– Polarized retroreflective photo-electric switch
– Capacitive proximity, inductive proximity, and limit switches
– Motor-operated circuits using sensors
– PLC-controlled circuits using sensors

Campus license:

en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Sensors



Troubleshooting Industrial Controls

Course designed for use with the Industrial Controls Learning System, LabVolt Series 8036.

Training content
– Troubleshooting: introduction and methods
– Troubleshooting basic motor control circuits (manual reversing starter circuit, motor starter with jogging circuit, plugging with time relay circuit)
– Troubleshooting PLC circuits (PLC circuit, PLC reversing motor starter with jogging circuit, PLC motor starter with jogging circuit)
– Troubleshooting AC and DC drive circuits (AC drive circuit, AC drive braking and jogging circuit, DC drive circuit)

Campus license:

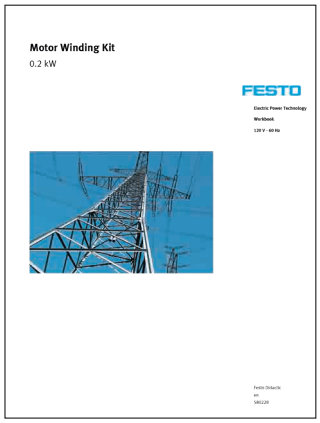
en	**On request**

Note: This workbook is included in multiple campus licenses. Please check with your representative to confirm which one applies to you.

Course on Festo LX:
→ Troubleshooting Industrial Controls

Workbooks

Electric Power Technology



Motor Winding

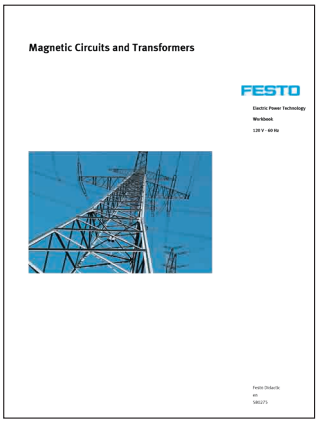
Course designed for use with the Motor Winding Kit.

Training content
- Split-Phase Capacitor-Start Motor
- Three-Phase Squirrel Cage Induction Motor
- Three-Phase Wound-Rotor Induction Motor
- Synchronous Machine

Campus license:

120 V, 60 Hz, en	**580232**
220 V, 50 Hz, en	**580233**

Course on Festo LX:
→ Motor Winding



Magnetic Circuits and Transformers

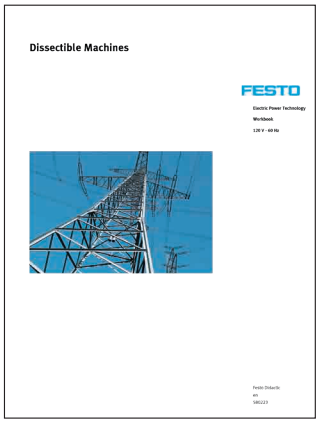
Course designed for use with the MagTran Learning System.

Training content
- Examples of Faraday's Law
- Principles of AC Induction and Magnetic Coupling
- Resistance, Reactance, and Inductance of a Coil
- Saturation Curve and Voltage Ratio of a Transformer
- Impedance Transformation
- Current Ratio and Impedance of a Transformer
- Regulation Curves of a Transformer
- Polarity of a Transformer
- The Autotransformer
- Eddy Currents and Laminated Cores
- Properties of a Permanent Magnet
- The Choke
- The Magnetic Amplifier
- Measurement of Flux and Leakage Flux
- Hysteresis Loop and Core Losses
- Peaking Transformer
- Self-Inductance, Mutual-Inductance, and Coupling Factor
- The Three-Phase Transformer
- Principle of a Shaded-Pole Magnet

Campus license:

en	**580280**
es	**8174177**

Course on Festo LX:
→ Magnetic Circuits and Transformers



Dissectible Machines

Course designed for use with the Dissectible Machines Learning System.

Training content
- Direct Current Machine Assembly
- Split-Phase Capacitor-Start Motor Assembly
- Capacitor-Run Motor Assembly
- Two-Value Capacitor Motor Assembly
- Universal Motor Assembly
- Three-Phase Wound-Rotor Induction Motor Assembly
- Three-Phase Squirrel Cage Induction Motor Assembly
- Synchronous Machine Assembly
- Synchronous Reluctance Motor Assembly
- Two-Speed Variable-Torque Motor Assembly
- Two-Speed Constant-Torque Motor Assembly
- Two-Speed Constant-HP Motor Assembly
- Two-Phase Wound-Rotor Induction Motor Assembly
- Triple-Rate Motor Assembly

Campus license:

en	**580227**

Course on Festo LX:
→ Dissectible Machines

Introduction to Protective Relaying

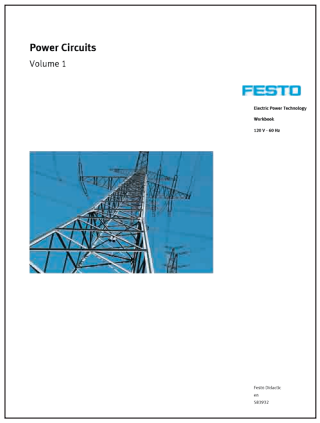
The learning activities in this workbook are designed to be performed using the 0.2-kW Protective Learning Systems, LabVolt Series 8007.

Course content
- Protection of a synchronous generator: differential, reverse power, rotor earth fault, loss of excitation, overvoltage, overspeed, overcurrent
- Generator synchronization and protection scheme
- Transformer protection: magnetizing inrush, differential, restricted earth fault, overcurrent, three-phase protection scheme
- Stator-winding fault protection
- Induction motor protection: overcurrent, phase reversal, phase unbalance and undervoltage, mechanical overload/underload, stall

Campus license:

120 V, 60 Hz, en	**584220**
120 V, 60 Hz, es	**595127**
120 V, 60 Hz, fr	**595128**
240 V, 50 Hz, en	**595129**

Course on Festo LX:
→ Introduction to Protective Relaying



Power Circuits

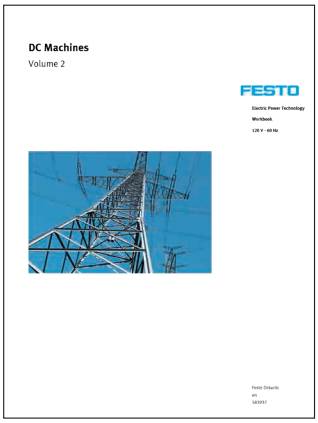
Course designed for use with the 2-kW Electromechanical Learning System, LabVolt Series 8013.

Training content
- Series and parallel equivalent resistances
- Resistances in parallel, in series and in series-parallel
- Ohm's Law
- Circuit solution
- Power in DC circuits
- Transmission line
- AC voltage and current measurement
- Wattmeter
- Phase angle, active, and reactive-power
- Capacitive and inductive reactance
- Phase sequence
- Three-phase circuits

Campus license:

120 V, 60 Hz, en	**583936**
220 – 240 V, 50 Hz, en	**595932**

Course on Festo LX:
→ Power Circuits



DC Machines

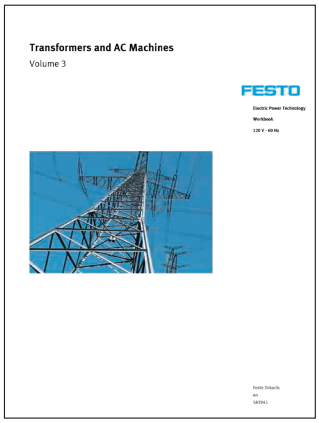
Course designed for use with the 2-kW Electromechanical Learning System, LabVolt Series 8013.

Training content
- Prime mover and torque measurement
- DC motor
- DC shunt/series/compound motors
- DC separately excited and self excited shut generator

Campus license:

120 V, 60 Hz, en	**583936**
220 – 240 V, 50 Hz, en	**595932**

Course on Festo LX:
→ DC Machines



Transformers and AC Machines

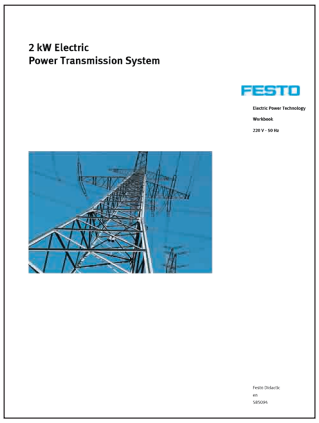
Course designed for use with the 2-kW Electromechanical Learning System, LabVolt Series 8013.

Training content
- The single-phase transformer
- Transformer polarity and regulation
- The autotransformer
- Transformers in parallel
- The distribution transformer
- Three-phase transformer connections
- Prime mover and torque measurement
- The squirrel cage and wound-rotor induction motor
- The synchronous motor
- The three-phase alternator
- The alternator under load
- Alternator synchronization
- Alternator power
- Three-phase motor starters
- Frequency conversion
- Reactance and frequency
- Selsyn control

Campus license:

120 V, 60 Hz, en	**583936**
220 – 240 V, 50 Hz, en	**595932**

Course on Festo LX:
→ Transformers and AC Machines



2-kW Electric Power Transmission

Course designed for use with the 2-kW Electric Power Transmission Learning System, LabVolt Series 8059.

Training content
- Power measurements and voltage regulation: power transmission capability of a transmission line, shunt capacitors, phase angle between sender and receiver
- Factors affecting power flow: active and reactive power, power-handling capability, parallel lines
- Series compensation: effects on power transfer capability, system stability, voltage regulation, and power factor
- Machines and devices: alternator, synchronous motor (including behavior under load), synchronous compensator, long high-voltage lines
- Transmission networks: transmission line networks, three-phase regulating autotransformer
- System dynamics: hunting, system oscillation, power system transient

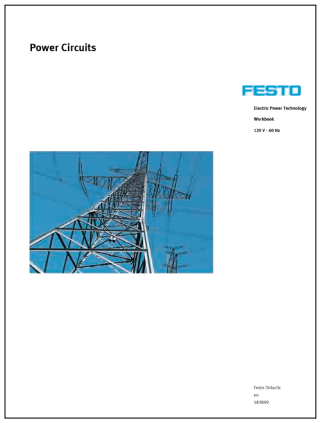
Workbooks

Student manual, en (PDF)	**591675**
Instructor manual, en (PDF)	**591676**

Course on Festo LX:
→ 2-kW Electric Power Transmission System

Workbooks

Electric Power Technology



Power Circuits

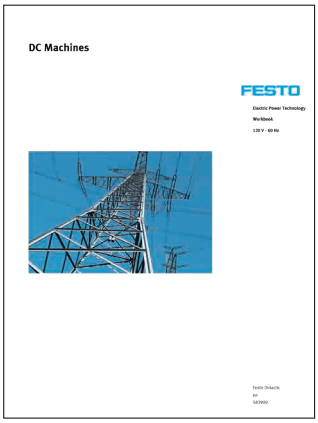
Course designed for use with the 0.2-kW Electromechanical System with Analog Meters, LabVolt Series 8001.

Training content:
- Series and Parallel Equivalent Resistances
- Resistances in Parallel, in Series and in Series-Parallel
- Safety and the Power Supply
- Ohm's Law
- Circuit Solution
- Power in DC Circuits
- The Transmission Line
- AC Voltage and Current
- The Wattmeter
- Phase Angle, Active, and Apparent Power
- Capacitive and Inductive Reactance
- Watt, Var, Volt-Ampere, and Power Factor
- Vectors and Phasors – Series and Parallel Circuits
- Impedance
- Three-Phase Circuits
- Three-Phase Watts, Vars, and Volt-Amperes
- Three-Phase Power Measurement
- Phase Sequence

Campus license:

120 V, 60 Hz, en	**583903**
120 V, 60 Hz, es	**583904**
120 V, 60 Hz, fr	**8174175**
220 V, 60 Hz, en	**583905**
240 V, 50 Hz, en	**583902**

Course on Festo LX:
→ Power Circuits



DC Machines

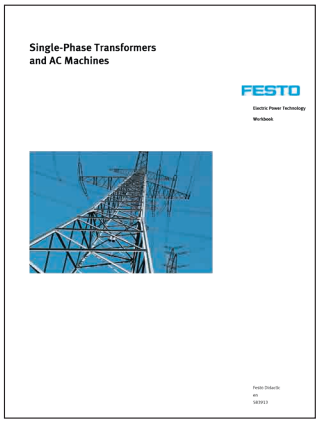
Course designed for use with the 0.2-kW Electromechanical System with Analog Meters, LabVolt Series 8001.

Training content:
- Safety and the Power Supply
- Prime Mover and Torque Measurement
- The Direct Current Motor
- The DC Shunt Motor
- The DC Series Motor
- The DC Compound Motor
- The DC Separately Excited Shunt Generator
- The DC Self Excited Shunt Generator
- The DC Compound Generator
- DC Motor Starter
- Thyristor Speed Controller
- Thyristor Speed Controller with Regulation

Campus license:

120 V, 60 Hz, en	**583903**
120 V, 60 Hz, es	**583904**
120 V, 60 Hz, fr	**8174175**
220 V, 60 Hz, en	**583905**
240 V, 50 Hz, en	**583902**

Course on Festo LX:
→ DC Machines



Single-Phase Transformers and AC Machines

Course designed for use with the 0.2-kW Electromechanical System with Analog Meters, LabVolt Series 8001.

Training content:
- Safety and the Power Supply
- The Single-Phase Transformer
- Transformer Polarity
- Transformer Regulation
- The Autotransformer
- Transformers in Parallel
- The Distribution Transformer
- Prime Mover and Torque Measurement
- The Split-Phase Inductor Motor
- The Capacitor-Start Motor
- The Capacitor-Run Motor
- The Universal Motor

Campus license:

120 V, 60 Hz, en	**583903**
120 V, 60 Hz, es	**583904**
120 V, 60 Hz, fr	**8174175**
220 V, 60 Hz, en	**583905**
240 V, 50 Hz, en	**583902**

Course on Festo LX:
→ Single-Phase Transformers and AC Machines

Three-Phase Transformers and AC Machines

Course designed for use with the 0.2-kW Electromechanical System with Analog Meters, LabVolt Series 8001.

Training content
- Safety and the Power Supply
- Three-Phase Transformer Connections
- Prime Mover and Torque Measurement
- The Wound-Rotor Induction Motor
- The Squirrel-Cage Induction Motor
- The Synchronous Motor
- The Three-Phase Alternator
- The Alternator Under Load
- Alternator Synchronization
- Alternator Power
- Three-Phase Motor Starter
- Frequency Conversion
- Reactance and Frequency
- Selsyn Control

Campus license:

120 V, 60 Hz, en	**583903**
120 V, 60 Hz, es	**583904**
120 V, 60 Hz, fr	**8174175**
220 V, 60 Hz, en	**583905**
240 V, 50 Hz, en	**583902**

Course on Festo LX:
→ Three-Phase Transformers and AC Machines

Distribution Transformer Trainer

Course designed to guide students through different sections of an exercise that can be carried out using the Distribution Transformer Trainer.

Campus license:

en	**584075**

Course on Festo LX:

→ Distribution Tranformer Trainer

Some learning solutions included in this product guide do not have a CE mark and cannot be ordered for delivery to Europe.

If you are located in a country where this marking is required, please contact your Festo sales representative before placing an order.

Publisher

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